Regional Transmission Expansion Planning Update

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& Interregional Planning

Presented to ISAC

Nov. 28, 2022

Agenda

- 2023 RTEP Cycle and Input Assumptions
- Ongoing Planning Scenario Studies
- Reliability Update 2022
- Market Efficiency Update
- NJ Offshore SAA Window Update

- Annually, PJM develops new base case models for purpose of performing the annual RTEP baseline analysis, which also forms the basis for the base case used for interconnection planning studies.
- Annually, PJM reviews the planning assumptions that will be used for PJM's planning analyses. The assumptions are based on a consistent set of fundamental assumptions regarding load, generation and transmission that are built into power flow models. Details of the fundamental assumptions are discussed in Manual 14B, Section 1.3.

- PJM Manual 14B

  https://www.pjm.com/-/media/documents/manuals/m14b.ashx

- Upcoming PJM meetings where the assumptions will be discussed
  - TEAC – Jan. 10, 2023
  - SRRTEP - Mid-Atlantic – Dec. 14, 2022
  - SRRTEP - South – Dec. 14, 2022
  - SRRTEP - West – Dec. 16, 2022

- TEAC meeting January 11, 2022 – 2022 Reliability Assumptions

  https://www.pjm.com/-/media/committees-groups/committees/teac/2022/20220111/20220111-item-05a-2022-rtep-assumptions-update.ashx

- PJM Transmission Planning Scenario Studies
  - Offshore Wind Transmission Study Phase 2
  - Grid of the Future Transmission Scenario Studies

Reliability Update – 2022 RTEP Cycle

- Three FERC Order 1000 proposal windows opened during the 2022 RTEP cycle
  - 2022 Multi Driver Window 1- 60 day window
  - 2022 RTEP Window 1 - 60 day window
  - 2022 RTEP Window 2 - 30 day window

2022 Multi-Driver Proposal Window 1

2022 RTEP Multi-Driver Window 1

- 2022 RTEP Multi-Driver Window 1 opened on June 7, 2022 and was closed August 8, 2022.
  - The Multi-Driver Window 1 was conducted to address reliability and market efficiency needs identified on the 2027 RTEP year case.
  - For this Window, PJM sought technical solutions, also called proposals, to resolve potential reliability criteria violations on the identified multi-driver facilities in accordance with all applicable planning criteria (PJM, NERC, SERC, RFC, and Local Transmission Owner criteria).
  - 14 total proposals submitted from 3 different entities (includes 3 carry-over proposals from 2021 Proposal Window 2)
    - 8 Greenfield proposals
    - 6 Upgrades
  - Cost Estimates: Approximate range from $215K – $127M
  - PJM's reliability and economic evaluation of the proposals is underway is expected to be completed sometime in December 2022.

2022 RTEP Window 1

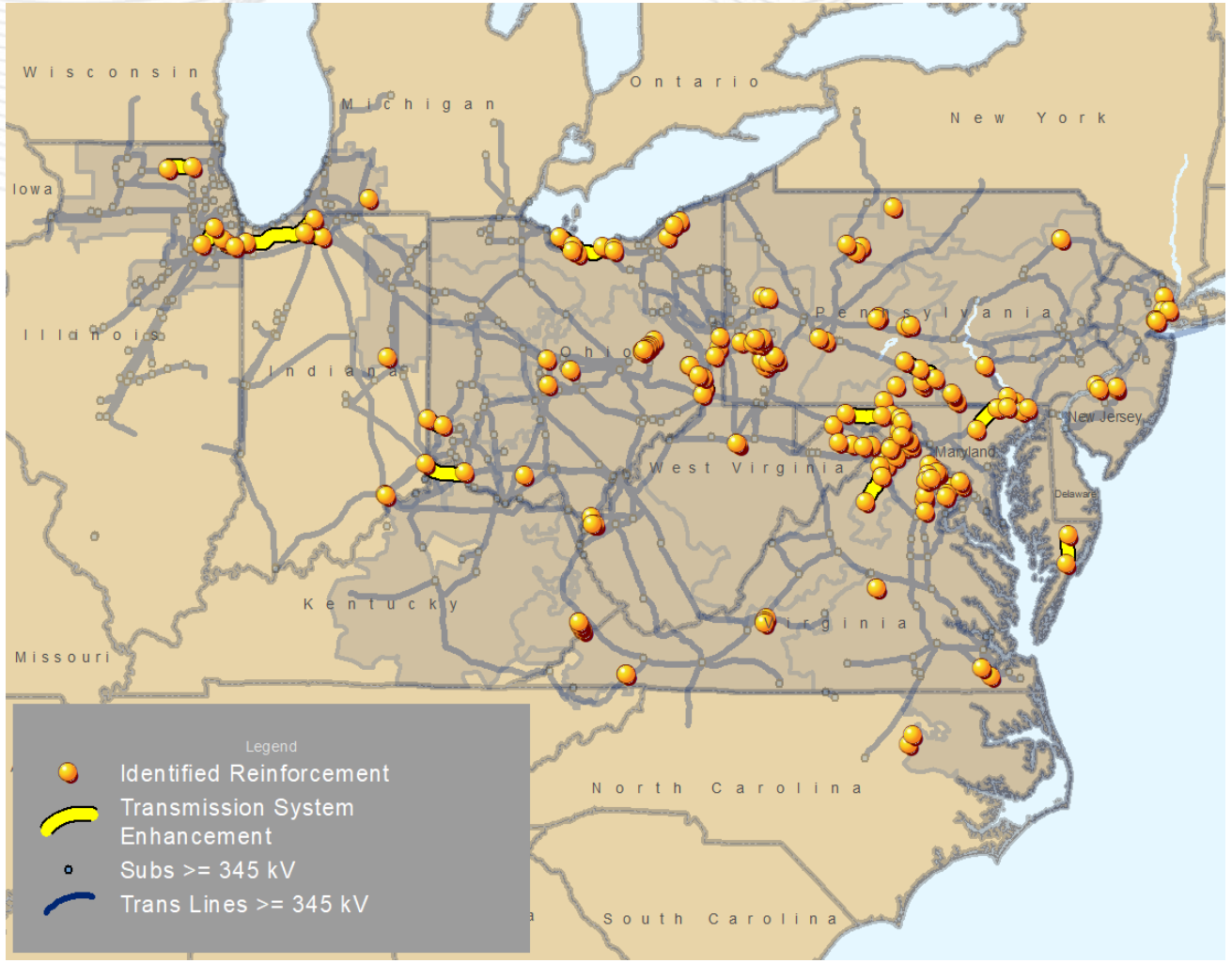
- PJM, as part of the annual RTEP, conducted reliability studies and identified needs on 852 flowgates. PJM determined that 269 of those flowgates were eligible for competition and 583 of the flowgates were excluded from the competition for various reasons.
  - Window opened on 7/01/2022
  - Window closed on 8/30/2021

Overview of 2027 RTEP Results

Overview of 2027 Results
Total of 852 flowgates identified

- 269 flowgates are eligible
  - 19 in the PJM Mid-Atlantic Region
  - 250 in the PJM Western Region

- 583 flowgates excluded
  - 407 due to the below 200kv Exclusion
  - 39 due to Substation Equipment Exclusion
  - 20 due to Immediate Need Exclusion
  - 13 are addressed in the Multi Drive window 1
  - 63 in Dominion and are either addressed with an immediate Need or will be addressed in the 2022 Window 2
  - 41 due to other variety reasons



- For this window, PJM sought technical solutions, also called proposals, to resolve potential reliability criteria violations on facilities identified in accordance with all applicable planning criteria (PJM, NERC, SERC, RFC, and Local Transmission Owner criteria).
- A total of 17 proposals submitted from 7 different entities (see https://www.pjm.com/-/media/committees-groups/committees/teac/2022/20220906/item-09b---reliability-analysis-update.ashx)
  - 6 Greenfield proposals
  - 11 Upgrades
- Cost Estimates: Approximate range from $0.26k to $386.73M
- 7 Proposals identified with cost containment

- PJM completed the evaluation for majority of the proposals and the projects already completed the stakeholder review process. The projects will go to the December PJM Board meeting for approval.

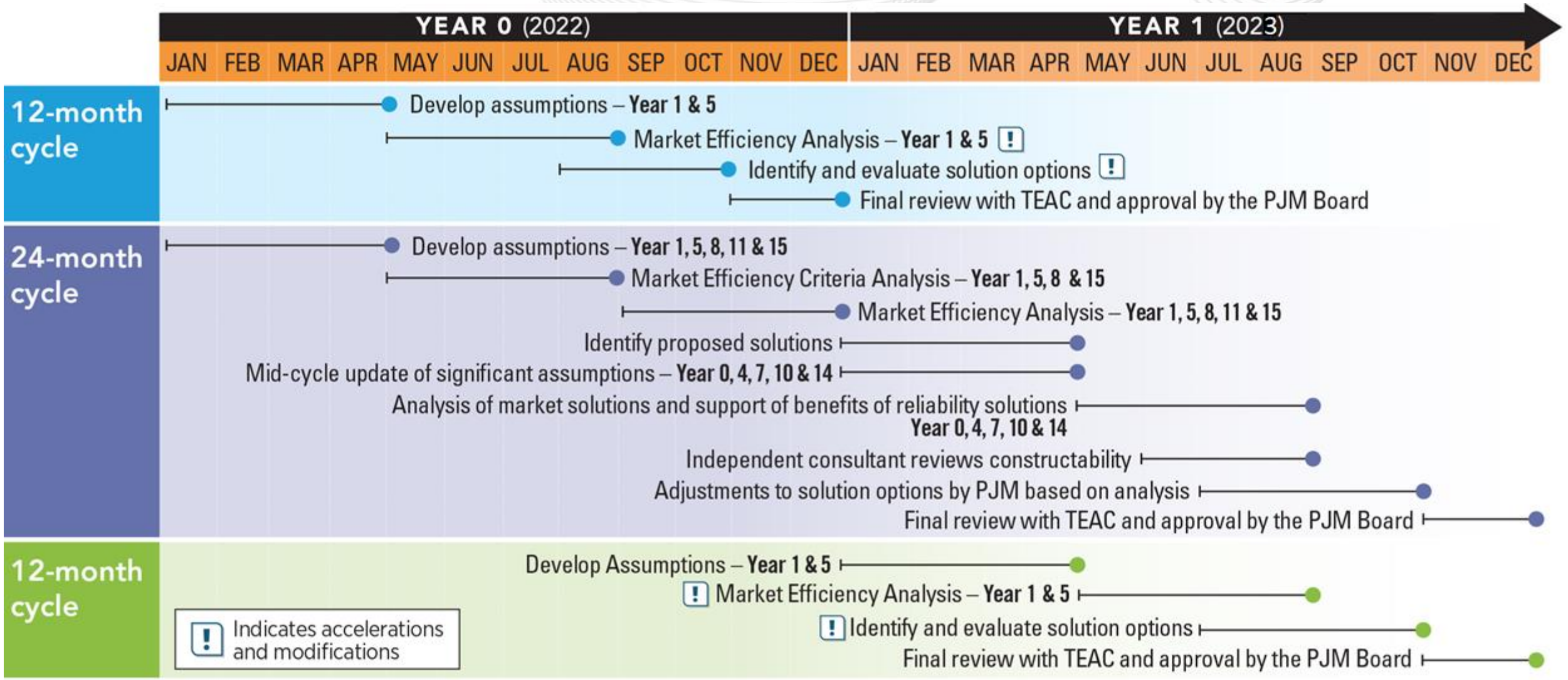
- The evaluation for the remaining proposed projects is in progress and is expected to be completed by the end of December 2022.

2022 RTEP Window 2 Update

- 2022 RTEP Window 2 opened on Nov. 1, 2022 and is anticipated to be closed on Dec. 1, 2022
  - Reliability Window 2 is required to address the remaining Window 1 violations in the Dominion area after inclusion of the Immediate Need solution.

2022/23 Market Efficiency Cycle

2022/23 Market Efficiency Timeline



- Posted update to the Market Efficiency Base Case (PROMOD 11.4 XML format)
  - Posted Sensitivity Scenarios.
  - Activated Bus/Hub reports in the Base Case.
  - Updated some generation settings to stay consistent with previous models.
  - Applied rating corrections based on feedback received.
- Posted Market Efficiency Sensitivity Scenarios.
- Market Efficiency Training scheduled for November 29, 2022.
- Final Market Efficiency Base Case and Congestion Drivers to be posted before the start of 2022/23 Long-Term Window.

Base Case Preliminary Results - Simulated Congestion [1]

Constraint [3)]	Congested Area	Type	Historical 2021 Day Ahead Congestion	Historical 2022 (through Sep) Day Ahead Congestion	Simulated 2027 Congestion	Simulated 2030 Congestion	Comment
Black Oak-Bedington Interface		Inter	$ -	$ 72,436,702	$ 54,119,278	$ 97,404,855	2022 Reliability Window 1 – Black Oak 500kV Voltage Drop
BC-PEPCO Interface		Inter	$ 4,065	$ 262,743	$ 27,128,125	$ 1,488,360	-
Safe Harbor-Graceton 230 kV	PPL-BGE	Line	$ 25,862,337	$ 18,926,344	$ 23,435,336	$ 16,239,930	2022 Reliability Window 1
Messick Road to Morgan 138 kV	APS	Line	$ -	$ -	$ 19,167,071	$ 36,863,712	2022 Reliability Window 1
Dumont-Stillwell 345 kV	AEP-NIPS	M2M	$ 2,034,732	$ 2,381,596	$ 11,568,222	$ 13,427,287	2022 Multi-Driver Window 1
AP South Interface		Inter	$ 465,361	$ 55,483,098	$ 7,885,910	$ 19,389,792	-
AEP-DOM Interface		Inter	$ 323,916	$ 23,390,296	$ 7,393,603	$ 30,019,220	-
Olive-University Park 345 kV	AEP-CE	M2M	$ -	$ 75,167	$ 4,918,360	$ 12,482,576	2022 Multi-Driver Window 1
Lincoln-Straban 138 kV	METED	Line	$ 375,627	$ 2,033,549	$ 3,194,140	$ 8,875,815	2022 Reliability Window 1
Germantown-Straban 138 kV	METED	Line	$ 323,093	$ 2,856,930	$ 2,935,052	$ 10,166,810	2022 Reliability Window 1

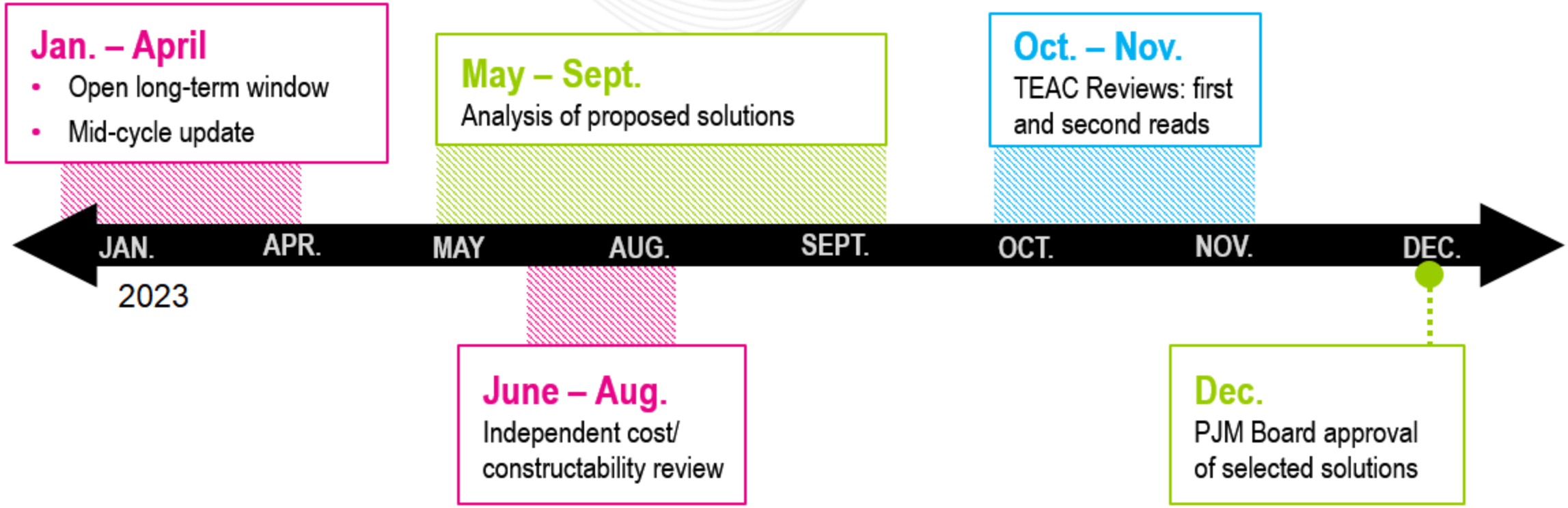
Notes:

1) Preliminary results, not final congestion drivers. List of constraints and congested areas may change in the final base case.

2) Table identifies correlated historical constraints with 2027 PROMOD simulated congestion in the same area/group.

3) Included only flowgates with hr bindings > 25 hrs. and annual simulated congestion > $1 million.

2022/23 Long-Term Window – Timeline



Interregional Market Efficiency Update

Inter-regional Planning Update

- IPSAC – PJM / New York & New England
  - Dec. 5, 2022 meeting

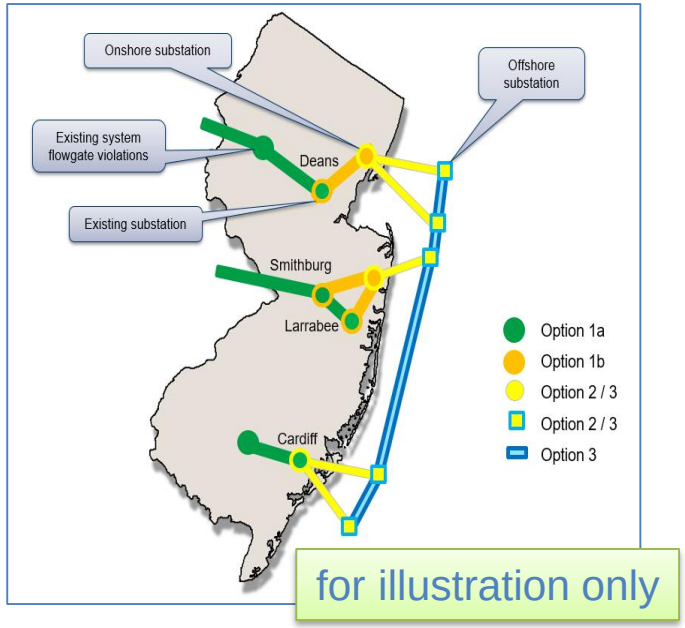
- IPSAC – PJM / MISO
  - Dec. 15, 2022 meeting

NJ Offshore SAA Window Update

2021 SAA Proposal Window to Support NJ OSW Update

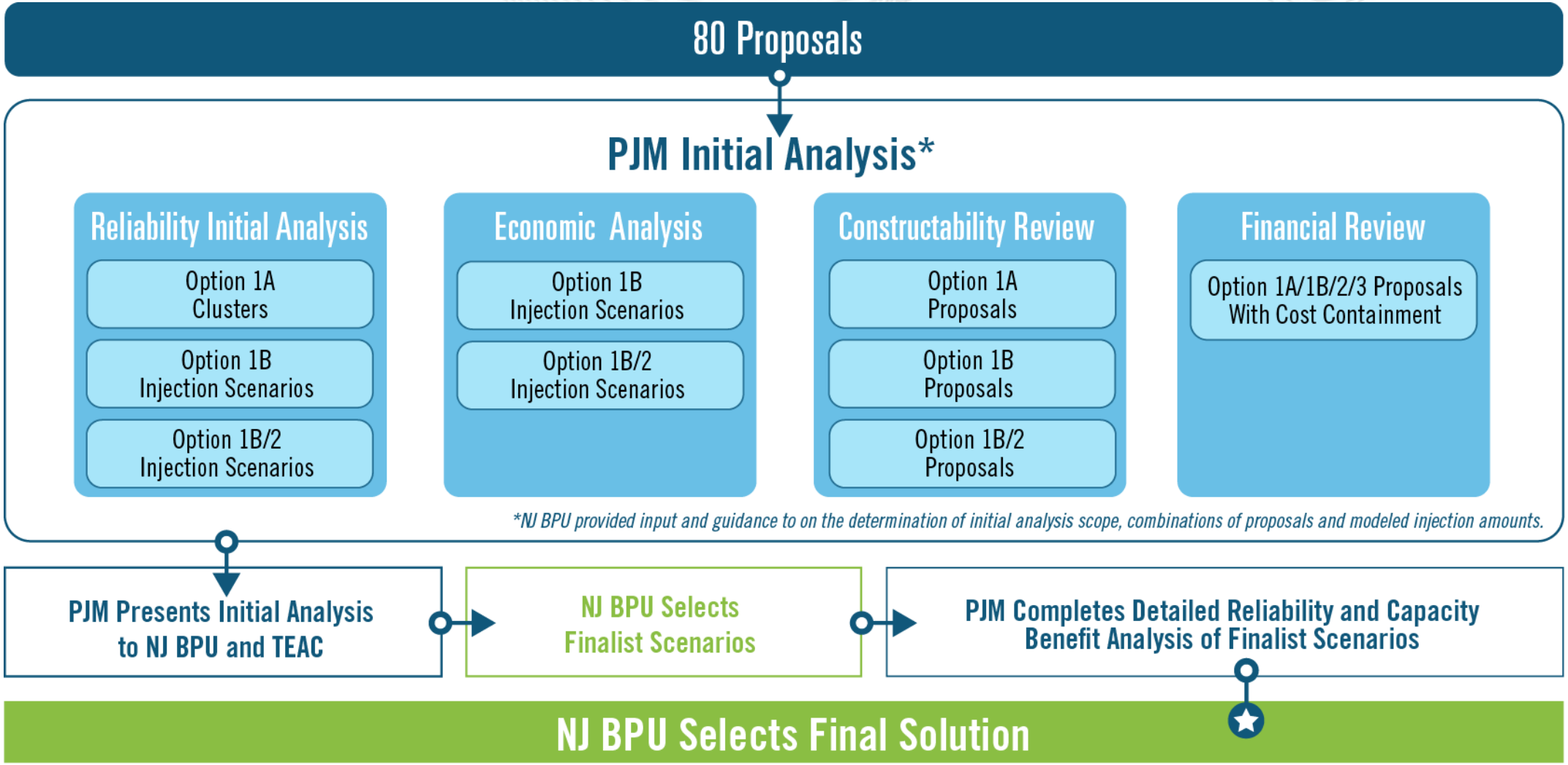
2021 SAA Proposal Window

- PJM opened an RTEP proposal window to solicit submissions to build the necessary transmission to meet New Jersey's goal of facilitating the delivery of a total of 7,500 MW of offshore wind through 2035
    - Window opened April 15, 2021
    - Window closed September 17, 2021
- Proposals were sought for upgrades for the follow options:
    - Option 1a – Onshore transmission upgrades
    - Option 1b – Onshore New Transmission Connection Facilities
    - Option 2 – Offshore New Transmission Connection Facilities
    - Option 3 – Offshore New Transmission Network



Note: Option designations refer to the four portions of the requested proposal as outlined in the *PJM RTEP – 2021 NJ OFFSHORE WIND TRANSMISSION SAA PROPOSAL WINDOW OVERVIEW* document

Evaluation Process Overview



- The completion of the initial reliability analysis screening and identification of an initial set of onshore upgrades for each scenario was necessary to provide the NJBPU with a comparative framework of preliminary transmission cost estimates for the scenarios under evaluation that consider both the offshore and onshore transmission needs. The NJBPU used this information to select four scenarios for a final, comprehensive reliability evaluation that included both a further review of the competitive Option 1a proposal clusters as necessary and a full set of reliability studies.
  - The four finalist scenarios were
    - Scenario 1.2c
    - Scenario 16a
    - Scenario 18
    - Scenario 18a
- PJM performed a comprehensive reliability analysis on these four finalist scenarios, to ensure the final transmission buildout satisfied all PJM reliability criteria.
- PJM also performed economic analysis, constructability evaluation, cost containment review and energy/capacity market benefits simulations as part of the initial screening analysis phase.

2021 SAA Proposal Window

- After the comprehensive reliability analysis and all other evaluations were complete, PJM provided the results to NJBPU.
- The NJBPU completed its independent evaluation of the proposals and selected the project, inclusive of all necessary components, that it will sponsor as a public policy project.
- the NJBPU issued an order notifying PJM of its selection of the transmission project, inclusive of all components, that it will sponsor to achieve its stated public policy goals of injecting 7,500 MW of offshore wind into New Jersey by 2035.
- The NJBPU has selected Scenario 18a solution identified as the “Larrabee Tri-Collector Solution” or “MAOD-JCP&L Option 1b Solution,” which includes elements of the Jersey Central Power & Light (JCP&L) Option 1b proposal #453, as well as scaled-down elements of Mid-Atlantic Offshore Development’s (MAOD’s) Option 2 proposal #551, and the necessary Option 1a upgrades to create the SAA Capability associated with the SAA scenario evaluating the Larrabee Tri-Collector Solution. The total cost for the selected solution is estimated to be $1.08 billion.

For more detail see links below

https://www.pjm.com/-/media/committees-groups/committees/teac/2022/20221104-special/nj-osw-saa-summary-report.ashx

https://www.pjm.com/-/media/committees-groups/committees/teac/2022/20221104-special/item-01---nj-osw-saa.ashx

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Appendix:

2022 RTEP Window 1 Proposal Cluster #2 Update

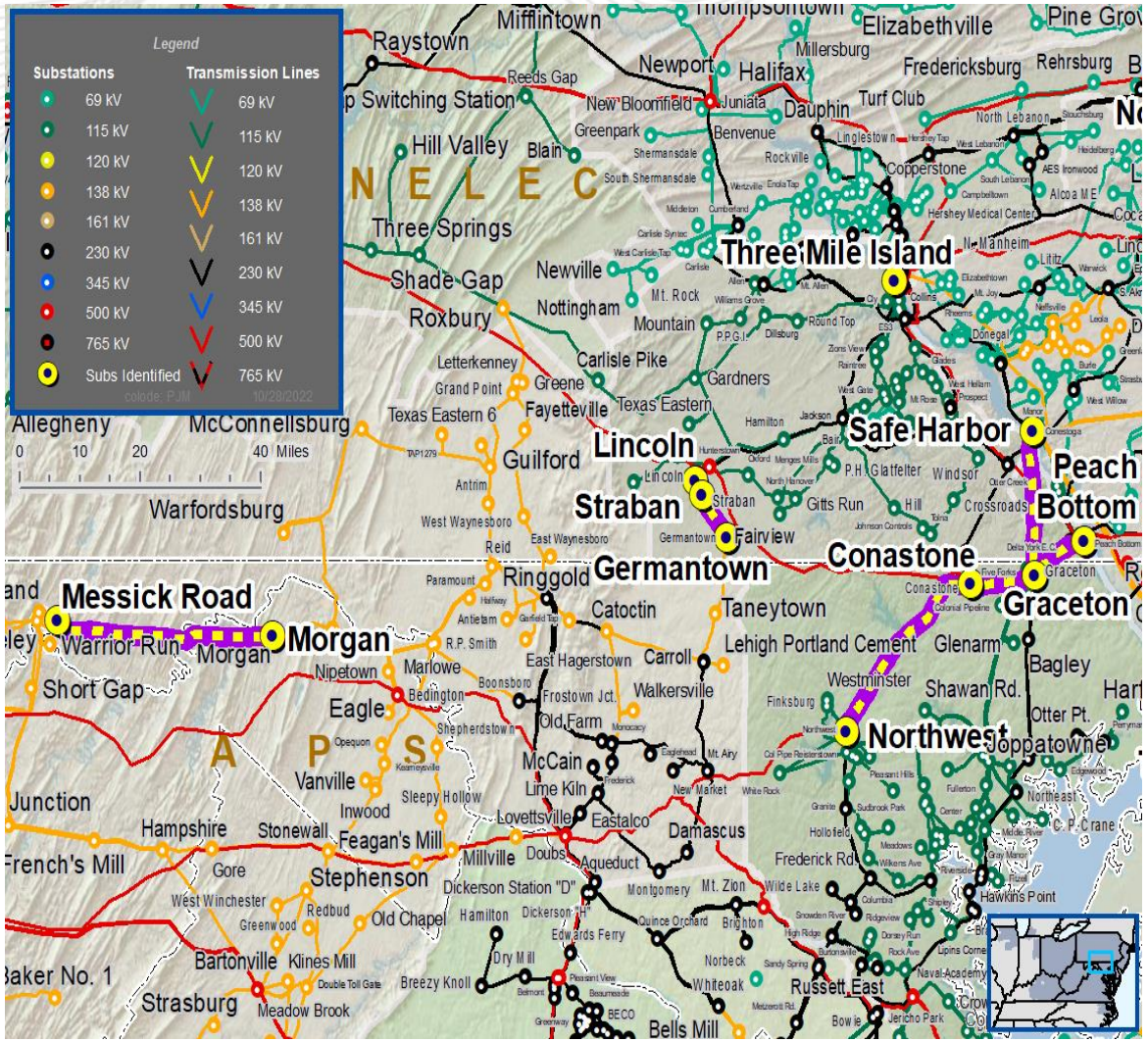
APS, BGE, MetEd and PECO Transmission Zone: Baseline

2022 RTEP Window 1 Cluster 2 - Projects Evaluation Progress

Problem Statement:

Thermal and voltage violations identified in the APS, BGE, MetEd, PECO area.

	List of Flowgates in Cluster #2				
Violations were posted as part of the 2022 Window 1	2022W1-GD-S10	2022W1-GD-S558	2022W1-GD-W33	2022W1-GD-W387	2022W1-GD-W42
	2022W1-GD-S1043	2022W1-GD-S559	2022W1-GD-W35	2022W1-GD-W388	2022W1-GD-W53
	2022W1-GD-S14	2022W1-GD-S570	2022W1-GD-W36	2022W1-GD-W39	2022W1-GD-W55
	2022W1-GD-S29	2022W1-GD-S578	2022W1-GD-W37	2022W1-GD-W391	2022W1-GD-W57
	2022W1-GD-S38	2022W1-GD-S634	2022W1-GD-W376	2022W1-GD-W411	2022W1-GD-W60
	2022W1-GD-W623	2022W1-N2-VM4	2022W1-N2-VM5	2022W1-N2-VM15	2022W1-N2-VM16
	2022W1-N2-VM17	2022W1-N2-VM18	2022W1-N2-VM19	2022W1-N2-VM20	2022W1-N2-VM21
	2022W1-N2-VM22	2022W1-N2-VM23	2022W1-N2-VM24	2022W1-N2-VM27	2022W1-N2-VM32
	2022W1-N2-VM33	2022W1-N2-VM34	2022W1-N2-VM35		



In this cluster, the below summarizes the projects being evaluated to address the violations;

- PJM received 9 proposals from five entities.
- Cost ranges between $2M and $386M
- PJM is working on the reliability evaluation.

First Review

Baseline Reliability Projects

Penelec Transmission Zone: Baseline

Process Stage: First Review

Criteria: TPL-001-4 R2 section 2.1.5 (Spare Equipment)

Assumption Reference: 2026 RTEP assumption

Model Used for Analysis: 2022 Summer, and 2026 RTEP Summer and Winter case

Proposal Window Exclusion: Substation Equipment

Problem Statement:

There are 2- 80 MVAR shunt reactors at Mainesburg 345 kV substation. High voltage violation at Mainesburg for the outage of the two Mainesburg shunt reactors. There is no spare reactor currently to address the high voltage issue if both shunt reactors are out of service.

Proposed Solution:
Purchase one 80 MVAR 345 kV spare reactor.

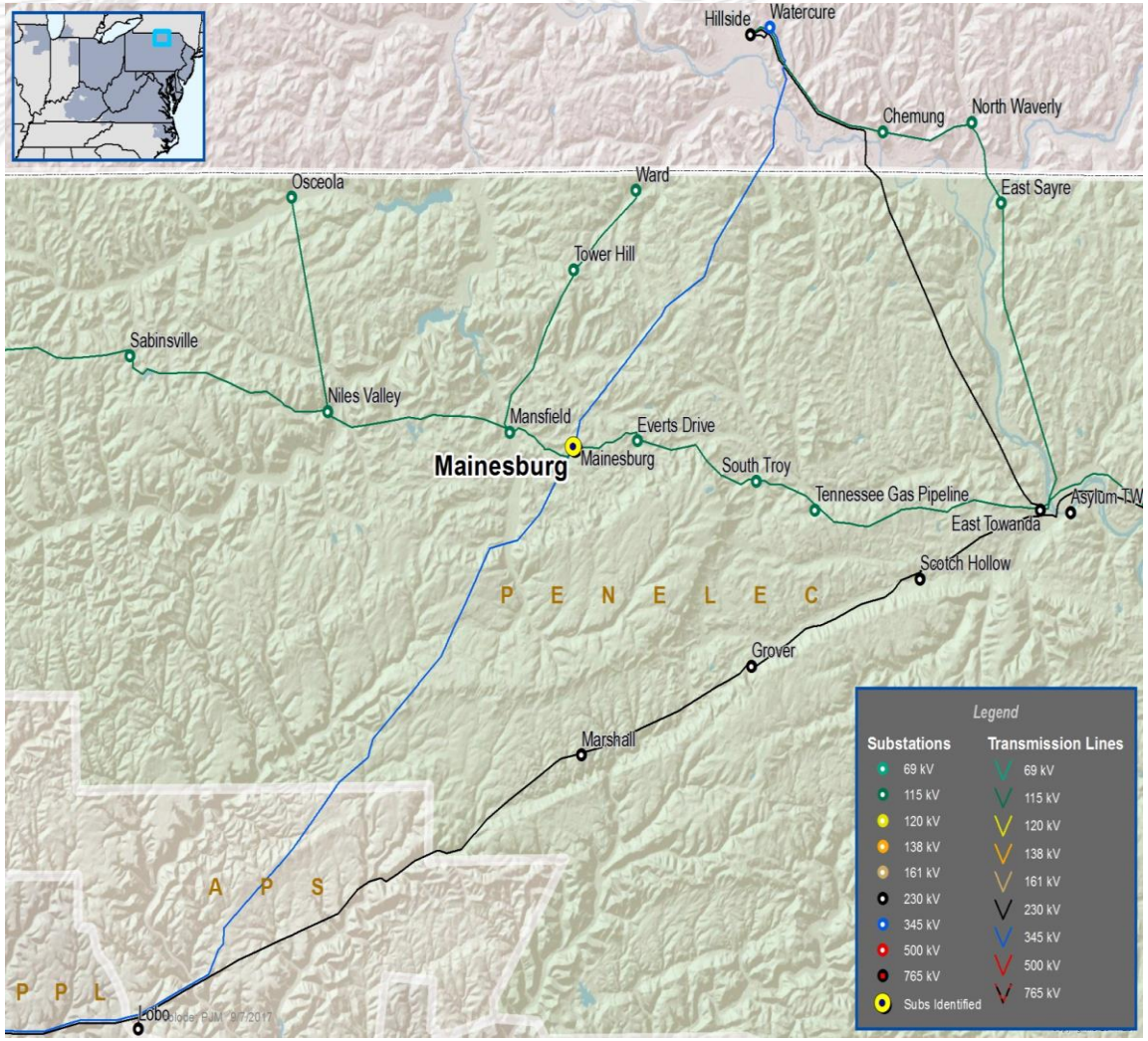
Estimated Cost: $6.44 M

Alternatives:

N/A

Required In-Service: 2022

Projected In-Service: 12/1/2025



Second Review

Baseline Reliability Projects

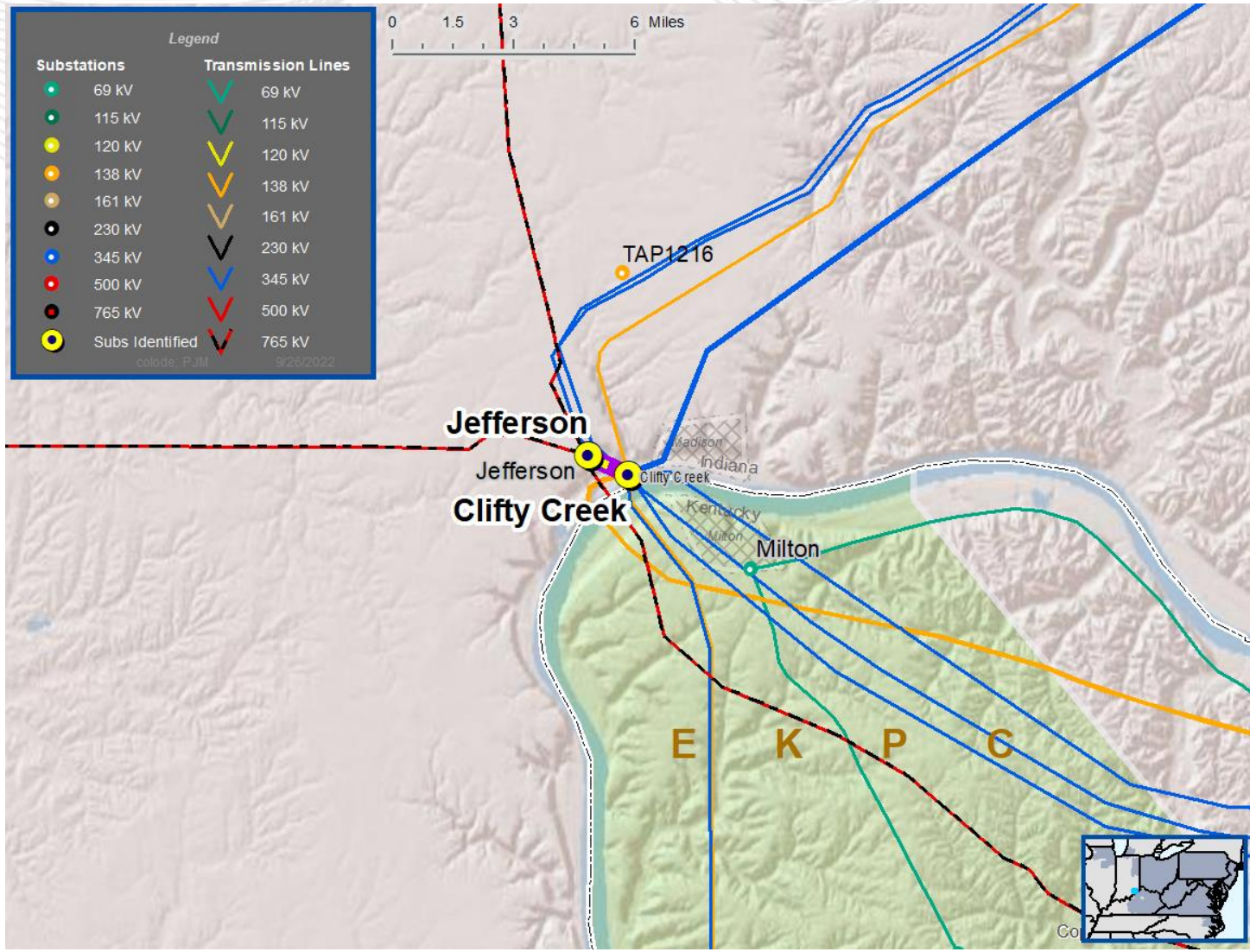
AEP Transmission Zone: Baseline Clifty Creek Switch Replacements

Process Stage: Recommended Solution
Criteria: Summer Generator Deliverability
Assumption Reference: 2027 RTEP assumption
Model Used for Analysis: 2027 RTEP Summer case
Proposal Window Exclusion: None
Problem Statement:
2022W1-GD-S632

In 2027 RTEP Summer case, The Jefferson – Clifty 345KV line is overload for a N-2 contingency in generator deliverability test.

Existing Facility Rating:

Branch	SN/SE/WN/WE (MVA)
05JEFRSO – 06CLIFTY 345kV	2056/2255/2669/2833



AEP Transmission Zone: Baseline Clifty Creek Switch Replacements

As part of the 2022 RTEP Window #1, the project listed in the table below is proposed to address the following violations: 2022W1-GD-S632

Proposal ID	Proposing Entity	Upgrade Description	Upgrade Cost ($M)
965	AEP	Replace four Clifty Creek 345 kV 3000 A switches with 5000 A 345 kV switches. Anticipated SN/SE rating for the branch section to be addressed (242865 to 248000) by the project is 2354/2354 MVA.	0.852

AEP Transmission Zone: Baseline Clifty Creek Switch Replacements

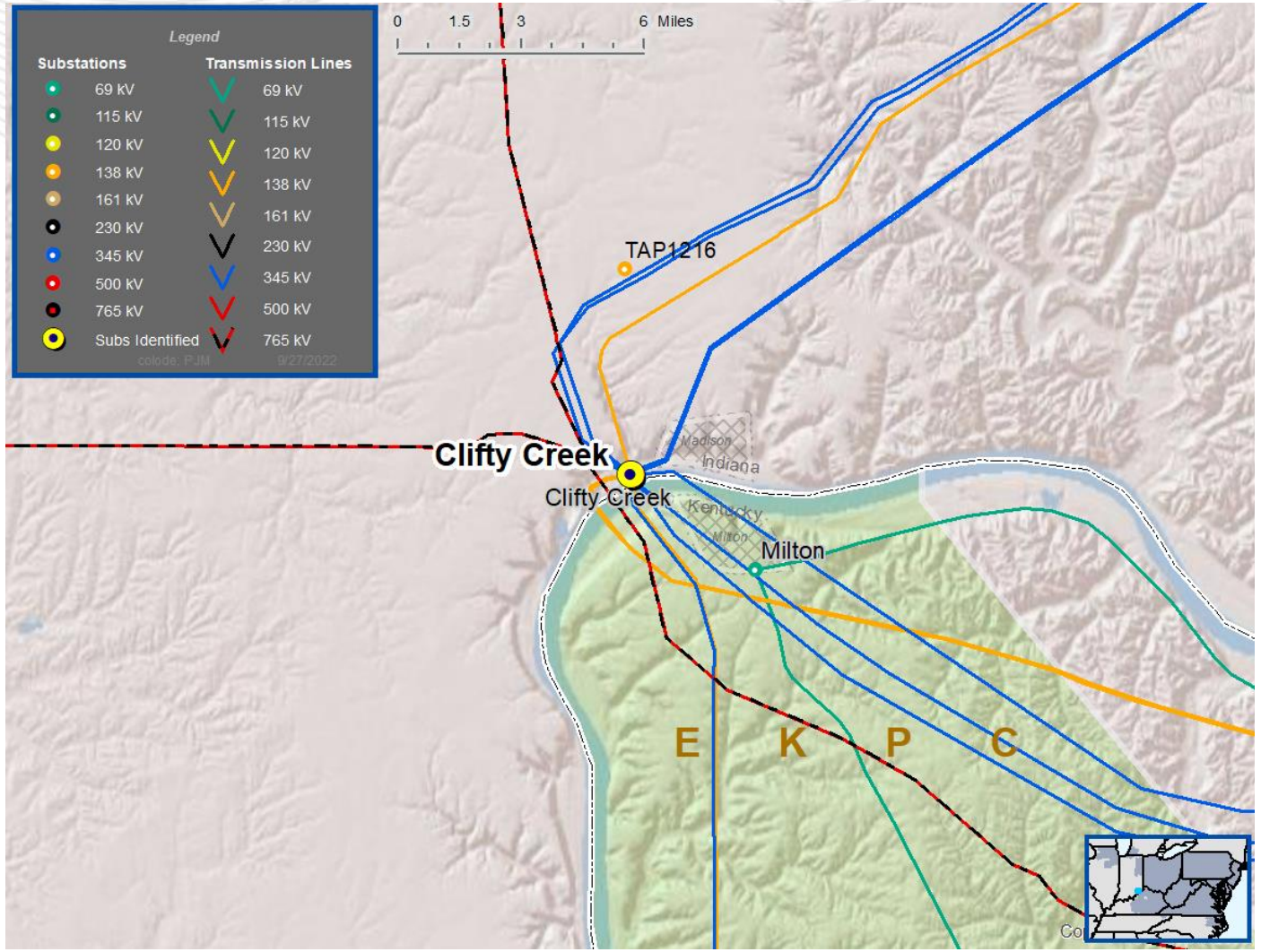
Recommended Solution: Proposal #2022_W1-965

Replace four Clifty Creek 345 kV 3000 A switches with 5000 A 345 kV switches. **(B3728)**

Preliminary Facility Rating:

Branch	SN/SE/WN/WE (MVA)
05JEFRSO – 06CLIFTY 345kV	2354/2354/2991/2991

Estimated Cost: $0.852M
Required IS Date: 6/1/2027
Projected IS Date: 6/30/2024
Previously Presented: 10/4/2022



APS Transmission Zone: Baseline
Black Oak Substation

Process Stage: Recommended solution

Criteria: Summer and Winter N-1-1 baseline Analysis

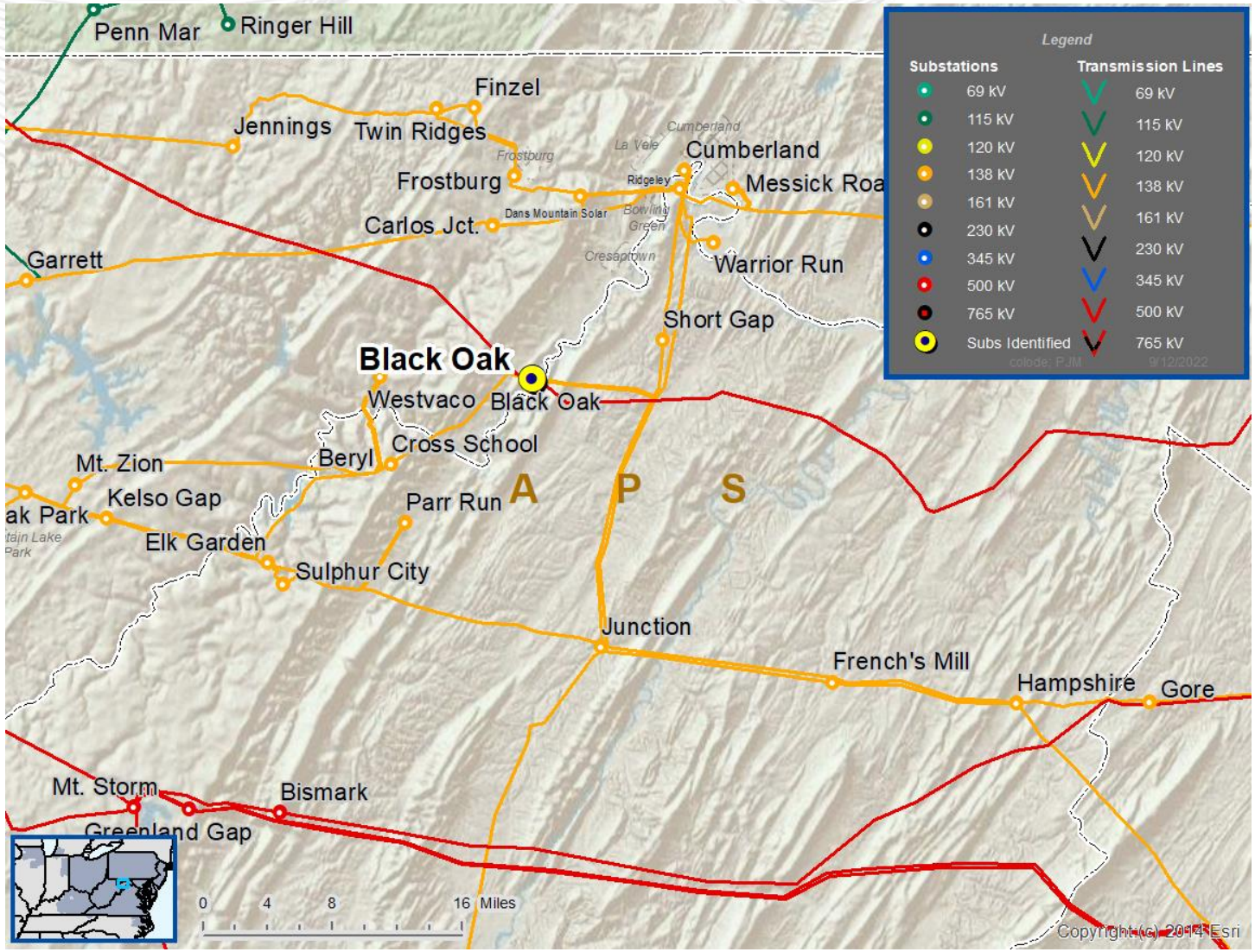
Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 RTEP winter case

Proposal Window Exclusion: None

Problem Statement: 2022W1-N2-SVD1 through 2022W1-N2-SVD41, 2022W1-N2-VD1 through 2022W1-N2-VD198

In the 2027 RTEP Summer and Winter case, there are several Voltage drop violations at the Black Oak 500 kV substation.



APS Transmission Zone: Baseline
Black Oak Substation

As part of the 2022 RTEP Window #1, the project listed in the table below is proposed to address the following violations: 2022W1-N2-SVD1 through 2022W1-N2-SVD41, 2022W1-N2-VD1 through 2022W1-N2-VD198

Proposal ID	Proposing Entity	Upgrade Description	Upgrade Cost ($M)
21	APS	Black Oak 500 kV Substation: Install New Bay Position for SVC and Install Transformer High Side Breaker	17.37

Recommended Solution: Proposal #2022_21

- Install two new 500 kV breakers on the existing open SVC string to create a new bay position. Relocate & Re-terminate facilities as necessary to move the 500 kV SVC into the new bay position.
- Install a 500 kV breaker on the 500/138 kV #3 transformer. Upgrade relaying at Black Oak Substation . **(b3726)**

Total Estimated Cost: $17.37M

Required IS Date: 6/1/2027
Projected IS Date: 6/1/2027
Previously Presented: 10/4/2027

BGE/PECO Transmission Zone: Baseline

Process Stage: Second Review

Criteria: Winter Generator Deliverability

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 RTEP Winter case

Proposal Window Exclusion: Substation Equipment

Problem Statement:

The Peach Bottom – Conastone 500 kV kV circuit is overloaded for multiple contingencies.

Violations were posted as part of the 2022 Window 1: FG# GD-W35, GD-W39, GD-W53, GD-W57 and GD-W60

Existing Facility Rating: 2828SN/3526E, 3464WN/3700WE MVA

Proposed Facility Rating: 2920SN/3620SE, 3592WN/4290WE

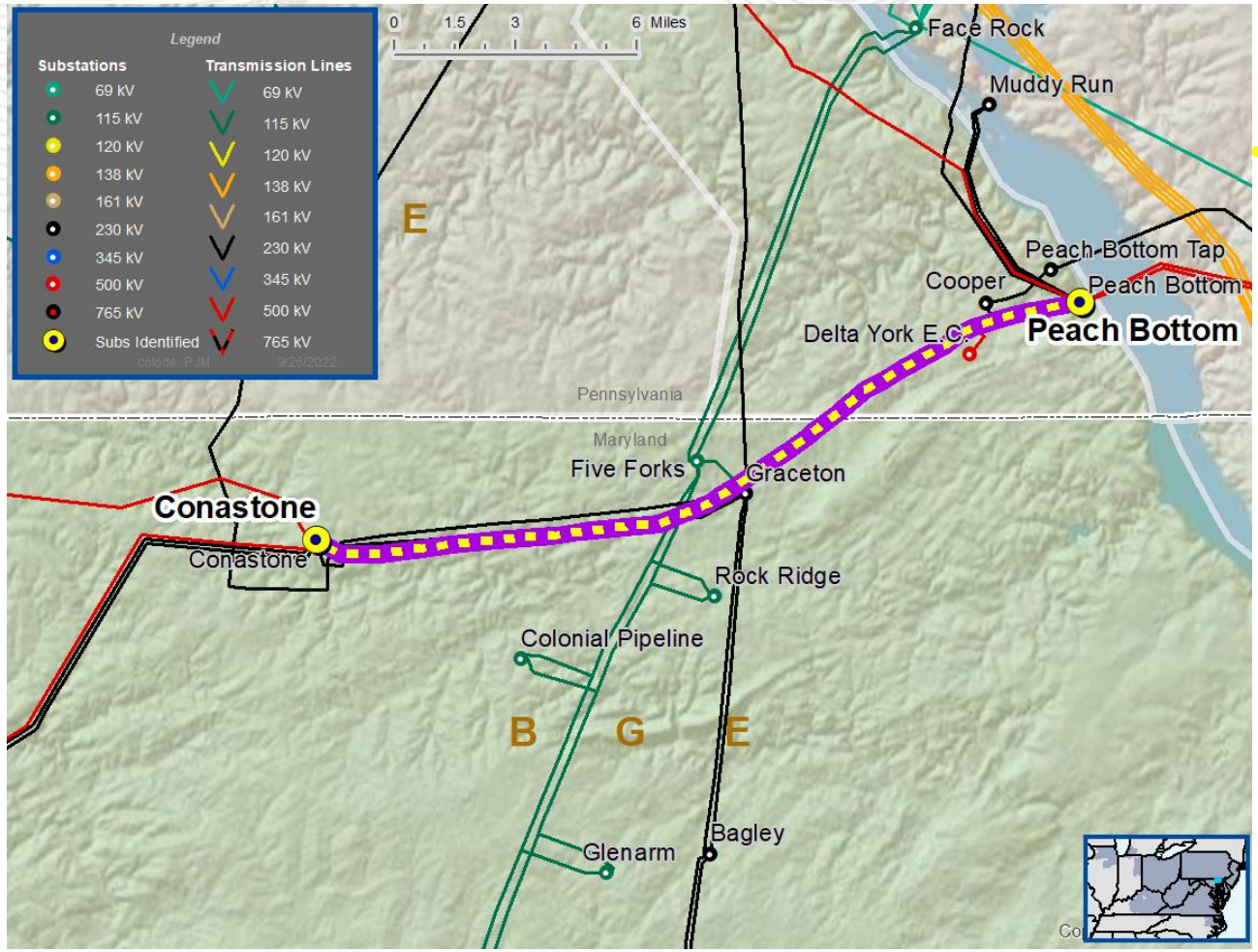
Recommended Solution:
BGE: - Upgrade two Breaker bushinsgs on the 500kV Line 5012 (Conastone – Peach Bottom) at Conastone Substation. (B3728.1)
PECO: Replace 4 meters and bus work inside Peach Bottom substation on the 500 kV Line 5012 (Conastone – Peach Bottom). (B3728.2)

Estimated Cost: $5.8 M

Alternatives: N/A

Required In-Service: 12/1/2027

Projected In-Service: 12/1/2027



DPL Transmission Zone: Baseline

Process Stage: Second Review

Criteria: Summer Generator Deliverability

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 RTEP Summer case

Proposal Window Exclusion: None

Problem Statement:

The Conowingo – Colora 230 kV kV circuit is overloaded for single contingency.

Violations were posted as part of the 2022 Window 1: FG# GD-S36

Existing Facility Rating: 420SN/536E, 485WN/604WE MVA

Proposed Facility Rating: 462SN/559SE, 520WN/636WE

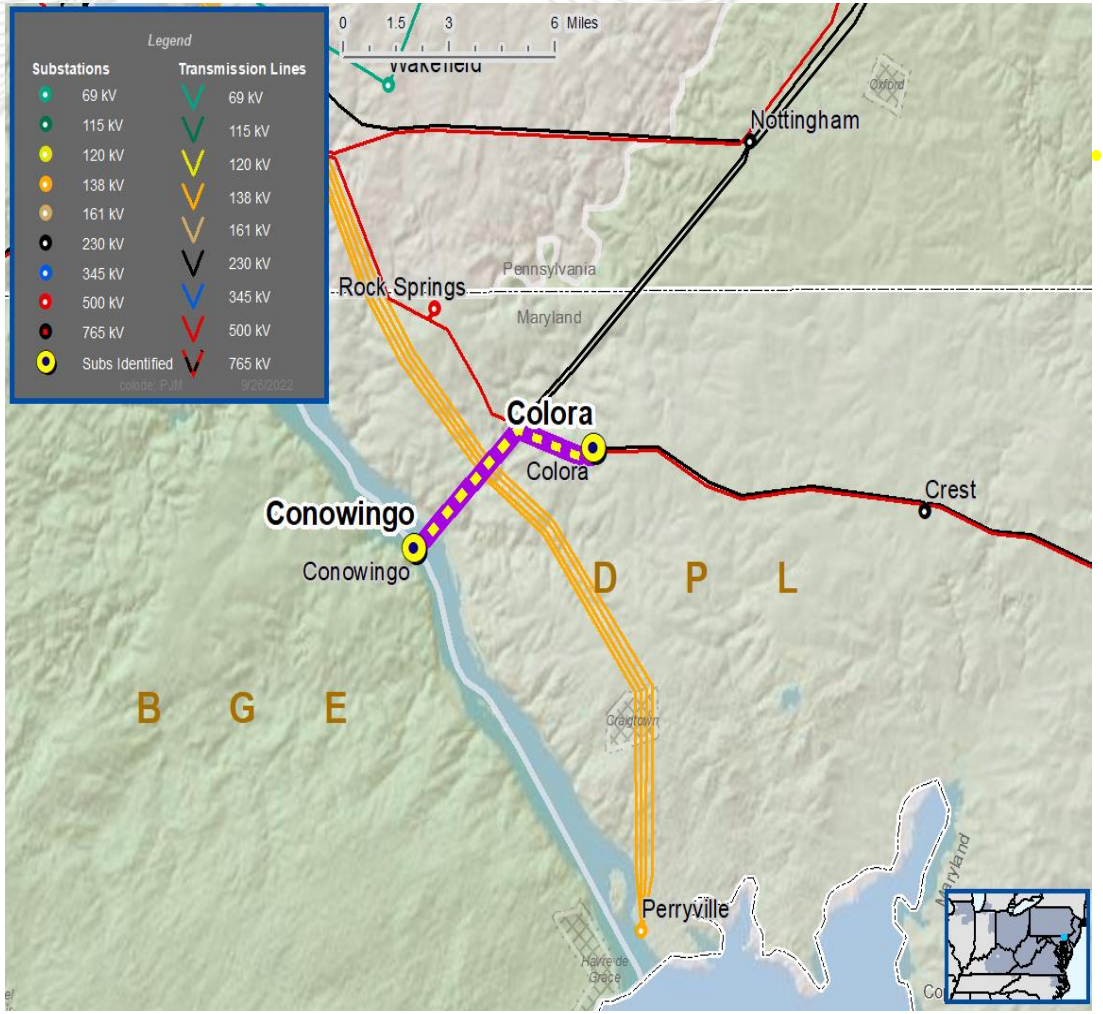
Recommended Solution:
Proposal ID 236: Upgrade dead end structures on Conowingo – Colora 230 kV line in DPL to increase the line rating. Increase the Maximum Operating Temperature of DPL Circuit 22088 from 125 C to 140 C, by installing cable shunts on each phase, on each side of four (4) dead-end structures, and replacing the existing insulator bells. (B3729)

Estimated Cost: $0.2625 M

Alternatives: N/A

Required In-Service: 6/1/2027

Projected In-Service: 6/1/2027



PPL Transmission Zone: Baseline

Process Stage: Second Review

Criteria: Summer Generator Deliverability

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 RTEP Summer case

Proposal Window Exclusion: None

Problem Statement:

The Lackawanna 500/230 kV transformer # T3 is overloaded for line fault stuck breaker contingency.

Violations were posted as part of the 2022 Window 1: FG# GD-S595

Recommended Solution:
Proposal ID 127: Re-terminate the Lackawanna T3 and T4 500/230 kV transformers on the 230 kV side to remove them from the 230 kV buses and bring them into dedicated bay positions that are not adjacent to one another. (B3730)

Estimated Cost: $10.7 M

Alternatives:

Proposal ID 553: Replace the existing Lackawanna 500/230 kV T3 and T4 transformers with larger 1250 MVA units. Upgrade bay equipment to accommodate the new higher rated transformers. (Cost Estimate: $55.97 M)

Proposal ID 907: Re-terminate the Lackawanna Energy from 230 kV to 500 kV through new 500/230 kV transformer. (Cost Estimate: $51.48 M)

Required In-Service: 6/1/2027

Projected In-Service: 1/30/2026