**MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION AND MAINE BOARD OF ENVIRONMENTAL PROTECTION**

| IN RE: CITIZEN PETITION FOR RULEMAKING TO REQUIRE THE MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION TO FULFILL ITS CONSTITUTIONAL, PUBLIC TRUST, AND STATUTORY OBLIGATIONS TO REDUCE GREENHOUSE GAS EMISSIONS ALONG A TRAJECTORY THAT IS BASED ON THE BEST CLIMATE SCIENCE AND THAT WILL ACHIEVE SAFE ATMOSPHERIC CONCENTRATIONS OF CARBON DIOXIDE BY 2100. |
| CITIZEN PETITION TO INITIATE RULEMAKING |

*Filed by*

216 VOTERS REGISTERED IN THE STATE OF MAINE AND 164 YOUTH PETITIONERS

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*On Behalf of Petitioners*

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7. Declaration of Dr. Ove Hoegh-Guldberg, Foster v. Wash. Dep’t of Ecology, SEA,
9. Summary of Statutory Goals
Now come 216 registered voters of the State of Maine and 164 youth, together with Earth Guardians and 350 Maine (collectively “Petitioners”) to petition the Department of Environmental Protection (“Department” or “DEP”) and Maine Board of Environmental Protection (“Board”) pursuant to 5 M.R.S.A. §8055(3) to initiate rulemaking under the Department and Board’s authority and pursuant to its obligation under the Constitution of the State of Maine, the Public Trust Doctrine, and statutory law to promulgate rules that protect the common welfare of present and future generations of Mainers by implementing an effective carbon dioxide (“CO₂”) and greenhouse gas (“GHG”) reduction strategy that is based on the best climate science and is aimed at ensuring that Maine does its part to restore the concentration of CO₂ in the atmosphere to 350 parts per million (ppm) by 2100. Such a rule is necessary in order to ensure that the worst impacts of climate change and ocean acidification are avoided and do not cause catastrophic and irreversible harm to present and future generations.

Specifically, Petitioners request that the Department and Board promulgate the rule proposed below:

Proposed Rule

PREAMBLE:
Human activity, primarily from burning fossil fuels, has increased the global concentration of greenhouse gases in the atmosphere. Science informs us that the increase in atmospheric carbon dioxide (CO₂) concentrations has already warmed the global climate system and acidified the oceans, causing significant adverse effects to human health, safety, and welfare and Earth’s natural systems. Left unabated, global climate destabilization and ocean acidification will have long-term catastrophic effects on human systems and the habitability of Maine and the nation. Currently, climate scientists believe that the global concentration of CO₂ in the atmosphere must be reduced to no more than 350 parts per million (ppm) to protect the climate system humans depend upon. If global CO₂ emissions are reduced by at least 85% from 1990 levels by 2050, and continue to decline thereafter, and there is significant reforestation around the world, global atmospheric CO₂ levels could stabilize at 350 ppm by 2100 and the most severe impacts of climate destabilization could be avoided. These targets reflect the global average emission reductions required to remedy the current climate emergency without accounting for the differentiated and equitable responsibilities of individual states and their historic contribution to carbon pollution.

The goal of this rule is to protect the rights of present and future generations of Mainers to a healthy atmosphere and stable climate system. Specifically, this rule is intended to achieve Maine’s constitutional obligation to “promote our common welfare” and protect unalienable
rights, including the rights of life, liberty, property, safety, and happiness; to fulfill the State’s public trust obligation to prevent waste and substantial impairment of trust resources; and to fulfill the Department’s existing statutory goal of reducing the State’s greenhouse gas emissions “sufficient to eliminate any dangerous threat to the climate.”

DEFINITIONS:

1. “Best Climate Science” means:
   a. the most current scientific knowledge and understanding from qualified climate system scientists on safe levels of CO₂ and other greenhouse gases and their near-term and long-term impacts; and
   b. the most current scientific knowledge and understanding from qualified climate system scientists as to the greenhouse gas emissions reductions required to stabilize the climate system and preserve a habitable and safe climate system for future generations.

2. “Board” means the Maine Board of Environmental Protection.

3. “Carbon Budget” means the total amount of CO₂ emissions that can be released over a specific time frame while ensuring a return to the maximum safe limit of 350 ppm of CO₂ by 2100, or a lower level as may be determined by the best climate science.

4. “CO₂” means carbon dioxide.

5. “Consumption Emissions and Inventory” means a greenhouse gas inventory including estimates of embedded emissions associated with the life cycle of materials and services, including electricity and fuels, consumed in Maine. These emissions are included regardless of whether they physically originate in Maine. A consumption-based inventory uniquely counts out-of-state emissions associated with producing the products, services, and fuels consumed in Maine. It also counts emissions associated with producing fuels that are used to generate electricity consumed in Maine.

6. “Department” means the Maine Department of Environmental Protection.

7. “Greenhouse Gas” or “GHG” means any gas that has contributed to anthropogenic global warming, including but not limited to carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

8. “In-boundary Emissions and Inventory” means the greenhouse gas inventory focused on all emissions produced within the state. In-boundary emissions inventories exclude many of the emissions associated with materials and goods produced outside, and imported into, the state.


10. “MMTCO₂e” means million metric tons of carbon dioxide equivalents.

11. “PPM” means parts per million.

EMISSION REDUCTIONS:

1. The Department shall:
   a. Ensure that Maine reduces its total in-boundary and consumption CO₂ emissions to at least 85% below 1990 levels by 2050 in order for its emission reductions to be consistent with the global average emission reductions required to return global atmospheric CO₂ to 350 ppm by the end of the century;
b. Establish interim benchmarks for minimum levels of emission reductions for at least the years 2020, 2030, and 2040 to guide progress toward the 2050 reduction goal;
c. Ensure that Maine’s in-boundary CO\textsubscript{2} emissions are reduced by at least 8 percent per year beginning in 2017\textsuperscript{1}; and
d. Prepare a numerical statewide goal or “carbon budget,” taking into account both in-boundary and consumption emissions, for Maine to do its share in achieving 350 ppm of CO\textsubscript{2} in the atmosphere by the year 2100.

CARBON ACCOUNTING AND INVENTORY:
2. The Department shall augment its current accounting, verification, and inventory system for statewide greenhouse gas emissions so as to provide an accounting to Maine citizens of its management of the atmospheric trust asset by publishing biennial progress reports on statewide GHG emissions measured in both MMTCO\textsubscript{2} and MMTCO\textsubscript{2}e. These reports must include an accounting and inventory for each and every substantial source of GHG emissions within Maine, including, but not limited to:
   a. in-boundary emissions from the transportation, industrial, commercial, institutional, residential, electrical, agricultural, and waste sectors; and
   b. consumption emissions associated with Mainers’ consumption of goods and materials.
Reports must be available to the public no later than January 31 of each year, beginning in the year 2017, with a lag time of no more than two years (i.e., the 2017 report should contain emissions data from 2015).

LEGISLATIVE RECOMMENDATIONS:
3. The Department shall recommend to the Legislature that:
   a. The State’s statutory greenhouse gas emission reduction targets be revised based on the best climate science for global climate stabilization, which indicates that a return to a maximum concentration of 350 ppm of atmospheric CO\textsubscript{2} by 2100 would stabilize the Earth’s energy balance and avoid the worst impacts of climate change and ocean acidification;
   b. The State must reduce its total in-boundary and consumption CO\textsubscript{2} emissions to at least 85% below 1990 levels by 2050 in order for its emission reductions to be consistent with the global average emission reductions required to return global atmospheric CO\textsubscript{2} to 350 ppm by the end of the century;
   c. The Legislature establish interim benchmarks for minimum levels of emission reductions for at least the years 2020, 2030, and 2040 to guide progress toward the 2050 reduction goal; and
   d. The Legislature develop and implement mechanisms, such as a rising price on carbon, to facilitate swift in-boundary and consumption emission reductions.

CLIMATE ACTION PLAN:
4. Within six months of adoption of rules and regulations establishing emission reduction targets, the Department, with input from stakeholders, shall adopt a new Climate Action Plan to meet the reduction goals specified therein.

\textsuperscript{1} The requisite annual rate of emissions reductions increases every year so if Maine delays implementation of this
REVISIONS:

5. Two years after the effective date of the regulations, the Department shall amend these regulations to adjust the reduction requirements as necessary to assure that the State is reducing its greenhouse gas emissions in a manner that is consistent with the best climate science, taking into account the State’s equitable responsibility for staying within the global 350 ppm carbon budget.

* * *

Petitioner’s proposed rule is based on the best climate science. The best climate science indicates that atmospheric CO₂ concentrations must return to 350 ppm by century’s end in order to avoid the most catastrophic and irreversible impacts of climate change and ocean acidification (see Exhibit 1). If global CO₂ emissions are reduced by at least 85% from 1990 levels by 2050, and continue to decline thereafter, and there is significant reforestation around the world (approximately 100 gigatons of carbon drawdown must happen through reforestation), global atmospheric CO₂ levels could stabilize at 350 ppm by 2100. In order to meet this target, CO₂ emissions must be reduced by an adequate margin each year. The rate of emission reductions required to return the global atmospheric CO₂ concentrations to a safe level depends on the year in which emissions peak. For example, “if [global] emissions reduction had begun in 2005, reduction at 3.5%/year would have achieved 350 ppm at 2100.” A global peak in 2012 or 2020 would require annual reductions of 6% and 15%, respectively. For emission reductions beginning in 2017, an 8% reduction in emissions from Maine, and the rest of the world, in conjunction with reforestation, would still be sufficient to stabilize the atmospheric concentration of CO₂ at 350 ppm by 2100. Importantly, these targets reflect the global average emission reductions required to remedy the current climate emergency without accounting for the differentiated and equitable responsibilities of individual states and their historic contribution to carbon pollution.

While Maine’s emissions have been declining in recent years, they have not been declining at a steep enough rate, and Maine’s greenhouse gas inventory does not include Maine’s

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2 Petitioners incorporate by reference into the official administrative record all materials cited to and relied upon in this Petition for Rulemaking. If the Department of Environmental Protection or Maine Board of Environmental Protection requires copies of these materials please inform Petitioners. Otherwise, because all materials cited are publicly available, Petitioners assume that the materials are part of the official administrative record.


5 Id. at 10, 18.

6 Id.

7 Id. at 10.

consumption emissions, so likely underestimates Maine’s actual emissions. Additionally, because Mainers’ per capita emissions are higher than the global average\(^9\) and because Mainers are wealthy compared to the rest of the world\(^{10}\) and, therefore, more capable of generating and paying for clean energy, emission reductions in Maine of greater that 8% a year would be preferable and more just from a global perspective. For these reasons, the proposed rule seeks emission reductions of at least 8% each year, which correlates to Maine reducing its emissions to approximately 85% below 1990 by the year 2050.

The proposed rule also asks the Department to prepare a statewide carbon budget for Maine, taking into account both in-boundary and consumption emissions, which would be consistent with Maine doing its share of emission reductions necessary to achieve 350 ppm of CO\(_2\) in the atmosphere by the year 2100. The primary factor causing global warming is the cumulative level of CO\(_2\) and other GHG emissions that have been emitted into the atmosphere since the industrial revolution. A carbon budget accounts for how much more carbon can be emitted while still staying within the safe concentration of CO\(_2\) in the atmosphere: 350 ppm. Because we have already exceeded the safe level, the carbon budget assumes that CO\(_2\) drawdown will also be occurring through reforestation. Using a peer-reviewed methodology developed by climate scientists at NASA’s Goddard Institute for Space Studies and Columbia University, and used by Eugene, Oregon, (see Exhibit 4, Eugene Sustainability Office, Methodology for Establishing a Community Carbon Budget (2016) (describing this methodology) it is possible to scale down the global carbon and reforestation budget to various scales, such as a statewide scale. The development of this carbon budget will inform Maine of their per capita share of the remaining carbon budget.

Unless immediate action is taken to reduce CO\(_2\) emissions, the required annual reductions may become so great as to be unachievable. Because CO\(_2\) is the principal force driving changes in the Earth’s energy balance and because CO\(_2\) remains in the atmosphere for millennia\(^{11}\) (as compared to some other shorter-lived greenhouse gases), Petitioners are especially concerned that Maine do its part to reduce CO\(_2\) emissions and that it acts with a sense of urgency and without delay.

This rule is based on the best available climate science and if the Department or Board do not agree with this science or the required emission reductions, Petitioners respectfully ask that the Department or Board present the climate science they are relying on and also demonstrate how Maine’s emission reductions are sufficient to eliminate any dangerous threat to the climate and to Petitioners’ future.

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\(^{10}\) Maine’s median household income is over $48,000, while worldwide, the median household income is just under $10,000. U.S. Census Bureau, State & County Quick Facts: Maine, [http://quickfacts.census.gov/qfd/states/23000.html](http://quickfacts.census.gov/qfd/states/23000.html) (last visited Sept. 17, 2015); Glenn Phelps & Steve Crabtree, Worldwide, Median Household Income About $10,000 (Dec. 16, 2013), [http://www.gallup.com/poll/166211/worldwide-median-household-income-000.aspx](http://www.gallup.com/poll/166211/worldwide-median-household-income-000.aspx).

Text of the proposed rule, description of proposed actions, and petition signatures, as verified and certified pursuant to 21-A M.R.S. §354(7), have been submitted to the Department and Board simultaneously with this Petition. The materials circulated during the petition drive are attached as Exhibit 5.
I. SUMMARY

Anthropogenic climate change and ocean acidification are the greatest threats facing human civilization. Given the persistence of certain long-lived greenhouse gases (“GHG”) in the atmosphere, especially, carbon dioxide (“CO₂”),¹² the negative impacts of climate change and ocean acidification will be borne most heavily by today’s youth and by future generations. Petitioners, 216 registered voters, 164 youth, Earth Guardians, and 350 Maine bring this action to ensure that the climate remains stable enough to maintain their, and their posterity’s, fundamental and unalienable rights to a livable future, which includes a healthy atmosphere and stable climate system.

Petitioners’ claims are based upon three legal mandates. First, the State¹³ has a constitutional obligation to “promote our common welfare”¹⁴ and protect unalienable rights, including the rights of life, liberty, property, safety, and happiness,¹⁵ the protection of which are fundamentally linked to a stable climate. Second, the State has a fiduciary duty under the Public Trust Doctrine to hold shared assets, such as the seas, shores of sea, and atmosphere (air), in trust and to regulate them in a way that gives decisive weight to the “common good”¹⁶ and prevents their substantial impairment.¹⁷ Moreover, the State may not violate its fiduciary obligation by “wasting” the atmospheric asset in a manner that causes injury to the beneficiaries of the public trust, present and future generations (i.e., Maine citizens and their posterity). Finally, the Department of Environmental Protection has the statutory authority and obligation to “control the pollution of the air . . . and prevent diminution of the natural resources of the State,”¹⁸ to regulate air contaminants in “a manner that reasonably insures the continued health, safety and general welfare of all the citizens of the State,”¹⁹ and to reduce GHG emissions to a level “sufficient to eliminate any dangerous threat to the climate.”²⁰

Science unequivocally shows that anthropogenic climate change and ocean acidification are occurring and are threatening the stability of the global climate system.²¹ Evidence of climate

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¹³ As agents of the State of Maine, the DEP and Board are required to comply with the Maine Constitution, the Public Trust Doctrine, and applicable statutes.
¹⁴ Me. Const. preamble.
¹⁵ Me. Const. art. I, § 1 (“All people are born equally free and independent, and have certain natural, inherent and unalienable rights, among which are those of enjoying and defending life and liberty, acquiring, possessing and protecting property, and of pursuing and obtaining safety and happiness.”).
²⁰ 38 M.R.S. § 576(3) (2012).
change is already being observed in Maine and the State is projected to be significantly impacted in the future by climate change and ocean acidification. Fortunately, the best climate science provides a prescription for stabilizing the climate near current temperatures: “A 6%/year decrease of [global] fossil fuel emissions beginning in 2013, with 100 GtC reforestation, achieves a CO$_2$ decline to 350 ppm near the end of this century.”

The requisite rate of emission reductions is now 8% a year since three years have passed since 2013. The figure 350 ppm refers to the concentration of CO$_2$ in the atmosphere that is necessary to stabilize the climate system at a level that is consistent with the range in which human civilization has developed. The current atmospheric concentration of CO$_2$ is over 400 ppm (compared to the pre-industrial concentration of 280 ppm), well past the safe level.

For these reasons, Petitioners request that the Department and Board promulgate the rule proposed below:

**Proposed Rule**

**PREAMBLE:**

Human activity, primarily from burning fossil fuels, has increased the global concentration of greenhouse gases in the atmosphere. Science informs us that the increase in atmospheric carbon dioxide (CO$_2$) concentrations has already warmed the global climate system and acidified the oceans, causing significant adverse effects to human health, safety, and welfare and Earth’s natural systems. Left unabated, global climate destabilization and ocean acidification will have long-term catastrophic effects on human systems and the habitability of Maine and the nation. Currently, climate scientists believe that the global concentration of CO$_2$ in the atmosphere must be reduced to no more than 350 parts per million (ppm) to protect the climate system humans depend upon. If global CO$_2$ emissions are reduced by at least 85% from 1990 levels by 2050, and continue to decline thereafter, and there is significant reforestation around the world, global atmospheric CO$_2$ levels could stabilize at 350 ppm by 2100 and the most severe impacts of climate destabilization could be avoided. These targets reflect the global average emission reductions required to remedy the current climate emergency without accounting for the differentiated and equitable responsibilities of individual states and their historic contribution to carbon pollution.

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23 *Id.* at 15 (“[H]umanity and nature, the modern world as we know it, is adapted to the Holocene climate that has existed more than 10,000 years. Warming of 1°C relative to 1880-1920 keeps global temperature close to the Holocene range, but warming of 2°C, to at least the Eemian level, could cause major dislocations for civilization.”).


The goal of this rule is to protect the rights of present and future generations of Mainers to a healthy atmosphere and stable climate system. Specifically, this rule is intended to achieve Maine’s constitutional obligation to “promote our common welfare” and protect unalienable rights, including the rights of life, liberty, property, safety, and happiness; to fulfill the State’s public trust obligation to prevent waste and substantial impairment of trust resources; and to fulfill the Department’s existing statutory goal of reducing the State’s greenhouse gas emissions “sufficient to eliminate any dangerous threat to the climate.”

DEFINITIONS:
1. “Best Climate Science” means:
   a. the most current scientific knowledge and understanding from qualified climate system scientists on safe levels of CO₂ and other greenhouse gases and their near-term and long-term impacts; and
   b. the most current scientific knowledge and understanding from qualified climate system scientists as to the greenhouse gas emissions reductions required to stabilize the climate system and preserve a habitable and safe climate system for future generations.
2. “Board” means the Maine Board of Environmental Protection.
3. “Carbon Budget” means the total amount of CO₂ emissions that can be released over a specific time frame while ensuring a return to the maximum safe limit of 350 ppm of CO₂ by 2100, or a lower level as may be determined by the best climate science.
4. “CO₂” means carbon dioxide.
5. “Consumption Emissions and Inventory” means a greenhouse gas inventory including estimates of embedded emissions associated with the life cycle of materials and services, including electricity and fuels, consumed in Maine. These emissions are included regardless of whether they physically originate in Maine. A consumption-based inventory uniquely counts out-of-state emissions associated with producing the products, services, and fuels consumed in Maine. It also counts emissions associated with producing fuels that are used to generate electricity consumed in Maine.
6. “Department” means the Maine Department of Environmental Protection.
7. “Greenhouse Gas” or “GHG” means any gas that has contributed to anthropogenic global warming, including but not limited to carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.
8. “In-boundary Emissions and Inventory” means the greenhouse gas inventory focused on all emissions produced within the state. In-boundary emissions inventories exclude many of the emissions associated with materials and goods produced outside, and imported into, the state.
10. “MMTCO₂e” means million metric tons of carbon dioxide equivalents.
11. “PPM” means parts per million.

EMISSION REDUCTIONS:
1. The Department shall:
   a. Ensure that Maine reduces its total in-boundary and consumption CO₂ emissions to at least 85% below 1990 levels by 2050 in order for its emission reductions to
be consistent with the global average emission reductions required to return global atmospheric CO₂ to 350 ppm by the end of the century;
b. Establish interim benchmarks for minimum levels of emission reductions for at least the years 2020, 2030, and 2040 to guide progress toward the 2050 reduction goal;
c. Ensure that Maine’s in-boundary CO₂ emissions are reduced by at least 8 percent per year beginning in 2017; and
d. Prepare a numerical statewide goal or “carbon budget,” taking into account both in-boundary and consumption emissions, for Maine to do its share in achieving 350 ppm of CO₂ in the atmosphere by the year 2100.

CARBON ACCOUNTING AND INVENTORY:
2. The Department shall augment its current accounting, verification, and inventory system for statewide greenhouse gas emissions so as to provide an accounting to Maine citizens of its management of the atmospheric trust asset by publishing biennial progress reports on statewide GHG emissions measured in both MMTCO₂ and MMTCO₂e. These reports must include an accounting and inventory for each and every substantial source of GHG emissions within Maine, including, but not limited to:
a. in-boundary emissions from the transportation, industrial, commercial, institutional, residential, electrical, agricultural, and waste sectors; and
b. consumption emissions associated with Mainers’ consumption of goods and materials.

Reports must be available to the public no later than January 31 of each year, beginning in the year 2017, with a lag time of no more than two years (i.e., the 2017 report should contain emissions data from 2015).

LEGISLATIVE RECOMMENDATIONS:
3. The Department shall recommend to the Legislature that:
a. The State’s statutory greenhouse gas emission reduction targets be revised based on the best climate science for global climate stabilization, which indicates that a return to a maximum concentration of 350 ppm of atmospheric CO₂ by 2100 would stabilize the Earth’s energy balance and avoid the worst impacts of climate change and ocean acidification;
b. The State must reduce its total in-boundary and consumption CO₂ emissions to at least 85% below 1990 levels by 2050 in order for its emission reductions to be consistent with the global average emission reductions required to return global atmospheric CO₂ to 350 ppm by the end of the century;
c. The Legislature establish interim benchmarks for minimum levels of emission reductions for at least the years 2020, 2030, and 2040 to guide progress toward the 2050 reduction goal; and
d. The Legislature develop and implement mechanisms, such as a rising price on carbon, to facilitate swift in-boundary and consumption emission reductions.

CLIMATE ACTION PLAN:

26 The requisite annual rate of emission reductions increases every year so if Maine delays implementation of this rule, the annual rate of reductions will need to be increased according to the best climate science.
4. Within six months of adoption of rules and regulations establishing emission reduction targets, the Department, with input from stakeholders, shall adopt a new Climate Action Plan to meet the reduction goals specified therein.

**REVISIONS:**

5. Two years after the effective date of the regulations, the Department shall amend these regulations to adjust the reduction requirements as necessary to assure that the State is reducing its greenhouse gas emissions in a manner that is consistent with the best climate science, taking into account the State’s equitable responsibility for staying within the global 350 ppm carbon budget.

**II. THE PETITIONERS**

This petition is brought by 216 registered Maine voters who live throughout Maine and represent a variety of interests. Each petitioner is concerned about the current and predicted impacts of climate change and ocean acidification in Maine and respectfully request that Maine use this petition as an opportunity to phase out fossil fuels and develop a comprehensive plan based on the best climate science to address climate change and ocean acidification with all deliberate speed.

The youth petitioners represent the youngest living generation of public trust beneficiaries, and have a profound interest in ensuring that the climate remains stable enough to ensure their rights to a livable future. A livable future includes the opportunity to drink clean water and abate thirst, to grow food that will abate hunger, to be free from imminent property damage caused by extreme weather events, and to enjoy the abundant and rich biodiversity on this small planet. The petitioners request the promulgation of the rule herein proposed in order to protect their interests in a livable future, and an inhabitable Maine.

Earth Guardians is a nonprofit organization with youth chapters on five continents, and groups throughout the United States with thousands of members working together to protect the Earth, the water, the air, and the atmosphere, creating healthy sustainable communities globally. They inspire and empower young leaders, families, schools, organizations, cities, and government officials to make positive change locally, nationally, and globally to address the critical state of the Earth.

350 Maine is a grassroots movement dedicated to solving the planetary climate crisis. We grow our power collectively to find real and lasting solutions, to end our dependence on fossil fuels, and to build a healthy, sustainable life for people and the planet. 350 Maine believes that Maine holds a unique position in this global movement as a gateway to coastal waters and foreign markets. We are in the path of many corporate plans to profit from extreme extraction. Maine also has abundant fresh water, and the largest contiguous forest east of the Mississippi River—ecosystems that must be protected.

**III. THE RESPONDENTS**
The **Maine Department of Environmental Protection** is the state agency responsible for protecting and restoring Maine’s natural resources and enforcing the state’s environmental and natural resource laws. The DEP is legally obligated to “prevent, abate and control the pollution of the air, water, and land” and to “protect and enhance the public’s right to use and enjoy the State’s natural resources.” In fulfilling this mandate, the DEP makes recommendations to the Maine Legislature; issues licenses, permits, and certifications; initiates enforcement actions; serves as the primary link to the federal government on environmental issues, even administering some federal programs; and works with the public, other state agencies, and legislators to implement environmental laws.

Importantly, the DEP has significant control and responsibility for Maine’s GHG emissions due to the **affirmative acts** the agency takes to permit and license facilities that emit GHG emissions. For example, the DEP issues permits and licenses for incinerators, internal combustion engines, fossil fuel burning facilities and equipment (including power plants), concrete plants, and other stationary and area sources, all of which emit GHGs. DEP is failing to perform its duty to protect and restore Maine’s natural resources and transition the state away from the use of fossil fuels. DEP’s actions and omissions have substantially contributed to unsafe levels of atmospheric CO$_2$ and a dangerous climate system.

The **Maine Board of Environmental Protection** is a board that performs major substantive rulemaking and provides a forum for public participation in DEP decisions. The Board has the authority to adopt, amend, or repeal rules designated by the DEP as major substantive rules. The Board has failed to adopt and promulgate rules and regulations that would reduce the state’s GHG emissions by amounts needed to contribute to a healthy atmosphere and stable climate and protect the public natural resources of the state.

**IV. CONSTITUTIONAL, PUBLIC TRUST, STATUTORY, AND REGULATORY FRAMEWORK**

**A. The Department of Environmental Protection and Maine Board of Environmental Protection have an obligation to initiate rulemaking per 5 M.R.S. §§ 8001-11008.**

The Maine Administrative Procedures Act obligates State agencies to “initiate appropriate rulemaking proceedings within 60 days” of receiving a petition signed by 150 or more registered voters. The Petitioners collected 216 signatures from registered voters (and an additional 164 youth signatures) during the winter of 2015 and spring/summer of 2016. The text of the proposed actions and signed petitions, as verified and certified pursuant to 21-A M.R.S. §

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28 Id.
29 Id.
32 5 M.R.S. § 8055(3).
354(7), have been submitted to the Department and Board simultaneously with this Petition. The materials circulated during the petition drive are attached as Exhibit 5.

**B. The DEP and Board Have the Authority and Obligation to Address Climate Change.**

**B.1 The State of Maine has a Constitutional Obligation to Protect Inherent and Unalienable Rights and Our Common Welfare**

The preamble to the Constitution of the State of Maine states that the purpose of the State government is to “establish justice, insure tranquility, provide for our mutual defense, promote our common welfare, and secure to ourselves and our posterity the blessings of liberty.”

There can hardly be a resource more necessary to our and our posterity’s “common welfare” than a healthy atmosphere and stable climate system.

Additionally, Article 1, Section 1 of the Maine Constitution states: “All people are born equally free and independent, and have certain natural, inherent and unalienable rights, among which are those of enjoying and defending life and liberty, acquiring, possessing and protecting property, and of pursuing and obtaining safety and happiness.” These enumerated rights are neither exhaustive nor exclusive. The Maine Constitution also states: “All power is inherent in the people; all free governments are founded in their authority and instituted for their benefit; they have therefore an unalienable and indefeasible right to institute government, and to alter, reform, or totally change the same, when their safety and happiness require it.”

A healthy atmosphere and stable climate system are required in order to enjoy and defend life, liberty, property, safety, and happiness. As one court recently stated, “[i]f ever there were a time to recognize through action this right to preservation of a healthful and pleasant atmosphere, the time is now . . . .” That court also noted that youth petitioners “very survival depends upon the will of their elders to act now, decisively and unequivocally, to stem the tide of global warming by accelerating the reduction of emission of GHG’s . . . .” Furthermore, as the Maine Constitution states, governments are founded for the benefit of the people, and the most central benefit that a government can provide its people is to protect those essential natural resources that enable its people to survive and thrive and allow society to function, evolve, and reproduce for future generations.

Moreover, ensuring public safety is “among the most basic obligations state government owes its people.” Conversely, the State’s actions that contribute to GHG emissions, and thus climate change and ocean acidification, and the State’s failure to adequately respond to the threat of climate change, affirmatively harms Maine’s citizens. For instance, an increasingly

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33 Me. Const. preamble (emphasis added).
34 Me. Const. art. 1, § 1.
36 Me. Const. art. 1, § 2.
38 Id. at 5.
destabilized climate system brings more frequent and intense storms, temperature extremes, the spread of pests and allergens, and ocean acidification. By taking actions that allow GHG emission to continue at dangerous levels and not taking sufficient action to ensure public safety in the face of climatic changes, the State is effectively devaluing the future and infringing upon the constitutional rights of current generations, including Petitioners, and posterity.

Under the terms of the 14th Amendment to the U.S. Constitution, United States citizens have the right not to be deprived of life, liberty, or property, without due process of law, nor be denied equal protection of the laws. These rights belong to present generations as well as to future generations (our “Posterity”). These inherent and inalienable rights reflect the basic societal contract of the U.S. Constitution to protect citizens and posterity from government infringement upon basic freedoms and basic (or natural) rights.

Our nation’s climate system, including the atmosphere and oceans, is critical to Petitioners’ rights to life, liberty, and property, yet the nation’s climate system has been, and continues to be, harmed by dangerous levels of greenhouse gas emissions. Furthermore, youth petitioners and future generations will be denied their constitutional rights to equal protection of the laws because they will disproportionately experience the irreversible and catastrophic impacts of an atmosphere and oceans containing dangerous levels of CO₂ and a dangerous destabilized national climate system. The adults living in our country today will not experience the full scope of catastrophic harms that will be experienced by youth petitioners and future generations. In order to ensure that the U.S. Constitutional rights of Petitioners, and all Mainers, to life, liberty, and property, and equal protection of the laws, are not infringed upon, Maine must do its part to ensure that the climate system is restored and CO₂ levels are reduced to no more than 350 ppm.

The impacts of climate change described below (see sections IV.A and IV.B) threaten the State and Federal constitutional rights of all Mainers, including Petitioners and future generations. Indeed, without immediate science-based actions to reduce CO₂ emissions, the impacts of climate change and ocean acidification will lead to a very different, far less hospitable planet, and will threaten the very survival of humanity and civilization as we know it.

B.2 The DEP has an Obligation Pursuant to the Public Trust Doctrine to Protect Maine’s Public Trust Resources for Present and Future Beneficiaries

The State of Maine, including the Department of Environmental Protection and Maine Board of Environmental Protection, has an obligation pursuant to the Public Trust Doctrine to manage and protect its natural resources for Mainers. The idea that essential natural resources are the collective property of humanity was first documented almost 1500 years ago in Roman law. The text of the Institutes of Justinian declared that, “By the laws of nature, these things are common to mankind—the air, running water, the sea, and consequently the shores of the sea.”

40 U.S. Const. amend. XIV, § 1.

41 Justinian, Institutes, 1.2.1, 2.1.1 (T. Sandars trans. 1st Am. ed. n. 1876). The Institutes of Justinian is one of three fundamental works of jurisprudence issued from 533 to 534 A.D by order of the Eastern Roman Emperor Justinian I. Collectively, the works were intended to be the sole source of Roman law. Roman law provides the foundation for
This ancient pronouncement provides the foundation of the Public Trust Doctrine, which holds that the sovereign (i.e., the state) holds shared resources—the *jus publicum*—in trust for beneficiaries, present and future generations.\(^{42}\) A 1965 White House report articulated the public trust doctrine and stated: "The land, water, air and living things of the United States are a heritage of the whole nation. They need to be protected for the benefit of all Americans, both now and in the future."\(^{43}\) Trustees have an obligation that they cannot abdicate to preserve and maintain trust assets for both present and future beneficiaries of the trust and to prevent the substantial impairment of trust resources.\(^{44}\)

The Public Trust Doctrine is reiterated in state constitutional provisions across the nation. In *PPL Montana, LLC v. Montana*, the United States Supreme Court recognized that the Public Trust Doctrine “is of ancient origin” dating back to Roman civil law; that the Public Trust Doctrine is reflected in state laws and constitutional provisions throughout our nation; and that federalist principles of our nation affirm the State’s rights and duties over public trust resources within their borders.\(^{45}\) The universal constitutional application of the Public Trust Doctrine is evident in that citizens’ rights to essential natural resources reflect “‘inherent and independent rights’ of mankind relative to the environment.”\(^{46}\) As the Pennsylvania Supreme Court decided in *Robinson Township*, Article I, § 27 of the Pennsylvania Constitution requires government to “conserve and maintain” the State’s natural resources, and imposes the duty “to refrain from permitting or encouraging the degradation, diminution, or depletion of public natural resources, whether such degradation, diminution, or depletion would occur through direct state action or indirectly, *e.g.*, because of the state’s failure to restrain the actions of private parties.”\(^{47}\) Government also has the duty “to act affirmatively to protect the environment” via legislative or regulatory action.\(^{48}\)

Maine has an affirmative and mandatory duty under the Public Trust Doctrine to prevent substantial impairment to the State’s essential natural resources, including the atmosphere (air), oceans, beaches, freshwaters of the State, fish, wildlife, and forests. The public’s right to essential natural resources reflects inherent rights that are preserved by the State Constitution.\(^{49}\)

The Supreme Judicial Court of Maine acknowledged this public trust obligation in a case in which it was called upon to make a determination regarding competing public uses of a frozen

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\(^{42}\) See *Bell v. Wells*, 557 A.2d 168, 181 (Wathen, J., dissenting).

\(^{43}\) Report of the Environmental Pollution Panel: President’s Science Advisory Committee, *Restoring the Quality of Our Environment* 2 (1965).


\(^{47}\) *Id.* at 956.

\(^{48}\) *Id.* at 957.

\(^{49}\) *Id.* at 947 n.35 (recognizing that citizens’ rights to essential natural resources reflect “‘inherent and independent rights’ of mankind relative to the environment.’”) (stating that citizens’ environmental rights codified and protected by state constitution are “inherent in man’s nature and preserved rather than created by the Pennsylvania Constitution.”).
river (i.e., ice harvesting versus travel). The court noted that nobody had an absolute property interest in either use because such uses “are derived from a natural right which all have, to enjoy the benefit of the elements, such as air, light and water, and are common or public rights which belong to the whole community.” In the first instance, it is the legislature that is the “trustee of the public rights for the people.” Consequently, the legislature, in its role as trustee and by authority of the Maine Constitution, must regulate shared resources such that “the common good of all must have a decisive weight on the question of individual enjoyment.” With the passage of the Protection and Improvement of Air Act and the Act to Provide Leadership in Addressing the Threat of Climate Change, the Maine legislature has acted in its role as trustee of atmospheric resources under the Public Trust Doctrine to delegate authority to DEP to protect the trust resources for present and future generations. The Department must now fully implement both the letter and the spirit of the laws in such a manner as to protect Maine citizens from catastrophic climate change. If the Department, as trustee of the atmosphere, does not take immediate and extraordinary action to protect, preserve, and bring the Earth’s atmosphere back into balance, then children in Maine and countless future generations of children will suffer continually greater injuries and damaging consequences. Failure to act will be construed as a breach of the State’s fiduciary duty to protect the atmospheric trust asset for the benefit of current and future Maine people.

The public trust imposes a legal obligation on the Department to affirmatively preserve and protect the citizens’ trust assets from damage or loss, and not to use, waste or dispose of the asset in a manner that causes injury to the trust beneficiaries, be they present or future. Maine’s fiduciary duty in this instance is defined by scientists’ concrete prescriptions for CO₂ reductions. The current level of CO₂ in the atmosphere, over 400 ppm, constitutes substantial impairment of the atmosphere and the ocean, and is causing substantial impairment to other trust resources as well. Additionally, this level of CO₂ in the atmosphere is causing the substantial impairment of other trust resources including Maine’s coastal waters and marine life, Maine’s freshwaters, as well as Maine’s fish, wildlife and forests. Scientists have clearly expressed the minimum CO₂ reductions that are needed and requisite timelines for their implementation. Maine may not disclaim this fiduciary obligation, and is subject to an ongoing mandatory duty to preserve and protect the atmosphere and other trust assets.

B.3 Environmental Protection is the DEP’s Essential Purpose

The essential purpose of the Department of Environmental Protection is to protect Maine’s natural resources for the public’s benefit. Specifically, “The department shall prevent, abate and control the pollution of the air, water and land and preserve, improve and prevent

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50 See Woodman v. Pitman, 79 Me. 456, 10 A. 321 (1887).
51 Id. at 458, 10 A. at 322 (emphasis added).
52 Id. at 459, 10 A. at 323 (But if legislature fails to act, then “such matters necessarily become the subjects of judicial interpretation. . . . [T]here can be no doubt that it is within the scope of judicial authority to determine the manner in which such public privileges may be best enjoyed by the public.”).
53 Id at 459-60, 10 A. at 323.
diminution of the natural environment of the State. The department shall protect and enhance the public’s right to use and enjoy the State's natural resources.”

B.4 DEP is Authorized and Required to Regulate Air Pollution, including Greenhouse Gas Emissions

Per the Protection and Improvement of Air Act, the Department is authorized to “exercise the police power of the State in a coordinated state-wide program to control present and future sources of emission of air contaminants to the end that air polluting activities of every type shall be regulated in a manner that reasonably insures the continued health, safety and general welfare of all of the citizens of the State; protects property values and protects plant and animal life.”

The Act defines air pollution as “the presence in the outdoor atmosphere of one or more air contaminants in sufficient quantities and of such characteristics and duration as to be injurious to human, plant or animal life or to property, or which unreasonably interfere with the enjoyment of life and property throughout the State or throughout such areas of the State as shall be affected thereby.” The scientific consensus is clear: elevated levels of greenhouse gases in the atmosphere are injurious to human, plant and animal life, and to property (see Section IV below). Additionally, Maine’s definition is consistent with the definition of “air pollutant” contained in the federal Clean Air Act. The U.S. Supreme Court found that CO₂ is an air pollutant covered by the Clean Air Act and the Department already regulates GHG emissions from a number of sources.

B.5 DEP has a Statutory Obligation to Eliminate Threats Due to Climate Change and Ocean Acidification

More than a decade ago, the State of Maine was a self-declared leader in efforts to address climate change. In 2003, the 121st Maine State Legislature adopted L.D. 845, An Act to Provide Leadership in Addressing the Threat of Climate Change. The Act established a “lead by example” initiative for State government; set short-, medium-, and long-term targets for greenhouse gas emission reductions; mandated the creation of a Climate Action Plan; and established the Department’s authority to evaluate the State’s progress toward meeting the statutory reduction goals and to make recommendations to the Maine Legislature regarding adjustment of the reduction goals. The statute defined greenhouse gases as:

57 38 M.R.S. § 582(3) (2012).
58 See 42 U.S.C.S. § 7602(g) (“The term ‘air pollutant’ means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term ‘air pollutant’ is used.”).
60 See, e.g., 06-069 C.M.R. ch. 137(1)(C) (emission statements), 06-096 C.M.R. ch. 127 (new motor vehicle emission standards).
62 Id.
[A]ny chemical or physical substance that is emitted into the air and that the department determines by rule may reasonably be anticipated to cause or contribute to climate change. ‘Greenhouse gas’ includes, but is not limited to, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

The specific reduction goals are: 1) reduce greenhouse gas emissions within the State to 1990 levels by 2010; 2) reduce greenhouse gas emissions within the State to 10 percent below 1990 levels by 2020; and 3) in the long term, reduce greenhouse gas emissions to a level “sufficient to eliminate any dangerous threat to the climate. To accomplish this goal, reduction to 75% to 80% below 2003 levels may be required.”

It is important to note that these emission reductions goals were set in 2003. There have been a lot of new developments in climate science in the past 13 years necessitating a review and update of these targets.

Maine succeeded in meeting the 2010 goal of reducing GHG emissions to 1990 levels. Emissions from fossil fuels and waste incineration in 1990 were 19.09 MMTCO2 (though, importantly, Maine’s GHG inventory does not currently include consumption emissions). Emissions from these same sources in 2010 were 18.35 MMTCO2. The decline in GHG emissions is largely due to a shift from petroleum to natural gas in the electrical generation sector. While the combustion of natural gas produces fewer greenhouse gases than the combustion of oil or coal, these emission reductions at the point of combustion are offset by the release of methane (CH4), a potent greenhouse gas, during and after the process of hydraulically fracturing wells for shale-gas and during the transport of natural gas. On a 20-year time scale, “the GHG footprint for shale gas is at least 20% greater than and perhaps more than twice as great as that for coal when expressed per quantity of energy available during combustion.” Consequently, “[t]he large GHG footprint of shale gas undercuts the logic of its use as a bridging fuel over coming decades, if the goal is to reduce global warming.”

In just the past decade, there has been an increase of more than 30% in methane emissions from the United States. Furthermore, there is ample research now that documents a multitude of health and environmental impacts due to hydraulic fracturing (fracking). In order to account for the

63 38 M.R.S. § 574(1) (2012).
64 38 M.R.S. § 576 (2012).
66 Id. at 14. If one considers emissions from energy consumption, industrial processes, agriculture, and waste management, the total emissions for 2010 were 20.80 MMTCO2e. Id. at 12.
68 Robert W. Howarth, Renee Santoro, & Anthony Ingraffea, Methane and the greenhouse-gas footprint of natural gas from shale formations, 106 Climatic Change 679, 685 (2011) (“Methane is a far more potent GHG than is CO2, but methane also has a tenfold shorter residence time in the atmosphere, so its effect on global warming attenuates more rapidly.”).
69 Id. at 679.
70 Id. at 687.
71 Id. at 688.
73 See, e.g., Angels K. Werner et al., Environmental Health Impacts of Unconventional Natural Gas Development: A Review of the Current Strength of Evidence, Science of the Total Environment 505, 1127 (2015); New York State
fugitive emissions associated with the production of natural gas, Petitioners are asking the Department to include these consumption emissions in its biennial inventory of greenhouse gas emissions. Put differently, the Department should consider the full lifecycle GHG emissions for natural gas.

As noted above, the mid-term goal is to reduce greenhouse gas emissions to 10 percent below 1990 levels—that is, to 17.18 MMTCO$_2$—by January 1, 2020$^{74}$ and the long-term goal is to reduce greenhouse gas emissions to a level “sufficient to eliminate any dangerous threat to the climate.”$^{75}$ The long-term goal is too vague to provide meaningful guidance and should be clarified based on findings by leading climate scientists that rapid GHG emissions reduction is needed to restore Earth’s energy balance and, thereby, stabilize the climate.$^{76}$ Similarly, the mid-term goal should be recalibrated to ensure that Maine is on track to reduce greenhouse gas emissions to at least 85% below 1990 levels by 2050, the level that the best climate science dictates is required to avoid catastrophic and irreversible impacts of climate change and ocean acidification.

A Climate Action Plan for Maine (“CAP”) was released on December 1, 2004 per the requirement of 38 M.R.S. § 577.$^{77}$ The Plan, which was developed through a stakeholder process and built upon previous work conducted by the State Planning Office and the Conference of New England Governors and Eastern Canadian Premiers (“NEG/ECP”), contains fifty-four actions, which if implemented, would enable Maine to make significant progress toward the statutory reduction targets. Each of the individual actions requires its own separate plan of implementation, ranging from legislative action, rulemaking, and executive orders, to the encouragement of voluntary activity on the part of Maine people, organizations and businesses.$^{78}$ The Department included several noteworthy observations in the CAP. First, is stated: “each year of delay in implementing an option, for whatever reason, slows its impact.”$^{79}$ Second, the Department indicated that it viewed the CAP as a continuing and living document, which it expected to modify as better information became available.$^{80}$ Finally, the Department stated that it expected that “all the recommended mitigation options, as well as others for which the analysis is not yet complete, will be needed over time to meet the statutory targets. . . . [and that] adopting and implementing a combination of actions that exceeds the minimum statutory requirements is both prudent and desirable.”$^{81}$ These observations, taken together, support more aggressive action now—over a decade after the CAP was released—based on more advanced scientific understanding of the climate system and the urgent need to dramatically reduce CO$_2$ and GHG emissions in order to avert dangerous climate change and ocean acidification.

$^{74}$ 38 M.R.S. § 576 (2).
$^{75}$ 38 M.R.S. § 576 (3).
$^{76}$ Hansen, Assessing “Dangerous Climate Change,” supra note 3, at 16.
$^{78}$ Id. at 5.
$^{79}$ Id. at 7.
$^{80}$ Id. at v.
$^{81}$ Id. at 8.
The Department is also required by statute to evaluate the State’s progress toward the emission reduction goals every two years and, based on the evaluation, to amend the CAP as necessary to ensure that the State meets its GHG emission reduction targets. The joint standing committee of the Legislature having jurisdiction over natural resources matters may report out legislation relating to the evaluations to the second regular session of any Legislature.

The last evaluation, *Fifth Biennial Report on Progress toward Greenhouse Gas Reduction Goals*, was issued in January 2014. As noted above, Maine met its short-term goal of reducing emissions to 1990 levels by January 1, 2010. Since 2003, Maine’s emissions have declined at an average rate of 4.3 percent per year. While this decline in emissions is a positive sign, Maine’s emission reductions are still short of what the best climate science says is necessary. Also, it is important to note that Maine does not currently include consumption emissions when calculating its GHG emissions inventory. Therefore, greater emission reductions are required in order to ensure that Maine does its part to avoid the worst impacts of climate change and ocean acidification. During this period of overall decreased energy consumption and declining emissions, Maine’s real gross domestic product (“GDP”) increased from $33.440 billion in 1990 to $45.763 billion in 2011. The Department did not report on progress in implementing the action items described in the CAP. It is, therefore, difficult to determine to what extent the fifty-four actions have been undertaken. Also, rather than specifically amending the Climate Action Plan as required by 38 M.R.S. 578, the Department merely observed that the current mid-term goal of reducing emissions statewide to 10% below 1990 levels by 2020 will be more easily met if: 1) Maine continues to encourage replacement of petroleum products with carbon-neutral renewable energy sources and low carbon emitting natural gas; and 2) future policies and programs focus on the reduction of petroleum consumption in the residential, commercial, and transportation sectors.

Finally, the climate change statute authorizes DEP to make recommendations to the joint standing committee of the Legislature having jurisdiction over natural resources matters that the statutory GHG emission reduction goals be either increased or decreased. Given the urgent need to reduce CO₂ and GHG emissions, DEP should advise the Legislature that the GHG statutory emission reduction targets should be revised to: 1) provide a scientifically-based, numeric emission reduction target for 2050 calibrated to achieve the existing long-term goal of reducing emissions “sufficient to eliminate any dangerous threat to the climate”; and 2) to include emission reduction benchmarks for the years 2020, 2030, 2040, and 2050.

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82 38 M.R.S. § 578 (2012).
83 Id.
85 The average annual reduction was calculated by dividing the annual reduction in emissions from fossil fuels and waste incineration by the number of years since emissions peaked: (2.07+1.24+9.55+1.62+8.47+3.86+1.82+5.83)/8=4.3075. Emission data was taken from Appendix B in the *Fifth Biennial Report on Progress toward Greenhouse Gas Reduction Goals*, Maine DEP, *Fifth Biennial Report on Progress*, supra note Error! Bookmark not defined., at 13-14.
87 Id. at 10.
88 38 M.R.S. § 578 (2012).
89 38 M.R.S. § 576 (2012).
specifically, the DEP should recommend to the Legislature that Maine reduce greenhouse gas emissions to at least 85% below 1990 levels by 2050. The annual rate of emission reductions must be at least 8%, if the reductions begin in 2017. For every year that Maine delays in implementing the proposed rule the annual rate of emission reductions will increase.

While Petitioners support Maine’s participation in the Regional Greenhouse Gas Initiative (“RGGI”), the emission reductions mandated by RGGI are insufficient for Maine to fulfill its constitutional, public trust, and statutory obligations for multiple reasons. Due to RGGI’s cap and trade structure, Maine power plants could actually increase emissions as long as the power plants purchased allowances from other states in the region. The regulatory structure of RGGI allows emission reductions to occur outside of a particular state in-lieu of in-state emission reductions, and thus does not ensure that Maine’s emission reductions from power plants decline. More importantly, RGGI only applies to GHG emissions from power plants and does not account for all other sources of Maine’s emissions, such as transportation, land use, consumptions emissions, and others. RGGI is not a comprehensive approach reducing Maine’s GHG emissions and to ensuring that Maine adequately reduces its GHG emissions according to the best climate science.

The DEP’s statutory obligations must be considered in the context of the public trust doctrine and the Maine Constitution. As one court in Washington has explained, an agency’s statutory duty “must be understood in the context not just of the [State’s] Clean Air Act itself but in recognition of the Washington Constitution and the Public Trust Doctrine.” Accordingly, given the aforementioned grants of authority, description of obligations, and statements of policy, Petitioners respectfully request that the Department and Board adopt the proposed rule. Cumulatively, the proposed rule will put Maine back on course to achieve emission reductions on the scale necessary to avert disastrous consequences and substantial impairment to public trust resources. Failure to take immediate action to significantly reduce carbon dioxide emissions will increase the cost and magnitude of future reduction requirements and, more significantly, will result in catastrophic and irreversible adverse effects on petitioners, children, and future generations of Mainers.

C. Maine has the Administrative Infrastructure to Address Climate Change and Ocean Acidification

Maine has many existing offices and programs that are currently tasked with addressing energy policy and climate change. The primary actors, in addition to the Department of Environmental Protection, are the Governor’s Energy Office, the Public Utilities Commission (“PUC”), and Efficiency Maine Trust (“EMT”). Additionally, the legislature has established a series of statutory targets related to GHG emission reductions, energy conservation, and the promotion of renewable energy (see Exhibit 9 for a summary of statutory goals). Also, as already noted, Maine has developed a number of plans to guide State action, including A Climate Action Plan for Maine (2004), State of Maine Comprehensive Energy Plan 2008-2009 (2009), and

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People and Nature: Adapting to a Changing Climate (2010). These and other efforts have established the basic infrastructure Maine needs to effectively address climate change.

V. STATEMENT OF REASONS

While the State’s ongoing efforts to reduce GHG emissions are laudable, they are insufficient to adequately protect the interests of current and future citizens of Maine. Science unequivocally shows that anthropogenic climate change is occurring and is threatening the stability of the global climate system. Furthermore, climate change is already occurring in the state of Maine and is projected to significantly impact the state in the future. Fortunately, the best climate science provides a prescription for restoring the atmosphere, stabilizing the climate system, and protecting the oceans from acidification and warming.

A. The Science Unequivocally Shows that Anthropogenic Climate Change is Occurring and is Threatening the Stability of the Global Climate System

A.1 Climate Change is Caused by Anthropogenic Activities

For over fifty years, the United States of America has known that carbon dioxide pollution from burning fossil fuels was causing global warming and dangerous climate change, and that continuing to burn fossil fuels would destabilize the climate system on which present and future generations of our nation depend for their wellbeing and survival. In a 1965 Report of President Lyndon Johnson’s Scientific Advisors, “Restoring the Quality of Our Environment, the President’s Science Advisory Committee stated: “that “pollutants have altered on a global scale the carbon dioxide content of the air” through the “burning of coal, oil and natural gas.” The Executive Branch warned that “carbon dioxide [gases] are accumulating in such large quantities that they may eventually produce marked climatic change.” The 1965 Report confirmed that anthropogenic pollutants, including CO$_2$, threaten “the health, longevity, livelihood, recreation, cleanliness and happiness of citizens who have no direct stake in their production, but cannot escape their influence.” The Executive Branch described the marked climatic changes from CO$_2$ pollution as including the melting of the Antarctic icecap, rising sea levels, warming oceans, acidifying waters, and additional releasing of CO$_2$ and methane due to these events. It recommended reducing the heating of the Earth because of the “extraordinary economic and human importance” of our climate system. Since 1965, numerous other studies and reports also have made clear the significant harms that would be caused if we did not reduce reliance on carbon-intense energy from fossil fuels and rapidly transition to carbon-free energy.

92 President’s Science Advisory Committee, Environmental Pollution Panel, Restoring the Quality of Our Environment (1965); see also T. C. Chamberlin, An Attempt to Frame a Working Hypothesis of the Cause of Glacial Periods on an Atmospheric Basis, J. of Geology 7, 575 (1899) (Scientists understood that CO$_2$ concentrations in the atmosphere cause heat retention on Earth and that a doubling or tripling of the CO$_2$ content in 1899 would significantly elevate Earth’s surface temperature.).
93 Id. at 1.
94 Id. at 12.
95 Id. at 1.
96 Id. at 123-24.
97 Id. at 127.
Since 1990, it has been known that CO₂ levels in the atmosphere must be stabilized at or below 350 ppm in order to protect our nation’s climate system and that a swift transition away from fossil fuels was necessary. 98 In December 1990, EPA submitted a report to Congress on “Policy Options for Stabilizing Global Climate.” The EPA’s 1990 Report concluded: “responses to the greenhouse problem that are undertaken now will be felt for decades in the future, and lack of action now will similarly bequeath climate change to future generations.” 99 The 1990 Report called for stabilizing atmospheric CO₂ concentrations at 350 ppm, the current level of that time. In its 1990 Report, EPA confirmed the Executive Branch’s findings from 1965 that CO₂ was a “dangerous” pollutant. Twenty-five years later, today’s best science confirms that 350 ppm is the maximum safe level of atmospheric CO₂ required to restore a stable climate system.

On October 15, 1992, the Senate ratified the United Nations Framework Convention on Climate Change (“UNFCCC”). The UNFCCC was executed to “protect the climate system for the benefit of present and future generations of humankind.” The UNFCCC evidences an “overwhelming weight” of support for protection of the atmosphere under the norms and principles of intergenerational equity. 100 The minimal objective of the UNFCCC is the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.” 101

The United States Global Change Research Program 102 has confirmed that global warming is occurring and adversely impacting the Earth’s climate. 103 The present rate of global heating is occurring as a result of human activities that release heat-trapping GHGs and intensify the Earth’s natural greenhouse effect at an accelerated rate, thereby changing Earth’s climate. 104

99 Id. at III-15.
100 UNFCCC, Art. 3.
101 UNFCCC, Art. 2.
102 “The U.S. Global Change Research Program (“USGCRP”) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (“GCRA”) of 1990 to “assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.” The organization’s vision is to produce “[a] nation, globally engaged and guided by science, meeting the challenges of climate and global change.” Their mission is “to build a knowledge base that informs human responses to climate and global change through coordinated and integrated Federal programs of research, education, communication, and decision support.” http://www.globalchange.gov/about.
103 U.S. Global Change Research Program (“USGCRP”), Climate Change Impacts in the United States: Third National Climate Assessment 7 (2014) [hereinafter Climate Change Impacts], http://nca2014.globalchange.gov/downloads (“Evidence for climate change abounds, from the top of the atmosphere to the depths of the oceans . . . . Evidence of climate change is also visible in the observed and measured changes in location and behavior of species and functioning of ecosystems. Taken together, this evidence tells an unambiguous story: the planet is warming, and over the last half century, this warming has been driven primarily by human activity.”).
104 Id. (“Multiple lines of independent evidence confirm that human activities are the primary cause of the global warming of the past 50 years.”); Deutsche Bank Climate Change Advisors, Climate Change: Addressing the Major Skeptic Arguments 9 (2010), http://www.climateaccess.org/sites/default/files/Carr_Address%20Skeptic%20Arguments.pdf; Intergovernmental
This abnormal climate change is unequivocally human-induced, is occurring now, and will continue to occur unless drastic measures are taken to curtail it. Climate change is damaging both natural and human systems, and if unrestrained, will alter the planet’s habitability.

According to the United States Environmental Protection Agency (“EPA”), “the case for finding that greenhouse gases in the atmosphere endanger public health and welfare is compelling and, indeed, overwhelming.” The EPA further stated in April 2009 that “the evidence points ineluctably to the conclusion that climate change is upon us as a result of greenhouse gas emissions, that climate changes are already occurring that harm our health and welfare, and that the effects will only worsen over time in the absence of regulatory action.”

Human beings have benefited from living on a planet that has been remarkably hospitable to our existence and has provided conditions that are just right for human life to evolve, expand, and flourish. The Earth is a “Goldilocks” planet with an atmosphere that has fewer GHGs than that of Venus (which is too hot), and more than that of Mars (which is too cold), which is just perfect for the amazing diversity of life that has developed and thrived on planet Earth.

GHGs in the atmosphere act like a blanket over the Earth to trap the heat that it receives from the sun. More GHGs in the atmosphere means that more heat is being retained on Earth, with less heat radiating back out into space. Without this greenhouse effect, the average surface temperature of our planet would be 0°F (-18°C) instead of 59°F (15°C). Scientists have understood this basic mechanism of global warming since the late-nineteenth century.


105 USGCRP, Climate Change Impacts, supra note 103, at 7.
106 Id. at 14 ("The cumulative weight of the scientific evidence contained in this report confirms that climate change is affecting the American people now, and that choices we make will affect our future and that of future generations."); IPCC, AR5, supra note 104, 1.2.2, 124 (2013) ("Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.").
107 USGCRP, Climate Change Impacts, supra note 103, at 5 ("While some climate changes will occur slowly and relatively gradually, others could be rapid and dramatic, leading to unexpected breaking points in natural and social systems.").
109 Id. (emphasis added).
110 John Abatzoglou et al., A Primer on Global Climate Change and Its Likely Impacts, in Climate Change: What it Means for Us, Our Children, and Our Grandchildren 11, 15-22 (Joseph F. C. DiMento & Pamela Doughman eds., 2007) [hereinafter A Primer on Global Climate Change] ("The earth’s climate system can be thought of as an elaborate balancing act of energy, water, and chemistry involving the atmosphere, oceans, ice masses, biosphere, and land surface.").
111 James Hansen, Storms of my Grandchildren 224-25 (2009); See Abatzoglou, A Primer on Global Climate Change, supra note 110, at 23.
112 Abatzoglou, A Primer on Global Climate Change, supra note 110, at 22.
113 Id. at 16-17.
114 Id. at 17.
115 See id. at 35 (describing the efforts of Swedish chemist Svante Arrhenius).
Human beings have significantly altered the chemical composition of the Earth’s atmosphere and its climate system. Collectively, we have changed the atmosphere and the Earth’s climate system by engaging in activities that produce or release GHGs into the atmosphere. Carbon dioxide is the key GHG, and there is abundant evidence that its emissions are largely responsible for the current warming trend. Although much of the excess carbon dioxide is absorbed by the oceans, plants, and forests, the increase of GHG concentrations resulting from historic and present human activities has altered the Earth’s ability to maintain the delicate balance of energy it receives from the sun and that which it radiates back out into space.

In 2013, the CO₂ concentration in our atmosphere exceeded 400 ppm for the first time in recorded history (compared to the pre-industrial concentration of 280 ppm). For the first time since CO₂ levels in the global atmosphere have been tracked, the monthly global average concentration of CO₂ was 400 ppm for the entire month of March 2015. Current atmospheric CO₂ concentrations are the highest they have been in the last 3 million years. The rate of fossil fuels emissions has also increased from 1.5%/year during 1973-2000 to 2.6%/year in 2000-2014. The increase in atmospheric CO₂ concentrations is also increasing, from 0.85 ppm per year in the 1960-1970 period, to 2.0 ppm per year in the 2000-2010 period.

Concentrations of other GHGs in the atmosphere have also increased from human activities. Atmospheric concentrations of methane, for example, have increased nearly 250 percent since the pre-industrial period. Concentrations of nitrous oxide have also increased by 120 percent.

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116 Naomi Oreskes, The Scientific Consensus on Climate Change, in Climate Change: What it Means for Us, Our Children, and Our Grandchildren 65, 93 (Joseph F. C. DiMento & Pamela Doughman eds., 2007) (“We have changed the chemistry of our atmosphere, causing sea level to rise, ice to melt, and climate to change. There is no reason to think otherwise.”); Wash. Exec. Order No.14-04 (Apr. 29, 2014).
117 Id.
119 Abatzoglou, A Primer on Global Climate Change, supra note 110, at 15-22.
120 NOAA, Greenhouse Gases Continued Rising in 2013, 34 Percent Increase Since 1990, (May 2, 2012), http://research.noaa.gov/News/NewsArchive/LatestNews/TabId/684/ArtMID/1768/ArticleID/10553/Greenhouse-gases-continued-rising-in-2013-34-percent-increase-since-1990.aspx (“We continue to turn the dial up on this ‘electric blanket’ of ours without knowing what the resulting temperatures will be.”).
122 Dec. of Dr. James E. Hansen, supra note 8, at 4; Dieter Lüthi et al., High-resolution Carbon Dioxide Concentration Record 650,000-800,000 Years Before Present 453 Nature 379, 379-82 (May 2008), http://www.nature.com/nature/journal/v453/n7193/full/nature06949.html [hereinafter High-resolution Carbon Dioxide Concentration Record] (prior to this publication it was accepted atmospheric CO₂ record extended back 650,000 years, but now research indicates that the record can be extended 800,000 years, or two complete glacial cycles).
123 Dec. of Dr. James E. Hansen, supra note 8, at 5.
124 Id. at 7.
125 IPCC, AR5, supra note 104, at TS.2.8.3, 52 (“The concentration of CH₄ has increased by a factor of 2.5 since pre-industrial times, from 722 [697 to 747] ppb in 1750 to 1803 [1799 to 1807] ppb in 2011.”).
126 Id. at TS.2.8.4, 52.
Humans not only continue to add GHGs into the atmosphere at a rate that outpaces their removal through natural processes, but the current and projected CO$_2$ increase, for example, is about one hundred times faster than any that has occurred over the past 800,000 years. This increase has to be considered in light of the lifetime of greenhouse gases in the atmosphere. In particular, a substantial portion (around 20%) of every ton of CO$_2$ emitted by humans persists in the atmosphere for as long as a millennium or more, and while there, it continues to affect the climate system. The current concentrations of GHGs in the atmosphere, therefore, are the result of both historic and current emissions. What this means is that the impacts associated with the GHG emissions of today will be mostly borne by our children and future generations.

Changes in different aspects of Earth’s climate system over the last century tell a coherent story: the impacts we see today are consistent with the scientific understanding of how the climate system should respond to GHG increases from human activities and how the Earth has responded in the past (reflected in such evidence as: ice cores that have trapped air from thousands to a few million years ago, tree rings, and seabed sediments that show where sea level was thousands and even millions of years ago). Collectively, these changes cannot be explained as the product of natural climate variability alone. A large human contribution provides the best explanation of observed climate changes.

These well-documented and observable impacts from the changes in Earth’s climate system highlight that the current level of atmospheric CO$_2$ concentration has already taken the planet into a danger zone. The Earth will continue to warm in reaction to concentrations of CO$_2$ from past emissions as well as future emissions. Warming already in the pipeline is mostly attributable to climate mechanisms that slowly heat the Earth’s climate system in response to atmospheric CO$_2$.

A.2 Global Temperature Increases

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127 EPA, *TS Endangerment Findings*, supra note 25, at ES-2 (“Atmospheric GHG concentrations have been increasing because anthropogenic emissions have been outpacing the rate at which GHGs are removed from the atmosphere by natural processes over timescales of decades to centuries.”).

128 Lüthi, High-resolution Carbon Dioxide Concentration Record, supra note 122, at 379-82.

129 Hansen, *Where Should Humanity Aim?*, supra note 118, at 220; see also EPA, *TS Endangerment Findings*, supra note 25, at 16 (“Carbon cycle models indicate that for a pulse of CO$_2$ emissions, given an equilibrium background, 50% of the atmospheric increase will disappear within 30 years, 30% within a few centuries, and the last 20% may remain in the atmosphere for thousands of years.”); Abatzoglou, *A Primer on Global Climate Change*, supra note 110, at 29 (“Since CO$_2$ has a lifetime of over one hundred years, these emissions have been collecting for many years in the atmosphere.”).


133 USGCRP, *Climate Change Impacts*, supra note 103, at 7.


One key observable change is the rapid increase in recorded global surface temperatures. As a result of increased atmospheric GHGs from human activities, based on fundamental scientific principles, the Earth has been warming as scientists have predicted. The increased concentrations of greenhouse gases in our atmosphere, primarily CO₂, have raised global surface temperature by 0.9°C (1.5°F) from 1880 to 2015, which is close to, and probably slightly above, the maximum warming of the Holocene area, the period of relatively stable climate over the last 10,000 years over which human civilization developed. In the last century, the Earth has warmed at a rate “roughly ten times faster than the average rate of ice-age-recovery warming.” Because of the centuries it takes for the climate system to respond to changes in atmospheric CO₂ composition, due to the ocean’s great thermal inertia, there is substantial additional warming already “in the pipeline,” meaning that it is inevitable.

Because of year-to-year variations in these thermometer readings, as with daily readings, scientists compare temperature differences over a decade to determine patterns. Employing this decadal scale, the surface of the planet has warmed at a rate of roughly 0.12°C per decade since 1951. Global mean surface temperature has been decidedly higher during the last few decades of the twentieth century than at any time during the preceding four centuries. Global surface temperatures have been rising dramatically since 1951; 2010 tied for the hottest year on record, and “[t]he year 2013 tied with 2009 and 2006 for the seventh warmest year since 1880.” Then, 2014 became the new hottest year on record. In 2015 the average global temperature “shattered the previous mark set in 2014 by 0.23 degrees Fahrenheit (0.13 Celsius).” Only once before has a new temperature record exceeded the old record by this much. Now, 2016 is on track to exceed 2015 for the hottest year on record (there is a 99% chance in atmospheric CO₂ recovery warming).

136 NSTC, Scientific Assessment, supra note 25, at 51; IPCC, AR5, supra note 104, at 1.3.1, 131; USGCRP, Climate Change Impacts, supra note 103, at 22; Nat’l Aeronautics and Space Admin. (“NASA”) & Goddard Institute for Space Studies (“GISS”), Global Surface Temperature, http://climate.nasa.gov/keyIndicators/#globalTemp (illustrating the change in global surface temperatures) (last visited Apr. 22, 2016).
137 IPCC, AR5, supra note 104, at TS.2.2.1, 37; USGCRP, Climate Change Impacts, supra note 103, at 22.
138 IPCC, AR5, supra note 104, at TS.2.8, 50.
139 Id. at B.1, 5; Dec. of Dr. James E. Hansen, supra note 8 at 12; NASA, Climate Change: Key Indicators, http://climate.nasa.gov/key_indicators#globalTemp (last visited Apr. 22, 2016).
141 Dec. of Dr. James E. Hansen, supra note 8, at 12.
142 IPCC, AR5, supra note 104, at TS.2.2.1, 37.
143 Id. at B.1, 5.
144 The Nat’l Academies Press (Board on Atmospheric Sciences and Climate), Surface Temperature Reconstructions for the Last 2,000 Years 3 (2006), http://www.nap.edu/catalog.php?record_id=11676.
148 Id.
chance this will happen). This would be the first time three consecutive years were the hottest year on record.

The dramatic increase of the average global surface temperature is alarming. It has become quite clear that the past several decades present an anomaly, as global surface temperatures from 2000-2009 are registering higher than at any point in the past 1,300 years. The IPCC has observed that “[w]arming of the climate system is unequivocal.” The United States EPA has recognized the scientific consensus that has developed on the fact of global warming and its cause: the Earth is heating up due to human activities.

Changes in many different aspects of Earth’s climate system over the past century are consistent with this warming trend. Based on straightforward scientific principles, human-induced GHG increases lead not only to warming of land surfaces, but also to the warming of oceans, increased atmospheric moisture levels, rises in the global sea level, and changes in rainfall and atmospheric air circulation patterns that affect water and heat distribution.

As expected (and consistent with the temperature increases in land surfaces), ocean temperatures have also increased. This has led to changes in the ocean’s ability to circulate heat around the globe; which can have catastrophic implications for the global climate system. The average temperature of the global ocean has increased significantly despite its remarkable ability to absorb enormous amounts of heat before exhibiting any indication thereof. In addition, the most significant indicator of the planet’s energy imbalance due to human-induced GHG increases is the long-term increase in global average ocean heat content over the last 50 years, extending down to several thousand meters below the ocean surface.

149 Eric Levitz, It’s Been the Hottest Month on Record, for a Full Year Now, New York Magazine (May 18, 2016), http://nymag.com/daily/intelligencer/2016/05/been-the-hottest-month-ever-for-a-year.html.
150 Id.
151 USGCRP, Climate Change Impacts, supra note 103, at 23.
152 IPCC, AR5, supra note 104, at B.4.
153 EPA, TS Endangerment Findings, supra note 25, at ES-2 (“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level . . . . Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations.”) (emphasis added).
154 IPCC, AR5, supra note 104, at TS.2.2.1, 37.
155 Id. at TS.2.2.3, 38.
157 IPCC, AR5, supra note 104, at TS.2.6, 46.
158 USGCRP, Climate Change Impacts, supra note 103, at 26, 32-33, 36.
159 IPCC, AR5, supra note 104, at TS.2.4, 39; Hansen, Ice Melt, Sea Level Rise and Superstorms, supra note 3.
160 USGCRP, Climate Change Impacts, supra note 103, at 560.
A.3 Precipitation, Storms, Wildfires, and Drought

As predicted, precipitation patterns have changed due to increases in atmospheric moisture levels and changes in atmospheric air circulation patterns, another indicator that the Earth is warming.\(^{163}\) As the Earth warms, moisture levels increase when temperature increases because warmer air generally holds more moisture.\(^ {164}\) In more arid regions, however, higher temperatures lead to greater evaporation.\(^ {165}\)

These changes in the Earth’s water cycle increase the potential for, and severity of, severe storms, flooding, and droughts.\(^ {166}\) Storm-prone areas are already experiencing a greater chance of severe storms and this heightened threat will continue.\(^ {167}\) In arid regions, increased precipitation is likely to cause flash flooding followed by drought.\(^ {168}\)

These changes are already occurring. Droughts in parts of the midwestern, southeastern, and western United States have increased in frequency and severity within the last fifty years, coinciding with rising temperatures.\(^ {169}\) Most of the recent heat waves can be attributed to human-caused climate disruption.\(^ {170}\) For example, in September 2015 almost 20% of the United States was experiencing a severe to exceptional drought and over 50% of the United States was abnormally dry.\(^ {171}\) For the western United States, over 40% was experiencing a severe to exceptional drought and 92% of California was experiencing a severe to exceptional drought.\(^ {172}\) Nearly 60 million people in the west were being affected by drought.\(^ {173}\) Despite a 2015-2016 winter that has been wetter than the previous year, 2016 is still off to a dryer than normal start, which will likely have significant implications for agriculture, rivers, fish, and drinking water supplies during the summer and fall. As of March 2016, one-third of the contiguous United States was abnormally dry while two-thirds of the west was abnormally dry.\(^ {174}\)

Based on the laws of physics and the past climate record, scientists have concluded that precipitation events will increase globally, particularly in tropical and high latitude regions, while decreasing in subtropical and mid-latitude regions,\(^ {175}\) with longer periods between normal heavy rainfalls.\(^ {176}\) Climate change is already causing, and will continue to result in, more...

\(^{163}\) USGCRP, Climate Change Impacts, supra note 103, at 1, 27, 32, 36.
\(^{164}\) EPA, TS Endangerment Findings, supra note 25, at 111.
\(^{165}\) Id.
\(^{166}\) Id.
\(^{167}\) Id. at 120-21; USGCRP, Climate Change Impacts, supra note 103, at 43.
\(^{168}\) EPA, TS Endangerment Findings, supra note 25, at 115.
\(^{169}\) Id. at 143, 145, 148.
\(^{170}\) USGCRP, Climate Change Impacts, supra note 103, at 38 (“The summer 2011 heat wave and drought in Texas was primarily driven by precipitation deficits, but the human contribution to climate change approximately doubles the probability that the heat was record-breaking.”).
\(^{172}\) Id.
\(^{173}\) Id.
\(^{174}\) Id.
\(^{175}\) EPA, TS Endangerment Findings, supra note 25, at ES-4, 74.
\(^{176}\) Id.
frequent, extreme, and costly weather events (such as hurricanes).\textsuperscript{177} The annual number of major tropical storms and hurricanes has increased over the past 100 years in North America, coinciding with increasing temperatures in the Atlantic sea surface.\textsuperscript{178}

Other changes consistent with climate modeling resulting from global warming have been observed not just in the amount, intensity, and frequency of precipitation but also in the type of precipitation.\textsuperscript{179} In higher altitude and latitude regions, including in mountainous areas, more precipitation is falling as rain rather than snow.\textsuperscript{180} With early snow melt occurring because of climate change, the reduction in snowpack can aggravate water supply problems.\textsuperscript{181} The snow cover extent of North America in June 2013 was the fourth lowest ever recorded.\textsuperscript{182} According to a snow report from March 2015, snow cover extent for the contiguous U.S. was 500,000 square miles, which is 244,000 square miles below the 1981-2010 average.\textsuperscript{183} This means the March 2015 snow cover extent was the 5th smallest on record and the smallest since 2012.\textsuperscript{184} In March 2016, the snow cover for the contiguous U.S. was 382,000 square miles, 359,000 square miles below the 1981-2010 average and the second smallest snow cover in the 50-year period for which records exist.\textsuperscript{185}

As the 2010 Russian summer heat wave graphically demonstrated, heat can destroy crops, trigger wildfires, exacerbate air pollution, and cause increased illness and deaths.\textsuperscript{186} Similar impacts are occurring across the United States. The “number and frequency of forest fires and insect outbreaks are increasing in the interior West, the Southwest, and Alaska. Precipitation and stream temperatures are increasing in most of the continental United States. The western United States is experiencing reduced snowpack and earlier peaks in spring runoff. The growth of many crops and weeds is being stimulated.”\textsuperscript{187} Climate change and ocean acidification are threatening the survival and wellbeing of millions of species of plants, fish and wildlife, and Earth’s biodiversity. As many as one in six species are threatened with extinction due to climate change.\textsuperscript{188} Many more species that do not face extinction will face changes in abundance, distributions, and species interactions that cause adverse impacts for ecosystems and humans.

\begin{enumerate}
\item \textsuperscript{177} USGCRP, \textit{Climate Change Impacts}, supra note 103, at 38.
\item \textsuperscript{178} NSTC, \textit{Scientific Assessment}, supra note 25, at 7.
\item \textsuperscript{179} \textit{Id.} at ES-2.
\item \textsuperscript{180} USGCRP, \textit{Climate Change Impacts}, supra note 103, at 75.
\item \textsuperscript{181} \textit{Id.} at 72.
\item \textsuperscript{182} C. Derksen et al., \textit{Arctic Report Card: Update for 2013 – Snow} (Nov. 15, 2013), http://www.arctic.noaa.gov/reportcard/snow.html (“[T]he below normal June SCE in North America was driven by rapid snow melt, rather than anomalously low snow accumulation prior to melt onset.”).
\item \textsuperscript{183} NOAA National Centers for Environmental Information, \textit{National Snow and Ice – March 2015} (last visited Apr. 21, 2016), http://www.ncdc.noaa.gov/sotc/snow/201603.
\item \textsuperscript{184} \textit{Id.}
\item \textsuperscript{185} NOAA National Centers for Environmental Information, \textit{National Snow and Ice – March 2016} (last visited Apr. 21, 2016), http://www.ncdc.noaa.gov/sotc/snow/201603.
\item \textsuperscript{187} EPA, \textit{TS Endangerment Findings}, supra note 25, at 25 (citing P. Backlund et al., \textit{Executive Summary, in The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States} (2008)).
\item \textsuperscript{188} Mark C. Urban, \textit{Accelerating Extinction Risk from Climate Change}, 348 Science 6234 (2015).
\end{enumerate}
Climate change, and related warmer temperatures and drought, are leading to longer and more destructive wildfire seasons. In 2015 for example, Alaska had its second worst wildfire season in history with over 5 million acres burned as of August.\(^{189}\) Meanwhile, wildfires ravaged the western United States. The Governor of Washington, Jay Inslee, referred to the situation in Washington as “an unprecedented cataclysm.”\(^{190}\) Fires burned millions of acres, destroyed hundreds of homes, and caused multiple fatalities. Indeed, the 2015 fire season set an ominous record: for the first time on record, U.S. wildfires burned more than 10 million acres.\(^{191}\) 2015 was also the most expensive wildfire season on record with over $1.7 billion spent to fight fires.\(^{192}\) Wildfire seasons are expected to become increasingly destructive, dangerous, and expensive in the coming years as a result of climate change.

### A.4 Sea Level Rise

As expected, global sea levels have also risen, and are expected to continue to rise at an exponential rate, not linearly.\(^{193}\) Sea levels have been rising at an average rate of 3.2 millimeters per year based on measurements from 1993 to 2010.\(^{194}\) Though sea levels rose about 6.7 inches over the last century, within the last decade, that rate has nearly doubled.\(^{195}\) Ice melt doubling times of 10, 20, or 40 years would result in sea level rise of several meters in 50, 100, or 200 years and, as evidenced by recent ice melting, it appears that the ice melt doubling time is at the low end of the 10-40 year range.\(^{196}\) Rising seas, brought about by the melting of polar icecaps and glaciers, as well as by thermal expansion of the warming oceans, will cause flooding in coastal and low-lying areas.\(^{197}\) The combination of rising sea levels and more severe storms creates conditions conducive to severe storm surges during high tides.\(^{198}\) In coastal communities this can overwhelm coastal defenses (such as levees and sea walls), as witnessed during Hurricane Katrina and Hurricane Sandy.\(^{199}\) Because of the long time that CO\(_2\) persists in the climate system, without immediate and rapid reductions in CO\(_2\) emissions we will lock in catastrophic consequences, such as multi-meter sea level rise, which would mean all coastal

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\(^{192}\) Doyle Rice, 2015 Now USA’s Costliest Wildfire Season on Record, USA Today (Dec. 17, 2015).

\(^{193}\) Hansen, Ice Melt, Sea Level Rise and Superstorms, supra note 3, at 3761; USGCRP, Climate Change Impacts, supra note 103, at 44; EPA, TS Endangerment Findings, supra note 25, at ES-3; IPCC, AR5, supra note 104, at B.4, 11.

\(^{194}\) IPCC, AR5, supra note 104, at B.4, 11.


\(^{196}\) Hansen, Ice Melt, Sea Level Rise and Superstorms, supra note 3, at 3761.

\(^{197}\) EPA, TS Endangerment Findings, supra note 25, at ES-7; USGCRP, Climate Change Impacts, supra note 103, at 45.

\(^{198}\) USGCRP, Climate Change Impacts, supra note 103, at 45; EPA, TS Endangerment Findings, supra note 25, at 75.

\(^{199}\) EPA, TS Endangerment Findings, supra note 25, at 86, 118.
cities would “los[e] functionality” with “practically incalculable” economic and social costs.\(^{200}\) Relying on adaptation to these threats “will be unacceptable to most of humanity.”\(^{201}\)

Sea level is not uniform across the globe, because it depends on variables such as ocean temperature and currents.\(^{202}\) Unsurprisingly, the most vulnerable lands are low-lying islands, river deltas, and areas that already lie below sea level because of land subsidence.\(^{203}\) Based on these factors, scientists have concluded that the immediate threats to the United States from rising seas are the most severe on the Gulf and Atlantic Coasts.\(^{204}\) Worldwide, hundreds of millions of people live in river deltas and vulnerable coastlines along the southern and western coasts of Asia where rivers draining the Himalayas flow into the Indian and Pacific Oceans.\(^{205}\)

If carbon pollution is not quickly abated, there is near scientific certainty that humanity will experience sea level rise of several meters this century,\(^{206}\) submerging much of the eastern seaboard of the U.S., as well as low lying areas of Europe, the Far-East, and the Indian sub-continent. This would mean that we would lose the functionality of all coastal cities, with “incalculable” economic and socials costs.\(^{207}\) “Today, rising sea levels are submerging low-lying lands, eroding beaches, converting wetlands to open water, exacerbating coastal flooding, and increasing the salinity of estuaries and freshwater aquifers.”\(^{208}\) Low-lying lands are especially vulnerable to sea level rise. Scientists have predicted that wetlands in the Mid-Atlantic region of the United States cannot withstand a 7-millimeter per year rise in sea levels.\(^{209}\) As wetlands are inundated, further impacts from sea level rise will multiply, as “protection of coastal lands and people against storm surge will be compromised.”\(^{210}\)

Glacial and ice cap melting is one of the major indicators of global warming and a significant cause of global sea level change.\(^{211}\) When glaciers and ice caps melt, this adds water to the ocean.\(^{212}\) Another cause is that as ocean water warms, it expands and takes up more space.\(^{213}\) Therefore, “sea level rise is expected to continue well beyond this century as a result of both past and future GHG emissions from human activities.”\(^{214}\)

A.5 Glaciers, Sea Ice, and Permafrost

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\(^{200}\) Hansen, *Ice Melt, Sea Level Rise and Superstorms*, supra note 3, at 3762.

\(^{201}\) Id.


\(^{203}\) EPA, *TS Endangerment Findings*, supra note 25, at 121.

\(^{204}\) Id. at 128; USGCRP, *Climate Change Impacts*, supra note 103, at 589 (Annual damage resulting from sea level rise “in the Gulf region alone could be $2.7 to $4.6 billion by 2030, and $8.3 to $13.2 billion by 2050.”).

\(^{205}\) EPA, *TS Endangerment Findings*, supra note 25, at 159.


\(^{207}\) Id. at 20062.


\(^{209}\) Id. at 4.

\(^{210}\) USGCRP, *Climate Change Impacts*, supra note 103, at 402.


\(^{212}\) USGCRP, *Climate Change Impacts*, supra note 103, at 44.

\(^{213}\) Id.

\(^{214}\) Id. at 45.
As expected, mountain glaciers, which are the source of freshwater for hundreds of millions of people, are receding worldwide because of warming temperatures. In 2010, Glacier National Park in Montana had only twenty-five glaciers larger than twenty-five acres, down from one hundred and fifty in 1850. These glaciers may be completely gone in the coming decades. Mountain glaciers are in retreat all over the world, including on Mt. Kilimanjaro, in the Himalayas and the Alps (99% in retreat), among the glaciers of Peru and Chile (92% in retreat), and in the United States. In the Brooks Range of northern Alaska, all of the glaciers are in retreat and in southeastern Alaska 98% are in retreat.

Although a relatively minor contribution to sea level rise, the melting of mountain glaciers is particularly serious in areas that rely on snow melt for irrigation and drinking water supply. In effect, a large snow pack or glacier acts as a supplemental reservoir or water tower, holding a great deal of water in the form of ice and snow through the winter and spring and releasing it in the summer when rainfall is lower or absent. The water systems of the western United States (particularly California) and the Andean nations of Peru and Chile, among other places, all heavily rely on these natural forms of water storage. In addition to providing a more reliable water supply, the storing of precipitation as ice and snow helps moderate potential flooding. Yet as temperatures warm, not only will these areas lose this supplemental form of water storage, but also severe flooding is likely to increase (because when rain falls on snow, it accelerates the melting of glaciers and snow packs).

Scientists have also documented an overall trend of Arctic sea ice (frozen ocean water) thinning. Arctic sea ice plays an important role in stabilizing the global climate because it reflects back into space much of the solar radiation that the region receives. In contrast, open ocean water absorbs much more heat from the sun, thus, amplifying human-induced warming and creating an increased global warming effect. As Arctic sea ice decreases, the region is less capable of stabilizing the global climate and may act as a feedback loop (thereby aggravating global warming). Arctic sea ice is declining precipitously and is expected to disappear

completely in the coming decades.\textsuperscript{228} During the 2007 melt season, the extent of Arctic sea ice declined precipitously to its lowest level since satellite measurements began in 1979.\textsuperscript{229} In 2013, Arctic sea ice extent for September was 700,000 square miles less than the 1981-2010 average for the same period.\textsuperscript{230} In 2014, the Arctic sea ice extent for September was 463,000 square miles below average.\textsuperscript{231} In 2015, the maximum extent of the Arctic sea ice was the lowest in the satellite record.\textsuperscript{232} The 2015 record was broken just a year later, in 2016, when the wintertime extent of the arctic sea ice hit another record low, according to NASA.\textsuperscript{233} With less sea ice, less solar radiation is reflected back to space. Thus, the melting of ice is a positive feedback loop that amplifies warming.

Similarly, there has been a general increase in permafrost temperatures and permafrost melting in Alaska and other parts of the Arctic.\textsuperscript{234} Substantial methane releases from thawing permafrost have been detected in Alaska and Siberia.\textsuperscript{235} Because much of the Arctic permafrost overlays old peat bogs, scientists believe (and are concerned) that the melting of the permafrost\textsuperscript{236} may release methane that will further increase global warming to even more dangerous levels.\textsuperscript{237} Carbon dioxide and methane released from thawing permafrost could contribute “as much as 0.4° F to 0.6° F of warming by 2100.”\textsuperscript{238}

Beginning in late 2000, the Jakobshavn Isbrae Glacier (which has a major influence over the mass of the Greenland ice sheet) lost significant amounts of ice.\textsuperscript{239} In August 2010, an enormous iceberg (roughly ninety-seven square miles in size) broke off from Greenland.\textsuperscript{240} Nine Antarctic ice shelves have also collapsed into icebergs in the last fifty years (six of them since 1996).\textsuperscript{241} An ice shelf roughly the size of Rhode Island collapsed in 2002, and an ice bridge

\textsuperscript{228} USGCRP, \textit{Climate Change Impacts}, supra note 103, at 28 (“The observed drastic reduction in sea ice can also lead to a “tipping point” – a point beyond which an abrupt or irreversible transition to a different climate state occurs. In this case, the dramatic loss of sea ice could tip the Arctic Ocean into a permanent, nearly ice-free state in summer, with repercussions that may extend far beyond the Arctic.”).


\textsuperscript{231} Id.


\textsuperscript{234} IPCC, \textit{AR5}, supra note 104, at 4.3.3.4, 46.

\textsuperscript{235} USGCRP, \textit{Climate Change Impacts}, supra note 103, at 48.

\textsuperscript{236} Id.

\textsuperscript{237} See IPCC, \textit{AR5}, supra note 104, at 149; USGCRP, \textit{Climate Change Impacts}, supra note 103, at 48.

\textsuperscript{238} USGCRP, \textit{Climate Change Impacts}, supra note 103, at 48.


\textsuperscript{241} Alister Doyle, \textit{Antarctic Ice Shelf Set to Collapse Due to Warming}, Reuters (Jan. 19, 2009), http://www.reuters.com/article/idUSTRE50J4G520090119.
collapsed in 2009, leaving an ice shelf the size of Jamaica on the verge of shearing off.\(^\text{242}\) The 2002 collapse of the Larsen Ice Shelf, which had existed for at least 11,000 years, was “unprecedented in respect to both area and time.”\(^\text{243}\) The “sudden and complete disintegration” of the Larsen Ice Shelf took a mere 35 days.\(^\text{244}\)

Most recently, scientific reports warn of the disintegration of both the West Antarctic ice sheet and the East Antarctic ice sheet, causing multi-meter sea-level rise.\(^\text{245}\) Such sea level rise will devastate coastal regions, including much of the eastern seaboard. Millions of Americans and trillions of dollars in property damage will result. The risk of this devastation approaches certainty, unless fossil fuel emissions are rapidly phased out. The recent studies more fully that prior studies account for the potential for non-linear ice sheet melting, which could raise the sea level by 10 feet (or more) by mid-century.\(^\text{246}\) The rate of melting for these ice sheets is exceeding scientists’ expectations, requiring scientists to forecast even greater increases in global sea level rise.\(^\text{247}\)

### A.6 Ocean Acidification and Coral Reefs

The negative effects of increased CO\(_2\) emissions are not limited to changes in our climate systems. Rather, CO\(_2\) emissions are also having a severe impact on our oceans. As it stands, the oceans absorb around 30% of global CO\(_2\) emissions.\(^\text{248}\) This absorption has greatly mitigated the effects CO\(_2\) otherwise would have had on our climate.\(^\text{249}\) However, the cost of this mitigation has been a pernicious change in our ocean’s chemistry.\(^\text{250}\)

Ocean acidification is defined as “a reduction in the pH of seawater for an extended period due primarily to the uptake of carbon dioxide from the atmosphere by the ocean.”\(^\text{251}\) Over the last 250 years, humans have increased atmospheric CO\(_2\) concentrations by 40%.\(^\text{252}\) The oceans, in turn, have absorbed about a quarter of this CO\(_2\).\(^\text{253}\) As CO\(_2\) has been absorbed and

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\(^{244}\) Id.


\(^{246}\) J.S. Greenbaum et al., *Ocean Access to a Cavity Beneath Totten Glacier in East Antarctica*, 8 Nature Geoscience 294 (Apr. 2015).

\(^{247}\) Id.; Hansen, *Ice Melt Sea Level Rise and Superstorms, supra* note 3, at 3800.


\(^{250}\) Id.

\(^{251}\) Id.


\(^{253}\) Id. at 9.
dissolved in the seawater it has had an acidifying effect. As a result, “over the last 250 years, the average upper-ocean pH has decreased by about 0.1 units, from about 8.2 to 8.1.” This drop in pH corresponds with a 30% increase in surface ocean acidity.

This carbon dioxide absorption and resulting acidity in oceans cause a decrease in the concentration of carbonate ions, which threatens the formation of calcium carbonate shells and skeletons in many marine organisms. When CO₂ enters into solution with water (H₂O), carbonic acid (H₂CO₃) is formed. The carbonic acid then breaks down, releasing a bicarbonate ion (HCO₃⁻) and a hydrogen ion (H⁺). As increasing quantities of CO₂ dissolves in seawater, the concentration of hydrogen ions increases, causing a decrease in pH (pH is inversely proportional to the concentration of hydrogen ions: the greater the concentration of hydrogen ions, the lower the pH) and an increase in acidity. The newly free hydrogen ion then bonds with a free carbonate ion, forming another bicarbonate ion (HCO₃⁻). Thus as the concentration of hydrogen ions increases, the concentration of carbonate decreases. This is significant because carbonate is essential to many life-functions, such as forming calcium carbonate shells and skeletons. This process has been described in the following figure:

![Figure 1: The Chemistry of Ocean Acidification](image)

As CO₂ is absorbed by the atmosphere it bonds with sea water forming carbonic acid. This acid then releases a bicarbonate ion and a hydrogen ion. The hydrogen ion bonds with free carbonate ions in the water forming another bicarbonate ion. This free carbonate would otherwise be available to marine animals for making calcium carbonate shells and skeletons.

254 Id.
255 Id.
256 Id.
257 Harrould-Kolieb, Acid Test, supra note 248, at 8.
258 Id.
259 Id.
260 Id.
261 Id.
262 Id.
Ocean acidity has been rising at a geologically unprecedented rate. Currently, acidity is rising at least 100 times faster than at any other period during the last 100,000 years.\textsuperscript{263} There have been periods during which levels of atmospheric CO\textsubscript{2} concentration and ocean acidity were higher than today’s levels. However, the rate at which these levels were reached was much slower than the rate at which atmospheric CO\textsubscript{2} and oceanic pH are changing today.\textsuperscript{264} For example, around 55 million years ago, during the Paleocene-Eocene Thermal Maximum (PETM), atmospheric CO\textsubscript{2} concentrations increased to around 1800 ppm and the pH of the oceans declined by around 0.45 units over roughly 5000 years.\textsuperscript{265} This rise in pH resulted in an extinction event, during which “about half of benthic foraminifera (tiny shelled protists) species went extinct over a 1000-year period.”\textsuperscript{266} Today, the rate at which acidity is rising is nearly ten times faster than during the period leading up the PETM extinction event.\textsuperscript{267} The danger here is that the rate of acidification may outpace the natural capacity of the ocean to buffer the excess CO\textsubscript{2} levels.\textsuperscript{268} Scientists have projected that if anthropogenic CO\textsubscript{2} emissions continue at present trends, oceanic pH may drop another 0.5 units by 2100.\textsuperscript{269} This represents a threefold decrease from pre-industrial times. Such a drop would also bring oceanic pH outside the natural range of CO\textsubscript{2}.

The oceans have a limited ability to buffer increases in the availability of hydrogen ions.\textsuperscript{270} As the concentration of hydrogen ions increases, due to increased concentrations of atmospheric CO\textsubscript{2}, more of these newly available hydrogen ions react with carbonate ions to form bicarbonate.\textsuperscript{271} This process, known as a carbonate buffer, then reduces the total resulting decrease in pH.\textsuperscript{272} However, as more and more carbonate is consumed through the natural dissolution of CO\textsubscript{2} and through the buffering processes, “[t]he capacity of the buffer to restrict pH changes diminishes as increased amounts of CO\textsubscript{2} are absorbed by the oceans.”\textsuperscript{273} As such, as carbonate ions become less readily available, the oceans will acidify at increasingly rapid rates.\textsuperscript{274}

Many important marine organisms, including shellfish and corals, require sufficient concentrations of carbonate and bicarbonate in order to build structures, such as shells, out of calcium carbonate (CaCO\textsubscript{3}).\textsuperscript{275} Calcium carbonate will dissolve in seawater unless the water is

\textsuperscript{263} Id. at 7
\textsuperscript{266} Id.
\textsuperscript{267} Id.
\textsuperscript{268} Id.
\textsuperscript{269} Id.
\textsuperscript{270} The Royal Society, \textit{Ocean Acidification Due to Increasing Atmospheric Carbon Dioxide} vi (2005), \url{http://coralreef.noaa.gov/aboutcrp/strategy/reprioritization/wgroups/resources/climate/resources/oa_royalsociety.pdf}.
\textsuperscript{271} Id. at 6.
\textsuperscript{272} Id.
\textsuperscript{273} Id. at 6.
\textsuperscript{274} Id.
\textsuperscript{275} Id. at 10.
saturated with carbonate ions. Calcium carbonate also becomes more soluble as temperature decreases and pressure increases. As a result, as depth increases, causing temperature to decrease and pressure to increase, calcium carbonate becomes more soluble. These variables (carbonate ion concentrations, temperature, and pressure) interact to create a natural barrier, known as a saturation horizon, below which calcium carbonate will dissolve, and above which calcium carbonate is capable of forming. As more and more anthropogenic CO₂ has dissolved, the carbonate ion concentration has decreased causing the saturation horizon for calcium carbonate to rise. To survive, calcium carbonate-dependent species must live above the saturation horizon. As the saturation horizon rises, it poses a greater threat to calcium carbonate-dependent marine species by encroaching upon their habitat.

The shoaling, or rising, of calcite and aragonite (two forms of calcium carbonate) saturation horizons poses a real threat to the world’s coral reefs. Scientists have found that “where coral reefs occur, carbonate-ion concentrations over the past 420,000 years have not fallen below 240 mmol kg⁻¹.” Today, “carbonate-ion concentrations (~210 mmol kg⁻¹) [are] lower than at any other time during the past 420,000 years.” Today, coral reefs are not found in waters with aragonite concentrations below 3.25 mmol kg⁻¹. As the concentration of atmospheric carbon dioxide increases, the potentially viable coral habitats decrease. The current rate at which carbonate ion concentrations are decreasing is likely to outpace the ability of the world’s corals to adapt to, let alone mitigate against, the changes.

As is clear, over the past 136 years (from 1870-2006) atmospheric CO₂ changed 136 times faster than during the previous 420,000 years, and temperature changed 70 times faster. As the present and projected future rates of change “dwarf even those of the ice age transitions . . . it is likely that [the rate of these] changes will exceed the capacity of most organisms to adapt.” Given that “[c]oral reefs are among the most biologically diverse and economically important ecosystems on the planet, providing ecosystem services that are vital to human societies and industries through fisheries, coastal protection, building materials, new biochemical compounds, and tourism,” the impact of their loss on the planet cannot be overstated.

A.7 Agricultural and Forest Losses
Changes in water supply and water quality will also impact agriculture in the United States. Additionally, increased heat and associated issues such as pests, crop diseases, and weather extremes, will all impact crop and livestock production and quality. For example, climate change in the United States has produced warmer summers, enabling the mountain pine beetle to produce two generations of beetles in a single summer season, where it had previously only been able to produce one. In Alaska, the spruce beetle is maturing in one year when it had previously taken two years. The expansion of the forest beetle population has killed millions of hectares of trees across the United States and Canada and resulted in millions of dollars lost from decreased timber and tourism revenues.

Agriculture is extremely susceptible to climate changes and higher temperatures generally reduce yields of desirable crops while promoting pest and weed proliferation. Global climate change is predicted to decrease crop yields, increase crop prices, decrease worldwide calorie availability, and by 2050 increase child malnutrition by 20%. Climate change threatens global food security and so any effort to mitigate global warming is effectively promoting a secure food supply.

A.8 Human Health Impacts

Human-caused fossil fuel burning and the resulting climate change are already contributing to an increase in asthma, cancer, cardiovascular disease, stroke, heat-related morbidity and mortality, food-borne diseases, and neurological diseases and disorders. Climate change has been called “the most serious threat to the public health of the 21st century.” Droughts, floods, heat waves and other extreme weather events linked to climate

294 Id.
295 USCCSP & USDA, The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity, in Synthesis and Assessment Product 4.3 59 (May 2008), http://www.usda.gov/oce/climate_change/SAP4_3CCSPFinalReport.pdf (“Many weeds respond more positively to increasing CO₂ than most cash crops. . . . Recent research also suggests that glyphosate, the most widely used herbicide in the United States, loses its efficacy on weeds grown at CO₂ levels that likely will occur in the coming decades.”).
297 Id.
298 Id. at ix (“Climate change will pose huge challenges to food-security efforts. Hence, any activity that supports agricultural adaptation also enhances food security.”).
change also lead to a myriad of health issues. The World Health Organization has stated that “[l]ong-term climate change threatens to exacerbate today’s problems while undermining tomorrow’s health systems, infrastructure, social protection systems, and supplies of food, water, and other ecosystem products and services that are vital for human health.” Climate change is not only expected to affect the basic requirements for maintaining health (clean air and water, sufficient food, and adequate shelter) but is likely to present new challenges for controlling infectious disease and even “halt or reverse the progress that the global public health community is now making against many of these diseases.” Children are especially vulnerable to adverse health impacts due to climate change.

Recent studies have highlighted the adverse mental health effects that result from climate change. One study noted that as many as 200 million Americans are expected to have mental health problems as a result of climate change and added that mental health disorders are likely to be one of the most dangerous indirect health effects of climate change. The mental health effects can include elevated levels of anxiety, depression, PTSD, and a distressing sense of loss. The impacts of these mental health effects include chronic depression, increased incidences of suicide, substance abuse, and greater social disruptions like increased violence.

A.9 National Security and Global Politics

The changing climate also raises national security concerns, as “climate change will add to tensions even in stable regions of the world.” The U.S. Department of Defense has acknowledged the severity of climate change and its connections to national security. The Quadrennial Defense Review classified climate change as a “threat multiplier.” Specifically, “Pentagon leaders have identified three main ways that climate change will affect security: accelerating instability in parts of the world wracked by drought, famine, and climate-related migrations; threatening U.S. military bases in arid Western states or on vulnerable coastlines; and increasing the need for U.S. forces to respond to major humanitarian disasters.” The United States may experience an additional need to accept immigrant and refugee populations as droughts increase and food production declines in other countries. Increased extreme weather events (such as hurricanes) will also present an increased strain on foreign aid and call for

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301 Id.
306 Keith Johnson, A Clear and Present Danger, Foreign Policy 3 (May 6, 2014), http://www.foreignpolicy.com/articles/2014/05/06/a_clear_and_present_danger (“Environmental issues, energy issues - they are all connected, and they are all integrated into our national security.”).
307 Thompson, Climate Change: The Evidence and Our Options, supra note 217, at 3.
308 Id.
military forces. For instance, by 2025, 40% of the world’s population will be living in countries experiencing significant water shortages, while sea-level rise could cause displacement of tens, or even hundreds, of millions of people.

B. Climate Change is Already Occurring in the State of Maine and is Projected to Significantly Impact the State in the Future.

In November 2007, then-Governor John Baldacci requested that the Climate Change Institute at the University of Maine, Orono, prepare an assessment of the likely impacts of climate change specific to the State of Maine. The purpose of the evaluation was to enable policy makers to use the best available scientific information to inform management and policy decisions related to climate change. The authors assumed an intermediate level of greenhouse gas emissions and describe the trends and changes discussed in the report as “conservative estimates.” The information put forth below is largely drawn from that report and a 2015 update to that report.

B.1 Changes Over the 19th and 20th Centuries

Average annual temperatures in Maine have increased 1.7º C (3º F) between 1895 and 2014. For the past century, the rate of warming in Maine has been increasing. Maine is characterized by three climate divisions: Northern, Southern Interior, and Coastal. All three of Maine’s climate divisions are warmer today than they were 30 years ago. Consequently, the horticultural plant hardiness zones for Maine have shifted by one zone to the north. All three climate divisions have trended toward wetter conditions over the time span from 1950-2007.

B.2 Predictions for Maine’s Climate Future

Models show a strong overall trend in Maine toward warmer and generally wetter conditions in all four seasons over the 21st century with the exception of summer precipitation. Projected increases in both temperature and precipitation tend to be least along the coast and greatest in the north. These trends “imply a significant shift in the regional hydrology, from a snowmelt-dominated regime (in Northern and Southern Interior climate divisions) to one that shows significant runoff during winter.” There has been an increase of 6 inches of total annual precipitation in Maine since 1895 and the Intergovernmental Panel on

310 Id.
311 Id. at 16.
313 Id. at 14.
315 Univ. of Maine, Maine’s Climate Future: An Initial Assessment, supra note 312, at 11.
316 Id.
317 Id.
318 Id.
319 Id. at 15.
320 Id.
321 Id.
Climate Change (“IPCC”) predicts that precipitation will continue to increase by 5-10% by 2050. IPCC models also predict that Maine’s temperatures will increase by at least another 2-3º F by 2050. Excessively hot days (over 95º F) are expected to increase from four days annually to over ten in some parts of Maine by 2050. Snowpack duration has decreased by two weeks at present, and is expected to decrease another two weeks by 2050. Average annual snowfall is also declining and is expected to continue to decline in the coming decades (see Figure 1).

![Projected Snowfall Decline](image)

**Figure 1: Projected Snowfall Decline in Maine**

B.3 The Meaning of a Changed Environment: Gulf of Maine

The Gulf of Maine supports commercial and recreational fisheries with a combined value in excess of $1 billion. Additionally, Maine’s coastal zone is home to the majority of the State’s population and is the destination for millions of visitors each year.

Over the next century, the Gulf of Maine will experience warmer water temperatures and changes in water chemistry, such as increased nutrient inputs and ocean acidification. Such

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322 Univ. of Maine, Maine’s Climate Future: 2015 Update, supra note 314, at 8.
323 Id. at 3
324 Id. at 4
325 Id. at 10.
326 Id.
327 Univ. of Maine, Maine’s Climate Future: An Initial Assessment, supra note 312, at 17.
328 Id.
329 Id.
changes can affect the marine food web and, consequently, impact wildlife and commercial fisheries.\textsuperscript{330} Ocean acidification results when carbon dioxide combines with water at the ocean surface to form carbonic acid.\textsuperscript{331} Acidic water can dissolve the shells of a range of sea creatures and can prevent proper shell growth in others. Moreover, acidification could combine with or magnify other stressors in unpredictable ways (e.g., if lobsters build softer shells or change their time of shedding, their susceptibility to shell disease would increase).\textsuperscript{332} The cold waters of the Gulf of Maine are more susceptible to ocean acidification than other regions in the United States for two reasons: 1) the relative freshness of water entering the Gulf of Maine, meaning higher acidity as a characteristic of fresh water and a decreased ability to “buffer” against increased acidity; and 2) CO\textsubscript{2} is more soluble in colder water, therefore the Gulf of Maine has higher absorption of CO\textsubscript{2} than other warmer bodies of water.\textsuperscript{333}

Species most impacted by acidified waters include crustaceans (e.g., lobster, crabs, shrimp), mollusks (e.g., clams, mussels, oysters, scallops, periwinkles), echinoderms (e.g., sea urchins, sea cucumbers), calcareous macroalgae, and plankton. Bivalves, including softshell clams, sea scallops, eastern oysters, blue mussels, mahogany quahogs, hard clams and surf clams are a major component of Maine’s coastal fisheries. While adults are more resilient to acidified waters, during larval stages, bivalves are very sensitive to ocean acidification.\textsuperscript{334} As much as 87\% of the landed value of Maine’s marine life comes from organisms that make calcium carbonate shells, and thus are vulnerable to ocean acidification.\textsuperscript{335}

In addition to ocean acidification, the ocean waters are warming. The 100-year record from Boothbay Harbor indicates that sea surface temperatures have already increased.\textsuperscript{336} Since 1970, regional sea surface temperatures have increased almost 1.1\degree C (2\degree F).\textsuperscript{337} Since 2004, the rate of warming for the Gulf of Maine has been 0.41\degree F per year; this rate has been calculated as 99\% faster than the rate of warming for the rest of the world’s oceans.\textsuperscript{338} The Gulf of Maine currently represents the southern extent of many cold-water marine species and the northern limit of many warm-water species.\textsuperscript{339} As the Gulf of Maine continues to warm, it is likely that cold-water species will be replaced by temperate species that are currently found south of Cape Cod.\textsuperscript{340} While some of these new arrivals may be commercially valuable (e.g., blue crabs and sea bass), others are likely to be nuisance or invasive species (e.g., Asian shore crab).\textsuperscript{341}

\textsuperscript{330} Id. at 18.
\textsuperscript{331} Id. at 19.
\textsuperscript{332} Id.
\textsuperscript{334} Id. at 5.
\textsuperscript{335} Id. at 4.
\textsuperscript{336} Univ. of Maine, Maine’s Climate Future: An Initial Assessment, supra note 312, at 17.
\textsuperscript{337} Id.
\textsuperscript{338} Univ. of Maine, Maine’s Climate Future: 2015 Update, supra note 312, at 13.
\textsuperscript{339} Univ. of Maine, Maine’s Climate Future: An Initial Assessment, supra note 312, at 19.
\textsuperscript{340} Id.
\textsuperscript{341} Id.
Shifting marine populations are already having detrimental effects on seabird populations. For instance, during the summer of 2012, the puffin chick survival rate was poor at Maine’s two largest colonies (there are only three colonies of these iconic birds in Maine), probably due to a lack of herring. The director of the National Audubon Society’s seabird restoration program observed: “Instead of feeding their young primarily herring, puffin parents were giving them large numbers of butterfish, a more southerly fish that’s becoming more abundant in the Gulf or perhaps more accessible to seabirds because they’ve moved higher up in the water column. But the chicks ended up starving to death because the butterfish were too big and round for them to swallow.” Extreme ocean conditions have also washed away puffin burrows in recent years.

The lobster industry is Maine’s most lucrative fishery. It contributed $339 million to the Maine economy in 2012 and accounted for 69% of landed value of Maine’s fisheries in 2013. The continued success of the fishery is threatened by climate change and ocean acidification, however. For example, warmer temperatures create new predator/prey interactions; research indicates that higher ocean temperatures require cold-blooded animals, like lobsters, to use more energy for breathing, leaving less energy for feeding, growth, energy storage, immune response and reproduction; warming waters are driving lobsters to migrate into cooler, northern waters; scientists have evidence linking rising sea temperatures to a condition that makes female lobsters molt more frequently, making them more vulnerable; and carbon pollution acidifies ocean waters, making it harder for lobsters to get the calcium needed to harden their shells, leaving them stressed and more susceptible to damage. A 2012 ocean heat wave, which affected the Gulf of Maine, caused an unprecedentedly early lobster season, overwhelming Canadian processing plants and lowering prices paid to fishermen, about 70% below normal price.

Harmful algal blooms (i.e., red tides) are another concern both for commercial fisheries and human health. The most common species in the Gulf of Maine is *Alexandrium*, which can contain toxins that cause paralytic shellfish poisoning. The incidence of *Alexandrium* in the Gulf of Maine has increased in recent years.

Sea level rise is yet another threat to both natural and human communities along Maine’s 4,000-plus miles of coast. Half of Maine’s shoreline is composed of erosion-resistant bedrock but the remainder is highly susceptible bluffs, sand beaches, and vegetated wetlands. Many

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343 Id.
344 Id.
346 Id.
349 Id. at 20.
350 Id. at 21.
351 Id.
high salt marsh environments may revert to low salt marsh habitats or disappear altogether. Likewise, the vast freshwater bogs that lie just inland of many salt marshes in Maine will likely die as salt water inundates them. Additional wildlife habitat will likely be lost as tidal mudflats flood too frequently to serve the millions of shorebirds that visit on their annual migrations. Developed shorelines are also at risk. Over the next several decades, the “100-year coastal storm” could occur as frequently as every two to three years. Such storms will cause property damage and may trigger sewer overflows, threatening coastal water quality. In just York County, “over 260 businesses representing $41.6 million in wages are at risk for coastal flooding and the resulting property destruction and higher insurance costs.”

Over the past 5,000 years sea level rise has been tracked at around 0.01-0.04 inches per year but currently sea level rise is estimated at a rate of 0.07 inches annually. The USGS identified a “hotspot” along the Northeastern Atlantic coast that is experiencing sea level rise more than three times faster than the global average. This area was identified from North Carolina to north of Boston. Tide gauges reveal that between 1950 and 2009 sea level went up 0.08 inches, as compared to the global average of 0.02 inches. Within the span of two years, between 2009 and 2010, the area between New York and Newfoundland, which includes Maine, experienced a sea level rise spike of four inches. A NOAA co-author of the study reports that these intense changes along the northeastern coast will be further exacerbated by mean sea level increase. The Natural Resources Council of Maine calculated that Maine stands to lose 20-30% of its land area to sea level rise. This includes municipal infrastructure and highways. As a result of sea level rise, flood zones have expanded and moved inland, expanding the costs of insurance for home owners to include thousands of dollars for flood insurance. Currently, in Maine $2 billion worth of flood insurance policies are in effect. See Figure 2 for Maine’s sea level rise predictions.

352 Id.
353 Id.
354 Id.
355 Id.
356 Id.
357 Id. at 22.
362 Univ. of Maine, Maine’s Climate Future: 2015 Update, supra note 314, at 17.
Figure 2: Sea Level Trend at Portland, Maine\textsuperscript{363}

B.4 The Meaning of a Changed Environment: Freshwater Ecosystems

Freshwater ecosystems are influenced by “master variables” such as temperature, precipitation, and timing of significant aquatic events (\textit{e.g.}, intense rain, ice-out, spring flooding, drought). All climate models predict changes in these master variables.\textsuperscript{364}

Increased water temperature will affect the abundance and distribution of freshwater plants and animals.\textsuperscript{365} Warmer temperatures may also increase the incidence of West Nile virus and other mosquito-borne diseases.\textsuperscript{366}

Preliminary assessments indicate that more winter precipitation will come in the form of rain.\textsuperscript{367} Changes in freeze dates and evaporation will lead to earlier spring runoff, decreased snow depth, greater lake fluctuations, and saline intrusion of coastal aquifers.\textsuperscript{368} Stream gauges in Maine indicate that peak flows are occurring earlier in the spring and lower flows later in the season.\textsuperscript{369} Similarly, ice-out dates on New England lakes have advanced by up to two weeks.

\begin{itemize}
\item \textsuperscript{363} \textit{Id.} at 16.
\item \textsuperscript{364} Univ. of Maine, \textit{Maine’s Climate Future: An Initial Assessment}, supra note 312, at 23.
\item \textsuperscript{365} \textit{Id.}
\item \textsuperscript{366} \textit{Id.}
\item \textsuperscript{367} \textit{Id.}
\item \textsuperscript{368} \textit{Id.}
\item \textsuperscript{369} \textit{Id.}
\end{itemize}
since the 1800s. These changes result in shorter seasons for ice-fishing, skating, skiing, and other winter activities.

These master variables also serve as triggers for certain wildlife behavior. For example, warming water and spring rains compel salamanders and frogs to spawn. Similarly, spring flows and water temperatures signal hatching times for aquatic insects and cue migration of sea-run fish. Temporal changes in such behavior can lead to mismatches in predator/prey relations. Intense rain events have been linked to deaths of marine life. In May 2012, for example, intense rainfall within the span of 24 hours led to eutrophication in Lake Auburn, causing an increase in algae responsible for the deaths of numerous trout.

Lower flows in summer will reduce aquatic habitats like cold-water holding pools, spawning beds, and vernal pools. Longer periods without rain during the summer months could cause Maine’s thousands of acres of peatlands, marshes, and forested swamps to dry out and, hence, release stored carbon and other greenhouse gases.

More frequent and more intense storms will lead to habitat and infrastructure damage. Increased storm flows will scour riverbeds, flood roadways, breach dams, and cause washouts. Much of Maine’s infrastructure for water delivery, wastewater transport, and transportation is not designed to handle the predicted increases in intense precipitation events. Maine is a large, rural state in which 89% of the workforce commutes to work by passenger vehicle. It is likely that major storms will bring flooding and erosion that will washout roads and culverts, leading to unplanned and costly repairs. Between 1958 and 2010, the Northeast saw more than a 70% increase in rain falling through heavy precipitation events.

B.5 The Meaning of a Changed Environment: Forests and the Forest Products Industry

Maine is the most heavily forested state in the country. As the climate changes, Maine will continue to have abundant forests, but the composition of the forests and the way trees grow may be different from today. Red spruce and balsam fir may become less common, while fast-growing deciduous species such as red maple and “weedy” shrubs are expected to increase. Forest-based manufacturing is Maine’s largest manufacturing sector and is responsible for $5.31 billion, which represents roughly 36% of the State’s manufacturing sales. With climate change, the timing of forest operations are likely to change. For example, shorter periods

370 Id. at 24.
371 Id.
372 Id.
373 Univ. of Maine, Maine’s Climate Future: 2015 Update, supra note 314, at 11.
374 Univ. of Maine, Maine’s Climate Future: An Initial Assessment, supra note 312, at 24.
375 Id.
376 Id. at 25.
377 Id.
378 Id. at 53.
379 Id. at 54.
380 Id. at 26.
381 Id. at 28.
382 Id. at 45.
of hard freezes and longer mud seasons will limit harvesting seasons and could have significant economic impacts for Maine’s forestry industry.\textsuperscript{383}

Climate change may result in increased susceptibility to insects and disease, which could result in slower growth or diebacks, both of which would profoundly affect the industry.\textsuperscript{384} The logging sector could be overwhelmed by the need to salvage dead and dying timber; stumpage prices would plummet as local markets were flooded; and forestland owners would need to coordinate salvage operations, address fire protection issues, and accelerate reforestation schedules.\textsuperscript{385} Future forest operations are subject to wide uncertainties under likely climate change scenarios. Warm weather patterns in the last decade have been linked to white pine needle disease causing trees to lose needles and be vulnerable to more damage.\textsuperscript{386}

Maine’s paper industry is dominated by coated fine paper and specialty paper production that is well suited to Maine’s slow-growing tree species. Transitioning to products that take advantage of faster-growing species presents both technical and economic challenges.\textsuperscript{387}

\textbf{B.6  The Meaning of a Changed Environment: Biodiversity}

In a warmer climate, Maine could lose some of its most iconic species including loons, moose, and puffins.\textsuperscript{388} Just as the Gulf of Maine is home to marine species at both the northern and southern limits of their ranges, so too are many land species in Maine at the edges of their geographic ranges.\textsuperscript{389} Consequently, climate change will almost certainly lead to significant changes in Maine’s overall assembly of plants and animals.\textsuperscript{390} Mobile northern species (e.g., Canada lynx) are likely to withdraw northward while species adapted to high altitudes could decline or disappear altogether as alpine ecosystems shrink.\textsuperscript{391} Conversely, some southern species, which currently have only limited ranges in Maine, might greatly expand into the State.\textsuperscript{392} In 2013, two-thirds of Maine’s plant and animal species were reported as either highly or moderately vulnerable to climate change.\textsuperscript{393}

The species least likely to be able to adapt to a changing climate are long-lived species and those with small population sizes.\textsuperscript{394} Those species that do expand from the south will tend to be those that travel easily, are adapted to a variety of conditions, and which reproduce quickly.\textsuperscript{395} These characteristics are typical of weedy or invasive species. There is potential that deer ticks (which are vectors for Lyme disease) could expand to cover the whole state.\textsuperscript{396} Other

\textsuperscript{383} Id.
\textsuperscript{384} Id.
\textsuperscript{385} Id.
\textsuperscript{386} Univ. of Maine, \textit{Maine’s Climate Future: 2015 Update, supra} note 314, at 11.
\textsuperscript{387} Univ. of Maine, \textit{Maine’s Climate Future: An Initial Assessment, supra} note 312, at 48.
\textsuperscript{388} Id. at 30.
\textsuperscript{389} Id.
\textsuperscript{390} Id.
\textsuperscript{391} Id. at 31.
\textsuperscript{392} Id.
\textsuperscript{393} Univ. of Maine, \textit{Maine’s Climate Future: 2015 Update, supra} note 314, at 5.
\textsuperscript{394} Univ. of Maine, \textit{Maine’s Climate Future: An Initial Assessment, supra} note 312, at 32.
\textsuperscript{395} Id.
\textsuperscript{396} Id.
exotic invasive species could become common, including the hemlock woolly adelgid (an invertebrate pest of hemlock that is capable of causing up to 90% mortality), Asiatic clam (which compete with native freshwater mussels), and largemouth bass (a warm-water predator of native fish).397

The State’s official list of endangered and threatened species is expected to grow as a result of climate change and ocean acidification.398 Migratory birds are particularly susceptible to climate change because they must find suitable habitats in multiple locations (e.g., breeding grounds, migration corridors, and wintering grounds).399 One broken link in the chain could pose serious challenges to the species’ continued existence. Mismatches between migration time and the availability of food are brought about both by changes in the birds’ behavior and in the phenology of plants and insects.400 Birds are also shifting their geographic ranges. Of 305 bird species tracked in North America, 177 have shifted their centers of abundance northward during winter by 35 miles on average over the past 4 decades.401 Since habitats are not shifting at the same rates or into the same areas, these changes are likely to disrupt existing complexes of birds and habitats, or to create new complexes with unknown consequences.402 Changes to Maine’s bird populations are already underway. For example, hummingbirds, a long-distance migrant, are arriving 11 to 18 days earlier than they did a century ago.403 Also, the abundance of Bicknell’s thrush, which breed in New England’s mountaintop coniferous forests, are expected to decline as the balsam pine and red spruce they prefer are replaced by hardwood forests encroaching from lower elevations.404

B.7 The Meaning of a Changed Environment: Indigenous People

Four tribes of indigenous peoples, allied in the Wabanaki Confederacy, have lived in and around Maine for over 12,000 years: Penobscot Nation, Passamaquoddy Tribes, Houlton Band of Maliseet Indians, and the Aroostook Band of Micmacs.405 Given this long heritage, “[i]ndigenous people are spiritually and culturally invested in specific areas of Maine and many of their values, meanings, and identities are closely interlinked with features of the natural landscape and physical interactions with the landscape.” 406 For example, Wabanaki artists use birch bark, brown ash, and sweetgrass to create traditional arts.407 The loss of these and other culturally significant natural resources is a potential consequence of climate change (e.g., moose

397 Id.
398 Id.
401 Id. at 7.
402 Id. at 8.
403 Id. at 19.
404 Id.
405 Univ. of Maine, Maine’s Climate Future: An Initial Assessment, supra note 312, at 37, 39.
406 Id. at 39.
407 Id. at 38.
populations are expected to be negatively affected by increases in ticks, as well as by less than optimal habitat conditions).\textsuperscript{408}

Currently, significant economic and health disparities exist between the indigenous people of Maine and the broader population. It is likely that climate change will magnify these existing problems, negatively influencing the adaptive capacity of indigenous people.\textsuperscript{409}

B.8 Impacts to Agriculture

A changing climate will bring a mix of opportunities and challenges to Maine’s $1 billion agricultural sector.\textsuperscript{410} Farming in Maine is dominated by small to mid-sized, family-owned farms. Principle products include dairy, potatoes, grains, vegetables and fruits, wild blueberries, and ornamental and turf products.\textsuperscript{411} Certain crops, like potatoes, have relatively low temperature optima. Consequently, temperature increases may result in yield reductions.\textsuperscript{412} Plants grown under elevated CO$_2$ levels consistently have reduced concentrations of protein.\textsuperscript{413} In 2012, the U.S. Department of Agriculture noted that agricultural zones had already shifted north by half a zone.\textsuperscript{414}

Changes in precipitation have obvious implications for farmers. The anticipated increase in frequent, high-intensity rainfalls will be less effective at replenishing soil water supplies and will be more likely to erode soil.\textsuperscript{415} Also, under warmer conditions, plants will lose water via greater transpiration and soils will lose moisture due to greater evaporation. Consequently, additional irrigation, with its related capital expenses, will be required for many sectors.\textsuperscript{416}

Increases in agricultural pests (including insects, weeds, and viruses) are also likely. For example, current pests, like the Colorado potato beetle, will be able to produce multiple generations during a longer growing season rather than the single generation they currently produce.\textsuperscript{417} More pests mean increased potential for crop damage and increased costs for pest control. Increased use of pesticide also has implications for environmental and human health.

Increased temperatures produce generally negative effects on livestock. Heat stress can lead to reduced productivity, compromised reproductive function, and increased incidences and severity of infections.\textsuperscript{418} During winter months, higher temperatures mean wetter, muddier conditions that contribute to animal stress and increased infections.\textsuperscript{419} Storing feed stocks under conditions characterized by increased temperatures and precipitation is also problematic: feed

\textsuperscript{408} Id.
\textsuperscript{409} Id. at 39.
\textsuperscript{410} Id. at 41.
\textsuperscript{411} Id.
\textsuperscript{412} Id. at 42.
\textsuperscript{413} Id.
\textsuperscript{414} Univ. of Maine, Maine’s Climate Future: 2015 Update, supra note 314, at 7.
\textsuperscript{415} Univ. of Maine, Maine’s Climate Future: An Initial Assessment, supra note 312, at 42.
\textsuperscript{416} Id. at 43-44.
\textsuperscript{417} Id. at 42.
\textsuperscript{418} Id. at 43.
\textsuperscript{419} Id.
stored in silos can spoil when exposed to humidity and feed degrades more rapidly in warmer temperatures. Droughts in other parts of the country, like the 2013 drought in the Midwest, increased grain prices that harmed many dairy farmers in Maine and caused some to close their farms.

Maine maple producers have begun tapping their trees earlier in the calendar year to take advantage of earlier sap flows. Producers will have to contend with greater variability in the weather and more powerful weather events, including droughts, which could ruin maple syrup production.

B.9 Impacts to Tourism and Recreation

Tourism is one of Maine’s largest industries and is heavily reliant on outdoor activities. The tourism industry supports 140,000 jobs and generates $3 billion annually in earnings.

Currently, tourism activity peaks in July and August. Increasing temperatures may extend the peak season for warm-weather pursuits (e.g., mountain climbing, bicycling, and sailing) to span the period of May through October. Despite a longer summer season, predicted increases in humidity and rain may discourage summer visitors. Also, changes in the landscape brought about by climate change may diminish tourist experiences with regard to such activities as bird watching, wildlife viewing, and fishing. Meanwhile, the period of cold weather suitable for activities such as snowmobiling, skiing, and ice fishing will likely be reduced.

B.10 Impacts to Human Health

Globally, climate change has major implications for human health. The primary areas of vulnerability include: 1) threats to clean air and fresh water; 2) unpredictable influxes of germ-caused diseases; 3) increasing extreme weather events; and 4) mental health issues produced by disasters, including death, injury, and displacements.

In Maine, as elsewhere, most health effects of climate change are expected to be negative and will include increased incidences of heat-related illnesses and insect-borne diseases, such as Lyme disease (transferred by deer ticks) and West Nile virus (carried by mosquitos). The rate

420 Id.
421 Id.
423 Id.
424 Id.
425 Id. at note 314, at 11.
426 Id. at 50.
427 Id. at 51.
428 Id.
429 Id. at 50-51.
430 Id. at 60.
431 Id.
432 Id. at 60-61.
of Lyme disease in Maine reached a record high in 2013 at 1,377 cases (in 2001, 108 cases of Lyme diseases were reported).\textsuperscript{433}

Air quality is expected to diminish with climate change, leading to negative impacts on lung health.\textsuperscript{434} Ozone and CO\textsubscript{2} contribute to smog, which exacerbates asthma and chronic obstructive pulmonary disease.\textsuperscript{435} More CO\textsubscript{2} in the atmosphere may cause plants that produce allergenic pollens (e.g., ragweed) to become more numerous and to produce greater quantities of pollen or pollen that is more allergenic.\textsuperscript{436}

Extreme rain events could overwhelm sewage treatment plants, leading to contamination of water supplies. Sewage can contain more than 100 pathogens known to cause illness, including norovirus Norwalk, hepatitis A, and E. coli.\textsuperscript{437} Intrusion of seawater into coastal groundwater, due to sea level rise, may contaminate drinking water supplies.\textsuperscript{438}

\textbf{C. The Best Climate Science Provides a Prescription for Restoring the Atmosphere, Stabilizing the Climate System, and Protecting the Oceans from Acidification and Warming}

To protect Earth’s climate for present and future generations, we must restore Earth’s energy balance. The best climate science shows that if the planet once again sends as much energy into space as it absorbs from the sun, this will restore the planet’s climate equilibrium.\textsuperscript{439} Scientists have accurately calculated how Earth’s energy balance will change if we reduce long-lived greenhouse gases such as CO\textsubscript{2}.\textsuperscript{440} Humans have altered Earth’s energy balance\textsuperscript{441} and are currently causing a planetary energy imbalance of approximately one-half watt.\textsuperscript{442} We would need to reduce atmospheric CO\textsubscript{2} concentrations by about 50 ppm, in order to increase Earth’s heat radiation into space by one-half watt, if other long-lived gases stay the same as today.\textsuperscript{443}

We must reduce atmospheric CO\textsubscript{2} concentration to 350 ppm to avoid the threats contained herein, to avoid significant disturbance of physical and biological systems as a result of global climate change, and to achieve stabilization of the GHG concentrations in the

\textsuperscript{433} Univ. of Maine, Maine’s Climate Future: 2015 Update, supra note 314, at 5.
\textsuperscript{434} Univ. of Maine, Maine’s Climate Future: An Initial Assessment, supra note 312, at 61.
\textsuperscript{435} Id.
\textsuperscript{436} Id. at 62.
\textsuperscript{437} Id. at 61.
\textsuperscript{438} Id.
\textsuperscript{439} John Abatzoglou et al., A Primer on Global Climate Change and Its Likely Impacts, in Climate Change: What It Means for Us, Our Children, and Our Grandchildren 11, 15-22 (Joseph F. C. DiMento & Pamela Doughman eds., 2007).
\textsuperscript{440} James Hansen, Storms of My Grandchildren 166 (2009) (“Also our best current estimate for the planet’s mean energy imbalance over the past decade, thus averaged over the solar cycle, is about +0.5 watt per square meter. Reducing carbon dioxide to 350 ppm would increase emission to space 0.5 watt per square meter, restoring the planet’s energy balance, to first approximation.”).
\textsuperscript{441} IPCC, AR4, supra note 21, at 37 (“The global average net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 [+0.6 to +2.4] W/m\textsuperscript{2},”).
\textsuperscript{442} Hansen, Ice Melt, Sea Level Rise and Superstorms, supra note 3, at 3763.
\textsuperscript{443} James Hansen, Storms of My Grandchildren 166 (2009); see also Hansen, Where Should Humanity Aim?, supra note 118, at 217-31.
atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.\textsuperscript{444}

The current science also shows that to protect Earth’s natural systems, long-term average global surface heating should not exceed 1°C this century. According to the current climate science, to prevent global heating greater than 1°C, concentrations of atmospheric CO\textsubscript{2} must decline to 350 ppm or less by the end of this century.\textsuperscript{445} However, today’s atmospheric CO\textsubscript{2} levels are over 400 ppm and rising.\textsuperscript{446}

A target of keeping global surface heating to 2°C above pre-industrial temperatures, which approximately equates to an atmospheric CO\textsubscript{2} concentration of 450 ppm, cannot be considered a safe target for present or future generations, and is not supported by current science of climate stabilization. Earth’s paleoclimate history demonstrates that climate impacts accompanying global warming of 2°C or more would be irreversible and catastrophic for humanity. For example, the paleoclimate record shows that warming consistent with CO\textsubscript{2} concentrations as low as 450 ppm may have been enough to melt almost all of Antarctica.\textsuperscript{447} The warming of the past few decades has brought global temperature close to if not slightly above the prior maximum of the Holocene epoch. Human society must keep global temperature at a level within or close to the Holocene range to prevent dangerous climate change. Global warming of 2°C would be well above Holocene levels and far into the dangerous range and has been described as “an unacceptably high risk of global catastrophe.”\textsuperscript{448}

The widely used models that allow for 2°C temperature increase, and therefore advocate for a global CO\textsubscript{2} emission reduction target aimed at a 450 ppm CO\textsubscript{2} standard, do not take into account significant factors that will compound climate impacts. Most importantly, they do not include the slow feedbacks that will be triggered by a temperature increase of 2°C.\textsuperscript{449} Slow feedbacks include the melting of ice sheets and the release of potent greenhouse gases, particularly methane, from the thawing of the tundra.\textsuperscript{450} These feedbacks might show little change in the short-term, but can hit a point of no return, even at a 2°C temperature increase, that will trigger further warming and sudden catastrophic impacts. For example, the Greenland and Antarctic ice sheets “required millennia to grow to their present sizes. If ice sheet disintegration reaches a point such that the dynamics and momentum of the process take over, reducing greenhouse gases may be futile to prevent major ice sheet mass loss, sea level rise of many meters, and worldwide loss of coastal cities—a consequence that is irreversible for practical purposes.”\textsuperscript{451}

\begin{itemize}
\item \textsuperscript{444} See id. at 217 (2008) (“If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, Paleoclimate evidence and ongoing climate change suggest that CO\textsubscript{2} will need to be reduced from its current 385 ppm to at most 350 ppm.”).
\item \textsuperscript{445} See id.; James Hansen, Storms of My Grandchildren (2009).
\item \textsuperscript{446} NASA, Facts, Carbon Dioxide, \url{http://climate.nasa.gov/vital-signs/carbon-dioxide/} (last visited May 2, 2016).
\item \textsuperscript{447} Dec. of Dr. James E. Hansen, supra note 8, at 14
\item \textsuperscript{448} Id. at 17.
\item \textsuperscript{449} Id.
\item \textsuperscript{450} Hansen, Assessing “Dangerous Climate Change,” supra note 3 at 15.
\item \textsuperscript{451} Id. at 13.
\end{itemize}
These slow feedbacks are a part of the inertia of the climate system, where “[t]he inertia causes climate to appear to respond slowly to this human-made forcing, but further long-lasting responses can be locked in.”

Thermal inertia is primarily a result of the global ocean, which stores 90% of the energy surplus, and therefore perpetuates increased global temperature even after climate forcings, or emissions, have declined. Thus, the longer we wait to reduce global CO\(_2\) concentrations, the more thermal inertia will already be in play and climate impacts will continue to escalate.

Furthermore, 2°C targets would lead to an increase in the use of fossil fuels that are more difficult to extract, and thus are compounded with the expenditure of greenhouse gases due to the transport and intensive mining process resulting in “more CO\(_2\) [emissions] per unit useable energy.” The 2°C target also reduces the likelihood that the biosphere will be able to sequester CO\(_2\) due to carbon cycle feedbacks and shifting climate zones. Under the allowable emissions with this target, other greenhouse gases, such as methane and nitrous oxide would continue to increase, further exacerbating climate change impacts. These factors are missing from the 2°C scenarios, which have been widely accepted and used in the creation of climate policies and plans.

A temperature rise of 2°C will not only lock in a further temperature increase due to thermal inertia, but it will also trigger irreversible impacts, including rapid, nonlinear sea level rise and species loss described above. Most models look at sea level rise as a gradual linear response to melting ice sheets. However, “it has been argued that continued business-as-usual CO\(_2\) emissions are likely to spur a nonlinear response with multi-meter sea level rise this century.” This sea level rise would occur at a pace that would not allow human communities or ecosystems to respond.

An emission reduction target aimed at 2°C would “yield a larger eventual warming because of slow feedbacks, probably at least 3°C.” Once a temperature increase of 2°C is reached, there will already be “additional climate change “in the pipeline” even without further change of atmospheric composition.” Dr. James Hansen warns that “distinctions between pathways aimed at 1°C and 2°C warming are much greater and more fundamental than the numbers 1°C and 2°C themselves might suggest. These fundamental distinctions make scenarios with 2°C or more global warming far more dangerous; so dangerous, we [James Hansen et al.] suggest, that aiming for the 2°C pathway would be foolhardy.” This target is at best the equivalent of “flip[ping] a coin in the hopes that future generations are not left with few choices

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453 Id. at 4-5, 13.
454 Id. at 15.
455 Id. at 15, 20.
456 Id. at 20.
457 Id. at 6.
458 Id.
459 Id. at 15.
460 Id. at 19.
461 Id. at 15.
beyond mere survival. This is not risk management, it is recklessness and we must do better.\textsuperscript{462} Thus, a global average atmospheric concentration of \(\text{CO}_2\) of 450 ppm, or a concentration of \(\text{CO}_2\) between 450 and 550 ppm, would result in dangerous anthropogenic interference with the climate system and would threaten all public natural resources in Maine and the health and well-being of Mainers.

Importantly, the Intergovernmental Panel on Climate Change (“IPCC”) has not established nor endorsed a target of 2°C warming above the preindustrial period as a limit below which the climate system will be stable.\textsuperscript{463} The 2°C figure was reached as a compromise between the emission reduction scenarios and associated risks summarized by Working Group I of the 2007 IPCC Fourth Assessment Report,\textsuperscript{464} and because policy makers felt that it was politically achievable.\textsuperscript{465} As the IPCC makes clear, “each major IPCC assessment has examined the impacts of [a] multiplicity of temperature changes but has left [it to the] political processes to make decisions on which thresholds may be appropriate.”\textsuperscript{466} Two degrees Celsius warming above pre-industrial levels has never been universally considered “safe” from either a political or scientific point of view. As the United Nations Framework Convention on Climate Change (“UNFCCC”) stated: “The ‘guardrail’ concept, in which up to 2°C of warming is considered safe, is inadequate and would therefore be better seen as an upper limit, a defense line that needs to be stringently defended, while less warming would be preferable.”\textsuperscript{467} And according to a Coordinating Lead Author of the IPCC’s 5th Assessment Report, the 2°C “danger level” seemed:

utterly inadequate given the already observed impacts on ecosystems, food, livelihoods, and sustainable development, and the progressively higher risks and lower adaptation potential with rising temperatures, combined with disproportionate vulnerability.\textsuperscript{468}

The most recent IPCC synthesis of climate science confirms that additional warming of 1°C (we have already have 0.9°C warming above the preindustrial average) jeopardizes unique and threatened systems, including ecosystems and cultures.\textsuperscript{469} The IPCC also warns of risks of extreme events, such as heat waves, extreme precipitation, and coastal flooding, and “irreversible regime shifts” with additional warming.\textsuperscript{470} See Figure 3 below.

\textsuperscript{463} See Dec. of Dr. James E. Hansen, supra note 8 at 5.
\textsuperscript{468} Petra Tschakert, 1.5 °C or 2 °C: a conduit’s view from the science-policy interface at COP20 in Lima, Peru, Climate Change Responses 8 (2015), http://www.climatechangeresponses.com/content/2/1/3.
\textsuperscript{470} Id.
Oceans have the same scientific standard of protection. Marine organisms and ecosystems are already harmed and will increasingly continue to be harmed by the effects of ocean acidification. Critically important ocean ecosystems, such as coral reefs, are severely threatened by present day CO$_2$ concentrations of approximately 400 ppm and it is vitally important that atmospheric CO$_2$ levels are reduced to below 350 ppm in order to protect ocean ecosystems. The IPCC never concluded that 2°C warming would be safe for ocean life. According to Dr. Ove Hoegh-Guldberg, one of the world’s leading experts on ocean acidification and the Coordinating Lead Author of the oceans chapter of the 5th Assessment Report of the IPCC:

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472 See Dec. of Dr. Ove Hoegh-Guldberg, supra note 54, at 1.
473 Id. at 2.
“Allowing a temperature rise of up to 2°C would seriously jeopardize ocean life, and the income and livelihoods of those who depend on healthy marine ecosystems. Indeed, the best science available suggests that coral dominated reefs will completely disappear if carbon dioxide concentrations exceed much more than today’s concentrations. Failing to restrict further increases in atmospheric carbon dioxide will eliminate coral reefs as we know them and will deny future generations of children from enjoying these wonderful ecosystems.”

Even the 2015 Paris Agreement backed off 2°C as a safe level of warming (though it did not go far enough to note that 1°C was the maximum safe level of long-term warming). To prevent further degradation or the eventual depletion of the oceanic resources, it is imperative that atmospheric CO₂ concentrations be returned to below 350 ppm by the end of this century.

It is imperative that Maine set GHG emission limits targeted at 1°C temperature change, or a maximum of 350 ppm in global CO₂ levels, in order to avoid the cascading impacts that will occur with a 2°C or 450 ppm target. To reduce global atmospheric CO₂ to 350 ppm by the end of this century, this target would require that if global CO₂ emissions had peaked in 2012, they be reduced by 6% per year beginning in 2013, alongside 100 GtC of global reforestation throughout the century. If emissions peaked and reductions began in 2005, only a 3.5% per year reduction would have been necessary to reach 350 ppm by 2100. If emission reductions begin in 2017 the annual rate of reduction would be 8%. However, if emission reductions do not begin until 2020, a 15% per year reduction rate will be required to reach 350 ppm by 2100. If reductions are delayed beyond 2020, it might not be possible to return to 350 ppm until well after 2500.

As noted above, Maine’s efforts to reduce GHG emissions to date, and their planned future efforts have been inadequate and much steeper emission reductions are required. This fact is illustrated in the chart below. The chart shows Maine’s historic emissions (solid red line), forecast emissions (dotted red line), and emissions reduction trajectory to meet Maine’s 2020 target (blue line). The green line, which was not originally in the chart and was added by petitioners, shows the emissions reduction trajectory that Maine must be on in order to reduce emissions to the 2050 standard that the best climate science says is necessary – at least 85% below 1990 levels. Looking at this chart, it is obvious that Maine is not on track to reduce emissions by the requisite amount in order to avoid the most catastrophic and irreversible consequences of climate change and ocean acidification.

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474 Id.
475 Paris Agreement, Article 2, Section 1(a).
Figure 4: Maine’s Historic and Forecast GHG Emissions and Required Emissions Reduction Trajectory. The dashed green line represents the emissions reduction trajectory that Maine needs to be on to avoid the most catastrophic and irreversible consequences of climate change and ocean acidification. Meanwhile, the dotted red line is Maine’s forecasted GHG emissions, far above what is safe.477

Continued delay makes it harder and harder for Petitioners and future generations to protect a livable world. It is imperative that the Department calibrate State emission limits to put Maine on a trajectory aimed for 350 ppm and then establish a plan that will put Maine on a track towards ensuring that Maine does its part to meet these limits.

Previous projections based on maintaining atmospheric carbon concentrations at or below 450 ppm are not sufficient to avoid severe, irreversible damage as a result of ocean acidification and ocean warming. According to current science, 450 ppm represents a tipping point for coral reefs worldwide. If atmospheric CO₂ levels reach this tipping point, coral reefs as we know them will be extremely rare, if not extinct, and at least half of coral-associated wildlife will become rare or extinct. As a result, coral reef ecosystems will likely be reduced to crumbling frameworks with few calcareous corals remaining.

Atmospheric CO₂ levels are currently on a path to reach a climatic tipping point.478 Absent immediate action to reduce CO₂ emissions, atmospheric CO₂ may reach levels so high that life on Earth as we know it is unsustainable at these levels.

The Department has the present ability to curtail the environmental harms detailed above. Atmospheric CO₂ concentrations will decrease if states stop (or greatly reduce) their burning of fossil fuels.479 The environmental harms and threat to human health and safety as described

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479 Harvey Blatt, America’s Environmental Report Card xiii (2005) (“How can we stop this change in our climate? The answer is clear. Stop burning coal and oil, the sources of nearly all the carbon dioxide increase.”).
above can only be avoided if atmospheric CO$_2$ concentrations are immediately reduced. Any more delay risks irreversible and catastrophic consequences for youth and future generations.

Fossil fuel emissions must decrease rapidly if atmospheric CO$_2$ is to be returned to a safe level in this century.\textsuperscript{480} Improved forestry and agricultural practices can provide a net drawdown of atmospheric CO$_2$, primarily via reforestation of degraded lands that are of little or no value for agricultural purposes, returning us to 350 ppm somewhat sooner.\textsuperscript{481} However, the potential of these measures is limited. Immediate and substantial reductions in CO$_2$ emissions are required in order to ensure that the Petitioners and future generations inherit a planet that is inhabitable.

A zero-CO$_2$ U.S. energy system can be achieved within the next thirty to fifty years without acquiring carbon credits from other countries. In other words, actual physical emissions of CO$_2$ from fossil fuels can be eliminated with technologies that are now available or reasonably foreseeable. This can be done at reasonable cost by eliminating fossil fuel subsidies and creating annual and long-term CO$_2$ reduction targets. Net U.S. oil imports can be eliminated in about 25 years, possibly less. The result will also include large ancillary health benefits from the significant reduction of most regional and local air pollution, such as high ozone and particulate levels in cities, which is mainly due to fossil fuel combustion.\textsuperscript{482}

Experts state that approaches to transition to a renewable energy system and to phase out fossil fuels by about 2050 include: A cap on fossil fuel use that declines to zero by 2050 or a gradually rising carbon tax with revenues used to promote a zero-CO$_2$ emissions energy system and to mitigate adverse income-distribution effects; increasingly stringent efficiency standards; elimination of direct and indirect subsidies and other incentives for fossil fuel extraction, transportation, and combustion; investment in a vigorous and diverse research, development and demonstration program; banning new coal-fired power plants and phasing out existing coal-fired power plants; adoption of a policy that would aim to have essentially carbon-free state and local governments, including almost all of their buildings and vehicles by 2030; and adoption of a gradually increasing renewable portfolio standard for electricity until it reaches 100% by about 2050.\textsuperscript{483} Products and services already exist for building or remodeling buildings to have zero GHG emissions; for generating sufficient electricity with zero carbon dioxide emissions; for zero-emission transportation and industrial processes; and agricultural and forest processes that can also decrease GHG emissions and increase CO$_2$ sequestration. The Department should fully consider these measures in achieving its own annual emissions reduction measures to transition off of fossil fuels.

Furthermore, experts have already prepared plans for Maine (as well as every other state and over 100 countries) that would allow Maine to transition off fossil fuels and get 100% of its energy, for all energy sectors, from clean and renewable energy sources: wind, water, and sunlight by 2050.\textsuperscript{484} Maine’s plan would have the state getting about 70% of its energy from

\textsuperscript{480} Hansen, Where Should Humanity Aim?, supra note 118, at 217 (discussing the need to reduce the atmospheric CO$_2$ concentration to 350 ppm).
\textsuperscript{481} Id. at 227.
\textsuperscript{483} See \textit{id}.
\textsuperscript{484} Mark Z. Jacobson et al., 100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for the 50 United States, 8 Energy & Envtl. Sci. 2093 (2015) [hereinafter 100% Clean and Renewable
onshore and offshore wind, 22% from photovoltaic cells (solar), 6% from hydro-electric, and 2% from wave and tidal energy. If implemented, the plan would save Mainers money, create jobs, and reduce mortalities. Specifically, by 2050, the cost savings would be $8,912 per person, per year; there would be a net job creation of 18,706 with net earning of $1.07 billion per year; and 71 deaths per year would be avoided. This plan is economically and technologically feasible, and provides a readily available plan that Maine could implement, or use as a model.

VI. REQUESTED ACTION AND PROPOSED RULE

As indicated above, the Maine Department of Environmental Protection has both the legal obligation and authority to protect the citizens of Maine from catastrophic climate change. The best climate science indicates that a return to an atmospheric concentration of 350 ppm of CO\textsubscript{2} by the end of the century is needed. Therefore, Petitioners respectfully request that the Department lead Maine’s efforts to reduce carbon dioxide and other greenhouse gas emissions by promulgating this proposed rule (or a similar rule that accomplishes the intended purpose of this rule):

PREAMBLE:
Human activity, primarily from burning fossil fuels, has increased the global concentration of greenhouse gases in the atmosphere. Science informs us that the increase in atmospheric carbon dioxide (CO\textsubscript{2}) concentrations has already warmed the global climate system and acidified the oceans, causing significant adverse effects to human health, safety, and welfare and Earth’s natural systems. Left unabated, global climate destabilization and ocean acidification will have long-term catastrophic effects on human systems and the habitability of Maine and the nation. Currently, climate scientists believe that the global concentration of CO\textsubscript{2} in the atmosphere must be reduced to no more than 350 parts per million (ppm) to protect the climate system humans depend upon. If global CO\textsubscript{2} emissions are reduced by at least 85% from 1990 levels by 2050, and continue to decline thereafter, and there is significant reforestation around the world, global atmospheric CO\textsubscript{2} levels could stabilize at 350 ppm by 2100 and the most severe impacts of climate destabilization could be avoided. These targets reflect the global average emission reductions required to remedy the current climate emergency without accounting for the differentiated and equitable responsibilities of individual states and their historic contribution to carbon pollution.

The goal of this rule is to protect the rights of present and future generations of Mainers to a healthy atmosphere and stable climate system. Specifically, this rule is intended to achieve Maine’s constitutional obligation to “promote our common welfare” and protect unalienable rights, including the rights of life, liberty, property, safety, and happiness; to fulfill the State’s

\textit{Wind, Water, and Sunlight} (attached as Exhibit 11) (see Exhibit 12 for two page summary of Maine’s clean energy plan, including information on the sources of renewable energy, job gains, money savings, health benefits, and other information); see also Travis Madsen & Rob Sargent, \textit{We Have the Power: 100\% Renewable Energy for a Clean Thriving America}, Environment America Research & Policy Center (2016).

\textsuperscript{485} Jacobson, \textit{100\% Clean and Renewable Wind, Water, and Sunlight}, supra note 484, at 2099.

\textsuperscript{486} The cost savings include electricity cost savings, air quality damage savings, and climate costs savings to the world.

\textsuperscript{487} Jacobson, \textit{100\% Clean and Renewable Wind, Water, and Sunlight}, supra note 484, at 2106, 2108, 2111.
public trust obligation to prevent waste and substantial impairment of trust resources; and to
fulfill the Department’s existing statutory goal of reducing the State’s greenhouse gas emissions
“sufficient to eliminate any dangerous threat to the climate.”

DEFINITIONS:
1. “Best Climate Science” means:
   a. the most current scientific knowledge and understanding from qualified climate
      system scientists on safe levels of CO₂ and other greenhouse gases and their near-
      term and long-term impacts; and
   b. the most current scientific knowledge and understanding from qualified climate
      system scientists as to the greenhouse gas emissions reductions required to
      stabilize the climate system and preserve a habitable and safe climate system for
      future generations.
2. “Board” means the Maine Board of Environmental Protection.
3. “Carbon Budget” means the total amount of CO₂ emissions that can be released over a
   specific time frame while ensuring a return to the maximum safe limit of 350 ppm of CO₂
   by 2100, or a lower level as may be determined by the best climate science.
4. “CO₂” means carbon dioxide.
5. “Consumption Emissions and Inventory” means a greenhouse gas inventory including
   estimates of embedded emissions associated with the life cycle of materials and services,
   including electricity and fuels, consumed in Maine. These emissions are included
   regardless of whether they physically originate in Maine. A consumption-based inventory
   uniquely counts out-of-state emissions associated with producing the products, services,
   and fuels consumed in Maine. It also counts emissions associated with producing fuels
   that are used to generate electricity consumed in Maine.
6. “Department” means the Maine Department of Environmental Protection.
7. “Greenhouse Gas” or “GHG” means any gas that has contributed to anthropogenic
   global warming, including but not limited to carbon dioxide, methane, nitrous oxide,
   hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.
8. “In-boundary Emissions and Inventory” means the greenhouse gas inventory focused
   on all emissions produced within the state. In-boundary emissions inventories exclude
   many of the emissions associated with materials and goods produced outside, and
   imported into, the state.
10. “MMTCO₂e” means million metric tons of carbon dioxide equivalents.
11. “PPM” means parts per million.

EMISSION REDUCTIONS:
1. The Department shall:
   a. Ensure that Maine reduces its total in-boundary and consumption CO₂ emissions
      to at least 85% below 1990 levels by 2050 in order for its emission reductions to
      be consistent with the global average emission reductions required to return
      global atmospheric CO₂ to 350 ppm by the end of the century;
   b. Establish interim benchmarks for minimum levels of emission reductions for at
      least the years 2020, 2030, and 2040 to guide progress toward the 2050 reduction
      goal;
c. Ensure that Maine’s in-boundary CO₂ emissions are reduced by at least 8 percent per year beginning in 2017⁴⁸⁸; and

d. Prepare a numerical statewide goal or “carbon budget,” taking into account both in-boundary and consumption emissions, for Maine to do its share in achieving 350 ppm of CO₂ in the atmosphere by the year 2100.

CARBON ACCOUNTING AND INVENTORY:

2. The Department shall augment its current accounting, verification, and inventory system for statewide greenhouse gas emissions so as to provide an accounting to Maine citizens of its management of the atmospheric trust asset by publishing biennial progress reports on statewide GHG emissions measured in both MMTCO₂ and MMTCO₂e. These reports must include an accounting and inventory for each and every substantial source of GHG emissions within Maine, including, but not limited to:
   a. in-boundary emissions from the transportation, industrial, commercial, institutional, residential, electrical, agricultural, and waste sectors; and
   b. consumption emissions associated with Mainers’ consumption of goods and materials.

Reports must be available to the public no later than January 31 of each year, beginning in the year 2017, with a lag time of no more than two years (i.e., the 2017 report should contain emissions data from 2015).

LEGISLATIVE RECOMMENDATIONS:

3. The Department shall recommend to the Legislature that:
   a. The State’s statutory greenhouse gas emission reduction targets be revised based on the best climate science for global climate stabilization, which indicates that a return to a maximum concentration of 350 ppm of atmospheric CO₂ by 2100 would stabilize the Earth’s energy balance and avoid the worst impacts of climate change and ocean acidification;
   b. The State must reduce its total in-boundary and consumption CO₂ emissions to at least 85% below 1990 levels by 2050 in order for its emission reductions to be consistent with the global average emission reductions required to return global atmospheric CO₂ to 350 ppm by the end of the century;
   c. The Legislature establish interim benchmarks for minimum levels of emission reductions for at least the years 2020, 2030, and 2040 to guide progress toward the 2050 reduction goal; and
   d. The Legislature develop and implement mechanisms, such as a rising price on carbon, to facilitate swift in-boundary and consumption emission reductions.

CLIMATE ACTION PLAN:

4. Within six months of adoption of rules and regulations establishing emission reduction targets, the Department, with input from stakeholders, shall adopt a new Climate Action Plan to meet the reduction goals specified therein.

REVISIONS:

⁴⁸⁸ The requisite annual rate of emission reductions increases every year so if Maine delays implementation of this rule, the annual rate of reductions will need to be increased according to the best climate science.
5. Two years after the effective date of the regulations, the Department shall amend these regulations to adjust the reduction requirements as necessary to assure that the State is reducing its greenhouse gas emissions in a manner that is consistent with the best climate science, taking into account the State’s equitable responsibility for staying within the global 350 ppm carbon budget.

VII. CONCLUSION

As this summer has illustrated with frightening clarity, the devastating impacts of climate change are already upon us. In Louisiana, Maryland, and West Virginia devastating floods have combined to kill dozens of people and flood tens of thousands of homes. The Louisiana flooding was the eighth rainfall event in just over a year that NOAA classifies as a once every 500 years event. Unprecedented wildfires are blazing across the parched western states, destroying hundreds of homes and overwhelming firefighters. At the same time dangerous heat waves are occurring across the United States; each of the past 15 months, through July 2016, has been the warmest such month on record. Arctic sea ice is melting at rapid rates while Arctic temperatures are at also record highs. As Michael Mann, director of Penn State University’s Earth System Science Center stated: “The ‘signal’ of climate change is no longer subtle. We are seeing climate change impacts now play out, on our television screens, in the headlines, on our television sets. Whether it’s the multitude of thousand-year flooding events we’ve seen over the past year, the massive wildfires, the strongest hurricanes in both hemispheres, etc., we are now dealing with the impacts of climate change on a daily basis.”

There is a mind-blowing urgency for Maine, along with other governments, to implement science-based climate recovery plans before the devastating climate disruption we are already experiencing get worse and become locked in.

The State of Maine, through the Maine Department of Environmental Protection and the Maine Board of Environmental Protection, has the authority and obligation, pursuant to the Maine Constitution, the Public Trust Doctrine, and Maine statutory law to implement a strategy to reduce CO₂ and GHG emissions on a trajectory consistent with a goal of returning atmospheric concentrations of CO₂ to 350 ppm by 2100. By adopting such a strategy, Maine will also be fulfilling its sovereign duty to protect Mainer’s constitutional rights and protect the atmosphere and other trust assets, for both current and future generations. Failure to reduce fossil fuel emissions with great urgency will ensure that Petitioners, youth, and future generations will be forced to confront an inhospitable future marked by rising seas, mass migrations, food and water shortages, heat waves and droughts, extreme weather events, public health system collapse, and the extinctions of numerous species. Accordingly, Petitioners respectfully request that the Department promulgate the rules and implement the actions requested herein in order to ensure that present and future generations of Mainers, including Petitioners, are able to secure

490 Id.
492 Id.
493 Id.
494 Id.
their legal right to a healthy atmosphere and stable climate system and all the other vital natural resources that they depend on for their survival and wellbeing.

Respectfully submitted this 27th day of September 2016,

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EXHIBITS


3. Declaration of Dr. James E. Hansen in Support of Our Children’s Trust et al.’s Submission to the UN Committee on the Rights of the Child Regarding State Obligations, Children’s Rights and Climate Change (Aug. 19, 2016)


5. Materials Circulated During Petition Drive


9. Summary of Statutory Goals

