APPENDIX B

U.S. EPA REGION 8 CLIMATE CHANGE STRATEGIC PLAN

Summary of State Greenhouse Gas Emissions Inventories in EPA Region 8

DRAFT

The greenhouse gas (GHG) emissions inventories for the States of Colorado, Montana, South Dakota, Utah and Wyoming were performed by the Center for Climate Strategies, a nonprofit 501c3 organization whose mission is to help states tackle the issue of climate change through the creation and management of climate change mitigation plans and policies, along with related energy, economic, and environmental policies. They performed these inventories in partnership with the states through an effort of the Western Regional Air Partnership (WRAP). The reports contain an inventory and forecast of the State's GHG emissions from 1990 to 2020 to provide an initial comprehensive understanding of current and possible future GHG emissions, presented in metric tons of carbon dioxide equivalent (MtCO2e) or million metric tons of carbon dioxide equivalent (MMtCO2e). The information provides the States with a starting point for developing targeted climate change action plans.

The approach taken in these GHG emissions inventories could be termed a "*net-consumption-based*" approach. It accounts for the electricity produced in-state for consumption in the state, plus emissions from imports of electricity, if any. It does not account for emissions from electricity produced for export outside the state. Emissions related to electricity imports are based on emission intensities that reflect the regional fuel mix that is used.

The emissions inventory for the State of North Dakota was performed by the EPA Headquarters Climate Protection Partnerships Division in the Office of Air and Radiation. They used the State GHG Projection Tool that was developed for them by ICF Consulting. It calculates emissions from 1990 through 2020 using a top-down approach considering direct emissions only. The methods used, and the sectors covered, are the same as those in EPA's National Greenhouse Gas Inventory, produced annually: http://epa.gov/climatechange/emissions.

References for the data can be found in the actual documents available on the WRAP Web site at http://www.wrapair.org/WRAP/ClimateChange.

Colorado:

In 2005, activities in Colorado accounted for approximately 118 MMtCO2e gross emissions, an amount equal to 1.7% of total US GHG emissions. Colorado's gross GHG emissions are rising faster than those of the nation as a whole. Colorado's gross GHG emissions were increased by 35% from 1990 to 2005, while national emissions rose only 16% during the same period. Colorado's per capita emission rate is roughly equal to the national average of 25 MtCO2e/yr. Between 1990 and 2004, per capita emissions in Colorado and national per capita emissions have changed relatively little. Economic growth exceeded emissions growth in Colorado throughout the 1990-2004 period. From 1990 to 2004, emissions per unit of gross product dropped by 40% nationally, and by 53% in Colorado.

Electricity use and transportation are the State's principal GHG emissions sources. Together, the combustion of fossil fuels for electricity generation and in the transportation sector accounted for 60% of Colorado's *gross* GHG emissions in 2000. The remaining use of fossil fuels — natural gas, oil products, and coal — in the residential, commercial, and industrial (RCI) sectors, plus the emissions from fossil fuel production, constituted another 27% of total State emissions. Industrial process emissions comprised almost 3% of State GHG emissions in 2000. Although industrial process emissions are rising rapidly due to the increasing use of HFC as substitutes for ozone-depleting chlorofluorocarbons (CFCs), their overall contribution is estimated to be only 4% of Colorado's gross GHG emissions in 2020 due to significant growth estimated for the other major contributors to GHG emissions. Other industrial process emissions result from CO_2 released during soda ash, limestone, and dolomite use. Agriculture (CH_4 and N_2O emissions from manure management, fertilizer use, and livestock), landfills and wastewater management facilities, and the fossil fuel industry produced CH_4 and N_2O emissions that together accounted for the remaining 11% of the State's emissions in 2000.

Coal figures prominently in electricity generation and accounts for 88% of the GHG emissions from power plants in Colorado. The plant with the highest emissions, Craig, accounts for 24%-27% of Colorado's GHG emissions on a production basis. In 2004, electricity demand (sales + losses) in Colorado was about 51,500 GWh, while electricity generation in the State was 47,900 GWh. Net imported electricity from other states provided the additional 3,400 GWh. 620 MW of the capacity at the Craig and Hayden power plants is owned by out-of-state utilities. Similarly Colorado utilities own or have long term contracts for 500 MW of hydro capacity and 340 MW of coal capacity from outside of the State. Thus, electricity trade counts for a significant portion of the electric power associated with Colorado.

The variables with the most important implications for GHG emissions are the type and number of power plants built in Colorado between now and 2020, and the potential growth in vehicle miles traveled and air travel.

Forestry and agricultural soils are estimated to be significant sinks in Colorado. Forested lands account for a sink of -31.8 MMtCO2e per year. Agricultural soils account for another GHG sink of -2.0 MMtCO2e per year. Uncertainty remains on estimates for historic and projected GHG sinks from forestry, which can greatly affect the net GHG emissions attributed to Colorado.

Montana:

In 2005, activities in Montana accounted for approximately 37 MMtCO_2e gross emissions, an amount equal to 0.6% of total U.S. GHG emissions. Montana's *gross* GHG emissions are rising at about the same rate as the nation as a whole. Montana's gross GHG emissions were up 14% from 1990 to 2005, while national emissions rose by 16% during this period. Although Montana's GHG emissions are low on an absolute scale compared to the total national output, on a per capita basis, Montanans emitted about 38 metric tons MtCO_2e in 2005, much higher than the national average of 25 MtCO_2e. The reasons for the higher per capita intensity in Montana are varied, but include the state's strong fossil fuel production industry, large agricultural industry, large distances for transportation, and low population base. Like the nation as a whole, per capita emissions have remained fairly flat, while economic growth exceeded emissions growth throughout the 1990-2004 period. From 1990 to 2004, emissions per unit of gross product dropped by 25% nationally, and by 18% in Montana.

Electricity use, agriculture, and transportation are the state's principal GHG emissions sources. Together, the combustion of fossil fuels for electricity generation used in-state and in the transportation sector account for about 46% of Montana's *gross* GHG emissions. The relative contribution of agricultural emissions (methane and N_2O emissions from manure management, fertilizer use, and livestock) is much higher in Montana (26%) than in the nation as a whole (7%). This is a result of more agricultural activity per capita in Montana compared to the U.S. The state also has higher levels of emissions (methane) from the fossil fuels industry – natural gas, oil products, and coal - than the national average (11% of the state's emissions). The remaining use of fossil fuels in the residential, commercial, industrial and institutional (RCII) sectors constitutes another 12% of state emissions. Industrial process emissions comprise only about 3% of state GHG emissions in 2000, but these emissions are expected to rise in the future due to the increasing use of HFC as substitutes for ozone-depleting chlorofluorocarbons.[4] Other industrial process emissions result from CO_2 released during aluminum and cement production, soda ash, limestone, and dolomite use. Landfills and wastewater management facilities produce CH_4 and N_2O emissions accounting for the remaining 1% of the state's emissions in 2000.

Montana has significant sinks of GHG emissions due to the forestry sector and agricultural soils. Based on data from 1989 to 2004, Montana's forests are estimated to account for a sink of -23.1 $MMtCO_2$ of GHG emissions. Also, agricultural soils are estimated to sequester an additional -2.3 $MMtCO_2$.

North Dakota:

Because the North Dakota GHG emission inventory was performed by EPA Headquarters, not the Center for Climate Strategies, and used a different methodology (it is production-based, not consumption based), it is difficult to make direct comparisons between their emissions profile and that of the other EPA Region 8 States. Nevertheless, as attempt has been made to extract some of the same data and facts for this summary.

In 2005, activities in North Dakota accounted for approximately 46.19 MMtCO2e gross emissions (consumption-based), an amount equal to about 0.7% of total US gross GHG emissions (based on 2005 US data). North Dakota's gross GHG emissions increased about 26% from 1990 to 2005, while national emissions rose by only 16% from 1990 to 2005. On a per capita basis, North Dakotans emitted about 88 MtCO2e/yr in 2005, while the per capita emissions for the US have remained constant at 25 MtCO2e/yr. Although a low population largely accounts for the State's low *total* energy consumption, North Dakota's per capita energy consumption ranks among the highest in the Nation, in large part due to high demand for heating during cold winters and an energy-intensive economy. Industry accounts for nearly one-half of the State's total energy consumption.

Coal-fired plants provide nearly all of North Dakota's electricity generation. Most of the coal used for power generation is supplied by several large surface mines in the central part of the State. Hydroelectric dams account for most of the State's non-coal-generated electricity. The Garrison Dam, located about 75 miles northwest of Bismarck, is North Dakota's fifth largest plant in electricity generation capability. The vast majority of the State is rich in wind energy potential, a dozen wind power projects are currently operational, and the State has plans for further development. Nearly three-tenths of North Dakota households use electricity as their primary energy source for home heating. North Dakota is also one of the few States that allow the statewide use of conventional motor gasoline. (Most States require the use of specific gasoline blends in non-attainment areas due to air-quality considerations.)[1]

The principal sources of North Dakota's GHG emissions are the agriculture and electricity supply sectors. Emissions associated with the agricultural sector include CH4 and N2O emissions from enteric fermentation, manure management, and agricultural soils. Methane emissions from enteric fermentation are the result of normal digestive processes in ruminant and non-

[1] Energy Information Administration, Official Energy Statistics from the U.S. Government, North Dakota

ruminant livestock. Methane and N2O emissions from the storage and treatment of livestock manure (e.g., in compost piles or anaerobic treatment lagoons) occur as a result of manure decomposition. The agricultural soils category accounts for several sources of N2O emissions, including decomposition of crop residues, synthetic and organic fertilizer application, manure and sewage sludge application to soils, and nitrogen fixation.

Gross GHG emissions from agricultural sources ranged between 7.9 and 15.35 MMtCO2e from 1990 through 2020, respectively. In 1990, enteric fermentation accounted for about 2.09 MMtCO2e of total agricultural emissions and is estimated to account for about 2.16 MMtCO2e of total agricultural emissions in 2020. The manure management category, which is the only source projected to decline, was estimated to produce .24 MMtCO2e emissions in 1990 and is estimated to produce .22 MMtCO2e emissions in 2020. The agricultural soils category shows 1990 emissions estimated at 5.55 MMtCO2e and 2020 emissions estimated to be about 12.92 MMtCO2e. Agricultural burning emissions were estimated to be relatively large for North Dakota (compared to the US total), about 0.04 MMtCO2e/yr in 1990 remaining constant through 2020.

No information is available regarding the GHG sinks in North Dakota.

South Dakota:

In 2005, activities in South Dakota accounted for approximately 36.5 MMtCO2e gross emissions, an amount equal to about 0.5% of total US gross GHG emissions (based on 2004 US data). South Dakota's gross GHG emissions are rising faster than those of the nation as a whole (gross emissions exclude carbon sinks, such as forests). South Dakota's gross GHG emissions increased about 36% from 1990 to 2005, while national emissions rose by only 16% from 1990 to 2004. On a per capita basis, South Dakotans emitted about 38 MtCO2e in 1990, and about 44 MtCO2e/yr in 2000, which is higher than the national average of 25 MtCO2e/yr. Per capita emissions increased to about 48 MtCO2e/yr by 2005, while the per capita emissions for the US have remained constant at 25 MtCO2e/yr. The higher per capita emission rates in South Dakota are driven by emissions growth in the agricultural industry (agricultural industry emissions are much higher than the national average), electricity supply, and transportation sectors. As with the nation as a whole, economic growth exceeded emissions growth throughout the 1990-2005 period (leading to declining estimates of GHG emissions per unit of state product). During the 1990s, emissions per unit of gross product dropped by 40% nationally, and by 43% in South Dakota.

The principal source of South Dakota's GHG emissions is agriculture, accounting for 46% of South Dakota's gross GHG emissions in 2005. The next largest contributors are the transportation and electricity supply sectors that together accounted for 38% of gross GHG emissions in 2005. The transportation sector accounted 19% of total gross GHG emissions in 2005. Emissions associated with in-state production and generation of imported electricity to meet South Dakota demand accounted for another 19% of South Dakota's total gross GHG emissions in 2005. A significant change in electricity supply emissions occurred between 2000 and 2005 as a result of changes in the mix of generation sources (hydro-electric generation from three dams on the Missouri river, coal-fired generation from the Big Stone power plant, and net imports of electricity from other states). With uncertain levels of future hydro-electric generation plus several proposals for large coal and large wind generating facilities, South Dakota's future generation could change significantly. The use of fossil fuels — natural gas, oil products, and coal — in the residential, commercial, and industrial (RCI) sectors contributed another 11% of gross State emissions in 2005. The fossil fuel production, waste, and industrial processes non-energy use categories together accounted for 5% of gross emissions in 2005.

Emissions associated with the agricultural sector include CH4 and N2O emissions from enteric fermentation, manure management, and agricultural soils. Methane emissions from enteric fermentation are the result of normal digestive processes in ruminant and non-ruminant livestock. Methane and N2O emissions from the storage and treatment of livestock manure (e.g., in compost piles or anaerobic treatment lagoons) occur as a result of manure decomposition. The agricultural soils category accounts for several sources of N2O emissions, including decomposition of crop residues, synthetic and organic fertilizer application, manure and sewage sludge application to soils, and nitrogen fixation.

Gross GHG emissions from agricultural sources range between 12.5 and 22.6 MMtCO2e from 1990 through 2020, respectively. In 1990, enteric fermentation accounted for about 32% (4.05 MMtCO2e) of total agricultural emissions and is estimated to account for about 27% (6.14 MMtCO2e) of total agricultural emissions in 2020. The manure management category, which is the only source projected to decline, accounted for 6% (0.75 MMtCO2e) of total agricultural emissions in 1990 and is estimated to account for about 2.8% (0.62 MMtCO2e) of total agricultural emissions in 2020. The agricultural soils category shows 1990 emissions accounting for 61% (7.68 MMtCO2e) of total agricultural emissions and 2020 emissions estimated to be about 70% (15.8 MMtCO2e) of total agricultural emissions. Including the CO2 sequestration from soil carbon changes, the historic and projected emissions for the agriculture sector on a net basis would range between about 11.5 and 21.6 MMtCO2e/yr from 1990 through 2020, respectively. Agricultural burning emissions were estimated to be relatively large for South Dakota (compared to the US total), about 0.03 MMtCO2e/yr in 1990 and 0.05 MMtCO2e in 2020. For South Dakota, this category accounts for about 0.24% of total gross GHG emissions associated with the agricultural sector from 1990 through 2020, respectively.

Forests and agricultural soils are minor sinks in South Dakota accounting for approximately -1.53 MMtCO2e in 2005.

Utah:

In 2005, activities in Utah accounted for approximately 69 MMtCO2e gross emissions, an amount equal to about 1% of total U.S. gross GHG emissions. Utah's gross GHG emissions are rising at a faster rate than those of the nation as a whole (gross emissions exclude carbon sinks, such as forests). Utah's gross GHG emissions increased 40% from 1990 to 2005, while national emissions rose by only 16% during this period. On a per capita basis, Utahans emitted about 27 metric tons (Mt) of CO_2e in 2005, slightly higher than the national average of 25 MtCO_2e/yr. As in the nation as a whole, per capita emissions in Utah have changed relatively little (with a slight decrease in the post-2000 period), while economic growth exceeded emissions growth throughout the 1990-2005 period (leading to declining estimates of GHG emissions per unit of state product). During the 1990s, emissions per unit of gross product dropped by 40% nationally, and by 52% in Utah.

The principal source of Utah's GHG emissions is electricity use (electricity production netting out electricity exports), accounting for 37% of total State gross GHG emissions in 2005. The next largest contributors to total gross GHG emissions are the transportation sector (25%) and the residential, commercial, and industrial fossil fuel combustion sector (18%). Utah's gross GHG emissions continue to grow, and are projected to climb to 96.1 MMtCO_2e per year by 2020, 95% above 1990 levels. Emissions associated with electricity generated to meet Utah's demands is projected to be the largest contributor to future emissions growth, followed by emissions from the transportation sector. The figure shows that electricity generation will add more than 10 MMtCO_2e to Utah's emissions by 2020, while the transportation sector will add almost 6 MMtCO_2e.

Coal figures prominently in electricity generation and accounts for 99% of the GHG emissions from power plants in Utah. The plant with the highest GHG emissions, Intermountain, accounts for about 40% of all Utah's GHG emissions on a production basis. Based on the difference in growth rates for electricity generation and consumption in Utah, net exports have declined from about 42% of total in-state generation in 1990 to 25% in 2004.

In 2004, electricity demand (sales + losses) in Utah was about 28,282 GWh, while electricity generation in the State was 37,579 GWh. Net exported electricity to other states accounts for the additional 9,296 GWh, but net exports generally encompass a mix of both imports and exports from the State.

Carbon sinks within Utah's forests and agricultural soils are relatively small within EPA Region 8. Current estimates indicate that about 12.3 MMtCO_2e are sequestered annually in Utah forest biomass. However, there is a significant degree of uncertainty in the size of the forest sink in Utah. The estimates presented here are believed to be at the high end of the possible range of sequestration estimates.

Wyoming:

In 2005, activities in Wyoming accounted for approximately 56 MMtCO2e gross emissions, an amount equal to 0.8% of total US gross GHG emissions. Wyoming's gross GHG emissions increased 25% from 1990 to 2005, while national emissions rose by only 16% from 1990 to 2004. Wyoming's per capita emission rate was more than four times greater than the national average of 25 MtCO2e/yr in 2005 at 110 MtCO2, and higher than any other western state due to the size and type of industries in the State and relatively low population. This large difference between national and State per capita emissions occurs in the following sectors: Electricity, industrial, fossil fuel production, transportation, industrial process and agriculture. The reasons for the higher per capita intensity in Wyoming are varied but include the State's strong fossil fuel production industry and other industries with high fossil fuel consumption intensity, large agriculture industry, large distances, and low population base. Between 1990 and 2005, per capita emissions in Wyoming have increased, mostly due to increased activity in the fossil fuel industry, while national per capita emissions have changed relatively little. Economic growth exceeded emissions growth both nationally and in Wyoming throughout the 1990-2005 period, as seen by the decreasing GHG emissions per Gross Domestic Product or Gross State Product.

The principal sources of Wyoming's gross GHG emissions are electricity use (excluding electricity exports to other states), fossil fuel consumption in the residential, commercial and industrial sectors, and fugitive (non-energy) emissions from the fossil fuel production industries. The next largest contributor to emissions is the transportation fuel use sector. Wyoming's gross GHG emissions are expected to continue to grow to 69 MMtCO2e by 2020, 56% above 1990 levels. Demand for electricity is projected to be the largest contributor to future emissions growth, followed by emissions associated with transportation. Although GHG emissions from fossil fuel production had the greatest increase by sector in the period 1990 to 2005, the growth from this sector is projected to decline due to assumption of decreased carbon dioxide emissions from venting at processing plants.

Electricity consumption accounted for about 28% of Wyoming's gross GHG emissions in 2005 (about 15 MMtCO2e), which was lower than the national average share of emissions from electricity consumption (34%). The GHG emissions associated with Wyoming's electricity sector increased by just over 2 MMtCO2e between 1990 and 2005, accounting for about 20% of the State's net growth in gross GHG emissions in this time period. Wyoming's electric sector is dominated by coal generation, with much of this generation being exported to meet electricity demand in other states. Coal accounts for almost 100% of the GHG emissions from power plants in Wyoming. The two largest plants, Jim Bridger and Laramie River, account for about 67% of Wyoming's GHG emissions on a production basis.

Annual sequestration of GHG emissions, mostly due to forestry but also to other land-uses in Wyoming are estimated at 36 MMtCO2e in 2005, the highest in EPA Region 8.