Programmatic Environmental Impact Statement

for the BLM's Federal Coal Leasing Program

COMMENTS OF UTAH PHYSICIANS FOR A HEALTHY ENVIRONMENT ON PROGRAMMATIC EIS FOR FEDERAL COAL LEASING PROGRAM

(July 23, 2016)

Utah Physicians for a Healthy Environment (UPHE) is a non-profit organization of over 400 physicians, scientists, and engineers that was formed to clarify the link between environmental degradation and impaired human health. Our objective is to encourage policy makers to make better informed decisions concerning the mitigation of pollution and the benefits that such mitigation has on public health. UPHE members share a concern that the health of the residents of Utah, and the viability of its environment, are suffering ever greater adverse impacts from pollution and climate disruption largely from the burning of fossil fuel.

On March 30, 2016, the Department of the Interior published its Notice of Intent to Prepare a Programmatic Environmental Impact Statement to Review the Federal Coal Leasing Program. See 81 FR 17720-29. According to the Notice of Intent, one major motivation for this broad review of the Federal coal leasing program was the assertion that the lack of competitive bidding for the vast majority of Federal coal leases has led to below-market valuations of leases and effective royalty rates below statutory minimums. Another major motivation is the conflict between the Administration's Climate Action Plan designed to transition away from reliance on coal at home and abroad, and the BLM's coal leasing program that incentivizes overreliance on coal through liberal leasing policies and below-market pricing. The Notice specifically invites comments on the public health consequences of relying on Federal coal as an energy source and suggestions as to how

the external costs of doing so should be accounted for in the coal leasing program. These comments will address the economic issues, public health issues, and climate disruption issues that are raised in the Notice of Intent.

I. SUMMARY

UPHE agrees with the General Accounting Office, the DOI's Inspector General, Taxpayers for Common Sense, Headwaters Economics, the Center for American Progress, and others in their conclusions that Federal coal is being leased in non-competitive auctions far below its true market value. This results in drastic subsidies of the price of Federal coal. These subsidies distort U.S. energy markets, over-incentivize the domestic consumption of coal, over-incentivize U.S. coal exports by subsidizing transportation costs, and delay the shift to cleaner sources of energy. Subsidizing the price of Federal coal increases the pollution and climate disruption caused by coal beyond what it would otherwise be, and ultimately undercuts the president's Climate Action Plan.

Most alarmingly, subsidizing the price of Federal coal incentivizes speculation in coal leases whereby private mining companies seek to obtain 20-year lock-ins of the current subsidized price for purposes of exporting it to the countries of South Asia. Those speculators can reasonably expect to sell PRB coal for from five- to ten-times the current subsidized price. Shipping massive amounts of subsidized Federal coal to the Asian market can be expected to artificially drive down the price of coal from all suppliers to that market.

Because Asia's demand for coal is highly elastic, shipping subsidized coal into that market will stimulate the use of coal in that region. This prospect is in direct conflict with the objectives of the Obama Administration's Climate Action Plan, including its Clean Power Plan, its recent agreements with China and India to reduce their reliance on coal for power generation, and its agreement with the 30 OECD countries to phase out their financing of coal-fired power plants in less developed countries. The Mineral Leasing Act of 1920 and the Federal Coal Leasing Amendments Act require that larger social and environmental consequences of leasing Federal coal such as these be taken into account in the process of deciding what coal to lease, and on what terms.

The Federal coal leasing program must be reformed to disregard the Powder River Basin mine companies' self-dealing with their own affiliates. It must also assess royalties

based on final sale prices to end-users. The current 12.5% royalty rate for coal is the lowest royalty rate allowed under current law. It is lower than the 18.75% charged for offshore oil and gas production, and lower than the rates charged by many key Western states, including Wyoming, New Mexico, Colorado, and Utah. Although the Bureau of Land Management (BLM) has the statutory authority to increase the royalty rate, it has not done so. It should exercise its authority to bring the royalty rate for coal up to the rate paid by owners of offshore oil leases.

Finally, the Powder River Basin must be formally recertified as a Coal Production Region so that market demand (particularly the demand from the export market) and the social and environmental impacts of the Federal coal leasing program are properly taken into account in decisions to lease this critically important public resource.

UPHE believes that these reforms are necessary to make the Federal coal leasing program fair to the American tax payer and consistent with the Administration's Clean Power Plan and its international climate protection objectives. The main focus of these comments, however, will be on the need to include the social costs of burning fossil fuels in the price of Federally-auctioned coal, and on how those social costs should be defined and measured.

II. BACKGROUND

One simple ratio is enough to condemn the BLM's current coal leasing program. From 2006 to 2015, 4.3 billion tons of coal were produced on BLM leases. The amount of revenue received for that coal was $9.55 billion.[1] Dividing the program revenue received by American taxpayer by the tons produced yields an average overall effective price of $2.22 per ton! Simpy stated, the BLM's leasing program is a program designed to give away the public's coal.

Congress has repeatedly directed Federal agencies to ensure a fair return to the government for the development of public assets, such as coal. Ever since the leasing of Federal coal began, however, Congress and regulators have struggled to ensure that the public gets a fair return when its coal is sold. There is an inherent tendency of officials who manage publicly-owned natural resources to view their mission as one of easing the transfer of these resources into the hands of private business at the least cost and difficulty to that business. While this tendency seems ubiquitous in Third World countries,

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[1] See Notice of Intent to Prepare a Programmatic Environmental Impact Statement to Review the Federal Coal Leasing Program, March 30, 2016, 81 FR 17720 at 17721.

it is a serious risk even in more advanced societies such as the United States when the management of the public's natural resources takes place in the shadows, unnoticed by elected officials whose tenure in office is temporary, and unnoticed by the press.

That seems to be what has happened with Federal coal leasing in the United States. Federal coal leasing has undergone three separate moratoriums. President Theodore Roosevelt's administration discovered that private companies had fraudulently acquired large quantities of coal and lands by manipulating the 1873 Coal Lands Act. In response, President Roosevelt instituted the first coal leasing moratorium, withdrawing 66 million acres of coal lands from sale.

The Mineral Leasing Act of 1920 (MLA) set up a formal leasing program for federal coal, centered on the requirement that availability and pricing of leases be determined by competition. Despite the mandate of the MLA, increasing amounts of coal tracts were leased through unstructured negotiations by the Secretary of the Department of the Interior with individual private companies, with little weight given to actual market conditions. Upon review, the BLM found that even though coal leasing had increased tenfold by 1970, production had decreased by 75 percent. This evidence that coal leases were being pursued primarily for speculative purposes led to the second moratorium on coal leasing in 1971. The Federal Coal Leasing Amendments Act (FCLAA) amended the MLA to replace the process of conducting unstructured negotiations with individual private buyers. The FCLAA required 1) competitive leasing, 2) at fair market value, and 3) diligent development of all leases obtained. A royalty of 12.5% of Fair Market Value (FMV) was established as the minimum required.

Despite these reforms, more abuses emerged in the early 1980s. Employees of the since-disbanded Minerals Management Service had leaked appraisal information in advance of coal sales, ignored guidelines drawn up to ensure that coal was sold at fair market value, and improperly handled environmental assessments leading up to the sales. A GAO investigation concluded that as a result of undervaluing coal and minimal bidder participation, leases in the Powder River Basin had been acquired for $100 million under their fair market value. This prompted Congress to create the Commission on Fair Market Value Policy (the Linowes Commission), which concluded that excessive amounts of coal had been leased at what it described as "firesale prices." This led to the program's third moratorium.

For the 33 years since the Linowes Commission, there have been no significant revisions to the Federal coal leasing program and little meaningful oversight of the program. Over that time, both the market for coal, and Federally-owned coal's share of that market, have changed dramatically. The GAO, and the DOI's Inspector General have

both concluded that Federal coal leases are once again characterized by dysfunction and mismanagement, with most Federal coal selling at far less than market prices.

Chronically selling Federal coal far below its market value continues to have a number of socially damaging effects. It has resulted in depriving both Federal and state governments of some $40 billion in revenue[2] since the market made its major turn from privately-sourced coal to underpriced Federally-leased coal. Chronically selling Federal coal far below its market value has also had a damaging effect on employment. Most Federally-leased coal is surface mined. Selling it below its market price displaces coal from the privately-held underground mines of Appalachia and Illinois. In the process, it substantially reduces overall employment in the coal mining industry. Mining coal underground in Appalachia is labor intensive, while surface mining is capital intensive. Coal strip mined in the Powder River Basin supports one-tenth as many jobs as the same quantity of coal mined underground in Appalachia, and one-fifth as many jobs as the same quantity of coal mined in the Illinois Basin.

Selling Federal coal below market also encourages the domestic American economy to delay its urgently-needed transition from polluting, climate-disrupting fossil fuels to clean sources of electric power.[3] These economically- and socially-damaging effects of selling Federal coal below its market value have revived the need for a fourth moratorium on the leasing of Federal coal. During that moratorium, another high-level review and overhaul of the Federal coal-leasing program should be conducted.

As far as electric power in the United States is concerned, coal is still king, providing one-third of our country's electricity, and the Powder River Basin (PRB) is the king of coal. The PRB, located in eastern Wyoming and Montana, accounts for 42 percent of U.S. coal production. The Federal government owns 80% PRB coal reserves. There are only 16 active mines in the PRB, worked by only 7 mining companies, but these mines are gigantic--each one sufficient by itself to turn rolling prairie into moonscapes. Together, they produce 500 million tons of coal each year fueling 200 power plants in 35 states. PRB-fueled power plants are responsible for 14% of the nation's total carbon emissions.

In his 2015 State of the Union address, President Obama addressed the problem of climate change head on. According to the President

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[2] Federal coal revenue is split 50/50 with the state of origin under the Mineral Leasing Act.

[3] The Federal court ruling halting the leasing of Federal coal in Colorado in June of this year rests, in part, on a finding that increasing the quantity of cheap Federal coal available to the energy market shifts domestic demand away from low-carbon sources of energy. See Restraining Order issued June 27, 2014, in High Country Conservation Advocates vs. U.S. Forest Service, Civil Action No. 13-cv-01723-RBJ (Federal District Court, Colorado) at 30.

> No challenge--no challenge--poses a greater threat to future generations than climate change.
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> 2014 was the planet's warmest year on record . . . Now, one year doesn't make a trend, but this does: 14 of the 15 warmest years on record have all fallen in the first 15 years of this century.
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> Our activities are changing the climate, and if we do not act forcefully, we'll continue to see rising oceans, longer, hotter heat waves, dangerous droughts and floods, and massive disruptions that can trigger greater migration, conflict, and hunger around the globe.
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> That's why, over the past six years, we've done more than ever before to combat climate change, from the way we produce energy, to the way we use it. That's why I will not let this Congress endanger the health of our children by turning back the clock on our efforts. I am determined to make sure American leadership drives international action.
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> In Beijing, we made an historic announcement: the United States will double the pace at which we cut carbon pollution, and China committed, for the first time, to limiting their emissions. And because the world's two largest economies came together, other nations are now stepping up, and offering hope that, this year, the world will finally reach an agreement to protect the one planet we've got.

These are laudable sentiments from our nation's leader, and they are long overdue. But while he vows not to let Congress "endanger the health of our children by turning the clock back on [the Administration's] efforts," he seems to be content to let his own employees in the Bureau of Land Management do precisely that.

III. THE SOCIAL COST OF BURNING POWDER RIVER BASIN COAL

According to the BLM, every ton of PRB coal burned yields 1.7 metric tons of CO_2. Under the Obama administration's first seven years, the Bureau of Land Management leased 2.2 billion tons of publicly owned coal, unlocking 3.9 billion metric tons of carbon pollution. This is equivalent to the annual emissions of over 825 million passenger vehicles, and more than the 3.7 billion tons that was emitted in the entire European Union in 2012. Each ton of publicly-owned coal leased during the Obama administration, when burned, will cause economic damage estimated at between $22 and $237, using the

Department of Environmental Quality's own estimates of the social cost of carbon. Yet the average price charged by the Federal government per ton for that coal was a mere $1.03.

The carbon pollution from publicly owned coal leased during the Obama administration will cause damages estimated at between $52 billion and $530 billion, using the federal government's own methodology for estimating the social cost of carbon. In contrast, the total amount of Federal revenue generated from those coal leases sales was $2.3 billion.

Despite the link between Powder River Basin coal and climate disruption, the Department of Interior as recently as 2015 had been pushing to greatly expand the use of this resource. When the coal leasing moratorium was adopted, the BLM was in the process of issuing 16 new coal leases in the PBR containing 10.2 billion tons of coal. If these plans had been implemented, they would have injected 16.9 billion additional metric tons of CO_2 into the atmosphere. This would have made the climate-disrupting impact of building the Keystone Pipeline, which the President vetoed because of its potential to disrupt the earth's climate, would have looked trivial in comparison. Considering how PRB coal dominates the domestic market, it is clear that America's overall contribution to the heating of the earth's climate won't be brought under control unless its PRB resource is managed in a way that contributes to the solution.

Nationwide, the value of Federal coal to a domestic power plant averages $35 a ton. For this, the Federal government collects a little over $2. It is obvious on its face that this is a giveaway of a vast public endowment--a "rip off" of the American taxpayer, in street parlance. What isn't obvious are the broken bureaucratic procedures that make this monumental giveaway possible. This PEIS invites the public to comment on how those procedures could be fixed. Before UPHE comments on how they can be fixed, we first attempt to identify exactly how they are broken.

IV. FLAWS IN THE CURRENT COAL LEASING SYSTEM

Proper management of PRB coal leasing has proved elusive. Until the 1960s, private mines in Appalachia supplied most of the nation's coal. As noted, in the 1960s and 70s, Federal coal leasing expanded, but was primarily motivated by speculation, since little actual mining occurred. This prompted the reforms of the Federal Coal Leasing Amendments Act (FCLAA) which required that coal lease auctions be competitive, that fair market value (FMV) be the bidding floor, that 12.5% of FMV be the royalty floor, and that any lease awarded has to be actively worked.

A. The Consequences of Decertification

A key feature of the reforms called for by the FCLAA was the establishment of Coal Production Regions (CPRs). The purpose was to ensure that coal leasing would follow a plan that takes into account the regional impacts of leases on the market for fossil fuels, on affected communities, and on the environment. Public hearings in the region were to be held by the Secretary prior to the lease sale. Within each region, leasing was to be administered by a Regional Coal Team (RCT) made up of BLM officials who oversee BLM lands in each of the various states in the region, a representative of the Governor of each of the those states, and the Director of the BLM. This RCT was supposed to "guide" all phases of the competitive leasing planning process, including identifying leasing areas, recommending leasing levels to the Secretary, issuing calls for expressions of leasing interest, making preliminary tract delineations, giving each tract a regional ranking, making final tract selection, conducting the environmental analysis, and scheduling the sales.

The reforms of the FCLAA were abandoned before they were ever fully implemented, and the integrity that they were designed to bring to the coal leasing process never materialized. All of these reforms hinged on the establishment of Coal Production Regions. The regulations define "producing" as actually severing coal from the ground. A lease is considered to be "producing" if the operator/lessee is processing or loading severed coal, or transporting it from the point of severance to the point of sale.

Despite a definition of this simplicity and clarity, the Powder River RCT, in 1987, recommended that the Powder River Coal Production Region be abolished ("decertified") on the ground that no coal was being "produced" there. The RCT also recommended that it (the RCT) should continue to exist after decertification to award leases under the Lease-By-Application (LBA) process. Rather than a regional planning process that seeks to balance all of the impacts of coal leasing, LBA is an ad hoc process that responds to requests for leases that are drawn up by private companies to meet their perceived needs. Under LBA, environmental impacts need only be evaluated for an individual lease, not the leasing activity of the PRB as a whole.

The Powder River RCT's rationale for decertification was that the PRB had "matured," that demand for new leases was weak, and that going forward private operators would only be interested in "maintenance leases"—leases that are at the rim of existing strip mines and are needed to allow outward expansion of the existing mine. The RCT, therefore, proposed that only maintenance tracts would be leased under the LBA system, and that requests for new mines or broader leasing would be considered by the RCT on a case by case basis. It asserted that "most industry interests could be accommodated [by the LBA process]" and "widespread leasing would not be necessary."

The BLM Director at the time this "reform" happened was Cy Jamison. He approved all of the recommendations of the Powder River Basin RCT. Shortly thereafter, Secretary of the Interior Manual Lujan, Jr., declared that there were no coal production regions anywhere in America. With this gambit, the Bush I Administration effectively gutted the reforms contained in the FCLAA. And that is where the BLM is today—managing a coal resource of staggering importance to the national and international coal market by an ad hoc process that is expressly designed to "accommodate . . . most industry interests," rather than protect the public interest, as the Mineral Leasing Act and the aborted reforms of the Federal Coal Leasing Amendments Act envisioned.

In the years immediately following the decertification of the PRB as a Coal Production Region, production surged.[4] This surge completely discredits the official rationale for pretending that the Powder River Basin was not a Coal Producing Region. As the conservative watchdog organization Taxpayers for Common Sense describes the BLM's decision "even the huge and valuable PRB Region was decertified in this Alice in Wonderland scenario–even though that Region currently provides 42 percent of the coal used for electricity in the United States, and is the source of 83 percent of total federal coal production." See *Federal Coal Leasing: Fair Market Value and a Fair Return for the American Taxpayer*, Taxpayers for Common Sense, September 18, 2013, [Taxpayers for Common Sense] published on line at http://www.taxpayer.net/library/article/federal-coal-leasing-fair-market-value-and-a-fair-return-for-the-american-t.

B. Avoidance of Competition in the Current PRB Leasing Process

To understand why competition is largely avoided by the current approach to coal leasing in the PRB, some insight is needed into the nature of competition in that market. PRB coal is classified as "sub-bituminous" and contains about two-thirds of the energy content of Appalachian "bituminous" coal. The Powder River Basin was also remote from most major markets for thermal coal. For those reasons, it was essentially worthless until 1990. That is the year that the EPA set limits on SO_2 and NO_x emissions from coal-fired power plants under the Clean Air Act in an effort to reduce acid rain. Because PRB coal is very low in sulfur (and ash), demand by eastern coal-fired power plants for PRB coal soared.

The PRB is the largest coal mining region in the United States. Much of the coal lies close enough to the surface to be strip mined using massive drag lines and loaded into gigantic trucks—a technology that requires very little labor and makes it much

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[4] In 1983, before decertification, the PRB coal region produced 151 million tons of coal. This jumped to 275 million tons in 1993. As noted, the region now produces 500 million tons of coal each year.

cheaper to mine than Appalachian coal, most of which lies deep underground. Geologically, PRB coal beds are inverted, elongated bowls with a north-south orientation. As mines expand from east to west, they go “down the sides of the bowl”—meaning that the layer of overburden increases as the mine expands outward. Large-scale strip mines are expensive to establish and permit. Consequently, they are generally sited near the highest quality, most easily accessed coal, then expanded from there through the leasing of “maintenance tracts.”

As noted, the PRB has only 16 active coal mines operated by just seven companies. Each member of this small pool of bidders is generally only interested in the coal adjacent to its existing mines. When another mining company nominates an individual tract for lease that is adjacent to its own mine, there is little incentive for a different mining company to bid on that tract.

The statutory process that the BLM was supposed to follow to establish leasing levels was designed to foster competitive bidding, involve extensive public participation, and entail a balancing of the wide ranging impacts of exploiting the coal resource, including competing uses of the public lands, current market conditions, and expected future market conditions.

Since decertification, individual coal companies have decided what tracts they want to lease and under what circumstances, rather than follow a regional leasing plan where the Secretary of the Interior controls the process. This has forestalled potential competition, removed what would have been BLM’s obligation to evaluate environmental impacts above the level of individual leases, and ended effective oversight by either the DOI or the affected public.

The BLM maintains that it does not simply accept a tract for leasing as it is described in a mining company’s application. Instead, it claims to use

> “… a wide variety of information, including geologic data that delineates the location, quality, and quantity of coal within a given area, to determine the most appropriate tract configuration that would encourage competition and help achieve maximum economic recovery of the resource.”

The evidence, however, shows that instead of deciding whether there is sufficient demand for coal and designing tracts to maximize competition, the BLM defers to the mining companies, who—not surprisingly--design tracts to avoid competition. A report by mining consultant John T. Boyd Company that was prepared for XCEL Energy describes the current system this way:[5]

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[5] Cited in Taxpayers for Common Sense, referenced above.

As a practical matter, most companies will attempt to define LBA tracts that, because of location or geometry, are of interest only to the nominating company. This minimizes competitive bidding on the tract, and may result in a lower cost lease. Where competition has existed for coal (mostly in the southern Gillette area but recently in the central portion of the coalfield) relatively high bonus bids in the range of $0.90 –$1.10/ton have resulted. BLM has, even in non-competitive cases, required “Fair Market Value” bids in this range, particularly in the Southern PRB.

C. The Lease by Application (LBA) Procedure Discourages Competitive Pricing of Coal Leases and Underestimates their Fair Market Value

Decertification sidesteps the competitive system mandated by the FCLAA by eliminating the first step on which all the other procedures depend—drawing up a regional leasing plan. This makes the ad hoc LBA system the only system. Under the LBA system, the BLM does not set the level of coal that it leases by taking into account changes in the market, such as the recent decline in domestic demand for coal brought about by the dramatic decline in the price of domestic natural gas, and the increase in the profitability of coal exports. Instead, it receives a request for a lease tract containing the amount of coal desired by the requester. It determines a fair market value floor for the tract currently being requested by identifying the most recent comparable lease and treating the sale price of that lease as a proxy.

The problem with this approach is that the most recent comparable tract that was leased is typically one that was tailored by the bidder to suit its own interests. That sale price, therefore, typically reflects the unsuitability of that tract for any other buyer. The fair market value of a lease determined in this artificial manner is typically a fraction of what the same coal would be worth if it were mined outside of the Powder River Basin. “Fair market value” determined with this downward bias sets the floor for evaluating the acceptability of bids. It therefore imparts a downward bias to the price ultimately paid for leases. The artificially-reduced lease price, in turn, lowers the price that the mining company charges to sell its leased coal to a broker. This reduces the amount of royalties collected, because royalties are calculated as a percentage of the price at which the mining company sells its coal to a broker. Using the price of a lease designed to be non-competitive as a proxy for the fair market value of the subsequent lease results in a rolling sequence of under-market valuations that shortchanges Federal and state governments and the public that they represent.

As noted, the LBA system allows mining companies to take the initiative in delineating tracts for leasing.[6] It is in the company's interest to delineate tracks in a way that avoids competitive bidding because it lowers the price that it pays for the lease. For this reason, a mining company typically nominates one tract for lease from the BLM at a time. The nominated tract typically borders its own existing strip mine and is far from the operations of other mining companies.

The company that nominates a tract for lease has often already built the needed roads and rail spurs to access the tract and transport its coal. Such a tract has little appeal to any other company.[7] This explains why, according to the DOI's Inspector General:

> over 80 percent of the sales for coal leases in the PRB received only one bid in the past 20 years. No coal lease has had more than two bidders on a sale….This lack of competition also applies to the coal producing regions in other States.

Office of the Inspector General, U.S. Department of the Interior, *Coal Management Program, U.S. Department of the Interior*, Report No. CV-EV-BLM-0001-2012, June, 2013 [I.G. Report], at 8. Although it recognizes the general lack of competition in the leasing process, the IG does not offer specific recommendations as to how leases could be made more competitive. Recent investigations by Congress and the GAO have also criticized the lack of meaningful competition in coal leasing in the PRB, but they, too, do not make specific recommendations as to how leasing could be made more competitive.

Even though PRB mining companies are generally interested only in leases that expand the borders of their own existing mines, it should still be possible to design tracts that are attractive to at least two bidders. As mines expand, for example, they begin to encroach upon each other, which increases potential competition. In these instances, competition is reflected in the size of bonus payments offered for the right to bid on the lease. Where this occurs, sales could provide reasonable proxies for determining the fair market value of other leases containing coal of comparable quality and amounts. See Taxpayers for Common Sense, cited above.

UPHE agrees with Taxpayers for Common Sense that a resource as important as the PRB should not continue to be disposed of through sequential, single-bid, limited-

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[6] Allowing coal companies to take the lead on delineating tracts as a general rule has the potential to set up a vicious cycle: offering tracts of limited interest results in sales with limited numbers of bidders, which in turn justifies the avoidance of the competitive system.

[7] This role of companies in delineating tracts of interest only to themselves seems to conflict with the MLA, under which the opportunity for applicants to request a lease sale applies only to putting a tract up for sale, not to the delineation of tracts that will be offered for sale.

interest tracks at far below their fair market value. Instead, the BLM should wait for times of adequate market demand to offer new leases and then aggregate a sufficient number of adjacent tracts to attract multiple bids from the incumbent mining companies, or even bids by new entrants to the PRB market. To encourage aggressive bidding, the BLM should experiment with specifying in the lease offer that only a certain percentage of tracts attracting the highest bids above the fair market value of the coal will be sold. Of course, these specific reforms should be instituted in the context of recertifying the Powder River Basin (and other Federal coal leasing areas, where justified) as an official Coal Producing Region in which regional planning that takes market conditions and environmental impacts into account is the first step in the leasing process.

D. Ignoring PRB Coal's Export Potential Underestimates Fair Market Value

As recently as 2015, the low-sulfur coal from the PRB could be sold for $70 dollars a short ton and up in South Asia markets. The same coal sold for under $16 a short ton domestically. Not surprisingly, exports of PRB coal to South Asia have recently doubled. Coal companies are well aware of the growing demand for thermal coal in South Asia and are trying to build shipping terminals in the Pacific Northwest that will be capable of handling large volumes of exported PRB coal. Permits for five new port facilities in the Pacific Northwest have been applied for that would be able to handle 170 million tons of PRB coal per year.[8] While it costs more to transport coal to China from the United States than it does to transport it from Australia or Indonesia, the subsidized mine-mouth price of PRB coal is so much lower than the price at which competing Asian suppliers can acquire coal that PRB coal can still be sold to China for less.

Taking into account transportation costs and other fees and charges, the mine-mouth price of PRB coal could be as high as $53.93 per ton--a fourfold increase from the current price—and still be competitive with benchmark delivery prices in China and various other Asian markets. While international coal prices have declined in recent years, the completion of ports along the American West Coast would still make PRB coal exports viable at all but the lowest recent prices of coal in southern China. See Center for American Progress, *5 Things You Should Know about Powder River Basin Coal Exports*, August 18, 2014, available at http://www.scribd.com/doc/237152057/5-Things-You-Should-Know-About-Powder-River-Basin-Coal-Exports.

[8] Economists Thomas M. Power and Donovan S. Power estimate that with this new infrastructure in place, the projected delivery cost of PRB coal to China will be approximately $77.16 per ton. (Power,M., et al, 2013 at 22.) The price of thermal coal shipped to the industrial southeastern region of China has fluctuated between roughly $70 and $135 per ton over the last five years. Id. at 20, Table 1.

The reports by both the Inspector General, and the GAO note the recent rise in exports of PRB coal to Asia and its growth potential. Both reports have concluded that in making fair market value determinations, it is essential that the BLM consider not just the domestic demand for thermal coal (which is currently flat, due to the competition of low-priced domestic natural gas), but the robust demand and the substantially higher prices that can be obtained for PRB coal sold in the Asian market. (GAO Report, 2013 at 7; IG Report at 7.) UPHE agrees that legitimate assessments of the fair market value of 20-year leases of PRB coal cannot be made without factoring in the dominant factor that will drive future demand—the potential for export, and the growth of that potential, that can be expected over the life of such leases.

E. Playing the Affiliate Shell Game Drives Revenues from Coal Royalties Far Below the Statutorily-Required Level

In a competitive marketplace, a product's market value is the maximum price that the consumer of the product is willing to pay. The consumer of thermal coal is the electric power plant. Therefore, the true market value of thermal coal is the price that the power plant is willing to pay. The applicable statutes require that the royalty for surface-mined coal be 12.5% of the true market price. BLM and the mining companies have collaborated in the development of a convoluted leasing procedure that gives BLM officials multiple opportunities to reduce the effective royalty rate well below its true market price. This system subsidizes the production of PRB coal at the taxpayer's expense.

BLM officials reduce effective royalties below the statutory rate in three ways:

1) The BLM applies royalties to the price that the mining company receives from the first sale of its coal to another entity. It calls this the "first arms-length transaction" and presumes that it is the true market price. If the first sale is to the mining company's own affiliate/subsidiary, the BLM still treats such a "sale" as having occurred at the true market price if its Office of Natural Resource Revenue (ONNR) finds that the price is the same as it would have been if the sale had been at arm's length. The first "sale" is often made at the mine-mouth to the mining company's own affiliate, rather to a power plant or other end user, such as a broker that exports the coal. In most cases, there is no economic or business reason to record a sale before the coal reaches the power plant, except to reduce the nominal price of the first "sale" in order to avoid paying the full royalty amount that would have been owed if the sale had been recorded when it was delivered to the end user (the power plant).

2) The BLM can reduce the royalty rate to as low as 2 percent of the sale price if a mine becomes unprofitable due to unfavorable conditions—such as limited access to coal or a decrease in its quality.

3) Mining companies can deduct transportation and washing costs from the sale price before applying the royalty. This translates into an allowance for the full cost of transporting federal coal from the mine mouth to a remote point of sale or to transport the coal to a distant wash plant.

According to the National Mining Association, "Changes to the existing regulations are not justified as there have been no significant market changes in the last 25 years and markets are even more transparent." Over that time, however, PRB has been transformed from a minor player to become the nation's largest supplier of thermal coal.

As the PRB's share of the market has grown, the system used to market its coal has changed. Over the last ten years, the affiliate shell game has become standard operating procedure, as each of the coal companies operating in the PRB has built an extensive network of captive affiliates through which it sells and distributes its coal. The trend toward captive transactions took off in 2004, rising 105 percent in just one year. According to data from the U.S. Energy Information Administration, Wyoming PRB coal sold through such "captive transactions" went from 4% in 2004 to 42% in 2012.

After reviewing corporate documents from five of the biggest coal companies operating in the PRB, the Center for American Progress found that since 2004, each of these five mining companies together have set up more than 500 captive affiliates. See https://www.americanprogress.org/issues/green/report/2015/01/06/103880/cutting--and-closing-loopholes-in-the-u-s-department-of-the-interiors-coal-program/. [CAP--Closing Loopholes]. The five PRB mining companies reviewed and the number of their affiliates are:

Peabody Energy -- 141 domestic subsidiaries and 101 foreign subsidiaries

Alpha Natural Resources -- 184 domestic and foreign subsidiaries

Arch Coal -- 83 domestic and foreign subsidiaries

Cloud Peak Energy -- 31 domestic subsidiaries

Ambre Energy -- 26 domestic and foreign subsidiaries

Selling coal to captive affiliates has not changed how PRB coal is mined or the markets into which it is sold. It has simply reduced royalties below what the mining company would pay if its first "sale" were a true sale, rather than a shell transaction between the mining company and itself. The shell game has this effect on coal royalties because the ONRR personnel tasked with determining whether a captive transaction was based on an arm's-length price must make that determination based on complex formulas employing an array of alternative benchmarks, each of which is an imperfect market proxy that is subjectively chosen and is easily manipulated.[9] As a result, in captive transactions, ONRR often ends up basing royalties on prices that are well below the true market price of the coal.

Mining companies' financial filings reveal that sales to captive affiliates masquerading as arm's length transactions to reduce Federal royalty payments has become an important factor in mining companies' profitability. For example, in its 10K filed in 2013 with the Securities and Exchange Commission, Cloud Peak energy says:

> If the federal government were to materially alter the method for valuing royalty payments for our non-arms' length sales, our profitability and cash flows could be materially adversely affected.

Shell transactions with affiliates are also used by PRB coal companies when selling coal to foreign buyers. A Reuters investigation in 2012 noted that PRB coal sells for an average of $13 per ton domestically, but sells for up to 10 times that price in Asian markets. Because royalties currently are applied to "sales" to captive affiliates at $13 a ton at the mine mouth, and later sold to Asian customers at up to 10 times that price, some PRB coal companies can make four times as much profit when they sell to Asian markets than if they sell the same coal domestically, despite the high cost of transporting coal to Asia. See investigations.nbcnews.com/_news/2012/12/04/15676862-asia-coal-export-boom-brings-no-bonus-for-taxpayers.

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[9] In determining the value of the coal to which royalties will be applied, the ONRR's analyst chooses from five alternative benchmarks. These include using comparable sales, the income approach, and "netback pricing." Netback pricing starts with a price charged downstream (typically the sale by the marketing affiliate) and deducts eligible costs. The ONRR's process of determining if a sale is an arm's-length sale or not, and determining whether the contract price reported to the agency is fair when no market transactions exist, is unwieldy and costly to administer, and provides a loophole that can be used to minimize the amount of royalties owed. (Headwaters Economics, 2015, at 9.)

In 2011, the affiliate shell game caused Michael Geesey, director of the Wyoming Department of Audit, to tell the ONRR that non-arm's-length coal lease transactions are "highly susceptible to manipulation," and to ask ONRR to change current regulations to prevent coal company sales to "affiliates, partners, marketing agents, and trade and export associations" from qualifying as arm's-length transactions. Republican and Democratic members of Congress and independent reviewers also have asked that this loophole be closed.

The Extractive Industries Transparency Initiative (EITI) is a global initiative to improve the transparency of how governments manage the revenues obtained from the exploitation of their natural resources. President Obama has stated that the United States joined the EITI to ensure that "industries, governments and civil society, all work together for greater transparency so that taxpayers receive every dollar they're due from the extraction of natural resources." The ONRR's willingness to base its assessment of royalties on captive sales of coal, and applying allowances for washing and transportation before royalties are assessed, must end if the U.S. is to comply with EITI.

Extensive reliance on shell transactions with affiliates, and allowing transportation, washing, and similar preparation costs to be deducted from sale prices before calculating royalties are at odds with international commercial norms. Pacific markets, such as Indonesia and Australia, do not allow many of the subsidies currently in place under the U.S. system. For example, the Center for American Progress reports that Indonesia bases royalties for exported coal on the true market value of the coal received at the export terminal, which is a price determined from the benchmark price or actual sales price, whichever is higher. Further, Indonesia does not allow transportation costs to be deducted from the price of coal upon which a royalty is levied. Likewise, states in Australia do not allow transportation deductions for domestic shipments of coal. (CAP-Closing Loopholes.)

F. The DOI's Current Approach to Coal Leasing Needs Broader Procedural Reforms than Those in the Proposed Rule.

The ONRR has proposed reforms that consist of closing the captive transaction loophole. In making this change, ONRR would treat the price of the first arm's length sale as the true market price of coal, but after transportation and other eligible costs are

deducted. However, that partial reform would still allow non-affiliated brokers to an important role in the PRB coal market. In those instances, the rulemaking would do little to bring royalties up to 12.5% of the true (gross) market price required by the Federal Coal Leasing Act Amendments. To the extent that severed coal needs to be washed and transported to the end-user, these disadvantageous economic characteristics are reflected in the price of the lease by which the mining company obtains the coal in the first place. To use those very same factors to artificially deflate the market value of that severed coal (the value that the end user places on it) before applying the royalty is to credit the mining company twice for the same disadvantageous economic characteristics of the leased coal.

An analogous situation would be a Washington D.C. resident who just totaled his truck and has to replace it. Aware that truck prices are lower in West Virginia, he calls a Ford dealer in Charles Town and asks if he has a 2010-model F150, and, if so, to quote a price. The salesman says the only one he has will soon need a new engine and a new transmission. The customer says "Suppose I pay the Bluebook price, less the cost of overhauling the engine and the transmission--and bus fare from D.C. so I can come pick it up." The salesman agrees. But when the customer gets to Charles Town, he says "I think you should pay me to overhaul the engine and the transmission, and my bus fare from D.C." The salesman says "I already reduced the sale price to reflect those things." But, because he once worked for BLM, the salesman says "I'll tell you what I'll do. Before I calculate your sales tax, I will deduct the cost of overhauling the engine, overhauling the transmission, and bus fare from D.C. from the price of the truck." The customer drives back to D.C. in his Ford F150, congratulating himself on his negotiating skills. To reform royalty assessments by ending the practice of basing royalties on captive transactions, but continue to deduct washing and transportation costs before assessing the royalty would be to allow royalties on Federally leased coal to be calculated the same way that the Ford dealer in this scenario calculated sales tax.

The role of brokers must change. As Headwaters Economics notes in its whitepaper, the rise of the Powder River Basin (PRB) as the largest supplier of the nation's coal has dramatically increased the role of affiliate and non-affiliate brokers. Its mines are huge and are far from most energy markets so that most of the coal must be shipped by rail to end users. This creates an opportunity for midstream exchanges through brokers. PRB coal is typically sold (and valued) when it is loaded into trains at the mine. Brokers buy coal from these massive mines, and seek out the highest market price. The current regulatory structure bases royalties on the price of the first sale, whether it occurs at the mine mouth or at the doorstep of a distant end user. If the first sale occurs at the mine mouth, the sale price can be far below the price at which coal is sold to end users, such as power plants on the East Coast or in South Asia. If the first

sale occurs at the mine mouth, the lease yields much lower royalty collections than if it occurs at the doorstep of a distant end user. (Headwaters Economics, at 10.)

This approach to royalty valuation does not provide a fair return on Federal coal. This approach results in large Federal subsidies of coal lease holders and their customers because it yields royalty collections that are far below the 12.5% of true market value that is required by statute. To end the subsidies that have evolved under the BLM's current leasing approach, *it is essential to apply the Federal royalty at the final point of sale to an end user for both domestic and export sales.* Otherwise, non-affiliated brokers in the PRB market will still be able to buy coal at the mine mouth at a discounted price that reflects the low royalty payment made by the mining company. Such brokers would still enjoy a cost advantage over a mine that sells its coal directly to an end user and pays royalties on the full price of the sale to the end user. Federal and state royalties avoided are the primary source of the broker's profit and is the broker's primary reason for being. To capture these profits, mining companies in the PRB have established elaborate networks of affiliated brokers.

Transparency would end the need to rely on proxies and benchmarks to calculate "fair market value." Currently, the Energy Information Agency publicly provides information showing the final sales price for Federal coal. ONRR auditors could use this information to calculate and verify royalty obligations. This would eliminate the need for ONRR analysts to estimate a true market price through subjective analysis of proxies and benchmarks that are inherently inaccurate. Relying on the price of the final sale is the only straightforward and transparent way to determine the true market price at which mining companies sell their coal. This straightforward reform would make the administratively burdensome and inherently unreliable royalty assessments that ONRR currently makes unnecessary. It would also make it more likely that DOI will actually collect the 12.5% royalty on the true market value of coal that the law requires.

Fair Market Value should be the final price paid by the end user, particularly for exported coal. Basing the calculation of royalties on the final price to the end user would have its most beneficial effect if applied to exports of PRB coal to Asia because that is where the price paid by the end user (between $70 and $135 per ton) can be as much as ten times the mine-mouth price ($13 per ton).

The room for extremely high profit margins on PRB coal exported to Asia that is created by the current rules allowing the sale price to be determined at the mine mouth is reflected on the balance sheets of the PRB mining companies. For example, less than 5 percent of Cloud Peak's coal was shipped to Asia last year, but that accounted for nearly 19 percent of its total revenue--about $290 million. A year earlier, Cloud Peak's Asian sales were only 3.4 percent of the total volume but 12 percent of revenue. See http://

investigations.nbcnews.com/_news/2012/12/04/15676862-asia-coal-export-boom-brings-no-bonus-for-us-taxpayers.

Sometimes, PRB mining companies don't even try to defend the logic behind the rule that allows the sale price of PRB coal to be determined at the mine mouth. They simply assert the rules are what they are, and they are just following them.[10] Ending the practice of allowing sales to be recognized as occurring at the mine mouth could increase royalties on exports by from four- to eight-fold.

There is precedent in the leasing of other Federal mineral resources for treating overseas values as the relevant values for purposes of calculating royalties. In the late 1970s, Marathon Petroleum Corp used an accounting system in which it valued natural gas at the well head in Alaska, rather than its value delivered to the customer in Japan. A federal court held that Marathon was obligated to pay royalties on the overseas value. Marathon was assessed a $10 million fine for not doing so. According to Peter Appel, a professor at the University of Georgia School Of Law who prosecuted cases for the DOJ's Environment and Natural Resources Division, the Marathon Oil precedent "should give officials confidence to take a hard look at coal sales." Quoted at http://investigations.nbcnews.com/_news/2012/12/04/15676862-asia-coal-export-boom-brings-no-bonus-for-us-taxpayers.

The PRB mining companies are now laying the groundwork for massive coal exports to Asia to take advantage of the huge subsidy of PRB coal taking place under the current Federal coal leasing program. If DOI does not take steps to eliminate that subsidy, the consequence will be additional CO_2 emissions in Asia that more than offset all the emission reductions that the Obama Administration's Clean Power Plan is struggling to achieve domestically. It will not only doom the Obama Administration's climate mitigation goals within the United States to failure, but could undo commitments made by 190 nations at the Paris climate summit last December to mitigate climate change.

In a 2013 report prepared for The Energy Foundation, Professor Emeritus Thomas Power concludes that the five new coal export facilities that PRB mining companies are seeking to build in the Northwest will result in more coal consumption in Asia and undermine China's progress towards more efficient power generation and usage. Specifically, he models the effect of annually exporting 140 million tons of PRB coal to the

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[10] According to Karla Kimrey, spokeswomen for Cloud Peak Coal, "In my neighborhood, I don't stop at every block. I could. But that's not where the stop signs are. You can say you don't like the regulations, but we play by the rules." http://investigations.nbcnews.com/_news/2012/12/04/15676862-asia-coal-export-boom-brings-no-bonus-for-us-taxpayers.

south coast of China, as PRB mining companies anticipate. He notes that China currently consumes about 660 million tons of coal delivered by ship.

Taking into account the sensitivity of both demand[11] and supply to price, he finds that these exports would lower the delivered cost of coal by about 12 percent and ultimately lead coal consumption to increase by about 15 percent. As a result, he estimates, China's coal consumption would rise by 98 million tons. That is, about 70 percent of the PRB coal exports would represent net additional coal consumption and GHG emissions. Only 30 percent of the PRB exports were estimated to displace other sources of coal. The 98-million-ton increase in annual coal consumption would emit about 183 million tons of CO_2. (Power, T.M., 2013, at 3-4).

Dr. Power warns that the decisions that the Northwest coastal communities and the BLM make now will impact Chinese energy habits for the next half-century. The below-market export prices that current Federal coal leasing rules make possible will encourage China and India to choose coal over renewable energy options that otherwise would be price competitive, and will retard the investments in energy efficiency that China has already planned.

The damage from exporting this amount of subsidized coal to Asia would go beyond encouraging more coal consumption in that region which is struggling to respond to an air pollution crisis. As the world's top emitting countries, efforts by the United States and China to reduce carbon pollution are watched closely by other countries. If the United States government does nothing to stop the current plans of the PRB mining companies to ship massive quantities of publicly-owned coal to Asia at drastically subsidized prices, it will signal to the rest of the world that the United States' efforts to mitigate climate change are hypocritical, as the United States suppresses coal burning at home while it promotes it abroad.

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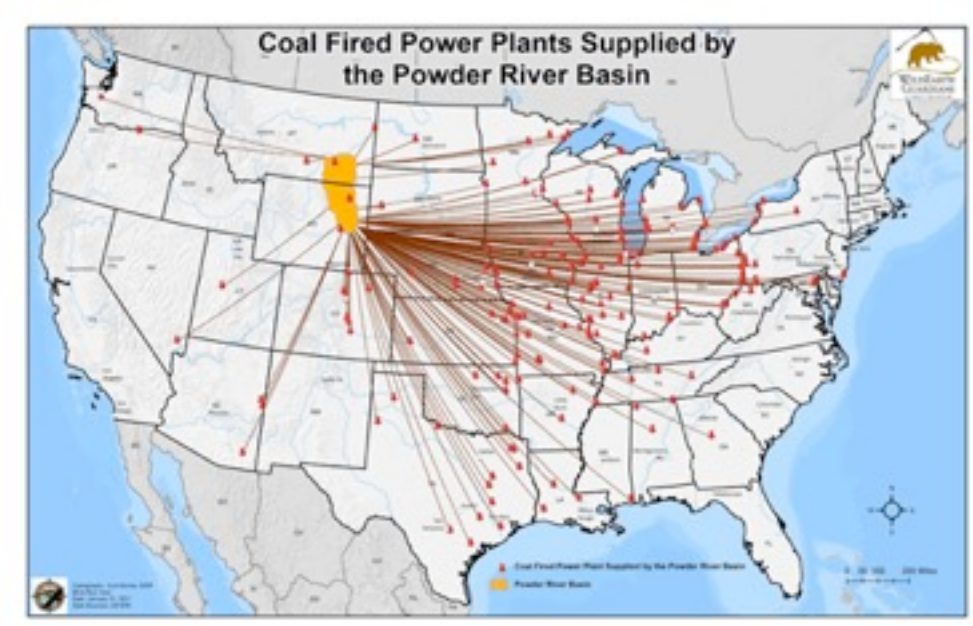
[11] Dr. Power asserts that demand for coal in China is price elastic (meaning that lowering its price by 1% will cause an increase in the amount of coal purchased by more than 1%). He bases that assertion primarily on a model of that demand over a period that ended in 2006. There are other academicians that conclude China's demand for coal is price inelastic (meaning that a 1% reduction in price will cause less than a 1% reduction in the amount of coal purchased). Those academicians reason that China has made such a large investment in coal-fired power plants that it is not in a position to substitute other sources of power for coal, based on price. The conclusion that China's demand for coal is price inelastic appears to have been made obsolete by the agreement signed last fall by China with the Obama Administration to 1) reach peak coal use by 2020, 2) reach peak CO_2 emissions by 2030, and 3) build out renewable energy to 20% of total energy output by 2030. Taken together, these recent public commitments by China show a political resolve to rapidly shift its energy mix toward renewables beginning immediately. This implies that for additions to its energy capacity, China will be evaluating the tradeoff between coal and renewables based, in large part, on price. It is already experimenting with regional cap and trade systems and with taxes on carbon—both of which should engender a sensitivity of coal demand to the relative price of alternative forms of energy. . Recent econometric studies strongly suggest that the Chinese consumer will be highly responsive to price in deciding how much electric power to purchase. (Shi, G., et al., 2012.)

G. Measuring the Extent of the Domestic Subsidy of PRB Coal

As can be seen from the map below, PRB coal has become the primary source of fuel for the power plants of the Mid-West and the Ohio Valley.



The value of a short ton of PRB coal to these power plants averages $35. For this, the Federal government collects a little over $1. As noted at the beginning of these comments, the current Federal leasing program transfers this vast resource into private hands practically for free. This constitutes a squandering of a vast public endowment. It has a number of detrimental effects to our society in terms of damage to the health of the residents of these regions, to the environment, and to the President's efforts to mitigate climate change. In this section, we describe how the amount of the subsidy can be measured in relation to the minimum royalty rates that are prescribed by statute.[12]

In its white paper, Headwaters Economics estimates the size of the government subsidy of PBR mining companies and their customers that has evolved under the BLM's current leasing system. To make its estimate, Headwaters distinguishes between the royalty rate that is required by statute, the rate that the mining company reports, and the "effective" rate. The mineral leasing statutes establish 12.5% of the gross market value of

[12] In a later section, we discuss whether limiting royalty rates on Federal coal to the statutory minimum leads to an optimum allocation of the nation's coal resource in light of the extensive harm that burning coal causes to the health of the nation's people and its environment.

coal as the royalty floor for surface mines. Headwaters defines the “reported” royalty rate as royalties paid divided by the contract price that the lessee reports for its first arm’s-length sale (the “mine price”). Headwaters defines the “effective royalty rate” as total royalties paid divided by the market price at which Federal coal is ultimately sold to the end user.

Headwaters quotes from the literature of natural resource economics[13] that, as a measure of value received by the government, it is the effective tax (or royalty) rate that matters, not the nominal rate. The effective rate takes into account all incentives, deductions, and valuation policies.

Headwaters quantifies total revenue collections by the Federal government under three reform scenarios: 1) the current leasing system with administrative reforms only, 2) the system reformed as ONAA proposes, and 3) a system that calculates collections based on the gross market value of the coal (the effective royalty rate). As inputs, the Headwaters analysis uses actual sales of Federally-sourced coal and actual royalty collections nationwide between 2008 and 2012.

On the left side of the table below, Headwaters estimates total royalties collected for Federal leased coal under the BLM’s current leasing system over the period 2008-2012.

REVENUE IMPACT OF ALTERNATIVE FEDERAL COAL LEASING REFORMS

(2008-2012)

CURRENT ROYALTY STRUCTURE	PROPOSED ROYALTY STRUCTURE
Royalties Based on Mine Price	Royalties Based on Market Price

[13] 23 Headwaters Economics, at 11, cites Kunce, M., S. Gerking, W. Morgan, R. Maddux. 2003. State taxation, exploration, and production in the U.S. oil industry. Journal of Regional Science 43: 749-770 (Page 755).

Current Structure (Royalties Based On Mine Price)	Revenue Neutral	GNet Price	ChGross Price
Current Mine Price	**Gross Market Price**	**Net Market Price**	**Gross Market Price**
$15.59	**$34.43**	**$17.79**	**$34.43**
Royalties	Royalties	Royalties	Royalties
$1.70	$1.70	$2.09	$4.14
Effective Royalty Rate	Effective Royalty Rate	Effective Royalty Rate	Effective Royalty Rate
4.9%	4.9%	6.1%	12.0%
Total Collections	Total Collections	Total Collections	Total Collections
$3.9 Billion	$4.8 Billion	$4.8 Billion	$9.5 Billion

Source: Headwaters Economics, 2015, at 2.

The table shows an average price for all Federal coal sales of $15.59 per ton. Royalty collections averaged about $1.70 per ton over this period, for an effective royalty rate of 4.9 percent.

It should be noted that $15.59 is less than half of the average end-user price of Federally-leased coal ($34.43). Consequently, the average effective royalty rate for Federally-leased coal (4.9%) is less than half of the rate required by statute (12.5%). The low "sale" price, and low effective royalty rate that is currently collected for Federal coal generally, reflects the fact that most Federal coal revenue is from PRB coal that is "sold" at the mine mouth. PRB coal sells for an average of $13 a ton. This is one-fifth to one-fourth of the price of privately-sourced Appalachian coal, which is the next largest source of coal in the United States.

On the right side of the table, Headwaters compares current collections with revenues that would be collected under the three reform scenarios described above. The first reform scenario is revenue neutral. It would achieve transparency and reduce administrative costs without changing royalty collections.

The second reform scenario is the one that the ONRR proposed in its 2015 rulemaking. For purposes of calculating royalties, it determined a net market price (the price obtained from the coal's first arm's length sale, with transportation and other eligible

costs deducted). Headwaters estimates that ONRR's proposed reforms would have boosted the effective royalty rate over the period 2008-2012, but only slightly--to $2.09 a ton, or 6%. Total collections would have been about $850 million higher than under the current system ($4.8 billion rather than $3.9 billion). Headwaters notes that the average net market price for coal delivered from states with Federal leases between 2008 and 2012 was $17.72, which is about two-dollars-per-ton higher than the current reported sales price. The difference, Headwaters says, reflects the profit margins earned by affiliated and non-affiliated brokers that paid a low mine-mouth price, and then remarketed the coal at higher domestic- and export-market prices.

The third reform option evaluated by Headwaters shows what would have happened over the period 2008-2012 if ONRR had applied royalties to Federal coal's gross market value. Essentially, this means that transportation costs would no longer be deductible expenses. Average royalty collections per ton would have been $4.14, for an average effective royalty rate of 12%. This is more than twice the effective royalty rate collected under the current leasing system, and almost equal to the 12.5% floor mandated by statute. Total royalty collections under the gross-market-value scenario would have been about $5.5 billion higher than actual royalties over this period ($1.375 billion on an annual basis).

This analysis doesn't include bonus payments. These are payments that a mining company makes to the BLM for the right to bid on a lease. If these are treated as the equivalent of royalties, the effective royalty rate under the current leasing system over the 2008-2012 period increases from 4.9% to 6.7%. (Headwaters Economics 2015, at 20.) Comparing royalty revenue collected under the current leasing system at the 6.7% rate with the royalty revenue that would have been collected under a gross-market-value system at a 12% rate, implies that Federal and state governments lose just over $1 billion a year under the current system.

This estimate of the size of the annual Federal subsidy of leased coal is corroborated by a study done in 2012 for the Institute for Energy Economics and Financial Analysis. That study estimated that the Federal coal leasing program has collected $28.9 billion less in royalties than the law requires over the period 1982-2012 (roughly $1 billion per year) due to flaws in the current leasing system. (Sanzillo, T., 2013).

The DOI should level the playing field between mining companies that exploit public coal reserves and those who exploit private coal reserves, and ensure that taxpayers are receiving a fair return on their publicly- owned resources by applying the Federal royalty rate to the true market value of coal at its final point of sale.

H. Effective Reform Requires Recertification of the PRB as a Coal Producing Region

The BLM is obligated by the Federal Mining Act and its amendments to manage its mineral resources in a way that balances multiple and diverse objectives. Obtaining a fair return for the sale of these non-renewable resources is only one of those objectives. Others include economic development and job creation, energy security, and environmental health—including mitigating climate change. However, the trade-offs between these goals cannot be well understood in the context of the current leasing approach. The necessary starting point of any attempt to evaluate these trade-offs in an informed way is an accurate measure of the direct economic costs and the direct economic benefits of leasing Federal coal.

Under the current leasing process, the direct economic costs and benefits of leasing Federal coal are obscured behind a cloak of confidential data and analysis in which ONRR personnel use subjective judgment to select from a set of imperfect proxies or benchmarks for true market value. The necessary first step in estimating the direct economic costs and benefits of leasing Federal coal is to base the estimate on transparent, objective data. Once the direct effects are estimated, they can be balanced with the wider social objectives that the statutory framework says are supposed to guide the use of this public resource. Ironically, the procedural framework for taking this approach is already in place--it just isn't used. The nation's Federal coal leasing laws (MLA and FCLAA) require the BLM to conduct coal leasing within a framework of regional planning. The purpose of that planning is to balance a wide range of social objectives that are affected by the way that the public's mineral resources are used.

But, as already explained, to take a regional planning approach to coal leasing that evaluates tradeoffs among competing social objectives, it is first necessary under the current law to certify a particular region as a Coal Production Region. The official rationale for decertifying the PRB as a Coal Production Region a generation ago was that the market for PRB coal had "matured" and demand for its coal was on the wane. Relying on this conclusion was not legally sufficient even if it had been true. As these comments have already shown, the assertion that demand for PRB coal was waning was baseless.

What was baseless then has become almost ludicrous now. The PRB has grown to become the country's largest coal producing region, and the mining industry is trying to build five new deep-water terminals in the Pacific Northwest to export PRB coal to the burgeoning Asian market. No one can say with a straight face that the PRB isn't "producing" coal. This undeniable reality, by itself, requires recertifying it as a Coal Production Region.

Additional reasons for recertifying the PRB is that climate change is a far more serious risk to the physical and economic wellbeing of this nation's citizens than it was recognized to be 25 years ago. Coal is the nation's largest source of greenhouse gases and PRB coal has become the nation's largest single source of greenhouse gas emissions--accounting for 10% of the total. On a Btu basis, it is twice as carbon intense as natural gas. For that reason, the current Administration has acknowledged that burning coal for electric power poses a uniquely grave threat of further climate disruption.

To mitigate that threat, the Obama Administration has devised a Clean Power Plan (CPP) that applies to every part of the country, including the part containing the PRB. The goal of the Clean Power Plan is to enforce the Clean Air Act's mandate to reduce CO_2 emissions, which have been found to endanger public health. To do this, the CPP requires each state or region to reduce the carbon intensity of the electricity that it generates. The CPP's primary strategy for achieving that objective is to shift the nation's electric power industry away from its reliance on coal. By selling massive amounts of coal far below its fair market value, current Federal coal leasing policies pull strongly in the opposite direction.[14]

If the Department of the Interior, for some reason, refuses to recertify PRB as a Coal Production Region, and continues the current leasing system with only the minor tweaks that are currently proposed, the production of PRB coal will continue to be subsidized and the broader effects of these subsidies will continue to be ignored. Continuing such subsidies, for example, will give the electric power industry an artificial incentive to reject clean energy in favor of coal. This will directly conflict with the Administration's efforts to reduce the nation's carbon emissions. Continuing such subsidies will also artificially widen the permanent damage that strip mining does to the rangelands and aquifers of the PRB. It will artificially accelerate the loss of jobs in the Appalachian coal industry, and it will weaken the nation's energy security by providing artificial incentives to sell the nation's lowest-cost, most easily accessed coal overseas.

As noted earlier, continuing to subsidize PRB coal has the potential to alter the economics of exporting coal to South Asia. Subsidizing the price of PRB coal will artificially make exporting this coal to China and India profitable where it would not

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[14] A key assumption underlying the emission-reduction targets that the EPA has assigned to each State is that they can cut the CO_2 emissions of a coal-fired power plant in half by converting it to a gas-fired plant of equivalent Btu capacity. The presence of massive amounts of cheap PRB coal in our domestic energy markets, however, is a powerful disincentive to do that. By one estimate, the presence of low-priced PRB coal in the domestic energy market (the 800-pound gorilla in the room) reduces domestic demand for natural gas by 27%, and thereby prevents the use of 5.5 trillion cubic feet of natural gas annually in the electric power industry. (Considine, T., 2013.)

otherwise be. If China and India can count on a long-run supply of underpriced coal from the United States, it will increase their use of coal to generate electric power and raise the odds that they will rely on coal rather than renewable forms of energy as both of these countries race to industrialize. This would undermine the commitment that the Administration secured from China in 2015 to cap its reliance on coal after the year 2020.

Promoting trade in subsidized PRB coal to Asia would also have adverse impacts on the Pacific Northwest that need to be considered before such trade gains momentum. Permits for five new port facilities in the Pacific Northwest have been applied for that total 170 million tons of capacity per year. That much coal would translate to an additional 63 trains per day through Wyoming, Montana, Oregon, and Washington above today's traffic. They would pass through towns and cities along railroad corridors and rivers, exposing them to substantial amounts of toxic coal dust. (Western Resource Councils, 2014.) The Oakland, California, City Council, in a resolution addressing the possibility of expanded use of its port to export coal, observed

> Each coal car in a 125-car coal train loses, on average, 500 pounds of coal per car in transit, for a total of up to 60,000 pounds lost per train on an average trip. Uncovered rail cars contaminate cities, towns, farmland, forestland, streams and rivers across California with coal dust, petcoke and chunks of coal.

Billings Montana pulmonologist Dr. Robert Merchant warns that "shipping export-bound coal through towns like mine has significant health impacts ranging from increased problems with asthma and COPD to increased heart attacks and strokes." http://billingsgazette.com/news/local/dr-robert-merchant/image_c6e64340-54b3-5622-a19c-15914eb8c246.html.

The Administration's Clean Power Plan is essentially an attempt to mitigate the warming and disrupting of the nation's (and the world's) climate caused by burning coal to produce domestic electricity. The approach that the CPP takes is to encourage state- and region-wide planning to dampen demand for electricity and to shift the supply of electricity to low carbon sources. With its left hand, the Administration discourages the use of coal through the Clean Power Plan to minimize the damage that coal does to the world's climate. With its right hand—prior to the coal leasing moratorium--the Administration has been promoting the use of coal through massive subsidized leasing. If allowed to resume, this will undo the expected benefits of the Clean Power Plan.

Subsidized coal leasing is pushing the world's climate closer to the 2°Celsius temperature increase that the nations of the world agreed in Copenhagen in 2009 is the likely tipping point above which there will be wide-scale irreparable damage to the earth's natural systems. It is ironic that the Administration has made careful, environmentally-

conscious planning of how energy is sourced and used at the state- or region-wide level the centerpiece of its Clean Power Plan, while it took the opposite approach with respect to coal leasing. With respect to coal leasing, the Administration had been dealing with each lease one at a time, on an ad hoc basis, without regard to its competitive effects, regional effects, or its effects on human health or the environment.

V. SUBSIDIZING FEDEREAL COAL CAUSES BROADER SOCIAL AND ENVIRONMENTAL HARMS

Taxpayers are not the only ones hurt by the BLM's outdated coal leasing program. We have noted that Federal coal subsidies unfairly disadvantage coal producers in Appalachia and other regions, causing economic dislocation and lowering total employment in the United States. More broadly, the BLM's subsidies of coal distort U.S. energy markets, incentivize U.S. coal exports by subsidizing transportation costs, place low-carbon sources of energy at a disadvantage, and ultimately undercut the president's Climate Action Plan. DOI's subsidies of coal also harm public health and damage America's natural systems, directly through strip mining, and indirectly by accelerating changes to America's climate. The health and climate effects do particular harm to the Western United States.

A. Harm to Public Health.

The value of avoiding the various forms of harm that burning coal causes to the health of the public is best appreciated by discussing the major efforts to estimate the Social Cost of Carbon. In its Notice of Proposed Rulemaking, the EPA estimated that its Clean Power Plan would reduce CO_2 and other pollutant emissions (SO2, NOx, PM2.5) by 30% with respect to 2005 levels. The EPA estimates that this co-benefit of CO_2 reduction would save from $48 to $84 billion in health-related costs (primarily, the economic value of lives saved). The EPA estimated the cost of complying with the Clean Power Plan would be between $7.3 and $8.8 billion in the year 2030. This, it estimated, would raise electricity prices by 3%. The EPA estimated that the ratio of benefit to cost for the Clean Power Plan ranges from 7:1 to 12:1.[15]

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[15] See Notice of Proposed Rulemaking, *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units*, June 18, 2014, 79 FR 13726, section X.A.

These estimates of the effect of the Clean Power Plan on CO_2 and related emissions, however, are much too low because they are based on stale data and because they look at only part of the benefits of carbon reduction. The most recent data relied on by the EPA is for the year 2010. The Natural Resources Defense Council has gathered data for the years since 2010 and updated the EPA estimate. The new data reflects both a sharp drop in the demand for electric power and a sharp drop in the cost of utility-scale wind and solar power. The NRDC has input the new data into the same Integrated Planning Model that the EPA used to generate its initial cost estimates. The updated model's estimate of reduced CO_2 and related emissions for 2030 is 30% *with respect to 2012 levels, not 2005 levels, as was case with the EPA's original estimate.*

The updated model's estimate is that complying with the Clean Power Plan will save from $28 to $63 billion in health related costs in 2030, due to reduced emissions of ozone precursors and fine particulates. When environmental benefits are added to these health benefits, the savings range from $64 to $99 billion in 2030. The NRDC update also estimates that the Clean Power Plan would *reduce* the annual costs to electric power consumers by between $6.4 and $9.4 billion in the year 2030.[16] That translates to an expected reduction in consumer's electric bills of 3% in 2030.

The NRDC's updated cost/benefit analysis strongly suggests that the carbon reduction goals incorporated in the CPP will pick only the carbon reduction "fruit" that hangs lowest on the tree. This analysis also indicates that the EPA has plenty of slack to adopt more ambitious carbon reduction standards without harming the nation's economy. It is extremely important that the EPA adopt more ambitious standards, because that is the only way that the United States can do its part to achieve the 2°C limit on global warming that the world embraced in 2009 in Copenhagen, and the only way that it can achieve the carbon reductions that it announced jointly with China this November.

On November 12, 2014, the International Energy Agency issued its *World Energy Outlook 2014* report. According to that report, by the year 2040, the world will emit all the carbon it can afford to if global warming is to remain below 2°C—the threshold above which truly dangerous levels of climate disruption set in. Because the effect of carbon in the atmosphere is cumulative, the IEA explains, staying below that threshold requires a hard limit on the amount of carbon that can be sent into the atmosphere. If current plans are adhered to (plans that *include* the Clean Power Plan as proposed, and the carbon restriction goals jointly announced this month by the Obama administration and China), all world carbon emissions would, nevertheless, have to immediately drop to zero after 2040 if global warming is to remain under 2°C, leaving 80% of the world's remaining fossil fuel reserves in the ground. While the IEA expects renewables to grow rapidly to supply one-

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[16]See http://www.nrdc.org/air/pollution-standards/.

fourth of world energy by 2040, the other three-fourths of the world's energy will still come from coal, natural gas, and oil--in approximately equal amounts. That, according to IEA, puts us on course for roughly 3.6°C of global warming by 2100.[17]

The IEA notes that because investments in energy infrastructure have long lead times, the sources of energy in use by 2040 will be determined by the investments that are made now. It says that annual investments in sources of renewable energy would have to be boosted to $ 1 trillion, starting immediately, if the 2°C limit on warming is to be met. This, it says, is four times the current annual pace of investment in renewables ($230 billion). It expects the current pace to remain unchanged through 2040 unless world governments dramatically change their energy policies at the Paris summit conference scheduled for December 2015. The IEA observes that it is urgent that investments in energy sources shift immediately from carbon-based to carbon-free if dangerous levels of climate disruption are to be avoided. Id.

The IEA's research demonstrates the urgent need to shift more investment from carbon to non-carbon sources of energy than is currently called for by the governments of the United States, Europe, and China, but its research also shows that such a shift is likely to *increase*, rather than slow, the growth of those economies. In September, a coalition of 340 global investors representing $24 trillion in assets reached a similar conclusion. It issued a statement calling on national governments to institute meaningful and reliable carbon pricing policies in order to help accomplish such a shift in global investment.[18]

A study by the New Climate Economy Project[19] and a working paper from the International Monetary Fund[20] recently corroborated the results of the NRDC's update of the EPA's Integrated Planning Model. They conclude that because of recent advances in renewable technology and the secondary health benefits of cutting fossil fuel emissions,

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[17] See summary of the IAE's Word Energy Outlook 2014 report at http://thinkprogress.org/climate/2014/11/17/3593093/iea-report-carbon-budget-2040/. The IEA analysis that current carbon emission agreements put the world on a course that will warm the earth by 3.6°C by the end this century is independently corroborated at http://www.decodedscience.com/china-us-climate-agreement-business-usual/50805.

[18] See http://www.unep.org/newscentre/Default.aspx?DocumentID=2796&ArticleID=10984&l=en.

[19] See *New Climate Economy Project*, Global Commission on the Economy and Climate, available at http://newclimateeconomy.report/.

[20] See *Carbon Pricing, Good for You, Good for the Planet*, iMF direct, the International Monetary Fund's Global Economy Forum, available at http://blog-imfdirect.imf.org/2014/09/17/carbon-pricing-good-for-you-good-for-the-planet/.

the choice between a strong economy and a strong response to climate change is a false one. They found that ambitious policies to cut carbon emissions would either have a very small drag on economic growth or lead to faster growth. See Jeff Spross, *Would Limiting Carbon Emission's Destroy the Economy?*, October 16, 2013, at http://thinkprogress.org/climate/2013/10/16/2730271/carbon-regulations-economy/. Recent modeling of an extremely aggressive national carbon tax for the United States found a similar result, even before the health benefits are factored in. (Nystrom, S., 2014.) A recent assessment of upcoming British policy to cut emissions from its economy reached a similar conclusion. (Cambridge Economics, 2014.)

The cost of more ambitious carbon emission reduction standards, according to all of these studies would be at, or near zero, while the benefits would be in the hundreds of billions of dollars annually. Our own analysis of benefits that are not considered by these studies is presented toward the end of this section. There, we conclude that the annual benefits of a more ambitious national standard for reduced carbon emissions could exceed $1 trillion by 2030 if the labor productivity gains from reducing the future workforce's exposure to neurotoxins from the burning of coal is fully accounted for.

B.A More Complete Modelling of the Clean Power Program's Economic Impacts Shows That they Would Be Enormously Positive

The opponents of the EPA's Clean Power Plan rest their opposition on the premise that energy obtained from burning carbon is a boon to the economy because it is modestly cheaper than carbon-free alternatives. Energy obtained by burning carbon, however, is "cheap" relative to renewable forms of energy only when most of the costs of carbon-based energy are left out of the price of that energy.

By insisting that the price of carbon-based power reflect only a small part of its costs, goods that are lower in economic value on a per-unit basis (those produced with relatively more dirty energy) are overproduced and goods that are higher in economic value on a per-unit basis (goods produced with relatively less dirty energy) are underproduced. Labor and other resources are diverted from producing more valuable goods to producing less valuable goods. Maintaining a price for carbon-based power that badly understates its true cost makes the nation's economy less efficient, and, in the process, reduces its overall level of employment.

If the price of a product does not reflect both its direct and social costs, economic efficiency is sacrificed. If the social costs that are left out of the sale price are large relative to the direct costs, the sale price misrepresents the product's total cost. If the product is an important part of the overall economy, this sale price will cause large inefficiencies in the way society allocates its resources. That is the case with electric power obtained from fossil fuel.

While coal-fired power plants provide the direct benefit of slightly cheaper power than clean alternatives (a circumstance that will last for only three or four more years), the indirect costs of such costs are staggering. This is because coal-fired power plants are essentially enormous neurotoxin factories—an economic reality that has yet to be reflected in the price of the power that they produce.

Burning coal produces airborne compounds, known as fly ash and bottom ash (collectively referred to as coal ash), which can contain large quantities of heavy metals that settle or wash out of the atmosphere into oceans, streams, and land. In 2012, coal plants in the United States produced over 75 million short tons of coal ash, 70% of which was disposed of in landfill. See www.epa.gov/epawaste/conserve/tools/warm/pdfs/Fly_Ash.pdf.

In 2010, utilities in the United States burned 1.05 billion tons of coal. (Energy Information Agency, 2014.) This coal contains 109 tons of mercury, 7884 tons of arsenic, 1167 tons of beryllium, 750 tons of cadmium, 8810 tons of chromium, 9339 tons of nickel, and 2587 tons of selenium. http://www.precaution.org/lib/laid_to_waste.000601.pdf., p. 2. On top of emitting 1.9 billion tons of carbon dioxide each year, coal-fired power plants in the United States also create 120 million tons of toxic waste. That means each of the nation's 600 coal-fired power plants produce an average 240,000 tons of toxic waste each year. A plant that operates for 40 years will leave behind 9.6 million tons of toxic waste. This coal combustion waste (CCW) constitutes the nation's second largest waste stream, after municipal solid waste. See http://www.precaution.org/lib/08/prn_is_coal_green.081106.htm.

When coal is burned, toxins in the coal are released into the smokestack. If modern air pollution controls are in place, airborne toxins are captured through filtration systems before they can become airborne. The captured toxins end up in coal ash. As a result, heavy metals such as mercury are concentrated in what the EPA considers "recycled air pollution control residue." This only delays the exposure of the public to these toxins. The EPA concedes that all coal ash landfills eventually leak, and Federal regulation of coal ash landfills is minimal. Rain falling on ash piles leaches out these heavy metal compounds. The heavy metals eventually end up in ground water, or in lakes and streams, contaminating drinking water sources.

Only by ignoring its enormous health and environmental impacts can coal-fired power be considered a “low-cost” energy source, the use of which promotes economic efficiency and job creation. Failing to reflect all of the cost of a product in the product’s sale price misallocates resources. If society, through a tax or a regulation, shifts a dollar of spending away from a product that is less valuable to society to a product that is more valuable to society (on a unit basis) it creates more jobs than it “kills.” This principle is

taught in Economics 101 in every accredited undergraduate course in the country, and is undisputed. Applied in the context of using fossil fuel to provide electricity, a kilowatt/hour obtained from coal is actually worth from one-half to one-one tenth as much to society as a kilowatt/hour obtained from a non-polluting source, depending on how many of its external costs are accounted for.

There are over 3,500 peer-reviewed scientific studies that document the harm to public health from air pollution, especially in urban environments in developed economies. (D'amato, g., et al., 2010.) Fossil fuel combustion is responsible for the vast majority of air pollution in developed countries.[21] Air pollution has been found to damage every major organ system in the human body. These studies have caused the World Health Organization to conclude that air pollution is the most important environmental cause of cancer, more important than second-hand cigarette smoke. http://www.usatoday.com/story/news/world/2013/10/17/cancer-air-pollution-carcinogens/3002239/.

Cigarette smoke contains 69 known carcinogens. Coal-fired power plant emissions contain 67 known carcinogens or neurotoxins (U.S.EPA, 1998)—many of the same ones found in cigarette smoke. Cigarette smoke and power-plant emissions both contain

- Fine particulate matter (PM2.5)
- Carbon monoxide
- Ozone precursors
- Volatile Organic Compounds (VOCs), such as benzene, toluene, and formaldehyde;
- Acid gases, such as hydrogen chloride and hydrogen fluoride;
- Dioxins and furans;
- Lead, arsenic, and other toxic heavy metals;
- Mercury;
- Polycyclic Aromatic Hydrocarbons (PAH); and

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[21] Emissions from the burning of fossil fuels come directly from the production of electric power and domestic heat, or indirectly in mining, construction, or transportation activity. Several natural processes contribute to air pollution including forest fires, volcanic eruptions, windstorms, and turpene emissions from conifers. The extent and damage from these natural sources, however, is a minute portion of the air pollution emitted by manmade activities. www.eoearth.org/view/article/149931/.

- Thorium, Uranium, Polonium and other radioactive metals

The harm to public health that second-hand cigarette smoke and fossil fuel emissions pose is remarkably similar. The difference is primarily quantitative, not qualitative. A typical life-long smoker will shorten his life by ten years. The American Lung Association reports that the typical urban dweller in the United States is exposed to enough airborne fine particulate matter to shorten his life by one-to-three years. (Pope, C.A. III, 2000.) Nearly all of that exposure is due to pollution from the burning of fossil fuels. This shortened life span of a typical urban dweller is not just the effect of his exposure to fine particulate pollution. Exposure to other components of air pollution caused by burning fossil fuels--such as ozone and Hazardous Air Pollutants (HAPs)--further shortens his life.

One major difference between second-hand cigarette smoke and fossil fuel emissions is that second-hand smoke is localized. One can usually escape second-hand smoke and its effects by leaving the building where the smoke is generated. Fossil fuel emissions permeate entire air sheds of most urbanized regions of the country. The largest single source of fossil fuel emissions is coal-fired power plants. To escape fossil fuel pollution, one would have to find a region without coal-fired power plants or concentrated automobile traffic. Air quality maps show that most regional air sheds in the United States are moderately or heavily polluted—almost entirely the result of burning fossil fuels.

1. No Level of Exposure to the Toxins Produced By Burning Coal Is “Safe”.

Clean air standards have yet to catch up to the science. Up to now, the approach that Federal and state governments have taken to regulating fossil fuel emissions has been based on an assumption that the harm from these pollutants at concentration levels commonly experienced is minor, and is a small price to pay for a healthy economy. This reflects a precept that was once central to the science of toxicology--that “the poison is in the dose.”

This precept assumes that most poisons, including those in ambient air, are harmless below a certain threshold concentration, and the public policy task is to find that threshold and keep the poisonous substance below it. This precept, however, has been shown to be false by a wealth of more recent studies that show that the principal fossil fuel pollutants (lead, mercury, fine particulates, and ozone) harm human health at every level of concentration.

In a major survey of recent research the World Health Organization concluded (World Health Organization Report, 2004):

> The potential for serious consequences of exposure to high levels of ambient air pollution was made clear in the mid-20th century, when cities in Europe and the United States experienced episodes of air pollution, such as the infamous London Fog of 1952 and Donora Smog of 1948, that resulted in large numbers of excess deaths and hospital admissions. Subsequent clean air legislation and other regulatory actions led to the reduction of ambient air pollution in many regions of the world, and particularly in the wealthy developed countries of North America and Europe. New epidemiological studies, however, conducted over the last decade, using sensitive designs and methods of analysis, have identified adverse health effects caused by combustion-derived air pollution even at the low ambient concentrations that now generally prevail in cities in North America and western Europe (Health Effects Institute 2001).

If fact, many studies show that these pollutants not only cause significant damage at very low concentrations, but that the damage is proportionally the greatest (on a parts per billion basis) at the lowest concentrations. Just as the first five cigarettes have been found to do more damage to the lung, per cigarette smoked, than the next 15, the relationship between concentrations of such pollutants as fine particulates and their impact on health shows a similar non-linear curve, i.e. further reductions in atmospheric levels have even more public health benefit when levels are comparatively low than when they are high. (Peters, A., 2009.)

The U.S. Center for Disease Control ranks toxic heavy metals as the number one environmental health threat to children.[22] Recent research on the effects of lead pollution, for example, invalidates the notion that exposure to lead is safe below a particular threshold concentration.

Human activity has increased the concentration of lead in the environment more than 1,000-fold over the past three centuries. This reflects the fact that lead does not break down, so its concentration in the environment continually increases. http://www.atsdr.cdc.gov/PHS/PHS.asp?id=92&tid=22. A typical coal-fired power plant without pollution controls emits 114 pounds of lead each year. http://www.ucsusa.org/clean_energy/coalvswind/c02c.html#.VG4Z3YvF-H4. Lead pollution from power plants enters the environment by several pathways. It begins as vapor, is deposited in the soil, leaches into streams, lakes, and aquifers, and ends up in drinking water and food supplies.

Lead is a powerful neurotoxin. At levels that currently prevail in developed countries, it causes substantial harm to public health. In the United States, for example,

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[22] ATSDRA/EPA Priority List for 2005: Top Hazardous Substances. Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services, www.atsdr.cdc.gov/clist.html.

until very recently the Center for Disease Control defined an "elevated" lead blood level (the level assumed to require additional pollution controls and/or medical intervention) as 10.0 micrograms per deciliter. www.cdc.gov/mmwr/preview/mmwrhtml/mm5420a5.htm.

Recent research indicates that the 10.0 µg/dL tolerance level of lead exposure is too high by a factor of 50. Acknowledging the findings of more recent research, the CDC conceded in 2012 that there is no level of lead in blood serum that is small enough to be considered "safe." At that time, the CDC cut its tolerance level for blood-level lead from 10.0 µg/dL to 5.0 µg/dL (rather than zero) without a clear explanation of the basis for the new tolerance level. See www.cdc.gov/mmwr/preview/mmwrhtml/mm6213a3.htm. Even CDC's current tolerance level of 5.0 µg/dL is 25 times too high, according to the most recent research.[23]

An example of the current research on the toxicity of lead is provided by a major study of the relationship between lead exposure levels and reduced intellectual capacity that was completed in Italy in 2012. (Lucchini, R.G., et al., 2012.) The study found that the I.Q. of Italian teenagers is reduced in proportion to their lead exposure, no matter how small their lead exposure is. Specifically, the study demonstrated that every 0.19 micrograms of lead per deciliter in an adolescent's blood is accompanied by a one-point reduction in that teenager's I.Q.

According to this study, the I.Q. of Italian adolescents has been reduced by 9 points on average, given their average blood serum lead level of 1.71 micrograms. The most recent lead exposure data available for the United States focuses on the 1-5 year-old age group. For the years 2007-2010, their average blood serum level was 1.3 µg/dL. Id. The Italian study results imply that the I.Q. of preschoolers in the United States has been reduced by 7 points, on average, due to their exposure to lead pollution, since the

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[23] It is important to note that the EPA's current National Ambient Air Quality Standard (NAAQS) for lead [0.15 µg/m³] was adopted in 2008. Because it has yet to be reconciled with the current research, the EPA's NAAQS for lead pollution that is now in effect still reflects the CDC's now-abandoned (and exceedingly lax) blood-lead tolerance level of 10.0 µg/dL.

exposure of American preschoolers is a little more than three-fourths that of Italian teenagers.[24]

It is estimated that average blood lead levels are 50 times higher than natural lead levels were before the industrial revolution. (Flegal, A.R., et al., 1992.) In the United States, as in Italy, lead exposure has historically had three main sources: lead paint, leaded gasoline, and coal-fired power plants. Lead exposure from paint and gasoline has largely been brought under control. Coal-burning power plants are now the primary source of lead exposure for young children in most of the United States. The loss of intellectual capacity from unnecessary exposure to lead in the United States (and in the rest of the developed world that relies on coal to generate power) is not only a personal and social tragedy, it has caused a drastic reduction in the productivity of the workforce in the economies of countries that obtain their energy primarily from burning coal.[25]

The harm to public health from lead pollution from coal-fired power plants, however, is modest compared to the harm that they cause through mercury pollution. Estimates of the amount of mercury in the environment that is generated by human activity range from 70 to 96%. The World Health Organization estimates that total world-wide mercury emissions have tripled as a result of the industrial revolution. The single largest source of environmental exposure to mercury in the United States (65%) is from coal-fired power plants. (AMAP/UNEP, 2013 at 3-4.)[26]

From the perspective of epidemiologists, coal-fired power plants are huge neurotoxin factories. A typical coal-fired power plant without modern pollution controls emits 170 pounds of mercury each year. In 2009, coal-fired power plants in the United

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[24] The implication that the degree of mental impairment in American pre-school children due to their average blood-serum levels of lead is approximately three-fourths of the impairment experienced by Italian teenagers is based on the assumption that impairment is proportional to exposure levels. This is a conservative assumption since other research consistently shows that the younger children are, the more vulnerable they are to exposure to neurotoxins. In addition, although blood lead concentrations in American preschool children of 1.3 µg/dL are less than the 1.71 µg/dLin Italian teenagers, these concentrations would likely be comparable if American teenagers were measured, because blood levels of heavy metals generally increase quadratically until age 50. See Caldwell KL1, Mortensen ME, Jones RL, Caudill SP, Osterloh JD., Total blood mercury concentrations in the U.S. population: 1999-2006, Int J Hyg Environ Health. 2009 Nov;212(6):588-98. doi: 10.1016/j.ijheh.2009.04.004. Epub 2009 May 29.

[25] Baghouse technologies for eliminating most of this aerosol lead are effective and readily available, but are not yet widely implemented. Wider adoption of this technology will be a major indirect benefit of implementing the EPA's new Mercury and Air Toxics (MATS) ambient air standards.

[26] The main sources of man-caused mercury pollution are the proliferation of coal-fired power plants, the use of mercury in small-scale, low-technology (and typically illegal) gold and silver mining in less developed countries, and the use of lead in dental amalgum. See www.psr.org/assets/pdfs/coal-fired-power-plants.pdf.

States injected 134,365 pounds (more than 67 tons) of mercury into our environment. Ninety percent of this mercury could be removed by using activated carbon injection (ACI) technology combined with baghouses. As of 2011, however, only 8% percent of coal-fired power plants were equipped with this technology. (EPA Trends Report, 2010.)

When coal is burned by a power plant without controls, mercury is released into the air and settles onto bodies of water where it is converted to its organic form (methylmercury). Methylmercury accumulates in the tissue of fish and shell fish. Eating fish is the main source of methylmercury exposure for most of the population.

Methylmercury is the most powerful non-radioactive neurotoxin in nature. It is many-fold more toxic than lead. This is confirmed by a recent study conducted at the University of Calgary medical school. In the study, brain neurons were exposed in vitro to a series of metals that were known or suspected neurotoxins. At concentrations so small that neither lead, cadmium, aluminum, nor manganese affected neuron integrity, methylmercury caused 77% of exposed neuron endings to disintegrate. (Leong, C.C., et al., 2001.)

According to the World Health Organization, exposure to methylmercury damages not just the nervous system, but the digestive, respiratory, and immune systems as well. It causes intellectual impairment during fetal development and childhood, attention deficit disorder, impaired vision and hearing, tremors, paralysis, insomnia, and emotional instability. (WHO Report, 2005.) In adults, mercury poisoning closely mimics the symptoms of Alzheimer's disease. (Mutter, J., et al., 2010.) The World Health Organization observes that "mercury may have no threshold below which some adverse effects do not occur." Id.

As an indication of its potency, just 1/70th of a teaspoon of mercury deposited in a 25-acre lake can make all of the fish in that lake unsafe to eat for a year. (Weiner, J.G., et al., 1990.) It is estimated that over 6 million acres of lakes, reservoirs, and ponds in the United States have unsafe concentrations of mercury. (EPA Watershed Assessment, 2010.) In 47 of the 50 states, wild fish cannot be eaten because their methyl mercury exceeds safe levels, due, primarily, to emissions from coal-fired power plants. www.ucsusa.org/clean_energy/coalvswind/c02c.html#.VHQPMfRDuSq.

Human fetuses are five to ten times more vulnerable than adults to the brain-addling powers of methylmercury. There are two reasons, 1) they typically receive a 70% greater exposure to mercury than the mother (because of the placenta's concentrating action), and 2) their brain cells need to move from the center of the brain to the surface before they multiply. Methylmercury paralyzes brain cells, blocking the movement and multiplication that is necessary for normal fetal development. (Mahaffey, K., et al., 2004 at 562-570; Mahaffey, K., EPA Methylmercury Update, 2004, Slide 9.)

In the United States, one in six mothers of childbearing age has enough mercury in her blood to put her fetus at risk of intellectual impairment. (Center for Disease Control, 2001; Mahaffey, K., EPA Methylmercury Update, 2004.) This implies that 689,000 of the 4.1 million babies born every year are at risk of reduced mental capacity as a result of mercury exposure. (National Center for Health Statistics, 2010 at 1.) The estimate that one in six mothers of childbearing age have blood lead levels that are unsafe for a fetus, however, is almost certainly understated because it is based on the EPA's definition of a safe blood level of 0.58 µg/dL. This is higher than the World Health Organization's definition of a safe blood level of lead [0.5 µg/dL]. The recent research described above, however, implies that methylmercury is much more toxic than lead and other toxic metals, and, therefore, the definition of a safe blood level of methylmercury (if there were one) should be well below that of other such metals.

There is evidence that the neurotoxic effects of methylmercury in the presence of other heavy metals in blood and tissues is not merely additive, but is synergistic, and amplifies the neurotoxic effects of both metals. (Schubert, J., et al., 1978.) Child development experts have recently been warning chemical and metal brain toxicity is increasingly prevalent in the human population, causing a silent, global pandemic of neurobehavioral disorders and intellectual compromise in children. (Grandjean, P., et al., 2014.) The rapid proliferation of neurotoxins that children are exposed to, and the likelihood that they act synergistically, provide a powerful argument for the Federal government to become more aggressive in reducing their exposure. At the top of the list of known neurotoxins that are contributing to this tragic trend are mercury, lead, and arsenic—all prominent components coal-fired power plant emissions.

While overall exposure to some neurotoxins like lead has decreased in recent years for a variety of reasons having nothing to do with reduced coal power plant emissions, mercury exposure has increased. A study showed that in 2006, 30% of women had detectable levels of mercury, up from 2% in 2000. (Laks, D., 2009.)

Mercury is also implicated as a cause of Alzheimer's disease. A recent meta-analysis reviewing 1,041 studies clearly showed a strong relationship between this increasingly common illness and exposure to mercury. (Mutter, J., et al., 2010.) Research shows that Alzheimer's was the underlying cause in 500,000 deaths in the United States in 2010. This represents a 68% increase from 2000. http://www.alz.org/alzheimers_disease_facts_and_figures.asp#cost.

More money is spent on treating Alzheimer's patients than on any other disease. Care for Alzheimer patients is costing the nation about $200 billion annually, a figure which does not reflect the costs of lost productivity, nor the emotional and financial burden of the "free care" that family members provide. If the rapid growth of Alzheimer's

continues, it has the potential to bankrupt the nation's health care system. Mercury emitted by coal-fired power plants appears to bear a significant share of the blame.

2. Accounting for the Combined Effect of Exposure to Methylmercury and Lead on Intellectual Capacity and Workforce Productivity

A crucial question is what the combined effect of exposure to methylmercury and lead is on the public's intellectual capacity. We know that methylmercury is far more toxic than lead to the nervous system, and we know that the separate effects of methylmercury and lead are amplified when they occur in combination. Although we do not know precisely how much more toxic to the nervous system methylmercury is than lead, or how synergistic it is with lead, it is safe to assume that its toxicity is at least equal to that of lead. Therefore, it is also safe to assume that the effect of blood serum levels of mercury and lead are at least additive when exposure to mercury and lead occurs together at levels near their current average concentrations.

Under this conservative hypothesis, to account for the combined impact of currently prevailing blood levels of both methylmercury and lead on the intellectual capacity of the preschool population, one would have to assign a neurological effect to methylmercury in blood serum that is at least equal to the neurological effect of an equivalent concentration of lead in the blood. Average blood levels of methylmercury among American preschool female children are 0.356 μg/m^3. [27] This implies that, on average, blood serum levels of methylmercury in preschool children in the United States have reduced their intellectual capacity by roughly 2 points (at a minimum) in addition to the 7 I.Q. points from their exposure to lead, or a total of 9 I.Q. points.

If the current generation of American workers had escaped exposure to both methylmercury and lead, their average I.Q. could be expected to be at least 9 points higher. Reducing the intellectual capacity of an entire workforce by 9 points transforms the intellectual capacity that workforce. National average I.Q. has a strong correlation with GDP per worker. Research suggests that while an increase of 15 points (one standard deviation) results in a 15% increase in average wages of individuals, it results in proportionately greater increases in national productivity (approximately 150%), due largely to a multitude of external effects that increased intellectual capacity has on the economic processes of a society as a whole.[28] Again, taking a conservative approach, if the average I.Q. of American school-age children has been reduced at least 9 points due to exposure to lead and methylmercury, this amounts to a reduction of one-half of a

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[27] Caldwell KL1, et al. 2009, cited above. Total mercury in blood serum occurs overwhelmingly in the form of methylmercury.

[28] See, e.g., research summarized in Jones, G., 2011.)

standard deviation. Therefore, such exposure has likely reduced the productivity of the national workforce by at least 75% (half of 150%).

The loss of intellectual capacity from the avoidable exposure of America's children to methylmercury and lead pollution is a personal and social tragedy. The recent epidemiological and macroeconomic studies cited above imply that this loss of intellectual capacity is drastically reducing the productivity of our nation's workforce, as illustrated by our back-of-the-envelope estimate of those effects presented below. This strongly implies that the most important co-benefit of reducing reliance on coal to generate electric power —as the Administration's Clean Power Plan hopes to do--is that it reduces the level of exposure of the American workforce to methylmercury and lead pollution.

Climate disrupting CO_2 emissions come primarily from coal-fired power plants. Reducing those emissions also reduces other pollution (notably SO2, NOx, and PM2.5), which brings major health benefits to the American public. The EPA's Integrated Planning Model yields an updated estimate that implementing the Clean Power Plan would reduce CO_2 and related emissions in the year 2030 by 30% relative to 2012 levels. This would yield health and environmental benefits of from $64 to $99 billion by reducing SO_2, NO_x, $PM_{2.5}$ emissions (without taking the effects of reduced exposure to neurotoxins into account). http://www.nrdc.org/air/pollution-standards/. However, if political or legal considerations keep the Clean Power Plan from being implemented, or an unreformed Federal coal leasing program continues to offset its effects, coal-fired power plants will continue to inject neurotoxins into the environment at the current pace. The result could be that the productivity of the nation's children will be far below what it could otherwise be at the time that those children enter the workforce.

One might ask whether continuing to expose our children to environmental neurotoxins in the current concentrations could affect their productivity so drastically. A rough estimate of the reduction in GDP from lost productivity due to intellectual impairment from exposure to lead and methylmercury indicates that it could.

An estimate of the effect of reducing childhood exposure to neurotoxins on future productivity in the workplace should begin with a measure of the value of the output that labor currently produces. The best available proxy for this value is what the nation's workforce is currently paid. The nation's total wages and salaries earned by those not self-employed came to an annualized $6.3821 trillion as of May, 2014.[29] This figure must be adjusted upward to reflect the value of total benefits that are earned in conjunction with

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[29] Total annualized wages earned through May 2014 is calculated as the product of the mean annual wage of $47,230 and total employment of 135,128,260. See United States Bureau of Labor Statistics, Occupational Employment Statistics, May 2014 National Occupation Employment and Wage Estimates, All Occupations, available at www.bls.gov/oes//current/oes_nat.htm#00-0000.

those wages, which average 30.6%.[30] Multiplying total wages by 1.306 brings the value of total wages and benefits earned annually to $8.335 trillion.

The next step in the analysis is to estimate lost workforce productivity due to exposure to methylmercury and lead. This can be approximated by holding total workhours constant while increasing a nation's labor productivity by 75%. This is consistent with the research referenced earlier which suggests that this is the likely effect of increasing the average I.Q. of the workforce by one-half of a standard deviation. This is the arithmetic: $8.335 trillion x 1.75 = $14.586 trillion. The implication of the Italian study is that the intellectual capacity of America's future workforce could be one-half of a standard deviation higher, and its workforce's annual production could be more than $14 trillion higher than it is now, if it were spared all exposure to just two neurotoxins—methylmercury and lead.

BLM leases are the source of 40% of the thermal coal burned for power in the United States. Current Federally-leased reserves are projected to run out in 20 years. If the current moratorium were made permanent, it might eventually reduce the amount of thermal coal burned in the United States by as much as 40%. Such a moratorium would then bring with it a roughly 40% reduction in exposure of the American public to SOx, NOx, PM2.5, and to mercury, lead, and other toxic heavy metals. A back-of-the-envelope estimate of the long-term value to the American economy of phasing out Federally leased thermal coal under these assumptions is an increase in the productivity of the American workforce worth about $5.83 trillion per year ($14.586 x 0.40 = $5.83).[31]

On a general level, the estimates by the EPA and the NRDC that implementing the Clean Power Plan would have a positive benefit/cost ratio are corroborated by a number of other studies that find reducing coal emissions would have external benefits that are far greater than the current price of coal in the United States.

The EPA estimates that the health care costs imposed on society as a whole from burning a ton of coal (which it labels the Social Costs of Carbon) would be $43 in 2020

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[30] Bureau of Labor Statistics, Economic News Release, Table 5, Employer costs per hour worked for employee compensation and costs as a percent of total compensation: Private industry workers, by major occupational group and bargaining unit status, December 2014.

[31] As mentioned earlier, if the electric generating capacity that had been supplied by phased-out coal is replaced primarily by energy efficiency and renewable forms of energy, as is contemplated under the Clean Power Plan, the National Resources Defense Council has shown that retail electric rates would actually fall by 2030. This implies that in calculating the economic value of a long-term phasing out of Federal coal as a source of electric power, there is no need to adjust that value downward for increases in retail electric rates.

($36 on a present value basis at 3%).[32] An alternative Social Cost of Carbon estimate based on middle-of-the-road assumptions is $62 in 2020 ($55 on a present value basis at 2%). (Johnson, L., et al., 2012.) The average price of a short ton of coal delivered to the electric power industry in 2012 was $45.77. The future value of $45.77 in 2020 at 2.3% interest is $52.46. These Social Cost of Carbon estimates indicate that the average price of coal in 2020 would need to increase by from 82% to 105% if it were to cover its social costs. It should be borne in mind that these are only a partial estimate of coal's external costs. They do not include the most economically significant ones, such as the long-term reduction in labor productivity described above.

An alternative estimate of the social cost of carbon is found in a study by the faculty of Harvard Medical School. Published in 2011, it compiled an estimate of the social costs incurred in the United States annually by using coal to generate electric power. It is more comprehensive than the EPA's Social Cost of Carbon estimate because it considers the costs incurred at each stage of the life cycle of coal—extraction, transport, processing, and combustion. It does not, however, consider future losses in labor productivity.

Over its life cycle, coal generates a waste stream that carries multiple hazards for human health and the environment. These costs are not imposed on the coal industry, but on the rest of society. The Harvard study estimates that the life-cycle effects of coal and the waste stream generated are costing the American public from one-third to over one-half of a trillion dollars annually. The costs of substituting energy efficiency and renewable forms of energy for the output of existing coal-fired power plants are a small fraction of the costs of not doing so, when the life-cycle costs of coal are taken in to account.

The Harvard study monetized costs imposed on the public health system by NO_x, SO_2, $PM_{2.5}$, and mercury emissions; fatalities of members of the public due to rail accidents during coal transport; the added public health burden in Appalachia incurred by coal mining; government subsidies; and the lost value of mined land after it has been abandoned. The estimate is conservative in that it does not account for damages outside of Appalachia, nor does it account for unquantifiable costs, such as the cost to a family of losing a wage earner due to black lung disease. It notes that many of these external costs of coal are cumulative. (Epstein, et al, 2011.)

The Harvard study conservatively estimates that if the external costs of coal were accounted for, they would double or triple its price. If electricity produced from burning

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[32] Technical Support Document, *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, available at: http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf.

coal were priced to cover its social costs (which amount to $345.3 to $523.3 billion annually), it would add a tax of from 17.7 to 26.9 cents to the current average retail price of electric power (11 cents per kilowatt hour).

Although the EPA's proposed Clean Power Plan would not tax carbon, it would achieve similar results, producing a more economically efficient mix of energy sources by regulatory means. On a dollar-for-dollar and kilowatt/hour-for-kilowatt/hour basis, adding the social cost of carbon to the price of electricity would shift investment quickly from fossil fuels, which have high social costs, to low-carbon forms of energy (renewables and efficiency programs) that have much lower social costs. As the National Resources Defense Council's analysis of the Clean Power Plan shows, this would increase economic efficiency and boost total economic output and employment. The current Federal coal leasing program, with its drastically subsidized carbon prices, has all of the opposite effects. Ending new Federal coal leasing would have qualitative and quantitative impacts on the economy and the environment similar to implementation of the Clean Power Plan.

If the current moratorium on new Federal coal leases is not made permanent, the next best option is for the BLM to require that the price of Federally leased coal cover the Social Cost of Carbon before the sale can go forward. Currently, there is no consistent approach that State and local BLM offices follow when they draft Environmental Impact Statements accompanying fossil fuel lease applications. Some offices make reference to carbon pollution and climate disruption and even include some efforts to estimate these externalities. Others offices mention these externalities in the abstract, but argue that the social cost of carbon cannot be objectively determined, or they view the potential climate effects of a particular lease proposal on a global scale and dismiss them as de minimis or unquantifiable as a percentage of the entire globe's warming.

There is a critical need for the Secretary of the Interior to require an organized and consistent approach to the issue of carbon pollution and climate disruption and how it relates to a particular fossil fuel lease, whether a coal, conventional oil, or shale gas lease is involved. The new approach should make it clear that carbon pollution and climate disruption are external costs of burning fossil fuel, that there are objective standards and methods for determining a reasonable range of what those costs are on a per-ton basis, and that the percentage of total global warming that might be caused by a particular proposed lease is not normally a meaningful criterion to apply in an Environmental Impact Statement. Rather, above a certain threshold, estimating a carbon contribution and climate impact of a fossil fuel lease is meaningful when estimated on a per-ton, or per-Btu basis.

The Federal court ruling halting the leasing of Federal coal in Colorado in June of 2014 rests, in part, on a finding that the social cost of carbon was an important

component of a cost/benefit analysis and could have been estimated on a per-ton basis by referencing the Social Cost of Carbon estimates approved by the Council on Environmental Quality. The ruling also rests on a finding that increasing the quantity of cheap Federal coal available to the energy market shifts domestic demand away from low-carbon sources of energy. See Restraining Order issued June 27, 2014, in *High Country Conservation Advocates vs. U.S. Forest Service*, Civil Action No. 13-cv-01723-RBJ (Federal District Court, Colorado) at 30.

On December 18, 2014, in response to the High Country ruling, the White House Council on Environment Quality (CEQ) issued a second draft guidance intended to provide direction on how Federal agencies should address the effects of greenhouse gas (GHG) emissions and climate change as those agencies satisfy their duties when preparing an Environmental Impact Statement (EIS) or an Environmental Assessment (EA) under the National Environmental Policy Act. The draft guidance says

> When an agency determines it appropriate to monetize costs and benefits, then, although developed specifically for regulatory impact analyses, the Federal social cost of carbon, which multiple Federal agencies have developed and used to assess the costs and benefits of alternatives in rulemakings, offers a harmonized, interagency metric that can provide decisionmakers and the public with some context for meaningful NEPA review.

There is a threshold of 25,000 metric tons per year of CO_2 emissions above which a Federal permitting agency is obligated to conduct a quantitative analysis of the effects of a lease on the climate. The draft guidance states that agencies may need to consider alternatives to the proposed action that reduce or mitigate GHG emissions and climate change effects. It also states that where

> mitigation measures are designed to address the effects of climate change, the agency's final decision should identify those mitigation measures and the agency should consider adopting an appropriate mitigation monitoring program.

The draft guidance is especially important in the energy sector. Many types of Federal actions involve the management of Federal and tribal land and resources, and could qualify, in the language of NEPA, as "major federal actions significantly affecting the quality of the human environment," thereby triggering the need to prepare an EIS. Also, many energy projects require permits from federal agencies, and thereby require the preparation of an EIS or EA. In either case, this guidance expands the scope of any EIS or EA prepared for energy-related projects.

The draft guidance directs agencies to,

> consider the extent to which a proposed action and its reasonable alternatives contribute to climate change through GHG emissions and take into account the ways in which a changing climate over the life of the proposed project may alter the overall environmental implications of such actions.

The CEQ expressly warns agencies that their NEPA duties are not satisfied by recitations in EISs or EAs that emissions resulting from a government action or approval represent only a small fraction of global emissions and therefore require no further analysis. Instead, agencies are to follow a principle of proportionality in which the extent of analysis of GHG emissions is commensurate with the quantity of proposed GHG emissions.

NEPA requires Federal agencies to consider the direct, indirect and cumulative impacts of proposed actions. See, 40 C.F.R. §§ 1508.7, 1508.8. NEPA also requires consideration of "connected actions." The CEQ defines "connected actions" as those that automatically trigger other actions which may require an EIS, actions that cannot or will not proceed unless other actions are also taken, or actions that are interdependent parts of a larger action. Based on these broad, long-standing definitions, CEQ now believes that Federal agencies must discuss climate change and GHG emissions in an EIS or EA if the effects are significant, including a discussion of emissions from other activities that have a reasonably close causal relationship with the proposed action and are either "upstream" or "downstream" from the proposed action.

The CEQ offers the example of a proposed open pit mine that requires some form of Federal approval. Under this guidance, the EIS would include a discussion of GHG emissions from land clearing, access road construction, transporting the extracted resource, refining or processing the resource and, importantly, "using the resource." After considering these impacts, an agency must also address GHG emissions and climate change in terms of the cumulative impact of the proposed action which is the incremental impact of the action when added to other past, present and reasonably foreseeable actions, regardless of which agency or entity undertakes such other action.

Coal mining on federal lands accounts for an estimated 14% of U.S. CO_2 emissions. This is a very large number compared to the emissions of any individual facility or project. The approximately 160 billion tons of coal that remain to be potentially mined in the Powder River Basin, and the 272 billion tons of CO_2 which burning that coal would emit, are also very large numbers. According to the declaration by climate scientist Mike MacCracken in *High Country*, this amount, by itself, would equal ½ of the world's remaining carbon budget if the global warming is to be kept below 2 degrees Celsius. This is the amount of coal (and associated CO2 emissions) that falls within this updated

programmatic EIS. It is no longer possible to deflect an assessment of the BLS coal leasing program on the earth's climate. This PEIS must undertake that assessment.

The most important reform that the BLS can make to its coal leasing program is to require that Federal leasing of additional coal not proceed unless the minimum price for that coal per ton exceeds the Social Cost of Carbon that reflects the effect of the resulting CO_2 on the earth's climate. To achieve consistency, the Social Cost of Carbon used should be a standardized measure, or range of measures, approved by the Council of Environmental Quality.

VI. RISING CO_2 IS DAMAGING THE CLIMATE OF THE WESTERN UNITED STATES

According to the National Climate Assessment and most other climate modelling research, climate change is affecting all of the United States, but its greatest impacts are being felt in the Western United States, including Utah. There is near unanimity among the scientifically literate that these effects are being driven by the burning of fossil fuels. The largest of those drivers is coal. Heat, drought, dust, and fire are what the future holds for the American West unless America and the world quickly shift to low-carbon alternatives. A critical first step in that process is an end to subsidies in the Federal coal leasing program.

A. What the Fossil Record Says About Climate Change in the Great Basin

The majority of Utah lies in the Great Basin. The Great Basin is North America's largest desert, encompassing 135 million acres of land between the Rocky and Sierra Nevada Mountains. As Figure 1 shows, it includes parts of Nevada, Utah, Idaho, Oregon, and California.

Figure 1

Its climate is arid. Over half of the area receives less than 12 inches of annual precipitation. Its climate has fluctuated widely both on a relatively short and long time frame. It can experience extremes in precipitation in which an occasional wet year can be followed by several years of droughts and high temperatures.

National Forest Service scientists maintain that to understand what abrupt climate change is currently doing to the Great Basin ecosystem, it is necessary to understand what impacts more gradual climate change has had in the past. They describe that history briefly. See Humboldt-Toiyabe National Forest Climate Change Vulnerability Report, available at http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5294901.pdf./

At the end of the Pleistocene epoch (11,000 years ago) the Great Basin was emerging from the most recent ice age. Its climate was cool and moist. Lakes, marshes, and rivers were abundant in valley bottoms. Sagebrush, perennial grasses and forbs

(such as clover) were the dominant vegetation. Biodiversity was relatively high. Juniper and Pinyon Pine were relatively rare. Fir, spruce, and pine were more abundant than now, growing at elevations 3,000 to 6,000 lower than at present.

During the Holocene Drought (2,500 to 550 years ago), the temperature rose. Winters became mild and short. What precipitation there was fell mostly in the spring and summer. Wildfires increased. The increased heat, drought, and fire, removed much of the sagebrush/perennial grass vegetative cover. As a result, soils were stripped from the hillsides and deposited on valley floors and on side-valley alluvial fans. Streams became heavily sedimented, and streambeds had a natural tendency to incise and erode, rather than recharge groundwater. This caused a lowering of water tables.

The Holocene Drought ended with the Holocene Little Ice Age (550 to 160 years ago) when a cooler, wetter climate allowed the sagebrush/perenial grass ecosystem to recover, and the Great Basin ecosystem to heal. This process lasted until 160 years ago, when it was interrupted by two severe disturbances--man started intense grazing, mining, and logging activity, and the climate began a rapid warming trend. Now, patterns of soil erosion and stream incision reminiscent of the Holocene Drought have resumed, but they are happening much more rapidly.

B. Evidence That Current Climate Change is Abrupt

In the last 100 years, the Great Basin has warmed by 1 to 3°F and is projected to warm another 3.6 to 9°F by the end of the century. (Chambers and Pellant, 2008, pp. 29-33.) Since about 1980, winter temperatures in the western U.S. have been consistently above the historical average, and winter snow packs have declined. Periods of slightly higher than average precipitation have partly offset the effects of declining snow packs. (McCabe and Wolock, 2009.)

This pattern is consistent with general climate trends. Across the globe, winter temperatures are rising more rapidly than summer temperatures, particularly in the northern hemisphere, and there has been an increase in the length of the frost-free period in mid- and high-latitude regions of both hemispheres. (Loehman, R., 2010.)

Eighty-five percent of the water available in the Great Basin for human use comes from snowmelt. (Loehman, R., 2010). The onset of snow runoff in the Great Basin is currently 10–15 days earlier than 50 years ago, with significant impacts on the downstream utilization of this water. (Ryan, M., et al., 2008, p. 362). Annual precipitation increased slightly. (Chambers and Pellant, Id.). Future precipitation is the most difficult to

predict with existing Global Circulation Models. However, higher temperatures are predicted, which will increase evapotranspiration. The Palmer Drought Index, which measures the deficit of water compared to the needs of natural systems, is expected to increase as the region becomes more arid. (Chambers, J., 2011).

Since 1986, the length of the active wildfire season has increased by 78 days and the average burn duration of large fires has increased from 7.5 days to 37.1 days. Forest wildfire frequency is nearly four times higher and the total area burned by these fires is more than six and a half times its previous levels. (Westerling, A., 2008). In 1999, a consortium of organizations led by The Nature Conservancy identified the Great Basin as the third most endangered ecosystem in the United States. It described native sagebrush and perennial grasses, weakened by heat, drought, and overgrazing, succumbing to juniper, Pinyon Pine, and exotic annuals and weeds. These replacement plant communities are more fire-prone, shallow-rooted, and less able to hold the soil in the face of floods, winds, and drought.

These effects are expected to accelerate as global warming accelerates. Compared with other ecosystems, the impact of climate change on Great Basin ecosystems is magnified because its environment is more arid and its ecosystems are more fragile than most. Rangelands in the Great Basin exist at the margin of viability, given the uncertain timing and quantity of precipitation, the pressure from invasive species, intensified fire regimes, and increasing human population pressures. (Humboldt-Toiyabe Report, 2011).

C. Causes of Climate Trends in the Great Basin.

Among earth scientists there is nearly complete consensus that accumulating greenhouse gas emissions have the planet on a long-run path to an ever hotter atmosphere and ocean, and ever greater climate disruption. The debate about this survives only at the political level. It is kept alive primarily by commercial interests who are aware of the implications of climate science, but would be disadvantaged if this country were to deal with them seriously. As rangeland scientist Dr. Thad Box observes, the controversy between scientists and climate change critics over whether human-induced changes simply exacerbate “natural” climatic cycles or drive the major changes is irrelevant. The countermeasures required in either case are the same, and the diverts society from making the responses that it must in order to survive.

Greenhouse gases in the upper atmosphere warm the earth by allowing high-frequency radiation from the sun (which includes visible light) to pass through the atmosphere to the earth. When that radiation reflects back off the earth’s surface, it becomes low-frequency (infrared) radiation. Greenhouse gases trap the infrared radiation and recycle it as heat. If it weren’t for this property of greenhouse gases, the average

temperature on the earth's surface would be below freezing, and the earth would be far less hospitable to life. To keep the earth hospitable to life, it is necessary to keep its climate in balance. To keep its climate in balance, it is necessary to keep its greenhouse gases in balance. A large and sudden buildup of greenhouse gases has huge adverse impacts on the Great Basin's native species which are not accustomed to short winters, early snowmelt, higher evapotranspiration, and frequent, intense fires. (Humboldt-Toiyabe Report, 2011, p. 4.)

Since the industrial revolution began in the early 1800s, the atmospheric concentration of CO_2 has increased from 280 parts per million (ppm) to 400 ppm—an increase of 40%. Today's CO_2 concentrations are higher than any that have been observed in the past 800,000 years, when CO_2 varied between about 180 and 300 ppm. The concentration of methane, a more potent greenhouse gas, is now 2.5 times as high as at any time in the past 800,000 years. (National Academies of Science Brochure, p. 7, available at http://nas-sites.org/americasclimatechoices/more-resources-on-climate-change/.)

These are radical changes in the chemical composition of the earth's atmosphere. The large and sudden rise in greenhouse gases has knocked the earth's climate out of balance. Various lines of evidence point strongly to human activity being the main reason for the recent increase. The main factor is the burning of fossil fuels (coal, oil, gas) with smaller contributions from land-use changes and cement manufacture. Evidence that the global warming now underway is caused primarily by burning fossil fuels includes the consistency between the amount of total CO_2 emitted and the percent that climate models predicted would not be absorbed by natural carbon sinks, but, instead, would build up in the atmosphere. The proportions of CO_2 isotopes in the atmosphere provide a chemical "fingerprint" revealing how much CO_2 comes from natural sources, and how much from the burning of fossil fuels. Finally, the depletion of atmospheric oxygen is the amount that models predicted would result from the amount of fossil fuel that is now being burned. (Id., p. 8)

Since the injection of fossil carbon into the atmosphere began on a large scale in the late 19th Century, only 55% has been absorbed by oceans, forests, and other natural carbon sinks. Forty-five percent has remained in the atmosphere. An appropriate metaphor is to view the earth as a bathtub with carbon constantly coming out of the tap. Forty-five percent of the carbon entering the tub now spills over the rim. With no legitimate place to go, the excess carbon is flooding humanity's "house," undermining its foundation, and, ultimately, will destroy it.

Since 1750, the infrared energy that falls on each square meter of the earth's surface every second has gone up by 1.6 Watts. Over the entire earth's surface, this

extra energy amounts to 800 trillion Watts per second. In any given second, the extra heat is 50 times the amount of power produced by all of the power plants in the world combined. (National Academies of Science Brochure, p. 8.) Scientist's ask what physical mechanism could account for this huge increment of energy now being absorbed by the earth's surface. They know that over this period, the amount of solar radiation reaching the earth's atmosphere has been virtually unchanged. (Id.) There is no physical mechanism that can plausibly account for the added infrared energy that now bathes the earth's surface, other than greenhouse gases, whose concentration has gone up more than 40 percent over the same period. This is the "smoking gun" that should put an end to any skepticism that might remain among the scientifically literate about the central role that greenhouse gases play in warming the globe.

D. Calculating the Social Cost to Utah of Relying on Carbon Must Include the Effects of its Rapidly Deteriorating Climate.

The most recent fourteen years include 13 of the 14 hottest years the earth has experienced since recording of global temperatures began in 1880. As reported in March, 2013, in the journal Science, global temperatures now are warmer than at any time in at least 4,000 years. If this rate of warming continues, global temperatures in the coming decades will exceed levels not experienced since before the last ice age, which ended roughly 12,000 years ago.[33] As a result, an economic and public health catastrophe looms for the Western United states generally, and for Utah, in particular.

Putting the relevant climate science in a nutshell: Global warming has weakened the force of the giant convection cells (the Polar, Ferrel, and Hadley Cells) that circulate air from the tropics to the North Pole and back. As a result, the subtropical jet stream that brings winter snows and spring rains into the parched Western states has been weakening and retreating northward since the mid-1900s, as predicted by climate models. See http://robertscribbler.wordpress.com/2013/07/16/dr-jennifer-francis-top-climatologists-explain-how-global-warming-wrecks-the-jet-stream-and-amps-up-hydrological-cycle-to-cause-dangerous-weather/; http://www.sciencedaily.com/releases/2008/04/080416153558.htm. The result has been increasingly severe drought expanding

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[33] See news article "Global Temperature Highest in 4,000 Years," by Justin Gillis, New York Times, March 7, 2013, summarizing research published in the journal Science. [DOI: 10.1126/science.1228026, Science 339, 1198 (2013); Shaun A. Marcott et al. A Reconstruction of Regional and Global Temperature for the Past 11,300 Years.] This study reconstructed global temperatures over virtually the entire Holocene period (the period since most recent ice age). It used such proxies as the distribution of fossils of microscopic, temperature-sensitive ocean creatures to determine past climate. It suggests that changes in the amount and distribution of incoming sunlight, caused by wobbles in the earth's orbit, contributed to a sharp temperature rise in the early Holocene. Dr. Michael Mann of Penn State University points out that the early Holocene temperature increase was almost certainly slow, giving plants and creatures time to adjust. But, he said, the modern temperature spike is so sudden that it threatens the survival of many species, in addition to putting severe stresses on human civilization.

from the Southwest through Nevada, Utah, and Colorado, and now into the Northwestern states.

Added to this phenomenon is the disintegration of the polar vortex due to the rapid melting of the ice cover of the Arctic Ocean. Once a strong, coherent, and relatively predictable east-west flow, this weakened polar jet has begun to wobble erratically. It has lost so much force that the basic storm track that had traditionally moved storms from east to west across North America, has, in the past year, moved from south to north. The loss of polar ice, and the bizarre weather that it caused across the Northern Hemisphere in the most recent 12 months, were predicted by climate change models. See http://e360.yale.edu/slideshow/loss_of_arctic_sea_ice_already_influencing_weather/74/4/.

The disintegration of the polar jet allows it to "kink" or bend in on itself. This has allowed high-pressure areas of unprecedented strength and duration to form over North America. These powerful blocking highs are responsible for Superstorm Sandy and for the unprecedented drought now destroying California's agriculture. In the past two winters it has brought tropical air from the Hawaiian region of the Pacific all the way to Alaska, causing Alaska to have a higher average winter temperature than the continental United States—an upside down weather pattern that has persisted for almost a year. This same powerful blocking high pressure area allowed arctic air to spill down the eastern United States all the way to Florida, while leaving the West parched under a ridge of high pressure. See http://robertscribbler.wordpress.com/2014/01/23/arctic-heat-wave-to-rip-polar-vortex-in-half-shatter-alaskas-all-time-record-high-for-january/.

These phenomena are caused by the rising concentration of greenhouse gases in the earth's atmosphere. A recent study funded by the National Science Foundation confirms a growing body of research that finds "The atmospheric conditions associated with the unprecedented drought in California are very likely linked to human-caused climate change." The study used a novel combination of computer simulations and statistical techniques to show that a persistent region of high atmospheric pressure over the Pacific Ocean–one that diverted storms away from California–was much more likely to form in the presence of modern greenhouse gas concentrations.

The recent unprecedented droughts in the Western United States combine a reduction in precipitation with higher temperatures that increase evaporation, leaving soil parched. The NSF study notes that "combined with unusually warm temperatures and stagnant air conditions, the lack of precipitation has triggered a dangerous increase in wildfires and incidents of air pollution across the state." (Swain, D., et al., 2014)

As a result of these extreme atmospheric conditions, California's twelve-year drought has reached a severity not seen in 1,200 years. The snowpack in the Sierra Nevada, on which California relies to keep functioning during the 10-month dry season, is

6% of normal—the lowest since record keeping began. This summer, in a number of towns in California's Central Valley, there won't be enough water to drink, let alone enough to keep its orchards, vineyards, and livestock alive.

California's Central Valley produces the majority of the country's homegrown fruits and vegetables. Larry Bernstein, in an article published in the February 9. 2014, Washington Post, describes grocery and hardware stores in small towns across the Central Valley going out of business due to the drought. By some estimates, half a million acres of San Joaquin Valley farmland will lie fallow during the upcoming growing season.

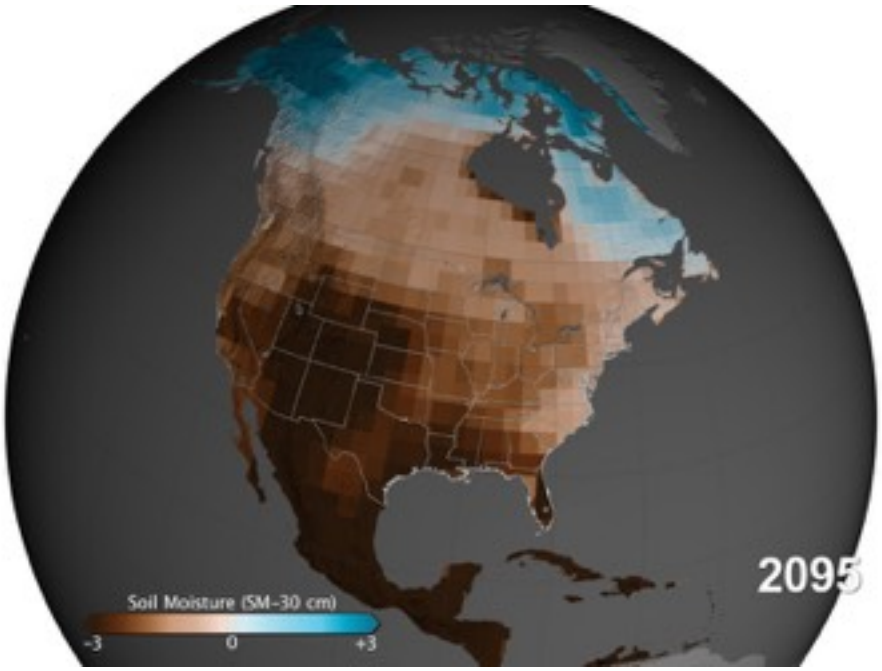
This climate disruption, traceable primarily to the historically unprecedented warming of the Arctic, is turning California's hills and valleys—the nation's grapevine, orchard, and garden—into a dustbowl before our eyes. The damage to California's agricultural industry is expected to run into the tens of billions of dollars. The water outlook for Oregon, Nevada, Arizona, New Mexico, and Southern Utah is bleak as well. See http://droughtmonitor.unl.edu/. Herds are being sold off because parched rangelands will produce no feed. In once fertile valleys, soil moisture is so low that there is no point in planting crops.

The long and severe drought in the Americaqn Southwest pales in comparison with what is coming: a "megadrought" that will grip that region and the central Plains later this century and probably stay there for decades, according to a new study by commissioned by NASA. The study takes advantage of tree-ring data in high geographic detail showing soil moisture trends going back 1,000 years. It adds those data to 17 separate climate models to estimate drought risk for the remainder of this century.

The authors report that the results were remarkably consistent across all 17 models. They lead to the conclusion that heating of the Southwest resulting from the climate effects of burning fossil fuels will dramatically increase the odds that the region will experience droughts as severe as droughts have been historically, but will last as much as ten times longer. According to lead author Ben Cook, "natural droughts like the 1930s Dust Bowl and the current drought in the Southwest have historically lasted maybe a decade or a little less. What these results are saying is we're going to get a drought similar to those events, but it is probably going to last at least 30 to 35 years." (Cook, B.I., et al., 2015)

According to the study, the severity of future droughts depends on society's efforts to reduce carbon emissions in the coming years. The study concludes that at current levels of greenhouse gasses in the Earth's atmosphere, the possibility of a drought lasting 30 years is around 12 percent. If society waits until 2050 to stabilizing carbon emissions, however, the odds that the Southwest and Central

Plains will suffer a megadrought in this century rise to 60 percent. If society does nothing to restrain the growth of carbon emissions (for example, if the BLM continues its drastic subsidies of Federal coal), the odds that these regions will experience a megadrought over the period 2050-2099 rise to 80 percent. The study illustrates the geographic reach of the megadrought predicted under the Intergovernmental Panel on Climate Change's "business as usual" long-term carbon emissions trend with the graphic reproduced below:



This is a map of predicted soil moisture 30 cm below ground projected through the year 2095 under "business as usual" long-term carbon emissions trends (the scenario that the IPCC labels "RCP 8.5.") The darker the brown color, the more depleted the soil moisture. These soil moisture data are standardized to the Palmer Drought Severity Index and are deviations from the 20th-century average.

The study's authors warn of major water shortages and conditions that dry out vegetation, which can lead to monster wildfires in southern Arizona and parts of California.

Ominously, this study is a *best case* scenario of the future impact of a "business as usual" carbon policy. The authors based their analysis only on precipitation projections, omitting the increase in evapotranspiration that

accompanies higher temperatures. They note that other studies that consider the combined impact of reduced precipitation and increased evapotranspiration on soil moisture find that:

> drought conditions like the Dust Bowl will become normal in the Southwest and in other subtropical dry zones. If such transitions are indeed "imminent," as stated in those studies, then the risk of decadal drought is 100 percent, and the risk of longer-lived events is probably also extremely high. By orienting our analysis around precipitation, the risks of prolonged drought we show here are in fact the lowest levels consistent with model simulations of future climates.

http://thinkprogress.org/climate/2014/09/04/3478274/global-warming-megadroughts/?elq=~~eloqua..type--emailfield..syntax--recipientid~~&elqCampaignId=~~eloqua.

The dire water outlook in the Southwest and Central Mid-West will require major changes to the nation's system for producing. In 2014, California began to run out of drinking water in some portions of the State. Further efforts to conserve culinary water have barely made a dent in California's water deficit because 80% of its water is currently consumed by agriculture. The reality is that California's Central Valley, which is the center of California's agricultural industry, is a desert. It continues to produce one-third of the nation's fruits and vegetables (a $40 billion industry) only by mining fossil water stored in ancient aquifers. When that non-renewable supply is gone, agriculture in the Central Valley will come to an end, and the United State will have to do without the one-third of its food supply that once came from California.

The crippling drought in California is just one example of what economists call the "external cost," or "social cost," of continuing to rely on carbon to power our nation. It is a "social cost" because neither the producer nor the consumer of carbon pays it directly—society as a whole pays it. The cost of the intensifying drought that is virtually certain to grip the Southwest and the Central Plains before this century is out is not reflected in the Social Cost of Carbon estimates developed by the EPA or the Harvard Medical School described earlier. This provides another reason for treating those estimates as lower-bound estimates.

VII. IMPACT OF RISING CO_2 ON UTAH'S ECOLOGY

The subtropical jet stream and the storms that it brings to Utah in the winter and spring, is being weakened, and pulled north, away from Utah, by global warming. Studies of precipitation and runoff over the past several centuries and climate model projections for the next century indicate that ongoing greenhouse

gas emissions at or above current levels will likely result in a long-run decline in Utah's mountain snowpack and an increased threat of severe and prolonged episodic drought in Utah, even though the possibility of occasional extreme precipitation and periodic flooding will remain. See http://www.deq.utah.gov/BRAC_Climate/docs/Final_Report/Sec1_SCIENCE_REPORT.pdf; http://robertscribbler.wordpress.com/tag/dr-jennifer-francis. What follows are just a few of the ways in which the long-run increase in heat and drought expected from climate change is likely to damage Utah's economy and the health of its citizens.

A. Impact on Sagebrush Ecosystems.

The Great Basin takes in portions of the states of Utah, Idaho, Nevada, Oregon, and California. The author Stephen Trimble memorialized the Great Basin as "the sagebrush ocean." In 1845, explorer John C. Fremont first recognized the uniqueness of the Great Basin's internal drainage and coined its name. The Great Basin covers 75 million acres. It is a series of dry, windswept valleys whose few rivers and streams never reach the sea. Instead, they flow inland to terminal lakes, marshes, and salt flats.

As Figure 2 shows, plant communities define different portions of the Great Basin. Forest communities occur at high elevations. Lower in elevation are the pinyon/juniper woodlands.

Figure 2

As elevation decreases further, the ecosystem is dominated by sagebrush, several perennial grasses, and forbs (such as clover). The lowest elevations are at the bottoms of valley basins. These areas often have very salty soils, and the only plants that can tolerate these conditions grow in salt-desert shrub communities.

Most of the native plants found in the Great Basin are relatively long-lived perennials that are slow to replace themselves when disturbed. Because of this, Great Basin rangelands have gone through cyclical vegetation changes. In sagebrush steppe communities, perennial grasses and forbs are faster growing and dominate first. Eventually, these herbaceous species give way to the longer-lived shrubs. The longer-lived shrubs persist until there is a disturbance (usually fire) which returns the rangeland to perennial grasses and forbs.

The disruptive effect that global warming is having on this cycle is summarized by the Bureau of Land Management and the National Forest Service. Rising temperatures associated with global warming have already altered the characteristics of a broad range of plant and animal species (80% of species from 143 studies). These changes include reduced species density, northward or range shifts, altered timing of organism growth and reproduction, and reductions in the diversity of species' gene pools.

There has been a rapid expansion of invasive species. This can be attributed primarily to the direct and indirect effects of climate change, including elevated CO_2 and N deposition. Changes in past and present land uses, such as intense grazing, have also contributed. Consequently, approximately 20% of the sagebrush ecosystem's native flora and fauna are considered imperiled, and the remaining components of the sagebrush-based ecosystem are in decline. (Miller and Tausch, 2000, pp. 15–30).

Prior to the 1860s, the Great Basin was dominated by a sagebrush ecosystem featuring an understory of perennial grasses (bunchgrasses). This ecosystem was resilient to drought and flood, and effective in holding the soil in place. Since 1860, much of the sagebrush ecosystem has been supplanted by pinyon and juniper woodland or by invasive annual grasses and a wide variety of thistles and other noxious weeds. (Id.)

Today, invasive annuals are displacing the native sagebrush ecosystem. This takeover is being carried out primarily by the ecologically deadly combination fire and cheatgrass.[34] In the last half of the 19th century, after the completion of the transcontinental railroad, the Great Basin saw a rapid influx of farmers and ranchers. They brought with them alfalfa seed from Europe that was contaminated with cheatgrass seed. Foreign cheatgrass thrived in the Great Basin climate, but had no natural enemies to keep it in check.

Cheatgrass is a short-rooted annual that moves in to a plant community when perennial grasses are destroyed by fire or overgrazing. Its success is based on its ability to respond with rapid growth to the brief spring wet period in the Great Basin. Once established, cheatgrass grows densely, pushing aside all competitors for moisture and nutrients. This results in unbroken swaths of short-rooted grass that dry out in mid-summer, providing a continuous source of fuel to sustain fires once they start. When fire comes, cheatgrass transforms what would have been occasional patchy burns into large-scale infernos that occur more often and earlier in the season.

Frequent, intense fires reduce the ability of many perennial plants to re-establish, furthering the dominance of cheatgrass. In this way, cheatgrass and fire perpetuate one another, and the problem magnifies itself with every reoccurring blaze. http://www.usu.edu/weeds/great_basin/ecology.html. Given the synergy between fire and cheatgrass, anything that promotes fire, including global warming, hastens the demise of the native sagebrush-dominant ecosystem of the Great Basin.

As Figure 3 shows, cheatgrass now dominates many landscapes once occupied by perennial shrubs, grasses, and forbs. The increased heat and episodes of drought associated with global warming also encourage the replacement of sagebrush ecosystems with stands of juniper and pinyon pine.

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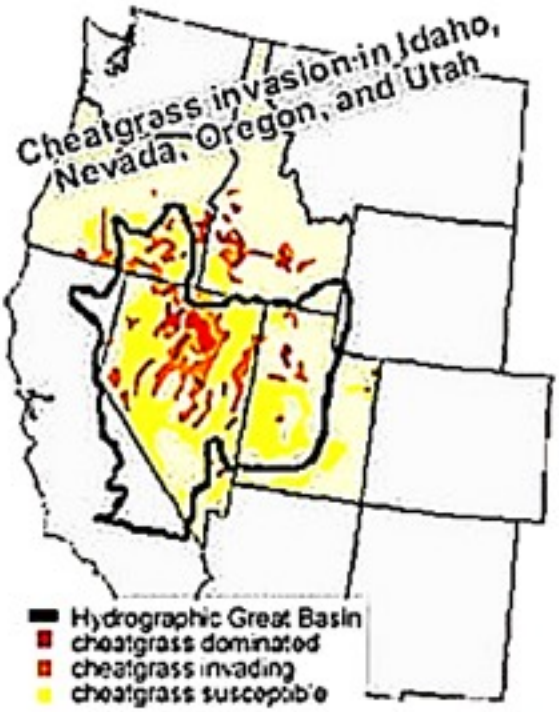
[34] Overgrazing of perennial grasses by cattle and sheep is also an important contributor.

Figure 3



Because the juniper and pinyon ecosystem is not hospitable to perennial grasses, it is less able to protect the soil against the forces of wind and water. The juniper/ pinyon ecosystem also promotes fire, especially where the stands are dense and their crowns merge. (Miller and Tausch, 2000, pp.15–30).

As discussed in more detail below, global warming is dramatically increasing the frequency and intensity of fire in the Great Basin. Increased wildfires in shrublands in the Great Basin that have been converted to cheatgrass have now transformed rangelands that were carbon sinks into carbon sources on a large scale (Bradley et al., 2006). The combined effects of increased burn area and overgrazing mean that, by the end of the century, almost 59% of sagebrush-bunchgrass communities throughout the western U.S. could be replaced by communities of annual grasses and noxious weeds, or juniper and pinyon pines.

The consequences for mule deer, pronghorn and other species that depend on the sagebrush ecosystem will be devastating. (Glick, 2006). The consequences for the Great Basin's soils will be equally grim. Juniper, pinyon, annual grasses, and noxious weeds do little to prevent fluvial erosion, and do not facilitate infiltration of moisture into soil and ground water recharge. The decline in the sagebrush-bunchgrass ecosystem in the Great Basin will expose those soils to

erosion by wind, rain, and flood. Although overgrazing, road building, and urban construction all contributing to demise of the sagebrush ecosystem, global warming is the main forcing mechanism, largely through its facilitation of fire. (Humboldt-Toiyabe Report, p. 9).

Global warming threatens the integrity of the soils of the American West in another important way. In the drier parts of the Great Basin, as well as the lower elevations of the Colorado Plateau in eastern and southern Utah, vegetation is sparse or absent. The open ground, however, is not bare, but is covered with a thin layer of biological soil crusts.

Biological soil crusts are formed by interactions between soil particles and cyanobacteria, algae, microfungi, lichens, and bryophytes (in different proportions) which live within, or immediately on top of, the uppermost millimeters of soil. The presence and activity of these biota knit the soil particles together. The resultant living crust covers the surface of the ground as a coherent, protective layer.

Biological crusts are a vital part of the Utah's two major ecological zones—the lower elevations of the Colorado Plateau and of the Great Basin. These crusts are fragile and easily damaged. These are the hottest and driest portions of the Plateau and Basin, where there is little vegetation to anchor the soil against wind and rain. In such places, soil is only held in place by the thin, dark crust formed on the surface by cyanobacteria. These tiny organisms, along with soil particles held together by materials they produce, provide the foundation for many biological processes. In addition to protecting the soil from erosion, they fix nitrogen and carbon to the soil, facilitating seed germination and plant growth. (Belnap and Lange, 2003, p. 503.)

Because of the harsh conditions of their environment, such crust can take centuries to form. When it is crushed by cattle hoofs, road grading, recreational off-road vehicle traffic, traffic associated with mining and oil and gas exploration, or urban construction, it can take centuries to re-form.[35]

They are also vulnerable to the higher air temperatures and more frequent droughts associated with global warming. Heat and drought shorten the time that these crusts can remain biologically active before they dry out. When dry, they are unable to produce or repair chlorophyll and/or pigments that would provide protection from solar radiation. (Belnap, et al., 2004, pp. 306-316.)

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[35] In southern Utah one can find places where a lone wagon cut into bioactive crusts more than 150 years ago and the wagon's ruts remain as clear and sharply defined as if they had been laid down yesterday.

The damage to these crusts caused by changes to the climate, combined with the mechanical damage from human activity, has increased erosion of Utah's desert soils. One ominous impact of this increased erosion is a substantial increase in the amount of dust that coats the snowpack of the Rocky Mountains. Dust on snow causes it to absorb rather than reflect solar radiation. It is estimated that increases in the dust that coats the mountain snowpack has reduced the flow of the Colorado River by 6%. http://www.colorado.edu/news/releases/2013/11/14/new-study-dust-warming-portend-dry-future-colorado-river. Since the population centers of Arizona, Southern Nevada, and Southern California are utterly dependent on the Colorado River, an ongoing reduction in its flow will have a major impact on those desert cities.

B. Impact on Forests.

Changes in temperature and precipitation associated with climate change are causing widespread deforestation across the globe. (Bonan, et al., 2008.) Deforestation, in turn, is responsible for 20% of the "greenhouse effect."

In the Great Basin, climate change is expected to continue to produce hotter, drier conditions at high elevations, drought-weakened trees, broader insect infestations, more frequent and more intense wildfires, and impaired forest ecosystems. White Pine and Aspen are in special peril. http://www.deq.utah.gov/BRAC_Climate/docs/Final_Report/Sec-A-1_SCIENCE_REPORT.pdf.

Of particular concern are the greatly expanded burn acreage caused by a warming climate and the effects of extreme wildfire events on ecosystems. It is estimated that increases in temperature will cause annual mean area burned in the western United States to increase by 54% by the 2050s relative to the present-day. The forests of the Pacific Northwest and Rocky Mountains will experience the greatest increases--78% and 175% respectively. The increase in the area burned is expected to cause a near doubling of wildfire carbonaceous aerosol emissions by mid-century. (Spraklen et al., DOI:10.1029.) In 2004, researchers at the U.S. Forest Service's Pacific Wildland Fire Lab looked at past fires in the West to create a statistical model of how future climate change may affect wildfires. They found that by the year 2100, the area annually burned in Montana, New Mexico, Washington, Utah, and Wyoming could be five times greater than at present. (McKenzie, et al., 2004, pp. 890-902.)

Although wildfire activity in the forests of the western United States has increased in recent decades, neither the extent of recent changes, nor the degree to which climate may be driving regional changes in wildfire, has been

systematically documented. Much of the earlier research has laid the majority of the blame on the effects of 19th- and 20th-century land-use history.

A study published in *Science* magazine in 2006 corrects this misassumption. It compiled a comprehensive database of large wildfires in western United States forests since 1970 and compared it with hydroclimatic and land-surface data. It shows that large wildfire activity increased suddenly and markedly in the mid-1980s, with higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons. It found that the greatest increases in burn areas occurred in mid-elevation, Northern Rockies forests. It noted that land-use histories have had relatively little effect on fire risks in these zones. Instead, it demonstrates, those risks are driven by increased spring and summer temperatures and an earlier spring snowmelt associated with climate change. (Westerling, et al., 2006, pp. 940-943.)

Global warming gives the various species of bark beetle an overwhelming advantage in their assaults on host spruce and pine trees. Higher temperatures benefit every aspect of the bark beetle's life cycle, from the number of eggs laid by a single female beetle, to the beetles' ability to disperse to new host trees, to individuals' over-winter survival. Higher temperatures associated with climate change speed up reproductive cycles, particularly when there are consecutive warm years. Warmer winters make it easy for spruce and pine beetles to survive even at the highest elevations. Drought-weakened trees have few defenses against the newly robust beetle populations. www.fs.fed.us/ccrc/topics/bark-beetles.shtml. As a result, bark beetle infestations destroyed 9 million acres of forest in the Western US in 2009 alone. http://www.scientificamerican.com/article/mountain-pine-beetle-damage-declines/.

In the Western U.S., as noted above, the forest fire season is 79 days longer than 25 years ago. The severity of these fires is greatly enhanced by the unchecked depredations of bark beetles. The dead tree litter caused by bark beetle infestations creates ideal conditions for catastrophic forest fires. Northern latitude forests on other continents have been similarly affected.

The impact of the loss of forests to bark beetle infestations is magnified by the fact that dead trees not only cease to absorb carbon from the atmosphere but release it back into the atmosphere as they decay.

C. Impact on Species Extinction

Current trends suggest that the fastest and most wide spread mass extinction of species in the Earth's history is very likely underway. In the tropics

alone, we may now be losing 27,000 species per year to extinction. http://www.pbs.org/wgbh/evolution/library/03/2/l_032_04.html. By the year 2050, it is estimated that 15–37% of land plants and animals will become extinct as a result of climate change. (Thomas, C. et al., 2004.) Many species will die because they will not be able to migrate to places where the climate remains suitable. Others will die because suitable habitat will no longer exist. http://www.nature.com/nature/links/040108/040108-1.html.

When viewed on an evolutionary time scale, the current pace of climate change is essentially instantaneous. For example, studies of the fossil record indicate that for tree species to adapt to the current pace of climate change, they would have to migrate to suitable habitats ten times faster than most species were able to respond to climates shifts in the past two million years. Few tree species have this ability. (Davis and Shaw, 2001.)

Species mortality has serious consequences. In plant communities, reduced diversity leads to lower productivity, less nutrient retention in ecosystems and ecosystem instability. An average plot containing one plant species is less than half as productive as an average plot containing 24–32 species. As plant diversity is lost, leaching of nutrients from the soil increases, reducing its fertility. (Tilman, D., 2000).

It is helpful to consider that the species presently inhabiting the earth are the result of over 3 billion years of natural selection that fostered efficiency, productivity, and specialization. These organisms are the agents that capture and transform energy and materials, producing, among other things, food, fuel, fiber, and medicines. These species recycle wastes, create pure drinking water, drive global biogeochemical cycles that created and maintain an aerobic atmosphere, regulate global climate by absorbing greenhouse gases, regulate local climate through plant evapotranspiration, make soils fertile, and provide other natural “goods and services.”

In addition, the Earth's biodiversity is the source of all crops and all pollinators of crops, of all livestock, and of many pharmaceuticals and pesticides. Just three crops--corn, rice and wheat--provide about 60% of the human food supply. To remain viable, these crops must remain genetically diverse. Among other things, genetic diversity ensures that strains are available that are resistant to emerging and evolving diseases and pests. In the long term, food stability will require development of new crops from what are now wild plants, because disease or pesticide-resistant pests will cause the loss of current crops, just as disease eliminated chestnuts, elms, and other tree species from North American forests.

Ours is a society that is accustomed to the availability of natural resources. We think of them as free and take them for granted. But, a decade ago, the World Resources Institute estimated an annual global price tag of $33 trillion dollars for the array of services that natural systems provide. These natural systems cannot provide these services unless they are healthy, functioning ecosystems. All of these natural systems are threatened by climate disruption.

Utah is where the Great Basin's ecosystems and those of the Colorado Plateau meet. It is where four, major, unique ecosystems intersect. As a result, despite being a predominantly desert state, Utah is ranked fifth in the nation for biodiversity. A large portion of the State is covered by the Great Salt Lake. Of all the wetlands in the United States, the Great Salt Lake may be one of the most vulnerable to climate change. The diversity of Utah's ecosystems can be expected to suffer more than the diversity of ecosystems generally as a result of climate change because its water-constrained ecological systems already exist at the margin of viability.

VIII. IMPACT OF RISING CO_2 ON PUBLIC HEALTH IN UTAH.

Climate change can be expected to harm the health of Utah residents in the following ways.

A. Impaired Respiratory Function from Increased Ground-Level Ozone.

The chemical reaction that forms ozone is, in part, heat driven. Hotter temperatures will create higher ozone concentrations. The incidence of forest fires is also heat driven. Forest fires are a major source of ground-level ozone. As forest fires become more frequent and intense, exposures to ground-level ozone will increase. The significance of forest fires as sources of ozone can be appreciated by considering that smoke plumes from forest fires in Alaska have been shown to significantly increase ground-level ozone concentrations as far away as Europe. (Real E., et al., 2007).

Ozone creates a positive feedback mechanism for global warming because ozone itself is a greenhouse gas. In yet another feedback mechanism, higher ozone concentrations retard the growth of trees, which reduces the ability of forests to absorb CO_2.

The American Lung Association estimates that at least one-third of Utah is vulnerable to the impacts of air pollution. Of a population of 2.8 million, more than 1 million are under 19 or over 64. About 230,000 have asthma, and nearly

494,000 have cardiovascular disease. The effect of ground-level ozone pollution on the delicate lining of the lungs is analogous to the effects of sunburn on the skin. It aggravates respiratory diseases like asthma, and impairs lung function in the population generally.

Until recently, high concentrations of ground-level ozone in the Mountain West had been observed only in the summer in population centers, as auto and industrial emissions reacted in the presence of sunlight and heat. Now high concentrations of ground-level ozone are appearing in the Mountain West's remote areas as well, especially in areas where oil and gas producers have recently drilled thousands of wells. Oil and gas drilling, as presently practiced, releases large quantities of ozone precursors, such as nitrogen oxide (NOx), volatile organic compounds (VOCs), and formaldehyde. http://rd.usu.edu/files/uploads/ubos_2011-12_final_report.pdf. Recently, for the first time, concentrated ozone has appeared in the winter in the remote energy development areas of Wyoming and Colorado and Utah's Uinta Basin.

Utah's Uinta Basin covers nearly 6 million acres. In winter, emissions from energy production collect in the lower atmosphere where they are transformed into ozone by interacting with sunlight and snow. Air pollution monitors installed in the Uintah Basin measured ozone concentrations exceeding federal health standards more than 68 times in the first three months of 2010. http://www.nytimes.com/gwire/2010/10/01/01greenwire-air-quality-concerns-may-dictate-uintah-basins-30342.html?pagewanted=all. Maximum 8-hour average ozone concentrations at the Ouray air monitoring station during 2013 reached 142 ppb. This exceeds federal air quality standards by 89%. http://www.deq.utah.gov/envrpt/Planning/s12.htm. For long periods of time, ground-level ozone concentrations in the Uinta Basin now exceed those of Los Angeles County, where the nation's highest ozone concentrations traditionally occur.[36]

Atmospheric currents are capable of transporting ozone and particulate matter thousands of miles away from their original sources. Ozone is showing up now in high concentrations in the air over the middle of the Atlantic Ocean. This raises the prospect that the rapidly growing supply of ozone precursors in the Uinta Basin, combined with the higher temperatures that global warming will bring, will

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[36] The Uinta Basin's average ozone concentration for 2010-2011 was 116.5 ppb (based on the NAAQS-created measurement of the fourth-highest value averaged over the two years). In comparison, Los Angeles County averaged 108 ppb over the same two years. http://www.blm.gov/pgdata/etc/medialib/blm/ut/lands_and_minerals/oil_and_gas/november_2011.Par.75557.File.dat/Email%20July%2015%202011%20Garbett%20-%20SUWA%20Comments%20Nov%202011.

increase ground-level ozone both there and in adjacent regions, such as the mountain valleys of the heavily populated Wasatch Front.

Another source of ozone adjacent to the Wasatch Front is the ultraviolet light that reflects off of the surface of the Great Salt Lake and interacts with the chemical soup produced by the refinery emissions and the vehicle exhaust emitted near the shore of the lake. This adds to the concentration of ozone along the Wasatch Front, and makes the Wasatch Front all the more vulnerable to the ozone-promoting effects of global warming.

A recent study of ozone by Utah's Division of Air Quality reports annual concentrations of ozone in the Salt Lake City of 0.079 ppb, violating the National Ambient Air Quality Standard of 70 ppb (based on the 4th highest annual 8-hour maximum). Furthermore, the study shows, ozone is expanding far beyond the areas traditionally affected by photochemical reaction. It reports ozone levels virtually as high in the parks of Southern Utah as in the urbanized North. http://www.airquality.utah.gov/Public-Interest/Current-Issues/Ozone/2012_Utah_Ozone_Study.pdf. Utah's air quality is already being affected by events and policies in other parts of the world, this trend will intensify.

A recent, landmark study led by Brigham Young University's Arden Pope has enhanced our understanding of the impact of ozone on public health. It clearly demonstrates that ozone exposure increases rates of respiratory death. Along the Wasatch Front, the study concludes, exposure to ground-level ozone increases the rate of respiratory death by about 25%. Other studies establish that ground-level ozone negatively impacts lung function across all segments of the population, including young, healthy adults, even at levels below current national air quality standards.

B. Impaired respiratory and cardiac function due to excessive heat events.

Models from climate researchers indicate that climate change will not just warm the average climate, but will also increase extreme climate events, such as heat waves. Studies show a correlation between temperature and hospital admissions for respiratory failure and for cardiac death. For example, a study published in The American Journal of Respiratory and Critical Care Medicine examined populations in 12 different European cities. For each city they found a temperature/humidity threshold beyond which each degree of increase resulted in a 4% increase in respiratory admissions for all ages, but especially those over 75.

In the summer of 2003, a heat wave in Europe killed 70,000 people within a few weeks. The similar heat wave struck Russia in 2010. In the Russian event,

monthly temperatures were more than 5 degrees Celsius above average, and daily temperatures peaked at up to 12 degrees above average, reaching over 40 degrees Celsius (104F). These conditions caused an estimated 55,000 deaths, a 25% drop in annual crop production, and a total economic loss of more than $15 billion.

An Oxford University study published in 2012 estimates that the risk of a heat wave of the magnitude of the Russian event has approximately tripled due to the warming of the globe that has occurred since the 1960s, caused mostly by increases in greenhouse gas emissions. The study concluded that this kind of extreme weather event can be "mostly natural" in terms of magnitude, but "mostly human-induced" in terms of the probability of incurrence. By modeling these distinct aspects of this event, the study was able to calculate how much human-induced climate change cost the Russian economy in the summer of 2010. http://phys.org/news/2012-02-russian-manmade-natural.html#jCp.

A study published in the Proceedings of the National Academy of Science in 2012 concluded that the global distribution of temperature anomalies has shifted toward higher temperatures, and that the range of such anomalies has increased. This has created a category of extreme summertime outliers, more than three standard deviations (3σ) warmer than the climate in the 1951–1980 base period. The distribution of such heat extremes covered much less than 1% of Earth's surface during the base period. Now, such heat extremes typically cover about 10% of the land area. The study concludes that it is extremely unlikely that the heat waves that struck Moscow in 2010, and those that struck Texas and Oklahoma in 2011, would have occurred absent global warming. http://www.pnas.org/content/early/2012/07/30/1205276109.

Global warming also increases the severity of heat waves indirectly. Using broad measurements taken in southeastern Europe, a study demonstrates that the moisture contained in soils acts as a heat sink, absorbing heat until the moisture in the soil is exhausted. The study concludes that compared to wet summers, the frequency of very hot days increases tenfold in summers with dry soils. Soils dried out by heat and drought associated with global warming cannot function as a heat sink to moderate regional heat waves when they occur. http://www.ethlife.ethz.ch/archive_articles/101213_hitzewellen_paper_ga/index_EN. As the climate warms, Utah can expect to experience extreme summertime "heat wave" events similar to recent heat waves in Europe, Russia, Texas, and Oklahoma. It cannot expect to have moist soils to mitigate these events.

C. Hazardous substances distributed by dust pollution.

As described earlier, hotter temperatures and reduced precipitation expected in the Great Basin as a result of climate change is likely to result in widespread loss of native vegetation in the already water-stressed Great Basin. This can be expected to expand the sources of dust, or particulate matter pollution, to which Utah residents are exposed. Earlier this spring, for example, a storm moving in from the Great Basin filled the atmosphere with enough dust to send levels of fine particulates in northern Utah ten times higher than the EPA maximum limit. Kinds of particulate exposure that are likely to increase as a result of global warming, and the additional threats that they pose to the health of Utah's residents, are discussed below.

Erionite exposure

Erionite is a mineral that forms long fibers that have an effect on the lungs similar to asbestos, producing Malignant Mesothelioma (MM). Before discussing the hazards associated with exposure to erionite, it would be useful to review several key technical facts about MM. MM is a rare and unusually deadly form of cancer that develops from cells of the mesothelium, the protective lining that covers many of the internal organs of the body.

Most often MM develops in the pleura (the outer lining of the lungs and internal chest wall), but it can also develop in the peritoneum (the lining of the abdominal cavity), the pericardium (the sac that surrounds the heart), or the tunica vaginalis (a sac that surrounds the testis). MM has a latency period of from 30 to 60 years. This tends to obscure both its sources, and its prevalence. Despite the various forms of treatment available (chemotherapy, radiation therapy, sometimes surgery), MM carries a poor prognosis once contracted.

MM is most commonly caused by exposure to asbestos, but exposure to erionite is a far more potent cause. Erionite is a fibrous mineral with properties similar to asbestos. Animal studies, however, have shown it to be 300 to 800 times more carcinogenic than asbestos. (Wagner, et al.,1985, pp. 727-730). It is the most toxic naturally occurring fibrous mineral known. (Pass, et al., 2005).

Erionite was first recognized as a serious health hazard in the 1980s and found to cause the same types of cancer and interstitial fibrosis as asbestos. In villages in Turkey contaminated with naturally occurring erionite, the rate of cancer is about 1000 times the normal rate. Three villages there are known locally as "cancer villages" because MM was the cause of 40 percent to 50 percent of all

deaths. (Baris, et al.,1978, pp. 181-192). Epidemiological studies linked these high concentrations of MM to exposure to erionite released into the air from the soil and rock formed from the local volcanic tuff. (Int. J. Cancer 39, 1987, pp.10-17); Proceedings of the National Academy of Sciences, (June, 2011) www.pnas.org/cgi/goi/10.1073/pnas.1105887108.

The ambient fiber concentrations that produced this extraordinarily high incidence of MM were very low. This, together with the prevalence of erionite in other parts of the world, indicated an urgent need to develop animal models to investigate the relationship between erionite and MM.

Erionite is one of a group of silicate minerals called zeolites. It is usually found in volcanic ash that has been altered by weathering or exposure to alkaline ground water. Like naturally occurring asbestos, zeolite beds containing erionite are present in many Western states. Figure 4 shows that Utah lies in the center of an arc of erionite that sweeps from Arizona through Nevada and Oregon to Montana and North Dakota.

Figure 4

The Great Basin is uniquely suited to the formation of erionite in that a great deal of volcanic ash has accumulated in the valley basins. The permanent saline, alkaline lakes and playas provide ideal circumstances for the volcanic ash to transform into zeolites. When eronite is disturbed, it can release fibers into the air that cause MM. An environmental survey confirmed that erionite was the main component of the fibers in the airborne dust in the “cancer villages” of Turkey. It also confirmed that the source of the erionite fibers was poorly consolidated, incompletely formed rock. (Wagner, J. et al., pp. 727-730)

A systematic survey of the characteristics of the many erionite deposits in Oregon, Nevada, and California that are generally upwind of Utah has yet to be made. Therefore, it is not known how many of them consist of poorly consolidated rock that was characteristic of erionite outcroppings in Turkey, which is prone to weathering and release into the air.

It is known that erionite-containing gravel has been mined and used for road building in locations in eastern Oregon and western North Dakota, and these roads are now sources of windborn erionte-laden dust. Erionite- contaminated gravel in North Dakota has resulted in levels of exposure similar to what was found in Turkish villages ravaged by mesothelioma cancer. (Carbone, et al., 2011, pp. 13618–13623). The first North American with erionite-related lung disease was recognized in Utah and reported in 1981. (Weissman and Keifer, 2011). The patient was a road construction worker who lived in an area rich in zeolite deposits. He had extensive parenchymal and pleural fibrosis and had a lung biopsy revealing the presence of both fibrous particles which were found to be consistent with erionite.

The toxicity of even small amounts of erionite is established. The facts described above also demonstrate a risk that Utah’s residents are being exposed to erionite-laden dust from the many deposits that are upwind of the State. What is needed now is a systematic study of levels of exposure in the western United States and any correlation between levels of exposure and the incidence of MM. Outside of North Dakota, however, such studies have yet to be funded. Seeing this need, Dr. William N. Rom, currently director of the pulmonary division at the New York University School of Medicine, and Dr. Kenneth R. Casey, now at the University of the Cincinnati College of Medicine, requested a grant from NIH to conduct such studies. Their request was rejected.

The people of Utah are at risk from the failure to conduct such studies. As noted, erionite deposits are prevalent in the parts of the Great Basin that are upwind of Utah. It is entirely possible that erionite occurs in loose, weathered

outcrops that are susceptible to natural dispersion by dust storms. In addition, roads, mines, pipelines, power lines, wind and solar farms, and recreation sites, are proliferating in those areas, making it likely that such activity will unwittingly disturb erionite and release it into the air. Because exposure to erionite is not regulated, there are no applicable Federal standards to enforce. Federal agencies have failed to alert land-use officials, developers and residents of affected areas to look for erionite outcrops or to avoid disturbing them by their development activity. For these reasons, there is a compelling need to inventory erionite deposits and assess their susceptibility to both man-made and natural dispersion.

If there are weathered erionite outcrops or artificially disturbed erionite beds upwind of Utah, they place Utahns at risk of inhaling erionite fibers and contracting MM. It is probable that climate change, by damaging the vegetation and biological crusts that now hold the soil of these regions in place, will increase Utahn's exposure to dust-borne erionite. The risk that dust containing erionite (and a wide range of other hazardous substances that contaminate Nevada's soil) will be carried to Utah's population centers will be much greater if Las Vegas goes ahead with its plans to dewater central Nevada and Western Utah.

Radionuclide exposure

In 2006, the Federal government announced plans for a non-nuclear bomb test in Nevada dubbed "Divine Strake." Utahns sent ten thousand letters to the Federal government opposing "Divine Strake," most of them citing the risk that radioactive contaminated dust would drift into Utah. Divine Strake was cancelled due to public opposition and pressure from Utah's Governor Jon Huntsman. Increased desertification from climate change, made worse by Las Vegas's plan to drain nearby acquirers, would increase the risk that radionuclides will be dispersed downwind from the radioactive test sites.

Over 900 above-ground nuclear bomb tests occurred at the Nevada test site in the mid-20th century. The Department of Energy (DOE) also conducted numerous "safety tests" in which it blew up mock nuclear war heads. While not nuclear explosions, safety tests caused significant contamination of the surface with plutonium. Nuclear "rocket tests" added additional radioactive contamination.

In terms of cumulative effects, the contamination from above-ground testing, along with the safety shots, and cratering events, left an estimated 27,000 acres (42 square miles) of surface soils contaminated at levels in excess of 40 pico curies per gram (20). (Walker, et al., 1998). Underground tests, which continued until 1992, also released significant radioactivity into the atmosphere.

DOE has stated that it is not possible to fully define the level of residual contamination that remains from the atmospheric testing program, but admits that radioactive isotopes that are still in Great Basin soil include americium, plutonium, uranium, cobalt, cesium, strontium, and europium. (Id.)

Some of these radioactive elements are alpha-emitters, some of the most carcinogenic substances known. To illustrate this point: since 1943, the military has been aware of the extreme toxicity of uranium as a gas. In a document dated October 30, 1943 and declassified June 5, 1974, three major scientists from the Manhattan Project, Drs. James Conant, A. H. Compton, and H. C. Urey wrote to Brigadier General Leslie R. Groves, who was the head of the atom bomb project, concerning "Radioactive Materials as a Military Weapon." In that document they stated:

> As a gas warfare instrument the material (uranium) would be ground into particles of microscopic size to form dust and smoke and distributed by a ground-fired projectile, land vehicles, or aerial bombs. In this form it would be inhaled by personnel. The amount necessary to cause death to a person inhaling the material is extremely small. It has been estimated that one millionth of a gram accumulating in a person's body would be fatal. There are no known methods of treatment for such a casualty.

Uranium was also recommended as a permanent terrain contaminant which could be used to destroy populations by contaminating water supplies and agricultural land with radioactive dust. http://www.mindfully.org/Nucs/Groves-Memo Manhattan30oct43.htm. One millionth of a gram of uranium yields 1,000 alpha particles per day, each alpha particle carries over 4 million electron volts, and it takes only 6-10 electron volts to break a DNA strand.

The longer-lived radioactive elements, including plutonium, Cesium 137, and Strontium 90, bioconcentrate as they rise up the food chain, reaching concentrations as much as thousands of times higher in meat and milk, including human breast milk. Humans reside at the top of the food chain, especially human embryos.

Once ingested, these radioactive elements continue to bioconcentrate, accounting for their distinctive carcinogenic patterns and enhancing the toxicity of low dose exposures. Strontium concentrates in bone, bone marrow and teeth, resulting in bone cancers and leukemia. Cesium resembles potassium, which is ubiquitous in every cell. It concentrates in brain, muscle, ovary and testicles, leading to brain cancer, muscle cancers (rhabdomyosarcomas), ovarian and testicular cancer. Most importantly, Cesium 137 can mutate genes in eggs and sperm, causing genetic diseases in future generations.

The Nevada Test Site and other nuclear test areas are shown in Figure 1. Figure 5, taken from a 1997 National Cancer Institute study, shows the pattern of deposition of all of the Plutonium dust released from those sites.

Figure 5

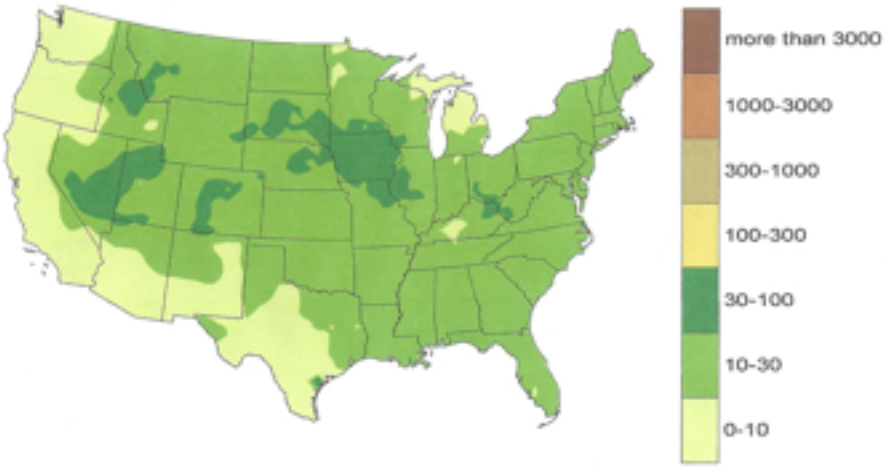

Figure 3.4. Plutonium (239+240) deposition density (Bq/m^2) due to all NTS tests.

The six test main series which took place in 1951, 1952, 1953, 1955, 1957, and 1962, deposited different amounts of fallout within the United States. For example, the 1957 Plumbbob series deposited 35% of the total cesium followed by the 1953 Upshot-Knothole series that contributed 23%. These proportions are shown in Figure 3.5.

Of all the alpha emitters, Plutonium is the most deadly. If inhaled, it is transported from the lung to thoracic lymph nodes where it can induce Hodgkins disease or lymphoma. Because it is an iron analogue, it combines with the iron transporting protein and concentrates in the liver, causing liver cancer, and the

bone marrow causing bone cancer, leukemia, or multiple myeloma. It also concentrates in the testicles and ovaries where it can induce testicular or ovarian cancer, and/or mutate genes to induce genetic disease in future generations.

Plutonium can cross the placental barrier which protects the embryo. Once lodged within the embryo, one alpha particle could kill the cell that would eventually have formed the left side of the brain, or the right arm, as thalidomide did years ago. The half-life of plutonium is 24,400 years, so it can cause harm for 500,000 years; inducing cancers, congenital deformities, and genetic diseases for the rest of time, not only in humans, but in all life forms.

The Nevada Test Site has a "Soils Program" to determine the extent of surface contamination and develop mitigation plans for these areas, which may involve soil removal. Prior to 2006, there was an estimated 20-25 million cubic feet of plutonium-contaminated soil at the NTS and the adjacent Tonopah Test Range. How much of that remains is unclear.

It is estimated by the National Nuclear Security Administration that about 3,000 acres are contaminated with plutonium at levels in excess of 40 pCi/g (with some areas in excess of 12,000 pCi/g) left by the "safety tests." In a 2003 document, all of the safety test areas were to have been cleaned up by 2006 to a "target level" of 200 picograms plutonium per gram of soil (a picogram is one-trillionth of a gram). While this level seems very small it is still 4 times the clean-up level for Rocky Flats. Over time some of the longer-lived radioactive particles have been taken up by plants in the area or concentrated in drainage gullies. The Site Wide Draft Environmental Impact statement for the NTS does not say whether these sites have been cleaned up. It does say that there is a target date of 2022 for all the soils sites to be "closed." Unfortunately, DOE does not say what level of clean-up will be achieved at a "closed site" in its public documents. Nevada Test Site Public Information Brief - March 2012. http://www.h-o-m-e.org/nts-vision-project/nts-briefing-paper.html.

An article published in 1979 in the Washington Post quoted Utah scientists stating that in the 1950s, plutonium was spread across the most densely populated part of Utah (the Salt Lake City area) that produced levels of plutonium as much as 3.8 times higher than concentrations elsewhere. These scientists were surprised that plutonium was found in such large quantities. The scientists attributed it to the safety tests in which mock warheads were blown up. A study conducted in the 1990s by a Nevada graduate student found plutonium dust in the attics of homes in Las Vegas and other towns in Nevada and Utah. He also attributed this contamination to the safety tests.

The dirtiest of all the safety tests was 'Project 57,' which contaminated Nevada Test Site's Area 13 with four times more Curies of radioactivity than the average at nine other safety test sites. At Area 13, hundreds of acres of soils are contaminated at the level of 46 Curies – a level immensely higher than that which would provide a fatal dose to humans. The plume cloud from Project 57 went north-northeast and deposited just over 200 Curies of plutonium over a large area extending towards Ely, Nevada, and into Utah, and possibly Salt Lake City.

Since plutonium concentrations greater than 10 picoCuries (10 trillionths of a Curie) per gram are fatal for humans, there are a lot of 'hot' areas at Area 13, and downwind of that area in Nevada and Utah, that still contain dangerous levels of plutonium.[37] The danger will remain for the next 240,000 years. Ninety-nine percent of the plutonium particulates at Area 13 (and possibly elsewhere) are small enough to be picked up by wind. Area 13 has yet to cleaned up and the plutonium there keeps on getting resuspended into other areas that don't have radiation monitoring equipment. The current monitoring network run by DOE cannot detect alpha or beta radiation (e.g., plutonium 239). (Wilshire, et al., 2008, pp. 395-398).

Utahns, both in the Southern and the more heavily-populated Northern end of the State, were, and still are, "downwinders." Many residents of the St. George and the Salt Lake City areas were heavily exposed at the time of the tests. Some are still dying from that exposure. The lack of data and fallout maps regarding these safety tests has prevented the public from appreciating the seriousness of ongoing risks of radiation-induced illness that lingers from the atomic tests that were conducted upwind of the State. The Department of Energy has yet to provide comprehensive data that would allow the risk to be quantified. The DOE's environmental analysis of Area 13 remains incomplete and its environmental cleanup of the area has stalled. The DOE should complete a new, full-blown EIS for the Nevada test sites to address these lingering radiation hotspots, the dangers of resuspension, and the lack of adequate airborne radiation monitoring in and around downwind communities.

It is almost certain that dust storms from the Great Basin still deliver radioactive isotopes to the environment where millions of Utah's residents live. While the risk of radionuclide contamination has not been quantified, we do know that the risk that contaminated soil will be resuspended in the atmosphere and exported beyond the original deposition site rises dramatically where the size of

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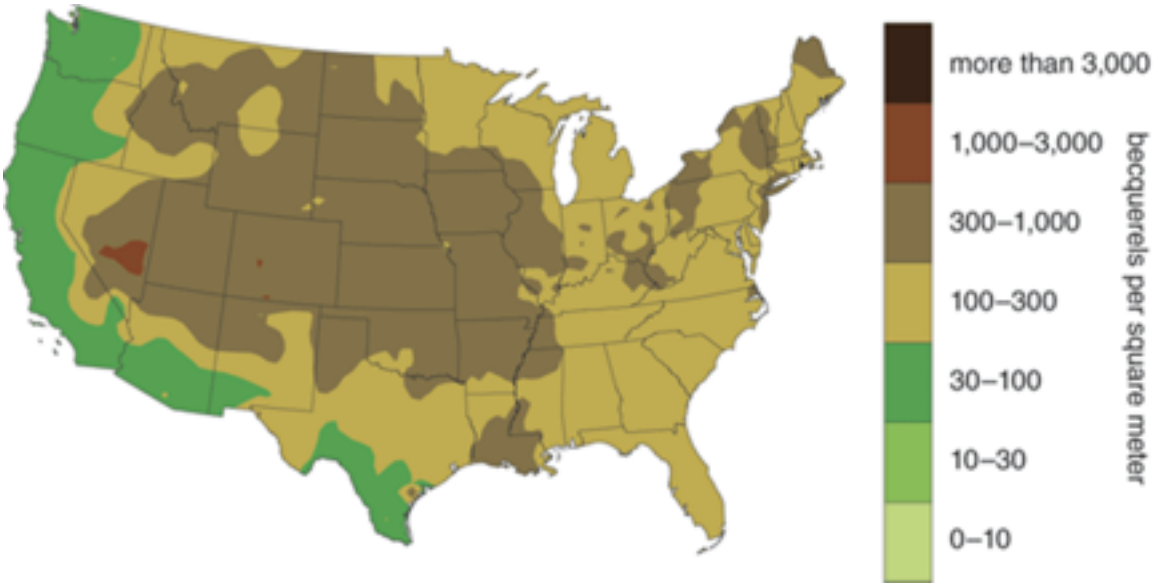
[37] Figure 4 shows that the region of highest Plutonium soil deposition covers the region that Las Vegas plans to dewater with its groundwater pumping project. With the predictable die off of the vegetation cover of this region, its Plutonium-contaminated soils can be expected to become airborne during periods of high wind.

the particles of contaminated soil are small, the soil has been mechanically disturbed (by grazing animals' hooves, road cuts, etc.), or the surface has been subjected to fire. (Gilbert, et al., 1988, pp. 869-87). DOE should conduct a survey of the deposition region that collects data on all of these characteristics to inform future land use plans.

Figure 6, taken from a 1997 National Cancer Institute study, shows the pattern of soil deposition of cesium-137, a radionuclide traditionally used for reference, resulting from all NTS tests in the entire United States.

Figure 6

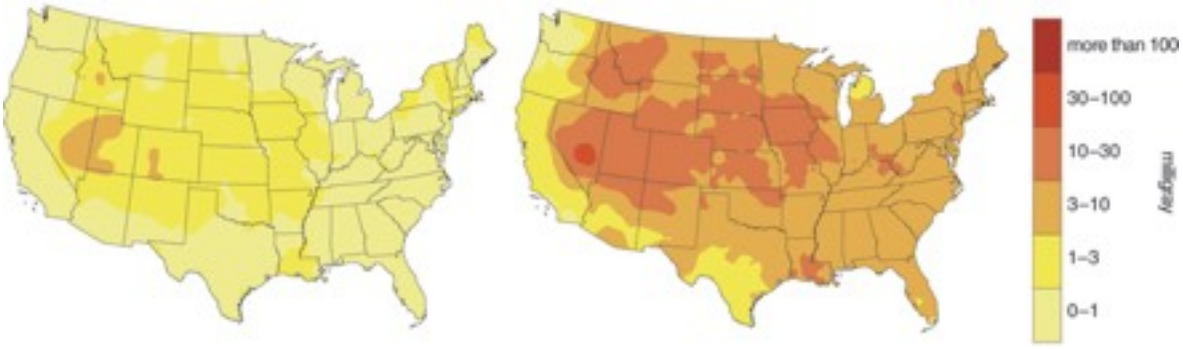


Cesium-137 deposition density resulting from the cumulative effect of the Nevada tests. Data from 1997 National Cancer Institute study.

Fallout decreased with distance from the NTS along the prevailing wind direction, which was from west to east. Very little fallout was observed along the Pacific coast, which was usually upwind from the NTS. The soil deposition of Strontium 90, another long-lived radionuclide, is virtually identical to that of Cesium 137. (Dept. of Health and Human Services, 2005).

Estimated internal doses of Cesium 137 absorbed by bone-marrow and the thyroid gland are illustrated in Figure 7 on the left. External doses are illustrated on the right. The internal doses present the greatest health risk. The fact that both external and internal doses were roughly proportional to the deposition density is reflected in similarities between the two figures.

Figure 7



Total external and internal dose to the red bone marrow of persons born on January 1, 1951, from all Nevada tests is shown at left. Data from NCI 1997.

In a 2009 masters thesis, a study was conducted using soil samples from Utah's Washington County to determine how much Cesium 137 still exists there. Over a hundred soil samples were collected and analyzed. Only one did not have detectable amounts of Cesium. The author noted that several of the samples contained levels substantially higher than earlier estimates would have predicted, which led him to conclude that doses to the public from the testing could also have been higher than had previously been estimated. http://ir.library.oregonstate.edu/xmlui/handle/1957/9293.

If Cesium 137 is still that prevalent in soil in Washington County, Utah, one can assume that it, and other long-lived radioactive isotopes, would be all the more prevalent in soil in the area of the State where aquifers would be drained, parts of which are closer to the Nevada Nuclear Testing Site. The combined effects of global warming and aquifer draining could well destroy the vegetative cover that

keeps those soils in place. Windstorms could then carry that radioactive dust to the Wasatch Front, as air currents did during the bomb testing of the 1950s.

Science has established that there is no safe level of radioactivity exposure. The National Academy of Sciences Biological Effects of Ionizing Radiation (BEIR) Report VII from 2005 states,

> [a] comprehensive review of available biological and biophysical data supports a “linear-no-threshold” (LNT) risk model, that the risk of cancer proceeds in a linear fashion at lower doses without a threshold and that the smallest dose has the potential to cause a small increase in risk to humans.

Radiation damage is cumulative and each successive dose builds upon the cellular mutation caused by the last. One mutation, in one gene, in a single cell, if unrepaired, can result in a fatal cancer. Many cancers, especially solid tumors, and other genetic diseases have a latency period of many decades. Utah residents are still contracting new cancers from the original nuclear testing program conducted more than 50 years ago.

Even small increases in risk per person become significant public health hazards in the aggregate, when large numbers of people are exposed. In other words, when millions of people are exposed to slightly increased risks, there will be thousands of new victims.

It should be emphasized that cancer is not the only health risk of radiation exposure. Cardiovascular disease causing heart attacks, strokes and diseases consequent to immunosuppression are all correlated to radiation exposure, as are any diseases related to chromosomal dysfunction, such as birth defects. Children are much more susceptible to radiation-caused health effects and human embryos, especially during early gestation, are perhaps thousands of times more at risk for genetic mutations from radiation exposure than are adults. There are over 2,600 diseases described in the medical literature caused by genetic mutations. Once they occur, mutations are, in a sense, immortal. They are passed down from generation to generation in perpetuity, impacting the health of future generations.

The radioactive contamination from nuclear testing still present in Great Basin soil and dust has medical ramifications that will never cease. It will affect the health and viability of future generations forever; inducing epidemics of cancer, leukemia and genetic disease. There is a critical need for a systematic survey of concentrations of residual radioactive isotopes in the surface soil of the Nevada nuclear test sites and adjacent contaminated areas so that modeling could be done to assess potential public exposure to radioactive dust from those sites should

future climate change and aquifer draining combine to destroy the vegetation that now holds those soils in place.

Mercury exposure

On a per-weight basis, mercury is considered the most toxic substance on earth, after plutonium, and the most toxic natural heavy metal. The exposure of Utah's residents to mercury can be expected to increase as a result of the effects of climate change in all parts of the globe. Mercury has become a ubiquitous contaminant of the global environment primarily because of industrial emissions from coal power plants and cement production plants. As the arctic thaws, mercury from those sources that is now trapped in ice will be released into the global atmosphere.

Forest fires release mercury as well. As the forest fire season becomes longer and more severe, mercury contamination will increase. New studies also suggest that the particulate matter component of forest fire pollution may be as much as ten times more toxic than industrial or vehicle pollution--due, in large part, to its mercury content. A potential source of additional exposure to mercury is windblown dust from the surface soils of central Nevada which have been contaminated by mercury released during the smelting phase of the numerous gold mine operations in the region.

Mercury is a potent neurotoxin. In one out of six U.S. women of child bearing age, it is already in high enough concentrations that any child conceived would be at risk for some loss of intellectual function. Mercury contamination of fish is already ubiquitous throughout the US. A recent US Geological Survey demonstrated mercury contamination of every fish that was sampled from over 300 streams and rivers in the country. Utah already has a serious problem with environmental mercury contamination. The fish in most of its lakes and streams have so much mercury that they are unsafe for human consumption.

The Great Salt Lake has the highest level of mercury of any inland body of water measured in the United States. Because of toxic mercury levels found in ducks along the Great Salt Lake ecosystem, Utah has the nation's only advisories against eating waterfowl. http://articles.latimes.com/2008/aug/10/news/adme-saltlake10. As Utah's climate becomes hotter and dryer, the level of the lake will inevitably drop, exposing more of the contaminated lake bed to windstorms, increasing the mercury exposure of the people that inhabit the Wasatch Front. As noted below, the Great Salt Lake Minerals Corporation plans to triple the size of its

evaporating ponds. If that plan is implemented, it will lower the level of the lake still further, exposing more contaminated lake bed, further increasing the public's exposure to windblown heavy metals, including mercury and selenium.

Particulate exposure

As described above, climate change can be expected to lead to further desertification of the Great Basin, threatening to turn it into a dust bowl. This is especially true of central Nevada, which lies upwind of the Wasatch Front, and faces the prospect of disastrous drying out and ground cover die off due to Las Vegas's plans to drain those aquifers.

The Southern Nevada Water Authority (SNWA) is aggressively pursuing permission to build pipelines to drain the aquifers of central Nevada and western Utah and transfer the water to Las Vegas. The proposed pipeline would cost more than $15 billion. It would run from Las Vegas 285 miles to the northeast to Spring Valley with three primary laterals connecting Spring, Snake, and Cave Valleys to the pipeline. It would pump up to 180,000 acre feet from valley wells. It would be the biggest groundwater pumping project ever built in the United States. It would have devastating ecological impacts across vast areas of central Nevada and Western Utah.

The basic premise of the project is to mine water from valleys that receive 6 inches of rain a year, to supply a region that gets 4 inches of rain a year. There is no surplus water in these valleys. This is evident from the effect that pumping much smaller amounts to water livestock and crops currently has. This amount of pumping is trivial compared to what SNWA proposes, and it already has caused springs and marshes to dry up. The Snake Valley is known for its fierce winds that can blow as much as 70 miles an hour for anywhere from several hours to several days. According to Snake Valley rancher Dean Baker:

> Virtually any level of pump irrigation here leaves nearby springs dry, and the vegetation dies. And once the vegetation goes, the dust will really start blowing around. If the pipeline dries this county up, and I'm certain the water just isn't there, then what happens?"

(PLAN Report, 2006, at 40). These valleys already live on the margin of viability. Every acre-foot of water taken can be expected to cause plants or animals currently living in these ecosystems to die.

Groundwater is the source of seeps and springs. It can be a major source of marshes, streams, and lakes, as well, which is why these often dry up when groundwater wells are pumped. The aquifers under these valleys are a connected system, so that draining the groundwater under one valley can dry up another. Seventy percent of the 100-mile-long Snake Valley lies in Utah, so this project would dewater a substantial portion of Utah as well. The balance of aquifer systems is delicate, and the balance of desert areas is often extremely delicate. It doesn't take much disruption to wreak havoc, as the history of similar dewatering projects in the United States and elsewhere shows.

If this $15 billion project is built, it will become a beast that must be fed. Rather than be allowed to sit empty, it will be put to work mining water, regardless of the ecological damage that such mining might do. This will accelerate the decline of central Nevada's sagebrush-bunchgrass ecosystems that is already underway due to climate change, and is likely to convert a large portion of central Nevada and western Utah into a dust bowl.

There is also an application before the Army Corps of Engineers by the Great Salt Lake Minerals Corporation for permission to greatly increase the amount of Great Salt Lake water they are allowed to divert to settling ponds for mineral extraction. If that is allowed, the water level will drop and thousands of acres of dry beach will be exposed. This will create an additional source of new dust pollution contaminating the air shed of the Wasatch Front whenever a storm front moves through.

When evaluating the likely effects of climate change on the health of the people of Utah, it is prudent to consider how the Dust Bowl formed in the Great Plains in the 1930s. It is also essential to consider why projects of the kind proposed by SNWA have already turned the Owens Valley and the Aral Sea to dust.

In his book, "The Worst Hard Time", Pulitzer Prize winner Timothy Egan chronicles the nightmare of the 1930s Dust Bowl, arguably the world's worst environmental disaster. For nine years tsunamis of dust pounded the Great Plains. Sometimes they lasted for weeks at a time, reached 10,000 feet high and blew as far east as the middle of the Atlantic Ocean. Because dirt coated every indoor surface, house cleaning began with a shovel. People and animals trapped outside in the storms risked blindness or suffocation.

Woody Guthrie wrote a song about the chronic "dust pneumonia", a lung disease that sickened or killed thousands of Midwesterners, especially children. In some counties one third of all deaths were due to "dust pneumonia." Heat waves

led to plagues of insects. For mile after mile not a single green leaf survived as waves of grasshoppers devoured any plants that survived the weather.

The Dust Bowl of the 1930s had three ingredients: unusual heat and drought, coupled with land use mismanagement. With roots 18 feet deep, native prairie grasses had kept the soil in place for centuries. But, encouraged by ignorant government agencies and greedy real estate speculators, settlers were duped into plowing under native grasses to plant winter wheat that had no chance to survive extreme conditions.

The same three ingredients that led to the formation of the Dust Bowl are now coming together in the Great Basin. As noted earlier, climate modeling predicts that if CO_2 emissions are not quickly curtailed, the result will be a high probability that the Southwest and the Central Plains will experience megadroughts—droughts of the intensity of the dustbowl of the 1930s, but lasting three times as long. If SNWA's groundwater mining project is implemented, it will supply the third ingredient that led to the Dust Bowl--land-use mismanagement and the loss of native vegetation that for centuries anchored the soil.

In the 1930s the ecological disaster of the Dust Bowl got very little attention in Washington, D.C., until the dust started filling the skies and affecting the air quality of the Nation's capital. But despite reform of Federal land use policies, the Dust Bowl of the 1930s did not end until rain finally returned to the Great Plains. The Great Basin is not likely to see rain reverse the environmental damage that draining its aquifers will cause.

The desiccated bed of Owens Lake has become the largest source of particulate air pollution in the United States. It has set the record for particulate concentrations measured in the U.S. Keeler, California is the nearest town, 60 miles away. It experiences particulate pollution that violates the NAAQS about 25 days per year. Dr. Bruce Parker, one of the emergency room physicians at Ridgrecrest Community Hospital made this statement:

> When we see the white cloud headed down through the pass, the ER and doctors' offices fill up with people who suddenly got worse. It's pretty straightforward cause and effect. http://geochange.er.usgs.gov/sw/impacts/geology/owens/.

An additional health hazard presented by the particulate pollution generated in the Owens Valley is arsenic and other trace metals carried by the dust. These appear in concentrations as high as 400 ng/m3. http://geochange.er.usgs.gov/sw/impacts/geology/owens/.

The history of Kazakhstan's diversion of the inlet waters to the Aral Sea must also be considered when examining the consequences of climate change coupled with the planned draining of central Nevada's aquifers. Called one of the world's worst environmental disasters by the UN's Secretary General Ban Ki-Moon, the Aral Sea is now 10% of its original size. Due to increased dust storms generated in the now-dry lake bed, respiratory illnesses, including drug resistant tuberculosis, brucellosis, cancer, digestive disorders, anemia, and infectious diseases are now common ailments in the region. Liver, kidney and eye problems can also be attributed to the toxic dust storms. There is an unusually high fatality rate amongst vulnerable parts of the population. The child mortality rate is 75 in every 1,000 newborns, and the maternity death rate is 12 in every 1,000 women.

In 2002 the UN estimated that winds carried an average of 200,000 tons of salt and toxic dust every day throughout the Aral Sea region and thousands of miles beyond, as far as Russia's arctic north. The dust is heavily polluted with herbicides, heavy metals, and salt. http://www.columbia.edu/~tmt2120/impacts%20to%20life%20in%20the%20region.htm; http://www.reuters.com/article/2008/06/24/idUSL23248577.

Average life expectancy in the Aral Sea region has declined from 64 to 51 years. Reproductive pathologies and adverse pregnancy outcomes are much higher than the rest of the former USSR and present-day Russia. Eighty-seven percent of newborn babies are anemic and 5% have birth defects. Ataniyazova, O., 2003). Health authorities in the area are largely in agreement that the newly formed dust bowl and the toxic chemicals contained in the dust is the primary cause of these disturbing public health trends.

Some skepticism is natural that dust originating in central Nevada could travel 200 miles downwind to be deposited on the Wasatch Front. PM10, however, can be transported more than 1,000 km even in light storms. (Tsoar and Pye, 1987, p. 139-153.) Researchers from the University of Washington found that dust from the Gobi and Taklimakan deserts in China is routinely present in the air over the western United States. http://www.sciencedaily.com/releases 2007/12/071213000427.htm. The National Weather Service has stated that dust generated in the Gobi Desert affects the air quality and sunsets visible in Utah. http://www.usatoday.com/weather/news/2001/2001-04-18-asiandust.htm. Researchers from the University of California at Davis, using a monitoring station at the top of Donner Summit, concluded that most of the particulate pollution measurable over Lake Tahoe originates in China and that one third of it is dust from drought and deforestation. http://www.sierrasun.com/article/20060731/NEWS/60731006. NASA has documented that forest fires in Russia and Canada have

created a poisonous ring of particulate pollution around the entire planet. http://www.thehindu.com/news/internationalarticle566562.ece.

As noted above, dust from the Southwest has already been shown to hasten the melting of snow in the Rocky Mountains, reducing the amount of runoff into the upper Colorado River by 6%, ultimately causing a loss of 250 billion gallons of water a year. http://latimesblogs.latimes.com/greenspace/2010/09/colorado-river-water-california-dust-grazing.html; (Painter T, et al., 2010, pp. 17125-17130. Dust from the Sahara Desert is regularly transported to Europe. In fact, a recent study demonstrated that Sahara Desert dust is frequently responsible for violating the European Union's standard for PM10. Furthermore, a study of over 80,000 residents in Rome, Italy, found increased death rates from cardiac, respiratory, cerebrovascular, and natural causes related to increases in PM10 from Saharan dust outbreaks. The relationship was present even at levels that would have been below the EPA's standards in the United States. http://www.thehindu.com/news/internationalarticle566562.ece.

The World Health Organization published a hundred-page document titled, The Health Risks of Particulate Matter From Long-Range Transboundary Air Pollution. It observes that PM in the size between 0.1 μm and 1 μm can stay in the atmosphere for days or weeks and thus can be transported over long distances in the atmosphere (up to thousands of kilometres). The coarse particles are more easily deposited and typically travel less than 10 km from their place of generation. However, dust storms may transport coarse mineral dust for over 1000 km.

Medical research of the last ten years has identified ultrafine particle pollution as the most dangerous because it travels deeper into body membranes when inhaled, can invade virtually any cell in the body, penetrate cell membranes, and create a chemical toxicity within organelles and the nucleus of the cell. (Geiser, et al., 2005, pp.:1555-1560). The WHO report goes on to state,

> Health effects are observed at all levels of exposure, indicating that within any large population there is a wide range of susceptibility and that some people are at risk even at the lowest end of the observed concentration range.

Medical research conducted since this 2006 report has significantly strengthened that contention.

These case studies demonstrate that climate change in the Great Basin, coupled with the planned dewatering much of the Great Basin that lies upwind from the Wasatch Front, has the potential to repeat the tragedies of the dust bowls created in the Great Plains, the Owens Valley, and the Aral Sea.

The vast majority of Utah's population resides along the Wasatch Front. Every county along the Wasatch Front violates the current PM2.5 24-hour standard of 35 µg/m,3 and, therefore, are designated PM2.5 nonattainment areas.38 Across the U.S., high concentrations of PM2.5 and ozone usually occur together because the sources are largely the .same—coal-fired power plants and heavy vehicular traffic. There are, however, regional variations. In the Mountain West, the summer forest fire season and winter temperature inversions in mountain valleys also contribute to high concentrations of PM2.5. In the Ohio Valley, where coal-fired power plants are heavily relied on to produce electricity, concentrations of PM2.5 are higher than most of the rest of the country year round. This reflects the fact that burning coal as fuel generates 33 times as much fine soot (the main component of PM2.5) as burning oil or gas, on a per-Btu basis.

Despite significant improvements in air quality in recent decades, recent levels of ozone and PM2.5 still pose a public health risk in many regions of the United States. PM2.5 and ozone at current average concentrations significantly increase mortality rates above those that would prevail in the absence of man-caused emissions. For example, a study was conducted in 2011 of the health impacts of exposure to 2005 concentrations of ozone and RM2.5 for one year and compared to what those health effects would have been if there had been no man-caused ozone and PM2.5.

The study estimated that the man-caused PM2.5 resulted in additional mortality of between 130,000 and 340,000. This estimated range of mortality means that PM2.5 was a leading cause of death in 2005. For perspective, in that year, there were 120,000 deaths caused by accidents, 72,000 deaths caused by Alzheimer's, and 63,000 deaths caused by influenza.

In addition to increased mortality due to man-caused PM2.5, the study estimated that it resulted in 80,000 additional cases of chronic bronchitis, 180,000 additional non-fatal heart attacks, 30,000 additional hospital admissions for respiratory ailments, 62,000 additional hospital admissions for cardiovascular ailments, 110,000 additional emergency room visits for asthma, 200,000 additional occurrences of acute bronchitis, 2,400,000 additional occurrences of lower respiratory symptoms, 2,000,000 additional occurrences of upper respiratory symptoms, 2,500,000 additional instances of asthma exacerbation, and 18,000,000 additional lost work days.

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[38] See Utah Division of Air Quality 2015 Annual Report at 6.

The same study concluded that the effects of man-caused ozone were generally much less. It estimated that in 2005, exposure to the man-caused increment of ground-level ozone resulted in 19,000 additional deaths, 58,000 additional hospital visits, 19,000 additional emergency room visits, 11,000,000 million additional school absences, and 29,000,000 additional days in which minors' outside activities were curtailed.

These estimates of the harm to human health of exposure to 2005-levels of man-caused PM2.5 concentration of 7.8 μg/m^3. Although these national average concentrations are well below the EPA's annual average ambient air health standard of 12 μg/m3 for PM2.5, the study found that they still impose the large burdens on public health described by the study.[39] This means that any significant percentage reduction in the amount of coal burned to generate electricity that results from reforming the BLM's coal leasing program will result in substantial benefits to public health by reducing prevailing average concentrations of PM2.5 throughout the country.

Pathogen exposure

Soils in the Western United States also harbor significant concentrations of microorganisms like *coccidiodomycosis*, the fungal spores that cause Valley Fever. Valley Fever is a disease with flu-like symptoms that is difficult to diagnose, and is sometimes fatal. It is spread by inhaling windblown coccidiodomycosis spores, known by the inhabitants of the Southwest as "Death Dust." Valley Fever has quadrupled in the last ten years in the Southwest. The American Academy of Microbiology estimates that 200,000 people per year contract the disease, which is fatal in about one in 1,000 cases. People who are immunosuppressed, women who are pregnant, and diabetics, are particularly susceptible to serious courses of this disease.

Hotter temperatures associated with global warming will give the cocci a survival advantage over other microorganisms. More frequent and intense dust storms are the perfect delivery system for increasing this infectious disease among residents of the Western U.S. Dale Griffin, a USGS microbiologist, says that one gram of desert soil can contain as many as one billion microorganisms. Fungi can travel long distances because the spore "housing" acts like a cocoon, protecting

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[39] See Estimating the National Public Health Burden Associated with Exposure to Ambient PM2.5 and Ozone Neal Fann,* Amy D. Lamson, Susan C. Anenberg, Karen Wesson, David Risley, and Bryan J. Hubbell, DOI: 10.1111/j.1539-6924.2011.01630.x, at 12.

the fungus from environmental stresses. More than 140 different organisms have been identified as "hitchhiking on to dust particulates." These include SARS, meningitis, influenza and foot and mouth disease. http://wwwp.dailyclimate.org/tdc-newsroom/valley-fever/Valley-Fever-blowin2019-on-a-hotter-wind.

Climate change, through weather extremes, pollution, habitat fragmentation and destruction, and widespread extinction of species, is reducing the viability of world's ecosystems. If allowed to continue, the collapse of these ecosystems is likely to be a major contributor to future pandemics of infectious disease.

IX. CONCLUSION

Sustaining life as we have known it in Utah presumes a future climate that is at least as favorable as it has been in the past 160 years. The science is very clear: the Southwestern United States is headed into a hotter, drier climate that will threaten our forests, rivers, streams, lakes, pastures, and air quality, and virtually all of the resources we depend on for our quality of life. It will also threaten the continued viability of many of the industries that support our economy. Unless CO_2 emissions are curtailed substantially, and soon, Utah can expect to suffer megadroughts that will last far longer than the dustbowl that devastated the Central Plains in the 1930s. The resulting damage to Utah's natural systems and its economy will have a profound impact on the health of its rapidly growing population. Climate change threatens everything that makes this desert we call Utah beautiful, unique, and life sustaining.

We join thousands of other scientists throughout the world who believe that prompt government action and international cooperation are necessary to avoid the multi-dimensional catastrophe that unchecked climate change will bring. No ideological tug-of-war should be allowed to obscure this message: climate change is the greatest public health threat of the 21st century—in Utah, as in the rest of the planet. Falling to respond to this threat is the riskiest course of all, because climate change is a long-term problem that carries with it a huge procrastination penalty.

The Federal government's Clean Power Plan proposes state standards for reducing CO_2 emission-rates for existing power plants. This is a modest first step towards meeting America's obligation to keep global warming within the 2°C limit that was committed to in the landmark COP 21 Agreement reached in Paris last December. The Federal coal leasing program currently transfers massive quantities of coal to private hands virtually without charge, thereby incentivizing

America's over reliance on coal. If not reformed, it will offset all of the benefits of the Clean Power Plan and increase the risk that the COP 21 agreement to mitigate climate change signed by 190 nations will unravel.

The BLM's subsidies of Federal coal distort U.S. energy markets, incentivize U.S. coal exports by subsidizing transportation costs, put clean sources of energy at a disadvantage, and ultimately undercut the goals of the President's Climate Action Plan. It is essential that the Bureau of Land Management reform its current leasing program by formally certifying the Powder River Basin as a Coal Production Region, thereby invoking the legal obligation to begin the leasing process with regional planning that takes into account market conditions and the environmental and climate impact of leasing Federal coal.

The program must be reformed to eliminate a mining company's self-dealing with its affiliates and use final sale prices to assess royalties. This would help ensure that taxpayers are receiving a fair return on their publicly-owned resources. The royalty rate for coal leases should be increased to match the 18.75% that is paid by owners of off-shore oil leases. Such reforms would go a long way toward ending the artificial advantage that holders of Federal coal leases have over their private competitors in Appalachia.

Most importantly, the BLM's coal leasing program should require that the price of Federally-leased coal cover the Council on Environmental Quality's estimate of the Social Cost of Carbon before it can be leased. These reforms would demonstrate to the world that America intends to take meaningful action to address the number one issue on which the well-being of its children depends—mitigating climate change.

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