

Transmission Expansion Advisory Committee

September 8, 2011

Issues Tracking

- Open Issues
 - None
- New Issues

At-Risk Generation Study

- At previous meetings we discussed results of EMAAC studies that considered the impact of at-risk generation
- PJM staff will be performing additional at-risk analyses focusing on other parts of the RTO
- MAAC will be the next area investigated

- Analytical approach will be similar to previous studies
- At-risk units will be identified based on retrofit costs to comply with EPA environmental regulations and state High Electric Demand Day (HEDD) regulations.
- Other considerations

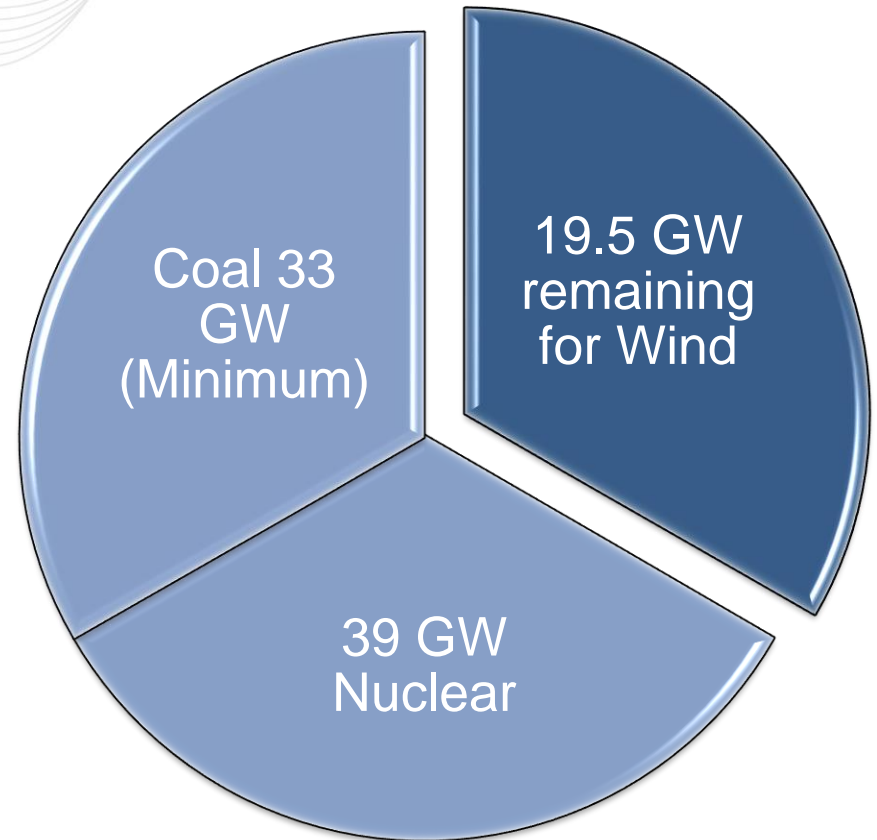
PJM Generation Scenario Analysis

- Evaluation of renewable generation to meet state RPS goals
 - 11 GW (nameplate) of solar
 - 41 GW (nameplate) of wind

- Base transmission overlay is input to PJM Renewable Integration Study (PRIS)

- Evaluations of 2026
 - Scenarios
 - Base
 - Base + 41 GW of renewable
 - Analytic Methods
 - Reliability analysis
 - SCOPF analysis
 - Market Efficiency analysis

- Min Gen Issues
 - Year 2026
 - Forecast 91.5 GW load in PJM at 50% of summer peak forecast
 - Generation surplus at this demand level



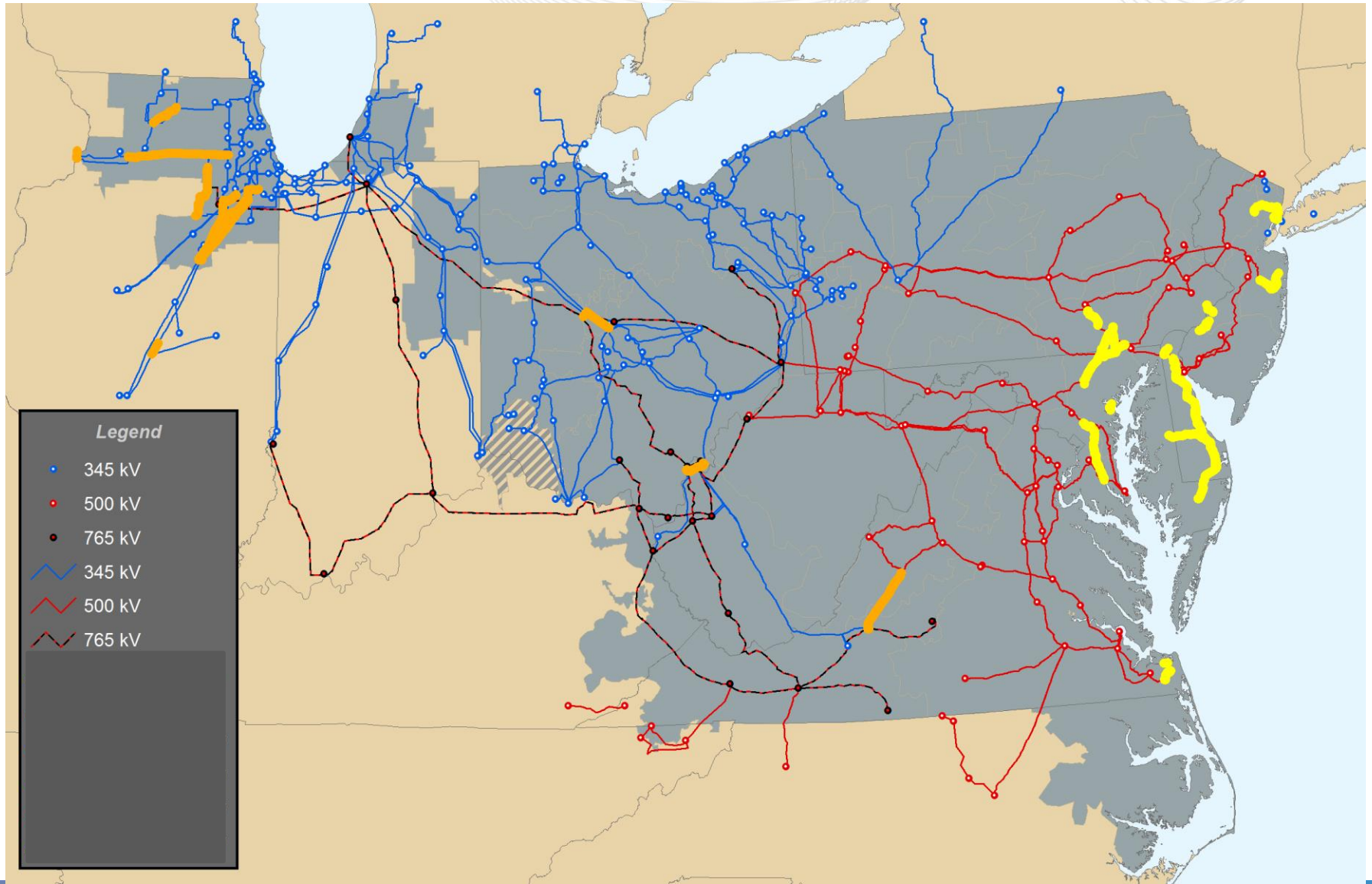
- SCOPF
 - minimize total operation cost
 - meet power balance constraints
 - enforce operating limits under normal and contingency conditions
- Consistent with market efficiency analysis
 - Light load snapshot

- Analysis of 41GW wind penetration
 - Assumption: wind not curtailable – maintained at 80%
 - ✓ Scenario assuming 4GW offshore
 - ✓ Scenario assuming 20GW offshore
- SCOPF metrics
 - Unenforceable constraints (unable to alleviate through re-dispatch – reliability issues)

- Analyses Results
 - Generator Deliverability & Common Mode Outage Test
 - Thermal overloads
 - SCOPF
 - Unenforceable Constraints

# of Violations		
Voltage Level	Offshore Wind Scenario	
	4GW	20GW
765kV	1	0
500kV	3	3
345kV	15	1
230kV	0	49

pjm Security Constrained Optimal Power Flow (SCOPF) Constraints



Total Annual Congestion (Absolute)

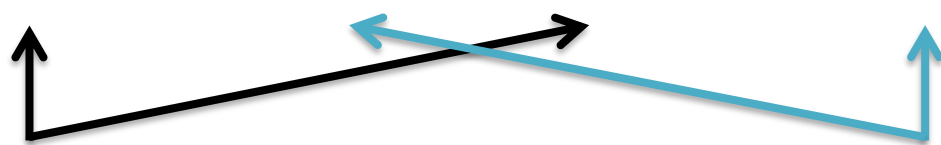
Congestion Year 2026	Base Expansion	4 GW Offshore Scenario	4 GW Offshore Scenario	20 GW Offshore Scenario	20 GW Offshore Scenario
	no overlay	no overlay	With Overlay	no overlay	With Overlay
PJM - Eastern MAAC	\$(1,512,002,234)	\$(2,055,908,942)	\$(2,723,123,336)	\$(3,108,766,450)	\$ (841,676,396)
PJM - Rest of MAAC	\$ (94,229,765)	\$ (139,295,728)	\$ (244,953,606)	\$ (105,539,332)	\$ (151,982,900)
PJM - Rest of RTO	\$(3,344,638,314)	\$(6,556,847,363)	\$(3,186,690,237)	\$(4,223,174,922)	\$ (5,587,681,669)
PJM Interfaces	\$ (95,363,264)	\$ (35,573,795)	\$ (476,663,504)	\$ (9,289,413)	\$ (77,402,728)
PJM Total	\$(5,046,233,576)	\$(8,787,625,829)	\$(6,631,430,684)	\$(7,446,770,117)	\$ (6,658,743,693)

Total Annual Congestion (Comparison)

Congestion Year 2026	Base Expansion	4 GW Offshore Scenario	4 GW Offshore Scenario	20 GW Offshore Scenario	20 GW Offshore Scenario
	no overlay	no overlay	With Overlay	no overlay	With Overlay
PJM - Eastern MAAC		\$ 543,906,709	\$ 667,214,394	\$ 1,596,764,216	\$ (2,267,090,054)
PJM - Rest of MAAC		\$ 45,065,963	\$ 105,657,878	\$ 11,309,568	\$ 46,443,568
PJM - Rest of RTO		\$ 3,212,209,050	\$ (3,370,157,126)	\$ 878,536,608	\$ 1,364,506,747
PJM Interfaces		\$ (59,789,469)	\$ 441,089,709	\$ (86,073,851)	\$ 68,113,315
PJM Total		\$ 3,741,392,253	\$ (2,156,195,145)	\$ 2,400,536,541	\$ (788,026,423)

Function
 = RPS – Base
 = Congestion change due to RPS

Function
 = With Overlay – Without Overlay
 = Congestion change due to overlay



Total Annual Congestion (Comparison)

Congestion Year 2026	Base Expansion	4 GW Offshore Scenario	4 GW Offshore Scenario	20 GW Offshore Scenario	20 GW Offshore Scenario
	no overlay	no overlay	With Overlay	no overlay	With Overlay
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Observation

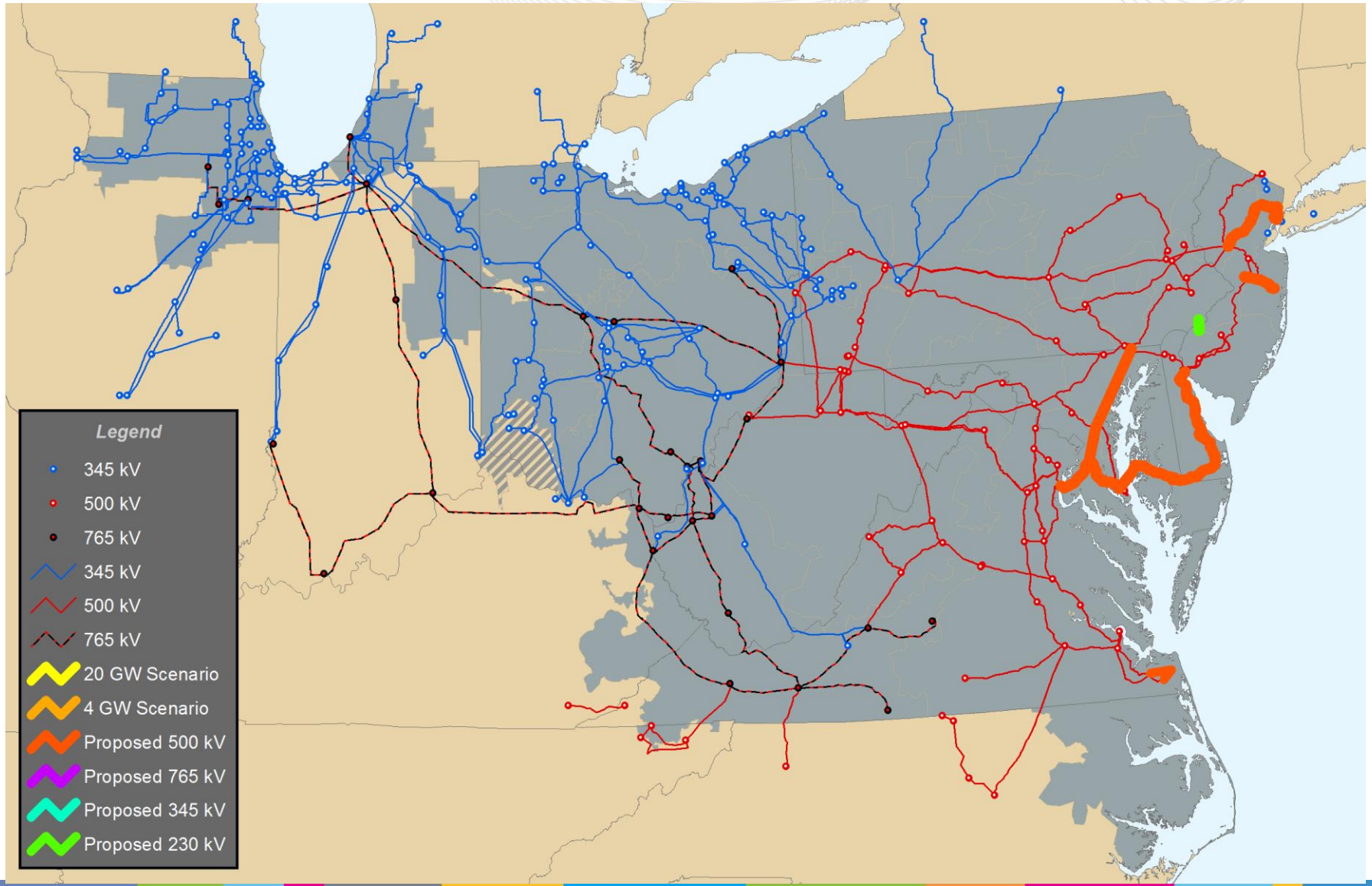
- Highest Congestion
 - 4GW offshore scenario: West
 - 20GW offshore scenario: East

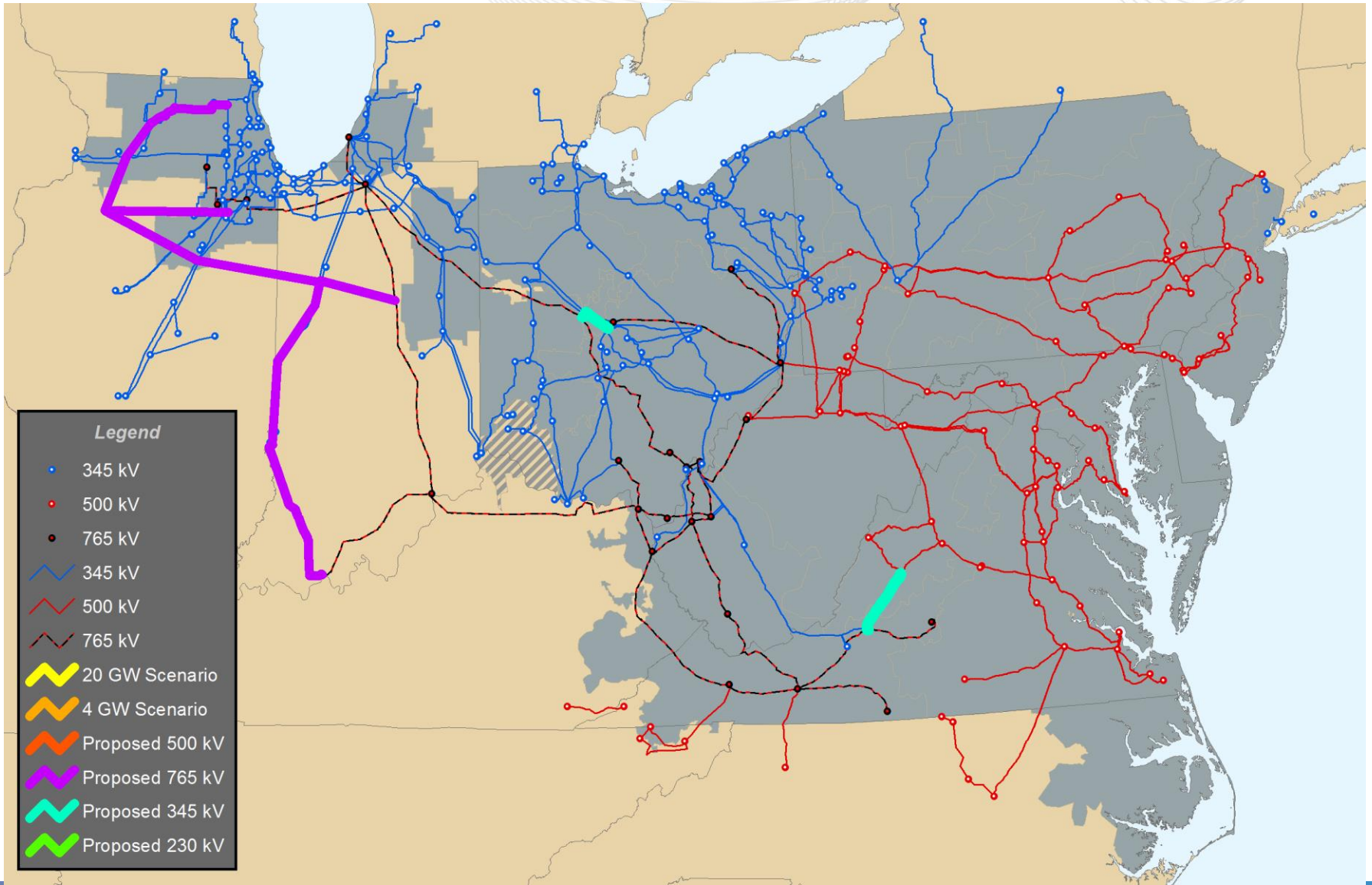
Observation

- Highest overlay savings near injection points

Observation

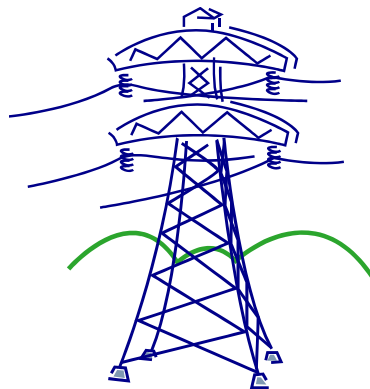
- Lower congestion in 20GW Scenario due to proximity to PJM load centers





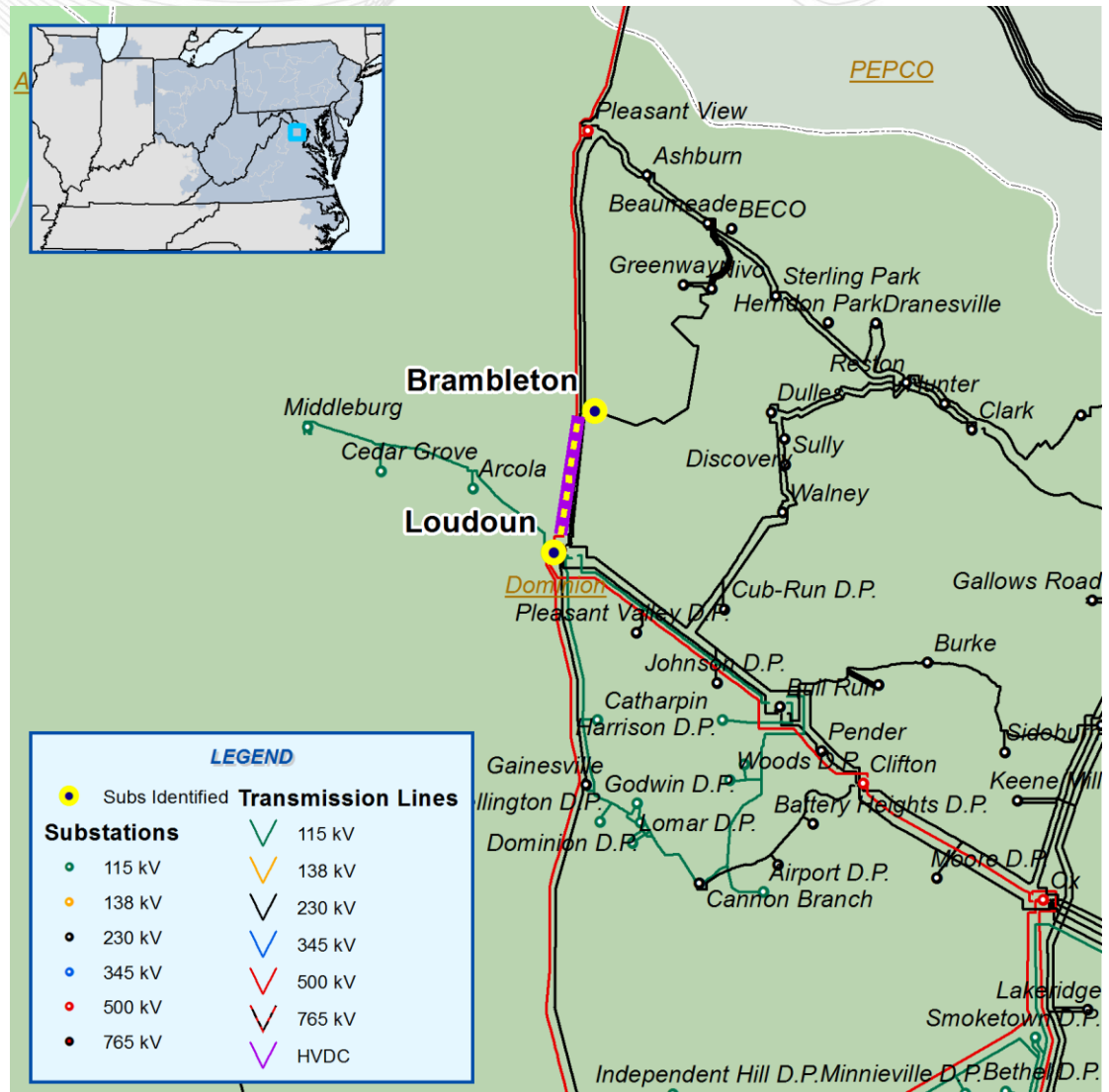
- High wind penetration
 - Impact to existing transmission
 - Impact to existing generation
 - Operational considerations
 - Installed reserve

- Achievement of RPS goals
 - Collateral impact
 - Economic impact



Baseline Reliability Update

- Generator Deliverability Violation
- An outage of Line #551 (Mt Storm – Doubs 500 kV) overloads the Loudoun – Brambleton 500 kV Line
- Proposed Solution: (B1694)
- Rebuild Loudoun – Brambleton 500 kV
- Estimated Project Cost: \$ 40 M
- Expected IS Date: 6/1/2016

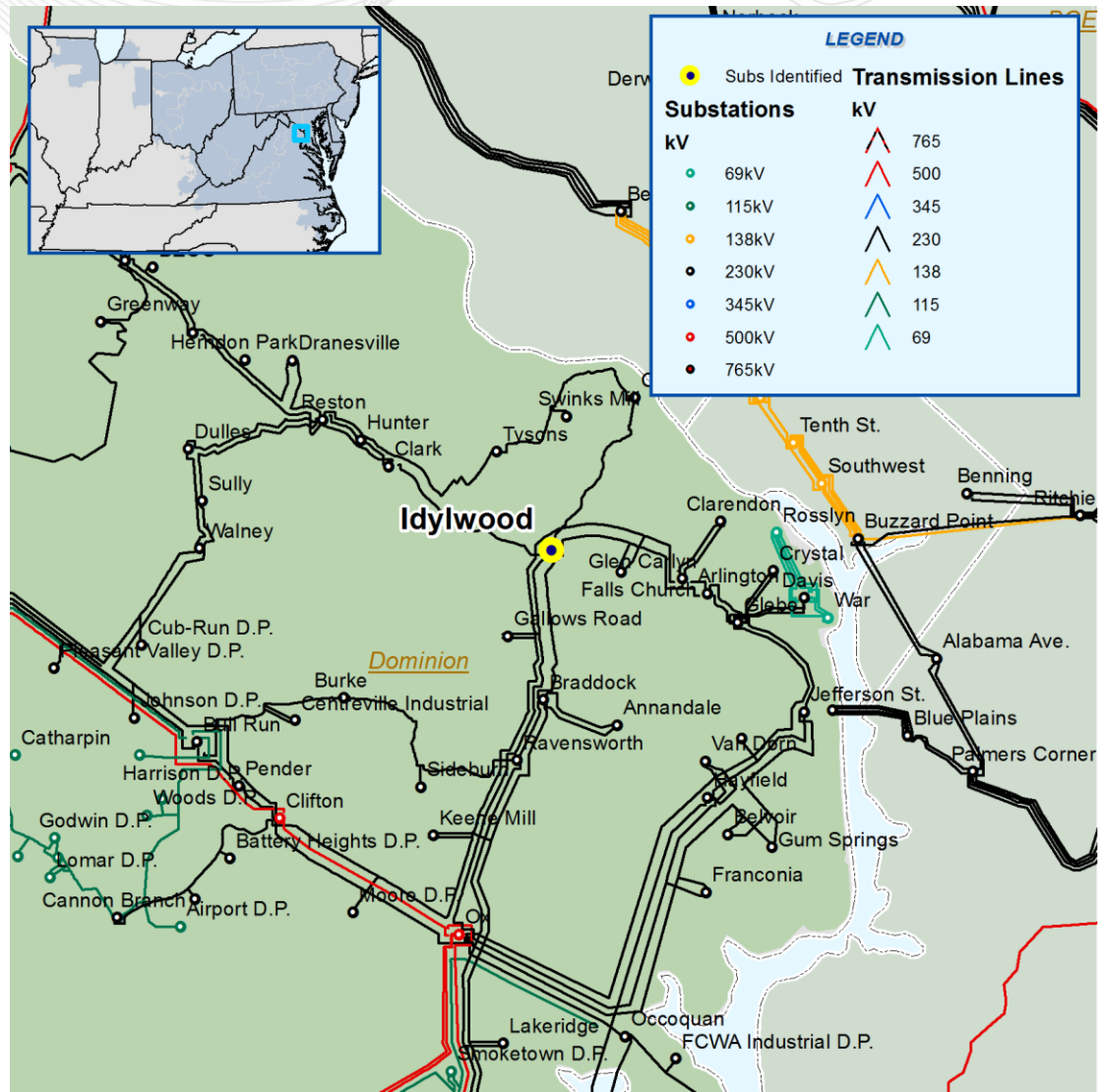


- Generator Deliverability & Common Mode Outage Violations
 - Outage of Line #2035 (Idylwood – CIA) overloads Idylwood 230 kV Bus
 - An outage of Line #215 (Possum Pt to Hayfield) overloads Idylwood 230 kV Bus
 - An outage of Line #241 (Hayfield – Jefferson St) overloads Idylwood 230 kV Bus
 - Outage of Tower Line Ox – Glebe 230kV and Jefferson St – Glebe 230kV overloads the Idylwood Bus

- Proposed Solution: (B1696)
- Convert straight bus to a Breaker and Half Scheme with a minimum of eight 230kV breakers for five existing lines

- Estimated Project Cost: \$12 M

- Expected IS Date: 6/1/2016

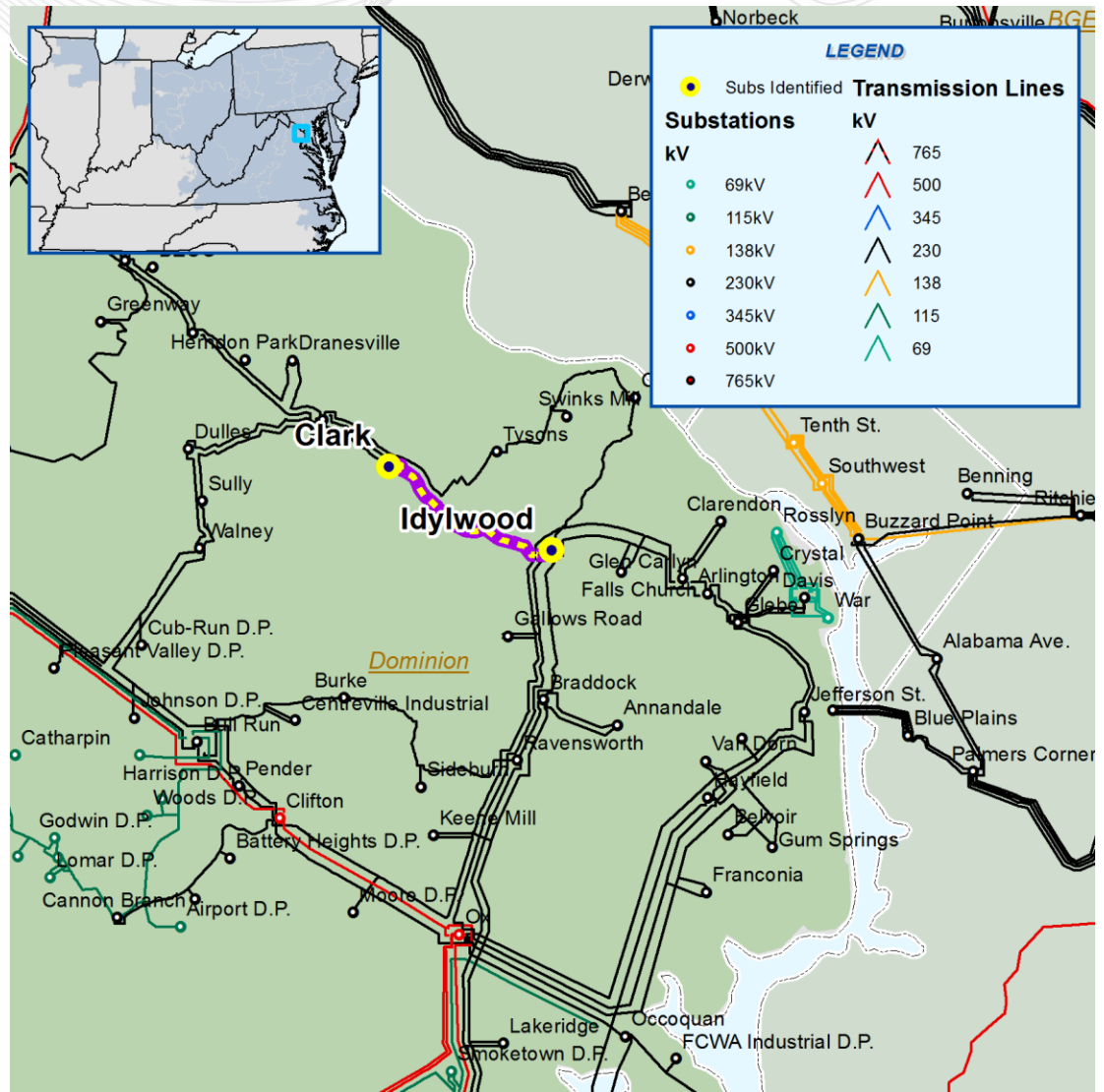


- **Generator Deliverability Violation**
 - An outage of Line #558 (Loudoun to Brambleton) overloads Clark to Idylwood 230 kV Line #202
 - An outage of Line #560 (Possum Pt – Burches) overloads the Clark to Idylwood 230 kV Line #202
 - An outage of Line #265 (Clifton – Sully) overloads the Clark to Idylwood 230 kV Line #202
 - An outage of Line #2035 (Idylwood – Redfield) overloads the Clark to Idylwood 230 kV Line #202

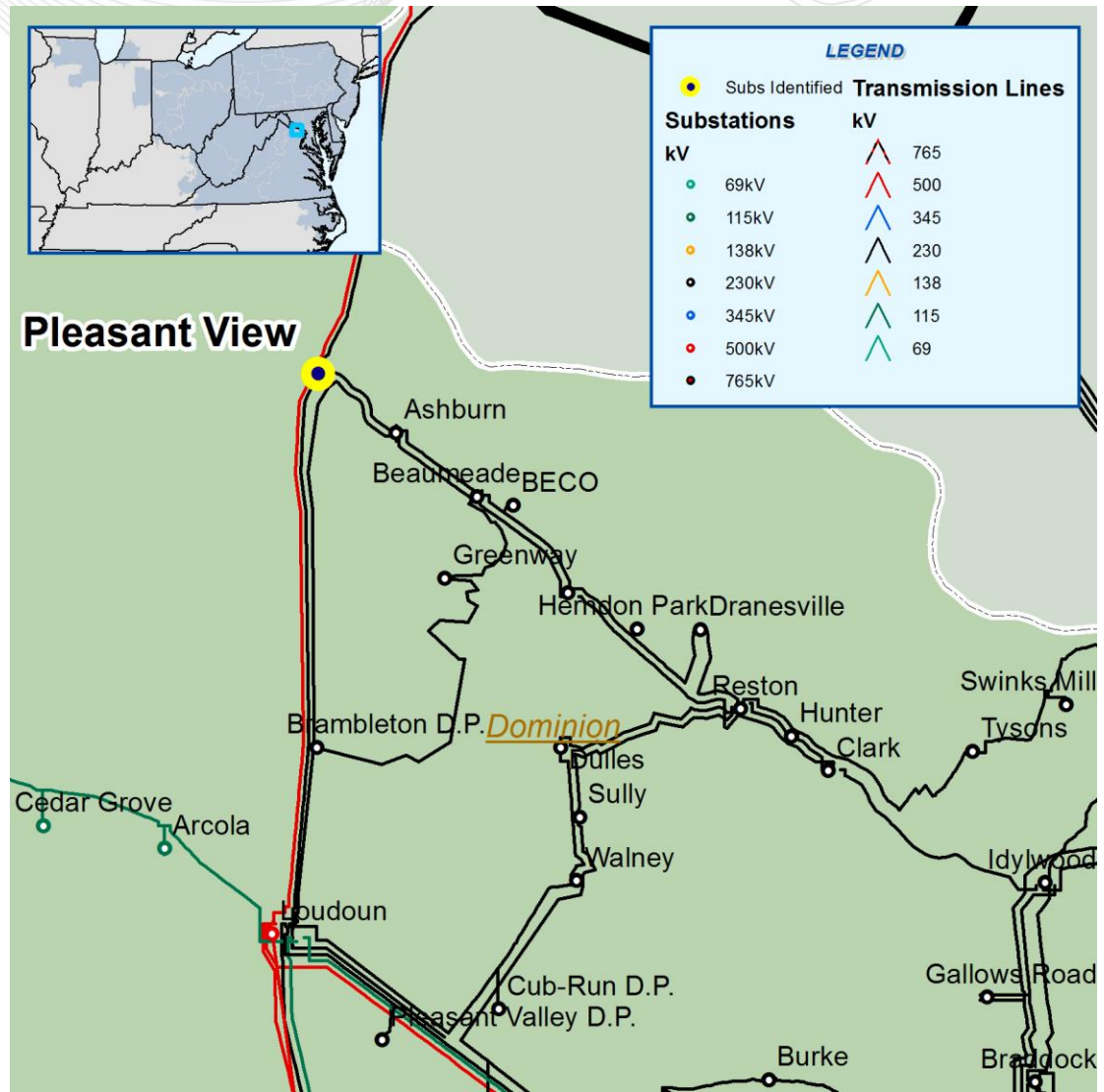
- **Proposed Solution: (B1697)**
 - Build a 2nd Clark – Idylwood 230 kV Line
 - Install 230kV gas-hybrid breakers at Clark

- **Estimated Project Cost: \$20 M**

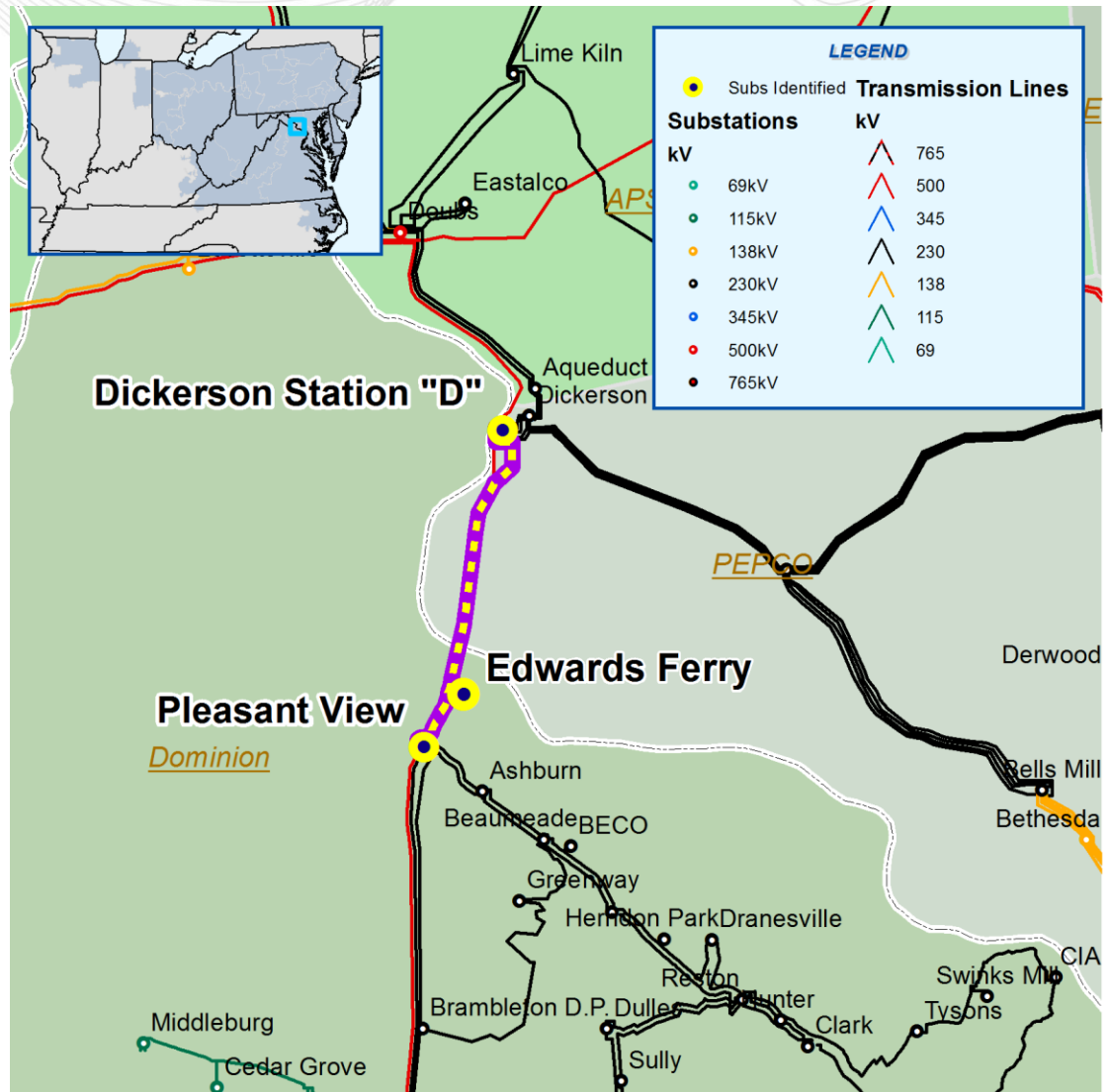
- **Expected IS Date: 6/1/2016**



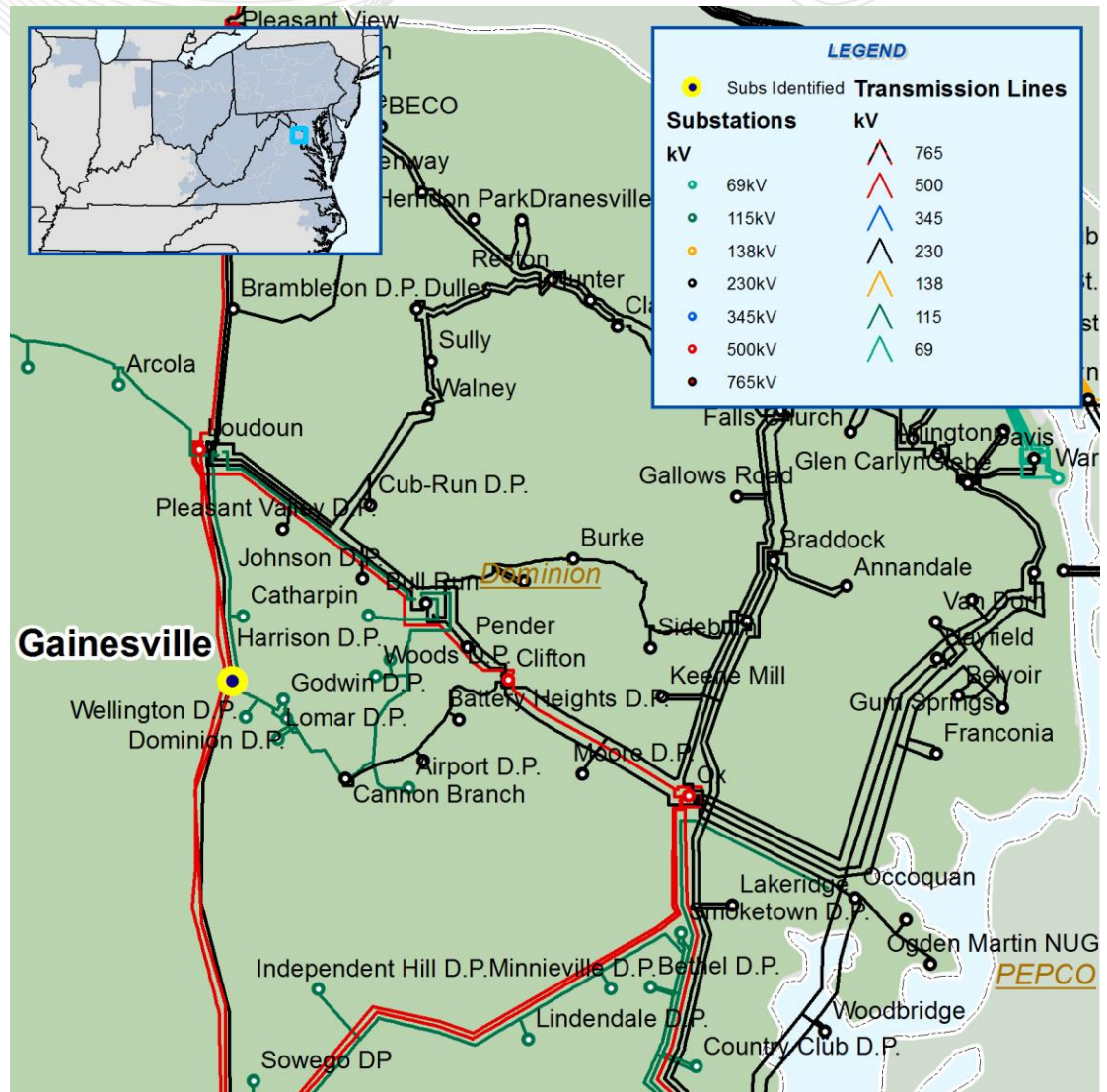
- Generator Deliverability Violation
- An outage of the Brambleton 500/230 kV Transformer or Doubs - Brighton 500 kV Line overloads the Pleasant View 500/230 kV Transformer
- Proposed Solution: (B1698)
 - Install a 2nd 500-230 kV Transformer at Brambleton Substation \$14 M
 - Install 500 kV Breaker at Brambleton \$2 M
- Estimated Project Cost: \$16 M
- Expected IS Date: 6/1/2016



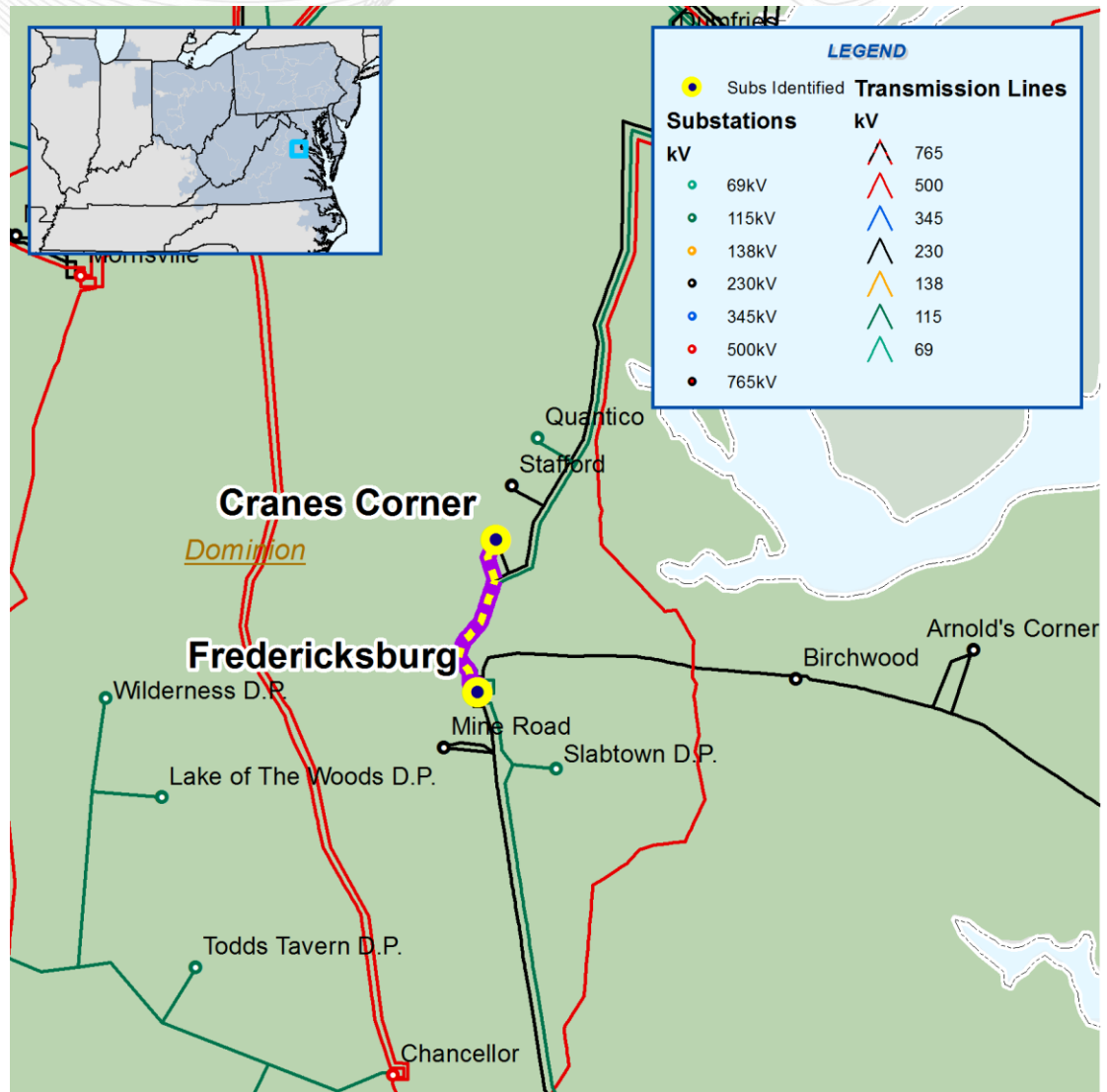
- Generator Deliverability Violation
- An outage of Line #560 (Possum Pt – Burches 500 kV) overloads the Pleasant View - Edwards Ferry section of Line #203
- Proposed Solution: (B1699)
 - Reconfigure Line #203 to feed Edwards Ferry Sub radial from Pleasant View 230 kV and install new breaker bay at Pleasant View Sub.
- Estimated Project Cost: \$4 M
- Expected IS Date: 6/1/2016



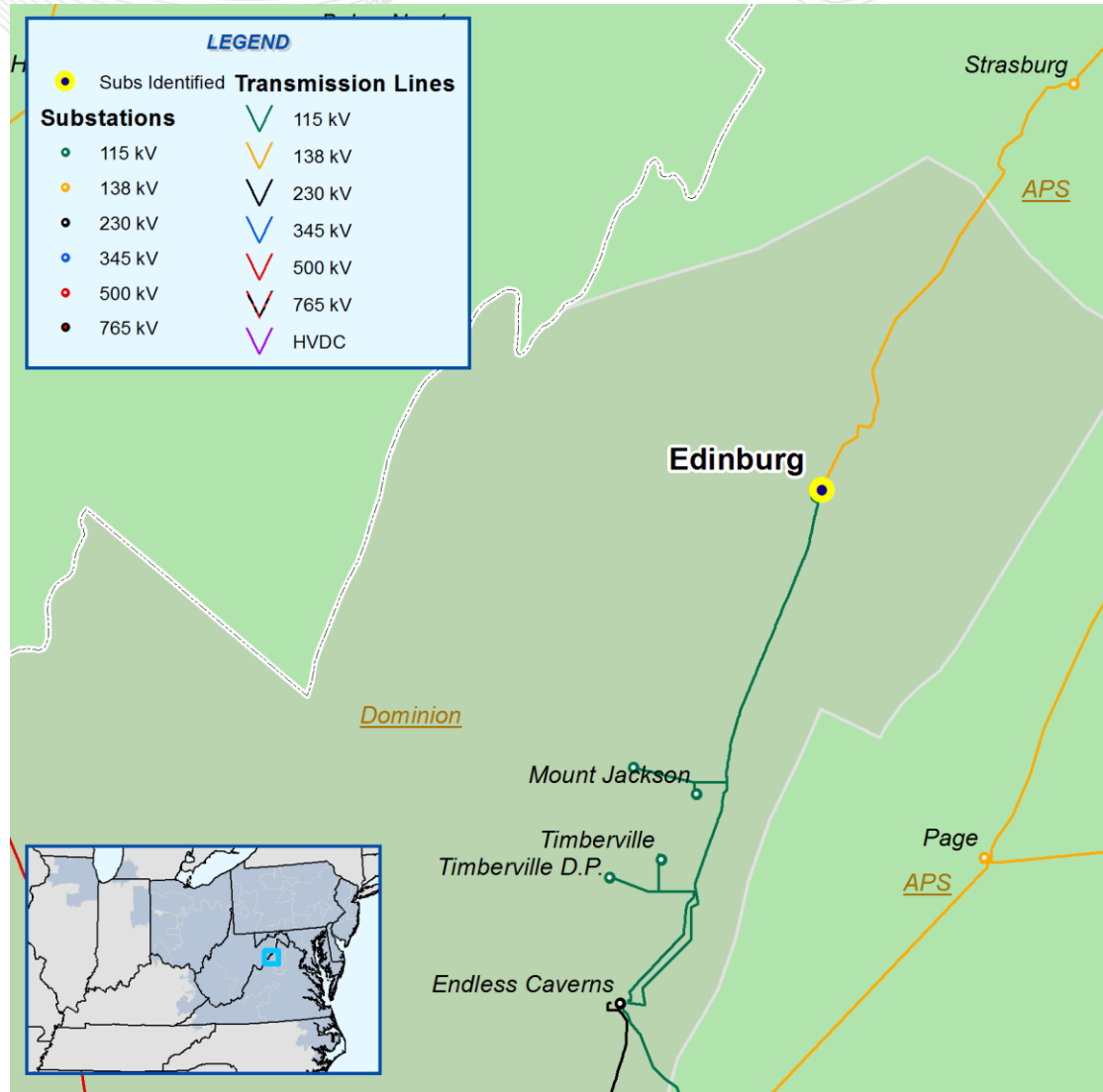
- Generator Deliverability Violation
- An outage of Line #124(115kV) or #2030(230 kV) (Gainesville – Loudoun) overloads the Gainesville 230-115 kV #3 Transformer
- Proposed Solution: (B1700)
 - Install a 230-115 kV Transformer at the new Liberty Substation to relieve Gainesville Transformer #3
- Estimated Project Cost: \$4.5 M
- Expected IS Date: 6/1/2016



- Generator Deliverability Violation
- An outage of Line #568(Ladysmith – Possum Pt 500 kV) overloads Line #2104 (Fredericksburg – Cranes Corner 230 kV)
- Proposed Solution: (B1701)
 - Re-conductor Line #2104 (Fredericksburg – Cranes Corner 230 kV)
- Estimated Project Cost: \$5.5 M
- Expected IS Date: 6/1/2016



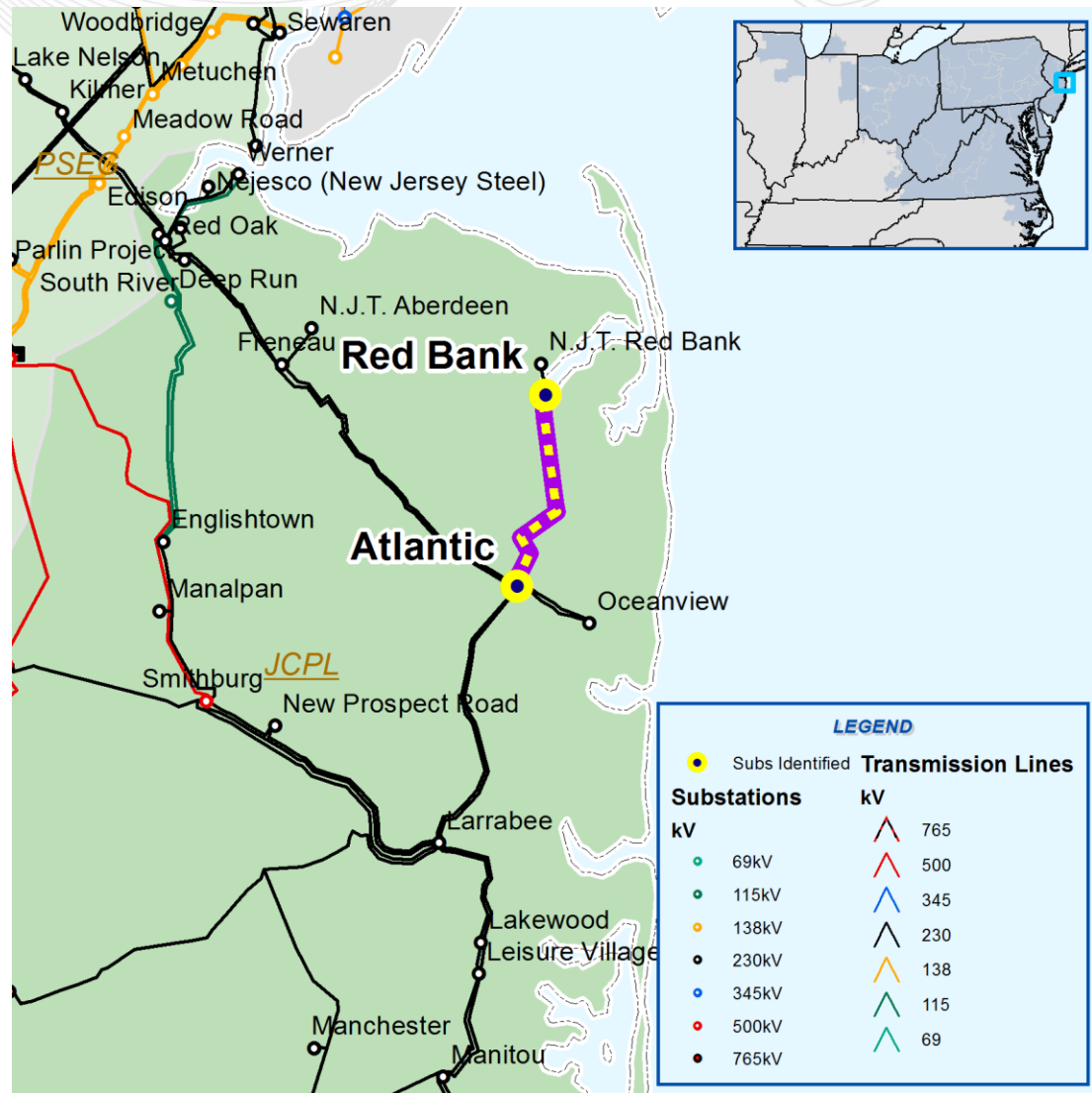
- Single Contingency Violation – Dominion Criteria
- An outage of Line #553(Cunningham – Elmont500 kV) overloads Edinburg 138-115 kV Transformer (Warren gen off line)
- Proposed Solution: (B1724)
 - Install 2nd 138-115 kV Transformer
- Estimated Project Cost: \$4.5 M
- Expected IS Date: 6/1/2016



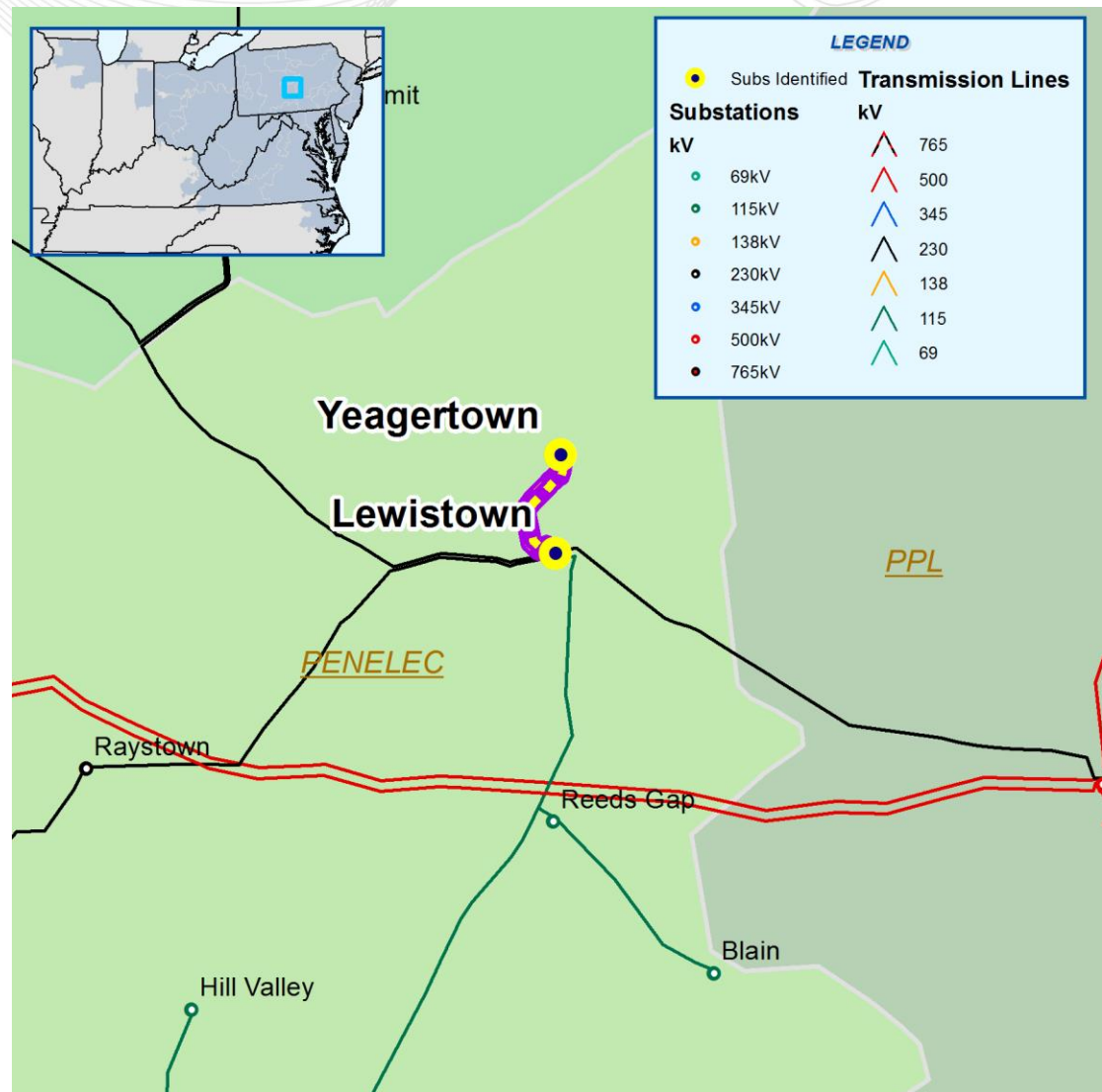
- FE Planning Criteria
- Potential local voltage collapse for a stuck "B4", "B5" or "GR" 230 kV breaker at Atlantic, "B11" maintenance outage with loss of Atlantic – Larrabee R1032 line. "RX" maintenance outage with loss of Atlantic – Freneau H1022 line.
- Proposed Solution:
Atlantic Sub - 230 kV ring bus reconfiguration. Put a "source" between the Red Bank and Oceanview "loads" to keep SVC/Caps, Bank 3 and Oceanview Bank 1 energized with the loss of Atlantic – Red Bank DCT line. (B1689).
- Estimated Project Cost:
\$ 0.555 M
- Expected IS Date:
6/1/2012



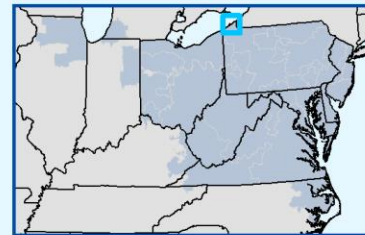
- FE Planning Criteria
- Potential local voltage collapse on the 34.5 kV system for the loss of the Atlantic - Red Bank S1033 & T2020 230 kV lines.
- Proposed Solution:
Red Bank – Build a new third 230 kV line into the Red Bank 230 kV substation (B1690).
- Estimated Project Cost:
\$ 22 M
- Expected IS Date:
6/1/2016



- Basecase/Common Mode Outage Procedure
- Overload on the Lewistown 230/46 kV transformer and voltage drop violation at Lewistown and Yeagertown 230 kV substations for a couple of contingencies.
- Proposed Solution: Install a new 230 kV circuit breaker at Yeagertown (B1610).
- Estimated Project Cost: \$ 0.70 M
- Expected IS Date: 6/1/2016



- Common Mode Outage Procedure
- Overload on the Wayne – Geneva 115 kV, Wayne 345/115 kV transformer and Erie West 345/115 kV #3 transformer for line fault and Erie West 345 kV stuck breaker
- Proposed Solution:
Install 345 kV breaker at Erie West and relocate Ashtabula 345 kV line (B1713).
- Estimated Project Cost:
\$ 0.65 M
- Expected IS Date:
6/1/2016

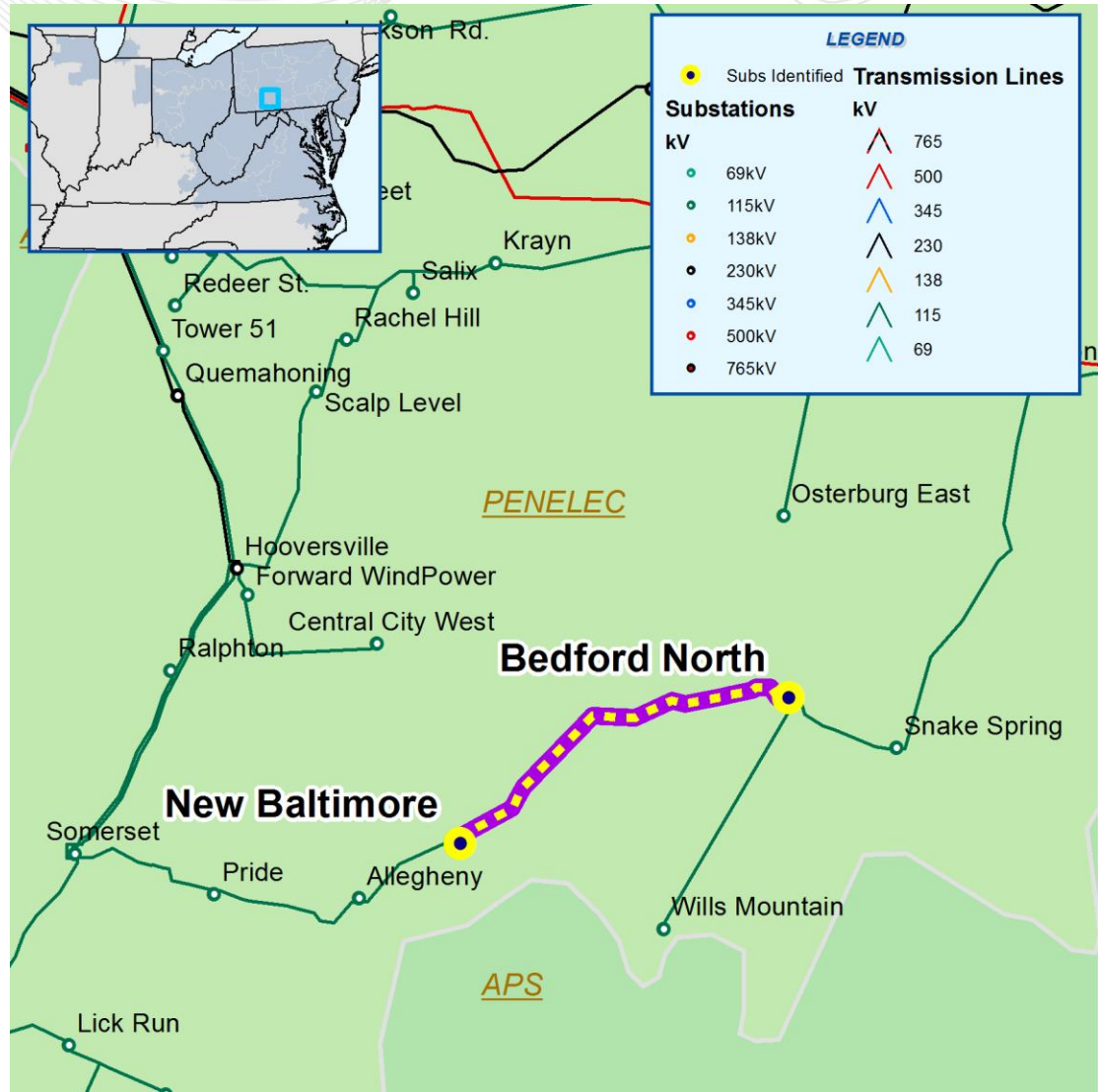


LEGEND

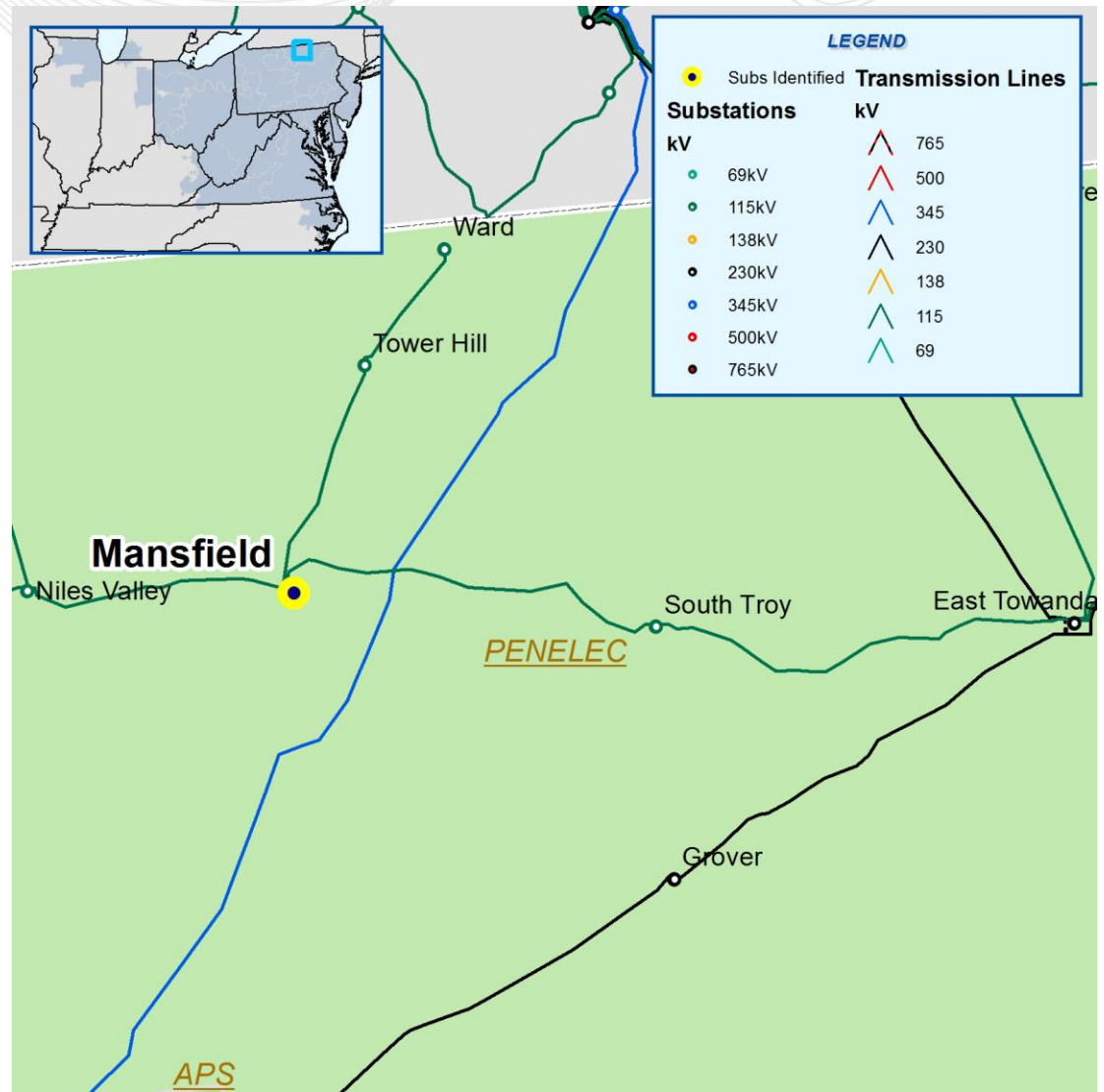
Substations		Transmission Lines	
kV	Symbol	kV	Symbol
69kV	Green circle	765	Black triangle
115kV	Light green circle	500	Red triangle
138kV	Yellow circle	345	Blue triangle
230kV	Black circle	230	Black triangle
345kV	Blue circle	138	Yellow triangle
500kV	Red circle	115	Light green triangle
765kV	Black circle	69	Light blue triangle



- Common Mode Outage Procedure
- Overload on the New Baltimore – Bedford North 115 kV circuit for several multiple facility contingencies.
- Proposed Solution: Reconductor the New Baltimore – Bedford North 115 kV circuit (B1607).
- Estimated Project Cost: \$ 11 M
- Expected IS Date: 6/1/2016

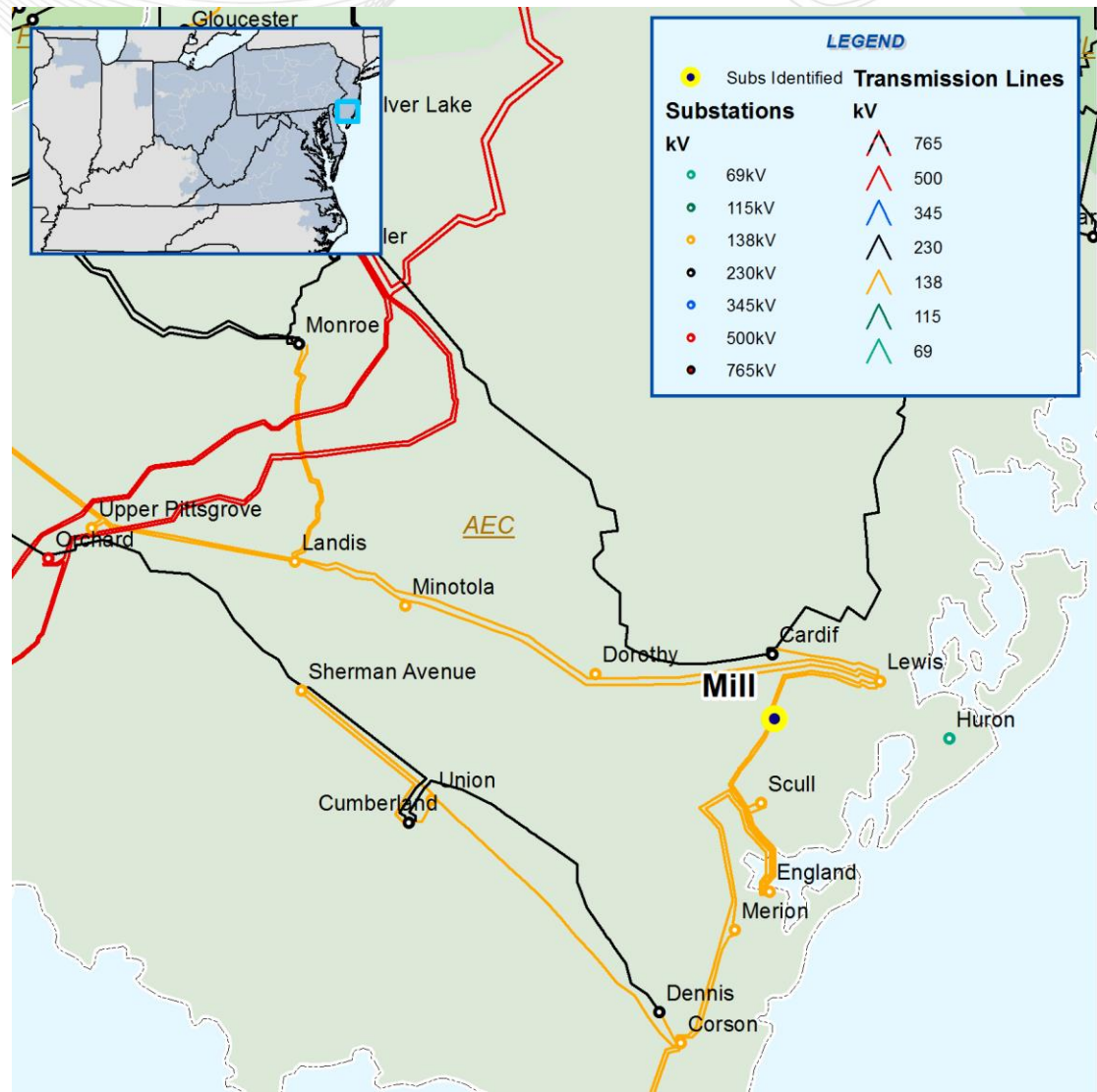


- Basecase/Common Mode Outage Procedure
- Thermal and voltage violations in the northern Penelec 115 kV system for several contingencies.
- Proposed Solution:
Construct a new 345/115 kV substation and loop the Mansfield – Everts Drive 115 kV line (B1608).
- Estimated Project Cost:
\$ 13 M
- Expected IS Date:
6/1/2016



Proposed 2011 RTEP Upgrades presented at Previous TEAC meetings

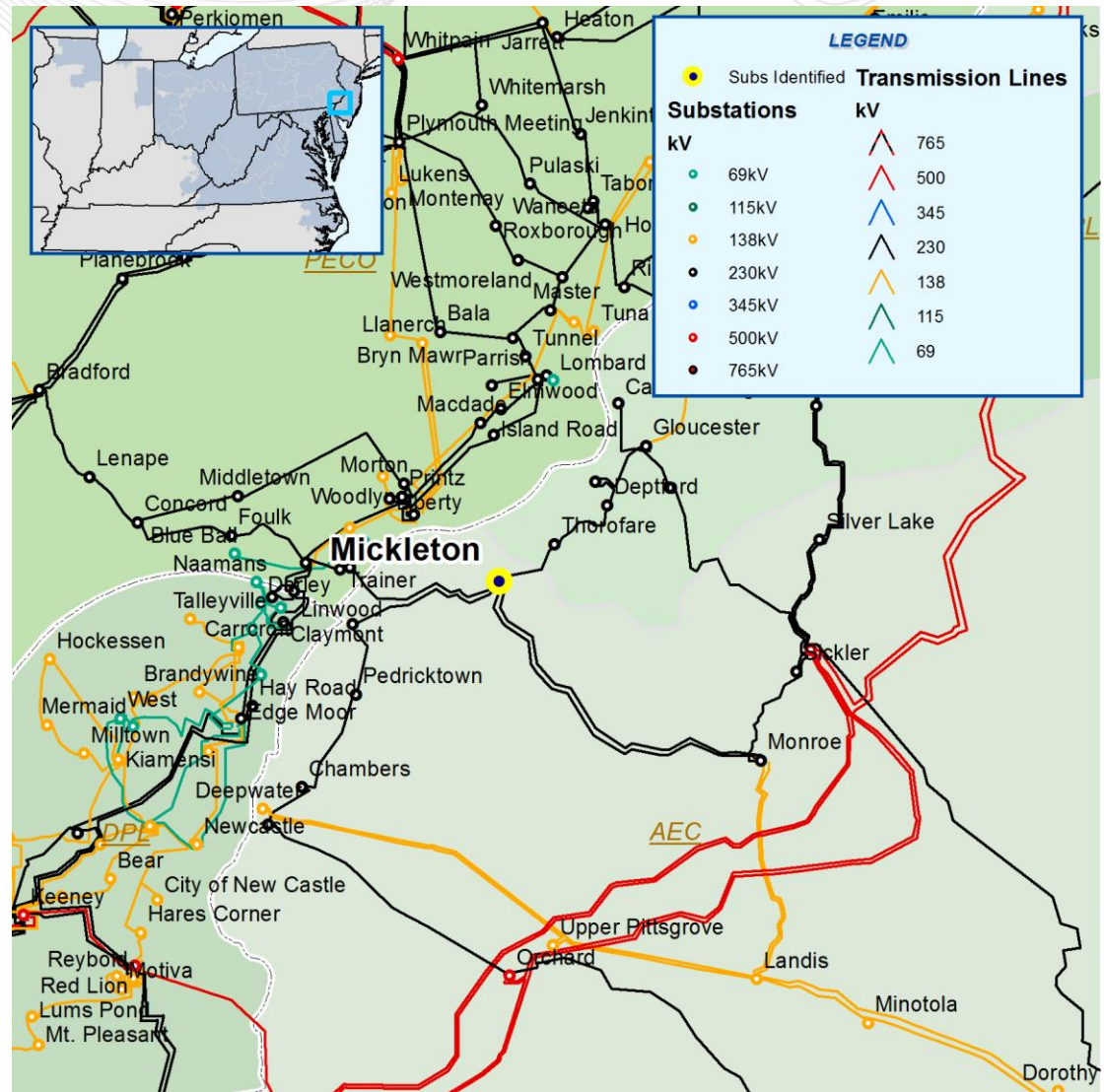
- Common Mode Outage Procedure
- Overload on Mill T2 138/69 kV transformer for a few contingencies
- Proposed Solution:
Upgrade the Mill T2 138/69 kV transformer (B1600).
- Estimated Project Cost:
\$ 5.0 M
- Expected IS Date:
6/1/2016



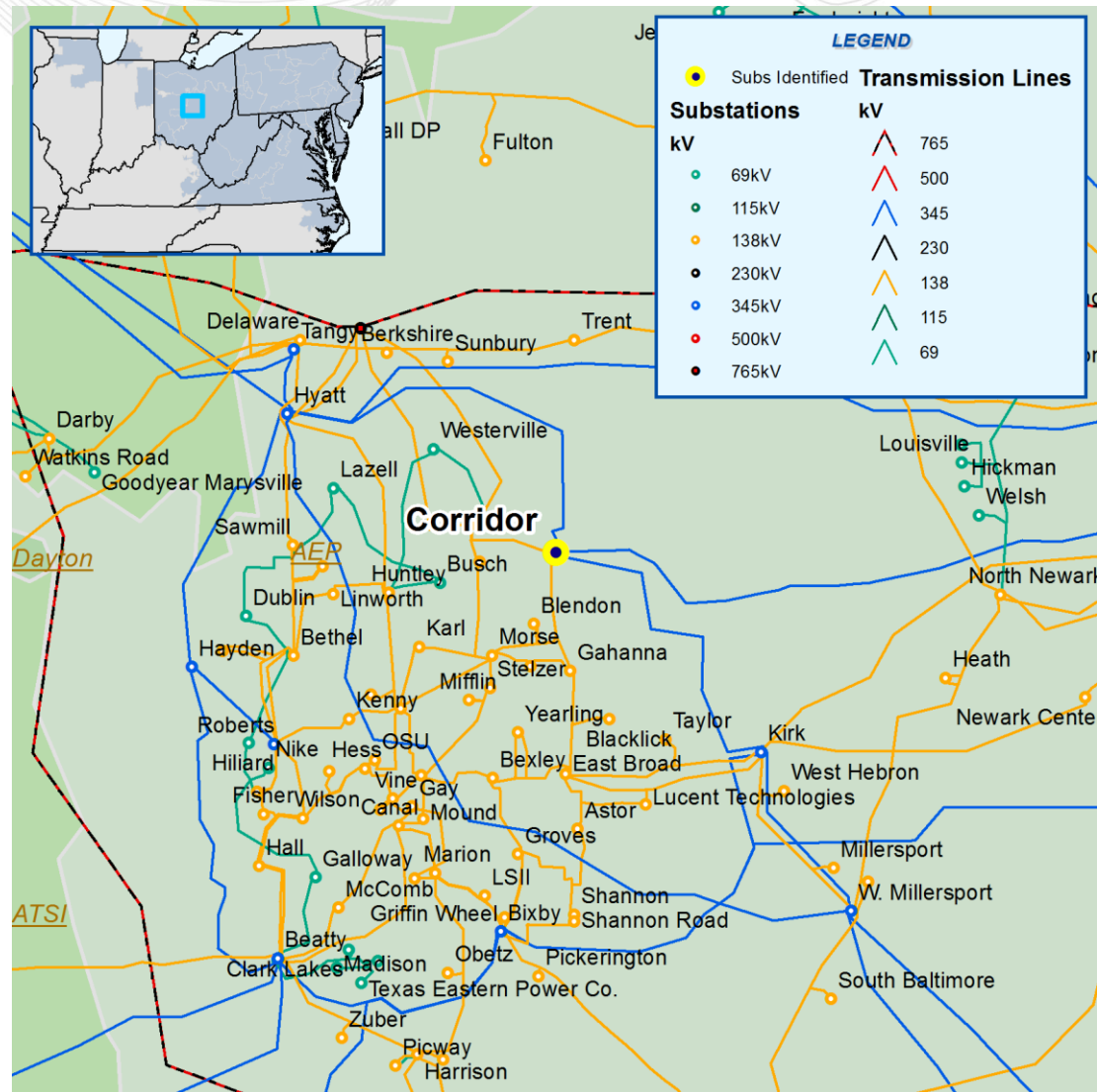
- Common Mode Outage Procedure
- Overload on Sherman Ave. – Carl’s Corner 69 kV circuit for several contingencies
- Proposed Solution: Reconductor the Sherman Ave. – Carl’s Corner 69 kV circuit (B1598).
- Estimated Project Cost: \$ 5.6 M
- Expected IS Date: 6/1/2016



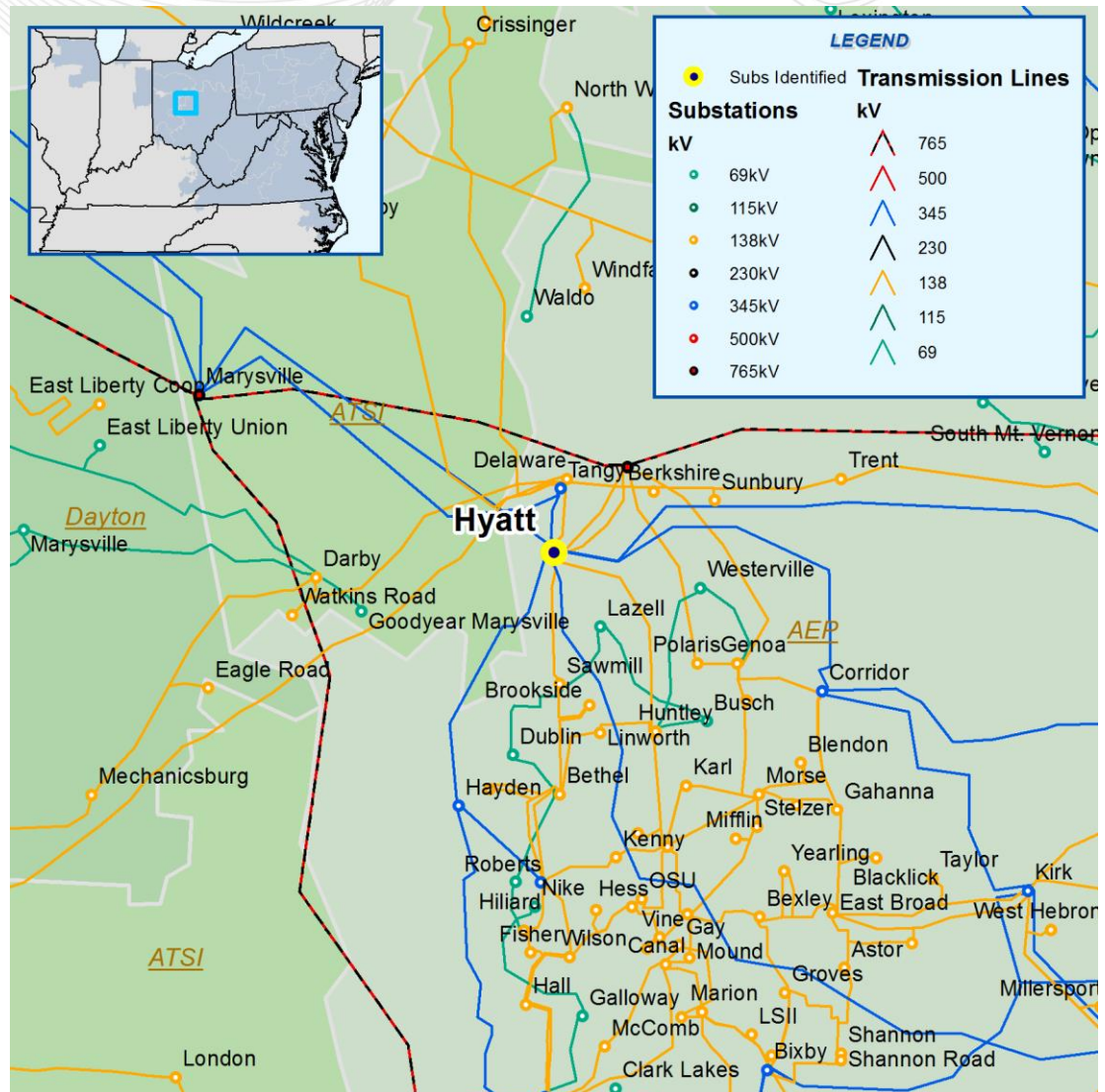
- Common Mode Outage Procedure
- Overload on Central North – Shieldalloy 69 kV circuit for tower-line contingency loss of the BL England – Lewis 138 kV circuits
- Proposed Solution: Replace terminal equipments at Central North 69 kV substation (B1599).
- Estimated Project Cost: \$ 0.476 M
- Expected IS Date: 6/1/2016



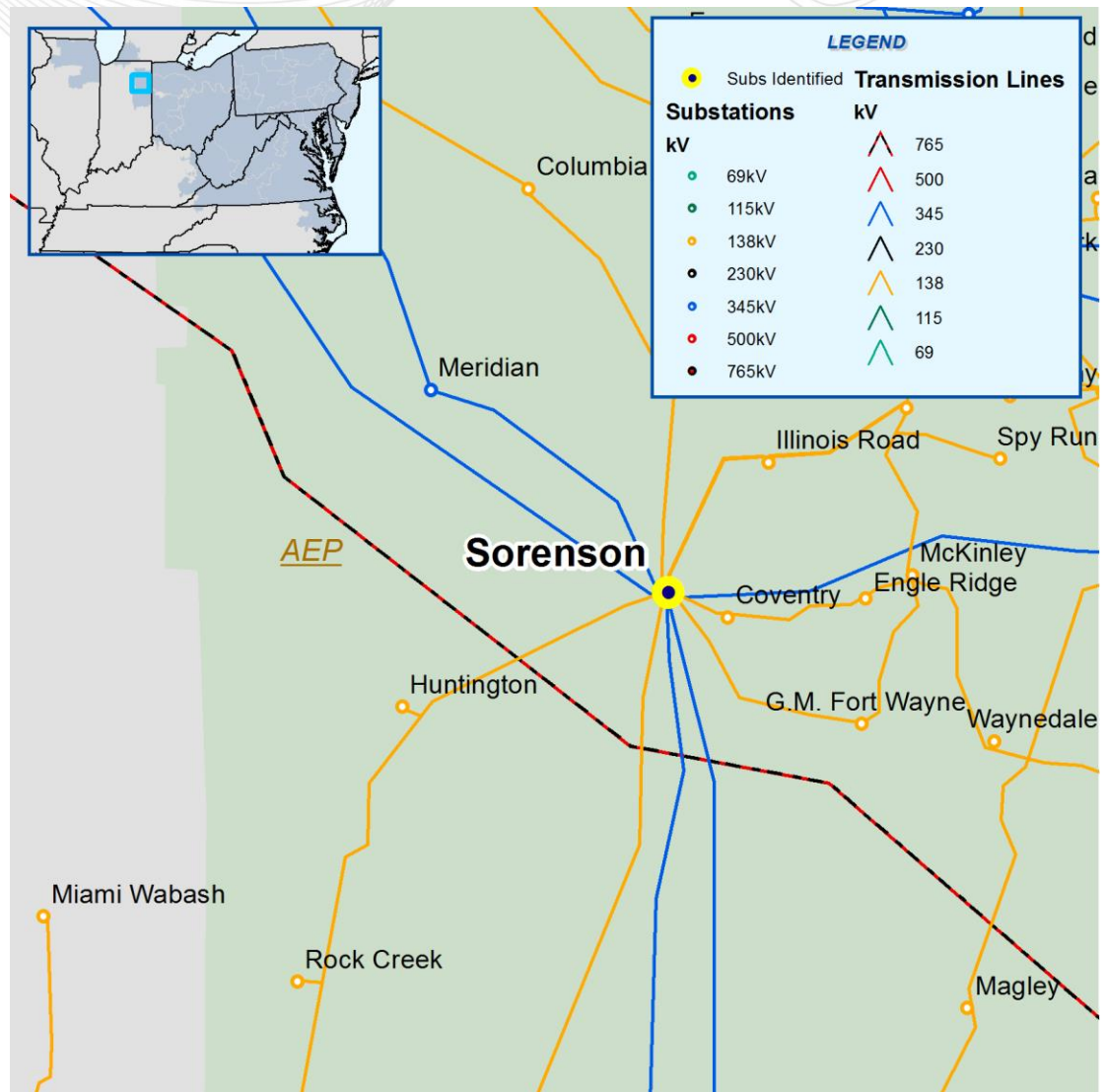
- The Corridor 138 kV breakers '106C', '104S', and '104C' are overstressed
- Significant Driver: Build a new "Vassel" 765/345/138 kV Station to the North of Columbus, OH at the intersection of Kammer – Maliszewski 765 kV line and the Hyatt – Corridor 345 kV line
- Proposed Solution: Replace the Corridor 138 kV breakers '106C', '104S', and '104C' (s0251.6 – s0251.8)
- Estimated Project Cost: \$1.448 M per breaker
- Expected IS Date: 5/1/2014



- The Hyatt 138 kV breaker '104C' is overstressed
- Significant Driver: Build a new "Vassel" 765/345/138 kV Station to the North of Columbus, OH at the intersection of Kammer – Maliszewski 765 kV line and the Hyatt – Corridor 345 kV line
- Proposed Solution: Replace the Hyatt 138 kV breaker '104C' (s0251.9)
- Estimated Project Cost: \$1.1 M
- Expected IS Date: 5/1/2014



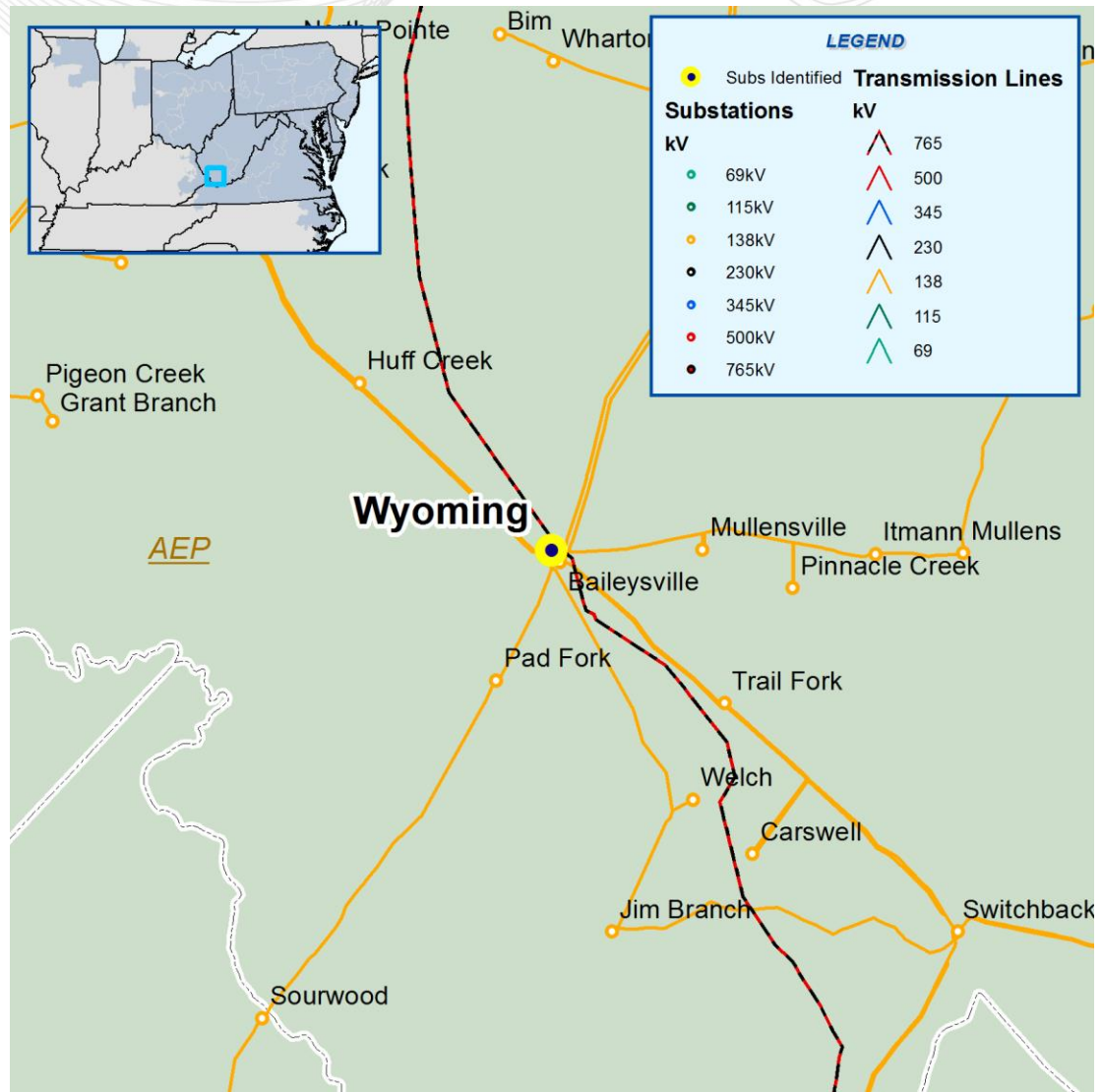
- N-1-1 Voltage Violation
- Low voltage magnitude and deviation violations at approximately Forty Nine 138 kV buses in Urban Fort Wayne and Western Ohio areas for the loss of Robison Park 345 kV transformer in combination with another Category B contingency in the Urban Fort Wayne area
- Proposed Solution: Establish Sorenson 345/138 kV station as a 765/345 kV Station. (B1659)
- Estimated Project Cost: \$85 M
- Expected IS date: 6/1/2016



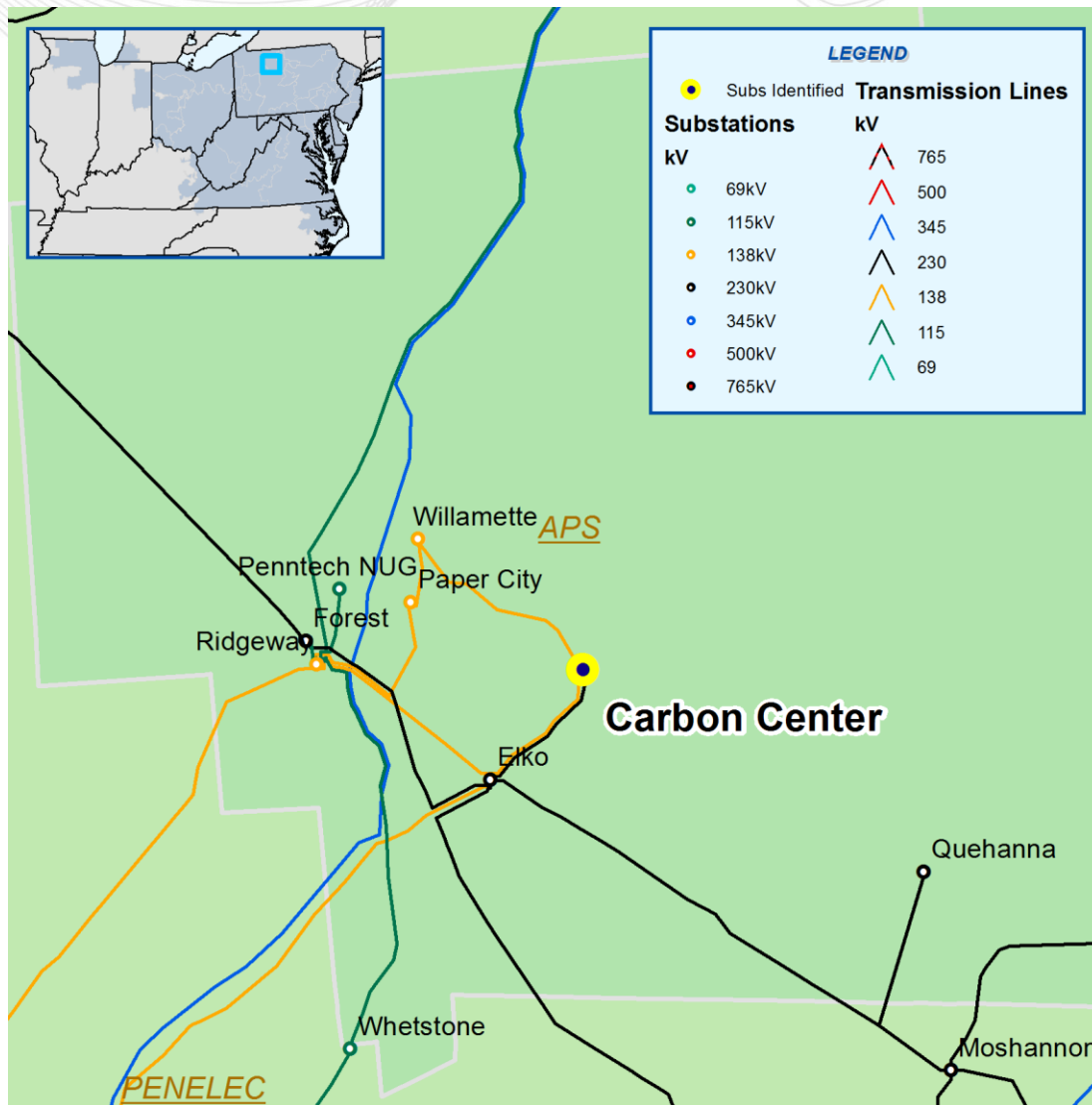
- N-1-1 Voltage Violation
- Low voltage magnitudes and voltage drops in the Roanoke, VA area and suburbs for the loss of Cloverdale - Lexington 500 kV line in combination with other 765 kV or 345 kV facilities.
- Proposed Solution: Install a 765/500 kV transformer at Cloverdale. (B1660)
- Estimated Project Cost: \$65 M
- Expected IS date: 6/1/2016



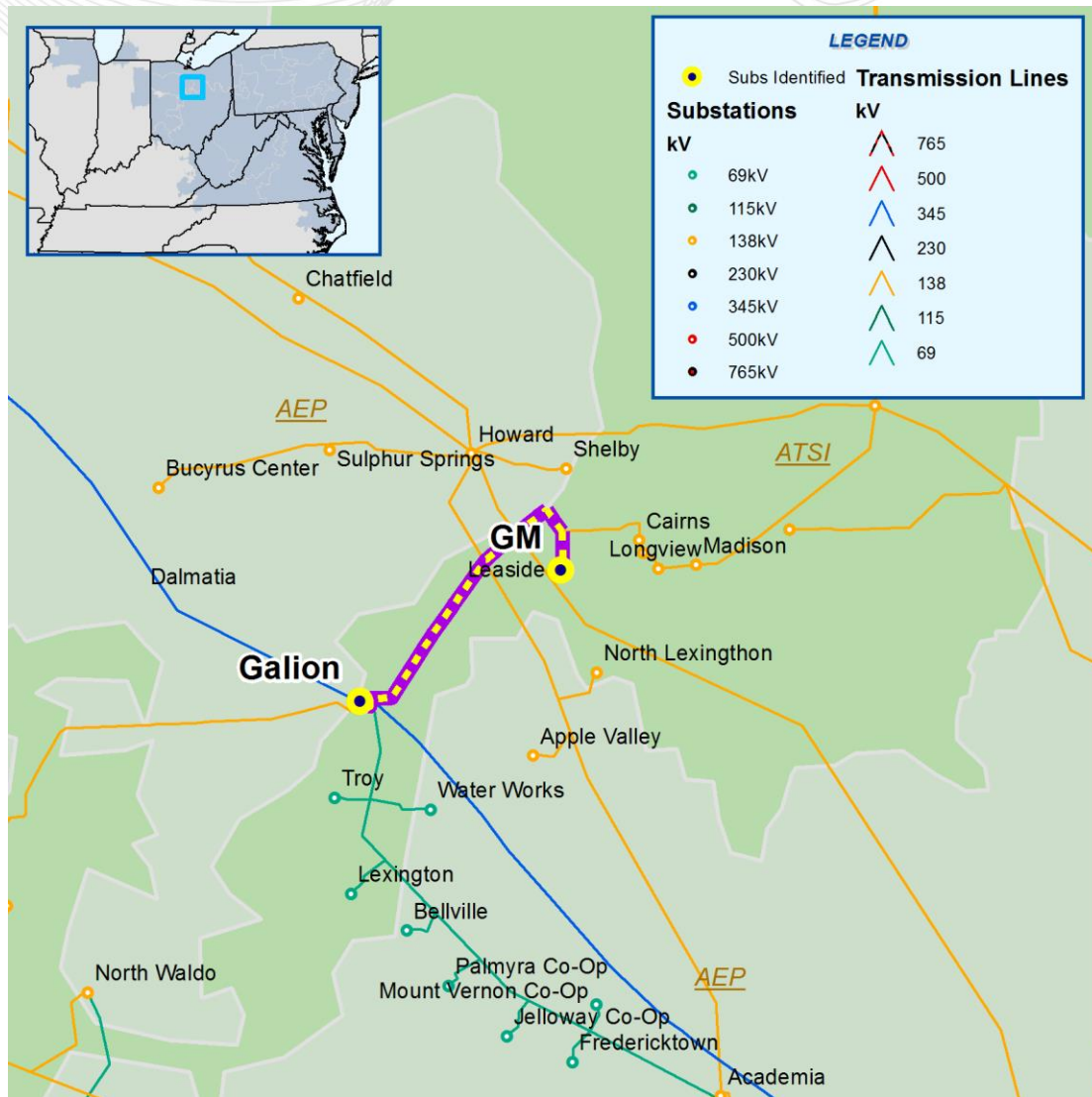
- N-1-1 Voltage Violation
- Low voltage magnitude and deviation violations Logan WV area for the loss of the transformers along with loss of other major 138 kV facilities in Logan, WV area
- Proposed Solution: Install a 765 kV circuit breaker at Wyoming station. (B1661)
- Estimated Project Cost: \$2M
- Expected IS date: 6/1/2016



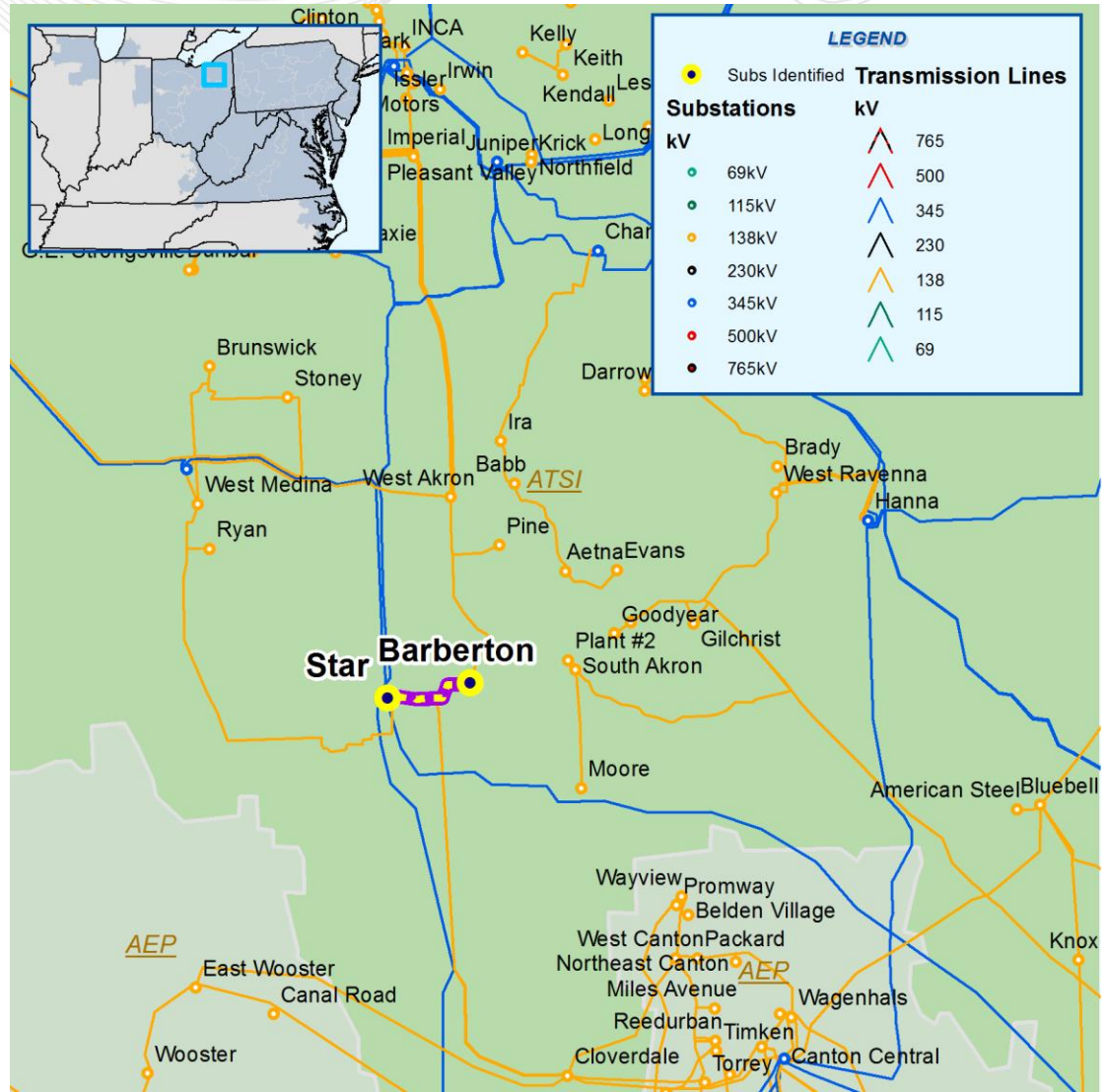
- Install a 230 kV breaker at Carbon Center (B1672)
- Replaced projects (B1221.1 – B1221.4) with the project B1672
- Convert Carbon Center 138 kV to 230 kV and change the operation of the 230/138 kV transformer at Carbon Center. The 230/138 kV transformer LTC will be operated in manual (b1221.1)
- Construct Bear Run Substation (b1221.2)
- Convert Carbon Center Junction-Bear Run from 138 kV to 230 kV (b1221.3)
- Convert Carbon Center Junction-Carbon Center from 138 kV to 230 kV (b1221.4)
- Estimated Project Cost: \$0.4 M
- Expected IS date: 6/1/2014



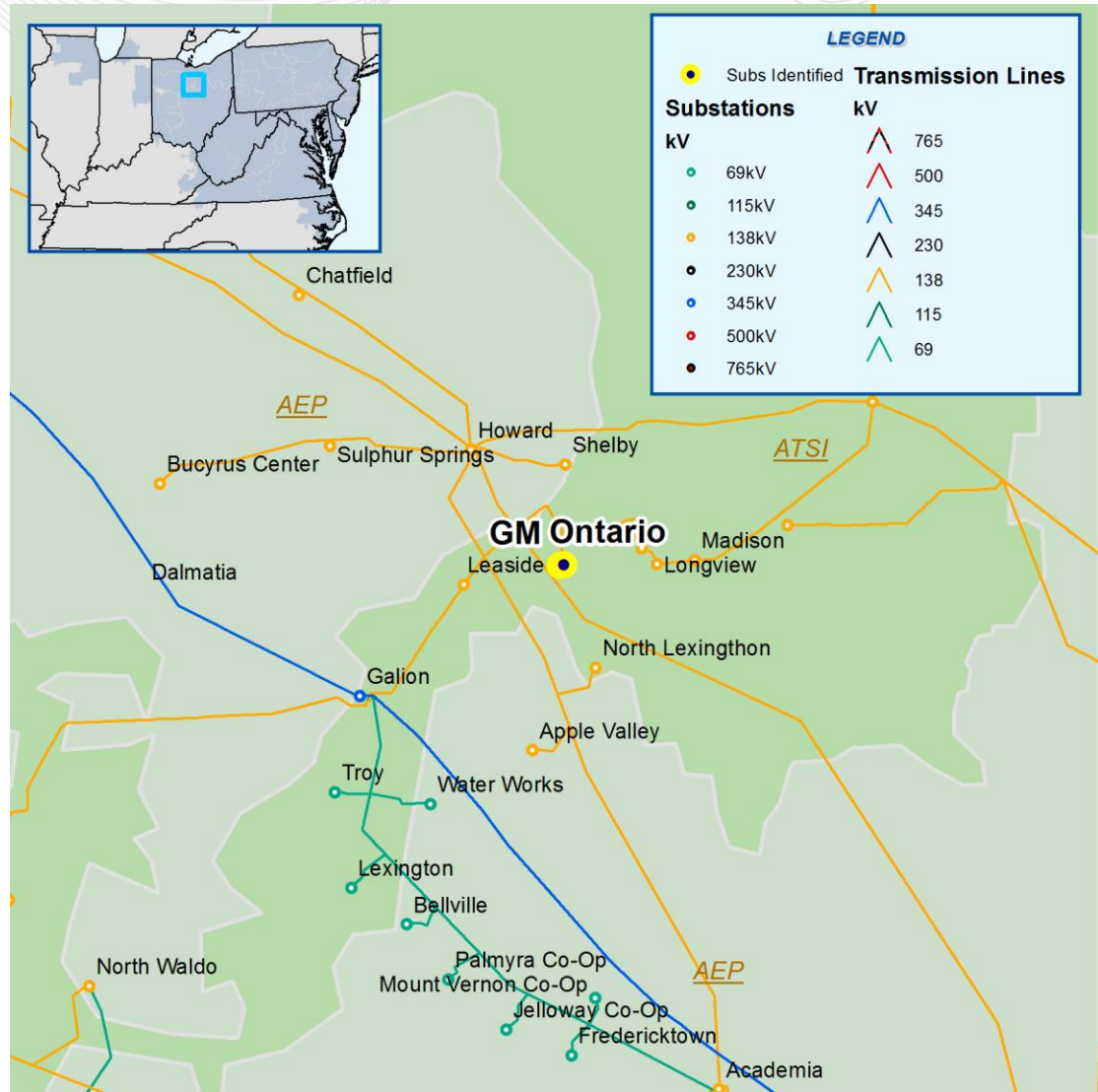
- Common Mode Violation
- Galion –GM Mansfield 138KV line is overloaded for various category C contingencies.
- Recommended Solution:
Galion-GM Mansfield-Longview 138 kV line: Bypass GM Mansfield substation (b1585)
- Estimated Project Cost: \$0.05M
- Expected IS date: 06/01/2016



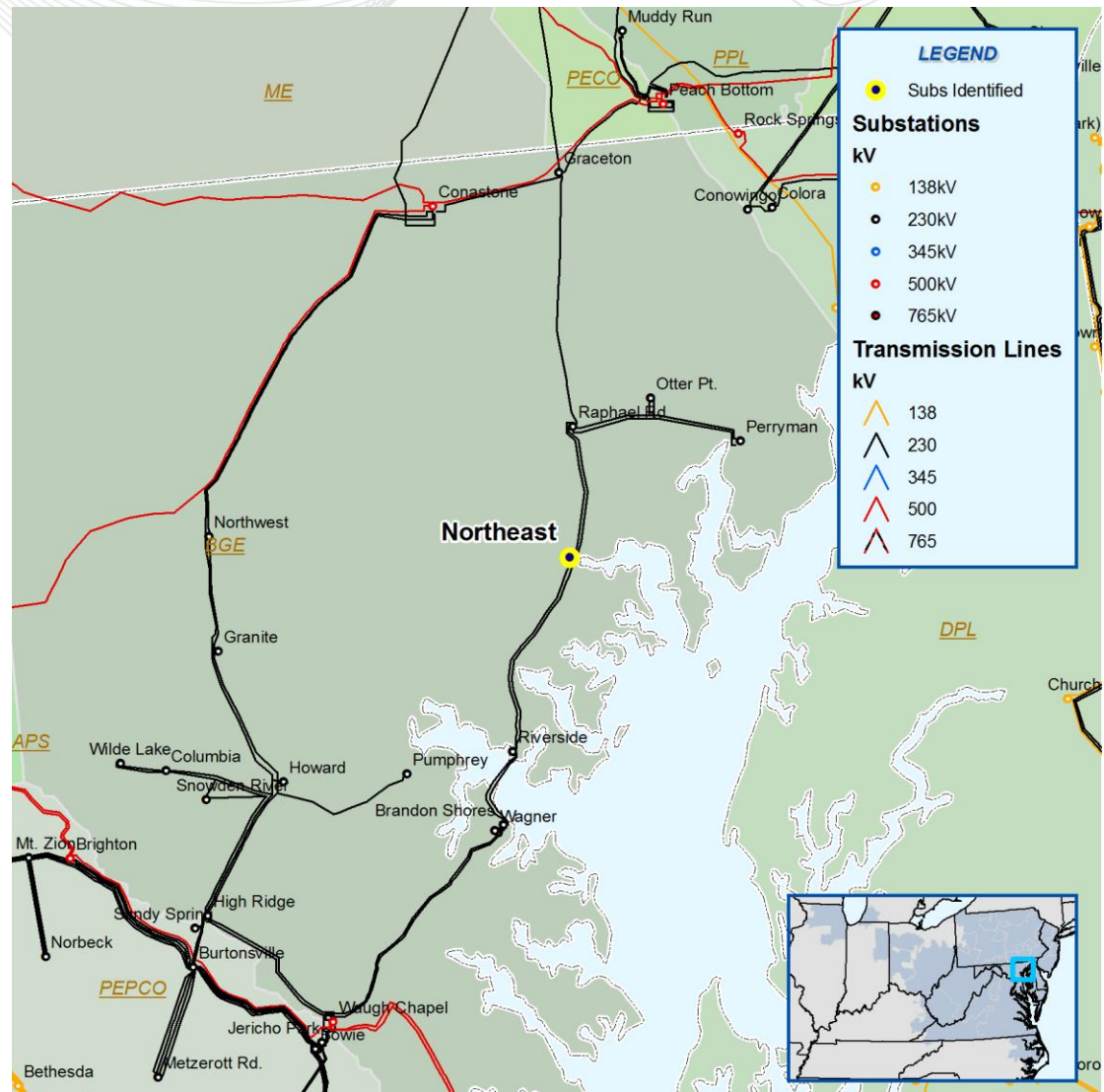
- Common Mode Violation
- Barberton – Star #2 138KV line is overloaded for the tower outage of Barberton – Star 138kV line #1 and Cloverdale – Start 138kV line
- Recommended Solution:
- Change the relay setting Limit (B1586)
- Estimated Project Cost: \$0M
- Expected IS date: 06/01/2016



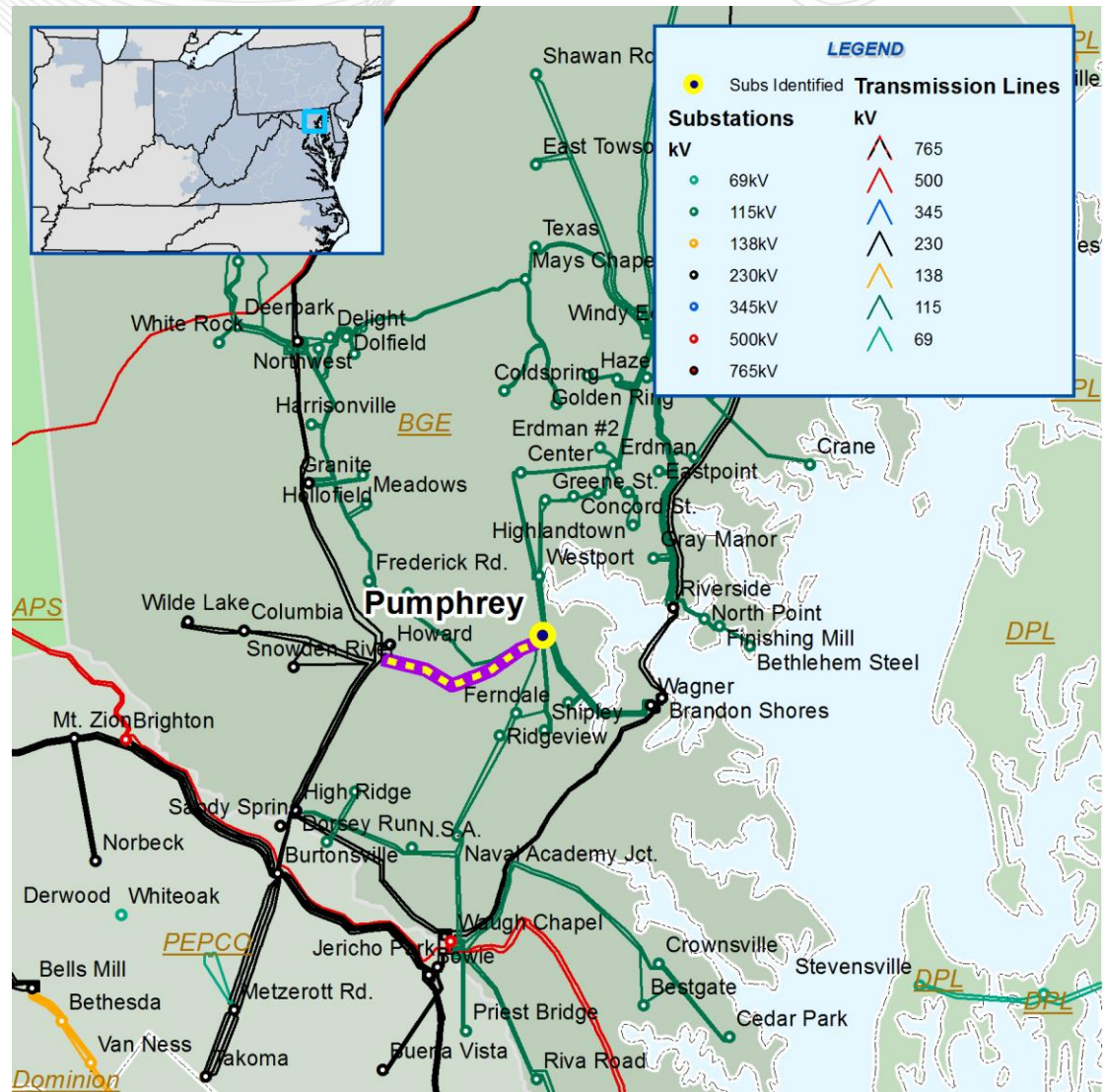
- Common Mode Violation
- GM Mansfield – Ontario 138kV line is overloaded for various category C contingencies.
- Recommended Solution:
• Build New Mansfield 69kV Switching Station networking Leaside, Longview, and Galion Subs @ existing Alta 69kV Sub Site (B1587)
- Estimated Project Cost: \$6.8M
- Expected IS date: 06/01/2016



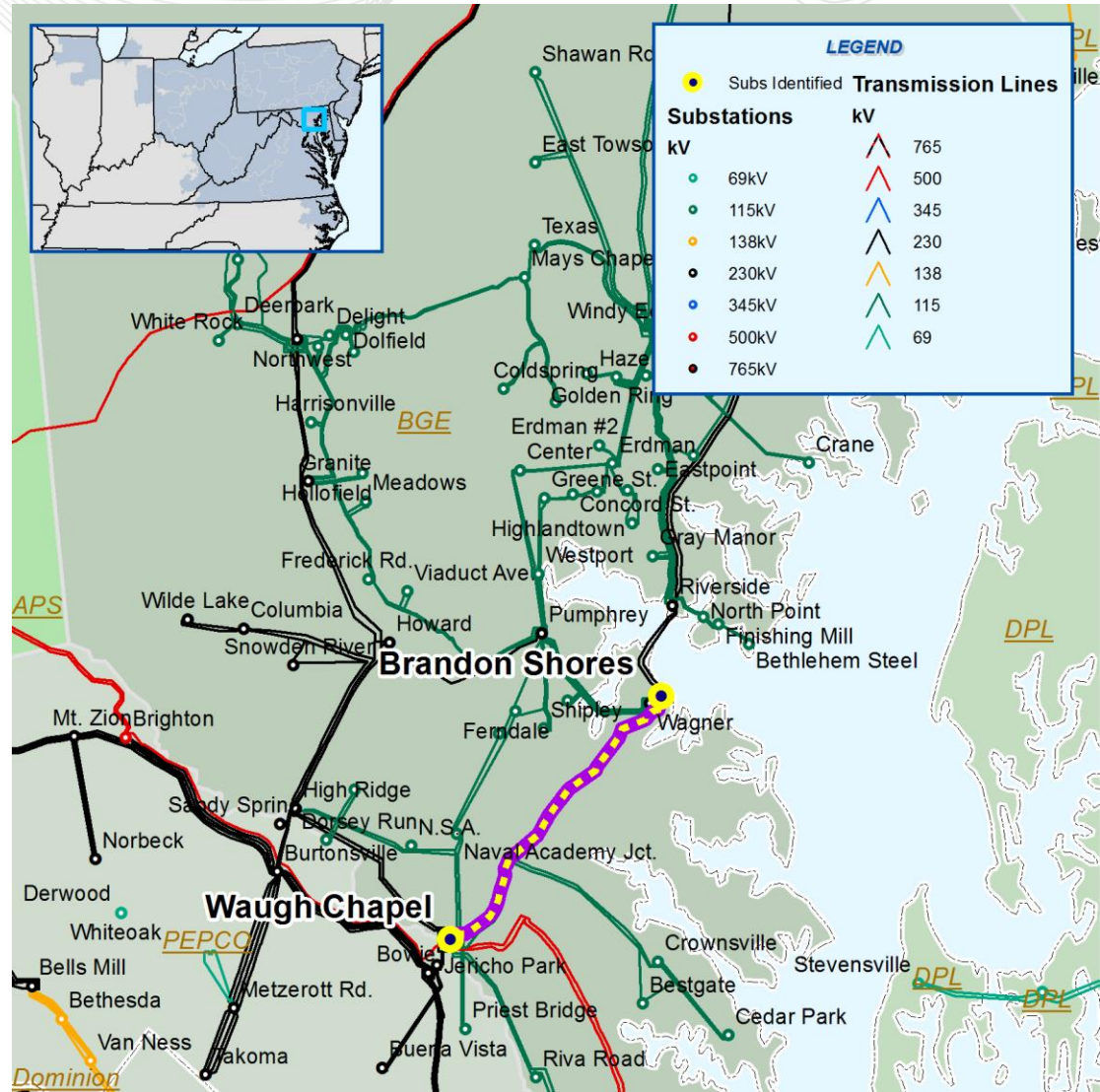
- The Northeast 230 kV breaker '2317/315' is overstressed
- Significant Driver: Replace the existing Northeast 230/115 kV transformer #3 with 500 MVA (b1253)
- Proposed Solution: Replace the Northeast 230 kV breaker '2317/315' (b1253.1)
- Estimated Project Cost: \$550 K
- Expected IS Date: 6/01/2015



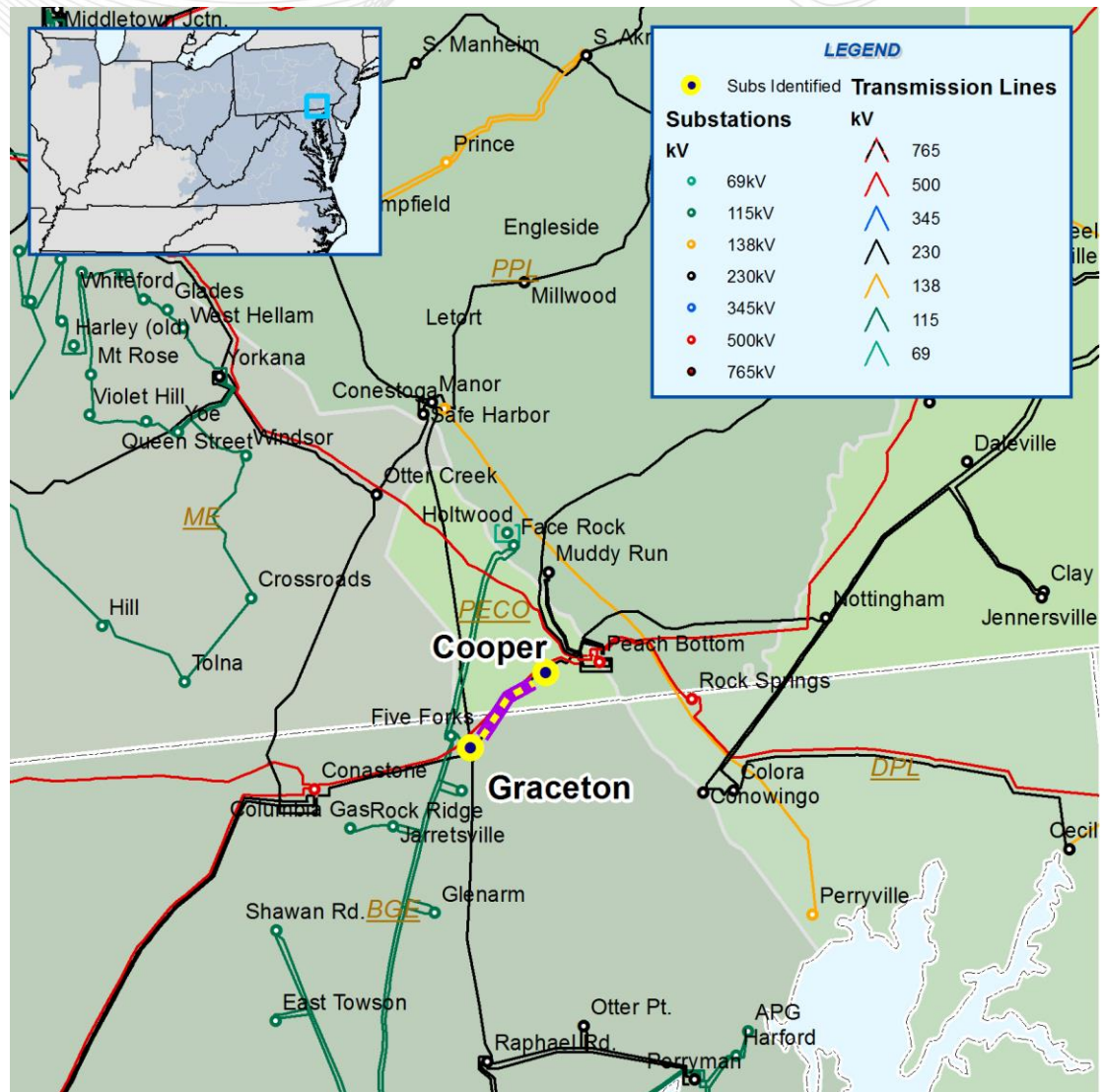
- Operational Performance:
- PJM identified this project to improve operational performance
- Recommended Solution: Advance the baseline upgrade B1252 to upgrade terminal equipment removing terminal limitation at Pumphrey Tap on BGE 230 kV circuit 2332-A (B1544).
- Estimated Project Cost: \$28 K
Expected IS Date: 06/01/2011



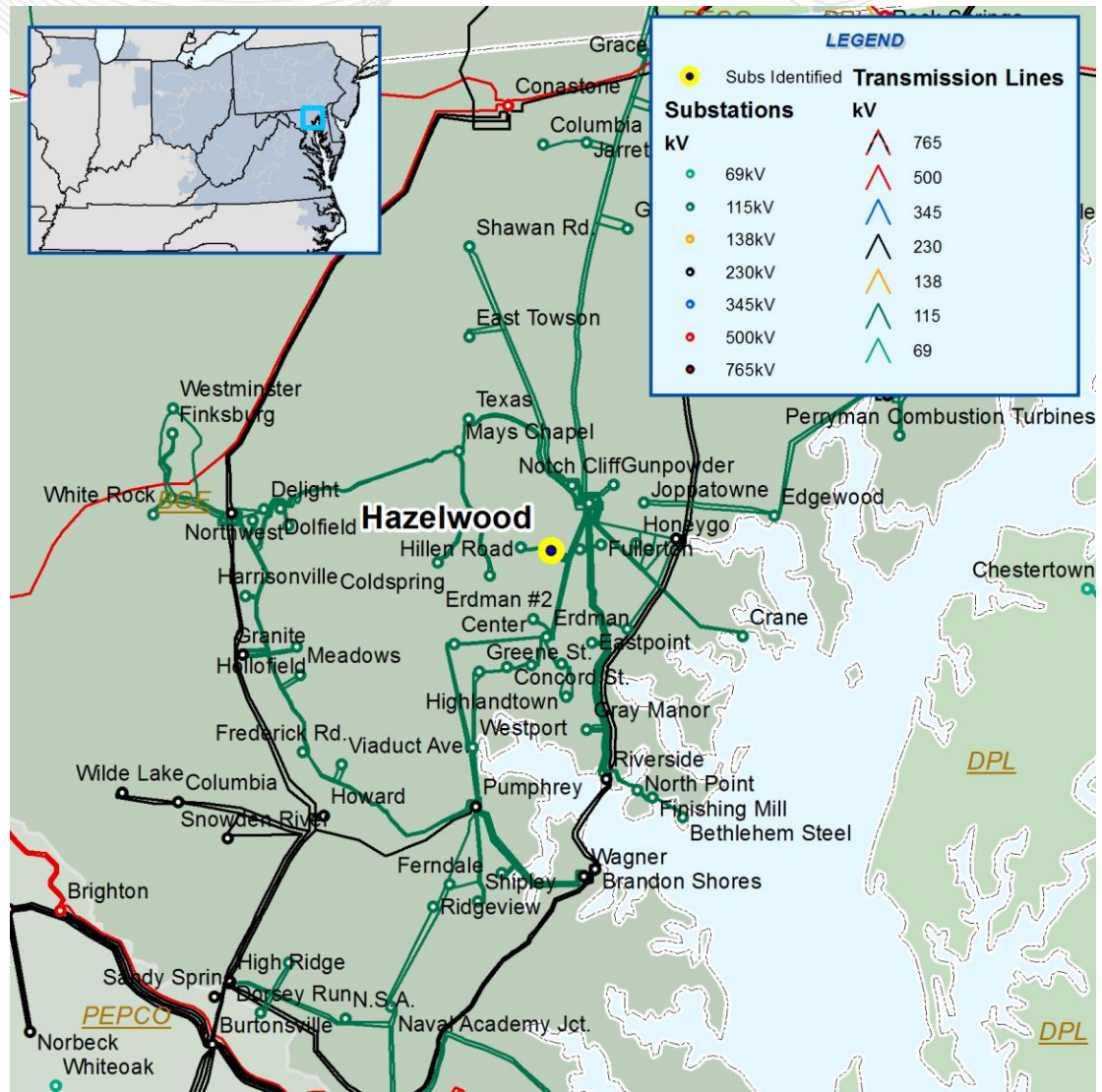
- Operational Performance:
- PJM identified this project to improve operational performance
- Recommended Solution: Upgrade terminal equipment at both Brandon Shores and Waugh Chapel removing terminal limitation on BGE 230 kV circuit 2343 (B1545).
- Estimated Project Cost: \$18 K
- Expected IS Date: 06/01/2011



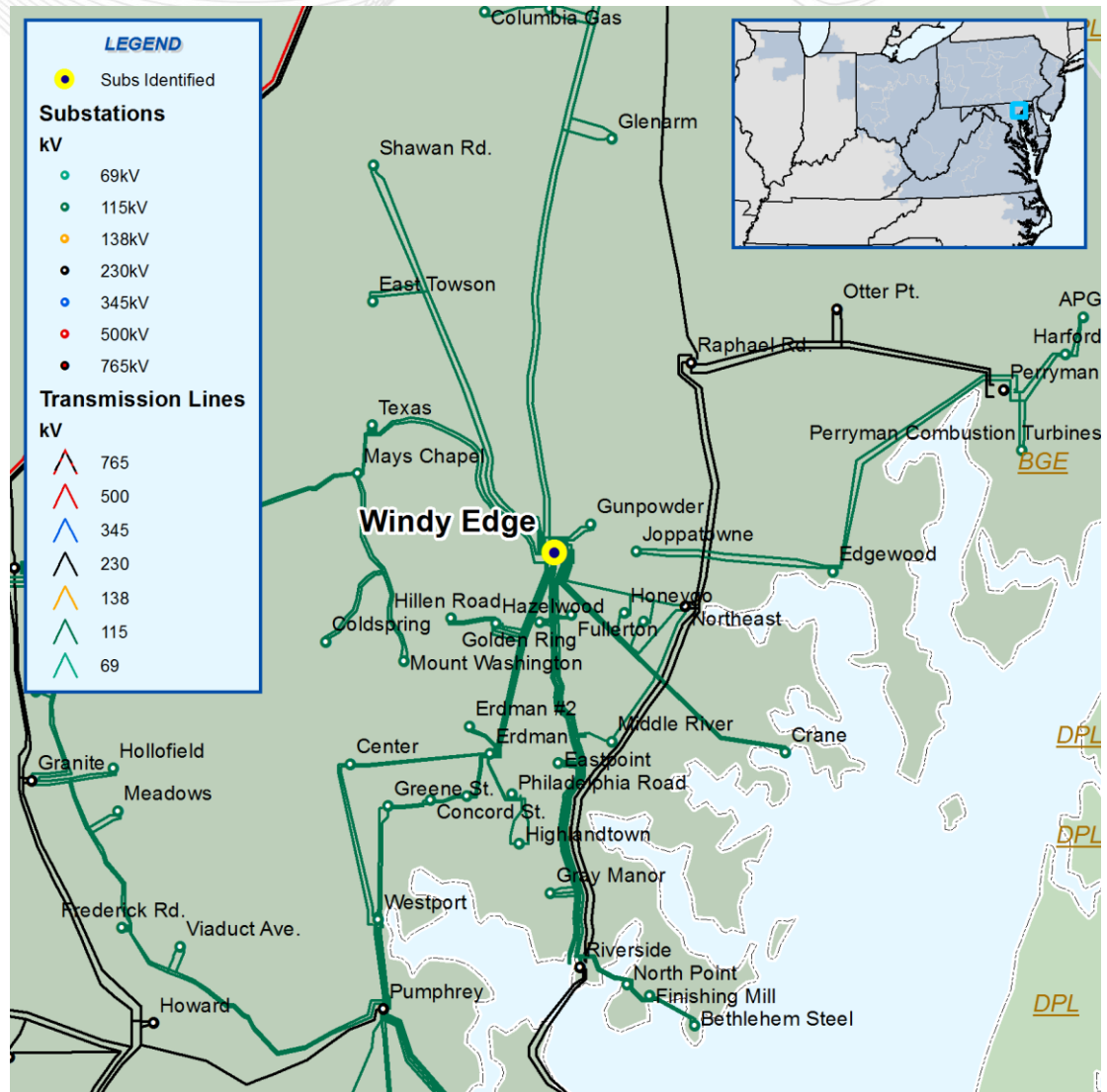
- Operational Performance:
- PJM identified this project to improve operational performance
- Recommended Solution:
Upgrade terminal equipment at Graceton removing terminal limitation on BGE portion of the 230 kV Graceton – Cooper circuit 2343 (B1546).
- Estimated Project Cost:
\$11 K
Expected IS Date:
06/01/2011



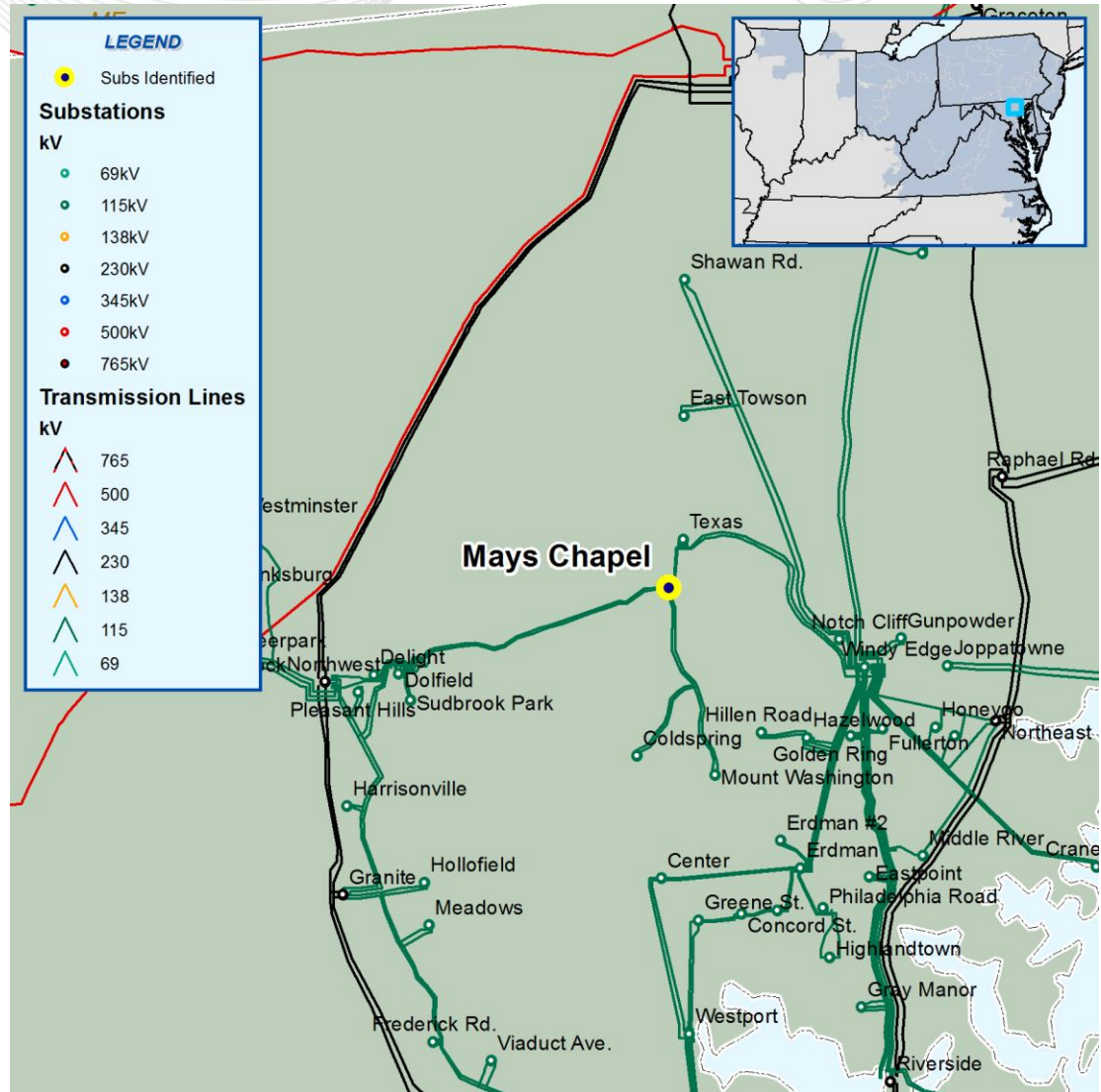
- The Hazelwood 115 kV breakers '110602' and '110604' are overstressed
- Proposed Solution: Replace Hazelwood 115 kV breakers '110602' and '110604' (b1583, b1584)
- Estimated Project Cost: \$130 K per breaker
- Expected IS Date: 12/1/2012



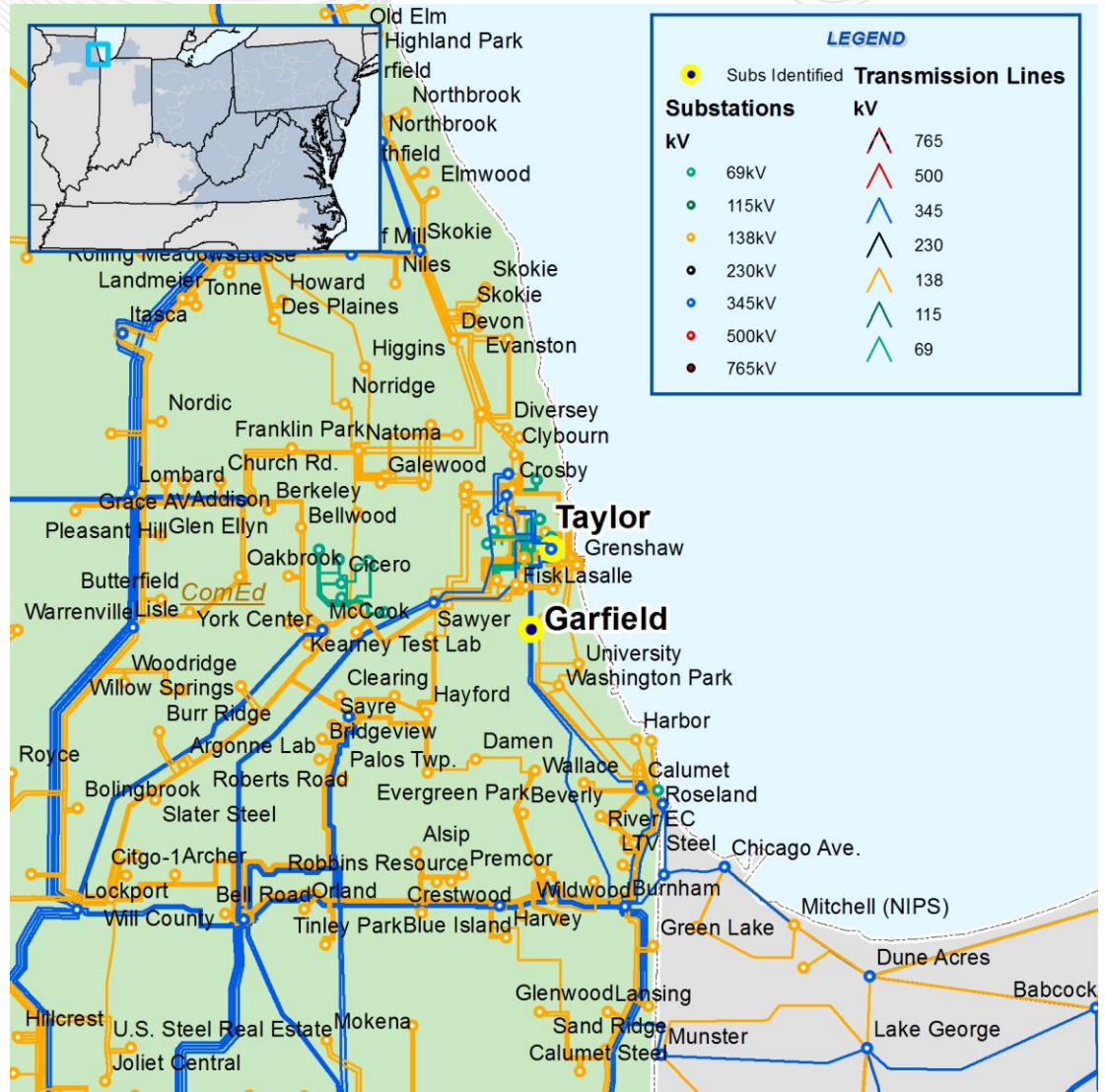
- The Windy Edge 115 kV breakers '110515', '110516', and '110517' are overstressed
- Driver: Previous baseline upgrade to replace the existing Northeast 230/115 kV transformer #3 with 500 MVA (b1253)
- Proposed Solution:
 - Revise the reclosing on the Windy Edge 115 kV breaker '110515' (b1253.2)
 - Revise the reclosing on the Windy Edge 115 kV breaker '110516' (b1253.3)
 - Revise the reclosing on the Windy Edge 115 kV breaker '110517' (b1253.4)
- Estimated Project Cost: \$0 K
- Expected IS Date: 6/1/2015



- The Mays Chapel 115 kV breakers '110515A' and '110579C' are overstressed
- Driver: Previous baseline upgrade to construct 115 kV double circuit underground line from existing Coldspring to Erdman substation. (1267.1)
- Proposed Solution: Replace the Mays Chapel 115 kV breakers '110515A and '110579C' (b1267.2 and b1267.3)
- Estimated Project Cost: \$334.5 K per breaker
- Expected IS Date: 6/1/2015



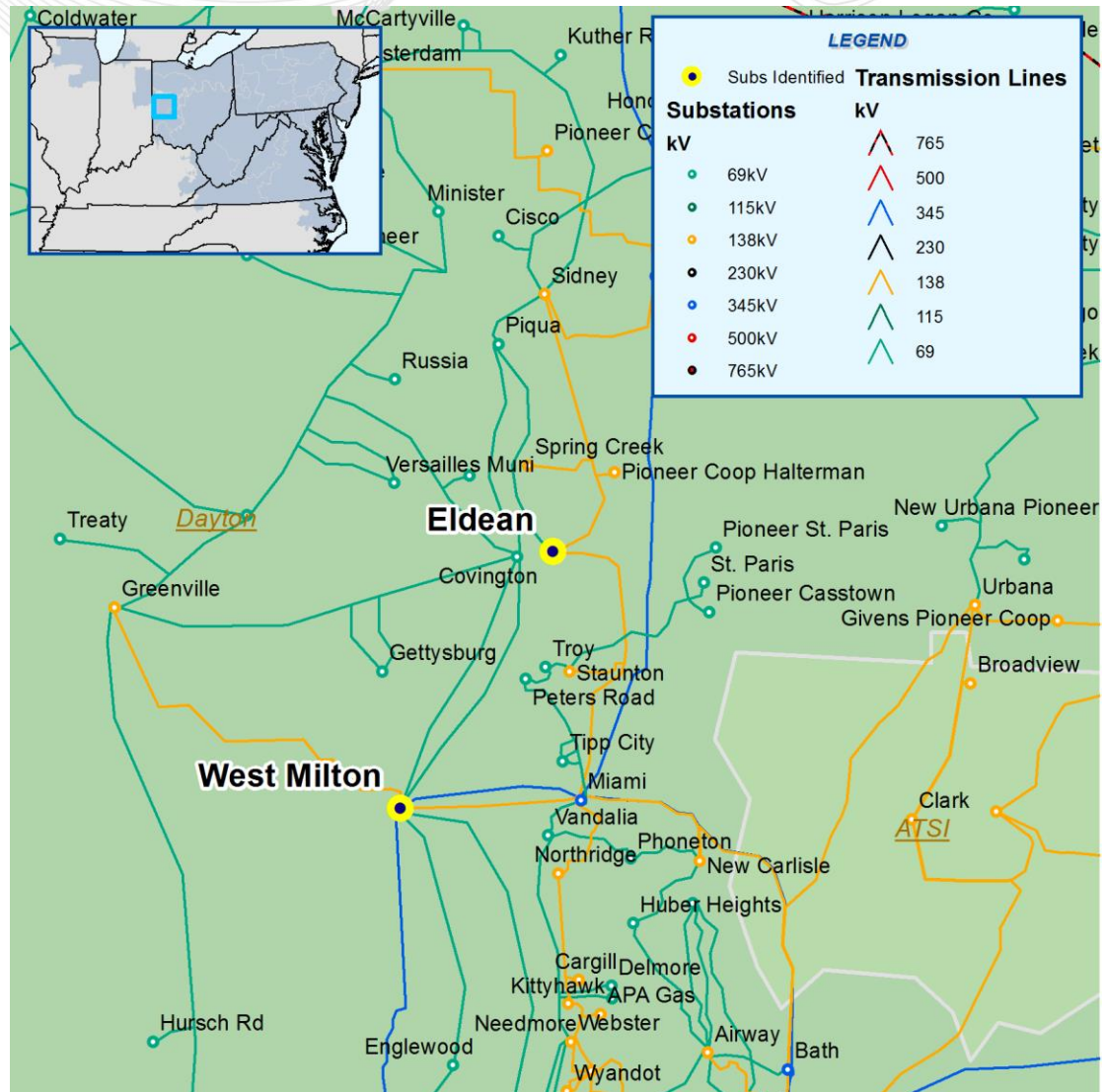
- N-1-1 Thermal Violation
- The existing Garfield-Taylor lines are overloaded at normal system conditions for the loss of 345 kV line 1311 or 1312 from Goodings Grove to Crawford
- Advance B1301 IS Date from 6/1/2015 to 6/1/2014



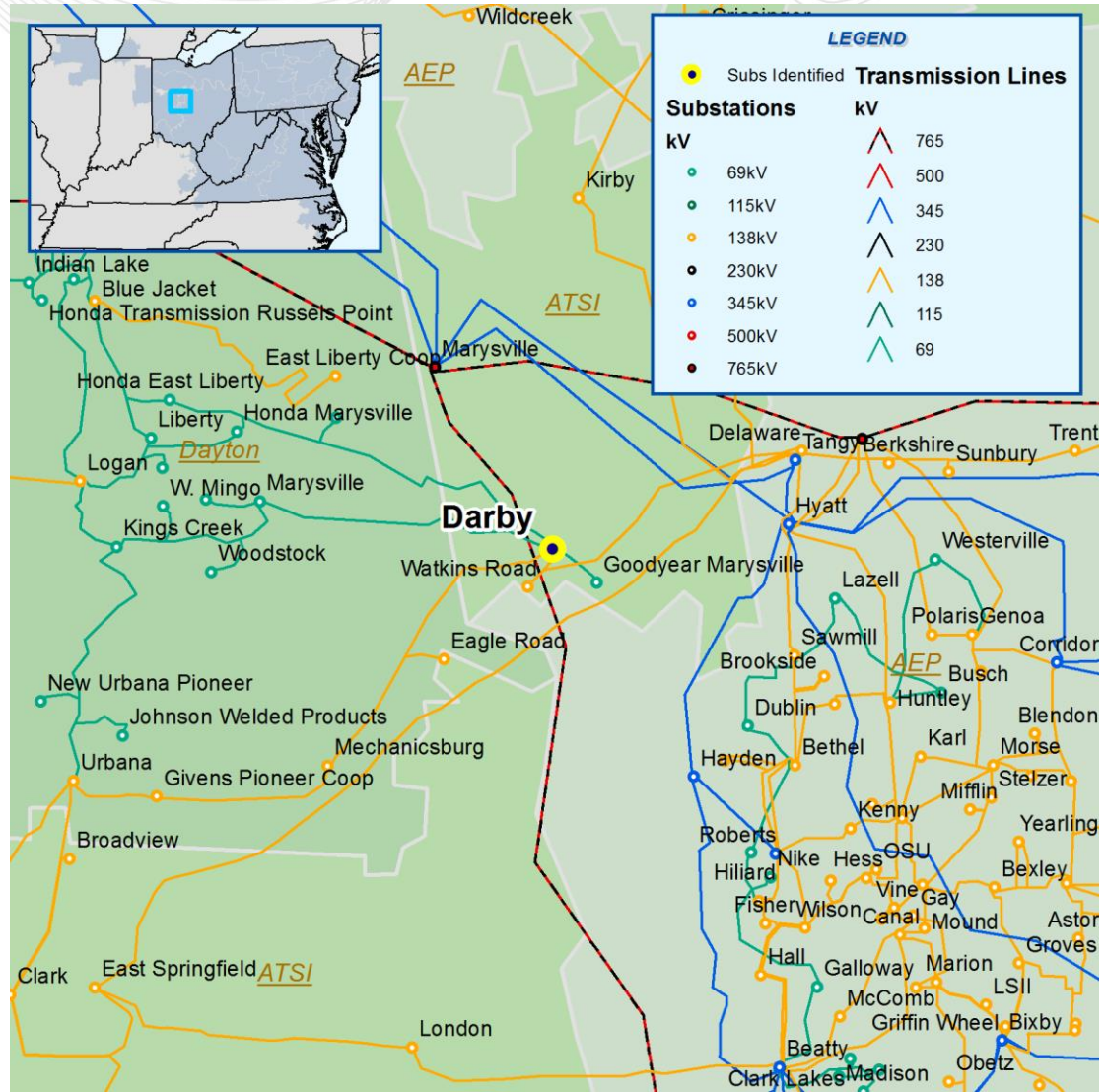
- The previously presented Marysville project to add a 345/69kV transformer at AEP Marysville 345kV bus, add a Marysville – Darby 69kV line, Marysville – Union REA 69kV line, and reconductor Union REA 69kV – Honda MT 69kV replaces the need for other baseline projects
- Recommended Solution:
- Cancel B1065.1, B1065.2 , B1065.3, B1067, and B1077
 - Cancelled projects below:
 - Install a new Shelby 138/69 kV transformer at Shelby station
 - Install a 69 kV line between Shelby 69kV station and Blue Jacket 69 kV station
 - Install a new 30 MVAR capacitor bank at Blue Jacket 69 kV station
 - Install a new 30 MVAR shunt at Logan 69 kV station
 - Reconductor East Sidney-Shelby 138 kV



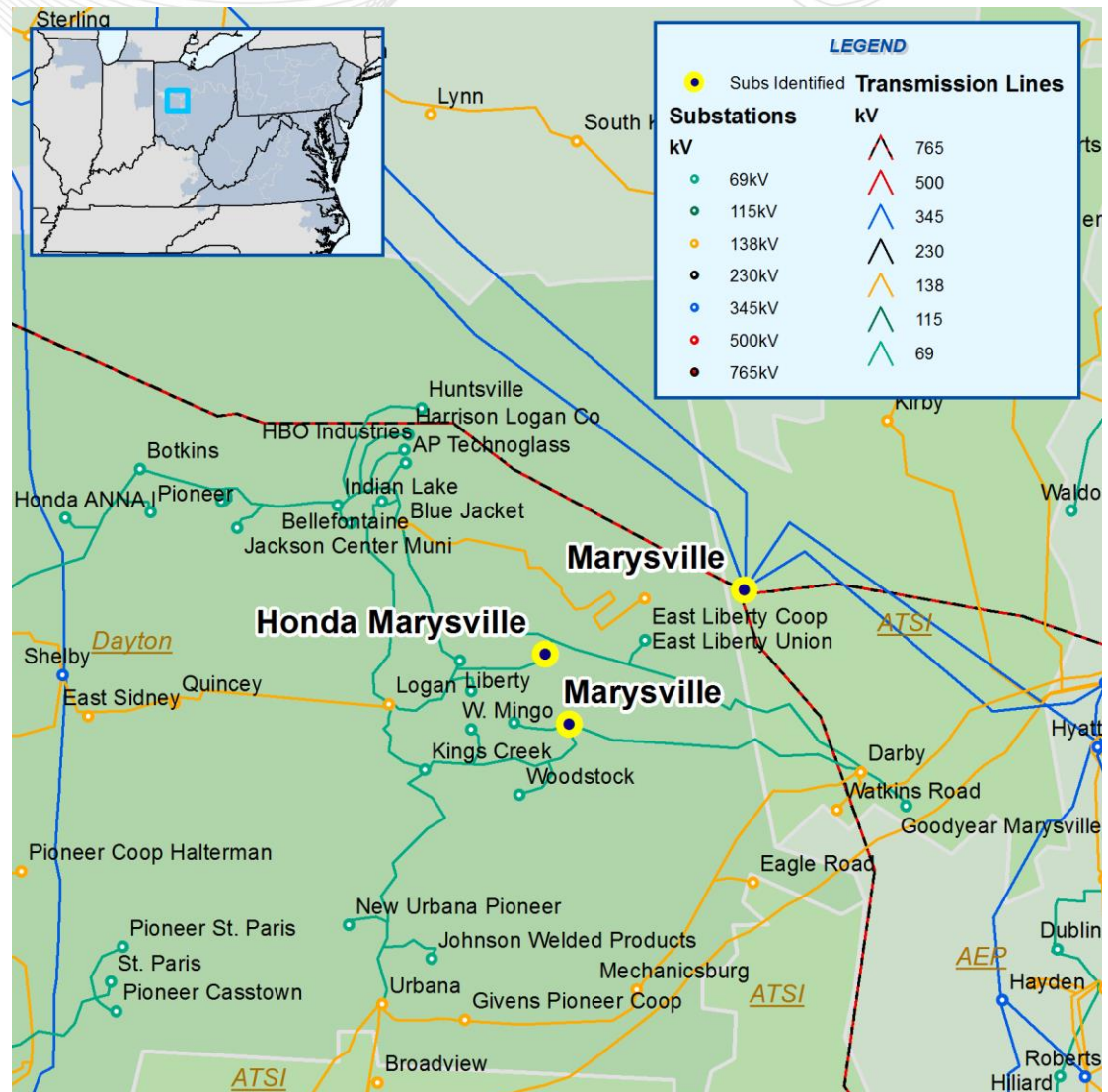
- N-1-1 Voltage Violation
- Replace the project B1063, B1064, and B1066, which are not feasible due to the space limitation; Low voltage at Springcreek and Hal Terman 138kV buses for the loss of the Sidney – Shelby 138kV line and the loss of the Miami – Eldean 138kV line
- Construct a new 138kV line from West Milton to Eldean (B1572)
- Estimated Cost: \$16 M
- Required IS Date: 6/1/2014



- N-1-1 Voltage Violation
- Cancel project B1068
- The voltage violation that drove the need for B1068 is no longer an issue due to updated transmission topology



- Common Mode , N-1-1 Thermal and Voltage Violation
- Staunton Tap – Eldean 138kV line overload for the Shelby – Miami 345kV line fault with stuck breaker at Shelby; Quincy - East Sidney – Shelby 138 kV line overload for loss of Darby 138/69 kV XFMR and Urbana 138/69 kV XFMR; Replace B1065.1, B1065.2 , B1065.3, B1067 , and B1077
- Proposed Solution:
 - add a 345/69kV transformer at AEP Marysville 345kV
 - Add/reconductor Marysville 69kV – Darby 69kV
 - Add/reconductor Marysville 69kV – Union REA 69kV
 - Reconductor Union REA 69kV – Honda MT 69kV
- Estimated Project Cost: \$16 M
- Expected IS Date: 6/1/2014

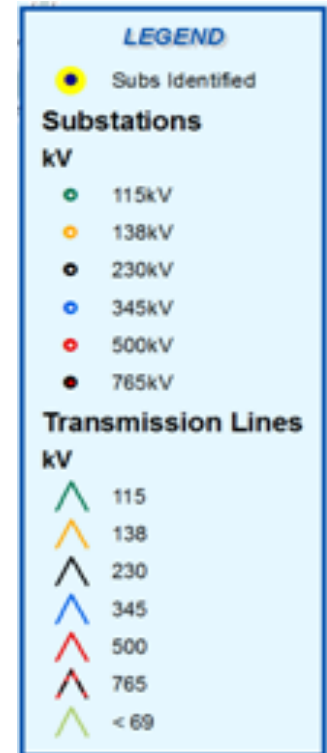


- ODEC criteria violation:
 - Radial load exceeds 50 MW on 69 kV circuit south of Tasley, VA.
 - Tapped transformer without its own protection. Kellam Transformer #1 limits the line to Bayview to less than 20 MVA for certain operating conditions.
 - Additionally, the existing 336 ACSR is over 50 years old
- Proposed Solution:

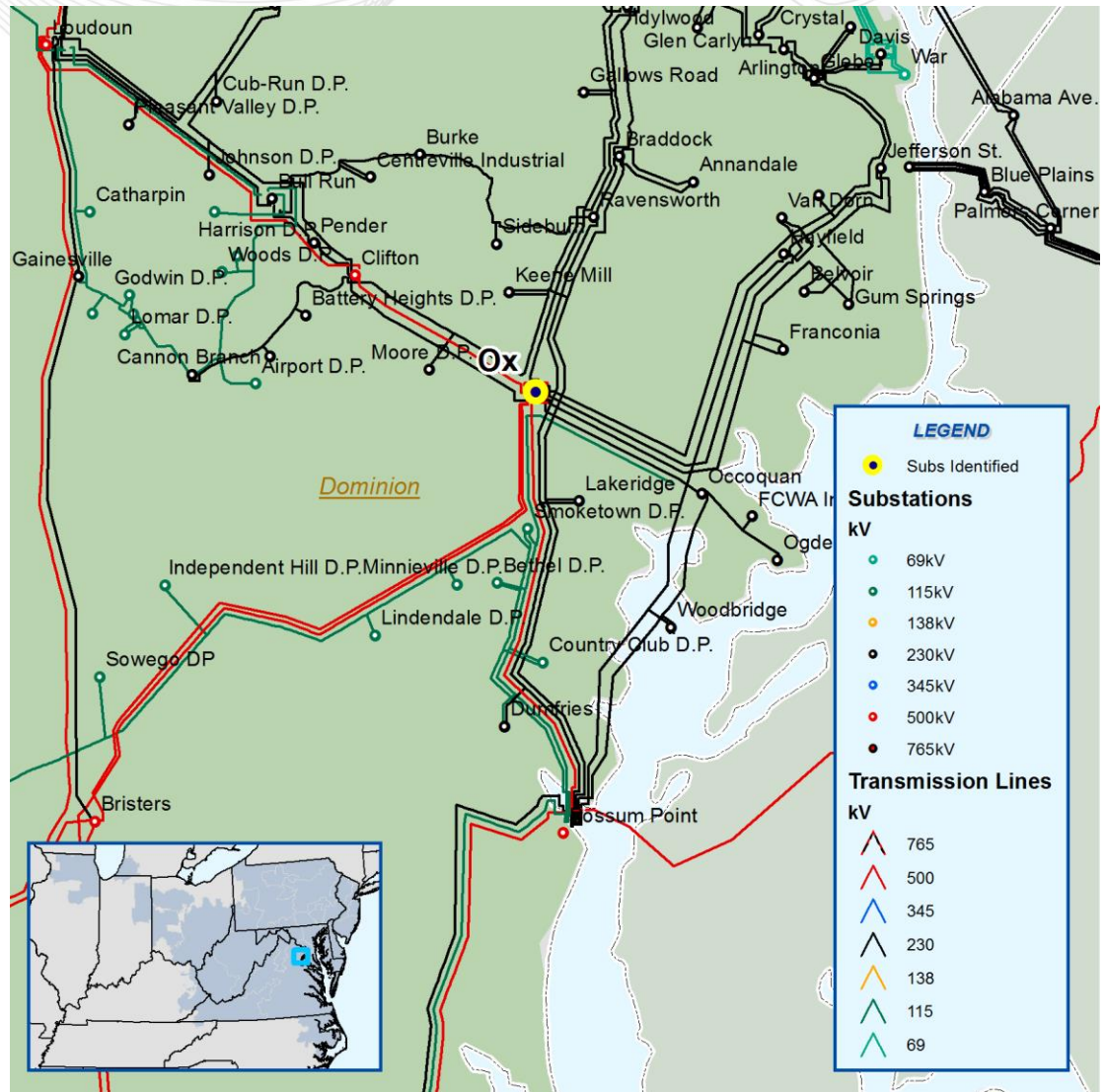
Replace existing line with a new double circuit line and add a breaker to complete the ring bus at Kellam (B1675).
- Estimated Project Cost:

\$12 M
- Required IS Date:

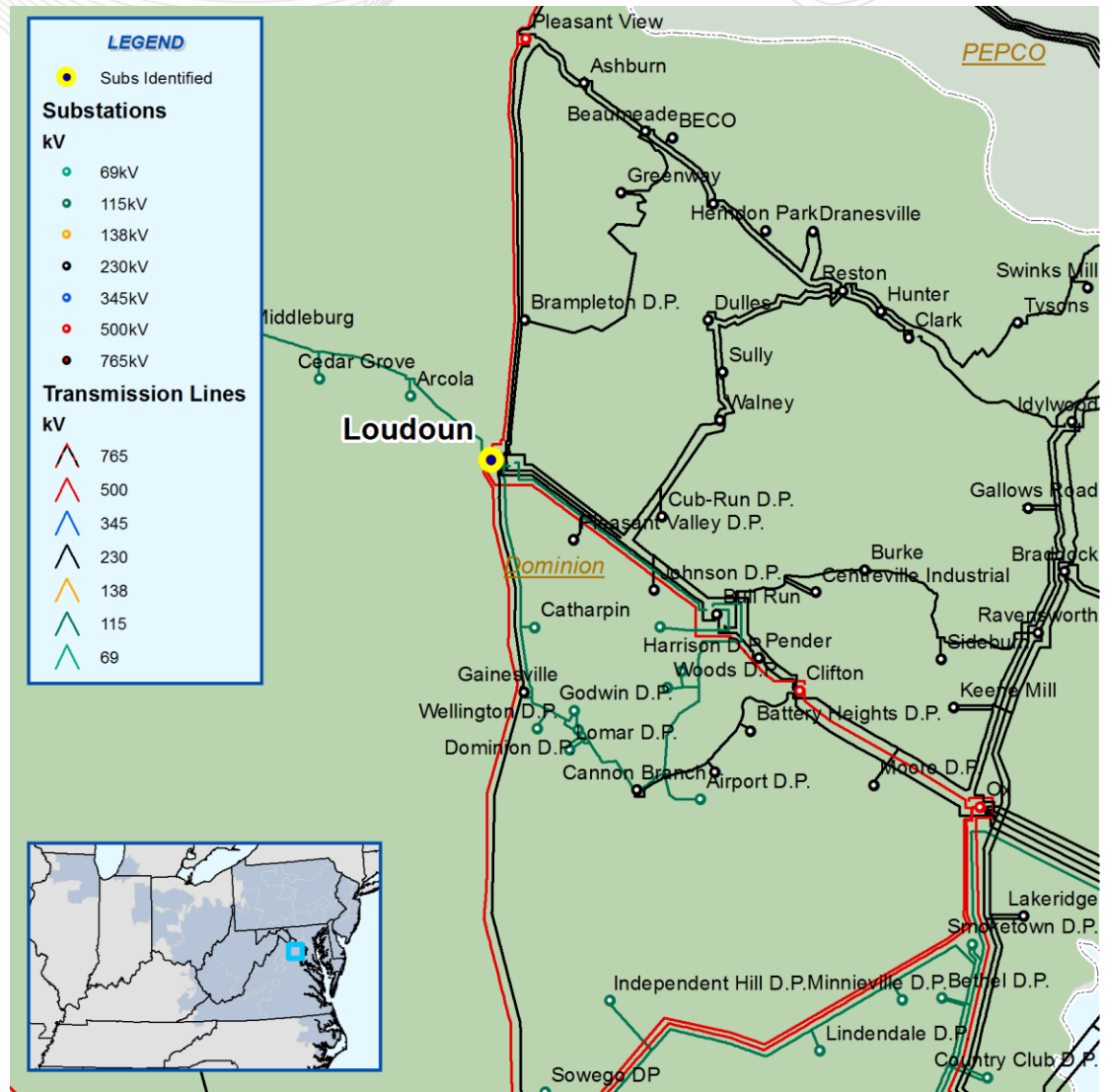
6/1/2016



- The Ox 230 kV breakers '24342' and '243T2097' are overstressed
- Previously identified as being driven overdutied by V1-031
 - V1-031 projected in-service date 4/1/2016
- Proposed Solution: Advance n1752 and n1753 to replace the Ox 230 kV breakers '24342' and '243T2097' with 63kA breakers (b1536 & b1537)
- Project Advancement Cost: \$25 K per breaker
- Expected IS Date: 6/01/2015

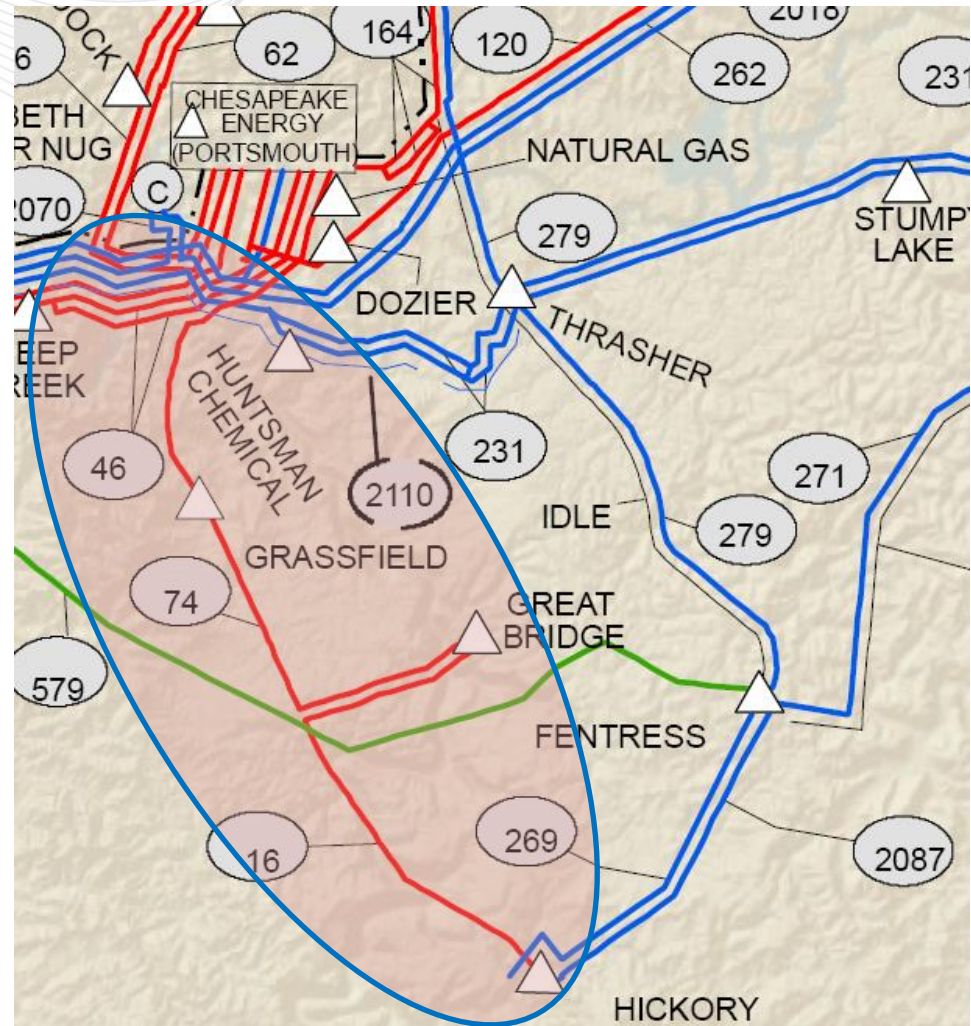


- The Loudoun 230 kV breaker '29552' is overstressed
- Proposed Solution: Replace the Loudoun 230 kV breaker '29552' (b1538)
- Estimated Project Cost: \$210 K
- Expected IS Date: 6/01/2015

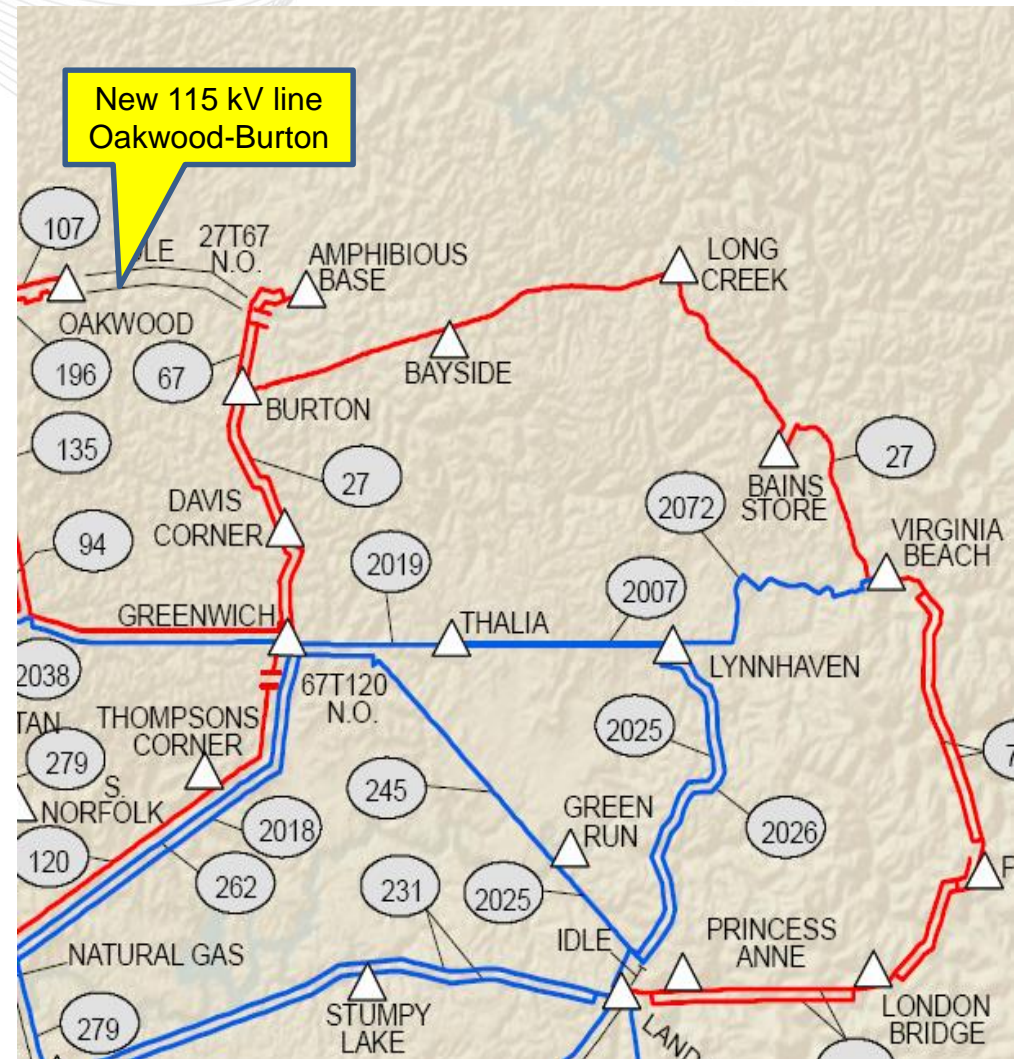


Region with thermal issues

- NERC Category B Violations
- Problem:
 - For the loss of 115kV line #74 at Chesapeake, the Great Bridge switch 16T74 will be closed to restore service to line #74. The Hickory 230/115 kV autotransformer is overloaded for this condition.
 - For the loss of the Hickory 230/115 kV autotransformer, the Great Bridge switch 16T74 will be closed to restore service to line #16. 115 kV line #74 is overloaded for this condition.
- Proposed Solution:
 - Move Hickory loads off the 115 kV system by replacing the 115/34.5 kV transformer #1 at Hickory with a 230/34.5 kV transformer.
- Estimated Project Cost: \$ 0.75 M
- Expected IS Date: 6/1/2013



- NERC Category B
- Problem A: For the N-1 loss of line #27 (Greenwich 115 kV to Davis Corner 115 kV) the loading on line #27 (Virginia Beach 115 kV to Bains Store 115 kV) exceeds its emergency rating.
- Problem B: For the tower line outage of both line #27 and line #67 at Greenwich 115 kV, line #27 cannot pick up all of the loads on line #67 (about 167 MVA in summer 2014)
- Potential Solutions:
 - Option A: Add 4 breaker ring bus at Burton 115 kV substation. Construct a 115 kV line approximately 3.5 miles from Oakwood 115 kV substation to Burton 115 kV substation
 - Option B: Rebuild Line #27 from Virginia Beach to Bains Store
 - Option C: Open Line #27 into two radials



Solution Evaluation:

	Estimated Project Cost	Right of Way	Does solution resolve criteria violations?	
			A	B
Solutions Considered:				
Option A: Burton 115 KV Ring Bus and 115 kV Line	\$ 4.3-13 M	Existing	Yes	Yes
Option B: Rebuild Line #27 between Va Beach and Bains Store	\$ 13-27 M	Existing	Yes	Yes
Option C: Open Line 327(create two radials)	----	Existing	Yes	No

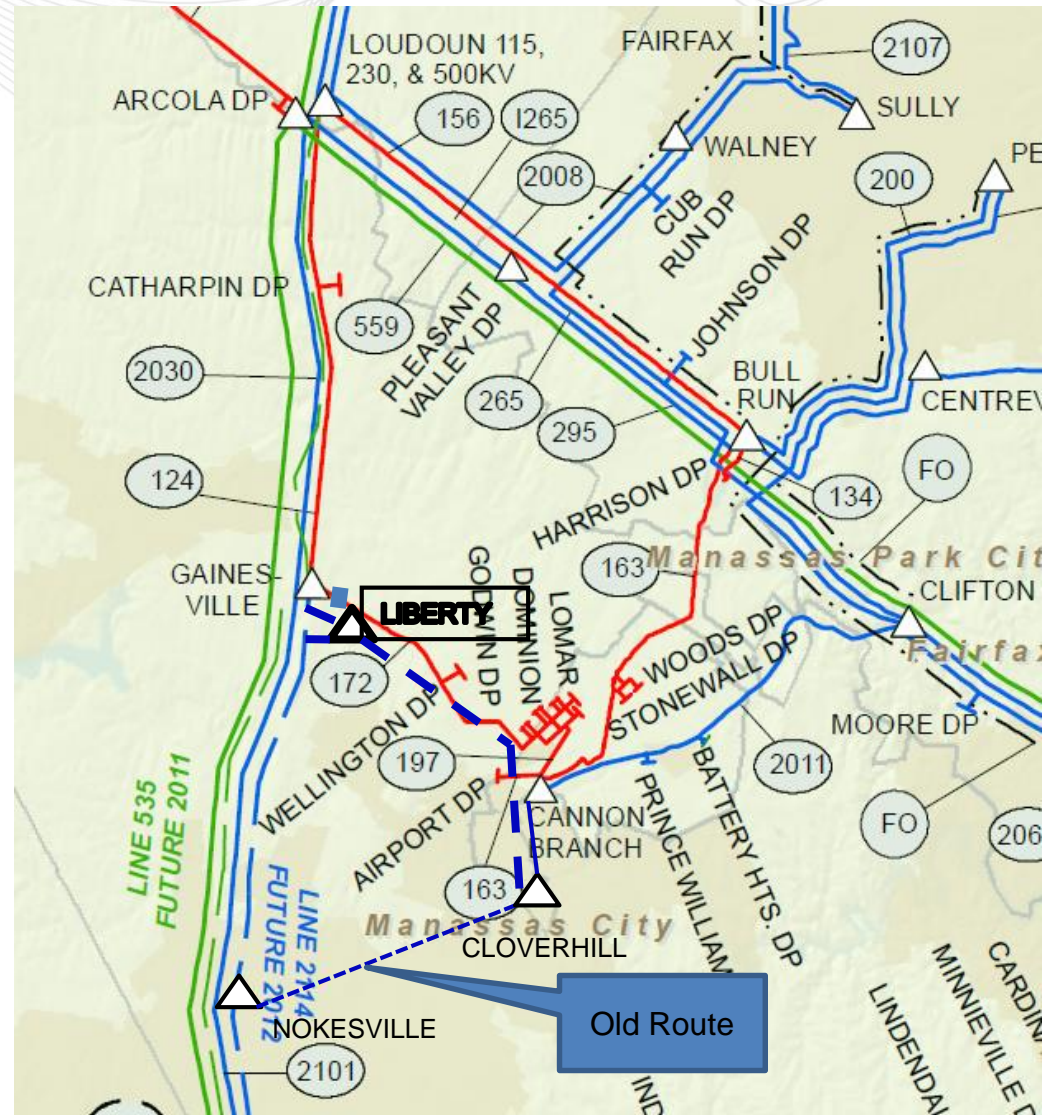
Recommended Solution:

Option A - Add 4 breaker ring bus at Burton 115 kV substation. Construct a 115 kV line approximately 3.5 miles from Oakwood 115 kV substation to Burton 115 kV substation

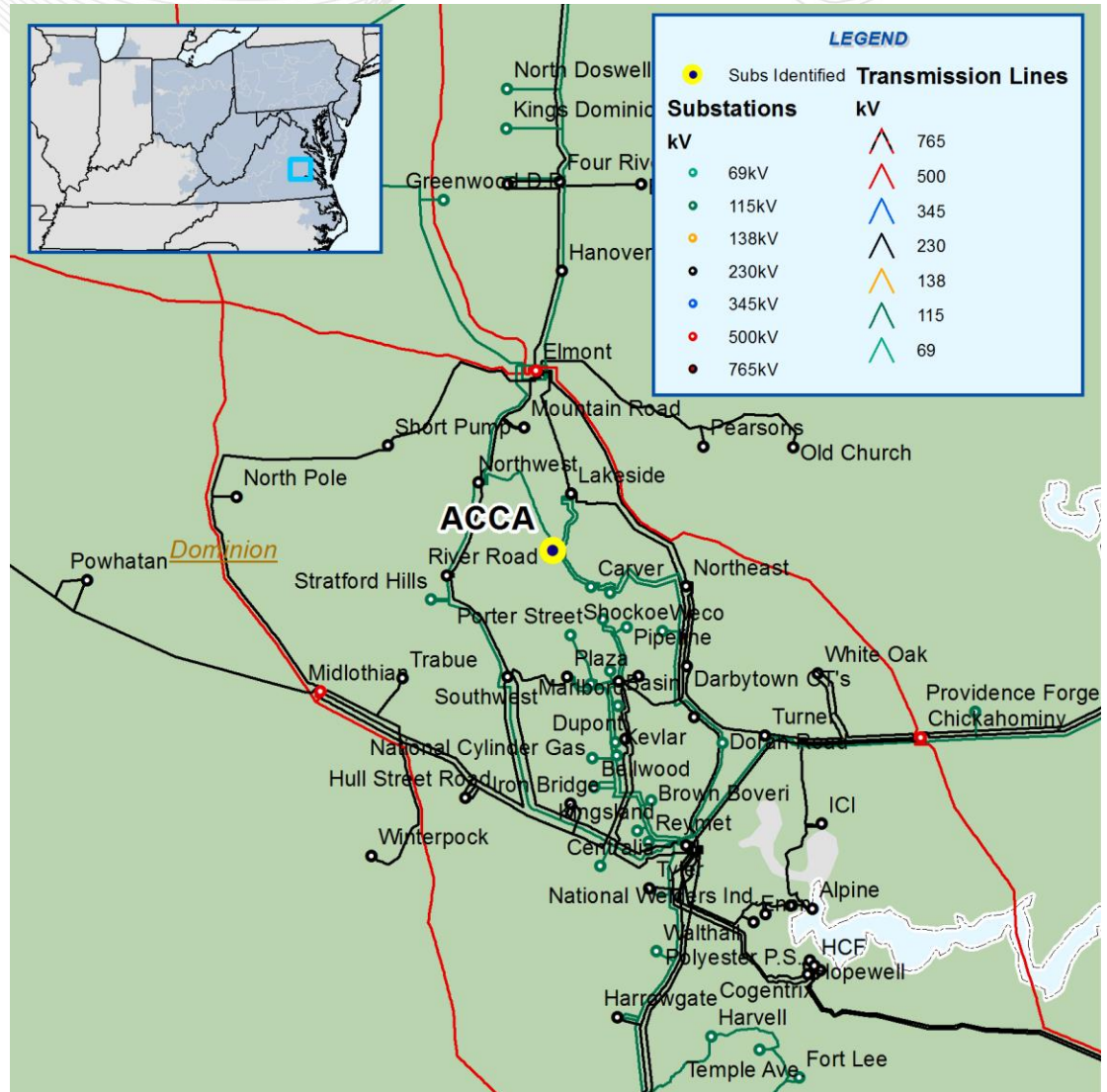
Expected IS Date: 6/1/2014

NERC Category B&C

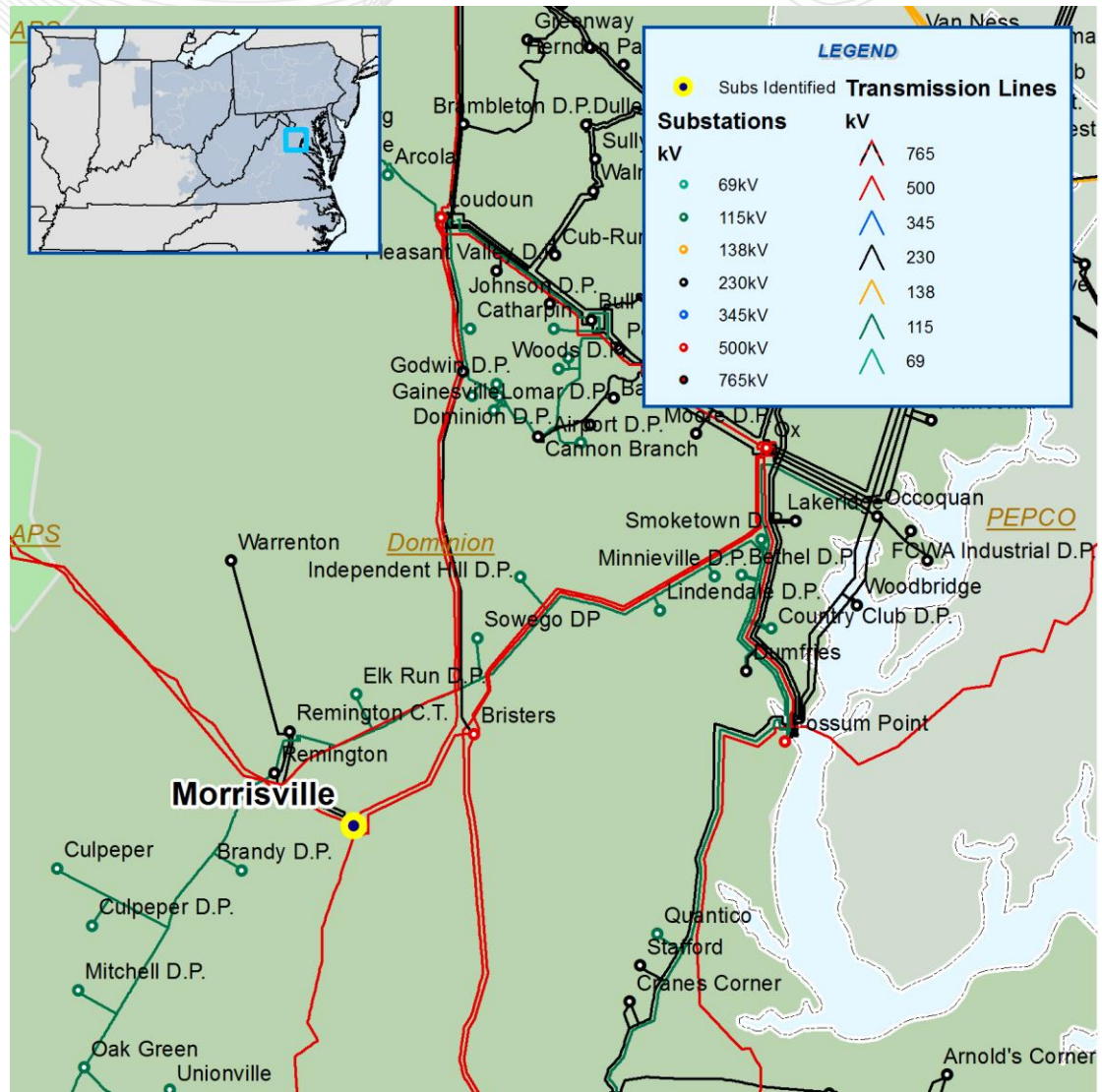
- **Update to existing PJM baseline upgrade B1332 - Cannon Branch to Cloverhill to Nokesville 230 kV**
- Routing issues are requiring a re-route of the proposed line.
- Terminal point for new 230kV line changed from Nokesville to new Liberty Substation to maximize utilization of existing ROW.
- Construct a 230kV line approximately 5.75 miles along existing right-of-way from Cloverhill Substation to Liberty Substation.
- Line #2101 will be looped in and out of the new Liberty Substation along existing right-of-way and a new 230/115 kV Tx will be installed.
- The section of 115 kV line between Gainesville and Liberty will be removed.
- Revised Proposed Solution - Build Cannon Branch to Cloverhill to Liberty 230 kV Line
- Estimated Project Cost: \$44 M (\$4 M increase)
- Expected IS Date: 6/1/2015



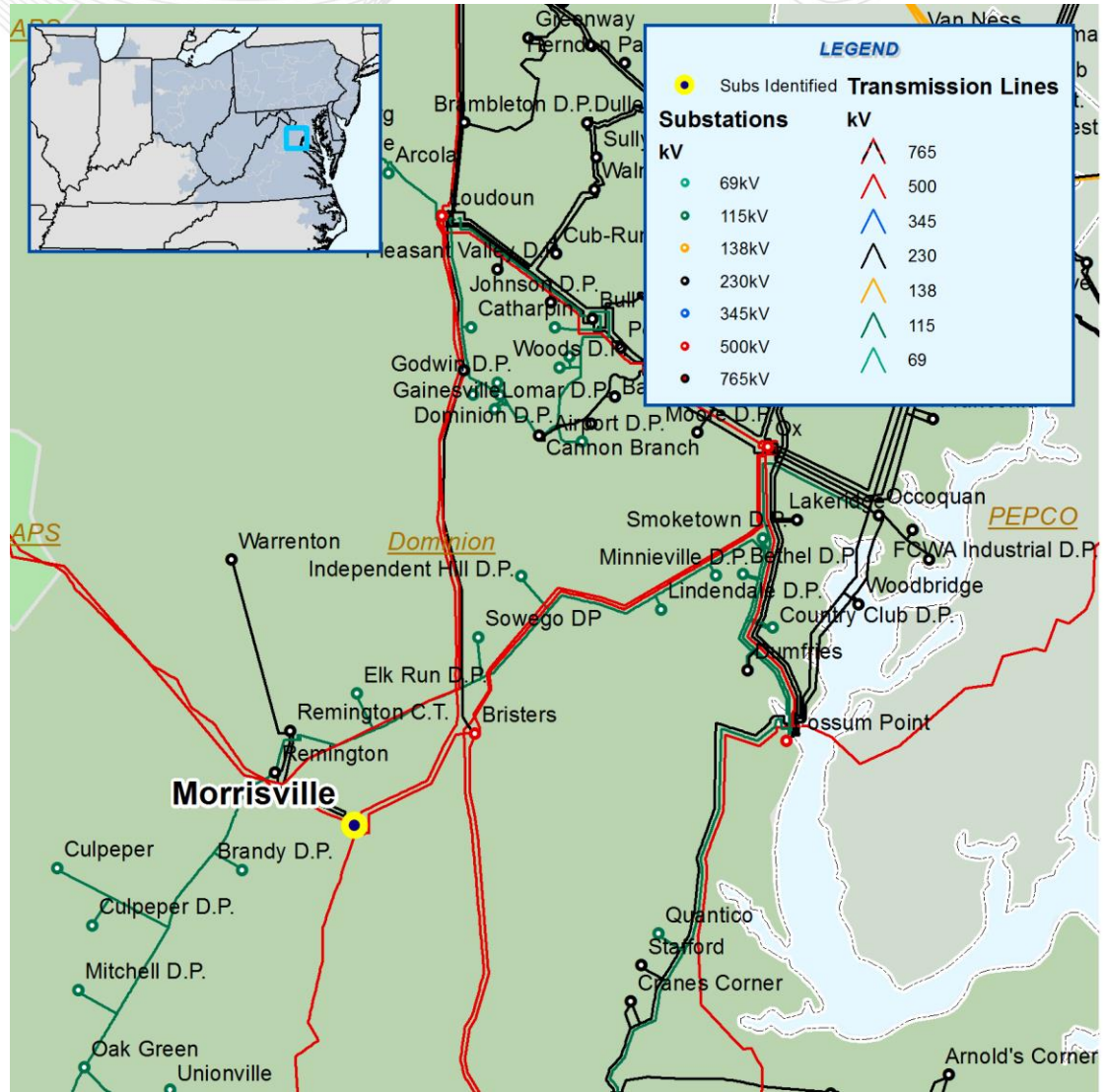
- The Acca 115 kV breaker '6072' is overstressed
- Proposed Solution: Replace the Acca 115 kV breaker '6072' with 40 kA (b1571)
- Estimated Project Cost: \$150 K
- Expected IS Date: 6/1/2015



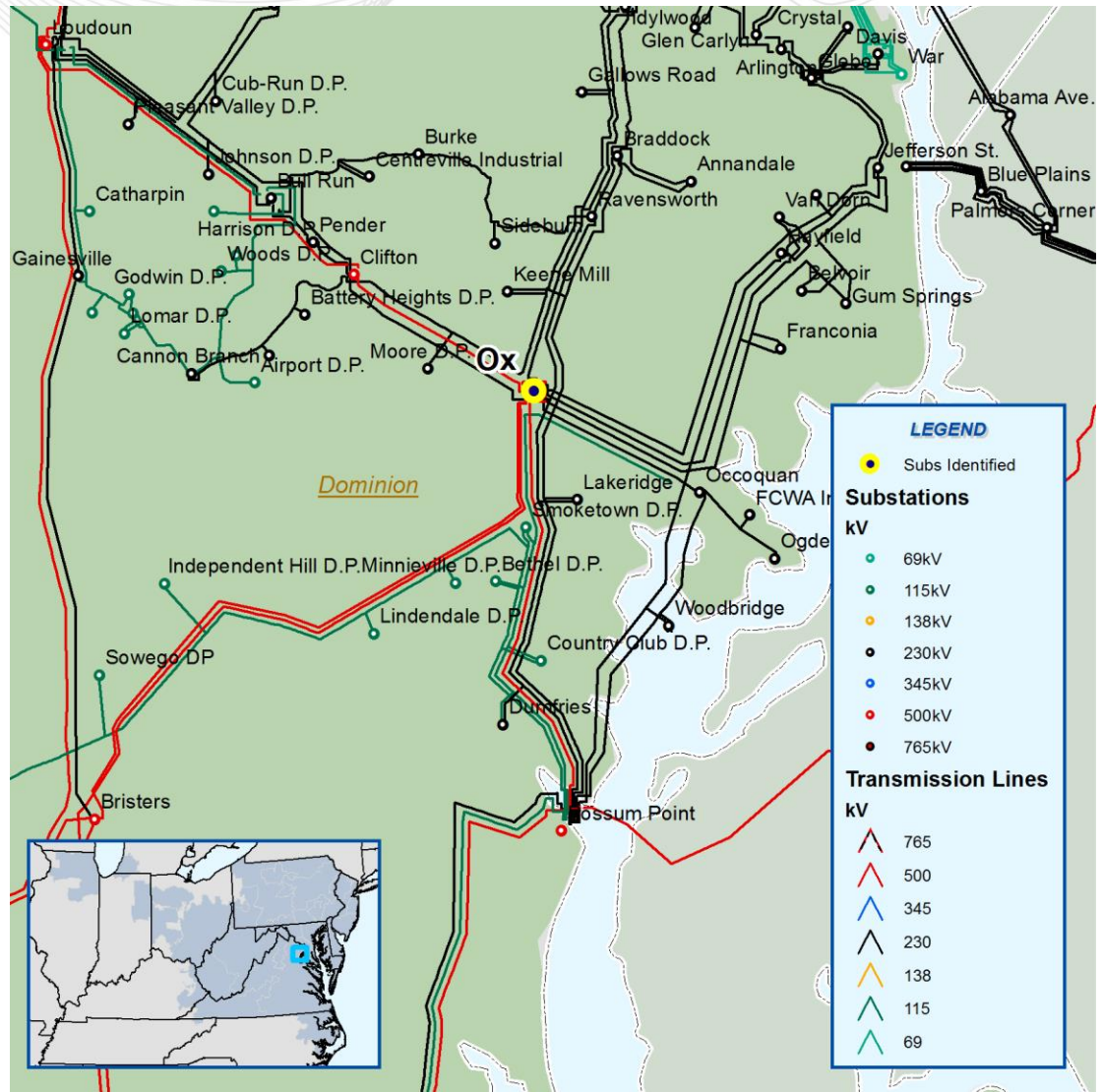
- The Morrisville 500kV breakers 'H1T573', and 'H1T545' are overstressed
- Proposed Solution: Replace Morrisville 500kV breakers 'H1T573', and 'H1T545' (b1647 & b1648)
- Estimated Project Cost: \$2 K per breaker
- Expected IS Date: 6/1/2016



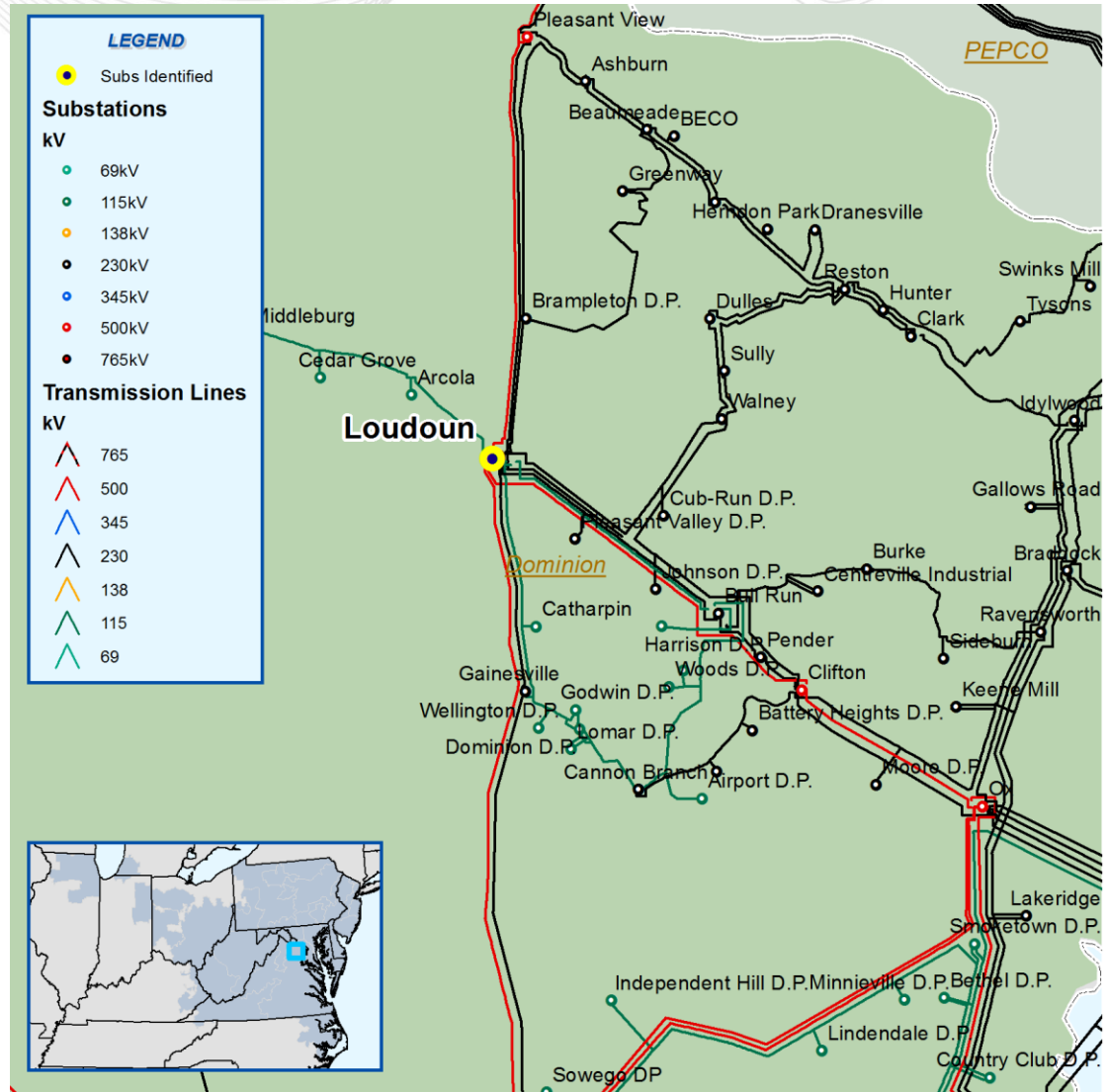
- The Morrisville 500kV breakers 'H1T580', and 'H1T569' are overstressed
- Proposed Solution: Replace Morrisville 500kV breakers 'H1T580', and 'H1T569' (b1649 & b1650)
- Estimated Project Cost: \$680 K per breaker
- Expected IS Date: 6/1/2016



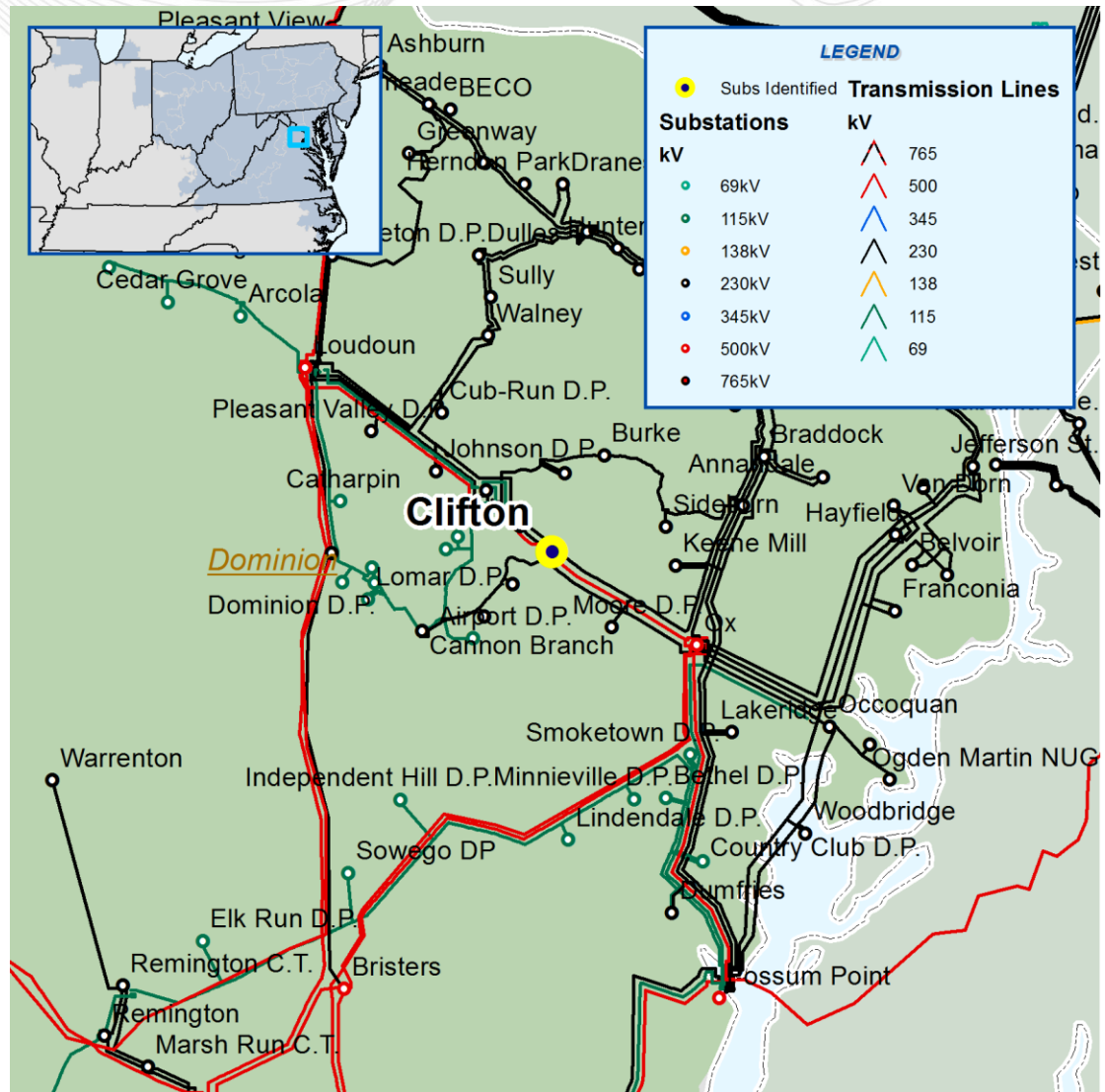
- The Ox 230kV breaker '209742' is overstressed
- Proposed Solution: Replace Ox 230kV breaker '209742' (b1652)
- Estimated Project Cost: \$215 K
- Expected IS Date: 6/1/2016

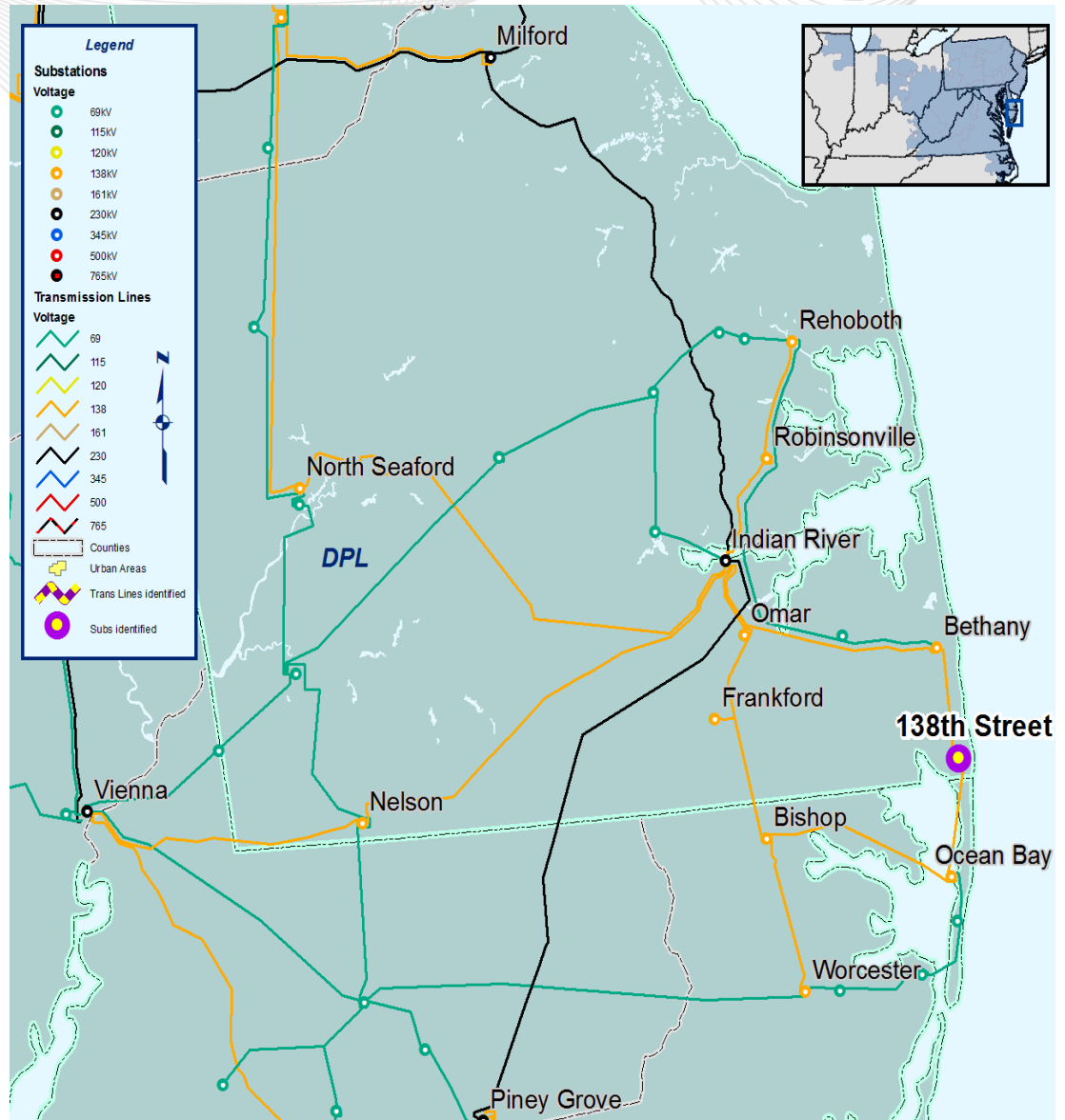
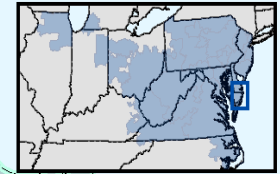


- The Loudoun 230kV breaker '295T2030' is overstressed
- Proposed Solution: Replace Loudoun 230kV breaker '295T2030' (b1651)
- Estimated Project Cost: \$215 K
- Expected IS Date: 6/1/2016



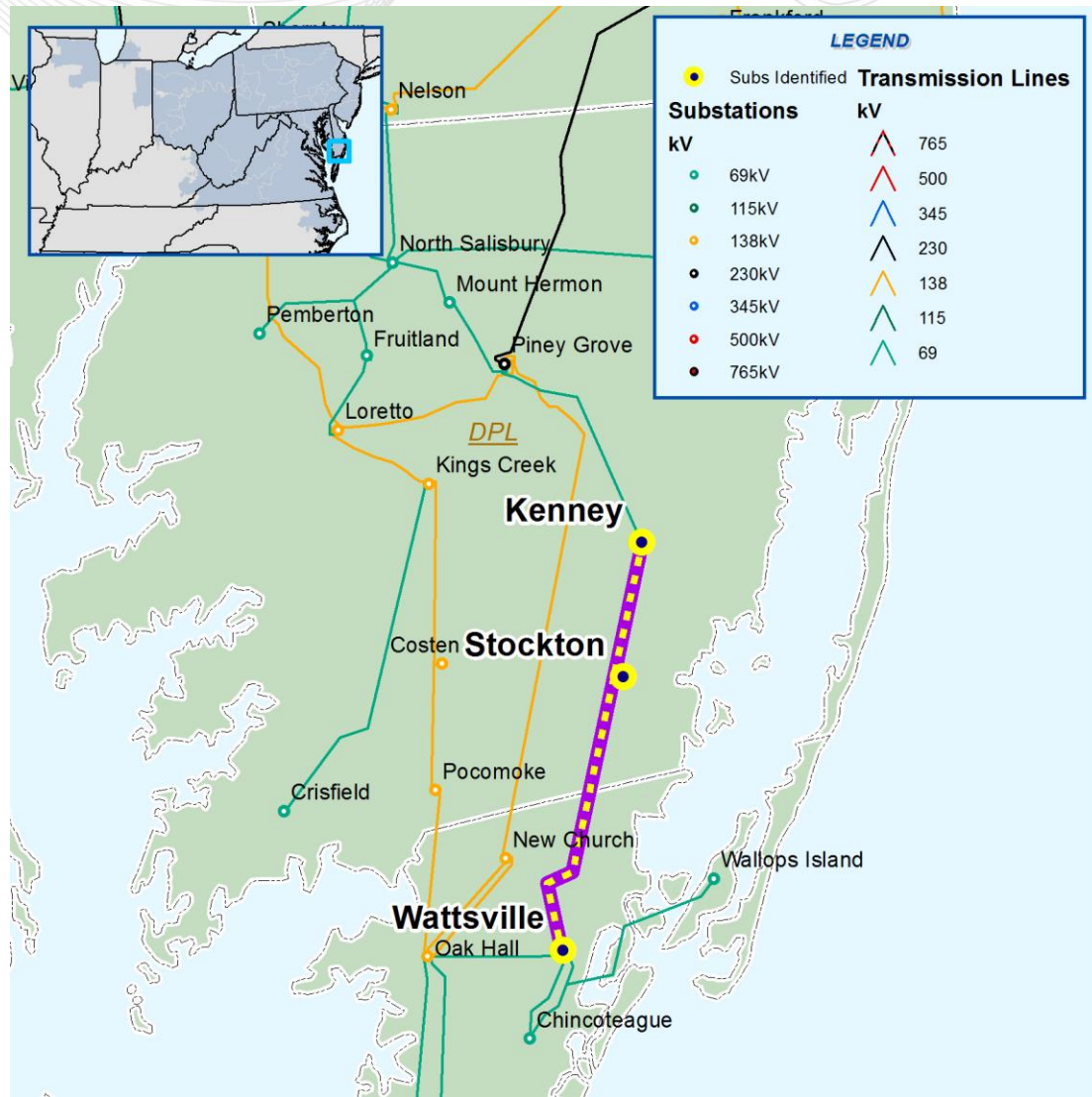
- The Clifton 230kV breakers '26582', '26682', '205182', '265T266', and '2051T2063' are overstressed
- Proposed Solution: Replace Clifton 230kV breakers '26582', '26682', '205182', '265T266', and '2051T2063 (b1653-b1657)
- Estimated Project Cost: \$215 K per breaker
- Expected IS Date: 6/1/2016



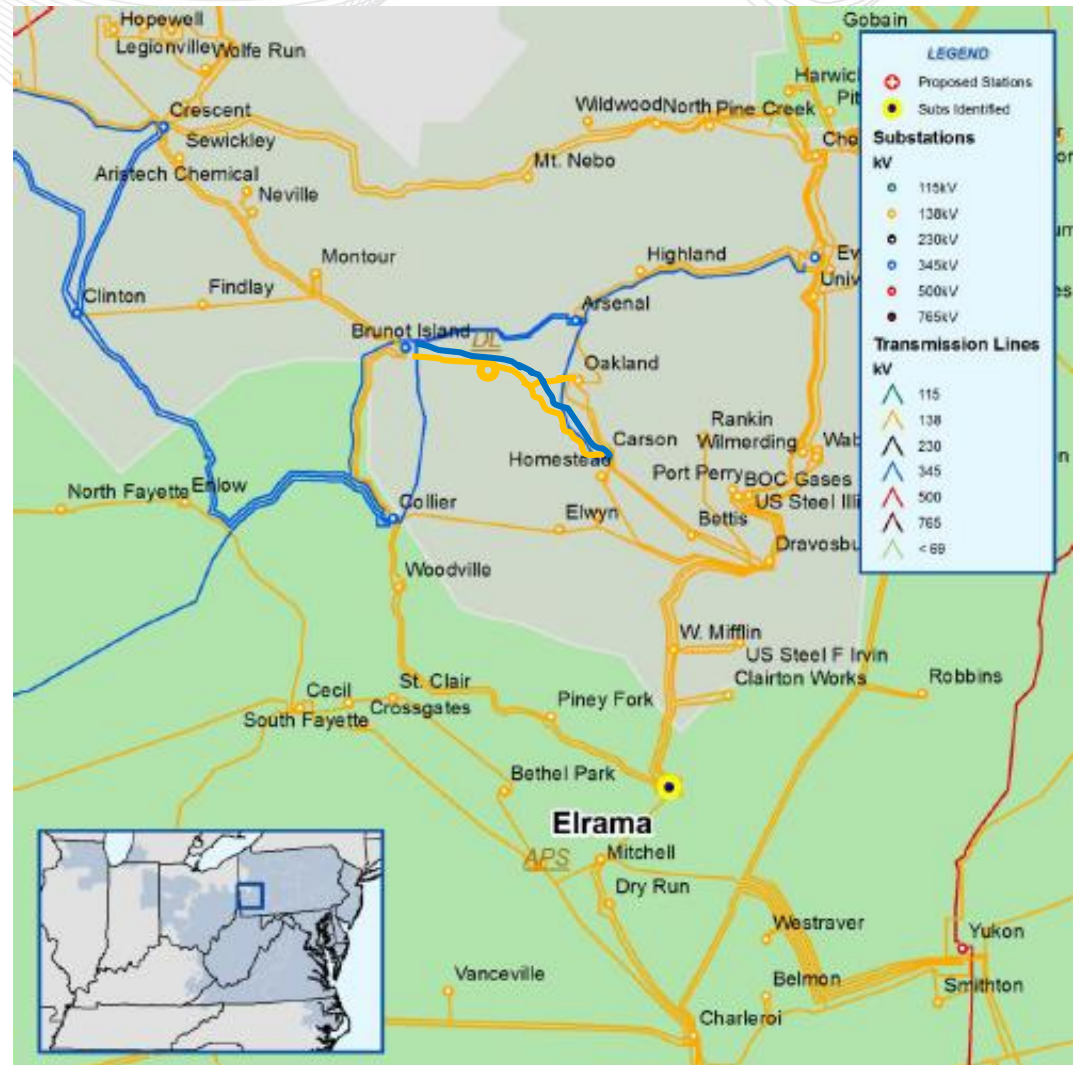


- Baseline upgrade to install 50 MVAR SVC at the 138th Street 138 kV bus (B0876) is replaced with install 75 MVAR SVC at the 138th Street 138 kV bus due to N-1-1 criteria violation
- Original Estimated Project Cost: \$8.65M
- New Estimated Project Cost: \$22.8
- Expected IS Date: 6/1/2013

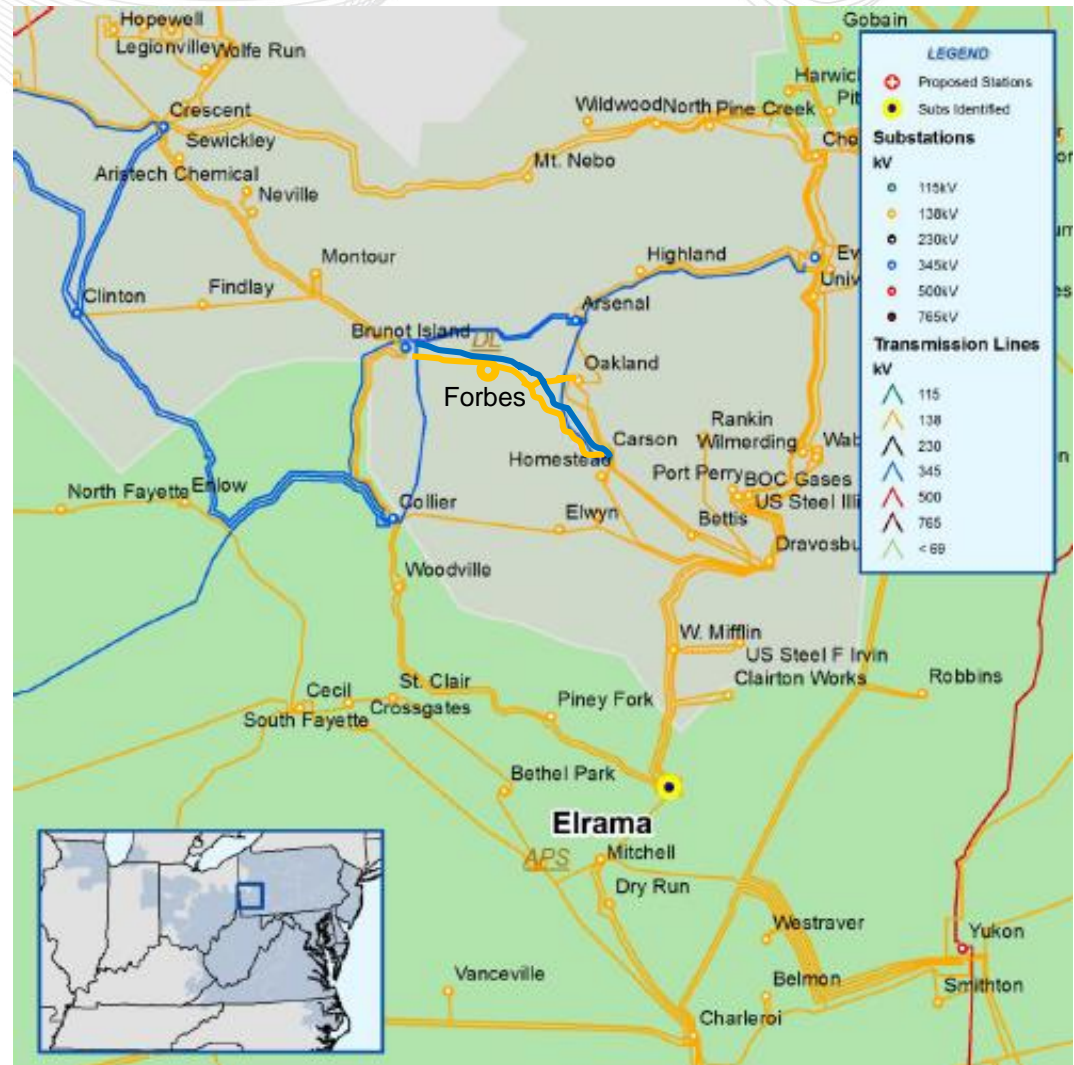
- Common Mode Outage Procedure
- Overload on the Wattsville – Signpost – Stockton – Kenney 69 kV circuit for the stuck breaker contingency loss of Piney Grove 230/138 kV transformer and Piney Grove – New Church 138 kV circuit.
- Proposed Solution: Upgrade 19 miles conductor (B1603).
- Estimated Project Cost: \$ 15 M
- Expected IS Date: 6/1/2016



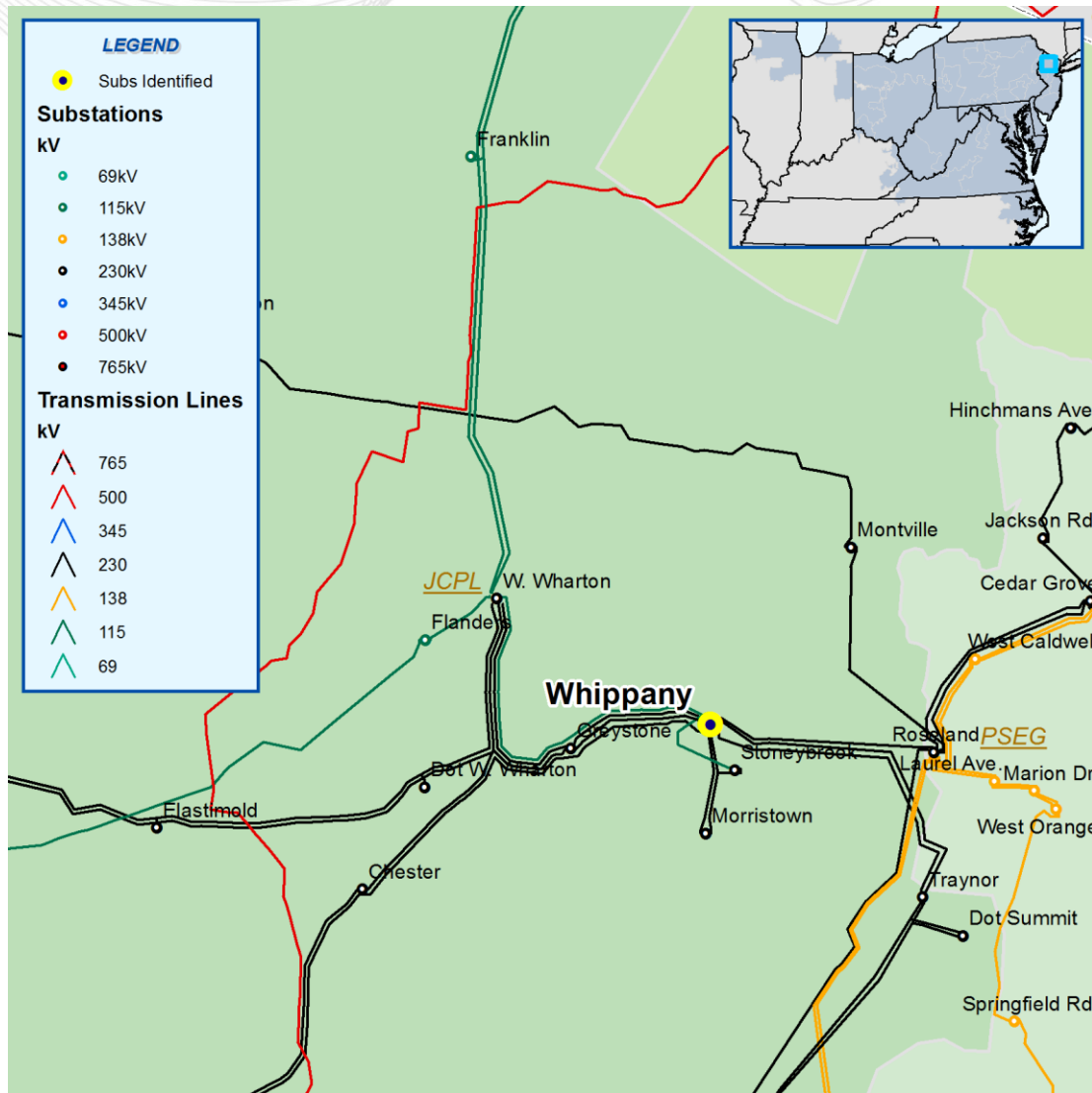
- Revision for Brady Project
- Initially identified in 2007 RTEP N-1-1 study of 2012 summer case
 - Overloads of Carson – Oakland 138 kV and Arsenal – Brunot Island 345 kV
- Initial projects to change scope (\$291.3M):
 - B0501 - New Brady 345 kV substation and 345 / 138 kV transformer at Brady
 - B502 - New Underground Carson - Brady - Brunot Island 345 kV circuit
 - B0503 - Loop existing Carson - Oakland 138 kV into new Brady 138 kV substation



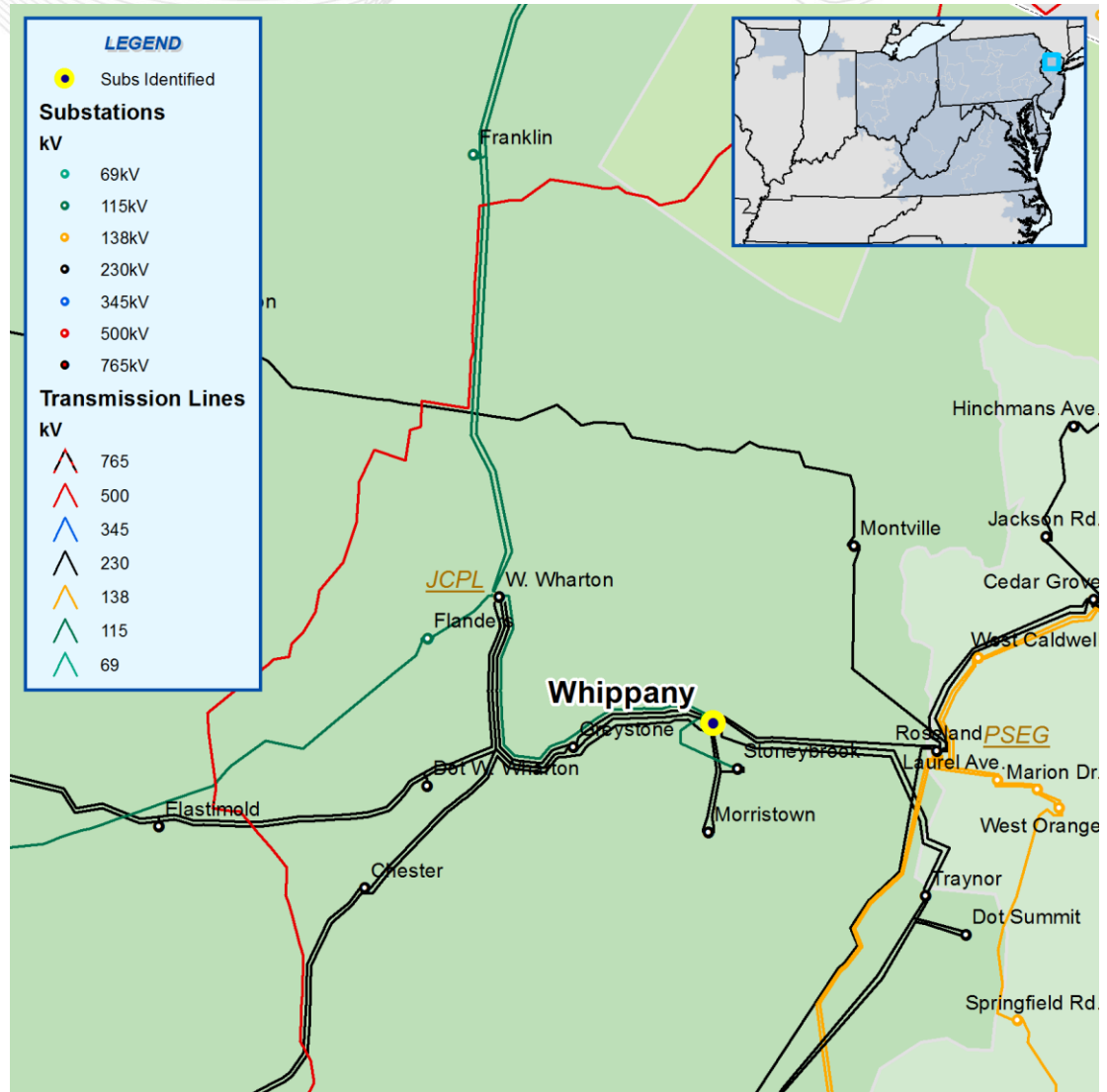
- Revised recommended Solution:
 - Construct new Brunot Island to Carson 345 kV line.
 - Convert Forbes to 138 kV Supply.
 - Extend & recable existing Carson - Oakland 138 kV.
- Expected IS Date:
 - Phased in approach
 - 6/12 to convert Forbes & recable portion of existing Carson - Oakland
 - 6/13 to recable remainder of Carson-Oakland
 - 6/16 to complete 345 kV loop
- Estimated project cost: \$188M



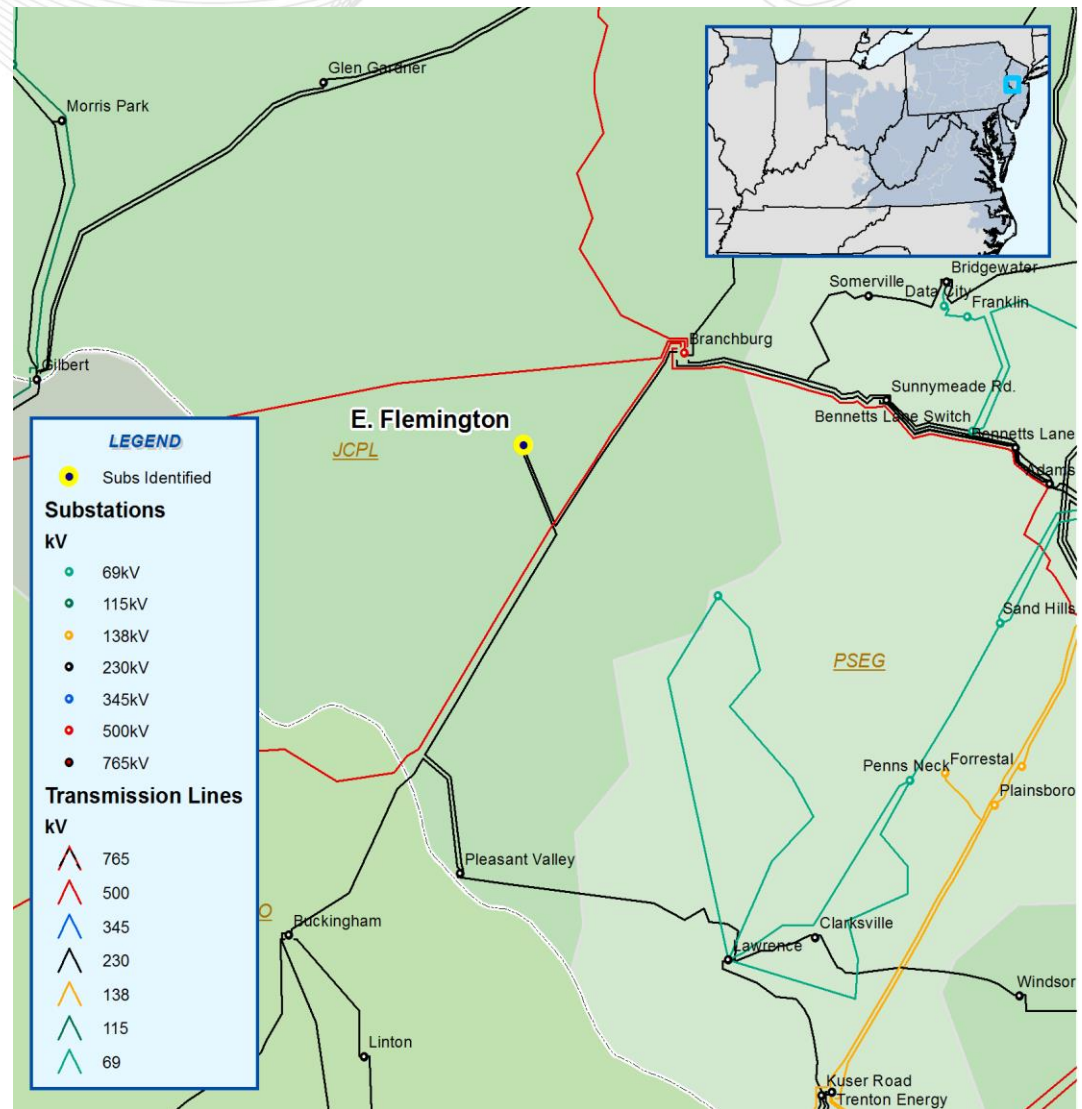
- The Whippany 230 kV breaker 'JB' is overstressed
- Significant Driver: Convert the West Orange 138 kV substation, the two Roseland – West Orange 138 kV circuits, and the Roseland – Sewaren 138 kV circuit from 138 kV to 230 kV (b1154)
- Proposed Solution: Upgrade the Whippany 230 kV breaker 'JB' (b1154.1)
- Estimated Project Cost: \$258.2 K
- Expected IS Date: 6/01/2014



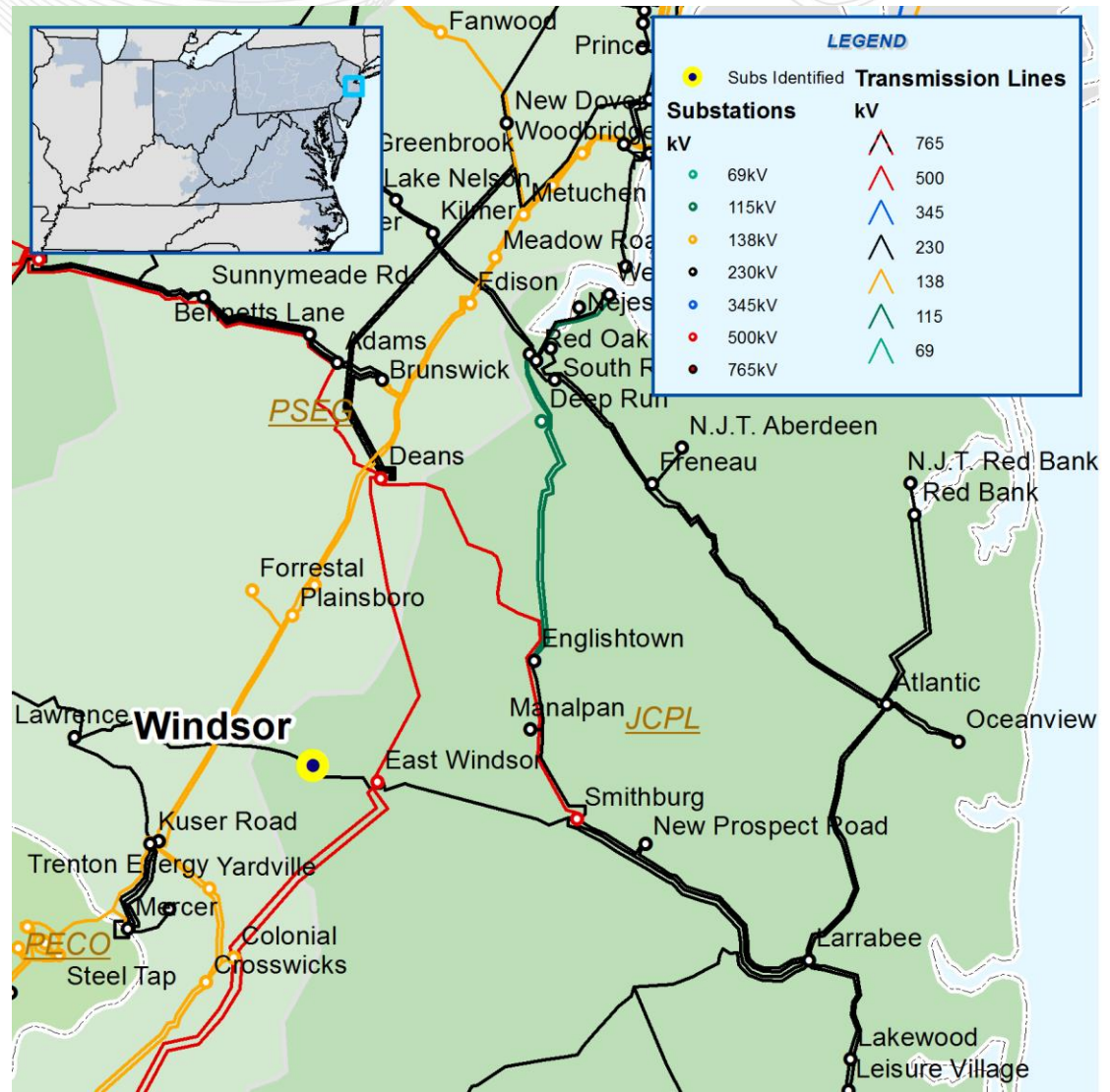
- The Whippany 230 kV breaker 'QJ' is overstressed
- Significant Driver: Convert the 138 kV path from Aldene –Springfield Rd. - West Orange to 230 kV (b1399)
- Proposed Solution: Upgrade the Whippany 230 kV breakers 'QJ' (b1399.1)
- Estimated Project Cost: \$258.2 K
- Expected IS Date: 6/01/2014



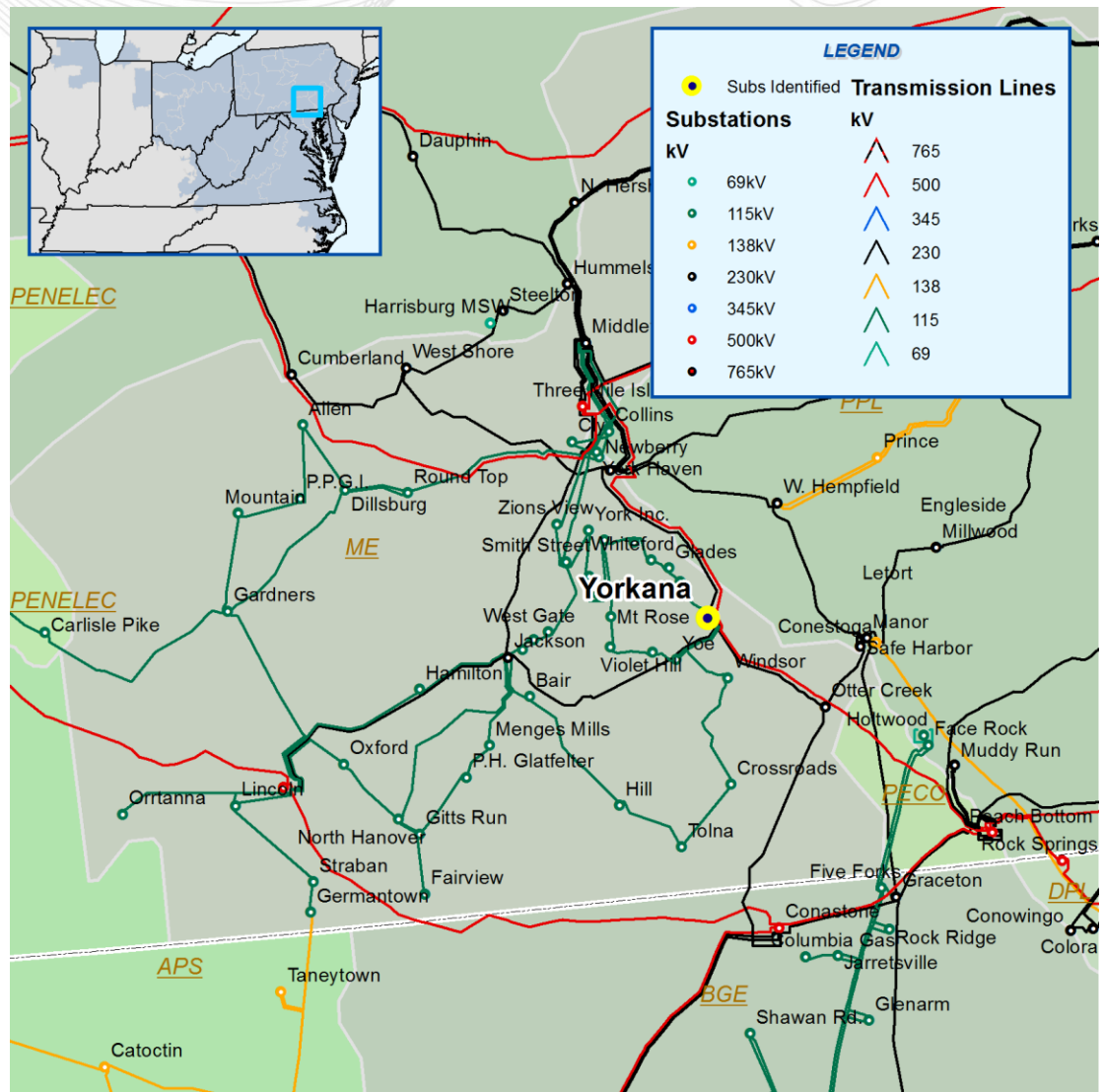
- FE Planning Criteria
- Local voltage collapse on 34.5 kV for the loss of the East Flemington – US Bronze 34.5 kV (Y727) line.
- Proposed Solution:
Install a 230/34.5 kV transformer at Rocktown by looping the Pleasant Valley - E Flemington 230 kV Q-2243 line (0.4 miles) through the Rocktown 34.5 kV substation (B1673).
- Estimated Project Cost:
\$7.836 M
- Expected IS Date:
6/1/2013



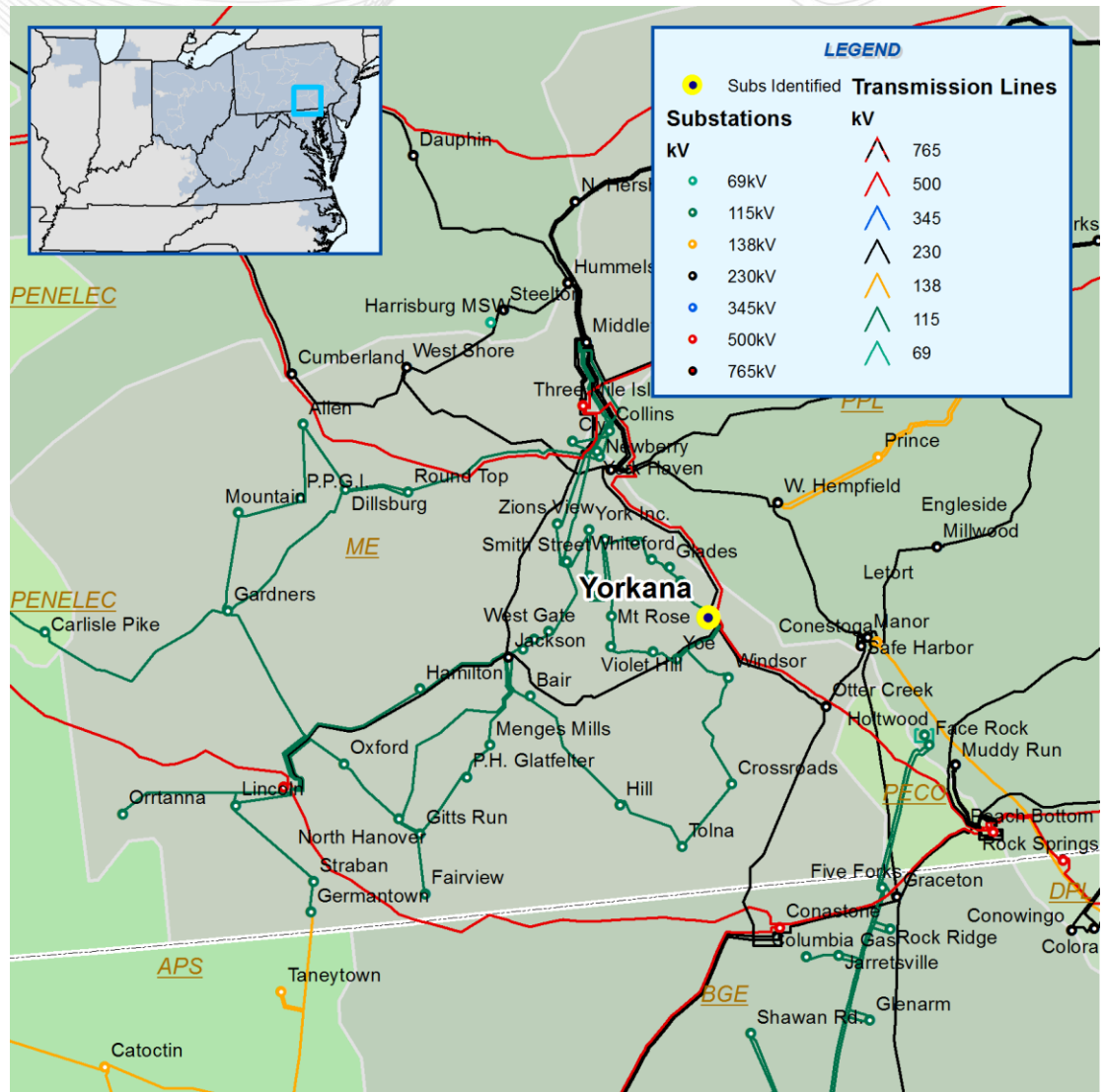
- FE Planning Criteria
- Overload on the Windsor 230/34.5 kV # 1 transformer for the loss of the Windsor 230/34.5 kV # 3 transformer.
- Proposed Solution:
Build a new Englishtown - Wyckoff Street (15 miles) 115 kV line and install a 115/34.5 kV transformer at Wyckoff Street (B1674).
- Estimated Project Cost: \$18.4303 M
- Expected IS Date: 6/1/2014



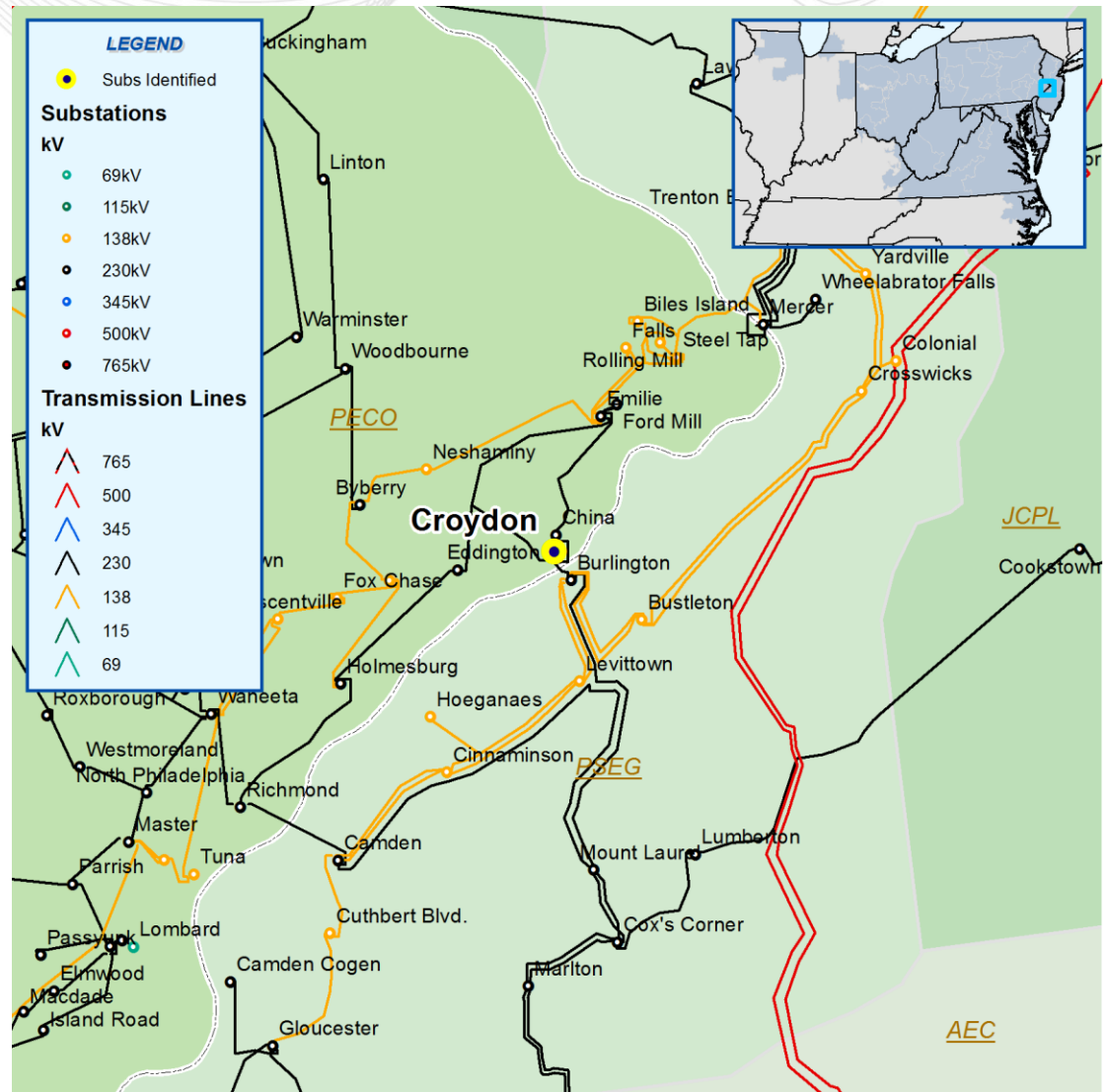
- The Yorkana 115kV breaker '97282' is overstressed
- Driver: Previous baseline upgrade to replace existing Yorkana 230/115 kV transformer banks 1 and 4 with a single, larger transformer similar to transformer bank #3 (b1061)
- Proposed Solution: Replace the Yorkana 115kV breaker '97282' (b1061.1)
- Estimated Project Cost: \$211.3 K
- Expected IS Date: 12/31/2012



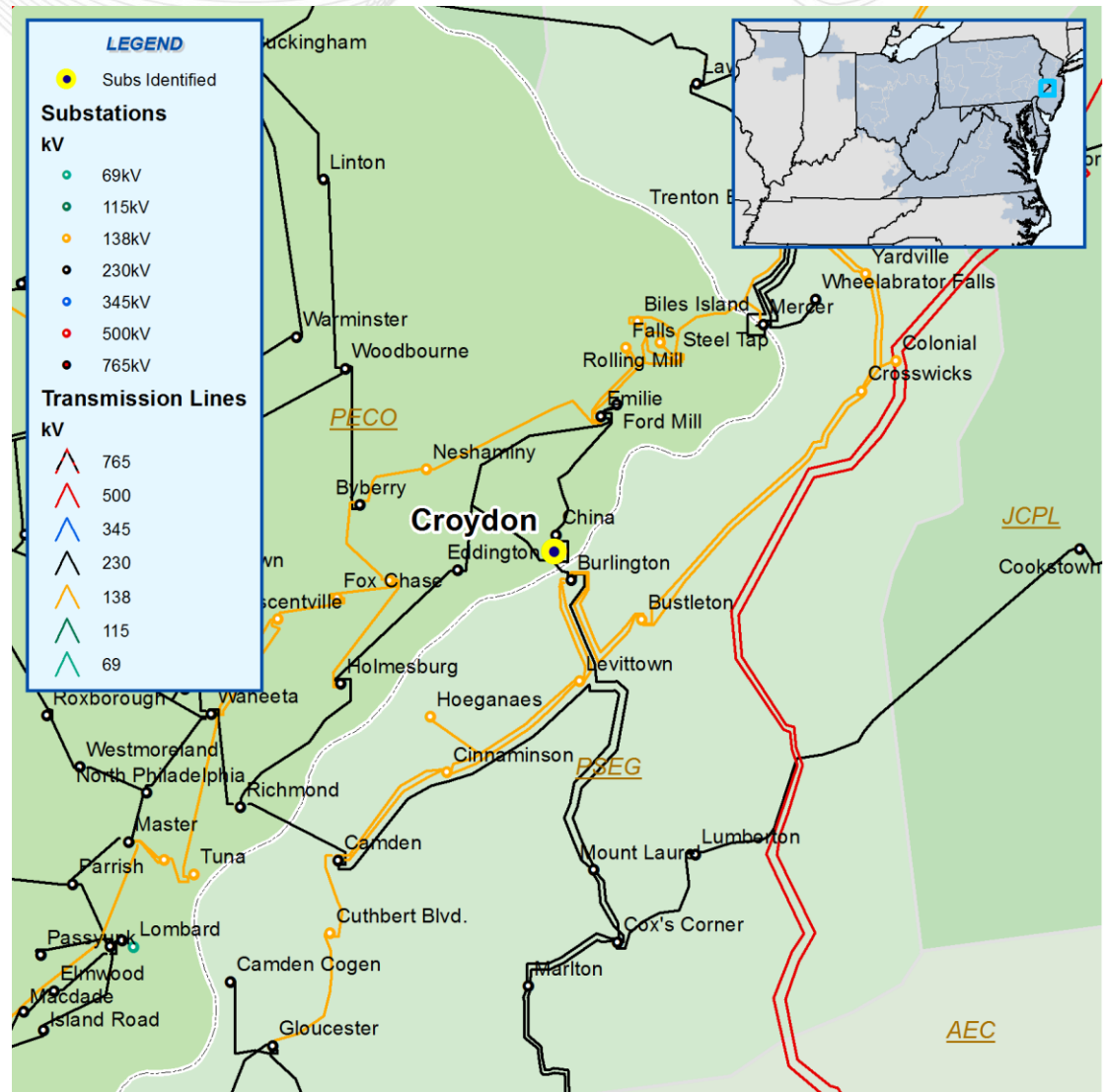
- The Yorkana 115kV breaker 'B282' is overstressed
- Driver: Previous baseline upgrade to replace existing Yorkana 230/115 kV transformer banks 1 and 4 with a single, larger transformer similar to transformer bank #3 (b1061)
- Proposed Solution: Replace the Yorkana 115kV breaker 'B282' (b1061.2)
- Estimated Project Cost: \$147 K
- Expected IS Date: 6/1/2011



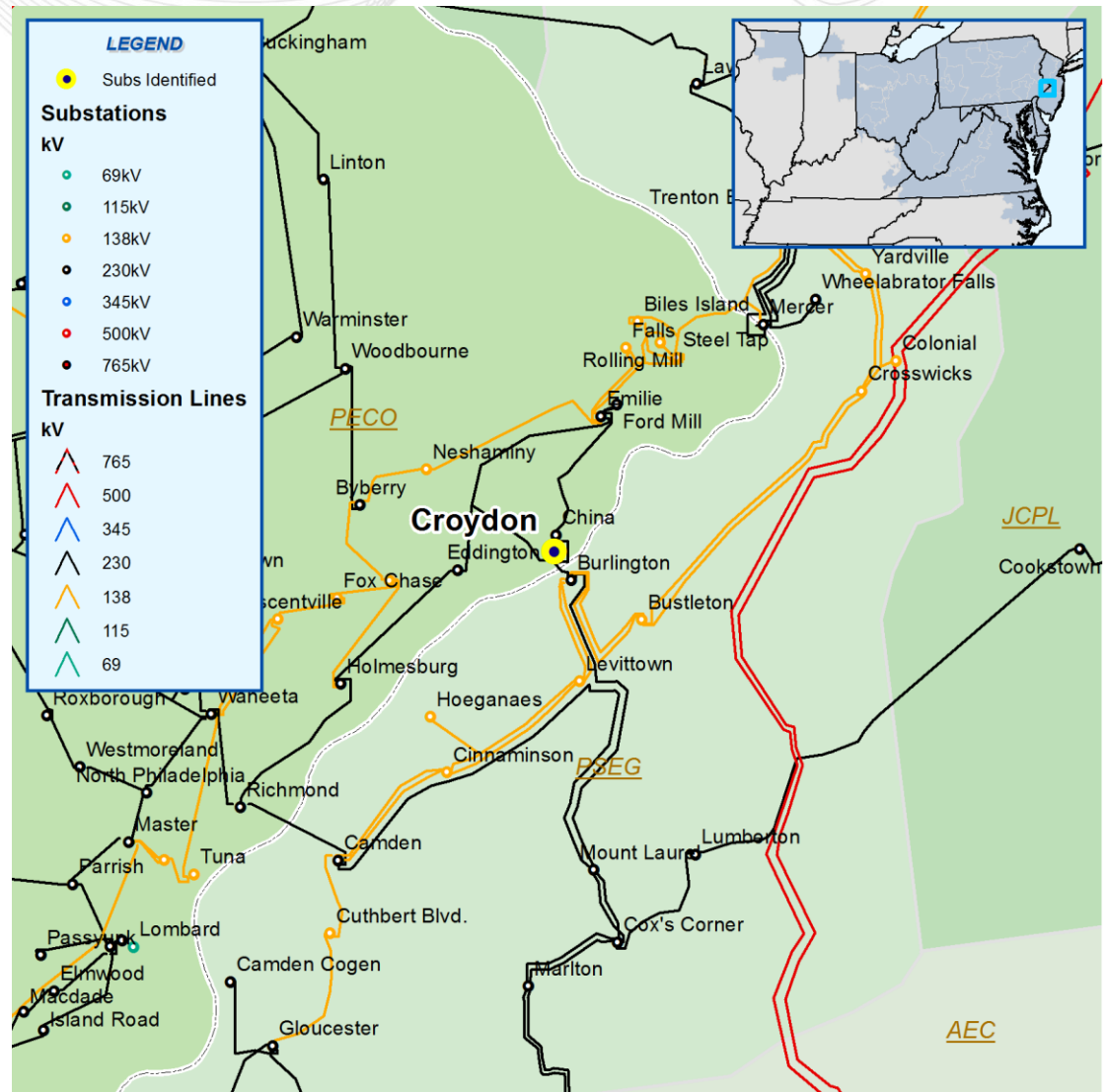
- The Croydon 230 kV breaker '135' is overstressed
- Significant Driver: Build two new parallel underground circuits from Gloucester to Camden (via Cuthbert Blvd) (b1398)
- Proposed Solution: Replace the Croydon 230 kV breaker '135' (b1398.9)
- Estimated Project Cost: \$500 K
- Expected IS Date: 6/01/2015



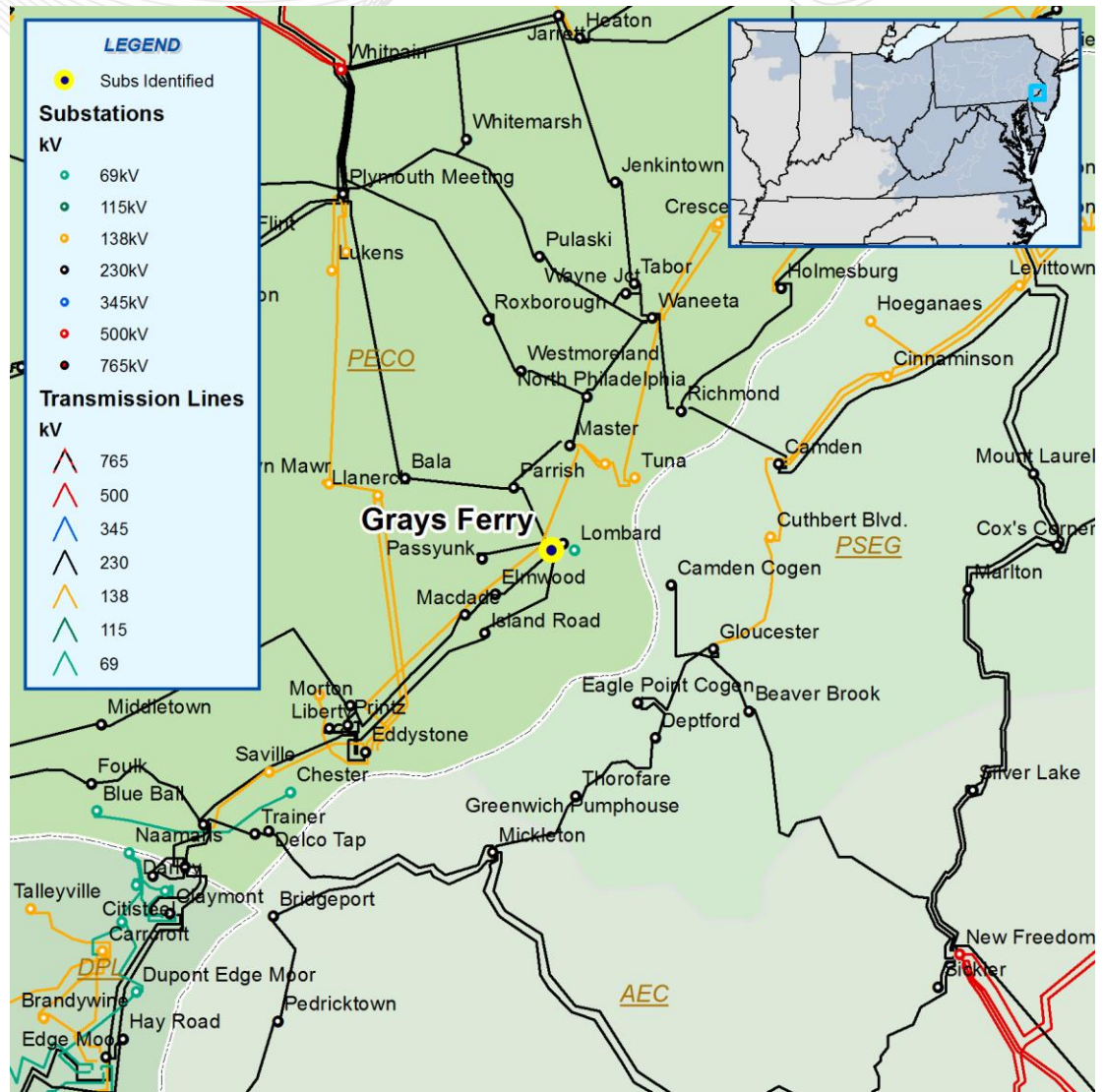
- The Croydon 230 kV breaker '315' is overstressed
- Significant Driver: Build two new parallel underground circuits from Gloucester to Camden (via Cuthbert Blvd) (b1398)
- Proposed Solution: Upgrade the Croydon 230 kV breaker '315' (b1398.10)
- Estimated Project Cost: \$100 K
- Expected IS Date: 6/01/2015



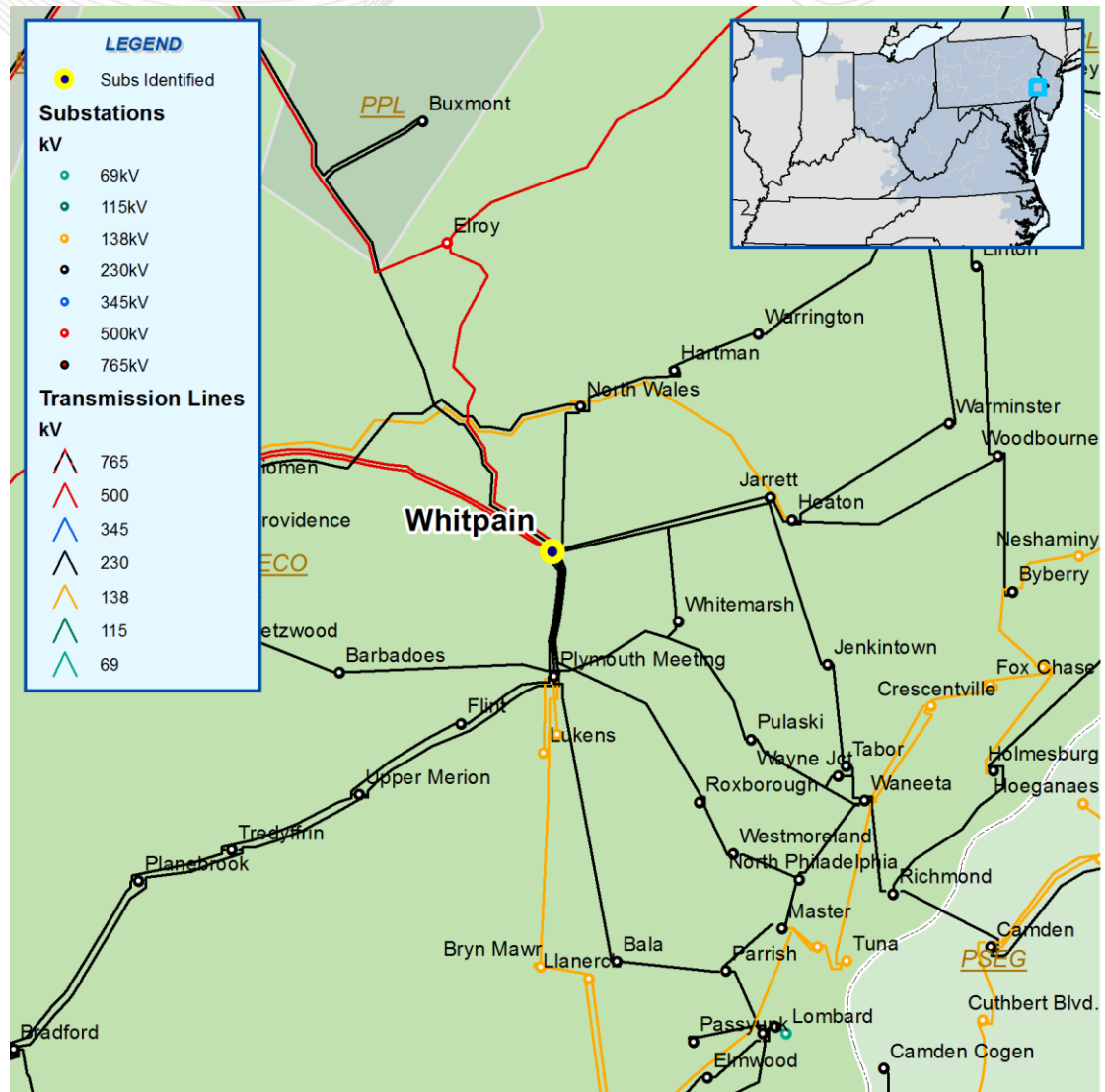
- The Croydon 230 kV breaker '335' is overstressed
- Significant Driver: Build two new parallel underground circuits from Gloucester to Camden (via Cuthbert Blvd) (b1398)
- Proposed Solution: Replace the Croydon 230 kV breaker '335' (b1398.11)
- Estimated Project Cost: \$500 K
- Expected IS Date: 6/01/2015



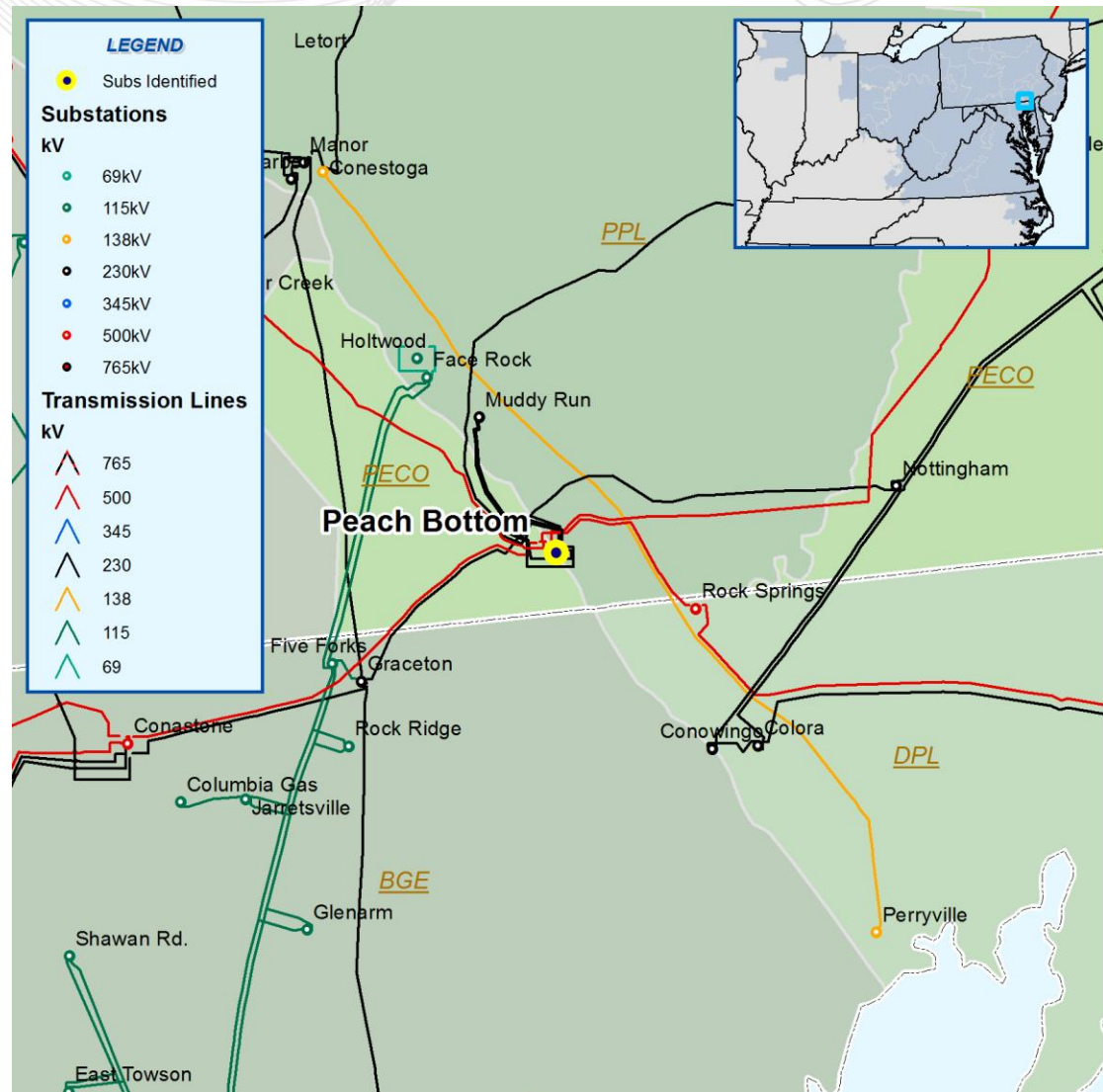
- The Grays Ferry 230 kV breaker '115' is overstressed
- Significant Driver: Build two new parallel underground circuits from Gloucester to Camden (via Cuthbert Blvd) (b1398)
- Proposed Solution: Replace the Grays Ferry 230 kV breaker '115' (b1398.12)
- Estimated Project Cost: \$500 K
- Expected IS Date: 6/01/2015



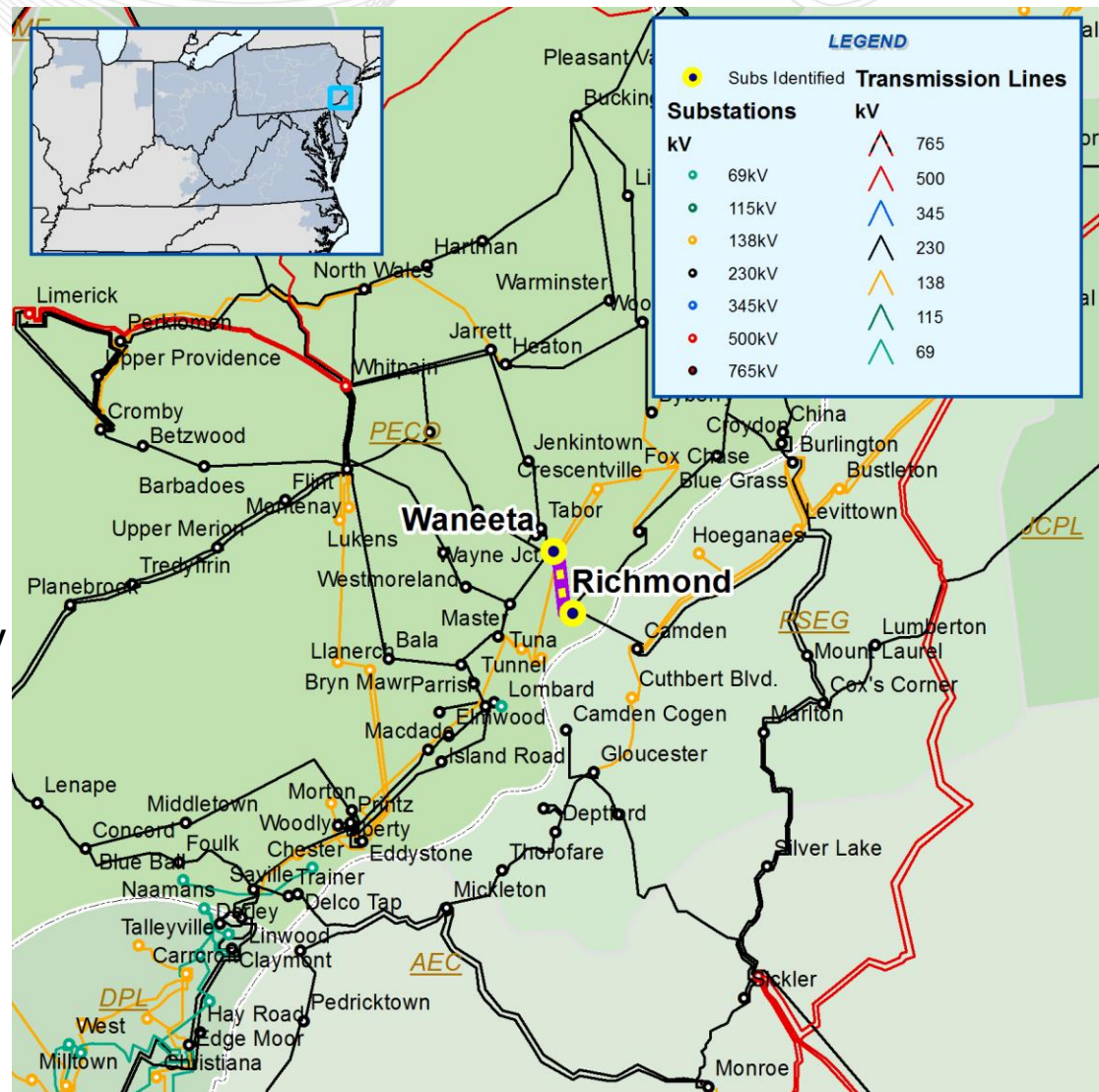
- The Whitpain 230 kV breaker '105' is overstressed
- Significant Driver: Build two new parallel underground circuits from Gloucester to Camden (via Cuthbert Blvd) (b1398)
- Proposed Solution: Replace the Whitpain 230 kV breaker '105' (b1398.14)
- Estimated Project Cost: \$500 K
- Expected IS Date: 6/01/2015



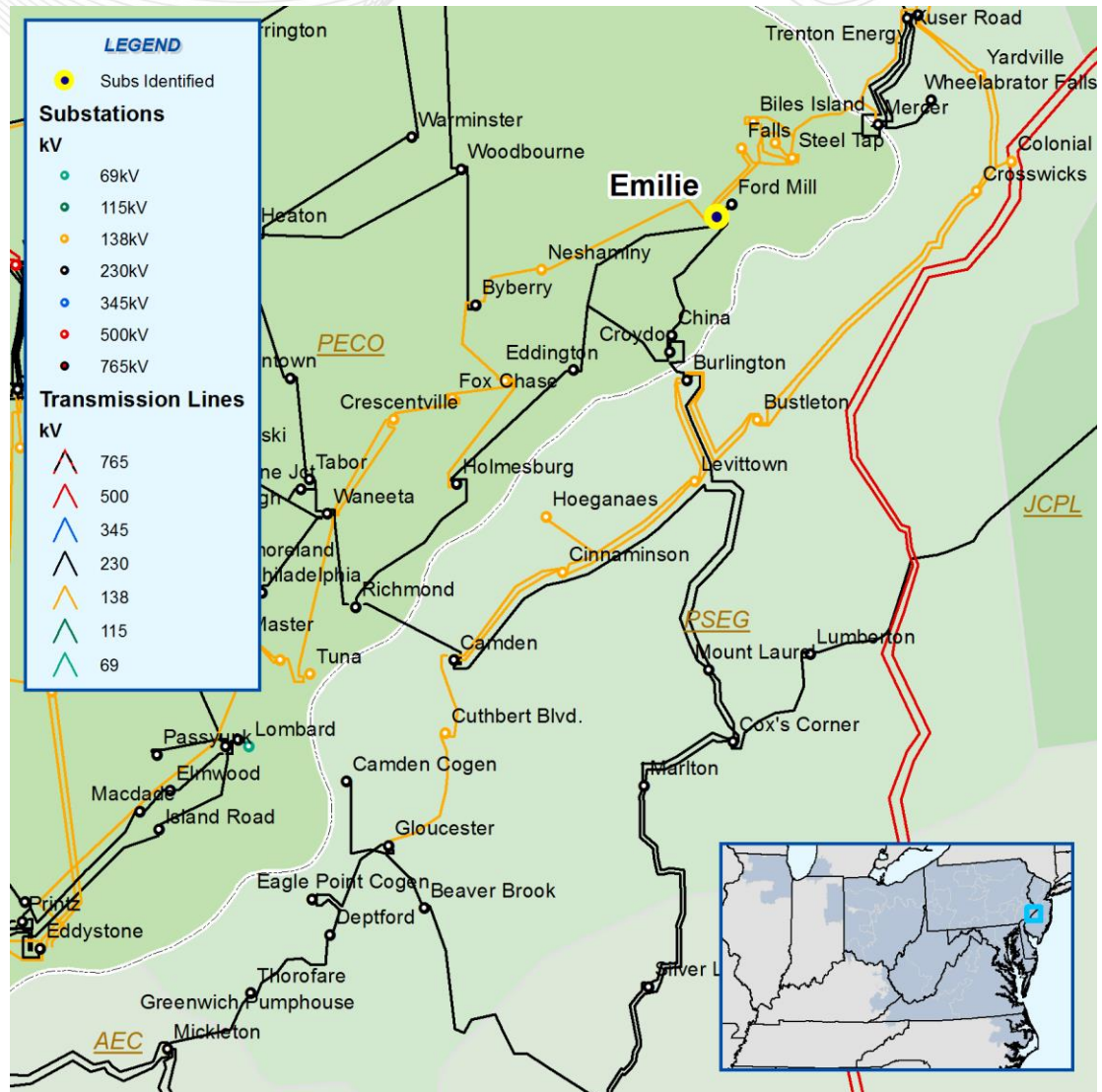
- The Peach Bottom 500 kV breaker '225' is overstressed
- Significant Driver: Build two new parallel underground circuits from Gloucester to Camden (via Cuthbert Blvd) (b1398)
- Proposed Solution: Upgrade the Peach Bottom 500 kV breaker '225' (b1398.13)
- Estimated Project Cost: \$250 K
- Expected IS Date: 6/01/2015



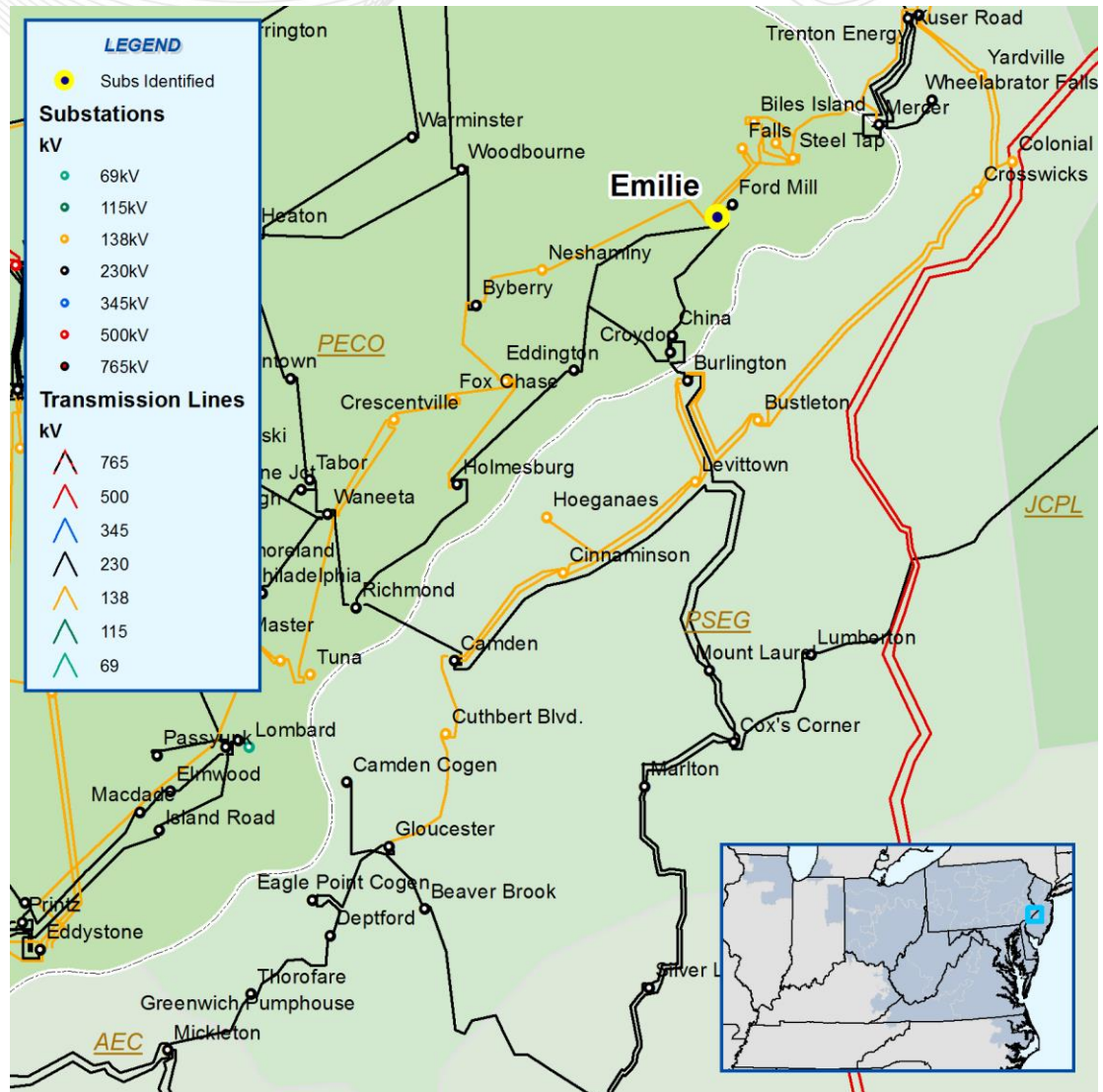
- Common Mode Outage Procedure:
- Overload on the Waneeta – Richmond 230 kV circuit for the loss of several bus and line fault stuck breaker contingencies.
- Proposed Solution:
Reconductor the underground portion of the Richmond – Waneeta 230 kV circuit and replace terminal equipments (B1591).
- Estimated Project Cost:
\$ 12 M
- Expected IS Date:
6/1/2016



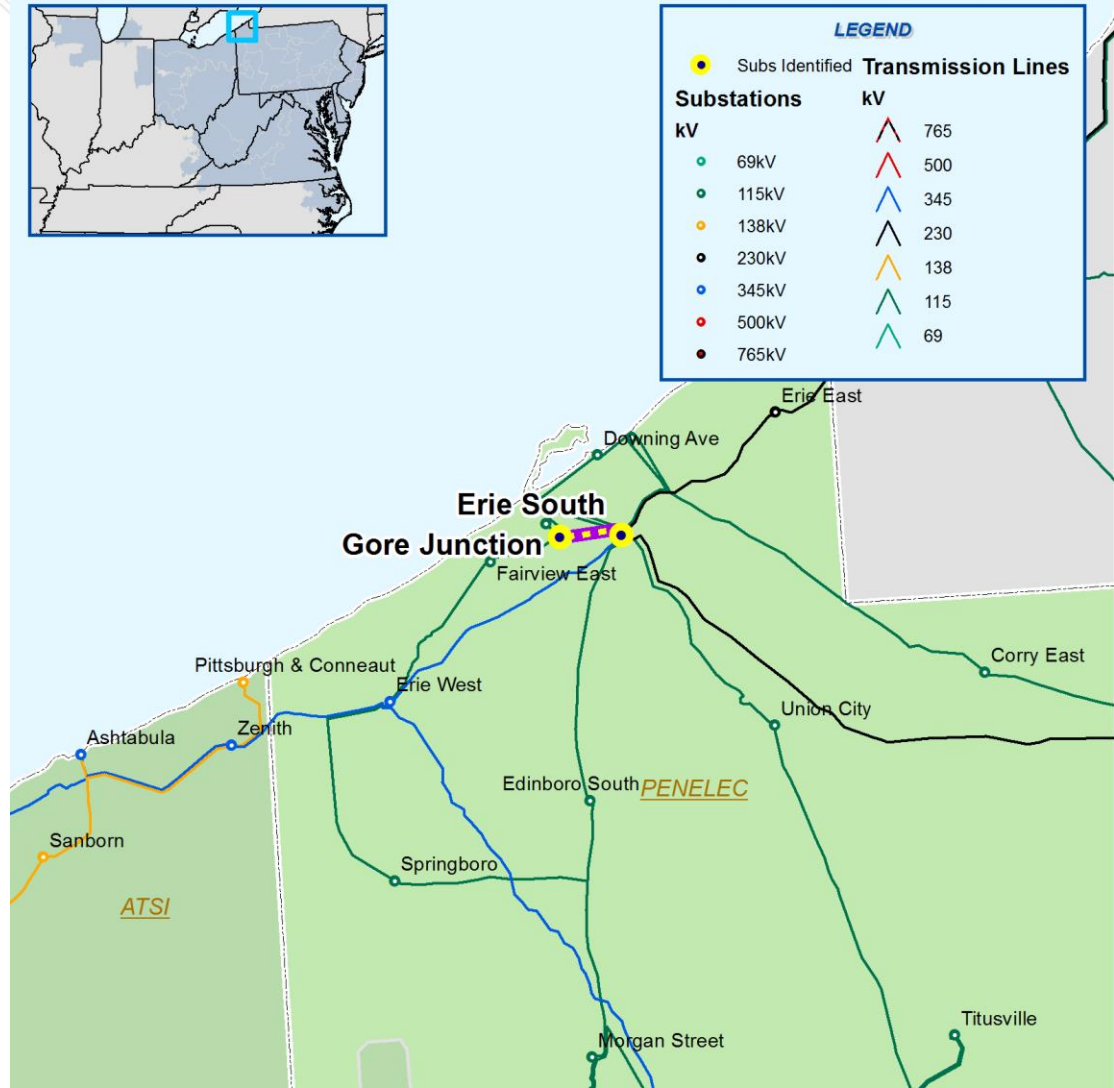
- The Emilie 138 kV breaker '190' is overstressed
- Driver: Previous baseline upgrade to convert the Burlington, Camden, and Cuthbert Blvd 138 kV substations, the 138 kV circuits from Burlington to Camden, and the 138 kV circuit from Camden to Cuthbert Blvd. from 138 kV to 230 kV (b1156)
- Proposed Solution: Replace the Emilie 138 kV breaker '190' (b1156.12)
- Estimated Project Cost: \$500 K
- Expected IS Date: 6/1/2014



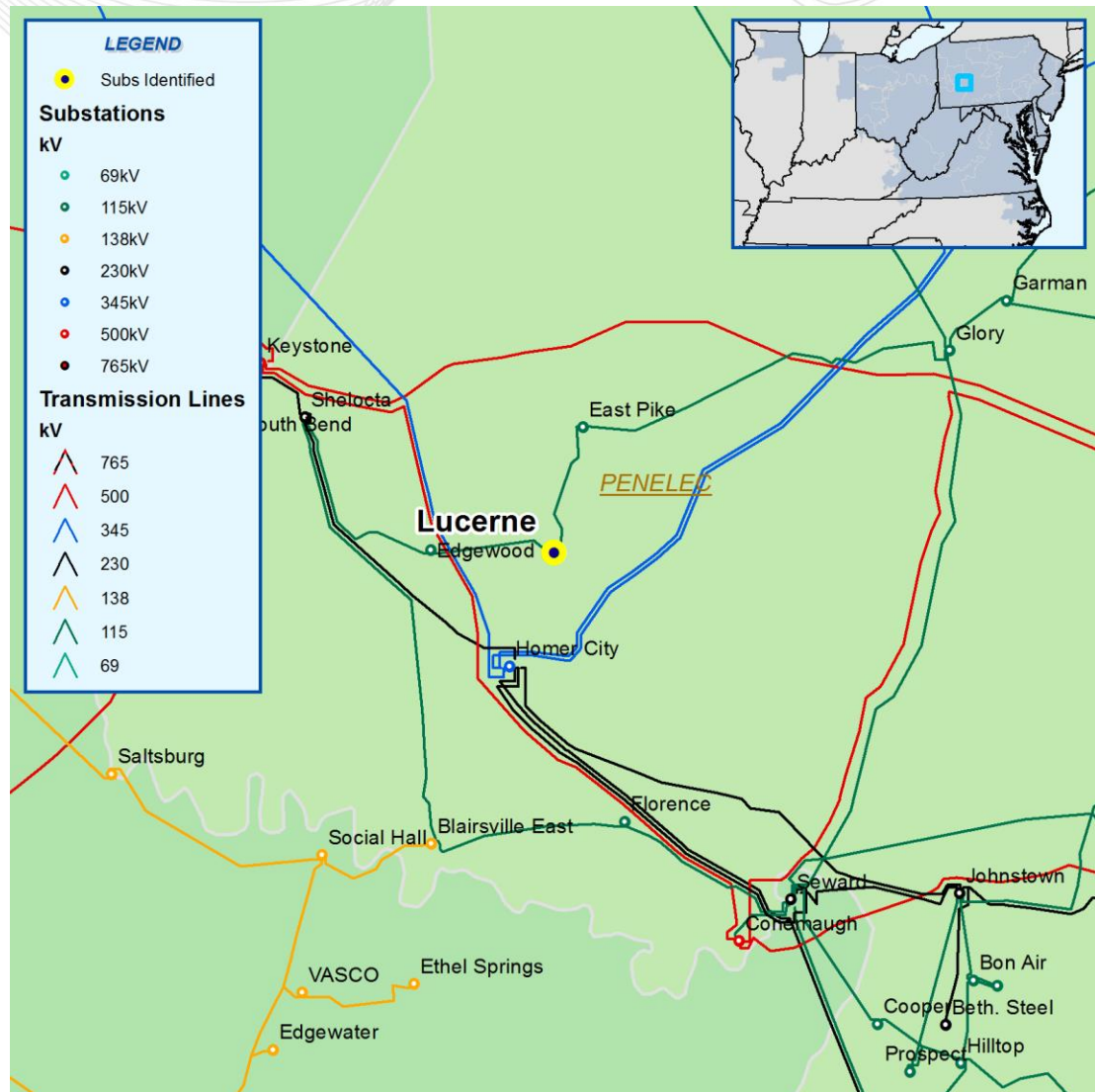
- The Emilie 138 kV breaker '190' is overstressed
- Driver: Previous baseline upgrade to convert the Burlington, Camden, and Cuthbert Blvd 138 kV substations, the 138 kV circuits from Burlington to Camden, and the 138 kV circuit from Camden to Cuthbert Blvd. from 138 kV to 230 kV (b1156)
- Proposed Solution: Replace the Emilie 138 kV breaker '190' (b1156.12)
- Estimated Project Cost: \$500 K
- Expected IS Date: 6/1/2014



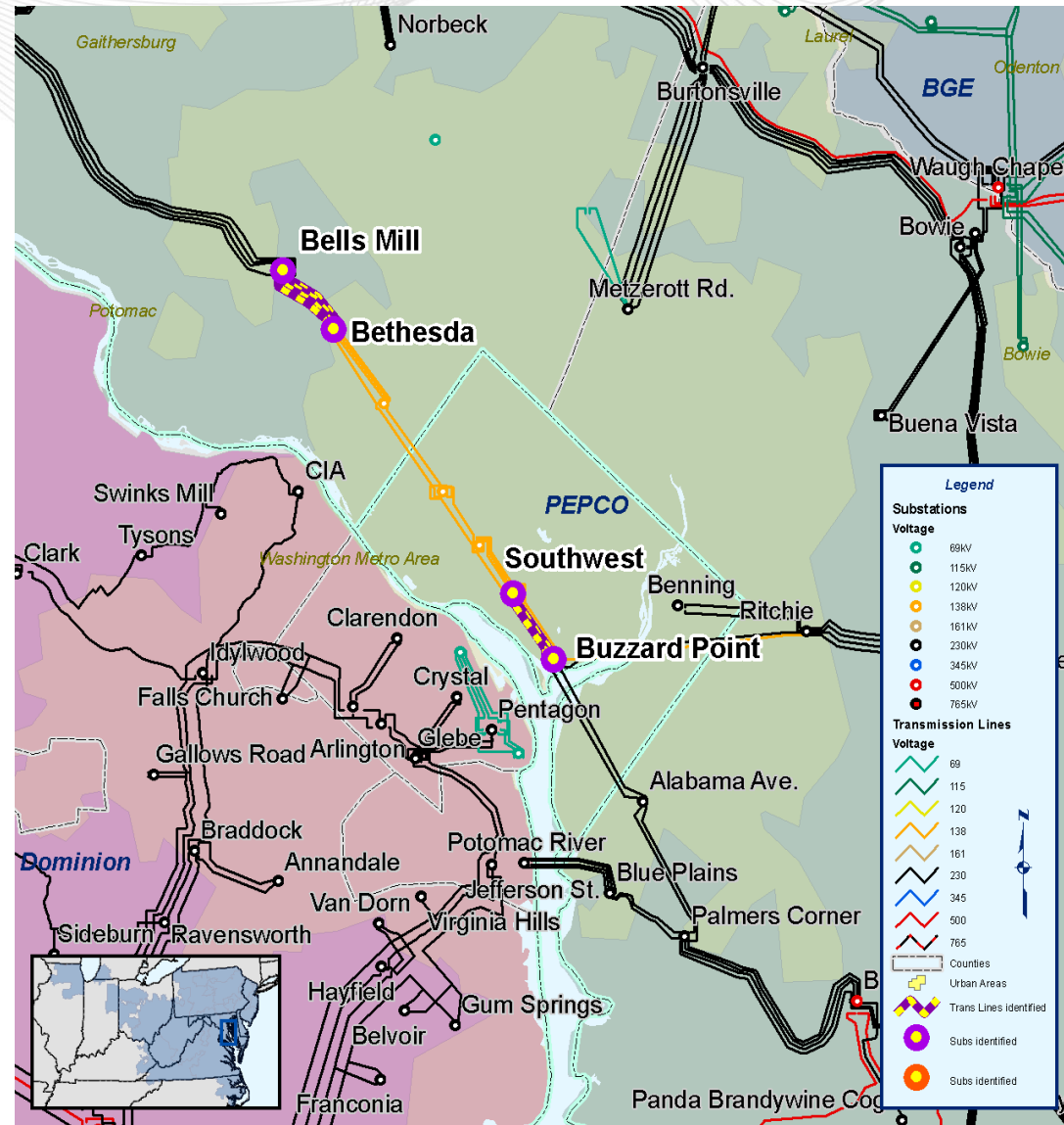
- FE Planning Criteria Violation
Overload on the Gore Junction – ESG Tap 115 kV line for the loss of the Erie South – Erie West 345 kV line.
- Recommended Solution:
Reconductor 0.8 miles of the Gore Junction – ESG Tap 115 kV line with 795 ACSS (B1535).
- Estimated Project Cost:
\$0.163 M
- Expected IS Date:
6/1/2012



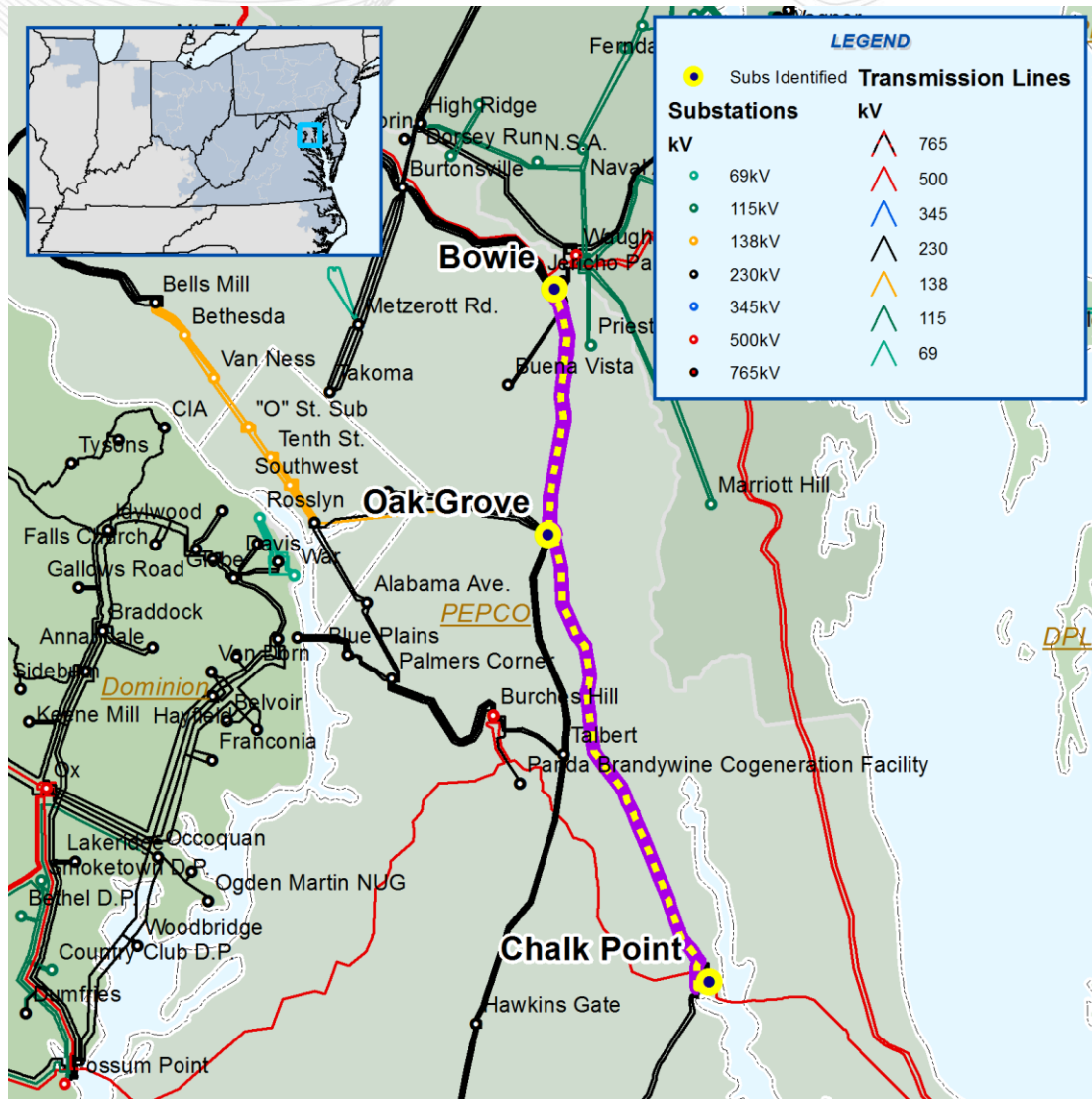
- The Shelocata 115 kV breaker 'Lucerne' is overstressed
- Driver: Previous baseline project to upgrade Conemaugh 500/230 KV transformer and new line from Conemaugh-Seward 230 kV (b1153)
- Proposed Solution: Revise the reclosing on the Shelocata 115 kV breaker 'Lucerne' (b1153.1)
- Estimated Project Cost: \$0
- Expected IS Date: 6/1/2014



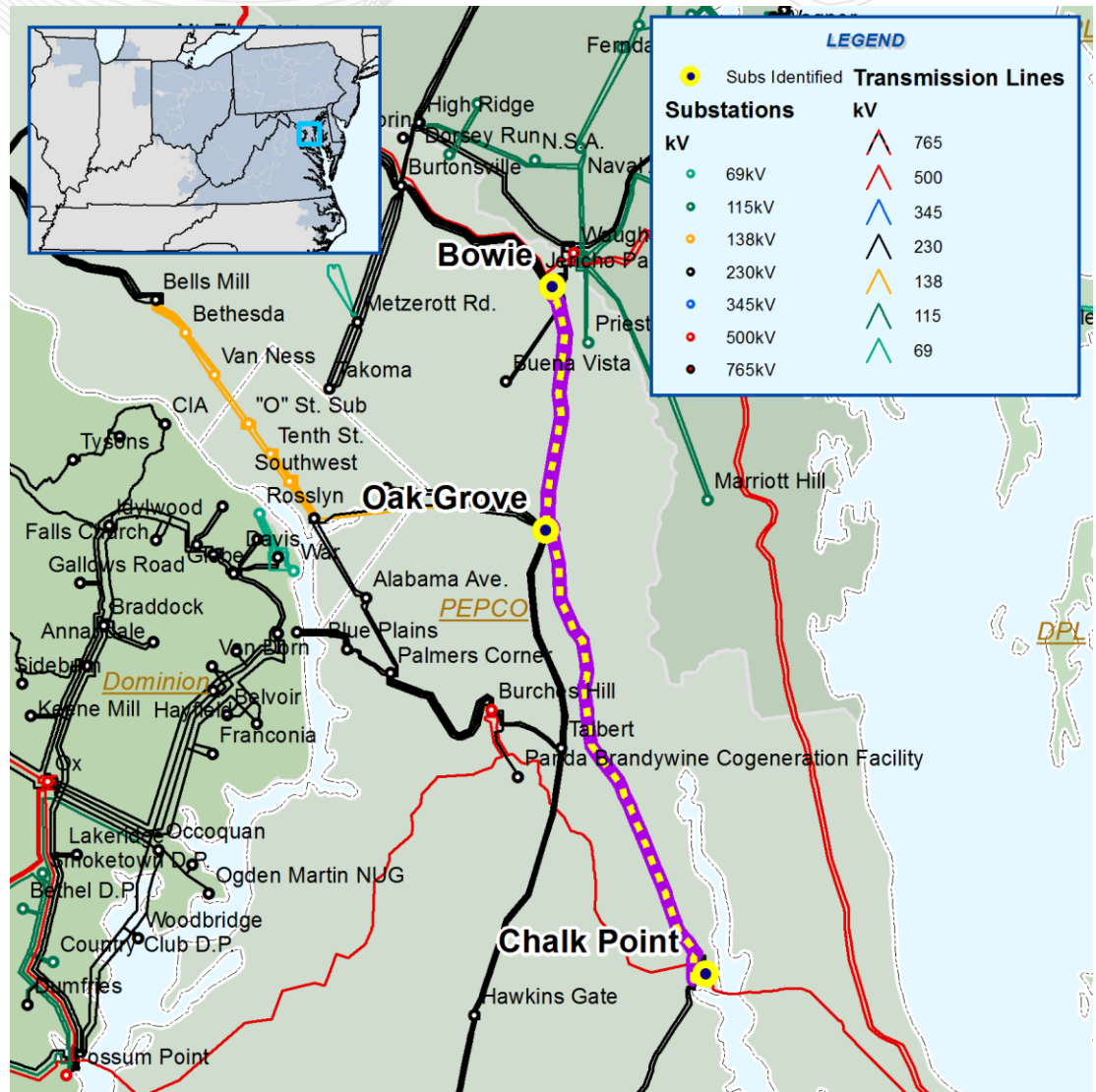
- There is an existing upgrade B0730 to add slow oil circulation to 4 Bells Mill Road – Bethesda 138 kV lines & also to the 2 Buzzard Point – Southwest 138 kV lines. PEPCO has determined that slow oil circulation or forced cooling is not a viable option for these feeders. The scope of the project needs to be modified.
- Modify scope of B0730
 - Increase the rating of the 4 Bells Mill Road – Bethesda 138 kV lines & the 2 Buzzard Point – Southwest 138 kV lines, and replace terminal equipment at Bells Mill Road, Southwest and Buzzard Point substations.
 - Replace the 138kV “O” Street Phase Shifters
- Original Estimated Project Cost Estimate: \$6.0 M
- New Estimated Project Cost Estimate: \$15.0 M
- Expected IS Date: 6/1/2013



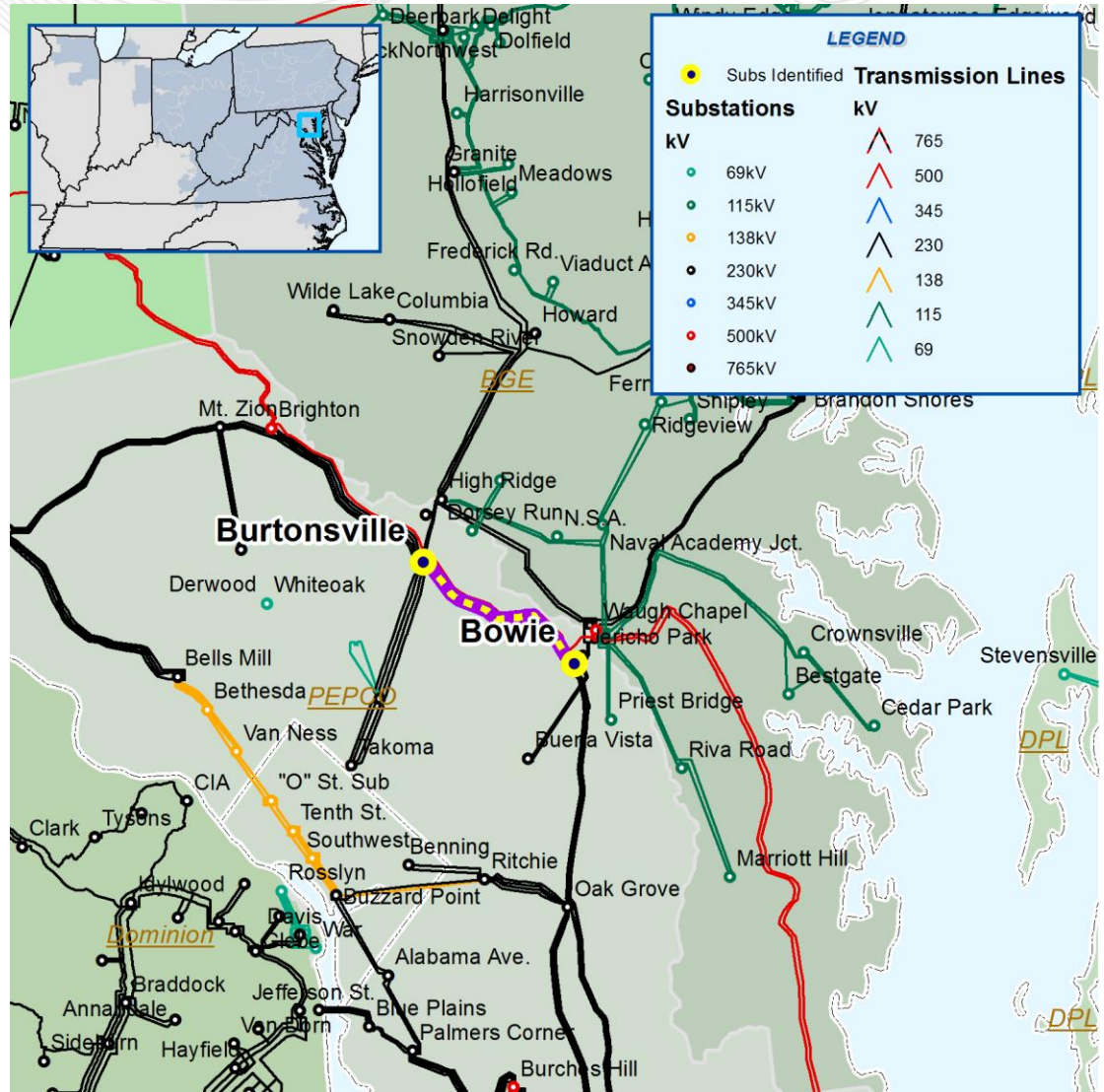
- Common Mode Outage Procedure
- Overload on Oak Grove - Bowie 230 kV '23045' circuit for the tower-line outage of the Chalk Point – Bowie '23054' and Oak Grove – Burtonsville '23042' 230 kV circuits.
- Proposed Solution:
Reconductor the Oak Grove – Bowie 230 kV '23045' circuit and upgrade terminal equipments at Oak Grove and Bowie 230 kV substations (B1592).
- Estimated Project Cost:
\$ 17 M
- Expected IS Date:
6/1/2016



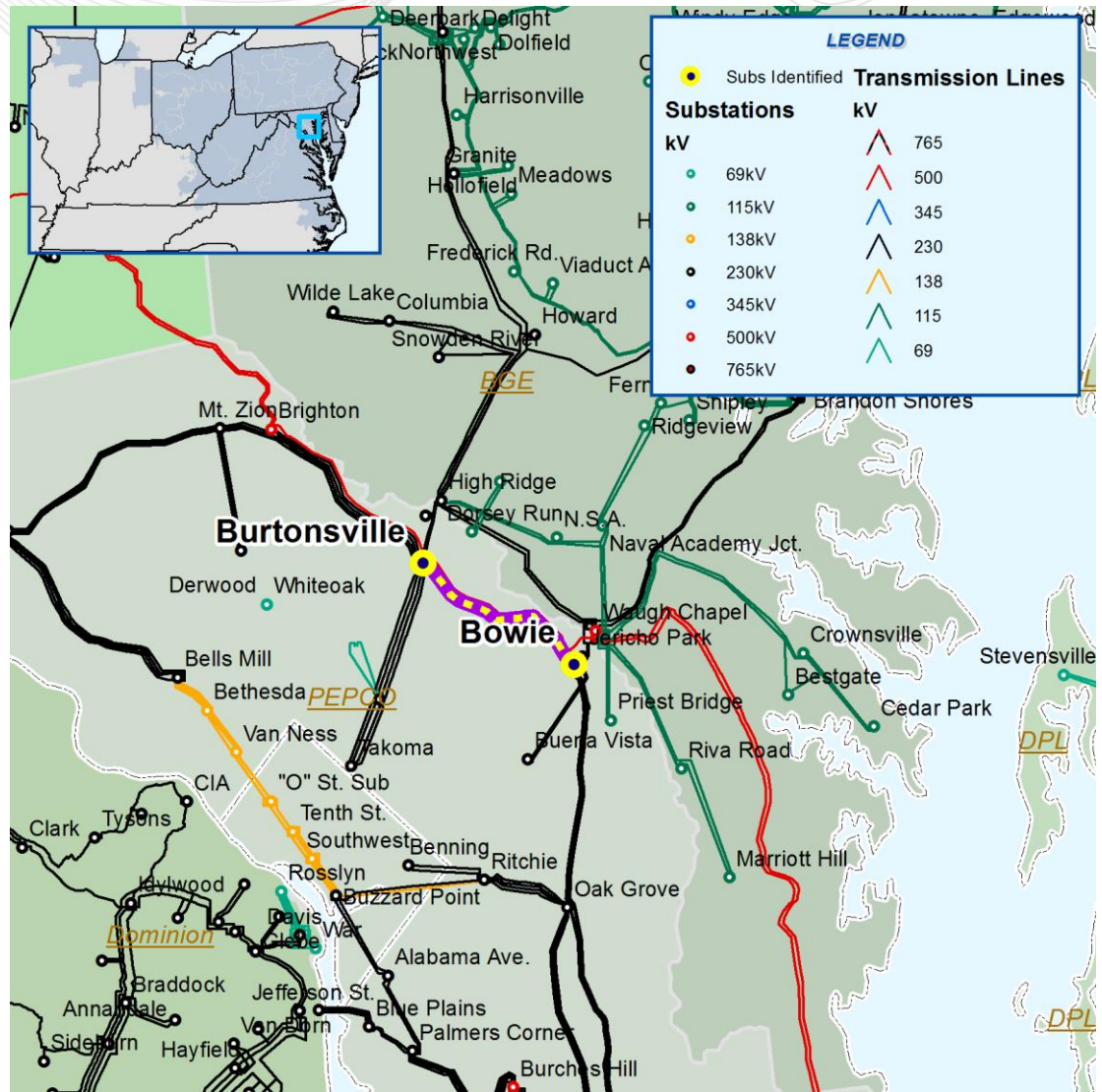
- Common Mode Outage Procedure
- Overload on Oak Grove - Bowie 230 kV '23042' circuit for the tower-line outage of the Chalk Point – Bowie '23065' and Oak Grove – Burtonsville '23045' 230 kV circuits.
- Proposed Solution:
Reconductor the Oak Grove – Bowie 230 kV '23042' circuit and upgrade terminal equipments at Oak Grove and Bowie 230 kV substations (B1594).
- Estimated Project Cost:
\$ 17 M
- Expected IS Date:
6/1/2016



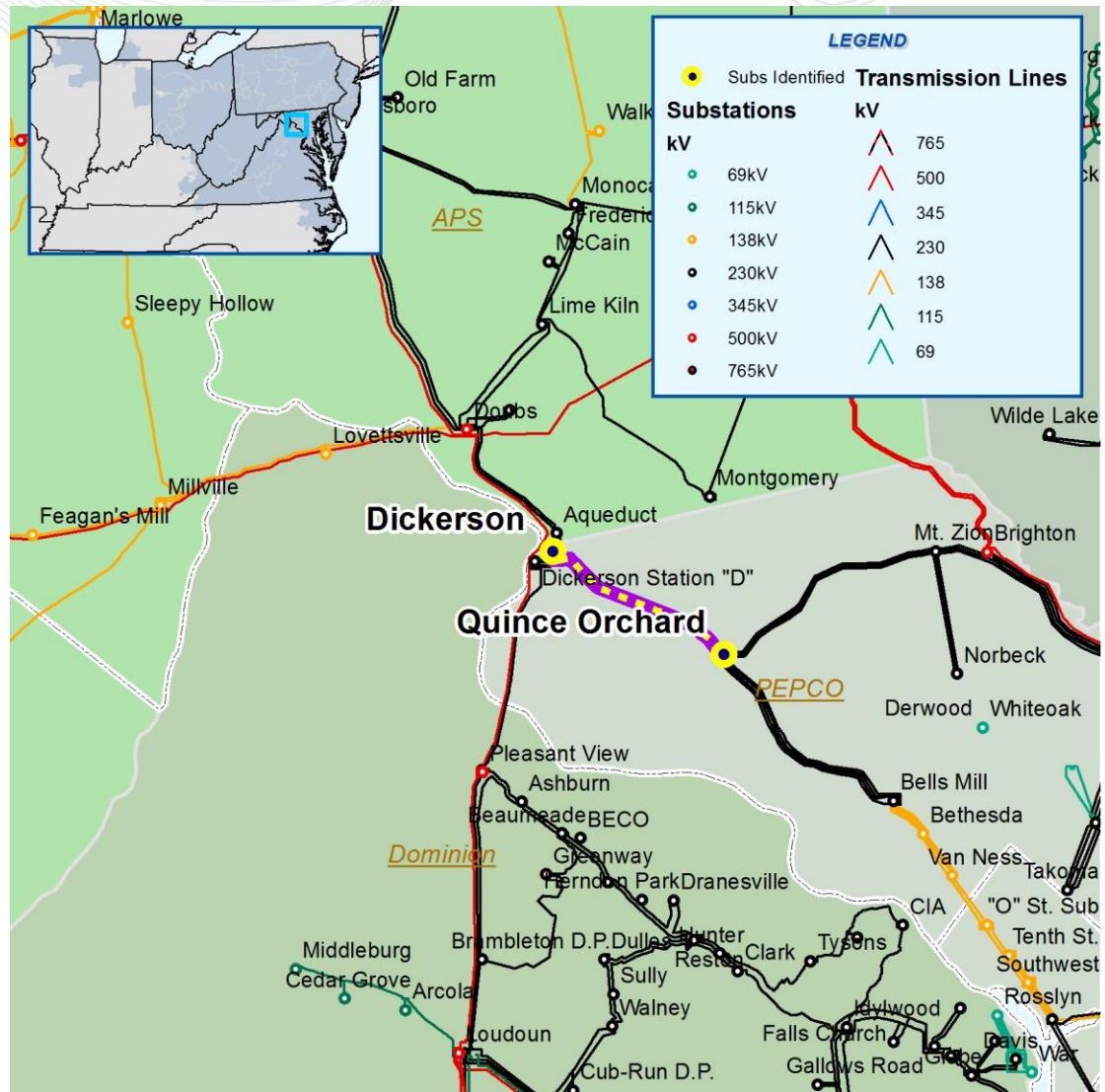
- Common Mode Outage Procedure
- Overload on Bowie – Burtonsville 230 kV ‘23045’ circuit for the tower-line outage of the Chalk Point – Bowie ‘23054’ and Oak Grove – Burtonsville ‘23042’ 230 kV circuits.
- Proposed Solution: Reconductor the Bowie - Burtonsville 230 kV ‘23045’ circuit and upgrade terminal equipments at Bowie and Burtonsville 230 kV substations (B1593).
- Estimated Project Cost: \$ 8.0 M
- Expected IS Date: 6/1/2016



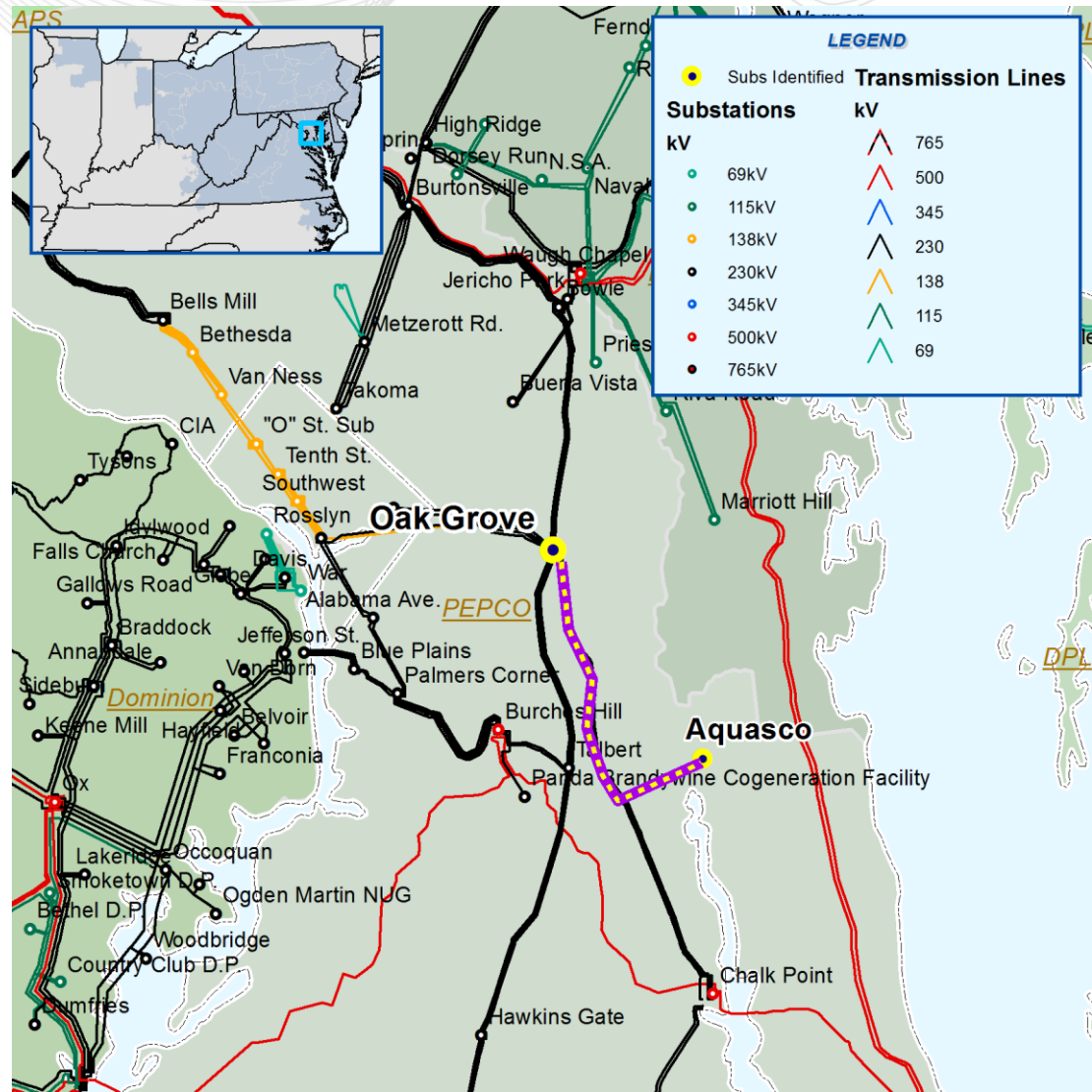
- Common Mode Outage Procedure
- Overload on Bowie – Burtonsville 230 kV ‘23042’ circuit for the tower-line outage of the Chalk Point – Bowie ‘23065’ and Oak Grove – Burtonsville ‘23045’ 230 kV circuits.
- Proposed Solution: Reconductor the Bowie – Burtonsville 230 kV ‘23042’ circuit and upgrade terminal equipments at Oak Grove and Burtonsville 230 kV substations (B1595).
- Estimated Project Cost: \$ 8.0 M
- Expected IS Date: 6/1/2016



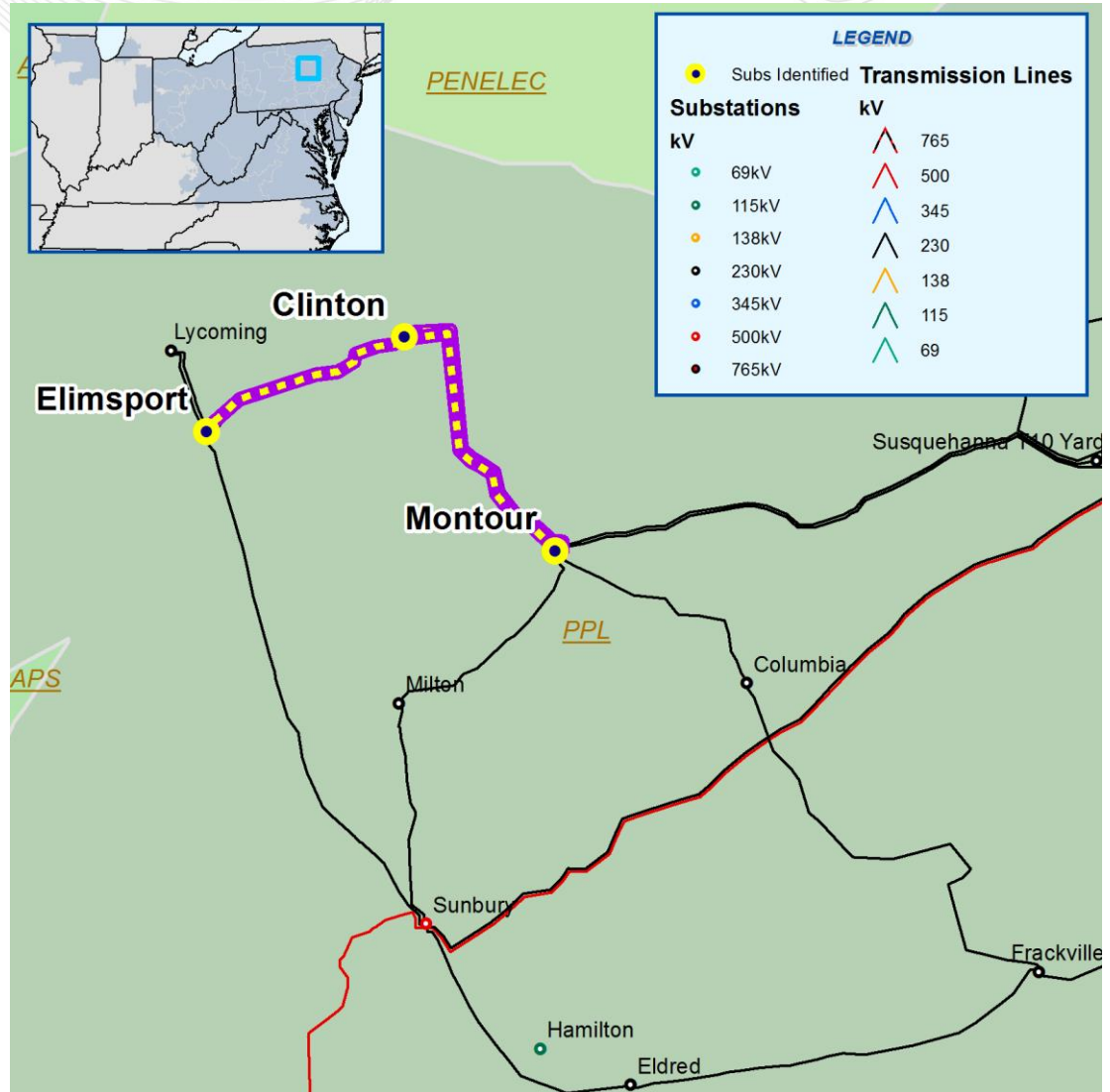
- Common Mode Outage Procedure
- Overload on Dickerson station “H” – Quince Orchard 230 kV ‘23032’ circuit for the tower-line outage of the Dickerson station “D” – Quince Orchard 230 kV circuits ‘23033’ & 23035’.
- Proposed Solution:
Reconductor the Dickerson station “H” – Quince Orchard 230 kV ‘23032’ circuit and upgrade terminal equipments at Dickerson station “H” and Quince Orchard 230 kV substations (B1596).
- Estimated Project Cost:
\$ 9.2 M
- Expected IS Date:
6/1/2016



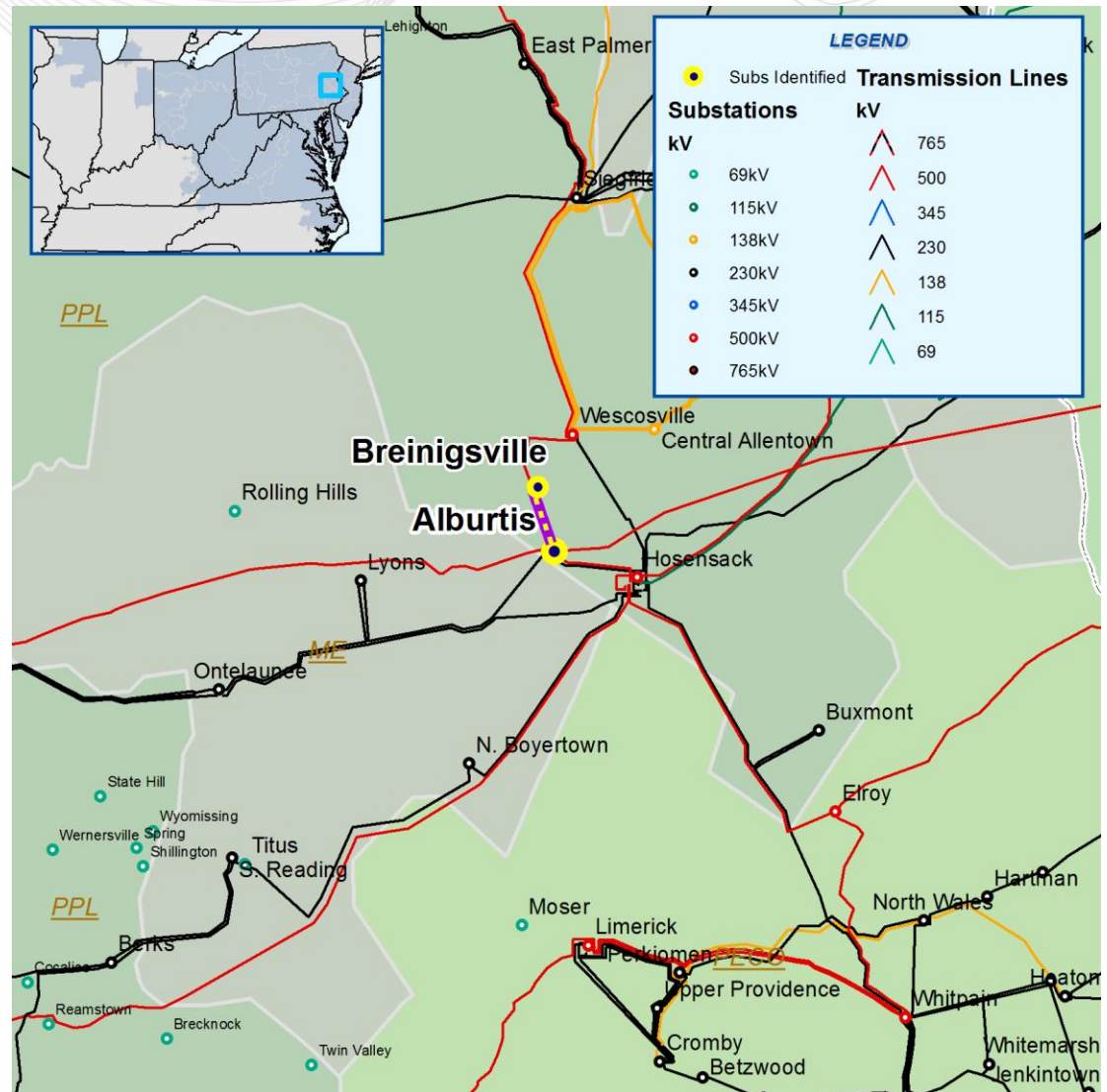
- Common Mode Outage Procedure
- Overload on Oak Grove - Aquasco 230 kV '23062' circuit for the tower-line outage of the Chalk Point – Bowie '23063' '23065' 230 kV circuits.
- Proposed Solution:
Reconductor the Oak Grove - Aquasco 230 kV '23062' circuit and upgrade terminal equipments at Oak Grove and Aquasco 230 kV substations (B1597).
- Estimated Project Cost:
\$ 27 M
- Expected IS Date:
6/1/2016



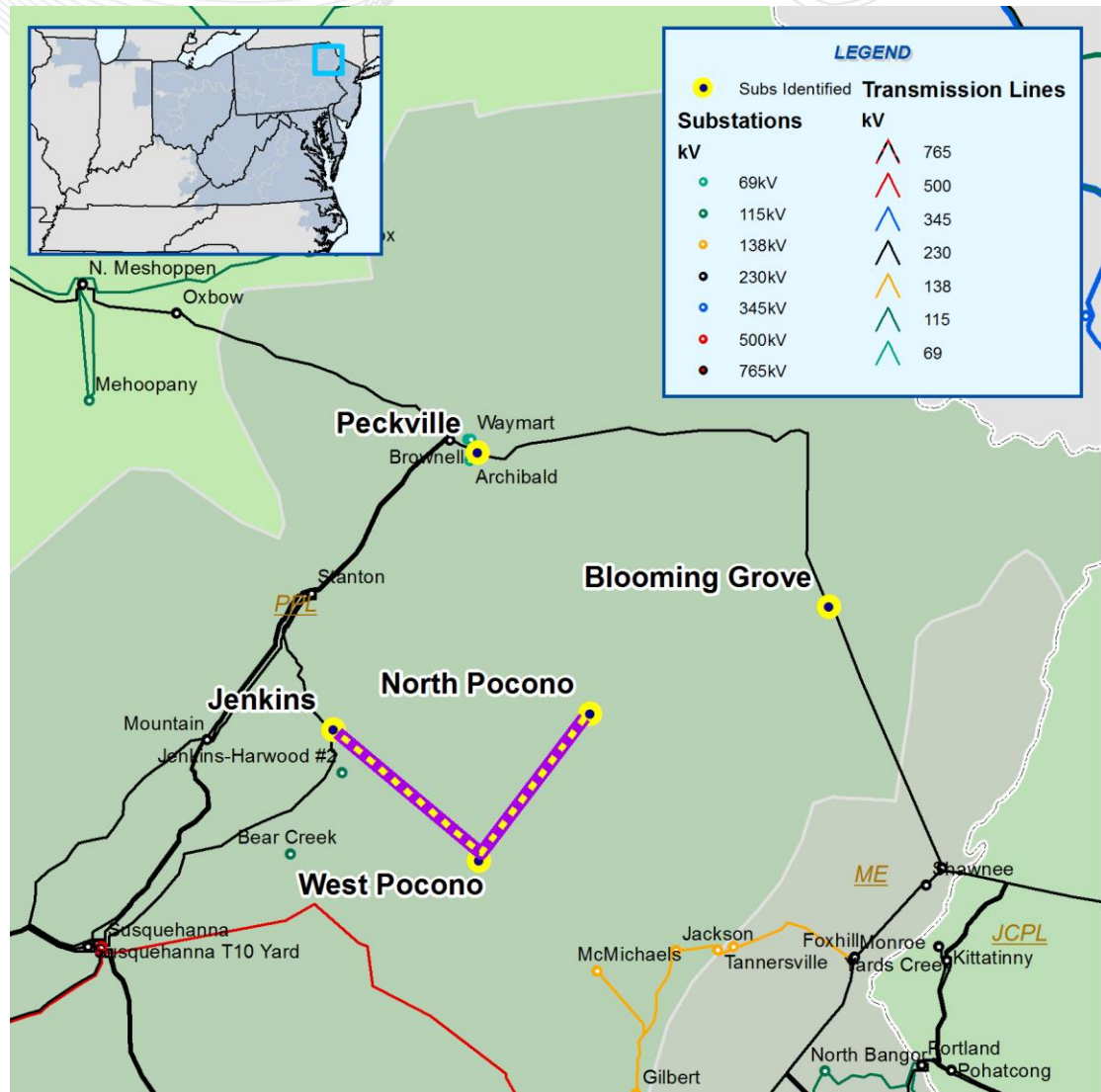
- Baseline analysis:
- Voltage drop violation on Elimspport, Clinton and Lycoming 230 kV substations for towerline outage of the Montour – Elimspport and Montour – Clinton 230 kV circuits
- Proposed Solution:
Re-configure the Elimspport 230 kV substation to breaker and half scheme and install 80 MVAR capacitor (B1602).
- Estimated Project Cost:
\$ 3.7 M
- Expected IS Date:
6/1/2016



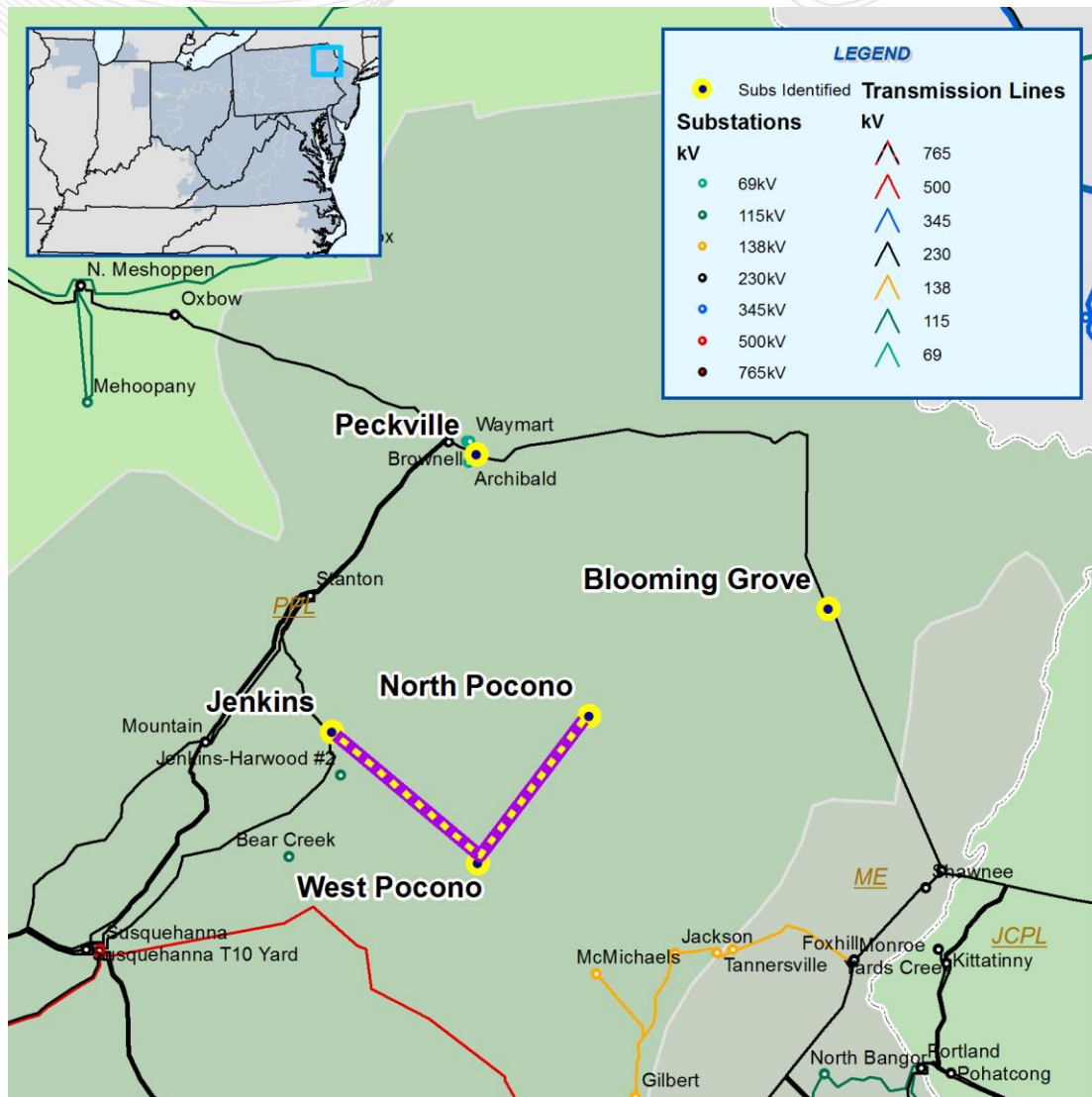
- Basecase Category C:
- Voltage drop violation on several 138 kV PPL substations for a line fault on Alburdis – Breinigsville 500 kV circuit and stuck breaker at Breinigsville 500 kV substation.
- Proposed Solution: Reconfigure the Breinigsville 500 kV substation with additional two 500 kV circuit breakers (B1601).
- Estimated Project Cost: \$ 2.1 M
- Expected IS Date: 6/1/2015



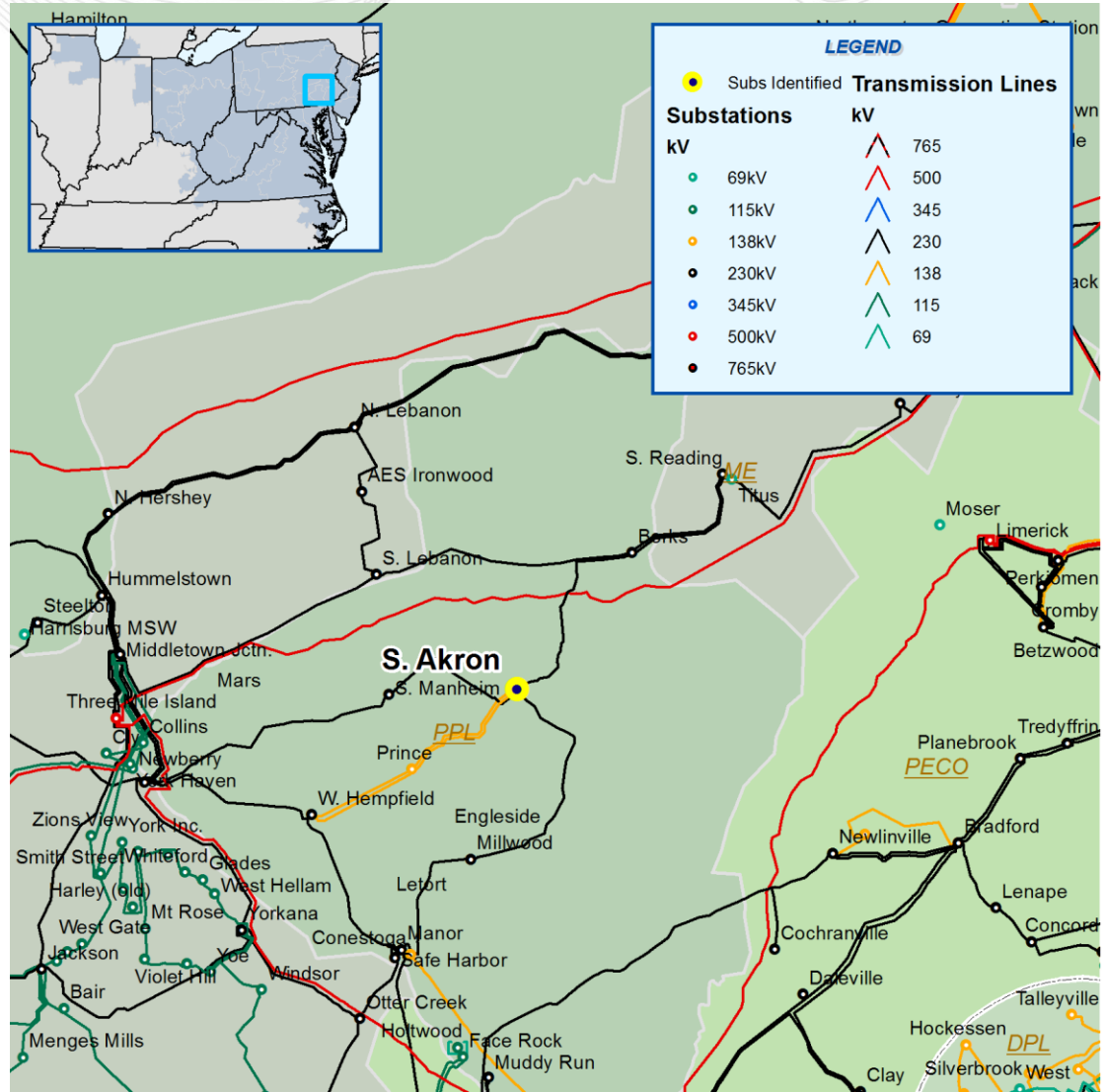
- PPL EU Reliability Principles and Practices :
Exceeds maximum allowable load drop guidelines for the loss of Blooming Grove – Jackson 69 kV and Peckville – Jackson 69 kV lines.
- Recommended Solution:
Build a new North Pocono 230/69 kV substation. (B1524)
Build approximately 21 miles new 230 kV West Pocono – North Pocono line (B1524.1)
Install 69 kV MOLSABs at Mt. Pocono substation (B1524.2)
- Estimated Project Cost:
\$17.6 M
\$28.6 M
\$0.38 M
- Expected IS Date:
11/30/2015



- PPL EU Reliability Principles and Practices :
Exceeds maximum allowable load drop guidelines for the loss of East Palmerton-Wagners #1 69 kV and East Palmerton-Wagners #2 69 kV Lines.
- Recommended Solution:
Build new West Pocono 230/69 kV Substation (B1525).
Build approximately 16 miles new 230 kV Jenkins-West Pocono 230 kV Line (B1525.1).
Install Jenkins 3E 230 kV circuit breaker (B1525.2).
- Estimated Project Cost:
\$18.3 M
\$28.5 M
\$0.97 M
- Expected IS Date:
11/30/2015



- PPL EU Reliability Principles and Practices :
Exceeds maximum allowable load drop guidelines for the loss of double circuit South Akron – Morgantown #1 and #2 69 kV lines.
- Previous Solution: b0716 - Add Second 69 kV Circuit from Morgantown to Twin Valley
- New Recommended Solution: Install a new Honeybrook – Twin Valley 69/138 kV tie (B1526)
- Estimated Project Cost: \$7.63 M
- Expected IS Date: 6/1/2016



- PPL EU Reliability

Principles and Practices :

Exceeds maximum allowable load drop guidelines for the loss of double circuit South Akron – Morgantown #1 and #2 69 kV lines; loss of the double circuit Face Rock – Kinzer #13 & #13 69kV Lines; loss of the double circuit Earl 69kV Taps.

- Recommended Solution:

Construct a new 230/69 kV North Lancaster substation. The sub will be supplied from the SAKR-BERK 230kV Line (B1527).

Construct new 69/138 kV transmission from North Lancaster 230/69 kV sub to Brecknock and Honeybrook areas (B1527.1).

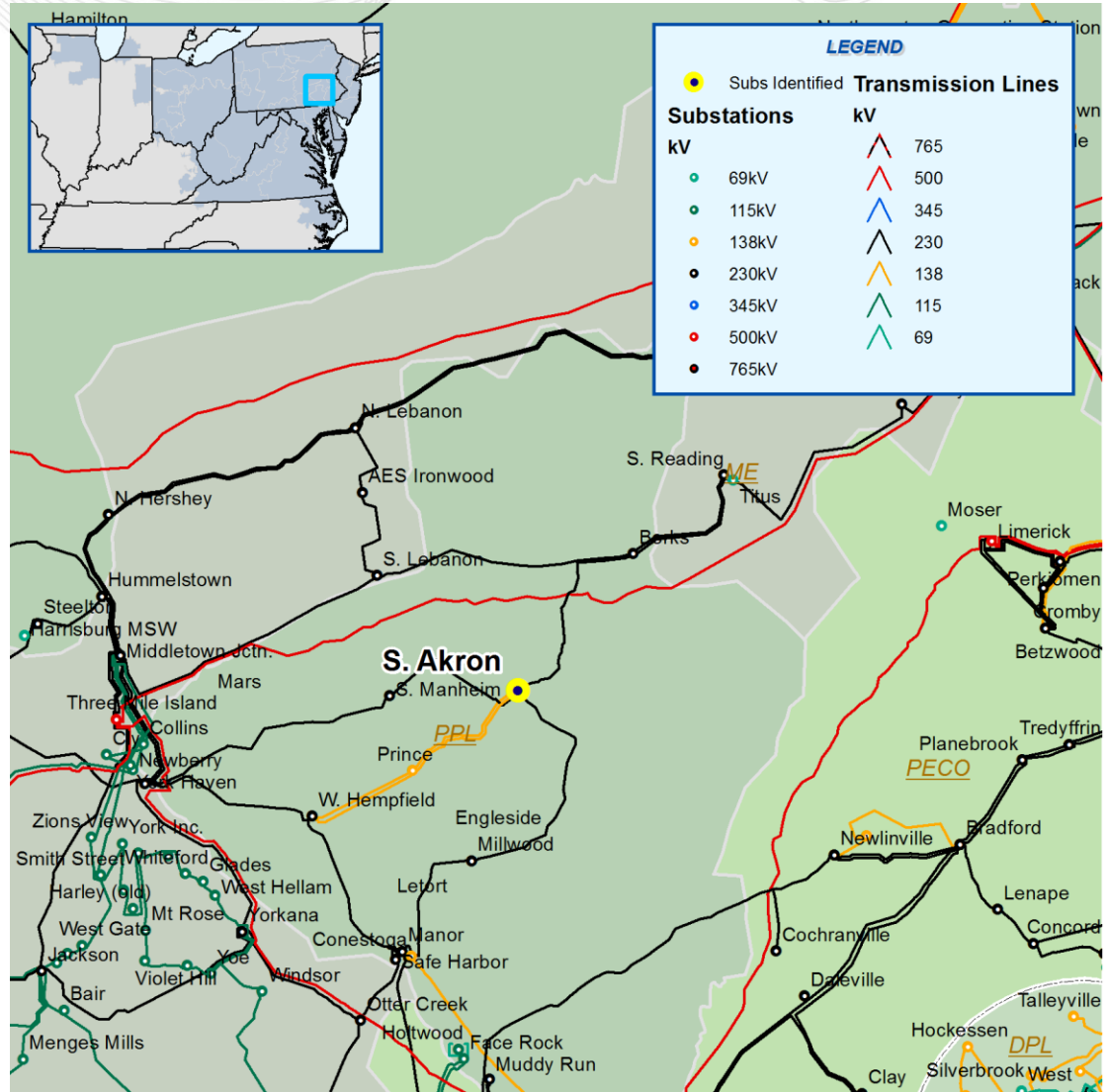
- Estimated Project Cost:

\$7.65 M

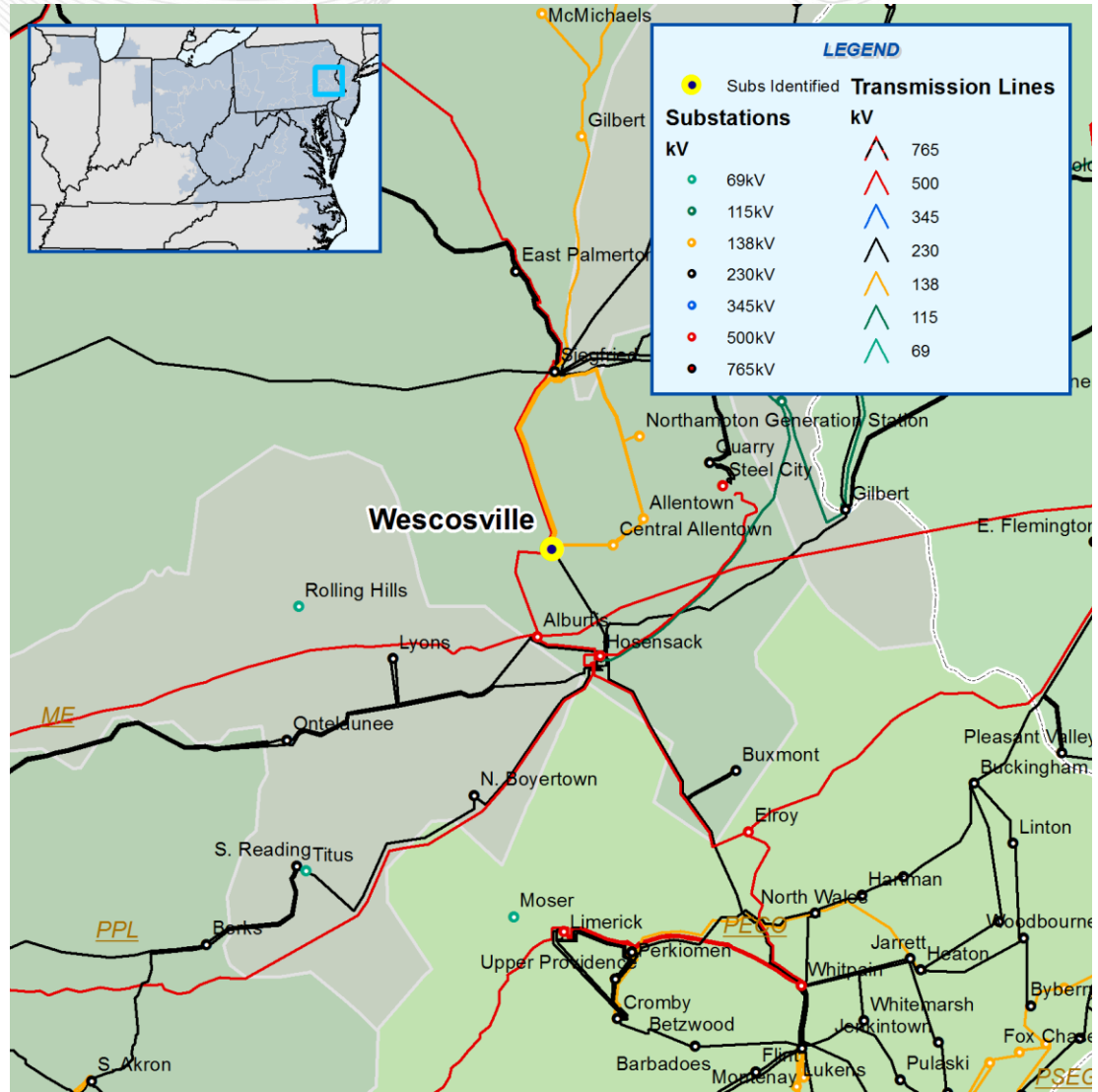
\$13.64 M

- Expected IS Date:

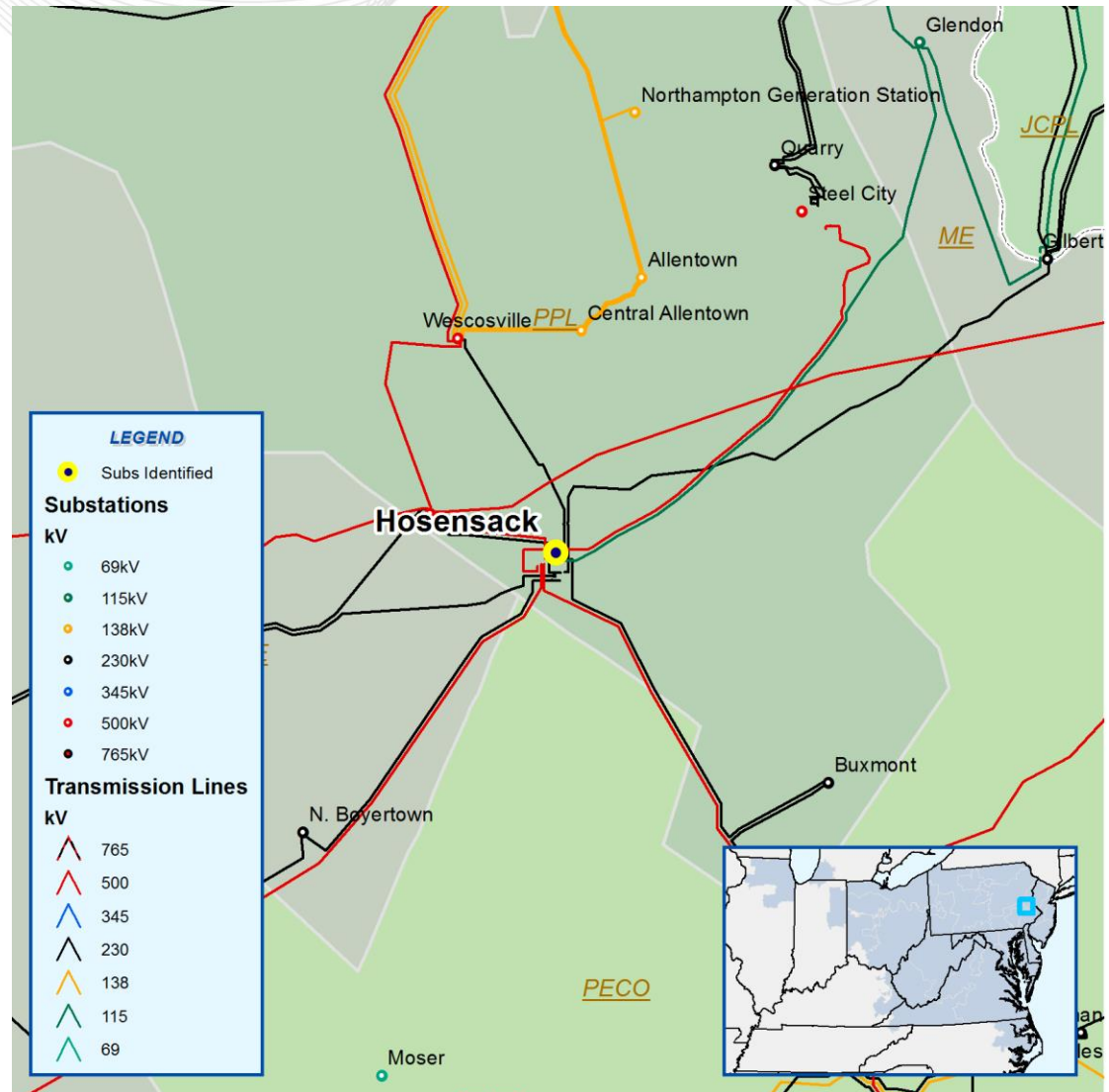
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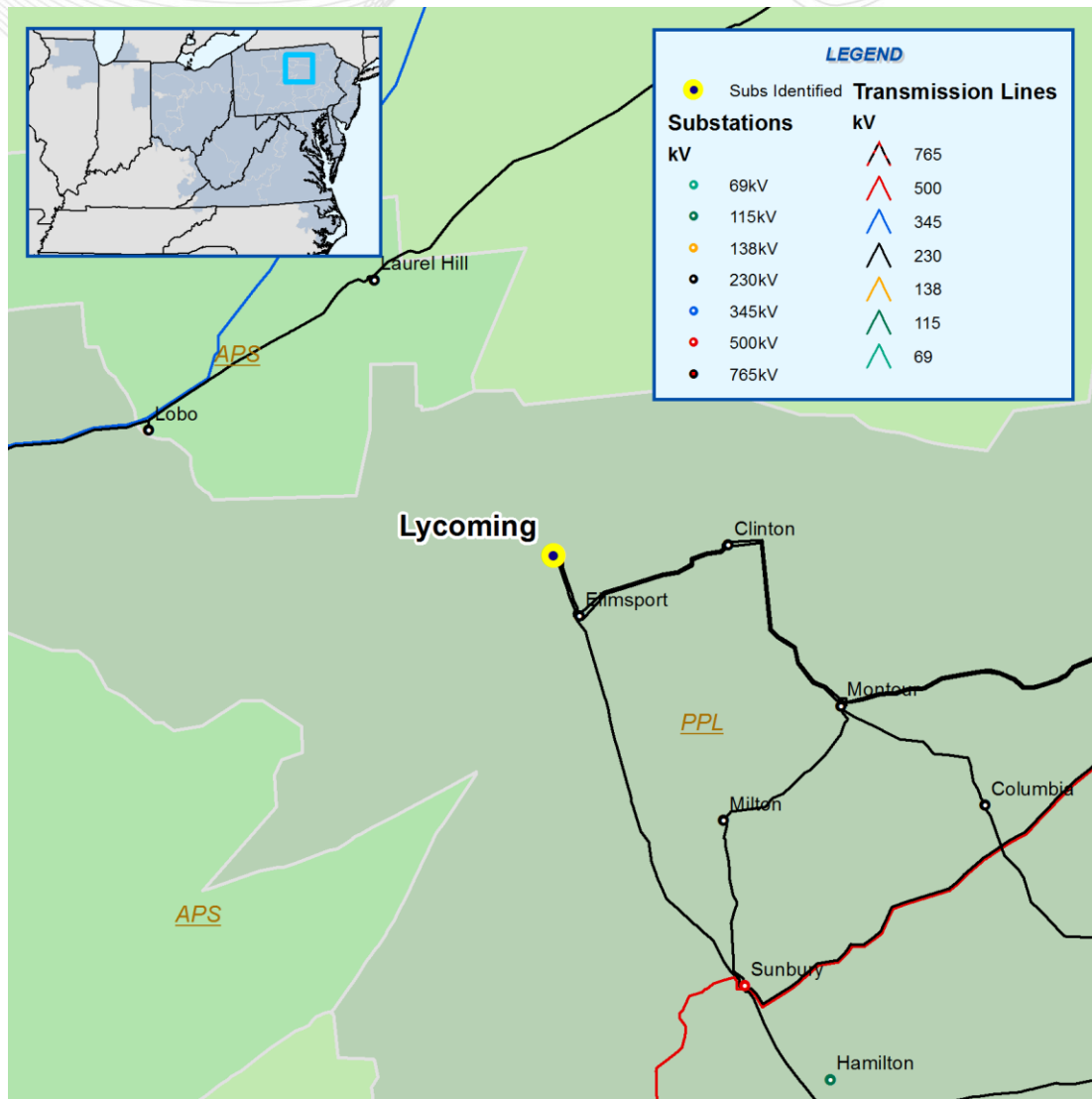
- PPL EU Reliability Principles and Practices :
- Exceeds maximum allowable load drop guidelines for the loss of Breinigsville - Wescosville #1 & #2 69 kV lines.
- Recommended Solution: Install motor operated switches on the Wescosville - Trexlertown #1 & #2 69 kV lines at East Texas Substation (B1528).
- Estimated Project Cost: \$0.22 M
- Expected IS Date: 6/1/2015



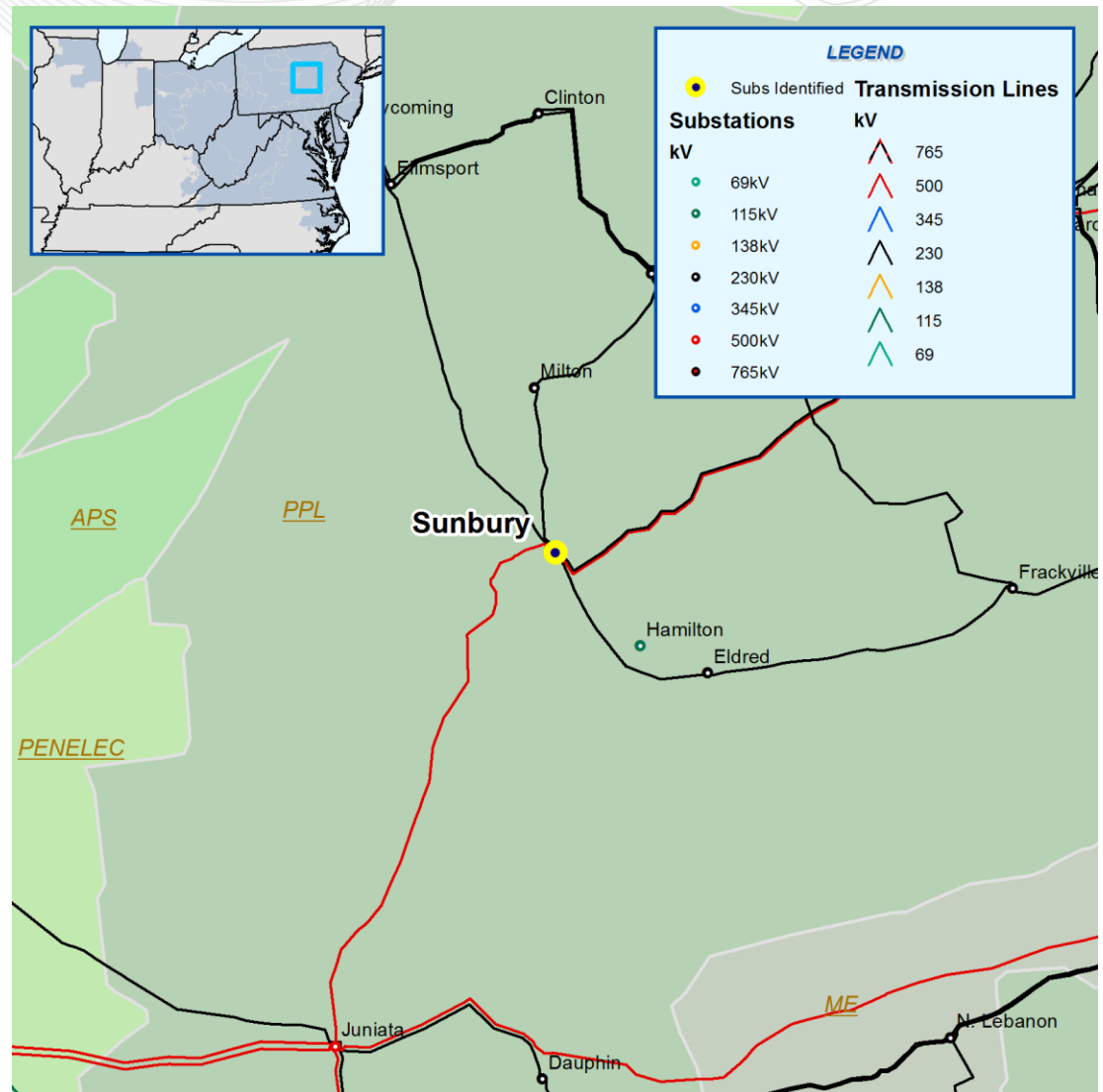
- PPL EU Reliability Principles and Practices :
- Overload on the 230/69 kV 150 MVA transformer at Hosensack for stuck 230 kV breaker at Hosensack that interrupts two of the three 230/69 kV transformers.
- Recommended Solution: Add a double breaker 230 kV bay 3 at Hosensack (B1529).
- Estimated Project Cost: \$1.37 M
- Expected IS Date: 6/1/2015



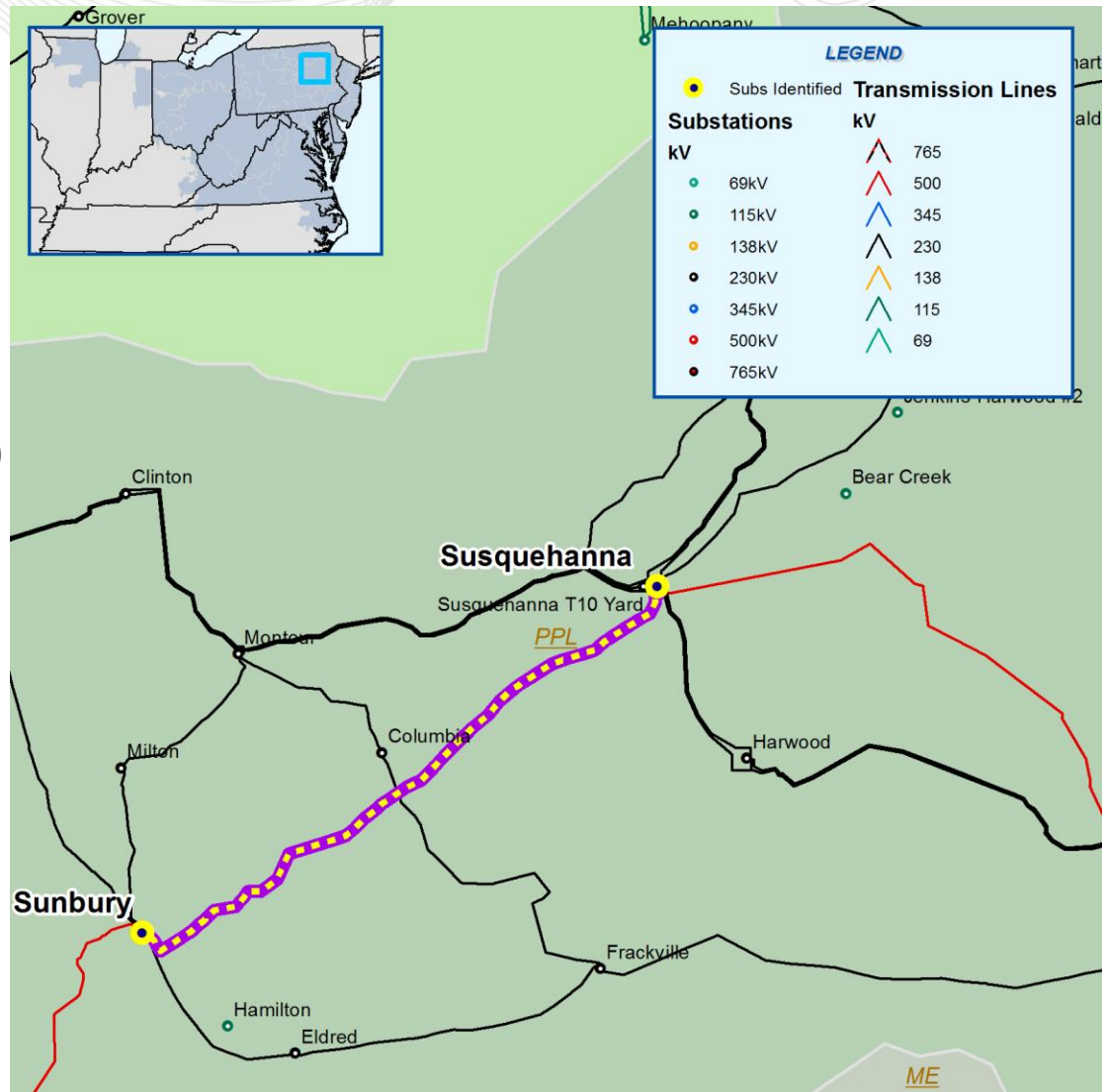
- PPL EU Reliability Principles and Practices :
- Greater than 5% voltage drop on the Lock Haven ring 69 kV bus during maintenance conditions for the loss of Lycoming-Lock Haven #3 69kV line.
- Recommended Solution: Replace Lock Haven 69 kV ring bus with standard breaker and half design (B1530).
- Estimated Project Cost: \$20.5 M
- Expected IS Date: 6/1/2013



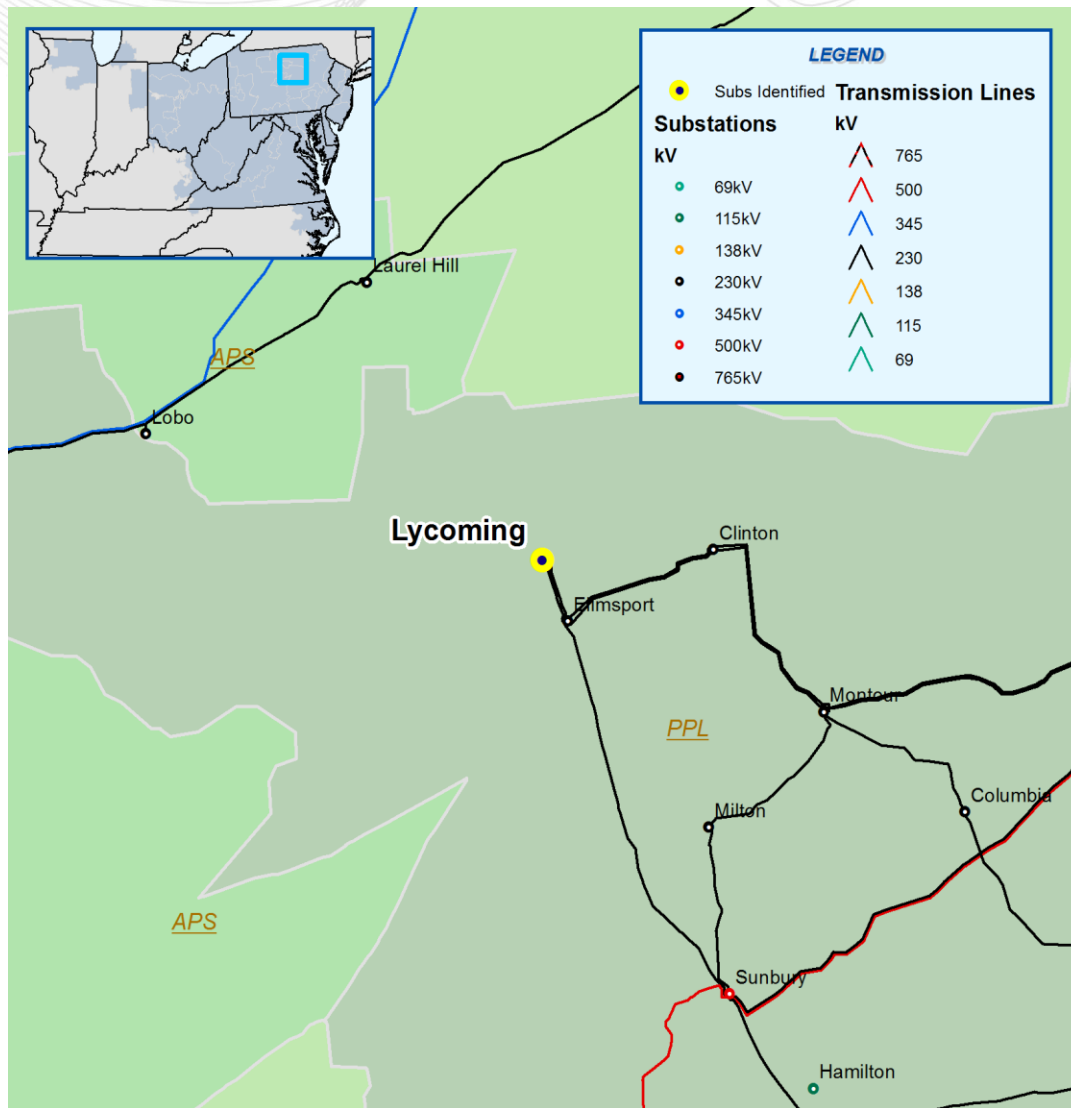
- PPL EU Reliability Principles and Practices :
- Maintenance/outage of Sunbury generation units #1, #2, and #3 will cause normal rating violations. The loss of either T22 or T23 transformer will cause emergency rating violations.
- Recommended Solution: Upgrade Sunbury T22 and T23 transformers to 170 MVA each (B1531).
- Estimated Project Cost: \$8.68 M
- Expected IS Date: 6/1/2012



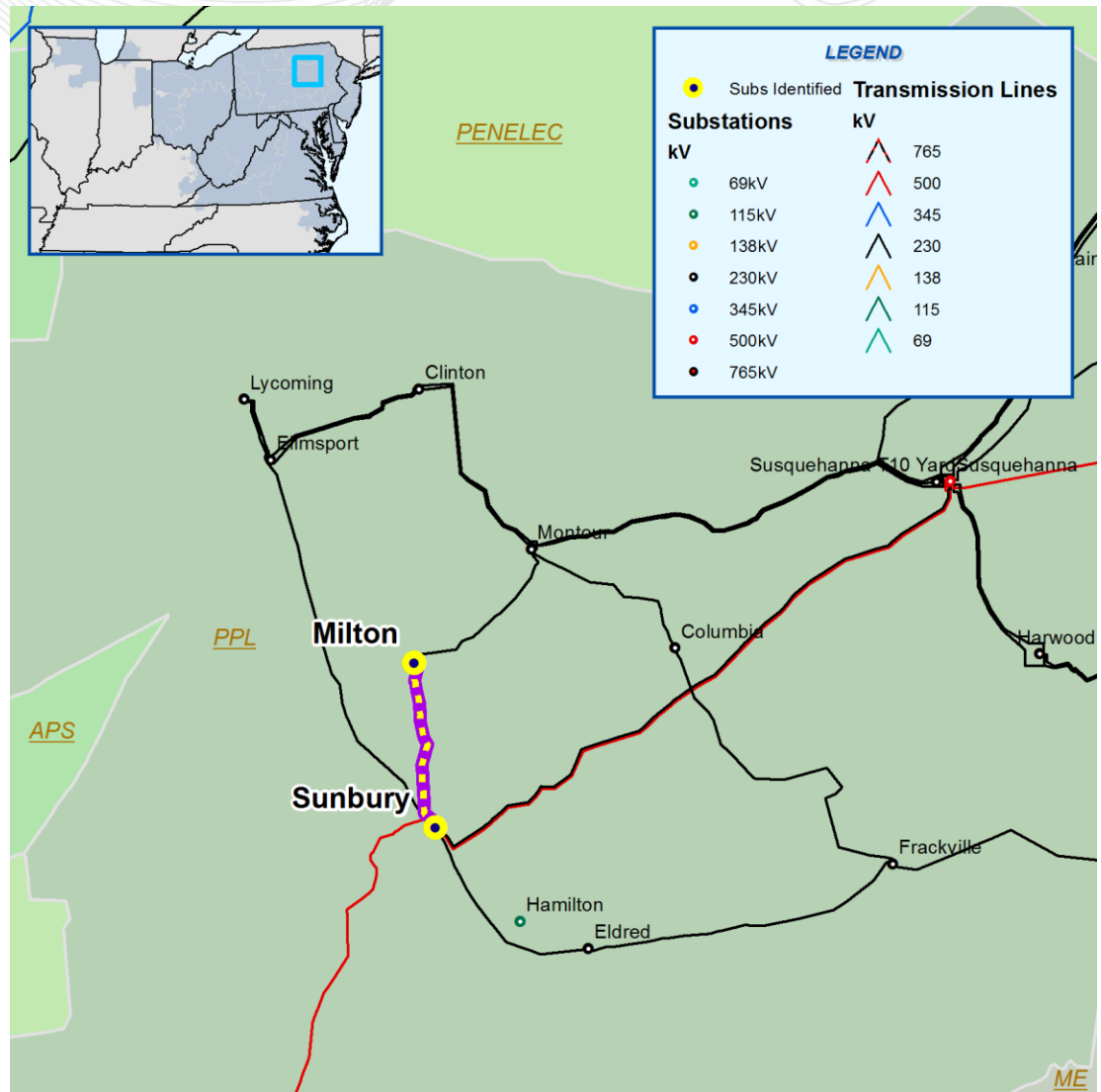
- PPL EU Reliability Principles and Practices :
- Exceeds maximum allowable load drop guidelines for maintenance/outage of Sunbury generation units #1, #2, and #3 and loss of Sunbury – Susquehanna 230 kV line and Sunbury T22.
- Recommended Solution: Install new 32.4MVAR capacitor bank at Sunbury(B1532).
- Estimated Project Cost: \$0.842 M
- Expected IS Date: 6/1/2012



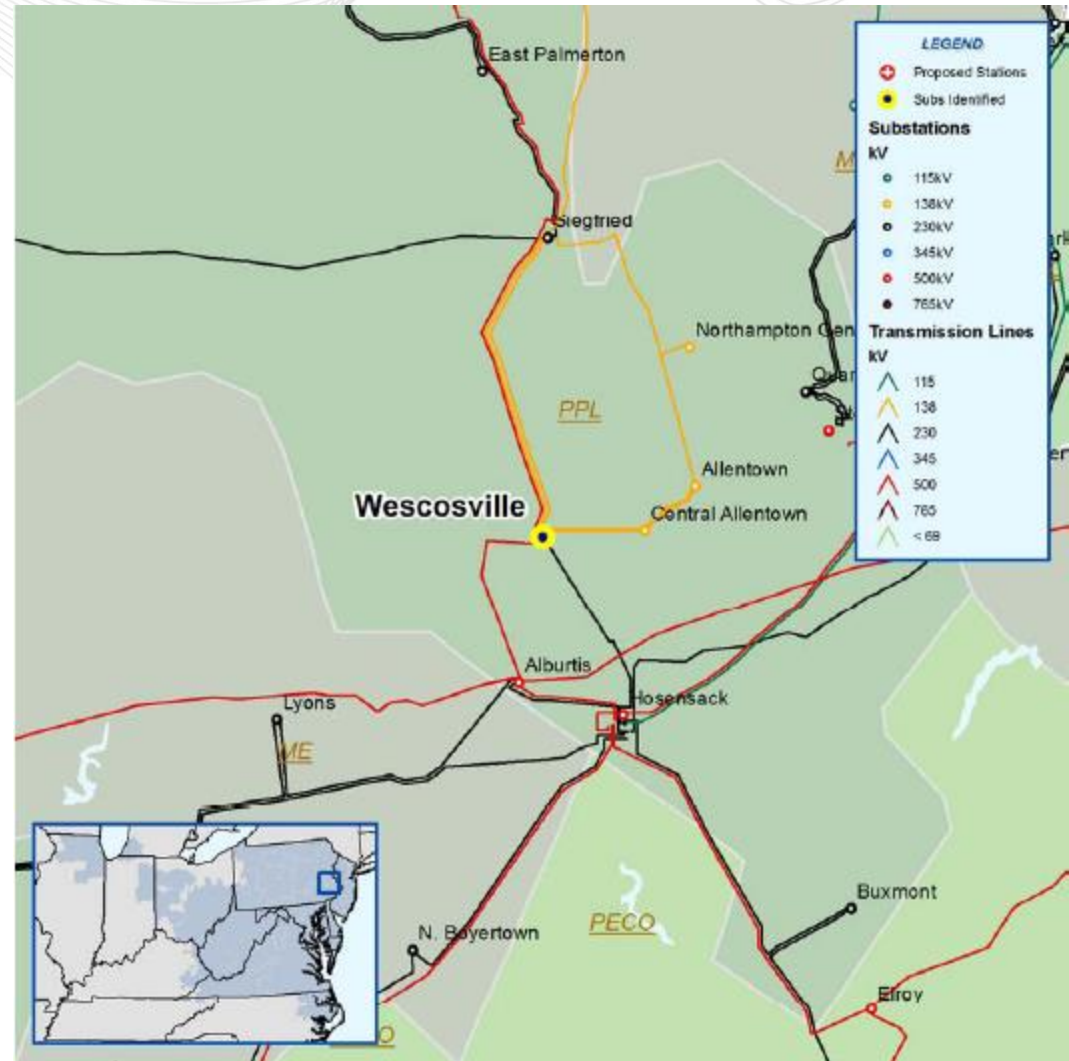
- PPL EU Reliability Principles and Practices :
- Overload on the Lycoming-Lock Haven #1 69kV line and Lycoming-Lock Haven #2 69kV line for the loss of the Lycoming-Lock Haven #3 and Lycoming-Lock Haven #4 69kV lines (tower).
- Recommended Solution: Rebuild Lycoming-Lock Haven #1 and Lycoming-Lock Haven #2 69kV lines (B1533).
- Estimated Project Cost: \$17.74 M
- Expected IS Date: 6/1/2015



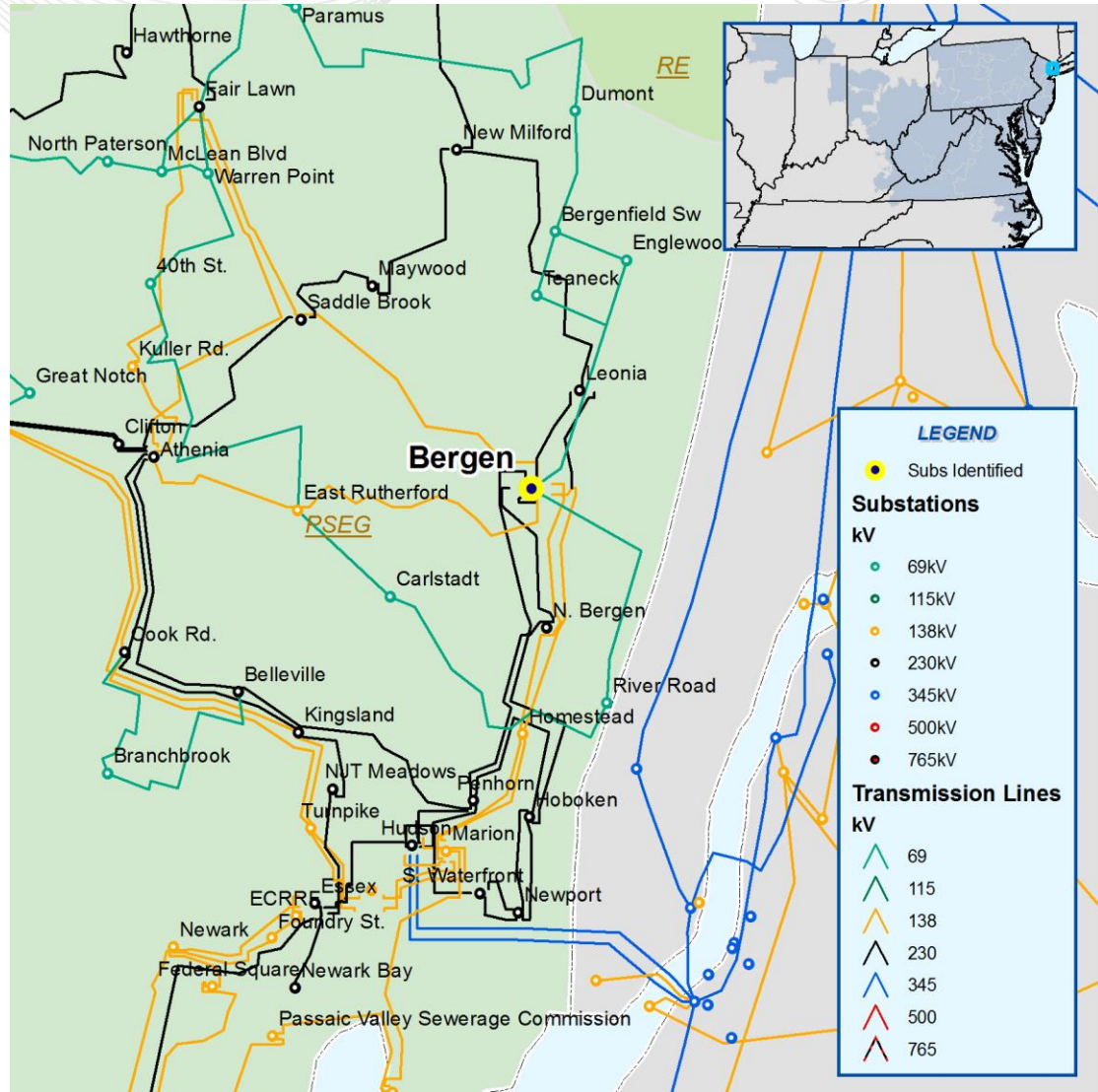
- PPL EU Reliability Principles and Practices :
- Overload Sunbury-Milton 69kV line for the loss of the Clinton-Milton 69kV line.
- Recommended Solution: Rebuild 1.4 miles of the Sunbury-Milton 69kV (B1534).
- Estimated Project Cost: \$1.8 M
- Expected IS Date: 6/1/2014



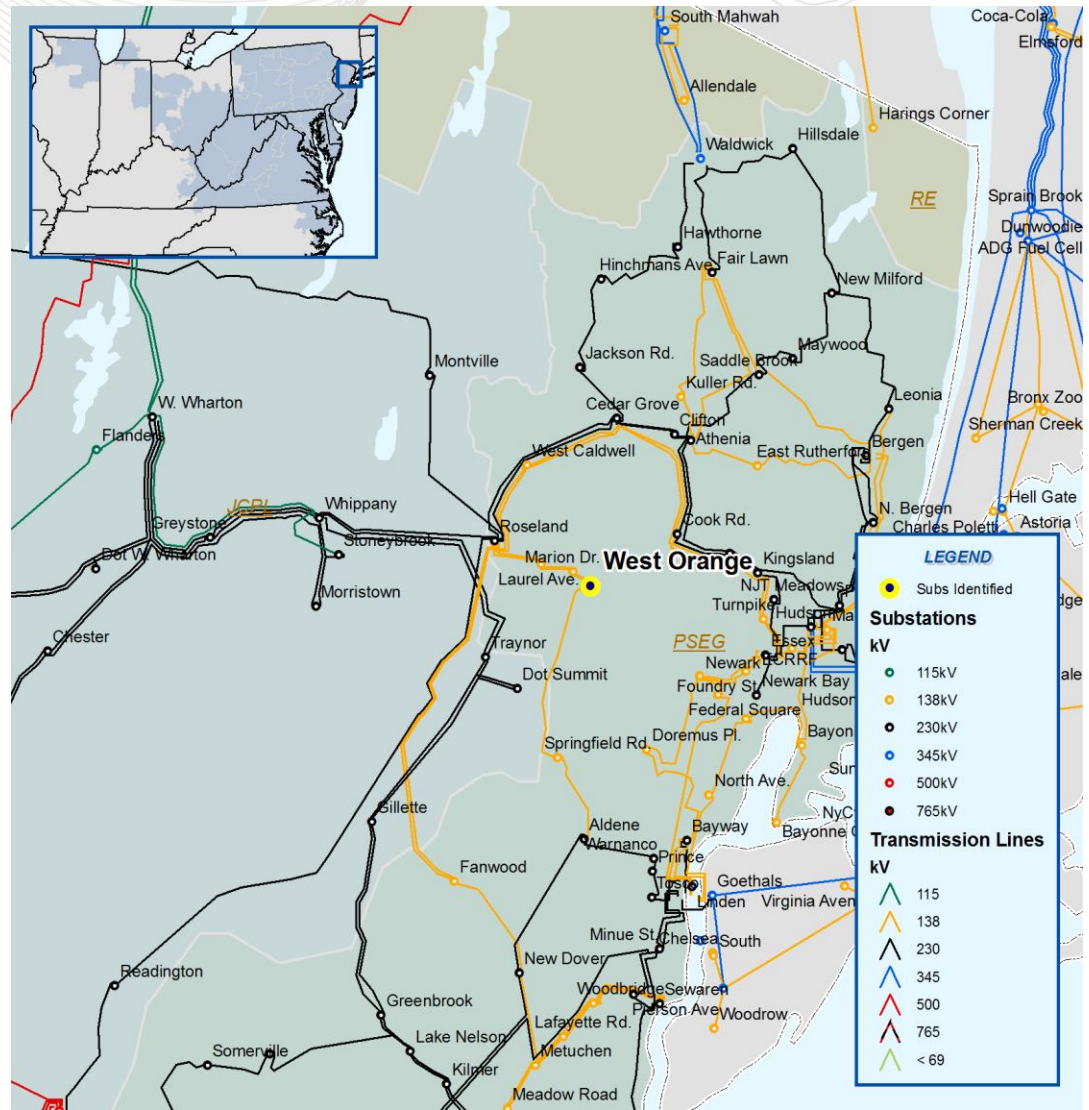
- PPL EU Reliability Principles and Practices:
- B1204 scope and cost change.
- New Breinigsville 230/69 kV substation is replaced with new Breinigsville 500/138/69 kV Substation (B1204).
- Estimated Project Cost:
Previous → \$34.65 M
New → \$40.13 M
- Proposed IS Date:
6/1/2015



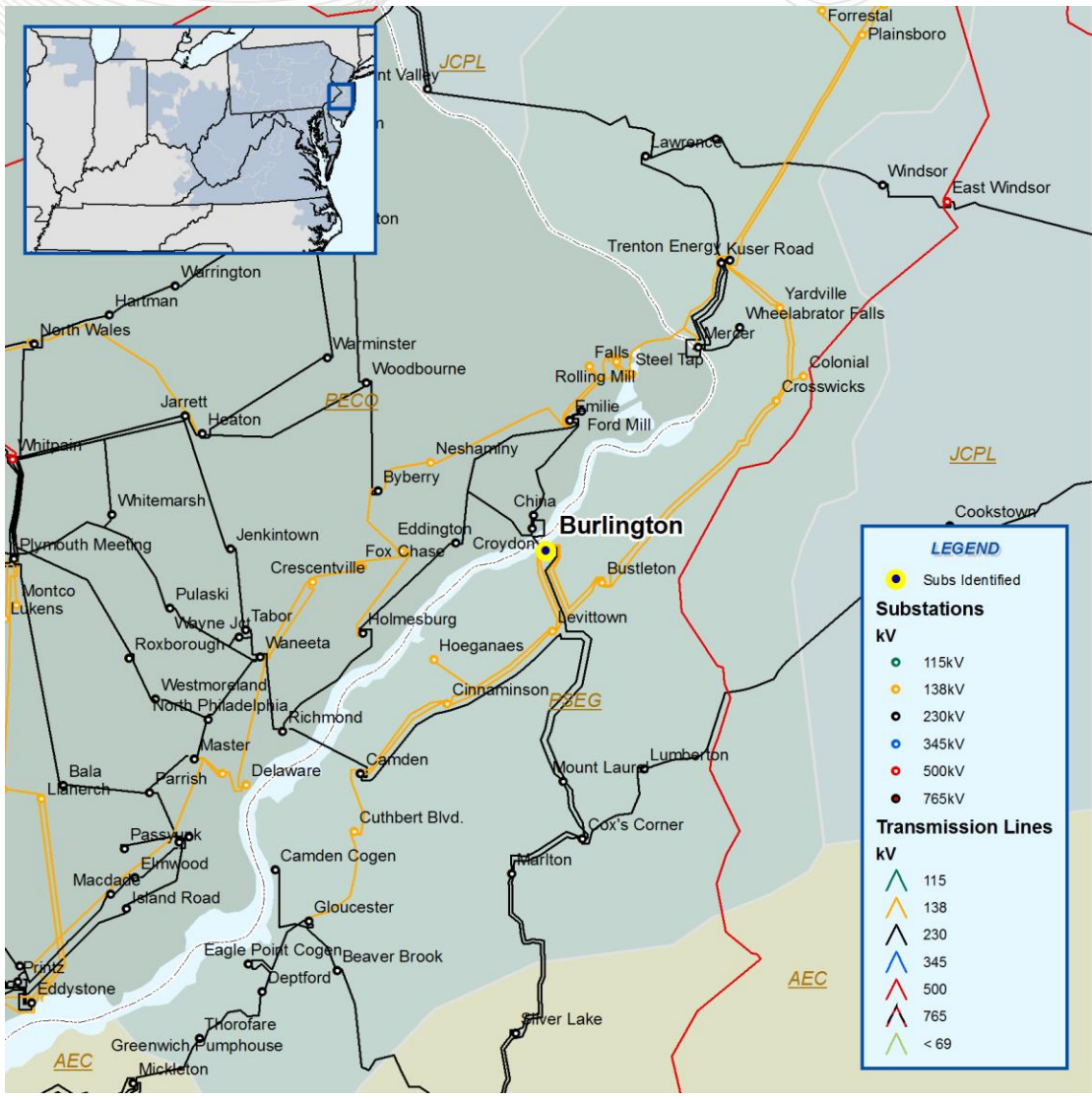
- The Bergen 230 kV breakers 'GSU1', 'GSU2', and 'GSU3' are overstressed
- Proposed Solution: Replace the Bergen 230 kV breakers 'GSU1', 'GSU2', and 'GSU3' (b1521-b1523)
- Estimated Project Cost: \$1.0 M per breaker
- Expected IS Date: 6/01/2014



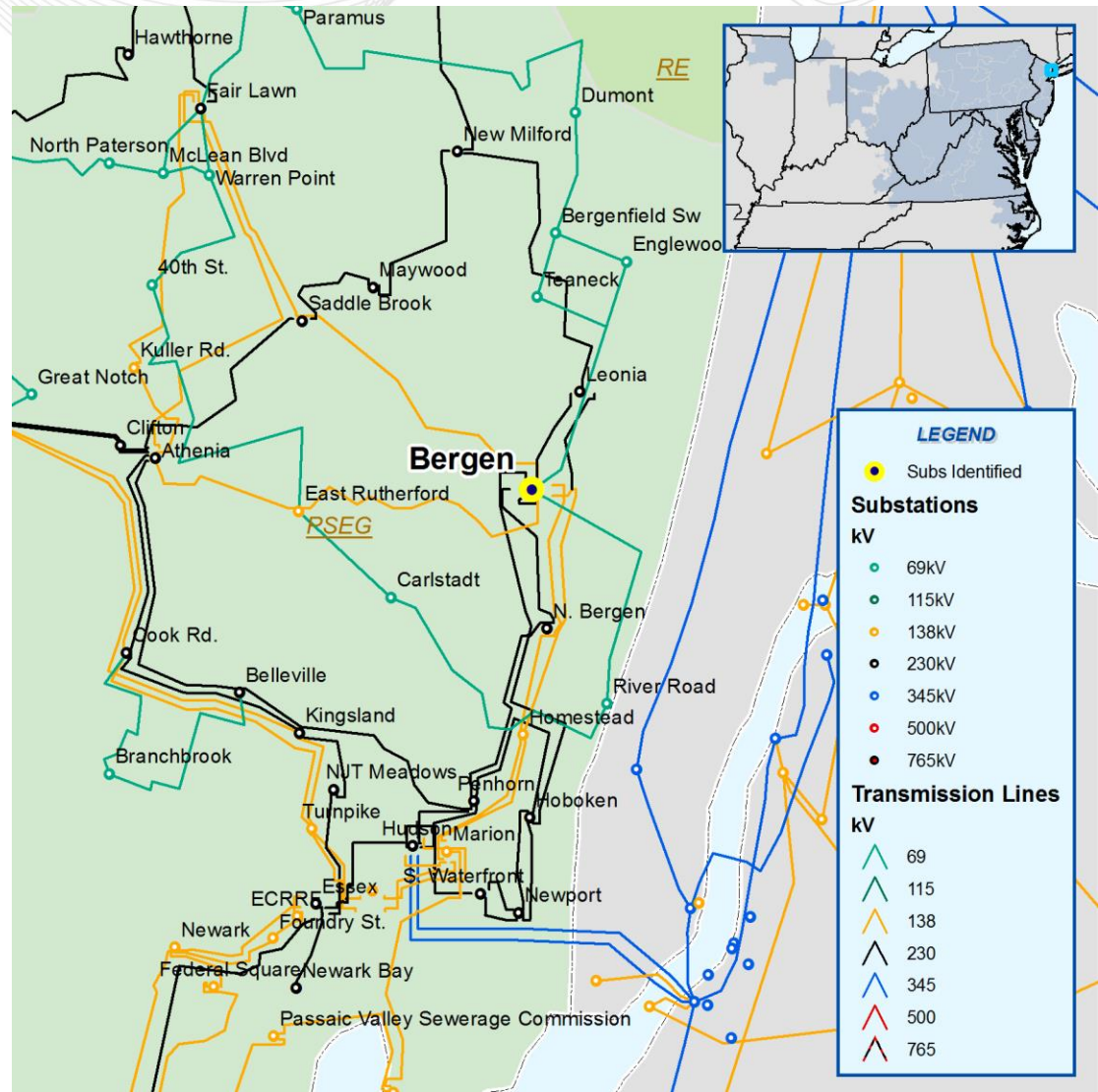
- Scope Change: Baseline upgrade B1154 – West Orange Conversion
- Original Project Drivers: numerous thermal and voltage violations for various NERC C3 contingency pairs
- Project Description: Convert the West Orange 138 kV substation , the Roseland to West Orange and Roseland to Sewaren lines from 138 kV to 230 kV
- Scope Increase due to more extensive transmission structure work, permitting and siting costs and contract labor costs.
- Original Estimated Cost: \$200 M
- New Estimated Cost: \$336 M
- Expected IS Date: 06/01/2014



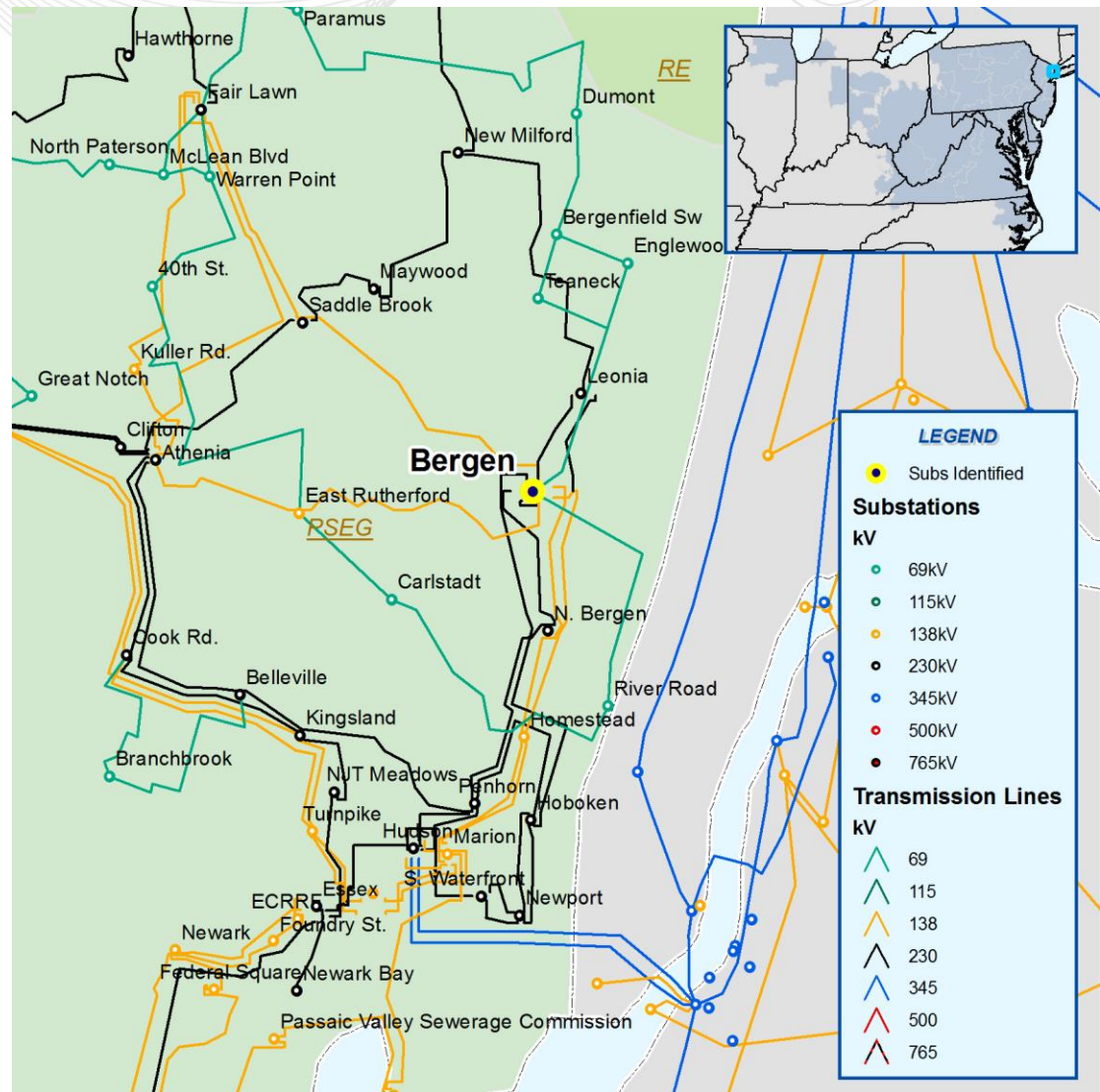
- Baseline upgrade B1156 – Burlington – Camden – Cuthbert Conversion scope change
- Original Project Drivers: Voltage violations for multiple NERC C3 contingency pairs
- Project Description: Convert Burlington, Camden and Cuthbert stations and associated lines from 138 kV to 230 kV operation
- Scope Increase due to more extensive transmission structure and substation work, permitting and siting costs and contract labor costs.
- Original Estimated Cost: \$150 M
- New Estimated Cost: \$381M
- Expected IS Date: 06/01/2014



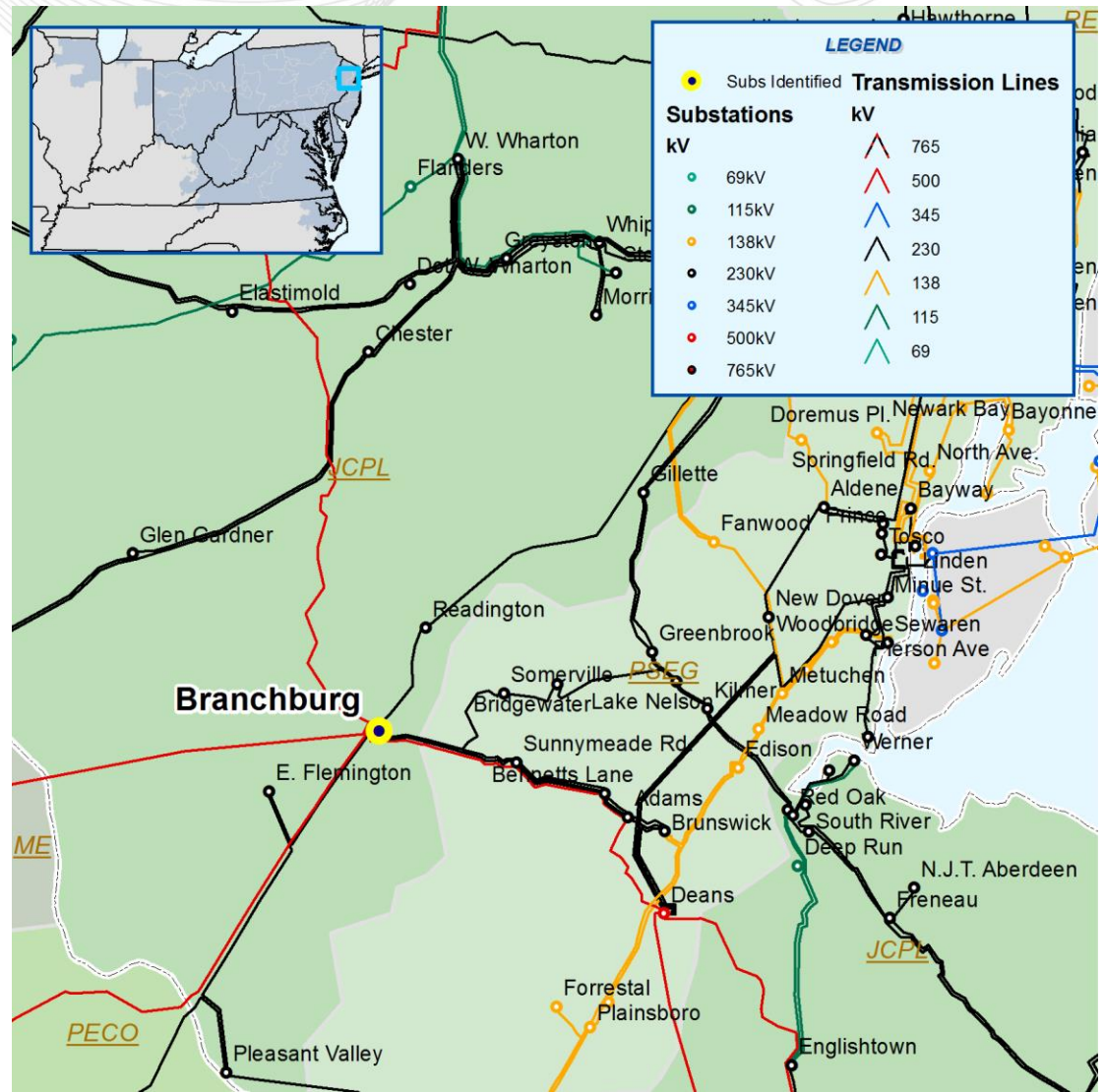
- The following breakers are overstressed:
 - Bergen 138 kV breaker '30P'
 - Bergen 138 kV breaker '80P'
 - Bergen 138 kV breaker '70P'
 - Bergen 138 kV breaker '90P'
 - Bergen 138 kV breaker '50P'
 - Bergen 230 kV breaker '12H'
 - Bergen 230 kV breaker '21H'
 - Bergen 230 kV breaker '11H'
 - Bergen 230 kV breaker '20H'
- Significant Driver: Install 230/138 kV transformer at Bergen (b1082)
- Proposed Solution:
 - Replace the Bergen 138 kV breaker '30P' with 80 kA (b1082.1)
 - Replace the Bergen 138 kV breaker '80P' with 80 kA (b1082.2)
 - Replace the Bergen 138 kV breaker '70P' with 80 kA (b1082.3)
 - Replace the Bergen 138 kV breaker '90P' with 63 kA (b1082.4)
 - Replace the Bergen 138 kV breaker '50P' with 63 kA (b1082.5)



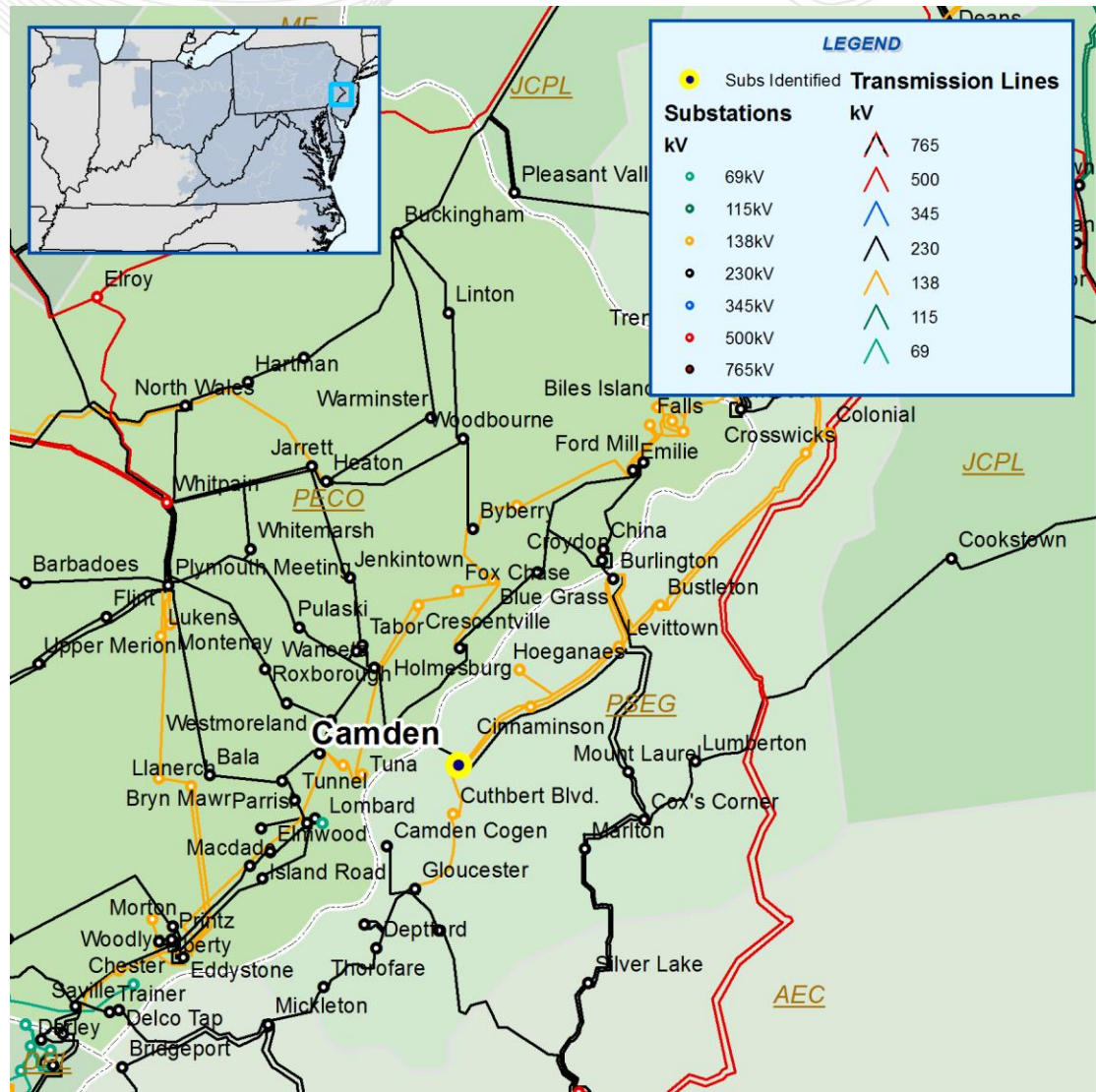
- Proposed Solution (cont'd):
 - Replace the Bergen 230 kV breaker '12H' with 80 kA (b1082.6)
 - Replace the Bergen 230 kV breaker '21H' with 80 kA (b1082.7)
 - Replace the Bergen 230 kV breaker '11H' with 80 kA (b1082.8)
 - Replace the Bergen 230 kV breaker '20H' with 80 kA (b1082.9)
- Estimated Project Cost:
 - \$1.5 M per breaker for each 80 kA breaker
 - \$0.6 M per breaker for each 63 kA breaker
- Expected IS Date:
6/01/2014



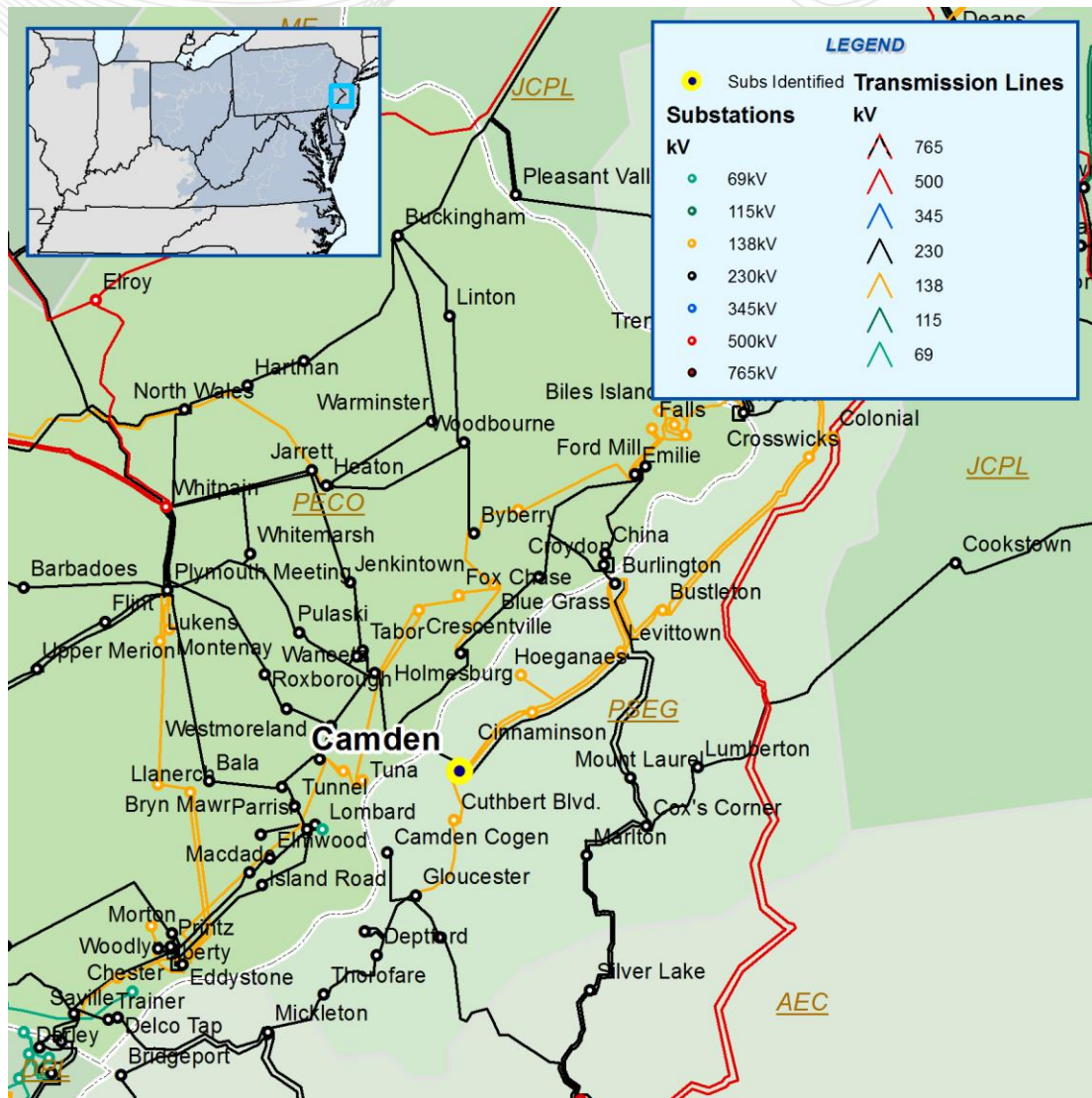
- The following breakers are overstressed:
 - Branchburg 230 kV breaker '81H'
 - Branchburg 230 kV breaker '72H'
 - Branchburg 230 kV breaker '61H'
 - Branchburg 230 kV breaker '41H'
- Significant Driver: Build a new 230 kV circuit from Branchburg to Middlesex Sw. Rack (b1155)
- Proposed Solution:
 - Replace the Branchburg 230 kV breaker '81H' with 63 kA (b1155.3)
 - Replace the Branchburg 230 kV breaker '72H' with 63 kA (b1155.4)
 - Replace the Branchburg 230 kV breaker '61H' with 63 kA (b1155.5)
 - Replace the Branchburg 230 kV breaker '41H' with 63 kA (b1155.6)
- Estimated Project Cost:
 - \$0.6 M per breaker
- Expected IS Date:
6/01/2014



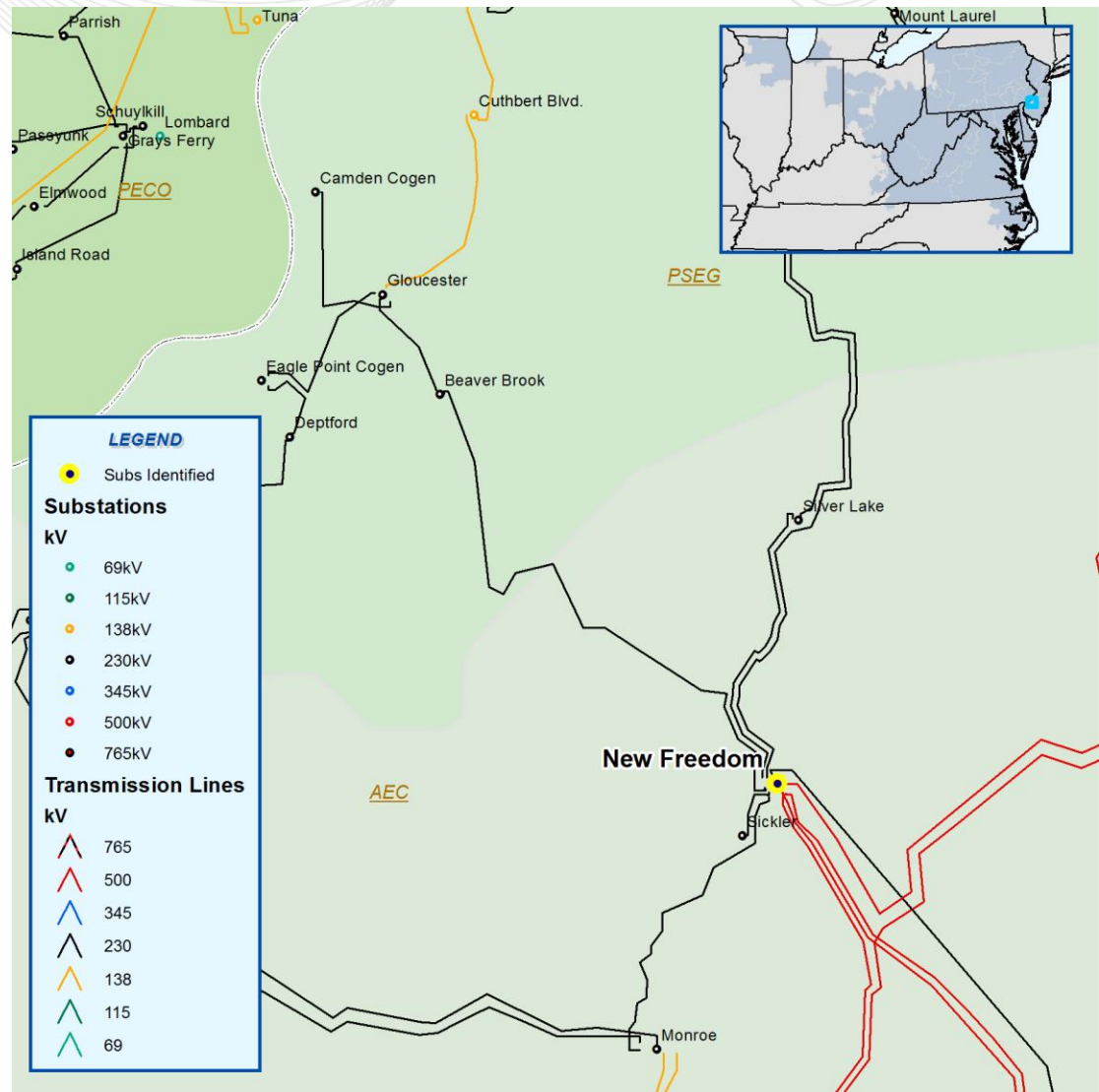
- The following breakers are overstressed:
 - Camden 230 kV breaker '22H'
 - Camden 230 kV breaker '32H'
 - Camden 230 kV breaker '21H'
- Significant Driver: Convert the Burlington, Camden, and Cuthbert Blvd 138 kV substations from 138 kV to 230 kV (b1156)
- Proposed Solution:
 - Replace the Camden 230 kV breaker '22H' with 80 kA (b1156.13)
 - Replace the Camden 230 kV breaker '32H' with 80 kA (b1156.14)
 - Replace the Camden 230 kV breaker '21H' with 80 kA (b1156.15)
- Estimated Project Cost:
 - \$1.5 M per breaker
- Expected IS Date: 6/01/2014



- Fault levels are above 63 kA at the Camden 230 kV substation.
- Significant Driver: Convert the Burlington, Camden, and Cuthbert Blvd 138 kV substations from 138 kV to 230 kV (b1156)
- Proposed Solution:
 - Rebuild the Camden 230 kV substation to 80 kA (b1156.19)
- Estimated Project Cost:
 - \$18 M
- Expected IS Date: 6/01/2014



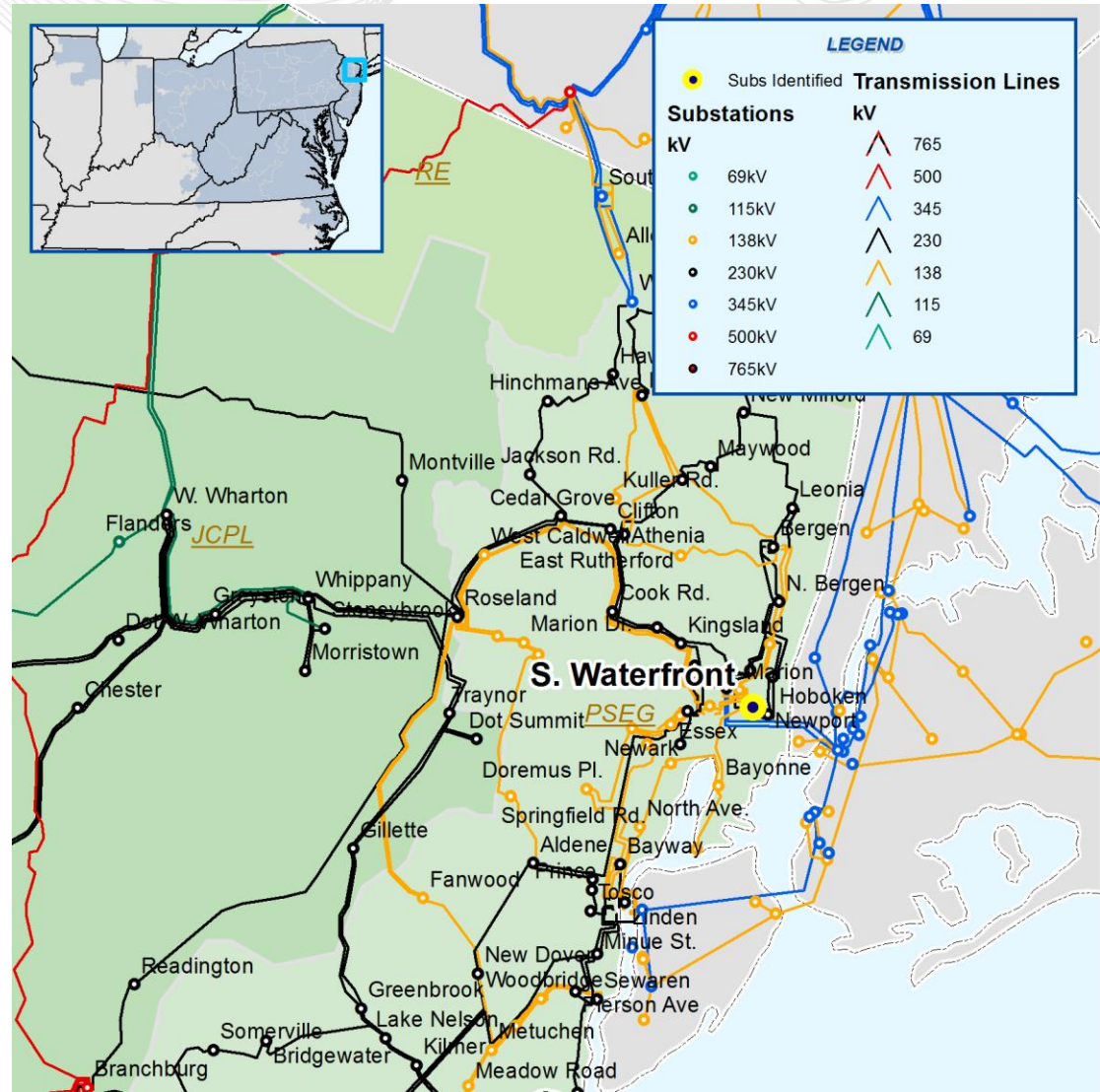
- The following breakers are overstressed:
 - New Freedom 230 kV breaker '50H'
 - New Freedom 230 kV breaker '41H'
 - New Freedom 230 kV breaker '51H'
- Significant Driver: Convert the Burlington, Camden, and Cuthbert Blvd 138 kV substations from 138 kV to 230 kV (b1156)
- Proposed Solution:
 - Replace the New Freedom 230 kV breaker '50H' with 63 kA (b1156.16)
 - Replace the New Freedom 230 kV breaker '41H' with 63 kA (b1156.17)
 - Replace the New Freedom 230 kV breaker '51H' with 63 kA (b1156.18)
- Estimated Project Cost:
 - \$0.6 M per breaker
- Expected IS Date:
6/01/2014



- The following breakers are overstressed:
 - South Waterfront 230 kV breaker '12H'
 - South Waterfront 230 kV breaker '22H'
 - South Waterfront 230 kV breaker '32H'
 - South Waterfront 230 kV breaker '52H'
 - South Waterfront 230 kV breaker '62H'
 - South Waterfront 230 kV breaker '72H'
 - South Waterfront 230 kV breaker '82H'

- Significant Driver: Build second 230 kV underground cable from Hudson to South Waterfront (b1304.4)

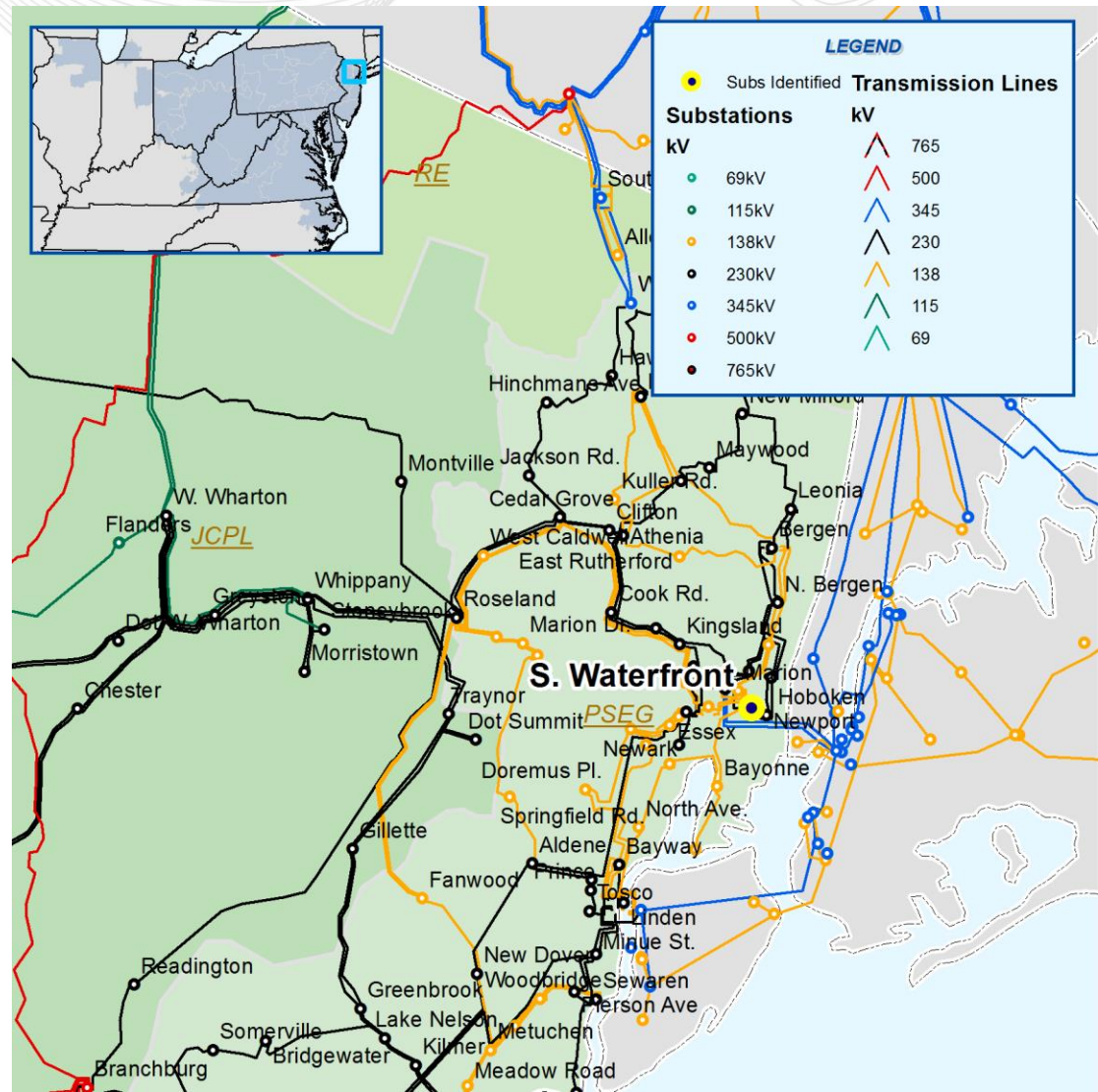
- Proposed Solution:
 - Replace the South Waterfront 230 kV breaker '12H' with 80 kA (b1304.7)
 - Replace the South Waterfront 230 kV breaker '22H' with 80 kA (b1304.8)
 - Replace the South Waterfront 230 kV breaker '32H' with 80 kA (b1304.9)
 - Replace the South Waterfront 230 kV breaker '52H' with 80 kA (b1304.10)
 - Replace the South Waterfront 230 kV breaker '62H' with 80 kA (b1304.11)



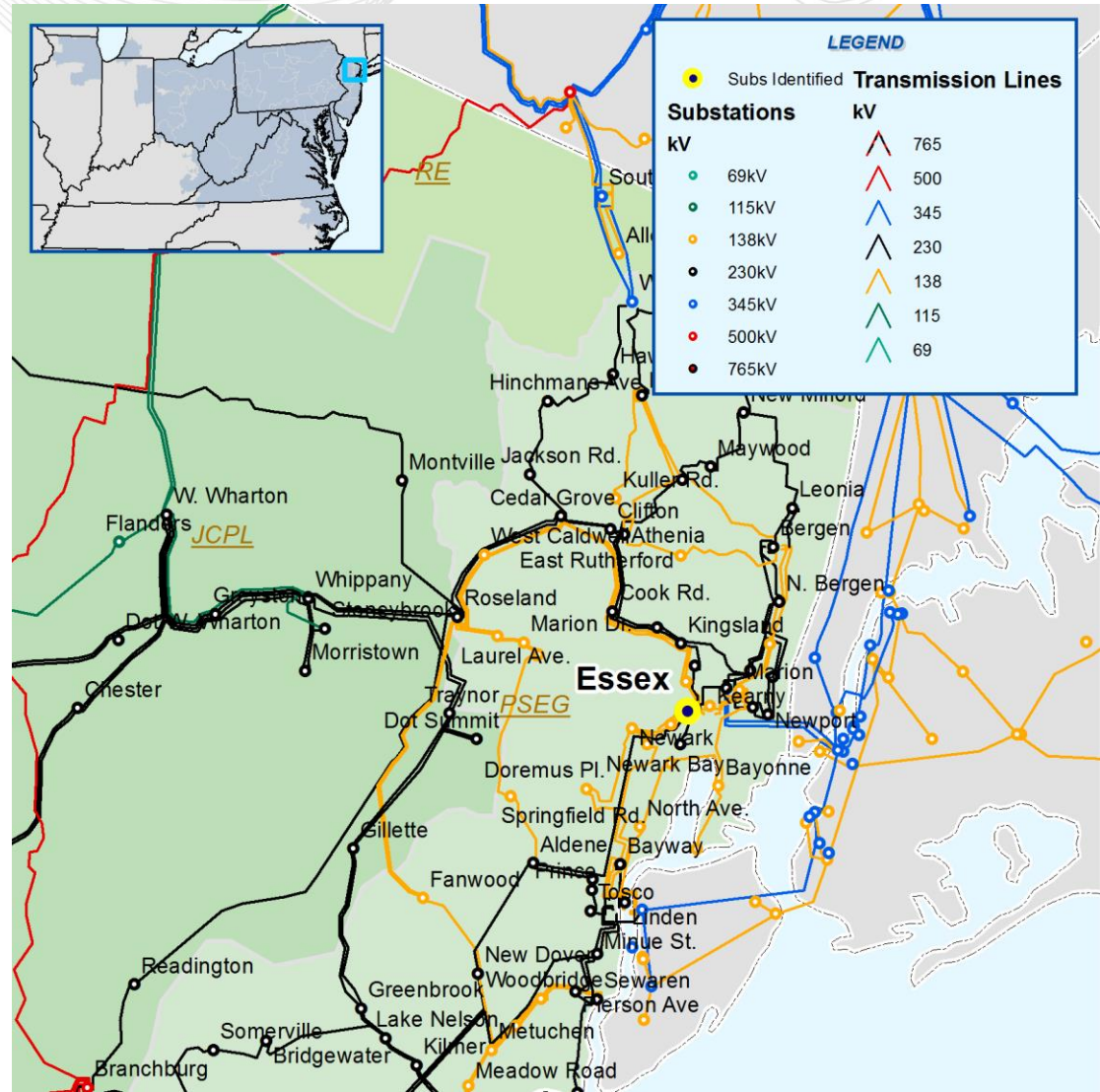
- Proposed Solution (cont'd):
 - Replace the South Waterfront 230 kV breaker '72H' with 80 kA (b1304.12)
 - Replace the South Waterfront 230 kV breaker '82H' with 80 kA (b1304.13)

- Estimated Project Cost:
 - \$1.5 M per breaker

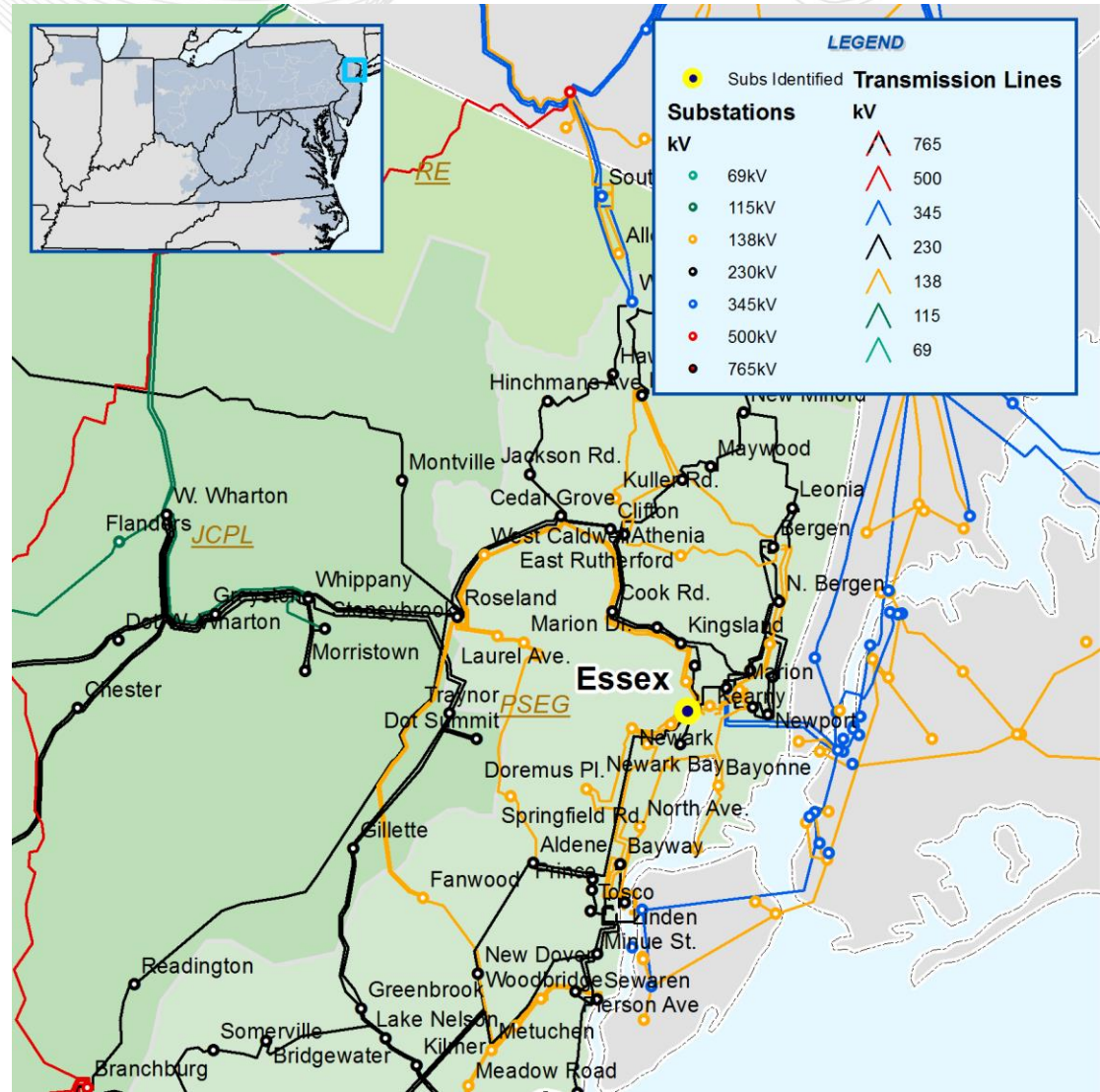
- Expected IS Date:
 - 6/01/2015



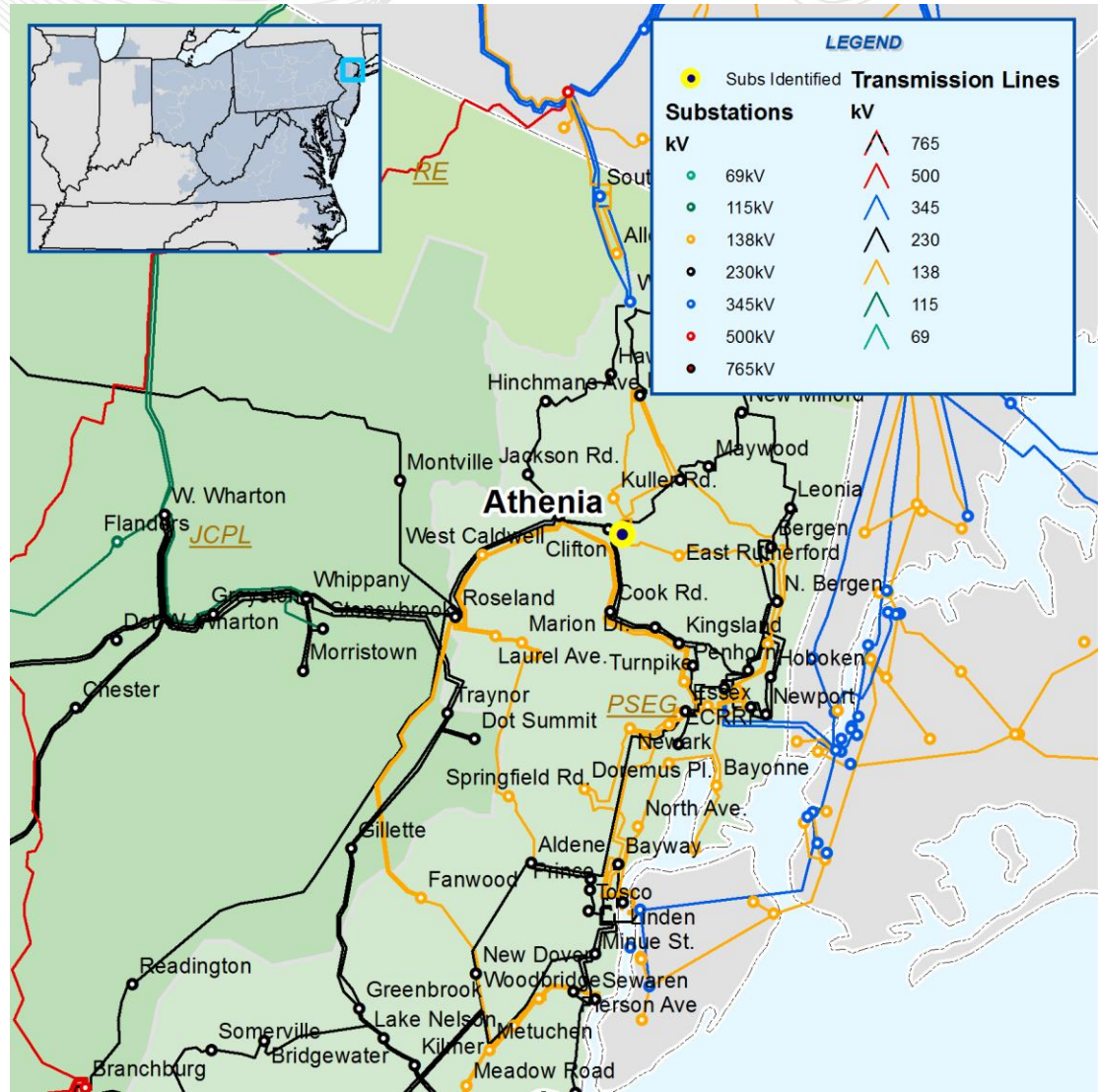
- The following breakers are overstressed:
 - Essex 230 kV breaker '20H'
 - Essex 230 kV breaker '21H'
 - Essex 230 kV breaker '10H'
 - Essex 230 kV breaker '11H'
 - Essex 230 kV breaker '11HL'
- Significant Driver: Convert the existing 'D1304' and 'G1307' 138 kV circuits between Roseland - Kearny-Hudson to 230 kV operation (b1304.1)
- Proposed Solution:
 - Replace the Essex 230 kV breaker '20H' with 80 kA (b1304.14)
 - Replace the Essex 230 kV breaker '21H' with 80 kA (b1304.15)
 - Replace the Essex 230 kV breaker '10H' with 80 kA (b1304.16)
 - Replace the Essex 230 kV breaker '11H' with 80 kA (b1304.17)



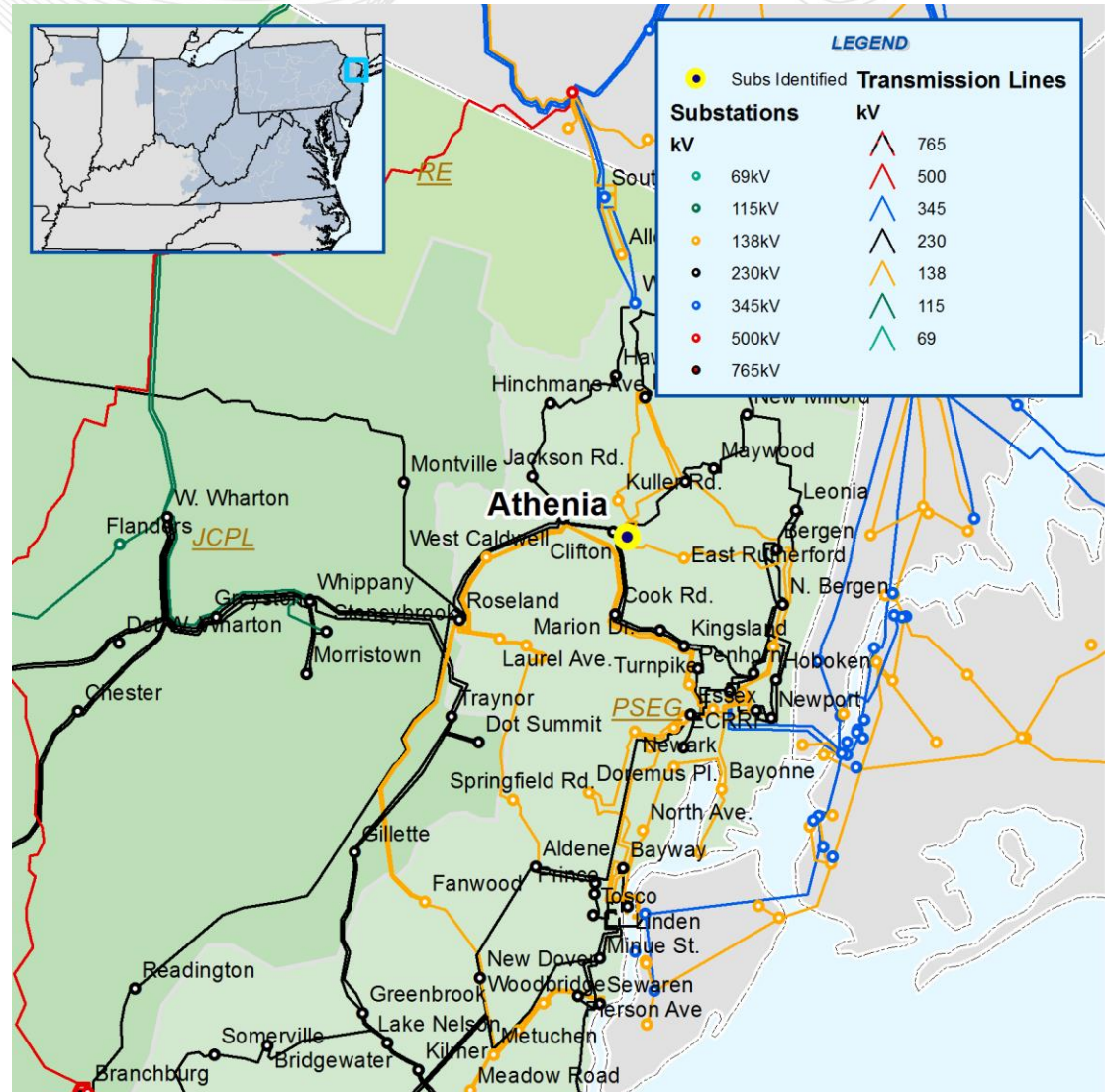
- Proposed Solution (cont'd):
 - Replace the Essex 230 kV breaker '11HL' with 80 kA (b1304.18)
- Estimated Project Cost:
 - \$1.5 M per breaker
- Expected IS Date:
 - 6/01/2015



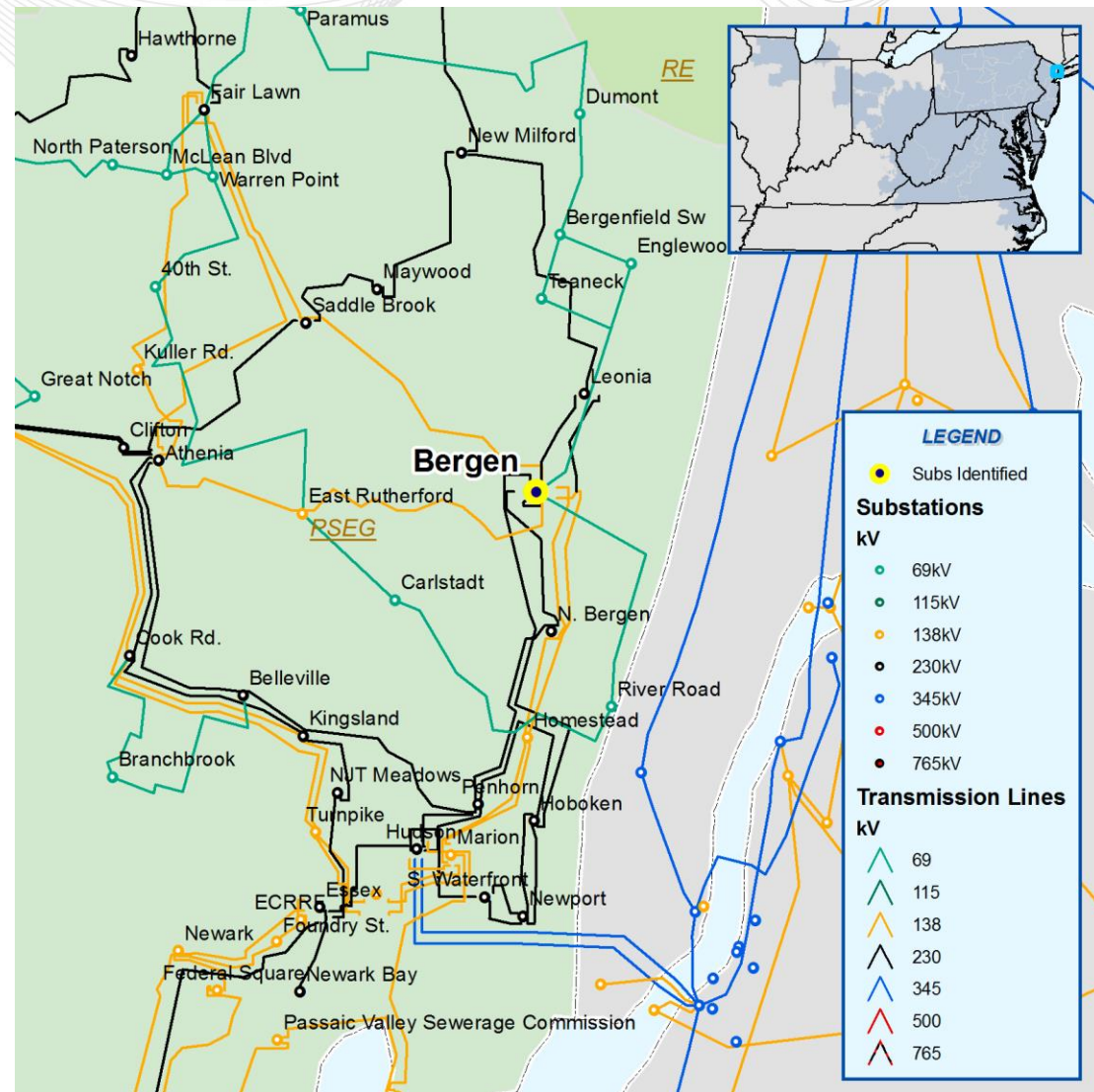
- The following breakers are overstressed:
 - Athenia 230 kV breaker '21H'
 - Athenia 230 kV breaker '41H'
- Significant Driver: Build second 230 kV underground cable from Bergen to Athenia (b1304.3)
- Proposed Solution:
 - Replace the Athenia 230 kV breaker '21H' with 80 kA (b1304.5)
 - Replace the Athenia 230 kV breaker '41H' with 80 kA (b1304.6)
- Estimated Project Cost:
 - \$1.5 M per breaker
- Expected IS Date: 6/01/2015



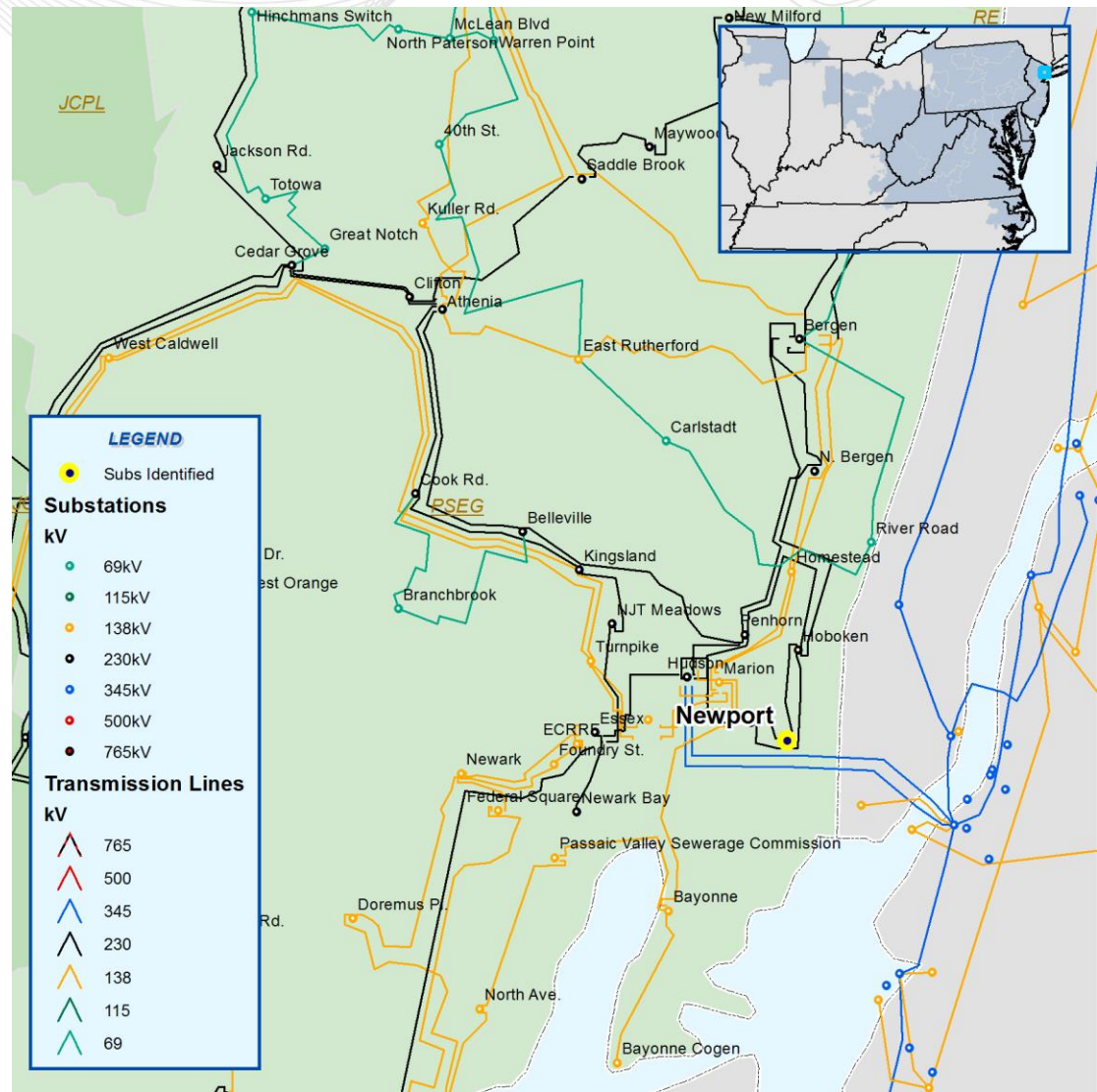
- Fault levels are above 63 kA at the Athenia 230 kV substation.
- Significant Driver: Build second 230 kV underground cable from Bergen to Athenia (b1304.3)
- Proposed Solution:
 - Rebuild the Athenia 230 kV substation to 80 kA (b1304.20)
- Estimated Project Cost:
 - \$21 M
- Expected IS Date: 6/01/2015



- Fault levels are above 63 kA at the Bergen 230 kV substation.
- Significant Driver: Build second 230 kV underground cable from Bergen to Athenia (b1304.3)
- Proposed Solution:
 - Rebuild the Bergen 230 kV substation to 80 kA (b1304.21)
- Estimated Project Cost:
 - \$0 M
 - The cost for this upgrade has already been captured in the cost estimate for b1304.1 and b1304.2.
- Expected IS Date:
6/01/2015



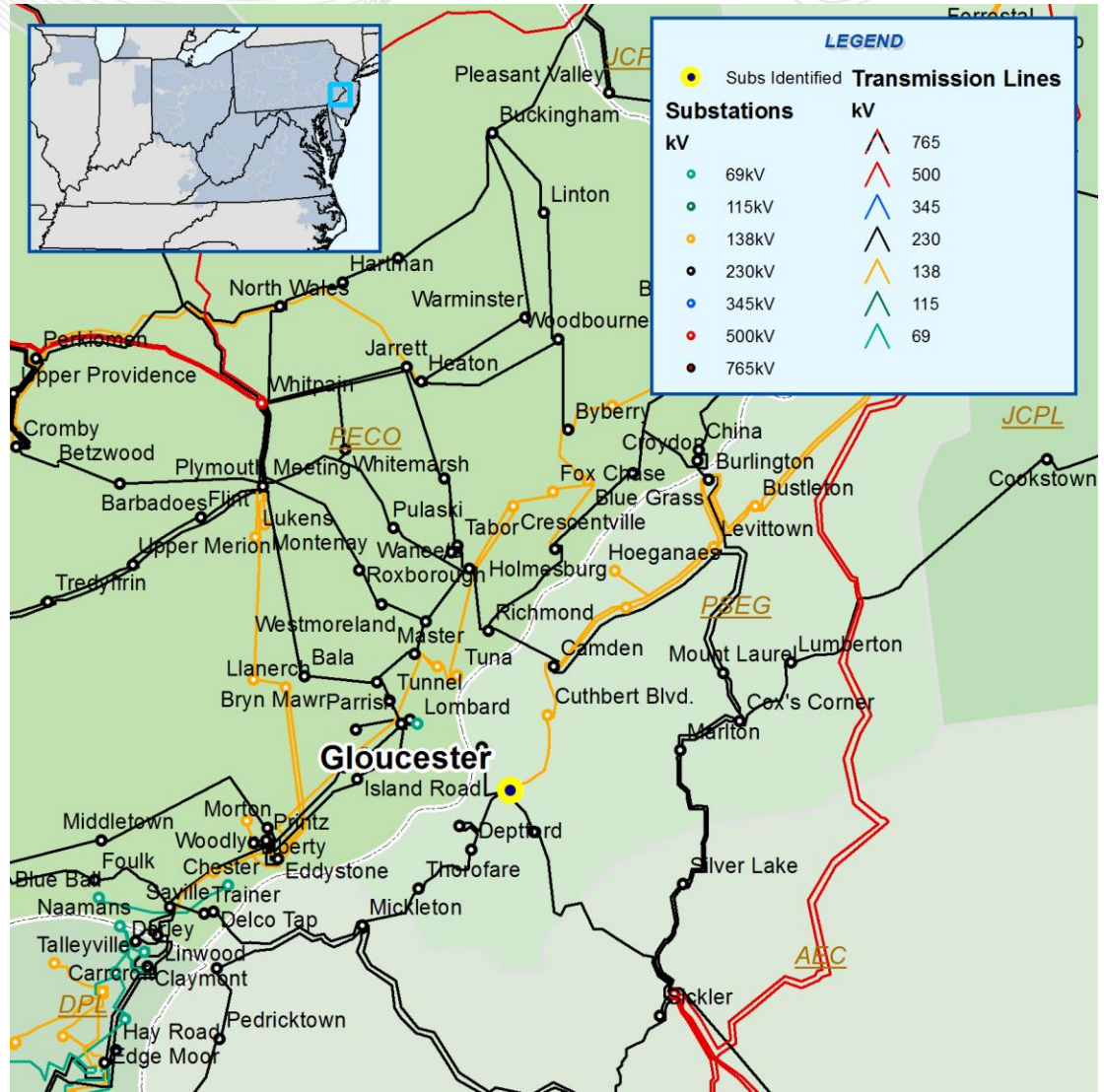
- The following breaker is overstressed:
 - Newport R 230 kV breaker '23H'
- Significant Driver: Build second 230 kV underground cable from Hudson to South Waterfront (b1304.4)
- Proposed Solution:
 - Replace the Newport R 230 kV breaker '23H' with 63 kA (b1304.19)
- Estimated Project Cost:
 - \$0.6 M per breaker
- Expected IS Date: 6/01/2015



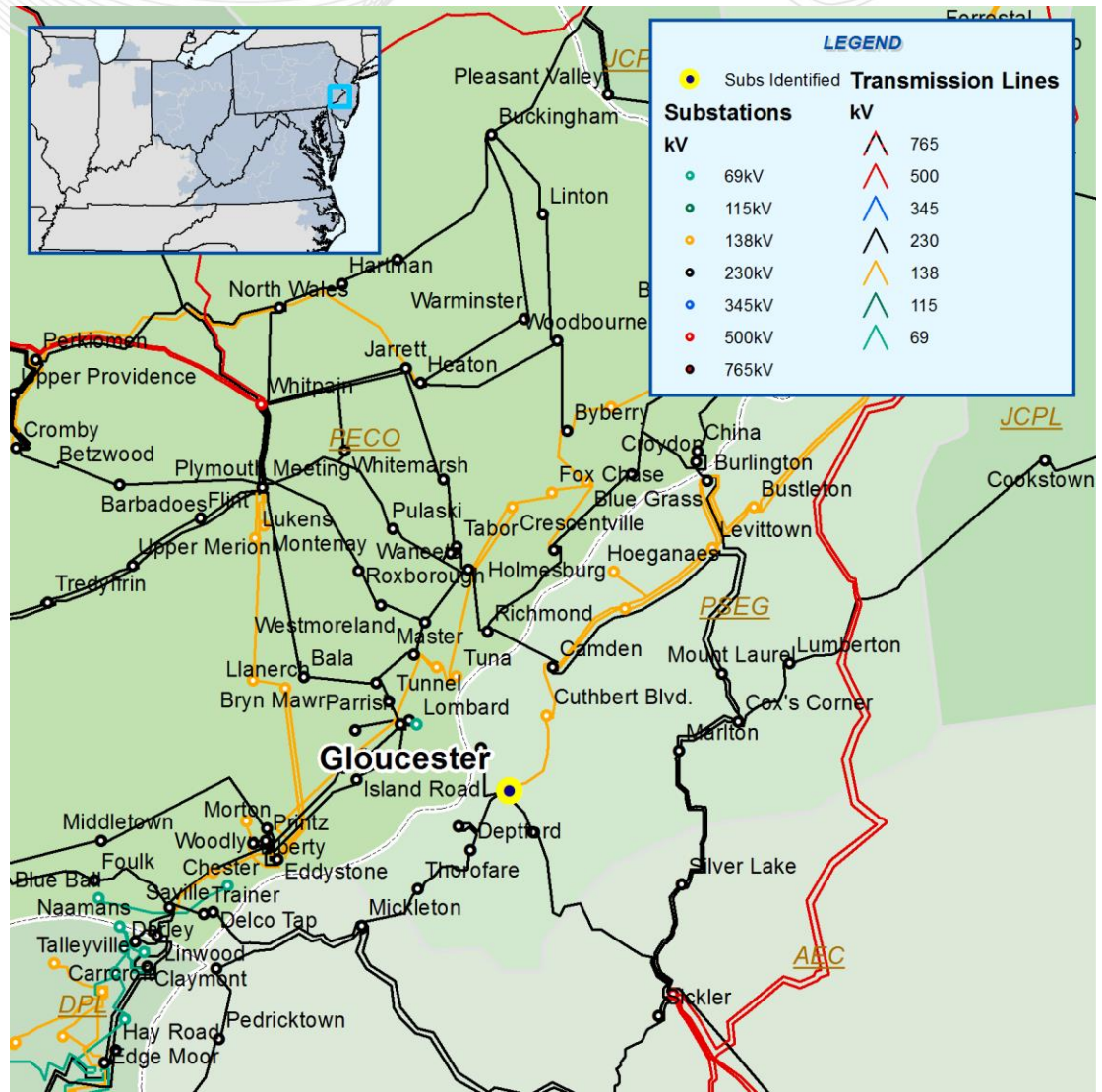
- The following breakers are overstressed:
 - Gloucester 230 kV breaker '21H'
 - Gloucester 230 kV breaker '51H'
 - Gloucester 230 kV breaker '56H'
 - Gloucester 230 kV breaker '26H'
 - Gloucester 230 kV breaker '71H'

- Significant Driver: Build two new parallel underground circuits from Gloucester to Camden (via Cuthbert Blvd) (b1398)

- Proposed Solution:
 - Replace the Gloucester 230 kV breaker '21H' with 63 kA (b1398.15)
 - Replace the Gloucester 230 kV breaker '51H' with 63 kA (b1398.16)
 - Replace the Gloucester 230 kV breaker '56H' with 63 kA (b1398.17)
 - Replace the Gloucester 230 kV breaker '26H' with 63 kA (b1398.18)



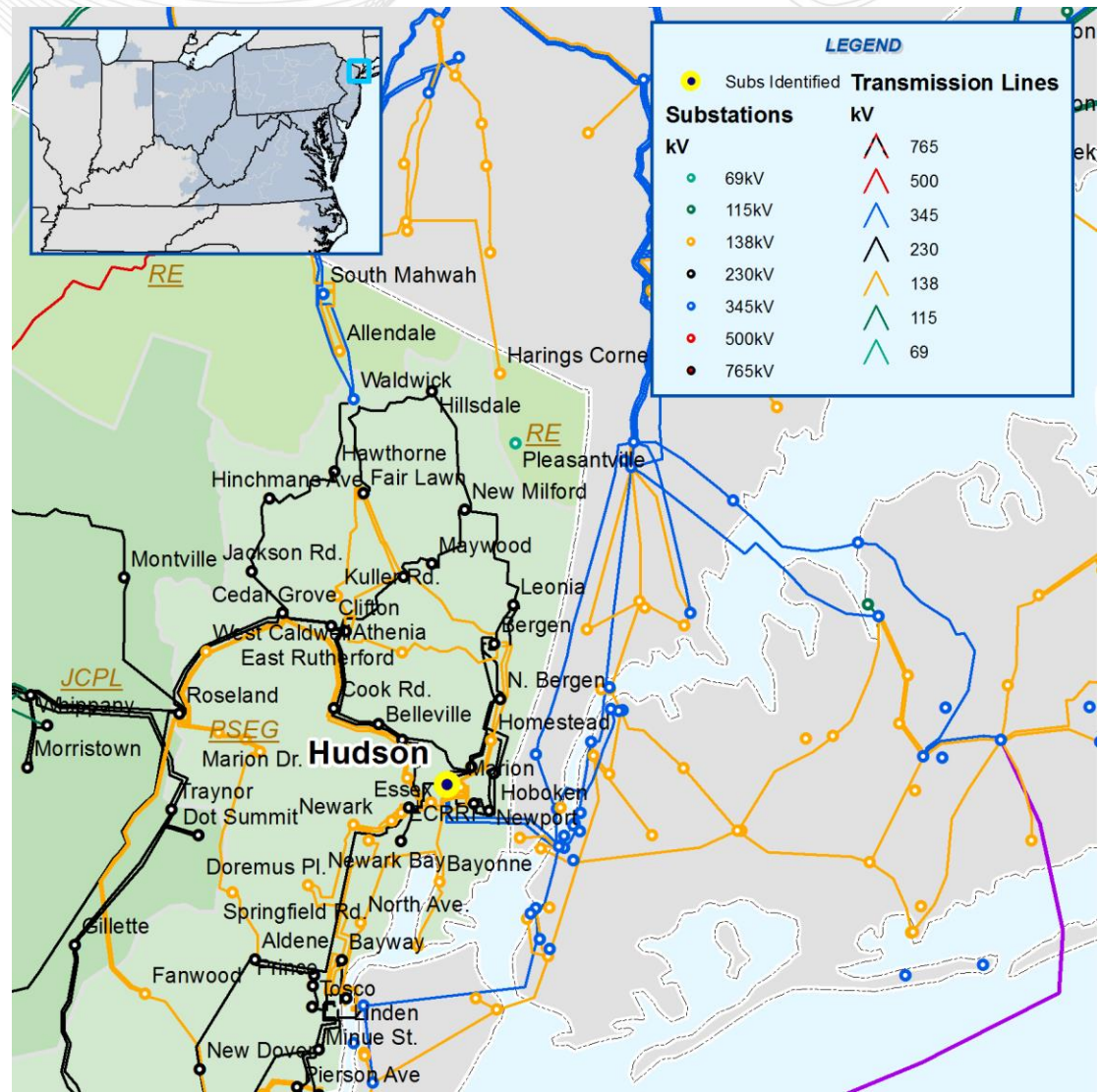
- Proposed Solution (cont'd):
 - Replace the Gloucester 230 kV breaker '71H' with 63 kA (b1398.19)
- Estimated Project Cost:
 - \$0.6 M per breaker
- Expected IS Date:
 - 6/01/2015



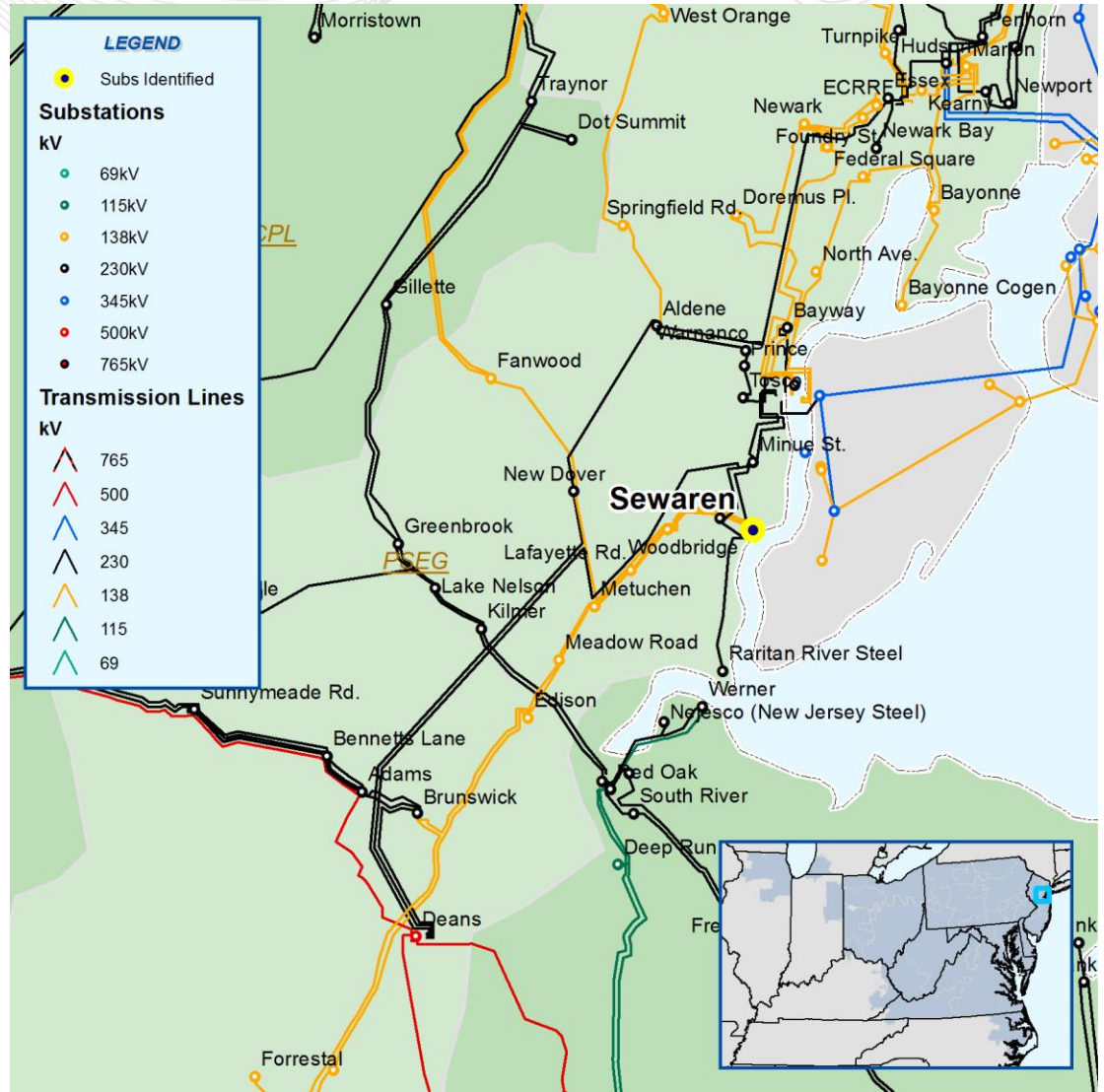
- The following breakers are overstressed:
 - Tosco 230 kV breaker 'CB1'
 - Tosco 230 kV breaker 'CB2'
- Proposed Solution:
 - Replace the Tosco 230 kV breaker 'CB1' with 63 kA (b1539)
 - Replace the Tosco 230 kV breaker 'CB2' with 63 kA (b1540)
- Estimated Project Cost:
 - \$0.6 M per breaker
- Expected IS Date: 6/01/2015



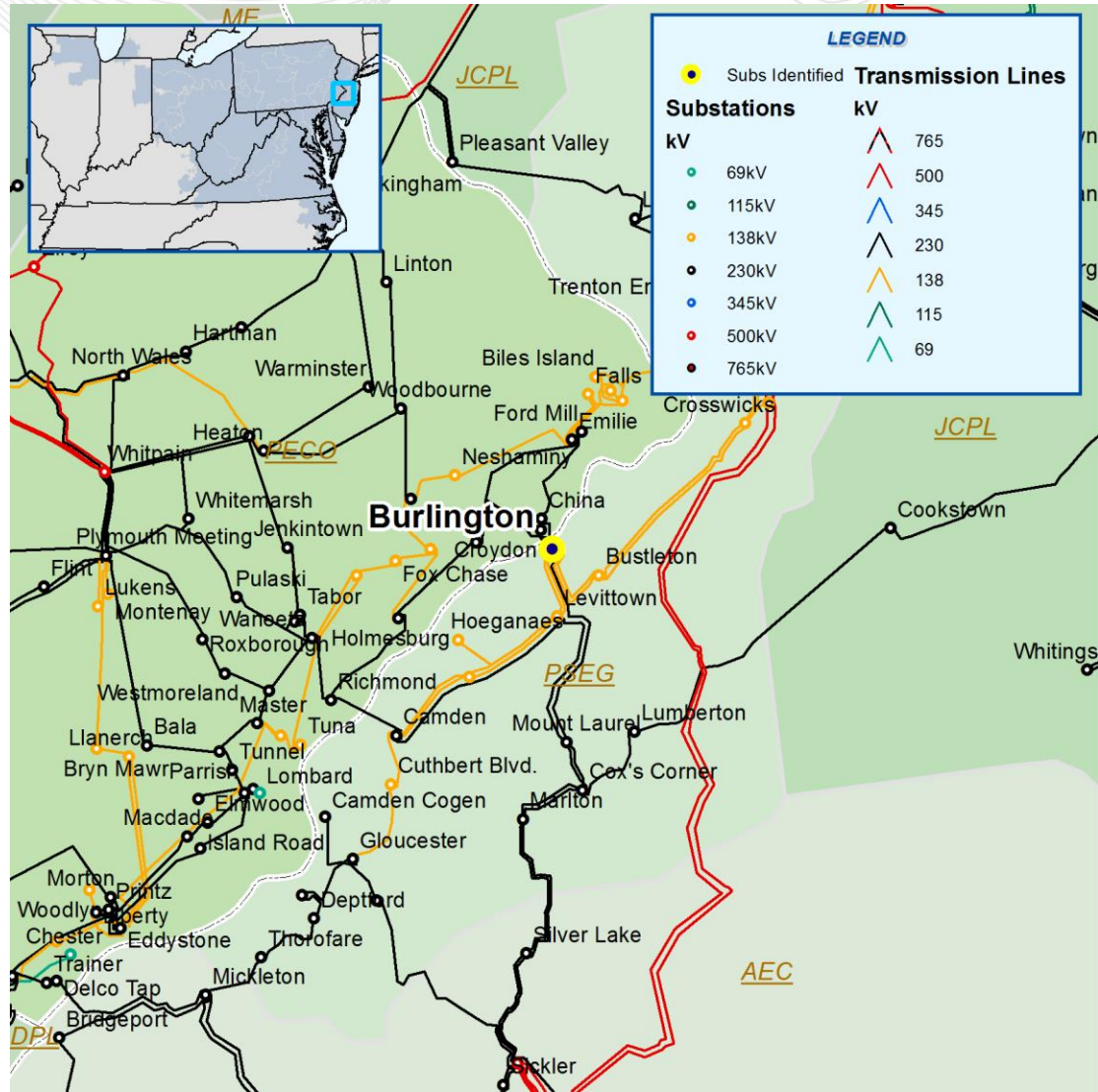
- Fault levels are above 80 kA at the Hudson 230 kV substation.
- Significant Drivers: BRH alternative upgrades (b1304)
- Proposed Solution:
 - Create baseline upgrade to ensure the Hudson bus tie is open
 - Open the Hudson 230 kV bus tie (b1541)
- Estimated Project Cost:
 - \$0 M
- Expected IS Date: 6/01/2015



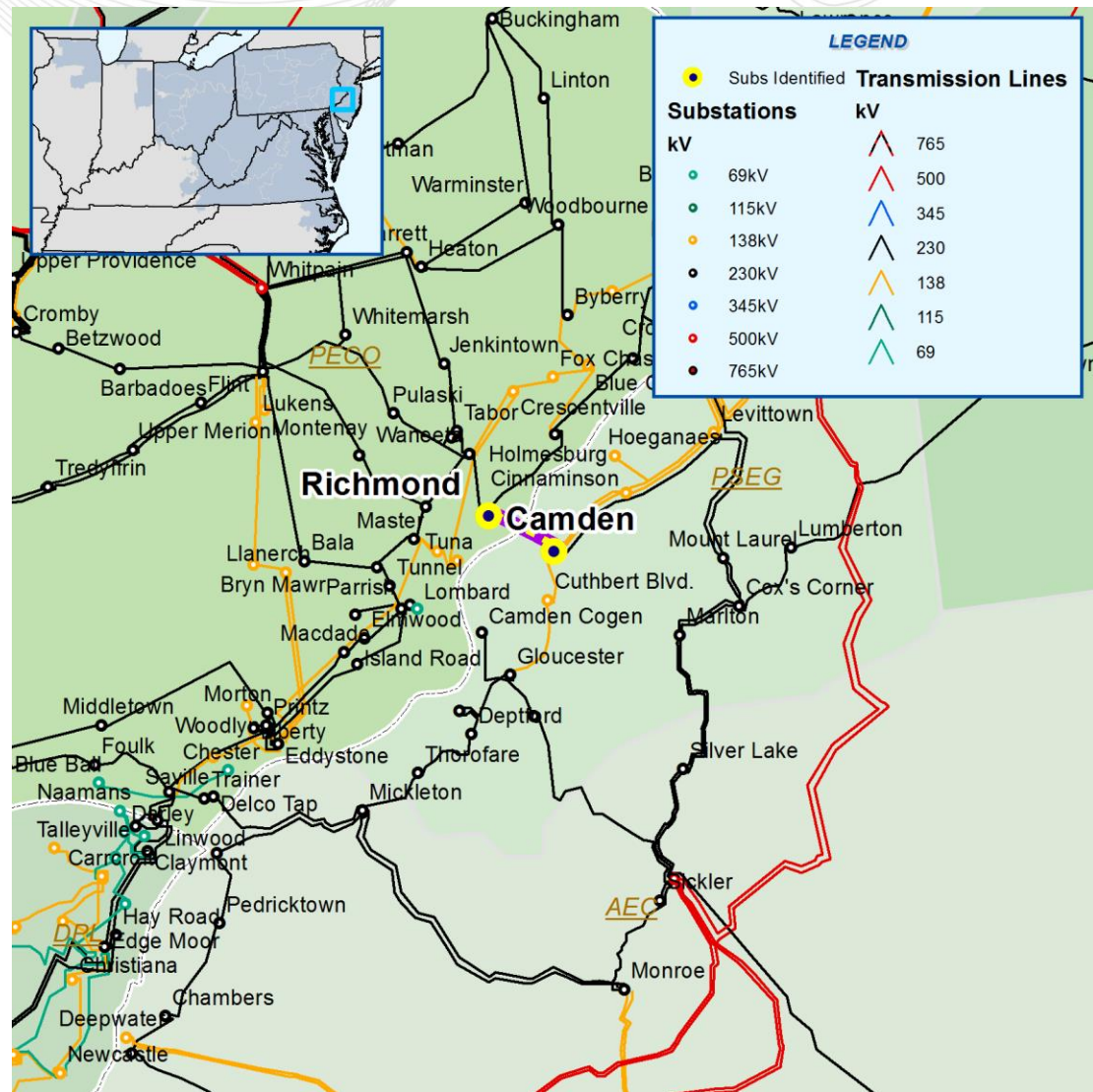
- The following breakers are overstressed:
 - Sewaren 138 kV breaker '31P'
 - Sewaren 138 kV breaker '1PL'
- Significant Driver: Replace the Sewaren 230/138 kV transformer (s0260)
- Proposed Solution:
 - Replace the Sewaren 138 kV breaker '31P' with 63 kA (s0260.2)
 - Replace the Sewaren 138 kV breaker '1PL' with 63 kA (s0260.3)
- Estimated Project Cost:
 - \$0.6 M per breaker
- Expected IS Date: 6/01/2013



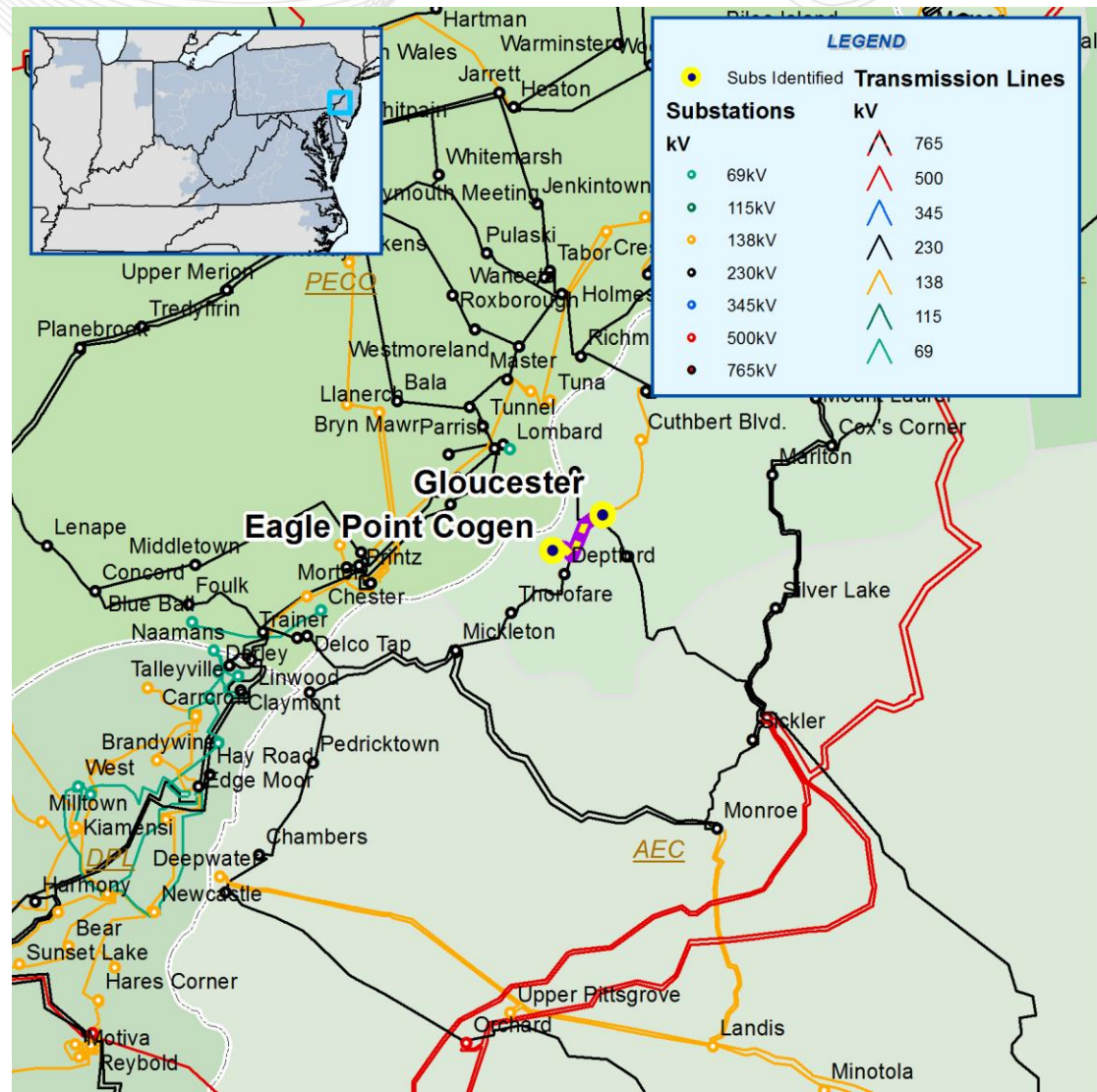
- Fault levels are near 63 kA at the Burlington 230 kV substation.
- Significant Driver: Convert the Burlington, Camden, and Cuthbert Blvd 138 kV substations from 138 kV to 230 kV (b1156)
- Proposed Solution: Rebuild the Burlington 230 kV substation to 80 kA (b1156.20)
- Estimated Project Cost: \$5 M
- Expected IS Date: 6/1/2014



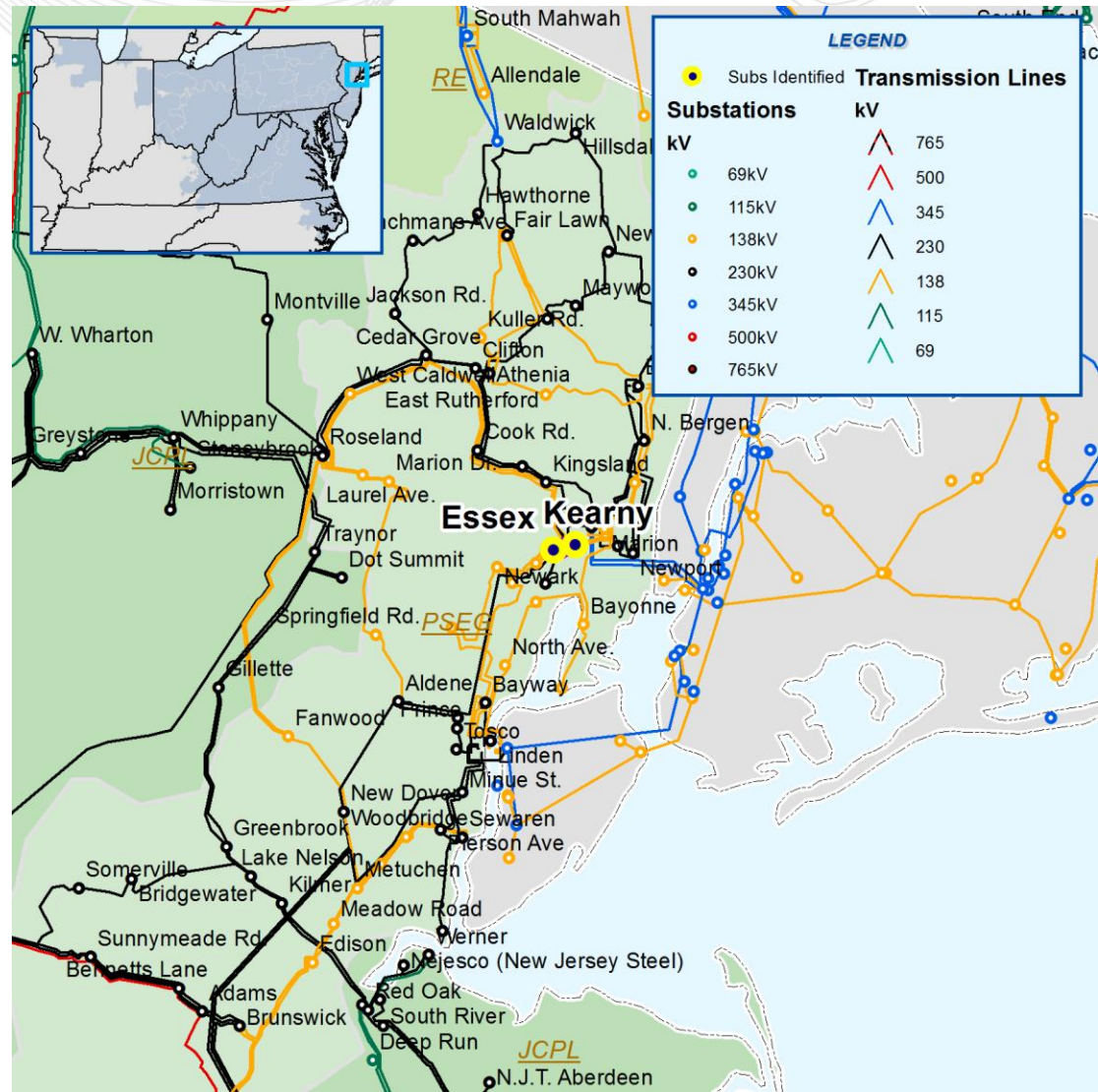
- Common Mode Outage Procedure:
- Overload on the Camden – Richmond 230 kV circuit for the loss of several bus and line fault stuck breaker contingencies.
- Proposed Solution:
Replace the B1398.6 upgrade scope with upgrade the PECO portion of the Camden – Richmond 230 kV to a six wire conductor and replace terminal equipment at Richmond . In 2016, replace terminal equipment at Richmond (B1590.1).
- Estimated Project Cost:
\$ 2.7 M (B1398.6)
\$ 0.8 M (B1590.1)
- Expected IS Date:
6/1/2015 (B1398.6)
6/1/2016 (B1590.1)



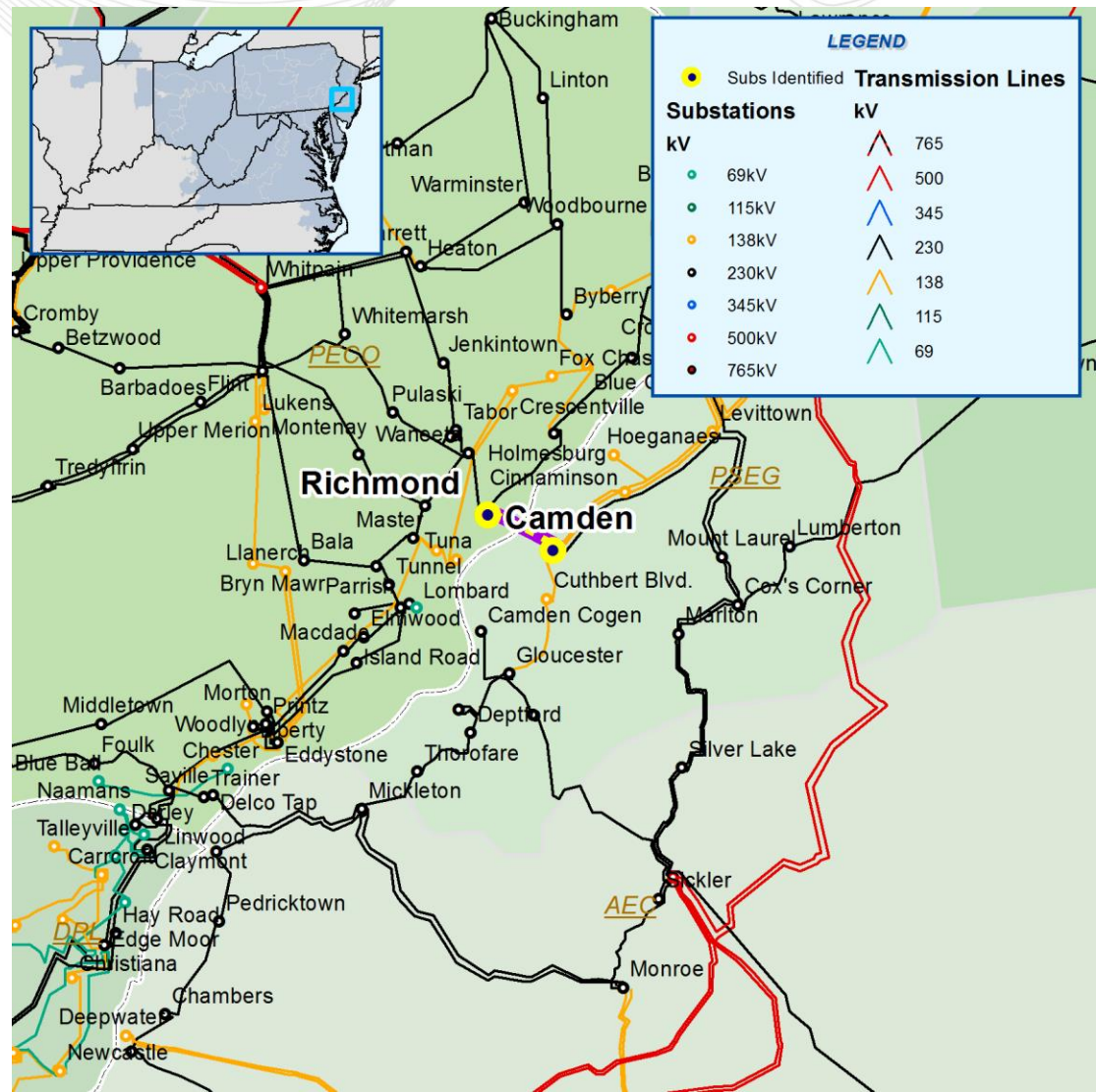
- Generation Deliverability:
- Overload on the Eagle Point – Gloucester 230 kV circuit #1 and #2. Loss of one circuit overloads the other circuit.
- Proposed Solution: Reconductor the Eagle Point – Gloucester 230 kV circuit #1 and #2 with higher conductor rating (B1588).
- Estimated Project Cost: \$ 25 M
- Expected IS Date: 6/1/2016



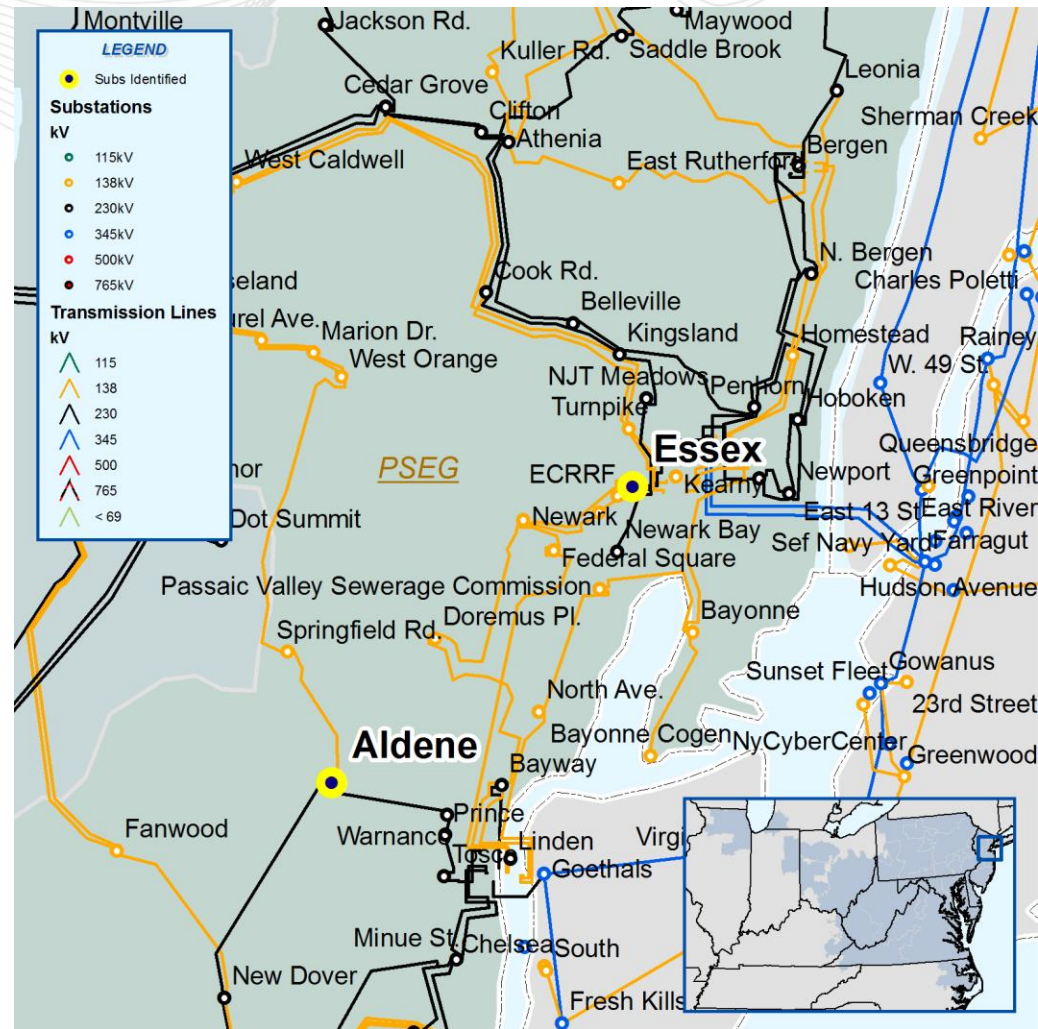
- Common Mode Outage Procedure
- Overload on the Essex - Kearny 230 kV circuit for the tower-line outage loss of the Hudson – Essex and NJT Meadows – Athenia 230 kV circuits.
- Proposed Solution: Re-configure the Kearny 230 kV substation and loop the P-2216-1 (Essex – NJT Meadows) 230 kV circuit (B1589).
- Estimated Project Cost: \$ 48 M
- Expected IS Date: 6/1/2016



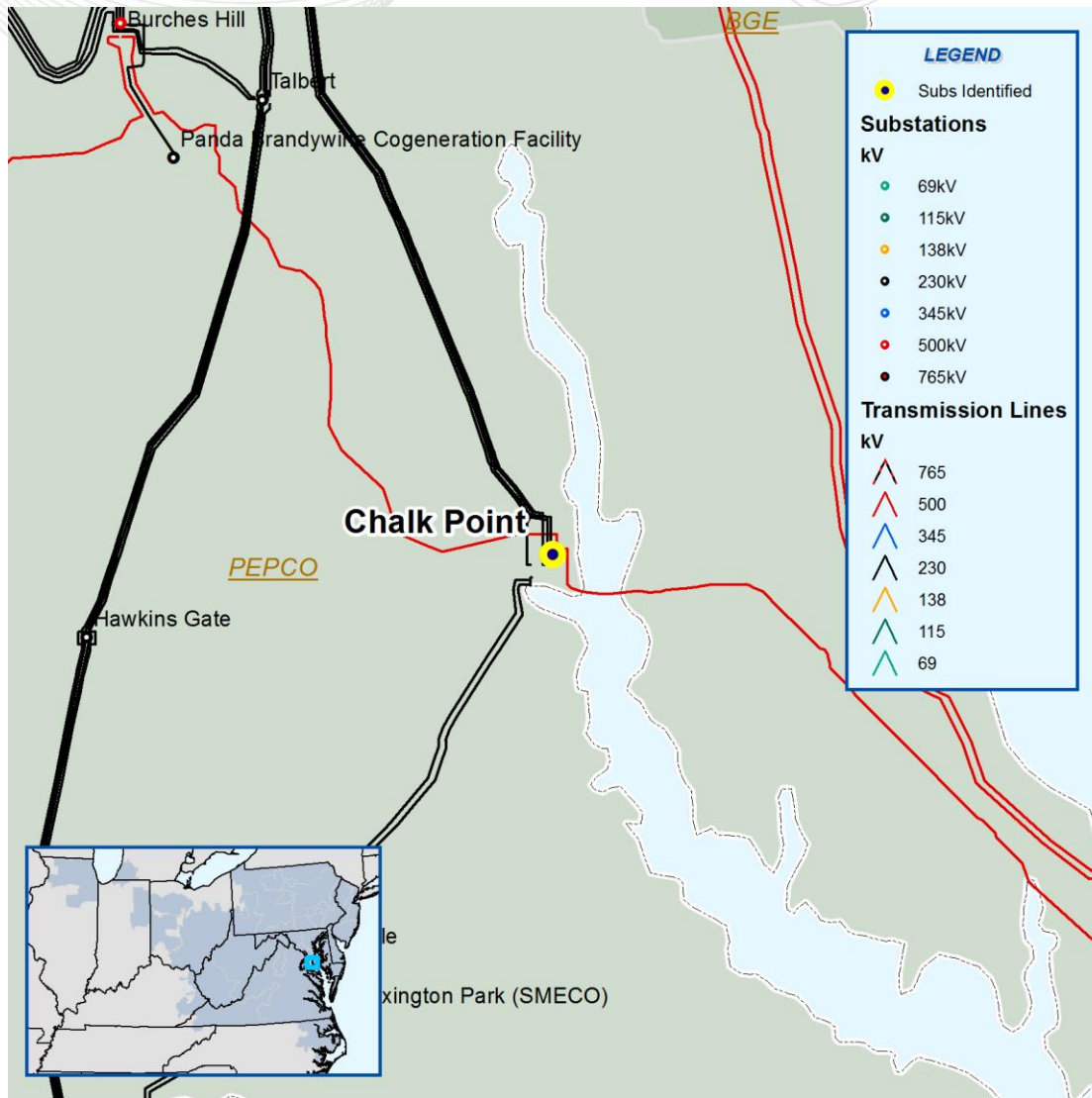
- Common Mode Outage Procedure:
- Overload on the Camden – Richmond 230 kV circuit for the loss of several bus and line fault stuck breaker contingencies.
- Proposed Solution: Upgrade the PSEG portion of the Camden – Richmond 230 kV to a six wire conductor and replace terminal equipments at Camden (B1590).
- Estimated Project Cost: \$ 40 M
- Expected IS Date: 6/1/2016



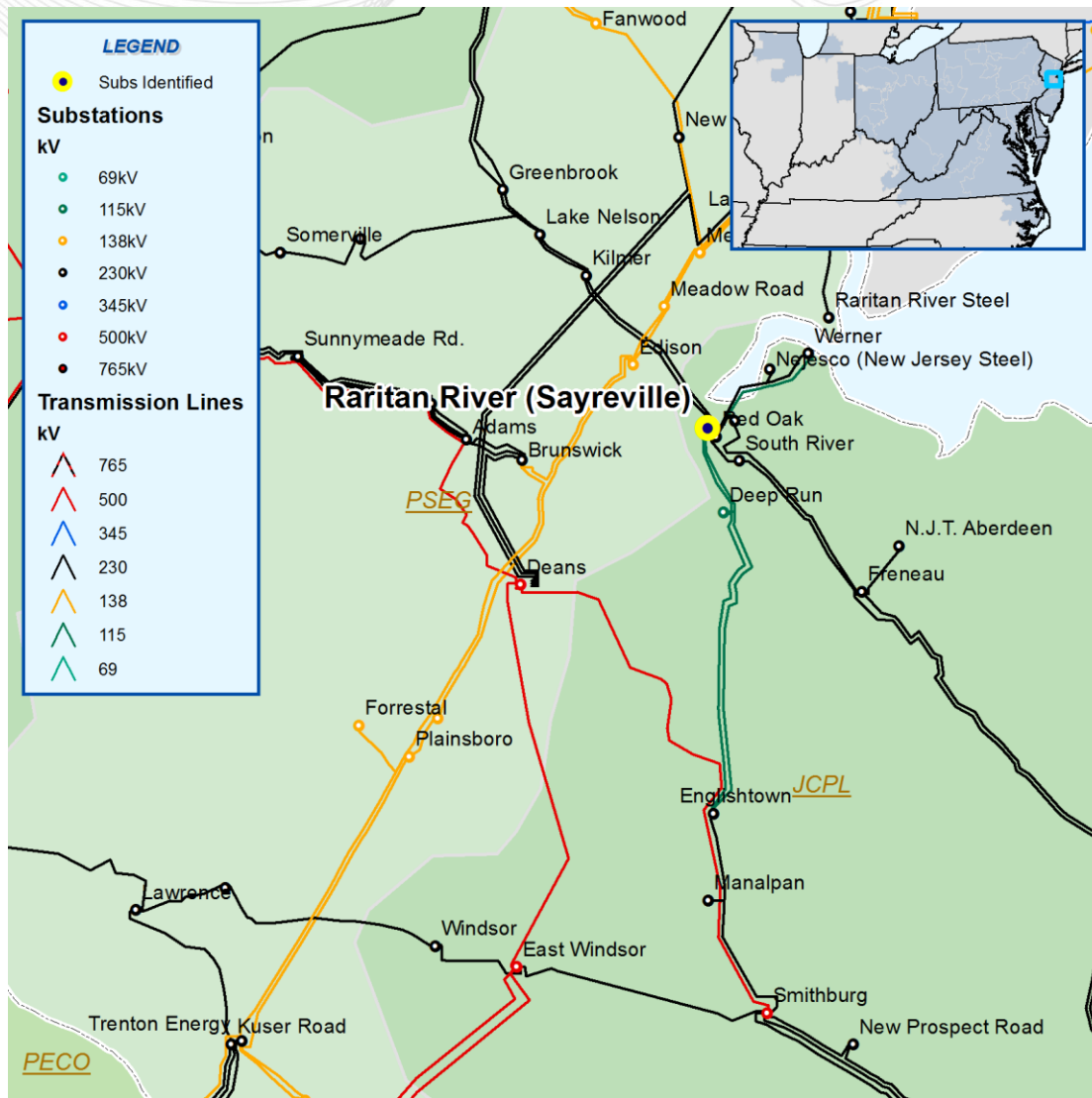
- B1099 Upgrade Scope Change
- The baseline upgrade B1099 - Build a new 230 kV substation by tapping the Aldene – Essex circuit and install three 230/26 kV transformers, and serve some of the Newark area load from the new station - was identified as part of the 2009 RTEP to resolve N-1-1 violation in PSEG
- Project cost has increased to include a third transmission feed from West Orange to address PS reliability criteria and to address higher than expected real estate costs.
- Original Estimated Project Cost: \$137 M
- New Estimated Project Cost: \$230 M
- Expected IS Date: 6/1/2014



- The Chalk Point 230 kV breakers '4C', '5C', '6C', and '7C' are overstressed
- Proposed Solution: Replace the Chalk Point 230 kV breakers '4C', '5C', '6C', and '7C' (b0864-b0867)
- Estimated Project Cost: \$2 M per breaker
- Expected IS Date: 12/31/2014



- The Raritan River 230 kV breaker 'BK15' is overstressed
- Proposed Solution: Upgrade or replace the Raritan River 230 kV breaker 'BK15' (b1520)
- Estimated Project Cost: \$200 K
- Expected IS Date: 6/01/2013

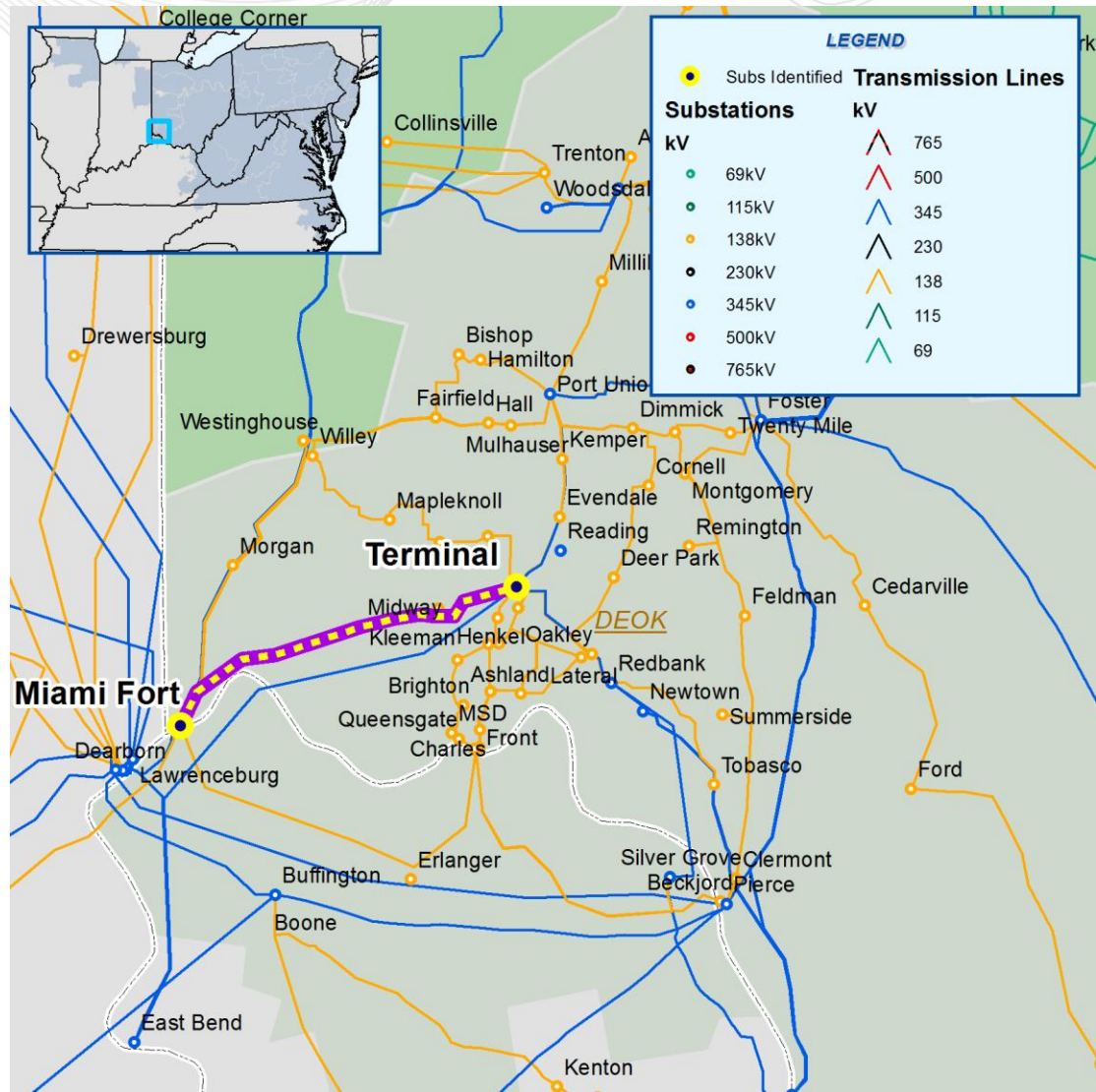


- Baseline upgrade solutions in this presentation (with the exception of DEOK) will be Proposed to the PJM Board in October 2011 for approval and inclusion in the RTEP
- Network upgrade solutions (associated with interconnection projects) that were presented at the July 14, 2010 TEAC will be Proposed to the PJM Board in October 2010 for approval and inclusion in the RTEP
- DUKE mitigation plans will continue to be reviewed with the TEAC and will be presented to the PJM Board for approval following the planned June 1, 2011 ATSI integration

Duke Energy Ohio Kentucky

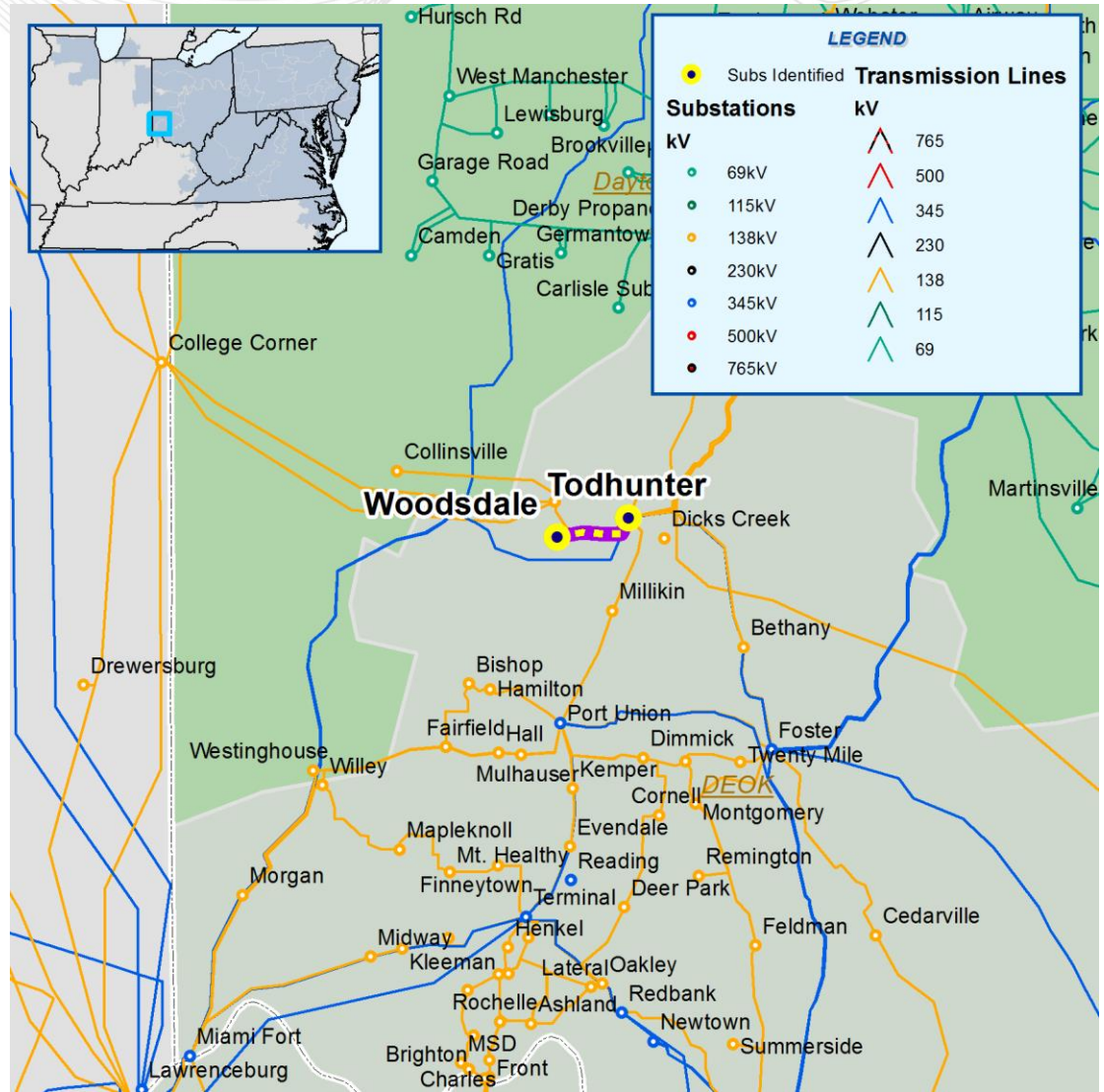
- The following DEOK upgrades were previously presented but have been assigned new baseline upgrade identifiers due to a conflict with existing upgrade identifiers

- Common Mode Violation
- The Circuit 4515 Miami Fort - Terminal 345kV circuit is overloaded for the tower contingency of losing both circuit #4561 and circuit #4562
- Recommended Solution:
- Replace wavetrapp and line switch (B1704)
- Estimated Cost: \$0.104M
- Expected IS date: 06/01/2013

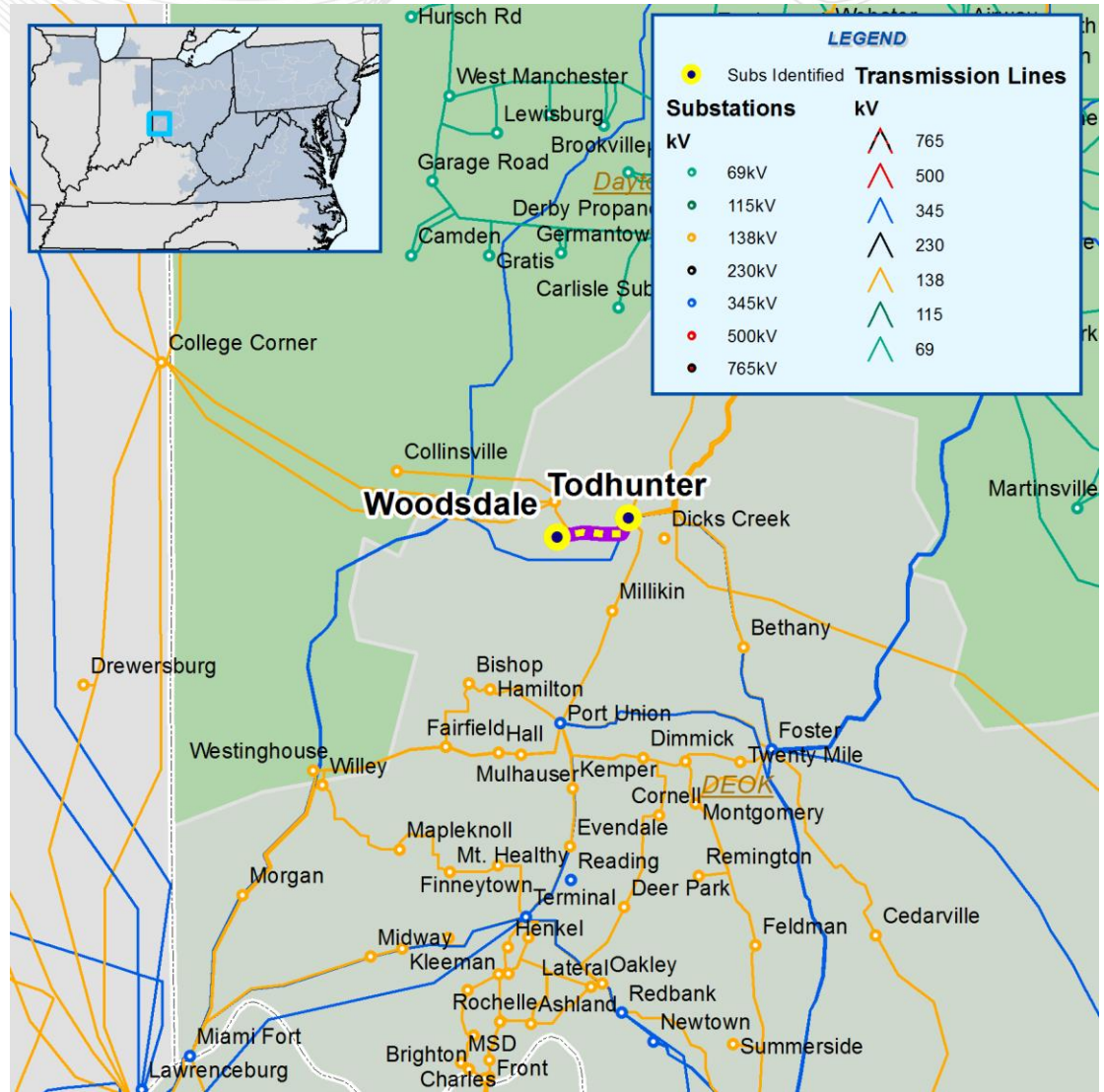


Duke Energy Ohio Kentucky Transmission Zone

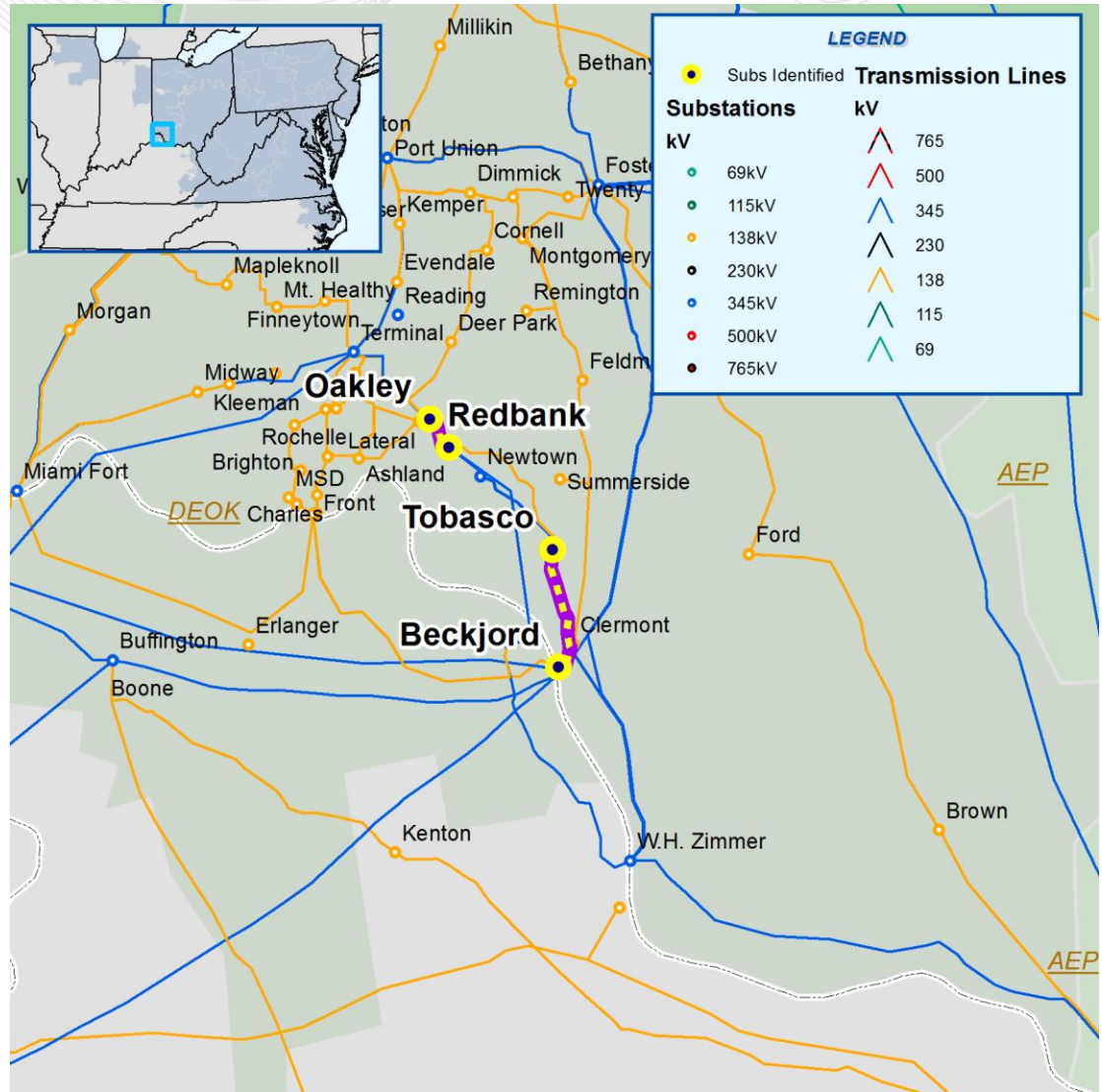
- Generator Deliverability Violation
- The circuit 4561 Woodsdale - Todhunter 345kV circuit is overloaded for the loss of circuit #4562
- Recommended Solution:
- Replace wavetraps and line switches (B1705)
- Estimated Project Cost: \$0.21M
- Expected IS date: 06/01/2013



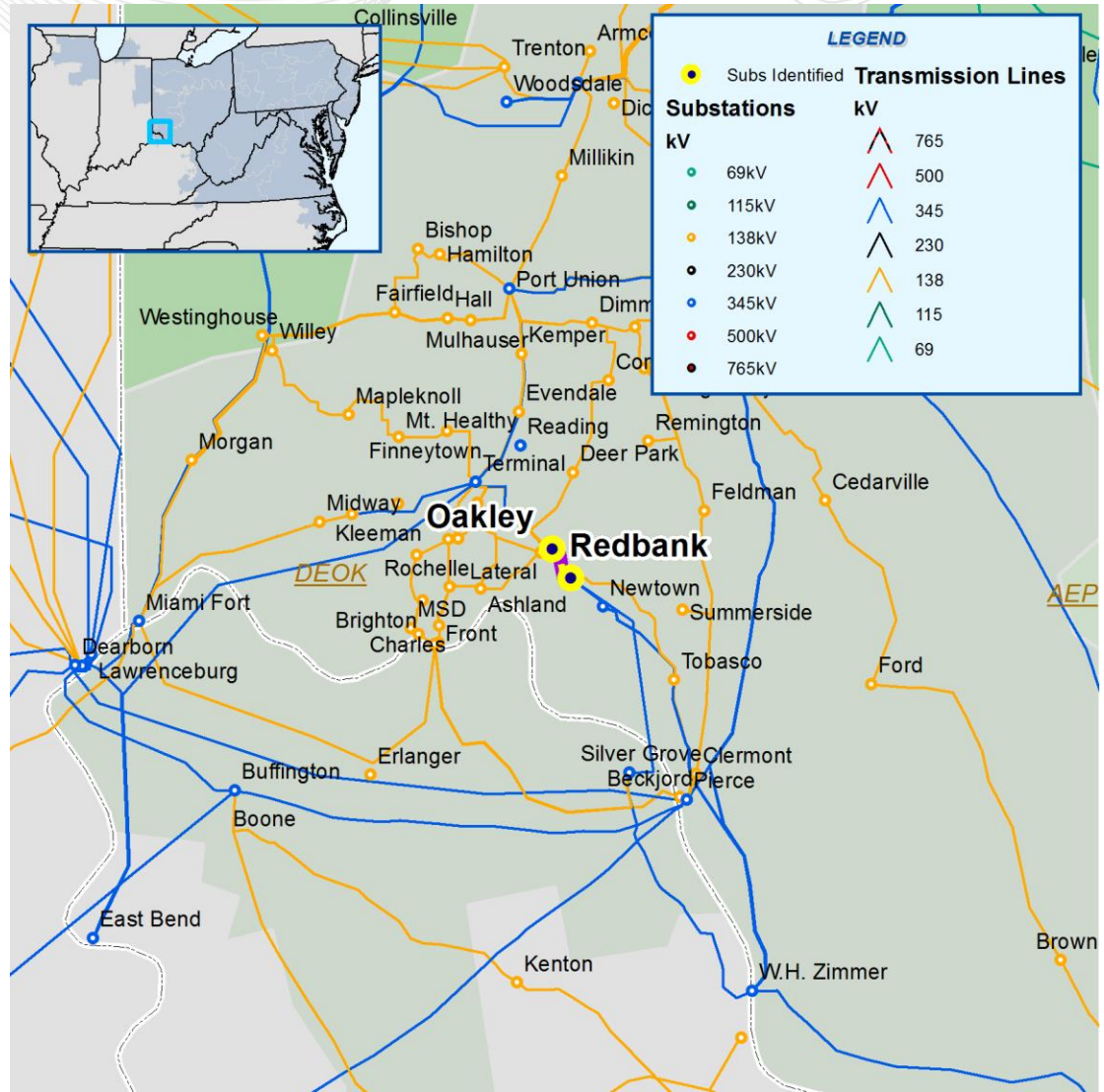
- Generator Deliverability Violation
- The circuit 4562 Woodsdale - Todhunter 345kV circuit is overloaded for the loss of circuit #4561
- Recommended Solution:
- Replace wavetraps and line switches (B1706)
- Estimated Project Cost: \$0.21M
- Expected IS date: 06/01/2013



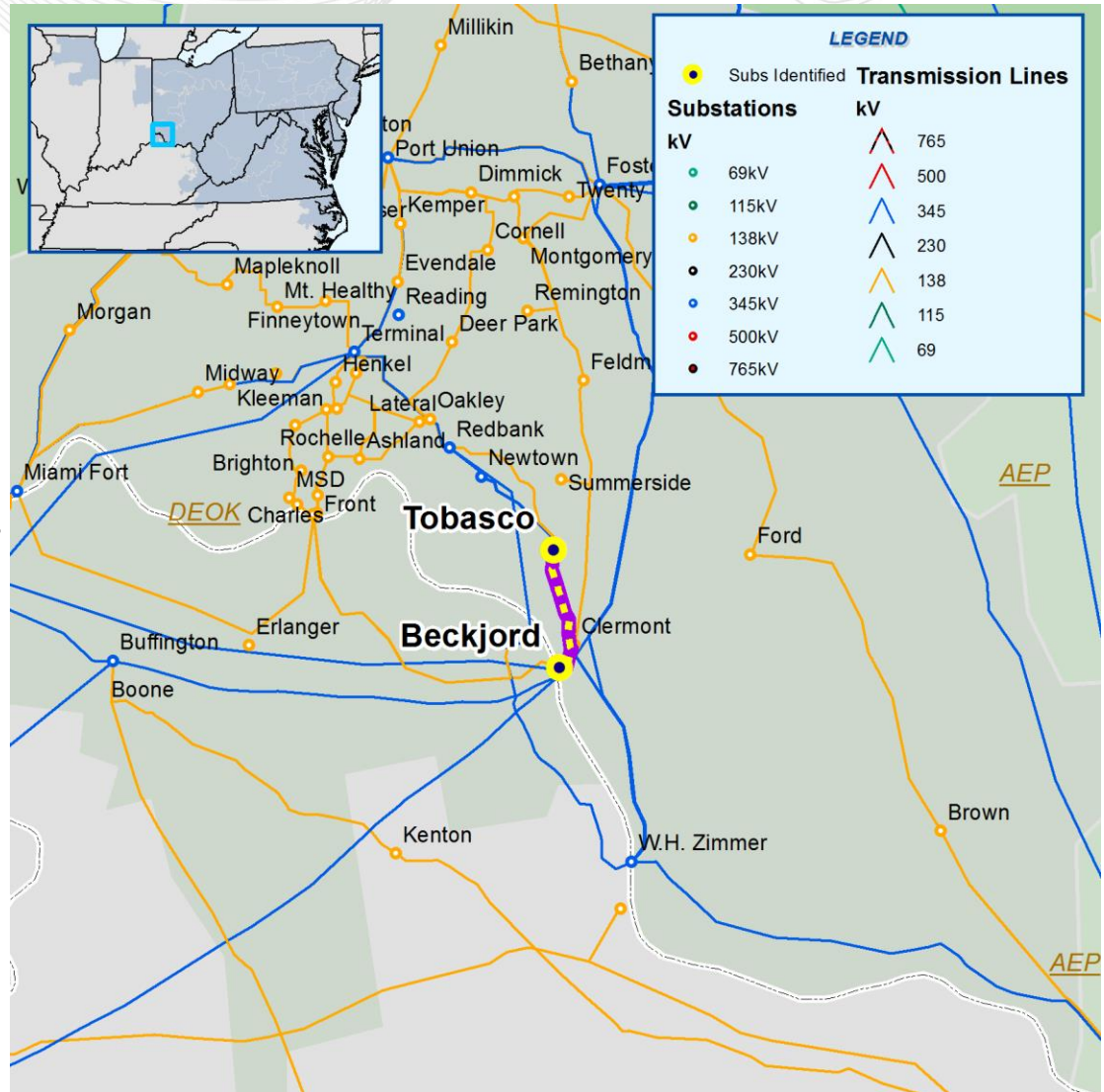
- Common Mode Violation
- The Berjord - Tobasco 138kV circuit (#1885) is overloaded for several multiple facility contingencies;
- The Red Bank - Oakley 138kV circuit (#885) is overloaded for several multiple facility contingencies.
- Recommended Solution:
 - Add a 138/69kV transformer at Newtown substation (B1707.1)
 - Add a new 69kV line Newtown – Mt. Washington B1707.2)
 - Add a new 69kV line Newtown – Berkshire (B1707.3)
 - Reconfigure the 69kV loop (B1707.4)
- Estimated Project Cost: \$8M
- Expected IS date: 06/01/2014



- Common Mode Outage Procedure
- the Red Bank - Oakley 138kV circuit (#885) is overloaded (104.13%) for the tower contingency of losing both circuits #1885 and #886
- The metering equipments will be replaced (B1575)
- Estimated Project Cost: \$0.2M
- Projected IS date: 6/1/2012

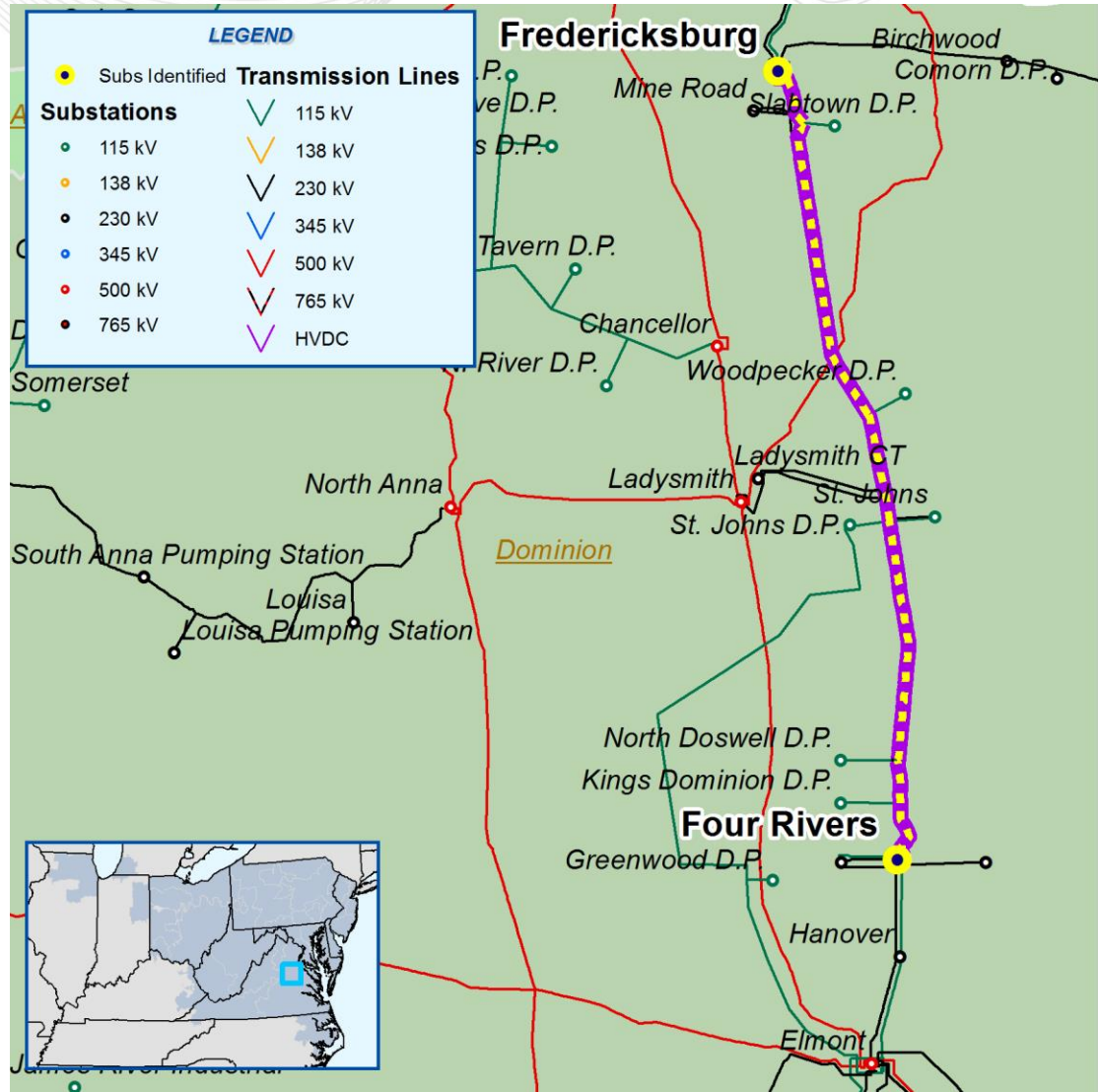


- Common Mode Outage Procedure
- The Beckjord - Tobasco 138kV circuit (#1885) is overloaded (100.82%) for the tower contingency of losing both circuit #3881 and circuit #6984
- The metering equipments will be replaced (B1577)
- Estimated Project Cost: \$0.2M
- Projected IS date: 6/1/2012



Potential 2011 RTEP Upgrades

- Single Contingency Violation – Dominion Criteria
- An outage of Line #2090(Ladysmith CT – Mine Rd 230 kV) overloads Line #47(Four Rivers – Kings Dominion 115 kV) (P PT5 off line)
- An outage of Fredericksburg – Slabtown 115 kV cause low voltage at Slabtown (Four Rivers off line)
- Potential Solution:
 - Uprate or rebuild Line #47
 - Install capacitors
 - Convert load from 115 kV System to 230 kV System
- Potential IS Date: 6/1/2016

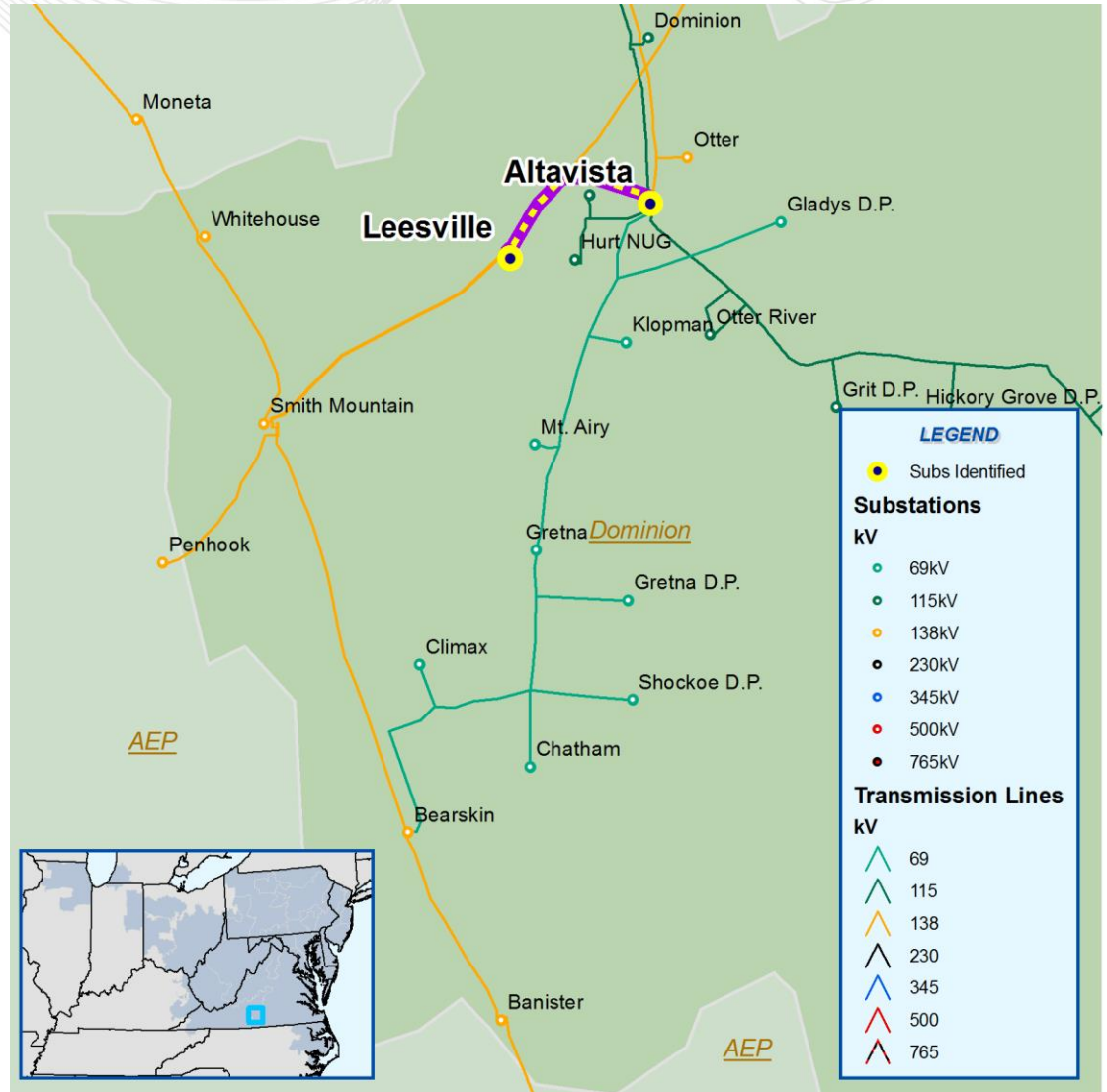


Retirement Analysis Update

Altavista Retirement Upgrades

Altavista is planned to
deactivate on 09/13/2010

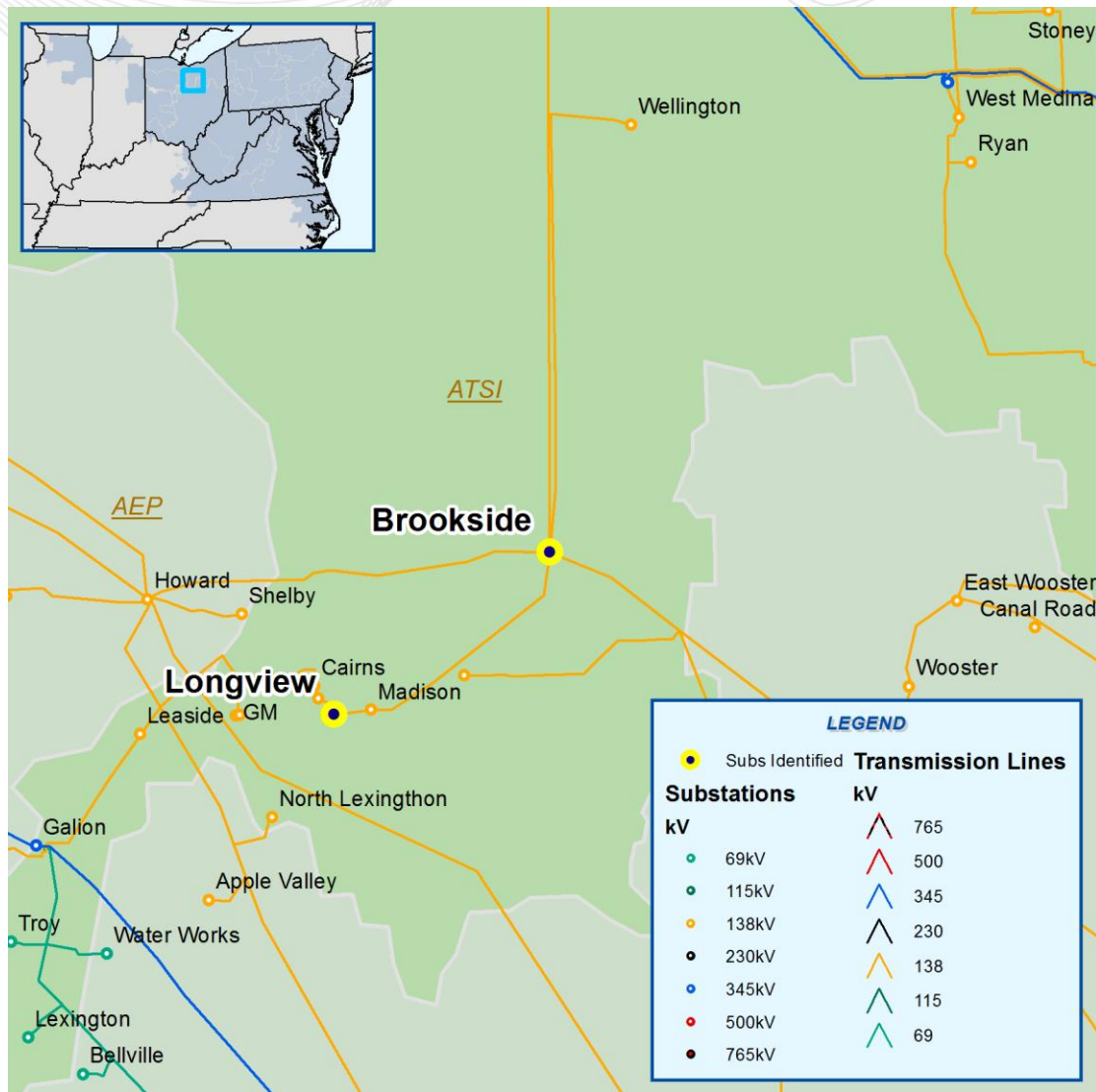
- Generator Deliverability violation
- Thermal violation on Altavista-Leesville 138 kV line for the loss of Banister-Bearskin-Smith Mountain 138 kV line + Bearskin 138/69 kV transformer as a result of Altavista 63.7 MW generator retirement.
- Altavista area re-configuration:
 - Perform sag study on Altavista-Leesville 138 kV line (b1712.1)
 - Rebuild the line Altavista-Leesville 138 kV line (b1712.2)
- Estimated Project Cost: \$7,520,500
- Required IS Date: N/A



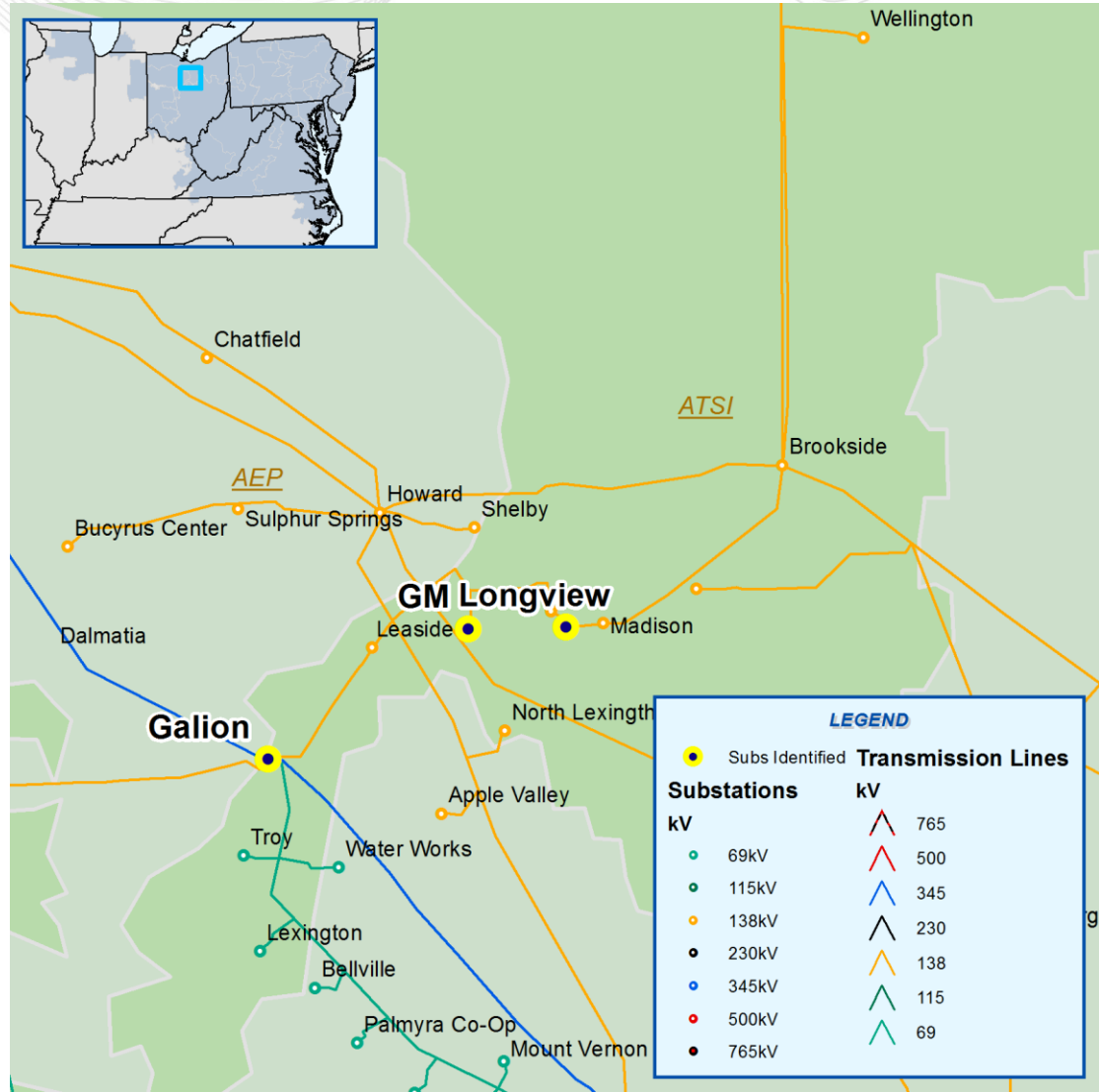
Burger 3 Retirement Upgrades

Burger unit 3 is planned to deactivate on 9/1/2011

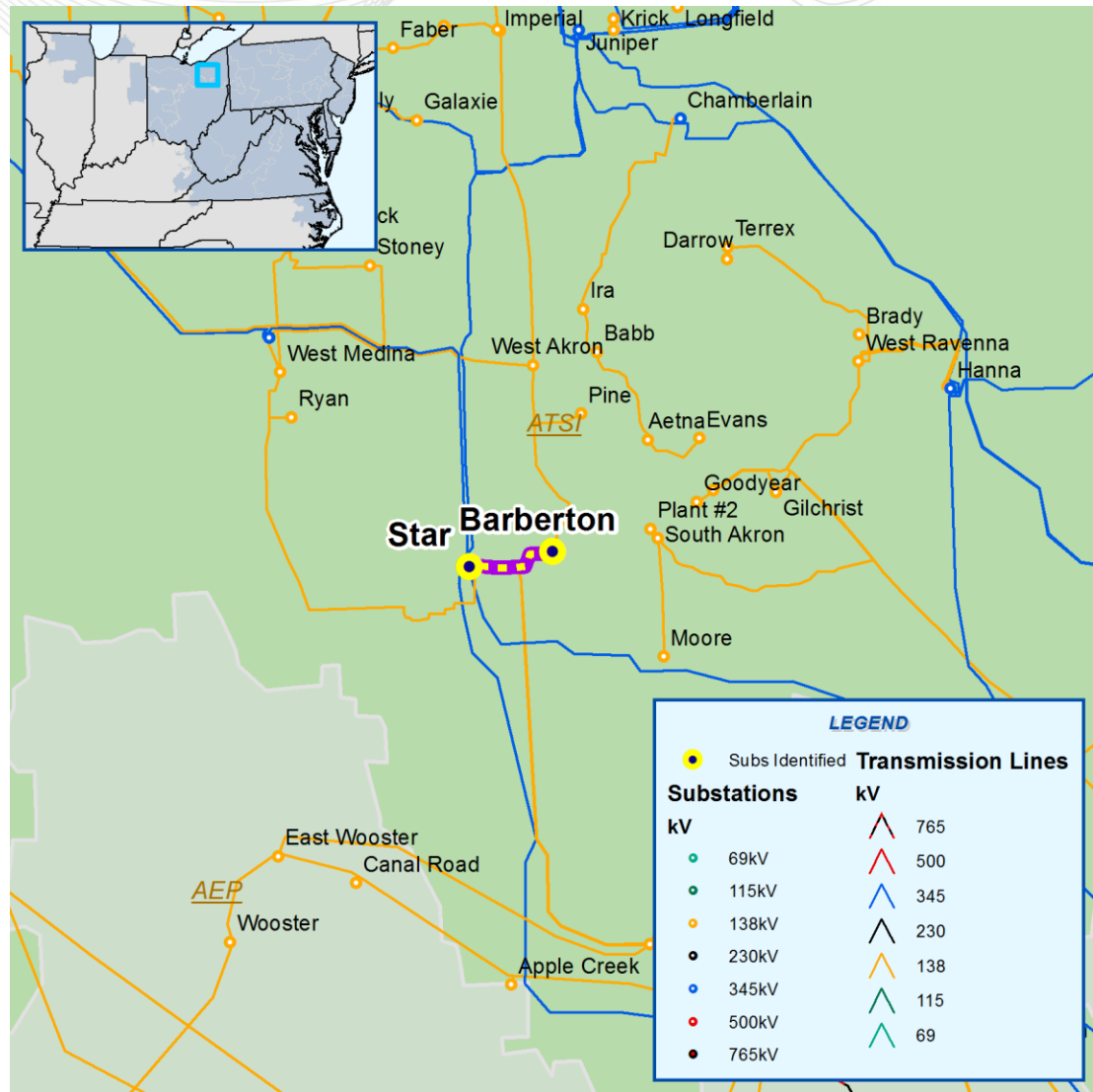
- Due to the expected generation retirements at Burger, the following upgrade is proposed to reinforce the Burger area:
- Burger area re-configuration:(b1694)
 - Create Brookside - Reedsburg - Longview 138 kV line
 - Open Burger-Cloverdale #2 & #3 138 kV lines
- Estimated Project Cost: NA
- Required IS Date: 9/1/2011



- Due to the expected generation retirements at Burger, the following upgrade is proposed to be advanced:
- Galion-GM Mansfield-Longview 138 kV line: Bypass GM Mansfield substation (b1585)
- PJM Required Date: Advance from 6/1/2016 to 9/1/2011
- Expected IS Date: 6/1/2012



- Due to the expected generation retirements at Burger, the following upgrade is proposed to be advanced:
- Replace Barberton - Star 138 kV #1 wavetrap, CFZ relay, and line exit conductor at Barberton (b1285)
- PJM Required Date: Advance from 6/1/2015 to 9/1/2011
- Expected IS Date: 6/1/2012



- Due to the expected generation retirements at Burger, the following upgrade is proposed to be advanced:
- Barberton - Star 138 kV #2: Change the relay setting limit at Barberton (b1586)
- PJM Required Date: Advance from 6/1/2016 to 9/1/2011
- Expected IS Date: 6/1/2012



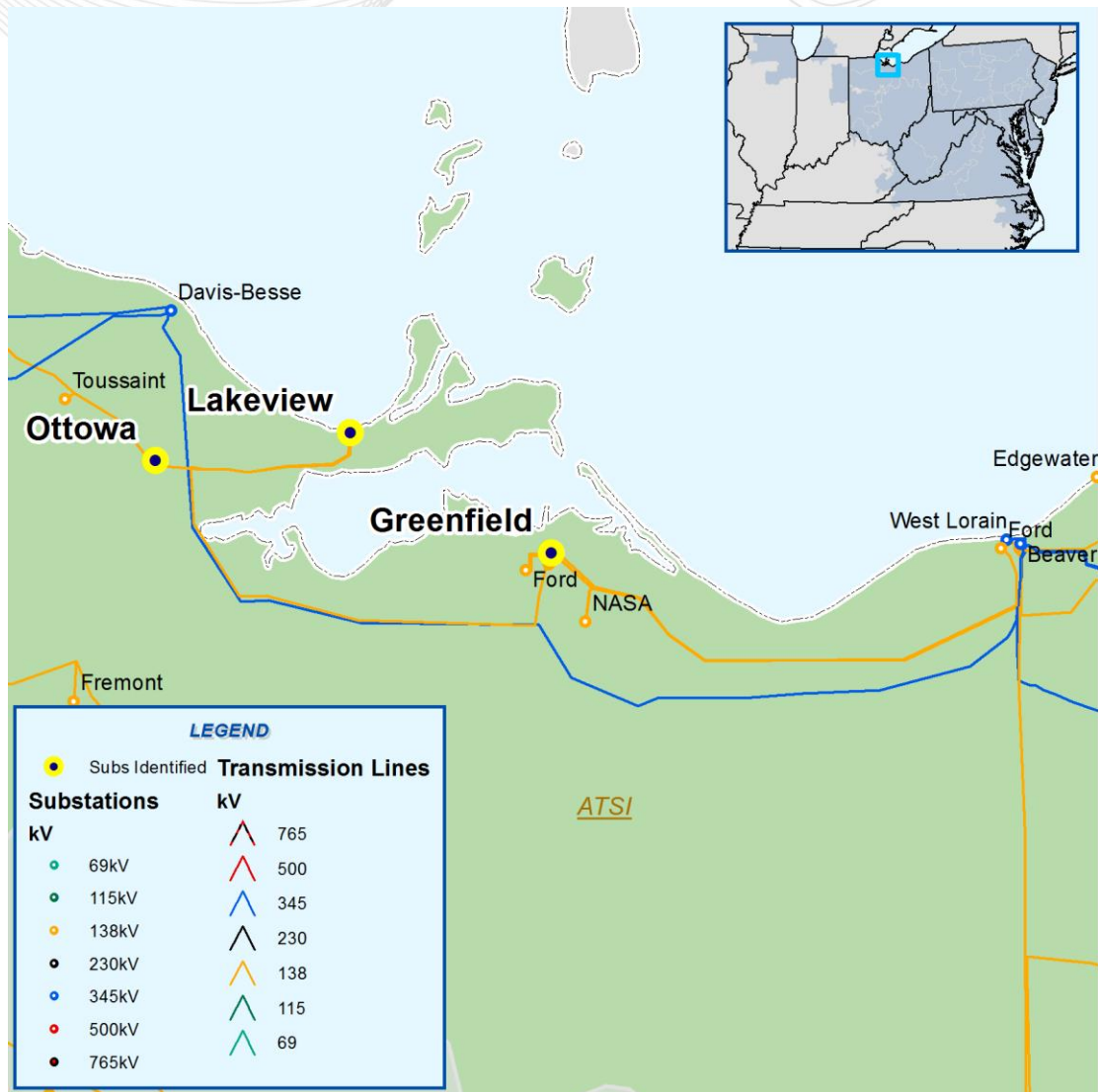
- Due to the expected generation retirements at Burger, the following upgrade is proposed to be advanced:
- Replace the Star 345/138 kV transformer #3 (b1693)
- PJM Required Date: Advance from 6/1/2016 to 9/1/2011
- Expected IS Date: 6/1/2013



- Due to the expected generation retirements at Burger, the following upgrade is proposed to be advanced:
- Loop the E.Akron – Sammis 138 kV line into Knox (b1692)
- PJM Required Date: Advance from 6/1/2016 to 9/1/2011
- Expected IS Date: 6/1/2013



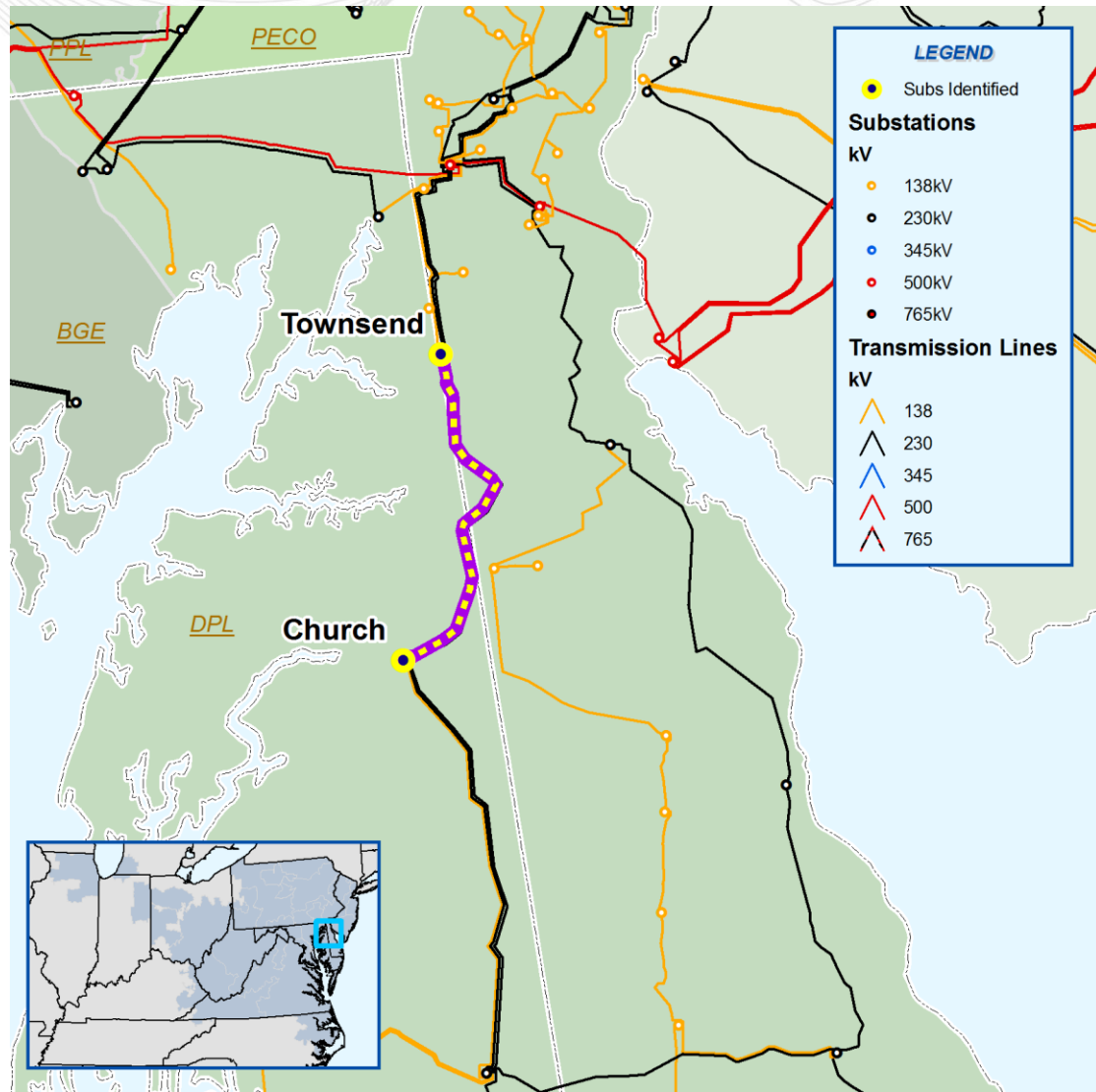
- Due to the expected generation retirements at Burger, the following upgrade is proposed to be advanced:
- Re-conductor Ottawa – Lakeview – Greenfield 138 kV line (b1547 & b1548)
- PJM Required Date: Advance from 12/31/2012 to 9/1/2011
- Expected IS Date: 12/31/2012



Indian River 3 Retirement Upgrades

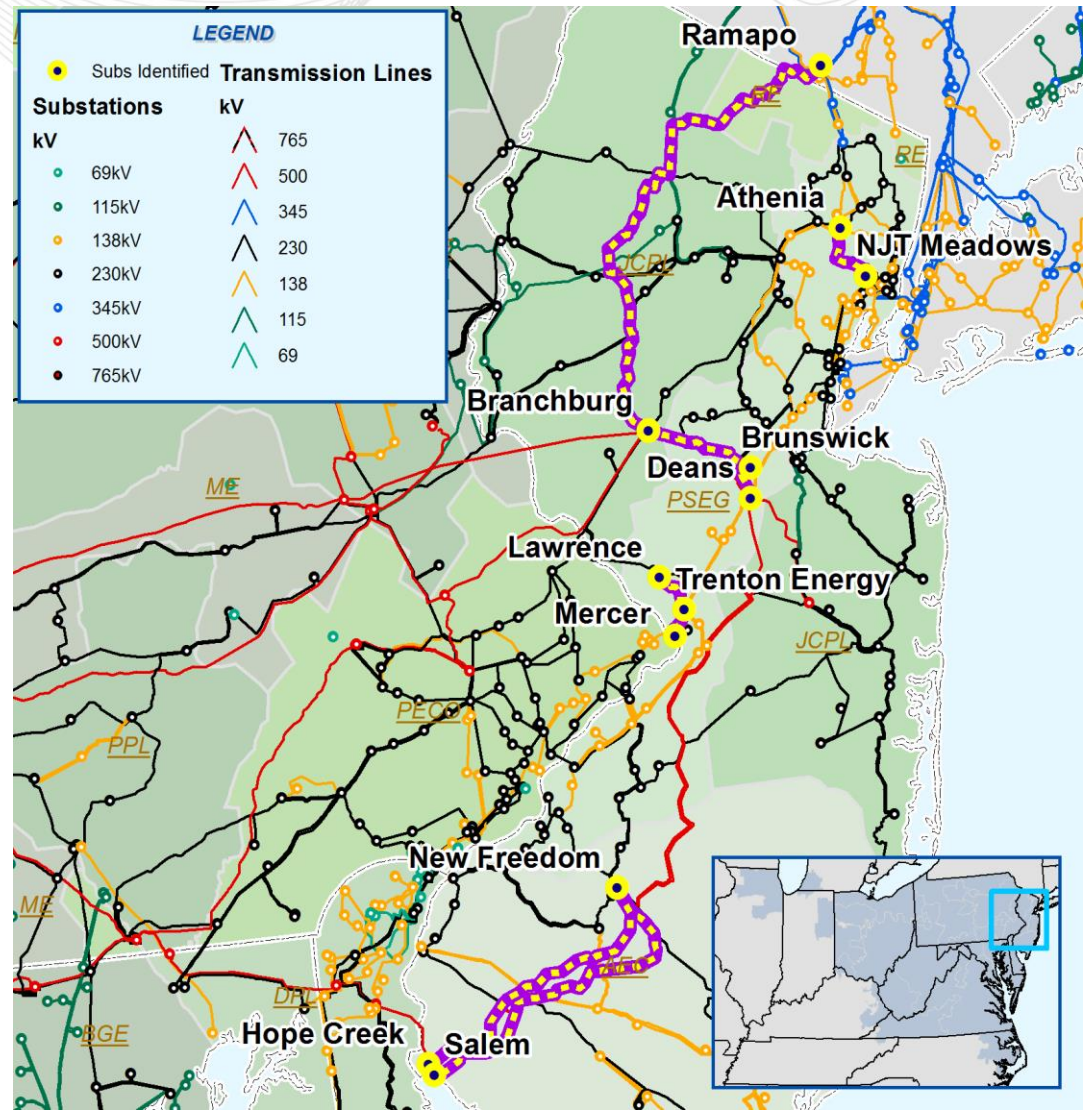
Indian River 3 is planned to deactivate on 12/31/2013

- Generator Deliverability and N-1 Violation:
- Thermal violation on Townsend-Church 138 kV line for the loss of Keeney –Steel 230 kV DCTL (tower) as a result of Indian River (169.7 MW) generator retirement.
- Proposed Solution:
- Rebuild Townsend-Church 138 kV circuit (b1246)
- PJM Required Date: Advance from 6/1/2015 to 6/1/2014
- Estimated cost: \$16 M



Supplemental Projects

- PSE&G Reliability:
- Static Wire Replacement is an on-going program that entails replacing aged tower static wires with a new approach, installing static wire with Optical Guide Wire (OPGW). This provides strength, lightning protection and a potential communications path for high speed relaying.
- Replace static wire at the following location (S0315):
 - Deans – Brunswick/Brunswick – Branchburg
 - Trenton – Mercer – Lawrence
 - Athenia – NJT Meadows
 - Salem – New Freedom/New Freedom - Hope Creek
 - Branchburg – Ramapo
- Estimated Project Cost: \$ 75 M
- Expected IS Date: 2012-2015



- 2016 N-1-1 Voltage
- Retool studies
- Light load criteria

Interconnection Queue Update

Email RTEP@pjm.com with any comments or questions