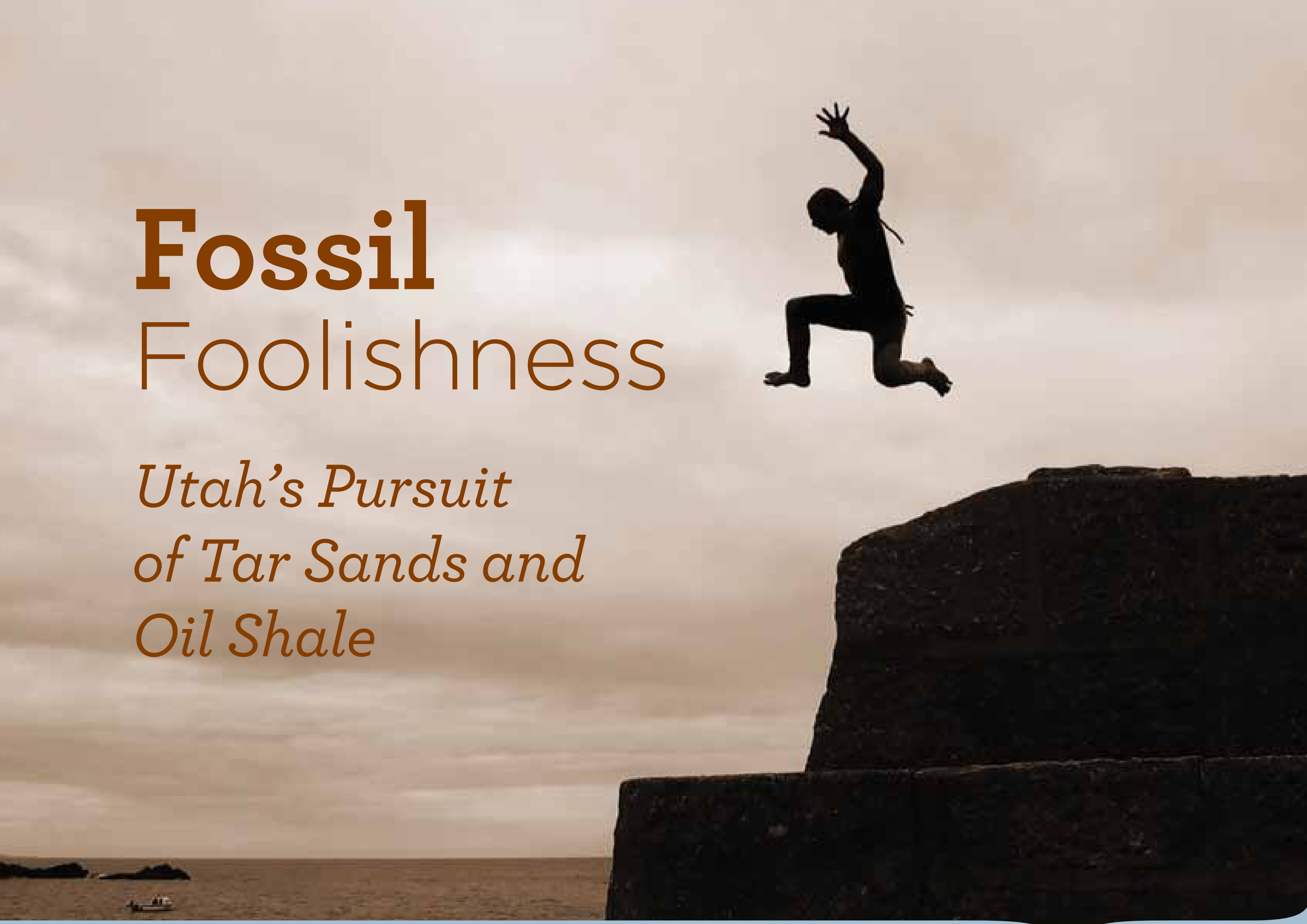

Fossil Foolishness

Utah's Pursuit of Tar Sands and Oil Shale

WESTERN RESOURCE
ADVOCATES

This report was written by Dan Glick of The Story Group, with invaluable assistance from David M. Abelson, Joro Walker, Karin P. Sheldon, Mike Chiropolos, Anita Schwartz, Peter Roessmann, Nicole Theerasatiankul, Rob Harris, Stacy Tellinghuisen, and Bart Miller. The project was funded by a grant from the William and Flora Hewlett Foundation.

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About Western Resource Advocates:
Western Resource Advocates is a nonprofit environmental law and policy organization dedicated to protecting the West's land, air, and water.

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A Letter from Western Resource Advocates' President

Why Tar Sands and Oil Shale Are Poor Energy Choices for America

By Karin P. Sheldon

In his 2010 "State of the State" address,[1] Utah Governor Gary Herbert challenged Utah to be at the "forefront of solving the world's energy challenges." By launching the Utah Energy Initiative, a 10-year plan to assess Utah's energy options, Gov. Herbert outlined the need to develop a range of energy sources, from traditional fossil fuels to renewables, such as solar or wind.

The governor's speech did not mention tar sands or oil shale, and rightly so. These environmentally damaging fuels are incompatible with Utah's identity as a state that protects its world-class natural wonders and is a leader in new energy sources to power our 21st century global economy. Utah is blessed with outstanding potential for wind, solar, and geothermal energy. Commitment to these and other forward-looking, clean technologies should chart the course towards the state's energy future.

Unfortunately, with the governor's support, Utah is now considering developing dirty and environmentally destructive fuels. In addition to its wealth of renewable energy sources, Utah has the United States' major tar sands deposits. Spurred by the production of oil from Canadian tar sands, Utah energy companies want to produce oil from the mixture of sand, clay, water, and bitumen found in the Uintah Basin that has historically been used for road paving.

To do that, energy companies would have to establish giant strip-mining operations to dig the layer of tar sands out of the ground, and then transport it to a facility where it would be heated to extract the bitumen from the sand and clay. This ex situ technique creates giant, unreclaimable open pits and waste piles, large, open toxic waste ponds, and an array of other adverse environmental consequences. Some companies are developing an in situ technique that would heat the tar sands under the ground, basically liquefying the bitumen and pumping it to the surface to be refined. While there would be less surface disturbance from this technique, heating and processing the bitumen would still require substantial

1 Utah Governor Gary Herbert, "Governor Herbert delivers State of the State Address," press release of January 26, 2010, http://www.utah.gov/governor/news_media/article.html?article=2944.

amounts of energy and water. As this report discusses in detail, water is a natural resource that Utah, as the country's second most arid state, must use with great wisdom and forethought in the coming years.

The oil shale industry is speculative, as it has been for more than 150 years. Over that period, the oil shale deposits of Utah, Colorado, and Wyoming have lured opportunists, energy companies, and the federal government to try to exploit the energy potential of what the Ute Indians called "the rock that burns." In modern times, there is renewed interest in oil shale each time the price of oil shoots up. In 2005, the interest translated into Congressional approval for energy companies to begin leasing federal land to support oil shale research. One such lease has been issued for lands in Utah, with more possibly on the horizon.

Despite the long-standing fascination with turning rock into oil, the technology to do so in an economically and environmentally sound way remains a dream. Energy companies who believe in oil shale acknowledge that commercial development of this resource is at least a decade or two away. Before that time arrives, it is critical that we apply all of our national expertise to develop better ways to fuel our cars and airplanes.

We at Western Resource Advocates know that when it comes to finding energy solutions, there are no simple answers. Americans face significant challenges as energy demand soars and oil becomes harder to find. At present, every method we choose to heat our homes and fuel our cars requires trade-offs to balance political, economic, public health, and ecological needs.

With that thought in mind, we have examined tar sands and oil shale as potential sources of transportation fuel in the 21st century, with special attention to what that means for the people of Utah. In this report, we focus on the likely impacts of commercial tar sands and oil shale development on Utah's water, air, recreation, and economy, as well as the fabric of its rural communities so central to Utah's soul.

It is not a pretty picture.

SEDUCED BY A ROCK

At first blush, it is easy to fall for the seductive picture painted by tar sands and oil shale supporters. As some describe it, the United States possesses an untapped and unimaginably large reservoir of oil, laced in bitumen deposits or encased in rock and buried on federal lands around the vast Green River formation in Colorado, Utah, and Wyoming.

The numbers seem staggering: It is estimated that Utah tar sands may contain 11 billion barrels of oil.[2] Estimates of U.S. oil shale reserves range from a half a trillion barrels to more than 1.5 trillion barrels of oil. These resources, the argument goes, would be sufficient to power our country for centuries, and, if developed, would allow us to thumb our nose at Venezuelan dictators and Middle Eastern oil

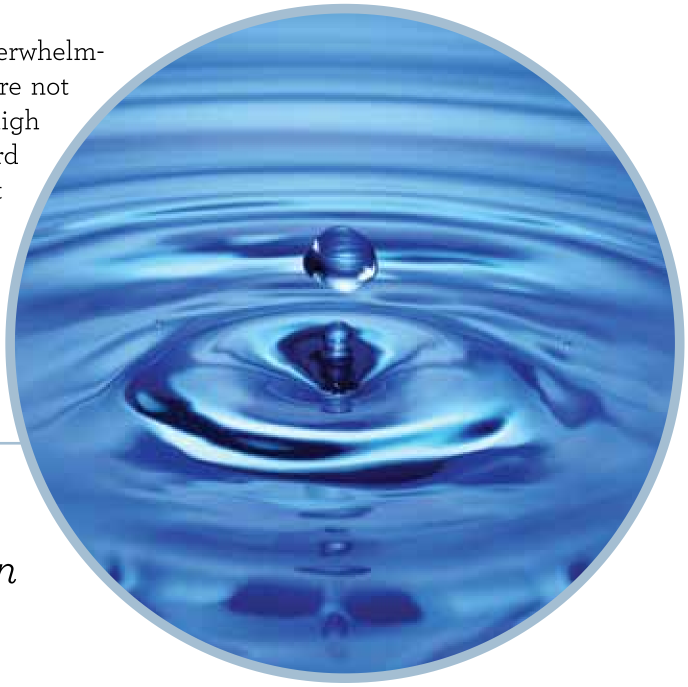
2 Task Force on Strategic Unconventional Fuels, *Development of America's Strategic Unconventional Fuels,* Vol. III - Resource and Technology Profiles, September 2007, pg. III-54, http://www.unconventionalfuels.org/publications.html.

cartels. Right under our feet, these "unconventional fuel" boosters tell us, the United States government controls the means to lower the price of oil on world markets, eliminate our dependency on foreign oil, and send the "peak oil" prophets packing.

It is a seductive thought, isn't it?

Unfortunately, as the cautionary adage goes, "If something seems too good to be true, it probably is." The more we research tar sands and oil shale, the more apparent it is that due to the relatively small amount of fuel that could be developed, these energy sources would not decrease in any measurable way our dependence on foreign fuel. Utahns, however, would pay an unacceptable price to pursue a commercial unconventional fuels industry that is still wildly speculative. Before any piecemeal approaches are considered, the cumulative, life-cycle effects of pursuing this industry should be evaluated — including water use, energy use, land disturbance, and the uncertain prospects of reclaiming the mining and processing sites.

Both tar sands and oil shale development present overwhelming challenges and drawbacks. For starters, there are not eleven billion barrels of oil under Utah's rocky high desert soil. For tar sands, the raw material is a hard mixture of clay and bitumen that needs significant processing to become liquid fuel. In the case of oil shale, there are quadrillions of tons of rock under the desert that, in theory, could be heated (using lots of energy) and transformed into a murky liquid called kerogen, which still is not oil. Kerogen could then be upgraded and refined (using more energy) into something we could put in our cars, trucks, and airplanes. The laws of physics tell us that it will require a substantial amount of energy to transform tar sands or oil shale into a fuel that can be used in a car or truck. Any technology to do this would be unavoidably and unacceptably wasteful.



"The human body just will not go on without water. It will go on without oil."

Another inescapable problem posed by commercial tar sands and oil shale development in Utah is the amount of water required to produce oil from bitumen or rock. In Utah, water is without a doubt the most precious — and limited — natural resource. As Don Christiansen, general manager of the Central Utah Water Conservancy District, says on page 20 of this report, "You just can't get along without water. The human body just will not go on without water. It will go on without oil."

Allocating huge quantities of water required by an unconventional fuels industry would mean siphoning it from other uses. Since Utah's most productive tar sands and oil shale deposits are found in the Uintah Basin, the water would come from the Colorado River Basin, most likely from the Green, White, and Duchesne Rivers. All signs are that water from these river systems will be in shorter supply in the years to come.

Tar sands and oil shale developers cannot yet tell us exactly how much water they will use, because, in the case of oil shale, they do not know what technology may make it economical to produce oil from rock. With tar sands, they promise lower-water use techniques, but refuse to open their books to allow the community to understand how these methods would work and what the resulting broad resource needs and impacts would be. In both cases, it will require substantial additional water and energy to upgrade kerogen and bitumen into usable fuels. We do not know where this additional refining will take place, the exact energy and water requirements for upgrading, what the air quality impacts will be, or any details about how the kerogen will be transported.

What we do know is sobering enough. Based on studies by the Bureau of Land Management and the RAND Corporation, it is certain that commercial development of either resource would require significant amounts of water. A commercial-scale industry would compete with existing irrigated agriculture, growing cities, and other demands for Utah's water, especially if tar sands and oil shale were developed at the same time.

Water quality is also at stake. The process of mining and refining tar sands and oil shale will unavoidably degrade water quality. When tar sands or oil shale is mined and processed, chemicals leach into groundwater and are transported to surface waters. This is the water that we rely on to drink, to water our crops, and to support wildlife. We already spend millions of dollars to clean up the effects of industrial runoff into our rivers; commercial development of these dirty fuels would only make matters worse.

Finally, commercial tar sands and oil shale industries would require huge amounts of energy to power the production process. Whether from coal-fired power plants, natural-gas-fired power plants, or nuclear power plants, the new energy requirements would be substantial. Any new power production or refining process that utilizes fossil fuels would add more air pollution and carbon dioxide pollution to our atmosphere, further contaminating our air, marring our viewsheds, and straining our climate system. Coal-fired power plants emit large quantities of pollutants, including the neurotoxin mercury and sulfur dioxide, a main contributor to acid rain. Particulate matter from coal plants is already literally staining our snow cover a darker color, which in turn absorbs more heat and helps to melt snow faster — snow that supports the economic engine of Utah's ski industry.


Photo Chris Evans, The Pembina Institute

Canada's tar sands experience offers Utah a stark cautionary tale. While Canada's tar sands industry has produced significant quantities of oil, it has also created region-wide environmental damage. Alberta is struggling to cope with groundwater contamination, toxic wastewater that harms human health and kills wildlife, the depletion of water resources even in a much wetter environment, and outsized strip-mining operations that have destroyed large tracts of forests. Tar sands production comes with an unacceptable carbon footprint and pollution output that Utah should not welcome.

Even if energy companies developed technologies that could economically produce vast quantities of oil from bitumen or rock, what would be the cost to our water, to our air, to the lands on which we hunt, fish, and recreate, to our warming planet? Are we not better off moving towards sustainable, renewable energies — of which Utah has a vast natural bounty? Should we cling to the fossil fuel economy of the past, or focus our energy on building a cleaner, more sustainable future?

This report cuts through the hype about these dirty fuels. We present facts for Utahns to use to make informed decisions about their energy future. The evidence establishes that oil shale is a backward-looking, inefficient fuel that would likely be a regional environmental disaster if pursued on a commercial scale. Tar sands, with its gigantic carbon footprint, water requirements, and pollution output, are no better.

After reading this report, we expect that you will agree.

The good news is that there are better ways to fuel our future that will preserve our natural environment, provide jobs, and help Utah become a key player in a vibrant clean energy economy. As Gov. Herbert said in his 2010 State of the State address, "Utah can — and must — be at the forefront of solving the world's energy challenges."

Based on current knowledge and technologies, tar sands and oil shale do not promise to be clean enough, efficient enough, environmentally sound enough, or smart enough to be part of our energy future. Utah is rightly committed, as Gov. Herbert said, "to ensure Utah's continued access to our own clean and low-cost energy resources; to be on the cutting edge of new energy technologies; and to foster economic opportunities and create more jobs."

Making this dream come true will require Utahns to demand that the state pursue energy solutions — not thermodynamic delusions. The pursuit of low-grade hydrocarbons, like tar sands and oil shale, amounts to what we believe is fossil foolishness.

Karin P. Sheldon

Karin P. Sheldon
President

ES

Executive Summary

Tar sands and oil shale development are poor choices for Utah's energy future. There are too many uncertainties, including the industry's claims on how much energy they would use, how they would contain the environmental damage from mining and refining, and — importantly for Utah —how the industry would affect the state's water resources. If Utah embraces these water-intensive and pollution-producing energy industries, the impacts will reverberate throughout the state and beyond.

Utah's population is rapidly expanding,[1] putting increased pressure on water and energy needs, from the Wasatch Front to St. George. The state is fast approaching the day when all of its allocations under the Colorado River Compact are spoken for, which will further pressure the state to take bold action to prioritize uses for its water. Compounding the problem is the growing number of independent, scientific projections concluding that much of Utah will become even drier, thereby further straining the state's most precious resource: water.

There is already enormous competition for Utah's limited water supply. State water managers agree that it is already likely that there are more legal claims to Utah's water than there is water to go around. Tar sands and oil shale supporters have downplayed their water needs, and have claimed that various independent experts have exaggerated the water consumption needs of unconventional fuel production. Yet, energy companies who wish to develop these dirty fuels are vague about the answers to key questions regarding the impacts of their activities. In many cases, the companies do not have the answers, and admit it.

Much of what we have gathered about these technologies and

1 The population in 2009 was approximately 2.78 million and is projected to exceed 5 million by 2050. Source: U.S. Census Bureau, http://www.census.gov/compendia/statab/and Utah Governor's Office of Planning and Budget, "Utah's Long Term Population Projections," 2006, http://www.cppa.utah.edu/uir/summit/2006/Spendlove-Utah's Long Term Population Projections.ppt.

impacts is based on admittedly speculative information, or on such examples as the Estonian oil shale industry or Canadian tar sands development. Neither is a perfect model for future development in Utah, but we can absorb important lessons from those and other examples. As the U.S. Bureau of Land Management stated in its 2008 Final Programmatic Environmental Impact Statement on oil shale and tar sands, "support[ing] immediate leasing decisions would require making many speculative assumptions regarding potential, unproven technologies." [2]

Until such time that industry and government examine the full suite of economic and environmental impacts and until such time that objective data is out on the table for public consumption, Western Resource Advocates (WRA) remains skeptical about the latest round of claims that feasible and acceptable tar sands and oil shale development is on the horizon. The public deserves to have concrete responses before companies are permitted to move forward on public land with taxpayer money — whether in the form of government incentives or tax breaks.

Missing Data: What the Public Deserves to Know

- **Water quantity:** Independent assessments of how much water will be required for commercial development are needed.
- **Water quality:** Independent baseline assessments are needed of existing stream conditions for aquatic life and potential impacts from commercial development on surface and groundwater.
- **Energy sources:** Industry needs to identify the sources of electricity — whether coal, nuclear, natural gas, or renewable power – that will be used to power production. Based on this information, there needs to be an assessment of the impacts from this energy use.
- **Energy return on investment (EROI):** Independent assessments are needed of the energy produced versus the energy used to produce tar sands or oil shale.
- **Air quality:** Independent data regarding air quality impacts is needed.
- **Climate:** Independent data regarding greenhouse gases and contributions to climate change is needed.
- **Life-cycle impacts:** Analysis is needed of the cumulative impacts of both tar sands and oil shale development, from mining operations through reclamation plans.
- **Regulatory scheme:** A determination must be made as to whether existing environmental and safety regulations are sufficient to protect Utah communities, recreational activities, and ecosystems from damage.

Based on what is publicly known, WRA has reached the following conclusions about development of these dirty fuels in Utah:

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2 U.S. Bureau of Land Management, *Approved Resource Management Plan Amendments/Record of Decision (ROD) for Oil Shale and Tar Sands Resources to Address Land Use Allocations in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement,* November 2008, pg. 43, http://ostseis.anl.gov/documents/docs/OSTS_ROD.pdf.

- **Tar sands and oil shale production would not contribute significantly to domestic U.S. oil supply unless it is done at a large scale, and industrial production in Utah would have significant impacts.** Production of several hundred thousand barrels[3] per day would mean giant mining operations, huge infrastructure development, and enormous impacts on the state's and region's water, air, energy, and people.

- **Commercial tar sands and oil shale development would require huge quantities of water in the country's second-most arid state.** Producing oil from rock and tar sands would siphon water from Utah's lakes, rivers, streams, and aquifers at a time when the West's water supplies are tightening and competition for Utah's remaining allocations are causing cities such as St. George to plan a 130-mile water pipeline from Lake Powell to meet growing demands. Pending proposals for massive diversions from Flaming Gorge Reservoir on the Upper Green River to Colorado's Front Range introduce additional uncertainty. Utah's remaining Colorado River allocation should not be used for a speculative energy source at the expense of municipal, agricultural, recreational, or ecological purposes.

- **Water quality would be adversely affected by commercial development.** Water used in tar sands and oil shale production would contain contaminants that would degrade the quality of Utah's water, raising costs for water treatment and placing burdens on downstream uses.

- **There is too much uncertainty about how commercial tar sands and oil shale development would proceed.** Industry has not explained how much water will be used or how much energy will be required to power the conversion of tar sands or oil shale to liquid fuel. Not knowing what technologies will be used for processing makes this a gamble for the state and for the federal government, which are being asked to prop up the industry.

- **The impacts on the recreation economy would harm Utah.** Skiers, anglers, rafters, and millions of tourists visit Utah for its five vaunted national parks and world-class recreational lands. They come for the state's stunning vistas, clean air, and free-flowing rivers. Degraded water and air quality would adversely impact Utah's $7.1 billion recreation economy, which provides 113,000 jobs.

- **Climate change is real, and oil shale development can only make it worse.** Refining oil from tar sands and oil shale produces toxic by-products and large amounts of greenhouse gases. The West, including Utah, has warmed more rapidly in the past 150 years than any region in the United States besides Alaska. Scientists tell us that humans are heating the planet by burning fossil fuels that release carbon dioxide, which becomes trapped in our atmosphere and warms the planet. Tar sands and oil shale would be among the most carbon-intensive energy sources, adding burning fuel to a global fire. The Alberta tar sands industry is now Canada's leading emitter of greenhouse gases.

- **Utah must be a new energy leader.** By focusing finite human and financial capital on commercial oil shale development, we divert attention from the very real opportunity we have to provide new, renewable energy sources that will power a vibrant economy and maintain a livable planet for our children and grandchildren.

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3 The United States currently uses 19.5 million barrels of oil per day. Source: U.S. Energy Information Administration, "Petroleum Basic Statistics," http://www.eia.doe.gov/basics/quickoil.html, accessed June 3, 2010.

1

A Matter of Scale

The allure of tar sands and oil shale as a viable domestic energy source is predicated on some outsized numbers.

Photo C. Campbell, The Pembina Institute

Approximately 60% of the world's oil shale deposits and all of the United States' tar sands deposits are located in a three-state region in the Green River Basin, encompassing swathes of Utah, western Colorado, and southwest Wyoming. Geologists estimate that there are as many as a trillion barrels of kerogen and bitumen locked in rock under some 16 million acres[1] of U.S. land, most of it owned by the federal government.

Not all of that kerogen and bitumen is recoverable, even by the most optimistic assessments. But oil shale supporters believe that several hundred billion barrels of oil — enough to tilt world supply and demand in the United States' favor — could be economically recoverable. The federal Task Force on Strategic Unconventional Fuels predicted in 2007 that the U.S. could ultimately produce 2.5 million barrels a day of shale oil and 350,000 barrels a day of oil from tar sands by 2030[2] — assuming massive taxpayer subsidies, access to public land, myriad incentives, and special treatment, including guaranteed price support by the U.S. Department of Defense.[3]

These same big numbers also illuminate these unconventional fuels' perils. Any commercial industry that could make a dent in U.S. oil imports would have to be gigantic, with massive ecological and social effects. "We're talking about the impacts of large-scale development," says James T. Bartis, an analyst for RAND Corporation and one of the world's oil shale experts.

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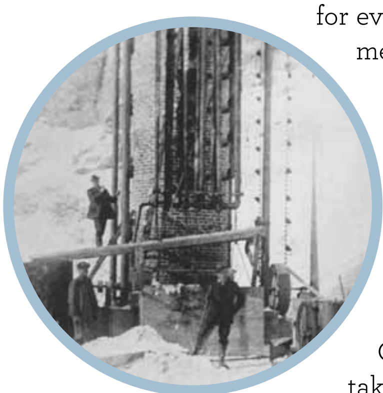
1 Task Force on Strategic Unconventional Fuels, *Development of America's Strategic Unconventional Fuels*, Vol. III - Resource and Technology Profiles, September 2007, pg. III-54, http://www.unconventionalfuels.org/publications.html.

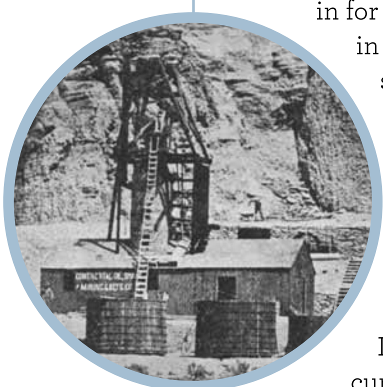
2 The Task Force projects the tar sands industry could produce 250,000 bbl/day in 2025; for simplicity, we assume this production rate for the year 2030.

3 NSURM, Executive Summary p. ES-3, http://www.unconventionalfuels.org/publications/reports/executiveSummary.pdf Task Force Report, Vol. II - Resource-Specific and Cross-Cut Plans.

Those impacts notably include a high demand for water. To produce 2.4 million barrels per day (about a quarter of U.S. daily imports), oil shale production would utilize between 180,000 and 420,000 acre-feet of water per year — according to very conservative water use estimates by the U.S. Department of Energy. (The low estimate assumes 1 barrel of water per barrel of oil, and the higher estimate assumes 3 barrels of water per barrel of oil.) In Canadian tar sands production, it takes at least 3 barrels of water to produce 1 barrel of oil.

Other agencies estimate even higher water use. The Bureau of Land Management (BLM) calculates that surface mining and retorting (heating) would require 2.6 to 4 barrels of water for every barrel of shale oil produced, and in 1980 the Office of Technology Assessment[4] published estimates that could exceed a ratio of water use to oil production of 5:1, or about 800,000 acre-feet per year for a 2.4 million barrel-per-day industry. (To put those estimates into perspective, Utah's entire allocation from the Colorado River each year is approximately 1.2 million acre-feet.) Ancillary water uses, such as domestic supply for the workforce population and associated regional growth, for energy production, or for the water demands of upgrading the initial product into a useable fuel, are not included in these estimates.





Courtesy of the Bureau of Land Management

Clearly, not all of that theoretical 2.4-million-barrel-per-day production would take place in Utah. But whatever ratio of water use to oil production that you plug in for Utah's share of production — 1:1, 3:1, or 5:1 — the water demands are substantial in the country's second-driest state. Additional water is necessary to "upgrade" oil shale liquid into transportation fuel, and the BLM estimates that could require an additional 20 barrels of water per barrel of oil.[5]

Any commercial unconventional fuels industry would emit enormous amounts of pollution into the air, land, and water, and would transform the region from a rural area into an industrial zone. There is relatively little, if any, "new" unclaimed water in the region to support such an industry, and allocating the state's remaining water rights will be a high-stakes competition. Inevitably, water to support a tar sands or oil shale industry would come from current agricultural uses, forcing a shift in the social and cultural bedrock in many communities.

After tar sands and oil shale are upgraded for transport, the product must be refined. Currently, at least two oil shale and tar sands developers are planning on refining their product at facilities along the Wasatch Front. Any resulting increase in capacity at these refineries could further degrade air quality there, where air pollution is already so severe that the state routinely issues advisories to warn its population of unhealthy conditions.

There is a global scale to consider as well. Every discussion about energy must include an assessment of the carbon footprint of any new project and its implications

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4 U.S. Office of Technology Assessment, *An Assessment of Oil Shale Technologies*, June 1980, http://www.fas.org/ota/reports/8004.pdf.

5 386,000 bbl/day of water to upgrade a 20,000-bbl/day operation. Source: U.S. Bureau of Land Management, *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*, Vol. 2, September 2008, Table 5.1.2-1, http://ostseis.anl.gov/documents/fpeis/volumes/OSTS_FPEIS_Vol_2.pdf.

for global warming pollutants. Commercial tar sands and oil shale production would be among the dirtiest sources of fuel, and one of the most carbon-intensive industries on the planet. The production of liquid from tar sands and oil shale requires energy-intensive processes, and transporting that liquid and refining it into useable fuel would use more energy. The end product, when burned, would add to the world's concerns about rising carbon dioxide emissions and their link to global climate disruption.

Optimistic projections of industrial oil shale production gloss over the enormity of the scale-up challenge. Today, only a few countries produce oil from oil shale. According to a report by Headwaters Economics, current worldwide production of oil from oil shale (mostly in Estonia, Brazil, and China) is about 15,000 barrels of oil equivalent per day.[6]

The challenges of getting from 15,000 barrels per day worldwide to a projected 2.4 million barrels a day in three states cannot be easily discounted — not to mention the expense. "The less you know about a technology, the cheaper it is," says RAND's oil shale expert Bartis. "Everybody should be skeptical about whether oil shale will be commercialized in our lifetimes." Even the executive director of the National Oil Shale Association, Glenn Vawter, acknowledges the steep climb ahead. "We're planning for something that may not happen," he recently told attendees of a Denver oil shale conference.

Commercial tar sands and oil shale production presents a number of problems without an acceptable equation to solve them. These industrial numbers represent a paradox for unconventional fuel supporters: Small-scale development would have fewer impacts, but would not provide any significant relief to prices, supply, or availability of liquid fuels. Development that would produce tar sands and oil shale in significant quantities would inevitably create a massive, dirty footprint on the affected counties, the states, the region — and the world. Do Utahns really want their state to be a sacrifice zone to produce inefficient and wasteful fuels?

The Governor's Impediments Memo — Even the Boosters Are Concerned

A number of independent analyses of tar sands and oil shale cast considerable doubt on the viability of a commercial industry in Utah. One is most striking — a draft memorandum dated December 27, 2006, from Dr. Laura Nelson to former Governor Jon M. Huntsman, Jr., discussing the "impediments" to large-scale oil shale development. Nelson, former Energy Advisor to Governor Huntsman, now serves as Vice President, Energy and Environmental Development, for Red Leaf Resources, Inc., a Utah-based oil shale developer.

What we find most interesting about this document is that Nelson and her colleagues raised the same concerns we discuss in this report. These concerns she identified as "impediments." Here are excerpts from a draft memorandum entitled "DRAFT — Oil Shale/Tar Sands Impediments Report."

6 http://www.headwaterseconomics.org/energy/14Questions_2010.pdf

"Near [oil shale] operations, water needs for domestic demand, retort processes, reclamation and mining operations will need to be addressed. While past proposals relied on White River impoundments for at least part of these supplies, this may no longer be a solution and other sources of water may be relied upon. A need for ground or surface water that is a consolidation of existing rights may be an ultimate solution. Wastewater created by mining or retorting operations is a certainty that must be dealt with as plans are implemented. While mitigation devices for surface runoff are fairly easily designed and placed into service, ground water protection is a task requiring considerable background and monitoring information. Creative scientific solutions based on existing conditions and regulatory requirements will be required for effective results."

The memo goes on to explain a list of "impediments":

- "Technology for commercial development of both oil shale and tar sands is basically unproven … there are no definite results available that demonstrate commercial viability."
- "Long-term market prices for crude oil at current levels are not guaranteed. Also, purchases of kerogen are not assured. Price supports and purchase guarantees may be needed to obtain and continue investor participation in tar sands and oil shale technologies."
- "Both air and water quality issues may be proposed that cause pollution to reach critical levels and need further examination."
- "Water sources need consolidation so that a reliable and consistent supply is available in the development areas. No specific water supply is set out in preliminary plans for OS/TS development and technologies are still developing. While water supplies are generally available, consolidation needs to be done."
- "Infrastructure in the way of housing, roads, utilities, and the essential services for workers are lacking at current levels and supplies need to be improved. These are items needing work from both local government and State government."
- "Available trained labor in the local areas may be limited. … Competition for labor is an inevitability when other industries are working in full force."
- "Transportation of both raw and refined product as well as workers needs to be assured … transportation is a large enough concern to be in a category of its own."
- "Refining capacity in the Uintah Basin and in the State as a whole is lacking. As previously discussed, the need for a refinery that will refine more black wax crude oil is already apparent. The entry of kerogen into the mix of supply causes one to consider this an issue with real impact."

2

An Introduction to Utah's Unconventional Fuels

Both tar sands and oil shale are inferior hydrocarbons compared to oil. Unlike crude oil, which can be used to power internal combustion engines with a minimum of processing from its raw state, both tar sands and oil shale require substantially more refining before reaching a gas station pump. They pack dramatically less BTU punch per ton than oil, and are inherently inefficient fossil fuels for the modern world.

Let's start with a quick tar sands primer.

Tar Sands, Sticky Subject

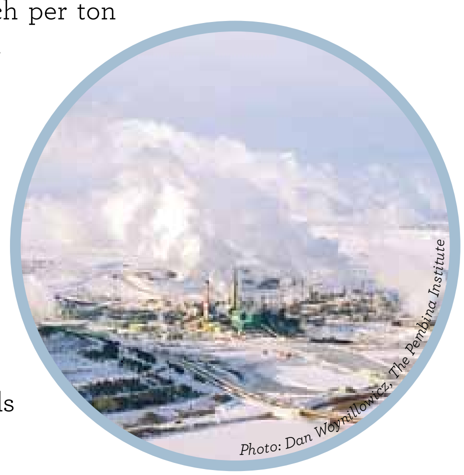

Photo: Dan Woynillowicz, The Pembina Institute

In Uintah County, a strip of high-desert land just southwest of Vernal is striated with a dark substance. For years, the county has mined this tarry material to use as road base, since it contains high concentrations of bitumen. Now, however, with the Canadian tar sands industry in Alberta as a lure, companies are attempting to mine Utah's tar sands and cook them into oil.

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

Photo: David Dodge, The Pembina Institute

Tar sands upgrading, Alberta, Canada

Utah's Uintah Basin contains most of the nation's tar sands deposits, with known reserves estimated at 11 billion barrels of oil.[7] Some tar sands development began in Utah in the late 1960s, and in 1981, the U.S. Congress formally established 11 Special Tar Sands Areas (STSAs) in Utah's most promising tar sands deposits, covering approximately 656,000

7 Task Force on Strategic Unconventional Fuels, *Development of America's Strategic Unconventional Fuels*, Vol. III - Resource and Technology Profiles, September 2007, pg. III-54.

acres of BLM-managed land. Most of Utah's tar sands are concentrated in four deposits: the Asphalt Ridge, P.R. Spring, Sunnyside, and Tar Sands Triangle regions.

In November 2009, the Canadian company Earth Energy Resources Inc. announced it had received "regulatory approval" to begin tar sands production on a state lease in Uintah County and Grand County.[8] The company says that it has developed a proprietary process that uses less water and produces fewer toxic chemicals,[9] but the company has not been forthcoming with details. Moreover, the site's proximity to Canyonlands National Park has provoked concern among Utah residents.[10] Several environmental groups, including WRA, have filed appeals.

The problems associated with turning tar sands into liquid fuel are similar to those encountered with oil shale: They are both a poor excuse for an industrial-age hydrocarbon. In the most productive Alberta sites, it takes 2 tons of tar sands to produce 1 barrel of oil. (Utah's tar sands deposits are generally inferior to Alberta's deposits in both quality and composition. [11]) In other words, every time you put 20 gallons of gas made from tar sands in your car,[12] you will have displaced at least 4,000 pounds of earth. And, like oil shale, tar sands require a tremendous amount of energy to heat the bitumen and turn it into a liquid.

Oil Shale & Tar Sand Deposits in Utah

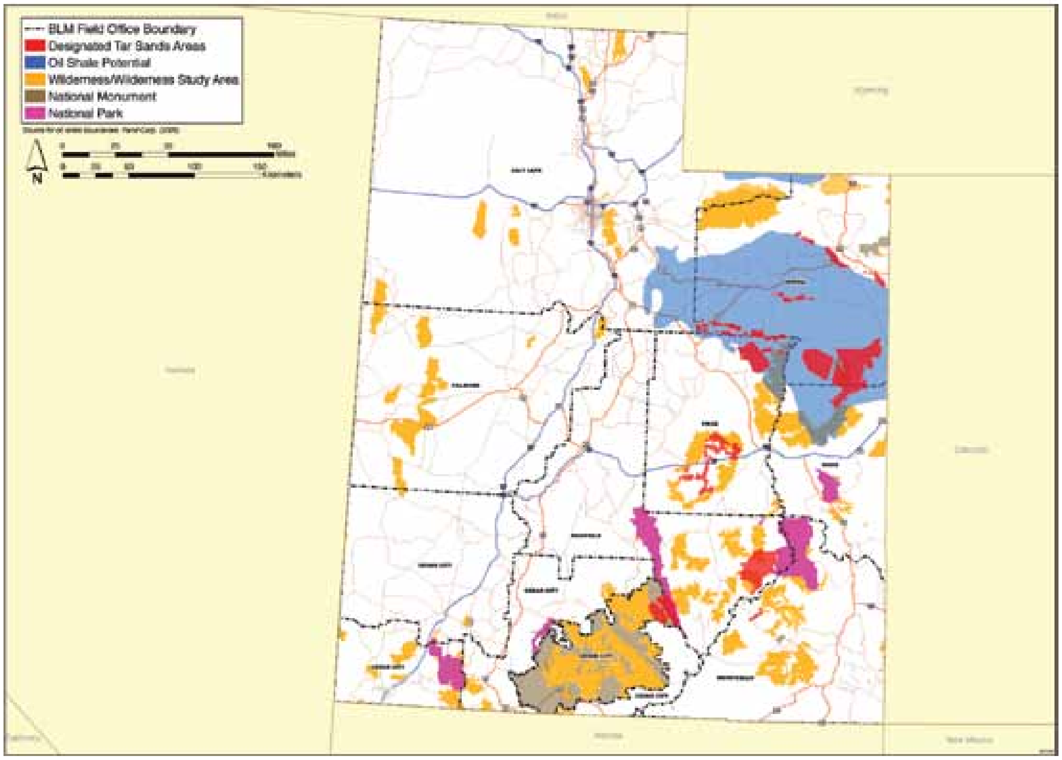

Image courtesy of Oil Shale and Tar Sands Programmatic EIS

8 Earth Energy Web site, http://www.earthenergyresources.com, accessed June 3, 2010.
9 Ibid.
10 Kurt Repanshek, "Is a Tar Sands Project Coming Close to a National Park You Love?" March 23, 2010, http://www.nationalparkstraveler.com/2010/03/tar-sands-project-coming-close-national-park-you-love5560.
11 Utah Mining Association, *Development of Utah Oil Shale and Tar Sands Resources*, October 2008, http://www.utahmining.org/UMA%20White%20Paper%20on%20Development%20of%20Utah%20OS%20TS.pdf.
12 U.S. Energy Information Administration, "Frequently Asked Questions – Gasoline," http://tonto.eia.doe.gov/ask/gasoline_faqs.asp#gallons_per_barrel, accessed June 3, 2010.

This "energy return on investment," or EROI (see 10),[13] is so low that you can think of it this way before filling up on the idea of tar sands production in Utah: Every time you fill your car with gas from made-in-Utah tar sands (imagine a 20-gallon tank), pour an extra 4 or 5 gallons on the ground. And that is being optimistic about the quality of Utah's tar sands and the ability of companies to mine and process it on much smaller scales than in Alberta.

The environmental consequences of commercial tar sands development are staggering. In Alberta, an enormous industrial complex has sprung up over the past 50 years, transforming a swath of boreal forest into a Florida-sized industrial zone you can see from space. Thousands of forested acres have been turned into open pit mines, and the destruction now stretches to an area larger than the city limits of Provo.[14] Tailings dams filled with toxic water cover 20 square miles.

Our conclusion for Utah's tar sands: It is a great resource for road base, but a poor choice for fuel.

Utah tar sands

Oil Shale: Diet Ice Cream

The term "oil shale" is a misnomer, akin to "synthetic natural gas" or "diet ice cream." Oil shale is not oil, nor is it shale, but a rock that contains a compound called kerogen. It is more accurately called "argillaceous mudstone."[15] (Argillaceous means containing fine particles, and mudstone is self-explanatory.) It is, in effect, the geological precursor to petroleum.

Oil shale might, if given a few million years of heat and pressure, be transformed by nature into usable oil. But spending millions of dollars (including taxpayer subsidies and guaranteed price supports) and causing untold environmental damage to mimic these geological forces is highly misguided. Energy analyst Randy Udall, co-founder of the Association for the Study of Peak Oil-USA, calls the idea of commercial oil shale development "thermodynamic lunacy." He has calculated that per ton, oil shale contains one-tenth the energy of crude oil, a quarter the energy of dung, and about the same energy density as a baked potato. The reality of oil shale's deficiencies, he says, is a function of the physical characteristics of the resource itself. It simply takes too much energy to extract fuel from this rock — and no process can evade that hurdle.

As Udall points out, the only countries that have chosen to develop oil shale for commercial production are "resource poor" nations, like Estonia, that are willing to settle on a small return on energy invested — because they feel they have no viable choice. The technology these countries use is called "retorting." Retorting involves surface or underground mining

13 In simple terms, EROI is a commonly used calculation of how much energy is needed to locate, extract, and refine an output of energy — in this case, oil from shale. In more technical terms, EROI is the ratio of the energy delivered by a process to the energy used directly and indirectly for that process. An EROI of 1:1 would be breaking even.

14 "Provo, Utah," http://en.wikipedia.org/wiki/Provo,_Utah, accessed June 3, 2010. "Vancouver Travel Information," http://www.vacationsmadeeasy.com/VancouverBC/articles/VancouverTravelInformation.cfm, accessed June 3, 2010.

15 Dr. Jeremy Boak, "Impacts of Oil Shale on Carbon Emissions," presentation at The Promise and Peril of Oil Shale Conference, Denver, Colorado, February 5, 2010, http://www.colorado.edu/law/centers/nrlc/events/documents/oil%20shale/Oil%20Shale%20PowerPoints/PPT%20-%20BOAK,%20Jeremy.pdf.

of the oil shale rock, then baking it at around 900 to 1,000 degrees F.[16] This technique has been proposed in Utah. In Colorado, Shell Oil is experimenting with an in situ technology that heats the rock underground with giant heating elements, and then surrounds those heating elements with deep freezing devices that will keep groundwater separate from the oil. Chevron is also experimenting in Colorado with a chemical heating process.

The numbers for oil shale production's energy demands are just as astounding. That is because it takes a lot of energy to heat oil shale rock into liquid kerogen. According to a definitive report by RAND's oil shale expert Bartis, to produce 100,000 million barrels of oil per day from oil shale, it would require approximately 1.2 gigawatts of dedicated electric generating capacity. That estimate is for an unproven, in situ technology that is more efficient than Utah's proposed retort facilities.[17] That is the equivalent output of two and a half new coal-fired power plants the size of Bonanza, in eastern Utah. That new electricity would likely be produced through some combination of new coal-fired plants, natural gas-fired plants, or nuclear plants. (Some companies hope to produce energy from natural gas captured during the mining process; that gas would still need to be turned into electricity.)

Utah's Unrequited Oil Shale Romance

Oil shale has shimmered on the energy horizon in this country for more than 150 years. Members of the Church of Jesus Christ of Latter Day Saints built the first oil shale operation in the Rocky Mountain West, a retort facility in the mid 1850s near what is now Levan, Utah.[18] Apparently, the effort was short-lived. After Pennsylvania oil was discovered in 1859, the Utah oil shale effort was abandoned.

Oil shale's modern history is littered with promises and failures, followed by more promises and failures. In the early 1900s, stock promoters gathered oil shale samples from the Wild West and lit them on fire on Chicago street corners, luring investors but yielding little oil. In 1916, President Woodrow Wilson set aside parts of Utah and Colorado to become a "Naval Petroleum and Oil Shale Reserves." The next year, Interior Secretary Franklin K. Lane boasted, "these oil-shale reserves can be considered of immediate importance to the oil industry and to the defense of the nation."[19]

Fueled by such testimonials, the 1920s saw the first of a series of terrific booms — and equally loud busts — in oil shale country. More than 100 companies formed to pull the oil from the stone. Federal legislation in the 1920s opened much of oil shale country to mining claims. The Great Depression put the oil shale dreamers on hold, but World War II revived the government's interest when the U.S. was again eager for domestic fuel supplies.

16 James T. Bartis et al., *Oil Shale Development in the United States: Prospects and Policy Issues*, 2005, report prepared by the RAND Corporation for the U.S. National Energy Technology Laboratory, pg. 13.
17 Ibid., pg. 21.
18 Jason L. Hanson and Patty Limerick, *What Every Westerner Should Know About Oil Shale: A Guide to Shale Country* (Boulder, CO: Center of the American West, University of Colorado, June 2009), http://www.centerwest.org/publications/oilshale/0home/index.php.
19 Ibid at http://www.centerwest.org/publications/oilshale/2history/1boom.php

But even after President Herbert Hoover encouraged oil shale production in the 1950s with federal largesse, companies did not bite.

Utah, however, began to catch a case of oil shale fever. In 1965, the Utah Water and Power Board applied to appropriate 250,000 acre-feet of water for the oil shale industry in the southeastern portion of the Uintah Basin, including the domestic requirements of 51,000 persons and 93,000 families to support the oil shale industry and "shale related industries."[20] Plans emerged to build a dam and reservoir on the White River for the main purpose of oil shale mining and retorting in what was called the "Uintah Basin Oil Shale Mining District."[21] (The reservoir was never built, and very few people think it will be built today.)

After the Arab Oil Embargo of 1973, interest in domestic exploration for energy sources skyrocketed. President Richard Nixon announced plans to explore for more domestic oil, and oil shale appeared ready to take off — again. It didn't.

After the 1979 Iranian Revolution, President Jimmy Carter created another oil shale boom by creating a federally subsidized program to develop "synthetic fuels." This boom exploded on "Black Sunday," a date that oil shale promoters would prefer the world forgets. On May 2, 1982, Exxon unexpectedly closed the doors on its oil shale production plants in western Colorado, causing what the Center of the American West called "an $85 million vanishing act."[22] More than 2,000 people were put out of work in a single day.


SHALE: Bust recalled as 'Black Sunday'

Exxon Halts Giant Shale Oil Project

Interest in oil shale was virtually dormant until President George Bush encouraged another pass at it. Congress enacted the 2005 Energy Policy Act, which included incentives for energy companies to explore oil shale. Utah was awarded one of six research, development, and demonstration (RD&D) leases to begin developing new oil shale sites on federal land. The Oil Shale Exploration Company (OSEC) received Utah's lone RD&D lease. (There were five in Colorado.) In addition, Utah-based Red Leaf Resources has proposed developing its own technology on state-owned and state-managed school trust lands in the Uintah Basin — which it calls "EcoShale."

In September 2008, the BLM issued its Final Programmatic Environmental Impact Statement (PEIS) for commercial leasing of tar sands and oil shale on public lands. The BLM's report serves as an important step toward developing a larger, commercial tar sands and oil shale industry.

Since that time, President Barack Obama's administration has taken a

20 Utah Division of Water Rights, Application to Appropriate, A36979, May 19, 1965, available at http://waterrights.utah.gov/cgi-bin/docview.exe?Folder=49-113.

21 Utah Division of Water Rights, Notice to Water Users, July 1978, available at http://waterrights.utah.gov/cgi-bin/docview.exe?Folder=49-113.

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

more cautious approach towards oil shale, especially with regard to commercial leasing and royalty discussions. Although Interior Secretary Ken Salazar has been a qualified supporter of oil shale development, and offered a second round of RD&D leases, he has also indicated that some of the questions posed by oil shale critics (and even their supporters; see page 6 for an "impediments" report from the former Utah governor's office) must be answered before receiving more government go-ahead.

The Physics of Energy — Tar Sands and Oil Shale's Fatal Flaw?

At the dawn of the oil age, wildcatters merely had to drill a hole in the ground to release gushers. The energy it took to drill the well was inconsequential, and the energy return on investment was more than 100:1 — every unit of energy it took to get the oil was repaid a hundredfold. As oil became more difficult to find, in more remote places like the Arctic or under the ocean, that EROI plummeted. Today, conventional crude oil's EROI is about 20:1.[23]

The Alberta tar sands industry, already scaled up to gigantic levels and benefiting from that scale, has been estimated as having an EROI of between 1:1 and 7:1. Charles Hall, from the SUNY College of Environmental Science and Forestry and who has been credited as the father of the EROI concept, has suggested 5.2:1 as a reasonable estimate.[24] Other estimates for tar sands are less optimistic.

Oil shale's EROI will ultimately depend on which technology is used. Utah will likely use a surface or pillar mine and retort technique, which is very energy-intensive. A recent report by Dr. Cutler Cleveland, a professor of geography and environment at Boston University, suggests the EROI for oil shale is between 1:1 and 2:1.[25] Other estimates suggest the EROI could be as high as 4:1.[26]

Why does EROI for oil shale and tar sands matter? The oil shale and tar sands resources in Utah are being promoted as a fuel source of the future. What the EROI for oil shale and tar sands show is that should these fuels ever be commercially developed, they would be a poor energy source.

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23 Cutler J. Cleveland and Peter O'Connor, "An Assessment of the Energy Return on Investment (EROI) of Oil Shale," On file with WRA.
24 Charles A.S. Hall, Stephen Balogh, and David J.R. Murphy, "What is the Minimum EROI that a Sustainable Society Must Have?" Energies 2 (2009): 25-47, doi:10.3390/en20100025, http://www.mdpi.com/1996-1073/2/1/25/pdf.
25 Cutler J. Cleveland and Peter O'Connor, "An Assessment of the Energy Return on Investment (EROI) of Oil Shale," On file with WRA.
26 "The Oil Drum: Net Energy — Discussions About Energy and Our Future," http://www.theoildrum.com/node/3839, accessed June 3, 2010.

3

Setting the Water Table – Rivers in the Desert

When Brigham Young arrived in Utah, he knew that the only way to forge a viable civilization in this arid land was to create a system of irrigation and an intelligent distribution of the state's limited water resources. He knew that water was life, especially in the desert, and set out to develop the state's flowing miracles. In the late 1800s and early 1900s, settlers began diverting water to feed a growing Salt Lake City and establish farming communities throughout the state. What emerged, as water historian Marc Reisner put it, was "the foundation of the most ambitious desert civilization the world has ever seen.[28]"

> *"I will even make a way in the wilderness, and rivers in the desert, because I give waters in the wilderness, and rivers in the desert, to give drink to my people..."* [27]
>
> **Isaiah 43:19 and 43:20**

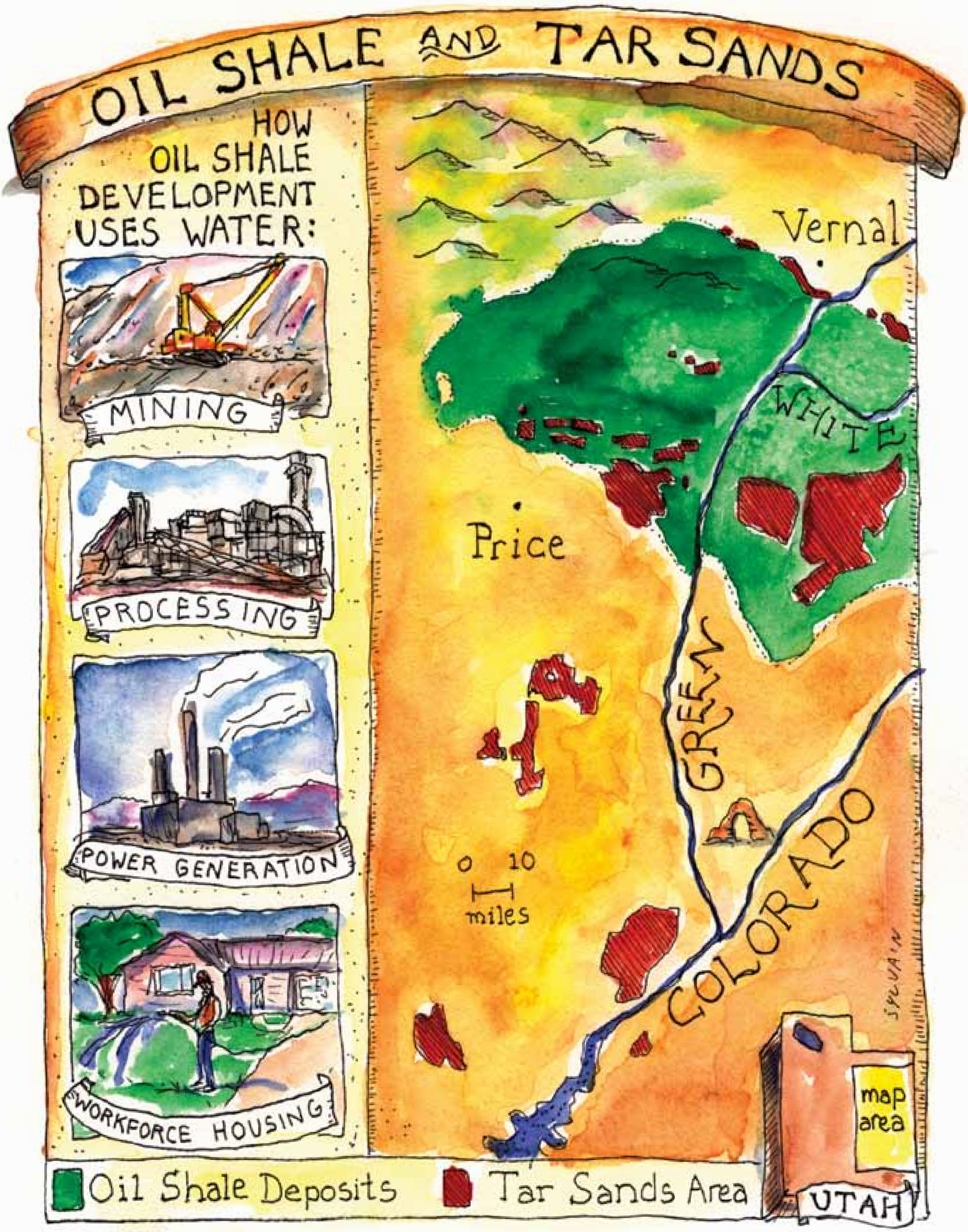
Utah is the United States' second most arid state, after Nevada. Not only does Utah receive meager annual precipitation, it also has a limited right to use water from its rivers and streams because of claims by upstream and downstream states. The Colorado River and its tributaries that flow through Utah, including the Green and White Rivers, contain some of the most sought-after water in the country. Tar sands and oil shale industries will need to draw large amounts of water from this intensely regulated river basin to be viable. The consequences of allocating water to these industries need to be fully understood, especially if tar sands and oil shale are developed together.

Water is indeed life, but there is a lot more life in Utah than there used to be. Utah's population remained relatively small in the early parts of the 20th century, when western states that shared the Colorado River gathered to apportion the great river's waters. The Colorado River Compact of 1922 (see sidebar, page 14) divvied up the river basin's waters (really, two major river systems: the Green and the Colorado) among seven western states. Utah has the right to use a fixed amount of Colorado River water, including from tributaries of the Green, like the White River and the Duchesne River.

During the middle part of the 20th century, the federal government built dams and diver-

27 Net Bible Web site, http://net.bible.org/verse.php?book=Isa&chapter=43&verse=19, accessed June 3, 2010.
28 Marc Reisner, *Cadillac Desert: The American West and Its Disappearing Water* (New York: Penguin Publishing, June 1993).

How Oil Shale and Tar Sands Use Water



sions like Glen Canyon, which formed Lake Powell, and the Central Utah Project, which helped bring water from the eastern part of the state to the Wasatch Front. At the same time, a growing population around the state continued to make water claims: alfalfa farmers in the Sevier Valley, subdivision developers in St. George, oil and gas drillers in Vernal, and swimming pool owners in Sandy. Utah, like its Colorado River Compact neighbors Nevada and Arizona, has been one of the fastest growing states in the nation in recent years, and more growth is on the horizon: By 2030, Utah expects to be home to 4.4 million residents.

Even before the recent flurry of interest in tar sands and oil shale, the stage was set for the inevitable: growing water conflicts in a growing region. Every barrel of oil produced from tar sands and oil shale will require water from Utah's rivers and aquifers in order to produce it. Exactly how much water is part of the great unconventional fuels debate. In fact, one of the biggest problems with any proposed tar sands or oil shale development is the highly speculative numbers that state planners must work with to determine exactly how many barrels of water are needed to produce each barrel of oil.

Water for Tar Sands and Oil Shale

One of the most important questions facing Utah is exactly how much water would be used for tar sands and oil shale development. Various reports and analyses have reached differing conclusions. Although the range of water use is uncertain, and industry projections do not account all of the ancillary uses of water, like power generation, refining, or reclamation, even the most optimistic numbers for a water-to-oil ratio are high enough to give pause. No matter what ratio of barrels of water to barrels of oil are used for a commercial oil shale and/or tar sands industry in the state, the impacts on Utah's water resources would be extraordinary.

The Strategic Unconventional Fuels Task Force report projects a 250,000-barrel-per-day (bbl/day) tar sands industry in Utah, and a 2.4-million-bbl/day oil shale industry throughout Utah, Colorado, and Wyoming. (Utah has most of the tar sands and about 16% of the oil shale; Colorado has most of the oil shale.) Based on data in this report, we modeled the impact of a 634,000-bbl/day industry in Utah, which includes both tar sands and oil shale. Assuming a mid-range of 3:1 of bbl/day water to oil, a commercial tar sands and oil shale industry producing 634,000 bbl/day would require approximately 90,000 acre-feet per year.

In June 2006, the National Energy Technology Laboratory (NETL)[29] estimated that an aboveground, retort facility producing one million barrels of oil per day would consume up to 240,000 acre-feet of water per year. That translates to more than 150,000 acre-feet per year for Utah's projected industry of 634,000 bbl/day.

Two Utah companies, Red Leaf and OSEC, have presented data to the

29 Melissa Chan et al., *Emerging Issues for Fossil Energy and Water: Investigation of Water Issues Related to Coal Mining, Coal to Liquids, Oil Shale, and Carbon Capture and Sequestration*, June 2006, report prepared for U.S. National Energy Technology Laboratory, DOE/NETL-2006/1233.

Utah Department of Water Quality on their plans for commercial oil shale developments. In total, the two companies anticipate producing 150,000 bbl/day of oil by 2020. Red Leaf has indicated in public meetings that it hopes its process will use significantly less water, but the company has not presented any data to suggest it has achieved or can achieve this goal. But as the NETL report states, "even if these [water] volumes were cut in half, water requirements could constrain long-term oil shale development."[30]

These numbers do not include all of the water requirements. The BLM's 2008 Programmatic Environmental Impact Statement concluded that in order to "upgrade" tar sands for transport to a refinery, it will require another 20 barrels of water per barrel of oil.[31] Because upgrading is necessary for transport, this water use will necessarily take place on-site in Utah.

A Quick Brush with the Law of the River — Utah and the Colorado River Compact

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

In 1922, when water was supposedly plentiful and people were scarce, each compact state was allocated a certain amount of water. Hydrologists (and politicians) calculated that the river could provide 15 million acre-feet each year, on average, based on a "period of ten consecutive years." Under the compact, Upper Basin states had to deliver an average of 7.5 million acre-feet per year to the Lower Basin states, to a mid-point on the river, at Lee's Ferry. More populous states received more water than smaller states, but each state had a legal right to hold on to their water allocation, even if they didn't plan to use it all right away. Utah was given 23% of the Upper Basin's share.

The states started with an inaccurate assumption of how much water the Colorado River actually contained. That is because the river's average flow during the years before the 1922 compact was thought to be about 17 million acre-feet per year. Unfortunately, that number was incorrect; many

30 Melissa Chan et al., *Emerging Issues for Fossil Energy and Water: Investigation of Water Issues Related to Coal Mining, Coal to Liquids, Oil Shale, and Carbon Capture and Sequestration*, June 2006, report prepared for U.S. National Energy Technology Laboratory, DOE/NETL-2006/1233, pg. 39.

31 U.S. Bureau of Land Management, *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*, Vol. 2, September 2008, Table 5.1.2-1, see also Table 5.1.1-1 for surface mining, http://ostseis.anl.gov/documents/fpeis/volumes/OSTS_FPEIS_Vol_2.pdf.

experts now think that the long-term average flow of the river is less than 14 million acre-feet per year. Today, Utah's share has been reduced after policymakers agreed on more realistic projections, and is now thought to be 1,322,550 acre-feet.

Even this estimate may be too high. The U.S. Bureau of Reclamation, the federal agency responsible for much of the management of the river, estimates that the Upper Basin share is between 5.55 and 5.72 million acre-feet, depending on assumptions about hydroelectric power needs. The lower estimate would mean Utah has the right to 1,276,500 acre-feet.

Utah believes its current use is 1,007,500 acre-feet, leaving the state with between 269,000 and 315,050 acre-feet for all future uses. The state has already exceeded this limit with allocations it has already made, having permitted rights to 493,100 acre-feet above and beyond the current use levels. Last year, State Engineer Kent Jones told a committee of the Utah Legislature that the basin is essentially maxed out, and that "any use of water in the Colorado River Basin will have to be done based on existing rights." Former state Senate Majority Leader and water attorney Fred Finlinson says "There is more 'paper water' than there is 'wet water.'"

What that means is that almost any level of tar sands and oil shale development would require the transfer of water rights, via purchase or some other means, from existing water rights holders.

Colorado River

4

Down to the Last Drops –
A Utah Water Primer

"Oil shale development would require significant amounts of water, however, and water supply in the Colorado River Basin, where several oil shale reserves are located, is limited."

Cynthia Broughter, legislative attorney,
American Law Division,
Congressional Research Service

Because most of the proposed tar sands and oil shale development in Utah would take place in the Colorado River Basin, which includes the Green, White, and Duschesne Rivers, it is crucial to examine how much water is available from those sources — and how state water law will affect how those waters are allocated now and into the future.

What's Left in the Pot

In Utah, virtually every drop of water is already claimed. Some say more water has already been claimed from the Colorado River Basin than the state has a right to claim. (See sidebar, page 20, "A water manager speaks out.") The state engineer estimates that only 360,000 acre-feet of Utah's Colorado River Compact allocation are not presently being used. But the state Division of Water Rights predicts that approved but unperfected Utah water rights in the Colorado Basin — paper water — "could significantly exceed 500,000 acre-feet."[32] That means the state's water deficit could exceed 140,000 acre-feet.[33] That is like overdrawing your checking account, but without the possibility of getting overdraft protection.

Some of the "paper water" is on the books of state and regional water management agencies. The Utah Board of Water Resources holds the largest approved but unperfected Utah water right on the Green River, which it received from the federal government in 1996.[34] The right originally constituted nearly 450,000 acre-feet of water stored in the Flaming Gorge Reservoir; however, today, only approximately 299,684 acre-feet remains after some of it has been "segregated," or promised to specific users.[35]

32 Ibid.
33 Ibid.
34 Utah Division of Water Rights, Water right print out 41-3479 (A30414d), http://nrwrt1.nr.state.ut.us/cblapps/wrprint.exe?wrnum=41-3479, accessed December 21, 2009.
35 Id. A segregation is the division of a water right or an application for a water right into two or more legal parts. Although the State Engineer must grant segregation applications, such a grant does not confirm the validity of the water right or extend the deadline to perfect the application. Utah Code Ann. § 73-3-27.

There are only a few large "pots" of Colorado River water left that the Utah State Engineer may consider doling out for energy development if and when companies make formal applications to use it. (Energy companies currently own very few water rights specifically for tar sands and oil shale development in Utah; in Colorado, energy companies have purchased vast quantities of water rights.[36]) Two such large pots come from allocations of the Flaming Gorge water that the Utah Division of Water Rights doled out to the Uintah Water Conservancy District and the Duchesne County Water Conservancy District. Each received approximately 45,000 acre-feet, and both conservancy districts have signaled their willingness to allow some of this water to be used for tar sands and oil shale development.

That may be it, however, for potential paper water. Although the remaining Flaming Gorge water may appear to be an attractive potential source of water supply for tar sands and oil shale development, the state water board recently declared its intention to use that right for the proposed Lake Powell Pipeline Project, which would supply municipal water to St. George and the surrounding area.[37] Therefore, it seems unlikely that there will be any more big pots of undeveloped water available to be used for tar sands or oil shale.

Here's another catch for state water managers to consider: Utah already has significantly less water available to develop than is currently being projected. That is because some of the current projections are based on extremely optimistic annual runoff predictions. WRA's calculations, which incorporate recent estimates of average annual runoff in the basin, indicate those numbers are not realistic. Various analyses, including a 2007 estimate by the Bureau of Reclamation, indicate that under current scenarios, Utah will use more water from the Colorado River in 2020 than may be available — without including tar sands or oil shale development.

Utah's Projected Colorado River Upper Basin Water Use

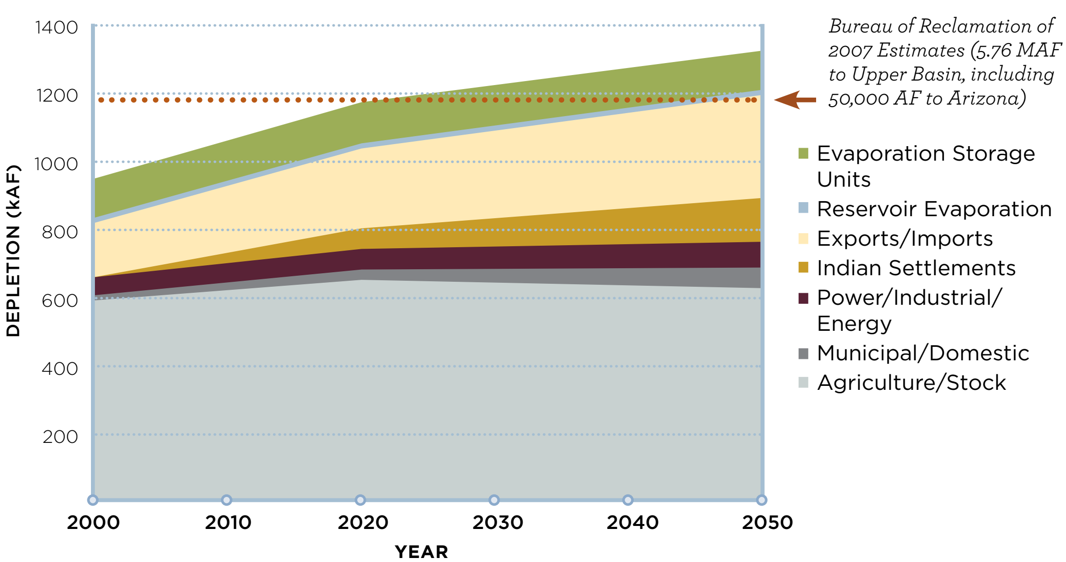


Figure 1. *Note: Projections Do Not Include Water for Tar Sands and Oil Shale Development*

36 Western Resource Advocates, *Water on the Rocks: Oil Shale Water Rights in Colorado* (Boulder, CO: WRA, 2009).
37 Utah Division of Water Rights, Extension of Time Request for Water Right 41-3479 (A30414d), October 29, 2009, available at http://waterrights.utah.gov/cgi-bin/docview.exe?Folder=41-3479. Lake Powell Pipeline Project Web site, http://www.lakepowellpipeline.org, accessed December 21, 2009.

Not only is Utah's water pool completely allocated and quite possibly over-allocated already, it is also likely that the amount of Colorado River water available to Utah will decline. Already, the amount of water that Utah receives from the Colorado River Compact (see sidebar on page 14) has been reduced between 20% and 40% from its original 1922 allocation. Most scientists believe there will be less water in the basin's future (see sidebar on page 32). In 2000, the state had a right to 396,000 acre-feet per year. That amount could decline to less than 200,000 acre-feet per year in 30 years, according to projections of future supply and demand from the BLM's Programmatic Environmental Impact Statement.[38]

Overview of Utah Water Law

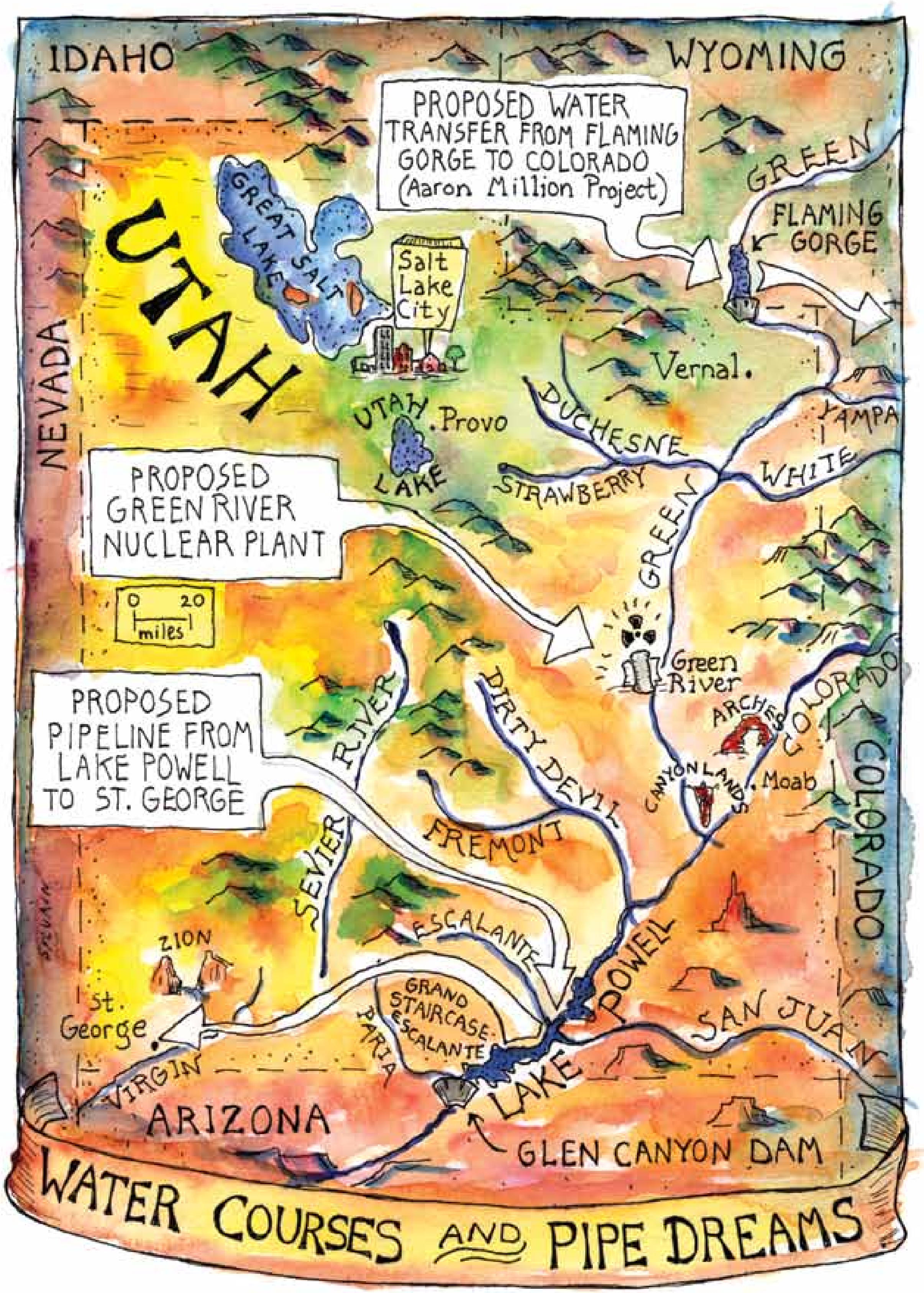
As discussed in Appendix A in greater detail, Utah water law is complex. Three essential facets of Utah water law that might bind commercial development include:

Water availability is a zero sum game — and possibly a negative sum game. There is a limited amount of water available that is not already being used by farmers, for residential consumption, or for existing industrial uses. Many analyses indicate there is more "paper water" than "wet water" available.

The state has leeway to determine how future water uses are allocated, but also some legal constraints. The state engineer can approve or deny an application for a water right after answering a number of key questions. By state law, the state engineer must make decisions based on the entire state's needs. Among other considerations, the state engineer must also adhere to federal environmental laws and fulfill the state's obligation to treaties, contracts, and existing rights holders.

Most new sources of water for tar sands and oil shale projects will require changing existing water rights from agricultural to industrial uses. The State Engineer must consider many factors before agreeing to a change. Because most existing water rights are for agriculture, the state must consider the effects on Utah's bedrock rural communities before agreeing to allocate water from agricultural use to industrial use.

38 U.S. Bureau of Land Management, *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*, Vol. 1, September 2008, http://ostseis.anl.gov/documents/fpeis/volumes/OSTS_FPEIS_Vol_1.pdf.


IDAHO
WYOMING
PROPOSED WATER TRANSFER FROM FLAMING GORGE TO COLORADO (Aaron Million Project)
GREEN
FLAMING GORGE
GREAT SALT LAKE
UTAH
Salt Lake City
Vernal.
NEVADA
UTAH LAKE
.Provo
DUCHESNE
YAMPA
WHITE
STRAWBERRY
GREEN
PROPOSED GREEN RIVER NUCLEAR PLANT
0 20 miles
Green River
PROPOSED PIPELINE FROM LAKE POWELL TO ST. GEORGE
RIVER
DIRTY DEVIL
ARCHES
COLORADO
CANYONLANDS
.Moab
COLORADO
SEVIER
FREMONT
ESCALANTE
ZION
POWELL
St. George
GRAND STAIRCASE-ESCALANTE
PARIA
SAN JUAN
VIRGIN
LAKE
ARIZONA
GLEN CANYON DAM
WATER COURSES AND PIPE DREAMS

How Oil Shale Use Water

In the Uintah Basin, oil shale, in all likelihood, would be mined and retorted. Using this technology, there are at least six categories of water use, each with a different level of uncertainty about the amount of water associated with it:

Mining: Mining operations require water for dust abatement and for the building of roads, pads, and other infrastructure. Some energy companies claim they will produce water from the mining process, since oil shale can be found among underground pockets of water that can be liberated by mining. (This "connate" water has its own problems, discussed in chapter 3).

Processing: In Utah, the main proposal for turning oil shale into oil is to heat the rock up in a retort facility, which is essentially a big oven to cook the rock. This processing requires water, including water to cool and reclaim spent shale and for upgrading raw shale oil.[39]

Energy production: Heating oil shale (and tar sands) into liquid requires a lot of energy. Any form of electricity used to heat the rock will need to be produced, since there is not enough excess energy in Utah's grid to supply this scale of new electricity demands. Currently, the most likely choices are coal-fired electricity and/or natural-gas-fired electricity. Each of these new electricity production sources requires vast amounts of water. Power plants would account for an additional 1.4 gallons of water per gallon of kerogen produced.

Workforce: Any oil shale industry would require more water to support its workers and underlying businesses. It is unclear where that water would come from, except by buying rights held by local farmers and ranchers.

Refining: Currently, there are not enough refineries in the region to support oil shale refining, which is both energy- and water-intensive.

Reclamation: Very little information exists about how energy companies plan to revegetate the areas affected by development; more water will be required for this stage.

A Utah Water Manager Speaks Out — Q&A with Don Christiansen, General Manager, Central Utah Water Conservancy District

Don Christiansen is general manager of the Central Utah Water Conservancy District. He is the former mayor of Alpine, Utah, and former member of the Central Utah Water Conservancy Board of Directors, where he has worked for three decades. WRA caught up with him at the Colorado River Water Users Association annual meeting in Las Vegas in December 2009 to ask him about water use and oil shale development in Utah. Excerpts:

39 James T. Bartis et al., *Oil Shale Development in the United States: Prospects and Policy Issues*, 2005, report prepared by the RAND Corporation for the U.S. National Energy Technology Laboratory, pg. 50.

WRA: Can you explain the difference between wet water and paper water?

DC: Wet water is water that's wet, you can drink it, you can irrigate something with it, you can do whatever with it. Paper water is a right on a piece of paper.

WRA: Is there a discrepancy in Utah between the amount of wet water and the amount of paper water?

DC: I think the State Engineer is the one to answer that question. But I have an opinion, and I would be happy to share that opinion with you. I think we may have over-appropriated Utah's water supply in many areas of the state. But that's Don's opinion. That's not scripture.

WRA: I would call it a considered opinion.

DC: As we look around the state, [in places like] Utah County and Salt Lake County, for years they were approving water rights and approving water rights, and not all have been proved up on. They are now paper water and not wet water. If you were to convert all this paper water to wet, you may not have enough of the wet stuff to go around.

WRA: Oil shale development will use a substantial amount of water. Where could that water come from?

DC: I'm not a big strong believer in oil shale. I guess I hope that we find an energy source other than oil before we have to get into developing oil shale. I don't want to sound anti-development, but from what I understand, it's very expensive, very disruptive to the environment, and takes an awful lot of water for every barrel of oil that is to be recovered. If our nation has to rely on oil shale as our last source of oil, we're in deep trouble.

WRA: If we get to the point where we need to use oil shale, isn't water going to be as much or more in demand than oil?

DC: I don't pretend to predict what the future may hold, but I suspect that if it ever got to the point that the recovery of oil from the oil shale was absolutely important to us, we would certainly find a way to balance the amount of energy or oil we needed to recover with the other uses of water — the human uses and the agricultural uses — to grow our food. Certainly it doesn't make much sense to recover all the oil in the world out of oil shale and then die of thirst or starvation, does it? It doesn't take a rocket scientist to figure out that we'll have to find a balance, if oil shale ever becomes that absolutely last chance or last hurrah for the United States of America.

I happen to have an awful lot of faith in the American people and the American way of life. We will find another source of energy. I don't know what it is. There are scientists a lot smarter than I am and they probably have a clue as to where we're headed. But we'll find another source of energy that will continue to fuel our economy and our lifestyle.

It won't be popular with a lot of people, what I'm saying, but I don't think it's going to be oil shale.

WRA: Do you see a problem with transferring agricultural rights to oil shale? What will it do to the state?

DC: Well, it scares me for those who follow me, for my children and grandchildren and down the line, that we would take the water away from the agricultural industry. We're going to have to be concerned about saving some of that resource for this endangered species of humans. You just can't get along without water. The human body just will not go on without water. It will go on without oil. It may not go on the way we like it, and we may not be very comfortable, but you can go on. Without water you can't go on.

5

Water Quality – The Impacts of Tar Sands and Oil Shale on Water

Even in the arid regions where tar sands and oil shale are found, there are significant amounts of underground water. When these resources are mined and retorted, some of that water is "produced" and can be released into adjacent watercourses. In addition, both tar sands and oil shale themselves contain water, which is released during processing. The produced water may be filled with chemicals and organic materials that can significantly degrade water quality in the region.

Mining operations, such as those proposed for Utah's unconventional fuels, would leave large piles of spent shale or tar sands, which could leach remaining hydrocarbons, salts, trace metals, or other minerals into surface and groundwater supplies. According to a report by Michael Vandenberg of the Utah Geological Survey, "saline water disposal is the single most pressing issue with regard to increasing petroleum and natural gas production in the Uinta Basin of Utah." In other words, this problem of processed water is already looming as an expensive and potentially limiting factor in tar sands and oil shale development.

In oil shale retorting, for example, two kinds of "processed" water are generated: water already in the ground and water that is "liberated" from the rock when it is heated to release the oil locked in the rock. Each poses its own water quality problems and challenges.

Water that is generated when the shale rock is heated generally contains phenols, hydrogen sulfide, and other organics. Hydrogen sulfide is an extremely hazardous gas that can cause breathing problems and can affect the central nervous system.[40] Plans submitted to the BLM proposed storing and trucking this retort water to some off-site treatment or disposal facility.[41] That is a lot of trucking and storing of toxic material.

Underground water in the rock deposits must be removed so that mining can take place. Some recent claims by oil shale developers have suggested that their operations would be "net producers" of water — meaning they would not be using the vast quantities of water suggested by previous reports of existing oil shale production. That sounds like good news in an arid environment. Unfortunately, this water is often contaminated due to its proximity

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40 U.S. Occupational Safety and Health Administration, *Hydrogen Sulfide (H2S) Fact Sheet*, October 2005, http://www.osha.gov/OshDoc/data_Hurricane_Facts/hydrogen_sulfide_fact.pdf.
41 U.S. Bureau of Land Management, *Oil Shale Research, Development and Demonstration Project, White River Mine, Uintah County, Utah Environmental Assessment*, April 2007, pg. 32, http://www.blm.gov/pgdata/etc/medialib/blm/ut/vernal_fo/planning/white_river_oil_shale.Par.44590.File.dat/OSEC%20Oil%20Shale%20Final%20EA%20EA%20UT%20-%20080%20-%2006%20-%20280.pdf.

to hydrocarbons (like bitumen in tar sands or kerogen in oil shale), and must be treated or stored safely.

In the case of tar sands, the Alberta example should give pause. Study after study has concluded that the water resources in Canada are being severely degraded by the commercial tar sands industry. Vast tailings ponds are essentially permanent repositories for toxic water, and scientists have documented that these poison ponds adversely affect waterfowl and migrating birds — and threaten human health.[42] In addition, ecologists are concerned that the year-round drawdown of the Athabasca River has impacted fish species. If using too much water is an issue in Alberta, which has much higher rainfall and water availability, Utah should reflect on what that would mean in a desert environment.

Water quality impacts, Alberta, Canada

As with so much about oil shale, there are unanswered questions about how all this produced water will be treated: Stored indefinitely in lined ponds? Treated and released back into rivers? Left to leach into aquifers? One recurring issue about oil shale is that nobody — not the federal agencies, the state, or the energy companies — appears to be seeking answers to critical questions regarding the impact of oil shale production on local water quality.

In the application for RD&D leasing in Utah, companies did not offer details of their methods for capturing, storing, or treating the water that would be produced by oil shale mining and retorting. This is no small matter, since the "sour" water could be produced at a high rate.

The industry would also have secondary impacts on water resources. Industrial development would disturb soils and ground surfaces, increasing rates of erosion and the amount of sediment washed into streams and rivers. Traffic on rural, dirt access roads would add to this problem.

As with many of the issues surrounding oil shale and tar sands, there are many unknowns. The companies have not demonstrated their willingness to conduct baseline studies of existing groundwater conditions, and the Environmental Assessment done for OSEC's RD&D lease specifically gives no information on how past oil shale mining efforts in the region have already affected the groundwater.

In comments submitted by David Atkins, a hydrologist from Watershed Environmental, LLC in Colorado, on a 2006 Environmental Assessment of the RD&D leases, Atkins states that the companies have simply not done an adequate water quality analysis to be given permission to proceed. Atkins says it is "highly unlikely" that energy companies would be able to prevent contaminants from oil shale retorting and mining from reaching groundwater. "If

42 Kevin P. Timoney and Peter Lee, "Does the Alberta Tar Sands Industry Pollute? The Scientific Evidence," *The Open Conservation Biology Journal 3* (2009) 65-81, http://www.globalforestwatch.ca/climateandforests/TarsandsPollute/Timoney_and_Lee_TOConBJ.pdf.

all the spent shale generated is determined to leach hazardous substances, according to the [Environmental Assessment], the entire 38-acre dump would be encapsulated to eliminate infiltration and leaching," Atkins' report states.[43] The scale of the development would make it unlikely that companies would build lined waste facilities with an impermeable barrier over an area of many tens of acres. And, as we have noted, a scaled-up industry would be even more damaging. If oil shale were to grow into a significant industry, it is more than reasonable to assume that the impacts of water quality will grow commensurately.

The BLM's Environmental Assessment, writes Atkins, "does not present specific water quality standards and criteria for surface and groundwater releases; the public and decision-makers have no guarantee that downstream uses will be protected." That should be a matter of concern for downstream users, and a priority for the public agencies charged with protecting water quality.

A Yellow Raft in No Water — Utah's Recreation Economy

In Vernal, Melanie Morrison sits at the Main Street headquarters of her River Runners' Transport rafting company, flanked by red life vests, yellow paddles, and blue rafts, and wonders what would happen if tar sands and oil shale development took off in the region. "The biggest concern we have is withdrawing water from the rivers," she says. "If the water's not there, people are not going to run rivers."[44]

Morrison's company, which has been in operation for 30 years, supports clients heading off on raft trips down the Green River and the Yampa. She considers businesses like hers an enduring foundation for many of the state's rural communities — like Vernal. "We're the one industry that keeps going and going and going," she says of the hunters, anglers, hikers, mountain bikers, and campers that visit the area. "Visitors buy groceries at the local grocery store, stay at local hotels, and eat at local restaurants. They bring dollars to the mom and pop companies just like mine. It's not the big dollars, but it's still something."

Morrison worries that industrial-sized tar sands and oil shale development will siphon water from the rivers she depends on, and thus completely change the character of the town she has called home for 25 years. She has witnessed the energy industry go through several highs and lows in Vernal, including the recent slowdown over the past couple years after a natural gas boom peaked around 2006.

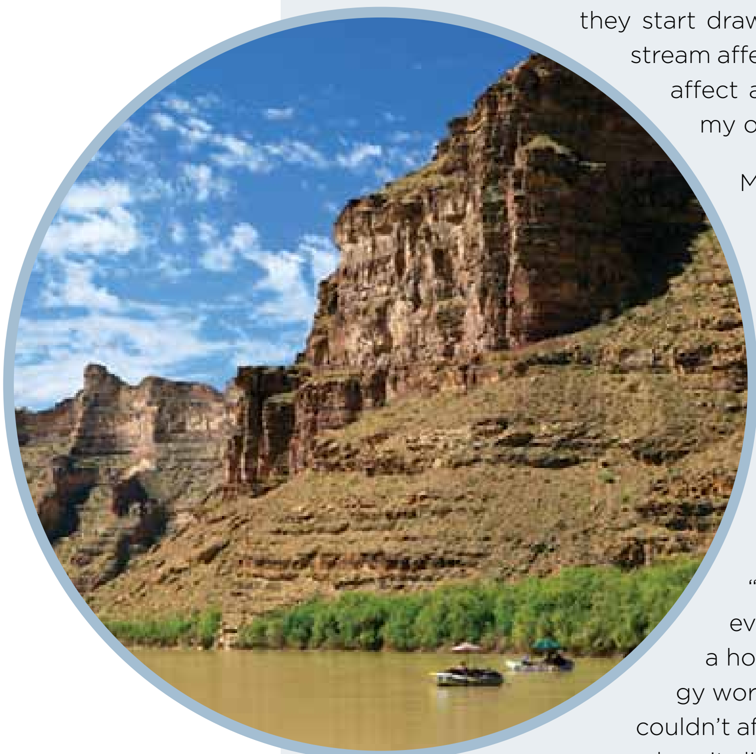
Her business, however, and those like hers, has remained through thick and thin. "This economy depends on the tourism business," she says, noting the proximity to Dinosaur National Monument and some of the West's

43 David Atkins, Comments on Environmental Assessment for the Oil Shale Research, Development and Demonstration Project, White River Mine, Uintah County, Utah, UT-080-06-280, Regarding Water Quantity and Quality Impacts, October 18, 2006. On file with the BLM.
44 Personal communication between Dan Glick and Melanie Morrison, October 2009.

most storied multi-day river trips outside of the Grand Canyon. "Everybody's not making $25 an hour driving a water truck for an energy company," she admits. "But we're still working. It's the one industry that is constant through all the booms and busts."

Morrison is part of Utah's $7.1 billion recreation economy, which provides 113,000 jobs around the state. Site-seers, hikers, anglers, rafters, and millions of other tourists who visit Utah's five vaunted national parks, state parks, and national recreation areas come for the state's stunning vistas, clean air, and free-flowing rivers with enough water to float, fish, or just enjoy as is.

Access to water is central to the tourism industry's survival. Morrison worries not just about her business, but the downstream effects of too much water being used for tar sands and oil shale development. "If they start drawing out water, the consequences downstream affect fishing, affect endangered species, and affect all the wildlife that live along the river. In my opinion, it would be devastating."



Morrison also raises the specter of what would happen to the fabric of small towns, like Vernal, if an influx of workers for a commercial tar sands or oil shale industry brought in tens of thousands of new residents. If the recent oil and gas boom was any indication, she says, "I don't think this town can handle it."

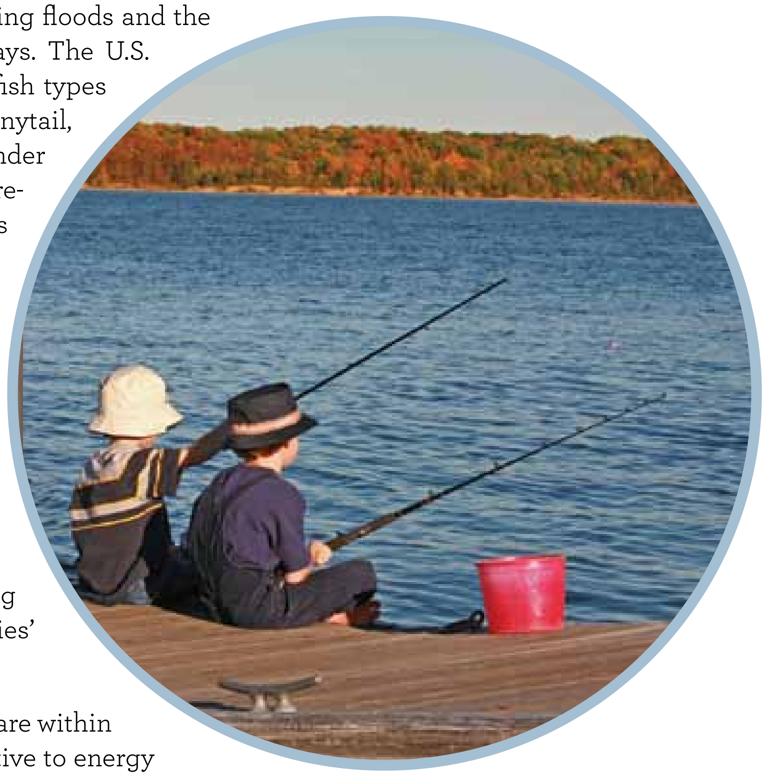
She describes the boom-time congestion with a shudder. "It was tough to even get out on Main Street," she says. "Highway 40 between Vernal and Roosevelt reminded me of L.A." Housing became a hot commodity, and the demand from energy workers shot hotel prices so high that tourists couldn't afford to stop there. Then, when a bust happened, as it did in the late 1980s, she recalls there were 700 foreclosures. "I'd hate to see that happen again," she says.

6

Save Some for the Fish – Water and Endangered Species

The Colorado River drops two miles in elevation from its headwaters in the Rocky Mountains to its mouth in the Sea of Cortez. Historically, it was a muddy, fast-flowing torrent, at least during parts of the year. Even now, despite a number of large dams, it still roars during the spring snowmelt. The basin's geographic isolation and its powerful flows led to a number of exquisitely adapted freshwater species accustomed to rapid currents. Many of its fish species are found nowhere else in the world and are so distinct in form that they are instantly recognizable to ichthyologists and anglers alike.

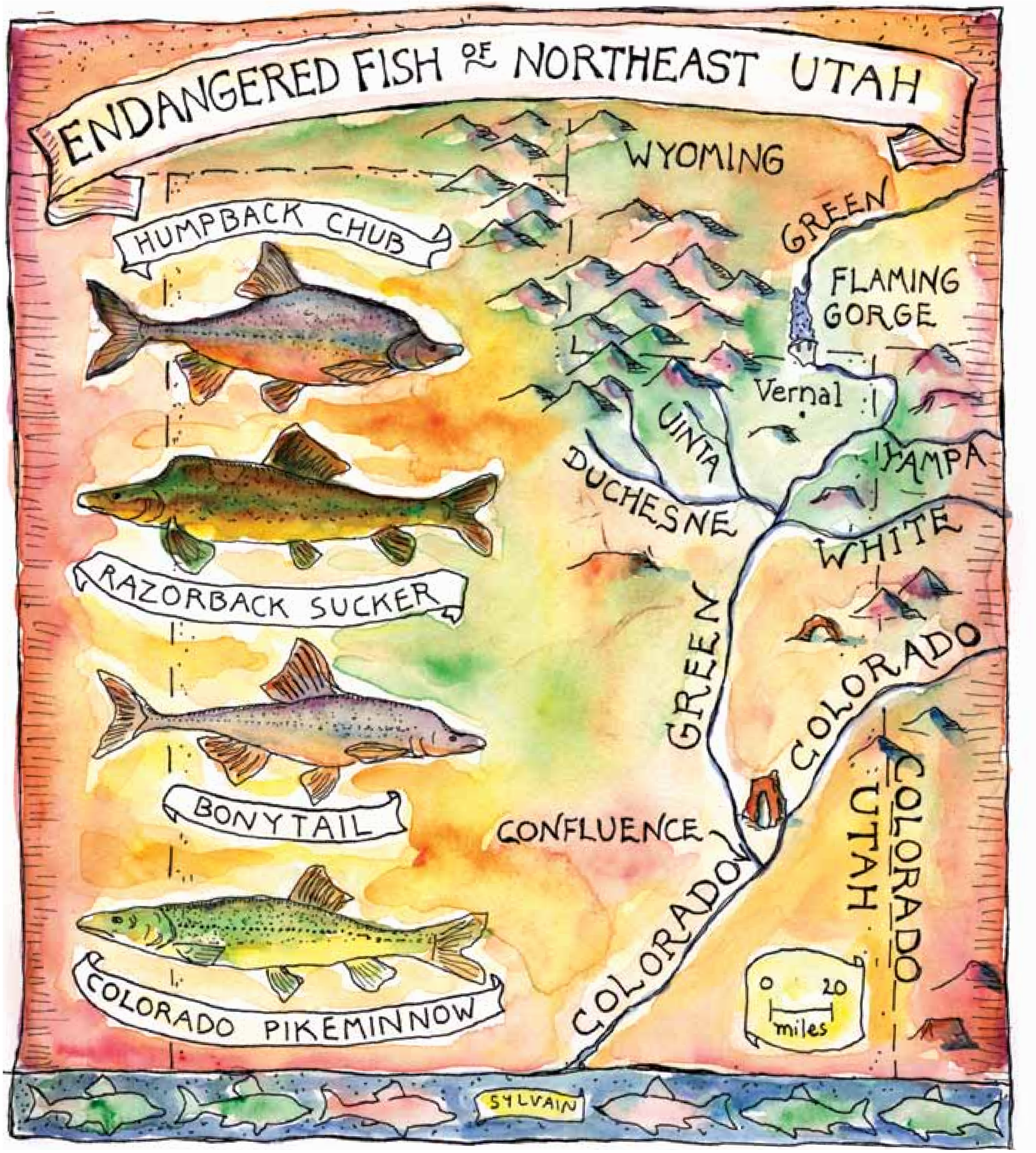
Perhaps no other group of fish better exemplifies the problems confronting aquatic ecosystems in the Southwest than the fish of the Colorado River. Large dams and reservoirs have drastically changed water temperature, converted the river from sediment-laden to relatively clear, altered historical patterns of spring floods and the water-flow regime, and blocked migratory pathways. The U.S. Fish and Wildlife Service has listed four of these fish types — the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker — as endangered species under the Endangered Species Act. As such, federal law requires that any proposed development that affects these species or their critical habitat must carefully study and mitigate for negative effects.



If these endangered native fish are ever to be restored in the Upper Basin, it will likely be between Flaming Gorge Reservoir and well upstream of Glen Canyon Dam. Tar sands and oil shale development, were it to occur at a commercially viable scale in Utah, would seriously undermine the past successes and future potential of recovery efforts. It would also put Utah at risk for lawsuits challenging the state's management of these endangered species' habitat.

The most important river valleys for the native fish are within the Uinta Basin, the very region that is most attractive to energy developers. Until recently, conflict between water interests and those concerned with the protection of the river's endangered fish had been long and acrimonious. But by the mid-1980s, all parties to the conflict — the responsible federal and state

Endangered Fish of the Upper Colorado River



agencies, water developers, and the environmental community — settled on a more cooperative approach. This resulted in a formal agreement to provide for the recovery of the endangered fish. The agreement, now in its twenty-third year, established a roadmap that would provide for native fish populations to recover while permitting each state to develop its water under the Colorado River Compact.

The detailed agreement set out a series of actions for each of the important drainages in the Upper Basin. The agreement detailed how much water needed to be flowing in each drainage at certain times of the year to encourage spawning, and quantified water quality standards for all rivers.

The tar sands and oil shale basins (Green, Yampa/Little Snake, White, Colorado, and Duchesne) are also at the epicenter of these fish recovery efforts. Vast new water development would seriously threaten the agreement as it relates to flow needs for the native fish found in these drainages. The recovery agreement is designed to make compact entitlement development possible, but not necessarily at any level and at all places in all basins. In Utah, the important basins are the Green, the Duchesne, and the White.

Furthermore, a tar sands and oil shale industry would operate year-round. In most western rivers, runoff occurs in the late spring, as snow melts. In order for tar sands and oil shale facilities to have a year-round supply of water, they would have to capture and store the water in new or existing surface reservoirs. Reservoirs, particularly in an arid state like Utah, have high evaporative losses, further increasing the water footprint of these industries.

Green River

The Green River Basin is the highest priority area for recovery of the Colorado pikeminnow and humpback chub, and historically has supported populations of bonytail and razorback sucker. The Desolation and Gray Canyons on the Green River support a self-sustaining humpback chub population, and the last known riverine concentration of wild bonytail was found not far upstream in Dinosaur National Monument. The basin is the most important and the highest priority area for recovery of these species.

The flow recovery actions in the Green River have focused on refining the operation of Flaming Gorge Dam to enhance habitat conditions for the endangered fish. The first set of refinements was made in the mid-1990s and subsequently revised to establish year-round flows for the fish. The state of Utah is responsible for establishing legal mechanisms to protect these flows. The initial focus of this effort was to legally protect Flaming Gorge releases down to the confluence of the Duchesne River for the months of July through October. The state is now in the process of establishing flow protection for the remainder of the year (November through June) and extending the protection downstream to Canyonlands National Park. When in place, this protection will guide and limit any future depletions in the Green River from Flaming Gorge to Lake Powell. Recognizing the state's obligations, Utah's State Engineer has stopped approving any large new water development proposals.

Duchesne River

Colorado pikeminnow and razorback sucker regularly utilize the mouth of the Duchesne River, especially during spring runoff. Fishery surveys conducted in 1993 documented the use of the lower 15 miles of the Duchesne River by Colorado pikeminnow and razorback sucker. More recently, fish surveys have been conducted in the lower 33 miles of the Duchesne River and have documented seasonal use by Colorado pikeminnow and razorback sucker.

Initial flow recommendations were developed for the Duchesne in 1995, refined in 1997, and finalized in 2003. During that interval, a water availability study that identified sources of water to meet the flow recommendations was also concluded, as was a coordinated reservoir operations study. Agreements are now being developed to provide flows and flow protection in the basin. With this agreement in place, there will likely be no room for new depletions in the Duchesne.

White River

Adult Colorado pikeminnow occupy the White River from its mouth in Utah well upstream into Colorado, in relatively high numbers in some places. Adult Colorado pikeminnow in the White River spawn in the Green and Yampa rivers. Juvenile and subadult Colorado pikeminnow also utilize the White River on a year-round basis. Incidental captures of razorback sucker have been recorded in the lower White River.

Interim flow recommendations for the White River were completed in 2004 and are now under review for possible refinement. This review involves the addition of peak flows to the base flow targets in the 2004 recommendations. When the flow recommendations are available and their review complete, their implementation will necessitate establishing depletion limits on the White River in both Colorado and Utah.

7

Hotter and Drier – Gambling with Climate Change

Water managers from around the West gathered at the Colorado River Water Users Association annual meeting last December in Las Vegas. At a well-attended presentation on climate change, participants heard from three presenters who did not believe that global warming was an issue that water managers —or anybody —should worry about. Many in the crowd cheered when Bill Gray, a retired Colorado State University hurricane expert, called human-caused climate change "a hoax."

Others in the audience were flabbergasted. Dr. Jonathan Overpeck, a paleoclimatologist at the University of Arizona, said the "hoax" presentation might as well have come from the Flat Earth Society. "The Colorado River Basin is among the most rapidly warming regions of the world," he said in a later presentation, with huge implications for water managers. Planetary warming is not a theory, but an established, measurable fact with profound implications for water use in the West.

The Colorado River Basin faces a "perfect storm," Overpeck said, consisting of increased population growth, a water-sharing system that is already allocated or over-allocated, rising temperatures, and a cascade of other climate effects that will, like it or not, lead to water regime-change.

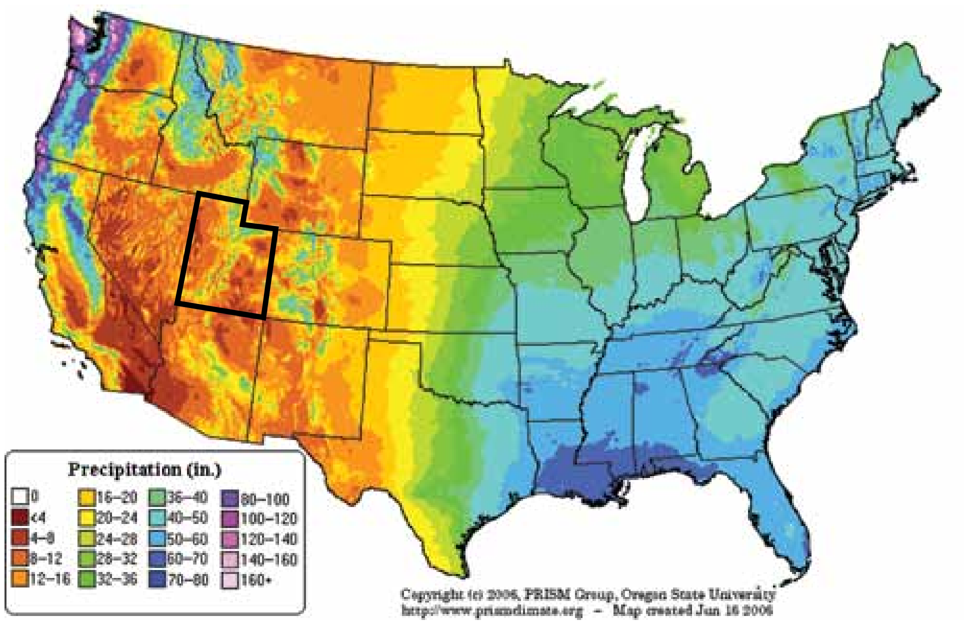
Scientists like Overpeck use the word "unequivocal" when they describe the body of evidence that climate patterns are changing, and humans are contributing to these trends through the large-scale burning of fossil fuels. "Unequivocal," according to *Webster's Collegiate Dictionary*, means "virtually without doubt; almost certainly true." In science, humans have come to understand that certain laws of physics are "unequivocal," like the existence of gravity or the fact that two hydrogen molecules and one oxygen molecule combine to create water.

It is unequivocal that the planet is warming: 2009 was the second-hottest year on record. The period from January 2000 through December 2009 was the hottest decade since thermometers were invented.[45] According to thousands of scientists who have studied our planet's systems, it is also "unequivocal" that humans are contributing to the planet's measurably increased temperatures. Carbon dioxide, a by-product of burning fossil fuels like oil and coal, acts like an insulating layer in the earth's atmosphere, trapping heat as effectively as donning a down jacket on a summer day. Humans have burned a lot of fossil fuels since the dawn of the Industrial Revolution, and our new atmospheric parka is warming the planet.

Even those who do not believe humans are causing the planet's warming must understand that the region is known for periodic droughts. We experienced one for much of this century's first decade already.

What is happening appears to be much more than a severe, if historically familiar, drought. Spring is arriving earlier, snow is melting faster, and birds are migrating sooner. That is because over the past 150 years, the western United States has warmed considerably — faster than any other region outside of the Arctic. In a 2008 report by the Rocky Mountain Climate Organization and the Natural Resources Defense Council entitled *Hotter and Drier: The West's Changed Climate*, the authors note that "compared to the 20th century average, the West has experienced an increase in average temperature during the last five years that is 70 percent greater than the world as a whole."

United States Precipitation Map



Scientists have documented that across the western United States, snowpack is decreasing, snow is melting earlier, glaciers are shrinking, there are more winter rainstorms, and summer flows in the West's rivers are reduced. There are more fires and longer fire seasons, and pest outbreaks, like that of the pine beetle, present a tangible sign that climate change is here and now. (Beetles appear to have higher survival rates when winter temperatures do not drop sufficiently to kill the larvae; nighttime winter temperatures in the West have recently been warmer than they have been historically.) In 2002, according to the *Hotter and*

45 "2009: Second Warmest Year on Record; End of Warmest Decade," http://www.nasa.gov/topics/earth/features/temp-analysis-2009.html, accessed June 3, 2010.

Drier report, "Drought hit Utah so hard that every county in the state qualified for disaster relief. 2,600 Utahns lost their agricultural jobs and the dryland harvest shrank 30 percent."

Regional warming in the West has the potential to dramatically reduce water availability in the Colorado River system. Recent publications considering climate change in the basin project that runoff in the Colorado River Basin will be reduced by 10% to 30% by the period 2041 to 2060. In 2008, Tim Barnett and others from the SCRIPPS Institute projected that, if demand in the basin continues to grow and the current drought deepens, Lake Mead has a 50% chance of being dry by 2021, and a 10% chance of running out of "usable" water supplies by 2014.[46] (Although Utah does not draw water directly from Lake Mead, Lakes Mead and Powell are operated in coordination, and long-term drought will impact both reservoirs.)

The scientific consensus is very strong that the future looks even drier. In a recent, comprehensive assessment, researchers found that 46 out of 49 global circulation model simulations[47] project a more arid southwestern U.S. in future years — with the droughts of the past becoming the norm. Their analysis projects precipitation to decrease slightly in most of Utah, but increase slightly in northwestern Utah.

In the Rockies and the Colorado Plateau, climate change will affect water resources, through changes in temperature, precipitation, and evapo-transpiration. Higher temperatures lead to higher rates of evaporation, from both reservoir surfaces and plants. Higher average winter and spring temperatures will result in more winter precipitation —including earlier snowmelt. This change is particularly important in the West, where snowpack represents an important storage reservoir, melting at the time when it is most valuable to farmers.

Here is a catch for water planners: The production of "unconventional fuels" like tar sands and oil shale will produce significantly more carbon dioxide than conventional petroleum. According to Dr. Adam Brandt of Stanford University's Department of Energy Resources Engineering, the Alberta Taciuk Processor (ATP) method of retorting oil shale produces 1.5 to 1.75 times as much greenhouse gas emissions than that from conventionally produced gasoline.[48]

Brandt calls oil shale a "low-quality hydrocarbon resource," and his research has demonstrated that a transition to large-scale use of tar sands or oil shale fuels would have profound effects on global greenhouse gas emissions — raising them by several gigatons.[49] What that means is that developing a tar sands and oil shale industry would only accelerate our carbon dioxide output, resulting in more warming, increased water scarcity, and greater conflict over dwindling supplies.

46 Tim P. Barnett et al., "Human-Induced Changes in the Hydrology of the Western United States," *Science* 319 (2008) 1080-1083.

47 These ensemble runs were produced by 19 global circulation models. Source: R. Seager et al., "Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America," *Science* 316, no. 5828 (2007) 1181-1184, doi: 10.1126/science.1139601 (accessed from http://www.ldeo.columbia.edu/res/div/ocp/drought/science.shtml).

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

49 Brandt, Adam R. and Alexander E. Farrell (2007). "Scraping the Bottom of the Barrel: Greenhouse Gas Emission Consequences of a Transition to Low-quality and Synthetic Petroleum Resources," Climatic Change, Vol. 84, Nos. 3-4, pp. 241-263. October 2007.

Greenhouse Gas Emissions Comparison

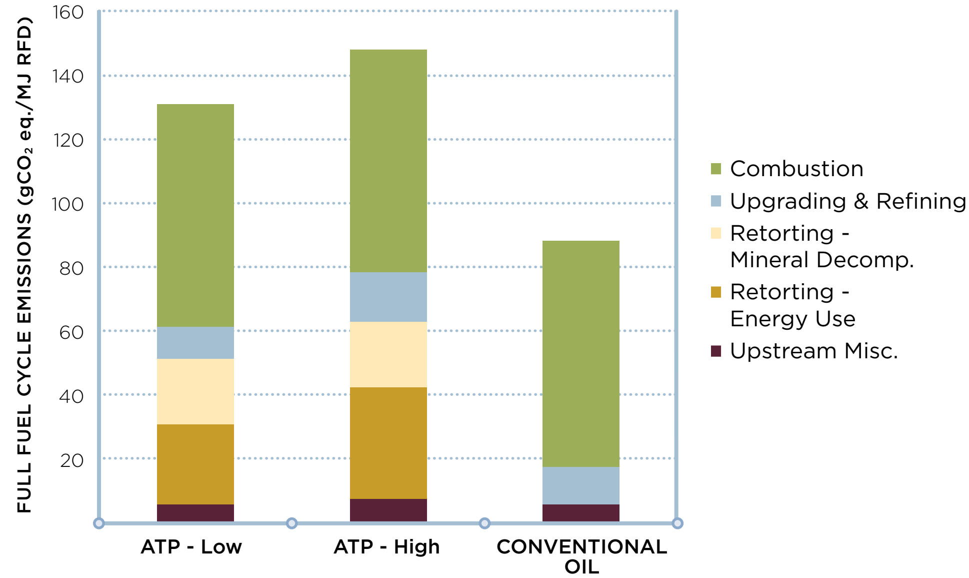


Figure 2. Greenhouse gas emissions from low and high ATP cases vs. conventional oil production, measured in grams of carbon dioxide equivalent per megajoules of final fuel delivered (g CO_2 equiv/MJ RFD).[50]

The good news is that in recent years, Utah's water planners have done an admirable job of beginning to recognize the need to conserve water and guard against future droughts. That is a good sign, since all available evidence suggests that we are likely to experience a hotter, drier West, where water is in shorter supply. If members of the Colorado River Water Users Association want to dismiss all this evidence, they do so at the peril of some 27 million —and counting — of their water-using customers.

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

8

Looking for Fuel in All the Wrong Places – A Future with Conservation and Renewables

Even with the most optimistic projections of tar sands and oil shale production, the United States cannot drill for or manufacture enough domestic hydrocarbons to power our economy. Instead of following this destructive path to a dirty-fuel future, we should harness every ounce of American ingenuity to create energy sources that the world will emulate —and buy.

If our nation remains unwilling to break its addiction to oil, we will be left behind by history. The signs are everywhere, urging us to move decisively to kick the oil addiction that is hobbling our economy, jeopardizing our national security, and harming our environment. The recent oil spill spreading throughout the Gulf of Mexico is one more exclamation point telling us that we need to propel our economy towards a post-oil future.

The very fact that we are seriously discussing the development of inferior fossil fuels like tar sands and oil shale is proof enough that the days of easy, gusher oil are behind us. The worldwide demand for oil is increasing, and supplies are not. Commercial tar sands and oil shale are not a viable replacement. Their development might, at best, delay the inevitable day of reckoning, at an intolerable cost.

America is squandering important research dollars on tar sands and oil shale. Instead of pouring more money into this dubious effort, we need to direct public and private dollars to clean energy solutions. Continuing to divert mountains of money into the dirtiest of all fossil fuels is poor public policy. We cannot predict exactly what technologies and fuels will power tomorrow's economy and transport fleet, but one thing is sure: The fuels of the future will, by necessity, be cleaner and more sustainable than those from today's sources.

For the western United States, in particular, any fuel that requires more water and more energy to produce than is gained should simply be a non-starter. "We should be figuring out a way to use less water, because we're going to have to, at the same time we're figuring out how to emit less carbon dioxide," says Jonathan Overpeck, a co-director of the Institute of the Environment at Arizona State University and a leading world climate change expert. "So you put those two things together and what you get is a need for energy sources in the Colorado basin that use little water and emit little CO_2. We would be foolish to pursue new fossil fuel projects in the region."[51]

Alternatives are already appearing across the nation and world. According to the U.S. Energy Information Administration, in 2008 there were more than 1.5 million "alternative fuel and hybrid vehicles" on the road in the U.S., nearly double the number in 2004.[52] These include hybrids, electric cars, and vehicles that run on compressed natural gas, ethanol, and other alternative fuel sources. We have achieved this growth without any concerted federal effort, while continuing to heavily subsidize oil and gas development.

Every analysis of U.S. energy consumption shows that we can save substantial amounts of energy through increased efficiency and conservation. The U.S. recently raised auto efficiency standards, which still lag behind the rest of the developed world. Increased investment in such transportation options as hybrid vehicles, electric cars, and smart transportation grids will all contribute to our transformation to a transportation system with a significantly reduced carbon footprint and reduce the need for dirty fuels.

American ingenuity has been harnessed many times in the past to move this nation past crises and into a new era. We are at a decision point with regard to tar sands and oil shale development, and the evidence clearly points to more promising technologies to pursue.

Governor Gary Herbert's energy plan identifies four abundant renewable energy sources in Utah: wind, solar, biomass, and geothermal. Pursuing these and other sources is not just good for the nation, but also for Utah's economy, creating jobs and bringing stability to the state that often suffers from fossil fuel busts. We are encouraged that, despite the governor's ongoing commitment to the fossil fuel industry, he has promised to look in these new directions as well. "I will lead by example," Herbert has promised, "with a focus on conservation and encouraging the development of new technologies in energy."[53]

Working together we can propel our economy and protect our environment.

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51 Jonathan Overpeck, December 2009, video by WRA. On file with WRA.
52 U.S. Energy Information Administration, *Alternatives to Traditional Transportation Fuels 2008*, April 2010, http://www.eia.doe.gov/cneaf/alternate/page/atftables/afv-atf2008.pdf.
53 Dianne R. Nielson, *Utah Energy: Energy Advisor's Annual Report 2009*, October 2009, http://www.energy.utah.gov/Utah_Actions/docs2/ENERGY_ADVISOR_ANNUAL_REPORT.pdf.

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Appendix A:
A Concise Water Law Course

Utah is governed by the "prior appropriation" doctrine, which means that although water is public property, it can be allocated through "water rights" to an individual or corporation. A water right is the right to use a specific amount of water based upon quantity, source, priority date, nature of use, point of diversion, and how the water is utilized: its "beneficial use."

Today in Utah, virtually all the state's waters are "allocated." Water allocation can exist for either "wet water" or "paper water." In its simplest terms, what that means is that if somebody 1) makes a claim to water coming from a river; 2) "perfects" that claim by gaining permission from the State Engineer to use it; and then 3) applies the water for a "beneficial use," she or he acquires a water right that is essentially as good as a deed to a piece of land.

"Wet water" is a person's right to use a designated amount of water, from a designated source, for a designated period of time each year, for a designated use. For example, an alfalfa farmer in Duchesne County may have permission to irrigate a certain number of acres of land with a certain number of acre-feet of water from an irrigation ditch running from the Duchesne River during the spring and early summer. The farmer can sell this water right almost as if it were a tractor or a ranch house.

Then there is "paper water." If the State Engineer has approved a person's application to withdraw a certain amount of water from a water source, but that person has not actually started to siphon that water, she or he has an "unperfected" water right or "paper water."

In another complicated piece of Utah water law, only a certain amount of water from the Colorado River may be "depleted."[54] This means that most of the water cannot be for "consumptive use" and must be returned to the river. Think of it as the difference between flood irrigation, where much of the unabsorbed water returns to the source or to an aquifer, and sprinkler irrigation, where most of the water is either absorbed by the crop or evaporates: "depleted."

"Consumptive use" is a vitally important issue when it comes to water for energy development. In the case of commercial tar sands and oil shale development, it is unclear how much of the water will be "depleted." Part of this depends on whether water produced by the mining and refining can be cleaned enough to meet federal and state water quality standards and then returned to watercourses. Part of it depends on how the water is used during the mining and refining process. Water used for dust abatement during mining operations, for example, is consumed. Much of the water used in coal-fired power plants is also con-

54 Utah Division of Water Rights, Water right print out 41-3479 (A30414d), http://nrwrt1.nr.state.ut.us/cblapps/wrprint.exe?wrnum=41-3479, accessed December 21, 2009.

sumed (because it is turned to steam), as is the water necessary to provide residential use for workers and a growing community to support them. The amount of consumptive use of water is one of the biggest unknowns for State Engineers to ponder as they consider any water allocation or change of water rights for commercial tar sands or oil shale production.

Here is another consideration. Water is currently allocated for either agricultural or "municipal and industrial" uses. Energy companies can purchase approved, "absolute" or "perfected" water rights from existing users. If a farmer, for example, decides to retire and the children do not want to take over the farm, the farmer can sell his or her water rights on the open market. However, if the water right that is designated for agriculture is changed to an industrial use like oil shale, the State Engineer must approve a "change application" after considering many factors. The State Engineer is required to consider whether:

1. There is unappropriated water in a proposed source.
2. The proposed use will impair existing rights or interfere with more beneficial uses of the water.
3. The proposed plan is physically and economically feasible.
4. The applicant has the financial ability to complete the proposed works.
5. The application is filed in good faith and not for purposes of speculation or monopoly.
6. The water use will unreasonably affect public recreation or the natural stream environment.
7. The water use will be detrimental to the public welfare.

These are all important points of state law, but in considering any water affecting the Green River for tar sands or oil shale development, the State Engineer has to also consider federal law with regard to the sixth point in the above list. Utah is obligated under many federal laws to ensure that certain water quality and quantity standards are upheld. In particular, the stretch of the Green River from Flaming Gorge to Lake Powell is crucial habitat for a number of endangered fish species. (See "Save Some for the Fishes," page 27.) It is quite possible that Utah's obligations in a collaborative "Recovery Implementation Program" for these species will mean that further depletions from the river will not be legal.

One more water law wrinkle is what is known as the "first in time, first in right," or priority rights, principle. Every water right has as its "priority date" the date the right was approved. The older, or more senior, the right, the more likely the right holder is to receive his or her full share of water in a year where there is drought or water shortage. The Flaming Gorge right, for example, has a priority date of 1958. If any of those rights were transferred to an oil shale company, they would have priority over a downstream farmer with a more recent "junior" right if the state had a bad water year. Conversely, any water rights claimed prior to 1958 would be first served in a drought year, potentially leaving energy companies with a 1958 right high and dry.

What all this water law means for oil shale development is this: Because there is no current commercial oil shale business, water for oil shale mining and refining would have to come from other "pots" of water — either "wet" or "paper." Both State Engineer Kent Jones and Utah Division of Water Resources Director Dennis Strong have both made it clear that current water rights holders in the agricultural sector will be the likely targets of future tar sands and oil shale developers.

And as Brigham Young knew, not only is Utah's foundation inextricably linked to agriculture, water, and irrigation, but so is its future.

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