U.S. Environmental Protection Agency
Mid-Atlantic Region III

Climate Change Adaptation Implementation Plan

Prepared by the Region III Climate Network Climate Adaptation Working Group

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the

most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

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Deputy Administrator

September 2013

US EPA Region III – Climate Adaptation Implementation Plan

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Acknowledgements

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Introduction

We live in a world in which the climate is changing. Because many of the environmental outcomes that EPA is working to attain (e.g., clean air, safe drinking water) are sensitive to changes in weather and climate, these changes are posing new challenges to EPA's ability to fulfill its mission of protecting human health and the environment.

To address these challenges, EPA has developed a Climate Change Adaptation Plan. The Adaptation Plan relies on peer-reviewed scientific information and expert judgment to begin to identify vulnerabilities to EPA's mission and goals from climate change. The Adaptation Plan also presents priority actions the Agency will take to integrate climate adaptation planning into its programs, policies, rules, and operations, to ensure they are effective in a changing climate. EPA's focus on climate adaptation is part of a larger federal effort to promote a healthy and prosperous nation that is resilient to a changing climate.

EPA's vision is for the Agency to continue to fulfill its mission of protecting human health and the environment even as the climate changes. In the coming years, EPA will build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

EPA's *Policy Statement on Climate-Change Adaptation*[1], issued in 2011, called for EPA to plan for future changes in climate and to mainstream considerations of climate change into its activities. As part of that effort, the *Policy Statement* called for the Agency to develop and implement a *Climate Change Adaptation Plan*. It also called for each EPA National Environmental Program Office and Regional Office to develop Implementation Plans to explain how they will carry out the work called for in the Agency-wide Plan. To answer this call, EPA Region III has prepared the following Climate-Change Adaptation Implementation Plan. The plan will address how our Regional Office hopes to integrate climate adaptation into our planning and work, as well as, address the cross-EPA priorities identified in the Agency-wide Adaptation Plan. The information and actions listed in this plan has been based on the best available science and will reflect unique regional circumstances. The plan will updated as the Region learns by through the experience of integrating climate change adaptation planning into our activities.

[1] http://www.epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf

Chapter 1: Regional Programmatic Vulnerability Assessment

Background / Approach

This section contains an assessment of the vulnerabilities of selected EPA Region III programs to the impacts of climate change. It builds on the work presented in Part 2 of EPA's Agency-wide Plan, as well as the individual assessments completed by various EPA National Program Offices, eg. Office of Air and Radiation. It summarizes vulnerabilities related to the goals in EPA's FY 2011-2015 Strategic Plan.

This assessment was developed by a working group within the Region III Climate Network. The assessment is based on peer-reviewed literature (climate impacts) and the professional judgment of regional staff (programmatic impacts). Vulnerability assessment is an ongoing process. This plan should be viewed as a living document that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission.

EPA's Five Strategic Goals:

1. Taking Action on Climate Change and Improving Air Quality.
2. Protecting America's Waters.
3. Cleaning Up Communities and Advancing Sustainable Development
4. Ensuring the Safety of Chemicals and Preventing Pollution
5. Enforcing Environmental Laws

Important climate change impacts in the region that will be covered within this assessment include:

- Increased tropospheric ozone pollution
- Increasing extreme temperatures
- Effects on the stratospheric ozone layer
- Increasing heavy precipitation events
- Increasing intensity of hurricanes
- Sea level rise
- Ocean acidification
- Increasing water temperatures
- Increasing risk of floods
- Increased frequency and intensity of wildfires

Regional Description

Region 3, EPA's Mid-Atlantic office, serves Delaware (DE), the District of Columbia (DC), Maryland (MD), Pennsylvania (PA), Virginia (VA), and West Virginia (WV). The Region is unique in that it straddles two different climate regions, as defined by the U.S. Global Change Research Program (USGCRP 2009) – the Northeast (DE, DC, MD, PA, WV, and northern VA) and the

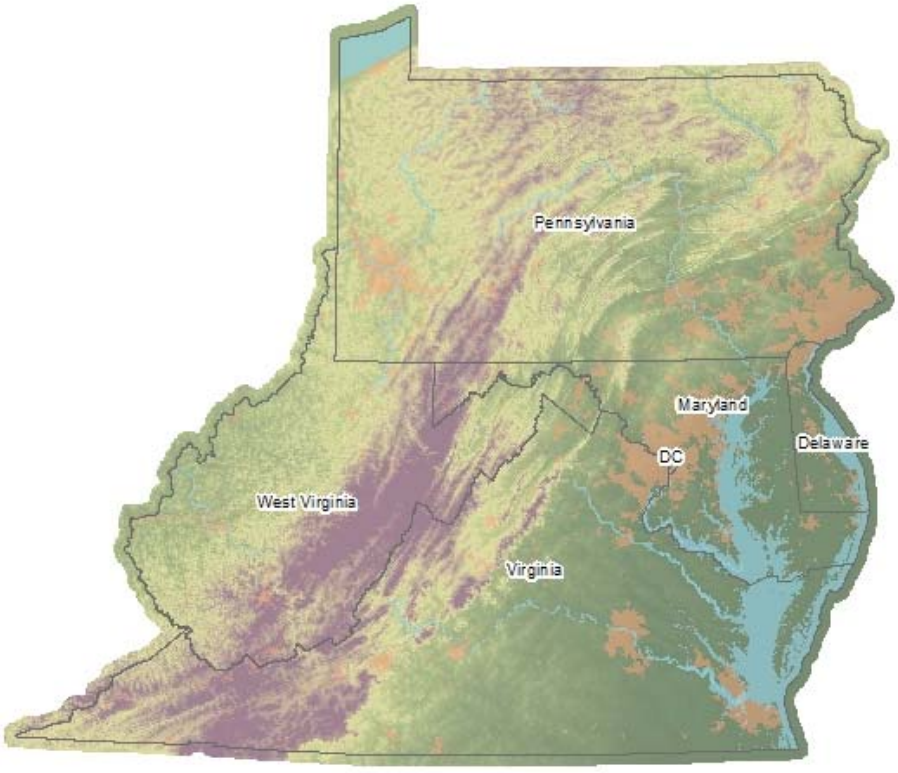
Southeast (southern VA). As a result, the Region represents a diverse climate, which includes snowy winters, vibrant autumns, and extreme events (such as nor'easters and heat waves) characteristic of the Northeast, and mild temperatures and high humidity characteristic of the Southeast. The western portions of Region III (sections of western PA and WV) sometimes mimic USGCRP's Midwest region.

There are diverse agricultural, industrial, and residential sectors within the region that use and impact resources that may be affected by climate change. In addition, the region contains various types of geographic features and sub-regions, including barrier Islands, the Appalachian Mountains, the Piedmont Plateau, the Chesapeake Bay, as well as, the Delaware Bay and Delmarva Peninsula. Coastal areas, estuaries and river systems, including the Chesapeake and Delaware Bays, comprise a significant portion of the Region's population centers. The Region contains a significant amount of coastline and a number of large urban areas (Philadelphia, Baltimore, Washington, DC), with sensitive populations that are particularly vulnerable to the impacts of a changing climate. Outside of the urban areas there are wetlands, uplands, and forested areas with both pristine and degraded ecosystems.

Figure 1. Map of Region III

Expected Changes in Climate

The following is a summary of the range of key impacts and trends that are foreseen in the Region–from the USGCRP June 2009 report.



The Region has significant geographic and climatic diversity within its relatively small area. The character and economy of the Northeast have been shaped by many aspects of its climate including its snowy winters, colorful autumns, and variety of extreme events such as nor'easters, ice storms, and heat waves. This familiar climate has already begun changing in noticeable ways. Since 1970, the annual average temperature in the Northeast has

increased by 2°F, with winter temperatures rising twice as much. Over the next several decades, temperatures in the Northeast are projected to rise an additional 2.5 to 4°F in winter and 1.5 to 3.5°F in summer. By mid-century and beyond, however, today's emissions choices would generate starkly different climate futures; the lower the emissions, the smaller the climatic changes and resulting impacts. Warming has resulted in many other climate-related changes, including:

- More frequent days with temperatures above 90°F
- A longer growing season
- Increased heavy precipitation
- Less winter precipitation falling as snow and more as rain
- Reduced snowpack
- Earlier breakup of winter ice on lakes and rivers
- Earlier spring snowmelt resulting in earlier peak river flows
- Rising sea surface temperatures and sea level

Under a higher emissions scenario:

- Winters in the Northeast are projected to be much shorter with fewer cold days and more precipitation.
- The length of the winter snow season would be reduced by a week or two.
- Cities that today experience few days above 100°F each summer would average 20 such days per summer, while certain cities, such as Philadelphia, would average nearly 30 days over 100°F.
- Sea levels in the Region are projected to rise more than the global average.

Selected Programmatic Climate Change Vulnerabilities

The following section discusses how EPA Region III environmental and human health programs may be vulnerable when faced with the impacts of a changing climate. This initial selection of programmatic vulnerabilities will be described in context of the major goals in EPA's Strategic Plan. The issues described here should not be seen as a complete listing of vulnerabilities to EPA programs. Region III, working with other EPA offices and other regional stakeholders, will periodically update the information and scope of the programmatic vulnerability assessment.

Goal 1: Taking Action on Climate Change and Improving Air Quality

EPA's Air Protection Programs are a part of protecting the Region's citizens from air pollution through implementation of the Clean Air Act (CAA). The Air Protection programs are responsible for ensuring implementation of the National Ambient Air Quality Standards which includes reviewing and enforcing State Implementation Plans and CAA permits. To complement the regulatory work, the Air Protection Programs include energy efficiency, renewable energy, clean diesel, indoor air quality and radon outreach programs to reduce emissions of criteria

pollutants, greenhouse gases and air toxics. Extreme temperatures and increased average temperatures, as well as, extreme flooding events in urban areas are the climate change impacts of most concern for the Air Protection programs. As the air quality in the Region worsens due to climate change impacts; the workload of the Air Protection Programs will increase.

A. Tropospheric ozone is likely to increase in the Mid-Atlantic due to the effects of climate change.

The Mid-Atlantic Region currently has eight nonattainment areas for the 2008 ozone standard, as well as 4 nonattainment areas and twenty-five maintenance areas for the 1997 8-hour ozone standard. With climate change, higher temperatures and weaker air circulation in the United States will lead to more ozone formation even with the same level of emissions of ozone forming chemicals.[2] Various studies project daily ozone levels to increase between two and five parts per billion across the eastern U.S. between 2020 and 2080 due to climate change if no additional emissions controls for ozone precursors are implemented.[3]

In addition to the direct impact of temperature change on ozone formation, an increase in energy demand due to increased temperatures may also lead to a worsening of air quality. Sources in or upwind of the Region may be required to implement additional control measures.

In terms of Regional resources, greater collaboration with our states will be necessary on planning and rule development to address any additional challenges in achieving or maintaining attainment. A majority of the current nonattainment areas in the Mid-Atlantic Region are urban areas with sensitive populations, including Philadelphia, Pittsburgh, Washington D.C., and Baltimore. Exacerbating the health impacts from ozone pollution on urban populations will likely be higher nighttime temperatures expected in urban areas, both as a consequence of climate change but also because of enhanced effects from urban heat islands.[4]

Climate change also has the potential to increase the length of the ozone season.[5] Currently, the ozone season runs from April through October. During this period, daily ozone levels are recorded and reviewed. An increase in the length of the ozone season would require a longer reporting period, translating to more time spent for data reviews in the Region.

B. Particulate matter levels may be affected through changes in the frequency or intensity of wildfires.

In the Mid-Atlantic Region, there are currently 8 nonattainment areas for the 2006 24-hour PM2.5 standard and 16 nonattainment areas for the 1997 annual PM2.5 standard. While the

[2] Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[3] IPCC Fourth Assessment, GCAQ-EPA
[4] IPCC Fourth Assessment
[5] Ibid

impact of climate change on ambient PM2.5 levels remains somewhat uncertain, there is evidence indicating that climate change will impact PM levels through changes in the frequency or intensity of wildfires.[6]

In 2008, monitors in the Norfolk area of Virginia experienced 24-hour PM2.5 levels four times (83 ug/m3) the standard due to wildfires in North Carolina. While these fires were not caused by climate change, this example portrays the impact of fires on PM levels in the region, and is indicative of the potential health and environmental concerns.

The adaptive capacity of Region 3 for this issue is limited, as this data can be treated as an "exceptional event" under the National Ambient Air Quality Standards. If determined to be due to an exceptional event, monitoring data during fire events may be ignored when determining attainment.

C. Climate change may worsen and increase the exposure to indoor air problems in the Mid-Atlantic.

Existing indoor environmental problems may worsen and new ones may be introduced as climate change alters the frequency and severity of adverse outdoor conditions.[7]

Extreme temperatures will very likely increase and heavy precipitation events will likely increase as a result of climate change[8], which, along with increased dampness, moisture, and flooding affecting homes and occupied buildings, may contribute to indoor environmental problems in the Mid-Atlantic.[9]

Frequent breakdowns in a building's protective envelope, as a result of extreme weather conditions, may lead to water infiltration into indoor space, increased dampness, and, in turn, increased exposure to mold and other biological contaminants.[10]

Changes in the emergence, evolution, and geographic ranges of pests, infectious agents, and disease vectors may lead to shifting patterns of indoor exposure to pesticides as occupants and building owners respond to new infestations.[11]

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[6] Committee on Environment and Natural Resources, "Scientific Assessment of the Effects of Global Change on the United States" (Committee on Environment and Natural Resources of the National Science and Technology Council, U.S. Climate Change Science Program, 2008), http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf.

[7] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

[8] IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

[9] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

[10] Ibid.

[11] Ibid.

Residents may weatherize buildings to increase comfort and save energy. Although in general these actions should be encouraged, this may lead to a reduction in ventilation and an increase in indoor environmental pollutants unless measures are taken to preserve or improve indoor air quality. [12] EPA has developed practical guidance for improving or maintaining indoor environmental quality during home energy upgrades or remodeling in single-family homes and schools. EPA's guidance and protocols may need to be revised to include state and local considerations for projected climatic changes. In addition, these programs may need to increase partnerships with other agencies to address training needs and workforce development for building owners, managers, and others, as well as develop new tracking mechanisms to assess the effectiveness of weatherization and remodeling techniques as they relate to indoor environmental quality.

The Mid-Atlantic Region is comprised of several large urban areas, which are very likely to see increases in the risk of illness and death related to extreme heat and heat waves. For example, Philadelphia is projected to jump from an average of just a few days above 100°F each summer to nearly 30 days above 100°F each summer by late this century, under a higher emissions scenario. The elderly and those with existing health problems are particularly vulnerable.[13] Increased frequency of extreme weather events may result in power outages, leading to increased exposure to potentially dangerous indoor conditions.[14]

Region III may need to build its adaptive capacity to these increasing and changing health risks through its indoor air quality programs, resources, and public outreach and assistance. Partnerships between Region III and stakeholders, such as state/local governments, non-profits, etc., will need to be strengthened in order to inform affected populations on how to adapt to higher temperatures. Strengthening ties between the Region's energy efficiency and indoor air quality programs will be necessary in order to address the relationship between building ventilation during efficiency retrofits and potential, resulting indoor air problems.

D. Climate change may alter the effects of and strategic priorities within EPA Region III regulatory and voluntary programs to help restore the stratospheric ozone layer.

Climate change will likely have effects on the stratospheric ozone layer; however, the interactions between the changing climate and ozone layer are complex. Climate change affects the ozone layer through changes in chemical transport, atmospheric composition and temperature. In turn, changes in stratospheric ozone can have implications for the weather

[12] Ibid.

[13] USGCRP, 2009: *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

[14] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

and climate of the troposphere. Climate change may exacerbate the health effects of ozone layer damage at some latitudes and mitigate them at others.[15]

In order to build adaptive capacity with respect to this vulnerability, Region III may need to heighten public awareness of the health risks of ultraviolet (UV) radiation exposure, through existing EPA partnership programs such as SunWise. Climate change may also lead to an increase in the use of cooling devices, such as air conditioners, which contain ozone depleting substances (ODSs) or ODS substitutes. Region 3 may need to make changes to its current efforts to promote programs such as GreenChill and Responsible Appliance Disposal in the Mid-Atlantic, as a result.

E. Climate change may impact energy production and efficiency in the Mid-Atlantic.

Rising temperatures, as a result of climate change, are expected to increase energy requirements for cooling and decrease energy requirements for heating. The former will result in significant increases in electricity use and higher peak demand. The electricity grid is also vulnerable to the effects of climate change, such as extreme weather events and peak demand increases resulting from rising temperatures, which could cause interruptions in the electric power supply.[16] The Mid-Atlantic's urban areas and sensitive populations, such as the elderly, are particularly vulnerable to power interruptions during extreme weather events like heat waves.

F. Extreme weather events may impact the regional monitoring systems.

Extreme weather events, including severe winds, flooding and lightning, could cause damage to the PM2.5 and RADNET monitoring systems in Region III. The standard operating procedure for deploying monitors currently includes consideration of extreme weather. The Region will need to continue following the monitoring SOP to ensure that monitors can be safely accessed and operated.

G. Scientific understanding related to ways that climate change may affect the interactions of sulfur, nitrogen, and mercury deposition with ecosystems is evolving.

While there is limited scientific evidence on this topic, additional research is underway to better understand how patterns in the atmospheric deposition of sulfur, nitrogen, and mercury with projected changes in the climate and carbon cycle will affect ecosystem growth, species

[15] World Meteorological Organization, Scientific Assessment of Ozone Depletion: 2010, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011). Note: the word "expected" is used in the report to characterize projected climate change impacts on the stratospheric ozone layer. For purposes of this assessment, the word "likely" has been used as a proxy for "expected."

[16] USGCRP, 2009: *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

changes, surface water chemistry, and mercury methylation and bioaccumulation.[17] The potential impacts could have consequences for the effectiveness of ecosystem protection from Agency emissions reduction programs.

Goal 2. Protecting America's Waters

A. Flooding from increasingly frequent and intense storm events

In the Northeast, the annual number of days with very heavy precipitation has increased in the past 50 years. Flooding often occurs when heavy precipitation persists for days to weeks in small and large watershed. Precipitation and runoff are likely to increase in the Northeast in winter and spring. Increases in the impacts from precipitation and flooding may damage regional drinking and wastewater facilities and may exacerbate non-point source pollution water quality issues in reservoirs, wetlands, streams and rivers within the Region.

B. Coastal wetland loss

Coastal wetlands often migrate landward, disappear, or change in type in response to sea level rise through accretion. Dense coastal development is often protected by shoreline armoring, which prevents wetland migration and leads to loss of submerged wetlands. Coastal wetlands are essential for providing storm surge buffers, preserving estuarine water quality as well as supporting economically important fish and wildlife habitat.

C. Threats to coastal water-related infrastructure

The densely populated coasts of the Northeast face substantial increases in the extent and frequency of storm surge, coastal flooding, erosion, and property damage. Much of this coastline is exceptionally vulnerable to sea-level rise and related impacts.

D. Water Quality impacts from climate changes

Shallow groundwater aquifers that exchange water with streams are likely to be the most sensitive part of the groundwater system to climate change. Small reductions in groundwater levels can lead to large reductions in stream flow and increases in groundwater levels can increase stream flow. Further, the interface between streams and groundwater is an important site for pollution removal by microorganisms. Their activity may change in response to increased temperature and increased or decreased streamflow as climate changes, this may affect water quality and affect Clean Water Act goals related to water bodies in non-attainment and affect TMDL development.

A specific mid-Atlantic water quality concerns is the Delaware River Basin, which includes portions of New York, Pennsylvania, New Jersey, and Delaware that drain to the 330-mile long Delaware River and Bay. The basin's total area is over 13,500 square miles, and over 15 million people rely on its water resources for potable, industrial, and agricultural use. The main focal

[17] Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011: National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, 114 p.

points of climate change in the basin include increased temperature, changes in precipitation patterns, and sea level rise. The Delaware River Basin Commission monitors the salt line location as it fluctuates along the tidal Delaware River as stream flows increase or decrease in response to changing inflows, which either dilute or concentrate chlorides in the river. The salt line location plays an important role in the Delaware River Basin water quality and drought management programs because upstream migration of brackish water from the Delaware Bay during low-flow and drought conditions could increase sodium chloride concentrations in public water supplies, presenting a public health concern. *(Courtesy Delaware River Basin Commission State of the Basin Report 2008)* As salt-laced water moves upriver, it increases corrosion control costs for surface water users, particularly industry, and can raise the treatment costs for public water suppliers. Salinity levels also affect aquatic living resources. Normal location of the salt line is the mouth of the Delaware Bay, or river mile 67, but at times will move further north. During the summer months of 1999, the salt line moved to river mile 88 and during the 1960's 'drought of record' the salt line reached its farthest recorded upstream location at river mile 102, just 8 miles below important drinking water intakes in PA and NJ.

E. Severe flooding from sea-level rise and extreme precipitation is likely to increase

Sea-level rise is expected to increase saltwater intrusion into coastal freshwater aquifers, making some unusable without desalination. Increased evaporation or reduced recharge (drought) into coastal aquifers exacerbates saltwater intrusion. Like water quality, research on the impacts of climate change on groundwater, ecosystems, and infrastructure has been minimal and remedies may be difficult.

F. Water & Energy Infrastructure

Many water systems in the Northeast are already taxed due to aging infrastructure, population increases, and competition among water needs for agriculture, municipal use, recreation, and ecosystems. Extreme precipitation events may exacerbate existing problems in many cities in the Northeast, especially combined sewer systems. Drinking water and sewer infrastructure is expensive to build and maintain. Climate change may present a new set of challenges for designing upgrades to the nation's drinking water and wastewater infrastructure.

Also, a significant fraction of the region's energy infrastructure is located near the coasts and tide influenced Bays, from power plants, to oil refineries, to facilities that receive oil and gas deliveries. Rising sea levels are likely to lead to direct losses, such as equipment damage from flooding or erosion, and indirect effects, such as the costs of raising vulnerable assets to higher levels or building new facilities farther inland.

G. Changes in aquatic ecosystems/species composition and distribution

Various forces of climate change at the coasts pose a complex array of management challenges and adaptation requirements. For example, relative sea level is expected to rise at least two feet in Chesapeake Bay (located between Maryland and Virginia) where the land is subsiding,

threatening portions of cities, inhabited islands, most tidal wetlands, and other low-lying regions. Climate change also may affect the volume of the bay, salinity distribution and circulation, as will changes in precipitation and freshwater runoff. These changes will affect seasonal oxygen depletion and efforts to reduce the agricultural nitrogen runoff into water bodies.

	Impacts in Northeast (DE,DC,MD,PA,WV) and in Southeast (VA)				
		Northeast		***Southeast***	
		DW	**WW**	**DW**	**WW**
Drought	Reduced Groundwater recharge	√		√ √	
	Lower Lake and Reservoir Levels	√		√ √	
	Changes in seasonal runoff & loss of snowpack	√ √		√	
Water Quality	Low flow conditions & altered water quality		√ √		√
	Saltwater intrusion into aquifers	√		√ √	
	Altered surface water quality	√	√	√ √	√ √
Floods	High flow events and flooding	√ √	√ √	√	√
	Flooding from coastal storm surges	√ √	√ √	√ √	√ √
Ecosystem Changes	Loss of coastal landforms / wetlands	√ √	√ √	√ √	√ √
	Increased fire risk & altered vegetation	√	√	√ √	√ √
Service Demand &	Volume & temperature challenges	√ √	√ √	√	√
	Changes in agricultural water demand	√		√	
	Changes in energy sector needs	√		√	
	Changes in energy needs of utilities	√ √	√ √	√ √	√ √

Figure 2: Comparison of potential Climate Change impacts for the North and Southeast on water infrastructure, specifically, Drinking Water (DW) and Waste Water (WW).

Warmer Chesapeake Bay waters will make survival difficult for northern species such as eelgrass and soft clams, while allowing southern species and invasive species transported in ships' ballast water to move in and change the mix of species that are caught and must be managed. Additionally, more acidic waters resulting from rising carbon dioxide levels will make it difficult for oysters to build their shells and will complicate the recovery of this key species.

H. Vulnerability & Uncertainty related to impacts to Water in the Region:

Water temperature, precipitation, and sea level are critical variables in almost everything the Region does in the water program, from setting water quality standards, developing TMDLs, and issuing NPDES permits to helping build drinking water and wastewater treatment infrastructure. Having better data and information on how much and how fast water temperature will increase, how extreme storms may be, and how high and fast sea level will rise will enable Region to fulfill statutory and regulatory responsibilities. Developing consistent scientific methods and robust datasets to support long-term policy decisions on climate change vulnerability assessments and adaptation planning will help inform these decisions.

Goal 3. Cleaning Up Communities and Advancing Sustainable Development

EPA's waste and land clean-up programs play a crucial role in protecting public health and the environment from exposure to hazardous materials, remediating contaminated property, and

making these properties available for reuse. Changes in climate should be taken into consideration in order for the Region to continue to serve these important functions. It may be necessary to design site-specific clean-up or remedy that can withstand the projected climate change impacts and which may impact the Region's ability to exercise statutory authority and may add cost. Sea-level rise, storm and flood events, and increased ambient temperatures are climate change impacts of particular concern for the programmatic focus areas – Restoring and Preserving Land and Emergency Response.

A. Restoring and Preserving Land

Increased flooding and sea-level rise may increase the risk of contaminant releases from vulnerable RCRA Corrective Action sites, Superfund sites, Brownfield sites, LUST sites, other contaminated sites, and landfills. Flooding from more intense and frequent storms and extreme storm events could affect the migration and management of contaminants. Sea-level rise can lead to inundation and salt water intrusion which may impact the performance of the remedies and cause the transport of contaminants at sites in coastal areas. Contaminant migration could also occur after prolonged power loss at cleanup sites with pump and treat systems dependent on grid electricity.

Impacts may be most severe for cleanup sites that are not yet completed; however sites with waste in place following a cleanup and permitted facilities that manage hazardous materials may also be vulnerable. Sites with on-site containment or treatment remedies within the 100 or 500 year flood plain of a surface water body and/or within the sea-level rise zone 1.5 meters above high tide are of particular concern in Region III. Sediment sites with in situ capping remedies are vulnerable to flood regime changes and re-suspension and deposition of contaminated sediment. Flooding from storms and inundation due to sea level rise could jeopardize land revitalization efforts including renewable energy generation, greener cleanups, and ecological revitalization projects, as well as other site reuse or redevelopment plans at Brownfield sites and completed Superfund Sites.

Increased ambient temperatures and extreme heat may impact the design and operation of remediation systems. Cleanup sites with waste in place phytoremediation, or a vegetative cap may be vulnerable in areas that experience drought or changing plant hardiness zones. Slowed growth rates during heat waves could impact the success of the remedy or revitalization effort, and excessive vegetation loss could lead to erosion. Coastal, stream, and mountain ridge top habitats are examples of ecosystems in Region 3 that are vulnerable to increases in ambient temperature.

B. Emergency Response

As storm and flood events increase in frequency and severity, emergency responses to hazardous materials release and oil spills may also increase. Financial constraints and response capacity for Emergency Response staff and Response Support Corps are potential vulnerabilities in Region III. Existing emergency planning and chemical containment strategies at oil and chemical facilities may not be sufficient. Current landfill capacity may also be insufficient to handle surges in disposal of hazardous and municipal wastes generated from extreme storm

events. Availability of utilities and transportation infrastructure may be limited as a result of increased impacts to those systems. Power loss and blocked roads can hamper emergency responses.

Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

A. Use of Toxic chemicals:

A changing climate will likely result in changes in the timing and location of planting crops, which in turn affects the volume and timing of agricultural chemical use. This change in agricultural chemical use could impact the appropriate risk management decisions made by EPA Pesticides and Toxic Substances Program, particularly with regard to the protection of migrant farm workers.

Changes in temperature and precipitation levels are expected to lead to the increase in mosquitoes and other pests controlled by regulated pesticides. An increase in cases of the West Nile Virus and other diseases carried by mosquitoes may lead to an increase in calls by the public for the use of pesticides to control these disease vectors. This may in turn affect the workload of the EPA Pesticides program.

B. Storage of Toxic Chemicals:

Flooding from more intense and frequent storms and extreme events could compromise chemical containment strategies at oil facilities and toxic chemical and pesticide storage facilities. Facilities located in coastal areas and/or within the 100-500 year flood plain of a surface water body are of concern to Region III. If these facilities do not properly manage the storage of these chemicals and/or store them at higher elevations, the extreme weather events that are expected as a result of climate change may result in the release of toxic chemicals into the environment, including to surface waters via storm water discharges.

C. Exposure to Toxic Chemicals from Demolition/Renovation Activities:

The extreme weather events that are likely to occur as a result of climate change (e.g., high winds, heavy precipitation events) may damage community infrastructure (e.g., schools and child care facilities) and residential homes. As a result, there may be an increased risk of exposure to lead, asbestos, and PCBs if buildings are renovated or demolished as part of the recovery efforts.

Assessment of Potential Vulnerabilities for Region III Managed Facilities and Operations

Results from climate change include an increase in extreme temperatures, droughts, intensity of precipitation and ground level ozone pollution which will affect Region III facilities and employees to varying degrees depending on their location. Employee impacts such as an

increase in heat-related illness, absenteeism, exposure to vector-borne diseases and mold could result. In addition, localized flooding of roads and infrastructure could affect the commute and business travel of our employees resulting in tardiness and reduced efficiency. Facility impacts such as an increase in electricity use and decrease in indoor air quality are also possible.

As discussed in the Expected Changes in Climate section of this plan, Philadelphia could average more than thirty days over 100˚ F in the future. This could lead to an increase in heat-related illnesses for our employees especially, older employees and workers doing field work who do not or can't reduce their exposure by limiting exertion and time outdoors due to mission requirements. More frequent hot summer days can also worsen air pollution, especially in urban areas and threaten the health of vulnerable employees. This could increase absenteeism and/or reduce the productivity of our staff. Higher temperatures will likely cause an increase in electricity use and cost in our building to power air conditioning. This increased use could stress the power supply grid resulting in brown outs, black outs and the need to use backup power generators.

As discussed in more detail in the Goal 1 section of this plan, climate change may worsen and increase exposure to indoor air quality problems in our buildings from dampness and mold, and expose occupants to different pests, infectious agents and disease vectors, as well as any pesticides applied to address these infestations. As discussed in more detail in the Goal 2 section of this plan, an increase in the frequency and intensity of heavy precipitation events, that have already been experienced, is projected to be worse in the future, leading to more frequent flooding and impact our road and mass transit systems. Climate change impacts, including increased severe weather, may affect the Region's Continuity of Operations Plan (COOP) that describes efforts to prepare and react to issues affecting the operation of our facilities. Unique or site specific vulnerabilities are described below.

Philadelphia Office located at 1650 Arch Street, Philadelphia, Pennsylvania

Over 90% of our approximately nine hundred Philadelphia based employees use mass transit to commute to work. Any impact to this system is a large vulnerability that on any given day will affect hundreds of our employee's ability to get to work and for the Region's ability to function and carry out its mission. A recent example of this vulnerability occurred when our office was closed on October 29 -30, 2012 as a result of a shutdown of mass transit in Philadelphia due to impacts from Hurricane Sandy.

Past periods of drought in the Delaware watershed have resulted in salt water intrusion causing concern for the Philadelphia drinking water supply intake on the tidal Delaware River north of the city. Expected sea level rise from climate change may exacerbate this vulnerability in the future.

Environmental Science Center (ESC) located at 701 Mapes Road, Fort Meade, Maryland

Vulnerability to flooding of the Environmental Science Building should not be an issue since building site has a very robust stormwater runoff system that directs rain water falling on approximately 70% of the site to a large capacity infiltration basin that can capture all the volume produced by a two year storm and almost all the volume of a ten year storm before there would be any discharge. However, localized flooding of area roads could still be an issue for the approximately one hundred sixty employees who must commute to the laboratory to do their work and have little if any ability to work from alternate locations.

Wheeling Office located at 1060 Chapline Street, Wheeling, West Virginia

Despite its location which is less than a one quarter mile from the Ohio River with an upstream drainage area of approximately 25,030 square miles, flooding of the Wheeling office is not expected to be a problem. The office is over fifty feet above the river level and has never been impacted by historic flood events associated with hurricanes in the drainage area or other severe weather. As discussed above, localized flooding of area roads could still be an issue for the approximately 25 Wheeling office employees on their commute to work and for business travel.

Chesapeake Bay Office located at 410 Severn Avenue, Annapolis, Maryland

Our Chesapeake Bay office is located in a marina office complex directly on the water in a watershed that contains over one hundred fifty major rivers and streams and drains approximately 64,000 square miles. An increase flood risk is likely at this facility but mostly impacting storage and parking areas that are at a lower elevation. The offices in the building are approximately eleven feet above the Bay water level. A predicted increase in the intensity of hurricanes could impact the office directly due to its proximity to the coast and through storm surge impacting the Chesapeake Bay. As discussed in more detail in the Goal 2 section of this plan, sea level rise is also a threat to this facility as it will compound the effect of heavy precipitation, increase in flooding and storm surge.

Vulnerable Populations

Certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation Plan identifies key programmatic vulnerabilities and the priority actions that will be taken to address those vulnerabilities over time. As the work called for in this Plan is

conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (e.g., Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

An important facet of climate adaptation are potential impacts to the health of the Region's vulnerable populations. In areas where populations carries a heavy burden of disease or poverty, the populations have less resiliency and the effects of climate change may be more severe. The connections between our climate and human health have been known for years, although now the changing climate has compelled scientist to re-examine these relationships (Jonathan A. Patz 2000).

Populations such as children may be more vulnerable to both direct and indirect health effects of climate change (Shea and Health 2007). Other vulnerable populations include the elderly, the poor, individuals with co-morbidities, and the disabled.

These key impacts to the environment involve most of the programs in the Region (EPA. 2010). Warmer temperatures will increase morbidity and mortality associated with both extreme heat and cold weather patterns. This changing climate is also expected to affect air quality, threatening the health of vulnerable populations, including the very young, the elderly, outdoor workers, and those without access to air conditioning or adequate health care (USGCRP 2009). An increase in the strength and frequency of extreme events (droughts, storms, and floods) will likely increase the threat to overall human health and safety (EPA. 2010). These patterns of temperature and precipitation can affect the seasons for pollen and the range of specific diseases in the Region including Lyme disease and West Nile virus. The inner cities within Region 3 will also pose many challenges to EPA as well as our partners in local government due to urban heat island effect. The vulnerability of urban areas to climate change involves consideration of the sensitivity of urban systems and people living within them to climate change and other interacting stressors, their exposure to those stressors, and the ability of systems and people to adapt to present and future changes.

Chapter 2: DRAFT Regional Priority Actions for Climate Adaptation

Introduction

Based on the vulnerabilities described in the previous chapter, existing Regional priorities, and the current understanding of potential adaptation opportunities, the Region's Climate Adaptation workgroup identified "Priority Actions" that may assist EPA in accomplishing its mission and operate at multiple locations in the face of a changing climate. Priority Actions are listed below and categorized according to their relevance to programmatic goals in EPA's current strategic plan. An additional list of cross-cutting actions are also proposed and will support multiple strategic plan goals or build general capacity for future work on climate

adaptation. Proposed actions or activities will be reviewed by the Office of Regional Counsel to assure compliance with existing statutes, regulations, and guidance.

The Region will continue to identify other vulnerabilities that may occur and may need to change the scope or focus of ongoing priority actions over time. The workgroup used a simple set of criteria to identify and prioritize potential actions either developed from the vulnerability assessment or suggested by a diverse set of stakeholders. The workgroup developed criteria to *qualitatively* rank possible actions. The following is a summary of the criteria used to determine the priority actions included in this plan:

Criteria for EPA Mid-Atlantic Region Climate Adaptation Implementation Plan Priority Actions

- Likelihood, timeframe, and anticipated severity of specific projected impacts to regional programs or objectives.
- Ability to successfully implement a proposed action.
- Alignment with any existing environmental priorities (i.e. national, regional, divisional, programmatic).
- Alignment with priorities of key external partners and/or stakeholders (i.e. State and municipal governments).
- Ability for the action to build institutional capacity within EPA to better identify vulnerabilities and actions that will successfully address those vulnerabilities over time.
- Actions that may directly support one or more of the Agency-wide Strategic Measures for Climate Adaptation.

Priority Actions, Cross-Cutting:

- Develop an interactive Climate Knowledge Base, including GIS maps and data based on information from the Programmatic Vulnerability Assessment, training materials, project descriptions, and staff contacts for use by the region.
- Engage with local government stakeholders in the region to better understand the adaptation planning needs of cities and urban areas. Develop, maintain, and promote a simple “adaptation toolkit” with consolidated information and resources for urban areas within the region.
- Work with EPA HQ to develop general Climate Impacts and Adaptation training materials and make them widely available.
- Continue to develop the existing Region III Climate Change Strategy and Workplan and align it with this Climate Adaptation Implementation Plan.
- Work with the Office of Federal Activities to determine how to address climate adaptation issues under the National Environmental Policy Act (NEPA).

- Develop a continuous improvement process for climate adaption implementation planning using the "Plan Do Check Act" framework currently used in the Region's multi-site Environmental Management System (EMS).
- Build capacity internally through general education as well as targeted training to ensure that all employees are aware of climate change impacts on EPA programs and begin to integrate adaptation measures into their work.
- Participate in EPA regional and national workgroups as appropriate to assist the national program in revising EPA guidance and regulations and implement as appropriate.

Priority Actions, Goal 1: Taking Action on Climate Change and Improving Air Quality:

- Strengthen and form partnerships to increase outreach on indoor air quality, ultraviolent radiation exposure, and energy efficiency to respond to increased risks due to climate change impacts.
- Train additional staff to respond to indoor air quality calls/questions from the public due to the increased number of calls after extreme events and flooding.
- Build internal capacity to be able to incorporate climate change data into modeling and emissions analyses. Examples include 1) determining emission trends for sources associated with climate change impacts (frequent and more intense storms, more high temperature days), such as portable electric generators and peaking power plants, and 2) updating current datasets used for dispersion modeling to take into account human activities like sprawl and meteorological datasets (rainfall patterns, temperatures, etc).
- Strengthen partnerships to encourage ozone-tolerant urban tree planting, as well as, white and green roofs, to reduce pollution and the urban heat island.
- Work with other Regions and HQ air program managers to develop a strategy, in context to other programmatic priorities, on how to incorporate climate adaptation into air quality programs (e.g., SIP, permits).
- After discussions with HQ and Regions, incorporate climate change impacts into comments on permit applications, where appropriate.
- Consider integrated modeling approaches to incorporate new research on changes in air deposition to water bodies and land due to climate changes.
- Leverage existing climate and energy partnership programs, such as ENERGY STAR, Green Power Partnership, and Combined Heat and Power (CHP) Partnership to build adaptive capacity to address energy related vulnerabilities to climate impacts and extreme weather.

Priority Actions, Goal 2 Protecting America's Waters:

- Include climate change parameters in next Chesapeake Bay TMDL and associated implementation plans.

- Work with states and source water protection partners to raise awareness of climate change impacts and assist states and water protection partners in incorporating climate adaptation actions into source water assessments and protection plans.
- Promote awareness and encourage use of the Climate Ready Water Utilities Tools with an aim toward incorporating climate change impacts into resiliency planning by drinking water and wastewater utilities.
- Messaging to decision makers to encourage utilities to make sustainable investments, including improvements to prepare utilities for extreme weather events.
- Continue work in the Anacostia area of DC, Patapsco area of Baltimore and greater Philadelphia Area/lower Delaware River watershed through the Urban Waters Federal Partnership (UWFP) to assist with and leverage our partners' ongoing climate adaptation planning activities.
- Support Maryland Inland Bays and Delaware Coastal Bays as they incorporate climate change and adaptation into their amended Comprehensive Management Plans.
- Incorporate adaptation and resiliency principles into ongoing "greening" discussions with the U.S. Department of Transportation.
- Host climate change workshops for Region III water utilities to broaden the need for resiliency and awareness of available planning tools.
- Begin discussions with state water quality standards managers on possible climate change impacts on current and future water quality standards.
- Work with the EPA's Office of Water (OW) as a pilot region to develop a framework and inventory of relative wetland vulnerabilities, at multiple scales, based on integration of information on vulnerability assessment methods and wetlands classification systems. This framework will use relevant information from OW's CWA Section 404, HWI, and NWCA program efforts, and the results will be framed to inform on best approaches for development of further guidance for integrating climate change considerations into each of these program's practices.
- Work with the EPA's Office of Research and Development (ORD), along with regional state bioassessment scientists, to lay the foundation for a regional reference/climate change monitoring network in the Mid Atlantic, including a vulnerability analysis for streams.
- Work with the EPA's Office of Wetlands, Oceans, and Watersheds to include adaptation actions in the future work plans for our Wetlands permitting and enforcement programs.
- Continue efforts with the Partnership for the Delaware Estuary on climate change adaption planning by expanding upon the work of the climate change adaptation plan of 2010 developed through Climate Ready Estuaries Funding.

Priority Actions, Goal 3 Cleaning Up America's Communities & Advancing Sustainable Development:

- Educate staff to incorporate changing climate into decision making and long term planning (Removal & Remedial cleanups, RE-Powering America, Brownfields grants, Response Support Corps, Emergency Response, RCRA, Oil and Risk Management Program).

- Work with EPA's Office of Solid Waste and Emergency Response to develop a national strategy to ensure Oil and Risk Management Program facilities prepare for climate change and ensure that spill prevention and response strategies at facilities are sufficient for extreme events.
- Prepare to dedicate additional resources including funding and staffing for Emergency Response and Response Support Corps.
- Work with states to assess landfill capacity for surges in disposal of hazardous and municipal waste generated by extreme storm events.
- Identify RCRA Corrective Action, Superfund, Brownfields, LUST, Oil and Risk Management Program facilities, and other OSWER sites within 100 and 500 year FEMA flood plains; within the sea level rise zone 1.5 meters above high tide; and within NOAA "SLOSH" (Sea, Lake and Overland Surges from Hurricanes) model storm surge zones to assist in preparedness for extreme storm events.
- Identify sites within the region that have vulnerable ecosystems—coastal, stream, mountain ridge top habitats.
- Perform vulnerability analyses during site investigation, cleanup design, operations and maintenance, five year reviews, etc. Encourage states to consider doing the same for state-led states.
- Incorporate other OSWER adaptation implementation priorities, as applicable to Region III.
- Begin work to integrate climate adaptation into pertinent financial assurance mechanisms.

Priority Actions, Goal 4 Ensuring Safety of Chemicals & Preventing Pollution:

- Consider climate change in the administration of Pollution Prevention (P2) and associated sustainability initiatives. Assist the Region in identifying the most sustainable approaches for mitigating and adapting to climate change through emphasizing the lifecycle and risk reduction aspects of P2.
- Participate in EPA regional and national workgroups on such issues as appropriate to assist the national program in revising EPA guidance and regulations.
- Develop and deliver targeted training on Climate Adaptation to staff and managers working on EPA pesticide programs.
- Train staff and managers working on demolition, renovation, and disaster debris programs on climate adaptation and chemical risk issues.
- Incorporate other OSCPP adaptation implementation priorities, as applicable to Region III.
- Integrate climate adaptation into pertinent financial assistance mechanisms.

Priority Actions; Region III Managed Facilities and Operations:

- Determine if policy, guidance or email notification is warranted to those employees and contractors conducting field work during excessive heat warning or ozone action days.

- Determine the number of employees that are currently using flexiplace and can work from alternate locations.
- Determine the number of employees who lack the ability to use flexiplace due to resources or their job function.
- Determine if a COOP is needed for the Chesapeake Bay Program Office and Wheeling Office.
- Determine if special criteria should be developed for the Chesapeake Bay Program Office employees to warn them of the potential for office or localized flooding.

Chapter 3: Measurement and Evaluation

This section will describe how Region III will update the information and analysis in this implementation plan, evaluate the success of any activities undertaken, and continually improve the process of programmatic climate adaptation over time. Since one of the goals of the plan is to build adaptive capacity within EPA Region III programs the initial measurement and evaluation plan will focus on the capacity building elements of the plan, as well as, developing and refining the Region's approach to evaluation. This approach utilize along three pathways and use existing systems and workgroups whenever possible.

Adaptive Management through Continuous Improvement

The central task will be to create a Continuous Improvement Process, similar to the *Plan, Do, Check, Act* process used in our regional Environmental Management System, to adaptively manage the execution and management of the Implementation Plan. This process will seek to include a schedule for updates to the climate vulnerabilities, adaptation objectives, and activities in the plan, a set of measurable goals, a management review, and a method for sharing the results of the plan with our stakeholders.

Integration with Existing Regional Climate Strategy

The second pathway will be the integration of this implementation plan within the existing (internal) Region III Climate Change Strategy. In practical terms, this means the objectives and activities will be the same for both and all activity tracking and measurement will occur using the existing the workplan process developed for the Strategy. Oversight will be the responsibility of the Climate Change Senior Steering Committee and the cross-divisional Regional Climate Network Workgroup will work to implement the plan. The current workplan includes individual project management tracking and metrics for each activity. Currently, these metrics focus on the outputs of work. For example, we will track the number of training programs offered to regional staff and the number of participants. The workgroup responsible for this actions contained in this implementation plan will revise the plan annually.

One objective of future work for the planning process will be to identify metrics that measure outcomes. For example, a questionnaire was provided to regional employees to determine their level of understanding regarding climate change to determine appropriate training. We have used the information from the questionnaire to create a qualitative baseline to eventually measure the outcomes of our ongoing capacity building efforts.

Develop Tools for Evaluation and Engagement

The third pathway will be the creation or use of specific tools to help with the important task of evaluating progress, measuring the results of activities, and making changes and improvements as necessary. This toolbox will need to include improvements to vulnerability analyses in addition to tools focused on helping individual programs implement priority actions. Tools under consideration include: Developing Logic Models similar to those used by EPA's Office of Water, an Interactive Knowledge Base for mapping expected impacts and vulnerabilities, and the use of decision support tools developed by EPA national program offices.

Another key aspect of the plan will be a robust engagement process with key external stakeholders to both understand their approaches to measurement and evaluation and collaborate on the development of evaluation methodology and tools for our shared priorities. In addition, this engagement process will include targeted efforts to engage with representatives from vulnerable populations with the Region.

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