

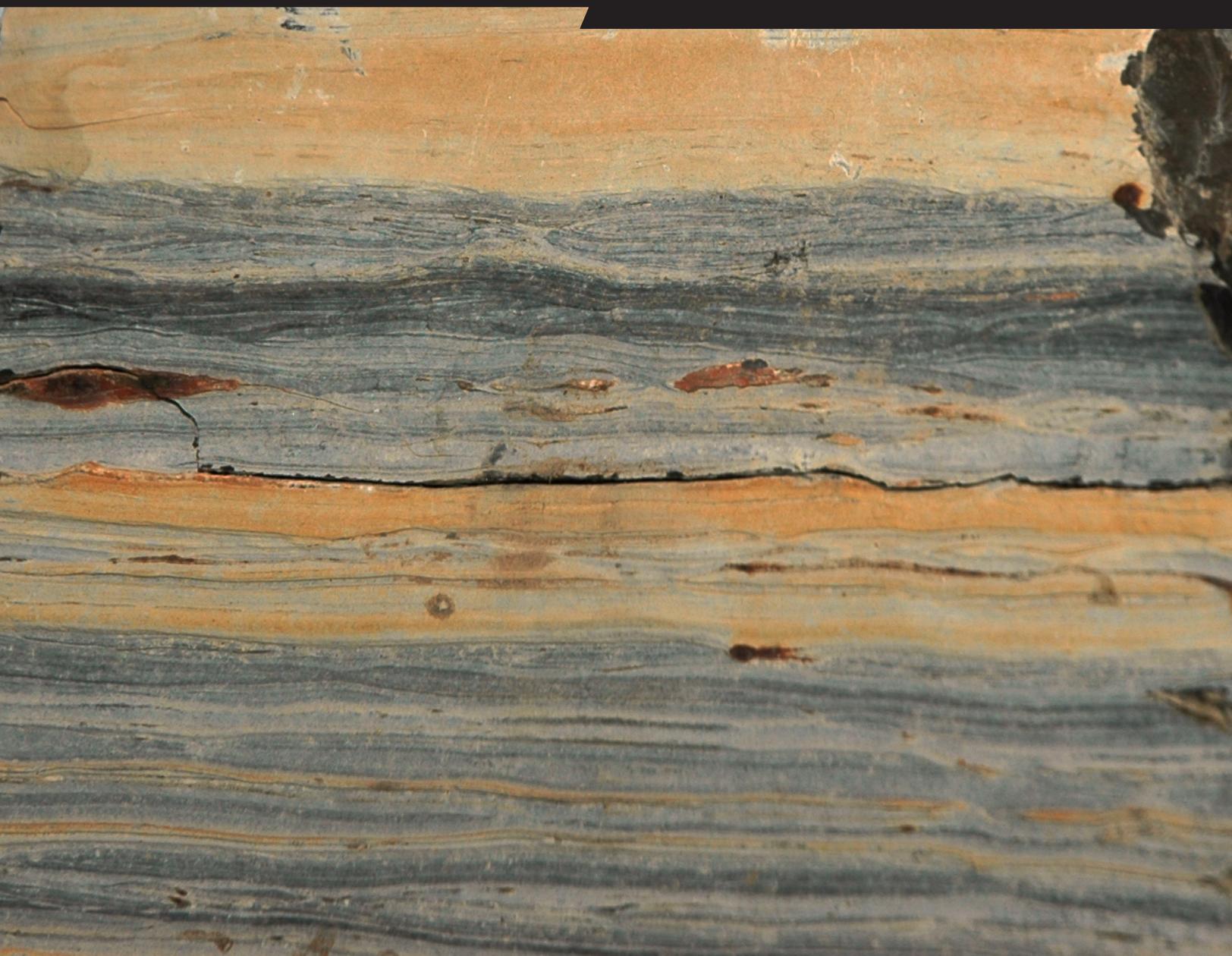
REPORT FROM THE CENTER #10

# WHAT EVERY WESTERNER SHOULD KNOW ABOUT OIL SHALE: A GUIDE TO SHALE COUNTRY

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# TABLE OF CONTENTS

<b>ABOUT THIS GUIDE</b>	<b>1</b>
Why You Should Know About Oil Shale	1
About This Guide	1
About the Authors	2
<b>WELCOME TO SHALE COUNTRY</b>	<b>3</b>
What is Oil Shale?	3
How Many Rocks Fit in a Barrel?	3
The Answer to the Energy Crisis?	4
<b>A BRIEF HISTORY OF OIL SHALE</b>	<b>6</b>
Early History	6
The First Boom	6
Mineral Leasing Act	8
The First Bust	9
Waiting for the Next Boom	9
<b>ENGINEERING A BOOM</b>	<b>11</b>
Shale Country Real Estate	11
Private Lands in Shale Country	12
Shale for Sale	12
The “Boom” Goes Boink?	13
How to Make a Mining Boom	13
The Second Boom Arrives	14
Black Sunday	16
<b>WE’LL GET IT RIGHT NEXT TIME</b>	<b>18</b>
The 2005 Energy Policy Act	18
RD&D Leases	18
Commercial Leasing	21
Show Me the Money	22
<b>MANAGING &amp; MITIGATING THE NEXT BOOM</b>	<b>24</b>
Why the Time Might Be	24
Right for Oil Shale	24
Environmental Impacts	25
People	26
Land & Ecology	30
Water	35
Air	39
<b>WHAT’S NEXT IN SHALE COUNTRY?</b>	<b>43</b>
<b>ACKNOWLEDGMENTS</b>	<b>47</b>
<b>RECOMMENDED READINGS</b>	<b>49</b>
<b>ENDNOTES</b>	<b>50</b>



# ABOUT THIS GUIDE

## Why You Should Know About Oil Shale

On the Western Slope of the Rocky Mountains, teams of scientists and engineers are working on a feat of modern day alchemy: turning rocks into oil. The object of their attention is oil shale, a rock so rich in an oil-like substance that certain pieces will ignite when held up to a flame.

No place in the world has more oil shale – an amount large enough to dwarf the proven oil reserves of Saudi Arabia – than the American West’s Shale Country, the region that straddles the T-shaped border of Colorado, Utah, and Wyoming. And although daunting technical, economic, environmental, and political challenges must be dealt with before it will be a viable resource, the potential benefits attached to tapping such an immense domestic energy supply are hard to ignore. The allure of freeing the oil in these rocks has convinced some of the world’s largest energy companies (and dozens of their smaller counterparts) to place big bets on the future of oil shale.

The prospect of extracting oil from the rocks of Shale Country raises many questions, both practical and philosophical:



The Piceance Creek flows through ranchlands, past oil and gas operations, and over the richest oil shale deposits in the world on its way to join the Colorado River. Credit: Jason L. Hanson (2007)

- What can we learn from past experiences with oil shale and other Western resource booms, and what lessons can guide us as we move into the future?
- Who are the stakeholders that will be affected by oil shale development? What are their rights, and what responsibilities do they have to one another?
- Can the inherent value of a preserved environment be quantified or successfully balanced against the benefits of energy development?
- What does the concept of sustainability mean in the context of oil shale development?

Our ability to discuss these questions as a society, and the answers we ultimately arrive at, will reverberate beyond Shale Country and through the larger debate about our nation’s energy policy in the 21st century.

## About This Guide

This online guidebook to Shale Country aims to be an accessible, informative, and evenhanded overview of the compelling and often contentious issues surrounding oil shale. We will update it regularly with new developments in Shale Country to ensure that it stays current as Americans debate the wisdom of pursuing oil shale development as part of a long-term strategy for our nation’s energy security.

We believe that history can provide crucial perspective on the dilemmas that face us in the present, reducing the agitation of the moment and turning down the heat on conflicts. As the public discussion grows in agitation and heat, the prospect of oil shale development in the 21st century offers a prime opportunity to test this belief. Therefore, we begin our guide with a look at the history of oil shale, from the earliest recorded discoveries of the rock that burns to the tumultuous boom and bust

cycle that rocked the Western Slope in the late 1970s and early '80s.

We further believe that we can harness the lessons of this look backward in the service of foresight. In the second part of this guide, after surveying some of the current research and development being conducted on federal leases and private property in Shale Country, we explore ways in which contemporary stakeholders can anticipate and more effectively manage the socioeconomic and environmental challenges posed by the prospect of oil shale development.

We hope this guide will serve as a basis for a broader discussion about our nation's energy policy and the impact it has on our lives and landscapes. Our goal has been to present the ideas and information that should be on the minds of responsible citizens as they consider the possibilities and potential pitfalls of oil shale development in the 21st century. This online guidebook is a place where we hope you will find the opportunity to consider respectfully the positions taken by people on all sides of the issue; to think with depth, breadth, and recognition of complexity about an issue of great importance to the West; and to participate in a deeper, more responsible, more productive form of decisionmaking about it.

## About the Authors



**Patty Limerick** is the Faculty Director and Chair of the Board of the Center of the American West at the University of Colorado-Boulder, where she is also a Professor of History. Limerick has dedicated her career to

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# WELCOME TO SHALE COUNTRY

## What is Oil Shale?

### The Rock That Burns

On the Western Slope of Colorado's Rocky Mountains, local lore tells of an early settler named Mike Callahan who built his home in the shadow of the Book Cliffs along Parachute Creek in 1882. He cut and assembled sturdy local pines into a log cabin. To heat his new home, he built a fireplace and chimney out of the abundant and easily-quarried rocks he found on nearby hills. When his work was complete, he threw a housewarming party that turned into a tragically bad pun (some might say metaphor) when the fire he lit in the hearth quickly spread up through the mahogany-colored chimney rocks and set the entire house ablaze.<sup>1</sup>

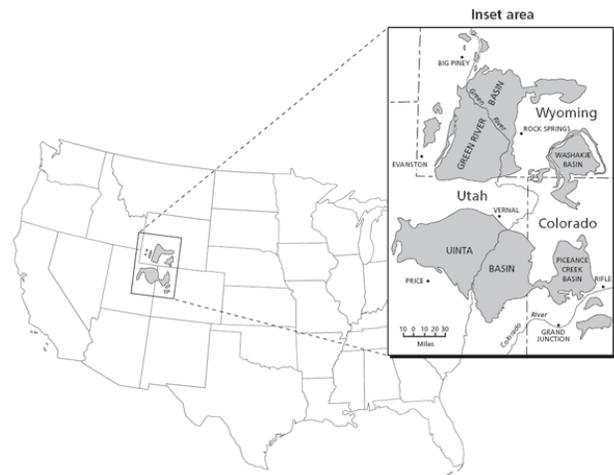
Although nobody told Mr. Callahan until it was too late, the dark-hued shale rocks found in pockets along the Western Slope boast a high concentration of petroleum-like kerogens that will ignite when exposed to enough heat. While oil shale, a convenient umbrella term for a variety of fine-grained and organic-laden sedimentary rocks, formed in prehistoric lakebeds in a process similar to oil, it has not (yet) been subject to enough heat and pressure to be transformed into a liquid state.

Given a few million more years, the kerogens trapped in the Western Slope shale may become liquid oil. But an influential combination of energy companies and politicians – all responding to the energy demands of American citizens, we should remember – would prefer not to wait for nature to take its course. They are inclined to speed up the process with the application of human ingenuity.

## How Many Rocks Fit in a Barrel?

The most bountiful oil shale beds in the world lie in basins within the Green River Formation along the T-shaped border of Colorado, Wyoming, and Utah. The richest known deposits are located in Colorado's Piceance Basin, an area of more than

Location of the Green River Formation Oil Shale and Its Main Basins



SOURCE: Adapted from Smith, 1980.  
RAND MG414-2.1

The richest oil shale beds in the world are found in the basins of the Green River Formation along the T-shaped border between Colorado, Utah, and Wyoming. Credit: US Bureau of Land Management

1300 square miles just north of the city of Grand Junction and centered in Garfield and Rio Blanco Counties. (Say it right: The Piceance Basin, the site of all this excitement, is pronounced “PEE-ants” or “PEE-awnts” Basin, possibly as a derivation of a Ute Indian word for tall grass.)

rich oil shale beds

The vast majority of these deposits, and 72% of all oil shale resources within the entire Green River Formation, lie beneath public land controlled by federal agencies such as the Bureau of Land Management and the US Forest Service. Estimates of the oil contained in the tristate Shale Country area range from 1.2 to 1.8 trillion barrels, with between 500 billion and 1 trillion located in the Piceance Basin alone. (One barrel equals 42 gallons of oil.) The United States consumes about 20.6 million barrels of oil total every day, of which roughly 75% is imported. Although not all of the oil in Shale Country will be recoverable, judicious estimates suggest that 800 billion barrels – more than triple Saudi Arabia's proven reserves, enough to meet current US demand for over a century – might ultimately be extracted.<sup>2</sup>

This 800-billion-barrel figure was put forward as a reasonable estimate by Jame Bartis, a widely recognized expert on the subject, in an influential report he wrote for the Rand Corporation in 2005. As with all estimates of oil reserves, and especially with those as tricky as oil shale, not everyone agrees. Some more recent estimates suggest that the amount of recoverable oil is upwards of a trillion barrels, and that the total resource represents 5 or even 8 times more than Saudi Arabia's reserves. But the scope of the resource is, beyond question, already so large that a 200-billion-barrel bump makes little difference for broad social, economic, and environmental considerations addressed in this report.<sup>3</sup>

The potential geopolitical and economic ramifications of such an immense resource for our nation and for the global community stagger the mind. With such a large prize waiting beneath the western flanks of the Rockies, oil shale promises to remain part of the nation's thinking about energy sources into the foreseeable future.

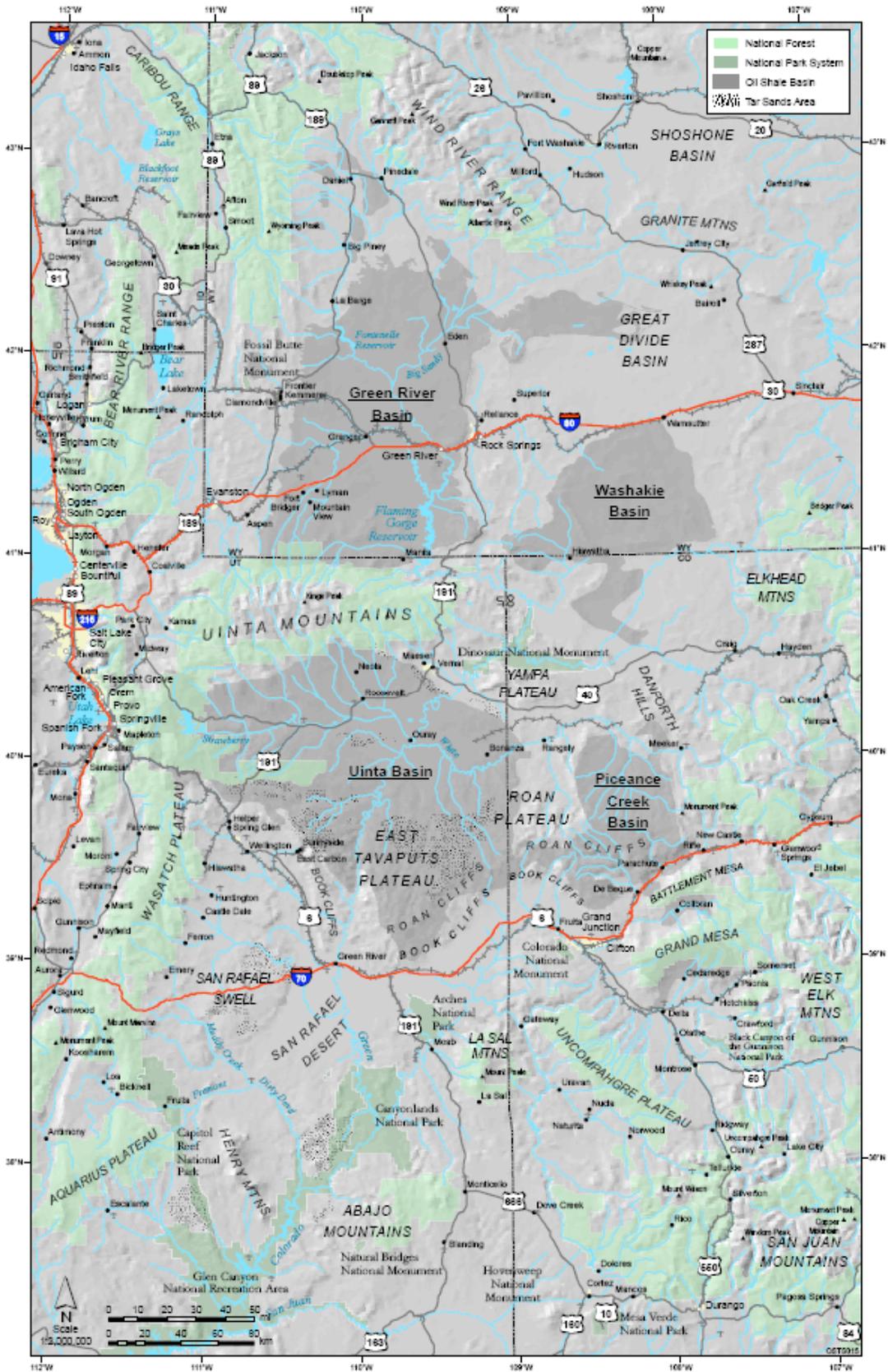
### **The Answer to the Energy Crisis?**

As the international oil markets continue to fluctuate precipitously, surging to historic highs before plummeting to prices that haven't been seen in nearly a decade, frazzled consumers and their elected representatives have begun to view energy sources found close to home as a more reliable alternative to foreign suppliers. Interest in domestic unconventional fuels like oil shale has surged accordingly. The prospect of wringing billions of barrels of oil from these rocks is becoming a hot topic around the halls of government and the boardrooms of energy companies, not to mention the town halls of communities near the shale deposits and the meeting rooms of environmental organizations.

Fossil fuel resources like oil shale are considered unconventional in the sense that they are more difficult and more expensive to recover or produce than the free-flowing light crude oil that has been the industrialized world's main energy source for the past century. Therefore they have remained largely untapped. Among the United States' strategic unconventional fuel portfolio, oil shale is noteworthy because of the extraordinary size of the resource. The rich shale deposits on the Western Slope of the Rocky Mountains may contain the equivalent of 3 to 8 times more oil than all of Saudi Arabia's proven reserves. Boosters promote these tremendous domestic oil shale reserves as a key part of the solution to the twin problems of declining worldwide crude oil production and increasing US dependence on foreign energy suppliers.

This is not the first time that the Western Slope's oil shale fields have been promoted as an ace in the hole for national energy security. Twice in the twentieth century, the federal government encouraged mineral rushes intended to develop oil shale into a major energy resource. However, despite intense efforts, neither of these past booms unlocked the secret of turning oil shale into a viable commercial energy resource. Instead of establishing a new industry, both of these previous oil shale booms lead to excruciating busts that battered the communities of Shale Country, including a regionally devastating downturn in 1982.

Today it looks as though another oil shale development cycle is on the horizon, a prospect that local residents and concerned citizens throughout the nation regard with a mix of anticipation and apprehension. Energy companies are experimenting with a variety of new ways to unlock oil shale at public and privately owned sites throughout Shale Country. Like modern-day alchemists, they are looking for a way to turn rock into oil.



A map of Shale Country showing the location of the major oil shale deposits.  
 Credit: US Bureau of Land Management

# A BRIEF HISTORY OF OIL SHALE

## Early History

The promise of oil shale has been tantalizing people around the world since long before Mike Callahan accidentally publicized its existence on the Western Slope.<sup>4</sup> For centuries, people have heated shales to coax the oil out of the stone. Apothecaries and physicians in Austria used oil from shale for medicinal purposes as early as 1350. In England, where the word “petroleum” has been used to describe oil since the mid-fourteenth century, the first known patent for “a way to extract and make great quantities of pitch tarr and oyle out of a sort of stone” was issued in 1694. Commercial production, in which large quantities of shale were mined and heated in specialized ovens called retorts, began in France in the 1830s. Following the French lead and improving upon their methods, Scottish energy entrepreneurs initiated an oil shale industry around Edinburgh in 1850 that successfully operated into the 1960s.

In North America, Ute Indian words for “the rock that burns” indicate an early recognition of oil shale’s unique properties. The first small processing



The old Mormon Retort near Levan, Juab County, Utah, photographed in 1916. Built by Mormon pioneers roughly 60 years earlier, it was the first known oil shale operation in the Rocky Mountain West, extracting as much as a barrel of oil a day from the surrounding rocks for use in dressing leather harnesses, lubricating wagon wheel axles, and lighting lamps. Credit: US Geological Survey

facility for shale was opened in Alberta, Canada, in 1815. By the eve of the US Civil War, more than 50 companies in Canada and the United States were retorting shale to distill oil from rocks (albeit none very successfully), most of which was used to produce kerosene. Mormon settlers founded the first known oil shale operation in the Rocky Mountain West, perhaps as early as 1855, building a retort in a ravine near the small present-day town of Levan, Utah, about 100 miles south of Salt Lake City down Interstate 15. But the Drake oil strike in Pennsylvania in 1859 – and the subsequent birth of the modern American petroleum industry – quickly made oil shale an unprofitable venture in places that had access to its liquid counterpart. For a time, interest subsided.<sup>5</sup>

## The First Boom

### Federal Encouragement. . .

After flagging for decades in the wake of the 1859 Drake oil strike and the subsequent development of an American petroleum industry, attention to Western oil shale resources revived as World War I engulfed Europe. The US Navy was in the midst of converting from coal- to oil-burning ships and needed a secure supply of oil in case of war or national emergency. The search for this new reliable fuel source prompted the US Geological Survey to explore the Western Slope shale deposits beginning in 1913. In 1916 President Woodrow Wilson withdrew from the public domain 45,444 acres divided between two sites in Colorado and 86,584 acres across the border in Utah for designation as Naval Oil Shale Reserves. (These sites joined already-established strategic oil reserves at Elk Hills in California and Teapot Dome in Wyoming, and were augmented in 1924 by President Coolidge with 23,000 acres in Colorado and 4880 acres in Utah).

As the US geared up for its entry into World War I, officials were optimistic about the development of

shale. In his 1917 annual report, Secretary of the Interior Franklin K. Lane reported that “it is now possible to work selected deposits of shale in [economic] competition with the oil from oil wells, and that these oil-shale reserves can be considered of immediate importance to the oil industry and to the defense of the nation.”<sup>6</sup>

Federal optimism was broadcast and amplified by effusive articles that appeared in influential popular publications like *National Geographic* and the *Saturday Evening Post*, in which excited authors extolled the promise of “billions of barrels of oil locked up in rocks” on the Western Slope.<sup>7</sup>

### ... Plus Insufficient Regulation. . .

Interest and optimism from the federal government triggered the first oil shale boom on the Western Slope. Between 1916 and 1920, a stampede of speculators and prospectors claimed nearly every cliff outcrop in the region – sometimes twice – under the inadequate auspices of the Petroleum Placer Act of 1897, a law that extended the basic principles of the 1872 Hardrock Mining Law to oil development.

Designed to encourage Western settlement, these laws assumed that mining was the most valuable use to which land could be put and made all public lands open to mineral entry, thus establishing a “right to mine” above all other uses of the land. When valuable mineral deposits were discovered, the laws gave claimholders the right to patent the land (that is, to own the property outright by obtaining fee simple title) for \$5 an acre. However, the laws were written to govern minerals found in placer deposits (among the gravel of a streambed) and clearly defined lodes (veins running through rock). Gold, silver, and other minerals that sparked 19th-century mining booms could be relied upon to present themselves in one of these two ways, but Western oil shale did not clearly conform to either type of deposit considered in these pieces of legislation.

Without an adequate legal mechanism for governing oil shale, the government found itself with very little ability to regulate mining methods or much of



The federal government helped stir up interest in oil shale by sending the US Geological Survey to survey the deposits. Encouraging reports from surveyors such as these men, shown sampling an outcropping of shale in Sweetwater County, Wyoming, in 1914, fed optimistic predictions about oil shale development and helped trigger a boom. Credit: US Geological Survey

anything else as “oil fever” took hold on the Western Slope.

### ... Equals Boomtime Shenanigans

Lacking a law designed to fit their unique situation, oil shale prospectors were forced to shoehorn the existing laws to fit around their claims. Inviting prospectors to stretch the law during a mineral boom is a sure way of asking for trouble, and the government’s early attempts to apply these inadequate mining laws to oil shale discoveries provided ample opportunity for claim jumping, coattail speculation (letting someone else do all the work to locate a deposit and then filing claims as nearby as possible, if not simply jumping the claim), dummy locations (making a claim with the intent of turning it over to someone else, such as an employer who wants larger holdings than the law will allow), shady stock deals, and other boomtime shenanigans. A new approach to regulating oil shale was clearly needed.<sup>8</sup>



The first oil shale retort in Colorado, shown here in a photograph printed in *National Geographic* in 1918, was built by the Oil Shale Mining Company on Dry Fork west of De Beque, Garfield County, Colorado. Designed from illustrations found in the *Encyclopedia Britannica* entry on the Scottish oil shale industry, the retort heated crushed shale to extract oil. Credit: US Geological Survey

## Mineral Leasing Act

By 1920, as “oil fever” gripped the nation, enough citizens recognized the shortcomings of the 1897 Petroleum Placer Act that Congress took note. In an effort to impose some order on the chaos of the boom and tailor the law more effectively to the requirements of the resource it regulated, Congress replaced the Petroleum Placer Act with the Mineral Leasing Act of 1920 (MLA). The new law made fossil fuel-bearing lands in the public domain available for development only under specific federally-set conditions that included a minimum royalty payment on production. The law also included a “savings” clause that allowed claimants who had filed their claims before the passage of the MLA to secure private ownership of the oil shale lands. This exception gave the energy industry a foothold on the Western Slope’s public lands that it maintains to this day, but all other oil shale lands

reverted back to federal control and were subject to the new law.

The MLA, which (with minor revisions) is still the law governing fossil-fuel development on federal land today, differs from the 1872 Hardrock Mining Law in several significant ways. First and foremost, there is no “right to mine” on the public lands. Unlike the 1872 law, which declares the public domain open to mineral development and ranks mining preeminent among competing uses of the land, the MLA requires would-be developers to obtain permission from the federal government through a competitive bidding process before prospecting or mining operations commence. The government, moreover, retains the discretion to determine which, if any, bid to accept.

When federal land managers do award a lease under the MLA, the lessee must compensate the public for the depletion of nonrenewable energy resources through royalties, rents, and bonus payments, as opposed to the flat \$5 per acre purchase fee in the 1872 law. The Secretary of the Interior may reduce, waive, or suspend these royalties in order to encourage development (a provision of the statute that specifically references the promise of oil shale), but in cases when the government does collect royalties, it returns a portion (set at 50% in a 1976 amendment) to the state that hosts the operation. The government offers each lease for a fixed term (usually 5 years for oil and gas), with the option of renewal if the operator is profitably producing resources, as well as an option for the government to compel timely development or cancel the lease if the operator does not proceed with due diligence. When the law was passed, oil shale leases were limited to 5120 acres (8 square miles) and each company or individual miner was allowed only one lease.

The MLA also includes provisions meant to protect the environment, a consideration not likely to have even entered the thoughts of the legislators who authored the 1872 law. Throughout the leasing process, federal land managers have the authority to impose conditions and regulate the extraction process to protect competing resources and the environment. These environmental considerations

extend beyond the life of the mine, discouraging the “get rich and get out” mindset displayed by many miners during earlier mineral booms. Those miners fortunate enough to be awarded a lease must promise to reclaim the area – typically by posting a bond up front designated for the purpose – once mining operations have ceased.<sup>9</sup>

## The First Bust

Despite the eternal concern in certain circles that additional regulation will stifle industry, the new law did not dampen the widespread enthusiasm for oil shale. By 1922 at least 100 companies had formed to unlock the secret of the oil in the rock. That number again and more joined the rush during the mid-1920s, until the onset of the Great Depression and a flood of new lower-cost free-flowing crude oil discoveries conspired to kill the boom.



When the first oil shale boom went bust in the 1920s, companies abandoned Shale Country as quickly as they had appeared, leaving the ruins of retorts such as this one on Willow Creek southwest of Vernal, Utah, as monuments to their failed efforts. Credit: National Energy Technology Laboratory

There wasn't much to show for all the commotion. The small mining outfits had never been able to raise sufficient capital to pursue ventures on a profitable scale. And, in any case, the industry never developed effective technology to extract the fuel from the rock in a way that would make it competitive with domestic liquid oil. With only token amounts of oil to show for their efforts, companies shut down and abandoned the Shale Country as quickly as they had appeared. While some prospectors pocketed their deeds in hopes of waiting out the bust, most sold their claims to long-term speculators who were willing to bet on oil shale's future.

Even the federal government got out of the oil shale business. The Bureau of Mines, which opened an experimental mine and processing facility on Naval Oil Shale Reserve land near Rulison (about 11 miles west of Rifle) in 1925, closed its operation in the summer of 1929. That same year, the Teapot Dome Scandal concluded with former Secretary of the Interior Albert Fall going to prison for accepting bribes in exchange for leasing the strategic oil reserves at Elk Hills and Teapot Dome. Eager to preclude any chance of another headline-grabbing scandal in the nation's energy fields, in 1930 President Herbert Hoover issued Executive Order 5327 temporarily (but indefinitely) withdrawing all federal oil shale lands from lease “for the purpose of investigation, examination, and classification.”<sup>10</sup> The gesture was largely symbolic – the boom had played itself out and, for the time being, the industry was moribund.

## Waiting for the Next Boom

Interest in oil shale grew again during World War II, as petroleum shortages encouraged the search for domestically plentiful alternative fuels. In 1944, Congress passed the Synthetic Liquid Fuels Act, authorizing the establishment of federal demonstration facilities to produce synthetic fuel (an engineered substitute for oil) from coal, oil shale, biomass, and anything else that might power American tanks, ships, airplanes, and automobiles. Pursuant to the act, the Bureau of Mines opened a new research facility at Anvil Points, near the old

Rulison Project, and experimented with a variety of oil shale mining and retorting methods.

In 1952, President Harry Truman partially cleared the way for an industry revival by lifting Hoover's order and allowing the Department of Interior to entertain bids for the lease of oil shale lands. However, Interior officials were still wary of exploitation by speculators, some of whom the department was challenging in court over the validity of their claims. With these reservations and without proven technology to successfully develop

the shale resources, Secretary Oscar Chapman, a Coloradan, declined to open the land for leasing. Congress dealt the final blow to hopes of the resurgence of oil shale in 1956 when it suspended funding for the Anvil Points facility. Unlike earlier in the century, federal interest had this time failed to prompt a commercial shale boom. But many of the basic mining methods and equipment designs developed at Anvil Points became the industry standard (albeit with some technological improvements) when a new boom did come to the Western Slope over a decade later.<sup>11</sup>

# ENGINEERING A BOOM

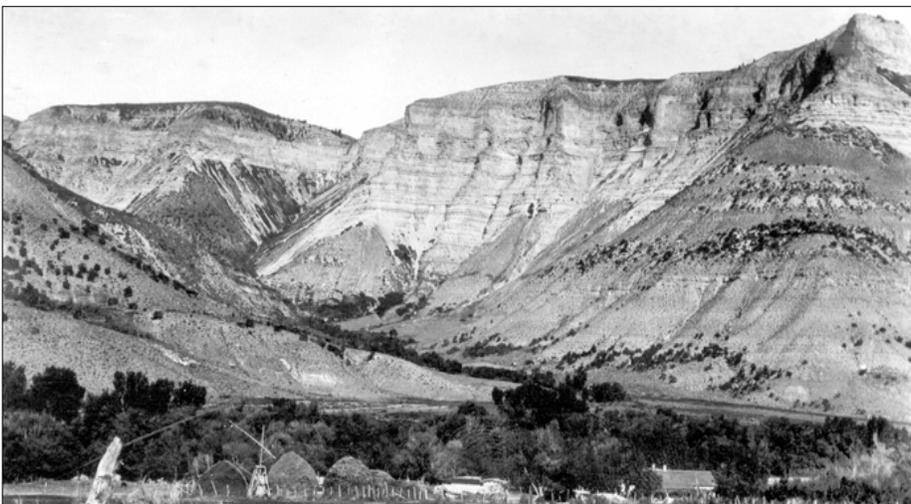
## Shale Country Real Estate

Although prospectors staked more than 30,000 claims on over 4 million acres throughout Shale Country during the first rush, they focused on escarpments and elevations where the dark-colored rock was exposed or easily accessible. Very few mining claims were filed in the Piceance Creek Basin, where the rich deposits were generally too deep for early prospectors to discover. But the presence of water in this arid country did attract homesteaders.

Both before and during the early-twentieth-century boom, settlers filled in the valley bottoms along the Piceance Creek and its tributaries and set about the hard work of proving up their homesteads. Those who successfully made a go of it won the title to their land, and through this homesteading process much of the valley land passed into private hands. However, not every homesteader received the same title to the land. Those who filed before the passage of the Stock Raising Homestead Act of 1916 obtained the deed to both the land's surface and any minerals beneath. Those who filed after 1916 settled on split estates, where only the surface of the land belonged to the homesteader and the government retained rights to any minerals found beneath, with access to and development of those mineral governed by federal mining law.<sup>12</sup>

In the years after the boom faded, a small cadre of farsighted and deep-pocketed speculators and energy companies set about purchasing claims throughout Shale Country, securing potentially rich holdings in anticipation of a day when oil shale could be worked profitably. They bought, often at bargain prices, many of the mineral claims that had been filed before the 1920 leasing regime. And as prospectors began to discover some of the deep, rich deposits under the valley bottomlands, some of these investors also purchased homestead deeds that predated the 1916 split estate system.

Although these purchases were sometimes islands of private property surrounded by a sea of federal land, too small for large commercial-scale development on their own (especially in the days when massive underground or open pit mines seemed the only feasible way to get at the shale), their acquisition gave the buyer a foothold in Shale Country. Through land-swaps with the government or other landholders, these individual parcels could be parlayed into consolidated blocks of land that promised to become major oil shale fields in the future. These savvy investors, true believers that oil shale would one day be a significant part of the nation's energy picture, intended to be well-positioned to take advantage when that day came.



Scenes like this one on the west side of Parachute Creek in Colorado, photographed in 1916, drew thousands of hopeful prospectors to the area to work the rich oil shale deposits exposed on this and similar cliff faces. While these prospectors focused on cliffs and outcroppings, the bottomlands along the creek attracted homesteaders, a presence attested to by the ranch in the foreground. Homesteaders who claimed their land before 1916 often found themselves owners of the mineral rights to even richer oil shale deposits deep under their property. Credit: US Geological Survey

In the end, after all the hullabaloo and heartbreak, this large-scale transfer of valuable tracts of resource-rich land out of the public domain and into private ownership, facilitated by early mining and homesteading claims, proved to be the most significant legacy of the first oil shale boom. Today private property owners, mainly energy companies, control about 20% of the land that overlies oil shale deposits in the Piceance Basin and the associated mineral rights – enough, according to some, to get an oil shale industry off the ground without the incentive of federal leases.<sup>13</sup>

### Private Lands in Shale Country

Although it may not always look like it on the surface, today about 20% of Shale Country is owned by private individuals and corporations. When energy companies bought the title to one of the area's original homesteads (one that predated the 1916 split estate law and thus owned the mineral rights to the land), they often provided lease-back agreements that allowed for the land's continued operation as a ranch. During the Depression, when a number of homesteads reverted to federal land because their occupants could not pay the taxes, these lease-back offers must have been especially attractive.

Other Western Slope residents – notably Dr. Tell Ertl and John W. Savage Sr – purchased old claims in anticipation of the day when their value would once again rise. In the decades after World War II, Ertl, Savage, and their heirs tracked down the descendants of the original prospectors, fought legal battles with the Department of Interior over the legitimacy of their claims, and diligently proved up and maintained the claims until by 1980 the Ertl family controlled 67% and the Savage family 13% of the individually-owned oil shale lands in the Piceance Basin. Their efforts paid off that year when the US Supreme Court ruled that the government was required to honor oil shale claims originally filed before 1920, clearing the way for the families to lease their property to energy companies willing to pay a premium to join the second oil shale rush.

With these substantial private holdings in Shale Country – more than 200,000 total acres by some counts – Garfield County Commissioner Larry McCown, an oil shale worker during the last boom, thinks that leases on public land might not be necessary for the development of oil shale: “What everybody always seems to forget is that all the major oil shale players the last time around still have sizable private holdings where they could start a project without the BLM.”<sup>14</sup>

Energy companies and oil shale advocates acknowledge that significant resources are in private hands, but they have consistently maintained that the richest deposits – meaning those that will yield the most oil and be most likely to provide profit margins capable of supporting the high startup costs of a new industry – underlie federal lands.

### Shale for Sale

In 1968, responding to the tireless boosterism of energy companies and oil shale advocates and hoping to assuage the public's perpetual anxieties about the domestic energy supply, Stewart Udall exercised his authority as Secretary of the Interior to offer 3 federally owned tracts of oil shale land for lease. However, the boosters had overhyped the appeal of their potential product (or, perhaps, were just a few years too far ahead of their time). The limited private lands already available were sufficient for the inchoate industry at the time, and this offering attracted little attention from the big energy companies that provided most of the nation's oil. Even as domestic oil production began the final climb toward its peak, oil shale was still more trouble than it was worth to multinational energy companies awash in cheap free-flowing crude oil overseas.

Beginning in 1973 and stretching into 1974, the Arab Oil Embargo changed all that. President Richard Nixon responded to the embargo by outlining Project Independence, a plan to free the nation from foreign energy sources by the end of the decade. Interest in domestic energy sources surged,

and boosters quickly portrayed oil shale as “an ace in the hole for national security.”

When Interior offered 6 more federally owned tracts in 1974 – two each in Colorado, Utah, and Wyoming at more than 5000 acres apiece, this time around those in Colorado and Utah attracted considerable attention. The site dubbed C-a (as in “Colorado tract A”) in Rio Blanco County drew the most interest, receiving 7 sealed bids that averaged \$91.6 million and topped out with a winning bid of over \$210 million – at the time the highest per-acre price ever paid for a federal energy lease.<sup>15</sup>

### The “Boom” Goes Boink?

Development got off to a slow start as the winning companies moved into the planning and design process. Some of the delay arose from the fact that, before they could get shovels in the ground, the companies had to gather baseline environmental data to comply with the slew of new environmental laws recently adopted by Congress – the Wilderness Act in 1964, the Clean Air Act in 1970, the National Environmental Policy Act (NEPA) in 1970, the Clean Water Act in 1972, the Endangered Species Act in 1973, and the Safe Drinking Water Act in 1974. Furthermore, any operations beginning on BLM lands after 1976 would also have to meet the requirements of that year’s Federal Lands Policy and Management Act (FLPMA), which compels the agency to develop land use plans that accommodate multiple uses and protect the scenic qualities of the landscape.

Whether these new regulations, economic fluctuations, the old technological difficulties, or (most likely) a combination of factors were responsible, by 1976 oil shale development seemed more boink than boom. The embargo-induced energy crisis had abated, inflation was up, lessees had started requesting a suspension of their leases until the situation changed for the better, two companies had given up their leases entirely (although they maintained other private holdings in the area), and the industry’s outlook was generally

sour. Even the official industry magazine, *Shale Country*, folded up.<sup>16</sup>

### How to Make a Mining Boom

The gloom in Shale Country didn’t last long. In 1977 President Jimmy Carter gave a series of televised speeches to Congress and the American public (including one fireside chat in which he infamously donned a tan cardigan) outlining a new energy policy to reduce the nation’s dependence on foreign oil. Calling the difficult task ahead “the moral equivalent of war,” Carter argued that Americans “must start now to develop the new, unconventional sources of energy we will rely on in the next century.”



President Jimmy Carter explained his energy strategy to the public during a series of televised fireside chats such as this one on February 2, 1977. Credit: National Archives, Jimmy Carter Library

The 1979 Iranian Revolution punctuated his point, accelerating fears about the security of the nation's foreign oil supply. The following year, Carter signed the Energy Security Act of 1980, allotting billions of dollars for the creation of a Synthetic Fuels Corporation that would provide loans, price guarantees, and other financial incentives to stimulate synthetic fuel development projects. A dozen companies immediately applied for money to support their oil shale endeavors and began gearing up for production.<sup>17</sup>

The industry got another boost when the Supreme Court agreed to settle the long-running dispute between the Department of the Interior and some oil shale claimholders over the validity of their purchased claims. Interior insisted that many of the claims never met the criterion of the 1872 and 1897 hardrock and petroleum mining laws, which specified that only a discovery of "valuable mineral deposits" could be patented. Because oil shale had never been profitably developed, the department argued, it could not be considered valuable. Under that logic, the pre-1920 claims, most of which had sat unworked for decades, were not legitimate and had technically reverted back to the government, making their purchase by private third (and, in many cases, fourth and fifth) parties like the Savage and Ertl families invalid.

However, in June 1980 the US Supreme Court ruled in favor of the claimholders in *Andrus v. Shell Oil Co.*, citing an earlier Interior Department ruling that "present marketability" is not required to recognize certain minerals as valuable and therefore affirming the validity of their oil shale claims as a vested property right. The decision removed a significant legal and economic risk for companies that wanted in on the action in Shale Country. And with the stars aligning for another oil shale boom, energy companies moved fast to ensure that they were not left out. Even before the court's decision was announced, in April Philips Petroleum paid the Ertl family a hefty premium with promises of multimillion-dollar royalties for a long-term lease on some of the family's land.<sup>18</sup>

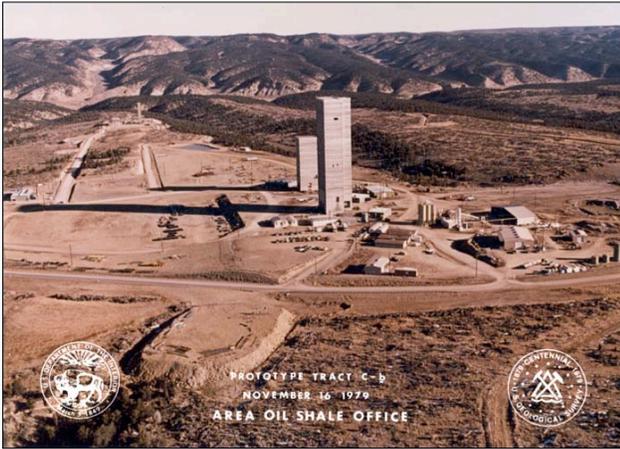
After the passage of the Energy Security Act, Carter next proposed the creation of a national Energy Mobilization Board with the sweeping authority to bypass state and local permitting processes, as well as national environmental regulations, in the interest of national security. Though many expressed their willingness to do their part for the good of the nation, a vocal contingent of residents of the Western Slope saw this proposal as an attempt to turn their home territory into a "national sacrifice zone" and fiercely opposed it with the support of a number of Western governors. Carter had overreached, Congress rejected the proposal, and the phrase "national sacrifice zone" still rings bitterly in the ears of Western Slopers.

However, no more federal mobilization or legislated local sacrifice was necessary; Carter had already done enough to promote an energy rush on the Western Slope. The boom was on.

## **The Second Boom Arrives With a Vengeance**

In a significant change from the earlier rush, where the government had encouraged prospectors with only its own official optimism, this time around the federal government had deliberately engineered a corporate mining boom on the Western Slope through legislation and subsidies.

These two distinct approaches produced markedly different impacts on local economic and social arrangements. The relatively small amount of capital investment and its diffusion through numerous small companies in the first boom did not create any boomtowns among the communities of Shale Country, but the second boom was characterized by rapid economic and population growth that engulfed existing communities, creating wholesale disruption that lasted long after the boom ceased.<sup>19</sup>



Towering retorts cast a shadow across tract C-b in Rio Blanco County, Colorado, in November 1979. A consortium of companies including Atlantic Richfield (Arco), Ashland Oil, Shell Oil, and TOSCO paid \$117.8 million to lease the site for oil shale development. Credit: US Geological Survey

### Boomtime Frenzy

As they watched their communities change with the rapid influx of capital and the newcomers it brought, residents of the Western Slope found that a rapid boom can create nearly as much pain and turmoil as a sudden bust.

People from around the nation made the trek to Western Colorado to find work and high boomtime wages. Even if they did not find work at the mines, they could still cash in by building roads, constructing new housing, upgrading old wooden city water lines to handle increased flows, serving meals at suddenly crowded restaurants, and otherwise providing the many requirements that came with transforming small rural towns into a new urban frontier created by oil shale development.<sup>20</sup> Those who did find jobs often did not find housing right away, and semipermanent campgrounds sprung up in and around every town within driving distance of the oil shale fields.

Turnover among workers was frequent. Because construction occurred in phases, the workforce was in constant flux as groups of skilled tradesmen cycled through according to the needs of the projects. Coping with a drastic population increase is difficult enough for the communities caught up in a boom – constantly managing and serving this

enormous ebb and flow of transient workers and their families can be overwhelming. Elected officials, longtime locals, and newcomers alike struggled to contend with housing shortages, strained social services, rising crime, overtaxed sanitation systems, insufficient water supplies, pollution, traffic congestion, and noise.<sup>21</sup>

### Gillette Syndrome

As the small communities caught up in the boom – particularly Parachute (preboom population 300), Rifle (2200), Silt (900), and New Castle (700) – worked to keep from being overwhelmed, they were well supplied with examples of the stakes they faced. The most potent of these examples came from Gillette, a small ranching town on Interstate 90 in Wyoming’s Powder River Basin that sits atop a massive coal seam. Gillette’s boom had started a few years before the oil shale leases were issued, and by 1974 sociologists who studied the town felt they were documenting a public health disaster. “Gillette Syndrome” soon became shorthand for the dark side of energy development.

Researchers identified sharply increased rates of drinking, divorce, delinquency, and depression – dubbed the Four Ds – as the once agrarian town’s population quadrupled from 3000 to 17,000. Although more recent studies have questioned the data supporting these findings, and Gillette today is a community of 40,000 working to transcend its bad rap, the term Gillette Syndrome became a frightening watchword for communities confronting an energy boom.<sup>22</sup>

### Exxon’s Colony Project

In May 1980, just before Carter signed the Energy Security Act, the stakes on the Western Slope grew even higher when Exxon, the largest company in the world, announced that it had paid \$400 million to buy out Atlantic Richfield Company (Arco) and partner with The Oil Shale Company (Tosco) to develop the Colony Oil Shale Project on a 22-square-mile parcel up Parachute Creek. Chevron, Unocal, Mobil, Tennaco, Occidental, and other major energy companies were already developing

projects in Shale Country, but Exxon planned to outdo them all. In a now infamous “white paper,” Exxon officials outlined a grand \$5 billion vision that proposed digging up to 6 of the world’s largest open pit mines, rerouting water from the Missouri River Basin for shale processing, and ultimately producing 8 million barrels of oil a day by 2010. To accommodate the 22,000 workers Exxon estimated would be required for this extreme scenario, the company planned to build an entirely new town on Battlement Mesa, across the Colorado River from Parachute, with a projected population of 25,000.<sup>23</sup>

The commitment of the world’s largest company to oil shale, and the mind-boggling scale of its plans, persuaded even the most skeptical residents of the Western Slope that this time the boom was real. One longstanding local summarized the conflicted feelings many residents had about the new boom, explaining that although oil shale was “badly needed by the nation” and he was patriotically willing to do his part, “I have mixed emotions about what’ll happen to the countryside, and you know they’ll tear up the mountains and add pollution, but on the other hand we need the economic stimulus of industry.”<sup>24</sup>

Economic stimulus proved to be a mild term for the ways in which Exxon’s arrival on the Western Slope pushed the boomtime frenzy to new levels. The populations of existing towns mushroomed: Parachute grew from 300 in 1979 to 1200 in 1982 and projections topped out around 15,000. In Rifle, home to 2200 residents before the boom, “modest” projections by the city (geared to a smaller industry than was outlined in the Exxon white paper’s extreme scenario) called for 700 new police and firemen with 140 vehicles, 200 new doctors, and 75,000 new homes within a decade.

Wages and property values soared with the insatiable demand for labor and housing. Carpenters who might have been unemployed or working a minimum wage job (\$3.10 in 1980) to make ends meet in Oregon or Ohio earned \$16 per hour in Western Colorado, and heavy equipment operators commanded more than \$20 per hour, plus per diem travel expenses. In Rifle, the total value of building permits went from a half-million dollars in 1976 to

\$14 million by 1980. In Grand Junction, the largest city and regional center of the Western Slope, city leaders built a new airport to handle the upsurge in business traffic, a new shopping mall, and 5 new schools to keep pace with the growing population. The establishment of a large-scale oil shale industry seemed so certain that the industry magazine *Shale Country* began publication again.<sup>25</sup>

## **Black Sunday** **Legacies of a Failed Policy**

And then, on May 2, 1982 – a day known on the Western Slope as “Black Sunday” – everything came to a catastrophic halt. Reckoning with falling oil prices that made oil shale no longer profitable, Exxon’s board of directors announced that they would pull the plug on the Colony Project, effective immediately. The evening news delivered the first word most people in Colorado heard about it. Overnight the 2100 people employed on the project became unemployed, locked out and not even allowed to retrieve their personal effects when they showed up at the job site the next morning. The impact shot through the entire region, leaving everyone from construction workers to bus drivers to area business owners to appraise what a post-shale future might hold for them.

Other energy companies followed Exxon out of town, and approximately \$85 million in annual payroll disappeared from the regional economy in just a few years. Many folks read the writing on the wall and didn’t wait around to see what an \$85 million vanishing act looked like, quickly deciding that there was no future for them on the Western Slope without the oil shale industry. Within a week of Black Sunday, a thousand people had left Garfield County. There were no more trucks or trailers left to rent.

The exodus continued as nearly 24,000 made their way out of Garfield and Mesa counties between 1983 and 1985 – diminishing the region’s population to less than it had been before the boom – while unemployment on the Western Slope climbed from near zero to 9.5%. Young people departed in search

of the wages and opportunities to which they had grown accustomed. Vacancy rates, once nonexistent, topped 14% in Grand Junction, and foreclosures in Mesa County increased from 98 in 1980 to over 1600 in 1985. Office buildings sat vacant. Businesses folded by the score. Banks that had survived the Depression now went under.<sup>26</sup>

Although a few companies did stick it out – Unocal and Occidental maintained their operations at limited capacity until the early 1990s, and several other companies, including Shell, continued research and development work on private sites – they were not enough to stem the tide of economic disaster. The oil shale bust triggered a regionwide financial collapse on a scale not seen even in most Midwestern steel towns.<sup>27</sup>

The first boom failed for lack of capital and inadequate technology, but the second failed

primarily due to poorly considered policy. Although there was still no technological breakthrough that made oil shale development profitable, the federal government (with President Carter leading the way) engineered a boom in reaction to the perceived crisis of high oil prices and unstable suppliers. Energy companies followed the government's lead, responding to government incentives with major investments of their own. Oil money and federal subsidies pumped unprecedented amounts of capital into Shale Country during the 1970s and '80s, but it was not enough to purchase the necessary technological innovation (nor was it clear that such a breakthrough was available for purchase at any price). When oil prices normalized again, neither the government nor private industry could continue to justify sustained investment. Taxpayers and energy companies had spent untold billions with negligible returns, but the residents of the Western Slope bore the brunt of the failed policy's cost.

# WE'LL GET IT RIGHT NEXT TIME

## The 2005 Energy Policy Act The Third Time Is the Charm (Right?)

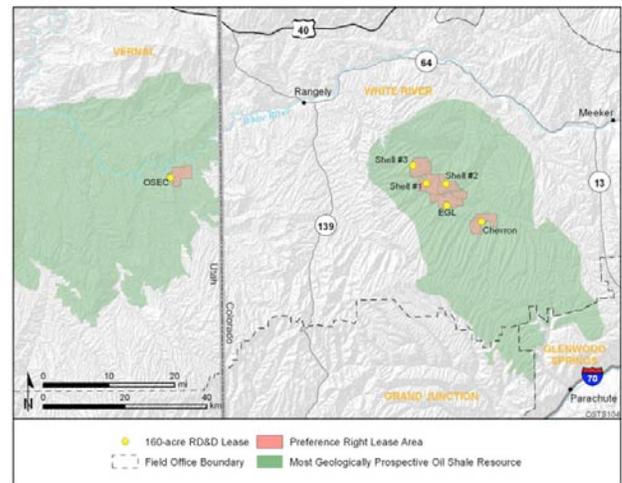
Today, a volatile international oil market, a recent bout of sticker shock at the gas pump, and growing recognition that dwindling oil reserves will struggle to meet the world's future energy demands have combined to once again pique interest in the rock that burns. And once again, the federal government is stimulating that interest.

In 2003, as oil prices began to climb, the Bureau of Land Management (BLM) initiated an oil shale development program in conjunction with President George W. Bush's National Energy Policy, soliciting applications for research, development, and demonstration (RD&D) leases. The 2005 Energy Policy Act (PL 109-58), section 369 (PDF), further encouraged the development of oil shale resources as part of a comprehensive approach to meeting the growing national energy demand by requiring the Department of the Interior to issue commercial oil shale leases by 2008. Although some research is also under way on privately owned claims, the RD&D and commercial leasing programs, which proceed along entirely separate tracks, account for the most significant activity in Shale Country today.

## RD&D Leases Testing a New Generation of Technology

In response to the BLM's oil shale development program, 20 companies applied for new oil shale leases in the Green River Formation. Ultimately, the BLM selected 6 proposals – 5 in Colorado (3 separate bids by Shell and one each from Chevron and EGL Resources, the latter of which has since been renamed American Shale Oil) and one in Utah (the Oil Shale Exploration Company) – as worthy of continued consideration.

Each of the Colorado proposals identified 160-acre tracts on public land in the Piceance Basin in Rio Blanco County southwest of Meeker for their RD&D operation, while the one in Utah focused on a parcel in Uintah County (see map). Each company also nominated a contiguous area of 4960 acres to be reserved for preferential commercial leasing options in the future, should their research pan out. The lease period is 10 years with a renewal option of 5 more. In 2007, once the BLM completed the Environmental Analysis required by NEPA and found that the proposed RD&D operations would produce “no significant impact,” the agency officially issued leases that allowed the companies to begin work.<sup>28</sup>



Location of the six RD&D tracts and associated preference right lease areas. Credit: US Bureau of Land Management

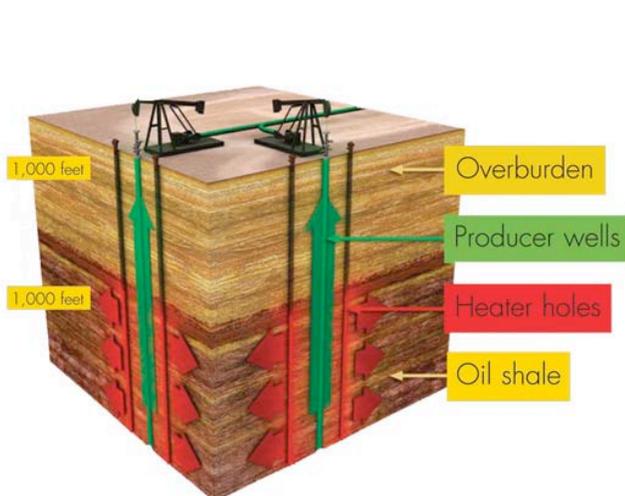
## Two Methods of Extraction

Of the 6 RD&D leases awarded, the one in Utah proposed a conventional surface mine and retort method at an existing mine site, while the 5 in Colorado were for in situ operations. The conventional mine and retort method (sometimes called ex situ) relies on digging the oil-bearing shale

out of the ground, crushing it into small pieces, and separating the oil-like kerogens from the rock by heating it in a centrally located piece of machinery called a retort. In situ refers to a method of recovering the oil contained in shale rock by heating it in place underground and using wells to extract it.

Essentially, the in situ process mimics the natural geologic process that produced conventional deposits of oil and gas, the process that would eventually take place in Shale Country over millennia. Although the details vary substantially between operators, the general in situ procedure is to artificially heat the rock within shale layers – the richest of which are called the “mahogany zone” because of the oily rocks’ rich brown color – over a period as long as several years until liquefied oil is ready to be pumped to the surface through wells.

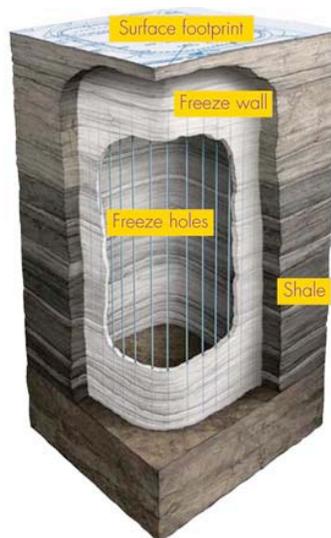
Despite significant technical obstacles and environmental questions still to overcome, in situ recovery appears to be the most viable approach to oil shale under the current economic and environmental regimes, offering lower recovery costs and a more limited footprint on the landscape compared to the conventional mining methods. The idea is not new, but the in situ techniques being developed at public RD&D leases and on private tracts today represent an original and innovative phase of thought and technology. A quick survey of some of these processes shows the variety of thought encompassed under the broad notion of in situ extraction.



## The Leaseholders

Of the 3 companies granted RD&D leases to develop in situ methods, Shell has garnered the most attention so far with its In situ Conversion Process (ICP), which it has been developing since the early 1980s at the company’s privately owned Mahogany Research Project site in the Piceance Basin. The process relies on electric heaters inserted down drilled holes to the depth of the targeted layer of shale, where they will gradually heat the rich rock formation over several years to a temperature of between 650 and 700 degrees Fahrenheit. The heat will fracture the shale rocks and convert the kerogen bound within them into oil and gas that can be pumped to the surface with conventional production wells. To prevent the mobilized oil and gas from contaminating groundwater, Shell is testing the viability of an underground freeze wall – a closed system of refrigeration pipes drilled 8 feet apart and 1800 feet down – designed to create an impermeable frozen barrier surrounding the heated zone.

On a lease site just to the south of the Shell claims, American Shale Oil (AMSO, formerly EGL Resources) is pursuing a similar concept, which they refer to as the Conduction, Convection, Reflux (CCR) Process. In the CCR process, rocks in the target zone will be heated by an L-shaped well drilled horizontally into the area. As the organic matter within the rocks boils, it will break the rocks apart and free the oil and gas to be collected and pumped to the surface by a conventional production well. AMSO believes that by heating the rock more



Graphic representations of Shell’s In situ Conversion Process and freeze wall plans. Electric heaters gradually heat the shale underground until the oil is freed from the rocks and can be pumped to the surface. Around the extraction zone, the underground freeze wall is designed to protect groundwater against contamination. Credit: Shell Oil USA (used by permission)

quickly than Shell plans to – 3 to 12 months as opposed to several years – the CCR process will consume less energy and require fewer wells, thus minimizing the amount of land disturbed on the surface and reducing the amount of water needed to less than one barrel per barrel of oil produced. To protect groundwater, the company plans to target deeper layers of oil shale below the basin’s aquifer (rather than the mahogany zone closer to the surface), leaving in place layers of rock above the target zone that will serve as a natural geologic barrier against groundwater contamination.

In contrast to these steady heating approaches being developed by Shell and AMSO, Chevron is hoping to use chemistry to produce oil from the rock. The company has teamed up with experts from Los Alamos National Laboratory and the University of Utah to explore a variety of methods, but the leading candidate is a process they call CRUSH (a loose acronym for Chevron’s Technology for the Recovery and Upgrading of Oil from Shale), which intends to rubblize rich swaths of shale with precisely controlled chemical explosions before injecting a solvent (such as heated carbon dioxide) to separate the kerogen from the shale. Once dissolved by the chemical reaction, the energy-rich hydrocarbons in the kerogen could be pumped out using a conventional production well. Chevron believes that the CRUSH process will require significantly less energy and water than other in situ methods and will sequester much of the carbon dioxide underground, thus reducing its environmental impact and making it more



RD&D operations at Shell’s Mahogany Research Project in the Piceance Basin, Rio Blanco County, Colorado. Credit: Shell Oil USA (used by permission)

economical even at lower oil prices. In fact, the company predicts that its method will consume less water than the quantity of groundwater pumped out of the target zone (a routine procedure in energy fields), leading the company to claim that it will be a net “producer” of water. To protect groundwater quality, much like AMSO, Chevron plans to target shale beds capped by impermeable geological formations that can permanently prevent groundwater from seeping through the contaminated rubble.

With so much still to demonstrate on these RD&D projects, none of these 3 in situ lessees expect to conclude testing or make any decisions about the next stages of production for several more years. Meanwhile, at the White River Mine RD&D lease site in Utah, the Oil Shale Exploration Company (OSEC) claims that its conventional surface mining and retort process, based on technology developed in the 1950s and used in Brazil for nearly two decades, is ready to produce 4000 barrels a day from deposits that lie closer to the surface than those in the Piceance. However, this more established form of resource extraction also carries a host of established environmental impacts – from carbon dioxide released during the retortion process to the difficulty of reclaiming mined sites and the potential for perpetual management – that cast it in a less attractive light for many policymakers than the promise, albeit unproven, held out by in situ processes.<sup>29</sup>

### **New Technology, Old Questions**

Although in situ technology holds out the hope of producing oil shale with a lighter environmental touch than the conventional method, the companies working on these new processes today face numerous challenges and uncertainties. The viability of in situ extraction hinges not only on perfecting the technology and chemistry but also on significant questions about how they will impact land, air quality, and water resources in Shale Country. Will the next generation of operators work with local communities in ways that create a sustainable positive impact on society and the economy? Can they tread lightly enough on the land to preserve the

integrity of native ecosystems? What will their presence mean for other uses of the land, such as ranching or recreation? In the arid West, how much water will these processes require? Where will it come from? Will the proposed protections against groundwater contamination be successful? Can operations be powered in a way that safeguards the area's near-pristine air quality?

These questions are not new. The conventional mine and re-vent operators faced many of the same questions – and too often failed to provide satisfactory responses – during the last boom cycle. But the energy companies developing the next generation of technology in Shale Country today will need to come up with novel answers if they are going to live up to their pledges to “get it right this time.”

## Commercial Leasing

Running parallel but independent of the RD&D program, the commercial leasing process stipulated by the 2005 Energy Policy Act is also underway. The act required the BLM to prepare a programmatic environmental impact statement (PEIS) for “the most geologically prospective lands” (meaning the land above the richest oil shale deposits) in the Green River Basin within 18 months of the bill's August 2005 passage. The act then mandated that commercial leasing commence roughly a year after the PEIS was completed. That was the original plan, anyway. Although the timeline for development is shorter than the RD&D program, the commercial leasing process has not proceeded as far as its counterpart, mainly due to opposition from key Colorado lawmakers.

### Slow Start on the Fast Track

In 2006 the BLM began the rulemaking process for commercial leasing, and in December 2007 it released a draft version of the PEIS for public comment, finalizing it nearly a year later in September 2008. Already well behind schedule with the PEIS, the BLM's commercial leasing program has been further slowed down by the consistent efforts of three Colorado lawmakers: Senator Mark

Udall (a representative prior to 2009), Representative John Salazar, and his brother, Secretary of the Interior Ken Salazar (a senator prior to 2009). These three, supported by allies at the federal and state level including Colorado Governor Bill Ritter, organized a legislative moratorium that delayed the BLM from finalizing the regulations for commercial leasing until the final week of the Bush Administration in January 2009.

This cautious coalition maintains that they are not categorically opposed to oil shale development, but that they want to ensure that any development proceeds in the most socially, economically, and environmentally responsible manner possible. As Secretary Salazar has explained, rather than the rush to development that they feel is at the heart of the 2005 Energy Policy Act's oil shale section, a “judicious approach to oil shale development will help Western Slope communities avoid any unfortunate bust that comes from an unchecked boom on commercial leasing. . . . as happened in the 1980s, when we went through our last bout of oil shale fever – of which many of the communities of Western Colorado are still feeling the effects of today.”

The likeminded legislators have been assisted by a coalition of environmental groups who filed multiple suits aimed at preventing the commercial leasing regulations from taking effect. The suits have put the status of commercial leasing and the BLM's land use plans for Shale Country into limbo while they slowly work their way through the courts. Meanwhile, the go-slow position gained new prominence when President Obama appointed Ken Salazar as Secretary of the Interior. A little more than a month after he was confirmed by the senate, and just days after he told a group of Western governors that oil shale was still “on the table,” in February 2009 Secretary Salazar announced that he was withdrawing the recently solicited second round of RD&D lease offerings. In their place, he has directed the BLM to offer a new round of RD&D leases that rectify what he considered the flaws of the earlier regulations.<sup>30</sup>

## Royalty Rate Debate

One of the most contentious aspects of the commercial leasing rulemaking process, and one that Secretary Salazar identified as a major problem with the regulations he withdrew, is the royalty rate, the percentage that companies pay for extracting public resources. In the now-withdrawn regulations, the BLM set the royalty rate at 5% for the first 5 years and then increasing 1% per year until it reached 12.5%. Ken Salazar (speaking as a senator when the rates were first announced in November 2008) called them a “pittance” compared to the 12.5% to 18.8% that the government typically collects on domestic oil production.

The royalty rate can be a powerful tool to encourage – or discourage – development. Oil shale advocates contend that a lower royalty rate will help offset the high startup costs and risks associated with developing a new industry and will go a long way toward encouraging companies to take the plunge. But policymakers like Udall and the Salazars are concerned that setting the rate too low will shortchange taxpayers if the industry takes off. Some would like to avoid setting the rate “prematurely” before the technology is proven and other key questions about its impact on the environment and local communities have been answered, but companies operating in Shale Country are hesitant to large long-term investments without some certainty in the regulatory framework they will be operating under.<sup>31</sup>

## Private Enterprises

Apart from the federal RD&D program, several energy companies, including independent ventures like Red Leaf Resources in Utah and energy industry heavyweights like ExxonMobil, are also working privately on oil shale processes with an eye toward obtaining commercial leases when the time comes.

Utah-based Red Leaf is developing a hybrid technology it calls the EcoShale Process, which combines elements of conventional mine and retort methods with in situ techniques. Exxon, in its return to Shale Country, is developing an in situ technology

it calls the Electrofrac process, which it may test on private property at the company’s defunct Colony Project site near Parachute, Colorado. Exxon plans to fracture the target oil shale formation and fill the cracks with an electrically conductive material that will serve as a heater. As the heated kerogen separates from the rocks, the resultant oil and gas will be pumped to the surface. Exxon believes this process will require less drilling than individual heaters and thus leave a smaller footprint on the landscape.

Other major energy industry players such as Schlumberger, the world’s largest oilfield services company, are positioning themselves to take advantage if an oil shale industry does get off the ground. In early 2008, the company put 375 acres of private rangeland near DeBeque, Colorado, under contract. Although the site will primarily be used as a base of operations to serve the current oil and gas operations in the Piceance Basin, the Paris-based company also has an eye toward oil shale. Around the same time they purchased the land, Schlumberger also acquired an in situ technology that uses radio wave technology to separate the kerogen from the rock underground. Additionally, Schlumberger is already dipping its toes into the shale deposits through a venture with AMSO to help characterize the resource on their RD&D lease.<sup>32</sup>

## Show Me the Money Where Oil Shale Revenues Go

Although no one can say for certain whether oil shale will one day be produced profitably and the royalty rate companies will pay is still a subject of debate, laws are already in place at the state and federal level to distribute any money generated for the public by the future industry.

Roughly half (the exact percentage has fluctuated by a few points over the past few years) of the money that energy companies pay to the federal government as royalties will be returned to the states in which the development occurred. Each state has a different method of distributing these funds. In Colorado, where the richness of the Piceance Basin deposits

mean that a successful oil shale industry could translate into enormous amounts of money washing through the state government, this money is funneled into the state's Oil Shale Trust Fund. State legislators created the fund in 1974 as a mechanism to distribute 100% of the state's share of the federal Mineral Leasing Act royalty monies derived from oil shale lands back to local governments for mitigation of the impact of oil shale development on the communities it directly affects.

Shale Country states will also receive money from individual companies in the form of severance taxes, which are charged to energy and mining companies in an effort to recapture part of the public wealth lost when nonrenewable resources are extracted and sold for private profit. In Colorado, which currently charges a lower severance tax than most of its Rocky Mountain neighbors, by law this money must be used for public purposes related to mineral development, for water projects, or help for local

governments to offset the impacts of energy development. The state distributes the revenues evenly into two channels: the Severance Tax Trust Fund, which funds statewide mitigation and resource stewardship projects through grants and loans, and the Local Government Severance Tax Fund administered by the Department of Local Affairs (DOLA), which directs 30% (up from 15% in 2007) of all state severance tax money to local governments to address the social and economic impacts of mineral production. Each fund has its own mind-boggling allocation formula and is the source of much political wrangling at the statehouse.

If a new oil shale boom does come to Colorado's Western Slope, these financial mechanisms and their counterparts in Utah and Wyoming will direct a significant portion of money back to the affected communities. Whether it – or any – amount of money will be sufficient to ease the strain of the next boom remains to be seen.<sup>33</sup>

# MANAGING & MITIGATING THE NEXT BOOM

## Why the Time Might Be Right for Oil Shale

During the 2008 legislative session, high energy prices throughout the United States turned a spotlight on the hazards of depending on overseas energy suppliers. As calls to develop domestic energy resources increased in volume and chants of “drill, baby, drill” rang out at political rallies, then-Senator Ken Salazar (now Secretary Salazar) and his allies were unable to extend the moratorium on commercial leasing regulations for another year, and it expired at the end of September.

Secretary Salazar has consistently maintained that he supports the development of oil shale if it can be done in a way that minimizes negative impacts on the human and ecological communities of Shale Country. Several energy companies – notably RD&D lease holders Shell, Chevron, and AMSO – echo this sentiment that oil shale development must be “done right” or not done at all. But with a bout of soaring energy prices fresh in their memories and geopolitical instability rippling through global energy supply lines – lines increasingly stretched thin by rising demand from developing nations like China and India – a growing portion of Americans believe that the United States must move faster to develop more of the energy sources within its borders, including offshore oil deposits deep under the ocean floor and the oil shale buried under the Western Slope of the Rocky Mountains.

### Domestic Benefits

Advocates for tapping more of our domestic energy sources persuasively point to a variety of national security and economic benefits that would accompany such development. Many of the world’s richest oil and gas supplies lie in places wracked by perpetual political instability or controlled by governments that view the US in less-than-friendly terms. Reliance on these unreliable suppliers poses a threat to America’s national security that can be

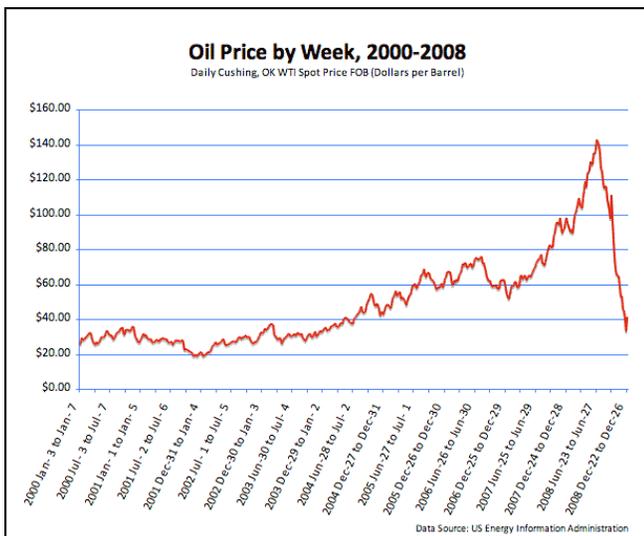
reduced by increasing production of domestic oil and gas resources.

Developing our domestic energy resources is not a panacea. In this globalized century, it is no longer credible to argue that the United States can drill its way out of this energy crisis. It is even time to reassess the late-twentieth-century dream of American energy independence in a fossil-fuel-driven world economy. Nevertheless, the development of major domestic energy sources like oil shale would be a significant step toward gaining greater national control over our energy supply. Oil shale has the potential to shift the center of gravity in the US petroleum supply away from the Persian Gulf and to the Americas, thus freeing the nation from our reliance on unfriendly oil producers overseas.

What’s more, such a shift would curtail the enormous transfer of wealth that results from US dependence on foreign oil. If more oil were produced in the United States, Americans would direct their dollars into energy industry jobs closer to home rather than send huge amounts of capital to overseas oil suppliers.

### Why Now?

The history of efforts to develop an oil shale industry on the Western Slope is not encouraging, but oil shale advocates point to several changes since the last bust that make the industry finally viable in the twenty-first century. First and foremost, global oil production has leveled off and may have reached its peak. In contrast to the 1970s, when oil prices were artificially driven up by the OPEC oil embargo, escalating energy prices today reflect increasing global demand for a truly limited resource. The anomalous oil price whiplash of 2008 notwithstanding, the relatively stable price trajectory created by this tightening market – and the steady revenue streams an upward trajectory will create –



With the exception of the spike in 2008, oil prices have risen steadily throughout the decade, a trend that many energy industry analysts expect to continue in the long term. This relatively stable price trajectory provides steady revenue streams and an economic incentive for energy companies to invest in new resources like oil shale without fearing sudden market fluctuations that might kill new development. Data Source: US Energy Information Administration.

provide an economic incentive for development and make it easier for companies to invest in new resources and new technologies without fearing sudden market fluctuations that might kill new development. Oil shale is near the top of the list of promising new fossil fuel resources to invest in because it is richer in energy than other remaining unconventional resources.

The energy companies at work in Shale Country today believe that, even if crude oil prices level out, oil shale's moment may finally be at hand. As Shell spokesman Tracy Boyd recently put it, "Regardless of where oil prices are, we think the opportunity is great and the benefit is great. We plan to continue our slow and methodical approach and stay the course." Although a commercial industry is still a decade or two in the future, the new generation of in situ technology that Shell and its counterparts in Shale Country are methodically investing in has the potential to make oil shale development economically and environmentally viable. And at a moment when national security concerns are converging with economic anxieties in a troubling pattern, the prospect – and potential ramifications –

of developing this massive domestic energy resource staggers the mind.<sup>34</sup>

## Environmental Impacts

### The Federal Government's Dark & Cloudy Crystal Ball

In September 2008, the BLM released its long-awaited final Programmatic Environment Impact Statement (PEIS) on oil shale lands. In the 1400-page document, the agency identified 3 broadly different development scenarios and the potential consequences of each. The first option, Alternative A, was to take no action and leave things as they stand in Shale Country (including the 6 RD&D leases but no other development on federal land); Alternative B proposed opening nearly two million acres in Colorado, Utah, and Wyoming to commercial oil shale leasing; and Alternative C advanced a more restrictive leasing program that would make roughly 830,000 acres available for development.

The BLM identified Alternative B as its preferred choice. As the statement's authors considered in turn the various consequences that the latter two plans might carry for the region's communities, economy, and environment, a breathtaking portrait of commercial oil development's consuming impact came into sharp focus.

The BLM predicted that the full development of a commercial oil shale industry under Alternative B will supplant nearly all other uses of the land, including recreation, ranching, agriculture, and all other oil and gas development. While oil shale development will bring thousands of new jobs to Shale Country, this displacement of traditional land uses is likely to cost thousands of jobs in existing industries like recreation. Where the balance lies in this exchange – whether an oil shale industry will mean a net gain or loss of jobs in the area over the long run – is a calculation that contains too many variables to figure with certainty.

Wildlife will assuredly lose habitat wherever development occurs, and the trappings of

development may increase the animals' stress and alter their behavior patterns. Plants will lose habitat and are likely to face increased competition from nonnative invasive species. Fish will suffer from any drop in water quality or flow volumes throughout the region's waterways.

Depending on how much water the extraction process requires, the industry may need to buy up agricultural water rights, putting an end to irrigated farming in some areas. Water quality is likely to be degraded under routine industry operating conditions, and the risk of severe contamination of surface or ground water from spills, faulty procedures, and inadvertent pollution is ever present.

Air quality is also liable to suffer due to emissions from oil shale operations and associated population growth, but the BLM cannot say to what degree until companies are able to provide more detail about their production processes.

The large and rapid population influx will urbanize the small rural communities around the shale fields as "substantial demographic and social change" makes itself felt. Traffic congestion will increase on roads never designed for such volume. Property values are likely to decline in places near operations, particularly for ranches. In periods of extreme growth, community social structures may break down under the strain, producing a whole host of negative results that raise the specter of Gillette Syndrome, including rising crime, increased domestic violence, higher rates of depression, substance abuse, and suicide.

The BLM's assessment of socioeconomic impacts concludes that "communities hosting these developments are likely to be required to adapt to a different quality of life, with a transition away from a more traditional lifestyle involving ranching and taking place in small, isolated, close-knit, homogenous communities with a strong orientation toward personal and family relationships, toward a more urban lifestyle, with increasing cultural and ethnic diversity and increasing dependence on formal social relationships within the community."<sup>35</sup>

It is a sobering assessment. What is a city government to do when confronted with the immense and complex impacts of full-scale commercial oil shale development? Which impacts should the communities of the Western Slope focus on mitigating if a new oil shale boom does come? What will these impacts mean for the energy companies trying to ensure that things are "done right"? No one can know the future, but even at this early stage it is clear that attention to certain social, economic, and environmental considerations might help moderate the trials associated with oil shale development.

## People

### The Socioeconomics of Planning for a "Maybe Boom"

Although locals often refer to Black Sunday as "the Exxon bust," the disaster tarred the entire industry and every operator in Shale Country today must continue to deal with the fallout. The next round of oil shale development will occur in the shadow of the past. Operators should be aware that their actions are being evaluated against and constantly compared to what happened before.

When Western Slopers discuss current prospects for development, it is almost always within an assumed context of boom and bust. Those who oppose renewed efforts to develop oil shale cite the earlier experience as a cautionary tale, while even those who support oil shale development, such as the leaders of Club 20 and the Associated Governments of Northwest Colorado, do so within a framework that lauds the deliberate pace of the RD&D program (often without mentioning the commercial leasing program) in contrast to the crisis-driven efforts of the 1970s.<sup>36</sup>

The sting of the 1982 bust is far from forgotten among residents who managed to stick it out, nor is the power of this experience lost on newcomers (a term that can follow a person around for a good portion of a lifetime in some Western Slope communities). The bust dogs discussions of current development projects. Very few people – with the

striking exception of some boosters and people associated with the energy companies – talk about oil shale as a career-length or sustainable economic endeavor. Indeed, the presumption on the Western Slope seems to be that the current cycle of development will follow the traditional boom-bust route, and those local officials responsible for managing its impact seem focused on softening the ride.

Managing the human impact of the development cycle is not only the responsibility of local governments. As a matter of corporate citizenship, but also as a matter of self-interest, the designers and managers of the next generation of oil shale operations must consider the social and economic consequences that their endeavors might carry for surrounding communities. The negative impacts of unmanaged boomtown growth have a clear adverse effect on energy operations, because a poor or deteriorating quality of life makes it difficult to retain an adequate and experienced workforce, and a substandard workforce equals less-than-optimum production. Furthermore, quality of life for energy workers is often colored by their employers' relationship with the existing community, and oil shale companies still have a great deal of work to do in rehabilitating their relationships on the Western Slope.

These companies stand to benefit in many ways from efforts to conduct the RD&D process with strong community involvement and sensitivity to stakeholder concerns. Actions perceived by local residents as careless or hasty will call up the specter of Black Sunday and reinforce animosity, if not create outright opposition, among community members. As an influential 2005 report from the RAND Corporation puts it, mildly, "Given the past volatility and future uncertainties associated with oil shale development, as well as evolving views in the United States toward environmental protection, open-space preservation, energy policy, and stakeholder involvement in local decisionmaking, an attempt to rush or shortcut development is likely to generate significant opposition at the local, state, and even national levels."<sup>37</sup>

## Boomtown Balancing Acts

Even with the best of corporate-community relationships and well-crafted mitigation strategies designed to reduce and cope with social stresses, resource booms can seem like a mixed blessing to the communities experiencing them. A quick look at the multifaceted impact of the recent boom – and, at the outset of 2009, the whispers of a bust – testifies to the challenges community leaders face as they work to balance the benefits and burdens of sudden prosperity.

As energy companies arrived in the area during the first part of the decade to work the oil and gas deposits, revenues, costs, and growth rates jumped in Garfield and Mesa counties in Colorado, where the boom is centered. Nearly every community in the two-county area grew by at least 6% between 2000 and 2006 (the most recent data available as we write), with regional center Grand Junction showing 11.7% growth (41,986 to 46,898) and the small town of New Castle posting the most prodigious growth rate at 66% (1984 to 3294). These communities have struggled to expand services at a rate that kept pace with growth.



A new building goes up on the outskirts of Rifle, Colorado. The influx of people arriving to work on the area's oil and gas operations has left housing in short supply in towns like Rifle. An oil shale boom overlapping with the current oil and gas boom could exacerbate the shortage. Credit: Jason L. Hanson (Oct 2007)

Oil shale development is likely to increase that challenge for the city of Rifle and its Garfield County neighbors, which stand to absorb the lion's share of impact from the in-migration of workers and their families. Meanwhile, most of the operations that brought them into the area will generate tax revenues across the county line in Rio Blanco County.

In Rifle, which grew from a population of 6784 in 2000 to 8446 in 2006, some studies have predicted that the town will top 20,000 residents by 2020. The growth is already beginning to take a toll: rising crime rates have stretched the police department thin, traffic-choked city streets laden with heavy trucks have prompted complaints from residents, and rapidly rising property values have made it difficult for middle class workers to live in the community.

As the median home price around Rifle skyrocketed from \$191,000 in 2003 to over \$297,000 in 2007, vital members of the town's workforce have been increasingly forced to live down the valley as far away as Grand Junction and commute. In the summer of 2007, more than 20 prospective teachers turned down job offers because they could not afford the housing costs in town (average net monthly pay for a new teacher in the district ranged to about \$2100, while an average 3-bedroom home commanded around \$1200 a month).

"Unless you have a two-person income, you're struggling to make ends meet here, and it's driving our workforce out of the area," explained Mayor Keith Lambert. "Teachers, police, firemen, hospital employees . . . all are having to look elsewhere to live." And the problem shows no sign of abating, despite the recent downturn in the nation's housing market. According to county assessor John Gorman, average home values throughout Garfield County declined only a little by the end of 2008.

Reeves Brown, the Executive Director of Club 20, neatly summed up the conundrum these communities find themselves facing: "One person's high-paying energy job is another person's housing shortage." And housing isn't the only commodity that has been in short supply in Garfield County.

Due to the demand from energy operations, gravel costs skyrocketed in recent years, multiplying the cost of numerous construction and road-building projects and raising the distasteful prospect of importing gravel from Utah. County officials have been forced to anticipate the energy boom's impact on every aspect of the local economy, literally down to the smallest pebble, when planning their coping strategies.

The story has been similar in Mesa County, where home prices increased 52% from \$129,000 in 2003 to \$196,000 in 2007 before dipping slightly in 2008. For officials at Mesa State College, students rather than teachers have been the concern, as male high school graduates have increasingly chosen oil and gas jobs with salaries that can hit \$80,000 rather than pursue higher education. Community leaders worry about the long-term effect of an undereducated population, yet business owners have appreciated the impact these high wages have had on the local economy. Over the course of the boom, restaurants in Grand Junction and other Western Slope communities have grown accustomed to pouring double shots of top shelf liquors to help diners wash down their premium-cut steaks. And before spiking gas prices and the national recession put a damper on truck sales, auto dealerships in Grand Junction had trouble keeping enough pickup trucks on the lot.<sup>38</sup>

Although the oil and gas boom insulated Western Slope communities against much of the worst of the recent national economic downturn, by the beginning of 2009 there were signs that the recession may be overtaking the industry – and the people who have come to rely on it. In the energy fields, although active wells continued to pump and construction went forward on a gas processing plant in Rio Blanco County, companies began to scale back plans for new wells and idled a significant number of the drill rigs they had been operating in the area. In town, even as construction proceeded on four new hotels in Rifle, homebuilding throughout the area slowed, and houses that once rented the same day they were listed began to sit on the market for weeks. At stores along these towns' Main Streets, lines began to form for job openings that had



A gas drilling rig located along Piceance Creek in Colorado. The current oil and gas boom in and around the Piceance Basin has had a powerful impact on nearby communities in Garfield, Mesa, and Rio Blanco Counties. Credit: Jason L. Hanson (Oct 2007)

previously gone unfilled, and area employers such as Wal-Mart in Rifle were able to staff all available positions for the first time in years, even as some considered cutting positions to reduce payroll expenses.

As this slump has taken hold, industry officials have begun to talk of “operating lean.” Community leaders like Rifle Mayor Keith Lambert have noted a “slowdown” but point out that town populations are still growing and the current situation is much different from the abrupt crash of Black Sunday. Nonetheless, a few roughnecks and area residents have begun to openly talk of a “bust.”<sup>39</sup>

### **The Dark Side of the Boom**

The problems posed by housing shortages, overstretched city services, and declining education rates trouble Western Slope communities negotiating the recent energy boom, but perhaps the issue that raises fears of Gillette Syndrome most ominously is the growing prevalence of substance abuse. In today’s energy boomtowns, the drug of choice is methamphetamine.

The prospect of a meth boom paralleling the energy boom is a particularly sobering thought for Western Slope community leaders already struggling to cope with a mounting epidemic. Methamphetamine is a highly addictive central nervous stimulant that can

be made from inexpensive household items and over-the-counter products. It produces a euphoric sensation while increasing energy and decreasing the user’s appetite. However, it can lead quickly to increased feelings of depression, and long-term meth use can cause heart problems, dental decay, significant and permanent changes in brain function, paranoia, hallucinations, delusions and other symptoms of psychosis, violent behavior, and, in some cases, death.

In addition, the process of making meth creates an explosive and highly toxic environment, putting everyone in proximity of the meth lab (including police and first responders) at risk whether or not they use the drug. Meth use ripples through the entire community, increasing the burden on healthcare providers, social services, foster care, police, the legal system, and prisons.

On the Western Slope, energy development is linked to a subculture of meth use that exacerbates these existing problems. Despite increased drug testing by companies in recent years, “you’re either wired or you’re fired” is a common saying among workers spending long days on the drill rigs, according to one well-traveled roughneck.

Reliable numbers that directly measure the causative relationship between energy development and meth use are difficult to come by, but it is hard to ignore the correlation between the timing of the oil and gas boom and the upsurge in meth use. According to a 2007 study, criminal cases involving meth in Mesa County increased by more than 40% between 1999 and 2007. The peak came in 2006, when meth was a factor in 89.3% of cases before the county’s courts.

Western Slope communities are fighting back. In 2005, Mesa County established a meth task force to stem the growing crisis. To help heal the social fabric torn by meth abuse, the county opened a \$5 million treatment center for addicts in June 2007. And in November 2007, the county district attorney’s office created a position for a full-time prosecutor to step up the legal battle against meth.

These aggressive countermeasures appear to be paying dividends. During the 2008 fiscal year, meth was a factor in only 69% of the county's court cases.<sup>40</sup>

### **How to Plan for a “Maybe Boom”**

The recent oil and gas boom coincides geographically with the prospective oil shale revival. In social and local economic terms, any future oil shale boom will, to some degree, look similar to the bonanza of the past few years. Operators looking ahead to oil shale will do well to study the examples now before them.

But if the recent oil and gas boom is a case study, it is one that will help shape the scenario it is meant to predict. Decisions and actions taken by oil and gas companies over the past few years are affecting the people and environment of the Western Slope in ways that will influence a future oil shale industry.

How that influence is felt will depend in large measure on the timing of the decline of the oil and gas boom and the upsurge in future oil shale development. If the current slowdown in oil and gas activity stretches into a full-fledged bust, how long will the Western Slope idle in economic doldrums before oil shale comes on line? Or will oil and gas production rebound and continue long enough for the two booms to pile on top of one another, stretching already strained communities to new levels? Or, ideally, might they dovetail sequentially, allowing impacted communities to continue using the expanded infrastructure and services already in place, as oil shale workers arrive to take advantage of housing, infrastructure, and services created for oil and gas workers? This finely calibrated (and somewhat improbable) transition would postpone the economic contraction brought by the end of energy development and make the job of community planners much easier.

With so many unanswered questions still surrounding oil shale production, communities looking ahead to the coming “maybe boom” face the difficult task of simultaneously planning for both a shortage and an overabundance of municipal

infrastructure, affordable housing, and even willing school bus drivers and other service providers. Officials at the city and county level expect the development of a commercial-scale oil shale industry, if it happens, to overlap with the current oil and gas economy, but no one is sure by how long, to what degree, or exactly how to plan for it.

What does seem clear is that the ways in which companies address and manage socioeconomic issues related to oil shale development will in large part determine how or whether the industry succeeds. “If we’re not able to address the socioeconomic issues,” one presenter told his audience at the 2007 Oil Shale Symposium at the Colorado School of Mines in Golden, “even if we have the economics and the technology to develop oil shale, we’re not going to be allowed to develop oil shale.”<sup>41</sup>

### **Land & Ecology New Ways to Count Coup**

There are no more unloved places in the American West, and all proposed sites for pits or well pads and their support infrastructure are likely to provoke spirited debate about the consequences they carry for the people, wildlife, plant life, and landscapes of the Piceance Basin.

Surface mining and retorting methods generate daunting and distasteful environmental challenges. The disposal of processed shale rock, in particular, presents problems for the reclamation of surface mines. Once the fuel has been removed, the crushed rock has expanded in volume, resists revegetation, and poses a threat to groundwater through toxic leaching. In situ extraction promises to be much less disruptive to the land surface than traditional surface or underground mining, although little is known about the prospects or challenges of reclaiming an in situ site.

Either method of oil shale extraction will require a significant buildup of infrastructure and the long-term withdrawal of lease sites from current uses. In addition to well pads, in situ operations will need

support infrastructure such as roads, pipelines, processing facilities, water storage and supply facilities, power supply and transmission systems, hazardous materials handling facilities, construction staging areas, man camps, and the other trappings of energy development.

Furthermore, some in situ processes currently in development may require dramatically more power than traditional mining operations in order to heat the shale underground over time, and no one is sure yet how many power plants such operations might need, where they might be located, or whether they will be coal-fired or rely on alternatives such as solar or wind power (both potentially viable options on the Western Slope, raising the tantalizing possibility that the companies could work at developing two new energy sources at once). Finally, after tabulating all of the effort and energy required to extract oil from the rock, no one is certain what the net energy gain will be.

### Coming Into Crowded Country

Whatever facilities are required, they will be shoehorned into in already well-occupied country. Wild horses, mountain lions, and black bears roam the landscape overlying the oil shale deposits, which currently hosts a variety of human uses as well, including hiking, hunting, fishing, sheep and cattle grazing, and oil and gas drilling. The region is home to large herds of elk, mule deer, and pronghorn antelope that draw 28,000 hunters annually, along with increasing numbers of outdoor recreation enthusiasts armed only with cameras. The Piceance Basin contains a diverse ecosystem that encompasses a variety of distinct habitats and provides a home to a wide assortment of plant and animal species, including several that are at risk and protected to varying degrees:

- Bald eagle (bird, threatened)
- Sage grouse (bird, candidate for listing)
- Colorado pikeminnow (fish, endangered)
- Boreal toad (amphibian, candidate for listing)
- Dudley Bluffs bladderpod and twinpod (plants, threatened)

- Parachute beardtongue (also called Parachute penstemon, plant, candidate for listing)

Overall, the various federal and state agencies charged with managing the ecological health of Shale Country list 210 species as sensitive, threatened, endangered, or otherwise protected by the federal and state governments. The plant species are particularly at risk from oil shale development because much of their habitat is found on what the BLM has categorized as “geologically prospective” land. The Dudley Bluffs twinpod, for instance, is a small perennial named for its heart-shaped fruits that grows in only a dozen places in the world, and all of them sit above oil shale deposits in Rio Blanco County.<sup>42</sup>

### Land Wars: Ecosystems Under Siege

If operators move into the remote expanses of the Piceance, they will be traversing through Pinon-Juniper Woodlands and Sagebrush Steppe, two distinct ecosystems found in Shale Country. The Pinon-Juniper Woodlands may provide a home for more bird species than any other habitat on the Colorado Plateau, but scientists know little about the impact of human activity on this ecosystem. The Sagebrush Steppe, on the other hand, we know to be an ecosystem in trouble. An arid landscape of crusty earth, dotted by shrubby big sage plants and native perennial bunchgrasses, which stretches across eye-



The Dudley Bluffs twinpod is one of the plants threatened by oil shale development. A small perennial named for its heart-shaped fruits, it grows in only a dozen places in the world, and all of them sit above oil shale deposits in Rio Blanco County. Credit: US Fish and Wildlife Service



The sage and juniper that dot the landscape at the Chevron RD&D lease site are typical of the Piceance Basin ecosystem. Credit: Jason L. Hanson (Oct 2007)

straining expanses of western scenery, Sagebrush Steppe is the dominant lowland plant community in the Intermountain West.

Once nearly ubiquitous throughout the Great Basin, the sagebrush ecosystem is now threatened by the spread of an exotic annual species called cheatgrass. Cheatgrass grows quickly in sagebrush country and provides fuel for fires that burn with more frequency and greater intensity than in the past. Unaccustomed to fire, sagebrush plants are killed completely by it and can take centuries to reestablish, clearing the way for more cheatgrass and the repetition of the cycle across more and more acreage. As a result, millions of acres of former sagebrush country are now virtual monocultures of cheatgrass, and thus a very poor habitat for native species.<sup>43</sup>

Cheatgrass is not the only destructive invasive species threatening Shale Country. Tamarisk trees (also known as saltcedar) line waterways and drink more than their share. Oxeye daisies virtually pave over once-diverse meadows. Poisonous black henbane waits for unwitting victims. Russian olive, leafy spurge, yellow starthistle, and a host of other wonderfully named but terribly destructive noxious weeds are encroaching on native habitats throughout

Shale Country. (For a full overview of the invasive plants threatening Shale Country ecosystems, check the state noxious weed lists for Colorado, Utah, and Wyoming.) Once these invasive plants have been introduced into an ecosystem, long-term biocontrol measures, including the uncomfortable prospect of introducing of other nonnative competitors, are often the only strategy for effectively controlling them.

But natural species are pretty good competitors when given a fair chance, and a healthy native plant community left undisturbed can usually hold its own against intruders. Invasive species usually require help to gain a successful foothold, and humans (and their livestock) are often their unwitting assistants. Every time indigenous ecosystems are disrupted – every time a road is built or a development goes in or a pasture is overgrazed – it creates a chink in the natural armor, a vulnerable place that can be assailed by nonnatives, and the problem grows. “Build a road and weeds are sure to follow,” Colorado State Weed Coordinator Kelly Uhing recently explained, “unless you have a good plan to prevent that from happening.”<sup>44</sup>

Even with good plans in place to limit impacts, oil shale operations will encroach on the habitat of a

number of native species and expand the human/wildlife zone of conflict both directly and indirectly. Equipment brought from other sites may carry with it destructive nonnative species like cheatgrass. Roads and foot trails will break up the fragile microbiotic crust, the thick organic layer of “desert pavement” that stabilizes and increases the fertility of the soil in this sparse and windswept landscape, creating vulnerable places for invasive species to establish themselves. Well pads and facilities will displace the dwindling sagebrush.

Habitat loss and the creation of larger production sites and corridors will disrupt wildlife migration patterns. The noise from compressors may inhibit the reproductive success of birds nesting in nearby pinon and juniper trees. The man camps set up to house workers near operations in an effort to reduce the stress on area communities and roads may become magnets for black bears hoping to score an easy meal – a dangerous situation for humans and often a fatal one for bears, which must be killed if they persist.

Indirectly, as leasing closes off portions of the public lands, the increased population brought to the area by development will intensify the use of those lands that remain open. Energy companies and BLM managers will need to carefully consider the impact (and legal ramifications) that even minimal destruction of habitat might have and develop a coordinated strategy to manage and minimize impacts on plants and wildlife.

### **Balancing Bulls With Booms**

So what are we to do? Should we assign an economic value to plants, fish, and all of the other members of an ecosystem, measure their worth against our need for oil, and live with the consequences of choosing either environmental preservation or energy development?

Quantifying the value of preserving a certain species or a specific place is, at best, an imprecise enterprise and, at worst, downright quixotic. In contrast, calculating the monetary worth of a commodity like the oil that might be extracted from the Piceance



A dirt road cuts through the sagebrush landscape near the Chevron RD&D lease site, providing access to oil and gas operations in the area. Roads can have a major impact on ecosystems, providing an entry point for invasive species and disrupting wildlife movements. Credit: Jason L. Hanson (Oct 2007)

Basin is a comparatively straightforward undertaking. Furthermore, it can be difficult to articulate what benefit protecting a species like the Colorado pikeminnow or the Parachute beardtongue imparts to people on the Western Slope, much less those in Boston or Bogota or Beijing. But it takes only the turn of a car key to appreciate the benefits of plentiful oil.

In the past, when American society has debated the inherent value of preserving an intact and undisturbed environment in contrast to the measurable value of developing natural resources, the benefits of development have traditionally triumphed. Fortunately, energy development in Shale Country does not necessarily present us with this type of either/or framework (though the tenor of contemporary political and environmental debates may suggest otherwise).

Groups like the Nature Conservancy believe that there is a way to have our cake and eat it too – or to have our Dudley Bluffs twinpod and the gas to drive out and see it too – if development proceeds with deliberation and a commitment to balancing the

value of developing resources against the significant inherent values these ecosystems possess in their undisturbed state. Allowing that our modern standard of living requires the development of some natural resources, these pragmatic environmental advocates work to identify and protect crucial areas that will permanently ensure the area's biodiversity without putting every acre off limits.<sup>45</sup>

The Nature Conservancy is part of a diverse and often disconnected collection of groups and individuals concerned about the environmental impact of oil shale development. In Shale Country, the opposition to energy development cannot simply be written off as agitation by overwrought or elitist armchair environmentalists. The Western Slope's breathtaking scenery and magnificent wildlife attract tourism that amounts to a significant economic driver for local communities – greater in the long term than energy development, by some estimates. The concerns of the tourist industry are reconfiguring traditional opponents and allies in ways that complicate stereotypical notions of what it means to be an environmentalist. Predictable liberal environmental constituencies have been joined by hunters, ranchers, and other close-to-the-land conservatives on the Western Slope (a reliable conservative stronghold since the waning years of



A bull elk is silhouetted against the Colorado sky. The opportunity to take such pictures has contributed to a valuable tourism industry on the Western Slope. Many people feel that the region's existing economic drivers, such as tourism, are threatened by the landscape-sized signature of energy development. Credit: Jason L. Hanson (July 2008)

the New Deal) to urge cautious and limited energy development.

At the center of these strange but increasingly compatible bedfellows are the outfitters who guide backcountry hunting and packing trips. Like others who earn their living from the land, outfitters often feel the environmental impacts of development through direct economic consequences. The greatest impact comes from roads punched through previously roadless areas, with their rumbling traffic and fringe of nonnative species, which carve artificial boundaries through habitats and displace wildlife. “Roads destroy everything” was the blunt assessment offered by Kurt Schultz of the Colorado Outfitters Association.

The outfitters, like many others who share concerns about oil shale, do not expect to prevent energy development altogether, and they accept that some roads will have to be built and some areas may be unusable for a while. They want to be involved in a discussion with the energy companies over how to proceed in a responsible way that acknowledges and seeks to balance the range of values found between the poles of unhindered development and absolute preservation.

The incentive to strike this balance in the picturesque country of the Western Slope has grown in recent years as guides have discovered a new and growing source of income in nature tourism. For the modern outfitter, counting coup on the screen of a client's digital camera can be more lucrative than traditional trophy hunting. “A lot of our outfitters are finding that there's more money in watching wildlife than shooting it,” Mr. Shultz explained. “You can take one hunter out to shoot a bull, and then that bull is gone. Or you can take 10 people out to see that bull and take pictures, and then 10 more people out the next day to see that same bull, and soon you're saying ‘Don't shoot that bull!’”<sup>46</sup>

As the value of such experiences increases, so too does the likelihood of conflict over well pads, roads, and the other aspects of energy development's footprint on the land. It takes only a few small steps to go from “don't shoot that bull!” to “don't put a

road through that bull's range!" to "don't put a rig in the background of my photo of that bull!" In areas of energy development, a picture is liable to provoke a thousand words of protest and acrimonious debate. The visual impact created by energy development can stir up great environmental controversies without even mentioning ecological or economic concerns. Simply put, many people – both tourists and residents – do not like to see the machinery of energy development where they expect wide-open Western spaces, and they will fight to protect the scenic integrity that many take to be a key aspect of quality of life.<sup>47</sup>

## **Water** **More Precious than Oil?**

Westerners have long observed that the region is short on water. The Colorado River Compact of 1922 made the traditional lament a mathematical truth by apportioning the river between upper and lower basins based on data from some of the wettest years ever recorded.

Using flow rates from 1905 onward, the negotiators of the Colorado River Compact calculated the average flow of the river to be 16.4 million acre feet and agreed to split 15 million acre feet evenly between the upper and lower basin, divided at Lee Ferry at the head of the Grand Canyon, 10 miles from the Utah border in northern Arizona. The upper basin states of Colorado, Wyoming, Utah, and New Mexico agreed to deliver at least 75 million acre feet to Lee Ferry during every 10-year period. This formula (as opposed to requiring 7.5 million feet every year) leaves some wiggle room for the upper basin to adjust how much it delivers year to year in accordance with the river's flow, but it ultimately gives the lower basin states of Arizona, Nevada, and California a priority claim to their full share.

However, in the years since the agreement was reached, the river's flow has fluctuated widely, and often it has not met the levels assumed by the compact's architects. In December 2007, prompted by a tenacious drought that has kept river flows low since 2000, the compact states collaborated with the

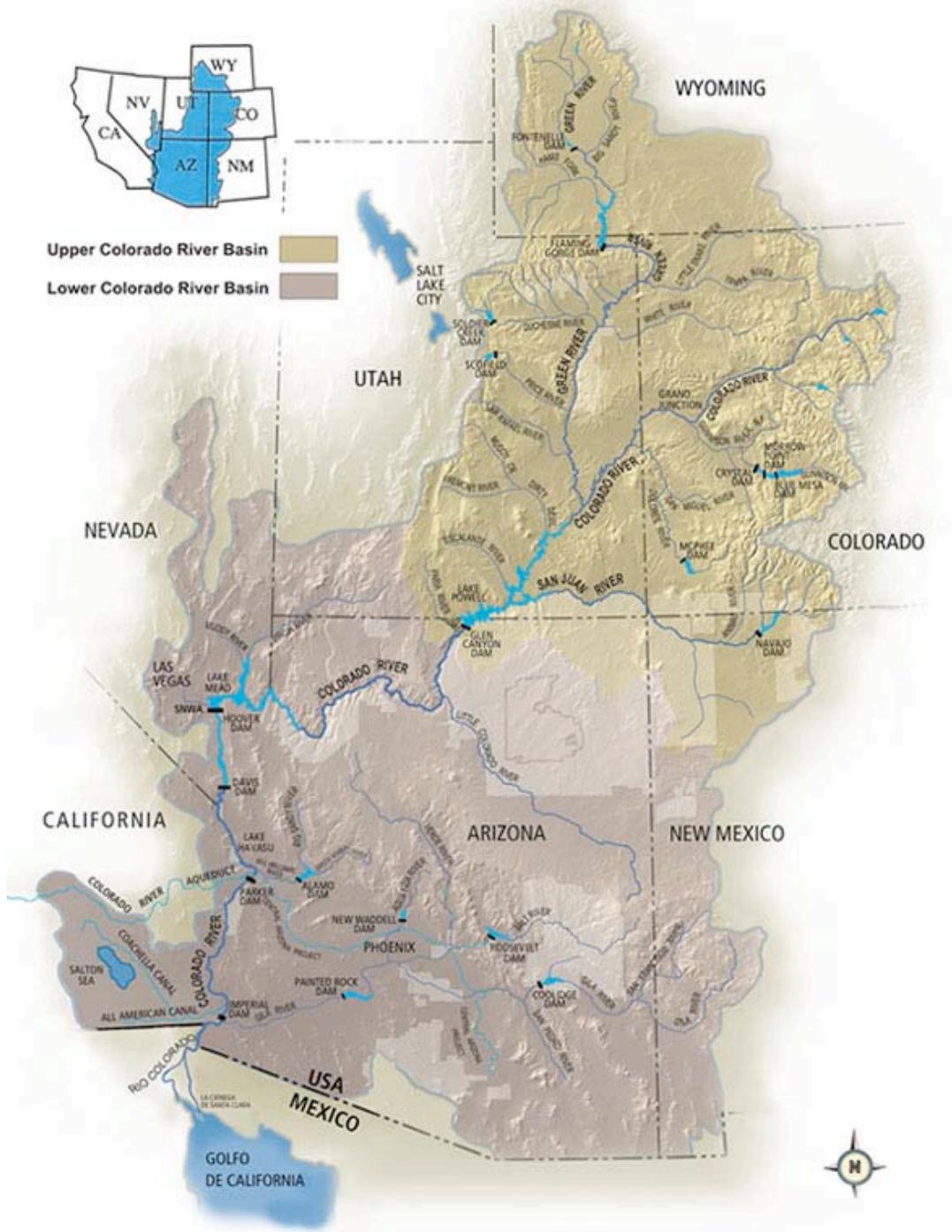
Bureau of Reclamation in the Department of Interior to agree upon new guidelines to follow in such times of shortage. The new supplementary agreement helps water managers plan drought strategies with greater certainty by specifying the order and timing in which states will take reductions of their water supply. It also creates provisions for increasing coordination and conservation throughout the system, essential aspects of effective water management as population and demands upon the system continue to grow throughout this arid region.<sup>48</sup>

## **A Potential Dealbreaker**

Historically, problems from the overestimation of the river's annual average flow have been postponed, because the upper basin states have used much less than their share. But this is changing as growing numbers of coastal Americans relocate to the Rocky Mountains and to the desert Southwest, especially to swelling cities like Phoenix, Tucson, Las Vegas, Denver, and Salt Lake. These booming population centers are now laying claim to their share of the river, considerably reducing the margin of surplus in the system that Southern California had been soaking up. In fact, in 2003 Secretary of the Interior Gale Norton ordered California to relinquish 800,000 acre-feet it had grown accustomed to using because the water rightfully belonged to the upper basin states.<sup>49</sup>

Today, more than ever before, a variety of competing industrial, municipal, agricultural, tribal, and environmental interests in 7 states as well as Mexico battle over every acre foot of water in the Colorado River system. Farmers and ranchers, recreational anglers and whitewater rafters, and residents of major metropolitan areas, not to mention endangered fish species and the other members of the region's intricate ecosystem, rely on adequate flows and water quality in the Colorado and its tributaries. Water is a potential dealbreaker for any extraction process that requires too much or poses too great a risk of groundwater contamination.

At the outset, water for an oil shale industry will likely come out of local sources such as the White



The Colorado River system reaches through most of the southwestern United States. Credit: Glen Canyon Dam Adaptive Management Program

River, which runs along the northern edge of the Piceance Basin and into the heart of the Uintah Basin. Operators may also tap the Colorado River running to the south of both basins, and Shell recently made a claim farther afield on unappropriated waters in the Yampa River to the north. Companies have obtained water most often by purchasing senior water rights from established users. They might also claim unallotted water in the system (if they can find some, as Shell did in the Yampa's spring runoff flows), or theoretically they might bring water to the area from outside the Colorado River Basin (a tricky engineering and legal maneuver that Exxon briefly proposed during the previous boom).

Of the 3 companies with RD&D leases in Colorado, Chevron maintains the largest claim to existing water rights on the Western Slope as a result of its involvement in the earlier booms, but Shell has been actively purchasing them and making claims in recent years. Both trail ExxonMobil, which owns the most water rights of any energy company in Shale Country. According to a report from Western Resource Advocates (WRA), an environmental law center that conducted a survey of water rights in Shale Country, 6 energy companies have filed for a total of 7.2 million acre-feet of water rights on the Colorado and White Rivers. The amount equals nearly the entire Upper Basin allotment under the 1922 Colorado River Compact, although it is not credible to suggest that all of these rights would be developed at the same time.

Shell disputes some of the WRA report's methodology and conclusions about how much water has been claimed for oil shale, but the company does not deny that a future oil shale industry will require significant amounts of water. Shell contends that maintaining a broad water rights portfolio is the best way to provide the flexibility needed to avoid impinging on other users, but users with junior rights – including many cities along Colorado's populous Front Range that rely on water drawn from the other side of the Continental Divide – are nervous that large scale oil development will make it more difficult to attain the water they count on.<sup>50</sup>

No one is yet sure how much water a commercial-scale industry using a next-generation in situ process will require, but the engineers and scientists working on it are confident that they can do a good bit better than their predecessors. The traditional mining and retort methods planned and tested in the last boom require tremendous quantities of water for dust control, scrubbing off-gasses, hydrogenation, evaporative cooling, disposal, cooling and compaction of spent shale, revegetation of spent shale, and other uses in the production process. Estimates made during the previous boom range between roughly 2 and 5 barrels of water for each barrel of oil produced from shale. In situ recovery methods promise to consume less water because the disposal, cooling, compaction, and revegetation of spent shale would be unnecessary (although other stages of an in situ process might need considerable volumes). The best current estimates for in situ water requirements are between 1 and 3 barrels of water for each barrel of oil (with some companies like AMSO and Chevron promising to use even less), but it will not be clear exactly how much water they will need until operations are ready to be scaled up to larger operating dimensions.<sup>51</sup>

The new generation of in situ processes that energy companies are studying and testing in Shale Country today – ambitious technologies that significantly reduce the amount of water required to produce a barrel of oil, and even allow Chevron to envision being what it calls a net producer of water – have to be more economical with water than their predecessors because they are being designed under greater constrictions.<sup>52</sup> Water demand is rising with population throughout the Colorado River system, leaving a smaller and smaller portion available for new industries. The manifold impacts of increased water usage for an oil shale industry near the headwaters will ripple downstream through the entire basin, reducing hydroelectric power generation, sharpening the effects of drought, requiring more water storage facilities, and impairing the already fragile fisheries. Prized species such as the Colorado River cutthroat trout and endangered fish such as the humpback chub, bonytail, Colorado pikeminnow and razorback sucker stand to lose substantial portions of their

habitats and populations from reduced instream flows.<sup>53</sup>

### How Much Is Left?

Complicating any predictions about water in the Colorado River basin is the latest global warming forecast, which calls for earlier and faster snowmelts and even drier summers throughout the West in the coming century. The specter of climate change combined with booming population growth throughout the basin introduces myriad uncertainties into discussions of how much water will be available for industry and other users in the future.

Under such indeterminate conditions, planning is a tricky proposition at best. Some studies suggest that, with the addition of more reservoir storage on the system, the Colorado River system contains enough water to support the region's population growth and an oil shale industry in coming decades. In its Final PEIS, the BLM concluded that there was water still available in the Colorado River system to support oil shale development in the three Upper Basin states that constitute Shale Country. Some advocates specifically point to the 800,000 acre-feet of water relinquished by California as enough to supply the industry. Other equally confident analyses predict severe shortfalls that may dry up key reservoirs such as Lake Mead and Lake Powell in a little over a decade, leaving the parched region unable to support even current inhabitants, much less a growing populace or new water-intensive industries.

In Colorado, no less an authority than Eric Kuhn, the General Manager for the Colorado River Conservation District, cannot be more precise than this: "Colorado has either a lot of water to develop – upwards of another million acre-feet – or Colorado may already be at or above full development of its Colorado River supplies at certain periods." And the situation changes from year to year as river flows rise and fall, leading the BLM to note that just because water is available under the allocation formula of the Colorado River Compact, "this calculation does not imply that the water is readily or physically available." In fact, by the time they produced the Final PEIS, the agency had backed

away from some of its more confident earlier claims about the availability of water for oil shale development. Seeking to put a number on just how little might be left, Eric Kuhn has suggested that the river may have only 150,000 acre-feet left to reliably give in Colorado, far below the figure of 1.5 million acre-feet commonly cited by state officials.<sup>54</sup>

In addition to intensifying questions about the finite quantity of water available in the basin, oil shale operations – both traditional mining and surface retorting methods and, to a lesser extent, in situ methods – pose a number of challenges to water quality. Depending on the extraction process and technology, oil shale production may produce quantities of saline water large enough to impair the quality of local surface water. Retorting produces water with high levels of pH capable of dissolving and thereby introducing into the environment toxic metals such as arsenic and selenium. Carbonate salts are also a common byproduct of oil shale retorting processes, but their environmental impact may be minimal if left in the ground and isolated from ground water systems.<sup>55</sup> However, these threats depend upon – and vary in response to – local geographic and hydrologic conditions and the exact extraction processes used. And, as we mentioned earlier, every in situ method currently in development seeks to minimize threats to groundwater, albeit through some very divergent methods.



The Colorado River flows out of the Rocky Mountain high country and along the southern edge of Shale Country. It is not clear how much water new oil shale production technologies will require, but in the thirsty Colorado River Basin, water is a potential dealbreaker. Credit: Jason L. Hanson (September 2008)

The number and degree of challenges to water quality presented by new in situ processes are still largely in the speculative realm. A number of key questions around water await answers as the RD&D process begins. How much water will production require? Is it available? In the heavily appropriated Colorado River system, who (if anyone) loses water if industry gains it? Can creating freeze walls or controlled fracture zones control groundwater contamination and maintain water quality? And in such a thirsty region, what should operators do with the water pumped out of the extraction zone (a problem that has confounded operators in other energy fields)?

Answers to these questions are, according to a 2005 RAND analysis, still a number of years away, raising the prospect that, unless policymakers dramatically slow down the commercial leasing program outlined in the 2005 Energy Policy Act, the first commercial-scale operations may be permitted and built without this information.<sup>56</sup>

## **Air**

### **Success on the Horizon**

The air over Shale Country is largely clear and free of pollution, features that have earned it protection under the Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act. The Environmental Protection Agency (EPA), the federal agency charged with overseeing air quality throughout the nation, enforces strict limits on air pollution throughout the region. These constraints – particularly those driven by a recent ruling that extends the EPA’s authority to regulate greenhouse gasses such as carbon dioxide under the Clean Air Act, as well as the potential for forthcoming federal legislation that caps greenhouse gas emissions – are poised to have a significant impact on the siting and permitting of oil shale operations.

### **What’s Blowing in the Wind**

Most parts of Shale Country are designated Class II under the Clean Air Act’s PSD provisions, meaning

that the federal government will allow only moderate increases in ambient air pollution over the region. However, interspersed with the potential shale lease sites are a number of places that have near-pristine air and special value as wilderness, national monuments, national parks, and other protected areas. These Class I areas are held to even stricter air pollution standards, and their proximity to potential lease sites promises to drastically limit acceptable emission levels upwind.

The BLM has cataloged 10 places designated Class I by the federal or state government within 50 miles of prospective shale deposits:

- Flat Tops Wilderness Area in White River National Forest (Colorado)
- Maroon Bells-Snowmass Wilderness Area in White River National Forest (Colorado)
- Colorado National Monument (Colorado)
- Dinosaur National Monument (Colorado/Utah)
- Arches National Park (Utah)
- Bryce Canyon National Park (Utah)
- Canyonlands National Park (Utah)
- Capitol Reef National Park (Utah)
- Bridger Wilderness Area in Bridger-Teton National Forest (Wyoming)
- Fitzpatrick Wilderness Area in Bridger-Teton National Forest (Wyoming)

Clearly, with high standards for air quality in Shale Country and so many protected national treasures potentially downwind, federal clean air regulations will play a significant role in permitting or siting oil shale operations.

Although the regulation of air quality falls under the jurisdiction of the EPA, the BLM is certain to take it into account when reviewing oil shale lease applications, and the proximity of these Class I areas may help determine the conditions imposed by the BLM on commercial leases. Such conditions might include requiring companies to use existing Best Available Control Technologies (BACT), or the agency may dictate technological improvements to clear air safeguards before approving a company’s plan of operations. Although BACT is considered a



lower standard because it utilizes available technology as opposed requiring the invention of new technology, either condition may be viewed as onerous by oil shale operators.<sup>57</sup>

### Something in the Air

Whether the federal government calls the air they breathe Class I, Class II, or something else, many residents of Shale Country view pure air as a major part of their quality of life. Meanwhile, some people who currently live near oil and gas development sites perceive ill health effects from airborne pollution generated by those operations. Although not as clear cut as the pollution regulations of the Clean Air Act, this negative perception (and possible fact) of the health costs associated with energy development may become an equally large problem facing the oil shale industry. To appreciate the importance of perceived public health risks in our energy policy, one needs only to stop and consider when the last nuclear plant was built.<sup>58</sup>

The requirements of the Clean Air Act are more data-oriented and straightforward than reckoning with people's perceptions, but no recent data is publicly available to assess the air quality impact of modern oil shale extraction methods. However, the oil shale industry viewed the Clean Air Act as a constraining factor during the previous boom, and the law seems poised to play that role again unless operators can find ways to reduce expected emissions.

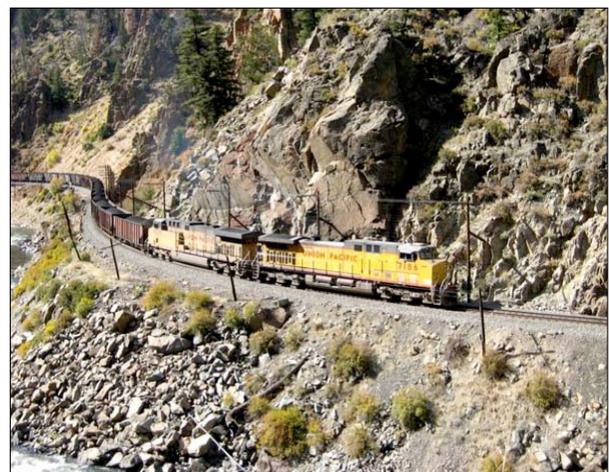
One of the key questions surrounding the development of viable twenty-first-century oil shale operations is how regulators can protect air quality without unduly limiting the growth of a commercial industry. Indeed, whether a commercial-scale industry of a few million barrels a day is even possible under the Clean Air Act remains an open question. Already air quality concerns have delayed gas drilling in the Vermillion Basin near Dinosaur National Monument so that the EPA can conduct further study. And under the federal PSD system, which allows for only so many increments of pollution total in an area, the first operations to go online (or even operations from the current

conventional oil and gas boom), especially if they are allowed to apply the lower standard of BACT, could use up the pollution quota and shut latecomers out of development opportunities entirely.<sup>59</sup>

### Using Energy to Make Energy

Air quality impacts from the development of an oil shale industry will not be limited to the extraction site or the nearby vicinity. The potential for increased power demands, particularly with in situ operations, raises concerns about pollution from the construction of new power plants. The way in which operators generate the energy for heating the shale underground will have a significant impact on the amount of pollution generated by the operation.

Based on the process proposed by Shell, which uses electricity to provide the down-hole heat, the RAND analysis estimates that an operation producing 100,000 barrels a day would require 1200 megawatts. From this estimate, Western Resource Advocates (WRA) and an associated coalition of environmental organizations further infer that such an operation would require a power plant "as big as any in Colorado history, large enough to serve a city of 500,000 people" that would cost roughly \$3 billion to build and consume 5 million tons of coal (assuming it is coal fired) while emitting 10 million tons of greenhouse gasses annually. A commercial-



A train carrying coal chugs alongside the Colorado River east of Kremmling, Colorado. The prospect of building coal-fired power plants to provide energy for in situ oil shale operations raises questions about air quality in Shale Country. Credit: Jason L. Hanson (Sept 2008)

scale industry of a million barrels a day would require 10 of these plants and, again according to WRA, 5 new coal mines.<sup>60</sup>

The potential for substantial greenhouse gas emissions from the otherwise “lighter touch” in situ method may prove to be a dealbreaker under stringent clean air regulations, all the more so as concern about global warming gains credence with the American public. The EPA’s April 2009 decision to regulate climate-changing greenhouse gasses such as carbon dioxide under the Clean Air Act, if it is upheld by the courts, is likely to up the ante on companies looking for ways to reduce the overall carbon intensity of their oil shale operations.

Companies planning on the electric heating of the underground shale are aware of this potential pitfall and are searching for low-carbon solutions. Shell is working to develop more efficient heaters that will maximize their energy returned on energy invested (a measure the industry refers to as EROIE). AMSO believes that heating the rock more quickly than Shell plans to – 3 to 12 months as opposed to several years – will offer an increased level of energy efficiency. Companies such as Chevron are looking for methods that do not depend on electricity and will leave only the faintest of carbon footprints.

The most direct way for these companies to reduce the carbon intensity of oil shale may be to harness lower-carbon sources than coal to power their operations. Natural gas presents an attractive alternative in this respect because it requires less water and emits less carbon dioxide than other fossil fuels, and recent advances in extraction techniques have allowed energy companies to dramatically increase their estimates of recoverable gas reserves in Shale Country and worldwide. (This bounty is a double-edged sword, however, as abundant natural gas reserves may relieve some of the pressure to develop new fossil fuel sources like oil shale.)

While natural-gas-fired power plants would present a lower-carbon alternative than traditional coal-fired power plants, a few Shale Country operators such as Shell have publicly mused about the possibility of pursuing even cleaner energy sources to provide at least part of the power needed for their in situ processes. The Western Slope boasts prodigious wind, solar, and geothermal resources waiting to be tapped. Could turning the oil shale fields into a laboratory for renewable energy technologies as well as new oil production processes be the way forward under the limitations of the Clean Air Act?

# WHAT'S NEXT IN SHALE COUNTRY?

*[T]he recent striking demand in industrial life for oil in its many forms, the failure of domestic wells to meet this demand in full, the rapid advance in the price of petroleum, the warning of geologists and government experts that the underground supply of oil cannot much longer be depended upon to supply the ever increasing demand, all unite in pointing unerringly to the one permanent supply of the raw material which we have—the deposits of oil shale. Whether we wish it to be so or not, we shall soon be forced to resort to the oil shales for our supply of oil. Regardless of the number and complexity of problems to be solved in establishing the oil shale industry on a commercial basis, yet they must be solved, and it remains for the American mining engineer, chemist, and inventor to provide the solution. . . . The successful retorting of oil from shale and the establishment of the oil shale industry on a permanent and profitable basis is the great problem of this decade. No other phase of our industrial life can compare with it. The finger of fate points towards it.*

- Victor Clifton Alderson,  
president of the Colorado School of Mines,  
in *The Oil Shale Industry*, 1920.

## Sustaining a Better Future

There's a saying in Colorado, a saying that we imagine is popular in awkward conversations between strangers in Shale Country bars, but a saying that nonetheless gets at a sincere sentiment beneath its corniness: "Oil shale has a fantastic future – it always has, and it always will."<sup>61</sup>

People on the Western Slope can be forgiven their cynicism. After nearly a century of listening to pronouncements like Victor Clifton Alderson's, and despite numerous scientific and technological advances, they find the resource still in the ground. Perhaps the new generation of in situ technologies will finally prove successful, but at the moment even the energy companies admit that it is too early to know.

Meanwhile, the industry's earlier fumbles have shaken the Western Slope in ways that continue to reverberate. The Black Sunday bust in 1982 was devastating, but after a period of doldrums the region's economy recovered and embarked on a long-term amenity boom. The slack from the oil

shale bust has been taken up by service workers, retirees, second-home owners, and cybercommuters, and Western Slope communities are thriving in ways that are not likely to be greatly undone by the current recession. With the recent oil and gas boom already straining local resources even as it adds more wealth to the regional economy and helps to mitigate the local impact of the nation's current economic woes, residents are understandably wary of what another wild ride with oil shale might mean for their communities and quality of life.

But the residents of Shale Country are not the only stakeholders in the matter. American society relies on abundant energy. It was not a coincidence that the rise of the Fossil Fuel Age, which unleashed enough energy to significantly reduce the labor burden on human beings, corresponded with the end of slavery and the expansion of democratic government. Today, people in developed and developing nations depend on easily available energy to drive large segments of the economy, to transport themselves over long distances, and to power a variety of everyday items that increase both productivity and quality of life. Simply put, abundant and affordable

energy from fossil fuels has made life better for countless people around the world.

We believe that the Fossil Fuel Age is winding down. But until the next era arrives, Americans and people around the world will continue to demand enough energy to maintain and improve their quality of life. Until renewable sources are ready to shoulder this burden, fossil fuels such as oil, coal, natural gas – and perhaps oil shale and their other unconventional counterparts – will continue to be important and necessary energy sources.

As the world moves toward a renewable energy future, oil shale may well be the end game of the Fossil Fuel Age. But it is a very big play. Although the social and local economic challenges are momentous and the environmental questions are serious and significant, the world class proportions of the oil shale in the Green River Formation and the national security impetus to secure a domestic energy supply seem certain to continue attracting the interest of energy operators, especially whenever the price of oil jumps a tier.

Twice in the past century, interest in oil shale has swelled into a full-fledged boom. These earlier rushes grew out of periods of national anxiety about the energy supply, when the federal government encouraged the creation of an oil shale industry in hopes of developing a secure and abundant domestic energy source. Despite intense efforts, neither boom produced commercially viable technology for extracting oil from the rocks, and the federal government withdrew its support of the nascent industry once public anxiety about energy had subsided. Instead of establishing a new industry, without viable technology or long-term commitment from the government, both booms ended in sudden busts that battered the communities of Shale Country.

It would be a mistake to presume that the failures of the past necessarily predict the future for oil shale. Our world today would be very different if people throughout history had walked away from endeavors after only two (or five or a dozen) unsuccessful attempts. But studying the tumultuous history of oil

shale in the Green River Formation will help energy companies, government officials, and Shale Country communities deal more effectively with the next round of potential oil shale development. Examining the causes of the previous booms and the reasons for their failure provides a variety of applicable lessons for those who see oil shale on our nation's energy horizon.

This time around, the industry seems to be taking a more deliberate and methodical approach to oil shale, refusing to buy into the false polarity that confidence leaves no room for caution. We value the current commitment of major industry players like Shell, Chevron, and AMSO (which is part-owned by French supermajor Total) to the research and development of a process that will be “done right.” Doing it right in Shale Country will mean developing operations that address not just the technical challenges of oil shale recovery but that are also mindful of social, economic, and environmental consequences. However, just as “the Exxon bust” painted operators with a broad brush in the early 1980s, the industry today runs the risk that its image will be shaped by the least cautious and deliberate operator in Shale Country. Companies that build a solid foundation in Shale Country communities will be best positioned to survive the fallout from another high-profile failure of one of their competitors.

For energy companies in Shale Country, building a solid foundation within the community means



Sage and juniper dot the Shale Country landscape on Hunter Ridge in Colorado. Credit: Jason L. Hanson (October 2007)

inviting public participation and engaging with local concerns. We heard a story once about an energy company executive who organized a series of public meetings around the Western Slope at which residents could voice their concerns and get information about development. At one particular meeting, the executive sat with a pad of paper in front of him, nodding his head as one person after another shared their views, but never once did he take out his pen and make any notes. Public involvement in the process must mean more than feigning interest. Companies should work to create a mutually beneficial relationship with the communities they affect (and depend upon for workers, schools for their children, social services, etc.) to identify community hopes and advance them. This type of long-term investment promises real benefits and is a necessary component of success, not just a philanthropic option, in Shale Country.

While all nonrenewable resources, even those as vast as oil shale, will eventually dwindle, sustainability is the key term for energy companies seeking to build relationships with Shale Country communities. In local economic terms, it signifies business models that will promote planned growth rather than boom-and-bust chaos. Beyond the purview of the local chamber of commerce, it denotes operational plans that demonstrate a commitment to preserving the area's unique and fragile environment. Companies should work to ensure (and demonstrate to residents) that, due to thorough research and development, careful selection of sites, and new extraction technologies, production will extend over a career-length (or longer) time horizon and preserve a healthy environment that can be enjoyed for generations.

This is a great deal to ask of the energy companies. A century ago, these sorts of socioeconomic and environmental concerns would not have even been on the radar of a mining company. In fact, a century ago, the terms “socioeconomic” and “environmental” were not even part of miners' vocabularies. But the history of the West is well-supplied with examples of people acting in haste without pausing to consider the consequences of their actions for other people or the natural world.

And after generations spent reckoning with their legacies of economic boom and bust cycles and environmental damage, we know now that theirs is an example to learn from rather than emulate.

If the boom does come, Western community leaders, energy developers, policymakers, and residents are fortunate to have a great selection of historical and contemporary case studies to draw upon as they chart a course through their own unique moment. In many ways, particularly with regard to social impacts, the earlier oil shale boom and the area's current oil and gas boom both offer valuable lessons that these stakeholders can apply to the next round of potential oil shale development.

The environmental impact is harder to predict because new technology is being tested at the RD&D lease sites. As they develop their processes, companies must do everything they can to respect and sustain the health and integrity of Shale Country's ecosystems, water resources, and air quality. As environmentalists often note, the price of resource development grows exponentially when it does environmental damage that requires long-term or perpetual management. The responsibility of reckoning with these costs is too often postponed and pushed onto a succeeding generation. In the worst cases, the harm to the environment can be irreversible, such as the extinction of a species. In these cases, absolute measures of value – such as the price assigned to a barrel of oil or a gallon of gasoline – cannot meaningfully account for the external costs of energy development.

Americans today are more attuned to environmental issues than ever before, and natural resource extraction is often the subject of national debates. Previews of the public's environmental concerns about oil shale development may be found in the debates over drilling on the Roan Plateau, in the Arctic National Wildlife Refuge, and in the waters off of our shores. That these areas have attracted nationwide attention is a reminder that, although residents of the Western Slope will feel the impact most keenly, the development of oil shale is far from just a local issue. A great number of sincere people throughout the nation (and around the world) care

deeply about such beautiful places and their environmental health as much or more than they care about the price of gas. In an arena where public perception and sentiment can weigh equally with scientific data in determining the worthiness of a project, energy companies cannot ignore public opinions about their environmental impacts.

No report – not even one professing to cover “what every Westerner should know” – can anticipate all of

the issues that will be raised by oil shale development on the Western Slope of the Rocky Mountains. There are too many uncertainties. But there is one guarantee: There will be unintended consequences. Of all of the questions surrounding oil shale in the coming years, the most important question facing the stakeholders in Shale Country and elsewhere is this: Will we have sufficient nimbleness, agility, and will to respond when those consequences appear?

## ACKNOWLEDGMENTS

Over two crisp autumn days in October 2007, the Center of the American West conducted a workshop in Glenwood Springs, Colorado, for a team of engineers and scientists from Chevron, Los Alamos National Lab, and the University of Utah on the social, economic, and environmental issues surrounding the possibility of oil shale development. The workshop was initiated at the request of Robert Lestz, the Oil Shale Technology Manager at Chevron. Chevron's lease on Hunter Ridge is one of several issued by the Bureau of Land Management (BLM) to begin a new round of oil shale research and development. As his team began work on designing the new extraction process, Mr. Lestz wanted them to be able to anticipate and avoid as many of the potential pitfalls as possible. The result of this workshop was a lively and constructive dialogue that gave rise to a larger project: Creating an evenhanded, informative, and accessible resource for anyone who wants to learn more about oil shale.

Although this project grew out of the workshop funded by Chevron in 2007, the report itself was produced independently and was not funded by any outside source. The Center of the American West is responsible for all editorial content. Along the way, we have drawn on the generosity, guidance, advice, and outstanding contributions of a wide range of experts and stakeholders, including people employed in the energy industry; representatives of environmental organizations; government officials at the local, state, and federal level; geologists, biologists, climatologists, hydrologists, chemists, and a host of other scientists; local residents; historians and observers of the Western Slope; and our colleagues at the Center of the American West. Without them, this online guidebook could not have been completed. We would like to thank:

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- Reeves Brown, Executive Director of Club 20, for participating in the workshop;
- Aron Diaz, Executive Director of the Associated Governments of Northwest Colorado, for participating in the workshop;
- Kelly Uhing, Colorado State Weed Coordinator, for participating in the workshop;
- Dan Bean, Director of Biological Pest Control and Manager of the Palisade Insectary, for participating in the workshop;
- Robert Randall, then with Western Resource Advocates and now Federal Lands Coordinator at the Colorado Department of Natural Resources, for sharing his knowledge of federal mineral leasing law and recent energy legislation;
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- Jane and Carl Bock of the University of Colorado for conducting a workshop session on ecology and contributing to that section of the report;
- Michael Hannigan of the University of Colorado for conducting a workshop session on air quality issues and reviewing that section of the report;
- Cathy Wilson, Deputy Division Leader for Earth and Environmental Sciences at Los Alamos National Labs, for sharing her views on water availability in the Colorado River basin;
- Jeremy Boak, Director of the Center for Oil Shale Technology and Research at the Colorado School of Mines, for sharing his views on the future of oil shale development;
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- Joe Brown of Starz Down to Earth Films for sharing his film, National Sacrifice Zone, and his thoughts;
- Ed Quillen, columnist and trenchant observer of all things Western, for helping trace the origins of the phrase “national sacrifice zone”;
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## RECOMMENDED READINGS

We would like to acknowledge the valuable work on oil shale done by others and invite you to read more about the subject after you have finished our report. On both counts, the list of recommended readings below offer a good place to start. (For a more detailed listing of sources we consulted during this project, please see the Endnotes.)

- US Bureau of Land Management, *Oil Shale and Tar Sands Programmatic EIS Information Center* (includes links to the final Programmatic Environmental Impact Statement).
- James T. Bartis, Rom LaTourrette, Lloyd Dixon, et al., for RAND Corp., *Oil Shale Development in the United States: Prospects and Policy Issues* (Santa Monica, CA: RAND Corporation, 2005).
- Paul L. Russell, *History of Western Oil Shale* (East Brunswick, NJ: The Center for Professional Advancement, 1980).
- Andrew Gulliford, *Boomtown Blues: Colorado Oil Shale* (Boulder, CO: University of Colorado Press, 2003).
- Lawrence J. MacDonnell, David Ableson, for Western Resource Advocates, *Water On the Rocks: Oil Shale Water Rights in Colorado* (Boulder, CO: Western Resource Advocates, 2009).
- BBC Research & Consulting, for Associated Governments of Northwest Colorado, *Northwest Colorado Socioeconomic Analysis and Forecasts* (Rifle, CO: Associated Governments of Northwest Colorado, 2008)
- Strategic Unconventional Fuels Task Force, *Development of America's Strategic Unconventional Fuels* (Washington, DC: US Department of Energy, 2007).
- Harry R. Johnson, Peter M. Crawford, James W. Bunker, for the US Department of Energy Office of Naval Petroleum and Oil Shale Reserves, *Strategic Significance of America's Oil Shale Reserve* vol. I and II (Washington, DC: US Department of Energy, 2004).
- Anthony Andrews, for the Congressional Research Service, *Oil Shale: History, Incentives, and Policy*, (Washington DC: Congressional Research Service, 2006).
- Patricia Nelson Limerick, Claudia Puska, et al, *What Every Westerner Should Know About Energy* (Boulder, CO: Center of the American West, 2002).

# ENDNOTES

1. This anecdote is widely repeated. See, for example, “Digging into Shale’s Rocky Past,” *Shale Country* (Oct 1975): 20; Colorado Geologic Survey, “Oil Shale – Enormous Potential But...?” (PDF) *RockTalk* 7, no 2 (April 2004): 13-15. Today one of the peaks above Parachute is named after Callahan.
2. James T. Bartis, Rom LaTourrette, Lloyd Dixon, et al., *Oil Shale Development in the United States: Prospects and Policy Issues* (Santa Monica, CA: RAND Corporation, 2005), 5-9; BLM, “About Oil Shale, “Oil Shale and Tar Sands Leasing Programmatic EIS Information Center; US Energy Information Administration, “Petroleum Basic Statistics” (July 2008). The US currently produces just over 5 million barrels of oil a day from domestic sources, according to the EIA.
3. Bartis, *Oil Shale Development in the United States*, 5-9.
4. In addition to the specific citations listed in the notes below, information on the early history of the oil shale industry in this section was synthesized from Victor Clifton Alderson, *The Oil Shale Industry* (New York: Frederick A. Stokes Co, 1920), 15-45; Paul L. Russell, *History of Western Oil Shale* (East Brunswick, NJ: The Center for Professional Advancement, 1980), 5-114; Andrew Gulliford, *Boomtown Blues: Colorado Oil Shale* (Boulder, CO: University of Colorado Press, 2003), 1-84; David W. Miller, “The Historical Development of the Oil and Gas Laws of the United States,” *California Law Review* 51 (1963): 506-34; “Digging into Shale’s Rocky Past,” *Shale Country* (Oct 1975): 20; and Colorado Geological Survey, “Oil Shale – Enormous Potential But...?” (PDF) *RockTalk* 7, no. 2 (April 2004): 13-15.
5. Alderson, *Oil Shale Industry*, 26-7, 33-45; Russell, *History of Western Oil Shale*, 3, 85-7; “History,” *Shale Country* 5, no 4 special edition (1983), 2; European Academies Science Advisory Council, “A Study on the EU Oil Shale Industry – Viewed in the Light of the Estonian Experience” (May 2007), 15-6. Russell provides an excellent summary of what is known about the Mormon Retort.
6. Quoted in Russell, *History of Western Oil Shale*, 5. Wilson’s presidential authority to withdraw public lands from mineral entry had been affirmed by the US Supreme Court the year before in *United States v. Midwest Oil Company*.
7. See Guy Elliott Mitchell, “Billions of Barrels of Oil Locked Up in Rocks,” *National Geographic* 33, no. 2 (Feb. 1918): 195-6; and Floyd W. Parsons, “Oil From Shale: Everybody’s Business,” *Saturday Evening Post* (20 March 1920). These and a thorough list of additional articles on the topic are cited in Andrew Gulliford, *Boomtown Blues: Colorado Oil Shale* (Boulder, CO: University of Colorado Press, 2003), 54, 247-8, n.2 and 14.
8. Russell, *History of Western Oil Shale*; Gulliford, *Boomtown Blues*.
9. Charles Wilkinson provides a helpful and concise overview of the 1920 Mineral Leasing Act in *Crossing the Next Meridian: Land, Water, and the Future of the West* (Washington, DC: Island Press, 1992), 52-8. See also Bartis, *Oil Shale Development in the United States*, 26-7. Permission to mine is awarded through a competitive bidding process that usually includes bonus payments, and royalties that typically amount to between one eighth and one sixth of total revenues for oil production must be paid on the extracted resource. Typically, the lease is awarded to the qualified bidder submitting the highest bonus bid, since royalties are usually fixed by the BLM in advance. In addition to these provisions for compensation to the public for mineral extraction, the MLA also provides land managers with much greater authority to regulate the extraction process. In keeping with its authority to stipulate special protections for competing resources and the environment, federal officials often prescribe construction standards and access routes to minimize environmental disturbance.
10. Executive Order No. 5327, April 15, 1930; quoted in Robert P. Baker and Robert D. Mulford, “Problems and Policies in Oil Shale Development,” *Stanford Law Review* 19, no. 1. (Nov. 1966): 194-5; Anne Wasko, “A Look at Shale Country – January 1981,” *Shale Country* (Jan. 1981): 5.
11. Russell, *History of Western Oil Shale*, 103-7; Wasko, “A Look at Shale Country – January 1981,” 5.
12. Only a small percentage of the oil shale lands are split estates. See Tables 2.3.3-1 and 2.3.3-2 in BLM, *Proposed Oil Shale and Tar Sands Resource Management Plan Amendments to Address Land Use Allocations in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement* (hereafter *Final PEIS*), 2-27, 2-32.
13. Gulliford, *Boomtown Blues*, 61-2, 104; Colorado Geological Survey, “Oil Shale – Enormous Potential But...?” (PDF) 14; Russell, *History of Western Oil Shale*, 10; Bartis, *Oil Shale Development in the United States*, 9; Mike McKibben, “Officials’ opinions on oil shale mixed,” *Grand Junction Daily Sentinel*, 20 December 2007.
14. Gulliford, *Boomtown Blues*, 61-2, 104; Senator Ken Salazar (now Secretary of the Interior) supplied the 200,000-acre figure for private oil shale holdings in “Heedless Rush to Oil Shale,” *Denver Post*, 15 July 2008; Larry McCown is quoted in Mike McKibben, “Officials’ opinions on oil shale mixed,” *Grand Junction Daily Sentinel*, 20 December 2007.
15. Russell, *History of Western Oil Shale*, 117-8; P.A. Petzrick, “Oil Shale – An Ace in the Hole for National Security,”

- Shale Country (Oct 1975): 18-9; Alys Novak, “Oil Shale – 1976: Review/Preview,” *Shale Country*, 5. A joint bid of \$210.3 million from Standard Oil Company of Indiana and Gulf Oil Corporation won tract C-a. Tract C-b was leased for \$117.8 million by a consortium of companies that included Atlantic Richfield (Arco), Ashland Oil, Shell Oil, and TOSCO. In Utah, the U-a tract went to a partnership of Sun Oil and Phillips Petroleum for \$75.6 million, and U-b was let to the White River Shale Oil Corporation for \$45.1 million. No bids were received for the two less-rich tracts offered in Wyoming (Russell). Both Colorado leases were relinquished in the 1990s.
16. The mood in Shale Country during this time was the topic of numerous articles, including year-in-review pieces published in *Shale Country* just before it suspended publication and first thing after it came back. See Wasko, “A Look at Shale Country – January 1981,” 5-6; Novak, “Oil Shale – 1976: Review/Preview,” 4-9; “Shale Spins Off Unique Legacy” (editorial statement), *Shale Country* (Dec. 1976): 1.
  17. Gulliford, *Boomtown Blues*, 93-103. Carter’s speech, given at the White House on 18 April 1977, is widely available. The exact amount allotted for the Synthetic Fuels Corporation is hard to pin down; sources range from \$12-20 billion, the discrepancies presumably a result of variable funding mechanisms.
  18. *Andrus v. Shell Oil Co.* 446, U.S. 657 (1980); Gulliford, *Boomtown Blues*, 61-2. The earlier ruling cited by the court was the Secretary of Interior’s decision in the 1927 case of *Freeman v. Summers*.
  19. Gulliford, *Boomtown Blues*, 46; Patricia Nelson Limerick, William Travis, and Tamar Scoggin, *Boom and Bust in the American West* (Boulder, CO: Center of the American West, 2002), 9 (PDF).
  20. “Urban frontier” is a term popularized by Duane Smith, who showed in his book *Rocky Mountain Mining Camps: The Urban Frontier, 1860-1901*, (Niwot, Colorado: University Press of Colorado, 1967) that the rapid growth of the towns that sprang up around mineral rushes gave them an urban character distinct from more rural farming and ranching communities elsewhere in the West. Although Smith was writing about nineteenth-century boomtowns, the thesis seems clearly applicable to modern scenarios as well. See also: Duane Allan Smith, “Mining Camps: Myth vs. Reality,” *Colorado Magazine* 44, no. 2 (1967): 93-110.
  21. Gulliford, *Boomtown Blues*, 90-2; Patricia Nelson Limerick, Claudia Puska, et al, *What Every Westerner Should Know About Energy* (Boulder, CO: Center of the American West, 2002), 18 (PDF).
  22. Andrew Gulliford, “The Tiger Empties the Tank: The Oil Shale Boom-and-Bust in Colorado,” *Journal of the West* 28, no. 4 (1989): 22; Limerick, *What Every Westerner Should Know About Energy*, 18-19 (PDF). The original paper, entitled “Social Consequences of Boom Growth in Wyoming” (PDF), was presented by El Dean Kohrs at the 1974 meeting of the Rocky Mountain Section of the American Association for the Advancement of Science, although it was never formally published. For an example of the questions since raised about the legitimacy of Gillette Syndrome, see James G. Thompson, “The Gillette Syndrome: A Myth Revisited?” *Wyoming Issues* 2, no. 2 (1979): 30-5(PDF); Kenneth P. Wilkinson et al, “Local Social Disruption and Western Energy Development: A Critical Review”, *Pacific Sociological Review* 25, no. 3 (July 1982): 275-96 (PDF). For additional information, Michael S. Coburn has compiled a wealth of data and research on his Sublette County Socioeconomics website.
  23. Gulliford, “The Tiger Empties the Tank,” 22-3; Gulliford, *Boomtown Blues*, 88, 113, 121-3. Although it was circulated around the Western Slope at the time, including at a meeting sponsored by Club 20 in July in Grand Junction, the Exxon white paper, which was officially titled “The Role of Synthetic Fuels in the United States Energy Future,” is now difficult to get ahold of. Understandably, the company is not eager to share this printed faux pas, and we have relied here on Andrew Gulliford’s rendering of it, which is no doubt accurate but perhaps not cast in the most sympathetic light.
  24. Robert Wamsley, retired schoolteacher, Rifle, CO, quoted in Gulliford, *Boomtown Blues*, 13.
  25. Information in these two paragraphs about the boom’s projected impact on the Western Slope after Exxon’s arrival is drawn from: Gulliford, *Boomtown Blues*, 111-34; Limerick, *What Every Westerner Should Know About Energy*, 19 (PDF); US Department of Labor, Employment Standards Administration, “History of Federal Minimum Wage Rates Under the Fair Labor Standards Act, 1938 – 2007”; “Shale Country: Born Again,” *Shale Country* (Jan. 1981): 1-2.
  26. Gulliford, *Boomtown Blues*, 153-94; Congressional Testimony by Jim Evans, Executive Director Associated Governments of Northwest Colorado, “A Local Government Perspective on Federal Oil Shale Research and Development Efforts,” before the Senate Committee on Energy and Natural Resources Washington, D.C. (12 April 2005); Nicholas Lemann, “Grand Junction Can’t Win for Losing,” *Atlantic Monthly* 255, no. 18 (April 1985): 18-28. In his Senate testimony, Jim Evans, then Executive Director of the Associated Governments of Northwest Colorado, noted that “At the peak of the cycle, the combined population of the 2 most impacted counties (Garfield and Mesa) increased from 1981 to 1983 by 12%, from 112.0 thousand to 125.6 thousand. Then in the next 2 years the combined population dropped back to 111.8 thousand.”
  27. Congressional Testimony By Jim Evans, Executive Director Associated Governments of Northwest Colorado, “A Local Government Perspective on Federal Oil Shale Research and Development Efforts,” Before the Senate Committee on Energy and Natural Resources Washington, DC (12 April

- 2005); Nicholas Lemann, "Grand Junction Can't Win for Losing," *Atlantic Monthly* 255, no. 18 (April 1985): 18-28.
28. BLM, Final PEIS, 1.9-10; BLM, "Interior Department Issues Oil Shale Research, Development and Demonstration Leases for Public Lands in Colorado" (15 December 2006); BLM, "Interior Department Issues Oil Shale Research, Development and Demonstration Lease for Public Lands in Utah" (28 June 2007). Originally, the BLM announced 8 bids worthy of further consideration ("BLM Announces Results of Review of Oil Shale Research Nominations" [17 January 2006]), but this number was ultimately paired down to 6. Of these 6, the 5 in Colorado received their leases on January 1, 2007, and the one in Utah received its go-ahead on July 1, 2007. The 160-acre size of their initial RD&D lease tracts is minimal in the overall scope of potential oil shale developments, but, for perspective, these small parcels are the same size as the quarter-sections originally surveyed and allotted to Western homesteaders by the General Land Office.
  29. Shell: Royal Dutch Shell, "Welcome to the Mahogany Research Project"; BLM, Environmental Assessment: Shell – CO-110-2006-117-EA (2006), 5-9; Gary Harmon, "Shell Wants to Test Oil Shale Technology in Tiny Mideast Nation," *Grand Junction Daily Sentinel*, 11 Aug. 2008. AMSO: American Shale Oil, "Our Plan"; BLM, Environmental Assessment: EGL Resources – CO-110-2006-118-EA (2006), 5-10. Chevron: BLM, Environmental Assessment: Chevron Oil Shale Research, Development, and Demonstration – CO-110-2006-120-EA (2006), 5-10; Dennis Webb, "Chevron Studying Chemistry to Develop Oil Shale Underground: Plant 10 Years Out," *Grand Junction Daily Sentinel*, 7 Aug. 2008. For specific information on Chevron, we have also relied on a presentation by Robert Lestz, Oil Shale Technology Manager at Chevron, on the in situ process his team is developing (23 October 2007). OSEC: Oil Shale Exploration Company website; Associated Press, "Utah Company Says Oil Shale Technology Is Ready to Go," *Glenwood Springs Post Independent*, 18 June 2008. General: In addition to company-specific resources, overviews of the processes being explored throughout the industry can be found in Peter M. Crawford and Emily Knaus, *Secure Fuels from Domestic Resources* (Washington DC: US Department of Energy, June 2007) (PDF); Bobby Magill, "Many Methods, One Basic Idea Shape New Oil-Shale Technology," *Grand Junction Daily Sentinel*, 30 April 2007; Joe Hanel, "Big Oil Casts Shadow over Colorado's Water Future," *Durango Herald*, 6 January 2008; Bartis, *Oil Shale Development in the United States*, 11-23; BLM, Final PEIS, "Appendix A," A.21-30.
  30. "Senator Salazar Lauds Oil Shale Limitations in Omnibus Bill," press release, 17 December 2007; HR 2764, section 433; Thomas Burr, "Salazar: Oil Shale Development on the Table," *Salt Lake City Tribune*, 22 February 2009; "Secretary Salazar to Offer a New Round of Oil Shale Research, Development and Demonstration Leases," Department of Interior news release, 25 February 2009.
  31. BLM, "Oil Shale Management – General; Final Rules" (18 November 2008) (PDF); Mark Jaffe, "Oil-Shale Royalties Strike Rich Vein of Debate," *Denver Post*, 18 November 2008; Mark Jaffe, "Salazar Halts Oil Shale Leases," *Denver Post*, 26 February 2009; Phillip Yates, "Oil Shale Remains in the Crosshairs," *Glenwood Springs (CO) Post Independent*, 14 December 2008; "Secretary Salazar to Offer a New Round of Oil Shale Research, Development and Demonstration Leases," Department of Interior news release, 25 February 2009.
  32. Peter M. Crawford and Emily Knaus, *Secure Fuels from Domestic Resources* (Washington DC: US Department of Energy, June 2007), 28-9 (PDF); Bobby Magill, "Many Methods, One Basic Idea Shape New Oil-Shale Technology," *Grand Junction Daily Sentinel*, 30 April 2007; Information about Red Leaf and their proprietary oil shale technology, EcoShale, can be found at the company's website; Andy Vuong, "Schlumberger Buying Land for Oil Field Services," *Denver Post*, 22 February 2008; "Raytheon Technology Tapped by Schlumberger to Extract Oil from Shale," *Ratheon press release*, 23 January 2008; Phillip Yates, "Oil Shale Remains in the Crosshairs," *Glenwood Springs (CO) Post Independent*, 14 December 2008.
  33. The Consolidated Appropriations Bill passed at the end of 2007 contained a provision that reduced the amount of federal oil shale royalties that are returned to the states where the development occurs from 50% to 48%. The best overview of state financial mechanisms related to oil shale can be found in two recent performance audit reports by the Office of the State Auditor, *Severance Tax: Department of Revenue, Department of Natural Resources* (PDF) (June 2006), and *Severance Tax Direct Distribution Payments: Department of Local Affairs* (PDF) (August 2007).
  34. For the companies' expressed commitment to conducting the next round of oil shale development the "right way," with careful attention to environmental and community impacts, see statements on the Shell and AMSO websites. We have also heard personal assurances that oil shale must be "done right" this time from Chevron officials such as Robert Lestz and Sean Norris and Shell officials Tracy Boyd and Gale Norton. The arguments for the development of oil shale are repeated by many proponents, but the most comprehensive case for oil shale was made by the Task Force for Unconventional Fuels in America's *Strategic Unconventional Fuels* vol. 1-3 (Sept 2007), available for download here. See also Harry R. Johnson, Peter M. Crawford, and James W. Bunger for the Deputy Assistant Secretary for Petroleum Reserves, Office of Naval Petroleum and Oil Shale Reserves, *Strategic Significance of America's Oil Shale Resource* vol. 1-2 (March 2004), available for download here; James W. Bunger, Peter M. Crawford, Harry R. Johnson, "Is Oil Shale America's Answer to Peak-Oil Challenge?" *Oil and Gas Journal* (9

- Aug. 2004): 16-24 (PDF); and others. Tracy Boyd of Shell quoted in Jerd Smith, "Shell Stakes Claim on Yampa River," Rocky Mountain News, 8 January 2009.
35. BLM, Final PEIS, quote on page 4-156. The document's second chapter discusses the alternatives considered by the BLM. The entire fourth chapter of the PEIS deals with the wide range of possible impacts from oil shale development discussed in the preceding paragraphs.
  36. See, for example, the opposition positions represented on the Western Colorado Congress's background information page and position paper on oil shale, as well as Randy Udall and Steve Andrews, "The Illusive Bonanza: Oil Shale in Colorado – Pulling the Sword from the Stone" (Aspen, CO: Community Office for Resource Efficiency, date unspecified) (PDF). For supportive statements, see Jim Evans, Executive Director of the Associated Governments of Northwest Colorado, "A Local Government Perspective on Federal Oil Shale Research and Development Efforts," testimony before the Senate Committee on Energy and Natural Resources, Washington, DC, 12 April 2005 and Club 20, "Oil Shale, Development and Implementation of a National Strategy," resolution 05-4 EN 02, adopted 1 April 2005 and amended 30 March and 8 September 2006.
  37. Gulliford, *Boomtown Blues*, 92; Bartis, *Oil Shale Development in the United States*, 43.
  38. Examples and quotes about the impact of the current oil and gas boom were compiled from: Andy Vuong, "Western Slope Finds an Economic Oasis," *Denver Post*, 29 June 2008; Mike Saccone, "Mesa, neighboring counties experience population surge," *Grand Junction Daily Sentinel*, 22 July 2007; Burt Hubbard, "State coping with fallout created by oil-gas boom," *Rocky Mountain News* (Denver), 25 July 2007; Judith Kohler, "Ridin' the boom in Rifle," *Casper Star Tribune*, 2 September 2007; Leslie Robinson, "Rifle Booms Under Record Housing Starts, Construction Projects," *Colorado Independent*, 29 April 2008; Mike Saccone, "Rifle's rapid growth, high demand push out 'middle class' workers," *Grand Junction Daily Sentinel*, 22 July 2007 (includes Mayor Lambert quote); John Gorman, "Property Values Soar from 2006 to 2008," *Glenwood Springs Post Independent*, 21 April 2009; Steve Raabe, "Grand Junction becomes boom town," *Denver Post*, 9 June 2007; Anna Maria Basquez, "Median Sale Price on GJ Homes Takes Tumble," *Grand Junction Daily Sentinel*, 29 Oct. 2008; Christy Hamrick, "Impacts of an Oil Shale Boom on Local School Districts," presentation at 27th Oil Shale Symposium, Colorado School of Mines, Golden, CO, 16 October 2007; Jesse Smith, Assistant Garfield County Manager, spoke of the rising cost of gravel during his presentation at the Center of the American West's Chevron Oil Shale Workshop, Glenwood Springs, CO, 23 October 2007; Reeves Brown, presentation at the Center of the American West's Chevron Oil Shale Workshop, Glenwood Springs, CO, 23 October 2007.
  39. At the beginning of 2009, a spate of articles reporting cutbacks in drilling operations appeared in Colorado newspapers. See, for example: Nancy Lofholm, "W. Slope Oil and Gas Tent Folds," *Denver Post*, 3 February 2009; Gary Harmon and Dennis Webb, "Williams Revises Drilling Cutbacks," *Grand Junction Daily Sentinel*, 19 February 2009.
  40. National Institute on Drug Abuse, Methamphetamine Abuse and Addiction; Patrick Farrell, "Meth Fuels the West's Oil and Gas Boom," *High Country News*, 3 October 2005; Meth-Free Mesa County (Mesa County Meth Task Force); Steve Raabe, "Grand Junction becomes boom town," *Denver Post*, 9 June 2007; LeRoy Standish, "DA's office to hire meth prosecutor, statistician," *Grand Junction Daily Sentinel*, 30 October 2007; Amy Hamilton, "Few Felony Cases Filed in Mesa County," *Grand Junction Daily Sentinel*, 31 December 2008. The ingredients in meth include ephedrine or pseudoephedrine (a common decongestant found in cold tablets) in combination with iodine crystals, battery acid, red phosphorous, and anhydrous ammonia. It can be formulated as a liquid, a powder, a waxy solid (glass), or a clear rock (ice).
  41. In a panel discussion at the Center of the American West's Chevron Oil Shale Workshop in Glenwood Springs, CO, on 23 October 2007, Mayor of Rifle Keith Lambert and Assistant Garfield County Supervisor Jesse Smith expressed their belief that, if the estimated timeline of 2030-35 for a commercial-scale oil shale industry is correct, it will overlap with current oil and gas activities. David Olsen commented on the importance of socioeconomic issues to the developing industry in his presentation on "Summary Oil Shale Environmental Issues and Research Needs" at the 27th Oil Shale Symposium, Colorado School of Mines, Golden, CO, 16 October 2007.
  42. Bartis, *Oil Shale Development in the United States*, 35-7; BLM, Final PEIS, 3-150-175. The BLM's PEIS provides helpful individual overviews of a number of the at-risk species in Shale Country.
  43. We are indebted to Carl and Jane Bock of the University of Colorado for presenting much of the information in this report about the potential ecological impacts of oil shale development in the Piceance Basin at the Center of the American West's Chevron Oil Shale Workshop in Glenwood Springs, CO, on 22 October 2007. They also suggest the following sources for a fuller treatment of the issues than there was room to give in this overview. For a general overview of ecosystems of the region: P.L. Fradkin, *Sagebrush Country: Land and the American West* (New York: Knopf, 1989); M.L. Floyd, D. Hanna, W.H. Romme, and M. Colyer, eds., *Ancient Pinon-Juniper Woodlands: A Natural History of Mesa Verde Country* (Niwot, CO: University of Colorado Press, 2003); C.A. Beidleman, *Partners in Flight Land Conservation Plan for Colorado* (Estes Park, CO: Colorado Partners in Flight, 2000), available at [www.blm.gov/wildlife/plan/pl-co-10.pdf](http://www.blm.gov/wildlife/plan/pl-co-10.pdf). On the

- vulnerability of these ecosystems compared to those of the Great Plains: R.N. Mack and J.M. Thompson, "Evolution in Steppe with Few Large, Hooved Mammals," *American Naturalist* 119, no. 6 (1982): 757-73. On microbiotic crusts: J. Blenap, "The World at Your Feet: Desert Biological Soil Crusts," *Frontiers in Ecology and the Environment* 1, no. 4 (2003): 181-9; R.D. Evans and J.R. Joansen, "Microbiotic Crusts and Ecosystem Processes," *Critical Reviews in Plant Sciences* 18, no. 2 (1999): 183-225. On the Sagebrush Steppe, the Cheatgrass fire cycle, and likely impacts on plants and wildlife: W.L. Baker, "Fire and Restoration of Sagebrush Ecosystems," *Wildlife Society Bulletin* 34, no. 1 (2006): 177-85; S.T. Knick, D.S. Dobkin, J.T. Rotenberry, et al., "Teetering on the Edge or Too Late? Conservation and Research Issues for Avifauna of Sagebrush Habitats," *Condor* 105, no. 4 (2003): 611-34; L.J. Sperry, J. Belnap, and R.D. Evans, "Bromus tectorum Invasion Alters Nitrogen Dynamics in an Undisturbed Arid Grassland Ecosystem," *Ecology* 87, no. 3 (2006): 603-15; J.C. Chambers, B.A. Roundy, R.R. Blank, et al., "What Makes Great Basin Sagebrush Ecosystems Invasible by Bromus tectorum?" *Ecological Monographs* 77, no. 1 (2007): 117-45; L.H. Ziska, J.B. Reeves, and B. Blank, "The Impact of Recent Increases in Atmospheric CO<sub>2</sub> on Biomass Production and Vegetative Retention of Cheatgrass: Implications for Fire Disturbance," *Global Change Biology* 11, no. 8 (2007): 1325-32; C.L. Aldridge and M.S. Boyce, "Linking Occurrence and Fitness to Persistence: Habitat-Based Approach for Endangered Greater Sage Grouse," *Ecological Applications* 17, no. 2 (2007): 508-26; J.A. Crawford, R.A. Olson, N.E. West, et al., "Synthesis Paper – Ecology and Management of Sage Grouse and Sage Grouse Habitat," *Journal of Range Management* 57, no. 1 (2004): 2-19; W.M. Vander Haegen, "Fragmentation by Agriculture Influences Reproductive Success of Birds in a Shrubsteppe Landscape," *Ecological Applications* 17, no. 3 (2007): 934-47. On Pinon-Juniper Woodlands and its bird populations: A. Clements, "An Ecosystem Approach to Combat Desertification on the Colorado Plateau," *Environmental Monitoring and Assessment* 99 (2004): 233-43; C.D. Francis, C.P. Ortega, and J. Hansen, "Nest Site Selection and Success of Three Common Pinon-Juniper Birds in Response to Chronic Industrial Noise Disturbance" (abstract), Annual meeting of the American Ornithologists' Union, Laramie, WY, August 2007; D.C. Pavlacky and S.H. Anderson, "Comparative Habitat Use in a Juniper Woodland Bird Community," *Western North American Naturalist* 64 (2004): 376-84; ; D.C. Pavlacky and S.H. Anderson, "Habitat Preferences of Pinon-Juniper Specialists Near the Limit of the Geographic Range," *Condor* 103, no. 2: 322-31.
44. Dan Bean, Director of Biological Pest Control and Manager of the Palisade Insectary for the Colorado Department of Agriculture, and Kelly Uhing, the State Weed Coordinator for the Colorado Department of Agriculture, presented their views on biocontrol methods for invasive species and noxious weeds – many of which we have gratefully incorporated into the text – at the Center of the American West's Chevron Oil Shale Workshop, Glenwood Springs, CO, 23 October 2007. More information about noxious weeds in Garfield and Rio Blanco Counties can be found at the Colorado Department of Agriculture. Noxious weed is a legal term for an invasive nonnative species that must be controlled by state law.
45. We are grateful to Tim Sullivan of the Nature Conservancy of Colorado for discussing the Nature Conservancy's "Conservation by Design" approach at the Center of the American West's Chevron Oil Shale Workshop in Glenwood Springs, CO, 23 October 2007. Our understanding of the nature of balance was confirmed in Merriam-Webster's Collegiate Dictionary, 10th edition (Springfield, MA: Merriam-Webster Inc, 1996).
46. These comments come from Kurt Schultz's presentation to the Center of the American West's Chevron Oil Shale Workshop, Glenwood Springs, CO, 23 October 2007. We are grateful that Mr. Schultz made the cold ride out from his mountain camp to join us. For more examples of the tension between energy development and tourism on the Western Slope, see Mark Jaffe, "Energy, Tourism Vie Over Western Slope," *Denver Post*, 18 Aug. 2008.
47. Western Resource Advocates et al, *Oil Shale and Tar Sands Resources Leasing Programmatic EIS Scoping Comments (PDF)*, 31 Jan. 2006.
48. Norris Hundley Jr., "The West Against Itself: The Colorado River – An Institutional History," in *New Courses for the Colorado*, ed. Gary Weatherford and F. Lee Brown (University of New Mexico Press, 1996), 9-49; Robert H. Webb, Gregory J. McCabe, Richard Hereford, and Christopher Wilkowske, "Climatic Fluctuations, Drought, and Flow of the Colorado River," *US Geological Survey Fact Sheet 2004-3062*; US Department of Interior, *Record of Decision: Colorado River Guidelines for Lower Basin Shortages and the Coordinated Operations of Lake Powell and Lake Mead (Dec. 2007) (PDF)*. Although Lees Ferry is commonly cited in discussions about the "law of the river," as the Colorado River Compact and subsequent agreements are often called, the compact specifically denotes Lee Ferry as the point of division. They are actually two different places a mile apart on the Colorado River. Lee Ferry is the point of the hydrologic divide, while Lees Ferry, a mile upstream, is where the US Geological Survey maintains a stream gage (which could not be installed at the actual divide for logistical reasons). Between these two points, the Paria River enters the Colorado, and its flow is added to that measured at Lees Ferry to calculate the upper basin's total water delivery. Both places are named for controversial pioneer ferry operator John D. Lee, who homesteaded along the river after being excommunicated from the Mormon Church and exiled by Brigham Young for his alleged role in the 1857 massacre of a wagon train of 120 non-Mormons at Mountain Meadows in Southern Utah. Lee was executed in 1877, but his wife Emma continued to run the operation until

the Mormon Church bought it from her in 1879, sending another church member to run Lees Ferry. (See Western Water Assessment [a joint venture between the University of Colorado and the National Oceanic and Atmospheric Administration], “The Compact and Lees Ferry”; National Park Service, “Glen Canyon National Recreation Area: Lees Ferry History.”)

49. Western Water Assessment, “The Compact and Lees Ferry.”
50. Joe Hanel, “Big Oil casts shadow over Colorado’s water future,” *Durango Herald*, 6 January 2008; Gary Harmon, “Shell Seeks Yampa River Water for Oil-Shale Plans,” *Grand Junction Daily Sentinel*, 6 January 2009; Mark Jaffe, “Shell Eyes Yampa River,” *Denver Post*, 7 January 2009; Jerd Smith, “Shell Stakes Claim on Yampa River,” *Rocky Mountain News*, 8 January 2009; Lawrence J. MacDonnell, *Water on the Rocks: Oil Shale Water Rights in Colorado* (Boulder, CO: Western Resource Advocates, 2009); Mark Jaffe, “Oil Shale Plans Create Ripple,” *Denver Post*, 19 March 2009. Chevron, Shell, and other companies in Shale Country acquired many of their water rights during previous booms and have maintained them to the present. Most of the rights date to the 1950s and ‘60s and are conditional, as opposed to absolute, meaning that they preserve the holder’s seniority under the law of prior appropriation but cannot be utilized until a state water court decrees them available for use. Holders of these conditional rights must undergo a diligence test in court every 6 years in court to demonstrate that they still intend to use the water. See also US Department of Energy, Office of Petroleum Resources, “Fact Sheet: Oil Shale Water Resources” (PDF).
51. We are grateful to Cathy J. Wilson of Los Alamos National Laboratory for sharing her thoughts about the water requirements of energy development and to Robert Lestz, the Oil Shale Technology Manager at Chevron, for providing an overview of the in situ process his team is developing at the Center of the American West’s Chevron Oil Shale Workshop, Glenwood Springs, CO, 23 October 2007. See also Cathy J. Wilson and Jean Foster, “Estimating Water Resource Demands and Availability for Oil Shale Development,” presented at the Geological Society of America Annual Meeting, 31 Oct. 2007; Western Resource Advocates, *Scoping Comments* (PDF), 19-26; BLM, *Final PEIS*, 4-33.
52. We are grateful to Robert Lestz of Chevron for explaining his company’s ambition to become a “net producer” of water at the Center of the American West’s Chevron Oil Shale Workshop, Glenwood Springs, CO, 23 October 2007. The claim is based on the idea that more water will be produced by pumping it out of a targeted underground shale zone than will be required for Chevron’s production process.
53. Western Resource Advocates, *Scoping Comments* (PDF), 19-26. Western Resource Advocates cites a BLM study that the surface disturbance, reduced flows, and long-term aquifer disruption created by energy development would result in a loss of up to 35% of the total population of Colorado River cutthroat. However, in 2007 the US Fish and Wildlife Service found that traditional oil and gas development posed little threat to the Colorado River cutthroat and that population numbers were healthy, leading the agency to decline listing the trout as an endangered species.
54. Gregg Garfin and Melanie Lenart, “Climate Change Effects on Southwest Water Resources,” (PDF) *Southwest Hydrology* 6, no. 1 (January/February 2007): 16-7, 34; Martin Hoerling and Jon Eischeid, “Past Peak Water in the Southwest,” (PDF) *Southwest Hydrology* 6, no. 1 (January/February 2007): 18-9, 35; Bobby Magill, “Water at risk from climate change,” *Grand Junction Daily Sentinel*, 23 August 2007; Steve Lipsher, “Strain on Colorado water predicted,” *Denver Post*, 23 August 2007; Wilson, “Estimating Water Resource Demands and Availability for Oil Shale Development” (presentation); BLM, *Final PEIS*, 4-41, 6-93; Tim Barnett and Eric Pierce, “When Will Lake Mead Go Dry?” *Water Resources Journal* (29 March 2008), (free abstract); Eric Kuhn, “Certainty in Uncertain Times: Policy Implications of the Colorado River Compact”; Eric Kuhn, “The Colorado River’s Uncertain Future: How Climate Change May Affect Future Planning Decisions on the Colorado River,” (PDF); Eric Kuhn, *The Colorado River: The Quest for Certainty on a Diminishing River* (Roundtable edition, 8 May 2007), 109 (PDF); Matt Jenkins, “How Low Will It Go?” *High Country News* 41, no. 4 (2 March 2009). It is notable that the BLM dialed down the level of certainty it expressed about how much water is available for oil shale between the publication of the Draft PEIS and the Final PEIS. In the Final PEIS, the BLM cited Cathy Wilson’s work and offered the conclusion that “Water requirements to support oil shale development are still unknown, but it is known that general water availability has become more constrained, and not merely from a legal appropriation standpoint. There is the likelihood that present senior water rights would be purchased to either support development and/or obtain water in a specific location” (6-121). Compare that statement to this passage in the Draft PEIS: “Water requirements to support oil shale development are still unknown, but it is known that general water availability has become more constrained, and not merely from a legal appropriation standpoint. However, there is water available in the Colorado River system in the 3 basin states that could be used to support oil shale development. Additionally, there is the likelihood that present senior water rights would be purchased to either support development and/or obtain water in a specific location” (emphasis added, 6-93).
55. Natural deep groundwater in the Piceance Basin is saline, as demonstrated by S.G. Robson and G.J. Saulnier Jr., *Hydrogeochemistry and simulated solute transport, Piceance Basin, northwestern Colorado, U.S. Geological Survey Open-File Report OF 80-72* (1980). Spent oil shale retort also leaches dissolved solids, primarily sodium carbonate (J.L.

- Freerer, A.G. Miller, W.F. Ramirez, "X-ray photoelectric spectroscopy determination of a conceptual leaching model of retorted oil shale," *Environmental Science and Technology* 20, no. 7 [1986]: 695-702), dissolved organic carbon (J. Leenheer and H.A. Stubner, "Migration through soil of organic solutes in an oil shale process water," *Environmental Science and Technology* 15, no. 12 [1981]: 1467-75), sulfate (K.G. Stollenwerk, "Geochemistry of leachate from retorted and unretorted Colorado oil shale," ([doctoral dissertation, University of Colorado at Boulder, 1980]), and molybdenum and fluoride (K.G. Stollenwerk and D.D. Runnells, "Leachability of arsenic, selenium, molybdenum, boron, and fluoride from retorted oil shale," proceedings of the Pacific Area Engineering Conference [Denver, CO] 2, no 2 [1977]: 1023-30).
56. Bartis, *Oil Shale Development in the United States*, 40-2; Western Resource Advocates, *Scoping Comments (PDF)*, 26-31; "What's the rush on oil shale?" (editorial), *Denver Post*, 17 May 2007; Kim McGuire, "No one is neutral in a water fight," "Uncharted waters for Wellington," "Battle looms over water quality" (3-part series), *Denver Post*, 12-14 August 2007.
57. BLM, Final PEIS, 3-102-109, Table 3.5.3-3; Bartis, *Oil Shale Development in the United States*, 38.
58. Nancy Lofholm, "Oil and gas well-ness checkup," *Denver Post*, 6 May 2007.
59. Bartis, *Oil Shale Development in the United States*, 21, 38-40; Western Resource Advocates, *Scoping Comments (PDF)*, 31-4; Steve Lipsher, "Drilling Plan for Vermillion Basin Delayed," *Denver Post*, 24 August 2007.
60. Bartis, *Oil Shale Development in the United States*, 38-40; Western Resource Advocates, *Scoping Comments (PDF)*, 31-4.
61. Western Resource Advocates claims that this is an old saying even if it's not exactly a well-known conversational fixture.