Market Efficiency Update

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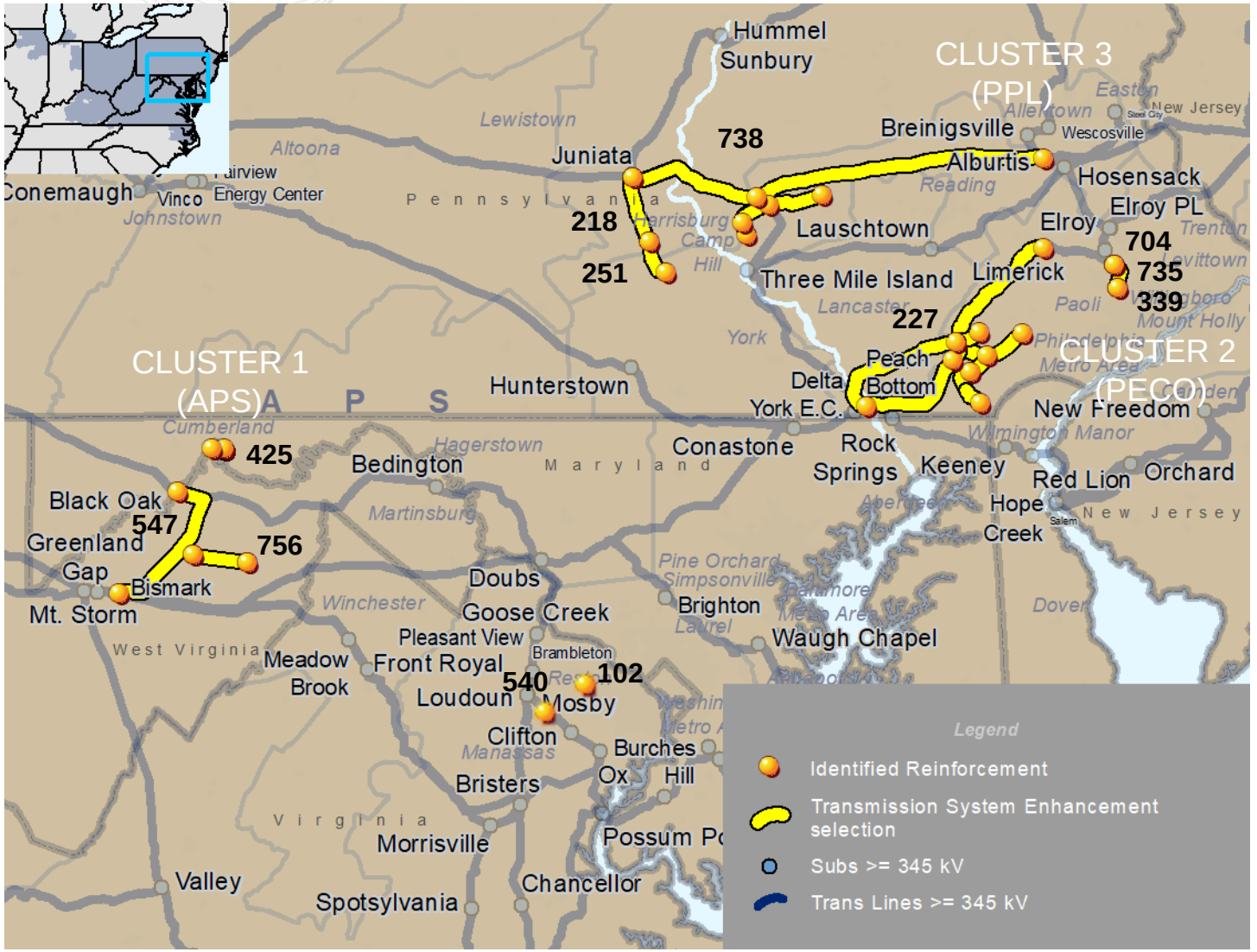
2020/21 Long-Term Window 1

2020/21 Long-Term Window 1 - Overview

- 2020/21 Long-Term Window 1
  - Opened on January 11, 2021 and closed on May 11, 2021.
  - 4 congestion drivers posted:
    - Cluster No. 1 (APS) - French's Mill to Junction 138 kV.
    - Cluster No. 2 (PECO) - Plymouth Meeting to Whitpain 230 kV.
    - Cluster No. 3 (PPL) - Juniata to Cumberland 230 kV.
    - Cluster No. 4 (DOM) - Charlottesville to Proffit 230 kV.
  - 24 proposals received from 7 submitting entities (10 greenfield proposals, 14 upgrades).

- Charlottesville to Proffit 230 kV (DOM)
  - Constraint also posted as a reliability violation in the 2021 Window 1.
  - Proposals must be submitted to the 2021 Window 1 to be included in the reliability window evaluation.

2020/21 Long-Term Window 1 – Map Clusters 1, 2, 3



**Cluster 4 (DOM) not shown on the map.*

Initial Review and Screening – Cluster Nos.1, 2, and 3

- Completed
  - Data validation.
  - Preliminary reliability and market efficiency analyses Cluster Nos. 1 (APS), 2 (PECO) and 3 (PPL).
  - Cluster 4 proposals will be evaluated in conjunction with the reliability window*.
- Initial Reviews
  - Performance Review – PJM evaluated whether or not the project proposal satisfied the benefit to cost ratio threshold of 1.25 and solved the required congestion driver.
  - Planning Level Cost Review – PJM reviewed the estimated project cost submitted by the project sponsor and any relevant cost containment mechanisms submitted.
  - Feasibility Review – PJM reviewed the overall proposed implementation plan to determine if the project, as proposed, can feasibly be constructed.
- Individual descriptions of submitted proposals included in Appendix A.
  - Redacted Public Proposals for 2020/2021 RTEP Proposal Window 1.

Preliminary B/C Ratios – Clusters No.1, 2, and 3

- All proposals passed a preliminary N-1 thermal violation screening.
  - Also used to determine list of flowgates to monitor.

- Calculated PJM benefits and determined preliminary B/C ratios.
  - Preliminary B/C ratios were computed using the submitted in-service cost of components.
  - Base case – first presented at the August TEAC.
  - Sensitivities*: FSA, High/Low Load Forecast, High/Low Gas Price Forecast (see slides 9, 12, 15).

- A high level review of the plans identified in each of the proposals did not reveal any other concerns at this stage of PJM's review.

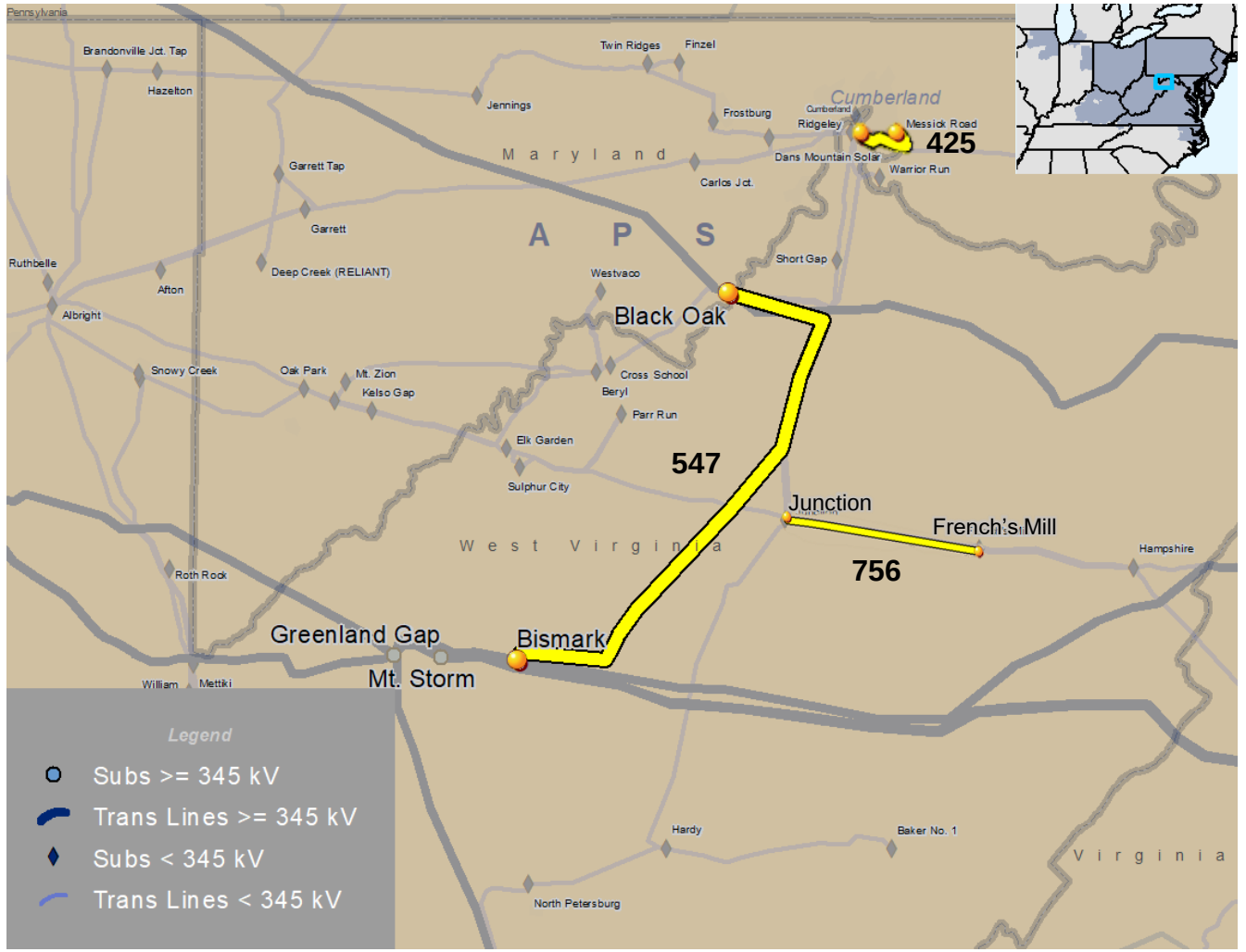
*For informational purposes only

2020/21 Long-Term Window 1
Preliminary Results Cluster No. 1 (APS)

Cluster No. 1 (APS) - Map

- 102*: Capacitor bank at Reston 230 kV substation.
- 425: Replace terminal equipment on the French's Mill-Junction 138 kV line. Reconductor Messick Road-Ridgeley 138 kV line.
- 540*: Capacitor bank at Bull Run 230 kV substation.
- 547: Build 500 kV transmission line connecting Black Oak Substation and Bismark Substation.
- 756: Replace terminal equipment on the French's Mill-Junction 138 kV line.

Note: More details in Initial Review & Screening - 2020-2021 Long Term Window 1 - Cluster 1 (APS).



** Proposals 102 and 540, capacitor banks at Reston and Bull Run 230 kV, are not show on the map.*

Cluster No. 1 (APS) - Preliminary B/C Ratios: Base Case and Sensitivities

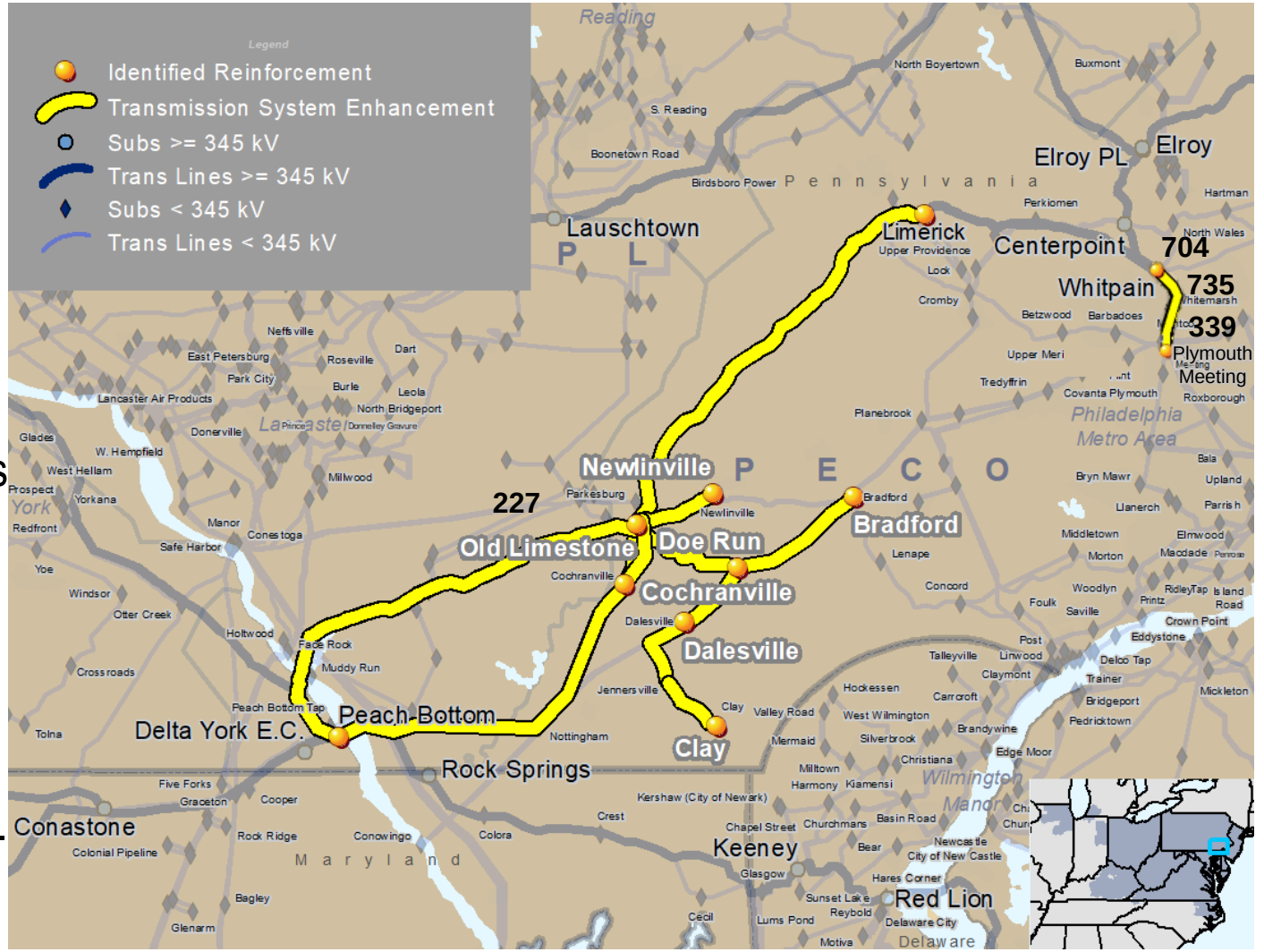
Proposal ID	102	425	540	547	756
Proposal Description	Reston 230kV Capacitor	Reconductor Messick Rd-Ridgeley	Bull Run 230kV Capacitor	Black Oak to Bismark 500kV Line	French's Mill - Junction Terminal Upgrades
Project Type	Upgrade	Upgrade	Upgrade	Greenfield	Upgrade
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Regional	Lower Voltage
In-Service Cost ($MM)*	$1.89	$11.99	$5.73	$128.75	$0.77
Cost Containment*	No	No	No	Yes	No
In-Service Year	2022	2025	2023	2025	2022
% Cong Driver Mitigated	0%	100%	0%	100%	100%
Shifted Congestion	N/A	Bla-Bed Interface	N/A	Bla-Bed Interface	Messick Rd-Ridgeley, Bla-Bed Interface
Base Case B/C Ratio	N/A	13.64	N/A	0.74	189.91
FSA Sens. B/C Ratio	N/A	22.62	N/A	1.12	327.83
Low Load B/C Ratio	N/A	6.41	N/A	0.35	103.74
High Load B/C Ratio	N/A	6.02	N/A	0.49	77.68
Low Gas B/C Ratio	N/A	2.51	N/A	0.22	31.90
High Gas B/C Ratio	N/A	7.88	N/A	0.44	112.23

** Note: Costs under review by PJM.*

2020/21 Long-Term Window 1
Preliminary Results Cluster No. 2 (PECO)

Cluster No. 2 (PECO) - Map

- 227: Interconnect Peach Bottom - Limerick 500kV and Cochranville - Newlinville 230kV lines via new Old Limestone 500/230 kV substation. Build new 230 kV Doe Run substation and interconnect Daleville - Bradford and Clay Tap - Bradford 230kV lines. Build new Old Limestone to Doe Run line.
- 399: Install Smart Wires device in series with the 220-13 and 220-14 Whitpain-Plymouth 230 kV lines and upgrade terminal equipment at Whitpain and Plymouth substations.
- 704: Upgrade terminal equipment at Whitpain and Plymouth substations.
- 735: Reconductor the 220-13 and 220-14 Whitpain-Plymouth 230 kV lines.



Note: More details in Initial Review & Screening - 2020-2021 Long Term Window 1 - Cluster 2 (PECO).

Cluster No. 2 (PECO) - Preliminary B/C Ratios: Base Case and Sensitivities

Proposal ID	227	399	704	735
Proposal Description	Old Limestone - Doe Run 500/230kV New line	Plymouth-Whitpain 220-13, 220-14 SmartWires	Plymouth-Whitpain 220-13, 220-14 Terminal Upgrades	Rebuild Plymouth-Whitpain 220-13, 220-14 Circuits
Project Type	Greenfield	Upgrade	Upgrade	Upgrade
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage
In-Service Cost ($MM)*	$73.51	$8.42	$0.62	$14.98
Cost Containment*	Yes	No	No	No
In-Service Year	2025	2025	2025	2025
% Cong Driver Mitigated	99.81%	100%	97.82%	100%
Shifted Congestion	No significant shift	No significant shift	No significant shift	No significant shift
Base Case B/C Ratio	0.84	6.18	77.06	2.60
FSA Sens. B/C Ratio	0.93	2.40	20.48	0.47
Low Load B/C Ratio	0.66	2.10	26.83	1.24
High Load B/C Ratio	0.72	5.56	79.75	3.31
Low Gas B/C Ratio	0.42	2.61	34.89	1.59
High Gas B/C Ratio	0.69	4.13	44.91	2.14

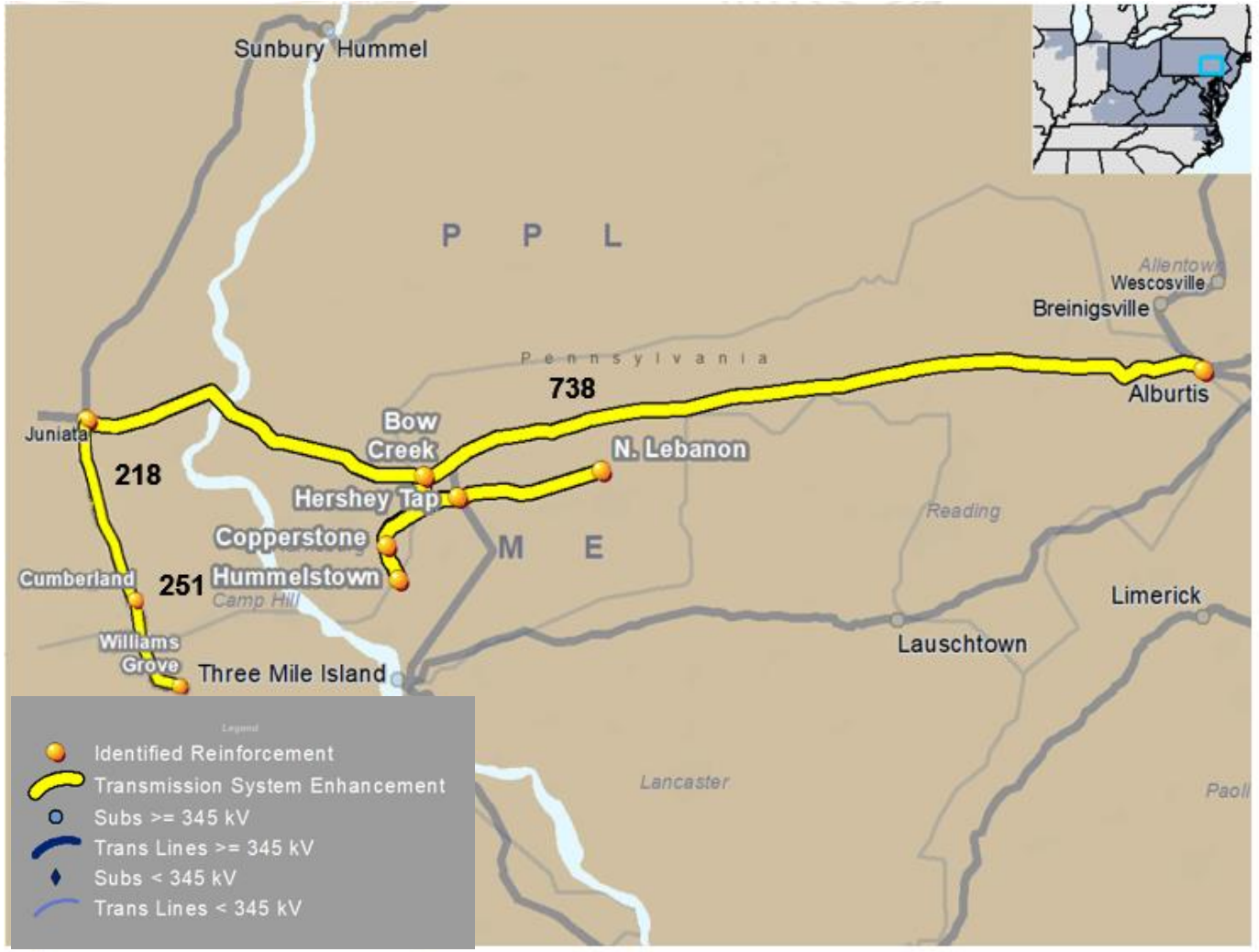
** Note: Costs under review by PJM.*

2020/21 Long-Term Window 1
Preliminary Results Cluster No. 3 (PPL)

Cluster No. 3 (PPL) - Map

- 102*: Capacitor bank at Reston 230 kV substation.
- 218: Reconductor the Juniata - Cumberland 230 kV line.
- 251: Rebuild the existing single circuit Juniata - Cumberland 230 kV section to double circuit. Upgrade the Cumberland to William Grove 230 kV line.
- 540*: Capacitor bank at Bull Run 230 kV substation.
- 738: Build new 500/230 kV Bow Creek tap substation on Juniata – Alburtis 500kV line to interconnect North Hershey - Hummelstown and North Lebanon – Copperstone 230kV lines.

Note: More details in Initial Review & Screening - 2020-2021 Long Term Window 1 - Cluster 3 (PPL).



** Proposals 102 and 540, capacitor banks at Reston and Bull Run 230 kV, are not show on the map.*

Cluster No. 3 (PPL) - Preliminary B/C Ratios: Base Case and Sensitivities

Proposal ID	102	218	251	540	738
Proposal Description	Reston 230kV Capacitor	Juniata - Cumberland 230 kV Line Reconductor	Juniata - Cumberland 230 kv Double Circuit Rebuild	Bull Run 230kV Capacitor	Bow Creek 500/230kV Project
Project Type	Upgrade	Upgrade	Upgrade	Upgrade	Greenfield
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage
In-Service Cost ($M)*	$1.89	$9.00	$49.05	$5.73	$55.05
Cost Containment*	No	Yes	No	No	Yes
In-Service Year	2022	2023	2024	2023	2025
% Cong Driver Mitigated	0%	100%	100%	0%	95.85%
Shifted Congestion	N/A	No significant shift	No significant shift	N/A	No significant shift
Base Case B/C Ratio	N/A	13.61	2.88	N/A	2.71
FSA Sens. B/C Ratio	N/A	21.01	3.40	N/A	2.60
Low Load B/C Ratio	N/A	5.90	1.13	N/A	1.06
High Load B/C Ratio	N/A	11.32	2.21	N/A	2.01
Low Gas B/C Ratio	N/A	6.52	1.09	N/A	1.29
High Gas B/C Ratio	N/A	12.82	2.42	N/A	2.20

** Note: Costs under review by PJM*

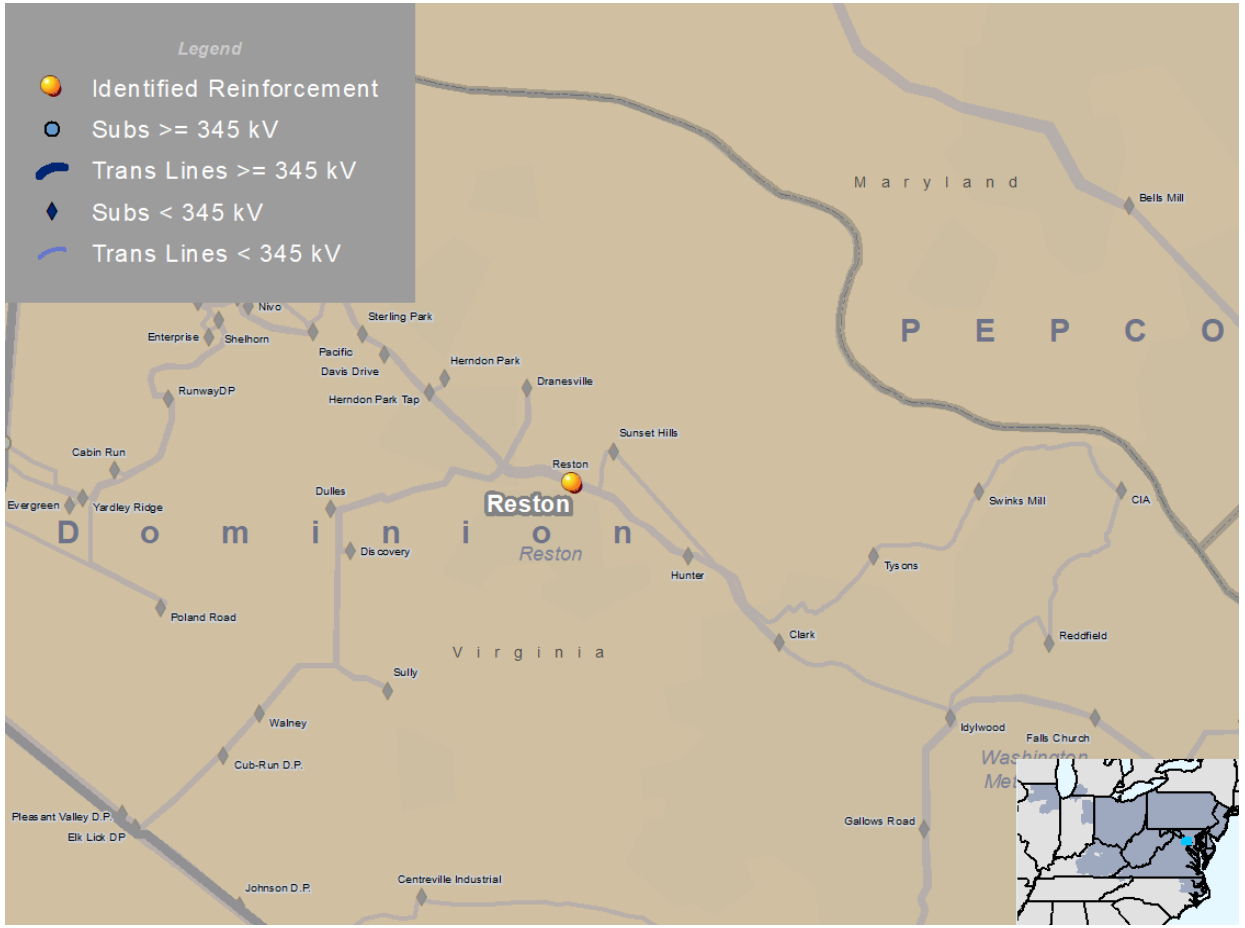
Next Steps

- Finalize retooling Market Efficiency Base Case that will be used to conduct the final review of all proposals.
- Cost / Constructability Analysis as needed.
- PJM intends to share the results of the final review with stakeholders at the December TEAC after which a final recommendation will be made to the PJM Board for review and approval.

Appendix A
2020/21 Long-Term Window 1
Individual Proposal Descriptions

Proposal No. 102 (Reston 230kV Capacitor)

Project ID: 202021_102
Proposed Solution: Install 178.2 MVAR capacitor at Reston 230 kV substation
Project Type: Upgrade
kV Level: 230 kV
In-Service Cost ($M): $1.89
In-Service Year: 2022
Target Zone: APS, PPL
ME Constraints: Junction to French's Mill 138 kV, Cumberland to Juniata 230 kV
Notes: Redacted Public Proposal 102



Proposal No. 425 (Reconductor Messick Rd-Ridgeley)

Project ID: 202021_425

Proposed Solution:
Replace terminal equipment on the French's Mill-Junction 138 kV line. Reconductor existing line segments on the Messick Road-Ridgeley 138 kV line. Replace the remote end equipment for the Messick Road-Ridgeley 138 kV line.

Project Type: Upgrade

kV Level: 138 kV

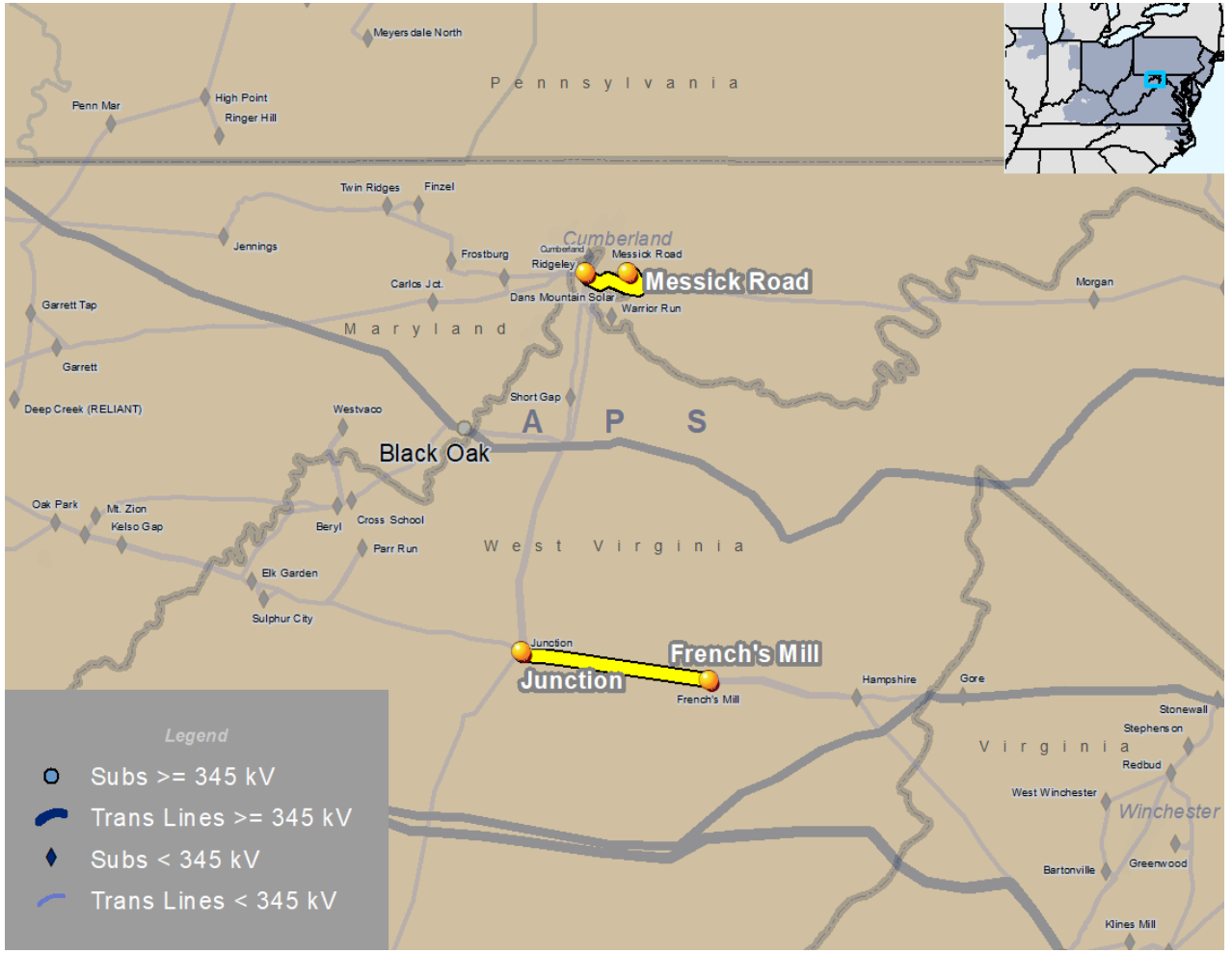
In-Service Cost ($M): $11.99

In-Service Year: 2025

Target Zone: APS

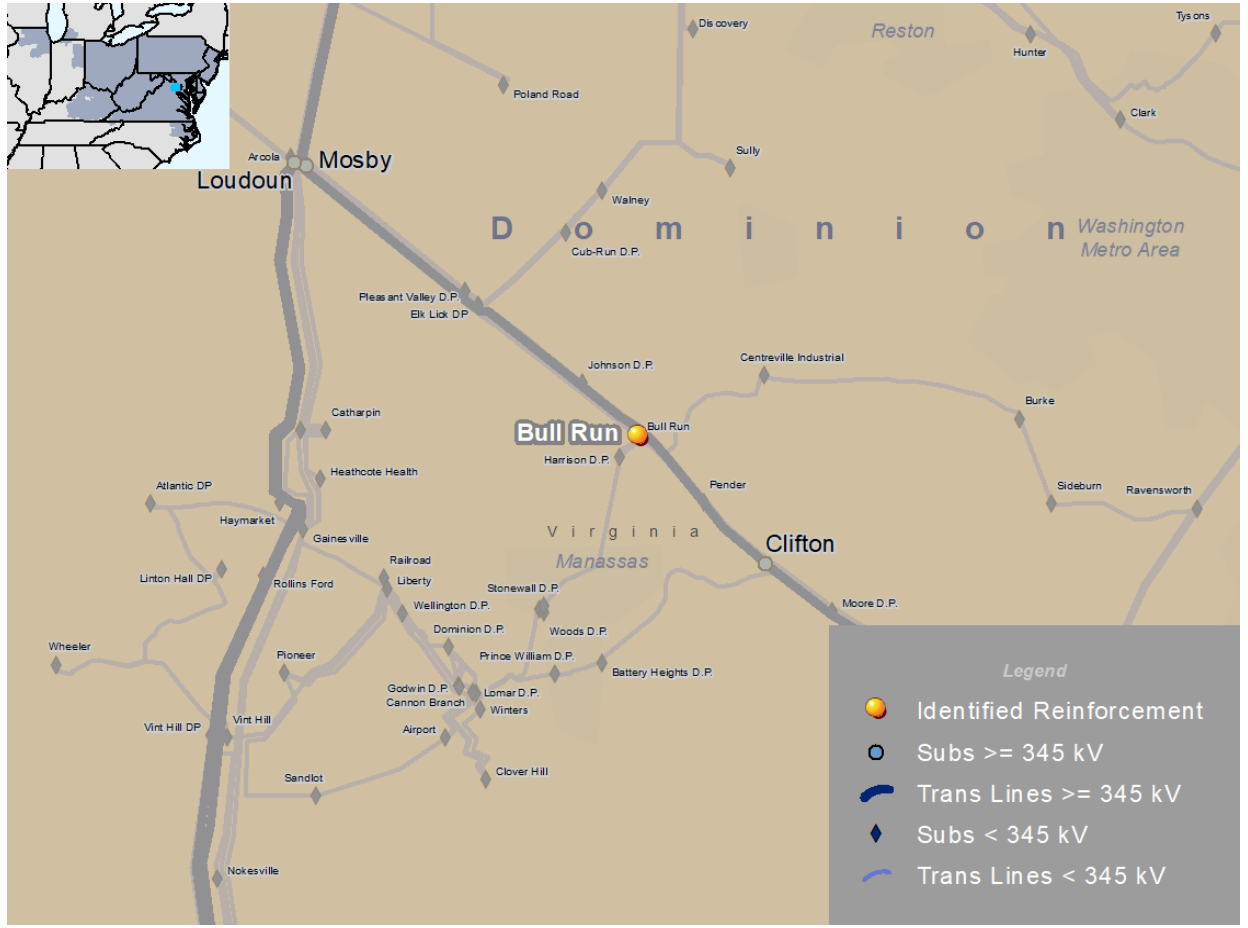
ME Constraints:
Junction to French's Mill 138 kV

Notes: Redacted Public Proposal 425



Proposal No. 540 (Bull Run 230kV Capacitor)

Project ID: 202021_540
Proposed Solution: Install 356 MVAR capacitor at Bull Run 230 kV substation
Project Type: Upgrade
kV Level: 230 kV
In-Service Cost ($M): $5.73
In-Service Year: 2023
Target Zone: APS, PPL
ME Constraints: Junction to French's Mill 138 kV, Cumberland to Juniata 230 kV
Notes: Redacted Public Proposal 540



Proposal No. 547 (Black Oak to Bismark 500kV Line)

Project ID: 202021_547

Proposed Solution:
The Black Oak - Bismark 500kV Transmission Project will include a new 500kV Transmission Line connecting to new line positions at Black Oak Substation and Bismark Substation.

Project Type: Greenfield

kV Level: 500 kV

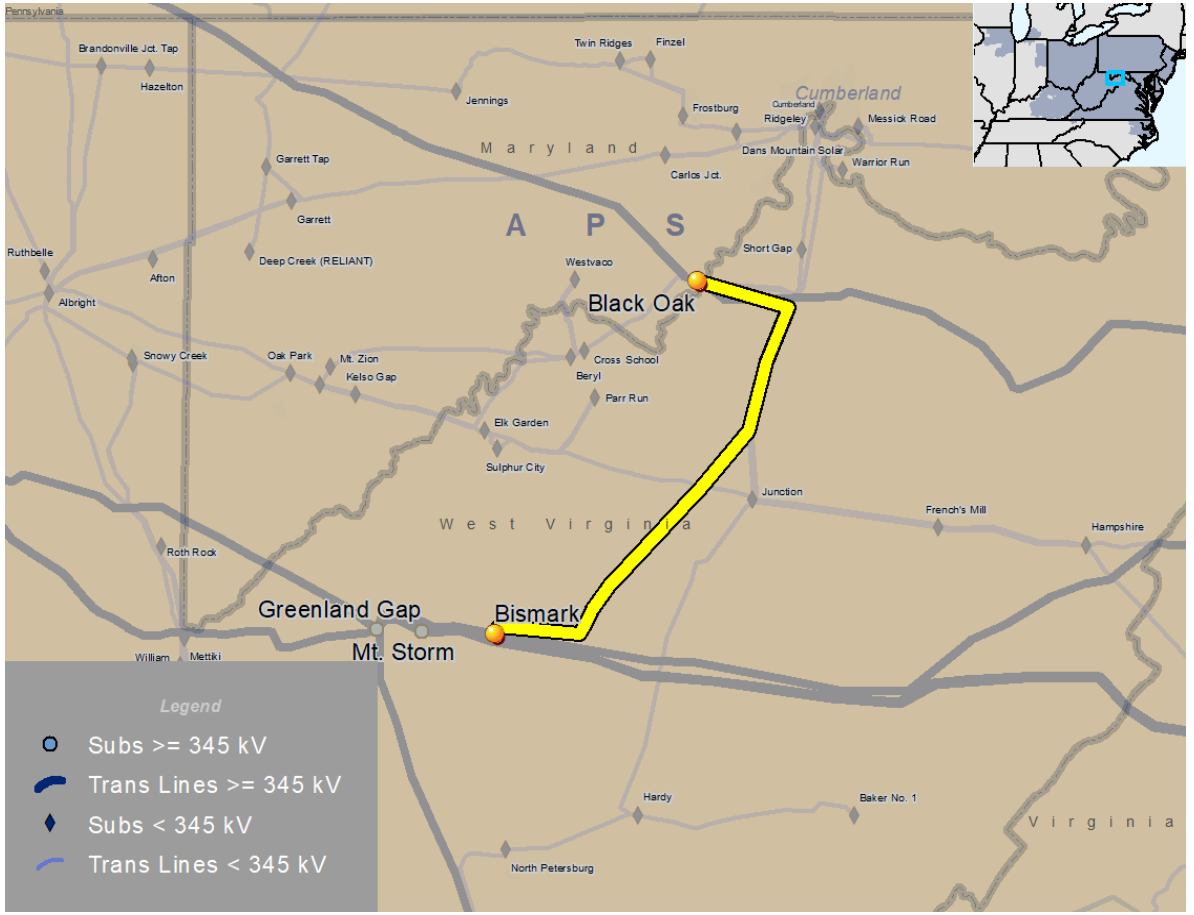
In-Service Cost ($M): $128.75

In-Service Year: 2025

Target Zone: APS

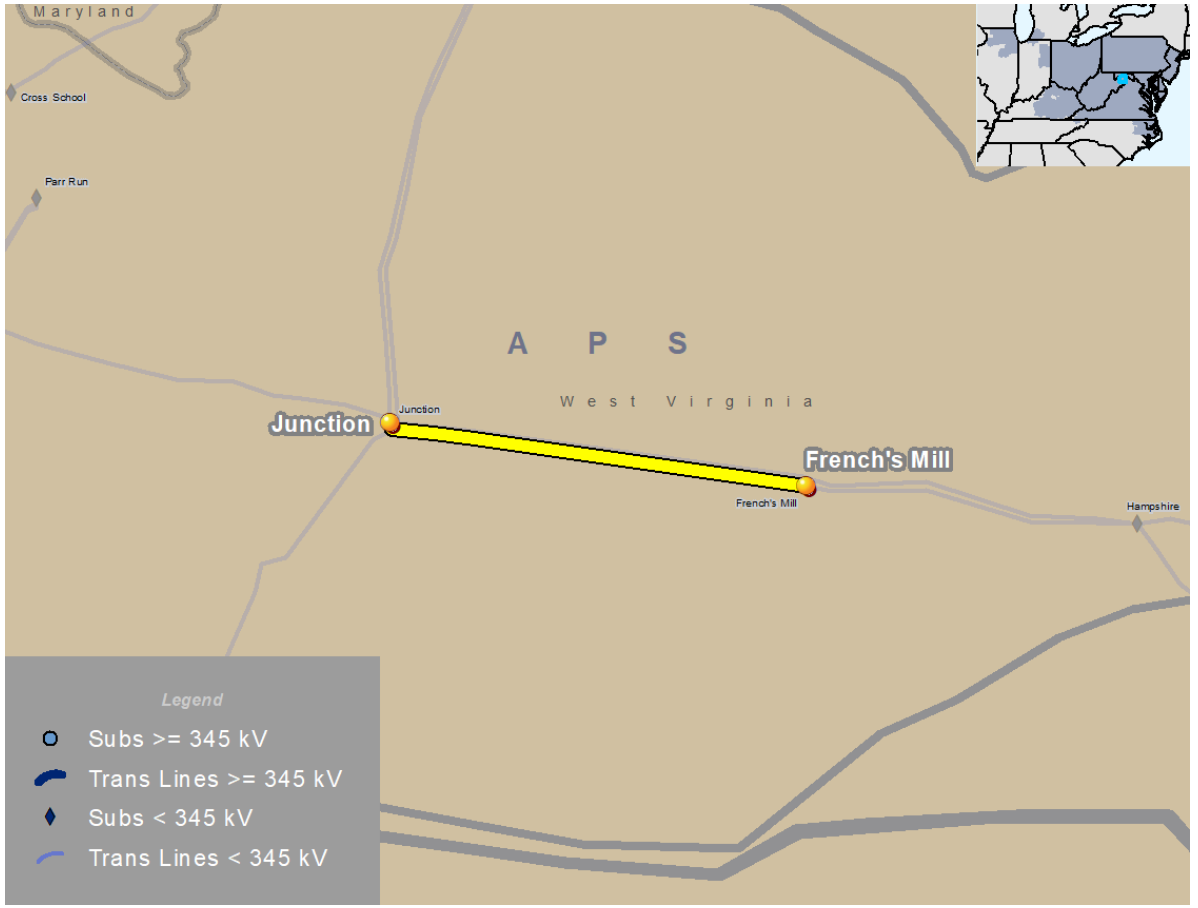
ME Constraints:
Junction to French's Mill 138 kV

Notes: [Redacted Public Proposal 547]



Proposal No. 756 (French's Mill - Junction Terminal Upgrades)

Project ID: 202021_756
Proposed Solution: Replace terminal equipment on the French's Mill-Junction 138 kV line.
Project Type: Upgrade
kV Level: 138 kV
In-Service Cost ($M): $0.77
In-Service Year: 2022
Target Zone: APS
ME Constraints: Junction to French's Mill 138 kV
Notes: Redacted Public Proposal 756

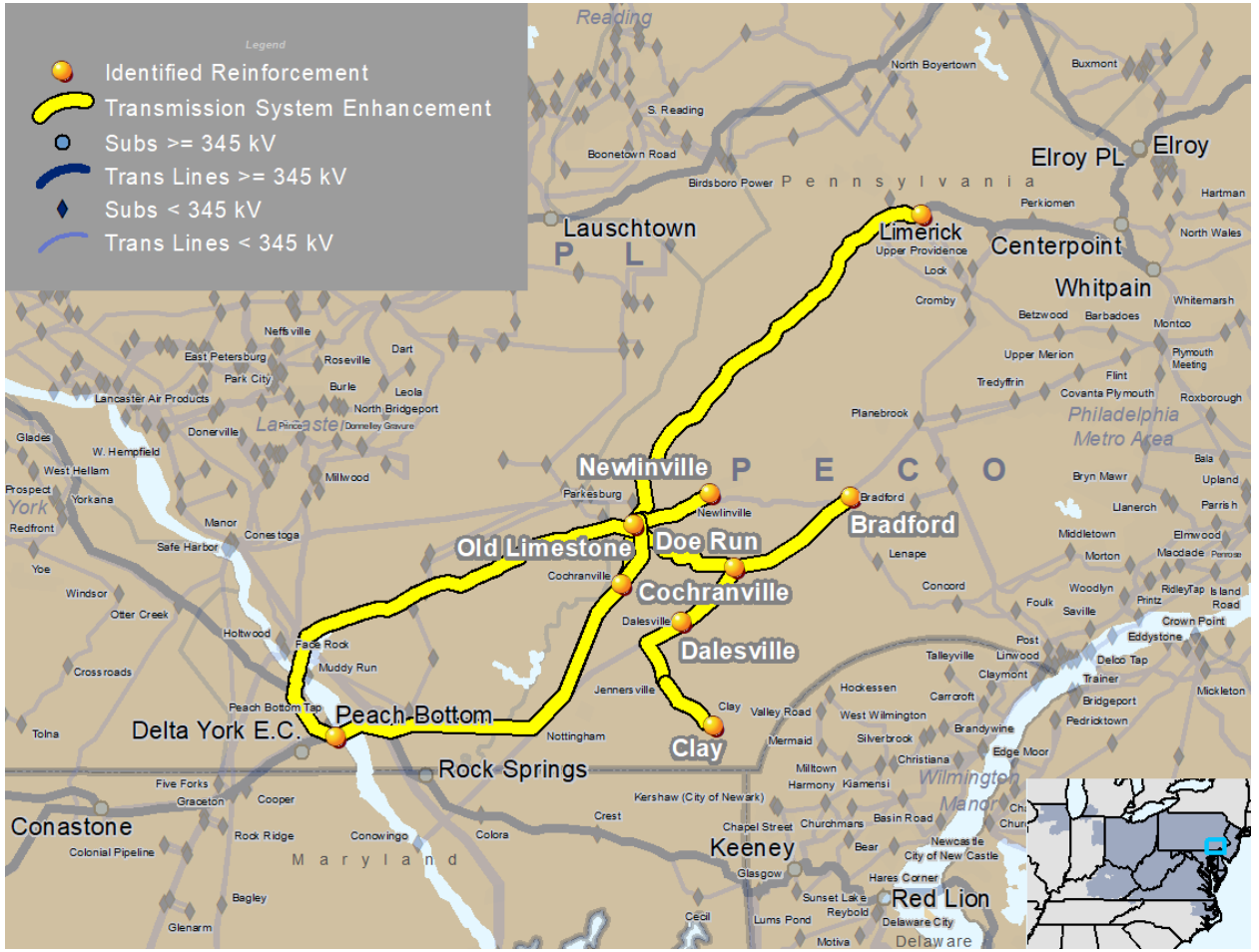


Proposal No. 227 (Old Limestone - Doe Run 500/230kV New line)

Project ID: 202021_227

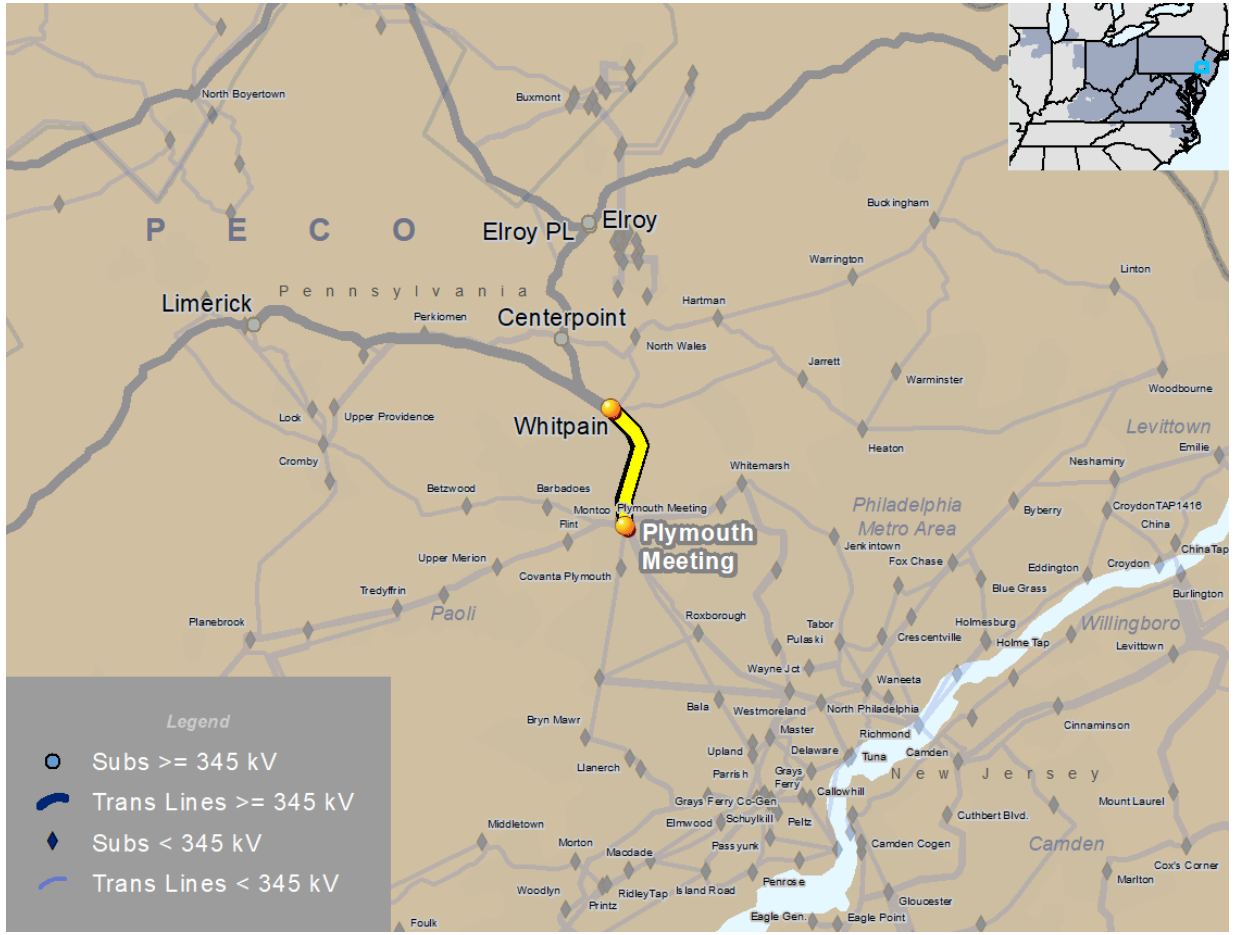
Proposed Solution:
Interconnect the Peach Bottom - Limerick 500kV and Cochranville - Newlinville 230kV lines via a new Old Limestone 500/230 kV substation. Build new 230 kV Doe Run substation and interconnect Daleville - Bradford and Clay Tap - Bradford 230kV lines. Construct a new 230 kV line from Old Limestone to Doe Run.

Project Type: Greenfield
kV Level: 500 kV, 230 kV
In-Service Cost ($M): $73.51
In-Service Year: 2025
Target Zone: PECO
ME Constraints: Plymouth Meeting to Whitpain 230 kV
Notes: Redacted Public Proposal 227



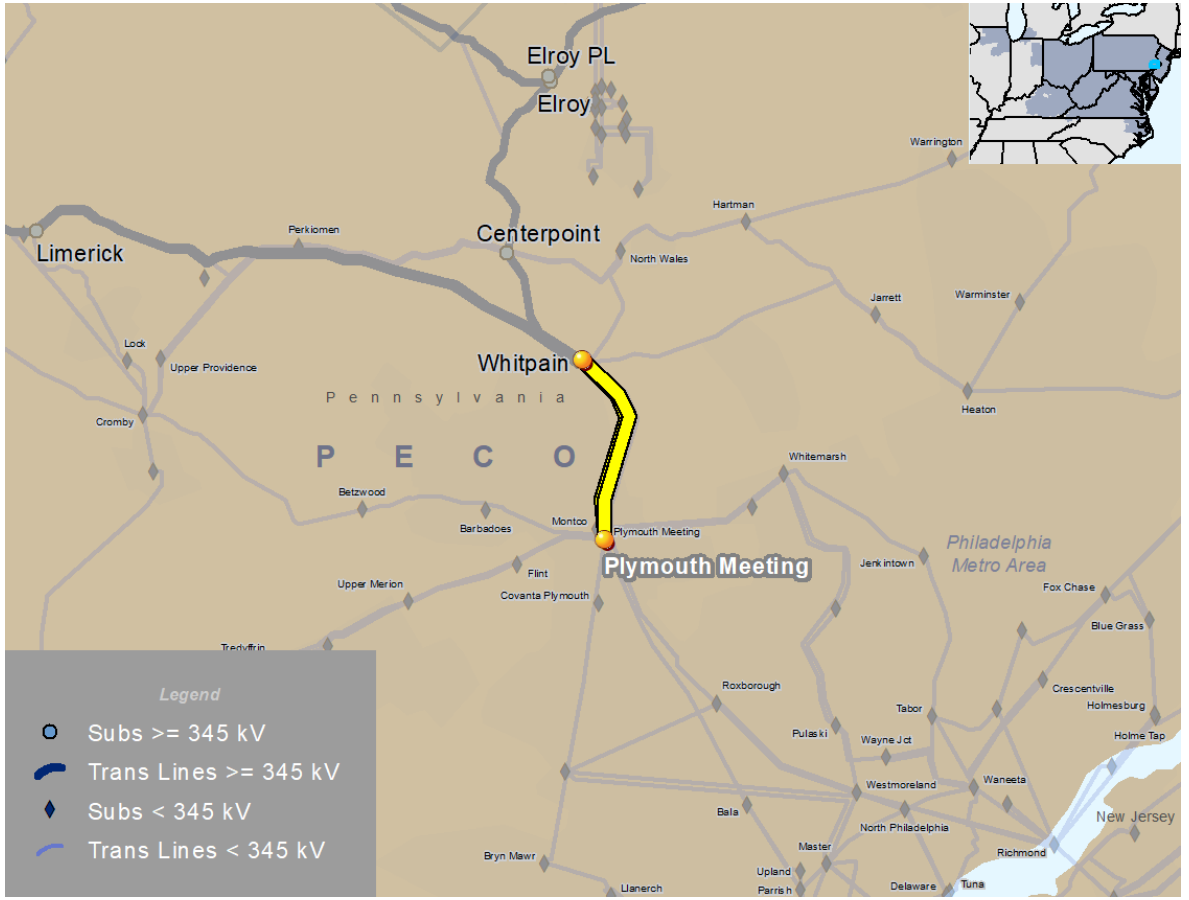
Proposal No. 399 (Plymouth-Whitpain 220-13, 220-14 SmartWires)

Project ID: 202021_399
Proposed Solution: Install Smart Wires device in series with the 220-13 and 220-14 Whitpain-Plymouth 230 kV lines and replace station conductor and metering inside Whitpain and Plymouth substations.
Project Type: Upgrade
kV Level: 230 kV
In-Service Cost ($M): $8.42
In-Service Year: 2025
Target Zone: PECO
ME Constraints: Plymouth Meeting to Whitpain 230 kV
Notes: Redacted Public Proposal 399



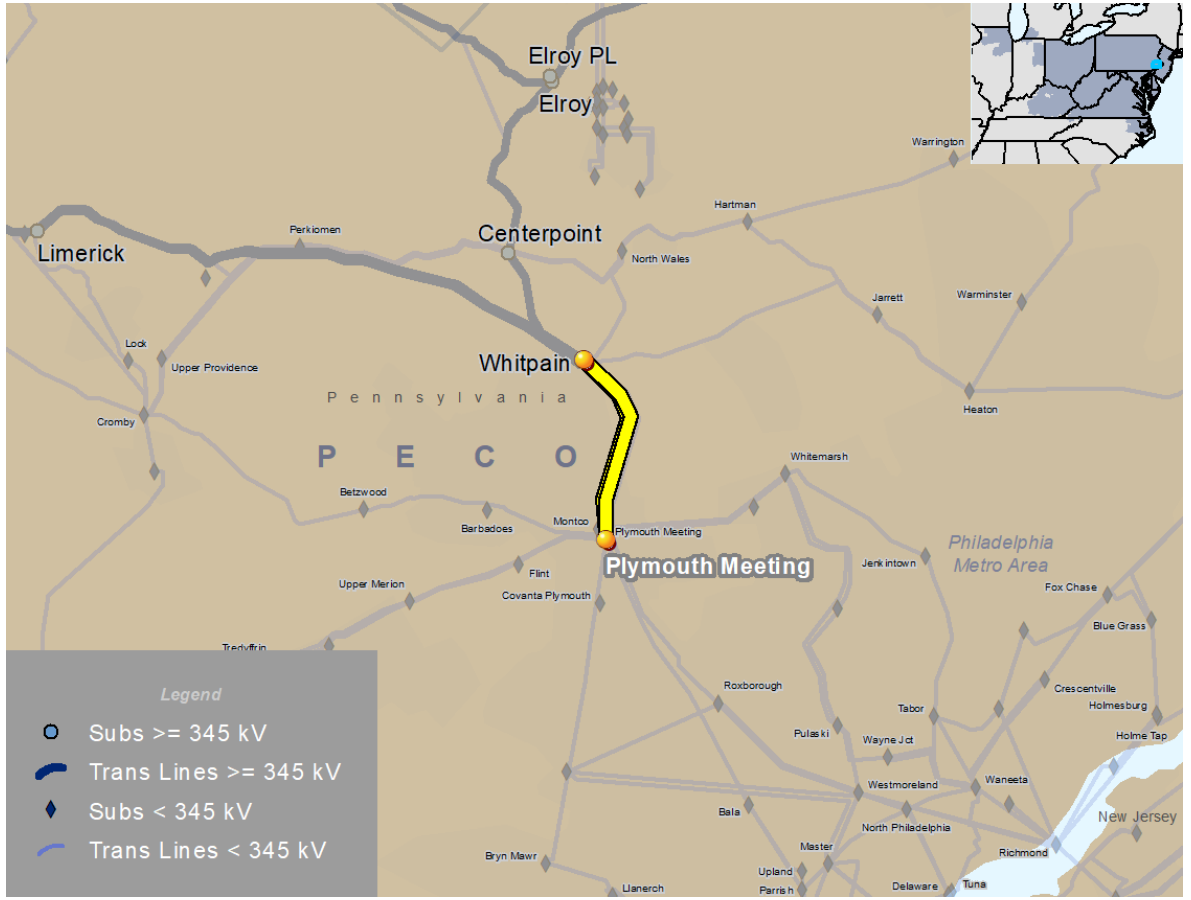
Proposal No. 704 (Plymouth-Whitpain 220-13, 220-14 Terminal Upgrades)

Project ID: 202021_704
Proposed Solution: Replace station conductor and metering inside Whitpain and Plymouth substations.
Project Type: Upgrade
kV Level: 230 kV
In-Service Cost ($M): $0.62
In-Service Year: 2025
Target Zone: PECO
ME Constraints: Plymouth Meeting to Whitpain 230 kV
Notes: Redacted Public Proposal 704



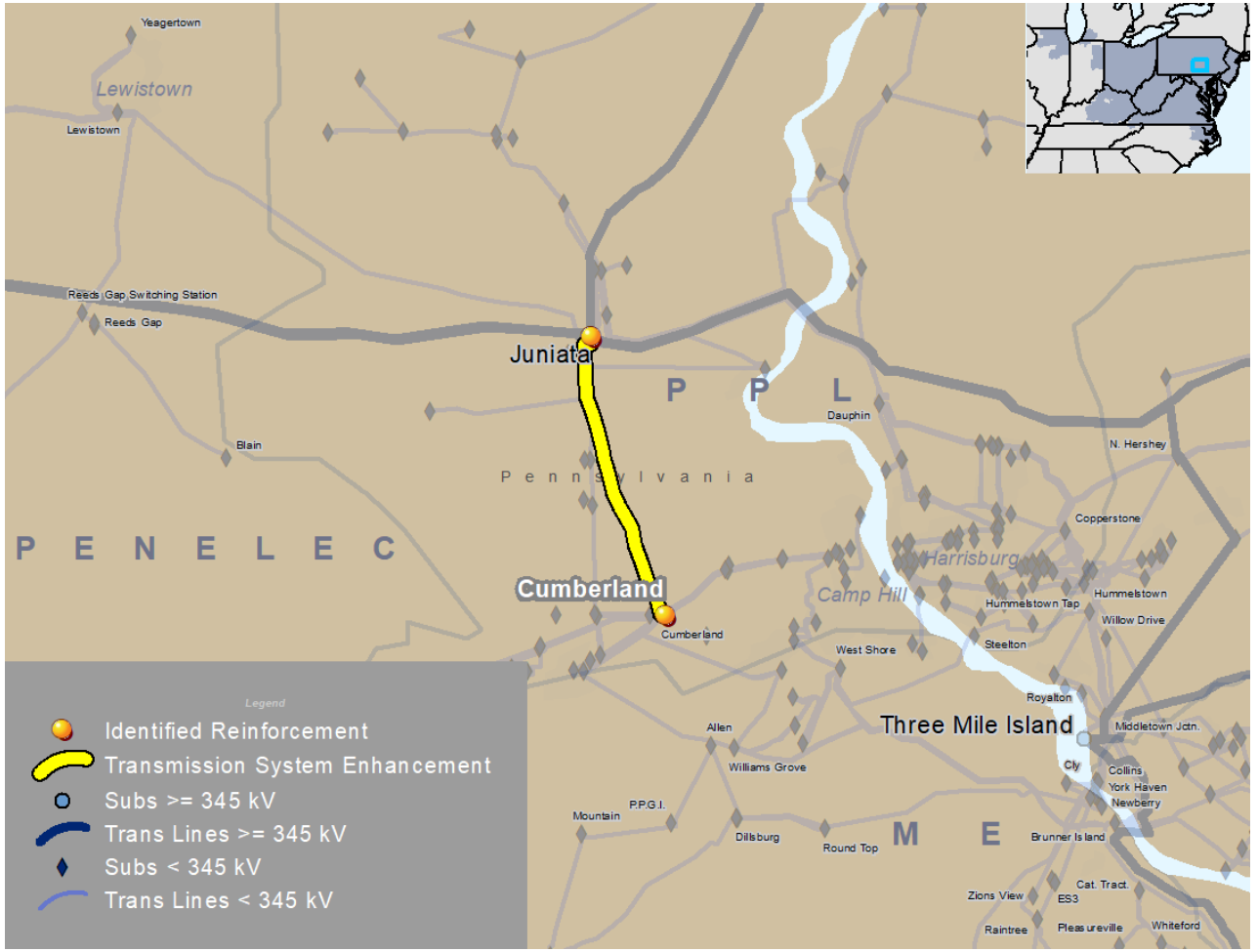
Proposal No. 735 (Rebuild Plymouth-Whitpain #13, #14 Circuits)

Project ID: 202021_735
Proposed Solution: Reconductor the 220-13 and 220-14 Whitpain-Plymouth 230 kV circuits.
Project Type: Upgrade
kV Level: 230 kV
In-Service Cost ($M): $14.98
In-Service Year: 2025
Target Zone: PECO
ME Constraints: Plymouth Meeting to Whitpain 230 kV
Notes: Redacted Public Proposal 735



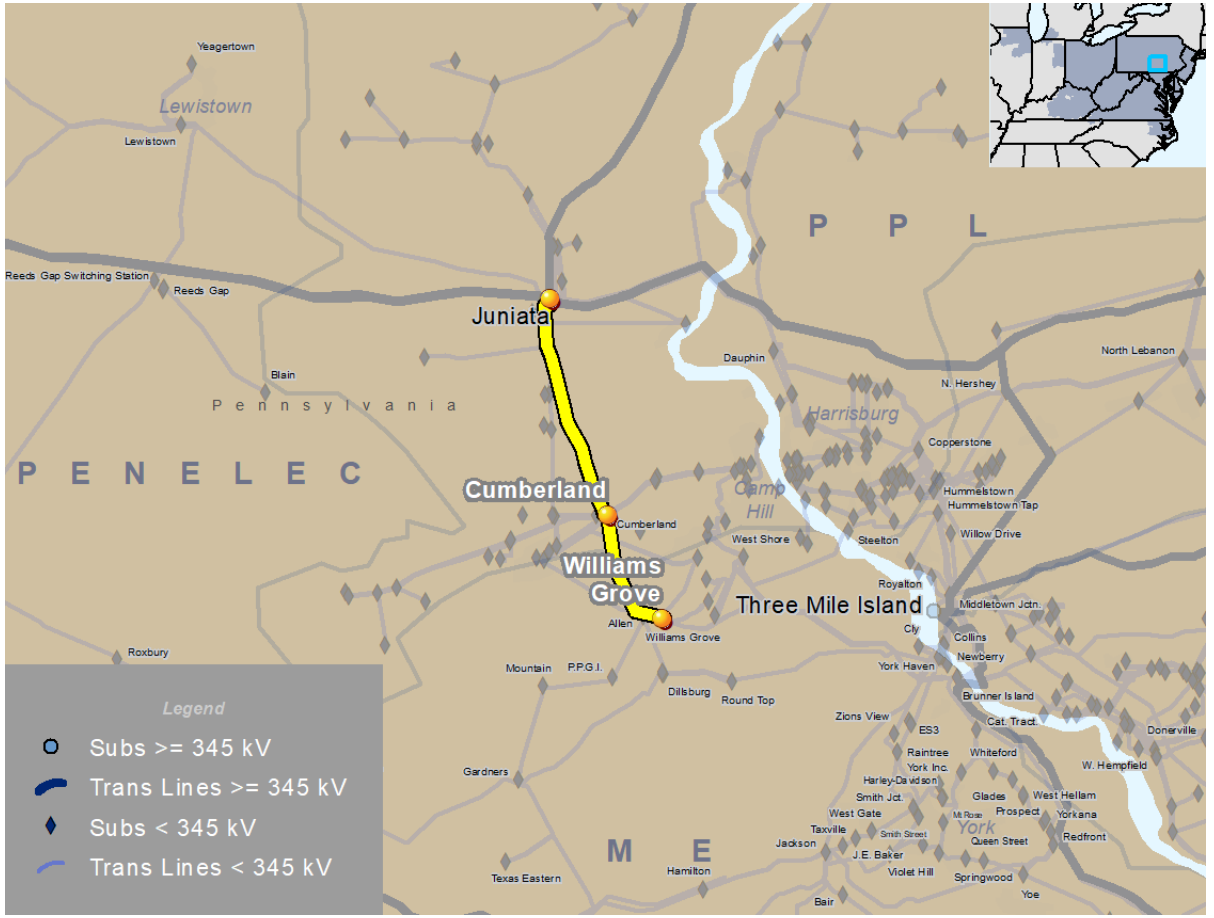
Proposal No. 218 (Juniata - Cumberland 230 kV Line Reconductor)

Project ID: 202021_218
Proposed Solution: Reconductor the Juniata - Cumberland 230kV line.
Project Type: Upgrade
kV Level: 230 kV
In-Service Cost ($M): $9.00
In-Service Year: 2023
Target Zone: PPL
ME Constraints: Cumberland to Juniata 230 kV
Notes: Redacted Public Proposal 218



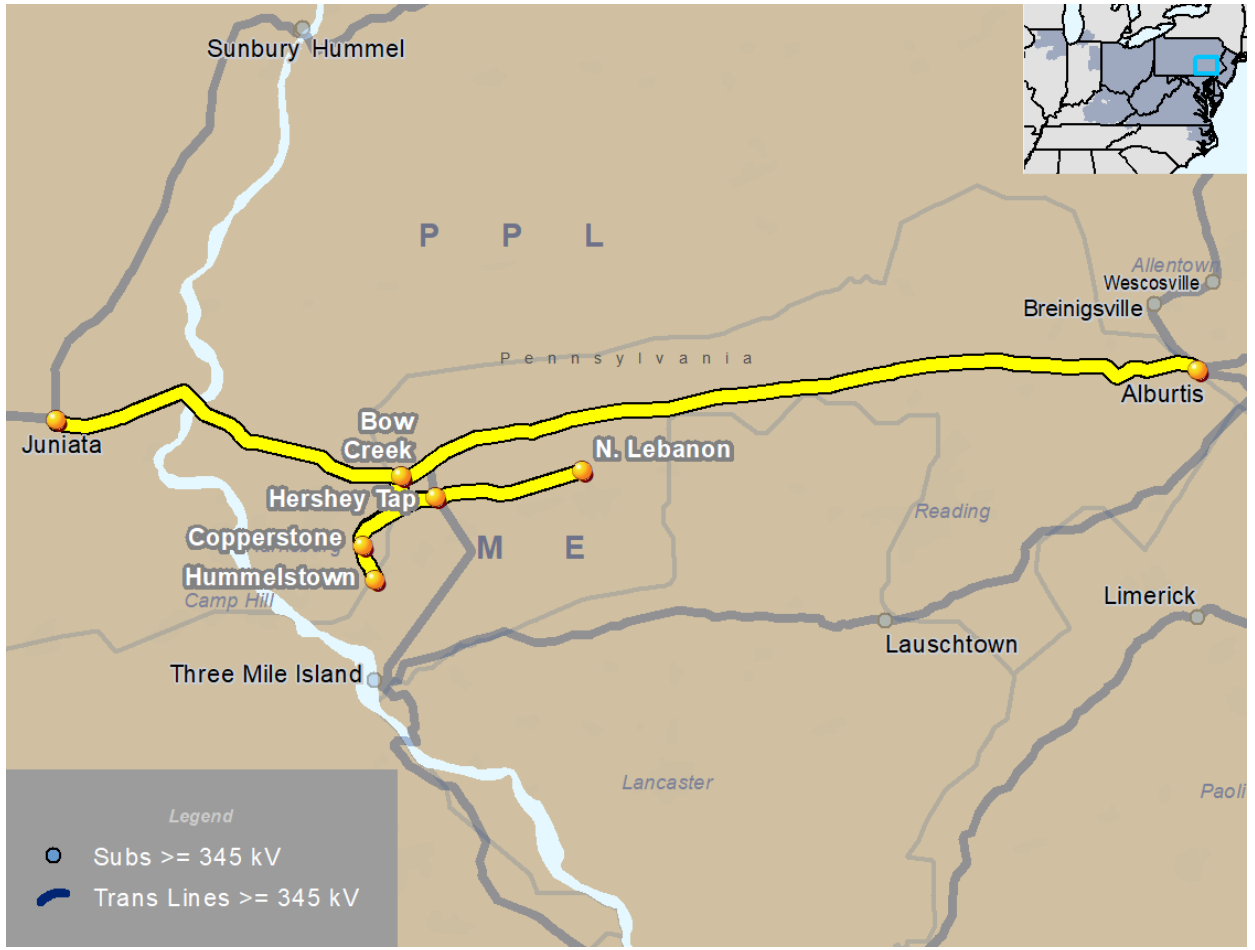
Proposal No. 251 (Juniata - Cumberland 230 kv Double Circuit Rebuild)

Project ID: 202021_251
Proposed Solution: Rebuild the existing single circuit Juniata -Cumberland 230 kV tower section to double circuit. Add a second circuit to the existing Juniata - Cumberland tower section that is presently already built for double circuit. Reconductor the Cumberland to Williams Grove 230 kV line.
Project Type: Upgrade
kV Level: 230 kV
In-Service Cost ($M): $49.05
In-Service Year: 2024
Target Zone: PPL
ME Constraints: Cumberland to Juniata 230 kV
Notes: Redacted Public Proposal 251



Proposal No. 738 (Bow Creek 500/230kV Project)

Project ID: 202021_738
Proposed Solution: Build new 500/230 kV Bow Creek tap substation on the Juniata – Alburtis 500kV line. Interconnect North Hershey - Hummelstown and North Lebanon – Copperstone 230kV lines to the Bow Creek substation.
Project Type: Greenfield
kV Level: 500 kV, 230 kV
In-Service Cost ($M): $55.05
In-Service Year: 2025
Target Zone: PPL
ME Constraints: Cumberland to Juniata 230 kV
Notes: Redacted Public Proposal 738



Revision History

- V1 – 08/25/2021 – Original slides posted