



Reliability Analysis Update

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Transmission Expansion Advisory Committee
December 6, 2022

First Review

Baseline Reliability Projects

Process Stage: First Read

Criteria: Summer Generator Deliverability

Assumption Reference: 2027 RTEP assumption

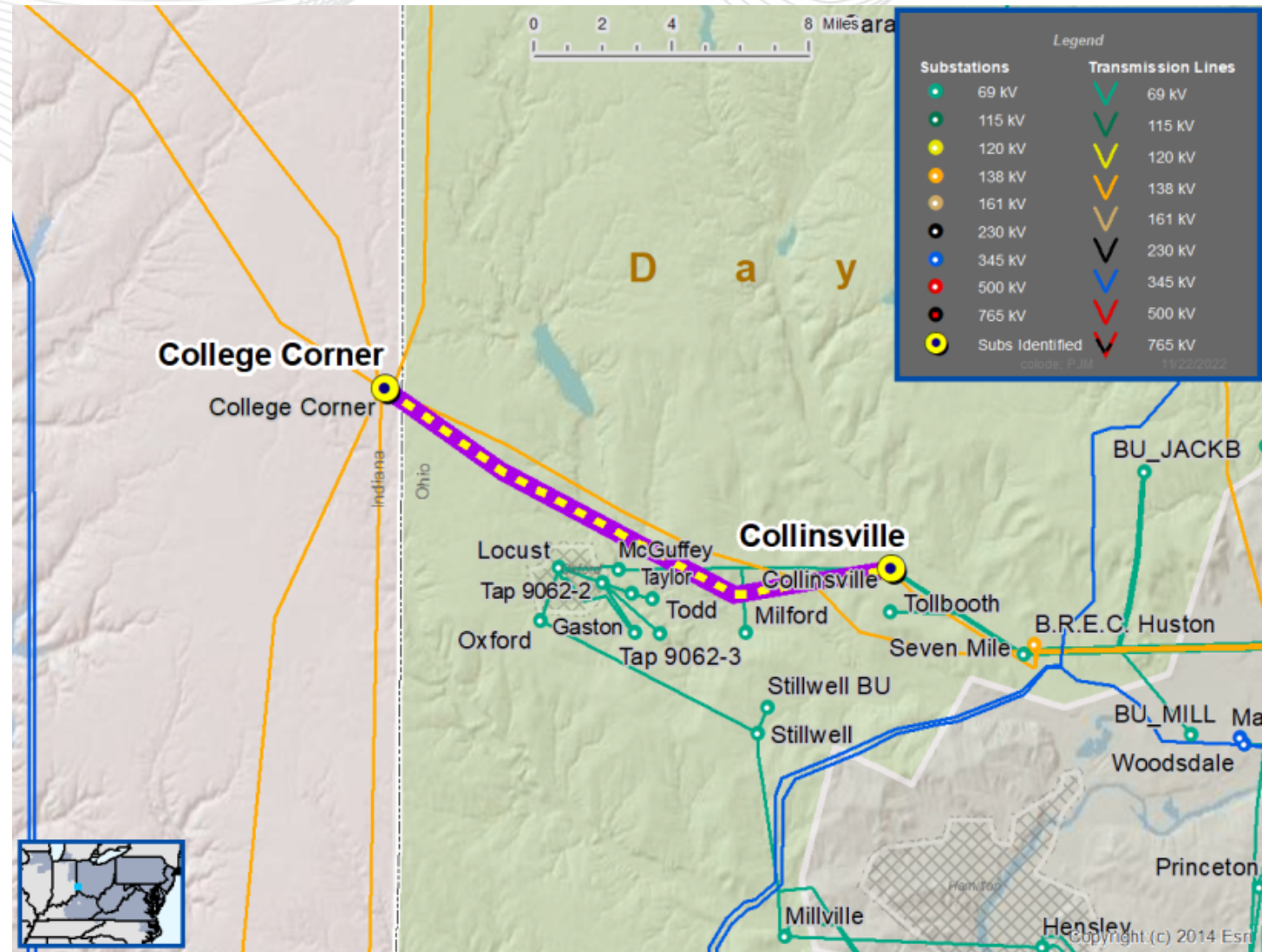
Model Used for Analysis: 2027 RTEP Summer case

Proposal Window Exclusion: None

Problem Statement:

FG#: 2022W1-GD-S586, 2022W1-GD-W377,

In 2027 RTEP Summer/Winter cases, the College Corner – Collinsville 138KV line is overload for a N-2 contingency in generator deliverability tests.





AEP/DEOK Transmission Zone: Baseline 2022 RTEP Window 1 Cluster 1

As part of the 2022 RTEP Window #1, the project listed in the table below are proposed to address the following violations: 2022W1-GD-S586 and 2022W1-GD-W377

Proposal ID	Proposing Entity	Project Description	Project Cost (\$M)
27	AEP	Install a 345KV breaker “R” at Tanners Creek and move the Tanners Creek – East Bend 345kV circuit from the “T” and “T1” line position to the “R” and “R1” line position.	3.07
994	TRNSRC	Build a new 138 kV 3-breaker ring station called “Johnson Fork” just North of the existing Wesley SW 138 kV station (AEP). Bring the existing Tanners Creek–College Corner 138 kV line (AEP) “in and out” of Johnson Fork. Build a new 138 kV line from Johnson Fork (AEP) to Willey (Duke) stations (13 miles). Install 2 breakers at Willey to terminate the new line.	25.52
446	TRNSRC	Build a new 138 kV 4-breaker ring station called “Pribble.” Bring the existing Tanners Creek–College Corner (AEP) & Miami Fort–Hubbell (Duke) 138 kV lines “in and out” of Pribble station. Rebuild Tanners Creek–Pribble 138 kV (5 miles) and upgrade station equipment at Tanners Creek 138 kV. Rebuild Pribble-Miami Fort 138 kV (6 miles).	39.7
893	TRNSRC	Build a new 345 kV line from Tanners Creek station (AEP) to Miami Fort (Duke) station (11.4 miles). Rebuild a portion of the existing Tanners Creek – Hanna 345 kV and Greendale – Miami Fort 138 kV lines to double circuit (4 & 3 miles respectively) to facilitate construction of the new line. Install 1 breaker at Tanners Creek and 2 breakers at Miami Fort to terminate the new line.	58.11
PJM Identified Option	PJM	Convert S2585.2, S2585.3, S2585.4, S2585.11, S2585.12, and S2585.13 into baseline: Install a new AEP “Hayes” 138kV substation, Construct a new Hayes station - New Westville – West Manchester 138kV transmission line. Expand West Manchester substation.	38.64



AEP/Dayton Transmission Zone: Baseline 2022 RTEP Window 1 Cluster 1

Proposed Solution: PJM Identified Option: Converting s2585.2 through .4 and .11 through .13, **S2585.2:** Construct a 138kV 1.86-mile single circuit transmission line from New Westville – AEP Hayes station. Estimated Cost: \$3.7M,

S2582.3: Construct a new approximate 11-mile single circuit 138kV line from New Westville to the Lewisburg tap off 6656. Convert a portion of 6656 West Manchester – Garage Rd 69kV line between West Manchester - Lewisburg to 138kV operation (circuit is built to 138kV). This will utilize part of the line already built to 138kV and will take place of the 3302 that currently feeds New Westville. The 3302 line will be retired as part of this project. Estimated Cost: \$16.0M,

S2585.4: The West Manchester Substation will be expanded to a double bus double breaker design where AES Ohio will install one 138kV circuit breaker, a 138/69kV transformer, and eight new 69kV circuit breakers. Estimated Cost: \$9.9M

S2585.11: Hayes – New Westville 138 kV line: Build ~0.19 miles of 138 kV line to the Indiana/ Ohio State line to connect to AES’s line portion of the Hayes – New Westville 138 kV line with the conductor size 795 ACSR26/7 Drake. Estimated Cost: \$0.38M

S2585.12: Hayes – Hodgin 138 kV line: Build ~0.05 miles of 138 kV line with the conductor size 795 ACSR26/7 Drake. Estimated Cost: \$1.22M

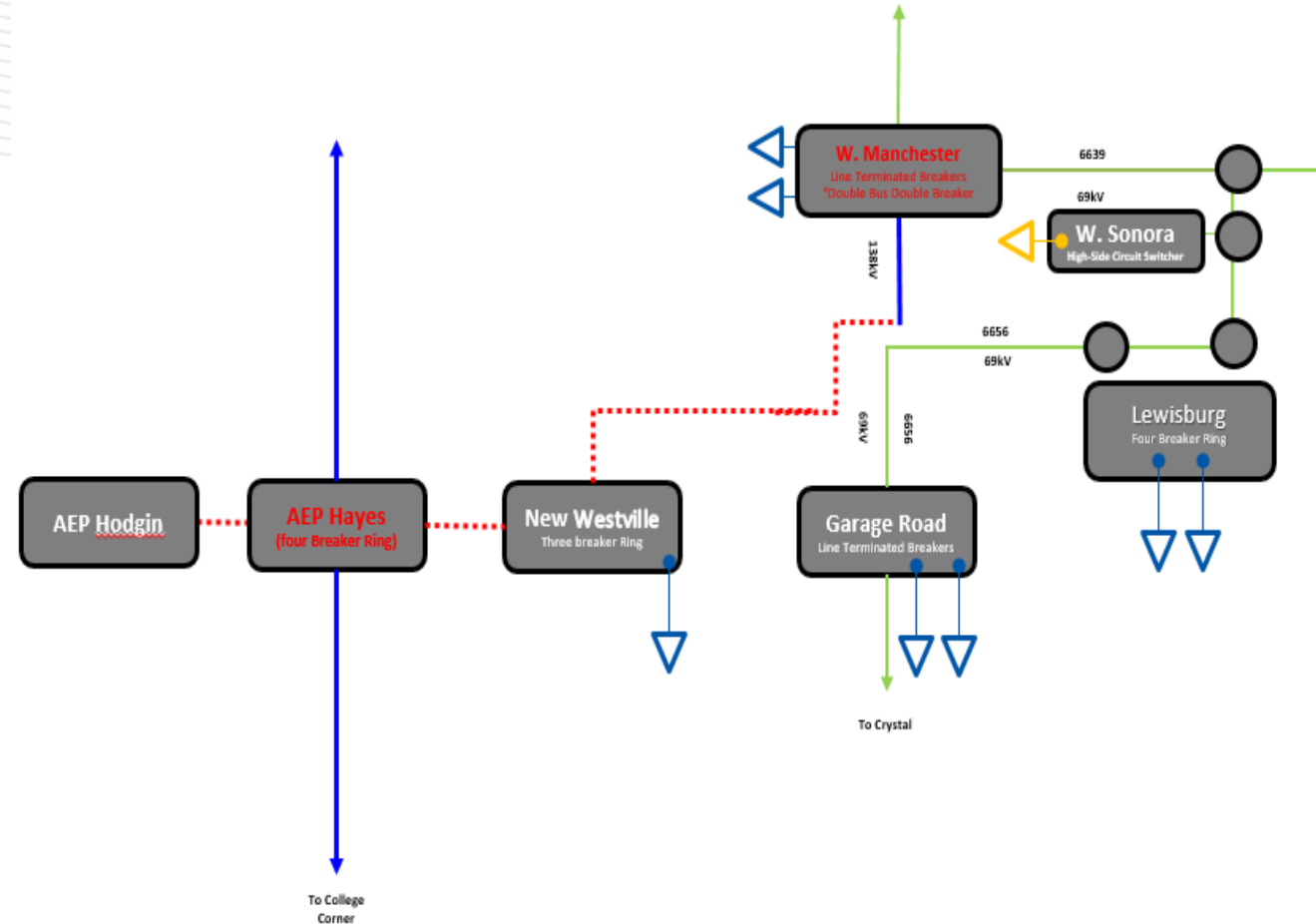
S2585.13: Hayes 138 kV: Build a new 4-138 kV circuit breaker ring bus. Estimated Cost: \$7.44M

Total Estimated Cost: \$38.64M

Additional Benefits: This project is part of the solution to address Dayton-2020-011, Dayton-2021-001, Dayton-2021-008. No additional transmission cost is needed to address the reliability violations.

Required IS Date: 6/1/2027

Projected IS Date: 12/31/2026





2022 RTEP Window 1 Proposal Cluster #2 Update

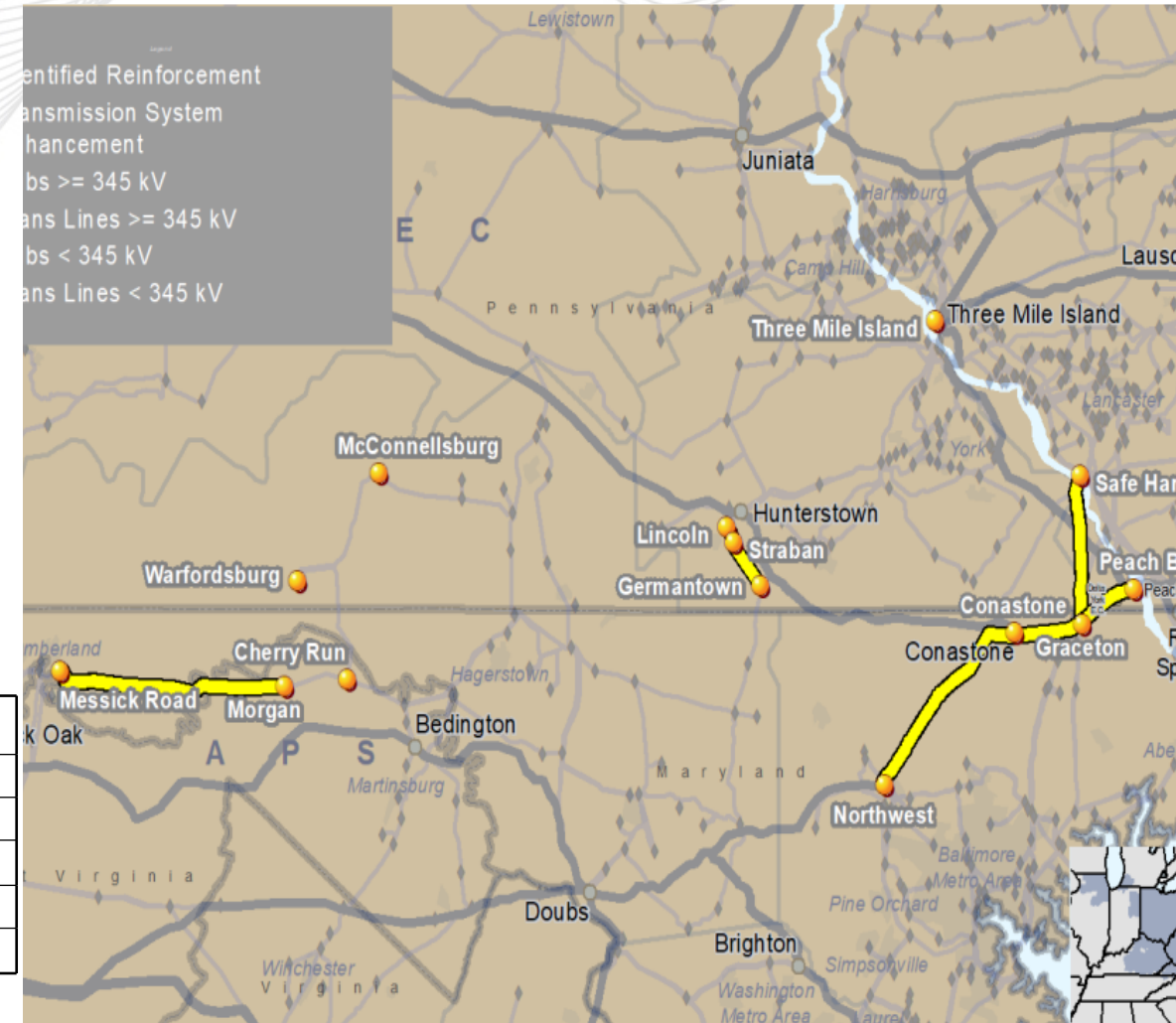
Problem Statement:

PJM identified 26 thermal and 25 voltage flowgates violations in the APS, BGE, MetEd, and PECO areas.

- 17 flowgates → open for Competition
- 34 flowgates → excluded from competition for varies reasons

Violations were posted as part of the 2022 Window 1	List of Flowgates in Cluster #2 (Thermal)				
	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				

Violations were posted as part of the 2022 Window 1	List of Flowgates in Cluster #2 (Voltage)				
	2022W1-N2-VM1	2022W1-N2-VM12	2022W1-N2-VM19	2022W1-N2-VM24	2022W1-N2-VM29
	2022W1-N2-VM2	2022W1-N2-VM15	2022W1-N2-VM20	2022W1-N2-VM25	2022W1-N2-VM32
	2022W1-N2-VM3	2022W1-N2-VM16	2022W1-N2-VM21	2022W1-N2-VM26	2022W1-N2-VM33
	2022W1-N2-VM4	2022W1-N2-VM17	2022W1-N2-VM22	2022W1-N2-VM27	2022W1-N2-VM34
	2022W1-N2-VM5	2022W1-N2-VM18	2022W1-N2-VM23	2022W1-N2-VM28	2022W1-N2-VM35



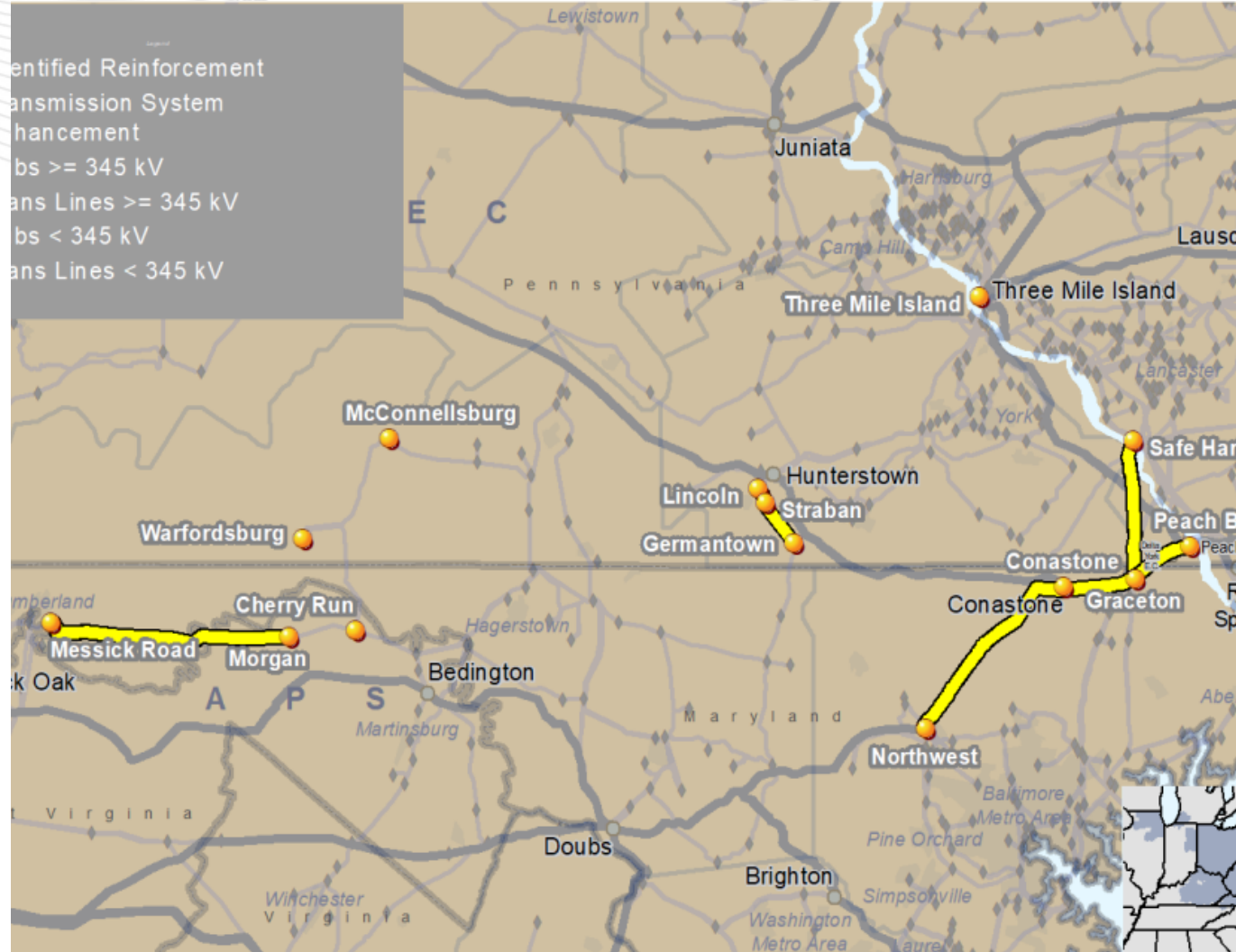
APS, BGE, MetEd and PECO Transmission Zone: Baseline

Problem Statement:

The list of flowgates include 7 thermal and 4 voltage facilities in the APS, BGE, MetEd, and PECO areas.

Facility Name	Limiting Equipment	Areas
3 Mile Island 500/230 kV	Transformer	MetEd
Peach Bottom - Conastone 500 kV	Terminal	BGE/PECO
Lincoln - Straban 115 kV	Conductor	MetEd
Germentown - Straban 115 kV	Conductor	MetEd
Conastone - North West 230 kV	Conductor	BGE
Graceton - Safe Harbor 230 kV (BGE portion)	Conductor	BGE
Messick Rd - Morgan 138 kV	Conductor	APS

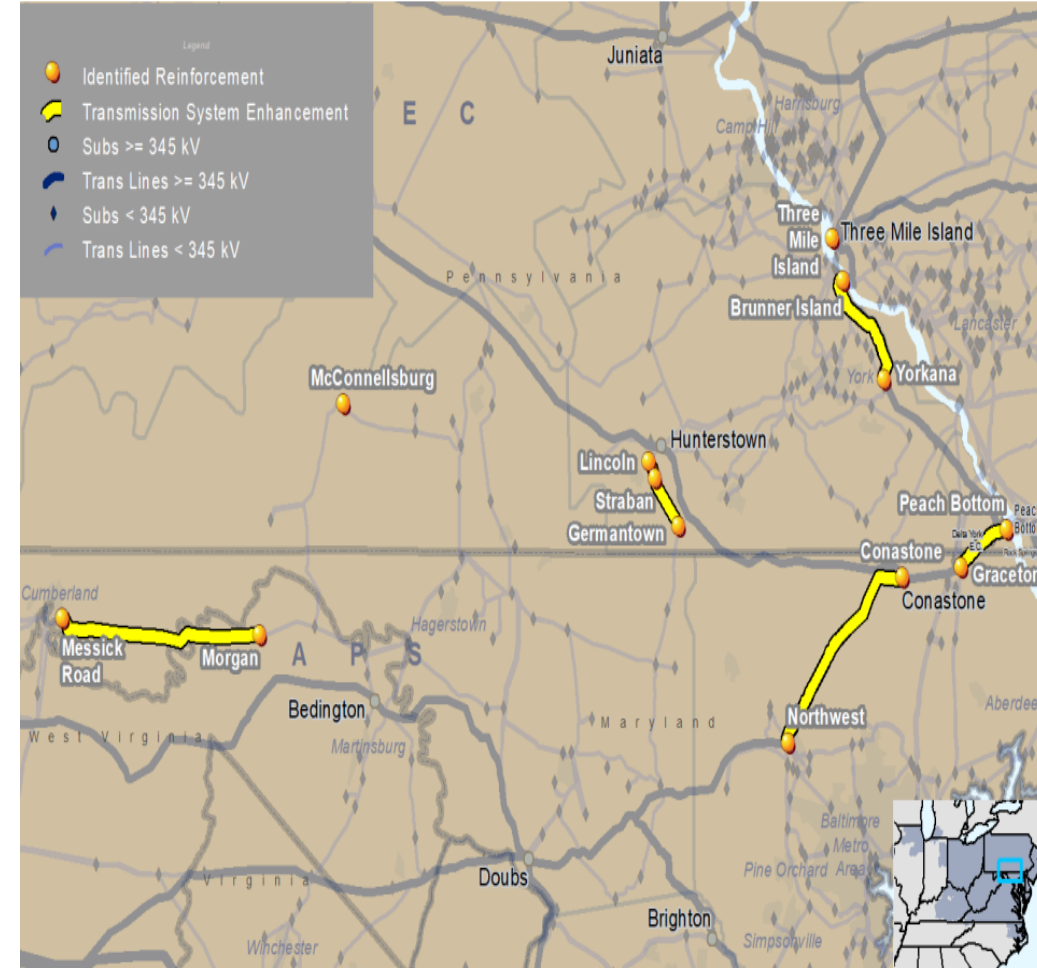
Facility Name	Violation	Areas
Cherry Run 115 kV	Low voltage	APS
Morgan 115 kV	Low voltage	APS
Warfordsburg 115 kV	Low voltage	APS
McConnellsburg 115 kV	Low voltage	APS



- There are several projects proposed to address the cluster #2 violations.
- The upgrades are grouped in to three sets (Option 1, Option 2 and Option 3)
 - Option 1 – Includes all upgrades on existing facilities
 - Option 2 - Includes upgrades on existing facilities and one new 230 kV circuit using existing ROW
 - Option 3 – Includes upgrades on existing facilities and greenfield (new substation as well as new circuits).
- PJM evaluated all three options
 - Performed the DNH analysis to ensure the proposals solve the identified violations and don't cause a harm to the system.

APS, BGE, MetEd and PECO Transmission Zone: Baseline Cluster #2 Proposals Evaluation

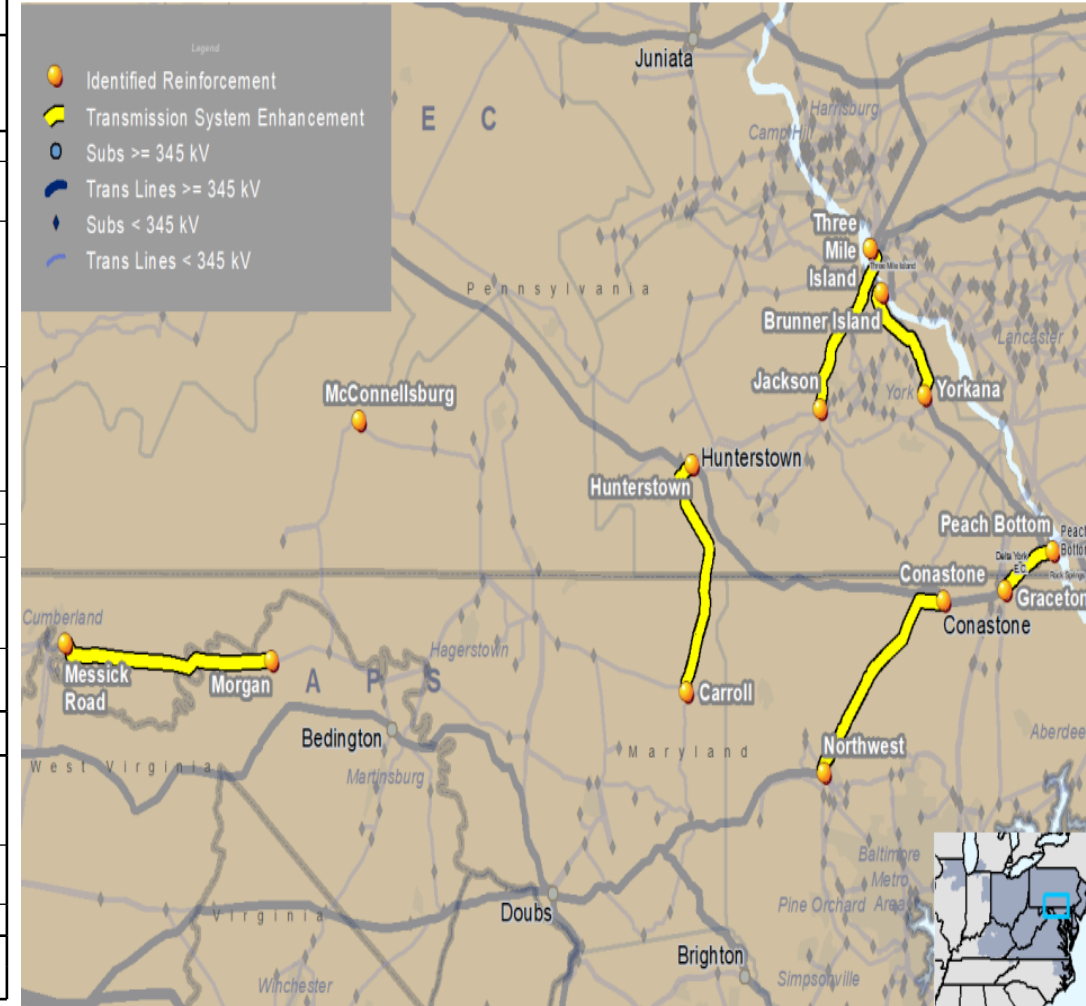
Option #1			
Proposing Entity	Project Description	TO Zone	Cost Estimate (M)
PECO	Replace 4 meters and bus work inside Peach Bottom substation	PECO	3.8
BGE	Increase Ratings of breaker bushings for the two breakers on 500kV line 5012 at Conastone Substation.	BGE	2
APS	Reconductor 27.3 miles of the Messick Road - Morgan 138 kV Line from 556 ACSR to 954 ACSR At Messick Road Substation: -Replace 138 kV wavetrap, circuit breaker, CT's, disconnect switch, and substation conductor. - Upgrade relaying At Morgan Substation: - Upgrade Relaying	APS	49.23
MATLIT (#209)	Rebuild/Reconductor the Germantown - Lincoln 115 kV Line. Approximately 7.6 miles. Upgrade limiting terminal equipment at Lincoln, Germantown and Straban.	MetEd	17.36
MATLIT (#880)	Install second 500/230kV Transformer with additional 500 and 230 bus expansions.	MetEd	30.19
BGE (#94)	Reconductor two (2) 230 kV circuits from Conastone to Northwest #2.	BGE	37.76
BGE (#912)	Rebuild 1.4 miles of existing single circuit 230 kV tower line between BGE's Graceton substation to the PPL tie-line at the MD/PA state line to double circuit steel pole line with one (1) circuit installed to uprate 2303 circuit.	BGE	8.4
APS	At McConnellsburg 138 kV Substation: Install a 138 kV Breaker, Install 33 MVAR switched capacitor and Upgrade relaying	APS	3.05
Sub-total			151.79
Additional Upgrades due to DNH study			
PPL	Upgrade terminal equipment at Brunner Island (on the Brunner Island - Yorkana 230 kV circuit)	PPL	2.5
Total cost			154.29



APS, BGE, MetEd and PECO Transmission Zone: Baseline Cluster #2 Proposals Evaluation

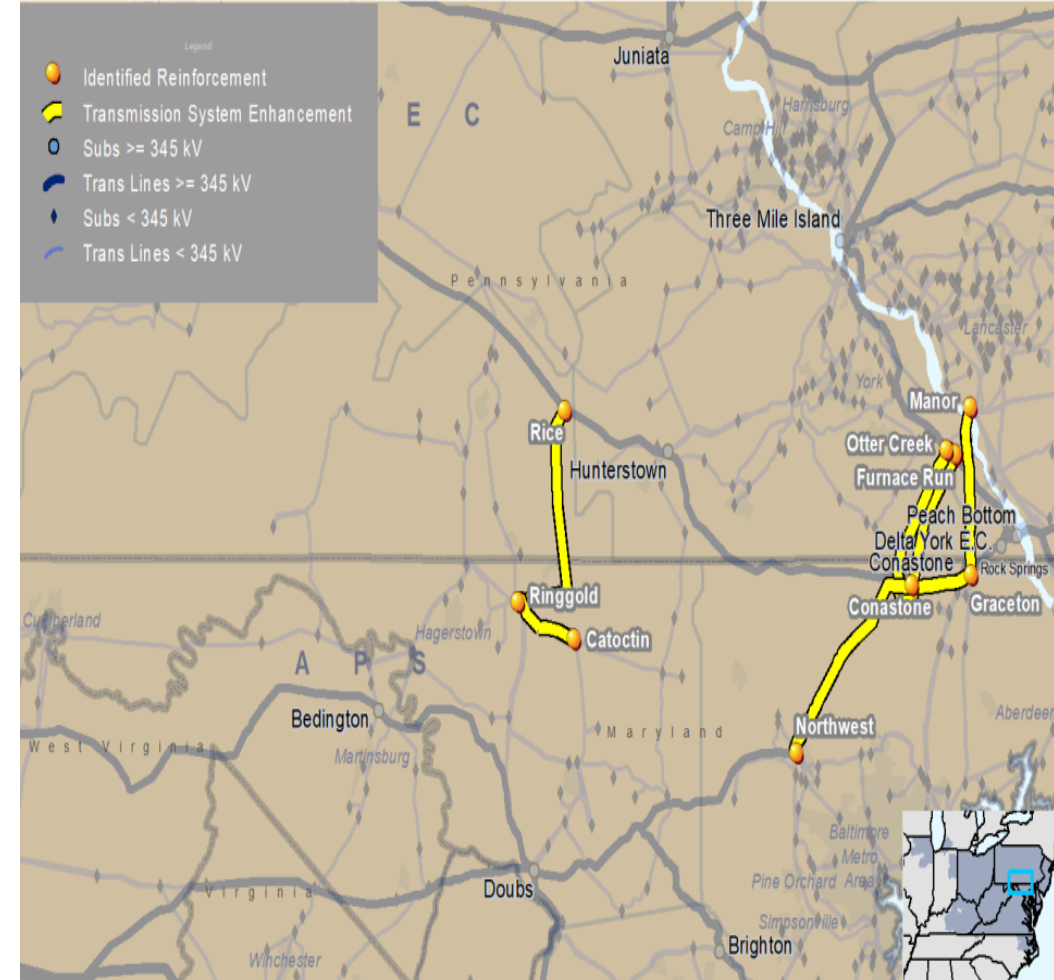
Option #2

Proposing Entity	Project Description	TO Zone	Cost Estimate (M)
PECO	Replace 4 meters and bus work inside Peach Bottom substation	PECO	3.8
BGE	Increase Ratings of breaker bushings for the two breakers on 500kV line 5012 at Conastone Substation.	BGE	2
APS	Reconductor 27.3 miles of the Messick Road - Morgan 138 kV Line from 556 ACSR to 954 ACSR At Messick Road Substation: -Replace 138 kV wavetrapp, circuit breaker, CT's, disconnect switch, and substation conductor. - Upgrade relaying At Morgan Substation: - Upgrade Relaying	APS	49.23
MATLIT (#476)	Rebuild the Hunterstown – Carroll 115/138 kV Corridor as Double Circuit using 230kV construction standards. New circuit will be operated at 230kV. Existing circuit to remain at 115/138kV. Construct a new 230 kV Ring Bus at Carroll (PE) and add a new 230 kV Breaker to the Hunterstown 230 kV Substation	APS MetEd	148.83
MATLIT (#880)	Install second 500/230kV Transformer with additional 500 and 230 bus expansions.	MetEd	30.19
BGE (#94)	Reconductor two (2) 230 kV circuits from Conastone to Northwest #2.	BGE	37.76
BGE (#912)	Rebuild 1.4 miles of existing single circuit 230 kV tower line between BGE's Graceton substation to the PPL tie-line at the MD/PA state line to double circuit steel pole line with one (1) circuit installed to uprate 2303 circuit.	BGE	8.4
APS	At McConnellsburg 138 kV Substation: Install a 138 kV Breaker, Install 33 MVAR switched capacitor and Upgrade relaying	APS	3.05
Sub-total			283.26
Additional Upgrades due to DNH study			
PPL	Upgrade terminal equipment at Brunner Island (on the Brunner Island - Yorkana 230 kV circuit)	PPL	2.5
MetEd	Rebuild the 14.1-mile line section of the Jackson – TMI 230 kV line	MetEd	47.09
Total			332.85



Option #3 (Proposal #633)

Proposing Entity	Proposing Entity	TO Zone	Cost Estimate (M)
TRNSRC	The IEC West Portion, build new 500/230 kV station (Rice) by tapping the existing Conemaugh - Hunterstown 500 kV. Construct approximately 29 miles of new double-circuit 230 kV AC overhead transmission line between the existing Ringgold Substation and the new Rice Substation.	APS Penelec	386.73
	The reconfigured IEC East Portion - build new 500/230 kV substation (Furnace Run) by tapping the existing Peach Bottom - TMI 500 kV. The 230 kV will be comprised of adding 230 kV AC overhead transmission lines between the new Furnace Run Substation in York County, Pennsylvania and the existing BGE Conastone (via Baltimore County) and Graceton Substations in Harford County, Maryland. The Manor - Graceton 230 kV and Conastone - Otter Creek 230 kV circuit will loop into the New Furnace Run 230 kV.	BGE MetEd PECO PPL	
	Rebuild Conastone - Northwest 230 kV circuits	BGE	
	Rebuild Ringgold 230 kV to breaker and half configurations and replace the Ringgold 230/138 kV transformers	APS	
	Rebuild the Ringgold - Catoclin 138 kV to 230 kV	APS	
APS	At McConnellsburg 138 kV Susbtation: Install a 138 kV Breaker, Install 33 MVAR switched capacitor and Upgrade relaying	APS	3.05
Total			389.78





APS, BGE, MetEd and PECO Transmission Zone: Baseline Cluster #2 Proposals Comparison and Conclusion

	Option 1	Option 2	Option 3
Upgrade/Brownfield/Greenfield	Upgrade	Upgrade/Brownfield	Upgrade/Brownfield/Greenfield
Address All Cluster 2 violations	Y	Y	N
Additional upgrades due to harm	1	2	0
Additional cost due to harm	\$2.50	\$49.59	0
Additional Upgrade cost to address all cluster 2 violations	0	0	\$3.05
Window proposed cost	\$151.79	\$283.26	\$386.73
Total cost	\$154.29	\$332.85	\$389.78

PJM is proposing Option 1 based on the type of Upgrades, and the total cost

- Resolved all identified violations
- Is the least cost among submitted proposals
- The projects are all upgrades to existing facilities.

Additional Benefit

- Proposal ID #94 utilizes an already proposed project associated with 9A
- Proposal ID #912 utilizes and already proposed project with modified 9A

As part of the 2023 RTEP studies PJM anticipates a long term solution to the AP South and Northern Virginia area:

- The 2023 RTEP will look into a holistic solution considering all influencing developments (NJOSW, Data Centers in APS and Dominion).

Process Stage: First Review

Criteria: Summer and Winter Generator Deliverability

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 RTEP Summer and Winter cases

Proposal Window Exclusion: No

Problem Statement:

The Lincoln – Straban – Germantown 115 kV circuit is overloaded for multiple contingencies.

Violations were posted as part of the 2022 Window 1: Violations were posted as part of the 2022 Window 1: FG, GD-S10, GD-S14, GD-S70, GD-S78, GD-W33, GD-W37, GD-W376 and GD-W391

Existing Facility Rating: 175SN/208SE, 208WN/238WE MVA

Proposed Facility Rating: 257SN/313SE, 291WN/371WE

Proposed Solution:

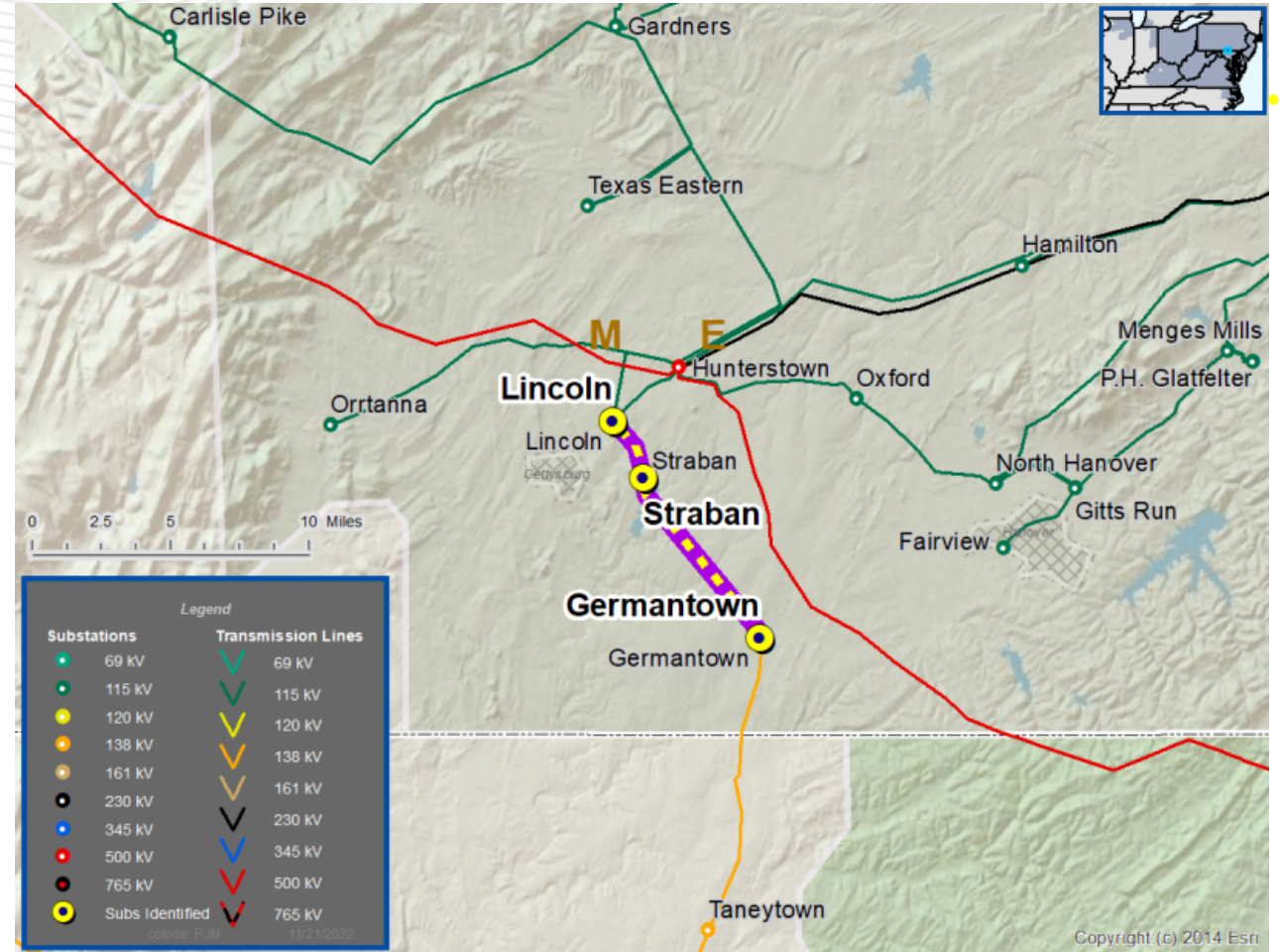
Rebuild/Reconductor the Germantown - Lincoln 115 kV Line. Approximately 7.6 miles.
Upgrade limiting terminal equipment at Lincoln, Germantown and Straban

Estimated Cost: \$17.36 M

Alternatives: See slide # 7 and #8

Required In-Service: 6/1/2027

Projected In-Service: 6/1/2027



Process Stage: First Review

Criteria: Summer and Winter Generator Deliverability

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 RTEP Summer and Winter cases

Proposal Window Exclusion: No

Problem Statement:

The TMI 500/230 kV transformer is overloaded for multiple contingencies.

Violations were posted as part of the 2022 Window 1: Violations were posted as part of the 2022 Window 1: FG, GD-S29, GD-S34, and GD-W36

Existing Facility Rating: 840SN/1070SE, 1049WN/1219WE MVA

Proposed Facility Rating: 972SN/1100SE, 1182WN/1364WE

Proposed Solution:

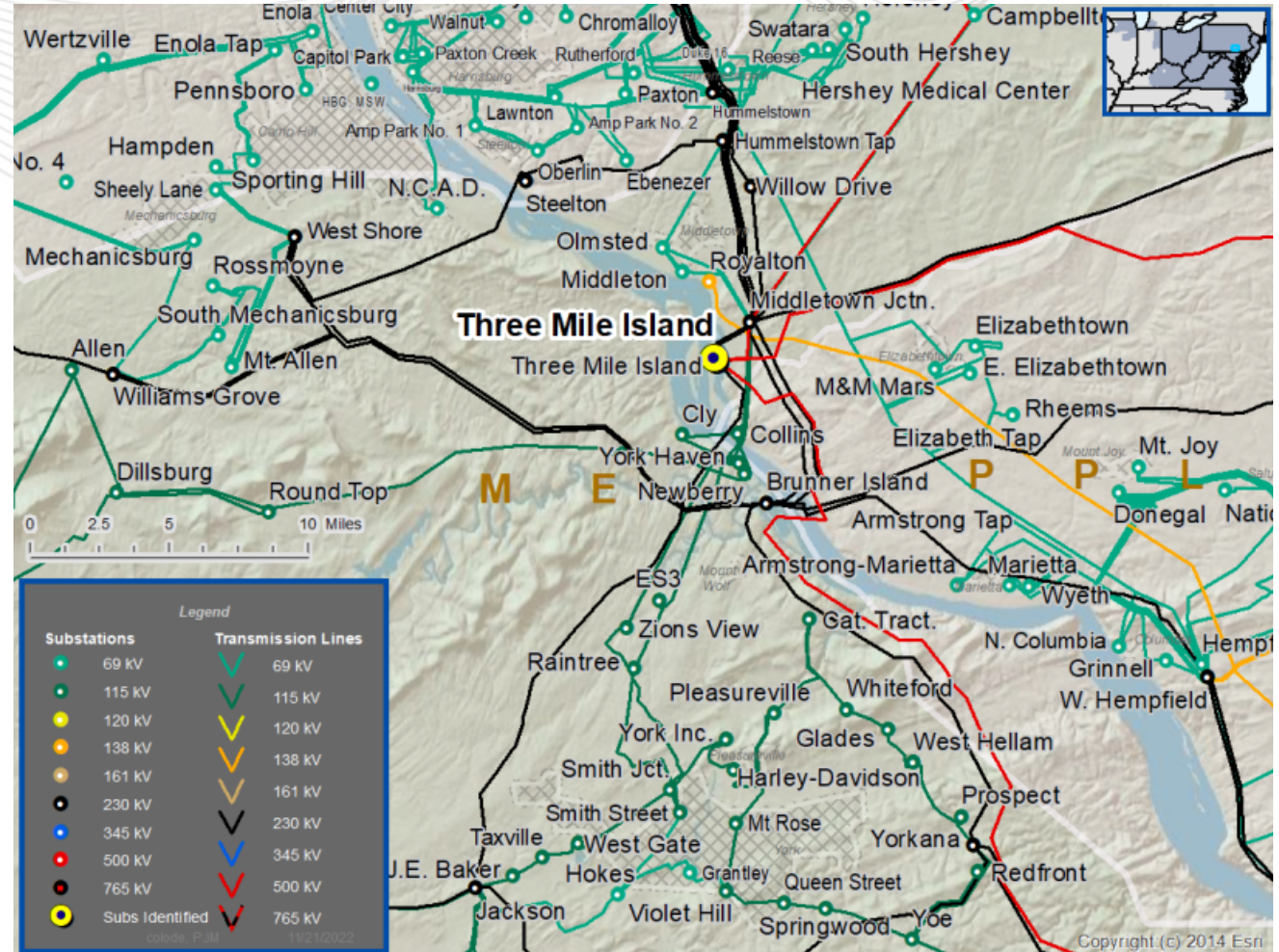
Install second TMI 500/230kV Transformer with additional 500 and 230 bus expansions.

Estimated Cost: \$30.19 M

Alternatives: See slide #8

Required In-Service: 6/1/2027

Projected In-Service: 6/1/2027



Process Stage: First Review

Criteria: Summer and Winter Generator Deliverability

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 RTEP Summer and Winter cases

Proposal Window Exclusion: No

Problem Statement:

The BEG section of the Graceton – Brunner Island 230 kV circuit is overloaded for multiple contingencies.

Violations were posted as part of the 2022 Window 1: Violations were posted as part of the 2022 Window 1: FG, GD-S1043, GD-W411, GD-W55 and GD-W623

Existing Facility Rating: 501SN/598SE, 554WN/652WE MVA

Proposed Facility Rating: 666SN/797SE, 767WN/898WE

Proposed Solution:

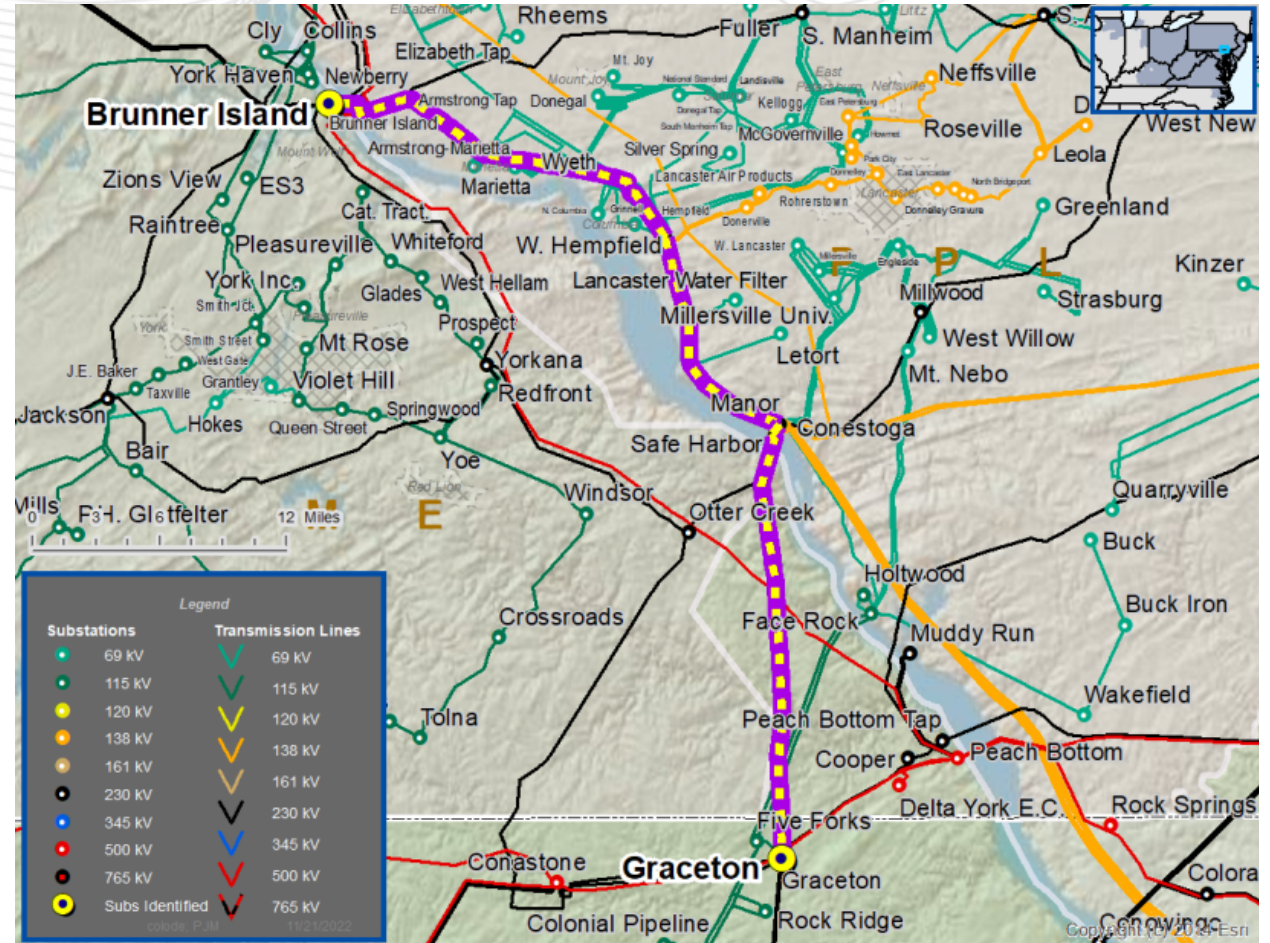
Rebuild 1.4 miles of existing single circuit 230 kV tower line between BGE's Graceton substation to the PPL tie-line at the MD/PA state line to double circuit steel pole line with one (1) circuit installed to uprate 2303 circuit.

Estimated Cost: \$8.4 M

Alternatives: See slide #8

Required In-Service: 6/1/2027

Projected In-Service: 6/1/2026



Process Stage: First Review

Criteria: Summer and Winter Generator Deliverability

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 RTEP Summer and Winter cases

Proposal Window Exclusion: No

Problem Statement:

The Conastone – North West 230 kV circuit is overloaded for multiple contingencies.

Violations were posted as part of the 2022 Window 1: Violations were posted as part of the 2022 Window 1: FG, GD-S38 and GD-W42

Existing Facility Rating: 670SN/852SE, 802WN/912WE MVA

Proposed Facility Rating: 1100SN/1364SE, 1170WN/1381WE

Proposed Solution:

Proposal ID #94 - Reconductor two (2) 230 kV circuits from Conastone to Northwest #2.

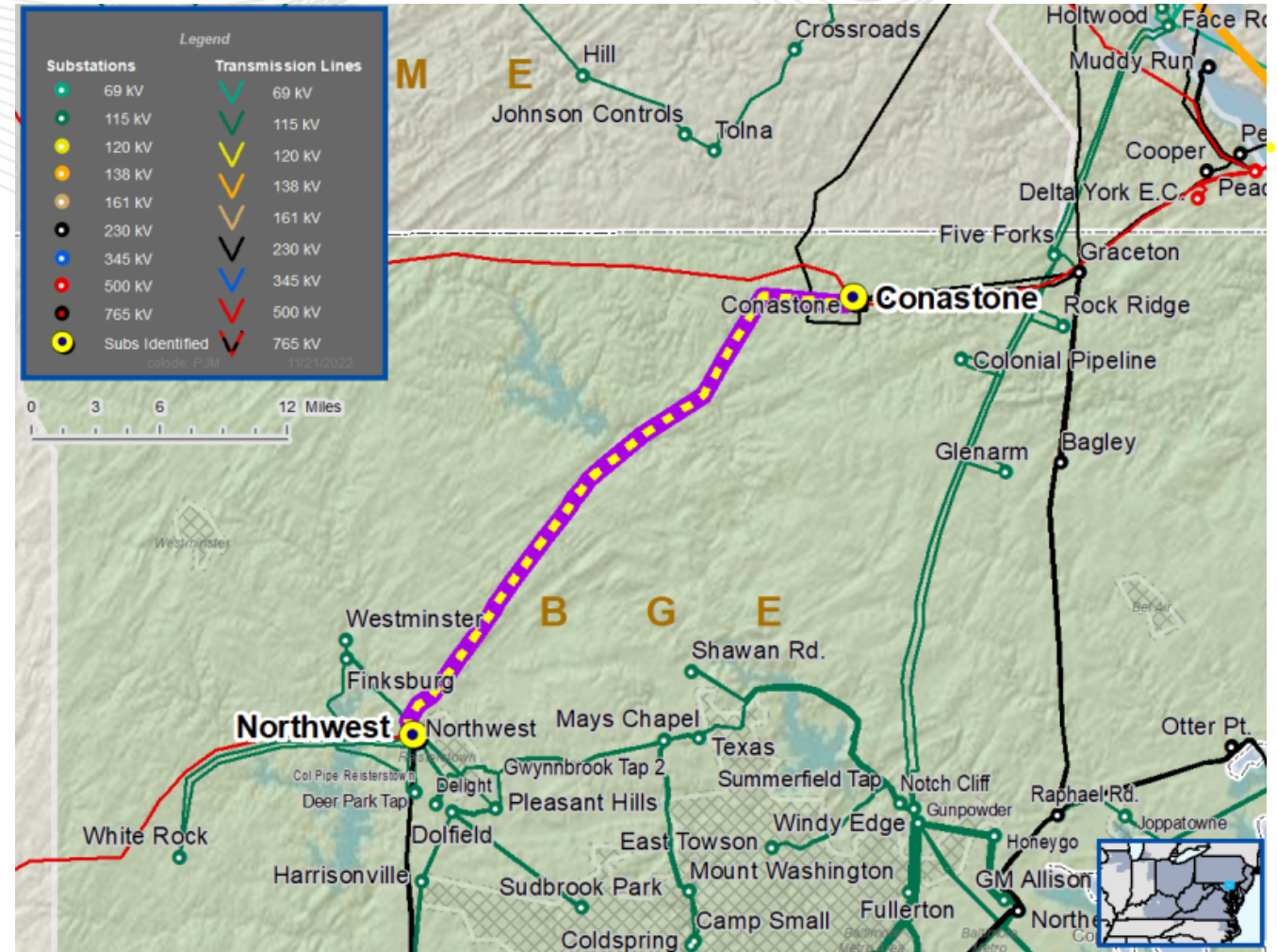
The total cost of the project is approximately \$81 M and \$43.6M spent to date as part of 9-A project

Estimated Cost: \$37.76 M

Alternatives: N/A

Required In-Service: 6/1/2027

Projected In-Service: 6/1/2026



APS Transmission Zone: Baseline Messick Road - Morgan 138 kV

Process Stage: First Review Solution

Criteria: Generation Deliverability

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 Summer and Winter RTEP case

Proposal Window Exclusion: Below 200 kV Exclusion

Problem Statement: 2022W1-GD-S558, 2022W1-GD-S559, 2022W1-GD-W387 and 2022W1-GD-W388

In 2027 RTEP Summer and Winter cases, Messick road to Morgan 138 kV line is overloaded due to two breaker contingencies.

Existing Facility Rating: 221SN/268SE, 250WN/317WE MVA

Proposed Facility Rating: 308SN/376SE, 349WN/445WE

Proposed Solution:

- Reconductor 27.3 miles of the Messick Road - Morgan 138 kV Line from 556 ACSR to 954 ACSR
- At Messick Road Substation: Replace 138 kV wave trap, circuit breaker, CT's, disconnect switch, and substation conductor and upgrade relaying
- At Morgan Substation: Upgrade Relaying

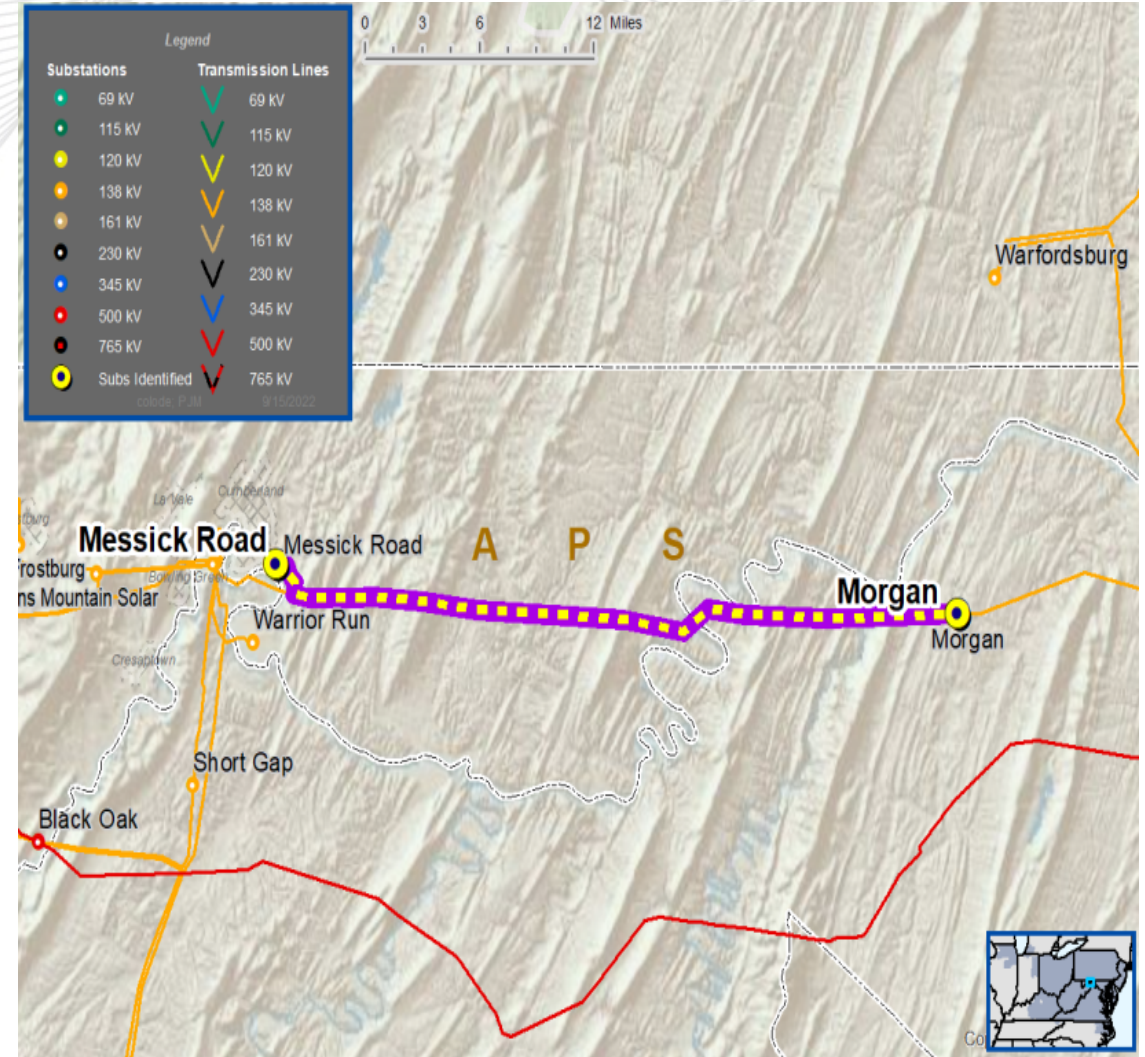
Estimated Cost: \$49.23M

Alternatives: -See slide #8

-A full rebuild of the Beddington 500 kV substation into a breaker and half configuration to eliminate the breaker contingency.

Required in-service date: 6/1/2027

Projected in-service date: 6/1/2027



Transmission Zone: Baseline McConnellsburg 138 kV

Process Stage: First Review Solution

Criteria: Baseline Analysis

Assumption Reference: 2027 RTEP assumption

Model Used for Analysis: 2027 Winter RTEP case

Proposal Window Exclusion: Below 200 kV Exclusion

Problem Statement: 2022W1-N2-VM1 to 2022W1-N2-VM5, 2022W1-N2-VM12, 2022W1-N2-VM15 to 2022W1-N2-VM29, 2022W1-N2-VM32 to 2022W1-N2-VM35

In 2027 RTEP Winter case, Low Voltage is observed at McConnellsburg, Warfordsburg, Morgan and Cherry Run 138 kV substation due to N-1-1 contingencies.

Proposed Solution:

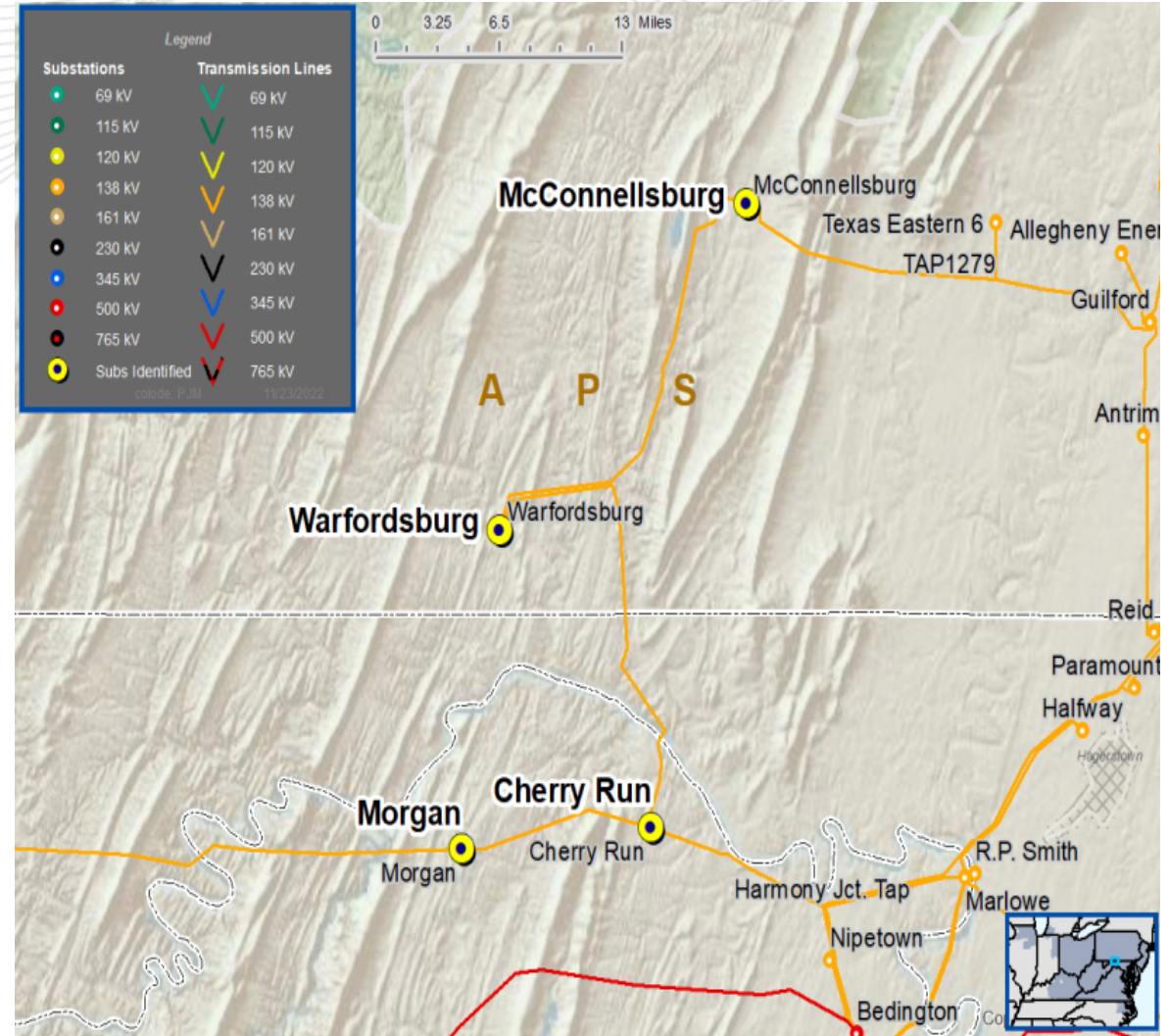
- McConnellsburg 138 kV Substation: Install 33 MVAR switched capacitor, 138 kV Breaker, and associated relaying.

Estimated Cost: \$3.05M

Alternatives: N/A

Required in-service date: 6/1/2027

Projected in-service date: 6/1/2027



Second Review

Baseline Reliability Projects

Process Stage: Second 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.

Recommended Solution:

Purchase one 80 MVAR 345 kV spare reactor. (B3765)

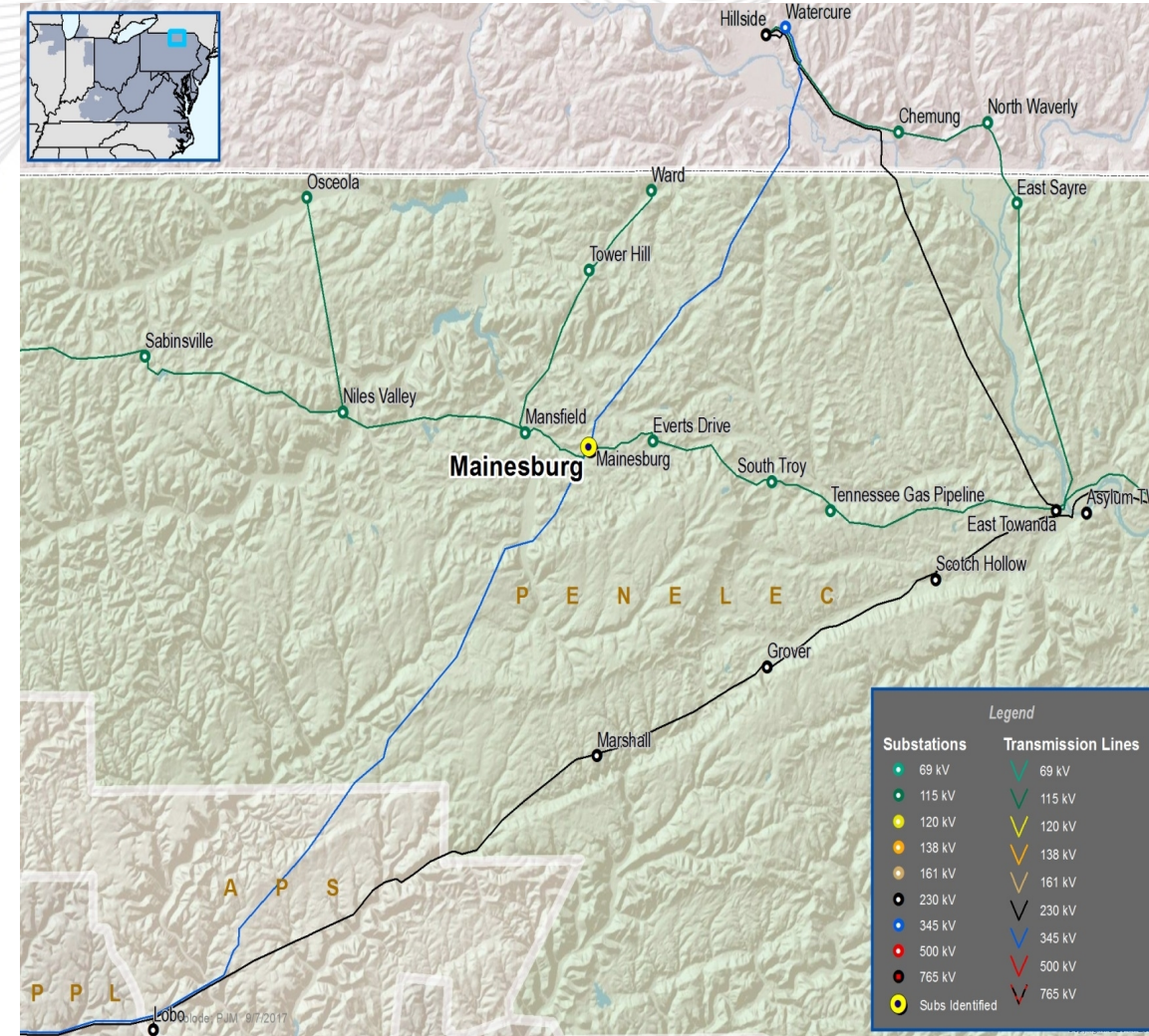
Estimated Cost: \$6.44 M

Alternatives:

N/A

Required In-Service: 2022

Projected In-Service: 12/1/2025



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Reliability Analysis Update



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Version No.	Date	Description
1		<ul style="list-style-type: none">• Original slides posted
2	10/31/2022	<ul style="list-style-type: none">• Added map on slide # 16• Added slide # 15 to include a title page
3	12/7/2022	<ul style="list-style-type: none">• Slide #5: Added additional benefits

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