OIL SHALE 2050

Data, Definitions, & What You Need to Know About Oil Shale in the West

WESTERN RESOURCE
ADVOCATES

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ABOUT WESTERN RESOURCE ADVOCATES

Western Resource Advocates is a nonprofit conservation organization dedicated to protecting the West's land, air, and water.

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INTRODUCING PROFESSOR ROCK

Professor Rock will point out key educational features throughout this report.

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This report is largely an educational tool, concentrating on the salient issues central to the ongoing debate over the wisdom and feasibility of producing liquid fuel from oil shale.

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FORWARD *Message from the President*

The first car I ever bought was a blue, two-door Peugeot Deux Chevaux that we just about drove into the ground. Today I drive a Honda Accord, a car that barely shares the same vehicular DNA as my beloved old Peugeot. If I were to buy a new car today, I would consider fuel and mileage options that weren't readily available when I chose my Honda.

The Toyota Prius, the first really commercially successful hybrid electric vehicle, was introduced worldwide just 10 years ago. Toyota sold fewer than 30,000 Prius models in 2001; by April 2011, the company had sold more than 2 million cars worldwide, including more than 1 million in the United States.[1] At the end of 2011, we marked the first full year that all-electric cars were available in the United States.

It may be a cliché to talk about how quickly technology changes, but it's a lesson we would be wise to remember as we consider our energy future. We can't think about what our vehicles might look like in 40 years without considering what kind of fuel we'll use to power them. It is a question of particular importance when it comes to an issue such as oil shale development: Will we be spending the next several decades developing a fuel that consumers won't even use?

As the debate over potential oil shale development in the western United States continues, Western Resource Advocates (WRA) has focused on understanding the nature of the oil shale deposits; the state of the technologies companies are trying to advance; the environmental, economic, social, and climate impacts of exploiting these deposits; and what development would mean for our energy demands and goals. This report explores these matters.

This report is largely an educational tool, concentrating on the salient issues central to the ongoing debate over the wisdom and feasibility of producing liquid fuel from oil shale. Many of the issues discussed in this report are framed from the perspective of the year 2050. Why 2050? First, it is a baseline that states commonly use to project water demands. It is also roughly the date by which such companies as Royal Dutch Shell predict they might be in a position to produce large quantities of oil from shale, depending on the results of current research and testing.

1 David Schepp, "Toyota Prius Hits Million-Sale Milestone in U.S.," *Daily Finance*, April 6, 2011, http://www.dailyfinance.com/2011/04/06/toyota-prius-hits-million-sale-milestone-us/ (accessed November 18, 2011).

WHY 2050?

By the year 2050, economists, biologists, climatologists, and a variety of other scientists predict huge changes to the West. Their models forecast that there will be less water in the Colorado River Basin, with escalating demand from a rapidly growing population. The population of the state of Colorado is projected to swell by 57% over the next 30 years. Utah, the second-driest state in the nation, anticipates a 105% increase in its population by 2050. Because of this growth, in Colorado alone, municipal and industrial water demands are estimated to increase by as much as 83%.

By 2050, the competition for water will be fierce and will only be compounded by climate change. Decisions we make today about a host of concerns, including whether or not to develop oil shale, will directly impact the amount of available water in 2050. As a result of climate change, water in the Colorado River Basin is projected to decrease anywhere from 5% to 20% by 2050. Current projections conclude that we will rely heavily on water currently used for agriculture to cover growing municipal and industrial demands.

By 2050 we might be less reliant on fossil fuels for planes and automobiles. Alternatives might include electric cars powered by renewable sources, or biodiesel made from algae, or energy sources that researchers are not yet exploring.

As today's teenagers approach retirement age, what will the environment look like? If water demands, population growth, and climate projections hold true, these teenagers will likely face a far different environment than the one that currently sustains our western communities and economies.

As we found in our research, any reasonable analysis of commercial oil shale production would make it hard to conclude that this is a wise energy pursuit. After reading this report, I think you'll agree.

Karin P. Sheldon

Karin P. Sheldon
President, Western Resource Advocates

INTRODUCTION

Energy policy — and its nexus to economic policy — is a pressing issue that warrants our nation's continued focus. At Western Resource Advocates (WRA), we abide by the idea that a healthy economy depends on a healthy environment. We also believe that innovation yields positive economic benefits. That is why we advocate for clean energy solutions, including development of emerging technologies, while identifying strategic uses of fossil fuels to bridge the gap between "business as usual" and our future renewable energy economy.

The more we delve into oil shale, the more concerns we have about oil shale as an energy source in general, but also its potential negative impacts on the environment and on other land and energy development initiatives. The debate over oil shale is not just a discussion about a potential source of energy.

At stake in the debate over oil shale are water supplies and how states would balance competing needs for this dwindling resource. Also at stake is the quality of the air we breathe. Already, because of fossil fuel development, certain rural areas of Colorado, Utah, and Wyoming have worse air quality than Los Angeles. Sustainable communities are also at risk, as towns in western Colorado are already beginning to bend under the strain of energy development. One question that needs to be addressed is whether these communities can support an additional influx of workers, many of whom would likely be temporary. These and other issues are central to an assessment of oil shale development.

The oil shale debate must, likewise, evaluate the potential impacts on our climate. As explained in this report, oil shale is projected to produce roughly 25% to 75% more greenhouse gases than comparable quantities of conventional crude oil. Colorado has adopted the vitally important goal of reducing its greenhouse gas emissions by 80% by 2050. Other states are advancing similar goals. Large-scale production of oil shale would likely undermine these important goals.

WHY INVEST IN OIL SHALE?

Recently, students at the University of Colorado met with WRA staff to learn about western energy and water issues. When discussing oil shale, students asked why, with all of oil shale's drawbacks, companies would invest in oil shale. This question, WRA realized, captures the pith of questions and concerns many in this region have about oil shale.

The short answer is that if oil shale were to prove commercially viable, the potential financial returns to an investor could be significant. Any financial investment comes with a certain amount of risk, but oil shale development is particularly hazardous; oil shale has been touted as the beginning of a "new era"[1] in oil production since at least the early 20th century, but 100 years later, it has yet to see commercial success.

History aside, RAND Corporation identified several potential benefits that might result from the development of oil shale, including economic and national security impacts.[2] Those possible gains, however, must be weighed against the numerous impacts that are discussed throughout this report. Large-scale development of oil shale would come at a significant cost in terms of resources, such as water, and of its overall impact on the environment.

When all of the available information on oil shale is considered, it is hard not to conclude that the costs of pursuing development far outweigh the benefits. Furthermore, even if companies were to develop economically viable technologies for oil shale, it would still be difficult to argue that pursuing development would really be in our country's long-term best interest. This report draws out those issues.

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1 *Pittsburgh Press*, October 6, 1916, see http://checksandbalancesproject.org/tag/oil-shale/.

2 James T. Bartis et al., *Oil Shale Development in the United States: Prospects and Policy Issues*, 2005, report prepared by the RAND Corporation for the U.S. National Energy Technology Laboratory.

Sunrise along the Colorado River.

WHAT INDUSTRY AND GOVERNMENT AGENCIES DON'T KNOW, AND WHAT THE PUBLIC DESERVES TO KNOW

For all of the research done on oil shale, it is remarkable just how much the industry and government agencies still do not know. Commercially viable technologies remain in their infancy, and without workable technologies, commercial development of liquid fuels from oil shale remains speculative at best.

In preparing this report, Western Resource Advocates grappled with how to present data, knowing that at any point in time the oil and gas industry may only be presenting part of the picture. New data and claims can emerge rapidly, but any new information must be considered in a much broader context. Data on a PowerPoint presentation often represents information frozen in time, without any context or any independent vetting of its usefulness, completeness, or accuracy.

For example, consider this claim from 30 years ago: In 1980 Exxon made a presentation in western Colorado in which it claimed that by 2010 it would be producing 10 million barrels of oil per day from oil shale. Less than two years later, its Colony Shale Project was shut down and more than 2,000 people lost their jobs overnight. Those 1980 claims were clearly suspect — and may have been deployed as a tool to influence public policy and public opinion rather than a legitimate estimate of success. Even if those claims were technically justifiable in 1980, the context of that information shows that Exxon's ability to predict market trends, costs, and other potential problems proved woefully inadequate.

A more recent example shows the same problems with trying to incorporate new industry "data." Enefit American Oil posits that by 2025 in Utah alone it will be producing 50,000 barrels of oil per day.[3] But energy expert Jim Bartis of the RAND Corporation undermined this claim in Congressional testimony in June 2011:

> *In Estonia, oil shale is primarily used as a solid fuel for the generation of electric power. A small amount is converted to a liquid fuel, all of which is used in power generation or cogeneration plants. To our knowledge, oil shale in Estonia is not used to produce transportation fuels. A recent environmental assessment of oil shale produced and consumed in Estonia indicates severe impacts have occurred. These include subsidence over underground mining areas, overexploitation of underground waters, pollution of surface and underground waters, and the emission of hazardous air pollutants.*[4]

Perhaps Enefit will really be able to produce 50,000 barrels of oil per day by 2025. But before it can even consider that kind of production, Enefit will need to overcome the technical, economic, and environmental obstacles to producing a commercial transportation fuel from oil shale.

3 Enefit, "Development projects: Enefit American Oil," https://www.enefit.com/en/oil/projects/usa (accessed December 12, 2011).

4 James T. Bartis, RAND Corporation, document submitted as an addendum to testimony presented before the Senate Energy and Natural Resources Committee on June 7, 2011, June 29, 2011, pages 11-12.

Because of these uncertainties — and because many claims made by companies and paid supporters cannot be independently verified — WRA was very careful in using information sources that we believe present impartial, unbiased conclusions.

The burden of proof should be on the industry and elected officials who are seeking government subsidies to provide independently verified data. In the coming years, as industry works to develop commercial technologies, it must candidly disclose information on the impacts of these technologies on a broad range of resource values. **The public needs to be able to properly evaluate the economic, environmental, and community impacts of the following disclosures:**

The public needs to be able to properly evaluate impacts to water quantity, water quality, air quality, energy sources, and climate.

1 **Water quantity.**
The federal government and private contractors, such as the RAND Corporation, have concluded that significant amounts of water would be needed to develop oil shale. Before considering initiating a commercial leasing program, governmental agencies must fund independent assessments of how much water would be required for commercial development. This need is especially important in the arid West.

2 **Water quality.**
Commercial development poses huge challenges to protecting surface water and groundwater quality. To properly evaluate the effects of commercial development and to adopt and implement appropriate mitigation measures, governmental agencies must (a) establish independent baseline assessments of existing stream conditions for aquatic life, and (b) require industry to provide quantifiable data on the potential impacts of development on surface water and groundwater quality.

3 **Air quality.**
Protecting air quality might pose the greatest challenge to oil shale producers. To evaluate development and to adopt effective and enforceable mitigation measures, governmental agencies must put forth independent air quality data assessing the adverse health and environmental impacts of oil shale mining, production, and refinement.

4 **Energy sources.**
Water quality and air quality, along with water demands, are directly tied to electricity production. Coal, natural gas, and nuclear energy might be used to provide the increased electricity demand necessary to support oil shale development, and each source of electricity has different demands and impacts. As research progresses, industry and environmental regulators need to identify the sources of electricity production, with the agencies funding independent assessments of such impacts on other resources.

5 **Climate.**
Independent analyses have concluded that, depending on the technology utilized, development would produce 25% to 75% more greenhouse gases per barrel of oil from oil shale than from conventional fuel.[5] More analysis of oil shale's contribution to climate change is needed, and regulatory agencies must specify how impacts would be mitigated.

5 Adam R. Brandt, "Converting Oil Shale to Liquid Fuels with the Alberta Taciuk Processor: Energy Inputs and Greenhouse Gas Emissions," *Energy Fuels* 23, no. 12 (2009) 6253–6258, doi: 10.1021/ef900678d, http://pubs.acs.org/doi/abs/10.1021/ef900678d.

TERMINOLOGY

"OIL SHALE" *vs.* "SHALE OIL" *vs.* "SHALE GAS"

"Oil shale," "shale oil," and "shale gas" are terms that are often incorrectly used in place of one another, but they are different entities.

SHALE GAS is natural gas trapped in impervious shale formations. Advances in horizontal drilling techniques and the use of hydraulic fracturing technology have made this resource economical to exploit. The Marcellus Formation in Pennsylvania, New York, Virginia, and West Virginia is a shale gas formation.

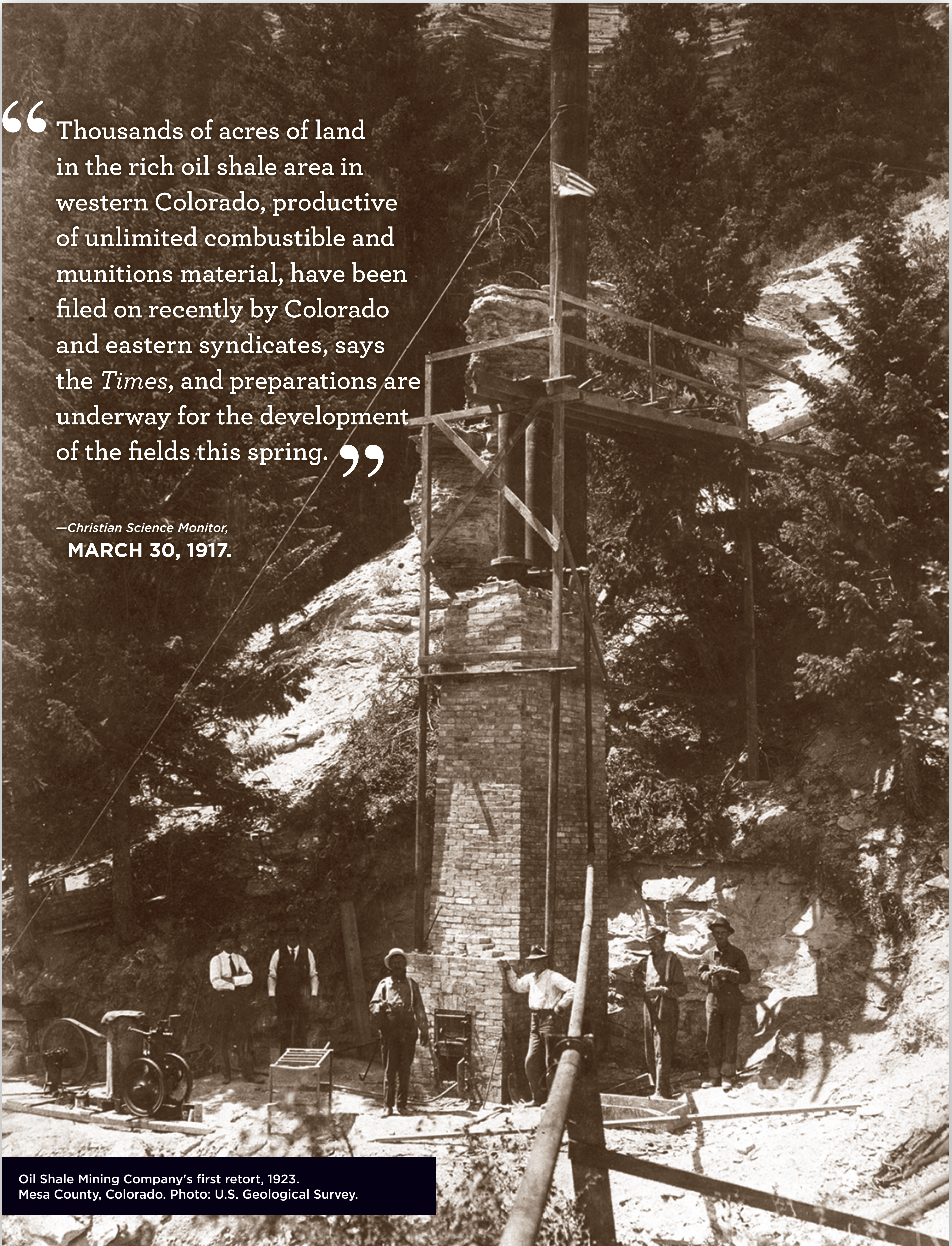
SHALE OIL is oil trapped in tight rock formations. Borrowing the horizontal/directional drilling and "fracking" techniques from shale gas extraction, shale oil has recently become a feasible resource. The Bakken Formation in Montana, North Dakota, and Saskatchewan, and the Niobrara Formation in northeast Colorado and southeast Wyoming are shale oil fields.

OIL SHALE is neither oil nor gas; in fact, it doesn't contain oil at all. It is kerogen, or fossilized algae, locked in shale rock. The technologies necessary to develop oil shale are unproven and fundamentally different from shale oil and shale gas technologies.

This is the one we're talking about!

"Thousands of acres of land in the rich oil shale area in western Colorado, productive of unlimited combustible and munitions material, have been filed on recently by Colorado and eastern syndicates, says the *Times*, and preparations are underway for the development of the fields this spring."

—*Christian Science Monitor,*
MARCH 30, 1917.



Oil Shale Mining Company's first retort, 1923.
Mesa County, Colorado. Photo: U.S. Geological Survey.

When you think of oil shale, picture a rock. Despite its name, oil shale does not contain oil; instead, the rock contains kerogen, a waxy precursor to oil. Given a few million years of heat and pressure, the kerogen in shale would, in theory, yield oil naturally. It is that drive for oil, that drive to extract kerogen and upgrade it into a liquid fuel, that has sustained this oil shale quest for more than 100 years.

Since the early 1900s, speculators have been working to develop technologies they could deploy to shortcut nature's geologic process and unlock oil shale. Although research continues, and small quantities of oil from shale have been produced, producing oil shale on a commercial level in the United States remains theoretical. The vision that sustains political discourse surrounding oil shale is that this rock can solve our growing energy needs — and that all we need to do is give industry unfettered access to public lands.

However, as the history of oil shale shows — and as oil shale's energy and water demands reinforce — the picture is not so rosy nor so simple. **The history of oil shale is, quite simply, a recurring period of hype followed by bust.** Interspersed amongst these cycles, and fueling dreams of striking it rich, are a litany of politicians, speculators, and news stories playing up oil shale's great promise. Consider this excerpt from the March 30, 1917, edition of *The Christian Science Monitor*:

> *Thousands of acres of land in the rich oil shale area in western Colorado, productive of unlimited combustible and munitions material, have been filed on recently by Colorado and eastern syndicates, says the* Times, *and preparations are underway for the development of the fields this spring.*[6]

That view has been repeated too many times to count. However, unlike other energy development activities that mark western history, commercial oil shale production has proven elusive, thereby making the hype much more dubious.

6 *Christian Science Monitor*, March 30, 1917, see http://checksandbalancesproject.org/tag/oil-shale/.

A PERSISTENT MYTH

"Oil-bearing shale… in the green river area of Colorado, Wyoming, and Utah… contain about 300 billion barrels of shale oil."

Deseret News, April 22, 1948

Exxon Halts Giant Shale Oil Project

HOUSTON (AP) — Exxon, the world's largest oil company, has announced that it is closing the Colony Shale Oil Project, the largest synthetic fuels undertaking in the nation.

The plan was to mine oil-bearing rock and crush and heat it to extract oil.

Dropping the project means, in effect, that Exxon has paid more than $900 million for oil-shale resources in Colorado that it now has no plans for developing. Exxon did not say how much of a loss it planned to record on the investment.'

It was the second major setback for synthetic fuels in recent days. Last week, subsidiaries of Royal Dutch-Shell Ltd. and Gulf Oil Corp., two of the world's seven major oil companies, announced that they were dropping out of the world's largest synthetic fuel project, a plan to extract oil from tar sands in the Canadian province of Alberta.

Exxon's retreat left only Union Oil Co. of California proceeding actively with commercial shale oil development in the United States. The company is building a 10,000-barrel-a-day facility in western Colorado.

Randall Meyer, the president of the subsidiary Exxon USA, said the cost of the Colony project, near Parachute, Colo., which had been estimated at $2 billion to $3 billion, had doubled while oil prices had fallen.

Exxon bought out Atlantic Richfield's 60 percent interest in the project in 1980 for $300 million, and spent $400 million more to develop the site.

Exxon said its contract with Tosco Corp. required it to pay $380 million more to Tosco because the

(Continued on Page A-12, Column 5)

SHALE: Bust recalled as 'Black Sunday'

Continued from 6G

crude that are relatively easy to tap.

Companies have spent years researching how to melt oil out of rock, but it could be 2010 before any decide whether shale mining is commercially and environmentally feasible. It takes a large amount of water to recover the oil and the process can take months.

Many also worry about the effect a large-scale operation — particularly coupled with robust natural gas, coal and oil production already under way — would have on the environment, wildlife and the people who spent years recovering from the last shale bust in the early 1980s.

Amy Beasley, whose grandparents homesteaded on Parachute Creek near here, was just a child when major shale production began in the late 1970s. She has lived with the effects of the boom and the bust and, now, a surging interest in domestic natural resources driven of late by high crude oil prices and the effects of Hurricanes Rita and Katrina.

At her Old Mountain gift shop just off Interstate 70, Beasley welcomes economic development but worries about her family's water supply.

"I just wish they would have more compassion," she said of energy companies.

Pete Kolbenschlag, a director of the Colorado Environ-

An aerial photo shows a ranch east of Parachute, Colo., that has 70 gas and oil drilling sites on it. The Roan Plateau, rich in oil shale is at left. Interstate 70 and the Colorado River are at right.

and there were booms just after World War II and again in the 1960s.

When that one hit, Parachute was a farming and ranching community whose 300 residents felt safe enough to leave their doors unlocked at night. Roads were dirt, there was no police department and government was overseen by a part-time town administrator.

With the companies came thousands of workers who parked trailers where they could or slept in the streets, under bridges and even in root cellars. Parachute Mayor John

The natural gas boom in particular has brought a fresh group of companies and workers to the region, packing hotels, restaurants and homes. Loschke says Parachute even has rush-hour traffic congestion at its main intersection, where there still is no traffic light.

In Vernal, Utah, also hit hard by the shale bust, workers are wanted for jobs in everything from energy development to retail. The town's population of about 8,000 is expected to double in 10 years.

"You take a look around,

It leaves a lot of leftover shale for disposal and requires huge amounts of water for processing.

The other is an underground process in which the rock is heated beneath the surface. Although it would not require as much water, pollution of underground water supplies and the air remain possibilities.

Shell Exploration & Production Co. has been testing this method with buried heaters in a remote stretch of Colorado, about an hour's drive north of here.

A BRIEF HISTORY OF FAILED ATTEMPTS TO COMMERCIALLY DEVELOP OIL SHALE

In the early 1900s, westerners stood on street corners in Chicago and lit shale rocks in an attempt to lure investment.[7] The investment scheme worked, but not for the investors. The rocks could burn, but oil did not flow from them.

In 1912, to spur growth and "ensure an emergency domestic supply of oil,"[8] President Howard Taft established the Office of Naval and Petroleum Oil Shale Reserves. Over the next 12 years, through numerous executive orders, federal land was set aside in three separate naval oil shale reserves. By 1922, "at least 100 companies had formed to unlock the secret of the oil in the rock."[9] That interest in oil shale development continued until the Great Depression, when "a flood of new lower-cost free-flowing crude oil discoveries conspired to kill the boom."[10] Despite this bust, private industry and associations continued to fan the (invisible) flames, keeping the hopes of commercial-scale shale production alive.

A 1948 edition of *Deseret News*, one of Utah's leading newspapers, carried an Associated Press story touting the American Chemical Society's estimate that the "oil-bearing shale…in the green river area of Colorado, Wyoming, and Utah…contain about 300 billion barrels of shale oil."[11] The operative idea — the myth that still transcends discussions about oil shale — is that the rocks contain oil. If that were true, oil shale would have been developed long ago.

Still, that myth persists, which gave birth to the idea that these deposits can be commercially developed. In a 1980 presentation to Club 20, a group representing the 22 counties in western Colorado, Exxon announced that by 2010 our country could produce eight million barrels of oil from shale per day.[12] Less than two years later, on May 2, 1982, a day known as "Black Sunday," Exxon's $5 billion Colony Shale Project collapsed, leaving more than 2,000 people out of work and western Colorado's economy in tatters. Other companies left the region or scaled back operations in the following years, and $85 million in annual payroll contributions disappeared. [13] Unemployment skyrocketed.[14]

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7 Western Resource Advocates, *Fossil Foolishness: Utah's Pursuit of Tar Sands and Oil Shale*, September 2010, page 8.

8 U.S. Government Accountability Office, *Energy-Water Nexus: A Better and Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development*, October 2010, GAO-11-35, http://www.gao.gov/assets/320/311896.pdf, page 4.

9 Jason L. Hanson and Patty Limerick, *What Every Westerner Should Know About Oil Shale: A Guide to Shale Country* (Boulder, CO: Center of the American West, University of Colorado, June 2009), http://www.centerwest.org/publications/oilshale/0home/index.php, page 8.

10 *Id.*

11 "Oil Shale Ample To Supply Gas Over 150 Years," *Deseret News*, April 22, 1948, http://news.google.com/newspapers?id=6DQxAAAAIBAJ&sjid=9U0DAAAAIBAJ&pg=5975,3441307&dq=oil+shale+chicago+history&hl=en (accessed November 13, 2011).

12 Exxon Corporation, "The Role of Synthetic Fuels in the United State Energy Future," presentation to Club 20, Grand Junction, Colorado, August 25, 1980, page 18.

13 Jason L. Hanson and Patty Limerick, *What Every Westerner Should Know About Oil Shale: A Guide to Shale Country* (Boulder, CO: Center of the American West, University of Colorado, June 2009), http://www.centerwest.org/publications/oilshale/0home/index.php, page 15.

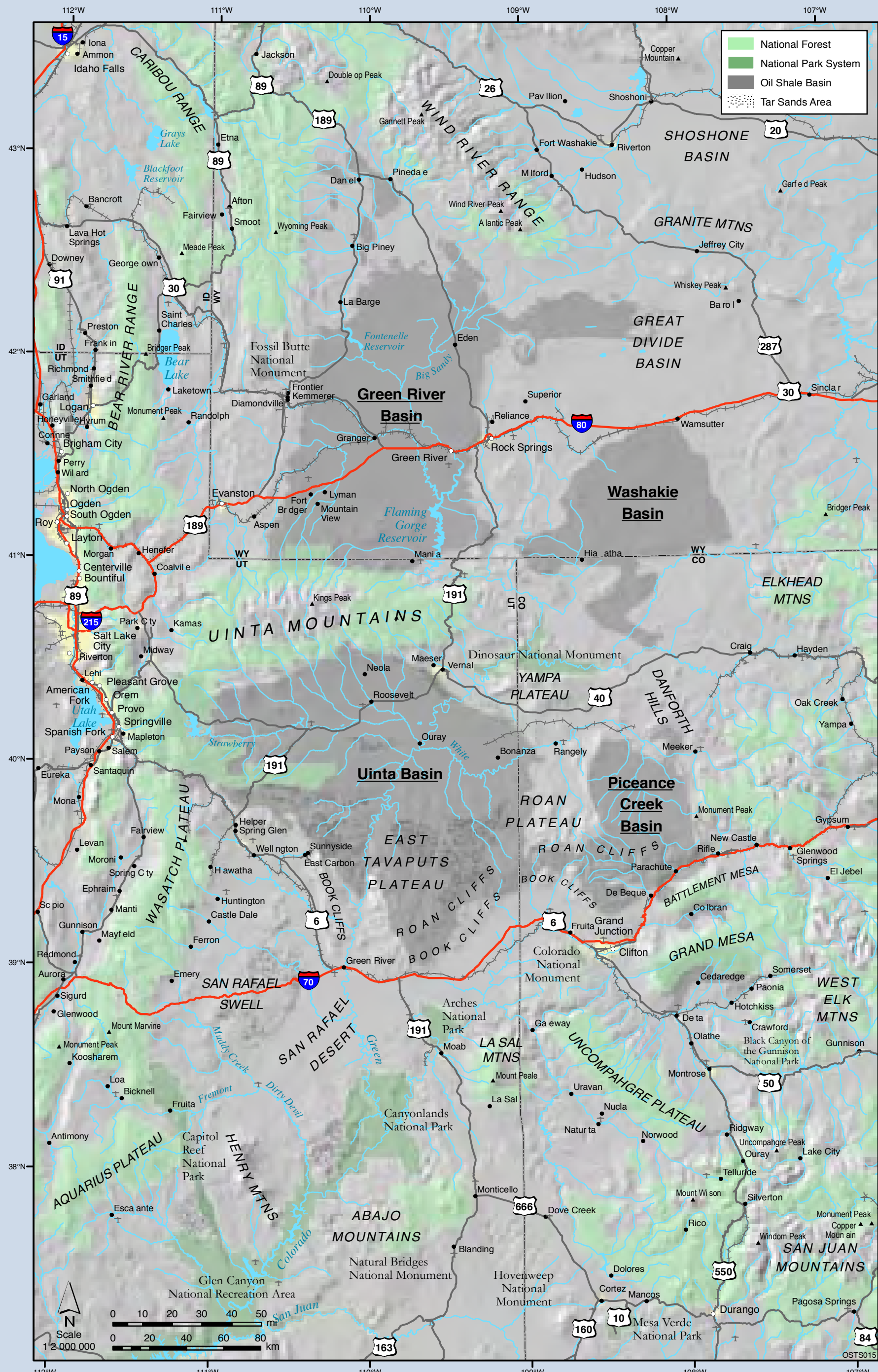
14 *Id.*

A PRIVATE AFFAIR

While much of the attention to developing oil shale has focused on federal land, there are large, non-federal, oil shale deposits across Colorado, Utah, and Wyoming. The Department of Energy's Office of Naval Petroleum and Oil Shale Reserves has estimated that more than three million acres of oil shale lands in the three-state region are in state, private, or tribal ownership, and have been for decades.* Exxon, for instance, owns more than 50,000 acres of oil shale lands in Colorado's Piceance Basin. ConocoPhillips also has extensive private shale lands in the Piceance Basin in Colorado that it acquired from TOSCO. Red Leaf Resources has access to approximately 16,000 acres of non-federal land in Utah. Similarly, Enefit American Oil (formerly The Oil Shale Exploration Company) has access to more than 45,000 acres of non-federal land in Utah.

Access to land is not the problem. The problem is the rock.

Why does private land matter? In certain policy debates, pro-oil shale voices argue that federal policy is stymieing development. The problems industry faces are, fundamentally, not access to land, but rather the same ones that have challenged oil shale development over the past 100 years. It's the rock — and it's always been the rock.



Map source: http://ostseis.anl.gov/guide/maps/
Map data is currently under review by the BLM.

* U.S. Department of Energy, Office of Naval Petroleum and Oil Shale Reserves, *National Strategic Unconventional Resource Model*, April 2006, http://fossil.energy.gov/programs/reserves/npr/NSURM_Documentation.pdf, page 6.

NO SHORTAGE OF ROCK, BUT IS ANY LIQUID FUEL ECONOMICALLY RECOVERABLE?

Despite bust after bust, the dream of developing oil shale has shown amazing resiliency. In 2005, as energy prices surged and the United States fought two wars, interest in oil shale was again stoked when Congress passed the Energy Policy Act of 2005.[15] That bill, which addressed a host of energy issues, sought to boost oil shale by, among other things, instructing the Department of the Interior (DOI) to initiate a federal research-leasing program. By December 2011, the Bureau of Land Management (BLM) had issued six research leases and was evaluating three others. Other research efforts on non-federal lands in Colorado, Utah, and Wyoming were also underway.

Oil shale deposits sit underneath a mixture of federal, state, tribal, and private lands. The most extensive deposits in the world are found in the Green River Formation, a geologic formation underlying western Colorado, eastern Utah, and southwestern Wyoming. Although estimates vary, one independent study concluded that approximately 20% of the oil shale lands are owned by individuals and private corporations.[16] State and tribal lands also contain substantial holdings. The rest underlies federal land.

The United States Geological Survey (USGS) estimates that the Green River Formation contains enough oil shale that if the technologies were to be developed, industry could theoretically produce approximately 800 billion to 1.4 trillion barrels of oil from the formation.[17] Those are impressive numbers, but upon closer look, it is clear that the idea that there are vast quantities of recoverable oil is a theoretical construct. As the USGS's Oil Shale Assessment Team stated in a 2011 report evaluating oil shale deposits in Colorado, Utah, and Wyoming, "no attempt was made to estimate the amount of oil that is economically recoverable, largely because there has not yet been an economic method developed to recover the oil."[18]

WHAT ABOUT OIL SHALE IN WYOMING?

While Wyoming is often mentioned in conjunction with Colorado and Utah when discussing oil shale mining, the challenges facing Wyoming differ in important ways. The deposits in Wyoming are generally shallower than those found in Colorado and thus mirror those in Utah. Accordingly, the air and water impacts, water consumption needs, and climate impacts would roughly approximate those Utah would face. However, unlike in Colorado and Utah, the deposits are not as rich, which could result in little or no development pressure on the state. Accordingly, this report de-emphasizes oil shale development in Wyoming, and instead focuses on Colorado and Utah.

15 See Energy Policy Act of 2005, Pub. L. 109–58, Section 369.

16 Jason L. Hanson and Patty Limerick, *What Every Westerner Should Know About Oil Shale: A Guide to Shale Country* (Boulder, CO: Center of the American West, University of Colorado, June 2009), http://www.centerwest.org/publications/oilshale/0home/index.php, page 20.

17 U.S. Government Accountability Office, *Energy-Water Nexus: A Better and Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development*, October 2010, GAO-11-35, http://www.gao.gov/assets/320/311896.pdf, page 1.

18 U.S. Geological Survey Oil Shale Assessment Team, *Assessment of In-Place Oil Shale Resources in the Eocene Green River Formation, Greater Green River Basin, Wyoming, Colorado, and Utah*, 2011, http://pubs.usgs.gov/dds/dds-069/dds-069-dd/REPORTS/69_DD_CH_1.pdf, chapter 1.

OIL SHALE DEVELOPMENT TECHNOLOGIES

To develop oil shale and produce a transportation fuel, it is first necessary to extract kerogen, a waxy petroleum precursor, from the shale rocks. To do this, companies must heat the rock in a process called "retorting." Once extracted, kerogen then must be upgraded and refined. Unless kerogen is upgraded on site, the product either has to be shipped in a heated container because of its high viscosity, or diluted with naphtha (a hydrocarbon) or comparable substance for transport.

There are two primary methods for developing oil shale that are being pursued, neither of which has been proven to be commercially viable:

- **Mining and surface retorting.**[19] Mining and surface retorting requires mining the shale, crushing it, and heating the rock in an aboveground furnace to separate the kerogen. The technology in use leading up to Black Sunday was aboveground retorting. In Utah, because the deposits are shallow, companies are seeking to use aboveground retorting.
- **In-situ retorting.** In-situ (or in place) retorting would extract kerogen underground and then pump the waxy substance to the surface, where it is upgraded and refined. Shell Oil, to name one company, is, in short, researching the feasibility of using underground heaters to heat the shale and free the kerogen. Other companies are evaluating the possibility of burning natural gas in the shale formation and then extracting the kerogen, or utilizing chemical processes to separate the kerogen from the rock. These processes require varying amounts of water and energy, and incredible amounts of time.

"At present a number of firms are making investments in research directed at developing technologies that economically produce liquid fuels from oil shale. However, to my knowledge, none of these firms has gathered enough technical information adequate to support a decision to invest hundreds of millions, and more likely billions, of dollars in first-of-a-kind commercial oil shale production facilities."

—James T. Bartis, RAND Corporation

Testimony presented before the House Energy and Commerce Committee, Subcommittee on Energy and Power, June 3, 2011, page 2.

Neither of these methods for developing oil shale is commercially viable.

19 James T. Bartis et al., *Oil Shale Development in the United States: Prospects and Policy Issues*, 2005, report prepared by the RAND Corporation for the U.S. National Energy Technology Laboratory, page x.

2

DOWN TO THE LAST DROP

Water is the lifeblood of the West. It is the foundation of communities and economies. It gives life to our crops and livestock, provides habitat for numerous species, and is central to many recreational activities. Most oil shale development would take place in the Colorado River Basin, which supplies water to 30 million people and more than two million acres of irrigated land in seven arid states. By 2020, estimates are that the basin will be home to almost 40 million people.[20] By 2050, the river basin will face even greater pressures from population growth and climate change.

According to the U.S. Bureau of Reclamation, since 2003, the 10-year average consumptive use of water in the Colorado River Basin has exceeded the 10-year average supply (see chart on facing page). Around 2050, the timeframe that the BLM predicts industry could be developing large-scale commercial oil shale operations, 23 of 24 global circulation models project that runoff of the upper Colorado River will decrease by 5% to 20%.[21] A drier climate will also further challenge water providers' ability to meet projected demands. Oil shale development would not only contribute to climate change, but would compete for the same dwindling water resources.

Water for oil shale, thus, must be viewed against the backdrop of current and future uses — and must be evaluated not simply on a mine-by-mine basis, but within the broader context of state and regional demands for water.

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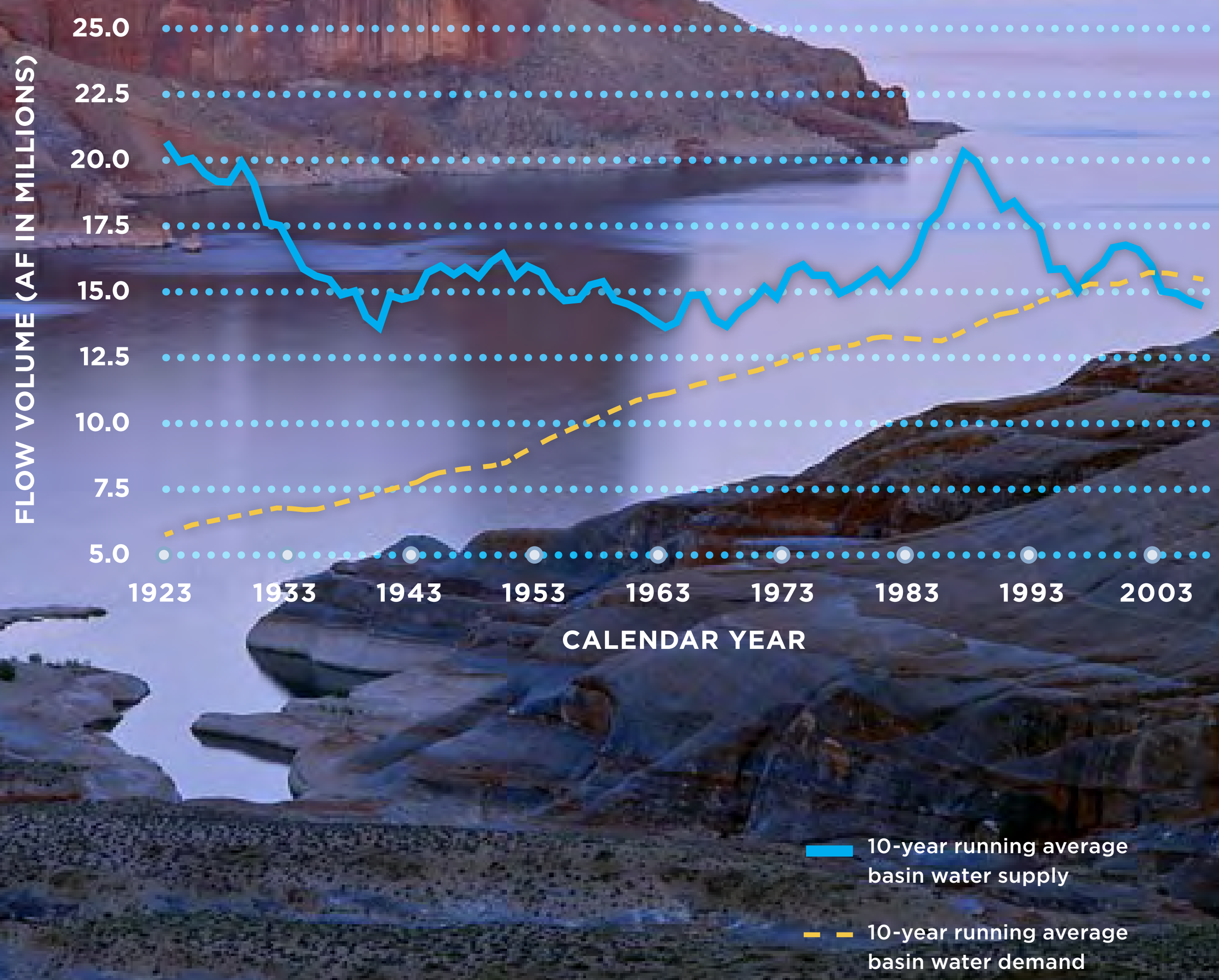
20 S. Gray and C. Andersen, *Assessing the Future of Wyoming's Water Resources: Adding Climate Change to the Equation* (Laramie, WY: William D. Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, 2009), http://www.uwyo.edu/enr/_files/docs/uofw-water_climate_final_comp.pdf, page 5.

21 Western Resource Advocates and Environmental Defense Fund, *Protecting the Lifeline of the West: How Climate and Clean Energy Policies Can Safeguard Water*, 2010, http://www.westernresourceadvocates.org/water/lifeline/lifeline.pdf, page 5 (primary sources are found in footnote #16 of the report).

Colorado River Runoff & Demands

In the Colorado River Basin, water demands already exceed available supplies. Any reductions in water supplies will result in unmet demands.

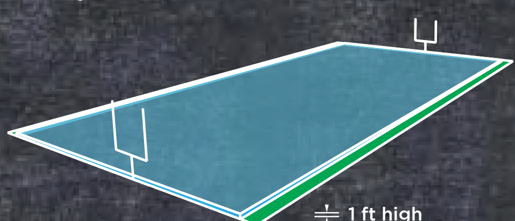


A long narrow butte in Lake Powell, Utah. Lake Powell is formed by the Glen Canyon Dam on the Colorado River.

Oil shale development could require 375,000 acre-feet of water — that's 122 billion gallons!

QUICK DEFINITION: WHAT IS AN ACRE-FOOT?

One way to measure water volumes is by acre-feet. One acre-foot of water can fill one acre of land, approximately the size of a football field, one-foot deep. An acre-foot contains about 325,900 gallons of water and can supply the annual needs of two to three urban households. To put this amount in perspective, Denver Water currently supplies water to 1.3 million people through demands of roughly 225,000 AF/yr.



HOW MUCH WATER WOULD BE NEEDED?

While there are many uncertainties and unknowns regarding the amount of water that would be needed for commercial oil shale production, independent analyses by the BLM and others raise serious concerns. In a 2008 environmental analysis, the BLM concluded that by shifting water from agriculture to oil shale, oil shale development would likely transform communities in western Colorado from agricultural-based economies to industrial economies.[22] Similar changes are projected for Utah, and for Wyoming to a lesser degree. The questions for elected officials and other community leaders are how, when, where, and to what extent such changes would occur, and how communities would address these changes.

Because of the importance of water — and because oil shale would be developed in a high mountain desert — oil shale discussions often pivot around the critical question of how much water would be needed to sustain a given commercial operation. Water demand is one of the many impacts of oil shale development that is not fully understood.

This uncertainty is rooted in two fundamental realities. First, there are no commercially viable oil shale technologies in the United States. Until commercial technologies are developed and scaled up, we continue to rely on existing analyses from the BLM, RAND Corporation, and the October 2010 report from the Government Accountability Office (GAO). These studies project development would require huge volumes of water — up to 375,000 acre-feet (AF), equivalent to 122 billion gallons, each year.[23] To put this amount in perspective, Denver Water currently supplies water to 1.3 million people through demands of roughly 225,000 acre-feet per year (AF/yr). (These studies do not distinguish between surface retort and in-situ technologies, but the water needs would differ.)

Another study is worth noting. AMEC, a leading engineering, project management, and consultancy company with expertise on western water issues, issued a report in 2011 in which it evaluated consumptive uses that might be generated by energy demand in Western

22 U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Final Programmatic Environmental Impact Statement (PEIS)*, September 2008, available at http://ostseis.anl.gov/eis/guide/index.cfm, pages 4-144 to 4-145.

23 An acre-foot is a volume of water equal to 325,851 gallons.

Colorado, including oil shale."[24] The report concluded that large-scale commercial production (1,500,000 barrels/day) would require up to 120,000 (AF/yr),[25] less than the BLM and GAO projections. AMEC noted that "an oil shale industry, developed incrementally, using water and natural gas resources found on-site, with minimal in-basin coal-fired electrical production is not likely to exceed the[se] high use water demands."[26]

AMEC's report assumes, among other things, (1) that technologies would be able to utilize water produced from the oil shale formations in lieu of surface diversions, (2) that combined-cycle natural gas plants, and not coal-fired electricity, would be used to power production, and (3) that upgrading (the process of stabilizing kerogen before shipping it) would not be needed or would be minimally needed. AMEC further assumes that should any large-scale, coal-fired electricity be needed, it would not be produced in western Colorado due to numerous air quality concerns. Whether these and other assumptions prove true is hugely uncertain. For that reason, AMEC notes, development could require 350,000 AF annually.[27]

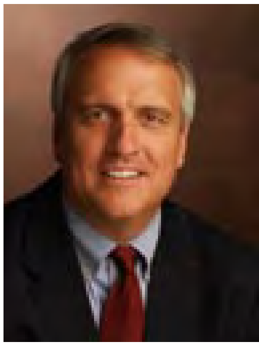
Regardless of which numbers prove more accurate, it is clear that oil shale development would require massive amounts of water, enough to meet the needs of hundreds of thousands, if not millions, of people.

The second huge uncertainty regarding oil shale is that industry does not know to what extent any of its development scenarios are truly realistic. Is it possible to produce 10,000 barrels/day by 2050? How about 100,000 barrels/day? Could the BLM's projection of 1,550,000 barrels/day by 2050 be met? Production levels tie directly to water needs, and if production remains non-existent or is low (~20,000 barrels/day), then the water demands will be far less than the BLM and others project. If they are high, which is industry's stated goal, then the use conflicts and impacts identified in this report and captured by the BLM in their analysis would likely be realized.

"Oil shale would usher in the largest industrial development in the state's history — with enormous consequences for all of northwest Colorado and for the state itself."

**—Bill Ritter, Jr.
Governor of Colorado**

Testimony before the Senate Committee on Energy and Natural Resources, Oversight Hearing: Oil Shale Resources, May 15, 2008.



24 AMEC, *Energy Development Water Needs Assessment, Phase II, Final Report*, February 2011, report prepared for the Colorado River Basin Roundtable and Yampa/White Basin Roundtable, http://www.crwcd.org/media/uploads/Energy_Development_Water_Needs_Assessment_Phase_II_Final_Report.pdf.

25 *Id.* at 8.

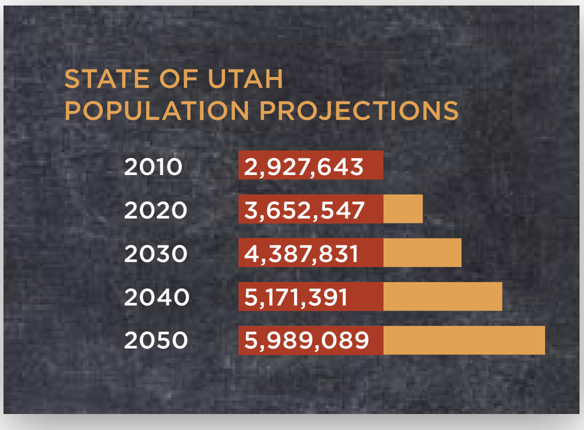
26 *Id.* at ES-4.

27 *Id.* at ES-4 to ES-5.

PUTTING WATER FOR OIL SHALE IN CONTEXT: COMPETITION FOR WATER IS INCREASING

If commercially viable technologies are eventually developed and oil shale development is pursued, any water for oil shale must be viewed within the context of projected water needs states will face by 2050.

Take Utah, the United States' second-most arid state after Nevada. Utah receives meager annual precipitation and has a limited right to use water from its rivers and streams because of claims by upstream and downstream states. The Colorado River and its tributaries that flow through Utah, including the Green and White rivers, contain some of the most sought-after water in the country. Oil shale industries would need to draw large amounts of water from this river basin to be viable. The consequences of allocating water to these industries need to be fully understood as populations increase.



The state of Utah projects the state's population will increase from 2.9 million in 2010 to 5.9 million by 2050,[28] although those projections might slow due to the recession. (Beyond 2050, the state projects it will add another 900,000 people by 2060.) Even before the recent flurry of interest in oil shale, the stage was set for inevitable water conflicts in a rapidly expanding region. In 2003, Utah projected that statewide municipal and industrial demand would increase from 904,000 AF/yr in 1995, to 1,951,000 AF/yr in 2050, a 115% increase.[29] With conservation, the state hopes to reduce the 2050 demand to 1,550,000 AF/yr, but none of these plans account for potential oil shale development.[30]

The state of Utah recognizes the challenge of balancing population needs with energy needs. As the state concluded in its March 2011 10-year energy study:

> *Limited quantities of water may be available for new energy development. Most areas of the state are closed to new surface- and ground-water appropriations (especially new consumptive appropriations) and those that are still open are primarily for ground water in relatively small quantities. What little may be currently available will undoubtedly decline over the next decade. Water currently used at other facilities or by other water users may be purchased for use in energy development in the future. …* ***Given Utah's population growth and projected economic growth over the next decade, the possibility of increased drought, and with***

28 State of Utah, Governor's Office of Planning and Budget, "Demographic and Economic Projections, 2008 Baseline Projections," January 10, 2008, http://www.governor.state.ut.us/dea/projections.html (accessed November 16, 2011).

29 Utah Division of Water Resources, *Utah's M&I Water Conservation Plan: Investing in the Future*, July 14, 2003, http://www.water.utah.gov/M&I/Plan7-14-03.pdf, page 4.

30 *Id.*

> *limited new water resources available, water consumption of energy resources should be given careful consideration. … As an arid state, an energy portfolio* [sic] *that encourages low water-use technologies should be considered.*[31]

Without using one drop of water for oil shale development, these states face huge increases in water demands.

Colorado faces a similar challenge. The 2010 Statewide Water Supply Initiative report projected that by 2050, after taking into account conservation, statewide municipal and industrial demand (M&I) will increase by somewhere between 538,000 AF/yr and 812,000 AF/yr (55% to 83%) over 2008 baseline demand.[32] M&I does not include water for oil shale or thermoelectric power production, so any water for oil shale, as well as water for existing and new electricity/energy production, would come in addition to statewide M&I demands. Meeting these demands — demands that are principally driven by an increasing population — will prove challenging. Since the water rights for oil shale are senior in priority to some existing decrees for municipal use, it remains an open question how Colorado would meet M&I obligations should large-scale oil shale development come to fruition.

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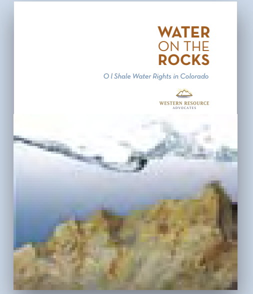
31 State of Utah, Governor's Office, *Energy Initiatives and Imperatives: Utah's 10-Year Strategic Energy Plan*, March 2, 2011, http://www.utah.gov/governor/docs/10year-stragegic-energy.pdf, page 25 (emphasis added).

32 *State of Colorado 2050 Municipal & Industrial Water Use Projections*, July 2010, report prepared by Camp Dresser & Mckee, Inc. and Harvey Economics for Colorado Water Conservation Board, http://cwcbweblink.state.co.us/weblink/0/doc/144800/Electronic.aspx?searchid=c1469548-e589-49df-a54f-6b03612a38e3, Table 3-3, "M&I Forecast by River Basin," page 3-11.

"WATER ON THE ROCKS: OIL SHALE WATER RIGHTS IN COLORADO"



An interesting dynamic is unfolding in Colorado. Oil companies and water districts hold substantial water rights that can be used for oil shale development. Many of these rights are from the late 1800s and mid-1900s. The extent of these rights is staggering. As WRA catalogued in its 2009 report on oil shale water rights in Colorado,* water districts and companies seeking to develop oil shale hold substantial water rights that could be used for commercial development. On the Colorado River and White River in Colorado, these parties own or have the right to use 10,689 cubic feet per second (cfs)** and 1,553,310 AF of water. Again, to put these volumes in context, Denver Water, which serves a population of approximately 1.3 million, uses roughly 225,000 AF of water per year. Utilizing a portion of these rights would still dwarf Denver Water's annual use.

Regardless of whether the BLM or industry projections prove most accurate, industry does not need anywhere near the volume of water decreed in these rights. Using these rights for oil shale development could force curtailment of transbasin diversions used for Front Range agriculture and municipal use, as many of these oil shale water rights are senior to existing and planned future uses.

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* Western Resource Advocates, *Water on the Rocks: Oil Shale Water Rights in Colorado*, 2009, http://www.westernresourceadvocates.org/land/wotrreport/.

** Cubic feet per second (cfs) is the unit of measurement for water that is in motion. See "Water Measurement," Colorado Water District website, http://www.crwcd.org/page_98 (accessed November 16, 2011).

*"Well it scares me for those who follow me,
for my children and grandchildren and down the line,
that we would take the water away from the agricultural industry.
We're going to have to be concerned about saving some of that
resource for this endangered species of humans. You just can't
get along without water.*

*The human body just will not go on without water.
It will go on without oil. It may not go on the way we like it, and we
may not be very comfortable, but you can go on. Without water you
can't go on."*

Quote by Don Christiansen, in Western Resource Advocates, *Fossil Foolishness: Utah's Pursuit of Tar Sands and Oil Shale*, September 2010, page 23. Don Christiansen is general manager of the Central Utah Water Conservancy District. He is the former mayor of Alpine, Utah, and former member of the Central Utah Water Conservancy Board of Directors, where he has worked for three decades.

Autumn colors along a riverbed in southern Utah.

What these statistics show is that without using one drop of water for oil shale development, these states face huge increases in water demands, and project significant changes in the way in which water is used. Water for oil shale would therefore require difficult and perhaps untenable tradeoffs, especially if large-scale commercial production (i.e., greater than 500,000 barrels per day) becomes reality.

Importantly, as discussed on page 28, climate change would reduce water availability even more, further straining existing supplies. When taken together — growing demands for M&I, reduced water due to climate change, and huge increases in demands for oil shale — these factors increase the risk that use limits under the Colorado River Compact (see "Colorado River Compact" sidebar) could be exceeded, thereby resulting in a curtailment of water available for Colorado, Utah, and Wyoming.

HOW IS WATER USED FOR OIL SHALE DEVELOPMENT?

Water would be used at various points in the development process, each with a different level of uncertainty about the amount of water needed:

- **Extraction and retorting.** As discussed in chapter 1, there are two primary ways to develop shale: mining and surface retorting, and in-situ retorting. As the GAO explained, "During extraction and retorting, water is used for building roads, constructing facilities, controlling dust, mining and handling ore, drilling wells for in-situ extraction, cooling of equipment and shale oil, producing steam, in-situ fracturing of the retort zones, and preventing fire. Water is also needed for on-site sanitary and potable uses."[33]
- **Upgrading.** Upgrading is the process of stabilizing and purifying kerogen so that it can be transported to a refinery for processing. The degree to which kerogen needs to be upgraded varies according to the retort process.
- **Reclamation.** Reclaiming a mine site is a key component of mining activities. Water is needed to stabilize the shale waste piles of retorted shale, and to revegetate disturbed surfaces. In-situ development would also require water to remove residual hydrocarbons.[34] Very little information exists about how energy companies plan to revegetate the areas affected by development, so the amount of water needed is likewise unclear.
- **Power generation.** Heating oil shale requires a lot of energy — and, depending on the technology that was developed, would require a great deal of electricity. (The amount of water needed varies according to generation and cooling technologies.) Currently, there is not enough excess energy in the grid to supply this scale of new electricity demands.
- **Population.** Any oil shale industry would require more water to support its workers and the businesses needed to support these employees and development activities.

"The unproven nature of oil shale technologies and choices in how to generate the power necessary to develop this resource cast a shadow of uncertainty over how much water is needed to sustain a commercially viable oil shale industry."

U.S. Government Accountability Office, *Energy-Water Nexus: A Better and Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development*, October 2010, GAO-11-35, http://www.gao.gov/assets/320/311896.pdf, page 44.

33 U.S. Government Accountability Office, *Energy-Water Nexus: A Better and Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development*, October 2010, GAO-11-35, http://www.gao.gov/assets/320/311896.pdf, page 15.

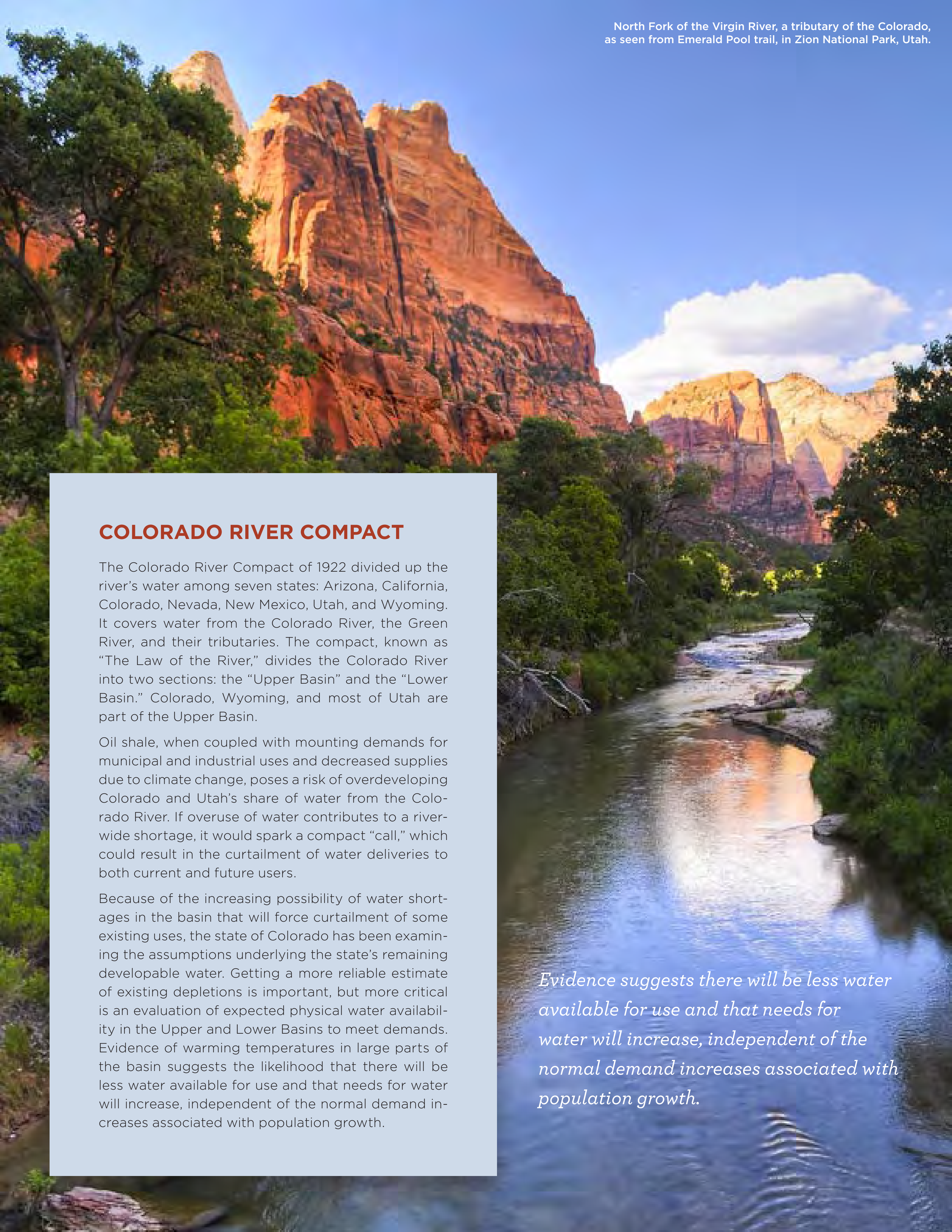
34 *Id.*

GAO's Word of Caution

"Water is likely to be available for the initial development of an oil shale industry, but the size of an industry in Colorado or Utah may eventually be limited by water availability. Water limitations may arise from increases in water demand from municipal and industrial users, the potential of reduced water supplies from a warming climate, fulfilling obligations under interstate water compacts, and the need to provide additional water to protect threatened and endangered fishes."

U.S. Government Accountability Office, *Energy-Water Nexus: A Better and Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development*, October 2010, GAO-11-35, http://www.gao.gov/assets/320/311896.pdf, page 44.


Flaming Gorge Reservoir, Wyoming.



North Fork of the Virgin River, a tributary of the Colorado, as seen from Emerald Pool trail, in Zion National Park, Utah.

COLORADO RIVER COMPACT

The Colorado River Compact of 1922 divided up the river's water among seven states: Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. It covers water from the Colorado River, the Green River, and their tributaries. The compact, known as "The Law of the River," divides the Colorado River into two sections: the "Upper Basin" and the "Lower Basin." Colorado, Wyoming, and most of Utah are part of the Upper Basin.

Oil shale, when coupled with mounting demands for municipal and industrial uses and decreased supplies due to climate change, poses a risk of overdeveloping Colorado and Utah's share of water from the Colorado River. If overuse of water contributes to a river-wide shortage, it would spark a compact "call," which could result in the curtailment of water deliveries to both current and future users.

Because of the increasing possibility of water shortages in the basin that will force curtailment of some existing uses, the state of Colorado has been examining the assumptions underlying the state's remaining developable water. Getting a more reliable estimate of existing depletions is important, but more critical is an evaluation of expected physical water availability in the Upper and Lower Basins to meet demands. Evidence of warming temperatures in large parts of the basin suggests the likelihood that there will be less water available for use and that needs for water will increase, independent of the normal demand increases associated with population growth.

Evidence suggests there will be less water available for use and that needs for water will increase, independent of the normal demand increases associated with population growth.

A POOR ENERGY SOURCE WITH HUGE CLIMATE IMPACTS

3

Too often debates over oil shale hinge around the question of the potential barrels of liquid fuel that could be produced from shale. Often missing from such debates is the quality of the deposits and, in turn, the question of whether our country should pursue developing these deposits.

In less than one decade, corn-based ethanol went from being the fuel of the future to a fuel that draws great skepticism and concern. The change in opinion about corn-based ethanol is directly tied to a closer examination of the nature of the fuel source and the tradeoffs our country makes in developing this fuel. Corn-based ethanol was perhaps pursued too quickly and without enough information on its potential impacts in other areas.

Oil shale, likewise, demands close scrutiny. An examination of oil shale's energy demands and greenhouse gas emissions must be carefully evaluated as technology development is pursued. These two challenges are discussed below.

CHALLENGE #1
A POOR ENERGY SOURCE

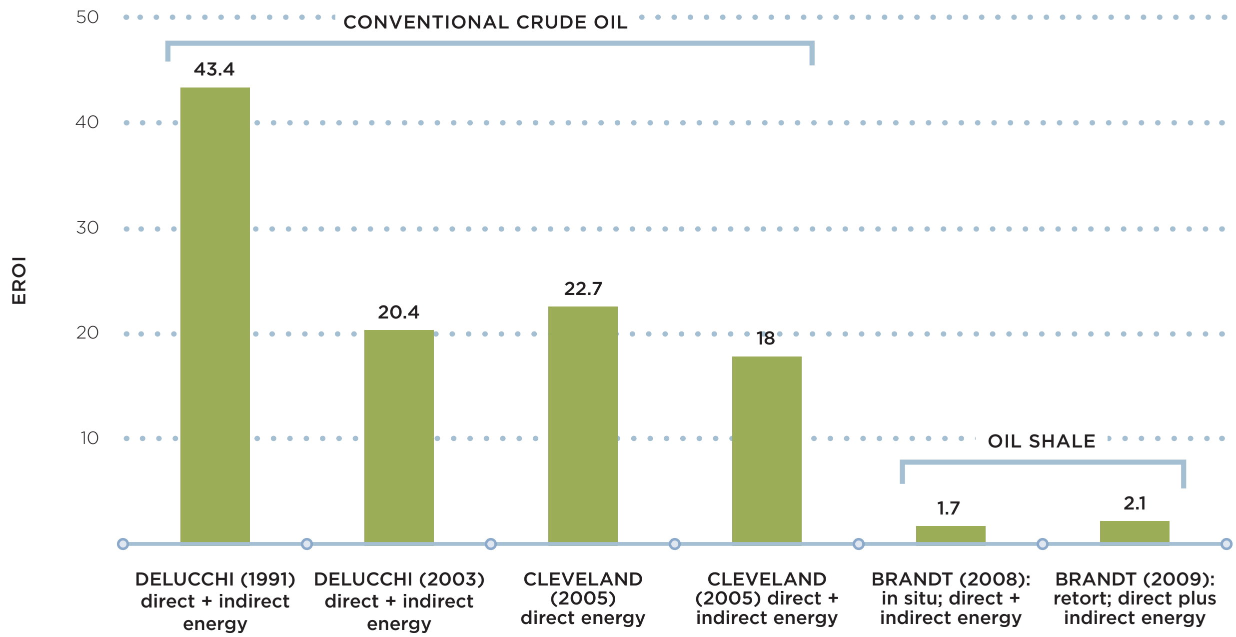
Energy return on investment (EROI) underpins any analysis of the value of energy produced. In simple terms, EROI is a comparison of the amount of energy that goes into a production process versus the amount of energy delivered by the process. An EROI of 1:1 means there is no energy profit from the investment of energy.

An analysis of the EROI of oil shale conducted by Dr. Cutler Cleveland at Boston University concluded that, based on the most reliable studies, the EROI for oil shale would fall, depending on the technology used, between 1:1 and 2:1 when internal energy in counted as a cost.[35] (Internal energy includes the energy released by the oil shale during production that is then used to power that operation — e.g., natural gas co-produced during extraction that is used as part of the processing.) The poor EROI of oil shale calls into question whether its development is really worth the effort.

35 Cutler J. Cleveland and Peter O'Connor, *An Assessment of the Energy Return on Investment (EROI) of Oil Shale*, June 2010, report prepared for Western Resource Advocates, http://www.westernresourceadvocates.org/land/oseroi.php.

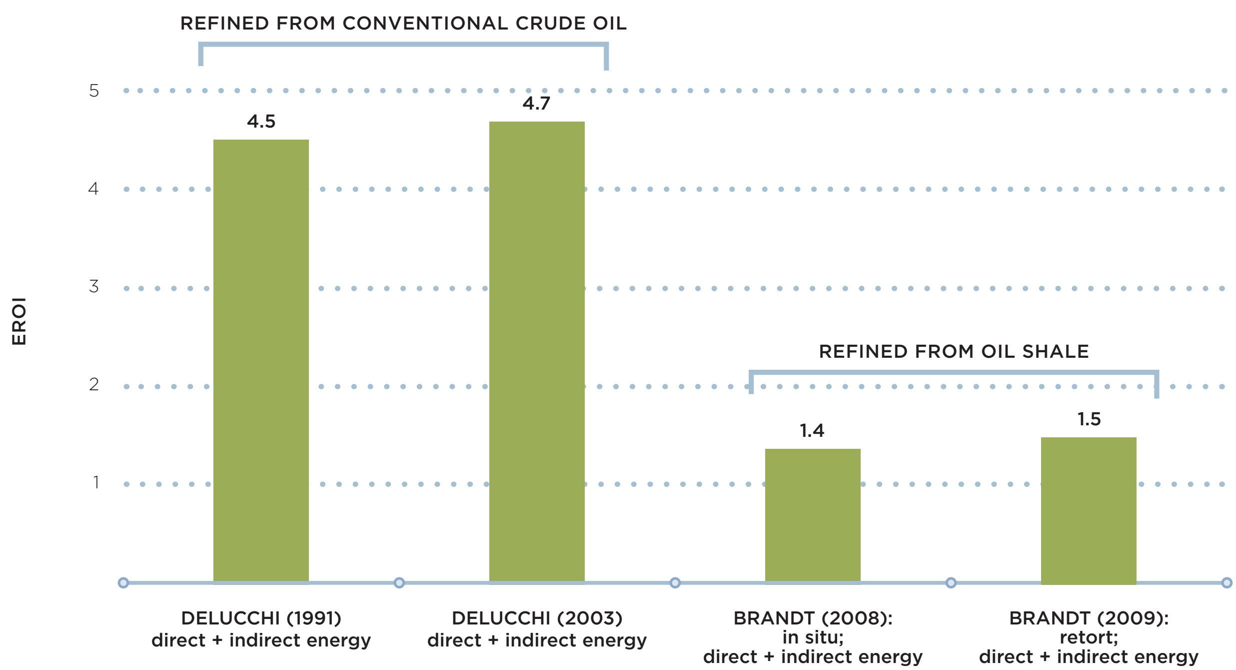
EROI: conventional crude oil vs. oil shale

A comparison of estimates of the energy return on investment (EROI) for refined fuel produced from conventional crude oil and from oil shale.



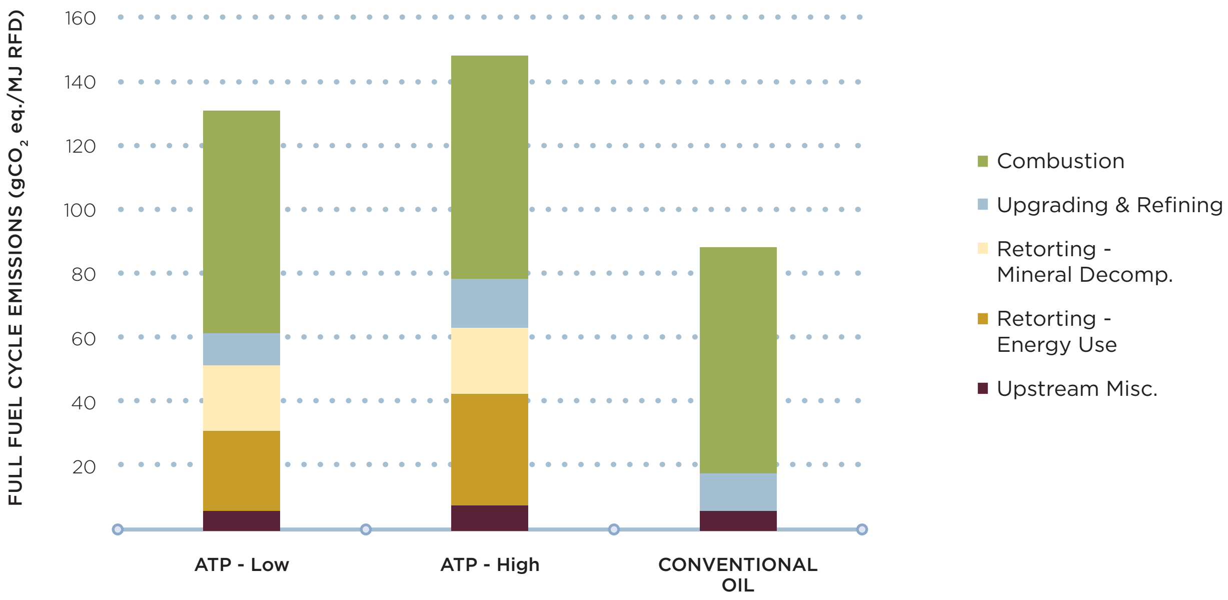
EROI at the well head

A comparison of estimates of the energy return on investment (EROI) at the well head for conventional crude oil, or for crude product prior to refining for oil shale.



Greenhouse Gas Emissions Comparison

Greenhouse gas emissions from low and high Alberta Taciuk Processor (ATP) cases vs. conventional oil production, measured in grams of carbon dioxide equivalent per megajoules of final fuel delivered (g CO2 equiv/MJ RFD).



Source: Adam R. Brandt, "Converting Oil Shale to Liquid Fuels with the Alberta Taciuk Processor: Energy Inputs and Greenhouse Gas Emissions," *Energy Fuels* 23, no. 12 (2009) 6253–6258, doi: 10.1021/ef900678d, http://pubs.acs.org/doi/abs/10.1021/ef900678d.

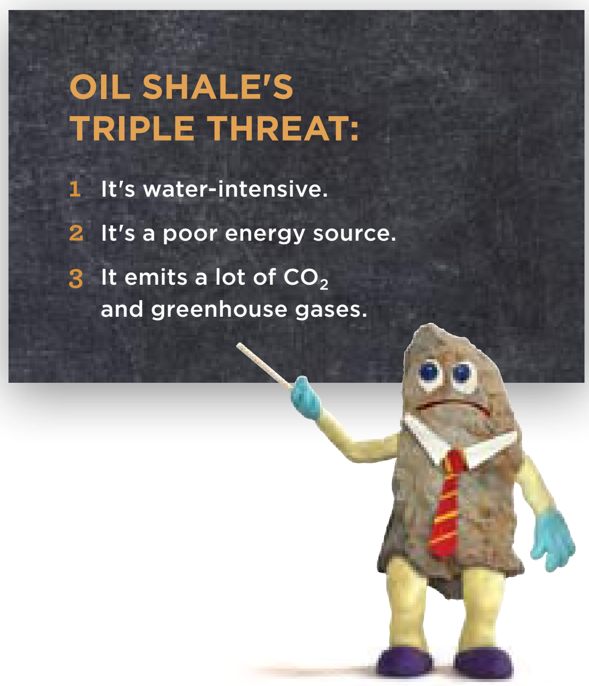
As Cleveland found, the EROI for oil shale is considerably less than the EROI of conventional crude oil, both at the wellhead and at the refined fuel stages of processing. Even under marginal conditions, such as smaller and deeper well fields, or loss of artesian pressure, conventional crude oil still generates a significantly larger energy surplus than oil shale — approximately 20:1.

Why does oil shale have a low EROI? The kerogen in oil shale is solid organic material that has not been subject to the temperature, pressure, and other geologic conditions required to convert it to liquid form. In effect, humans must supply the additional energy required to upgrade the oil shale to the functional equivalent of conventional crude oil. This extra effort carries a large energy penalty, producing a much lower EROI for oil shale than conventional crude.

CHALLENGE #2
HIGH GREENHOUSE GAS EMISSIONS

Dr. Adam Brandt at Stanford University has determined that oil shale's low EROI is closely connected to a significant release of greenhouse gases. The large quantities of energy needed to process oil shale, combined with the thermochemistry of the retorting process, would produce disproportionally high levels of carbon dioxide and other greenhouse gas emissions. Depending on the process used, oil shale would emit 25% to 75% more greenhouse gases than conventional liquid fuels from crude oil feedstocks.[36]

Brandt calls oil shale a "low-quality hydrocarbon resource," and his research has demonstrated that a transition to large-scale use of oil shale fuels would have profound effects on global greenhouse gas emissions, raising them by several gigatons.[37] What that means is that developing an oil shale industry would only accelerate our carbon dioxide output, resulting in more warming of the climate, increased water scarcity, and greater conflict over dwindling supplies of water.



36 Adam R. Brandt, "Converting Oil Shale to Liquid Fuels with the Alberta Taciuk Processor: Energy Inputs and Greenhouse Gas Emissions," *Energy Fuels* 23, no. 12 (2009) 6253–6258, doi: 10.1021/ef900678d, http://pubs.acs.org/doi/abs/10.1021/ef900678d.

37 Adam R. Brandt and Alexander E. Farrell, "Scraping the Bottom of the Barrel: Greenhouse Gas Emission Consequences of a Transition to Low-Quality and Synthetic Petroleum Resources," *Climatic Change* 84, nos. 3–4 (October 2007) 241–263.

CLIMATE CHANGE IN ACTION

Climate change is already affecting our lives and our communities in tangible ways. As WRA and Environmental Defense Fund discussed in our 2010 report, *Protecting the Lifeline of the West: How Climate and Clean Energy Policies Can Safeguard Water:*

> *Climate change is already impacting western water resources. Scientists have measured long-term downward trends of snowpack in western coastal states and shifts toward earlier spring runoff in mountainous river basins across the region. If climate change is not addressed, future changes will greatly exacerbate the West's water supply challenge. … In the Colorado River Basin, climate change issues could not be more pressing. … Today, water demands exceed supplies in the basin; any further reduction in available water will directly impact current users—farmers, cities, and industry.*[*]

Climate change in the American West is real. The Rocky Mountain Climate Organization and Natural Resources Defense Council's March 2008 report, *Hotter and Drier: The West's Changed Climate*, underscores the changes the West will face:[**]

- **The West is getting hotter.** The American West has experienced more frequent and severe heat waves, with the number of extremely hot days increasing by up to four days per decade since 1950.
- **The West is getting drier.** In the arid and semi-arid West, global warming is already having serious consequences for the region's scarce water supplies—less snowfall, earlier snow melt, more winter rain events, increased peak winter flows, and reduced summer flows have been documented.
- **Climate change is disrupting ecosystems.** The Intergovernmental Panel on Climate Change (IPCC)[†] concluded that forests across the West are suffering. as warming has extended the range of some damaging insects, such as bark beetles. The warming of the West is also disrupting the natural timing of seasons and leading to loss of wildlife.
- **Climate change is affecting wildlife.** The IPCC reports that 30% of animal and plant species could be at an increased risk of extinction if global warming continues unabated.[‡]
- **Warmer temperatures affect business, recreation, and tourism.** In the first few years of the 21st century, western farmers and ranchers have suffered significantly from the combination of above-normal heat and drought. Warming temperatures and other manifestations of a changing climate are already diminishing fishing and hunting opportunities in the West.

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* Western Resource Advocates and Environmental Defense Fund, *Protecting the Lifeline of the West: How Climate and Clean Energy Policies Can Safeguard Water*, 2010, pages i–ii, http://www.westernresourceadvocates.org/water/lifeline/lifeline.pdf.

** See generally Rocky Mountain Climate Organization and Natural Resources Defense Council, *Hotter and Drier: the West's Changed Climate*, March 2008, http://www.nrdc.org/globalwarming/west/west.pdf.

† Intergovernmental Panel on Climate Change, "Summary for Policymakers," in *Climate Change 2007: Fourth Assessment Report, Synthesis Report*, http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf, page 3.

‡ *Id.*

> A central foundation of any strong economy is diversity. Diversity is, likewise, a critical indicator of a healthy environment. Oil shale, if it were produced on a large scale, holds the potential to narrow existing economic and environmental diversity by focusing economies and land uses on a singular, dominant industry.

Part of the challenge facing western officials is how to balance competing land uses to ensure western economies remain diverse (and support diversification where needed) and, at the same time, how to ensure that landscapes support a range of terrestrial and aquatic species.

At stake: Environmental quality, including the quality of the social and natural environments, is a critical economic asset in oil shale country. Oil shale development overlaps with increasing tourism, agriculture, and recreational opportunities. Older workers and retirees are drawn to the West and bring with them investment, retirement, and other non-employment income. Younger people are, likewise, drawn to the area because of the quality of life they find here. The recovery of Colorado's West Slope from the oil shale and energy collapse of the early 1980s, for example, rests strongly on outdoor recreation opportunities, scenic beauty, open space, small towns, and an influx of retirees. As former Colorado Governor Bill Ritter, Jr. noted in 2007, "oil shale leasing on top of this existing network of energy development and changing land uses will put more pressure on an already fragile ecosystem and public temperament."[38]

At risk: Water demands for shale development may undermine local farms and ranches. Industrial development of the natural landscape can conflict with and displace the roots of local economies. As explained below, the socioeconomic trajectory of these areas is not one in which oil shale development is necessary to save the local economy. Quite the opposite may be true: A solid, diversified, and vital socioeconomic environment may be undermined by commercial oil shale development.

The challenge: There are simply too many unknowns about the economic and socioeconomic impacts of commercial development for industry and the federal government to adequately forecast the many impacts resulting from large-

38 Colorado Governor Bill Ritter, Jr., letter to members of the Task Force on Strategic Unconventional Fuels, September 2007.

scale development. Despite the BLM's attempt to address this information deficit through the federal R&D program, there are inextricable questions that need to be answered regarding how industrial-scale oil shale operations would impact the region and the nation before committing to opening federal lands for commercial leasing.

A bull elk in a mountain stream.

CONSIDER THE FOLLOWING POINTS:

1 Over the past 30 years, western economies have shifted from largely extractive industries to more diversified economies based on recreation, tourism, knowledge-based industries, and the professional and service sector. A 2004 study examining the impact of public lands on economic well-being in 11 western states found that only 3% of western counties could be classified as dependent on resource extraction.[39] A September 2008 report prepared for the Colorado Division of Wildlife concluded that the 2007 direct annual expenditures in Colorado from hunting and fishing alone were approximately $1.1 billion.[40] Secondary impacts of the dollars re-spent within the economy in 2007 are estimated to be $767 million, for a total economic impact of more than $1.8 billion. The same study found wildlife-watching yields an additional total economic impact of $1.2 billion annually.[41] Wildlife plays a similarly important role in Utah and Wyoming.

2 While there are great uncertainties about the potential impacts of commercial leasing on wildlife and wildlife habitat, some of what is known is stunning. In 2008, BLM identified at least 735,000 acres of mule deer winter habitat, 649,700 acres of elk winter habitat, and 501,503 acres of identified sage-grouse habitat as at risk from oil shale development.[42]

3 The BLM presumes that most oil shale projects would disturb 100% of the leased surface. As stated by the National Wildlife Federation in 2008, oil shale development would "completely eliminate the value of those lands as wildlife habitat. In the arid environs where oil shale and tar sands development is being proposed, reclamation to functional systems similar to that found pre-disturbance will take in excess of 50 years."[43]

4 Lands in Colorado, Utah, and Wyoming hold vast and important habitats that would be open for commercial development under the BLM's 2008 oil shale plan.

39 R. Rasker, B. Alexander, J. van den Noort, and R. Carter, *Public Lands Conservation and Economic Well-Being* (Tucson, AZ: The Sonoran Institute, 2004).

40 BBC Research & Consulting, *The Economic Impacts of Hunting, Fishing and Wildlife Watching in Colorado, Final Report*, revised September 18, 2008, report prepared for Colorado Division of Wildlife, page 1. Main report web page: http://wildlife.state.co.us/About/Reports/EconomicImpacts/; report-specific web page: http://wildlife.state.co.us/SiteCollectionDocuments/DOW/AboutDow/Revised2004DOWEconomicImpactReport.pdf.

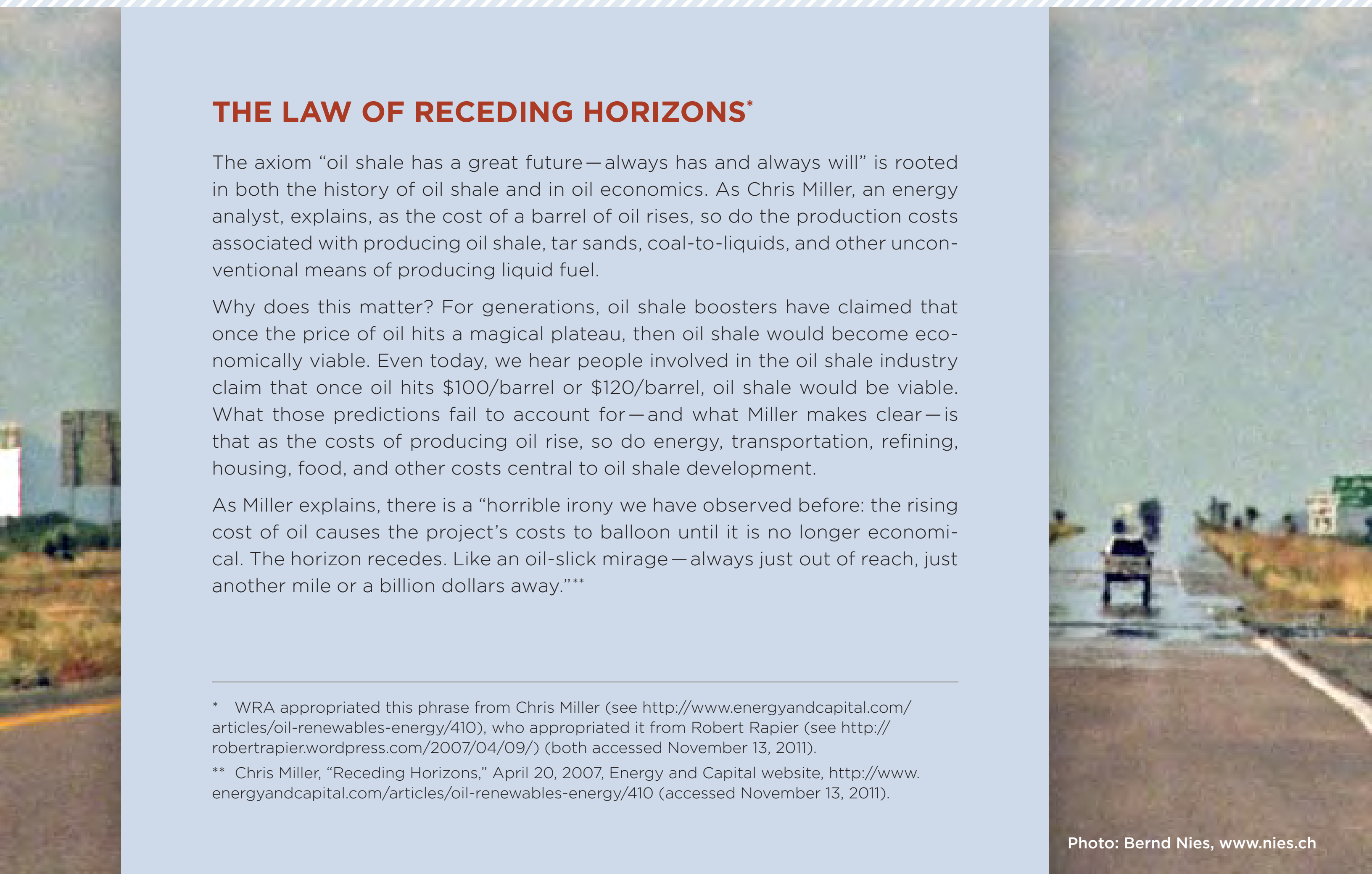
41 *Id.* at 2.

42 U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Final Programmatic Environmental Impact Statement (PEIS)*, September 2008, available at http://ostseis.anl.gov/eis/guide/index.cfm, Table 6.1.2-4, page 6-77.

43 National Wildlife Federation, March 20, 2008 comments, page 6 (citation in original quote omitted), on file with the BLM, about U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Draft Programmatic Environmental Impact Statement (DPEIS)*, December 2007.

"Most of the high value resources lie within in a very small area (roughly 30 by 35 miles) within Colorado's Piceance Basin and within a small portion of the nearby Uintah Basin within Utah. This means that oil shale leasing decisions made by the federal government may have a profound impact on the residents in the northwestern quarter of Colorado and the northeastern quarter of Utah. In particular, large-scale development of oil shale will cause federal lands to be diverted from their current uses. In the absence of environmental and economic mitigation measures, unprecedented in scope and scale, such development would almost certainly have adverse ecological impacts, and would likely be accompanied by socioeconomic impacts that could be particularly severe, especially in the northwest quarter of Colorado."

James T. Bartis, RAND Corporation, testimony presented before the House Energy and Commerce Committee, Subcommittee on Energy and Power, June 3, 2011, page 2.



THE LAW OF RECEDING HORIZONS*

The axiom "oil shale has a great future—always has and always will" is rooted in both the history of oil shale and in oil economics. As Chris Miller, an energy analyst, explains, as the cost of a barrel of oil rises, so do the production costs associated with producing oil shale, tar sands, coal-to-liquids, and other unconventional means of producing liquid fuel.

Why does this matter? For generations, oil shale boosters have claimed that once the price of oil hits a magical plateau, then oil shale would become economically viable. Even today, we hear people involved in the oil shale industry claim that once oil hits $100/barrel or $120/barrel, oil shale would be viable. What those predictions fail to account for—and what Miller makes clear—is that as the costs of producing oil rise, so do energy, transportation, refining, housing, food, and other costs central to oil shale development.

As Miller explains, there is a "horrible irony we have observed before: the rising cost of oil causes the project's costs to balloon until it is no longer economical. The horizon recedes. Like an oil-slick mirage—always just out of reach, just another mile or a billion dollars away."**

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* WRA appropriated this phrase from Chris Miller (see http://www.energyandcapital.com/articles/oil-renewables-energy/410), who appropriated it from Robert Rapier (see http://robertrapier.wordpress.com/2007/04/09/) (both accessed November 13, 2011).

** Chris Miller, "Receding Horizons," April 20, 2007, Energy and Capital website, http://www.energyandcapital.com/articles/oil-renewables-energy/410 (accessed November 13, 2011).

Photo: Bernd Nies, www.nies.ch

IN OCTOBER 2010...

the Government Accountability Office concluded, "Oil shale development can bring a sizeable influx of workers, who along with their families, put additional stress on local infrastructure such as roads, housing, municipal water systems, and schools. ... Furthermore, traditional rural uses could be replaced by the industrial development of the landscape, and tourism that relies on natural resources, such as hunting, fishing, and wildlife viewing, could be negatively impacted."*

* U.S. Government Accountability Office, *Energy-Water Nexus: A Better and Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development*, October 2010, GAO-11-35, http://www.gao.gov/assets/320/311896.pdf, pages 7–8.

Those lands include Adobe Town in Wyoming, one of the Red Desert's most iconic landscapes; Colorado state wildlife areas that are downstream of proposed oil shale development lands; and areas proposed for wilderness designation in Utah.[44] These areas are not simply important for their environmental values; they are also important for their economic value.

5 The Uintah Basin in Utah and areas around Rifle, Colorado, are suffering from extremely poor air quality from ongoing oil and gas development. So too is Pinedale, Wyoming, and parts of Wyoming's Red Desert. Oil shale development would likely further degrade air quality.

6 A 2008 report prepared for the Associated Governments of Northwest Colorado concluded that concurrent oil/gas and large-scale oil shale development would cause existing towns to reach capacity, resulting in new towns needing to be built. Moreover, after accounting for payments made to the cities and counties, growth-related capital costs could exceed energy revenues by $1.3 billion.[45]

It is imperative that the relationship between protected public lands in the area and the local economy be given a thorough, comprehensive examination across the three-state region. As rural communities continue to diversify their economies, the framework for making public land management decisions must also continue to evolve. When evaluating alternatives, management plans for public lands need to account for all aspects of the economic and social systems of these communities, including investment and retirement income, recreation, tourism, and entrepreneurial businesses attracted to scenic locations. Management plans must also consider the increasing importance of industries and economic sectors that rely on these public lands, and not only on the extraction of natural resources. As the population of the entire country grows, the presence of undeveloped lands becomes increasingly important. These lands strengthen western rural economies by meeting growing needs for clean air and water, wildlife habitat, and recreation opportunities.

44 See U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Final Programmatic Environmental Impact Statement (PEIS)*, September 2008, available at http://ostseis.anl.gov/eis/guide/index.cfm, pages 4-144 to 4-145.

45 *Northwest Colorado Socioeconomic Analysis and Forecasts, Final Report*, April 2008, report prepared by BBC Research & Consulting for Associated Governments of Northwest Colorado, http://agnc.org/reports/08-socioecomic/agnc_final_mail_report_4-07-08.pdf.

ENDANGERED FISH IN THE COLORADO RIVER BASIN

Beginning in the 1970s, the U.S. Fish and Wildlife Service (USFWS) began reviewing proposed federal actions related to additional water development in the upper Colorado River Basin under the Endangered Species Act. At issue was the continued survival of four species of fish found only in this basin—the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker. USFWS had determined that additional depletions of the basin's water would jeopardize the continued existence of these fish. Concern for survival of these species continues today, and any new water development—whether for oil shale or otherwise—must satisfy substantial program requirements intended to protect and recover these species.

If these endangered native fish are ever to be restored in the Colorado River Basin, it will be in its upper reaches, where habitat still remains. In Utah, that area includes stream segments between Flaming Gorge Reservoir and well upstream of Glen Canyon Dam. Oil shale development, were it to occur at a commercially viable scale in the Utah, could seriously undermine the past successes and future potential of recovery efforts. It could also put Utah at risk for lawsuits challenging the state's management of these endangered species' habitat.

As Dan Luecke, a leading environmental scientist and water resources expert, explains:

> *The Upper Colorado River Endangered Fish Recovery Implementation Program (RIP) established as its central feature the working assumption that the native fish could be recovered while, at the same time, the states of Colorado, Utah, and Wyoming developed water to which they were entitled under the Colorado River Compact and the Upper Colorado River Compact. The parties to the agreement structured it in such a way as to accommodate both environmental and water development concerns. This accommodation provides ESA [Endangered Species Act] coverage for water depletions in exchange for support of water and habitat related improvement activities designed to restore the native fish populations to self-sustaining levels.*[*]

Accordingly, the recovery program would likely limit water development to ensure recovery of the species.

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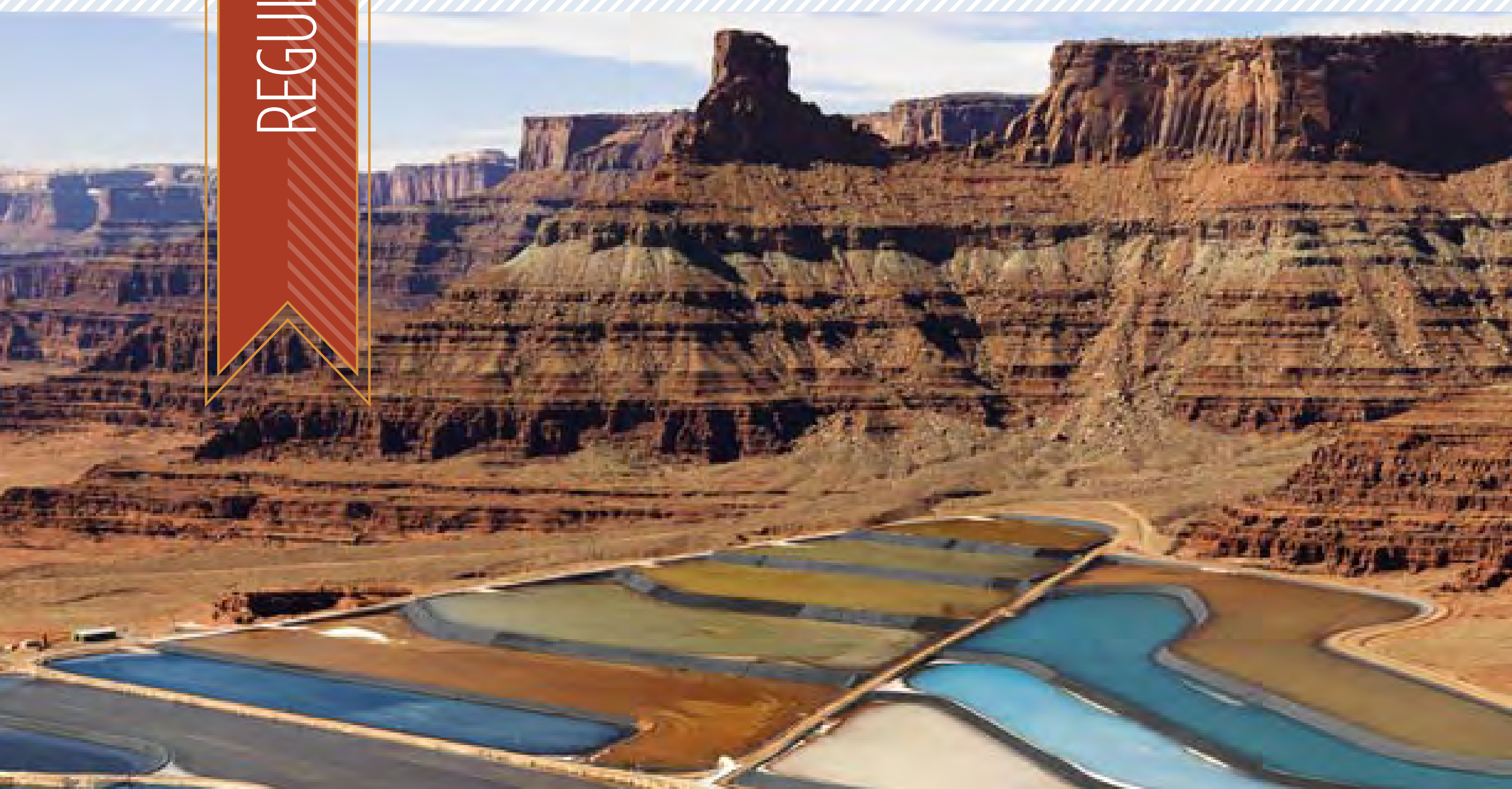
* Dan Luecke, April 21, 2008 comments, pages 1–2, on file with the BLM, about U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Draft Programmatic Environmental Impact Statement (DPEIS)*, December 2007.

In response to concerns WRA and others have raised about the prospects of oil shale development harming public health and the environment, industry is quick to point out that commercial development would need to comply with all applicable regulations. WRA agrees with that view, but industry's position presumes that the applicable regulatory framework is both comprehensive and adequately tailored to address the environmental, social, and economic impacts of both aboveground and in-situ development. The regulatory framework thus far fails to meet this basic threshold.

WRA knows from our legal review of applicable federal and state regulations that the regulatory framework guiding potential commercial development varies between states and is full of gaps. This patchwork approach, and the many uncertainties about the technologies, raises important questions regarding whether existing environmental and safety regulations would be sufficient to protect communities and ecosystems from commercial development.

Aerial detail of tailing ponds for mineral waste in rural Utah.



WHY REGULATIONS MATTER

Fundamentally, regulatory agencies cannot protect public health and the environment if they do not know what technologies they are regulating, as well as the health and environmental impacts of that technology. With research progressing, it is important that regulations be structured to account for oil-shale-specific technologies.

Moreover, as the EPA explained in a May 2011 letter to the BLM, the cumulative impacts of energy extraction in these areas have the potential to further impact public health and the environment in a region that is, at the moment, suffering the significant ill effects of energy development.[46] This view aligns with the BLM's conclusion in 2008 that large-scale oil shale development would require significant amounts of energy, disturb hundreds of thousands of acres of land, require storage and disposal of hazardous constituents, increase particulate in the air, and decrease water quality. We also have subsequently learned that oil shale would increase greenhouse gas emissions. Each of these elements means adverse consequences to health and the environment.

The BLM concluded in 2008 that large-scale oil shale development would require significant amounts of energy, disturb hundreds of thousands of acres of land, require storage and disposal of hazardous constituents, increase particulate in the air, and decrease water quality.

In 2005, the RAND Corporation noted that potential oil shale development raises a number of critical policy issues,[47] many of which overlap with a comprehensive regulatory structure. Some issues include:

- **Land use and ecological impacts** stemming from extensive surface-disrupting activities
- **Air quality impacts** over a broad region
- **Greenhouse gas emissions** that would be significantly higher than those from conventional crude oil
- **Water quality impacts** from leaching of salts and toxins from spent shale
- **Socioeconomic impacts** due to significant and rapid population growth

The RAND Corporation's list of potential impacts of oil shale development.

In 2008, the U.S. Environmental Protection Agency (EPA) concluded that "oil shale and tar sands development processes may have significant, adverse

46 U.S. Environmental Protection Agency, May 16, 2011 comments, pages 2–3, on file with the BLM, about U.S. Department of the Interior, Bureau of Land Management, "Notice of Intent To Prepare a Programmatic Environmental Impact Statement (EIS) and Possible Land Use Plan Amendments for Allocation of Oil Shale and Tar Sands Resources on Lands Administered by the Bureau of Land Management in Colorado, Utah, and Wyoming," in *Federal Register* 76, no. 72 (April 14, 2011): 21003–21005, http://ostseis.anl.gov/documents/docs/ostseisnoi04142011.pdf.

47 See James T. Bartis et al., *Oil Shale Development in the United States: Prospects and Policy Issues*, 2005, report prepared by the RAND Corporation for the U.S. National Energy Technology Laboratory, page x.

impacts to air quality, in particular by increasing levels of ozone and nitrogen deposition and by impairing visibility on a regional level."[48] Rural Utah is not starting with a clean slate. Utah's Uintah Basin is suffering from extremely poor air quality from ongoing oil and gas development. Monitors in the Uintah Basin have shown that concentrations of both ozone and $PM_{2.5}$, a fine particulate matter that can lodge deeply in the lungs,[49] are above the current air quality standards. In winter 2010–2011, ozone levels in Uintah County, Utah, reached nearly twice the federal health standard.

What does this data suggest? Even without oil shale development, Utah is struggling to achieve compliance with health-based air quality regulations. Colorado could face similar problems.

Protecting water quality is, likewise, critically important. Aboveground retorting and in-situ development would disturb huge swaths of land and, as EPA recognizes, have significant adverse impacts on surface water and groundwater quality. Adequate regulation of point-source and non-point-source discharges from oil shale waste — a problem particular to mining and aboveground retorting activities — is essential to protecting surface water and groundwater quality. However, the EPA and state of Utah regulate water quality impacts from oil shale under oil and gas regulations, which would exempt some mining activities from certain provisions under the Clean Water Act and fail to regulate other activities adequately. Oil and gas does not provide a good model for oil shale, as the technology, possible sources of contamination, and surface disturbance implicated by the two types of development are not at all similar. What is instead needed is a regulatory framework structured to oil shale.

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Finally, both in-situ and aboveground retorting would have significant ground-disturbing activity. The BLM projects that regardless of the technology developed, "the entire lease area will be disturbed."[50] Development would, among other impacts, eliminate all wildlife habitat. The regulatory framework must account for such impacts.

48 U.S. Environmental Protection Agency, April 17, 2008 comments, page 2, on file with the BLM, about U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Draft Programmatic Environmental Impact Statement (DPEIS)*, December 2007.

49 According to the EPA, "particulate matter (PM) is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. Some particles are large or dark enough to be seen as soot or smoke. Others are so small that individually they can only be detected with an electron microscope. Many manmade and natural sources emit PM directly or emit other pollutants that react in the atmosphere to form PM. These solid and liquid particles come in a wide range of sizes. Particles less than 10 micrometers in diameter (PM10) pose a health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter (PM2.5) are referred to as "fine" particles and are believed to pose the greatest health risks. Because of their small size (approximately 1/30th the average width of a human hair), fine particles can lodge deeply into the lungs." Source: U.S. Environmental Protection Agency, "Fine Particle (PM2.5) Designations: Frequent Questions," http://www.epa.gov/pmdesignations/faq.htm (accessed November 13, 2011).

50 U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Final Programmatic Environmental Impact Statement (PEIS)*, September 2008, available at http://ostseis.anl.gov/eis/guide/index.cfm, Tables 4.1.1-1, 4.1.2-1, and 4.1.3-1, and footnote C.

WHAT ABOUT THE MONEY?

Another key regulatory issue concerns royalties — payments companies make in return for extracting and selling public resources. For development of federal lands, royalties are set by the BLM. The debate over oil shale royalties pits those who claim that a low royalty is necessary to encourage development against those concerned about a fair return to the taxpayer (as required by law) and revenues to cover infrastructure needs.

As Tom Kenyon, mayor of Grand Junction, Colorado, and Keith Lambert, Rifle, Colorado councilor, stated in an August 21, 2011, editorial in the *Grand Junction Daily Sentinel*, "Royalties are split between federal and state entities with 49 percent returning to states and local communities to help deal with the impacts associated with extraction. Cutting the royalty rate by more than half, as rules set in place by the previous administration provide, effectively removes millions of dollars intended to help our communities provide the increased services and infrastructure necessary to accommodate the industry."[51] Massive commercial oil shale development could add thousands of residents to small towns that would require significant infrastructure upgrades. With many state and municipal budgets already at historic lows, inadequate royalty payments could cripple local governments.

51 Tom Kenyon and Keith Lambert, "Oil Shale Hearing Should Look at Impacts on Affected Communities," *Grand Junction Daily Sentinel*, August 21, 2011, http://www.gjsentinel.com/opinion/articles/oil_shale_hearing_should_look (accessed November 13, 2011).

WATER QUALITY

The quality of both surface water and groundwater is a critical concern. As the GAO noted in its October 2010 oil shale report, "oil shale development could have significant impacts on the quality and quantity of water resources." When these resources are mined and retorted, some of that water is "produced" and can be released into adjacent watercourses. The produced water may be filled with chemicals and organic materials that can significantly degrade water quality in the region. Mining operations, such as those proposed for Utah, would leave large piles of spent shale, which could leach remaining hydrocarbons, salts, trace metals, or other minerals into surface water and groundwater supplies. As the BLM recognizes, salinity in the Colorado River Basin is a huge issue.* Additionally, cleaning processed water is already looming as an expensive issue, even without oil shale development.

In-situ oil shale development could pose its own problems. Shell Oil, one of the companies holding a federal oil shale research lease, is working to develop a freeze wall to protect groundwater. Whether this technology is viable, not to mention protective of groundwater at a commercial scale, remains unclear. Others, such as Chevron and AMSO, are looking to develop shale below the groundwater zone. What is unknown, among other things, is whether these fracking and down-hole heating technologies would create fissures that would create pathways for contaminants. If so, groundwater could be adversely affected.

* U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Final Programmatic Environmental Impact Statement (PEIS)*, September 2008, available at http://ostseis.anl.gov/eis/guide/index.cfm, page 3-63.

In 2008, Club 20, an organization representing the 22 western counties in Colorado and a strong supporter of large-scale oil shale development, noted, "with the increasing natural gas development activity in northwestern Colorado, we are already experiencing (a) housing shortages, (b) dramatic increases in retail and housing prices, (c) overwhelming demands on the community's social and physical infrastructure (schools, police and fire services, social services, water and sewer), and (d) a lack of available workforce to sustain each community's traditional Main Street economy."[52] These are all issues that will only get worse if large-scale oil shale development takes place.

In late 2008, the BLM adopted commercial oil shale leasing regulations. The royalty was set at 5% for the first five years before increasing 1% per year until it reached 12.5%. Compare those rates to domestic oil production royalties, which are generally set between 12.5% to 18.8%. WRA and 12 other conservation organizations sued to block implementation of the oil shale regulations, arguing that these rates did not ensure a fair return to the taxpayer and thus violated the law. In February 2011, the BLM agreed to review the regulations. A decision is due in late 2012.

52 Club 20, March 20, 2008 comments, pages 4–5, on file with the BLM, about U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Draft Programmatic Environmental Impact Statement (DPEIS)*, December 2007.

Oil shale research in Colorado.
Photo courtesy of The Story Group.

6

TAR SANDS Oil Shale's Water-Intensive, High-Carbon, Air-Fouling, Strip-Mining Cousin

As unconventional fuel sources, oil shale and tar sands are linked at the hip. The 2005 Energy Policy Act declared that oil shale and tar sands are "strategically important domestic resources that should be developed to reduce the growing dependence of the United States on politically and economically unstable sources of foreign oil imports."

Despite this view and corresponding mandate that DOI should develop these deposits "in an environmentally sound manner, using practices that minimize impacts," both would be difficult to develop commercially, as both would carry large water and energy demands, and would require significant mining activity. **Like oil shale, tar sands would exacerbate climate impacts.** With that nexus, it is important to discuss tar sands within the context of this report.

Tar sands in the United States are found in eastern Utah, in the red rock desert that defines the arid landscape. The USGS estimates known reserves at 11 billion barrels of oil.[53] Most of Utah's tar sands are concentrated in four deposits: the Asphalt Ridge, P.R. Spring, Sunnyside, and Tar Sands Triangle regions.

For years, companies mined this tarry material to use as road base, since it contains high concentrations of bitumen. Now, with the Canadian tar sands industry in Alberta as a lure, companies are attempting to mine Utah's tar sands with the goal of cooking them into oil. Some tar sands development began in Utah in the late 1960s, and in 1981, the U.S. Congress formally established 11 Special Tar Sands Areas to encompass Utah's most promising tar sands deposits, covering approximately 656,000 acres of BLM-managed land. To spur development of these deposits for transportation fuels, in 2008 the BLM designated 431,224 acres of public land in Utah open for application for commercial development. Additional state and private lands are also available for development.

53 Task Force on Strategic Unconventional Fuels, *America's Strategic Unconventional Fuels, Volume III – Resource and Technology Profiles*, September 2007, page III-54, http://www.unconventionalfuels.org/publications/reports/Volume_III_ResourceTechProfiles(Final).pdf.

Tar sands development in Alberta.
Photo: Chris Evans, The Pembina Institute

Tar sands development in Utah risks contaminating surface water and groundwater.

Tar sands development in Alberta.
Photo: C. Campbell, The Pembina Institute

TURNING ASPHALT INTO FUEL

Tar sands, also known as "oil sands," are deposits of not-quite-oil, a mixture of sand, clay, and bitumen that can be extracted and processed using either vast strip mining operations or in-situ underground heating techniques. Like oil shale, tar sands development would require substantial energy, use multiple barrels of water to produce a single barrel of oil, and generate monumental problems with toxic waste, air pollution, groundwater contamination, and large-scale surface disruption.

The challenge facing tar sands development is how to turn material for roads and parking lots into a liquid fuel. As the BLM discussed in 2008, commercial development would occur on lands currently being used for a range of uses — recreation, hunting, mining, oil and gas production, and livestock grazing, among others. The BLM concluded that "development activities could have a direct effect on these uses, displacing them from areas being developed to process tar sands."[54] Uses of neighboring lands would, likewise, change to support and accommodate commercial development. According to the BLM, existing agricultural and open space lands would be developed to provide services and housing for employees moving to the area. The changes that have begun as a result of oil and gas development would continue should tar sands (and oil shale) be commercially developed.

More specifically, tar sands development in Utah — both in-situ and retort processing — risks contaminating surface water and groundwater. For in-situ tar sands extraction, the process of injecting high-pressure steam or a combination of high-pressure steam and chemicals into relatively porous tar sands layers poses significant challenges for neighboring groundwater resources. Because the steam increases the viscosity of the bitumen, residual steam under intense pressure would likely mobilize organic compounds from the tar sands deposits and contaminate neighboring groundwater aquifers with residual petrochemicals and salts.

This tendency to contaminate groundwater resources beyond the bounds of the tar sands deposits is especially problematic when chemical-laced steam is used, because the chemicals are designed to bond to residual petrochemicals at the molecular level. Surface water quality is also projected to degrade due to increased sediment load, while surface disturbance might also alter natural drainages.

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54 U.S. Department of the Interior, Bureau of Land Management, *Oil Shale and Tar Sands Final Programmatic Environmental Impact Statement (PEIS)*, September 2008, available at http://ostseis.anl.gov/eis/guide/index.cfm), page 5-12.

7 CONCLUSION

The debate over oil shale is not just a discussion about a potential source of energy; it is a debate over the future of western communities, and how we use our water and protect our air. As states take steps to balance competing resource needs, they must understand that pursuing oil shale would diminish water supplies and pollute the air we breathe — damaging at least two essential resources to extract a questionable one. Because of fossil fuel development, certain rural areas of Colorado, Utah, and Wyoming have worse air quality than Los Angeles.

The projected impacts to our climate are, likewise, extremely troubling and must be at the forefront of the debate. Oil shale is projected to produce roughly 25% to 75% more greenhouse gases than comparable quantities of conventional crude oil. If nothing else, oil shale development must be evaluated within the context of impacts on the global climate.

To address these and other issues, agencies at the federal, state, and local level must develop and implement a comprehensive regulatory structure. WRA knows from our legal review of applicable federal and state regulations that the regulatory framework guiding potential commercial development varies between states and is full of gaps. This patchwork approach, and the many uncertainties about the technologies, raises important questions regarding whether existing environmental and safety regulations would be sufficient to protect communities and ecosystems from commercial development.

Because of fossil fuel development, certain rural areas of Colorado, Utah, and Wyoming have worse air quality than Los Angeles.

Without commercially viable technologies, evaluating and quantifying the suite of environmental and economic impacts remains challenging. Nevertheless, as discussed in this report, and as supported by the BLM, GAO, and RAND Corporation's analyses, when all of the available information on oil shale is considered, it is hard not to conclude that the costs of pursuing development far outweigh the benefits. With the known and expected impacts, and with anticipated increases in efficiency, conservation measures, and emerging technologies, it would still be difficult to argue that pursuing oil shale development would be in our country's long-term best interest.

FUELING OUR FUTURE

Accelerating the transition of power production from conventional, environmentally damaging fossil fuel technologies to clean energy technologies is one of the best economic and environmental decisions we can make as a country. By 2020, WRA supports decreasing greenhouse gas emissions from the region's power sector to 20% below 2005 levels while starting down a path to achieve 80% reduction in carbon emissions by 2050.

Clean energy is not simply an economic and environmental issue. It is also a national security issue. The U.S. Navy, for one, is investing in clean energy sources, including development of biofuels to power jets. Reducing our dependence on oil is central to this effort.

While the Navy looks to the future, companies like United Airlines, Boeing, Virgin Atlantic, and United Parcel Service are also looking to speed the transition to clean, and in many cases, emerging fuel technologies. States like California and Oregon have passed renewable fuel standards, which are driving production and R&D for new biofuels, such as those made from algae and switchgrass.

While clean energy gains to date are significant, much more dramatic investments in clean energy technologies will be needed. Instead of pouring more money into oil shale and turning over vast natural resources to this questionable effort, Congress and the states should support and prioritize investment in clean and sustainable energy sources with a proven track record of success, while exploring new sources that have a far lower environmental impact than oil shale. That's what is needed to meet our water, climate, and other goals for 2050. Continuing to divert resources into unproven and unhealthy new fossil fuels is not only a bad investment, it's also poor public policy.

American ingenuity has been harnessed many times in the past. It is time again to invest in clean technologies and to finally put oil shale in our rear-view mirror.


Autumn along a bend of the Colorado River.

WESTERN RESOURCE
ADVOCATES

Western Resource Advocates is a nonprofit conservation organization dedicated to protecting the West's land, air, and water.