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THE COAL SLURRY PIPELINE ALTERNATIVE

In view of the interest in proposed construction of coal slurry pipelines for the transport of coal from western states, this preliminary report has been prepared. It is based on such information as WGREPO has been able to gather to this date.

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Prepared by
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The Coal Slurry Pipeline Alternative

THE COAL SLURRY PIPELINE ALTERNATIVE

Introduction

The shipment of coal by slurry pipeline is one of the presently available alternative methods of moving coal energy from western states to the more populous consuming regions of the United States. This paper makes comparisons between slurry pipelines and the other alternatives.

Coal mined in the west in the near future may be moved to the major consumption areas in these five ways:

1. Conversion of the coal to electricity at or near the mine by thermal generation, with the electricity transported by high voltage transmission lines.
2. Conversion of the coal into gas at or near the mine. Resulting high-Btu gas could then be moved across the country by pipeline; low- and medium-Btu gas cannot be economically moved over long distances.
3. Liquefaction of the coal at or near the mine into synthetic crude oil, which could then be moved by pipeline.
4. Rail transport of the coal to consumer load centers.
5. Transport of the coal by slurry pipeline to consumer load centers.

Other potential methods of beneficially using or moving coal are not applicable in the West at present. These include:

--Truck transport, which is not practical over the long distances involved.

--River barge transport, for which navigable rivers are not available in the western states. (The engineering firm of Commonwealth Associates, Inc. has submitted to the Department of Interior a proposal to study a plan to develop

the Missouri River for coal barge transport as far northwest as Gavins Point Dam, near Yankton, South Dakota. This would involve building 20 to 25 low-head dams and locks--plus or minus 35 feet elevation each--between St. Louis and Gavins Point.[1] This costly enterprise, if carried out, would not substantially affect decisions in WGREPO states, because coal still would have to be moved several hundred miles from coal producing areas to Gavins Point by rail or slurry lines.)

--In situ gasification, sometimes called "chemical mining," is scientifically feasible but faces difficult engineering problems, according to WGREPO Science and Research Advisor, Richard T. Meyer. Development of this alternative is not near at hand.

--Magnetohydrodynamic electric power generation is being studied as a more efficient use of coal, but the first commercial applications are not expected until about 1985.[5]

As the five presently available alternative dispositions of western coal are considered, these discussions sometimes become confused with the broader issue of whether or not there should be large scale mining of western coal. Environmentalists and, to a lesser extent, water conservationists, do not always separate the broader question of massive coal development from the more narrow question of how coal energy should be used or moved if and when large-scale coal mining occurs in the West. This report will not discuss the broad question of how much coal should be mined, but will be limited to comparisons of the five methods of conversion or shipment.

Each of the five alternatives will cause different environmental effects and socioeconomic impacts. These are briefly analyzed and compared in this report, but these comparisons must be viewed in the light that these impacts are merely add-ons

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1. Superior numbers refer to sources, which are listed at the end of this report.

to the equal or greater impacts which would be caused by the process of mining.

Water consumption is a critical issue in all phases of energy development. This report compares water consumption by each of the five alternatives, to the extent that facts are available. Water availability to meet the requirements of slurry pipelines and the conversion alternatives varies case by case, from coal field to coal field, and cannot be discussed with precision in a general report such as this.

A realistic assumption is that considerable coal will be mined in the West sooner or later and that each of the five alternatives movements of Western coal will be used to some extent. The development of one alternative will not preclude the use of one or more of the other alternatives. This report should be considered in that light.

I. The Slurry Pipeline Process

Slurry transportation is accomplished by grinding the solid material--in this case, coal--into a powder, mixing it with water or some other liquid, such as oil, and pumping the resultant slurry through pipelines similar to petroleum or water pipelines. In slurrying coal, a mixture of roughly 50% water and 50% coal is commonly used. The water may be of poor quality. We have heard of no advanced planning for use of liquids other than water for slurrying in the WGREPO region.

There also has been some experimentation with the use of air as a carrying agent, the coal thus being blown through pipelines in dust form. This apparently is feasible only for short distances, and we know of no consideration for long distance movement by this method.

Along the slurry line, pump stations are placed at intervals of about 100 miles, more closely spaced if the line must ascend to substantially higher elevations. In addition to pumps, each station facility includes a holding pond for drawing off of slurry from the segment of the line upstream from the station and a water pond or storage tanks to provide for flushing out of the downstream segment, in case of emergency.

In case of a draw-off of slurry, the coal may be allowed to settle out of the water, the water pumped off, and the residual coal trucked away. This is the arrangement on the Black Mesa slurry line in Arizona. On the proposed Wyoming-to-Arkansas line, planned by Energy Transportation Systems, Inc. (ETSI), consideration is being given to a new design which includes facilities at each pump station for re-slurrying drawn-off coal so that it can be reinjected into the line.[2]

At the end of the line, the coal and water are separated. On the Black Mesa line, this is done by centrifuging. The proposed ETSI line would use a vacuum filter system. Additional heat drying of the coal may be required. The

powdered coal is used in the furnaces of thermal generation plants. Water taken from the slurry is used in the power plant cooling system, typically supplying about one-eighth of the plant's cooling water requirements.

Some questions are raised about the efficiency of the slurry pipeline technology, but it appears to be satisfactory from mechanical and economic standpoints. Many electric companies are expressing willingness to buy slurried coal, and investors appear willing to provide large sums of money to build slurry lines.

In 1957, Consolidation Coal Co. placed in operation a line running 108 miles from Cadiz, Ohio to Eastlake, Ohio. This 10-inch line moved 1.3 million tons of coal per year for six years with a reported "reliability rating" of 98 percent; that is, the line operated at only two percent less than capacity because of malfunctions. This line was mothballed in 1973, because railroads reduced rates on coal hauling to a level lower than the pipeline rates.[3,4]

In 1970, Black Mesa slurry line began moving coal from a mine south of Kayenta, Arizona, 273 miles to a power plant at the southern tip of Nevada. The 18-inch line moves 4.8 million tons of coal per year, with a reported reliability rating of 98 to 99 percent.[3] On occasion, the supplying mine has not delivered sufficient coal; this has necessitated "batching" of the shipments by pumping water, instead of slurry, through the line for a time.[8] This would reduce the amount delivered, but it does not reflect technological failure by the line.

J.G. Montfort, manager of the Black Mesa line, reports that, after five years of operation, the line is considered a technical and economic success.[8] He adds these details:

Two occasions of dumping of slurry from sections of the line were necessary in the spring of 1971, none since. Slurry was dumped into retaining ponds on pipeline station property, the slurry dried out, and the remaining coal purchased on an "as is" basis and hauled away by buyers. Localized blowing of small amounts

of coal dust resulted. In addition, there have been occasional small dumps in the aggregate amount of about 100 tons per year. Loss of pressure has caused a few clogs in line, most of which were washed out by increasing pressure and a few of which required simple mechanical corrections. Experience gained will bring about technical improvements in future lines, in Montfort's opinion.

Centrifuging of the slurry at Southern California Edison's power plant at the terminus of the Black Mesa line has not completely separated coal and water, a residue of coal remaining in the water. The power company is experimenting with new techniques to solve this problem.[10,13]

II. Proposed Slurry Pipelines in WGREPO Region

From various sources, there come indications that half a dozen slurry pipelines serving coal fields in the WGREPO region are under consideration. Some of these are only in the concept stage, others are at advanced planning stages.

Most advanced is the line planned by Energy Transportation Systems, Inc. (ETSI), a joint venture of Bechtel, Inc. (an engineering firm), Lehman Brothers (the financial institution), and Kansas-Nebraska Natural Gas Co. (an operating natural gas transmission and distribution company).

This is a huge project involving an investment estimated in May, 1975 at $750 million, or one-eighth as much as the massive and difficult Alyeska petroleum pipeline project. Proposed is a 38-inch pipeline, running from Gillette, Wyoming, 1036 miles to White Bluff, Arkansas. Its capacity would be 25 million tons of coal per year, or more than 68,000 tons per day. By comparison, almost seven unit trains of 100 cars carrying 100 tons of coal each would have to leave the mine each day, and an equal number of empty trains would have to return each day to move the same amount of coal. This line would have more than five-fold the capacity of the Black Mesa line and would move coal almost four times as far.

Planning for the ETSI line is far advanced, with most of the engineering done and water rights secured. (See Section VI below.)

At various stages of conception or planning are these additional slurry lines originating in WGREPO states:

—A line from some point in Colorado to a point in Texas, probably near Houston. This proposal has taken two forms: (1) that the slurry line run all the way from the northwest Colorado coal mining area, near Craig, to a point near Houston, and (2) that coal be moved from Craig by train to a point in southeast Colorado, then by slurry line to Texas. By the latter alternative, the slurry line would be about 750 miles long. (Houston Natural Gas Company.)

--A line from the Hanna Basin in south-central Wyoming to a point in Oregon, about 800 miles. (Gulf Interstate-Northwest Pipeline.)

--A line from Alton, in southern Utah, 180 miles to Arrow Canyon, north of Las Vegas, Nevada. (Nevada Power Company.)

--A line from Star Lake, northwestern New Mexico, to St. Johnson, east-central Arizona. (Salt River System.)

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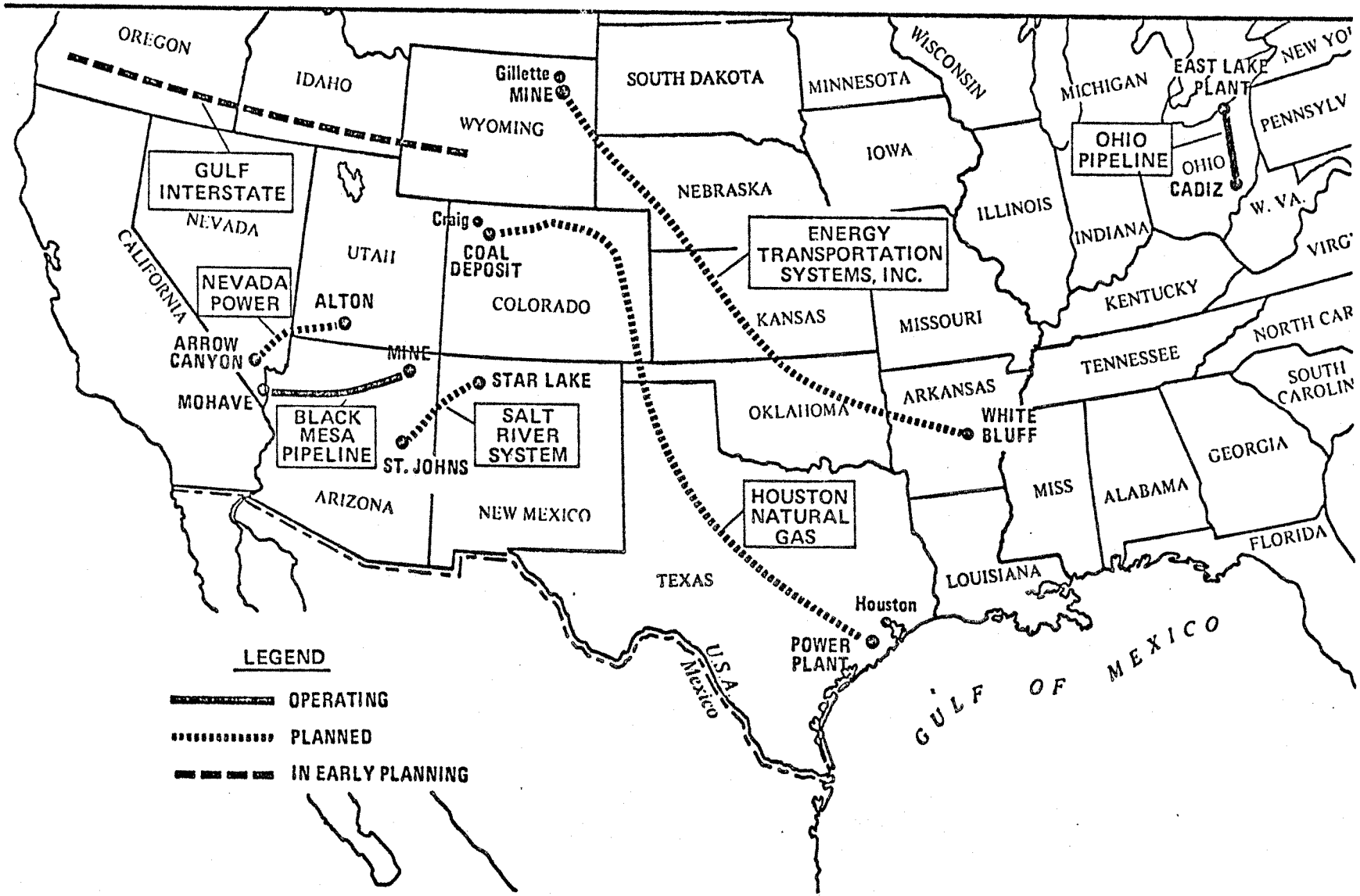
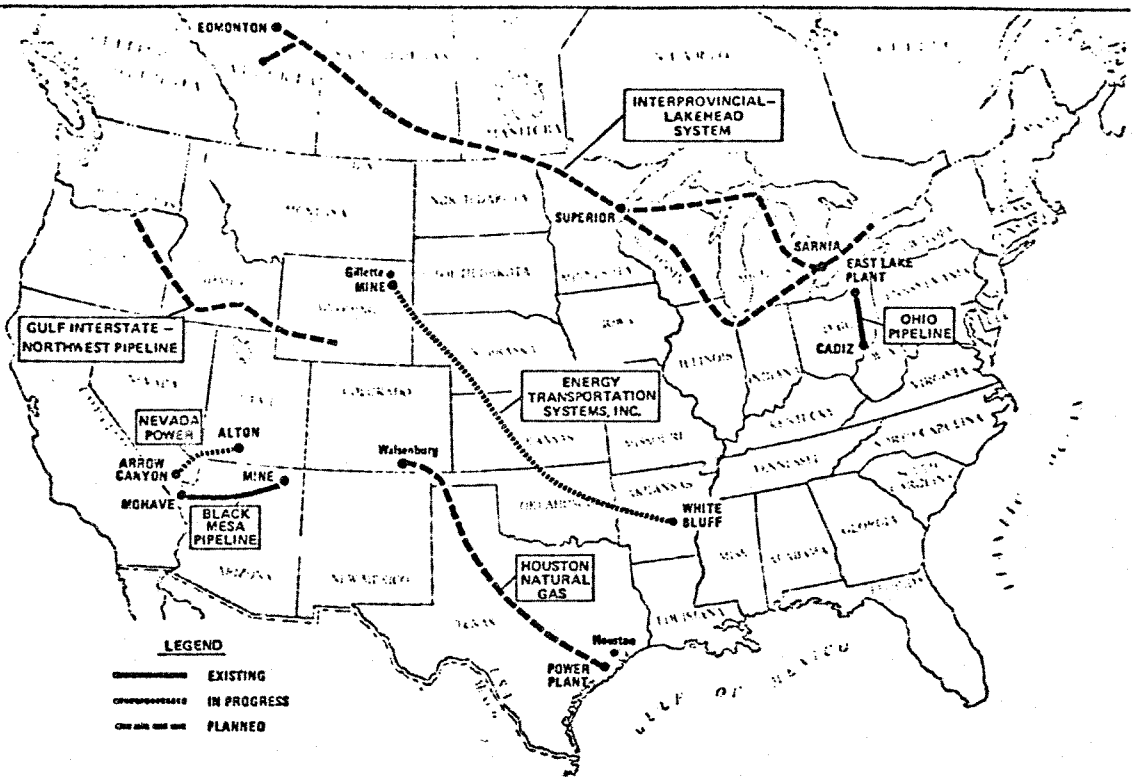
On the following two pages are reproduced two maps, varying somewhat in detail, showing existing and proposed slurry pipelines.

COAL SLURRY PIPELINES



COAL SLURRY PIPELINES



III. Impact on the Environment

Setting aside for the moment the knotty question of water consumption and availability, which will be discussed in Section VI, we conclude that slurry lines would affect the environment in the WGREPO states less than would any of the other alternatives.

But, taking a broader national view, the environmental impact of each alternative is more or less the same. The coal must be converted at one place or another--near the mine or near the consumer load centers. A measure of pollution--hopefully small--will take place wherever the coal is converted. It is a matter of which area shall be impacted and how much impact each area can accept. Some people say that sparsely populated areas of the west should be kept clean, as they are, and that the already soiled areas of higher population density and higher consumption should accept a bit more pollution. Others argue that wide open West can better endure a modicum of pollution than can the metropolitan consumption areas already carrying a considerable pollution burden.

Wherever conversion into liquid syncrude, medium-Btu gas, or low-Btu gas takes place, satellite industries likely will develop and further affect the environment, the degree being unpredictable at this time.

Transportation of energy must be carried out, regardless of which of the five alternatives is chosen. If coal is converted to electricity, high voltage transmission lines must be strung; if coal is converted to gas or liquid, pipelines must be laid.* There is no avoidance of transportation if coal is developed in the sparsely populated West to serve more densely populated areas, although transportation after conversion would be on a smaller scale than before conversion.

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*Disposition of gas derived from coal depends on the type of gas produced. Coal gasification at the first stage produces low- or medium-Btu gas not presently usable in small furnaces, such as those in homes, and which cannot be economically transported. It could be used in power plants and industrial installations adjacent to the conversion plant. If such low-Btu gas is upgraded to 900 Btu/scf or better, it can supplant or supplement natural gas and be moved economically in gas pipelines.

Disposition of waste--ash and/or solid residuals from gasification or liquefaction--must take place at one point or another. A proposed Arkansas power plant site includes 900 acres of land for ash disposal.[9] In the case of slurry transportation, there may be some problem of water disposal. This matter will be discussed in more detail below.

The consuming areas, as well as the coal producing areas, understandably resist further pollution. For example, in October, 1974, the Arkansas Public Service Commission gave Arkansas Power and Light Company a permit to build two 800-megawatt coal thermal generation plants at White Bluff but denied the company's application to build four such units because the commission found that the four-unit operation would cause air pollution beyond the level permitted by the state's Air Code.[9]

Returning to environmental impacts in the West, we draw these comparisons of the five alternatives:

Conversion

Each of the three conversion process entails some air pollution, the extent depending on the efficiency of emission controls. The Lurgi gasification process would produce potential air pollution by sulfur dioxide, oxides of nitrogen, hydrogen sulfide, reduced sulfur and particulates, methane, ethane, ethylene and aromatic phenols. The CO_2 Acceptor process would emit similar pollutants in different proportions. Liquefaction by COED process and Solvent Refined process would produce similar potential air pollutants.[6]

Coal-fired steam turbine electric generation plants pollute the air with sulfur dioxide, sulfur trioxide, nitrogen oxides, fly ash, and various trace elements,[6] the degree of pollution depending on caution taken in plant design and operations.

The wastewater from gasification, liquefaction, and power generation would contain traces of various pollutants.[6]

The extent of air and water pollution in all these cases is difficult to estimate. Great progress has been made in recent years in the techniques of cleansing industrial stack gases and wastewater, but none are perfect. Any conversion plant would cause some air pollution and require disposing of some tainted water and dumping of some ash or solid residual waste.

Land usage would not be massive for any of the alternatives. Lurgi gasification plant of the typical 250 mmcf daily capacity, consuming 9 to 10 million tons of coal per year, would require 800 to 900 acres of land, or on the order of 100 acres per million tons of coal annually. A CO_2 Acceptor gasification plant appears to require the same or slightly less land. A suggested liquefaction plant would need 1,500 acres for processing 35 million tons of coal a year and a 1,000 megawatt thermal power plant burning 4.5 million tons of coal per year would require 700 to 1,000 acres.[6]

Transportation

Neither train nor slurry line movement of coal poses water pollution problems in WGREPO states. As for air pollution, fugitive coal dust could escape unit train loading facilities or slurry mixing facilities. Stern regulations by state or local authorities would be in order to minimize this dust problem. Some coal dust would blow off open railroad coal cars. More pertinent environmental impact comparisons between the two forms of transport follow.

Slurry Lines. Land usage and disturbance for slurry lines would be less than in conversion processes. A site of 195 acres is suggested for the big ETSI line slurry grinding and mixing facilities at the mine.[6] On this particular line, a pump station and related facilities would be located approximately each 100 miles, each requiring a 50-acre site.[3] On lines ascending to higher altitudes, more closely spaced stations would be needed. At the delivery end of the line, about 140 acres would be required for the facilities separating the coal from the water.

Disturbance of land along the slurry line right-of-way, or more correctly, easement, would be mostly temporary. After laying of the line, ground surface would be returned to its original condition, so that farming, grazing, and wildlife activities could resume as before. Two qualifications should be made to this statement: one, provision should be made that the pipeline company take great care to do this and be responsible for revegetation, where appropriate; two, there is a possibility of permanent scars on the landscape in some types of terrain. The Black Mesa line in Arizona reportedly makes a scar for most of its length, as the ditch was cut through quite rocky soil. This would not be the case, assuming reasonable precautions, in less rocky soil.

Construction of any pipeline is quite rapid. An ETSI spokesman says that line laying crews would be working at any given point, typically, for only about four days. This estimate may be overly-optimistic, but certainly only a few days of pipelaying work would be required at any particular point, except at river, road, and rail crossings.

In estimating surface disturbance, comparison may be made with the many existing oil, oil products, and natural gas pipelines crisscrossing the country. Most of these are so well concealed as to be invisible to passersby. There is one minor difference in slurry line construction, of consequence only in rugged country. Slurry lines cannot bend sharply, and a maximum of 15 percent grade slope is allowed. This means that, in crossing steep bluffs, the line must be angled up the slope on a contour, or a cut must be made, as in laying rail lines.

Pipelines create no traffic problems and pose no grade crossing accident hazards. Decades of experience with many thousands of miles of pipelines carrying crude oil and petroleum products have shown high reliability, with breaks and spills occuring only rarely and with minimal surface damage. When liquids do leak from pipelines, the spill ordinarily is closely confined by the earth in which the lines are buried. In case of a spill, coal slurry would pose less danger than oil, since slurry is

not flammable.

As noted in Section I above, there must be holding ponds at each pump station for draw-off of slurry, in case of emergency. While this does not abuse land other than acreage already purchased and taken out of other uses for the station facility, some pollution could result if proper precautions are not taken. Holding ponds should be lined to prevent seepage of impure water into the ground. Some dust may blow from the dried out slurry; for that reason, consideration should be given to covering the holding ponds so as to contain dust.

Disposal of water separated from the slurry poses a problem at the terminus of a slurry line. Southern California Edison, which uses slurry delivered by Black Mesa, has had problems with water/coal separation.[10] Water expelled by centrifuging at the company's Mohave plant at the southern tip of Nevada contains 4 to 5 percent coal, most of which apparently is removed by a further step of settling and chemically treating the water in hydrofloculators. Aside from environmental considerations, the company has an economic incentive to recover the coal remaining in suspension in the water. Water further cleared in the hydrofloculators is used in the power plant cooling system, providing about one-eighth of the plant's cooling water requirements. Finally, some residual water is disposed of in lined evaporation tanks.

In early stages of the Mohave operation, these ponds were not lined and, for a time, pollution of the nearby Colorado River was threatened by seepage from the ponds of water containing undesirable minerals in solution. This threat was eliminated by lining of the ponds.

The position of the power company appears to be that the ultimate waste of water by evaporation from these ponds is no greater than that which takes place in power plants using conventional dry coal for fuel, and, with the new improvements, there is no water pollution.[10]

Spokesmen for ETSI say that they will use a vacuum filter method for separating the coal and water, instead of the centrifuging process and that this will avoid the separation difficulties encountered at Mohave. It is reasonable to assume that this or other new technologies will reduce the problem of water-coal separation. It is in the public interest to see that this is done.

If slurry lines are laid, each state traversed should require the application of firm criteria to protect the environment, these criteria to include the least disturbing routes for lines, proper location of pump stations, proper lining, and perhaps covering of holding ponds, full restoration of the previously existing land surface conditions after burial of the pipelines, etc.

Rail. Rail transport of coal threatens greater environmental impact than slurry lines.

Various environmental organizations have raised questions about the impact of slurry lines, but none have offered proof or even sound hypotheses of significant environmental damage. John McCormick of Environmental Policy Center and Richard Lahn of Sierra Club testified before a Senate Committee[14] in opposition to right of eminent domain for slurry line rights-of-way on June 11, 1974, but they addressed themselves more to economics and technology of transportation than to environmental questions. Their statements were singularly unconvincing. They did raise the pertinent question of consumption of water by slurrying (which will be discussed in Section VI below) but offered no specific or comprehensive data on the subject.

In a counter-attack, spokesmen for slurry lines have raised questions about the environmental impacts of rail transport of coal. ETSI Vice President E. J. Wasp charges[15] that (1) rail operations at current traffic levels are one of the two main causes of fires in the Powder River Basin, (2) trains lose one percent of their coal over a long haul in a year, (3) railroads control weeds and brush along tracks by using various chemical compounds usually rating at least No. 4 on the

Agriculture Department's toxicity rating chart, (4) trains generate noise at decibel levels as high as 98 at a distance of 50 feet, and (5) on a ton-mile basis, railroads incur 250 fatalities for each death involving a petroleum pipeline (and that coal lines will be safer than oil lines). Mr. Wasp's statements may be self-serving but are indeed founded on known facts.

Where new rails are laid, right-of-way land must be removed permanently from other beneficial usage. Assuming a right-of-way 150 feet wide, new rail lines consume 18.1 acres per mile.[6] The amount of new trackage needed for coal shipments varies for case to case. In all cases, some spur lines, loading facilities, and turn-around facilities for unit trains would be required. In different cases, various runs of branch lines would be needed. Burlington Northern and Chicago Northwestern have proposed to build a new 113-mile line between Douglas and Gillette, Wyoming to consume about 2,600 acres.[6] Most western coal mines could be served with much less new track.

New tracks with fenced right-of-way hamper movement of cattle, some species of wildlife, farm equipment, and miscellaneous traffic.

On existing rail lines, increased unit train traffic can impede traffic, cause noise and vibration affecting people, property, and animal life near the tracks. Traffic disruptions probably would be more severe in small towns and rural areas than in large cities, where there are more likely to be grade separations. Accident dangers likewise probably would increase more in non-metropolitan areas. All these adverse impacts would vary from situation to situation, depending on location of tracks, number of towns along the way, speed of trains, and other variables.

The railroads are moving toward the use of unit trains consisting of about 100 cars of 100 tons each capacity and, of course, these are moved as fast as roadbed conditions permit. The trains are heavier than typical freight trains and cause considerable vibration. If tracks are not in excellent condition, derailment danger is posed. It is in the public interest to enforce firmly safety

standards on rail operations, just as it is in the public interest to enforce firmly the environmental safeguards on slurry pipeline construction and operation suggested above.

In considering the slurry line/unit train alternative, it is noted that, to move the tonnage of coal to be carried by, for example, the huge ETSI line, nearly fourteen unit trains would have to pass each point on the track each day--seven loaded trains and seven empty trains returning.

IV. Socioeconomic Impacts

On a national basis, employment and population impacts of each of the five alternative dispositions of western coal would not vary greatly. As in the matter of effect on the environment, the question is where the most impact would be felt--at the mine site or in the consumption centers. At one point or the other, people would be employed in the conversion processes, and either coal or converted electricity would be transported from the coal fields to the consuming areas, if development of western coal takes place.

The question arises as to where the employment, population, and economic impacts would be most desirable or acceptable. If coal is to be stripmined in the West, there will be about 28.6 workers employed and a population increase of about 179 persons near the mine site for each million tons of coal mined annually, according to a Wyoming study.[6] A public policy question in the West is: How much additional employment, population, and economic impact is desired beyond that brought about by the mining?

Population Changes

The same Wyoming study mentioned above shows the following employment and population increases, on a long-term basis, not counting temporary construction workers, for each of the five alternative dispositions of the coal:

(Per Million Tons of Coal Annually)

Alternative	Employment	Population Increase
Slurry Lines	3.0	18.8
Unit Trains	4.8	30.1
Power Generation	40.0	250.0
Liquefaction	42.8	268.0
Gasification	89.5	559.2

(These figures are based on hypothetical cases involving arbitrary and presumably economical scales of operation for each alternative. These cases were developed for analytical purposes only. Actual results might be different, but it seems likely that the table provides a reasonable general comparison.)

The figures provided cover only the permanent employees and the extended population increases they would cause. Not included are the larger numbers of construction workers who would be on the scene temporarily. The Wyoming study provides some estimates on the size of construction work forces, based on assumed facility sizes, but does not break these down into numbers of workers per million tons of coal processed annually.

Certain safe generalizations can be made about construction labor impact. Building of conversion plants would require large construction crews during a period of five years, more or less. Laying of slurry lines and construction of slurrying facilities would bring in somewhat fewer workers and for a much shorter time. In the case of rail transport, relatively few construction workers would be needed, the number depending on the extent of new tracklaying necessary. Unit train operations would require erection of loading and rapid turn-around facilities for trains.

The Wyoming figures for permanent employment do not include further employment in satellite industries which potentially would develop around conversion plants but not in connection with transportation facilities.

Whether or not a state or community wants to encourage or discourage payroll and population increases is largely a matter of philosophy. On the one hand, there is the view that the population status quo should be left alone, because an influx of new people would upset existing social and political patterns, increase pressure on hunting, fishing, and other wilderness recreational opportunities, degrade the environment, and impose hardships on small towns unable to provide

adequate public services for rapidly growing populations.

On the other hand, there is the viewpoint that the addition of new payrolls with above average wage and salary scales, especially in some economically depressed regions, would improve the economy and the cultural diversity of those communities.

The present resident of a sparsely populated area who has an adequate income and a comfortable way of life may not want newcomers underfoot. His fears may be justified, or they may be only priggish or primeval fears of strangers from other tribes. Some alarms have been raised that the relatively high wages of coal and coal processing industries would siphon off agricultural and service workers to the detriment of employers presently enjoying low-wage labor.

Under-employed and low-wage workers and retailers whose cash registers are not ringing as frequently as they would like may view such new payrolls and potential customers as a blessing, rather than as a curse. Both conversion and transportation alternatives would provide relatively high-paying employment. Few unskilled workers would be needed in any of the five cases and, particularly in the conversion plants, there would be a significant proportion of engineers and technicians. Average earnings of the employees under any of the alternatives can be reasonably estimated at $16,000 to $16,500 per year, 1975 rates, plus the usual escalation in subsequent years.

The workers would include some from distant points and a considerable number of unemployed or underemployed people from nearby depressed areas. Employment opportunities would be provided in most coal areas to presently underemployed Indians.

In the Northern Great Plains coal area, there was a 10 percent net population loss in the 1960-70 decade. In that period, North Dakota lost 27,000 inhabitants, Montana, 8,000, Wyoming, 6,000, and Nebraska, 4,000.[7] By and large, population decreases have been proportionately more severe in rural areas than in metropolitan

areas; in each of these states, there has been some population growth in larger towns and cities. Overall state population decreases, therefore, are explained by stagnation of small communities and the decreasing number of family farms.

Population has been increasing sharply in the coal producing area of New Mexico and, no doubt, will increase further. The public policy of New Mexico presently is to encourage the creation of new job opportunities, because the per capita income of the state is distressingly low. Utah has been growing in population and economically, with encouragement from state government.

Cultural Impacts

Migration and abrupt population changes bring cultural impacts. Some established residents of potential growth areas view with alarm the prospect of in-migration by blue collar workers. Others believe that wellpaid newcomers would be stable, responsible assets to the community and point out that all of the conversion and transportation alternatives would employ high-wage workmen and a substantial mix of professionals and technicians with advanced education.

A high school principal in a small, formerly isolated community in one WGREPO state told Don Rapp, WGREPO Resource Planner, that he believed the quality of life in his town had been much improved when a large number of newcomers moved in to carry out a Defense Department project. He said that people had moved in from 46 states and that this mixture of people with different backgrounds had greatly broadened the horizons and understandings of his students. He added that various cultural activities were flowering because of the new people and the educational and financial resources they were contributing to the community.

WGREPO states are concerned with socioeconomic impact assistance and are paying close attention to measures designed to assist communities in accommodating new population. The provision of adequate public services, including schools,

police, and social services, sewer systems, streets, and so forth, as rapidly as new population comes on the scene can ameliorate the negative aspects of socio/cultural/economic impact and attract and hold the more stable and desirable sort of people. Individuals tend to live up to or down to their environments. One tends to be more careless with his cigarette ashes or chewing gum wrappers when the floor, or street, is already dirty. The amelioration of impacts, including cultural impacts, will depend on front-end financial assistance to communities.

Tax Revenue Impact

Assuming coal is to be mined with a resultant population increase of 179 people per million tons per year, the question arises as to how much additional population the locality wants to accept in choosing between the five coal energy movement alternatives.

As shown above in this section, slurry pipelines would cause the least further population impact, rail transport the second least.

The next question is, how much tax revenue would each alternative provide and, more pertinently, how much tax revenue per unit of population increase would each alternative provide?

According to a Wyoming study,[6] assessed valuation per unit of population for each process would be as follows in the tenth year after start of construction of the taxed facilities:

Electric Generation	$88,889
Slurry Pipeline	81,023
Liquefaction	26,667
Gasification	25,885
Unit Trains	6,823

Thus, power plants and pipelines would, over the long term, provide relatively high and nearly equal tax revenues per unit of population to be served, with the other alternatives now providing nearly as much.

But local authorities concerned about the initial cost of serving new residents might find slurry pipelines a much better tax source than power plants, because of the rapid construction schedules of the slurry lines.

The Wyoming study[6] shows the following ranking of tax valuation per unit of population in the second year after start of construction:

Slurry Pipelines	$9,016
Unit Trains	6,345
Power Plants	3,668
Liquefaction	3,707
Gasification	3,667

The same study shows a dramatic difference in tax valuations the third year:

Slurry Pipelines	$82,942
Liquefaction	12,143
Gasification	9,890
Power Generation	9,549
Unit Trains	7,286

Slurry line assessments would peak in the third year, due to rapid construction; thereafter, assessments would decline slowly, because of depreciation. Peak of investments and therefore of tax revenues would come later with the other alternatives--year 4 for unit trains and year ten for generation, gasification, and liquefaction, according to the Wyoming study.

The Wyoming study therefore leads to the observation that local tax assessors concerned with financing population impact costs would view slurry lines as the best of the five alternatives.

These tax comparisons are based on five specific and somewhat hypothetical cases in Wyoming. Other states and localities must make their own comparisons based on the specific data that is applicable. It seems likely, however, that the pattern of comparisons would be similar everywhere. Only in the case of rail transportation might there be significant variations depending on the mileage of new tracks to be laid.

V. The National Public Interest

As a practical matter, a slurry pipeline cannot be laid unless the construction company is given the power of eminent domain to secure right-of-way easements. The Black Mesa line was built without such power, but it was not opposed by the railroads, since there are no rail lines serving the points served by the pipelines. Also, Southern Pacific owns Black Mesa. In most cases, railroads simply would refuse to sell easements across their properties for competing slurry lines.

Slurry line proponents are lobbying in Congress and before various state legislatures for the power of eminent domain. The lead bill in Congress on this subject at this time is H.R. 1863, a copy of which is appended to this report. A similar congressional effort to provide eminent domain came in the form of an amendment offered by Senator Jackson to S. 2652 April 9, 1974, and hearings were held on it. H.R. 1863 is similar to the Jackson amendment, except that it includes various protections to the states and localities and certain regulations of slurry operations.

At this time, WGREPO opposes passage of H.R. 1863, pending more complete study of availability of water for slurrying, this opposition having been expressed in Public Policy Resolution 75-13, adopted by the governors July 29, 1975.

The suggested rationale for extending eminent domain power to coal slurry lines is different than those used in granting other forms of eminent domain, such as:

--To governmental entities for roads, public facilities, etc., based on general public service and the sovereign rights of government.

--To railroads, because they are common carriers obliged to serve all shippers on an equal basis.

--To utility companies for power lines and gas and water pipelines, because they render service to all of the public under governmental franchise and are

regulated. This rationale applies to interstate gas transmission lines, which are regulated by the Federal Power Commission.

The nearest comparison to coal slurry lines may be found in pipelines transporting crude oil and refined oil products. A vast, interlocking network of these pipelines accomplishes most of the movement of oil and oil products in the United States, except along seacoasts.

Oil pipelines do not enjoy federal eminent domain but have secured such from individual states. They have not been opposed by the railroads, for the railroads do not claim that they can fulfill this transportation function as efficiently and economically as pipelines. By and large, oil pipelines are common carriers. Although the typical oil line is owned by one company or a combine of oil companies, ordinarily it will accept shipments tendered by other oil companies as on a pro rata basis to capacity available. That is, an owning company is supposed to reduce the movement of its own oil or products, if necessary, in order to accept an equivalent share of any other shipper's oil or products. There have been charges from time to time by oil shippers that petroleum pipelines have not always fulfilled these common carrier obligations, but apparently they do so in nearly all cases, for there have not been widespread complaints.

Slurry lines do not meet the criteria of any of the above users of eminent domain. They are not truly common carriers in that they are designed to move coal only from one mining company or group of companies to one consuming company or group of companies on the basis of long-term contracts.

The basis for granting eminent domain power to a slurry line would be that construction of the line is in the public interest. Each such line would have to obtain a Certificate of Public Convenience and Necessity issued by the Department of the Interior, under the provisions of H.R. 1863. To ascertain the question of public convenience and necessity, the Secretary of the Interior, under H.R. 1863, would be required to consult with the administrator of FEA, the administrator of

EPA, and other "appropriate federal, state, and local agencies." The Secretary is instructed to ascertain if the slurry line would help meet national needs for coal utilization after consideration of alternate means of transportation and the relative costs of such alternate means, disruption to the environment by slurry lines, as compared to other transportation means, and the balance between energy needs of the area to be benefited by the project and the water requirements and other impacts on the area from which the coal would be transported.

Public notice and public hearings--at least one such in each state in which the project would be located--would be required before issuance of a Certificate of Public Convenience and Necessity.

The Attorney General would have to advise that the slurry line would not adversely affect competition, restrain trade, further monopolization or otherwise contravene antitrust laws.

H.R. 1863 also states that nothing in the Act shall be construed as affecting in any way any existing law governing appropriation, use, or diversion of water or any federal, state, or private right to water; as expanding or diminishing federal or state jurisdiction, responsibility, or interests in water resources development control; as displacing, superseding, limiting, or modifying any interstate compact or the jurisdiction or responsibility of any legally established joint or common agency of two or more states or of two or more states and the federal government.

The issue, then, on a case by case basis is whether or not construction of a particular slurry pipeline would be in the public interest. Debate on this issue may be broken down into two basic questions:

--Would or would not slurry lines benefit energy consumers by reducing transportation costs, conserving the use of energy in the transportation process, and reducing adverse environmental and socioeconomic impacts?

--In view of the broad common carrier responsibilities of railroads to carry a variety of freight, would eminent domain permit slurry lines to engage in unfair competition against railroads?

Consumer Costs, Energy Conservation

Slurry line proponents contend that such pipelines would reduce consumer costs and would be the most acceptable from the standpoint of environmental and socioeconomic impacts.[16]

Rail transport proponents disagree, asserting that unit train coal shipment is now or will be, in the long run, more economical than slurry shipment and therefore will provide lower consumer costs.[11,12]

Slurry lines are capital intensive and use little labor for operations after construction is completed. The proposed ETSI line would cost $750 million (1975 estimates) and would employ only about 300 people. Railroads are less capital intensive but employ more labor. Precise comparisons are hard to make, but Burlington Northern alone projects that it will employ an additional 5,190 people directly and provide indirectly for employment on other lines of 500 to 1,000 people by 1980 to handle coal shipments originated on Burlington Northern lines.[11] (It is not clear how many tons of coal movement would provide this much employment, while the 300 jobs created by ETSI would move 25 million tons per year.)

Slurry line proponents contend that the low manpower requirements would contribute to insulating costs of this form of transportation against inflation, to the benefit of the ultimate energy consumer.[16] Railroaders counter that this is a claim of dubious merit, asserting first that transportation costs are a small factor and second that the provision of some high wage jobs on the railroads would be good for the country. Said Louis W. Menk, chief executive officer of Burlington Northern in a statement filed July 1, 1975 with the House Committee on

Interior and Insular Affairs: "I come then to the policy issue involved in the theory that Government should encourage the investment of large amounts of scarce capital for the sake of making savings in labor costs--and this is ETSI's entire thesis. Would it be a sound public interest decision to deny railroad employment at high wages to thousands of people in times of chronic unemployment?"[11]

Present estimates, disputed by the railroads, appear to indicate that slurry transport is cheaper than rail transport. The Northern Great Plains Resources Program report of April 1975[7] makes this cost comparison for moving a million Btu's of coal:

	Rail Actual Average	Slurry (Estimated)
Montana to Minnesota (815 miles)	24.5¢	14.6¢
Wyoming to Minnesota (1,100 miles)	31.3¢	19.9¢
Montana to Ill.-Ind. (1,270 miles)	49.2¢	22.9¢

There is a possible flaw in these comparisons. The slurry costs are based on certain volumes of slurry movement and cost efficiencies in slurrying are achieved by constant high volume operations. The volume factor is less significant in rail transport.

Railroad spokesmen express particular skepticism about the predicted economies of the ETSI line, because of its large size. The line's economies are predicated on movement of 25 million tons per year. The Menk statement[11] quoted earlier in this section questions the feasibility of such huge movements from one source to one terminal market. Menk notes that use of so much coal at a single delivery point is a questionable possibility, citing the Arkansas PSC order[9] barring Arkansas Power and Light from installing more than two 800MW generation plants at one location because of the air pollution a greater concentration would cause. Menk then suggests that, if smaller branch lines were built to disperse the slurry to various terminal points, the high-volume economies of slurry transportation

would be lost.

Various railroad advocates have stated that in the long run, they will haul the coal cheaper than slurry lines can do so. Whether or not this is so remains to be demonstrated by both sides.

A second economy of concern to the public is the relative frugality of energy consumption in moving fuel to market. WGREPO recognized this merit of conservation in production as well as conservation in consumption in its original Statement of Policies and Positions adopted by the Governors in July, 1975.

Transmission of electricity by high voltage line is particularly wasteful of energy. This is noted in a report by the Environmental Quality Council of Montana in a 1975 study[17], which estimates that for each seven million tons per year of coal converted to electricity and moved by transmission lines there is a power loss--wastage--of 1,400 billion Btu's for each 100 miles. The Montana study suggests that this is a reason to locate thermal power plants near consumer load centers rather than near mines.

Transport of coal to load centers for power generation is shown by this same study to be more energy conservative by slurry line than by railroad. The Montana report draws on various technical sources to estimate that rail transport on a seven million ton per year basis consumes from 380 to 447 billion Btu's per hundred miles, while slurry transport consumes only 160 billion Btu's per hundred miles.

But Burlington Northern boasts of a fuel consumption of only 250 Btu's per ton mile,[11] which computes to 175 billion Btu's per hundred miles to move seven million tons a year, a much lower figure than the Montana study's 380 to 447 billions. However, the Burlington Northern citation apparently applies to a particular mainline unit train running from Montana to the Mid-West over relatively level terrain, while the Montana study covers different actual and hypothetical situations. The high figure in the Montana analysis is actual energy use on a rail route over

mountains from Colstrip, Montana to Spokane, Washington.

Both the coal mining industry and the electric power industry tend to support slurry pipelining, holding that use of this form of transportation would be in the national interest.

Carl E. Bagge, president of National Coal Association, testified before a House committee on July 25, 1975 in support of H.R. 1863 and related bills which would grant eminent domain to slurry lines.[19] He said that inadequate transportation already poses a constraint on the production of coal needed by the people and that transportation problems would be even more severe with a doubling or tripling of coal production within the next ten to fifteen years. "We simply must be able to move the product better, faster, and with greater reliability and economy," he said. "To do this, all modes of transport must be improved and new ones, like pipelining, must be introduced and used on a broader scale."

Bagge also said, "Based on our analysis of coal pipelining technology, we believe that the national interest dictates the granting of eminent domain to such pipelines. We take this position because we regard pipelining, not as a panacea for the coal transportation dilemma, but rather as one viable option open to coal to close the logistical gap between mine and consumer. We do not view our support for such pipelines as a threat to other means of coal transport. Rather, the pipeline is but one of many methods which must and will be used, if America is to make use of her vast coal reserves."

The American Public Power Association and various utility companies say that slurry pipelines are needed to provide assured deliveries of coal. Particular concern is expressed by utilities in the southeastern quadrant of the country--Texas and eastward--because these power companies now depend largely on natural gas for fuel and recognize that they must find replacement fuels.

Utility spokesmen have expressed lack of confidence in railroads as the sole deliverers of coal to their plants. "At the present time, some utilities are experiencing difficulties in securing transportation for coal," said Frank W. Frisk, Jr., Legislative Director and Special Counsel for the American Public Power Association, in a letter to Senator Jackson on June 26, 1974. "The long-range coal slurry line can serve as an important competitive alternative or as a supplement to rail transportation, and, consequently, APPA believes this concept deserves the support of Congress," he added.[14]

Floyd W. Lewis, President and Chief Executive Officer of Middle South Services, Inc., the parent company of a group of electric utilities serving 1,317,000 customers in Missouri, Arkansas, Louisiana, and Mississippi, testified in support of eminent domain in the June 11, 1974 Senate hearing referred to above.[14] In response to a question from Senator Haskell, he said that studies by his company indicated that coal moved by a slurry line in volumes of 10 to 25 million tons per year would be moved at a cost on the order of one-third of the cost for moving the same quantities by rail. He said that, over a period of 30 years, which he defined as the normal expected life of generating plants, this would mean a savings of $14 billion to consumers of electricity.

At the same hearing,[14] George Oprea, Vice President, Houston Lighting & Power Company, estimated savings by the use of slurry pipelines at somewhere between one-third and 50% below rail costs. He also said, "The use of two delivery systems, the slurry pipeline and railroads, should give our industry the necessary flexibility to assure long-term reliability and continuity of the delivery of coal."

The belief of many electric power company executives that slurry transport is cheaper than rail was reflected again by Floyd Lewis of Middle South Utilities (quoted above). In an interview with New York Times recently, in which the future

of nuclear generation was discussed, Mr. Lewis said, "We don't have any coal-fired plants now, but, in our case, looking at coal vs. nuclear power, the main consideration is what it costs to move coal here from Wyoming. If you can only move coal by rail, then you go to nuclear power, but if you can move it by coal slurry pipeline, the pendulum swings back to fossil."

It is in the national interest to move coal at the lowest feasible cost and with the lowest feasible consumption of energy. Not only those with vested interests in slurry line construction, but also potential customers (such as coal and utility companies) and public interest groups (such as the authors of the Montana Energy Policy Study[17]) estimate that these public interests would be served by construction of slurry lines. The railroads disagree. Full proof of the arguments is lacking, since much hypothesis is involved in the predictions. Experience with slurry lines is quite limited, and, even though railroad transportation is an old technique, there is only limited experience in moving large volumes of coal by unit train over western rail lines.

Better answers will be found when more experience is gained with each alternative. Probably both will be used to some extent within the next few years, and use of both will sharpen competition. This, within itself, may be construed as in the public interest.

Do Slurry Lines Threaten Unfair Competition?

In opposing eminent domain for slurry lines, railroad spokesmen go beyond direct comparison of the two transportation modes. They assert that diversion of coal hauling revenue from rails to pipelines would have secondary effects contrary to the public interest.

Railroads are common carriers of all sorts of freight for any person who wishes to make a shipment, within the regulations set down by the Interstate Commerce Commission. Coal movement is a major source of revenue sustaining the rail system, according to Association of American Railroads, which says that coal

accounts for 25 percent of tonnage hauled, 16 percent of ton miles, and 11 percent of revenue.[20] If this major source of revenue is taken from the railroads, their argument goes, they will be less able to render the service they are required to provide for shippers of other commodities.

The railroads point out that slurry pipelines would skim the cream of coal traffic, serving only the largest coal producers and users while the railroads, as common carriers, would be obliged to serve the remainder. This, they say, could impair railroad earning capacity, result in loss of rail jobs, and cause financing problems for the railroad industry.[20]

"The railroads must carry for all who apply. They must carry coal in single carload shipments or in a few carloads from small or medium sized mines to all kinds of consumers, large and small," said H. J. Breithaupt, Jr., General Counsel, Association of American Railroads, in testimony to a Senate committee.[14] By contrast, according to Breithaupt, slurry lines, of necessity, must "transport coal only in huge quantities from one or a very few large mines and only to the largest consumers; and it is only by such volume movements, to be guaranteed by contracts extending for lengthy terms, that the investment in a coal pipeline could be justified as creating a means of transportation cheaper than the rates charged by the railroads for carrying coal."

Numerous railroad industry statements raise the spectre of such economic damage to their industry from slurry line competition that the survival of rail service in general would be endangered.

"If rails lose the opportunity to transport coal because it is moving in pipelines, they lose revenue needed for investment. This means the cost of needed investment must be borne by the transportation of other commodities--with the result that any savings on energy would be offset by increases in the ultimate cost of other goods. Railroads have been--and continue to be--the backbone of the nation's transportation system, providing as much intercity freight transportation

as all the barges, trucks, and planes combined," reads a position paper by the Association of American Railroads.[12]

This paper goes on to say that government built highways over which trucks haul their goods in competition with railroads and improved waterways upon which barges move in competition with railroads, then concludes, "Now, it is proposed that the government grant special privilege to still another competitor (slurry lines)--for which there is no demonstrated public need."

Burlington Northern states[11] that "The construction of but one slurry line would have a major and possibly fatal effect on the ability of this railroad to finance the physical improvements necessary to provide adequate common carriage of coal to utility consumers not reached by pipeline." This company says that one line (presumably ETSI) carrying 25 million tons a year would cost Burlington Northern $150,000,000 per year in revenue, or $25,000,000 more than it earned in 1974 from hauling western coal and that this loss of revenue would greatly weaken its ability to raise capital for needed improvements in the system.

In short, the railroads say that their continued service as common carriers of all forms of freight for all shippers over an interlocking system of tracks serving small towns and large in every corner of the nation would be threatened by slurry lines which would skim off the most profitable coal haulages between fixed points.

If, indeed, survival of the railway systems is threatened by granting of eminent domain to slurry lines, the public must be sorely concerned. However, the proposition has been advanced that there will be coal hauling business enough for both. Predicting a quantum jump in the use of coal and urging the granting of eminent domain to slurry lines, a spokesman[14] for National Coal Association said, "We do not anticipate any major decline in rail's market share, although we do foresee a tremendous increase in the absolute volume of coal moved by rail."

There are general judgments which can be made as to the justification of slurry line competition with common carrier railroads. Beyond the general issue, there may be different situations in different cases. New competition might be appropriate in some cases, not justified in others. Under the terms of H. R. 1863, the granting of eminent domain would be decided on a case by case basis by the Secretary of Interior, as set forth above in this section.

VI. Water Consumption, Availability

Development of western coal requires the use of water, a valuable resource generally conceded to be in short supply nearly everywhere in the West.

Using certain assumptions as to thickness of the coal seam and other factors, the Wyoming study[6] frequently quoted in this report estimates that strip mining consumes about 230 acre feet of water per ton of coal mined annually. This water is for dust control and other mine site activities and for irrigation during the process of revegetating the land after mining. This use would vary from place to place, dependent particularly on climatic and weather conditions. Revegetation in an arid area or in an unusually dry year would require more irrigation than in an area with more precipitation or in a year with relatively abundant precipitation.

Comparative Water Demands

After mining, further consumption of water varies between the alternative uses of coal. To the extent that information is available, comparisons follow.

Rail. Water use for rail transport of coal is generally conceded to be negligible. Some water would be used for dust control and other processes at crushing and loading facilities. Where new trackage is laid, there would be moderate temporary use of water for compacting fills and revegetation. Moderate increase in population due to railroad employment would increase demand for domestic water. But there have been no suggestions that such small amounts of water would pose problems anywhere.

Slurry Lines. Use of water by slurry lines is reasonably accurately measureable. Slurry consists of approximately 50 percent water and 50 percent coal. The water may be of a quality unsuited for irrigation, domestic use, or livestock watering. Thus, the normal consumption of water by a slurry line would be 600 acre feet per million tons of coal transported.

However, consumption of water would be increased should the slurry line be unable to transport the optimum volume of coal. Since slurry must be kept moving

constantly through the line at a speed of four to six feet per second to prevent settling, a pipeline operator could not just slow down or stop pumping in case of a shortage of coal at the head of the line or a lack of demand at the terminus. Faced with inadequacy of either supply or demand, the slurry line operator has three options. He can shut down temporarily after flushing the slurry out of the line with water. He can reduce the volume of coal relative to the volume of water in the slurry, thus maintaining the necessary rate of flow while reducing the movement of coal and increasing the use of water. Or, he can use the device of "batching;" that is, normal slurry can be supplanted temporarily by plain water in the line, the slurry pumping resumed when coal movement is desired.

Black Mesa slurry line has resorted to the batching procedure on some occasions because of failure of the supplying mine to deliver enough coal.

In view of this supply and demand problem, a projection of 750 acre feet of water consumption per million tons of coal transported is used by the Wyoming study [6] in estimating water consumption by slurry pipelines, rather than the optimum figure of 600 acre feet per ton. Waste of water by inadequacy of supply or demand might be accomplished by state regulations placing an annual maximum on water consumption. This would give the slurry line operator an incentive to keep operations at the optimum level.

Conversion Processes. Estimates of water consumption by each of the three conversion alternatives are more difficult to make. Conventional steam generation power plants use about eight times as much water as do slurry pipelines, ton for ton of coal converted or transported.

If dry cooling is used by a thermal electric plant, water consumption drops markedly. Dry-cooled plants are more expensive to construct; the Northern Great Plains Resources Program study [7] draws from two studies to estimate that dry-cooling becomes economically competitive with water cooling when the cost of water delivered to the power plant is $200 to $250 per acre foot.

Water consumption by gasification and liquefaction plants is more difficult to estimate, due to lack of experience. The Wyoming study[6] makes these estimates of water usage per million tons of coal by each of the five alternatives:

Power generation.....from 1,556 a/f (dry cooling) to 6,444 a/f (water cooling)

Gasification.....from 500 to 1,463 a/f

Slurry Line.....750 a/f

Liquefaction.....314 a/f, assuming dry cooling

Railroad.....negligible

If these figures are valid, a simple generalization is that water demand for the five alternatives falls in the order the alternatives are listed above and that water conservation is achieved in reverse order.

Decisions on water consumption which can be permitted must be hinged, however, on water availability.

Water Availability

Gross figures as to the amount of uncommitted surface water in a given river drainage or as to the estimated reserves and recharge rates of underground reservoirs, such as the Madison Formation in the Northern Great Plains are of limited value in making judgments between the alternatives. Water availability must be determined on a case by case basis.

The Black Mesa line obtains underground water from a well field near the mine site. United States Geological Service monitors the water table to determine if it is being lowered by the withdrawal of water for the slurry line. Thus far, it has not sounded an alarm that there is a detectible drop.

ETSI has done preliminary development of a well field to draw water from the Madison Formation at depths of 3,000 to 3,500 feet for its proposed Wyoming-Arkansas line. The company says early test wells showed water to be of relatively high mineral content, 800 - 1,200 ppm TDS, and that later tests produced water with 545 ppm TDS. While this better water could be used for irrigation, ETSI says it would

cost $400 per acre foot at the well-head if developed for irrigation,[3] a price considered uneconomic for this use. J. D. Brunk, Executive Director of Wyoming Department of Economic Planning and Development, said in 1974 that $30 per acre foot was the maximum being paid for water by agriculture.[21]

In January, 1974, the Wyoming legislature passed a bill authorizing use of water for this slurry line, subject to final judgment of the State Engineer. After a study which included the results of a drilling test program he required of ETSI, the State Engineer granted well permits to ETSI in September, 1974.

Various safeguards are built into the water permits to protect other users, including a requirement for drilling of five monitoring wells to gauge water table levels and provisions for the company to find alternative sources of water or cease operations, if there is any interference with other uses of Madison water.

Controversy continues about the possible ill effects of withdrawal of Madison water. ETSI contends that the recharge rate of the Madison is estimated to be 150,000 acre feet annually, ten times as much as it would withdraw.[3] However, protectors of western water resources will bear in mind that this is but one of many proposed or potential industrial withdrawals of water if coal development occurs on a large scale.

The Northern Great Plains Resources Program report[7] cautions that "Major ground-water development from the Madison Group, should it occur, would, to a considerable extent, consist of mining of a resource and may exceed recharge (emphasis added). If wells are put down near the center of the basin, where most of the strippable coal occurs, major water development will probably not have any significant effect on recharge areas for many years. As mining of the water from the Madison occurs, the artesian head will decline, pump lifts will continue to

increase, and the cone of influence of the well field will enlarge."

This report also states, "Substantial study should be undertaken prior to and during development to assess the effects that mining of water from the Madison aquifer may have on water supplies in the recharge area. Monitoring of declines in artesion pressure and spread of zones of influence of well fields must be maintained to prevent damage to prior water users. The aquifer system, at present, has such minimal use that much potential recharge is rejected, but, as use increases, and if major well fields are located too close to zones of recharge, flow of springs from the Madison and streams crossing this sequence of rocks may decrease."

It is beyond the scope of this report or the competence of its author to measure and compare the conflicting arguments about Madison water. The above views are quoted more as examples of the controversy than as an attempt to draw comparisons that might point toward decisions. There appear to be many different opinions and a great deal of uncertainty among experts as to how much water can be safely withdrawn from the Madison and at what points.

The ETSI promoters have expressed a willingness to use an alternative source of water, diversion from the Oahe Reservoir on the mainstream of the Missouri in South Dakota, if water allocations and permits can be obtained. Surplus water apparently is available from Oahe, but complexities arise from state and federal authorities over that water. A pipeline running 288 miles from Oahe to the head of the ETSI line could also deliver water to small cities and other users along the route.

An ETSI spokesman[22] estimates that moving the 15,000 acre feet of water it would need each year by this line would cost the company about $1,200 per acre foot. A line carrying 100,000 acre feet annually and serving many other users would be more economical, lowering costs to $650 per acre foot, according to the ETSI estimate.

ETSI's cost estimates appear to be contradicted by other authorities. The Northern Great Plains Resources Program report[7] estimates the cost of moving water from Oahe to a point south of Gillette (where the ETSI line would originate) at $359 per acre foot and the cost of ground water from the Madison formation at $55 per acre foot. This discrepancy confuses the observer. However, from the public policy viewpoint, it may not be important. The cost of water to a slurry line company, or to a conversion plant company, is of less concern to the public than the question of whether or not water can be used for coal development without unacceptable sacrifices by agriculture and other users and unacceptable environmental impacts.

A different set of surface and underground water circumstances would be encountered at the head of each proposed slurry line (or each proposed conversion plant). Judgments must be made on a local basis by state and local authorities.

The entire controversy of water availability could be solved in the case of each pipeline by adopting the mechanically simple but financially expensive alternative of recirculating slurry water in a closed system; that is, water separated from the slurry at the pipeline terminus could be pumped back to the head of the line and re-used again and again for slurrying coal. Such a procedure would erase the worries of the water poor West. But ETSI estimates that, in the case of its proposed 1,036 mile line, this would raise water costs to $3,500 per acre foot, making the company's annual water bill come to about $52,500,000 or more than $2 per ton of coal transported. It might be in the public interest to make independent studies of this cost with a view to determining if the $3,500 per acre foot cost estimate is accurate and to determine if the added cost per ton of coal movement could be tolerated by the ultimate consumers of the energy.

Still another alternative might be to secure water at some point part-way down a proposed slurry line where surplus water is available and pump this water back up to the head of the line. For example, a slurry line serving the coal

hungry southeastern quadrant of the country might be so routed as to come close to a major river, such as the Lower Missouri or the Mississippi, part of the way down toward the terminus. At that point, water might be taken from the large river and pumped to the pipeline head through a pipeline parallelling the slurry line and on the same right-of-way.

A glance at the map of suggested slurry lines originating in the western states shows, however, that there probably are not many places that this could be done. The proposed Colorado to Houston slurry line would run across territory in which the rivers are small and from which there are extensive prior water claims. The suggested slurry line from the Hanna Basin of Wyoming to Washington and Oregon might join the Snake River at some point in Idaho. Availability of water from the Snake no doubt would be a matter of controversy in Idaho. This line also could potentially draw from the Green River if Wyoming and downstream Colorado River prior claims leave water available in the Green. The proposed Utah-Nevada line runs near no major stream and presumably would have to use underground water.

This commentary on water availability for the latter three suggested slurry lines is deliberately superficial and hasty, for it is obvious that the complex question of water availability must be answered on a local, case by case basis. No generalized report on behalf of ten WGREPO states should presume to offer expertise on this matter of local judgment and decision.

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Numerous additional sources were read but are not separately listed here because the information contained supplemented and complemented the information and opinions found in the listed sources, rather than offering additional information or different views.