3. Assessment of Climate Change Adaptation Strategies

3.1 Pennsylvania Climate Change Initiatives

Under the commitments of the *Pennsylvania Climate Change Act* (Act 70 of 2008)[1], DEP in May 2021 released the *Pennsylvania Climate Impacts Assessment 2021*[2] that provided a review of scientific findings and relative risks to inform priority climate change adaptation needs.

In addition to environmental justice/equity considerations and continued research needs, the *Climate Impacts Assessment 2021* identified the following five priority considerations for climate adaptation:

- Reduce extreme heat risks to human health, particularly for vulnerable populations
- Support key sectors in the transition to a warmer climate, including agriculture, recreation, and tourism, as well as forests, ecosystems, and wildlife
- Reduce flood risks to infrastructure and communities
- Help low-income households cope with an increased energy burden
- Enhance tropical storm and landside risk mitigation

Examples of climate changes by mid-century[2]:

- Increases in average annual temperature
- More frequent intense extreme heat events
- Increased total average rainfall with less frequent, but higher intensity rainfall events
- Tidal influenced flooding in the Delaware Estuary coastal zone
- Significant changes in water level, coastal erosion, and water temperature in Lake Erie

These five priority considerations formed a basis for developing priority adaptation needs as outlined in the *Pennsylvania Climate Action Plan 2021*[3] (CAP 2021) released in September of that year. The CAP 2021 outlines strategic opportunities in reducing greenhouse gases, a principal cause of climate change, along with the strategic opportunities in adapting to the impacts of climate change.

[1] Pennsylvania Climate Change Act www.legis.state.pa.us/CFDOCS/LEGIS/LI/uconsCheck.cfm?txtType=HTM&yr=2008&sessInd=0&smthLwInd=0&act=0070.

[2] Pennsylvania Climate Impacts Assessment 2021 www.depgreenport.state.pa.us/elibrary/GetDocument?docId=3667348&DocName=PENNSYLVANIA CLIMATE IMPACTS ASSESSMENT 2021.PDF

[3] Pennsylvania Climate Action Plan 2021 www.depgreenport.state.pa.us/elibrary/GetDocument?docId=3925177&DocName=2021 PENNSYLVANIA CLIMATE ACTION PLAN.PDF

3.2 Implementing Climate Adaptation Strategies through State Water Plan Priority Action Recommendations

It is in the domain of adaptation where specific water resources-related recommendations developed in the State Water Plan Update align with the adaptation strategies from both the CAP 2021 as well as the *Pennsylvania Climate Action Plan 2018*[4] (CAP 2018). These recommendations provide opportunities to help achieve climate adaptation strategies through informed policy, planning, and program decision making under the State Water Plan.

The following sections help make the connection between the strategies within the CAP 2018 and CAP 2021 with the State Water Plan regional and statewide priority assessment through: 1) relational tables in Section 3.4 that correlate climate adaptation impacts, approaches, and strategies to specific recommendation topic sections previously described in Chapter 2; and 2) narratives in Section 3.4 for each of the regional water resources committees that describe the priorities reflecting each of their unique water resources needs and challenges.

[4] Pennsylvania Climate Action Plan 2018 www.depgreenport.state.pa.us/elibrary/GetDocument?docId=1454161&DocName=2018 PA CLIMATE ACTION PLAN.PDF

3.3 Cross-referencing of Climate Adaptation with Statewide Priority Actions

Table 3.1. 2018 Pennsylvania Climate Action Plan

Water Resource Opportunities to Adapt to Climate Change	Related State Water Plan Priority Action Recommendation Topics	State Water Plan Priority Actions Recommendations
Use Stormwater Best Management Practices	Floodplain and Stormwater Management	• DEP establish an information center/clearinghouse to provide education and training on related permitting, design, maintenance, reporting of stormwater infrastructure • Funding of regular updates and addenda to the *Pennsylvania Stormwater Best Management Practices Manual* • Continued maintenance and update to the Stormwater Management Model Ordinance
Promote Integrated Water Resources Management and Water Conservation	Integrated Water Resources Management	• DEP develop and evaluate a framework and incentives for integrated water resources planning and management • DEP implement trial integrated water resources plans • DEP provide services to assist county and local officials to prepare and implement integrated water resources management plans

Table 3.2. 2021 Pennsylvania Climate Action Plan

Adaptation Opportunities to Impacts of Climate Change			Related State Water Plan Priority Action Recommendation Topics	State Water Plan Priority Action Recommendations
Most Significant Impacts	Water Resource Related Approaches	Example Strategies		
Impacts of increasing heat and flooding on health – harmful algal blooms	• State revise policies to support health given projected increased heat and flood risks	• Review zoning codes, create system to reflect climate projection data	• Floodplain and stormwater management	• Flood control recommendations involving reviewing and updating hazard mitigation plans, investment in enhanced flood forecasting and warning systems, updating flood insurance maps and communications with property owners, and establishment of information centers/clearing houses for education and training for municipal decisions
Impacts of increased heat and flooding on overburdened and vulnerable populations	• Support vulnerable populations when integrating climate risks into key plans • Improve infrastructure in vulnerable communities to reduce impacts	• Plant trees • Increase flood mitigation grant funds and reduce application barriers	• Integrated water resources management • Floodplain and stormwater management	• Development and evaluation of integrated water resources planning that links local land use planning with water resources management • Increase efforts to enhance community recovery assistance following flood events

Adaptation Opportunities to Impacts of Climate Change			Related State Water Plan Priority Action Recommendation Topics	State Water Plan Priority Action Recommendations
Most Significant Impacts	Water Resource Related Approaches	Example Strategies		
Impacts of increasing average temperatures on forests, ecosystems, and wildlife	• Identify and manage human stressors • Maintain and enhance genetic diversity • Ecosystem restoration • Ecosystem or species conservation • Improve connectivity	• Develop and use ecological flow thresholds to manage water withdrawals so they do not increase thermal stress on sensitive species and habitats • Adopt regulations that provide streamflow levels necessary to ensure the resilience and ecological integrity of both warm-water and cold-water streams • Promote sustainable land use planning and development - Intelligent land use planning promotes practices that provide the critical elements for quality of life for residents as well as protects and restores naturally functioning ecosystems and agriculturally productive lands	• Integrated water resources management • Water withdrawal and use	• Establishment of integrated water resources planning and enhanced agency coordination to achieve consolidation of water resources management, watershed restoration, and water quality management programs • Improvement to the use of water use data in projecting future demand trends

Adaptation Opportunities to Impacts of Climate Change			Related State Water Plan Priority Action Recommendation Topics	State Water Plan Priority Action Recommendations
Most Significant Impacts	Water Resource Related Approaches	Example Strategies		
Impacts of a warmer and wetter climate on agriculture	• Expand regional planning and coordination • Education and outreach • Improve research and analysis • Provide decision support tools and technical assistance	• Promote sustainable land use planning and development - Intelligent land use planning promotes practices that provide the critical elements for quality of life for residents as well as protects and restores naturally functioning ecosystems and agriculturally productive lands • Establish an information clearinghouse for growers on water conservation technology	• Integrated water resources management • Water efficiency	• Development and evaluation of integrated water resources planning that links local land use planning with water resources management • Development of information and materials on water efficiency technologies and practices

Impacts of flooding on built infrastructure	• Harden, protect or relocate at-risk assets • Encourage utilities to assess vulnerable assets • Implement new or modified land use policies and practices • Education and outreach • Stakeholder engagement and collaboration • Improve preparedness and early warning systems • Encourage adoption of adaptive design and flood management practices • Provide decision support tools and funding opportunities	• Improve the accuracy and technological capabilities of flood forecasting, early-warning, and emergency-preparedness systems • Update flood insurance rate maps and other regulatory tools that rely on FEMA maps to reflect evolving risks from climate change • Work with local jurisdictions to incorporate consideration of climate change into ongoing land use planning efforts (e.g., growth management, development planning) • Upgrade or implement design improvements for flood-control structures (e.g., levees, flood walls) that protect existing critical infrastructure • Require maps of areas vulnerable to future flooding in applications for new development • Preserve open space in flood hazard areas and channel migration zones	• Integrated water resources management • Sustainability of Pennsylvania drinking water and wastewater infrastructure • Stormwater and floodplain management • Water withdrawal and use	• Improvement to inter- and intra-agency coordination related to integrated water use planning to assure consistent planning, operations, and application of regulations and policies • Development and implementation of asset management plans for water and wastewater systems • Investment in enhanced flood forecast and warning systems • Updating of floodplain and flood insurance rate maps • Increase efforts to protect Pennsylvania floodplains • Increase efforts to enhance recovery assistance following flood events • Inclusion of floodplain management and floodplain regulations into local integrated water resource planning • Establishment of floodplain studies outside of detailed FEMA study areas • All community water systems (as well as self-supplied users) should evaluate the vulnerabilities of their respective sources to the impacts from expected increases in both the frequency and

Adaptation Opportunities to Impacts of Climate Change			Related State Water Plan Priority Action Recommendation Topics	State Water Plan Priority Action Recommendations
Most Significant Impacts	Water Resource Related Approaches	Example Strategies		
				intensity of flooding and droughts. • Establish technical design guidance for new encroachments and obstructions

3.4 Climate Change Adaptation Considerations within Regional Priority Assessments

3.4.1 Delaware River Region Climate Change Adaptation Considerations

The Delaware River regional committee assembled a series of priorities based on the unique needs and challenges which climate change presents for their region. With large population centers like Philadelphia and others in the region, there is increased risk from stormwater issues brought on by increased impervious surfaces in areas experiencing population growth and expanding development. The exacerbation of flooding problems by intensifying rain events brought on by climate change led the committee to focus on municipal infrastructure management and land development practices to adapt to these evolving conditions. The increased runoff from these events could also have a negative impact on water quality in the region, which will require further investigation. With temperatures on the rise, invasive species may also become more prevalent and disrupt the ecosystems of the region.

The committee advocates for leveraging the Delaware River Basin Commission's Advisory Committee on Climate Change, where possible, to assist with the research challenges of grasping this broad problem as well as creating needed tools. This emphasis on research and tool crafting leans into the creation and updating of scenarios and models that will give decision makers a clearer vision of their changing environment.

Even though it is predicted there will be increased annual precipitation, it's anticipated that this will mostly manifest in more frequent intense short-duration storm events. The spacing between those storms may still be long enough that periods of drought are possible. Additionally, healthy aquifers and soils are best served by consistent rain rather than isolated intense storm events. Therefore, the committee desires to increase awareness of a potentially lowered water table that may damage soils in the region.

Finally, the Delaware Estuary's port infrastructure and drinking water sources present a unique challenge for the region. Saltwater intrusion is a concern for drinking water sources and the region could face potential problems if critical infrastructure is not adapted to climate change.

The region has several water resource challenges to meet in the coming years which can be mitigated by consolidating research, ensuring broad access to needed data, and adopting a holistic approach to climate change adaptation.

3.4.2 Great Lakes Region Climate Change Adaptation Considerations

Given the unique nature of the Great Lakes region's hydrologic complexity, relatively large economy given its land area, and vast number of potential stakeholders, the Great Lakes regional committee had a challenging task in establishing priorities and recommendations for climate change adaptation. The first consideration was the many hands that would be involved in implementing potential policies. The committee recognizes that there are multiple state and provincial governments as well as municipalities with some jurisdiction over the Great Lakes. It's essential that the Commonwealth continue to play a role in interstate efforts to identify regional climate stressors and plan for economic and environmental resiliency efforts.

Due to its natural beauty and abundant fresh water, the Lake Erie coastline has also proven to be an attractive proposition to many industrial and commercial businesses (including a large tourism and recreation industry), as well as the many residents who call it home. The lake's surface elevation naturally fluctuates over time, but the changing climate has led to shorter intervals on these changes. The committee sees this as an opportunity to consider the potential impacts of these changes on bluff and beach erosion, industries, and coastal residences.

Present indicators show that climate change is increasing storm intensity, which poses an increased flooding risk. Climate change presents an opportunity to develop more robust resiliency strategies within the region's municipalities. This can include broader consideration of flash flooding as well as stormwater management. These local strategies should be developed with a regional strategy in mind as they consider their increasing vulnerability to these intense storm events.

While more intense storms are anticipated, the time intervals between these events are likely to increase. This means that there could be increased risk of both flood and drought, particularly where groundwater recharge is concerned. Though the coastal regions of the watershed have a large fresh drinking water supply in the form of Lake Erie, the Genesee River watershed in Potter County makes use of private wells. Water supply vulnerability in regions that are more reliant on groundwater should be considered a high priority as these impacts of climate change take effect.

3.4.3 Lower Susquehanna River Region Climate Change Adaptation Considerations

The Lower Susquehanna River regional committee crafted recommendations that would account for the unique impacts that climate change would have on their region. One of the primary concerns of the committee was the increased number of intense storms passing through the region. Due to population growth and the presence of major highways intersecting in the region, which have given rise to many logistics centers and other developments, the committee initially focused on flooding and stormwater management. The committee favored an approach which highlights floodplain restoration while considering obstructions and encroachments such as buildings, legacy sediment, undersized bridges, or culverts. Additionally, the committee recommended the development of floodplain management ordinances to keep these floodplains clear and encouraging the enhancement of structural and nonstructural strategies to reduce environmental impacts. These are long-term changes that will require a system of incentives to promote a more proactive approach to climate change that favors planning and adaptation.

While flooding and stormwater are the obvious concerns stemming from intense rain events, there are other impacts that should be considered. With large run-of-the-river dams and reservoir drinking water sources, harmful algal blooms (HABs) may be exacerbated by increasing temperatures, creating conditions that are favorable to HAB growth. Storms not only flood developed areas, but can also wash debris and pollutants into streams. Engaging stakeholders on the implications of intense rain events, their impacts on soil, and HABs is critical to establishing robust strategies with broad public support.

Despite predictions that annual precipitation will increase with intense short-duration storm events, increased time intervals between these storm events can potentially lead to droughts in the region. This could present some difficulty for the many manufacturers that are active in the region who need a lot of water to function. Therefore, the committee recommended proactive drought management for reservoir systems to facilitate protection and conservation of water resources.

All the above solutions will require continued cooperation and coordination amongst agencies at many levels to help effectively leverage resources to reduce these impacts of climate change.

3.4.4 Ohio River Region Climate Change Adaptation Considerations

The Ohio River region has a high municipal density with an inland port in Pittsburgh and receives water from southern New York and West Virginia before contributing to the broader downstream network that comprises the enormous Ohio River basin. The Ohio River regional committee sought to address climate change using a number a of strategies which focused on increased storm intensity and a concern for more frequent flash flooding. Floodplains are critical to containing and controlling floods, therefore the committee recommended the maintenance and use of riparian buffers, especially surrounding headwaters.

Despite increased instances of high-intensity storms, the time intervals between these storms could increase, leading to longer dry stretches and potential drought. This can pose a problem for replenishing aquifers, as intense storms tend to lead to more runoff than infiltration. The committee therefore recommended that, where possible, rain barrels and swales can be utilized to capture the runoff from intense storms, mitigating stormwater runoff and allowing for more infiltration. Additionally, municipalities should consider water supply vulnerability, availability, and reliability going forward despite the overall increased annual precipitation.

The United States Army Corps of Engineers owns and operates locks and dams within the region, and with continued proper maintenance, may help toward the region's overall climate resilience. These adaptive measures will help to ensure that the Ohio River region continues to be well supported and resilient in the face of a changing climate.

3.4.5 Potomac River Region Climate Change Adaptation Considerations

The Potomac River region represents a headwater for the watershed, making interstate coordination vital. The region also has diverse topography and population densities with urban sprawl from Baltimore and Washington, D.C., farmland, and mountainous regions. This broad spectrum of natural and anthropogenic characteristics across the region compounds the challenge for the Potomac River regional committee to develop priorities for climate change adaptation.

Because of the region's uniqueness, the committee recommended a focus on local data collection such as using the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS)[5] and on-site assessment where possible, rather than relying exclusively on global data trends. In addition to these data tools, the committee recommends that stakeholders explore ways to communicate climate change that won't alienate potential allies. These methods should bring a diverse array of stakeholders to the table to help promote an adaptive approach to climate resiliency.

Climate change will likely continue to impact the region with increased frequency of intense storm events. Since local geology and topography make groundwater recharge challenging, there is a greater risk of drought if the region experiences longer time intervals between storm events. The committee recommends riparian buffers and conveyance structures to help reduce the effects of flooding and promote groundwater recharge. Additionally, since much of the region is mountainous, the committee

[5] Community Collaborative Rain, Hail and Snow Network
www.cocorahs.org

saw a need to draw attention to the risks of flash flooding and preparing for intense storm events. The dual problems of both flooding and drought represent a broad, far-reaching suite of challenges that will require a holistic solution. Therefore, the committee recommends an integrated water resource planning approach to help coordinate these efforts throughout the region.

These various strategies will contribute to a better prepared Potomac River watershed that can adapt to the diverse challenges presented by climate change.

3.4.6 Upper-Middle Susquehanna River Region Climate Adaptation Considerations

The Upper-Middle Susquehanna River region is densely forested and has large variations in both its topography and many rural communities. The Upper-Middle Susquehanna River regional committee's efforts on climate change adaptation focused on the major trends that are taking root in Pennsylvania, namely, more intense storms with larger time intervals between events, as well as seeking buy-in from the region's residents. Densely forested regions perform well at recharging ground water supplies, but intense rain events are less beneficial for infiltration and create more runoff. The committee chose to highlight water supply vulnerability, especially in smaller communities that rely on groundwater sources.

Due to the regional variance, the committee believes an in-depth study of climate change implications on water supply, vulnerability, availability, and reliability would be beneficial. There are some areas within the region that have steep topography, which means that flash flooding may become a central issue for communities located in those areas.

Stakeholder buy-in is a key issue in this region as well as funding and a long-term flexible outlook that allows for incremental steps, especially where tight budgets are a concern. Education and outreach are critical components of this effort, where adaptation strategies are promoted to boost a community's resiliency, and where scientific data is used to help guide climate adaptation discussions. Co-benefits, such as a healthier ecosystem, should be emphasized to help persuade stakeholders to take part in adaptation efforts.

The combined work of adapting to trends that are already understood, analyzing the problem from a regional perspective, and pursuing stakeholder buy-in are essential strategies toward a well-adapted Upper-Middle Susquehanna River region.