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Draft Copy

ECONOMIC FEASIBILITY STUDY FOR CONSTRUCTION OF THE PROPOSED SAN JUAN RAILROAD

MARKET ANALYSIS

Prepared For:

New Mexico State Transportation Authority

San Juan Basin Transportation
Development District

September 6, 1991

By:

Freight Services Incorporated
and
Resource Data International, Incorporated

REPRESENTATIONS

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I. EXECUTIVE SUMMARY

Introduction

The San Juan Basin is rich in coal and other resources. Much of this potential remains outside the economic realm for practical development. A contributing reason for this situation is limited access to rail transportation, a critical link for moving coal longer distances at competitive prices. This need has been recognized for several decades. However, the necessary analysis to determine market demand and economic feasibility have not been done on a comprehensive basis.

The impact of the Clean Air Act amendments emphasizing a significant reduction in pollutants has substantially widened the market for cleaning burning, higher quality coals. With this shifting prospects for coal marketing, the spotlight has again been placed on the San Juan Basin's reserves. However without a rail connection, the possibility for the San Juan Basin area to participate in this and other market opportunities is poor.

Although coal represents the foundation for any San Juan Basin rail link, the opportunity for agricultural and industrial benefits are also present. There has certainly been lost opportunities for manufacturing and refining businesses due to a lack of direct rail services. Furthermore, the potential for value added opportunities in the agricultural sector are significantly restrained without competitive transportation options.

These latent opportunities prompted the San Juan Basin Transportation Development District to find the answer to three basic questions.

* What is the market potential for San Juan Basin coals?

* What are the additional development prospects and market expansions that a rail line would bring to the noncoal resources of the San Juan Basin?
* Can a business plan be structured that would withstand the scrutiny of an economic analysis and bring the proposed San Juan Basin Railroad to reality?

Subsequent to the original scope of work, it was decided to have a mid-point review. This review will consider the findings of the market analysis for both the coal and noncoal commodities. It was suggested that depending upon the market analysis finding, there might be some benefit in altering the second portion of the study to better reflect the results from the market analysis.

The following report presents the market analysis findings. At the end of the Executive Summary is an overall perspective on the market analysis results.

Coal Market Analysis

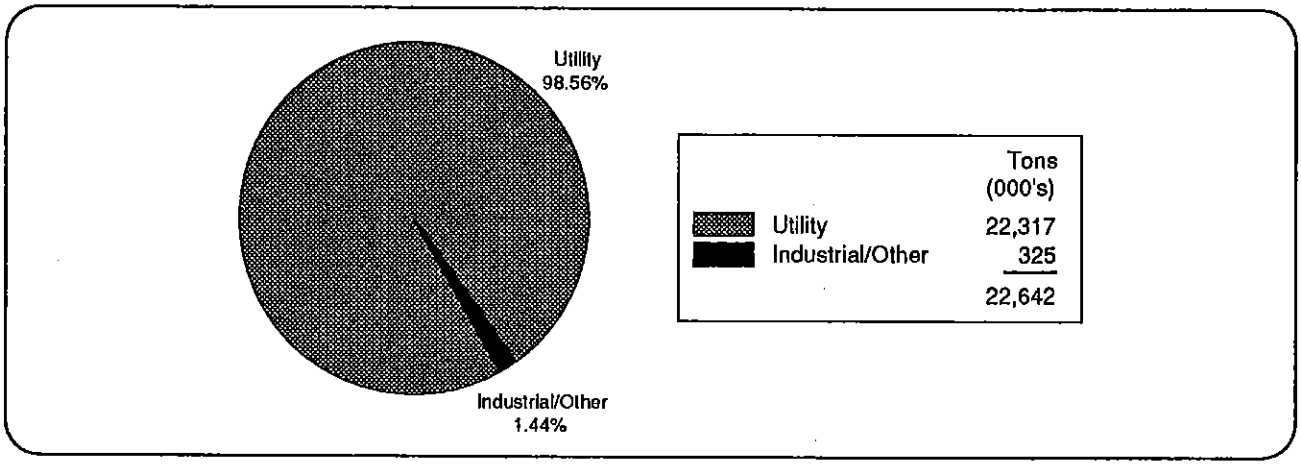
One of the objectives of this report is to provide a coal market analysis to determine the prospects for a San Juan Basin railroad. Key issues that are likely to influence the feasibility of a rail line include product competition from other coal producing regions; competition from alternative fuels, especially, natural gas; and the strength of the market potential for coal originating in the San Juan Basin that may result from requirements mandated by the Clean Air Act. The coal market study is in four sections: current San Juan Basin markets, current supply conditions, forecast of coal demand, and a summary of coal market dynamics and prices.

Current San Juan Basin Markets

Chart 1 indicates the current market for San Juan Basin coal is about 23 million tons per year. About 99 percent of this coal is shipped to utility consumers in Arizona and New Mexico. About 325,000 tons is shipped to industrial consumers in Arizona.

Chart 1

1990 Coal Shipments from the San Juan Basin

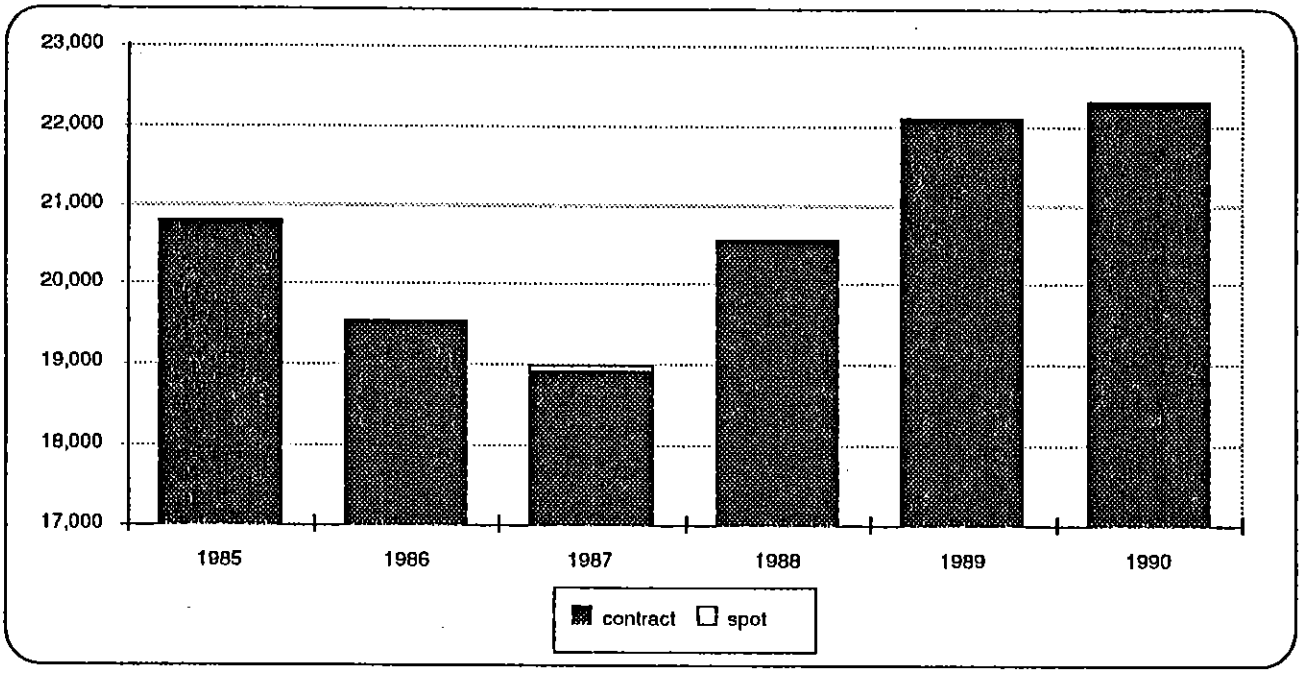


One unique characteristic of the current San Juan Basin coal market is its localized nature. Coal from the region tends to be consumed in the states of Arizona and New Mexico. A very small amount of San Juan Basin coal is moving to foreign markets, or markets in other states.

A second unique characteristic of the current San Juan Basin coal market is the ratio of contract to spot shipments. *Chart 2* indicates that between 1985 and 1990 over 98 percent of the coal moved under long-term agreements. This is a far higher contract to spot ratio that is generally experienced in the U.S. coal industry.

Chart 2

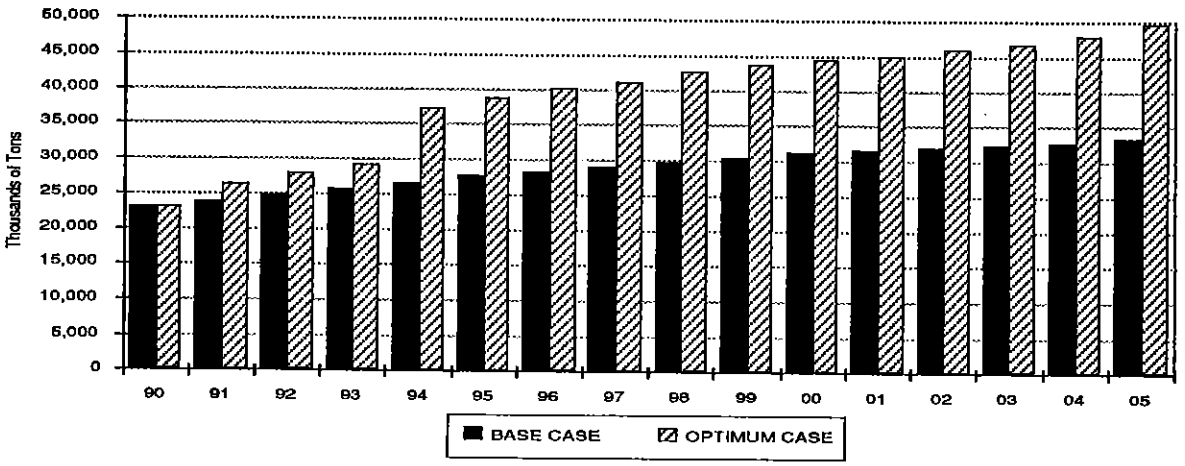
Annual Contract from the San Juan Region



In the Base Case forecast, it is assumed that the region's market growth in the next fifteen years will continue to be limited to local markets by relatively low coal quality, high mining costs, and distance from major coal markets outside the Arizona and New Mexico area. *Chart 3* illustrates that the Base Case demand is projected to grow to 27.7 million tons per year in 1995, 31.3 million tons per year in 2000, and 33.5 million tons per year by 2005. San Juan Basin mines currently have capacity to meet the 2000 Base Case forecast, so with very little expansion, the 2005 forecast can also be achieved.

Chart 3

Base Case vs. Optimistic Base Projections for San Juan Basin Utility Coal Demand



	BASE CASE	OPTIMUM CASE
1990	22,993	22,993
1991	23,795	26,377
1992	24,733	27,782
1993	25,660	29,321
1994	26,604	37,267
1995	27,641	38,783
1996	28,301	40,108
1997	28,978	41,089
1998	29,673	42,655
1999	30,386	43,577
2000	31,143	44,486
2001	31,531	45,029
2002	31,924	45,932
2003	32,273	46,831
2004	32,751	47,979
2005	33,335	49,563

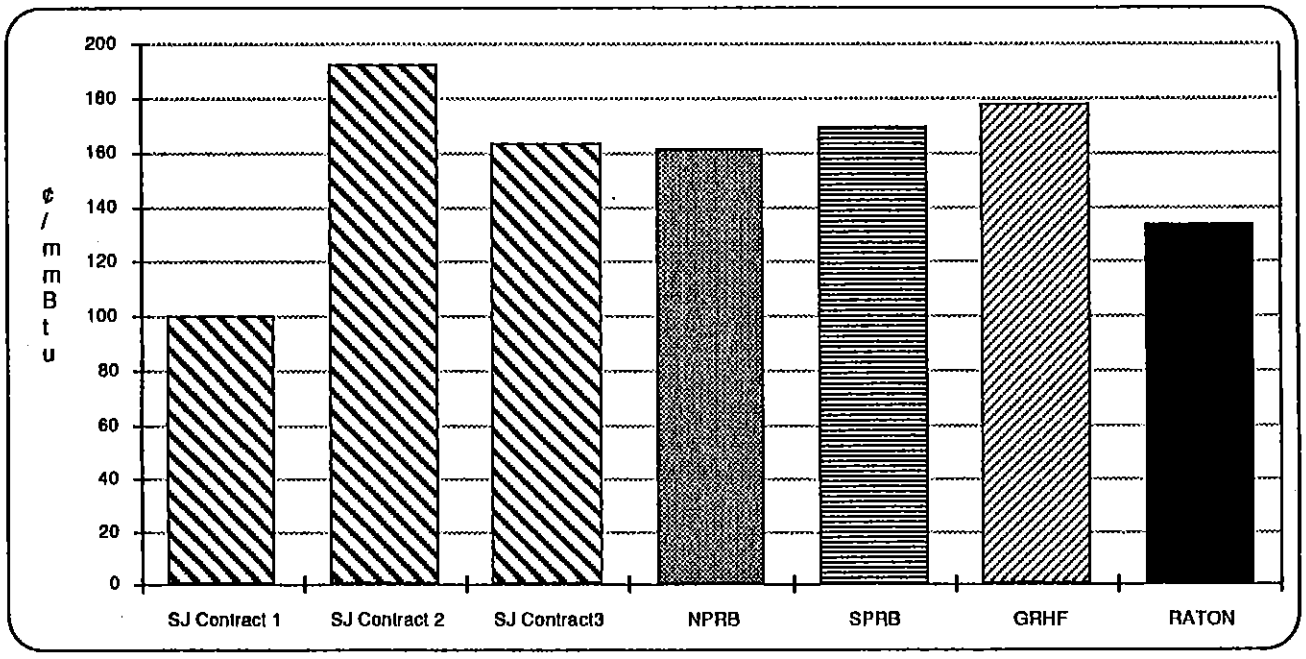
The Optimistic Case forecast assumes that three market sectors will experience stronger growth. Demand is projected to grow to 38.9 million tons per year in 1995, 44.5 million tons per year in 2000, and 49.6 million tons per year 2005. Utility demand growth is stimulated by the addition of three coal-fired electric generating units to the coal consumption base in the early 2000s. These additions hinge upon very strong electric demand growth in the southwestern U.S. Industrial and export demand growth is stimulated by San Juan Basin coal's competitive delivered price to industrial markets in Texas and California, and to exit ports in the Los Angeles/Long Beach area. However, the constant dollar delivered price would have to be reduced $6 to $25 per ton for San Juan Basin coal to be competitive in these markets.

A critical element to achieving optimistic case demand growth is to improve the competitiveness of the region's coal enough to offset quality disadvantages. **Such improvements will require lower production costs, lower taxes, and very competitive rail rates into major markets.**

Recently passed federal legislation to reduce "acid rain" will have little impact on utility demand for San Juan Basin coal even if a rail extension were to be built. Because 93 percent to 94 percent of the required sulfur reduction mandate falls on utilities located along or east of the Mississippi River, San Juan Basin coal suffers a transportation disadvantage into most of these markets. Because of the longer distances to these utilities and high mine costs, San Juan Basin coal is, and will remain, uncompetitive in major "acid rain" markets. In fact, the extension of a rail line into northwestern New Mexico could force reductions in existing contract coal prices due to low cost coal competition from other regions, particularly the Powder River Basin and Raton Mesa as illustrated in *Chart 4.*

Chart 4

Comparison of Delivered Price of Spot Coal into San Juan Utility Markets



There are several factors that could have negative effects on market forces, both in the near and long-term. In the near term, availability of nuclear power and low cost gas-fired generating capacity could significantly reduce coal-fired electric generation growth. Such an occurrence could reduce electric utility sector demand growth 1.5 to 3 million tons per year below the Base Case forecast.

In the long-term, abundant, low cost natural gas availability would influence the region's utilities to add conventional or combined cycle gas-fired generating capacity rather than coal-fired capacity. Such an occurrence would result in cancellation or deferral of the coal-fired generating capacity that supports the demand growth in the Optimistic Case forecast. Abundant low cost natural gas availability will influence California nonutility generators (NUG's) to install gas-fired rather than coal-fired electric generating capacity. Such an occurrence would result in a substantial reduction of industrial demand forecast in the Optimistic Case.

Current Supply Conditions

There are an estimated 215 billion tons of coal in the primary formations and seams currently mined in the San Juan Basin. The calorific value ranges from a relatively low 8,500 Btu per pound in reserves located in the central portion of the Basin to 12,000 Btu per pound in reserves located in southwestern Colorado. Coal produced in southern portion of the region averages 10,000 Btu per pound. Currently, coal output capacity in the San Juan Basin is estimated to be 31.8 million tons per year. This translates to a coal production capacity utilization rate of 72.1 percent.

Demand projected in the Base Case forecast (*Chart 3*, page 5) can be met by increasing output as existing mines and modest capacity expansion in New Mexico in the late 1990s. It is unlikely that any rail extension would be needed under Base Case demand assumptions. On the other hand, demand projected under the optimistic forecast would require capacity expansion of both truck and rail accessible coal reserves. Opening low cost operations in northwest New Mexico would be critical to becoming

competitive in crucial industrial and export markets projected in the Optimistic Case. Under Optimistic Case conditions an additional 4.9, 8.9, and 10 million tons of production capacity would need to be added to Base Case production by 1995, 2000, and 2005, respectively.

As *Table 5* (page 42) indicates, the current average cash production cost of coal produced in the region's major surface mines ranges between $14 and 21 per ton. There in only one underground mine producing in the region with an estimated cash production cost of about $24 per ton. It is estimated that San Juan Basin origin coal cash production costs could be reduced by $1.47 to $2.23 per ton if 33 percent to 50 percent reductions of royalties, state taxes, and local taxes were implemented, as has happened in Montana and Wyoming.

Many Wilderness Areas and Wilderness Study Areas exist in the San Juan Basin, and the existence of this land will affect future mining activities, as indicated by *Map IV* on page 47. Wilderness Act restrictions on environmental degradation impact the region's coal industry in two ways: reserves located near Wilderness Areas or Wilderness Study Areas either will not be developed at all or will face higher mining costs because of required environmental mitigation. Furthermore, power plants burning the region's coal may become less competitive if they are required to employ expensive pollution control devices or techniques to reach prescribed air, water, and soil quality levels.

Summary of Market Dynamics and Coal Prices

Because the region's production capability is controlled by a handful of companies, capacity will expand slowly to meet new market opportunities. Demand at "noncaptive" power plants (those not locked into nearby truck or conveyor served coal mines) is projected to increase at an annual average rate of 3.9 percent per year during the forecast period. Concurrently, coal production capacity is projected to increase at an annual rate of 1.5 percent per year.

Since the San Juan Basin is currently about 30 percent over capacity, demand growth will result in absorption of capacity at existing mines. The Optimistic Case demand forecast will require far different supply dynamics to evolve if the coal volumes projected for the utility, industrial, and export sectors are to be achieved. In the utility sector, production at mines along the existing Atchison, Topeka and Santa Fe Railway (Santa Fe) mainline will need to increase in the early 2000s--that can likely be achieved within the price structure projected for the Base Case.

In the Optimistic Case, demand is projected to be 2.6 to 16.2 million tons higher. To achieve market penetration in the industrial and export sectors of this magnitude will require substantial delivered price cuts in order to displace coal originating in Colorado, Utah, Wyoming, and lignite originating in Texas.

Delivered price cuts of this magnitude will require cooperation from both coal producers and rail transportation providers. In order to make a profit and cut mine prices, it will be necessary to cut cash production costs substantially. In order to successfully enter identified industrial markets, the delivered cost of San Juan Basin coal will have to be cut $8 to $25 per ton. In order to successfully enter identified export markets, delivered cost of the region's coal will have to be cut $6 to $8 per ton.

It is unlikely that cuts anywhere near the magnitude of the upper end of the range can be achieved. Proponents of market expansion for the San Juan Basin coal sector should realistically consider the cost of investment and lost tax and royalty revenue against the potential gains of increased coal sector employment. Cuts in the lower range ($6 to $8 per ton) will likely open the region to new export markets, and some new industrial markets in Texas, New Mexico, and Colorado.

While it is difficult to estimate the increased coal volume with $6 to $8 per ton delivered price cuts without assessing the competitive response from railroads and coal producers in Colorado, Utah, and Wyoming, it is unlikely that the total volume would exceed 2 million to 4 million tons per year above the Base Case demand in the next 5

to 10 years, and 6 million to 8 million tons per year in the following five years. Such tonnage volumes would create about 100 to 250 direct jobs initially, and 350 to 450 jobs in the last five years of the forecast period. The question can be raised as to whether the cost of investment and lost tax and royalty revenues will be matched or exceeded by the direct and indirect income effects from these jobs.

Noncoal Market Analysis

The noncoal commodity market analysis required a significant grass roots effort to gather pertinent information to determine existing freight flows in the San Juan Basin. The majority of the effort consisted of an extensive telephone interviewing process that contacted nearly 300 businesses located in the region. Some of these interviews lead to corporate or regional headquarters outside the San Juan Basin in cases where it was necessary to seek out the appropriate decision makers.

The results of these interviews indicated that the freight flows involving the San Juan Basin are generally under 500 miles and involve shipments from four areas where major distribution facilities have been established: Denver, Albuquerque, Salt Lake City, and Phoenix. Exceptions to this pattern involve less than 20 percent of the total freight shipments. Furthermore, over 90 percent of all San Juan Basin freight flows are less than truckload. This involves a single truck making multiple stops to serve a number of receivers. Major exceptions to this involve inbound oil and gas related equipment and supplies and the truck-rail shipments made to transload facilities located on the Santa Fe mainline, either in Thoreau or Gallup.

Another observation from the interview process was a great deal of misunderstanding relative to the benefits a rail link would create. A number of less than truckload shippers made note of the fact that smaller shipping volumes generally had poorer and less consistent service. It was believed that a direct rail link would offer an improved option. However, the beneficial economics for rail transportation stem directly from large volumes of freight moving between limited origins and

destinations. Many general freight, manufactured commodities do not fit this mold and particularly those shipped in the small volumes by less than truckload services.

The results of the survey indicate that the San Juan Basin is currently experiencing 12,000-14,000 annual truckloads of freight[1]. About one third of this represents the equipment and material needed for the current expansion in the gas production capabilities of the area. The San Juan Basin is also a much heavier consumer than producer, making the inbound to outbound ratio nearly nine to one. It is interesting to note that there appears to be a greater outbound volume of freight trucked to the Santa Fe mainline than is shipped out of the region by truck.

With most of the existing inbound freight using a logistical pattern that is not amenable to rail shipment, most of the noncoal business for the San Juan Railroad will need to come from either current truck-rail transload shipments or industrial development. It appears that all of the existing freight transloaded from truck to rail or vice versa at the Santa Fe mainline could be transported at lower cost by utilizing the proposed San Juan Railroad. The only exception to this might be in a case where a railroad extension was not appreciably north of the Santa Fe mainline.

The extent of rail stimulated business would be directly proportional to the industrial development and marketing efforts of the San Juan Railroad. There appear to be some substantial opportunities in the latter category including methanol and other refined products, processed food (particularly frozen potatoes), and humates. To the extent future expansions in gas production were to occur after a rail extension had been built, a substantial portion of this material would be shipped by rail.

Several potential opportunities that do not appear to have any likely development within the next ten years include intermodal freight and solid waste disposal. The key inhibitant for intermodal operations is based mostly on the

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[1] Does not include intra-Basin shipments or freight trucked to the Santa Fe for transloading.

economics of building and operating a terminal. Based on operations throughout the country, it would take a minimum monthly volume of about 3,000 trailers and/or containers to justify the relatively expensive intermodal terminal facilities, particularly the machine necessary to transfer trailers or containers between highway and rail cars. Because the total truck business in and out of the San Juan Basin does not begin to equal these volumes, the likelihood of a successful intermodal service appears quite remote.

Another option that was investigated was the disposal of municipal waste. This would be solid trash from major cities of a nonhazardous nature. By far the most viable opportunity from a transportation standpoint would be the city of Albuquerque. Albuquerque generates about 900 tons of solid waste on a daily basis that would generate several trainloads each week. However, Albuquerque is one of the few major cities in the nation that has recently opened a state-of-the-art disposal facility that is expected to last for at least 50 years, even with a one and one-half percent annual growth rate.

The potential for attracting waste from longer distance origins, although lower in probability could still be a longer term prospect. The key to establishing a disposal location appears to be more related to gaining the support for such a site with local residents than in distance per se. In other words, if a marketing effort for disposing of municipal waste were organized with the support of the Navajo Nation and other appropriate entities in the San Juan Basin, this could be a longer term prospect. However, attempting to measure that level of business before a serious proposal is placed on the table is highly speculative.

Combining all elements of the noncoal commodity research, it appears that the most likely volume that would develop within the first full year of operation (projected to be 1995) would be just under 2,000 annual carloads (Base Case). If an aggressive industrial development and marketing programs were successful, it seems probable that a total annual carload volume of about 5,000 cars could be realized within five years of start-up.

Summary

The combined carloads for the San Juan Railroad market analysis are summarized for the Base Case in *Exhibit I* on page 14. Under this scenario, the only coal development that would benefit the railroad would be a relatively modest volume increase to industrial users, with some additional export shipments. It is also unlikely that any new mines would open and that the coal for the Base Case would come from existing mines, primarily National King Coal in southern Colorado. Total rail volume would begin at nearly 2,400 carloads in 1995 and build to about 5,500 carloads by the year 2000. The most predominate commodity after coal is methanol. The agricultural industry would also play a major role with various inbound and outbound commodities providing about one in four of all shipments.

Exhibit II on page 15 outlines the Optimistic Case forecast. Under this forecast, coal production would be increased to reach export and industrial markets that would begin at one million tons annually in 1996 and reach 6.5 million tons by the year 2005. To be successful, it would also be necessary to reduce the delivered cost of the coal by $6 to $8 per ton. Under an optimistic outlook, other marketing and industrial development programs would show a larger impact with a methanol plant nearly double in size compared to the Base Case along with higher utilization of the railroad for agricultural commodities. It also assumed that near the turn of the century, additional pipeline building would impact the railroad. The Optimistic Case forecasts a carload volume of over 3,200 carloads in 1995, the first full year of operations, expanding rapidly to 40,000 carloads in the year 2000 and nearly 70,000 carloads five years later.

The risk associated with building the San Juan Railroad relates to the probability of any particular level of business being achieved. Clearly, coal represents the greatest potential to reach maximum coverage of operating and capital costs. Given that coal is the key factor, it would appear the next step would be to push the project from the realm of macro projections and into reality by determining whether any commitments would be forthcoming between particular coal suppliers and consumers, if a railroad existed. In other words, specifically what future sales could be made given the delivered cost from combining mining, transportation, and taxes.

Exhibit I

Proposed San Juan Basin Railroad
Projected Business Levels

Base Case Forecast

Commodity	1994	1995	1996	1997	1998	1999	2000-2005
INBOUND:							
Cement	25	35	45	50	50	60	65
Sand	15	25	35	40	35	40	45
Fertilizer	300	400	450	475	500	500	500
Building Products	45	75	75	80	90	95	95
Steel Products	60	75	80	80	85	85	90
Oil and Gas Supplies	20	35	40	50	50	55	55
Cooking Oil	30	35	45	50	50	50	50
Other	15	35	35	35	35	35	40
SUBTOTAL	**510**	**715**	**800**	**860**	**895**	**920**	**940**
OUTBOUND:							
Coal	400	500	1000	1500	2000	2200	2300
Alfalfa	0	0	0	0	0	0	0
Humates	0	0	0	0	0	0	0
Grain	250	275	350	350	350	350	350
Refined Products	0	300	800	1000	1000	1000	1000
Dried Beans	35	65	75	80	90	95	95
Forest Products	200	225	250	250	275	275	290
Processed Food	200	275	375	425	450	450	475
Other	25	30	35	40	50	50	60
SUBTOTAL	**1110**	**1670**	**2885**	**3645**	**4215**	**4420**	**4570**
TOTAL	**1620**	**2385**	**3685**	**4505**	**5110**	**5340**	**5510**

Forecast Summary

Source							
Truck-Rail Transload	1150	1400	2050	2575	3125	3325	3440
Truck Diversion	200	310	345	380	400	430	445
New Rail-Stimulated Business	270	675	1290	1550	1585	1585	1625
TOTAL	**1620**	**2385**	**3685**	**4505**	**5110**	**5840**	**5510**

Exhibit II

Proposed San Juan Basin Railroad
Projected Business Levels

Optimistic Forecast

Commodity	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
INBOUND:												
Cement	25	35	45	50	50	60	75	75	75	75	75	75
Sand	15	25	35	35	40	40	55	55	55	55	55	55
Fertilizer	300	400	450	500	500	500	600	600	600	600	600	600
Building Products	45	75	75	80	90	95	95	95	95	95	95	95
Steel Products	60	75	80	80	85	85	90	90	90	90	90	90
Oil and Gas Supplies	20	35	40	50	50	55	55	55	55	55	55	55
Cooking Oil	30	40	50	60	65	70	70	70	70	70	70	70
Other	25	45	50	50	500	500	200	100	50	50	50	50
SUBTOTAL	520	730	825	905	1380	1455	1240	1140	1090	1090	1090	1090
OUTBOUND:												
Coal	400	600	10000	17000	25000	30000	35000	40000	45000	50000	55000	65000
Alfalfa	50	75	80	90	125	175	200	200	200	200	200	200
Humates	0	75	200	250	275	300	350	350	350	350	350	350
Grain	250	300	350	375	400	400	400	400	400	400	400	400
Refined Products	250	700	1000	1300	1400	1600	1750	1750	1750	1750	1750	1750
Dried Beans	35	65	75	80	90	95	100	100	100	100	100	100
Forest Products	200	250	275	325	325	350	350	350	350	350	350	350
Processed Food	300	375	415	515	520	525	525	525	525	525	525	525
Other	25	40	50	50	65	75	80	80	80	80	80	80
SUBTOTAL	1510	2480	12445	19985	28200	33520	38755	43755	48755	53755	58755	68755
TOTAL	2030	3210	13270	20890	29580	34975	39995	44895	49845	54845	59845	69845

Forecast Summary

Source

Truck-Rail Transload	750	950	1075	1200	1225	1300	1350	1350	1350	1350	1350	1350
Truck Diversion	250	385	430	465	530	605	670	670	670	670	670	670
New Rail-Stimulated Business	1030	1875	11765	19225	27825	33070	37975	42875	47825	52825	57825	67825
TOTAL	2030	3210	13270	20890	29580	34975	39995	44895	49845	54845	59845	69845

For example, for a given transportation cost that can be negotiated with the Santa Fe, would or could any of the mines currently not rail served be willing or able to expand their markets by selling outside the region. It very well may be that the market niche the San Juan Basin mines are currently serving is so superior compared to markets outside the region, that price cuts or other concessions would make any attempts to serve these new markets unattractive. It has been noted that relative to the Powder River Basin where coal sells for less than $5 per ton that the costs of mining in the San Juan Basin are quite high. Perhaps intensely serving the New Mexico/Arizona coal consumption market, the bottom line benefits for mining employees, mining owners, and the states are greater than if a significant price cutting effort were made to compete with other coal producing regions. Certainly it appears that only a total cost cutting effort involving taxes, mining costs, and transportation costs could allow any significant market penetration outside the traditional area served by San Juan Basin coal mines. To look at it in another perspective, the value added benefit of generating electricity in the San Juan Basin appears to be producing a greater total benefit than shipping the coal to other parts of the country for power generation.

However, until the opportunity is specifically presented for coal ventures outside the current market area, there is no sure way of knowing. Therefore, it is proposed that discussions be commenced with the existing owners or operators of San Juan Basin coal mines along the proposed San Juan Railroad to determine what level of commitment could be gained prior to moving ahead. Indeed without some level of commitment by the potential users, the ability to raise the substantial sums necessary to construct the railroad will likely be difficult if not impossible to obtain.

II.

MARKET ANALYSIS OF COAL FOR SAN JUAN BASIN

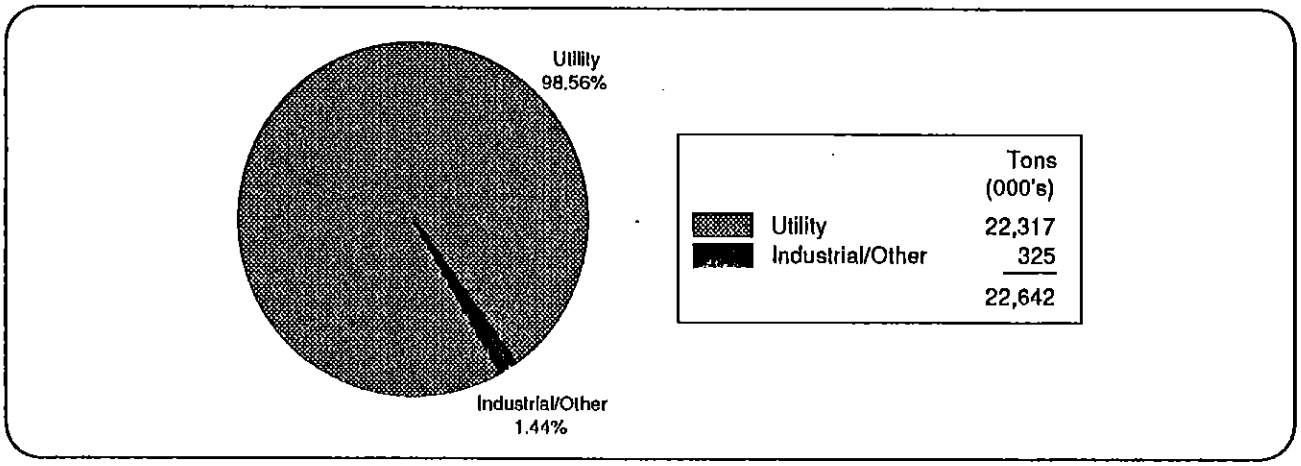
II. MARKET ANALYSIS OF COAL FOR SAN JUAN BASIN

Current San Juan Basin Markets

Coal sold by San Juan region producers moves primarily to domestic utility and industrial accounts. *Chart 5* illustrates that in 1990 over 98 percent of the total 1990 coal volume originating in the region was shipped to utility customers. *Chart 6* further confirms both the dominance of the utility sector in this coal producing region and reveals the contribution of the utility sector to demand growth for the past six years. The utility sector is the most important current market sector for San Juan region producers and will probably remain so for the next 15 years. The *Map* on the next page presents an overview of San Juan coal markets.

Chart 5

1990 Coal Shipments from the San Juan Basin



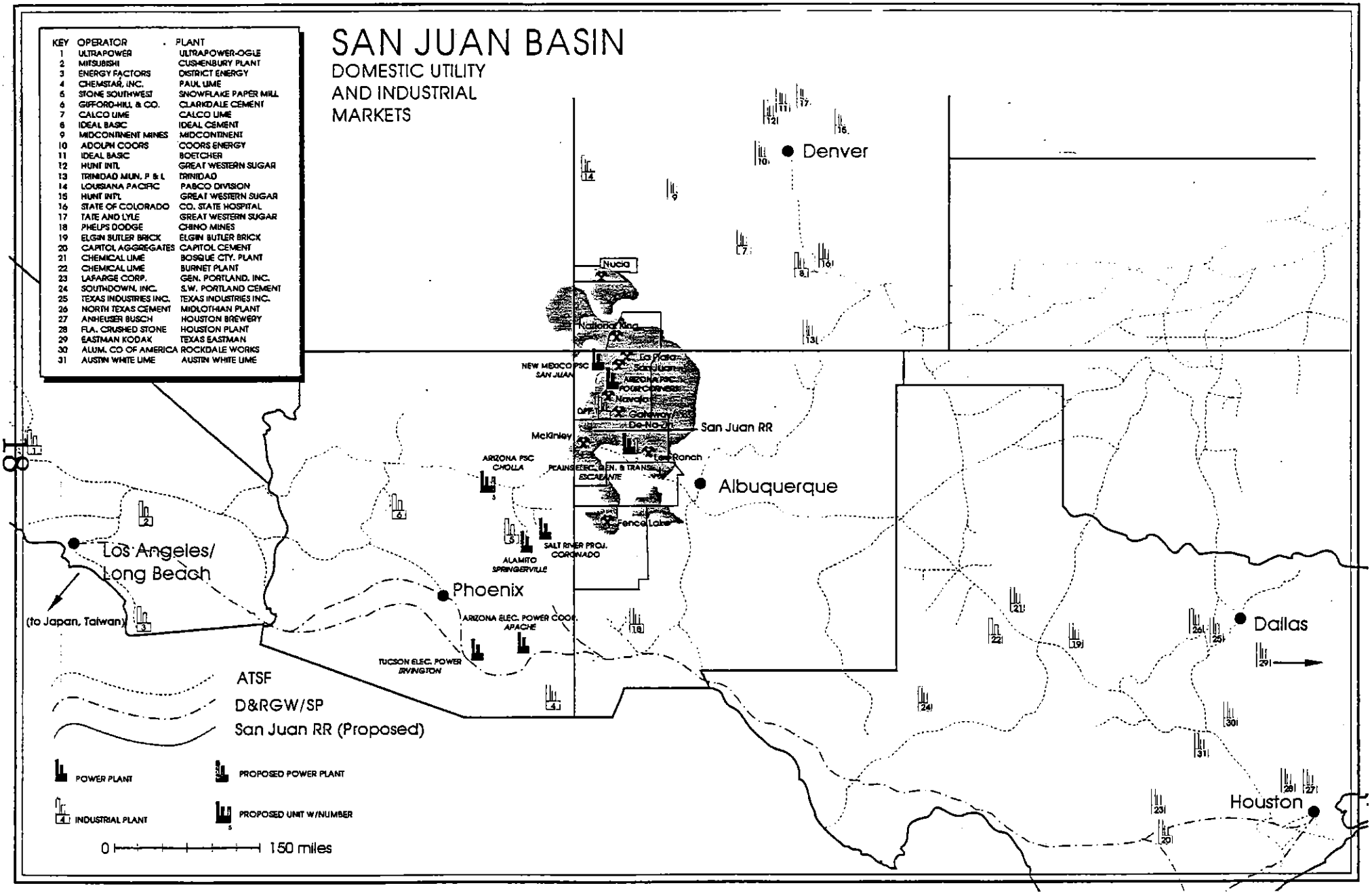
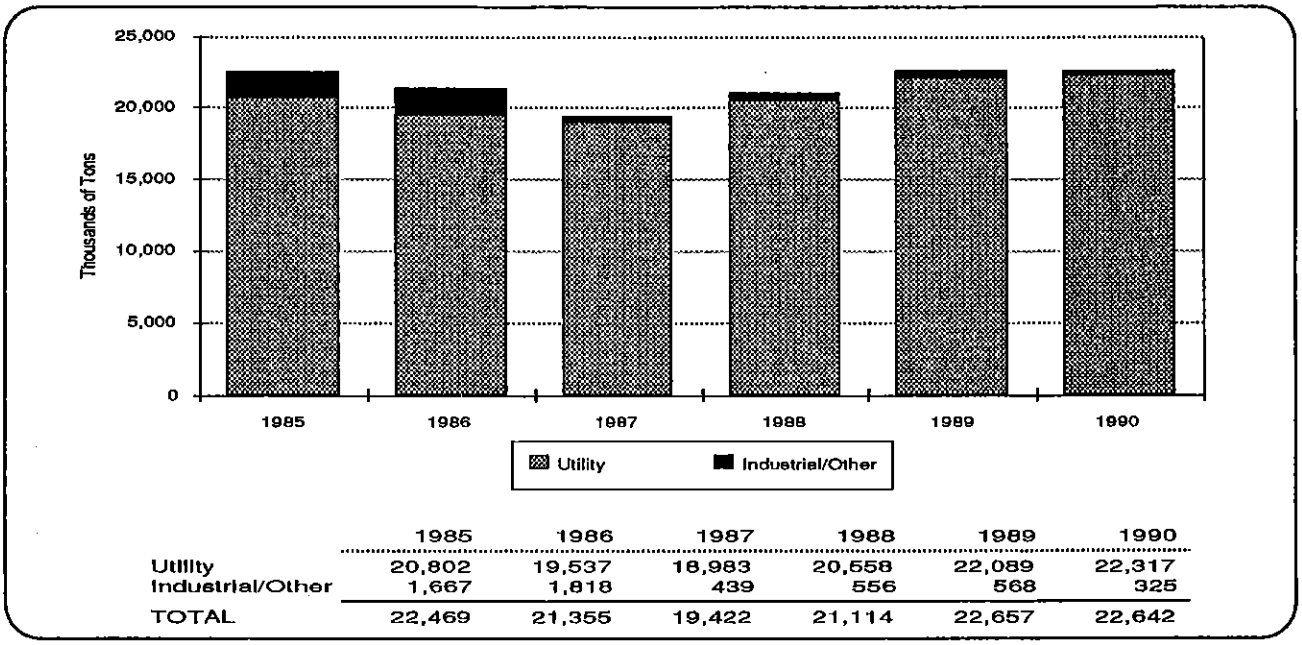

SAN JUAN BASIN
DOMESTIC UTILITY
AND INDUSTRIAL
MARKETS
KEY OPERATOR PLANT
1 ULTRAPOWER ULTRAPOWER-OGLE
2 MITSUBISHI CUSHENBURY PLANT
3 ENERGY FACTORS DISTRICT ENERGY
4 CHEMSTAR, INC. PAUL LIME
5 STONE SOUTHWEST SNOWFLAKE PAPER MILL
6 GIFFORD-HILL & CO. CLARKDALE CEMENT
7 CALCO LIME CALCO LIME
8 IDEAL BASIC IDEAL CEMENT
9 MIDCONTINENT MINES MIDCONTINENT
10 ADOLPH COORS COORS ENERGY
11 IDEAL BASIC BOETCHER
12 HUNT INTL GREAT WESTERN SUGAR
13 TRINIDAD MUN. P & L TRINIDAD
14 LOUISIANA PACIFIC PABCO DIVISION
15 HUNT INT'L GREAT WESTERN SUGAR
16 STATE OF COLORADO CO. STATE HOSPITAL
17 TATE AND LYLE GREAT WESTERN SUGAR
18 PHELPS DODGE CHINO MINES
19 ELGIN BUTLER BRICK ELGIN BUTLER BRICK
20 CAPITOL AGGREGATES CAPITOL CEMENT
21 CHEMICAL LIME BOSQUE CTY. PLANT
22 CHEMICAL LIME BURNET PLANT
23 LAFARGE CORP. GEN. PORTLAND, INC.
24 SOUTHDOWN, INC. S.W. PORTLAND CEMENT
25 TEXAS INDUSTRIES INC. TEXAS INDUSTRIES INC.
26 NORTH TEXAS CEMENT MIDLOTHIAN PLANT
27 ANHEUSER BUSCH HOUSTON BREWERY
28 FLA. CRUSHED STONE HOUSTON PLANT
29 EASTMAN KODAK TEXAS EASTMAN
30 ALUM. CO OF AMERICA ROCKDALE WORKS
31 AUSTIN WHITE LIME AUSTIN WHITE LIME
Denver
Nucla
National Mine
La Plata
San Juan
Arizona PSC
Four Corners
Navajo
Gateway
De-Na-Zin
McKinley
San Juan RR
Lee Ranch
Albuquerque
ARIZONA PSC
CHOLLA
PLAINS ELEC. GEN. & TRANS.
ESCALANTE
Fence Lake
SALT RIVER PROJ.
CORONADO
ALAMITO
SPRINGERVILLE
Los Angeles/
Long Beach
(to Japan, Taiwan)
Phoenix
ARIZONA ELEC. POWER COOP.
APACHE
TUCSON ELEC. POWER
IRVINGTON
Dallas
Houston
ATSF
D&RGW/SP
San Juan RR (Proposed)
POWER PLANT
PROPOSED POWER PLANT
INDUSTRIAL PLANT
PROPOSED UNIT W/NUMBER
0
150 miles

Chart 6

San Juan Coal Shipments by Major Market



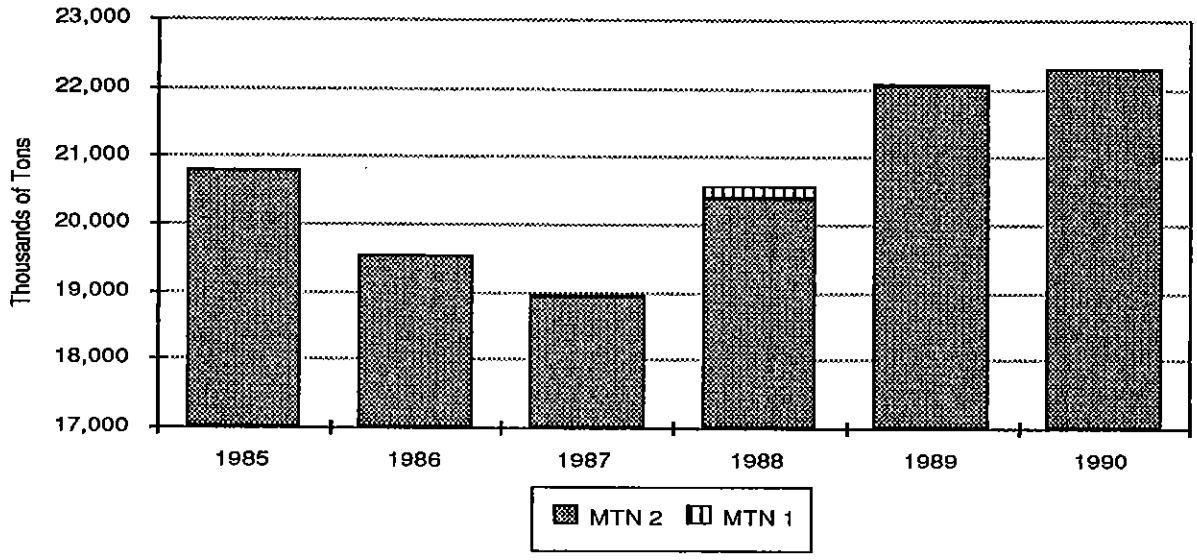
	1985	1986	1987	1988	1989	1990
Utility	20,802	19,537	18,983	20,558	22,089	22,317
Industrial/Other	1,667	1,818	439	556	568	325
TOTAL	22,469	21,355	19,422	21,114	22,657	22,642

Domestic Utility Markets

Utility coal produced in the San Juan region has been sold exclusively in the states of Arizona, Colorado, and New Mexico. Time series data on utility shipments for the past six years that are summarized in *Chart 7*, illustrate the long-term reliance of San Juan producers on utilities in the mountain region generally, and on Mountain 2 (New Mexico and Arizona) utilities in particular which purchased over 98 percent of the region's utility coal in 1990. The remaining volume was shipped to a utility plant in Colorado.

Chart 7

San Juan Utility Coal Shipments



	1985	1986	1987	1988	1989	1990
MTN 1	0	0	33	169	46	0
MTN 2	20,802	19,537	18,949	20,389	22,042	22,317
Total Shipments	20,802	19,537	18,982	20,558	22,088	22,317

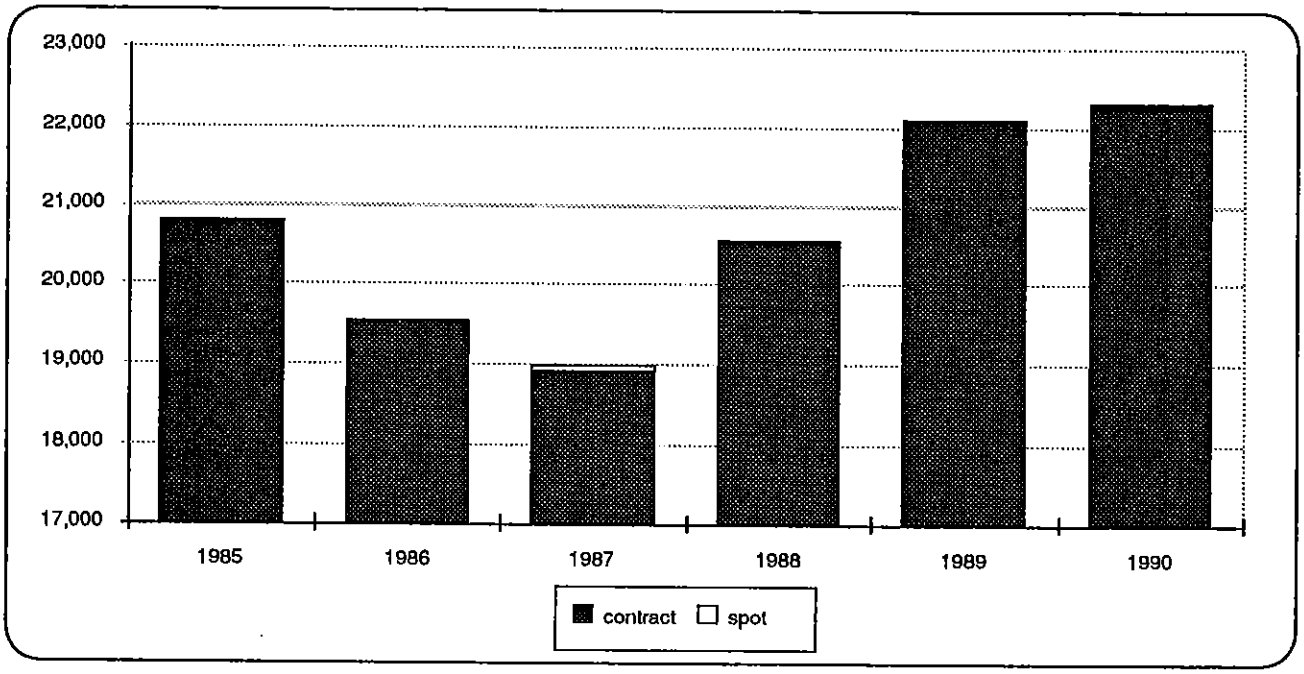
The San Juan utility market is strongly affected by some unique factors. First, many of the power plants served by the region are relatively remotely located and are captive to a single mode of transportation and/or a single carrier. Second, many of the coal supply relationships are governed by long-term contracts that were negotiated in the mid and late 1970s. These supply agreements were instrumental in providing security for the financing and development of the mines supplying the coal. Third, because coal mine development has been historically dependent upon contractual relationships with the market's few utilities, the supply side tends to be concentrated in the hands of the few producers who have negotiated these relationships. Generally, it is a coal producing region governed by heavy concentration on both the supply and demand sides, with most transaction relationships governed by long-term contracts. Further, because of transportation costs, coal consumers have limited economic options to buy coal from other producers or other coal producing regions.

The series of charts on the following page illustrates some of the effects of the market dynamics. *Chart 8* confirms that currently there is virtually no spot markets

for the San Juan producing region. The absence of a significant spot market, makes it difficult to gauge the impact that open market coal activity would have on FOB mine and delivered prices in the utility sector.

Chart 8

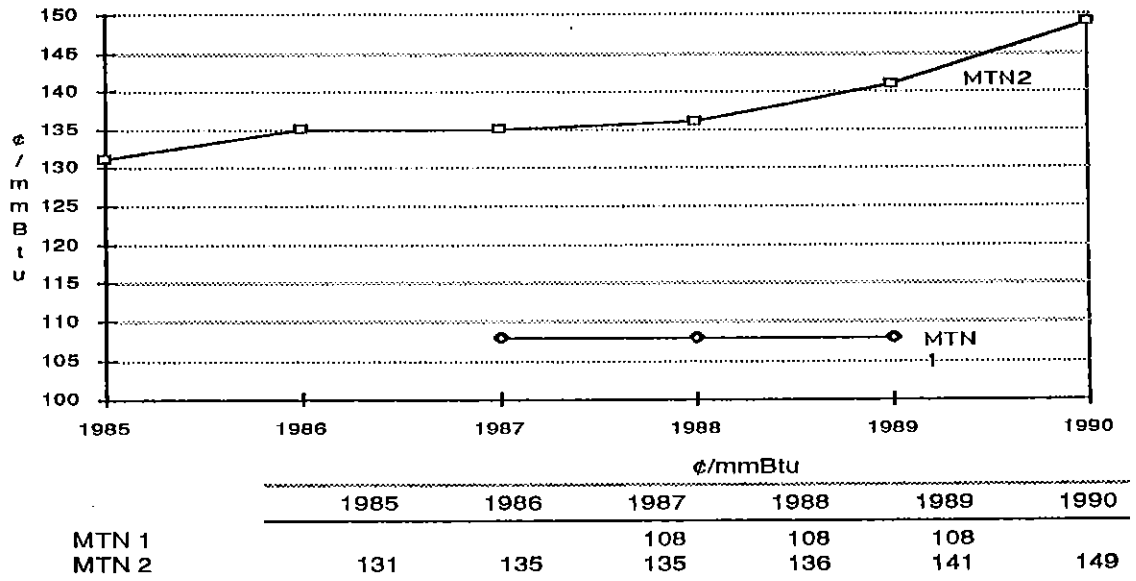
Annual Contract Shipments from the San Juan Region



In addition, the dominance of large, contractually based transactions has resulted in a steady increase in the delivered price of coal in San Juan's utility demand regions for the past six years (see *Chart 9*). This is clearly an unusual situation when viewed from a national coal market perspective, where delivered coal prices fell steadily from the mid-1980s to the early 1990s.

Chart 9

Delivered Coal Prices into Selected Markets from the San Juan Region



¢/mmBtu

	1985	1986	1987	1988	1989	1990
MTN 1			108	108	108	
MTN 2	131	135	135	136	141	149

The extension of a railroad from Gallup, New Mexico, could conceivable provide rail access to the Four Corners and San Juan power plants, operated by Arizona Public Service (APS) and Public Service of New Mexico (PNM), respectively. Using the experience of Arizona Electric Power Corporation (AZEC) as a basis to calculate the delivered costs of coal into the respective power plants, it is obvious that two high priced contracts between PNM and Utah International could be exposed to competitive pressure.

Chart 10

Comparison of Delivered Price of Spot Coal into San Juan Utility Markets

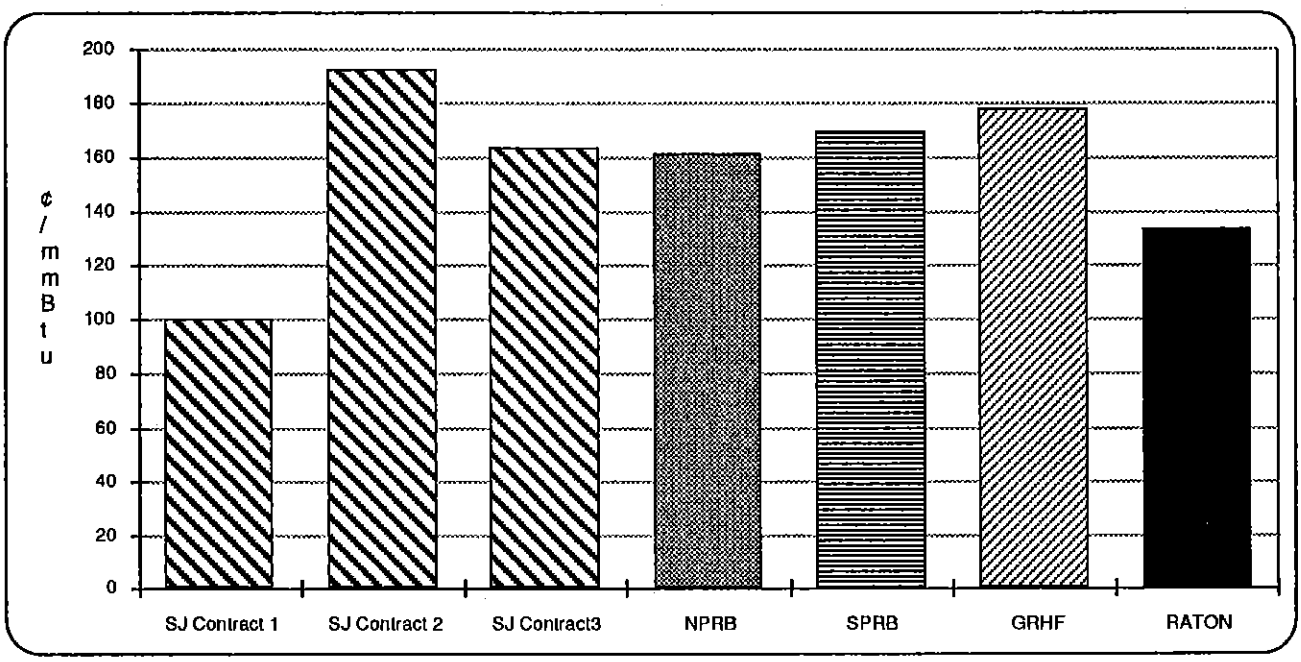


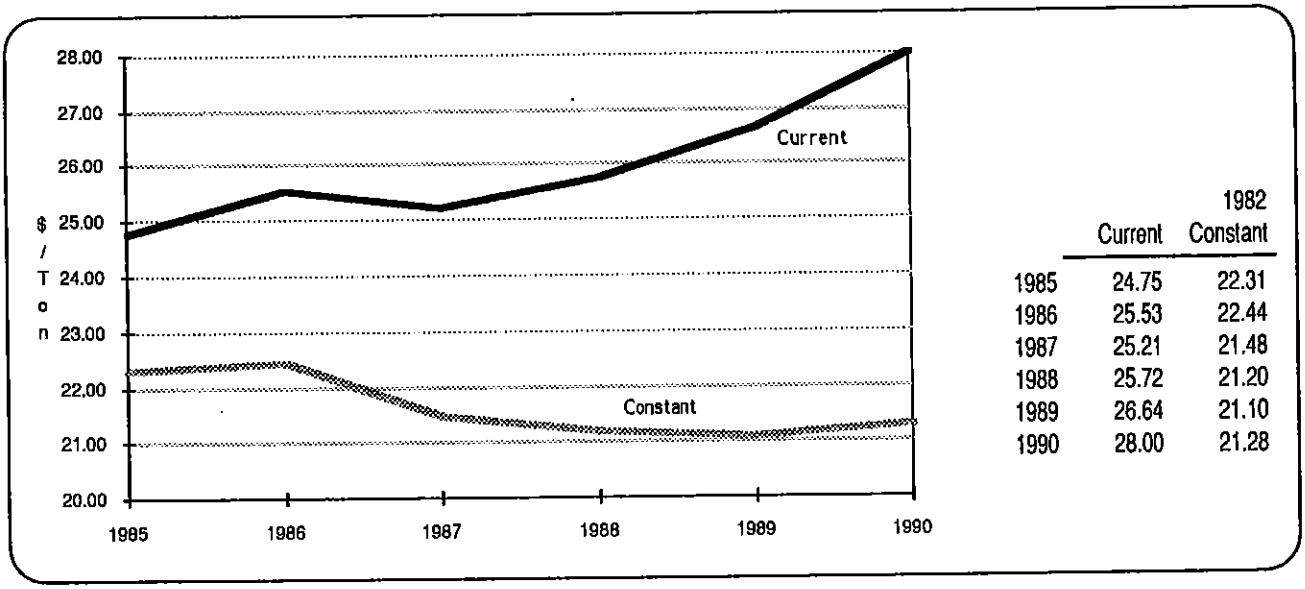
Chart 10 illustrates the difference in delivered price of spot coal supplied from the Powder River Basin, Green River/Hams Fork, and Raton Mesa regions to the San Juan and Four Corner's plants. Current contract prices for San Juan coal are also presented in order to illustrate the vulnerability of existing contracts relative to other available coal supplies. The most likely competitor for business at these plants would be the Raton Mesa region and possibly the Powder River Basin.

While it does not necessarily follow that the availability of competitive coal will stimulate a utility to break or renegotiate a coal contract, it has become common practice in recent years for both utilities and utility regulators to use these dynamics to "jawbone" or force price concessions from coal producers. (Several years ago, this was attempted unsuccessfully with PNM.) Again, the AZEC Apache plant is a case in point. The utility continues to contract with Raton Mesa suppliers for the bulk of its coal--business lost to San Juan Basin coal producers primarily because of higher coal costs. It should be recognized that a railroad extension could be a "two-edged sword" for a region with relatively high production costs. While it may open new coal markets in some areas, it will also permit lower cost producing areas with better quality coal to enter into markets which San Juan Basin coal producers have traditionally controlled.

A question about fairness of the current supply/demand and price structure in the region to utility consumers (and electric ratepayers) can be raised. Clearly, they did not reap the benefits of falling fuel prices that resulted in stable or falling real electric rates in many areas of the U.S.. However, the data suggests that they have nor fared badly. First, as *Chart 11* illustrates, even though nominal delivered coal prices have risen steadily, when adjusted for inflation, coal prices have actually declined modestly throughout the past six years. Second, coal-fired electric generation from the San Juan region competes on the regional electric dispatch "grid" with hydro, nuclear, and oil-based generation. While competition within the coal sector itself may not strongly influence the delivered price of coal in the San Juan region, competition among the forms of generation definitely limits the coal prices electric utilities and coal producers can allow. Utilities will respond to "excessive" coal prices by reducing coal-fired generation in favor of cheaper power sources, and producers will experience eroding markets--just as they would if their coal was priced out of line with coal supplied by other producers or regions. The steady, long-term growth of coal consumption and nominal coal prices, even as substantial new nuclear capacity has been added, suggests that coal generated electricity remains a bargain for utilities and electric ratepayers.

Chart 11

Average Delivered Price of San Juan Basin Utility Coal in Current and Constant Dollars



	Current	1982 Constant
1985	24.75	22.31
1986	25.53	22.44
1987	25.21	21.48
1988	25.72	21.20
1989	26.64	21.10
1990	28.00	21.28

Utility Consumers

Table 1 on page 27 summarizes 1989 and 1990 coal purchases from the San Juan region. The coal consumers are ranked by their 1990 purchases of coal from the region. The top four coal consumers constitute 92 percent of all coal purchases. Between 1989 and 1990, total coal purchases in this region dropped by 231,000 tons--less than a one percent decrease.

The largest utility buyer in both 1989 and 1990 is Arizona Public Service Company (APS). Although shipments reached nearly 12 million tons on both years, volume declined by 160,000 tons in 1990. Two factors may have contributed to a slightly lower take of coal in 1990--recession effects in APS's service territory and availability of nuclear power from the giant Palo Verde complex.

APS operates the Cholla plant in Joseph City, Arizona, and the Four Corners plant in Fruitland, New Mexico. Both are large, baseload power generating complexes that produce electricity for wheeling into APS's service territory, as well as the territories of several other prominent southwestern U.S. utilities. Cholla, located on the Santa Fe, is supplied under contract by Pittsburg and Midway's McKinley mine, approximately 116 rail miles east of the power plant. In 1990 APS received just over three million tons of coal under a contract which is scheduled to expire in 2000. The utility paid an estimated FOB mine average price slightly less than $27 per ton for the coal. San Juan receives coal by conveyor from Utah Mineral's Navajo mine, which is adjacent to the power plant site. In 1990 APS received just over 8.7 million tons of coal under a contract scheduled to expire in 2005. The utility paid an estimated FOB mine average price slightly less than $18.50 per ton for the coal.

The second largest utility buyer of San Juan coal is Public Service Company of New Mexico (PNM). Although shipments approached 5.7 million tons in 1990, volume declined by nearly 290,000 tons from its 1989 level. This represents the largest volume drop in the San Juan utility sector. PNM is a major participant in the Palo Verde

project, and both recession effects in the utility's service territory, and the availability of nuclear power could have contributed to the moderate decrease in coal receipts.

PNM operates the San Juan power plant located in Waterflow, New Mexico. Coal is delivered to the plant by truck and rail from mines located 5-30 miles distant on property adjacent to the plant site. In 1990 approximately 5.7 million tons of coal was shipped to San Juan from Utah Mineral's San Juan and La Plata mines. The estimated average price for coal originating at La Plata was near $38 per ton.

Salt River Project (SRP) is the third largest coal buyer in both 1989 and 1990. Shipments to the utility experienced a modest increase of 116,000 tons in 1990. The utility purchased 2.9 million tons of San Juan Basin coal in 1990.

SRP operates the Coronado plant, which is located on the Santa Fe in St. Johns, Arizona, and the Navajo plant, located in Page, Arizona. Coal for Navajo is produced in the Black Mesa region of Arizona. Both power plants are large, baseload facilities. They produce power for SRP's distribution companies and for wheeling into the service territories of other prominent southwestern U.S. utilities. Most of the coal for the Coronado plant is supplied by Pittsburg and Midway's McKinley mine located approximately 94 rail mines northeast of the plant. In 1990 about two million tons were shipped under a contract which expires in 2004. The estimated average FOB mine price for the coal is slightly more than $36 per ton. In addition, SRP purchased about 83,000 tons of spot coal from Santa Fe's Lee Ranch mine located to the northeast in New Mexico. The estimated FOB mine price for the spot coal is $24 per ton.

Table 1

Utility Coal Purchases from the San Juan Basin

Demand Region	Utility	1989 Tons (000's)	1990 Tons (000's)	Difference (000's)
MTN				
	Arizona Public Service	11,927.00	11,767.00	(160.00)
	PSC of New Mexico	5,971.90	5,683.00	(288.90)
	Salt River Project	1,428.90	2,037.90	609.00
	Century Power Corp. (Alamito)	1,475.00	1,785.00	310.00
	Plains Electric Gen. & Trans.	921.25	836.08	(85.17)
	Tucson Electric Power Co.	271.00	167.00	(104.00)
	Arizona Elec. Power Corp.	47.36	40.67	(6.69)
	Colorado Ute Electric Assn.	46.20	0.00	(46.20)
	Total San Juan Utility Purchases	**22,088.61**	**22,316.65**	**228.04**

As *Table 1* indicates, several other utilities made significant purchases from the San Juan region in 1989 and 1990. Century Power, an independent subsidiary controlled by Tucson Electric Power, received nearly 1.8 million tons in 1990, and also reported a one-year volume increase of 310,000. This represents the largest volume increase in the San Juan utility market. The utility received coal under contract from Santa Fe's Lee Ranch mine. The coal was shipped to the Springerville plant located in Springerville, Arizona. Access to the plant is via a private rail spur that connects to the Santa Fe. The estimated average FOB mine price paid for the coal ranged between $28 and $29 per ton.

Plains Electric Generation & Transmission (PEGT) reported coal receipts from the region of 836,000 tons in 1990--a modest decline from their 1989 level. Coal shipped to PEGT goes to the Escalante plant, located in Prewitt, New Mexico, on the Santa Fe. Coal for Escalante is shipped from Santa Fe's Lee Ranch mine under a contract which has no reported expiration date. The estimated average FOB mine price for the coal is slightly over $20.50.

Tucson Electric Power (TUCO) reported receipts of 167,000 tons at its Irvington power plant located in Tucson, Arizona. However, this represented a sharp decrease

from the utility's 1989 receipts. A combination of recession and competitive pressure from other electricity sources on the southwestern power "grid" may have contributed to the coal demand decline at TUCO. Coal for Irvington is supplied under a contract that expires in 2002 from Pittsburg and Midway's McKinley mine. The estimated average FOB mine price paid for the coal is about $38.50.

Two other utilities reported modest sized spot receipts from the San Juan region in 1989 and 1990. Arizona Electric Power Co-op purchased about 41,000 tons of coal from the Lee Ranch mine for its Apache plant in 1990. The estimated average FOB mine price for the coal is about $25 per ton. Colorado Ute Electric Association purchased about 46,000 tons of coal for its Nucla plant from Peabody's Nucla mine in 1989. This mine was closed in late 1989, and coal for the power plant has subsequently been supplied from mines located in the Uinta Basin and Green River/Hams Fork coal supply regions.

Utility Suppliers

Table 2 summarizes 1989 and 1990 shipments from the San Juan region to domestic utilities from a supplier's perspective. The suppliers are ranked from highest to lowest by 1990 utility coal shipments.

Table 2

Shipments from the San Juan Basin Supplier

Supplier	1989 Tons (000's)	1990 Tons (000's)	Difference (000's)
Utah Minerals Int'l (BHP)	14,316.90	14,405.00	88.10
Pittsburg & Midway Coal Co.	5,319.07	5,167.10	(151.97)
Santa Fe Coal Corp.	2,406.44	2,744.55	388.11
Peabody Coal Co.	46.20	0.00	(46.20)
Total San Juan Utility Sales	22,088.61	22,316.65	228.04

As previously mentioned, the region's coal supply capability is extremely concentrated. The entire supply from this region consists of four companies. The largest of these is Utah Minerals International (UMI), which is a subsidiary of Australian controlled Broken Hills Proprietary. UMI sold 14.4 million tons in 1990, which represents 43 percent of total regional sales. The company experienced a modest increase in volume over 1989. UMI's position in this market is supported by three major contracts that provide for shipment of nearly nine million annual tons of coal to APS and about 5.6 million annual tons to PNM. FOB mine prices for the coal range from $17.50 to APS to about $38 per ton at PNM. The contracts expire in 2005 and 2017 for APS and PNM, respectively.

The second largest supplier, Pittsburg & Midway's Coal Company (P&M), shipped nearly 5.2 million tons in 1990. Like Peabody, P&M experienced a decline in sales volume. However, it was a modest 152,000 tons. Most of this decline is attributable to the cut in shipments to Tucson Electric Power's (TUCO) Irvington plant. P&M's position in the market is governed by long-term contracts with APS, SRP, and TUCO. These contracts are scheduled to expire in 2000, 2004, and 2002, respectively. Current estimated FOB mine prices received for coal are about $27, $36, and $38 per ton for APS, SRP, and TUCO shipments, respectively.

The third ranking supplier in the region is Santa Fe Coal Corporation. The company's Lee Ranch mine sold a total of 2.7 million tons last year and experienced the largest utility sales volume increase in the San Juan region. Although Santa Fe is the smaller shipper in the market with four utility contracts and some activity in the spot market, it has the region's most diverse market in 1990. The company's largest utility customer is Century Power who takes coal for its Alamito plant. Lee Ranch shipped coal to Century Power on contracts expiring in 1995 and 2009. Other customers include Plains Electric Generation & Transmission, Salt River Project, and Arizona Power Co-op. The estimated average FOB mine price received for coal was about $28.50 per ton at Century Power, $25 at Arizona Electric, $20.50 at PEGT, and $19.50 at SRP.

Peabody Coal Company is the fourth largest supplier in the region, with over 11.4 million tons shipped in 1990. The volume represented a drop of nearly 506,000 tons from 1989 shipments. The decline is attributable to a loss of tonnage at SRP's Navajo plant and to closure of the Nucla mine in southeastern Colorado. Over 60 percent of Peabody's 1990 tonnage is still attributable to SRP. The remainder is coal shipped to Southern California Edison's (SCE) Mojave plant. Both accounts are governed by contracts expiring in 2011 at SRP and 2005 at SCE. The estimated FOB mine prices received from coal are about $20.50 and $21.50 for SRP and SCE, respectively.

Domestic Industrial Markets

Nonutility domestic and export markets are not major current consumers of San Juan region coal. Both coal quality and transportation limitations have prevented strong entry into these markets. Most domestic industrial and export accounts prefer coal with a higher Btu per pound, and lower ash content than the typical San Juan region products. At this time only two mines--P&M's McKinley and Santa Fe's Lee Ranch--can originate coal directly on a mainline railroad. Only a fraction of the region's capacity can ship to rail terminating domestic markets. The remaining producers are forced to truck coal dozens or even hundreds of miles to rail loadouts to enter these markets. Strong competition from many other regional producing regions makes this course of action economically unappealing to most other operations. The one exception is the National King mine that sold 52,000 tons to the Clarkdale plant of Phoenix Cement. Coal from National King is trucked 130 miles to Thoreau, New Mexico, and loaded on the Santa Fe for final delivery to Clarkdale.

Despite these limitations, the McKinley operation has been successful in the past at placing coal in certain industrial markets in Arizona and southern California. Where consumers are willing to take a lower quality coal in these areas, McKinley can be very competitive on a delivered price basis because of the close proximity of the mine via the Santa Fe. McKinley has successfully supplied between 300,000 and 500,000 annual tons

of industrial coal to a paper producer in Arizona and to a cement manufacturer in California. The estimated FOB mine price for these industrial shipments is $19 to $20 per ton. In the past three years, however, much of this business has been taken by Uinta Basin producers who, in conjunction with the Southern Pacific Railroad, have priced coal more competitively in the southern California market.

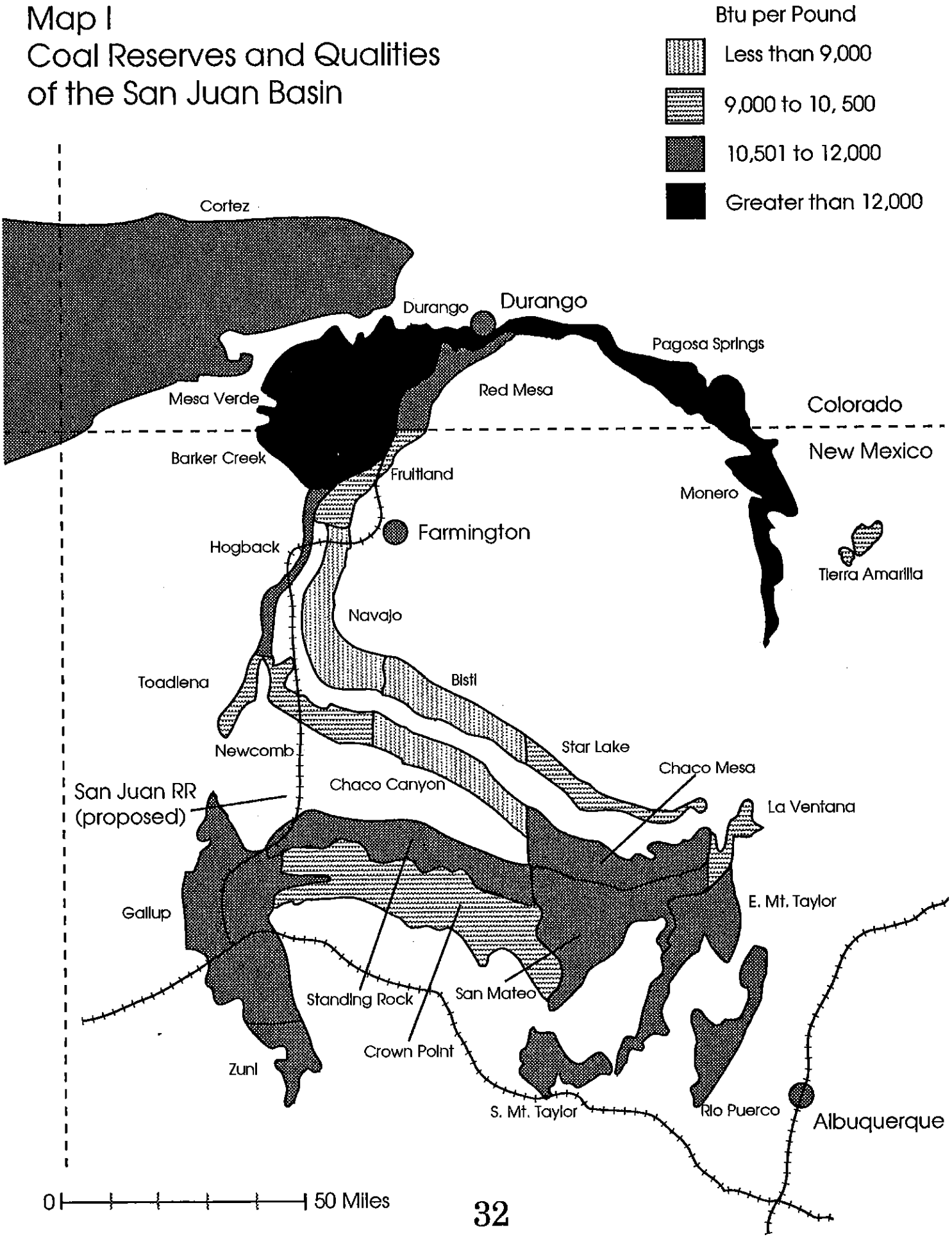
A small market for "house coal" and some local institutional and industrial boiler markets also exist for those producers willing to screen stoker coal. However, most large operations, targeted primarily at captive utility consumers, are unwilling to invest in facilities or risk jeopardizing their primary utility steam coal production cycle to enter these "niche" markets. For this reason, P&M will likely remain the lone major participant in the nonutility markets open to San Juan region coal operations.

Current Supply Conditions

The San Juan Basin is located in the areas where the states of Colorado, Utah, New Mexico, and Arizona meet. With over 7,050 square miles in the area, it is a broad geographic depression ringed by mountains. Coal that is currently mined in the region ranges in heating value from 8,763 Btu per pound at the Navajo mine in San Juan County, New Mexico, to 12,000 Btu per pound at the National King mine at La Plata County, Colorado. Generally, sulfur ranges between 0.8 and 1.5 pounds SO_2 per mmBtu. The region current consists of eight producing mines in three states, excluding one underground operation. *Map I* on page 32 illustrates the coal reserves and qualities located in this region.

In 1981 San Juan coal production was over 17.4 million tons. Throughout the 1980s production fluctuated between 18.8 and 23.2 million tons per year, and in 1990 annual production was 22.9 million tons. Based upon in-place equipment, permitted capacity, and production data, total current production capability is estimated to be 32.2 million tons per year. This estimate and 1990 production data suggest that the region's coal production capacity utilization rate is 71 percent.

Map I
Coal Reserves and Qualities of the San Juan Basin

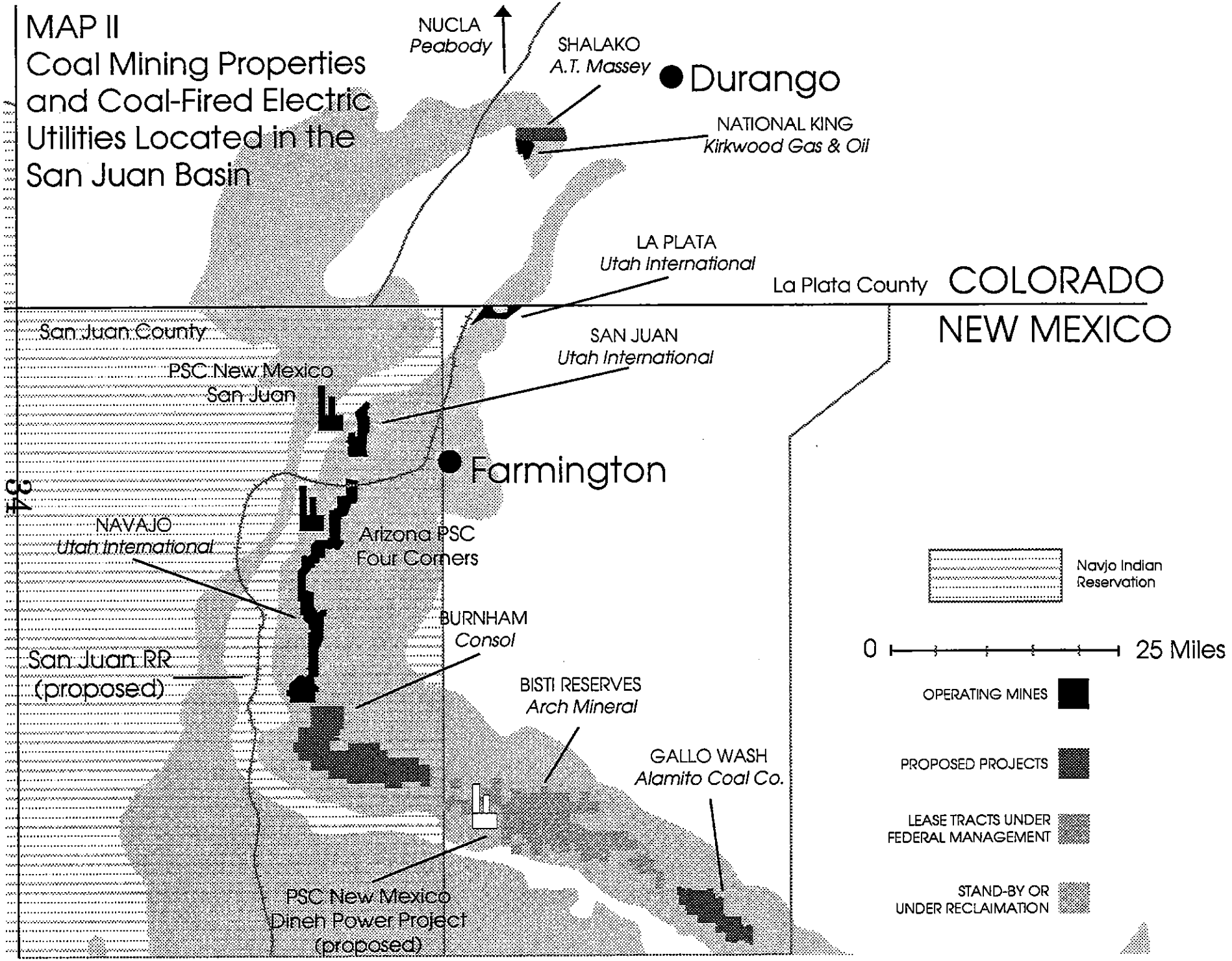


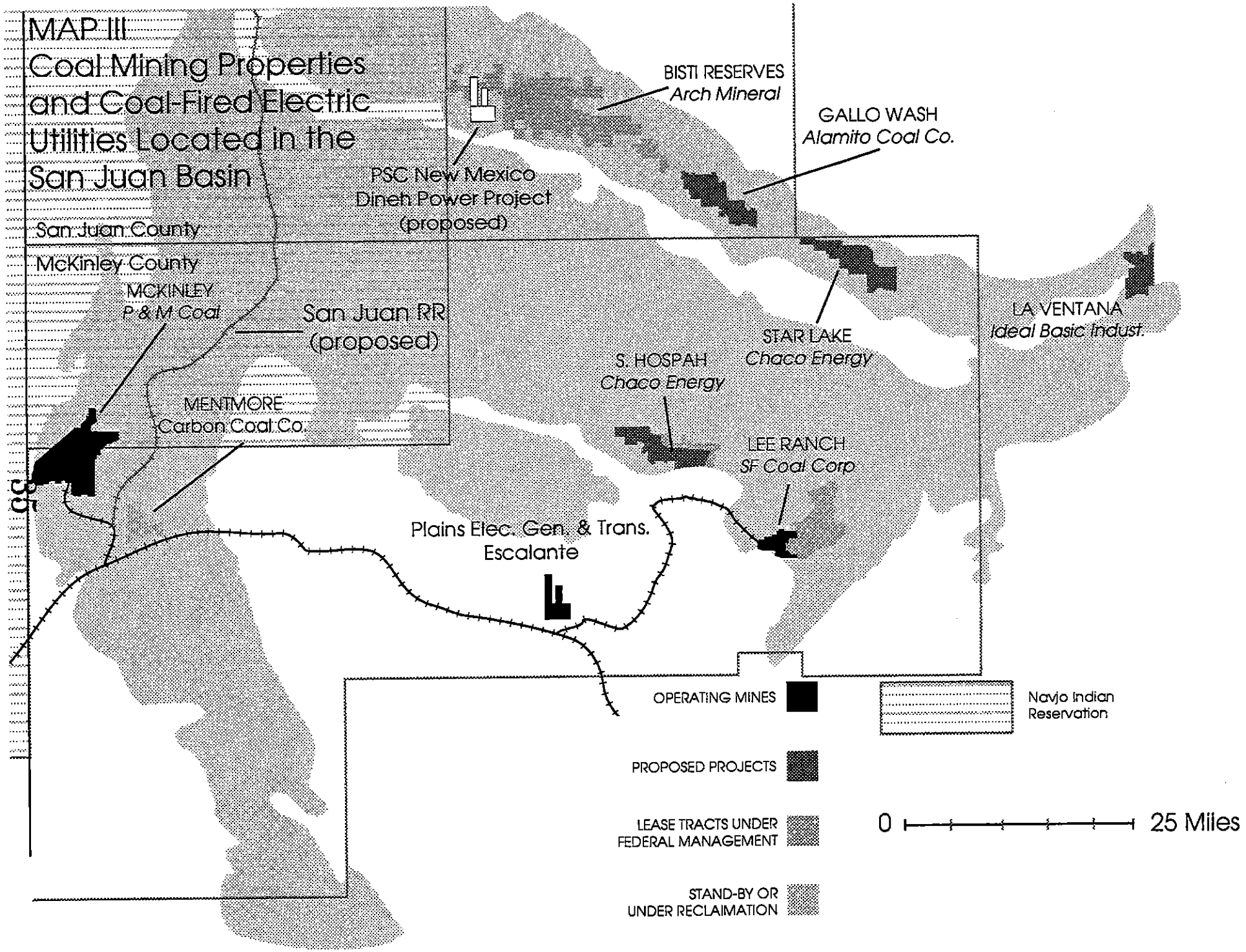
Reserves

In the San Juan Basin, coals occur in the Fruitland Formation, the Mesa Verde Group, and the Dakota Sandstone. Configuration of the region, with gently dipping strata, makes the coal beds suitable for strip mining in the central and southern parts of the region. Underground mining has occurred in the past, but those mines are currently inactive. In the north/central portion of the basin, where seams are thinner and overburden thicker, underground mining is the most often used extraction technique. The New Mexico/Colorado portion of San Juan is credited with about 215 billion tons of reserves, the majority (200 billion) are in the Fruitland Formation, with the remainder in the Menefee Formation.

About 80 percent of the land in the San Juan Basin is under federal management by the U.S. Bureau of Land Management (BLM), either as public or as Indian lands. While mineral rights on Indian lands are subject to control by the U.S. Bureau of Indian Affairs, they are generally administered by the BLM. About ten percent of the land in the basin is state owned (with the states retaining all mineral rights), and the remainder is privately owned (including county land, Spanish land grants, and individually owned parcels). The federal government has retained mineral rights for governmental properties sold since 1916.

In the New Mexico portion of the San Juan Basin, there are currently 26 active federal coal leases on over 65,000 acres. As well, prospecting permits (those awarded before 1970) still exist on over 160,000 additional acres. *Maps II and III* illustrate the mining properties and utility plants located in the San Juan Basin.


MAP II
Coal Mining Properties and Coal-Fired Electric Utilities Located in the San Juan Basin
NUCLA
Peabody
SHALAKO
A.T. Massey
Durango
NATIONAL KING
Kirkwood Gas & Oil
LA PLATA
Utah International
La Plata County
COLORADO
NEW MEXICO
San Juan County
PSC New Mexico
San Juan
SAN JUAN
Utah International
Farmington
NAVAJO
Utah International
Arizona PSC
Four Corners
BURNHAM
Consol
San Juan RR
(proposed)
BISTI RESERVES
Arch Mineral
GALLO WASH
Alamito Coal Co.
PSC New Mexico
Dineh Power Project
(proposed)
Navjo Indian Reservation
0
25 Miles
OPERATING MINES
PROPOSED PROJECTS
LEASE TRACTS UNDER FEDERAL MANAGEMENT
STAND-BY OR UNDER RECLAIMATION


MAP III
Coal Mining Properties
and Coal-Fired Electric
Utilities Located in the
San Juan Basin
BISTI RESERVES
Arch Mineral
GALLO WASH
Alamito Coal Co.
PSC New Mexico
Dineh Power Project
(proposed)
San Juan County
McKinley County
MCKINLEY
P & M Coal
San Juan RR
(proposed)
LA VENTANA
Ideal Basic Indust.
STAR LAKE
Chaco Energy
S. HOSPAH
Chaco Energy
MENTMORE
Carbon Coal Co.
LEE RANCH
SF Coal Corp
Plains Elec. Gen. & Trans.
Escalante
OPERATING MINES
Navjo Indian
Reservation
PROPOSED PROJECTS
LEASE TRACTS UNDER
FEDERAL MANAGEMENT
STAND-BY OR
UNDER RECLAIMATION
0
25 Miles

Four Indian tribes control mineral rights in the San Juan Basin: the Apache, the Mountain Ute, the Navajo, and the Southern Ute. Coal mining rights on Indian lands are granted by competitive bid. Leases normally carry a royalty on the tonnages produced, plus annual rental and development fees and a specified reclamation expenditure. Employment of Indian labor is also stipulated as a condition of the leases.

State managed coal properties are permitted via a competitive sealed bidding procedure. Santa Fe Coal Company is the largest single owner of privately held coal property in the basin.

Current Production

The La Plata and San Juan mines are both International Union of Operating Engineers-affiliated union surface mines owned by BHP-Utah International, Inc., and operated by subsidiary company, San Juan Coal Company. The company's lease of more than 31,000 acres on the Navajo Indiana reservation is estimated by the New Mexico Bureau of Mines and Minerals to contain almost one billion tons of strippable coal. Both mines are located in San Juan County, New Mexico.

The La Plata mine is a truck and shovel operation that produced 1.5 million tons in 1990, with a current capacity of 1.75 million tons per year. La Plata produced at a rate of 54.49 tons/miner/shift. San Juan is a much larger dragline operation, producing just under 4.3 million tons in 1990 and has a current capacity of 7.5 million tons per year. The San Juan produced at a rate of 55.51 tons/miner/shift. The mines were developed to serve a nearby power plant. Since existing capacity is capable of serving the plant, production capacity is not expected to increase at either operation. San Juan and La Plata each contain roughly 81 million tons of coal reserves.

Both mines sell all of their output to PSC of New Mexico under a long-term contract set to expire in 2017 at an average FOB mine price of $32.14 per ton. La Plata's cash mining cost for 1990 was $20.72 per ton, resulting in a net cash margin of

$11.42 per ton. With cash costs of $18.36 per ton, the San Juan mine had an average cash margin of $13.78 per ton--the highest in the basin.

BHP-Utah International, Inc. also owns and operates the Navajo mine in San Juan County, New Mexico, a property estimated by the New Mexico Bureau of Mines and Minerals to have over 50 million tons of strippable coal reserves on a 7,700 acre tract of federal and state leases. Expansion into the South Navajo tract will substantially add to reserves. In terms of production, it is the largest dragline operation in the San Juan area and has a current capacity level of 11.25 million tons per year--which is expected to remain constant at least into the early 2000s. In 1990 the Navajo mine produced almost 8.7 million tons of coal at a rate of 77.57 tons/miner/shift, making it the second most productive mine in the region.

All of the Navajo coal is trucked to Arizona Public Service under a long-term contract set to expire in 2005 at an average FOB mine price of $17.57 per ton. The average cash for the Navajo mine was just over $14 per ton in 1990, giving the mine an estimated cash margin of $3.49, the lowest of the three company mines in this region.

National King Coal owns and operates one nonunion underground mine in La Plata County, Colorado. This is the only deep mine producing in the San Juan region. A continuous miner section produces coal from the Menefee seam that is suitable for industrial applications. National King is the smallest producer in San Juan Basin mining 166,000 tons in 1990, with a capacity of 200,000 tons per year. About one third of 1990's production was trucked approximately 130 miles to a rail loading facility at Thoreau, New Mexico. Cash costs at this operation are the highest in the region--$24.74 per ton. Estimated FOB mine price for the industrial sales last year was $27.50 per ton, providing the company with a cash margin of $2.76 per ton.

Peabody's Nucla mine is a truck and shovel operation located in Montrose County, Colorado. Nucla did not produce in 1990, and company officials report that it is unlikely that the mine will reopen due to unfavorable market conditions.

Pittsburg & Midway operates one UMWA-affiliated mine in the San Juan Basin. The McKinley mine, located in the extreme southwestern corner of the basin, includes 8,155 acres of public land with a strippable reserve of over 200 million tons of coal. It is a dragline operation served by the Santa Fe and has a current capacity of seven million tons per year.

The majority of McKinley's 5.5 million tons of production is shipped to the utility sector under long-term contract. Arizona Public Service is McKinley's largest customer, receiving over three million tons annually. The Salt River Project receives approximately two million tons per year. The remaining tonnage is shipped into the industrial sector. Stone Container's Snowflake, Arizona, paper mill is one of the P&M's industrial customers. The average FOB mine price for 1990 was $30.78 per ton. McKinley's cash costs were $18.01 per ton, giving this operation an average cash margin of $12.53 per ton.

Santa Fe Coal Corporation[2] owns and operates the Lee Ranch operation in McKinley County, New Mexico, with a reserve base estimated by the New Mexico Bureau of Mines and Minerals also over 450 million tons. Lee Ranch is a truck and shovel operation served by the Santa Fe Railway via a spur from the mine.

Lee Ranch produced 2.7 million tons in 1990. Although Lee Ranch is one of the smaller operations in the basin, it was able to achieve the highest productivity level of the entire basin. In 1990 it mined 78.45 tons/miner/shift and has a current capacity of 4.1 million tons per year. Lee Ranch has recently acquired additional reserves in a federal lease tract which will be accessed as the market conditions warrant. In the Base Case forecast, Lee Ranch is projected to increase capacity to eight million tons per year by 2005.

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[2] The Santa Fe Coal Corporation is no longer affiliated with the Santa Fe Railway.

All of Lee Ranch's coal is shipped into the utility market. Santa Fe Coal has just completed the renegotiation of a contract with its largest customer, Century Power Corporation. The contract was extended from an expiration date of 1995 to 2009. In early 1991 Santa Fe signed a one-year contract with Salt River Project--replacing the contract that expired in September 1990. The average FOB mine price for all sales in 1990 was $25.88 per ton. Lee Ranch had estimated cash costs of $16.57 per ton.

Future Production Plans

The Base Case production forecast for the San Juan region assumes that markets will remain concentrated in the local utility sector, with a few nearby industrial markets serviced by rail. Total production capacity is projected to increase from 32.2 million tons in 1990, to about 32.5, 33.5, and 37 million tons in 1995, 2000, and 2005, respectively. The increased production capacity will be at mines capable of serving utility and industrial markets via the existing rail and highway system.

Three companies have announced plans for future development in the San Juan Basin. These projects are discussed below. *Table 3* presents a summary of the current reserve tracts and announced reserve development plans.

Table 3

Reserve Development in the San Juan Basin

State	Company	Reserve	Status
NM	Salt River Project	Fence Lake	Small Scale Mining
NM	PSC New Mexico	Sunbelt Reserve	pit development
CO	Lillylands Company	Montrose County	investigating permit process
NM	Alamito Coal Co.	Gallo Wash	Development contingent upon strengthening of market conditions
NM	Chaco Energy	Star Lake	
NM	Chaco Energy	South Hospah	
NM	Consolidated Coal	Burnham	
NM	Ideal Basic Industries	La Ventana	
NM	Carbon Coal Co.	Mentmore	
CO	A.T. Massey	Shalako	

Small scale surface mining is planned for Salt River Project's (SRP) Fence Lake property with expected production by the mid 1990s. The property is 40 miles east of the Coronado Generating Station. Reserves are approximately 117 million tons. The company has state and private leases for 11,000 acres in the Fence Lake area. In September 1988, SRP filed an application for a federal lease in the area adjacent to the state leases. This would add another 6,840 acres. Early production capacity is projected to be 250,000 tons per year. By the late 1990s, capacity may be up to 500,000 tons per year. At least 100,000 tons have been test burned successfully at the Coronado Generating Station.

Public Service Company of New Mexico's Sunbelt Reserve has pits already developed. Beginning as a small scale surface mine, capacity is projected to be added in the mid to late 1990s based on market condition strengthening.

The Montrose, Colorado, office of the BLM reports the Lillylands Company is investigating the permitting process for opening a small strip mine to be located near the Nucla mine in Montrose County, Colorado. In addition to new or reopened operations at Fence Lake, De Na Zin/Gateway, and Nucla, Lee Ranch is projected to nearly double capacity from 4.1 to 8 million tons per year in the Base Case forecast.

Much more rapid capacity expansion would be necessary to provide coal if the optimistic case demand volume is achieved. Because such a development is contingent upon opening more relatively low cost, competitive reserves, it is likely that existing rail accessible mines located along the proposed San Juan Railroad will expand capacity first. In addition, mines capable of producing higher Btu coal located in southwestern Colorado would have to significantly increase production.

In the Optimistic Case, capacity is projected to expand to 37.4, 42.3 and 47 million tons by 1995, 2000, and 2005, respectively. While it is impossible to project specific operations which will either expand or enter the production base, the most likely candidates are Massey's Shalako reserve, a reopened Nucla mine, Consol's

Burnham reserves, a reopened Fence Lake mine, and Arch's Bisti reserves. In addition, significant expansions are assumed for National King mine and Lee Ranch mine.

Production Capacity

Table 4 shows the estimate of in-place capacity of a mine-by-mine basis for each of the existing operations in the San Juan Basin. In 1990, the region's total estimated capacity was over 32 million tons per year, resulting in excess in-place capacity of over 9 million tons per year.

It should be noted that nearly 2.9 million tons of excess capacity is available at mines which can ship on the Santa Fe. In order to tap other uncommitted capacity for the general market outside of the San Juan region, it would be necessary to provide rail access to reserves further north. The capacity data suggest that an additional 6.5 million tons of production would be available on short notice from existing or idle mines, if the coal had access to additional markets.

Table 4

Production Capacity in the San Juan Region

				1990			
Company	Mine	Method	Union	Production Tons (000)	Productivity T/M/S	In-Place Capalty	Excess Capacity Tons (000)
-- Colorado							
Peabody Coal Co.	Nucla	TS	UMWA	0*	N/A	240	240
National King Coal Inc.	National King	Cv	None	166	18.04	200	34
Colorado Subtotal				166	18.04	440	274
-- New Mexico							
Pittsburg & Midway Coal Co.	McKinley	DL/TS	UMWA	5,573	56.87	7,000	1,427
S.F. Coal Corp.	Lee Ranch	TS	None	2,705	78.45	4,125	1,420
Utah Minerals Intl (Bhp)	Navajo	DL/TS	IUOE	8,665	77.57	11,250	2,585
Utah Minerals Intl (Bhp)	San Juan	DL/TS	IUOE	4,252	55.51	7,500	3,248
Utah Minerals Intl (Bhp)	La Plata	TS	IUOE	1,500	54.49	1,750	250
New Mexico Subtotal				22,695	65.16	31,625	8,930
San Juan Total				22,861	57.72	32,065	9,204

Cv = Underground - Conventional, TS = Truck Shovel, DL/TS = Dragline & Truck Shovel
*1989 production at the Nucla mine was 46,200 tons. There was no production in 1990.

Current Mining Costs

Table 5 provides the estimated 1990 cash production costs for each mine in the San Juan region. Costs range from just over $14 per ton to $24.74 per ton, but the estimated weighted average cash production cost region wide is $16.64 per ton. Based upon a 1990 average mine mouth realization of $23.86, the estimated cash margin regionwide in 1990 was $7.22 per ton.

Table 5

Estimated Cash Costs for the San Juan Region

				1990			
Company	Mine	Method	Union	Production Tons (000)	Productivity T/M/S	Cash Cost $/ton	Open Market Cash Cost $/ton
-- Colorado							
Peabody Coal Co.	Nucla	TS	UMWA	0*	N/A	N/A	N/A
National King Coal Inc.	National King	Cv	None	166	18.04	24.74	24.40
Colorado Subtotal				166	18.04	24.74	24.40
-- New Mexico							
Pittsburg & Midway Coal Co.	McKinley	DL/TS	UMWA	5,573	56.87	18.01	16.96
S.F. Coal Corp.	Lee Ranch	TS	None	2,705	78.45	16.57	16.28
Utah Minerals Intl (Bhp)	Navajo	DL/TS	IUOE	8,665	77.57	14.08	14.08
Utah Minerals Intl (Bhp)	San Juan	DL/TS	IUOE	4,252	55.51	18.36	17.17
Utah Minerals Intl (Bhp)	La Plata	TS	IUOE	1,500	54.49	20.72	19.46
New Mexico Subtotal				22,695	65.16	16.58	15.98
San Juan Total				22,861	57.72	16.64	16.04

Cv = Underground - Conventional, TS = Truck Shovel, DL/TS = Dragline & Truck Shovel
*1989 production at the Nucla mine was 46,200 tons. There was no production in 1990.

Because of the bulk of San Juan Basin coal moves under contract to nearby utility and industrial consumers, there is little "spot" or open market activity to gauge the relative competitiveness of the area's mines. A small amount of spot coal moved from FOB mine prices ranging between $20 and $21 per ton. When compared to the regionwide average cash production cost of $16.64 per ton, this implies that only a few mines could compete in wider open markets particularly if they had to cut prices further to get business. However, two factors that could affect the region's future competitiveness

should be noted. First, two mines (McKinley and Lee Ranch) which currently have access to wider markets are operating significantly below capacity. As production increases, economies scale and other efficiencies will likely reduce their cash production costs. Second, the lowest cost mine (Navajo) would be able to compete quite effectively at $18 to $20 per ton if it had access to a wider market via rail.

Taxes and Royalties

Severance taxes make up the largest tax burden on producers in the San Juan Basin. The highest rates are assessed in New Mexico--where the mines are assessed at $1.17 per ton for surface mines and $1.13 per ton for underground mines. Arizona accesses an effective rate of 3.25 percent of the coal value at the mine. When an "effective" percentage rate is used, this reflects credit for state taxes and royalty payments. In Colorado deep mines are assessed at 26 cents per ton after the first 100,000 tons and surface mines are assessed at 52 cents per ton after the first 100,000 tons.

Property taxes vary to a degree between counties because they are based upon the assessed value of mining property or sales revenue. In New Mexico, assessment values are set high, but millage rates tend to be moderate. In Colorado millage rates tend to be high, but assessed value which is based upon coal value, tends to be much lower than the other states in the region. Because assessment values tend to vary with market conditions (and prices) property taxes are estimated by applying a multiplier to the FOB mine price. This approach allows for variation in the value of mine property over time, yet remains accurate when updated regularly. Based upon the most recent survey, the effective rates assessed against the value of coal at the mine are 1.15 percent (deep and surface) for Colorado and in New Mexico, three percent for surface and two percent deep mines.

Federal taxes for reclamation and Black Lung are the same for all states-reclamation taxes for surface mines are ten percent of the value at the mine up to a

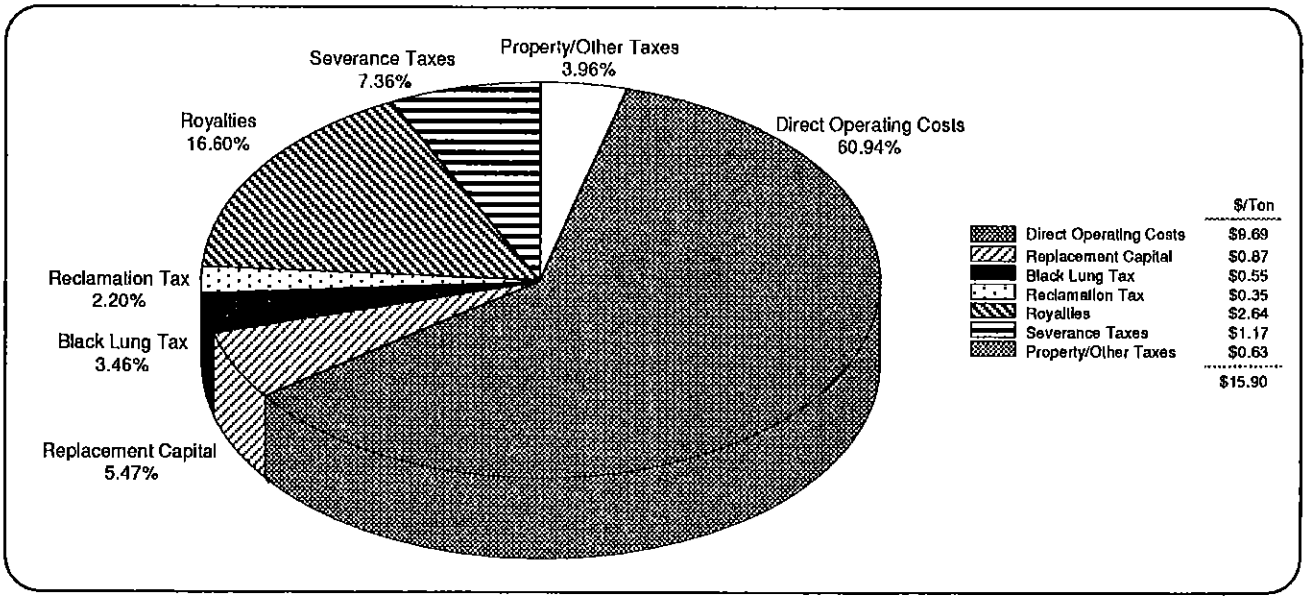
maximum of 35 cents per ton. Deep mines are assessed at ten percent of the value at the mine up to a maximum of 15 cents per ton. Black Lung taxes are 4.4 percent of the value at the mine for deep an surface mines--up to a maximum of 55 cents per ton at surface mines and $1.10 per ton for deep mines.

Over 70 percent of the coal mined in New Mexico is on land leased from the Navajo and Southern Ute Indian tribes, the state, or from private land owners. While these parties have the flexibility to assess their own royalty rates, the current practice is for the lease holders to charge the federally mandated maximum royalty rates of 12.5 percent (surface) and 8 percent (deep) of FOB price.

At an "open market" mine price of $21.09 per ton for example, the average cash cost for New Mexico surface producers in the San Juan Basin would be $15.90 per ton. The components of this average cash cost are shown in *Chart 12.*

Chart 12

Average 1990 Cash Cost for New Mexico Surface Mines



Direct operating costs and replacement capital are based on factors including: mining conditions, mining method, fuel cost, productivity, mine size, and union affiliation. These costs are directly related to the efficiency of the particular mining operation and will not be affected by procedural changes at the state or local level of government. The reclamation and Black Lung taxes are fixed by the federal government, and represent less than six percent of the average cash cost for regional producers. The final three components of cash cost--royalties, severance, and property taxes represent 28 percent of the total cost.

If concessions were made by leaseholders on the lease rates, state legislators on the severance taxes and by the counties on the property taxes, the average cash costs could be lowered--helping to make coals from this region more competitive. For example, if average royalty rates were lowered by 30 percent (to 8.75 percent), the royalty payments would be dropped by 79 cents per ton. A rate decrease of 50 percent (to 6.25 percent) would lower the royalty payment by $1.32 per ton.

Both Montana and Wyoming have made concessions on state severance taxes in recent years. Montana lowered its severance rate by 50 percent in an effort to boost the competitiveness of its coal. Wyoming lowered the tax by 50 percent for its higher cost operations. In New Mexico, a concession of 50 percent would lower the severance taxes by 58 cents per ton. If counties in New Mexico were to adopt property taxes on mining operations similar to rates assessed against Colorado mines (an average of 1.15 percent), property taxes could be lowered by 39 cents per ton.

Taking the maximum rate decreases discussed above, cash costs for New Mexico producers could be lowered by a total of $2.29 per ton. This would result in an average cash cost as low as $13.61 per ton.

Implications of the Wilderness Act

The National Wilderness Preservation System was established in 1964 by the Wilderness Act (the Act) and set forth a policy of administering, protecting, and preserving certain federally-owned public lands by maintaining their natural conditions "without permanent improvements or human habitation."

The Act stipulates that there shall be "no commercial enterprise and no permanent road within any wilderness area designated by this act." However, the Act also states that prior to December 31, 1983, "U.S. mining laws and all laws pertaining to mineral leases" were considered valid, and mining locations within the boundaries of the wilderness areas could be held and used for the purposes of mining and processing operations. After 1983, however, mining claims in wilderness areas have been subject to the same stringent guidelines as other commercial activities. Any adjustment to the uses or boundaries of wilderness areas are possible only after public hearings by state officials and federal agencies, recommendation of both the Secretaries of Agricultural and Interior, advocacy by the President of the U.S., and then subsequent approval by both houses of Congress.

Map IV illustrates the extent wilderness areas currently exist in the San Juan Basin. Particularly in the lower cost mining area of the central San Juan Basin, the location of these wilderness lands adjacent to coal properties makes the development of mining reserves considerably more difficult. Furthermore, environmental concerns over the impaired visibility caused by regional coal-fired power plants (e.g., Arizona Public Service's Apache plant, Public Service of New Mexico's San Juan plant, and the Salt River Project's Navajo plant) will increase generation costs as these plant are forced to install scrubbers to enhance visual air quality. Also the need for ash disposal at these plants have driven up costs and reduced the amount of area available for ash disposal at these sites.

Map IV
Location of National Wilderness, Wilderness Study and other Tracts in Primary San Juan Basin Coal Market Area

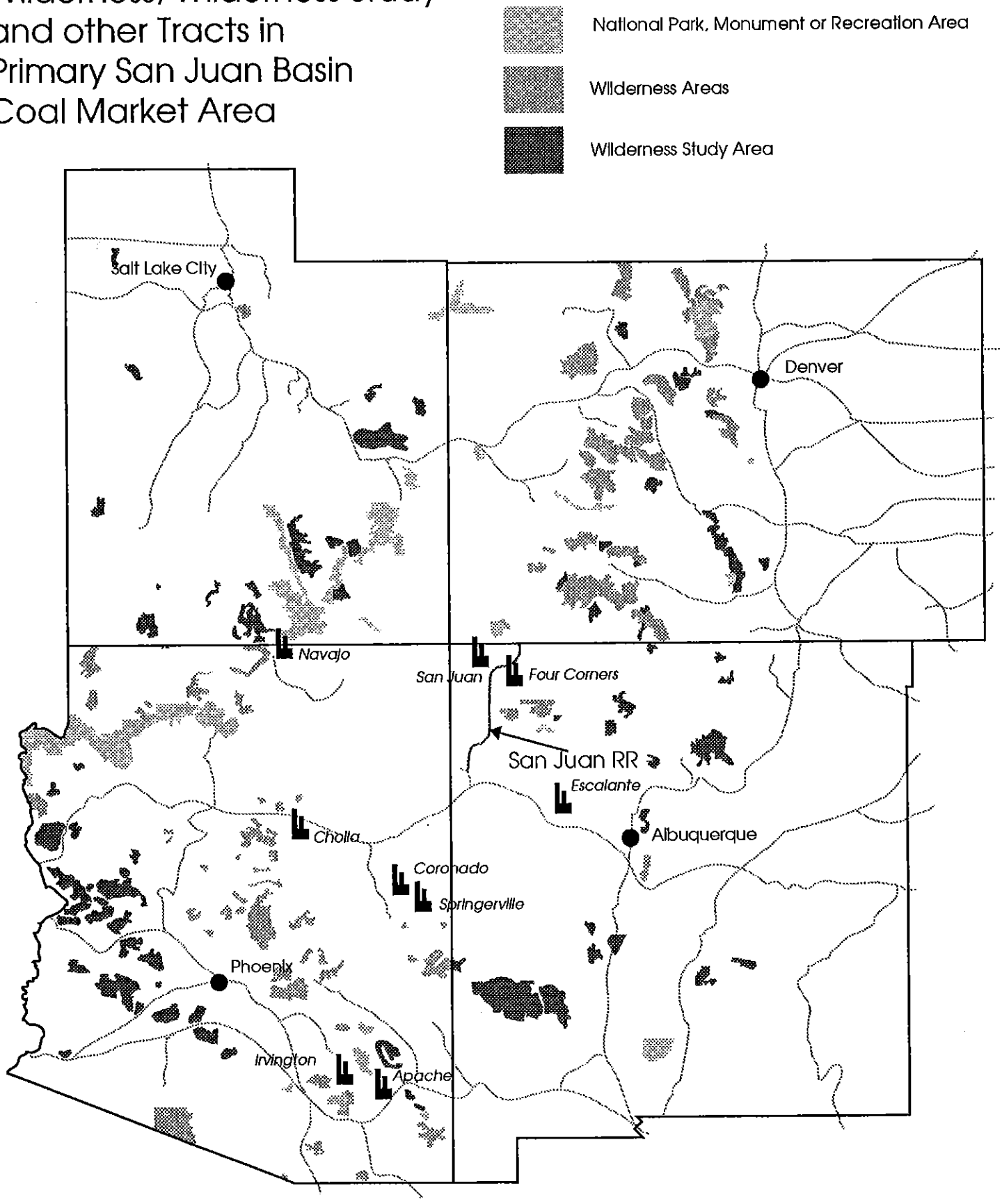
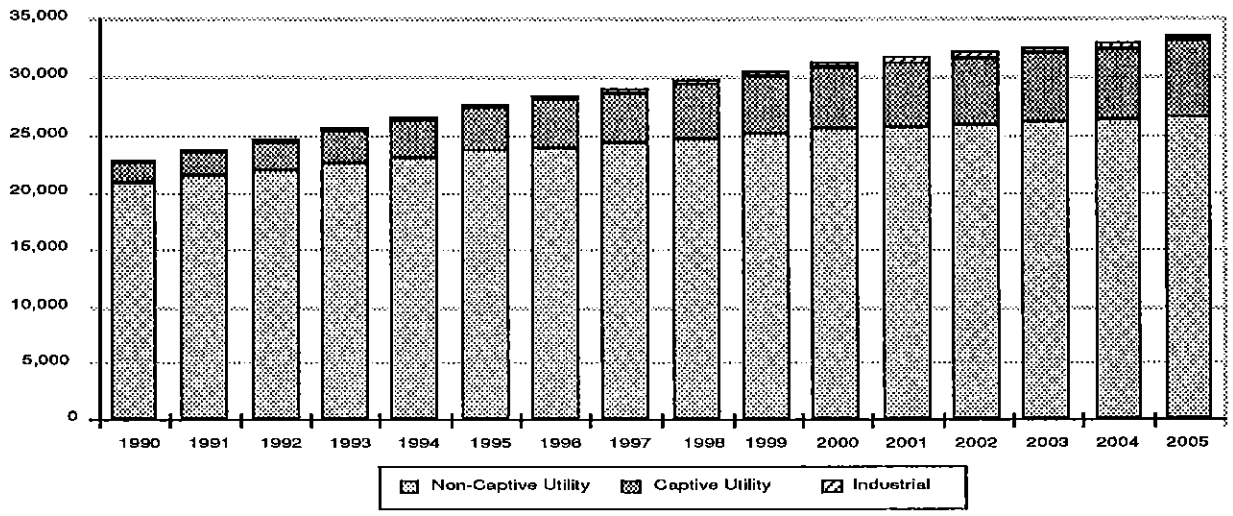


Chart 13

Base Case Projections for San Juan Basin Coal Demand (1991-2005)



Year	Captive Utility	Non-Captive Utility	Industrial	Total	Baseline 9,500 Btu/lb $/T
1990	1,688	20,980	275	22,943	21.09
1991	1,985	21,485	275	23,745	21.08
1992	2,406	22,003	285	24,694	21.10
1993	2,798	22,536	310	25,644	21.49
1994	3,196	23,084	340	26,620	21.31
1995	3,670	23,646	370	27,686	21.48
1996	4,116	24,007	400	28,523	21.60
1997	4,280	24,374	425	29,079	21.81
1998	4,599	24,749	450	29,798	22.03
1999	4,928	25,132	475	30,535	22.34
2000	5,296	25,522	500	31,318	22.45
2001	5,484	25,721	500	31,705	23.16
2002	5,676	25,922	500	32,098	23.02
2003	5,824	26,125	500	32,449	22.82
2004	6,097	26,330	500	32,927	22.29
2006	6,474	26,537	500	33,511	22.18

As suggested by the Base Case forecast chart, industrial markets will remain a minor factor. This is related to lack of competitiveness in California and Texas markets and to the region's low coal quality. Only two major producing mines in northwestern New Mexico have direct access to rail served markets in the southwest or to the Los Angeles/Long Beach coal piers. In the long run, strong demand growth may hinge on entry into domestic industrial, nonutility generation and export markets. These markets are extremely critical if the San Juan Basin is to experience market growth sufficient to justify an investment in a new railroad.

The consequences of these environmental and economic restrictions on developing San Juan coal reserves is that the higher costs of generating power with coal determine the extent to which coal demand will grow. It is quite likely that coal may become a less cost competitive fuel vis-a-vis nuclear and gas-generated power, thus reducing San Juan originating coal's favorable position in its important regional utility markets.

Coal Demand Forecast

Introduction

Currently, and in the next five years, the most important market sector for San Juan Basin coal producers will be the utility sector. Coal producers in the region have carved out a market territory in Arizona and New Mexico that they dominate with a substantial transportation advantage. While maintaining their position in this nearby market, San Juan producers have failed to penetrate large utility markets in Colorado and Texas due primarily to high delivered coal costs and supply constraints. The following "Base Case" demand forecast indicates that future market growth in the utility sector is dependent upon coal-fired power plant utilization rates in the region's traditional markets. A high growth scenario depends upon power plant additions in traditional and nearby markets and the development of a more competitive position in nearby industrial and Pacific Rim export markets.

Projected Utility Demand

A substantial portion of the San Juan area's utility volume is captive to specific mines, and mine capacity will be developed to supply the coal as load growth conditions warrant. In 1990 about 64 percent of the utility coal volume fell into this category. The remaining volume was shipped by rail and truck to a handful of power plants in Arizona and New Mexico. As *Chart 13* illustrates, in the Base Case scenario, total volume is projected to increase about 3.3 percent to 3.6 percent per year between 1990 and 1995. Growth in the noncaptive market can be achieved by existing rail-origin and captive mines with the addition of a few small mines to meet demand at truck served power plants.

The recent advent of more stringent air quality regulations is often used to support projections of utility demand for western coal. However, the San Juan Basin will receive little market stimulation from this factor. Because of their poor competitive stance relative to the bulk of the U.S. utility coal market, San Juan producers will experience little "acid rain" stimulated growth in the last two-thirds of the forecast period.

Demand for coal originating in the western U.S. was stimulated by passage of the Clear Air Act in 1970. The legislation mandated a substantial reduction of sulfur dioxide emissions at existing power plants in nonattainment areas and set limitations on the emissions from new power plants. Many western coal producers were able to capture new markets in the Great Plains and Midwest where consumers needed high quality low sulfur and compliance coal to remain within their sulfur emission requirements.

It should be noted that San Juan Basin producers also experienced little, if any, increased business from the 1970s and 1980s environmental initiatives. While coal producers in the Powder River Basin and Green River/Hams Fork regions experienced strong market expansion in the midsection of the U.S., San Juan Basin utility coal markets remained confined to the states of Arizona and New Mexico.

In the fall of 1990, new legislation was enacted that amended the Clean Air Act and mandated further sulfur dioxide reductions at many existing and planned power plants. In addition, this legislation "capped" total SO_2 emissions permissible by power plants. The caps, which will be implemented in 1995 and 2000, provide for reductions of sulfur dioxide emissions of about 4.5 and 10 million tons, respectively, from early 1980s sulfur emission levels. The aggregate result is to create a substantial new market for lower sulfur coal in 1995, and an even larger market for compliance (1.2 pounds SO_2 per mmBtu) and super compliance (1.0 pounds SO_2 per mmBtu or less) coal after 2000.

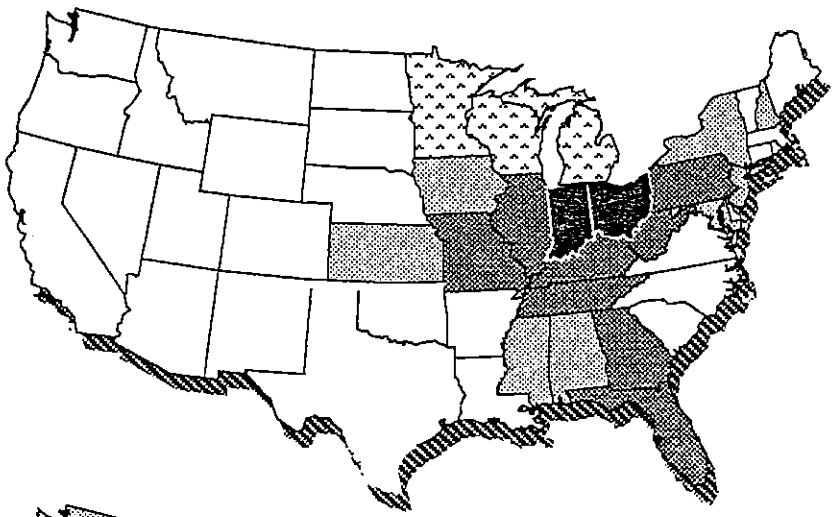
An "acid rain" compliance component is incorporated in the modeling of utility coal consumption in this study. The analysis suggests that about 5.9 gigawatts (gW) of existing coal-fired utility capacity will be retrofitted with scrubbers to meet Phase I "acid rain" caps, and an additional 38.5 gW of capacity will be retrofitted with scrubbers to meet Phase II caps.

Despite a significant move to retrofitted scrubbers at some coal-fired units, coal switching will be by far the most dominant "acid rain" compliance option adopted. In Phase I, about 135 million tons of coal will be switched. In Phase II, another 275 million tons of coal will be switched. While a great deal of this switching will take place within individual coal producing regions, particularly in Phase I, the net result will be to create substantial market opportunities for western low sulfur coal producers. Because many Rocky Mountain region producers have the capability to supply high quality specialty coals at boilers which cannot be derated, a significant portion of this volume will be open to producers of this region.

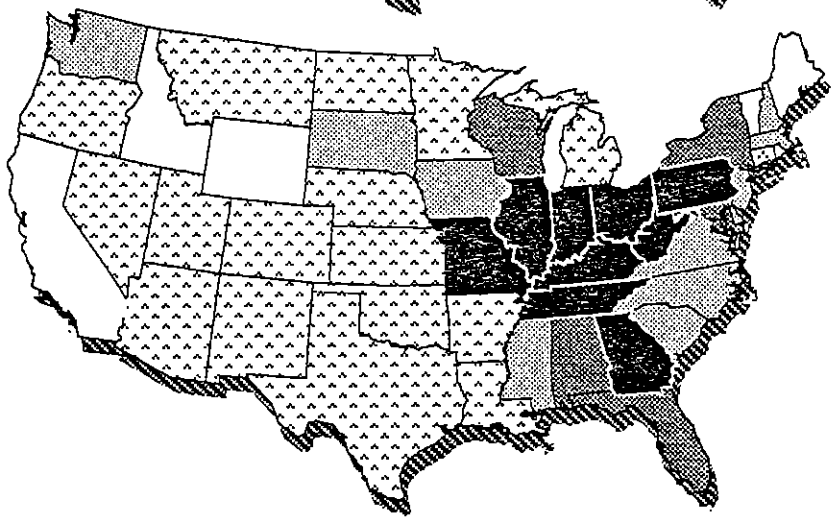
As the map on the next page illustrates, the most heavily affected "acid rain" areas tend to lay adjacent to or east of the Mississippi River.

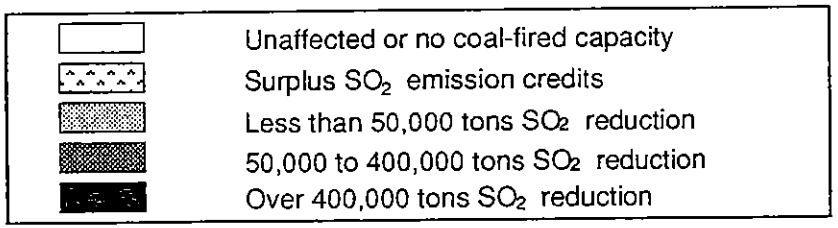
State SO_2 Emission Reduction Targets for Coal-Fired Capacity
Using 1990 SO_2 Emission Estimates

1995: Phase 1



2000: Phase 2





Reduction Targets (Excess Credits)

STATE	PHASE 1	PHASE 2
Alaska	NA	NA
Alabama	11,236	232,237
Arkansas	NA	(28,728)
Arizona	NA	(39,578)
Colorado	NA	(12,461)
Connecticut	NA	(1,901)
Delaware	NA	2,342
Florida	86,733	166,027
Georgia	83,168	439,928
Iowa	19,943	30,069
Illinois	323,757	494,811
Indianaq	496,305	893,622
Kansas	195	(29,386)
Kentucky	281,482	408,713
Louisiana	NA	(25,373)
Massachusettes	NA	26,056
Maryland	39,524	145,997
Michigan	(11,857)	(25,295)
Minnesota	(2,231)	(54,920)
Missouri	277,902	484,585
Mississippi	34,868	42,703
Montana	NA	(6,527)
North Carolina	NA	18,633
North Dakota	NA	(33,868)
Nebraska	NA	(22,393)
New Hampshire	8,637	24,120
New Jersey	9,670	15,729
New Mexico	NA	(28,862)
Nevada	NA	(18,546)
New York	28,708	168,261
Ohio	882,818	1,582,354
Oklahoma	NA	(10,272)
Oregon	NA	(2,926)
Pennsylvania	176,659	726,595
South Carolina	NA	49,197
South Dakota	NA	14,247
Tennessee	214,949	525,751
Texas	NA	(131,927)
Utah	NA	(24,777)
Virginia	NA	41,718
Washington	NA	18,547
Wisconsin	(17,139)	89,035
West Virginia	263,264	538,988
Wyoming	NA	(73,316)

NA= Not Affected

Table 6

"Acid Rain" Sulfur Dioxide Reduction Burdens by Region and State

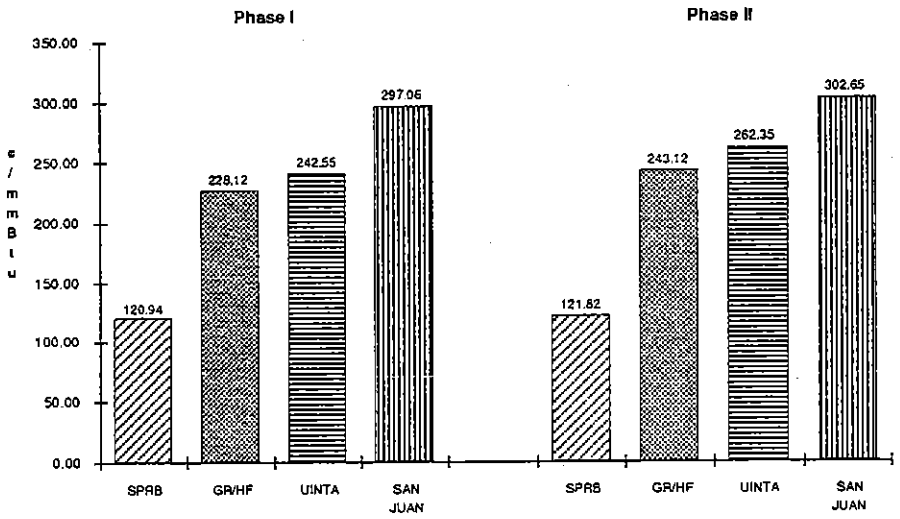
Reliability Region	States	Percent of Reduction Burden	
		Phase 1	Phase 2
East Central Area Reliability Council **(ECAR)**	IN,KY,MD MI,OH,PA, VA,WV	57	43
Mid-America Interpool Network **(MAIN)**	IL,MI,MO, WI	11	11
Southeastern Electric Reliability Council **(SERC)**	AL,FL,GA, MS,NC,SC, TN,VA	19	29
Mid-Atlantic Area Council **(MAAC)**	DE,MD,NJ, PA	7	11
TOTAL		**94**	**94**

The states comprising the heavily affected areas tend to be concentrated in four electric industry reliability regions which will bear about 94 percent of the total SO_2 reduction burden which the utility industry faces.

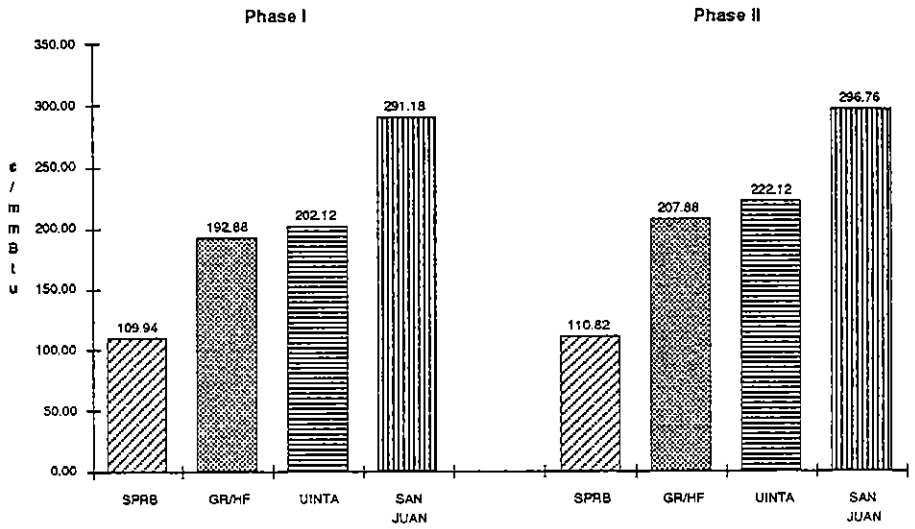
Western coal producers will likely be very price competitive for about 14.8 million annual tons of new business in 1995 resulting from sulfur emission reduction initiatives in the utility sector. Most of this business will be captured by more price competitive Powder River Basin (PRB) producers. However, about 3.8 million tons of volume will be captured by Western producers outside of the PRB. Prospects improve markedly in Phase 2, when non-PRB producers stand to gain anther 36.8 million tons of volume.

A series of charts on the next page illustrate the huge disadvantage that San Juan Basin coal producers must overcome to enter the prime "acid rain" markets. Coal prices are projected to range between $4.35 and $4.60 per ton in the PRB, between $16 and $20 per ton in the GRHF region, and between $16 and $21 per ton in the Uinta Basin.

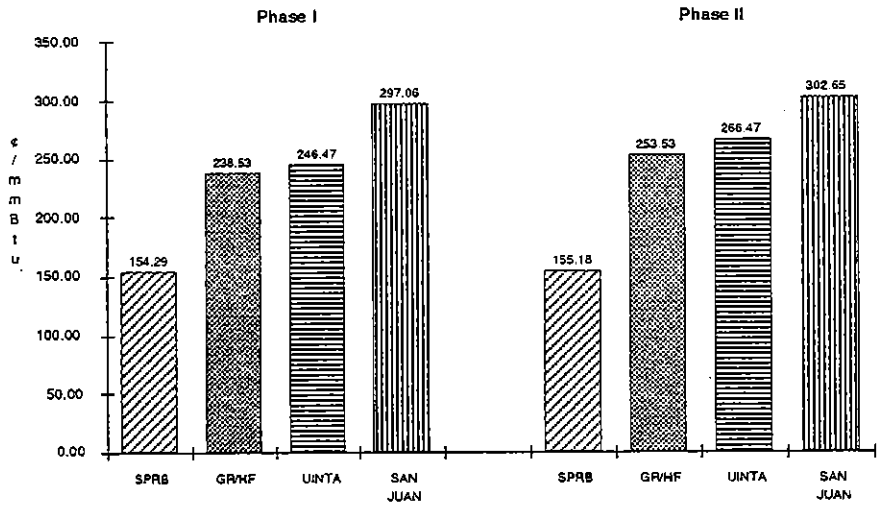
EAST CENTRAL AREA RELIABILITY COUNCIL (ECAR)



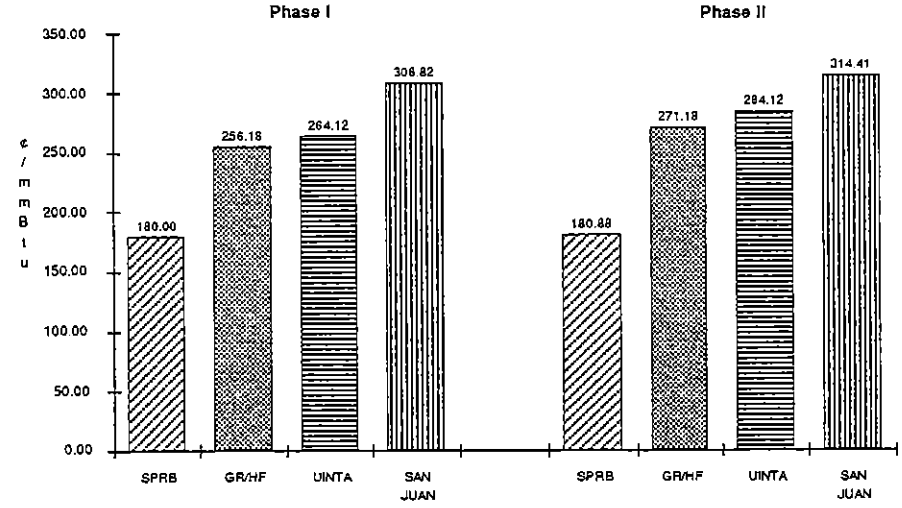
MID-AMERICA INTERCONNECTED NETWORK (MAIN)



SOUTHEASTERN ELECTRIC RELIABILITY COUNCIL (SERC)



MID-ATLANTIC AREA COUNCIL (MAAC)



The rail capacity currently exists to handle most of the incremental coal volume produced in the non-PRB western coal regions. Therefore, rail rates are expected to remain relatively flat in constant dollar terms. Based upon 1990 and 1991 transactions, estimated transportation costs are $14 to $26 per ton for PRB-origin coal, $16 to $27 per ton for GRHF-origin coal, and $17 to $29 for Uinta-origin coal. Although there are no San Juan Basin coal movements into these regions that can be used to gauge transportation costs, on the basis of current millage rates for similar distance movements, estimated costs would range between $28 and $31 per ton.

As the charts underscore, San Juan Basin producers and/or transportation providers would have to cut their delivered costs by $5 to $16 per ton to compete effectively against the two major "high quality" coal supply regions in the west. In order to compete effectively against PRB-origin coal, it would be necessary to reduce delivered costs by $25 to $35 per ton. Because of the vast differential between San Juan Basin delivered costs and the delivered cost of low sulfur coal originating in other western coal producing regions, little or no utility "acid rain" business will be captured by San Juan Basin producers. The production cost structure, the haul distances, and the capacity of the transportation infrastructure militate against the possibility of cost cuts of the magnitude necessary to capture any of this business. The hard reality is that market dynamics will, again, prevent San Juan Basin coal producers from entering lucrative eastern coal markets created by environmental initiatives.

Under Base Case assumptions, growth in the total market will gradually decline from about 2.2 percent per year in the 1995 to 2000 period, to the 1 percent to 1.5 percent range after 2000. Noncaptive utility growth will slow as well, but remain somewhat higher than total market growth. Total volume is projected to increase from 22.9 million tons in 1990 to 31.1 million tons in 2000 and 33.3 million tons by 2005. In the noncaptive sector, volume will increase from 11.4 million tons in 1990 to 13.1 million tons in 2000 and 14.4 million tons in 2005.

Three developments could significantly boost San Juan Basin utility coal demand. Baseload generation unit development has been discussed and/or planned by Arizona Public Service (APS), Plains Generation and Transmission (PG&T), and Public Service of New Mexico (PNM).

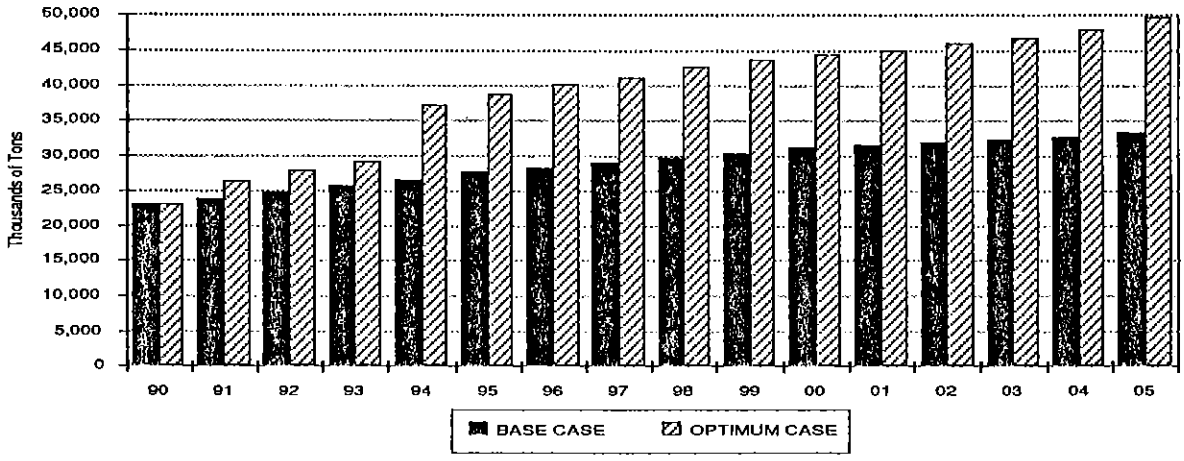
APS has reported its intention of constructing the Cholla 5 unit to its reliability council. Although the utility will not confirm a specific in-service date, the Base Case forecast assumes that this 375 mW unit will be placed into service in 2005. Stockpile building and plant testing result in modest coal shipments to the unit in 2003 and 2004. When fully operational, the unit will consume between 1.2 and 1.5 million annual tons of San Juan Basin coal. The coal would likely be supplied by rail-origin capable producers in San Juan and McKinley Counties in New Mexico.

PG&T plans to expand the Escalante power plant by adding a 233 mW unit in the early 2000s, possibly in 2006. When constructed, the unit will consume between 750,000 and one million annual tons of San Juan Basin coal. As at Cholla 5, the coal would likely be supplied by San Juan and McKinley County rail-origin capable suppliers.

Although PNM divested its coal operations in 1989, the company retained control of the site for Dineh Power Project (DPP). The project has been under discussion for several years, however, the utility and the Navajo Tribe have not set a schedule for obtaining necessary approval and financing. At this time, preliminary plans are to construct one to four 500 mW units in the early 2000s as electric load growth conditions warrant. Each 500 mW unit will consume between 1.5 and 2 million annual tons of San Juan Basin coal. The plant would be served by nearby mines on reserves currently controlled by Arch Mineral Corporation. Arch has indicated that its development of reserves in contingent on the construction of the power plant, and that rail service, though important, is of less concern than future plans for the DPP development. Coal for DPP would be delivered by off-road truck.

Chart 14

Base Case vs. Optimistic Base Projections for San Juan Basin Utility Coal Demand



	BASE CASE	OPTIMUM CASE
1990	22,993	22,993
1991	23,795	26,377
1992	24,733	27,782
1993	25,660	29,321
1994	26,604	37,267
1995	27,641	38,783
1996	28,301	40,108
1997	28,978	41,089
1998	29,673	42,655
1999	30,386	43,577
2000	31,143	44,486
2001	31,531	45,029
2002	31,924	45,932
2003	32,273	46,831
2004	32,751	47,979
2005	33,335	49,563

In the Optimistic Case scenario used for this study, it is assumed that Cholla 5 and Escalante 2 are placed into service in 2002 and 2003, respectively. The first DPP unit is placed into service in 2004. The accuracy of this assumption hinges on electric load growth and the competitiveness of coal-fired electric generation in the southwestern U. S. If the Optimistic Case is achieved, existing rail accessible operations would not be able to supply the volume of coal projected for both existing and new generation units. Utility coal consumers would experience increasing supply constriction in the early 2000s without the opening of new rail-accessible coal mines.

Projected Industrial Demand

Industrial sales have traditionally been a small part of San Juan's total coal market. The two major rail-origin capable mines in the region--McKinley and Lee Ranch--have shipped to the industrial sector in Arizona, California, and New Mexico. In 1990 industrial shipments reached about 325,000 tons, all shipped to Arizona markets.

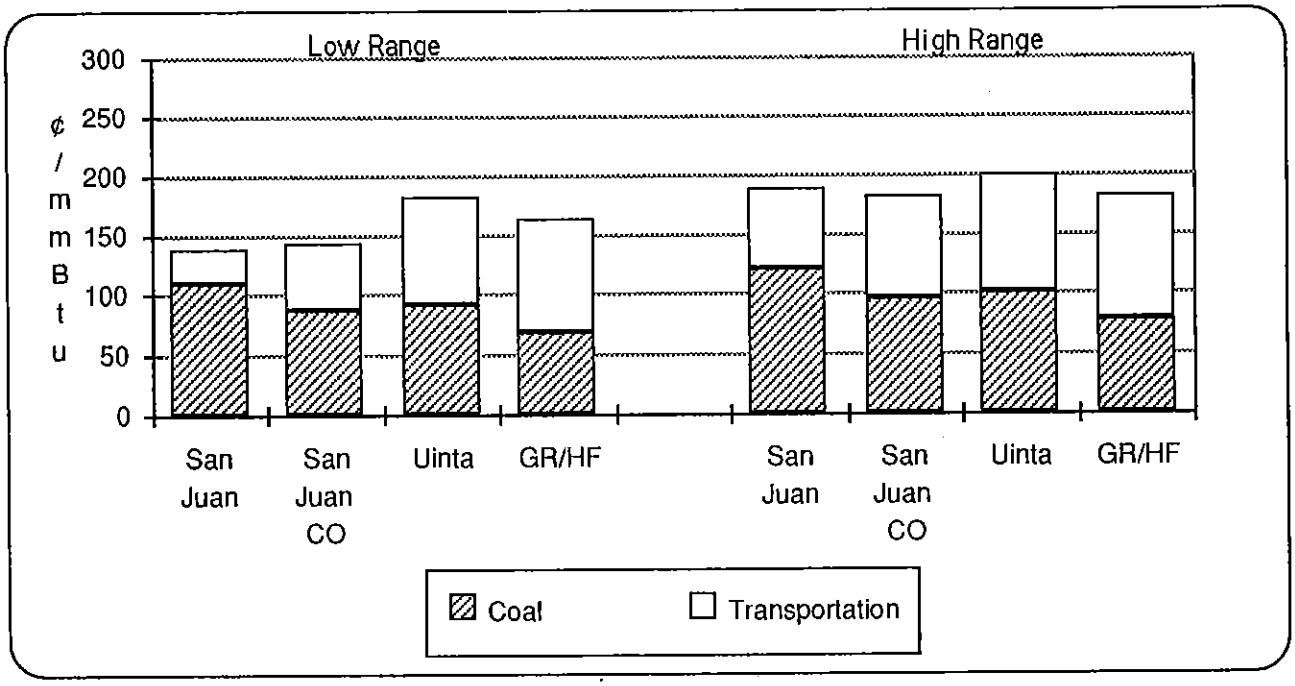
San Juan's potential industrial market area reaches from southern California to western and central Texas and extends into Colorado on the north. San Juan coal has two calorific value ranges, a 9,500 Btu per pound product originating in reserves located in the northwestern part of New Mexico and a 12,000 Btu per pound product originating in the southwestern Colorado portion of the basin. For purposes of analysis, the basin's industrial market potential has been segregated into two groups, New Mexico and Colorado. The potential New Mexico market has been defined as those industrial plants which burn a 10,000 Btu per pound or less product. The Colorado potential market has been defined as those plants whose coal requirements fall in the 10,001 to 12,500 Btu per pound range.

Out of the total possible regional demand 7.1 million annual tons of industrial coal, the Optimistic Case forecast identified a potential market New Mexico coal of 2.3 million annual tons into 16 plants in Arizona, Colorado, New Mexico, and Texas. The Optimistic Case forecast for Colorado designates a market consisting of 33 plants in Arizona, California, Colorado, New Mexico, and Texas, totalling almost four million tons of demand. The *Map* on page 18 illustrates the locations of plants identified in the optimistic forecast. Detailed data regarding plant locations, ownership, coal quality preferences, and terminating carriers are contained in the industrial table in Appendix B. A secondary market of plants whose preferred heating value for their coal supplies exceeds 12,500 Btu per pound is also presented in the industrial table. Coal consumption at these plants is not a factor in either the Base or Optimistic case forecast.

Coal producers in the Uinta Basin and the Green River/Hams Fork (GR/HF) region provide the greatest competition for San Juan suppliers into these industrial markets. A competitive analysis has been performed using low and high ranges of coal prices and transportation rates for both types of San Juan Btu quality compared to estimated prices for Uinta and GR/HF. Comparisons have been performed for shipments into each of the five identified states, and the competitive position of San Juan coal vis-a-vis these other western producers has been assessed.

Chart 15

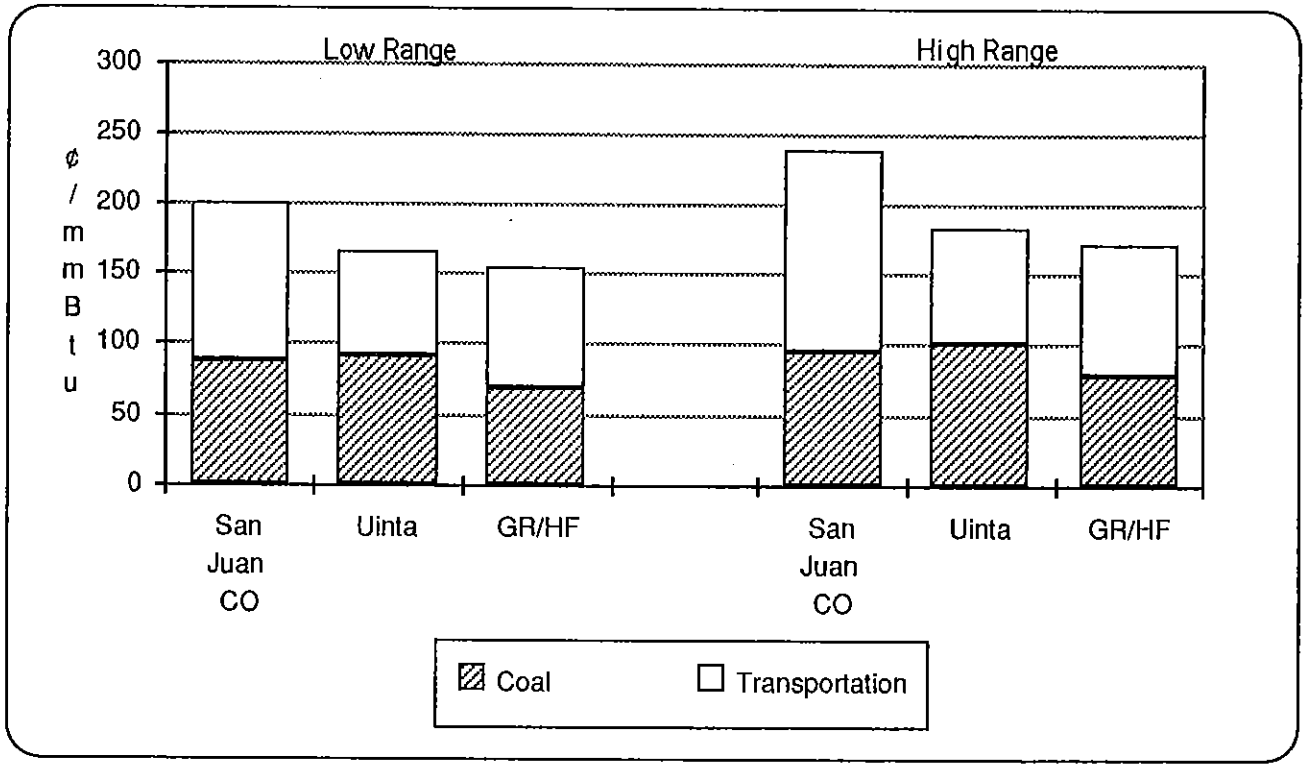
Arizona Industrial Market Prices



Both San Juan coals can compete fairly well for industrial customers in Arizona, as *Chart 15* indicates. The delivered cost of New Mexico coal ranges from 139.89 to 190.00 cents per mmBtus, generally lower than Uinta or GR/HF coal. However, New Mexico already supplies both industrial customers identified in this analysis. Colorado coal delivered into Arizona markets ranges between 16.88 and 38.46 cents per mmBtu lower than other western suppliers, but the size of the potential market is only about 240,000 tons annually.

Chart 16

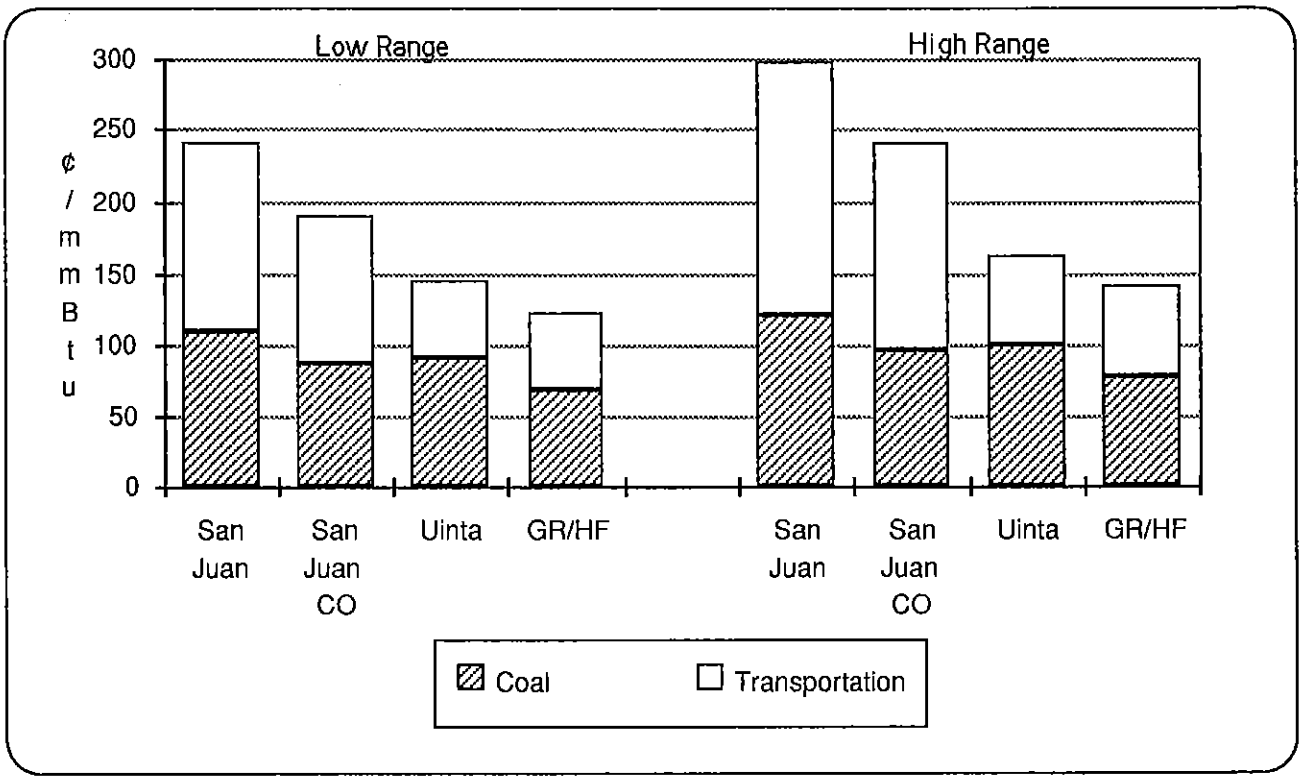
California Industrial Market Prices



Into southern California, there is no market for New Mexico lower Btu coal because the chemical and cement plants identified require coal with a higher heating value than New Mexico origin San Juan coal. While the southern California market for higher Btu coal from the Colorado portion of the basin is about 2.1 million tons annually, San Juan prices range between 44 and 99 cents per mmBtus higher than supplies from other regions. In order to compete in the southern California market against Uinta or GR/HF coal, a Colorado producer and the transportation costs would have to be reduced $8 to $14 per ton. *Chart 16* (above) compares the low and high range cost components of these industrial markets.

Chart 17

Colorado Industrial Market Prices



The Colorado markets for industrial coal--annually about 675,000 tons for a New Mexico product and about 300,000 tons for a Colorado product--are currently supplied by either Uinta or GR/HF producers. *Chart 17* illustrates the lower production costs and cheaper transportation rates that give producers from those regions large price advantages. Coal originating in the New Mexico portion of the San Juan Basin ranges from 94.75 to 156.51 cents per mmBtu higher than Uinta or Green River/Hams Fork suppliers. In particular, GR/HF's lower product costs and fairly direct transportation routing make it very attractive in local industrial markets. In order to compete in this market, San Juan delivered prices would need to be reduced $10 to $17 per ton to compete with Uinta coal and $18 to $25 per ton to compete with originating in the GR/HF region.

San Juan coal can be somewhat more competitive, albeit still higher that other supplies, in New Mexico industrial markets. Prices for New Mexico coal ranges

between 30.36 and 35.59 cents per mmBtu higher than Uinta or GR/HF originating coal. Colorado origin San Juan coal is generally lower than other western suppliers by between .006 and 18.63 cents per mmBtu. *Chart 18* (below) illustrates the competitive position of San Juan coals compared to coal with other Rock Mountain origins. The size of the New Mexico industrial market is currently less than 200,000 tons annually.

Chart 18

New Mexico Industrial Market Prices

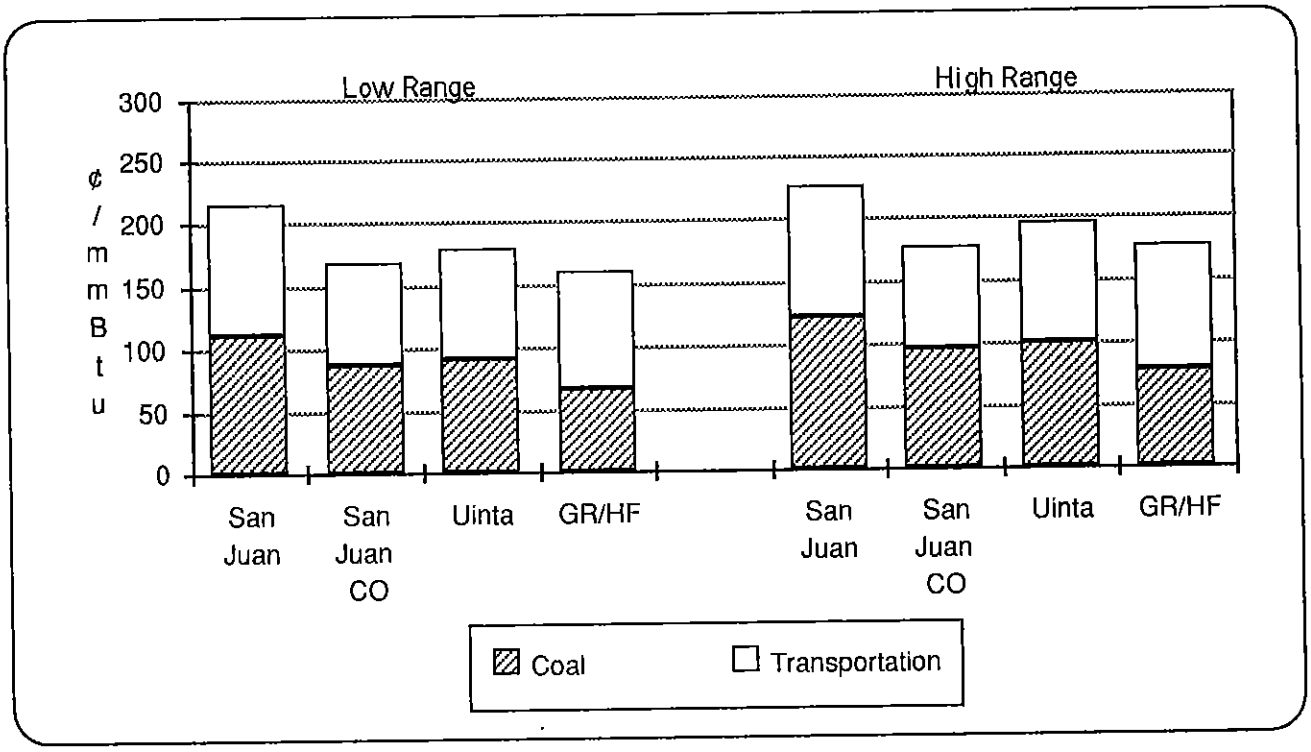
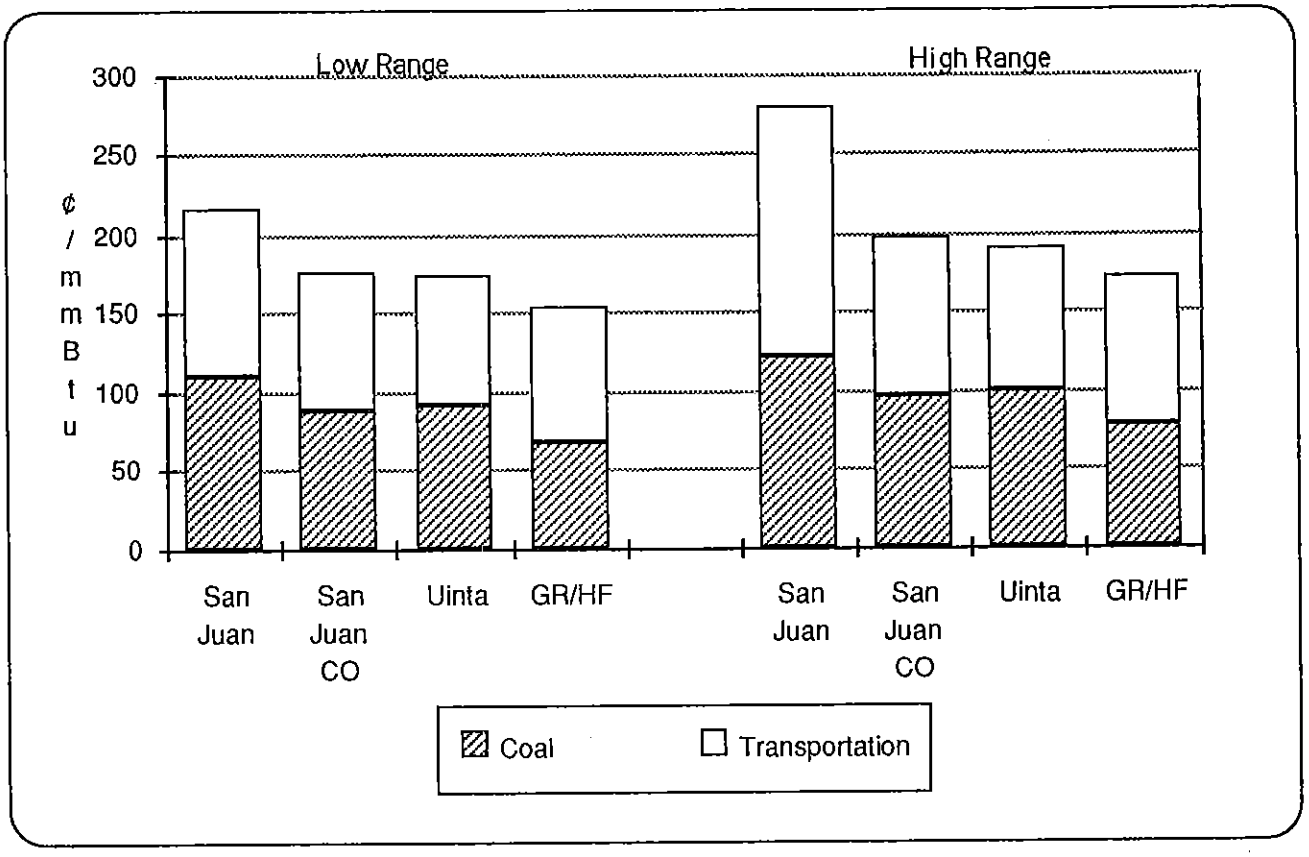


Chart 19

Texas Industrial Market Prices



Texas is the largest potential industrial market for western coal, with an estimated annual demand of 1.35 million tons for lower Btu coal and 1.28 million tons for higher Btu coal. *Chart 19* presents the competitive position of Rocky Mountain suppliers into the state. New Mexico coal is priced 62.85 to 105.96 cents per mmBtu higher than similar quality coal from GR/HF into Texas' lower Btu markets. Colorado coal is priced more competitively relative to Uinta coal, ranging only one to seven cents per mmBtus higher in price. It should be noted, however, that Powder River Basin producers have also entered the Texas industrial market, shipping about 600,000 tons in 1990 at an estimated price of 160.00 to 165.00 cents per mmBtu. This price is comparable to GR/HF prices into the same markets and between 15 and 27 cents per mmBtu lower than Uinta coal. San Juan's delivered prices for its New Mexico coal are between 57.37 and 113.69 cents per mmBtu higher than Powder River prices into these markets.

In summary, the analysis suggests that a combination of lower coal prices and transportation rates would be necessary to make San Juan coal competitive into the industrial markets we have identified. The Base Case forecast estimates the future market staying flat at today's current level of 325,000 tons per year. However, with price reductions on the part of both producers and carriers, the optimistic case forecasts a potential market of about 2.3 million tons of New Mexico and almost four million annual ton of Colorado coal demand. It should be noted, however, that achievement of this demand level hinges on delivered cost reductions of $8 to $25 per ton. Such a reduction will require substantial cuts in both cash production and rail rates.

Nonutility Generators (NUGs)

The nonutility generation market has grown at a rate of 25 percent per year since 1984, and NUGs account for nearly 3.5 percent of all power sold in the U.S. The impact of NUGs on San Juan's most likely markets, California, Arizona, Colorado, and Texas has been examined.

The North American Electric Reliability Council (NERC) reports that between now and the year 2000, over 3.2 gW of coal-fired, gas-fired, or undetermined fuel-fired capacity is planned in Arizona, Colorado, and California. Coal's portion of this overall market is only about eight percent (four planned coal-fired units to be located in Colorado and Texas), but there are an additional 569 mW of undetermined fuel capacity planned by nonutility generators. Almost three-quarters of the total planned capacity (2.4 gWh) is scheduled to be fueled by natural gas. Coal-fired capacity generally requires lower capital costs than larger coal-fired units, but there is considerable uncertainty and risk surrounding future natural gas prices, compounded price stability and proven transportation options.

It appears that the planned coal-fired NUG's market will not substantially impact San Juan coal suppliers. Of the four coal-fired units planned in this region, three are located in Colorado and will likely use Uinta or Green River/Hams Fork

supplies. The other unit, located in Texas, plans to burn lignite. Those 29 planned units whose fuel choice has not been made represent 569 mW of capacity, and their fuel decisions will likely be predicated on future movements in the price of coal relative to gas and other supply options as well as local political influences.

The baseline forecast does not anticipate any added demand for San Juan coal from NUGs as the four coal-fired plants will more than likely obtain their coal from local (GR/HF or Texas) suppliers. Our optimistic forecast projects that if the price of gas is high when the fuel decision is made, then it is likely that the "undecided" plants will choose coal. This could represent an additional 2.6 million annual tons of coal demand from the New Mexico portion of San Juan, as the Optimistic Case forecasts. However, competitively priced coal in these markets will have to be $4 to $12 below the estimated current delivered cost of San Juan Basin, New Mexico, origin coal to displace natural gas.

Projected Export Demand

Currently, San Juan Basin producers do not export a significant volume of coal. Therefore, the Base Case forecast does not project any export activity in the next 15 years. However, there is the potential to develop an export market if San Juan Basin producers can deliver a competitively priced product into the larger coal-consuming Pacific Rim countries. Western coal's export market into Pacific Rim countries currently exceeds 2.1 million tons and could reach as high as five million tons by 2005. In 1990, Japan, Taiwan, and South Korea imported nearly 60 million tons of coal, over 60 percent was sold into the utility market. In addition to the current heavy coal consumption, steam coal demand in these countries is projected to increase by another 63 to 80 million tons annually over the next 20 years as 50 new coal-fired electric generation plants are constructed.

Two factors work to the disadvantage of San Juan coal suppliers in the export market. Most coal-fired boilers in this market are configured to use coal supplied from

Australia and/or South Africa. Quality for this coal generally ranges between 11,500 and 12,000 Btu per pound with less than one percent sulfur. Most San Juan Basin producers can meet the sulfur restrictions, but San Juan Basin calorific value is 13 percent to 21 percent below the level most desired by Pacific Rim producers. This does not preclude shipments by San Juan producers to some boilers with wider quality range tolerances. Yet, consumers often expect significant price concessions when offered lower quality coal.

A second detrimental factor is transportation. In general, U. S. producers suffer a transportation disadvantage when compared to Australian suppliers. This is caused by coal sources being located farther from deep water ports. To penetrate Pacific Rim markets, U. S. coal producers must price low enough to offset this transportation disadvantage--a situation that often removes any strong incentive for U. S. producers to enter the market.

While these factors work to discourage San Juan Basin penetration into the export market, developments in the three key countries suggests that future market potential exists. Indeed, Japanese and Taiwanese coal consumers have been very active in other western U. S. coal producing regions in the past few years. This high interest level is primarily related to anticipated coal demand growth and a desire to diversify coal supply sources.

Japanese Markets

Japan, the world's largest importer of coal, purchased almost 30 million tons of foreign coal in 1990, mostly for its nine coal-fired utilities. Thirty additional coal-fired power stations (over 19,700 mW of additional capacity) are planned between now and the year 1000, and they will consume between 50 and 60 million annual tons of coal when fully operational. Japan has expressed a desire to diversify its current coal import sources--primarily in order to lessen its dependency on Australian supplies, the largest fraction of Japanese coal imports. However, Australian coal quality (e.g.,

averaging 12,000 Btu per pound, less than one percent sulfur, and less than 37 percent volatile matter) has become the standard by which most existing Japanese coal-fired steam boilers were designed. This ensures that Australian suppliers will dominate the existing utility market. However, new boilers will be designed to burn a range of coal qualities, and many use lower quality coal directly or as a blend when it is economical.

Into Japan, Indonesia is the highest cost supplier with an estimated cost per short ton of $51.80. Australia is second, with an average landed cost of $49.49 per ton, and the U. S. is slightly less at $49.08 per ton.

Over 1.2 million tons of U. S. coal were shipped to utilities and industrial consumers in Japan in 1990. The bulk of coal imported into Japan originated in Central Appalachia and was used by steel companies for pulverized coal injection. Electric Power Development Corporation of Japan (EPDC) and Chugoku Electric Power Company recently increased purchases of Uinta region coal. In addition, Japanese trading companies like Marubeni and Mitsubishi Kansei are purchasing Uinta coal for utility and industrial steam coal accounts in Japan. Also, a Japanese utility has performed several test burns of PRB coal blended with higher quality Canadian supplies. It should be noted that the Burlington Northern Railroad played a key role in this sale by granting significant price reductions on transportation rates in order to develop this export market. The optimistic forecast estimates that Japan's imports of western U. S. coal will double from current levels to almost 2.6 million tons by the year 2005.

South Korean Markets

Currently, South Korea and specifically Korea Electric Power Corporation (KEPCO) imports 12.7 million tons of coal for its five coal-fired units. Seven new coal-fired units are under construction and planned to come on-line by 1996 adding over 3,500 mW of capacity that could consume as much as 11 million additional tons of coal annually. Korea's National Energy Plan calls for as many as 25 new coal-fired plans

to come on-line between now and 2005. Because Korea has no bituminous coal reserves, the Korean government and private industry have invested in mines in the U. S. (Pennsylvania), Canada, and Australia. While Korea purchases some U. S. steam coal from Eastern producers, KEPCO uses lower Btu coal from a mine in Alaska, and newer boilers are being designed to use a wider range of coal qualities. This raises the potential for San Juan Basin producers to enter this market if they can deliver coal competitively.

Into South Korea, Canada is the highest priced supplier, with landed prices averaging $48.69 per ton. Indonesia's prices were second highest at $47.35, and Australia's coal was next highest at $45.26. Alaska's Usibelli mine exported about one million tons of 9,000 Btu per pound compliance coal to Korea in 1990. There are also discussions about opening two other mines north of Anchorage that would produce high quality (10,500 to 11,000 Btu per pound) compliance coal to be shipped out of the Seward Terminal exclusively for export markets.

The Optimistic Case scenario projects South Korean demand for western U. S. coal to remain fairly constant during the forecast period, growing from a current level of 30,000 tons per year to a high approaching 70,000 tons by 2005.

Taiwanese Markets

The U. S. share of Taiwan's coal imports in 1990 was 4.5 million tons out of a total of 20.3 million tons. The utility Tai Power is the largest consumer of imported coal in the country. Its main source for coal is Australia and is likely to remain so because of the strong traditional trade relationship between Taiwan and Australia--as well as because of Tai Power's need for a high Btu, low sulfur coal, which Australia can provide. The U. S. government has put pressure on Taiwan to open up its coal import market to U. S. sources, but most of Taiwan's U. S. supply has come from certain Central Appalachian producers who have developed long-term contract relationships with Taiwanese importers.

The U. S. is the highest cost supplier into Taiwan at over $57.50 per ton landed cost, but almost half of 1990's exports into this market were from high priced Central Appalachian producers. Canadian sources were the second most costly sources for Taiwanese consumers at $54.20 per ton at the terminating port, and Australian sources were third at $48.17 per ton. Central Appalachian producers shipped over 2.2 million tons to Taiwan in 1990, the same amount that they did in 1989. Over 600,000 tons of Uinta coal was sold to Taiwan, and the major consumer was Tai Power Company. Tai Power has nearly doubled its purchases of Uinta region coal in the last three years.

As 13 new coal-fired units come on-line between now and the year 2005--totalling 7,350 mW of new capacity--imports into Taiwan could increase by as much as 25 million tons overall. The optimistic case forecast projects that western U. S. coal supplies into Taiwan could increase to a high of 2.5 million tons per year by 2005.

Competitive Analysis of Pacific Rim Imports

A cost analysis of coal imports are reported by trade officials in Japan, Korea, and Taiwan has been performed. The average 1990 costs of imported coal at terminating ports ranged from an estimated $57.57 per ton from U. S. supplies delivered to Taiwan ports to $39.48 for coal brokered in Hong Kong and shipped to Japan. *Table 7* indicates the current average landed prices (i.e., prices for coal delivered to the terminating port for all current supplier of import coal into the Pacific Rim countries.)

Table 7

Competitiveness of U.S. Coal

Taiwan Coal Imports Year Ending 1990

Bituminous	US Tons	US$
Australia	7,415,162	$48.17
Canada	1,035,342	$54.21
Indonesia	599,884	$41.66
Japan	17,718	$41.82
Other Asia	619,731	$41.93
South Africa	5,672,624	$41.20
U.S.A.	4,918,040	$57.57
TOTAL	20,278,500	

Japan Coal Imports Year Ending Dec 1990

	US Tons	US$
China	3,219,525	$45.61
Indonesia	319,967	$51.80
USSR	2,936,153	$44.40
Canada	1,455,960	$46.44
USA	858,332	$49.08
South Africa	1,293,793	$46.16
Australia	22,543,291	$49.99
TOTAL	29,407,496	

South Korean Coal Imports, Year Ending Dec 1

	US Tons	US$
Hong Kong	37,203	$39.48
Indonesia	36,055	$47.35
Canada	1,486,375	$48.69
USA	816,116	$40.49
Australia	4,266,330	$45.26
Other	6,101,273	$41.27
TOTAL	12,743,352	

Several current exporters to the Pacific Rim will experience supply constraints in the long term. The South African coal industry is viewed with some concern because of expected disruptions in supply as a result of the abolition of apartheid. Columbia's distance from the Pacific Rim precludes a competitive rate because of high freight costs. The bulk of China's coal production is dedicated to domestic demand and any significant increase in export supplies is unlikely. The USSR, while able to deliver a low cost product, is hampered by unstable supply conditions. Canada, which ships over half of its steam coal exports to the Pacific Rim, will likely maintain its current market levels of about 20 million tons per year into these markets. While Australia is the dominant exporter into these markets, Japan--its largest market--has stated its intention to diversify its coal sources.

Using both a low and a high range scenario, coal prices have been calculated on a cents per mmBtus basis for coal originating in the San Juan Basin, the Uinta Basin, and the Green River/Hams Fork region. The analysis suggests that for San Juan coals to compete into export markets at West Coast port originations, prices would need to be reduced. *Charts 20 and 21* illustrates the cents per mmBtus cost differential among the three western coal supply regions.

Chart 20

Comparison of FOBT Cost Components for Export Coal Low Range Scenario

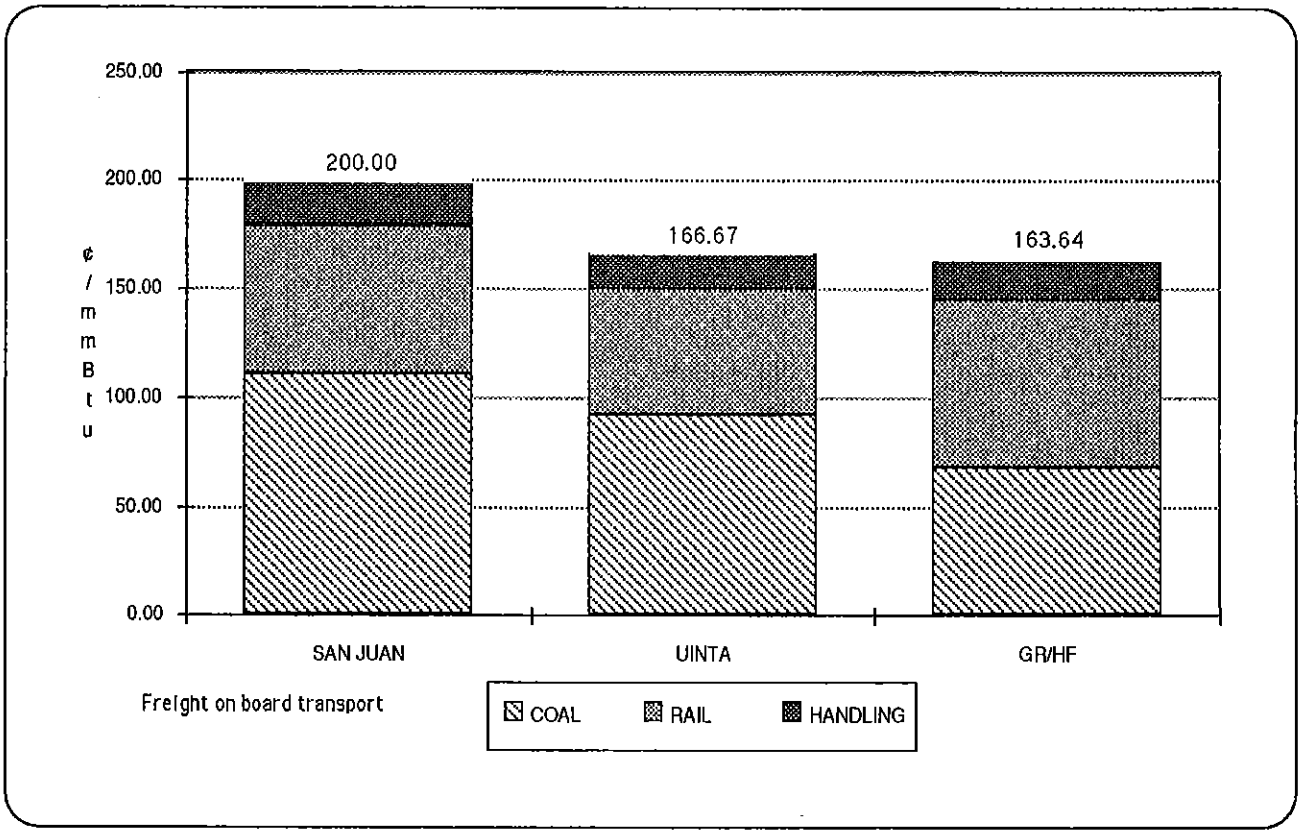
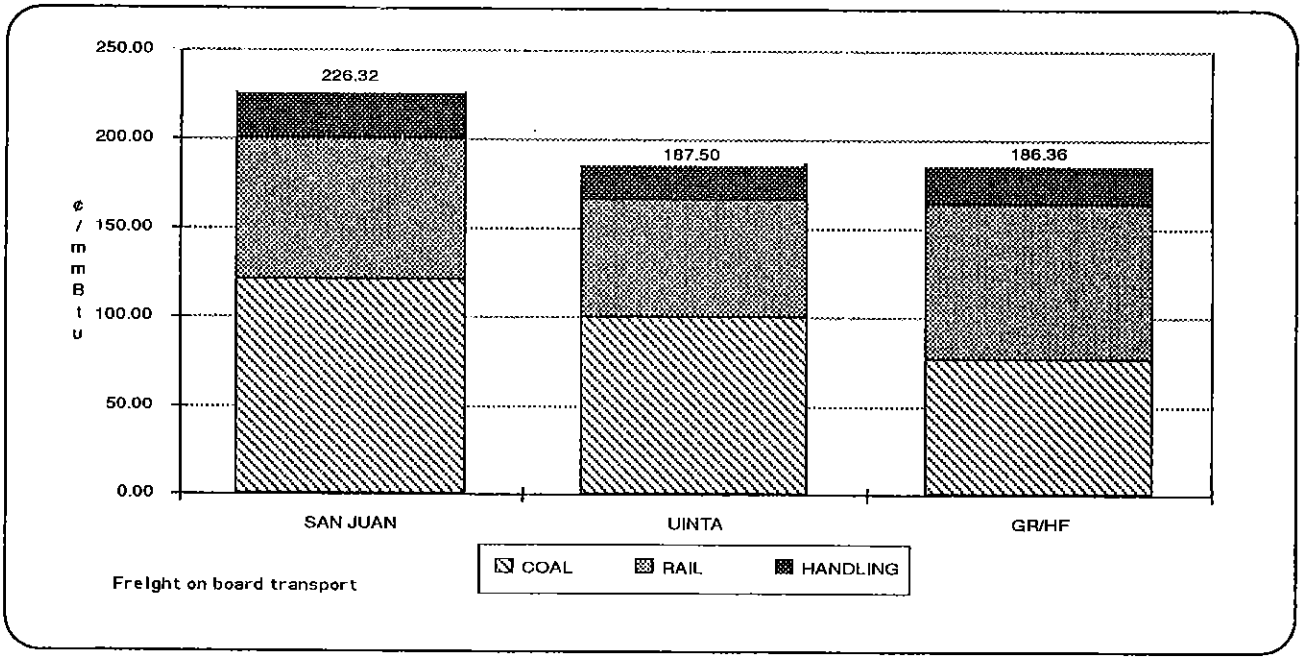


Chart 21

Comparison of FOBT Cost Components for Export Coal High Range Scenario



The Impact of Natural Gas and Other Fuels on San Juan Basin Coal Demand

By far, the largest potential for displacing coal in the market lies with natural gas. The two major states that are served by San Juan Basin coal all possess large gas-fired electric generation capability. In addition two states where electricity consumption has, or could have, a major impact on future San Juan Basin markets also possess large gas-fired electric generation capacity.

The Gas Research Institute (GRI), in its 1991 Baseline Projection of U. S. Energy Supply, forecasts the natural gas consumption in the U. S. electric sector will remain relatively flat through 1995, and then increase at an average annual rate of 7.2 percent through 2000. Between 2000 and 2005, natural gas consumption by electric utilities is projected to increase by 3.2 percent per year. GRI cites two primary factors driving natural gas consumption growth in the electric utility sector over the next fifteen years.

1. Environmental influences will result in the utilization of natural gas for more baseload electric generation;

2. Electric load growth will stimulate a need for more natural gas-fired intermediate and peaking electricity generation.

In addition, GRI stresses that natural gas consumption by nonutility generators (NUGS) will account for 30 percent of the growth it is projecting for natural gas in its baseline forecast.

The narrative accompanying the GRI forecast interjects that two factors could cause gas use for electricity generation to soar beyond the baseline projections. The first is stricter environmental policies related to carbon dioxide emissions that would severely restrict the choice of coal for future power plants. Second, higher electric demand growth that would have to be met by installing more natural gas-fired generating capacity.

The availability of natural gas in the southwestern U. S., and, moreover, its availability in large volumes at relatively moderate prices has, and will continue to have, an impact on electric capacity choices and generation mix in primary San Juan Basin coal markets.

Current Consumption and Projected Demand Growth of Natural Gas by Electric Utilities in the San Juan Basin Coal Market

State	% 1989 of Gas Use by El. Utilities	1989-2005 % An. Growth
Texas	23.3%	1.4%
California	28.5%	4.2%
Arizona and New Mexico	26.3%	5.4%

It must be recognized that the area that comprises the San Juan Basin's coal producing region's primary utility market is also a major gas producing region as well. In 1989 26.3 percent of the natural gas burned in Arizona and New Mexico was consumed at electric generating facilities. Nearby census regions that contain Texas and California used 23.3 percent and 28.5 percent of their total natural gas burn, respectively, for electricity generation. The fact that this is nearly double the average for the U. S. underscores the current penetration of natural gas into the area's electric utility sector.

Although GRI is presently projecting that electric load growth and stable natural gas prices will prevent a massive displacement of coal-fired electric generation by natural gas, the organization does forecast strong natural gas demand growth in the region's utility sector. As the table above suggests, demand growth over the next fifteen years will range between 1.4 percent and 5.4 percent. Growth will be strongest in the states constituting the San Juan Basin's primary utility coal market at this time.

While the baseline forecast incorporates the basic GRI natural gas price and demand forecast, the Optimistic Case assumes that electric load growth will be

approximately 30 percent higher over the period than the baseline forecast. At the same time, natural gas availability and price will remain the same as the basic GRI projections. Under these circumstances, marginal baseload electric demand increases will be dispatched to coal-fired capacity, and provides justification for adding three generating units earlier in the optimistic case forecast.

While GRI is forecasting natural gas prices to have an upward trend through the next 15 years, a decline in gas prices could substantially reduce the coal burn in San Juan Basin coal markets. Historic data on natural gas prices in the utility sector confirm that delivered prices have decreased steadily since the mid-1980s. The exposure of San Juan Basin coal producers to natural gas price changes, and other fuels is exposed further on a state-by-state basis in the following pages.

To evaluate the sensitivity of San Juan Basin coal markets to further penetration by natural gas and other fuels, a more detailed analysis of the electric generating sectors in three key states has been conducted. Arizona and New Mexico contain all the current San Juan Basin utility markets. Texas is considered by many a prime future market for the region's coal.

Arizona

Arizona is a net exporter of electric power. Since 1985 the total generation in Arizona has grown by over 36 percent. The single largest increase in generation was seen between 1987 and 1988 when Arizona Public Service brought its 4,210 mW Palo Verde nuclear plant on-line. Palo Verde is the only nuclear power plant in the state. In 1989 two units were taken out of service for an extended period, resulting in a 14 percent drop in total generation for the year. In 1989 coal, gas, and hydro-electric plants all increased their generation, but not enough to make up for the drop at Palo Verde. This resulted in a decrease in power sales, primarily to California. Palo Verde was returned to full use in mid-1990, and total utility generation in the state returned to slightly above the 1988 level. *Table 8* illustrates the generation changes over the

study period in terms of actual generation by fuel and as a percent of total generation. Busbar costs in cents per kWhr are also displayed for coal and gas.

Table 8

Changes in Arizona Generation Mix
1985 - 1991

Utility Generation (000 mWhrs)

Year	Coal	Gas	Nuclear	Hydro/ Other	Total	Change from Prev Yr	Fuel Cost (¢/kWhr) Coal	Gas
1985	28,481	3,884	1,130	10,336	43,831		1.38	4.26
1986	23,961	2,684	9,976	10,895	47,517	8%	1.44	2.80
1987	25,331	2,456	13,458	7,599	48,844	3%	1.40	2.46
1988	28,363	2,341	22,940	5,456	59,101	21%	1.49	2.45
1989	32,364	4,839	7,850	5,552	50,605	-14%	1.45	2.44
1990	31,636	2,257	20,598	5,209	59,700	18%	1.52	2.60
'91-3 mos	7,043	189	6,434	1,092	14,758		1.55	2.20

Generation as a Percent of Total

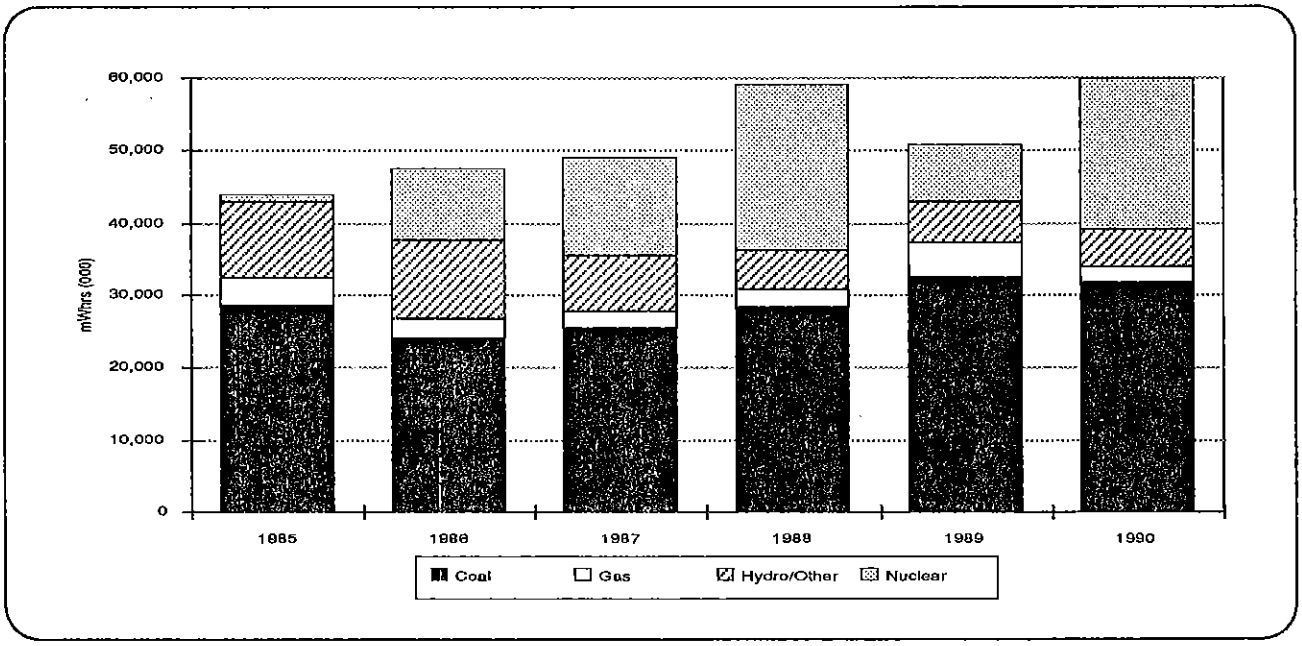
	Coal	Gas	Nuclear	Hydro/ Other
1985	65	9	3	24
1986	50	6	21	23
1987	52	5	28	16
1988	48	4	39	9
1989	64	10	16	11
1990	53	4	35	9
'91-3 mos	48	1	44	7

While total coal use has increased between 1985 and 1990, coal's percent of the total state generation has dropped by 15 percent during the period. The state currently uses coal for 53 percent of its generation, as compared to 65 percent in 1985. Although generation with natural gas has dropped steadily since 1985, natural gas steam generating capacity represents about 20 percent of total fossil fuel capability. Natural gas generation could easily be increased if demand or fuel price conditions warrant such an action. Generation from hydro and other fuels has dropped by over 50 percent since 1985--from 10.3 gWhrs in 1985 to just 5.2 gWhrs in 1990. Nuclear has been the fastest growing sector for utility generation. In 1985 total nuclear generation was only 1.1 gWhrs, and in 1990 the total was 20.6 gWhrs. A record high of 22.9 gWhrs was reached in 1988. Nuclear generation represented 35 percent of Arizona's total generation in 1990. In the first quarter of 1991, the nuclear percentage of total generation increased to 44 percent. Nuclear power will likely displace natural gas, and then coal-fired power

until demand growth in Arizona and California fully absorbs the Palo Verde complex's capacity. *Chart 22* shows the mix of generation sources in Arizona for 1985 through 1990.

Chart 22

Arizona Electric Generation Fuel Mix, 1985 - 1990



The busbar fuel cost for coal has increased by 12 percent between 1985 and early 1991--from 1.38 cents to 1.55 cents per kWhr. Gas fuel costs dropped by nearly 50 percent over the same time period. The greatest price drop was between 1985 and 1986. Drastic decreases in the delivered price of gas were stimulated by the oil price decline in 1985 and 1986, which caused gas prices to decline significantly wherever oil and gas competed directly at power plants, or indirectly in the electric power dispatch sequence. On a cents per mmBtu basis, gas prices in Arizona dropped from 375 cents to 199 cents between 1985 and 1991.

Chart 23

Comparison of Busbar Fuel Costs to Generation Mix In Arizona, 1985 - 1990

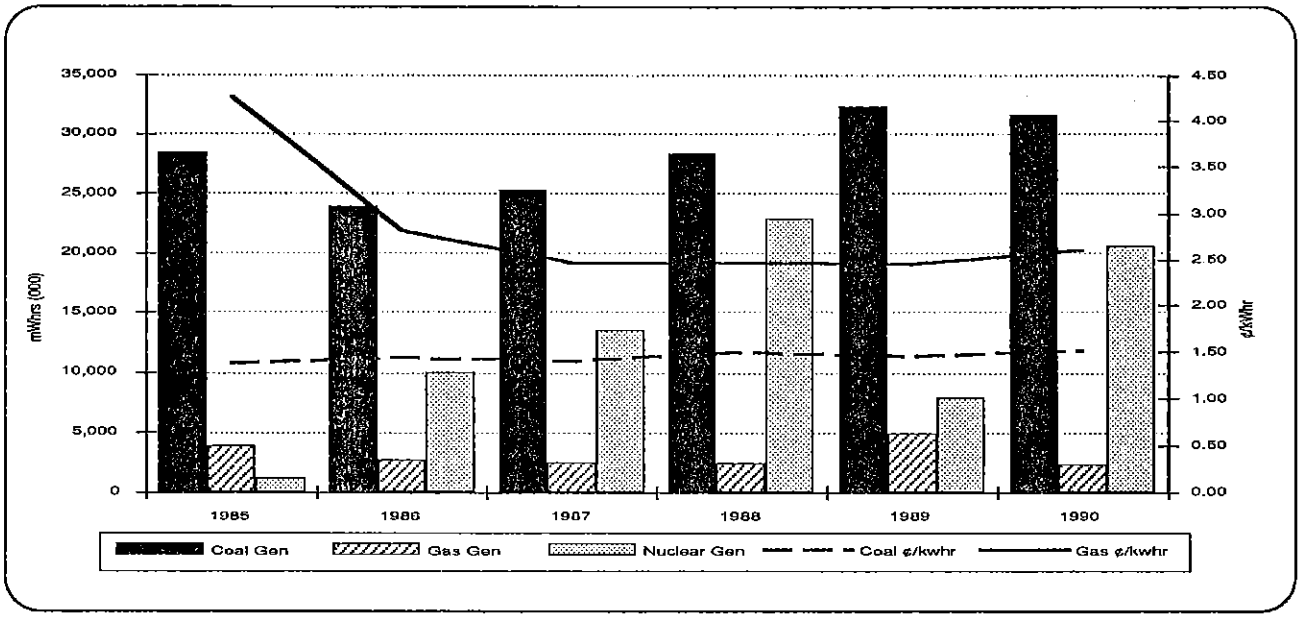


Chart 23 shows the relationship between the busbar fuel cost and generation for the three major energy sources in Arizona. Although coal's lock on future generation appears secure at this time, a drop of 25 percent to 30 percent in the price of natural gas delivered to Arizona utilities could jeopardize this security. As history verifies, natural gas price declines of this magnitude have occurred in the past. However, GRI has indicated that the margin between price and acquisition costs is too narrow at this time to sustain such a sharp cut in natural gas prices.

New Mexico

Utility generation in New Mexico is primarily from coal, with around 10 percent coming from gas and less than one percent from other fuels. Although natural gas generation has remained relatively low since the early 1980s, natural gas-fired steam generating capacity represents 18 percent of New Mexico's total fossil fired steam generation capability. Clearly, the potential exists for increasing gas-fired generation if fuel market conditions warrant it.

Total generation has grown by five percent between 1985 and 1990. The growth in generation has been erratic--with a 13 percent drop between 1985 and 1986, followed by annual growth ranging between one percent and nine percent a year. *Table 9* below shows the generation changes over the study period--in terms of actual generation by fuel and as a percent of total generation. Busbar fuel costs in cents per kWhr are also displayed for coal and gas.

Table 9

Changes in New Mexico Generation Mix

Utility Generation (000 mWhrs)

Year	Coal	Gas	Other	Total	Change from Prev Yr	Fuel Cost (¢/kWhr) Coal	Gas
1985	24,225	2,598	40	26,863		1.1986	3.69814
1986	21,473	1,834	39	23,346	-13%	1.2525	3.46256
1987	23,628	1,731	37	25,396	9%	1.3151	2.54999
1988	24,246	1,952	44	26,242	3%	1.2706	2.34153
1989	25,446	2,600	41	28,087	7%	1.3434	2.27935
1990	25,817	2,376	44	28,237	1%	1.3869	2.05914
'91-3 mos	4,625	594	5	5,224		1.4582	1.83685

Generation as a Percent of Total

Year	Coal	Gas	Other
1985	90	10	0
1986	92	8	0
1987	93	7	0
1988	92	7	0
1989	91	9	0
1990	91	8	0
'91-3 mos	89	11	0

Busbar fuel costs for coal have increased by nearly 22 percent between 1985 and early 1991--with an increase from 1.20 cents to 1.46 cents per kWhr. Coal prices (delivered) increased from 109 cents to 146 cents per mmBtu over this same time period--a 34 percent increase. Gas prices into New Mexico decreased from 352 cents to 232 cents between 1985 and 1991. This 34 percent decrease was the primary factor related to the busbar fuel cost for gas decreasing from 3.70 cents to 1.84 cents per kWhr. Natural gas busbar costs in New Mexico are converging with coal costs. This is a possible explanation for the slight upward trend in gas generation since 1987. During the same time period, coal's share of total electricity generation has dropped,

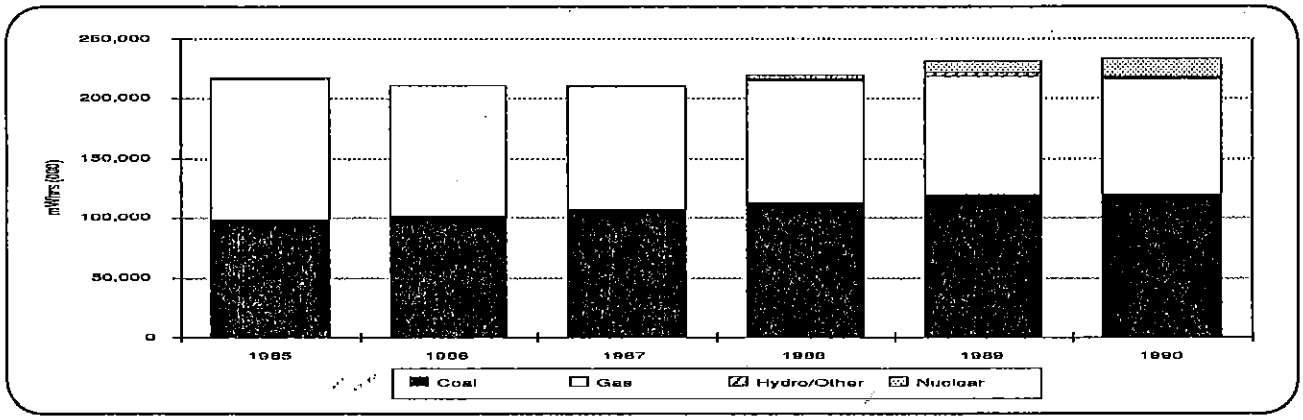
although coal generation has increased modestly. A 20 percent to 25 percent decline in natural gas prices would likely set the stage for substantial displacement of coal-fired capacity with natural gas-fired capacity. However, GRI does not anticipate natural gas acquisition prices in the region falling to this low point.

Texas

While Texas is not currently a San Juan Basin utility coal market, because of its proximity and growth, it is often proposed as a market with great future potential. Utility generation in Texas grew by eight percent between 1985 and 1990. While coal realized the greatest increase in terms of generation, the greatest increase in percentage terms was for nuclear generation. The first nuclear unit was brought on-line in 1988--this was Houston Lighting & Power's South Texas plant. Total nuclear generation in 1988 was 3.7 gWhrs, this has grown to nearly 16 gWhrs with the addition of Texas Utilities Company's Comanche Peak plant. South Texas has a capacity of 2709 mW, and reached a total of 12.5 gWhrs in 1990. Comanche Peak (1215 MW) was brought on-line in 1990, with a 3.4 gWhrs. A second unit will be placed into full operation in 1992. Nuclear power availability will significantly displace fossil fuel-fired capacity in Texas until load growth absorbs the South Texas and Comanche Peak capacity. *Chart 24* below shows the makeup of Texas utility generation between 1985 and 1990.

Chart 24

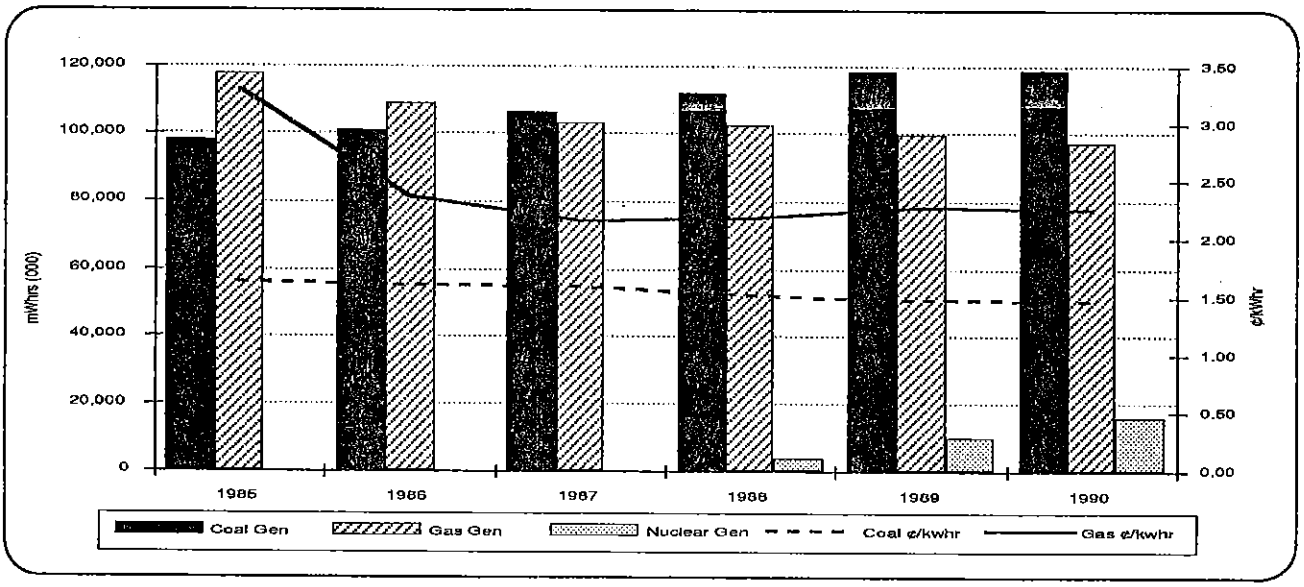
Texas Electric Generation Fuel Mix, 1985 - 1990



Average fuel costs for coal decreased by seven percent between 1985 and 1991 from 1.64 cents to 1.53 cents per kWhr. The primary factor related to this average price decrease was the increased use of local lignite for electric generation. While Texas uses coal from the Powder River Basin and Rocky Mountain region, no substantial increase in the volume of these coals occurred over the study period. Colorado is the major supplier out of the Rocky Mountain region, with between 1.5 million and 1.8 million tons per year. New Mexico shipped one quarter million tons to Texas in 1985--and smaller amounts in 1986 and 1987. This coal primarily originated in the Raton Mesa Region. Lignite has an average delivered price at least 70 cents per mmBtu below that of Powder River Basin coals, and approximately 100 cents per mmBtu below that of coals from Colorado. It is estimated that the delivered price of San Juan Basin coal is about 60 cents to 80 cents per mmBtu higher than the delivered price of Texas lignite. Therefore, Texas utility market volume has been omitted from both base and optimistic case market projections. *Chart 25* below illustrates the relationship between generation (by fuel) and fuel costs.

Chart 25

Comparison of Busbar Fuel Costs to Generation Mix in Texas, 1985 - 1990



The gas industry has been the loser in Texas with a 12 percent drop in its share of total generation. A substantial decrease in the busbar fuel cost (33 percent) was not sufficient to offset the nuclear advantage in this state. However, natural gas steam generating capacity represents 61 percent of the total fossil fuel generating capacity in Texas. In 1989 the production cost (includes fuel, operating and maintenance) for nuclear units (South Texas) was 1.82 cents per kWhr. This is 19 percent less than the production costs for electricity generated by burning fossil fuel, which had an average production cost of 2.17 cents per kWhr.

In 1990 the delivered cost of natural gas at electric utilities in Texas averaged 210.26 cents per mmBtu. The price dropped further in the first quarter of 1991 and is within 10 percent of the average delivered price of coal. In many cases, a 10 percent fuel price differential can be more than offset by lower operating costs and higher thermal efficiencies at large gas-fired plants. Therefore, natural gas is expected to remain competitive with coal in many sections of Texas. Further, San Juan Basin coal, as one of the more expensive coal options, will have no opportunity to enter the Texas utility sector in the next 15 years.

In summation, the Base Case forecast assumes that the competitive position of coal verses natural gas will not deteriorate in the key utility markets of Arizona and New Mexico. Although natural gas consumption is projected to increase in the forecast period, most of the growth is attributable to peaking, intermediate electricity generation. Baseload continues to be dispatched to existing coal-fired power plants that increase their consumption to San Juan Basin coal moderately throughout the forecast period.

In the Optimistic Case forecast, electricity load growth is sufficient to provide more baseload electricity demand growth in existing San Juan Basin coal markets. Increased baseload generation justifies the addition of three new coal-fired generating units in the early 2000s.

San Juan Basin coal is not currently competitive with other coal or lignite in Texas. Because San Juan-origin coal is projected to remain at a much higher cost than Texas lignite, and marginally higher cost than natural gas, no Texas utility markets are included in either the base or optimistic market forecasts.

Nuclear power availability will dampen fossil fuel demand growth in both Texas and Arizona for the next three to five years. This will have a stronger impact on natural gas consumption than coal consumption, unless gas prices decline 20 percent to 30 percent in real terms.

Because of the huge gas-fired steam generating capability in Arizona and New Mexico, coal generally and San Juan Basin coal producers specifically, could be exposed to severe displacement if natural gas prices decline 20 percent to 30 percent. While natural gas prices have dropped by as much as 50 percent since the mid-1980s, it is believed that the market dynamics that brought about this decline, have run their course. The Gas Research Institute is projecting flat gas prices through 1995, with an upward trend beginning in the second half of the 1990s and running through the first decade of the 2000s. The natural gas price and supply trends are consistent with the coal demand forecast in the Base and Optimistic Case scenarios of this market study.

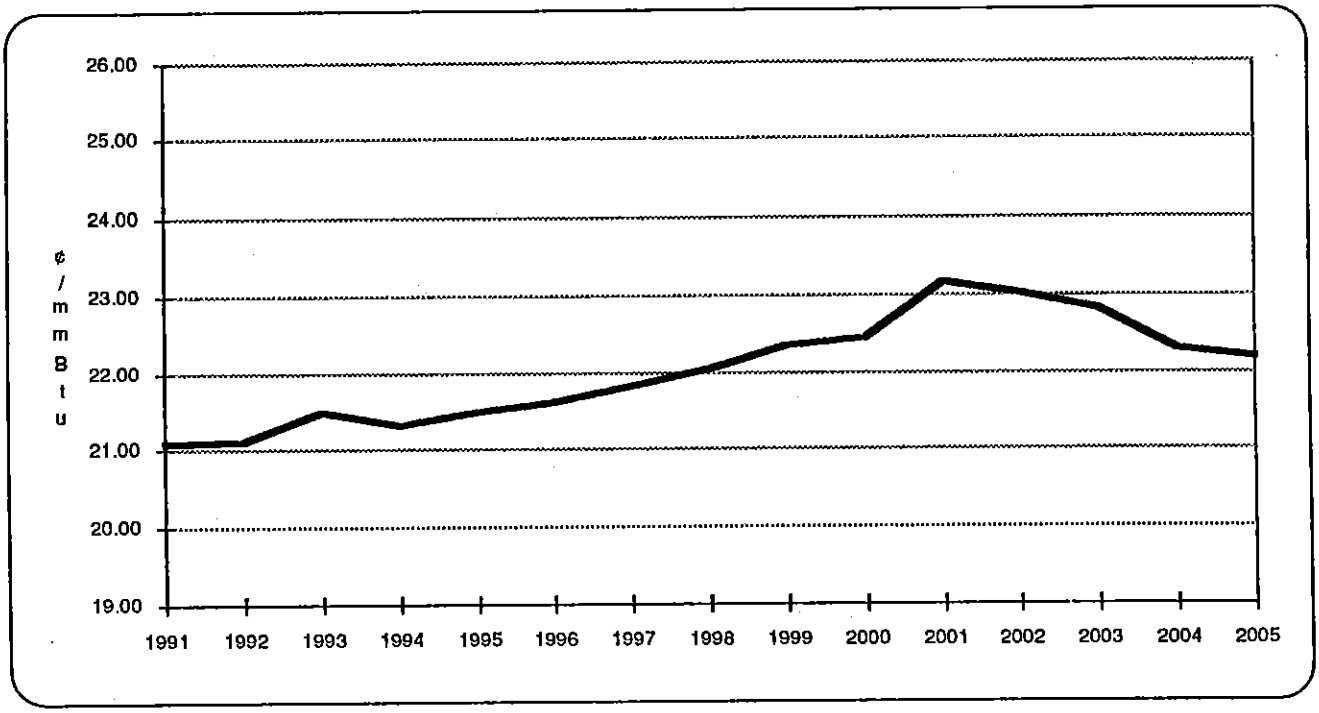
A Summary of San Juan Basin Market Dynamics and Coal Prices

In the Base Case forecast, San Juan Basin demand is characterized by strong utility sector growth in existing Arizona and New Mexico utility markets. Industrial demand remains limited to a few plants located in Arizona, which are easily accessible to existing San Juan Basin coal producers.

Because the region's production capability is controlled by a handful of companies, capacity will expand slowly to meet new market opportunities. Demand at "noncaptive" power plants (those not locked into nearby truck or conveyor served coal mines) is projected to increase at an annual average rate of 3.9 percent per year during the forecast period. Concurrently, capacity is projected to increase at an annual rate of 1.5 percent per year.

Chart 26

San Juan Basin Price Forecast

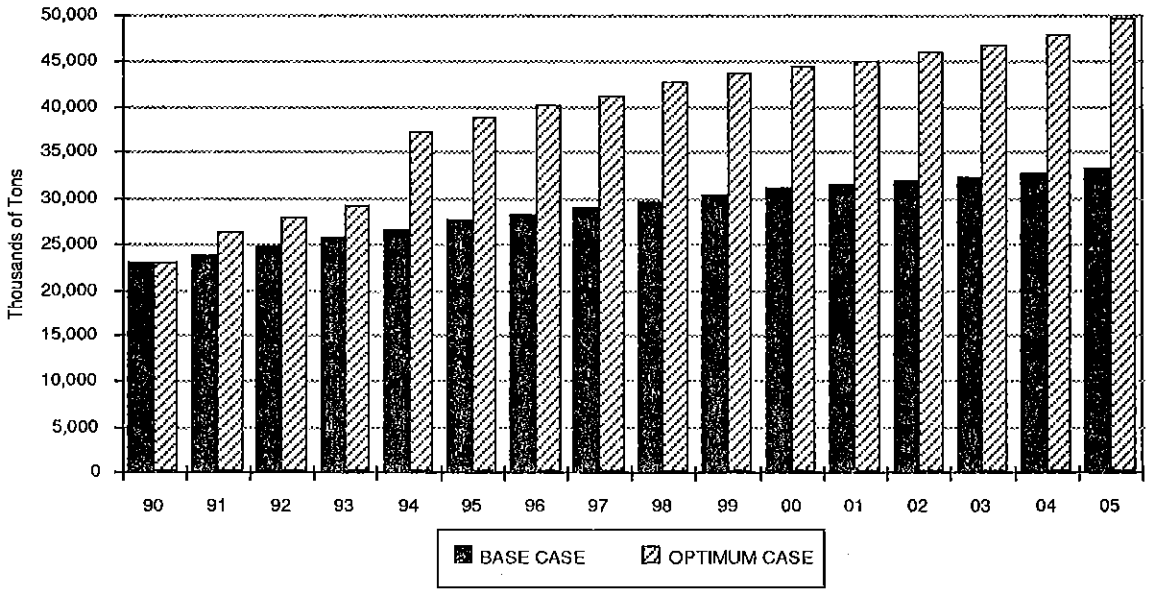


With the San Juan Basin currently about 30 percent over capacity, demand growth will result in absorption of capacity at existing mines. After capacity is absorbed in the late-1990s, a period of moderate open market price growth will occur between 1995 and 2002. The projected real price movement under Base Case assumptions for a 9,500 Btu per pound product is summarized in *Chart 26.* The open market, constant dollar price will remain flat through 1995, due to over supply conditions. However, strong utility sector demand will result in capacity utilization rates increasing in the mid- and late-1990s and permit producers to increase open market prices. Price growth will taper off after 2002, when utility demand growth subsides, and some new capacity is added to serve the market.

The Optimistic Case demand forecast will require far different supply dynamics to evolve if the coal volumes projected for the utility, industrial, and export sectors are to be achieved. In the utility sector, production at mines along the existing Santa Fe mainline and located near the site of the proposed Dineh Power Project will need to enter production in the early 2000s. These production increases can likely be achieved with the price structure projected for the Base Case.

Chart 27

Base Case and Optimistic Case Forecast for San Juan Basin Coal



	BASE CASE	OPTIMUM CASE
1990	22,993	22,993
1991	23,795	26,377
1992	24,733	27,782
1993	25,660	29,321
1994	26,604	37,267
1995	27,641	38,783
1996	28,301	40,108
1997	28,978	41,089
1998	29,673	42,655
1999	30,386	43,577
2000	31,143	44,486
2001	31,531	45,029
2002	31,924	45,932
2003	32,273	46,831
2004	32,751	47,979
2005	33,335	49,563

Chart 27 illustrates that demand is projected to be 2.6 million to 16.2 million tons higher in the optimistic case compared to the Base Case. To achieve market penetration in the industrial and export sectors of this magnitude will require substantial delivered price cuts in order to displace coal originating in Colorado, Utah, Wyoming and lignite originating in Texas. In order to successfully enter identified industrial markets, the total delivered cost of San Juan Basin coal will have to be cut $8 to $25 per ton. In order to successfully enter identified export markets, delivered cost of the region's coal will have to be cut $6 to $8 per ton.

Delivered price cuts of this magnitude will require cooperation from both coal producers and rail transportation providers. In order to make a profit and cut mine prices, it will be necessary to cut cash production costs substantially. As has been noted in an earlier section of this study, federal, state, and local governments can stimulate cash production costs cuts in the $1.47 to $2.23 per ton range by sharply reducing taxes and royalties. However, these reductions alone will not achieve the necessary cut in delivered prices.

Another option is to extend rail transportation into the central San Juan Basin region so that the area's lowest cost mines will have access to the markets. Cash production costs in this area tend to range in the $14 to $16 range, while costs in the southern reaches of the area are $1 to $3 per ton higher due to somewhat more difficult mining conditions. Nevertheless, such a transition would likely result to FOB mine prices only $1 to $3 per ton lower than the $20-$21 per ton range that is now standard in the region. This cut combined with the tax and royalty savings, results in a total of $2.47 to $5.23 per ton and is not enough to enter the market.

The final obvious option would require substantial rail rate concessions from the Santa Fe and the operator of the proposed rail line. Given the tax, royalty and possible production cost savings identified above, a strong competitive position for San Juan Basin producers in identified industrial and export markets would require further rail rate cuts of $3.53 to $19.77 per ton.

It is unlikely that cuts anywhere near the magnitude of the upper end of the range can be achieved. Proponents of market expansion for the San Juan Basin coal sector should realistically consider the cost of investment and lost tax and royalty revenue against the potential gains of increased coal sector employment. Cuts in the lower range ($6 to $8 per ton) will likely open the region to new export markets and modest industrial markets in Texas, New Mexico, and Colorado.

While it is difficult to estimate the increased coal volume with $6 to $8 per ton delivered price cuts without assessing the competitive response from railroads and coal

producers in Colorado, Utah, and Wyoming, it is unlikely that the total volume would exceed two million to four million tons per year above the Base Case demand in the next five years to ten years, and six million to eight million tons per year in the following five years. Such tonnage volumes would create about 100 to 250 direct jobs initially, and 350 to 450 jobs in the last five years of the forecast period. The question can be raised as to whether the cost of investment and lost tax and royalty revenues will be matched or exceeded by the direct and indirect income effects from these jobs.

III.

MARKET ANALYSIS OF NONCOAL COMMODITIES SUITABLE FOR RAIL TRANSPORTATION

III. MARKET ANALYSIS OF NONCOAL COMMODITIES SUITABLE FOR RAIL TRANSPORTATION

Noncoal Commodity Forecast

Introduction

There is no doubt that Four Corners area of the San Juan Basin generates a freight transportation demand that exceeds a level that would be suggested from population[3] alone. This demand is influenced heavily by the oil and gas developments, particularly natural gas that is found in abundant supply in the area. It is estimated that there are over 15,000 gas wells and over 3,000 oil wells operating in the northern New Mexico/Southern Colorado area. Nearly all of the pipe and equipment to build and support these ventures must be hauled from outside the Basin. The Navajo Indian Irrigation Project (NIIP-NAPI), with about 56,000 acres of a planned 110,000 acres under cultivation, has added additional stimulus.

The impact of this activity is producing a direct and indirect demand for an estimated 12,000-14,000 annual truckload equivalents of freight that will be shipped in or out of the San Jan Basin area in 1991[4]. About 90 percent of this volume is inbound with a wide range of products ranging from steel pipe to fresh fruit and vegetables. The current pipeline construction is adding a significant demand. Once the demand for the pipeline and supporting equipment subsides, a more normalized transportation demand would indicate an annual truck load equivalent volume of 8,000-10,000 truckloads annually[5].

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[3] San Juan County, New Mexico - 92,000 a 73 percent change since 1960.
La Plata County, Colorado - 33,000 a 68 percent change since 1960.

[4] Does not count intra-basin shipments or those transloaded with rail.

[5] Includes multiple drop loads that are dispersed among several receivers.

The rail mode has a minor participation in the Four Corners area freight picture. This is facilitated through truck-rail transfers along the Santa Fe mainline at Thoreau and Gallup. Rail shipments are generated by NIIP-NAPI with outbound grain and inbound liquid and dry fertilizers, National King Coal with outbound coal and Blue Mesa in Montrose, Colorado, with wood chips. It is estimated that the total impact of this business will be about 1,200 carloads[6] in 1991.

Noncoal Commodity Forecast

Unlike coal that moves in large volumes between a limited number of origins and destinations and has publically available statistics published covering the majority of the tonnage shipped, most of the other freight received or shipped in the San Juan Basin is much more difficult to identify. No routine, reliable source of data is available. Therefore, a basic data gathering effort was necessary.

The basis for the noncoal commodity projections was largely derived from telephone and direct interviews with almost 300 businesses in the Four Corners area. The truck volume estimates were extrapolated from this sampling procedure.

Due to the fact railroads are seldom effective competitors with trucks at distances under 500 miles, except for heavy bulk commodities, the screening process excluded general commodity shipment within this mileage range (please see *Map V*). Exclusions from this guideline were bulk commodities such as sand and cement. It is recognized that an aggressive marketing program could capture some of this short distance business, but including it in the San Juan Railroad[7] forecast would be speculative. Of the 300 businesses surveyed, only 15 percent shipped or received one or more truckloads moving outside the 500 mile radius. Most of the other businesses received less than truckload quantities over distances of less than 500 miles.

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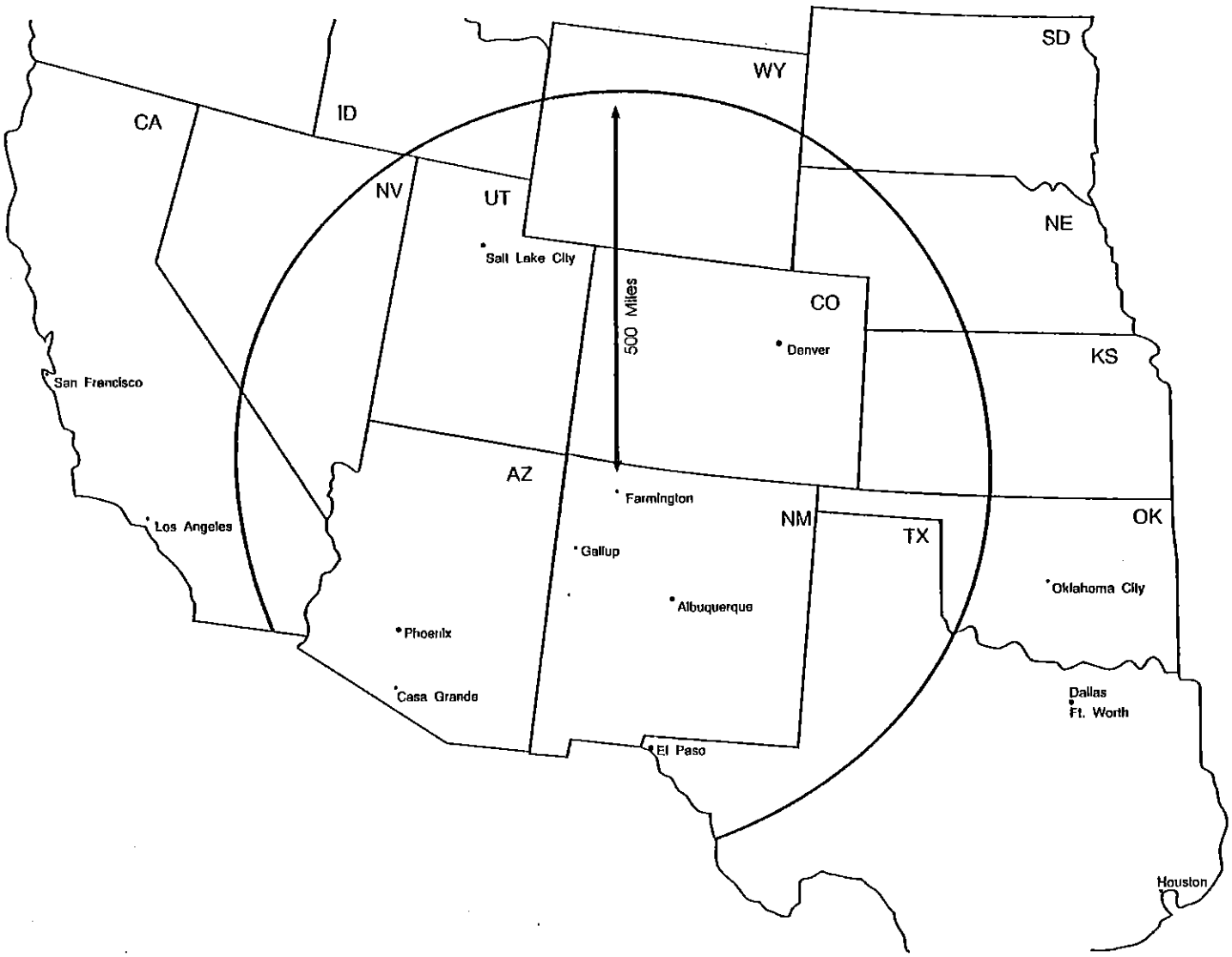
[6] Rail cars typically transport three to four truckload equivalents.

[7] The proposed extension into the San Juan Basin is hereinafter referred to as the "San Juan Railroad."

MAP V

Rail-Truck Competitive Distance



Rail is generally competitive with truck beyond 500 miles between origin and destination. Certain high volume, bulk shipments such as grain and coal unit trains are competitive over shorter distances.

A direct rail link into the Four Corners area would very likely capture all of the existing rail truck transloads and a small portion of the existing truck freight movements relatively quickly. Rail transportation is most economical when it transports heavy and bulk commodities over longer distances. On this basis, it appears that less than 20 percent of the 8,000-10,000 annual truckloads would be susceptible to rail diversion[8]. Commodities such as cement, sand, steel products, and lumber products would be the most likely diversion candidates. With creative marketing programs, additional diversion would be possible. However, a very significant portion of the existing freight shipments would not divert due the to greater flexibility of trucks and the short distance logistical patterns that have developed.

Map VI schematically characterizes the existing San Juan Basin truck traffic lanes. It is important to note that the majority of these freight flows are based around two primary and two secondary areas where distribution centers have been located. Denver and Albuquerque are the two primary distribution centers while Salt Lake City and Phoenix represent secondary distribution centers. Over 80 percent of the trucking activities (excluding pipeline material) involve these distribution centers.

Distribution centers serve many useful functions. They are generally set up with great care and often with significant capital investment. Changes from these distribution patterns are not made quickly or easily.

What the distribution center allows is a high volume in flow over longer distances, that is then dispatched to local destinations based on orders received at the point of sale. Examples include automobile terminals for major car manufactures. Large volumes of set up automobiles are shipped in via rail. As specific dealer orders are received, these are matched to cars in the distribution terminal and dispatched to the dealer in small quantities via truck.

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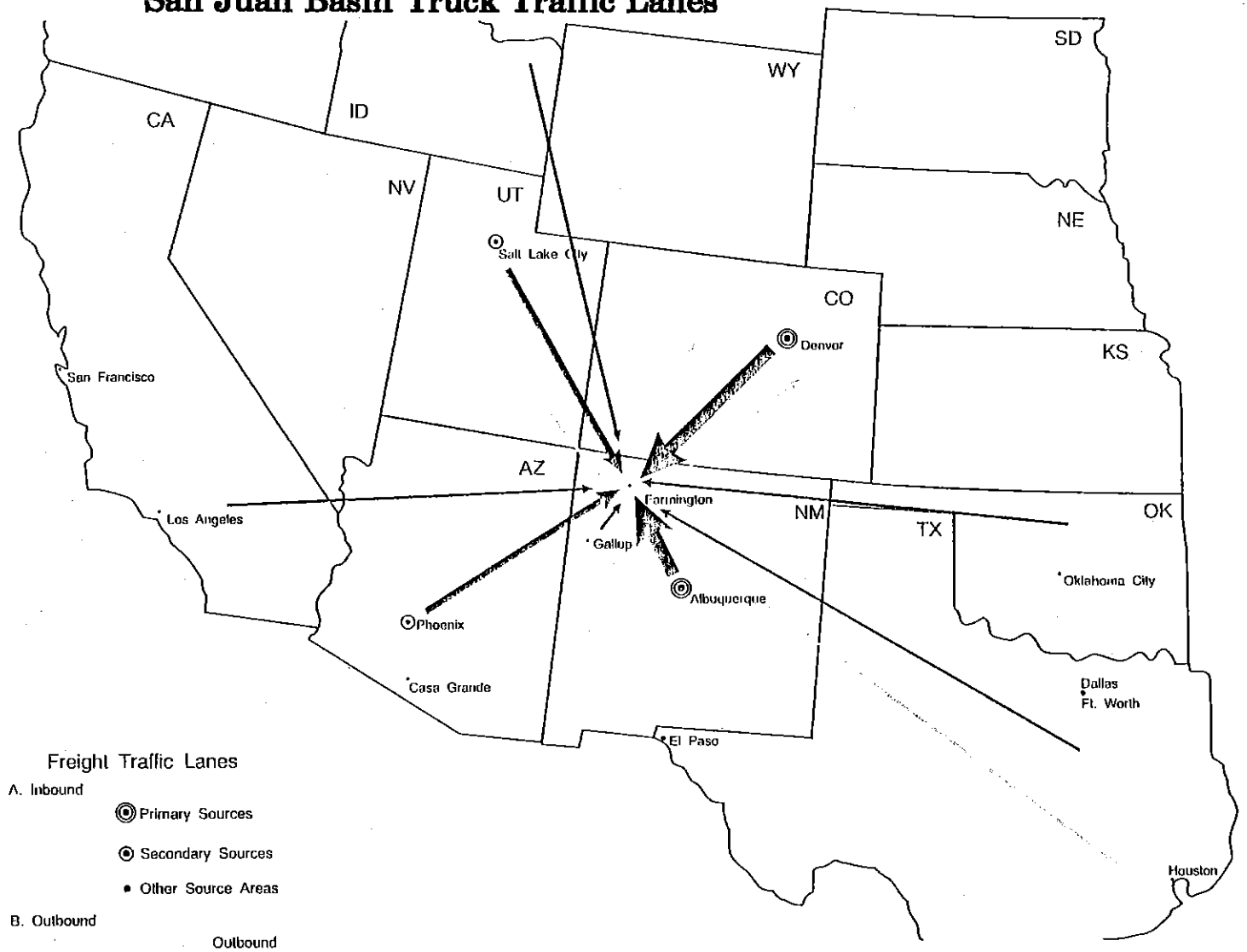
[8] If a direct rail line were available for pipeline material and supplies, 60-70 percent of this freight would likely be diverted to rail.

MAP VI

San Juan Basin Truck Traffic Lanes



Farmington - Denver:

Highway Distance: 400 miles
Rail Distance: *800 miles

* Assumes San Juan rail link between Gallup and Farmington.

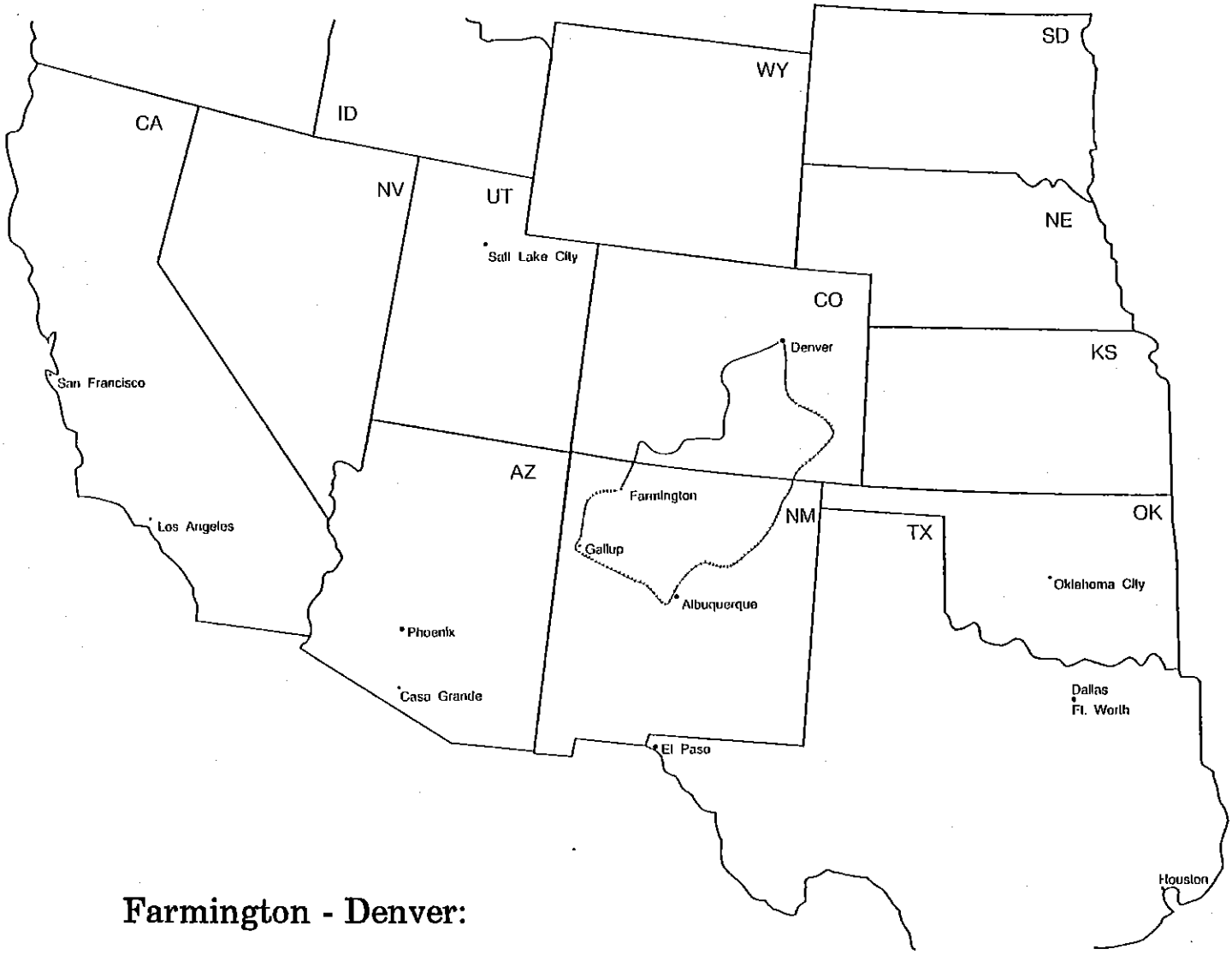
Another distribution technique that the terminal can utilize is drop shipments to a number of dealers. For example a truck carrying 12 automobiles may make several stops along a particular traffic lane leaving only two or three autos per stop. By utilizing this method, dealers can keep inventory down while receiving frequent deliveries to shorten the ordering time. Other commodities are also distributed effectively with this procedure.

Trucks are clearly more flexible and efficient at providing the shorter distance transportation than attempting to this via rail. Furthermore the circuity factors of highway distance verses rail miles often times make rail uneconomical. For example, *Map VII* shows the rail verses highway distances between Denver and Farmington. The highway distance from Denver to Farmington is about 400 miles, while the rail distance is 800 miles. The circuity disadvantage for rail would preclude almost any diversion of highway business on economical grounds alone to say nothing of the service disadvantage. *Map VIII* illustrates the disability in the Farmington-Phoenix/Casa Grande traffic lane. It is only 30 percent. This would generally preclude lighter density manufactured products, but is not great enough to overcome all the benefits of shipping dense commodities such as grain by rail. In fact this is currently done by NIIP-NAPI via the Thoreau, New Mexico, truck-rail transload. The circuitry disadvantages for Salt Lake City and Albuquerque are 215 percent and 50 percent, respectively.

These examples reveal the high volume truck traffic lanes involving the San Juan Basin noncoal commodities would be impacted only modestly should a direct rail line be extended into the region. High volume distribution centers utilizing the flexibility of truck services generally provide the optimum mix of transportation modes and services that would find utilizing direct rail to be of little, or most likely no benefit, because bypassing a distribution center for small volumes would generally not be practical. Under a most likely forecast scenario, only about 16 percent of the 8,000-10,000 truck load equivalents currently originating or terminating in the Four Corners area would be diverted to rail.

Map VII

Rail Vs. Highway Circuity Farmington - Denver, Colorado



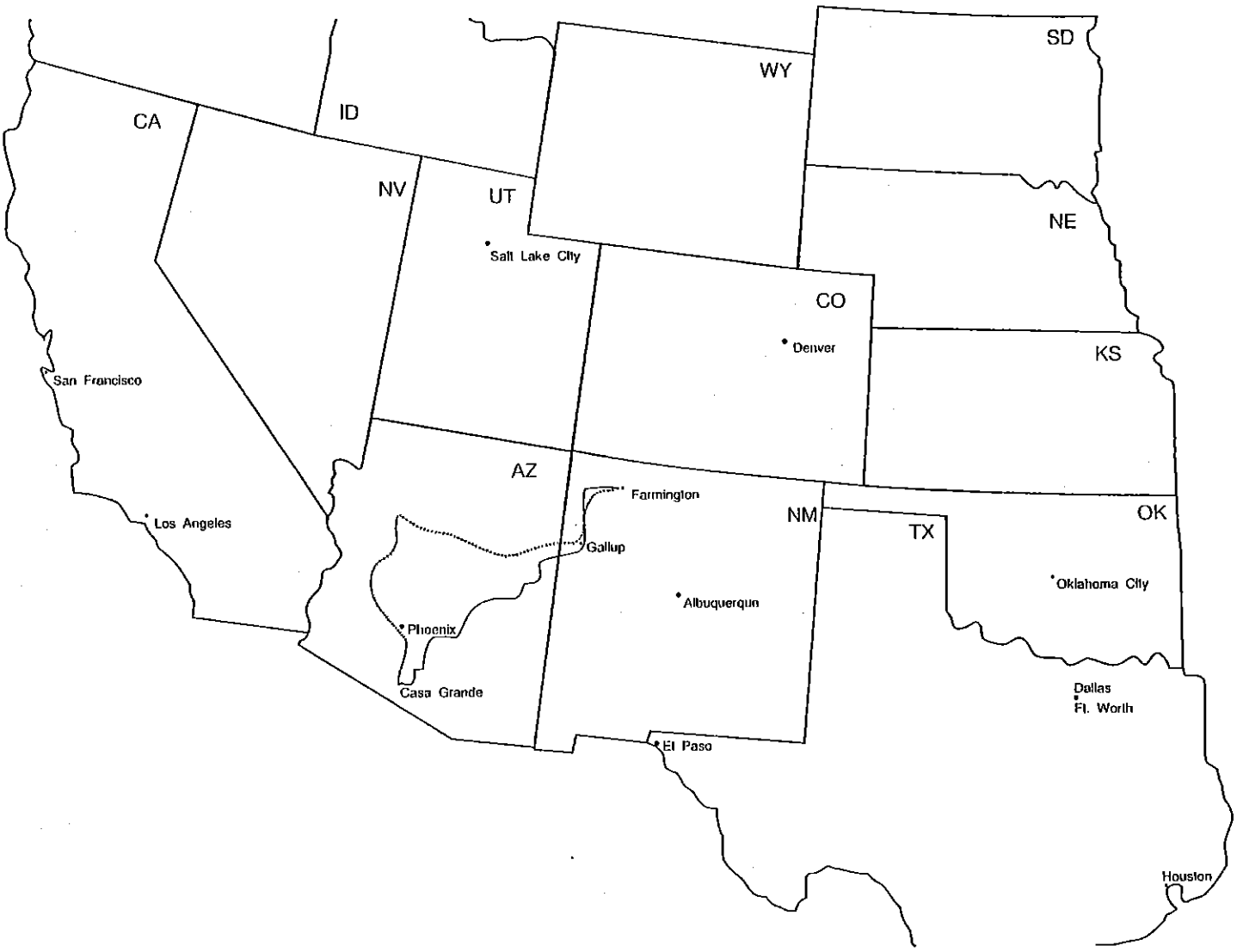
Farmington - Denver:

Highway Distance: 400 Miles
Rail Distance: *800 Miles

* Assumes San Juan rail link between Gallup and Farmington.

Map VIII

Rail Vs. Highway Circuity Farmington-Casa Grande, Arizona



Farmington - Casa Grande:

Highway Distance: 400 Miles

Rail Distance: *635 Miles

* Assumes San Juan rail link between Gallup and Farmington.

In addition to the considerations outlined above, all truck diverted shipments must be coordinated with the Santa Fe for the non-San Juan Railroad segment of the movement. A number of businesses interviewed that currently deal with the Santa Fe expressed support for the proposed railroad from the standpoint of creating an option to the Santa Fe. However, this will not be the case. In most situations, the Santa Fe will have more control than the San Juan Railroad.

Any opportunities where the Santa Fe does not meet the required rate or service levels will be lost causes for the San Juan Railroad. Given the fact that most of the Basin's general commodity freight does not meet the long distance, high volume criteria, a persistent effort to structure deals with the Santa Fe will be necessary to meet the volume projections under the optimistic forecast.

This means the majority of the potential rail business will likely be either existing shipments that are transloaded at the Santa Fe mainline or new development that would be made possible or improved with a direct rail link. This is illustrated in the following tables. *Table 10* on page 95 outlines the total forecast by major commodity group highlighting those commodities that would be favorably impacted with the rail link. *Table 11* on page 96 represents a more optimistic forecast that assumes a more aggressive marketing effort and local industrial development much more favorable to rail transportation. *Table 11* also assumes a pipeline project would begin in 1998. Both of these forecasts project the San Juan Railroad would begin operations in 1994, with 1995 the first full year of operations. Persistent and aggressive marketing and industrial development favorable to rail would be largely responsible for additional growth.

While it is recognized that even the optimistic forecast does not produce enough volume by itself to justify building the San Juan Railroad, there are many short line railroads doing quite well on similar traffic densities. The difference, of course,. is in the capital cost. Short lines are usually created by purchasing branchlines for amounts ranging from five to ten percent on a route mile basis compared to the projected construction cost of the San Juan. What is even more startling is the entire Southern

Table 10

Proposed San Juan Basin Railroad
Projected Carload Business Levels for Noncoal Commodities

Base Case Scenario

Commodity	1994	1995	1996	1997	1998	1999	2000
INBOUND:							
Cement	25	35	45	50	50	60	65
Sand	15	25	35	40	35	40	45
Fertilizer	300	400	450	475	500	500	500
Building Products	45	75	75	80	90	95	95
Steel Products	60	75	80	80	85	85	90
Oil and Gas Supplies	20	35	40	50	50	55	55
Cooking Oil	30	35	45	50	50	50	50
Other	15	35	35	35	35	35	40
SUBTOTAL	**510**	**715**	**800**	**860**	**895**	**920**	**940**
OUTBOUND:							
Alfalfa	0	0	0	0	0	0	0
Humates	0	0	0	0	0	0	0
Grain	250	275	350	350	350	350	350
Refined Products	0	300	800	1000	1000	1000	1000
Dried Beans	35	65	75	80	90	95	95
Forest Products	200	225	250	250	275	275	290
Processed Food	200	275	375	425	450	450	475
Other	25	30	35	40	50	50	60
SUBTOTAL	**710**	**1170**	**1885**	**2145**	**2215**	**2220**	**2270**
TOTAL	**1220**	**1885**	**2685**	**3005**	**3110**	**3140**	**3210**

Forecast Summary

Source							
Truck-Rail Transload	750	900	1050	1075	1125	1125	1140
Truck Diversion	200	310	345	380	400	430	445
New Rail-Stimulated Business	270	675	1290	1550	1585	1585	1625
TOTAL	**1220**	**1885**	**2685**	**3005**	**3110**	**3140**	**3210**

Table 11

Proposed San Juan Basin Railroad
Projected Carload Business Levels for Noncoal Commodities

Optimistic Scenario

Commodity	1994	1995	1996	1997	1998	1999	2000
INBOUND:							
Cement	25	35	45	50	50	60	75
Sand	15	25	35	35	40	40	55
Fertilizer	300	400	450	500	500	550	600
Building Products	45	75	75	80	90	95	95
Steel Products	60	75	80	80	85	85	90
Oil and Gas Supplies	20	35	40	50	50	55	55
Cooking Oil	30	40	50	60	65	70	70
Other	25	45	50	50	*500	*500	*200
SUBTOTAL	**520**	**730**	**825**	**905**	**1380**	**1455**	**1240**
OUTBOUND:							
Alfalfa	50	75	80	90	125	175	200
Humates	0	75	200	250	275	300	350
Grain	250	300	350	375	400	400	400
Refined Products	250	700	1000	1300	1400	1600	1750
Dried Beans	35	65	75	80	90	95	100
Forest Products	200	250	275	325	325	350	350
Processed Food	300	375	415	515	520	525	525
Other	25	40	50	50	65	75	80
SUBTOTAL	**1110**	**1880**	**2445**	**2985**	**3200**	**3520**	**3750**
TOTAL	**1630**	**2610**	**3270**	**3890**	**4580**	**4975**	**4995**

Forecast Summary

Source							
Truck-Rail Transload	750	900	1025	1150	1175	1200	1250
Truck Diversion	250	385	430	465	530	605	670
New Rail-Stimulated Business	680	1350	1850	2310	2955	3245	3200
TOTAL	**1630**	**2610**	**3270**	**3890**	**4580**	**4975**	**4995**

* Assumes 250-mile pipeline is built.

Pacific was purchased in 1988 at a route mile cost of less than 20 percent of the San Juan Railroad's estimated cost. In addition to the fixed facilities, the Southern Pacific purchase included cars and locomotives and a multi-billion dollar revenue base.

A Note on Forecasting

Forecasting almost anything beyond the immediate future with any accuracy is dangerous. Events and decisions within days or even hours can cause the best extrapolation of carefully researched data to be altered radically. Even the relatively straight forward forecast of New Mexico coal production made in prior years has been proven to be significantly off target. Attempting to incorporate a multi-commodity forecast into a data base increases the error potential exponentially.

Any shipments that would be tendered to the San Juan Railroad will be derived from decisions extending from the producer through the consumer. Actions by the railroad may have little impact. For example, from the San Juan Railroad's perspective, it would view shipping grain to Mexico as an excellent market, because the cars could be reloaded with potash in southeastern New Mexico and returned to the San Juan Basin at a savings to one way hauls. However, NAPI's bottom line may be better served to sell to other markets and pay a higher shipping charge for potash, if higher prices for grain outside of Mexico offset transportation savings.

Given the derived demand nature of freight transportation, this "forecast" is intended to outline the limitations and opportunities as well as establish carload volumes. Causing forecasted business to ring the cash register is a never ending challenge.

Potential New Rail-Stimulated Business

Three noncoal commodities were identified as potentially benefiting the most from direct rail. These include humates, refined products, primarily methanol and processed food.

Humates

Humates are black acidic organic matter associated with the coal in northwestern New Mexico. They are sold to the agricultural industry in several states as a soil conditioner as well as to the oil and gas industry for a component in drilling mud.

In the recent past, there have been three active sources of humate production: the Black Diamond Mine 19 miles north of Farmington, the Clod Buster Mine near Cuba, and the third mine near Star Lake. The Black Diamond Mine has been shut down, and it is anticipated it will be reclaimed early next year due to the fact that it is perceived that there is no economic value for operating the mine. The other two mines are currently in production and shipping either via truck or truck-rail transfer to a number of markets throughout the country.

Clearly a nearby rail loading point would benefit these shippers. However, the proposed San Juan Basin Railroad would not be built anywhere near the active mining locations. In fact the existing Santa Fe mainline is as close or closer to both of these mines than the San Juan Basin Railroad would be. Therefore, it is very unlikely that either of these producers would find it beneficial to load their product via the San Juan Railroad.

The only likely impact on the San Juan Railroad for humate transportation would be if it was found economical to reopen some of the reserves in the Black Diamond Mine. In this event, it is forecast that up to 350 carloads annually could be realized (optimistic scenario only).

Refined Products

At this time there is a surplus of gas in the Four Corners area. One of the most significant refining opportunities that would require rail transportation is methanol. Methanol is gaining attention as a possible fuel or fuel additive for the future. It can

be produced from natural gas or coal and used in vehicles that are equipped to tap a variety of fuel mixtures containing methanol, ethanol,and gasoline. Methanol's benefit extends from its capability to significantly reduce hydrocarbon emissions which are becoming a major issue in states such as California and in other areas where air quality is deteriorating. This is particularly true in high elevation intermountain cities such as Denver and Albuquerque. At this stage, there are conflicting opinions as to what role methanol will play in future motor vehicle fuel mixes. There is little question that it will play a role.

Farmington represents the most logical site to locate a refinery that would primarily serve the California market. The closest refinery to California is one projected to begin operations at the end of 1991 in Denver. Farmington's closer proximity to southern California and its huge gas reserves make it a natural location for a refinery. However, this is unlikely to materialize unless rail transportation is located nearby.

The minimum size refinery would produce 25 to 30 million gallons of methanol per year. Outbound shipments would be made in 100-ton, 30,000 gallon tank cars generating 1,000 carloads annually. Under a more optimistic projection, a larger refinery with higher volumes would be built. One of the major determinates for higher demand would be the extent that gasoline could be refined to meet more stringent air quality requirements. In July 1991 Arco, the biggest refiner and distributor in southern California, announced a new formula for a cleaner burning gasoline (EC-X). However, one of the additives for this fuel would be ethyl tertiary butyl ether (MTBE) that utilizes methanol as a component.

It appears highly certain that methanol will play a major role in motor vehicle fuels used in the future. However, Farmington's role in that future is dependent upon direct rail link.

Processed Food

As the NIIP-NAPI project grows, the opportunity for adding value to the crops it produces becomes greater. One of the key possibilities is to enter the very lucrative frozen potato market. Frozen potatoes in their various forms (french fries, shoe strings, hash browns, etc.) are a major component of the American diet, albeit not one of the most healthy aspects of it. The most significant consumption of frozen potatoes is when eating out, particularly at fast food restaurants. Institutional buyers such as McDonalds and Burger King represent a huge market on a nationwide scope that is largely served today by producers in the Pacific Northwest.

NAPI's geographical position is ideally suited to take advantage of its better proximity to markets (please see *Table 12*, page 101). However, to do so will require a demonstrated capability to produce a very high quality product. Institutional restaurant buyers pay a premium to purchase product that meets these high standard levels, so geographic positioning by itself will not automatically gain NAPI a piece of the market. However, the market is huge (in excess of 6,000 carload equivalents) and presents a golden opportunity to gain a much higher return from growing potatoes.

The standard transportation vehicle for these shipments is the cryogenic refrigerator car. These are highly insulated boxcars that are injected with liquid carbon dioxide to hold extremely cold temperatures (-20/60 degrees fahrenheit) for the trip to destination. Given the carbon dioxide that is currently being piped to the Farmington area, this represents another local product that could be used for cold storage and charging the railcars. In addition to the outbound shipments, there would also be the need for cooking oil, another benefit for the railroad.

It is estimated that the likely impact of food processing on the railroad would initially be 250 carloads annually. If the marketing of processed foods were very aggressive, it is estimated that up to 525 carloads of business would accrue to the railroad.

Table 12

Approximate Highway Mileages From Potato Production Areas to Selected Major Markets

MARKETS	PASCO WASHINGTON	AMERICAN FALLS IDAHO	FARMINGTON NEW MEXICO
Boston	2,950	2,450	2,050
Chicago	1,950	1,650	1,150
Dallas	1,850	1,370	820
Houston	2,060	1,610	1,020
Los Angeles	1,070	900	760
New Orleans	2,350	1,860	1,310
Oklahoma City	1,690	1,200	720
Phoenix	1,480	1,080	410

Another farming project similar to NIIP-NAPI is developing on the Ute Mountain lands south of Cortez, Colorado. While this is projected to be about one-third the size of the Navajo effort, it could still have an impact on the San Juan Railroad. Although it is not likely that processed foods will be part of the Ute project, a proportional addition to the grain and fertilizer needs has been incorporated in the forecast.

Oil and Gas Pipe and Supplies Potential

The natural gas and methane gas production activity in the San Juan Basin will have some impact on the railroad. Future developments will be related to the price of

gas that currently is somewhat depressed. A majority of well drilling and pipeline material could be supplied by rail. The impact on the railroad would be on a short-term basis as these supplies are shipped in. Equipment and supplies are now shipped via truck from points as far away as Tulsa, Oklahoma, and Birmingham, Alabama.

There are currently three pipeline projects underway that aggregate about 800 miles in length. However, these will be finished well before the mid-1990s, the earliest time that the rail line could be completed. The potential for future pipeline projects will be based on future gas demand and prices. However, the possibility for such events is considered likely only under the most optimistic forecast.

However, there will be some continuing need for steel, steel products, and oil and gas supplies that would find the rail link attractive. It is projected that these will amount to 110-145 carloads annually. If additional pipelines were to be constructed, it appears that up to 500 carloads of pipe and material per 100 miles of pipeline could be expected.

Nonquantifiable New Business

To what extent other businesses might find the Four Corners area to be an attractive location were the rail link in place is speculative. There is no doubt that many businesses have passed the area by due to transportation limitations. Certainly the methanol facility under construction in Denver would have been very prone to locate in the Farmington area, if a rail line had been closer.

Another case relates to a proposed Rubbermaid plant that was considering Durango. Rubbermaid was also of interest to Durango, because it is perceived as an environmentally compatible industry. Rubbermaid needed rail not to ship manufactured articles, but to receive the plastic resins that are the raw material. The standard plastics shipping container is the 100-ton covered hopper car.

Attempting to quantify similar opportunities for a long range forecast is extremely difficult. Therefore, no such projections were included in *Table 10 and 11.*

Summary

The net result of the noncoal forecast is that 1,885 carloads would be shipped in 1995, the first full year of operations, under the Base Case. This would increase to 3,210 carloads by the beginning of the 21st Century. Under the Optimistic Case, 2,610 carloads would be realized in 1995. The optimistic projection reflects 4,995 carloads by the beginning of the next century.

IV. RAILROAD LIMITATIONS AND OPPORTUNITIES

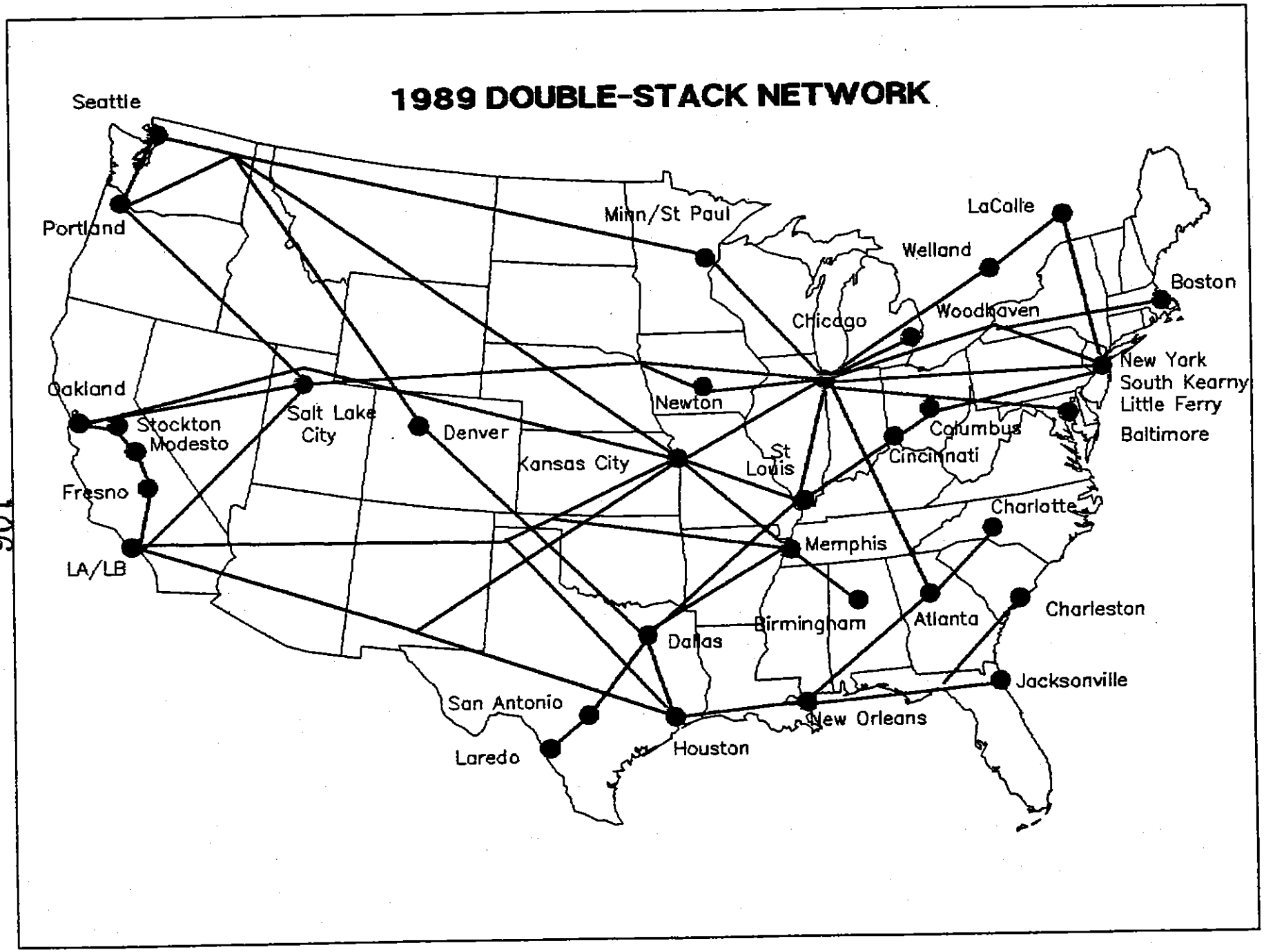
During the interview process to determine existing freight transportation levels and prospecting for potential rail business, a great many opinions were made relative to the desirability for a rail link. A good number of these comments reflected a poor understanding of the capabilities and limitations of rail transportation. For example, a number of complaints were expressed relative to less than truckload shipments that took several weeks in transit. However, it is very unlikely rail would have a role in the large volume of less than truckload shipments received in the San Juan Basin simply because rail transportation is designed for high density, high volume shipments. Furthermore, the ability of the proposed San Juan Railroad to be a major player in the transportation trailers and containers is questionable.

Intermodal Opportunities

Although the railroad industry currently is finding reasonable success in transporting truck trailers and containers (intermodal), particularly when containers are double stacked to increase the weight per car, the large volumes necessary to make this economical, limit the viable terminals quite severely (please see *Map IX*). For example, to reach the volume of containers necessary to justify running one double stack container train typically ranges from 150 to 200 containers. In addition, all containers must be moving between the same general terminal areas to reduce or eliminate en route switching. In other words, to reach the minimum volume for just one double stacked train would require most of the business now being trucked each week to the San Jan Basin area. Likewise, given the capital and operating requirements for the terminal facilities necessary to load and unload containers, about 3,000 loads per month would be the minimum necessary to bring the per unit handling cost to a reasonable amount. (For example, the transfer machine to move trailers or containers between rail cars and highway costs about $300,000.) This averages about

IV.

RAILROAD LIMITATIONS AND OPPORTUNITIES


1989 DOUBLE-STACK NETWORK
Seattle
Portland
Minn/St Paul
LaCalle
Welland
Boston
Chicago
Woodhaven
New York
South Kearny
Little Ferry
Baltimore
Oakland
Stockton
Modesto
Salt Lake City
Denver
Newton
Columbus
Cincinnati
St Louis
Kansas City
Fresno
Charlotte
Memphis
LA/LB
Birmingham
Atlanta
Charleston
Dallas
Jacksonville
San Antonio
New Orleans
Laredo
Houston

135 containers per working day, or about three days's worth of truck business for the San Juan Basin. Even if all the trucks serving the Basin could be converted to rail, the scattered traffic lanes (see *Map VI* page 91) would make one train between the Four Corners area to one other major terminal impossible.

Based on these economics, it does not appear feasible for the proposed San Juan Railroad to consider entering the realm of transporting containers and trailers on flat cars in a major way. There very well may be niche opportunities that would allow intermodal shipments, but the marketing analysis did not identify any obvious potential.

Santa Fe Railway Partnership

The key to penetrating any other markets will depend on the marketing capabilities of the San Juan Railroad along with the partnership it builds with the Santa Fe. Railroads have traditionally not had aggressive marketing efforts and have suffered for it. One indication of this can be seen in the change in market share between truck and rail during the 1980s. Over this time period, the share of the freight market for those commodities that are considered competitive for both modes, i.e. manufactured goods and nonbulk commodities, shifted in favor of the trucking industry a rather dramatic 40 percent. Although the total tonnage transported by the rail industry remained about the same over the decade, gains in coal, grain, and other dense, volume oriented commodities were largely responsible for increases to the same extent that the manufactured products were lost.

Much of this loss is attributable to more aggressive marketing efforts on the part of the trucking companies. It has long been noted that railroads tend to focus the majority of their marketing on pricing, while truckers emphasize service and transit time. In fact, much of the previously mentioned success the railroads have had in increasing intermodal shipments, even the highly touted double stacked service, can be attributable to third parties such as National Piggyback, American President Lines,

Clipper and Alliance Shippers. These firms retail the freight on a door-to-door basis, while using the railroad only for the longer distance, line haul move. This has allowed the consolidation of many shipper's commodities into trainloads and given the third party agents significant clout to force the railroads to perform. This need to perform is beginning to manifest itself, but there is still a significant distance to go.

Much of the success of the proposed San Juan Railroad beyond moving coal and other bulk commodities will be directly related to its capability to successfully deal with these marketing issues. For that reason, the noncoal commodity forecast reflects a relative low penetration of the existing freight market. In fact, it is somewhat below the national market share averages due to the fact the great majority of freight associated with the San Juan Basin moves relatively short distances as noted previously.

Terminal Facilities

Many of the commodities forecast for the San Juan Railroad can be realized only with the proper rail interface. Clearly a specialized handling terminal would be necessary if intermodal business were to be included. However, even with more conventional carload services, it is necessary to design a terminal interface to facilitate exchanges with the rail cars.

It is estimated that just over a $1 million will be necessary to install the minimum terminal facilities. The optimum location for this terminal appears to be southwest of the city of Farmington and about two miles west of Highway 371 between the San Juan River and the bluffs to the south. Minimal facilities include three classification tracks of about 2,000 feet in length and several team tracks in an area where small warehousing and other transload facilities can be located. (Please note that these facilities would be incremental to those required coal shipments.) In addition to the rail facilities, certain shippers or receivers may also wish to construct facilities there to provide an efficient interface and storage. To the extent the railroad were to

construct warehousing space, a 10,000 square foot building with parking, fencing, and lighting would be an additional $700,000.

At a cost of capital of 12 percent, there would be a carrying cost of about $10,000 per month to support the terminal facilities for noncoal commodities (excluding any warehouses.) Based on average of 3,000 noncoal commodity carloads per year, this would require each carload to bear a $40 expense to cover terminal facilities. This appears to be a reasonable level relative to other rail terminals.

Technology Gains for Bulk Commodities

Although the railroad industry has not fully realized it, new designs for open and covered hopper cars designed to carry bulk commodities such as coal and grain are nearing commercial realization. These car designs (please see Appendix D, E, and F) will allow a reduction in transportation costs in the range of 10 to 20 percent. These reductions will be realized due to the drastic reduction in tare weight that will allow individual cars to transport more product, while not increasing the gross weight on rail of the car and its contents.

The major breakthrough that will allow these efficiencies to be realized relates to the articulated design. By grouping car bodies together so that they share trucks (the wheels and other apparatus that support the cars on the track) significant amounts of car weight can be reduced. Combining this with recent technological gains that have not been previously exploited, along with lighter weight metals such as aluminum, allow up to 30 percent more product to be transported in a train whose total weight is not increased.

Currently there are prototype cars designed to carry coal and grain that have been successfully tested on several railroads. The initial designs contemplated two unit cars with one articulated joint. This equipment can carry up to 150 tons per car (75 tons in each car body) with net weight to gross weight gains of up to 20 percent over

today's conventional 100-ton hopper cars. More recently, several five unit prototype cars were built for the Santa Fe and are now being tested by several large grain shippers. It is expected that in the very near future there will be several production orders for this equipment. Due to the lighter weight aluminum construction and the four articulated joints between the car bodies, it appears that about a 30 percent gain in net weight to tare weight will be achieved.

The efficiency gains from this equipment will produce a number of benefits. These include reduced shipping costs for existing traffic lanes. More importantly, it will allow a wider competitive market area for bulk commodities that tend to be very transportation cost sensitive. An example of the latter situation could apply to export coal. Currently the U.S. western coal suffers competitively with coals in other countries in part due to the longer rail distances to reach deep water ports. To the extent the articulated cars allow price reductions to overseas buyers, U.S. coal will become more competitive on the world market.

Similar benefits can accrue to the San Juan Basin from the standpoint of realizing more distant markets for coal and grain shipments. Of course, other areas of the country providing product competition for the San Juan Basin will also have access to this more efficient rail car technology. However, aggressive marketing efforts will be aided by structuring transportation costs utilizing more efficient rail equipment.

Waste Disposal Opportunities

The largest metropolitan areas throughout the country are running out of acceptable disposal sites for municipal waste. One of the alternatives to help address this concern is moving trash to relatively distant disposal sites in areas that are compatible with this need. In most cases, these areas are geographically unattractive for alternate uses.

The most obvious possibility for municipal waste disposal for the San Juan Basin would be the city of Albuquerque. Albuquerque generates about 900 tons of waste each day that would be sufficient to justify several trains per week. However, one year ago the city cited a new landfill that covers 1,000 acres and is projected to last up to 50 years even with a 1.5 percent growth rate. Although many cities are finding it difficult to meet the tougher Environmental Protection Agency regulations, the new Albuquerque landfill is actually over-designed in this regard. For example, the proposed regulations require at least 250 feet between the bottom of the disposal site and ground water without installing a liner. The new Albuquerque facility is 700 feet from the nearest ground water, and also has a liner. Unless some new wrinkle develops that substantially changes the rules, it appears that Albuquerque will not be looking for additional disposal sites for many decades.

There are likely to be smaller cities in New Mexico and also larger cities outside the state that will be needing to locate trash disposal sites by the end of the century. However, the direction of these searches for new disposal options will be highly influenced by the politics behind regulations relating to municipal trash disposal. Another challenge will be gaining acceptance by those living in the Basin to locate a trash disposal site. The impact this could have on potential sites in the San Juan Basin is extremely speculative and has not been included in the forecast.

Attempting to forecast business heavily influenced by politics can be very risky. In one sense, except for the very largest cities, the municipal trash situation does not seem to be that overwhelming. For example at the current rate of trash generation, a landfill big enough to take the next 1,000 years worth of garbage for the entire United States would require land area of only 44 square miles and 120 feet deep.

Tourism

Tourism is a very important factor in the Four Corners area. Throughout the area there are points of attraction and geological wonders that attract thousands of

people each year. Railroads are already included in this list of tourist attractions with the Durango-Silverton Narrow Gauge Railroad in southern Colorado heading the list.

Tourist railroad operations tend to be low margin projects that are done often as much for goodwill as any economic gain. The Durango-Silverton Narrow Gauge Railroad is an exception due to the fact that it has fine tuned the transportation of tourists and has unique characteristics not found in high supply elsewhere, i.e. steam locomotives, narrow gauge track, and several spectacular segments along the Animas River.

From the standpoint of these features, little is likely to be found on the San Juan Railroad. However, this does not mean that the creative application of a tourist railroad with the proper marketing would not be a drawing card for tourists visiting the Four Corners area. There are many tourist railroad operations around the United States and few have the scenery found between Durango and Silverton. If a tourist railroad were to be established, it would probably be best to structure it as a separate operator utilizing the San Juan Railroad trackage. This would provide a number of benefits including placing the tourist railroad promotion with a specialized interest and reducing the distraction this would cause for the primary purpose for building the San Juan Railroad - freight.

Summary

The noncoal commodity forecast projects an annual carload volume for the first full year of operation (1995) of 1,885 carloads under the Base Case scenario. As marketing programs and other growth enter the picture over the next five years, this annual shipping volume is projected to increase to about 3,200 carloads by the beginning of 21st Century. Under an optimistic scenario the annual business transported by the San Juan Railroad is estimated to range from 2,610 in 1995 up to almost 5,000 carloads in the year 2000.

Although the railroad would be beneficial for several market niches in the San Juan Basin, the vast majority (over 80 percent) of the existing freight haulage involving shipments either originating or terminating in the Basin would still be trucked. This is for a number of reasons including the relatively short distances (generally under 500 miles) that most of the shipments experience due to the fact that distribution centers in Denver, Albuquerque, Phoenix, and Salt Lake City are feeding most of the freight into the Basin. Another factor is the extreme flexibility trucks have, allowing less than truckload distribution to a number of destinations and more frequent shipments of smaller sizes to benefit customer service and inventory control.

The composition of noncoal commodities for the San Juan Railroad would be about one-third that were previously trucked to the Santa Fe mainline for transloading. Less than 20 percent of the total shipments would be diverted from existing truck shipments. Most importantly, over 50 percent of the business would be stimulated by the rail line. Foremost among these shipments would be methanol and processed food, primarily frozen potatoes. The Optimistic Scenario would have a similar pattern with truck diversion and new business representing about 72 percent of the total, about eight percentage points more than the Base Case Scenario.

V.

SUMMARY

SUMMARY

The combined carloads for the San Juan Railroad market analysis are summarized for the Base Case in *Exhibit I* on page 115. Under this scenario, the only coal development that would benefit the railroad would be a relatively modest volume increase to industrial users, with some additional export shipments. It is also unlikely that any new mines would open and that the coal for the Base Case would come from existing mines, primarily National King Coal in southern Colorado. Total rail volume would begin at nearly 2,400 carloads in 1995 and build to about 5,500 carloads by the year 2000. The most predominate commodity after coal is methanol. The agricultural industry would also play a major role with various inbound and outbound commodities providing about one in four of all shipments.

Exhibit II on page 116 outlines the Optimistic Case forecast. Under this forecast, coal production would be increased to reach export and industrial markets that would begin at one million tons annually in 1996 and reach 6.5 million tons by the year 2005. To be successful, it would also be necessary to reduce the delivered cost of the coal by $6 to $8 per ton. Under an optimistic outlook, other marketing and industrial development programs would show a larger impact with a methanol plant nearly double in size compared to the Base Case along with higher utilization of the railroad for agricultural commodities. It also assumed that near the turn of the century, additional pipeline building would impact the railroad. The Optimistic Case forecasts a carload volume of over 3,200 carloads in 1995, the first full year of operations, expanding rapidly to 40,000 carloads in the year 2000 and nearly 70,000 carloads five years later.

The risk associated with building the San Juan Railroad relates to the probability of any particular level of business being achieved. Clearly, coal represents the greatest potential to reach maximum coverage of operating and capital costs. Given that coal is the key factor, it would appear the next step would be to push the project from the realm of macro projections and into reality by determining whether any commitments

Exhibit I

Proposed San Juan Basin Railroad
Projected Business Levels

Base Case Forecast

Commodity	1994	1995	1996	1997	1998	1999	2000-2005
INBOUND:							
Cement	25	35	45	50	50	60	65
Sand	15	25	35	40	35	40	45
Fertilizer	300	400	450	475	500	500	500
Building Products	45	75	75	80	90	95	95
Steel Products	60	75	80	80	85	85	90
Oil and Gas Supplies	20	35	40	50	50	55	55
Cooking Oil	30	35	45	50	50	50	50
Other	15	35	35	35	35	35	40
SUBTOTAL	**510**	**715**	**800**	**860**	**895**	**920**	**940**
OUTBOUND:							
Coal	400	500	1000	1500	2000	2200	2300
Alfalfa	0	0	0	0	0	0	0
Humates	0	0	0	0	0	0	0
Grain	250	275	350	350	350	350	350
Refined Products	0	300	800	1000	1000	1000	1000
Dried Beans	35	65	75	80	90	95	95
Forest Products	200	225	250	250	275	275	290
Processed Food	200	275	375	425	450	450	475
Other	25	30	35	40	50	50	60
SUBTOTAL	**1110**	**1670**	**2885**	**3645**	**4215**	**4420**	**4570**
TOTAL	**1620**	**2385**	**3685**	**4505**	**5110**	**5940**	**5510**

Forecast Summary

Source							
Truck-Rail Transload	1150	1400	2050	2575	3125	3325	3440
Truck Diversion	200	310	345	380	400	430	445
New Rail-Stimulated Business	270	675	1290	1550	1585	1585	1625
TOTAL	**1620**	**2385**	**3685**	**4505**	**5110**	**5840**	**5510**

Exhibit II

Proposed San Juan Basin Railroad
Projected Business Levels

Optimistic Forecast

Commodity	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
INBOUND:												
Cement	25	35	45	50	50	60	75	75	75	75	75	75
Sand	15	25	35	35	40	40	55	55	55	55	55	55
Fertilizer	300	400	450	500	500	500	600	600	600	600	600	600
Building Products	45	75	75	80	90	95	95	95	95	95	95	95
Steel Products	60	75	80	80	85	85	90	90	90	90	90	90
Oil and Gas Supplies	20	35	40	50	50	55	55	55	55	55	55	55
Cooking Oil	30	40	50	60	65	70	70	70	70	70	70	70
Other	25	45	50	50	500	500	200	100	50	50	50	50
SUBTOTAL	520	730	825	905	1380	1455	1240	1140	1090	1090	1090	1090
OUTBOUND:												
Coal	400	600	10000	17000	25000	30000	35000	40000	45000	50000	55000	65000
Alfalfa	50	75	80	90	125	175	200	200	200	200	200	200
Humates	0	75	200	250	275	300	350	350	350	350	350	350
Grain	250	300	350	375	400	400	400	400	400	400	400	400
Refined Products	250	700	1000	1300	1400	1600	1750	1750	1750	1750	1750	1750
Dried Beans	35	65	75	80	90	95	100	100	100	100	100	100
Forest Products	200	250	275	325	325	350	350	350	350	350	350	350
Processed Food	300	375	415	515	520	525	525	525	525	525	525	525
Other	25	40	50	50	65	75	80	80	80	80	80	80
SUBTOTAL	1510	2480	12445	19985	28200	33520	38755	43755	48755	53755	58755	68755
TOTAL	2030	3210	13270	20890	29580	34975	39995	44895	49845	54845	59845	69845

Forecast Summary

Source												
Truck-Rail Transload	750	950	1075	1200	1225	1300	1350	1350	1350	1350	1350	1350
Truck Diversion	250	385	430	465	530	605	670	670	670	670	670	670
New Rail-Stimulated Business	1030	1875	11765	19225	27825	33070	37975	42875	47825	52825	57825	67825
TOTAL	2030	3210	13270	20890	29580	34975	39995	44895	49845	54845	59845	69845

would be forthcoming between particular coal suppliers and consumers, if a railroad existed. In other words, specifically what future sales could be made given the delivered cost from combining mining, transportation, and taxes.

For example, for a given transportation cost that can be negotiated with the Santa Fe, would or could any of the mines currently not rail served be willing or able to expand their markets by selling outside the region. It very well may be that the market niche the San Juan Basin mines are currently serving is so superior compared to markets outside the region, that price cuts or other concessions would make any attempts to serve these new markets unattractive. It has been noted that relative to the Powder River Basin where coal sells for less than $5 per ton that the costs of mining in the San Juan Basin are quite high. Perhaps intensely serving the New Mexico/Arizona coal consumption market, the bottom line benefits for mining employees, mining owners, and the states are greater than if a significant price cutting effort were made to compete with other coal producing regions. Certainly it appears that only a total cost cutting effort involving taxes, mining costs, and transportation costs could allow any significant market penetration outside the traditional area served by San Juan Basin coal mines. To look at it in another perspective, the value added benefit of generating electricity in the San Juan Basin appears to be producing a greater total benefit than shipping the coal to other parts of the country for power generation.

However, until the opportunity is specifically presented for coal ventures outside the current market area, there is no sure way of knowing. Therefore, it is proposed that discussions be commenced with the existing owners or operators of San Juan Basin coal mines along the proposed San Juan Railroad to determine what level of commitment could be gained prior to moving ahead. Indeed without some level of commitment by the potential users, the ability to raise the substantial sums necessary to construct the railroad will likely be difficult if not impossible to obtain.

APPENDIX

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Acid rain impositions - The SO_2 control philosophy legislated by the 1990 Clean Air Act that is based on allocations of emissions, scrubbing options, and fuel switching.

Ash - The percentage of incombustible material in coal.

Bituminous - Soft coal that ranks between lignite and anthracite, usually having a heating value of more than 10,500 Btu per pound.

BL - Black Lung Tax imposition.

Btu per pound - An abbreviation of British thermal unit per pound, the measure of the calorific value of coal.

Capacity Utilization - Amount of annual production in subject year divided by estimated capacity in subject year.

Captive coal - Coal from a mine produced solely for use by the parent company.

Contract sales - Sales made under short- or long-term contracts.

DOC - Direct operating cost.

FAS - Free along side, meaning the price of export coal at the ship side -- including mine price and freight.

FOB - Free on board, meaning the price of coal loaded into rail cars or trucks.

FOBT - Free on board transport, meaning the price of coal loaded into a vessel -- including mine price, freight, and handling.

Green River/Hams Fork Region (GR/HF) - The coal region located in an area straddling northwestern Colorado and southwestern Wyoming.

Pounds SO_2 per mmBtu - A measure of sulfur content relative to the calorific value of a fuel. For coal, calculated as follows: $\text{Lbs.SO2/mmBtu} = \frac{((1{,}000{,}000)\%S)2)}{\text{Btu/lb.}}$

Loadout - Location where coal is loaded into rail cars or trucks.

Mmtpy - Millions of tons per year.

Powder River Basin - The dominant coal producing region in the western U. S. located in northwestern Wyoming and southeastern Montana.

PR/OT - Property/other taxes.

Raton Mesa Region (Raton) - The coal region extending from Huerfano Park Colorado in the north to Cimmaron, New Mexico in the south, with the Sangre de Cristo Mountain forming the western border and the Sierra Garde-Las Animas Arch as the eastern boundary.

R CAP - Replacement capital.

RECL - Reclamation taxes.

Roy. - Royalty rates.

S/C - Spot/Contract.

Sev. - Severance taxes.

Spot sales - Usually one-time sales made in the coal markets.

Subbituminous - The lowest rank of bituminous coal, having a calorific value of between 8,300 and 10,500 Btus.

Sulfur content - The quantity of sulfur in coal expressed in percent.

T & H - Transportation and handling.

Uinta Basin Region (Uinta) - The coal region located in western Colorado and east-central Utah, one of the largest coal producing regions in the western U.S.

Unit trains - A train made up entirely of coal carrying cars and operating directly from the loading place to a point of delivery, typically consisting of about 100 coal cars.

Wheeling - Wheeling occurs when a utility transmits power for others and is neither the generator nor the purchaser of that power.

APPENDIX B

SUPPORTING DATA

***** 1990 UTILITY SHIPMENTS *****
***** SAN JUAN BASIN *****

C/S	ST	OPERATOR	UTILITY	PLANT	EXP. DATE	TONS(000)	BTU/ LB	%SULF	LBSO2/ MMBTU	% ASH	$/TON	CENTS/ MMBTU
			-- PITTSBURG & MIDWAY COAL CO. --									
C	NM	PITTSBURG & MIDWAY COA	ARIZONA PUBLIC SERVICE	CHOLLA	1200	3,045.00	9860	.46	.93	13.97	32.80	166.32
			SALT RIVER PROJECT	CORONADO	1204	1,955.10	9827	.46	.94	14.33	40.62	206.64
			TUCSON ELECTRIC POWER	IRVINGTON	1202	167.00	10191	.49	.97	13.03	57.69	283.14
		===== SALE TYPE TOTAL:				5,167.10	9858	.46	.93	14.07	36.56	185.35
		===== COMPANY TOTAL:				5,167.10	9858	.46	.93	14.07	36.56	185.35
			-- S.F. COAL CORP. --									
C	NM	S.F. COAL CORP.	CENTURY POWER CORP.(AL	SPRINGERVI	1209	824.10	9318	.67	1.43	16.26	37.05	198.77
					1295	960.90	9223	.58	1.26	16.76	36.00	195.11
			PLAINS ELECTRIC GEN. &	ESCALANTE		836.08	9222	.65	1.41	17.19	24.24	131.34
			SALT RIVER PROJECT	CORONADO	0990	82.80	9545	.74	1.55	14.70	24.00	125.70
		===== SALE TYPE TOTAL:				2,703.88	9261	.63	1.37	16.68	32.31	174.38
S	NM	S.F. COAL CORP.	ARIZONA ELEC. POWER CO	APACHE		40.67	10117	.69	1.36	10.13	29.24	144.50
		===== SALE TYPE TOTAL:				40.67	10117	.69	1.36	10.13	29.24	144.50
		===== COMPANY TOTAL:				2,744.55	9274	.63	1.37	16.58	32.27	173.94
			-- UTAH MINERALS INTL (BHP) --									
C	NM	SAN JUAN COAL CO.	PSC OF NEW MEXICO	SAN JUAN	0817	5,683.00	9644	.80	1.66	22.03	32.87	170.37
		UTAH MINERALS INTL (BH	ARIZONA PUBLIC SERVICE	FOUR CORNE	0105	8,722.00	8763	.80	1.83	22.17	18.42	105.07
		===== SALE TYPE TOTAL:				14,405.00	9111	.80	1.76	22.11	24.12	130.84
		===== COMPANY TOTAL:				14,405.00	9111	.80	1.76	22.11	24.12	130.84

San Juan Basin
1990 Cash Costs

ST	Company	Mine	Mining Method	U/S	TRANS.	Union	90 Tons	90 Cap	90 T/M/S	Cash Margin	FOB Mine	Cash Cost	DOC $/T	R CAP $/T	Roy. $/T	BL $/T	RECL $/T	SEV $/T	PR/OT $/T
CO	National King Coal Inc	National King	Conventional	U	TK	NONE	166	200	18.04	2.76	27.50	24.74	20.30	0.41	2.20	1.10	0.15	0.26	0.32
NM	Pittsburg & Midway	Mckinley	Drgln/Truck	S	AT + SF	UMWA	5,573	7,000	56.87	12.77	30.54	18.01	10.23	0.94	3.85	0.55	0.35	1.17	0.92
NM	S.F. Coal Corp.	Lee Ranch	Truck/Shovel	S	AT + SF	NONE	2,705	4,125	78.45	9.31	25.88	16.57	9.71	0.78	3.24	0.55	0.35	1.17	0.78
NM	Utah Minerals Intl	La Plata	Truck/Shovel	S	TK	IUOE	1,500	1,750	54.49	11.42	32.14	20.72	12.84	0.83	4.02	0.55	0.35	1.17	0.96
NM	Utah Minerals Intl	Navajo	Drgln/Truck	S	TK	IUOE	8,665	11,250	77.57	3.49	17.57	14.08	8.53	0.76	2.20	0.55	0.35	1.17	0.53
NM	Utah Minerals Intl	San Juan	Drgln/Truck	S	TK	IUOE	4,252	7,500	55.51	13.78	32.14	18.36	10.22	1.09	4.02	0.55	0.35	1.17	0.96

San Juan Basin
1990 Western Utility Shipments with Estimated Transportation Costs

ST	County	Utility	Plant	Terminating Transportation	Controlling Compa	Operator	Mine/Source	C/S	Expir Date	Tons	Btu/Lb	% Sulf	LbSO2/ MMBtu	% Ash	FOB $/Ton	Transp $/Ton	Del $/Ton
NM	McKinley	Arizona PSCo	Cholla	At + Sf	Pittsburg & Midway	Pittsburg & Midway Co	Mckinley	C	1200	3,045	9,860	0.46	0.93	13.97	26.83	5.97	32.80
NM	McKinley	Salt River Project	Coronado	At + Sf	Pittsburg & Midway	Pittsburg & Midway Co	Mckinley	C	1204	1,955	9,826	0.46	0.94	14.33	36.30	4.32	40.62
NM	McKinley	Tucson Electric	Irvington	Sp	Pittsburg & Midway	Pittsburg & Midway Co	Mckinley	C	1202	167	10,191	0.49	0.97	13.03	38.30	19.39	57.69
NM	McKinley	Alamito Co.	Springerville	At + Sf/Pvt	S.F. Coal Corp.	S.F. Coal Corp.	Lee Ranch	C	1209	824	9,317	0.67	1.43	16.26	29.21	7.84	37.05
NM	McKinley	Alamito Co.	Springerville	At + Sf/Pvt	S.F. Coal Corp.	S.F. Coal Corp.	Lee Ranch	C	1295	961	9,222	0.58	1.26	16.76	28.16	7.84	36.00
NM	McKinley	Arizona Elec. Power	Apache	Sp	S.F. Coal Corp.	S.F. Coal Corp.	Lee Ranch	S		41	10,116	0.69	1.36	10.13	25.10	4.14	29.24
NM	McKinley	Plains Electric G&T	Escalante	At + Sf	S.F. Coal Corp.	S.F. Coal Corp.	Lee Ranch	C		836	9,221	0.65	1.41	17.19	20.63	3.61	24.24
NM	McKinley	Salt River Project	Coronado	At + Sf	S.F. Coal Corp.	S.F. Coal Corp.	Lee Ranch	C	990	83	9,544	0.74	1.55	14.70	19.68	4.32	24.00
NM	San Juan	Arizona PSCo	Four Corners	Mine Mouth	Utah Minerals	Utah Minerals Intl	Navajo	C	105	8,722	8,763	0.80	1.83	22.17	17.57	0.85	18.42
NM	San Juan	Psc Of New Mexico	San Juan	Tk	Utah Minerals	San Juan Coal Co.	San Juan	C	817	5,018	9,616	0.79	1.64	22.11	31.38	0.73	32.11
NM	San Juan	Psc Of New Mexico	San Juan	Tk	Utah Minerals	San Juan Coal Co.	San Juan/La Pla	C	817	665	9,840	0.87	1.76	21.44	37.85	0.73	38.58

BASE CASE AND OPTIMISTIC FORECASTS

Region	Utility	Plant	Unit	MW cap	90 000 T	91 000 T	92 000 T	93 000 T	94 000 T	95 000 T	96 000 T	97 000 T	98 000 T	99 000 T	00 000 T	01 000 T	02 000 T	03 000 T	04 000 T	05 000 T
MTN2	APS	CHOLLA	1	114	304	314	325	336	348	360	376	392	409	427	445	455	464	475	485	495
MTN2	APS	CHOLLA	2	289	774	793	812	832	852	873	919	968	1,020	1,074	1,131	1,161	1,192	1,224	1,256	1,289
MTN2	APS	CHOLLA	3	289	774	793	812	832	852	873	919	968	1,020	1,074	1,131	1,161	1,192	1,224	1,256	1,289
MTN2	APS	CHOLLA	4	414	1,109	1,179	1,254	1,334	1,418	1,508	1,530	1,552	1,575	1,598	1,621	1,633	1,645	1,657	1,669	1,681
MTN2	APS	CHOLLA	5	375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	350
MTN2	APS	FOUR CORNERS	1	190	750	753	756	758	761	764	786	808	831	855	879	891	904	917	930	943
MTN2	APS	FOUR CORNERS	2	190	750	753	756	758	761	764	786	808	831	855	879	891	904	917	930	943
MTN2	APS	FOUR CORNERS	3	253	1,000	1,011	1,022	1,034	1,045	1,057	1,079	1,102	1,125	1,148	1,172	1,184	1,197	1,209	1,222	1,234
MTN2	APS	FOUR CORNERS	4	818	3,228	3,302	3,378	3,456	3,536	3,617	3,649	3,682	3,715	3,748	3,782	3,799	3,816	3,833	3,850	3,867
MTN2	APS	FOUR CORNERS	5	818	3,228	3,302	3,378	3,456	3,536	3,617	3,649	3,682	3,715	3,748	3,782	3,799	3,816	3,833	3,850	3,867
MTN2	CPC	SPRINGERVILLE	1	397	1,053	1,106	1,162	1,220	1,282	1,346	1,375	1,405	1,436	1,467	1,499	1,515	1,532	1,548	1,565	1,582
MTN2	CPC	SPRINGERVILLE	2	397	1,053	1,100	1,149	1,201	1,255	1,311	1,347	1,384	1,421	1,460	1,500	1,520	1,541	1,562	1,584	1,605
MTN2	PG&T	ESCALANTE	1	233	845	843	841	840	838	836	860	885	910	936	963	977	991	1,005	1,019	1,034
MTN2	PSNM	SAN JUAN	1	361	1,136	1,166	1,196	1,227	1,259	1,292	1,339	1,388	1,439	1,491	1,546	1,574	1,603	1,632	1,662	1,693
MTN2	PSNM	SAN JUAN	2	350	1,101	1,105	1,109	1,113	1,117	1,121	1,125	1,129	1,134	1,138	1,142	1,144	1,146	1,148	1,151	1,153
MTN2	PSNM	SAN JUAN	3	534	1,680	1,743	1,809	1,878	1,948	2,022	2,072	2,124	2,177	2,231	2,287	2,316	2,344	2,374	2,403	2,433
MTN2	PSNM	SAN JUAN	4	534	1,680	1,743	1,809	1,878	1,948	2,022	2,072	2,124	2,177	2,231	2,287	2,316	2,344	2,374	2,403	2,433
MTN2	SRP	CORONADO	CO1	411	1,014	1,105	1,203	1,311	1,428	1,556	1,599	1,644	1,690	1,737	1,786	1,811	1,836	1,862	1,888	1,914
MTN2	SRP	CORONADO	CO2	411	1,014	1,108	1,210	1,322	1,444	1,577	1,617	1,657	1,699	1,742	1,786	1,809	1,831	1,854	1,878	1,901
MTN2	TGE	IRVINGTON	2	250	0	50	175	200	250	350	400	450	475	500	550	600	650	650	650	650
MTN2	TGE	IRVINGTON	1	250	175	200	250	350	400	450	475	500	550	600	650	650	650	650	650	650
	Total Utility Demand (Base Case)				22,668	23,470	24,408	25,335	26,279	27,316	27,976	28,653	29,348	30,061	30,818	31,206	31,599	31,948	32,426	33,010
	Change From 1990 (000 Tons)					802	1,740	2,667	3,611	4,648	5,308	5,985	6,680	7,393	8,150	8,538	8,931	9,280	9,758	10,342
	Change From Previous Year (%)					3.5%	4.0%	3.8%	3.7%	3.9%	2.4%	2.4%	2.4%	2.4%	2.5%	1.3%	1.3%	1.1%	1.5%	1.8%
	NM CAPTIVE UTILITY (Base Case)				14,553	14,879	15,214	15,558	15,912	16,276	16,559	16,848	17,144	17,446	17,756	17,915	18,075	18,237	18,401	18,568
	AZ RAIL/TRUCK (Base Case)				7,270	7,748	8,353	8,938	9,529	10,204	10,558	10,921	11,295	11,679	12,099	12,315	12,534	12,705	13,005	13,408
	NM RAIL/TRUCK (Base Case)				845	843	841	840	838	836	860	885	910	936	963	977	991	1,005	1,019	1,034
	NON CAPTIVE MARKET (Base Case)				8,115	8,591	9,195	9,777	10,367	11,040	11,418	11,806	12,205	12,615	13,062	13,292	13,524	13,710	14,025	14,443
						476	1,080	1,662	2,252	2,925	3,303	3,691	4,090	4,500	4,947	5,177	5,409	5,595	5,910	6,328
						5.9%	7.0%	6.3%	6.0%	6.5%	3.4%	3.4%	3.4%	3.4%	3.5%	1.8%	1.8%	1.4%	2.3%	3.0%
MTN2	APS	CHOLLA	5	375	0	0	0	0	0	0	0	0	0	0	0	125	350	500	750	900
MTN2	PG&T	ESCALANTE	2	233	0	0	0	0	0	0	0	0	0	0	0	0	75	200	400	500
MTN2	PSNM	DPP	1	500	0	0	0	0	0	0	0	0	0	0	0	0	0	50	250	1,100
	Total Utility Demand (Opt. Case)				22,668	23,470	24,408	25,335	26,279	27,316	27,976	28,653	29,348	30,061	30,818	31,331	32,024	32,698	33,701	35,160
	Change From 1990 (000 Tons)					802	1,740	2,667	3,611	4,648	5,308	5,985	6,680	7,393	8,150	8,663	9,356	10,030	11,033	12,492
	Change From Previous Year (%)					3.5%	4.0%	3.8%	3.7%	3.9%	2.4%	2.4%	2.4%	2.4%	2.5%	1.7%	2.2%	2.1%	3.1%	4.3%
	NM CAPTIVE UTILITY (Opt. Case)				14,553	14,879	15,214	15,558	15,912	16,276	16,559	16,848	17,144	17,446	17,756	17,915	18,075	18,287	18,651	19,668
	AZ RAIL/TRUCK (Opt. Case)				7,270	7,748	8,353	8,938	9,529	10,204	10,558	10,921	11,295	11,679	12,099	12,440	12,884	13,205	13,630	13,958
	NM RAIL/TRUCK (Opt. Case)				845	843	841	840	838	836	860	885	910	936	963	977	1,066	1,205	1,419	1,534
	NON CAPTIVE MARKET (Opt. Case)				8,115	8,591	9,195	9,777	10,367	11,040	11,418	11,806	12,205	12,615	13,062	13,292	13,524	13,710	14,025	14,443
						476	1,080	1,662	2,252	2,925	3,303	3,691	4,090	4,500	4,947	5,177	5,409	5,595	5,910	6,328
						5.9%	7.0%	6.3%	6.0%	6.5%	3.4%	3.4%	3.4%	3.4%	3.5%	1.8%	1.8%	1.4%	2.3%	3.0%

BASE CASE AND OPTIMISTIC FORECASTS, continue

	INDUSTRIAL DEMAND (Base Case)																
MTN2	STONE SNOWFLAKE	NM	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
MTN2	PNIX CM CLARKSDALE	NM	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	TOTAL INDUSTRIAL DEMAND (Base Case)		325	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325
	BASELINE NON CAPTIVE UTILITY		8,115	8,591	9,195	9,777	10,367	11,040	11,418	11,806	12,205	12,615	13,062	13,292	13,524	13,710	14,025	14,443
	BASELINE CAPTIVE UTILITY		14,553	14,879	15,214	15,558	15,912	16,276	16,559	16,848	17,144	17,446	17,756	17,915	18,075	18,237	18,401	18,568
	BASELINE INDUSTRIAL		325	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325
	TOTAL BASLINE DEMAND		22,993	23,795	24,733	25,660	26,604	27,641	28,301	28,978	29,673	30,386	31,143	31,531	31,924	32,273	32,751	33,335
	INDUSTRIAL DEMAND (Optim. Case)																	
MTN2	STONE SNOWFLAKE	NM	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
MTN2	PNIX CM CLARKSDALE	NM	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Low Quality Market		0	0	0	0	2,275	2,275	2,275	2,275	2,275	2,275	2,275	2,275	2,275	2,275	2,275	2,275
	High Quality Market		0	0	0	0	3,989	3,989	3,989	3,989	3,989	3,989	3,989	3,989	3,989	3,989	3,989	3,989
	NUGS Market		0	407	799	1,411	1,784	1,873	2,153	2,172	2,593	2,612	2,634	2,634	2,634	2,634	2,634	2,634
	TOTAL INDUSTRIAL DEMAND (Optim. Case)		325	732	1,124	1,736	8,373	8,462	8,742	8,761	9,182	9,201	9,223	9,223	9,223	9,223	9,223	9,223
	EXPORT DEMAND (Optim. Case)		0	2,175	2,250	2,250	2,615	3,005	3,390	3,675	4,125	4,315	4,445	4,475	4,685	4,910	5,055	5,180
	TOTAL UTILITY DEMAND (Opt. Case)		22,668	23,470	24,408	25,335	26,279	27,316	27,976	28,653	29,348	30,061	30,818	31,331	32,024	32,698	33,701	35,160
	EXPORT DEMAND (Optim. Case)		0	2,175	2,250	2,250	2,615	3,005	3,390	3,675	4,125	4,315	4,445	4,475	4,685	4,910	5,055	5,180
	TOTAL INDUSTRIAL DEMAND (Optim. Case)		325	732	1,124	1,736	8,373	8,462	8,742	8,761	9,182	9,201	9,223	9,223	9,223	9,223	9,223	9,223
	TOTAL OPT. CASE		22,993	26,377	27,782	29,321	37,267	38,783	40,108	41,089	42,655	43,577	44,486	45,029	45,932	46,831	47,979	49,563

POTENTIAL SAN JUAN BASIN INDUSTRIAL CUSTOMERS

SECONDARY MARKETS

ST	CTY	TOWN	OPERATOR	PLANT	BTU/LB	% SULF	(000)	CARRIER	MILEAGE	RATE
AZ	MARICOPA	PHOENIX	PHOENIX CEMENT	PHOENIX CEMENT	13,400	0.60	95	ATSF/SP	481	$6.97
AZ	MOHAVE	PEACH SPRINGS	GENSTAR	NELSON	12,000	1.00	75	ATSF	378	$5.48
AZ	PIMPA	RILLITO	PORTLAND CEMENT	RILLITO	12,000	6.00	150	T	500	$3.25
					TOTAL ARIZONA		**320**			
CA	IMPERIAL	BRAWLEY	HOLLY SUGAR	HOLLY SUGAR	12,800	0.72	23	SP	829	$11.19
CA	KERN	MOJAVE	CAL MAT	CAL PORT CEMENT	11,800	0.60	100	SP	829	$11.19
CA	KERN	LEBEC	LAFARGE CORP.	GEN. PORTLAND, INC.	12,000	2.50	60	T	815	$5.30
CA	KERN	KERN COUNTY	GULF OIL CORP.	FRUITVALE FIELD	13,000	0.70	20	(ATSF)	775	$10.46
CA	SAN BERNADINO	VICTORVILLE	SOUTHDOWN, INC.	S.W. PORTLAND CEMENT	11,300	1.00	250	UP	688	$9.31
CA	SAN BERNADINO	COLTON	CAL MAT	CAL PORT CEMENT	11,800	0.60	130	SP	736	$9.96
CA	SAN BERNADINO	ORO GRANDE	BEAZER WEST	OROGRANDE PLANT	12,000	0.70	250	UP	687	$9.30
CA	SAN BERNADINO	TRONA	KERR-MC GEE	KERR-MC GEE CHEMICAL	12,000	2.50	1,088	TRONA SPUR	793	$10.73
					TOTAL CA		**1,921**			
CO	BOULDER	LYONS	MARTIN MARIETTA	LYONS PLANT	12,000	0.70	100	BN	642	$8.69
CO	DENVER	DENVER	U. S. GOVERNMENT	DENVER FEDERAL CENTER	12,000	0.70	20	T	615	$4.00
CO	FREEMONT	CANON CITY	STATE OF COLORADO	COLORADO STATE PENN.	12,000	0.90	4	T	518	$3.37
CO	PUEBLO	PUEBLO	U.S. GOVERNMENT	U.S. ARMY DEPOT	11,500	1.00	13	T	477	$3.10
					TOTAL CO		**137**			
NM	BERNADILLO	TIJERAS	HOLDERBANK FINANCIER	IDEAL BASIC CEMENT	12,500	1.00	60	DRGW	99	$1.46
NM	LORDSBURG	PLAYAS	PHELPS DODGE	PHELPS DODGE	11,300	1.00	90	ATSF	362	$5.25
					TOTAL NM		**150**			**$0.00**
										$0.00
TX	BEXAR	SAN ANTONIO	BARRETT INDUSTRIES	SOUTHSIDE PLANT	12,000	1.70	4	T	918	$5.97
TX	BEXAR	SAN ANTONIO	REDLAND WORTH CORP.	REDLAND WORTH CORP.	12,000	1.80	13	MKT, MP	918	$12.42
TX	BEXAR	SAN ANTONIO	ALAMO CEMENT	1604 FACILITY	13,000	4.00	67	MP	918	$12.42
TX	COMAL	NEW BRAUNFELS	A.P. GREEN IND. INC.	APG LIME CORP.	11,500	3.50	60	ATSF	884	$11.93
TX	COMAL	NEW BRAUNFELS	TECAS INDUSTRIES	TXI CEMENT	11,500	1.20	24	MP	884	$11.96
TX	DEAF SMITH	HEREFORD	HOLLY SUGAR	HOLLY SUGAR	12,900	0.45	23	ATSF	378	$5.48
TX	EASTLAND	RANGER	JUSTIN IND.	FEATHERLITE CORP.	12,000	7.50	0	MP	649	$8.79
TX	EL PASO	EL PASO	ASARCO	EL PASO SMELTER	13,000	2.00	0	SP	301	$4.39
TX	GRAY	PAMPA	HOECHST CELANESE	PAMPA PLANT	11,300	0.40	500	ATSF, SP	478	$6.93
TX	HARRISON	MARSHALL	MCDONOUGH	GULF COAST CEMENT	12,000	1.50	35	(MP)	923	$12.49
TX	HAYES	BUDA	CENTEX CORP.	TEXAS CEMENT	13,000	1.40	140	MP	845	$11.43
TX	JOHNSON	CLEBURNE	RANGE AIR CORP.	TEXAS LIME	13,000	3.00	50	MKT	775	$10.49
TX	MCLENNAN	WACO	HEIDELBURG CEMENT	LEHIGH PORTLAND CEMENT	12,000	1.00	31	MKT, MP	834	$11.28
TX	NOLAN	MARYNEAL	LONE STAR IND.	LONE STAR IND.	12,000	1.00	85	ATSF	541	$7.30
TX	NUECES	CORPUS	CENTEX CORP.	CENTEX CEMENT CORP.	12,000	1.50	20	MP	1224	$15.33
TX	POTTER	AMARILLO	F & C DIVISION	IOWA BEEF PROC., INC	11,500	1.50	30	T	425	$2.76
					TOTAL TEXAS		**1,082**			

POTENTIAL SAN JUAN BASIN INDUSTRIAL CUSTOMERS

PRIMARY MARKETS

ST	CTY	TOWN	OPERATOR	PLANT	BTU/LB	% S.	AVG.TONS TERMINATING (000)	CARRIER	MILEAGE	RATE
AZ	COCHISE	DOUGLAS	CHEMSTAR, INC.	PAUL LIME	10,500	2.00	15	SP	532	$7.21
AZ	NAVAJO	SNOWFLAKE	STONE SOUTHWEST	SNOWFLAKE PAPER MILL	9,600	1.00	392	ATSF	196	$2.84
AZ	VAVAPAI	CLARKDALE	GIFFORD-HILL & CO.	CLARKDALE CEMENT	11,000	1.00	66	ATSF	363	$5.26
				TOTAL ARIZONA			**473**			
CA	KERN	BAKERSFIELD	ULTRAPOWER	ULTRAPOWER-OGLE	0	0.00	100	ATSF	790	$10.67
CA	SAN BERNADINO	LUCERNE VALLEY	MITSUBISHI	CUSHENBURY PLANT	11,000	1.00	250	ATSF	680	$9.18
CA	SAN DIEGO	SAN DIEGO	ENERGY FACTORS	DISTRICT ENERGY	0	0.00	0	(ATSF)	989	$13.35
				TOTAL CA			**350**			
CO	CHAFFEE	SALIDA	CALCO LIME	CALCO LIME	10,000	1.00	11	TRUCK	573	$3.72
CO	FREEMONT	FLORENCE	IDEAL BASIC	IDEAL CEMENT	10,000	1.00	200	(ATSF)	510	$6.89
CO	GARFIELD	CARBONDALE		MIDCONTINENT	0	0.00	5	(D&RGW)	754	$10.20
CO	JEFFERSON	GOLDEN	ADOLPH COORS	COORS ENERGY	6,500	0.90	400	CS	631	$8.54
CO	LARIMER	FORT COLLINS	IDEAL BASIC	BOETTCHER	10,300	1.00	40	BN	689	$9.33
CO	LARIMER	LOVELAND	HUNT INTL	GREAT WESTERN SUGAR	10,800	1.00	47	BN	669	$9.06
CO	LAS ANIMAS	TRINIDAD	TRINIDAD MUNI P & L	TRINIDAD	0	0.00	6	(ATSF)	371	$5.38
CO	MESA	FRUITA	LOUISIANA PACIFIC	PABCO DIVISION	0	0.00	0	(D&RGW)	822	$11.12
CO	MORGAN	FORT MORGAN	HUNT INT'L	GREAT WESTERN SUGAR	10,800	1.00	75	(UP)	693	$9.38
CO	PUEBLO	PUEBLO	STATE OF COLORADO	CO. STATE HOSPITAL	10,000	1.00	19	T	477	$3.10
CO	WELD	GREELEY	TATE AND LYLE	GREAT WESTERN SUGAR	9,800	1.00	45	BN	667	$9.03
				TOTAL CO			**848**			
NM	GRANT	HURLEY	PHELPS DODGE	CHINO MINES	8,000	1.50	100	ATSF	372	$5.39
TX	BASTROP	ELGIN	ELGIN BUTLER BRICK	ELGIN BUTLER BRICK	5,000	3.00		MKT	820	$11.10
TX	BEXAR	SAN ANTONIO	CAPITOL AGGREGATES	CAPITOL CEMENT	11,000	3.00	100	T	918	$5.97
TX	BOSQUE	CLIFTON	CHEMICAL LIME	BOSQUE CTY. PLANT	10,000	1.00	110	(MKT/TK)	730	$9.91
TX	BURNET	MARBLE FALLS	CHEMICAL LIME	BURNET PLANT	10,000	1.00	0	AU NW	879	$11.89
TX	COMAL	NEW BRAUNFELS	LAFARGE CORP.	GEN. PORTLAND, INC.	10,000	2.50	80	MKT	884	$11.96
TX	ECTOR	ODESSA	SOUTHDOWN, INC.	S.W. PORTLAND CEMENT	10,000	1.50	90	MP	588	$7.96
TX	ELLIS	MIDLOTHIAN	TEXAS INDUSTRIES INC.	TEXAS INDUSTRIES INC.	10,500	1.50	250	ATSF	778	$10.50
TX	ELLIS	MIDLOTHIAN	NORTH TEXAS CEMENT	MIDLOTHIAN PLANT	11,000	1.70	70	T	778	$5.06
TX	HARRIS	HOUSTON	ANHEUSER BUSCH	HOUSTON BREWERY	0	0.00	0	SP	937	$12.67
TX	HARRIS	HOUSTON	FLORIDA CRUSHED STONE	HOUSTON PLANT	10,000	0.70	0	SP	937	$12.67
TX	HARRISON	LONGVIEW	EASTMAN KODAK	TEXAS EASTMAN	7,000	0.60	500	UP	900	$12.18
TX	MILAM	ROCKDALE	ALUMINIUM CO OF AM.	ROCKDALE WORKS	7,000	1.00	570	(MP)	852	$11.53
TX	TRAVIS	AUSTIN	AUSTIN WHITE LIME	AUSTIN WHITE LIME	11,000	0.65	60	MP	841	$11.38
				TOTAL TX			**1,830**			

APPENDIX C

SAN JUAN BASIN BUSINESS CATEGORIES CONTACTED FOR NONCOAL ANALYSIS

San Juan Basin Business Categories Contacted for Non-coal Analysis

1. Acoustical Contractors and Supplies
2. Appliances
3. Automobile Dealers/Parts
4. Bakers-Wholesale
5. Boat Dealers
6. Boxes - Corrugated and Fiber
7. Brick - Clay (Albuquerque Only)
8. Building
9. Buildings - Metal
10. Carpet Dealers
11. Chemicals
12. Compressors
13. Concrete Aggregates
14. Concrete Blocks
15. Concrete Products
16. Contractors Equipment and Supplies
17. Conveyors
18. Counter Tops
19. Culverts
20. Diesel Fuel
21. Doors
22. Dry Wall Contractors
23. Electrical Equipment
24. Engines
25. Farm Equipment
26. Farm Supplies
27. Feed Dealers
28. Fence
29. Fireplaces
30. Floor Materials
31. Furniture
32. Gas Propane
33. Generators
34. Hardware
35. Heating Equipment
36. Hydraulic Equipment
37. Industrial Equipment
38. Irrigation Equipment
39. Lumber
40. Mining Equipment
41. Office Furniture
42. Oil and Gas Cementing
43. Oil and Gas Field Supplies
44. Oil and Gas Well Drilling Mud
45. Paint Wholesale
46. Pipe
47. Produce - Wholesale
48. Recycling Centers
49. Refrigerating Equipment
50. Roofing Materials
51. San and Gravel
52. Steel Distributors
53. Stone
54. Tanks
55. Tile - Ceramic
56. Tractors

APPENDIX D

HI CUBE II

High Cube
High Performance
Covered
Hopper Car

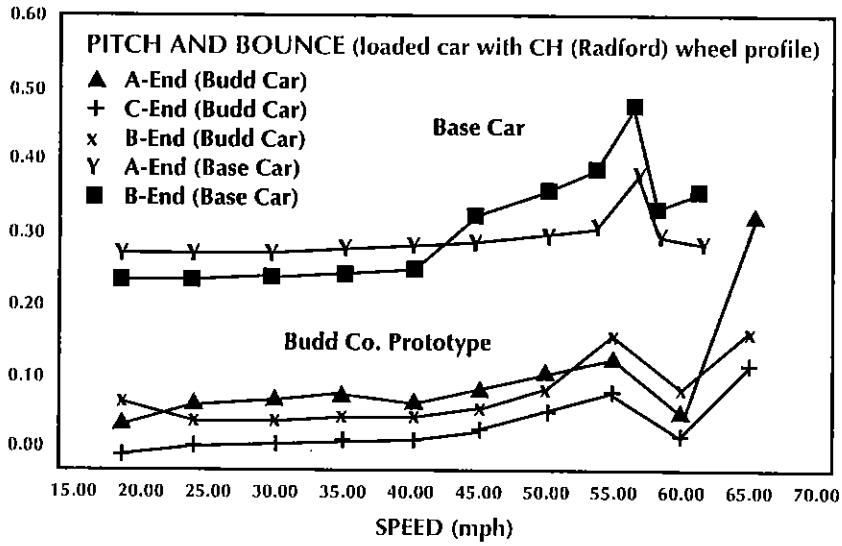
EQUIPMENT AND SPECIALTIES

- "Ride Control" trucks
  - 16" diameter center plate
    1- 100 ton with 36" wheels, 6 1/2 x 12 roller bearings, D5 springs (90C - 5 IC)
    2- 70 ton with 33" wheels, 6 x 11 roller bearings, D5 springs (70C - 6 IC)
- Constant contact side bearings, 8 per 2 unit car
- Articulated connector with 16" dia. center plate
- SBE 60 CHT couplers
- High capacity M901G draft gears, Y40AE yokes
- *Truck mounted brakes with integral slack adjuster, 8-1/2" dia. brake cylinders
- ABDW brake valve with fabricated reservoir
- 1 group "L" intermediate power hand brake
- 4- 24" x 30" gravity outlet gates
- 24" trough hatch with 12'-11-3/4" reinforced plastic covers

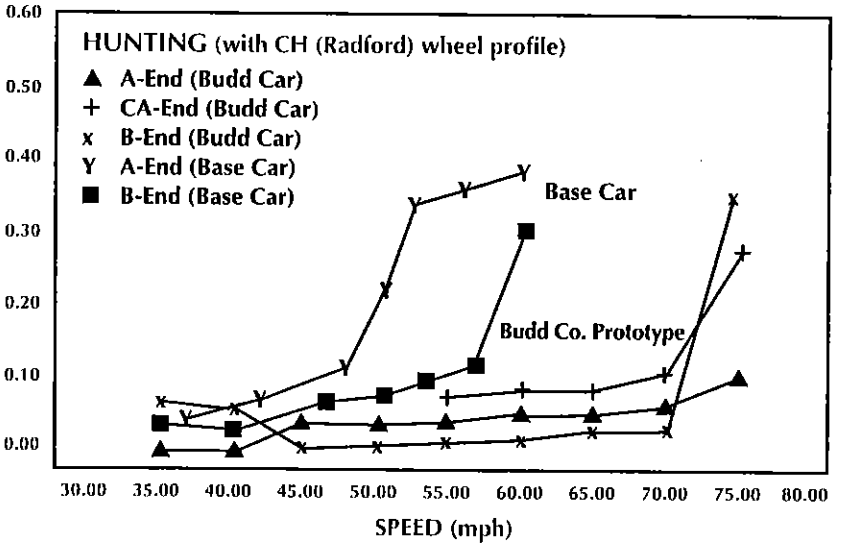
** A body mount ABU brake system is also available.*

Note: Specialties are suggested; if customer desires other suppliers, they can be considered.

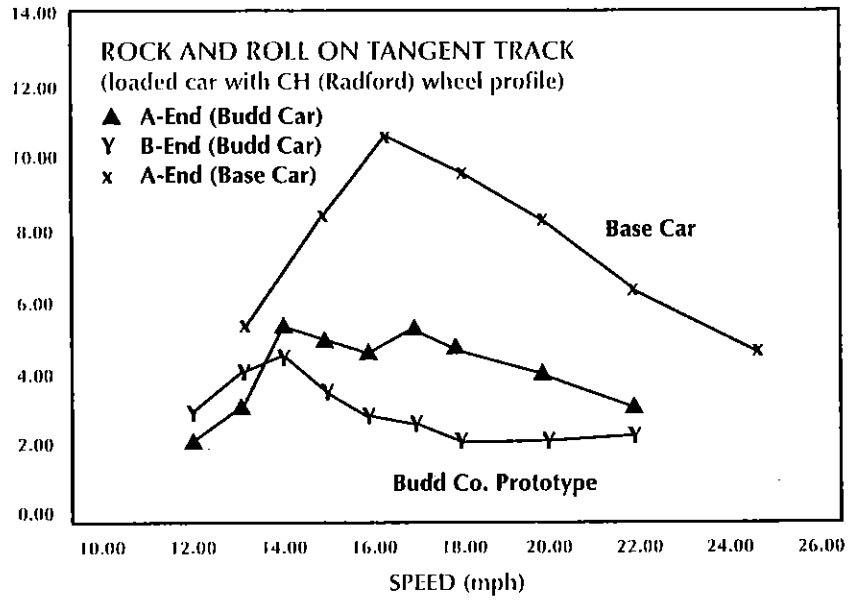
TYPICAL TEST RESULTS
Hi Cube 2000 vs. Conventional 4750 cu. ft. Car



RMS Vertical Acceleration at Center Plate *versus* Speed (Tangent Track, Loaded Condition)

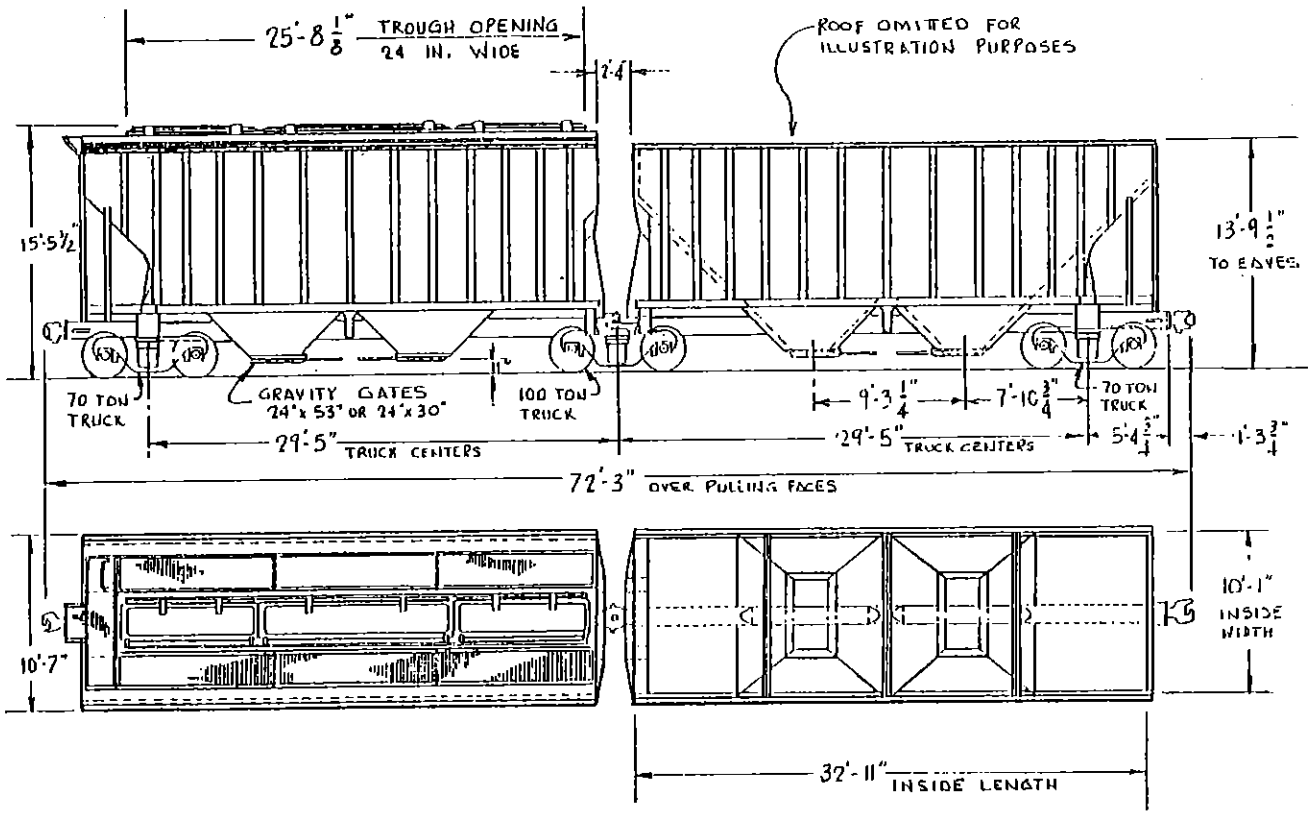


Car body RMS Lateral Acceleration *versus* Speed.



Peak-to-Peak Roll Angel *versus* Speed (Tangent Track, Loaded Condition)

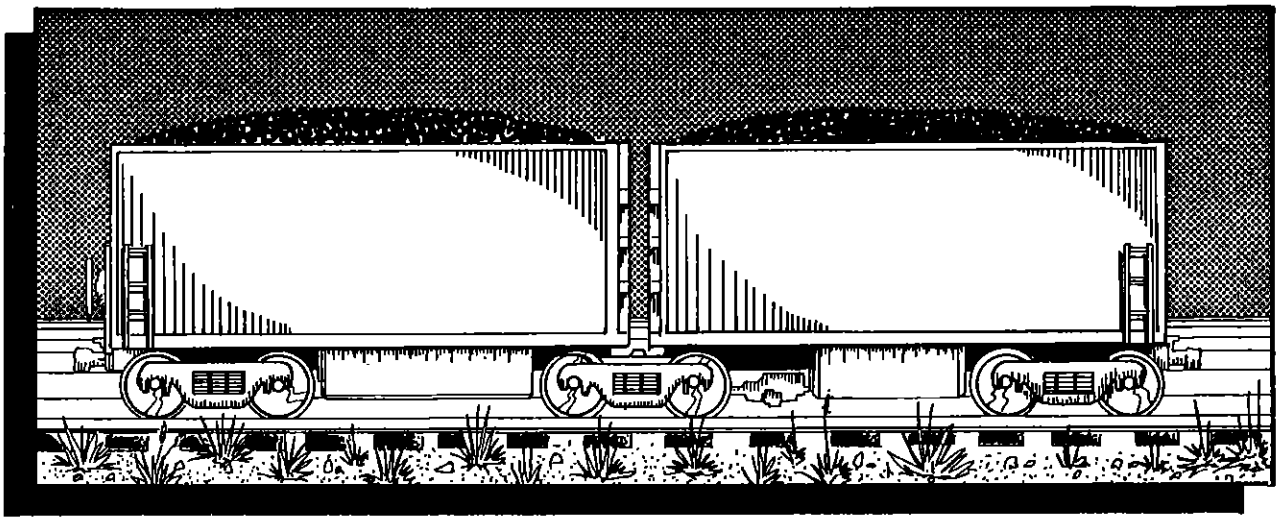
HIGH CUBE HIGH PERFORMANCE COVERED HOPPER CAR



APPENDIX E

HI CUBE II
Rotary Dump
Coal Gondola

HI CUBE II



ROTARY DUMP COAL GONDOLA

FREIGHT CAR PRODUCTS

Transit America Inc.

ROTARY DUMP COAL GONDOLA

Specifications for 2 unit high capacity rotary dump coal gondola

CAR DESCRIPTION:	2 unit/3 truck rotary dump coal gondola with thru center sill and twin tub floor construction
MATERIALS:	Welded steel design utilizing low alloy steels with minimum yield strengths of 50,000 PSI and low carbon steel.*
CAR CAPACITY: *(Volumetric)*	4800 cu. ft. level full (eastern version) 5200 cu. ft. with 10" avg. heap (eastern version) *Note: Eastern version is 12'-9-15/16" high.* 5050 cu. ft. level full (western version) 5450 cu. ft. with 10" avg. heap (western version) *Note: Western version is 13'-4" high.*
CAR CAPACITY: *(Weight)*	280,000 lbs. (140 tons)* *Note: Car capacity and load limit are below truck load limits due to center truck loading restriction.*
LIGHT WEIGHT:	63,000 lbs.*
GROSS WEIGHT:	343,000 lbs.*
LENGTH OVER PULLING FACES:	53'-1"
INSIDE LENGTH:	24'-0-1/8" @ top of car (x2)
LENGTH OVER END SHEETS:	49'-11-1/8"
TRUCK CENTERS:	20'-3 1/4" (x2)
MAX. WIDTH:	10'-7" over structure 10'-8" over safety appliances

** An Aluminum body steel underframe version of the car will weigh 57,000 lbs. and have a capacity of 285,000 lbs.*

INSIDE WIDTH: 10'-5-3/4" @ top of car

EXTREME HEIGHT: 12'-9-15/16"
(optional center loading baffle will be higher and can be made to suit)

FLOOR HEIGHT: 3'-5-11/16"

HEIGHT OF TUB: 0'-11"
(bottom of tub to top of rail)

COUPLER HEIGHT: 2'-10-1/2"

AAR CLEARANCE PLATE: "B"

MIN. HORIZONTAL CURVE: 150 ft. (uncoupled)

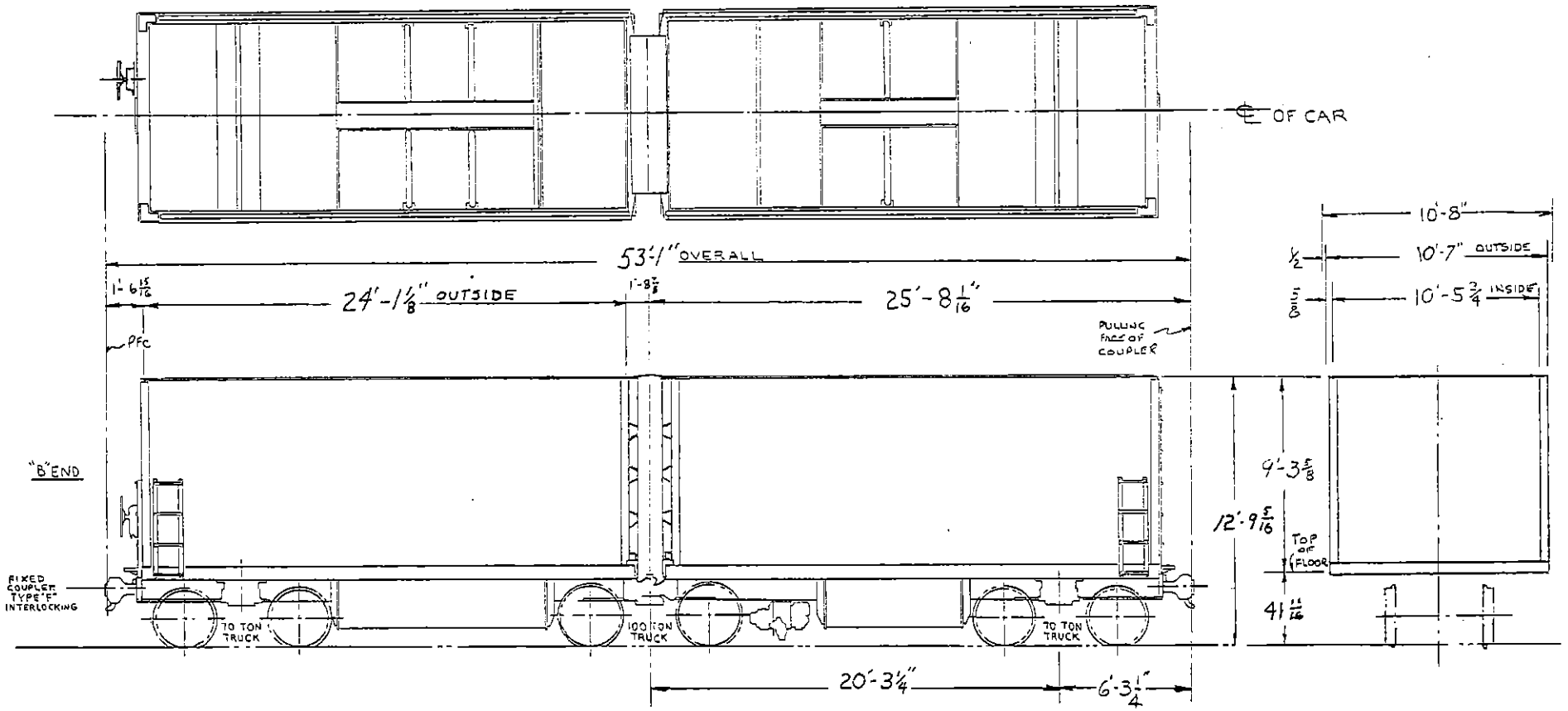
MIN. VERTICLE CURVE: 300 ft.

Comparison of Articulated Rotary Dump Coal

Type of Car	*Car Construction*	*Car Length over P.F.*	*Car Height*	*Volume cu. ft.*	*Capacity @ 50#/cu. ft.*	*Capacity @ 55#/cu. ft.*	*Load Limit*	*Tare Wt*	*Net/Tare @ ld. lmt*
ROTARY DUMP	Steel body/Steel UF	53'-1"	12'-10"	-4800 -5200 w/ 10" heap	240,000 260,000	264,000 286,000	286,000#	63,000#	4.54
ROTARY DUMP	Alum. body/Steel UF	53'-1"	13'-4"	-5050 -5450 w/ 10" heap	252,500 272,500	277,750 292,000	292,000#	57,000#	5.12
ROTARY DUMP	Alum. body/Steel UF w/125 Ton Truck	55'	13'-4"	-5295 -5710 w/ 10" heap	264,750* 285,500*	291,225* 313,000	313,000#	60,500#	5.17

* Can also be achieved with 100T Center Truck.

ROTARY DUMP COAL GONDOLA



VOLUMETRIC CAPACITY = 4800 CU. FT. (LEVEL FULL)

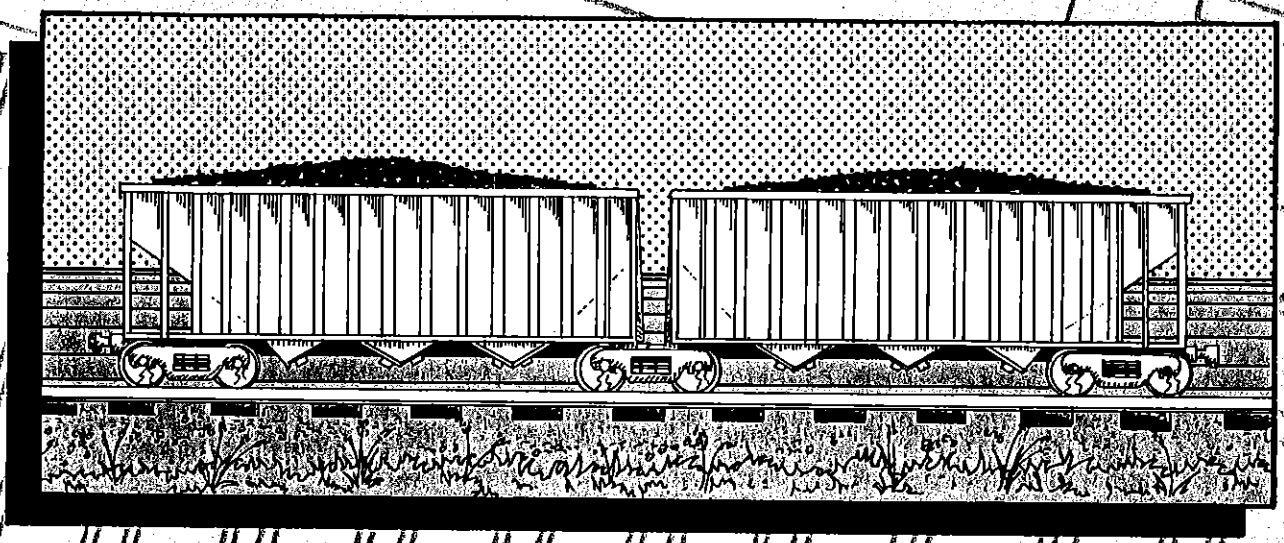
WEIGHT CARRYING CAPACITY = 283,000 LBS

FREIGHT CAR PRODUCTS *DIVISION TRANSIT AMERICA INC.* NO. 1 Red Lion Road, Philadelphia, PA 19115 (215) 934 - 3421

APPENDIX F

HI CUBE II
Quick-Discharge Coal Hopper

HI CUBE II

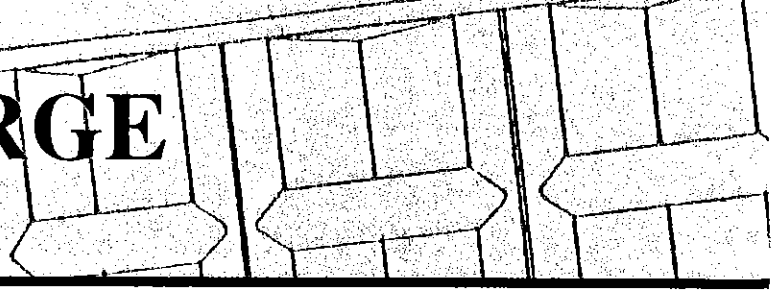


QUICK-DISCHARGE COAL HOPPER

FREIGHT CAR PRODUCTS

Transit America Inc.

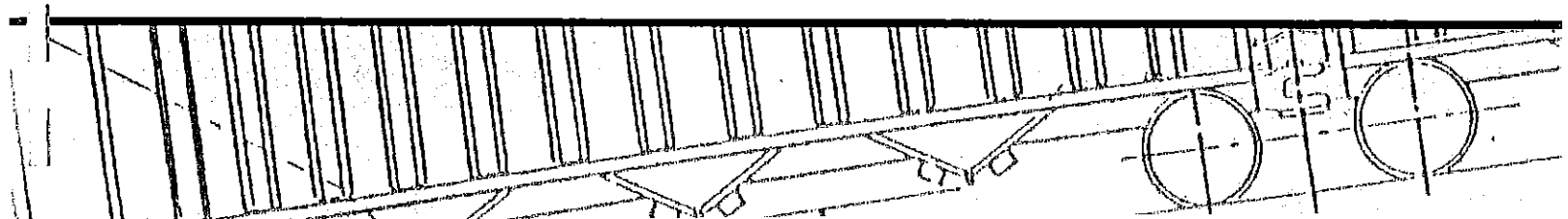
QUICK-DISCHARGE COAL HOPPER



Specification
Transit America/Freight Car Products Operation
High Capacity Quick Discharge Coal Car

CAR DESCRIPTION:	2 unit/3 truck articulated car for quick discharge bottom dump coal or aggregate service
CAR CONSTRUCTION:	*Welded steel underframe with thru center sill; aluminum car body structure utilizing mechanical fasteners and welded construction
MATERIALS:	*High strength low alloy steel with 50KSI yield strength and aluminum alloy sheet (5083-H321) and extrusions (6061T-6)
LADING DESCRIPTION:	Coal with densities up to 60 lbs. per cu. ft. (car capacity based on 55 lb. per cu. ft. coal)
CAR CAPACITY: *(Volumetric)*	5600 cu. ft. per car
CAR CAPACITY: *(Weight)*	300,000 lbs. per car (150,000 lbs. per unit) based on 55 lbs. per cu.ft. coal
LIGHT WEIGHT:	68,000 lbs.
GROSS WEIGHT:	368,000 lbs.
LOAD LIMIT:	300,000 lbs.
LENGTH OVER COUPLER PULLING FACES:	73'-9"
LENGTH OVER STRIKERS:	71'-1-1/2"

** An all steel version is also available with a light weight of 75,000 lbs.*



INSIDE LENGTH: 33'-4" (x2)

TRUCK CENTERS: 30'-7-1-1/4" (x2)

INSIDE WIDTH: 9'-11"

EXTREME WIDTH: 10'-7"

EXTREME HEIGHT: 12'-10"

SLOPE SHEET ANGLES: 45°

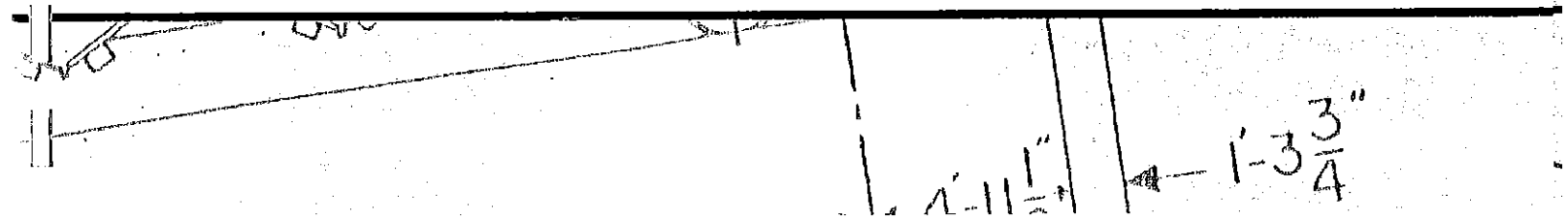
MIN. HORIZONTAL CURVE: 150'R (uncoupled)/185'R (coupled to base car)

MIN. VERTICLE CURVE: 500'R (uncoupled)/785'R (coupled to base car)

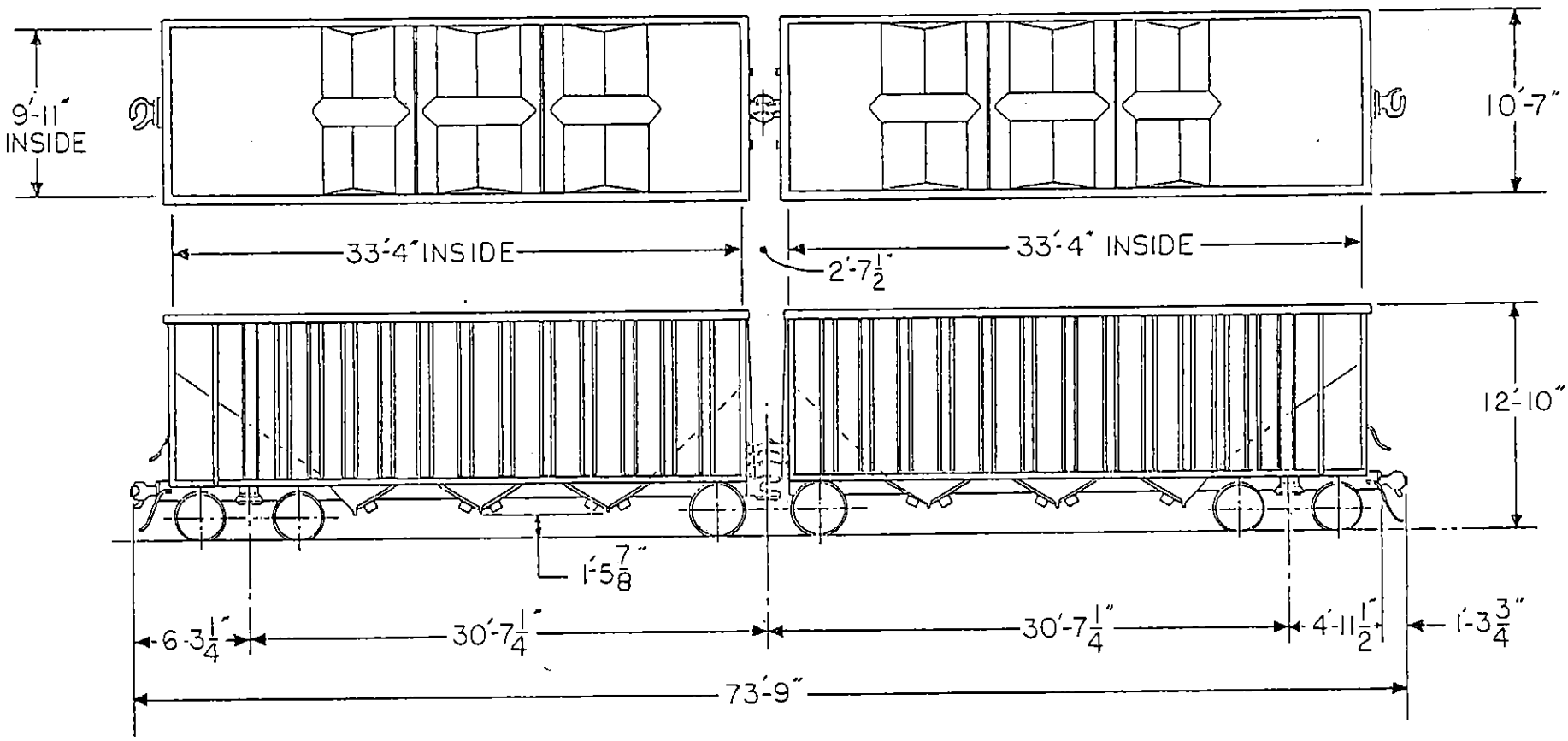
COUPLER HEIGHT: 34-1/2" above T.O.R.

Comparison of Typical Coal Hoppers

Type of Car	*Construction Material*	*Nominal Capacity (Tons)*	*Approx. Cubic Capacity (Cu. Ft.)*	*Capacity (Lbs)*	*Tare Weight (Lbs)*	*Net to Tare Ratio*	*Remarks*
TRIPLE HOPPER	Steel	70	2,800	154,000	55,000	2.80	Pre-1970 design stretched 50T Double Hopper
TRIPLE HOPPER	Steel	100	3,400	200,000	58,000	3.45	Pre-1970 design
QUAD HOPPER	Steel	100	3,600	205,000	58,000	3.53	Post-1970 design for lighter density western coal
QUAD HOPPER	Steel	100	4,000	200,000	60,000	3.33	Post-1970 design with maximum cubic capacity
QUAD HOPPER QUICK DISCHARGE	Steel & Aluminum	106	4,000	212,000	51,000	4.16	Current design
QUAD HOPPER QUICK DISCHARGE	Steel	98	4,000	198,000	65,000	3.05	Current design
ARTICULATED 2-UNIT QUICK DISCHARGE	Steel & Aluminum	150	5,600	300,000	68,000	4.41	Hicube 2000 design



QUICK-DISCHARGE COAL HOPPER



HICUBE II QD
CAPACITY 300,000 LBS.
5600 CU. FT.

FREIGHT CAR PRODUCTS *DIVISION TRANSIT AMERICA INC.* NO. 1 Red Lion Road, Philadelphia, PA 19115 **(215) 934 - 3421**

APPENDIX G

COMMONLY ASKED QUESTIONS AND ANSWERS ABOUT BIOLOGICAL FARMING

Commonly Asked Questions and Answers About Biological Farming

Q.) What is Biological Farming, FERTIMAX and Clod Buster?

Biological Farming insures the soil is fed and the biological elements in the soil are used to their fullest, providing optimum nutrition to the plant. The soil microflora then produce organic matter and Nitrogen, release Phosphate, Potash and other plant nutrients. Great increases of organic matter occur in low organic matter soils through microbial formation of organic compounds. All of these actions balance the soil nutrients, reducing input chemical costs, and plant stress resistance is improved, giving greater latitude in management and better crop survivability in times of stress.

Biological Farming is the scientific establishment of soil environments suitable for the spontaneous occupation by and proliferation of beneficial soil organisms, which, in turn, produce truly fertile, truly productive soils; increasing the availablility of nutrients through organic complexing. In short, it was what our farming parents recognized: "A fertile soil is a living soil."

FERTIMAX is the name of our total soil management program: the technical and management approach we use to create the best possible environment for Biological Farming. Because many areas of the country offer only NPK Fertilizers, we now blend specialized fertilizers (K-Mag, K2504, etc.) and micronutrients (Zinc, Borax, etc.) into Clod Buster, which then becomes FERTIMAX fertilizer, assuring that soil environments are stable FERTIMAX is total soil management and assures that soil environments are suitable.

Clod Buster is the master catalyst for FERTIMAX Total Soil Management. Its activities are numerous: the humic acids it contains perform wonders in the soil. The sooner Clod Buster is applied, the greater the improvement on your next crop will be.

Clod Buster is a unique, geologically concentrated form of humus with the necessary properties to make Biological Farming work. Clod Buster is fully ACTIVE organic matter unlike crop residue or compost, which are not fully active and will continue to decompose once put on the soil, using the valuable soil nutrients, such as nitrogen, in the process. "Crude" organics, such as feed lot manures, contain high salt levels, which build up in the soil and cause salt toxicity. Salt is added to feed lot rations and is the source of sodium. Animal manures contain high phosphate levels, which reduce the calcium availability in Eastern soils, and cause weed problems.

Q). I come across such terms as "sustainable", "renewable", etc. agriculture. Do you claim that Biological Farming is either, or both?

You can't "take" from the soil without putting back. Some soils have tremendous stores of all essential plant mineral foods; constant monitoring and replenishment of the low-level minerals is necessary. For example, the survivors at farming in much of the Deep South are applying up to 3,000 pounds of chemical fertilizers per acre of tobacco; 1,700 pounds for corn, and even 700 pounds for soybeans (unless following wheat).

Q). What can I expect from Biological Farming?

Freedom from problems found in today's normal farming practices and reduced input costs. Most of the soils we've worked with have plenty of phosphate, and we reduce the need for more by releasing it. Nitrogen can be produced in large amounts, if the soil is well-balanced and healthy, and the potash tied up in many soils can be released with our program.

Many of the problems blamed on the weather, such as lack of pollination, are actually soil related problems. Drought resistance can be raised substantially by balancing the salts in the soil, improving nutrient availablility, and increasing organic matter, which is normal for the FERTIMAX program. Weeds are a Calcium:Magnesium:Potash problem, which are yield limiters, because they rob the crop of nutrients in the soil. When the soil is in balance with the FERTIMAX program, we find crops are so vigorous that weeds rarely reduce yields.

On Western alkalai soils, the reduction of pH, increase in organic matter, and absorbtion of excess salts result in higher yields, better quality, healthier plants, reduced nitrogen requirements, and reduced water need (particularly if it is used for leaching salts).

Q). Does Biological Farming give any protection against insects?

We have not observed anything, even the deadliest chemicals, which give complete protection against insects in all situtations. However, we have frequently been shown by particularly observant farmers the great difference in corn-borer damage where dairy manure, manure and fertilizer, and Clod Buster and fertilizer were applied on various strips in the same soil.

An invasion of locusts will consume anything in its path that is green. On the other hand, earthworms are nature's greatest insecticide, as they thrive in Biologically Farmed soils, consuming insect eggs and larvae.

Q.) How does composting work on your program?

We can improve composting greatly by using Clod Buster as an innoculant because when well-mixed at a rate of 10-20% by weight, it provides the best form of microflora to stimulate decomposition of the composts.

One family of microflora can be seen as long, needlelike structures and are called actinomycetes, which secrete gels that hold the soil together. They increase organic matter in the soil and prevent nitrogen, as ammonia, from being lost by evaporation (the ammonia smell) and convert it to organic forms which are more stable and longer lasting. This technique is not a "hot" one, occurs very rapidly and is complete, thereby reducing the odor substantially. Once the compost is put on the soil, it goes to work rapidly to propogate other microflora and increase the biological activity in the soil.

Manures contain bacteria which are digestive related microflora and are antagonistic (harmful) to soil borne microflora. Clod Buster's microflora converts manure bacteria to soil microflora types which are more beneficial to the soil and plant. Composting with Clod Buster may take longer, but produces better, more completely decomposed and soil active humus from manures, paper, or other organics.

Composting is recommended, provided the salts are low in the feed stock, the phosphates are under control, and a soil test is used to determine other necessary micronutrient levels. Application rates of compost started with Clod Buster can be less because of the increased activity in the compost.

Q.) How does the FERTIMAX Program affect weeds?

If you notice, certain parts of a field will be more weedy than others. This is purely soil based differences. All other factors can be the same and weeds will persist or not. Applications of manure or compost will often promote weeds, not necessarily from additional weed seed content, but because the soil nutrient imbalances generated by these materials. The FERTIMAX Program

will change soil fertility and reduce weed pressure. In transitioning to this increased fertility, however, weeds will often germinate and emerge. This often raises serious concern with the grower who is likewise amazed to see the weeds disappear as the soil transitions further into fertility. It may take a season for this to occur. Maintenance applications are necessary to keep weeds from returning.

Q.) Exactly how is nitrogen produced under FERTIMAX?

Nitrogen is a growth stimulant and plant food which increases uptake of other nutrients. However, if the other nutrients are available, then ther is less nitrogen required, which means less water demand. Higher available nutrients also reduces water needed to solulitize nutrients. Nitrogen has been leaned on excessively for plant nutrition and leads to poor crops, water table contamination and other short and long term problems.

The two accepted methods of building soil nitrogen without adding chemical nitrogen are (1) to rotate to legumes, which "fix" nitrogen in the nodules on their roots (when the soil environment is suitable), and (2) to spread great quantities of manure, costly compost, or "plow down" of green manure crop to build soil organic matter, which is then "mineralized" to provide nitrogen.

Apparently completely overlooked, or intentionally ignored is the scientific fact that all soil organisms are protoplasm, which is protein, which is organic nitrogen.
Under the FERTIMAX Total Soil Management Program, the suitable soil environment established attracts the myriads of micro-organisms and earthworms, often written about, but heretofore not considered as THE MAJOR SOURCE of soil organic matter! In previous methods of soil management (organic and chemical), no lasting, higher levels of soil organic matter were possible. Under Biological Farming, the much greater quantities of soil organic matter are constantly replenished from the remains of beneficial soil organisms, consequently a steady supply of nitrogen is "mineralized" for crop use.

Because the USDA scientists bragged about increasing the soil organic matter by 12,000 pounds per acre in 25 years, we selected this sample of Biologically Farmed soil because the soil organic matter was also increased by 12,000 pounds per acre--BUT IN JUST FIVE MONTHS.

Q). Do I have to quit ag chemicals to farm biologically?

Of course not. Not all ag chemicals destroy soil organisms, not sterilize the soils. Biological Farming is highly successful whether done with ag chemicals or done to maintain "Organic Farming Certification." However, we refuse to supply Clod Buster to a farmer who continues to use Anhydrous Ammonia and/or Muriate of Potash (the K of NPK; 0-0-60) because that form of potash is Potassium Chloride. (Would you knowingly inject 120 pounds of chlorine gas per acre in your soil? That's what those who use Potassium Chloride do every time they apply 200 pounds of 0-0-60, or its equivalent).

Q). Someone offered to sell me a bacterial preparation which is supposed to work at one pint per acre. Should I buy?

Any element, by itself, MAY work. If there is something else missing that is essential for crop production, complete results will not be realized. Money has been wasted over and over again on miracle products.

The idea of applying bacteria to the soil to produce nitrogen has been tried for decades with spotty results. If there are too many chlorides, the bacteria will not survive and multiply to produce nitrogen. No life form can exist in an unsuitable environment and putting bacteria in most soils is sentencing them to death by starvation. Bacteria are not the most soil active microflora, other

microflora are much more important.

Other soil innoculants, stimulants, algae, and seaweed preparations are likewise limited. Only through a total program can you get maximum yields. Some products will give temporary improvements, only to give way to reduced benefits as some nutrient is consumed. This is the reason why many organizations are formed and disappear after a year or two and why product names are changed frequently.

FERTIMAX provides positive benefits and is not a "hit or miss proposition", as are singular applications of some preparations.

Q). How do you feel about Anhydrous Ammonia or other Nitrogen Forms?

Anhydrous Ammonia is a curse. It will oxidize and solubilize the organic matter in the soil, reducing it to inert ash. It immediately sterilizes a region where it is injected, killing nitrogen producing bacteria and other microflora. This limits the soil's ability to heal itself and balance. Ammonia is a known pH reducer in the soil and acidification of the soil will reduce calcium availability and cause an imbalance.

Ammonia forms Ammonia Hydroxide when mixed with soil moisture, causing the micronutrients, zinc, iron, manganese, and the major nutrients such as calcium and magnesium, to form hydroxides, which are largely insoluble. All of the hydroxides form cements which bind the soil particles tightly together, froming hte crusts which prevent water penetration, and hard soil, which reduces root growth and overall fertility of the soil.

When Anhydrous Ammonia is used with Clod Buster, improvements are generally reduced, but can be reversed by additional Clod Buster application. The reason appears to be that ammonia solubilizes reactive soil organic matter and Clod Buster's humus, thus causing it to leach.

We recommend other forms of Nitrogen, Liquid UN 32 and Urea, when necessary. The nitrate and sulfate forms are our preferred order of nitrogen. These forms have proper stability, availability, and chemical inertness in the soil. Cost factor can be part of your selection process and application equipment.
You will notice the use of nitrogen to reduce crop residue can be greatly reduced once the soil becomes active. Some nitrogen may still be recommended to supplement a high crop residue level, which will be consumed quickly on the program and will be reduced to organic matter rapidly.

Q). What will the FERTIMAX program cost?

FERTIMAX cost is divided into three parts: Clod Buster cost, additional micronutrient cost, and freight. Clod Buster, Clod Buster with micronutrients, and micronutrients without Clod Buster run $20-60 per acre for your heavier first application. Because of the individual needs of each soil, cost is not quoted more specifically prior to a soil analysis. All shipments are made by truck so freight rates fluctuate, but are always based on geographical proximity. Our Delaware customers, therefore, pay more than our New Mexico customers. Once the soil is started in the right direction, it needs very little to keep improving.

Q). When is the best time to start FERTIMAX?

NOW! The FERTIMAX program is most economical as a fall program, but such is often not possible. Fall treatment makes the soil work over the winter and results in an active soil in the spring. Soil is workable earlier; with the microfloral activity going, it will warm up sooner. Release of phosphate and potash take place during the dormant season. Nitrogen is produces in warmer soils and will begin production sooner. Spring application of the FERTIMAX program will

produce improvements that season.

We recommend the program as an annual event. The starting application will be higher than subsequent maintenance levels, but we have seen soils deteriorate rapidly when not maintained. The stress of growing a crop removes organics, which are supplied in Clod Buster, and which are built by biotic activity, thus the soil is kept active and highly productive. A growing crop and changing soil will always use up the micronutrients, so they require constant maintenance. The FERTIMAX program is a continuous program designed to optimize soil and plant conditions for top yields.

This series of Questions and Answers has been designed to assist you in your pursuit towards quality, high yield production. If you have any further concerns, we welcome your calls or letters.

Happy Farming!!

Leland B. "Lee" Taylor, Chairman

Leland T. "Tom" Taylor, President

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APPENDIX H

ARCO
EC-X FORMULA

The new formulation is made possible through a number of major changes in refining processes that affect distillation temperatures, oxygenate blending, and production of high octane components, said Cook. To make the fuel available in time to meet California's 1996 clean fuel requirements will mean substantial modifications at ARCO's Los Angeles Refinery over the next several years.

"The test results on our new formulation are spectacular. The regulatory agencies were fearful that gasoline reformulated to reduce hydrocarbon emissions would increase nitrogen oxide (NOx) emissions. ARCO has solved that problem," said Cook.

In designing the new formula, ARCO used data from the joint Auto/Oil Air Quality Improvement Research Project and ARCO's own Clean Fuels Task Force. Testing was conducted at a nationally recognized independent laboratory on a fleet of ten late model cars. ARCO's test results have been shared with the California Air Resources Board (ARB) and the South Coast Air Quality Management District (SCAQMD).

Compared to the average U.S. conventional gasoline in late-model vehicles, EC-X showed reductions of 28 percent in hydrocarbon tailpipe emissions, 36 percent in evaporative emissions, and 26 percent in NOx emissions -- the three main ingredients in smog. The fuel also achieved a 25 percent reduction in carbon monoxide (CO) emission and a 47 percent reduction in tailpipe emissions of toxic compounds. If used by all motorists in California, the EC-X formulation would reduce total hydrocarbon emissions each day by 580,000 pounds, NOx emissions each day by 280,000 pounds,

pollutants each day, including carbon monoxide, by 3.8 million pounds.

Other important environmental aspects of EC-X include: ultra low sulfur content, low distillation temperatures, very low olefin content, high oxygen content, and reduced Reid Vapor Pressure and aromatics content. The fuel has also been designed for outstanding driveability performance.

Test results also indicate that emissions from 1990 model-year vehicles using the EC-X formulation are no greater than emissions from state-of-the-art flexible fuel vehicles using M85, a blend of 85 percent methanol and 15 percent gasoline which some people believe is the major alternative to gasoline. This comparison applies to all major categories: hydrocarbon smog-forming potential, NOx, CO and toxics. EC-X's smog-forming potential has been reduced 37 percent through a reduction in both the mass and reactivity of its hydrocarbon emissions. (Reactivity is a measure of a hydrocarbon's ability to form ozone.)

"More importantly, the benefits of EC-X formulations can be realized as soon as the fuels are on the market," said Cook. "Comparable pollution reductions from alternative fuels such as M85 will not occur until specially built vehicles make up a significant portion of the on-the-road fleet many years later.

"This is good news for clean air and good news for consumers and the economy. Although EC-X is expected to cost about 16 cents per gallon more to produce than conventional gasoline, M85's fuel production costs are expected to be much higher -- between 25 and

40 cents more per gasoline-equivalent gallon. In addition to the increased fuel cost, an M85 flexible fuel vehicle is expected to cost about $300 more than a gasoline vehicle," Cook said.

ARCO's effort to formulate a new cleaner-burning gasoline began two years ago. EC-1 Regular, the first emission control gasoline, went on sale in September 1989 for use in pre-1975 cars and pre-1980 trucks that are not equipped with catalytic converters. A year later, in September 1990, ARCO introduced its 92-octane EC Premium, the lowest polluting high octane premium ever made for California. EC-X represents a continuation of ARCO's commitment to develop the cleanest-possible gasoline.

ARCO has been the industry leader in the development of cleaner burning fuels. The company began producing unleaded gasoline in 1970, four years before catalytic converters were mandated in California and five years before they were required in all states.

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For more information, contact: Douglas Elmets (213) 486-3181
Albert Greenstein (213) 486-3384

PROPERTIES OF ARCO TEST FUELS

FUEL	INDUSTRY AVERAGE	EC-X	EC-1	EC-P
VAPOR PRESSURE, psi	8.6	6.7	7.6	8.1
BENZENE, Vol %	1.6	0.8	1.0	1.0
AROMATICS, Vol %	34.4	21.6	19.0	23.6
OLEFIN, Vol %	9.7	5.5	10.0	12.5
OXYGEN, Wt %	0.0	2.7	1.0	2.3
T50, F (Degrees)	213	201	209	202
T90, F (Degrees)	323	293	351	320
SULFUR, ppm	349	41	245	113

APPENDIX I

MORE GOOD NEWS ABOUT DIRTY AIR?

CONSERVATION: A CLEAN-AIR SHORTCUT

One of the shortest paths to clean air is fuel conservation. Motorists who practice fuel-efficient driving are not only helping stretch gasoline supplies, they're cutting down on hydrocarbon emissions.

Here are a few simple gas-saving tips that can make a difference to your pocketbook, the environment, and fuel supplies:

+ **Ride share.** Carpools, vanpools, and public transportation are a sure way to reduce fuel consumption, pollution, and traffic congestion as well as wear and tear on your automobile.

+ **Combine short trips.** The worst mileage performance occurs on trips of 10 miles or less in a car that hasn't been driven in several hours. Combine errands to the bank, grocery, or drugstore and patronize neighborhood establishments.

+ **Accelerate smoothly.** More gas is used accelerating than cruising, so avoid jackrabbit starts and get to cruising speeds as soon as traffic conditions allow. Once you reach your optimum cruising speed, keep a light foot on the accelerator.

+ **Watch your speed.** Maintain your car's most efficient speed as closely as safety and the law permit. All cars have their own optimum cruising speed, based on design. For most cars, this is between 40 and 50 miles per hour.

+ **Keep your distance.** Tailgating causes repeated acceleration and braking and wastes gas. Leave room between you and the cars around you to react. Anticipate traffic flow, red lights, and stop signs.

+ **Minimize resistance.** Underinflated tires can reduce efficiency by one mile per gallon or more while causing tread to wear faster. Keep tires properly inflated. Close windows at highway speeds and use internal vents for air circulation. Avoid permanent roof racks.

+ **Get a tune-up.** Fouled plugs eat up gasoline, and poorly maintained cars are major polluters. Have your mechanic regularly check plugs, points, thermostat, antipollution equipment, filters, and wheel bearings and alignment. Remember, check your oil and water regularly and keep a record of mileage performance.

EC-1 Regular: The Breakthrough Fuel

EC-1 Regular, the country's first emission control gasoline, is formulated specifically for older model cars that lack catalytic converters to curb emissions. These vehicles, which furnish primary transportation for thousands of people in the community, produce a disproportionate share of the vehicular pollution in Southern California.

Recognizing that they can contribute to cleaner air by using reformulated gasoline, more customers are buying EC-1 Regular than were formerly using ARCO's leaded regular. EC-1 Regular has resulted in a reduction of 73 million pounds of pollutants from these cars and trucks in just one year (September 1989 – September 1990).

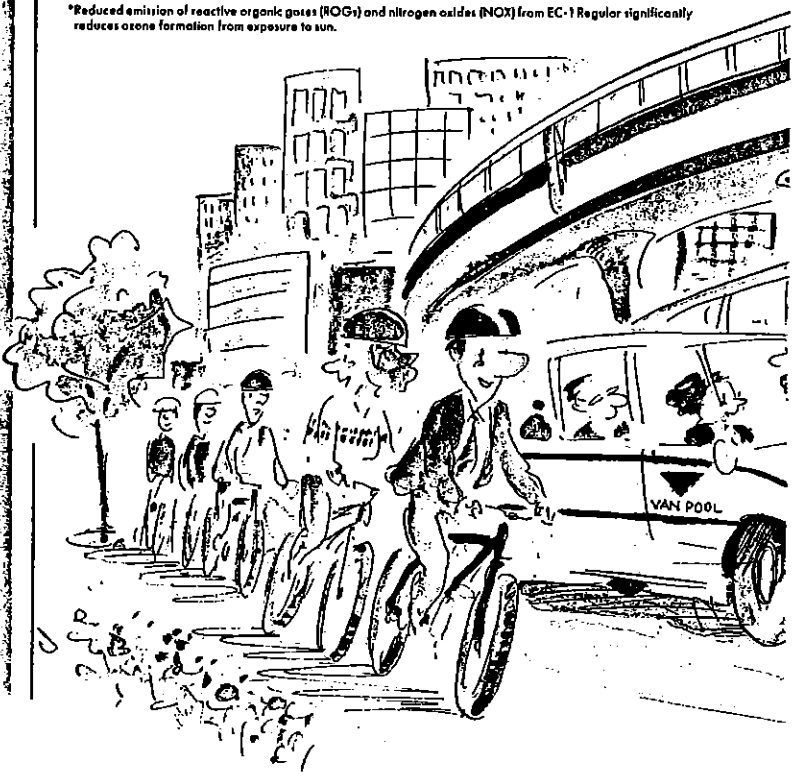
Independently conducted tests show that vehicles using EC-1 Regular emit fewer of the reactive chemical components that are precursors of smog, such as nitrogen oxides and organic gases.

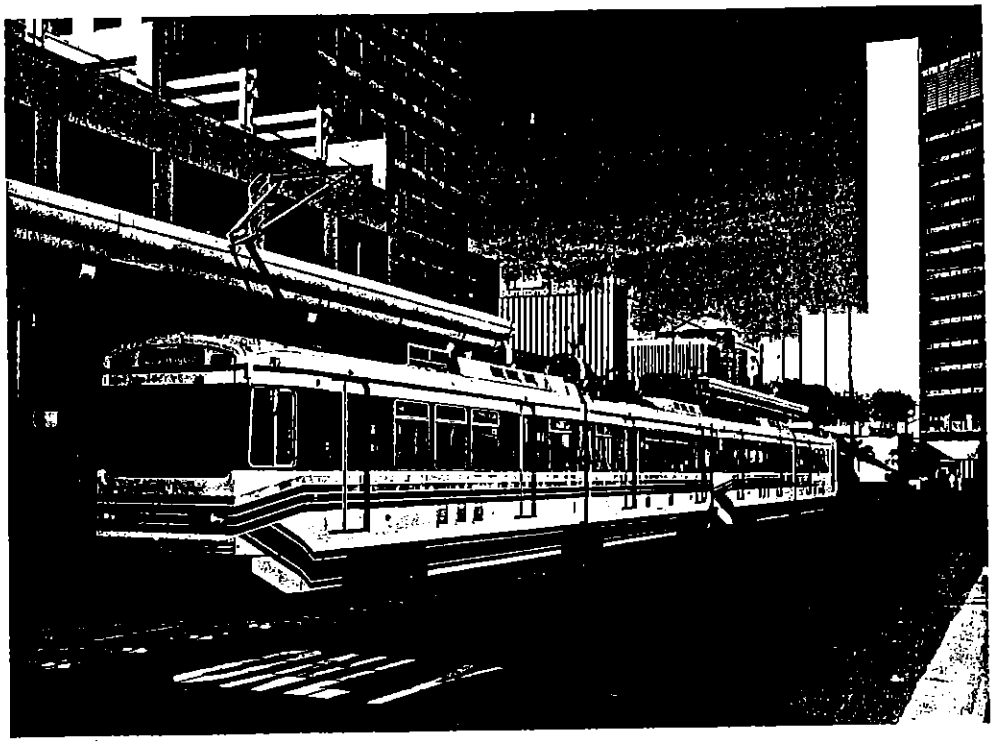
These vehicles also give off less carbon monoxide than those using conventional gasolines. And they produce fewer pollutants with no diminished engine performance or the need for costly new equipment or engine retrofits.

How ARCO EC-1 Regular Works

Gasoline Formula Modified	Tailpipe Emissions
▼ Reduces sulfur **80%**	Nitrogen oxides **down 5%***
▼ Reduces benzene **50%**	Reactive organic gases **down 4%***
▼ Reduces total aromatics **30%**	Cuts evaporative emissions by **21%**
▼ Lowers vapor pressure **1 lb.**	Sulfur dioxides **down 80%**
+ **5%** oxygenate added	Carbon monoxide **down 9%**

*Reduced emission of reactive organic gases (ROGs) and nitrogen oxides (NOX) from EC-1 Regular significantly reduces ozone formation from exposure to sun.



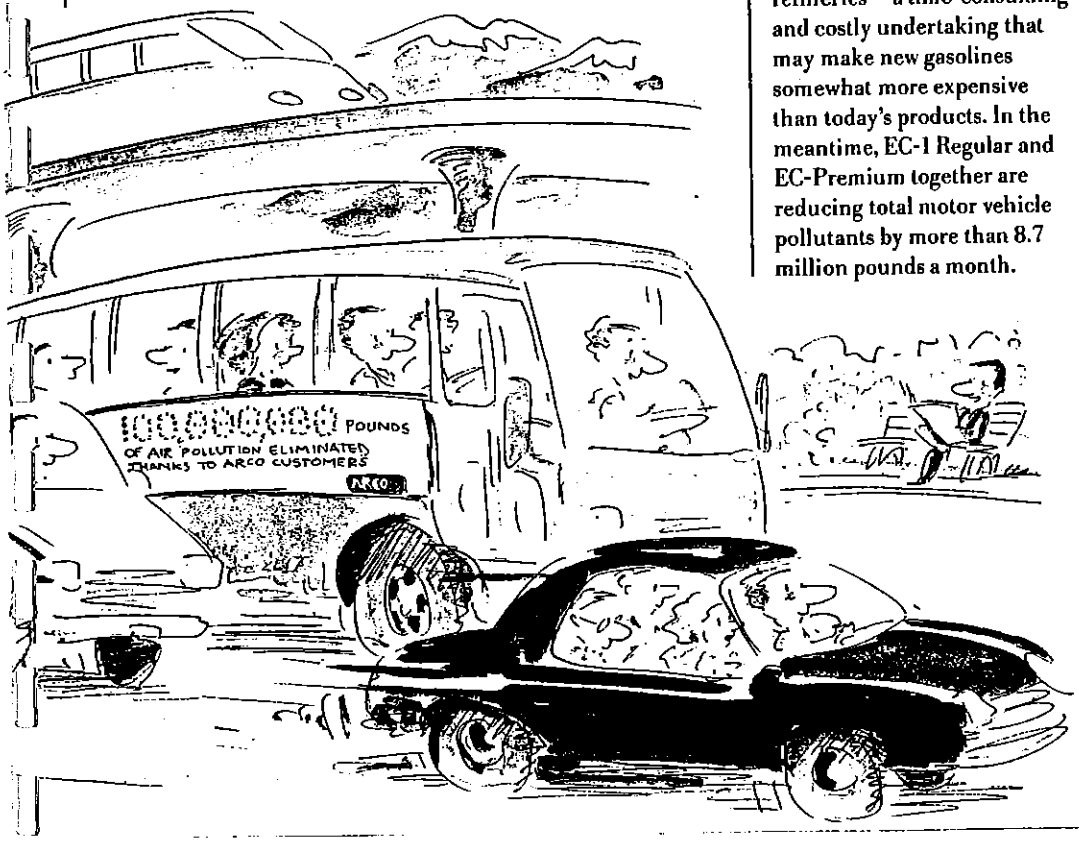


How EC-1 Works

EC-1 Regular burns cleaner for a number of reasons. First of all, it has no lead. Like EC-Premium, it uses MTBE to increase the oxygen in the gasoline to raise octane levels and lower pollutants. Secondly, the fuel contains less sulfur, aromatics, and olefins than the leaded gasoline it replaced.

All of the test data on both EC-1 Regular and EC-Premium have been shared with government regulators, including the California Air Resources Board and the South Coast Air Quality Management District.

ARCO plans eventually to make all its gasolines with emission control formulas. But that will require revamping its refineries — a time-consuming and costly undertaking that may make new gasolines somewhat more expensive than today's products. In the meantime, EC-1 Regular and EC-Premium together are reducing total motor vehicle pollutants by more than 8.7 million pounds a month.



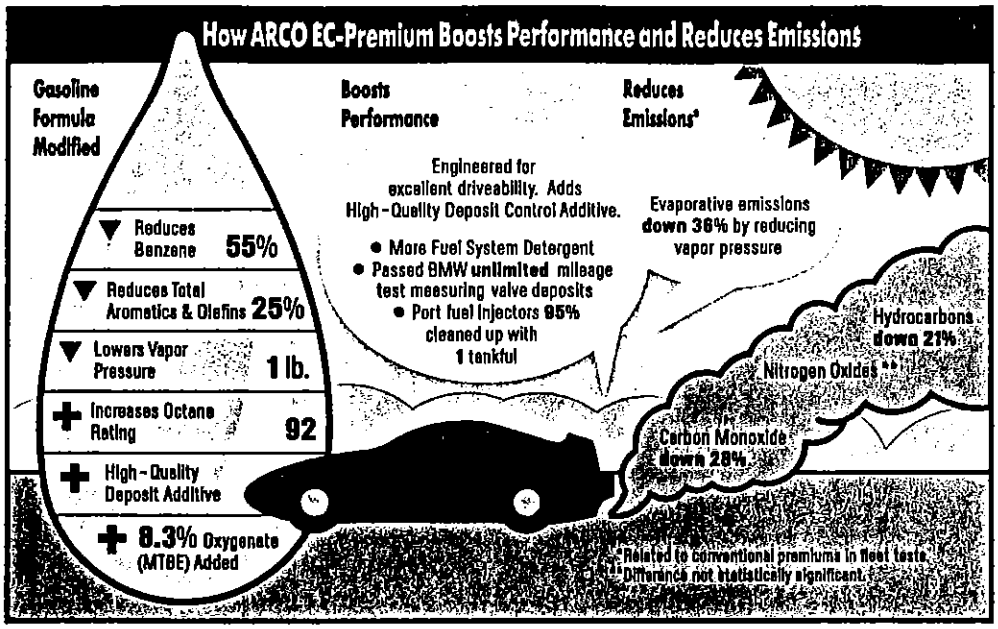
PROMISING NEW APPROACH

Two of the toughest air-quality agencies in the country are taking a close look at new technology that could cut exhaust hydrocarbon emissions by as much as 60 percent on gasoline-fueled vehicles.

The California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD) are examining electrically heated catalytic converters that can bring catalysts up to operating temperatures more rapidly than the current cold-start method permits. At present, in cold-starts, heating of the catalyst is accomplished by the exhaust, which emits pollutants during the time it takes to make the emissions system perform. CARB studies have shown that half of the harmful hydrocarbons discharged by a car in a 22-mile trip are emitted in the first two or three miles. By reducing these pollutants, the electrically heated catalytic converter could help gasoline-powered vehicles meet the strictest air-pollution rules.

ARCO is supporting efforts to evaluate electrically heated converters for commercial use. Initial tests indicate that the devices can significantly lower hydrocarbon, carbon monoxide, and nitrogen oxide emission levels. The system has excellent potential, but further road testing is needed before the converters come into widespread use.

ARCO introduced its newest emission control gasoline, EC-Premium, in Southern California on September 6, 1990, just one year after replacing its leaded gasoline in the region with EC-1 Regular.



EC-Premium is a reformulated unleaded fuel designed to improve both air quality and engine performance. It is a superior-grade gasoline, environmentally engineered to provide immediate air-quality benefits for the people of Southern California.

EC-Premium emits fewer pollutants than conventional premium fuels. One reason it's cleaner is because of its low benzene content. EC-Premium contains only 1 percent benzene — a level 63 percent below the 2.7 percent average reported for all premium gasolines in the Los Angeles area in a Motor Vehicle Manufacturers Association survey.

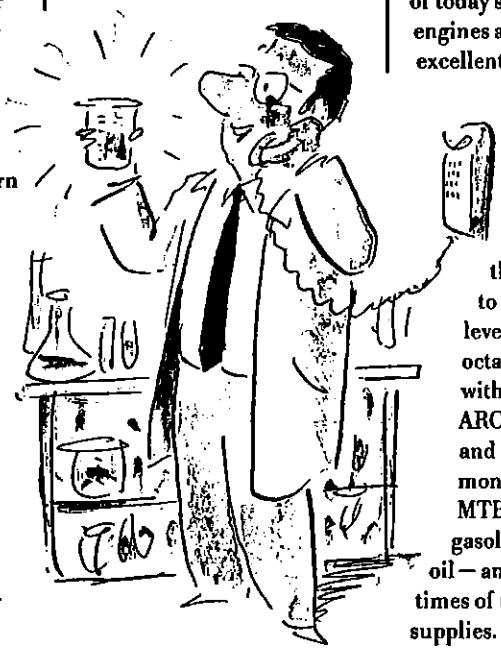
This dramatic reduction was achieved through refinery processing changes that lower the total amount of benzene produced by as much as 12,600 gallons a day.

In formulating EC-Premium, ARCO reduced total aromatics and olefins to decrease exhaust emissions and lowered evaporative emissions by cutting vapor pressure.

Fleet tests — conducted under government-approved procedures in nationally recognized independent labs — show that EC-Premium generates 28 percent less carbon monoxide and 21 percent less hydrocarbon emissions than the average unreformulated premium.

These reductions translate into an 86,000-pound cut in the motor vehicle pollutants that are emitted into the air every day in the Los Angeles Basin.

Besides the air-quality advantages, EC-Premium is tailored to meet the demands of today's high-performance engines and provide the excellent driveability motorists expect.



EC-Premium uses the oxygenate MTBE (methyl tertiary butyl ether) rather than extra aromatics to boost octane. Higher levels of MTBE raise the octane to 92 (compared with 91 for the former ARCO Super Unleaded) and reduce carbon monoxide emissions. MTBE also increases the gasoline yield from crude oil — an important plus in times of uncertain energy supplies.

EC-Premium is designed to guard against deposit build-up in the engine. It features a top-quality deposit-control additive with an increased amount of fuel-system detergent to clean clogged fuel injectors and prevent deposits on intake valves.

WAVE OF THE FUTURE

The notion that emission control gasolines can clean up dirty air is gaining strength. It is as if oil refiners had joined the Sierra Club. *The New York Times* wrote in a July 1990 article on the industry's push to develop cleaner fuels.

Since ARCO introduced EC-1 Regular in September 1989, several other oil companies have come up with their own distinctive formulas and marketing plans for reformulated gasolines.

The new cleaner-burning blends include premium, middle-grade, and regular gasolines as well as diesel fuel reformulations and substitutes for regular leaded gasoline.

Joining ARCO in the campaign for cleaner gasoline are such companies as Amoco, Chevron, Conoco, Diamond Shamrock, Exxon, Marathon, Phillips, Shell, and Sun. One oil company, Unocal, has paid up to $700 apiece to buy 7,000 pre-1971 cars and dispose of them to reduce pollution in the Los Angeles Basin.

THE OPTIONS

Reformulated gasolines are gaining acceptance as timely and effective alternatives to conventional gasolines, but there are other options worth considering in the war against pollution.

One option is propane, a liquefied petroleum gas already being used in many commercial fleets. Propane, which can reduce hydrocarbon emissions by about 30 percent, is convenient as long as drivers can fuel up at a central location. Cross-country travel, however, is another story, since propane stations are widely scattered.

Another alternative is compressed natural gas (CNG), which can lower hydrocarbon emissions by about 70 percent. General Motors is planning to sell at least 1,000 pickup trucks powered by natural gas in 1991, and United Parcel expects to adapt half its 100,000 delivery trucks to operate on compressed gas.

For all its potential, there are many problems to overcome before large numbers of motorists switch to CNG. To begin with, natural gas packs far less energy than gasoline. Vehicles running on CNG can go only half as far as those using gasoline, and refueling is inconvenient.

LPG/PROPANE

PROS & CONS

Furthermore, systems to compress and dispense the fuel are very expensive and require training for users. The systems must compress natural gas to at least 3,000 pounds per square inch — an extremely slow process requiring high-capacity compressors. Safe storage of the fuel is an additional consideration, and emissions of nitrogen oxides are likely to be higher with CNG than with gasoline.

Many clean-air advocates are convinced that electric cars are the best solution. Electric vehicles in fleet use are becoming more cost competitive with their gasoline-fueled counterparts. But they have a limited driving range of 50 to 200 miles before the battery pack has to be recharged.

ELECTRIC CAR

PROS & CONS

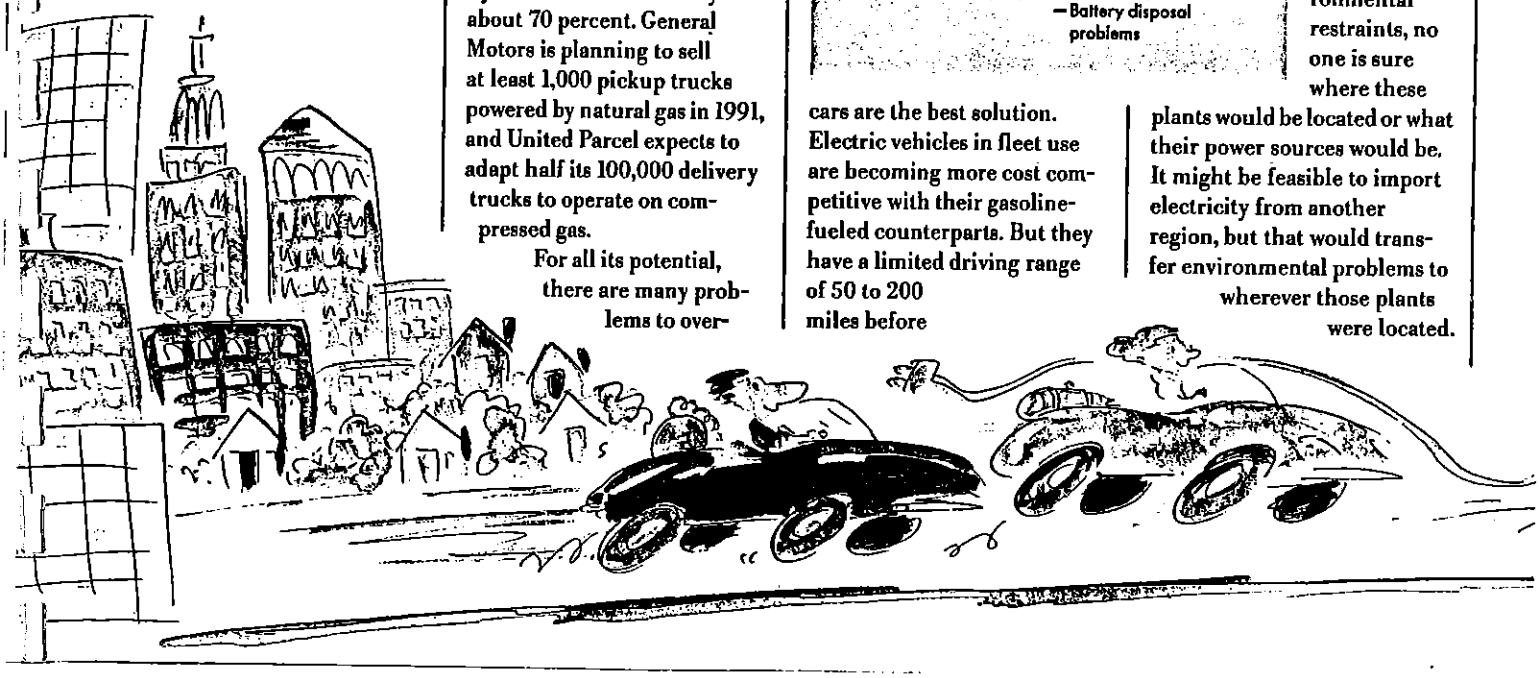
+ Reduces emissions substantially

— Limited driving range
— Insufficient supply of electricity for widespread use
— High cost
— Frequent and expensive battery replacement
— Battery disposal problems

Recharging takes time, and batteries may have to be replaced every 20,000 miles at a cost of about $1,500. Battery technology is still developing, and discarded batteries present another set of environmental headaches.

Los Angeles simply does not have the electrical generating capacity to recharge batteries for the number of cars that full-scale electrification requires. Offpeak slack could be tapped to recharge the batteries of perhaps 20-30 percent of the vehicles in the Basin, but new generating capacity would be needed for the remainder.

In light of strict environmental restraints, no one is sure where these plants would be located or what their power sources would be. It might be feasible to import electricity from another region, but that would transfer environmental problems to wherever those plants were located.



Questions About Methanol

Methanol is gaining attention as a possible fuel for the future. Made from natural gas or coal, it can be used in flexible-fuel vehicles that enable a driver to tap a variety of fuel mixtures containing methanol, ethanol, and gasoline.

METHANOL

PROS & CONS

+ Reduces hydrocarbon emissions	– Emits formaldehyde – Highly toxic; can cause blindness/death if ingested – Can easily invade groundwater – Cannot be used in existing cars – Requires new retailing facilities, transportation/storage infrastructure – Supply of natural gas highly uncertain – Lower energy value reduces driving range – Insufficient data about long-term environmental risks – Not price-competitive with gasoline

Some methanol proponents claim the fuel can cut hydrocarbon emissions by as much as 90 percent. But recent studies are not as optimistic, noting that M85 – a blend of 85 percent methanol and 15 percent unleaded gasoline – can reduce certain hydrocarbon emissions by only about 30 percent. "Neat," or 100 percent, methanol may get better results, but no vehicles that run on pure methanol are being manufactured for sale to the public.

Methanol has several serious drawbacks. For instance, it is a poison that can cause blindness or even death. It's colorless, tasteless, and virtually odorless, so exposure or ingestion poses more risks than gasoline does when the fuel is accidentally present.

It is not certain what large-scale combustion of methanol will do to the atmosphere. Methanol vehicles give off significant levels of formaldehyde – a toxic chemical that the federal Environmental Protection Agency lists as a suspected carcinogen. Because methanol is corrosive, it cannot be run through the existing petroleum infrastructure, or be used in today's vehicles without modification.

Studies of the health effects of using large amounts of methanol in selected air basins literally do not exist and should be done before we adopt methanol fuels as a major energy source for vehicles.

The economics and reliability of the methanol supply also raise questions. Since methanol has only about half the energy value of gasoline, California would need more than 22 billion gallons of methanol per year to replace gasoline completely. Current supply could not satisfy that kind of demand.

Building new methanol plants would be expensive. And where would those plants be built? Surely not in the Los Angeles Basin; permitting restrictions make that nearly impossible. Most of the new plants would probably have to be built abroad, close to sizable natural gas sources; supplies would thus be subject to foreign control.

Despite its limitations, methanol may ultimately prove to be a useful part of the alternative fuels mix. But further information is needed first to determine how methanol emission levels and total costs compare with those of reformulated gasolines.

COMPRESSED NATURAL GAS

PROS & CONS

+ Reduces reactive hydrocarbon and carbon monoxide emissions + Can be used in heavy-duty vehicles	– Increases emissions of nitrogen oxides – Limited driving range; less energy per gallon – Refueling problems (no service stations) – Limited passenger car application – Limited availability of domestic natural gas – Cost considerations – Risks from high-pressure natural gas in service stations – Requires engine/vehicle modifications

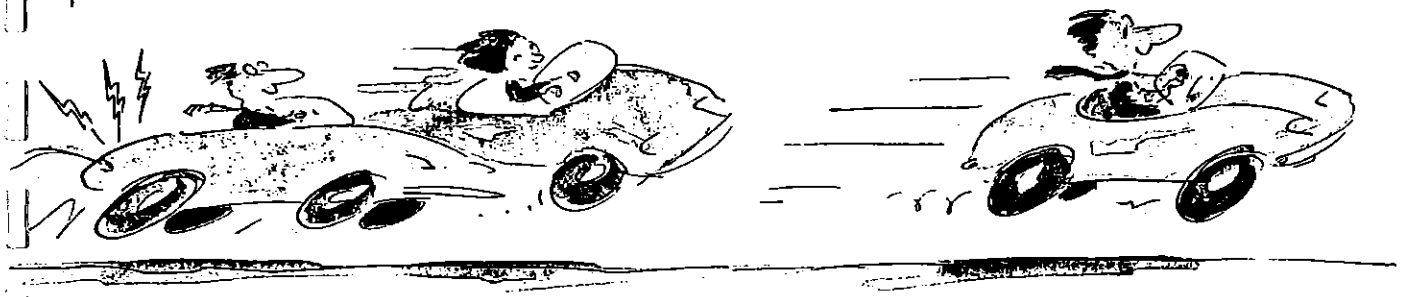
REFORMULATED GASOLINES

PROS & CONS

+ Reduce hydrocarbon emissions + Cost-competitive with conventional gasolines + Designed for existing engines + Produce immediate air-quality benefits + Improve engine performance + Require no new infrastructure	– Limited supply – Scarcity of available oxygenates – Research needed to reduce emissions further

Like methanol, ethanol is an alcohol fuel that can be used in neat form or mixed with gasoline to create gasohol. Distilled from corn, sugar-cane, or other grains, ethanol is an oxygenate like MTBE.

Use of ethanol in gasoline blends reduces carbon monoxide emissions, but its impact on other pollutants, including ozone, is uncertain. Cost is another issue. Tax exemptions and farm subsidies from taxpayers and consumers are needed to make ethanol competitive with less expensive fuels.



THE NEED TO KNOW

If you want to learn more about alternative fuels, here is a sampling of additional technical information available upon request:

Alternative Motor Vehicle Fuels to Improve Air Quality
California Council for Environmental and Economic Balance
100 Spear Street
San Francisco, CA 94105

EC-1 Emission Control Gasoline Final Report
ARCO Products Company
Available from:
ARCO Consumer Affairs
515 South Flower Street
Los Angeles, CA 90071

Quantitative Estimate of the Air Quality Impacts of Methanol Fuel Use
Prepared by Carnegie-Mellon University for the California Air Resources Board and the South Coast Air Quality Management District
Available from California Air Resources Board
1102 Q Street
Sacramento, CA 95814

Alternative Fuels for the United States: An ARCO Assessment
ARCO Products Company
Engineering & Technology
P.O. Box 61004
Anaheim, CA 92803-6104

Reformulated Gasoline for Cleaner Air
A Seminar Paper
University of California
Davis
Available from
ARCO Products Company
Engineering & Technology
P.O. Box 61004
Anaheim, CA 92803-6104

Finding Answers

More data about methanol and other fuels will aid decision-makers in evaluating the options — not just in Southern California, but in smog-ridden regions throughout the nation.

ARCO has an agreement with the state of California to install methanol pumps at up to 25 of its service stations to learn more about the fuel.

ARCO is also providing $500,000 over a five-year period in support of research on air pollution at Caltech's new Center for Air Quality Analyses. Researchers at the center are investigating the characteristics of emission sources, the chemistry of air pollutants, and the economic and technological feasibility of various emission controls. Their objective is to develop and test scientifically reliable methods that can better predict the air-quality results of different emission control strategies.

In another important effort, the Big Three U.S. automakers and 14 petroleum companies are working together to test the effectiveness of reformulated gasolines, methanol, and other fuels.

As we examine new fuels, we need to bolster fuel conservation, ride-sharing, and public transportation programs that help reduce pollution. Better maintenance and inspection of motor vehicles will contribute to cleaner air as well.

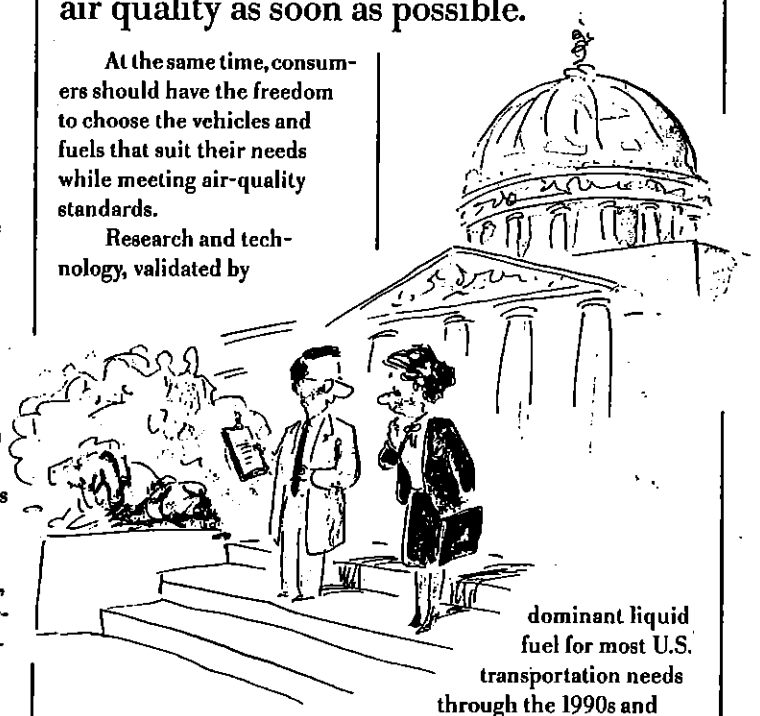
We also need to assess the clean-air potential of emerging technology, such as electrically heated catalytic converters. These catalytic converters are now experimental, but could possibly eliminate much of the emissions from new cars, which tend to discharge pollutants immediately after their engines are started and before the catalyst becomes hot.

JOINING FORCES

Winning the battle against the air pollution that plagues our cities is going to take the best thinking and work of everyone who can make a contribution. Regulators must be willing to let creative minds come together to find practical, cost-effective ways to improve air quality as soon as possible.

At the same time, consumers should have the freedom to choose the vehicles and fuels that suit their needs while meeting air-quality standards.

Research and technology, validated by consumer choice, can provide a number of fuel options that will enable those who live and work in Southern California and urban areas across America to enjoy cleaner, healthier air.



Propane, CNG, methanol, and ethanol will be useful in the midterm for fleets and in other specialized applications. Electricity and reformulated gasolines offer the strongest long-term potential. For cost reasons alone, reformulated gasolines will remain the dominant liquid fuel for most U.S. transportation needs through the 1990s and into the next century.

Reformulated gasolines are already working hard to remove pollutants from Southern California's air. By early 1991, ARCO's new gasolines will have eliminated some 100 million pounds of pollutants from the Los Angeles Basin. So, for the foreseeable future, at least, reformulated gasolines appear to be the only meaningful option for reducing polluting emissions from light-duty passenger vehicles.

ACCOLADES FOR ARCO EC GASOLINES

EC-1 Regular has drawn high praise from experts for leading the way to cleaner air. The nation's first emission control gasoline has won a number of awards and commendations, including:

+ **New Product Award** — First Place
  California Society of Professional Engineers
+ **Air Pollution Technology Award**
  South Coast Air Quality Management District
+ **Product of the Year**
  Fortune magazine
+ **Mayor's Significant Achievement Award in Pollution Prevention**
  Los Angeles Mayor Tom Bradley
+ **Resolution for Initiative in Producing Cleaner Gasoline**
  South Coast Air Quality Management District

EC-Premium was included in *Popular Science* magazine's "100 Best of What's New for 1990."

In addition, ARCO executives have received various commendations from the California State Legislature, and ARCO gave its own EC-1 Regular Development Team a pat on the back by presenting it with the company's first Environmental Achievement Award in May 1990.

For additional copies, contact:

ARCO Public Affairs
515 South Flower Street
Los Angeles, California 90071
Telephone: (213) 486-0950

20M0191 Printed in U.S.A. on recycled paper

Sound steps to cleaner air

In one Los Angeles announcement last week an oil company executive told of plans to produce a gasoline that will cause less air pollution than others.

The Los Angeles oil company is trying to make a point: that cleaner gasolines rather than substitute fuels are the right approach in

In another on

Cleaning up smoggy Southland air

Oil company on cutting edge of development

By MARIA deVARENNE
Sun Business Editor

Three major U.S. automaker and 14 petroleum companie have joined forces in a landma research and testing program assess the air-quality benefits cleaner fuels.

The $40 million research p ture is evaluating a wide ran reformulated gasolines an er alternative fuels for use cars and trucks of both Lod tomorrow.

Initial findings, releas 1990, indicate that chan composition of gasolin vorably alter vehicle emissions, although

oxide), but changing the level of olefins in gasolines does not have much of an impact on exhaust emissions.

Research further showed that

ther reduce or increase exhaus emissions depending on the v hicle type.

The findings thus far are l ed only on exhaust emissions do not yet include evapo emissions, which are cons cant emissi

Arco Unveils Gasoline For California Market That Burns Cleaner

By a WALL STREET JOURNAL Staff Reporter

LOS ANGELES—Atlantic Richfield Co. introduced a cleaner-burning high-octane gasoline that will replace its curre mium unleaded gaso fornia.

On a be line s Cook compar station

EC-P year ago trol regul

Arco plans new fuel to fight smog

Associated Press

LOS ANGELES — Atlantic Richfield Co., the first oil company with a low-emission gasoline, said Tuesday it would announce another less-polluting fuel this week.

Gasolines reformulated to fight smog, which typically cost l a gallon more at the have become common in here smog is a problem roduced the first in Au) in the Los Angeles a placement for regul ts, and has been stud kinds.

nalysts said the ga increases stemm Persian Gulf cr timing of Arco's n use it will mean rices.

is doing this bec ost the price sensit was

1990 Smog Season Had Cleanest Air on Record

By MARLA CONE
TIMES STAFF WRITER

From the foothills of San Bernardino County to the coast of Orange County and the valleys of Los Angeles, Southern Californians breathed the cleanest air on record in the 1990 smog season

improvement."

Days of smog alerts in th sin—which includes Los An Orange, San Bernardino and erside counties—declined by this smog season compared 1989, which

New Unleaded Premium Gas From ARCO

By MICHAEL LEV

Special to The New York Times

LOS ANGELES, Sept. 6 — ARCO, the largest seller of gasoline in Southern California, introduced a new unleaded premium today that it says emits fewer pollutants into the air than other fuels of its type.

The new gasoline, called EC-Pre- ll first be sold only in South- hich has the worst nd which in e of the the

poration have all introduced reformulated unleaded premium gasolines within year, but ARCO said leaner be- EC-1 caus th r l p

panies were gouging consumers by quickly raising prices.

A major component in ARCO's newest gasoline is methyl tertiary butyl ether, known as MTBE, which vert carbon monoxide to ARCO said that in tion's sup- ugh, the

Arco Delivers Its 2nd Punch in Cleaner-Burning Gas War

■ **Transportation:** The new premium unleaded fuel is touted as the cleanest on the market. The company hopes legislators will accept it as a low-polluting alternative to regular gasoline.

Arco unveils second low-polluting fuel

☐ The oil company will absorb the extra costs of making the low-emission fuel, executives claim.

By E. Scott Reckard
Associated Press

LOS ANGELES — Atlantic Richfield Co. introduced its second less-polluting gasoline Thursday, a premium unleaded it said would burn cleaner and cost less than any competitor's.

Arco Chairman Lodwrick M. Cook said the fuel also will help prove his contention that cleaner gasolines, not fuels such as methanol or

Cook said.

Arco currently has about 15 percent of the market for high-test gas in the five Western states in which it sells gas, including Nevada, he said.

The new gasoline, with

ARCO

gasoline—in this case, a reformulated product that is replacing Arco's 91-octane

cents a gallon more to make the new premium. Arco had raised wholesale prices for the old premium by "a couple of cents a gallon" before the Persian Gulf crisis, and believes it can absorb the additional cost without undue damage to profits, he said.

The key ingredient in the gas, as in EC-1, is the octane-booster methyl tiary butyl ether, or

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APPENDIX J

FSI CORRESPONDENCE

FREIGHT SERVICES INCORPORATED
P.O. Box 908 • Eugene, Oregon 97440
Fax (503) 343-8847 Phone (503) 484-2303

File: 31
August 16, 1991

Mr. Tsosie Lewis
General Manager
Navajo Agricultural Products Industry
PO Drawer 1318
Farmington, NM 87499

Dear Tsosie:

Many thanks for taking time from your busy schedule to discuss the benefits NAPI would realize, if a railroad were built into the four corners area. There is no doubt that your expertise will add creditability to our market analysis.

Again, your assistance is most appreciated. I am looking forward to visiting with you again in the near future.

Very truly yours,

Bill Anderson

E. William Anderson
Vice President

EWA/csf

FSI

FREIGHT SERVICES INCORPORATED

P.O. Box 908 • Eugene, Oregon 97440

Fax (503) 343-8847 Phone (503) 484-2303

File: 31
August 16, 1991

Mr. Marcelino Gomez
Attorney
Tax Unit
The Navajo Nation
Department of Justice
PO Box 2010
Window Rock, AZ 86515

Dear Marcelino:

Many thanks for taking time from your busy schedule to meet with me when I was in Gallup and Window Rock this week. There is no doubt that your expertise is of great assistance in the San Juan Railroad project.

I also enjoyed the opportunity to discuss the many challenges the Navajo Nation is addressing. It always seems that the higher up the mountain one climbs, the farther the summit is.

Again, your assistance is most appreciated. I will look forward to visiting with you again in the near future.

Very truly yours,

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E. William Anderson
Vice President

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Fax (503) 343-8847 Phone (503) 484-2303

File: 31
August 16, 1991

Mr. Paulson Chaco
Administrative Service Officer
The Navajo Nation
Navajo Department of Transportation
Division of Community Development
PO Box 308
Window Rock, AZ 86515

Dear Paulson:

Many thanks for taking time from your busy schedule to assist me with the San Juan Railroad project when I was in Window Rock on August 14, 1991. There is no doubt that your assistance vastly increased my productivity.

Your continued interest in this project is most appreciated. I look forward to visiting again with you in the near future.

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File: 31
August 16, 1991

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Statistician
Division of Community Development
The Navajo Nation
PO Box 1896
Window Rock, AZ 86515

Dear Larry:

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Fax (503) 343-8847 Phone (503) 484-2303

File: 31
August 16, 1991

Mr. Ed Morlan
Executive Director
Economic Development District
of Southwest Colorado
Miller Student Center
Fort Lewis College
Durango, CO 81301

Dear Ed:

Many thanks for taking time from your busy schedule to discuss the business opportunities for the Proposed San Juan Railroad. The leads you provided will be very useful for our marketing analysis.

It appears that southwestern Colorado would be a major beneficiary of a railroad built into the four corners area. Thanks to your direction, we will be able to identify these benefits better.

Again, your assistance was most appreciated. I will look forward to visiting with you again in the near future.

Very truly yours,

Bill Anderson

E. William Anderson
Vice President

EWA/csf

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P.O. Box 908 • Eugene, Oregon 97440
Fax (503) 343-8847 Phone (503) 484-2303

File: 31
August 16, 1991

Mr. William N. Hagler
President
Intermountain Chemical Inc.
PO Box 35
Farmington, NM 87499

Dear Bill:

Many thanks for taking time from your busy schedule to discuss the opportunity for a methanol plant in the Farmington area. The information you provided will be very useful for our marketing analysis for the San Juan Railroad project.

I also appreciated your briefing on the methanol plant you are now building in Denver. We will be following up that lead in the near future.

Again, your assistance was most useful. I am looking forward to visiting with you again in the near future.

Very truly yours,

Bill Anderson

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EWA/csf

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E. William Anderson
Vice President

EWA/csf

FREIGHT SERVICES INCORPORATED
P.O. Box 908 • Eugene, Oregon 97440
Fax (503) 343-8847 Phone (503) 484-2303

File: 31
August 16, 1991

Mr. J. Gregory Merrion
President
Merrion Oil and Gas Corporation
PO Box 840
Farmington, NM 87499

Dear Mr. Merrion:

Many thanks for taking time from your busy schedule to meet with me on August 15, 1991, to discuss the San Juan Basin Railroad project. There is no doubt that a railroad link into the Farmington area would be very beneficial to the local economy.

Your recommendation that I meet with Bill Hagler was followed up later that afternoon. This proved to be a very beneficial meeting and will add significantly to our marketing analysis.

Again, your assistance is most appreciated. If you have any further questions or comments relative to the proposed San Juan Railroad, please feel free to contact Jack Morgan or myself at your convenience.

Very truly yours,

Bill Anderson

E. William Anderson
Vice President

EWA/csf

cc: Mr. Jack M. Morgan

pollutants each day, including carbon monoxide, by 3.8 million pounds.

Other important environmental aspects of EC-X include: ultra low sulfur content, low distillation temperatures, very low olefin content, high oxygen content, and reduced Reid Vapor Pressure and aromatics content. The fuel has also been designed for outstanding driveability performance.

Test results also indicate that emissions from 1990 model-year vehicles using the EC-X formulation are no greater than emissions from state-of-the-art flexible fuel vehicles using M85, a blend of 85 percent methanol and 15 percent gasoline which some people believe is the major alternative to gasoline. This comparison applies to all major categories: hydrocarbon smog-forming potential, NOx, CO and toxics. EC-X's smog-forming potential has been reduced 37 percent through a reduction in both the mass and reactivity of its hydrocarbon emissions. (Reactivity is a measure of a hydrocarbon's ability to form ozone.)

"More importantly, the benefits of EC-X formulations can be realized as soon as the fuels are on the market," said Cook. "Comparable pollution reductions from alternative fuels such as M85 will not occur until specially built vehicles make up a significant portion of the on-the-road fleet many years later.

"This is good news for clean air and good news for consumers and the economy. Although EC-X is expected to cost about 16 cents per gallon more to produce than conventional gasoline, M85's fuel production costs are expected to be much higher -- between 25 and

CLEANER GAS MEANS CLEANER AIR

Good news is emerging from the front lines of the battle to combat dirty air in America's cities: Emission control gasolines are proving to be a powerful weapon against pollution.

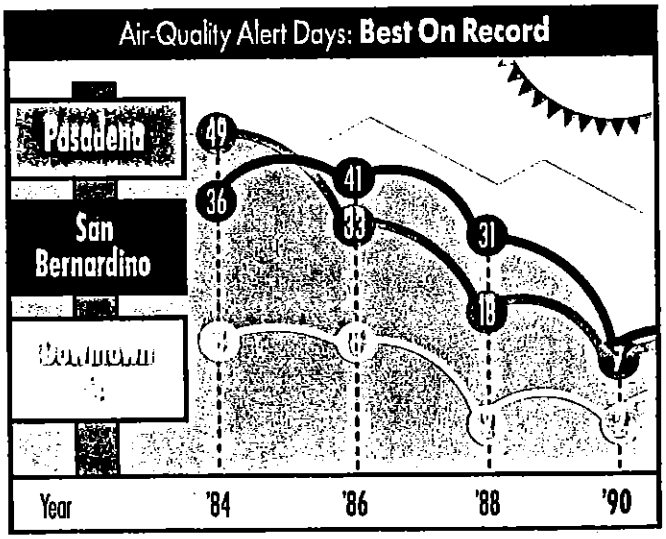
And there's more good news: Since ARCO formulated the nation's first emission control gasoline in 1989, cleaner-burning gasolines are catching on as a practical approach to cleaning up our air.

Even in Los Angeles, the smog capital of the nation, residents breathed the cleanest air on record during the 1990 smog season. Lower emissions from cars — thanks in part to these fuel reformulations — deserve some of the credit.

ARCO has been in the vanguard, introducing two emission control gasolines in Southern California: its pioneering EC-1® Regular, designed especially for pre-1975 cars and pre-1980 trucks, and EC-Premium, a higher-octane gasoline aimed at cutting pollution from newer cars with catalytic converters.

Other refiners have joined ARCO in the drive to produce gasolines that are kinder to the environment and do not require costly engine retrofits.

Congress, too, recognizes the potential of reformulated gasolines in improving air quality. Recent amendments to the federal Clean Air Act — the first ones since 1977 — require oil companies to offer new kinds of gasolines that burn more cleanly than conventional fuels. The 1990 amendments also identify reformulated gasolines as a clean-fuel option.



The Clean-Air Challenge

The problem of air pollution in urban areas defies a single solution. In the Los Angeles Basin, for example, ozone levels are sometimes triple the national standard, and the region fails to meet federal standards for carbon monoxide and fine particulate matter.

Ironically, the very geography and weather that have drawn residents and businesses to the area are the underlying cause of the region's severe air pollution.

The fact is, the Basin generates more pollutants than it can handle. Under certain conditions, the topography and a warm layer of air trap these pollutants and keep them from being blown away. The pollutants interact with sunlight to form ozone, a recognized health hazard.

Waging the War

Fighting pollution has seemed like an uphill battle in Southern California, but the air in the Basin is actually cleaner today than it was 30 years ago. Although the population has doubled and the economy has flourished, ozone levels have been reduced 30 percent.

Industry has spent millions of dollars to control emissions and meet strict new air-quality standards. This has led to a sharp reduction in pollutants from stationary

sources, like refineries and factories.

Lower emissions from cars and industry — along with favorable weather conditions — resulted in dramatic air-quality improvements in 1990. Days of smog alerts in the Basin declined by 24 percent during the May — October smog season, compared with 1989, which was also considered a light year.

But Southern California's reliance on the automobile makes further progress difficult. Mobile sources, namely passenger vehicles, account for about half the hydrocarbon emissions in the Basin.

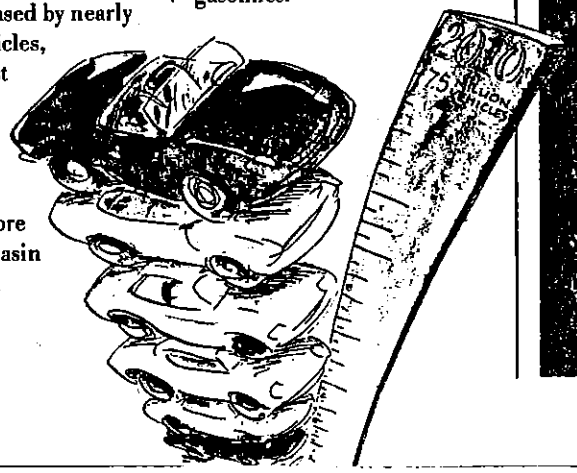
As the region's population has grown, so has the number of cars. From 1980 to 1988 automobile registration in the four-county Los Angeles Basin increased by nearly 1.5 million vehicles, reaching almost 7.5 million. By 2010, it is estimated that there will be 5 million more people in the Basin and another 1.1 million more passenger cars on the roads.

That's why public attention is focusing on cleaner-burning fuels and additional ways to reduce vehicular emissions in Southern California and in other smoggy urban areas.

The Search for Cleaner Fuels

As legislators and regulators at all levels of government call for a shift to less-polluting fuels and vehicles, fuel suppliers are trying to come up with answers that make sense for motorists, the environment, and the economy.

ARCO — the top gasoline marketer in the West — has led the way in changing the mixture of hydrocarbons and other chemicals it uses to produce cleaner gasolines.



TOUGH NEW STANDARDS

Far-reaching amendments to the federal Clean Air Act, which gained Congressional approval in October 1990, impose stiff new regulation on automobile emissions to help improve air quality across the nation.

The 1990 law mandates that tailpipe emissions of hydrocarbons and nitrogen oxides be reduced by 35 percent and 60 percent respectively in many new cars starting with the 1994 model year and in all new cars by 1996.

Oil companies will be required to offer new kinds of gasoline that burn more cleanly. Beginning in 1995, cleaner fuels are to be sold in cities with the worst carbon monoxide pollution problems.

Starting in 1996, all new cars will be required to have pollution control equipment that lasts 10 years or 100,000 miles. In addition, car manufacturers will have to produce an experimental fleet for sale in Southern California that uses new technologies to meet even more stringent standards. California adopted its own version in September 1990 that will meet this mandate.

California in fact has power over the auto industry that the federal government, with the force of the Clean Air Act behind it, does not. California emission standards often set the pace for the rest of the country and the world.

Under both federal and California regulations, reformulated gasolines — in combination with advanced automotive technology — will remain an option for meeting standards for very low emission fuels in the years ahead.

APPENDIX K

PHOTOGRAPHS

FREIGHT SERVICES INCORPORATED
P.O. Box 908 • Eugene, Oregon 97440
Fax (503) 343-8847 Phone (503) 484-2303

File: 31
August 22, 1991

Mr. Gary Jennings
Coordinator
San Juan Resource Conservation and Development
1911 Main Street Suite 248
Durango, CO 81301

Dear Gary:

Many thanks for the opportunity to discuss various issues relating to economic development when I was in Durango last week. I found your information perspectives and assistance to be most useful.

I particularly appreciated the opportunity to borrow several reports relating to NAPI and other development prospects in the Four Corners area. I am returning those to you with this letter.

Again, many thanks for your assistance. I will look forward to visiting with you again in the future.

Very truly yours,

E. William Anderson
Vice President

EWA/csf

Enclosure

Photo 3 & 4 - Rail participation in the San Juan Basin freight picture is through truck-rail transload terminals such as the one at Thoreau for coal (upper photo) and grain.

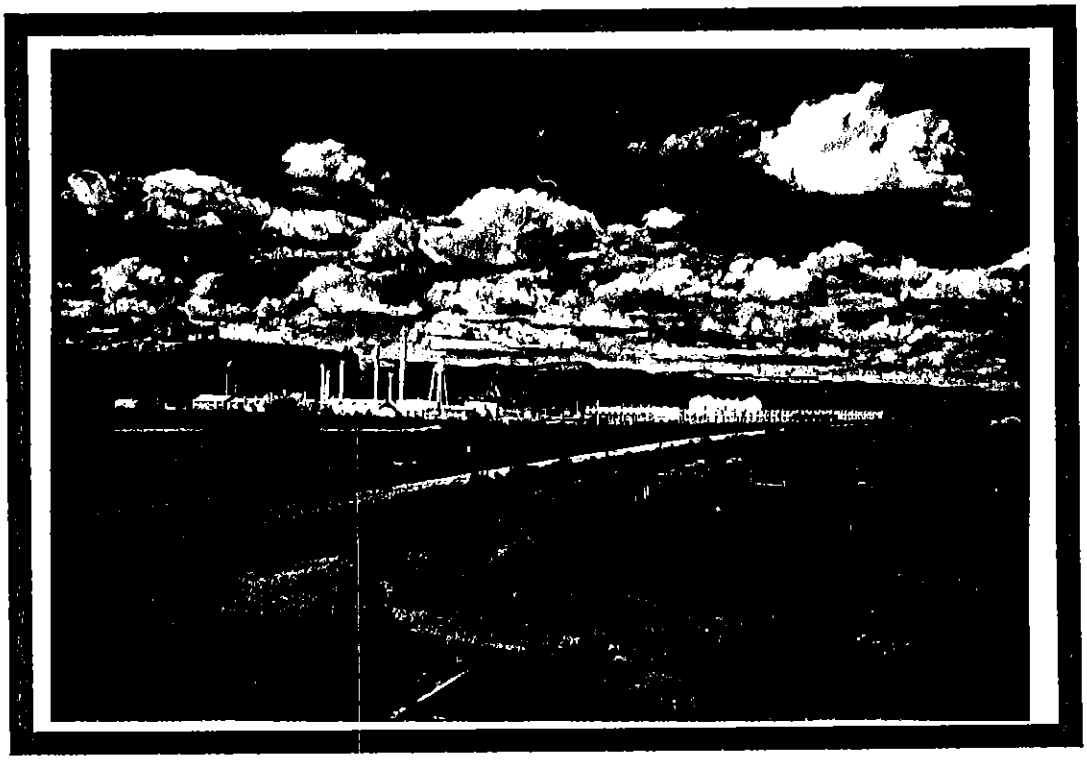


Photo 5 - The lack of rail facilities in the Farmington area has forced refineries to locate elsewhere such as this one east of Gallup.

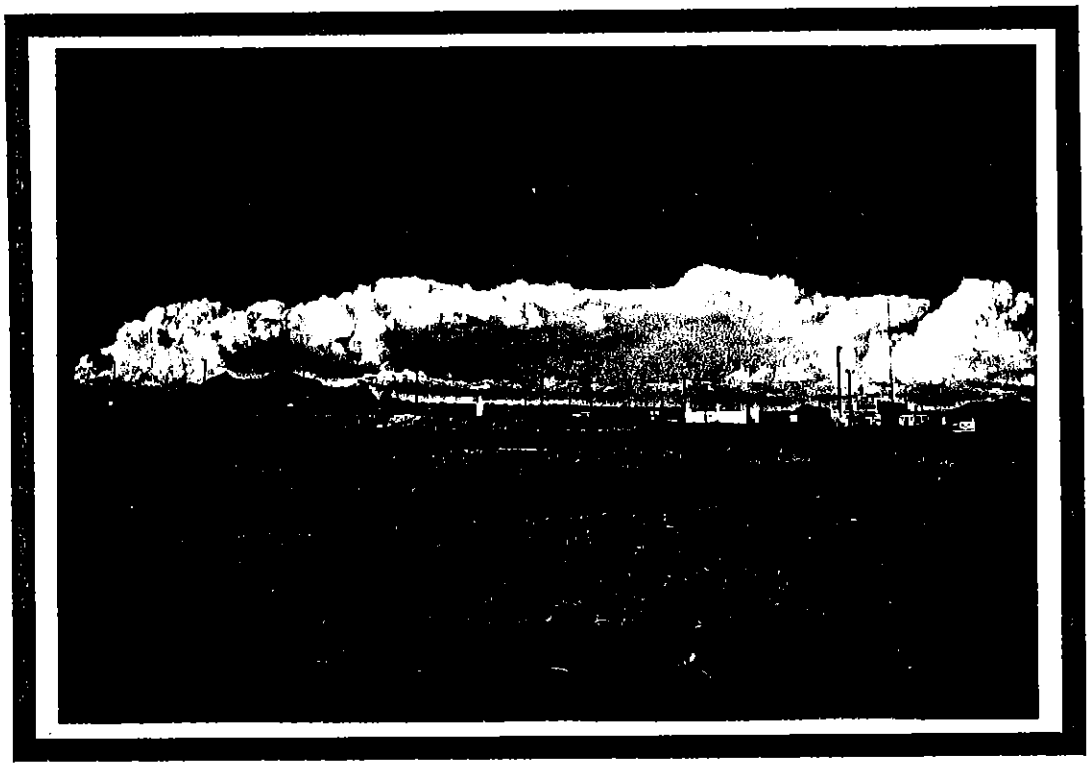


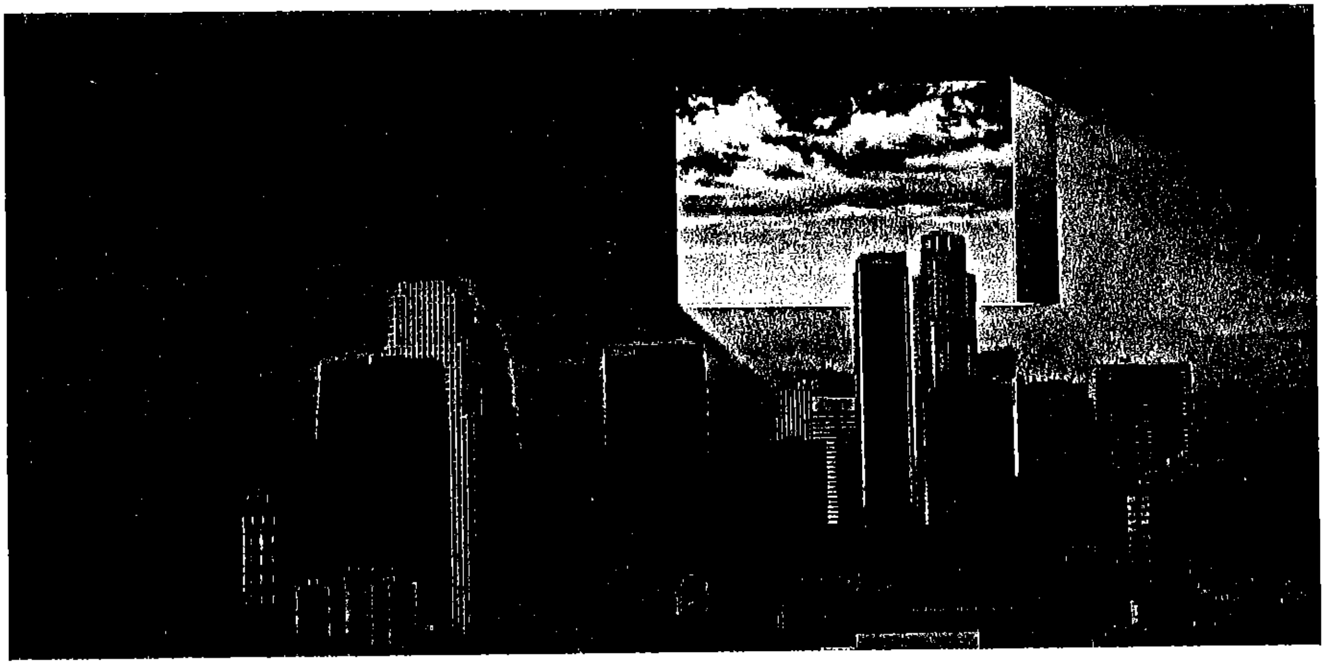
Photo 6 - One of the San Juan Basin mines closed down due to a need for better market access is the Burnam Mine owned by Consolidation Coal.

Photos 9 & 10 - The best general location for a rail terminal in the Farmington area appears to be several miles west of Highway 317, south of the San Juan River. An alternate site further south on NAPI land is also possible. (Upper photo is looking west while lower photo looks north up to the La Plata River valley.

MORE GOOD NEWS ABOUT DIRTY AIR?

ARCO

Searching for Clean Air Solutions



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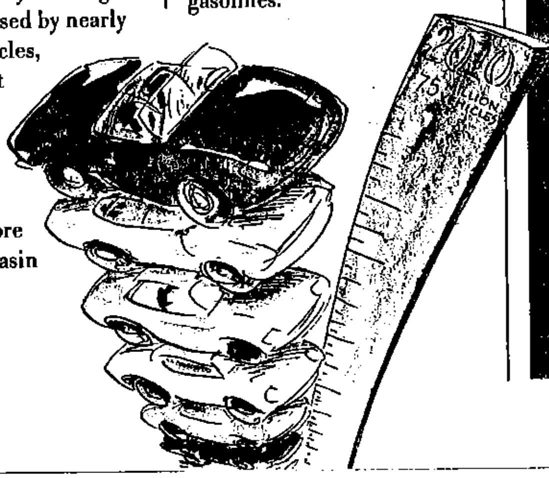

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Oil companies will be required to offer new blends of gasoline that burn more cleanly. Beginning in 1992, cleaner fuels are to be sold in cities with the worst carbon monoxide pollution problems.

Starting in 1996, all new cars will be required to have pollution-control equipment that lasts 10 years or 100,000 miles. In addition, automakers will have to produce an experimental fleet [illegible] for sale in Southern California that use new technology to meet even more stringent standards. California adopted [illegible] in September 1990 that will [illegible] standards.

California, in fact, has gone even further than the federal government, with the [illegible] Air Resources Board [illegible] world.

[illegible] federal and California regulations, reformulated gasoline — in combination with advanced automotive technology — will [illegible] option for meeting standards [illegible] in the years ahead.

CONSERVATION: A CLEAN-AIR SHORTCUT

One of the shortest paths to clean air is fuel conservation. Motorists who practice fuel-efficient driving are not only helping stretch gasoline supplies, they're cutting down on hydrocarbon emissions.

Here are a few simple gas-saving tips that can make a difference to your pocketbook, the environment, and fuel supplies:

+ **Ride share.** Carpools, vanpools, and public transportation are a sure way to reduce fuel consumption, pollution, and traffic congestion as well as wear and tear on your automobile.

+ **Combine short trips.** The worst mileage performance occurs on trips of 10 miles or less in a car that hasn't been driven in several hours. Combine errands to the bank, grocery, or drugstore and patronize neighborhood establishments.

+ **Accelerate smoothly.** More gas is used accelerating than cruising, so avoid jackrabbit starts and get to cruising speeds as soon as traffic conditions allow. Once you reach your optimum cruising speed, keep a light foot on the accelerator.

+ **Watch your speed.** Maintain your car's most efficient speed as closely as safety and the law permit. All cars have their own optimum cruising speed, based on design. For most cars, this is between 40 and 50 miles per hour.

+ **Keep your distance.** Tailgating causes repeated acceleration and braking and wastes gas. Leave room between you and the cars around you to react. Anticipate traffic flow, red lights, and stop signs.

+ **Minimize resistance.** Underinflated tires can reduce efficiency by one mile per gallon or more while causing tread to wear faster. Keep tires properly inflated. Close windows at highway speeds and use internal vents for air circulation. Avoid permanent roof racks.

+ **Get a tune-up.** Fouled plugs eat up gasoline, and poorly maintained cars are major polluters. Have your mechanic regularly check plugs, points, thermostat, antipollution equipment, filters, and wheel bearings and alignment. Remember, check your oil and water regularly and keep a record of mileage performance.

EC-1 Regular: The Breakthrough Fuel

EC-1 Regular, the country's first emission control gasoline, is formulated specifically for older model cars that lack catalytic converters to curb emissions. These vehicles, which furnish primary transportation for thousands of people in the community, produce a disproportionate share of the vehicular pollution in Southern California.

Recognizing that they can contribute to cleaner air by using reformulated gasoline, more customers are buying EC-1 Regular than were formerly using ARCO's leaded regular. EC-1 Regular has resulted in a reduction of 73 million pounds of pollutants from these cars and trucks in just one year (September 1989 – September 1990).

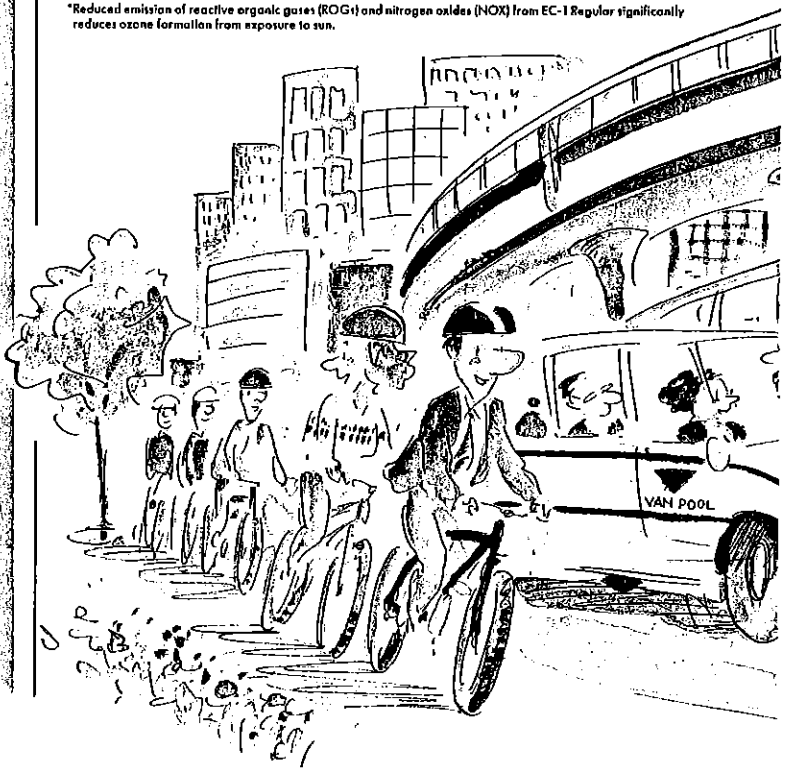
Independently conducted tests show that vehicles using EC-1 Regular emit fewer of the reactive chemical components that are precursors of smog, such as nitrogen oxides and organic gases.

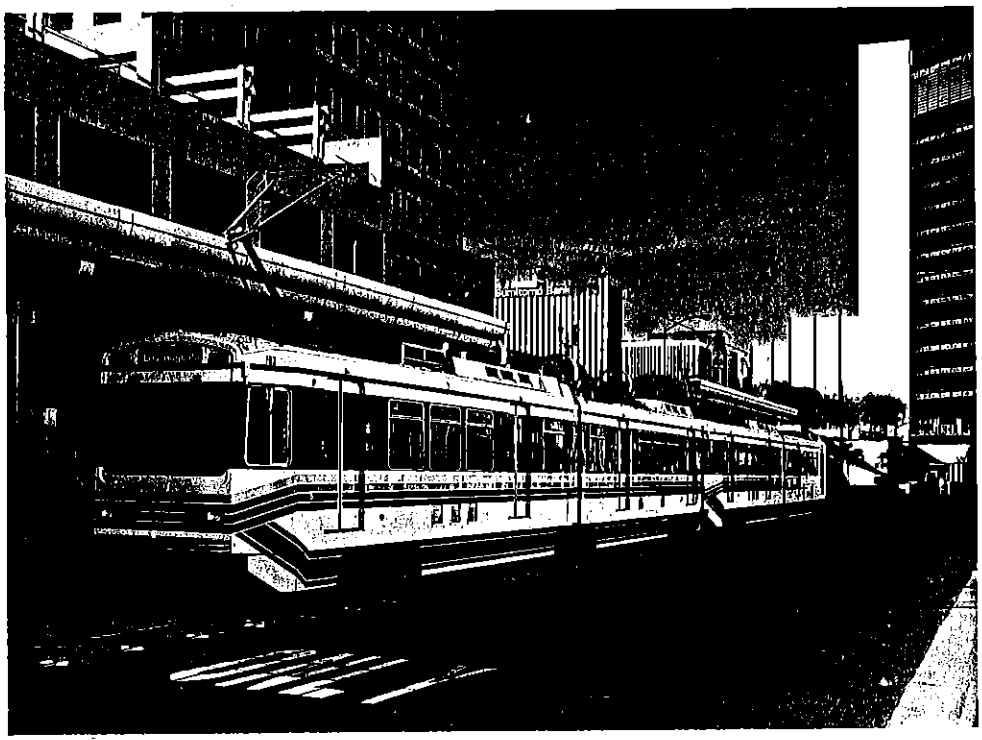
These vehicles also give off less carbon monoxide than those using conventional gasolines. And they produce fewer pollutants with no diminished engine performance or the need for costly new equipment or engine retrofits.

How ARCO EC-1 Regular Works

Gasoline Formula Modified		Tailpipe Emissions
▼ Reduces sulfur	**80%**	Nitrogen oxides **down 5%***
▼ Reduces benzene	**50%**	Reactive organic gases **down 4%***
▼ Reduces total aromatics	**30%**	Cuts evaporative emissions by **21%**
▼ Lowers vapor pressure	**1 lb.**	Sulfur dioxides **down 80%**
+ **5%** oxygenate added		Carbon monoxide **down 9%**

*Reduced emission of reactive organic gases (ROG's) and nitrogen oxides (NOX) from EC-1 Regular significantly reduces ozone formation from exposure to sun.



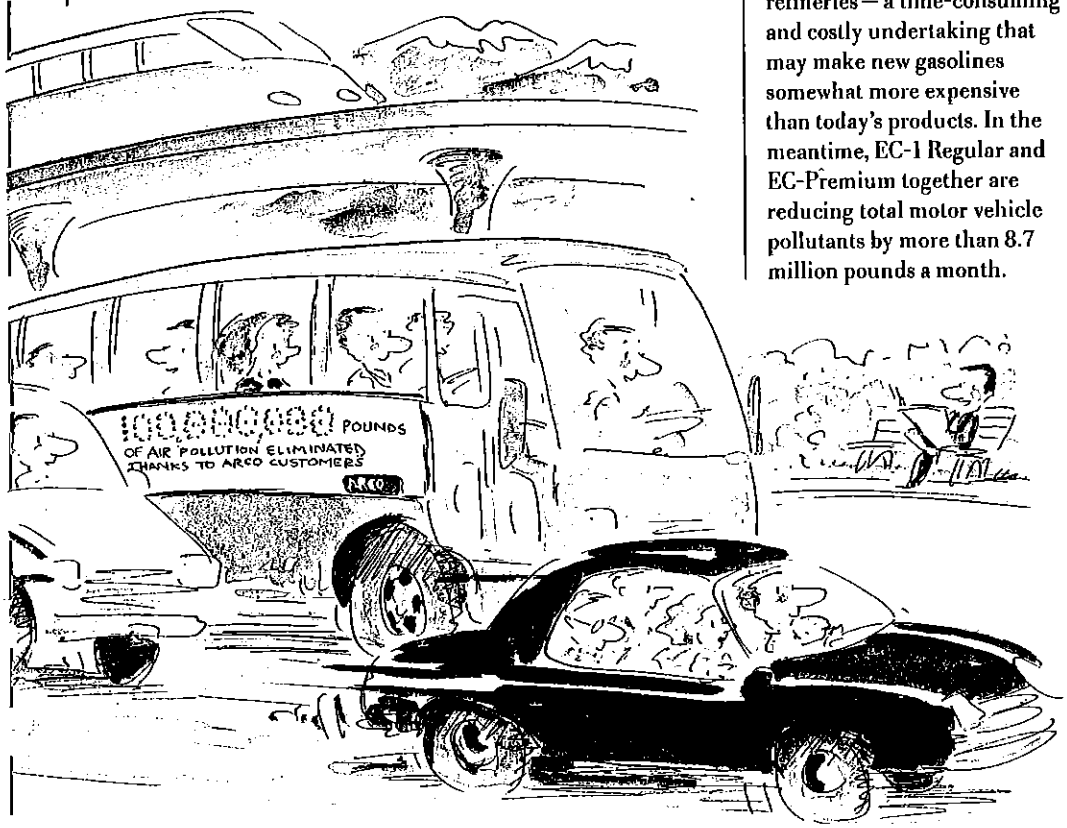


How EC-1 Works

EC-1 Regular burns cleaner for a number of reasons. First of all, it has no lead. Like EC-Premium, it uses MTBE to increase the oxygen in the gasoline to raise octane levels and lower pollutants. Secondly, the fuel contains less sulfur, aromatics, and olefins than the leaded gasoline it replaced.

All of the test data on both EC-1 Regular and EC-Premium have been shared with government regulators, including the California Air Resources Board and the South Coast Air Quality Management District.

ARCO plans eventually to make all its gasolines with emission control formulas. But that will require revamping its refineries — a time-consuming and costly undertaking that may make new gasolines somewhat more expensive than today's products. In the meantime, EC-1 Regular and EC-Premium together are reducing total motor vehicle pollutants by more than 8.7 million pounds a month.



PROMISING NEW APPROACH

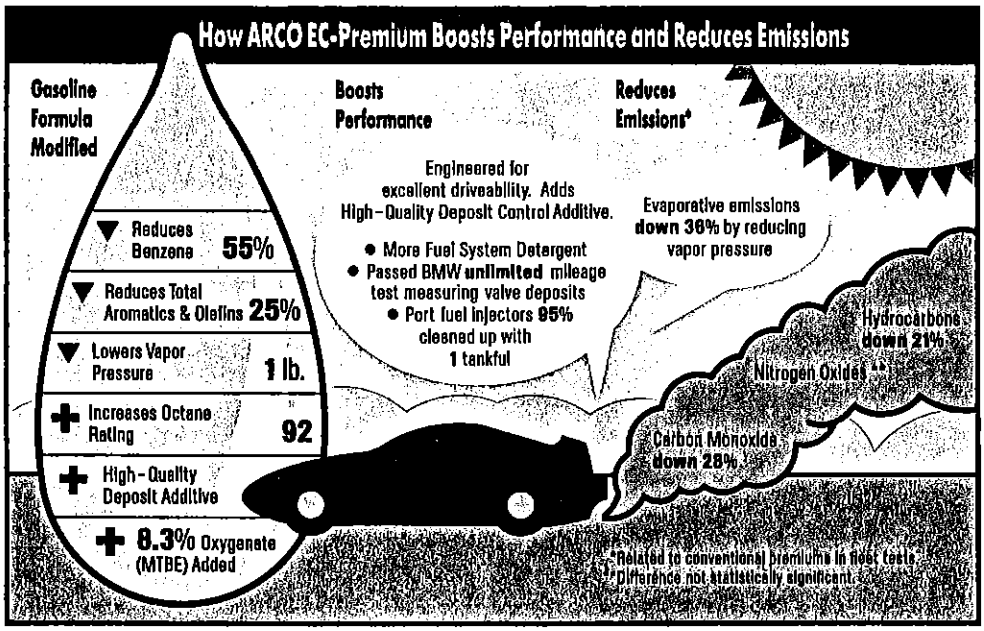
Two of the toughest air-quality agencies in the country are taking a close look at new technology that could cut exhaust hydrocarbon emissions by as much as 60 percent on gasoline-fueled vehicles.

The California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD) are examining electrically heated catalytic converters that can bring catalysts up to operating temperatures more rapidly than the current cold-start method permits.

In cold starts, heating of the catalyst is accomplished by the exhaust, which emits pollutants during the time it takes to make the emissions system perform. CARB studies have shown that half of the harmful hydrocarbons discharged by a car in a 22-mile trip are emitted in the first two or three miles. By reducing these pollutants, the electrically heated catalytic converter could help gasoline-powered vehicles meet the strictest air-pollution rules.

ARCO is supporting efforts to evaluate electrically heated converters for commercial use. Initial tests indicate that the devices can significantly lower hydrocarbon, carbon monoxide, and nitrogen oxide emission levels. The system has excellent potential, but further road testing is needed before the converters come into widespread use.

ARCO introduced its newest emission control gasoline, EC-Premium, in Southern California on September 6, 1990, just one year after replacing its leaded gasoline in the region with EC-1 Regular.



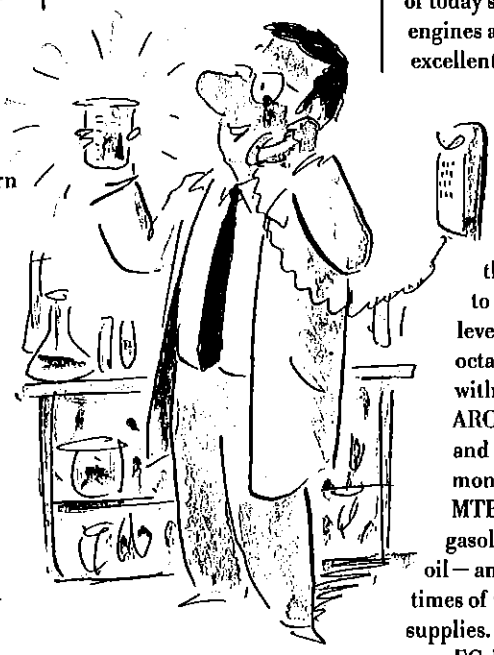
EC-Premium is a reformulated unleaded fuel designed to improve both air quality and engine performance. It is a superior-grade gasoline, environmentally engineered to provide immediate air-quality benefits for the people of Southern California.

EC-Premium emits fewer pollutants than conventional premium fuels. One reason it's cleaner is because of its low benzene content. EC-Premium contains only 1 percent benzene — a level 63 percent below the 2.7 percent average reported for all premium gasolines in the Los Angeles area in a Motor Vehicle Manufacturers Association survey.

This dramatic reduction was achieved through refinery processing changes that lower the total amount of benzene produced by as much as 12,600 gallons a day.

In formulating EC-Premium, ARCO reduced total aromatics and olefins to decrease exhaust emissions and lowered evaporative emissions by cutting vapor pressure.

Fleet tests — conducted under government-approved procedures in nationally recognized independent labs — show that EC-Premium generates 28 percent less carbon monoxide and 21 percent less hydrocarbon emissions than the average unreformulated premium.



These reductions translate into an 86,000-pound cut in the motor vehicle pollutants that are emitted into the air every day in the Los Angeles Basin.

Besides the air-quality advantages, EC-Premium is tailored to meet the demands of today's high-performance engines and provide the excellent driveability motorists expect.

EC-Premium uses the oxygenate MTBE (methyl tertiary butyl ether) rather than extra aromatics to boost octane. Higher levels of MTBE raise the octane to 92 (compared with 91 for the former ARCO Super Unleaded) and reduce carbon monoxide emissions. MTBE also increases the gasoline yield from crude oil — an important plus in times of uncertain energy supplies.

EC-Premium is designed to guard against deposit buildup in the engine. It features a top-quality deposit-control additive with an increased amount of fuel-system detergent to clean clogged fuel injectors and prevent deposits on intake valves.

WAVE OF THE FUTURE

"The notion that emission control gasolines can clean up dirty air is gaining strength. It is as if oil refiners had joined the Sierra Club," *The New York Times* wrote in a July 1990 article on the industry's push to develop cleaner fuels.

Since ARCO introduced its EC-1 Regular in September 1989, several other oil companies have come up with their own distinctive formulas and marketing plans for reformulated gasolines.

The new cleaner-burning blends include premium, middle-grade and regular gasolines as well as diesel fuel reformulations and substitutes for regular leaded gasoline.

Joining ARCO in the campaign for cleaner gasolines are such companies as Amoco, Chevron, Conoco, Diamond Shamrock, Exxon, Marathon, Phillips, Shell and Sun. One oil company, Unocal, has paid up to $700 apiece to buy 7,000 pre-1971 cars and dispose of them to reduce pollution in the Los Angeles Basin.

THE OPTIONS

Reformulated gasolines are gaining acceptance as timely and effective alternatives to conventional gasolines, but there are other options worth considering in the war against pollution.

One option is propane, a liquefied petroleum gas already being used in many commercial fleets. Propane, which can reduce hydrocarbon emissions by about 30 percent, is convenient as long as drivers can fuel up at a central location. Cross-country travel, however, is another story, since propane stations are widely scattered.

Another alternative is compressed natural gas (CNG), which can lower hydrocarbon emissions by about 70 percent. General Motors is planning to sell at least 1,000 pickup trucks powered by natural gas in 1991, and United Parcel expects to adapt half its 100,000 delivery trucks to operate on compressed gas.

For all its potential, there are many problems to overcome before large numbers of motorists switch to CNG. To begin with, natural gas packs far less energy than gasoline. Vehicles running on CNG can go only half as far as those using gasoline, and refueling is inconvenient.

PROPANE
PROS & CONS

Furthermore, systems to compress and dispense the fuel are very expensive and require training for users. The systems must compress natural gas to at least 3,000 pounds per square inch—an extremely slow process requiring high-capacity compressors. Safe storage of the fuel is an additional consideration, and emissions of nitrogen oxides are likely to be higher with CNG than with gasoline.

Many clean-air advocates are convinced that electric cars are the best solution. Electric vehicles in fleet use are becoming more cost competitive with their gasoline-fueled counterparts. But they have a limited driving range of 50 to 200 miles before the battery pack has to be recharged.

ELECTRIC CAR
PROS & CONS

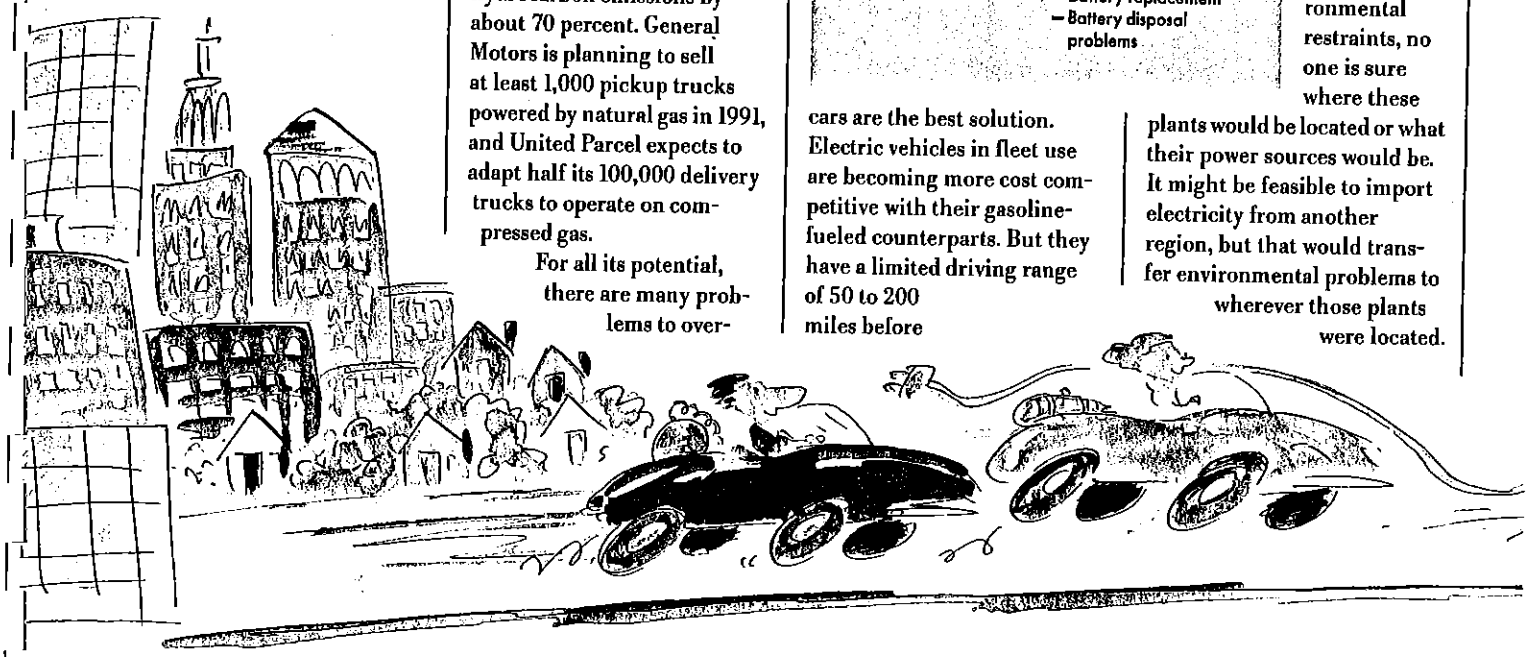
+ Reduces emissions substantially

– Limited driving range
– Insufficient supply of electricity for widespread use
– High cost
– Frequent and expensive battery replacement
– Battery disposal problems

Recharging takes time, and batteries may have to be replaced every 20,000 miles at a cost of about $1,500. Battery technology is still developing, and discarded batteries present another set of environmental headaches.

Los Angeles simply does not have the electrical generating capacity to recharge batteries for the number of cars that full-scale electrification requires. Offpeak slack could be tapped to recharge the batteries of perhaps 20-30 percent of the vehicles in the Basin, but new generating capacity would be needed for the remainder.

In light of strict environmental restraints, no one is sure where these plants would be located or what their power sources would be. It might be feasible to import electricity from another region, but that would transfer environmental problems to wherever those plants were located.



Questions About Methanol

Methanol is gaining attention as a possible fuel for the future. Made from natural gas or coal, it can be used in flexible-fuel vehicles that enable a driver to tap a variety of fuel mixtures containing methanol, ethanol, and gasoline.

METHANOL

PROS & CONS

+ Reduces hydrocarbon emissions	– Emits formaldehyde
	– Highly toxic; can cause blindness/death if ingested
	– Can easily invade groundwater
	– Cannot be used in existing cars
	– Requires new retailing facilities, transportation/storage infrastructure
	– Supply of natural gas highly uncertain
	– Lower energy value reduces driving range
	– Insufficient data about long-term environmental risks
	– Not price-competitive with gasoline

Some methanol proponents claim the fuel can cut hydrocarbon emissions by as much as 90 percent. But recent studies are not as optimistic, noting that M85 – a blend of 85 percent methanol and 15 percent unleaded gasoline – can reduce certain hydrocarbon emissions by only about 30 percent. "Neat," or 100 percent, methanol may get better results, but no vehicles that run on pure methanol are being manufactured for sale to the public.

Methanol has several serious drawbacks. For instance, it is a poison that can cause blindness or even death. It's colorless, tasteless, and virtually odorless, so exposure or ingestion poses more risks than gasoline does when the fuel is accidentally present.

It is not certain what large-scale combustion of methanol will do to the atmosphere. Methanol vehicles give off significant levels of formaldehyde – a toxic chemical that the federal Environmental Protection Agency lists as a suspected carcinogen. Because methanol is corrosive, it cannot be run through the existing petroleum infrastructure, or be used in today's vehicles without modification.

Studies of the health effects of using large amounts of methanol in selected air basins literally do not exist and should be done before we adopt methanol fuels as a major energy source for vehicles.

The economics and reliability of the methanol supply also raise questions. Since methanol has only about half the energy value of gasoline, California would need more than 22 billion gallons of methanol per year to replace gasoline completely. Current supply could not satisfy that kind of demand.

Building new methanol plants would be expensive. And where would those plants be built? Surely not in the Los Angeles Basin; permitting restrictions make that nearly impossible. Most of the new plants would probably have to be built abroad, close to sizable natural gas sources; supplies would thus be subject to foreign control.

Despite its limitations, methanol may ultimately prove to be a useful part of the alternative fuels mix. But further information is needed first to determine how methanol emission levels and total costs compare with those of reformulated gasolines.

COMPRESSED NATURAL GAS

PROS & CONS

+ Reduces reactive hydrocarbon and carbon monoxide emissions	– Increases emissions of nitrogen oxides
+ Can be used in heavy-duty vehicles	– Limited driving range; less energy per gallon
	– Refueling problems (no service stations)
	– Limited passenger car application
	– Limited availability of domestic natural gas
	– Cost considerations
	– Risks from high-pressure natural gas in service stations
	– Requires engine/vehicle modifications

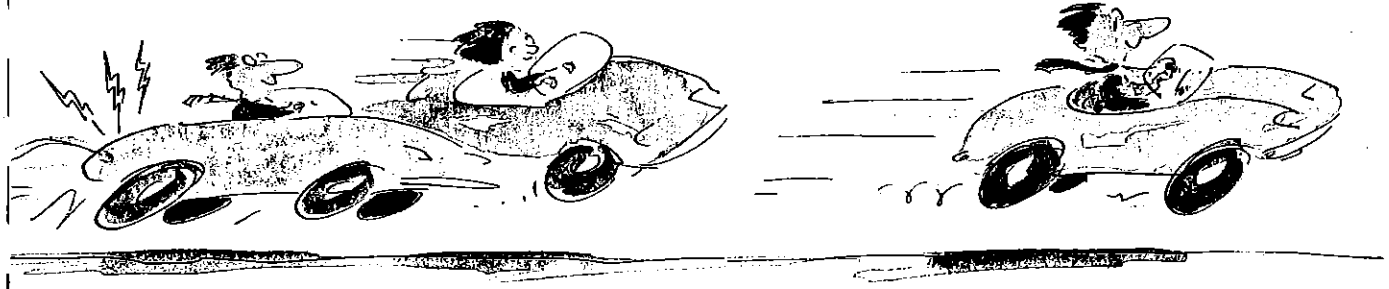
REFORMULATED GASOLINES

PROS & CONS

+ Reduce hydrocarbon emissions	– Limited supply
+ Cost-competitive with conventional gasolines	– Scarcity of available oxygenates
+ Designed for existing engines	– Research needed to reduce emissions further
+ Produce immediate air-quality benefits	
+ Improve engine performance	
+ Require no new infrastructure	

Like methanol, ethanol is an alcohol fuel that can be used in neat form or mixed with gasoline to create gasohol. Distilled from corn, sugar-cane, or other grains, ethanol is an oxygenate like MTBE.

Use of ethanol in gasoline blends reduces carbon monoxide emissions, but its impact on other pollutants, including ozone, is uncertain. Cost is another issue. Tax exemptions and farm subsidies from taxpayers and consumers are needed to make ethanol competitive with less expensive fuels.



Sound steps to cleaner air

In one Los Angeles announcement last week an oil company executive told of plans to produce a gasoline that will cause less air pollution than others.

The Los Angeles oil company is trying to make a point: that cleaner gasolines rather than substitute fuels are the right approach in ...

Cleaning up smoggy Southland air

Oil company on cutting edge of development

By MARIA deVARENNE
Sun Business Editor

Three major U.S. automaker and 14 petroleum companie have joined forces in a landma research and testing program assess the air-quality benefits cleaner fuels.

The $40 million research ture is evaluating a wide ran reformulated gasolines an er alternative fuels for use cars and trucks of both tod tomorrow.

Initial findings, releas 1990, indicate that cha composition of gasoli vorably alter vehicle emissions, although ...

oxide), but changing the level of olefins in gasolines does not have much of an impact on exhaust emissions.

Research further showed that ... and/or the ... can ei- ther reduce or increase exhaus emissions depending on the v hicle type.

The findings thus far are l ed only on exhaust emissions do not yet include evapo emissions, which are cont ...cant emissi

1990 Smog Season Had Cleanest Air on Record

By MARLA CONE
TIMES STAFF WRITER

From the foothills of San Bernardino County to the coast of Orange County and the valleys of Los Angeles, Southern Californians breathed the cleanest air on record in the 1990 smog season ... cially ...

Improvement."

Days of smog alerts in th sin—which includes Los An Orange, San Bernardino and erside counties—declined by this smog season compared 1989, which ...

Arco Unveils Gasoline For California Market That Burns Cleaner

By a WALL STREET JOURNAL Staff Reporter

LOS ANGELES—Atlantic Richfield Co. introduced a cleaner-burning high-octane gasoline that will replace its ... mium unleaded gaso... fornia.

On a ... line s Cook compar station

EC-P... year ago trol regul...

Arco plans new fuel to fight smog

Associated Press

LOS ANGELES — Atlantic Richfield Co., the first oil company with a low-emission gasoline, said Tuesday it would announce another less-polluting fuel this week.

Gasolines reformulated to fight smog, which typically cost ... a gallon more at the ...ave become common in ...here smog is a problem ...roduced the first in Au ... in the Los Angeles a ...placement for regula ...ts, and has been stud ...kinds.

...nalysts said the ga... increases stemm... Persian Gulf cr... timing of Arco's n... use it will mean ...ices.

...is doing this bec... ...ost the price sensi... was ...

New Unleaded Premium Gas From ARCO

By MICHAEL LEV
Special to The New York Times

LOS ANGELES, Sept. 6 — ARCO, the largest seller of gasoline in Southern California, introduced a new unleaded premium today that it says emits fewer pollutants into the air than other fuels of its type.

The new gasoline, called EC-Pre... ...m first be sold only in South... ...hich has the worst ... ...nd which in ...ne of the the

...poration have all introduced reformulated ...leaded premium gasolines within ... year, but ARCO said EC-... ...leaner be... caus... th... r... p...

panies were gouging consumers by quickly raising prices.

A major component in ARCO's newest gasoline is methyl tertiary butyl ether, known as MTBE, which ...vert carbon monoxide to ... ARCO said that in ...tion's sup... ...ugh, the

Arco Delivers Its 2nd Punch in Cleaner-Burning Gas War

■ **Transportation:** The new premium unleaded fuel is touted as the cleanest on the market. The company hopes legislators will accept it as a low-polluting alternative to regular gasoline.

gasoline—in this case, a reformulated ... product that is replacing Arco's 91-octane ... ...the com... ...the

Arco unveils second low-polluting fuel

☐ The oil company will absorb the extra costs of making the low-emission fuel, executives claim.

By E. Scott Reckard
Associated Press

LOS ANGELES — Atlantic Richfield Co. introduced its second less-polluting gasoline Thursday, a premium unleaded it said would burn cleaner and cost less than any competitor's.

Arco Chairman Lodwrick M. Cook said the fuel also will help prove his contention that cleaner gasolines, not fuels such as methanol or ... are the best ... tough ...

Cook said.

Arco currently has about 15 percent of the market for high-test gas in the five Western states in which it sells gas, including Nevada, he said.

The new gasoline, with an ... ing 92, will be ... Calif... ...

...rat- ...hern ...aces ...oc-

...sion gasoline in August ...stitute for the leaded ... cars and ...

...oil company ... when it introduced EC-1

cents a gallon more to make the new premium. Arco had raised wholesale prices for the old premium by "a couple of cents a gallon" before the Persian Gulf crisis, and believes it can absorb the additional cost without undue damage to profits, he said.

The key ingredient in the gas, as in EC-1, is the octane-booster methyl tertiary butyl ether, or ... gen-rich M...

ARCO

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