



# Reliability Analysis Update

Transmission Expansion Advisory  
Committee  
January 12, 2017



# Clean Power Plan (CPP) Reliability Studies

- Provide a representative overview of the types of reliability issues that can be expected.
- Each scenario has a distinct portfolio of generation additions and retirements derived from the economic studies PJM has performed.
- The starting base case that each of the scenarios will be built from is the 2019/20 RPM power flow model.
- All scenarios will be studied for year 2025

- Generator deliverability will be performed on the following scenarios
  - Reference
  - Trade Ready Mass
  - Trade Ready Rate
- Load deliverability will be performed only on the Reference scenario power flow model, but selected individual LDAs will be updated and examined separately to account for the most severe scenario for that LDA if the LDA's forecast CETO exceeds its forecast CETL
  - Reference: BGE & MAAC
  - Reference 5/20: DLCO & EMAAC
  - State MASS NSC: Dayton
  - Low Natural Gas Price: APS & AEP
- PV analysis will be performed on the following scenarios
  - Reference
  - Trade Ready Mass
  - Trade Ready Rate
  - State Mass
  - State Mass NSC
  - State Rate



# CPP Planning Generator Deliverability Results

<b>Scenario</b>	<b>Fr Name</b>	<b>To Name</b>	<b>kVs</b>	<b>Areas</b>
Reference	05MADDOX	05E LIMA	345/345	AEP
Reference	26CANYON	26N.MESHVN	230/230	PENELEC
Reference	26E.TWANDA	26CANYON	230/230	PENELEC
Reference	6CHARLVL	6PROFFIT	230/230	DOM
Reference	6CHSTF B	6BASIN	230/230	DOM
Reference	8BATH CO	8VALLEY	500/500	DOM
Reference	AA2-121 TAP	01WYLIE R	345/345	AEP/APS
Trade Ready Mass	6CHARLVL	6PROFFIT	230/230	DOM
Trade Ready Mass	6CHSTF B	6BASIN	230/230	DOM
Trade Ready Mass	6PRINCE EDW	6FARMVIL	230/230	DOM
Trade Ready Rate	05MADDOX	05E LIMA	345/345	AEP
Trade Ready Rate	6BREMO	6BREMODIST	230/230	DOM
Trade Ready Rate	6BREMODIST	6MTEAGLE	230/230	DOM
Trade Ready Rate	6BUCKING	6BREMO	230/230	DOM
Trade Ready Rate	6CHARLVL	6PROFFIT	230/230	DOM
Trade Ready Rate	6CHSTF B	6BASIN	230/230	DOM
Trade Ready Rate	6FARMVIL	6BUCKING	230/230	DOM
Trade Ready Rate	6MTEAGLE	6CHARLVL	230/230	DOM
Trade Ready Rate	6PRINCE EDW	6FARMVIL	230/230	DOM

- The reliability power flow models for each scenario have been developed.
- The generator deliverability studies are complete. The load deliverability studies are nearing completion. Results are expected to be available for the February TEAC.



# Immediate Need Reliability Projects

- **PJM Criteria Violation – Load Loss Limit**

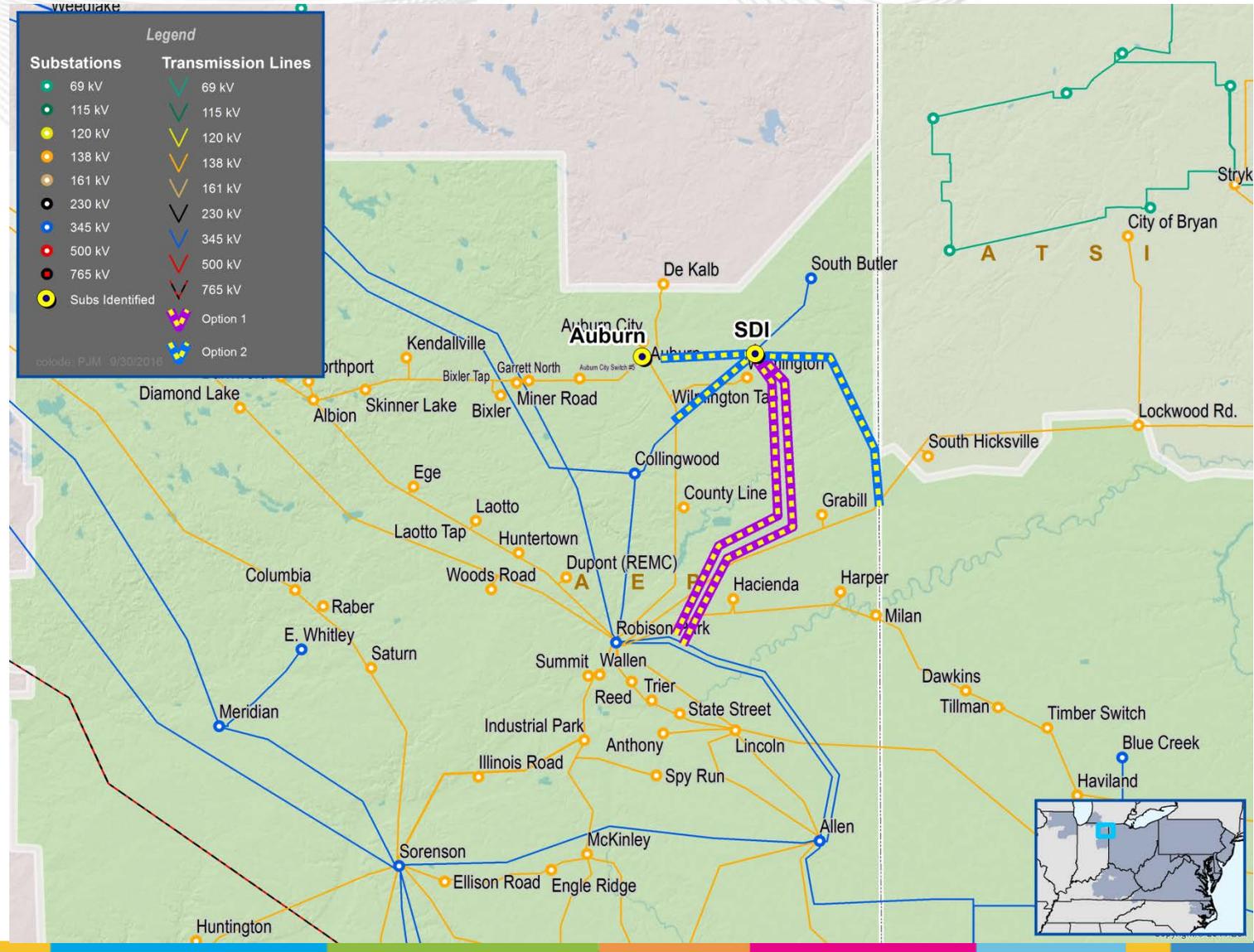
- Load model update -- Consequential Load Loss is greater than 300MW for the loss of the South Butler – Collingwood 345kV line

- **Immediate Need**

- Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible

- **Alternatives Considered**

- Option 1: Construct a new 345 kV switching station near the customer (SDI); Tap the Rob Park –Allen 345 kV line and extend a new double circuit 345kV line (around 17 miles) into this new station (\$76.5M)
- Option 2: Construct a new 138 kV station, Campbell Road, by tapping into the Grabill – South Hicksville 138kV line; Reconstruct sections of the Butler-N.Hicksville and Auburn-Butler 69kV circuits as 138kV double circuit and extend 138kV from Campbell Road station; Construct a new 345/138kV SDI Wilmington Station which will be sourced from Collingwood 345kV and serve the SDI load at 345kV and 138 kV respectively; 138kV circuits will be looped in-out of the new SDI Wilmington station resulting in a direct circuit to Auburn and in direct circuit to Auburn and Rob Park via Dunton Lake, and a circuit to Campbell Road; Reconnector 138kV line section between Dunton Lake – SDI Wilmington; Expand 138kV bus at Auburn (\$107.7M)



- Comparison of two Options**

	Estimated Cost (M)	Right of way Width (feet)	Additional ROW (miles)	Addresses Local Area Needs?	Ease of future area Outage Scheduling?
Option 1 (345kV double circuit)	\$ 76.5	150	~17	No	No
Option 2 (138 kV solution)	\$107.7	100	~7 (~15.5 existing)	Yes*	Yes

- \* Local 69kV lines built in the 1950s with wood pole construction with distribution class cross arms and the existing conductor is 4/0 ACSR.
- \* During 2013-2016, there were 6 outages on Auburn-Butler 69kV line and 4 outages on Butler-North Hicksville 69kV line.
- \* For the Auburn-Butler and Butler-North Hickville 69kV lines, there are 5 towers in A1 condition, 79 towers in A2 conditions, and 22 towers in A3 conditions.
- \* The existing 69 kV line passes through an industrial zone and continued area industrial growth is anticipated.
- \* Local wholesale distribution cooperative is also served from the 69 kV line of similar vintage and construction. This cooperative just West of this area has experienced multiple forced and momentary outages in the recent past.

NOTE: The 138KV option will use 795ACSR conductor. The cost difference between 556 ACSR and 795 ACSR is about 2-3% of the overall project cost and the rating difference are show in the following table:

Conductor Type	SN/SE (MVA) 69 kV	SN/SE (MVA) 138 kV
4/0 ACSR Penguin (existing)	50/50	N/A
556 ACSR Dove	102/142	205/284
795 ACSR Drake	129/180	257/360

- **Recommended Solution:**

- Construction a new 138 kV station, Campbell Road, tapping into the Grabill – South Hicksville 138kV line (B2779.1)
- Reconstruct sections of the Butler-N.Hicksville and Auburn-Butler 69kV circuits as 138kV double circuit using 795ACSR and extend 138kV from Campbell Road station (B2779.2)
- Construct a new 345/138kV SDI Wilmington Station which will be sourced from Collingwood 345KV and serve the SDI load at 345KV and 138 kV respectively; (B2779.3)
- 138Kv circuits will be looped in-out of the new SDI Willington station resulting in a direct circuit to Auburn and in direct circuit to Auburn and Rob Park via Dunton Lake, and a circuit to Campbell Road; Reconductor 138kV line section between Dunton Lake – SDI Wilmington; (B2779.4)
- Expand 138kV bus at Auburn (B2779.5)

- **Estimated Project Cost: \$107.7M**

- **Required IS Date: Immediate Need**

- **Expected IS Date: 6/1/2019**

❖ This recommendation had been presented in 1/5.2017 PJM WESTSRT 11.3. 2016 TEAC and 10.6.2016 TEAC

### Cost Details

138 kV Station on Rob Park-S Hicksville line, Campbell Road	\$4.8
138 kV line single and double ckt sections, 22.5 mi	\$33.0
138 kV Dunton Lake-Wilmington Reconductor, 9.5 mi	\$13.3
345/138 kV South Butler station, (5) 345 kV and (8) 138 kV CBs, (2) 345/138 kV XF, (2) 138 kV Cap Bank and CS, & Land	\$41.5
138kV Expansion at Auburn, (1) 138 kV CB	\$1.0
Total	\$93.6
15% Contingency	\$14.1
<b>Grand Total (Million)</b>	<b>\$107.7</b>

## Dominion End of Life Criteria Violation:

- The Dooms - Valley 500 kV Line has reached its End of Life
- Third party evaluation: Confirmed the Dooms - Valley 500 kV has reached its End of Life
- PJM Reliability Assessments without the line result in Criteria violations: Numerous thermal and voltage violations for various contingencies around and at Bath County, Lexington, Clifton, Lowmoor, and Dooms.

## Immediate Need:

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

## Alternatives Considered:

- Alternatives that would require new lines to be built were not considered.

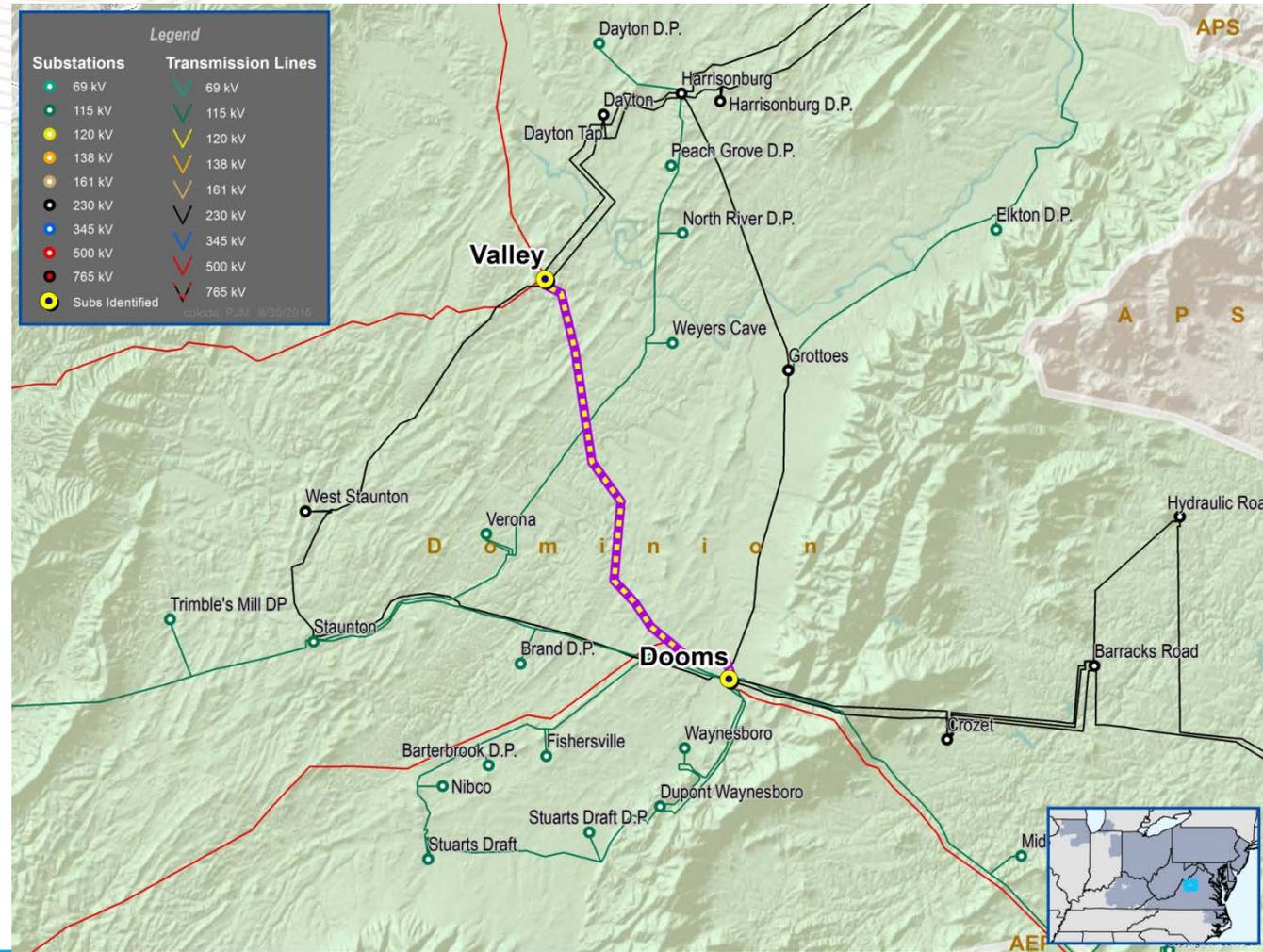
## Proposed Solution:

- Rebuild Line #549 Dooms – Valley 500kV (B2758)

**Estimated Project Cost:** \$58.16 M

**Required IS Date:** Immediate Need

**Projected IS Date:** 6/1/2021



- Rebuild Line #549 Doods – Valley 500kV (B2758)
- Number of violations with facility removed:

Violations	500 kV	230 kV	138 kV
Thermal Overload	4		
Voltage (Mag/Drop)	3	2	1
Non-Convergence	1 non-converged single contingency due to voltage violations		

- Present Rating vs. New Anticipated Rating:

	Present Rating	New Anticipated Rating
Rate A	2598.0	3464.0
Rate B	2598.0	4300.0
Rate C	2988.0	4900.0

## Dominion End of Life Criteria Violation:

- The Mt. Storm - Valley 500 kV Line has reached its End of Life
- Third party evaluation: Confirmed the Mt. Storm - Valley 500 kV has reached its End of Life
- PJM Reliability Assessments without the line result in Criteria violations: Numerous thermal and voltage violations for various contingencies around and at Barrack Road, Charlottesville, Bath County, Lexington, Clifton, Endless Caverns, Ox, and Possum.

## Immediate Need:

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

## Alternatives Considered:

- Alternatives that would require new lines to be built were not considered.

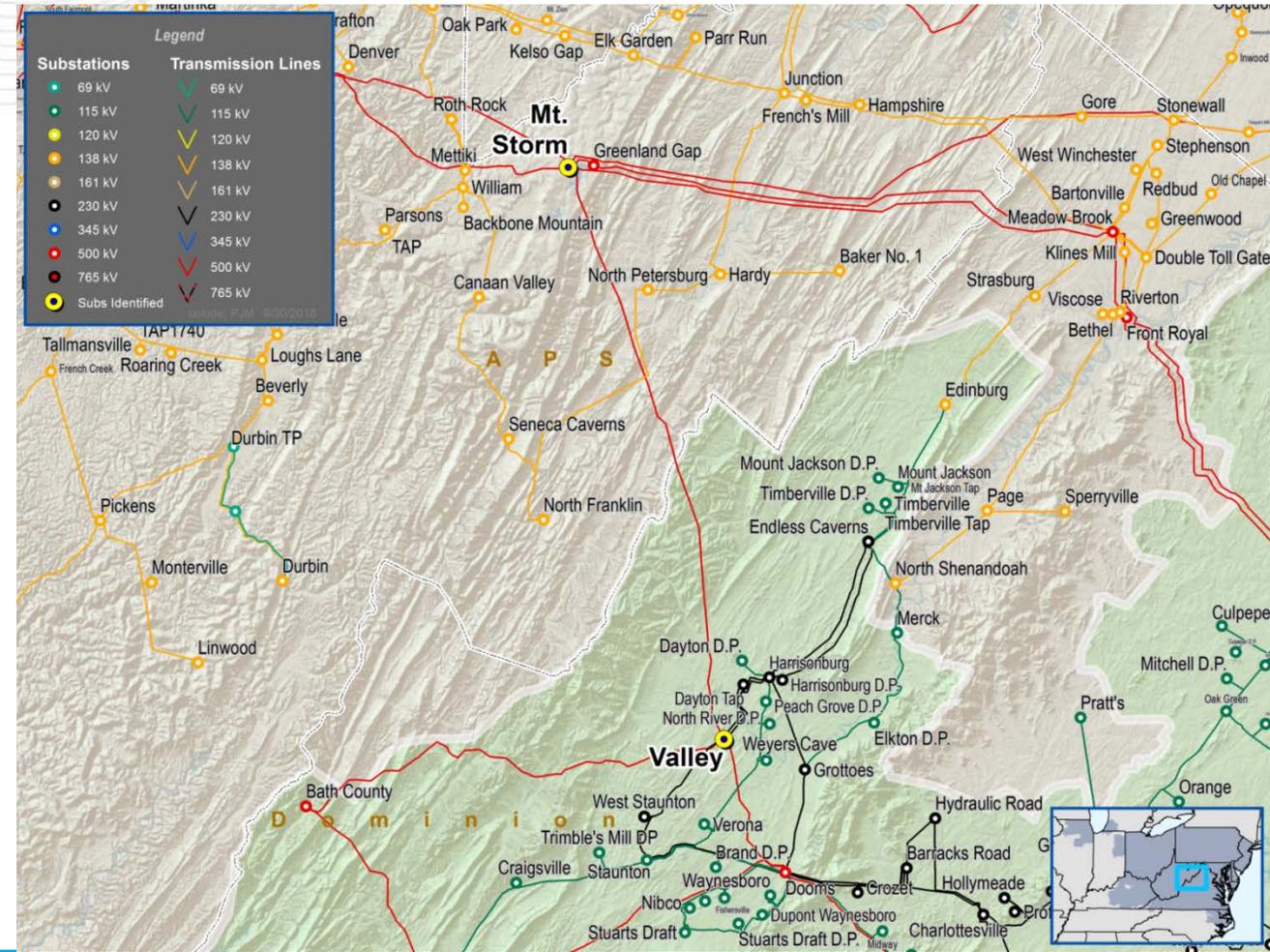
## Proposed Solution:

- Rebuild Line #550 Mt. Storm – Valley 500kV (B2759)

**Estimated Project Cost:** \$225 M

**Required IS Date:** Immediate Need

**Projected IS Date:** 6/1/2021



- Rebuild Line #550 Mt. Storm – Valley 500kV (B2759)
- Number of violations with facility removed:

Violations	500 kV	230 kV	138 kV	115 kV	69 kV
Thermal Overload	3	8	1	1	
Voltage (Mag/Drop)	6	7	11	14	3
Non-Convergence	5 non-converged single contingencies due to thermal and voltage violations				

- Present Rating vs. New Anticipated Rating:

	Present Rating	New Anticipated Rating
Rate A	2598.0	3464.0
Rate B	2598.0	4300.0
Rate C	2988.0	4900.0

# Potential High Voltage issue in PSEG During Light Load

- Background
  - The BLC (*Bergen –Linden Corridor* ) project in the Northern PSEG is under construction to be completed by June 2018. The project includes several pieces of underground cable.
  - The northern PSEG area previously experienced high voltage issue.
  - The last three years average load in PSEG was about 4000 MW during light load. The 2015-2016 load average was about 3900 MW during light load hours.

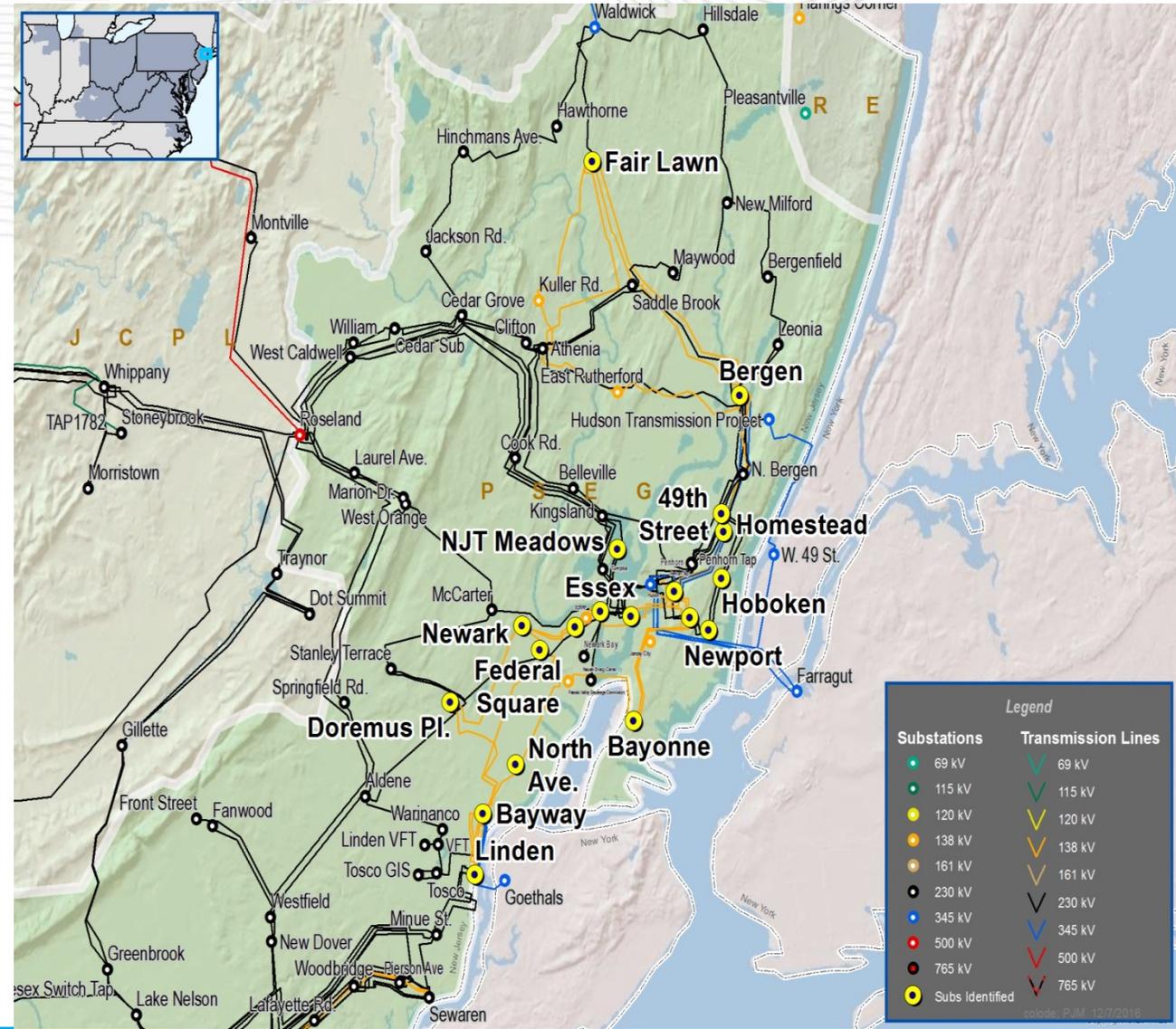
## Purpose:

- The purpose of this analysis is to determine if a high voltage violations exist after the Bergen – Linden Corridor is fully energized.

- Assumptions/Analysis
  - PJM performed voltage analysis using the 2021 RTEP Light Load case with 3900 MW load model for PSEG area and identified several high voltage violations in Northern PSEG.
  - System transmission topology is unchanged between 2019 and 2021 in the PSEG North area and therefore the violation is expected to occur during the 2018/2019.

- PSEG stations with High voltage violations

138 kV substation	230 kV substation	345 kV substation
Doremus Place 138 kV	49TH Street R 230 kV	Newark Airport 345 kV
Fair Lawn 138 kV	49th Street Y 230 kV	Bayonne 345 kV
Federal Square 138 kV	Essex 230kV	Bayway 345 kV
Foundry Street 138 kV	Hoboken 230 kV	Bergen 345kV
Newark 138 kV	Homestead 230 kV	Linden 345kV
	Kearny 230 kV	Marion 345 kV
	Madison 230kV	North Avenue 345 kV
	Newport 230 kV	
	NJT Meadows 230 kV	
	Penhoun 230 kV	
	South Water Front 230 kV	



- Conclusion
  - The voltage violations exist after the Bergen-Linden Corridor project is placed in-service in 2018.
  - The addition of reactive devices is an immediate need.
  - 600MVAR of new shunt reactors installed in PSE&G's northern and central zones will address the high system voltages.
  - Because of long shunt reactor procurement time, need to start as soon as possible to meet in-service dates.

- Recommended solution:

## Install shunt reactors in the following stations

Baseline #	Location	Size	Cost	In-Service
B2825.1	Kearny 230kV	2x50 MVAR	\$17.8M	May-19
B2825.2	Hudson 230kV	2x100 MVAR <sup>1</sup>	\$13.5M	Sep-19
B2825.3	Bayway 345kV	2x100 MVAR	\$30.6M	May-19
B2825.4	Linden 345kV	2x100 MVAR	\$28.5M	Jun-19

<sup>1</sup> Existing 2x50 MVAR at Hudson to be replaced with 2X100 MVAR for a net increase of 100 MVAR.

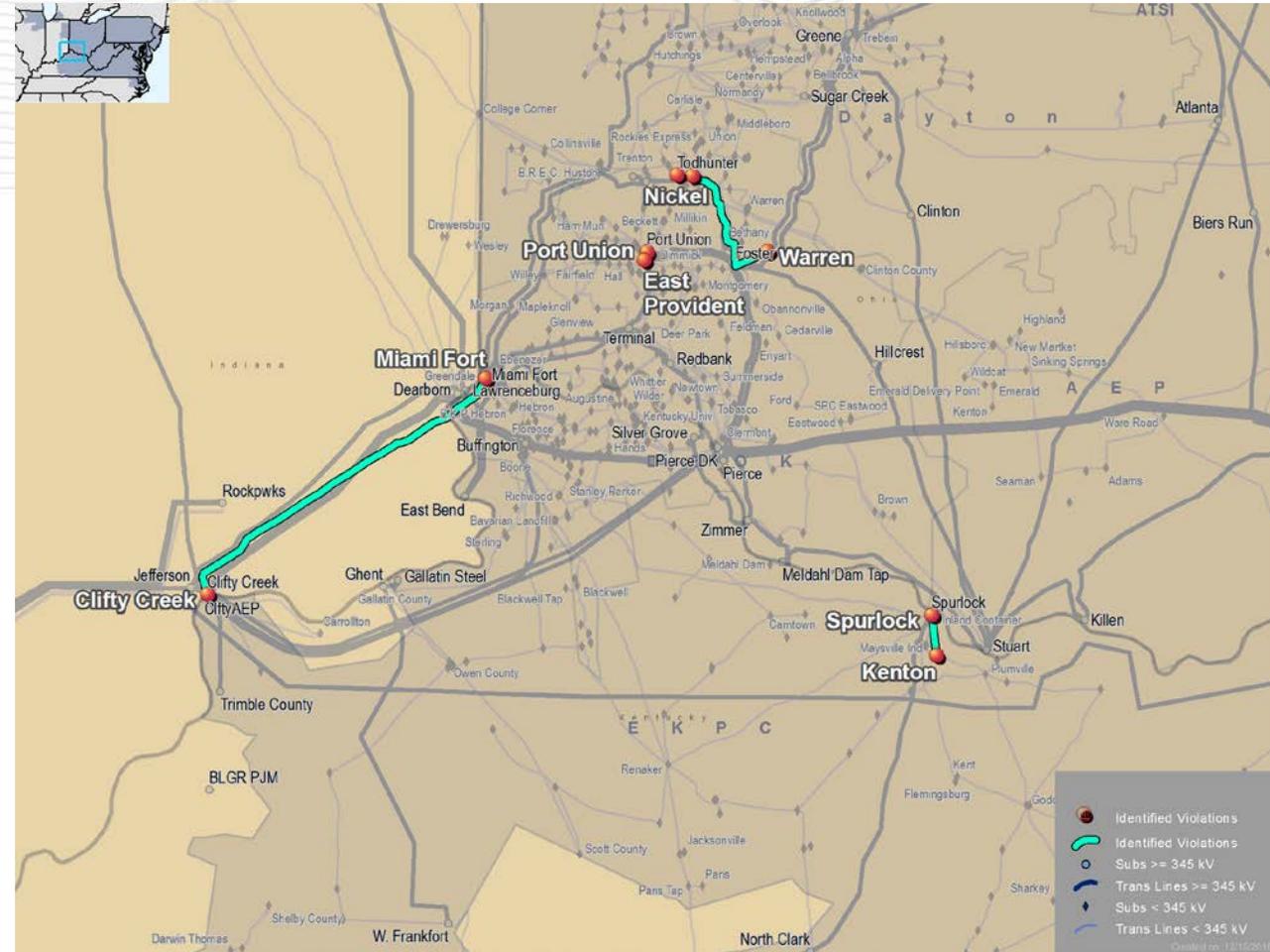


# 2016 RTEP Proposal Window #2 Updates and Recommendations

- DEOK and EKPC Transmission Zones

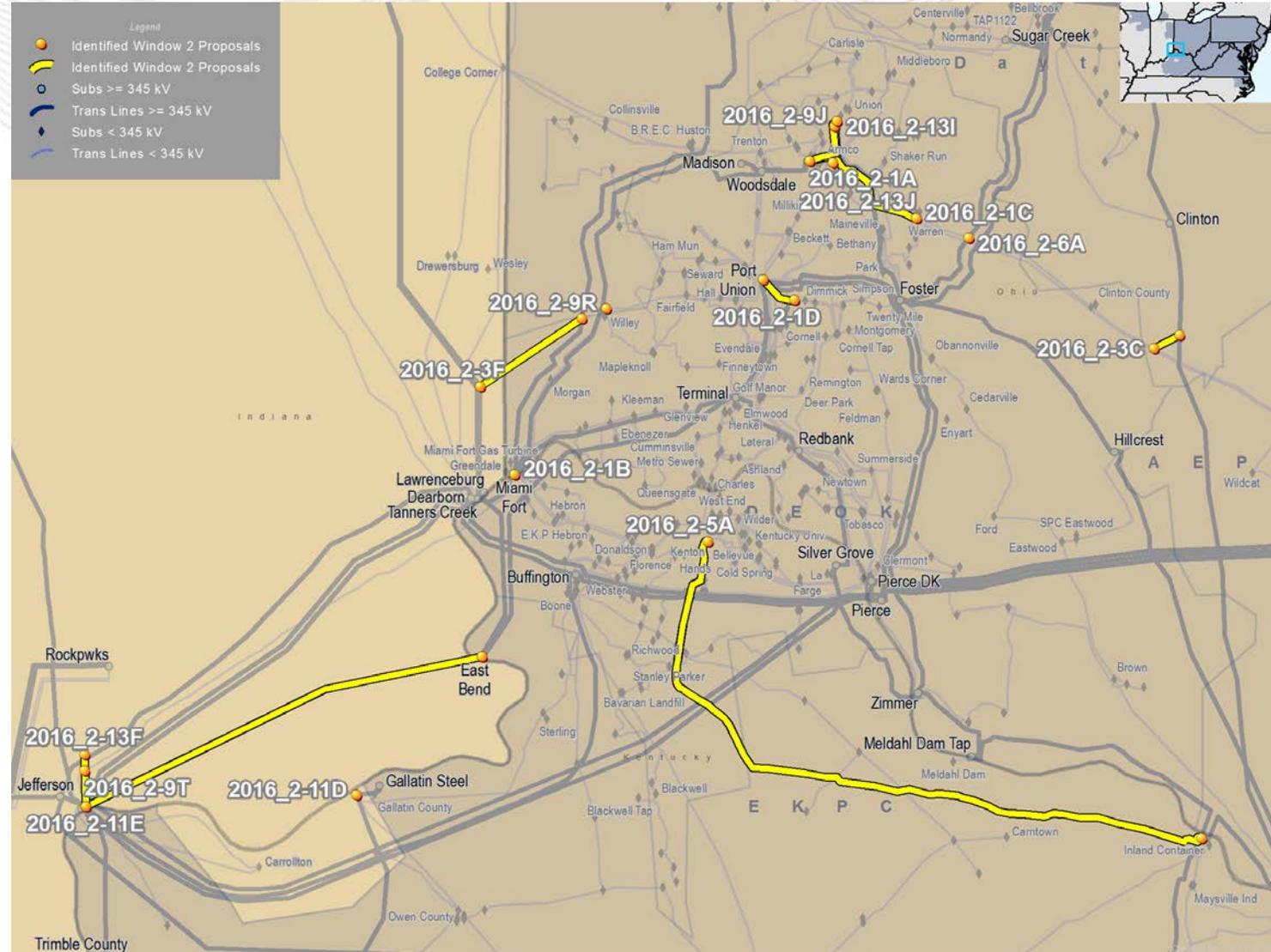
- Reliability Criteria FG#s:

- 897-Thermal Overload on Clifty-Miami Fort 138 kV
- 905-Thermal Overload on SpurKent-Kenton 138 kV
- 906-Thermal Overload on Spurlock-SpurKent 138kV
- 907-Thermal Overload on Nickel-Warren 138kV
- 1137-Thermal Overload on Clifty-Miami Fort 138 kV
- N2-T4-Thermal Overload on Port Union-E Provi 138 kV
- N2-T5-Thermal Overload on Port Union-E Provi 138 kV
- N2-T6-Thermal Overload on Tod Hunter 345/138 kV XFMR
- N2-T7-Thermal Overload on Tod Hunter 345/138 kV XFMR
- N2-T8-Thermal Overload on Tod Hunter 345/138 kV XFMR
- N2-T9-Thermal Overload on Tod Hunter 345/138 kV XFMR
- N2-T10-Thermal Overload on Tod Hunter 345/138 kV XFMR



## Proposals:

- 2016\_2-1A
- 2016\_2-1B
- 2016\_2-1C
- 2016\_2-1D
- 2016\_2-3C
- 2016\_2-3F
- 2016\_2-5A
- 2016\_2-6A
- 2016\_2-7S
- 2016\_2-9J
- 2016\_2-9R
- 2016\_2-9T
- 2016\_2-10B
- 2016\_2-11D
- 2016\_2-11E
- 2016\_2-13F
- 2016\_2-13I
- 2016\_2-13J



Proposal	Proposal ID	1A	1C	1D	3C	3F	5A	6A	1B	9J	9R
	Alternate Proposal		13I(\$11M), 13J(\$14M)					10B(\$30M)	7S(\$0.82M), 9T(\$6M),11D(\$44M), 11E(\$86M), 13F(\$12M)		
	Proposed Cost (\$M)	18.7	10.5	2.2	19	63	2.5	17.1	1.0	17	18.7
	Upgrade/Greenfield	Upgrade	Upgrade	Upgrade	Greenfield	Greenfield	Upgrade	Greenfield	Upgrade	Greenfield	Greenfield
	Proposing Entity	DEOK	DEOK	DEOK	Transource	Transource	EKPC	Nextera	DEOK	LS Power	LS Power
Flowgates	897				#	X			X		#
	905				#	X	X				
	906				#	X	X				
	907	○	X		X	X		X		X	
	1137				#	X			X		#
	N2-T4			X		X					X
	N2-T5			X		X					X
	N2-T6	X			X	X		X		X	#
	N2-T7	X			X	X		#		X	X
	N2-T8	X			X	X		#		X	#
	N2-T9	X			X	X		X		X	X
N2-T10	X			X	X		X		X	X	

○: Proposal solves the FG, but was not indicated in the proposal from the project sponsor

X: Proposal solves the FG as indicated in the proposal

#: Proposal does NOT solve the FG as indicated in the proposal



# DEOK/EKPC Transmission Zone Independent Consultant Cost Estimates

Proposal ID	1A <sup>2</sup>	1C	1D	3C <sup>2</sup>	3F	5A	6A	1B	9J <sup>2</sup>	9R
Proposing Entity	DEOK	DEOK	DEOK	Transource	Transource	EKPC	Nextera	DEOK	LS Power	LS Power
Upgrade / Greenfield	U	U	U	G	G	U	G	U	G	G
Proposed Cost (\$M)	18.7	10.5	2.2	19	63	2.5	17.1	1.0	17 <sup>4</sup>	18.7
Independent Cost Estimate (\$M)	15.1 <sup>1</sup>	8.8		24.2 <sup>1</sup>			22.3		23.2 <sup>3</sup>	19.1 <sup>3</sup>
Cost Containment	No	No	No	No	No	No	No	No	Cost Cap	Cost Cap
Recommended	Yes		Yes			Yes		Yes		

<sup>1</sup> The final Independent Cost Estimate report revised the estimate from that presented at the 12/15/16 TEAC

<sup>2</sup> Preliminary cost allocation analysis indicates these projects are allocated 100% to the DEOK zone

<sup>3</sup> Cost cap includes only proposing entity's work

<sup>4</sup> Cost estimate does not include additional breakers at Greentree substation

- Generally no significant permitting or siting issues identified for any of the proposals
  - Endangered species may require time-of-year work restrictions
- Transource 3C
  - Foster substation expansion has risk of scope increase
    - Current configuration is a 7 position 345kV ring bus
    - Estimate a potential additional impact of up to \$7.4 million
- LS Power 9R
  - Potential for additional studies or surveys to be required due to proximity of historic buildings



## Common Mode Outage (FG# 905, 906):

- Spurlock – Kenton 138 kV circuit is overloaded for loss of the tower lines of the Spurlock – Stuart 345KV and the Spurlock- Meldahl 345kV

## Alternatives considered:

- 2016\_2-3C (\$19 M<sup>2</sup>; \$24.2 M<sup>1</sup>)
- 2016\_2-3F (\$63.0 M)
- 2016\_2-5A (\$2.5 M)

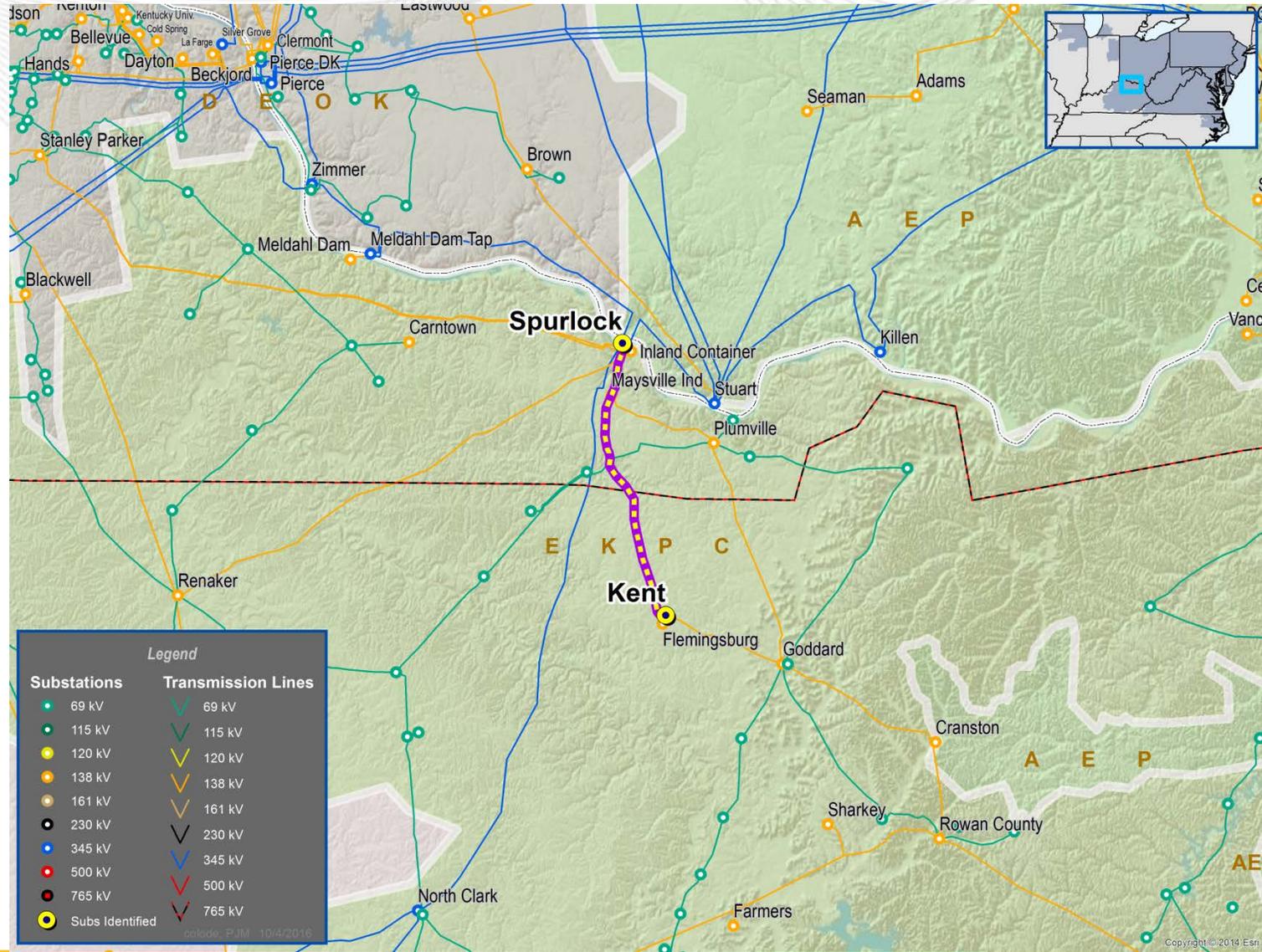
## Recommended Solution:

- Upgrade the current 5% impedance 1200A line reactor, which connects the 4SPURLOCK - 4SPUR-KENT-R and 4SPUR-KENT-R - 4KENTON 138kV line sections, to a 6.5% impedance 1600A line reactor.(2016\_2-5A)

**Estimated Project Cost: \$ 2.5 M**

**Required IS Date: 6/1/2021**

<sup>1</sup> Per independent cost estimate  
<sup>2</sup> Cost as proposed



## Common Mode Outage (FG# 897, 1137):

- The Clifty Creek– Miami Fort 138 kV circuit is overloaded for multiple common model Contingencies

## Alternatives considered:

- 2016\_2-1B (\$1.0M)
- 2016\_2-3C (\$19 M<sup>2</sup>; \$24.2 M<sup>1</sup>)
- 2016\_2-3F (\$63.0 M)
- 2016\_2-7S (\$0.82 M)
- 2016\_2-9R (\$18.7 M<sup>2</sup>; \$19.1 M<sup>1</sup>)
- 2016\_2-9T (\$6.1 M)
- 2016\_2-11D (\$44.3 M)
- 2016\_2-11E (\$85.7 M)
- 2016\_2-13F (\$12.4 M)

## Recommended Solution :

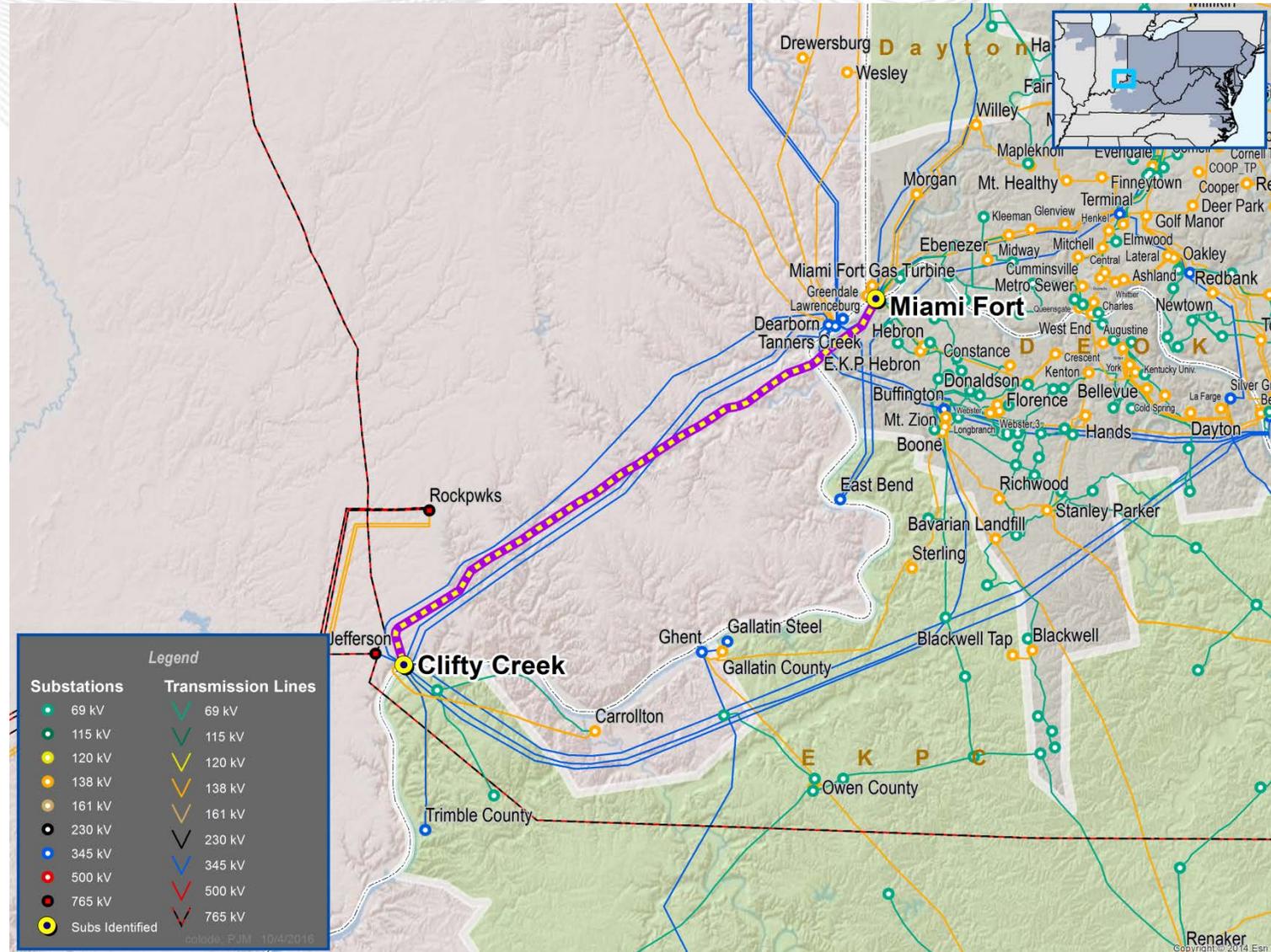
- Install 5% reactors at Miami Fort to limit current. (2016\_2-1B)

Estimated Project Cost: \$ 1.0 M

Required IS Date: 6/1/2021

<sup>1</sup> Per independent cost estimate

<sup>2</sup> Cost as proposed



## N-1-1 Thermal Violation (FG# N2-T4, N2-T5):

- The Port Union – EPROV 138 kV circuit is overloaded for loss of the Todhunter – Rockies Express 138kV and the Foster - Garver 345kV

## Alternatives considered:

- 2016\_2-1D (\$2.19 M)
- 2016\_2-3F (\$63.0 M)
- 2016\_2-9R (\$18.7 M<sup>2</sup>; \$19.1 M<sup>1</sup>)

## Recommended Solution :

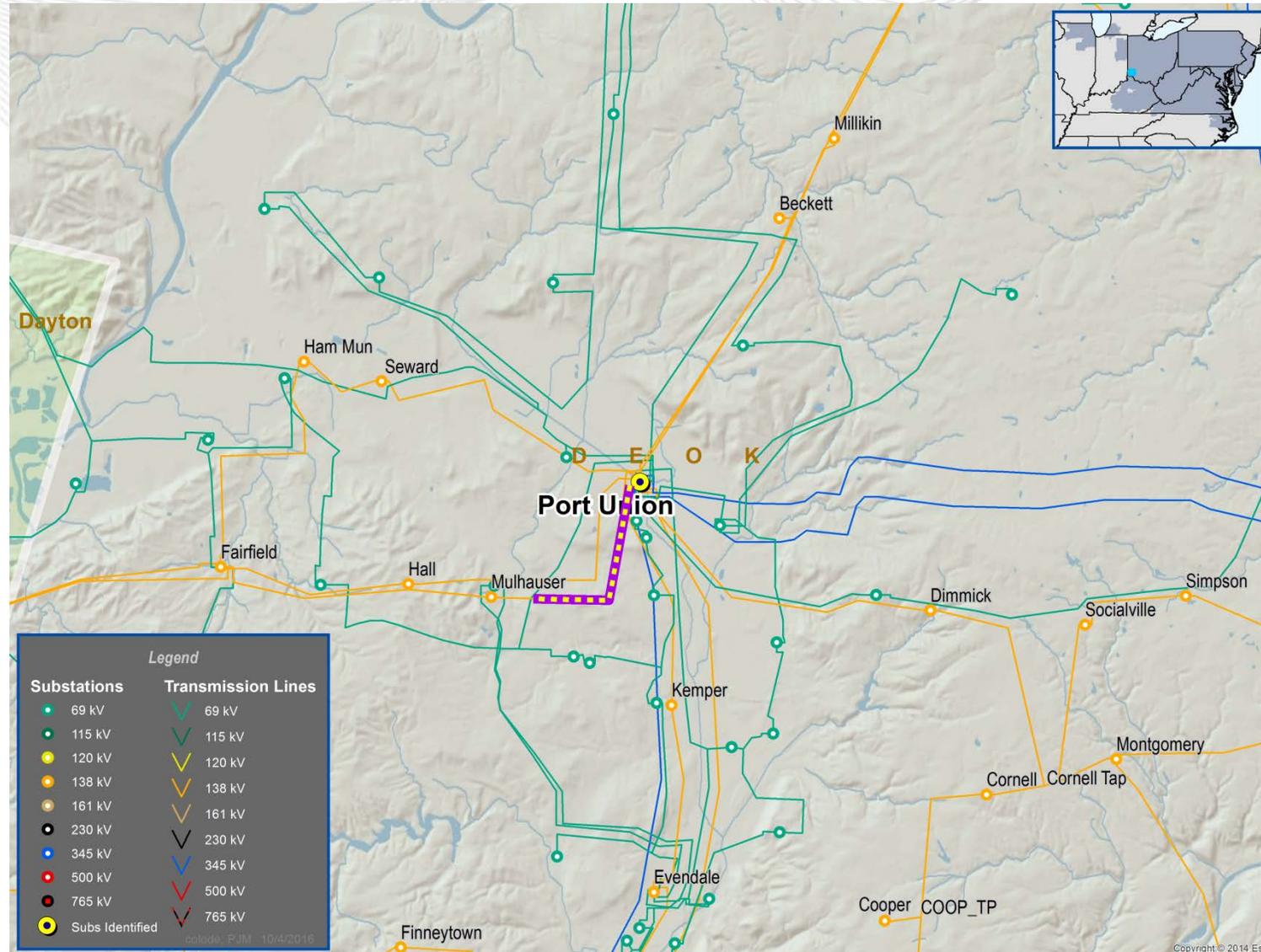
- Reconductor Feeder from Port Union to East Provident 138kV line for 300MVA. (2016\_2-1D)

**Estimated Project Cost: \$ 2.19 M**

**Required IS Date: 6/1/2021**

<sup>1</sup> Per independent cost estimate

<sup>2</sup> Cost as proposed



## Common Mode Outage (FG# 907):

- Nickel – Warren 138 kV circuit is overloaded for loss of the tower lines of the Todhunter – Rockies Express 138kV and the Foster- Garver 345kV

## Alternatives considered:

- 2016\_2-1C (\$10.5 M<sup>2</sup>; \$8.8 M<sup>1</sup>)
- 2016\_2-13I (\$11.19 M)
- 2016\_2- 13J (\$14.27 M)
- 2016\_2-3C (\$19 M<sup>2</sup>; \$24.2 M<sup>1</sup>)
- 2016\_2-3F (\$63.0 M)
- 2016\_2- 6A (\$17.1 M<sup>2</sup>; \$22.3 M<sup>1</sup>)
- 2016\_2\_9J (\$17 M<sup>2</sup>; \$23.2 M<sup>1</sup>)
- 2016\_2-10B (\$29.5 M)
- 2016\_2\_1A (\$18.7 M<sup>2</sup>; \$15.1 M<sup>1</sup>)

## Recommended Solution :

- Expand Garver 345kV sub to include 138kV. Install 1-345kV breaker, 1-345/138kV 400MVA transformer, 6-138kV Breakers and bus work. Connect local 138kV circuits from Todhunter, Rockies Express, and Union. (2016\_2-1A)

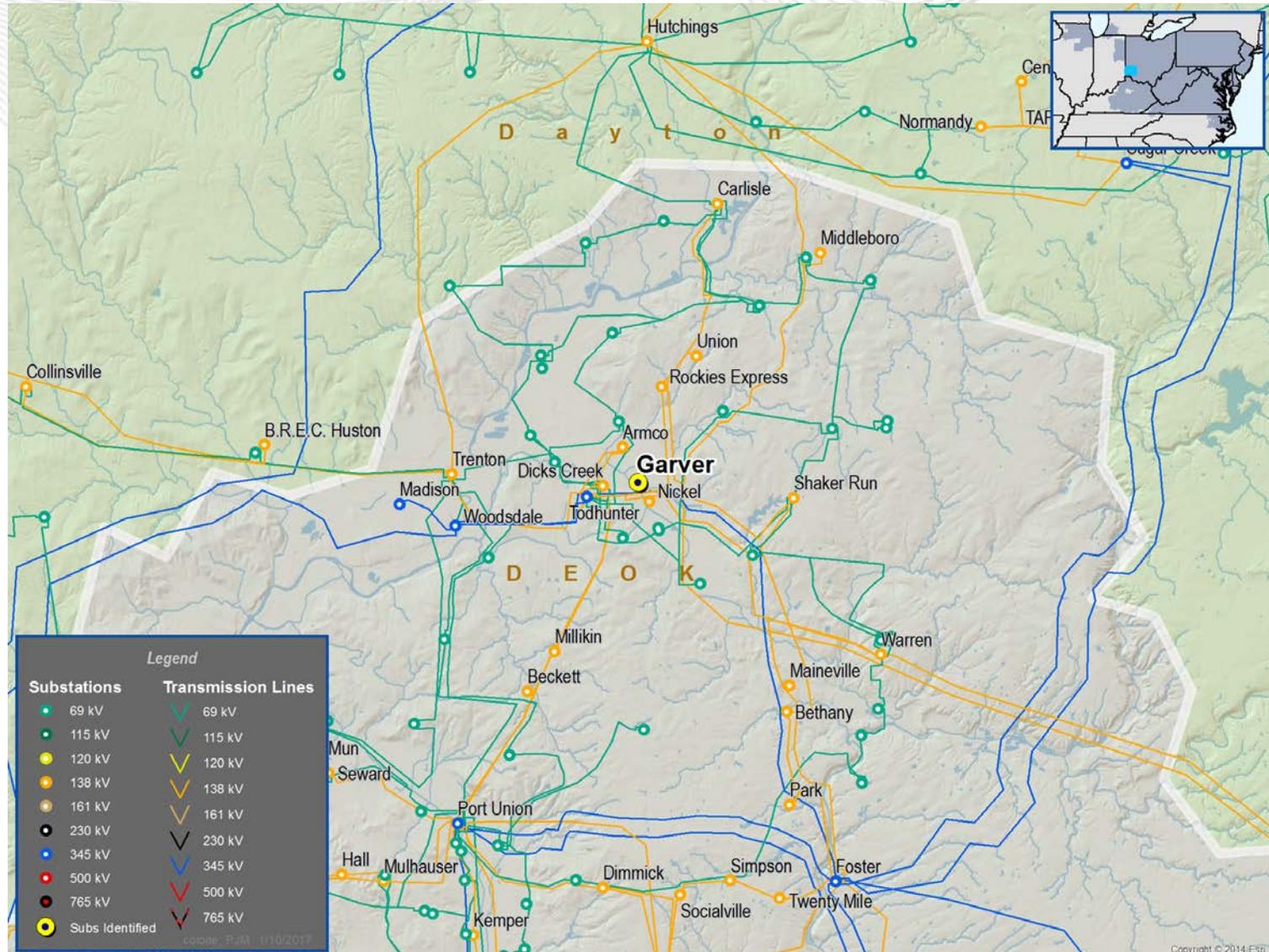
**Estimated Project Cost:** \$18.7 M<sup>2</sup>

**Required IS Date:** 6/1/2021

Note: The recommended solution “1A” for these flowgates is the same solution for several additional flowgates on the next slide.

<sup>1</sup> Per independent cost estimate

<sup>2</sup> Cost as proposed



N-1-1 Thermal Violation (FG# N2-T6, N2-T7, N2-T8, N2-T9, N2-T10):

- The remaining one of the three Todhunter 345/138kV transformers is overloaded for loss of the any two of them

**Alternatives considered:**

- 2016\_2-1A (\$18.7 M<sup>2</sup>; \$15.1 M<sup>1</sup>)
- 2016\_2-3C (\$19 M<sup>2</sup>; \$24.2 M<sup>1</sup>)
- 2016\_2-3F (\$63.0 M)
- 2016\_2-6A (\$17.1 M<sup>2</sup>; \$22.3 M<sup>1</sup>)
- 2016\_2-9J (\$17 M<sup>2</sup>; \$23.2 M<sup>1</sup>)
- 2016\_2-9R (\$18.7 M<sup>2</sup>; \$19.1 M<sup>1</sup>)
- 2016\_2-10B (\$29.5 M)

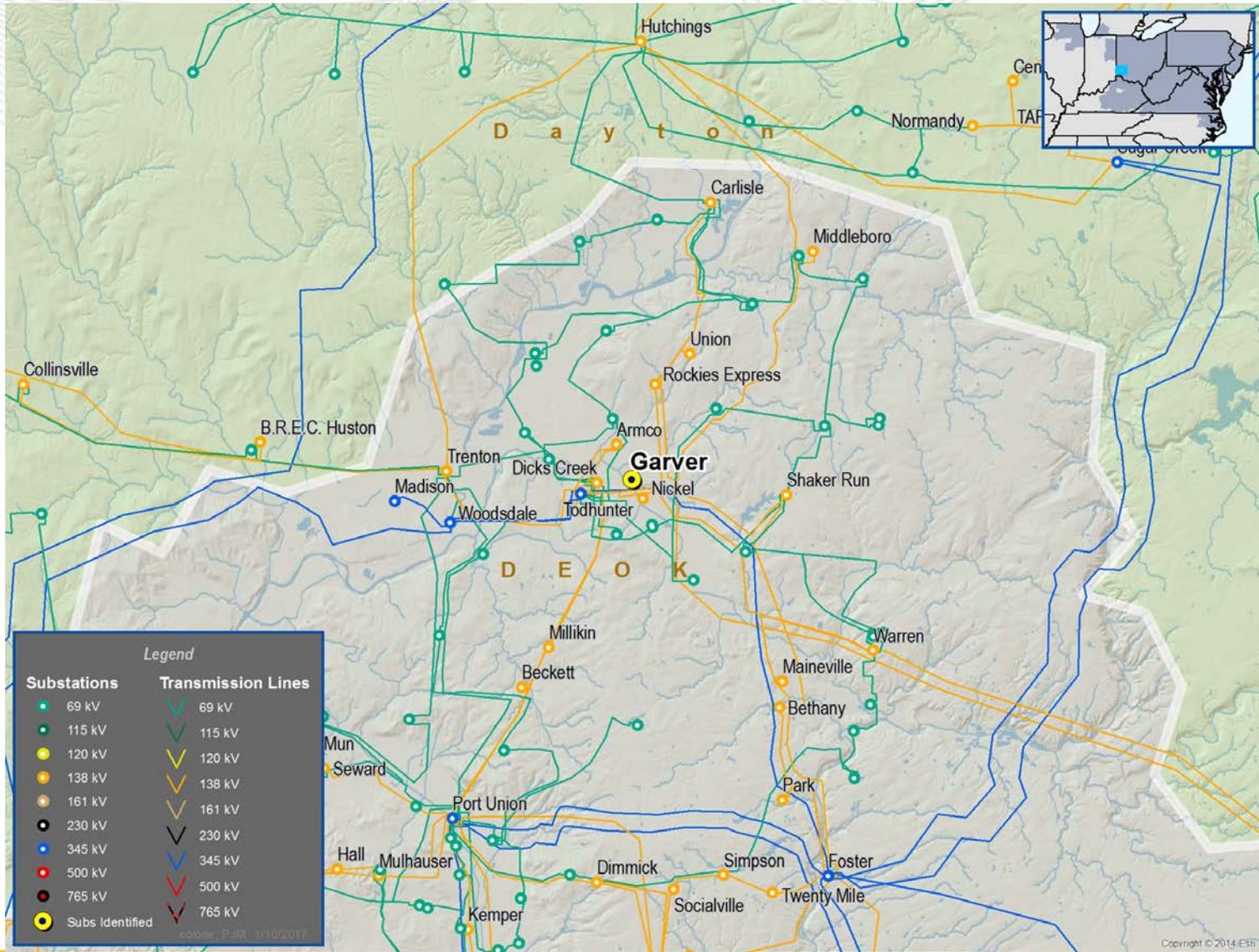
**Recommended Solution :**

- Expand Garver 345kV sub to include 138kV. Install 1-345kV breaker, 1-345/138kV 400MVA transformer, 6-138kV Breakers and bus work. Connect local 138kV circuits from Todhunter, Rockies Express, and Union. (2016\_2-1A)

**Estimated Project Cost:** \$18.7 M<sup>2</sup>

**Required IS Date:** 6/1/2021

Note: The recommended solution “1A” for these flowgates is the same solution for several additional flowgates on the previous slide.



<sup>1</sup> Per independent cost estimate

<sup>2</sup> Upgrade cost as proposed by DEOK



# 2016 RTEP Proposal Window 2

- PJM had to perform retool analysis for the following flowgates from 2016 2<sup>nd</sup> Window. The facilities are impacted by queue project that recently signed ISA (with IS date of prior to January 31, 2019), and the PSEG/ConED plus RAMAPO PAR settings. PJM completed the retool analysis and the overloaded facilities listed below are no longer overloaded with the exception of the Lackawanna 500/230 kV transformers. Due to the IS date of the queue project, the Lackawanna transformers upgrade will be an immediate need project.

FG #	Fr Bus	Name	To Bus	Name	CKT	KVs	Areas	Rating	FN DC Flow	FN AC Flow	FN DC %	FN AC %	Cont Label	Cont Type	Conductor Rating (MVA)
<a href="#">25</a>	200825	26MESH2REA	200706	26N.MESH2RE	3	115/230	226/226	188	232.01	231.57	123.41	123.18	'PN-P1-2-PN-230-013'	single	Transformer
<a href="#">29</a>	200677	26NO MESH2RE	200825	A	3	115/115	226/226	197	232.11	226.13	117.82	114.79	'PN-P1-2-PN-230-013'	single	Transformer
<a href="#">90</a>	200675	26E.TWANDA	200924	26CANYON	1	230/230	226/226	515	580.01	553.29	112.62	107.43	Base Case	single	Rate A/B = 546/666
<a href="#">91</a>	200675	26E.TWANDA	200924	26CANYON	1	230/230	226/226	615	661.97	634.55	107.64	103.18	'PL:P12:001029'	single	Rate A/B = 546/666
<a href="#">92</a>	200675	26E.TWANDA	200924	26CANYON	1	230/230	226/226	615	643.47	615.27	104.63	100.04	'PL:P12:000189'	single	Rate A/B = 546/666
<a href="#">1042</a>	208009	LACK	200074	LACKAW	4	230/500	229/225	1165	1344.52	1354.97	115.41	116.31	'PL:P42:101630'	breaker	Transformer
<a href="#">1044</a>	208009	LACK	200074	LACKAW	3	230/500	229/225	1165	1344.52	1351.41	115.41	116.	'PL:P42:101631'	breaker	Transformer
<a href="#">1059</a>	200927	26FOURMILE	200820	26ERIE SE	1	115/115	226/226	245	278.63	275.04	113.73	112.26	'PN-P2-3-PN-230-6G'	breaker	Same as basecase
<a href="#">1132</a>	130807	WESTOVER115	200680	26LAUREL L	1	115/115	102/226	149	154.84	154.18	103.92	103.48	'PN-P2-3-PN-115-46G'	breaker	Rate A/B =

## Common Mode Outage

- The Lackawanna 500/230 kV transformers # 3 and #4 are overloaded for line fault stuck breaker contingency loss of the Lackawanna – Susquehanna 500 kV circuit and the Lackawanna 500/230 kV transformer #3 or #4.

## Immediate Need:

- The Y2-089 queue generation project recently signed ISA and will be in-service by January 2019, in the immediate need timeframe.

## Alternatives Considered:

- Install series reactors along the Lackawanna 500/230 kV transformers (\$2.59 M)
- Install Phase Angle Regulator at Lackawanna (\$19 M)
- Replace Lackawanna 500/230 kV transformers (\$19.17 M)

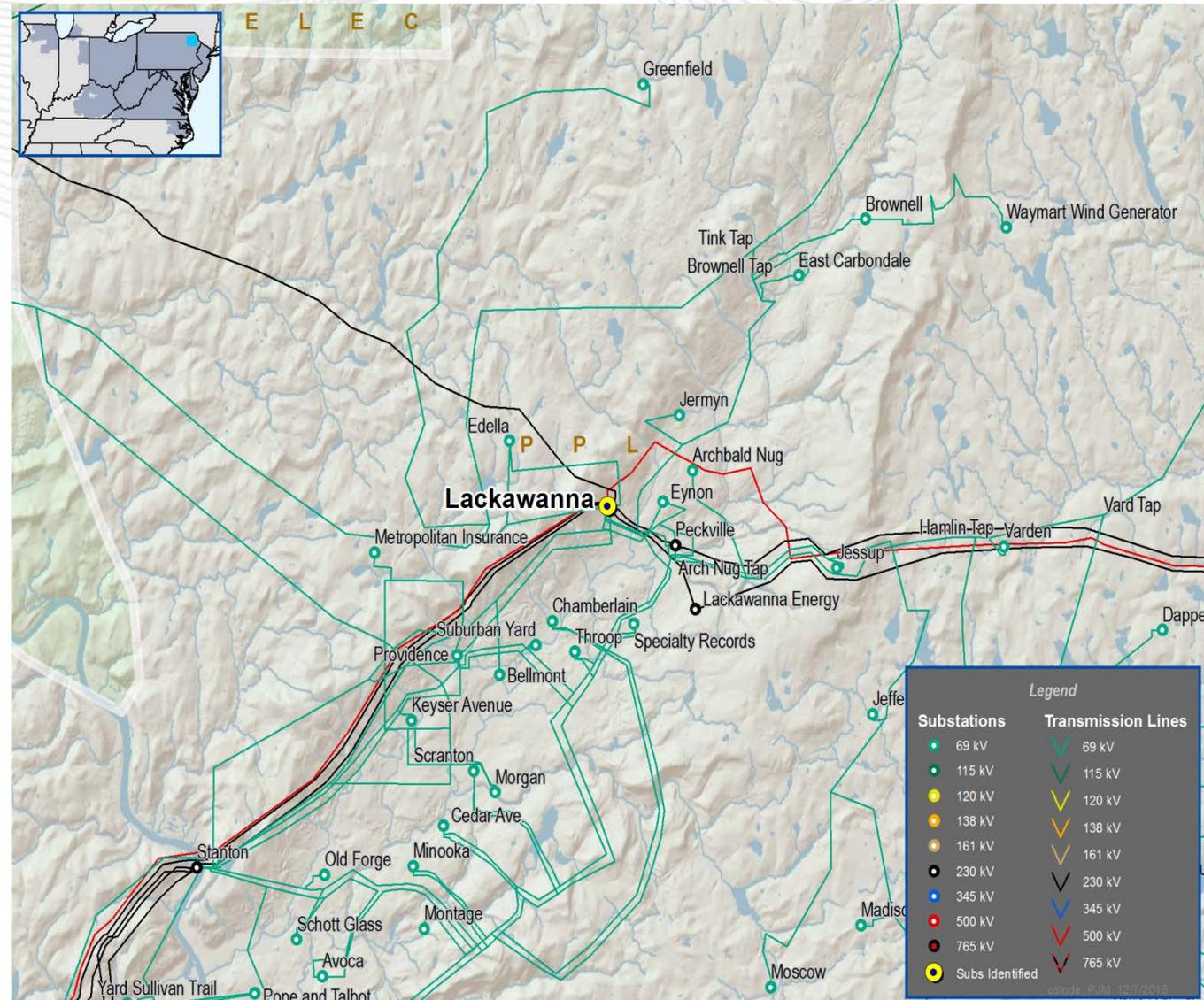
## Recommended Solution:

- Reconfigure/Expand the Lackawanna 500 kV substation by adding a third bay with three breakers.

**Estimated Project Cost:** \$ 11.26 M

**Required IS Date:** 1/31/2019

**Expected IS Date:** 1/31/2019





# 2016 RTEP Proposal Window #3 Update

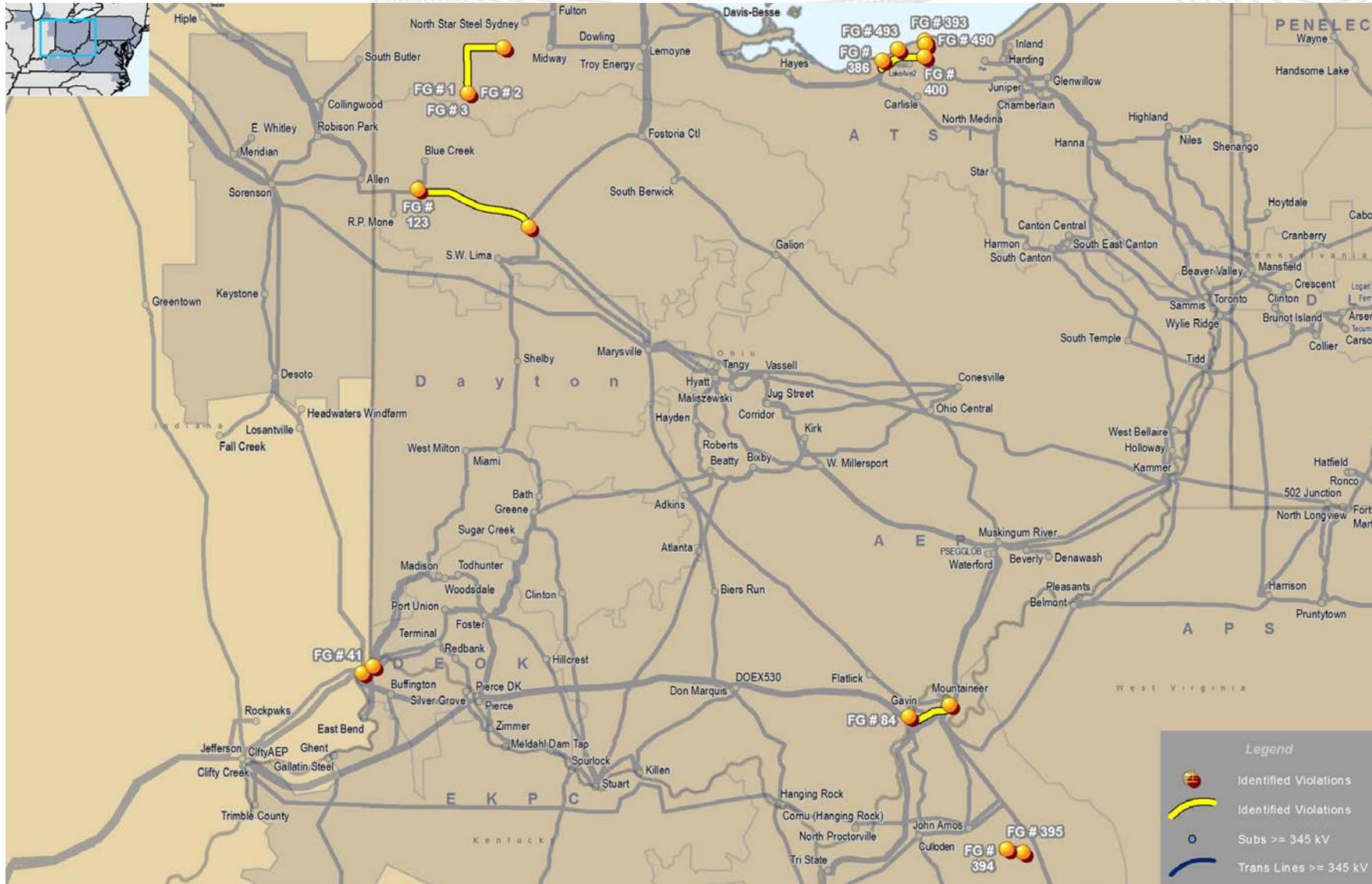
- Status: 30 Day Portion closed 10/31/2016, Final details due 11/15/2016
- Scope:
  - 2016 RTEP Winter Analysis
    - Baseline N-1 (thermal and Voltage)
    - Generation Deliverability and Common Mode Outage
    - N-1-1 (thermal and Voltage)
    - Load Deliverability (thermal and voltage)
  - 2016 RTEP Light Load Analysis
    - Baseline N-1 (thermal and voltage)
    - Generation Deliverability and Common Mode Outage
  - Short Circuit Analysis

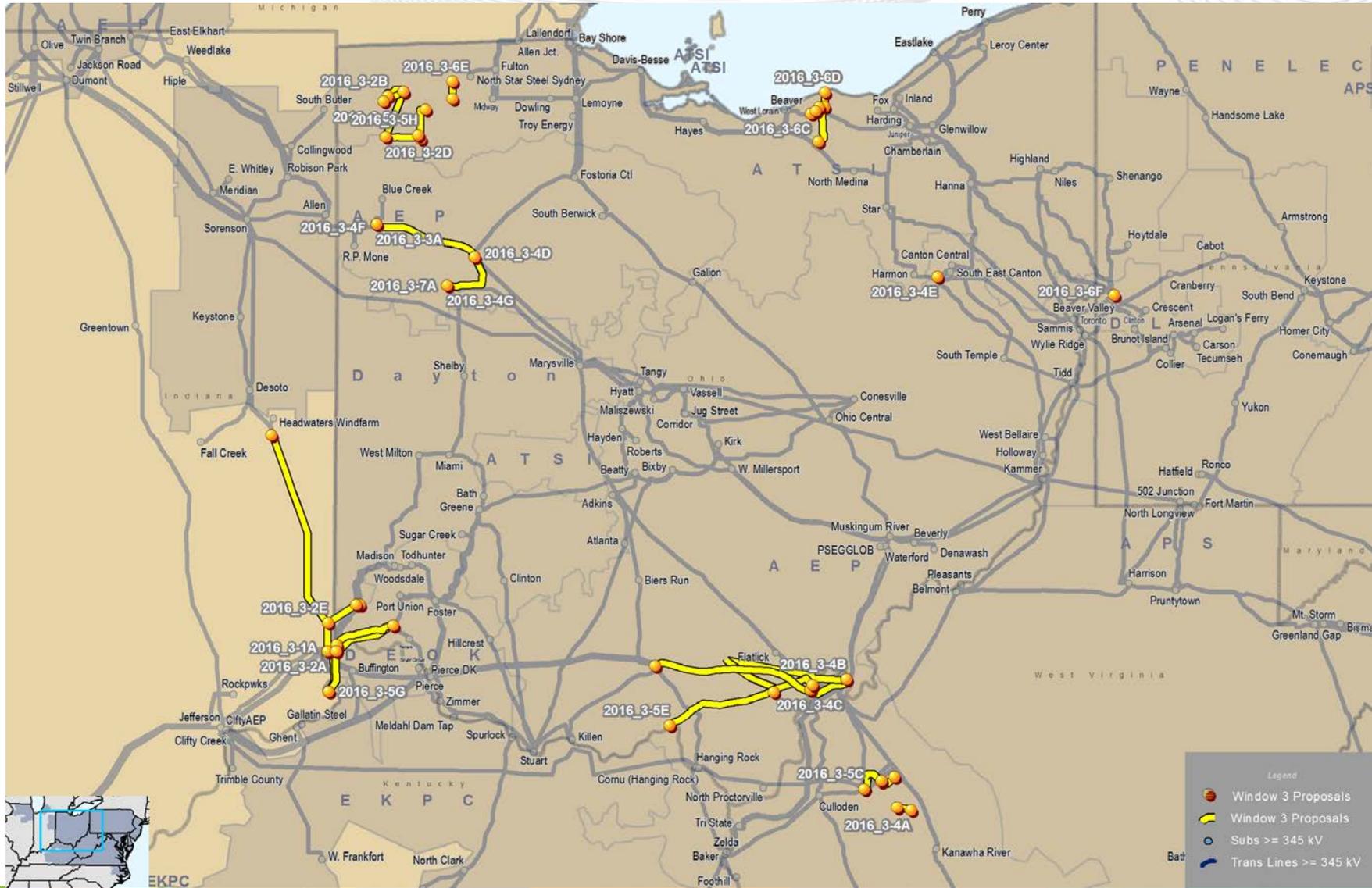
- Timeline
  - Window Opened: 9/30/2016
  - Window Closed: 10/31/2016
    - Proposal definitions, simulation data and planning cost estimate due
  - Detailed Cost due: 11/15/2016
    - Additional 15 days to develop and provide detailed cost data
    - See the window documentation for additional information

- 25 total flowgates

Test/kV Level*	<200 kV	230 kV	345 kV	500 kV	765 kV	Total
Short Circuit	2		1			3
Winter Baseline N-1						0
Winter Gen Deliv/CMO	17		3			20
Winter N-1-1						0
Winter Load Deliv						0
Light Load N-1						0
Light Load Gen Deliv						0
Gen Deliv	1					1
Winter Baseline Thermal	1					1
<b>Total</b>	<b>21</b>	<b>0</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>25</b>

\*Transformers are categorized based on low side kV



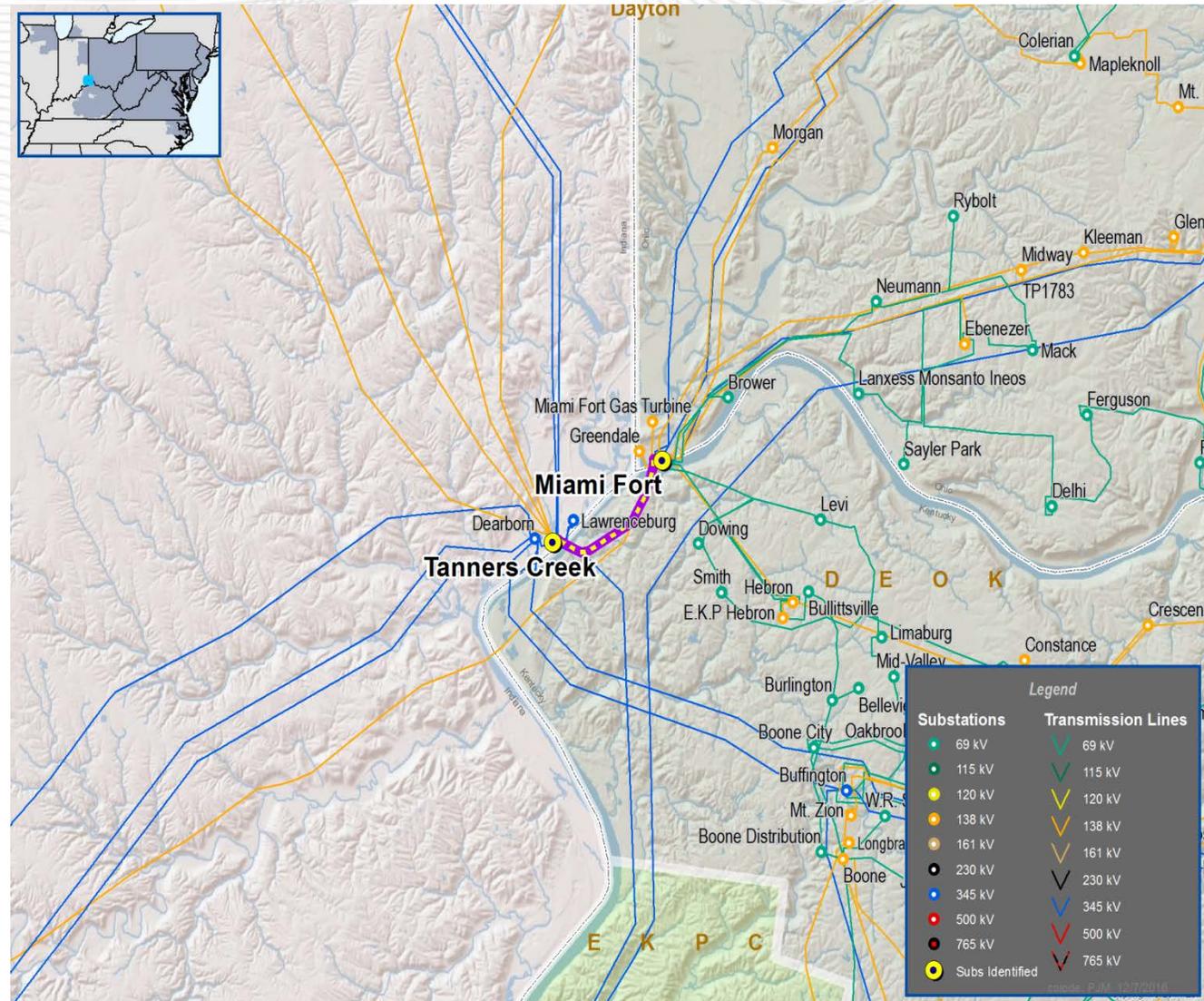


- 25 flowgates recommended for proposals
- 29 Proposals Received from 7 entities addressing 6 Target Zones
  - 17 Greenfield
  - 12 Transmission Owner Upgrade

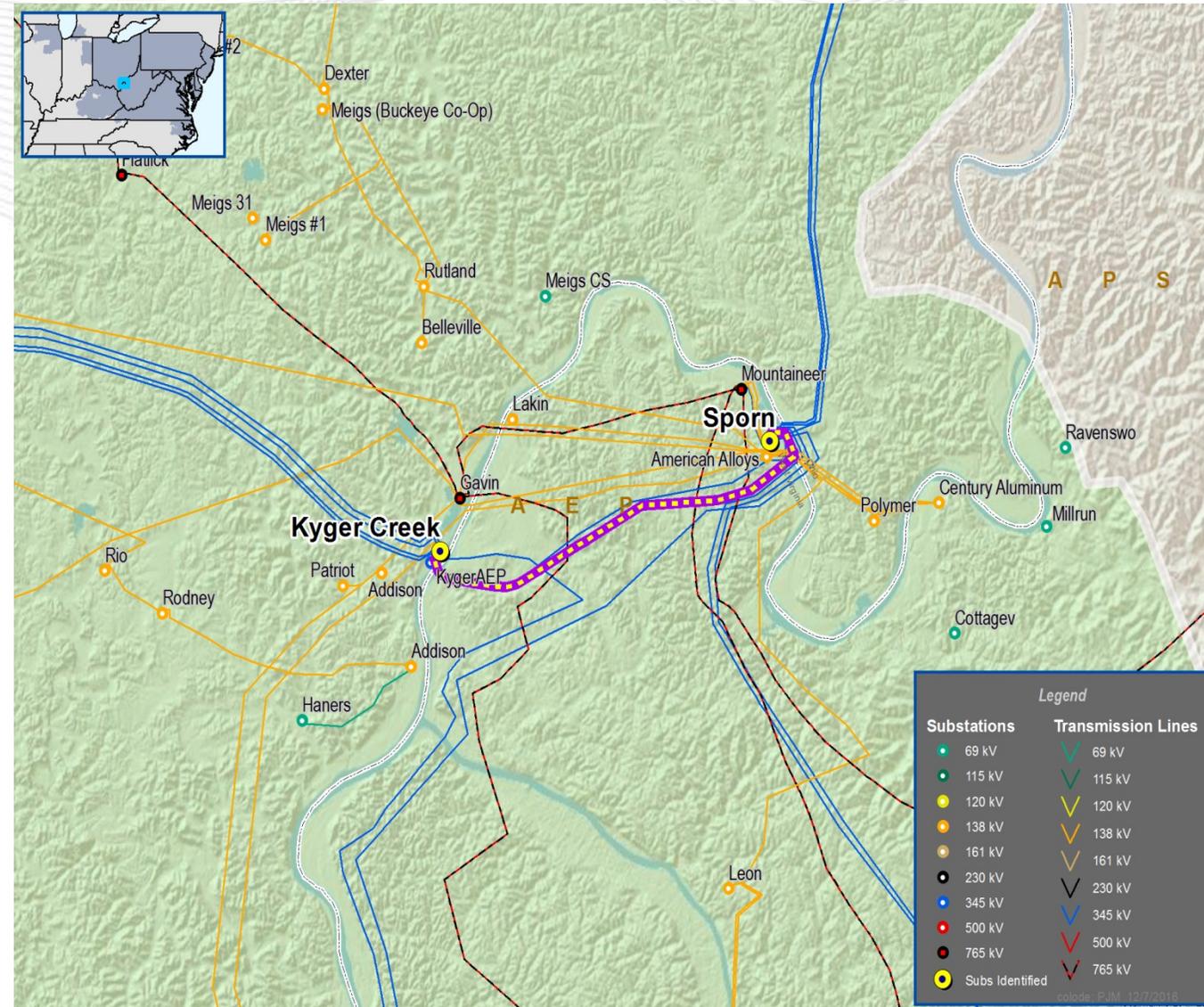


# 2016 RTEP Proposal Window #3 Recommendations

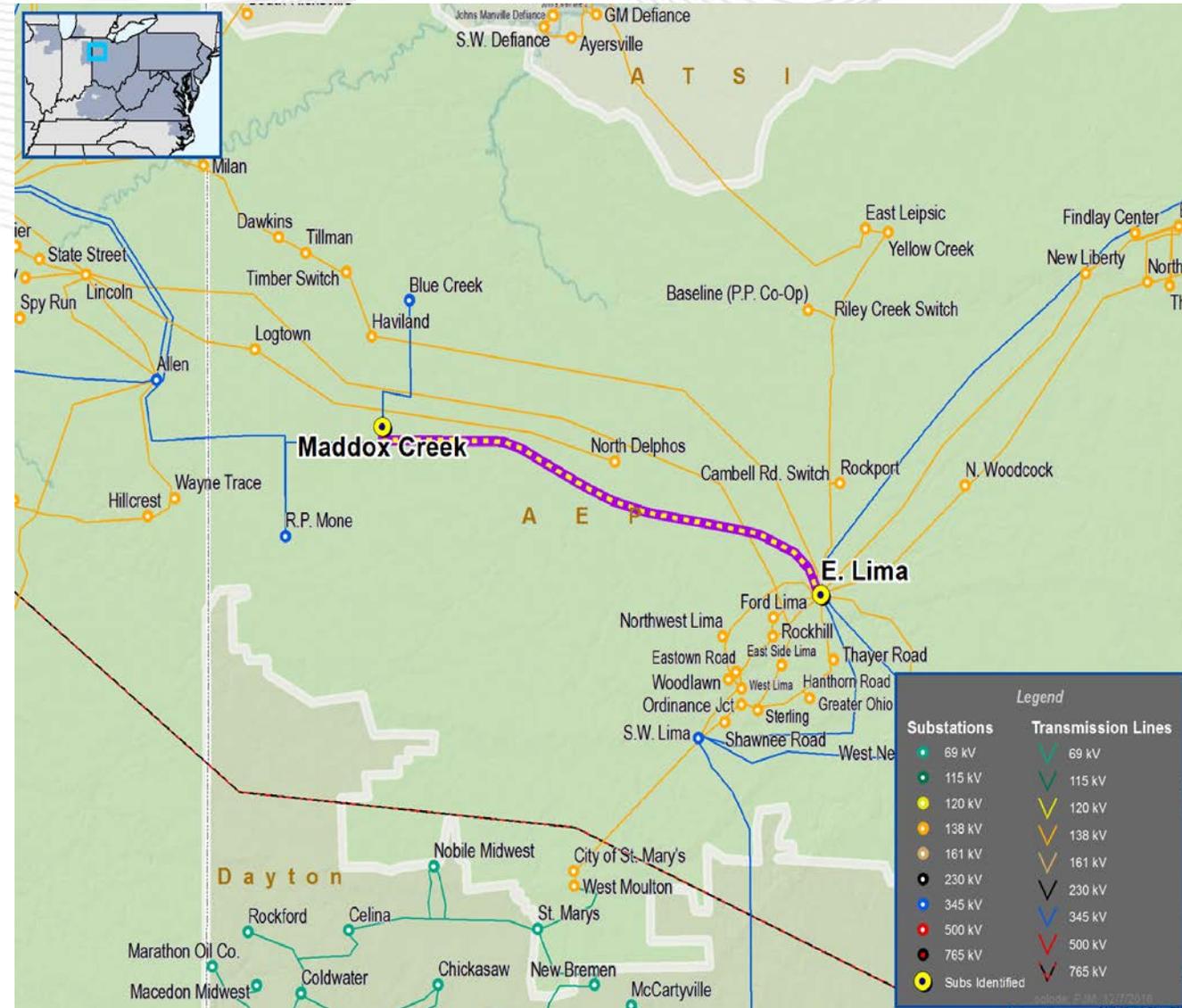
- Generation Deliverability (FG# 41):
- Tanner Creek to Miami Fort 345 kV circuit is overloaded for the loss of the Terminal – East Bend 345 kV circuit.
- **Alternatives considered:**
  - 2016\_3-1A (\$7.8 M)
  - 2016\_3-2A (\$14.5 M)
  - 2016\_3-2E (\$59.8 M)
  - 2016\_3-5G (\$14.5 M)
- **Recommended Solution:**
  - Upgrade the Tanner Creek to Miami Fort 345 kV circuit. (2016\_3-1A)
- **Estimated Project Cost: \$ 7.8 M**
- **Required IS Date: 12/1/2021**



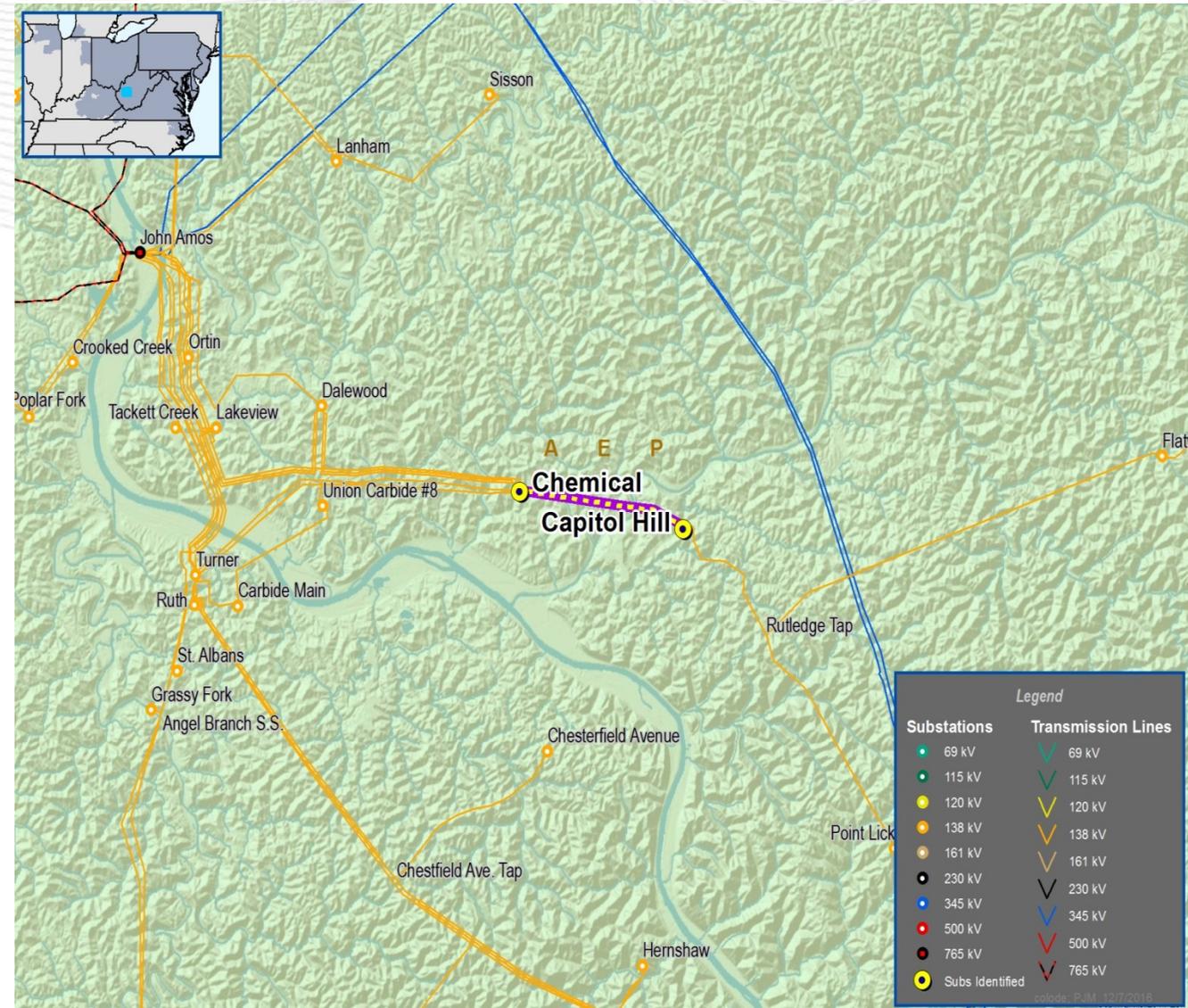
- Generation Deliverability (FG# 84) :
- Kyger Creek to Sporn 345 kV circuit #2 is overloaded for single contingency loss of the Kyger Creek – Sporn 345 kV circuit #1.
- **Alternatives considered:**
  - 2016\_3-4B (\$ 15.5 M)
  - 2016\_3-4C (\$ 0.3 M)
  - 2016\_3-5E (\$ 19.8 M)
- **Recommended Solution:**
  - Six wire the Kyger Creek to Sporn 345 kV circuits #1 and #2 and convert them to one circuit . (2016\_3-4C)
- **Estimated Project Cost:** \$ 0.3 M
- **Required IS Date:** 12/1/2021



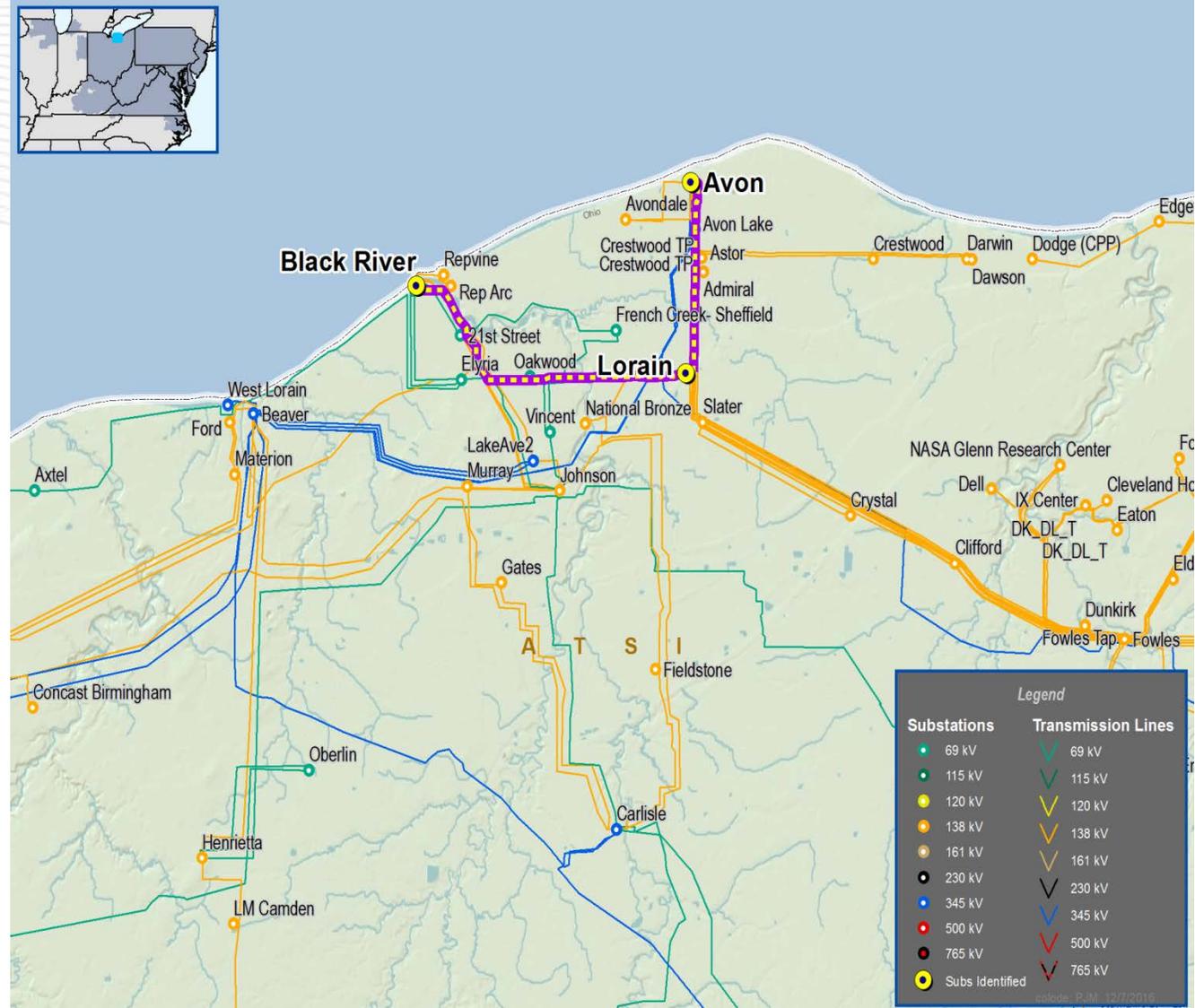
- Baseline and Common Mode Outage (FG# 123) :
- Maddox Creek to East Lima 345 kV circuit is overloaded for single contingency loss of the Marysville – Sorenson 765 kV circuit.
- **Alternatives considered:**
  - 2016\_3-3A (\$ 5.95 M)
  - 2016\_3-4D (\$ 18.2 M)
  - 2016\_3-4F (\$ 67.7 M)
  - 2016\_3-4G (\$ 69.3 M)
  - 2016\_3-7A (\$ 55.9 M)
- **Recommended Solution:**
  - Reconductor the Maddox Creek to East Lima 345 kV circuit with 2-954 ACSS Cardinal conductor. (2016\_3-4D)
- **Estimated Project Cost:** \$ 18.2 M
- **Required IS Date:** 12/1/2021



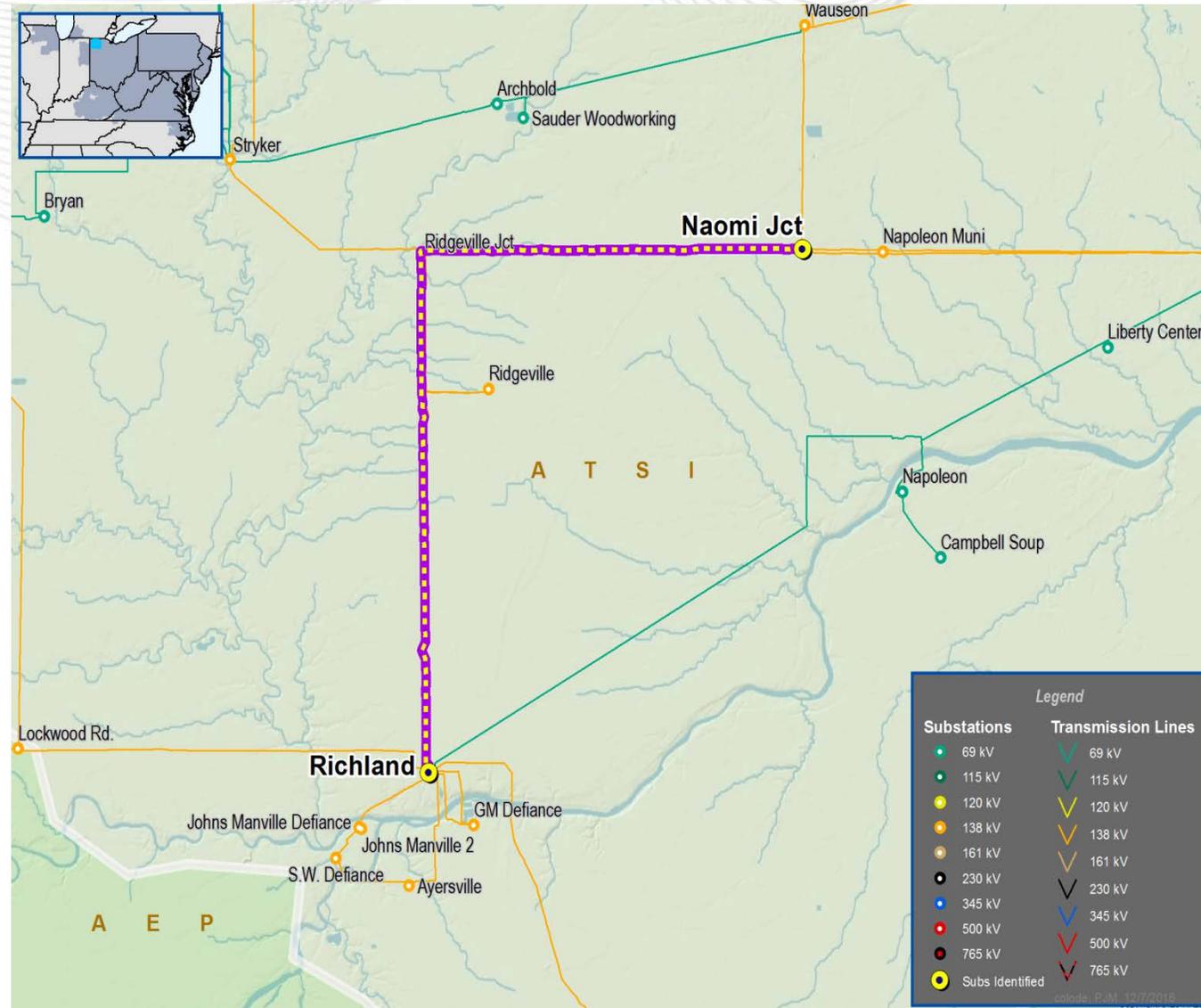
- Baseline and Common Mode Outage (FG# 394, 395, 396, 397, 398 and N1-35) :
- Chemical to Capitol Hill 138 kV circuit is overloaded for several tower outages.
- **Alternatives considered:**
  - 2016\_3-4A (\$ 7.3 M)
  - 2016\_3-5C (\$ 30 M)
- **Recommended Solution:**
  - Reconductor and string open position and sixwire 6.2 miles of the Chemical to Capitol Hill 138 kV circuit. (2016\_3-4A)
- **Estimated Project Cost:** \$ 7.3 M
- **Required IS Date:** 12/1/2021



- Generation Deliverability and Common Mode Outage (FG# 392, 393, 400, 407, 489, 490, 493 and 504) :
- Black River – Lorain - Avon 138 kV circuit is overloaded for tower outage loss of Avon – Lake Ave 345 kV circuits and line fault stuck breaker contingency loss of the Avon – Lake Ave 345 kV circuits.
- **Alternatives considered:**
  - 2016\_3-2C
  - 2016\_3-5B
  - 2016\_3-5D
  - 2016\_3-6B
  - 2016\_3-6C
  - 2016\_3-6D
- **Status:**
  - Evaluation in progress
  - PJM will continue to evaluate these proposals along with those submitted in 2016 RTEP Proposal Window 3 Addendum



- Common Mode Outage (FG# 1, 2, and 3) :
- Richland to Naomi Junction 138 kV circuit is overloaded for multiple bus and line fault stuck breaker contingencies.
- **Alternatives considered:**
  - 2016\_3-2B (\$ 8.3 M)
  - 2016\_3-2D (\$ 17.2 M)
  - 2016\_3-5A (\$ 8.5 M)
  - 2016\_3-5H (\$ 6.1 M)
  - 2016\_3-6E (\$ 9.1 M)
- **Status:**
  - Evaluation in progress





# 2016 RTEP Proposal Window #3 Addendum Recommendations

- Status: Window Closed 12/13/2016
- Scope:
  - 2021 RTEP Winter Reliability Analysis
  - 2021 RTEO Summer Reliability Analysis overlap
- Timeline
  - Window Opened: 11/28/2016
  - Window Closed: 12/13/2016
    - Proposal definitions, simulation data and planning cost estimate including detailed cost data

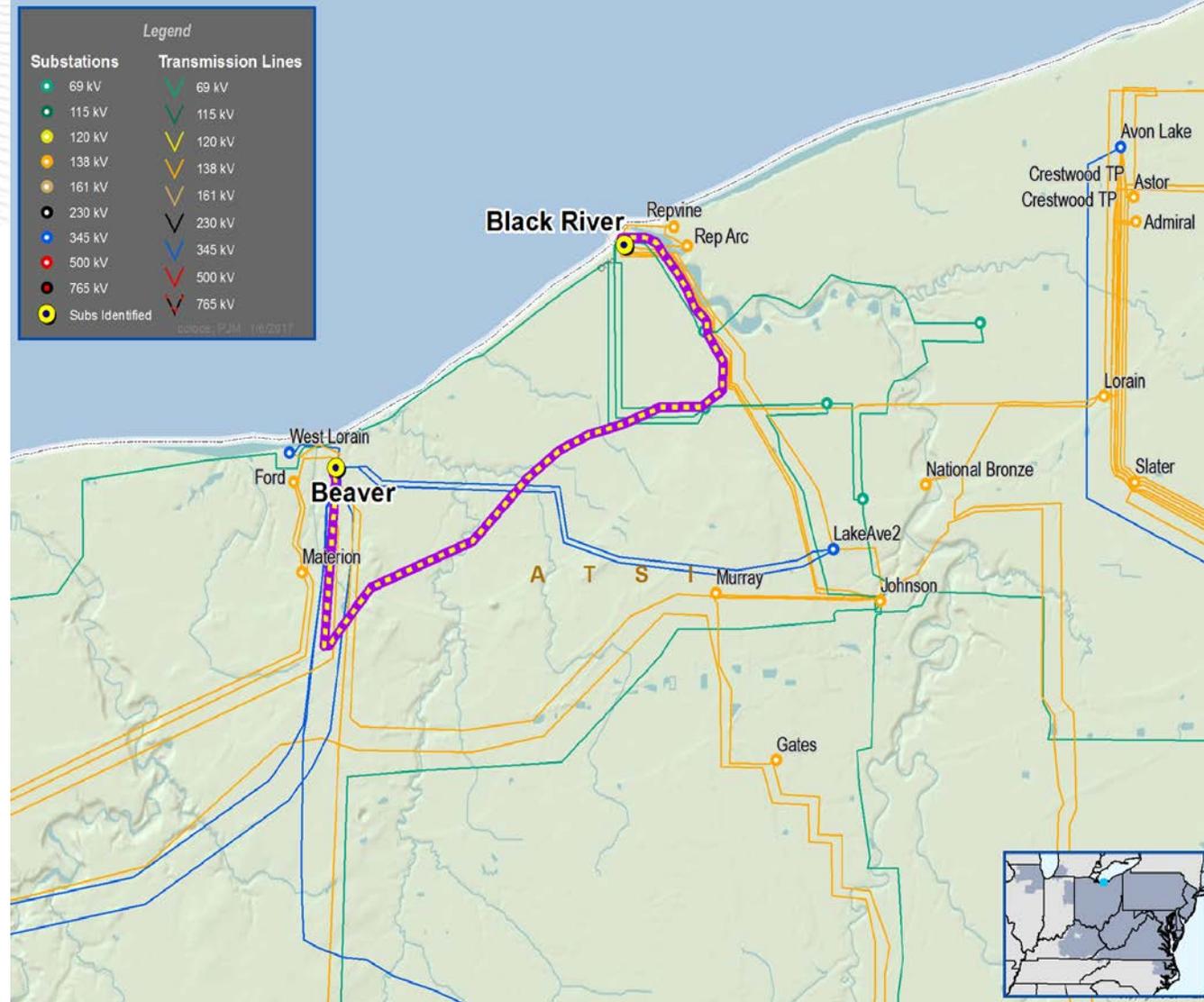
- 2 flowgates recommended for proposals
  - 8 additional flowgates, may be related



- 6 Proposals Received from 3 entities addressing 1 Target Zone
  - 3 Greenfield
    - \$44.6M - \$62.8M
  - 3 Transmission Owner Upgrade
    - \$3.2M-\$19.9M



- Common Mode Outage (Summer - FG# 915 and Winter – FG# 386) :
- The Beaver to Black River 138 kV circuit is overloaded for tower line contingency loss of the Lake Ave – Beaver 345 kV circuits .
- **Alternatives considered:**
  - 2016\_3-2C/ 2016\_3A-1A (\$44.9 M)
  - 2016\_3-5B (\$ 19 M)
  - 2016\_3-5D (\$ 35.4 M)
  - 2016\_3-5F (\$ 12.4 M)
  - 2016\_3A-3A (\$ 19.97 M)
  - 2016\_3A-1B (\$ 50.56 M)
  - 2016\_3A-2A (\$ 62.8 M)
- **Status:**
  - Study in progress



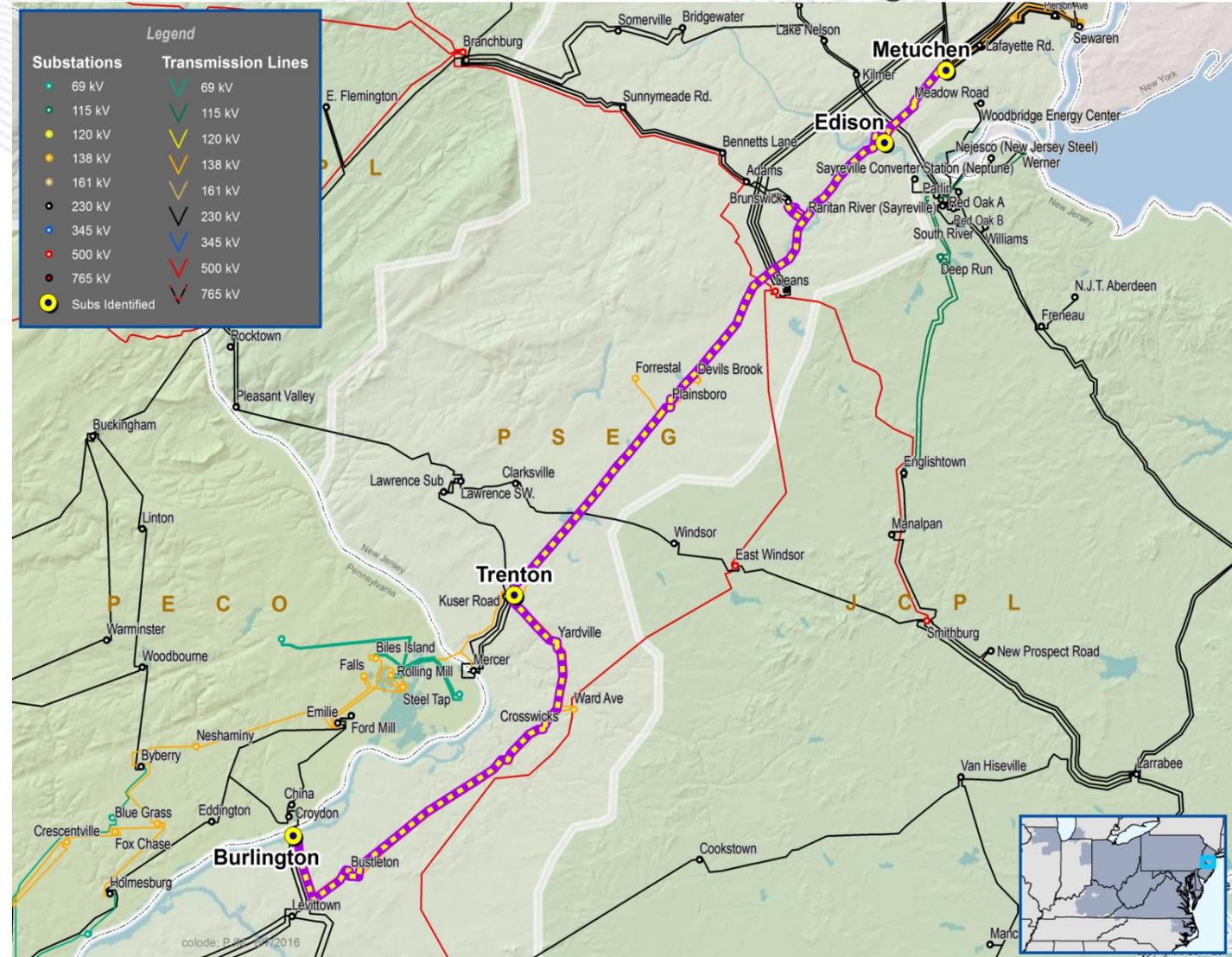
# Short Circuit

# PSE&G End Of Life Assessment Metuchen – Edison – Trenton – Burlington Corridor



# PSE&G Transmission Zone Metuchen – Burlington Corridor

- PSE&G's FERC 715 Transmission Owner criterion addresses equipment condition assessments
  - PSE&G assessed the condition of the Metuchen to Trenton (MT-T) and Trenton to Burlington (T-BU) 138 kV circuits.



- Refer to PSE&G criteria:

VII. EQUIPMENT ASSESSMENT AND STORM HARDENING

<http://www.pjm.com/~media/planning/planning-criteria/PSE&G-planning-criteria.ashx>

- Metuchen to Trenton is approximately 30 miles of 138 kV circuit and the average structure age is 86 years.
- Trenton to Burlington is approximately 22 miles of 138 kV circuit and the average structure age is 75 years.

- Assessment Result:
  - Consultant - Foundation assessment
    - 23% and 30% of structures for MT-T and T-BU respectively will require extensive foundation rehabilitation or total foundation replacement.
  - Consultant – Tower line assessment
    - 25% of the tower structures exceed the tower load carrying design capability
    - 35% of the towers are at 99-100% of the tower's load bearing capability, and 81% of the towers at 95-100% of the tower's capability.



Figure 1: Examples of 25-30% foundation structure loss

- Deteriorating tower leg, gusset plates and angles due to corrosion
- “Condition E” in the consultant report indicates greater than 50% thickness loss of steel member
- Load carrying capability compromised



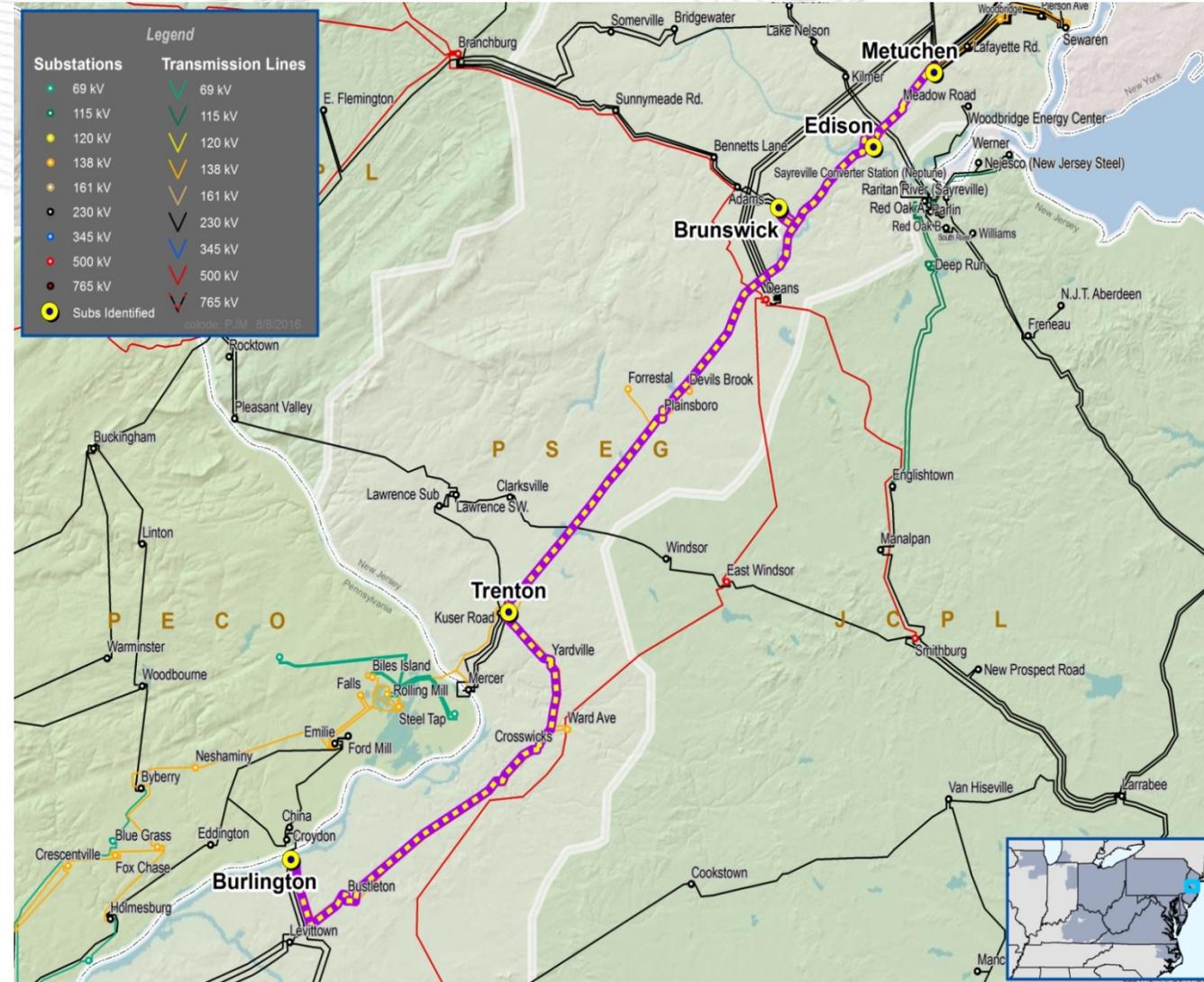
### Problem:

### PSE&G FERC 715 Transmission Owner Criteria

- Equipment condition assessment for the entire corridor
- Equipment has reached its end of life

### NERC Reliability Criteria

- N-1-1 voltage violations in the Metuchen vicinity in the 2016 RTEP Window #2



- Remove the 138 kV corridor without replacing
- Install new parallel circuit on new right of way and remove the existing corridor
- Replace / rebuild the 138 kV corridor in kind with new foundations, 138 kV structures and hardware.
- Convert the 138 kV corridor to 230 kV

# Remove Existing Corridor Without Replacing

- Load (approximately 544 MVA) would need alternative supply at nine stations
- No transmission supply available near Devils Brook, Plainsboro, Yardville, Crosswicks, and Bustleton.
- Would require extensive new 69kV line construction
- Loss of existing transmission corridor
- High population density
  - Would require extensive underground construction.
- This option does not eliminate b2590, “Install two 75 MVAR 230 kV capacitors at Sewaren station” (\$8.4M). Also, does not eliminate b2589, “Install a 100 MVAR 230 kV shunt reactor at Mercer station” (\$7.2M).

# Install New Circuit and Remove/Abandon Existing

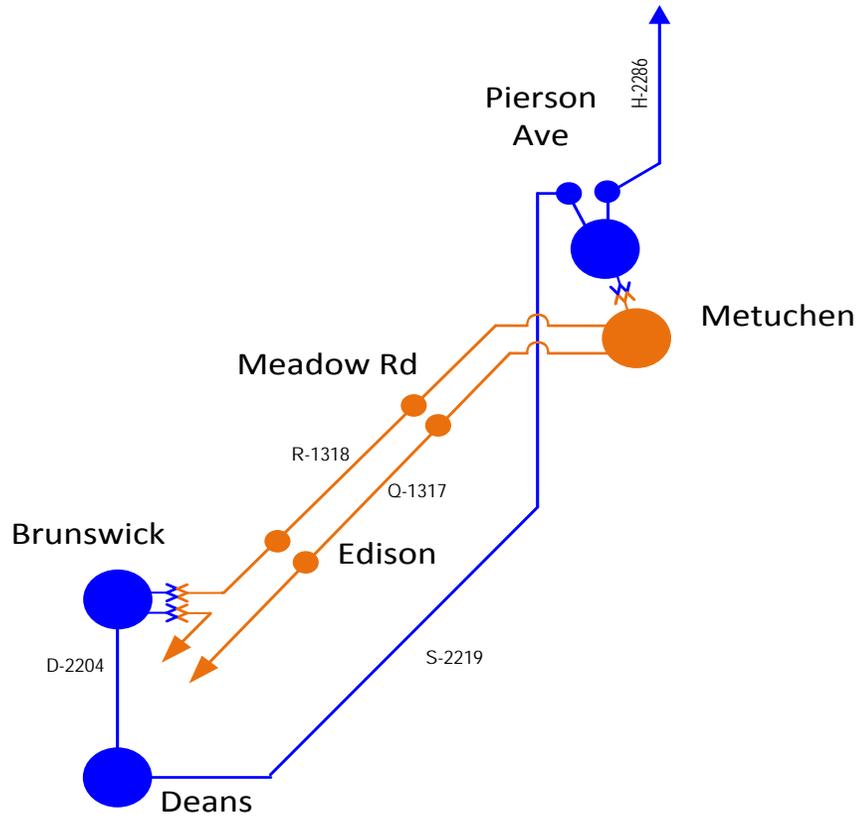
- High population density in the corridor
  - ability to obtain new transmission ROW feasibility is challenging or not feasible
  - would require extensive underground construction
- Need to supply nine existing stations, requiring new circuits to loop in an out of the existing stations
- Would require extensive new 69kV line construction.
- Limited 69 kV circuit capacity and line length due to voltage drop
- This option does not eliminate b2590, “Install two 75 MVAR 230 kV capacitors at Sewaren station” (\$8.4M). Also, does not eliminate b2589, “Install a 100 MVAR 230 kV shunt reactor at Mercer station” (\$7.2M).

- Rebuild / Replace existing facilities
- Costs
  - Metuchen to Brunswick - \$126M
  - Brunswick to Trenton - \$265M
  - Trenton to Burlington - \$293M

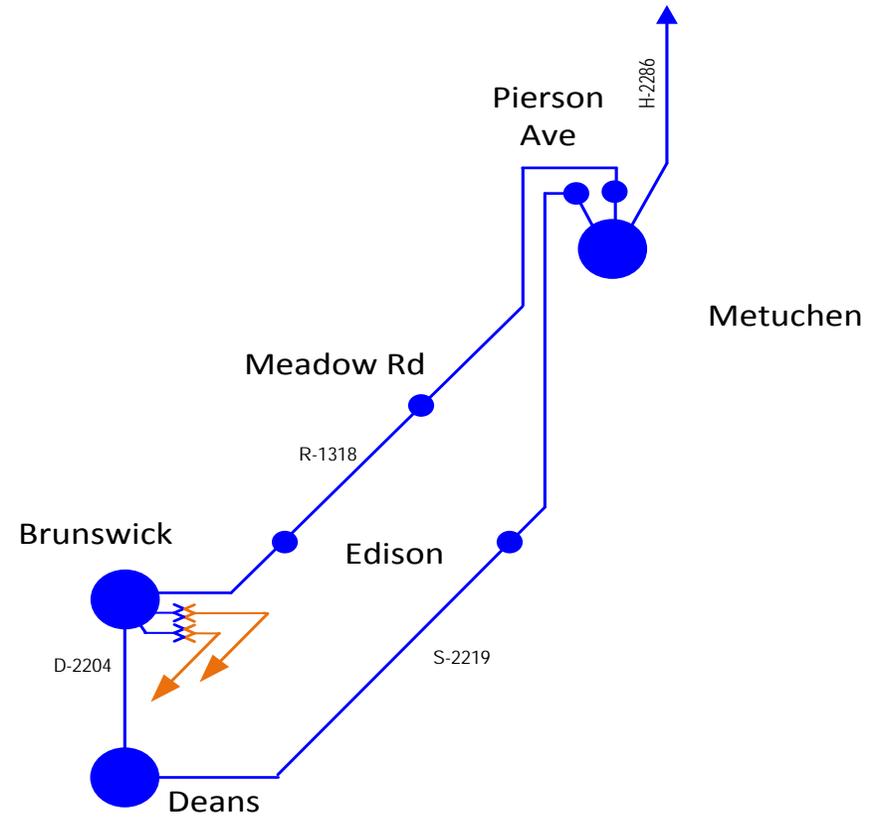
- Recommended Solution for Metuchen - Brunswick:
  - Convert the R-1318 and Q1317 (Edison – Metuchen) 138 kV circuits to one 230 kV circuit
    - Metuchen 138 kV will be eliminated
    - The Brunswick 230/138 kV autotransformer will be eliminated
    - The new converted 230 kV circuit will be terminated at the existing Metuchen and Brunswick 230 kV stations.
- Project Benefits:
  - Resolves voltage violation in the Metuchen vicinity identified in the 2016 RTEP 2<sup>nd</sup> Window
  - Eliminates the need for baseline upgrade (B2590 – Install two 75 MVAR 230 kV capacitors at Sewaren station) identified in the 2014 RTEP window.
  - Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
  - Creates a strong tie between Southern and Central PSE&G
  - Increases transfers capability to Central PSE&G
  - Addresses future reliability and economic needs
- Estimated Project Cost: \$ 125 M

# Metuchen – Brunswick Existing and Future Diagram

Before



After



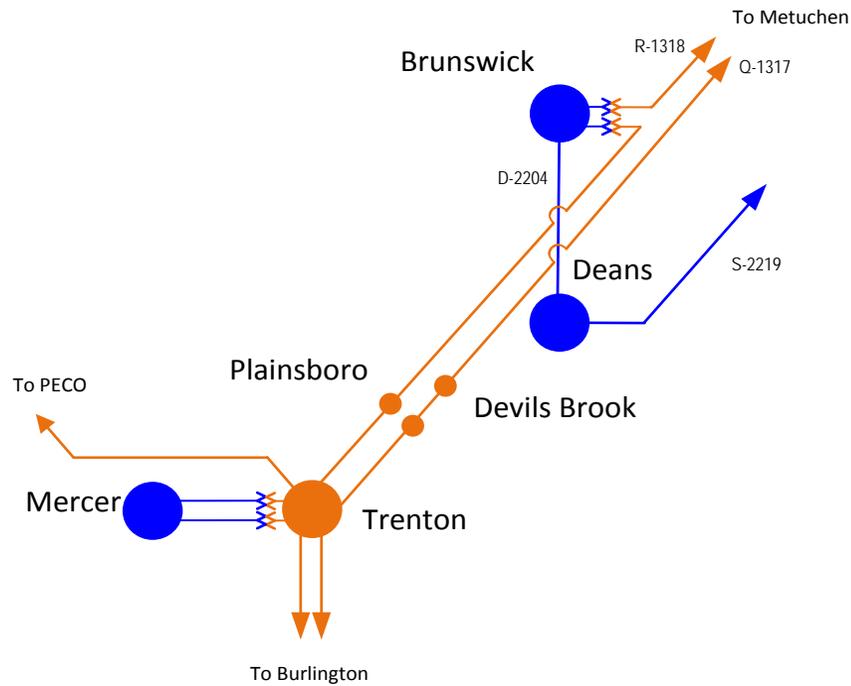
- Recommended Solution for Brunswick - Trenton:
  - Convert the N-1340 and T-1372/D-1330 (Brunswick – Trenton) 138 kV circuits to 230 kV circuits
    - The converted circuits will be terminated at the existing Brunswick 230 kV
    - The new converted 230 kV circuit will be terminated at the Trenton 138 kV station with two 138 kV transformers
- Project Benefit:
  - Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
  - Provides better transfers across the network
  - Addresses future reliability and economic needs

Estimated Project Cost: \$ 302 M

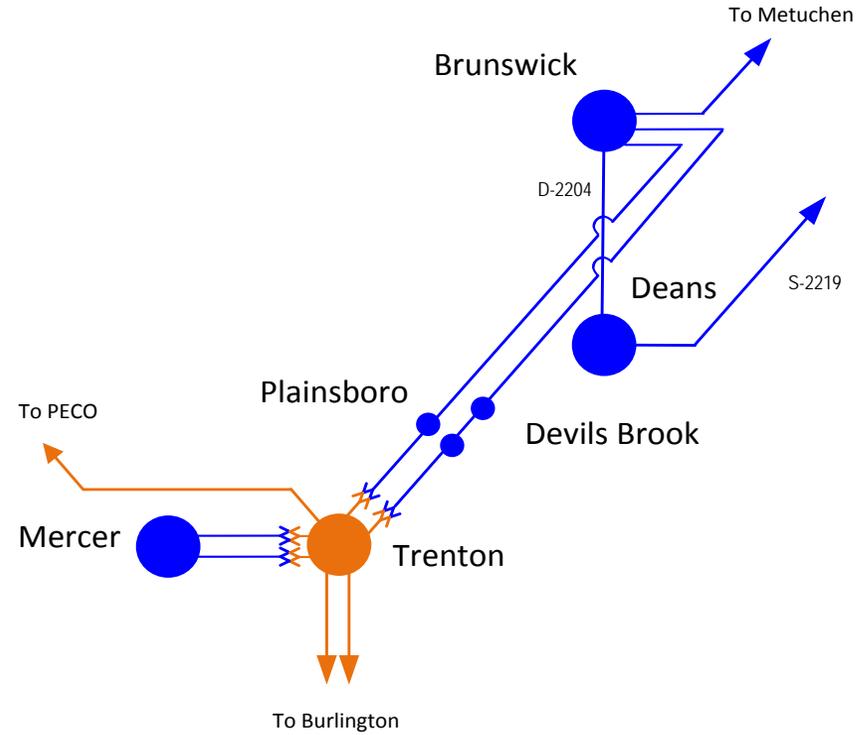


# Brunswick – Trenton Existing and Future Diagram

Before



After



## Recommended Solution for Metuchen - Burlington:

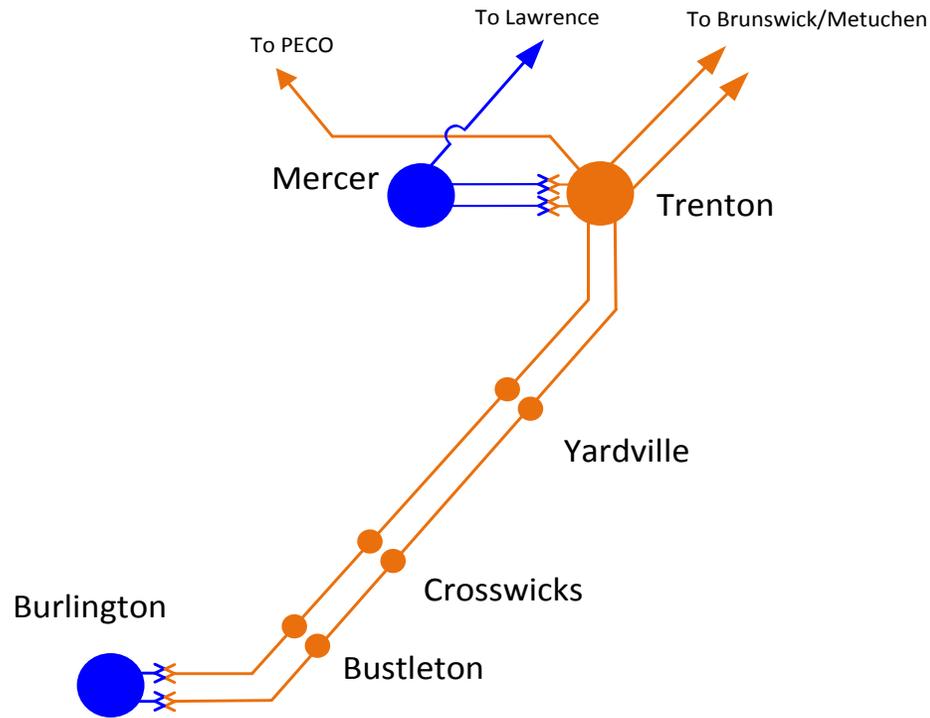
- Recommended Solution for Trenton - Burlington:
  - Convert the F-1358/Z1326 and K1363/Y-1325 (Trenton - Burlington) 138 kV circuits to 230 kV circuits
    - Trenton 138 kV substation will be replaced with six bay breaker and half 230 kV substation
    - Install 230/138 kV transformer at Trenton to serve the Trenton – US Steele 138 kV circuit.
- Project Benefit:
  - Eliminates the need for baseline upgrade (B2589 – Install a 100 MVAR 230 kV shunt reactor at Mercer station) identified in the 2014 RTEP window.
  - Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
  - Provides better transfers across the network

Estimated Project Cost: \$ 312

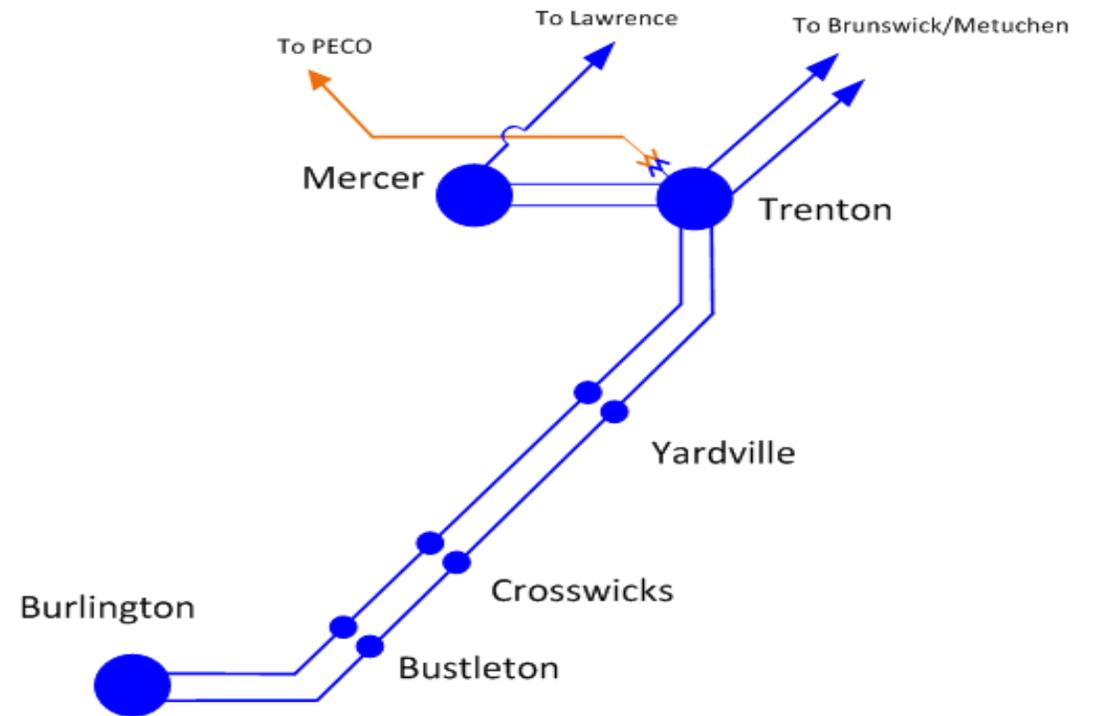


# Trenton – Burlington Existing and Future Diagram

Before



After



- Cost: 138kV vs 230kV cost estimates
  - Metuchen – Brunswick
    - \$126M for 138 kV and \$125M\* for 230 kV
  - Brunswick – Trenton
    - \$265M for 138 kV and \$302M for 230 kV
  - Trenton – Burlington
    - \$293M for 138 kV and \$312M for 230 kV
- Replacing with 138kV does not address voltage issues in the Metuchen area
- The 230 kV conversion option will eliminate the need for the following projects (total cost - \$67.1 M)
  - Metuchen and Edison 138kV Stations approaching end of life and require replacement in the near term - \$28 M
  - Sewaren Caps and Mercer Reactors required with the 138kV option - \$15.6 M
  - Class-H transformers that require replacement in the near term - \$10.5
  - Autotransformers (3) savings from other projects - \$7 M
  - Refurbishment of Trenton control house building - \$1 M
  - Refurbishment of Metuchen auto transformer and installation of Brunswick autotransformer - \$5 M

\*Higher cost of the 138kV attributed to replacement of the existing Brunswick 230-138kV transformer, the 230kV option eliminates the transformer.

- Recommended solution is to convert the Metuchen – Trenton – Burlington 138 kV circuits to 230 kV circuits.
  - The recommended solution has the following benefits
    - The 230 kV conversion option will eliminate the need for several reliability projects including the need to address the voltage violation in the Metuchen area. As a result the overall cost is less than the other options.
    - Provides a strong link between southern and central zones
    - Increases the capacity significantly
    - Provides better transfers across the network

# PSE&G End Of Life Assessment Newark Switch Review

- Refer to PSE&G criteria:

## VII. EQUIPMENT ASSESSMENT AND STORM HARDENING

<http://www.pjm.com/~media/planning/planning-criteria/PSE&G-planning-criteria.ashx>

- Risk of a transformer fire that may result in the entire building on fire and thus the loss of  $\sim >300$  MVA of load for a long duration. Nearby school/church & healthcare facility.
- Several common mode of failures

- Age: Substation: 1957
- T1: 1972 – T2 & T3: 1958
- Spare: 1992
- Special transformer: Dual ratio (138/26/13)
  - Wye-Wye 13 kV All PSEG 13 kV transformers are delta-wye (30°)
- Maintenance and Maintenance outages
- Rooftop transmission system
- Lower level indoor transformers
- Critical Station (City of Newark - Downtown) ~300 MVA Load
  - Financial buildings
  - City Hall
  - Other Government Buildings
  - NJIT, Rutgers
  - PATH Train, NJ Transit
  - 26kV and 13kV Source station
  - Several Data Centers
  - Downtown Newark
  - Prudential Arena, NJ Performing Arts Center
  - United States Citizenship and Immigration Services (USCIS)

- Basement: Oil rooms, 13 & 26 kV feeders & transmission lines entering the station
- 1st Floor: 26 kV switchgear & Transformers' vaults
- 2nd floor: Distribution reactors
- 3rd floor: Control room/AUX power rooms
- Roof: 138 kV Yard

- Station age and condition
  - Based on unique design, aged equipment and obsolete equipment Newark Switch is considered at end-of-Life.
- Potential risks and consequences
  - Any transformer fire or catastrophic failure would result in the destruction of the whole facility and the loss of 300 MVA of critical load for an extended period of time.
- 26/13 kV bus faults
- Other risks and common modes of failure
- Environmental/structural concerns

- Urban location
- Proximity to existing transmission system



- Distribution feeds below transformer vaults



- Transformers located below the 138 kV rooftop switchyard.
- A transformer fire would be significant and result in catastrophic loss



\* PSE&G Pierson transformer fire

\* Newark Switch transformer



# PSE&G Transmission Zone

**Problem:**  
**PSE&G FERC 715 Transmission Owner Criteria**  
**Newark Switch Aging Infrastructure**

**PSE&G FERC 715 Transmission Owner Criteria**

- Age
  - Substation: 1953
  - Transformer 1: 1972
  - Transformer 2&3: 1958
  - Spare: 1992
- Housed in an urban building
- Equipment condition assessment
- Equipment has reached its end of life

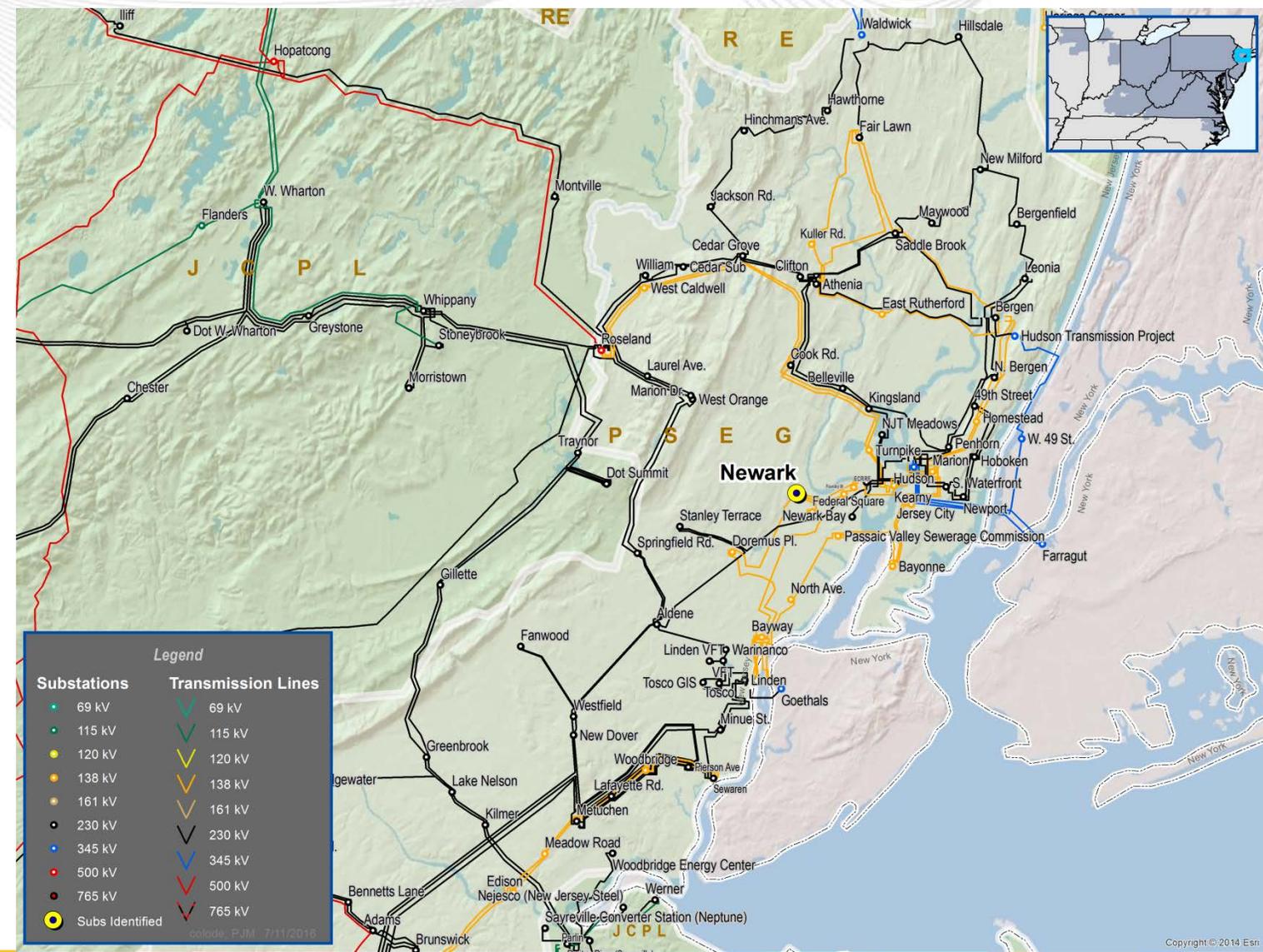
**Alternatives Considered:**

1. Build new Newark GIS station in a building located adjacent to the existing Newark Switch and demolish the existing Newark Switch
2. Build a new Newark GIS station elsewhere in Newark and relocate all transmission and distribution cables and protection equipment

**Potential Solution:**

**Alternative #1** - Build new Newark GIS station in a building located adjacent to the existing Newark Switch and demolish the existing Newark Switch

**Previous Alternative #1 Estimated Cost:** \$353 M (September 2016)  
**Current Alternative #1 Estimated Cost:** In-progress (January 2017)



## Other Alternatives Considered:

Alternative #2: Find a large property and build a new substation challenges: No large property available in the city of Newark

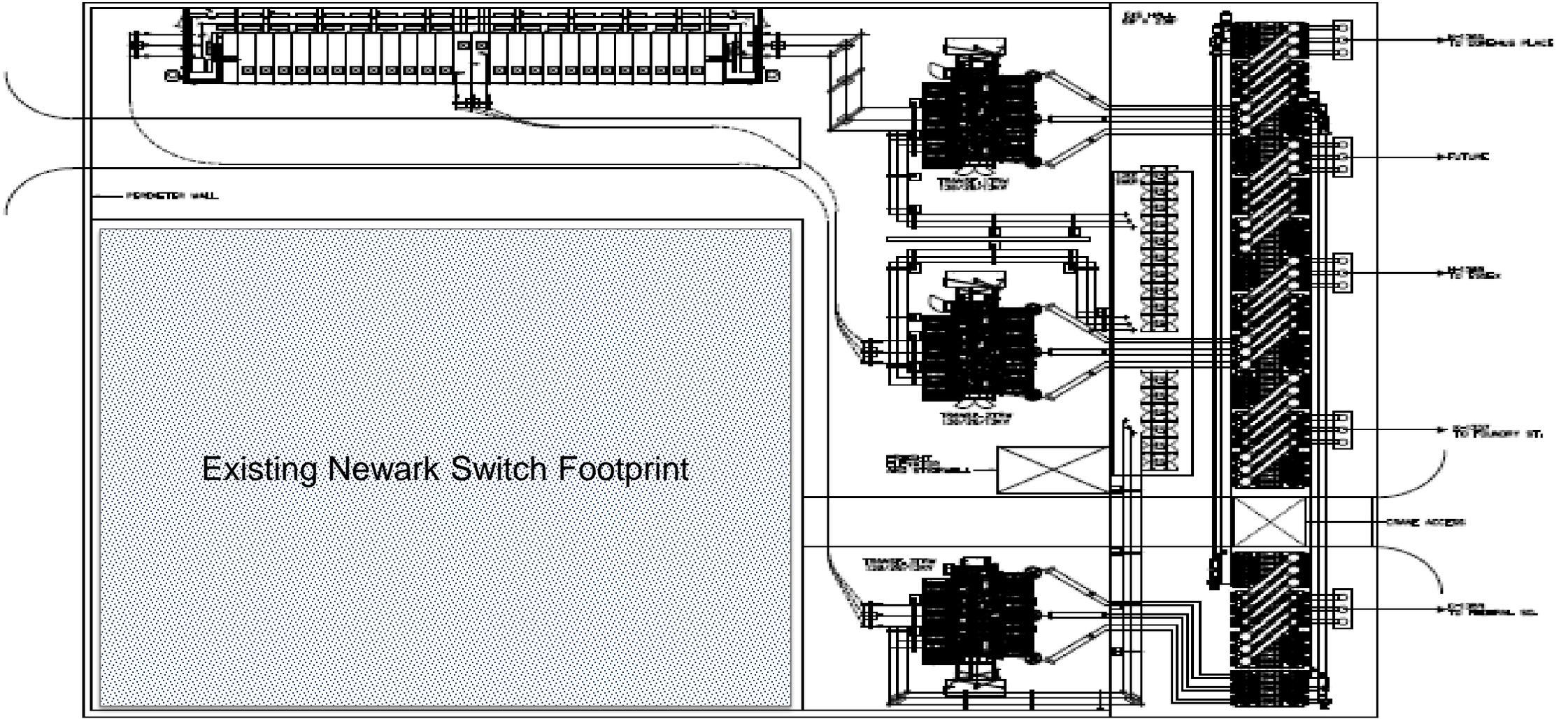
- Find new property
  - Challenge: No large property available in the city of Newark
- Relocate four (4) 138 kV transmission lines
- Relocate over thirty 26 & 13 kV distribution feeders.
- Requires extended transmission & distribution outages
- Assuming available property, the cost to relocate and rebuild Newark Switch will be ~\$458M (September 2016)

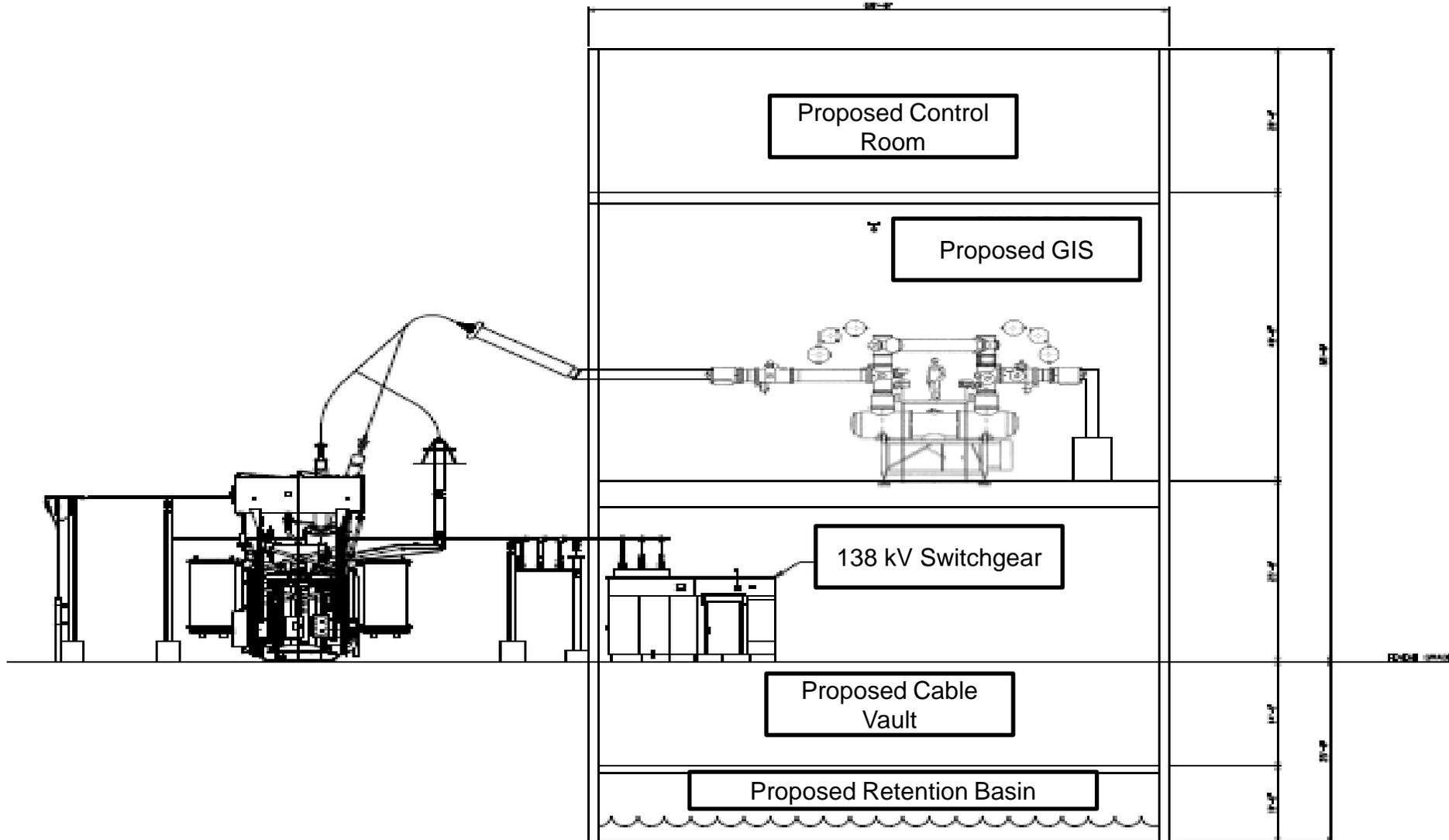
## Alternative #3:

- Status quo: Risk of a transformer fire that may result in the loss of entire building and station. The result is the loss of ~>300 MVA of load for a long duration.

## Status of the evaluation:

- PSEG is working with consultant to evaluate the design of the potential solution to build a new facility adjacent to the existing Newark Switch.
- PSEG expects the new design will improve the efficiency and constructability of the project and reduce the overall cost.





# Supplemental Projects

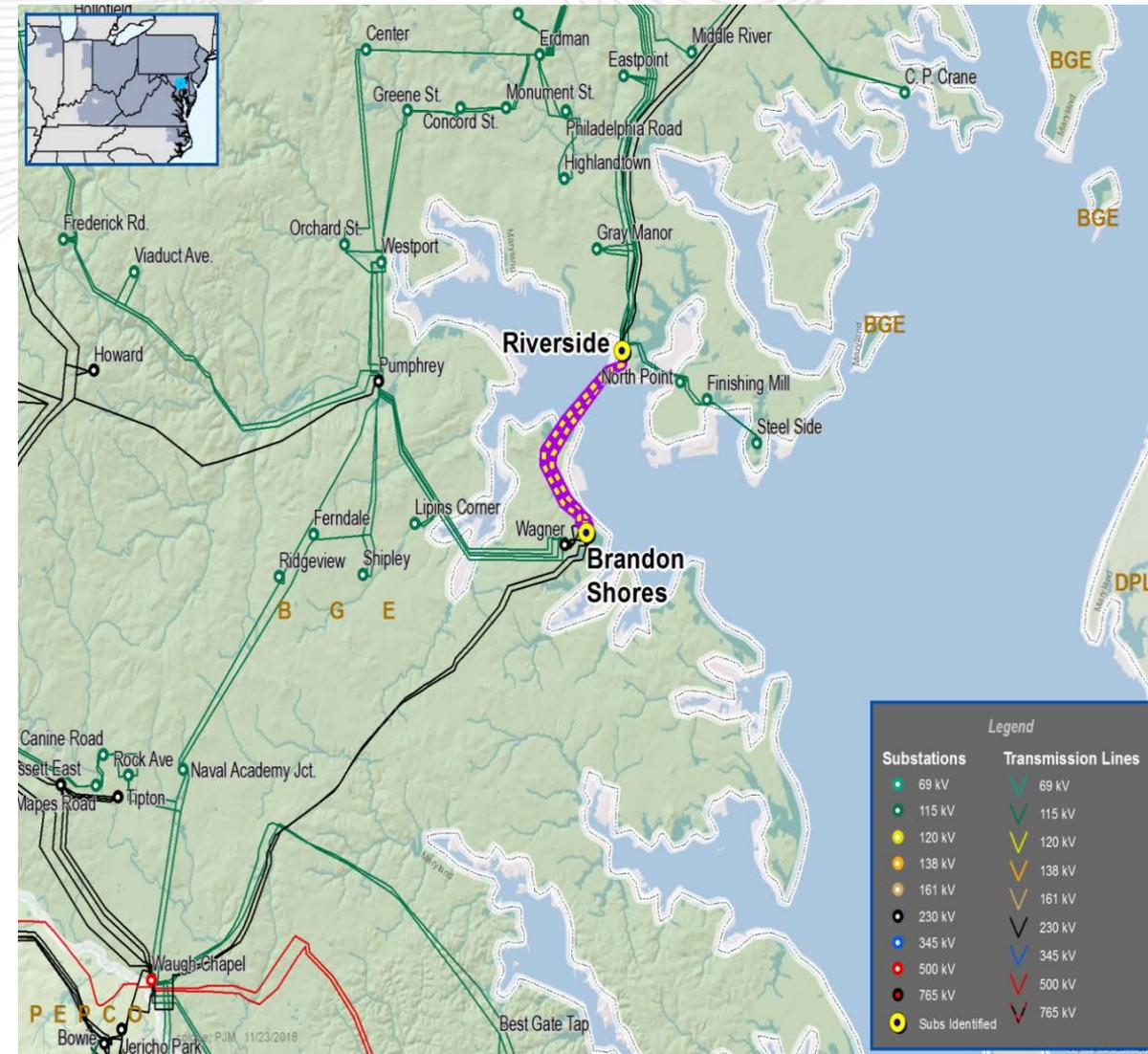
## Supplemental Upgrade: 230 KV Harbor Cables Replacement

### Problem Statement:

- BGE circuits #2344 and #2345 connect Brandon Shores to Riverside substations and are an important part of the 230 kV transmission ring enabling power transfer from southern generation (Brandon Shores, Wagner) to the northern portion of the BGE zone.
- A third of these circuits is under the Patapsco River near the Francis Scott Key bridge (~2 ¼ mile section of the total ~6 mile circuit length).
- This section is comprised of five identical 230kV oil filled pipe type transmission cables, two per circuit and an in service spare.
- Hawkins Point and Sollers Point Terminal Stations connect the cables to overhead lines.
- The oil filled pipe type transmission cables are nearing end of life and have an increased risk of failure as indicated by elevated levels of dissolved gasses within oil (2 to 3 times the action level for acetylene and hydrogen gases).
- All cables show the same symptoms. The gas levels continue to grow.
- Terminations have already been replaced. The cable oil has been degassed and gas generation continues.
- Pipe integrity is unknown. Pipe failure could result in contamination of remaining cables

### Proposed Project:

- Replace underground submarine cables with overhead conductors on towers. Install a double circuit single tower line from the existing OH transmission structures at Hawkins Point to the existing OH transmission structures at Sollers Point.
- The proposed OH conductors will tie into the existing OH portion of the circuits at or near the location of the existing terminal stations.
- Foundations and structures will be located in the Chesapeake Bay and will require protective collision prevention features or structures.



## Supplemental Upgrade: Continue from previous page 230 KV Harbor Cables Replacement

### Alternatives:

- Replace existing underground submarine cables with new solid dielectric transmission submarine cables from Hawkins Point to Sollers Point.
  - Two to three times more costly than OH option (\$320M to \$420M).
  - Longer to construct and slower to repair than OH.
  - Greater environmental risk on Chesapeake Bay during UG Cable installation than OH tower construction
  - Does not provide ability to increase capacity in the future if necessary.
- Run to Failure and Repair: Repair times could be in excess of 12 months (3-5 years depending on the extent of the failure) due to submarine nature of the cables. Permitting and Regulatory requirements will take significant amount of time to complete. Cables are experiencing systematic issue as opposed to single component failure. Single component repairs are costly and do not mitigate failure risk on cable system.

Estimated Cost: \$183M - \$203M (OH solution)

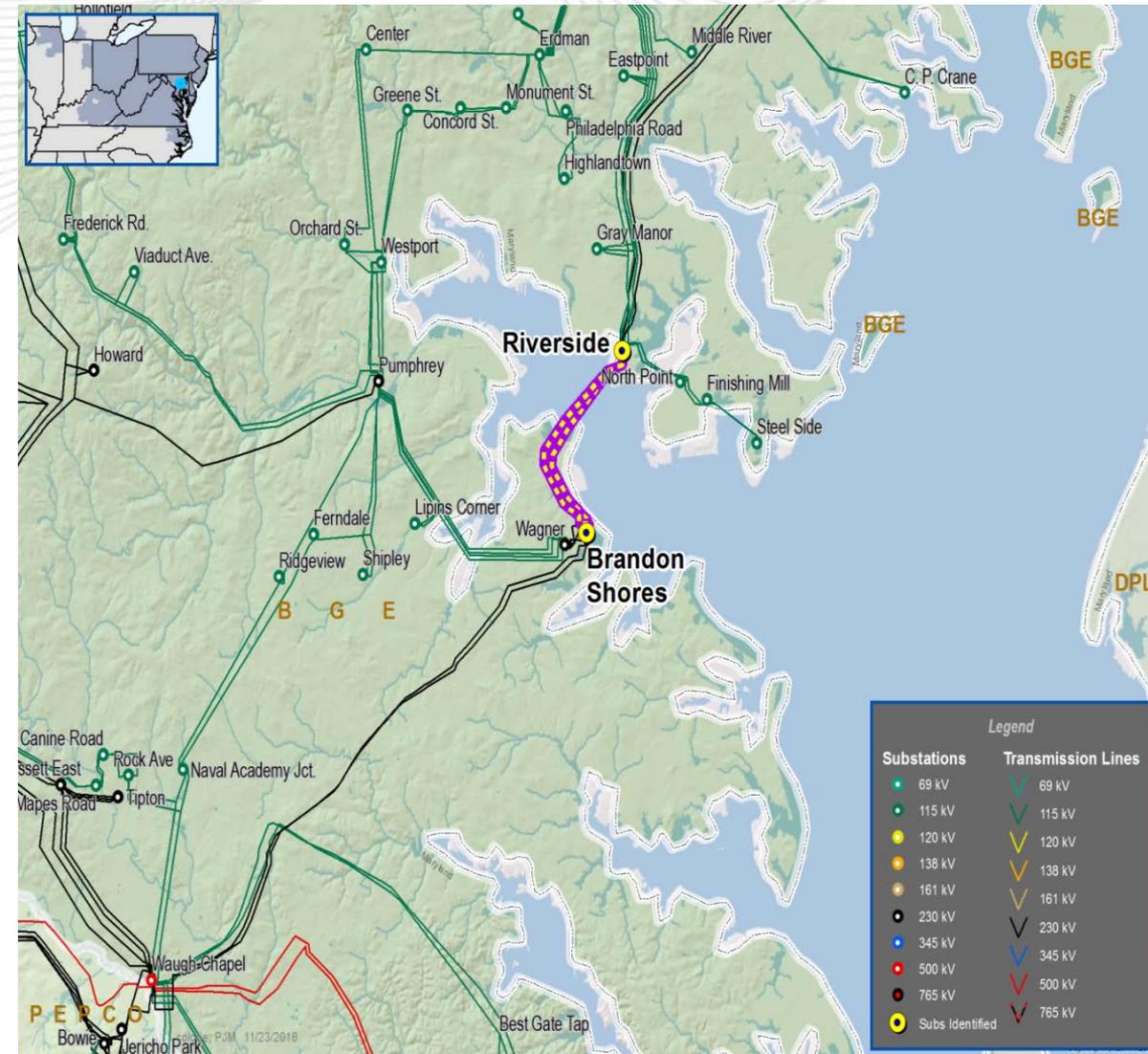
\$100M for tower and foundation construction

\$78M for islands and collision protection

\$5M for environmental costs

Scheduled IS Date: 12/31/2022

Project Status: Engineering Procurement



## Supplemental Upgrade: Install Stop Joints on 345 KV circuit J-3410, South Mahwah – Waldwick

### Problem Statement:

- J-3410 is a 5.45mi fluid-filled 345kV cable.
- Today, a breach in the pipe or termination will result in a significant loss of insulating fluid.
- It is a US EPA requirement to implement Spill Prevention, Control, and Countermeasure (SPCC) Plans

### Proposed Solution:

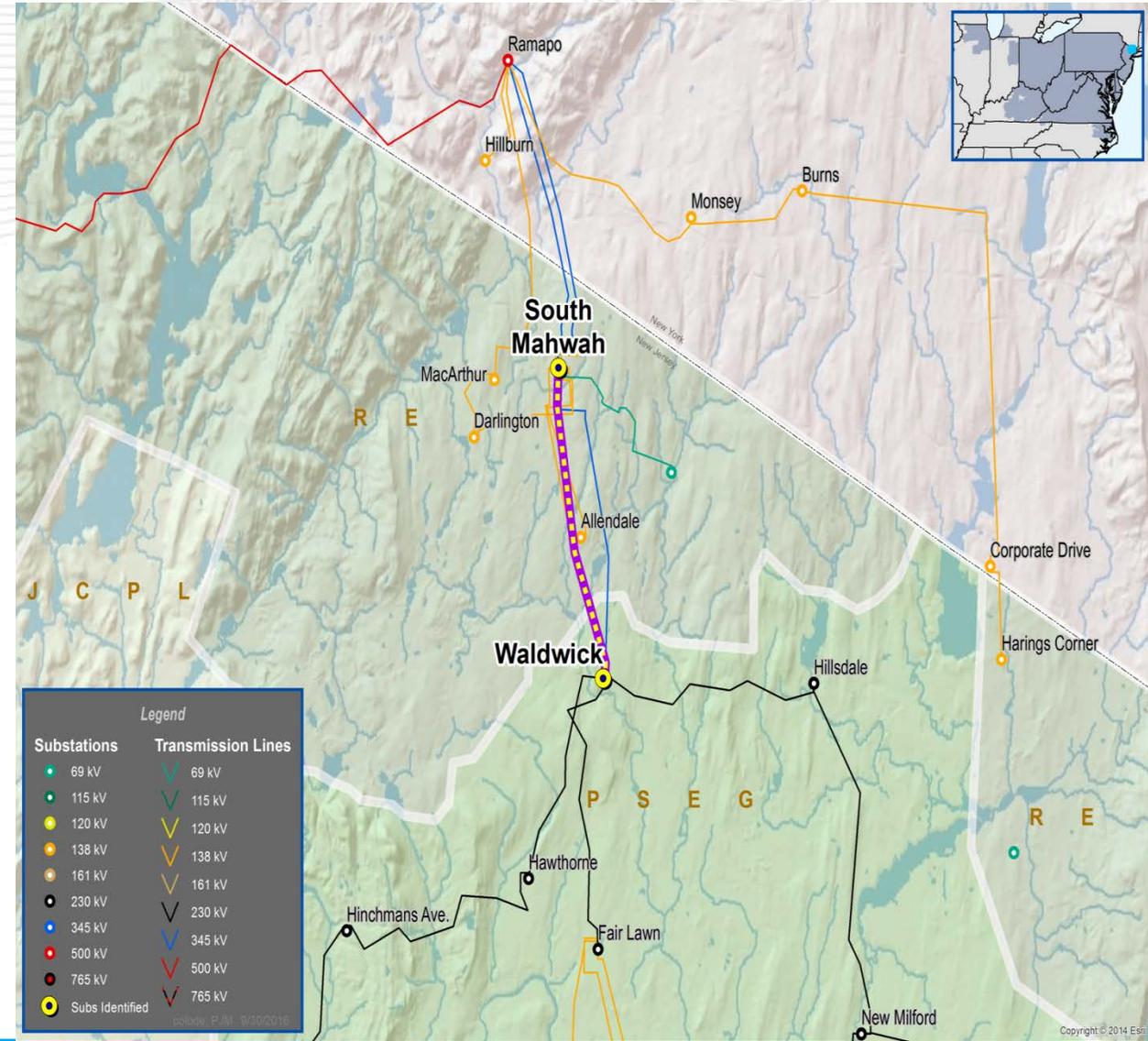
- Install two stop joints to limit the amount of fluid loss in the event of a breach.
- The purpose of a stop-joint is to prevent fluid from draining out of the circuit pipe when a breach occurs. The benefit of installing stop-joints is the reduced risk of contaminating the soil and waterways in the event of a breach

### Alternatives:

- No action. This alternative was eliminated because of the environmental risk of a breach.
- Remove 5.45 miles of pipe-type cable and replace with XLPE cable. Because no dielectric fluid is used with XLPE, it eliminates the environmental risk; however, it is significantly more expensive. It would require remove of the existing cable, widening of the trench through street openings, installation of new cable and replacement of potheads.

Estimated Cost: \$6 M

Scheduled IS Date: 5/23/2017





# February 2017 Recommendations to the PJM Board

- All recommended baseline solutions in today's presentation will be presented to the PJM Board in February and recommended for inclusion in the RTEP.



# RTEP Next Steps

- Complete 2020/2021 RPM Base Reliability Auction (BRA) planning parameters
- Finalize models for use in 2017 RTEP and exercise/benchmark cases
- Anticipated 1/24/2017 SRRTEP-W and SRRTEP-MAAC meetings
- Anticipated week of 2/13/2017 PJM Board Meeting

# Questions?

Email: [RTEP@pjm.com](mailto:RTEP@pjm.com)

# Appendix



# Previously Reviewed Baseline Upgrades for the February 2017 PJM Board Recommendation

## Scope and Cost Change for B2631 Upgrade

### Problem: Short Circuit

- The Linden 230kV GSU breakers are overstressed

### Existing Proposed Solution:

- Replace the four Linden 230 kV GSU breakers with 80kA breakers (b2631)

### New Recommended Solution:

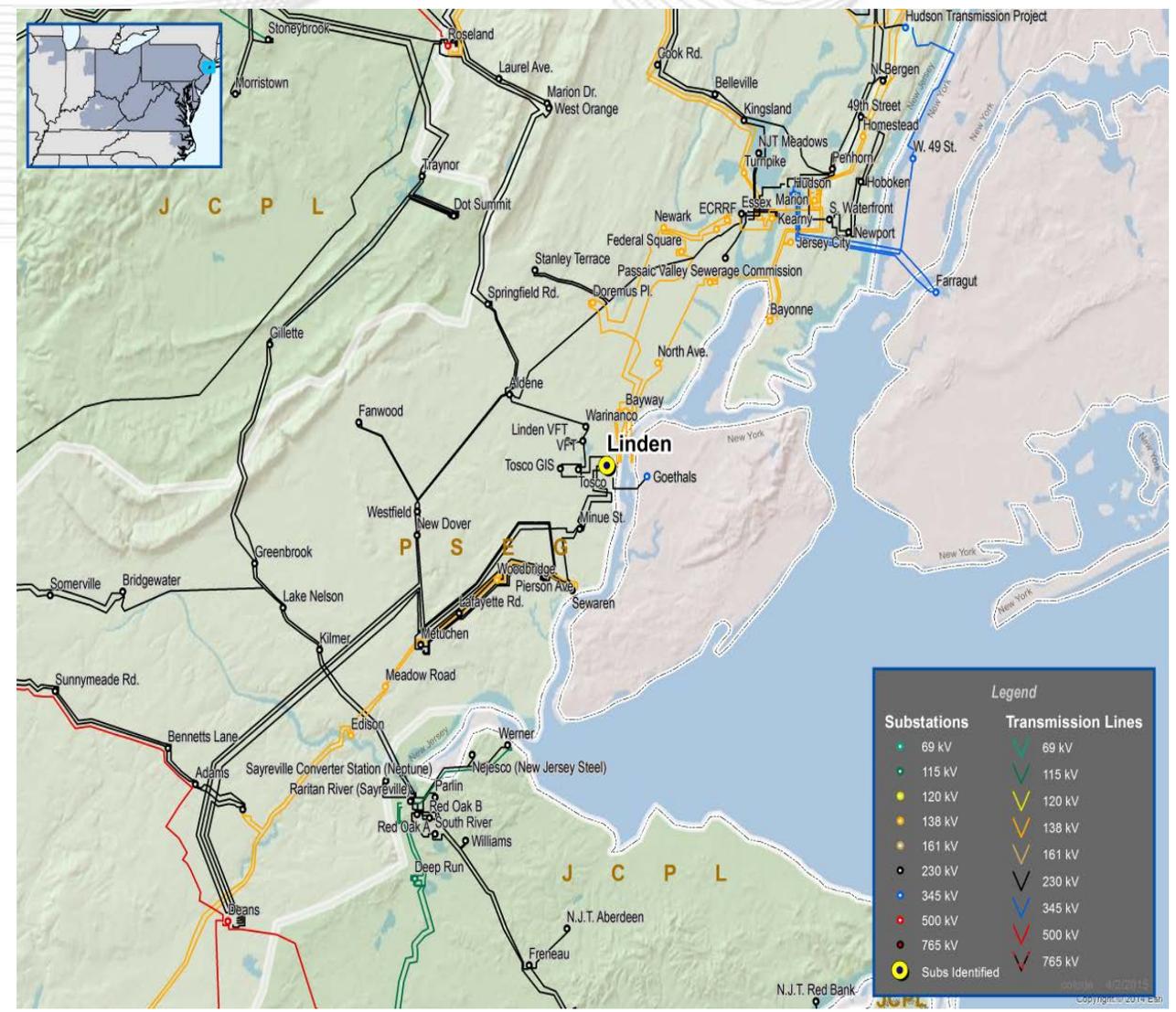
- Install 0.123% series reactor on the Z-2252 230 kV circuit connecting the Linden generators to Linden station.

**Old Estimated Project Cost: \$4.5 M**

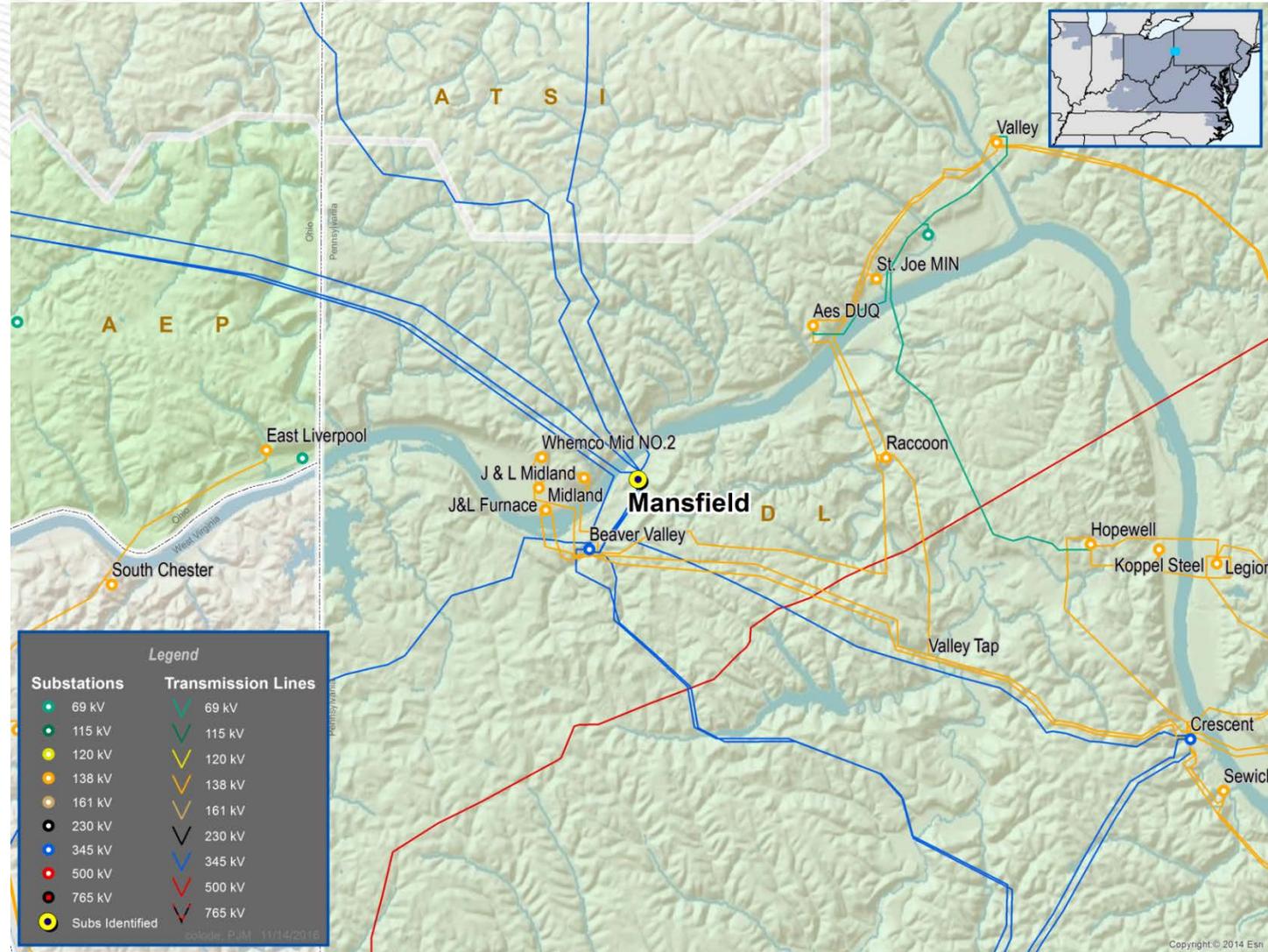
**New Estimated Project Cost: \$8.25 M**

This is a PSEG Power funded project.

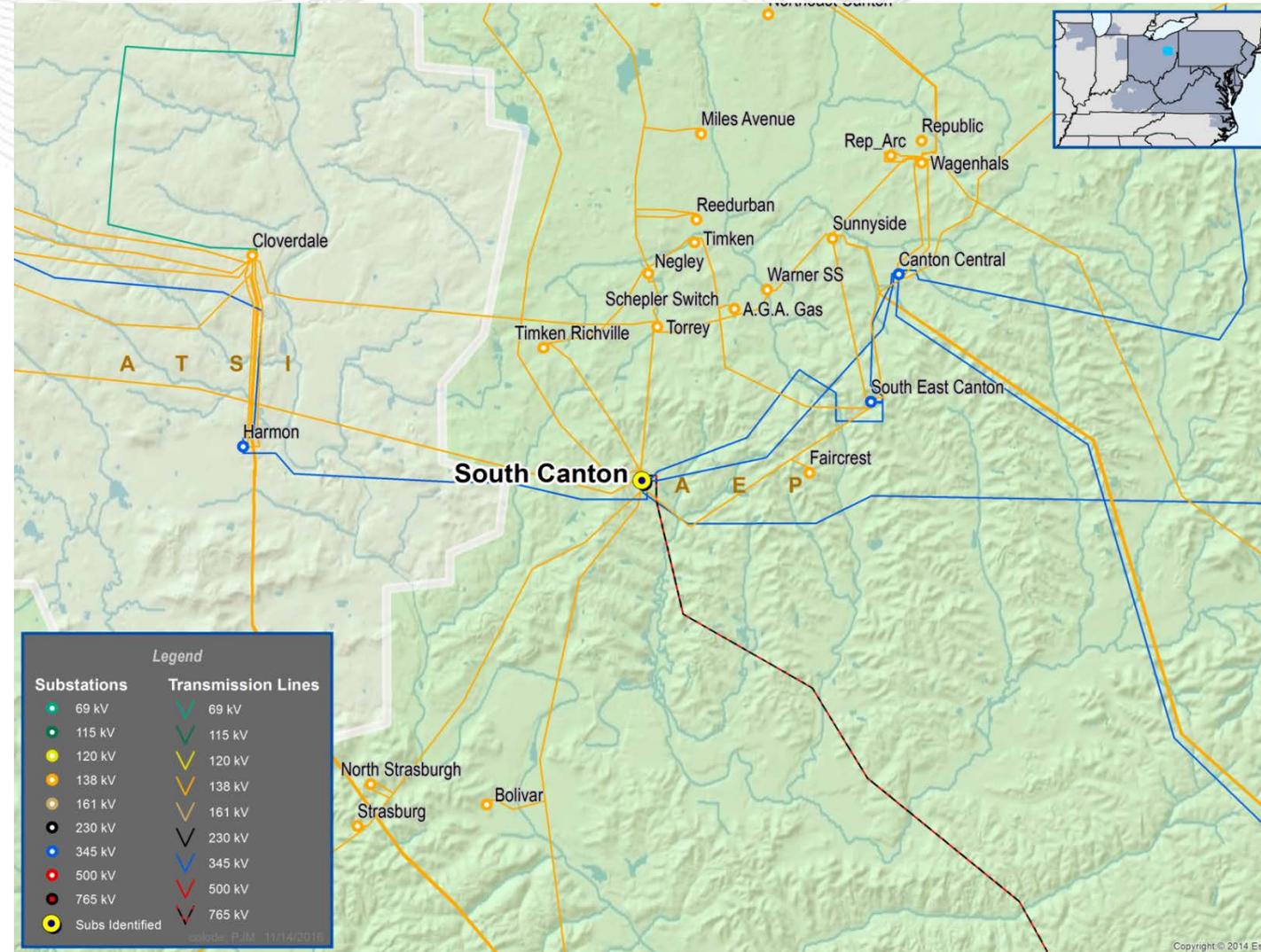
**Required IS Date: 6/1/2018**



- Short Circuit (FG# SC-1):
- The Bruce Mansfield 345 kV breaker 'B57' is overstressed.
- **Recommendation:**
  - Replace Bruce Mansfield 345 kV breaker 'B57' with an 80 kA breaker, and associated gang-operated disconnect switches D56 and D58 (2016\_3-6F) (B2780)
- **Estimated Project Cost: \$1.3 M**
- **Required IS Date: 6/1/2021**
- **Projected IS Date: 11/30/2017**



- Short Circuit (FG# SC-4, SC-5):
- The South Canton 138 kV breakers 'L' and 'L2' are overstressed.
- **Recommendation:**
  - Replace South Canton 138 kV breakers 'L' and 'L2' with 80 kA breakers (2016\_3-4E) (B2733)
- **Estimated Project Cost: \$780 K**
- **Required IS Date: 6/1/2021**



### Generator Deliverability Outage:

- Emilie – Falls 138 kV line (PECO) is loaded to 124.38% of its emergency rating of 248 MVA for the single contingency loss of the Emilie to Neshaminy 138 kV line ('130-25/\* \$BUCKS \$ 130-25 \$ L').

### Immediate Need:

- Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible

### Alternatives Considered:

- Due to the immediate need of the project no alternatives were considered

### Proposed Solution:

- Reconductor the Emilie - Falls 138 kV line, and replace station cable and relay (B2774)

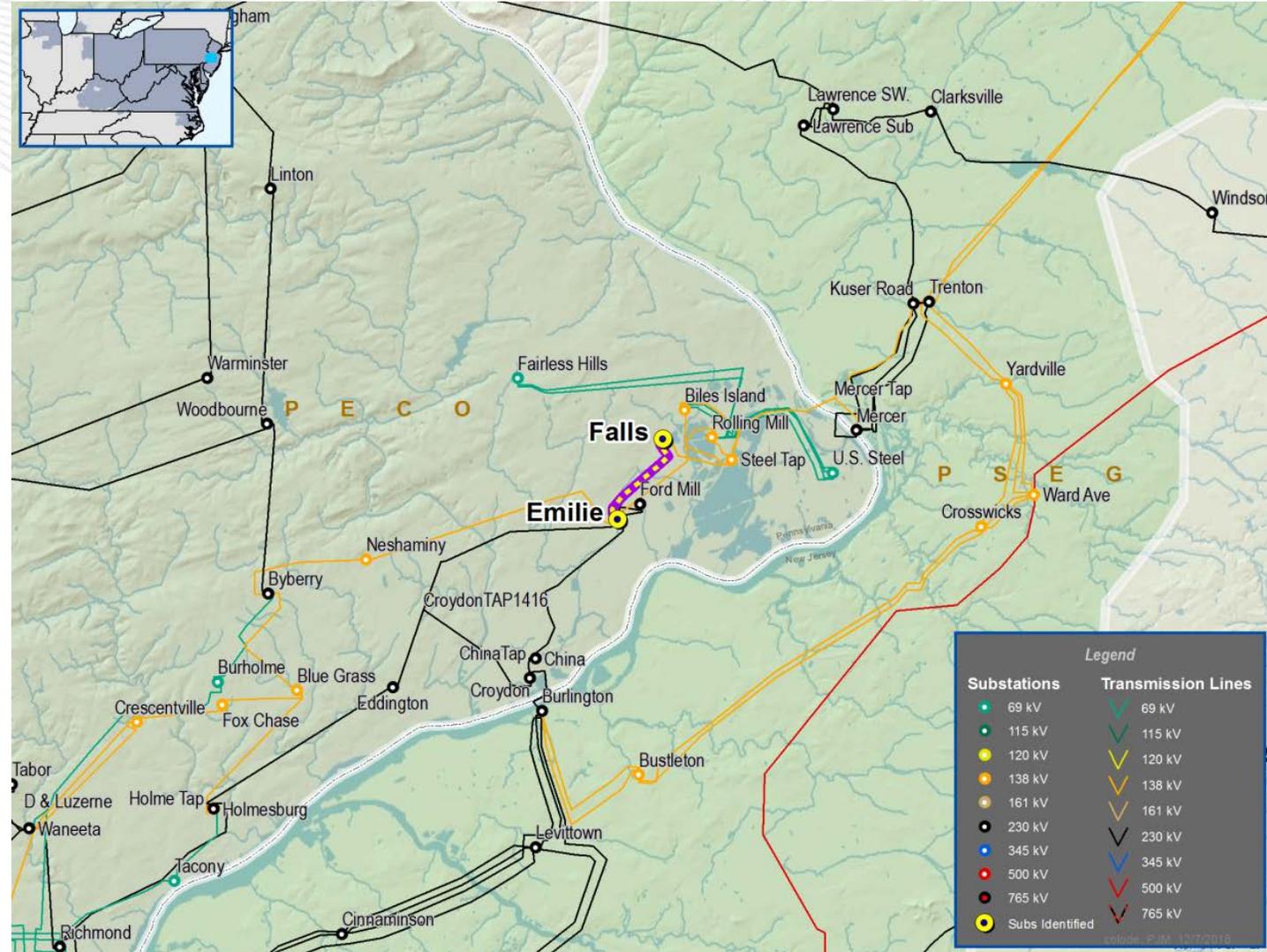
### Construction Designation:

- Due to the immediate need, the local Transmission Owner will be the Designated Entity

**Estimated Project Cost: \$ 4.5 M**

**Required IS Date: 6/1/2017**

**Projected IS Date: 12/15/2019**



### Generator Deliverability Outage:

- Emilie – Falls 138 kV line (PECO) is loaded to 122.97% of its emergency rating of 248 MVA for the breaker failure contingency loss of the Neshaminy 138 kV bus ('NESHANEW/\* \$ BUCKS \$ NESHANEW \$ STBK').

### Immediate Need:

- Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible

### Alternatives Considered:

- Due to the immediate need of the project no alternatives were considered

### Proposed Solution:

- Reconductor the Emilie - Falls 138 kV line, and replace station cable and relay (B2774)

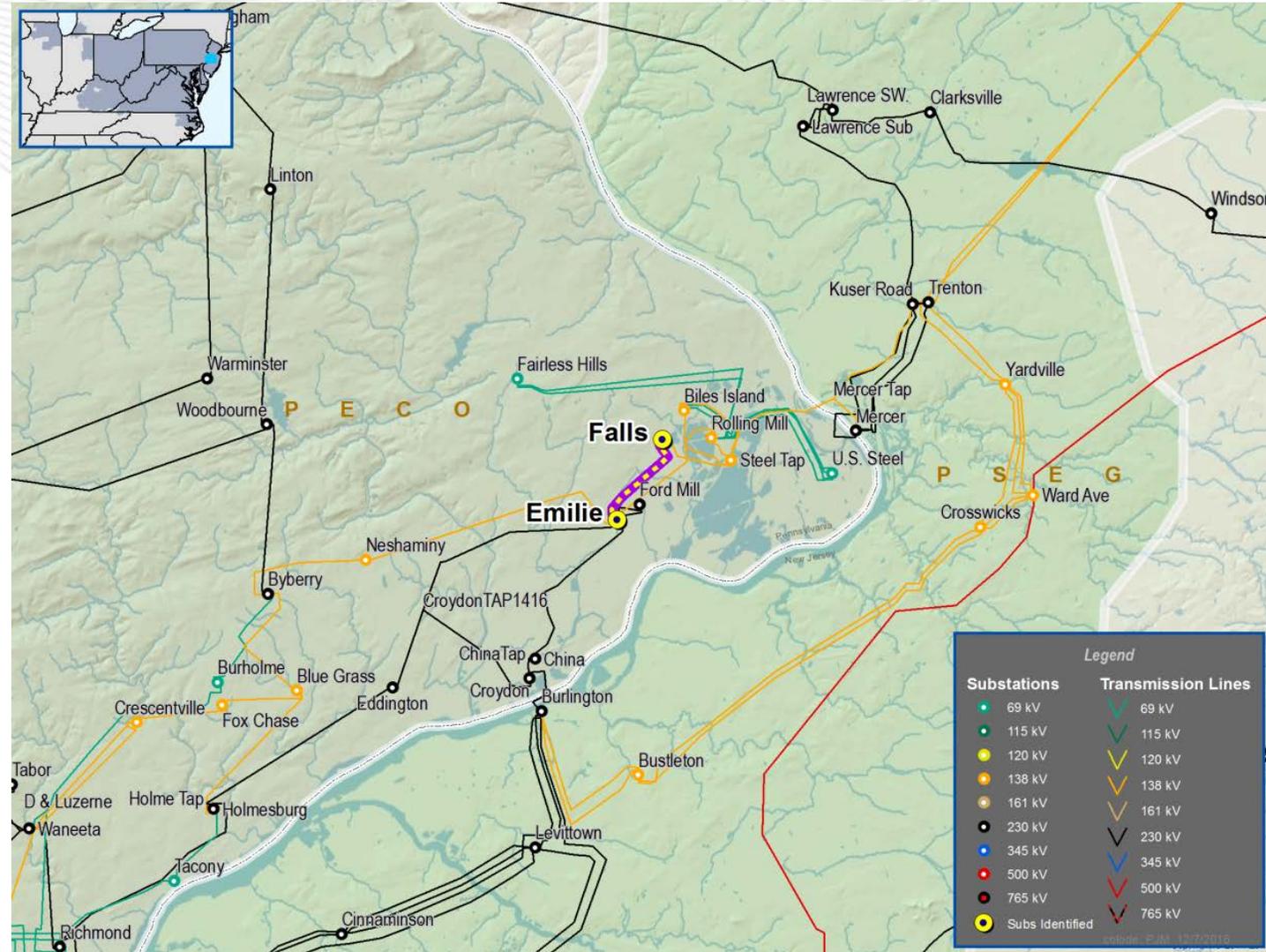
### Construction Designation:

- Due to the immediate need, the local Transmission Owner will be the Designated Entity

**Estimated Project Cost:** \$ 4.5 M

**Required IS Date:** 6/1/2017

**Projected IS Date:** 12/15/2019



### Generator Deliverability Outage:

- Falls – US Steel 138 kV line (PECO) is loaded to 109.67% of its emergency rating of 248 MVA for the single contingency loss of the Emilie to Neshaminy 138 kV line ('130-25/\* \$BUCKS \$ 130-25 \$ L').

### Immediate Need:

- Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible

### Alternatives Considered:

- Due to the immediate need of the project no alternatives were considered

### Proposed Solution:

- Reconductor the Falls – US Steel 138 kV line (B2775)

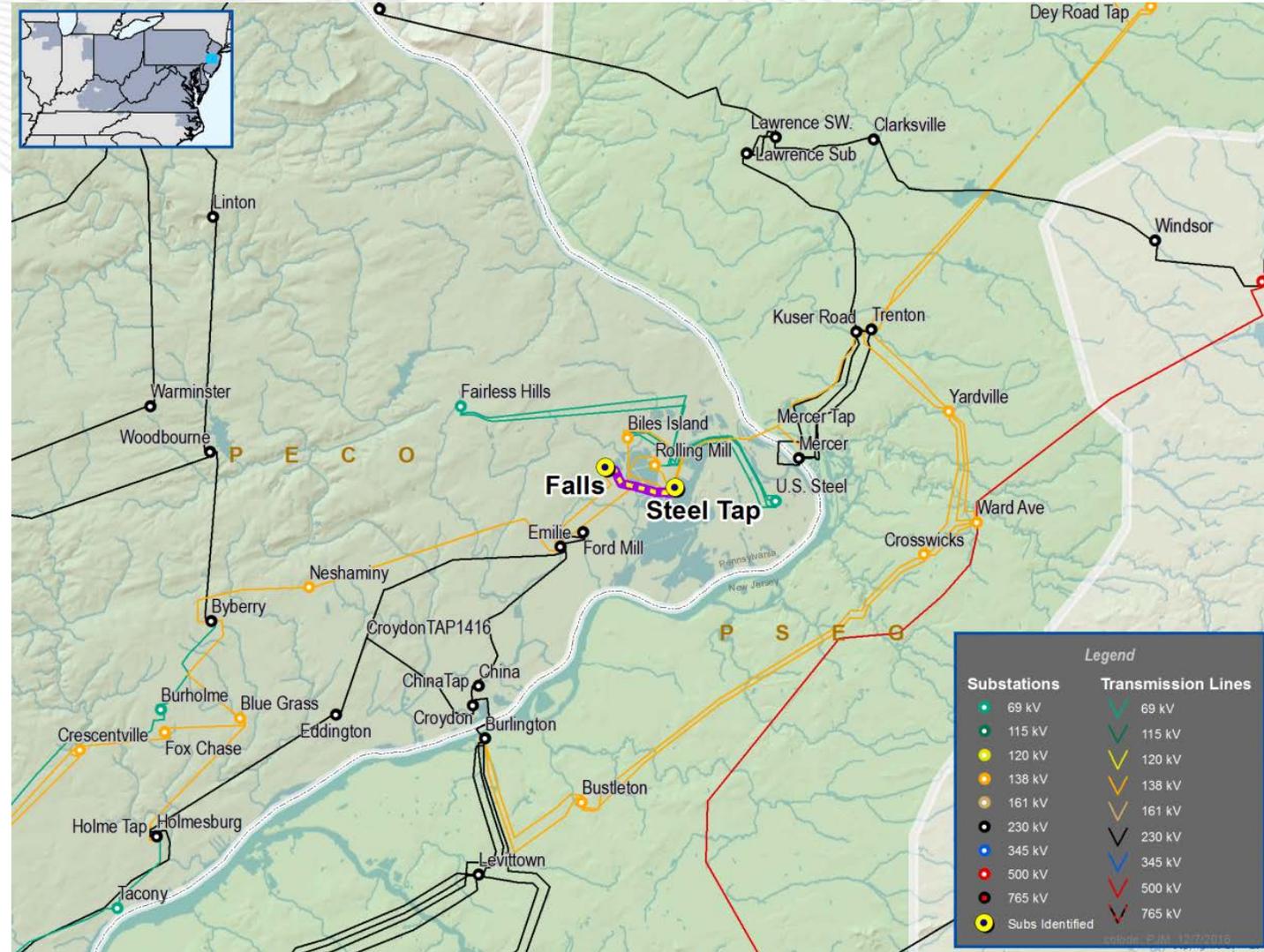
### Construction Designation:

- Due to the immediate need, the local Transmission Owner will be the Designated Entity

**Estimated Project Cost: \$ 2.5 M**

**Required IS Date: 6/1/2017**

**Projected IS Date: 12/15/2019**



**Generator Deliverability Outage:**

- Falls – US Steel 138 kV line (PECO) is loaded to 108.18% of its emergency rating of 248 MVA for the breaker failure contingency loss of the Neshaminy 138 kV bus ('NESHANEW/\* \$ BUCKS \$ NESHANEW \$ STBK').

**Immediate Need:**

- Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible

**Alternatives Considered:**

- Due to the immediate need of the project no alternatives were considered

**Proposed Solution:**

- Reconductor the Falls – US Steel 138 kV line (B2775)

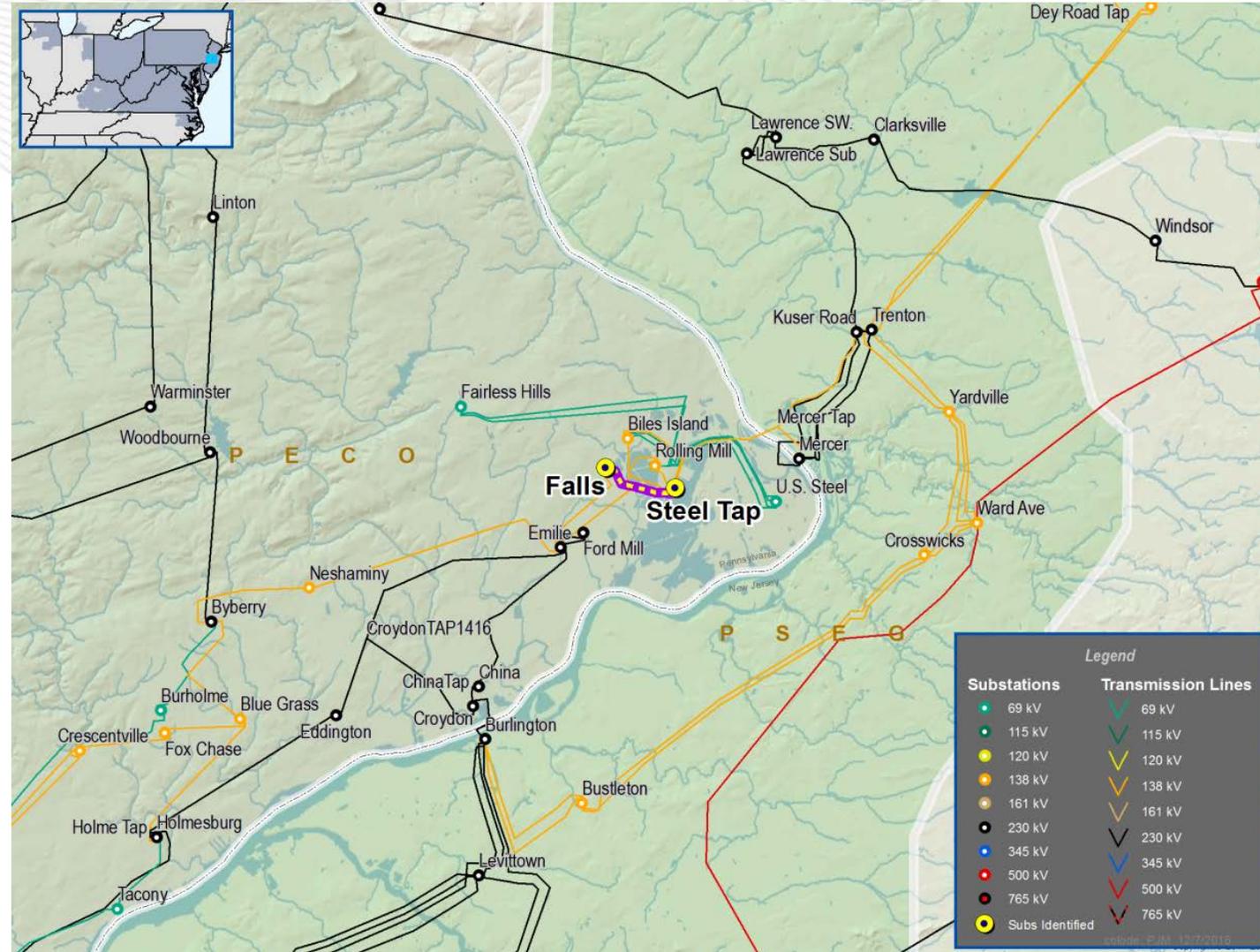
**Construction Designation:**

- Due to the immediate need, the local Transmission Owner will be the Designated Entity

**Estimated Project Cost:** \$ 2.5 M

**Required IS Date:** 6/1/2017

**Projected IS Date:** 12/15/2019



# Description: B2774 and B2775

## Emilie – Falls 138 kV:

- Reconductor the Emilie - Falls 138 kV line, and replace station cable and relay. (B2774) – PECO

## Falls – U.S. Steel 138 kV:

- Reconductor the Falls – US Steel 138 kV line. (B2775) – PECO

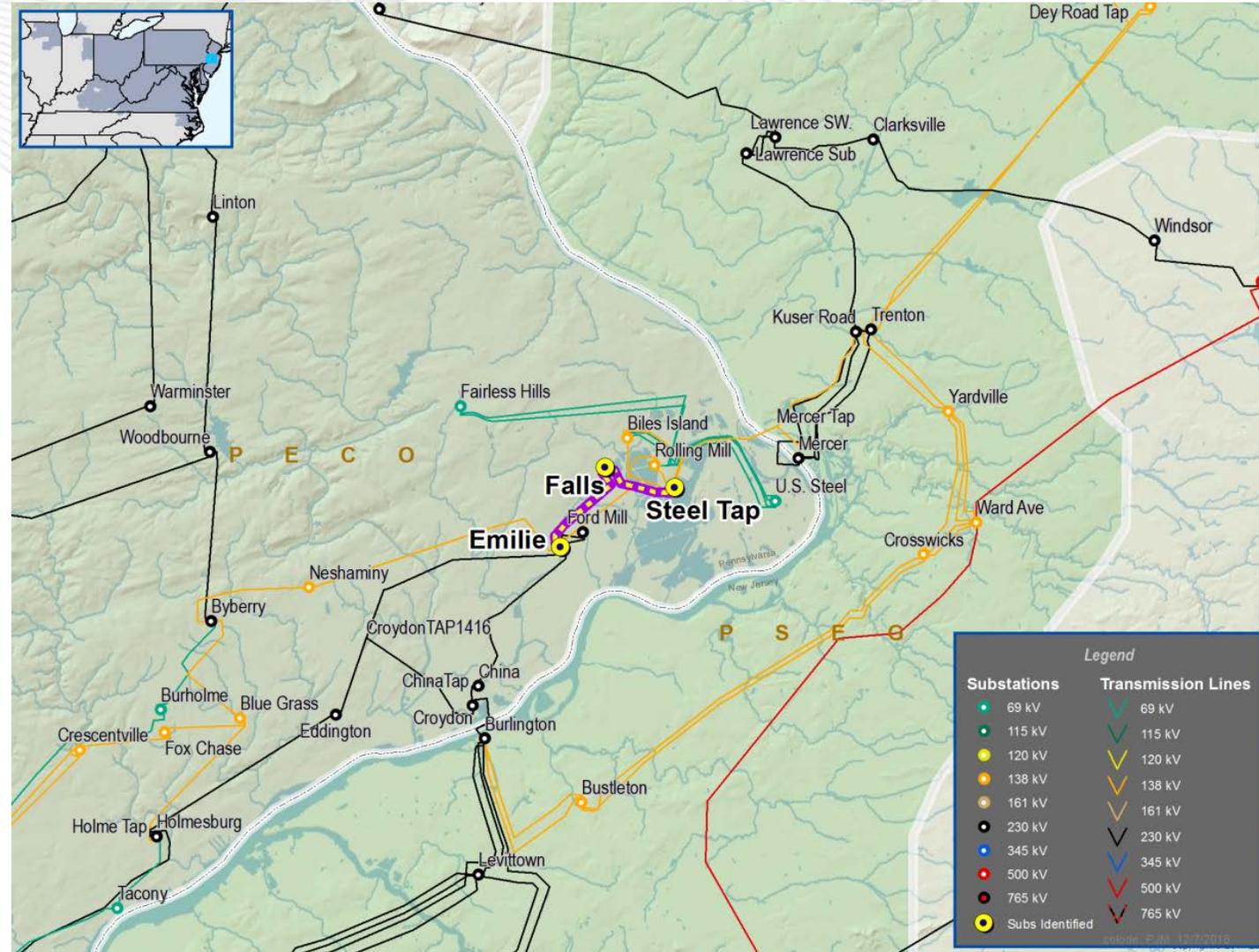
## Immediate Need:

- Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible

Impacts identified and will be resolved by upgrades that are scheduled to be completed in 2019. Interim operating measures identified and unit expected to deactivate as scheduled.

## Estimated Project Cost: \$7M (B2774-B2775)

- B2274: \$4.5M
- B2275: \$2.5M



## Short Circuit (FG# SC-1):

- The Bruce Mansfield 345 kV breaker 'B57' is overstressed.

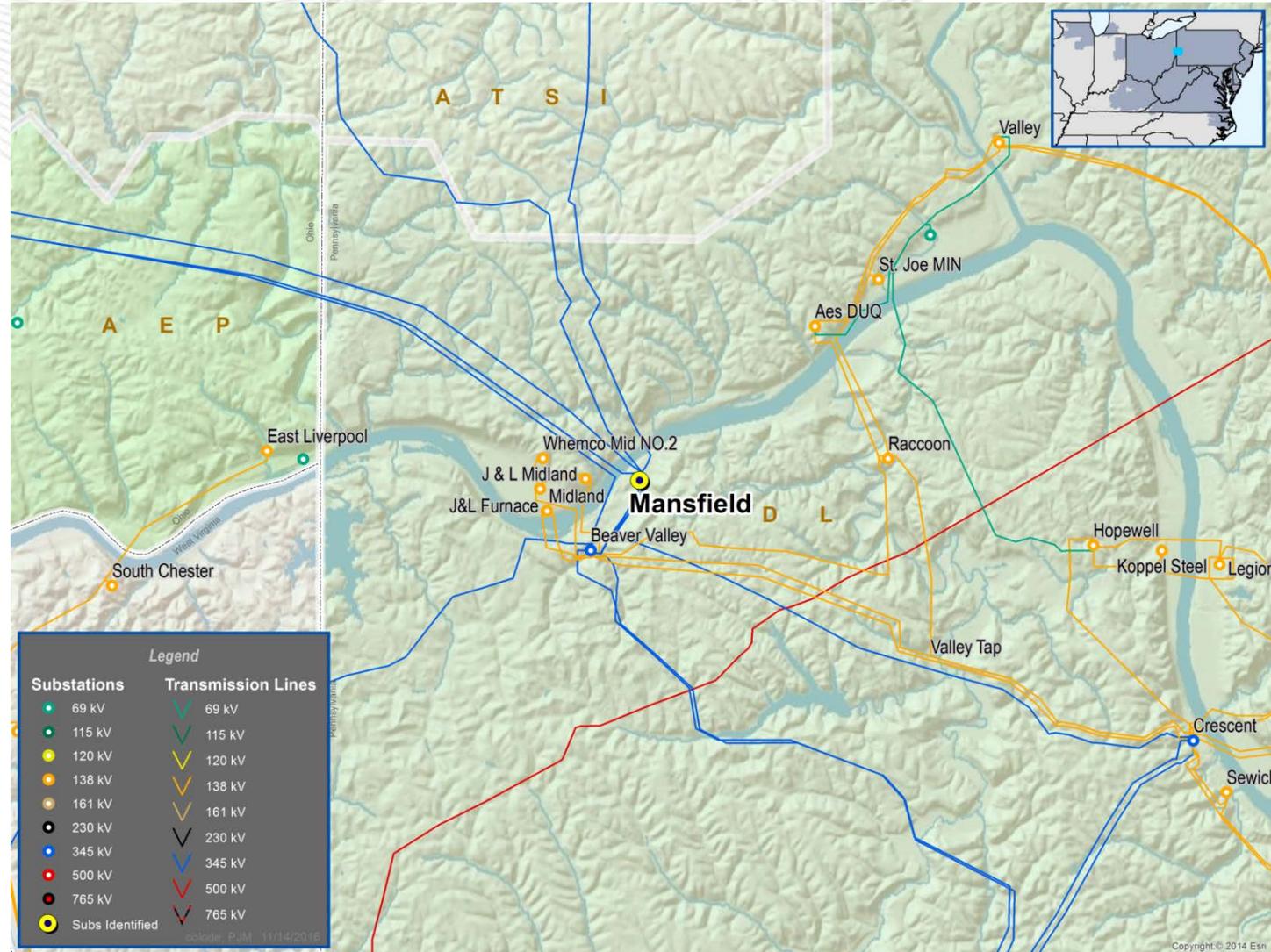
## Recommendation:

- Replace Bruce Mansfield 345 kV breaker 'B57' with an 80 kA breaker, and associated gang-operated disconnect switches D56 and D58 (2016\_3-6F) (B2780)

**Estimated Project Cost: \$ 1.3 M**

**Required IS Date: 6/1/2021**

**Projected IS Date: 11/30/2017**



## EKPC Transmission Owner Criteria Violation:

- Low voltage at Asahi M W 69kV bus for the loss of the Norwood- Shopville 69kV line and Brown unit #3.

## Immediate need:

- This voltage violation was identified during the 2016 screening after a capacitor bank on the system was retired.

## Alternative Considered:

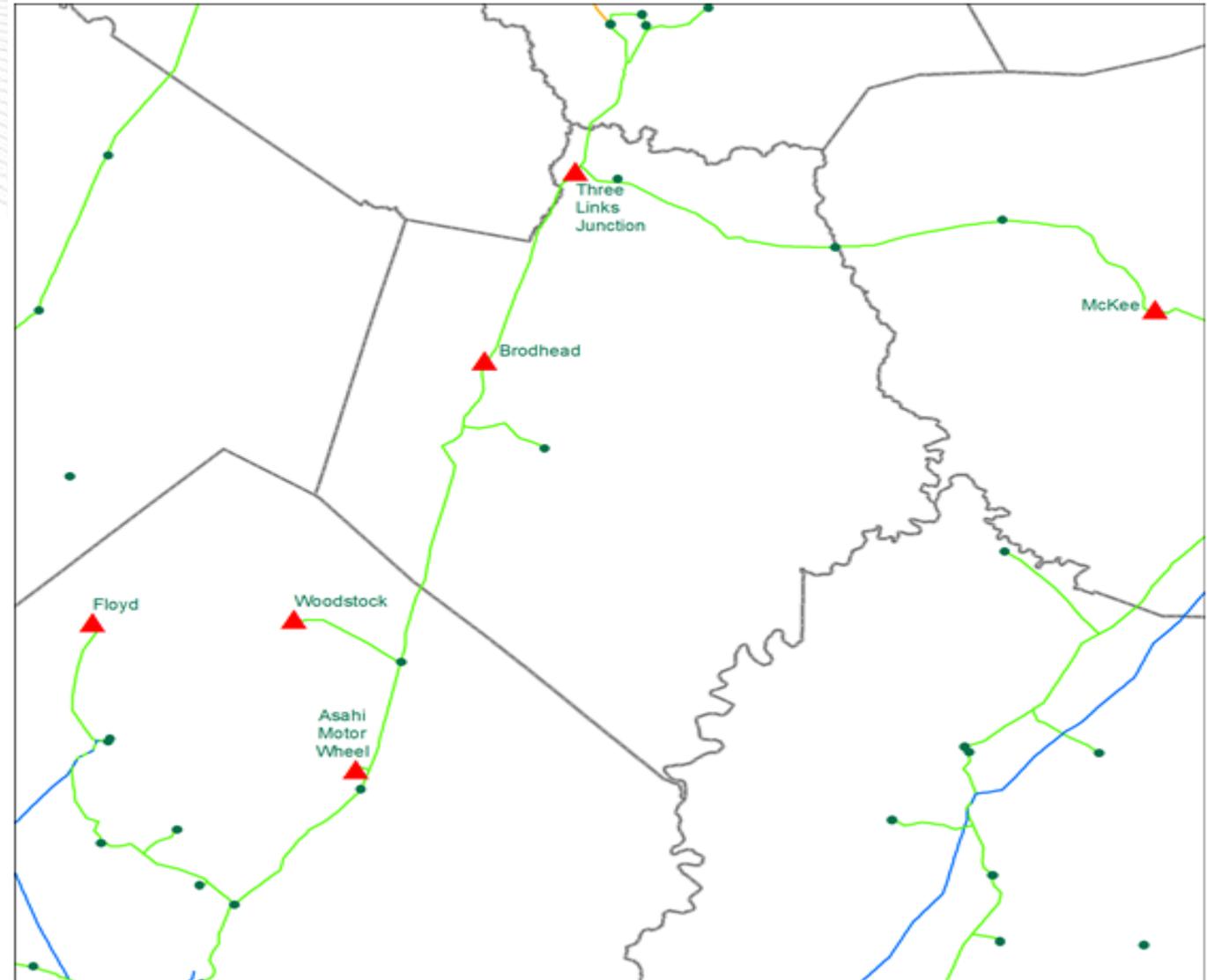
- Rebuild Brodhead – Three links Junction using 556.5 MCM ACSR/TW (8.2 miles).
- Build a new Floyd – Woodstock 69kV line section using 556.5 MCM ACSR/TW (7.2 miles).

## Recommended Solution:

- Install Three Links 13.776 MVAR 69kv cap bank (B2785)

**Estimated Project Cost:** \$ 0.35 M

**Required IS Date:** 12/1/2017



## Dominion End of Life Criteria Violation:

- Original SVC at its End of Life
  - Harsh Environment / High Salt Contamination has led to component corrosion
  - Cap/filters have reached end of life
  - Non-redundant design
  - Unique components with no spares

## Immediate Need:

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

## Alternatives Considered:

- Due to the immediate need of the project no alternatives were considered

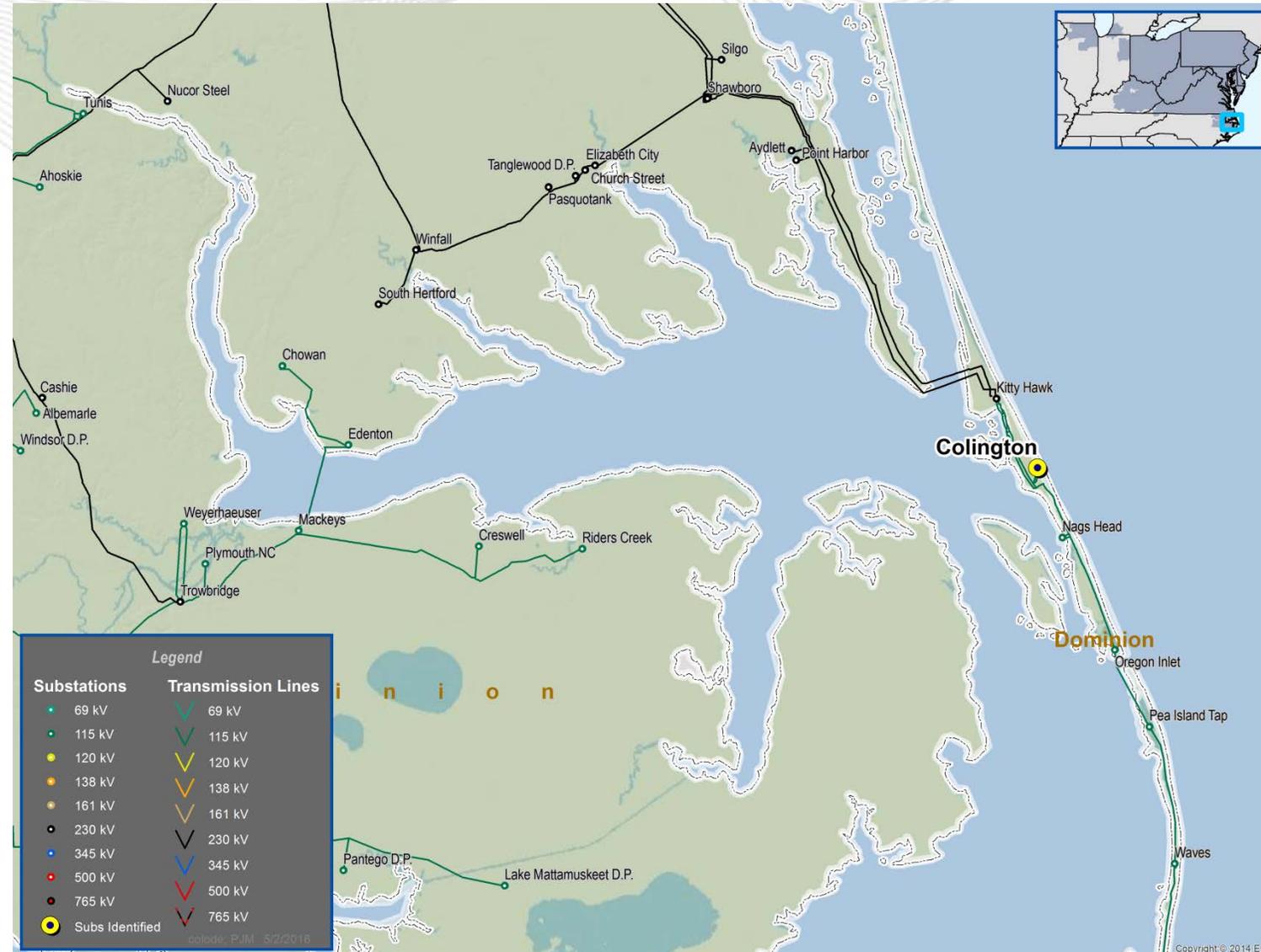
## Proposed Solution:

- Install a +/-125 MVar Statcom at Colington 230kV (B2757)

**Estimated Project Cost:** \$ 30 M

**Required IS Date:** 06/01/2017

**Projected IS Date:** 06/01/2017



## Existing B1794 Cost Increase

### Problem: N-1 Thermal Violation

- Overload of Rocky Mt – Battleboro 115kV for the loss of Battleboro – Carolina 115kV

### Scope:

- Build a new switching station west of Edgecombe NUG to be called Hathaway Switching Station with a 230-115kV transformer, 5-230kV breakers in a breaker and a half scheme, 4-115kV breakers in a ring. Re-configure Battleboro – Benson 115kV, Nash-Hornertown 230kV, and Edgecombe NUG – Rocky Mt 230kV to terminate into Hathaway (b1794).

### Reason for Cost Increase:

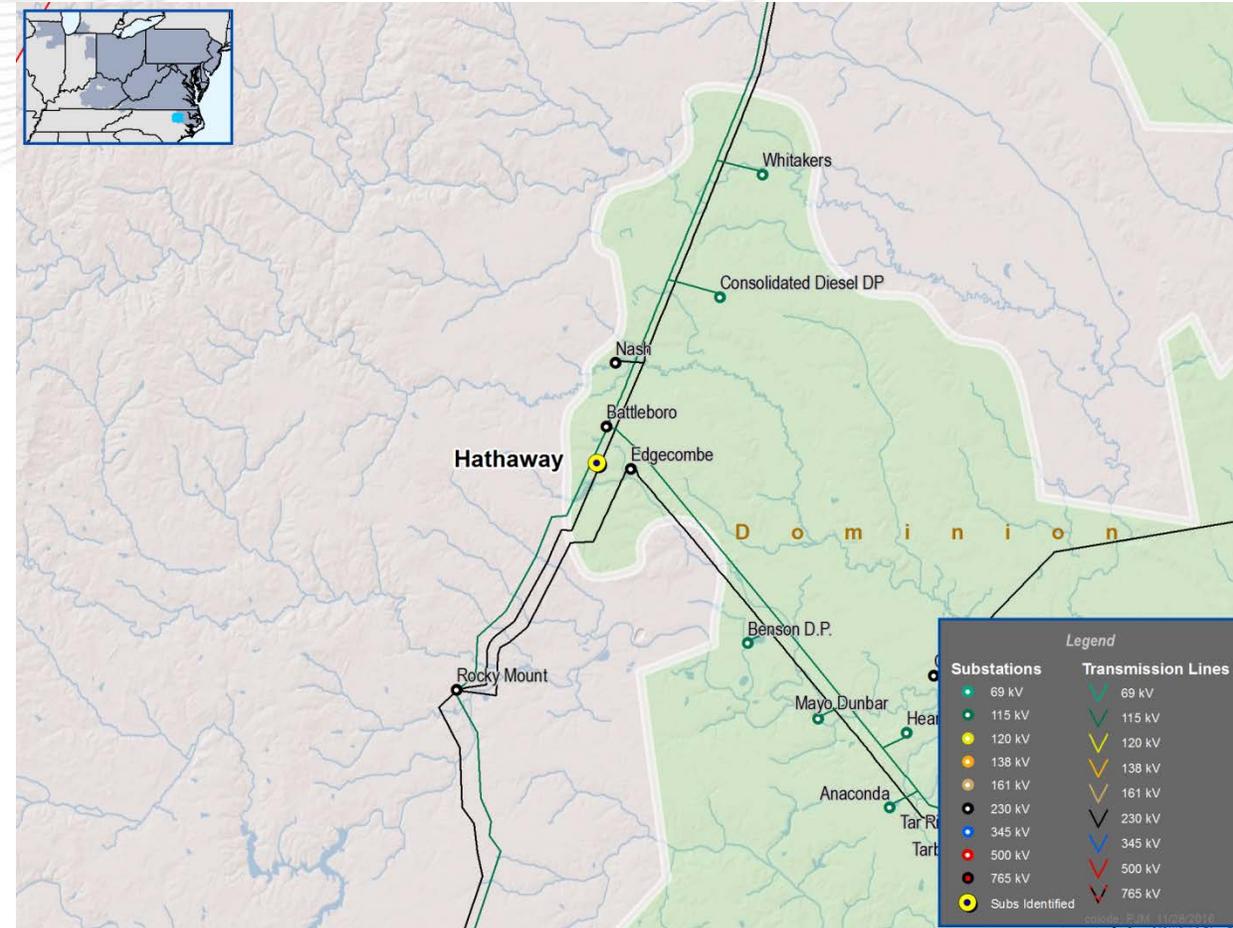
- The cost increase is due to additional substation expense, cost of land, expense for storm drainage and escalation of material and labor costs.

**Previous Estimated Project Cost:** \$ 19.0M

**Revised Estimated Project Cost:** \$ 25.4M

**Projected IS Date:** 06/01/2017

**Project Status:** Under Construction



## B2653.1 - .3 Cost Increase and Scope Modification

### Dominion Radial Line Criteria Violation:

- Line #82 is a 115kV radial line from Everetts to Wharton (13.8) miles that feeds radial line #189 from Wharton to Pantego (30.2 miles)
- The MW-miles for Lines #82 and #189 are 2156 and 1419 MW-miles respectively, a violation of the DOM radial line criteria

### Proposed Scope Modification:

- Network Lines #82 and #189 by building a 20 mile 115kV line from Pantego to Trowbridge with a summer emergency rating of 262 MVA. (b2653.1)
- Install a 115kV four breaker ring at Pantego (b2653.2) and a 115kV breaker at Trowbridge (b2653.3)

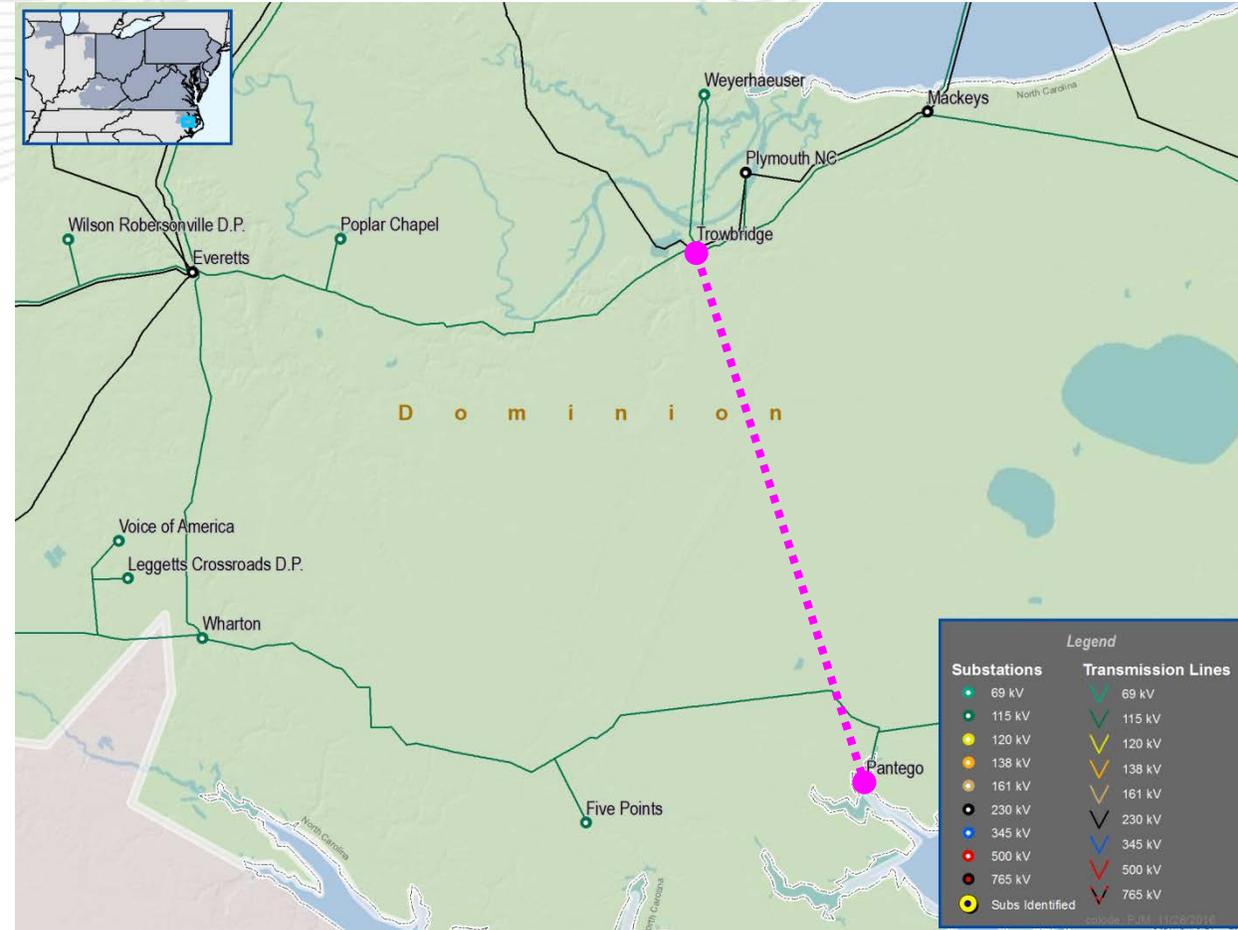
### Reason for Cost Increase and Scope Modification:

- Final routing increased the line mileage from 20 to 22 miles from Pantego to Trowbridge
- Summer emergency rating target changed to 346 MVA from 262 MVA
- The cost increase is due to refined detailed cost estimate updates and the increased line mileage for the final routing.

**Previous Estimated Project Cost:** \$ 35.0 M

**Revised Estimated Project Cost:** \$ 44.6 M

**Projected IS Date:** 06/01/2018





# Dominion Transmission Zone

## B2654.1 - .4 Cost Increase and Scope Modification

### Dominion Radial Line Criteria Violation:

- Line #126 is a 115kV 25 mile radial line from Earleys to Scotland Neck that feeds radial line on 2 pole wood H frames mostly built in 1969.
- The MW-miles for Line #126 is 775 MW-miles respectively, a violation of the DOM radial line criteria.

### Proposed Scope Modification:

- Network Lines #126 by building a 15 mile 115kV line from Scotland Neck to S Justice Branch with a summer emergency rating of 262 MVA. (b2654.1)
- Install a 115kV three breaker ring at S Justice Branch (b2654.2) and a 115kV breaker at Scotland Neck (b2654.3).
- Install a 2nd 224 MVA 230-115kV transformer at Hathaway (b2654.4) for contingency support (overload of Line #123 Rocky Mt - Battleboro 115 kV). The new line would be routed to allow HEMC to convert Dawsons Crossroads DP from 34.5kV to 115kV.

### Reason for Cost Increase and Scope Modification:

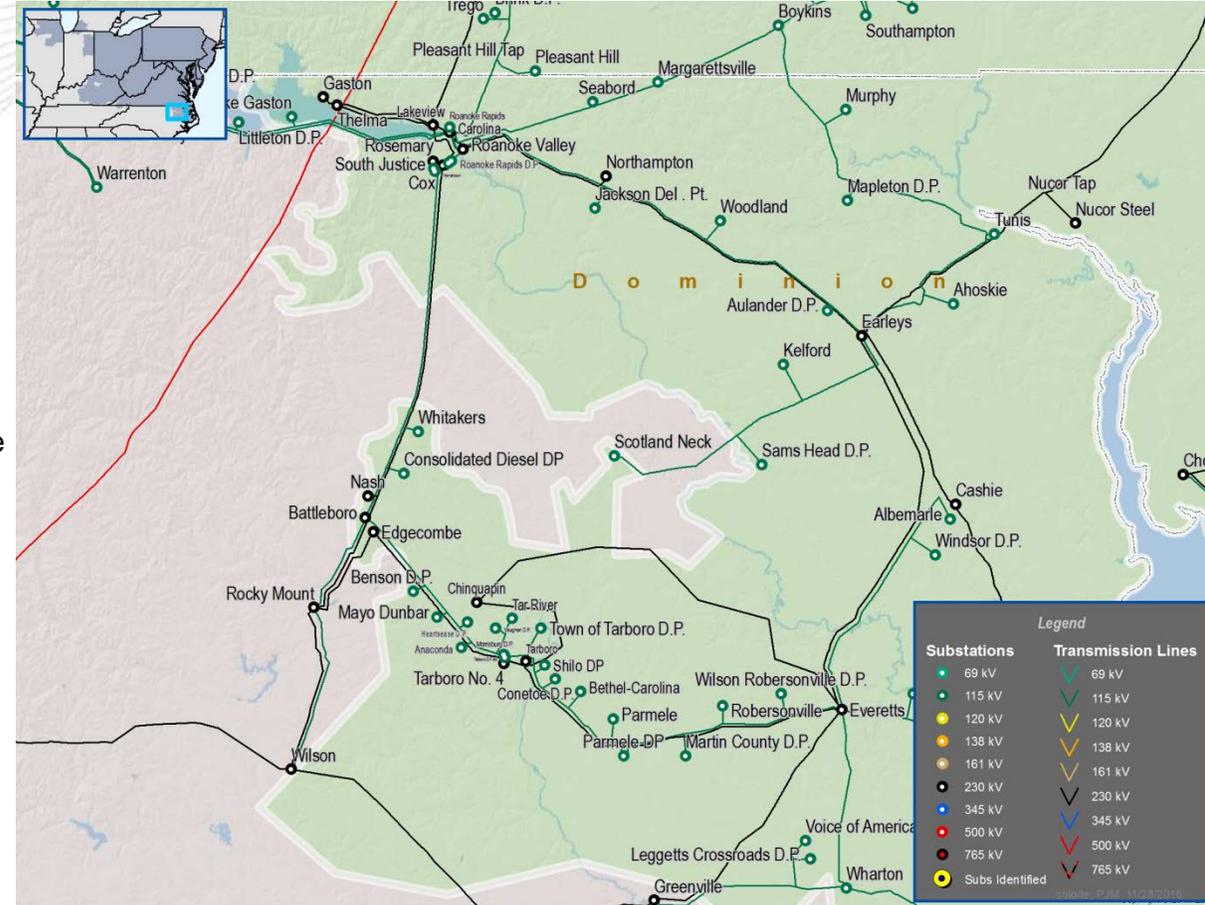
- Final routing increased the line mileage from 15 to 16 miles from Scotland Neck to South Justice Branch.
- Summer emergency rating target changed to 346 MVA from 262 MVA.
- Install an additional 115kV breaker in the breaker ring at S Justice Branch for a total of four 115kV breakers in the ring for breaker failure reliability.
- The cost increase is due to refined detailed cost estimate updates and the increased line mileage for the final routing.

**Previous Estimated Project Cost:** \$ 33.0 M

**Revised Estimated Project Cost:** \$ 46.0 M

**Projected IS Date:** 06/01/2018

**Project Status:** Completed Detailed Design





# Dominion Transmission Zone

## Existing B2719.1 - .3 Cost Increase

### Problem: DOM Limitation on Direct-Connect Load Violation

- Line #31, Altavista – Halifax 115kV, is 36 mile long network . It serves roughly 12,000 customers located in Halifax and Pittsylvania counties. It serves 4 MEC and 2 Dominion delivery points for a total of 6 direct-connect tapped facilities.
- Dominion’s Facilities Connection Requirements C.2.7 states that the number of direct-connect loads (tapped facilities) should be limited to 4 tapped facilities.
- The Hickory Grove DP tap is 8 miles long. Dominion’s Facilities Connection Requirements G.1 states that when tapping lines for loads less than 100 MW and length more than 1 mile, the tap connection may be connected with a 3 or 4 breaker ring.

### Scope:

- Expand Perth substation and add a 115kV four breaker ring. (b2719.1)
- Extend the Hickory Grove DP tap 0.28 miles to Perth and terminate it at Perth. (b2719.2)
- Split Line #31 at Perth and terminate it into the new ring bus with 2 breakers separating each of the line terminals to prevent a breaker failure from taking out both 115kV lines. (b2719.3)

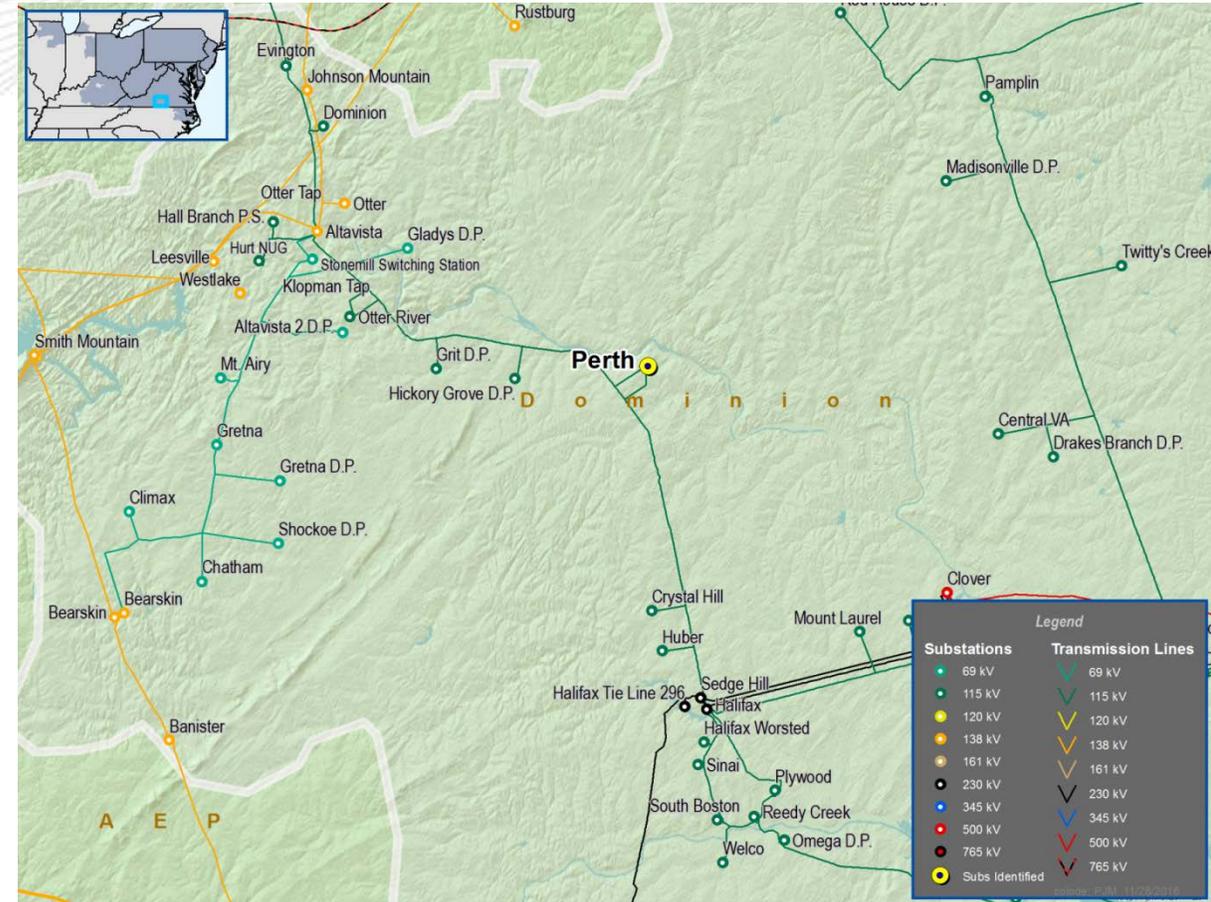
### Reason for Cost Increase:

- The cost increase is due to a high level preliminary planning cost estimate versus a detailed cost estimate.
- The cost increase included \$100,000 for a mobile transformer required to serve the distribution load that has no external ties.
- The date was changed from June to December due to the mobile transformer ratings limitation during the late spring and early summer time frame.

Previous Estimated Project Cost: \$7.0 M

Revised Estimated Project Cost: \$8.2 M

Projected IS Date: 12/01/2017



## Problem: DOM “End of Life Criteria”

- Line #171 Chase City to Boydton Plank Rd was constructed on wood H-frames with 3/8 inch steel static. The line is approximately 61 years old.
- Removal of this line would violate Dominion’s 700 MW-mile radial line criteria
- This is an immediate need project based on “End of Life” criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe.

## Alternatives Considered

Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

## Proposed Immediate Need Solution

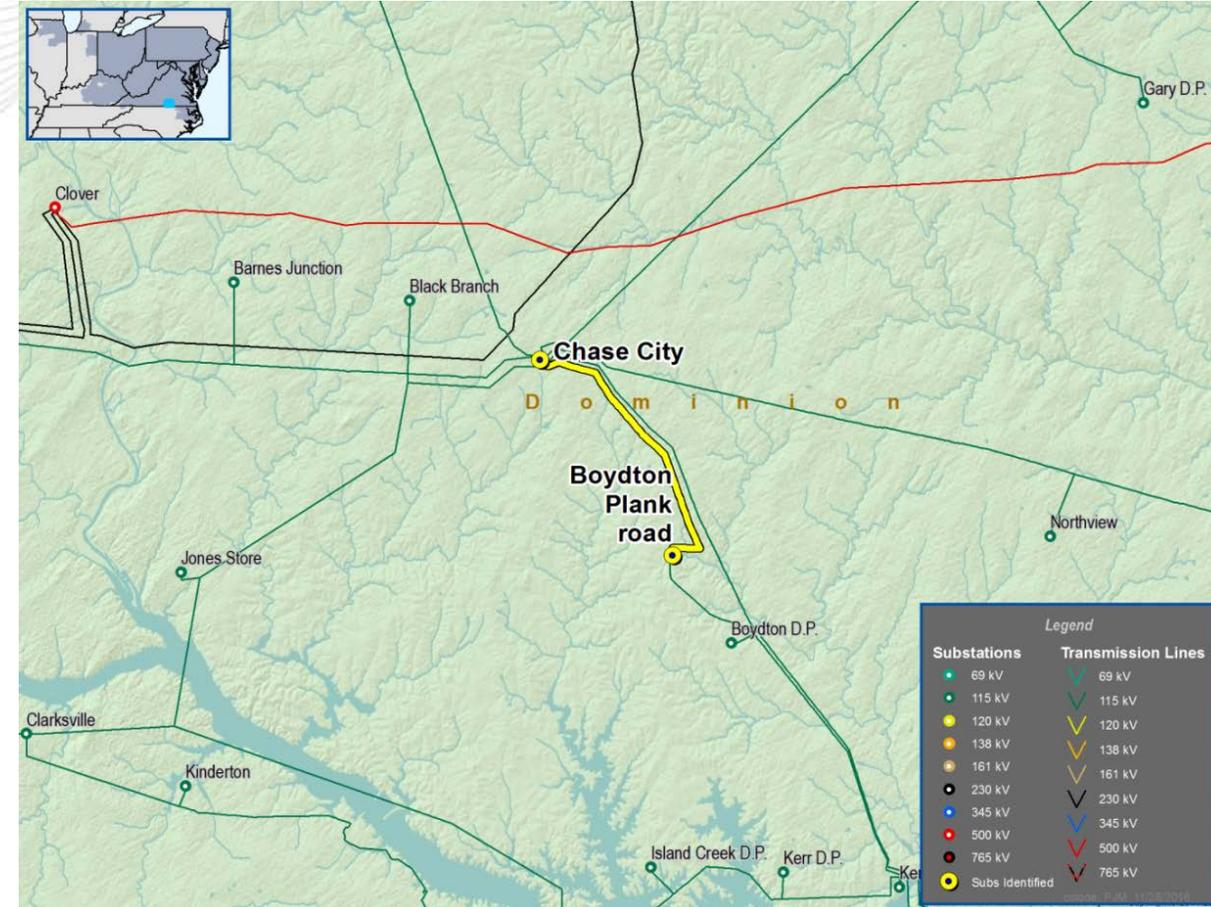
Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

- Double circuit structures will be installed as part of project b2746. This project removes Line #171 end-of-life facilities and installs new conductor on the other arms, 9.4 miles, from Chase City to the Boydton Plank Road tap. The conductor used will be at current standards with a summer emergency rating of 393 MVA at 115kV. (b2802)

**Estimated Project Cost:** \$3.5 M

**Projected IS Date:** 06/30/2019

**Required IS Date:** 06/30/2019



## Problem: DOM Limitation on Direct-Connect Load Violation

- Line #47 (Four Rivers – Fredericksburg) is a 34 mile long 115kV line and serves five delivery points (4 REC and 1 Dominion).
- The Dominion Planning Criteria states that the number of DP's on a transmission line should be limited to four and the Dominion Facility Connection Requirement states that transmission tap lines greater than a mile should be protected by a breaker to improve the reliability of the line.
- This is an immediate need project based on "Limitation on Direct-Connect Load" criteria.
- When this criteria violation was identified, the need date was already in the immediate need timeframe

## Alternatives Considered

Given the immediate need timing of the violation, alternatives that would require new lines to be built were not considered.

## Proposed Immediate Need Solution

Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

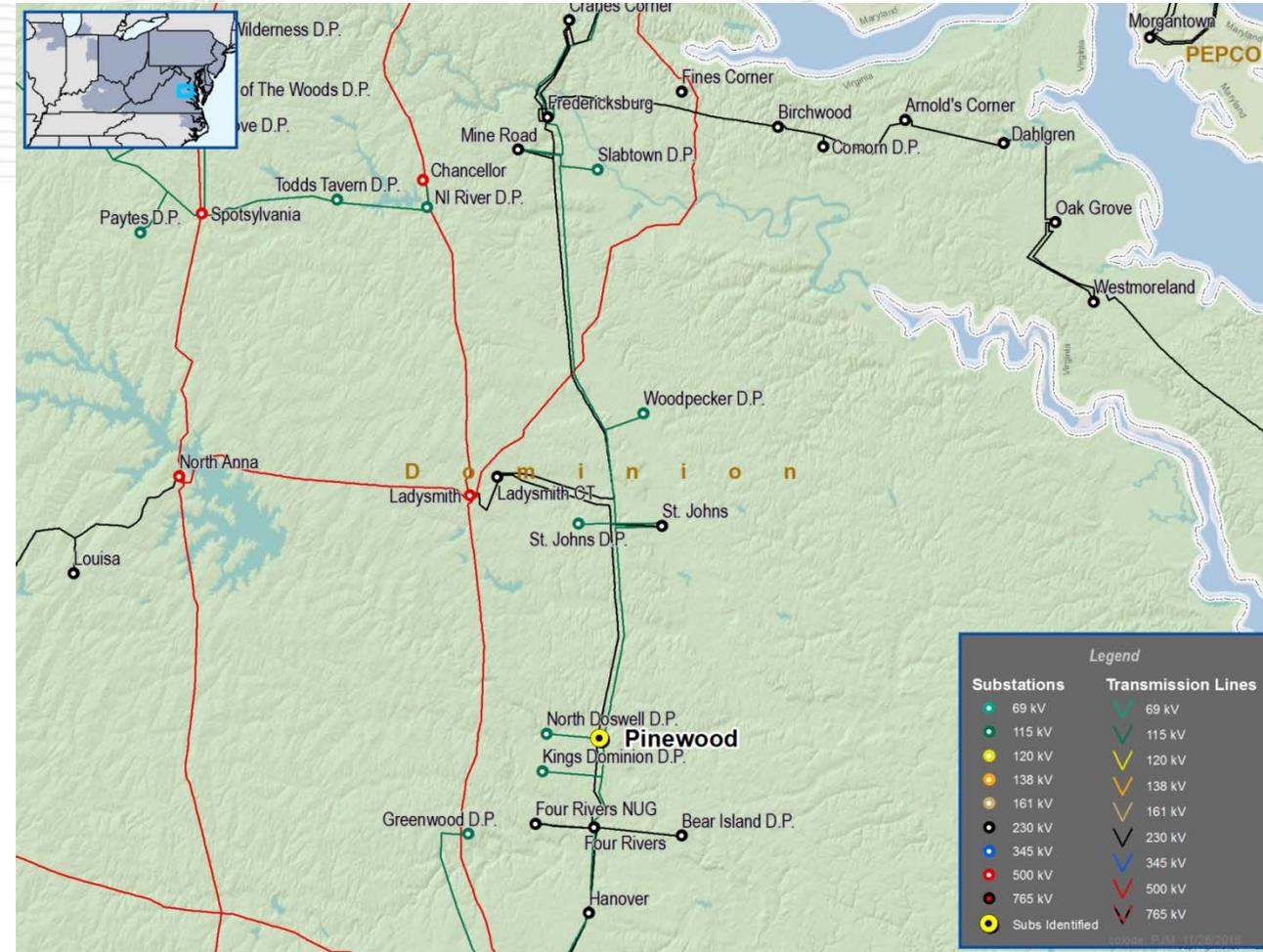
- Build a new switching station (Pinewood 115kV Switching Station) at the tap serving North Doswell DP with an 115kV four breaker ring bus (b2815)

**Estimated Project Cost:** \$ 12.8 M

**Projected IS Date:** 06/01/2017

**Required IS Date:** 06/01/2017

**Project Status:** Under Construction



## N-1 First Energy Planning Criteria (FERC Form 715):

- The Traynor - Whippany 34.5 kV (N14) circuit is overloaded for the loss of the Madison – Traynor 34.5 kV (R96) circuit .
- The facility is overloaded due to revised load forecast and modeling

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, JCPL (Local TO) will be the Designated Entity

## Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

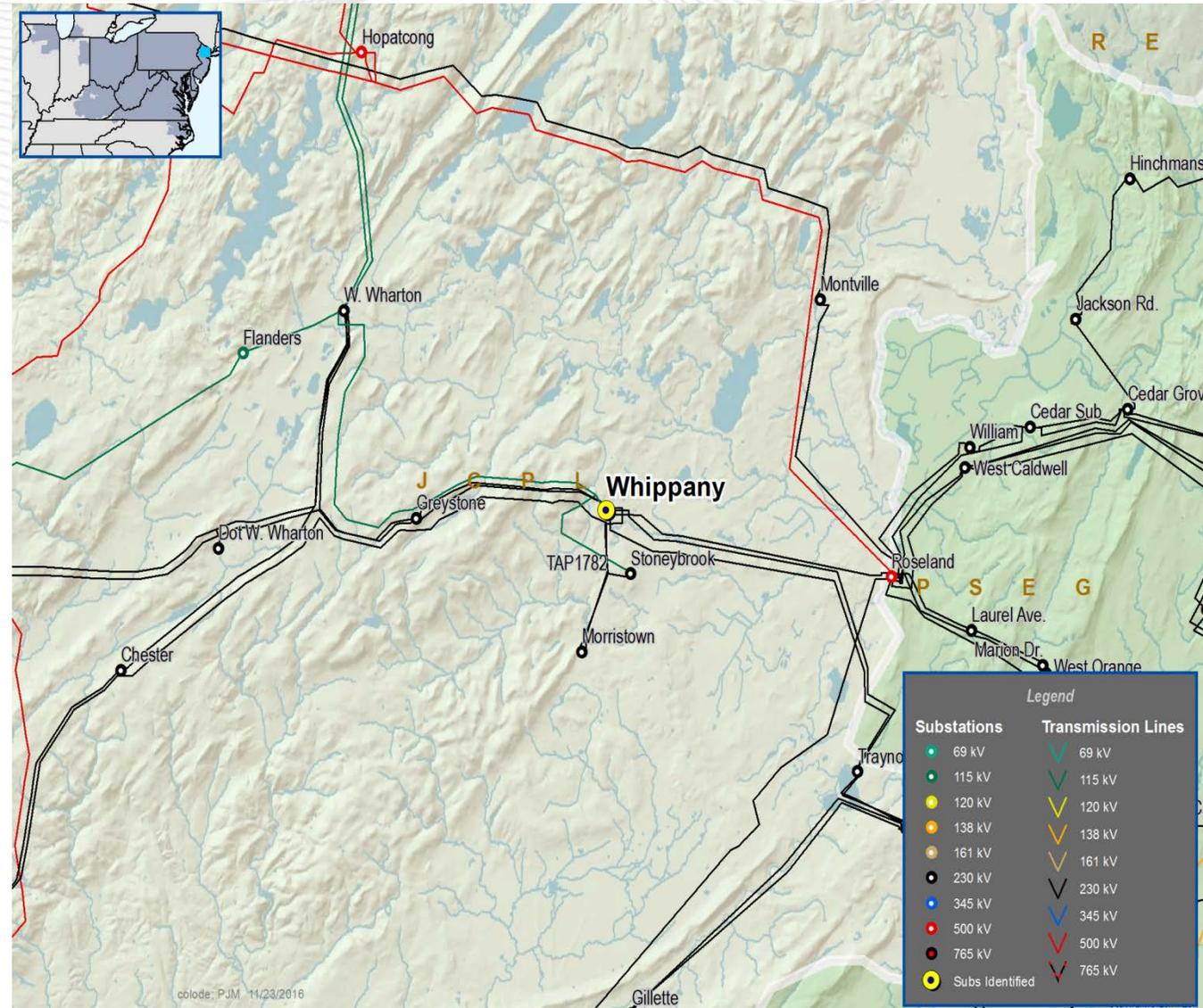
## Proposed Solution:

- Install a bypass switch at Mount Pleasant 34.5 kV substation to allow the Mount Pleasant substation load to be removed from the N14 line and transfer to O769 line. (B2809)

**Estimated Project Cost:** \$ 0.01 M

**Required IS Date:** 6/1/2017

**Expected IS Date:** 6/1/2018



## N-1 First Energy Planning Criteria (FERC Form 715):

- An existing customer in MetEd will be increasing their load incrementally starting from 2018 -2023. The load is radially served from Lyons 230/69 kV substation. In 2019 the Lyons 230/69 kV transformer #3 is overloaded for the loss of the #5 transformer.

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, Met-Ed (Local TO) will be the Designated Entity

## Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

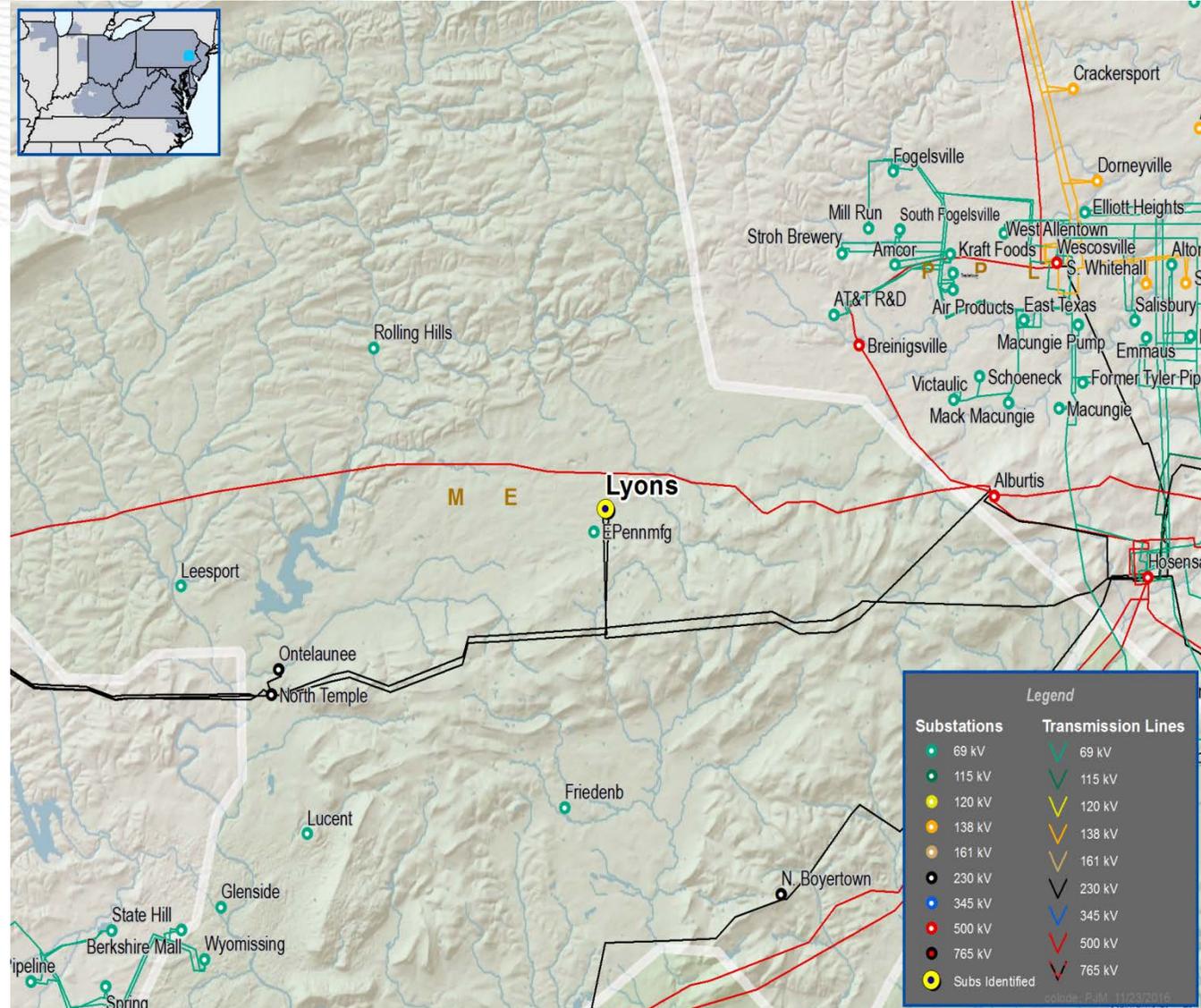
## Proposed Solution:

- Install a 3rd 230/69 kV 224 MVA Transformer at Lyons and install new terminal equipment for existing Lyons - East Penn(865) 69 kV Line. (B2814)

**Estimated Project Cost:** \$ 5.5 M

**Required IS Date:** 6/1/2019

**Expected IS Date:** 6/1/2019



## Cost Change for B2588 Upgrade

### Problem:

- Voltage drop and voltage magnitude violations at the Glendon 115 kV station for the N-1-1 contingency loss of the Northwood – Quarry 230 kV circuit, Northwood 230/115 kV transformer, and Portland – North Bangor 115 kV circuit.

### Proposed Solution:

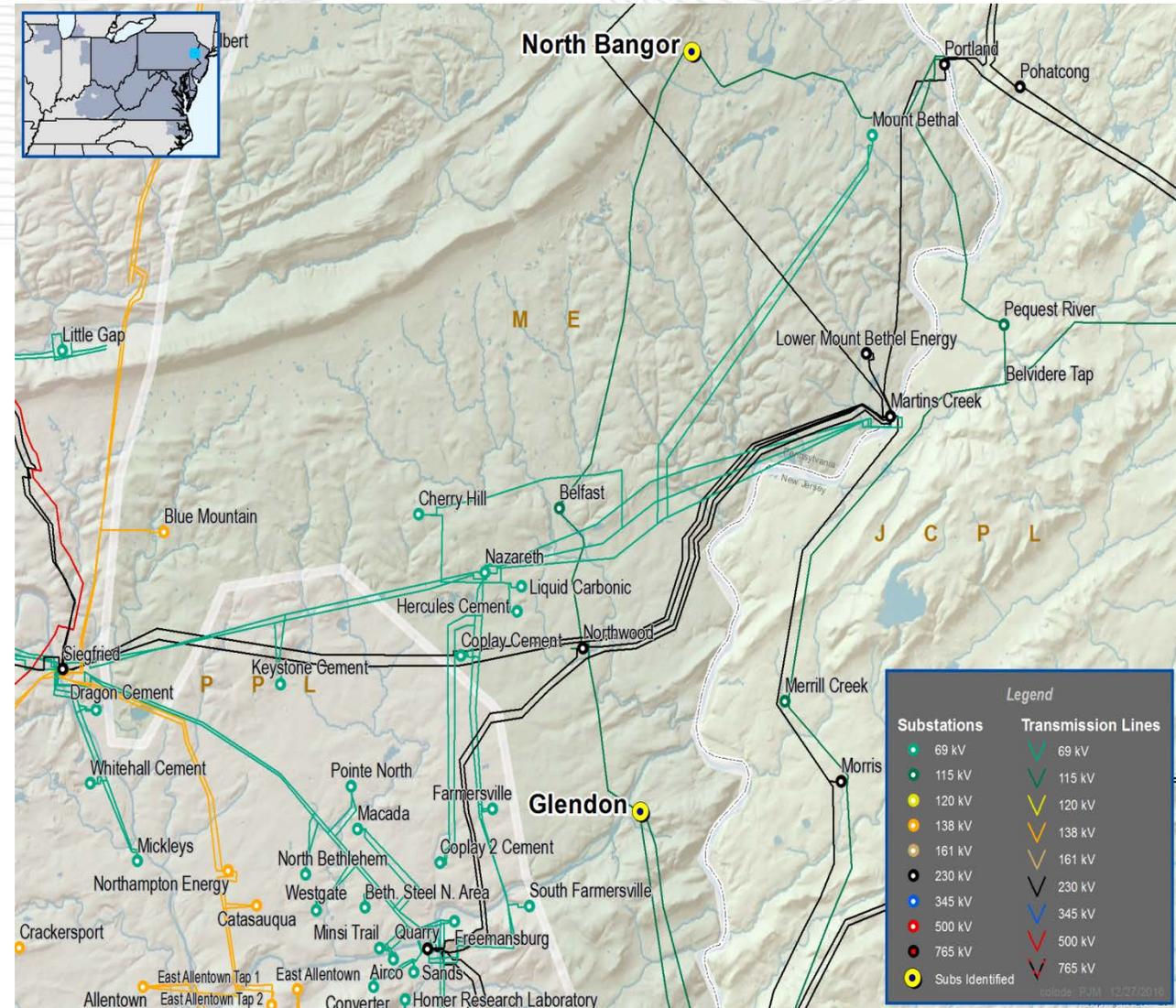
- Install a 36.6 MVAR 115 kV capacitor at the North Bangor substation
- Installing the capacitor requires reconfiguring the North Bangor 115 substation to ring bus configuration, the original cost didn't take the substation work into consideration.

**Old Estimated Project Cost: \$0.98 M**

**New Estimated Project Cost: \$6.5 M**

**Required IS Date:**

6/1/2019



## N-1 First Energy Planning Criteria (FERC Form 715):

- The Bethlehem to Leretto 46 kV circuit is overloaded for a single contingency loss of the Summit 115/46 kV transformer and the Summit – Claysburg, Summit – C. Slope 115 kV circuits.
- The facility is overloaded due to revised load forecast and modeling

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

## Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

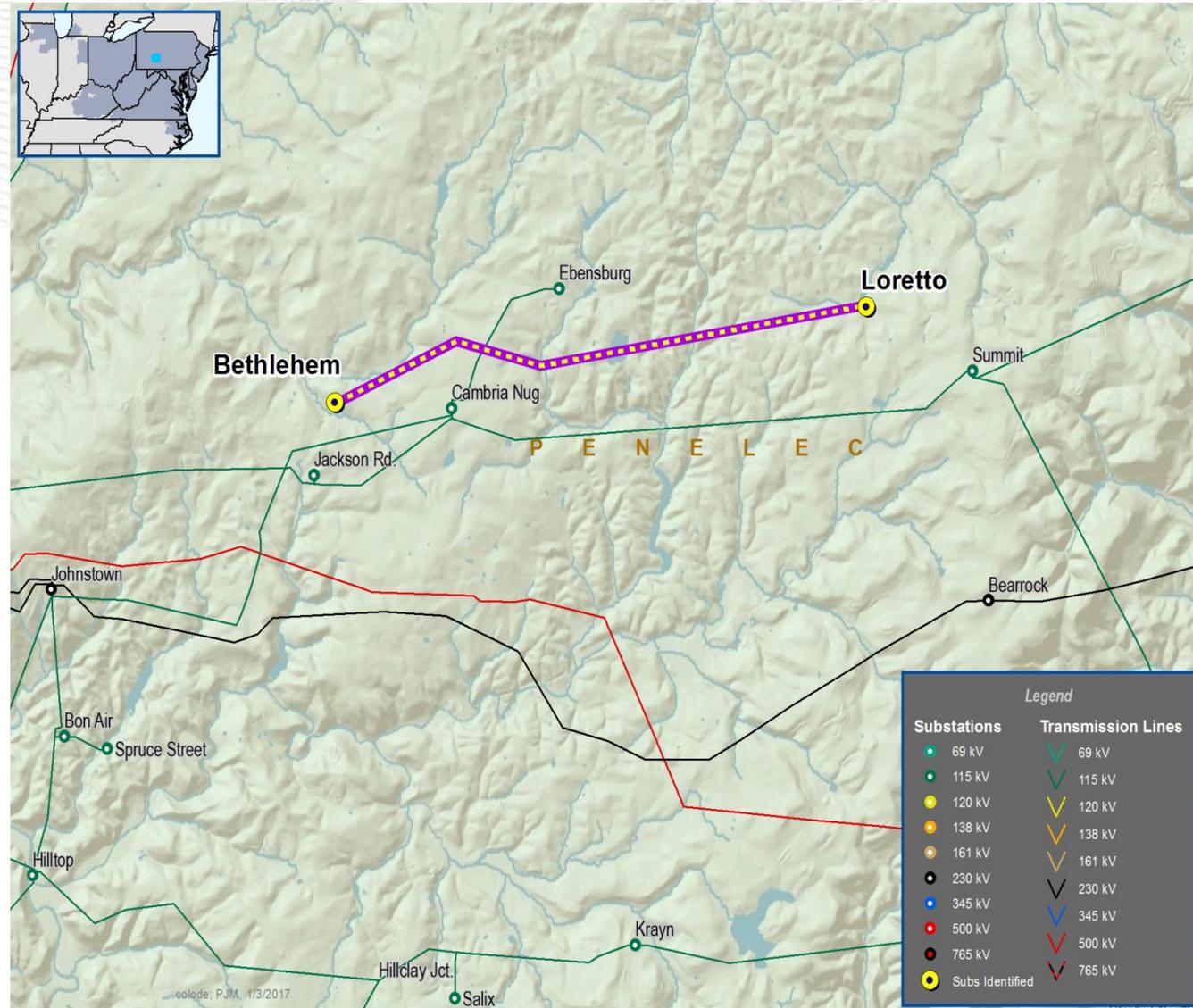
## Proposed Solution:

- Reconductor 3.7 miles of the Bethlehem to Leretto 46 kV circuit and replace terminal equipment at Summit 46 kV. (B2803)

**Estimated Project Cost:** \$ 4.0 M

**Required IS Date:** 6/1/2017

**Expected IS Date:** 12/1/2017



## N-1 First Energy Planning Criteria (FERC Form 715):

- The Huntingdon to C Tap 46 kV circuit is overloaded for single contingency loss of the Huntingdon – Raystown 46 kV circuit.
- The facility is overloaded due to revised load forecast and modeling

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

## Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

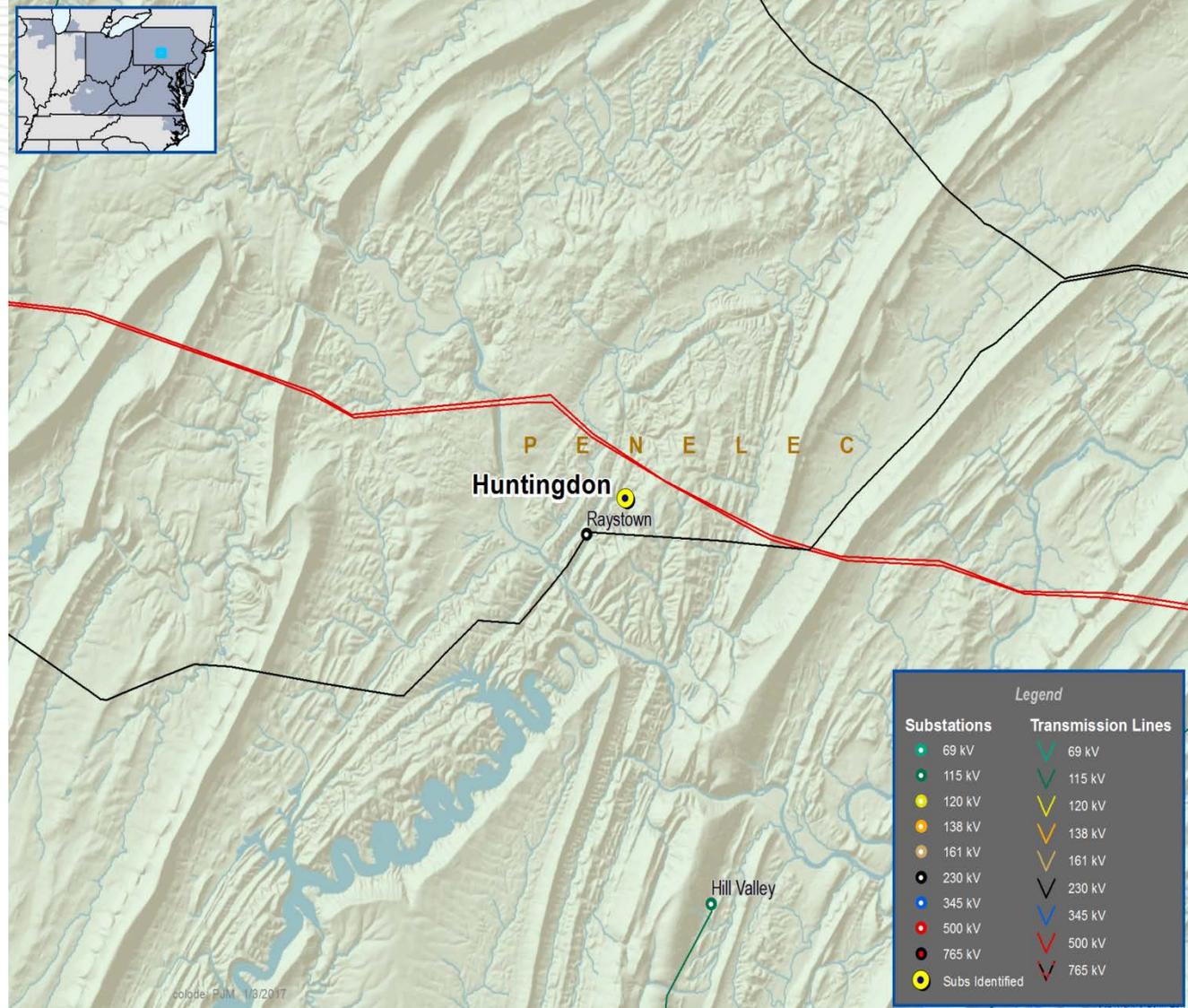
## Proposed Solution:

- Install a new relay and replace 4/0 CU bus conductor at Huntingdon 46 kV station: on the Huntingdon - C tap 46 kV circuit . (B2804)

**Estimated Project Cost:** \$ 0.5 M

**Required IS Date:** 6/1/2017

**Expected IS Date:** 12/1/2017



## N-1 First Energy Planning Criteria (FERC Form 715):

- The Hollidaysburg - HCR Tap 46 kV circuit is overloaded for single contingency loss of the Bear Rock – Johnstown 230 kV circuit.
- The facility is overloaded due to revised load forecast and modeling

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

## Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

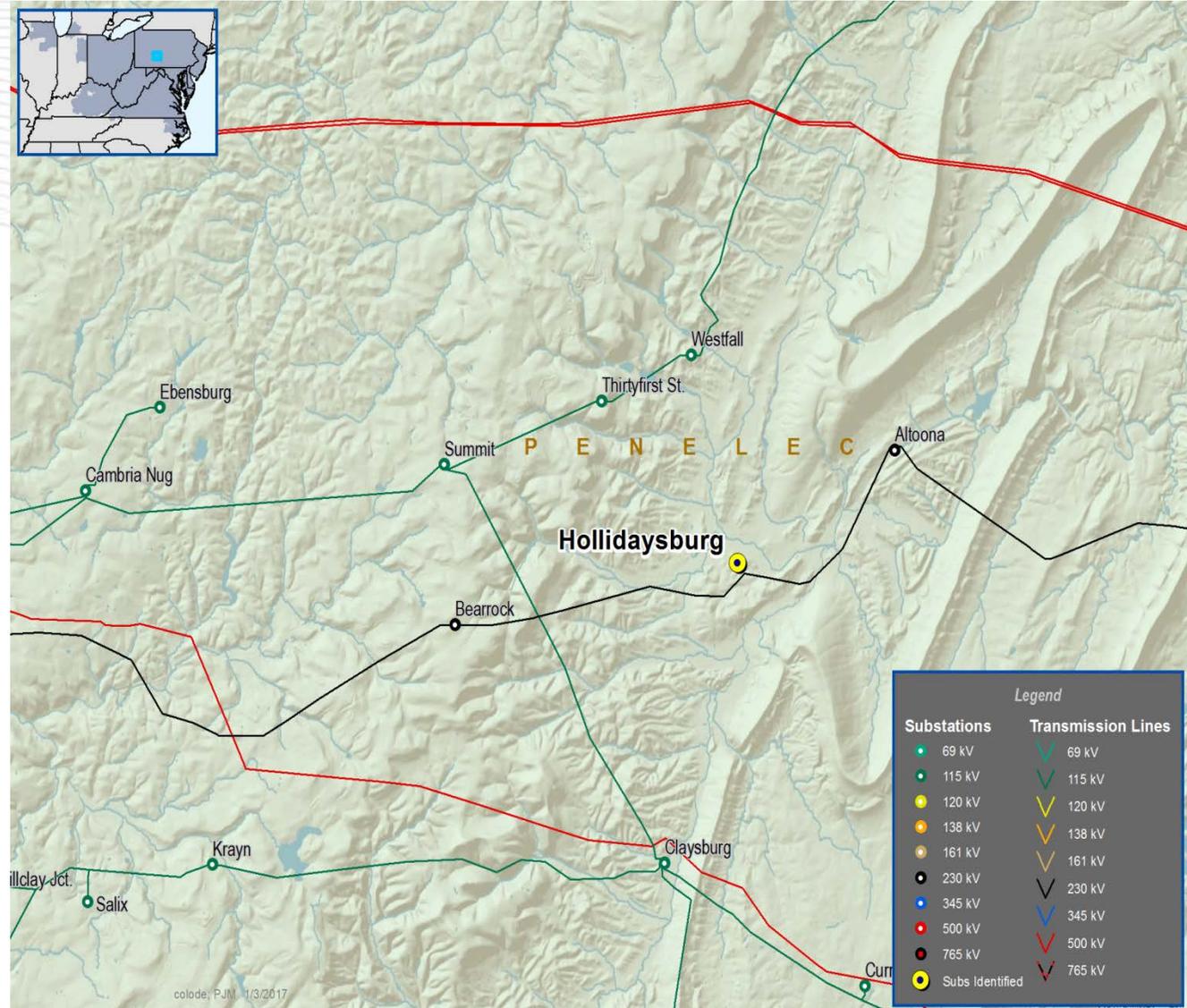
## Proposed Solution:

- Install a new relay and replace 4/0 CU & 250 CU substation conductor at Hollidaysburg 46 kV station: on the Hollidaysburg - HCR Tap 46 kV circuit. (B2805)

**Estimated Project Cost:** \$ 0.5 M

**Required IS Date:** 6/1/2017

**Expected IS Date:** 12/1/2017



## N-1 First Energy Planning Criteria (FERC Form 715):

- The Raystown - Smithfield 46 kV circuit is overloaded for single contingency loss of the Huntingdon – Raystown 46 kV circuit.
- The facility is overloaded due to revised load forecast and modeling

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

## Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

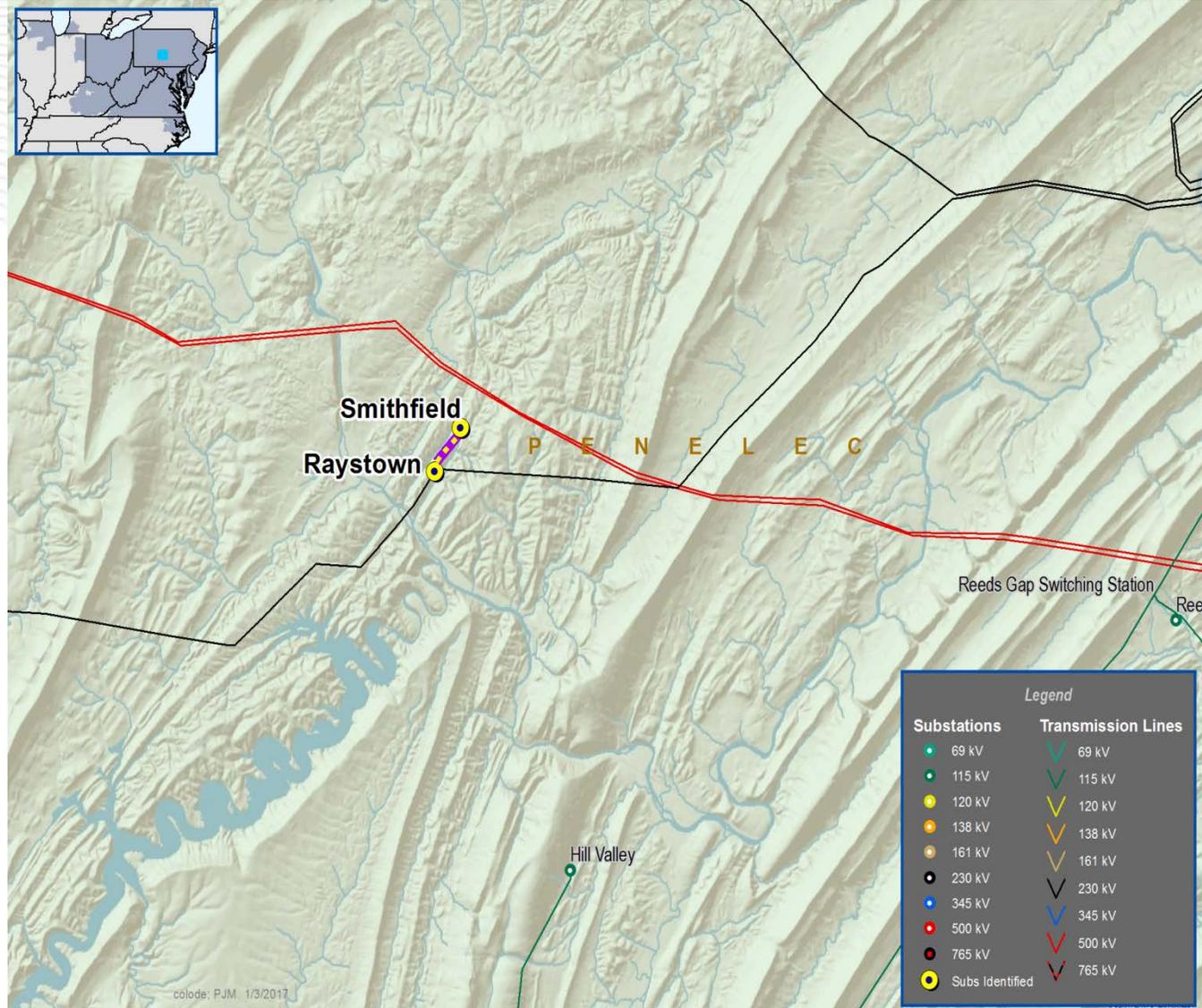
## Proposed Solution:

- Install a new relay and replace meter at the Raystown 46 kV substation: on the Raystown - Smithfield 46 kV circuit. (B2806)

**Estimated Project Cost:** \$ 0.5 M

**Required IS Date:** 6/1/2017

**Expected IS Date:** 12/1/2017



## N-1 First Energy Planning Criteria (FERC Form 715):

- The Eldorado - Gallitzin 46 kV circuit. is overloaded for single contingency loss of the Bear Rock – Johnstown 230 kV circuit.
- The facility is overloaded due to revised load forecast and modeling

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

## Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

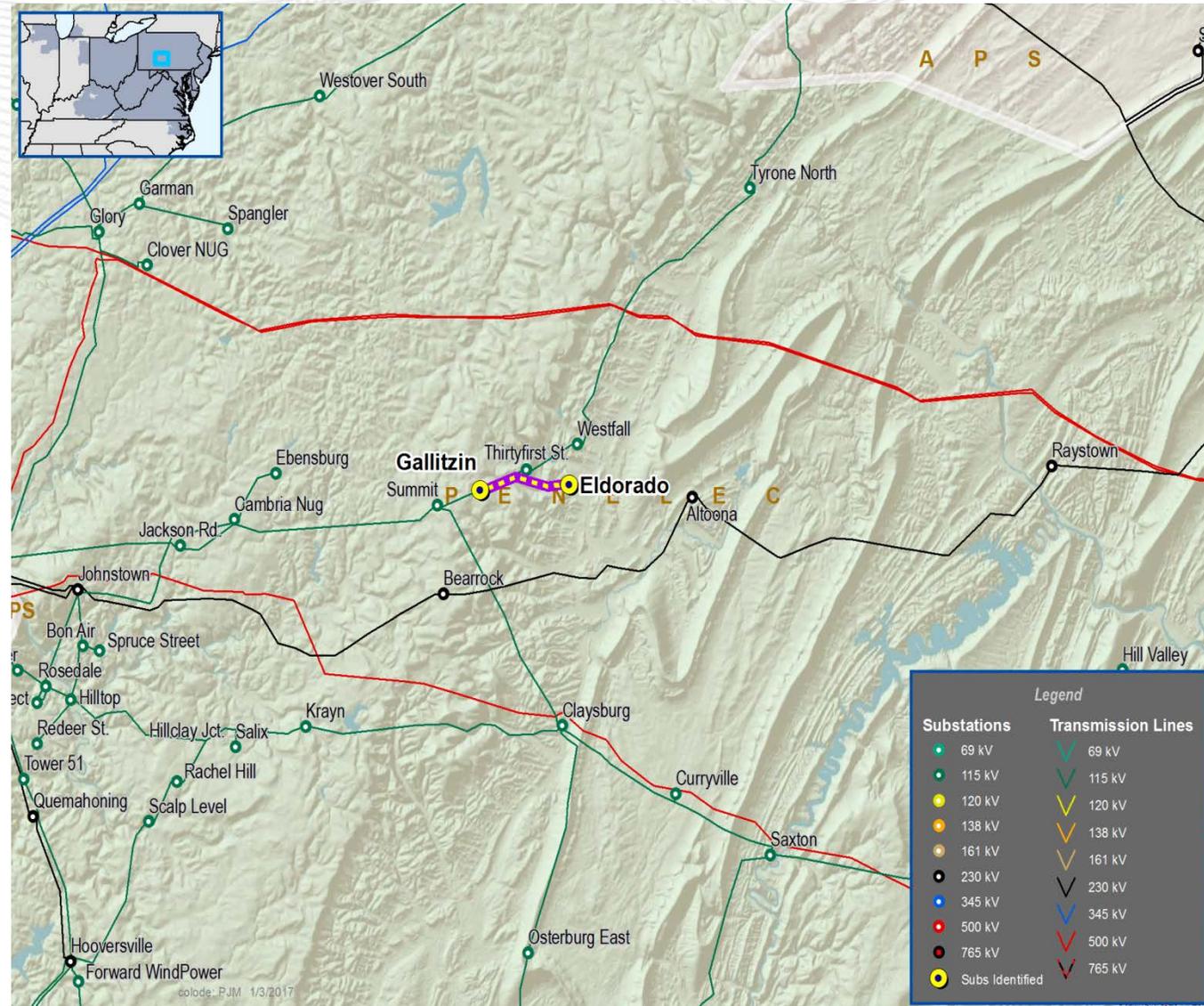
## Proposed Solution:

- Replace the CHPV and CRS relay, and adjust the IAC overcurrent relay trip setting; or replace the relay at Eldorado 46 kV substation: on the Eldorado - Gallitzin 46 kV circuit. (B2807)

**Estimated Project Cost:** \$ 0.3 M

**Required IS Date:** 6/1/2017

**Expected IS Date:** 12/1/2017



## N-1 First Energy Planning Criteria (FERC Form 715):

- The Raystown - Huntingdon 46 kV circuit is overloaded for single contingency loss of the Hill Valley - Huntingdon - Raystown 46kV circuit.
- The facility is overloaded due to revised load forecast and modeling

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

## Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

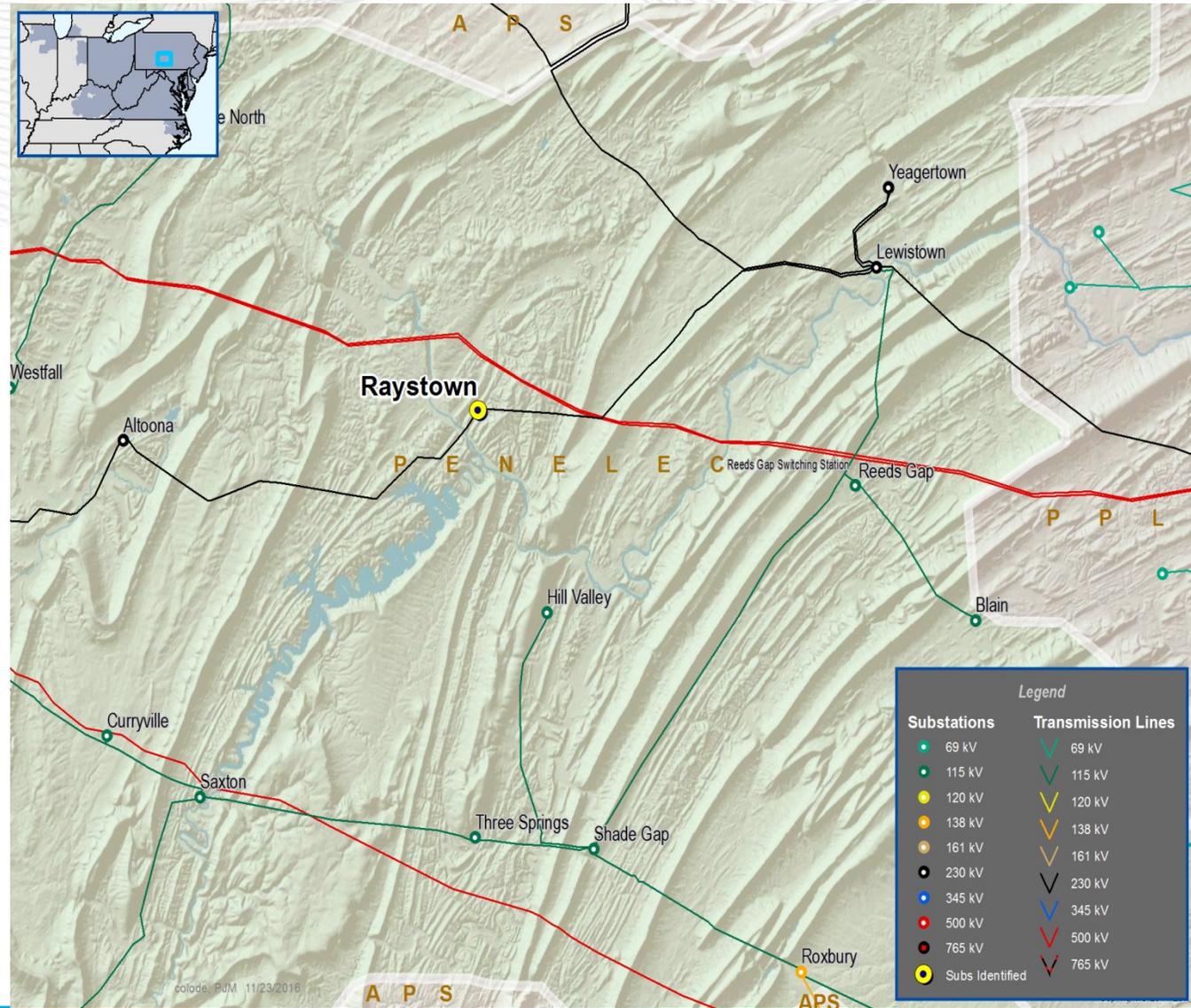
## Proposed Solution:

- Adjust the JBC overcurrent relay trip setting at Raystown, and replace relay and 4/0 CU bus conductor at Huntingdon 46 kV substations: on the Raystown - Huntingdon 46 kV circuit. (B2808)

**Estimated Project Cost:** \$ 0.3 M

**Required IS Date:** 6/1/2017

**Expected IS Date:** 12/1/2017



## PPL Planning Criteria (FERC Form 715):

- A stuck 69 kV bus section Circuit Breaker in the Lycoming 69 kV yard or a bus section failure in the Lycoming 69kV yard leads to more than acceptable (5 %) voltage drop and creates less than acceptable minimum voltage (0.90 pu).
- PPL TO Criteria for 69 kV System- No more than 5% voltage drop and not less than 0.90 pu voltage for P2-2 (bus section fault) or P4-6 contingency (stuck bus section Circuit Breaker).
- The above PPL criteria was filed with FERC on April 2016.

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PPL (Local TO) will be the Designated Entity

## Alternatives Considered:

- Building a new 230-69 kV regional substation and more than 50 miles of double circuit 230 kV line is the other possible alternatives to resolve this problem. However this alternative is not considered due to higher cost (\$188 M).

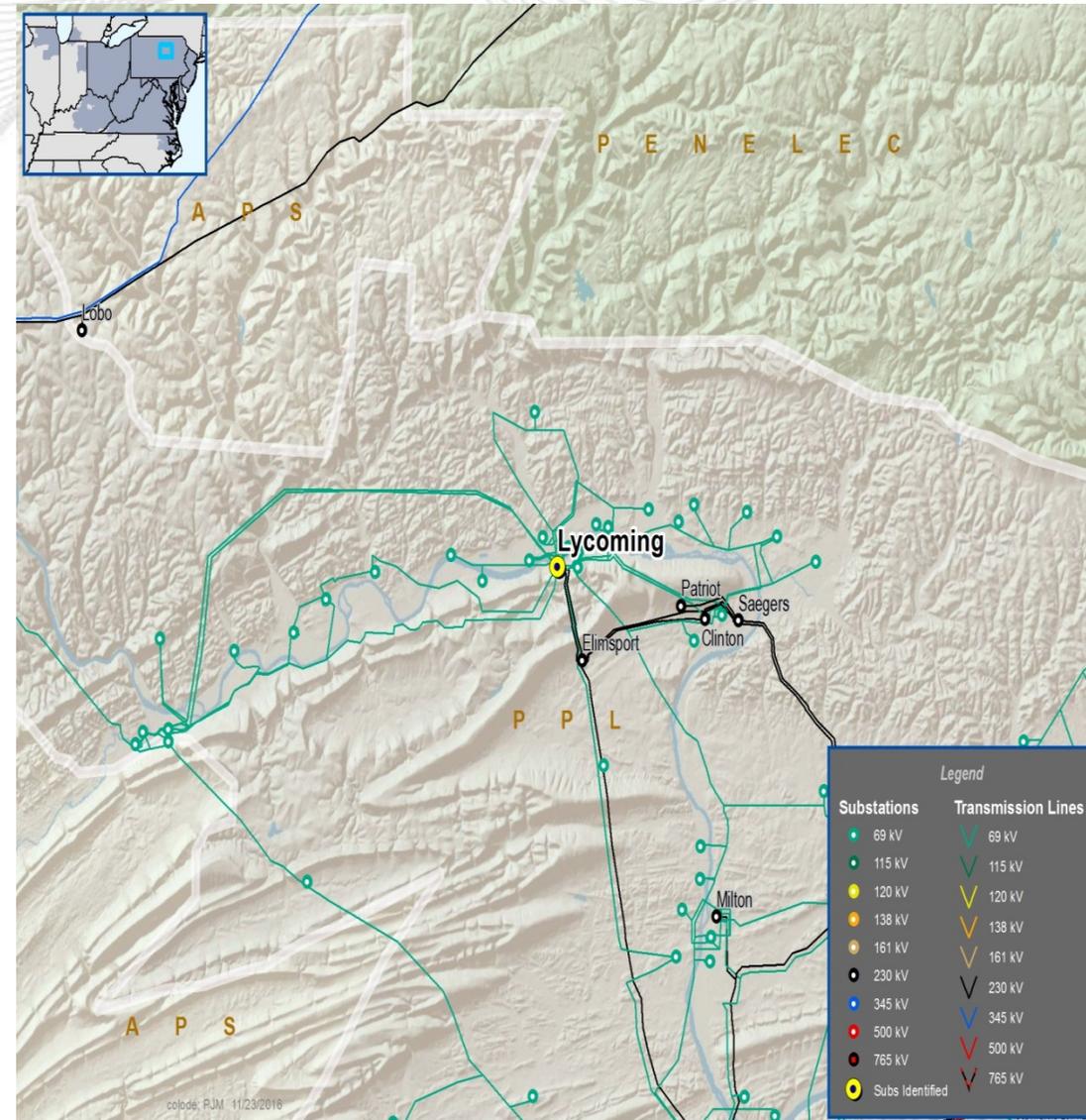
## Proposed Solution:

- Expand existing Lycoming 69kV yard to double bus double breaker arrangement. This will convert the substation from single operating bus to double bus configuration and will eliminate the risk of losing Lycoming source under a Stuck Circuit Breaker Contingency. **(B2813)**

**Estimated Project Cost:** \$ 22 M

**Required IS Date:** 6/1/2018

**Expected IS Date:** 11/30/2019





# PSEG Transmission Zone

## N-1-1 PSEG Planning Criteria (FERC Form 715):

- Great Notch currently has two 69kV circuits as its supply.
- During an N-1-1 contingency event, Great Notch 69kV substation loses its electric supply, which is a violation of PSEG's FERC 715 Planning Criteria.

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PSEG (Local TO) will be the Designated Entity

## Alternatives:

- Connect Great Notch to Jackson Rd. 69kV station. This route is much longer and will require major highway and river crossings. Estimated Project Cost: >\$48M

## Proposed Solution:

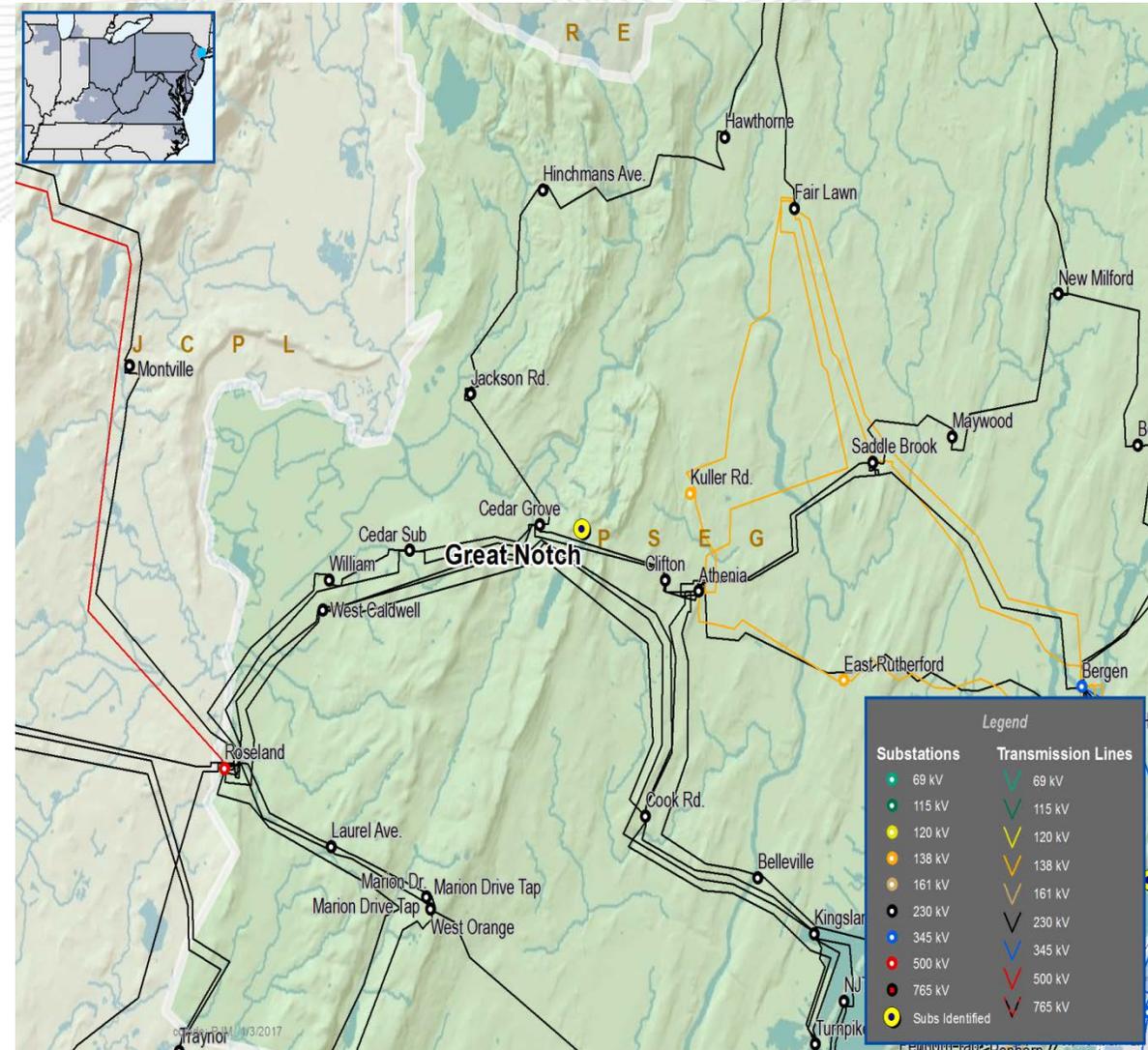
- Install second 230/69kV Transformer at Cedar Grove. (B2810.1)
- Build a new line between Cedar Grove 69kV and Great Notch 69kV. (B2810.2)

**Estimated Project Cost:** \$44M

**Required IS Date:** 6/1/2019

**Expected IS Date:** 4/1/2019

**Project Status:** Study Stage





# PSEG Transmission Zone

## N-1-1 PSEG Planning Criteria (FERC Form 715):

- Tonnelle Avenue and River Road currently have two 69kV circuits as its supply.
- During an N-1-1 contingency event, Tonnelle Avenue and River Road 69kV substations lose their electric supply, which is a violation of PSEG's FERC 715 Planning Criteria.

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PSEG (Local TO) will be the Designated Entity

## Alternatives:

- Connect River Rd. to Union City 69 kV station. This route will be double the distance and will be all underground construction.
- This alternative would also include a second circuit to be added from Bergen SW to Tonnelle Ave. The GIS at Bergen SW would have to be expanded. Estimated Project Cost: >\$40M

## Proposed Solution:

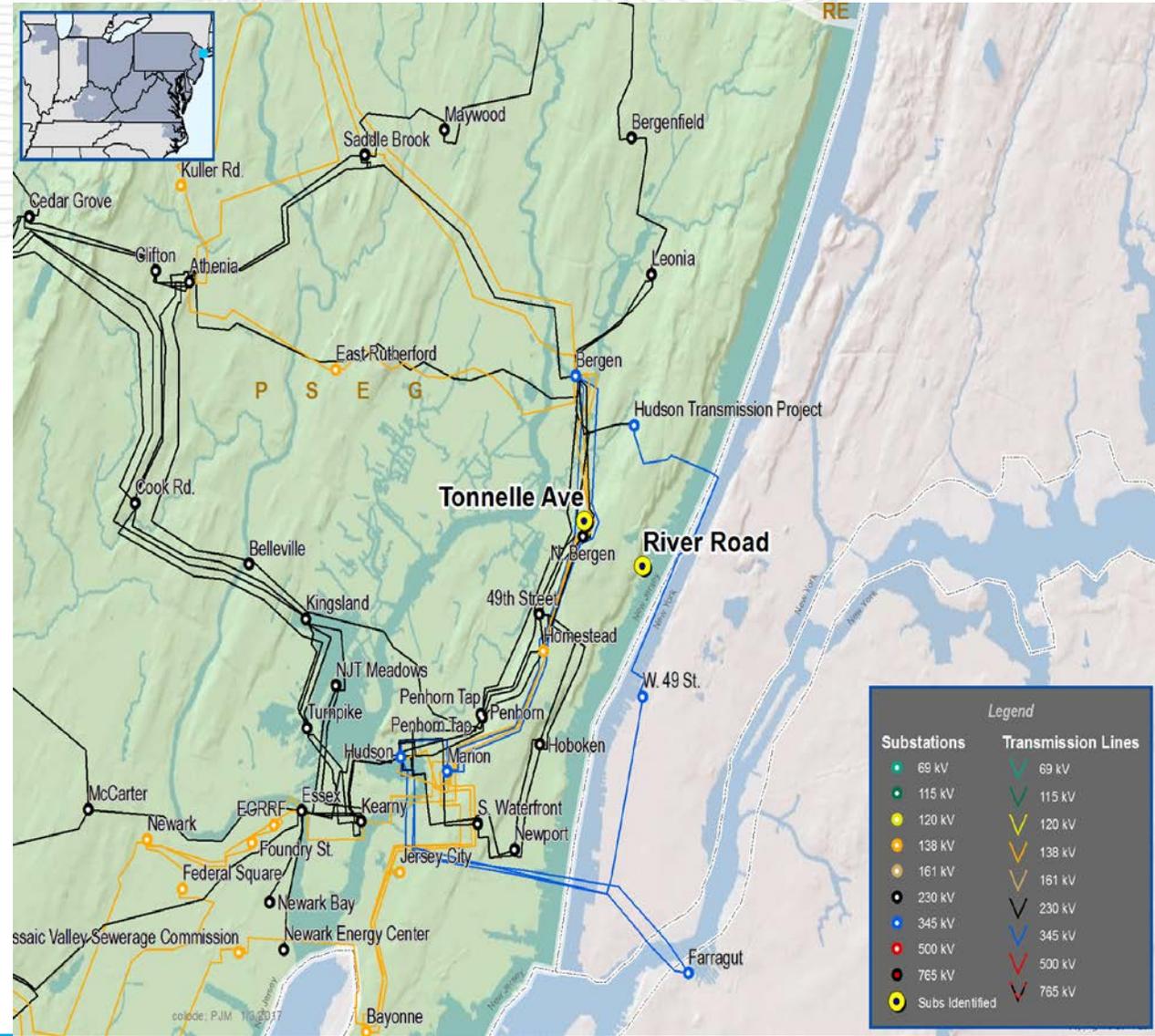
- Build a new line between Tonnelle Avenue and River Road . (B2812)

**Estimated Project Cost:** \$31M

**Required IS Date:** 6/1/2017

**Scheduled IS Date:** 4/1/2019

**Project Status:** Study Stage



## N-1-1 PSEG Planning Criteria (FERC Form 715):

- Delair and Locust Street currently have two 69kV circuits as its supply.
- Locust street is the main supply for load growth occurring in the Camden area.
- During an N-1-1 contingency event, Delair and Locust Street 69kV substations lose their electric supply, which is a violation of PSEG's FERC 715 Planning Criteria.

## Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PSEG (Local TO) will be the Designated Entity

## Alternatives:

- Connect Locust to East Riverton 69kV station. This route is approximately 60% longer. Estimated Project Cost: >\$20 M

## Proposed Solution:

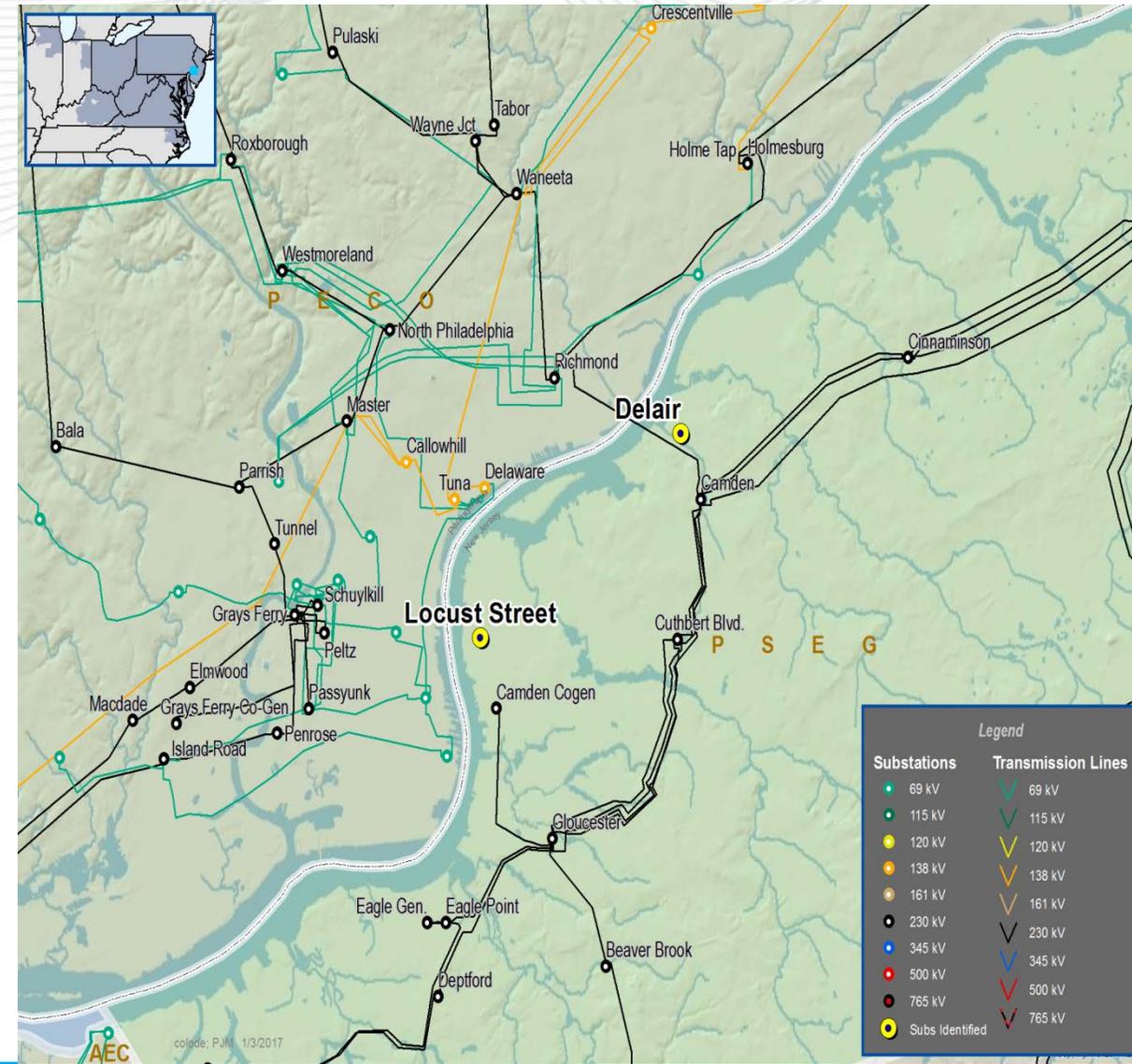
- Build a new line between Delair and Locust Street. (B2811)

**Estimated Project Cost:** \$13.5 M

**Required IS Date:** 6/1/2017

**Scheduled IS Date:** 6/1/2018

**Project Status:** Study Stage



## Project Cost Increase (B2750.1 and B2750.2)

B2750.1: Retire Betsy Layne station and replace it with the greenfield Stanville station about a half mile north of the existing Betsy Layne station.

B2750.2: Relocate the capacitor bank to the 69 kV bus at Stanville and increasing the size (the current 9.6 MVar capacitor at Betsy Layne is located on the 46 kV bus) to 14.4 MVar.

The cost for that project has increased after AEP finalized detailed scoping and engineering for the project.

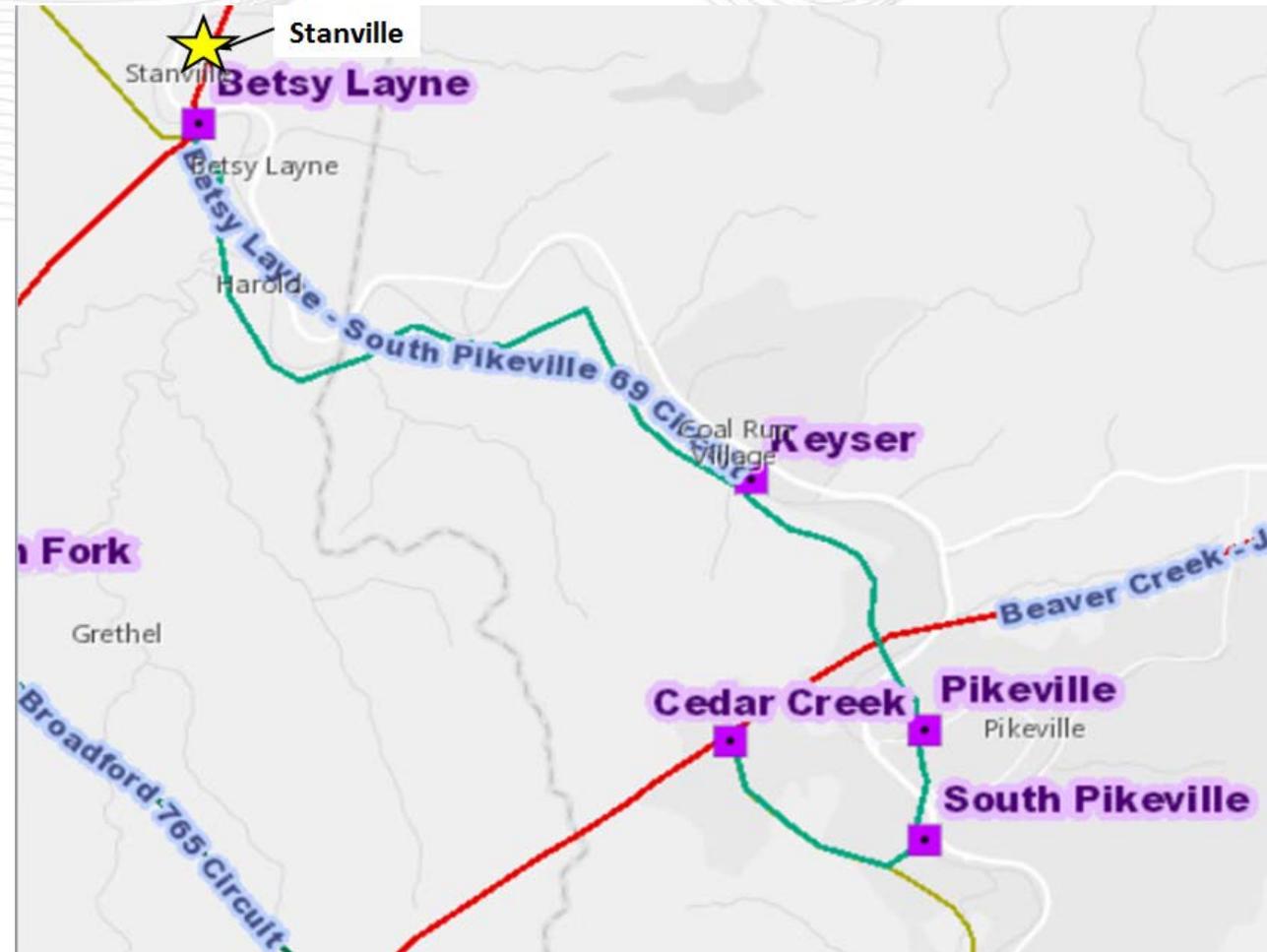
- The initial cost estimate did not have the benefit of detailed engineering and was therefore much lower than reality.
- The increase is driven mostly by the line work to connect the existing lines to the new station.
- The mountainous terrain surrounding both the Betsy Lane station and the new Stanville station site increased the line costs from an original ~\$2M estimate to now \$11M due to the number and size of structures required to cross the terrain.
- The greenfield station cost increased from \$10M to \$14M after detailed engineering.

**Old Estimated Project Cost:** \$14.0M

**New Estimated Project Cost:** \$28.1

**Required IS Date:** 12/1/2016

**Projected IS Date:** 12/1/2018



**Problem: Short Circuit**

- The Delaware 138 kV 'P' breaker is overstressed

**Proposed Solution:**

- Replace the Delaware 138 kV 'P' breaker with a 40 kA breaker (b2817)

**Immediate Need:**

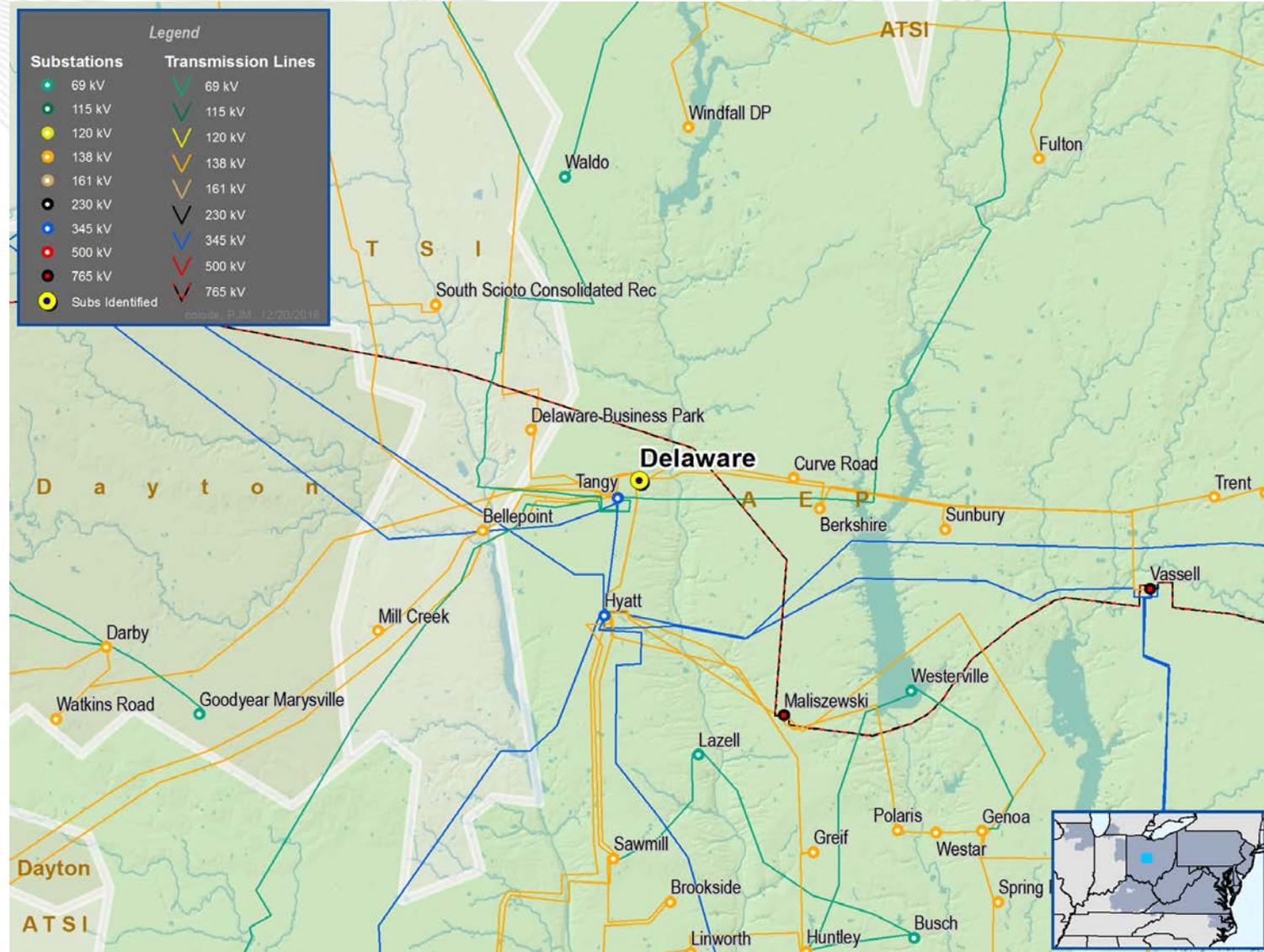
- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

**Alternatives Considered:**

- Due to the immediate need of the project no alternatives were considered

**Estimated Project Cost: \$1 M**

**Required IS Date: 6/1/2019**



**Problem: Short Circuit**

- The West Huntington 138 kV 'F' breaker is overstressed

**Proposed Solution:**

- Replace the West Huntington 138 kV 'F' breaker with a 40 kA breaker (b2818)

**Immediate Need:**

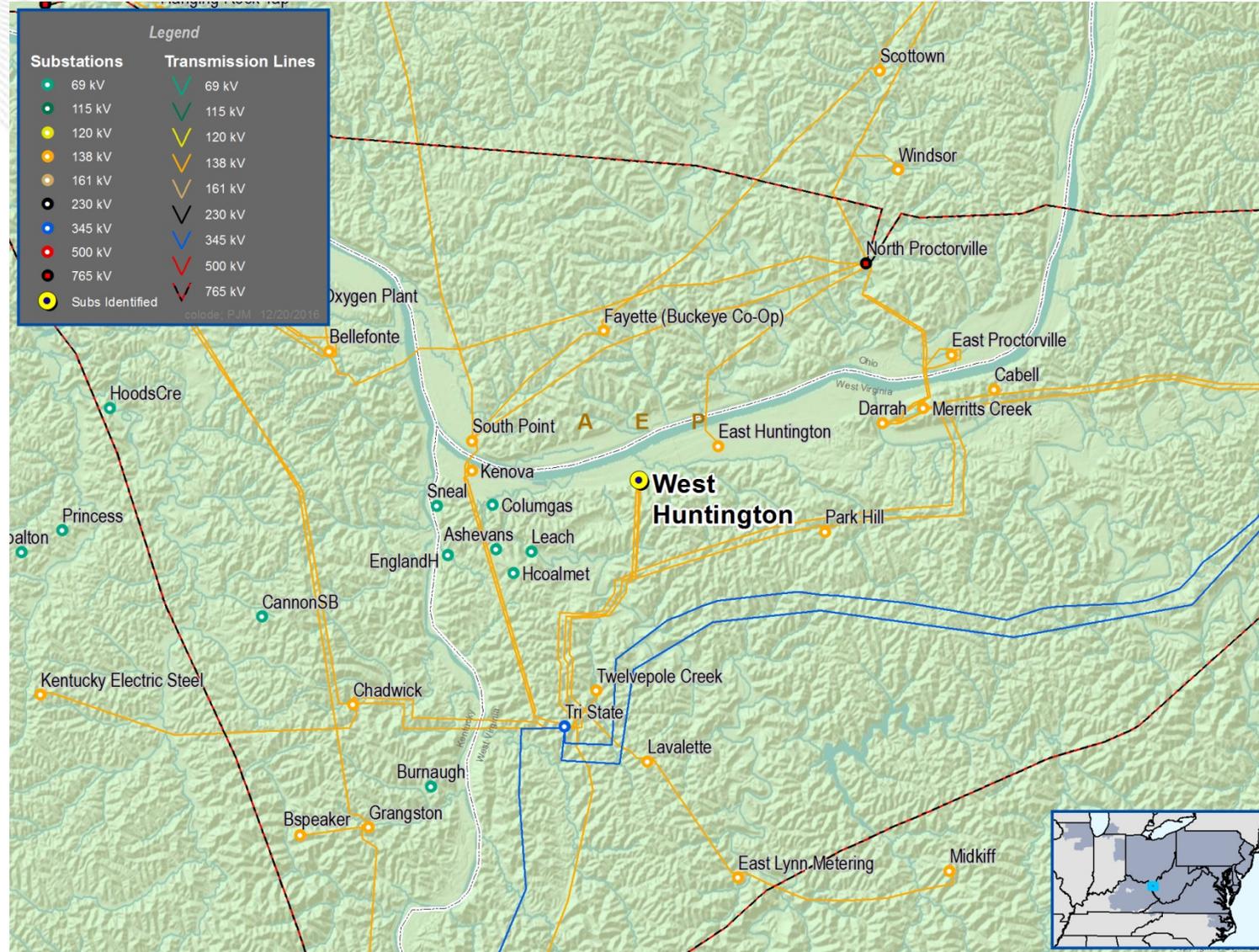
- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

**Alternatives Considered:**

- Due to the immediate need of the project no alternatives were considered

**Estimated Project Cost: \$1 M**

**Required IS Date: 6/1/2019**



**Problem: Short Circuit**

- The Madison 138 kV 'V' breaker is overstressed

**Proposed Solution:**

- Replace the Madison 138 kV 'V' breaker with a 63 kA breaker (b2819)

**Immediate Need:**

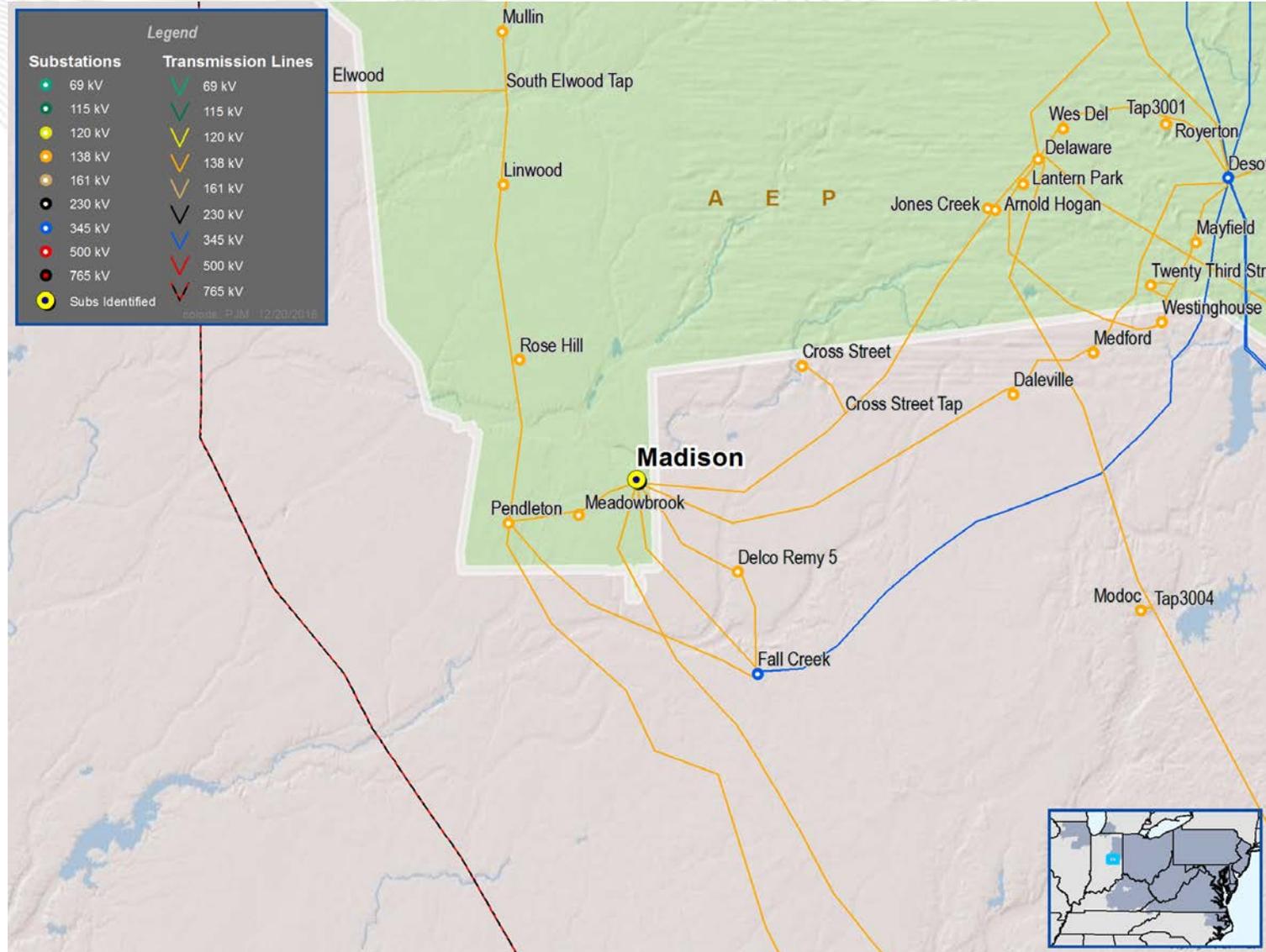
- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

**Alternatives Considered:**

- Due to the immediate need of the project no alternatives were considered

**Estimated Project Cost: \$1 M**

**Required IS Date: 6/1/2019**



**Problem: Short Circuit**

- The Sterling 138 kV 'G' breaker is overstressed

**Proposed Solution:**

- Replace the Sterling 138 kV 'G' breaker with a 40 kA breaker (b2820)

**Immediate Need:**

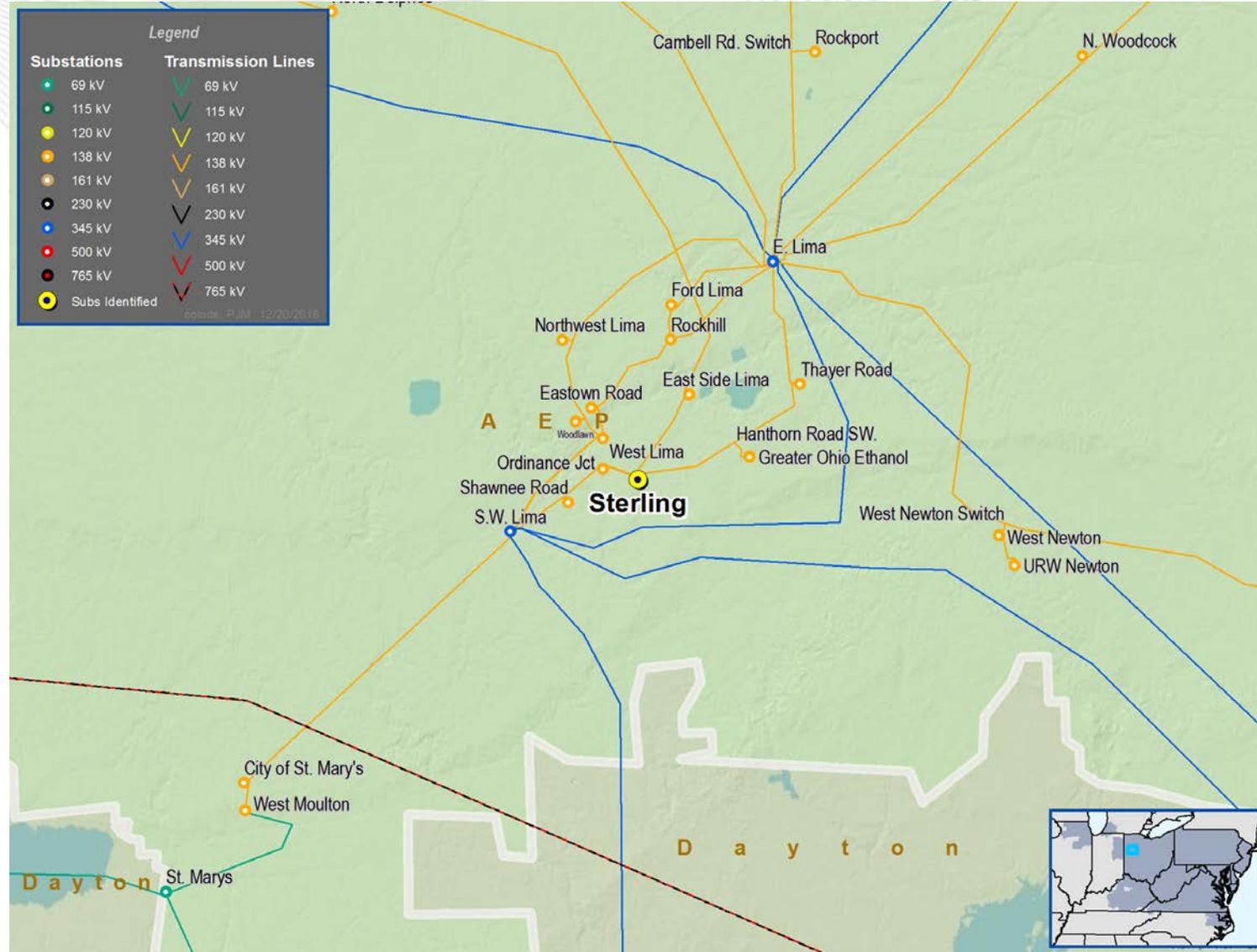
- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

**Alternatives Considered:**

- Due to the immediate need of the project no alternatives were considered

**Estimated Project Cost: \$1 M**

**Required IS Date: 6/1/2019**





**Problem: Short Circuit**

- The Clinton 138 kV '105' and '107' breakers are overstressed

**Proposed Solution:**

- Replace the Clinton 138 kV '105' and '107' breakers with 63 kA breakers (b2822)

**Immediate Need:**

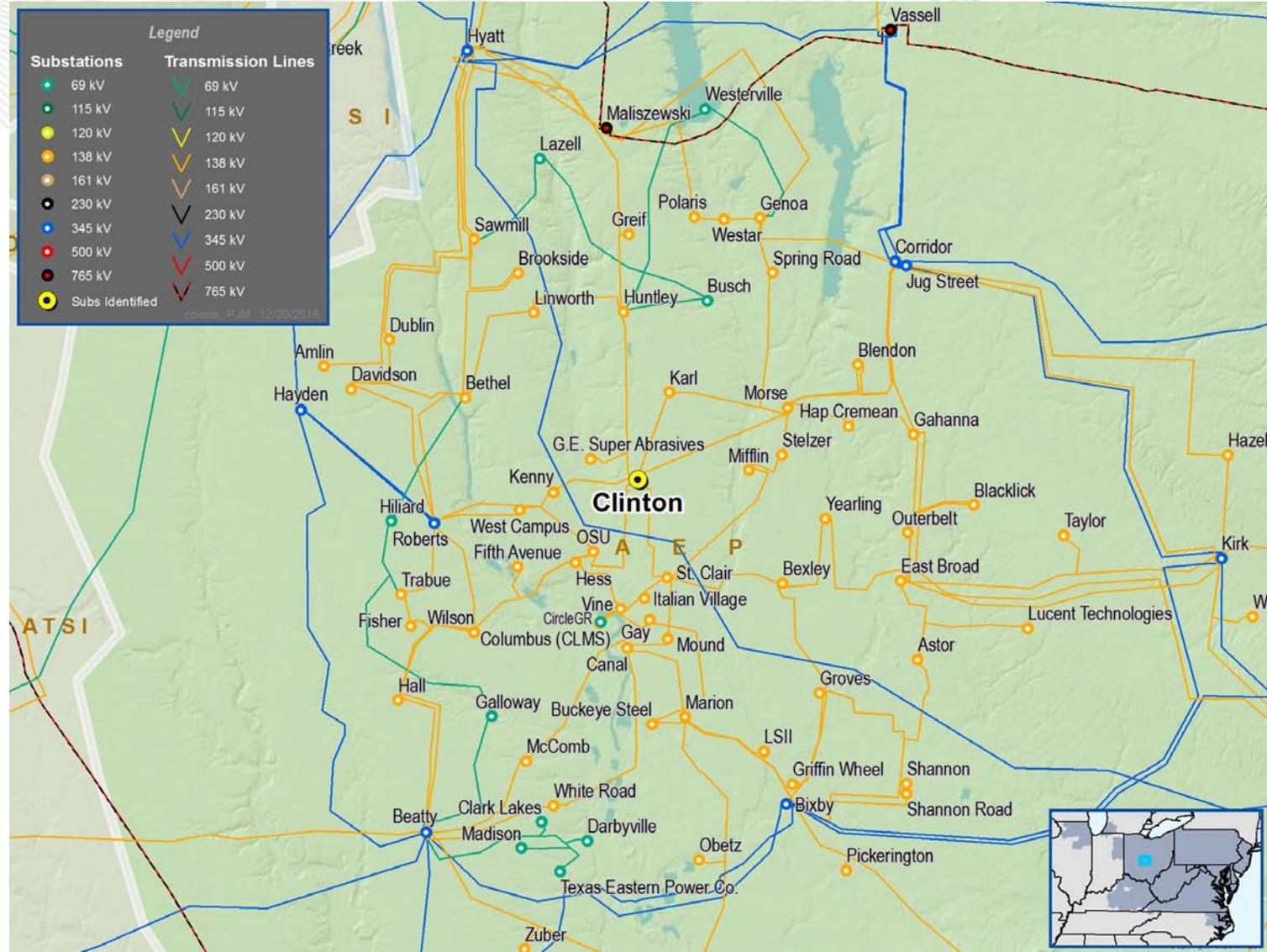
- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

**Alternatives Considered:**

- Due to the immediate need of the project no alternatives were considered

**Estimated Project Cost: \$1 M per breaker**

**Required IS Date: 6/1/2019**



**Problem: Short Circuit**

- The Ross 138 kV '106' breaker is overstressed

**Proposed Solution:**

- Replace the Ross 138 kV '106' breaker with a 40 kA breakers (b2823)

**Immediate Need:**

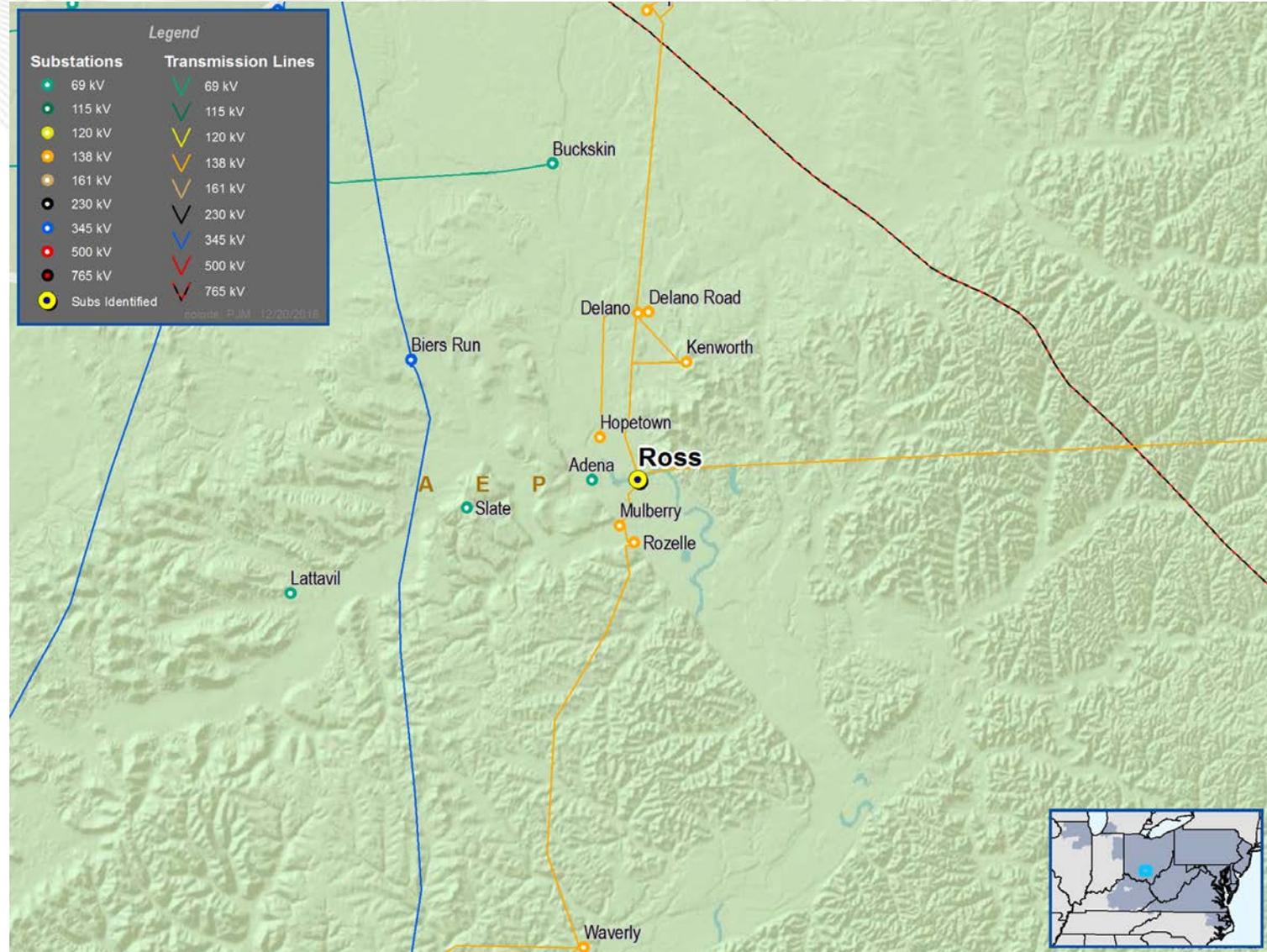
- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

**Alternatives Considered:**

- Due to the immediate need of the project no alternatives were considered

**Estimated Project Cost: \$1 M**

**Required IS Date: 6/1/2019**



- Revision History
  - V1 – 1/9/2017 – Original Version Posted to PJM.com
  - V2 – 1/10/2017
    - Modified map on slides #31 and 32
    - Added slides #13 and #14, and relocated Slides #11 and #13 to the Immediate Need section.
    - Added Slide #91 - anticipated Board Recommendation (including PSE&G shunt reactors)
    - Added slide #72 – Metuchen – Burlington (added Recommendation page)
    - Added slide #73 – 85 – Newark Switch discussion
    - Added slides #86 - 89 – Supplemental project discussion
    - Updated Contingency definition in Slides 100 and 102