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SHALE OIL, WATER, AND THE
POLITICS OF AMBIGUITY

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PREFACE

This report is one in the series of energy policy studies sponsored by the Center for Energy Studies, The University of Texas at Austin. It is a consideration of the public policy problems surrounding the development of shale oil, focusing on the many difficulties associated with shale and water, and the attempts of private and public decisionmakers to deal with those problems.

Deposits of shale oil in northwestern Colorado are so enormous that this fuel has the potential to liberate the United States from dependence on foreign sources of energy for many decades. Yet the technical, environmental, economic, and political problems facing the exploitation of this resource are themselves so great that they call into question the very possibility of development.

Two themes dominate the following discussion. The first and most important is ambiguity. Uncertainty pervades every discussion of shale oil and water, so much so that industry, academic, and political observers are unable to evaluate realistically the possible costs, benefits, and dangers of developing the shale resource. The second theme is complexity. The process of judging the opportunities and dangers of shale and water, and the political maneuvering surrounding this process, are almost endlessly complex. Ambiguity adds to complexity, and vice-versa. The result is that both private and public policymakers treat the subject of shale with extreme caution. Policy advances incrementally when it moves at all.

These are the general points. There is also a specific discussion of some of the political fights surrounding shale policy, to help illustrate the ambiguity and complexity of the process.

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The views expressed in this report are those of the author and do not necessarily represent any official or unofficial policy of the Center for Energy Studies or of The University of Texas at Austin.

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Department of Government

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INTRODUCTION

And we are here as on a darkling plain
Swept with confused alarms of struggle and flight,
Where ignorant armies clash by night.
Matthew Arnold
"Dover Beach"

Ever since the energy crisis descended upon an unprepared nation in 1973, Americans have been searching for a substitute for crude oil that is technologically feasible, economically viable, environmentally enduring, and strategically secure. Of the many candidates for "power source of the future," the various synthetic fuels--shale oil, coal gas, coal liquids, and tar sands--have recently been much in the public eye. This attention has come partly from the amount of both federal and private money that may be spent on them, and partly from the opposition that their possible exploitation has already created. Because the development of shale oil has incited the most political conflict, it is the most interesting. Shale oil has the potential to become the energy savior of the United States; it also has the potential to be a social, ecological, and economic disaster.

This paper is a discussion of the public policy issues surrounding one synfuel, shale oil. Because the entire subject is too large for a monograph, the focus here is on one aspect of the question: the problems, conflicts, and policies surrounding the relationship between shale oil and that other critical liquid, water. The problems of both water supply and water pollution are inseparable from any discussion of the potential of shale oil as an important fuel.

The argument of this paper is that the national discussion of oil shale is taking place in an atmosphere of profound ambiguity. Caught up in the problem of shale is a host of fundamental questions dealing with technology, economics, and politics. Despite the fact that tens of millions of dollars have been spent to try to answer these questions, as of the summer of 1982 most of them remain as murky as ever. Nevertheless, history does not pause for research projects, and governmental actors continue to make policy without knowing the ultimate consequences of their decisions. The options they choose, however, are conditioned by the uncertainty within which they are made. Furthermore, the political coalitions that maneuver to affect policymakers are themselves partly sustained by the indeterminate nature of the subject of their struggle. It is the task of this paper to examine the ways that ambiguity affects the political process that surrounds shale oil and water.

THE NATURE OF SHALE OIL

One of the problematic aspects of oil shale is that it is not a shale, and it contains no oil. It is a marlstone which, if crushed to pebble size and heated to about 900 degrees Fahrenheit, exudes a gas. When the gas is cooled, it becomes a carbonaceous liquid known as kerogen. When properly refined, kerogen burns very much like fuels derived from crude oil. Kerogen is better adapted to being a substitute for crude than is synthetic fuel derived from coal; in particular, it is easily turned into jet fuel.¹

Discussions about the magnitude of the nation's oil shale resources invariably include the word "enormous," but any attempt to discover their precise extent entangles the researcher in the coils of uncertainty. If no allowances are made for the quality of the resource and if optimistic geological assumptions are made, it is possible to derive a figure of 27 trillion barrels of crude oil equivalent existing in the United States.² No one, of course, expects to recover anything like this quantity. If technological and economic realities are taken into account, the consensus among experts is that between 400 and 600 billion barrels might be extractable.³ This figure is more than twice the crude oil reserves of Saudi Arabia and clearly presents a great opportunity to the nation.

Not all experts are so hopeful, however. One analysis, which makes pessimistic assumptions and subtracts the amount of energy necessary to produce shale from the quantity ultimately available, concludes that there are only 62 billion barrels of net usable energy in US shale.⁴ This amount is about twice the present national crude oil reserves, but it is only two thousandths of one percent of the original 27 billion barrel figure. Other studies, relying on successively more pessimistic economic assumptions, manage to revise recoverable reserves all the way down to zero.⁵ The ambiguity surrounding oil shale, then, commences with the first question: How much is there?

However much kerogen is potentially available to the nation, there is little doubt as to its location. The overwhelming majority of the shale oil that appears recoverable with present technology occurs in 16,000 square miles of the Green River formation of Colorado, Utah, and

Wyoming (see Map 1). Eighty percent of the richest ore (highest grade: at least 25 gallons of kerogen per ton of rock) lies in a small section of northwest Colorado known as the Piceance Creek Basin (pronounced pee-ahnce).⁶ It is the possible development of this great deposit of energy that is currently being considered in Colorado and Washington, DC.

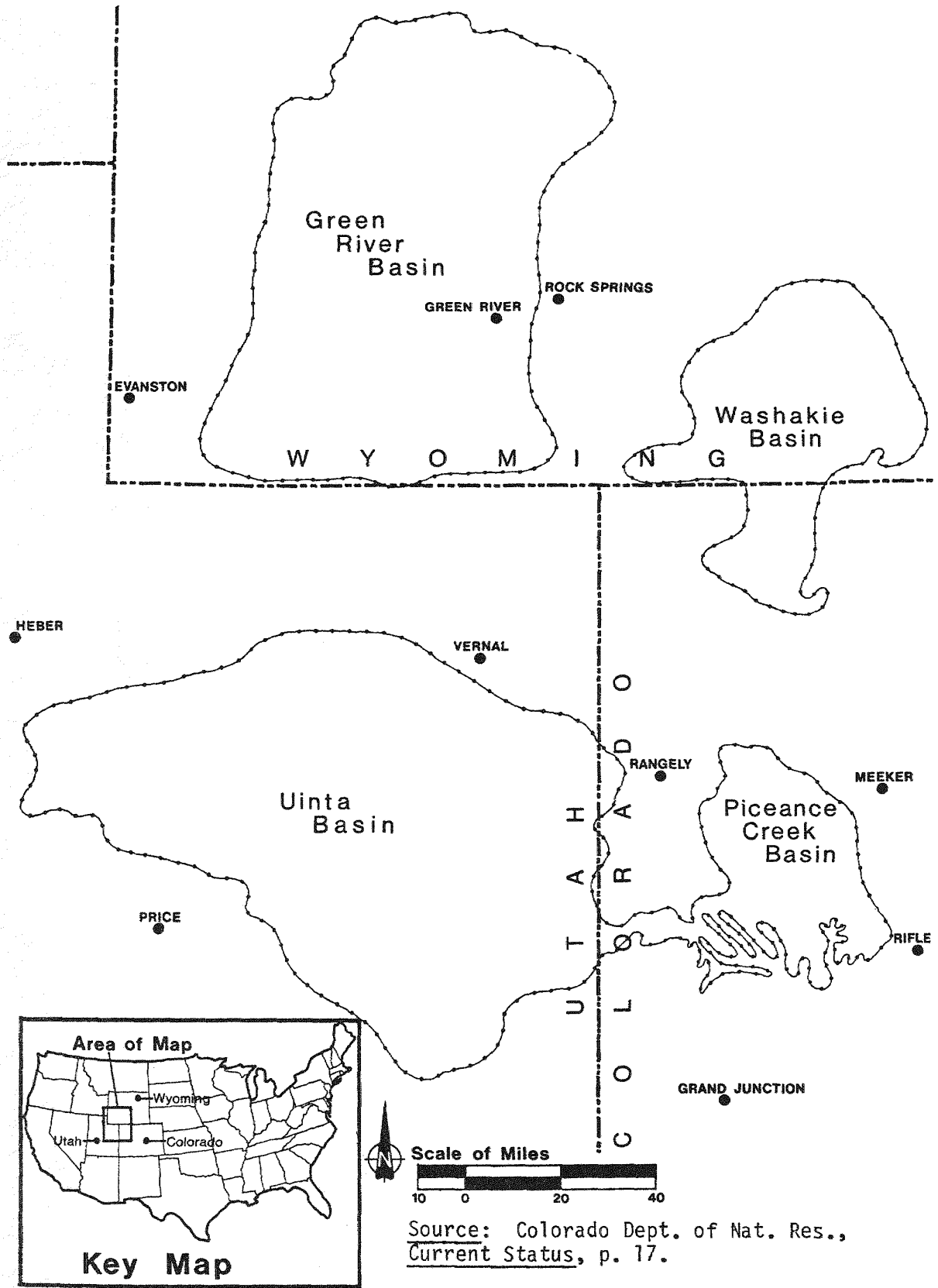
PROBLEMS FACING THE SHALE OIL INDUSTRY

The infant shale oil industry faces problems commensurate with its vast potential. A look at some of the more notorious suggests the context of difficulty in which the industry is attempting to grow.

Air Pollution

Oil shale processing is expected to be rather dirty, but because the many possible retorting ("retorting" refers to the act of processing the shale; this is done in a "retort") technologies are untested on a large scale, their individual contributions of unwholesome particles to the atmosphere are unknown. Moreover, because air movements around northwestern Colorado are not well understood, the potential pollution by an industry of any given size is the subject of speculation.⁷

From the standpoint of the industry, the problem of air pollution extends much farther than lack of knowledge about the contribution of any particular technology. The federal government also adds its share. When the Rio Blanco oil shale consortium (Gulf and Standard of Indiana) made its original baseline air quality studies, it discovered that the area was so dusty that three federal ambient air quality standards were



Map 1

WESTERN OIL SHALE: GREEN RIVER FORMATION

already being violated by nature, before any development.⁸ The Reagan administration is attempting to amend the Clean Air Act to take such problems into account, but the outcome of its efforts, too, is of course presently unknown. Meanwhile, Rio Blanco has chosen to proceed with a retorting technique that is expensive but that does not add any pollution to the already illegal air.⁹

Solid Waste Disposal

If the kerogen in a minable seam of shale averages 25 gallons per ton, to produce two million barrels a day of fuel, from those technologies which seem most feasible now, will require the mining, crushing, and disposing of more than three million tons of rock each day. This requirement would probably make the shale business the largest industrial effort in history.

Because returning the spent shale to the ground is uneconomical, the companies want to dump it in nearby canyons. This plan creates many environmental problems, disrupts scenery, and requires expenditures of energy for hauling and revegetation.¹⁰

Socioeconomic Impacts

Various towns of the mountain West, most notably Craig, Colorado, and Rock Springs and Gillette, Wyoming, have become famous examples of the "boomtown syndrome." Coal development there has brought in its wake a social disintegration and strain on municipal services that often seem to outweigh the community's economic advance. If a large shale oil industry were to develop, more than one million people could move to northwest Colorado, all of the area could become a boomtown, and the

resulting chaos could dwarf previous western experience with social dislocation.¹¹

Economics

The best available estimate is that one 50,000-barrel-per-day shale oil plant requires an investment of approximately \$1.7 billion in 1979 dollars.¹² For the nation to receive two million barrels of kerogen a day, therefore, someone would have to invest \$68 billion. The question that most concerns members of the industry is the potential profitability of such ventures. Because of the many critical uncertainties surrounding shale, the economic viability of the industry is still much open to doubt.¹³

Shale has a long history of seeming to be on the verge of profitability, only to founder on economic shoals.¹⁴ In the late 1970s, with the price of crude oil rocketing upward, the shale industry's potential at last seemed about to be realized, as many energy companies announced plans to begin operations in a serious way. But the retrenchment of crude prices that accompanied the worldwide oil glut of 1981 and 1982 once again made shale appear to be more of a risk. In December 1981, Occidental and Tenneco announced that they were mothballing their project at Cathedral Bluffs, Colorado. Five months later, Exxon stunned the residents of the western slope by announcing that it was scuttling its Colony project near Parachute. The final cost of the project, according to the company, would probably be "more than twice as much" as the \$3.1 billion original estimate.¹⁵

The Union Oil Company, beneficiary of a federal purchase agreement and price guarantee, immediately called a press conference to say that

its project would not be abandoned. In the face of an increasingly pessimistic economic outlook, it is unclear whether any of the other companies will stay interested in shale. Because they anticipated such economic dangers, several companies besides Union have turned to the federal government for loans, loan guarantees, price guarantees, and purchase agreements. At this point, economic uncertainty intersects political uncertainty, a topic to be taken up later.

Of all the problems faced by the shale industry, those that have so far inspired the most technical argument and political maneuvering revolve around the subject of water. Because both water supply and pollution are at the heart of the controversy over shale oil, the rest of this paper concentrates on them.

Water Supply

The problem of water supply begins with uncertainty about how much an industry will require. At least half a dozen major technologies exist for retorting oil shale. Some of these, in small test runs, have required a substantial amount of water per barrel of oil produced; some require almost none.¹⁶ The amount of liquid demanded by a mature industry, then, would depend upon the technological mix it employed. Since this mix cannot at present be ascertained, the future demand for water cannot be precisely determined.

Not that people haven't tried. The estimation of possible water usage, given different assumptions about the pace of development, is a cottage industry in both Colorado and Washington.¹⁷ Estimates of the amount of water required to sustain a one-million-barrel-a-day shale oil industry and its attendant socioeconomic infrastructure range from about

50,000 acre-feet of water per year to about 250,000 (Table 1). Since no one doubts that even the upper ranges of this volume are potentially available in Colorado, an industry of this size could plainly be supported. This amount equals about one third of United States oil imports in early 1982.¹⁸

At about two million barrels a day, the wide parameters of potential water demand begin to become important. The lower range of estimates--100,000 acre-feet a year--is well within the amount of water estimated to be available (more on this situation shortly); but the high range--500,000--would mean that shale would be competing with other uses, primarily agriculture. At present, as it attempts to get started, therefore, a shale industry is clearly not threatened by a water shortage, but its hypothetical problems become harder to anticipate as it grows.

The general uncertainty about the demands for water generated by a mature shale oil industry, however, is more than matched by confusion concerning the amount of water that might be available for its use (Table 2). There are, first, the vagaries of climate and topography. Northwestern Colorado is a semiarid region with a highly variable annual precipitation. Most of the water available for human use originates in the Colorado River and its tributaries. The Colorado is, by major river standards, rather small: it carries only about 8 percent of the water of the Columbia and 3 percent of the volume of the Mississippi.¹⁹ Furthermore, almost half its total flow originates in snowmelt and is thus procurable only in May and June, unless reservoir storage is available. When the frequency of drought is considered, the Colorado

Table 1
ESTIMATES OF WATER REQUIRED FOR ONE-MILLION-BARREL-PER-DAY
SHALE OIL INDUSTRY IN NORTHWEST COLORADO

Source	Year	Estimated Water Required (acre-feet/year)
Cameron and Jones ^a	1959	330,000
US Department of the Interior ^b	1973	121,000-189,000
Colony ^a	1974	175,000
Director, Colorado Water Board ^c	1974	200,000-250,000
Colorado Department of Natural Resources ^d	1979	46,000-216,000
Office of Technology Assessment, US Congress ^e	1980	170,000
Colorado Energy Research Institute ^f	1981	206,000

Note: Some researchers estimate separately the water demand by processing technology and the demand by the associated socioeconomic infrastructure; some do not clearly distinguish between the two. Where the figures are distinct, they have been combined for the present table.

^aEstimates by Cameron and Jones, and Colony, cited in David J. Eaton, "Shale Oil Technology: Status of the Industry," in Water for Energy Development, Gabor M. Karadi and Raymond J. Krizek ed. (Madison: University of Wisconsin, 1978), p. 143.

^bUS Department of the Interior, Final Environmental Statement for the Prototype Oil Shale Leasing Program, Vol. 1 (Washington, DC: Government Printing Office, p. III-35.

^cDirector, Colorado Water Board, from calculations made in 1974; interview with David Prindle, Denver, June 1981.

^dColorado Department of Natural Resources, The Availability of Water for Oil Shale and Coal Gasification Development in the Upper Colorado River Basin, Summary Report (Denver: Colorado Department of Natural Resources, 1979), pp. 5-3 to 5-9.

^eOffice of Technology Assessment, US Congress, An Assessment of Oil Shale Technologies (Washington, DC: Government Printing Office: 1980), p. 360.

^fColorado Energy Research Institute, Colorado Oil Shale: Development Scenarios, 1981-2000 (Golden: Colorado School of Mines, 1981), p. 46.

Table 2

ESTIMATES OF SURPLUS WATER AVAILABLE YEARLY FOR OIL SHALE DEVELOPMENT
IN COLORADO, 1981 AND 2000

Source	Year of Estimation	Estimated Water Available (acre-feet/year)	
		1981	2000
Director, Colorado Water Board ^a	1974	250,000	250,000
Colorado School of Mines Research Institute ^b	1975	800,000	800,000
Colorado Department of Natural Resources ^c	1979	----	205,000
Office of Technology Assessment, US Congress ^d	1980	818,000	225,000

Note: Some of these figures are derived from incomplete figures or from the implications of statements made in documents. Moreover, some sources do not clearly distinguish between groundwater and surface water supplies. Groundwater is much more uncertain.

^aDirector, Colorado Water Board, from calculations made in 1974; interview with David Prindle, June 1981.

^bColorado School of Mines Research Institute, A Practical Approach to Development of a Shale Oil Industry in the United States, (Golden: Colorado School of Mines Research Institute, 1975), p. v-18.

^cColorado Department of Natural Resources, The Availability of Water for Oil Shale and Coal Gasification Development in the Upper Colorado River Basin, Summary Report, (Denver: Colorado Department of Natural Resources, October, 1979), pp. 5-3, 5-9.

^dOffice of Technology Assessment, US Congress, An Assessment of Oil Shale Technologies, (Washington, DC: Government Printing Office, 1980), p. 360.

system becomes an unreliable source for an industry requiring a large, stable water supply.

Added to the undependability of nature is the indetermination created by human institutions. The river's water is apportioned among the states largely by two interstate compacts and a treaty with Mexico. And here complexity becomes the cause of ambiguity. The compact allots water shares to states on the basis of a presumed annual flow of 15 million acre-feet, which was the average when the agreement was signed. Water was promised to each state not on the basis of a proportion of any year's supply, but as an absolute amount: California and Arizona between them, for example, are entitled to 7.5 million acre-feet a year. It turns out, however, that the decades preceding the compact had comprised an unusually wet era in the Rocky Mountain states. In the years since, the average annual flow of the river has been only 13.9 million acre-feet.²⁰ In other words, more water has been apportioned than is likely to be available.

Because the compact rights have never been fully exploited, there has been no shortfall. But with further migration to the mountain states, deployment of the MX missile, and increased coal mining--all distinct possibilities over the next generation--it is reasonable to expect great increases in demand just when a growing shale industry can be anticipated to require significant amounts of water. If and when Colorado begins to request its agreed share of the river, the downstream states will have to give up a large portion of their usage. It takes no clairvoyant to predict that this necessity will ignite a political struggle, the outcome of which is unpredictable.

Within the state, the situation is clearer. About 90 percent of the state's water currently in use goes to agriculture.²¹ Although Colorado has a byzantine system of allocating water internally, this procedure is less important than the fact that water rights can be purchased. Because energy companies are far richer than farmers, they can afford to offer very attractive prices for water rights. In fact, many of the rights on Colorado's western slope have already been purchased by shale companies in anticipation of future needs. It is common knowledge in Colorado's Grand Valley (extending along the river from Grand Junction to Rifle) that many farmers are using water rights which they have sold to energy companies and then leased back. As early as 1968, five companies claimed that they owned enough water rights to produce several million barrels a day of shale oil.²² It thus appears that, legally, shale is in a position to crowd out at least the more marginal agriculture in competition for water. Whether it is in a political position to do so is addressed later in this paper.

Estimates of the size of an oil shale industry that could be supported in Colorado without its infringing on agricultural development range from about 500,000 barrels a day to roughly two million.²³ All of these estimates rest on the assumption that reservoirs will be constructed to store water, a point to which we will return. In addition, all analysts are acutely aware of the uncertainties inherent in their task. A passage from a report from the federal Office of Technology Assessment in 1980 represents the attitude of everyone who has looked at this question:

This conclusion is based on one interpretation of the law of the river, one set of depletion estimates for conventional users

in 2000, one assumed value of virgin flow, and an industry that employs a technology mix similar to that being developed in the present projects. If a different basis were selected, the estimated capacity of the industry could be significantly different.²⁴

The potential allocation of surface water is thus relatively clear for a small shale industry, but becomes more obscure as the hypothetical industry grows. The possibility of using groundwater, however, is more ambiguous even than the actors realize. There has been a good deal of speculation that the aquifers in the Piceance Creek Basin could be a source for industry and new municipalities. Various studies have claimed that an estimated 2.5 to 25 million acre-feet of water are stored in the basin, ready to be exploited.²⁵

A range that extends from 2.5 to 25 is large, but even these numbers are insubstantial. All estimates about groundwater rest upon work done by the United States Geological Survey (USGS). Technicians in this agency are the first to proclaim the unreliability of their estimates and to urge caution in their employment.

The USGS relies upon wells drilled by mining companies for data. It models the aquifers in the basin on these data. Because there has been so little development, few wells have been drilled, and thus the data are insufficient for modelers to feel confidence in their product.²⁶ The survey's models are considered highly tentative within that organization. There may be less than 2.5 million acre-feet of water in Piceance Creek Basin, or more than 25 million; no one knows.

The problem of groundwater modeling is a good example of the Catch-22 situation that is at the heart of the present discussion. Those who are suspicious of development demand that government

permission be withheld until there is sufficient knowledge about the industry's impact on air, water, and so forth. But because the information on which such knowledge is based can come only after experience with the industry, to demand reliable data before development takes place is to prohibit development. By the time the USGS has enough information to confidently create models of the basin's groundwater, the industry will already be in place and functioning. Policymakers, faced with such a situation, must make decisions without adequate information.

Water Pollution

Downstream problems confronting the shale oil industry are as difficult as upstream problems, and are of more immediate concern. Shale is a cornucopia of toxic chemicals and carcinogens, many of which have been identified, some of which, apparently, have not.²⁷ Given the fact that several million tons of retorted shale will be discarded daily by a mature industry, there is considerable concern that rainwater, percolating through the spent shale piles, could leach out dangerous chemicals and transport them to the river.

While this problem of leaching has attracted considerable attention from researchers, once again the discussion is steeped in ambiguity. Apparently the composition of spent shale differs according to the characteristics of the rock as mined, the type of retorting technology employed, and specific retorting conditions. This situation gives rise to the suspicion that no general knowledge of the shale waste hazard is possible, only site-specific (and therefore after-the-fact) knowledge. Moreover, some investigators have criticized the work of earlier researchers, suggesting that during chemical tests they failed to

duplicate important field conditions in the lab.²⁸ In other words, the possibility exists that, despite the years of work on the leaching problem, only partially useful information is available to policymakers.

Energy companies are attempting to forestall fears of water pollution by ensuring that no leachates reach the natural water supply. They have plans to create gigantic impoundment basins by lining canyons with a moistened shale mixture that hardens like concrete, then filling these basins over decades with spent shale, revegetating as they go. Some of these plans have been tested on a small scale over a short period and have worked well.²⁹ Environmentalists, however, point out that no testing has been done on a large scale, and, more important, that the potential problem is long term. Walls may hold for five years, they ask rhetorically, but what about fifty or five hundred? What if there is an earthquake or a major flood? If concrete rain culverts crack after a few years, why not spent-shale culverts after a few decades? Once again, the only way to answer such questions is to examine the shale piles after the industry has been long established.

In addition to fears about chemical pollution, there is widespread concern that the shale industry will worsen the Colorado River's salinity problem. Salinity refers to dissolved salts in water. Much of it is natural, but much of it results from man-made sources, such as irrigation, reservoir evaporation, and municipal and industrial wastes.

The Colorado is already so saline that its water, used for domestic purposes in Southern California, exceeds the recommended public health standard. At the international border, it must by treaty be processed through a desalinization plant before crossing into Mexico.³⁰ Without

expensive treatment efforts, further increases in the salinity levels caused by the shale industry might damage downstream agriculture.

With the salinity issue, as with so much else, the evidence is indecisive, contradictory, or absent. Because shale oil companies do not plan to discharge any of their process water, they will not directly increase the river's salinity. Indirect effects, however, could be substantial. If, during mining operations, companies pump large quantities of groundwater out of mines, and that water feeds the Colorado, its level may drop, increasing its salinity. If enough dams are built to ensure shale developers a steady water supply, the additional evaporation may increase downstream salinity. If there is massive urbanization because of shale, municipal wastes may increase salinity, and so on. Consequently, although some studies show little probable effects on the river from shale plants, the possible effects are sizable.³¹

On the other hand, it is conceivable that shale development could actually decrease the river's salinity. At Hoover Dam 37 percent of the Colorado's salinity is caused by fertilizer runoff from agricultural irrigation.³² If, as seems likely, a shale industry will grow at the expense of farming, the lessened irrigation might increase the river's purity. Moreover, some of the creeks in the Piceance Basin are highly saline; some researchers argue that their complete use by the industry would prevent their high concentrations of salts from reaching the Colorado and thus keep the main stream cleaner.³³ Once again, ambiguity overwhelms knowledge.

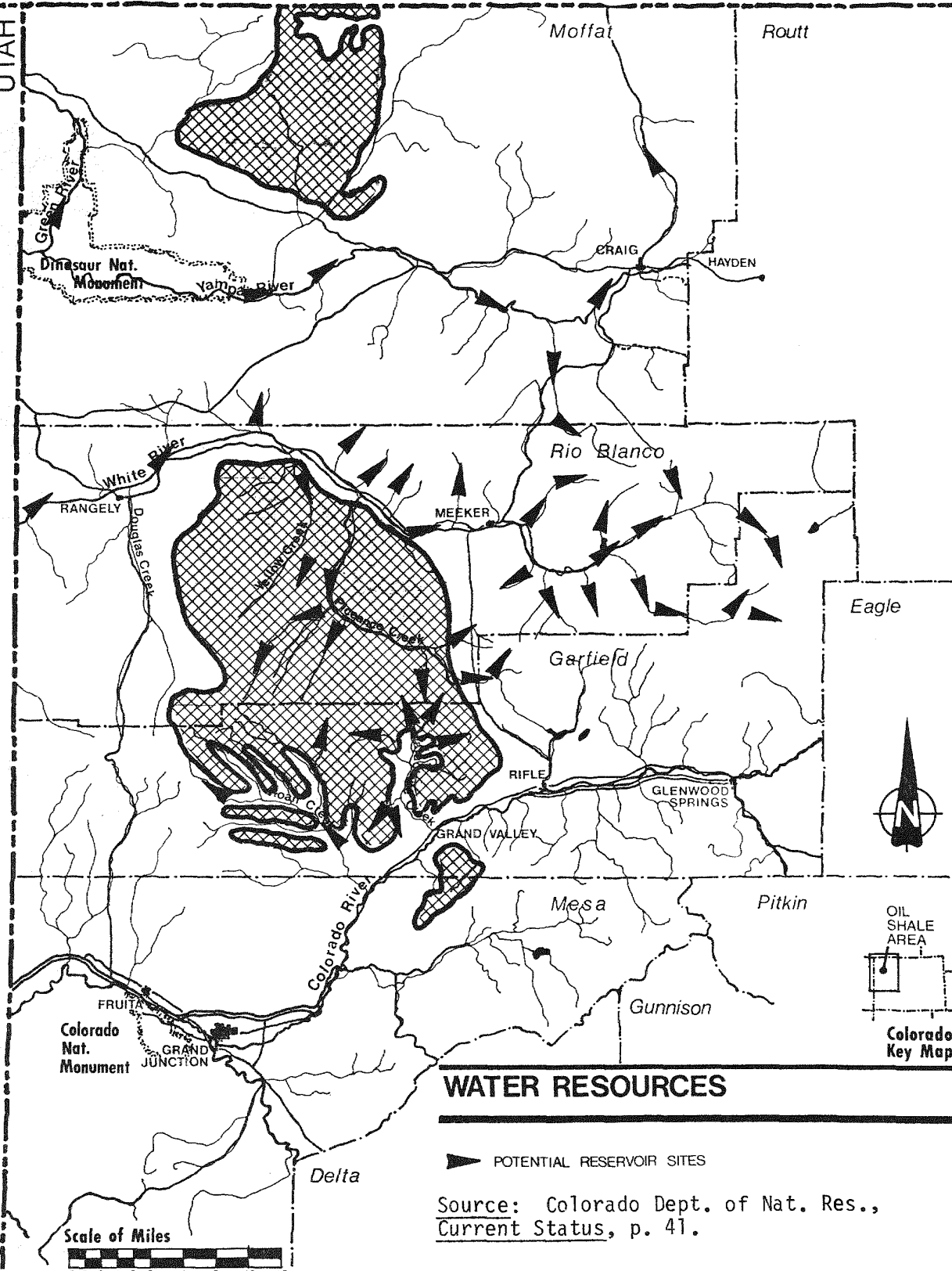
The difficulties just discussed do not exhaust the technical problems associated with oil shale development in Colorado, but they are representative of the bewilderment surrounding most of the problems. To their credit, researchers rarely attempt to gloss over the uncertainties in this area. Most of the professional papers, and all of the government reports, contain explicit warnings to the reader to tread cautiously, coupled with complaints about insufficient data. But inadequate information is part of the human condition, and it has not deterred energy companies from proceeding with their plans. Those opposed to shale development are likewise mobilizing, and the last few years have seen an escalation of clashes by political armies, equally ignorant and equally determined.

POLITICAL CONFLICT

There is widely believed to be enough water available in Colorado--without infringing on agriculture and without interbasin transfers--to support a moderate-sized shale industry, provided that enough new reservoirs are constructed to guarantee a steady yearly supply.³⁴ These dams are especially needed on the White River, one of the Colorado's tributaries and the closest source of unused water to the shale mining sites (see Map 2). The White is a small river, carrying on the average only a half million acre-feet a year; 60 percent of its flow occurs between April and June, and this volume varies markedly from dry to wet years. Without at least one major storage facility on the White, the shale industry faces very difficult economic and logistical problems.

WYOMING

UTAH



Map 2

WATER RESOURCES

One study by the Colorado Department of Natural Resources concluded that a really large industry (three million barrels a day) would require eight new dams.³⁵

The politics of shale oil therefore rapidly become the politics of dam-building. And just as answers to technological questions about water are enveloped in obscurity, answers to political questions about dams are equally ambiguous.

The Rocky Mountain west, as a semiarid region, can be viewed as an area made habitable by federal water projects. For decades a coalition of developers, stockmen, farmers, congressional representatives, and the federal dam-building agencies (the Army Corps of Engineers and the Bureau of Reclamation in the Department of the Interior) were able to attain authorization for and to implement large dam projects for water storage in the area. Because "reclamation projects," as they were called, were not highly visible nationally, and because of the decentralized, logrolling structure of Congress, a political situation was created in which the more populated, moist areas of the country subsidized civilization in the empty, dry areas.³⁶

The circumstances favorable to dam-building, however, have changed. First, the "cheap dam sites" are all taken; in the future, new reservoirs will grow more and more expensive, and will return less and less in the way of economic benefit.³⁷ The Bureau of Reclamation's own calculations of the cost-benefit ratio of eight authorized but unconstructed dams in Colorado suggest that only three would eventually pay for themselves.³⁸

As the price of new dams has soared in relation to their expected benefits, the rest of the country has grown increasingly reluctant to pay for them. President Carter's veto of nineteen dam projects in 1977 reflected the new realities of the political economy of reservoir construction.³⁹ It is impossible to believe that the Reagan administration will be more generous on this subject than the Carter administration.

Second, even if a dam is authorized by Congress and accepted by the president, it faces various administrative hurdles. Here again, complexity creates ambiguity. Under the Federal Power Act any dam along one of the streams over which Congress has jurisdiction under the commerce clause of the Constitution requires a license from the Federal Power Commission (now in the Department of Energy).⁴⁰ Federal bureaucracies have their own interests and purposes distinct from those of Congress, and the fact that a given project receives support on Capitol Hill does not mean that it will survive agency scrutiny.

Third, dam proposals now generate strong opposition from environmentalists. Any plan for a new reservoir can be expected not only to draw fire in Congress, but to face years of court challenges if it is authorized. In the shale lands, concern over the survival of two endangered fish, the Colorado River squawfish and the humpback chub, has already stalled construction of a dam on the White River in Utah, and such problems can be expected to multiply.⁴¹

For these reasons, many political observers in both Colorado and Washington doubt that a significant number of new federal reservoirs can

be begun, let alone finished, on the White River or elsewhere, in time to supply the needs of an emerging shale industry.

As the prospects for federal projects have faded, proshale people in Colorado have begun to talk about reservoirs being financed by energy companies and the state government in partnership. A 1973 state statute has authorized funding for dams and cooperative arrangements with industry. The Colorado Water Conservation Board is the agency responsible, and its officials have held meetings with industry executives about the \$300 million that would be needed for one adequate reservoir on the White. Whether the plans will go through, or whether they will fall victim to some of the same difficulties besetting federal projects, is impossible to say.⁴²

Looking beyond the troubles of the moment to a truly large industry--eight million barrels a day--Exxon has suggested that the nation might wish to consider a large interbasin transfer. The company believes that a 680-mile pipeline from the Oahe reservoir on the Missouri River in South Dakota might economically bring 1.1 million acre-feet of water yearly to the shale lands.⁴³ Such an undertaking would obviously be technologically gigantic and politically explosive.

This is not to say that Exxon or someone else will not eventually build an Oahe pipeline, or that the White River will not ultimately be festooned with dams. The point is not that these schemes are bound to fail, but that their success is problematical. To technical uncertainty over water supply in northwest Colorado is thus added political equivocality.

Another potential conflict results from the emerging competition for water between shale companies and agriculture. More than nine-tenths of the water now used in the area goes for irrigation. When the currently available spare water is appropriated, shale companies will compete with farmers for it. There is no doubt as to who would win this contest, were the market allowed to operate unhindered. Energy companies can afford to pay several times what agriculture can offer.⁴⁴ This means that, first, many of the farmers will sell their water rights; as mentioned, this has already happened. Further, as the industry expands and urbanizes the area, land values will rapidly increase, and many farmers will sell out, either because they want to realize a profit on the land, or because they cannot afford to pay the higher taxes. Unfettered, a large shale industry in Colorado would certainly replace marginal agriculture on the western slope of the Rockies and might eliminate farming entirely.

To partisans of the free market, this cycle is merely the natural order operating, but others are not so sanguine. Many Coloradans see a value in preserving an agricultural industry in the area, partly because they fear the possibility of social devastation if the shale industry, like the uranium industry before it, booms and then busts.⁴⁵ They see agriculture as a fallback occupation that will cushion, for the population, the possible swings of the energy companies. The present state governor endorses this position.⁴⁶

This attitude can only be reinforced by Exxon's shutdown of the Colony project in May 1982. Governor Lamm estimates that 2,100 jobs and 10,000 people will be affected by the company's move. Residents living

in nearby Parachute experienced "shock and uncertainty," according to the mayor. An undersheriff in Battlemen Mesa, Exxon's only partially completed bedroom community for its workers, described the situation as "very tense" as the news sank in that the whole town was suddenly unemployed.⁴⁷ Advocates of the free market will undoubtedly face even greater cynicism in the future when they argue that agriculture should not be protected from economic swings.

Other people, especially farmers, see an intrinsic value to agriculture that should be preserved. On the other hand, so it is said, some farmers can't wait to sell their water and land for millions and retire to Phoenix (whose water supply, they may not realize, will be drastically affected should problems arise with the Colorado River).

These conflicting sentiments make for an obscure political situation in Colorado. Individual spokesmen for agricultural interests sometimes speak out against energy development.⁴⁸ Nevertheless, it is, of course, organization that makes for power over policy. Agricultural interest groups are traditionally influential in Colorado politics. The fact, however, that most of the state's farming takes place on the plains of its eastern half, far removed from shale country, and that the western slope farmers are of several minds about the value of shale development, means that there is no organized, coherent agricultural position on shale matters.

Some farmers in the Grand Valley have organized the Mesa County Conservancy District, whose purpose is to preserve agricultural land against developers and rising taxes, but the organization is new, small, and untested in political battle. Rio Blanco County, where the richest

shale deposits lie, has rezoned all vacant land for agricultural use only. Shale companies must apply for a zoning variance before building facilities. This requirement appears to be a device for controlling the pace of growth rather than for preventing development, but it could turn into the latter if farmers in the area feel genuinely threatened.⁴⁹ In summary, despite the fact that the shale industry will probably grow at the expense of farming, there is as yet no certainty that it will be opposed by united, determined agricultural groups.

The only continuous, systematic opposition to shale comes from environmentalists. Their position can be easily summarized: the possible ecological costs of shale development are catastrophic. It therefore behooves policymakers to postpone permission to the industry until the many technical questions about water, air, spent shale, and so on, are answered.

In Colorado, antishale speakers are able to draw a telling analogy between uranium development in the 1940s and 1950s and oil shale development in the 1980s and 1990s. Like shale today, uranium was going to be the mineral that brought wealth to the residents of the western slope. Anticipating prosperity, few questioned the value of uranium mines and their attendant consequences. When the federal government offered mine tailings cheaply, they were purchased and used in construction in Grand Junction. Two decades later it came to light that the tailings were radioactive, and that, therefore, many of the public and private buildings in the city were dangerous.⁵⁰ Today there are residents of the city in their young adulthood who know that they grew up in radioactive houses and wonder what the consequences will be for

themselves and their children. They and their friends are receptive to the environmentalists' argument that, this time, they should look before they leap.

Nevertheless, in Colorado the environmentalists as an organized force are not numerically dominant, their sense of caution not widely shared, and their resources not extensive. A Harris Poll conducted in 1974 showed that more than 60 percent of the state's citizens favored shale development; there is no evidence that the proportion has diminished.⁵¹ The Republican-dominated state legislature tends to be hostile to their perspective; the Democratic administration, only partially sympathetic. Environmental groups say that together they are able to pay only a single lobbyist in Denver, and that he covers many subjects besides shale. Under ordinary conditions, they control a few thousand votes at best, a number that does not make for political clout.

In Washington, environmentalists are better financed and have extensive access to Congress, especially among liberal Democrats. But the 1980 elections, by greatly enhancing the power of conservative Republicans, undercut their influence.

Despite this relative political weakness, the environmental movement is able to exert a substantial influence over the politics of oil shale by participating vigorously in the permitting process. Here the complexity of the policymaking maze becomes truly significant. Before they can begin to fire their first retort, shale companies must satisfy about 175 regulatory requirements, processed through some 20 government agencies, in addition to obtaining roughly 25 mining variances. They must acquire permits from federal, state, county, and

municipal levels of government. The type of data required by each agency is usually different, although sometimes separate agencies demand similar information, albeit in different formats. Many of these permits must be preceded by public hearings. Furthermore, when all the permits have been acquired and all the regulations satisfied, citizens groups can file lawsuits forcing the whole process to a halt.⁵²

In the preternatural complexity of this permitting system lie many opportunities for environmentalists (or others) to influence policy by instigating delays. By keeping close and vocal track of government agencies as they process requests for permits, and by filing--or threatening to file--lawsuits, these groups have been able to make themselves a serious, if not decisive, impediment in a system that is already uncoordinated, self-contradictory, diffident, and above all, slow.

The longer a company must wait to begin production, the more money it has to invest before receiving revenues, and the more likely it is to drop a project. Indeed, many antishale activists are convinced that cheaper alternatives to synfuels will eventually come on line, making the whole industry unprofitable. "If we can just hold them long enough," one Grand Junction activist told me, "people will see that shale is uneconomic." The recent collapse of the Cathedral Bluffs and Colony projects can only increase this determination, and the complex nature of the permitting process provides an ideal setting for the politics of delay.

The final conflict that is relevant to shale oil occurs between parts of government. When the Constitution was created in 1787, the

framers hoped to prevent tyranny by fragmenting the national government's structure and reserving much power to the states. By ensuring that the United States political process must rely on the cooperation of various independent levels of power, they hoped to exhaust oppressive designs through sheer inefficiency.⁵³ In the politics of oil shale, the constitutional structure seems to be working as planned. There is conflict between the states, conflict between state and federal governments, and conflicts within branches and between agencies at both the state and national level.

Within Colorado, the Democratic Lamm administration has adopted a cautious approach to oil shale, while the Republican legislature is more eager to promote development. Utah, which has its own small oil shale reserves, is unhappy with Colorado's plans to dam the White River, while Colorado, because of prevailing west-to-east wind patterns, is concerned that development in Utah will pollute its air. Colorado administrators complain that federal agencies do not consult them before making decisions, while federal administrators in Washington accuse Coloradans of having a provincial attitude. Within the federal government, there are disagreements among the Department of Energy, the Department of the Interior, the Environmental Protection Agency, and the White House over the direction of national policy. All this means that the fate of the shale lands hinges on the answers to questions not only of technology and social conflict, but also of political influence. The answers to all the questions, it appears, are equally uncertain. To the technological and economic confusion associated with shale oil is thus added political unpredictability.

Policy: Colorado

The intellectual haze surrounding the problem of shale oil is merely an extreme example of the uncertainty under which government policy is usually made. Perfect knowledge is never found in the real world; even adequate knowledge is rare. Government agencies, like ordinary people, have to make decisions despite having access to only partial information. The problem of shale is just the problem of governing writ small.

Policymakers have a traditional method of dealing with pervasive ambiguity. They normally avoid great changes or radical innovations. Except under conditions of crisis they make only small decisions. Policy typically grows by slow accretions: a few more dollars spent here, a change of a rule or two there. Political scientists who have studied policymaking have concluded that this "incrementalism," as it is called, is the usual governing style in America.⁵⁴

The state of Colorado has reacted to the ambiguous opportunities and risks of oil shale development just as political scientists would expect. The administration of Governor Richard Lamm has adopted almost an ideal type of the incrementalist method. Since the federal government owns more than three-quarters of the shale lands, the state is not the main authority, but its regulatory powers give it some leverage. When it comes to shale, the byword of the Lamm administration is caution.

As one top aide to Governor Lamm put it, "We are not promoters of shale." Neither, however, are they attempting to be obstructionist, but rather to control the growth of the shale industry so that its costs to

Coloradans do not exceed its benefits. The summary phrase used in administration position papers is "phased development."⁵⁵ Lamm explicitly acknowledges that the many technical questions about shale cannot be answered until there is some development. He therefore favors a cautiously positive approach to the industry, with the state involved at every step, so as to be able to apply the brakes quickly. Shortly after taking office in 1975, Lamm established the Colorado Governor's Energy Policy Council, whose function is to review state policy toward development, with the intention of keeping it under control.⁵⁶ Lamm's lieutenants urge the industry to "proceed along a deliberate path," that is, to start small and grow slowly.⁵⁷ He has asked the legislature, unsuccessfully, for a strict facilities siting law, giving the state authority to oversee building, and a stronger state severance tax.⁵⁸

Lamm's strongest fear seems to be that the federal government, in its eagerness to develop a non-OPEC energy supply, will deem Colorado expendable and push a massive shale buildup.⁵⁹ For this reason, he and his aides constantly argue for more state participation in federal decisions, longer lead time on consultations, and more deference to state wishes.⁶⁰

But the Lamm administration is not just negative in its efforts to control the shale buildup. It has also attempted to help the companies overcome some of the frustrations of governmental complexity. Under Lamm, the Colorado Department of Natural Resources has established the Colorado Joint Review Process, an intergovernmental review procedure to coordinate the regulatory schedules of all relevant agencies. When working correctly, it encourages the concurrent unfolding of regulatory

processes, so that companies are able to comply with requirements in a minimum of time. Industry spokesmen are pleased.⁶¹

The Colorado legislature has been even more eager than the governor to eliminate the impediments to shale development. Until recently, the state's 1973 Water Quality Control Act required any new development (urbanization or any industry--not just shale) to meet severe water cleanliness standards before it could obtain a permit to discharge any pollutants. Opponents of the act argued that it effectively prohibited many kinds of development by, in effect, demanding that there be absolutely no degradation of downstream water.

Accordingly, the legislature passed amendments to the act sponsored by conservative Republican state senator Fred E. Anderson in the late summer of 1981. This new law requires the Colorado Water Quality Control Commission to consider "economic reasonableness" as one of the factors relevant to any new project. In other words, the old law forbade development to degrade water; the new law asks the state to consider the trade-offs between the value of the proposed activity and the value of the water.

Naturally, these amendments have provoked conflict over what standards of "reasonableness" to apply and how to define them. The commission is presently the scene of internal disputes over the meaning of the law. It is too early to predict the outcome of the struggle.⁶²

Policy: Federal

The splintering of power that is characteristic of the American political system means that there is no one federal policy toward oil shale. Not only do separate branches and agencies have their own

preferences, but there is disagreement within each of these. Nevertheless, two general tendencies can be detected in Washington under the Reagan administration. One, represented strongly in Congress, favors supporting parts of a synfuels industry, especially shale oil, with loans, loan guarantees, price guarantees, and purchase agreements. The other, which dominates the administration, opposes spending federal money but recommends encouraging the shale industry by loosening regulations and making federal land more accessible. The politics of shale in Washington, therefore, tend to come down to two questions: Will we subsidize the industry in its early stages and will we modify governmental rules and regulations to make the industry's growth easier? Because the technical and economic obscurity that envelops the national discussion over oil shale does not allow researchers to furnish reliable information pertinent to these questions, policy tends to be a function of ideology and clout.

In the late spring of 1979, as the country was enduring its second gasoline shortage in six years, a spate of bills was introduced in Congress to provide federal support to assist the birth of a synthetic fuels industry. In June 1980, Congress passed the Energy Security Act, which created the Synthetic Fuels Corporation.⁶³ A quasi-governmental body funded by taxpayers but largely independent of political control, it is governed by a seven-member board appointed by the president for terms of seven years.

Congress appropriated \$20 billion for the corporation to use to assist infant shale, coal liquefaction, coal gasification, and tar sands

industries. It was instructed to rely on loan guarantees, price supports, and purchase agreements in preference to outright subsidies.

In October 1980, President Carter submitted a list of five nominees to the Senate. With its eye on the imminent national election, this body failed to confirm them. During the congressional recess, Carter issued interim appointments so that the corporation could begin functioning, and these people hired staff and issued invitations to apply for project support. In January 1981, the new president fired Carter's interim appointments.⁶⁴

In April, President Reagan appointed Edward Noble to be chairman of the board. Since Noble was on record as opposing the concept of government support for synfuels, his appointment raised some anxiety in Congress. But Noble testified at his confirmation hearings that he would carry out the corporation's purposes, and he was confirmed.⁶⁵

The Synthetic Fuels Corporation, therefore, has had a chairman for less than a year. As of August 1981, it was still hiring staff and creating internal procedures. Although it had received sixty-three proposals from industry, it was still not organized enough to have adopted criteria by which to judge them.

Anticipating such problems, however, Congress had originally authorized the Department of Energy to spend \$3 billion on synfuels until the corporation could find its feet. By July 1981, the department, under Secretary James Edwards, was ready to announce a \$1.1 billion loan guarantee for TOSCO, a partner with Exxon in the since-abandoned Colony project, for price guarantees and a \$400 million purchase agreement for the Union Oil Company, which is building a shale

facility near Colony in northwest Colorado, and for the Great Plains coal gasification project in North Dakota.⁶⁶

At this point, the Reagan administration's ideological bias against government subsidies for private industry asserted itself. David Stockman, Director of the Office of Management and Budget in the White House, intervened and attempted to persuade the president to order Edwards to cancel the projects. Meanwhile, Stockman was joining in an improbable alliance with liberal Democrat Toby Moffett, chair of the Subcommittee on Environment, Energy, and Natural Resources of the House Government Operations Committee. Together they harassed the Department of Energy with requests for information on its negotiations with Union.⁶⁷

At a meeting of the Cabinet Council on Natural Resources on July 16, Stockman exchanged heated words with Edwards. At further meetings over the next two weeks these clashes were repeated. Stockman was often supported by Secretary of the Interior James Watt and Secretary of the Treasury Donald Regan, Edwards by Secretary of Defense Caspar Weinberger.⁶⁸ These arguments can be seen as an indication of the division in the cabinet over synfuels: Watt, Regan, and Stockman, the free-market ideologues, versus Edwards and Weinberger, the practical politicians.

The antisynfuels push, however, had been anticipated by the prosynfuels coalition in Washington, and by the first clash on July 16 it was already mobilizing. Just before the first White House meeting, Weinberger had sent a letter to Edwards, strongly emphasizing the value of a shale industry to the national defense.⁶⁹ This letter was

reproduced and distributed among potential supporters. The day of the meeting, thirteen prominent members of Congress from both houses and both parties, including Senator Paul Laxalt, the president's closest friend on Capitol Hill, signed an equally emphatic letter urging approval of the projects.⁷⁰ Under this sort of persuasion, the president abandoned the ideologues. On July 29 he approved the Union project and on August 5, the TOSCO and Great Plains projects.⁷¹

Despite this victory for the prosynfuels forces, it is clear that the Reagan administration is not hospitable to the concept of government subsidies, or potential subsidies, for oil shale. The three approved projects had developed considerable political momentum before they came to Stockman's attention. It is likely that, had they not been in such an advanced state, they never would have gotten off the ground. The present administration will not be hospitable to such projects in the future.

Members of the Reagan team look favorably, however, on plans to make the oil shale industry's life easier without spending federal funds. It is known, for example, that President Reagan advocates amendments to the 1970 Clean Air Act (strengthened in 1977) that would allow companies to emit more particulate matter.⁷² The administration has also endorsed legislation by Colorado's William Armstrong that would permit firms already leasing federal land for oil shale mining to acquire additional land for spent shale disposal.⁷³

Both of these proposals draw fire from environmental forces, and both are currently caught in the congressional maze. This situation illustrates an irony of the political process that adds to the ambiguity

surrounding shale: the administration, on balance, opposed the guarantees to TOSCO and Union, yet they succeeded; it endorses, on balance, the air pollution and off-site disposal changes, yet they are failing. Despite the administration's relatively clear policy stand toward oil shale development, therefore, the outcome of the governmental process in Washington remains obscure.

CONCLUSION

The problem of shale oil is of specific concern to the residents of Colorado and a few policymakers in Washington, but in a larger sense it is important and instructive to every citizen. Shale has unique potential and unique problems, but shale itself is not unique in that there are many other potential sources of energy, each facing an array of serious difficulties. The specific problem of underground water in the Piceance Basin belongs only to shale, but the resultant problem of ambiguity is universal. Whether they deal with shale, coal, solar, nuclear, or any other possible power source, policymakers are faced with the demand for action, yet they are apparently eternally lacking critical information.

Viewed not as individuals, but as a nation, the United States is coping with ambiguity in shale as it is with most other energy problems: it is advancing incrementally. There will be a shale industry. Some dams will be built, some environmental restrictions will be relaxed, some public money will be forthcoming, and some plants will be constructed and operated. But the industry will not suddenly arise to

huge proportions. The first few hundred thousand barrels of kerogen will be produced, atmospheric tests conducted, water supplies sampled, boomtowns studied, and so on. Then people in both government and industry will make more decisions about the size and pace of development. This procedure may be distressing both to those who think that shale is the wrong road entirely and to those who want to attain energy independence as soon as possible, but, given the needs and the uncertainties, it seems like the path of sanity.

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70. Letter from the Office of the Majority Leader, House of Representatives, to the President, 16 July 1981. House members signing were Thomas P. O'Neill, Jim Wright, Bill Alexander, Thomas Foley, Gillis W. Long, and Joseph McDade. Senate signers were Ted Stevens, Pete Domenici, James McClure, Bennett Johnston, Henry Jackson, Paul Laxalt, and Robert Dole.
71. "Reagan to Approve up to \$400 Million Aid for Union Oil Co.'s Synthetic-Fuel Plant," Wall Street Journal, 30 July 1981, p. 7; and "Reagan Administration Approves Loan Guarantees for Great Plains, Colony," Inside DOE, 7 Aug. 1981.
72. James Ridgeway, "Pollution Is Our Most Important Product," The Nation, 7 Nov. 1981, pp. 474-475.
73. "Watt: Water a Synfuels Problem," Rocky Mountain News, (Denver), 1 June 1981, p. 7; HR 4053 and S. 1484, 97th Cong., 1st sess.

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