



Reliability Analysis Update



Transmission Expansion Advisory
Committee

November 2, 2017

2017 Proposal Window #1 Update



Dominion Transmission Zone

Generation Deliverability (Summer) (GD-S126, GD-S585 and GD-S661):

Date Project Last Presented: 10/12/2017 TEAC

Problem Statement:

- The Pleasant View – Ashburn 230 kV is overloaded for single contingency loss of the (Brambleton – Yardley 230 kV, for a tower line outage loss of the (Brambleton – Yardley plus (Brambleton – Poland Rd. 230 kV circuits.
- The Ashburn - Beaumeade 230 kV is overloaded for a tower line outage loss of the (Brambleton – Yardley plus (Brambleton – Poland Rd. 230 kV circuits.

Alternatives considered:

- 2017_1-1A (\$4.52 M)
- 2017_1-1B (\$7.11 M)
- 2017_1-1C (\$3.05 M)
- 2017_1-7C (\$9.74 M)

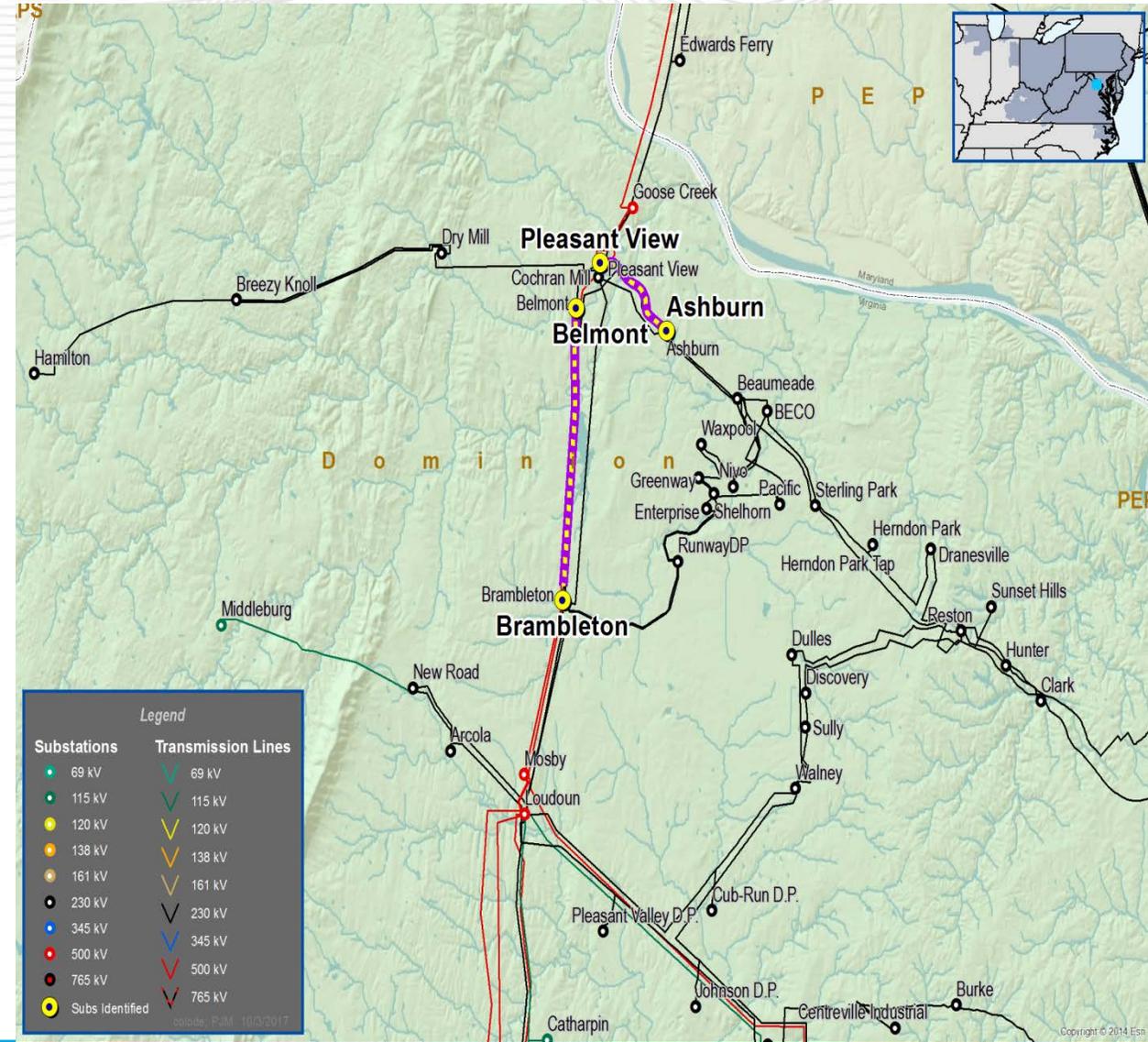
Recommended Solution :

- Split Line #227 (Brambleton – Beaumeade 230 kV)and terminate into existing Belmont substation. 2017_1-1C (**B2962**)

Estimated Project Cost: \$ 3.05 M

Required IS date: 6/1/2022

Project Status: Conceptual





Generation Deliverability (Summer) (GD-S107, GD-S159 and):

Date Project Last Presented: 10/12/2017 TEAC

Problem Statement:

- The Possum Point – Woodbridge – Occoquan 230 kV circuit is overloaded for single contingency loss of the Possum Point – Possum Creek - Woodbridge – E.P.G. – Hayfield 230 kV circuit.

Alternatives considered:

- 2017_1-1D (\$4.49 M)
- 2017_1-1E (\$4.96 M)
- 2017_1-1F (\$12.68 M)

Recommended Solution :

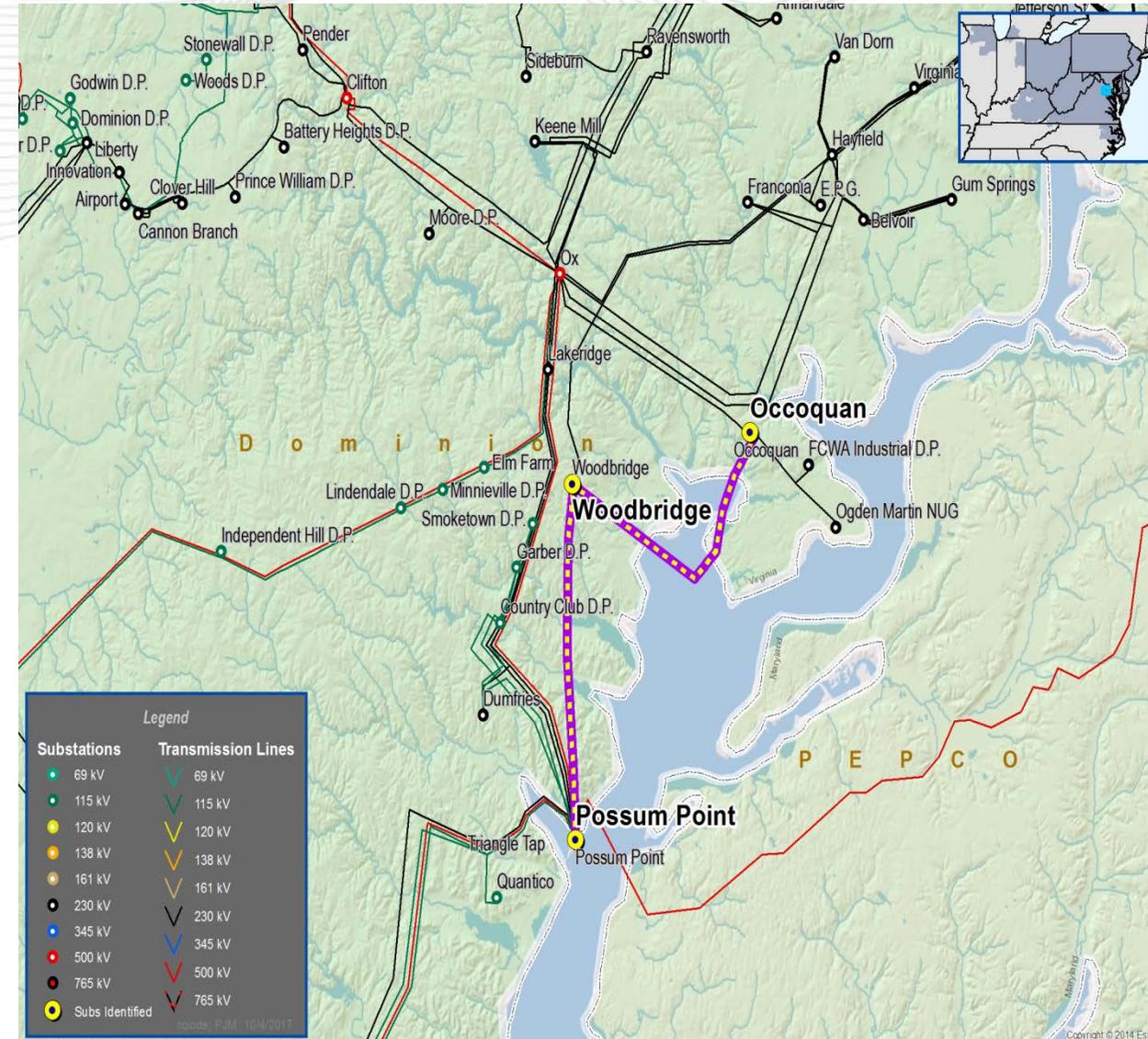
- Reconductor the Woodbridge to Occoquan 230kV line segment of Line 2001 with 1047 MVA conductor and replace line terminal equipment at Possum Point, Woodbridge, and Occoquan. 2017_1-1D (B2963)

Estimated Project Cost: \$ 4.49 M

Required IS date: 6/1/2022

Project Status: Conceptual

Dominion Transmission Zone





APS Transmission Zone

Generation Deliverability and Baseline (Summer), (GD-S579, GD-S587, and N1-S175):

Date Project Last Presented: 10/12/2017 TEAC

Problem Statement:

- The Pruntytown – White Hall Junction – McAlpin – Glen Falls 138 is overloaded for towerline outage loss of the Pruntytown – Maple Lake and Pruntytown – Shinns Run 138 kV circuits.

Alternatives considered:

- 2017_1-2A (\$39.1 M)
- 2017_1-5A (\$30.1 M)
- 2017_1-7E (\$34.74 M)
- 2017_1-10G (\$4.01 M)
- 2017_1-10H (\$11.1 M)
- 2017_1-10I (\$40.06 M)
- 2017_1-10J (\$34.82 M)

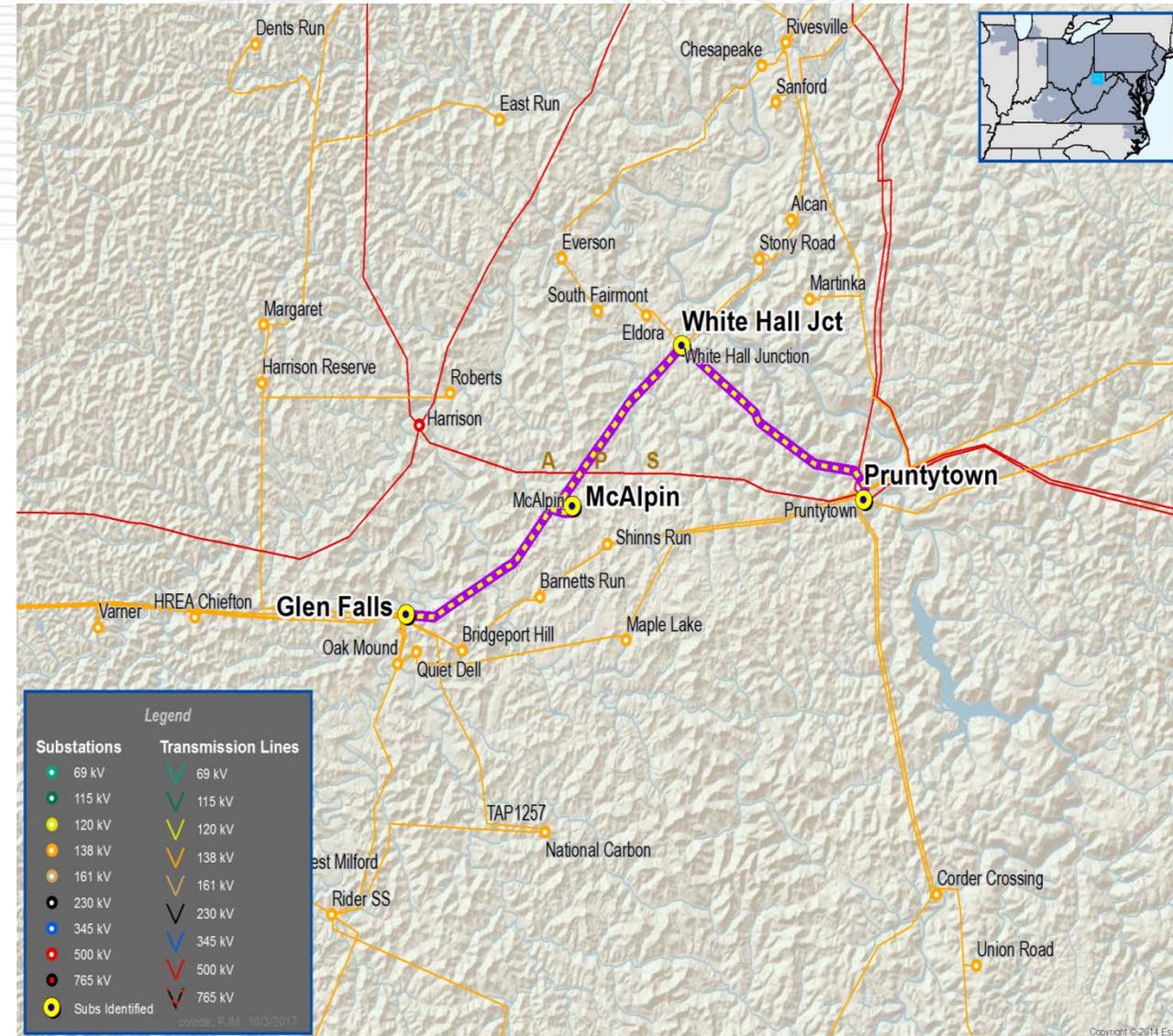
Recommended Solution :

- Replace terminal equipments at Pruntytown and Glen Falls 138 kV station. **(B2964.1)**
- Reconductor approximately 8.3 miles of the McAlpin - White Hall Junction 138 kV circuit. 2017_1-10G **(B2964.2)**

Estimated Project Cost: \$ 4.01 M

Required IS date: 6/1/2022

Project Status: Conceptual





APS Transmission Zone

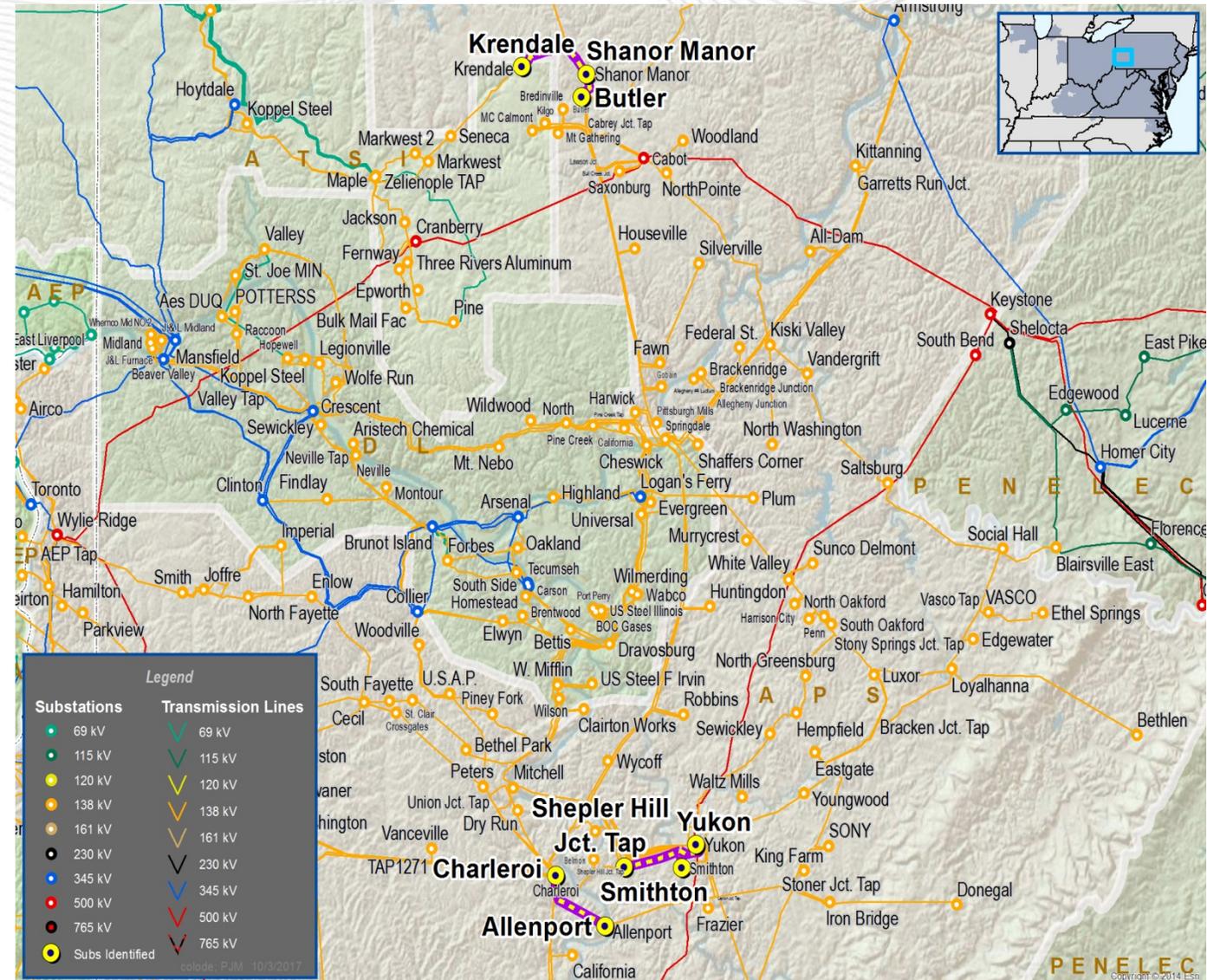
Generation Deliverability (Summer):

Date Project Last Presented: 10/12/2017 TEAC

Problem Statement:

- The Butler – Shanor Manor –Krendale 138 kV circuit for multiple contingencies. **(GD-S044, GD-S53, GD-S766, GD-S765, GD-S786 and GD-S787)**
- The Yukon – Smithon 138 kV circuit is overloaded for multiple contingencies. **(GD-S857, GD-S577 and GD-S578)**
- The Smithon – Shepler Hill Jct Tap 138 kV circuit is overloaded for tower line outages loss of the Charleroi – Yukon and Charleroi –Westraver 138 kV circuit OR loss of the Yukon – Chaleroi and Yukon – Westraver 138 kV circuits. **(GD-S583 and GD-S584)**
- The Allenport – Charleroi 138 kV circuit is overloaded for tower line outages loss of the Charleroi – Yukon and Charleroi –Westraver 138 kV circuit OR loss of the Yukon – Charleroi and Yukon – Westraver 138 kV circuits. **(GD-S581 and GD-S582)**

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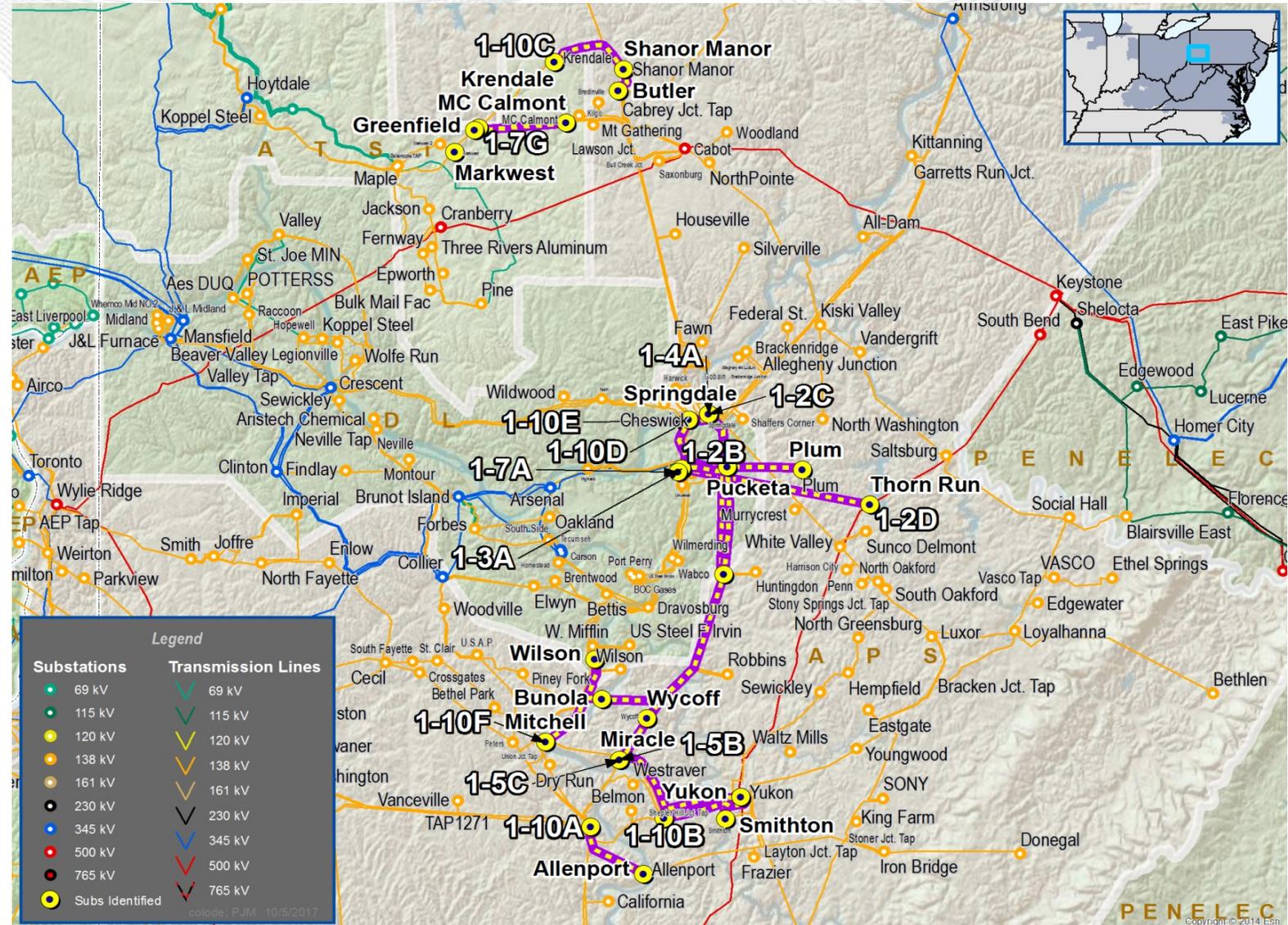
APS Transmission Zone

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**Generation Deliverability
 (Summer):**

Alternatives considered:

- 2017_1-2B (\$17 M)
- 2017_1-10A (\$7.08 M)
- 2017_1-2C (\$22.2 M)
- 2017_1-10B (\$3.19 M)
- 2017_1-2D (\$64.8 M)
- 2017_1-10C (\$6.96 M)
- 2017_1-3A (\$120.3 M)
- 2017_1-10D (\$0.12 M)
- 2017_1-4A (\$4.49 M)
- 2017_1-10E (\$2.69 M)
- 2017_1-5B (\$11.7 M)
- 2017_1-10F (\$23.4 M)
- 2017_1-5C (\$11.8 M)
- 2017_1-7A (\$29.46 M)
- 2017_1-7G (\$9.91 M)

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2022 Window 1 APS/Duquesne area proposals Comparison

Proposal ID	Type Of Upgrade	Proposing Entity	Project Cost Estimate (\$M)	FG #	Additional Issue
2017_1-10A	Upgrade	FirstEnergy	7.08	GD-S581, GD-S582	None
2017_1-10B	Upgrade	FirstEnergy	3.19	GD-S857, GD-S578, GD-S584, GD-S577, GD-S583	None
2017_1-10C	Upgrade	FirstEnergy	6.96	GD-S44, GD-S53, GD-S766, GD-S787, GD-S765, GD-S786	None
2017_1-10D	Upgrade	FirstEnergy	0.12	GD-S857, GD-S578, GD-S584, GD-S577, GD-S583, GD-S582, GD-S581	Springdale-Cheswick 138KV. Several Duquesne breakers overdutied
2017_1-10E	Upgrade	FirstEnergy	2.69	GD-S857, GD-S578, GD-S584, GD-S577, GD-S583, GD-S582, GD-S581	Springdale-Cheswick 138KV. Several Duquesne breakers overdutied
2017_1-2B	Greenfield	Northeast Transmission Development	17	GD-S857, GD-S578, GD-S582, GD-S584, GD-S577, GD-S581, GD-S583, GD-S44, GD-S53, GD-S766, GD-S787, GD-S765, GD-S786	Springdale - Pucketa 138kV #1&2 (approximately 2.5mi per circuit, \$2.5 M). Several Duquesne breakers overdutied
2017_1-5B	Greenfield	Nextera	11.7	GD-S581, GD-S582, GD-S577, GD-S857, GD-S578, GD-S583, GD-S584	Belmont - Charleroi 138 kV Miracle - Mitchell 138 kV
2017_1-5C	Greenfield	Nextera	11.8	GD-S581, GD-S582, GD-S577, GD-S857, GD-S578, GD-S583, GD-S584	Additional cost due to a low cost estimate for the incombant work (FE estimate is \$1.5M for the reconductor and \$0.7 M for the cut in and remote work)
2017_1-4A	Greenfield	Duquesne	4.49	GD-S577, GD-S578, GD-S581, GD-S582, GD-S583, GD-S584, GD-S857	Springdale-Plum 138KV Cheswick – Wycoff 138kV
2017_1-2C	Greenfield	Northeast Transmission Development	22.2	GD-S857, GD-S578, GD-S582, GD-S584, GD-S577, GD-S581, GD-S583, GD-S44, GD-S53, GD-S766, GD-S787, GD-S765, GD-S786	Several Duquesne breakers overdutied
2017_1-2D	Greenfield	Northeast Transmission Development	64.8	GD-S857, GD-S578, GD-S582, GD-S584, GD-S577, GD-S581, GD-S583, GD-S44, GD-S53, GD-S766, GD-S787, GD-S765, GD-S786	Cost not Competitive
2017_1-3A	Greenfield	PSEG	120.3	GD-S44, GD-S53, GD-S857, GD-S578, GD-S582, GD-S584, GD-S581, GD-S583, GD-S577, GD-S766, GD-S787, GD-S765, GD-S786	Cost not Competitive
2017_1-7A	Greenfield	Transource	29.46	GD-S44, GD-S53, GD-S857, GD-S578, GD-S582, GD-S584, GD-S581, GD-S583, GD-S577, GD-S766, GD-S787, GD-S765, GD-S786	Cost not Competitive
2017_1-7G	Greenfield	Transource	9.91	GD-S44, GD-S53, GD-S766, GD-S787, GD-S765, GD-S786	Cost not Competitive Short circuit under evaluation
2017_1-10F	Greenfield	FirstEnergy	23.4	GD-S857, GD-S578, GD-S584, GD-S577, GD-S583, GD-S582, GD-S581	Cost not Competitive



APS Transmission Zone

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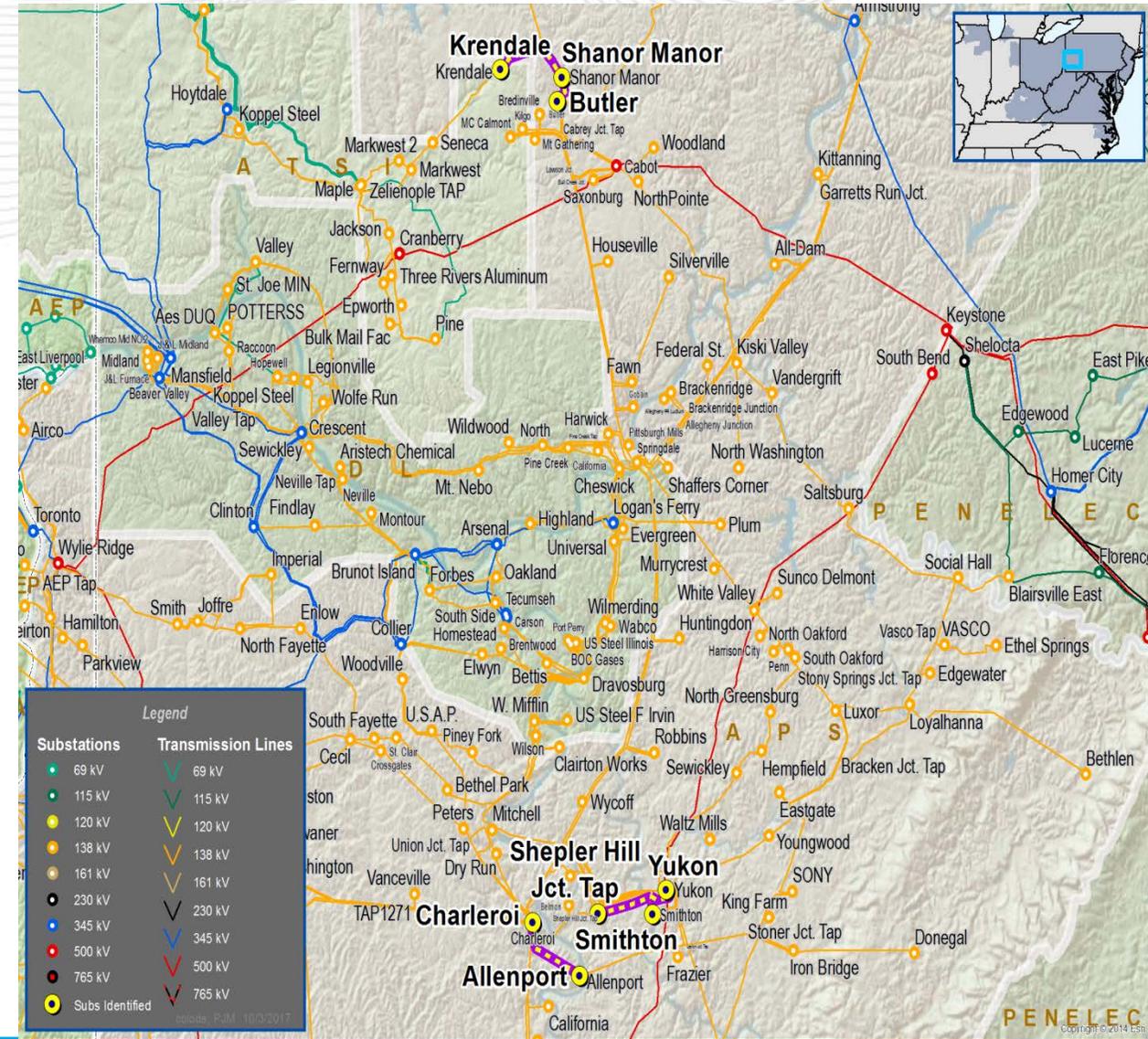
Recommended Solution:

- Reconductor the Charleroi –Allenport 138KV Line with 954 ACSR Conductor, Replace Breaker Risers at Charleroi and Allenport. (2017_1-10A). (B2965)
- Reconductor the Yukon - Smithton - Shepler Hill Jct 138 kV Line with 795 ACSS Conductor, Replace Line Disconnect Switch at Yukon. (2017_1-10B). (B2966)
- Convert the existing 6 wire Butler - Shanor Manor - Krendale 138 kV Line into two separate 138 kV lines. New lines will be Butler - Keisters and Butler - Shanor Manor - Krendale 138 kV. (2017_1-10C). (B2967)

Estimated Project Costs: \$ 7.08 M
 \$ 3.19 M
 \$ 6.96 M

Required IS date: 6/1/2022

Project Status: Conceptual





APS Transmission Zone

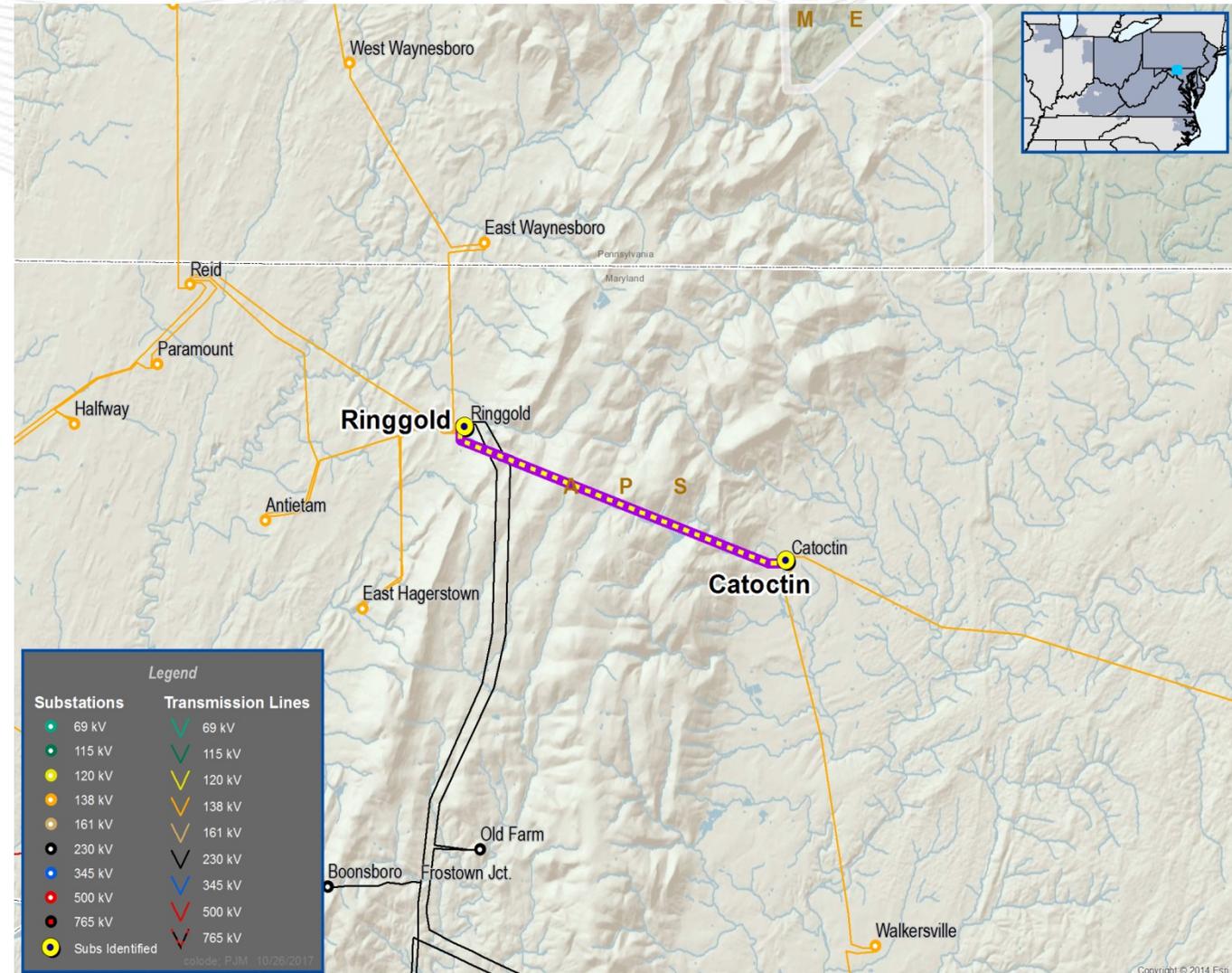
**Generation Deliverability (Summer & Winter) (GD-S80,GD-S82,GD-S702,GD-S699,GD-S700,GD-S703, GD-W421,GD-W422,GD-W89,GD-W419,GD-W420) ,
 Basecase Analysis (Summer & Winter) (N1-S131,N1-S132,N1-S134,N1-S135, N2-ST2,N2-ST3,N2-ST8,N2-ST9, N1-WT43,N1-WT44,N1-WT46,N1-WT47,GD-W91),
 N-1-1 Thermal (Summer) (N2-ST2,N2-ST3,N2-ST8,N2-ST9):**

Problem Statement:

- The Ringgold 230/138kV transformers #3 and #4 are overloaded for multiple contingencies.

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.

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Alternatives Considered:

Replacement of Ringgold 230/138 kV Transformers, which requests Non- standard FE transformer and there will be spare equipment issue.

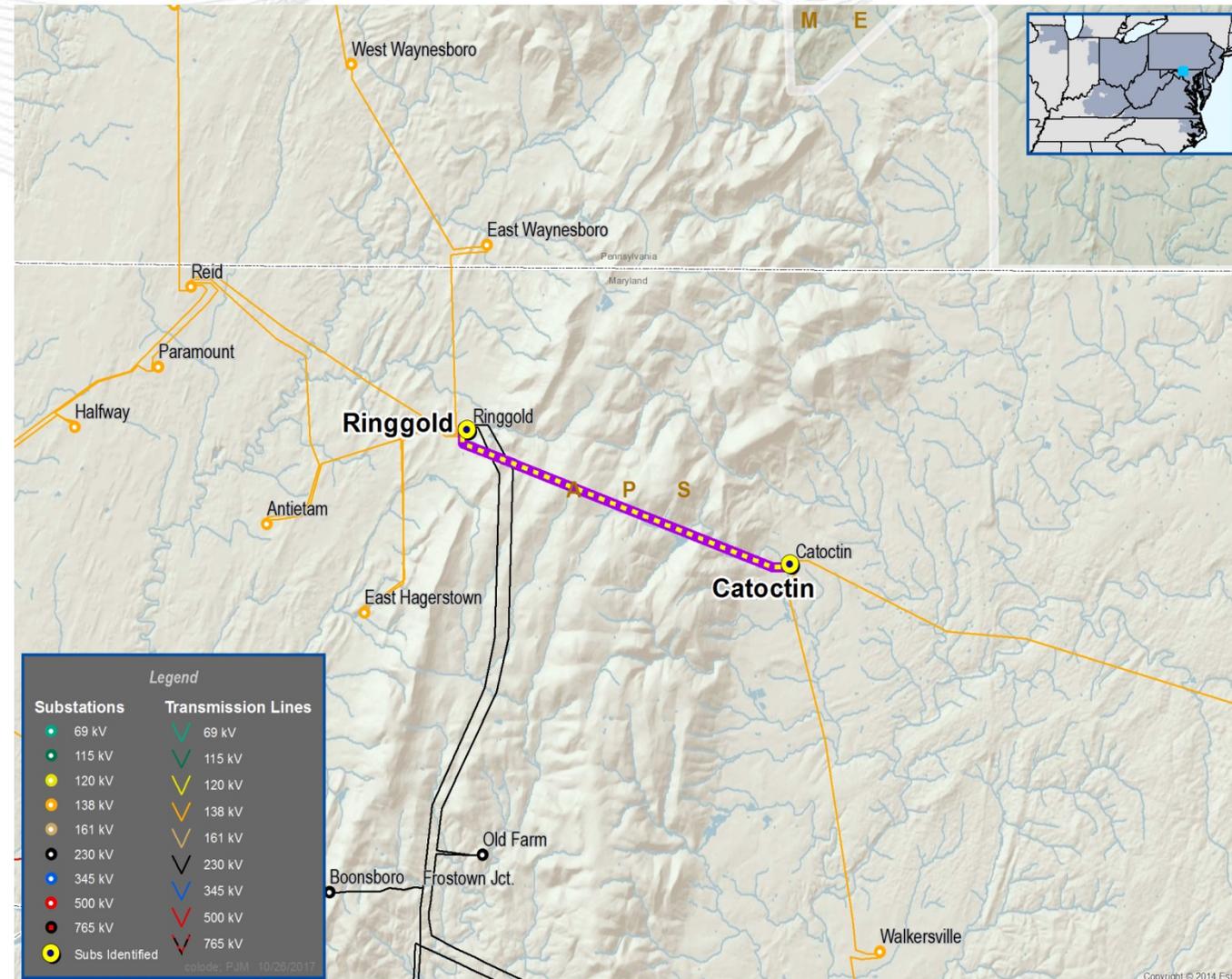
Recommended Solution :

- Install two new 230 kV positions at Ringgold for 230/138 kV transformers. **(B2970.1)**
- Install new 230 kV position for Ringgold – Catoctin 230 kV line. **(B2970.2)**
- Install one new 230 kV breaker at Catoctin substation. **(B2970.3)**
- Install new 230 / 138 kV transformer at Catoctin substation.
- Convert Ringgold-Catoctin 138 kV Line to 230 kV operation. **(B2970.4)**

Estimated Project Cost: \$ 13.33 M

Required IS date: 6/1/2020

Project Status: Conceptual





AEP Transmission Zone

Generation Deliverability (Winter) (GD-W92):
Date Project Last Presented: 10/12/2017 TEAC
Problem Statement:

- The Maddox – East Lima 345 kV line is overloaded for the loss of the Marysville – Sorenson 765KV line

Alternatives considered:

- 2017_1-8A (\$1.48 M)
- 2017_1-8B (\$111.64 M)

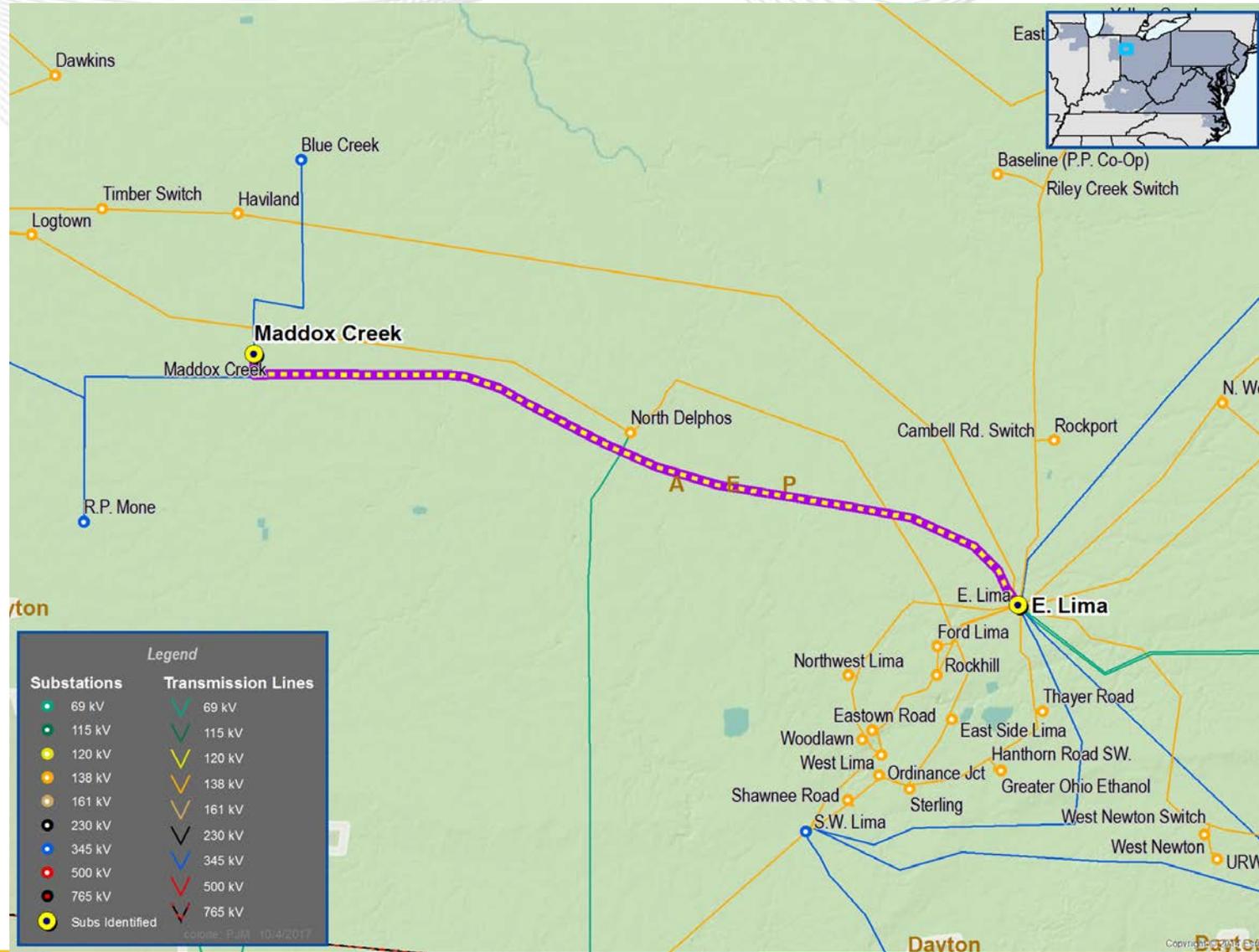
Recommended Solution :

- Replace terminal equipment on Maddox Creek - East Lima 345kV circuit.
 2017_1-8A. **(B2969)**

Estimated Project Cost: \$ 1.48 M

Required IS date: 12/1/2022

Project Status: Conceptual



Common Mode Outage and Basecase Analysis (Summer) (GD-S763, GD-S746, GD-S814, GD-S745, GD-S813, N1-S91, N1-S92 and N1-S126):

Date Project Last Presented: 10/12/2017 TEAC

Problem Statement:

- The Pierce 345 /138kV transformer #18 is overloaded for the loss of the Pierce 345/138kV transformer #17 with the breaker stuck at Pierce.
- The Pierce 345 /138kV transformer #17 and the connected Pierce –Beckjord 138kV circuit are overloaded for the loss of the Pierce 345/138kV transformer #18 with the breaker stuck at Pierce.

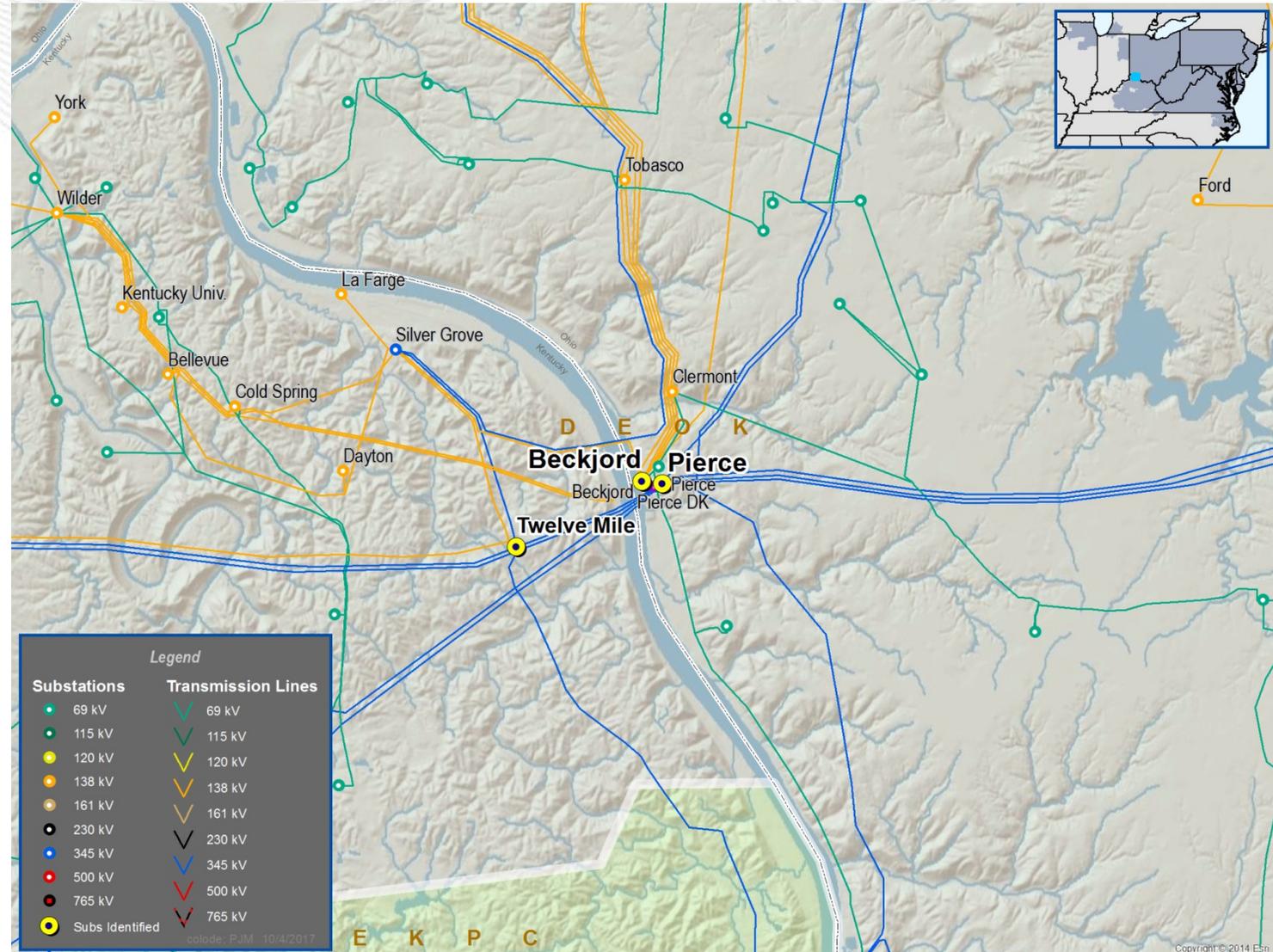
Alternatives considered:

2017_1-6A (\$20.16M) :The two existing 345/138kV transformers that connect Pierce 345kV Substation to Beckjord 138kV Substation are fed radially. This project will Reconfigure Pierce 345kV Substation by adding new breakers, moving a feeder, adding a third 345/138kV transformer, and feed the Pierce-Beckjord transformers in a breaker and a half or double bus configurations. The three transformer feeds will be distributed across the three sets of buses at Beckjord.

2017_1-2E (\$12.7 M): Build a 345 kV switching station ("Twelvemile") interconnecting the existing Silver Grove - Zimmer 345 kV transmission line and the Pierce - Buffington 345 kV transmission line

Portion of 2017_1-6A (\$9.17M): Reconfigure Pierce 345KV substation and upgrade terminal equipment at Beckjord 138kV on the Beckjord – Pierce 138kV line

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Project ID	Project Sponsor	2017 RTEP Window #1 target reliability flowgates solved?	Cost Analysis
2017_1-2E	NTD	Yes; But causes an N-1-1 thermal overload on the Beckjord – Pierce 138kV line (violation)	Estimated overall project cost by sponsor of \$12.7M (\$9.7 NTD scope + \$3M TO scope in current year) Cost cap = \$14M (in-service year \$'s) for NTD scope of work The fix for the new overload on the Beckjord – Pierce 138kv line is approximately \$1M;
2017_1-6A	DEOK	Yes, with no additional overloads	The submitted cost \$20.16M includes the Y3-064 merchant project cost, \$0.5M, which shouldn't be included as baseline cost, The total estimated cost is \$19.66M
Portion of 2017_1-6A	DEOK	Yes, with no additional overloads	The Estimated cost is \$9.17M. If the towers are not needed, it could lead to a cost reduction of \$1.25M from the total.

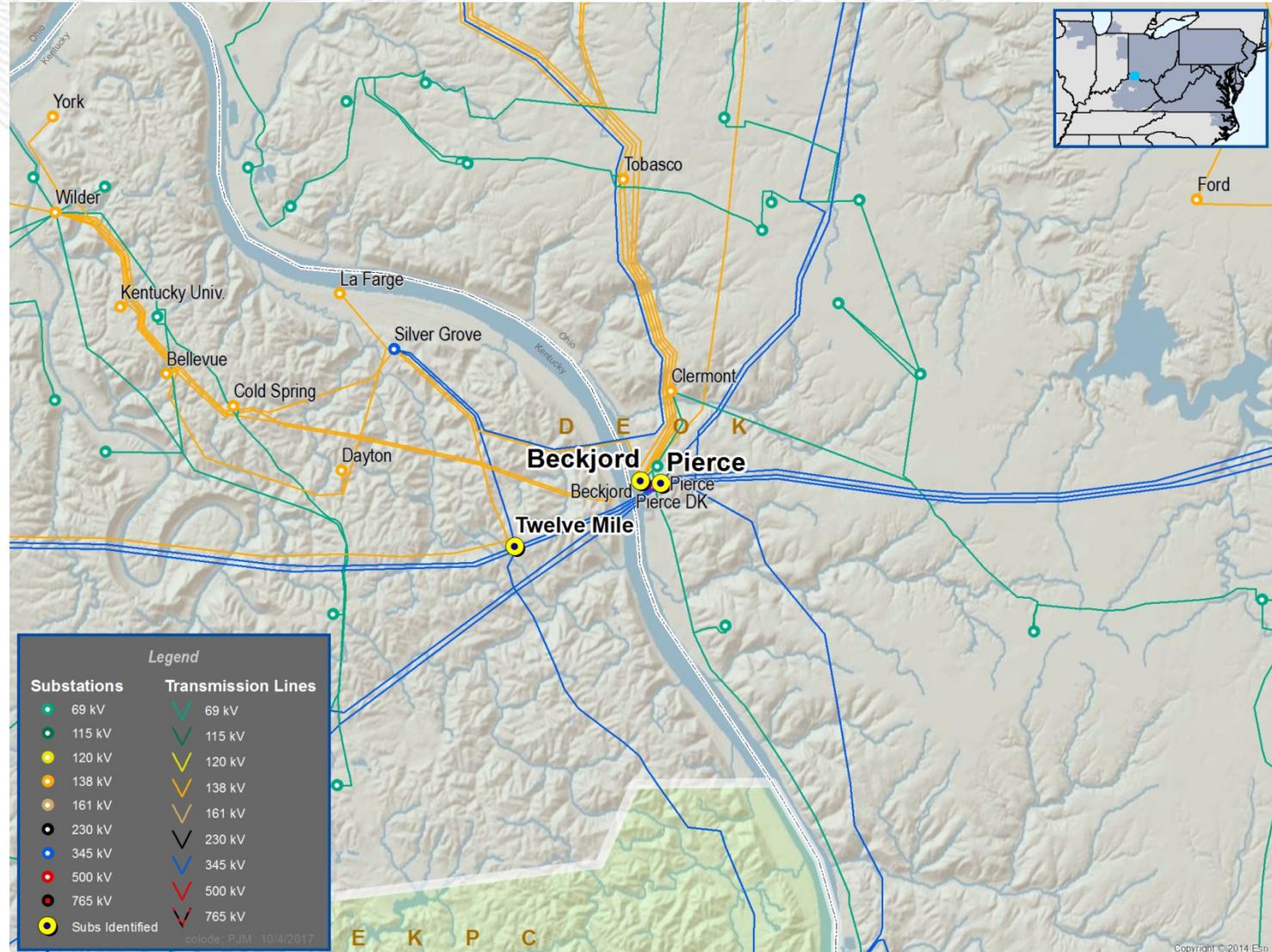
Preliminary Recommendation: (Portion of 2017_1-6A)

Install a new 345kV breaker “1422” so Pierce 345/138kV transformer #18 is now fed in a double breaker, double bus configuration.
 Remove X-533 No. 2 to the first tower outside the station. Install a new first tower for X-533 No.2.
 Install new 345KV breaker B and move the Buffington-Pierce 345kV feeder to the B-C junction. Install a new tower at the first tower outside the station for Buffington-Pierce 345kV line.
 Remove breaker A and move the Pierce 345/138kV transformer #17 feed to the C-D junction.
 Replace breaker 822 at Beckjord 138kV substation to increase the rating from Pierce to Beckjord 138kV to 603MVA.

Estimated Project Cost: \$ 9.17 M

Required IS date: 6/1/2021

Project Status: Conceptual



2017 RTEP Reliability Analysis Update



Dominion Transmission Zone Baseline Project

Baseline Reliability - TO Criteria Violation

Replacement of Fixed Series Capacitors on Line #547 Lexington–Bath County & Line #548 Valley–Bath County

Date Project Last Presented: 10/12/2017 TEAC

Problem Statement: Dominion “End of Life Criteria”

- The fixed series capacitors (FSC) on 500kV Line #547 at Lexington and on 500kV Line #548 at Valley were constructed in 2000/2001 to mitigate the Bath County angular stability issue. These two series capacitors need to be rebuilt to current standards based on Dominion’s “End of Life” criteria. The existing summer emergency rating (Rating B) of the FSCs is 3118 MVA. The existing summer emergency rating for the line segments is 3954 MVA.
- Replacement is needed because:
 - Existing series capacitor units run out of spare parts, manufacturer no longer produce parts for legacy models.
 - The breaker module of the capacitor has a current rating of 3000 Amps, which makes the FSCs the thermal limiting factor (normal operation rating 2858 MVA; emergency rating 3118 MVA) to the transmission line (normal operation rating 3954 MVA ; emergency rating 3954 MVA).

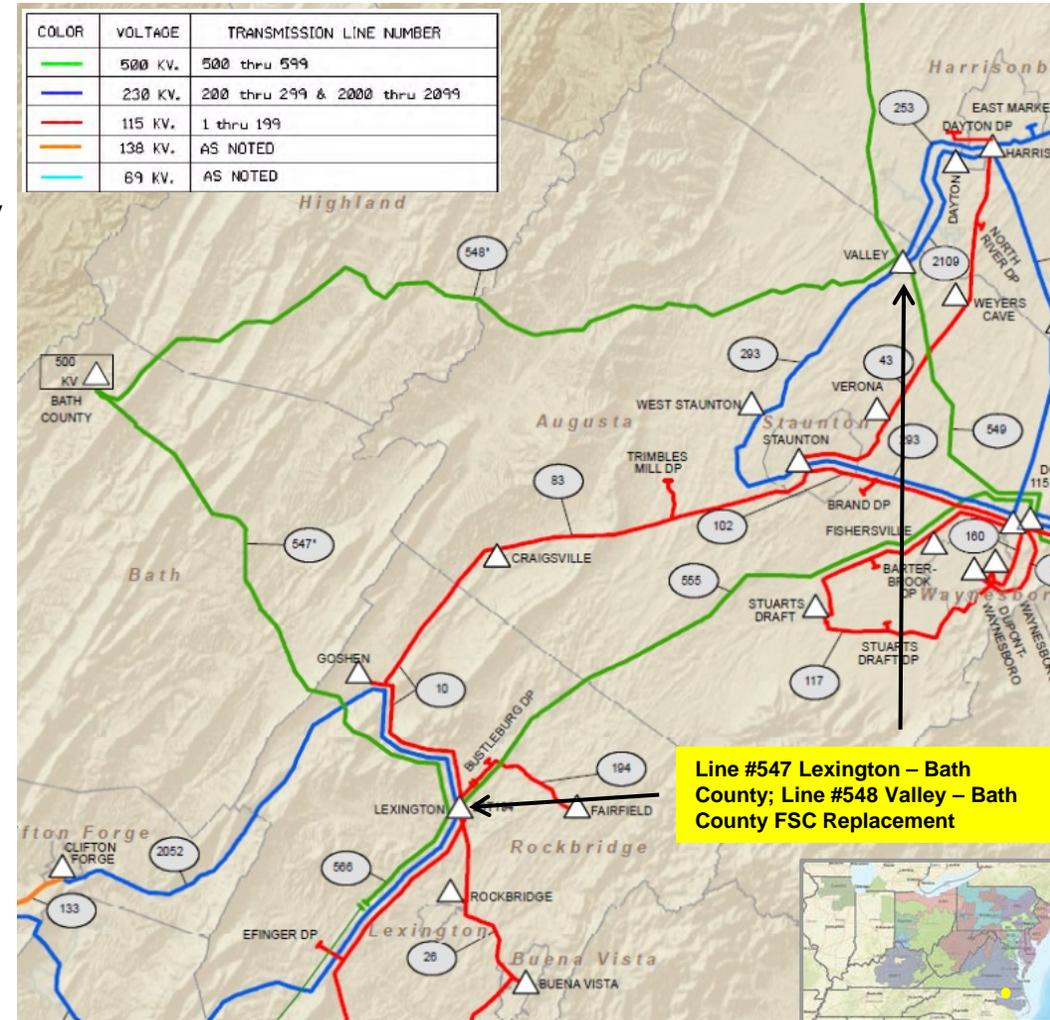
Recommended Solution:

Replace the existing FSCs with newer models of the same size. The current rating on the device will be increased from 3kA to 4kA for normal operation to provide higher thermal capacity. **(b2960)**

Estimated Project Cost: \$ 28.9 M

Projected IS Date: 4/1/2020

Project Status: Conceptual





Dominion Transmission Zone Baseline Project

Baseline Reliability - TO Criteria Violation

Line #205 and #2003 Partial Rebuild

Date Project Last Presented: 10/12/2017 TEAC

Problem Statement: Dominion “End of Life Criteria”

- 230kV line #205 and #2003 run from Chesterfield to Locks and Poe respectively. An approximate 3 mile section of these lines from Chesterfield to Tyler was built on double circuit weathering steel (Corten) towers in 1962. The corten structures are in poor condition.
- Permanent MW load loss for removal of these lines is 140MW.
- These line sections need to be rebuilt to current standards based on Dominion’s “End of Life” criteria.

Recommended Solution:

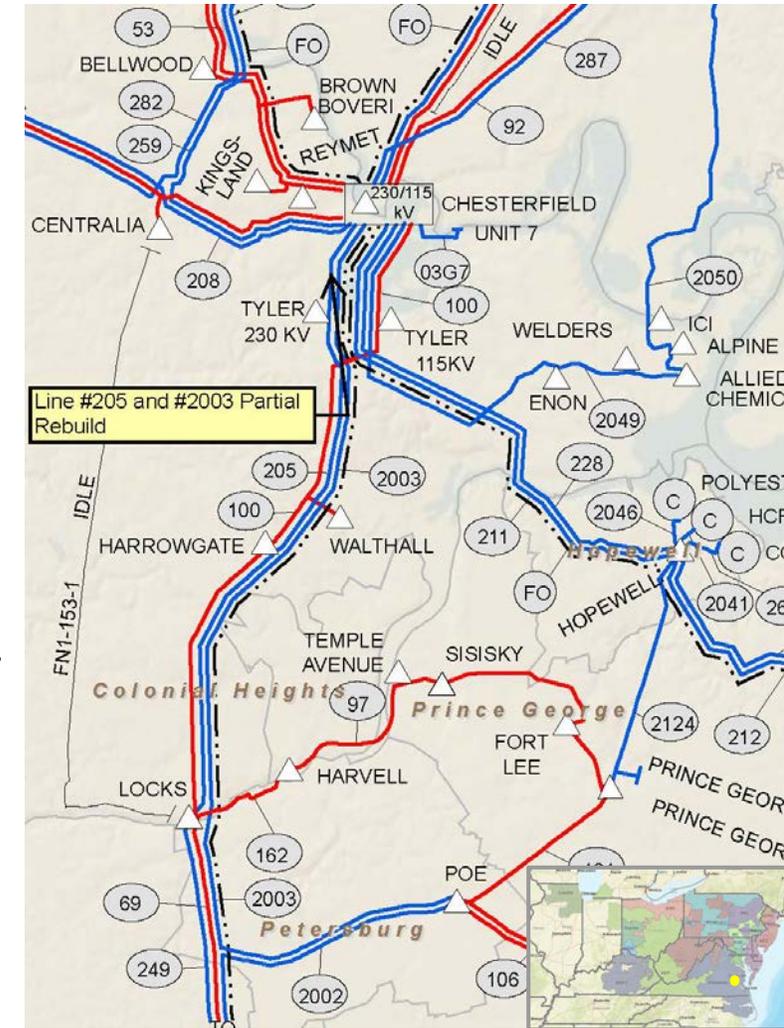
- Approximately 3 miles of line #205 and line #2003 will be rebuilt to current standard using with a summer emergency rating of 1047 MVA at 230kV. Proposed conductor is 2-636 ACSR. Considered structures include double circuit steel pole and double circuit galvanized steel tower. The Chesterfield - Tyler segments of line #205 and #2003 have an existing summer emergency rating of 478MVA. (b2961)

Estimated Project Cost: \$9.5 M

Projected IS Date: 12/31/2022

Project Status: Conceptual

COLOR	VOLTAGE	TRANSMISSION LINE NUMBER
Green	500 KV.	500 thru 599
Blue	230 KV.	200 thru 299 & 2000 thru 2099
Red	115 KV.	1 thru 199
Orange	138 KV.	AS NOTED
Cyan	69 KV.	AS NOTED



Date Project Last Presented:
10/12/2017 TEAC

Problem: Short Circuit

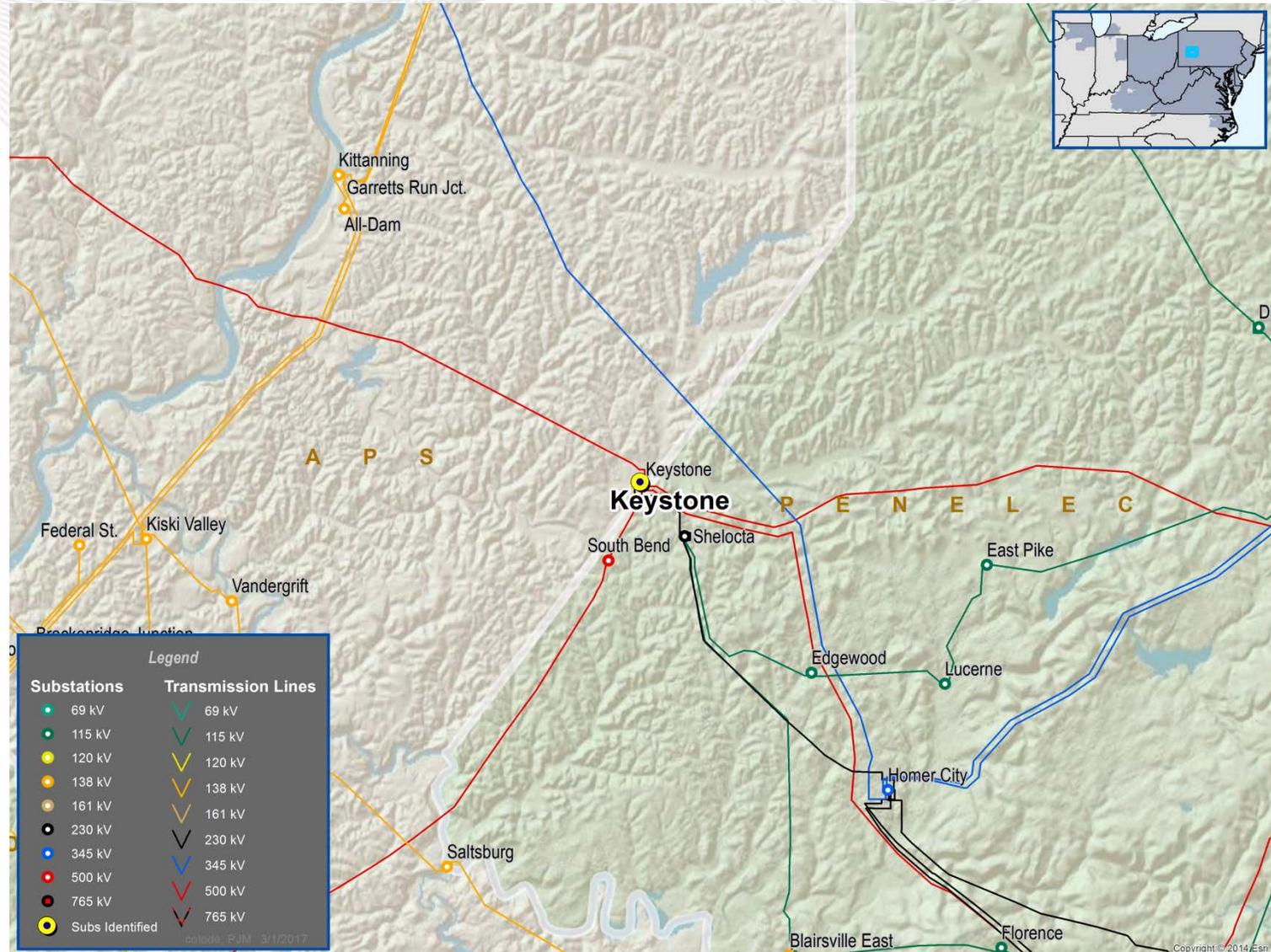
- The Keystone 500kV “NO. 14 Cabot” and “NO. 16 Cabot” breakers are overstressed

Recommended Solution:

- Replace the Keystone 500kV “NO.14 Cabot” and “NO. 16 Cabot” with 50kA breakers (b2953 &2954)

Estimated Project Cost:
\$1.24 M (per breaker)

Required IS Date:
June 1, 2020



2017 RTEP Next Steps

Upcoming TEAC Meetings and anticipated PJM Board Review

November

- 11/02 – [Sub-regional RTEP](#) – PJM West – Morning
- 11/02 – [TEAC Reliability Analysis Update](#) – Afternoon
 - *2017 RTEP Window #1 - Reliability Recommendations*
- 11/9 – [TEAC Reliability Analysis Update](#)

December

- 12/04 – [PJM Board](#) of Managers Review of November TEAC Recommendations
- 12/14 – [TEAC Reliability Analysis Update](#) and 2018 RTEP Assumptions Review
- 12/18 – [Sub-regional RTEP](#) – PJM South – Morning
- 12/18 – [Sub-regional RTEP](#) – PJM West – Afternoon
- 12/19 – [Sub-regional RTEP](#) – PJM Mid-Atlantic

Questions?



Appendix:

Previously Reviewed Baseline Upgrade Recommendations for the December 2017 PJM Board Review

Mid Atlantic Region

Date Project Last Presented: 10/12/2017 TEAC

Problem: Short Circuit

- The Conastone 230kV breakers '2322 B5' and '2322 B6' are overstressed

Significant Driver:

- Creating new Furnace Run 500kV and 230kV stations (b2752)"

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:

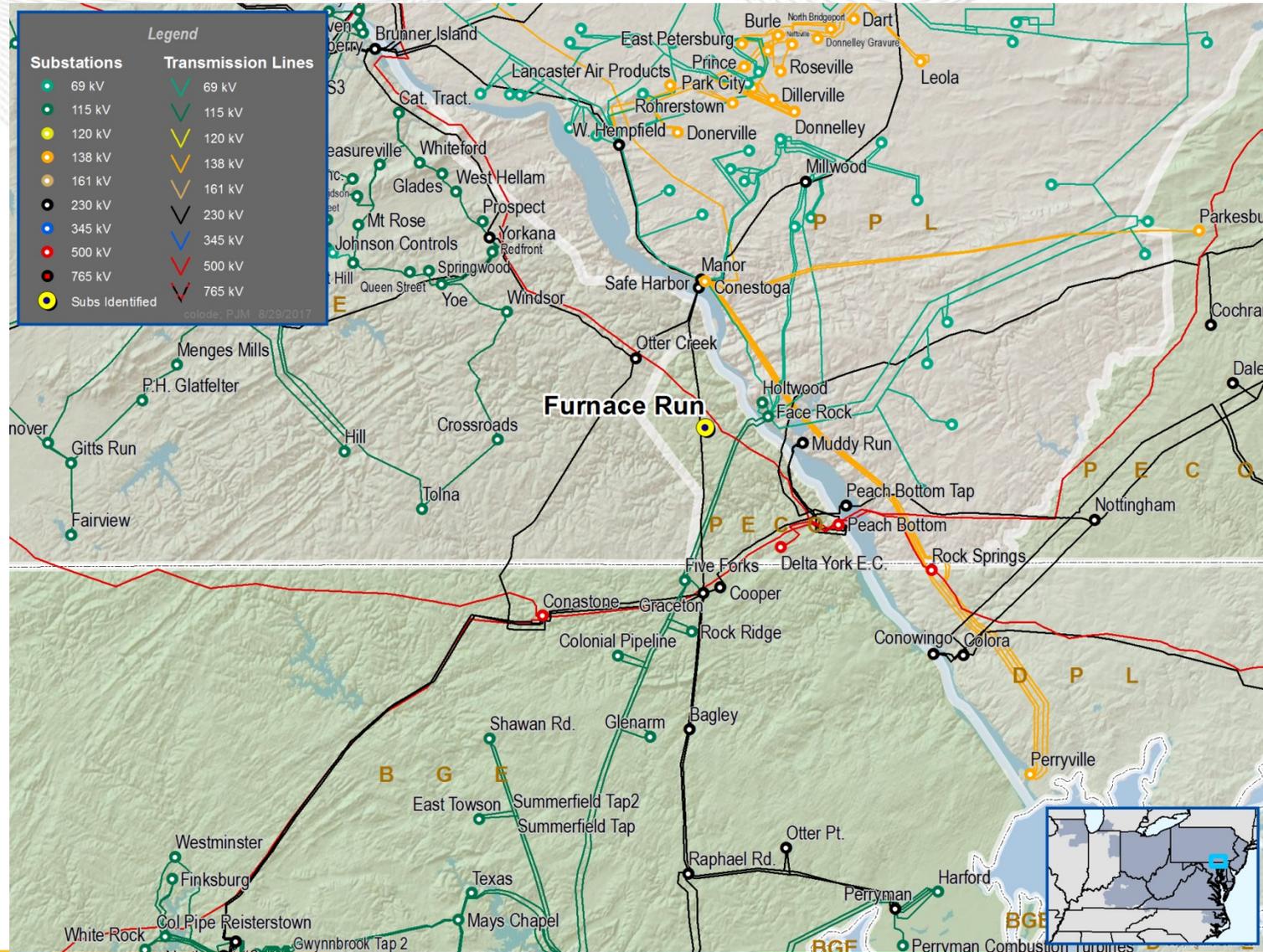
- Due to the immediate need of the project no alternatives were considered

Recommended Solution:

- Replace Conastone 230kV breakers '2322 B5' and '2322 B6' with 63kA breakers (b2752.8 & b2752.9)

Estimated Project Cost: \$1.07 M

Required IS Date: 6/1/2020





PSEG Transmission Zone

Generation Deliverability (Summer and Winter):

Presented: 9/14/2017 and 10/12/2017

Problem Statement:

- The VFT – Warinanco 230 kV circuit is overloaded for several contingencies. (FG# GD-S26, GD-S27, GD-S28, GD-S33, GD-S556, GD-W37, GD-W38, GD-W39, and GD-W348)
- The Warinanco – Aldene 230 kV circuit is overloaded for tower contingency loss of the Linden to Deans and Linden to Sewaren 230 kV circuits. (FG# GD-W353)

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.

Recommended Solution:

- Wreck and re-build the VFT – Warinanco – Aldene 230 kV circuit with paired conductor. Addresses tower age. Does not require new right of way. Paired conductor can address load requirement with room for future growth. (B2955)

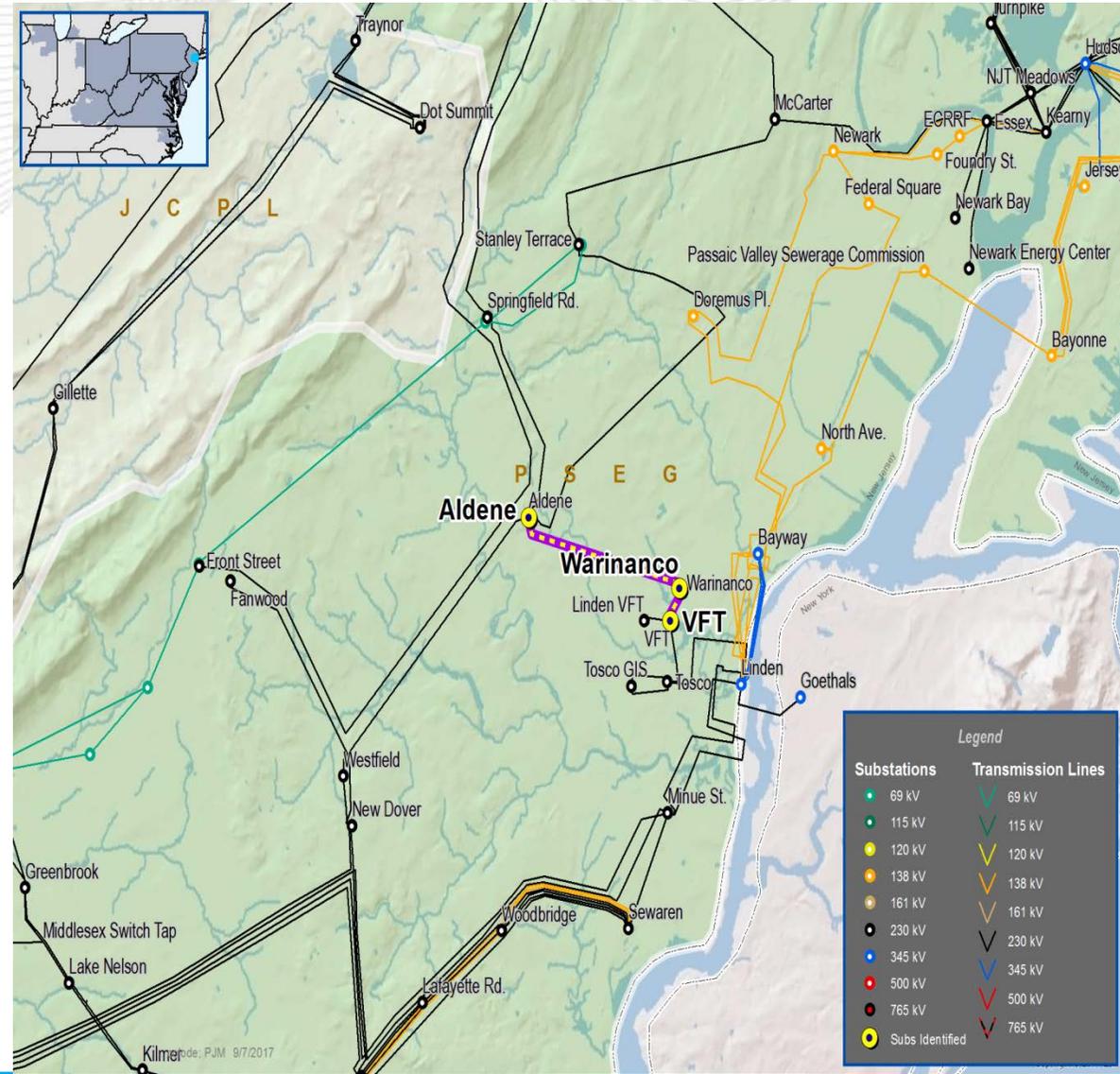
Alternative Solutions:

- Install parallel towerline - Dense, industrial area with limited property available. Would require new right of way and new station terminations.
- Install parallel XLPE cable - Requires opening the street. Adjacent to a railroad. Requires two new terminations. Create an impedance imbalance with the parallel overhead circuit. Cable will have lower impedance and lower capacity than the overhead circuit.

Estimated Project Cost: \$90.4 M

Required IS date: 6/1/2018

Project Status: Conceptual





PSEG Transmission Zone

Generation Deliverability (Summer):

Presented: 9/14/2017 and 10/12/2017

Problem Statement:

- The Cedar Grove – Jackson Rd. 230 kV circuit is overloaded for tower contingency loss of the Cedar Grove – Athenia 230 kV circuits B2228 and K2263. (FG# GD-S601)

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.

Recommended Solution:

- Replace existing cable with 5000kcmil XLPE cable. (B2956)

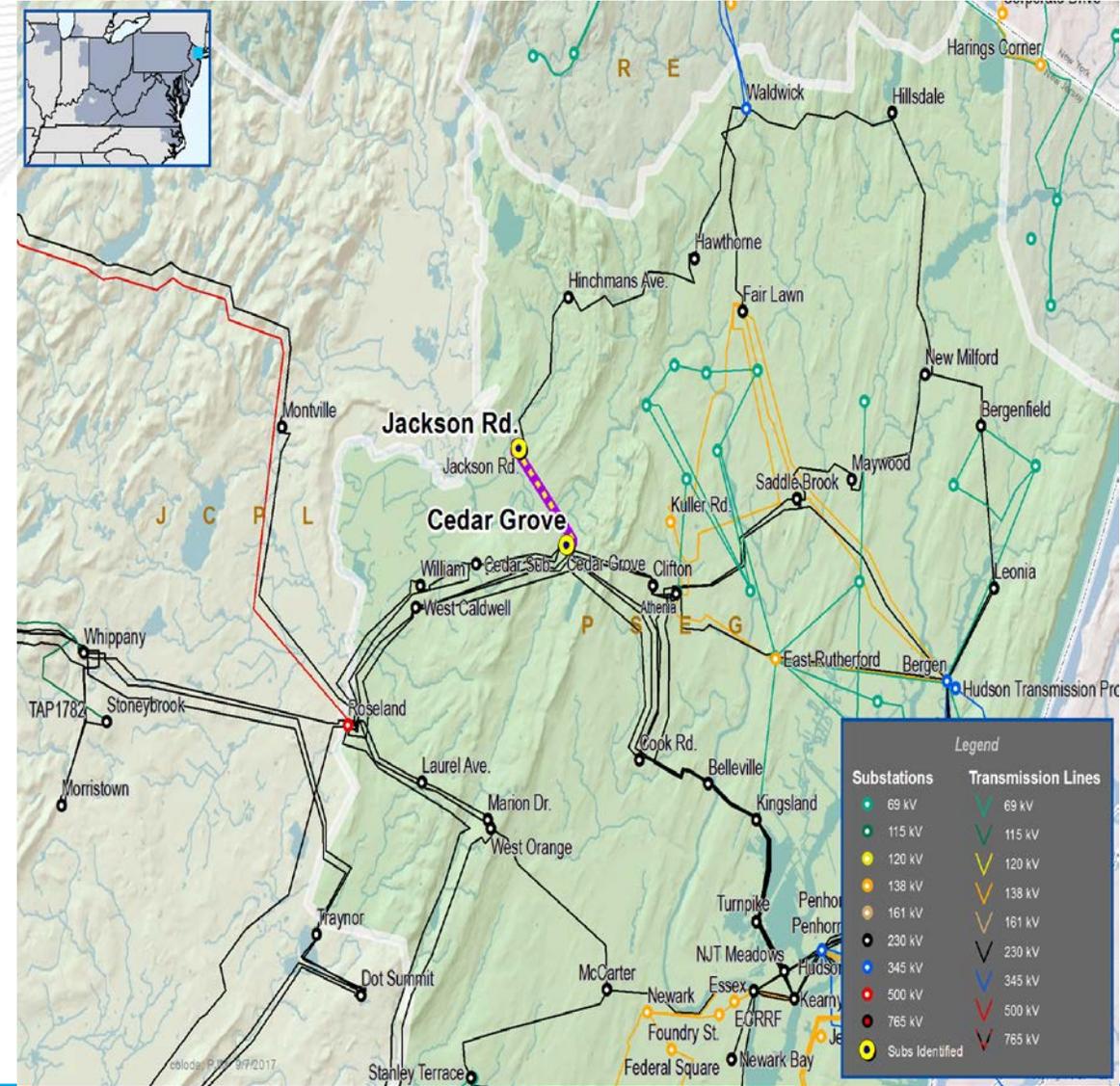
Alternative Solution:

- Re-conductor circuit with HPFF with 3500kcmil underground, pipe-type cable. Address age but not age of pipe. Alternative not recommended. Only one vendor for HPFF remains. Future availability of HPFF in question due to supply chain availability
- Abandon circuit - would leave a single transmission source from Waldwick 230kV for 215MW of load at Waldwick/Hawthorne/Hinchman/Jackson Rd. Violates FERC 715 criteria by leaving two sources to Jackson Rd. Would also render Waldwick PAR ineffective; 69kV would be the only outlet/inlet for PAR adjustments. Thermal overload on 69kV system for n-1-1.
- Replace with overhead construction - need right of way. Surrounding area is developed and densely populated. Requires two river crossings, interstate highway crossing, and a U.S. route crossing. Airport nearby. The construction of this alternative is not feasible.

Estimated Project Cost: \$80 M

Required IS date: 6/1/2018

Project Status: Conceptual





PSEG Transmission Zone

N-1-1 Thermal (Summer):

Presented: 9/14/2017 and 10/12/2017

Problem Statement:

- The Maywood – Saddle Brook 230 kV circuit is overloaded (Rate A) for the loss of the Leonia – Bergenfield 230 kV circuit. (FG# N2-ST13)

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.

Recommended Solution:

- Replace existing cable with 5000kcmil XLPE cable. (B2957)

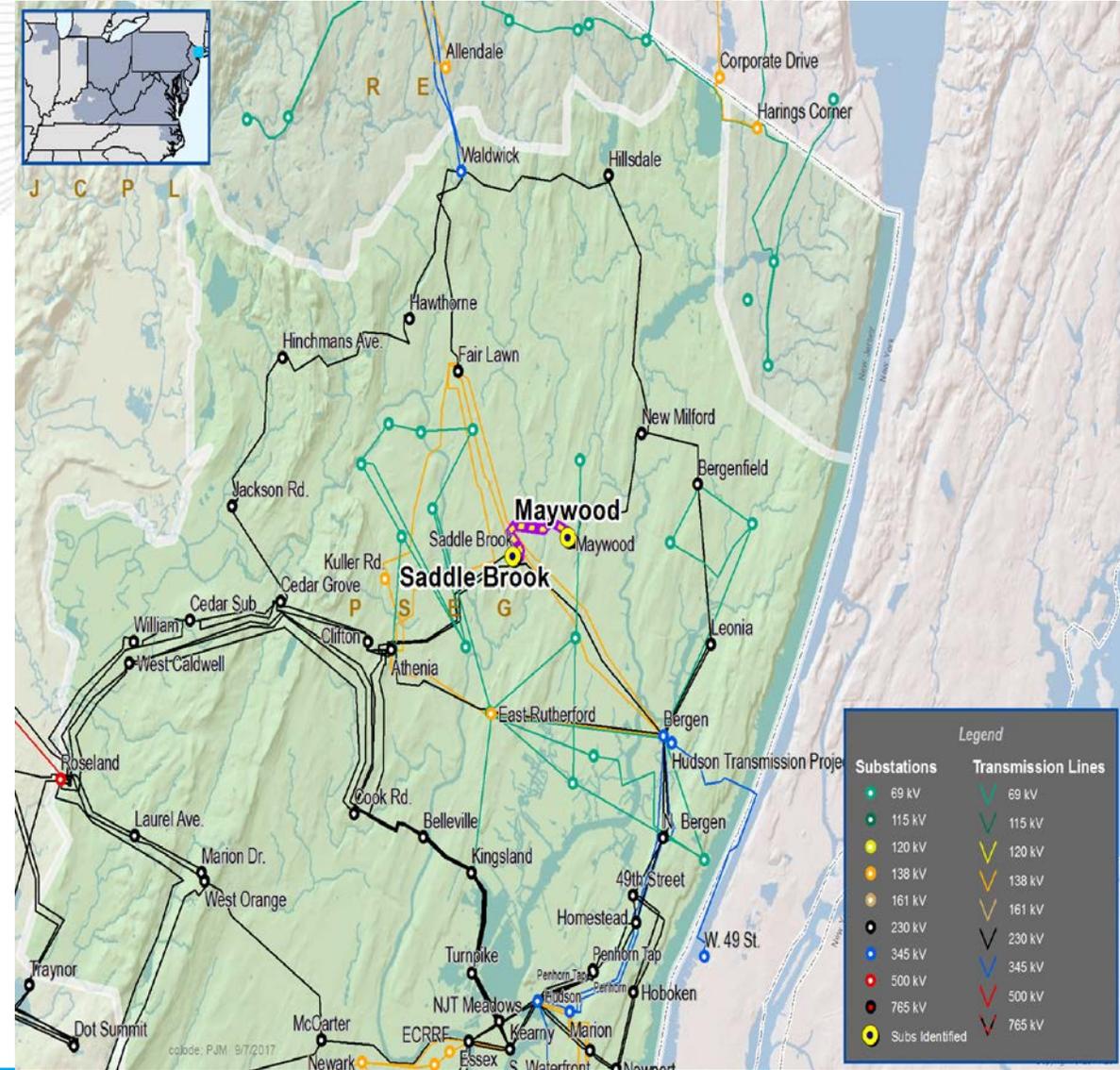
Alternative Solution:

- Re-conductor circuit with HPFF - Replace 2.71mi with 3500kcmil underground, pipe-type cable. Address age but not age of pipe. Alternative not recommended. Only one vendor for HPFF remains. Future availability of HPFF an issue in question due to supply chain availability
- Abandon circuit - Would leave a Maywood with a single underground transmission source. Violates FERC 715 criteria by leaving one source to Maywood.
- Replace with overhead construction - Need right of way. Surrounding area is developed and densely populated. Airport nearby. The construction of this alternative is not feasible.

Estimated Project Cost: \$57.5 M

Required IS date: 6/1/2018

Project Status: Conceptual



2017 RTEP Window #1 Recommendation Generation Deliverability and N-1-1 Thermal Violation (Summer):

Previously Presented: 8/31/2017 and 10/31/2017

Problem Statement:

- The BL England – Middle Tap 138 kV circuit is overloaded for multiple contingencies. (FG# GD-S569, N2-ST1 and N2-ST4):

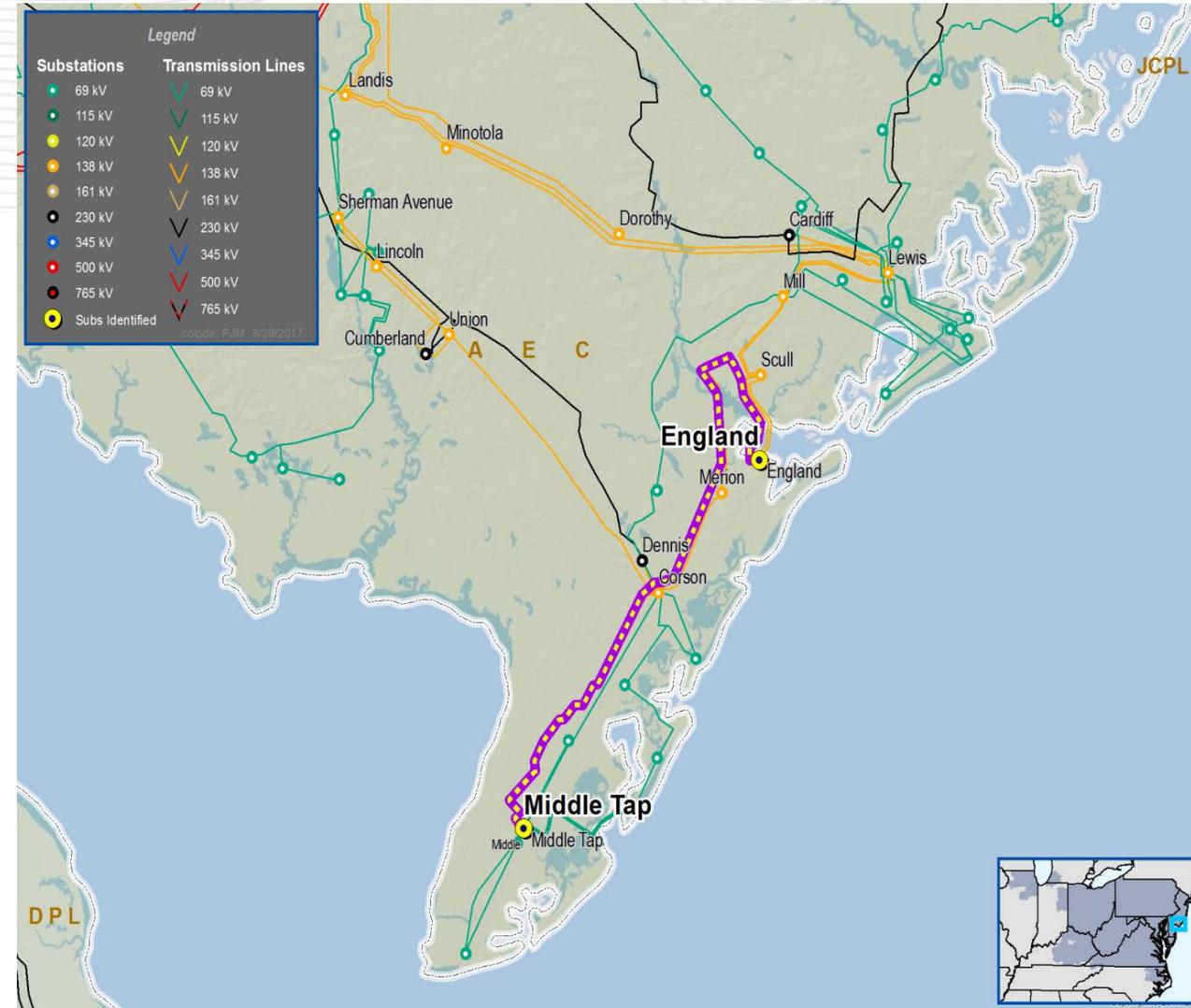
Recommended Solution:

- The BL England – Middle Tap 138kV line is a 10.12 mile double circuit line with the BL England – Merion and Merion – Corson 138kV lines, constructed on steel lattice towers. (B2945.1, B2945.2, and B2945.3)
 - Rebuild the BL England – Middle Tap 138kV line to 2000A on double circuited steel poles and new foundations at a cost of \$22,640,000
 - Re-conductor BL England – Merion 138kV (1.9miles) and Merion – Corson 138kV (8miles) lines at cost of \$3,923,000 and \$9,845,000 respectively as they share the same lattice towers.

Estimated Cost: \$36.4 M

Required In-service: 6/1/2022

Project Status: Conceptual





DPL Transmission Zone: Baseline Reliability Tanyard – Preston 69 kV

2017 RTEP Window #1 Recommendation Generation Deliverability Violation (Winter):

Previously Presented: 8/31/2017 and 10/31/2017

Problem Statement:

- The Tanyard – Preston 69 kV circuit is overloaded for line fault stuck breaker contingency loss of the Milford to Steele and Steele to Vienna 230 kV circuits. (FG# GD-W499):

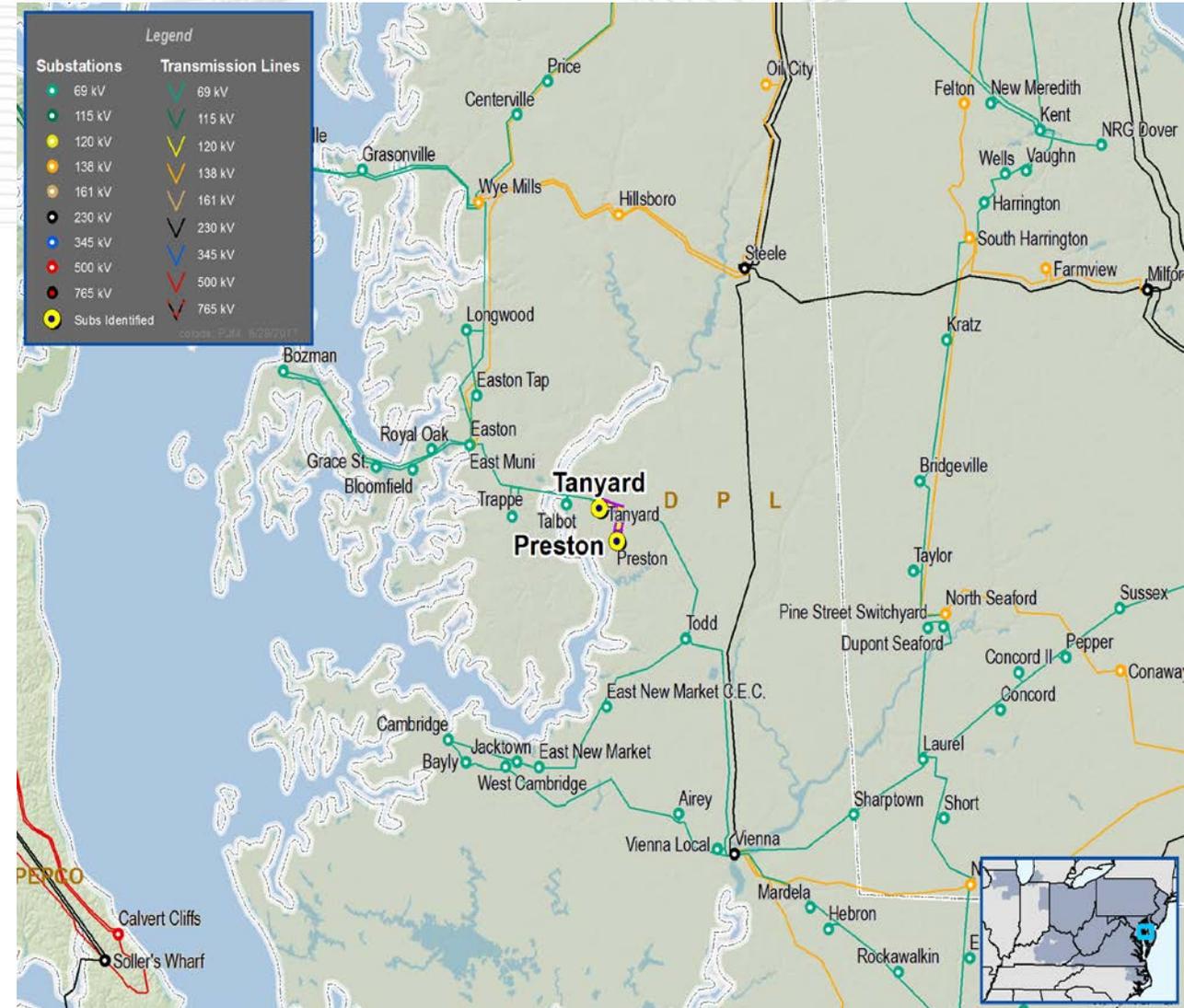
Recommended Solution:

- Convert existing Preston 69 kV Substation to DPL's current design standard of a 3-breaker ring bus. **(B2946)**
 - This solution resolves the overload, provides operation flexibility and the opportunity for future expansion at the Preston Substation.

Estimated Cost: \$2.64 M

Required In-service: 6/1/2022

Project Status: Conceptual





DPL Transmission Zone: Baseline Reliability Darley – Naamans 69 kV

2017 RTEP Window #1 Recommendation Generation Deliverability Violation (Summer):

Previously Presented: 8/31/2017 and 10/31/2017

Problem Statement:

- The Darley – Naamans 69 kV circuit is overloaded for tower line outage of the loss of the Edge Moor to Claymont and Edge Moor to Linwood 230 kV circuits. (FG# GD-SNew):

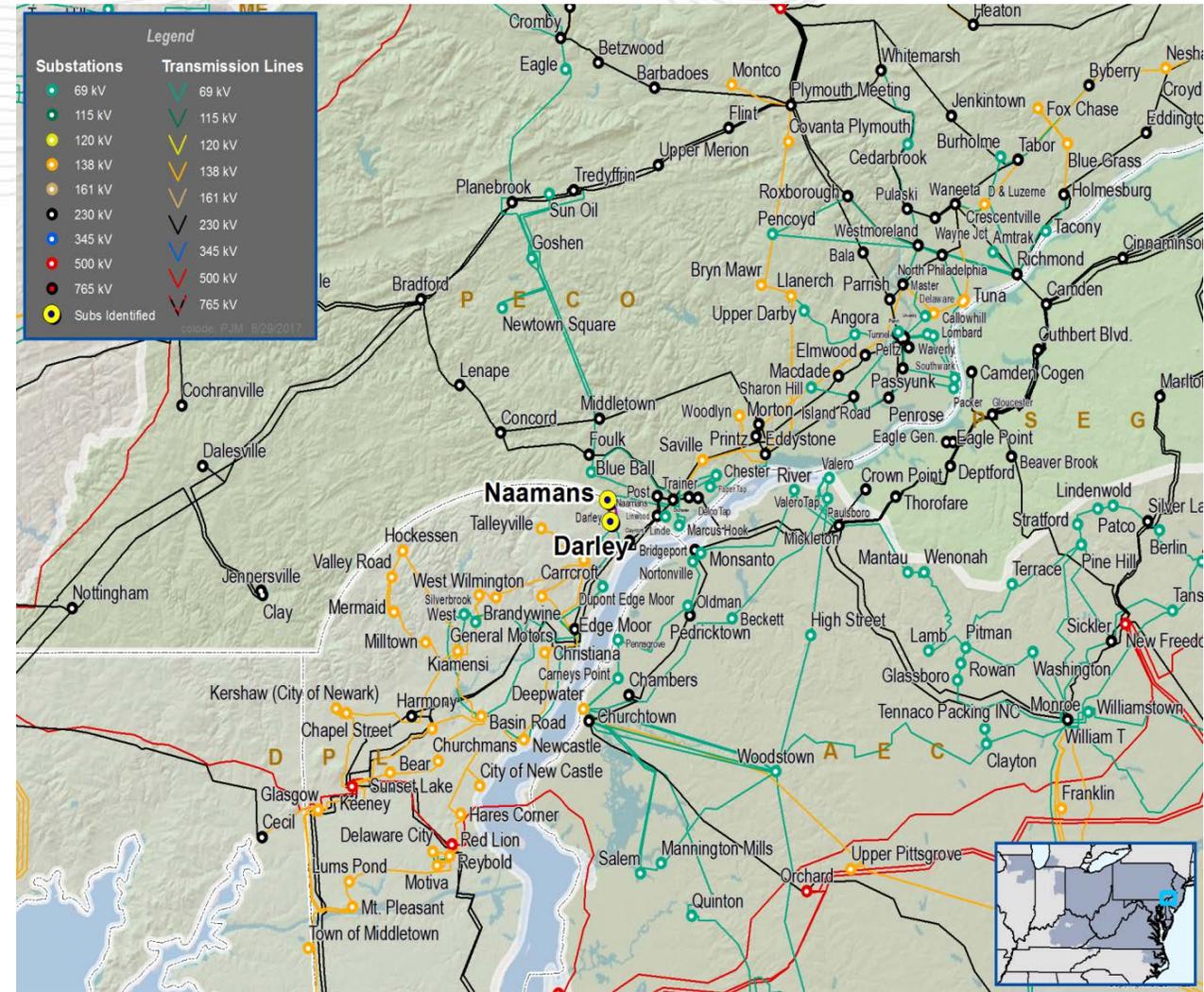
Recommended Solution:

- Upgrade terminal equipment at DPL’s Naamans Substation (Darley - Naamans circuit 69 kV) with an estimated cost of \$151,200. **(B2947.1)**
- Re-conductor 0.11 mile section of Darley - Naamans circuit 69 kV with an estimated cost of \$197,000. **(B2947.2)**
 - This reconductor and terminal upgrade will eliminate the aforementioned overloads.

Estimated Cost: \$0.3482 M

Required In-service: 6/1/2022

Project Status: Conceptual



DPL Transmission Zone: Baseline Reliability

Dupont Edge Moor – Silver R. 69 kV

2017 RTEP Window #1 Recommendation Generation Deliverability Violation (Summer):

Previously Presented: 8/31/2017 and 10/31/2017

Problem Statement:

- The Dupont Edge Moor – Silver R. 69 kV circuit is overloaded for tower line outage of the loss of the Edge Moor to Claymont and Edge Moor to Linwood 230 kV circuits. (FG# GD-S591)

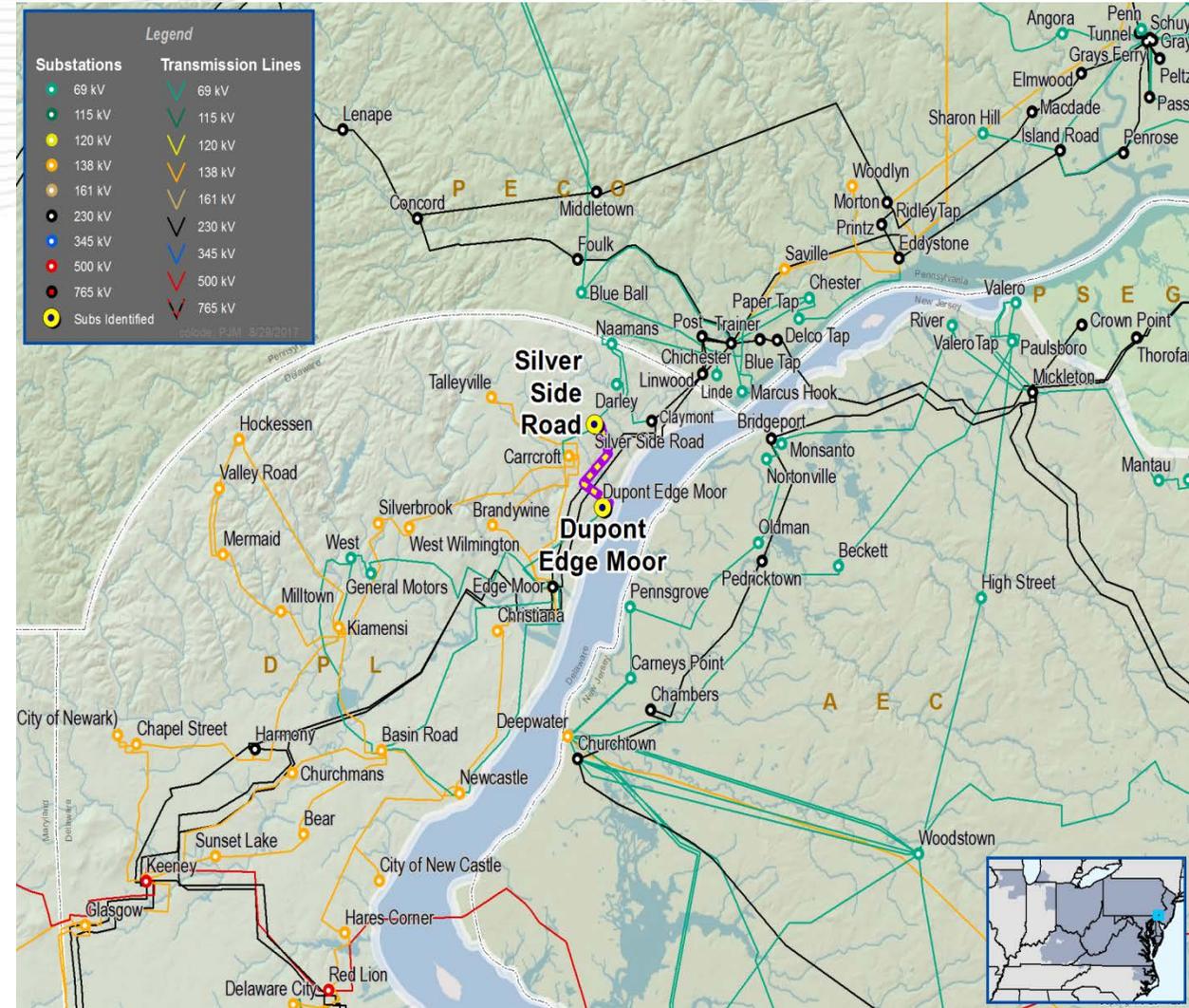
Recommended Solution:

- Upgrade terminal equipment at DPL's Silverside Road Substation (Dupont Edge Moor – Silver R. 69 kV). **(B2948)**

Estimated Cost: \$0.1512 M

Required In-service: 6/1/2022

Project Status: Conceptual



2017 RTEP Window #1 Recommendation Generation Deliverability (Summer):

Previously Presented: 8/31/2017 and 10/31/2017

Problem Statement:

- The Seward – Florence 115 kV circuit is overloaded for multiple line fault stuck breaker contingencies. (FG# GD-S792 and GD-S793):

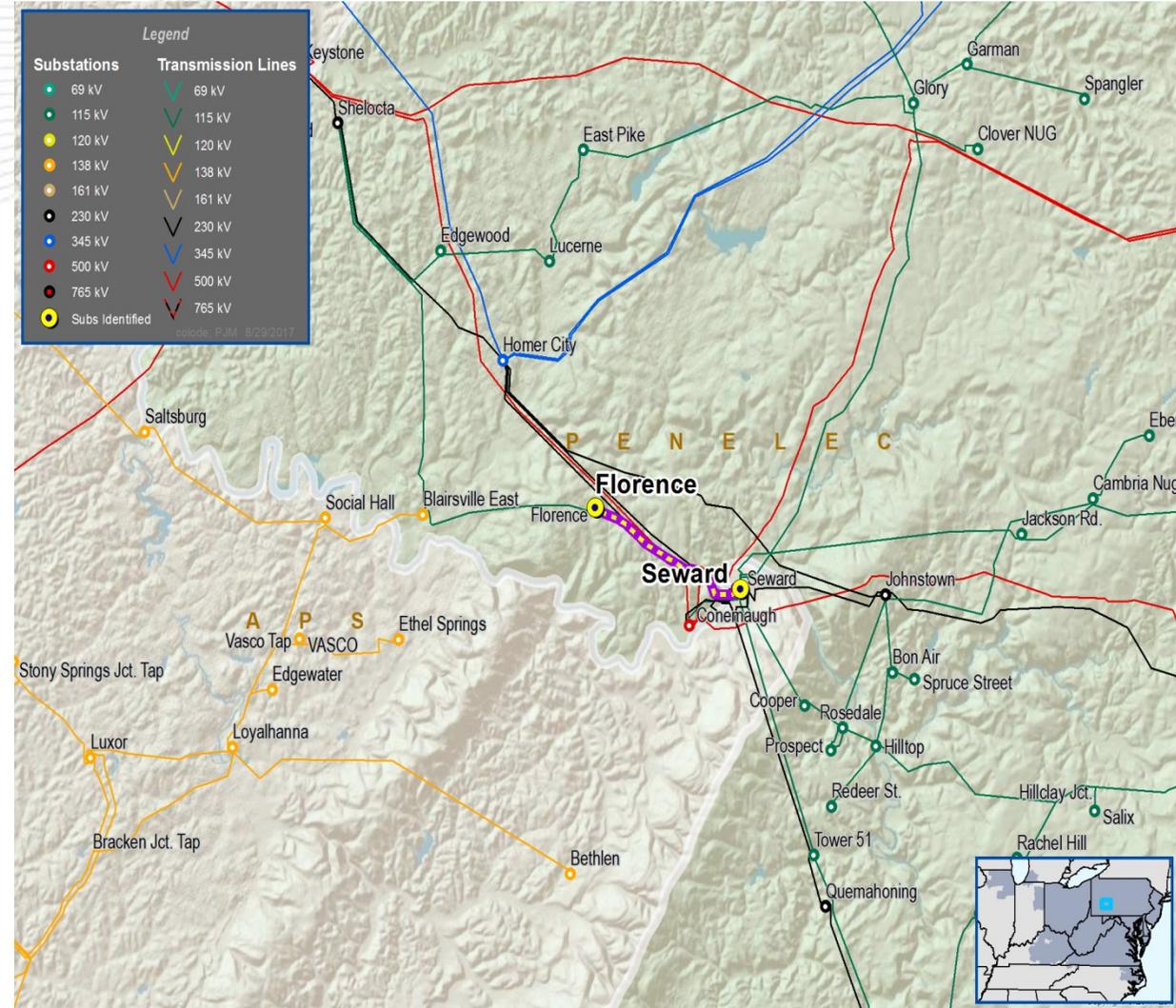
Recommended Solution:

- Upgrade Florence 115kV line terminal equipment at Seward SS. **(B2951.1)**
- Replace Blairsville East/Seward 115kV line tuner, coax, line relaying and carrier set at Shelocta SS. **(B2951.2)**
- Replace Seward/Shelocta 115kV line CVT, tuner, coax, and line relaying at Blairsville East SS. **(B2951.3)**

Estimated Cost: \$ 1.49 M

Required In-service: 6/1/2022

Project Status: Conceptual





PenElec Transmission Zone: Baseline Reliability North Meshoppen 230/115 kV transformer #3

2017 RTEP Window #1 Recommendation Generation Deliverability (Summer):

Previously Presented: 8/31/2017 and 10/31/2017

Problem Statement:

- The North Meshoppen 230/115 kV transformer #3 along with the 115 kV series reactor are overloaded for single contingency loss of the North Meshoppen – Canyon – E. Towanda 230 kV circuit and the North Meshoppen 230/115 kV transformer #4 . (FG# GD-W35 and GD-W75):

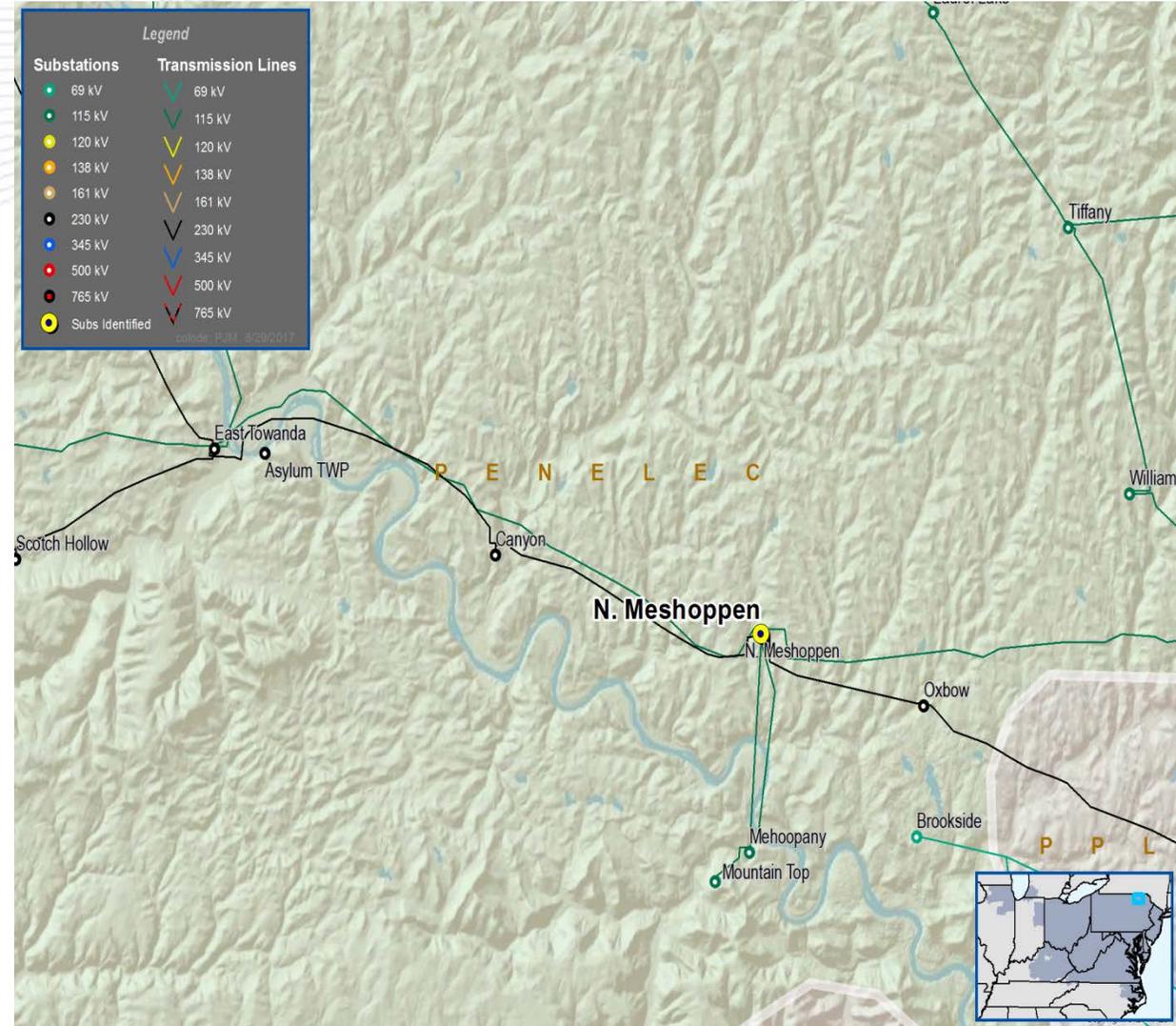
Recommended Solution:

- Replace the North Meshoppen #3 230/115kV transformer eliminating the old reactor and installing two breakers to complete a 230kV ring bus at North Meshoppen. **(B2952)**

Estimated Cost: \$6.802 M

Required In-service:6/1/2022

Project Status: Conceptual



Western Region

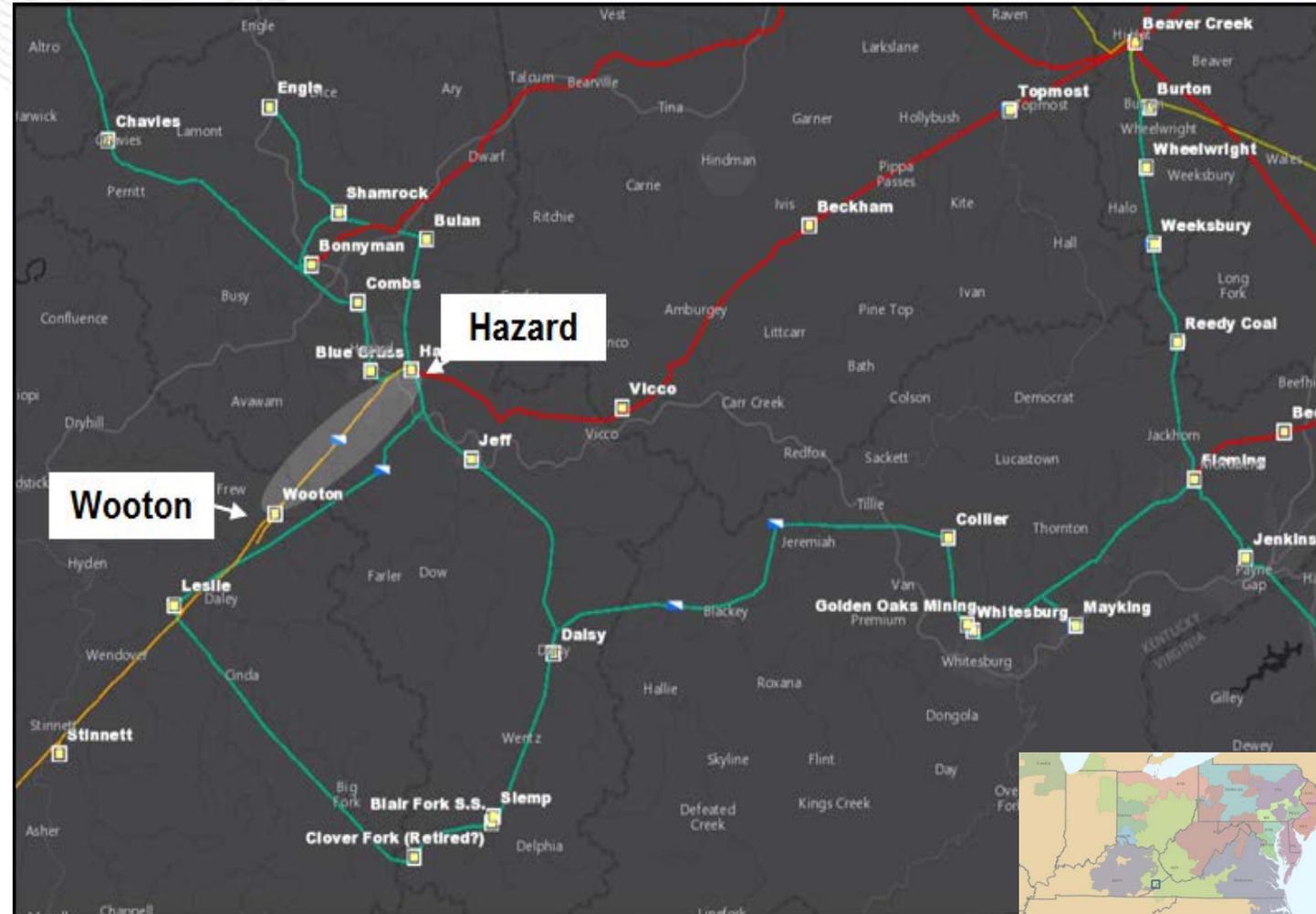
Baseline Reliability –Project Additional Scope Previously Presented: 9/11/2017 SRTEAC and 11/2/2017 SRTEAC

Problem Statement: The Hazard – Wooton 161 kV line overloads under summer and winter peak conditions during generation deliverability analysis performed as part of the 2016 PJM RTEP Window 2. During the 2016 PJM RTEP Window 2, the recommended solution is “Perform a Sag Study of the Hazard – Wooton 161 kV line to increase the thermal rating of the line” (B2761.2, presented on 10/6/2016 TEAC). The results of the sag study determined that 40 of the 45 structures which comprise the line would need to be replaced due to sag clearance issues. Additionally, approximately 6.3 of the 6.5 mile Hazard – Wooton 161 kV line utilizes wood structures from 1943. There are currently a total of 52 category A open conditions along the 6.5 mile long line which is comprised of 45 structures. These open conditions include damaged/rotted poles and damaged guy wires, shield wire, conductor, insulators, and cross arms. Therefore, the conclusion of the sag study is to rebuild the line.

Recommended Solution: Rebuild the Hazard – Wooton 161 kV line utilizing 795 26/7 ACSR conductor (300 MVA rating). (B2761.3)

Estimated Cost: \$16.48M

Expected In-service: 6/1/2021



Baseline Reliability – Light Load Deliverability Violation Previously presented: 9/11/2017 SRTEAC and 11/2/2017 SRTEAC

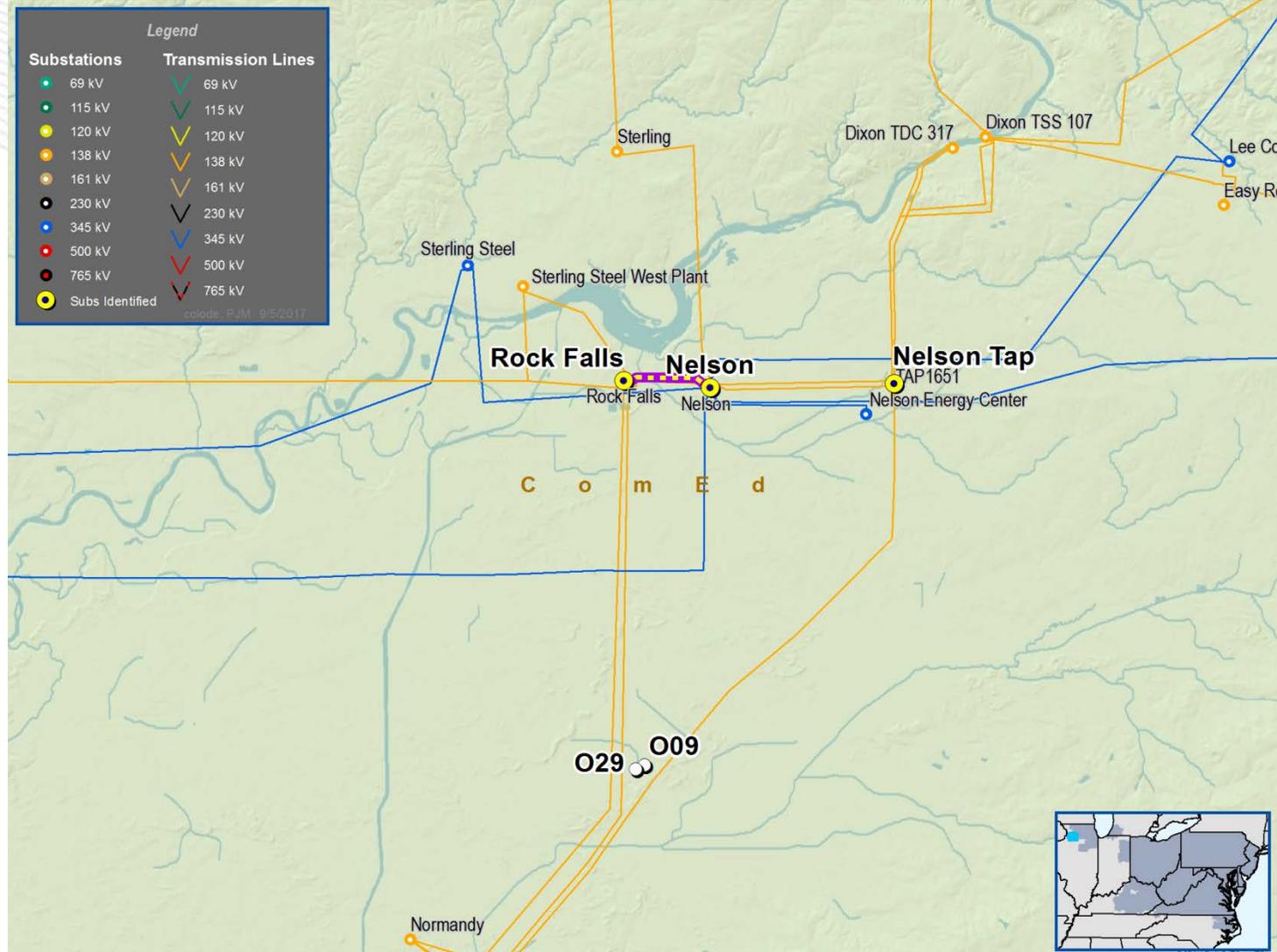
Problem Statement: Queue O-09 and O-29 are back to active from suspension. Rock Falls – Nelson 138KV Red line, Schauff Road (O09&O29) – Nelson Tap 138kV Red line and Schauff Road(O9&O29) – Rock Falls 138kV Red line are overload in base case and multiple single contingencies.

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

Recommended Solution: Install a new 138kV circuit 18702 from Schauff Road to Rock Falls and install a fourth breaker and a half run at Schauff Road. (B2959)

Estimated Cost: \$20M

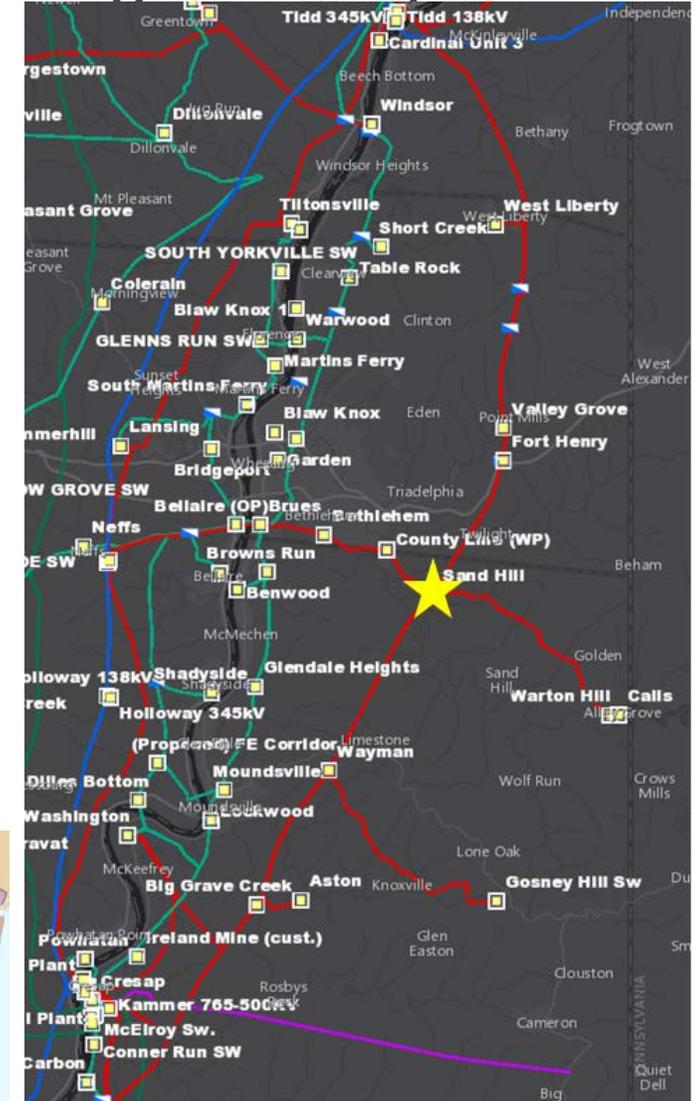
Expected In-service: 11/1/2019





AEP Transmission Zone: Baseline Reliability Sand Hill 138kV Ring Bus Expansion

- **Problem Statement: TO Criteria violation**
- Customer Service: The MarkWest Customer is increasing the peak demand of its Warton Hill & Calis Switch delivery points significantly (60 MW addition, 144 MW total) over the next couple of years. This load increase drives planning criteria violations on the surrounding 138kV system.
- Planning Criteria Violations: Due to major load increases at MarkWest's Majorsville, WV facilities (served via Calis SW & Warton Hill), the following thermal capacity and voltage violations are observed :
 - For loss of the Brues-Sand Hill & Tidd-Sand Hill 138kV lines or Sand Hill breaker 'A' failure:
 - Kammer-Aston 138kV line overload (556 ACSR conductor, 284 MVA rating)
 - Calis SW 138kV area low voltages (voltage-collapse)
 - For loss of the Brues - Sand Hill & Big Grave Creek - Kammer 138kV lines:
 - Tidd-Sand Hill 138kV overload (556 ACSR conductor, 284 MVA rating)
- **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.



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AEP Transmission Zone: Baseline Reliability Sand Hill 138kV Ring Bus Expansion

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Recommended Solution:

Cut George Washington – Tidd 138kV circuit into Sand Hill and reconfigure Brues & Warton Hill line entrances. (\$2.19M) (B2958.1)
Add 2 138kV 3000 A 40 kA breakers, disconnect switches, and update relaying at Sand Hill station. (\$5.06M) (B2958.2)

Alternatives: Re-conductor the area's overloaded 138kV circuits:

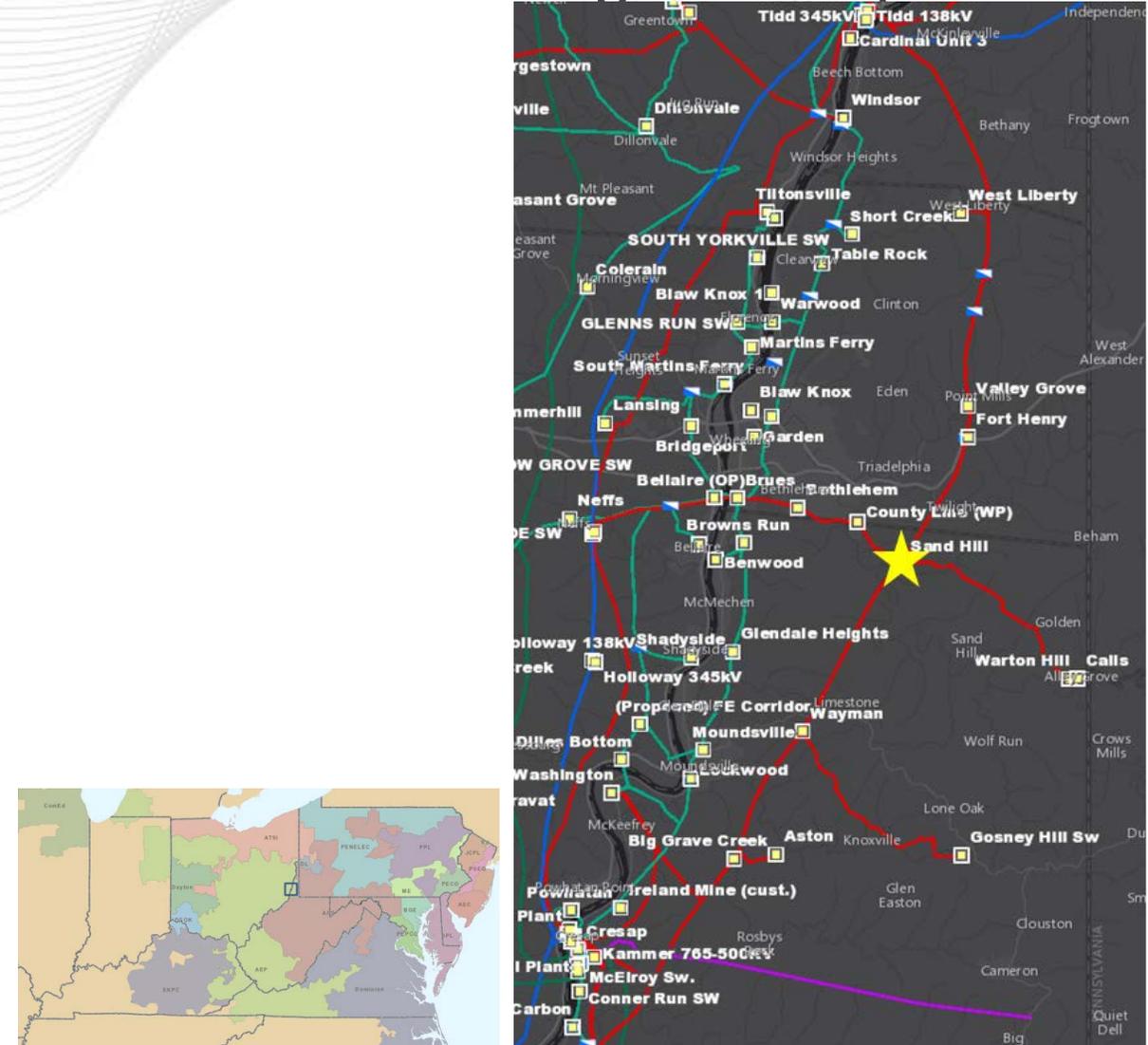
- Kammer-Aston 138kV (9.3 miles) and Tidd-Sand Hill 138kV (19.3 miles). This would be an expensive endeavor due to the long mileage and challenging terrain. In addition, the criticality of these circuits would make outage-scheduling very difficult. Plus, they are built as double-circuit tower-lines.
- To resolve the low voltage constraints, install additional 138kV capacitor banks, for area voltage support. The grid in the area already has substantial capacitor bank penetration and this addition is expected to saturate switchable capacitor banks thus resulting in poor coordination and mis-operations.

Alternative Cost: \$35-50M

Estimated Project Cost: \$7.25M

Expected ISD: 7/1/2017

Projected ISD: 12/1/2018



- PJM anticipates that all recommended baseline solutions in today's presentation (including the Appendix) will be presented to the PJM Board in December and recommended for inclusion in the RTEP.

- V1 – 10/27/2017 – Original Slides Posted
- V2 – 11/3/2017
 - Slide #8, Corrected the typo GD-S587 to GD-S857
 - Slide #10, Remove the Date Project Last Presented
 - Slide #14, Change “transformer #17” to “transformer #18” in the second bullet under problem statement
- V3 – 11/3/2017
 - Added Slides #40 and #41
- V4 – 1/5/2018
 - Slides #12 and #13, Corrected Required IS Date to 12/1/2022