Climate Change Vulnerability Study and Resilience Plan Update

Public Service Law (PSL) § 66(29) – PSC Case 22-E-022

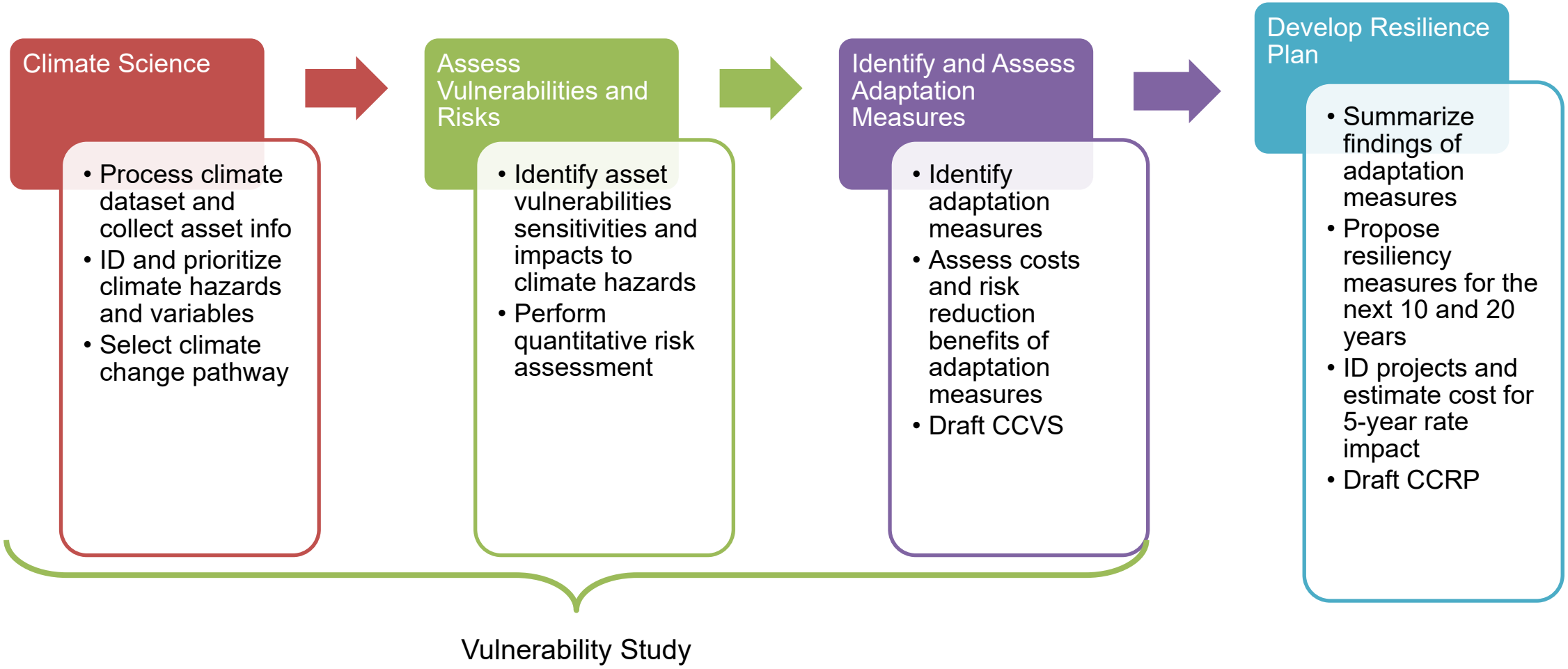
O&R Climate Resilience Working Group
March 29, 2023

DRAFT for working group discussion purposes only

AGENDA

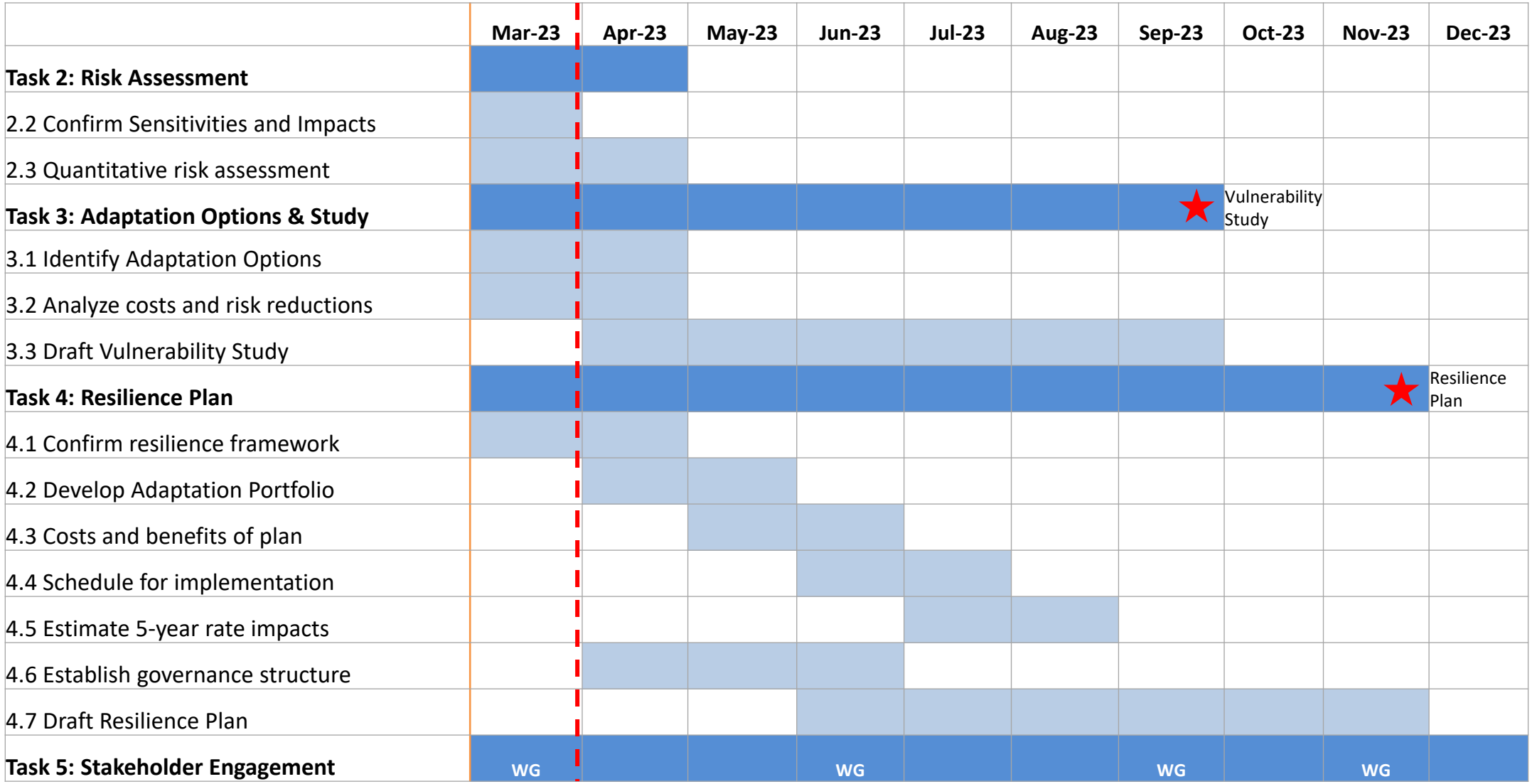
- Climate Change Vulnerability Study (“CCVS”) Update
- Climate Pathway Selection
- Vulnerability Assessment
- Climate Hazard Qualitative Findings
- Next Steps

Orange & Rockland CCVS & CCRP Process Flow



DRAFT for working group discussion purposes only

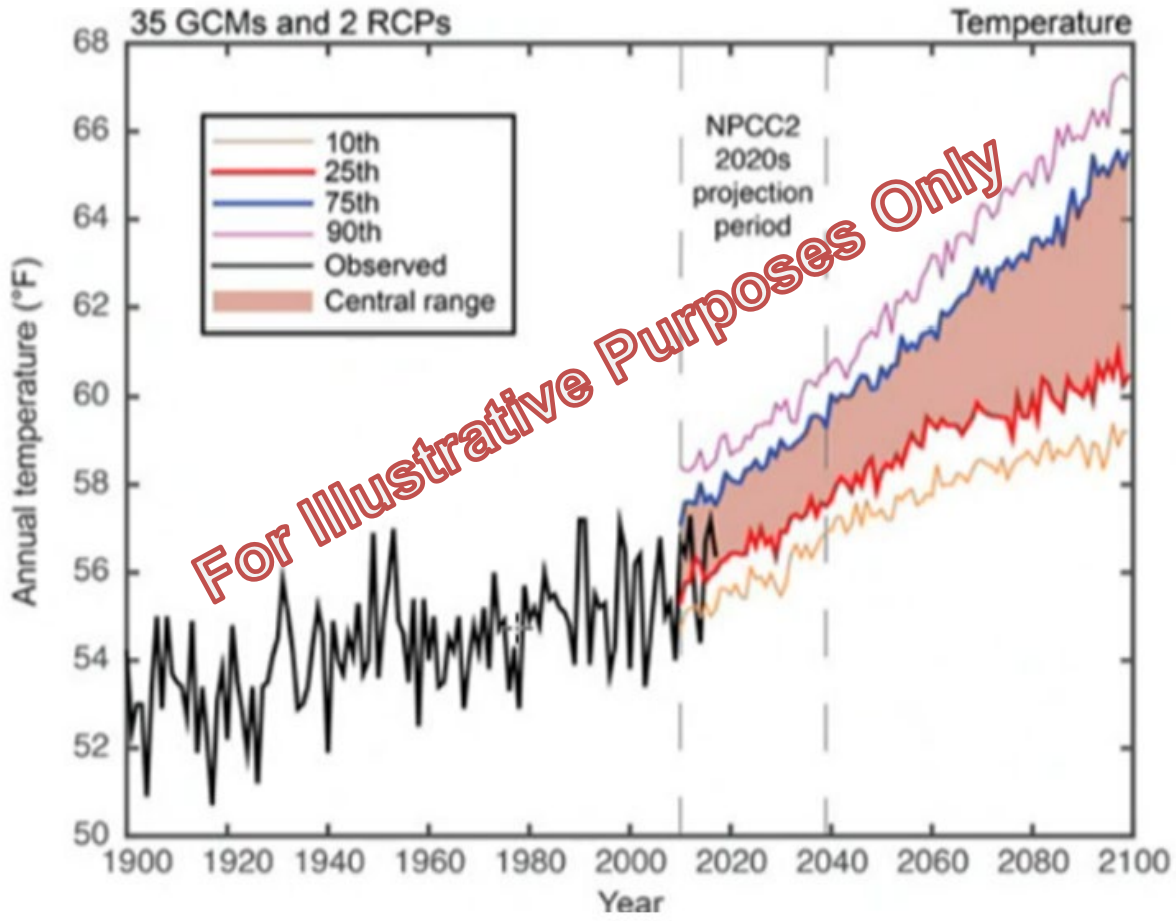
Timeline of Execution



DRAFT for working group discussion purposes only

Climate Change Pathways

- Climate change pathways provide guidance on the level of potential climate change in the service area and benchmark values for design parameters to plan to and make O&R's system more resilient to potential climate change risks.



Comparison of Sample Climate Change Projections to Historical Baseline

Mohonk Weather Station Data

Climate Variables	Current 30-year historical average	2050 Projection*	2080 Projection*
Days per year over 95°F	1	13	43.5
Heat waves per year (3-days max temp over 90°F)	0	0.2	1.8
Days over 2 inches precipitation	3.1	4.5	5.5

*Projection figures are based on SSP5-8.5 75th Percentile Climate Change Pathway

- Are there any climate variables of interest to you?

Climate Change Pathway Recommendation

- Are you comfortable with the selection of the 75th percentile pathway?
- Does this pathway align with other organizations you have interacted with?

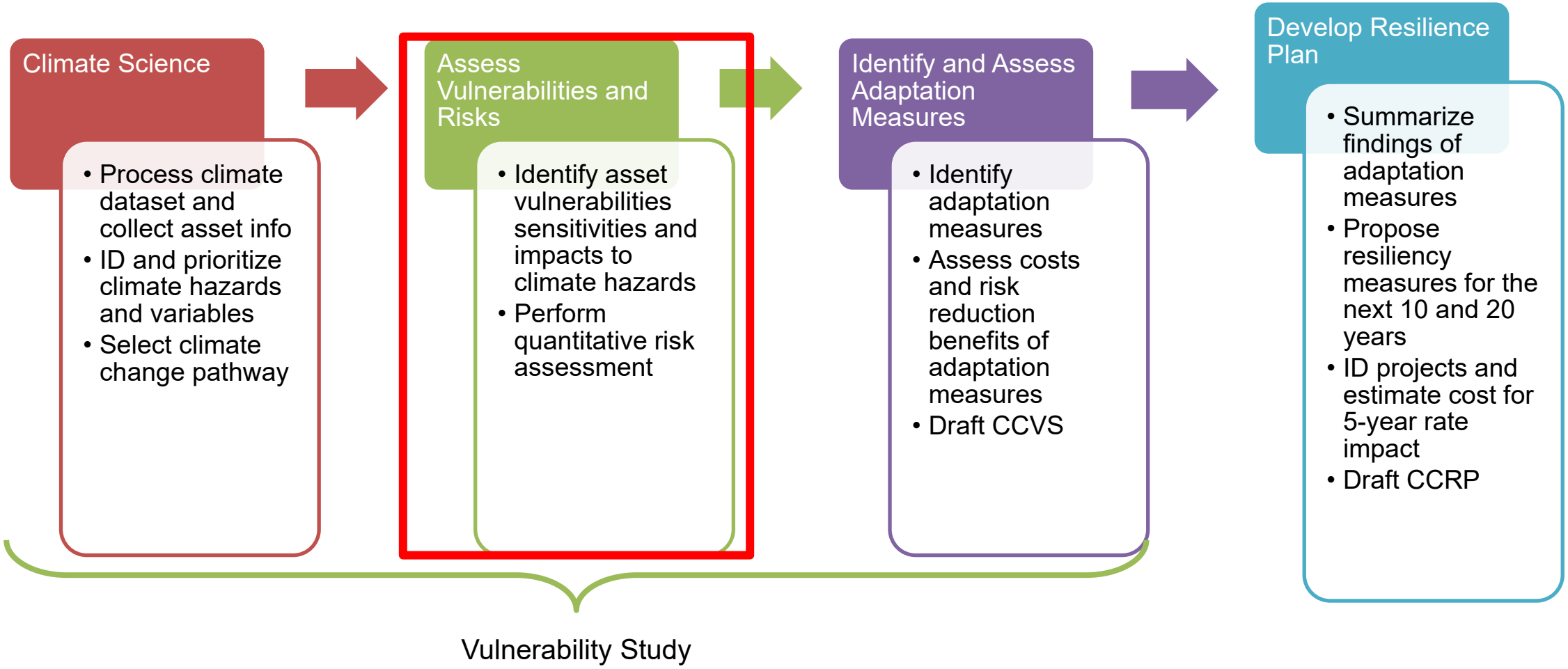
O&R Proposed Pathway Recommendation

- 75th percentile of SSP 5-8.5 projections for temperature, precipitation, and related variables.
- 50th percentile of combined SSP2-4.5 and SSP5-8.5 projections for sea level rise (may impact Hudson River assets).

Factors in Climate Change Pathway Recommendation

- The 50th and 75th percentiles of SSP5-8.5 remain in a narrow range through end of the century and do not show significant increases over baseline until after mid-century for the O&R service territory
- Peer utilities overall plan to use the “high-impact” than “low-impact” future climate outcome to de-risk assets and operations
- Proactively harden the system to increases in the frequency and intensity of extreme weather events and climate change

Orange & Rockland CCVS & CCRP Process Flow



DRAFT for working group discussion purposes only

Assess Vulnerabilities and Risks

Vulnerability Assessment
(Identified Assets at Risk)

Quantitative risk assessment for CCVS

Compile GIS Shapefiles (i.e., primaries, poles, transformers) and physical location data (i.e., substations, battery storage sites, office locations)

Creation of flood depth using updated digital elevation data and overlay can be imported into mapping software and used to overlay with O&R assets

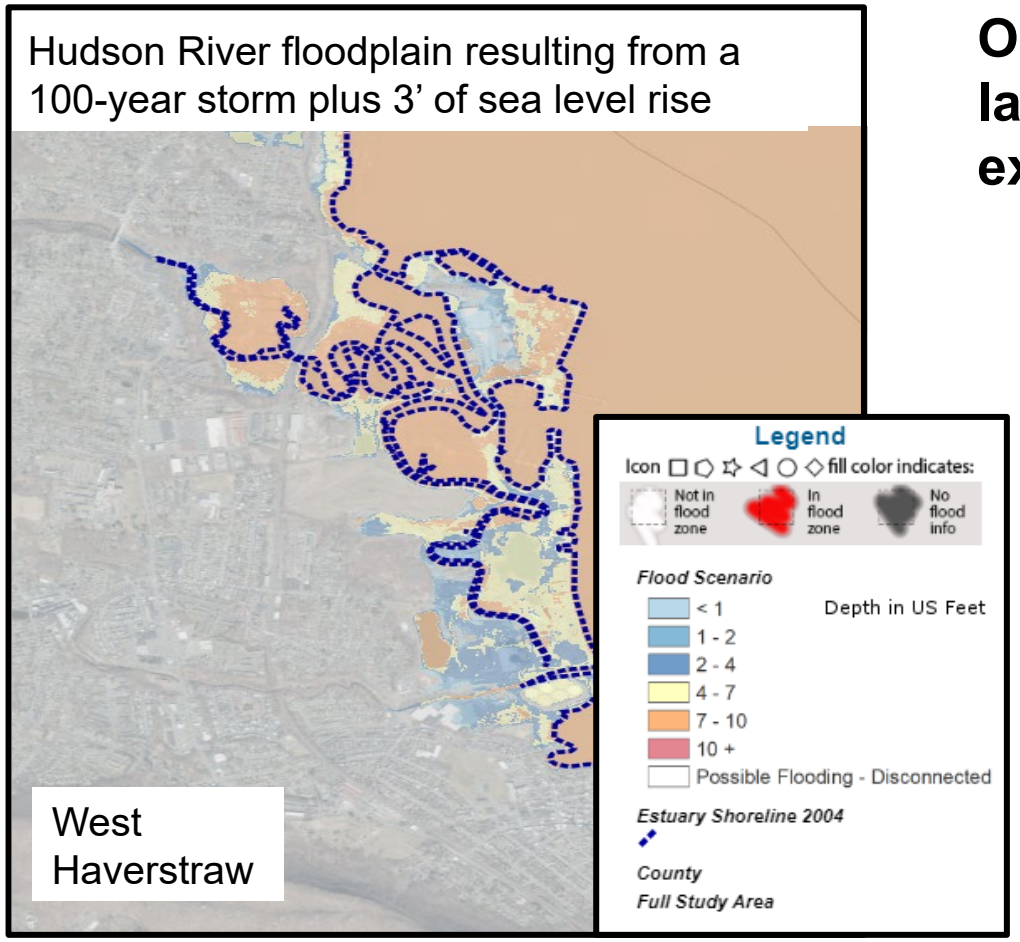
Screen for assets inundated and depth sampling of these assets for the 100-year storm (inland flooding)

Screen for assets inundated along the Hudson as a product of sea level rise and coastal storms, and depth sampling of these assets for the 100-year storm (coastal flooding)

DRAFT for working group discussion purposes only

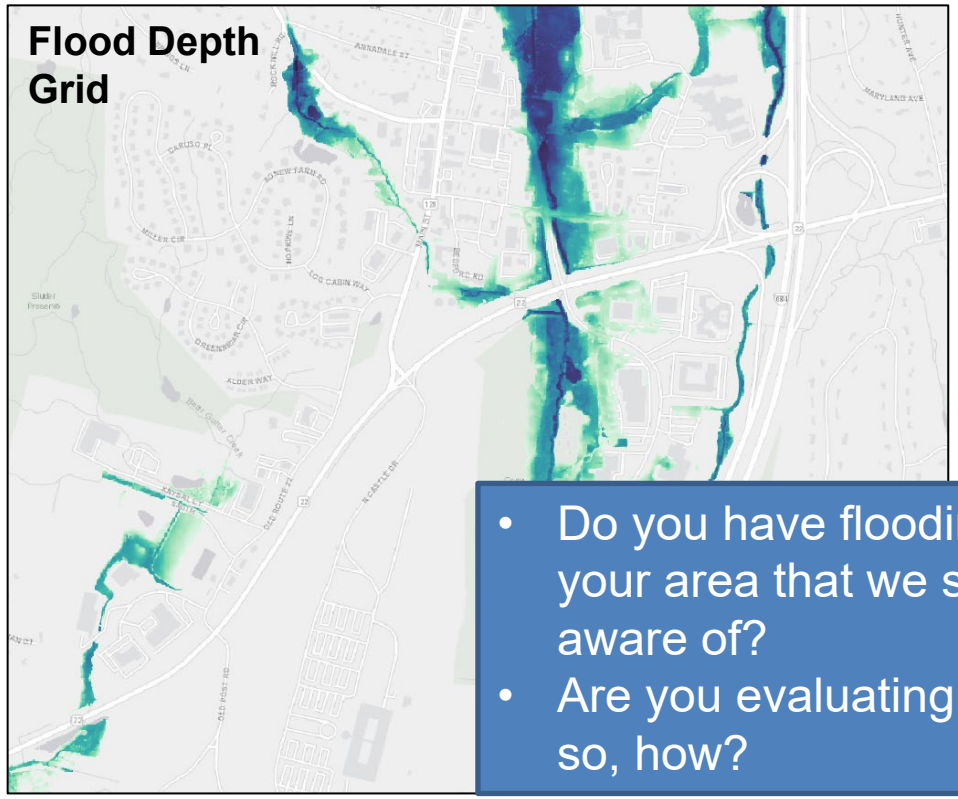
Flood Exposure Assessment

Hudson River floodplain resulting from a 100-year storm plus 3' of sea level rise



[Hudson River Flood Impact Decision Support System Version 2 (columbia.edu)]

O&R will use GIS-enabled flood depth and extent layers in combination with asset data to evaluate utility exposure to sea level rise and Hudson River flooding.



- Do you have flooding concerns in your area that we should be aware of?
- Are you evaluating flood risk? If so, how?

Climate Hazards

Heat		Temperature and humidity*	Flooding		Wind		Ice
Gradual	Extreme	Gradual	Gradual	Extreme	Gradual	Extreme	Extreme
Increasing maximum summer temperatures	Increasing frequency of 3-day heatwaves	Increasing maximum summer electric load	Projected sea level rise	Expansion of coastal and inland floodplains (100-year)	Increasing average wind speeds	Increasing likelihood of hurricane with CAT 2 wind speeds	Increasing accumulation from major winter storm events
Increasing number of high heat days		Increasing number of days per summer with high electric load	Increasing number of days per year with >2 in. of precipitation				
Increasing average summer temperatures							

- Are there any other hazards that are of interest to you?

*Temperature and humidity are evaluated in terms of their combined effect on Temperature Variable (TV), which is an engineering variable that is an indicator of load demand for cooling in the summer.

Qualitative Analysis of Hazards

Climate Hazard	Frequency	Intensity	Summary of Findings from Literature Review
Hurricanes and Tropical Cyclones	Unchanged	Increase	• Warmer air and ocean surface temperatures could result in increased frequency of stronger hurricanes further north • Future hurricanes projected to have higher maximum sustained winds and larger radius of hurricane force wind speeds
Lightning and Tornadoes	Potentially Increase	Potentially Increase	• Atmospheric conditions that facilitate thunderstorms could increase in frequency and intensity • Anticipated increases in temperature and atmospheric water vapor may increase precipitation rates during thunderstorms
Snow and Ice*	Decrease	Increase	• Shorter snow season could result in reduced snow cover and depth and fewer snow events in the future, however the largest snowfall events could produce higher snowfall totals • Warming temperatures could lead to increased freezing rain frequency and accumulation rather than snowfall

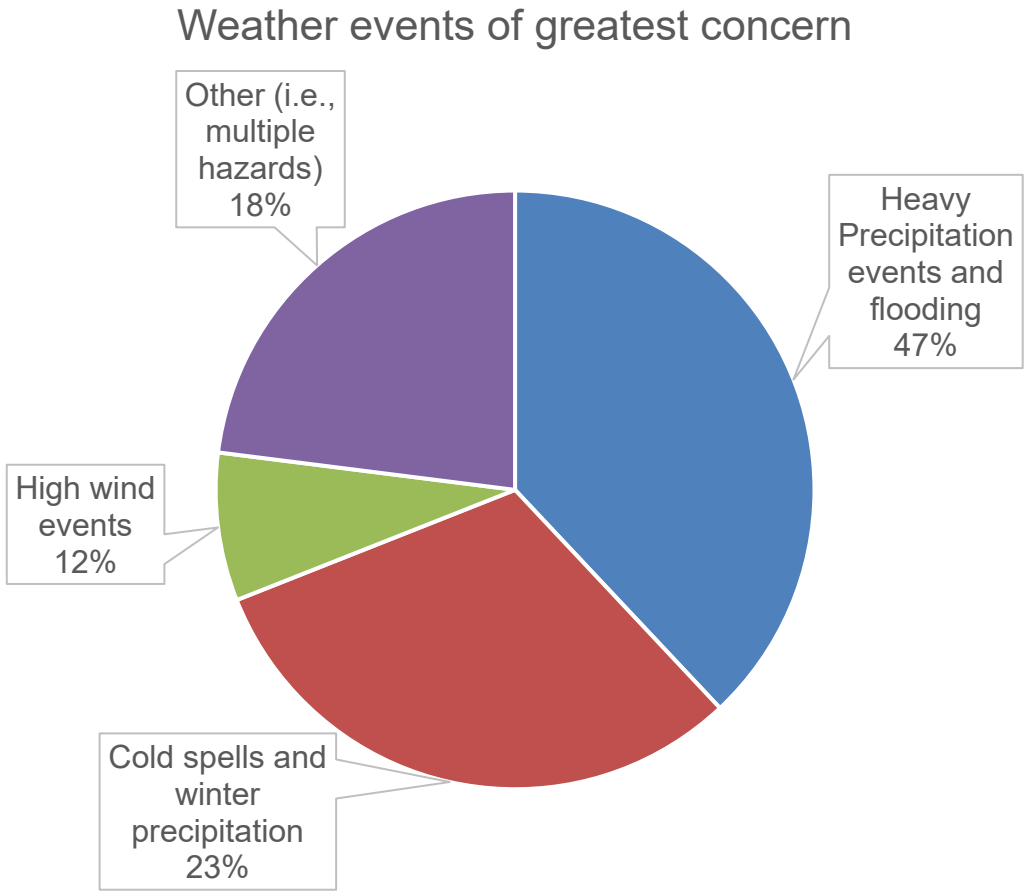
*Review of MIT dataset for potential additional quantitative findings on frozen precipitation variables.

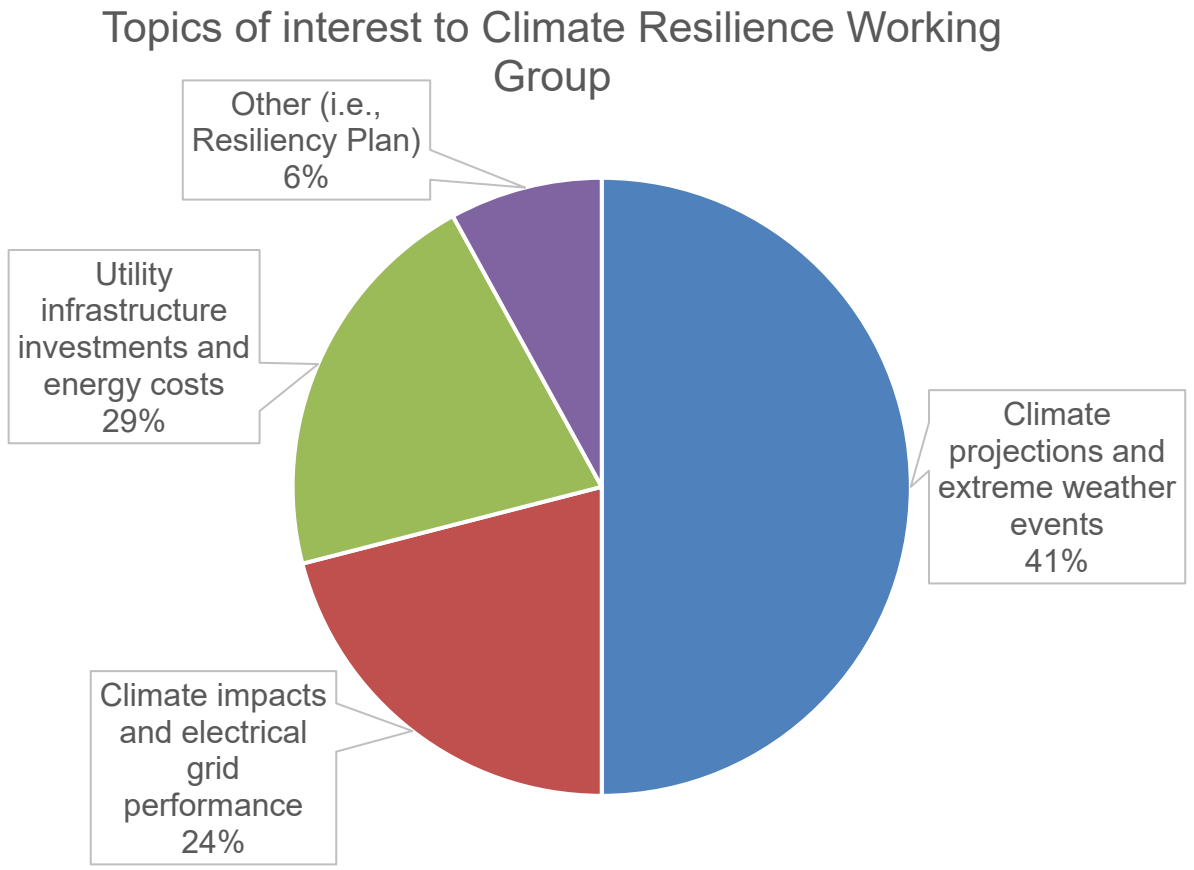
Qualitative Analysis of Hazards

Climate Hazard	Frequency	Intensity	Summary of Findings from Literature Review
Cold Snaps and Polar Vortex	Decrease	Potentially Increase	• While winter temperatures are projected to warm, complex processes amplified by climate change, such as Arctic amplification, could worsen some cold snaps and polar vortex events
Drought	Increase	Increase	• Warmer temperatures are projected to produce overall drier conditions, resulting in increased frequency and intensity of major droughts • While drought intensity and frequency are projected to increase in the region, drying in New York is likely lower in magnitude than more arid regions of the Country
Wildfire	Increase	Increase	• Warmer temperatures, decreases in fuel moisture, and increases in occurrence of lightning strikes could increase wildfires • Like drought, less impact from wildfires than more arid regions of the Country

Survey Feedback*

- Are you planning for climate adaptation?
- What actions have you taken to address climate hazards?





*Based on 20 responses. Link to survey: https://qfreeaccountssjc1.az1.qualtrics.com/jfe/form/SV_3WuBMqI5ueWt70y

Next Steps

- We are working with ICF to identify insights available within the MIT data
- Continued engagement with engineering on risk assessment of asset classes to climate hazards
- Next O&R Climate Resilience Working Group Meeting expected in June 2023
  - Review identified asset/climate hazard risk combinations
  - Share initial list of potential adaptation options
  - Discuss CCVS and Resilience Plan outlines

Orange & Rockland

Link to Website: Our Climate Change Resiliency Plan | Orange & Rockland (oru.com)

Questions or comments may be sent to: ResilientGrid@oru.com

Climate Change Vulnerability Study and Resilience Plan Update

Public Service Law (PSL) § 66(29) – PSC Case 22-E-0222

O&R Climate Resilience Working Group
June 22, 2023

DRAFT for working group discussion purposes only

AGENDA

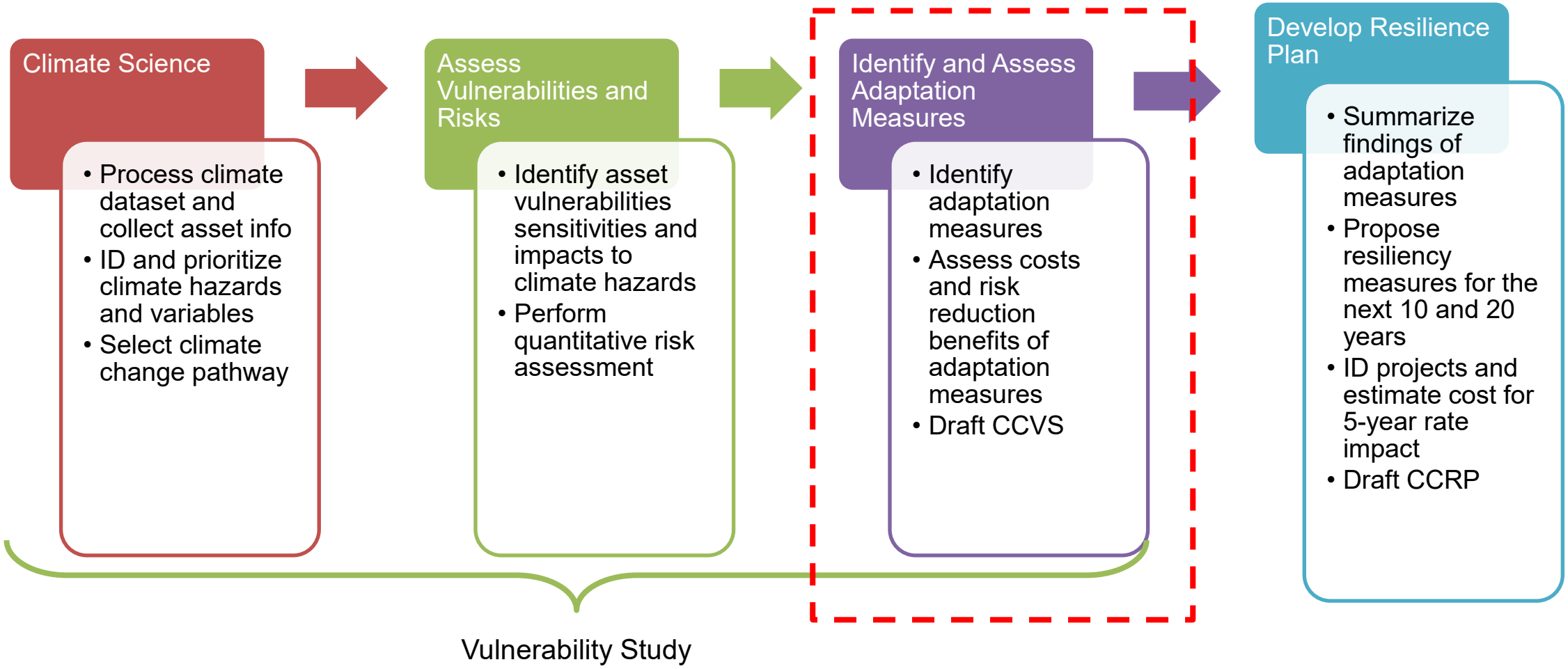
- Progress Update
- Vulnerability Assessment Results
- Potential Adaptation Options
- Climate Change Vulnerability Study Preview
- Climate Change Resilience Plan Outline
- Next Steps

Timeline of Execution

	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Task 3: Adaptation Options & Study							
3.1 Identify Adaptation Options							
3.2 Analyze costs and risk reductions							
3.3 Draft Vulnerability Study				★	Vulnerability Study Filing		
Task 4: Resilience Plan							
4.1 Confirm resilience framework							
4.2 Develop Adaptation Portfolio							
4.3 Costs and benefits of plan							
4.4 Schedule for implementation							
4.5 Estimate 5-year rate impacts							
4.6 Establish governance structure							
4.7 Draft Resilience Plan						★	Resilience Plan Filing
Task 5: Stakeholder Engagement	WG		WG		WG		

DRAFT for working group discussion purposes only

Orange & Rockland CCVS & CCRP Process Flow



DRAFT for working group discussion purposes only

Climate Hazards

Heat		Temperature & Humidity*	Flooding		Wind & Ice	
Gradual	Extreme	Gradual	Gradual	Extreme	Gradual	Extreme
Increasing maximum summer temperatures	Increasing frequency of 3-day heatwaves	Increasing maximum summer electric load	Projected sea level rise	Expansion of coastal and inland floodplains (100-year)	Increasing average wind speeds	Increasing likelihood of hurricane with CAT 2+ wind speeds
Increasing number of high heat days		Increasing number of days per summer with high electric load	Increasing number of days per year with >2 in. of precipitation			Increasing accumulation from major winter storm events
Increasing average summer temperatures						

*Temperature and humidity are evaluated in terms of their combined effect on Temperature Variable (TV), which is an engineering variable that is an indicator of load demand for cooling in the summer.

MIT Dataset Key Takeaways

- **What is it?** Dynamically-downscaled climate projections for the Northeast U.S., with gridded 3km, hourly data to derive tailored projections.
- Created using regional climate modeling that allows for severe weather, such as thunderstorms.
- MIT projections do not resolve all storm event types, such as tropical cyclones, and may not be fully calibrated for all extreme variables (e.g., deluge precipitation).
- **MIT provides a snapshot of climate change in the near-future to help us understand potential risks but does not derive a probabilistic range of outcomes that could be used to revise design standards.**

Columbia/NYSERDA	MIT
Ensemble of 14-16 Global Climate Models	One Global Climate Model
SSP2-4.5 and SSP5-8.5	RCP 8.5
2030s-2080s time horizons	One near-term time horizon (2025-2041)
30 years of data for each time horizon	17 years of data for one future time horizon
Daily time resolution	Hourly time resolution

Wind Speeds Examples

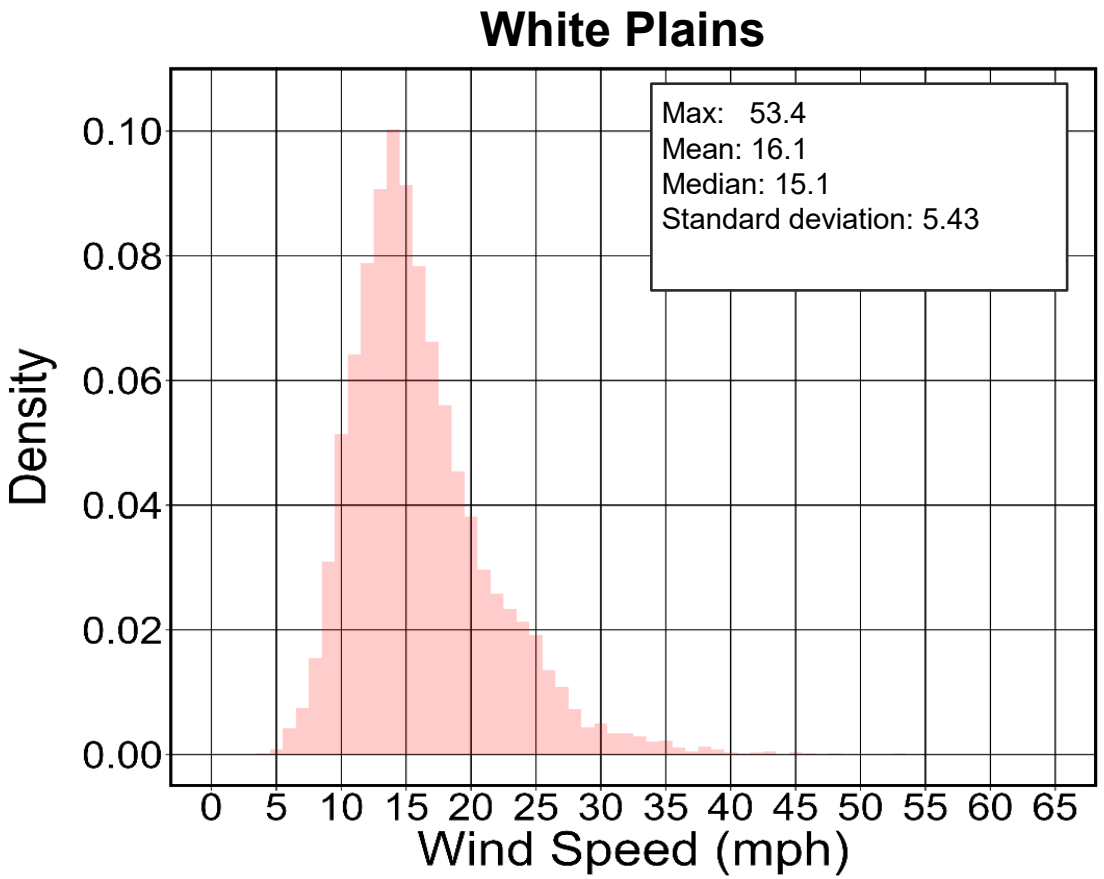


Figure. Histogram of the daily maximum 1-minute wind speeds at White Plains (the closest applicable station for this data set).

- The distribution is right tailed, meaning there is a large range of higher wind speeds at White Plains in MIT dataset.
- The most common winds are between 11 and 17 mph, peaking at 53.4 mph.
- Limitation: There is no baseline data due to different time-scales between model projections and historical actuals.

Radial Icing Examples

- High interannual variability in annual radial icing, with potential for significant icing on occasion.

- Limitation: There is no baseline data.

Annual Radial Icing Projections at White Plains		
Year	Total Annual Radial Icing (in.)	Number of Hours with Radial Ice Accumulation
2025	0.21	29
2026	0.05	7
2027	0.08	3
2028	0.07	11
2029	0.08	5
2030	0.76*	28*
2031	0.00	0
2032	0.06	3
2033	0.05	13
2034	0.04	3
2035	0.00	0
2036	0.17	6
2037	0.59	27
2038	0.11	10
2039	0.13	14
2040	0.96*	58*
2041	0.48	18

*Red values highlight the two highest years

Vulnerability Assessment Results

- Are there any specific vulnerabilities that concern you the most?

Vulnerability assessment results based on sensitivity and exposure of asset classes to climate hazards and is based on SME scoring input and climate projections for the O&R service territory.

	Temperature (Heat)		Temperature & Humidity	Flooding/Sea Level Rise		Wind & Ice	
	Gradual	Extreme	Gradual	Gradual	Extreme	Gradual	Extreme
Substations							
Overhead Transmission							
Overhead Distribution							
Underground T&D							
Critical Facilities							

High vulnerability
Medium vulnerability
Low vulnerability

DRAFT for working group discussion purposes only

Identified Climate Resilience and Potenti

- What adaptation options are you considering in your community?

Assessment of highly vulnerable asset/climate hazard risk led to identification of potential adaptation options to address climate hazards

Climate Variable	Temperature & Humidity (Heat)	Flooding/Sea Level Rise	Wind & Ice (Major Storms)
Potential Impact	• Equipment degradation and derating limiting system capacity during times of peak demand	• Disabling of equipment, access restrictions, and circuit failures	• Failure of overhead lines and structures resulting in system outages
Potential Adaptation Options	• Run peak load forecasts for multiple climate change scenarios • Review of transformer design standard • Acceleration of projects (i.e., substation, transformer replacement)	• Install temporary flood barriers • Install walls around substation equipment • Elevate control house • Raise site grade elevation • Replacement of substations in flood prone areas • Expand shoreline protection and erosion monitoring programs	• Additional selective undergrounding • Reinforce/replace poles and towers • Additional Smart Grid/Distribution Automation • Reinforced tree-resistant overhead cable • Review wind design standards • Additional weather station monitoring

Operational Vulnerabilities

Multiple O&R departments provided input to determine what processes/operations may be impacted by climate change. This table shows some key considerations and possible actions to address climate change.

	Key Considerations	Possible Actions
Worker Health & Safety	Hotter temperatures and extreme events pose a risk to staff who work in the field.	Revise protocols for working in high heat.
Emergency Response	More frequent extreme events will require more frequent activation of emergency response protocols.	Increase trainings, drill exercises and additional resources.
Design Standards	Changing temperature and wind patterns may mean design standards no longer account for projected climate conditions.	Update design guidelines using new climate data.
Load Forecasting	Higher temperature variable will lead to more demand on the system. Combined potential lower equipment capacity from higher operating temperatures, this could cause capacity issues.	Update load forecasting calculations and system planning to account for higher temperature variable and operating temperature.
Vegetation Management	Hotter temperatures and more precipitation will cause vegetation to grow faster, possibly infringing on O&R overhead lines.	Monitor for outage impacts, evaluate vegetation management cycles if necessary.

Climate Change Vulnerability Study

- Are there any other topics that you feel should be included?

Section	Contents
Executive Summary	Key Takeaways
Introduction	• Background • Broad baseline assumptions • Summary of priority vulnerabilities • Importance of equity
Historical Climate Data and Future Projections	• Methods • Results and Output
Vulnerability Assessment	• Methods • Identified Vulnerabilities • Anticipated future conditions
Potential Adaptation Measures	• High-level categories for consideration in Resilience Plan
Conclusion and Next Steps	• Knowledge gaps and anticipated needs • Consideration of equity moving forward

Climate Change Resilience Plan ("CCRI

- Are there any other topics that you feel should be included?

- Executive Summary
- Introduction and Background
- Summary of potential adaptation measures from the Study
- Potential Consequences
- Engagement of the Climate Resilience Working Group
- Multi-pronged Resilience Strategy and Approach
- Consideration of Equity
- Investment Plan
- Governance
- Performance Measures
- Conclusion and Next Steps

Next Steps

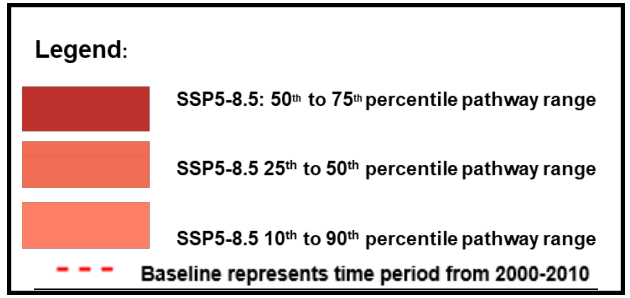
- Develop draft 10- and 20-year resilience plans with additional details for the first 5 years
- Provide draft CCVS to Working Group for review in mid-August
- Next O&R Climate Resilience Working Group Meeting expected in late August

Orange & Rockland

Climate Change Pathways Background

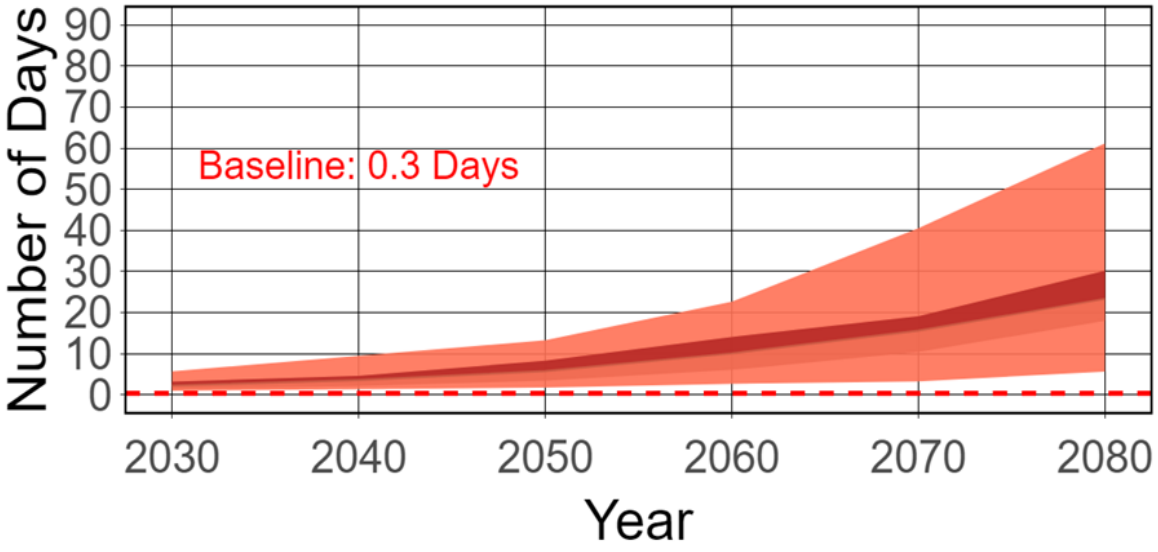
Climate Change Pathway selection to guide the design and planning process

Climate Change Pathways represent O&R's level of risk tolerance to future climate projections and are based on scenarios of socioeconomic activity, levels of GHG emissions and their atmospheric concentrations, known as Shared Socioeconomic Pathways (SSPs)



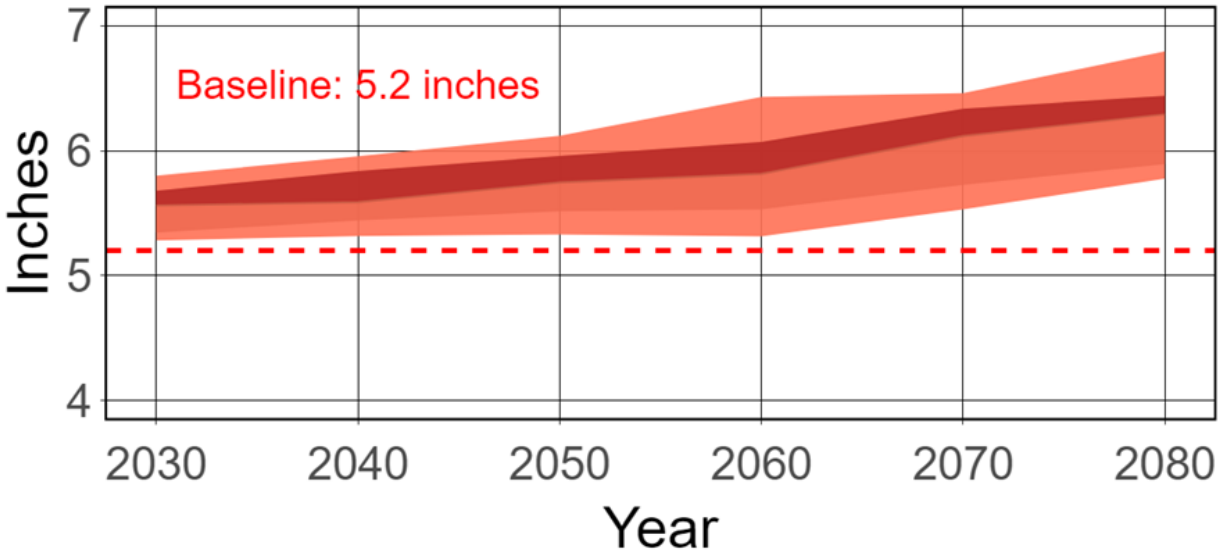
Mohonk SSP5-8.5 Projections:

Days per year with ambient daily temperature>86°F



Mohonk SSP5-8.5 Projections:

Maximum 5-day Precipitation (inches)



DRAFT for working group discussion purposes only

Climate Change Vulnerability Study and Resilience Plan Update

Public Service Law (PSL) § 66(29) – PSC Case 22-E-0222

O&R Climate Resilience Working Group
August 29, 2023

AGENDA

- Progress Update
- Climate Change Vulnerability Assessment Process & Results
- Potential Adaptation Options
- Identified Climate Resilience Measures
- Next Steps

Climate Study and Resilience Plan

Working Group Input and Support

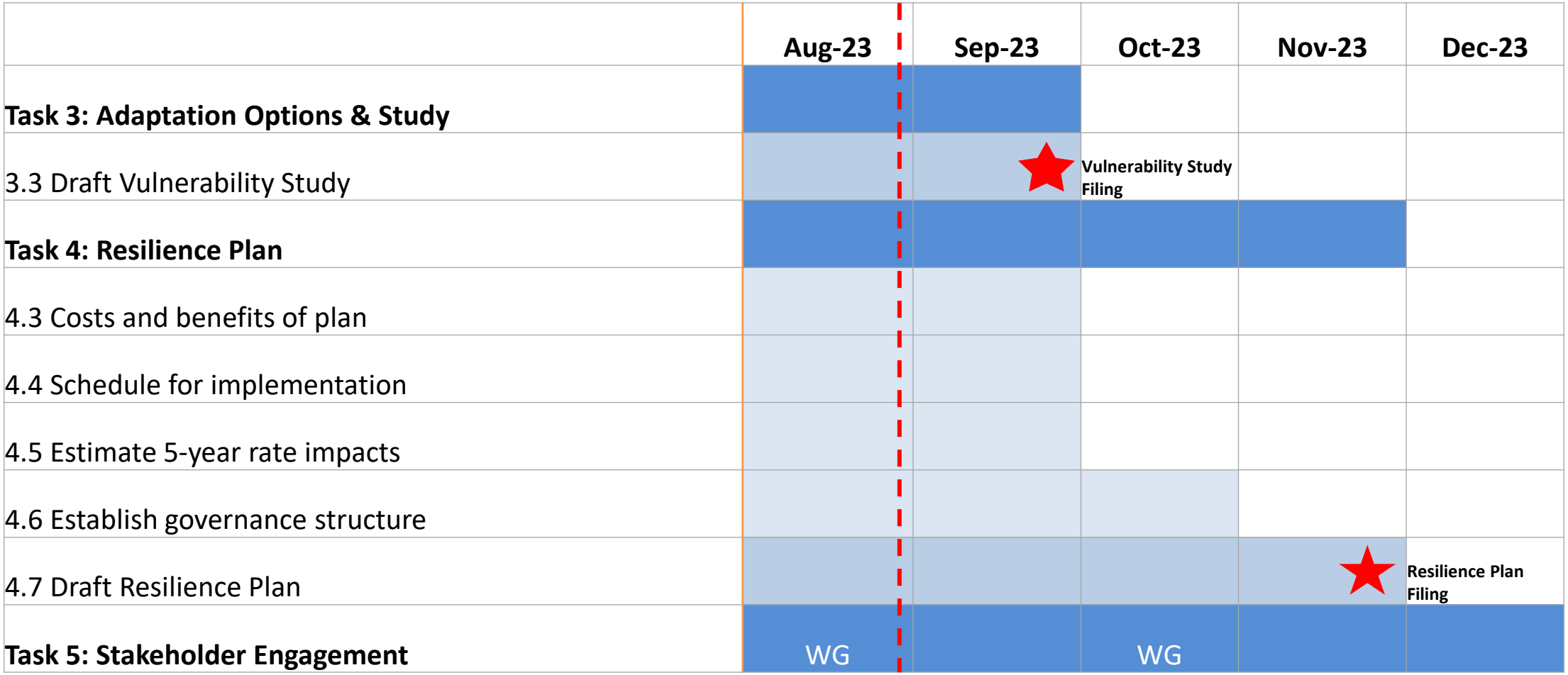
- ✓ **Awareness** of latest climate data projections and priority climate hazards
- ✓ **Alignment** on recommended climate pathways and associated risk tolerances
- ❑ **Considerations** for potential adaptation measures (ongoing)
- ❑ **Review and feedback** of CCVS and Resilience Plan at key draft stages

Timeline

Quarters	Key Milestones
2022 4Q 2023 1Q	Review impacts and trends of latest climate data Share recommended pathways and risk tolerances
2023 2Q	Adaptation options and implementation schedules
2023 3Q	**Climate Study Feedback from WG (8/23-9/6)** Climate Vulnerability Study filing (September) Initial investment plans for resilience-related projects and programs
2023 4Q	Finalize climate resilience plans **Climate Resilience Plan Feedback from WG (October)** O&R files Resilience Plan with PSC (November)
2024	Commission's action on Plan (October)

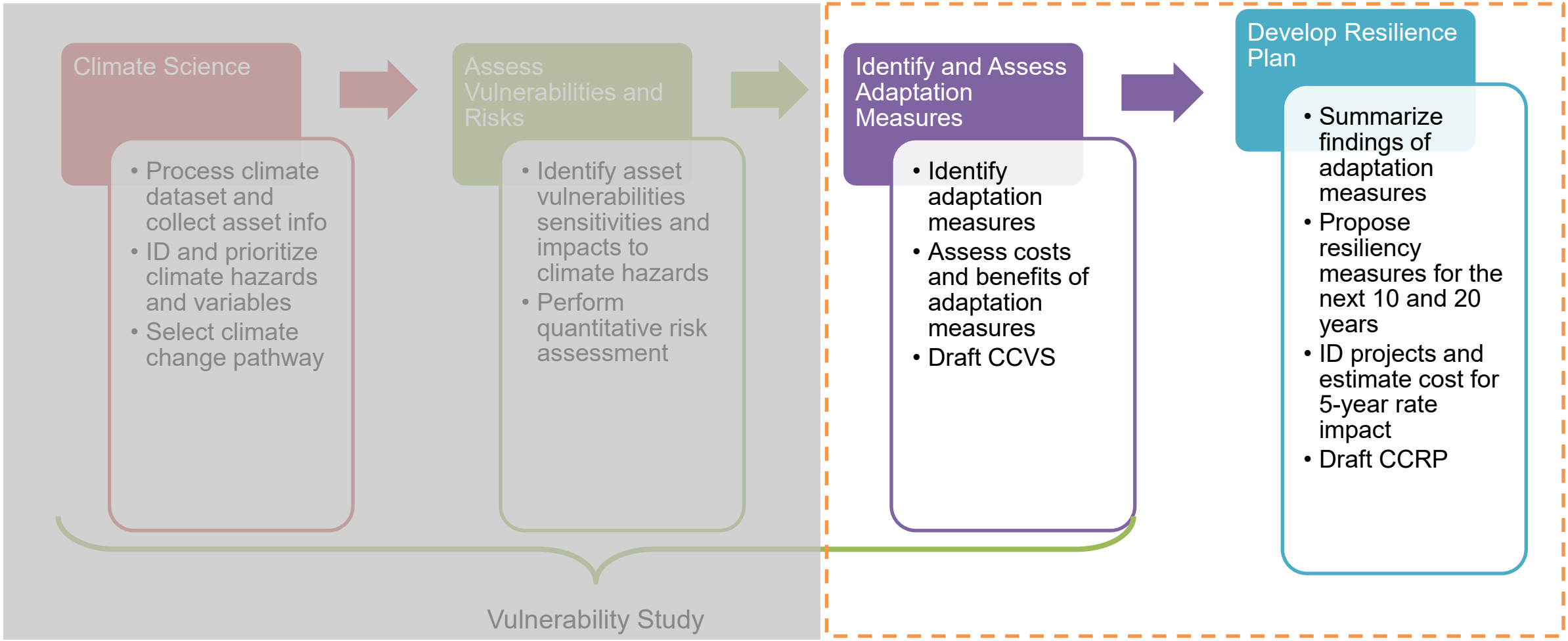
DRAFT for working group discussion purposes only

Timeline of Execution



DRAFT for working group discussion purposes only

Orange & Rockland CCVS & CCRP Process Flow



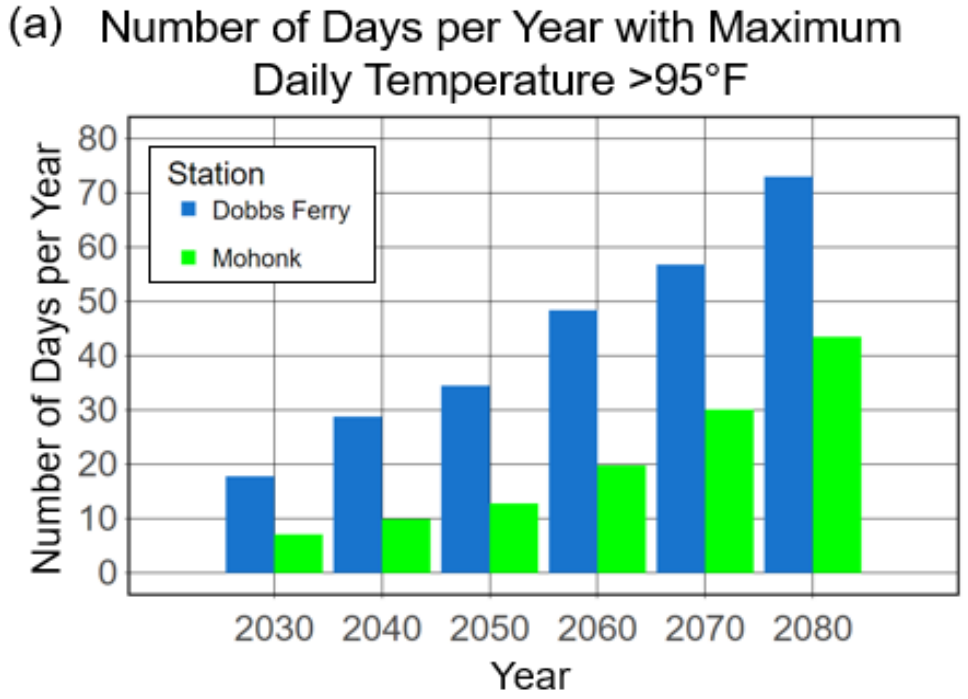
Stakeholder Engagement

DRAFT for working group discussion purposes only

Extreme Heat and Humidity

Climate Data Highlights

- Coincident high heat and humidity events are expected to increase in magnitude and frequency
  - Highest annual maximum daily temperature projected to reach 105°F (2050s) and 112°F (2080s)
- Duration of extreme heat events are projected to increase
  - Longest duration heat waves with maximum daily temperatures > 95°F projected to be over 7 days (2050s) and 14 days (2080s)



Vulnerability Highlights

- Substations could experience reduced capacity and accelerated asset degradation
- High heat events and increased demand leading to reduced margin and possible load relief planning
- Increasing heat, humidity and poor air quality events resulting in more frequent worker breaks

Extreme Precipitation and Flooding

Climate Data Highlights

- Increasing intensity and frequency of heavy rain events
  - Days with more than 2 inches of rain increasing 44% by 2050
  - 5-day maximum precipitation increasing 13% by 2050
- Sea level in the Hudson River rising, increasing size of the floodplain
  - 16” sea level rise projected by 2050
  - 30” sea level rise projected by 2080

Vulnerability Highlights

- 3 substations exposed to potential flooding hazard:
  - Lovett Substation (Hudson River)
  - Hillburn Substation (Ramapo River)
  - Summitville Substation (Delaware and Hudson Canal)
- Underground transmission and distribution lines could experience more frequent inundation
- Potential operational implications for emergency response and service restoration

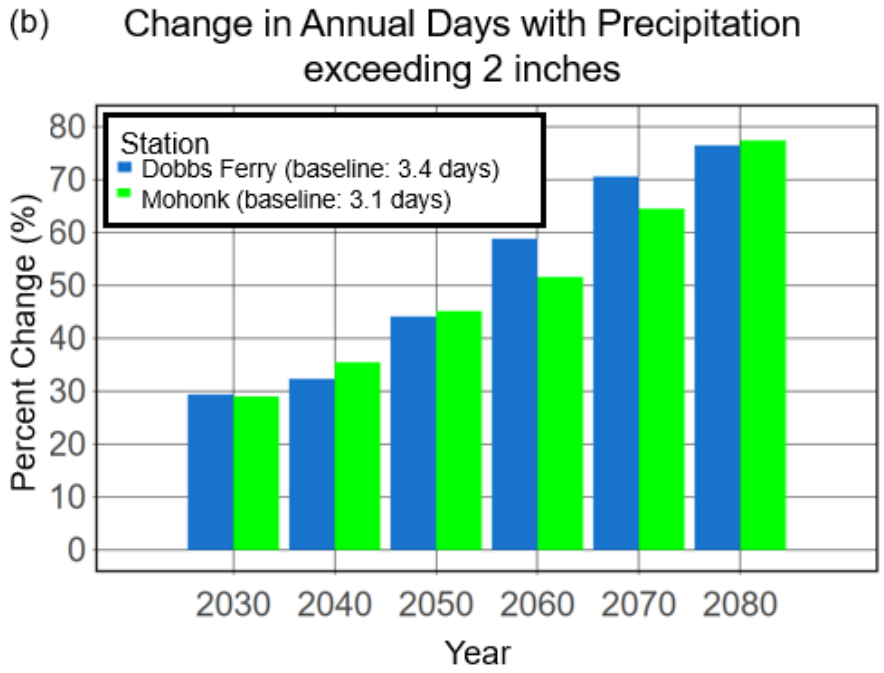


Figure. Summitville substation (red point) with the FEMA 100- and 500-year floodplains overlaid

DRAFT for working group discussion purposes only

Extreme Wind and Icing Events

Climate Data Highlights

- Increasing intensity of storms with high wind, including hurricanes, tropical cyclones, nor'easters
- Potential for increasing intensity of freezing rain and ice accumulation, decreasing frequency

Extreme Event	Future Frequency	Future Intensity
Hurricanes and tropical cyclones	Unchanged	Increase
Lightning and tornadoes	Potentially Increase	Potentially Increase
Snow and ice	Decrease	Increase

Table. Summarized future changes in frequency and intensity of extreme events in the O&R service territory.

Vulnerability Highlights

- Overhead distribution lines are most vulnerable to ice and wind
- Overhead transmission lines are also vulnerable, but are designed to withstand higher wind speeds and have larger clearances
- Impacts from wind are primarily vegetation contact to overhead lines
- Implications for vegetation management, emergency response, reliability planning, workforce safety, spare equipment management

Physical Asset Vulnerability Assessment Results

The most vulnerable asset/hazard combinations for O&R were flooding with substations and wind with transmission. The Study Team has identified three substations with high flood exposure to inland and tidal flooding.

	Temperature & Temperature Variable (TV)	Flooding	Wind & Ice
Substations			
Overhead Transmission			
Overhead Distribution			
Underground T&D			
Critical Facilities			

High vulnerability
Medium vulnerability
Low vulnerability

DRAFT for working group discussion purposes only

Identified Climate Resilience and Potential Adaptation Options

Assessment of highly vulnerable asset/climate hazard risk led to identification of potential adaptation options to address climate hazards

Climate Hazard	System	Asset	Adaptation Measures
Flooding	Substations	• All equipment	• Perimeter protection (temporary barrier or flood wall) • Elevate equipment • Relocate substation outside floodplain • Flood pumps • Install highest critical equipment in waterproof cabinets
Heat	Transmission	• Conductors	• Energy efficiency / demand response • Reconductoring to increase capacity • Install additional feeders • Non-wires solutions to reduce load
Heat	Substations	• Transformers • Regulators	• Replace with higher rated unit • Install additional transformers to reduce loading • Non-wires solutions to reduce load • Install additional cooling

Identified Climate Resilience and Potential Adaptation Options

Assessment of highly vulnerable asset/climate hazard risk led to identification of potential adaptation options to address climate hazards

Climate Hazard	System	Asset	Adaptation Measure
Wind & Ice	Transmission	• Conductors • Towers	• Replace towers • Reinforce towers • Undergrounding • Increase clearances
Wind & Ice	Distribution	• Conductors • Poles	• Undergrounding • Increase clearances • Retrofit with aerial cable and stronger poles
Various	Distribution	• All	• Intelligent grid technologies • Advanced voltage optimization • Self-healing technologies

Questions and Feedback on the CCVS

- Executive summary
- Introduction
- Climate Data and Future Projections
  - Data Sources
  - Selected Climate Change Pathway
  - Tailored Climate Data Analysis
  - Climate Data Results: Temperature, Humidity, Precipitation, Sea Level Rise and Coastal Flooding, Inland Flooding, Wind and Ice
- Extreme events
  - Hurricanes and Tropical Cyclones, Snow and Ice, Cold Snaps and Polar Vortex Events, Lightning and Thunderstorms, Drought, Wildfire, Multiple Extreme Events
- Physical vulnerability assessment
  - Methods
  - Summary of Findings
  - Temperature and Temperature Variable
  - Flooding
  - Wind and Ice
  - Compound and Sequential Events
- Operational vulnerability assessment
- Potential adaptation measures
- Conclusion and next steps
- References
- Appendices

CLIMATE CHANGE RESILIENCE PLAN (CCRP)

Preliminary List of Identified Resiliency Measures

The identified climate resilience measures include new projects (substation flood protection) and incremental changes to existing resilience programs based on the latest science.

Substation Flood Protection

- Hillburn Station Flood Protection
- Summitville Station Replacement
- Lovett 138 kV Station Flood Protection & Cabinet Retrofit

Shoreline Protection

- Erosion Monitoring Program
- Transmission Shoreline Restoration

- Load relief & capacity planning
- Overhead Hardening & Vegetation Management
- Accelerate Distribution Automation
- Storm Resilience Center*
- Worker Safety and PPE*
- Transmission Structures & Under-grounding
- Storm Material Management*
- Weather Monitoring*

***Denotes programs and projects that are Shared Services with CECONY (i.e., Emergency Preparedness, EH&S, Stores Operations)**

Climate Hazard Mitigation For:

- Flood
- Heat
- Wind
- Multiple

Next Steps on the CCVS and Resilience Plan

Date	Deliverable to Working Group
August 23 – September 6, 2023	Full draft of the CCVS for review and feedback
August 29, 2023	The Working Group can provide additional feedback on the CCVS during this meeting. We will also be discussing identified resilience measures for our Resilience Plan.
September 22, 2023	**CCVS filing**
Week of October 16	Send draft of the Resilience Plan for review and feedback
Week of October 23 (WG meeting)	The WG can provide additional feedback on the Plan submittal.
By November 21, 2023	**Resilience Plan filing**

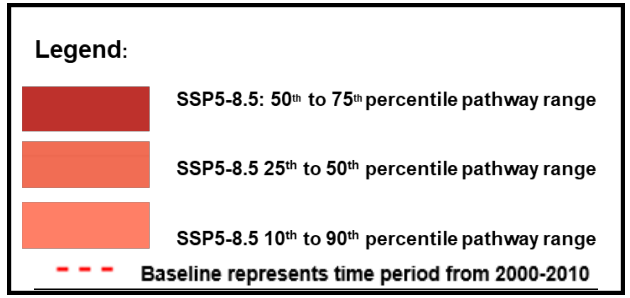
DRAFT for working group discussion purposes only

Orange & Rockland

Climate Change Pathways Background

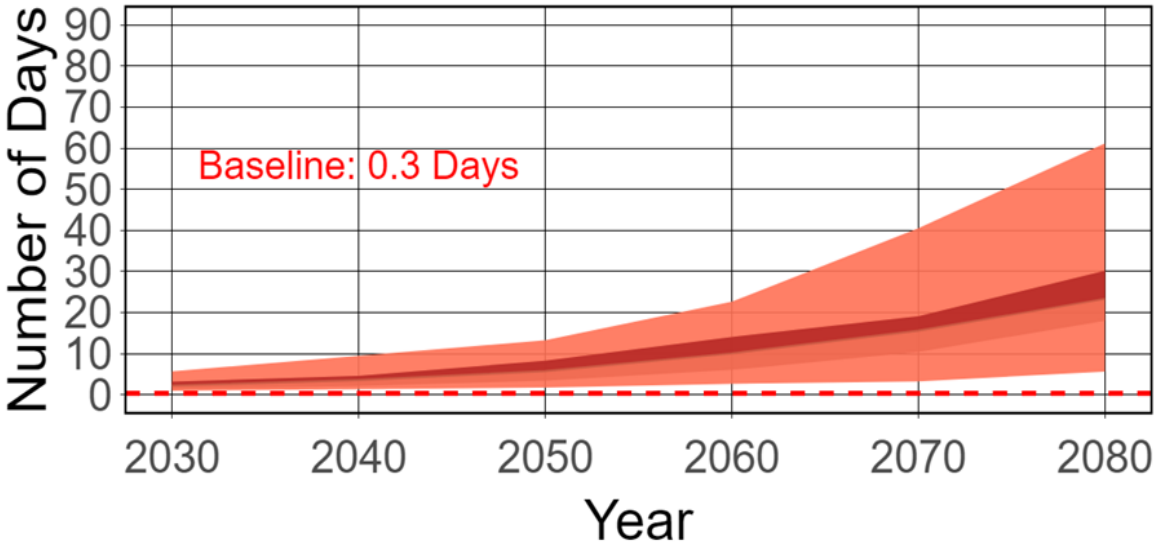
Climate Change Pathway selection to guide the design and planning process

Climate Change Pathways represent O&R's level of risk tolerance to future climate projections and are based on scenarios of socioeconomic activity, levels of GHG emissions and their atmospheric concentrations, known as Shared Socioeconomic Pathways (SSPs)



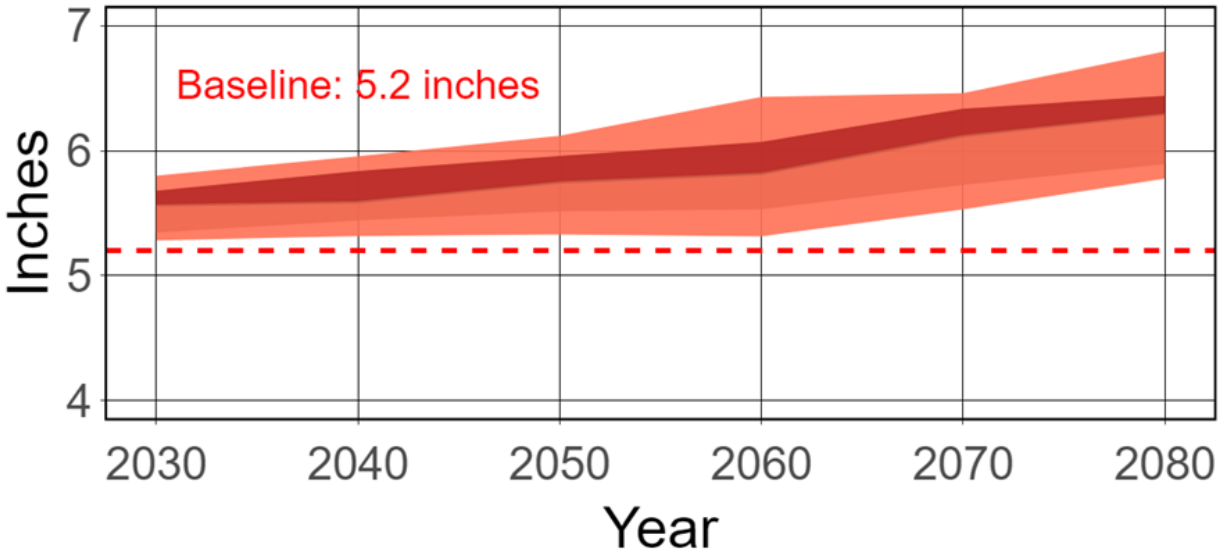
Mohonk SSP5-8.5 Projections:

Days per year with ambient daily temperature>86°F



Mohonk SSP5-8.5 Projections:

Maximum 5-day Precipitation (inches)



DRAFT for working group discussion purposes only

Climate Change Vulnerability Study and Resilience Plan Update

Public Service Law (PSL) § 66(29) – PSC Case 22-E-0222

O&R Climate Resilience Working Group
October 30, 2023

DRAFT for working group discussion purposes only

AGENDA

- Resilience Plan Progress Update
- Review of O&R Resilience Plan Portfolio
- Equity Considerations
- Feedback and discussion on Resilience Plan draft
- Next Steps

Climate Study and Resilience Plan

Working Group Input and Support

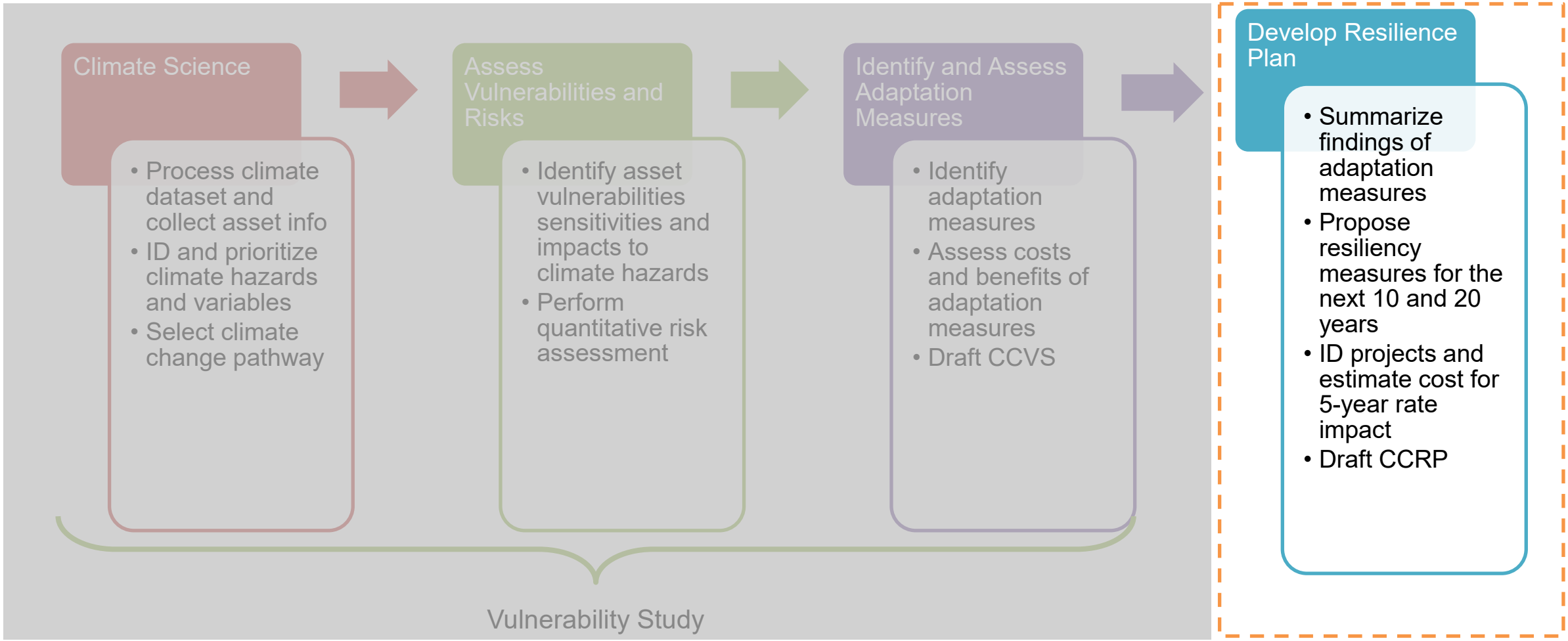
- ✓ **Awareness** of latest climate data projections and priority climate hazards
- ✓ **Alignment** on recommended climate pathways and associated risk tolerances
- ✓ **Considerations** for potential adaptation measures
- ❑ **Review feedback** of draft Resilience Plan

Timeline

Quarters	Key Milestones
2022 4Q 2023 1Q	Review impacts and trends of latest climate data Share recommended pathways and risk tolerances
2023 2Q	Adaptation options and implementation schedules
2023 3Q	**Climate Study Feedback from WG (8/23 – 9/6)** Climate Vulnerability Study filing (September) Initial investment plans for resilience-related projects and programs
2023 4Q	Finalize climate resilience plans **Climate Resilience Plan Feedback from WG (10/24 – 11/3)** O&R files Resilience Plan with PSC (November)
2024	Commission's action on Plan (October)

DRAFT for working group discussion purposes only

Orange & Rockland CCVS & CCRP Process Flow



Stakeholder Engagement

DRAFT for working group discussion purposes only

Flood Mitigation

Flood Mitigation

Summitville Substation Flooding Mitigation

Program Scope & Resiliency Benefits

Program Scope:

- In the near term, install a paved 30” perimeter berm to prevent or control flow of water until substation retirement in 2032
- Summitville substation set to be retired and replaced with the Wurtsboro station

Resiliency Benefits:

- Reduced substation equipment vulnerability to damage failure from flooding due to extreme rain events, and location within FEMA 100-year floodplain
- Avoid restoration and replacement costs
- Avoid customer service outages

Climate Drivers

Climate Change Vulnerabilities:

Precipitation

- FEMA 100-year flood map shows possible inundation depth of up to ~2 feet
- Maximum 5-day precipitation could increase 13% by 2050 at Dobbs Ferry.
- The number of days per year with precipitation exceeding 2 inches could increase 45% by 2050 and 77% by 2080 at Dobbs Ferry.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $0.14 million (capital)

	2025	2026	2027	2028	2029
Capital ($000)	$140	$	$	$	$
O&M ($000)	–	–	–	–	–

Flood Mitigation

Hillburn Substation Flooding Mitigation

Program Scope & Resiliency Benefits

Program Scope:

- In the near-term Install 48” perimeter berm to prevent or control water, and waterproof control cabinets as extra layer of protection
- In the longer term, two possible paths to enhance resilience to flooding:
  - Relocate substation to area less susceptible to flooding
  - Elevate the entire facility on raised site grade elevation

Resiliency Benefits:

- Reduce substation equipment damage failure from extreme rain events
- Increased reliability and life expectancy of assets
- Avoid customer service outages

Climate Drivers

Climate Change Vulnerabilities:

Precipitation

- FEMA 100-year flood map shows possible inundation depth around 1 foot adjacent to the substation site.
- Maximum 5-day precipitation could increase 13% by 2050 at Dobbs Ferry.
- The number of days per year with precipitation exceeding 2 inches could increase 45% by 2050 and 77% by 2080 at Dobbs Ferry.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $0.5 million (capital)

	2025	2026	2027	2028	2029
Capital ($000)	$500	$ -	$ -	$ -	$ -
O&M ($000)	–	–	–	–	–

Flood Mitigation

Lovett 138kV Substation Flooding Mitigation

Program Scope & Resiliency Benefits

Program Scope:

- In the near-term construct two primary flood protection measures: raising the control house and installing waterproof cabinets
- In the longer term, two possible paths to enhance resilience to flooding:
  - Relocate substation to area less susceptible to flooding
  - Elevate the entire facility and fortify with a retaining wall

Resiliency Benefits:

- Increased ability to withstand climate-driven flood risks
- Avoid restoration and replacement costs
- Avoid customer service outages

Climate Drivers

Climate Change Vulnerabilities:

Precipitation / Sea Level Rise

- Projections show sea levels could rise 16 inches by the 2050s.
- FEMA 100-year flood map combined with sea level rise could result in inundation of 5 feet by 2050
- Maximum 5-day precipitation could increase 13% by 2050 at Dobbs Ferry.
- The number of days per year with precipitation exceeding 2 inches could increase 45% by 2050 and 77% by 2080 at Dobbs Ferry.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $13.2 million (capital)

	2025	2026	2027	2028	2029
Capital ($M)	$ 2,550	$ 5,250	$ $5,400	$	$
O&M ($M)	–	–	–	–	–

Flood Mitigation

Shoreline Erosion Protection Program

Program Scope & Resiliency Benefits

Program Scope:

- Expand the existing inspection program with a more proactive mitigation approach
- Armoring additional structures along rivers per year
- Implement mitigation measures such as riprap or retaining walls to prevent erosion and potential failure of overhead structure

Resiliency Benefits:

- Provide long-term solution for shoreline erosion damage due to sea level rise and flooding from severe coastal storms
- Reduce flood risk to O&R's shoreline infrastructure
- Avoid customer service outages

Climate Drivers

Climate Change Vulnerabilities:

Precipitation / Sea Level Rise

- Projections show sea levels could rise 16 inches by the 2050s for assets near the Hudson River
- North Atlantic hurricanes could become more intense with rainfall amounts increasing approximately 10% to 15% relative to historical hurricanes.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $5.3 million (capital) and $1.04 million (O&M)

	2025	2026	2027	2028	2029
Capital ($000)	$ 1,000	$ 1,030	$ 1,060	$ 1,090	$ 1,130
O&M ($000)	$ 200	$ 210	$ 270	$ 170	$ 190

Wind & Ice

Wind & Ice

Selective Undergrounding Program

Program Scope & Resiliency Benefits

Program Scope:

- 2025-2027: Identified specific projects for undergrounding ~11 miles of overhead distribution lines and 4 underground transmission projects
- 2028-2029: Program target to underground an additional 19 miles of overhead distribution line

Resiliency Benefits:

- Enhance durability and reliability of distribution and transmission systems
- Mitigate exposure to external hazards such as weather events, wildlife contact, and car accidents
- Avoid customer service outages

Climate Drivers

Climate Change Vulnerabilities:

Wind / Ice

- The service area is likely to experience higher wind speeds and gusts during tropical cyclones, extratropical cyclones, and thunderstorms.
- The potential remains for increased freezing rain frequency and ice accumulation.
- North Atlantic hurricanes could become more intense (~5% increase) relative to historical hurricanes.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $143.4 million (capital)

	2025	2026	2027	2028	2029
Capital ($000)	$ 38,880	$ 47,860	$ 16,420	$ 18,000	$ 22,200
O&M ($000)	–	–	–	–	–

Wind & Ice

Enhanced Overhead (Hendrix System)

Program Scope & Resiliency Benefits

Program Scope:

- 2025-2028: Identified specific projects for reinforcing ~23 miles of overhead distribution lines with Hendrix spacer cable
- 2025-2029: Program target of reinforcing an additional ~56 miles

Resiliency Benefits:

- Enhance durability and reliability of distribution system
- Mitigate exposure to external hazards such as weather events and tree contact
- Avoid customer service outages

Climate Drivers

Climate Change Vulnerabilities:

Wind / Ice

- The service area is likely to experience higher wind speeds and gusts during tropical cyclones, extratropical cyclones, and thunderstorms.
- The potential remains for increased freezing rain frequency and ice accumulation.
- North Atlantic hurricanes could become more intense relative to historical hurricanes.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $66.8 million (capital) and $16.7 million (O&M)

	2025	2026	2027	2028	2029
Capital ($000)	$ 14,040	$ 10,800	$ 13,910	$ 14,250	$ 13,800
O&M ($000)	$ 3,510	$ 2,700	$ 3,480	$ 3,560	$ 3,450

Wind & Ice

Overhead Structure Replacement Program

Program Scope & Resiliency Benefits

Program Scope:

- Supplement inspection-based pole replacement with a proactive approach that gives a weighted consideration of pole age
- Would consider replacement of existing poles with either new wood poles or steel structures

Resiliency Benefits:

- Increased ability to withstand more frequent and intense storm events
- Reduces maintenance costs and minimizes unplanned repair expenditures
- Avoid customer service outages

Climate Drivers

Climate Change Vulnerabilities:

Wind / Ice

- O&R is likely to experience higher wind speeds and gust during tropical cyclones, extratropical cyclones, and thunderstorms in the future.
- Projections show that maximum wind gusts could reach 110 mph in the future.
- The potential exists for increased radial icing intensity during ice storms.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $20.1 million (capital)

	2025	2026	2027	2028	2029
Capital ($000)	$ 2,250	$ 3,090	$ 3,980	$ 4,920	$ 5,910
O&M ($000)	–	–	–	–	–

Wind & Ice

Expand Hazard Tree Removal

Program Scope & Resiliency Benefits

Program Scope:

- Expansion of Hazard tree program to a level to support removing ~4,000 hazard trees per year increased from the current level of ~1,300 per year
- Focus on ash trees weakened by impacts of the Emerald Ash Borer which elevate risk of impact to overhead lines under higher wind and rain projections
- Since program conception in 2018, over 7,100 hazards trees have been removed, of which 70% were ash trees

Resiliency Benefits:

- Avoid customer service outages from damage of downed trees to electric equipment, lines, and structures
- Increased ability of assets to withstand severe thunderstorms, strong winds, and ice accumulation

Climate Drivers

Climate Change Vulnerabilities:

Wind / Ice

- Projections show that the number of days per year with more than 2 inches of rain could increase 45% by 2050 and 77% by 2080 at Dobbs Ferry.
- North Atlantic hurricanes are projected to become more intense and have higher rainfall amounts (~10%-15% increase) relative to historical hurricanes.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $12.7 million (O&M)

	2025	2026	2027	2028	2029
Capital ($000)	–	–	–	–	–
O&M ($000)	$ 2,400	$ 2,470	$ 2,550	$ 2,620	$ 2,700

Multiple Hazards

Multiple Hazards

Distribution Automation/Smart Grid

Program Scope & Resiliency Benefits

Program Scope:

- Accelerate the installation and commissioning of SCADA controlled devices (reclosers, smart capacitors, remotely operated switches, and power quality sensors) on a feeder-by-feeder basis
- Install and upgrade field devices with command-and-control schemes
- Three-tiered approach: (1) Feeder Optimization, (2) Field Automation, (3) Centralized Automation Control

Resiliency Benefits:

- Reduce potential customer outages during storms by automatically isolating faults
- Expedite storm response by remotely activating devices

Climate Drivers

Climate Change Vulnerabilities:

Extreme Events

- Projections show that maximum wind gusts could reach 110 mph in the future.
- The frequency of strong storms could increase in the future, with higher rainfall amounts and stronger winds.
- The number of days per year with precipitation exceeding 2 inches could increase 45% by 2050 and 77% by 2080 at Dobbs Ferry.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $60.6 million (capital)

	2025	2026	2027	2028	2029
Capital ($000)	$ 12,000	$ 12,100	$ 12,100	$ 12,200	$ 12,300
O&M ($000)	–	–	–	–	–

Multiple Hazards

Emergency Response Operation and Control Facility

Program Scope & Resiliency Benefits

Program Scope:

- Install a dedicated emergency response operation and control facility on existing land owned by O&R across from the Blooming Grove Operating Center
- This location is centrally located within the O&R service territory and has easy highway access for emergency storm response events.

Resiliency Benefits:

- Having a dedicated facility that will be configured as an emergency response control facility will save time when mobilizing for storm coordination and response.

Climate Drivers

Climate Change Vulnerabilities:

Extreme Events

- The service area is likely to experience more frequent and intense events such as high winds, icing, and high heat.
- North Atlantic hurricanes could become more intense and have higher rainfall amounts (~10% to 15% increase) relative to historical hurricanes.
- The probability of coincident extreme events will likely continue to increase in both frequency and intensity in the future.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $14.6 million (capital) and $1.1 million (O&M)

	2025	2026	2027	2028	2029
Capital ($000)	$ 2,100	$ 5,040	$ 7,410	–	–
O&M ($000)	–	–	–	$ 550	$ 550

Multiple Hazards

Storm Material Management

Program Scope & Resiliency Benefits

Program Scope:

- This program will install a dedicated storm material warehousing facility on existing land owned by O&R across from the Blooming Grove Operating Center
- This location is centrally located within the O&R service territory and has easy highway access for emergency storm response events
- Facility will house critical spare equipment inventory for
  - $5 million for the transmission system
  - $9 million for the distribution system

Resiliency Benefits:

- Reduces event recovery time by making spare parts available more quickly
- Mitigates elongated lead times from existing supply chain issues

Climate Drivers

Climate Change Vulnerabilities:

Extreme Events

- The service area is likely to experience more frequent and intense events such as high winds, icing, and high heat.
- North Atlantic hurricanes could become more intense relative to historical hurricanes.
- The probability of coincident extreme events will likely continue to increase in both frequency and intensity in the future.

Resiliency Funding Request & Drivers

- Total 5-yr funding request: $35.2 million (capital) and $1.1 million (O&M)

	2025	2026	2027	2028	2029
Capital ($000)	$ 3,650	$ 8,470	$ 13,790	$ 4,590	$ 4,730
O&M ($000)	–	–	–	$ 550	$ 550

Multiple Hazards

Storm Resilience Center

Program Scope & Resiliency Benefits

Program Scope:

- State-of-the-art, joint use (Con Edison and O&R) storm response facility with two focus areas:
  - Reduce outage times through quicker mutual aid support facilitation
  - Provide training and coordination to better prepare and respond to extreme weather events

Resiliency Benefits:

- More efficient and faster recovery times after storms
- Promote utility and community collaboration

Climate Drivers

Climate Change Vulnerabilities:

Extreme Events

- The service area is likely to experience more frequent and intense events such as high winds, icing, and high heat.
- North Atlantic hurricanes could become more intense and have higher rainfall amounts (~10% to 15% increase) relative to historical hurricanes.
- The probability of coincident extreme events will likely continue to increase in both frequency and intensity in the future.

Resiliency Funding Request & Drivers

- Total O&R 5-yr funding request: $12.6 million (capital) and $0.37 million (O&M)

	2025	2026	2027	2028	2029
Capital ($000)	$ 2,060	$ 1,280	$ 3,410	$ 2,910	$ 2,960
O&M ($000)	–	$ 30	$ 70	$ 70	$ 200

Multiple Hazards

Micronet Weather Station Expansion

Program Scope & Resiliency Benefits

Program Scope:

- As part of a Shared Service, O&R is looking to installing 7 Micronet weather stations and instrumentation in Orange and Rockland Counties
- These instruments can measure temperature, wind, precipitation, humidity, and barometric pressure to capture hyperlocal weather conditions

Resiliency Benefits:

- Better understanding of the hyperlocal impacts of climate change
- Reduce restoration times and outage costs by providing a more granular view of weather progression and impacts

Climate Drivers

Climate Change Vulnerabilities:

Extreme Events

- The service area is likely to experience more frequent and intense events such as high winds, icing, and high heat.
- The probability of coincident extreme events will likely continue to increase in both frequency and intensity in the future.

Resiliency Funding Request & Drivers

- Total O&R 5-yr funding request: $0.38 million (capital) and $0.41 million (O&M)

	2025	2026	2027	2028	2029
Capital ($000)	$ 380	–	–	–	–
O&M ($000)	–	$ 100	$ 100	$ 103	$ 106

Proposed Performance Measures

The following are performance measures that are proposed for the Resilience Plan investments. We will continue to learn over time as we integrate resilience into our planning, operations, and response.

Program / Project	Proposed Implementation-Based Measures	Proposed Outcome-Based Measures
Distribution Automation/Smart Grid	Number of devices installed per year	Avoided outages
Hillburn, Summitville, Lovett 138kV Substations Flooding Mitigation	Completion of planned protection measures on schedule and on budget	Substation equipment impacted by flooding event
Overhead Structure Replacement Program	Number of overhead structures replaced per year	Average overhead pole health rating
Shoreline Erosion Protection Program	Number of structures armored per year	Average overhead pole health rating
Distribution Undergrounding Program	Miles of circuit undergrounded per year compared to planned miles	Average SAIFI (pre- and post- hardening, no storm exclusions)
Enhanced OH (Hendrix System)	Miles of overhead distribution line reinforced with Hendrix spacer cable per year compared to planned miles	
Storm Resilience Center / O&R Emergency Response Control Facility	Facility development on schedule and on budget	Time to onboard crews, Facility Utilization

Note: These measures will not be weather-normalized.

Equity Considerations

The following are equity considerations that are proposed in the Resilience Plan. We will continue to learn over time as we measure and report on investments in overburdened communities (i.e., DACs).

- Engineering, planning, safety and resilience needs remain primary drivers
- Biennial retrospective reporting on projects that impact DACs
  - Track our investments benefiting DACs
  - Report on customer outages in DAC vs. non-DAC areas
- For selective undergrounding, include equity considerations in project prioritization process as appropriate

Feedback on Climate Change Resilience Plan ("CCRP")

- **CCRP Outline:**
  - Executive Summary
  - Introduction and Background
  - Engagement of the Climate Resilience Working Group
  - Multi-pronged Resilience Strategy and Approach
  - Consideration of Equity
  - Investment Plan
  - Governance
  - Performance Measures
  - Conclusion and Next Steps

Next Steps on the Resilience Plan

Date	Deliverable to Working Group
October 24	Sent draft of the Resilience Plan for review and feedback
October 30	The WG can provide additional feedback on the Plan submittal during the Working Group meeting
November 3	Request feedback from Working Group for incorporation into the Resilience Plan
By November 21, 2023	**Resilience Plan filing**

Orange & Rockland