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Virginia Polytechnic Institute and State University
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Comparing the Studies of a Coal Slurry Pipeline

b by Clara B. Cox*

The proposal to build a coal slurry pipeline in Virginia has become a hotly debated topic. In this report, a former Water Center staff member compares what eight separate studies have to say about its economic feasibility and its impact on employment and the environment.

Introduction

In late September the House of Representatives defeated the Coal Pipeline Act of 1983. This act, designed to facilitate the development of coal slurry pipelines in the United States, would have granted the power of eminent domain for interstate pipelines needed for public convenience and necessity. Had it passed and been successful in the Senate, it could have facilitated the acquisition of rights-of-way for a coal slurry pipeline running through Virginia from another state. Its failure places the Virginia coal slurry pipeline issue back in the General Assembly, where legislators must decide whether to repeal a state law passed in the 1960's that specifically prohibits the use of eminent domain for a pipeline transporting coal.

The proposal to build a coal slurry pipeline in Virginia has become a hotly debated topic. Virginia Electric Power Company (VEPCO) and the Virginia Coal Association have voiced support for this means of coal transportation, while the state's railroads, which have a virtual monopoly on hauling coal in Virginia, have opposed it. In the process of the debate, questions have been raised about the economic and environmental impacts of a pipeline that would traverse the state. The eminent domain statute and the implications of Virginia's water allocation policy have been discussed.

*Former Information Officer, Virginia Water Resources Research Center.

Following publication of conflicting reports sponsored by opposing forces in the pipeline battle, the 1983 General Assembly established a joint study committee to examine the issue. The group, which sponsored two of the studies listed below, is expected to make its final report to the General Assembly by December 30, 1983.

Several reports and studies and a master's thesis have emerged in Virginia since mid-1982 to address one or more of the pipeline issues. Although some of these works reflect the interests of their sponsors, the works in toto do make a contribution to an understanding of the issues involved. This special report looks at the issues as they are addressed by the following publications:

1. Yucel, Oner, "Coal Slurry Pipelines in Virginia: A Preliminary Feasibility Study," June 1982, published by the Virginia Center for Coal and Energy Research (VCCER) and supported by funds from VEPCO;

2. Teknekron, Inc., "Issues and Analysis: Proposed Virginia Coal Slurry Pipeline," October 1982, funded by the Virginia Railway Association (VRA);

3. R. Stuart Royer and Associates, "Coal Slurry Pipeline Water Issues," January 1983, funded by Virginia Coal Slurry Associates (VCSA), an organization composed of VEPCO, Transco Energy, A.T. Massey Coal Company, and Baltimore Gas and Electric Company;

4. Virginians for Competitive Coal Transportation (VCCT), "Virginia Coal Pipelines," January 1983;

5. Santos, German Ricardo, "An Assessment of the Offstream Storage Requirements and Low-

Flow Frequencies Characteristic to Supply Coal Slurry Pipelines Originating in Southwestern Virginia," January 1983, unpublished master's thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia;

6. Virginia Society of Professional Engineers (VSPE), "Virginia Coal Transportation Study," July 1983;

7. The BDM Corporation, "Virginia Coal Slurry Pipeline Study," October 6, 1983, prepared for the Virginia Joint Study Committee; and

8. Rule, Joseph H., and Terri Mathews, "A Survey of Possible Uses of Coal Slurry Wastewater in Hampton Roads, Virginia," October 31, 1983, prepared for the Virginia Joint Study Committee

Economic Issues

Feasibility

A basic question about whether a pipeline should be built in Virginia, assuming the resolution of legal prohibitions, revolves around the economic feasibility of such a project. Yucel's study and the BMD study are the only ones to examine the economic feasibility of a pipeline. Teknekron's report reviews Yucel's study.

To establish a representative data base to evaluate possible future scenarios, Yucel considers a range of annual coal throughputs (the amount of coal piped through the pipeline) from 2.5 to 25 million tons a year (mty). Economic evaluations are made for each case using an annual interest rate of 10 through 30 percent and a project life of 30 years. Tax related aspects are not treated. Yucel looks at six routes with the pipeline starting at Grundy, Big Stone Gap, or Pound and ending at Portsmouth. Distances for these routes range from 380 miles to 470 miles. The study describes in five-mile intervals location characteristics based on U.S. Geological Survey topographic maps.

In each scenario the pipeline is considered to have a slurry preparation and feeding facility at the origin, pumping stations along the route, and a slurry dewatering facility at the terminal point. A collection system with access to nearby mines and a communication and supervisory control system also are included in the cost assessments. According to Yucel, his method for assessing economic feasibility was to enter technical design and unit-cost data in a computerized optimization model. The outputs consisted of optimum system characteristics for each application. Costs were calculated by reevaluating and modifying data collected from various sources.

Only two of the studies examine the economic feasibility of a coal slurry pipeline, and both conclude that it would be feasible. A third report reviews one of the studies and arrives at a different conclusion.

Yucel finds that transportation costs ($/ton) vary a great deal depending on route, throughput, and annual interest rate. However, since the major cost of pipelines is for construction, they are less affected by inflation than are other modes of coal transportation. Based on his preliminary investigation, Yucel finds "that coal slurry pipelines appear to provide an extremely competitive alternative to current coal transportation systems in Virginia. . . ."3

The study by Teknekron says Yucel overlooked several factors that would increase the costs associated with building and operating a pipeline. According to Teknekron, Yucel—

1. uses five-mile intervals to determine location characteristics, which "may produce substantial error in engineering cost estimates"[4] when hilly terrain is involved;

2. does not include costs for collecting, retaining, and transporting slurry feedwater to the pipeline origin;

3. does not estimate capital or operating costs of "disposing of slurry wastewater in a manner consistent with applicable environmental regulations and intended end-use";[5]

4. does not specify transportation costs for getting coal from the mines to the pipeline origin;

5. "assumes that the pipeline will have a single origin and a single terminus, with no intermediate terminals en route, thus ignoring the fact that some of the pipeline's alternative routings was [sic] designed to serve several VEPCO power plants consecutively on the way to tidewater";[6] and

6. although suggesting that surplus slurry will be sold, makes no explicit provision for the additional facilities to carry out this function.

In addition Teknekron says that Yucel's construction cost estimates, when compared to those for the

proposed Midwestern Energy Transportation System, Inc. (ETSI) pipeline, appear "unreasonably low."

In its economic assessment, BDM Corporation derives costs for five basic elements: (1) the ingathering (collection) system, (2) the slurry preparation facility, (3) the water slurry facility, (4) the transportation system, and (5) the dewatering facility. Capital (investment) costs and operation and maintenance costs, enumerated in mid-1983 dollars, are based on a 30-year pipeline operating 350 days a year. Also included are federal (25 percent) and state (3 percent) income tax rates, a debt-to-equity ratio of 40:60, and a 16.5 percent composite capital return rate. Although BDM estimates capital and operating costs at higher figures than did Yucel, who used 1981 dollars, it still foresees savings in coal transported by pipeline. At current rail transportation tariffs for coal, BDM states, "pipeline transportation of coal could save as much as $4 to $5 per ton of delivered coal at Hampton Roads."[8]

The VCCT report uses data compiled by Yucel in its discussion of economic issues. This report notes that although the preliminary feasibility study did not include all coal collection and distribution costs, "the difference between rail rates and the pipeline's costs is so large that the savings will still be substantial after accounting for the other pipeline costs."[9]

The VSPE report sees a definite economic analysis of costs of coal transportation as beyond its scope. However, it looks at basic factors that can form a basis for further economic studies. These include:

1. concentration of coal mines in a general area;
2. market volume;
3. transportation distance;
4. 4. routing of the line; and
5. need for additional transportation capacity.

The VSPE report also points out that if a coal slurry pipeline is built in the Commonwealth, it would be financed entirely by private capital. Since it would require a large capital commitment, the "investors will have to be satisfied that the project is tru1y viable from an economic standpoint."[10]

Would a slurry line hurt employment in Virginia? No (with some qualifications), say three reports. Probably, says a fourth.

Employment

The loss of employment for railroad workers versus the added employment created by the pipeline is another economic issue addressed by some of the reports. According to VCCT, a pipeline would result in increased employment in the coal--producing areas. "Lower transportation costs would make Virginia coal more competitive and amplify the expected growth in coal demand. Increased demand for coal would create more mining and other coal-related jobs." Its report, however, does not address the issue of lost railroad jobs.

Teknekron briefly addresses the employment issue. It notes that a lower throughput, such as 5 mty, would not have a major impact on railroad employment. Throughputs of 20 to 25 mty, however, "will remove significant revenue from Virginia's railroads."[12] According to Teknekron, "a railroad employs three to four times as many people per ton of coal moved as a pipeline would. . . . Thus, Teknekron concludes, a 20-25 mty capacity pipeline could result in a net loss of permanent jobs.

The VSPE report devotes a chapter to the employment issue. Based on the percentage of total freight hauled that is coal, the report concludes that 65.3 railroad employees are needed for every million tons of coal hauled. Using figures for pipeline employment from Yucel's study, VSPE estimates that 20 pipeline employees would be needed per million tons of capacity. Thus, the report derives a ratio of 3.3 railroad employees not required for each pipeline employee. However, according to VSPE, this ratio is probably an overestimation since (1) the authors lacked data "on the ratio of rail operating employees to total rail employment"[14] and (2) the pipeline employment used to calculate the ratio "includes operating employees and the corresponding rail employment includes both operating and non-operating employees."[15]

Based on projected increases in coal production, VSPE says a coal slurry pipeline of 25 mty capacity could cause a temporary drop in railroad-hauled coal if the pipeline were on line by 1990, but "positive coal traffic gains would still be made by the railroads by 1995."[16] Thus, "positive employment impacts"[17] would occur after 1995 for both the railroad and the coal slurry pipeline. Also, VSPE predicts, if lower delivered coal prices result from competition for transporting coal, thereby increasing demand for the coal, additional jobs would be created for miners.

The VSPE report also looks at the number of construction jobs that would be created by building a pipeline. Using figures from Yucel, VSPE predicts that 883 full-time, three-year jobs would be required to

construct a 400-mile, 10 to 25 mty pipeline. However, a 10 to 25 million ton increase in coal hauling for railroads "may trigger railroad-related construction as well, depending upon how near capacity the railroads were operating preceding this increase."[8] (The limiting factor for coal transportation is the coal-dumping capacity at the Hampton Roads pier.)

Any increase or decrease in employment created by the pipeline also would have a multiplier effect. According to the VSPE report, the multiplier in Virginia is 1.6; that is, for each employee gained or lost, an additional 1.6 employees will be gained or lost in supporting employment.

BDM also addresses the employment issue, which it says is affected by the level of incremental production and the ingathering process. The report estimates that between 1,963 and 2,936 construction jobs a year will be created. If coal production increases, the report says, a 15-mty scenario could increase primary mining employment by 5,619 workers. BDM comes to a different conclusion than other reports in analyzing employment of pipe and rail operations:

> While requirements for operational personnel are from 39 to 43 percent lower for rail operations, the differential in pipe vs. rail ingathering distances means that approximately three times as many truckers are required to ingather coal to the pipeline. Depending upon the scenario, total primary employment is from 15 percent to 38 percent greater for pipeline than rail transport of the same incremental tonnage.[19]

Even if railroads lose tonnage (called "the lost tonnage scenario") to the pipeline, BDM predicts "a substantial increase in employment and yearly compensation levels"[20] for the state and concludes that increases in pipeline-related or induced jobs will "more than offset the drop in rail jobs."[21]

Availability of and Demand for Virginia Coal

Two kinds of coal are mined in Virginia: steam coal and metallurgical, or met, coal. Steam coal is used to power electric generating plants, while met coal is used in steel production. Since met coal is not suited to slurry transport, a pipeline would move only steam coal. According to Teknekron, "only 40 to 50 percent of Virginia's annual coal production of 41 million tons is suitable, in terms of quality or economics, for the state's steam market."[22] Existing contract commitments of Virginia mines probably would preclude their ability "to satisfy the tonnage requirements of a 20 to 25 million-ton pipeline, Tekenkron says.

According to one report, only 40 to 50 percent of the coal mined in Virginia is suitable for slurry transport, and existing contract commitments of Virginia mines would prevent them from being able to satisfy the tonnage requirements of a 20 to 25 mty pipeline. Two other reports do not agree.

BDM reports that Virginia's highest coal-producing counties--Buchanan, Wise, and Dickenson--"have enough coal reserves to support a substantial increase in production through the year 2020."[24] New estimates of Virginia coal reserves indicate that the state's reserves are larger than originally estimated, BDM says.

Demand for Virginia coal will hinge on the development of steam coal markets. BDM predicts:

> I]f Virginia is to maintain its 5 percent share of increased U.S. coal production, its demand base will come from the steam coal export and in the domestic electric utility markets. Since Virginia's electric utility market is somewhat limited, demand in this sector will come from coastwise shipments of coal to electric utility companies along the east coast.[25]

According to BDM, the demand for steam coal in the Hampton Roads market was about 20 million tons per year in 1981. The consultant forsees a climb in demand to 50-million tons a year in 1990 and 100-million tons a year in 2000. Therefore, BDM concludes, "there should be sufficient demand for steam coal at Hampton Roads to support at least one 25-million ton per year . . . level slurry pipeline in the 1990 through 2020 time period."[26]

According to the VSPE report, Appalachian coal production is projected to lose ground to increasing competition from western coal. However, VSPE says, "Virginia's production is projected to remain at nearly 5 percent of the total."[27]

VSPE discusses the effect of intrastate electric utilities on steam coal demand. Utilities in the state have burned an average of 60 percent of the coal in Virginia since 1960, VSPE says. The report attributes a drop in coal usage after 1968 to a "shift by Virginia Electric and Power Company (VEPCO) from coal to oil for some electric power generation."[28] However, an upswing in both utility and industrial coal usage in 1978 may "indicate that the trend toward increased usage of coal has begun."[29] Further, VSPE predicts that "VEPCO's 1982 coal consumption of 3.7 million tons in its Virginia plants will rise by 1986 to about 6 million tons. "[30] The VSPE report foresees an increase in the demand for

coal and a change to coal by both utilities and industry in Virginia.

Environmental Issues

The reports and studies address a number of environmental concerns. These include water availability; slurry water quality; treatment and disposal of transport water; effects of pipeline construction; pipeline ruptures and spills; and aesthetic, noise, and air quality impacts.

Surface water was considered the most likely water source for the pipeline by reports considering the issue, but, emphasizes one report, impoundments may be necessary.

Water Availability

Questions have been raised about the availability of water in southwestern Virginia for a coal slurry pipeline. Since a ton of water generally is needed to transport a ton of coal, a slurry pipeline coal capacity of 2.5 mty (the lowest throughput under consideration) would require about 1.918 mgd of water; 25 mty (the highest capacity under consideration) would require approximately 19.183 mgd, Yucel reports. According to Royer and Associates, "Most any type of water can be used in a coal slurry pipeline."[31] Thus, groundwater, saline groundwater, mine drainage, wastewater (such as sewage effluent), and surface water have been considered by a number of reports.

In general, the studies agree that there is not enough groundwater in southwestern Virginia to supply a pipeline, although the BDM report says that groundwater extracted through wells in the Tennessee basin "could possibly be used to supplement a primary water supply."32 Disagreement exists with regard to the other sources of water, however. Yucel indicates that saline water and wastewater could be used, provided certain process controls and monitoring take place. Teknekron disagrees, saying that sufficient quantities of wastewater are not available and that saline water is unavailable. The Royer and Associates report notes that quantities of mine drainage and saline groundwater exist but cites the need for detailed studies "to determine exact quantities and locations. . . ."[33] VSPE notes that flooded mines "are not true renewable, reliable, long-term water sources."[34] According to the BDM study, a slurry water supply from mine dewatering facilities "is not guaranteed,"[35] while the area's supplies of available treated sewage are "too small to warrant further consideration."[36] Recycled slurry water, BDM notes, "can significantly increase total water cost per ton of coal shipped."[37]

Surface water was considered the most likely water source for the pipeline by reports considering the issue. Yucel investigates several streams as potential sources by analyzing U.S. Geological Survey stream gage data from the following locations: Levisa Fork at Big Rock near Grundy, the Clinch River at Richlands, the Clinch River at Clevdand, Russell Fork at Hays i, and the Powell River near Jonesville. Two impoundments also are mentioned in the study: the Flannagan Reservoir and the Pound River Lake. Based on these data, Yucel determines that Levisa Fork, the Clinch River at Richlands, and Russell Fork could supply adequate water for the pipeline with the assistance during low-flow of a seasonal-storage reservoir. The Powell River and the Clinch River at Cleveland, however, "seem to have quite adequate water supply characteristics for Big Stone Gap [one of the proposed starting points for the pipeline] with little or no impoundment required."[38] A brief discussion mentions the fact that the summer supply of Flannagan Reservoir--78,000 acre-feet--is four times greater than the amount of water needed for a 25 mty throughput and that the volume of Pound River Lake is 8,000 acre-feet/year, which is reserved for summer operations

. Yucel concludes that "the region seems quite manageable hydrologically from [a] water resources point of view, namely to provide [an] adequate supply of water for the slurry pipeline."[39] However, he recommends a detailed study of the hydrologic characteristics of the region. The Royer and Associates report comes to similar conclusions.

Teknekron, however, notes that Yucel did not consider downstream uses. "Such analysis must be completed before the adequacy of surface water for a slurry can be judged,"[40] says Teknekron. It also concludes that impoundments will be necessary since surface sources "may be inadequate to satisfy the pipeline's needs."[41]

Santos looks at the relative effects of withdrawas based on varying throughputs. In his assessment of impoundment requirements and low--flow frequencies at five stream-gaging stations on four streams in the area, he found that

> relatively small--sized offstream reservoirs can well provide sufficient amounts of water for the coal slurry pipelines planned to originate in southwestern Virginia, without a major impact on the natural streamflow characteristics.[4Z]

Using 1980 flow data, the VSPE examined rivers in southwestern Virginia with low flows able to supply a 10 mty throughput. It found that "even on the day of lowest

flow during a drought year, adequate water resources are available to support a coal slurry pipeline."[43]

While the BDM Corporation notes that streams in southwestern Virginia may have substantial average flows that indicate their capability to supply water for a pipeline, the consultant points out, "[I]t is the low flows that must be considered in establishing quantity of water available for withdrawal."[44] Based on its examination of streamflow data and existing and projected surface water demands, BDM concludes that the Clinch River below Cleveland is the only stream in the area capable of sustaining a withdrawal in the order of 20 cfs (cubic feet a second) "without interfering with existing competing uses."[45] BDM suggests that the yield of the river during low-flow periods could be materially increased by constructing a small impoundment upstream from the point of withdrawal. Although BDM agrees with other studies that a number of streams could provide slurry water, provided the streamflow was augmented by water from an impoundment, it questions the availability of suitable reservoir sites. BDM found one existing reservoir in the area with the potential to sustain slurry water requirements--the Flannagan Reservoir. However, the study notes that competing uses, such as flood control, low-flow augmentation, and recreation, "would have to be evaluated to establish the actual quantity available for a slurry water supply."[46]

Unlike BDM, VSPE says that a 100-acre impoundment "would be available in many locations."[47] The report bases this conclusion on the fact that the region is sparsely populated.

Slurry Water Quality

Another significant water issue surrounding the coal slurry pipeline proposal involves the quality of slurry water when it reaches the end of the pipeline. Questions have been raised about chemical interactions between the coal and water. The Royer and Associates report lists the following variables that affect the end--water quality:

1. The initial quality of the coal and water;
2. The detention, or travel, time in the pipeline;
3. The equilibrium characteristics of the chemicals in water;
4. The coal-to-water and water--to--coal migration of certain chemicals;
5. The length of time between mining of the coal and slurry preparation; and
6. Whether the coal is washed prior to slurry preparation.

Based on his review of the literature, Yucel reports that significant degradation of slurry water is not expected to occur. Despite the concentration of significant levels of environmentally important heavy metals in the coal, these heavy metals are not leached appreciably into the water. And most trace elements do not leach from the coal in any significant concentrations during the slurry transportation process. According to Yucel, chemical analyses on two simulated slurry filtrates (conducted for the ETSI pipeline) indicated that 112 of 114 potentially toxic organic constituents were below detection limits. Methylene chloride, detected at low levels, and bis-(2--ethylhexyl) phthalate, detected at trace levels below EPA criterion to protect human health, were attributed to unavoidable sampling contamination.

Teknekron disagrees with Yucel, pointing to several potential problems:

What will be the quality of the slurry water at the end of the pipeline? According to one report, the amount of degradation will be slight. Not so, says another, while a third concludes that contaminants would be removed by conventional water treatment methods.

1. The transport water increases in acidity, a situation "which may cause toxic metals, such as mercury and beryllium, to be leached from the coal";[48]
2. Once used in the pipeline, the water will "contain higher concentrations of suspended solids, total dissolved solids, and sulfates";
3. Any phosphorus compounds that are used to control pipeline erosion will increase phosphates in the water; and
4. Any treatment of the water with chlorine for reuse purposes may cause dissolved organic compounds released by the coal to react to form carcinogenic chlorinated hydrocarbons.

The VSPE report notes that the transport water "can be expected to be mildly acidic and to contain high levels of sulfates, chlorides, and dissolved solids. Transport wastewater may also contain metals and organic compounds."[50]

BDM discusses pollution problems in the Big Sandy and Tennessee River Basins that could affect slurry water quality. These problems include bacteriological contamination, low dissolved oxygen, and concentrations of iron and manganese. Some pH problems exist in certain streams as a result of mine drainage and natural runoff. Individual streams also

have problems with concentrations of chloride, dissolved solids, and mercury. To minimize problems with slurry wastewater, BDM suggests that a high quality slurry water be used. In view of the quality of available water, BDM advises that source water be tested: "Coagulation and clarification should be provided so that a clean slurry water is used. The alkalinity should be adjusted to ensure an adequate buffering capacity since leaching of potential contaminants is enhanced at low pH values."[51] BDM also advises that the bacteriological quality of the source water be evaluated to determine the need for disinfection.

BDM examined the literature to ascertain the effect of coal on slurry water quality and identified the following parameters "as potentially significant constituents in coal slurry wastewater": 2 total dissolved solids, hardness, sulfates, calcium, chromium, cadmium, iron, manganese, lead, magnesium, mercury, nickel, selenium, sodium, and arsenic. According to BDM, the dissolved solids, hardness, sulfates, and calcium

> have been present in large concentrations. Iron and manganese may be expected to be present in high concentrations for Virginia coal slurry wastewater. The remaining metals have not been identified as being present in excessively high concentrations in laboratory studies thus far, but some values have exceeded values for drinking water.[53]

BDM agrees with VSPE that specific coals and slurry water must be tested "before any conclusive statements can be made on the expected quality of Virginia coal slurry wastewater."[54] Nonetheless, BDM concludes that there is no evidence at present "to indicate problems with contamination of coal slurry water that would exceed the normal removal capacity of conventional water treatment methods."[55]

Treatment and Disposal of Transport Water

According to Rule and Mathews, the treatment and disposal of the large volume of wastewater produced by dewatering the slurry is an important issue. Depending on the pipeline capacity, the amount of wastewater will vary from 10 to 15 mgd. Although no specific means of disposal have been determined, the two researchers look at several disposal alternatives: industrial applications, supplement to potable water supplies, agricultural applications, discharge into the Elizabeth River, and discharge into the Hampton Roads Sanitation District (HRSD) facilities. Rule and Mathews discount potable use, agricultural use, and HRSD disposal for various reasons. Although they say that discharge into the Elizabeth River is "economically feasible,"[56] they see the need for specific information on the quality of the wastewater so that it can be appropriately treated first.[57] Their investigation indicates that a system to distribute slurry wastewater to small industrial users would be "economically prohibitive."[58] The two conclude that a proposal by VEPCO to use the water for cooling purposes at its Portsmouth power generating plant is "the choice method of coal slurry wastewater disposal."[59]

What to do with the slurry water? Using it to cool VEPCO's generators in Portsmouth "is the choice method of . . . disposal," says one report.

The VCCT report states that "coal slurry transport water can be cleaned to any desired level using existing water treatment technology."[60] Costs of such treatment, it notes, depend on "(1) the quality of the coal and water taken into the pipeline and (2) the end use or disposal of the water."[61] VCCT notes that preliminary cost estimates for treating 12.4 mgd for use in a cooling tower are 17-26 cents a ton, while treatment for drinking water supplies are about 60 cents a ton. The report predicts, "The level of treatment of the water would depend on its cost in relation to the cost of other sources of additional water."[62]

Yucel cites other studies indicating that quality and treatment will depend on a number of factors, including the characteristics of the coal and water, the degree of treatment during dewatering operations, and the travel time in the pipeline.

Teknekron scores Yucel's study for not specifying "any estimates of the capital or operating costs involved in disposing of slurry wastewater in a manner consistent with applicable environmental regulations and intended end-use."[63] Teknekron refers to its own previous studies which show "that effluent water from slurries . . . must be treated prior to disposal to remove coal fines (particles), chemical leachates (such as organic compounds, metallics, acids, and other impurities from coal), and water treatment chemicals."[64] According to the VRA-sponsored report, the wastewater will require different types and amounts of treatment depending on its intended disposition. "[T]ransportation of the treated effluent to the consumer or disposal site should be included in the engineering analysis,"[65] Teknekron adds.

The VSPE report sees a need to test actual coals and transport waters used in the pipeline. Without such assessments specific treatment requirements for the water and costs for the pipeline are viewed as being impossible to establish.

BDM surveys possible uses for coal slurry wastewater and discusses treatment requirements. It notes that water quality and availability are key factors in developing reuse options and that economic

considerations require the point of reuse to be located near the pipeline dewatering plant. The study considers four reuse options: agricultural, industrial, municipal, and a closed-loop system to recycle slurry water. It comes to conclusions similar to those of Rule and Mathews on the first three options.

Four reports examine the impact of pipeline construction on the environment and conclude that it could be serious, but two of the four believe that, with care, adverse effects could be greatly reduced or even eliminated.

Although it finds that returning the end-water for reuse as the slurry medium would be technically feasible, it does not consider such a system economically feasible.

The VCSA report by Royer and Associates considers four major disposal options: discharge to fresh water with no end use-reuse, discharge to saltwater with no end-reuse, reuse for cooling water, and reuse for potable water. The report acknowledges that treatment of the transport water will add to the total cost of operating a pipeline, but it concludes that

> the technology is known, and that the equipment is commercially available, for the treatment of the coal slurry transport water for reuse in the four . . . major end-uses and/or disposal options. . . . The final cost will be dependent upon the (1) origin and the chemical and physical characteristics of the coal, (2) the origin and chemical characteristics of the transport water, and (3) the degree of treatment required for the transport water which will be dependent upon its reuse role.[66]

Pipeline Construction Impacts

In general, most construction projects result in some environmental disruptions. Yucel, VSPE, BDM, and Teknekron look at the disruptions that can be expected from laying a coal slurry pipeline approximately 400 miles across the state.

According to reports cited by Yucel and VSPE, construction of a pipeline involves removal of vegetation and trenching, thereby destroying a wildlife habitat which "may not recover for a long time despite prompt revegetation."[67] Truck traffic and the movement of construction equipment hauling and stringing the pipe result in dust and noise. Construction at stream sites may cause serious disruption of aquatic life, including "clogging of fish gills, covering of benthic organisms and eggs, and reduction of photosynthetic capabilities because of increased turbidity."[68]

Yucel quotes a 1981 ETSI report,[69] which states that construction activities for a pipeline would be confined to an approximate 100-foot right-of-way. Storage and work areas would require 200 square feet at periodic staging sites such as each side of rivers, highways, and railroad crossings. Existing roadways would be used when possible to transport materials, equipment, and workers. In those remote areas lacking access roads, the right-of-way for the pipeline would serve as the primary path of travel. Vegetation would be removed only from those areas where necessary for the safe and efficient operation of construction equipment. Trench depths would vary according to existing conditions and regulations. Disturbed areas would be revegatated.

In addition to the impacts noted by Yucel, Teknekron predicts disruptions from the development of access roads, cofferdams, water impoundments, and bridges and cites environmental problems of noise, exhaust emissions, and refuse disposal. Based on ETSI pipeline studies, Teknekron estimates that a 420-mile Virginia pipeline would disrupt 5,200 acres of land in addition to land for surface facilities. The construction of any dams and reservoirs for water supply purposes would add to the environmental impacts, Teknekron says.

The BDM study reports that clearing and grading, the first aspect of construction, "can expose an area to erosion, loss of topsoil, and pollution of streams with suspended solids."[70] Additional impacts include "disruption of biological and terrestrial food chains, wildlife disruption, and loss of agricultural productivity."[71] Noise and fugitive dust emissions also can be expected in this phase of construction. The second phase of construction, preparation of the trench, would cause similar disruptions. In addition ground

Based on the experiences of other pipelines, the likelihood of a rupture or spill is not great, say three reports, while a fourth adds, "A coal slurry spill would result in significantly less long term environmental damage than a spill from an oil pipeline."

water aquifers might be harmed by blasting. Other phases also would result in environmental disruptions. Impacts associated with construction of a coal slurry preparation plant, pump stations, and dewatering facilities will be site specific, BDM states. Additional adverse effects could result from "construction of access roads, power lines, other utility lines, the coal slurry water supply line, and temporary housing for crews."[72] However, these impacts are expected to be short-term, BDM says.

According to Yucel, many of the distruptions can be minimized: "All of these impacts in the construction phase . . . can be prevented or greatly limited if proper precautionary measures are taken. These measures are common practice in today's technology of pipeline construction . . . based on numerous general and specific guidelines aimed at preserving the environment."[73] BDM agrees--"Mitigation measures can reduce or eliminate these environmental impacts"[74]--and discusses available methods to minimize the disruptions.

Ruptures and Spills

Pipeline ruptures and spills are not expected to present major problems. According to Royer and Associates, the existing Black Mesa Pipeline has experienced two spills in 12 years of operation. During this period, the Black Mesa system has transported over 40 million tons of coal. The first rupture spilled 1200 tons of coal; the second one spilled 100 tons. Another pipeline, which operated for six years, never experienced a spill. Based on these facts and improved technology, Royer and Associates conclude that a Virginia pipeline could "expect an even better spill record."[75]

Yucel and VSPE also foresee few problems with ruptures and spills. According to Yucel, frequency of spills and ensuing damages "can now be reduced to a minimum with adequate design considerations, and not necessarily at any substantial costs. . . .[76]

Questions arise, however, about the environmental consequences of spills that may occur. According to Royer and Associates, the harm to the environment will be proportional to the amount of slurry spilled and will be influenced by such variables as location, characteristics of the slurry, and the clean-up effort. The Royer and Associates and VCCT reports point to the decision not to clean up the Black Mesa 1,200-ton coal spill because it was determined that clean-up efforts would cause greater environmental damage than leaving the spill. Five months after the spill, approximately 80 percent of the coal had been dispersed naturally. According to VCCT, this spill did not damage game, fish, or vegetation.

The BDM study cites a report, prepared for the U.S. Congress Office of Technological Assessment, which states that spills on land are not expected to result in significant long-term damage to soils or vegetation. Impacts on streams, however, will depend on pre-existing streamflow, water quality parameters, the natural biota, stream size, velocity of flow, and current stream loading. BDM foresees a spill into a major river as having "minimal effect as flow would be sufficient to disperse and dilute the suspended solids." p[e] Such loading of a small stream, however, "could have severe localized impacts."[78] Coal particles could increase turbidity, form a layer on the stream bottom, kill swimming organisms, smother benthic organisms, hamper fish feeding, smother eggs and larvae, and affect spawning. Once the coal fines are removed, BDM adds, "conditions would return to normal."[79] The consultant concludes, "Long term impacts from slurry spills into water are not likely to be severe."[80] The BDM study agrees with Yucel and VSPE that control and mitigation of ruptures and spills are feasible under available technology. BDM adds, "A coal slurry spill would result in significantly less long term environmental damage than a spill from an oil pipeline."[81]

One report describes a coal slurry pipeline as "the least environmentally disruptive mode of coal transportation today."

Looking at the same issues, Yucel quotes a 1981 ETSI report:

> [S]imulation tests . . . indicate that potential toxic elements and compounds are not expected to be present in sufficient concentrations to result in any significant bioaccumulation following a spill. . . . Only a few of the constituents found in the slurry water are expected to exceed federal drinking standards, and spills entering surface waters would generally be diluted rapidly to levels within federal standards. Thus, no long-term impacts are anticipated to the health and safety of any human as a result of a coal slurry spill at any time during the project life.[82]

Aesthetics, Noise, and Air Quality

The VSPE study calls an in-place pipeline "the least environmentally disruptive mode of coal transportation today,"[83] while Yucel calls it "the most aesthetically positive mode of coal transportation today."[84] These two reports note that a buried pipeline is visible only at pumping stations and overpasses, although evidence of its presence can exist in cut-and-fill areas. Except for forested areas, the right-of-way is returned to a natural state. Yucel reports that agriculture and irrigation can continue unobstructed when the pipe is buried deep enough. However, he foresees some cases where "future irrigation may be impeded because the pipeline would obstruct ditches of certain depth."[85]

Noise from the pipeline is not expected to be a significant problem. Yucel and VSPE cite an ETSI study predicting operational noise to be negligible. Noise sources will essentially be limited to the coal preparation and dewatering plants and the pumping stations. The ETSI study cited by Yucel and VSPE says that noise from the pumping stations generally should become insignificant beyond 92 feet, while noise from preparation plants should become insignificant beyond about 870 feet (assuming no attenuation cause by irregular terrain or heavy vegetation).

Any air quality impacts of a coal slurry pipeline are expected to center around the coal preparation and dewatering plants, according to Yucel and VSPE. Yucel relies on an ETSI study which estimates controlled particulate emissions from a 22.4 mty preparation plant at 362 tons a year and nitrogen dioxide emissions at 70 tons a year. Air pollution from dewatering plants was considered insignificant. The environmental impact of such emissions, the VSPE report states, is difficult to assess. Nonetheless, VSPE predicts that "these emissions would increase local levels by less than a few percent and probably not have a significant impact on local ambient air quality."[86]

Legal Issues

The major legal problems facing the development of a coal slurry pipeline in Virginia are a state law prohibiting

As four reports note, a Virginia law withholding eminent domain powers for the construction of a coal slurry pipeline and the riparian doctrine of water allocation pose problems for pipeline advocates.

eminent domain powers for construction of a coal pipeline and the riparian doctrine of water allocation.

Eminent Domain

Eminent domain is the right of a government to take private property for public use while providing compensation to the property owner. The theory underlying this procedure is that public needs are superior to private interests. Historically, governments have made eminent domain procedures available to private concerns that operate for public purposes, such as railroads, power plants, electric and telephone transmission lines, and pipeline operations. Of all the states, only Virginia withholds the power of eminent domain for a coal slurry pipeline:[87]

> [T]he right of eminent domain shall not be exercised for the purpose of acquiring any lands or estates or interests therein nor any other property for the construction, reconstruction, maintenance or operation of any pipeline for the transportation of coal.[88]

Considering the present law, the VSPE report looks at three approaches that can be taken to develop a coal slurry pipeline in Virginia. First, the pipeline companies could rely on case-by-case negotiations for needed land. The report notes that right-of-way acquisition for the ETSI pipeline "was made without the use of eminent domain, including crossing rights from several railroads."[89] ETSI's inability to negotiate agreements with the Union Pacific Railroad resulted in 65 legal suits against the railroad, all of which have been settled in favor of ETSI. The litigation was based on the terms of the federal grants of right-of-way to the railroad. However, unlike western railroad beds, which are located on easements, eastern roadbeds usually are located on railroad-owned land. Thus, the VSPE report concludes that similar litigation involving railroads probably would not succeed in Virginia.

The second approach discussed by the VSPE report is the enactment of eminent domain legislation in the state. Such legislation, the report notes, could consider

1. "The public service nature of the particular pipeline"[90] and

2. "The benefits to the citizens of the Commonwealth of Virginia."[91]

The third approach is the enactment of federal eminent domain legislation. The VSPE report provides a one-sentence discussion: "This approach would require the reconciliation of certain state and local concerns."[92] However, since the publication of the VSPE report, the House of Representatives has overwhelmingly rejected federal eminent domain legislation. Because of the margin of victory, a similar bill pending in the Senate probably will not reach the floor, at least during the present Congress.

Yucel's study gives cursory attention to the eminent domain issue in Virginia since consideration of legal aspects of the pipeline are "neither the intention or within the scope"[93] of the work. Teknekron does not discuss the issue. BDM sees the eminent domain issue as a legislative decision that should be tied to riparian rights: "If the General Assembly chooses to allow the right of eminent domain for coal slurry pipelines, legislation should also address riparian property rights.[94]

VCCT calls the Virginia law prohibiting the power of eminent domain for a coal pipeline "anticompetitive," noting that the prohibition does not apply to oil or gas pipelines. The report predicts that Virginia's railroads "will block a pipeline by refusing to allow it to cross their property. This refusal means that coal pipelines cannot be built without the right of eminent domain."[95] VCCT proposes that legislation be enacted to allow coal pipelines "strictly limited use of eminent domain for establishment of right-of-way but not for acquisition

of water rights."[96] The organization calls on the General Assembly to "establish a process with appropriate standards that will allow a pipeline to be developed if and only if its proponents can meet all statutory tests required to protect the public interest."[97]

Riparian Doctrine

Virginia adheres to the riparian doctrine for surface water allocation; purposes. Under this common law system, BDM says, "each riparian owner has an equal right to the reasonable use of water flowing in a defined water course through or by his property, so long as this use does not unreasonably diminish the rights of downstream riparian user s."[98] BDM further notes that an owner of land "which contains water, or through or by which water flows . . . , has the right to make any 'reasonable use' of the water he desires so long as no other party having rights in such water is injured by the use."[99] The report cites two Virginia Supreme Court findings on reasonable use, which state that a riparian landowner may extract as much water as he wishes so long as the extraction does not affect downstream users.

In regard to the riparian doctrine, BDM discusses the interbasin transfer issue--the transport of water extracted from one basin for use on land outside the basin. Some jurisdictions, BDM says, have deemed such transfers unlawful "even though there is no leg al injury to any other riparian owner."100 BDM points to Virginia Supreme Court decisions that appear contradictory in the adjudication of this issue; however, the consultant also notes that a 1972 decision of the Virginia Attorney General concluded that a lower riparian user must show actual injury to obtain an injunction or legal damages because of an interbasin transfer of water by an upper riparian owner.

Because of the nature of the riparian doctrine itself, Yucel and VSPE note several potential obstacles this allocation concept poses for a coal slurry pipeline:

1. Use of water from a stream must occur on riparian land;
2. Water in a stream must be shared with other riparian users; and
3. Riparian land on a stream does not extend beyond the watershed of that stream (although use on non-riparian land has been allowed in the absence of injury).

While the Teknekron report does not examine legal issues, it does indicate that possible problems could arise as a result of interstate impacts. It points to a suit filed by the state of Nebraska against an appropriation of water by ETSI several hundred miles upstream in South Dakota. Teknekron concludes that "Kentucky and adjoining states can make similar claims regarding the downstream use of water originating in southwestern Virginia."[101]

Summary

Three major areas of concern face the proposal to build a coal slurry pipeline in Virginia: economic, environmental, and legal. An examination of the eight Virginia studies and reports that pertain to the pipeline in some respect reveals the issues in each of these areas.

Economic Issues

Strong disagreement exists over economic impacts. This disagreement centers around the economic feasibility of constructing a pipeline, the employment impacts a pipeline might have on the state, and the availability of and demand for Virginia coal. The Yucel and BDM studies, the only studies of costs done to date, indicate that the pipeline would be economically feasible. Although Teknekron points to costs not included in Yucel's study, the VCCT report notes that a pipeline would result in savings over current railroad coal transportation rates even with these added costs. The BDM study included these additional costs and found that savings in coal transportation would still occur. Nonetheless, as the VSPE report points out, investors in a pipeline project will have to be satisfied with the project's projected economic viability before a pipeline would be constructed.

The employment impact on the state is unsettled. The VCCT and BDM publications predict an increase in mining and other coal-related jobs as the result of a pipeline. Teknekron says that a 20 to 25 mty throughput could result in a net loss of permanent jobs since three to four times more railroad workers than pipeline employees are required to haul a ton of coal. BDM disagrees, noting that employment is greater for pipeline than rail transport of the same incremental tonnage. A pipeline, BDM continues, would result in a substantial increase in employment. While VSPE says that 3.3 railroad employees are needed per pipeline employee, it believes that both transporters would experience positive employment gains by 1995 if the projected increase in coal traffic occurs.

BDM and VSPE review the availability of and demand for Virginia coal. Both reports indicate that availability will not be a problem.

However, VSPE believes that an increase in demand for steam coal will come from the state's own utilities and industry, while BDM thinks that demand will hinge on the amount of steam coal Virginia can export to utilities along the east coast. Teknekron predicts that Virginia mines would not be able to satisfy tonnage requirements of a 20 to 25 mty pipeline because of existing contract commitments.

Environmental Issues

Environmental issues also involve several areas of disagreement, although most of the reports generally agree that impacts in this area should not be significant if proper precautionary measures are taken. Environmental issues include water availability; slurry water quality; treatment and disposal of transport water; pipeline construction impacts; ruptures and spills; and aesthetic, noise, and air quality impacts.

In general the reports agree that any water supply for the pipeline must come from surface water sources. While Yucel, ,VSPE, BDM, Santos, Royer and Associates, and Teknekron agree that surface sources supplemented with impoundments can provide adequate water, BDM questions the availability of land for such impoundments. VSPE, however, says that land is available for a 100-acre impoundment in many locations.

Disagreement exists with regard to the slurry water quality, which Royer and Associates say will be affected by a number of variables. Yucel and VSPE do not expect significant degradation of the slurry water to occur; Teknekron does. BDM indicates that several potential problems can be minimized by using a high-quality slurry water. BDM and VSPE see the need to test specific coals and water before conclusive statements can be made about the slurry water quality. However, BDM says that conventional water treatment methods should be adequate to handle any problems of contamination.

According to most of the reports, treatment and disposal of the transport water cannot be determined until two essential factors are known: the quality of the end-water and its intended use. The VCCT and Teknekron reports note that cost of treatment will depend on the end use of the water. Rule and Mathews examine several uses and determine that the best use of the water would be for cooling purposes in a VEPCO-owned power generating plant. BDM also examines several uses, including re-use as the slurry medium. However, it determines that this use would not be economically feasible.

While a number of construction impacts are noted by Yucel, VSPE, BDM, and Teknekron, the impacts are expected to be short-term. Yucel and BDM agree that many of these impacts can be reduced or eliminated through use of certain precautionary measures.

Royer and Associates, Yucel, VSPE, VCCT, and BDM all agree that spills from a pipeline should not result in long-term damage to the environment. The Yucel and VSPE reports predict that the occurrence of spills can be reduced to a minimum with current design technology.

Aesthetic, noise, and air quality impacts are not expected to pose any significant problems, according to Yucel and VSPE. These reports say that the buried pipeline will be visible only at pumping stations and overpasses. Noise, the reports note, will be limited to the preparation and dewatering plants and pumping stations. Air pollution, which VSPE says will not be significant, will be around the coal preparation plant.

Legal Issues

The reports cite two major legal problems: (1) the current statute forbidding eminent domain powers for a coal pipeline and (2) the riparian doctrine Yucel and VSPE note. several obstacles within the riparian doctrine concept, including interbasin transfer. Teknekron indicates that problems also could arise because of interstate impacts since the proposed surface water supplies are streams that flow into bordering states. BDM believes that if the General Assembly repeals the eminent domain prohibition statute, it should also address riparian property rights.

With the defeat of the federal legislation on eminent domain, the General Assembly must now decide the fate of the proposed coal slurry pipeline in Virginia. The issues surrounding the pipeline are many, and the assessment of these issues by the reports and studies summarized here is often contradictory. The job before the legislature will not be an easy one

Footnotes

1. Two of the reports summarized here note this near monopoly by the railroads: Virginians for Competitive Coal Transportation (VCCT), "Virginia Coal Pipelines," January 1983; and Virginia Society of Professional Engineers (VSPE), "Virginia Coal Transportation Study," July 1983.

2. Members of the committee include Delegate Owen B. Pickett, chairman; Senator Peter K. Bubalas, vice chairman; Delegates V. Earl Dickinson, W. Taylor Murphy, Jr., Charles C. Lacy, and Clinton Miller; Senators Howard P. Anderson and John C. Buchanan; Dr. Ronald Carrier, president of James Madison University; Gerald Halpin, president of West Gate Corp.; and Joseph Johnson, former chairman of the Virginia Coal and Energy Commission.

3. 0. Yucel, "Coal Slurry Pipelines in Virginia: A Preliminary Feasibility Study" (Virginia Center for Coal and Energy Research, June 1982), I-20.

4. Teknekron, Inc., "Issues and Analysis: Proposed Virginia Coal Slurry Pipeline" (Virginia Railway Association, October 1982), 2.

5. Id. at 3.

6. Id.

7. Id. at 17.

8. The BDM Corporation, "Virginia Coal Slurry Pipeline Study" (Virginia Joint Study Committee, October1983), I-6.

9. VCCT, supra note 1 at 6.

10. VSPE, supra note 1 at 95.

11. VCCT, supra note 1 at 13.

12. Teknekron, supra note 4 at 26

13. Id.

14. VSPE, supra note 1 at 69.

15. Id.

16. Id. at 70.

17. Id. at 74.

18. Id. at 72.

19. BDM, supra note 8 at VIII-12, 16.

20. Id. at VIII-20.

21. Id.

22. Teknekron, supra note 4 at 26.

23. Id.

24. BDM, supra note 8 at I-2.

25. Id. at I-4.

26. Id. at I-6.

27. VSPE, supra note 1 at 17.

28. Id. at 26.

29. Id.

30. Id. at 27.

31. R. Stuart Royer and Associates, "Coal Slurry Pipeline Water Issues"(Virginia Coal Slurry Associates, January 1983), 3.

32. BDM supra note 8 at IX-33.

33. Royer and Associates, supra note 31 at 4.

34. VSPE, supra note 1 at 42.

35. BDM, supra note 8 at IX-26.

36. Id.

37. Id. at IX-34.

38. Yucel, supra note 3 at I-15.

39. Id.

40. Teknekron, supra note 4 at 14.

41. Id. at 11.

42. G. Santos, "An Assessment of the Offstream Storage Requirements and Low-Flow Frequencies Characteristic to Supply Coal Slurry Pipelines Originating in Southwestern Virginia" (January 1983) (unpublished master's thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia), 37.

43. VSPE, supra note 1 at 43.

44. BDM, supra note 8 at IX-6.

45. Id. at IX-9.

46. Id. at IX-18.

47. VSPE, supra note 1 at 45.

48. Teknekron, supra note 4 at 14.

49. Id.

50. VSPE, supra note 1 at 47.

51. BDM, supra note 8 at X-7.

52. Id. at X-28.

53. Id.

54. Id. at X-29.

55. Id. at X-51.

56. Rule, J. H. and T. Mathews, "A Survey of Possible Uses of Coal Slurry Wastewater in Hampton Roads, Virginia" (October 31, 1983), 19.

57. Rule was indirectly quoted in the Virginian- Pilot (November 2, 1983) as stating that a discharge of water from a coal slurry line into the Elizabeth River could adversely affect the Chesapeake Bay. Neither this conclusion nor research to support it was included in his report to the Joint Study Committee.

58. Rule and Mathews, supra note 56 at 12.

59. Id. at 20.

60. VCCT, supra note 1 at 20.

61. Id.

62. Id.

63. Teknekron, supra note 4 at 3.

64. Id. at 7.

65. Id.

66. Royer and Associates, supra note 31 at 15.

67. Yucel, supra note 3 at V-10, 11; VSPE, supra note 1 at 56, 57.

68. Id.

69. Bureau of Land Management and Wood ward-Clyde Consultants, "Environmental Impact Statement on the ETSI Coal Slurry Pipeline," Final Report, 2 volumes, (July 1981).

70. BDM, supra note 8 at XI-8.

71. Id.

72. Id. at XI-18.

73. Yucel, supra note 3 at V-11.

74. BDM, supra note 8 at XI-8.

75. Royer and Associates, supra note 31 at 21.

76. Yucel, supra note 3 at V-12.

77. BDM, supra note 8 at XI-26.

78. Id.

79. Id. at XI-27.

80. Id.

81. Id. at XI-28.

82. Yucel, supra note 3 at V-13, 14.

83. VSPE, supra note 1 at 48.

84. Yucel, supra note 3 at V-3.

85. Id.

86. VSPE, supra note 1 at 49.

87. VCCT, supra note 1 at 26.

88. Va. Code Ann. 56-49(2).

89. VPSE, supra note 1 at 58,59.

90. Id. at 59.

91. Id.

92. Id.

93. Yucel, supra note 3 at VI-1.

94. BDM, supra note 8 at I-20.

95. VCCT, supra note 1 at 26.

96. Id. at 29.

97. Id. at 28.

98. BDM, supra note 8 at XIII-2.

99. Id.

100. Id. at XIII-3.

101. Teknekron, supra note 4 at 14.

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