

Easy Money, Hidden Costs:

Applying Precautionary Economic Analysis
to Coalbed Methane in the Powder River Basin

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June 2004

Science and Environmental Health Network ~ www.sehn.org

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A report of the Science and Environmental Health Network

<http://www.sehn.org>

June 2004

Abstract: Determining the net change large-scale projects bring to the general public welfare requires a more thorough consideration of the magnitude and distribution of benefits, costs, and uncertainties than conventional cost-benefit analysis offers. Decision processes built on the precautionary principle—the notion that prudent measures should be taken to avoid uncertain but likely harmful consequences—add essential ethical and analytic elements to economic analysis. This report subjects the proposal to expand coalbed methane extraction in the Powder River Basin of Wyoming and Montana to qualitative precautionary economic analysis. The outcomes of this analysis must be incorporated in action that upholds the public trust and assures ultimate gains to the public welfare.

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INTRODUCTION

This report applies economic analysis to the proposed exploitation of coalbed methane (CBM) resources in the Powder River Basin of southeastern Montana and Northern Wyoming. The goal of any thorough economic analysis is to provide a sense of the net gain or loss to the public good from a particular course of action, as well as a sense of the distribution of those gains and losses. That is the goal of this analysis as well.

In order to do that, we have looked at this project through the wide-angle lens of the precautionary principle. This view takes in what is unknown as well as what is known; the important costs that are vague or hidden as well as the benefits that are immediate and clear; and the interests of all concerned, not just the major actors. It examines both the planned development and the larger context in which it is proposed—the goal it serves, the need for the development, and alternatives to it.

One feature of this report is that, while it contains many numbers, we draw few bottom lines. That is because the first central question—*How does the cost of CBM compare with its benefits?*—is at best misleading and at worst impossible to answer in monetary terms. While many of the benefits can be measured that way, few of the costs can be assigned undisputable monetary values. We demonstrate, however, that translating even a few of the environmental costs into money reveals the stark inadequacy of the economic analyses that have been published to date on this project.

Instead of assigning monetary values to all possible costs, we concentrate on trade-offs: a short-term source of natural gas to help meet high short-term demand versus long-term security of water supplies, quality of life, health of surrounding ecosystems, and the viability of existing rural economic activity. We describe who reaps the benefits and who bears the costs, over what time frame. The differences are qualitative, not quantitative. They involve distributions of benefits and costs, lifestyles, and different economic opportunities for the present and future. They call for choices based on value and values, monetary and non-monetary. A few numbers with “cost” and “benefit” written next to them cannot tell us how to make these choices.

We do have guides for such choices, however. One is the precautionary principle, which suggests ways to both analyze information and act upon it. Another is the reminder that decisions on large-scale projects like this one lie squarely in the domain of the public trust. They involve public lands and mineral rights and enormous public subsidies, and they affect future generations. The American people have assigned government agencies trusteeship over these resources. It is up to individuals and communities both to act responsibly toward the public trust and to hold government accountable to it.

So the second central question is, *How should this analysis influence management of the public trust?*

We deal with these two questions in separate sections of this report.

Section 1: Analysis addresses the first question—How does the cost of CBM compare with its benefits? It begins with an overview of the CBM proposal and the challenges it poses. We then describe the goals of economic analysis and the inadequacy of current forms of cost-benefit analysis when applied to large, multifaceted projects such as this

one. We introduce the precautionary principle and explain how it offers essential richness and depth to economic analysis. We describe the tenets of precautionary economic analysis—assigning full value to human health and the environment, taking uncertainty into account, describing full costs and harms, and attending to distribution of costs, benefits, and uncertainty. We follow these tenets in a closer examination of the CBM proposal, paying special attention to water and soil problems and the hidden public subsidies behind the exploiting industries. We conclude with two charts summarizing benefits and costs to all parties over time.

Section 2: Action addresses the second question, How should this analysis influence management of the public trust? It describes the most promising fronts on which to use the results of the precautionary economic analysis. It focuses on three areas:

- ❑ Changing public discussion by looking at public trust responsibilities. We describe the nature and history of the Public Trust Doctrine and how it defines the role of government (as well as the responsibilities of all parties) in large, multifaceted projects with long-term effects. We name the government agencies that bear responsibility for upholding and protecting the public trust in this case.
- ❑ Two financial tools that could place the burden of responsibility for damage and repair where it belongs, on those who benefit from the drilling, and address the inequities of large-scale projects such as this one. One tool, the damage agreement, is being applied with mixed results. A form of the other tool, assurance bonding, has been proposed and rejected. But it has far more potential to assure an outcome that would increase the net public good resulting from this project
- ❑ Placing CBM in the larger context of national energy policy and the alternatives to projects like this one. Do the benefits of this project truly justify its costs?

Appendix A lists the main players involved in CBM in the Powder River Basin—corporate, government, and nongovernmental organizations—and describes sources for gathering further information and holding corporate actors accountable to the public interest. Appendix B describes some calculation methods.

SECTION 1: ANALYSIS

1.1 Coalbed Methane in the Powder River Basin: Facts and Context

This case study addresses a plan endorsed by the federal Bureau of Land Management to greatly expand coalbed methane extraction operations in the Powder River Basin of northern Wyoming and a small section of southeastern Montana. The large-scale extraction of coalbed methane poses financial, environmental, and social issues of national importance.

Like other fossil fuels, methane can form over time from the decomposition of organic matter. Its presence in coal deposits has long been known and noticed: coalmine explosions have almost always been a result of the unintentional ignition of escaping methane. The “canary in the coal mine” was traditionally brought underground to detect,

at its expense, methane levels that posed respiratory and explosion danger to miners. Due to its depth, and in part from pressure of underground water often closer to the surface, methane remains trapped in the coal deposits where it formed.

Relatively recently named coalbed methane (CBM), this resource has been identified as a promising potential source of natural gas at a time when natural gas prices and demand are soaring and promise to stay high for the foreseeable future. (Natural gas is about 85% methane.) Heavy subsidies for CBM development and technological advances in the past two decades have made CBM a viable resource, and it now represents about 7.5% of US natural gas production. It is the fastest growing domestic source of natural gas. The Powder River Basin in southeastern Montana and northern Wyoming is the primary frontier for expansion in CBM production, and the federal government currently plans to allow explosive CBM growth in the Powder River Basin over the next decade.

The extraction of CBM, however, has some negative impacts of economic and environmental significance. First and foremost is water. To reduce underground pressure in order to pump up the methane, CBM mines must pump out water trapped in the coalbeds. While the amount of water pumped out of a CBM well typically declines over time (as the production of methane increases), the quantities can be staggering: thousands of gallons per day for a single well. Considering the plans for 20,000–70,000 new wells in the Powder River Basin, the estimates of total “produced water” or wastewater generated start in the *trillions* of gallons. In the semi-arid West, this poses the potential for tremendous damage both in the extraction – lowering the water table in a region where farmers, ranchers, and residents generally rely on wells for their water supply – and disposal or use.

Water quality is another issue. The water from coalbeds always has some degree of salinity (dissolved salts of various kinds) and sodicity (sodium), related but distinct properties. The relative and absolute levels of salinity and sodicity determine the usability of this produced water. Much of the water is appropriate for irrigation or livestock watering, but water quality differs considerably from one place to another. Considering the current and impending water crises throughout the West, the water issue will continue to accompany CBM development.

CBM development also touches air quality, soil quality, and land use--the Montana section alone of the Powder River Basin has 1,205 grazing allotments covering about 1.6 million acres of federal land^[1]. Major expansion of CBM in the Powder River Basin will involve building tens of thousands of drillpads and other structures for new wells, more than 5 per square mile. Some 25,000 miles of unpaved roads and 47,000 miles of pipelines and power lines will transform thousands of acres of natural landscape into an industrial corridor—all for the sake of about 20 years of methane production, or the equivalent of about a year’s supply of natural gas in the United States.

While soil impacts will depend largely on how wastewater is used, there is evidence that the impacts will be significant. Researchers are investigating ways to mitigate the adverse properties of produced water, but the variation of soil types and water quality across the region will pose uncertain challenges for soil management and agriculture.

CBM raises difficult property rights issues. More than half of the areas identified for CBM development are on land with so-called split estate – that is, surface rights and mineral rights are separate. In practice, this means that local landowners own only the surface rights, while the American people own the mineral rights. The federal government (especially the Bureau of Land Management) auctions off mineral rights for the purpose of encouraging CBM extraction. Since the majority of long-term landowners rely on rural activities such as farming and ranching (which require good water and soil), CBM development is a flashpoint locally. Aside from the environmental issues, this peculiar division of property rights also raises questions of fairness. And given such factors as local politics, power relationships, and the gray areas of property and water rights, the split estate promises to be a legal battleground.

Nevertheless, the states of Wyoming and Montana, where the drilling will take place, are eager for the expansion. The reason is money. In Wyoming, CBM helped erase a \$200 million state budget deficit in 2000, according to a story issued by the US Department of Agriculture promoting its rural energy programs.^[2] The deficit is expected to turn into a \$400 million surplus by the end of 2004, says the USDA, adding that CBM will bring 7,000 new jobs to the state and that the \$1 billion investment by energy companies will translate to “an overall net effect of \$1.4 billion in all sectors of the Wyoming economy.” Whether these numbers are based in reality or not, they speak loudly in a sparsely populated state with little industry and few revenue sources.

But more than money is at stake. “How do you put a price on silence?” lamented one Wyoming rancher who lately discovered that someone else owns the riches under his soil.^[3] The question is whether the rugged beauty of the Powder River Basin should be sold to extract a year’s supply of natural gas. This is an economic question, but it is not only about finances. It is about value, and about what such a project would add to and subtract from the total public welfare.

There is also a national context: energy use and energy policy. With dwindling fossil fuel reserves of other kinds and in other regions of the US, conventional energy perspectives suggest that CBM-rich areas are a promised land. While oil and gas companies are pushing hard to make CBM a major part of our energy policy, it is crucial that we include the bigger picture in discussions of CBM’s attractiveness as an energy source.

CBM exploitation is a matter of land use, water and habitat impacts, property rights, and energy policy. The challenge is to bring some clarity to this multifaceted issue. We do this with a methodological twist on standard cost-benefit analysis.

1.2 A New Approach: Precautionary Economic Analysis

The Goals of Economic Analysis

Rigorous, well-intentioned economic analysis has two strengths and one weakness. The first strength is the notion of social benefits and costs, or net change in total public welfare; the second, a result of collecting *all* benefits and costs, is access to the notion of how benefits and costs are distributed. The weakness is a bias toward mechanistic ways of addressing risk and uncertainty. We treat each of these in turn in order to set the stage for adding the precautionary principle to our analysis.

First, economic analysis provides *a sense of aggregate public welfare*. By this, economists tend to mean the sum of benefits less the sum of costs; these are usually called “social benefits” and “social costs” – not in the sense of social versus economic but rather “society” as opposed to individual people and entities, which economics calls “private” benefits and costs. This means the inclusion of *all* benefits and costs, i.e., the sum of benefits and costs.

Second, the act of compiling all benefits and costs gives us *access to issues of distribution*, although most economic analyses choose not to deal with these questions explicitly or in depth. They may acknowledge that benefits and costs are unevenly distributed, but the typical preference is to pursue actions that carry *net aggregate* benefits and to develop separate mechanisms for addressing equity issues. In short, grow the pie now and worry later about making sure everyone gets the appropriately sized slice.

Third, economic analysis tends to take *a simplistic view of uncertainty* in order to generate comparable numbers. In cost-benefit analysis or conventional risk analysis, this calculation is typically a straightforward result of a cost multiplied by the probability of that cost being incurred. For example, a 20% chance of a \$100 cost to an individual is treated as equal to a certain cost of \$20. This can make sense when costs and benefits have similar probabilities, for all parties involved, but that is rarely the case.^[4]

Unfortunately, these assumptions – about the distribution of probabilities across costs and benefits, or of the distribution of costs and benefits across individuals – do not easily follow or stay attached to the data they generate. As a result, reductionist quantitative analyses (such as cost-benefit and risk analyses) often lose an important nuance: the connection between different levels of certainty about the costs and benefits and the distribution of those costs and benefits.

But the nuances of rigorous economic analysis are challenging, so decision makers have sought a more streamlined tool. This is how we ended up with conventional cost-benefit analysis. Since cost-benefit analysis represents an understandably appealing tool whose flaws are not necessarily self-evident, we examine it briefly below as a way of understanding how better to approach complex issues such as the development of CBM in the Powder River Basin.

Cost-Benefit Analysis: the next step – but in the wrong direction

Cost-benefit analysis is, in retrospect, the logical outcome of economic thinking as it has developed. In its typical manifestations, it is a predictable attempt to bring together the collapsing of monetary values and probabilities into a simple decision rule. It is appropriate in certain circumstances. Unfortunately, it has become the default for complex decisions.

Heinzerling and Ackerman’s recent critique of cost-benefit analysis^[5] has rightfully focused on certain simplifications inherent in standard cost-benefit analysis: problems with reducing issues of life, health, and the natural world to monetary values; the meaning of discounting future costs and benefits; the lack of equity considerations; and cost-benefit analysis’s claims of “objectivity and transparency.” We examine two of these, discounting and transparency, which are particularly relevant to this discussion.

Discounting

Discounting is the process of assigning less value to costs and benefits in the future based on an interest rate or “discount rate.” This technique is intended to account for what economics and business call “the time value of money” – the fact that money today is worth more than money next year, which is worth more than money two years from now and so forth. If your source of money is financial markets – i.e., any lender, whether a business or an individual or the public sector – this is appropriate and real. With resources in hand now, you can turn them into more resources tomorrow, and conversely, resources tomorrow will be worth less than the same resources in hand today.

However, discounting sheds little light on things for which there are no easy substitutes. It is unhelpful for thinking about equity considerations and the desirability of social outcomes. For example, few parents would intentionally “discount” the state of the world that they hand along to their children and grandchildren. When a future outcome is an important part of a bigger picture (such as the health of many individuals or a community), discounting loses its inherent meaning. You can substitute one small business venture for another in the future, but there is no substitute for clean air or clean water or human health.[\[6\]](#)

Transparency and fairness

Cost-benefit analysis promises transparency as a decision tool; that is, it purports to deliver a clear prescription for how to act, and demonstrate defensible reasoning for that prescription. However, the transparency of cost-benefit analysis for large-scale, long-term decisions is diminished on two counts (both in Heinzerling and Ackerman’s critique):

- Reducing all costs and benefits to financial values. At a philosophical and practical level, placing dollar values on mortality, morbidity, culture, and myriad components of the natural world (ecosystems, biodiversity, etc.) is anything but transparent. By reducing these components to a single index (money), richness and controversy are lost. This is not a problem when the comparison involves items such as bushels of wheat and barrels of oil; but it is a major problem when the comparison involves current and future health, or current and future water quality.
- Ignoring equity issues. Similarly, totaling the dollar figures for costs and benefits begins to mislead (i.e., loses its transparency) as soon as the distribution of the benefits starts to differ from the distribution of costs. When few actors are involved in the analysis,[\[7\]](#) the simplification does not compromise transparency. But a CBM development involves thousands of actors, with great uncertainty about costs and benefits but great certainty about the unevenness of their distribution. Using cost-benefit analysis to look at such an issue is like looking through a microscope at the night sky.

For small-scale decisions, with relatively short-term consequences that can be translated into financial costs and benefits without much controversy, cost-benefit analysis can be appropriate. However, as a more general tool for the larger scale and longer haul, it was

a step in the wrong direction: toward less richness of detail, toward less purchase on issues of equity and uncertainty.

Instead of simplifying economic analysis into cost-benefit analysis form, we need to take advantage of what it offers and shore up its limitations. This leads us to the precautionary principle.

The Precautionary Principle

Throughout the industrial age and particularly in the past century, human innovation produced powerful technologies and techniques for transforming nature's bounty into items of immediate appeal and usefulness. Unfortunately, as the pace of innovation has accelerated, so has the emergence of unintended consequences. It is this dual reality – the capacity for rapid innovation and the unintended consequences of change – that inspired the articulation of the Precautionary Principle:

"When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." – Wingspread Statement on the Precautionary Principle, January 1998

The logic of the precautionary principle is simple but far from simplistic. The idea of exercising caution in the presence of uncertainty is as old as human instinct. The idea of taking prudent measures to avoid uncertain but likely harmful consequences is as familiar as preventive medicine. The precautionary principle's original German formulation, *Vorsorgeprinzip*, suggests wise planning for the future—hardly a revolutionary concept.

This familiar concept has been called up and codified into international law because exercising precaution is now an urgent matter. The precautionary principle was formulated as a guide through the unintended consequences of human activity and innovations—specifically, adverse effects on the environment and human health. In that way, it makes an overt link between science and ethical—or political—choices. Science provides information, but the information it provides in many situations is limited, contradictory, and evolving. Scientific certainty is elusive. Meanwhile, according to the precautionary principle, we will not hesitate to protect ourselves, the earth, and future generations.

Although it is not a decision rule per se, the precautionary principle calls attention to the major flaw in decision rules developed over the past several decades to deal with the harmful consequences of human activity: over-reliance on mechanistic formulas as guides to policy. These formulas tend to place high value on quantifiable information and to ignore or obscure uncertainty and complexity. The formulaic approach to decisions affecting human health and the environment has come under the broad rubric of "risk assessment."^[8] Decisions based on conventional tools of risk assessment share the shortcomings of formulaic cost-benefit analysis, described above:

- They are suitable in situations where information is abundant and consequences clear and short-term but not in more complex situations.

- ❑ They rely on quantifying all factors, including the unquantifiable, and they obscure assumptions. This makes outcomes seem more certain, more precise, and more value-free than they really are.
- ❑ They provide no guidance on issues of equity, larger social goals, and alternatives. Risk assessment and cost-benefit analysis do not measure whether a project is necessary, whether society's goals would be better served by other means, or whether harms, costs, and benefits are fairly distributed.

Risk assessment and cost-benefit analysis have been closely linked in policy decisions, and the resulting policies have often been disastrous for human health and the environment. Scientific uncertainty is the loophole through which bad decisions slip. Too often, lack of proof of harm is considered proof that there is no harm; real evidence is ignored in the insistence on scientific certainty; and the benefit of the doubt goes to the suspect product, practice, or perpetrator of harm.

The precautionary principle closes that loophole by reintroducing wisdom and fairness to the decision process. It has several logical implications:

- ❑ Exercising precaution means accounting for and responding appropriately to what we do not know as well as what we know. *This attention to both information and uncertainty in an ethical context is the principle's chief contribution to economic analysis, described below.*
- ❑ The precautionary principle suggests that the burdens of proof and cost belong to the potential perpetrator of harm. This form of accountability is important when proposed actions involve uncertain, perhaps unknowable costs in terms of human health and impacts on complex ecosystems.
- ❑ Implementing precaution involves reaching out to and hearing from all key stakeholders, since health, environmental, and natural resource challenges have far-flung boundaries and impacts. This can mean setting goals, examining alternatives, and creating compensation schemes and other policies. We address some of these in Part II.

The Precautionary Principle and Economic Analysis

Applying the precautionary principle to economic analysis has the potential to fulfill the highest purpose of such analysis--calculating the net change in total public welfare and the distribution of benefits and costs, especially in such large-scale changes as the proposed exploitation of CBM resources in the Powder River Basin. Precautionary economic analysis should point toward less mechanistic, more realistic ways to address risk and uncertainty than such tools as cost-benefit analysis provide.

A precautionary model for economic analysis includes the following elements:

- ❑ *Acknowledgement of the full value of human health and the environment.* The wellbeing of communities and individuals includes but is not limited to financial economic concerns.

- *Uncertainty analysis.* The precautionary principle requires taking uncertainty into consideration. Lack of proof of harm does not mean there is no harm. Action should be determined not only by what we know for sure. What we do not know, what we know only partially, may be even more important. This is especially true when weighing economic benefits against a wide array of costs. Immediate and visible economic benefits seem more important than hidden, diffuse, or long-term costs/harms. Economic issues, and the relation between monetary and non-monetary costs, are rife with uncertainty.
- *Full disclosure.* Despite the difficulty of doing so, taking uncertainty into account requires us to attempt to *describe* those hidden, diffuse, and long-term costs/harms. Some of them can be expressed in financial terms. The case study that follows includes many of these, such as subsidies paid by taxpayers. Some costs are monetary but of uncertain dimensions—such as the financial health of companies involved in a project. Some are a combination of harm and monetary cost—health damage involves healthcare expenditures, loss of landscape involves tourism revenues, and water loss involves farm and community revenues--and highly uncertain. Many of these are diminished if we try to express them in monetary terms, and some—loss of a way of life, wasting of resources for future generations, loss of beauty, irreparable damage to ecosystems—are not monetary at all and even more uncertain. Indeed, when costs are unique, monetary values—the implied value in exchange or as a commodity—are never totally appropriate. *Nevertheless, all these costs must be described.*
- *Attention to the distribution of costs, benefits, and uncertainties.* The precautionary principle directs us away from policies that build economic benefit for some—energy companies, individuals, or even communities—on damage to others, including future generations.

1.3 Analyzing the Damage from CBM Exploitation

This section describes – with a focus on labeling what is known and what is uncertain – the types and distribution of costs and damages from CBM exploitation in the Powder River Basin.

Starting Points: Conclusions, Information, and Missing Information in Existing Analyses

Much has been written about the potential benefits and costs of CBM in the Powder River Basin. These analyses tell us a great deal both by what they say and by what they omit. We focus on the Final Environmental Impact Statement by the Montana BLM and a report prepared by a regional accounting firm. These are important samples of what the promoters of CBM have contributed to the public discourse.

BLM Final Environmental Impact Statement

In early 2003, in accordance with National Environmental Policy Act requirements, the BLM issued a Final Environmental Impact Statement as an amendment to the Powder

River and Billings Resource Management Plans (RMPs).^[9] RMPs are long-term planning documents intended to bring together science and public input periodically to ensure appropriate use of a given area's resources.

This environmental impact statement focused on CBM development in the region. It was prepared in conjunction with the Montana Department of Environmental Quality and the Montana Board of Oil and Gas Conservation. The impact statement considered a wide range of environmental and health consequences. In terms of hydrology, it considered surface water, groundwater, and beneficial reuse. It looked at air quality in terms of visibility and several types of emissions. Several other categories were considered in moderate detail, including soil, vegetation, and wildlife. The statement also addressed a series of impacts with "low intensity" or highly contained consequences, including impacts on local real estate, recreation, solid and hazardous wastes, environmental justice, livestock grazing, and others.

For the most part, the environmental impact statement was comprehensive within the boundaries that it set and for the scenarios that it considered. However, the set of alternatives considered was limited and therefore flawed; we return to the issue of alternatives in Section 2.4 below. And the statement had shortcomings in its coverage of water and soil issues that demand elaboration.

- ❑ Water: The statement assumed minor disruptions in surface water, i.e., that downstream uses "would not be diminished" and flows would only "moderately increase". Perhaps most notably, groundwater drawdown was assumed to be "minor".^[10]
- ❑ Soil: The document concluded that "disturbance to soils would be minor." This projection was meant to include land directly disturbed by wells and road building, not by wastewater use or disposal. Those impacts were to be mitigated by water quality protection measures.^[11]

These assumptions exemplify the shortcomings of this type of reductionist analysis. The section below, "Damages from and Uncertainty around CBM Waste Water: Technical Concerns," describes how the assumptions may be unreasonably optimistic. These lingering concerns from the environmental impact statement suggest a high degree of uncertainty about damages that are quite dispersed – that is, costs that fall on individuals and firms who do not benefit directly from CBM extraction. The impacts on soil and water extend over both space and time to include individuals throughout the region and future generations. Furthermore, the statement does not clearly communicate either this uncertainty or the distribution of the uncertainty about key damages and costs.

Industry-Funded Analysis of Benefits

A report by the accounting firm Anderson ZurMuehlen and Co. in 2001 was commissioned by the Montana Coalbed Natural Gas Alliance. The report provides specific quantitative estimates of the benefits to the region:

- ❑ Royalties to Montana schools --\$253.5 million

- ❑ Royalties to Montana state general fund -- \$426 million
- ❑ Production tax paid to Montana for schools, state and local governments and other agencies -- \$1.1 billion
- ❑ Potentially create up to 736 jobs
- ❑ Estimated total wages -- \$264 million
- ❑ Estimated total purchases of goods and services -- \$1.3 billion
- ❑ Total economic benefits -- \$4.2 billion

The analysis describes virtually no costs. Burdens on schools, public service systems, or the housing market are listed as “none identified”. Environmental costs are treated in one paragraph:

“The environmental impacts of the development are currently under evaluation. Any impacts identified would require mitigation. All costs of mitigation would be the responsibility of the producers.”

This report is available on the Montana Department of Environmental Quality web site, imputing credibility that the report may not merit.[\[12\]](#) Below we will demonstrate that, whether these calculations are accurate or not, the dollar costs of lost water alone could exceed them.

A Bucket of Warning Signs: Water in the West

Since the Powder River Basin is located in the semi-arid West, CBM development will have a major impact on water issues in the region. As all official analyses of the various proposed scenarios acknowledge, CBM exploitation and use creates many forms of damage, including the disruption of fragile soils through mining and road-building, air pollution from dust as a result of mining and transportation, and the contribution of additional fossil fuel use to climate change. Yet water is central to the region’s people and their livelihoods, as well as the crucial ingredient and limiting resource for ranching, farming, and most recreation.

The perilous state of water resources in the broader region has not been ignored. The U.S. Department of the Interior convened a conference in Denver early in 2003 titled “Water 2025: Preventing Crises and Conflict in the West.”[\[13\]](#) The impetus and message were clear: competing uses of water in the West are on a collision course. The conference report began by listing “five realities” about water in the West:

- ❑ Population is exploding.
- ❑ Water shortages exist.
- ❑ Water shortages result in conflict.

- Aging water facilities limit options.
- Crisis management is not effective.

CBM exploitation would exacerbate water quality and quantity problems wherever it occurred on a significant scale. Unfortunately, the analyses described previously did not set their projections in the context of impending water crises in the region. Water conflicts are brewing even if CBM is not expanded. Two of the Department of Interior's concerns are especially significant to this project:

- Projections of population growth. The arid West is still attracting migrants from throughout the US. One low-growth scenario estimates 17% increase for the Powder River Basin and adjacent Tongue River Basin, with a high-growth scenario delivering a 36% increase.[\[14\]](#) Population increase means competition for already strained water supplies.
- The need for collaboration on water issues. Examinations of water resources worldwide echo the same theme: collaboration is vital to avoiding crisis. Unfortunately, the pattern of CBM extraction weakens opportunities for collaborative efforts to manage water resources. First, in many situations, it builds on the pre-eminence of mineral rights in a split-estate scenario. This increases conflict over land use all the way down to the level of individual properties. Furthermore, it hands power to oil and gas companies from outside the regions, entities that have little or no vested interest in the health of the region's economies, people, or ecosystems beyond the projected two-decade window of peak extraction.

Direct Damage from and Uncertainty around CBM Waste Water: Technical Concerns

Evidence is growing that assimilating or using CBM wastewater is complicated at best and likely quite costly over the long term. We highlight the potential impacts on two resources, soil and groundwater. These issues underscore the enormous uncertainty around CBM's impacts on the natural resource base of the Powder River Basin.

Damages to Soil, and Future Use and Management Issues

More than a decade of research at Montana State University and elsewhere has elaborated the complex relationships between irrigation saline-sodic[\[15\]](#) water and soil properties.[\[16\]](#) Although this work has revealed much complexity, one message is clear: the consequences of using CBM wastewater for beneficial use in irrigation (or simply by disposing of it on soil) are potentially far reaching.

Saline and sodic waters by definition alter soil chemistry, an important variable for agriculture. These alterations of soil chemistry affect how water moves through the soil, potentially creating problems for irrigation-based cultivation.

These problems can be overcome. Irrigation use of saline water is still possible with salt-resistant crops. It is also theoretically possible to raise salinity with soil amendments and

mineral inputs to balance the impact of sodicity on chemical and physical properties of the soil, although it is impossible to control salinity and sodicity in rainfall.

Proper management of CBM wastewater further depends on local conditions such as soil types, rainfall, and the make-up of a given stream of wastewater, requiring additional, locally specific effort from those in charge of soil management. As in any extended area, soil types vary throughout the Powder River Basin. Soils vary from coarse to fine. They vary in content of minerals that have significant chemical interactions with saline and sodic water.[\[17\]](#) Absolute and relative levels of salinity and sodicity of different wastewater streams also vary substantially.[\[18\]](#)

This complexity matters because the burden of understanding and management falls on the short- and long-term users of wastewater and affected soils. For decades to come, farmers and ranchers in the region will have to deal in highly specific ways with the changes in soil properties. Although it is *possible* to address the water and soil issues posed by CBM wastewater, we must be clear about the methods and the plausibility of successful implementation of those methods. Successful beneficial reuse, either for agriculture or simply to ensure soil health, would demand widespread education on techniques for monitoring and measuring water and soil properties. This issue is given no attention in the Bureau of Land Management's environmental impact statement, perhaps because it involves building knowledge and capacity far beyond the immediate actors involved in CBM exploitation.

Depletion of Groundwater

CBM's major impact on water resources will be the drawdown of groundwater and the long-term effects on aquifers. The impacts on the water table and groundwater quality are both *regional* and *long-term*. By regional, we mean that the impacts extend beyond both the immediate surroundings of CBM activity and often well beyond the proposed spatial scope of compensation schemes (damage agreements). By long-term, we mean that the impacts extend well beyond the timeframe projected for CBM development.[\[19\]](#)

The Wyoming environmental impact statement anticipates an increase of 12,000–51,000 CBM wells over the next ten years[\[20\]](#), while the Montana statement anticipates between 10,000 and 26,000 new wells.[\[21\]](#) A massive increase in the number of CBM wells, each one pumping out large quantities of groundwater every day over a long period, will lower the water table over the region as a whole. CBM development as proposed could pump up as much as 13 trillion gallons of groundwater. *This removal of water will produce an estimated 600-foot drop in the coalbed water table in Montana and a 700-foot drop in Wyoming.*

In the Powder River Basin's semi-arid climate, residents and most rural economic activity rely on groundwater. Herskovits estimates conservatively that 5,000 wells will be affected by the drop in the water table. With expense at \$10,000 for each well that must be deepened or protected from contamination, costs would add up to \$50 million.[\[22\]](#) Since only a small portion of CBM development will happen on the lands of people with damage agreements, and given the difficulty in establishing proof of the cause of such damages, this burden is likely to fall entirely on the landowners who rely on well water.

In some places, CBM wastewater is relatively high quality with the potential for beneficial reuse. However, in many areas where the coalbed water is usable, nearby water wells are already drawing water essentially from the same source. Thus, even where beneficial use of wastewater appears viable, it is likely at the expense of existing uses, and there is little or no net gain of usable water as a by-product of CBM production. The Wyoming environmental impact statement acknowledges this phenomenon in its discussion of the circle of influence around a CBM well.

There is the additional likelihood of degraded water quality from wells in areas of CBM development. As the water level falls and the pressure on deep CBM falls, the wells can become a mixture of water and gas, in some cases making them unusable.

The Monetary Value of Lost Water

In November 2003, Wyoming Governor Dave Freudenthal made a move to address the uncertain costs of CBM development. He proposed forming a \$50 million contingency fund to compensate for unforeseen damages from the drilling. The governor's plan drew immediate fire from some legislators as well as energy industry lobbyists and Freudenthal withdrew the proposal. [\[23\]](#)

According to a November 20 Associated Press report, Representative Pete Illoway (R-Cheyenne) said he felt uncomfortable with the fund because it suggested the Department of Environmental Quality was not doing its job. "I'm of the disposition to think they are right on top of it," he said. [\[24\]](#) Energy lobbyists, who had urged the state to use taxpayer money for a coalbed methane environmental fund rather than levy fees on industry, criticized the proposal for being too open-ended.

However, the real problem with the fund may be that it was far too small. Consider the water costs largely unforeseen in the environmental impact assessments: conservative calculations suggest that a \$50 million contingency fund would be too small by at least two or three orders of magnitude to compensate for these losses.

We can expect very little precision in such estimates. For that reason, we have specified a range. At the low end, the water cost to the people of Montana and Wyoming over twenty years will be over \$2 billion--\$84 per person per year for 20 years. A high-end but still conservative estimate puts the cost at over \$10 billion, or nearly \$400 each year from each person in the two states.

The calculations are built on assumptions about three large-scale parameters:

- Value of water per acre-foot:
 - At the low end, we use \$258, the market price used in the large-scale pact that ended the most recent round of "water wars" in the West. [\[25\]](#)
 - There is evidence that the medium- and long-term value is much higher; so we use a figure of \$600, [\[26\]](#) although long-term prices could easily top \$900. This is relevant given the twenty-year timeframe for extraction.

- The number of gallons produced from planned CBM extraction:
 - With the Bureau of Land Management's preferred scenario (tens of thousands of CBM wells), the twenty-year quantity of produced water could reach 13 trillion gallons of water. We reduce this to 11 trillion for our high-end estimate.
 - For the low end, we assume 9 trillion gallons, or 44 percent below current estimates. In theory, this could be achieved with greatly improved technologies, but it would be plausible only with a substantially decreased scale of drilling.
- The percentage of water that is "lost," meaning either (a) unsuitable for agricultural, commercial, residential, industrial, or other purposes, or (b) otherwise unavailable for use (emitted as effluent, lost to evaporation, left in ponds, etc.):
 - At the high end, we assume 50 percent of the water is lost.
 - At the low end, we assume 25 percent. Since most CBM-produced water has high levels of salinity or sodicity, this is optimistic (see above).

What do these figures mean? At the low end – \$258 per acre-foot, 9 trillion gallons of produced water, 25 percent lost – the twenty-year water cost to the people of Montana and Wyoming is about \$2.1 billion. This is about \$1,679 over the next two decades, or \$84 each year, for every adult and child in the two states, solely in the value of lost water.

The high end is a bit more daunting. With still-conservative assumptions – \$600 per acre foot, 11 trillion gallons of produced water, half of it lost – the twenty-year water cost to the people of the two states comes to about \$10.1 billion. This is about \$7,952 over the next two decades, or nearly \$400 each year from each person in the two states.

The low-end numbers are all but incontestable; the high numbers are still far from the highest they could be. They can only give a sense of scale. Moreover, these costs represent *only the water*. We have described many costs, of which water is just one.

1.4 The Public Burden of CBM: Federal and State Subsidies

The development of coalbed methane production in the Powder River Basin has benefited from a considerable amount of government support and subsidies. At the national level, in addition to the preferential tax treatment that all oil and gas companies receive, CBM development has received a particularly large boost from a tax credit directed at non-standard methods of producing fossil fuels. The federal government has also supported the industry by providing research support through the Department of Energy, and by making a large amount of federal property available for CBM production. At the state level, Wyoming and Montana collect taxes from the extraction of fossil fuels

but also provide credits against these taxes for certain qualifying wells. Wyoming is committed to helping develop a pipeline to transport natural gas out of the Powder River Basin to population centers such as Chicago. Public universities in Wyoming and Montana conduct research related to various aspects of CBM production.

The total of these subsidies is significant, but it is difficult to put an exact dollar amount on all of them. At a minimum, U.S. and regional taxpayers are currently subsidizing already profitable CBM development to the tune of at least \$500 million annually. The descriptions below suggest that a more accurate estimate may be as high as several billion dollars per year.

Federal Subsidies

Section 29 Tax Credit

The largest direct subsidy that has spurred the development of the coalbed methane industry has been the “Section 29” tax credit for alternative fuels. The tax credit, originally intended as a short-term measure to boost production from new sources, has instead become a large and persistent subsidy to economically viable gas producers.

This tax credit originated in 1980 with the Crude Oil Windfall Profits Act and was aimed at spurring the development of a number of alternative methods of extracting fossil fuels that were considered experimental and uneconomical. It was established, in conjunction with a tax on conventional oil and gas, in response to the OPEC price spikes of the late 1970s.^[27] The tax on conventional oil and gas has long since expired, but the credit has persisted, even though some of the industries that receive the credit are no longer marginal and experimental and would turn hefty profits even without it.

The Section 29 credit applies to wells drilled before 1993. Most of the development in the Powder River Basin has come about since 1993, so the Powder River Basin CBM producers have not received much of the credit directly. We can estimate that the direct credit the Powder River Basin CBM industry has received from the 47 to 113 wells that were drilled before 1993 to be about \$10 million over the course of ten years of production from those wells.^{[28],[29]} This is a tiny proportion of the roughly \$1 billion a year that has been paid out from the Section 29 credit. However, this credit gave a major boost to development in other parts of the country, particularly in the San Juan River Basin in New Mexico and Colorado. Powder River Basin producers have benefited greatly from the technology development and testing that occurred.

Legislation has been proposed to extend the Section 29 credit, although the exact form of the extension is not yet clear. The energy bill passed by the House, HR 6, would extend the Section 29 credit so that wells produced between its passage and 2007 could claim credits for up to 4 years after being drilled. It would extend to 2007 the period in which production from wells drilled before 1993 could receive credit.^[30] The Senate version also contains an extension of the Section 29 credit, although it only applies to wells drilled before 2005 and lasts for 3 years after the well is drilled.^[31] However, an extension of a tax credit typically represents a foot in the door, so this extension promises a renewed fight over the tax credit later.

If Section 29 credit is extended—and the prospects for that are good—the Powder River Basin could soon be the largest recipient of these gigantic subsidies. The 47 wells that were producing CBM at the end of 1992 ballooned into 11,238 wells by May 2003.^[32] These are expected to continue to grow under the current plan to 77,000 within the next ten years. *If half of these wells become eligible for the tax credit, the subsidy received by the Powder River Basin alone could exceed \$300 million per year.*

Financial Accounting, Enron Style: Tax Code Subsidies

CBM producers have also benefited from a number of tax credits that apply to the entire oil and gas industry. In general, these subsidies exempt oil and gas producers from playing by the financial accounting rules that govern the rest of the US economy.

For example, independent oil and gas companies and royalty owners are allowed to deduct 15% of their gross receipts from their taxable income, a process known as percentage depletion. It is standard for the loss of land value that results from the depletion of mineral resources to be deducted from taxable income, but the percentage depletion method of calculating this loss allows the total amount deducted for depletion to exceed the initial investment. It also tends to allow a larger deduction than the more standard method of cost depletion. *The costs to the federal government of allowing independent producers to use percentage depletion rather than cost depletion was estimated at between \$200 million and \$700 million a year from 1999 to 2004.* ^{[33],[34]}

Oil and gas companies are also allowed to count most exploration and development costs as expenses, and deduct them from their taxable income. Normally, these costs would be considered investment expenditures, and the investment goods would be depreciated over time; eventually the entire expenditure would be deductible, but it would be spread out over a number of years. Giving them the deduction all at once allows them to defer their tax payments and earn interest on the money. The law differs slightly for independent producers (involved solely in primary resource extraction) and integrated producers (engaged in primary extraction and other activities such as refining and distribution). Independent producers are allowed to expense all of their exploration money. Integrated producers may expense all the money they spend on unsuccessful wells and 70% of the money spent on successful wells, with the other 30% treated as an investment. *The Congressional Budget Office estimates that changing expensing rules in 2003 would raise \$2.9 billion in 2004, \$3.9 billion in 2005, and \$15.7 billion over 10 years (mostly in the first 4).*^[35]

A final subsidy to the oil and gas industries is an exemption from passive loss limitations. Normally, companies may deduct passive losses, but only up to their net income, with the rest carried over until future years. Oil and gas companies are allowed to count all of their passive losses, which again allows them to receive the tax bonus earlier than otherwise.

Summary of Tax Breaks

Over the next five years, federal tax breaks for CBM development in the Powder River Basin could range from \$700 million to \$1.7 billion in the following categories:^[36]

Section 29:	\$676 million – \$1.57 billion
Percentage Depletion:	\$9.8 million – \$38.1 million
Expensing development costs:	\$21.4 million – \$42.8 million
<i>Total tax breaks:</i>	<i>\$707 million – \$1.65 billion</i>

Research Subsidies of Direct Benefit to Oil and Gas Producers

The federal government has funded a good deal of research that has helped the CBM industry to develop. Most of this funding has come from the Department of Energy, which funds a wide variety of research on fossil fuel technologies. In total, \$1.5 billion went to fossil fuel research from 2001 to 2003, with another \$519 million requested for 2004. In 2004, \$26.6 million of this was earmarked for “natural gas technologies.” [\[37\]](#) Some projects from this section have included:

- Four million dollars in the 1990s for testing new methods for evaluating and producing CBM from multiple geological strata;
- A recently completed computerized system for enhancing CBM recovery from wells that are near the end of their life;[\[38\]](#)^{[\[39\]](#)}
- The \$2.5 million line item for environmental protection in the 2004 natural gas budget, which goes primarily to CBM-related problems. In the 2004 budget request, the Department of Energy lists addressing “environmental barriers to coal bed methane production” as the first of two goals for the entire section.[\[40\]](#)

A large portion of CBM-related funding has come from other sections of the budget:

- Much of the \$8 million environmental protection line item within the oil research budget could also be applied to CBM, since the two goals of this section are finding ways to use product water from oil and gas wells and “ensuring maximum sustainable access to oil and gas resources on federal lands.”[\[41\]](#)
- Much of the Department’s research on carbon sequestration is focused on techniques of sequestering carbon dioxide by pumping it into oil and gas wells in order to speed up the rate of recovery of the oil or gas, a technique that is already being used profitably even without such incentives. At least \$8.6 million of this has gone to projects devoted to pumping CO₂ into CBM wells. A \$9.3 million project, \$7 million of which is provided by the Department, is working on the sequestration of CO₂ in coal seams in a way that would also use the CO₂ to enhance the release of methane, with the goal being to maximize both carbon sequestration and CBM recovery. A number of smaller projects work on the same issue.[\[42\]](#)
- Research into power generation technologies that would use natural gas receives even more Energy funding. From 2001 to 2003, \$219 million went into “advanced systems” for power generation, with \$11 million devoted to a particular turbine intended to be used with “opportunity fuels, with particular emphasis on coal bed methane.”[\[43\]](#)

- Another project, which interestingly falls within the budget for oil production rather than natural gas, provides \$250,000 to identify CBM resources available to the Northern Cheyenne in the Montana part of the Powder River Basin.[\[44\]](#)

In addition to this Department of Energy funding, the Bureau of Land Management and United States Geographical Survey, both in the Department of the Interior, have used some of their funding to analyze CBM resources in the Powder River Basin. This analysis is being used by the Bureau to help the agency update land-use plans in areas that have a high potential for oil and gas occurrence. The information is also useful, of course, for oil and gas companies.[\[45\]](#)

This is a preliminary and incomplete survey of federal research dollars that are likely to find their way to CBM exploitation in the Powder River Basin. However, the total value of these research subsidies alone is likely to be at least *\$11 million over the next 5 years*.

Federal Lands for CBM Exploitation

The federal government has contributed to CBM development in the Powder River Basin by making federal lands and mineral rights available for drilling. This is an important factor in the Powder River Basin, where about 56% of recoverable CBM is in federal mineral estates belonging to the people of the United States.[\[46\]](#) The Bureau of Land Management can have some control over the amount of drilling that takes place by deciding which parcels of land to make available.

Recently the Department of the Interior has been working hard to increase the amount of development of federal mineral estates in the Powder River Basin. The Department conducted a study to evaluate the mineral resources throughout the US and identify focus regions with high potentials for mineral development. The Bureau of Land Management has just released a new set of rules that are supposed to make it easier to get leases approved in these high potential areas, which not surprisingly include the Powder River Basin. In addition, the Bush administration has set up a committee known as the Rocky Mountain Energy Council, which is made up of industry representatives and officials from various federal agencies involved in regulating mineral development, and is aimed at coordinating these agencies to make the permitting process easier.

It is not clear how to determine the monetary benefit provided by increasing the amount of federal mineral estate available for drilling. The rights to drill on public land are not given away freely but are sold at a public auction. The highest bidder also has to pay a yearly fixed rental fee per acre of land, as well as royalty payments on their proceeds from the sale of the mineral. If the markets are perfectly competitive, the combined payments should come out to the market value of the property. If that were the case, it could be argued that companies were paying the same amount as for private land and were receiving no subsidies. However, the auctions are almost certainly not perfectly competitive, and the price being paid for these leases is likely below their true market value. The most convincing evidence that the oil and gas industries benefit from having more federal mineral rights available is that they have been lobbying hard for them.

Whether it is because drilling rights are cheaper on public lands or because public lands contain over half the available resources, CBM expansion in Powder River Basin depends on exploiting vast resources that are in the public domain.

State-Level Subsidies for Coal Bed Methane Development in the Powder River Basin

Tax Breaks

Wyoming, and to a lesser extent Montana, have large mineral extraction industries which have made connections in state government. The states have more limited resources than the federal government and have to rely on mineral taxes to support their budgets. They collect more in oil and gas taxes than they give back in subsidies. But the tax collections have been reduced by incentives for building certain types of wells, and the state governments have found a number of other ways to support mineral development.

As is common in states with mineral resources, Wyoming and Montana collect severance taxes on the extraction of these minerals, and Wyoming in particular is dependent on these taxes for a large portion of overall revenue. One prediction is that states will receive \$49 million a year in severance taxes from CBM development, or \$245 million over the next five years.[\[47\]](#) However, since the early 1980s, the severance tax rates in Wyoming have been eaten away, as more types of wells have been allowed reduced rates. The severance tax for natural gas was reduced from 6% to 2% for the first two years of production from new wells, as well as for enhanced production from old wells. In addition, a credit of up to 50% of the severance tax was established for research aimed at enhancing natural gas production.[\[48\]](#) By the year 2000, Wyoming was running into budget problems and was struggling to find ways to eliminate a large deficit. The need for increased revenues helped limit the call for new tax breaks, and several tax breaks were removed, most notably, the break for new CBM wells.[\[49\]](#)

Permitting

But the state is finding other ways to encourage the fossil fuel industry. The Wyoming legislature and governor have been urging state agencies to speed up the process of issuing permits for CBM production, under a plan described in the Wyoming Energy Commission's Energy Policy for 2003.[\[50\]](#) These suggestions do not appear to have been adopted yet, but with pressure from the Wyoming legislature, the governor, and the Bush administration, the local Bureau of Land Management offices are taking a good look at what they can legally do to speed up the process.

Pipelines

Another focus of Wyoming's energy policy is the expansion of pipelines to transport natural gas from the Powder River Basin to markets in the East. The creation of a new pipeline could have an enormous effect on the rate of CBM development in the Powder River Basin. A recent expansion of the Kern River pipeline helped raise the Wyoming gas price from several dollars below the national price to less than a dollar below.[\[51\]](#) If gas production in the Powder River Basin increases as much as has been predicted, there would again be an oversupply in the region, and the price differential would increase until a new pipeline was built. By providing access to the giant Chicago market, this pipeline should have a larger effect than the expansion of the Kern River pipeline, greatly increasing the profit that CBM producers can make from selling their gas.

However, the market could support the building of a pipeline without any government aid. A Canadian pipeline company, Enbridge Inc., is making plans to build such a pipeline because company officials see “an opportunity on a supply and demand basis.”^[52] But the Wyoming legislature is looking for ways to help get the pipeline finished as soon as possible and has revived the Wyoming Pipeline Authority for this purpose. The agency helped establish the Kern River Pipeline from southwest Wyoming to California in the early 1990s by providing \$250 million in low-interest loans and participating in the marketing of the pipeline.^[53] The bonding authority of the agency has now been increased from \$250 million to \$1 billion, and it has been given the ability to buy and sell capacity in pipelines. The pipeline agency could use this authority to combine the interests of small suppliers of natural gas, so that it can make large commitments of natural gas supply to pipeline companies.^[54]

University Brainpower

Public money is going into CBM research through public universities. To be sure, some money comes to universities from the coal and gas industry. The Institute for Energy Research, which is funded largely by industry groups, is affiliated with the University of Wyoming and staffed by University of Wyoming professors (who presumably also get some public funds). Not surprisingly, the Institute projects related to CBM, both funded by Anadarko Petroleum, are aimed at further CBM exploitation--one focused on identifying deep-basin coal beds and the other on shallow CBM.

When it comes to addressing the environmental problems of CBM, however, the public is footing the bill. Probably the most common CBM-related research area in the public universities of Wyoming and Montana is on understanding and remediating the effects of CBM product water. At the University of Wyoming, the environmental engineering department Water Research Program was recently awarded funding from the US Geological Survey and the State of Wyoming Water Development Commission to carry out five projects on CBM product water. These projects include modeling the erosion potential from CBM product water and looking at the effects of reinjecting the product water underground. ^[55]

Montana State University’s Department of Land Resources and Environmental Science is also a center for research on CBM product water. The department’s current projects include an attempt to separate salt from water by pressure, finding plants that will tolerate high salt levels and ones that could remove salt from the water, and looking at how the water moves through small pores in the soil.^[56]^[57] The Montana Bureau of Mines and Geology, which is a department of Montana Tech at the University of Montana, is also working on addressing the problems caused by CBM-related product water and lists this as a primary research area.^[58]

This is worthwhile research. But the public has taken on the responsibility—and expense—of figuring out how to deal with a pollutant released by the CBM industry. This not only removes the burden of responsibility from industry but could also prove a boon to CBM expansion. In effect, this diligent research may be the most profitable subsidy of all.

1.5 Conclusions of Analysis

The following two tables summarize qualitatively the distribution of benefits and costs for CBM development in Powder River Basin. The tables use as natural breaking points the dates of 2017, when most CBM will have been extracted, and 2060, when, according to analysis in existing environmental impact statements, groundwater levels will have returned to within 95% of current levels.

Benefits of CBM Development	Through 2017	2017 – 2060	2060 –
Oil/gas companies	Value of CBM extracted	None	None
Landowners in Powder River Basin <i>with</i> damage agreements	Compensation	None	None
Landowners in Powder River Basin <i>without</i> damage agreements	Compensation where damages can be established	None	None
Taxpayers in MT and WY	Taxes on CBM, small gains in employment	None	None
Taxpayers/citizens of United States	One year's supply of natural gas	None	None

Costs of CBM Development	Through 2017	2017 – 2060	2060 –
Oil/gas companies	Expenses of CBM extraction and agreed damage compensation	None	None
Landowners in Powder River Basin <i>with</i> damage agreements	Disruption of current uses, contamination of wells	Lower water table, potential soil damage and contamination, decreased economic value of land.	Some continued impacts on water (even assuming 95% recharge) and soil; therefore, potential decreased economic value.
Landowners in Powder River Basin <i>without</i> damage agreements	Same as above, plus expense to establish damages for obtain compensation	Same as above	Same as above.
Citizens of Montana and Wyoming	Loss of landscape, decreased recreation value in some areas, regional lower water supplies worth \$2–10 billion	Regional lower water supplies, loss of landscape OR costs to remediate damaged lands	Continued remediation expense OR lowered value of damaged lands

Citizens of United States	Substantial subsidies to oil/gas companies operating in region	Continued depreciation tax breaks; possible long-term burden of regionally degraded hydrology and remediation of damaged lands	Possible long-term burden of regionally degraded hydrology and remediation of damaged lands
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SECTION 2: ACTION

The previous section described a way of thinking and applied it to a problem, the issue of coalbed methane extraction in the Powder River Basin. The analysis describes both the known and the uncertain but probably enormous costs that CBM will impose over a long period of time. The charts on the preceding pages demonstrate that the public-- in the region and in the nation, in the present and for decades to come--would bear a large portion of those costs.

How should the results of such analysis be applied to policy? The following three subsections describe avenues for assuring that the public good is served—that, indeed, *the total public welfare is enhanced rather than diminished*. The first reaffirms government's role as guardian of the public trust and identifies the responsible government bodies. The second describes two financial tools meant to address the unfair distribution of risk and cost of such a project. The third section describes a precautionary approach to sound national energy policy. Appendix A to this report lists the major private (corporate), government, and NGO actors in this issue and assembles information that may be helpful in holding the private sector accountable to the public good in this enterprise.

2.1 Precautionary Economic Analysis and the Public Trust: Better Reasoning for the Public Good

Precautionary economic analysis is not an end in itself but a tool for measuring the total change to the public welfare. It is the duty of government to assure that the change falls on the positive side of the ledger, or, in the terms outlined below, that the public trust is enhanced rather than diminished. The question for this case is whether government, by supporting CBM exploitation in the numerous ways we have described, is upholding or violating the public trust. In the first part of this subsection we describe this duty of government. In the second, we name individuals, government agencies, and other public entities that bear particular responsibility to the public trust in this case.

Government's Duty to the Public Trust[\[59\]](#)

Caring for the commonwealth is an ancient duty of government. Sometimes this duty is considered so basic that it is taken for granted and not spelled out. At other times, this duty is given a name: the public trust.

As legal scholar Peter Manus describes it, "Under American democratic theory, the nation's people possess an abstract form of sovereignty over the land and its natural resources that may be termed original ownership. In creating the government, the people delegated many powers and duties to its sovereign authority, including managerial responsibilities over the country's resources. In trust terms, the people designated the government as trustee of the land and other natural resources and themselves as beneficiaries."[\[60\]](#)

The public trust doctrine has a long and venerable history, wending its way from Roman law through English Common Law and the founding principles of the United States of America. It is spelled out in many state constitutions, where it is generally applied to protection of natural resources, sometimes narrowly to navigable waters but often more

broadly to include the natural environment. In the spirit of the public trust doctrine, for example, the state of Montana includes this provision in its constitution: "The state and each person shall maintain a clean and healthful environment in Montana for present and future generations."

The essence of the public trust concept, according to Manus, is that "government has a fundamental duty to adhere to a program of environmental husbandry aimed at maintaining a regenerative natural environment." Acting with precaution is essential in managing the public trust. In a visionary decision the Supreme Court of Hawaii adopted the precautionary principle to further the public trust doctrine that is embedded in its constitution.^[61] The Hawaiian public trust article states, "For the benefit of present and future generations, the State and its political subdivisions shall conserve and protect Hawaii's natural beauty and all natural resources, including land, water, air, minerals and energy sources, and shall promote the development and utilization of these resources in a manner consistent with their conservation and in furtherance of the self-sufficiency of the State. All public natural resources are held in trust by the State for the benefit of the people" (Article XI).

The court used this provision in its Waiahole Ditch decision (2000), a case brought by small farmers challenging diversion of water to large sugar plantations. Siding with the farmers, the court said, "Where there are present or potential threats of serious damage, lack of full scientific certainty should not be a basis for postponing effective measures to prevent environmental degradation. In addition, where uncertainty exists, a trustee's duty to protect the resource mitigates in favor of choosing presumptions that also protect the resource."

The role of trustee casts government in a positive light. In fulfilling its central duty to protect the future for current and future generations, government has a heroic role to play. Government is the protector, the guardian, the shield of the public trust. This is a role that government officials can proclaim proudly, for it is their unique, specific duty to protect our common heritage so that we can pass it on to the future undamaged and, ideally, improved.

On the other hand, public subsidies to destructive activities constitute gross mismanagement of resources that are intended for the good of all. *Is state and federal support for CBM a violation of the public trust?*

In Whose Hands? CBM and Responsibility for the Public Trust in the Powder River Basin

Public servants are responsible for preventing harmful CBM development. However, the responsibility of good decision making belongs not to government in a general sense but to certain positions and agencies in state and federal governments. We list them in this section.

Leverage Points in State Government

Although a federal agency (Bureau of Land Management) has the mandate to analyze CBM, various state bodies bear responsibility as well.

- ❑ In Montana, the Department of Environmental Quality and the Montana Board of Oil and Gas Conservation both assisted in preparing the environmental impact statement. The Board has the authority “to issue or refuse to issue drilling permits, and is authorized to take measures to prevent contamination of or damage to surrounding land caused by drilling operations or the disposal of produced...water.”[\[62\]](#)
- ❑ Wyoming Oil and Gas Conservation Commission regulates disposal of wastewater from gas development; the Commission “also has a duty to prevent natural gas from polluting or damaging crops, vegetation, livestock, and wildlife.”
- ❑ However, the Wyoming State Engineer “has permitting authority over CBM-produced water.”
- ❑ Governors: Since most of the agencies involved in regulating various aspects of CBM development have assiduously avoided responsibility for the processes as a whole, constituents should call upon chief executives of the respective states to become involved. Water issues also involve top-level negotiations, intervention, or other involvement by governors.

Leverage Points in Federal Government

- ❑ Department of Interior: As the Water 2025 Report demonstrates, the Department of the Interior sees a looming disaster around water issues – hence the conference to raise awareness around and spur action on water conflicts, water shortages, water infrastructure. The Bureau of Land Management is part of the Department, and its analysis is silent on the regional water context and coming crisis. A public trust perspective calls for connecting those dots.
- ❑ Agencies in charge of ensuring Clean Water Act compliance and Clean Air Act compliance: On Clean Air Act issues alone, consider this quote from the summary of the Montana Final Environmental Impact Statement:

“Although the air quality modeling shows the potential for certain standards to be exceeded, these impacts would not occur. The air quality permitting process would be used to analyze emission sources at the project level. Emission sources that would violate standards would not be permitted by the agencies and therefore, residual impacts would remain within standards.”[\[63\]](#)

This is a stunning leap of faith by the agencies in charge. Consider analogous reasoning by highway patrol: “The speed limit will be 55 miles per hour, and although the analysis shows a chance of speeding by large numbers of drivers, the infractions will be handled individually, car by car, *ensuring no speeding problem.*” Since the emissions will happen at individual CBM wells, it is clear that the “traffic cops” in this case will be far too few to “analyze emission sources at the project level.” CBM development plans call for tens of thousands of wells, thousands of miles of unpaved roads and countless vehicles – all contributing to air pollution.

2.2 Distributing Costs and Risks More Fairly: Damage Agreements and Assurance Bonds

Two tools, damage agreements and assurance bonding, might address some of the problems brought by the large and long-term risks of CBM drilling and the unfair distribution of these risks. A certain number of damage agreements have been negotiated but these pose problems in themselves, as we will explain. Assurance bonding could provide a more comprehensive solution. Developing and applying this tool would require considerable courage and determination on the part of public officials dedicated to upholding their responsibilities as public trustees.

Damage Agreements: Viable Path or Major Distraction?

One reasonable proposal for addressing the economic and environmental damages from CBM extraction is the notion of a surface use and damage agreement. The concept is intended to address the clash of property rights in split-estate situations by assuring that, as damages to the surface occur, the owner of the mineral rights compensates the surface user.

This sort of agreement has long theoretical standing in economics and law, dating most conspicuously from Coase's famous article, "The Problem of Social Cost."[\[64\]](#) Coase's insight is that when property rights are well defined and the legal system functions effectively and transparently, it is possible for the parties involved to negotiate an agreement (usually a transfer scheme based on damages and benefits) that seems fair to everyone. This formulation has proved persuasive to economists and legal theorists, leading them to sanguine predictions that, in complex situations, a strong legal system can provide economically efficient outcomes.

Unfortunately, Coase's assumptions are occasionally problematic and unrealistic, as Coase himself admitted. In circumstances with many actors, poorly defined impacts of given actions, and disagreement over the probabilities of eventual outcomes, it becomes less likely that the parties will reach an agreement with which all are content. Furthermore, the notion of economic efficiency explicitly sets aside equity considerations. Economic theorists are generally comfortable separating mechanisms for generating economically efficient outcomes from the mechanisms that ensure equitable distribution, but this separation makes less sense in the Powder River Basin or any other area where the trade-offs between uses are so evident and the outcomes involve unique resources and lifestyles.

In the Powder River Basin discussion, these legal agreements have surfaced in a few places. A February 2003 report funded by the US Institute for Environmental Conflict Resolution[\[65\]](#) (Straube and Holland, 2003) offers a deep analysis of the potential for a "model surface use and damage agreement" to address conflict between surface rights and CBM mineral rights. The authors examined the technical challenges and interviewed more than fifty individuals, including landowners, agency employees, and CBM developers. The Wyoming environmental impact statement also proposes a "model well water agreement" for split-estate situations. In both cases, the reports grapple with the challenge of using a legal agreement to resolve the trade-offs created by the inherent and explicit physical conflict between surface users and mineral extraction.[\[66\]](#)

Unfortunately, even a smoothly functioning damage agreement by the various authors' criteria faces major problems. For example, there is disagreement over the appropriate "circle of influence" of a produced-water-generating CBM well. The proposed damage

agreement in the Wyoming impact statement uses a 0.5-mile radius, even though the draft statement suggested that water-table drawdown could extend 10-12 miles.^[67] Straube and Holland mention a figure of 4-5 miles, but there is no consensus for that figure either. And at a more expanded level, a basin full of decentralized damage agreements, negotiated one at a time or in small groups, cannot easily address the major basin-wide problem that everyone agrees will ensue from widespread CBM development: a significant fall in the water table that would negatively impact thousands of well-water users. Damage agreements would probably fail to address other less grave but similarly far-reaching problems at an aggregate scale, such as air pollution and the disruption of habitat.

Another challenge to such agreements is the inherent imbalance of power in the split estate. Despite the name, a “split estate” is not entirely split. When it is allowable to exploit mineral rights in a way that disrupts local hydrology (which means virtually any mineral extraction), the mineral rights effectively take precedence because their exploitation compromises the value of the surface rights. In other words, the rights that appear “split” in fact have a hierarchy in which mineral rights come first.

This imbalance will surely manifest itself in individual agreements. The imbalance is implied in the Straube and Holland report, which notes that the greatest resistance to the notion of a mandatory model damage agreement came from those stakeholders who already hold the greatest unilateral power, the owners and potential future owners of the CBM rights. Public discourse must acknowledge the distinction between “efficiency” and “equity” when the legal and statutory starting point is one of such unequal power. Given the established preeminence of minerals rights and general acceptance of it, space must be carved out in the discussion for questioning that imbalance.

This imbalance has no doubt shaped the damage agreements that are already in place. While the existence of such agreements may seem encouraging, the process that led to them offered ample opportunity for self-selection: landowners who were more willing to accept weaker agreements, for whatever reasons, would be the first to agree. Any analysis of existing agreements must acknowledge the potential need to strengthen the standards beyond the current precedent. Given the possibility that early weak damage agreements will set the frame of reference, it is important to influence the process as soon as possible.

Environmental Assurance Bonds: "Bottle Deposits" for Big Projects

Problems with damage agreements show how difficult it is to incorporate broadly distributed, long-term costs of large projects into our institutions of property rights, compensation, and legal liability. Costanza and Perrings^[68] refer to this class of situations as “social traps,” situations in which “the rational decisions of individual agents necessarily lead to an outcome that is inconsistent with the best interests of society.”

A concept that better addresses the risks, damages, and inequities associated with complicated natural-resource extraction is the practice of performance or assurance bonding. These bonds work much like bottle deposits, which encourage consumers to dispose of the bottle in the most desirable way (recycling) and help cover the cost if they do not. Performance bonds are already used in construction and mining projects. Bonds

paid by strip miners of public lands, for example, are returned only after the land is restored.

Costanza and Perring describe how environmental bonding could be developed more broadly and used to assure that developers of new technologies or others seeking to use society's resources are held financially responsible for any potentially damaging activity. The resource user would put into escrow an amount based on "the environmental authority's best estimate of the worst outcome" of the proposed activity. At the end of (or at intervals in) an agreed period, the environmental authority would return to the resource user the bond's value, less the assessed value of damages from the resource use. Like any financial instrument, the bond can be calculated to incorporate the time value of money and uncertainty surrounding future interest rates.

Environmental assurance bonds would shift the burdens of risk and responsibility onto those who gain from the activities that carry the risk--an essential corollary of the precautionary principle. They are not simply a tax or other redistributive mechanism. By redistributing *risk* rather than just reslicing a static pie, they give the resource user incentives to find the best ways to reduce the ultimate damaging impacts. These new incentives create the chance to "grow the pie" in ways that benefit both the resource user and the community.

Wyoming Governor Freudenthal's proposed "contingency fund" to compensate for unforeseen damages from CBM drilling would have been a form of assurance bond. The proposed fund would have been too small to address the real needs, and it was quickly tabled in the face of industry opposition, but the idea was sound. Implementing it would require strong public support for officials who were willing to use such tools to protect the public trust.

2.3 Reframing Our Choices: CBM and National Energy Policy

So far, this critique of CBM development has focused largely on local and regional considerations. However, a development on this scale must be placed in a national context. Markets for natural gas are regional and national. Energy policies and strategies are regional and national. These markets, policies, and strategies have effects that are national and global.

None of the analyses, environmental impact statements, or proposals for CBM development provides this broader context. None describes what we want from our energy supply, so none can examine how or whether CBM expansion in the Powder River Basin would fit into a broader strategy. *None asks the vital question, "Is this project necessary?"* Instead, the default assumption is that more natural gas is unequivocally better.

Such assumptions are the result of a national energy strategy without clear goals except to meet unlimited future growth in demand. What if we adopted more reasonable goals to direct such strategy—such as to develop reliable, sustainable, and affordable energy supplies that do not increase international instability? This goal would serve the values embodied in the precautionary principle and the public trust doctrine. This sub-section explores whether CBM development would fit into such a goal.

Since CBM development would produce a quantity of natural gas that matters beyond Powder River Basin and even beyond the multi-state region, the assessment of its impacts and desirability must reach beyond the region as well. Given the reach of natural gas markets, we consider national energy policy as the logical scale on which to assess the logic of CBM development in Powder River Basin. Is this project necessary in the context of a goal-oriented national energy plan?

The environmental impact statement examined five slightly different scenarios for CBM development in Powder River Basin. Four of the five scenarios involved widespread extraction of CBM at roughly the same level, approximately twenty times the current number of wells, while the fifth examined continued extraction at current low levels. This approach implicitly set up an all-or-nothing choice. This range of “alternative scenarios” may meet a narrow interpretation of the requirements of National Environmental Policy Act, but it fails to meet the primary reason for considering alternatives: a reasonable assessment of the merits of the project as a whole.

Abundant work has been done on developing a more sound national energy strategy. One starting point is the *Clean Energy Blueprint*, a draft national energy strategy prepared by the Union of Concerned Scientists and the Tellus Institute.[\[69\]](#) The Blueprint examines anticipated energy supply and demand through 2020 and generates these conclusions, among others:

- ❑ The United States can meet 20% of its electricity needs with renewable sources by 2020.
- ❑ Consumer savings of over \$100 billion can be generated by 2020 by combining the shift toward renewable energy sources, which have lower long-term costs, with fuel efficiency measures.
- ❑ Natural gas use can be *decreased by 31%* from a business-as-usual scenario.

An Alternative to Natural Gas: Wind Energy

The Blueprint calls into question the need for long-term development of new natural gas sources. However, we should note that, under the scenarios currently planned, the commercially viable natural gas in the Powder River Basin would be nearly depleted by 2020. Thus, the planned development does not address long-term energy security; instead, it is a short-term project prompted by current natural gas shortages.

One irony of CBM development is that it is taking place in a region with a rapidly growing base of the nation’s most promising renewable energy source, wind energy. The West and Midwest are experiencing rapid growth in installed wind power, and this source promises to displace an increasing share of natural gas. At the margin, additional wind generation tends to reduce consumption of natural gas more than other fuels since gas is more flexible and more expensive than coal, the source of more than half of our electricity.[\[70\]](#)

Wind energy is already making the natural gas shortage less acute by displacing gas use. The American Wind Energy Association estimates that by the end of 2004, wind

energy will provide the equivalent of 500 million cubic feet of natural gas per day and 3 billion cubic feet per day by 2008, *equivalent to 6% of total natural gas production.*[\[71\]](#)

Wind energy meets the criteria of sustainability and affordability. It does not increase international instability. And it is more reliable than the natural gas it would displace. Unlike natural gas prices, which are subject to the vagaries of highly unstable markets, wind energy costs are predictable over time.

This is not to say that all natural gas should be abandoned in favor of wind power. However, the proposed CBM development must be seen in its broader context. While natural gas shortages and crises will continue for some time, the ability of Powder River Basin production to mitigate this would be miniscule. Even Canada, a major exporter of natural gas to the United States, is losing its ability to fill the shortfall between production and consumption in the US.[\[72\]](#) Considering the tremendous cost of CBM development, the trade-off seems even more unreasonable.

Global Climate Change and Natural Gas

We are obliged to pull back even farther than national energy policy when examining CBM's impacts and desirability. With overwhelming scientific consensus on the major climate trends, nations and international research efforts are turning increasingly toward reshaping our patterns of energy use and supply. Since CBM is part of our fossil fuel portfolio, long-term strategy must address its role in global climate change.

At first blush, natural gas from any source appears desirable as a transition fuel because of its lower output CO₂, the principle greenhouse gas. Per unit of energy, natural gas produces 28% less CO₂ than oil and 45% less than coal.[\[73\]](#) It also generally results in lower particulate emissions, an unanswered question and potential wildcard in climate change research.

However, it is important to keep in mind that natural gas is only the least undesirable of the fossil fuels. Renewables such as wind, solar, and geothermal produce *no* regular emissions, and biomass produces *no net* emissions. Furthermore, for the US to make even the first stage of compliance with the Kyoto Accords (7% lower greenhouse gas emissions than the 1990 baseline), the only economically viable path is greater efficiency. Over the longer haul, we must make the transition away from fossil fuels altogether, rather than a transition to much more of the cleaner fossil fuels.

2.4 Conclusions

Economic analysis informed by the precautionary principle exposes trade-offs that would not be apparent under conventional cost-benefit analysis. This analysis calls attention to four major trade-offs of proposed CBM development:

- The benefits of CBM development occur in the immediate and near future, while the costs spread over several generations.
- The benefits are highly concentrated, spilling over slightly to the public as a whole and to the public sector in the region, but still overwhelmingly concentrated with the oil and gas companies that would develop the resource.

- ❑ Significant public resources have been directed to this project, further enriching the small cadre of beneficiaries at the expense of the larger public.
- ❑ The benefits and costs are inherently difficult to compare, because the benefits are mostly concrete, while the costs are qualitatively different, involve difficult- or impossible-to-quantify issues, and threaten changes that may take generations to reverse or that may never be fully reversed.

At one level, this is a choice between natural gas and water, two resources of enormous practical and symbolic importance. The fossil fuel represents our economy's previous foundations and the problems we have created for ourselves, while water represents both our enduring basic needs and humanity's emerging challenges.

The breadth of this project challenges us to frame it appropriately, that is, as an issue of the public trust encompassing far-reaching public well-being, national energy strategy, and regional water security. Economic analysis provides a framework for this discussion, but only if the analysis is thorough, taking into account all costs and benefits over time. If we get lost in discussions of cheap energy and local finances, we risk making decisions with a dangerously narrow focus. This pattern is all too evident in this project and many others that have scarred the landscape, depleted resources, damaged health and ecosystems, and destroyed ways of life. The choice we face is about our ability to step away from business as usual and to chart a new path toward health, prosperity, and justice.

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Appendix A: The Players in CBM

CBM development in the Powder River Basin poses huge potential damage, cost, and risk. The main beneficiaries of this activity will be the oil and gas companies that are gearing up to exploit CBM resources.

This appendix provides lists of companies likely to be involved in CBM development in Powder River Basin. Given the huge stakes, it is unsurprising that so many oil and gas companies are involved. For these companies to reconsider CBM activities, they and their key stakeholders must see different writing on the wall. Instead of only profit and abundance, they must see real costs, liability, and potential decreased shareholder value.

The challenge of ensuring that companies be held accountable for the consequences of CBM development will be enormous. A primary question will be, considering these companies' behavior and given their track records in other places, is CBM development prudent? Are these firms appropriate partners for natural resource exploitation? Unless the companies involved act in good faith, there is no reason to expect that CBM development will work as planned.

Accountability will depend not only on tracking behaviors of individual companies but also on changing the political landscape. The reigning political philosophy, "communities bear the costs," must change to "the polluter pays."^[74] Sub-sections give information on watchdog groups and contact information for the government agencies involved.

Companies likely to participate in Powder River Basin expanded drilling^[75]

GAS COMPANIES	Websites
ANADARKO PETROLEUM CORPORATION	http://www.anadarko.com/
ANCHOR BAY CORPORATION	http://www.anchorbaycorp.com/
ANTERO ENERGY LLC	
BEAR PAW ENERGY	http://www.bearpaw.com/
BIG BASIN PETROLEUM LLC	
BILL BARRETT CORPORATION	
BLACK DIAMOND ENERGY INC	http://www.blackdiamondenergy.com/
BLACKSTONE OPERATING INC	

BLAKE MARK	
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BOWDEN ENERGY COMPANY INC	
BOWERS OIL & GAS INC	
CARRIZO OIL & GAS, INC.	http://www.carrizo.cc
C & H WELL SERVICE INC	
CH4 ENERGY LLC	
CITATION OIL & GAS CORPORATION	
COLEMAN OIL & GAS INC	
COMET ENERGY SERVICES LLC	
CONOCOPHILLIPS COMPANY	http://www.conocophillips.com
CONTINENTAL INDUSTRIES LC	
COX KENDALL JAY	
CRESTED CORPORATION	1
DEVON ENERGY PRODUCTION COMPANY LP	http://www.devonenergy.com/
DNR OIL & GAS INC	
DUNCAN OIL INC	
EDGE PETROLEUM	http://www.edgepet.com
EMERALD OPERATING COMPANY	
ENERNET OF 1, LLC	
FEDERATED OIL & GAS PROPERTIES	
FIDELITY EXPLORATION & PRODUCTION CO	http://www.fidelityoil.com/
FIRST SOURCE ENERGY	http://www.firstsourceenergy.ca/index.html
FLORENTINE EXPLORATION & PRODUCTION	
GALAXY ENERGY CORPORATION	http://www.galaxyenergy.com/
GASTAR EXPLORATION	http://www.gastar.com/
HEARTLAND ENERGY COMPANY	http://www.heartlandoilandgas.com/
HI-PRO PRODUCTION	
HUBER J M CORP	http://www.huber.com/

INDEPENDENT PRODUCTION COMPANY	
JIMS WATER SERVICE INC	
KENNEDY OIL	
KLT GAS INC	http://www.greatplainsenergy.com/kltgas.html
L & J OPERATING INC	
LANCE OIL & GAS COMPANY	
MARATHON OIL COMPANY	http://www.marathon.com/
MAJESTIC PETROLEUM OPERATIONS LLC	
MCCARTNEY ENGINEERING LLC	
MERIT ENERGY COMPANY	http://www.meritenergy.com/
NANCE PETROLEUM CORPORATION	http://www.wtp.net/nancepet/
NORTHWEST ENERGY LLC	
OILFIELD SALVAGE & SERVICE COMPANY	
PALO PETROLEUM INC	http://www.palopetro.com/
PEABODY NATURAL GAS LLC	
PENNACO ENERGY INCORPORATED	
PETROLEUM DEVELOPMENT CORPORATION	http://www.petd.com/
POWDER RIVER GAS, LLC	
POWERS ENERGY INC.	
PRIMA OIL & GAS COMPANY	http://www.primaenergy.com/
QUEST OPERATING LLC	
REDSTONE RESOURCES INC	
RIM OPERATING INC	
ROCKY MOUNTAIN GAS INC	
SANDS OIL COMPANY INC	
SEYON LLC	
SKULL CREEK A LLC	

SRW INC	
ST. MARY LAND AND EXPLORATION COMPANY	http://www.stmaryland.com/
SUNCOR ENERGY	http://www.suncor.com/
SUNSHINE VALLEY PETROLEUM	
TINDALL OPERATING COMPANY	
TREND EXPLORATION I LLC	
U.S. ENERGY CORPORATION	http://www.usnrg.com/useg/
WELLSTAR CORPORATION	
WESTERN GAS RESOURCES	http://www.westerngas.com/indexf.html
WESTPORT OIL & GAS COMPANY LP	
WILLIAMS PRODUCTION R1 COMPANY	http://www.williams.com/
YATES PETROLEUM CORPORATION	

Helpful Websites for Corporate Investigation

The Public Register's Annual Report Service (<http://www.prars.com/>)
A service that mails annual reports free of charge

CorpWatch (<http://www.corpwatch.org/>)
Provides a useful research guide for corporate investigation.

Center for Responsive Politics: Open Secrets (<http://www.opensecrets.org/>)
The source for campaign spending data

State Public Interest Research Groups <http://www.pirg.org/>
Has a site on "enronesque" organizations: Enron Watchdog
<http://enronwatchdog.org/aboutus.html>

Environmental Working Group (<http://www.ewg.org/>)
Provides information about corporate environmental behavior.

A sample of research on one company— Marathon

The following web sites include information about Marathon Oil Company, one of the key Powder River Basin players. They illustrate the abundance of information available that should raise questions about practices of companies exploiting CBM in the Powder River Basin.

- ❑ How oil companies including Marathon are consolidating and cheating consumers by controlling oil production.
<http://www.corpwatch.org/bulletins/PBD.jsp?articleid=433>
- ❑ Marathon is significant violator of Clean Air Act in Michigan.
<http://www.ewg.org/reports/abovethelaw/Michigan.pdf>
- ❑ Violated Clean Air Act in Illinois and escaped with little or no fines.
<http://www.ewg.org/reports/abovethelaw/illinois.pdf>
- ❑ In violation of Clean Air Act in Indiana but not inspected.
<http://www.ewg.org/reports/primesuspects/IN.pdf>
- ❑ Other Clean Air Act violations.
<http://www.ewg.org/reports/abovethelaw/abovethelaw.pdf>
- ❑ Marathon contributed to Florida's congressional delegates who see no need for new clean air standards. <http://www.ewg.org/reports/flpacreport/FloridaPAC.pdf>
- ❑ Labor issues and U.S. Steel (which purchased Marathon Oil.)
http://www.multinationalmonitor.org/hyper/issues/1991/04/mm0491_09.html
- ❑ Marathon pays for a lobbyist to get Libya off U.S. sanction list.
<http://www.corporatewatch.org.uk/newsletter/issue10/newsletter2.htm>
- ❑ PACs associated with members of the American Petroleum Institute, but not with the National Wetlands Coalition, gave more than \$1.4 million to members of the House who voted against the Gilchrest amendment.
http://www.ewg.org/reports/Wet_PAC/Table5.html
- ❑ Toxic pollution of water, discharges of carcinogens, metals, reproductive toxins in Illinois http://www.ewg.org/pub/home/reports/dishonorable/DD_PDF/IL.pdf

Industry Associations

Powerful industry associations are the chief lobbying organizations. Here is how one association, the Petroleum Association of Wyoming (PAW), describes what it offers to members:

PAW's full time staff, with over seventy-five years of industry and association experience, represents members' interests before state, national, and local decision makers on an around-the-clock basis. PAW is recognized by legislators, regulators, business leaders, and media as the primary spokesperson for the oil and gas industry in Wyoming. The association's legislative and regulatory efforts save industry millions each year. Constant interaction with primary state and federal agencies facilitates access for leasing, drilling, development and associated industry activities.

Associations whose members include Powder River Basin CBM–exploiting companies include:

- ❑ American Petroleum Institute (<http://api-ec.api.org/frontpage.cfm>)
- ❑ American Gas Association (<http://www.aga.org/>)
- ❑ Montana Coalbed Natural Gas Alliance(<http://www.montanacoalbed.com>)
- ❑ Wyoming Coalbed Natural Gas Alliance (<http://www.wyomingcoalbed.com>)
- ❑ Independent Petroleum Association of America (<http://www.ipaa.org>)
- ❑ Independent Petroleum Association of Mountain States (<http://www.ipams.org/>)
- ❑ Montana Petroleum Association (<http://www.montanapetroleum.org/index.html>)
- ❑ Petroleum Association of Wyoming (<http://www.pawyo.org/>)

National Agencies

- ❑ U.S. Department of Interior
- ❑ Bureau of Land Management (<http://www.blm.gov/nhp/>)
 - Montana (<http://www.mt.blm.gov/>)
 - State Office

5001 Southgate Drive
PO BOX 36800
Billings, MT 59107
Phone: 406 896-5012
Fax: 406 896-5299
E-mail: MT_Information@blm.gov
State Director: Marty Ott
Associate State Director: Jerry Meredith

- Miles City Field Office (<http://www.mt.blm.gov/mcfo/index.html>)

111 Garryowen Road
Miles City MT 59301-0940
Phone: 406 233-2827
Fax: 406 233-2921
E-mail: mcfoinfo@mt.blm.gov
Field Manager: Dave McInay

- Wyoming[76] (<http://www.wy.blm.gov/>)
 - State Office
 - Buffalo Field Office (<http://www.wy.blm.gov/bfo/index.htm>)

1425 Fort Street
Buffalo, WY 82834-2436
Phone: 307.684.1100
Fax: 307.684.1122
E-mail: buffalo_wymail@blm.gov

Field Manager: Dennis Stenger

- Wyoming CBM Clearinghouse (<http://www.cbmclearinghouse.info>)
- U.S. Department of Energy (<http://www.energy.gov/engine/content.do>)
- White House Task Force on Energy Project Streamlining (<http://www.etf.energy.gov/>)
- Department of Fossil Energy (<http://www.fossil.energy.gov/>)
- National Energy Policy Development Group (created by Cheney)
- Securities and Exchange Commission (www.sec.gov)
- U.S. Geological Survey

States/State Agencies

State of Montana (<http://www.state.mt.us/>)

- DEQ (<http://www.deq.state.mt.us>)
 - CBM page (<http://deq.state.mt.us/CoalBedMethane/index.asp>)

- ❑ Montana Board of Oil and Gas Conservation (<http://bogc.dnrc.state.mt.us/>)

State of Wyoming (<http://www.state.wy.us/>)

- ❑ DEQ (<http://deg.state.wy.us/>)
- ❑ Wyoming Oil and Gas Conservation Commission (<http://wogcc.state.wy.us/>)
777 West First Street
P.O. Box 2640
Casper, WY 82602
E-Mail khutto@missc.state.wy.us
- ❑ Wyoming Energy Commission
(http://www.wyomingbusiness.org/minerals/energy_commission/)

Tribes

- ❑ Crow Nation (<http://www.crownations.net/>)
- ❑ Crow Tribal Council (<http://tlc.wtp.net/crow.htm>)
- ❑ Northern Cheyenne (<http://www.ncheyenne.net/>)
- ❑ Montana – Wyoming Tribal Leaders Council (<http://tlc.wtp.net/index.html.htm>)
- ❑ Bureau of Indian Affairs (BIA)
Rocky Mountain Regional Office
316 North 26th Street
Billings, MT 59101
406-247-7911

Grassroots Organizations

- ❑ Powder River Basin Resource Council (<http://www.powderriverbasin.org/>)
- ❑ Yellowstone Coalition (http://www.greateryellowstone.org/NG_crisis.html)
- ❑ Powder River Coalbed Methane Information Council (<http://www.cbmwyo.org/>)
- ❑ Northern Plains Resource Council
- ❑ Montana Environmental Information Center
- ❑ Oil and Gas Accountability Project (<http://www.ogap.org/>)

Media

- ❑ *Casper Star Tribune* (<http://www.casperstartribune.net/>)
- ❑ *Billings Gazette*
- ❑ *High Country News* (<http://www.hcn.org/>)
- ❑ Clearinghouse of Western Newspaper Articles and Editorials
- ❑ Focus West (<http://focuswest.org/hwnews/current.cfm>)
- ❑ *Headwater News* (<http://www.headwatersnews.org/>)

Appendix B: Subsidies Calculations

This is a description of calculations to arrive at estimates in Section 1.4 of this report, "The Public Burden of CBM: Federal and State Subsidies." The estimates were:

Section 29: \$676 million - \$1.57 billion.

Percentage Depletion: \$9.8 million - \$38.1 million.

Expensing development costs: \$21.4 million – \$42.8 million.

Total tax breaks: \$707 million - \$1.65 billion.

Section 29

The number given above came from a direct calculation of expected CBM production from the Powder River Basin that would be subject to the credit, if the House version of the extension is passed. The BLM's Environmental Impact Statements (and other projections) on CBM development in Wyoming and Montana anticipate from 28,000 to 65,000 new wells (10,000 – 26,000 in Montana, 18,000 – 39,000 in Wyoming) in the next ten years.^[77] If half of these are built by 2007, as required to claim the credit in the House version of the extension, that would amount to 14,000 - 32,500 wells, each claiming the credit for four years of production. In July 2003, the average production per well per year in the Powder River Basin was 28,972 mcf,^[78] and the rate of the credits proposed in the new energy bills is about \$0.50/mcf.^[79] This would yield a total subsidy of \$0.81 billion - \$1.88 billion over the life of the extension, just for the Powder River Basin. Multiply by 5/6 to get amount in next five years: \$0.68 billion - \$1.57 billion.

We can compare this with projections from the Joint Committee on taxation for the amount given out for the entire credit (not just the Powder River Basin.) The committee estimates that if Section 29 were extended, the total amount of the credit would be \$1.7 billion over 5 years (House version) or \$1.88 billion (Senate) - \$2.96 billion (House) over 11 years.^[80] (Almost all of this would come by 2009, when the credit expires.) This is fairly consistent with something in the range estimated above for just the Powder River Basin, since it is the center of new activity and would be likely to claim a large portion of the credit for new wells.

Other Tax credits

The following is used to calculate portion of general oil and gas subsidies to attribute to Powder River Basin: Total Powder River Basin CBM production, August 2003: 28,925,554 Mcf, or 933,082 Mcf/day. Total Nat Gas: (August 2003) 53.10643 BCFD, with the portion of total Natural Gas coming from Powder River Basin CBM 1.75%. In terms of energy, natural gas production is about 62% of total oil and gas production in the US. So Powder River Basin CBM is about 1.1% of total Oil and Gas. Powder River Basin CBM is about 22% of total CBM production.

Percentage Depletion: The costs to the federal government of allowing independent producers to use percentage depletion rather than cost depletion averaged over \$700 million a year between 1996 to 2002.^[81] If this rate continues, this would amount to \$3.5 billion over the next 5 years X 1.1% = \$38.1 million. The most recent projections from the

Congressional Budget Office (CBO) estimate a much lower savings of \$900 million over the next five years if percentage depletion were replaced by cost depletion. Multiplied by 1.1% for Powder River Basin's share totals \$9.8 million. So the range from these is: \$9.8 million to \$38.1 million.

Expensing exploration & development: This is difficult to calculate, because it is a case of delayed tax payment rather than outright credit. CBO estimates that changing expensing rules in 2003 would raise \$13.1 billion in the next five years, before leveling off a bit as the delayed payments start to catch up to the loss in current payments. The subsidy comes from the loss of interest on the money that isn't paid right away. Multiply the amount of short term revenue that would be received by eliminating the expensing of exploration costs, by the interest rate to get yearly subsidy. One way to think of this is that if the short term revenue gains are translated into an even yearly revenue stream, the yearly payments would be the interest rate times the short term gains. So 13.1 billion times an interest rate of 3% to 6% (depending on what happens to interest rates) is \$393 million - \$786 million. That's per year, so \$1.96 - \$3.93 billion over 5 years - multiplied by 1.1% to yield \$21.4 million - \$42.8 million.

[1] BLM et al, p. SUM-11.

[2] USDA, "Success Stories for Wyoming." Available at <http://www.usda.gov/rus/electric/success/wy-success.htm>.

[3] Becky Bohrer, "Ranchers Worry about Rights with Methane Development," *Casper Star Tribune*, Jan. 27, 2003.

[4] Over the past several decades, economists and psychologists have developed far subtler and more accurate conceptualizations of risk: research on contingent valuation, existence value, and willingness-to-pay and willingness-to-accept distinctions constitutes an entire sub-field. The distinct sub-field at the overlap of psychology and economics—including much of its experimental and survey work—has produced a wide variety of highly refined and focused refutations of the standard expected utility model, as well as some more accurate behavioral models. Unfortunately, most practitioners of risk assessment and cost-benefit analysis use outdated methodologies that incorporate none of these advances in our understanding of uncertainty.

[5] Heinzerling, Lisa, and Frank Ackerman, "Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection," Georgetown Environmental Law and Policy Institute, 2002.

[6] This lack of nuance in the use of discounting is both deceptive and unnecessary. When benefits and costs are clearly identified, their distribution over time must also be identified or at least estimated. It is entirely feasible to discount different streams of benefits and costs by using different discount rates. Unfortunately, conventional analysis typically uses a single discount rate, even in cases where uniqueness and substitutability might warrant different discount rates. This sort of technical shortcoming is both difficult for the public to grasp and easily obscured in the presentation of final results.

[7] It is useful to think of project-based financial analysis as an extreme case of CBA in this respect: the unit of analysis is a single actor (a company), so no distribution issues.

[8] For an analysis of risk assessment, see Mary O'Brien, *Making Better Environmental Decisions* (MIT Press 2000).

[9] "Statewide Oil and Gas Final Environmental Impact Statement (FEIS) and Amendment of the Powder River and Billings Resource management Plans (RMPs)," Bureau of Land Management, Montana Department of Environmental Quality, and Montana Board of Oil and Gas Conservation, January 2003. Available at: <http://www.deq.state.mt.us/CoalBedMethane/Issues.asp>.

[10] Ibid, p. SUM-12.

[11] Ibid, p. SUM-13.

[12] The Montana DEQ web site on CBM is at: <http://www.deq.state.mt.us/CoalBedMethane/>.

[13] A detailed description of the conference and downloadable copies of its documents are available at <http://www.doi.gov/water2025/>.

- [14] Watts and Associates, "Powder/Tongue River Basin Plan Population Projections: Task 4," February 2002, p. 10-12.
- [15] Salinity refers to the level of dissolved salts, while sodicity refers to the level of sodium. Water can be sodic without being saline. For a technical summary of this distinction, see Pearson, p. 1-2.
- [16] This section draws on the technical and non-technical summaries of Bauder and Pearson, respectively. These two publications draw heavily on original research by Bauder and colleagues, as well as on the work of others at Montana State University and elsewhere.
- [17] Bauder, "Quantity and Characteristics of Saline and Sodic Water Affect Irrigation Suitability," p. 2.
- [18] Bauder, et al, "Plant and Soil Response to Irrigation with Water Comparable to CBM Product Water from the Powder River Basin Greenhouse Experiment."
- [19] This section draws heavily on Simeon Herskovits, "Legal Implications of Groundwater Impacts Due to Coalbed Methane Development (Powder River Basin)."
- [20] <http://www.wy.blm.gov/nepa/prb-feis/index.htm>, Wyoming BLM Environmental Impact Statement (xxiii).
- [21] <http://www.mt.blm.gov/mcfo/cbm/eis/index.html>, Montana BLM Environmental Impact Statement (4-5)
- [22] This estimate appears in Herskovits and is from John Bredehoeft, a leading hydrogeologist.
- [23] Bill Luckett, "CBM clean-up fund withdrawn," *Casper Star-Tribune*, November 21, 2003.
- [24] Dustin Bleizeffer, "Industry raps CBM clean-up fund," *Casper Star-Tribune*, November 20, 2003.
- [25] Dean Murphy, "Pact ends western water war," *Salt Lake Tribune*, October 17, 2003, accessed December 2, 2003, at http://www.sltrib.com/2003/Oct/10172003/nation_w/nation_w.asp.
- [26] Market prices for water rights in Montana and Wyoming can run from \$3,000 to \$10,000 per acre-foot, according to the Wyoming State Water Plan's web site (<http://waterplan.state.wy.us/FAQ/FAQ.html>, accessed December 2, 2003). It is difficult to infer exactly what this market behavior means, but we can apply straightforward financial reasoning. Assuming a 30-year time horizon for the water rights (probably generous assumption, given the fragility of water in the west) and investors who require returns in the range of 4-7% (again, probably low), a cost of \$3,000 per acre-foot of water rights implies an assumption that water prices remain in the range of \$250-300. To justify a similar return at a price of \$10,000, the investor must assume that prices will be in the range of \$700-950 per acre-foot each year. In short, the market is telling us that prices will rise – probably by a lot.
- [27] <http://www.epa.gov/cmop/pdf/pol003.pdf>, EPA white paper, "Update on Application of Section 29 Tax Credit to Coal Seam Gas."
- [28] <http://wogcc.state.wy.us/coalbedchart.cfm>, Wyoming Oil and Gas Conservation Commission data.
- [29] <http://www.eia.doe.gov/emeu/finance/sptopics/majors/index.html>, Energy Information Association, "The Majors' Shift to Natural Gas"
- [30] <http://thomas.loc.gov/>, Thomas, Legislative Information on the Internet, H.R.6.EH
- [31] <http://thomas.loc.gov/>, Thomas, Legislative Information on the Internet, H.R.6.EAS
- [32] <http://wogcc.state.wy.us/coalbedchart.cfm>
- [33] http://www.cbo.gov/bo2001/bo2001_showhit1.cfm?index=REV-36
http://www.cbo.gov/bo2003/bo2003_showhit1.cfm?index=REV-23
- [34] <http://www.eia.doe.gov/oiaf/servicertp/subsidy/>, DOE Energy Information Administration, "Federal Financial Incentives and Subsidies in Energy Markets 1999: Primary Energy"
- [35] http://www.cbo.gov/bo2003/bo2003_showhit1.cfm?index=REV-22
- [36] Calculation assumptions and methods are described in Appendix B.
- [37] http://www.fossil.energy.gov/budget/04/pdf/04rd_natgas.pdf
- [38] <http://www.netl.doe.gov/scng/projects/resource/ra26026.html>
- [39] "Enhanced Coal Bed Methane Production Through Computerized Gas Lift Utilizing Casing Head Gas" <http://dominoweb.fossil.energy.gov/domino/apps/fred/fred.nsf/0/fedb44e7e09da3fd85256d08003f37fd?OpenDocument&ExpandSection=-1000>
- [40] http://www.fossil.energy.gov/budget/04/pdf/04rd_natgas.pdf
- [41] http://www.fossil.energy.gov/budget/04/pdf/04rd_oil.pdf
- [42] "Sequestration of Carbon Dioxide Gas in Coal Seams." From <http://dominoweb.fossil.energy.gov>
- [43] "Development and Testing of a Pre-Prototype Mach 2 Ramgen Engine," <http://dominoweb.fossil.energy.gov>
- [44] "Northern Cheyenne Reservation Coal Bed Natural Gas Resource Assessment

- and Analysis of Produced Water Disposal Options,” <http://dominoweb.fossil.energy.gov>
- [45] <http://www.blm.gov/nhp/news/legislative/pages/2001/te010906.htm>, Statement of Tom Fulton, DOI, before House subcommittee on Energy and Mineral Resources.
- [46] http://www.wyomingoutdoorcouncil.org/news/CBM_Law_Review_v1.pdf, Wyoming Outdoor Council, “Debunking the Natural Gas Clean Energy Myth: Coalbed Methane in Wyoming’s Powder River Basin.” p. 10581
- [47] <http://www.powderriverbasin.org/costs.htm>,
- [48] <http://legisweb.state.wy.us/budget/fiscal/taxesStatutory.htm>
- [49] <http://www.equalitystate.org/ESPC%20Website%20Generic%20Pages/legisfolder/2000legreport.html>, Equality State Policy Center, Report on 2000 Legislative Session.
- [50] http://www.wyomingbusiness.org/minerals/energy_commission/commission_meetings.cfm, Energy Policy recommendations, submitted by the Wyoming Energy Commission.
- [51] <http://www.petroleumnews.com/pnarch/030706-01.html>, article from Petroleum News.
- [52] <http://www.petroleumnews.com/pnarch/030706-01.html>, Quote of Jim Rennie, Enbridge’s director of media relations, in article from Petroleum News
- [53] http://www.wba.vcn.com/stroock_speech.htm, Speech by Bill Schilling, President of the Wyoming Business Alliance.
- [54] <http://www.casperstartribune.net/articles/2003/03/27/news/wyoming/cd0aee8bbf97d11101f59793535f1f43.txt>, “Robust New Pipeline Authority Sets Goals,” Article in Casper Star Tribune.
- [55] <http://wwweng.uwyo.edu/news/010701/>, U of Wyoming College of Engineering news article.
- [56] <http://www.montana.edu/commiserv/csnews/nwview.php?article=801>, MSU University news story about Jim Bauder.
- [57] <http://waterquality.montana.edu/docs/methane.shtml>, MSU Water Quality and Irrigation Management CBM research page.
- [58] <http://www.mtech.edu/Research/research/2001%20Research/Bureau2001.htm>, Montana Bureau of Mines and Geology, current research highlights.
- [59] This subsection is adapted in part from Peter Montague and Carolyn Raffensperger, “A New Tool for Environmental Protection and Justice,” *Rachel’s Environment & Health News* #775 (Aug. 7, 2003, published Sept. 23, 2003). Available at <http://www.rachel.org/bulletin/index.cfm?St=2>
- [60] Peter Manus, “To a Candidate in Search of an Environmental Theme: Promote the Public Trust,” *Stanford Environmental Law Journal* Vol. 19 (May 2000), pgs. 315-369. Available at <http://www.rachel.org/library/getfile.cfm?ID=234>
- [61] Carolyn Raffensperger, “Constitutional Experiments: Protecting the Environment and Future Generations,” *Conservation Biology*, Vol. 17, no. 6 (Dec. 2003).
- [62] Herskovits, p. 12.
- [63] BLM et al, SUM-15.
- [64] Coase, R. H. “The Problem of Social Cost.” *The Journal of Law and Economics* 3 (1960): 1-44.
- [65] Straube, Michele, and Melinda Holland, “A Conflict Assessment of Split Estate Issues and a Model Agreement Approach to Resolving Conflicts Over Coalbed Methane Development in the Powder River Basin,” prepared for US Institute for Environmental Conflict Resolution, March 14, 2003.
- [66] The current document does not provide additional detailed analysis of these discussions, except to clarify their potential shortcomings. However, we recommend the work by Straube and Holland as a valuable summary of the perspectives of a wide range of stakeholders as they relate to a model SUDA.
- [67] Herskovits, p. 6.
- [68] Costanza, R. and Perrings, C., “A flexible assurance bonding system for improved environmental management,” 1990. *Ecological Economics*, 2, p. 57-75.
- [69] *Clean Energy Blueprint*, Clemmer et al, UCS and Tellus (2001).
- [70] The details on wind power in the section come from Wind Energy Weekly #1048, published by the American Wind Energy Association.
- [71] Energy Information Administration, “U.S. Total Natural Gas Annual Supply and Disposition Balance.”
- [72] Simon, “Canada Is Losing Ability to Fill U.S. Natural Gas Needs.”
- [73] Ball State University, BSU Green Tips, <http://www.bsu.edu/provost/ceres/cote/tips.html>.

[74] See the recent Washington Post editorial, "Shifting the Burden," discussing the Bush administration's shift away from corporate accountability to local burden for environmental damage.

[75] This table is incomplete and subject to change.

[76] Campbell, Converse, Johnson and Sheridan counties.

[77] Wyoming and Montana Final Environmental Impact Statements.

[78] <http://wogcc.state.wy.us/coalbedchart.cfm>, Coalbed Production Statistics from Wyoming Oil and Gas Conservation Commission

[79] <http://www.taxpayer.net/energy/pdf/fullenergybillcomparison0903.pdf>, Taxpayers for Common Sense, "Comparison of Tax Provisions ..." (uses their number per barrel of oil equivalent, converted to mcf)

[80] <http://www.taxpayer.net/energy/pdf/fullenergybillcomparison0903.pdf>, Taxpayers for Common Sense, "Comparison of Tax Provisions in House Version of Energy Bill, Senate Version, and 2003 Domenici Proposal."

[81] <http://www.ctj.org/pdf/hideappl.pdf> Citizens for Tax Justice, "Tax Expenditures, Fiscal 1996-2002, A Detailed List."