Transmission Expansion Advisory Committee

September 8, 2010

Issues Tracking

Open Issues: None

New Issues:

MAAC Analysis Update

Retool Due to TrAIL Impedance Update

- 2010 RTEP analysis update of previous studies to include the latest TrAIL impedance as discussed at the August 2010 TEAC
- All other assumptions and methods used in this updated analysis were consistent with those discussed previously at TEAC
- Retool of previous analysis
  - Thermal
  - Reactive
  - N-1-1
  - RPS / DR / EE / At-Risk Generation Sensitivity Study
  - RPM Sensitivity
  - Alternative Analysis

2010 RTEP Baseline Thermal 15 Year Result

From Bus	To Bus	First Thermal Violation Date*	Failed Reliability Test** in First Thermal Violation Year
Lexington	Dooms	2017	Dominion Load Deliverability
Mt. Storm	T157 Tap	2015	MAAC Load Deliverability PEPCO Load Deliverability SWMAAC Load Deliverability
T157 Tap	Doubs	2015	MAAC Load Deliverability SWMAAC Load Deliverability
Pruntytown	Mt. Storm	2020	Dominion Load Deliverability MAAC Load Deliverability
Jacks Mountain	Juniata #1	2018	EMAAC Load Deliverability
Jacks Mountain	Juniata #2	2020	EMAAC Load Deliverability
Greenland Gap	Meadow Brook	2025	MAAC Load Deliverability
Mt. Storm	Greenland Gap	>2025	MAAC Load Deliverability
Bath County	Valley	2022	Dominion Load Deliverability
Keystone	Jacks Mountain	2022	EMAAC Load Deliverability
Harrison	Pruntytown	>2025	PEPCO Load Deliverability MAAC Load Deliverability
Keystone	Conemaugh	2025	EMAAC Load Deliverability

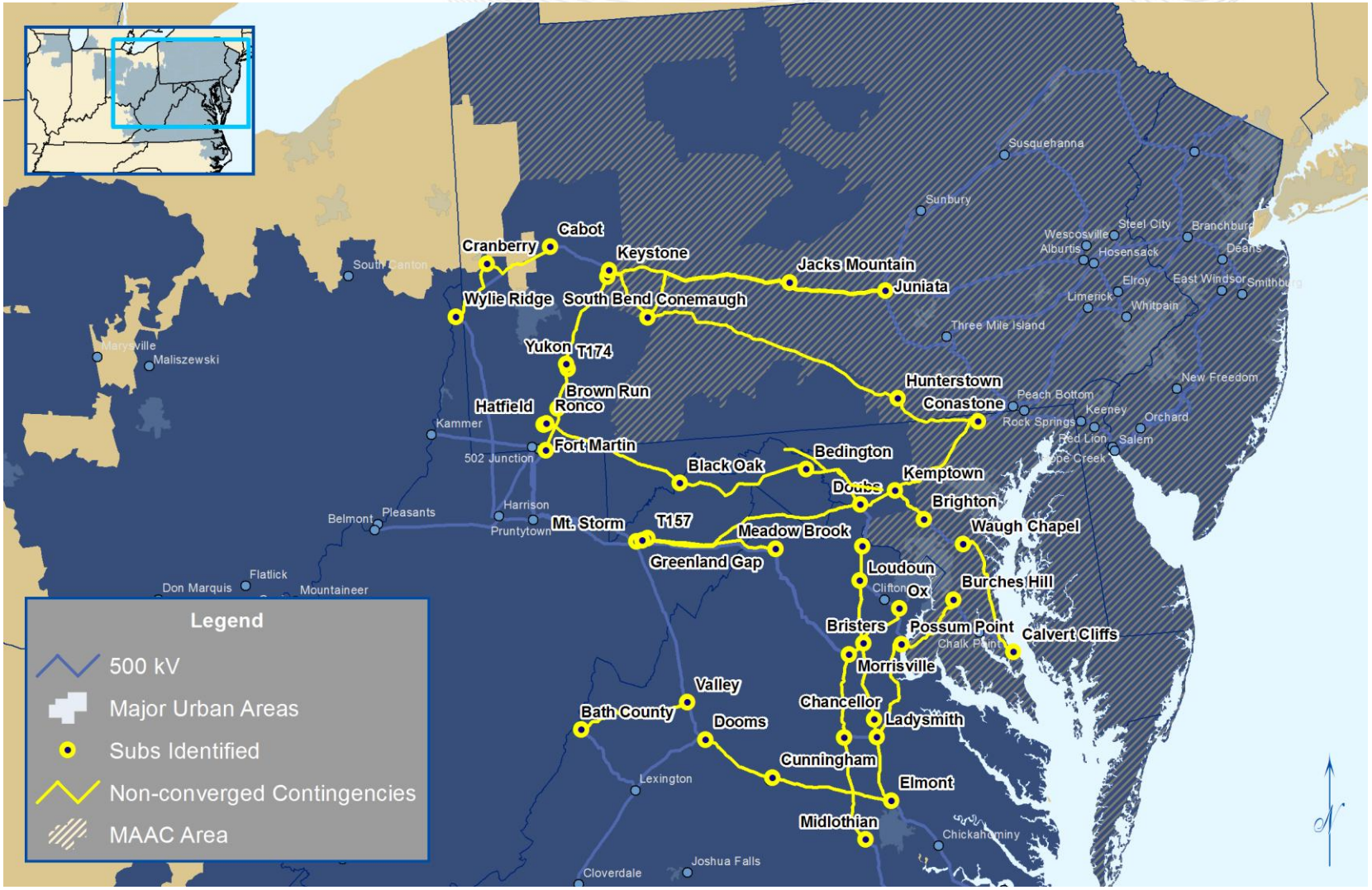
* The most limiting thermal condition from the generator deliverability or load deliverability test
** Some facilities failed multiple criteria tests in the first thermal violation year

2015 Baseline MAAC Load Deliverability – Voltage*
Non-Converged Contingencies

Bath County – Valley
Bedington – Doubs
Bedington Cap
Black Oak – Bedington
Black Oak - Black Oak SVC
Brighton – Conastone
Brighton – Doubs
Brister – Chancellor
Brister – Ox
Burches Hill - Possum Point
Cabot – Cranberry
Calvert Cliffs - Waugh Chapel
Calvert Cliffs #1 generator
Calvert Cliffs #2 generator
Conemaugh – Hunterstown
Conemaugh - Jacks Mountain
Conemaugh – Keystone
Cunningham – Dooms
Cunningham – Elmont
Doubs Cap
Elmont – Ladysmith
Fort Martin – Ronco
Hatfield's Ferry - Black Oak
Hatfield's Ferry - Brown Run
Hatfield's Ferry - Fort Martin
Hatfield's Ferry – Ronco
Hunterstown – Conastone
Jacks Mountain - Juniata #1
Jacks Mountain - Juniata #2
Keystone - Jacks Mountain
Keystone - South Bend
Ladysmith – Chancellor
Ladysmith - Possum Point
Loudoun - Meadow Brook
Loudoun – Morrisville
Loudoun - Pleasant View
Meadow Brook - Greenland Gap
Midlothian - North Anna
Morrisville - North Anna
Morrisville Cap
Mt. Storm - Greenland Gap
Mt. Storm - Meadow Brook
Mt. Storm - T157_Tap
T157_Tap – Doubs
T174_Tap - Brown Run
Wylie Ridge – Cranberry
Yukon - South Bend
Yukon - T174_Tap

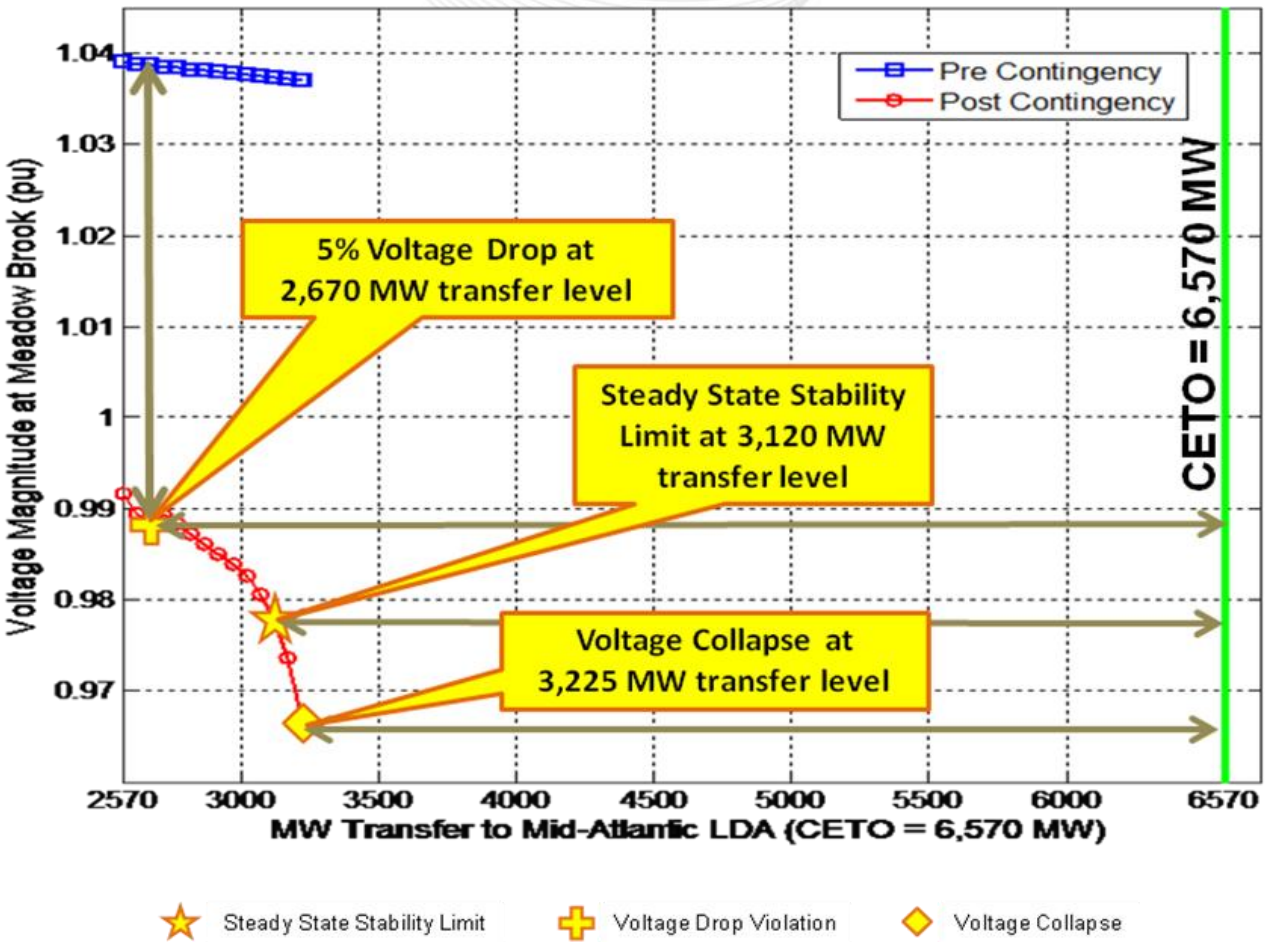
*Baseline analysis without PATH, MAPP, Branchburg – Roseland - Hudson

2015 Baseline MAAC Load Deliverability - Voltage



Baseline analysis without PATH, MAPP, Branchburg – Roseland - Hudson

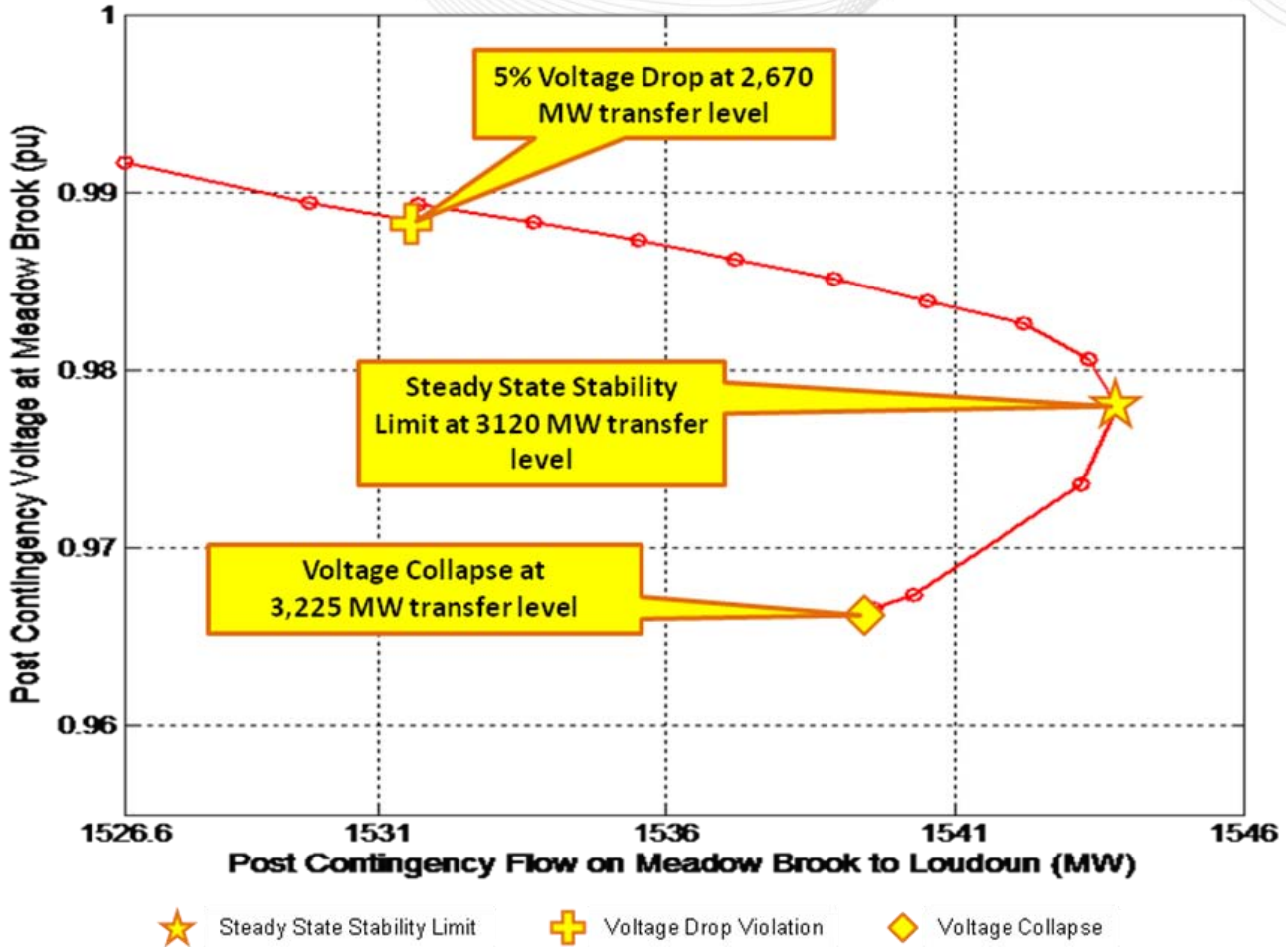
Baseline PV Analysis



Voltage Magnitude* at Meadow Brook 500 kV vs. MW Transfer to Mid-Atlantic LDA (Contingency: Loss of Black Oak to Bedington 500 kV)

* 2015 Study Year

Baseline PV Analysis



Voltage Magnitude* at Meadow Brook 500 kV vs. Post-Contingency Flow on Meadow Brook to Loudoun 500 kV (Contingency: Loss of Black Oak to Bedington 500 kV)

* 2015 Study Year

- Without PATH
  - Voltage
    - 35 N-1-1 contingency pairs are non-converged
  - Thermal
    - 4 facilities overloaded for numerous N-1-1 contingency pairs

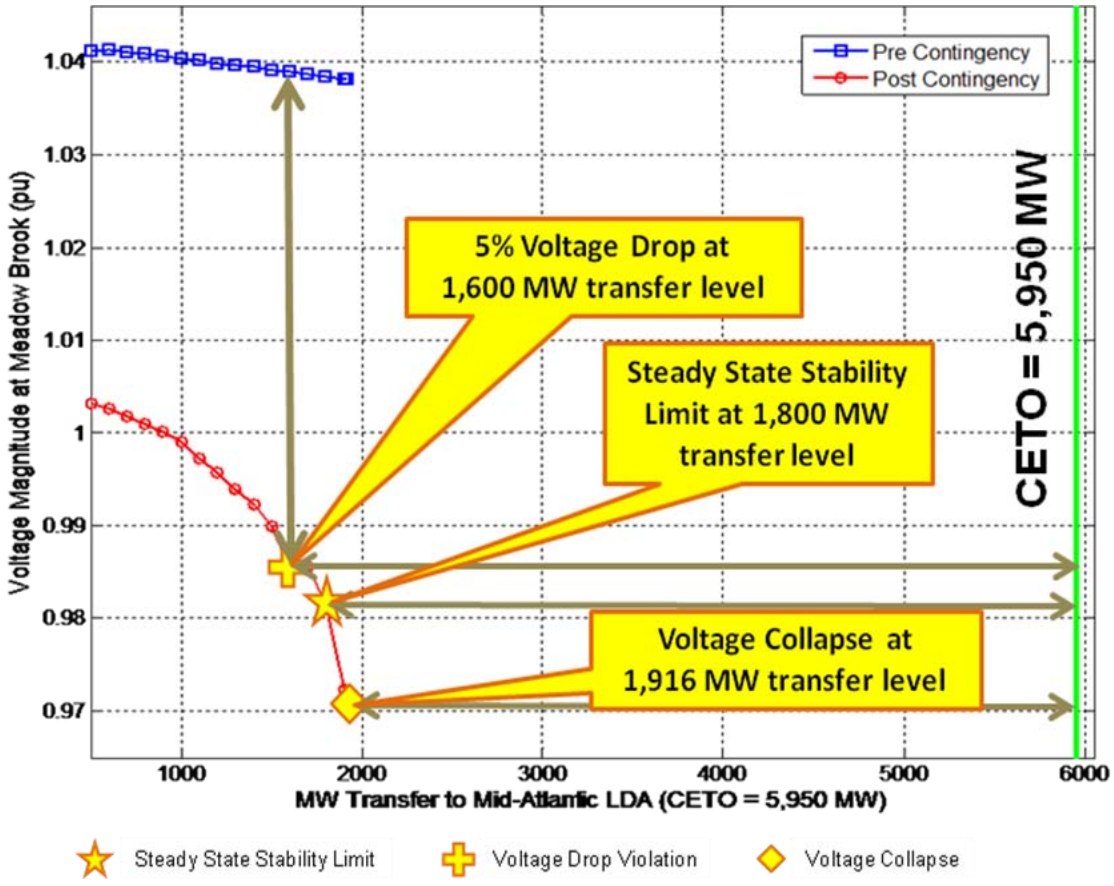
2013/2014 RPM Base Residual Auction Sensitivity Study

2013/2014 RPM Sensitivity Study – Thermal Violations

From Bus	To Bus	First Thermal Violation Year*	
		2010 RTEP	Sensitivity Study
Lexington	Dooms	2017	2017
Mt. Storm	T157 Tap	2015	2015
T157 Tap	Doubs	2015	2015
Pruntytown	Mt. Storm	2020	2019
Jacks Mountain	Juniata #1	2018	>2025
Jacks Mountain	Juniata #2	2020	>2025
Greenland Gap	Meadow Brook	2025	2025
Bath County	Valley	2022	2023
Keystone	Jacks Mountain	2022	>2025
Keystone	Conemaugh	2025	>2025

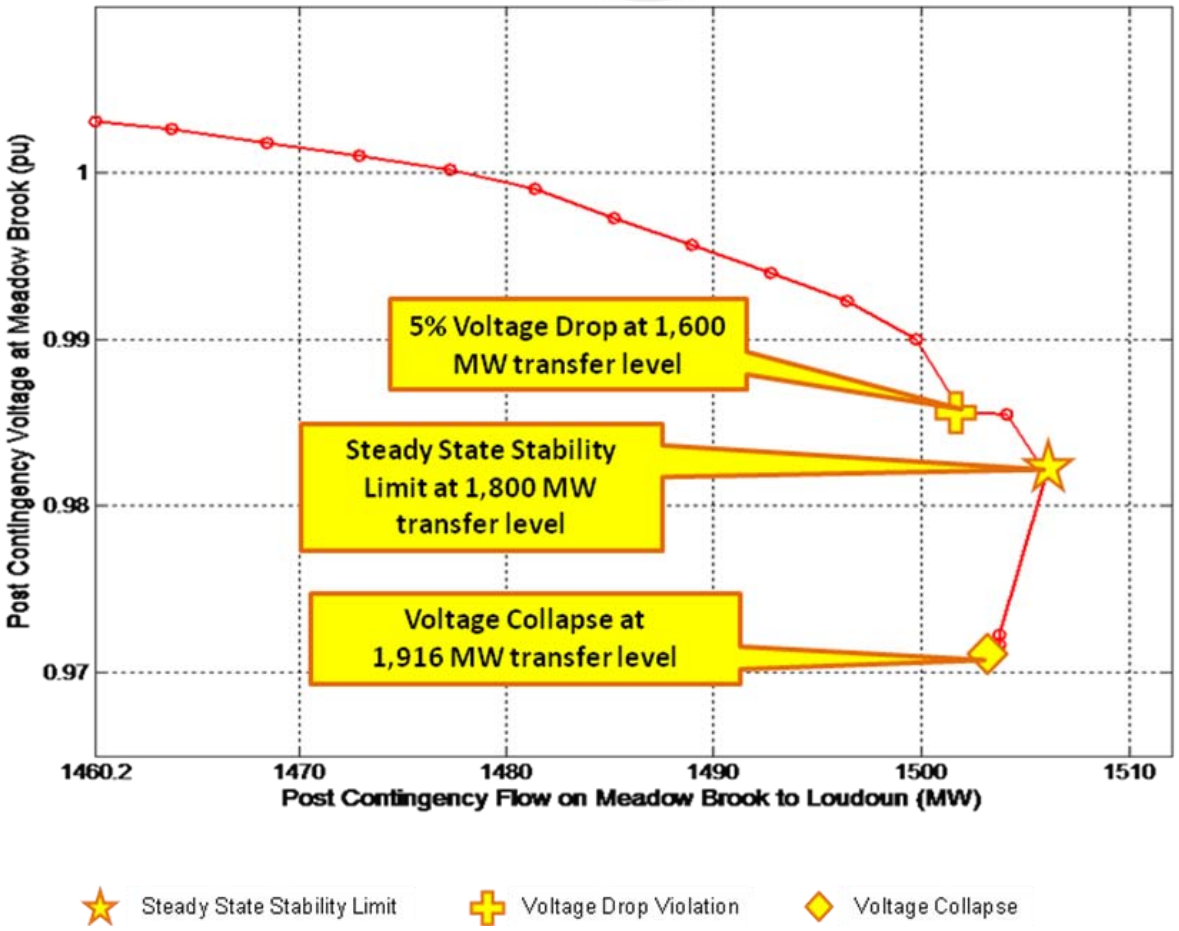
* The most limiting thermal condition from the generator deliverability or load deliverability test

Figure 1: Voltage Magnitude* at Meadow Brook 500 kV vs. MW Transfer to Mid-Atlantic LDA (Contingency: Loss of Bedington to Black Oak 500 kV)



* 2015 Study Year

Figure 2: Voltage Magnitude* at Meadow Brook 500 kV vs. Post-Contingency Flow on Meadow Brook to Loudoun 500 kV
(Contingency: Loss of Bedington to Black Oak 500 kV)



* 2015 Study Year

RPS / EE / DR / At-Risk Generation Sensitivity Study

RPS / DR / EE Sensitiviy Result
15 Year Analysis*

From	To	CKT	KVs	Base	RPS to Existing	RPS to At-Risk Generation	RPS+DR+EE to At-Risk
T157 Tap	Doubs	1	500/500	2015	2015	2015	2015
Mt. Storm	T157 Tap	1	500/500	2015	2015	2015	2015
Lexington	Dooms	1	500/500	2017	2016	2016	2016
Jacks Mountain	Juniata	1	500/500	2018	2016	2016	2023
Pruntytown	Mt. Storm	1	500/500	2020	2018	2018	2019
Jacks Mountain	Juniata	2	500/500	2020	2016	2016	2024
Keystone	Jacks Mountain	1	500/500	2022	2017	2019	2025
Bath County	Valley	1	500/500	2024	2020	2020	2022
Keystone	Conemaugh	1	500/500	2025	2020	2021	2025
Greenland Gap	Meadow Brook	1	500/500	2025	2022	2022	2023
Conemaugh	Jacks Mountain	1	500/500	> 2025	2022	2024	> 2025
Cunningham	Elmont	1	500/500	> 2025	2025	2025	2025
Mt. Storm	Greenland Gap	1	500/500	> 2025	2023	2023	2023
Doubs	Brighton	1	500/500	> 2025	2021	2023	> 2025
Harrison	Pruntytown	1	500/500	> 2025	2023	2023	2024
Black Oak	Bedington	1	500/500	> 2025	2022	2023	2023

* The most limiting thermal condition from the generator deliverability or load deliverability test
* All results include updated TrAIL impedance

MAAC Alternative Analysis Update

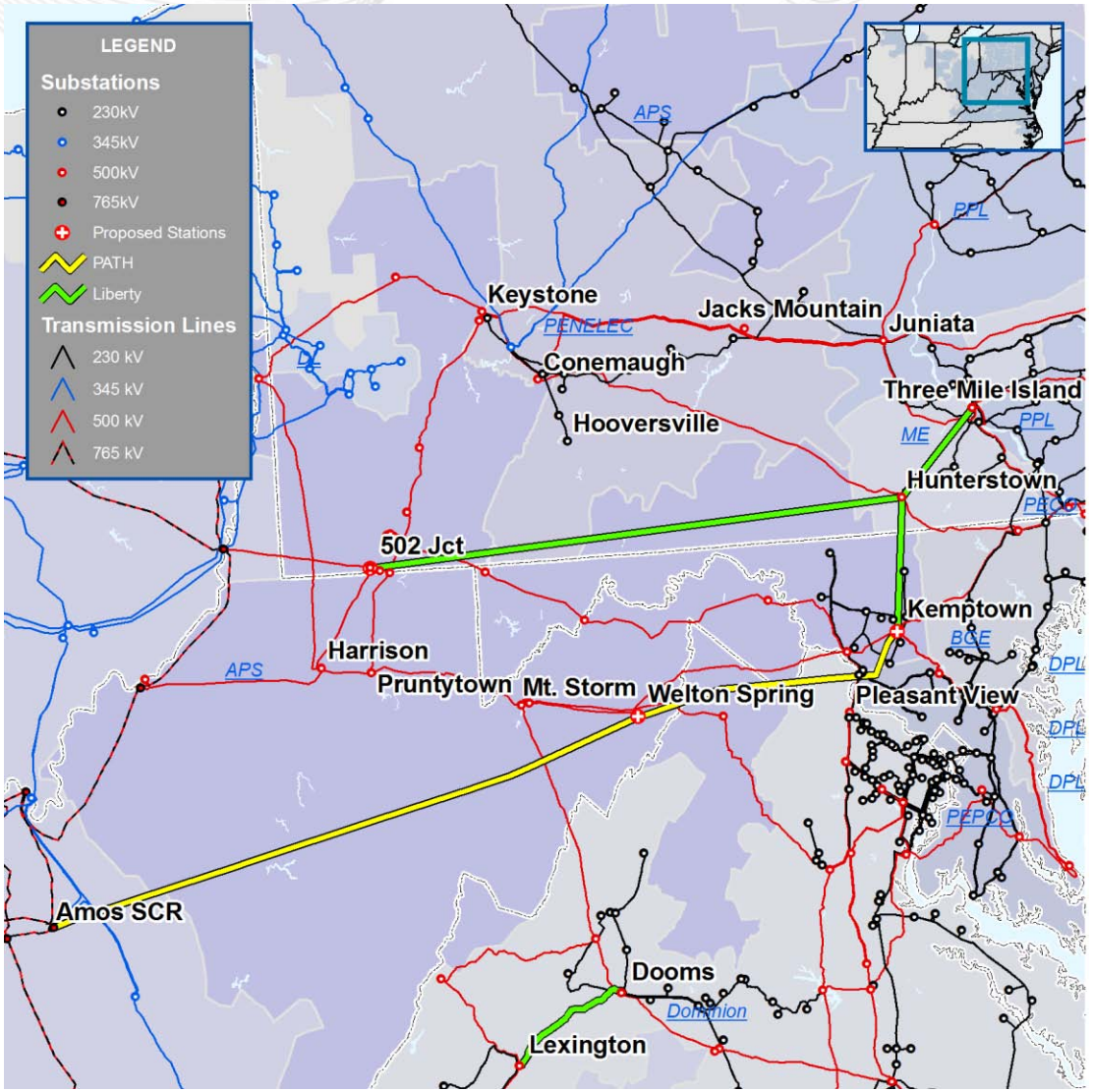
MAAC Alternative Analysis

Revised Liberty / LS Power

- 502J – Hunterstown 500 kV (includes 50% series compensation)
- Hunterstown – TMI 500 kV
- Hunterstown – Kemptown 500 kV
- Lexington – Dooms 500 kV

PATH

- Amos – Welton Spring – Kemptown
- Includes baseline reactive upgrades of 1000 MVAR shunt and 500 MVAR SVC at Welton Spring and a 250 MVAR shunt at Kemptown 500kV



MAAC Alternative Analysis

Dominion Alternative #1

- Rebuild Mt. Storm – Doubs
- 50% series compensation on Meadow Brook end of Trail
- Rebuild Mt. Storm – Pruntytown

Dominion Alternative #2

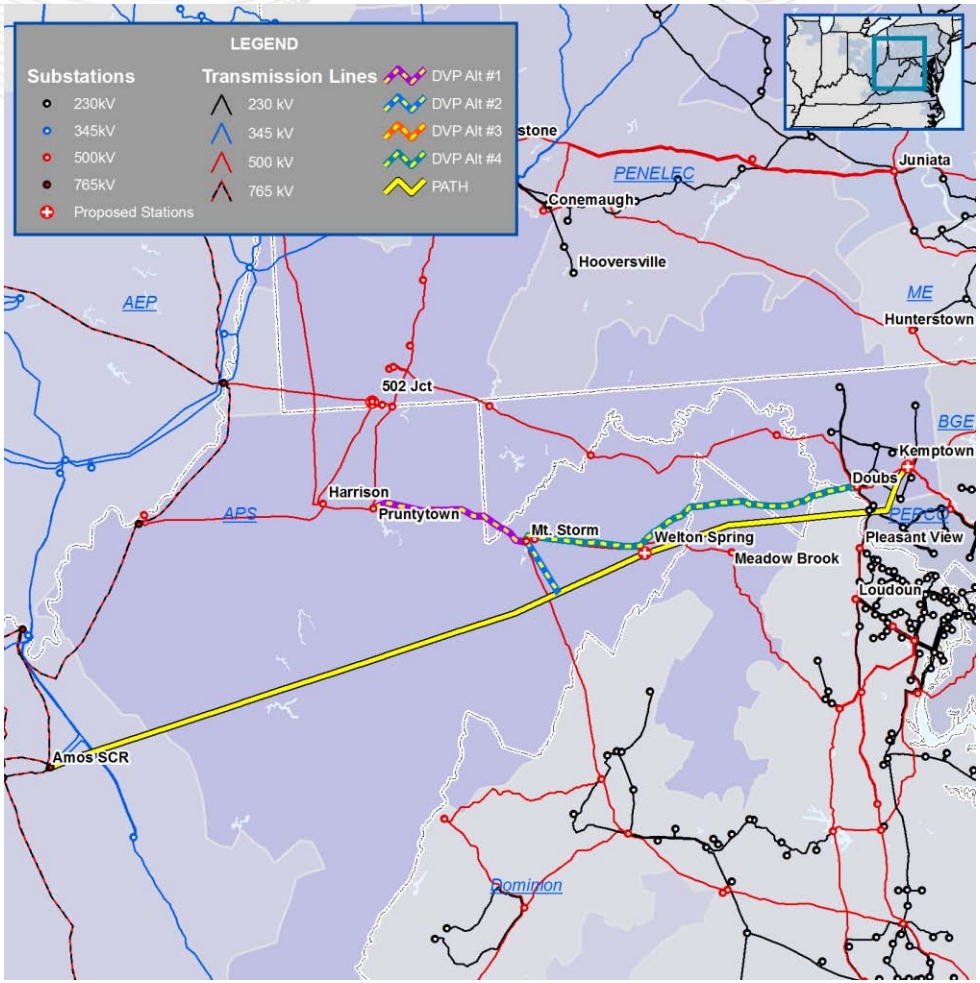
- Rebuild Mt. Storm – Doubs
- 50% series compensation on Meadow Brook end of Trail
- Build a portion of PATH stopping at Mt. Storm (requires a new 765/500 kV transformer)

Dominion Alternative #3

- Rebuild Mt. Storm – Doubs
- 50% series compensation on Meadow Brook end of Trail
- Build a portion of PATH stopping at Welton Spring (requires new 765/500 kV transformer)

Dominion Alternative #4

- Rebuild Mt. Storm – Doubs
- Build PATH proposal

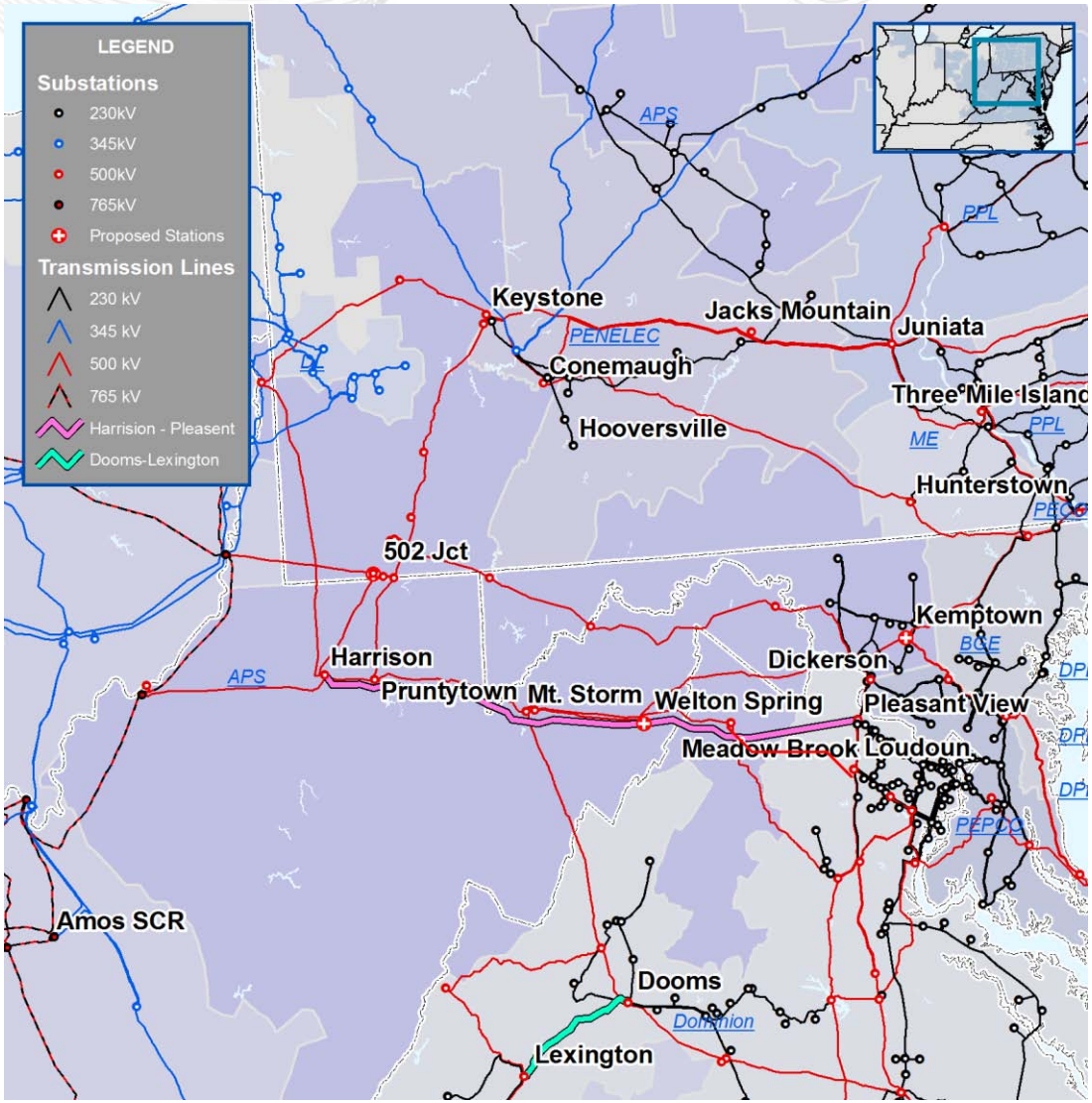


* All Dominion alternatives include 900 MVAR SVC's at Loudoun 230 kV and T157 Tap 500 kV and 900 MVAR of static capacitors at other locations

MAAC Alternative Analysis

Harrison – Dickerson Alternative

- Harrison – Dickerson New 500kV AC Line
- New Dickerson 500/230 kV Station
- Series Comp on Meadow Brook – Loudoun
- Lexington – Dooms 500 kV



15 Year MAAC Thermal Alternative Analysis*

From Bus	To Bus	2015 Baseline	5500 MVAR of SVCs*	PATH	Revised Liberty	Harrison - Dickerson	Dominion Alternative #1	Dominion Alternative #2	Dominion Alternative #3	Dominion Alternative #4
T157 Tap	Doubs	2015	2015	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025
Mt. Storm	T157 Tap	2015	2015	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025
Lexington	Dooms	2017	2018	> 2025	> 2025	> 2025	2018	> 2025	2025	> 2025
Jacks Mountain	Juniata #1	2018	2022	> 2025	> 2025	> 2025	2022	> 2025	2025	> 2025
Jacks Mountain	Juniata #2	2020	2023	> 2025	> 2025	> 2025	2024	> 2025	> 2025	> 2025
Pruntytown	Mt. Storm	2020	2020	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025
Keystone	Jacks Mountain	2022	2025	> 2025	> 2025	> 2025	2025	> 2025	> 2025	> 2025
Bath County	Valley	2024	2024	> 2025	> 2025	> 2025	2024	> 2025	> 2025	> 2025
Keystone	Conemaugh	2025	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025	> 2025
Greenland Gap	Meadow Brook	2025	> 2025	> 2025	> 2025	> 2025	2023	2020	2021	> 2025
Mt. Storm	Greenland Gap	> 2025	> 2025	> 2025	> 2025	> 2025	2024	2021	2022	> 2025
Harrison	Pruntytown	> 2025	> 2025	> 2025	> 2025	> 2025	2023	> 2025	> 2025	> 2025

* 1000 MVARs at Jacks Mountain, Doubs, Meadow Brook, Loudoun and T157 Tap 500 kV; 500 MVARs at Juniata 500 kV

* The most limiting thermal condition from the generator deliverability or load deliverability test
* All results include updated TrAIL impedance

15 Year MAAC Voltage Alternative Analysis

Alternative	2015 CETL - CETO Margin**
2015 Baseline Case - no alternatives	-3,900 MW
Liberty / 250 MVAR cap at Kemptown	650 MW
Harrison - Dickerson / 250 MVAR cap at Dickerson	-450 MW
Harrison - Dickerson / 750 MVAR cap at Dickerson	200 MW
Dominion Option 1*	400 MW
Dominion Option 2*	600 MW
Dominion Option 3*	700 MW
Dominion Option 4*	2,500 MW
Reactive Reinforcement (5500 MVAR SVCs)	1,500 MW
PATH / 250 MVAR cap at Kemptown	900 MW

* Results dependent on final voltage set point chosen for Jacks Mountain Fast Switched Capacitors

** Margin is calculated as the difference between the CETO and CETL

MAAC Next Steps

- Continue to evaluate the alternatives
  - Continue to develop side by side comparison
  - Reliability benefits
  - Cost
  - Feasibility
  - Other considerations

EMAAC Alternative Analysis Update

EMAAC Next Steps

- Continue to evaluate the alternatives
  - Continue to develop side by side comparison
  - Reliability benefits
  - Finalizing independent consultant report

Baseline Reliability Update

Eddystone & Cromby Retirement Update

- At the May 12, 2010 TEAC, PJM identified a number of required upgrades due to these retirement requests

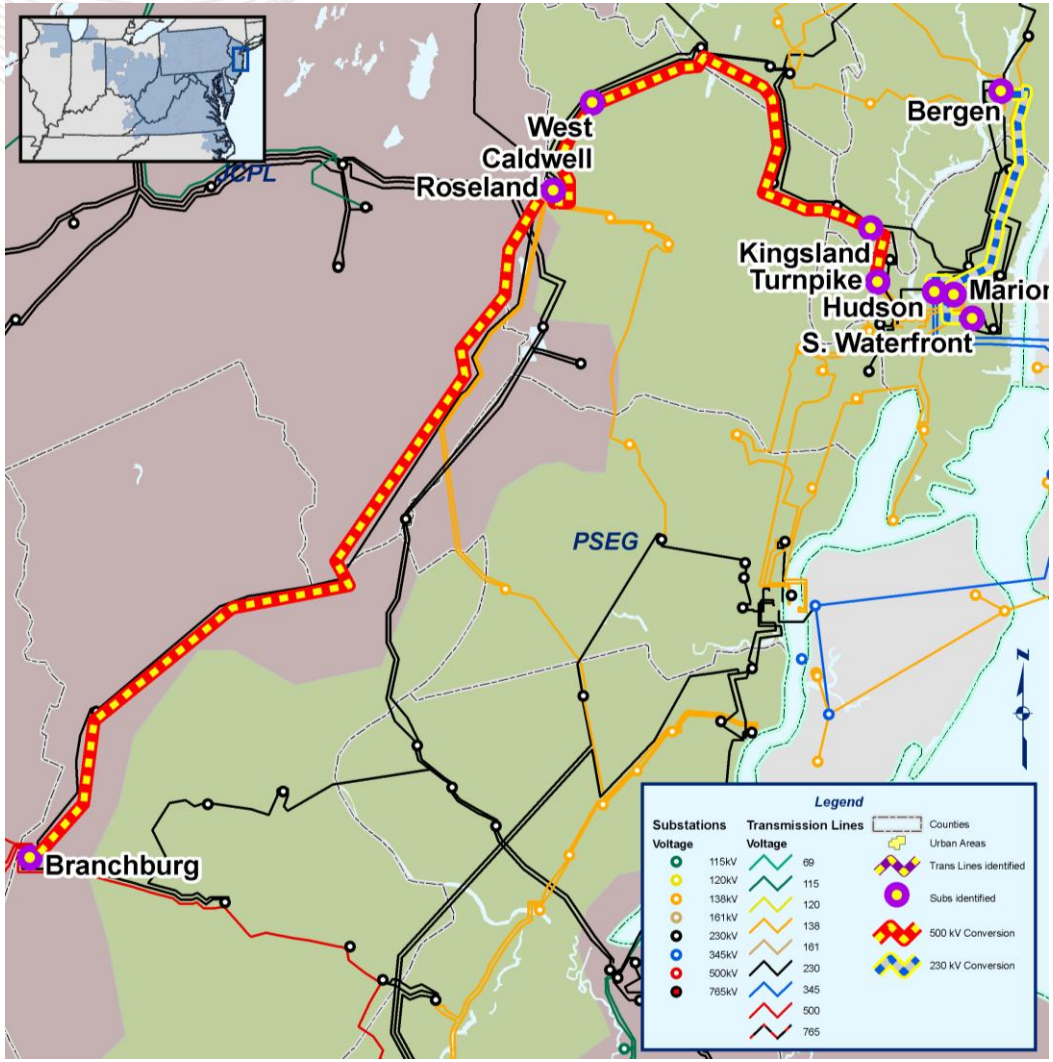
- Some of the upgrades are not expected to be placed in-service until after the requested deactivation date
  - Cromby #2 was requested RMR status until December 31, 2011
  - Eddystone #2 was requested RMR status until December 31, 2012

- Update
  - Chichester – Saville 138kV Upgrade (b1182)
    - Original in-service date of December 2012 drove the need for the Eddystone #2 RMR until December 31, 2012
    - The updated in-service date of Chichester – Saville 138kV is now expected to be June 1, 2012
  - Due to the updated in-service date of this upgrade, and assuming all other required upgrades are completed as scheduled, Eddystone #2 can be deactivated on June 1, 2012

BRH Alternative Analysis

Branchburg – Roseland – Hudson

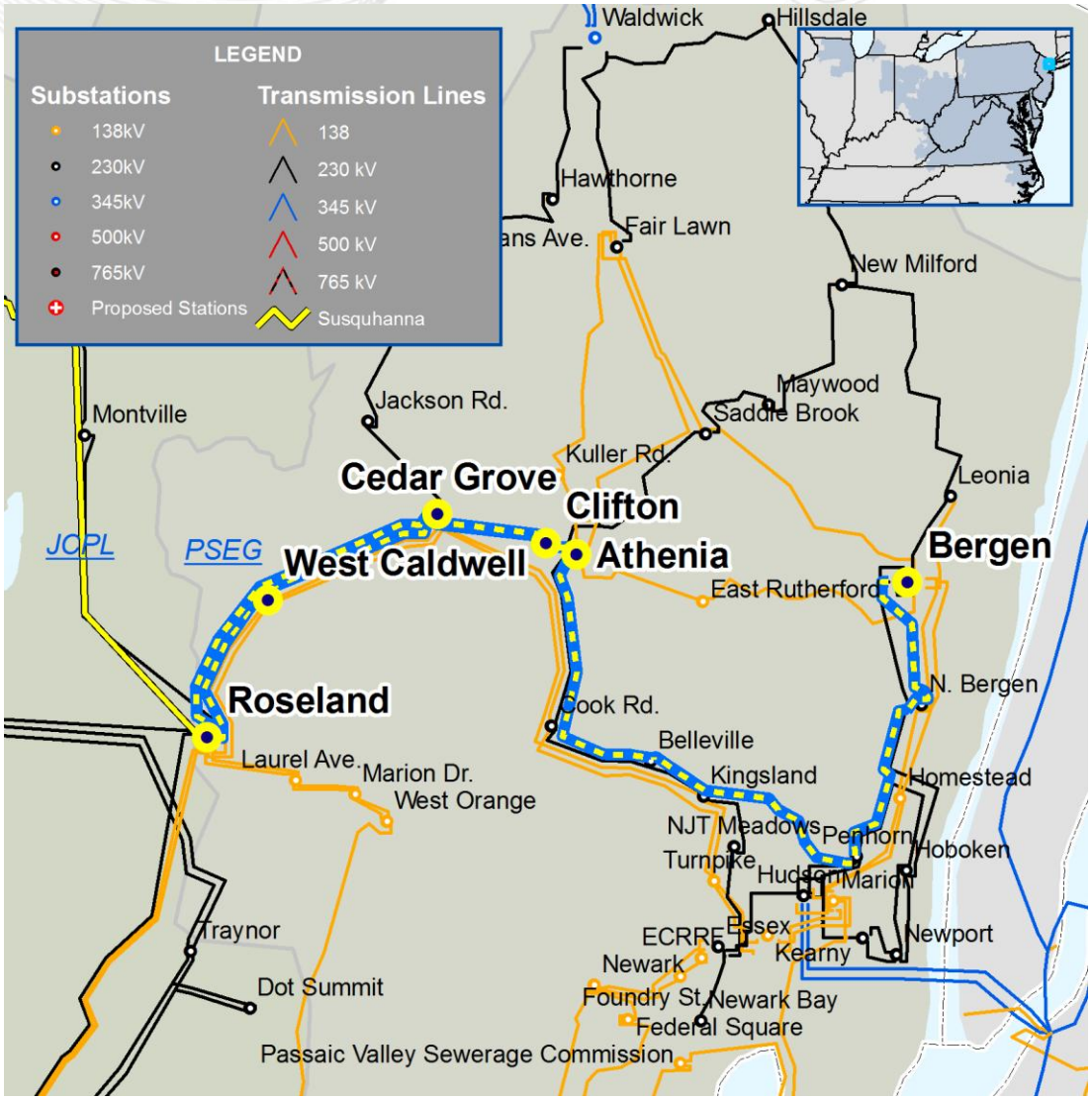
- Branchburg – Roseland – Hudson
- 2008 RTEP identified several overloads in northern PS starting in 2013
- Updated analysis completed as part of this year's RTEP shows fewer violations
- PJM evaluated below 500 kV alternative solutions



2015 PSEG Reliability Criteria Violations

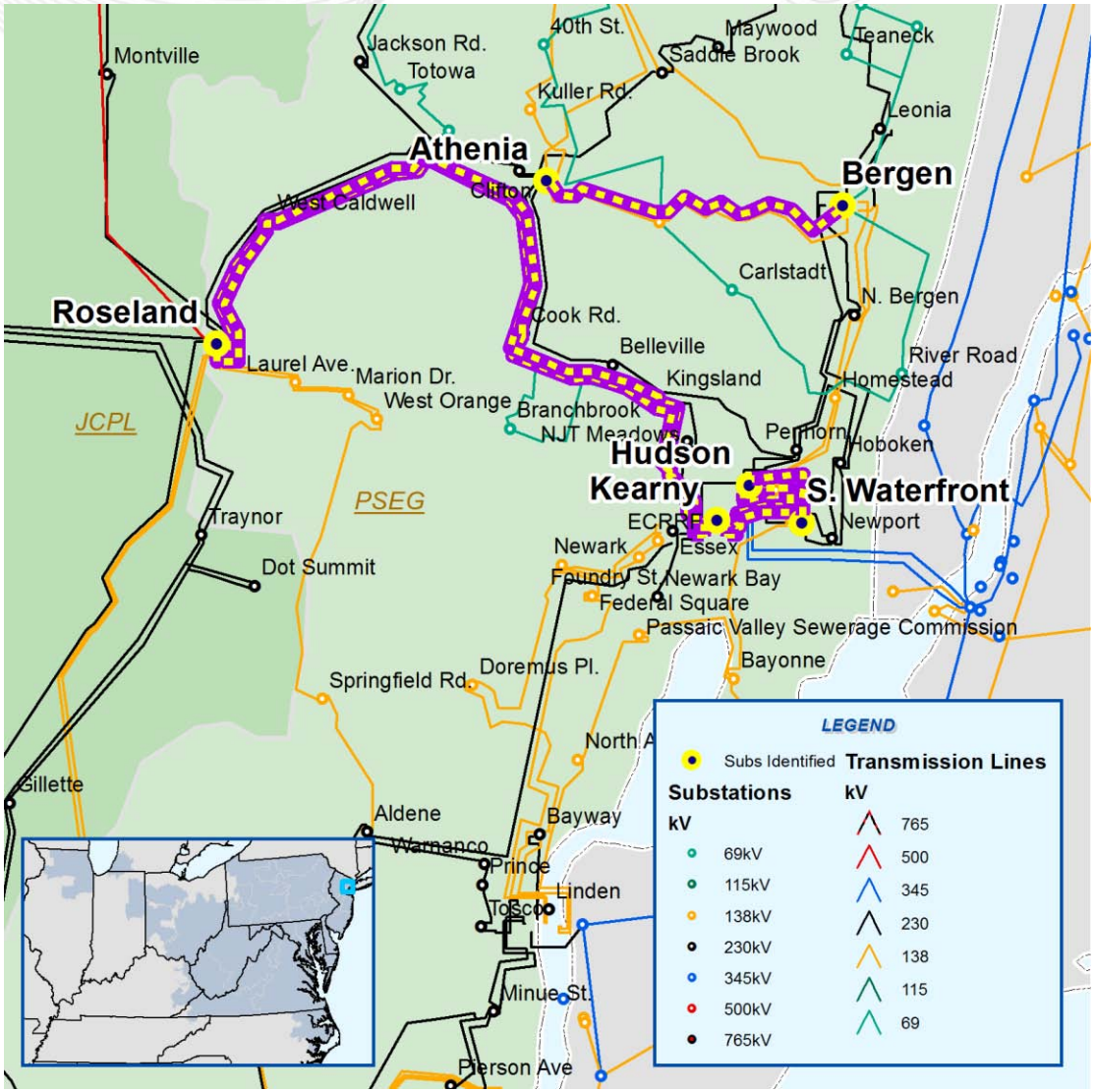
- Branchburg – Roseland – Hudson not modeled in 2015 case
- Analysis Performed:
  - Generator Deliverability
  - Load Deliverability (PS and PSNorth)
  - N-1-1
  - Baseline thermal and voltage analysis were performed

Reliability Thermal violations of existing system with no reinforcement
Essex - Hudson 230 kV
Kearny - Merion 138 kV
Essex 230/138 kV transformer
Roseland - Cedar Groove 230 kV "B"
Roseland - Cedar Groove 230 kV "F"
Cedar Grove - Clifton 230 kV "F"
Cedar Grove - Clifton 230 kV "B"
Athenia - Clifton 230 kV “K"
Athenia - Bergen 230 kV
Roseland - West Caldwell 138 kV "D"



BRH Alternative Analysis

- Proposed Solution
  - Convert the existing 'D1304 and G1307' 138 kV circuits between Roseland – Kearny – Hudson to 230 kV operation
  - Expand existing Bergen 230 kV substation and reconfigure the Athenia 230 kV substation to breaker and half scheme.
  - Build second 230 kV underground cable from Bergen to Athenia
  - Build second 230 kV underground cable from Hudson to South Waterfront
- Estimated Project Cost: $700 M
- Expected IS Date: 6/1/2015



- This alternative solution resolves all identified violations through the 15 year planning horizon

- The following table shows the 15 year analysis

Overloaded Facility			100% Year	
From Name	To Name	kV	Base Case	230 kV Option
Cedar Grove "B"	Clifton "B"	230	2015	> 2025
Cedar Grove "F"	Clifton "K"	230	2015	> 2025
Roseland	Cedar Grove "B"	230	2015	> 2025
Roseland	Cedar Grove "F"	230	2015	> 2025
Essex	Hudson	230	2022	> 2025
Essex	15th St.	230	2022	> 2025

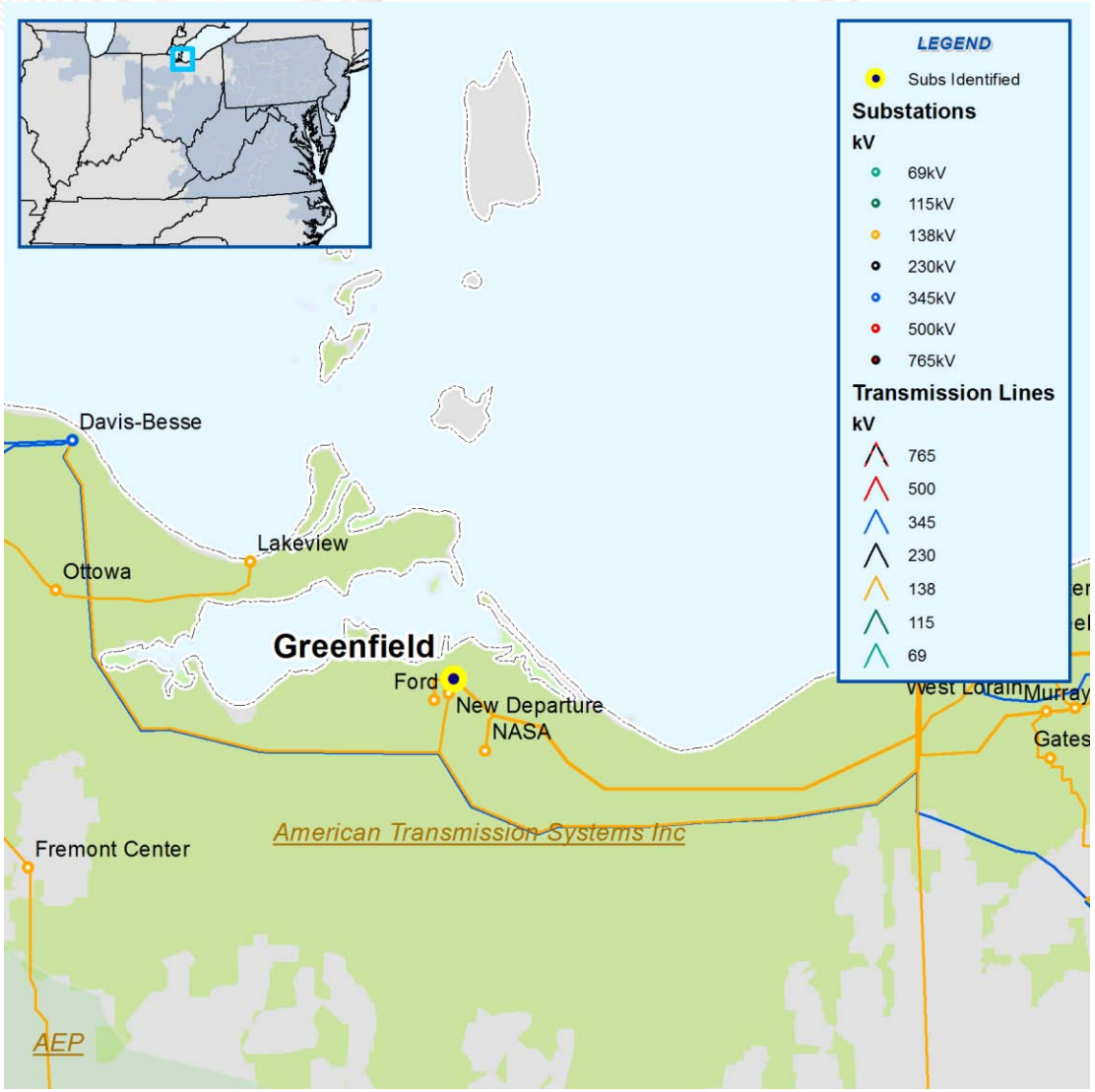
BRH Alternative Analysis Summary

- The Proposed 230kV alternative is effective at resolving the reliability criteria violations through the 15 year horizon
- PJM staff will recommend this alternative to the PJM Board for approval and inclusion in the RTEP
- PJM staff will recommend to the PJM Board that the Branchburg – Roseland – Hudson 500 kV project be removed from the RTEP

2015 ATSI Analysis Update

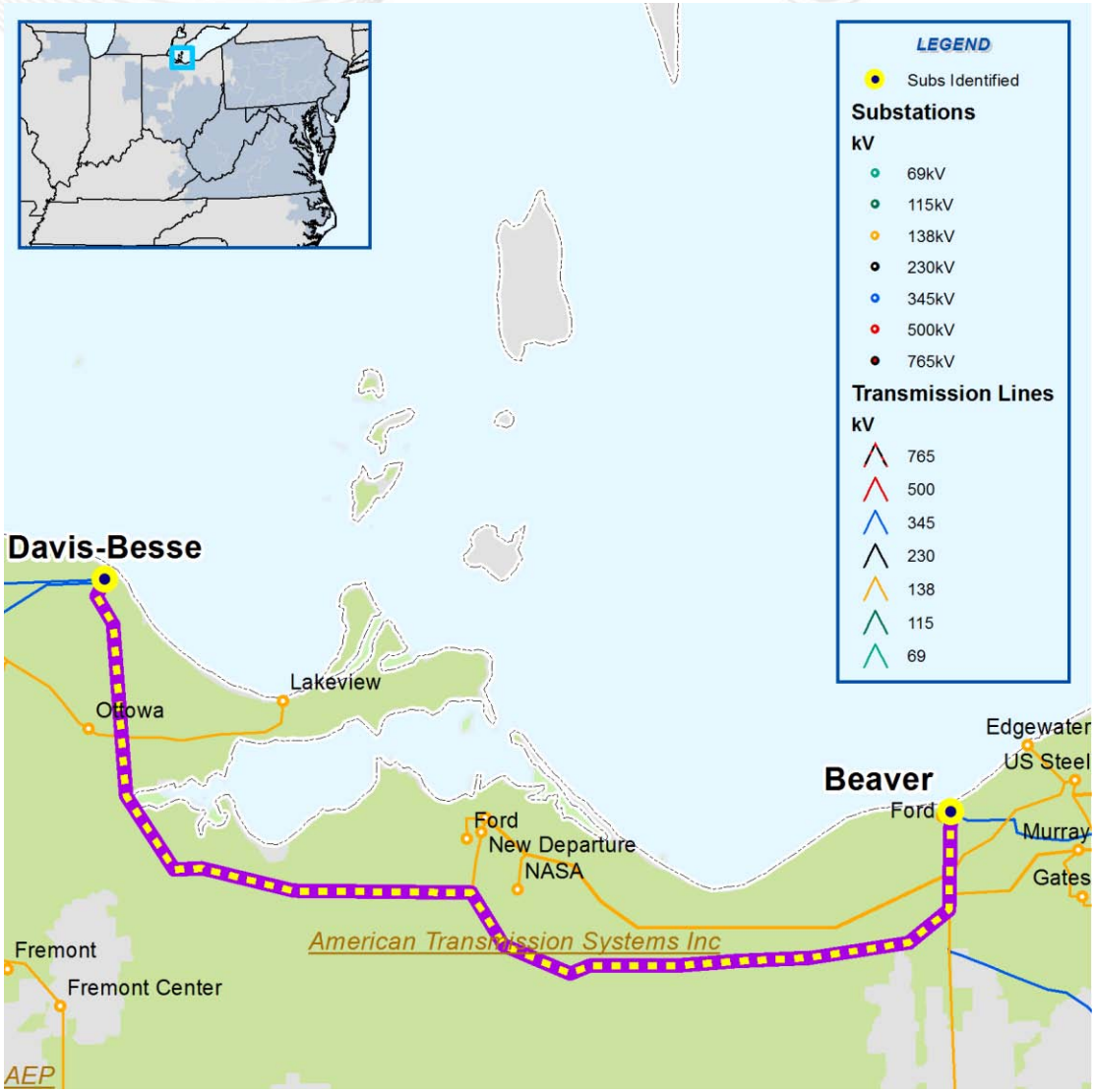
ATSI Transmission Zone

- Load Deliverability Voltage Violation
- Voltage collapse for various contingencies
- Proposed Solution: Build new Hayes 345/138kV substation (B1281)
  - 138kV lines to Greenfield #1
  - 138kV lines to Greenfield #2
  - 138kV line to Avery
- Estimated Project Cost: $33 M
- Expected IS Date: 6/1/2015



ATSI Transmission Zone

- Load Deliverability Voltage Violation
- Voltage collapse for various contingencies
- Proposed Solution: Build Beaver – Hayes – Davis-Besse #2 345kV line (B1282)
- Estimated Project Cost: $34.65 M
- Expected IS Date: 6/1/2015

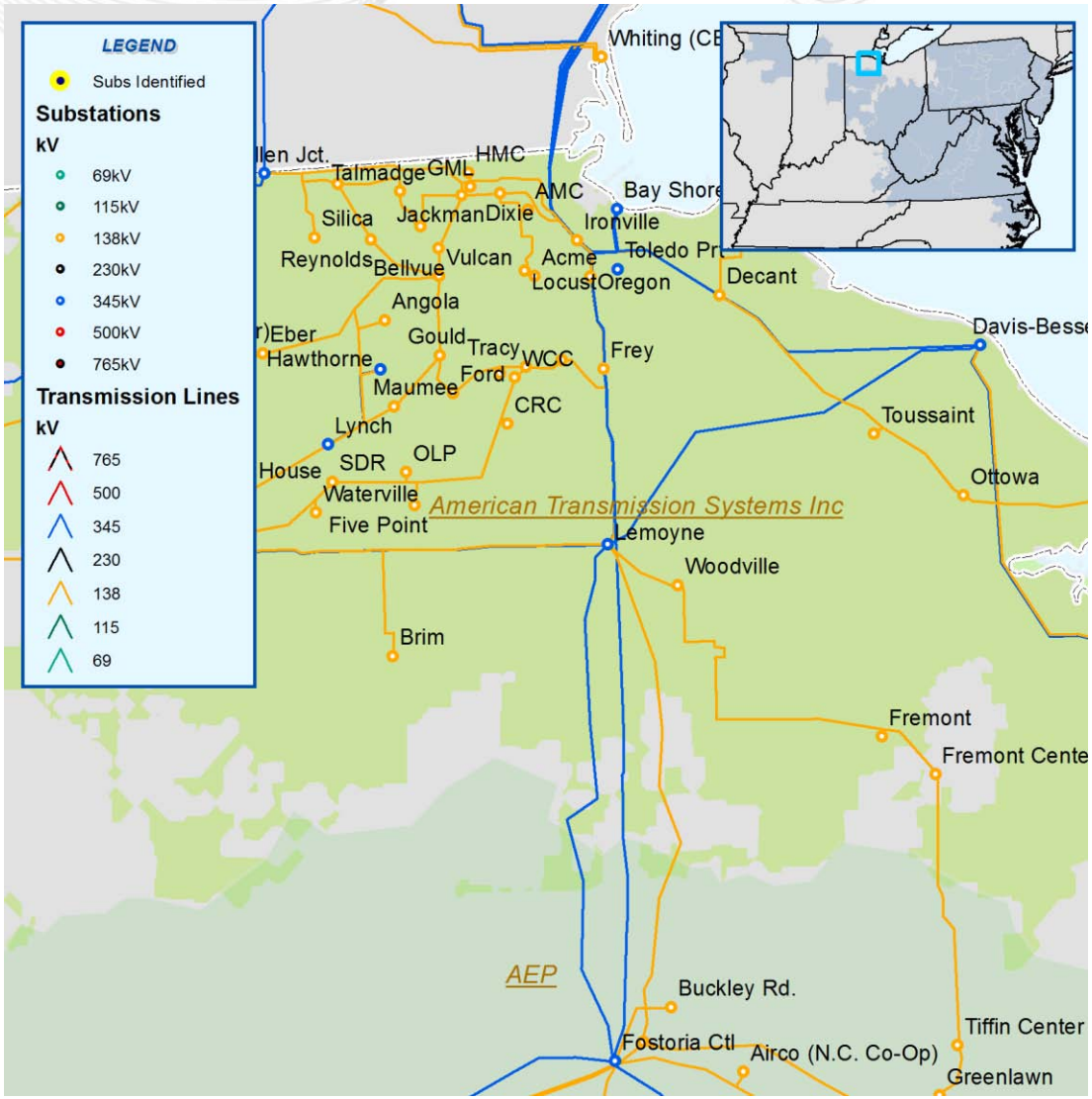


ATSI Transmission Zone

- Load Deliverability Voltage Violation
- Voltage collapse for various contingencies
- Proposed Solution: Loop the Chamberlin - Mansfield 345kV line into the Hanna 345kV Substation (B1283)
- Estimated Project Cost: $9.075 M
- Expected IS Date: 6/1/2015

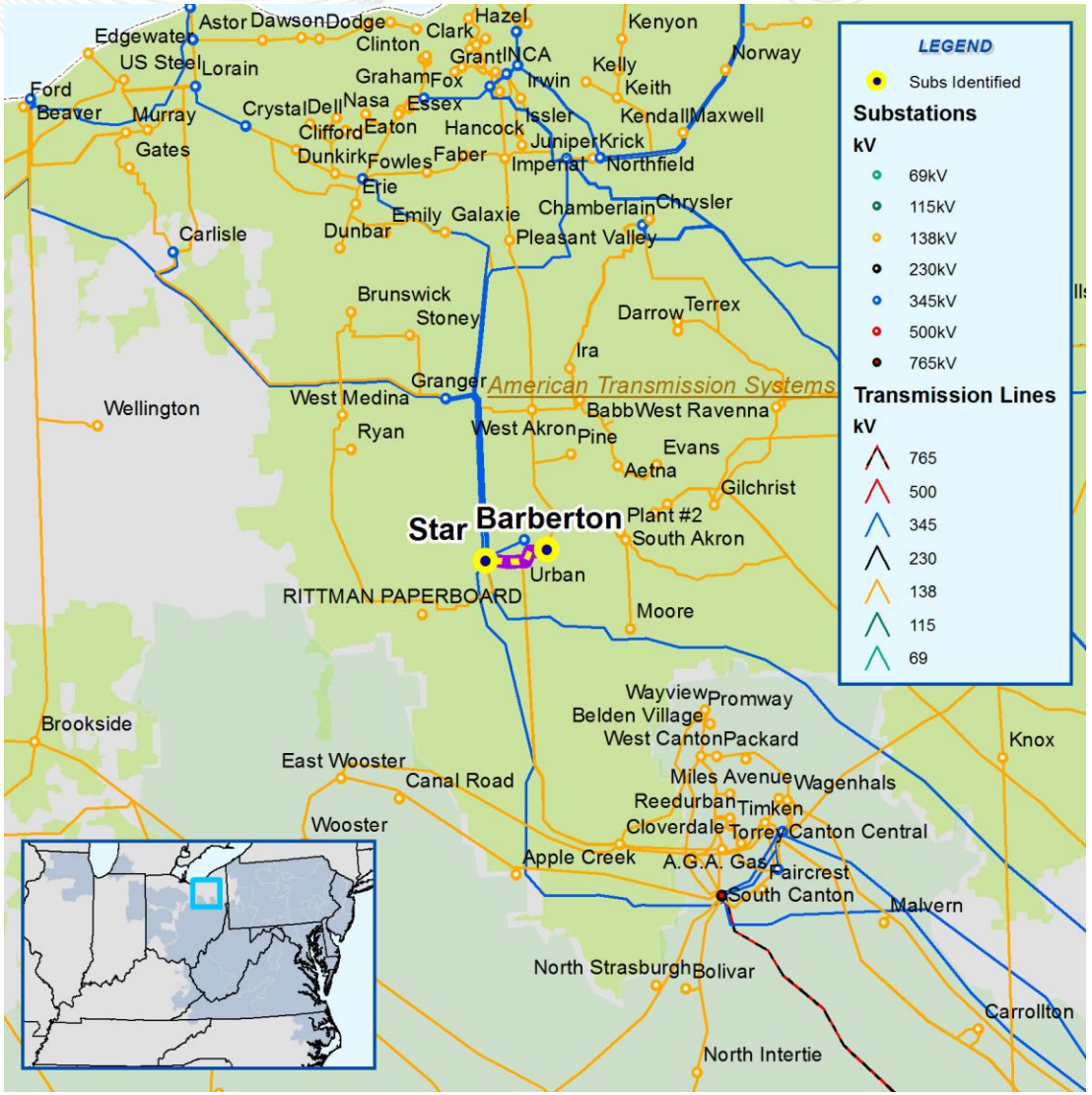
ATSI Transmission Zone

- Baseline Voltage Study Violation
- Low voltage at several 138kV substations for various contingencies
- Proposed Solution: Install 50.0 MVAR capacitor bank at the Lime City 138kv Substation (B1284)
- Estimated Project Cost: $2.35 M
- Expected IS Date: 6/1/2015



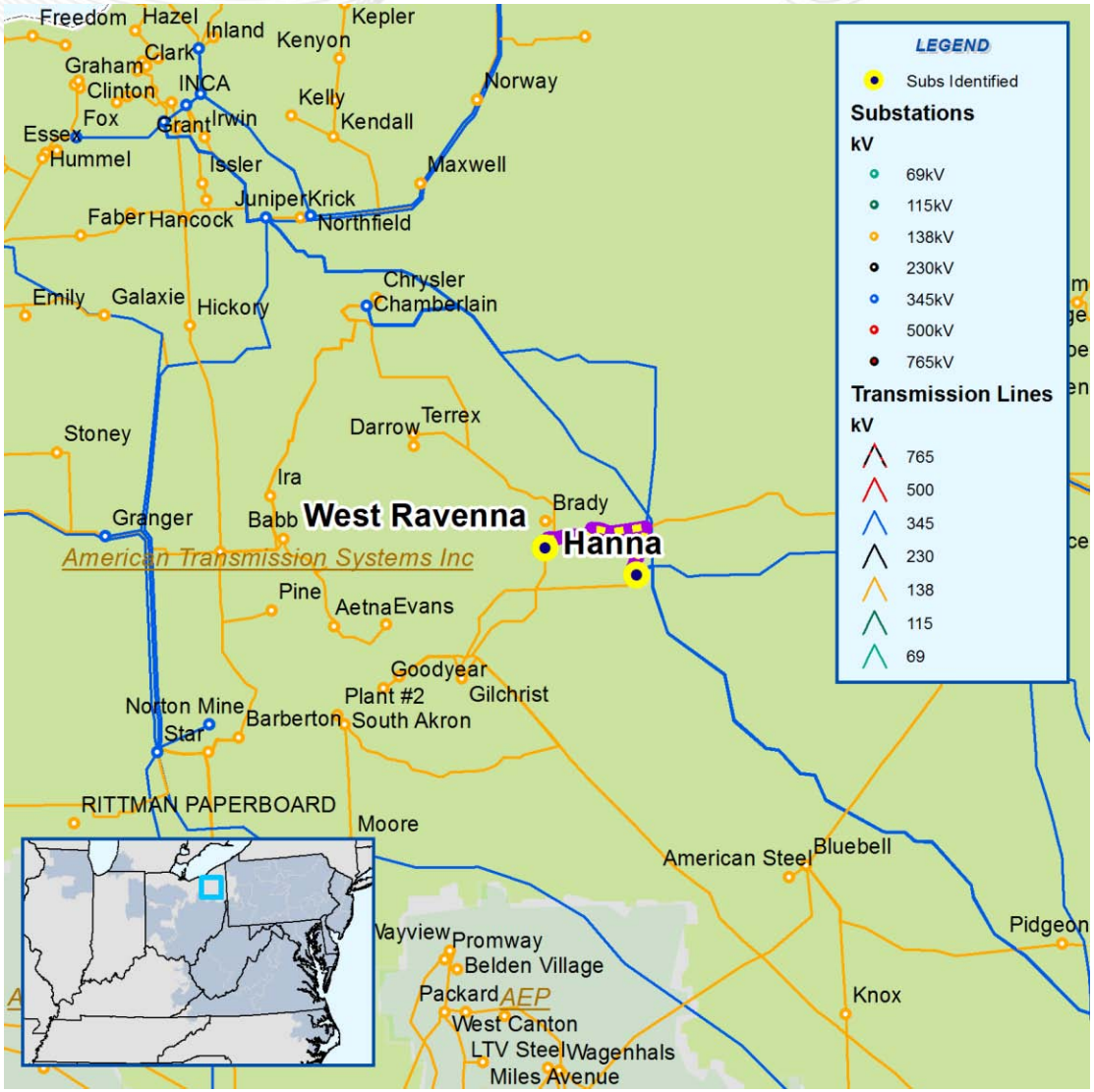
ATSI Transmission Zone

- N-1-1 Thermal Violation
- Barberton – Star 138kV line is overloaded for the loss of Star-Wadsworth 138kV line and the loss of the Start –Barberton #2 138kV line
- Replace Barberton-Star 138kV #1 wavetrap, CFZ relay, and line exit conductor at Barberton (B1285)
- Estimated Cost :$ 0.075 M
- Required IS Date : 06/01/2015



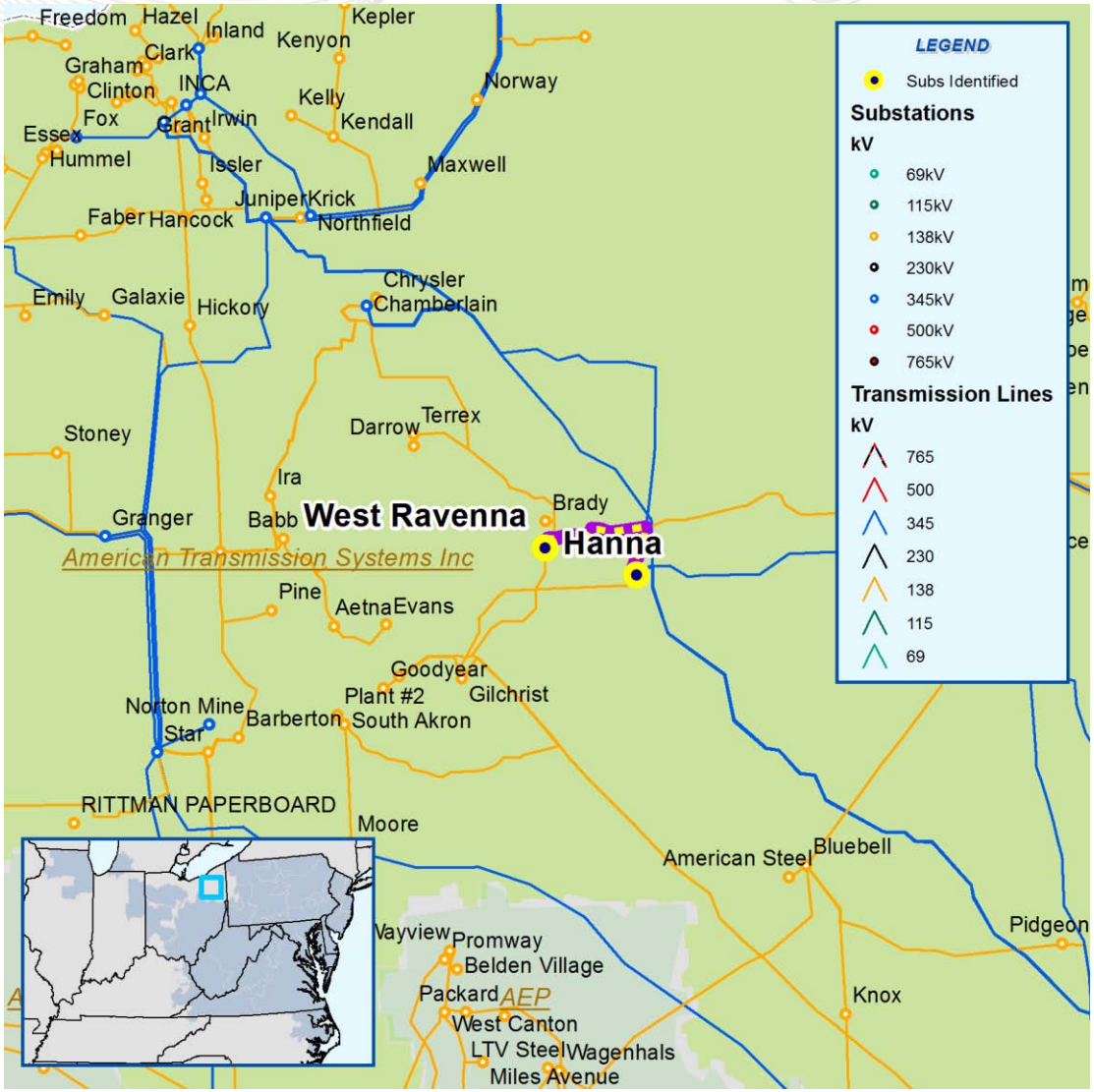
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Hanna - W.Ravenna 138kV #1 line is overloaded for the loss of the Hanna – W. Ravenna #2 138kV line and the loss of the Hanna – E. Akron 138kV line
- Proposed Solution: Reconductor Hanna - W.Ravenna 138kV #1 (4.7miles) with 636 ACSS conductor (B1286)
- Estimated Project Cost: $2.05 M
- Expected IS Date: 6/1/2015



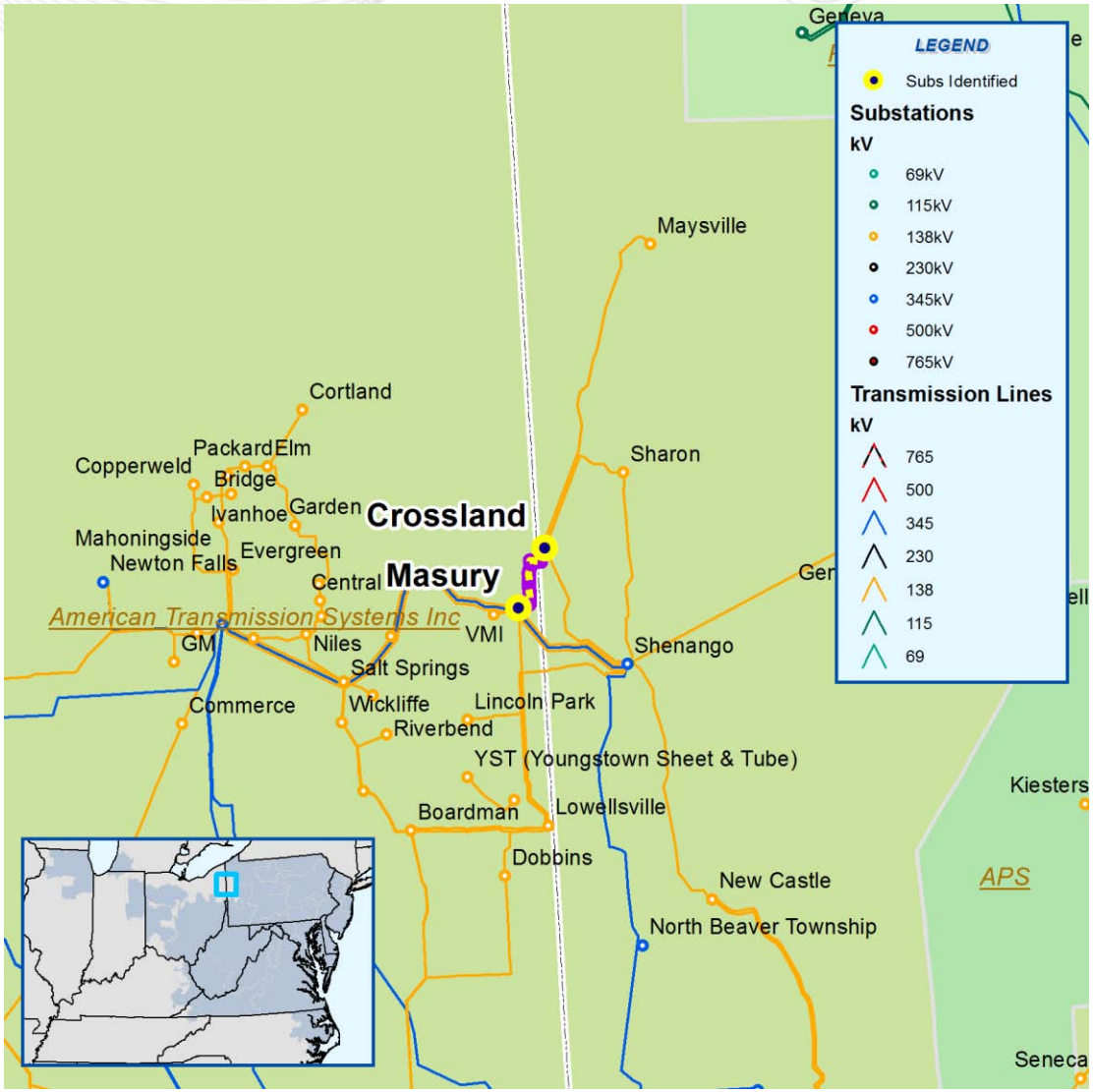
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Hanna - W. Ravenna 138kV #2 line is overloaded for the loss of and the loss of Hanna – W. Ravenna #1 138kV line and the loss of the Hanna – E. Akron 138kV line
- Proposed Solution: Reconductor Hanna - W.Ravenna 138kV #2 (4.7miles) with 636 ACSS conductor (B1287)
- Estimated Project Cost: $2.05 M
- Expected IS Date: 6/1/2015



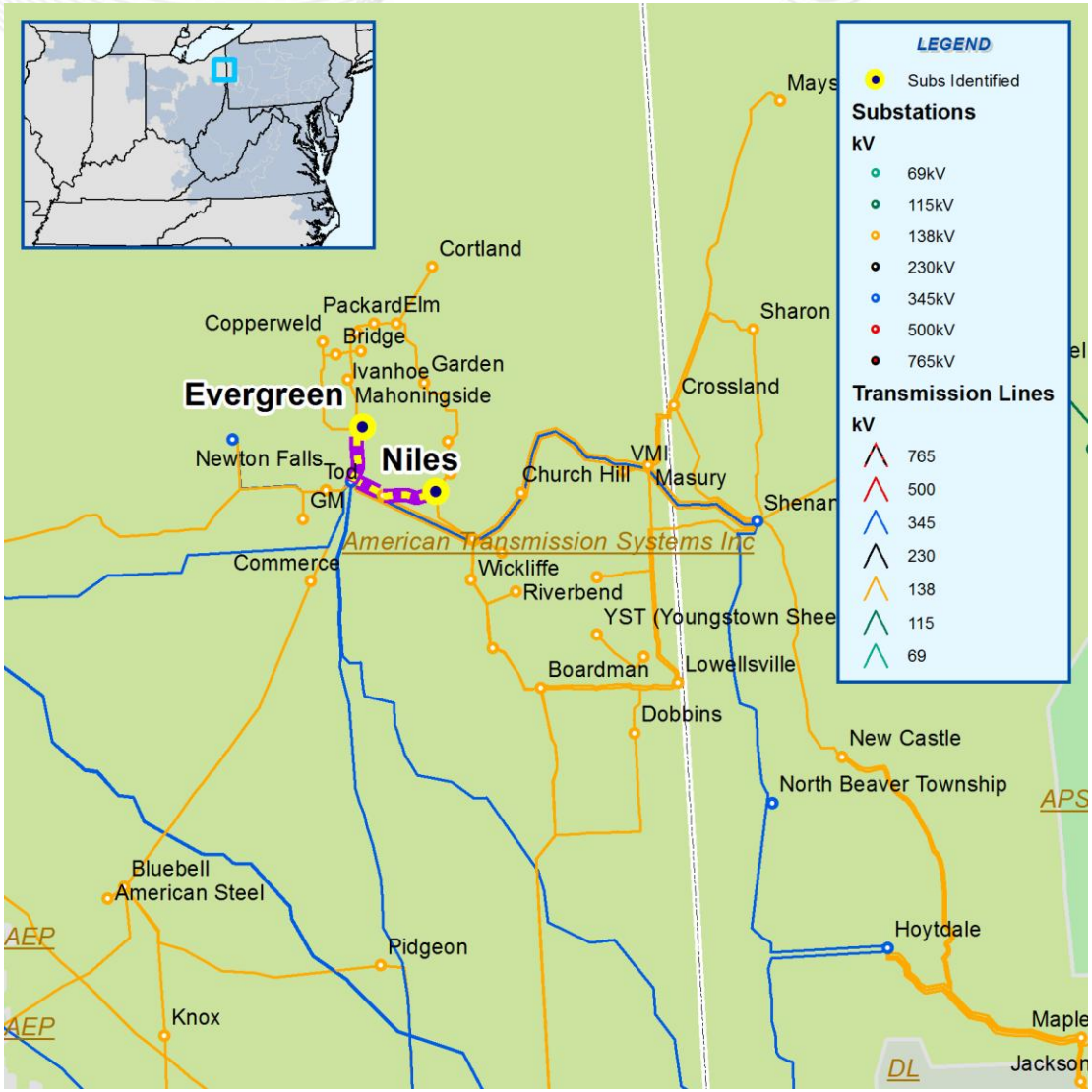
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Masury - Crossland 138kV line is over the normal rating following the loss of Masury – Shenango 138KV line even after system adjustments
- Proposed Solution: Replace Masury - Crossland 138kV terminal equipment at Masury (B1288)
- Estimated Project Cost: $0.01 M
- Expected IS Date: 6/1/2015



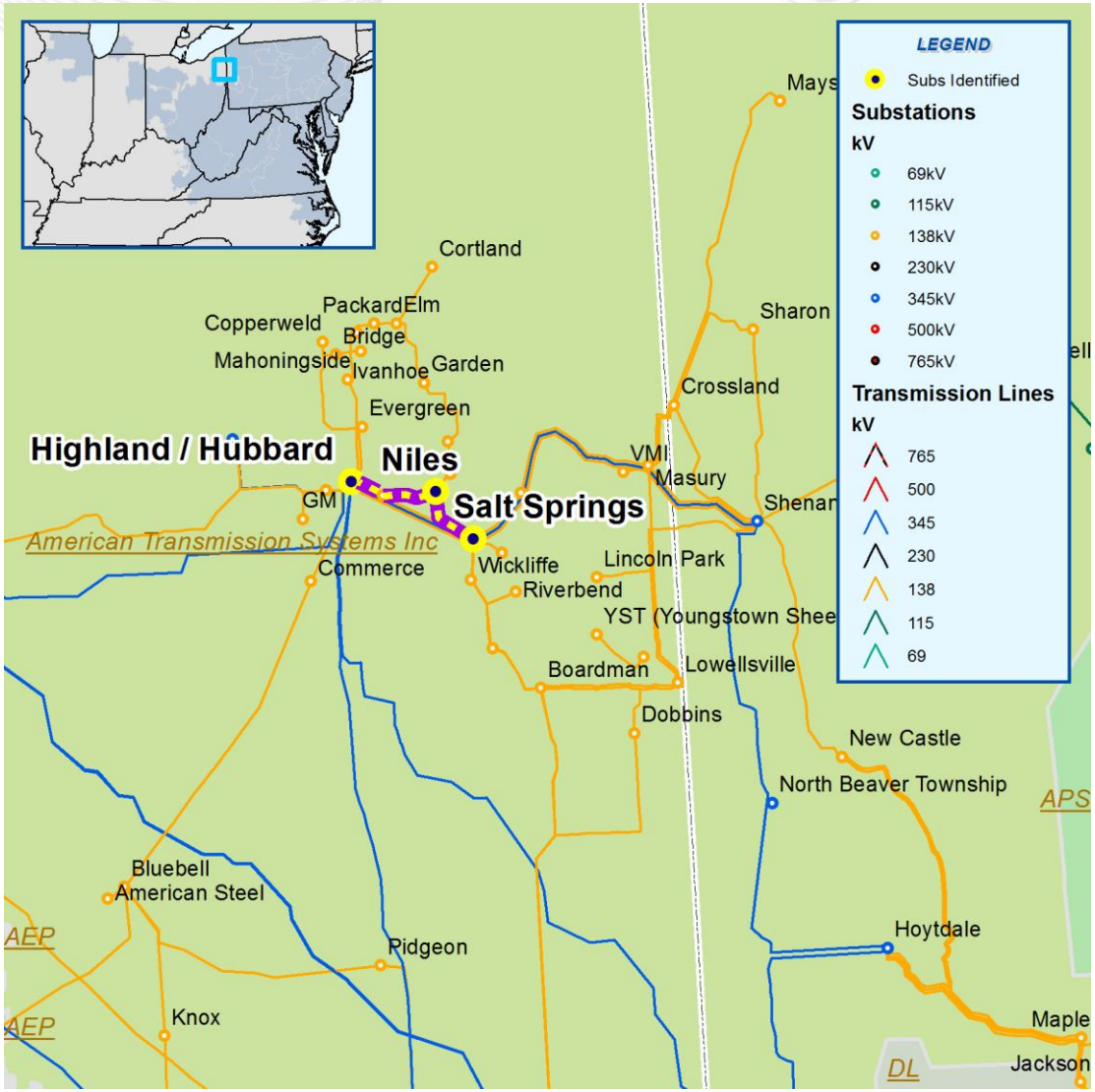
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Evergreen - Niles 138kV line is overload for various N-1-1 contingencies
- Proposed Solution:
  - Replace terminal equipment at Evergreen on the Evergreen – Niles 138kV circuit
  - Reconductor Evergreen-Niles 138kV (3.0 miles) with 477 ACSS (B1289)
- Estimated Project Cost: $0.87 M
- Expected IS Date: 6/1/2015



ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Niles – Salt Springs – Highland 138kV line is overloaded for various of combination of single contingencies
- Proposed Solution: Build new Niles-Salt Springs #2 138kV - 795 ACSR wire (B1290)
- Estimated Project Cost: $2.89 M
- Expected IS Date: 6/1/2015

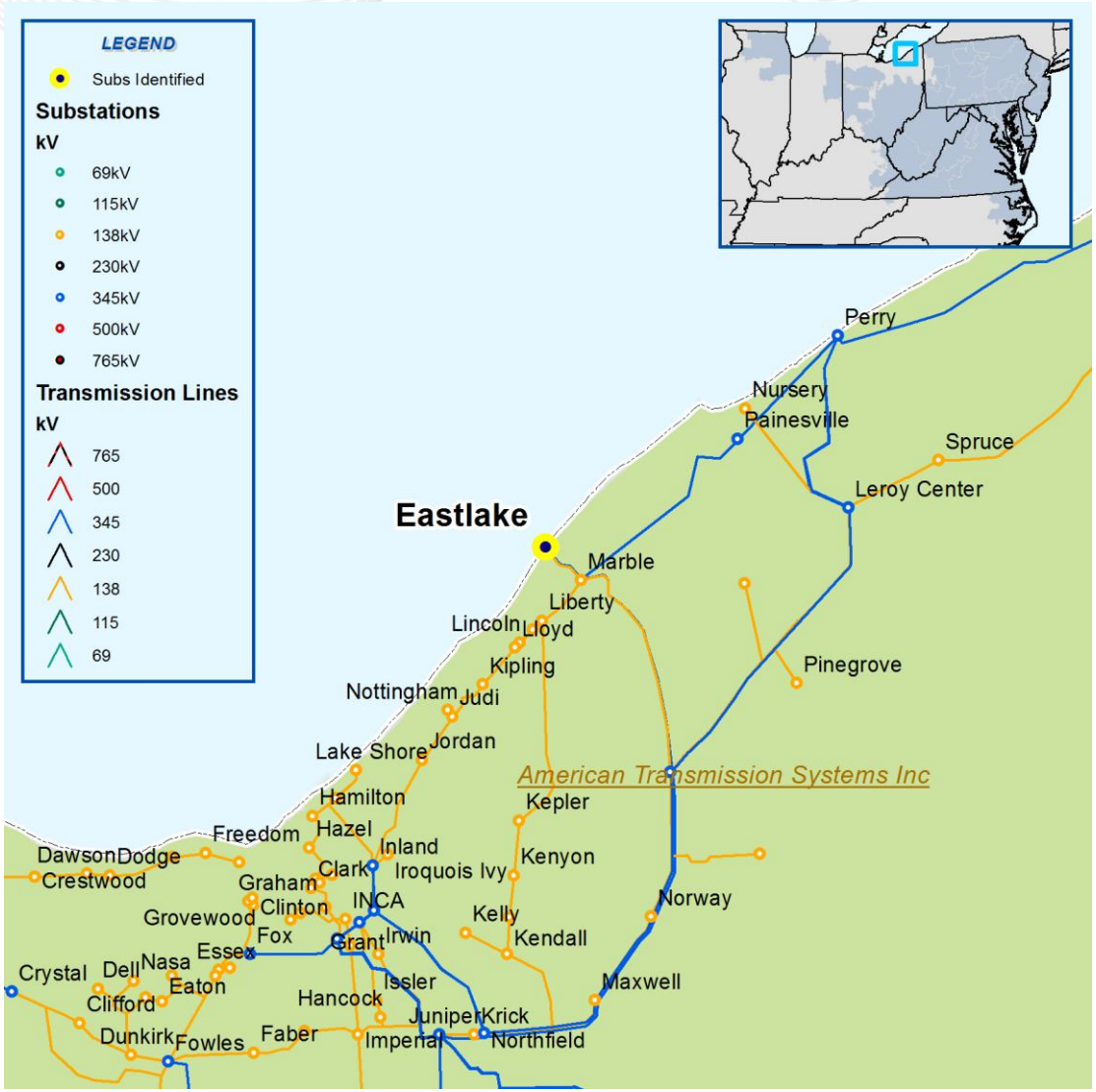


ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Eastlake - Q-12 138kV line is over the normal rating following the loss of Eastlake - Q-13 138kV line with system re-dispatch
- Proposed Solution: Replace substation equipment at Eastlake on the Q-12 138kV line exit (B1291)
- Estimated Project Cost: $0.0207 M
- Expected IS Date: 6/1/2015

ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Eastlake - Q-13 138kV line is overloaded for the normal rating after the loss of Eastlake - Q-12 138kV line with system re-dispatch
- Proposed Solution: Replace substation equipment at Eastlake on the Q-13 138kV line exit (B1292)
- Estimated Project Cost: $0.0207 M
- Expected IS Date: 6/1/2015

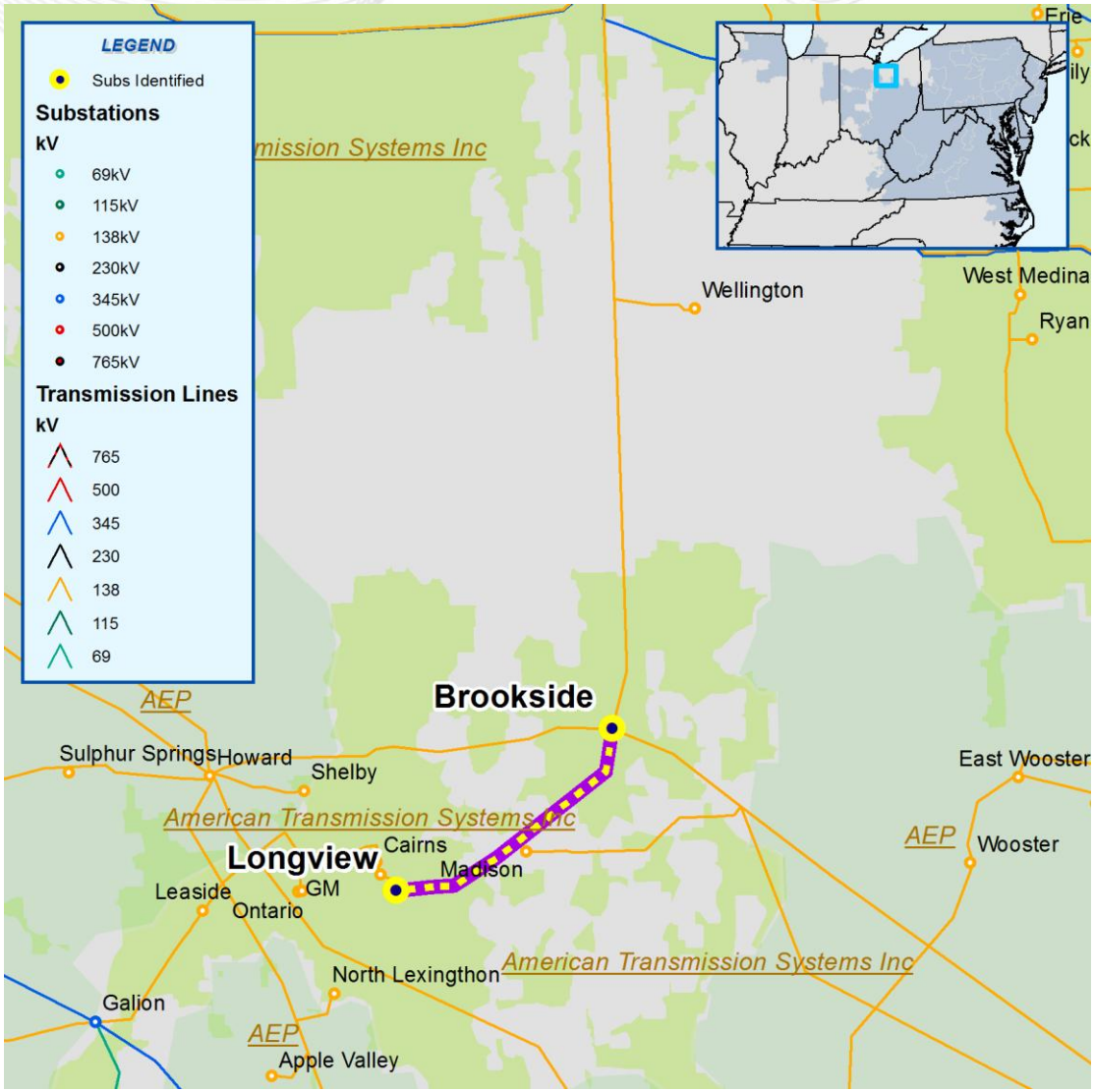


ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Tangy – Bellepoint 138kV line is overloaded for the loss of Greene 345/138kV transformer #2, the Greene – Clark 138KV line, and the loss of Urbana – Clark 138KV line
- Proposed Solution: Replace substation equipment at the Tangy sub on the E.Springfield – Tangy line (B1293)
- Estimated Project Cost: $0.014 M
- Expected IS Date: 6/1/2015

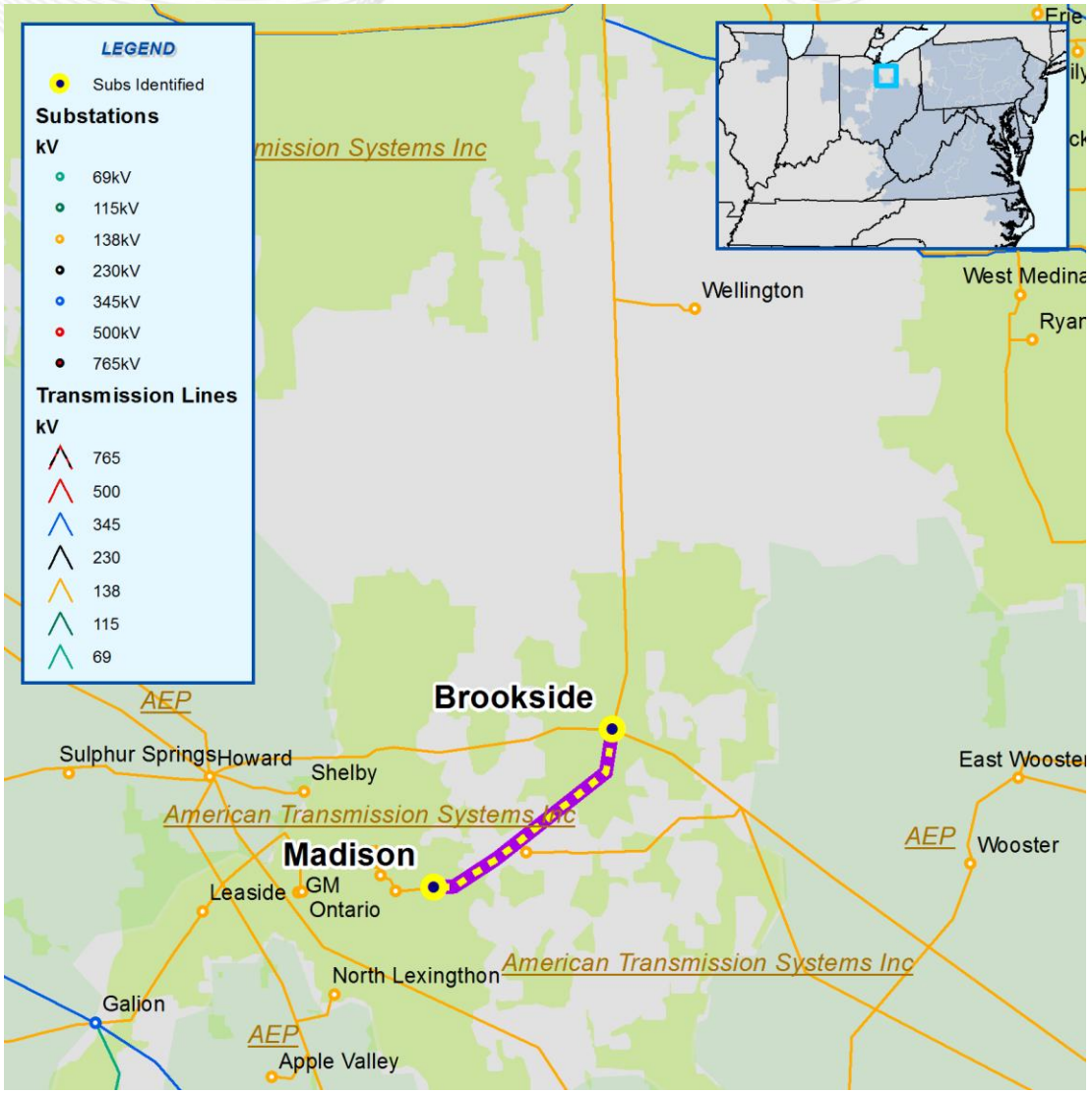
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Brookside – Longview #2 138kV line is overloaded for the loss of Madison-Brookside 138kV Line and the loss of Galion-GM Mansfield 138kV Line
- Proposed Solution: Modify the Brookside - Longview #2 138kV CT ratio and correct the design temperature (B1294)
- Estimated Project Cost: $0.025 M
- Expected IS Date: 6/1/2011



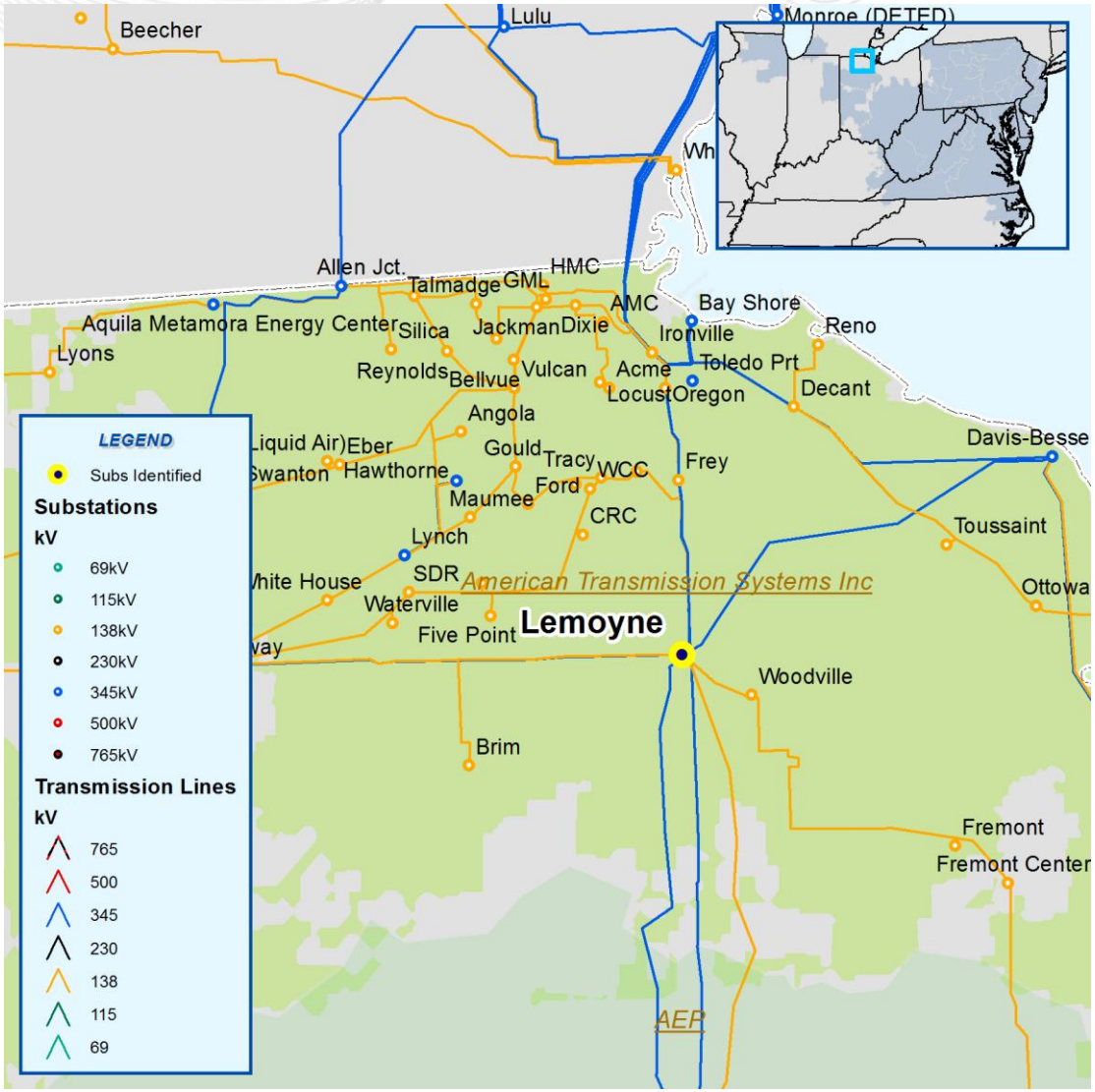
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Brookside – Madison - Longview 138kV line is overloaded for the loss of the Longview - Brookside 138kV Line and the loss of Galion - GM Mansfield 138kV Line
- Proposed Solution:
  - Modify the Brookside - Longview #1 138kV CT ratio + correct the design temperature (Longview-Madison) (B1295.1)
  - Estimated Project Cost: $0.025 M
  - Modify the Brookside-Longview #1 138kV CT ratio + correct the design temperature (Brookside-Madsion) (B1295.2)
  - Estimated Project Cost: $0.025 M
- Expected IS Date: 6/1/2011



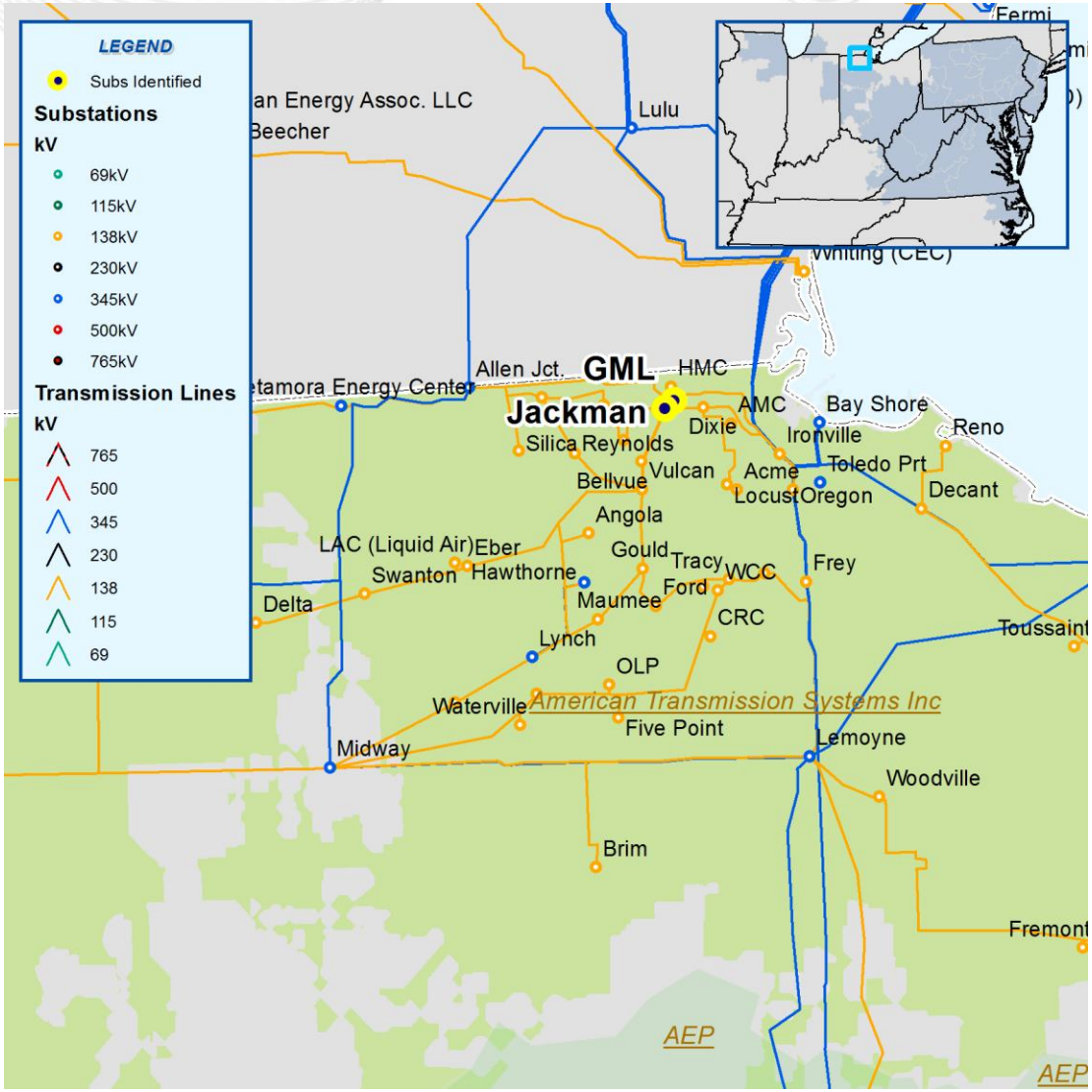
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The BG tap – Lemoyne 138KV line is overload for various combination of single contingencies
- Proposed Solution:
  - Reconductor BG line exit conductor at Lemoyne Sub (B1296.1)
  - Estimated Project Cost: $0.01 M
  - Change the CT ratio at Lemoyne B13213 towards Brim Tap to increase line loadability (B1296.2)
  - Estimated Project Cost: $0.01 M
- Expected IS Date: 6/1/2015



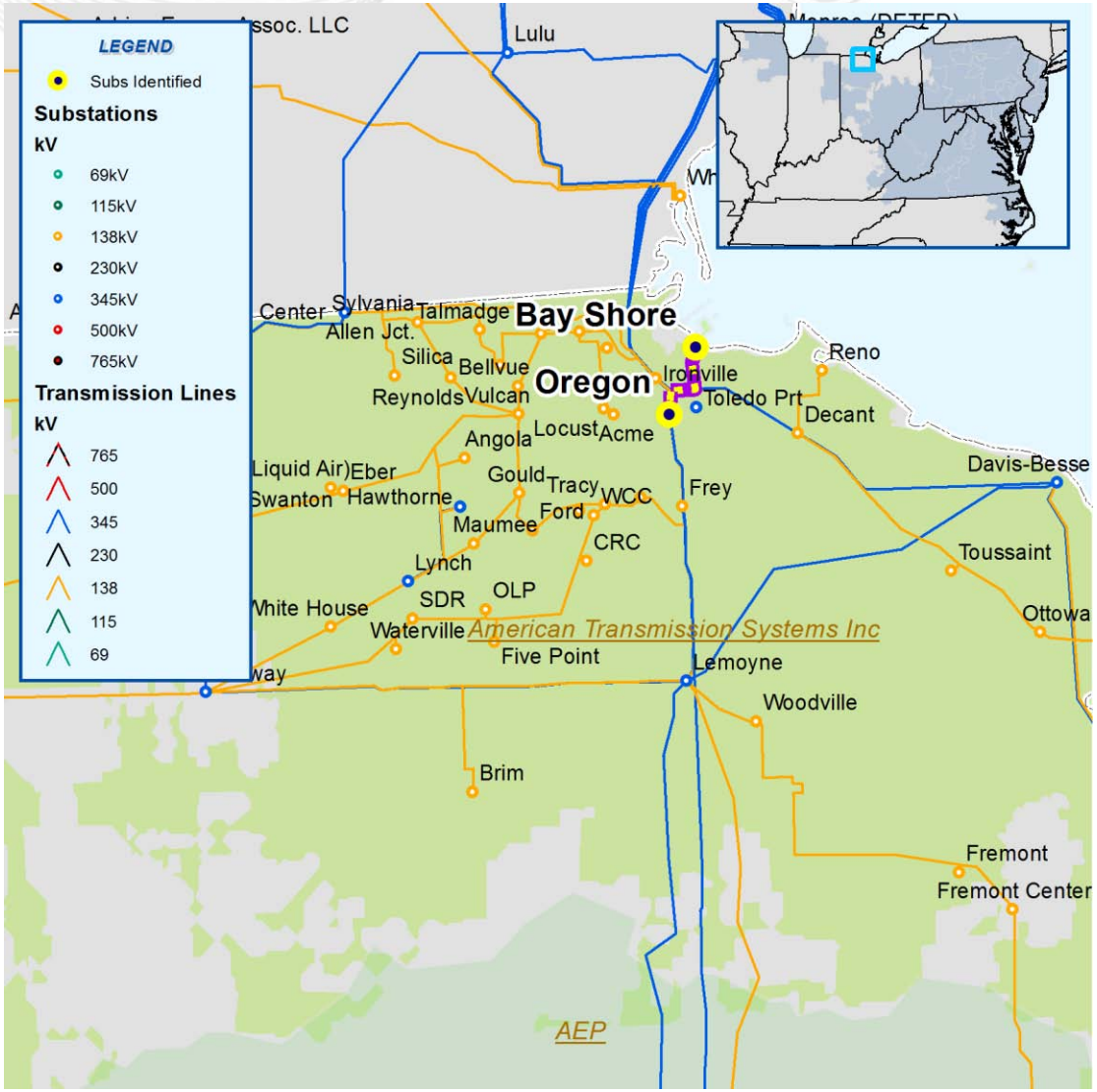
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Fort Industries – BP Oil 138kV line and the General Mill – Jackman 138kV lines are overloaded for the loss of the Allen 345/138kV transformer and the loss of the Bayshore – Jeep 138kV line
- Proposed Solution: Install a new Fulton 345/138kV substation (B1297)
- Estimated Project Cost: $23 M
- Expected IS Date: 6/1/2015



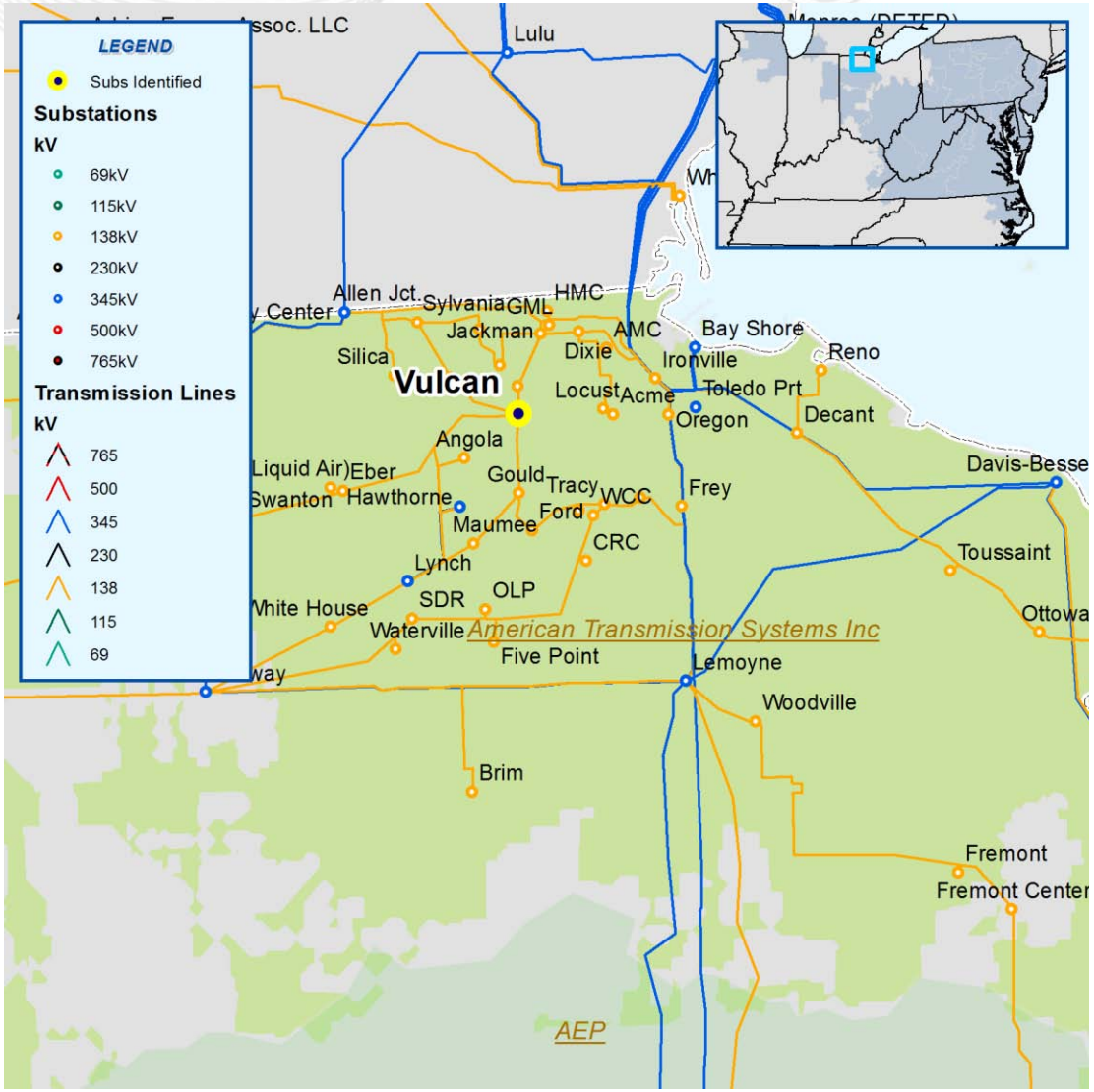
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The Bayshore – Oregon 138kV line is overloaded for the loss of the Midway – Waterville 138kV line and Lemoyne – Maclean 138kV
- Proposed Solution: Replace terminal equipment at the Oregon substation (B1298)
- Estimated Project Cost: $0.138 M
- Expected IS Date: 6/1/2015



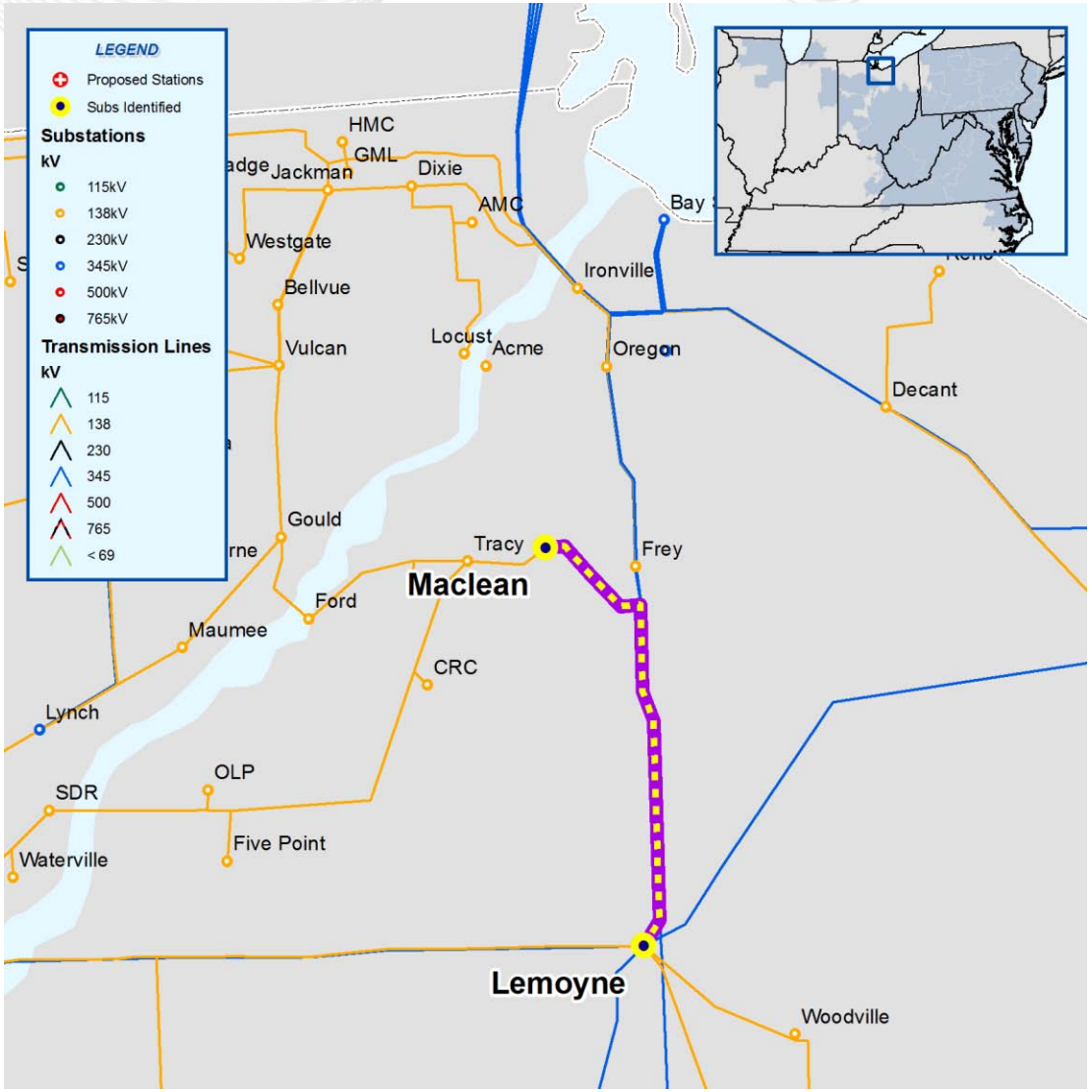
ATSI Transmission Zone

- N-1-1 Thermal Violation
- The UT - Vulcan 138kV line is overloaded for the loss of the Allen Junction – Silica 138KV line and the Jackman – Vulcan 138kV line
- Proposed Solution: Add SCADA control and motor operators to switches 13153 and 13154 near Silica (B1299)
- Estimated Project Cost: $0.55 M
- Expected IS Date: 6/1/2015



ATSI Transmission Zone*

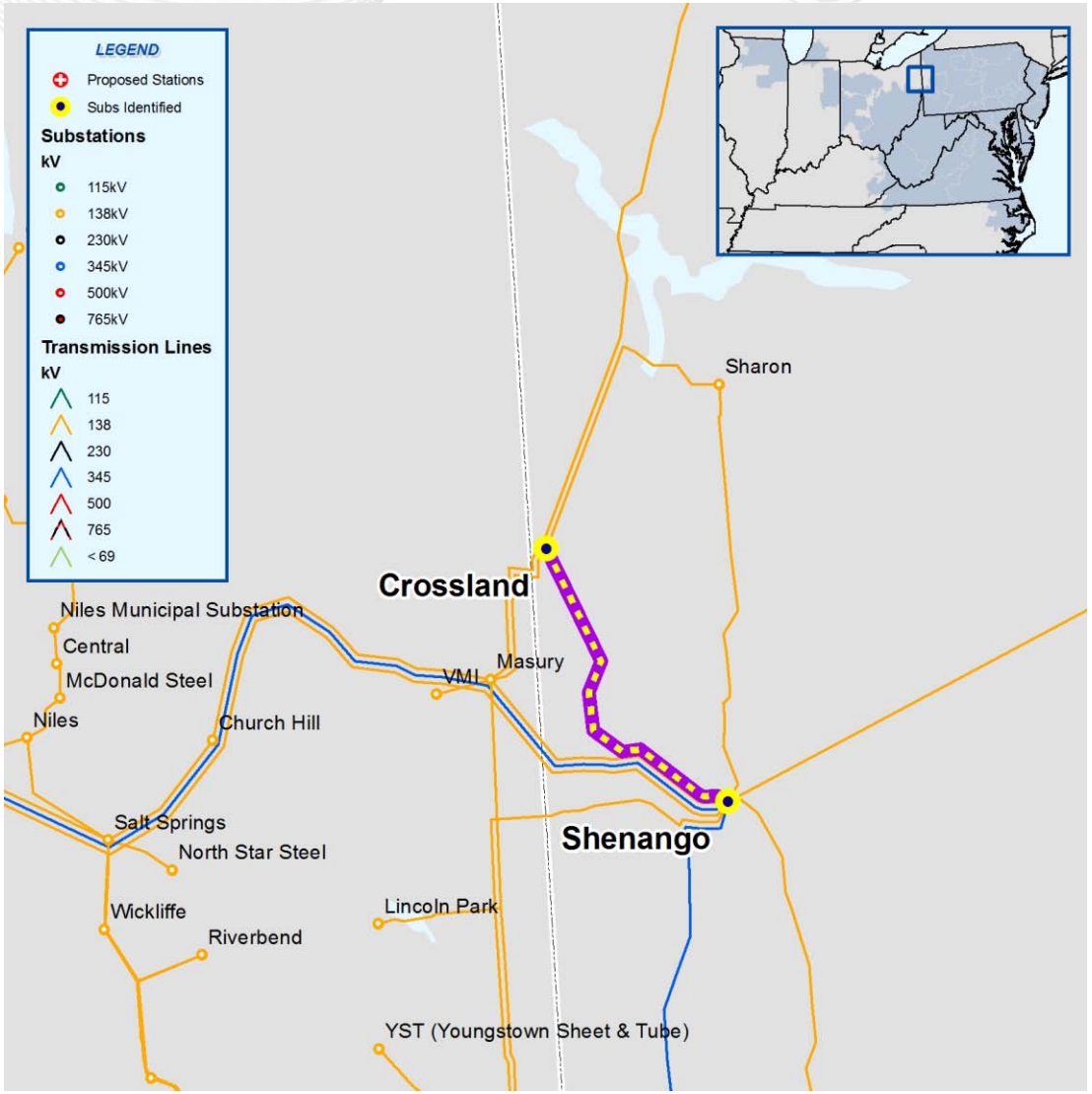
- For the common mode outage test the Lemonyne – Maclean 138 kV circuit is overloaded for breaker failure operation of Bayshore 138 kV BK-JL Breaker
- Proposed Solution: Reconductor Lemoyne – Maclean with 954 ACSS conductor (B1190)
- Estimated Cost: $4.3M
- Expected In-Service Date: 06/01/2013



*This upgrade was presented at a previous TEAC

ATSI Transmission Zone*

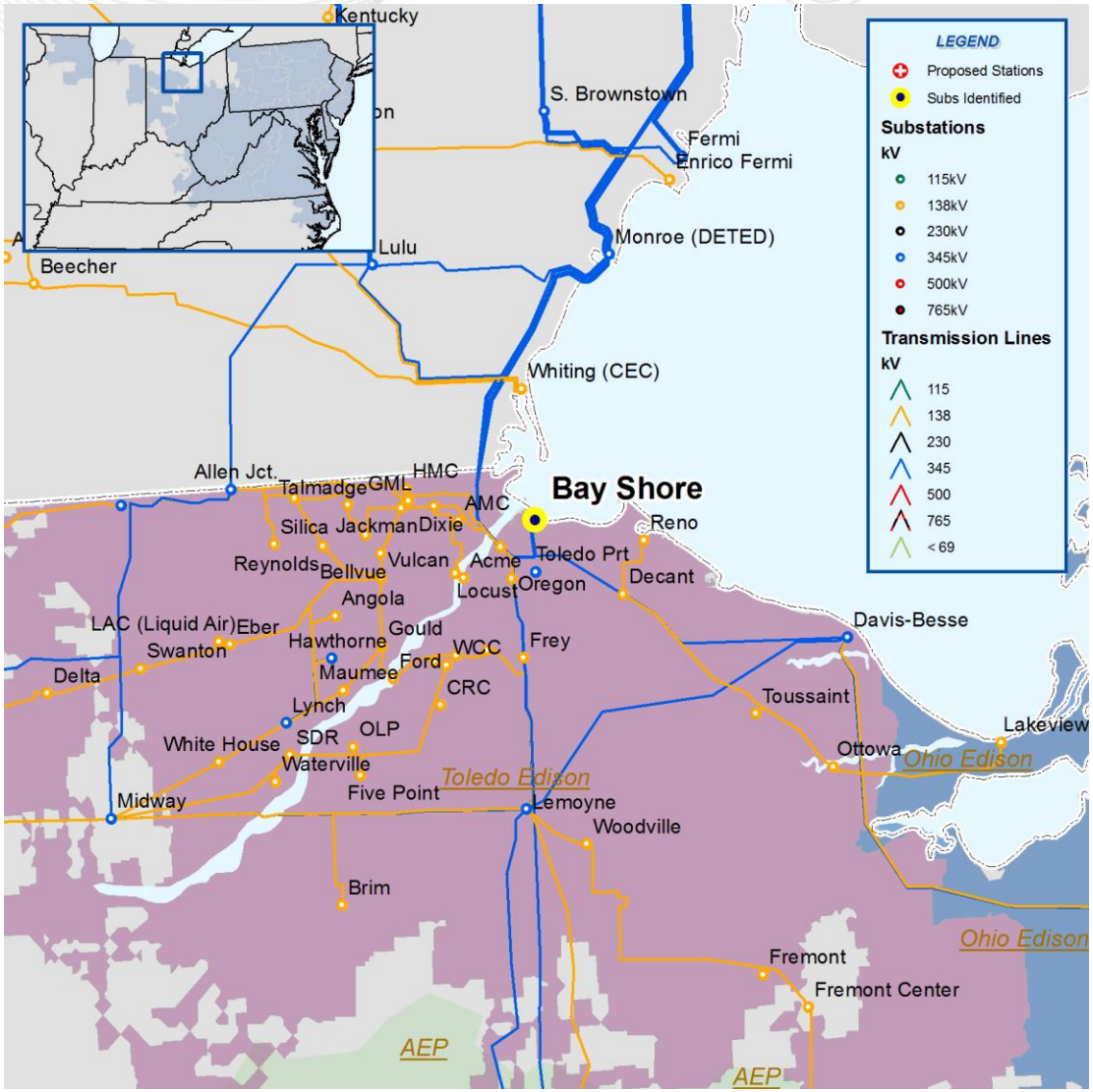
- For the common mode outage test the Shenango – Crossland 138 kV circuit #2 is overloaded for breaker failure operation of Shenango138 kV BK-18 Breaker
- Proposed Solution: Replace the meter at Crossland with a higher rated meter (B1191)
- Estimated Cost: $0.015M
- Expected In-Service Date: 06/01/2013



*This upgrade was presented at a previous TEAC

ATSI Transmission Zone*

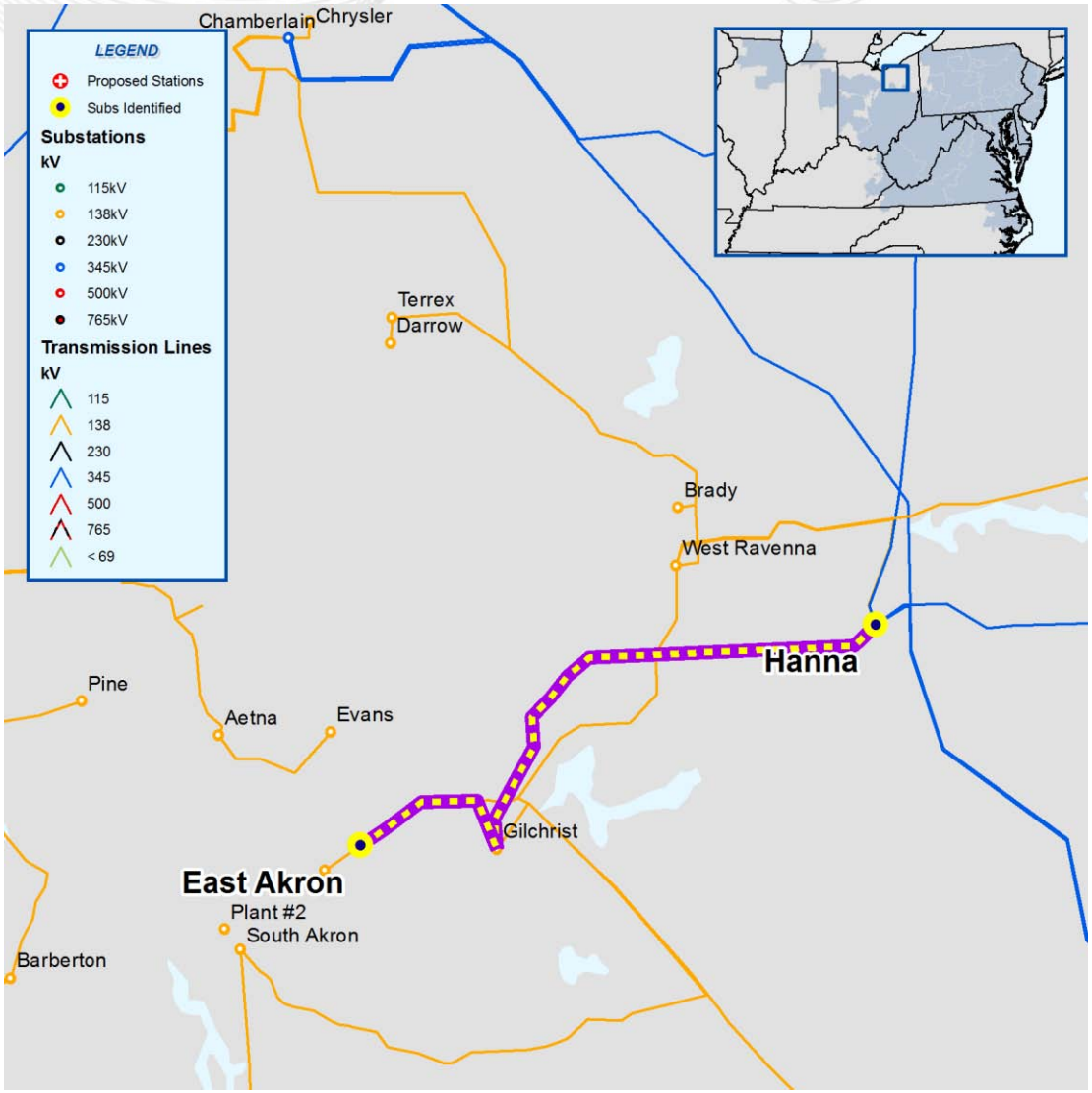
- For the common mode outage test the Bayshore – Chevy 138 kV circuit is overloaded for breaker failure operation of the Bayshore 138 kV BK-3K, BK-13254,BK-13256,BUS-K, BK-13252 or BK-KM breakers
- Proposed Solution: Reconductor Bayshore – Chevy 138 kV with 636 ACSS conductor (B1192)
- Estimated Cost: $4.3M
- Expected In-Service Date: 06/01/2013



*This upgrade was presented at a previous TEAC

ATSI Transmission Zone*

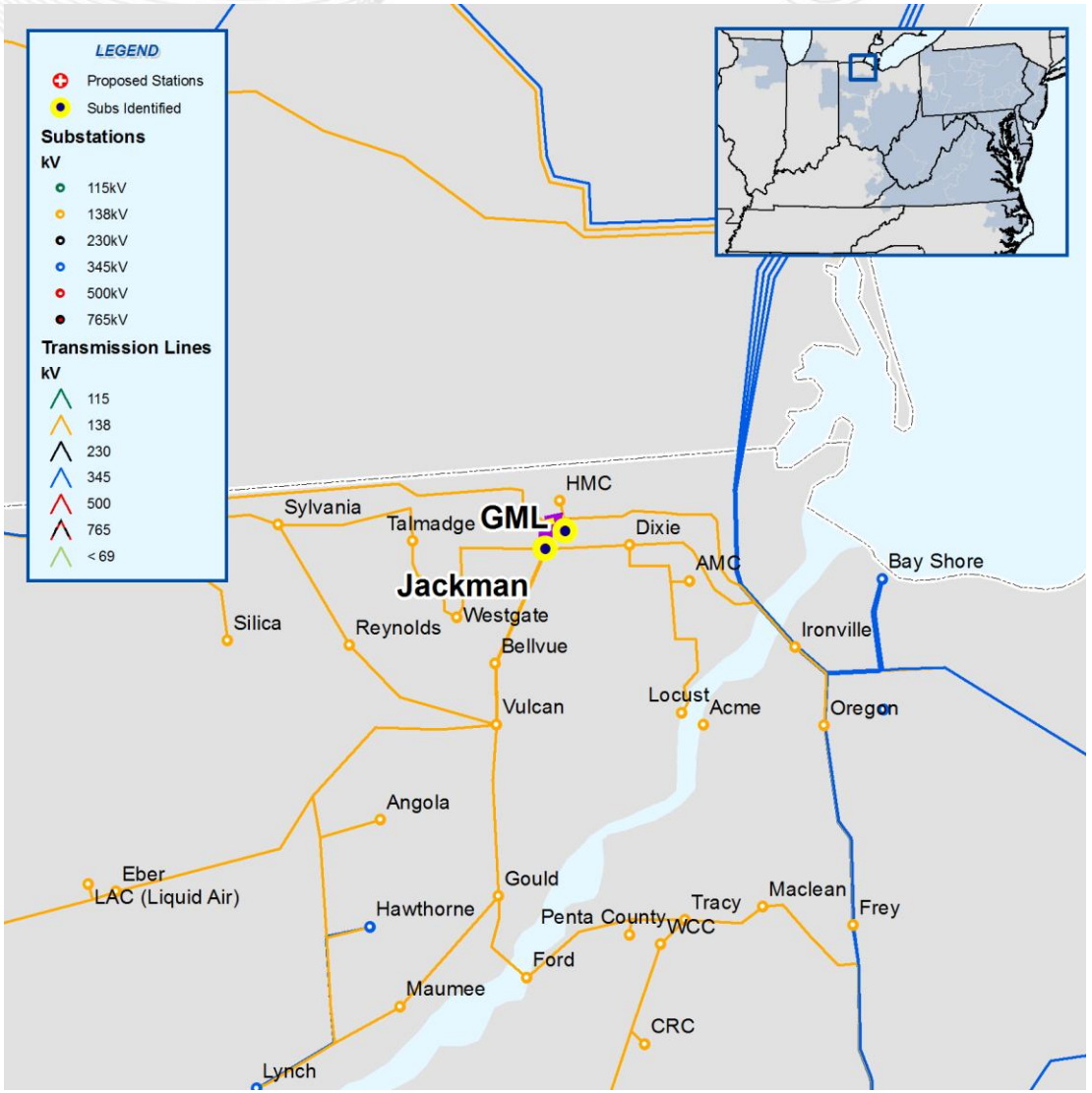
- For the common mode outage test the Hanna – East Akron 138 kV circuit is overloaded for breaker failure operation of West Ravenna 138 kV BK-15K and the tower outage of the Hanna – West Ravenna #1 and the Hanna – West Ravenna #2 138 kV lines
- Proposed Solution: Replace the 800 Amp wavetrap at East Akron with a 1200 Amp wavetrap (B1193)
- Estimated Cost: $0.052M
- Expected In-Service Date: 06/01/2013



*This upgrade was presented at a previous TEAC

ATSI Transmission Zone*

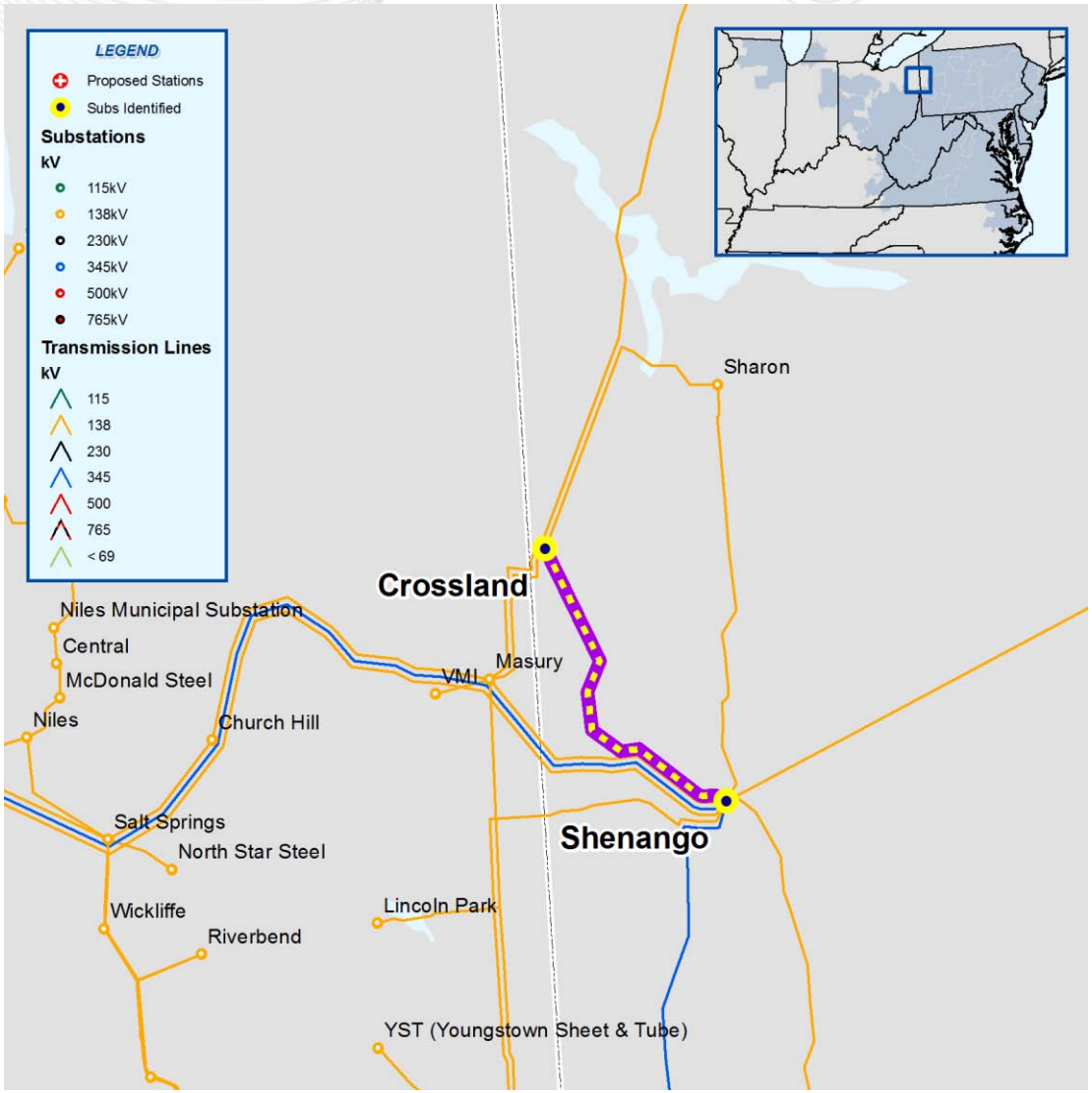
- For the common mode outage test the General Mills – Jackman 138 kV circuit is overloaded for the breaker failure operation of the Bayshore138 kV BK-13254, BK-13256, BK-13252, BUS-K, or BK-KM breakers
- Proposed Solution: Reconductor General Mills – Jackman 138 kV with 636 ACSS conductor (B1194)
- Estimated Cost: $0.647M
- Expected In-Service Date: 06/01/2013



*This upgrade was presented at a previous TEAC

ATSI Transmission Zone*

- Common Mode Contingency Violation
- Overload on the Masury – Shenango 138kV circuit for the tower outage of the Crossland – Shenango #1 138kV and Crossland – Shenango #2 138kV lines
- Proposed Solution: Replace the circuit terminal and sections of substation bus conductor at Masury 138kV substation with either 795 ACSR conductor or equivalent Copper wire (B1229)
- Cost Estimate: $0.247 M
- Expected IS Date: 6/1/2013

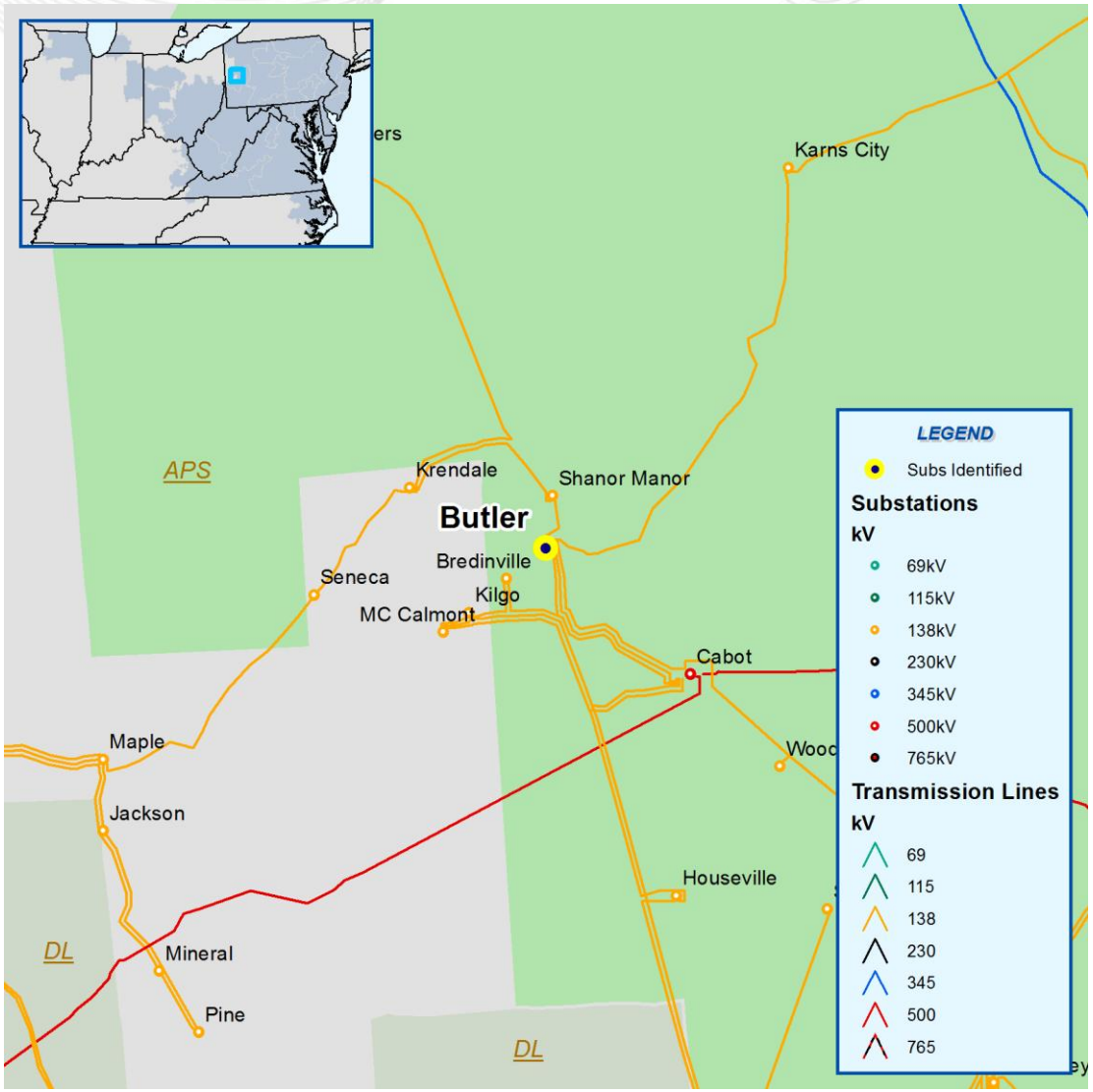


*This upgrade was presented at a previous TEAC

Short Circuit Upgrades

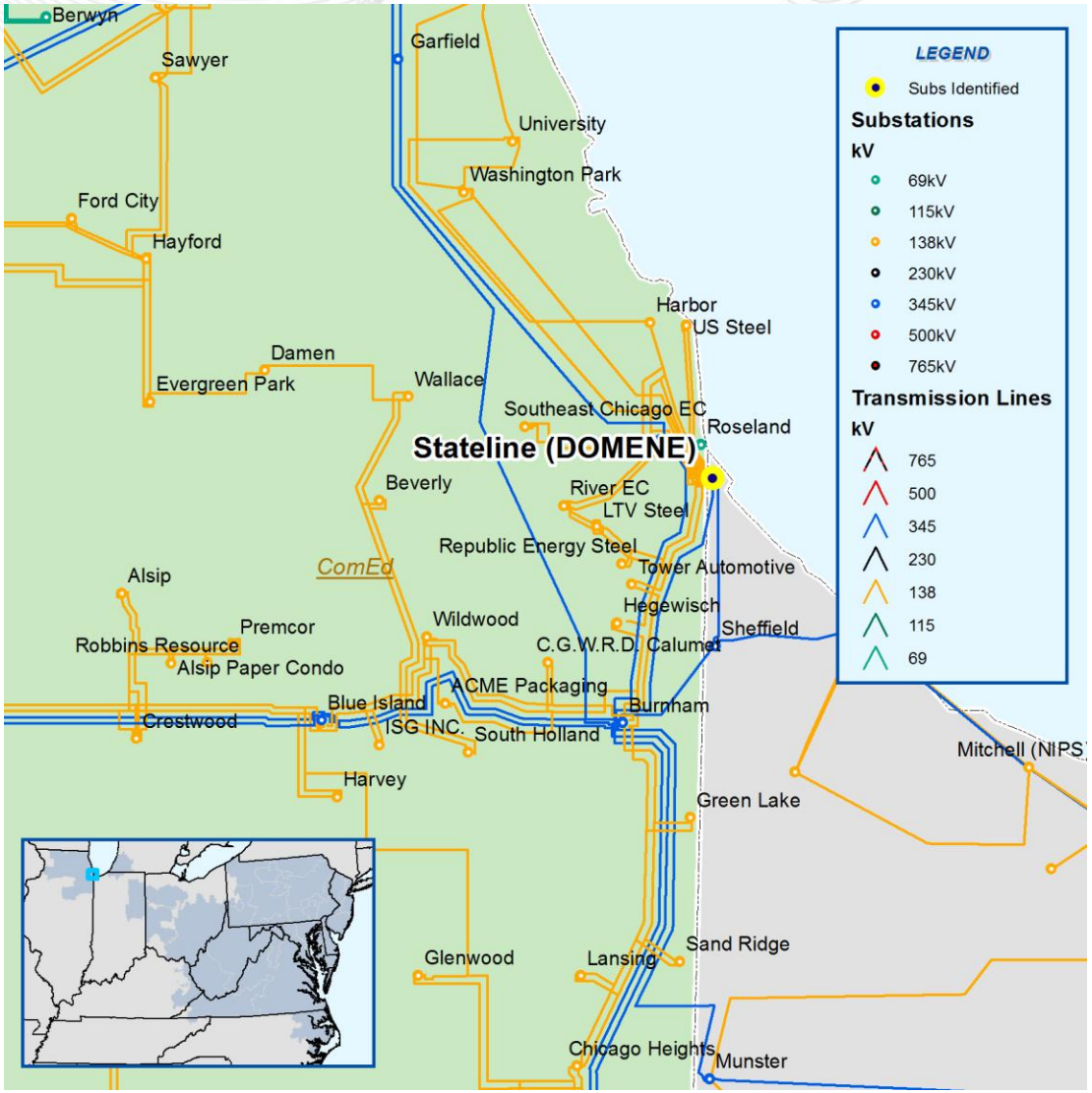
APS Transmission Zone

- The Butler 138 kV breaker '1-2 Bus 138' is overstressed
- Proposed Solution: Replace the Butler 138 kV breaker '1-2 Bus 138' (b1261)
- Estimated Project Cost: $300 K
- Expected IS Date: 6/01/2011



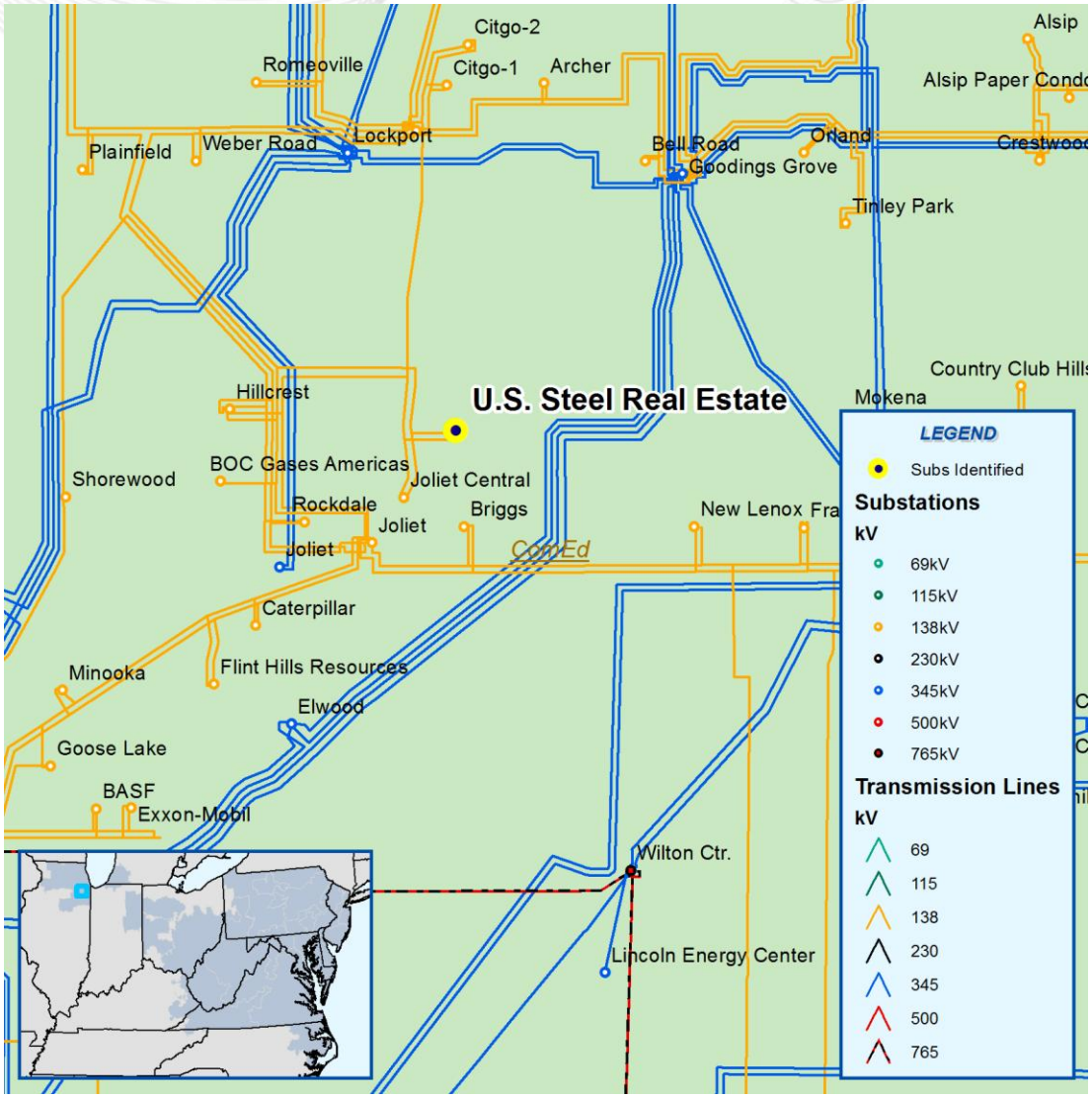
ComEd Transmission Zone

- The State Line Station 7 138 kV breaker 'Bustie 742' is overstressed
- Replace the State Line Station 7 138 kV breaker 'Bustie 742' (b1256)
- Estimated Cost: $760 K
- Required IS Date: 6/01/2011



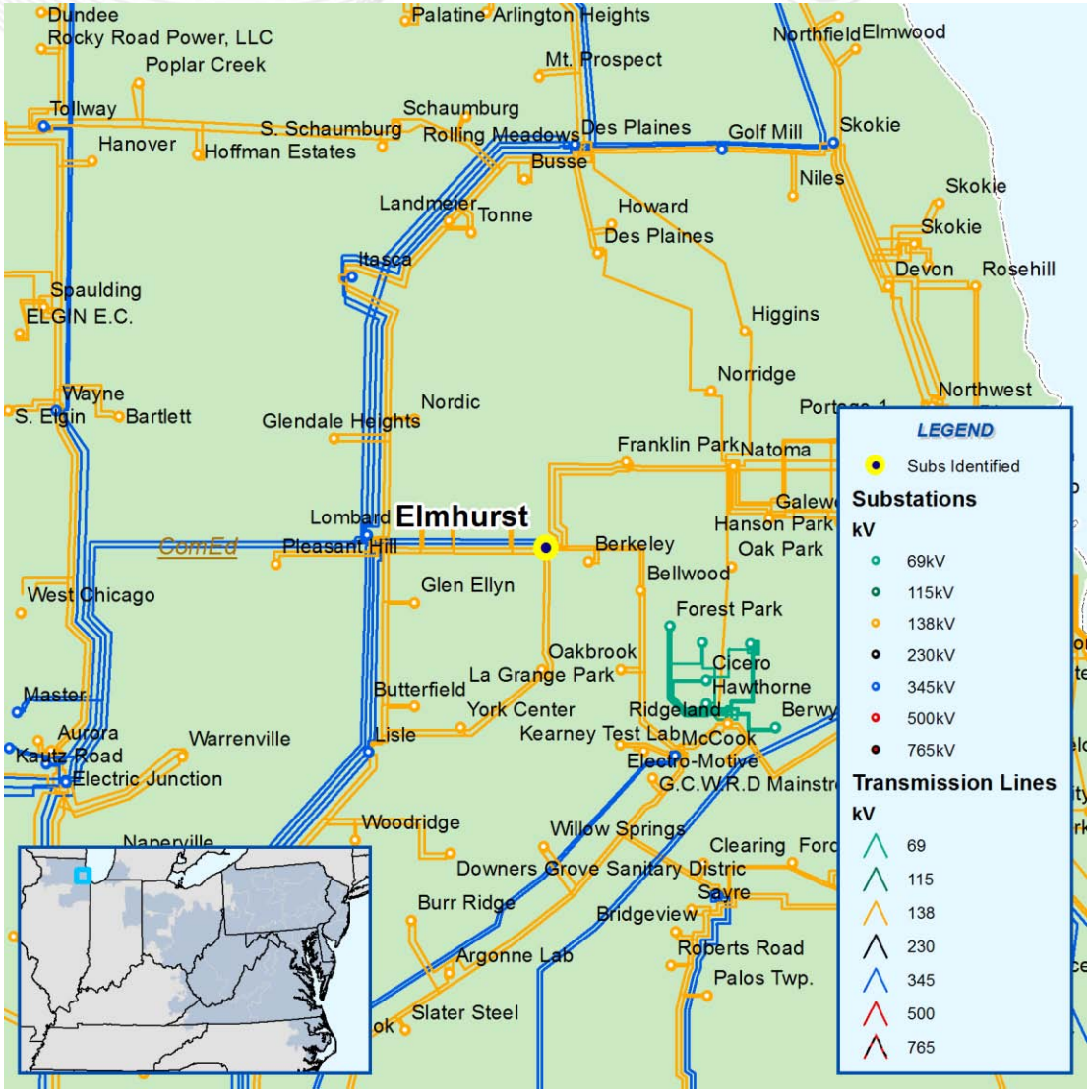
ComEd Transmission Zone

- The J322 138 kV breaker is overstressed
- Proposed Solution: Eliminate the J322 138 kV breaker 'L0906' and move customer to the distribution system (b1257)
- Estimated Project Cost: $35 K
- Expected IS Date: 6/01/2011



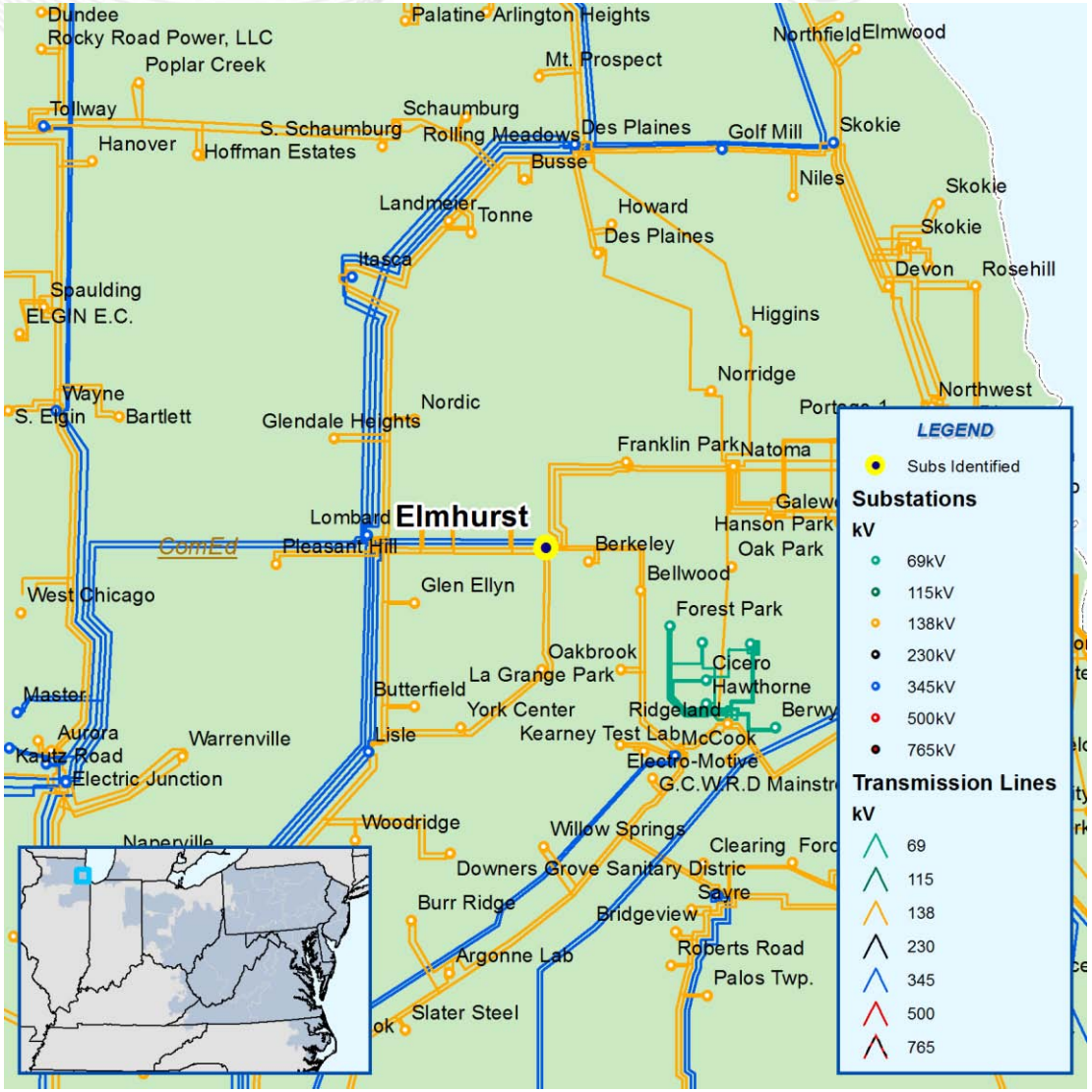
ComEd Transmission Zone

- The Elmhurst 138 kV bus B breaker ‘135 12008’ is overstressed
- Proposed Solution: Revise the reclosing on the Elmhurst 138 kV bus B breaker ‘135 12008’ (b1258)
- Estimated Project Cost: $75 K
- Expected IS Date: 6/01/2011



ComEd Transmission Zone

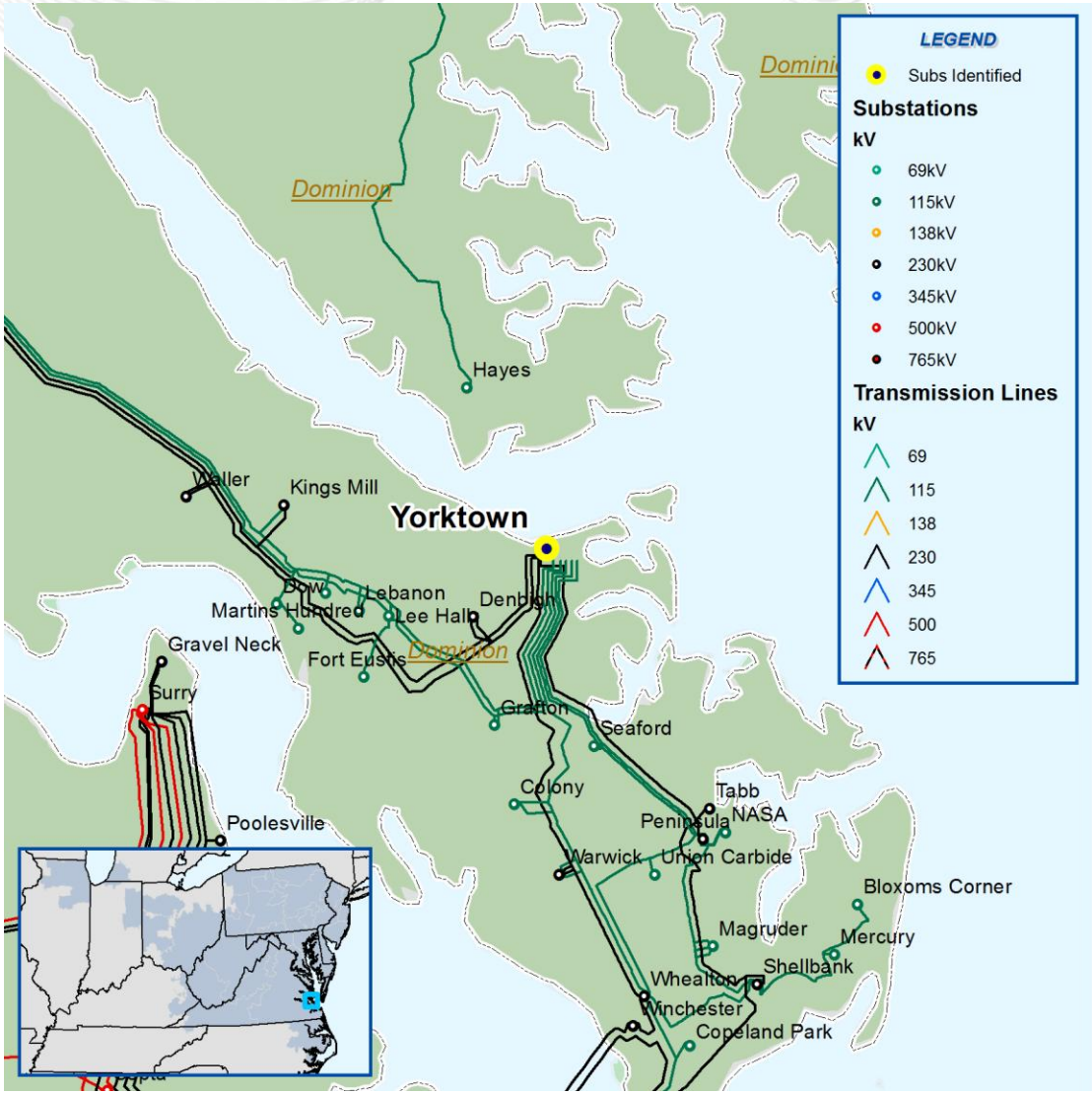
- The Elmhurst 138 kV bus R breaker '135 13510' is overstressed
- Proposed Solution: Revise the reclosing on the Elmhurst 138 kV bus R breaker '135 13510' (b1259)
- Estimated Project Cost: $75 K
- Expected IS Date: 6/01/2011



Dominion Transmission Zone

- The Yorktown 115 kV breaker ‘L982-1’ is overstressed
- Replace the Yorktown 115 kV breaker ‘L982-1’ (b1225)
- Estimated Project Cost:

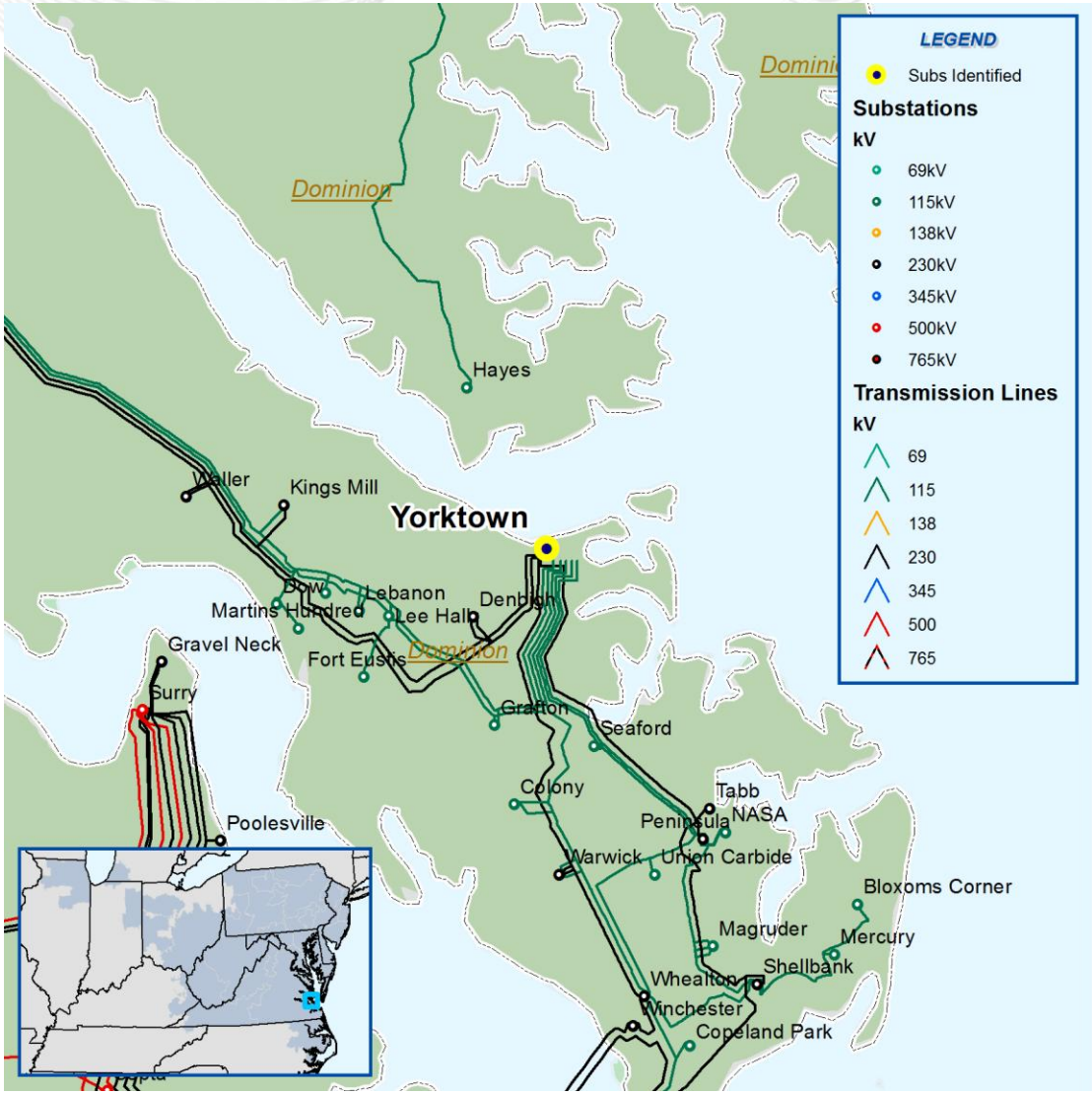
  $200 K
- Expected IS Date: 6/01/2011



Dominion Transmission Zone

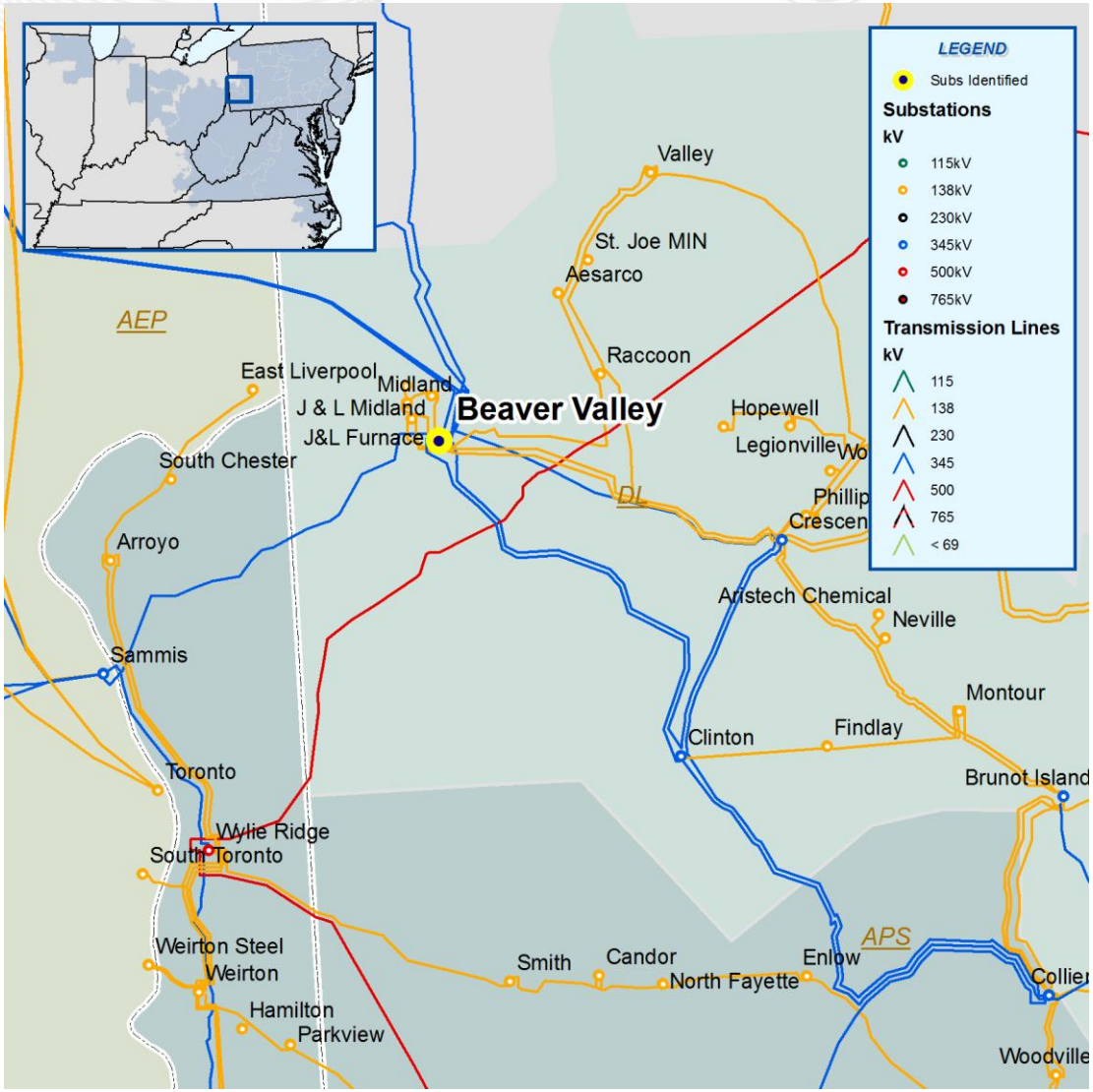
- The Yorktown 115 kV breaker ‘L982-2’ is overstressed
- Replace the Yorktown 115 kV breaker ‘L982-2’ (b1226)
- Estimated Project Cost:

  $200 K
- Expected IS Date: 6/01/2011



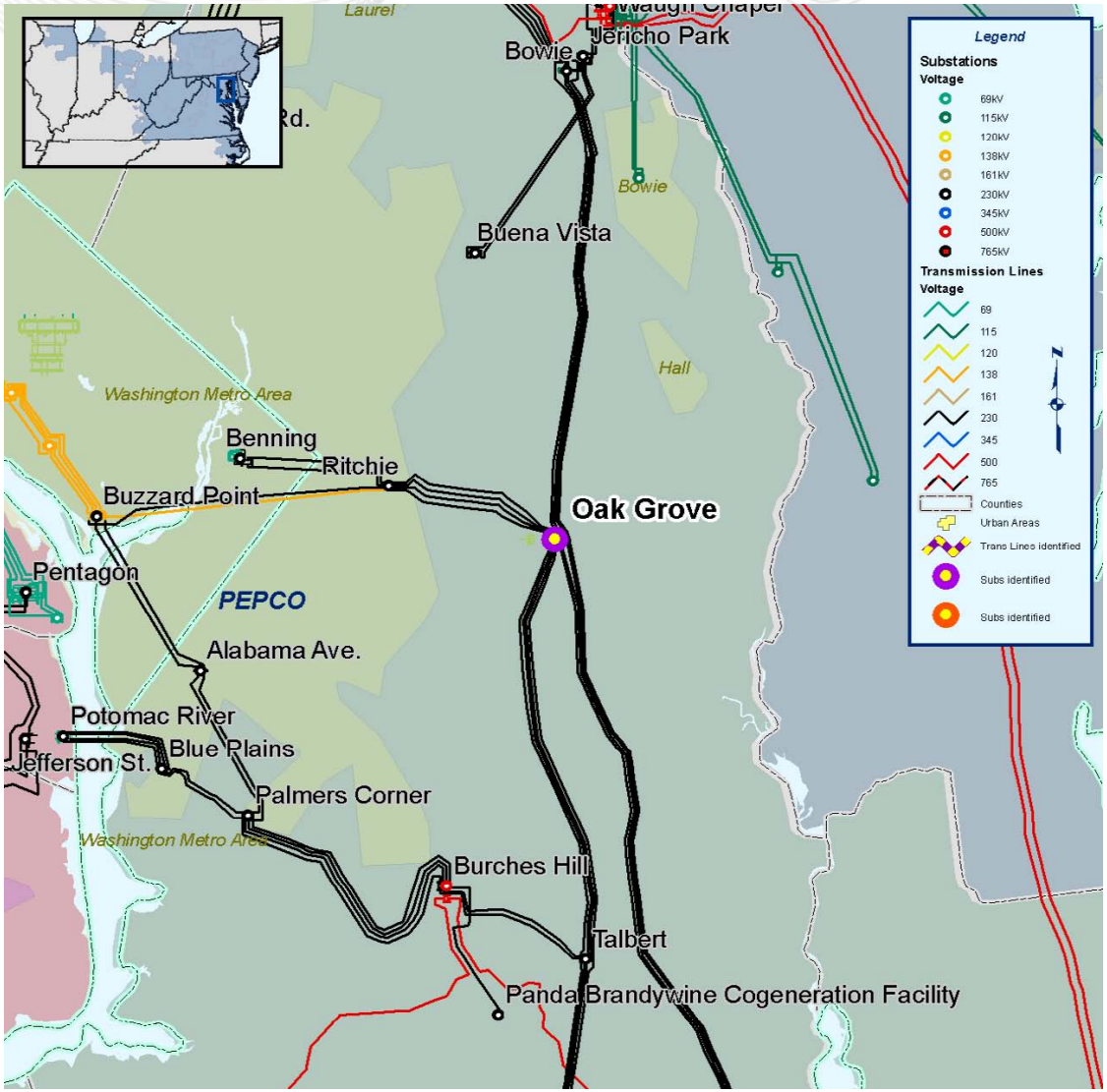
Duquesne Transmission Zone

- The Beaver Valley 138 kV breaker ‘Z33 J&L Midland’ is overstressed
- Proposed Solution: Replace the Beaver Valley 138 kV breaker ‘Z33 J&L Midland’ (b1260)
- Estimated Project Cost: $400K
- Expected IS Date: 6/01/2011



PEPCO Transmission Zone

- 13 Oak Grove 230 kV breakers are overstressed
- Latest analysis shows they are overstressed for 2011 baseline conditions
- Replace the 13 Oak Grove 230 kV breakers that are overstressed
- Revise existing baseline upgrades b0637-b0649 to reflect the new description, cost, and in-service date
- Estimated Project Cost:
  $1.5 M per breaker
- Expected IS Date: 6/01/2011



2015 Analysis Update

AE Transmission Zone

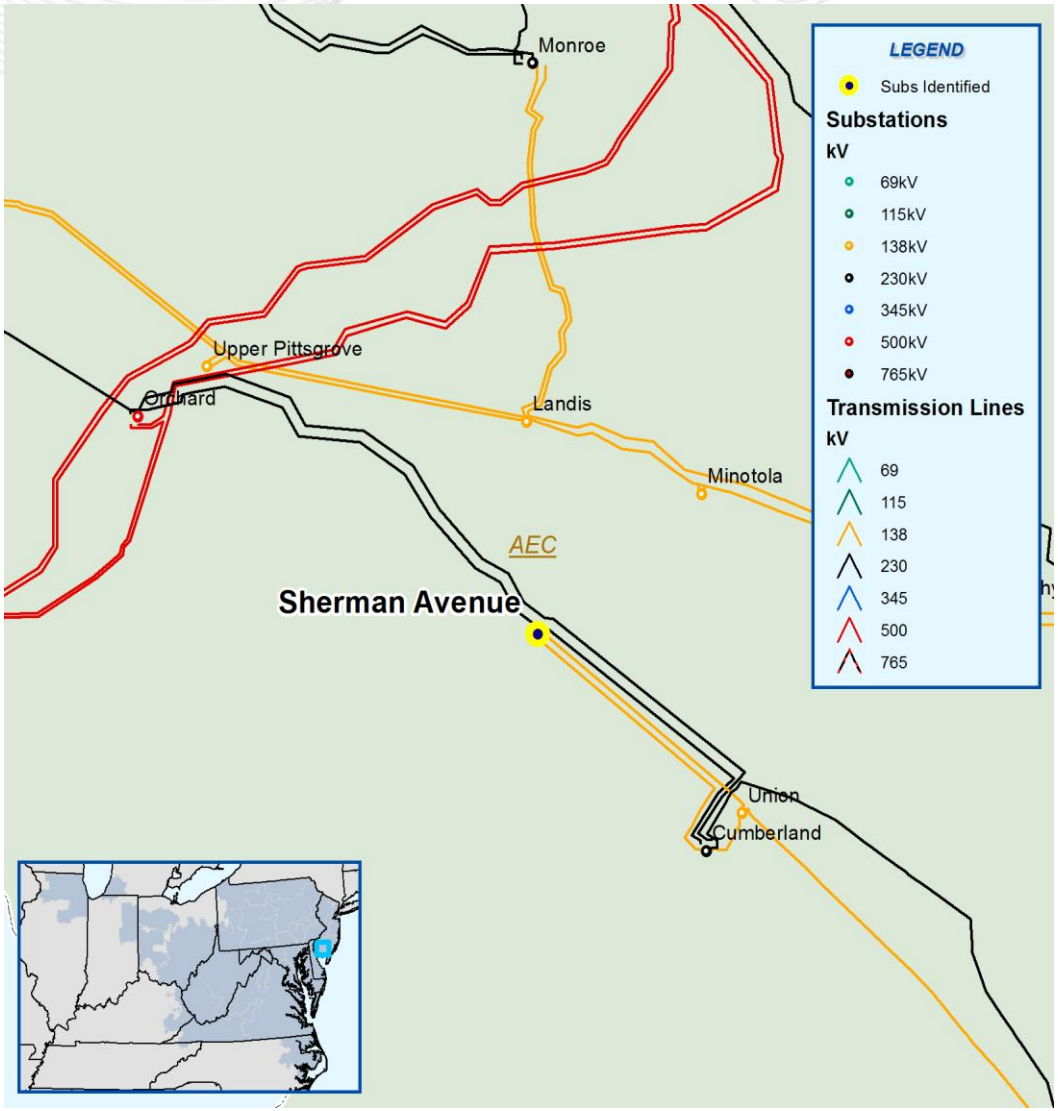
- PHI Planning criteria
- The Sherman 138/69 kV transformers # 1 and # 3 are overloaded for the loss of Sherman transformer # 2.
- Proposed Solution:

  Replace the three Sherman 138/69 kV transformers with two larger transformers (B1280) .
- Estimated Project Cost:

  $7.7 M
- Expected IS Date:

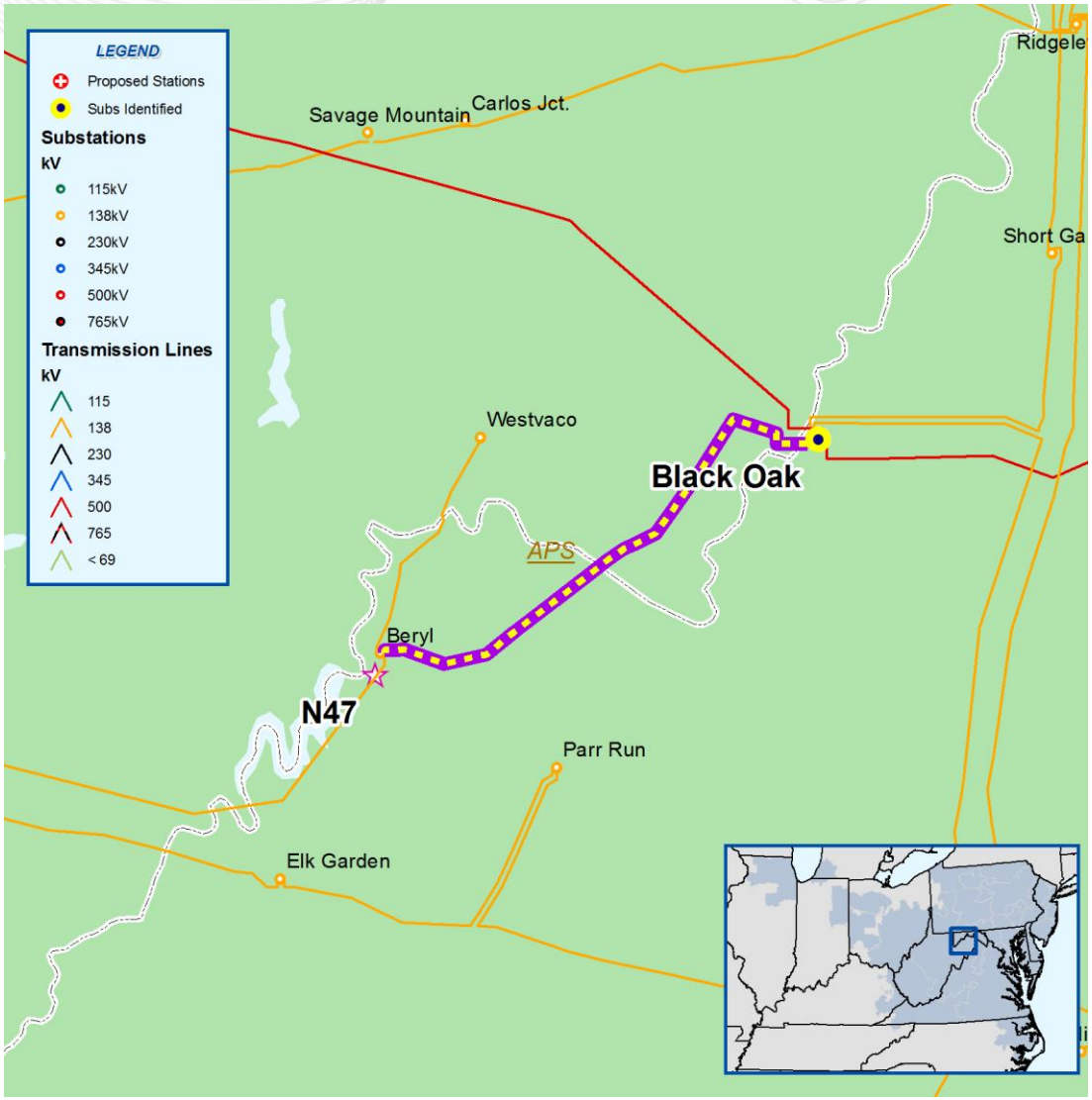
  First transformer 6/1/2011

  Second transformer 6/1/2012



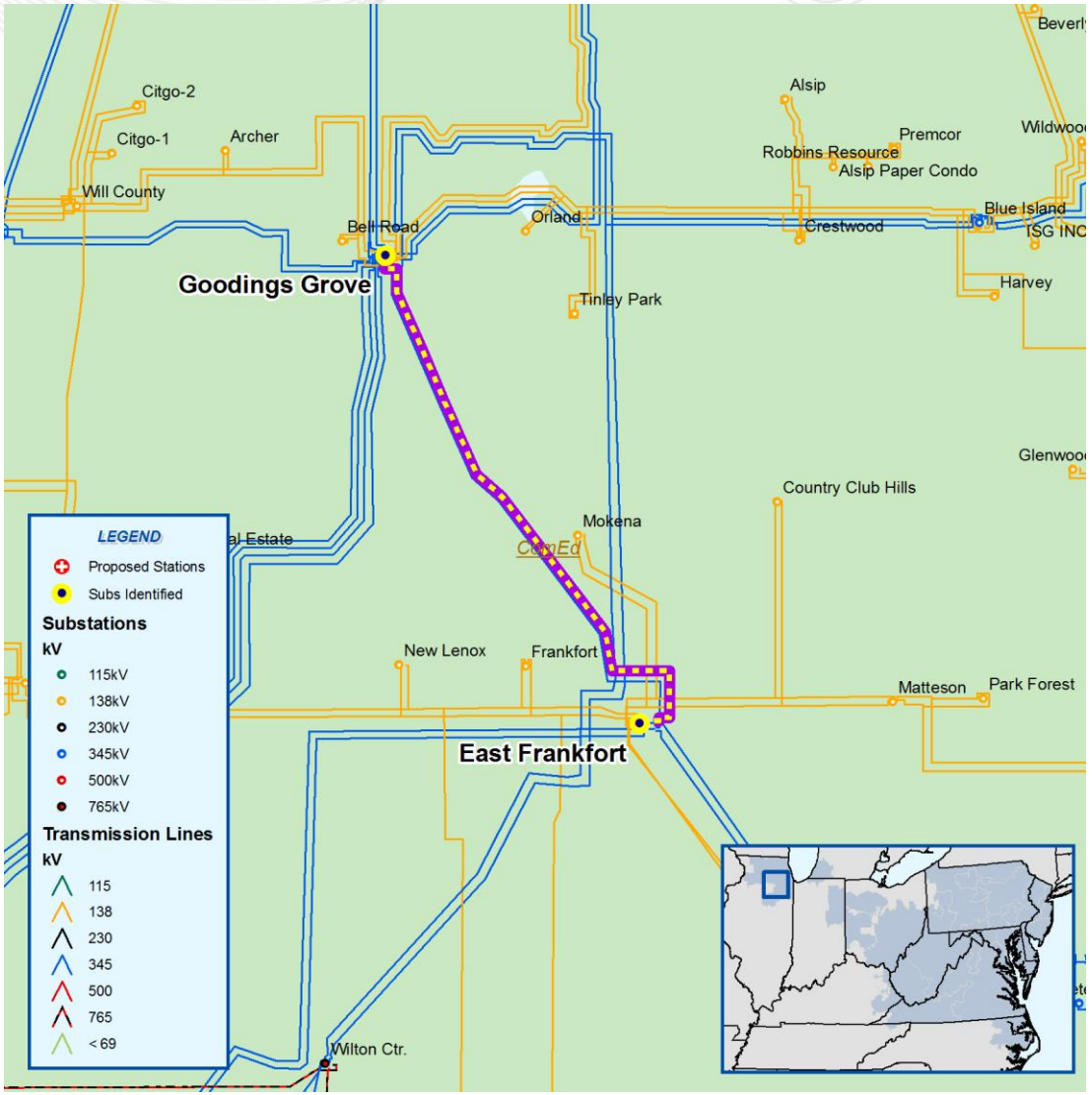
APS Transmission Zone

- Common Mode Contingency Violation
- N47 Tap – Black Oak 138KV line overload for the Black Oak500-Hatfield500 line fault with stuck breaker at Black Oak500 #4 with auto disconnect or at Black Oak500 #5 with auto disconnect switches
- Proposed Solution: Reconductor the Albright-Black Oak AFA 138 kV line with 795 ACSS/TW (B1235) – This upgrade will replace B1171.2
- Estimated Project Cost: $55 M
- Expected IS Date: 6/1/2013



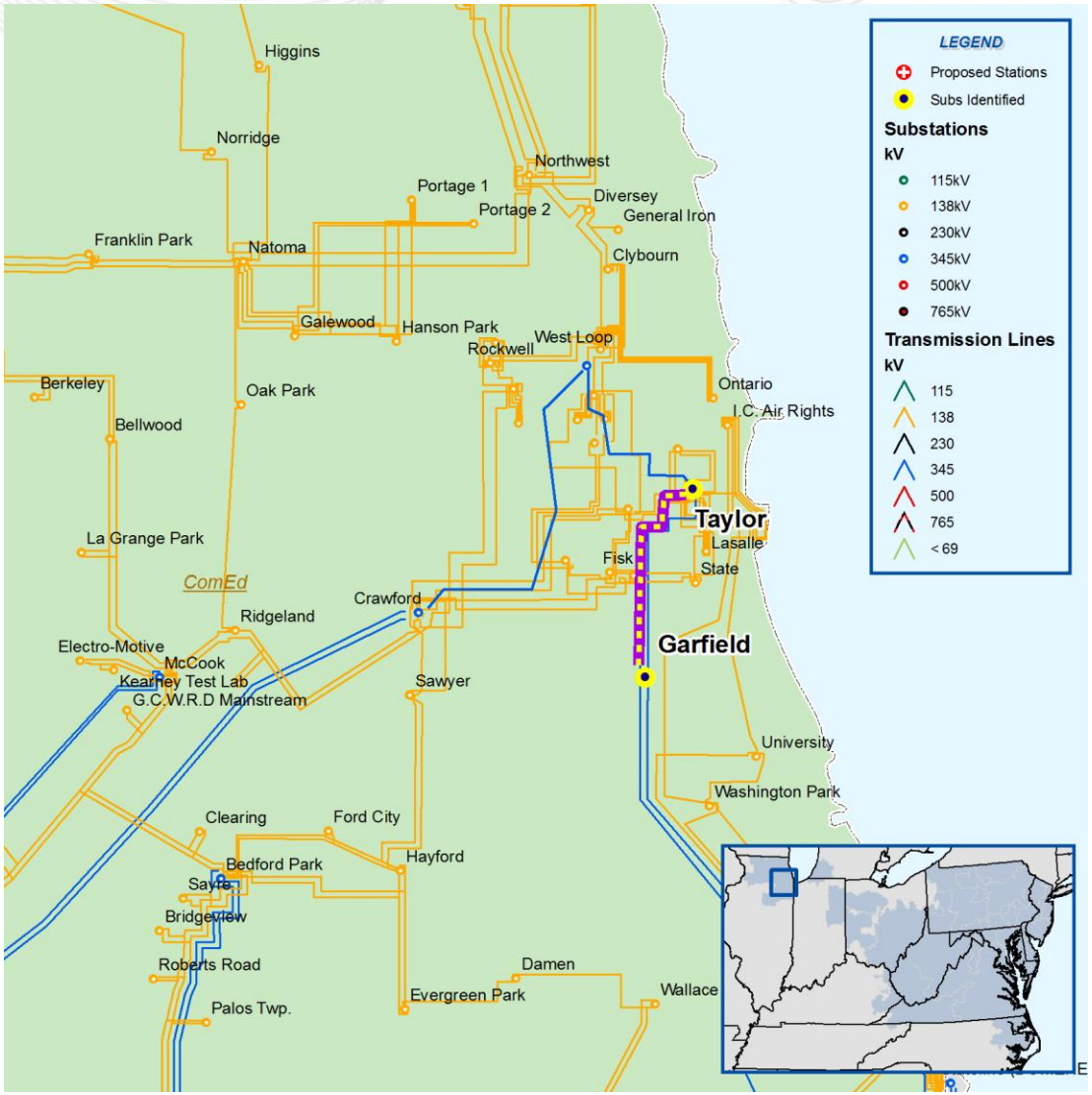
ComEd Transmission Zone

- Load Deliverability Violation
- East Frankfort – Goodings Grove (line 11601) 345kV line is overloaded for normal system conditions
- Proposed Solution: Reconductor the East Frankfort – Goodings Grove 345kV 11601 line (B1300)
- Estimated Project Cost: $22 M
- Expected IS Date: 6/1/2015



ComEd Transmission Zone

- Load Deliverability Violation
- The parallel Garfield – Taylor 345kV lines (17723 and 17724) are overloaded for normal system conditions
- Proposed Solution: Upgrade both Garfield – Taylor 345kV lines (17723 and 17724) (B1301)
- Estimated Project Cost: $150 M
- Expected IS Date: 6/1/2015



2015 Baseline Analysis Next Steps

- N-1-1 Voltage Analysis
- Mid-Atlantic local issues
  - Verify potential solutions to reliability issues in southern PSEG
- PJM West
  - Verify potential solutions in AEP and ComED
- Dominion
  - Verify potential solutions in Dominion

2012 Baseline Retool Update

- Reliability analysis performed without Susquehanna – Roseland

- 2012 Common Mode Outage procedure violations identified

Facility Overloaded	Contingency Type	% Loading
West Wharton - Greystone "J" 230 kV	Double circuit towerline	111.6%*
Newton - Lake Iliff 230 kV		106.5%*
Lake Iliff -Montville 230 kV		105.7%*
Kittatinny - Newton 230 kV		105.3%*
Portland - Greystone "Q" 230 kV		100.4%
Greystone - Whippany 230 kV		99.4%
Kittatinny - Pohatcong 230 kV		98.0%
Glen Gardner - Chester 230 kV		95.4%

* Conductor limited

2012 Baseline Retool Next Steps

- Continue reliability tests of 2012
  - N-1-1
  - Baseline thermal
  - Baseline voltage

- Evaluate alternatives to address reliability criteria violations, including the potential for operating procedures

Baseline Network Upgrade Cost Allocation

Baseline Network Upgrade Cost Allocation

COST ALLOCATION LENGEND

Short Name	Full Name
PEN	Pennsylvania Electric Company
APS	Allegheny Power
PPL	PPL Electric Utilities Company
ME	Metropolitan Edison Company
JC	Jersey Central Power and Light Company
PS	Public Service Electric and Gas Company
AEC	Atlantic City Electric Company
PE	PECO Energy Company
BGE	Baltimore Gas and Electric Company
DPL	Delmarva Power and Light Company
PEP	Potomac Electric Power Company
RE	Rockland Electrical Company
CE	Commonwealth Edison Company
AEP	AEP East Zone
DAY	The Dayton Power and Light Company
DL	Duquesne Light Company
DOM	Virginia Electric and Power Company
NEP	Neptune Regional Transmission System, LLC
ECP	East Coast Power, LLC
HTP	Hudson Transmission Partners, LLC
ATSI	American Transmission Systems, Incorporated

Baseline Network Upgrade Cost Allocation

Project #	Project Description	TO	Cost ($M)	APS	AEC	AEP	BGE	CE	DAY	DL	DPL	DOM	JC	ME	NEP	PE	PEN	PEP	PPL	PS	RE	HTP	ECP
b1171.1	Install the second Black Oak 500/138kV transformer, two 138kV breakers, and related substation work	APS	15				21.45				3.21	38.16		2.78		3.44		30.96					
b1171.3	Install six 500 kV breakers associated with the second black oak 500/138 kV transformer	APS	TBD	6.27	1.99	17.96	4.85	15.61	2.46	2.01	2.83	13.34	4.22	2.09	0.50	5.88	2.11	4.65	5.6	7.12	0.27		0.24
b1178	Add a second 230/138 kV transformer at Chichester. Add an inductor in series with the parallel transformers	PE	5.908										4.14		0.44	82.19				12.10	0.48	0.32	0.33
b1179	Replace terminal equipment at Eddystone and Saville and replace underground section of the line	PE	3.94													100							
b1180.1	Replace terminal equipment at Chichester	PE	0.475													100							

Baseline Network Upgrade Cost Allocation

Project #	Project Description	TO	Cost ($M)	PE	JC	NEP	EC P	HTP	PS	RE	ATSI
b1180.2	Replace terminal equipment at Chichester	PE	0.475	100							
b1181	Install 230/138 kV transformer at Eddystone	PE	3.6	100							
b1182	Reconductor Chichester - Saville 138 kV line and upgrade terminal equipment	PE	8.5	78.85	5.08	0.54	0.39	0.38	14.20	0.56	
b1183	Replace 230/69 kV transformer #6 at Cromby. Add two 50 MVAR 230 kV banks at Cromby	PE	6.142	100							
b1184	Add 138 kV breakers at Cromby, Perkiomen, and North Wales. Add a 35 MVAR capacitor at Perkiomen 138 kV	PE	3.9	100							
b1185	Upgrade Eddystone 230 kV breaker #365	PE	0.125	100							
b1186	Upgrade Eddystone 230 kV breaker #785	PE	0.125	100							
b1190	Reconductor Lemonyne –Maclean 138KV circuit with 954ACSS conductor	ATSI	4.3								100
b1191	Replace the Shenango –Crossland 138KV circuit #2 meter with a higher rated meter	ATSI	0.015								100
b1192	Reconductor the Bayshore –Chevy 138KV circuit with 636 ACSS conductor	ATSI	4.3								100
b1193	Replace the Hanna –East Akron 138KV 800 Amp wavetrap with a 1200 Amp wavetrap	ATSI	0.052								100

Baseline Network Upgrade Cost Allocation

Project #	Project Description	TO	Cost ($M)	PE	ATSI	AEC	PPL	APS
b1194	Reconductor the General Mills – Jackman 138KV line with 636 ACSS conductor	ATSI	0.647		100			
b1195.1	Upgrade the Corson sub T2 terminal	AEC	0.1			100		
b1195.2	Upgrade the Corson sub T1 terminal	AEC	0.03			100		
b1996	Remove the Siegfried bus tie breaker and install a new breaker on the Martins Creek 230 kV line west bay to maintain two ties between the 230 kV buses	PPL	1				100	
b1997	Reconductor the PECO portion of the Burlington - Croydon circuit	PE	1	100				
b1998	Replace terminal equipments including station cable, disconnects and relay at Conowingo 230 kV station	PE	0.5	100				
b2000	Reconductor Double Toll Gate - Greenwood 138 kV with 954 ACSR conductor	APS	3					100
b2001	Rebuild the Hercules Tap to Double Circuit 69 kV	PPL	1.95				100	
b2002	Mack-Macungie Double Tap, Singe Feed Arrangement	PPL	0.332				100	
b2003	Add the 2nd Circuit to the East Palmerton-Wagners - Lake Naomi 138/69 kV Tap	PPL	12.3				100	
b2004	New Breinigsville 230-69 kV Substation	PPL	34.65				100	
b2005	Siegfried-East Palmerton #1 69 kV Line- Install new 69 kV LSAB, Sectionalize, and Transfer Treichlers Substation	PPL	0.28				100	

Baseline Network Upgrade Cost Allocation

Project #	Project Description	TO	Cost ($M)	PPL
b2006	Siegfried-Quarry #1 & #2 69 kV Lines- Rebuild 3.3 mi from Quarry Substation to Macada Taps	PPL	3.8	100
b2009	Convert Neffsville Taps from 69kV to 138kV Operation	PPL	0	100
b2010	Convert Roseville Taps from 69kV to 138kV Operation (Part 1 – operate on the 69kV system	PPL	0.85	100
b2011	New 138kV Taps to Flory Mill 138/69kV Substation	PPL	0.03	100
b2012	Convert East Petersburg Taps from 69kV to 138kV Operation, Install two 10.8MVAR capacitor banks	PPL	0.69	100
b2013	Convert East Petersburg Taps from 69 kV to 138 kV operation, install two 10.8 MVAR capacitor banks	PPL	0	100
b2014	Terminate South Manheim-Donegal #2 at South Manheim, Reduce South Manheim 69kV Capacitor Bank, Resectionalize 69kV	PPL	0.08	100
b2015	Reconductor and rebuild 16 miles of Peckville-Varden 69 kV line and 4 miles of Blooming Grove-Honesdale 69 kV line	PPL	22.4	100
b2016	Build approximately 2.5 miles of new 69 kV transmission line to provide a “double tap – single feed” connection to Kimbles 69/12 kV substation	PPL	2.69	100
b2017	Provide a “double tap – single feed” connection to Tafton 69/12 kV substation.	PPL	2	100

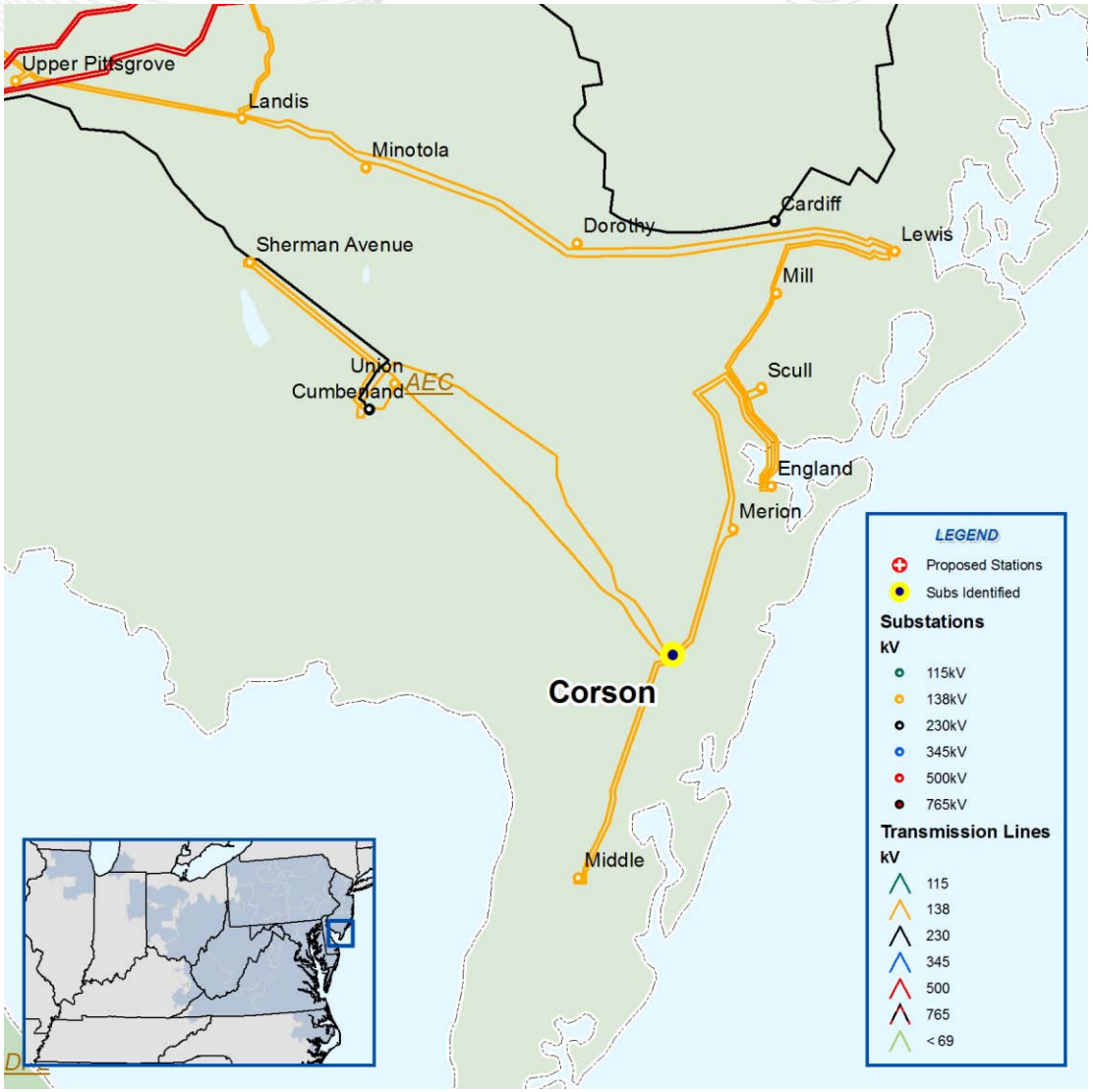
Baseline Network Upgrade Cost Allocation

Project #	Project Description	TO	Cost ($M)	APS	AEC	AEP	BGE	CE	DAY	DL	DPL	DOM	JC	ME	NEP	PE	PEN	PEP	PPL	PS	RE	ECP
b2024	Install 2nd Clover 500/230 kV transformer and a 150 MVAr capacitor	DOM	16				8.04				1.10	76.85		0.81		1.48		11.72				
b2062	Install Brambleton 500/230 kV transformer and associated 230 kV breakers	DOM	14.5		0.24		7.74				0.6	75.15		0.23		0.78		15.26				
b2062.1	Install 500 kV breakers associated with Brambleton 500/230 kV	DOM	3.5	6.27	1.99	17.96	4.85	15.61	2.46	2.01	2.83	13.34	4.22	2.09	0.5	5.88	2.11	4.65	5.6	7.12	0.27	0.24

Proposed 2010 RTEP Upgrades presented at Previous TEAC meetings

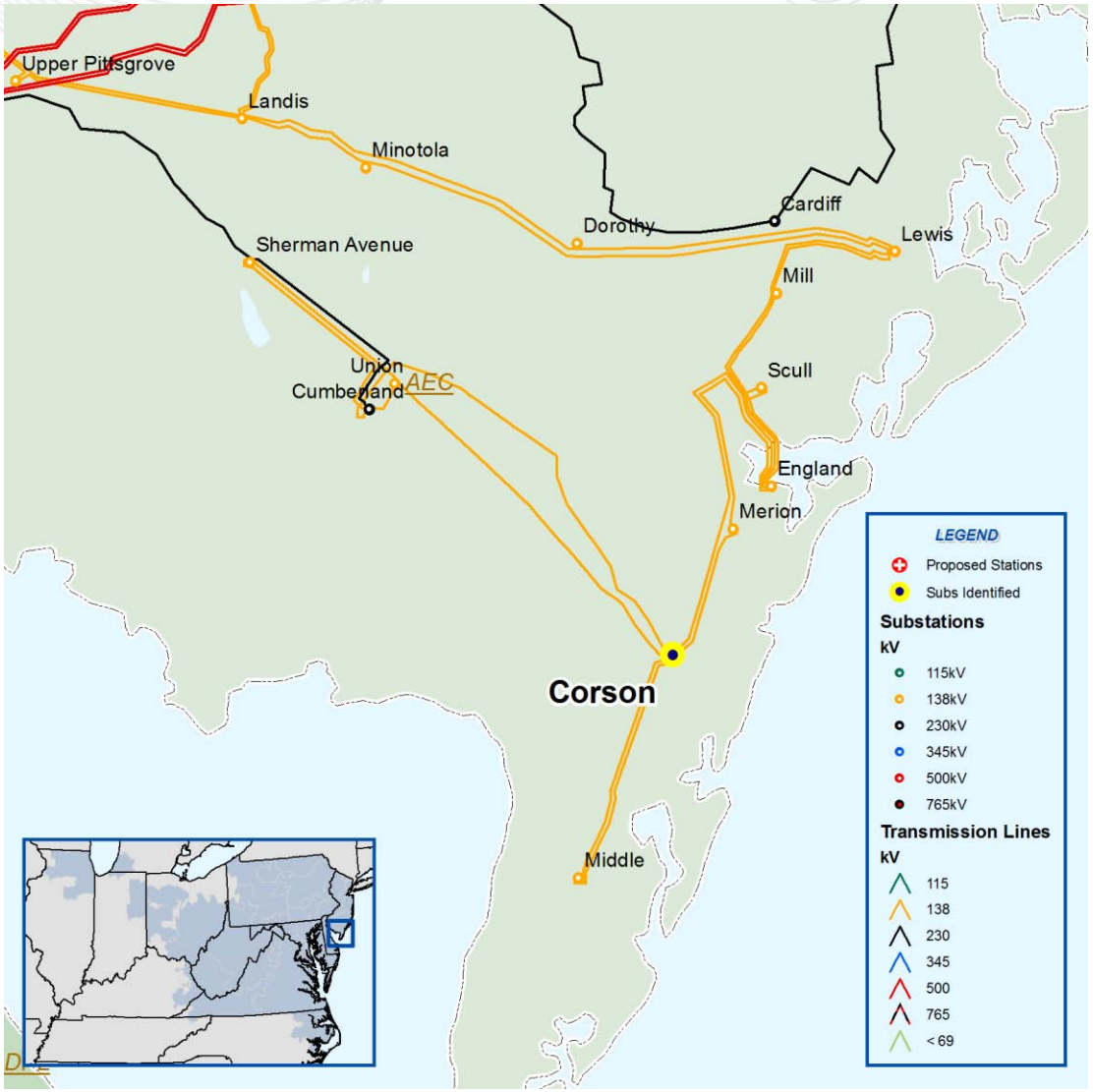
AE Transmission Zone

- Generation Deliverability
- The Corson 138/69 kV transformer # 2 is overloaded for the loss of the parallel transformer
- Proposed Solution: Upgrade the Corson Sub T2 terminal (B1195.1)
- Estimated Project Cost: $0.1M
- Expected IS Date: 5/31/2011



AE Transmission Zone

- Generation Deliverability
- The Corson 138/69 kV transformer # 1 is overloaded for the loss of the parallel transformer
- Proposed Solution: Upgrade the Corson Sub T1 terminal (B1195.2)
- Estimated Project Cost: $0.3M
- Expected IS Date: 5/31/2012

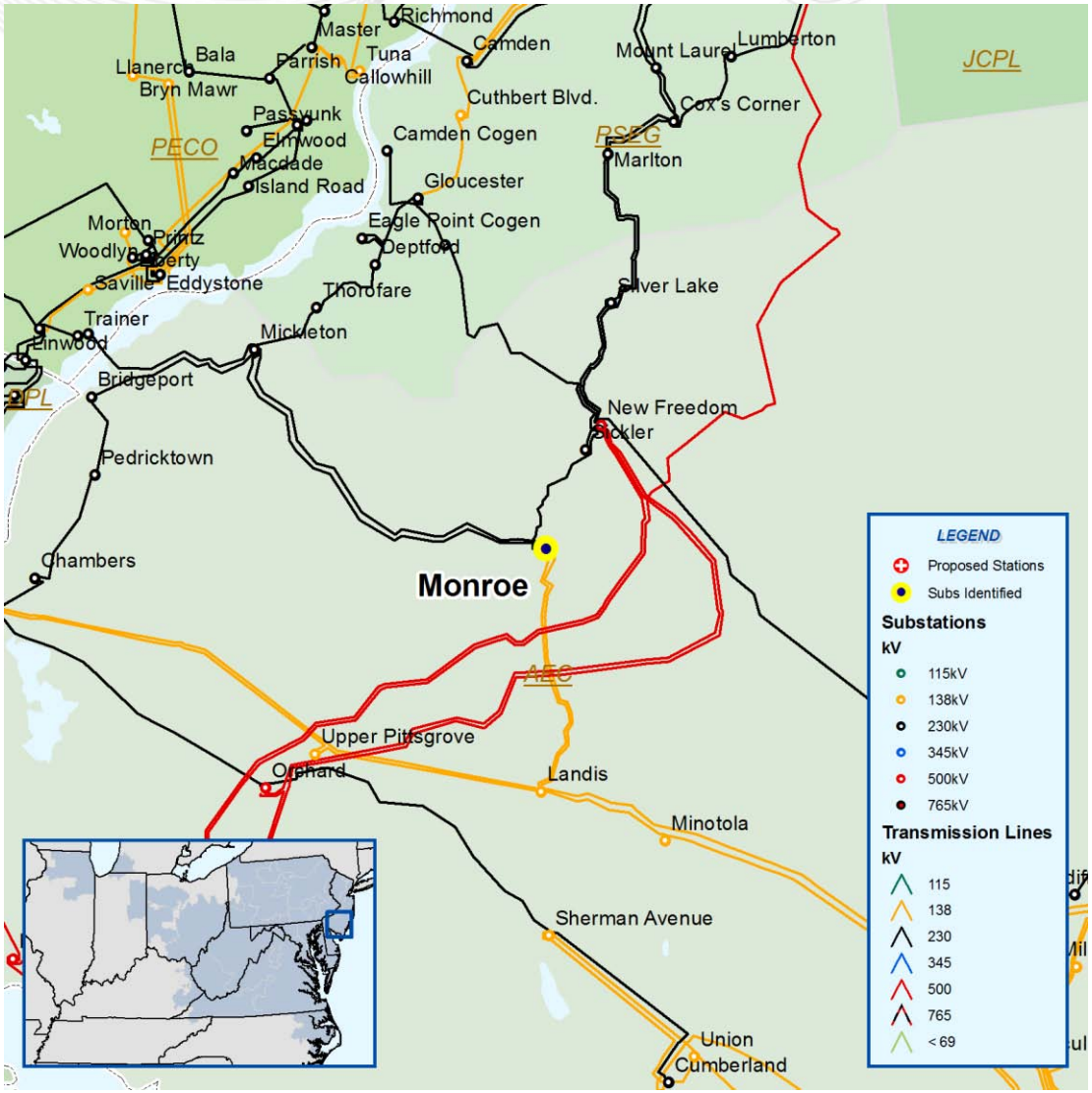


AE Transmission Zone

- Load Deliverability
- The Monroe 230/69 kV transformers # 2 and # 3 were overloaded and replaced in 2009 (B0267), as part of the project, a bus conductor will be upgraded to increase the rating of transformer # 2 (B0267.1)
- Estimated Project Cost:

  $0.25M
- Expected IS Date:

  5/31/2011



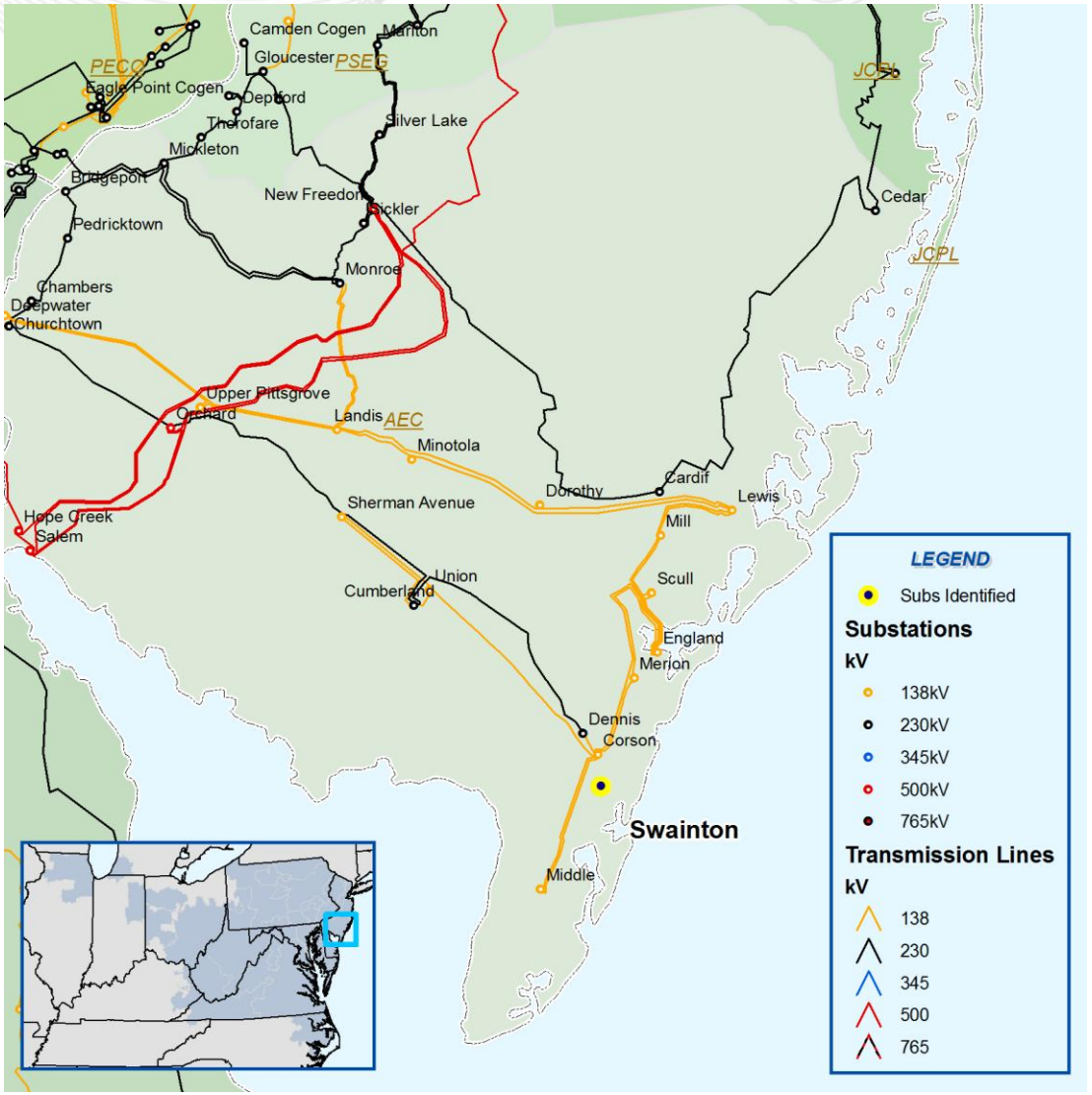
AE Transmission Zone

- Baseline Violation:
- Voltage magnitude violation on the Peermont and Swainton 69 kV buses for the loss of Corson – Swainton 69 kV single contingency.
- Proposed Solution:

  Install 10 MVAR capacitor at Peermont 69 kV substation. (B1244)
- Estimated Project Cost:

  $0.75M
- Expected IS Date:

  5/1/2015



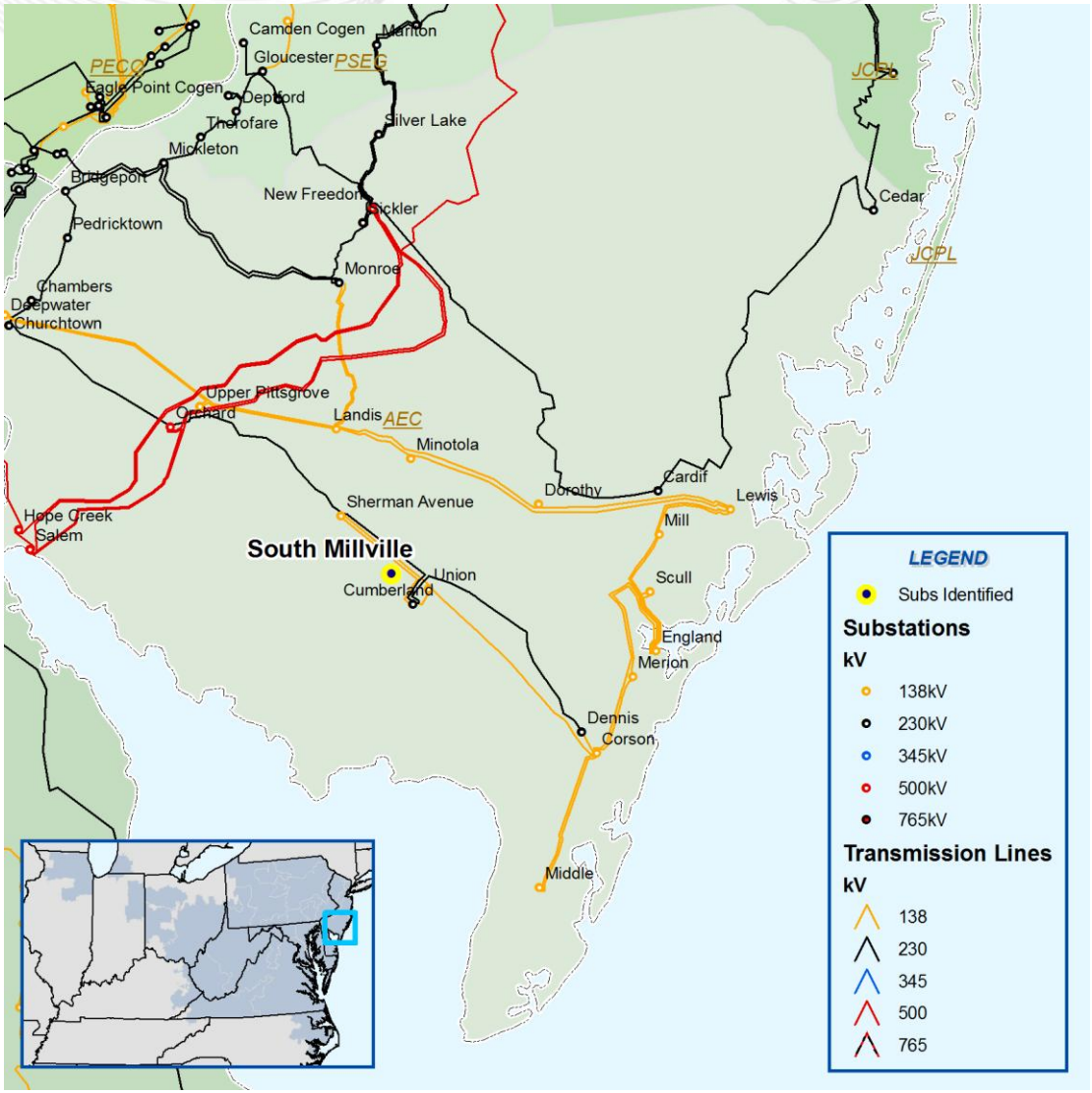
AE Transmission Zone

- Baseline Violation:
- The US SLC – South Millville 69 kV is overloaded for the loss of Laurel – Fairton 69 kV single contingency.
- Proposed Solution:

  Rebuild the Newport – South Millville 69 kV circuit (B1245).
- Estimated Project Cost:

  $1.9M
- Expected IS Date:

  5/31/2012



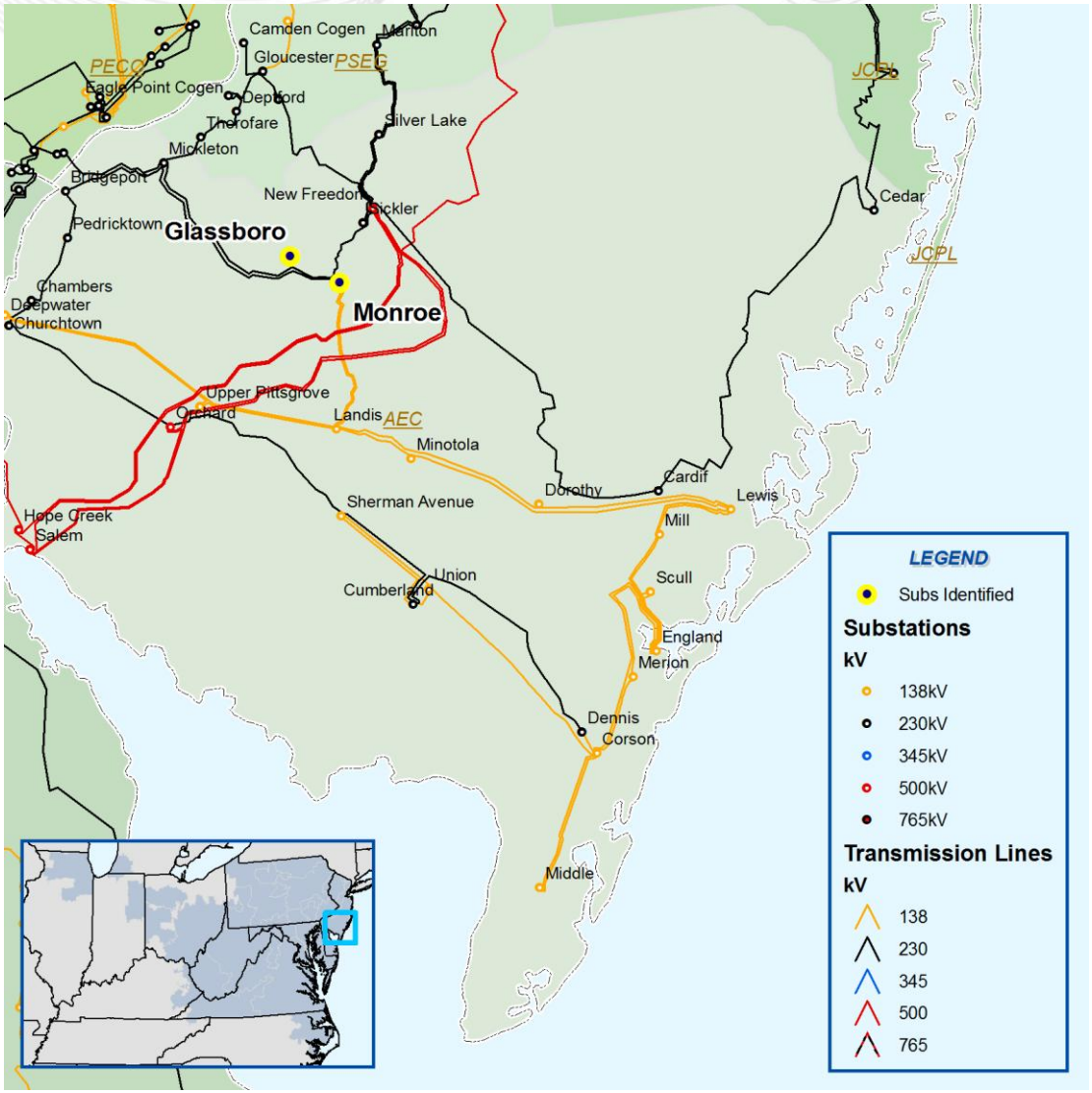
AE Transmission Zone

- N-1-1 Thermal Violation:
- The Monroe - Glassboro 69 kV is overloaded for the loss of the Terrace – Pine Hill 69 kV and the Monroe – Wash 69 kV contingences.
- Proposed Solution:

  Reconductor the Monroe - Glassboro 69 kV(B1250) and upgrade substation equipment at Glassboro (B1250.1).
- Estimated Project Cost:

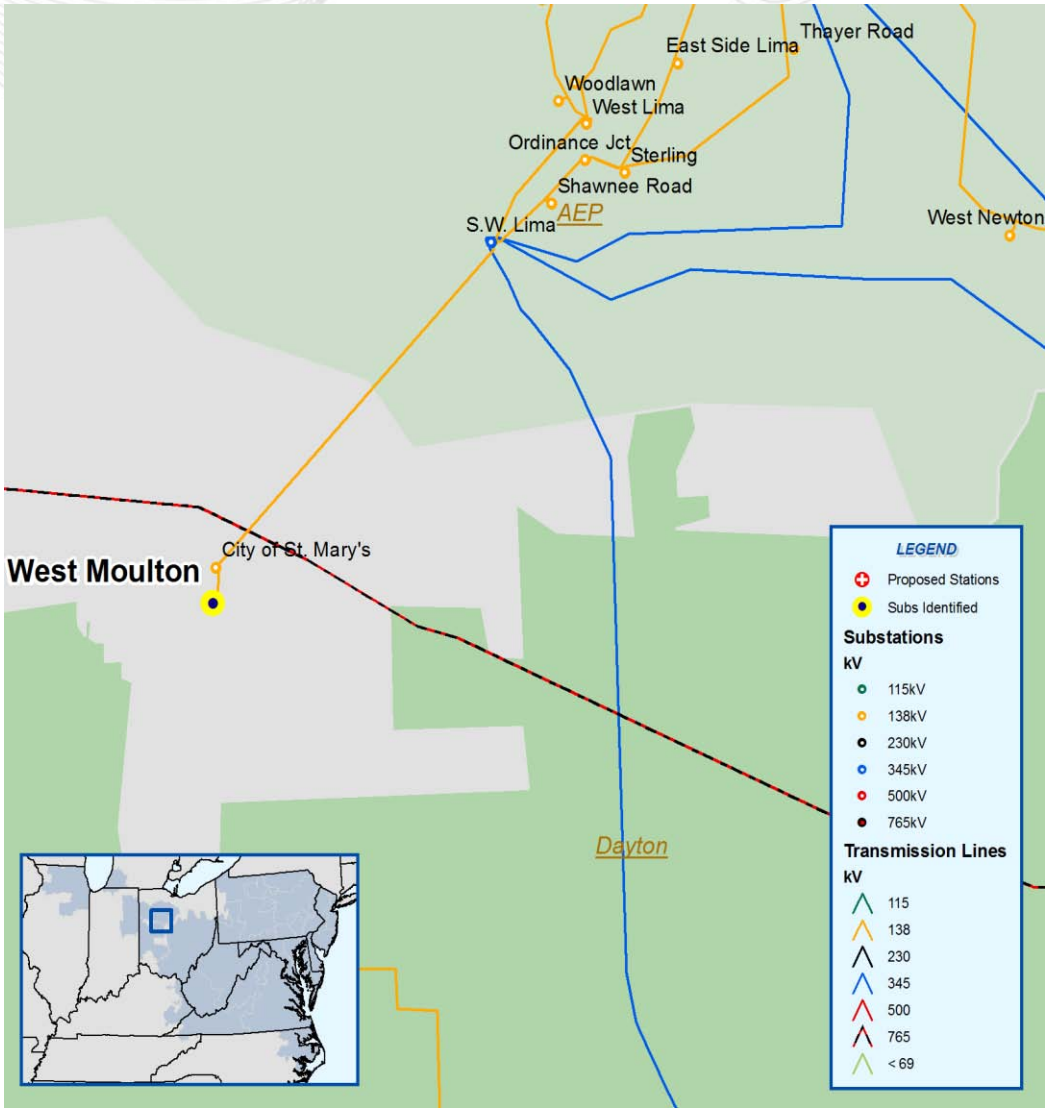
  $1.55M
- Expected IS Date:

  6/1/2015



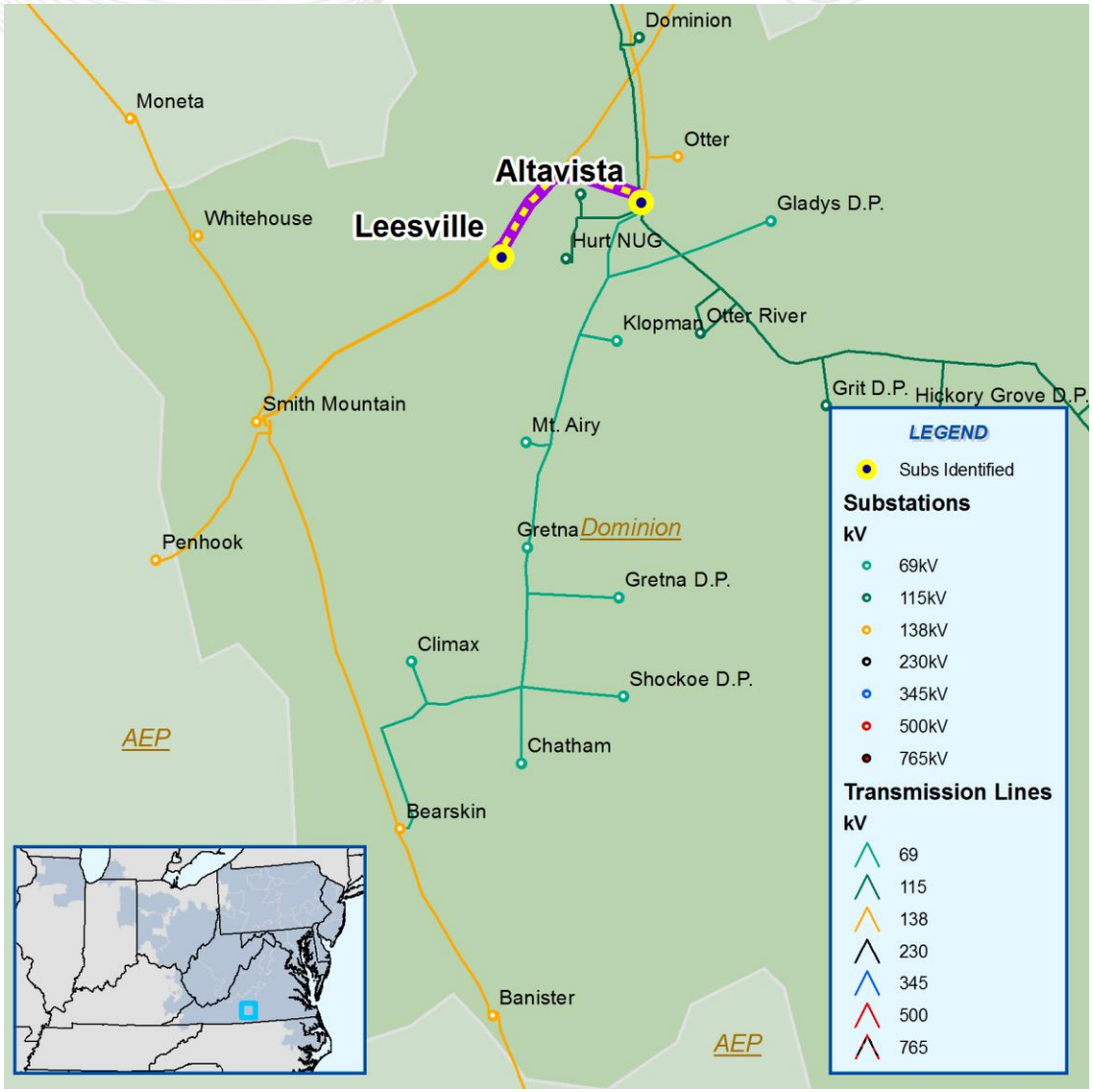
AEP Transmission Zone

- AEP study: The maximum temperature reading on the existing transformer at West Moulton exceeded its allowable temperature under normal system conditions. Furthermore, single-contingency outages overload the West Moulton – Wapakoneta 69 kV line beyond its rating
- Proposed Solution:
  - Replace the existing 138/69-12 kV transformer at West Moulton Station with a 200 MVA 138/69 kV transformer and a 69/12 kV transformer
  - Reconductor 7.23 miles of 69 kV line from Wapakoneta to West Moulton circuit using 556 ASCR (B1231)
- Cost Estimate: $11.9M
- Expected IS Date: 6/1/2012



AEP Transmission Zone

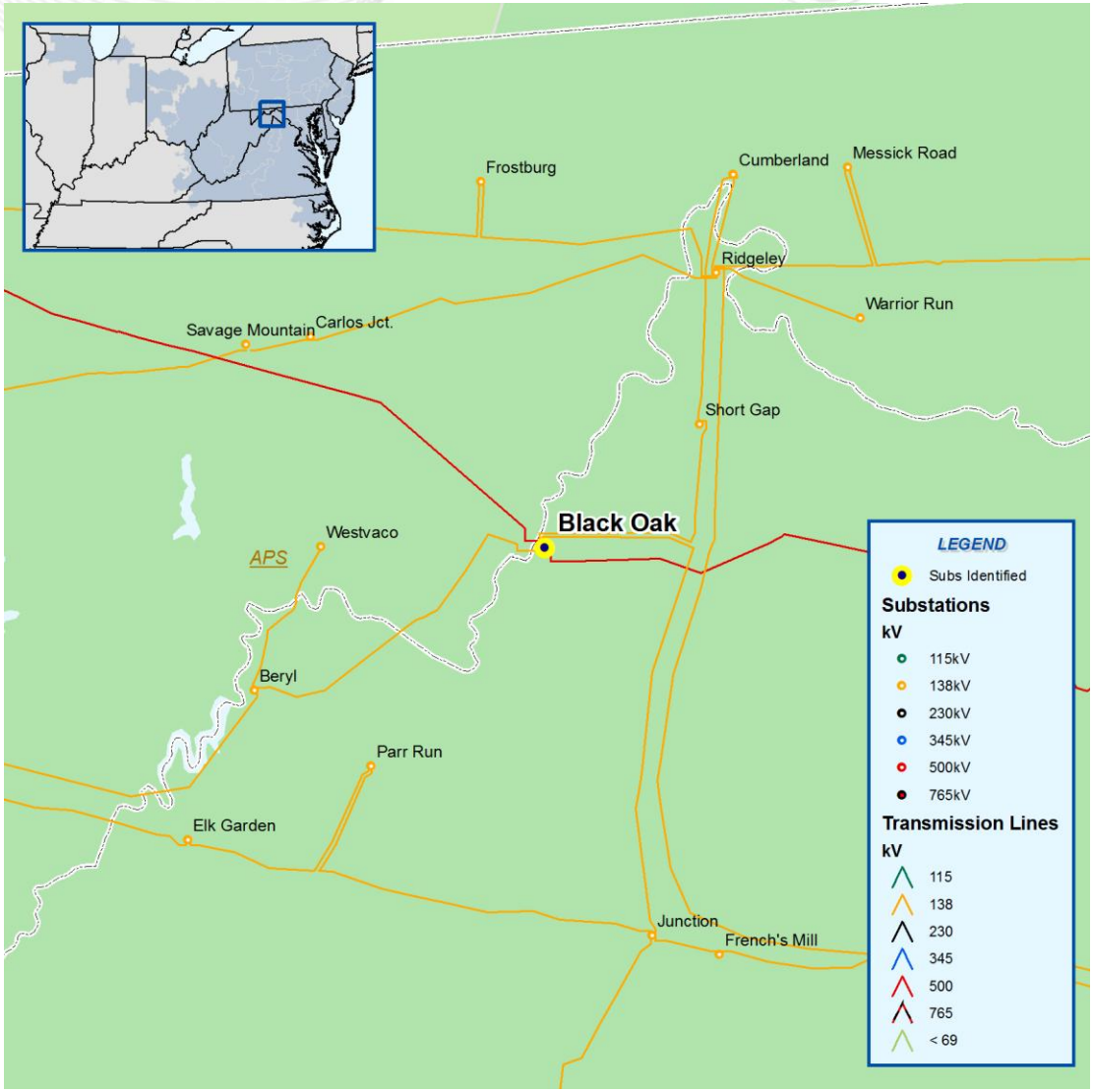
- Altavista 63MW Plant in Dominion requested retirement
- Altavista - Leesville* 138 kV is overloaded for the loss of the Banister – Bearskin - Smith Mountain 138 kV line or the Bearskin 138/69 kV transformer.
- Proposed Solution: Perform a sag study (B1227).
- Estimated Project Cost: $20,500



*Note: Altavista – Leesville 138kV is an AEP facility even though it appears to be in the Dominion zone

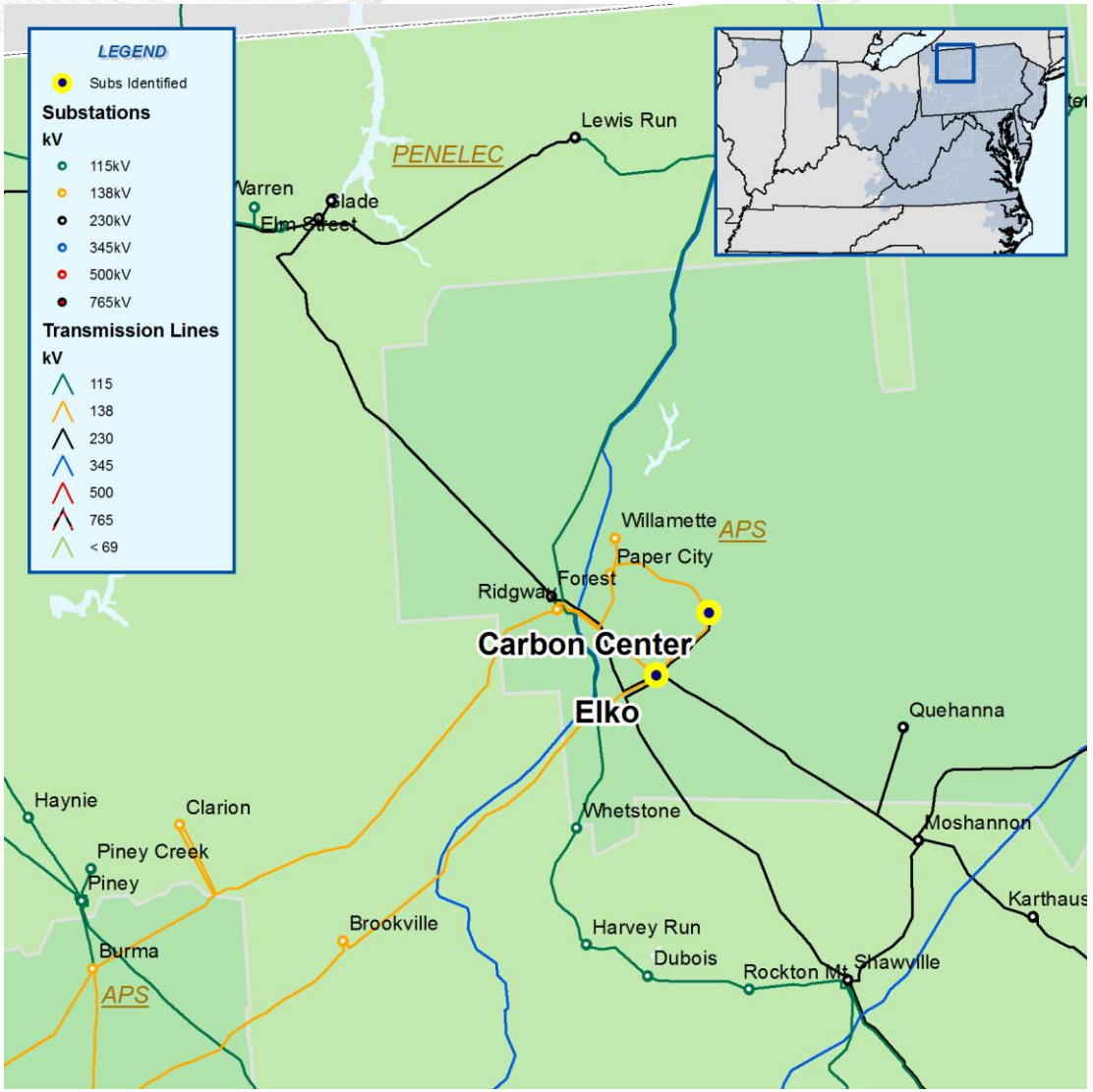
APS Transmission Zone

- Overload on Black Oak 500/138kV transformer for the loss of Hatfield – Black Oak 500 kV in Generation Deliverability test
- Install a second Black Oak 500/138kV transformer and associated substation equipment (B1171.1)
- Cost :$ 15 M
- Required IS Date : 06/01/2013



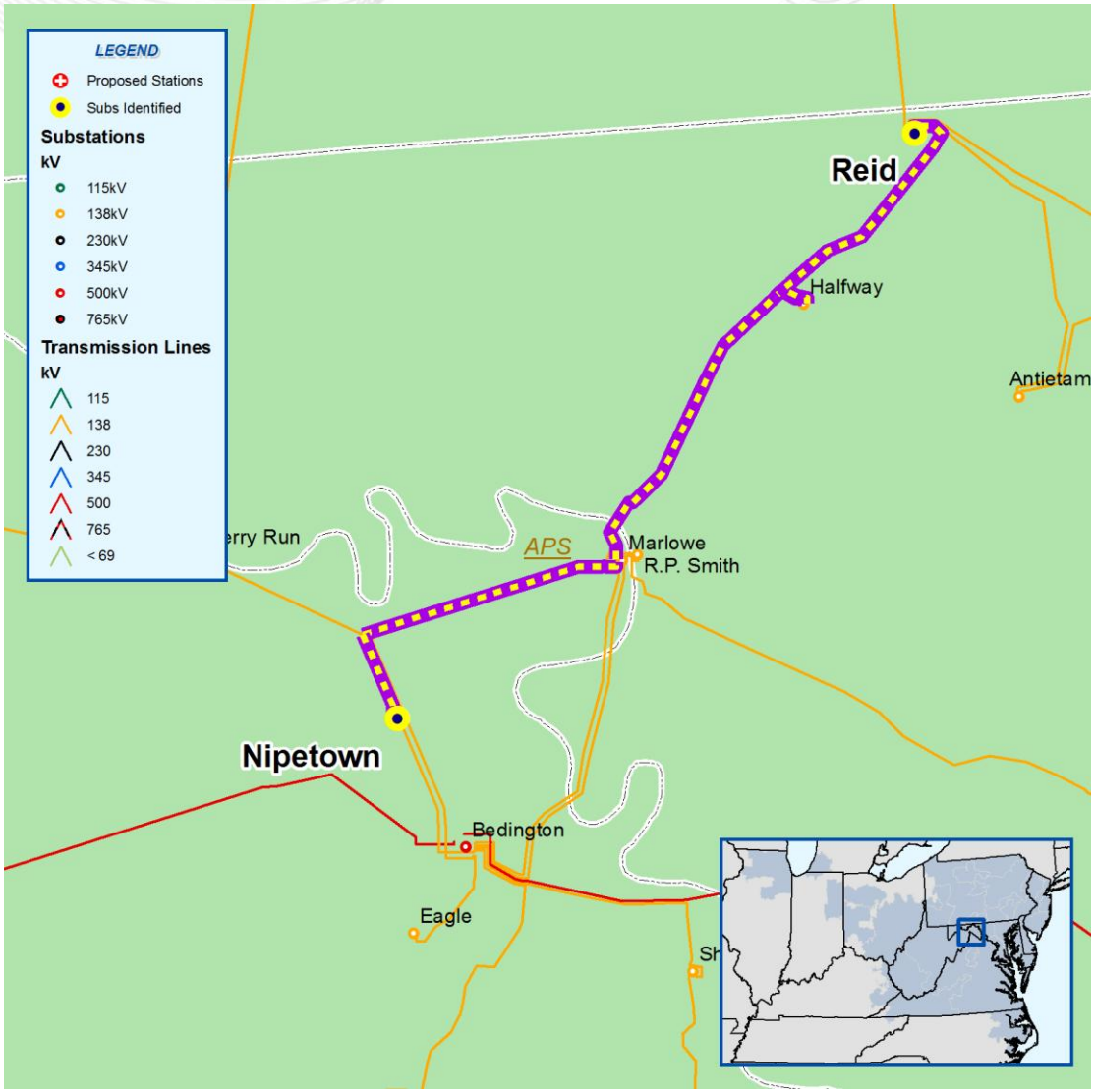
APS Transmission Zone

- Baseline Voltage Violation
- Voltage collapse for several stuck breaker contingencies at Elko and Carbon Center
- Proposed Solution:
  - Convert Carbon Center from 138 kV to a 230 kV ring bus (B1221.1)
  - Estimated Project Cost - $2.0M
  - Construct Bear Run 230 kV Substation with 230/138 kV transformer (B1221.2)
  - Estimated Project Cost - $6.0M
  - Loop Carbon Center Junction – Willamette line into Bear Run (B1221.3)
  - Estimated Project Cost - $3.2M
  - Carbon Center - Carbon Center Junction & Carbon Center Junction - Bear Run Conversion from 138 kV to 230 kV (B1221.4)
  - Estimated Project Cost - $4.3M
- Total Estimated Project Cost: $15.5M
- Expected IS Date: 6/1/2014



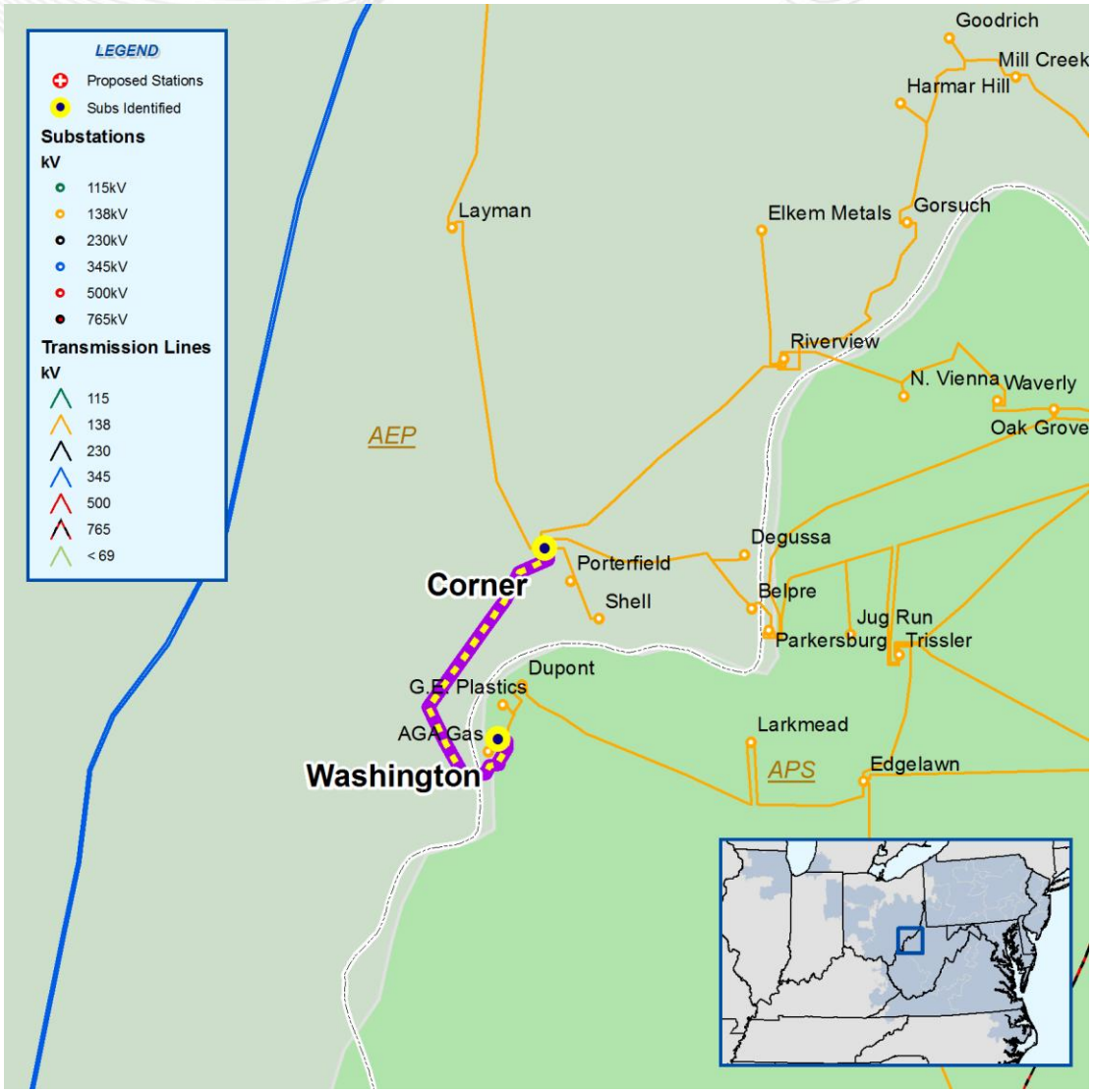
APS Transmission Zone

- Generator Deliverability Violation
- Nipetown - Reid 138kV line overload for the fault of Marlowe - Harmony Junction 138kV line with breaker failure at Marlowe
- Proposed Solution: Reconductor Nipetown - Reid 138kV with 1033 ACCR (B1232)
- Estimated Project Cost: $15 M
- Expected IS Date: 6/1/2015



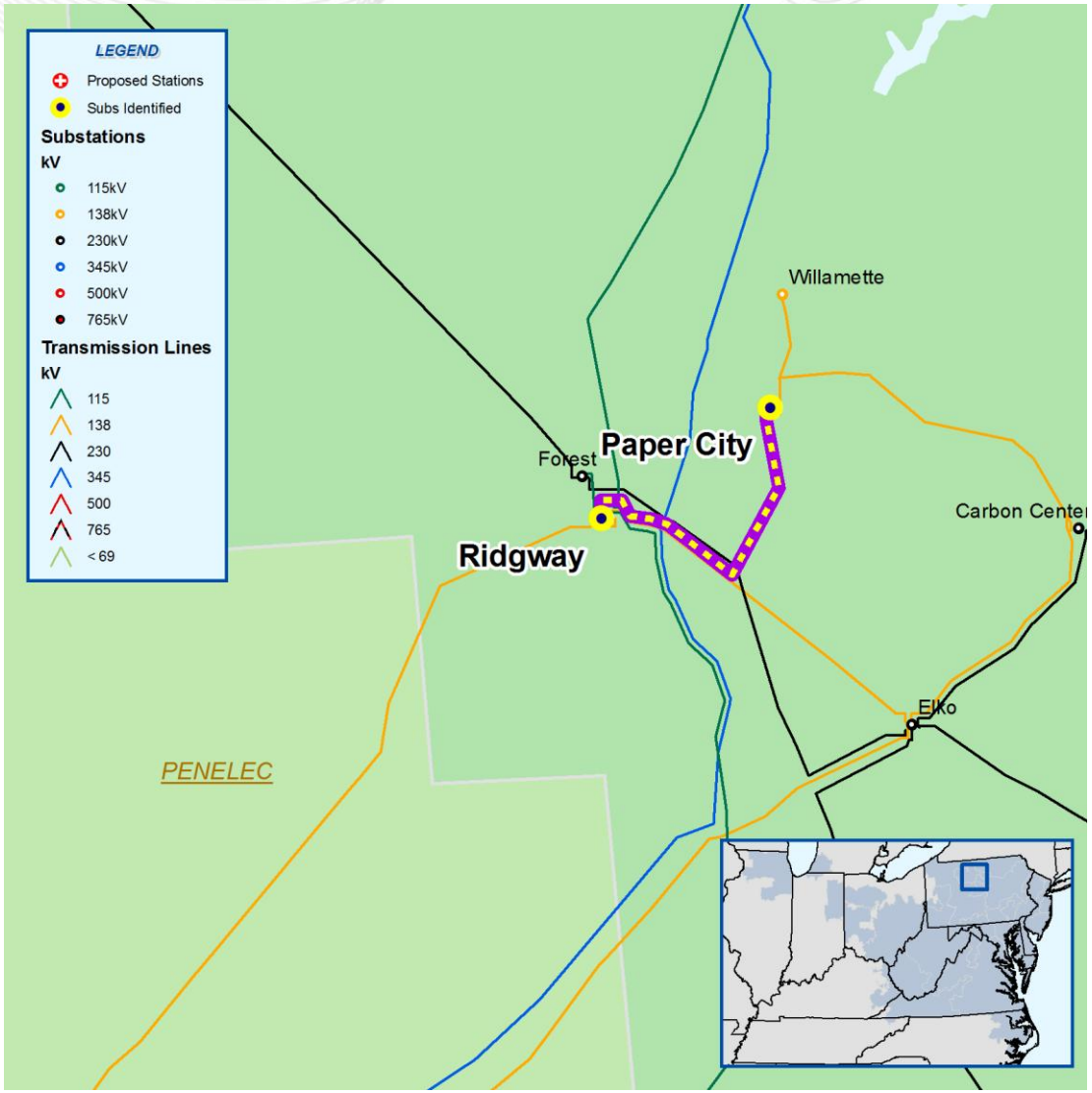
APS Transmission Zone

- Common Mode Outage Violation
- The Corner - Washington 138kV line is overloaded for the common tower outage of the Blemont – Trissler 138kV line #1 and the Belmont – Edgelawn 138kV line
- Proposed Solution: Upgrade Terminal Equipment at Washington (B1233.1)
- Estimated Project Cost: $0.05 M
- Expected IS Date: 6/1/2015



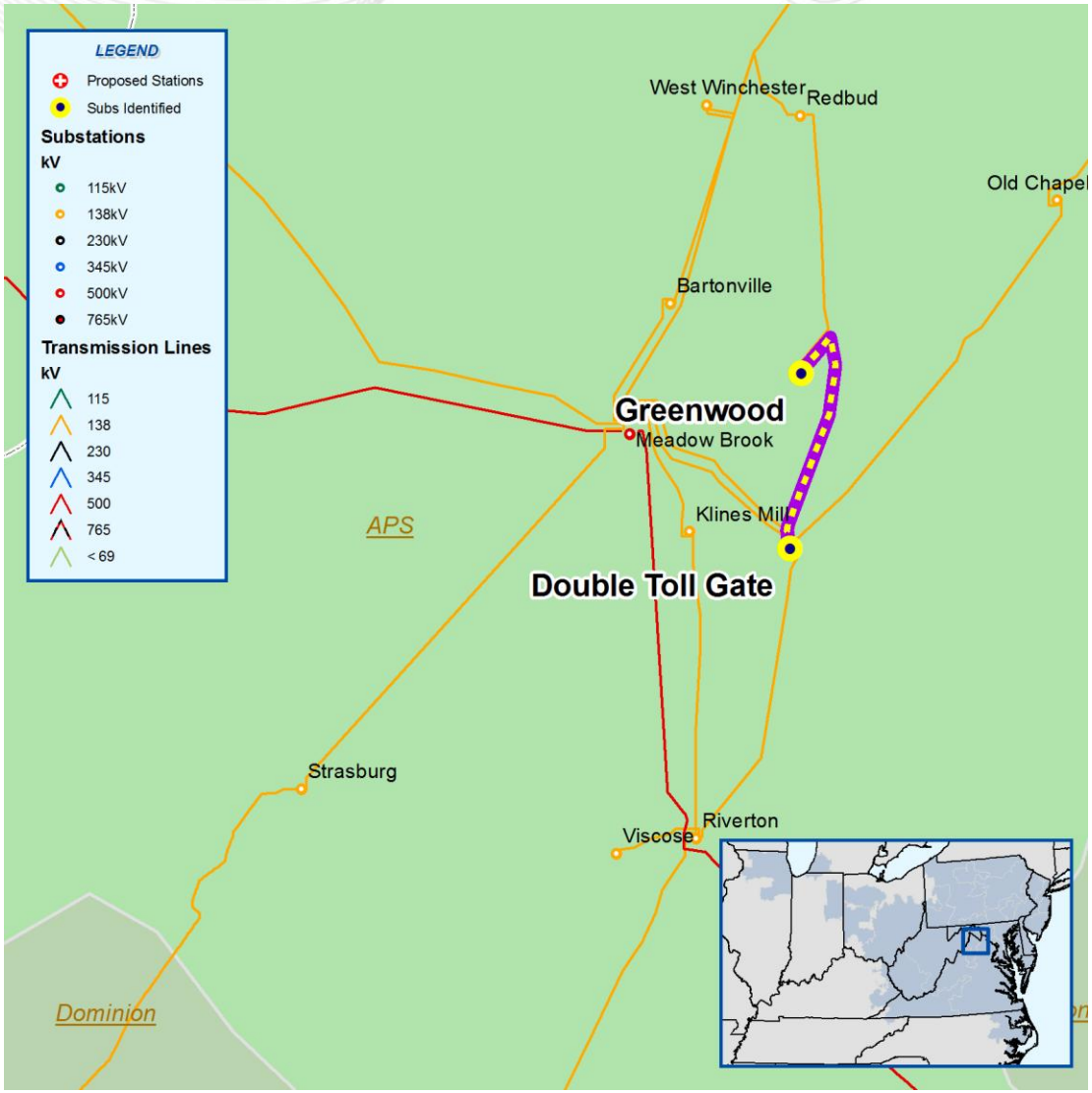
APS Transmission Zone

- Common Mode Outage Violation
- Ridgeway – Paper City 138kV line overload for the common mode outage of the Elko230 #4 Breaker Failure - Tie Breaker
- Proposed Solution: Replace Structures between Ridgeway and Paper City (B1234)
- Estimated Project Cost: $0.75 M
- Expected IS Date: 6/1/2015



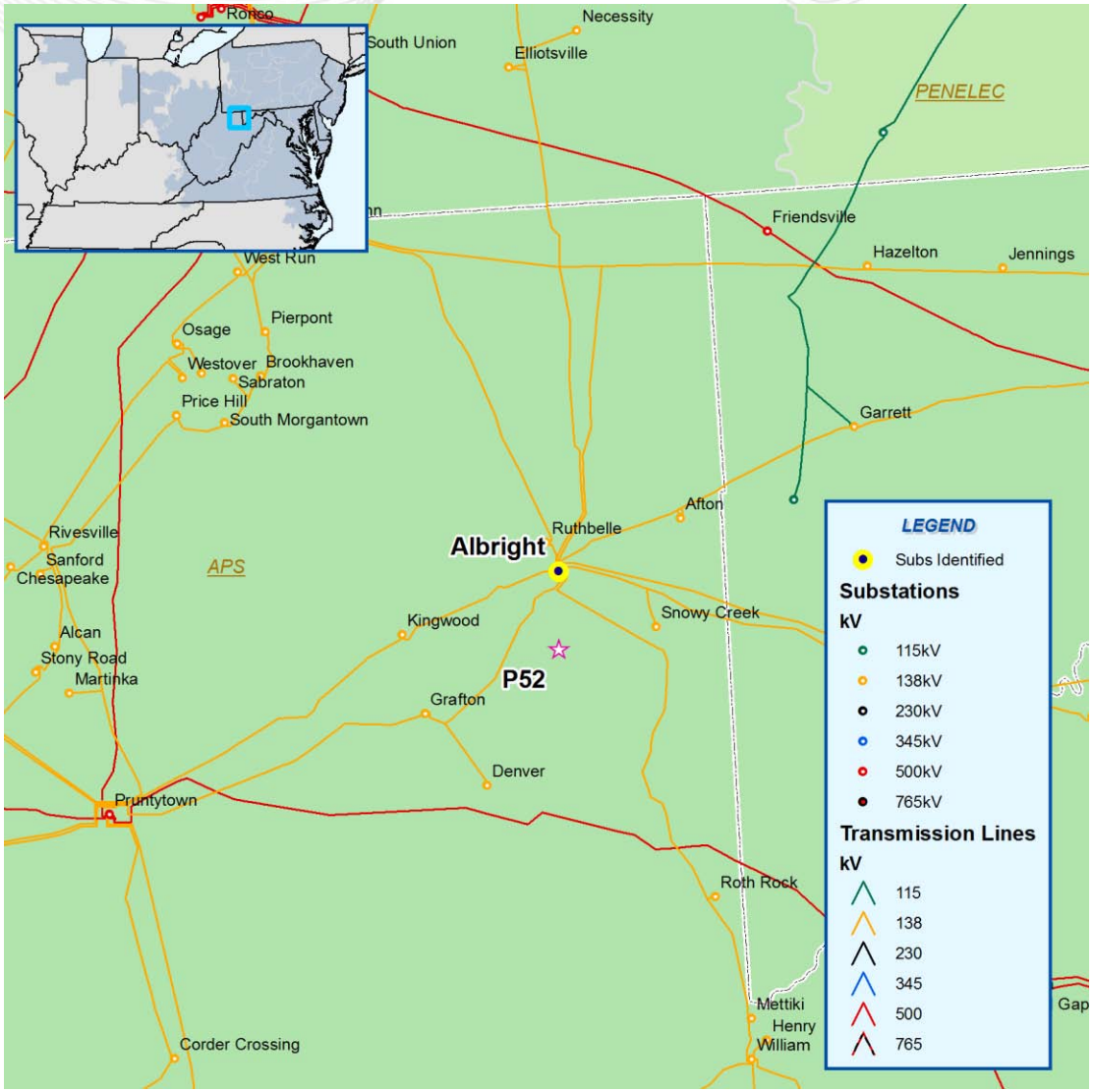
APS Transmission Zone

- Generator Deliverability Violation
- Double Tollgate-Greenwood 138kV line is overloaded for the loss of Meadow Brook – West Winchester 138kV line
- Proposed Solution: Reconductor Double Toll Gate - Greenwood 138kV circuit With 954 ACSR conductor (B1200)
- Estimated Project Cost: $3 M
- Expected IS Date: 6/1/2013



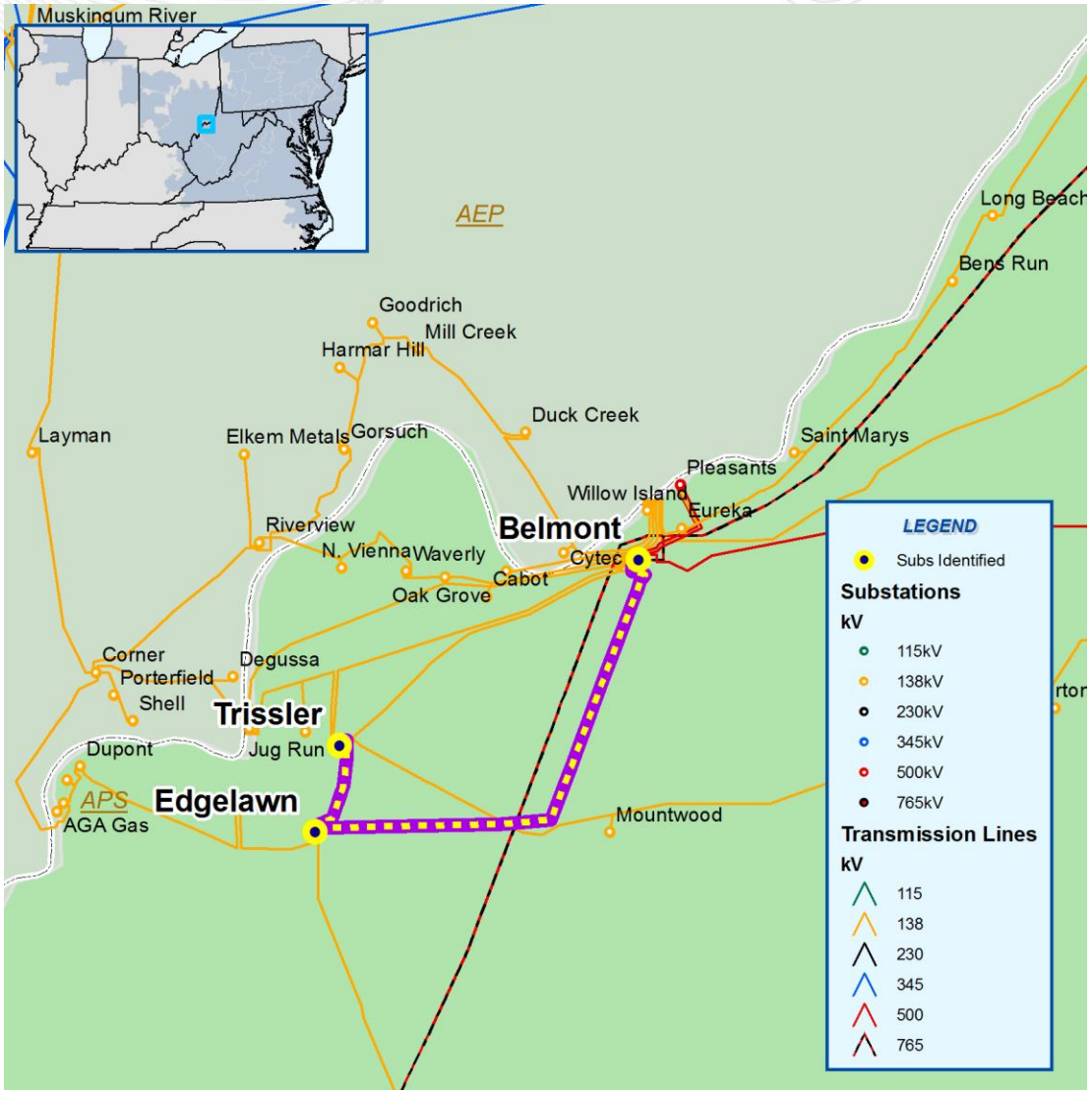
APS Transmission Zone

- Common Mode Outage Violation
- P52 Tap - Albright 138kV line is overloaded for North Petersburg Breaker Failure - Tie Breaker
- Proposed Solution: Upgrade terminal equipment at Albright, Replace bus and line side breaker disconnects and leads, Replace breaker risers, Upgrade RTU, Replace Line Trap (B1237)
- Estimated Project Cost: $0.5 M
- Expected IS Date: 6/1/2015



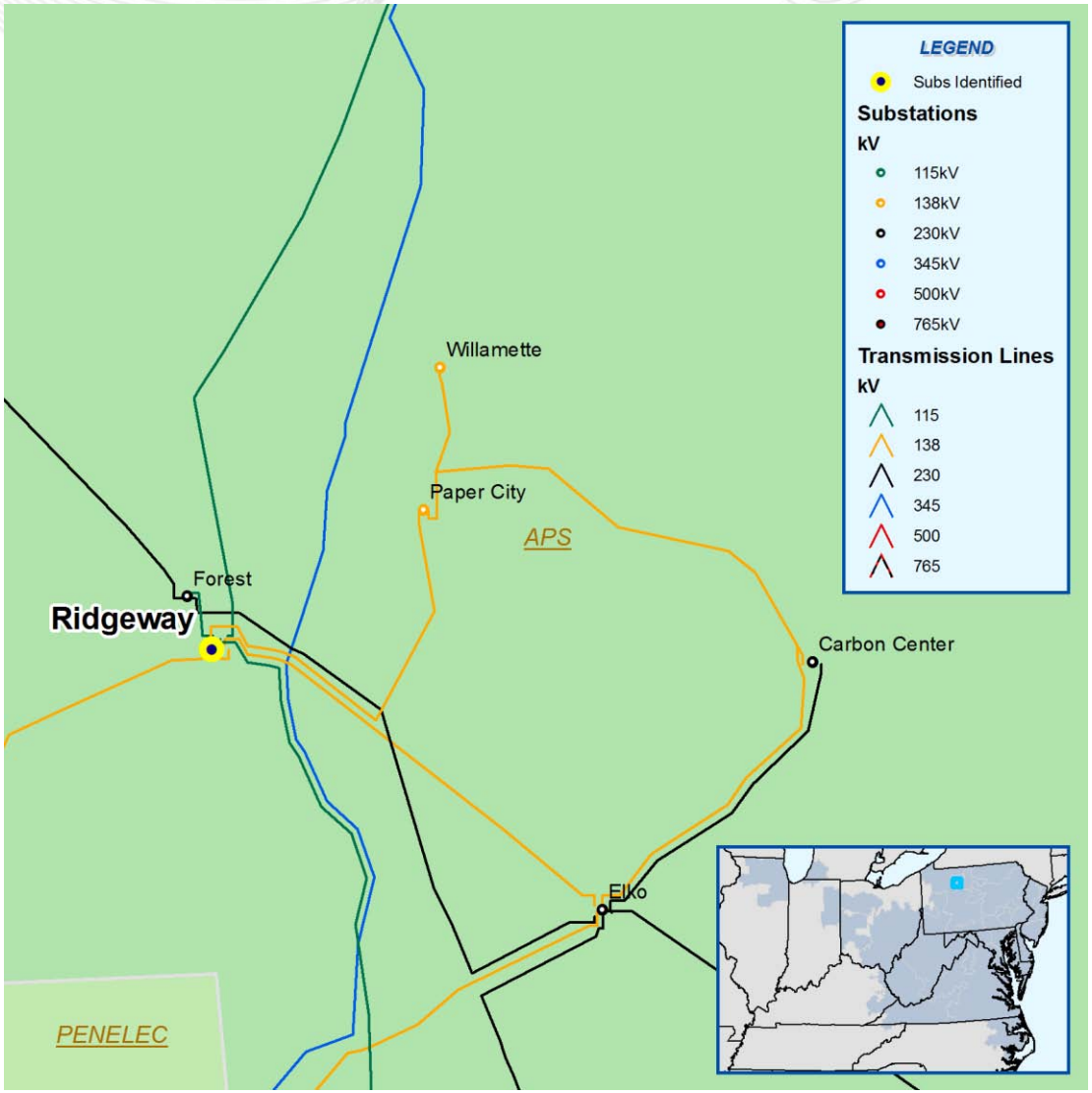
APS Transmission Zone

- Baseline Voltage Violation
- Low voltage due to the loss of Belmont – Edgelawn 138kV and Edgelawn – Trissler 138kV tower lines
- Proposed Solution: Install a 138 kV 44 MVAR capacitor at Edgelawn substation (B1238)
- Estimated Project Cost: $1.2 M
- Expected IS Date: 6/1/2015



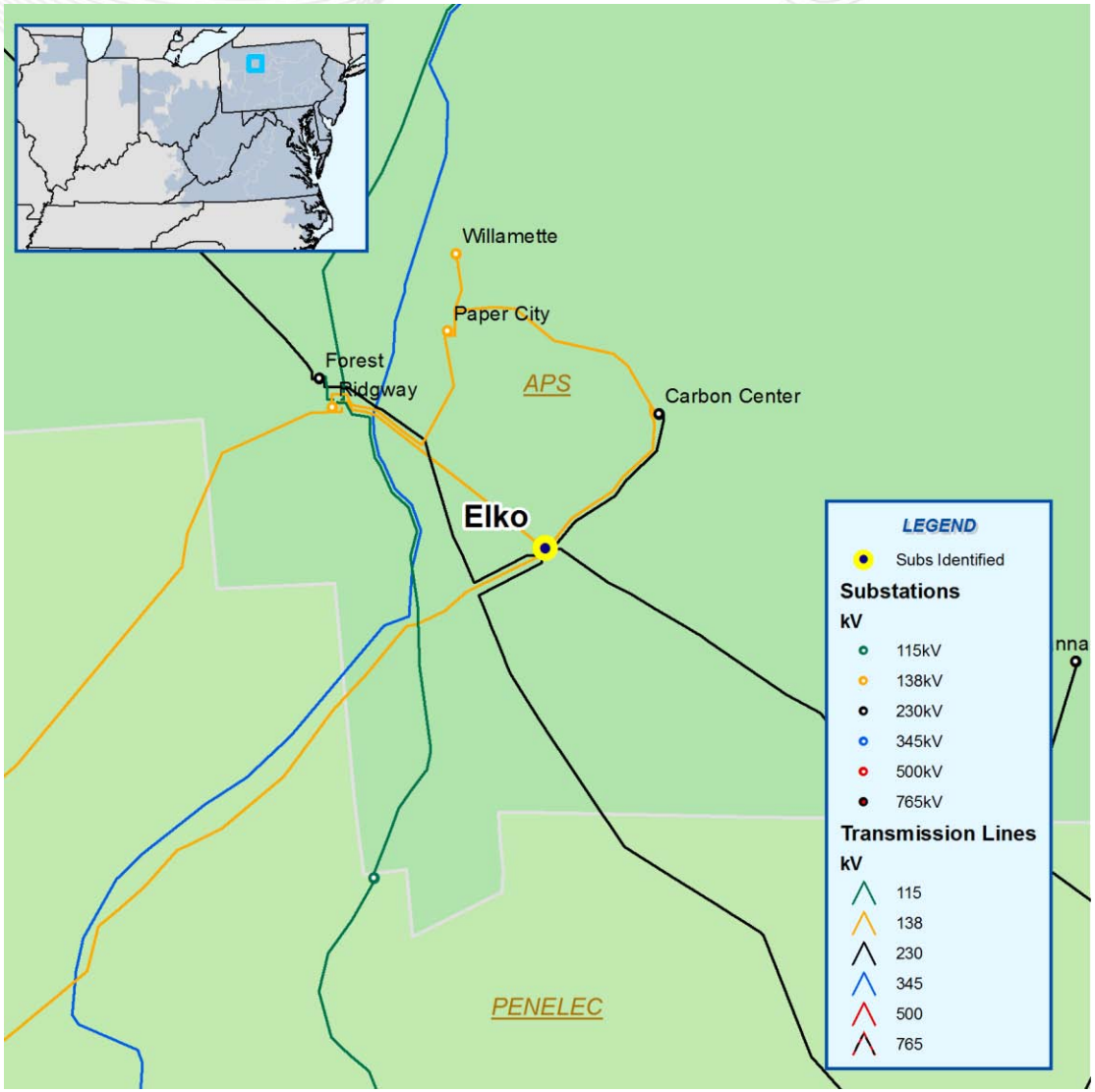
APS Transmission Zone

- Baseline Voltage Violation
- Voltage drop violation at Ridgeway 138kV for the stuck breaker contingency at Elko 230kV
- Proposed Solution: Install a 138 kV 44 MVAR capacitor at Ridgway substation (B1239)
- Estimated Project Cost: $1.2 M
- Expected IS Date: 6/1/2015



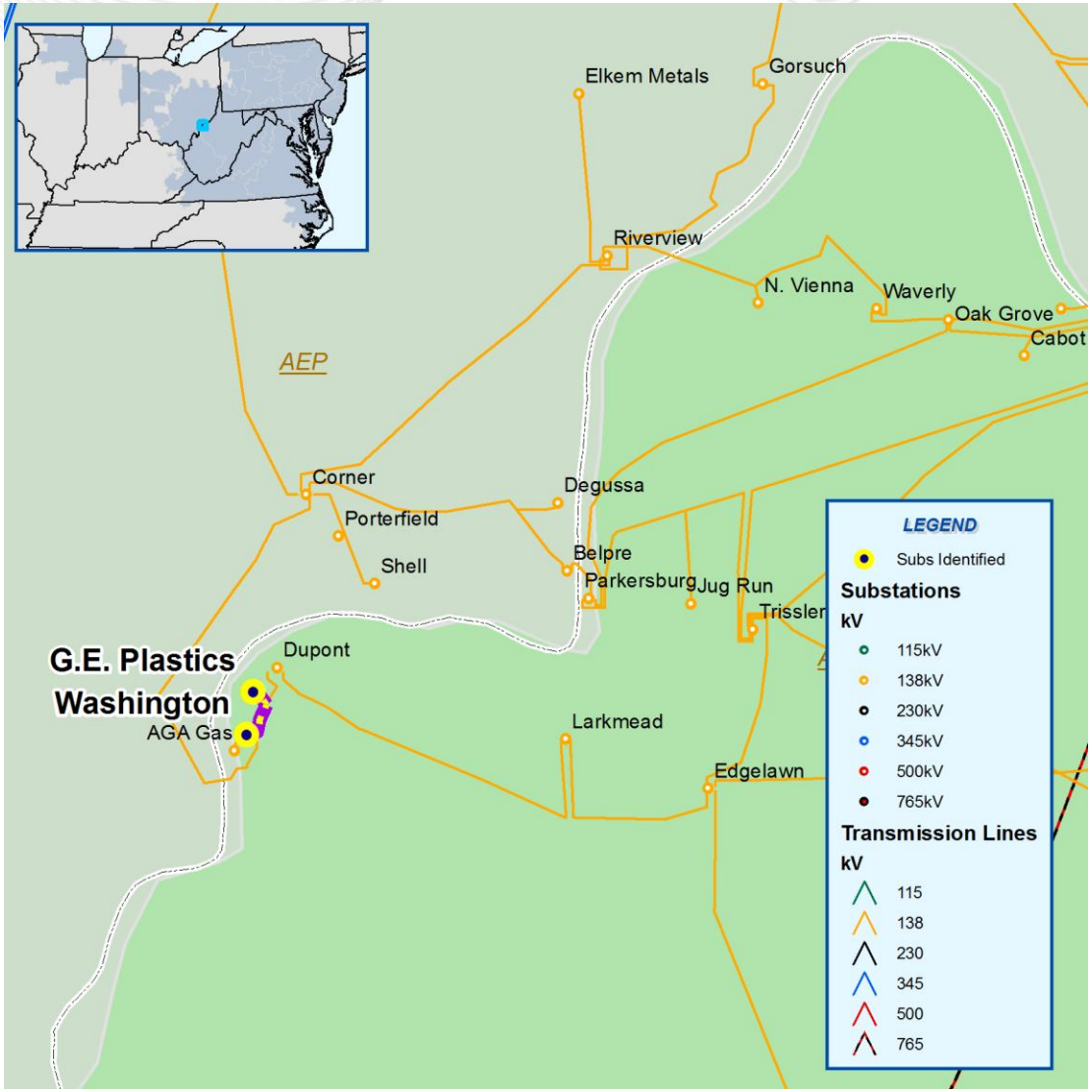
APS Transmission Zone

- Baseline Voltage Violation
- Low voltage drop at Elko 138kV bus for the stuck breaker contingency at Elko 230kV
- Proposed Solution: Install a 138 kV 44 MVAR capacitor at Elko substation (B1240)
- Estimated Project Cost: $1.2 M
- Expected IS Date: 6/1/2015



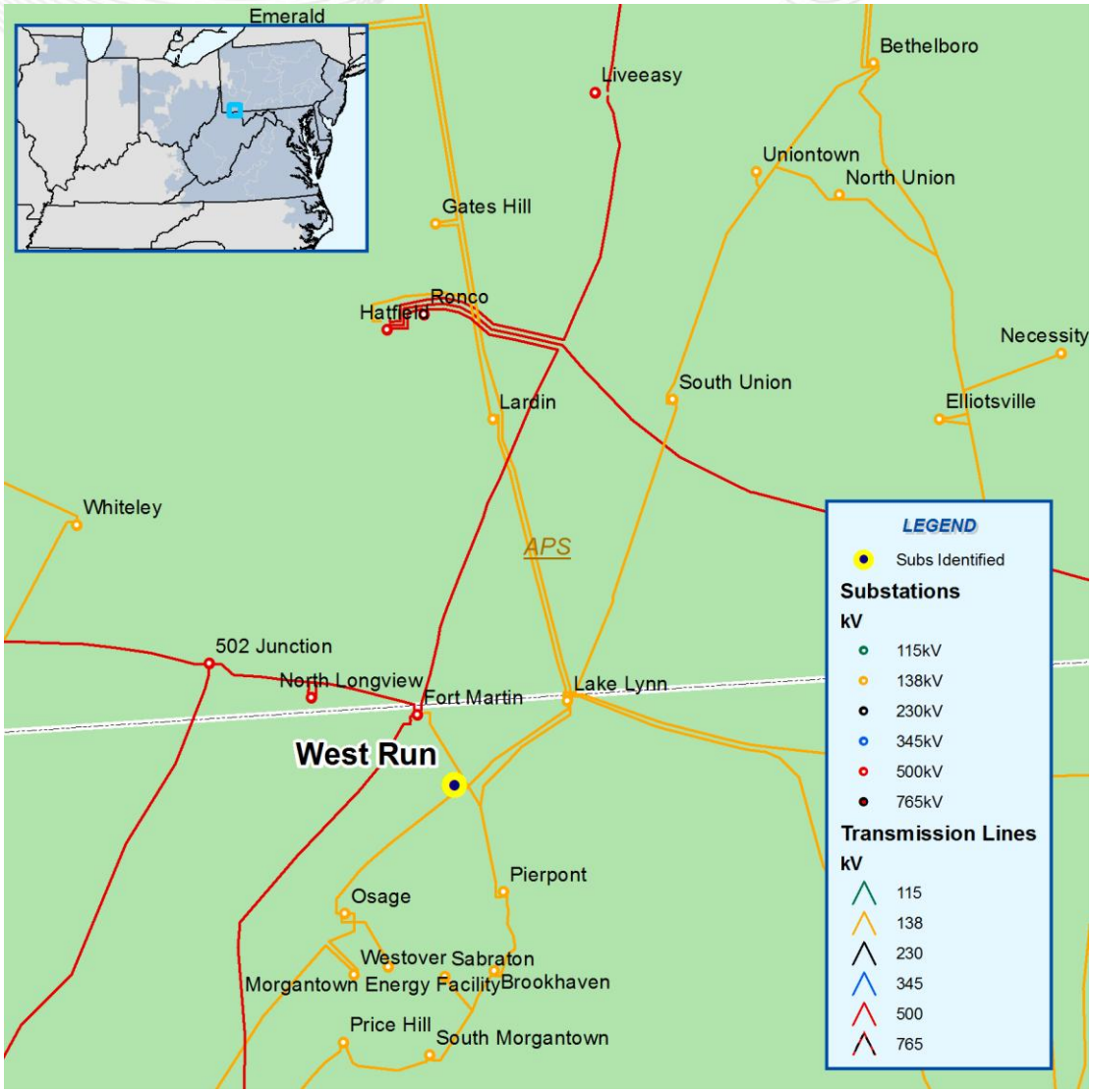
APS Transmission Zone

- Baseline Thermal Violation
- The GE Plastics – Washington 138kV line is overloaded due to the loss of Belmont – Edgelawn 138kV and Edgelawn – Trissler 138kV tower lines
- Proposed Solution: Upgrade terminal equipment at Washington Substation on the GE Plastics/DuPont terminal (B1241)
- Estimated Project Cost: $0.05 M
- Expected IS Date: 6/1/2015



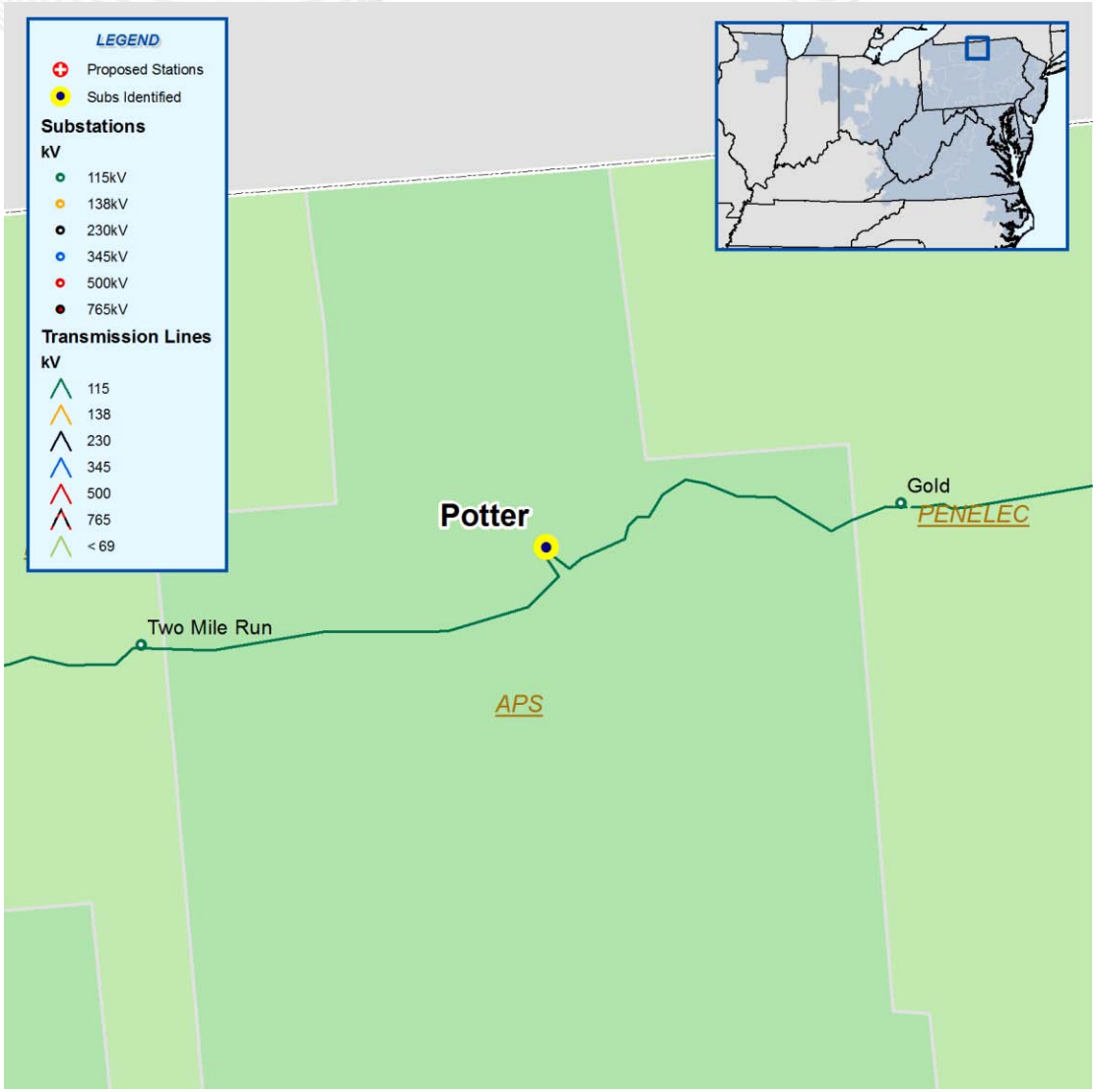
APS Transmission Zone

- Baseline Thermal Violation
- The Collins – West Run 138kV line is overloaded due to the loss of the Hatfield – Ronco 500kV line with the stuck breaker at Hatfield 500kV
- Proposed Solution: Replace Structures between Collins Ferry and West Run to eliminate clearance derate on the Collins – West Run 138kV line (B1242)
- Estimated Project Cost: $0.35 M
- Expected IS Date: 6/1/2015



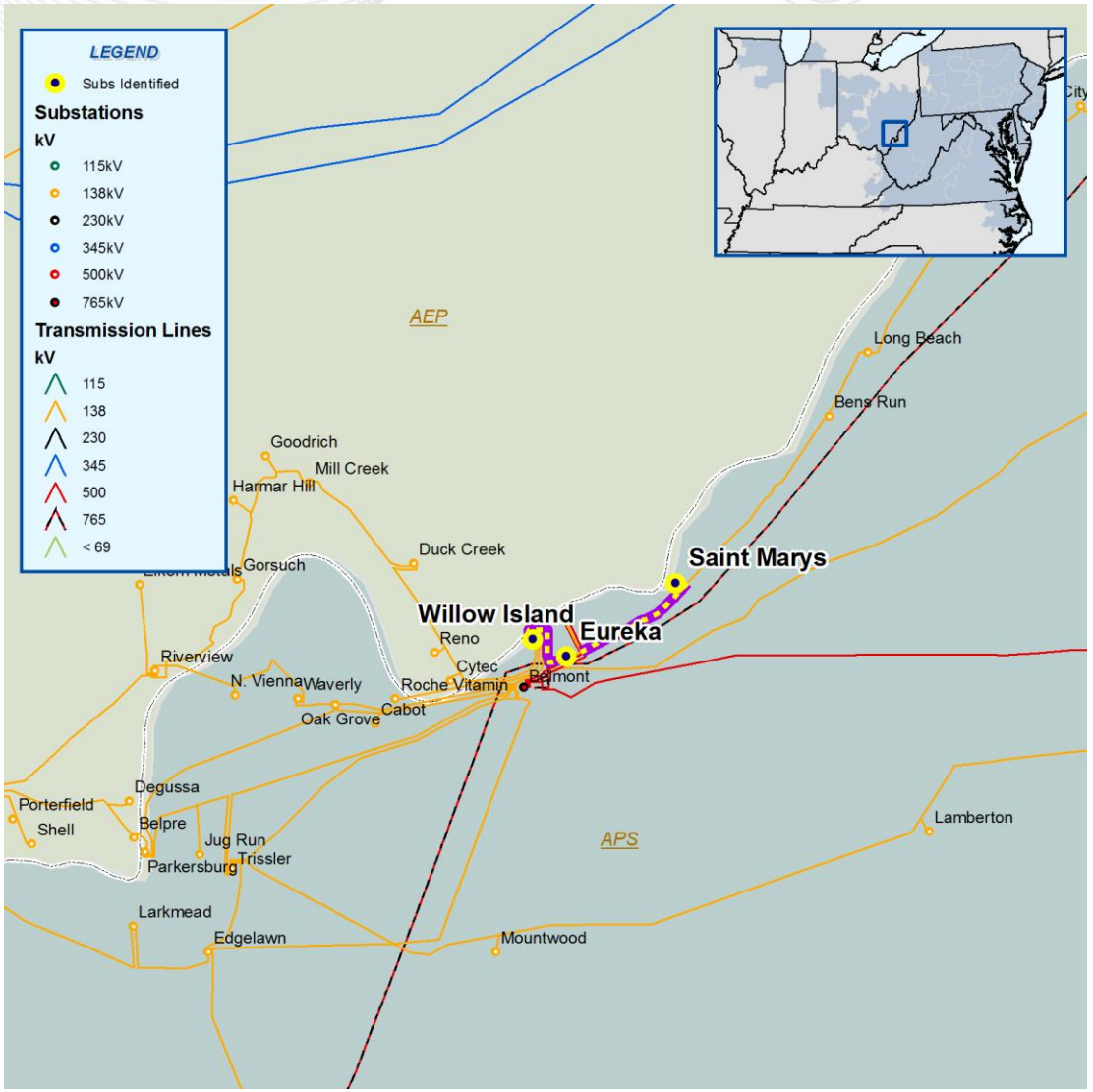
APS Transmission Zone

- Baseline Voltage Violation
- Low voltage magnitude and low voltage drop at Potter 138kV for the bus fault at Farmer Valley 115kV substation
- Proposed Solution: Install a 138 kV MVAR capacitor at Potter substation (B1243)
- Estimated Project Cost: $5 M
- Expected IS Date: 6/1/2015



APS Transmission Zone

- Generator Deliverability Violation
- Overload on Willow –Eureka 138kV line for loss of Kammer 345/138kV transformer and MLG unit #2
- Proposed Solution: Reconductor Willow-Eureka -St Mary 138kV lines (B1230)
- Total Cost Estimate: $4M
- Expected IS Date: 6/1/2013



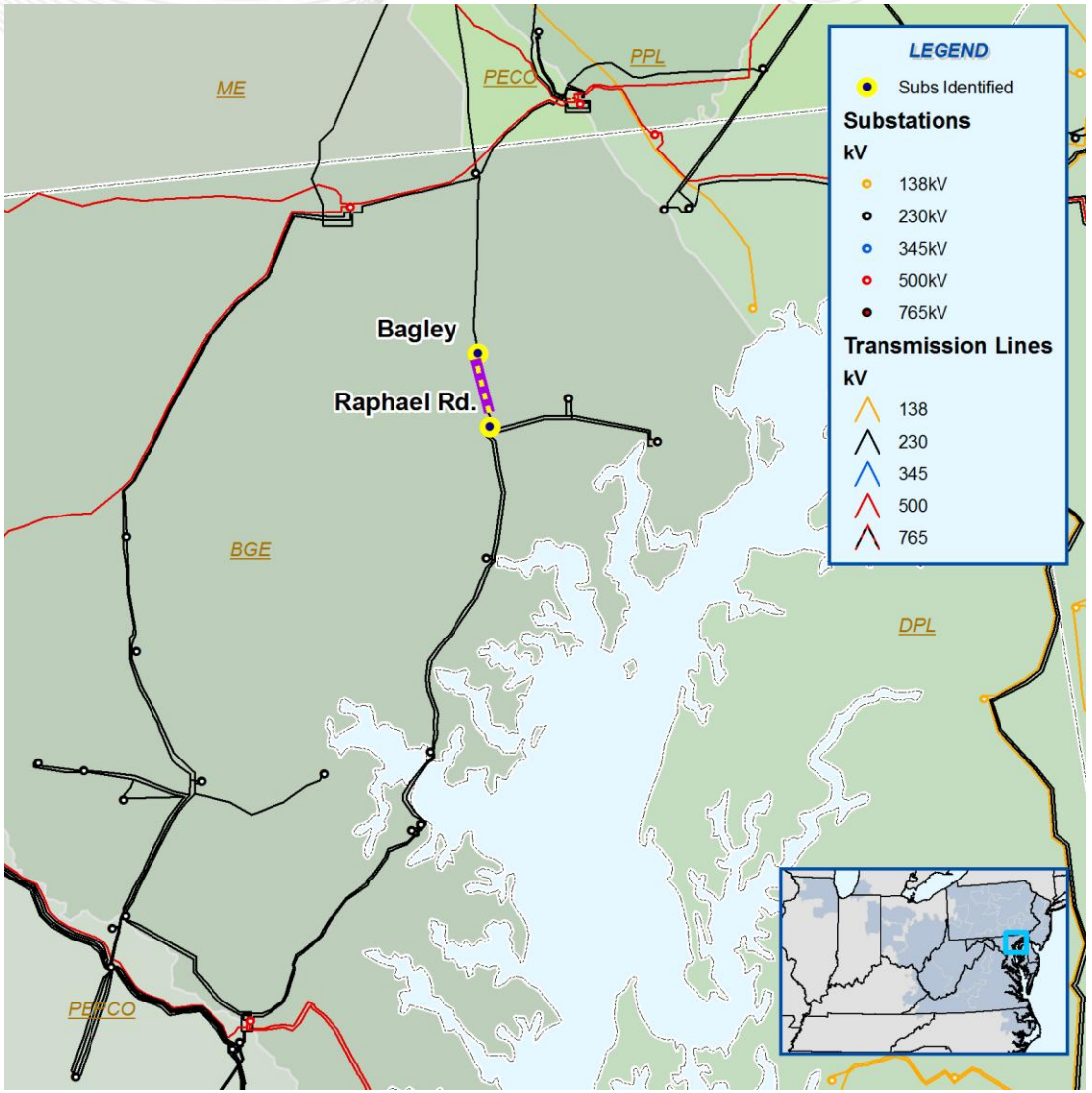
BGE Transmission Zone

- Common Mode Outage Procedure
- The Bagley – Raphael 230 kV circuit is overloaded for the loss of the Conastone – Northwest 230 kV double circuit tower contingency
- Proposed Solution:

  Rebuild the existing Bagley – Raphael Road 230 kV line to a double circuit 230 kV line (B1251) and reconfigure Raphael Road to terminate the new circuit (B1251.1)
- Estimated Project Cost:

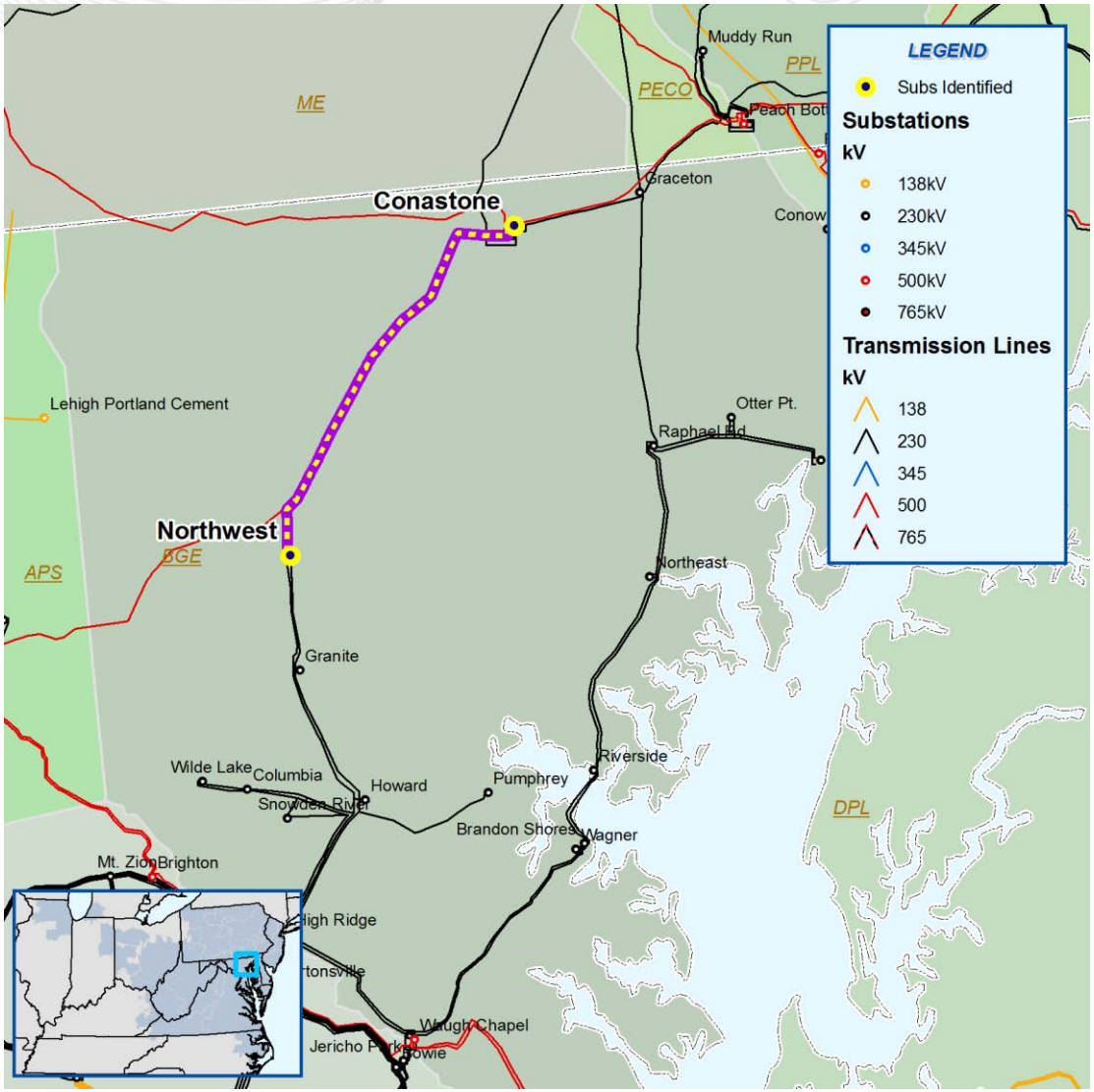
  $30 M
- Expected IS Date:

  6/1/2015



BGE Transmission Zone

- Baseline Voltage Violation
  - The loss of the Conastone – Northwest 230 kV double circuit tower contingency causes a voltage collapse
- N-1-1 Thermal Violation
  - The Northwest – Conastone 230 kV circuit '2322' has a violation of the normal rating for the loss of the Northwest – Conastone 230 kV circuit '2310'
- Generation Deliverability
  - The Conastone – Northwest 230 kV circuit is overloaded for the loss of the Brighton – Doubs and Brighton – Conastone 500 kV double tower contingency



BGE Transmission Zone

- Proposed Solution:

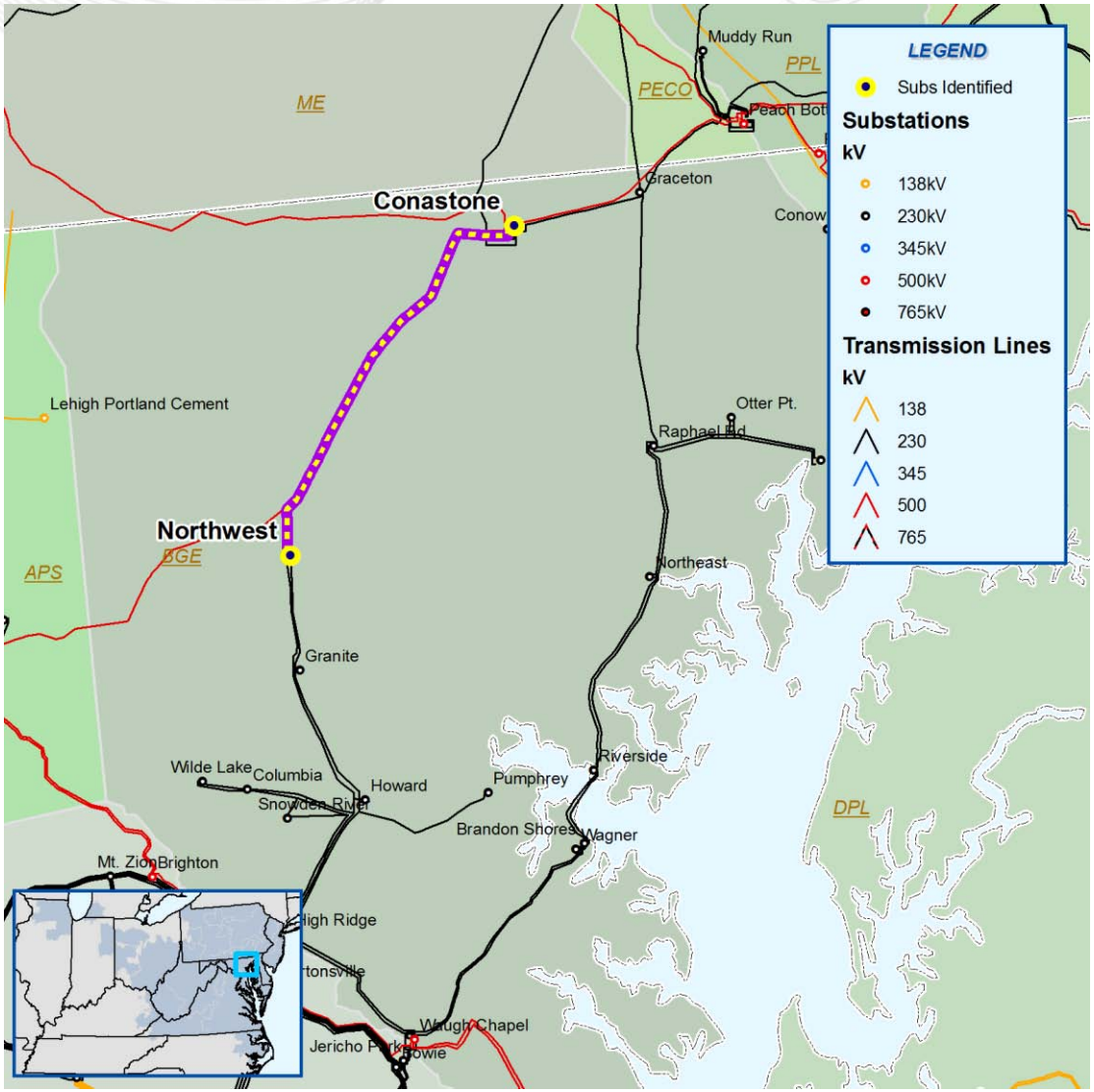
  Construct 500/230 kV Emory Grove station with a 500 kV double breaker configuration by tapping the Conastone–Brighton 500 kV, Conastone – Northwest 230 kV and rebuild Emory Grove to the Northwest circuits to separate pole-lines with bundled conductor (B1254)

- Estimated Project Cost:

  $71 M

- Expected IS Date:

  6/1/2015



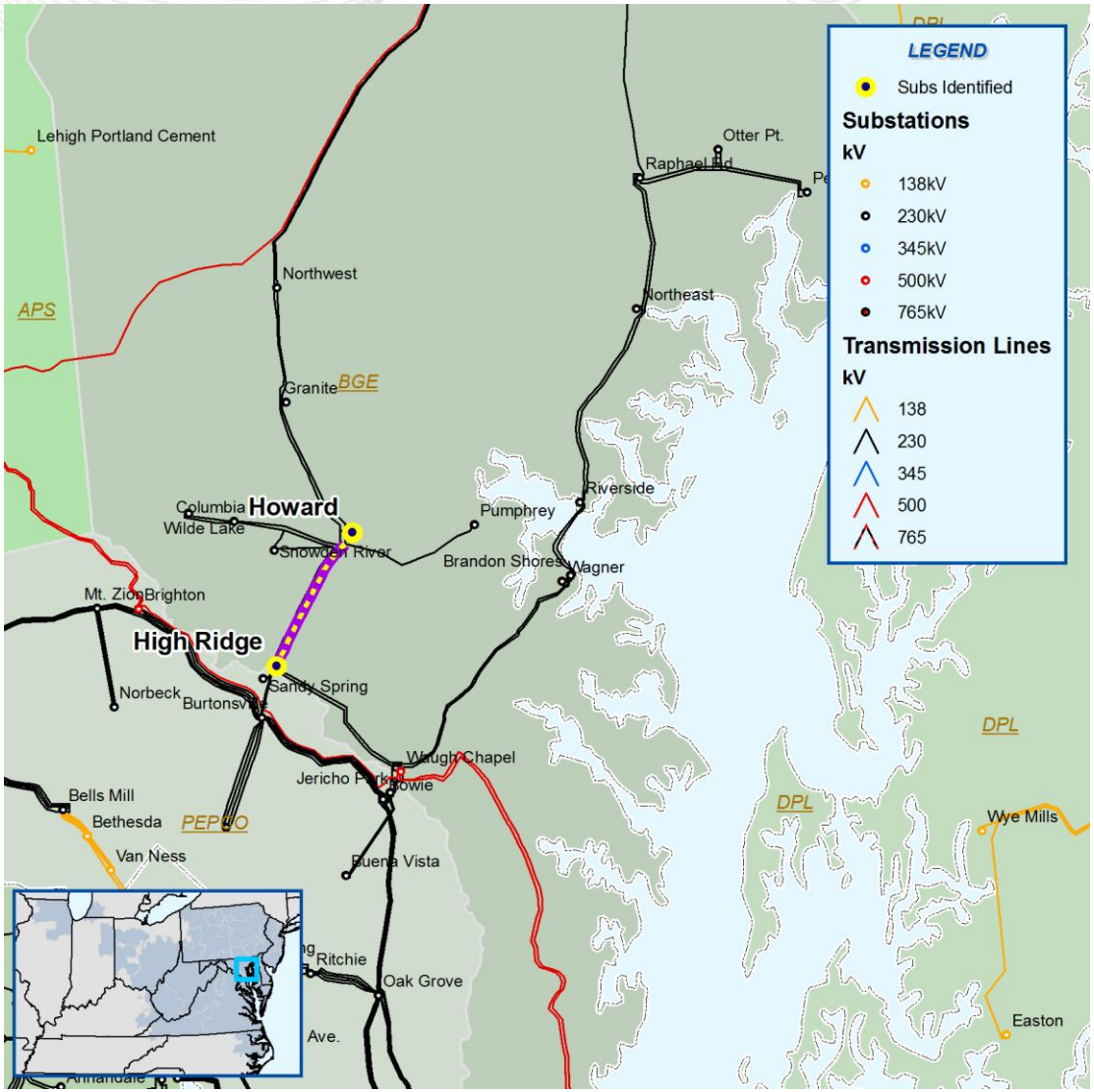
BGE Transmission Zone

- Baseline NERC Category C Thermal Violation
- The High Ridge – Howard 230 kV circuit is overloaded for the loss of the Conastone – Northwest 230 kV double circuit tower contingency
- Proposed Solution:

  Replace terminal equipment at Pumphrey tap 230 kV (B1252)
- Estimated Project Cost:

  $0.1 M
- Expected IS Date:

  6/1/2015



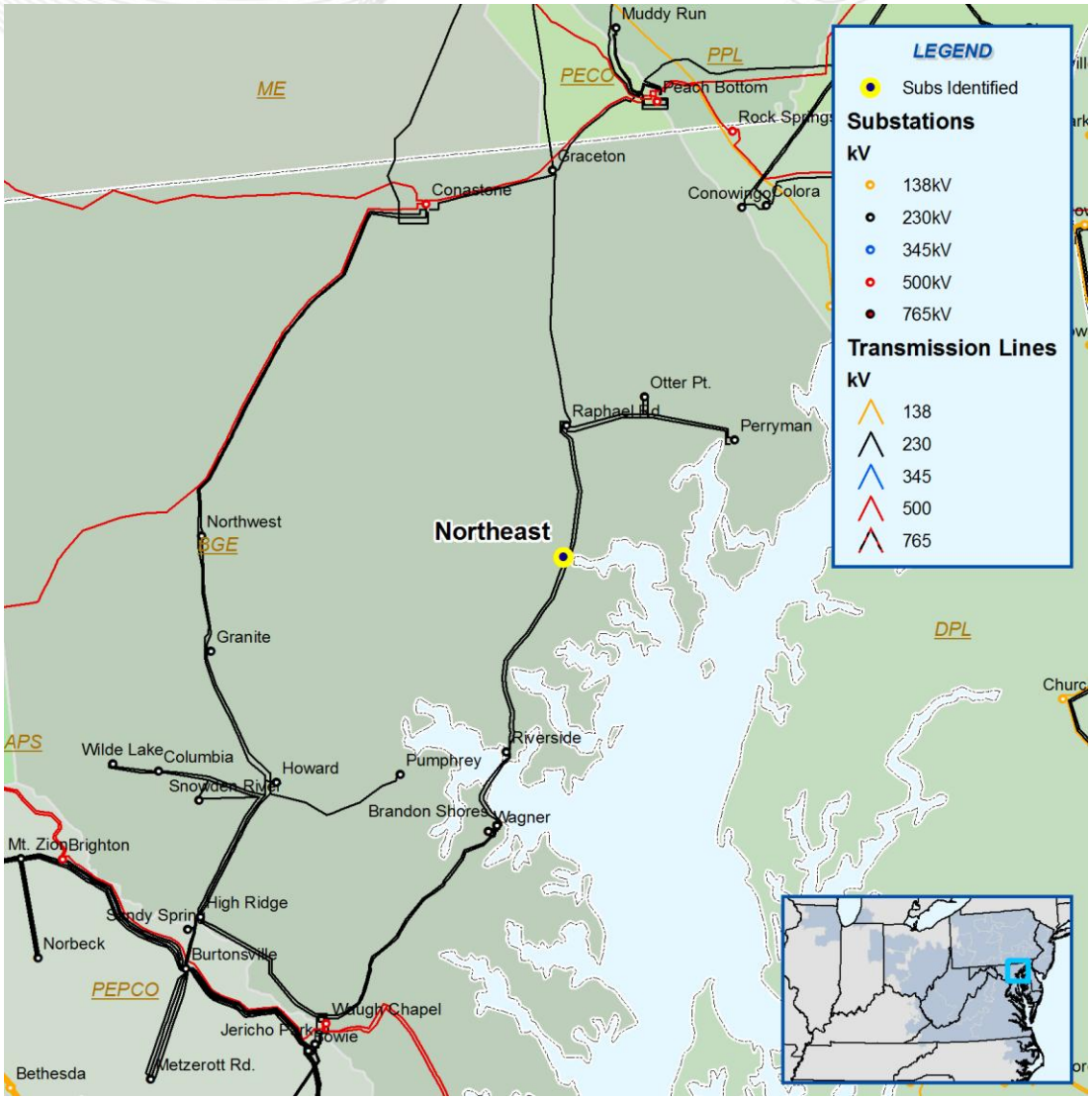
BGE Transmission Zone

- N-1-1 Thermal Violation:
- The Northeast 230/115 kV transformer # 3 is overloaded for the loss of North East – Riverside 230 kV circuit 2339 and North East transformer # 2 plus basecase .
- Proposed Solution:

  Replace the existing North East 230/115 kV transformers with 500 MVA (B1253).
- Estimated Project Cost:

  $10.1 M
- Expected IS Date:

  6/1/2015

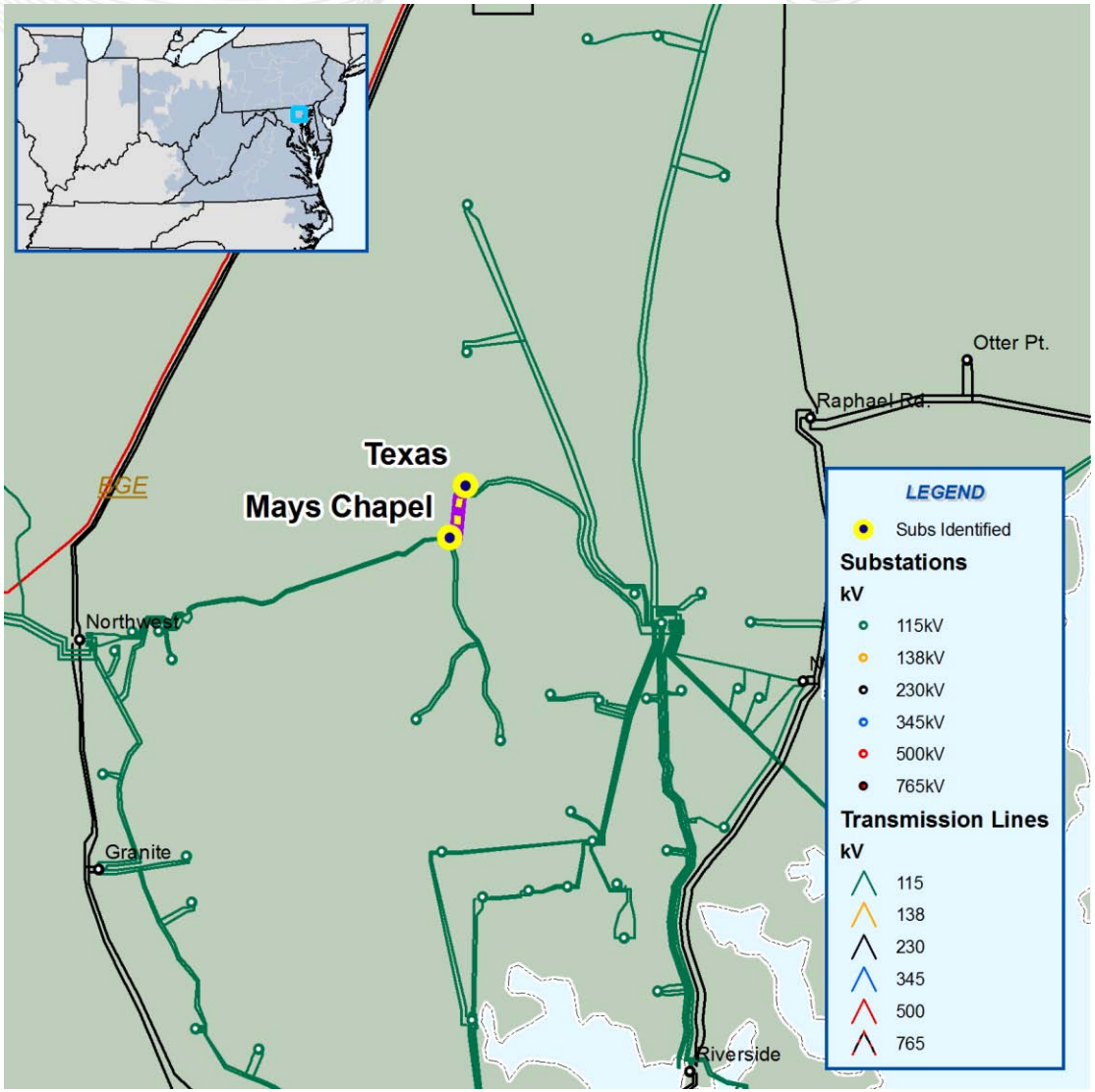


BGE Transmission Zone

- Baseline Violation:
- Voltage drop violations in the Mays Chapel, Texas and Gwynnbrook 115 kV vicinity for several line fault stuck breaker contingencies.
- Proposed Solution:
  - Rebuild existing Erdman 115 kV substation to a dual ring-bus configuration to enable termination of new circuits (B1267)
  - Construct 115 kV double circuit underground line from existing Coldspring to Erdman substation (B1267.1)
- Estimated Project Cost:

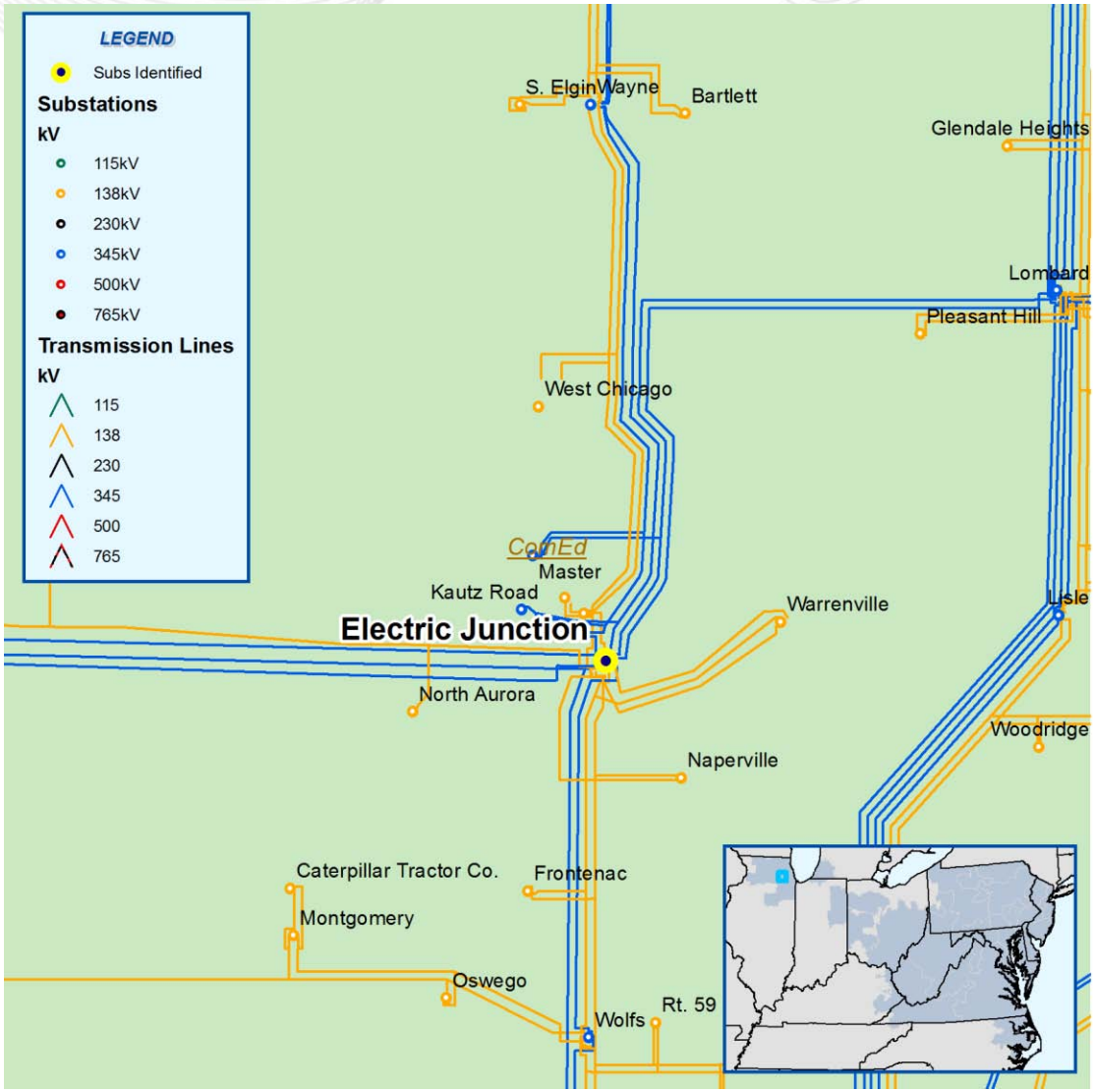
  $139.6 M
- Expected IS Date:

  6/1/2015



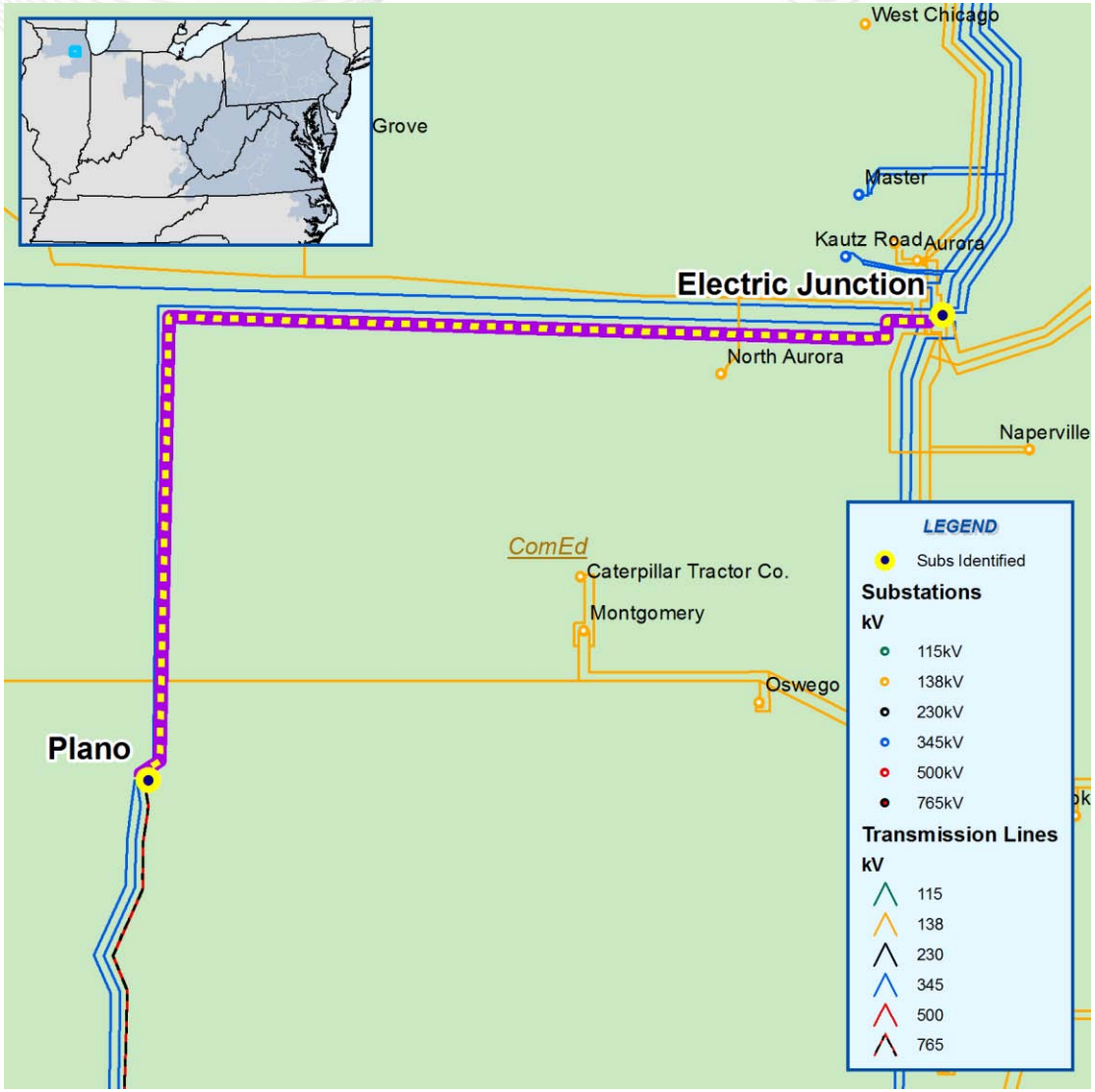
ComEd Transmission Zone

- Common Mode Outage Violation
- Electric Junction 345/138 kV Transformer and related 345 kV and 138 kV terminal lines at Electric Junction overloaded for loss of Electric Junction 345 kV bus 3 or bus tie 3-4
- Proposed Solution: Move line 16703 termination from bus 4 to bus 3 at Electric Junction (b1263)
- Estimated Project Cost: $3.0 M
- Expected IS Date: 6/1/2015



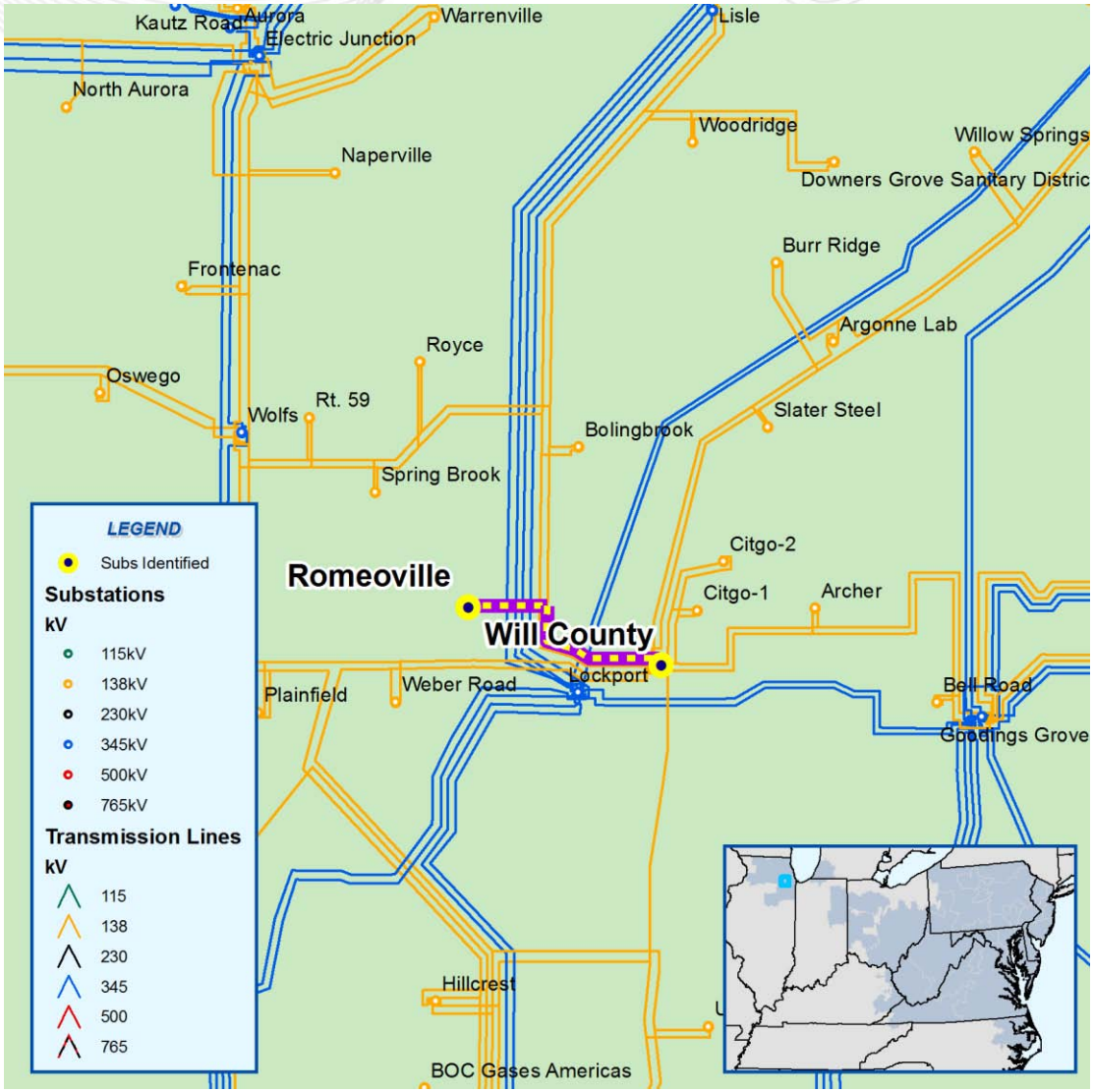
ComEd Transmission Zone

- Generator Deliverability violation
- Plano – Electric Junction 345 kV (line 16703) is overloaded for the loss of Plano – Electric Junction 345 kV (line 16704)
- Proposed Solution: Replace 345 kV bus ties 1-2 and 1-9 at Plano to increase rating on line 16703 (b1264)
- Estimated Project Cost: $2.0 M
- Expected IS Date: 6/1/2015



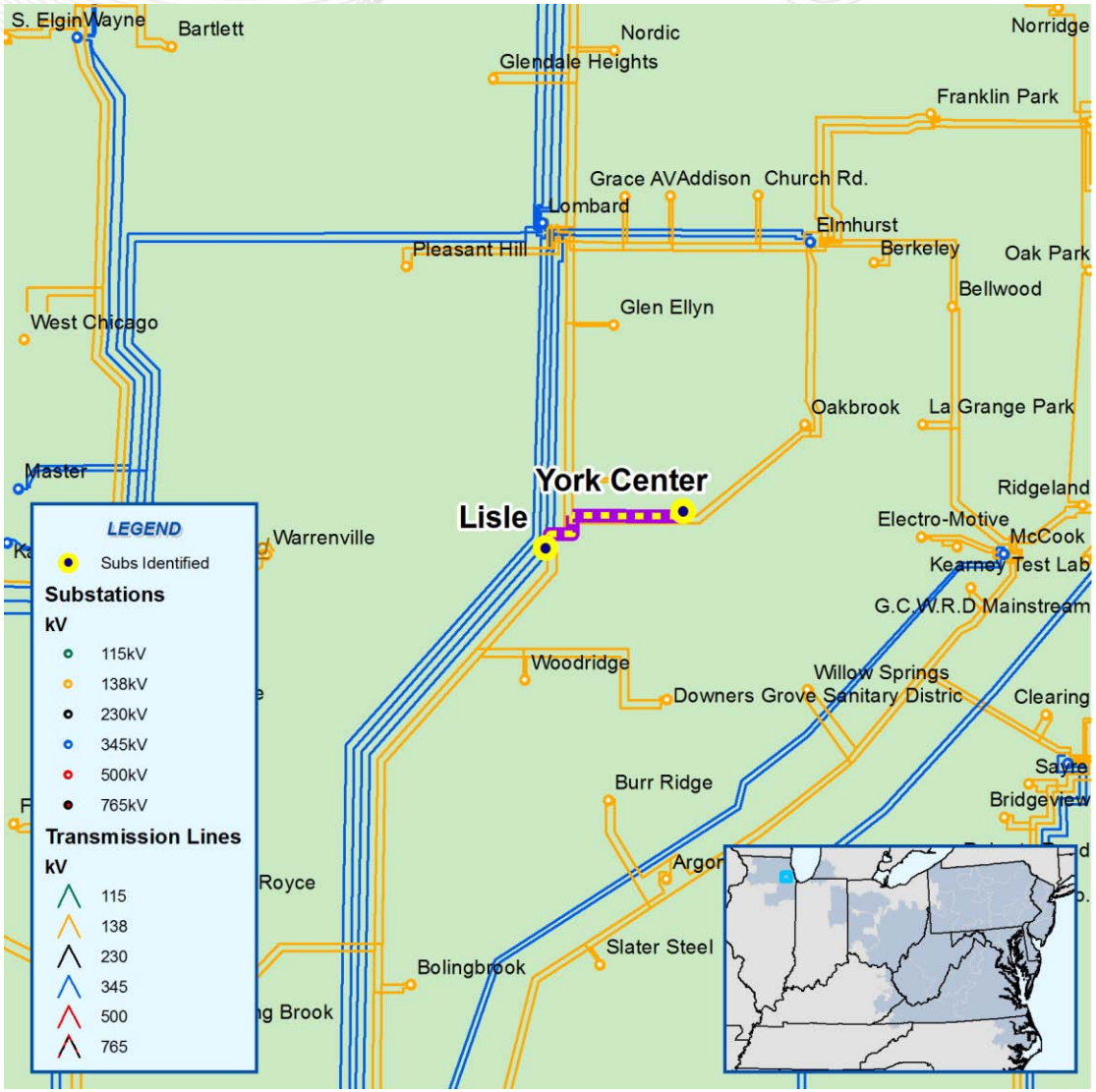
ComEd Transmission Zone

- Generator Deliverability violation
- Line L1809 138kV (Will County to Romeoville portion) is overloaded in the Base Case (no contingency)
- Proposed Solution: Reconductor approximately 2 miles of 138kV L1809 with ACSS conductor (B1265)
- Estimated Project Cost: $1.5 M
- Expected IS Date: 6/1/2015



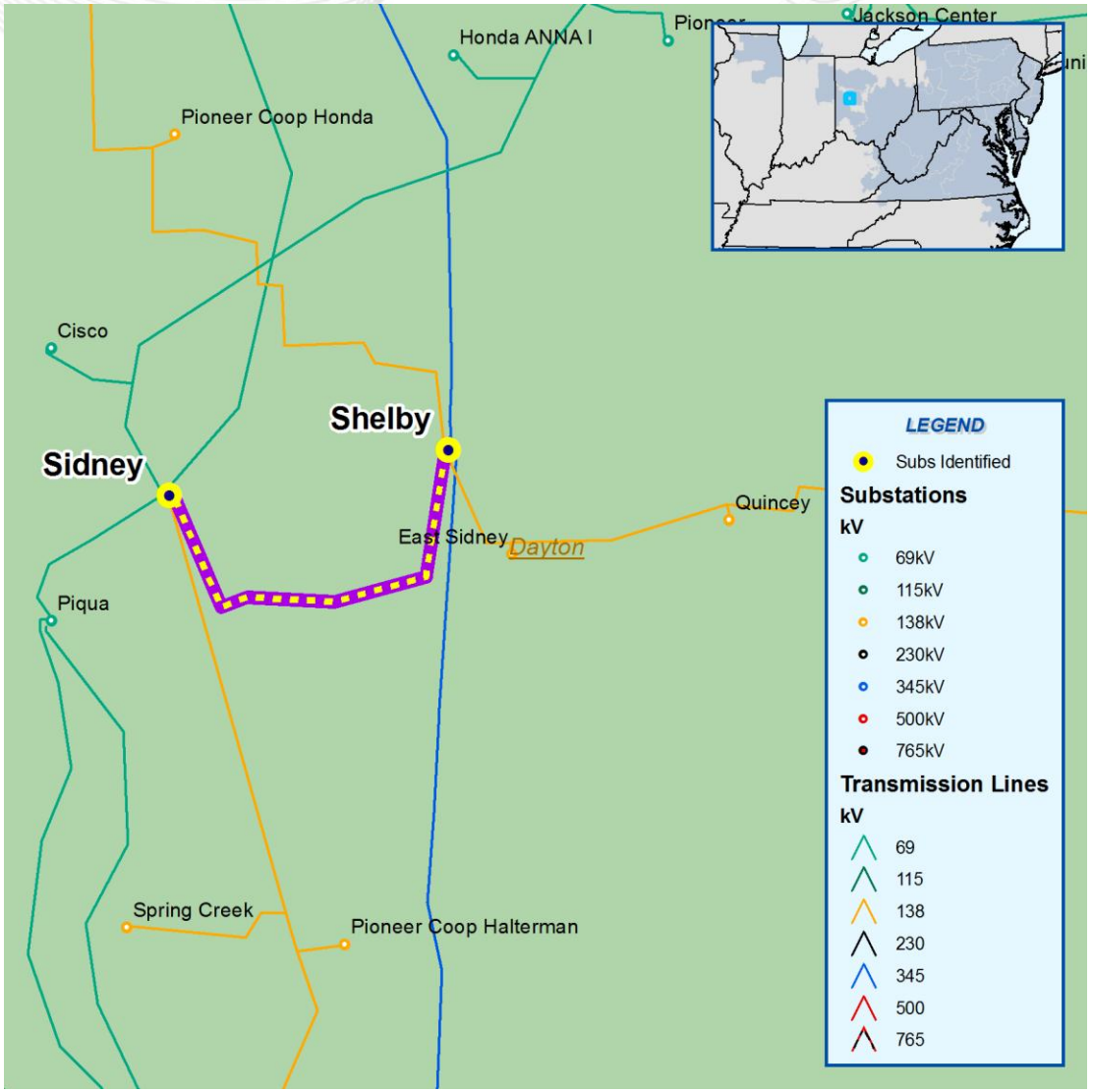
ComEd Transmission Zone

- Common Mode Outage violation
- The Lisle to York tap 138kV line portions (L10302 and L10301) overloaded for 345kV bus 2 and 345kV bus 4 faults at TSS 120 Lombard and stuck breakers on 345kV lines connected to 345kV bus 2 and 345kV bus 4 faults at TSS 120 Lombard
- Proposed Solution: Normally close 345kV BT 2-3 at TSS 103 Lisle (the red/blue bus tie), Replace one 345kV circuit breaker on BT 1-2 at TSS 103 Lisle overdutied by closing 2-3 bus tie (B1266)
- Estimated Project Cost: $1.0 M
- Expected IS Date: 6/1/2015



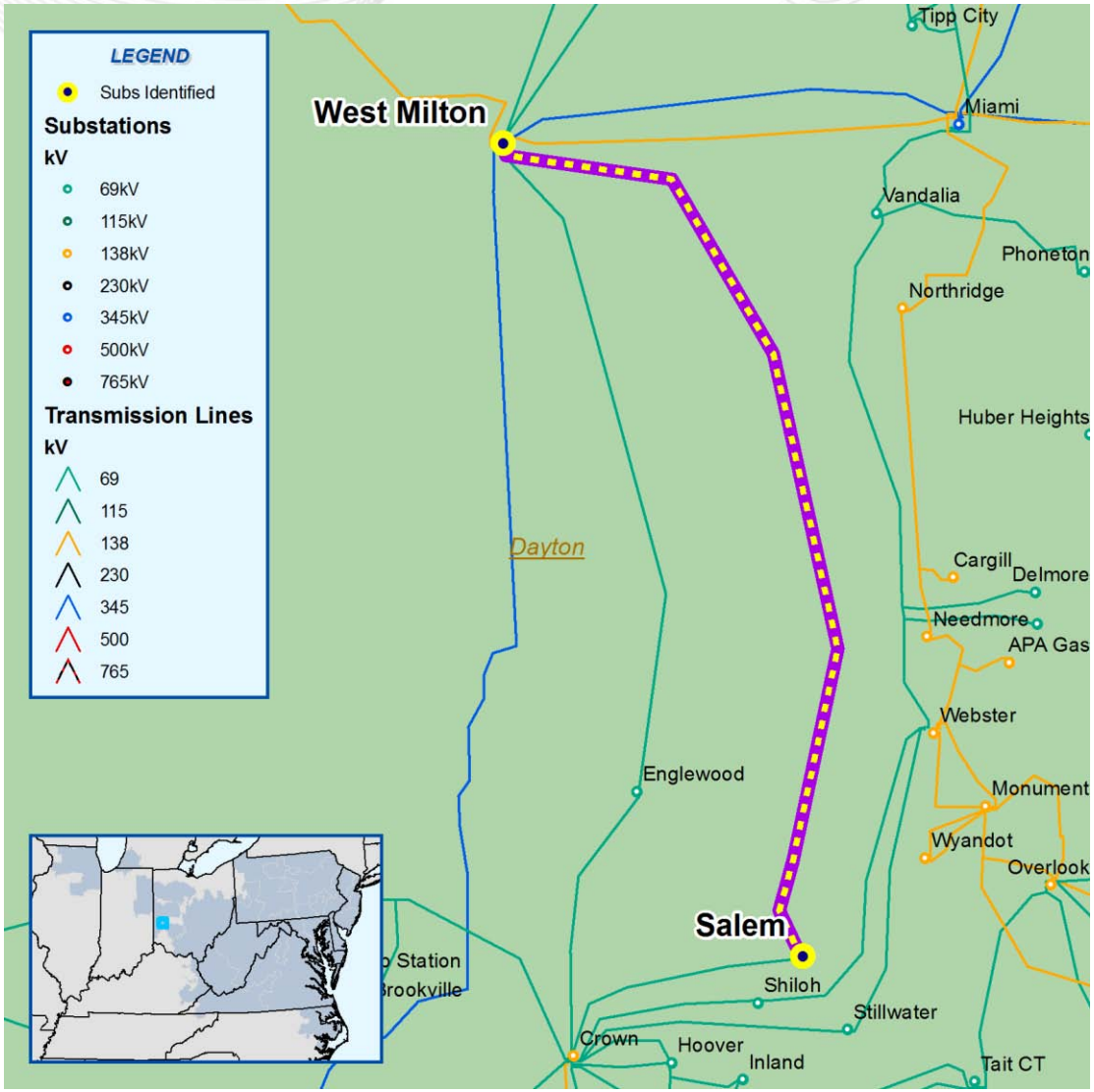
Dayton Transmission Zone

- N-1-1 Thermal Violation
- Various N-1-1 contingency combinations in the area thermally overload the Shelby – Sidney 138 kV circuit
- Proposed Solution: Reconductor Shelby - Sidney 138kV (B1268)
- Estimated Project Cost: $2.6 M
- Expected IS Date: 6/1/2015



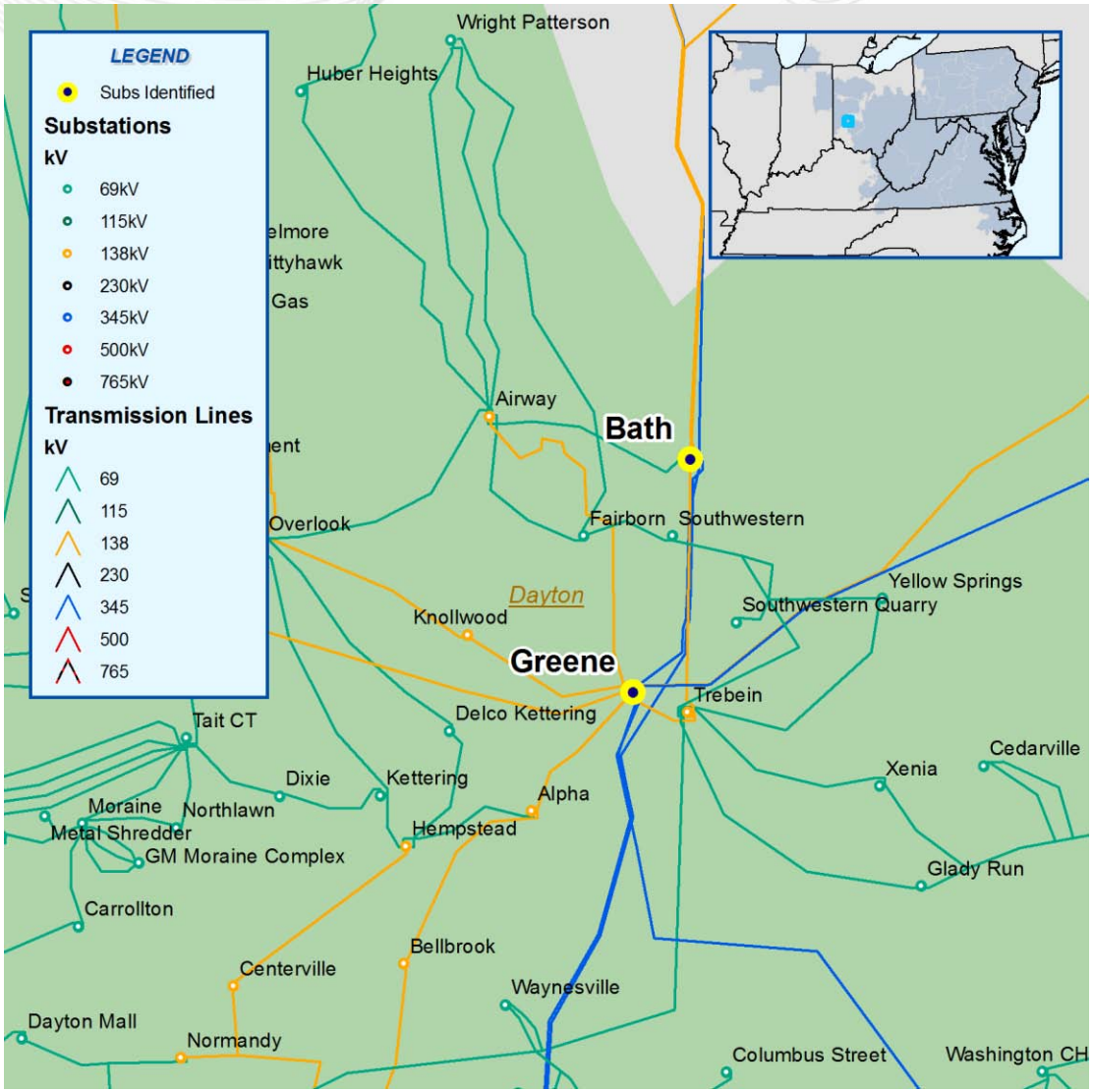
Dayton Transmission Zone

- N-1-1 Thermal Violation
- Various N-1-1 contingency combinations in the area thermally overload West Milton – Salem 69kV and West Milton – Englewood 69kV
- Proposed Solution: Reconductor West Milton - Salem 69kV and West Milton – Englewood 69 kV (B1269)
- Estimated Project Cost: $4.8 M
- Expected IS Date: 6/1/2015



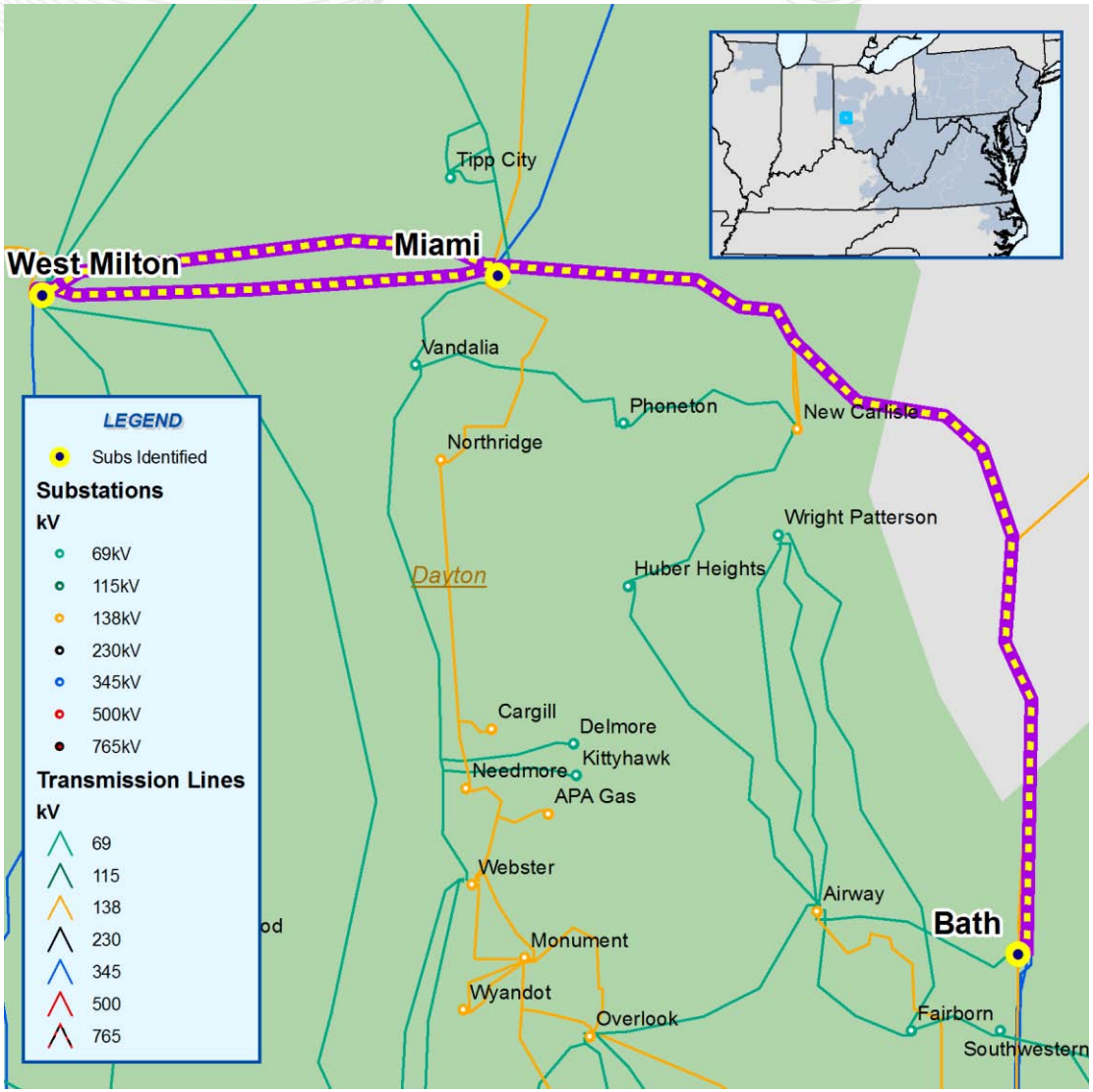
Dayton Transmission Zone

- N-1-1 Thermal Violation
- Loss of one Greene 345/138 kV transformer + Bath 345/138 kV transformer thermally overloads other Greene 345/138 kV transformer
- Proposed Solution:
  - Reconductor Bath - Trebein 138kV (B1270)
  - Cost: $1.3M
  - Reconductor Underground Section of OHH - Sugarcreek 138kV (B1271)
  - Cost: $2.4 M
- Estimated Project Cost: $3.7 M
- Expected IS Date: 6/1/2015



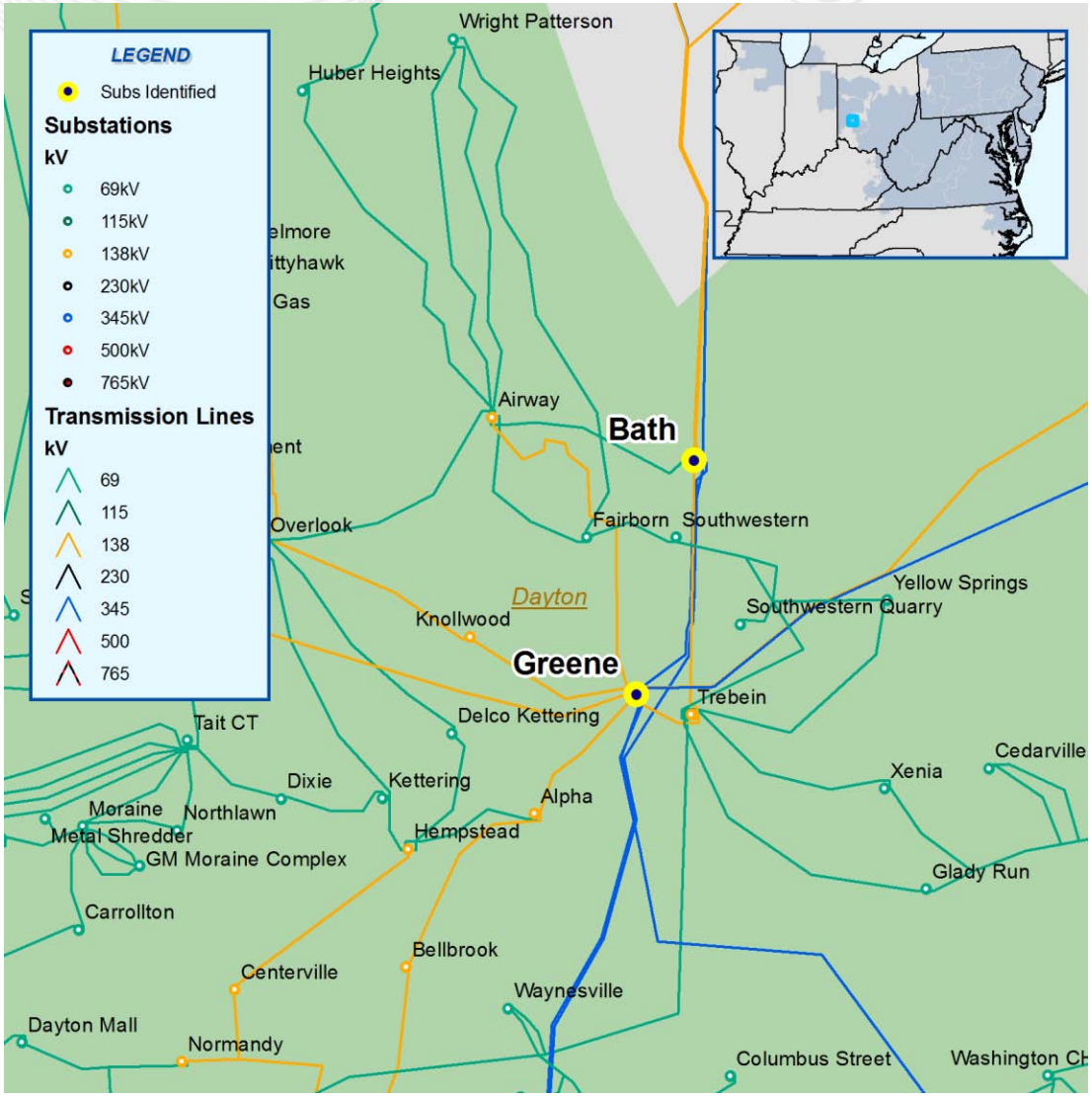
Dayton Transmission Zone

- N-1-1 Thermal Violation
- Loss of Miami - W. Milton 345kV, loss of W. Milton 345/138kV + Bath - Miami 345kV thermally overloads the Burdox - Webster 138kV circuit
- Reconductor Burdox - Webster 138kV (B1272)
- Estimated Project Cost: $1 M
- Expected IS Date: 6/1/2015



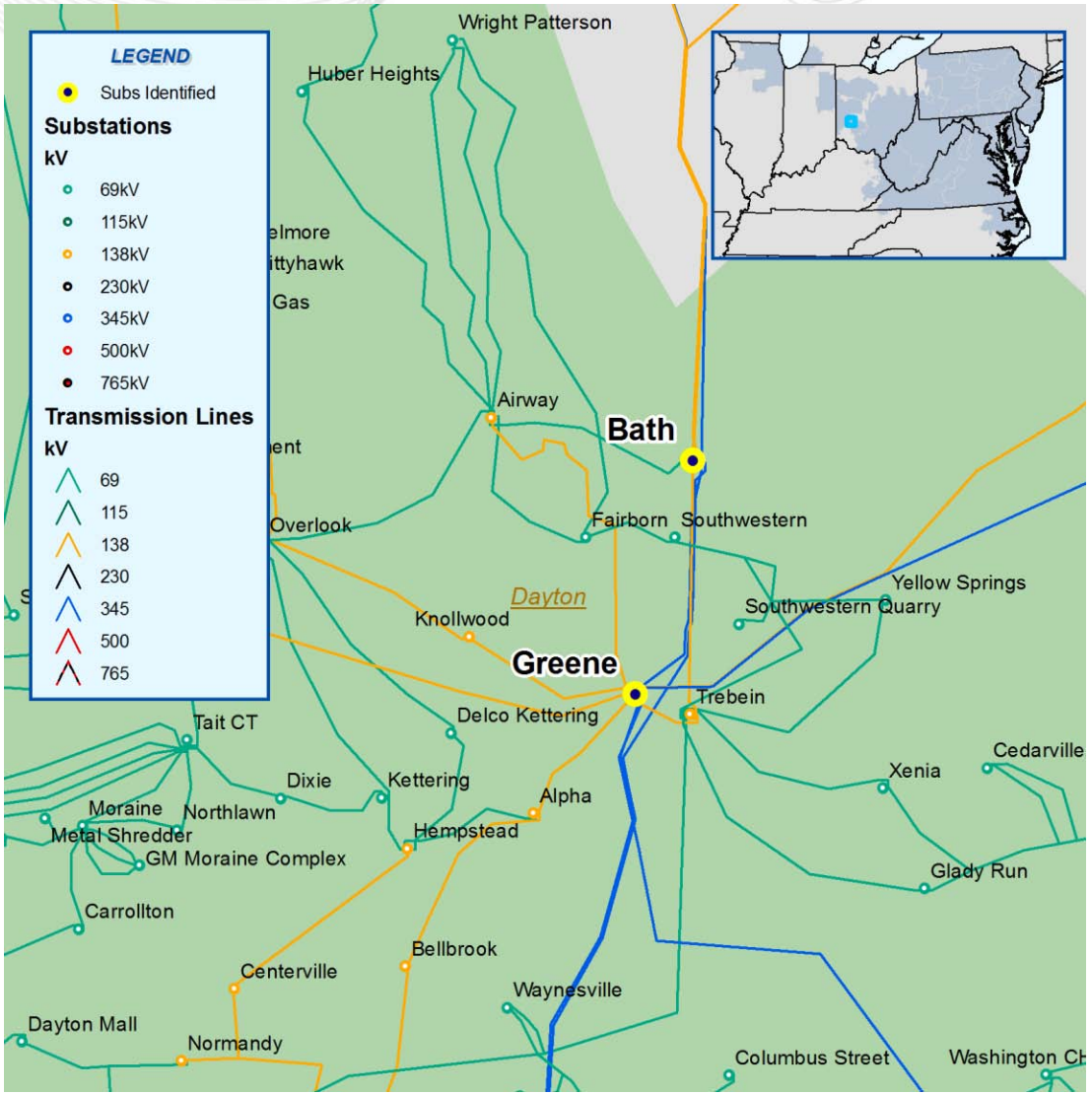
Dayton Transmission Zone

- N-1-1 Thermal Violation
- Loss of one Greene 345/138 kV transformer + Bath 345/138 kV transformer thermally overloads other Greene 345/138 kV transformer
- Add a 2nd Bath 345/138kV transformer (B1273)
- Estimated Project Cost: $7 M
- Expected IS Date: 6/1/2015



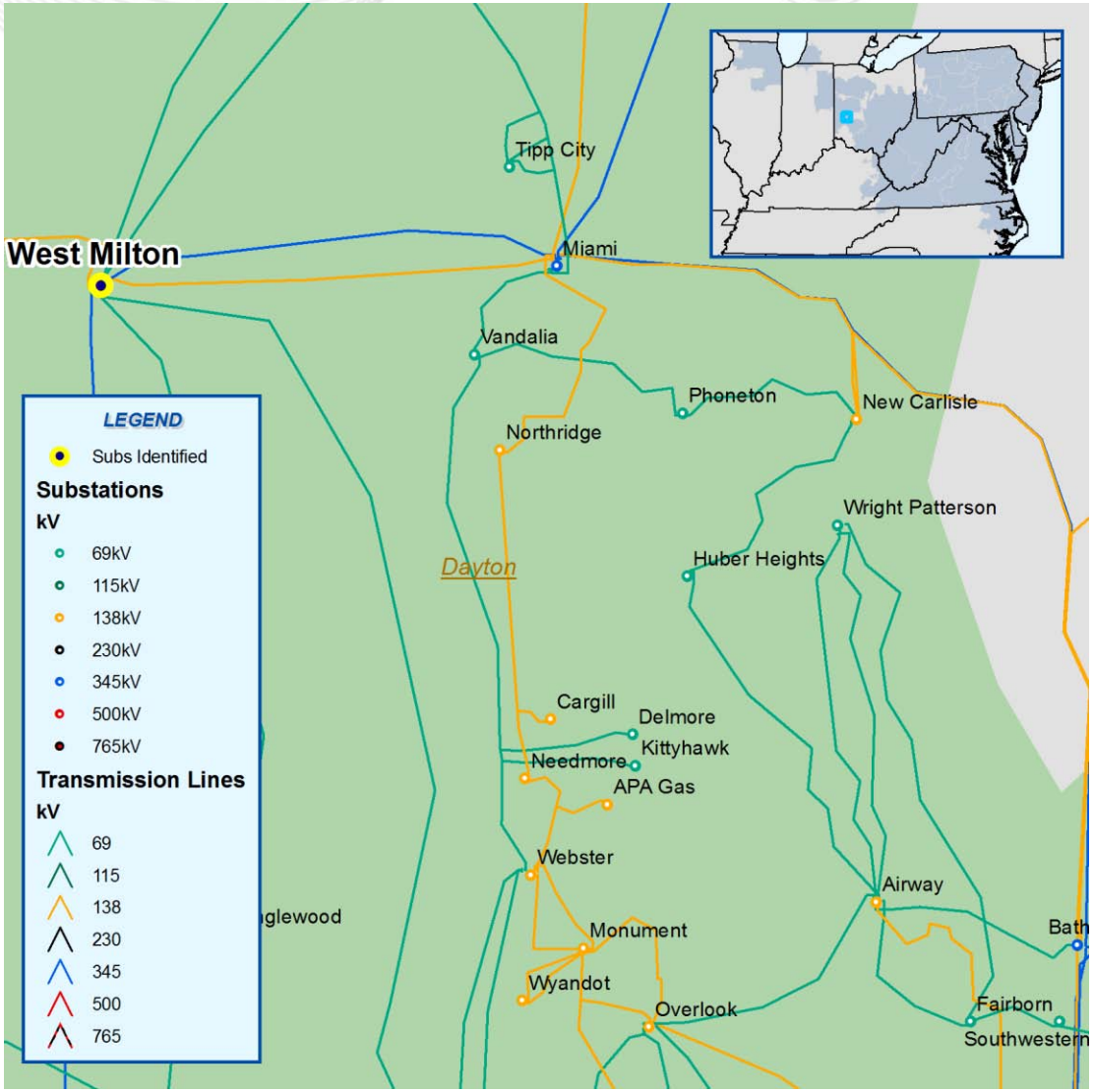
Dayton Transmission Zone

- N-1-1 Thermal Violation
- Loss of one Greene 345/138 kV transformer + Bath 345/138 kV transformer thermally overloads other Greene 345/138 kV transformer
- Proposed Solution: Add a 2nd Trebien 138/69kV Transformer (B1274)
- Estimated Project Cost: $5.3 M
- Expected IS Date: 6/1/2015



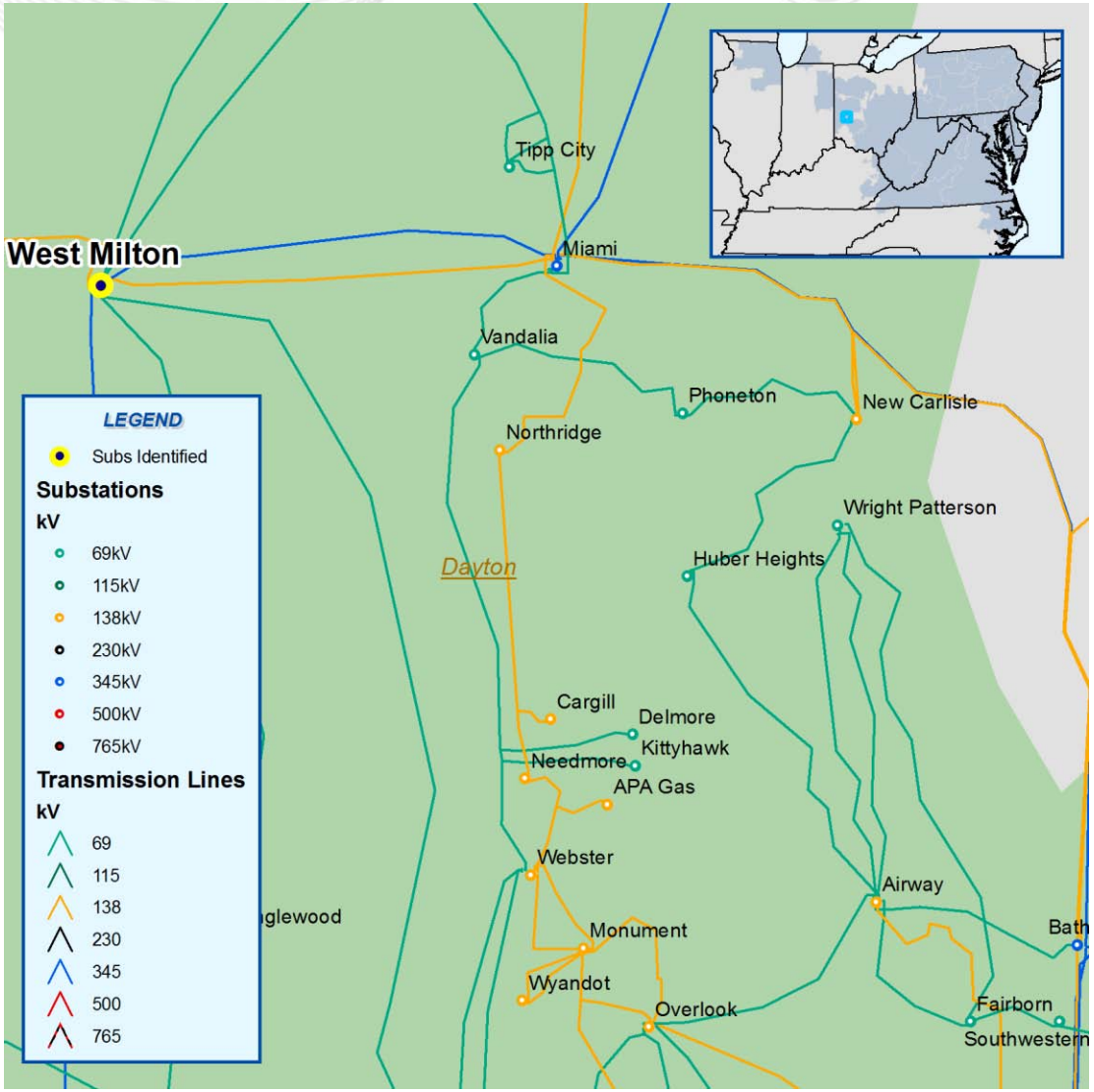
Dayton Transmission Zone

- N-1-1 Thermal Violation
- Various N-1-1 thermal overloads in the West Milton area
- Proposed Solution: Add a 2nd W. Milton 138/69 kV Transformer (B1275)
- Estimated Project Cost: $8.8 M
- Expected IS Date: 6/1/2015



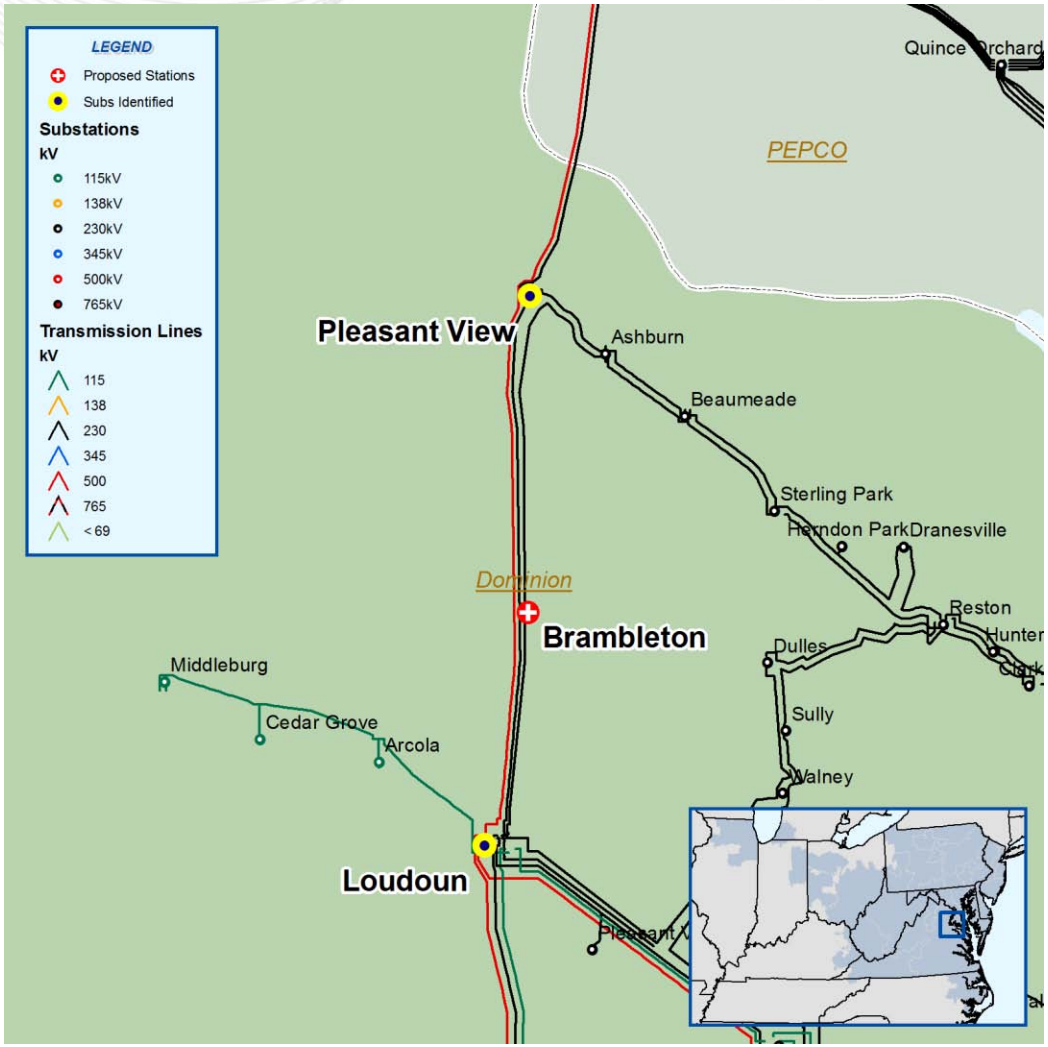
Dayton Transmission Zone

- N-1-1 Thermal Violation
- Various N-1-1 thermal overloads in the West Milton area
- Proposed Solution: Add a 2nd W. Milton 345/138 kV Transformer (B1276)
- Estimated Project Cost: $5.5 M
- Expected IS Date: 6/1/2015



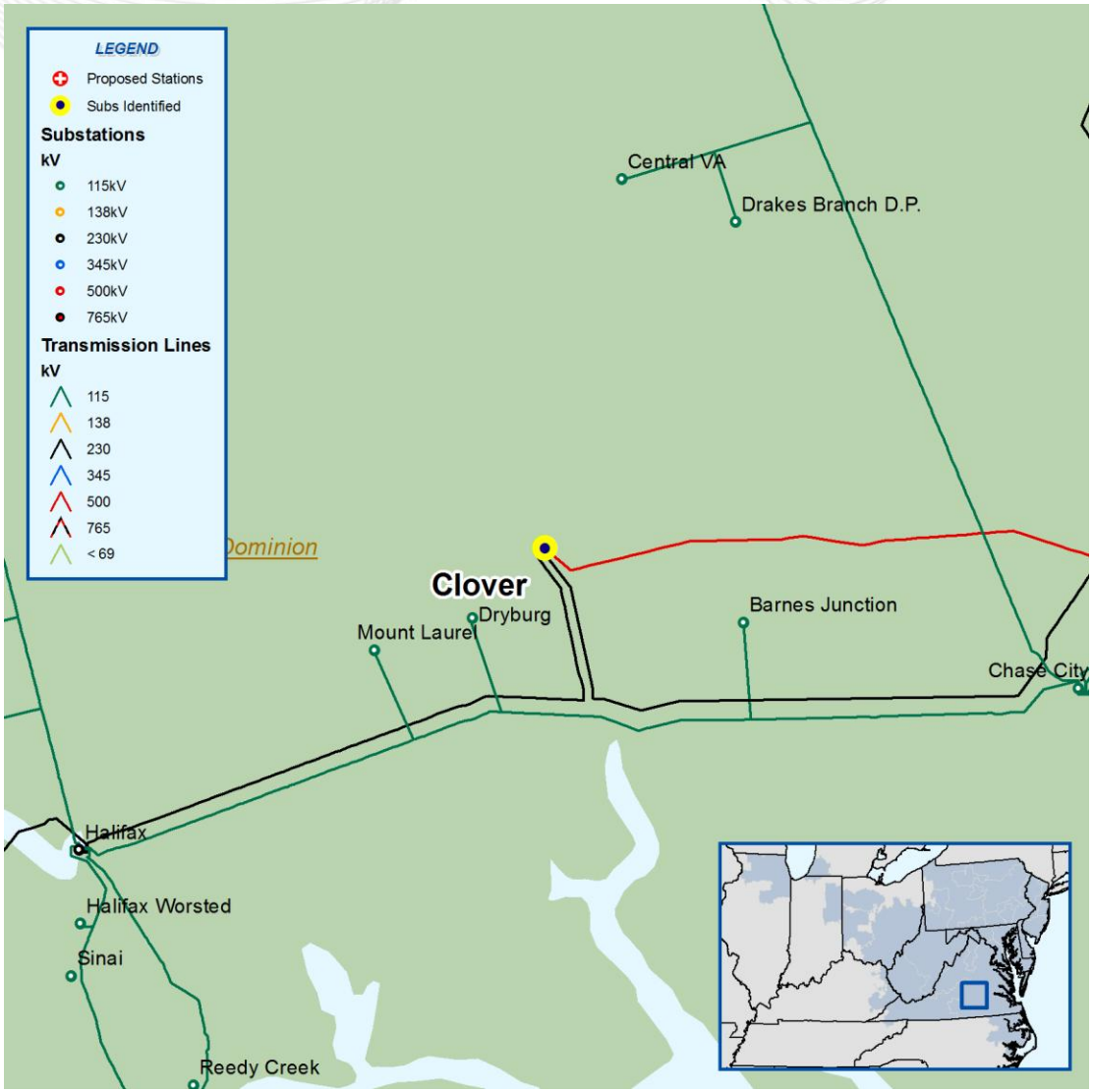
DominionTransmission Zone

- For Dominion and PEPCO Load Deliverability the Pleasant View 500/230 kV transformer is overloaded for the outage of Doubs to Brighton 500 kV and one Loudoun 500/230 kV transformer overloads for the outage of the parallel transformer
- Proposed Solution: Install Brambleton 500/230 kV transformer and associated breakers (b1188)
- Estimated cost: $18 M
- Expected In-service: 06/01/2014



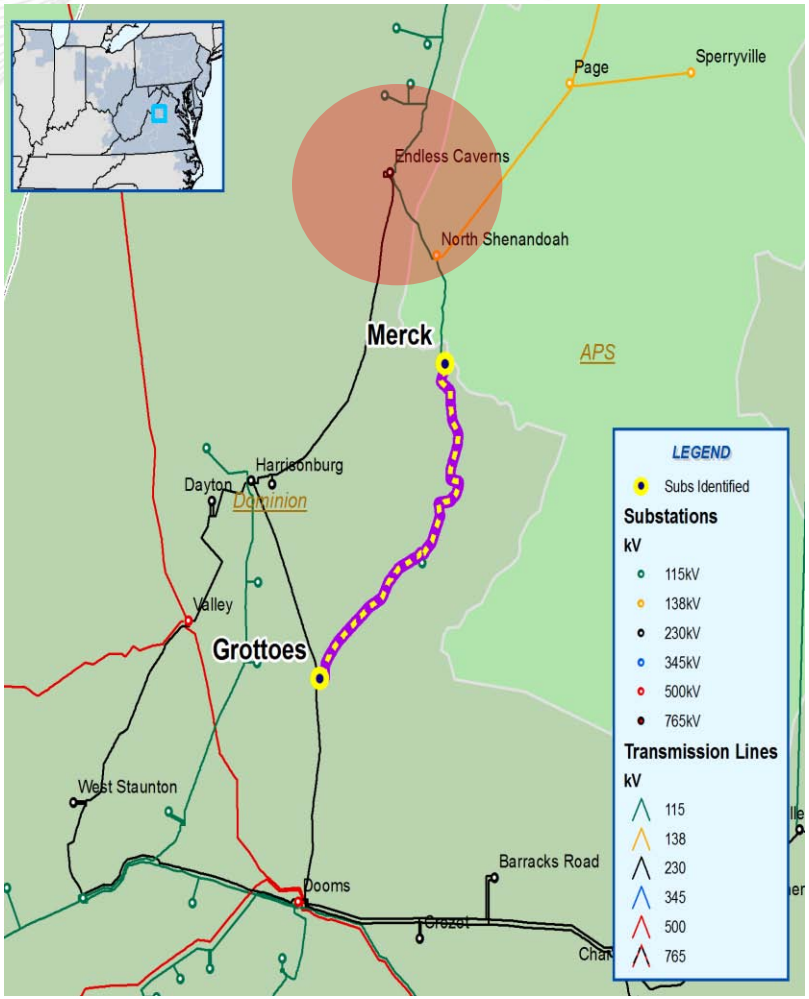
DominionTransmission Zone

- For Dominion Load Deliverability the Clover 500/230 kV transformer is overloaded for the outage of the Carson to Wake 500 kV line along with low voltages in the Clover area
- Proposed Solution: Install 2nd Clover 500/230 kV transformer and a 150 MVAr capacitor (b1224)
- Estimated cost: $16 M
- Expected In-service: 06/01/2015



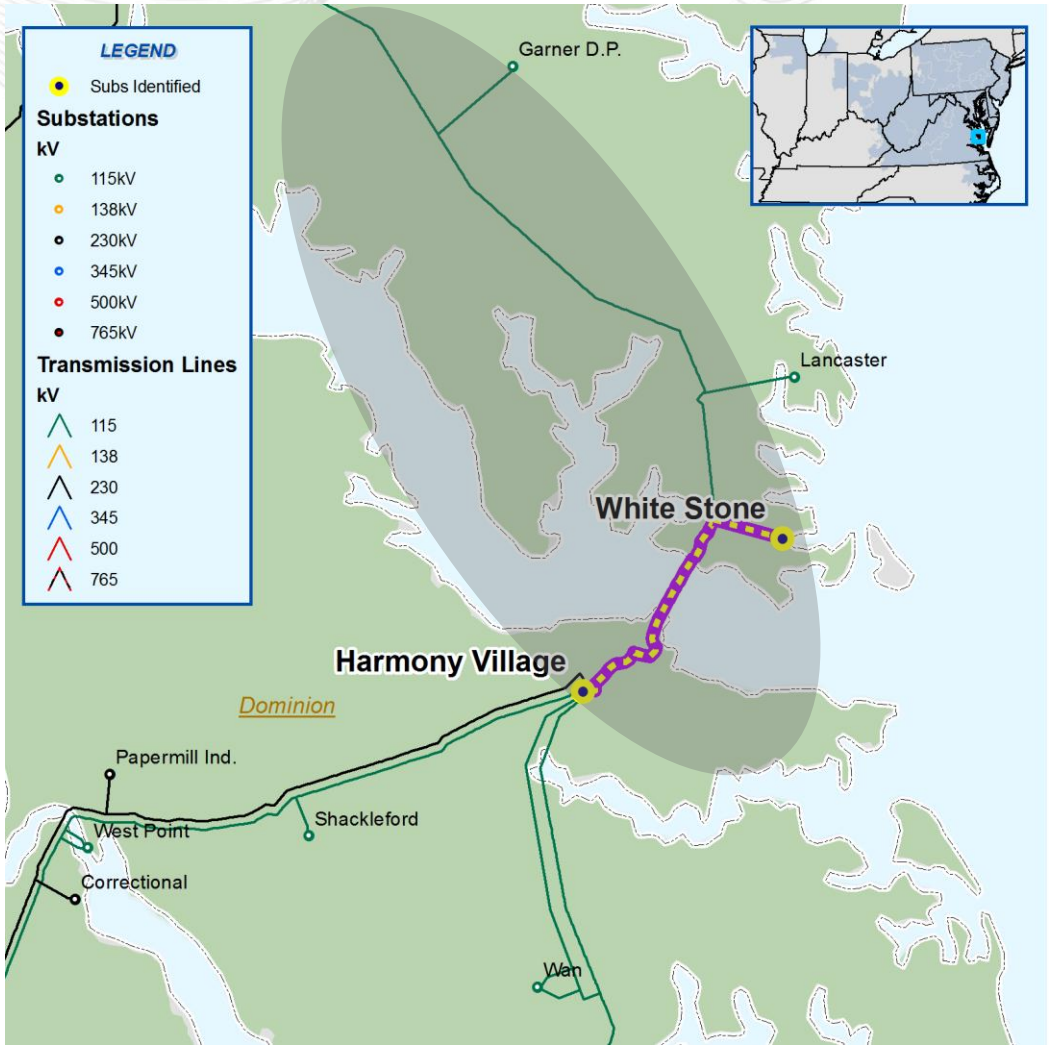
Dominion Transmission Zone

- NERC Category B Dominion Criteria violation
- Thermal loading on Endless Caverns Transformer #4 exceeds 94% of its rating for the loss of Line #119 (Grottoes to Merck) or the loss of the 230/115 Tx at Grottoes Substation
- Proposed Solution: Reconfigure 115kV bus at Endless Caverns substation such that the existing two 230/115kV transformers at Endless Caverns operate in parallel and share the network load.
- Estimated Project Cost: < $0.5 M
- Expected IS Date: Fall 2011



Dominion Transmission Zone

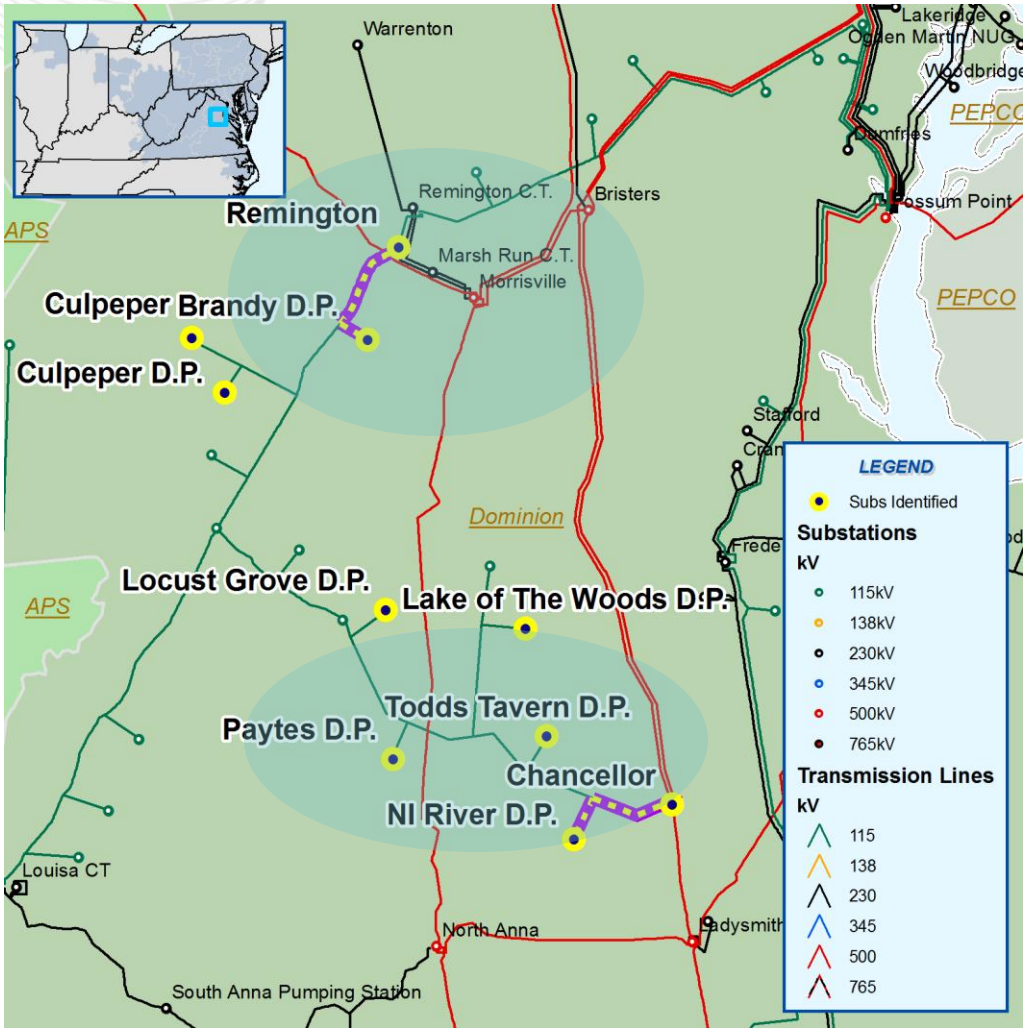
- The 115kV 65 line from Northern Neck to Harmony Village has a 1.5 mile section that is attached to the Norris Bridge as it crosses the Rappahannock River between Middlesex and Lancaster counties
- The Virginia Department of Transportation (VDOT) will require this facility to be de-energized for road maintenance
- The result is a radial 65 line serving over 18,000 customers and 80 MW of peak load for up to 24 consecutive months while maintenance is performed. While in this radial configuration, the only source for the 65 line is the 230-115kV, transformer #4 at Northern Neck. A failure of this transformer during bridge maintenance could result in a lengthy outage to the 65 line while VDOT crews and equipment are removed from the bridge and the line section re-energized. The present VDOT maintenance schedule will require this radial 65 line configuration from 3/2010 to 9/2011 and from 5/2012 to 5/2014.
- Proposed Solution: Install a 2nd 230-115kV transformer at Northern Neck Substation.
- Estimated Project Cost: $4.6M
- Expected IS Date: 03/31/2011



Dominion Transmission Zone

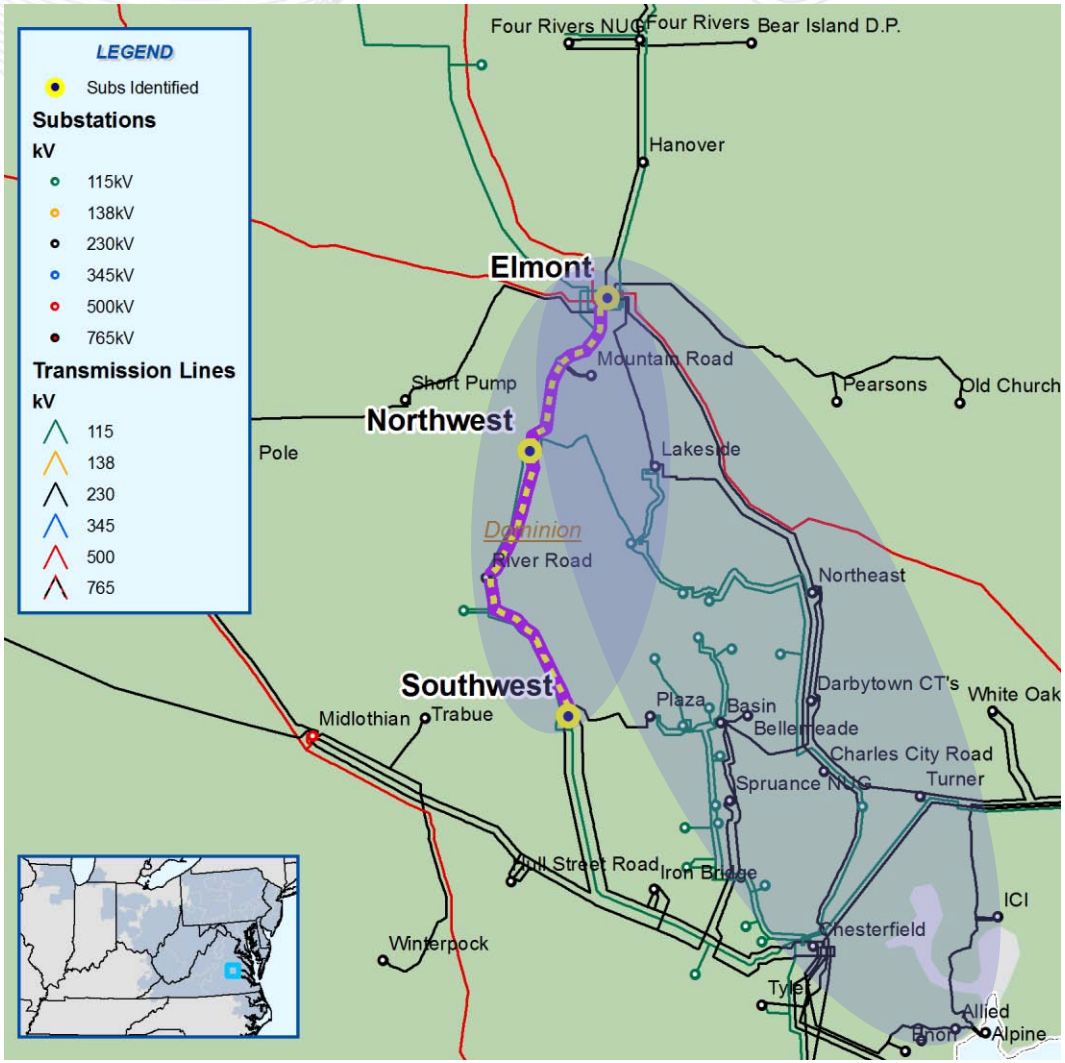
Regions with voltage issues

- NERC Category B violation
- Problems:
  - Chancellor Area: The Summer 2012 base case indicates that for loss of Line #198 section Chancellor to Ni River, with load on Line #198 restored (NERC Category B2 violation), the voltage at Ni River DP, Todds Tavern DP, Lake of Woods DP, Wilderness DP, Paytes DP, and Locust Grove DP drop below 0.93 p.u.
  - Remington Area: The Dominion Transmission Zone base case indicates that for loss of Line #70 section Remington to Brandy DP (NERC Category B2 violation, with load on Line #70 restored, the voltage at Brandy DP, Culpeper, and Mt. Run drop below 0.93 p.u. This also occurs for loss of 7042 breaker at Remington
- Proposed Solutions:
  - Improve LSE's power factor in zone to 0.973 PF.
  - Adjust LTCs at Gordonsville and Remington.
  - Move existing shunt capacitor banks.
- Estimated Project Cost $ 500K
- Expected IS Date: Spring 2012



Dominion Transmission Zone

- NERC Category C3 (N-1-1) Violation
- Problem A: Northwest 230-115kV transformer #7 loads to above its emergency rating for the loss of the Elmont Substation end of the 230kV, 221 line and the subsequent loss of the Southwest Substation end of the 230kV, 222 line. The amount of load that is affected by this overload is 417 MW which exceeds PJM and DVP Planning Criteria
- Problem: B For the loss of the Elmont to Lakeside 230kV line and the subsequent loss of the Chesterfield Substation end of the 230kV, 217 line, Northwest to Acca 115kV exceeds its emergency rating as well as several other 115 kV lines exceeding their emergency rating.
- Proposed Solution:: Install a 230kV line from Lakeside to Northwest utilizing the idle line and 60 line ROW's and reconductor the existing 221 line between Elmont and Northwest.
- Estimated Project Cost: $12.5M
- Expected IS Date: 6/1/2013



Dominion Transmission Zone

- Dominion Criteria

- Completion of the “Reconductor 40 & 71 Line & Network” project B0310 in May 2010 creates a 50 mile network line from Chase City to Clubhouse that resulting in two problems:

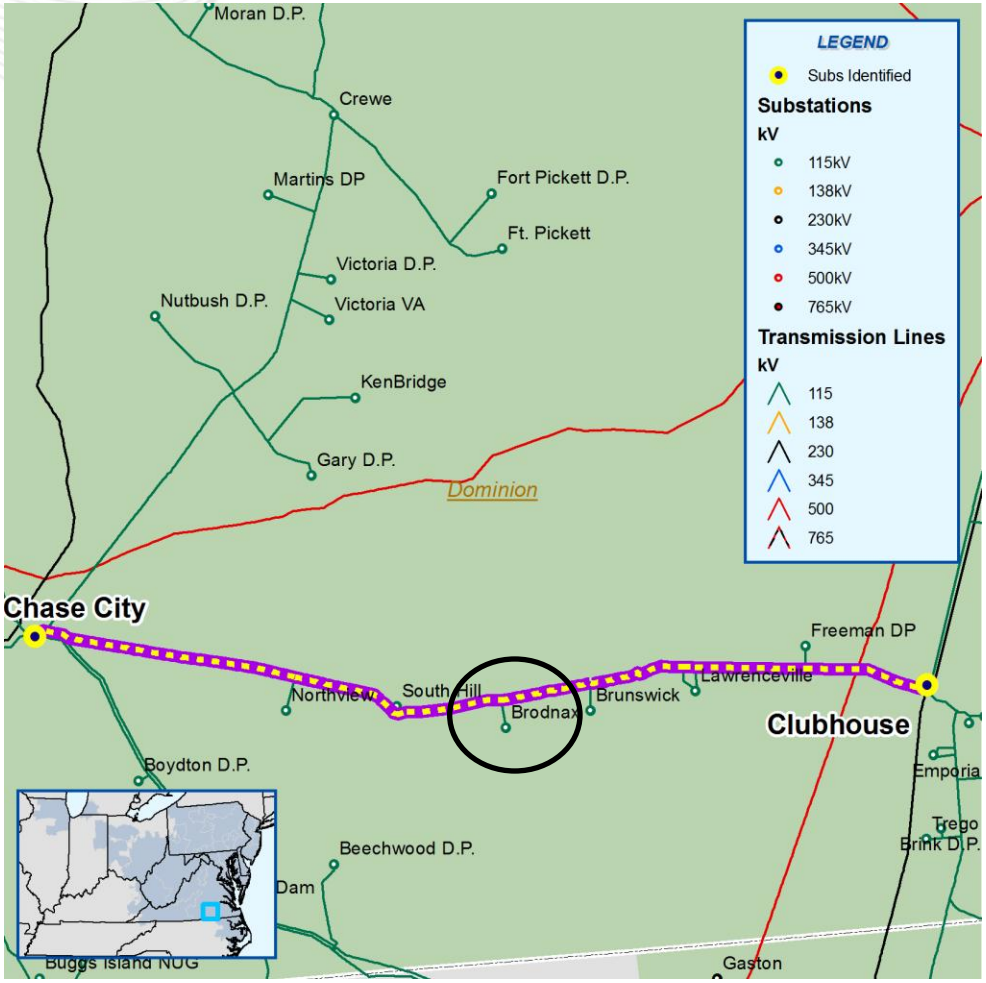
  1) Line rating is limited by relays to 253 MVA with conductor rated 347 MVA.

  2) Reliability exposure of a 50 mile line affecting all substations between Chase City and Clubhouse.

- Proposed Solution: Install a 115kV breaker at Broadnax Substation on the South Hill side of Broadnax

- Estimated Project Cost: $0.5 M

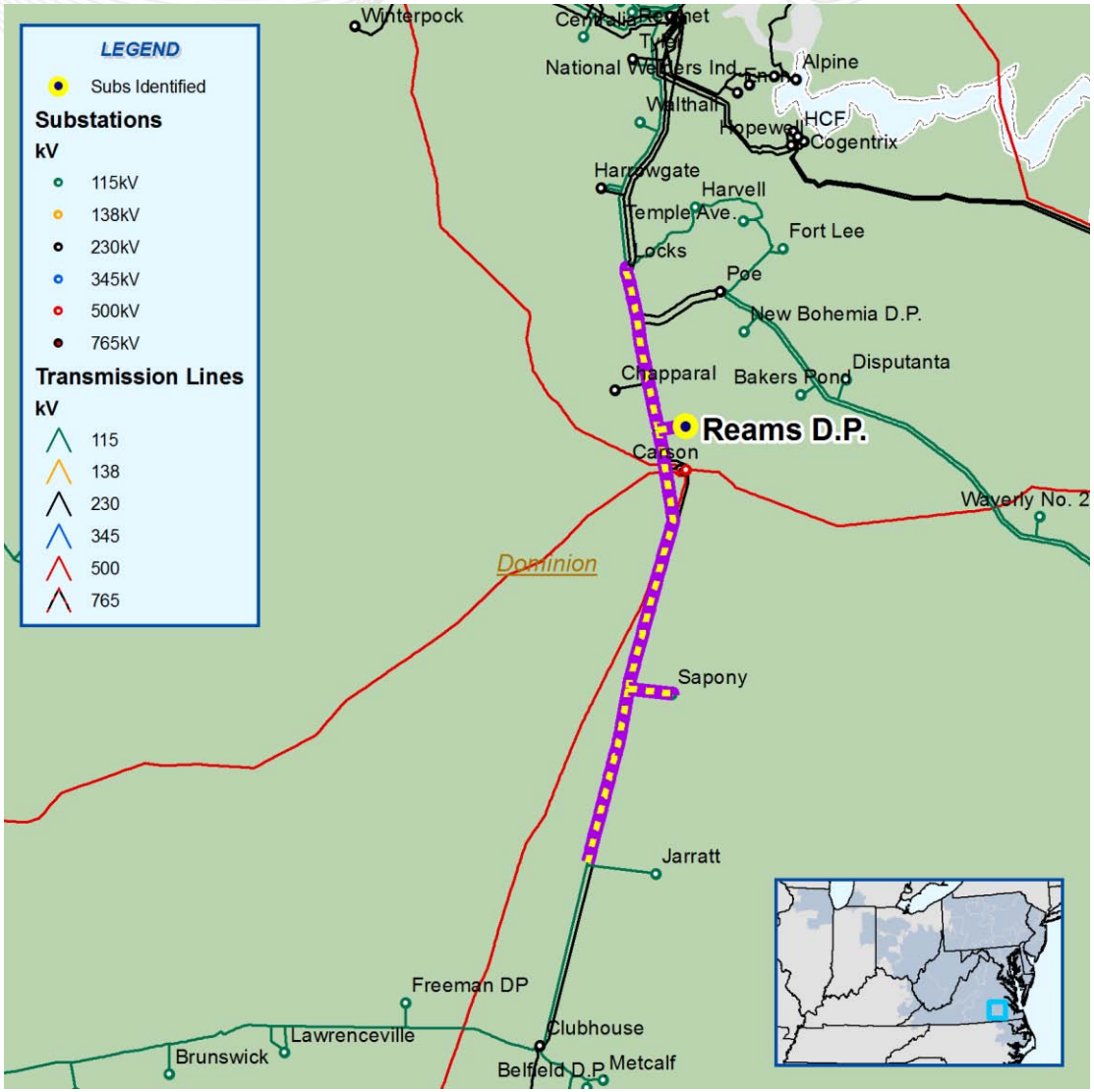
- Expected IS Date: 6/1/2013



Dominion Transmission Zone

NERC Category B violation

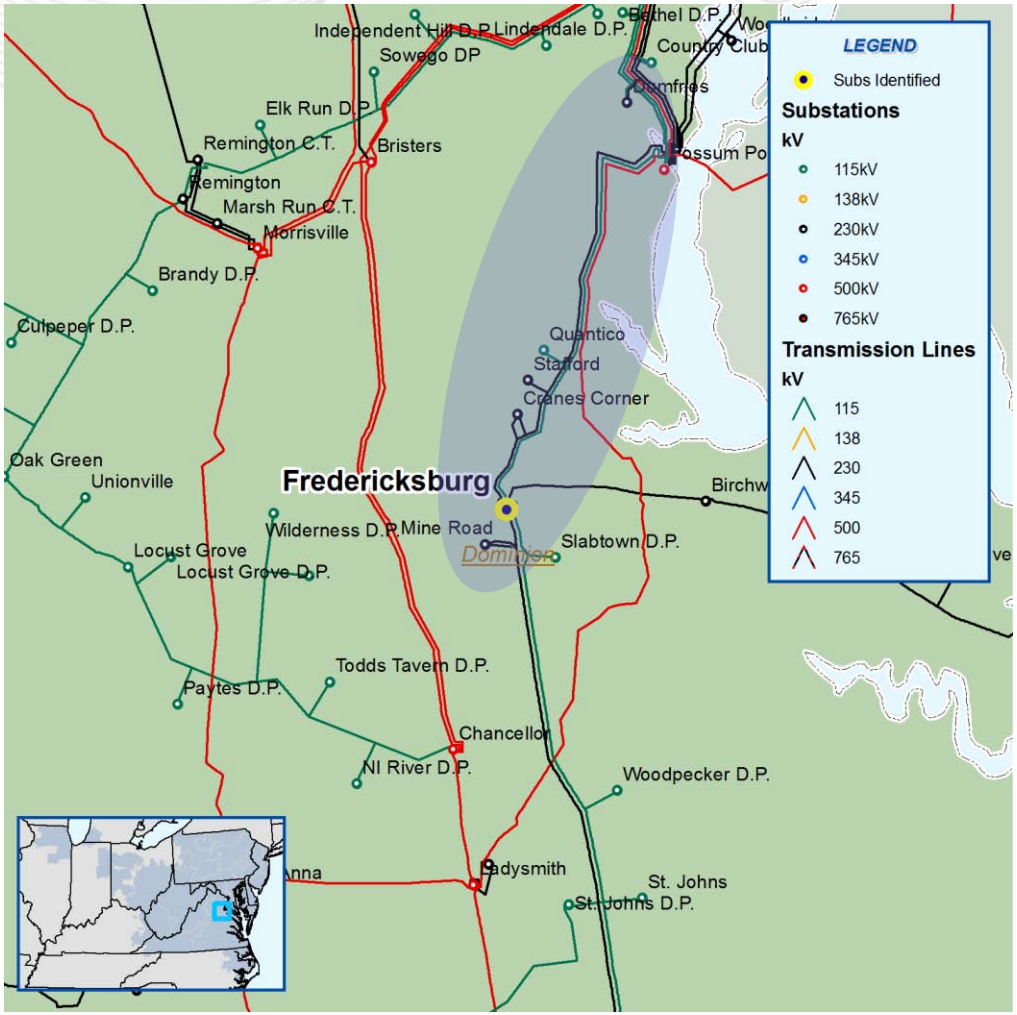
- Project S0141- Locks to Purdy 115 kV overloads for breaker trip on either end due to additional load growth at the Reams delivery point.
- Proposed Solution: Re-build first 6.65 miles of Reams DP to Locks 115 kV and re-conductor first span out of Locks sub. Replace 800 amp wave trap with 1600 amp trap. Upgraded ckt will be built for 230 kV and operate at 115 kV.
- This project is changed to baseline project B1279
- Estimated Project Cost: $9.4 M
- Project IS Date: 6/1/2014



Dominion Transmission Zone

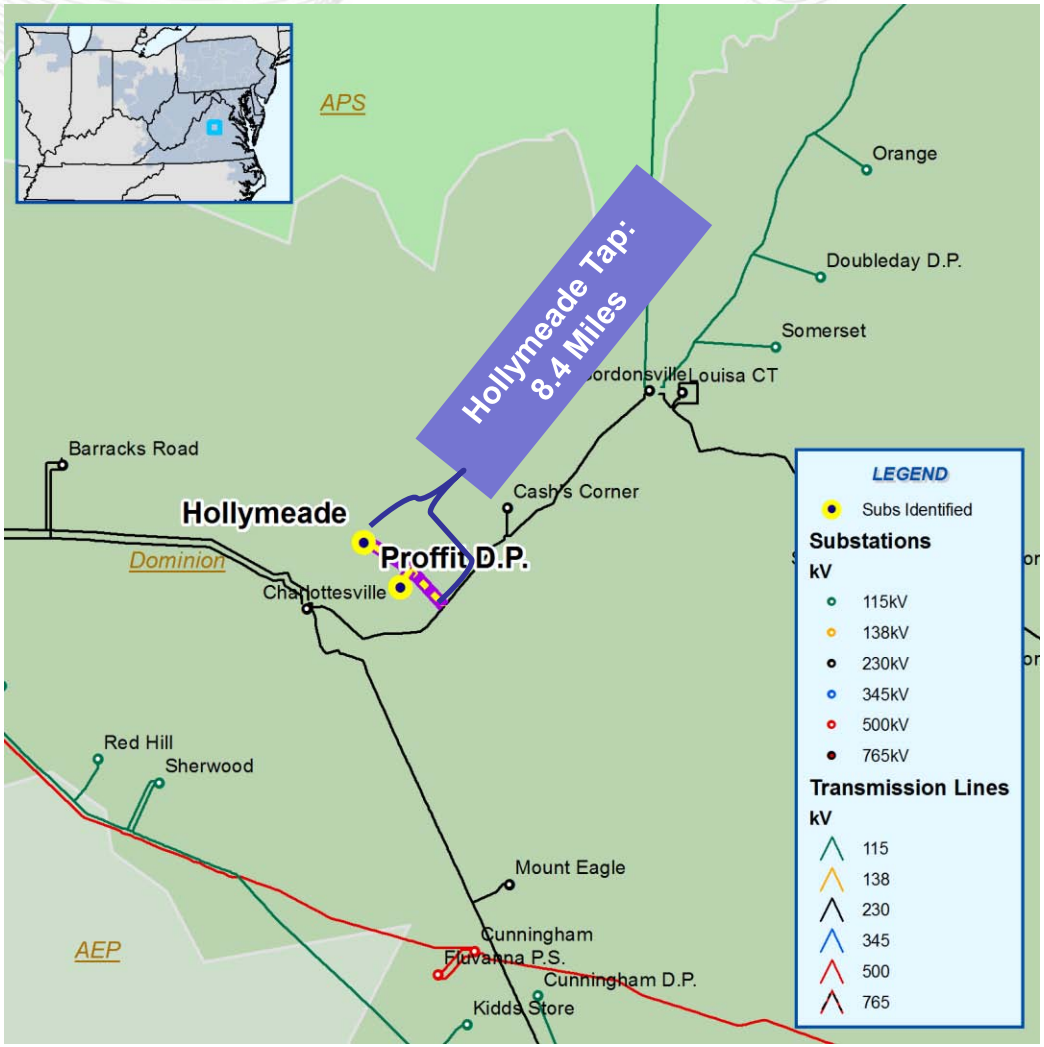
NERC Category C Violation

- NERC Category C
- Problem: The failure of the Fredericksburg 230kV breaker #2090T2104 results in load loss greater than 300MW – Dominion & PJM Criteria violation
- Proposed Solution: Install a 230kV, 3000 amp breaker at Cranes Corner Substation to sectionalize the 2104 line into two lines.
- Estimated Project Cost: $0.75 M
- Potential IS Date: 05/01/2014



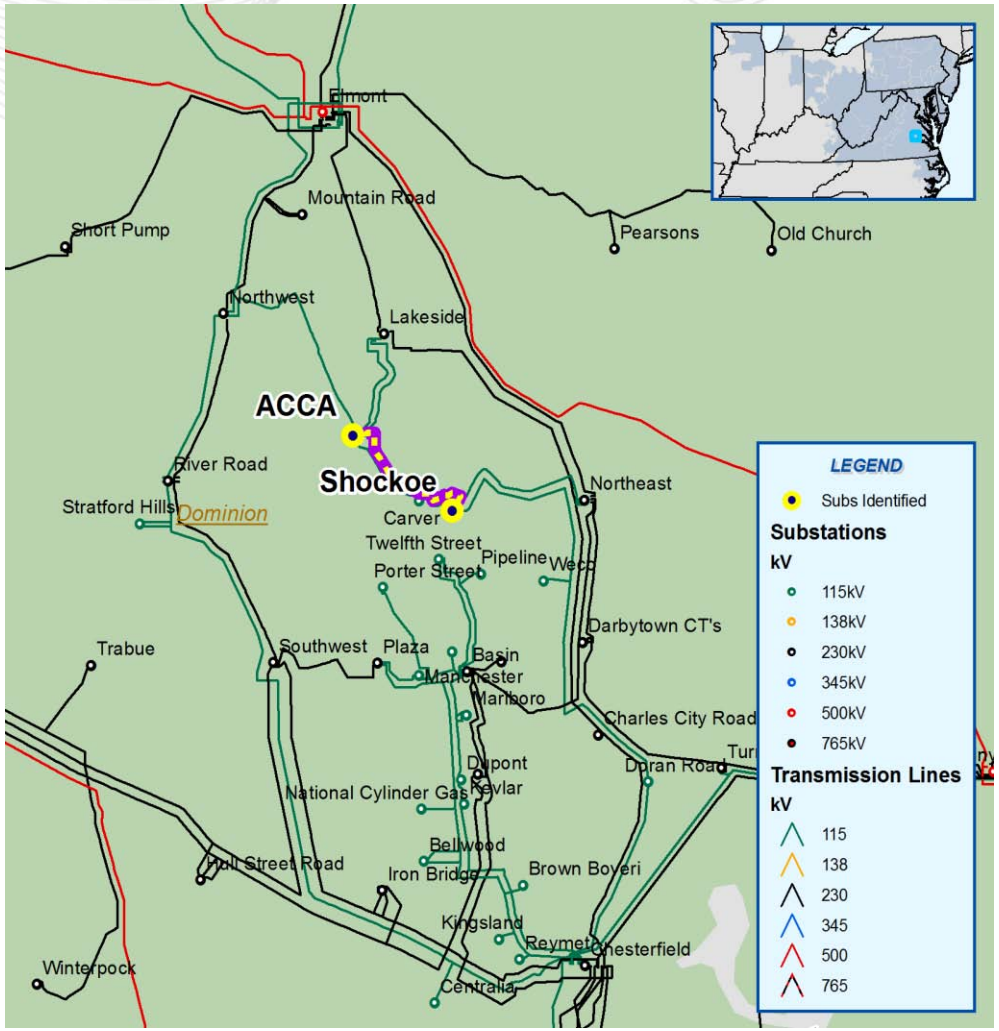
Dominion Transmission Zone

- Dominion Criteria Violation
  - Load on a radial line in excess of 100MW should have an alternate delivery point
- The load on the Hollymeade Tap (Line #2054) is forecasted to exceed 100MW in Winter of 2010. Tap currently serves the load at the Hollymeade Substation and REC's Profitt Delivery Point. There are currently no alternate transmission feeds for the distribution facilities fed from the Hollymeade Tap.
- Proposed Solution:
  - Loop the 2054 line in and out of Hollymeade and place a 230kV breaker at Hollymeade. This will split the existing 2054 line and create two lines: Charlottesville to Hollymeade and Hollymeade to Gordonsville.
- Estimated Project Cost: $30.5 M
- Expected IS Date: 6/1/2014



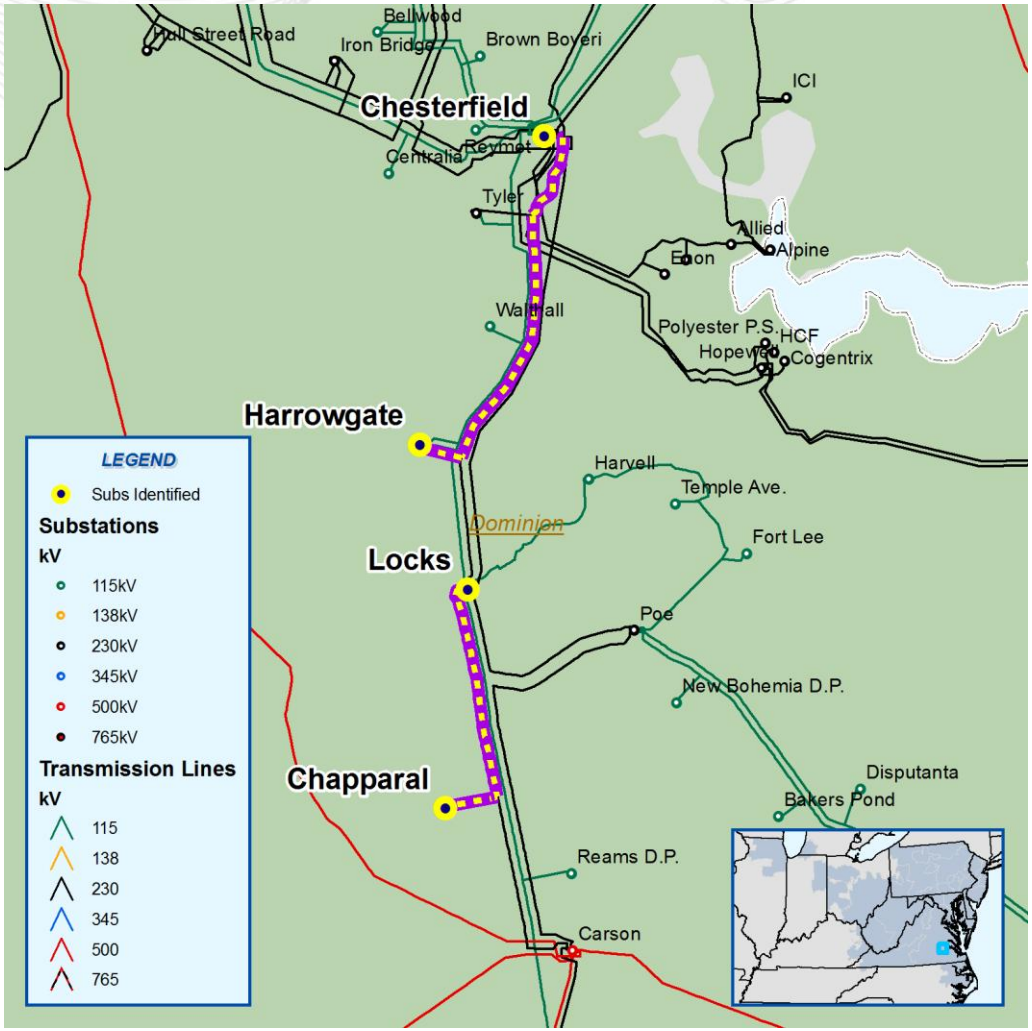
Dominion Transmission Zone

- NERC Category B Violation
- Problem: N-1 Loss of Line 159 Acca to Shockoe results in overloads on Line 17 from Shockoe to Chesterfield exceeding 94%.
- Proposed Solution: Resag wire to 125C from Chesterfield – Shockoe (18.5 miles) and replace line switch 1799 with 1200 amp switch. The new rating would be 231 MVA
- Estimated Project Cost: $1.5 M
- Expected IS Date: 6/1/2014



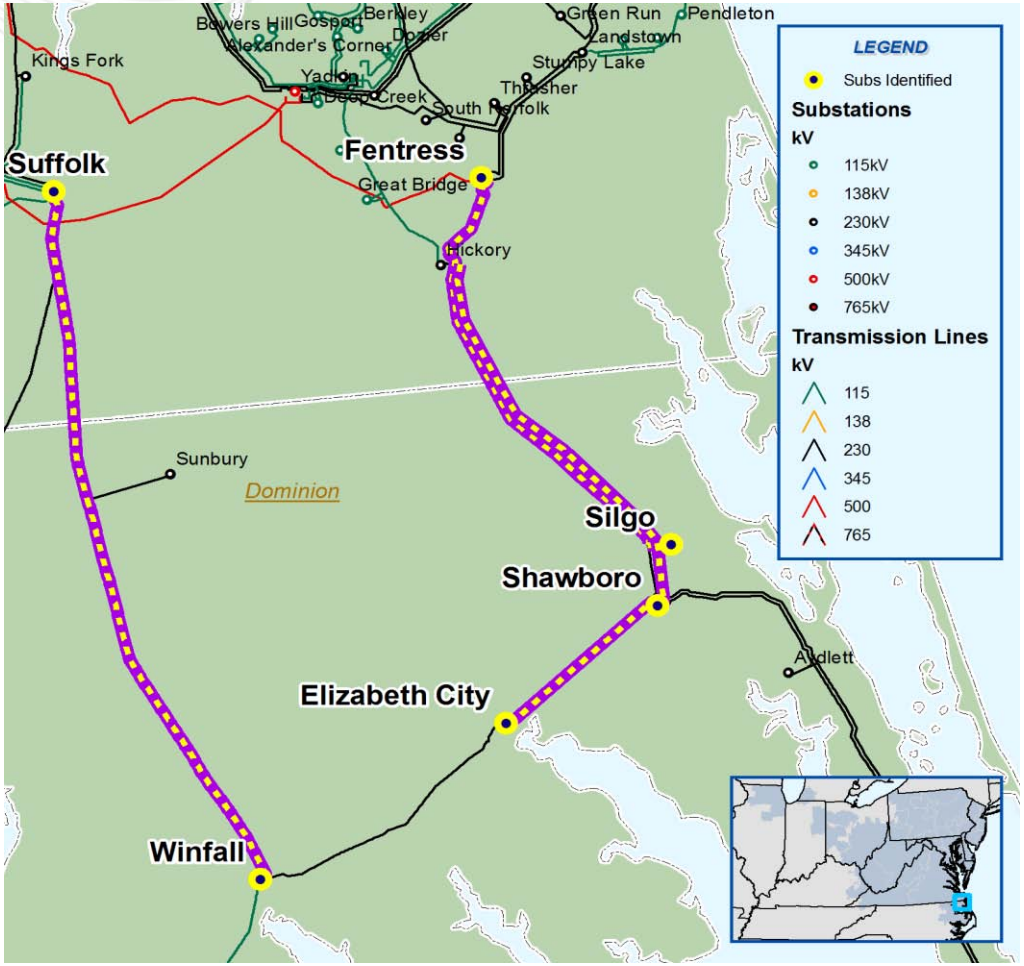
Dominion Transmission Zone

- NERC Category C N-1-1 Violation
- For the N-1-1 loss of 230 kV lines #249 Locks - Chapparal and #205 Chesterfield – Tyler results in overloads on line 100 Chesterfield – Harrowgate 115 kV
- Proposed Solution: Rebuild the 6.8 mile Line #100 from Chesterfield to Harrowgate 115 kV for a minimum 300 MVA rating
- Estimated Project Cost: $8 M
- Expected IS Date: 6/1/2014



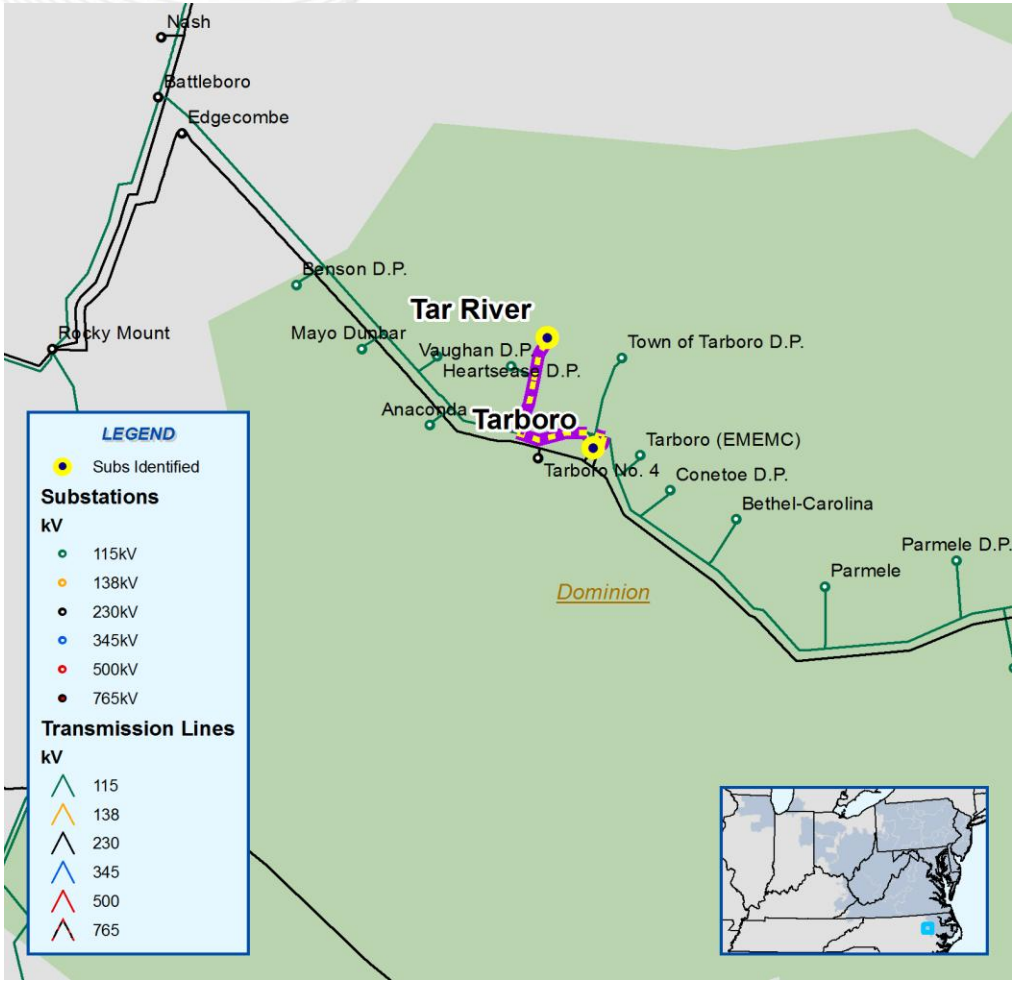
Dominion Transmission Zone

- NERC Category C N-1-1 Violation
- Problems:
  - For N-1-1 loss of 230 kV lines #2021 Shawboro-Elizabeth City and #247 Suffolk - Winfall, results in voltage collapse below 90%.
  - For N-1-1 loss of both 230kV lines #269 Fentress - Sligo and #2087 Fentress - Shawboro results in voltage collapse below 90%.
- Proposed Solution: Convert Line #64 Trowbridge to Winfall to 230kV and install a 230kV capacitor bank at Winfall. This project would replace RTEP Project B1056 since it does not resolve violation number 2.
- Estimated Project Cost: $23 M
- Expected IS Date: 6/1/2014



Dominion Transmission Zone

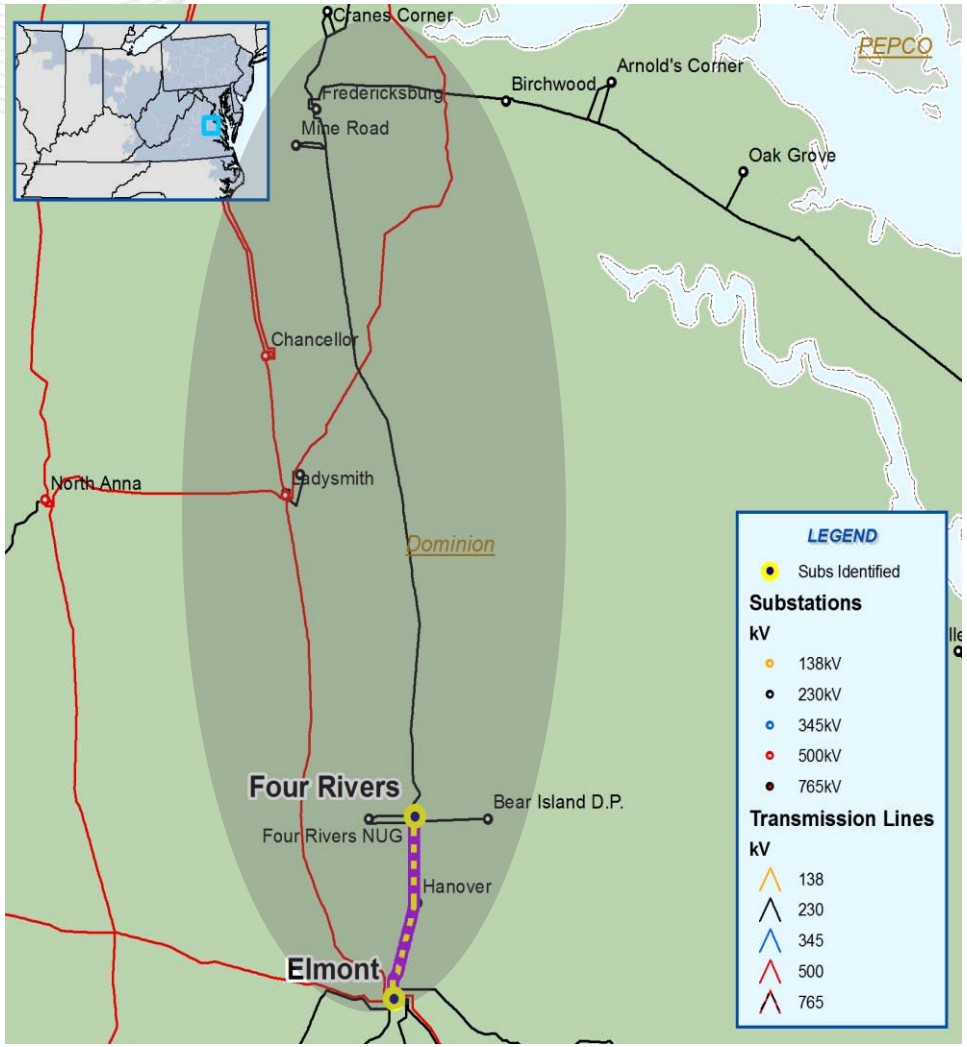
- NERC Category B Violation
- For loss of 115kV Line #55 at Tarboro to the Tar River tap, closing 55T80 at Anaconda results in line #80 Battleboro – Mayo Dunbar DP exceeding 94% of the thermal rating
- Proposed Solution: Rebuild 10.7 miles of 115kV Line #80 (Battleboro – Heartsease DP)
- Estimated Project Cost: $ 11M
- Expected IS Date: 6/1/2014



Dominion Transmission Zone

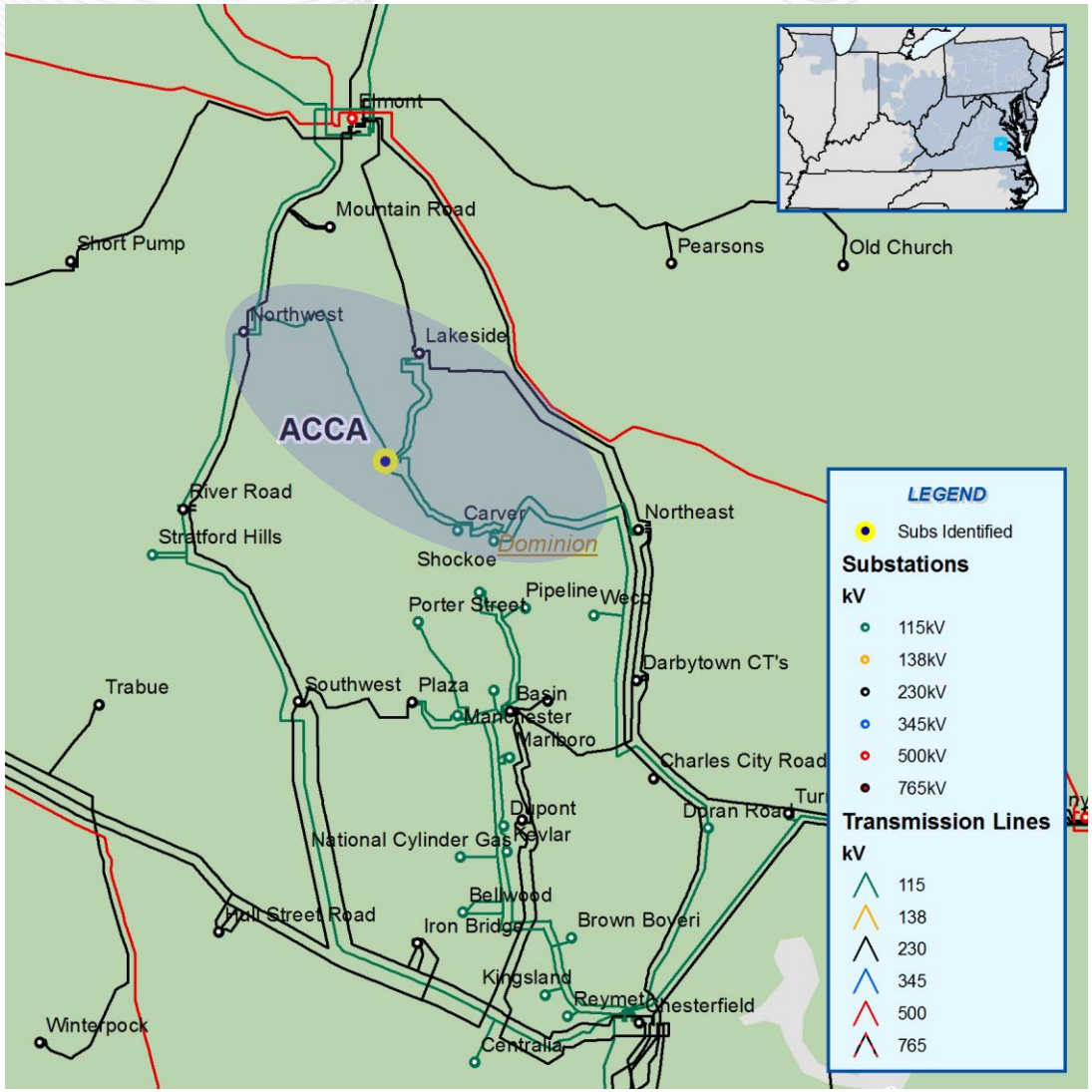
NERC Category B violation

- NERC Category B Violation results in low voltage below 93% for an outage of the Elmont to Four Rivers 115 kV line.
- Proposed Solution: LSE load power factor on the Line #47 line will need to meet MOA requirements of 0.973 in 2015 to further resolve this issue through at least 2019.
- Estimated Project Cost: < $0.5 M
- Potential IS Date: 05/01/2015



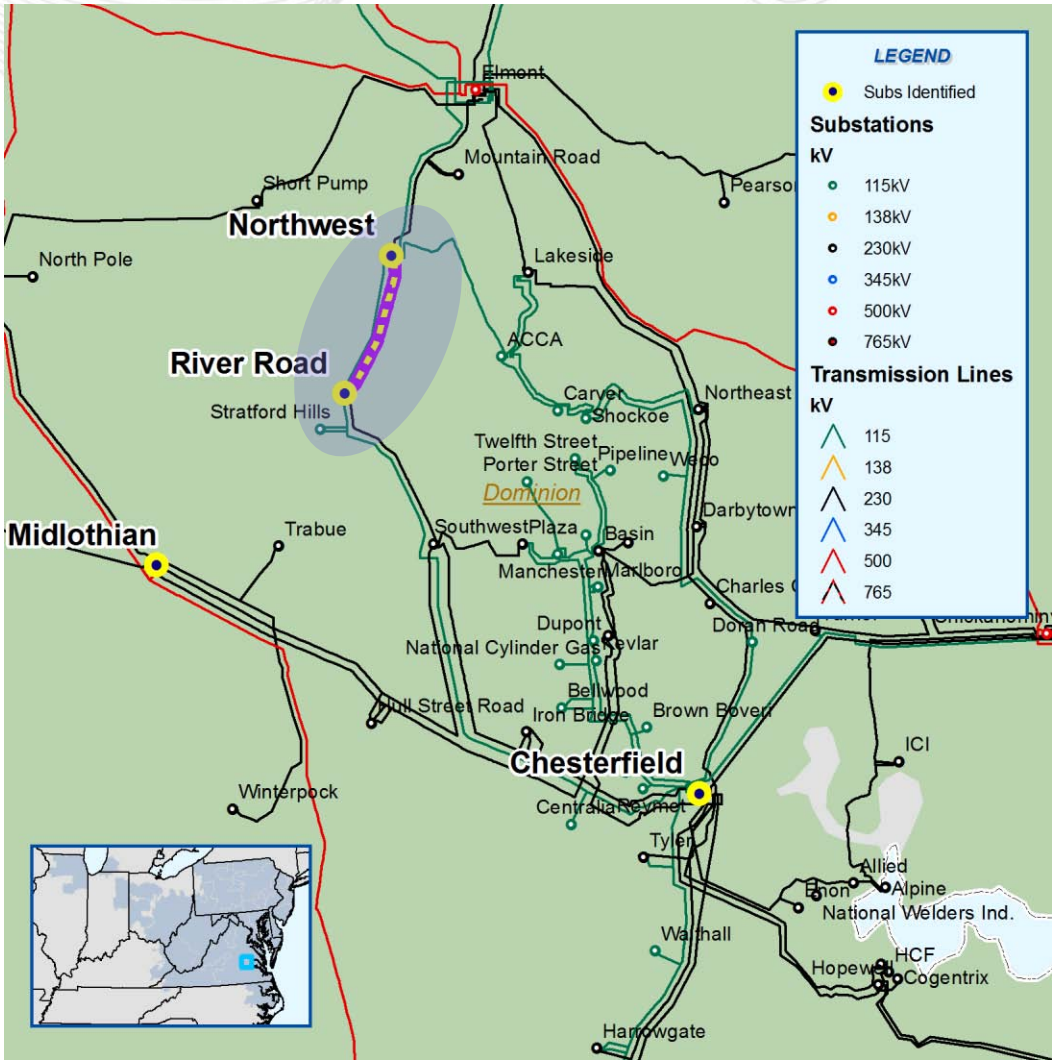
Dominion Transmission Zone

- NERC Category C Violation
- Problems:
  - Problem A: Acca Substation 115kV Bus #2 outage results in Lakeside transformer #5 loading to above the emergency rating.
  - Problem B: A line breaker failure on the 115kV Bus #2 at Acca results in Lakeside transformer #5 loading to above the emergency rating.
- Proposed Solution: Install a 115kV bus tie breaker at Acca Substation between the Line #60 and Line #95 breakers.
- Estimated Project Cost: $0.5 M
- Expected IS Date: 5/1/2015



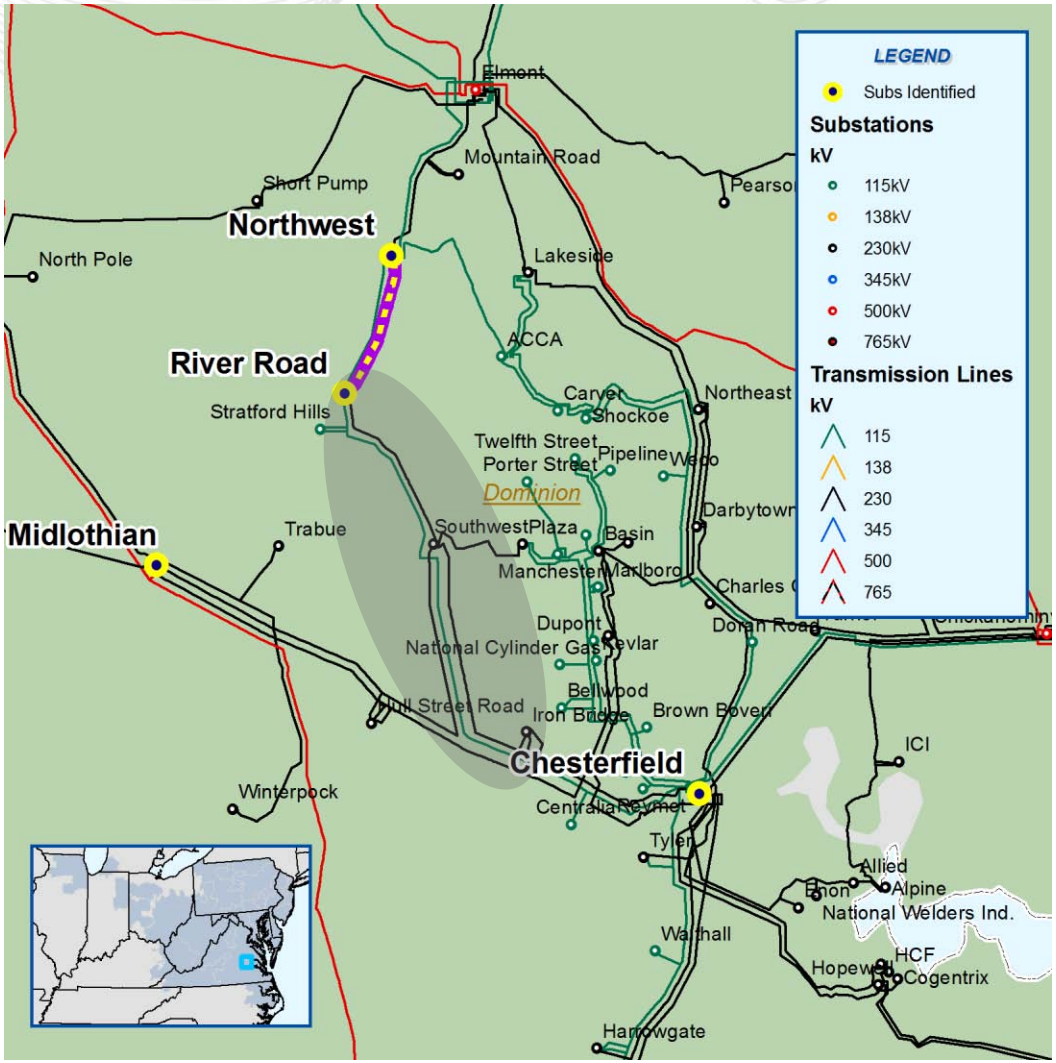
Dominion Transmission Zone

- NERC Category C N-1-1 Violation
- For the loss of the Midlothian Substation end of 230kV line #2066 and the subsequent loss of the Chesterfield Substation end of the 230kV line #208, the Northwest – River Rd segment of the 230kV Line #222 loads to above its emergency rating. The amount of load that is affected by this overload is above 300 MW which violates PJM and DVP Planning Criteria
- Proposed Solution: Resag line #222 to 150 C and upgrade any associated equipment to a 2000a rating to achieve a 706 MVA summer line rating.
- Estimated Project Cost: $1.0 M
- Expected IS Date: 5/1/2015



Dominion Transmission Zone

- NERC Category C N-1-1 Violation
- For the loss of the Northwest Substation end of the 230kV, Line #222 and the subsequent loss of the Chesterfield Substation end of the 230kV, Line #208 results in bus voltages in the area below 90% (River Rd & Ironbridge).
- Proposed Solution: Install a 230kV, 150 MVAR capacitor bank at Southwest Substation.
- Estimated Project Cost: $1.2 M
- Potential IS Date: 5/01/2015



Dominion Transmission Zone

Dominion Transmission Zone, voltage issues return

Region with thermal issues

- **NERC Category B and C Violations**

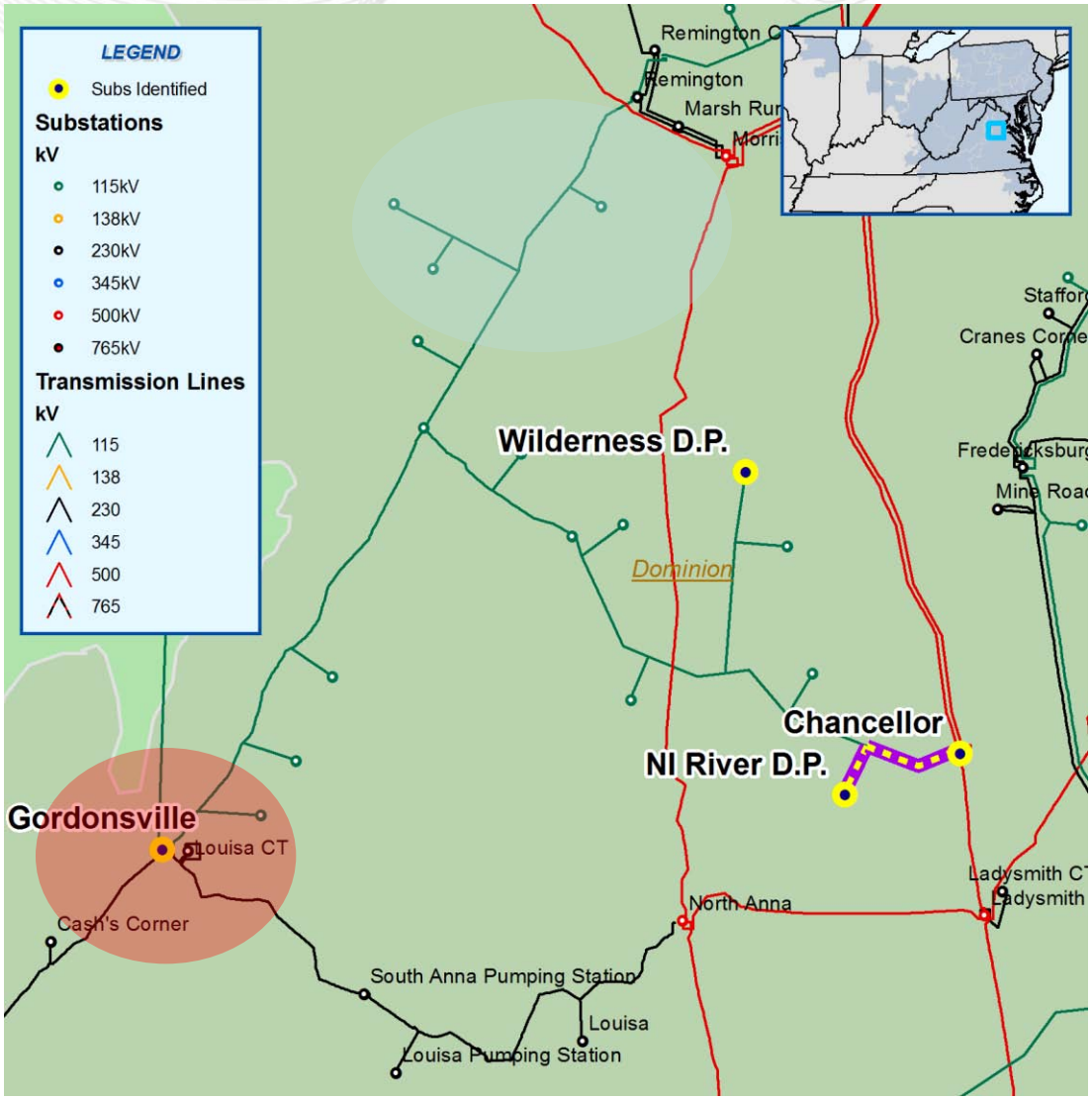
NERC Category B. Gen deliverability case indicates that the N-1 loss of the 230-115kV TX #1 at Gordonsville, results in thermal overload of the remaining 230-115kV TX #3 at Gordonsville.

NERC Category B. The N-1 loss of the 198 line section Chancellor to Ni River, with load on the 198 line restored, results in low voltage. Assumed zonal power factor of 0.97.

NERC Category C3. The N-1-1 loss of the 198 line Section (Ni River to Chancellor) and the loss of 11 line section (Gordonsville to Somerset) results in low voltage. Assumed zonal power factor of 0.97.

NERC Category C3. The N-1-1 loss of the 198 line Section (Ni River to Chancellor) and the loss of 70 line section (Brandy to Remington) results in low voltage. Assumed zonal power factor of 0.97.

NERC Category C3. The N-1-1 loss of both 500-115kV transformers at Chancellor results in low voltage. Assumed zonal power factor of 0.97.



Dominion Transmission Zone

- Continued from previous slide

- Proposed Solution:

Build a new 230kV line North Anna to Oak Green and install a 224MVA 230-115kV transformer at Oak Green

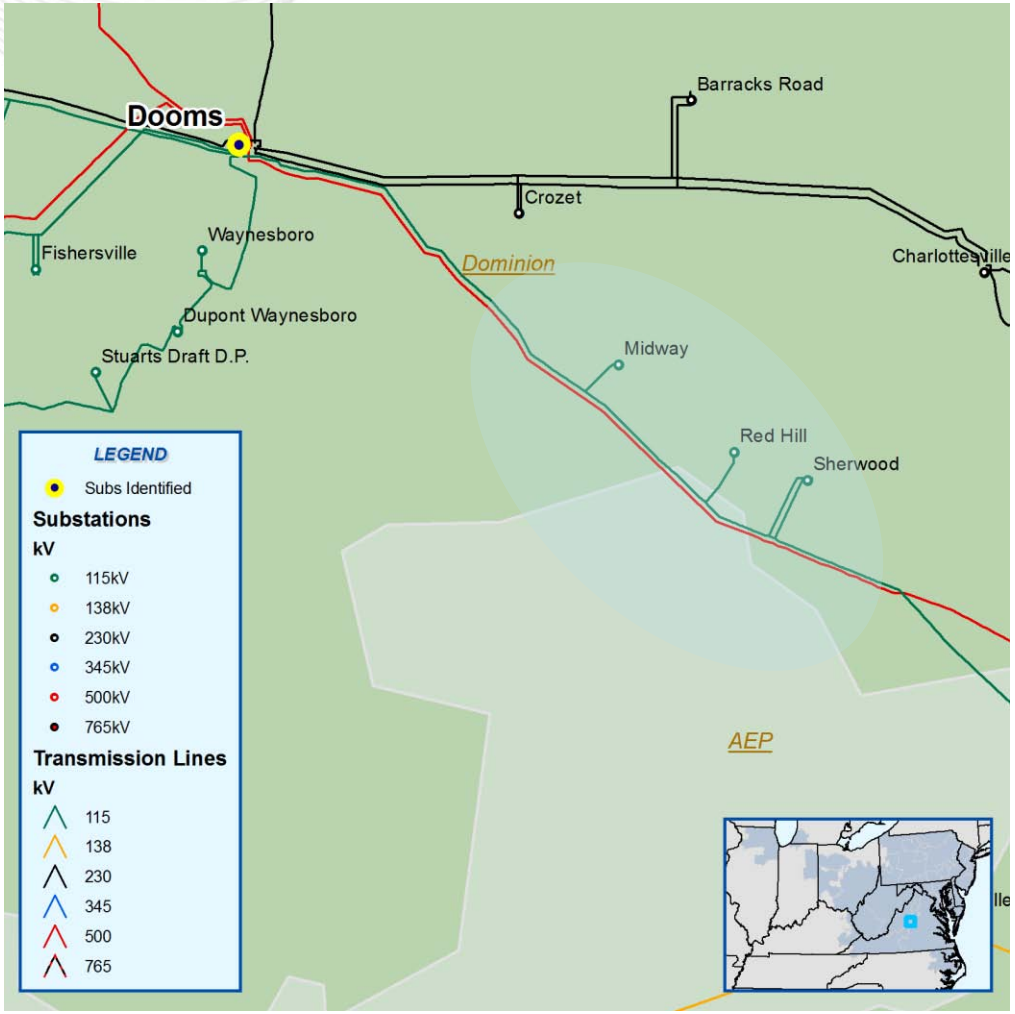
- Estimated Project Cost: $70M

- Expected IS Date: Dominion Transmission Zone

Dominion Transmission Zone

Region with voltage issues

- NERC Category C Violation
- Several NERC Category C2 violations (Breaker Failure at Dooms 115 kV Substation) result in low voltage (|V|< 0.90 p.u.) at Sherwood, Red Hill, and Midway DP on the 91 and 39 lines and exceeds the thermal rating of the line.
- Proposed Solution:
  - Rebuild the 39 Line (Dooms to Sherwood)
  - Rebuild the 91 Line (Sherwood to Bremo)
- Estimated Project Cost $ 100M
- Expected IS Date Dominion Transmission Zone

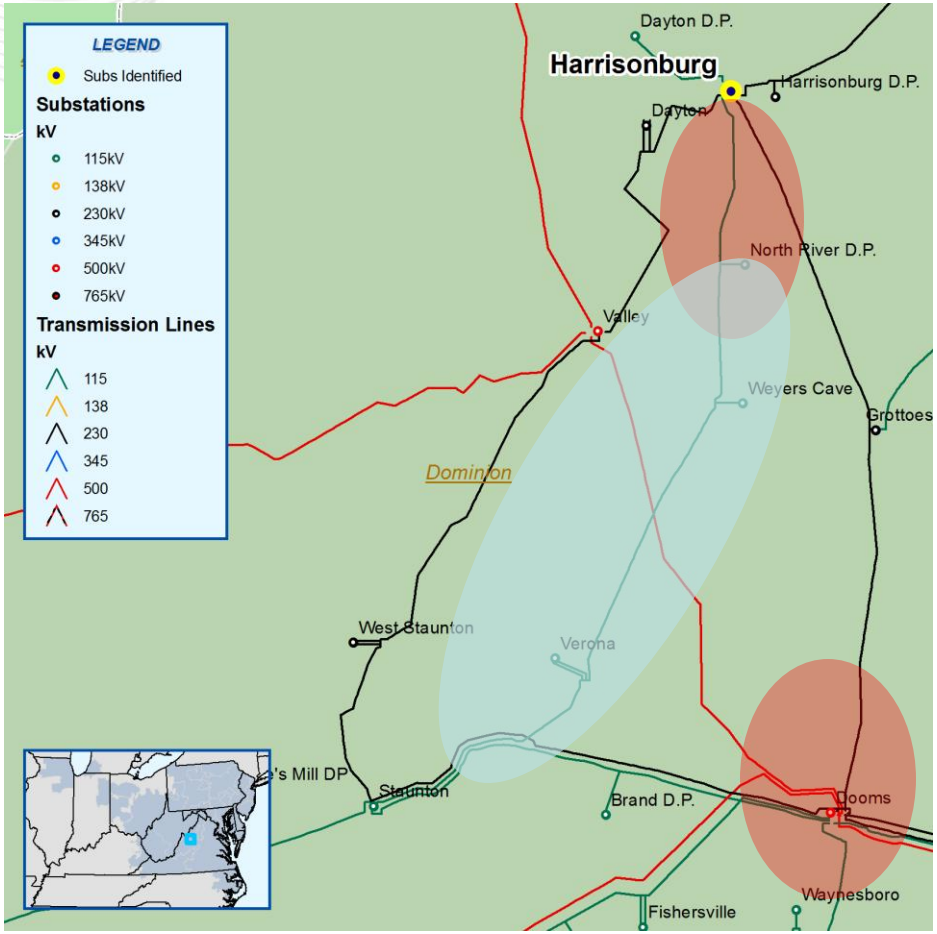


Dominion Transmission Zone

Region with voltage issues

Region with thermal issues

- NERC Category B and C Violations
- Problems:
  - NERC Category B. The N-1 loss of the 115kV Line # 102 section (Dooms to Brand) results in a thermal overload of the 115kV Line # 43 section (Harrisonburg to North River).
  - NERC Category B. The N-1 loss of the 230-115kV TX at Harrisonburg results in a thermal overload of the 115kV Line # 43 section (Staunton to Verona). This same contingency results in low voltage on the 115kV transmission system in the area.
  - NERC Category C3. The N-1-1 loss of the 230-115kV TX #6 (ID 2) and the loss of the 230-115kV TX #8 (ID 3) at Dooms results in the thermal overload of the remaining 230-115kV TX #5 (ID 1) at Dooms.



Dominion Transmission Zone

- Continued from previous slide

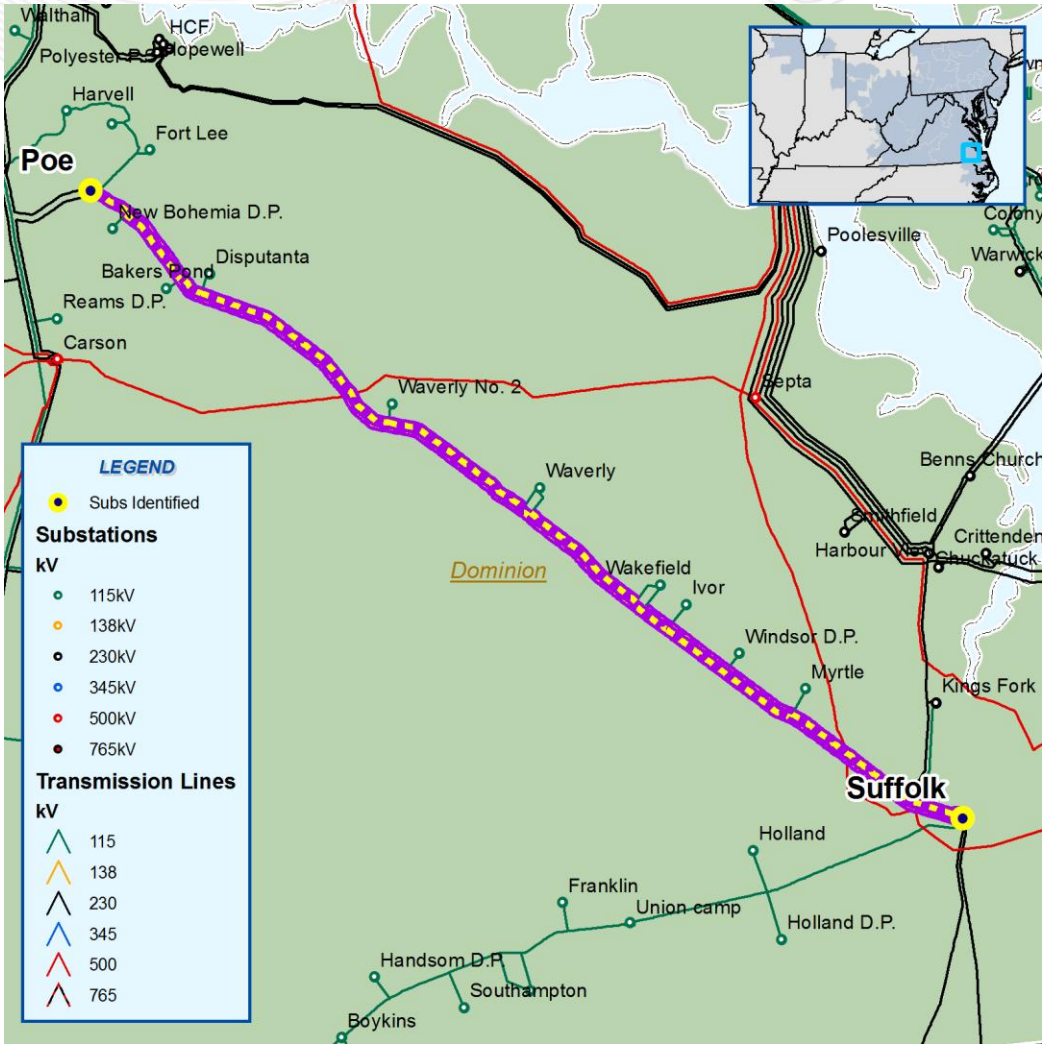
- Proposed Solution: Install a 230-115kV, 224MVA TX at Staunton. Rebuild the 115kV Line #43 section Staunton to Verona.

- Estimated Project Cost: $16.5M

- Expected IS Date: 6/1/2013

Dominion Transmission Zone

- NERC Category B and C Violations
- Problems:
  - The double circuit 115kV line from Poe to Suffolk is operated radially with normally open ties.
  - NERC Category C. The tower line outage of line #106 (Poe-New Bohemia) and #15 (Poe-Disputanta) with ties closed to restore load from other end results in line #23 (Suffolk-Oak Ridge) loading exceeding the emergency rating.
  - NERC Category C. The tower line outage of line #106 (Poe-New Bohemia) and #15 (Poe-Disputanta) with ties closed to restore load from other end results in voltage less than 92% at New Bohemia DP.
  - NERC Category C. The tower line outage of line #23 (Suffolk-Oak Ridge) and #44 (Suffolk-Myrtle) with ties closed to restore load from other end results in line #106 (Poe-New Bohemia) loading exceeding the emergency rating.
  - NERC Category C. The tower line outage of line #23 (Suffolk-Oak Ridge) and #44 (Suffolk-Myrtle) with ties closed to restore load from other end results in voltage less than 92% at Kings Fork.
  - NERC Category B. The N-1 loss of line #106 (Poe-New Bohemia) and tie closed to restore load from other end results in voltage less than 93% at New Bohemia DP.



Dominion Transmission Zone

- Continued from previous slide

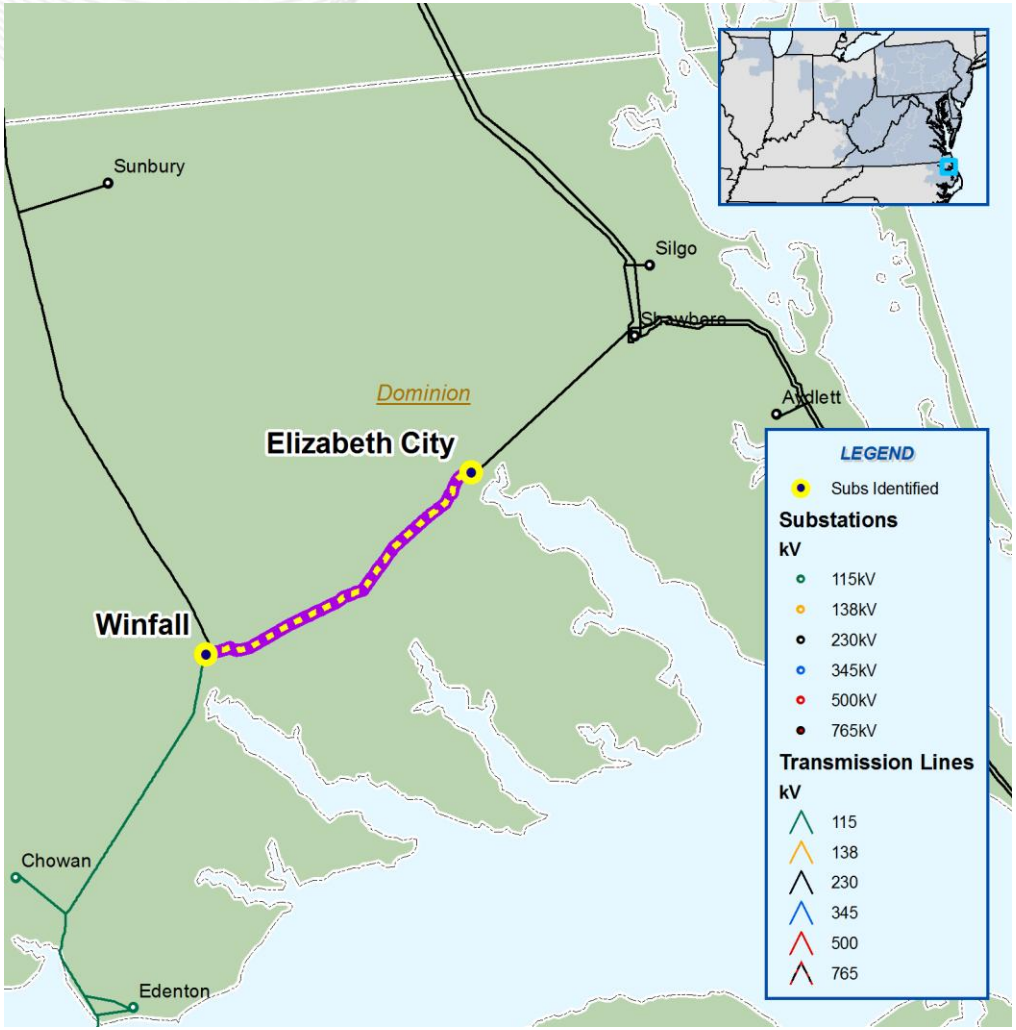
- Proposed Solution:
  - Install 115kV capacitor bank at Oak Ridge
  - Purchase land near New Bohemia and install a 115kV capacitor bank
  - Upgrade 230-34.5kV Transformer #3 at Kings Fork and move 115kV load on Transformer #2 to Transformer #3.

- Estimated Project Cost: $3M

- Expected IS Date: 6/1/2015

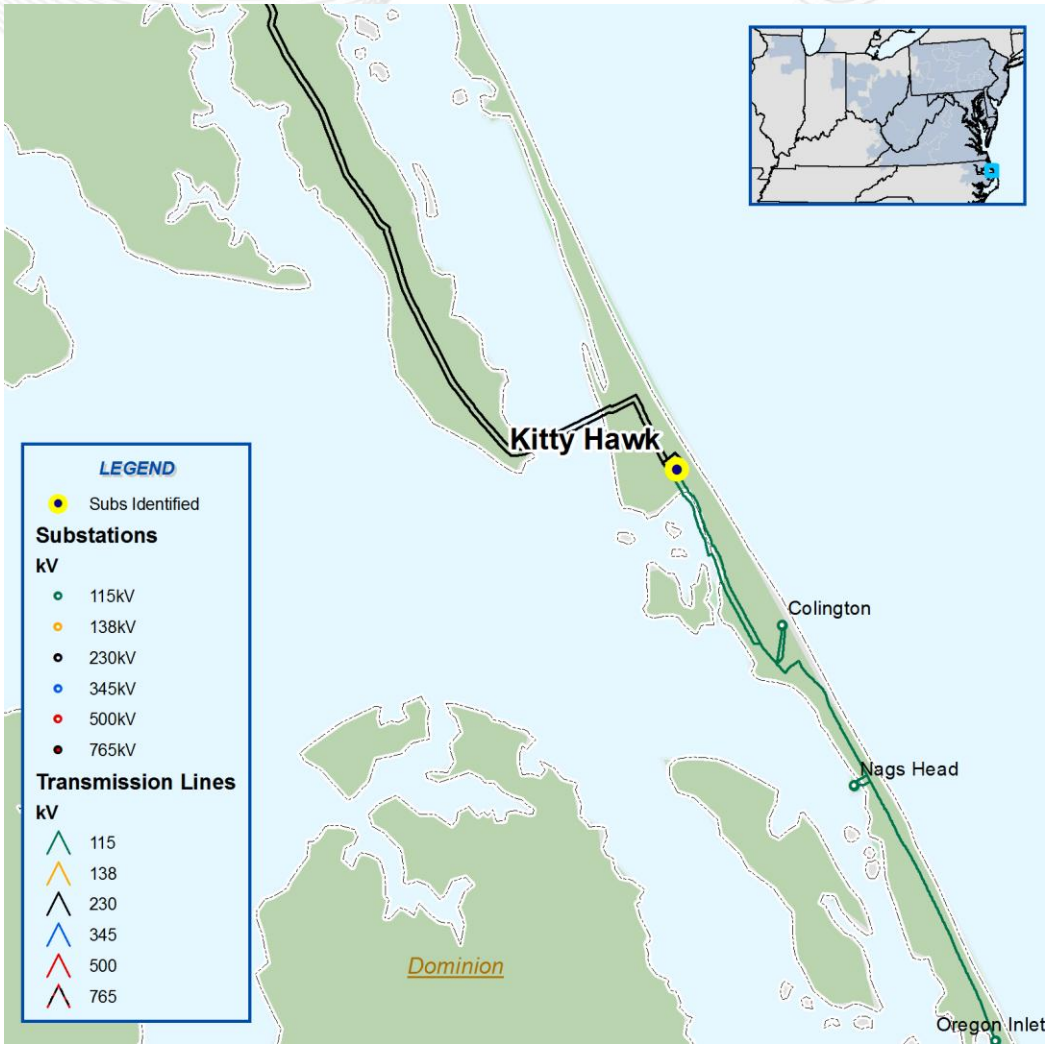
Dominion Transmission Zone

- NERC Category C N-1-1 Violation
- Problem: For N-1-1 loss of both 230kV lines #269 Fentress – Sligo and #2087 Fentress - Shawboro results in overload of 230kV line #2020 Winfall - Elizabeth City exceeding its emergency rating.
- Proposed Solution: Rebuild 15 mile line #2020 Winfall - Elizabeth City with a minimum 900 MVA rating.
- Estimated Project Cost: $18 M
- Expected IS Date: 6/1/2015



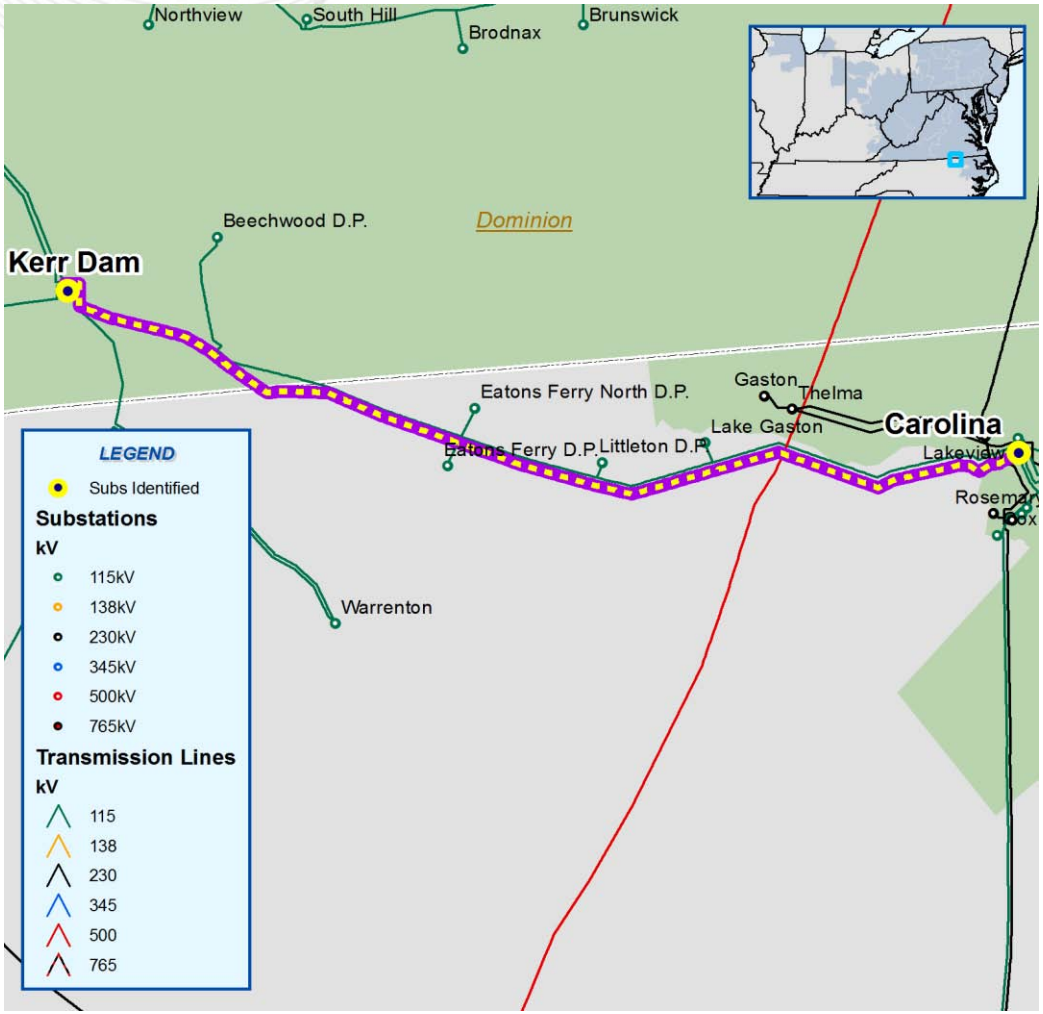
Dominion Transmission Zone

- NERC Category B Violation
- Problem: The N-1 loss of either of the two 230-115kV transformers at Kitty Hawk results in the remaining transformer load exceeding 94%.
- Proposed Solution: Install a third 168 MVA 230-115kV transformer at Kitty Hawk with a normally open 230 kV breaker and a low side 115 kV breaker.
- Estimated Project Cost: $6 M
- Expected IS Date: 6/1/2015



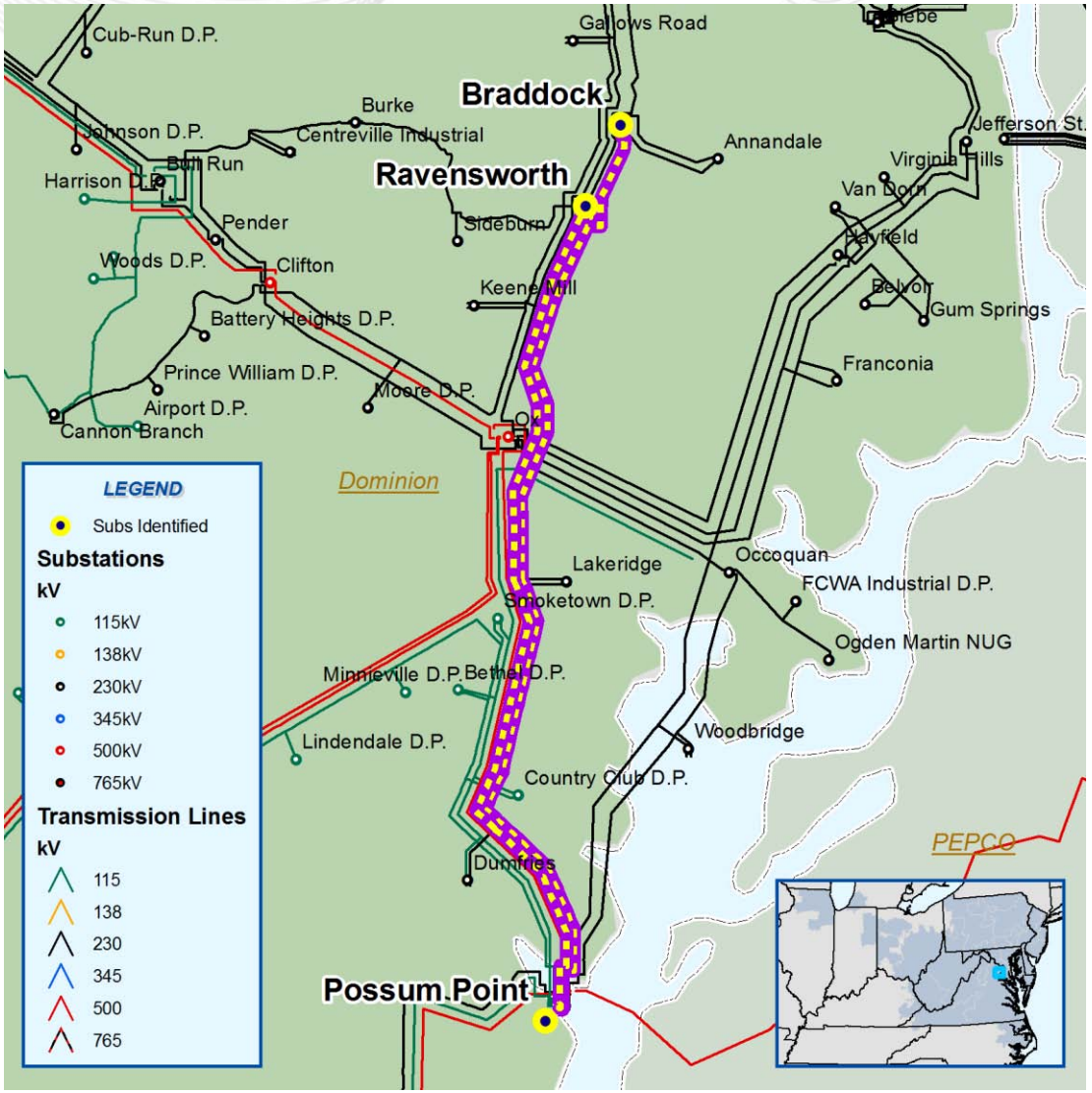
Dominion Transmission Zone

- NERC Category B Violation
- Problem: The N-1 loss of line #90 Kerr Dam - Carolina with the outage of the most critical generator at Surry results in loading on line #22 Kerr Dam – Carolina exceeding 94%.
- Proposed Solution: Rebuild the 20 mile section of line #22 between Kerr Dam and Eatons Ferry Substations.
- Estimated Project Cost: $20 M
- Expected IS Date: 6/1/2015



Dominion Transmission Zone

- NERC Category B Violation
- Problem: For an outage of Line #237 (Possum-Braddock), Line #2022 (Possum-Ravensworth) is loaded over 94% of it's applicable rating between Possum and Dumfries Substations.
- Proposed Solution: Uprate the 3.63 mile line section between Possum and Dumfries Substation to higher operating temperature. The 1600 Amp wave trap at Possum Point will also have to be replaced to increase the line rating.
- Estimated Project Cost: $5.5 M
- Expected IS Date: 5/1/2015

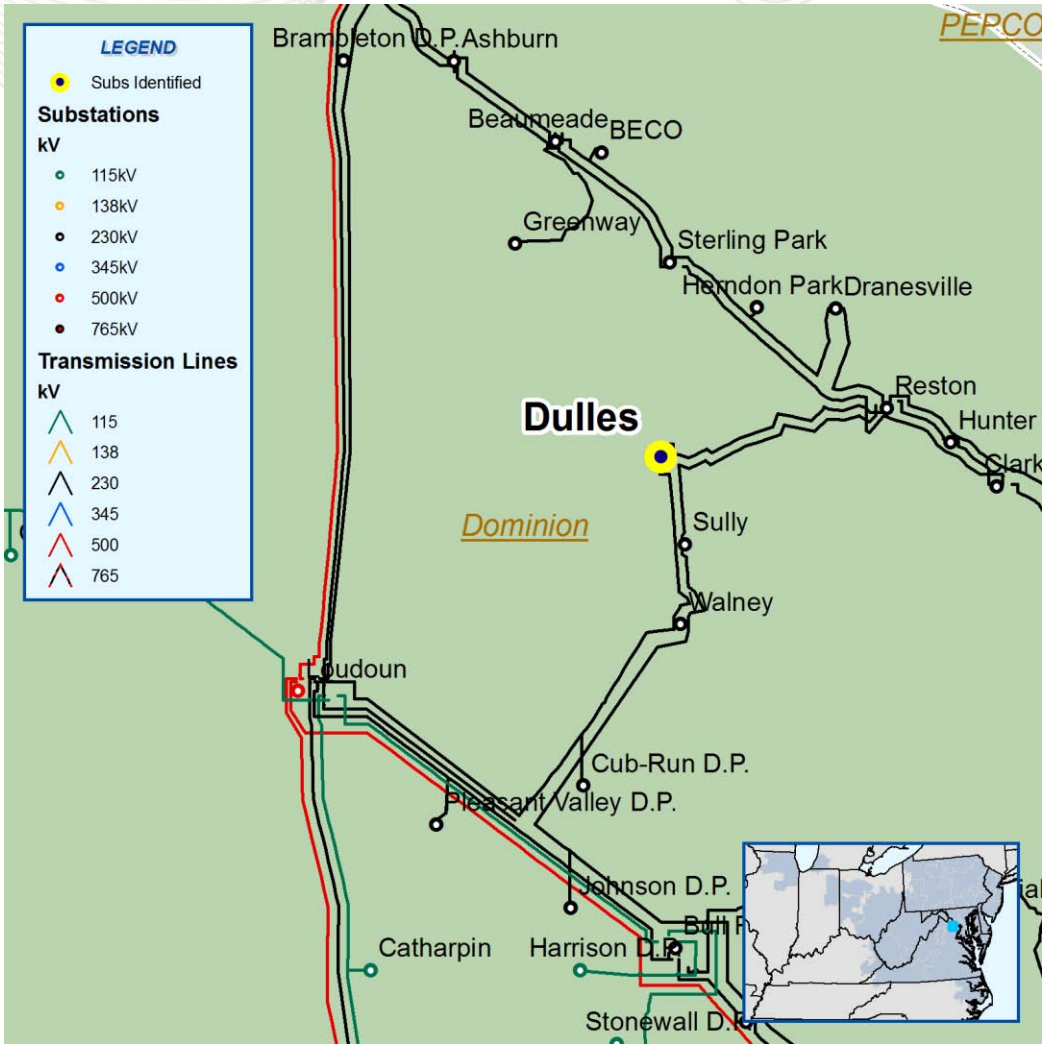


Dominion Transmission Zone

- NERC Category C Violation
- Problem: For a breaker-failure of 2062T2079 at Dranesville, over 300 MVA of load will be outaged. Which violates DVP and PJM Criteria
- Proposed Solution: Install line-tie breakers at Sterling Park Substation and BECO Substation.
- Estimated Project Cost: $3 M
- Expected IS Date: 5/1/2015

Dominion Transmission Zone

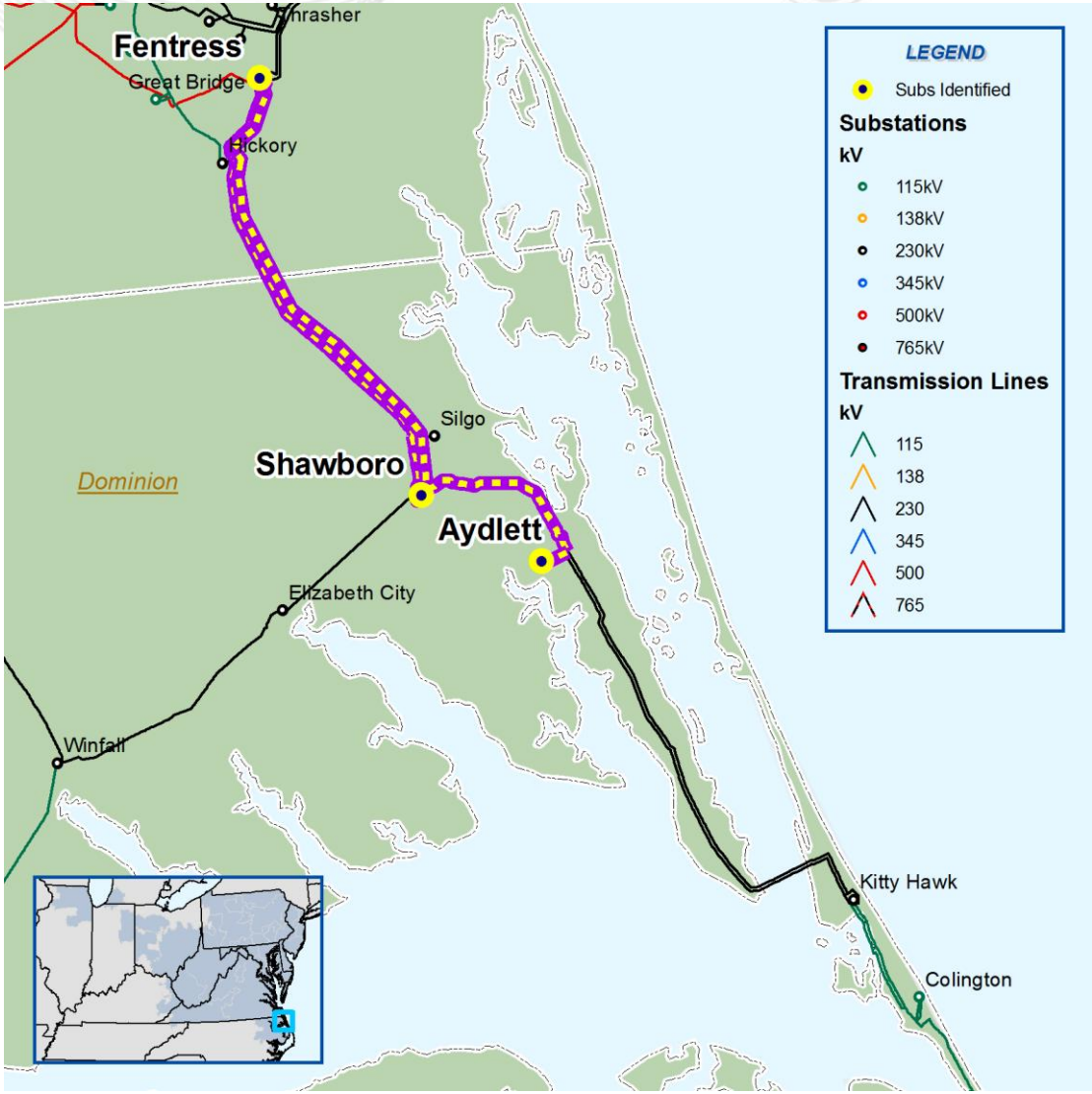
- NERC Category C Violation
- For a breaker-failure of 2008T2015 at Dulles, over 300 MVA of load is lost which violates DVP and PJM Criteria
- Proposed Solution: Install a five breaker ring bus at the expanded Dulles Substation to accommodate the existing Dulles arrangement, and support the Metrorail extension.
- Estimated Project Cost: $6 M
- Expected IS Date: 5/1/2014



Dominion Transmission Zone

NERC Category C

- NERC Category C Violation
- N-1-1 loss of 230kV lines #2073 Shawboro - Fentress and #2064 Shawboro - Fentress results in load loss exceeding 300MW
- N-1 loss of 230kV line #2073 Fentress-Aydlett results in loadings on line #2073 Fentress – Kitty Hawk exceeding 94%.
- Tower Line Outage of Line #2073 & 2064 results in over 300 MW being lost.
- Proposed Solution: Build a 230kV line from Shawboro to Aydlett tap (11 miles) and connect Aydlett to the new line.
- Estimated Project Cost: $22 M
- Expected IS Date: 6/1/2015



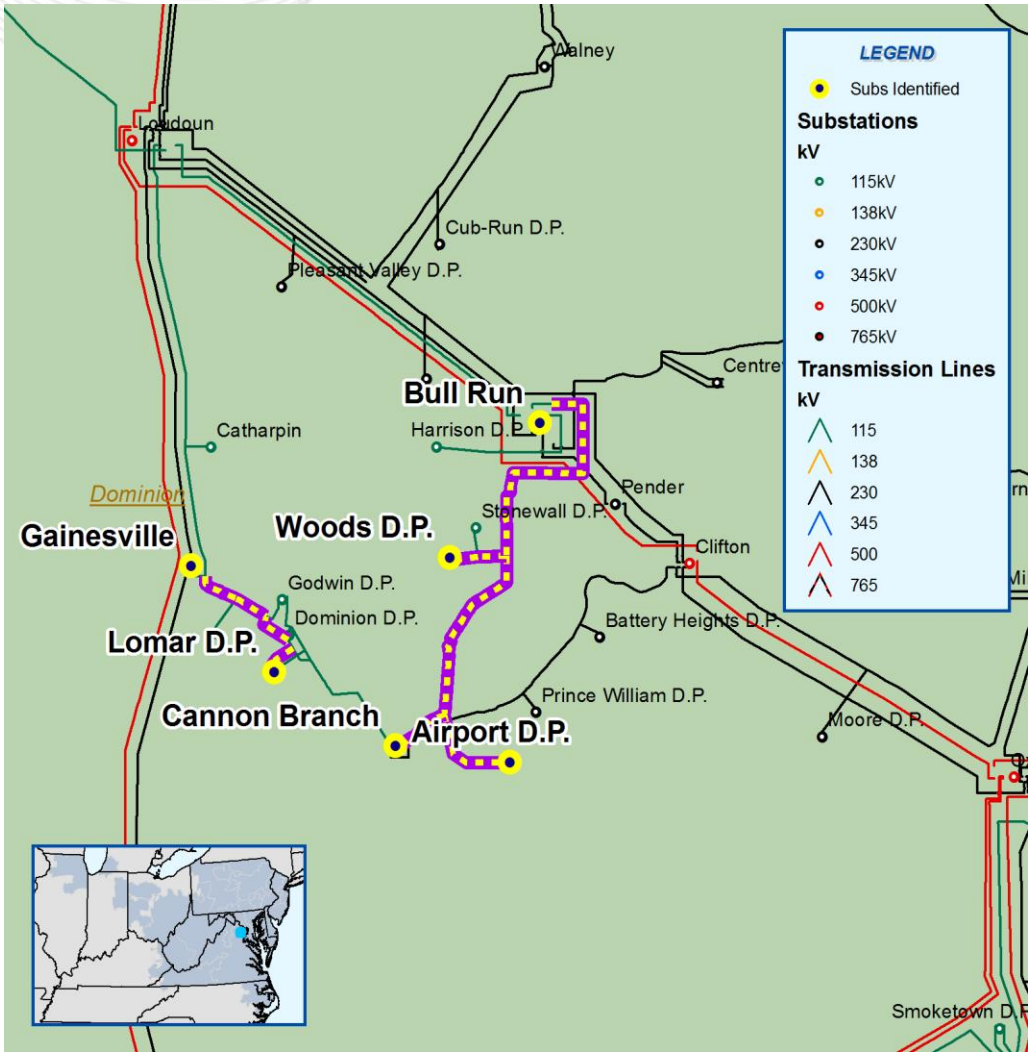
Dominion Transmission Zone

- NERC Category B & C Violation
- For the N-1 loss of radial 230kV Line #2011 (Clifton-Cannon Branch), Line #172 (Gainesville-Lomar DP) and Line #163 (Bull Run-Airport DP) will load to 102% and 105%, respectively, while trying to restore the load. Additionally, the Gainesville 230/115 kV transformer will load to 96%.
- For a 2nd N-1 event (loss of the Gainesville 230/115 kV TX), Line #163 would exceed its emergency rating between Bull Run and Woods DP (approx 4 miles) and between Woods DP and Cannon Branch (approx 2.7 miles).
- Potential Solutions Evaluated:

  A. Convert Line #163 (Bull Run to Cannon Branch) to 230 kV may require UG construction based on R/Way constraints. $70M

  B. Construct a 230kV line approximately 7 miles along new right-of-way from Cannon Branch Substation to Nokesville Substation. $40M

- Proposed Solution: Build Cannon Branch to Nokesville 230 kV Line
- Estimated Project Cost: $40 M
- Expected IS Date: 5/31/2018 (New load customers in the area may accelerated target date to June 2015)



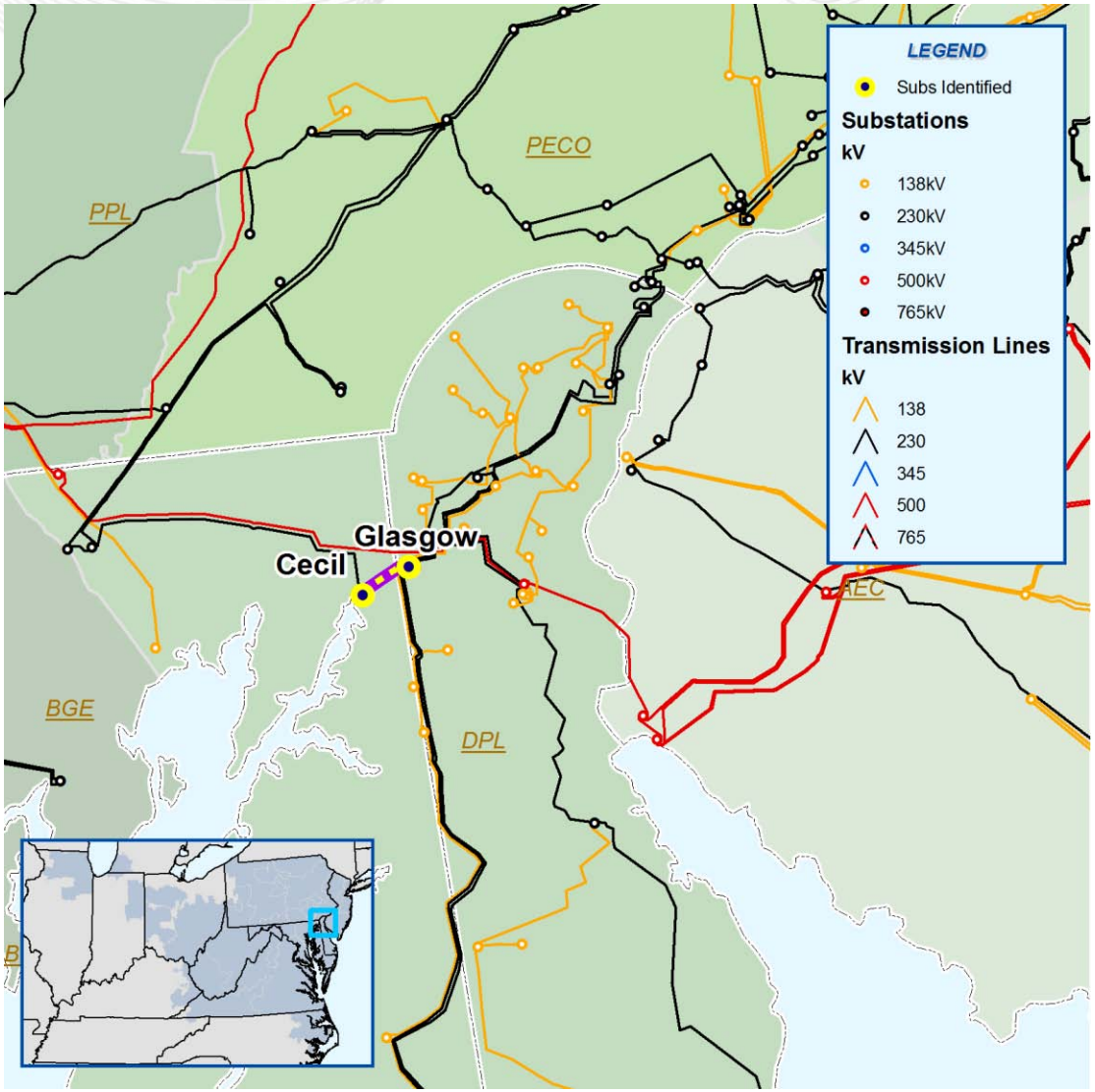
DPL Transmission Zone

- N-1-1 Violation:
- The Glasgow – Cecil 138 kV is overloaded for the loss of the Bradford – Clay – Colora 230 kV plus the Conowingo – Colora 230 kV circuits.
- Proposed Solution:

  Rebuild the Glassgow – Cecil 138 kV circuit (B1247).
- Estimated Project Cost:

  $5.959 M
- Expected IS Date:

  6/1/2015



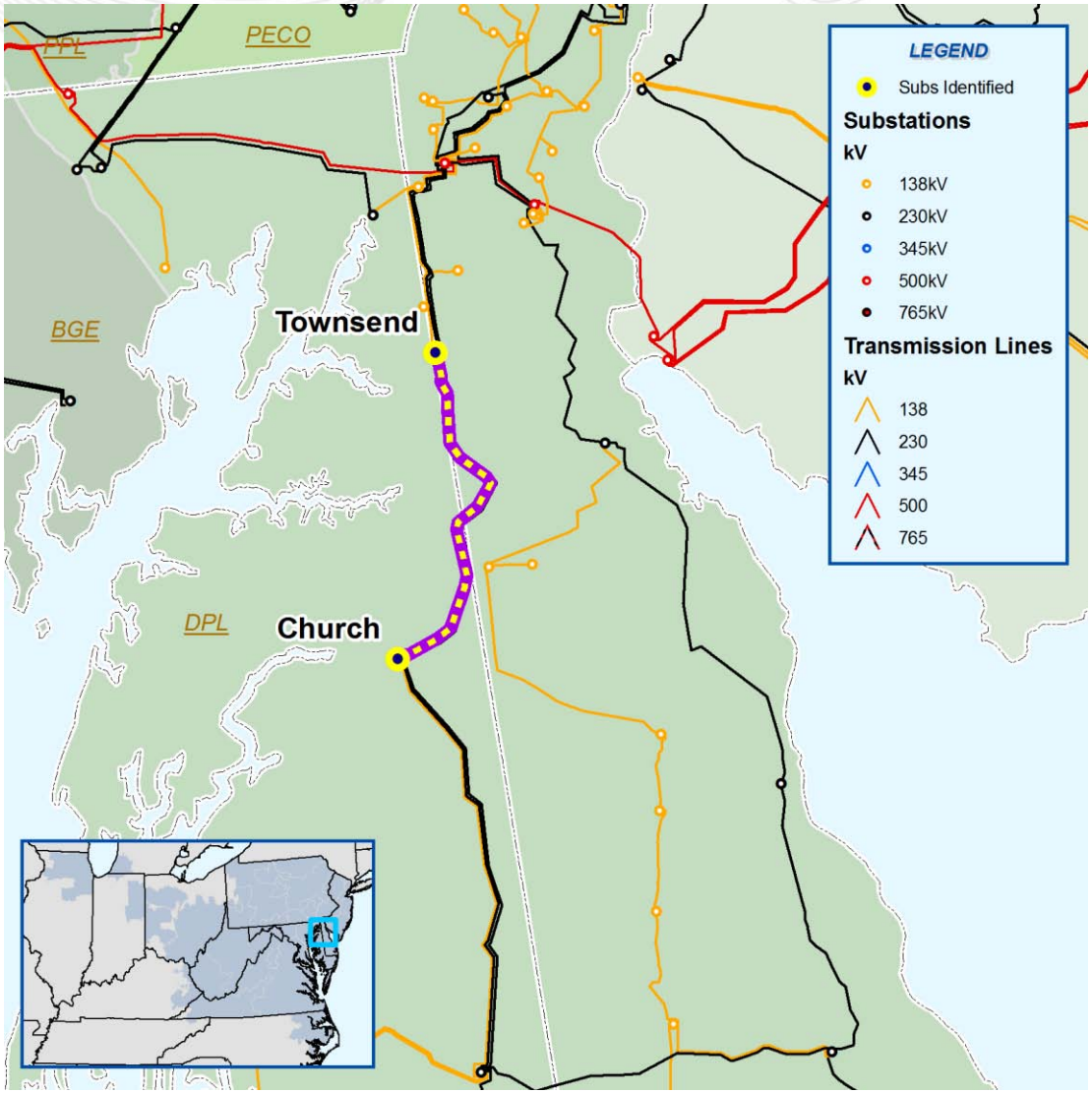
DPL Transmission Zone

- Baseline Violation:
- The Townsend - Church 138 kV is overloaded for the Keeney – Steele 230 kV double tower outage .
- Proposed Solution:

  Rebuild the Townsend - Church 138 kV circuit (B1246).
- Estimated Project Cost:

  $16 M
- Expected IS Date:

  6/1/2015



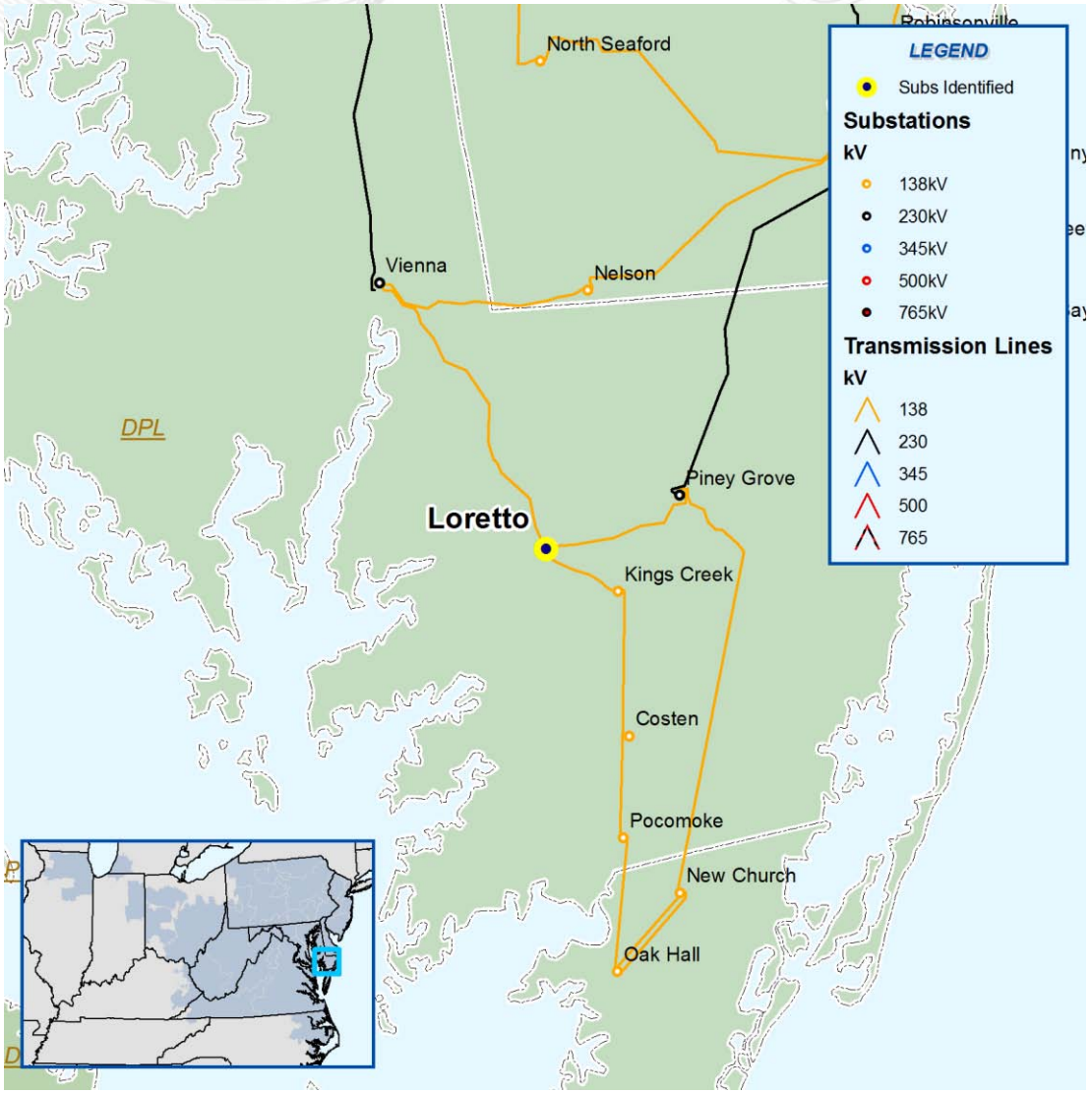
DPL Transmission Zone

- Baseline Violation:
- Voltage magnitude violation in the Loretto 69 kV vicinity for the loss of the Loretto 138/69 kV transformer # 1 and #2 single contingency .
- Proposed Solution:

  Install two 15 MVAR capacitors at Loretto 69 kV substation (B1248) .
- Estimated Project Cost:

  $1.3 M
- Expected IS Date:

  6/1/2015



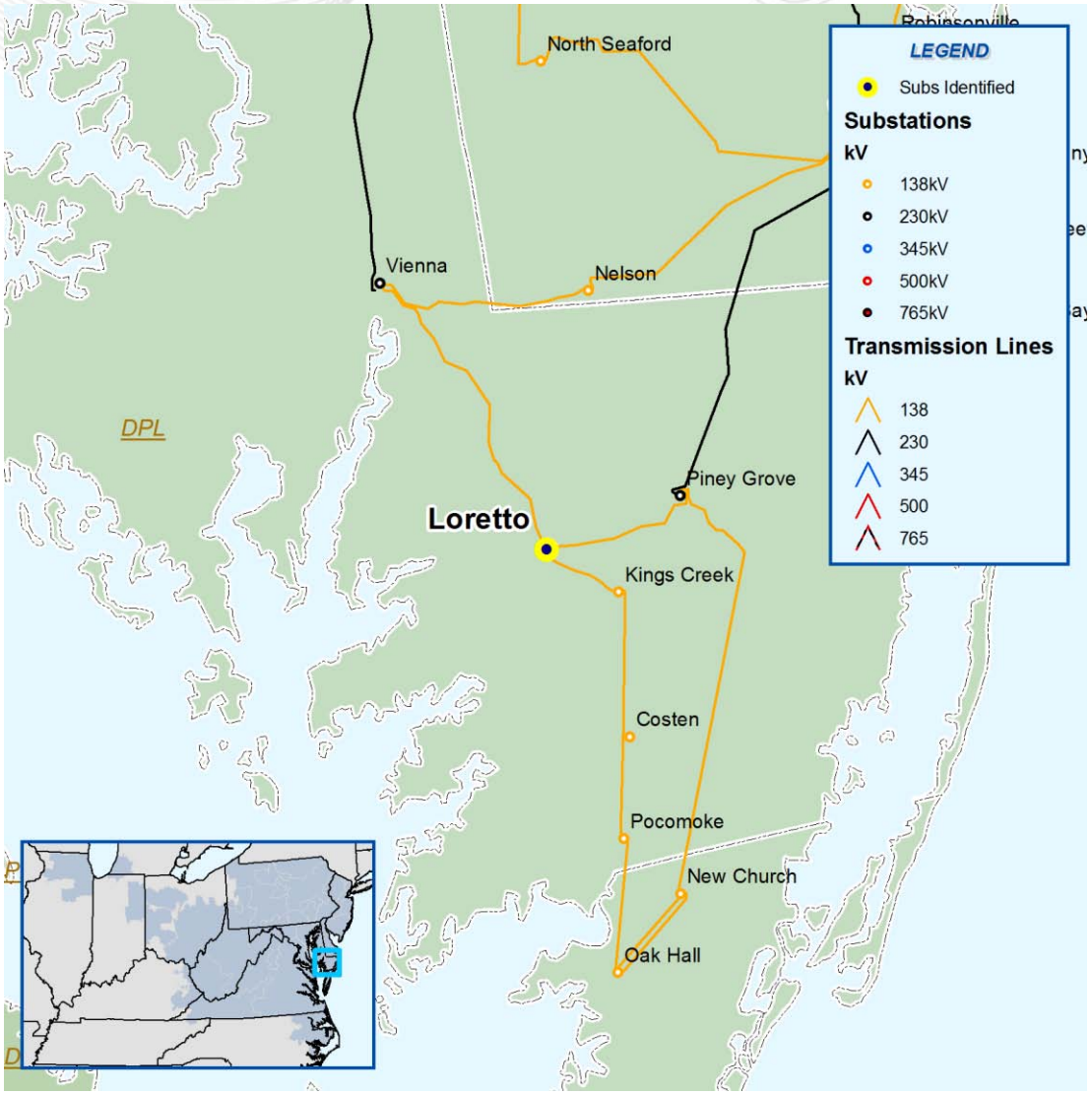
DPL Transmission Zone

- Baseline Violation:
- Voltage magnitude violation in the Sussex 69 kV vicinity for the loss of the Sussex – Harbeson 69 kV single contingency.
- Proposed Solution:

  Reconfigure the Sussex 69 kV capacitor (B1249).
- Estimated Project Cost:

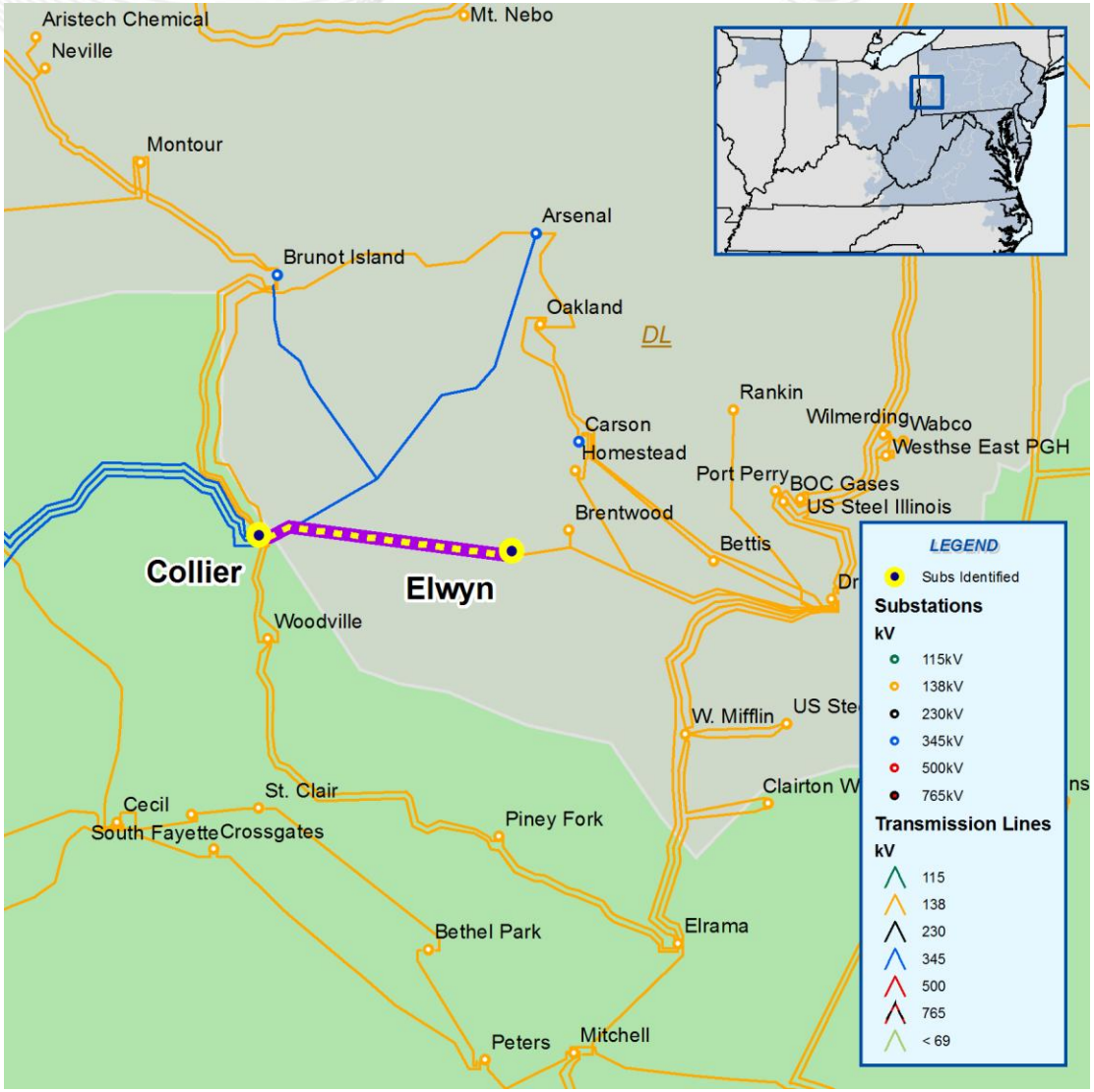
  $0.5M
- Expected IS Date:

  6/1/2015



Duquesne Transmission Zone

- DLCO planning criteria requires that *Transmission Supply to Bulk Stations* have three transmission sources
- Proposed Solution: Create a second Collier-Elwyn 138kV circuit (Z-162) by utilizing both sets of bifurcated conductors on the existing Collier-Elwyn (Z-62) 138kV circuit (B1174)
- Estimated Project Cost : $3.88M
- Expected IS Date: 5/31/2011



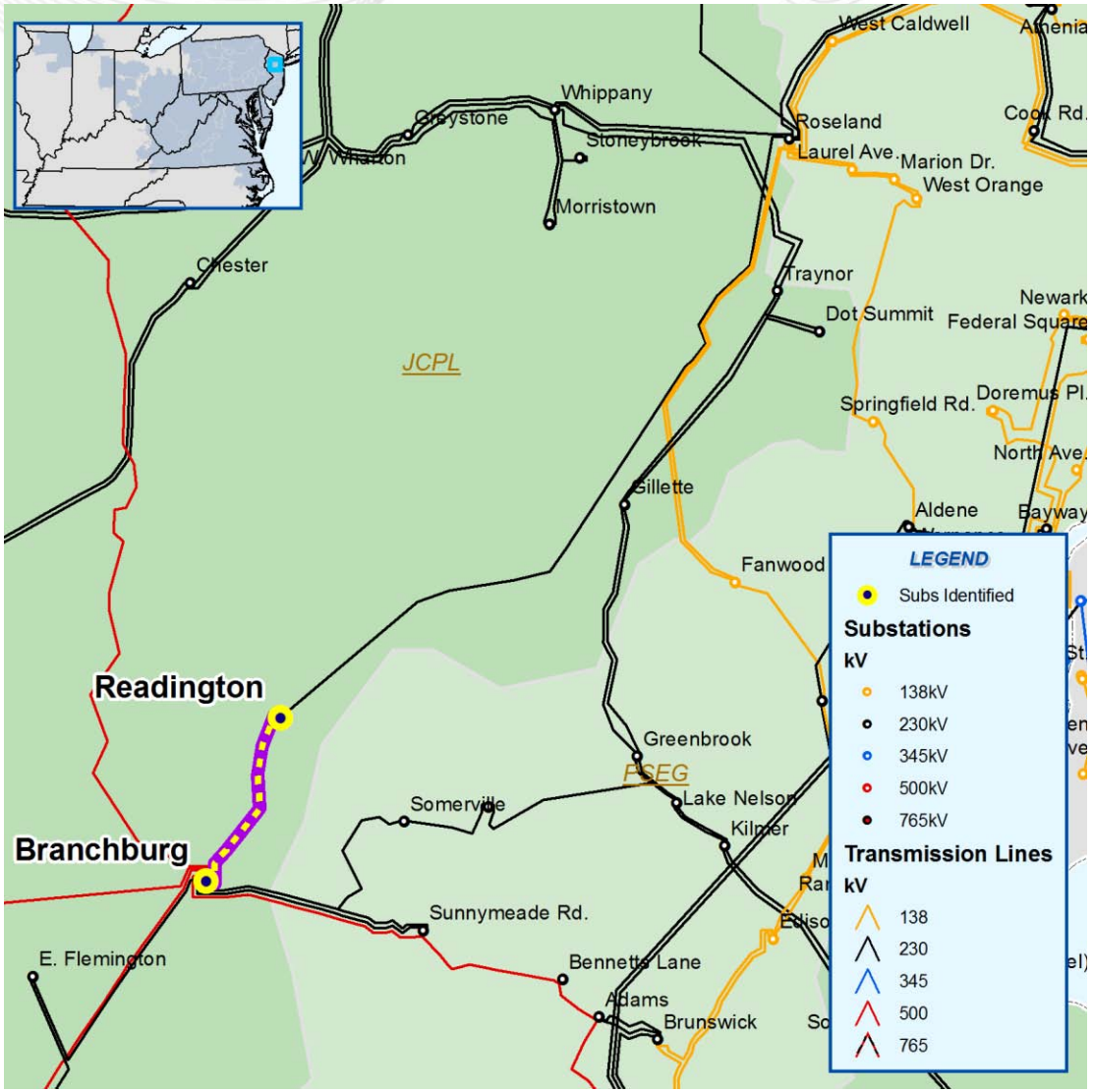
JCPL Transmission Zone

- PSEG Load Deliverability Violation
- Branchburg – Readington 230 kV circuit is overloaded for the loss of the Whippany – Roseland 230 kV circuit.
- Proposed Solution:

  Upgrade terminal equipment at Readington (substation conductor) (B0423.1).
- Estimated Project Cost:

  $0.10M
- Expected IS Date:

  6/01/2011



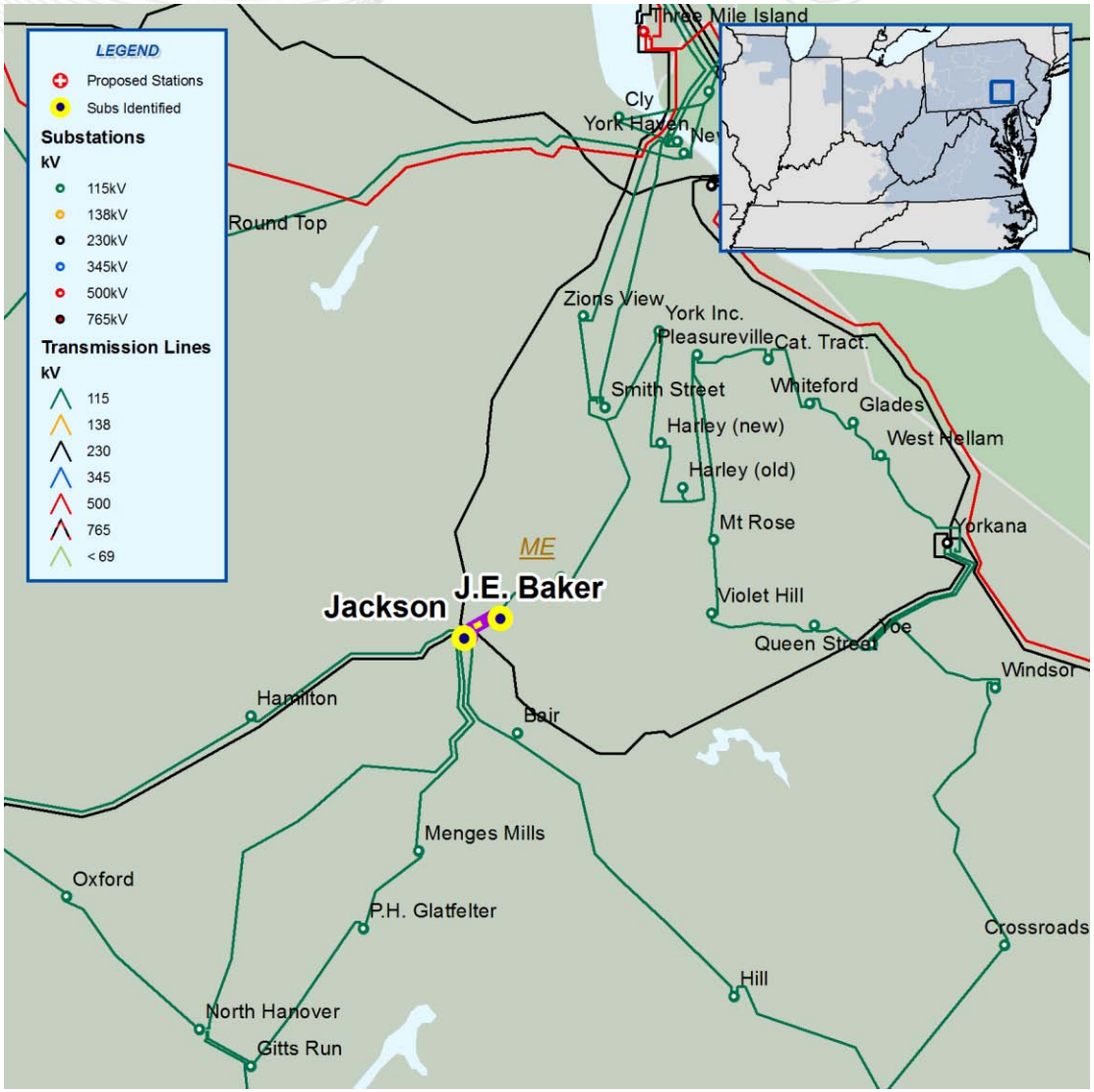
Meted Transmission Zone

- N-1-1 Thermal violation
- Jackson – JE Baker Tap 115 kV line is overloaded for the loss of two 230/115 kV transformers at Yorkana.
- Proposed Solution:

  Replace the limiting bus conductor and wave trap at the Jackson 115 kV terminal of the Jackson - JE Baker Tap 115 kV line. (B1302)
- Estimated Project Cost:

  $0.1 M
- Proposed IS Date:

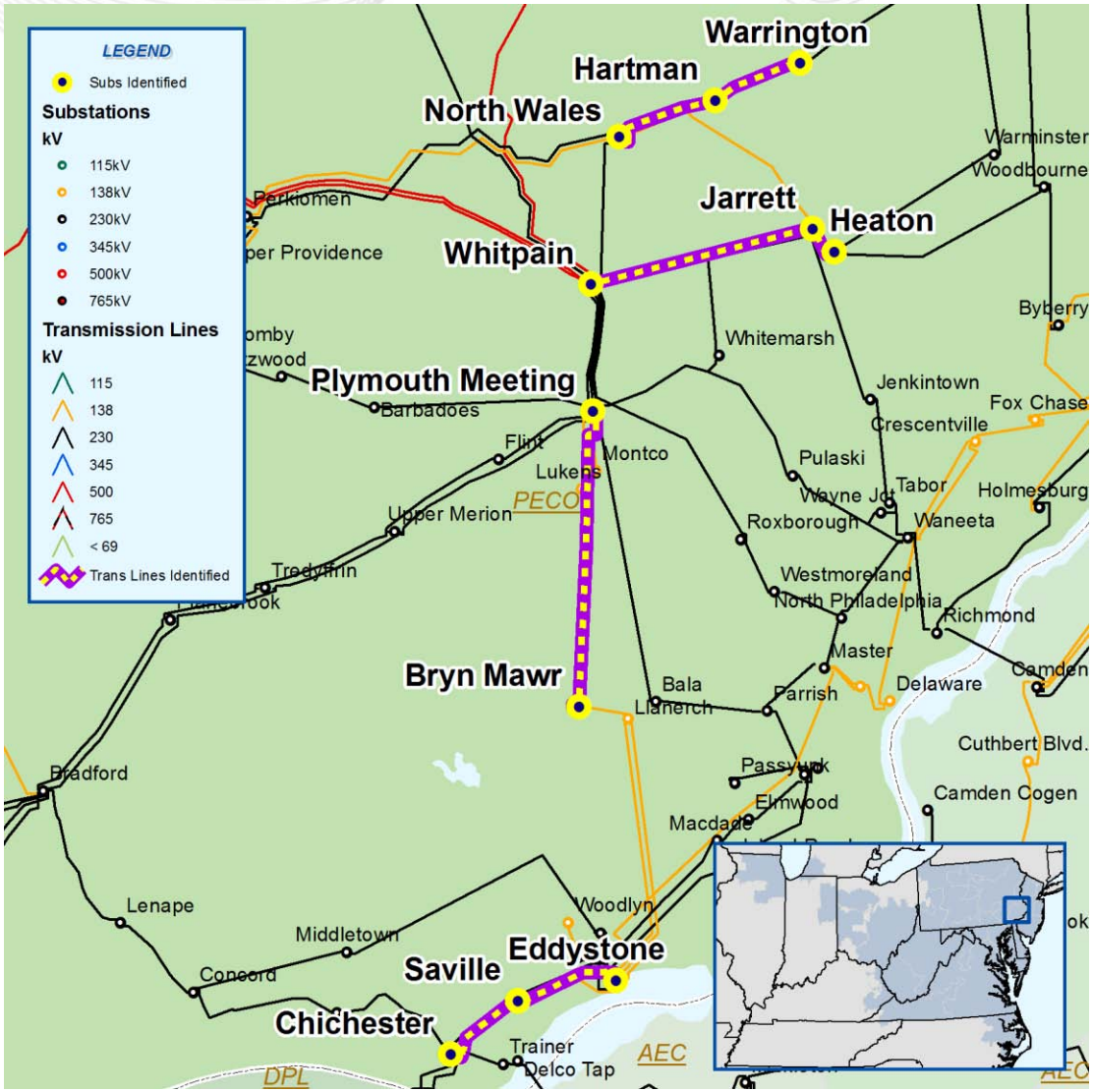
  6/1/2015



PECO Transmission Zone

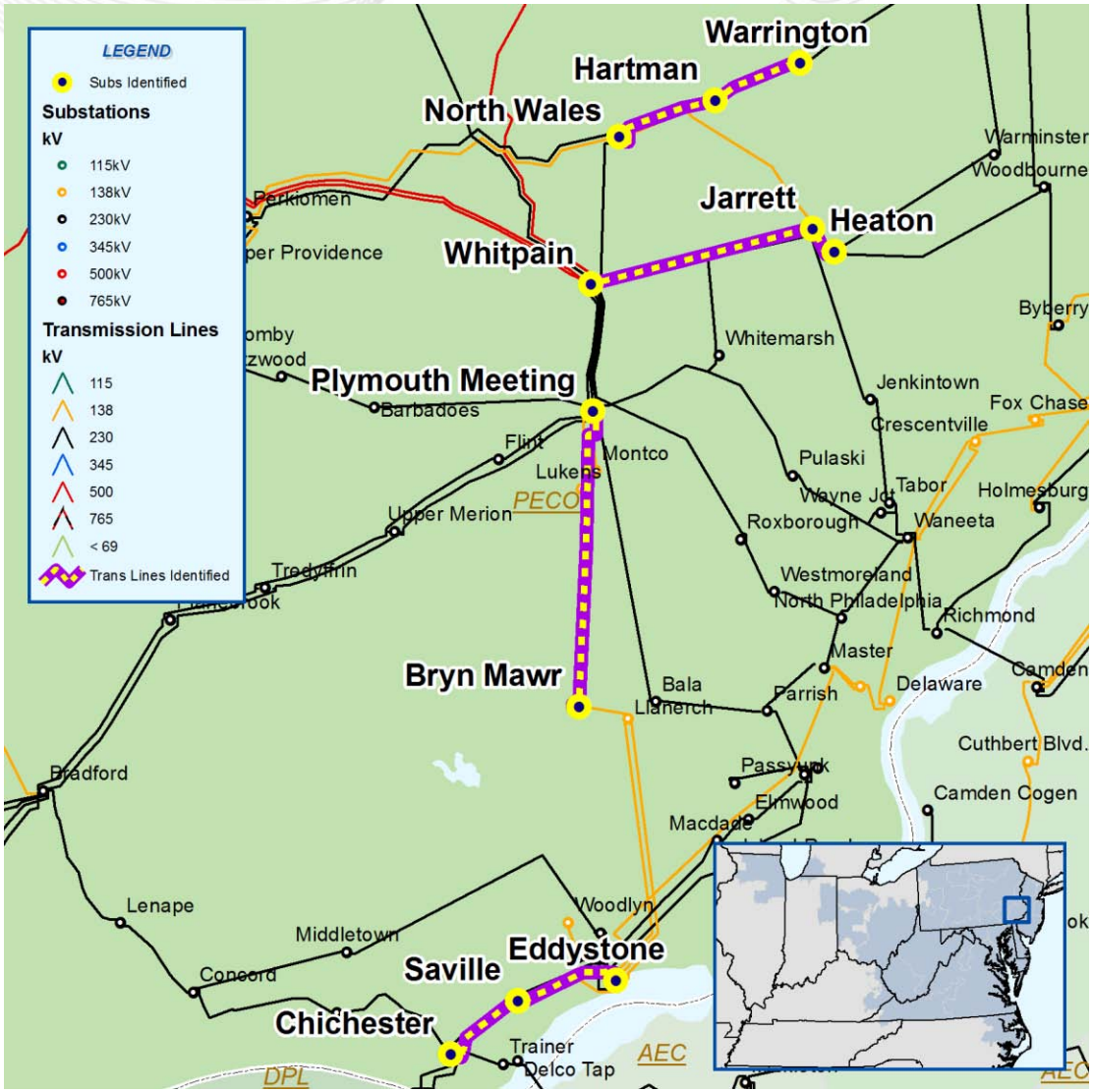
- Chichester 230/138 kV transformer / loss of Macdade – Ridley – Morton 230 kV line (220-46) + loss of Island Road – Eddystone 230 kV line (220-23)

- Proposed Solution: Add a second 230 / 138 kV transformer at Chichester. Add an inductor in series with the parallel transformers (b1178)
- Estimated cost: $5.908 M
- Expected In-service: December 16, 2011



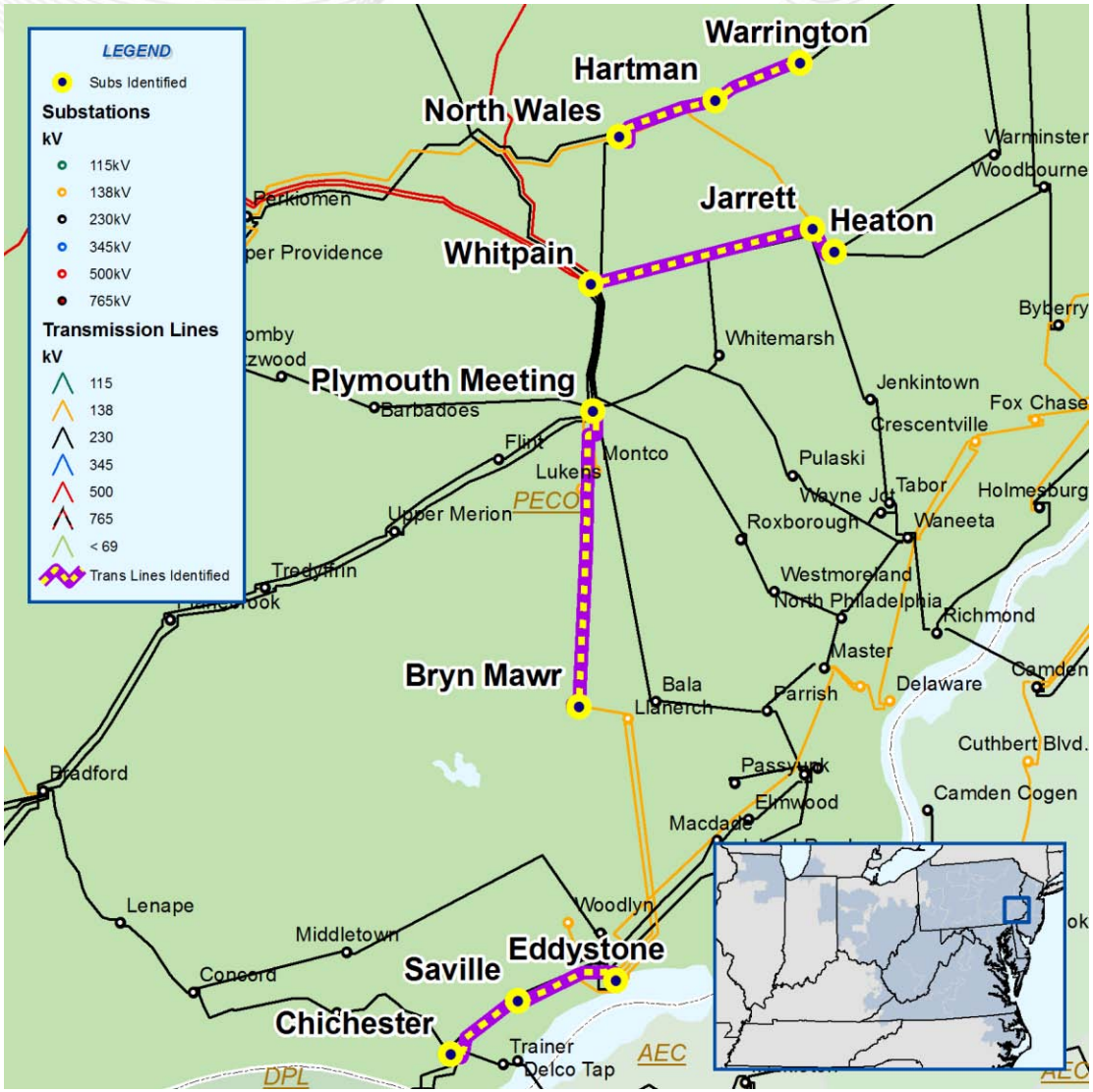
PECO Transmission Zone

- Eddystone – Saville 138 kV line / loss of Macdade – Ridley – Morton 230 kV line (220-46) + loss of Island Road – Eddystone 230 kV line (220-23)
- Proposed Solution: Replace terminal equipment at Eddystone and Saville and replace underground section of the line (b1179)
- Estimated Cost: $3.94 M
- Expected In-Service: May 27, 2011



PECO Transmission Zone

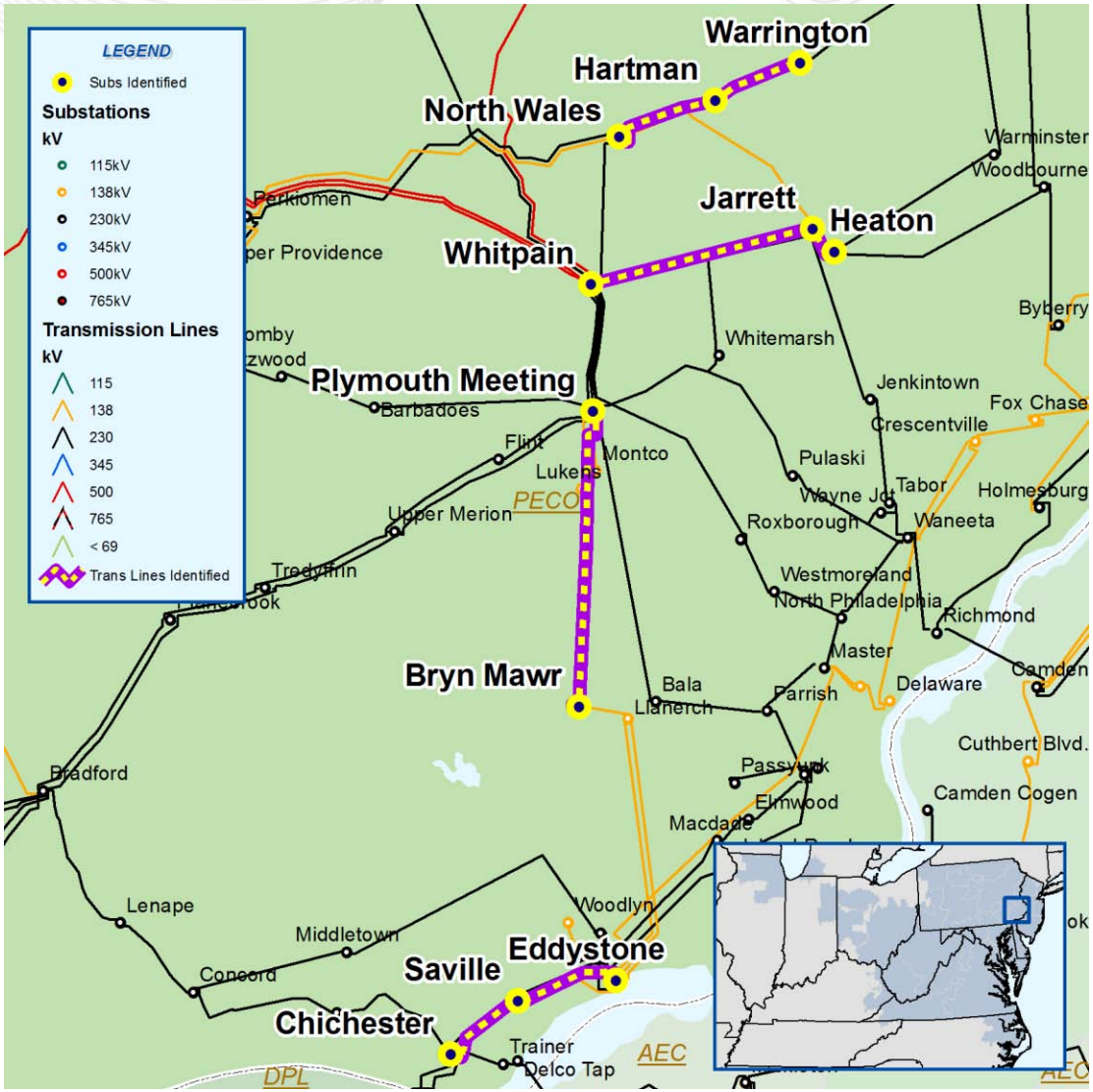
- Jarrett – Whitpain 230 kV line / loss of North Wales – Hartman 230 kV line (220-71) + Basecase
- Proposed Solution: Replace terminal equipment at Whitpain and Jarrett (b0920)
- Estimated Cost: $ 0.175 M
- Expected In-Service: May 27, 2011



PECO Transmission Zone

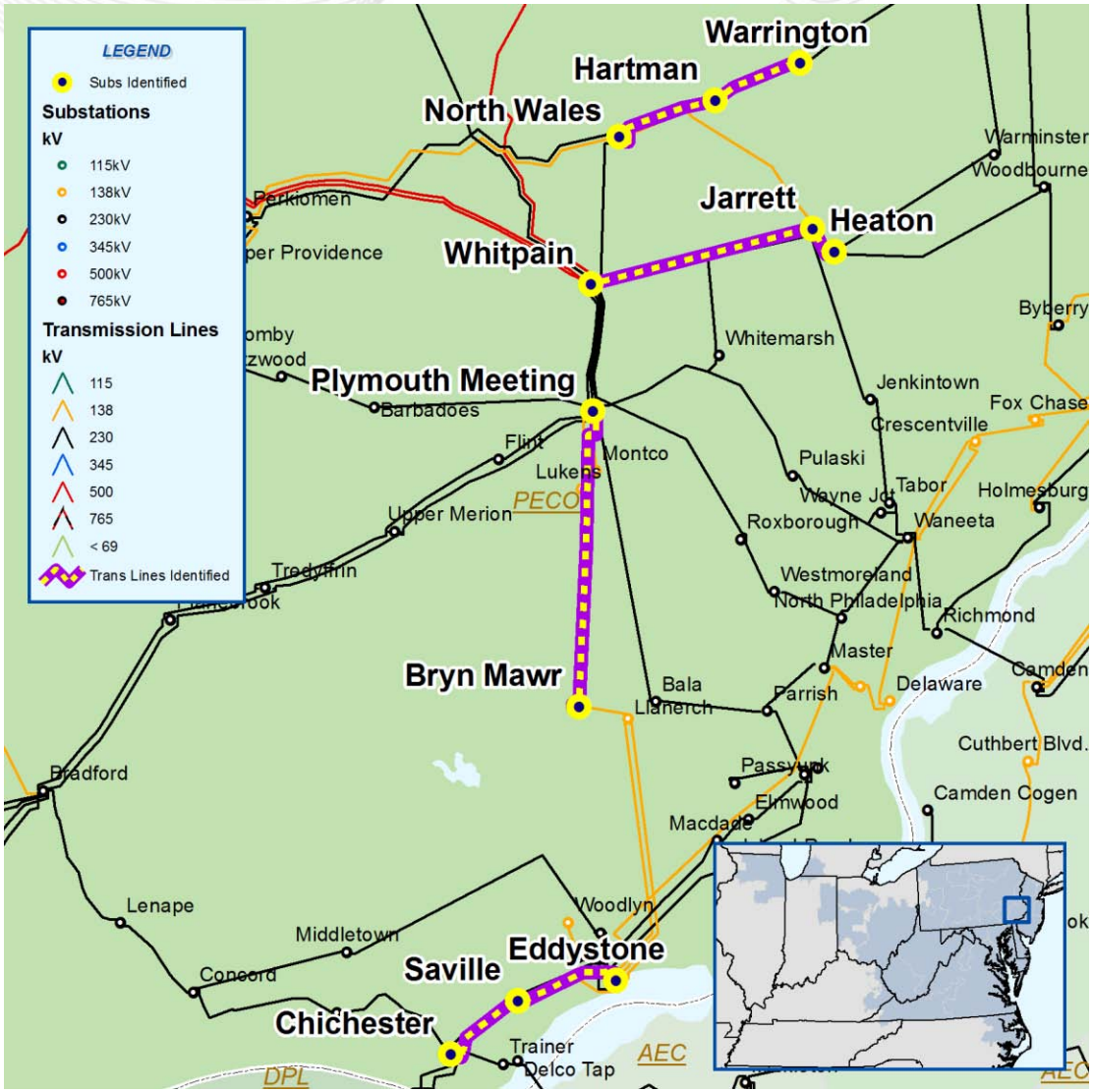
- Jarrett – Heaton 230 kV line / loss of North Wales – Hartman 230 kV line (220-71) + Basecase

- Proposed Solution: Replace terminal equipment at Heaton and Jarrett substations (b0509)
- Estimated cost: $ 0.525 M
- Expected In-Service: June 1, 2012



PECO Transmission Zone

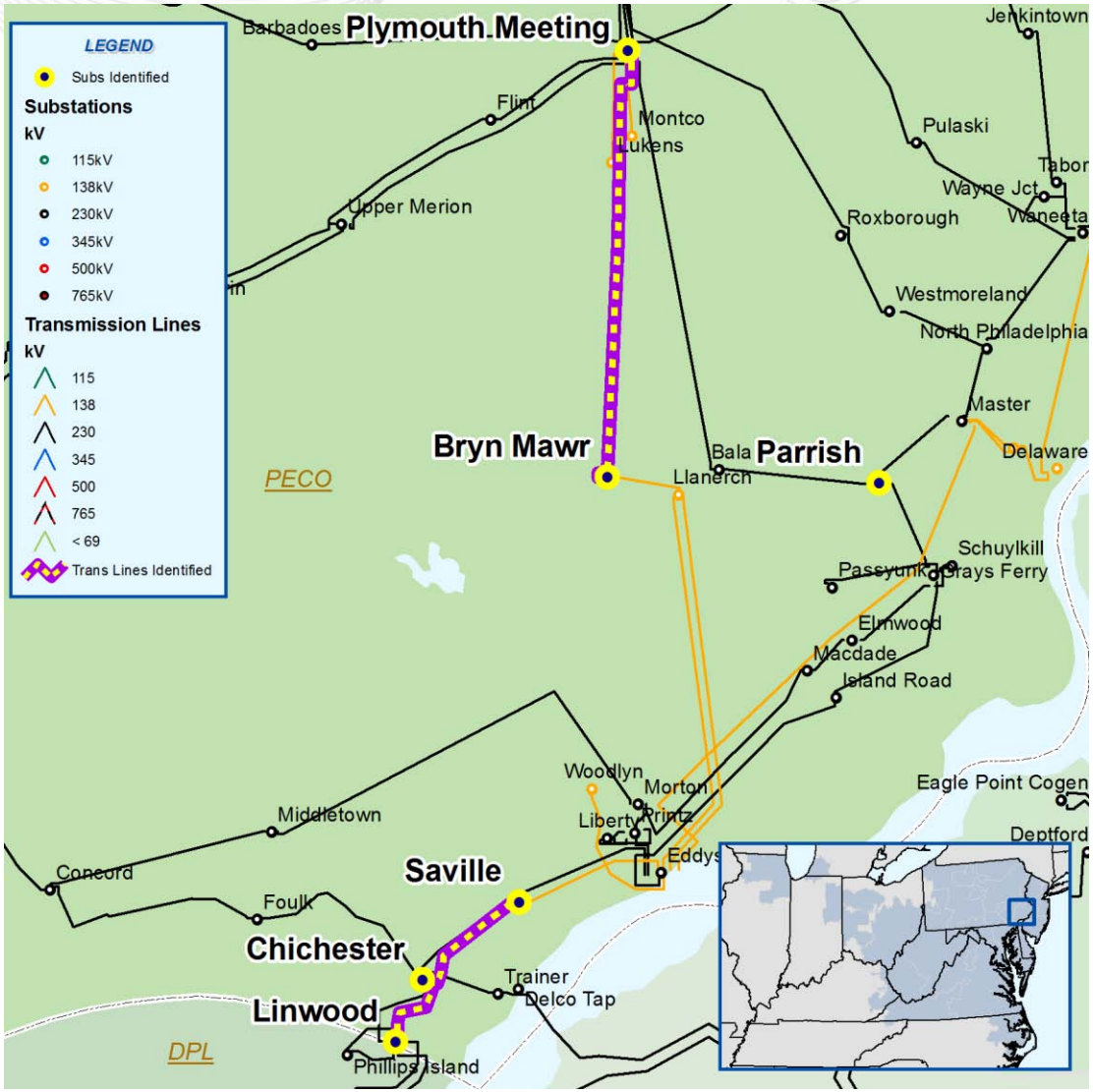
- Hartman – Warrington 230 kV line overload for the following contingencies
  - loss of Emilie – Neshaminy 138 kV line (130-25) + loss of Jarrett – Whitpain 230 kV line (220-52)
  - loss of Jarrett – Whitpain 230 kV line (220-52) + Basecase
- Proposed Solution: Replace terminal equipment at Warrington and Hartman (b0508.1)
- Estimated Cost: $ 0.375 M
- Expected In-Service: May 27, 2011



PECO Transmission Zone

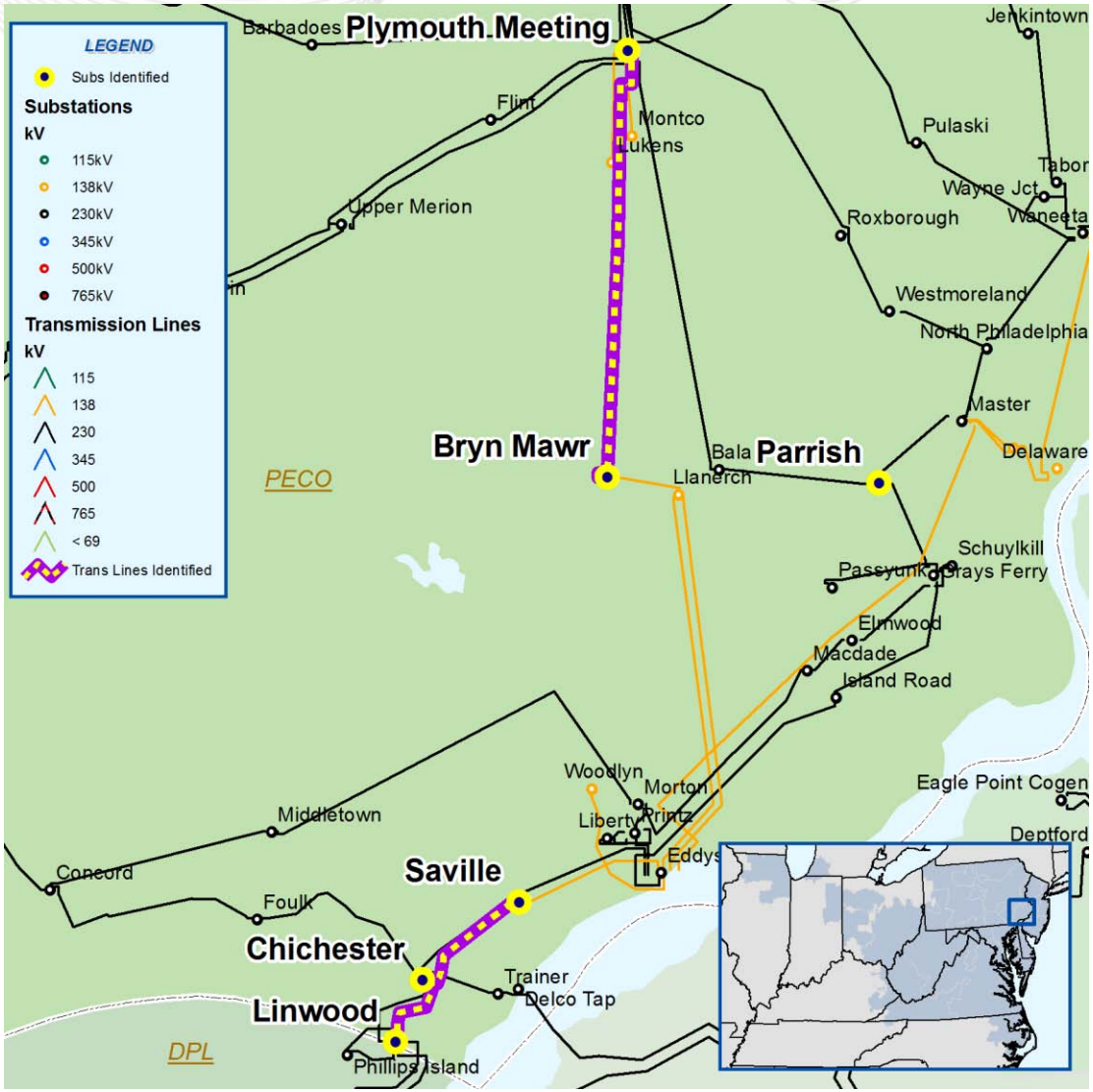
- Linwood – Chichester '220-43' 230 kV line / single contingency ('220-39') loss of Linwood – Chichester '220-39' 230 kV line and Philips island generating units CT2, CT3, and ST

- Proposed Solution: Replace terminal equipment at Chichester (b1180.1)
- Estimated Cost: $0.475 M
- Expected In-Service: May 27, 2011



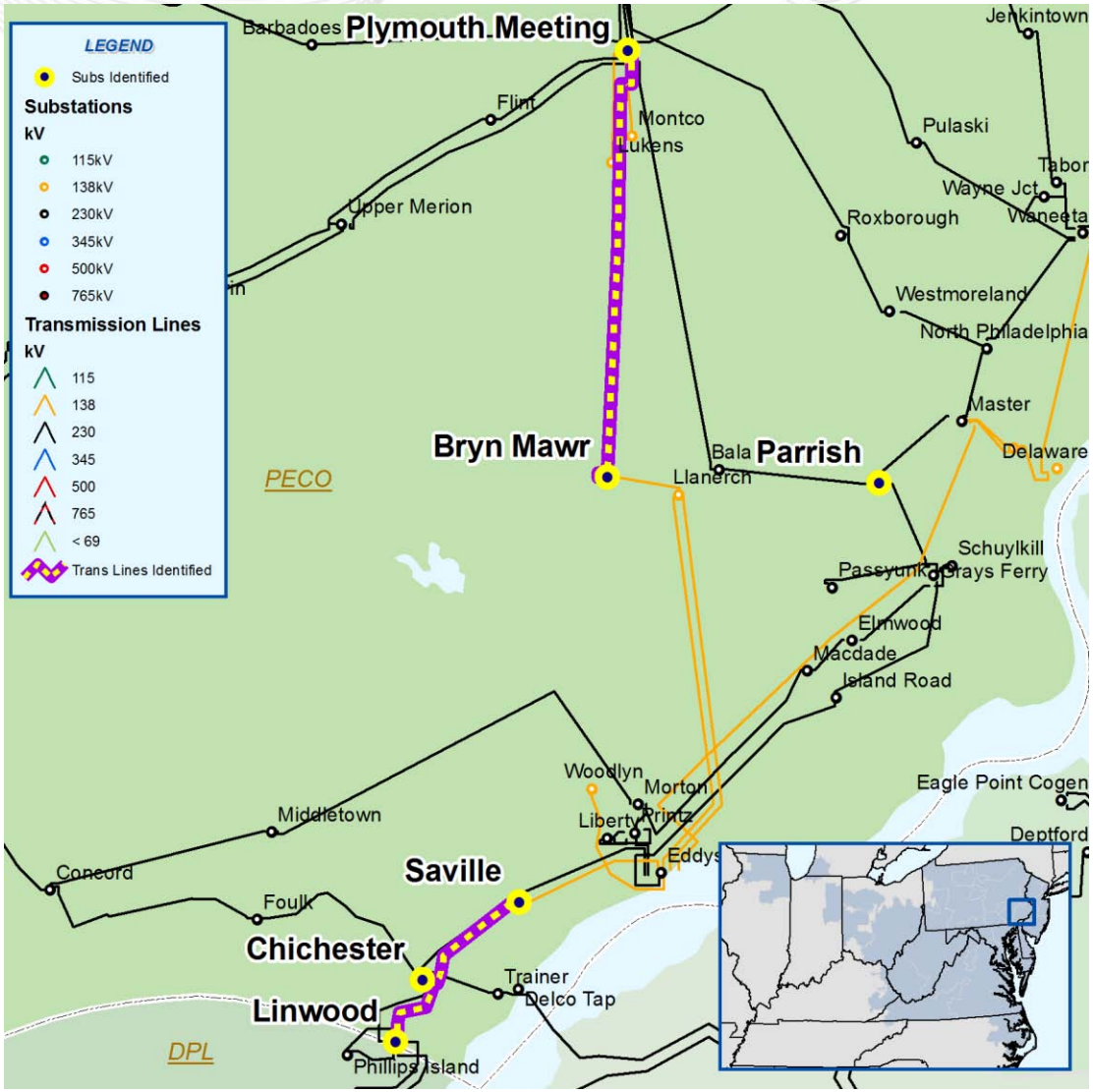
PECO Transmission Zone

- Linwood – Chichester ‘220-39’ 230 kV line / single contingency (‘220-43’) loss of Linwood – Chichester ‘220-43’ 230 kV line and Philips island generating units CT2, CT3, and ST
- Proposed Solution: Replace terminal equipment at Chichester (b1180.2)
- Estimated Cost: $0.475 M
- Expected In-Service: May 27, 2011



PECO Transmission Zone

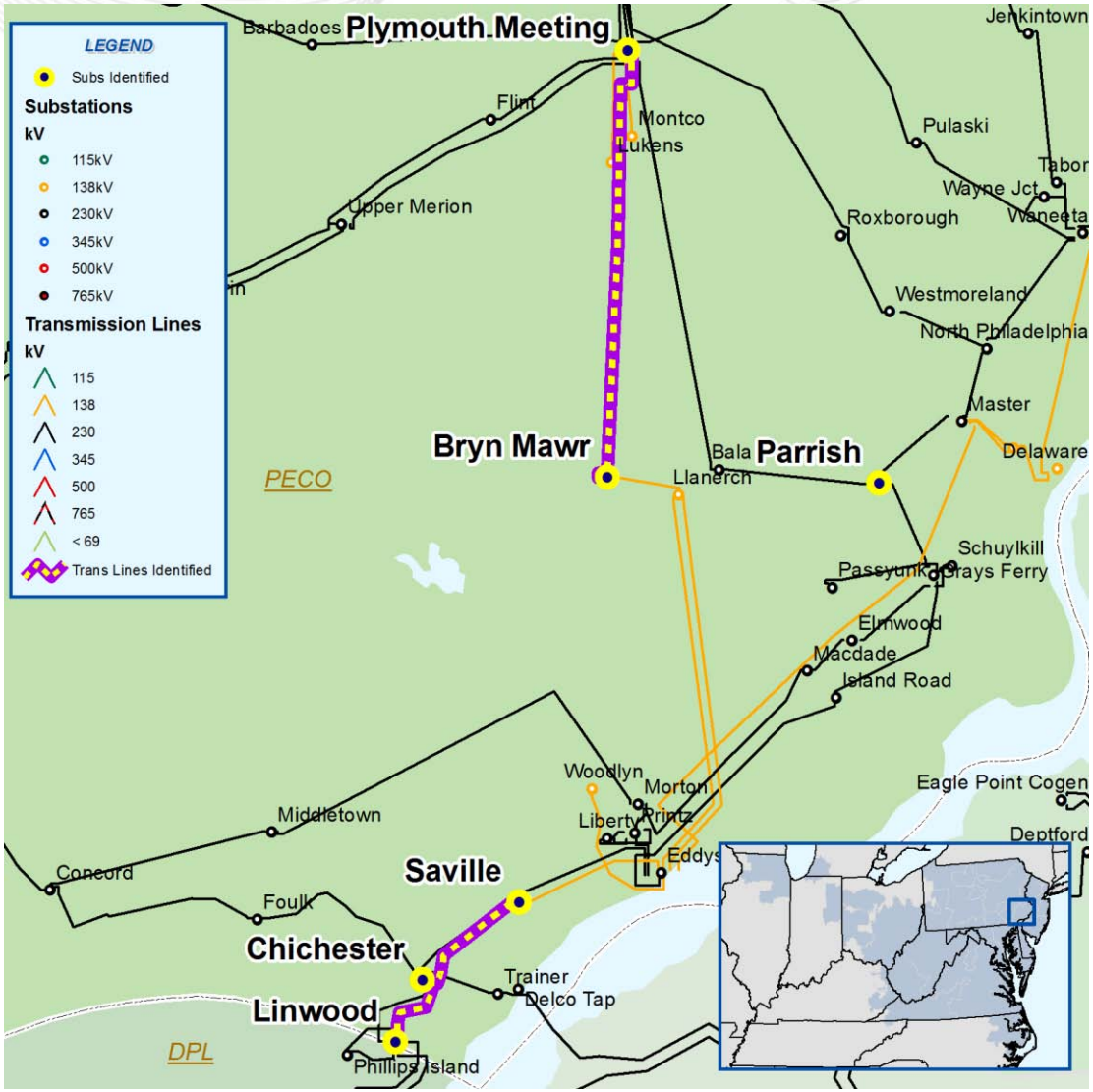
- Chichester – Saville 138 kV line overloaded for the following contingencies:
  - line fault with stuck breaker contingency ('GRAYS275') loss of Grays Ferry – Tunnel 230 kV line due to Grays Ferry stuck breaker '275'
  - bus contingency ('PLYM138B') loss of Plymouth Meeting 138 kV bus
  - single contingency ('220-27B') loss of Gays Ferry – Tunnel 230 kV line
  - Basecase for gen deliv test
  - loss of Macdade – Ridley – Morton 230 kV line (220-46) + loss of Island Road – Eddystone 230 kV line (220-23)
- Proposed Solution: Reconductor the line and upgrade terminal equipment (b1182)
- Estimated cost: $ 8.5 M
- Expected in-service: June 1, 2012



PECO Transmission Zone

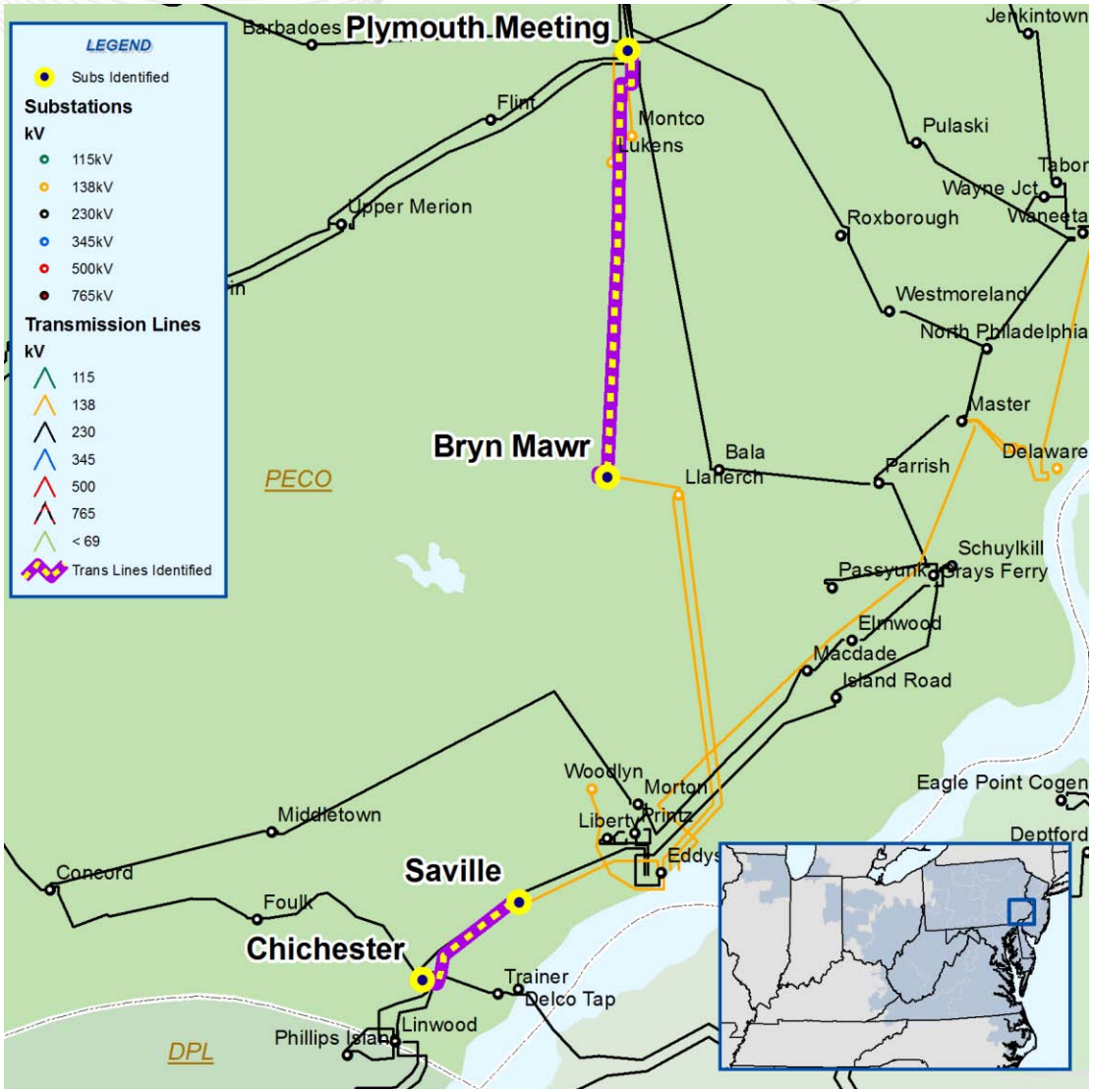
- Tunnel – Parrish 230 kV line overloaded for the following contingencies
  - single contingency ('PJM89_A') loss of New Freedom – East Windsor 500 kV for gen deliv test
  - Basecase for gen deliv test

- Proposed Solution: Replace terminal equipment at Parrish (b0352)
- Estimated Cost: $0.15 M
- Expected In-Service: May 27, 2011



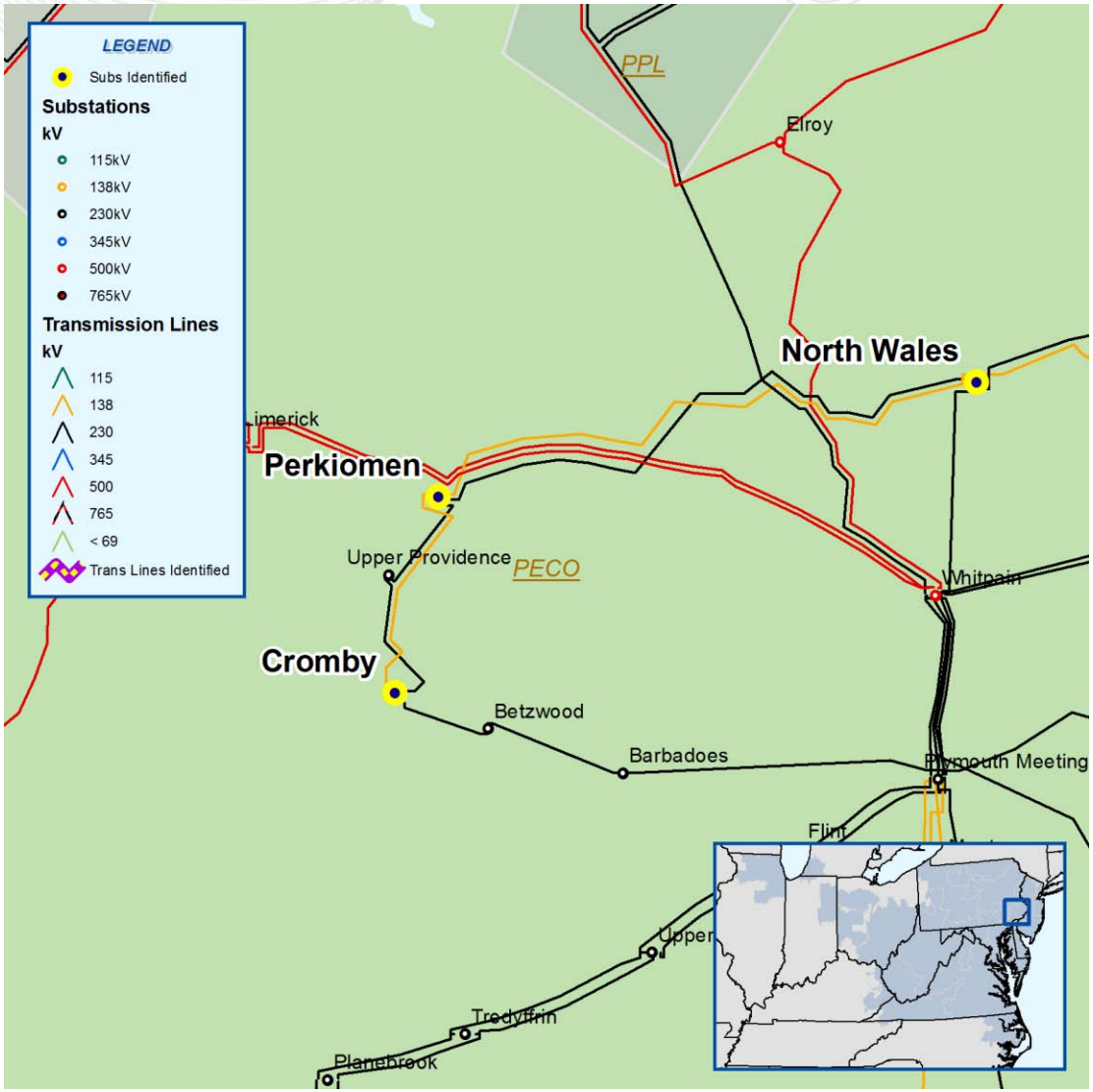
PECO Transmission Zone

- Plymouth Meeting – Bryn Mawr 138 kV line overload for the following contingencies:
  - bus contingency ('CHI230B1') loss of Chichester bus section 1
  - line fault with stuck breaker contingency ('CHICH045') loss of Chichester – Foulk 230 kV line and Foulk 230/13.8 kV transformer #2 as well as Chichester bus section 1 due to the Chichester stuck breaker '045'
  - loss of Chichester 230/138 kV transformer (CHICH-T9) + Basecase
  - loss of Chichester 230/138 kV transformer (CHICH-T9) + Eddystone – Master 138 kV line (130-43)
  - line fault with stuck breaker contingency ('CHICH785') loss of the Chichester 230/138 kV transformer and Chichester 138/69 kV transformer s #7 & 8
- Proposed solution: Install 230/138 kV transformer at Eddystone (b1181)
- Estimated cost: $3.6 M
- Expected in-service: June 1, 2011



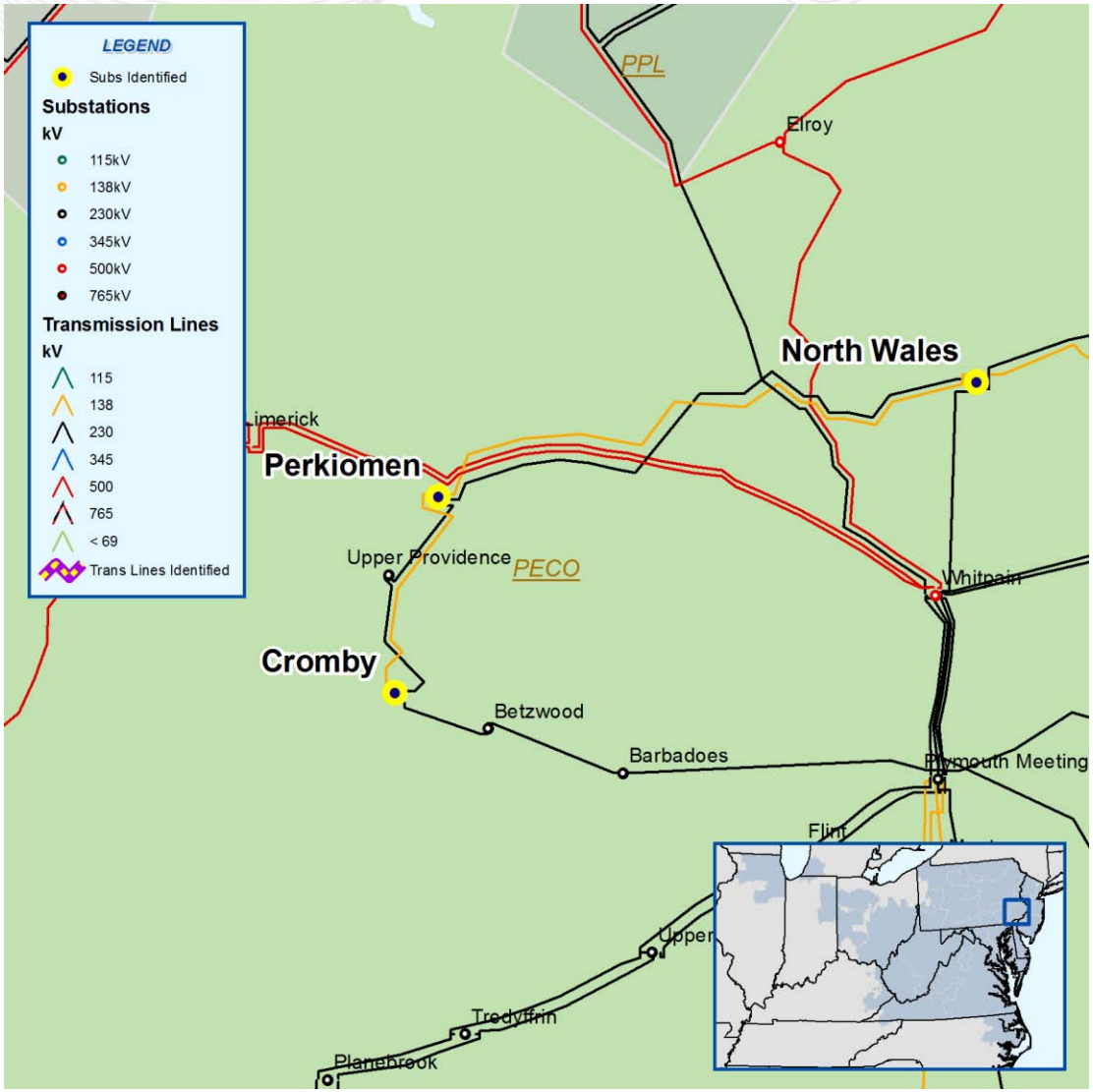
PECO Transmission Zone

- North Wales and Heaton 138 kV area low voltage violations for the following contingencies
  - bus contingency ('HEAT138B') loss of Heaton 138 kV station bus section 2
  - line fault with stuck breaker contingency ('HEAT0805') loss of Heaton – Woodbourne 230 kV line with stuck breaker 805
  - line fault with stuck breaker contingency ('HEAT0995') loss of Heaton – Woodbourne 230 kV line with stuck breaker 995
- Proposed Solution: Add a second 230/138 kV transformer at Heaton. Add a circuit breaker on the Heaton – North Wales 138 kV line. Add a 35 MVAR capacitor at Heaton (b0842)
- Estimated cost: $7.754 M
- Expected in-service: December 16, 2011



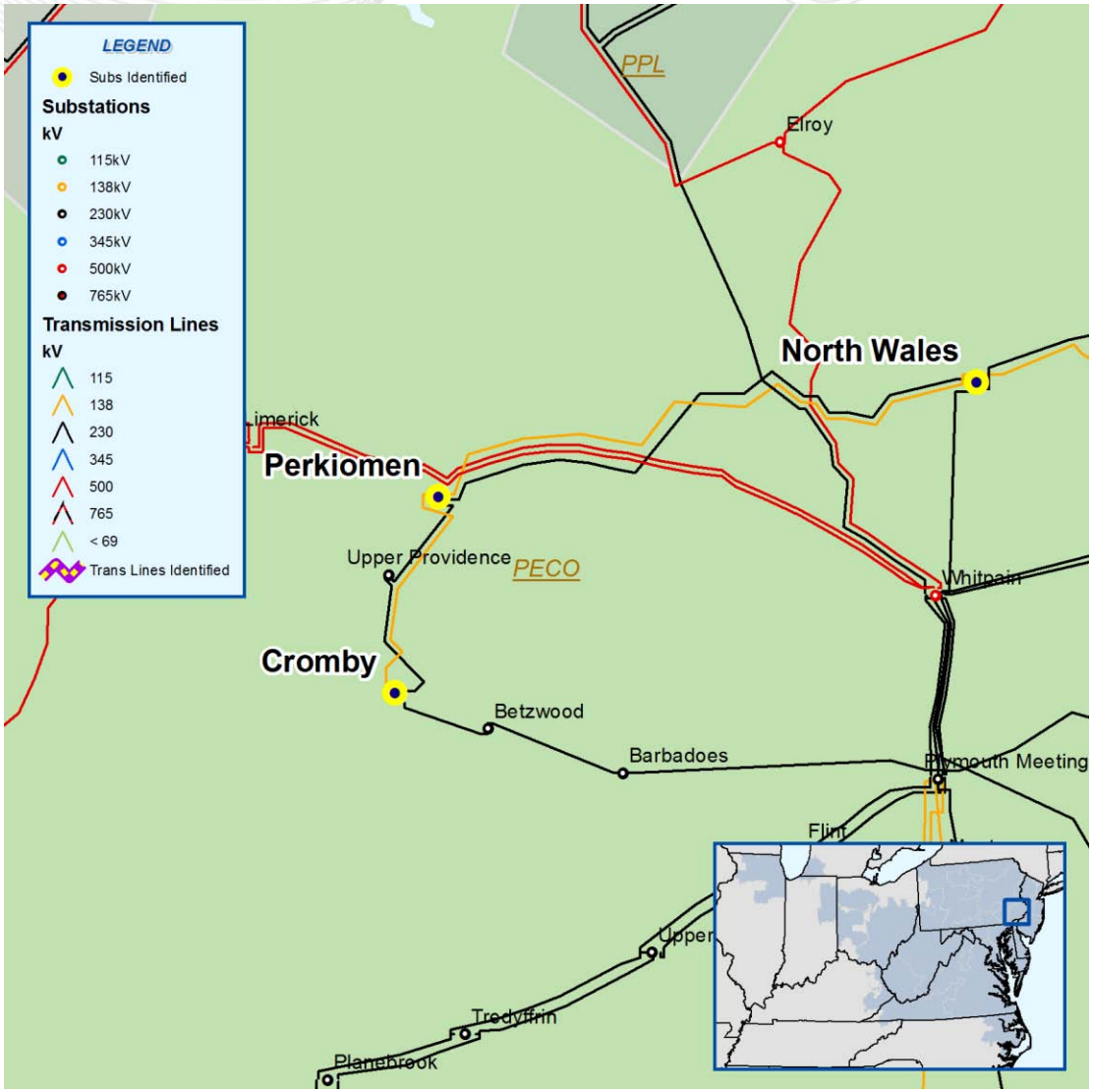
PECO Transmission Zone

- Cromby 138 kV station low voltage violations for the following contingencies:
  - bus contingency ('HEAT138B') loss of Heaton 138 kV station bus section 2
  - line fault with stuck breaker contingency ('HEAT0805') loss of Heaton – Woodbourne 230 kV line with stuck breaker 805
  - line fault with stuck breaker contingency ('HEAT0995') loss of Heaton – Woodbourne 230 kV line with stuck breaker 995
- Proposed Solution: Replace 230/69 kV transformer #6 at Cromby. Add two 50 MVAR 230 kV capacitor banks at Cromby (b1183)
- Estimated Cost: $ 6.142 M
- Expected in-service: December 31, 2011



PECO Transmission Zone

- Perkiomen 138 kV station voltage violations for the following contingencies:
  - bus contingency ('HEAT138B') loss of Heaton 138 kV station bus section 2
  - line fault with stuck breaker contingency ('HEAT0805') loss of Heaton – Woodbourne 230 kV line with stuck breaker 805
  - line fault with stuck breaker contingency ('HEAT0995') loss of Heaton – Woodbourne 230 kV line with stuck breaker 995
- Proposed Solution: Add 138 kV circuit breakers at Cromby, Perkiomen, and North Wales. Add a 35 MVAR 138 kV capacitor at Perkiomen (b1184)
- Estimated Cost: $ 3.9 M
- Expected In-Service: August 1, 2011



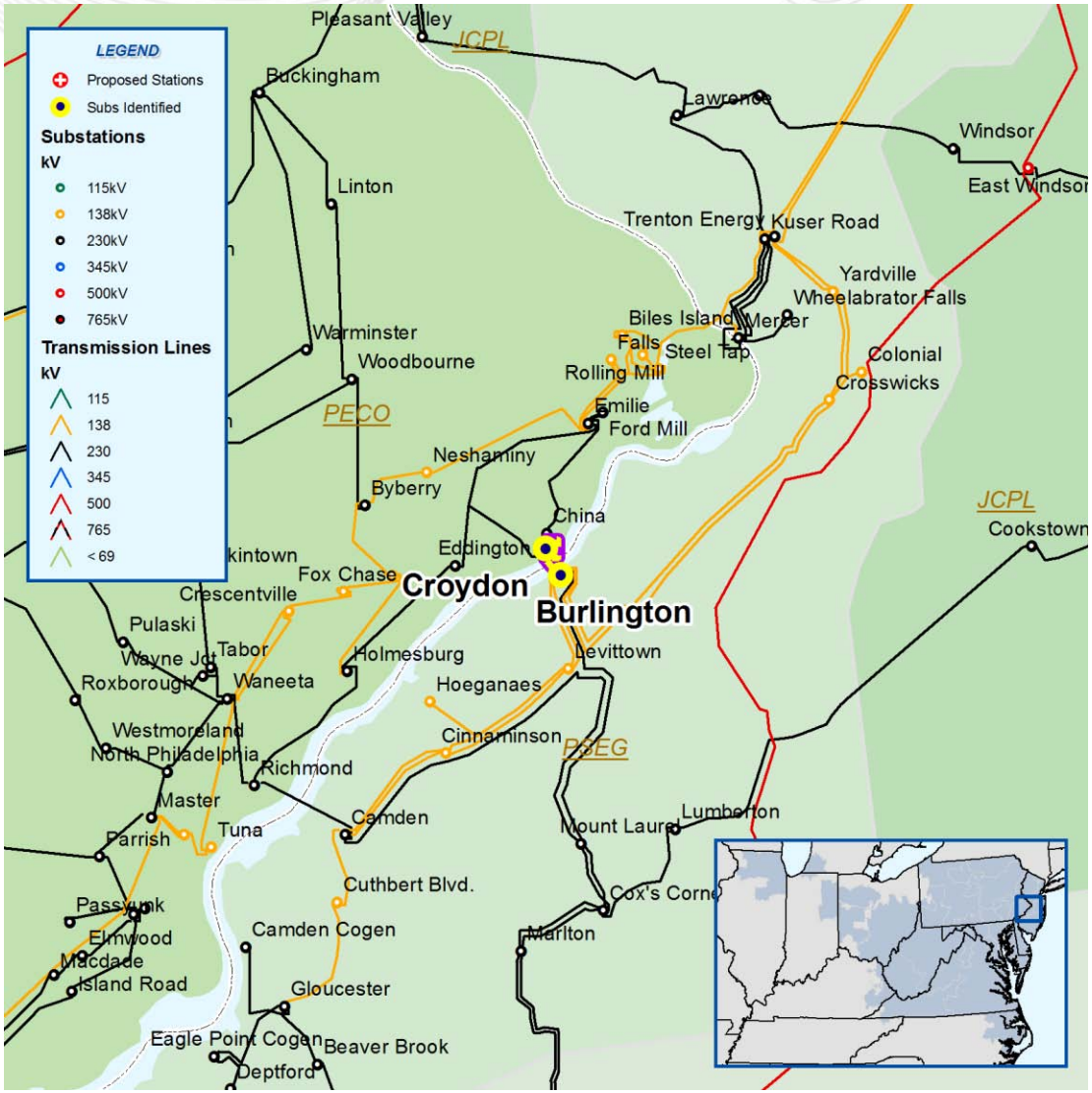
PECO Short Circuit Violations

- Eddystone 230 kV CB #365
  - Proposed solution: Upgrade the circuit breaker (b1185)
  - Estimated Cost: $0.125 M
  - Expected In-Service: May 31, 2011

- Eddystone 230 kV CB #785
  - Proposed solution: Upgrade the circuit breaker (b1186)
  - Estimated Cost: $0.125 M
  - Expected In-Service: May 31, 2011

PECO Transmission Zone

- Generation Deliverability and Common Mode Outage procedure
- The Burlington – Croydon 230 kV is overloaded for several contingencies
- Proposed Solution: Reconductor the PECO portion of the Burlington – Croydon circuit (B1197)
- Estimated Project Cost: $1.0M
- Expected IS Date: 6/1/2015

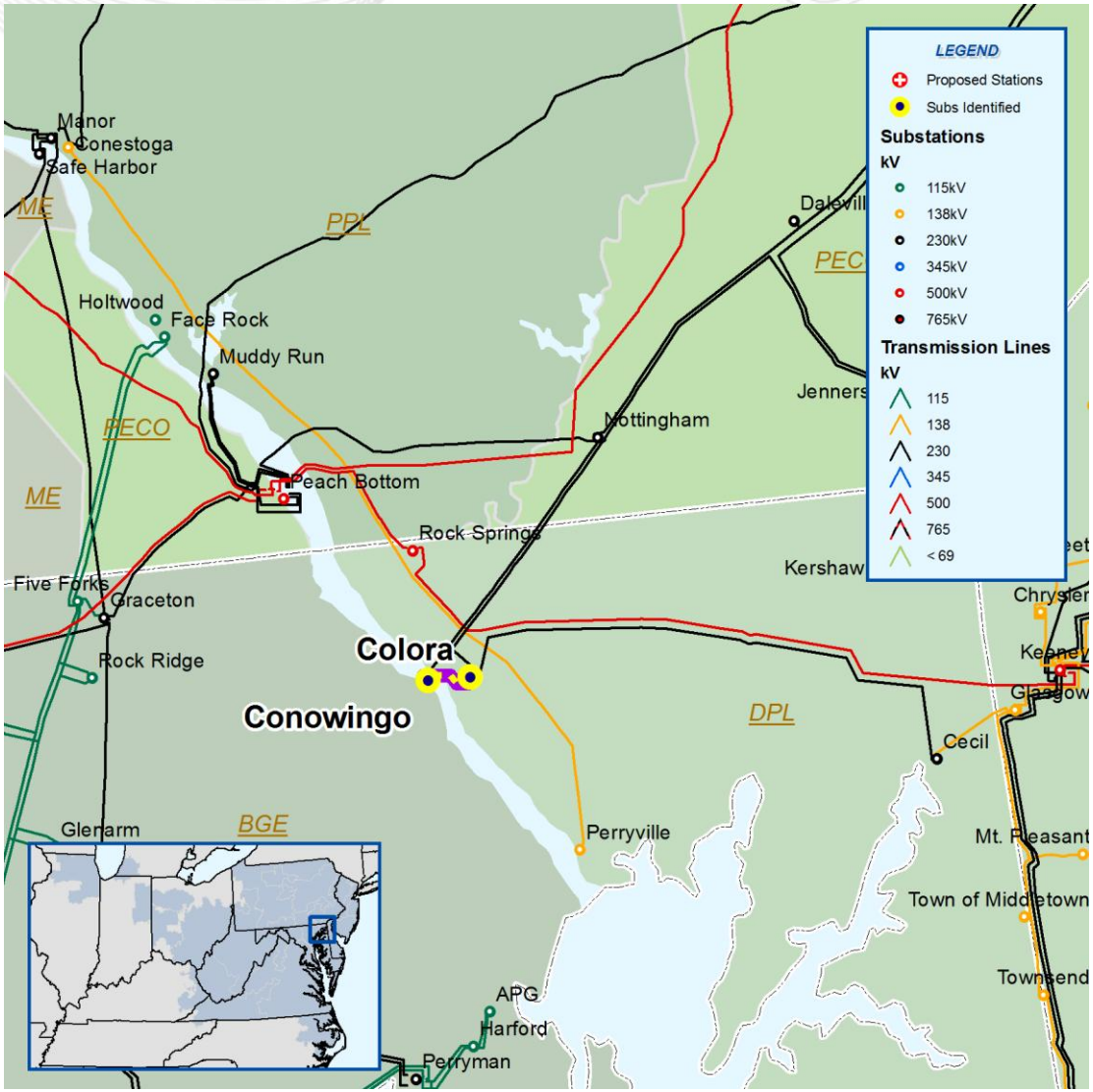


PECO Transmission Zone

- Generation Deliverability:
- Conowingo – Colora 230 kV is overloaded for the single contingency loss of either Conowingo – Nottingham 230 kV circuit
- Proposed Solution: Replace terminal equipment including station cable, disconnects, and relays at the Conowingo 230 kV station (B1198)
- Estimated Project Cost:

  $0.5 M
- Expected IS Date:

  6/1/2015



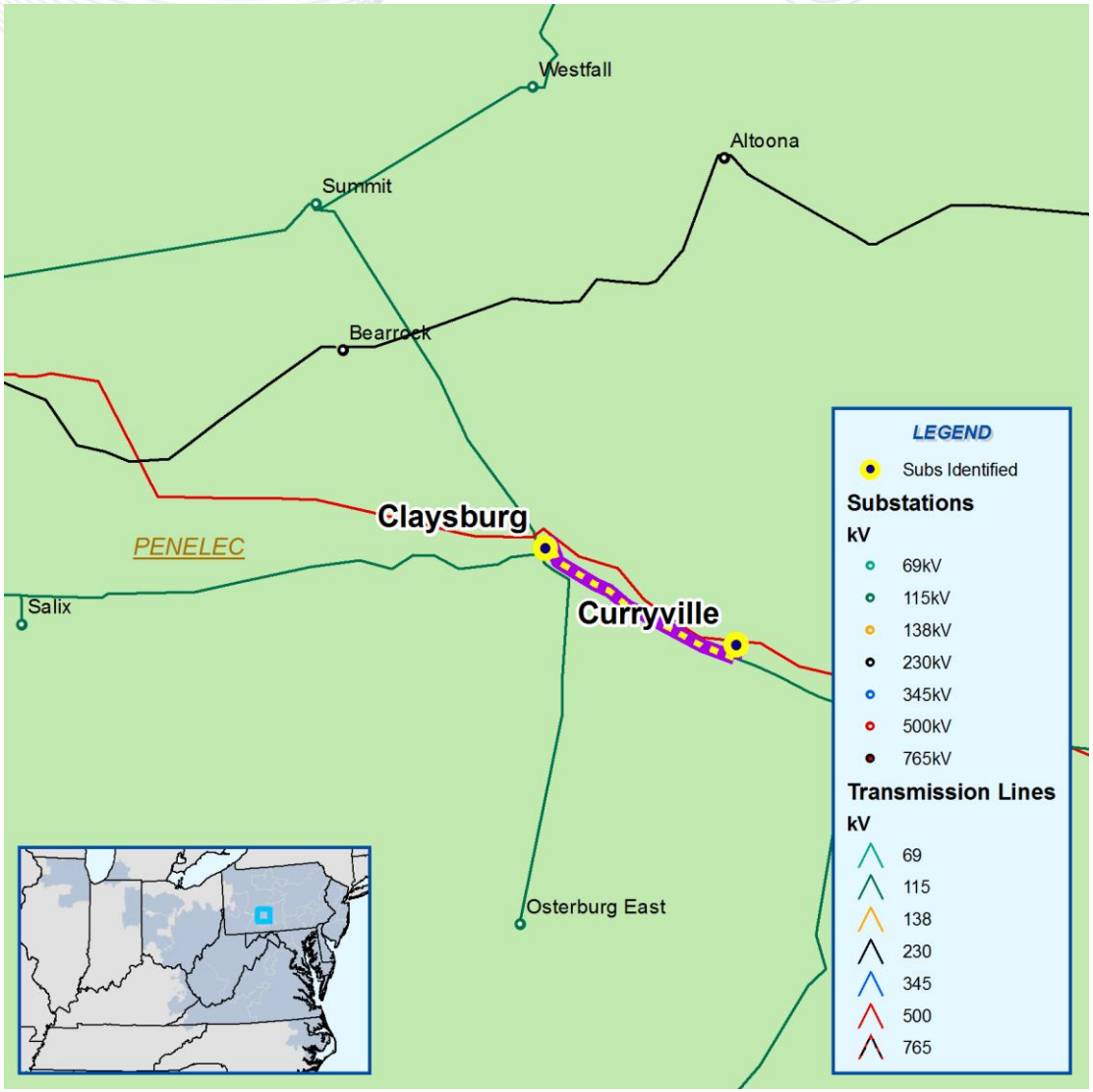
PenElec Transmission Zone

- FE planning criteria violation:
- Potential local voltage collapse for the loss of the Claysburg – Curryville 115 kV line section.
- Proposed Solution:

  Build a new Osterburg East - Bedford North 115 kV Line, 5.7 miles of 795 ACSR (B1277).
- Estimated Project Cost:

  $3.68 M
- Expected IS Date:

  06/01/2013



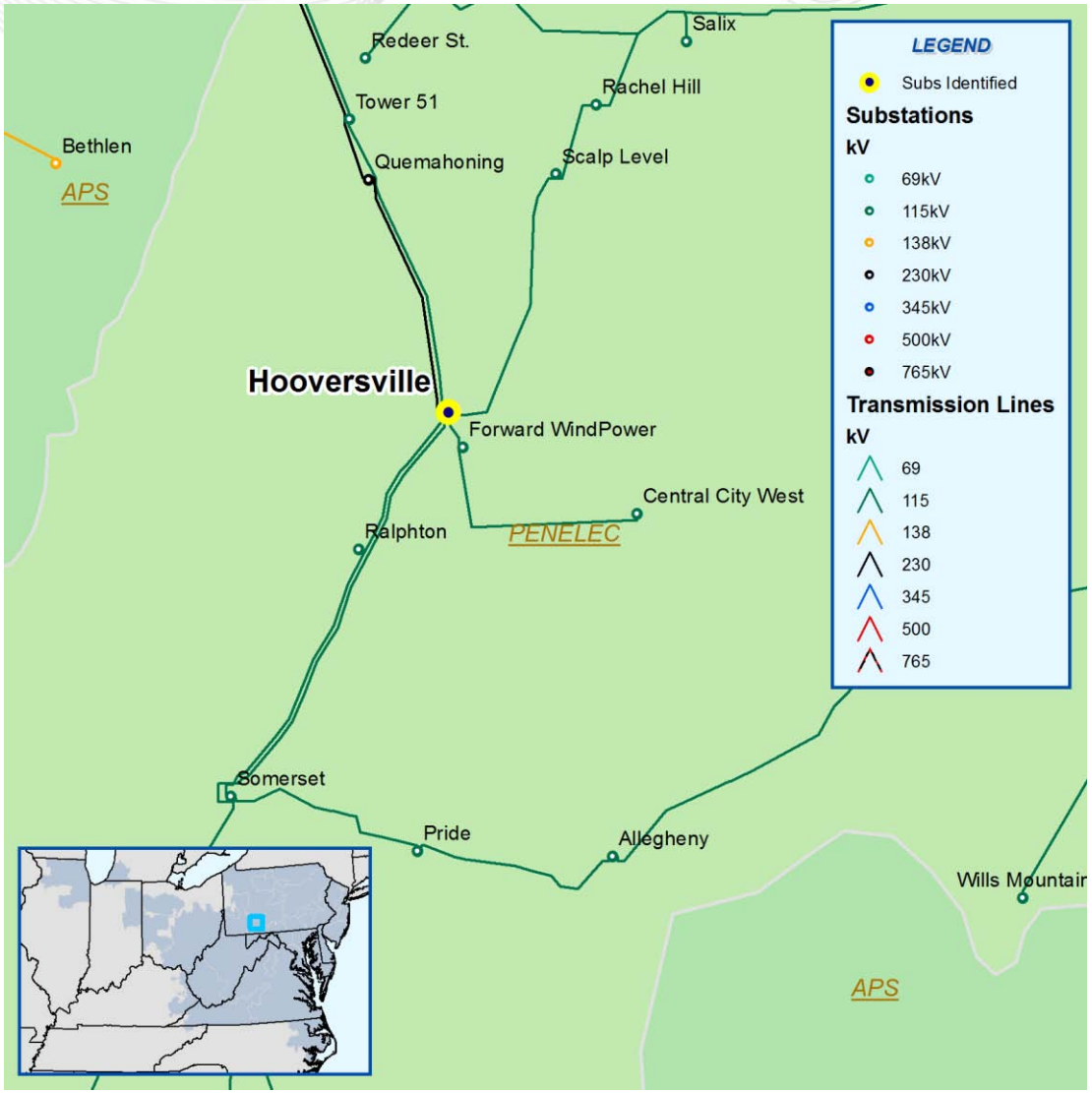
PenElec Transmission Zone

- FE planning criteria violation:
- Potential local voltage collapse for 115 kV breaker fault at Hooversville.
- Proposed Solution:

  Install 25 MVAR Capacitor Bank at Somerset 115 kV (B1278).
- Estimated Project Cost:

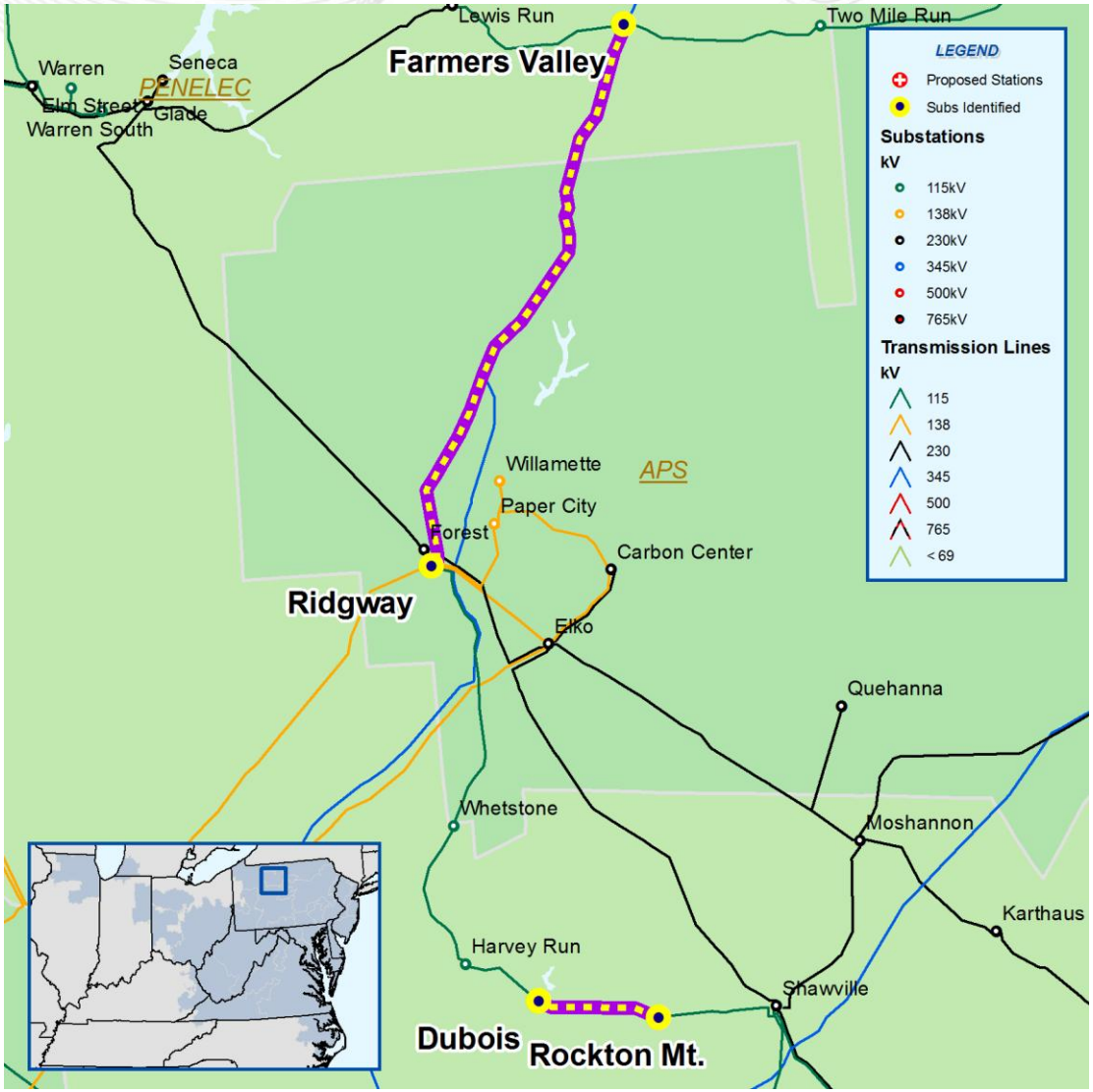
  $0.473 M
- Expected IS Date:

  06/01/2012



PenElec Transmission Zone

- N-1-1 Voltage Violation
- In 2014, voltage drop violations in the vicinity of Ridgway and Farmers Valley 115 kV for the loss of the Dubois – Rockton Mt. and Ridgway – Farmers Valley 115 kV circuits.
- Proposed Solution: Increase the size of the capacitor at Ridgway (B0564) to 25 MVAR.
- Estimated Project Cost: $1.029 M
- Expected IS Date: 6/1/2013

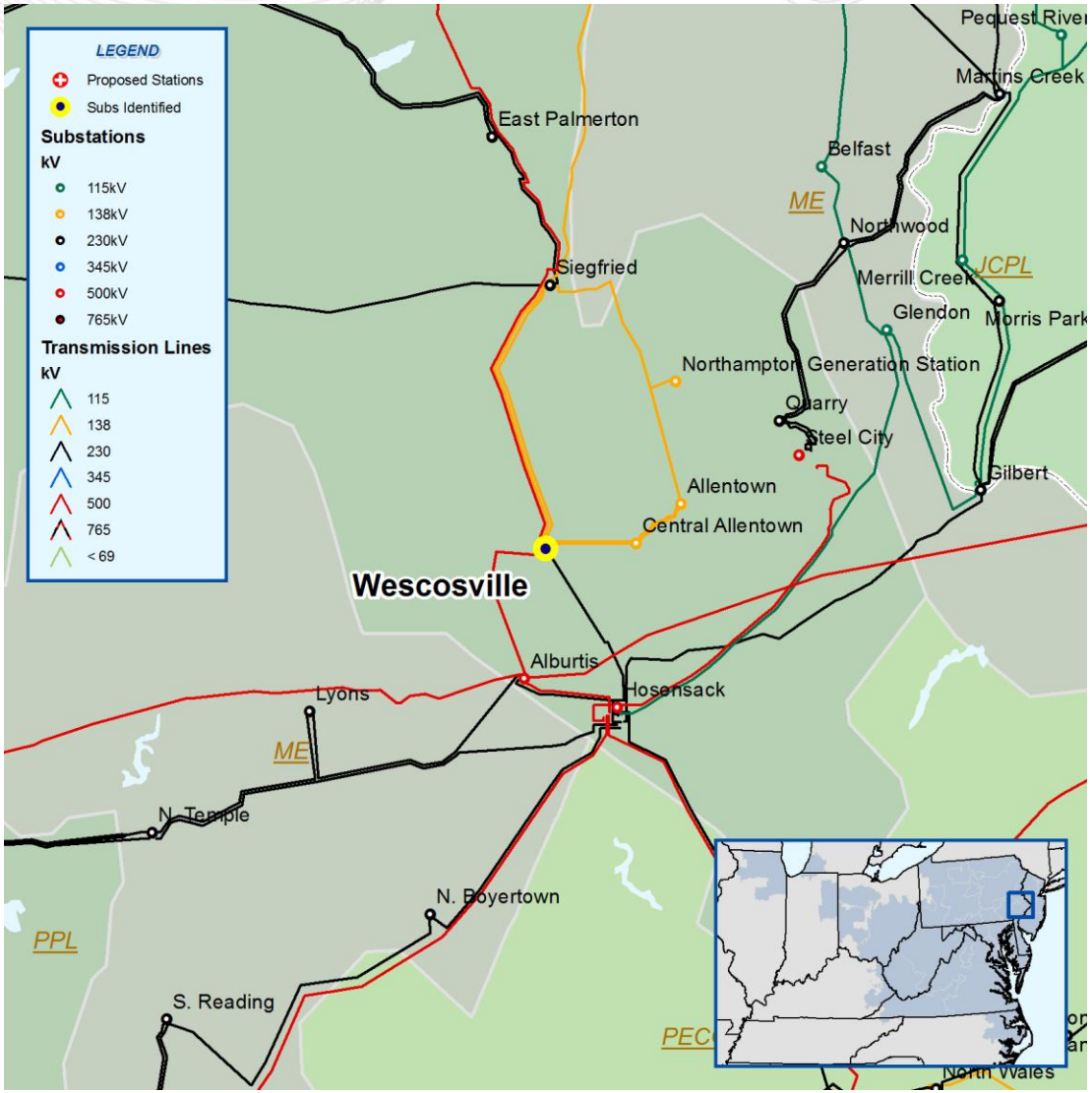


PPL Transmission Zone

- Common Mode Outage Procedure
- The Wescosville 500/138 kV transformer is overloaded for a fault on either Siegfried transformer #4 or #5 with the stuck breaker at Siegfried 230 kV East-West bus tie breaker
- Proposed Solution: Remove the Siegfried bus tie breaker and install a new breaker on the Martins Creek 230 kV line west bay to maintain two ties between the 230 kV buses (B1196)
- Estimated Project Cost:

  $1.0M
- Expected IS Date:

  6/1/2013



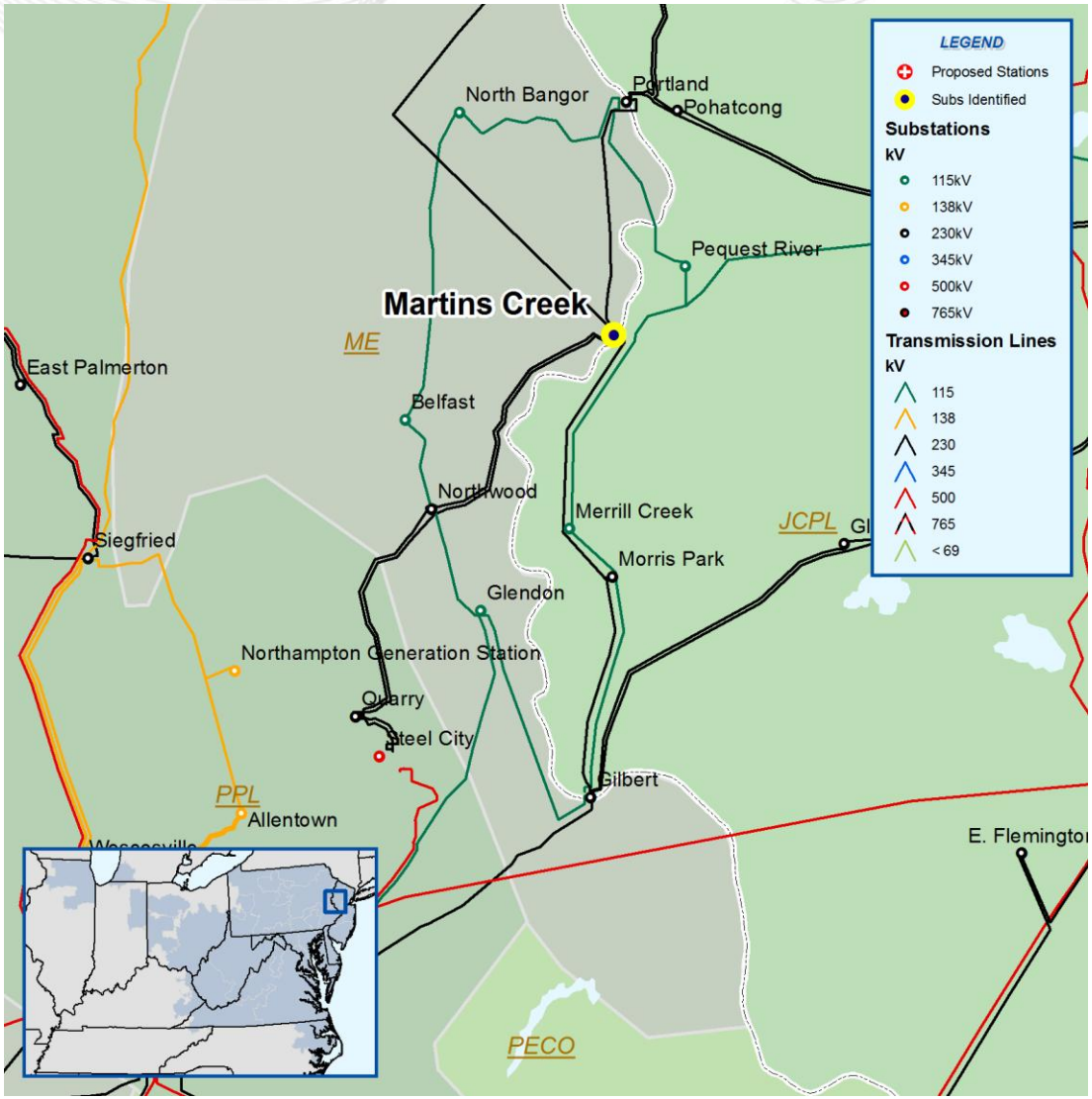
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Thermal overload of Martins Creek - Nazareth #1 69 kV, voltage drop violation at Martins Creek 69 kV and Mount Bethel 69 kV, low voltage magnitude on the Hercules Cement, Liquid Carbonic, and Cherry Hill 69 kV busses for the loss of Martins Creek 69 kV bus, Loss of Martins Creek T21, and Loss of Nazareth 69 kV Bus Section #1
- Potential Solution:

  Rebuild the Hercules Tap to Double Circuit 69 kV (B1201)
- Estimated Project Cost:

  $1.95 M
- Expected IS Date:

  5/31/2013



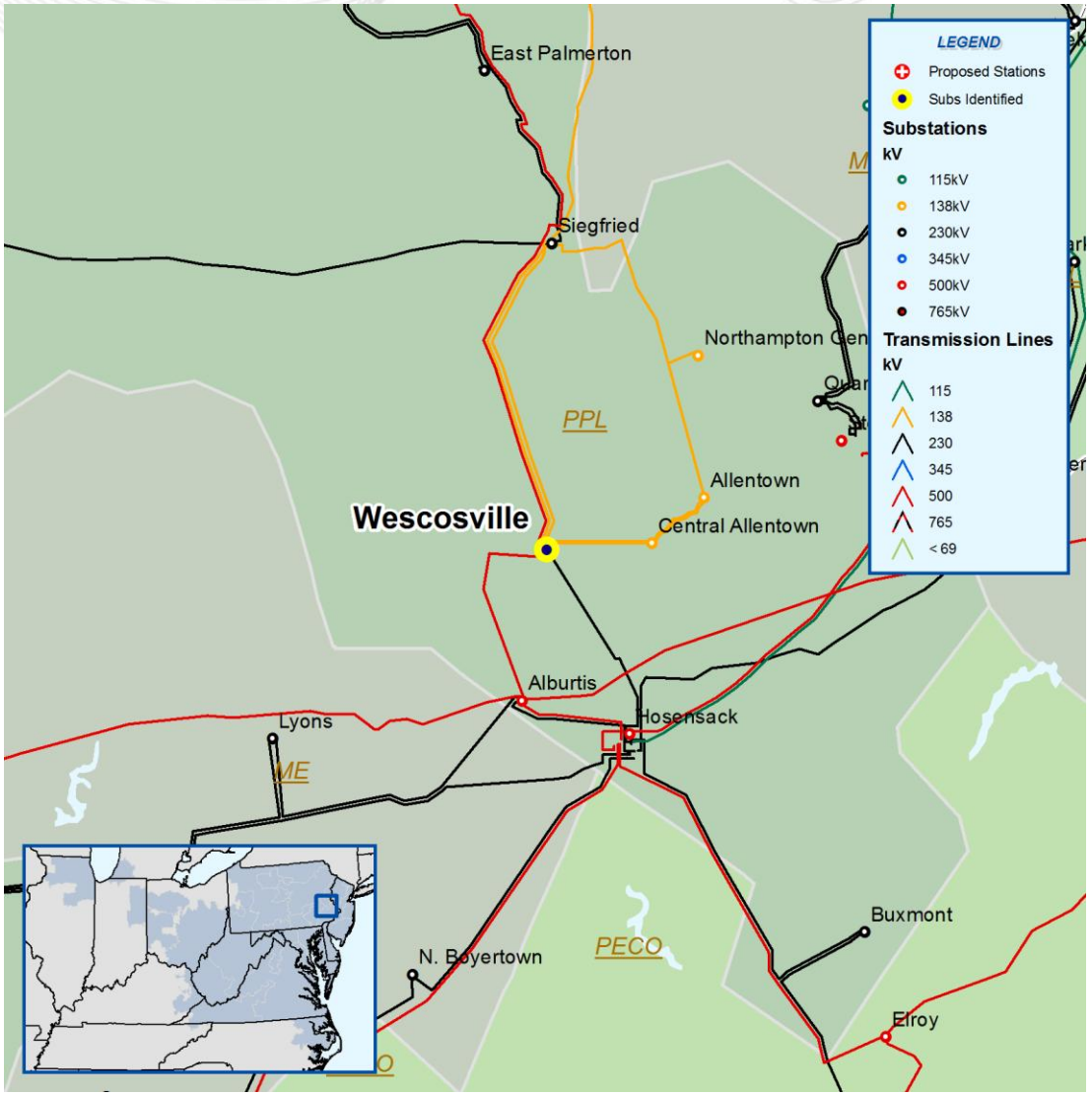
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines at Wescosville for the loss of the Wescosville - Trexlertown #1 138 kV Line
- Proposed Solution:

  Mack - Macungie Double Tap, Singe Feed Arrangement (B1202)
- Estimated Project Cost:

  $0.332 M
- Proposed IS Date:

  5/31/2013



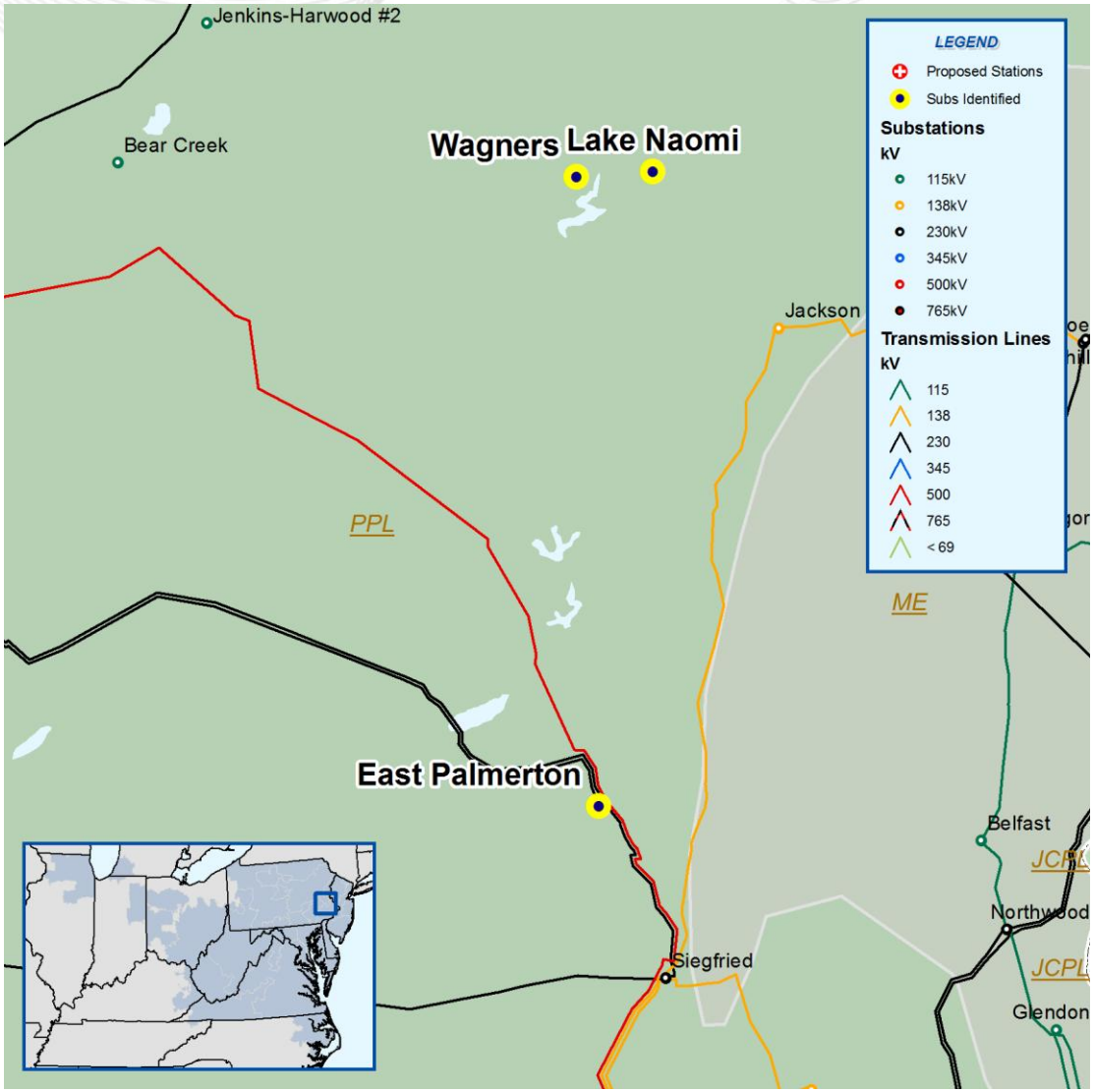
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of Lake Naomi 138 kV tap or the loss of East Palmerton - Wagners #1 & #2 138 kV Lines
- Proposed Solution:

  Add a 2nd Circuit to the East Palmerton – Wagners - Lake Naomi 138 kV Tap (B1203)
- Estimated Project Cost:

  $12.3 M
- Proposed IS Date:

  11/30/2014



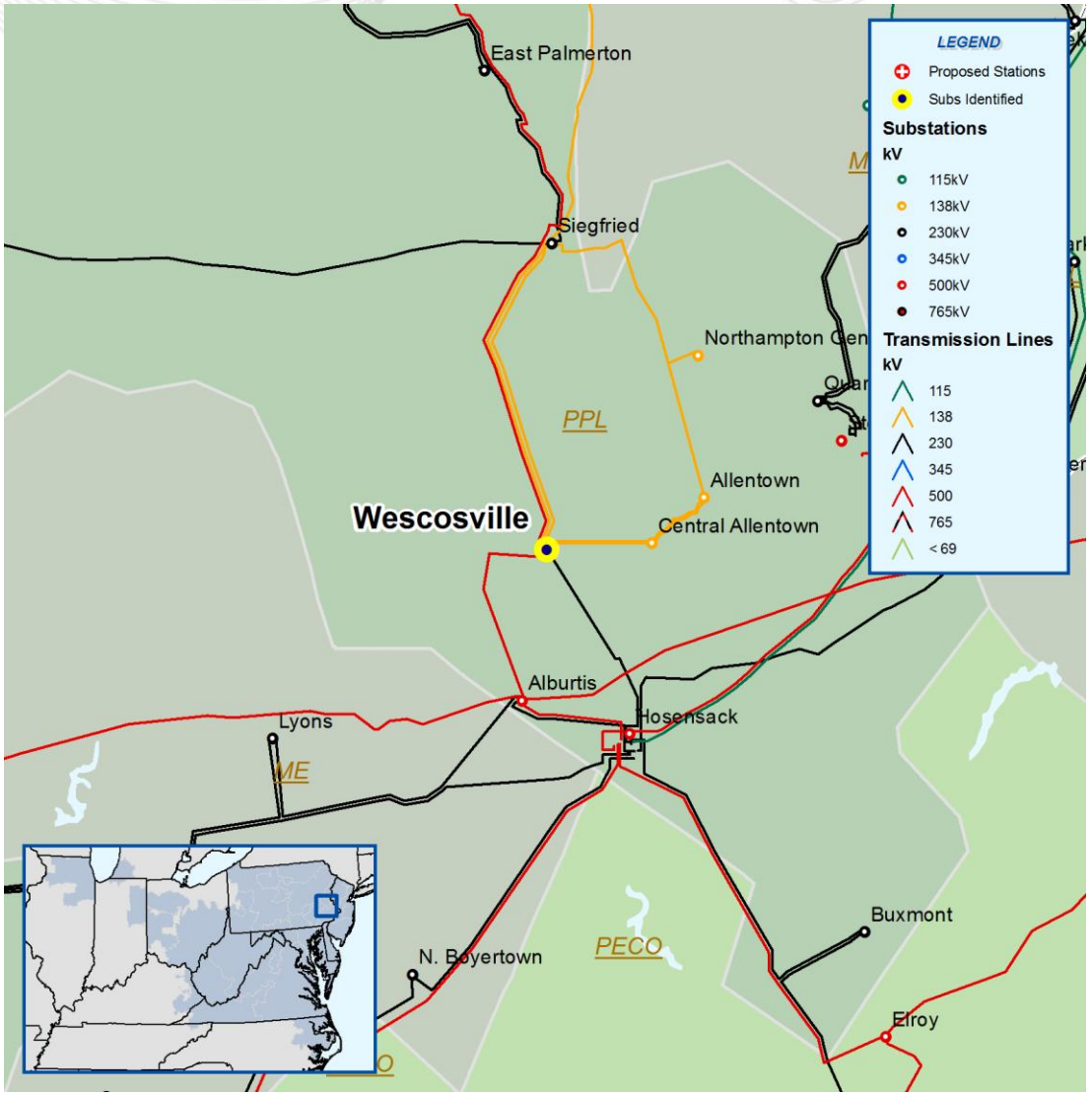
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of Wescosville - Trexlertown #1 & #2 69 kV Lines
- Proposed Solution:

  New Breinigsville 230/69 kV Substation (B1204)
- Estimated Project Cost:

  $34.65 M
- Proposed IS Date:

  05/31/2015



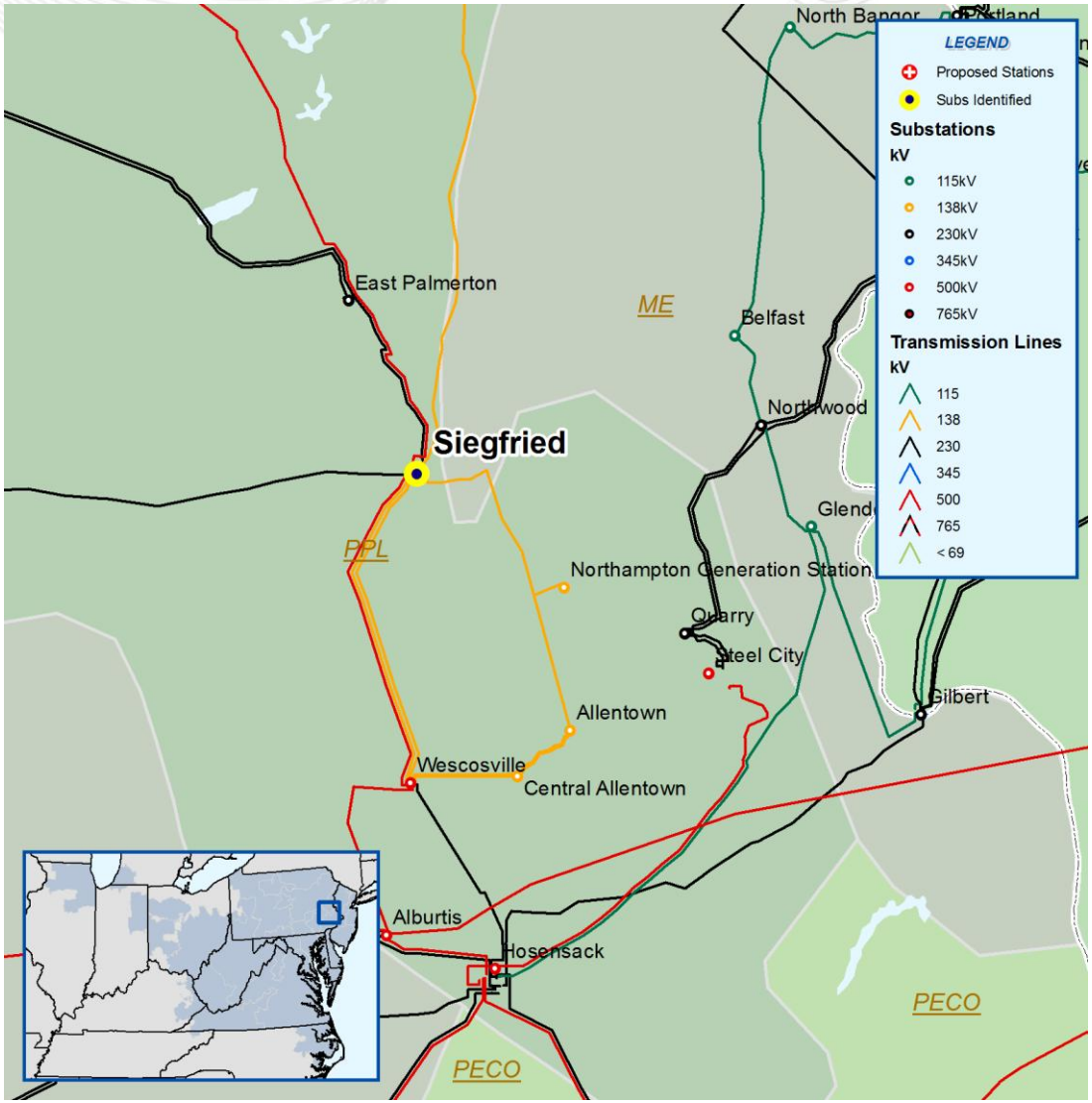
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Thermal overload of the Siegfried - East Palmerton #1 & #2 69 kV lines and overload of the Hauto - Siegfried #1 69 kV line for the loss of the Siegfried - East Palmerton #1 or #2 69 kV line and loss of the Hauto-Siegfried #4 69 kV line
- Proposed Solution:

  On the Siegfried - East Palmerton #1 69 kV Line, install new 69 kV equipment to sectionalize and transfer to Treichlers substation (B1205)
- Estimated Project Cost:

  $0.28 M
- Proposed IS Date:

  05/31/2014



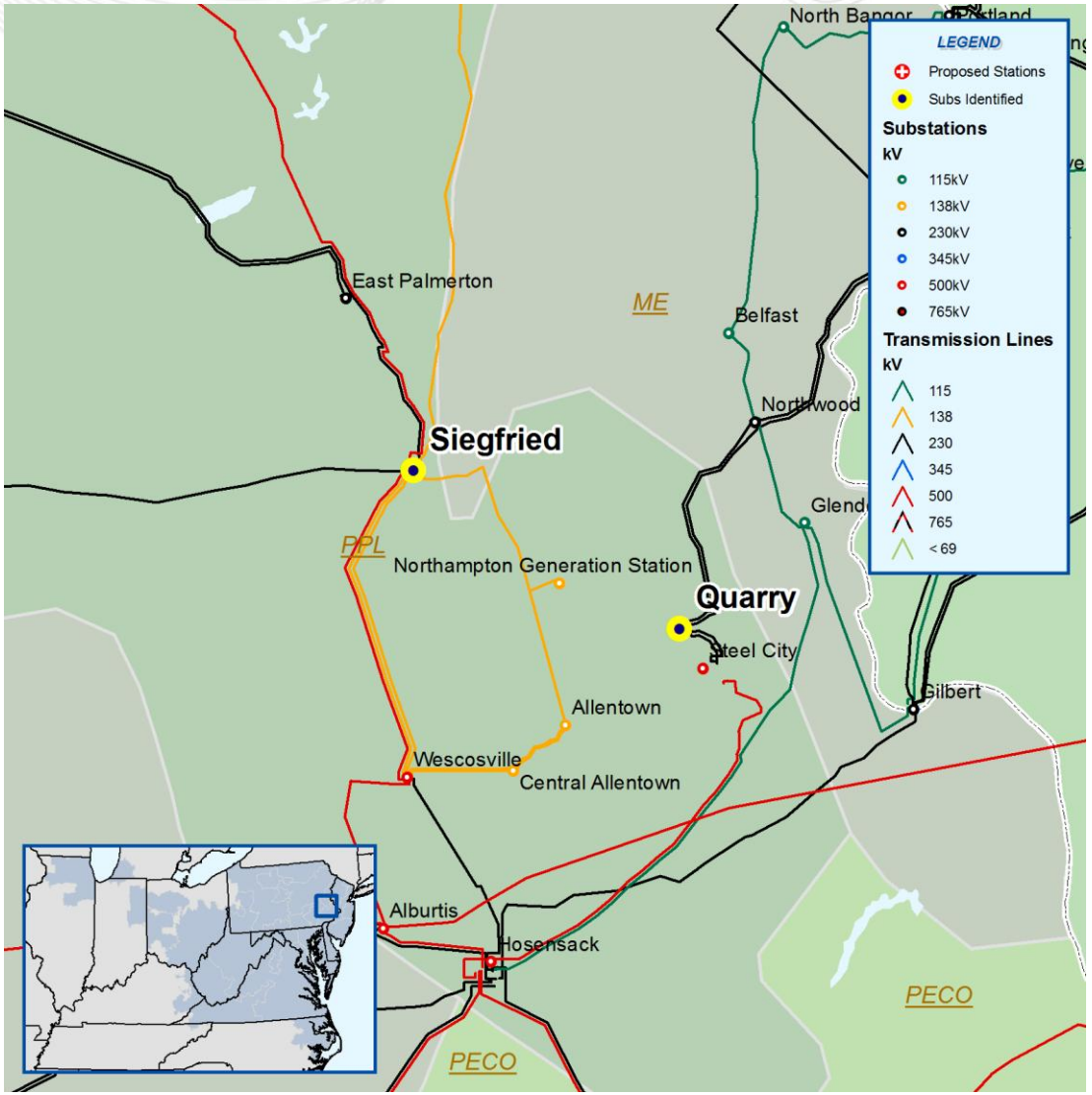
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of the double circuit Siegfried – Quarry 69 kV tower line from Siegfried to North Bethlehem
- Proposed Solution:

  Rebuild 3.3 miles from Quarry Substation to Macada Taps on the Siegfried – Quarry 69 kV tower lines (B1206)
- Estimated Project Cost:

  $3.8 M
- Proposed IS Date:

  05/31/2015



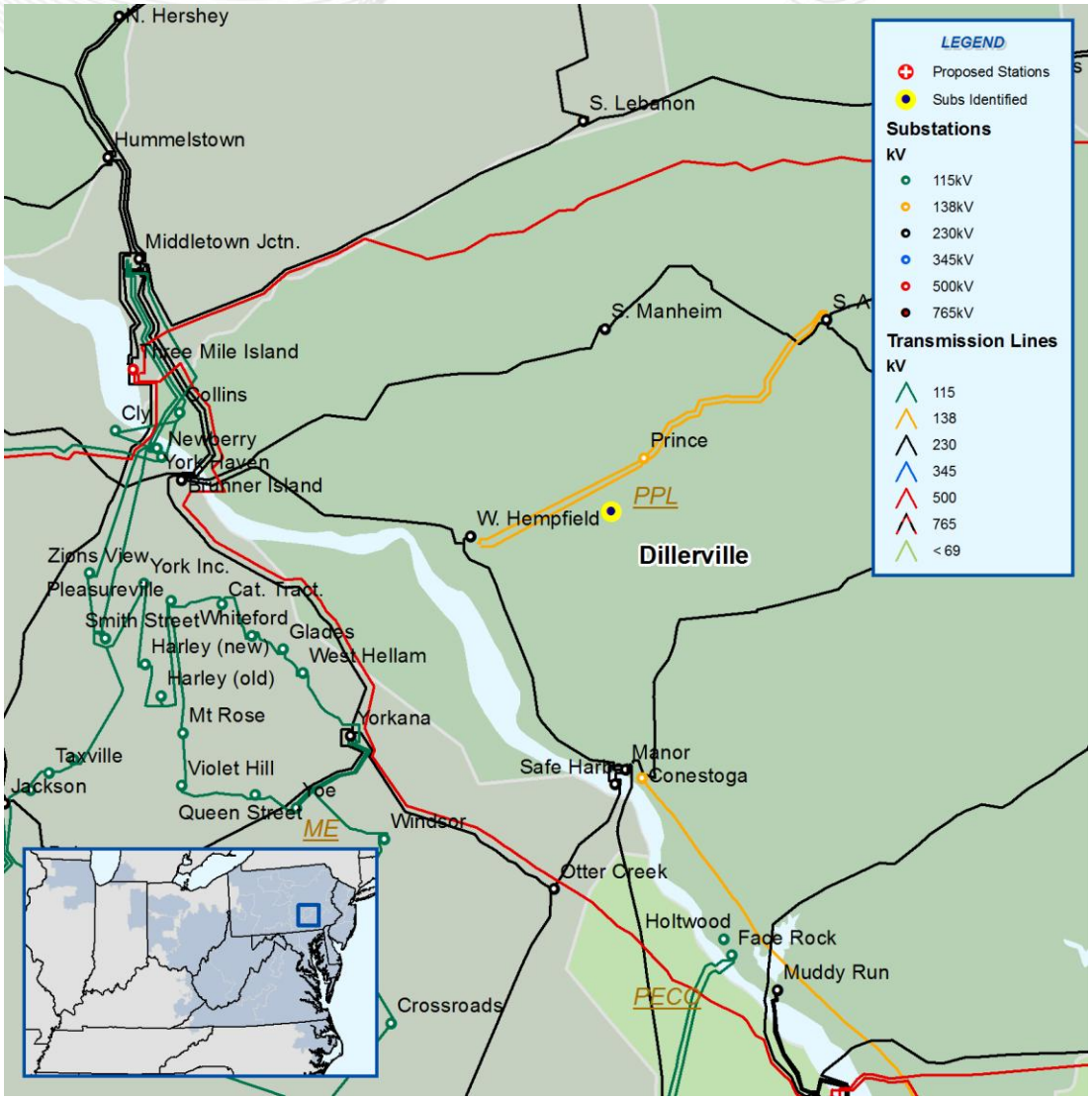
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of the double circuit Dillerville #1 & #2 69 kV Taps
- Proposed Solution:

  Convert Neffsville Taps from 69kV to 138kV Operation (B1209)
- Estimated Project Cost:

  $0.0 M
- Proposed IS Date:

  11/30/2012



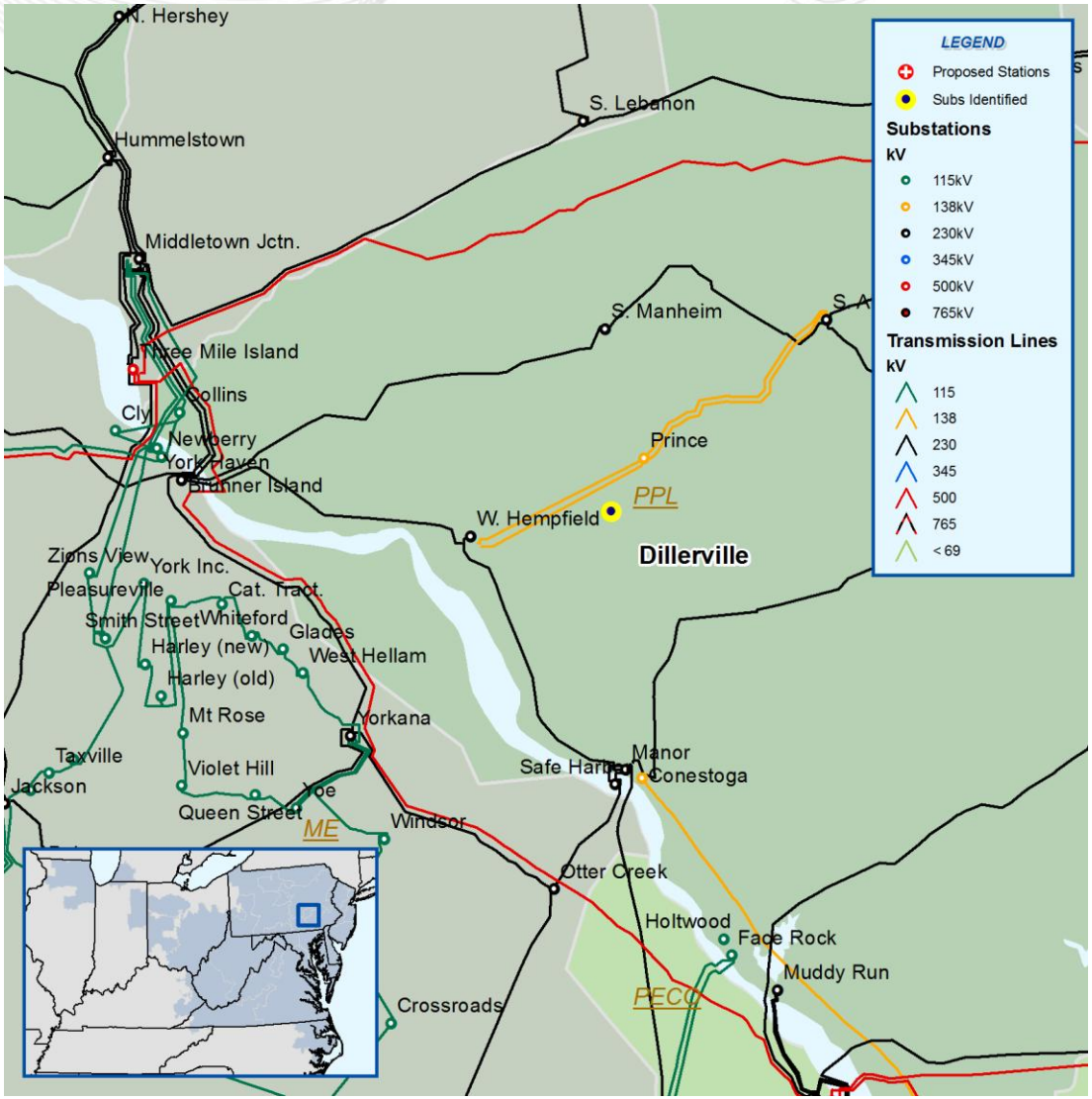
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of the double circuit Dillerville #1 & #2 69 kV Taps
- Proposed Solution:

  Convert Roseville Taps from 69kV to 138kV Operation (operate on the 69kV system) (B1210)
- Estimated Project Cost:

  $0.85 M
- Proposed IS Date:

  05/31/2011



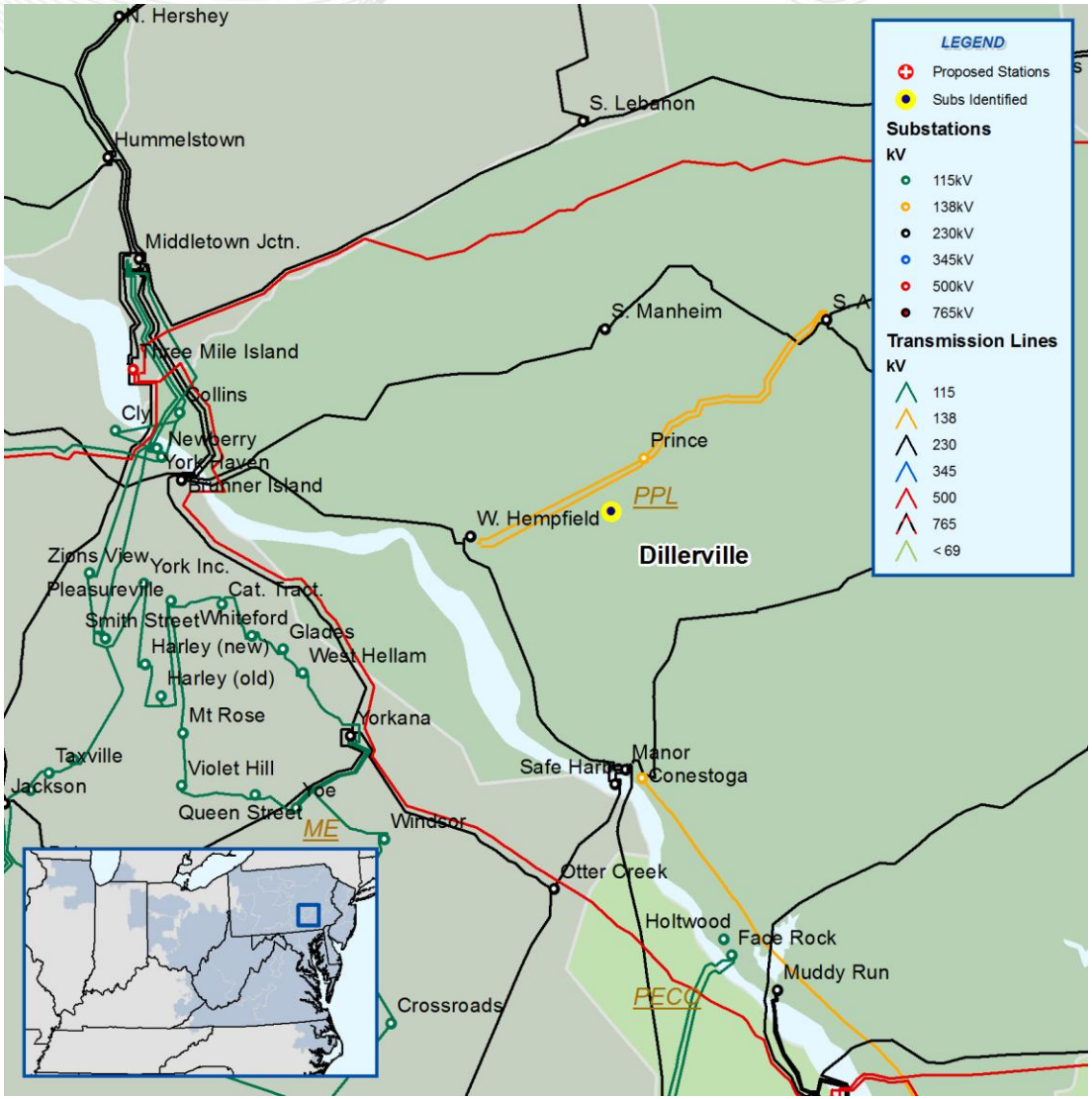
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of the double circuit Dillerville #1 & #2 69 kV Taps
- Proposed Solution:

  Convert Roseville Taps from 69kV to 138kV Operation (operate on the 138kV system) (B1211)
- Estimated Project Cost:

  $0.03 M
- Proposed IS Date:

  05/31/2013



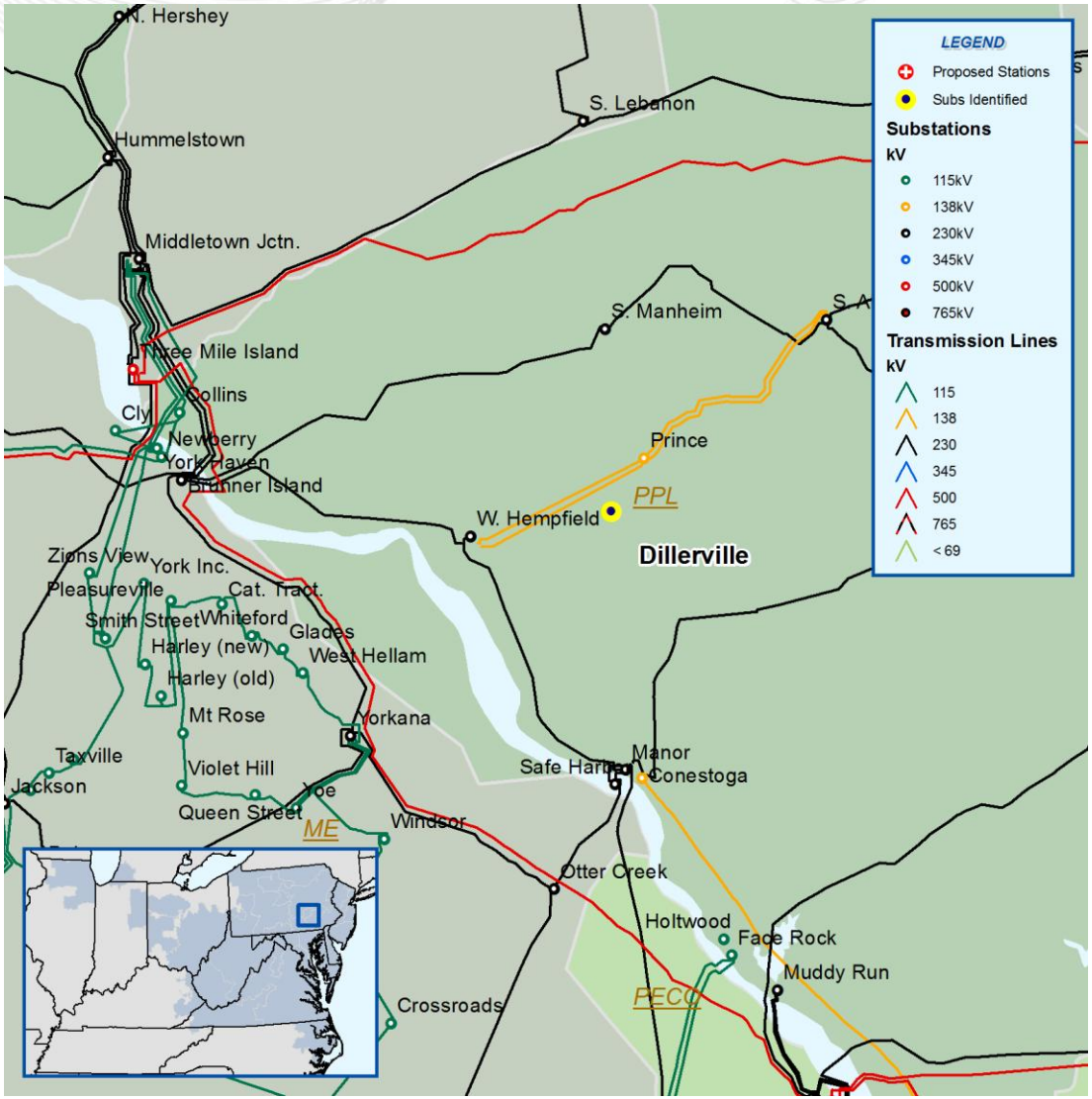
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of the double circuit Dillerville #1 & #2 69 kV Taps
- Proposed Solution:

  Install new 138kV Taps to Flory Mill 138/69kV Substation (B1212)
- Estimated Project Cost:

  $0.69 M
- Proposed IS Date:

  11/30/2013



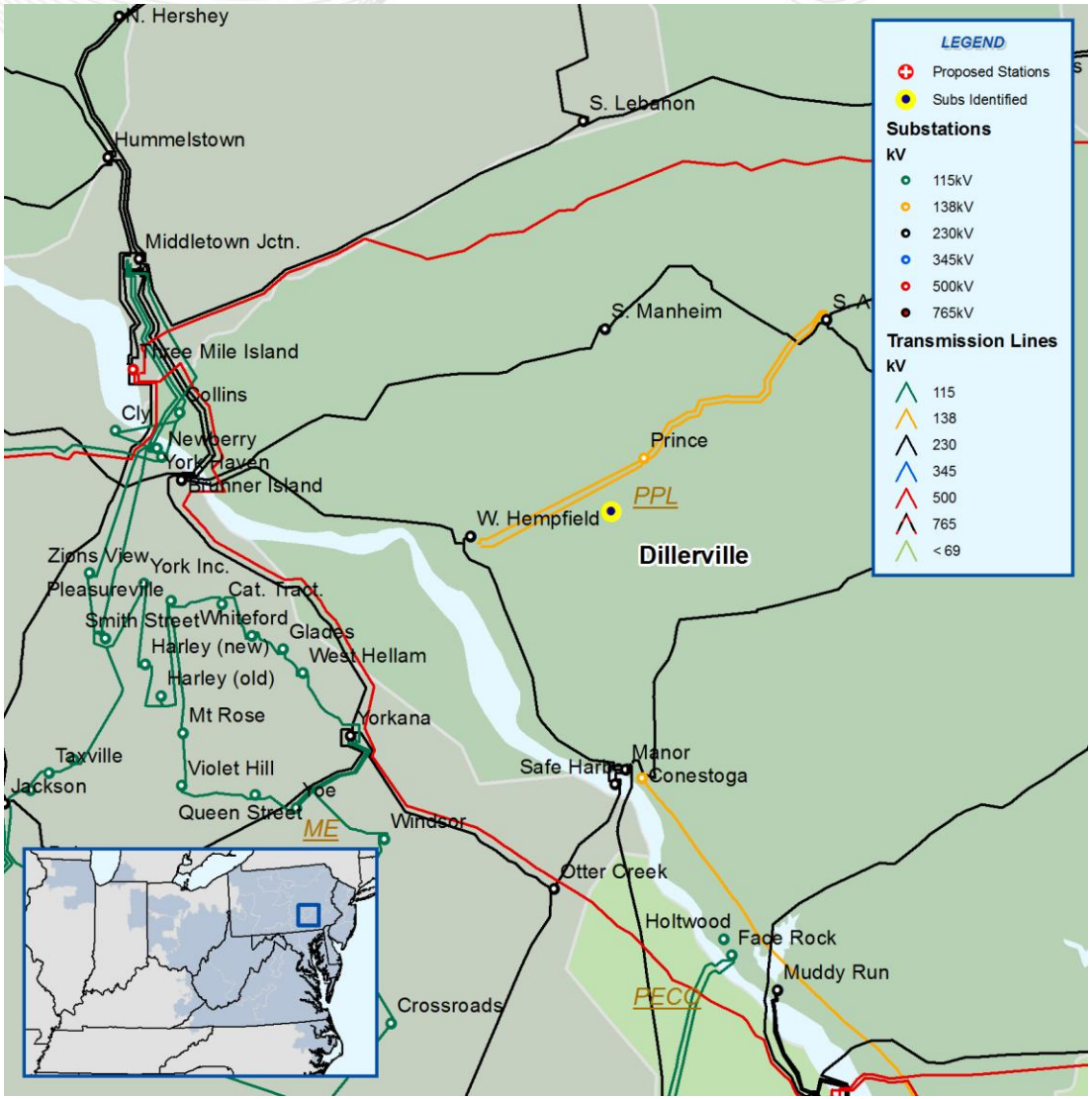
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of the double circuit Dillerville #1 & #2 69 kV Taps
- Proposed Solution:

  Convert East Petersburg Taps from 69kV to 138kV Operation, install two 10.8 MVAR capacitor banks (B1213)
- Estimated Project Cost:

  $TBD
- Proposed IS Date:

  11/30/2013



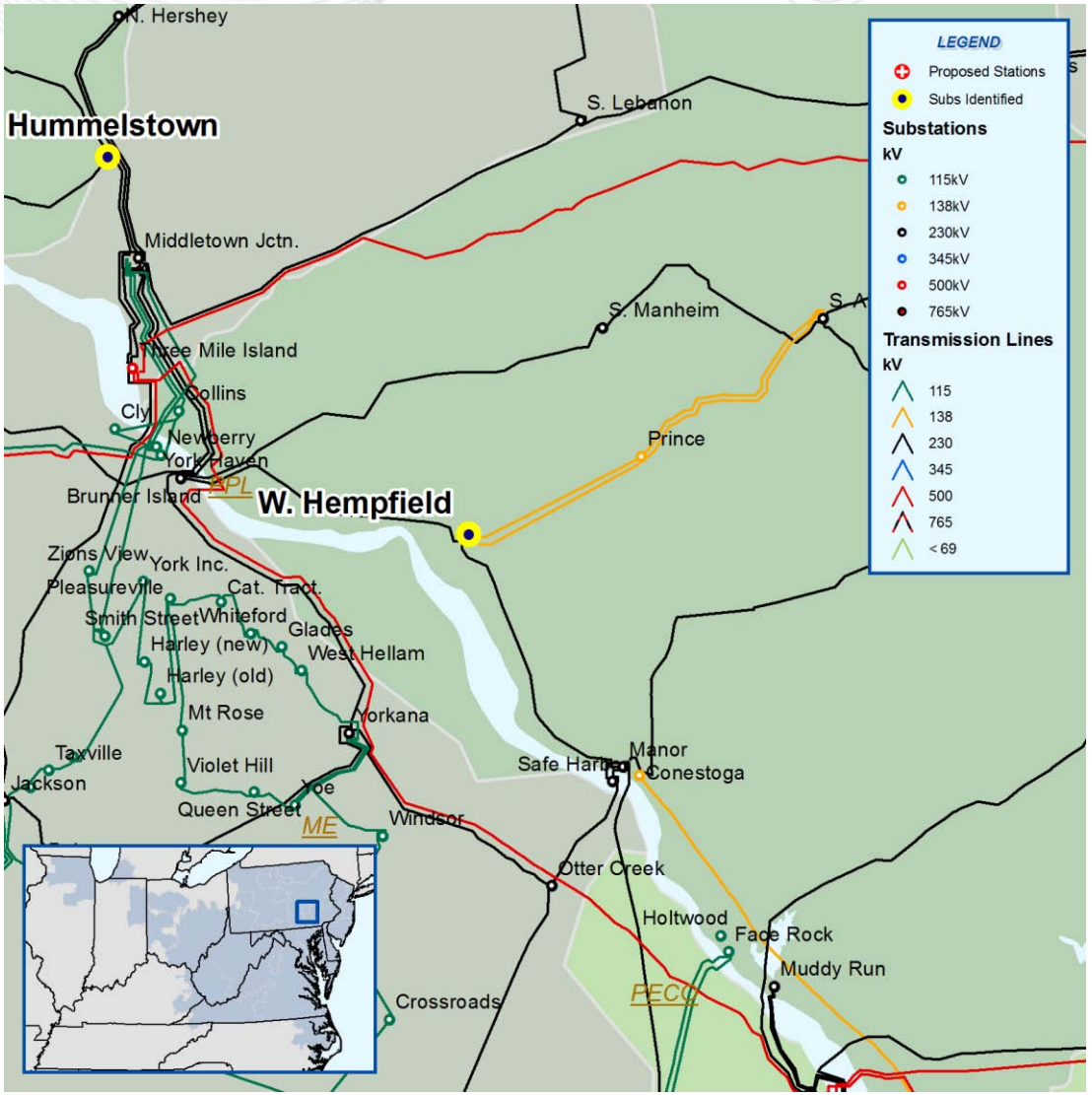
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Exceeds maximum allowable load drop guidelines for the loss of the double circuit West Hempfield – Hummelstown and West Hempfield – Armstrong Marietta 69kV Lines
- Proposed Solution:

  Terminate South Manheim - Donegal #2 at South Manheim, reduce South Manheim 69kV capacitor bank, resectionalize the 69kV network in the area (B1214)
- Estimated Project Cost:

  $0.08 M
- Proposed IS Date:

  11/30/2013



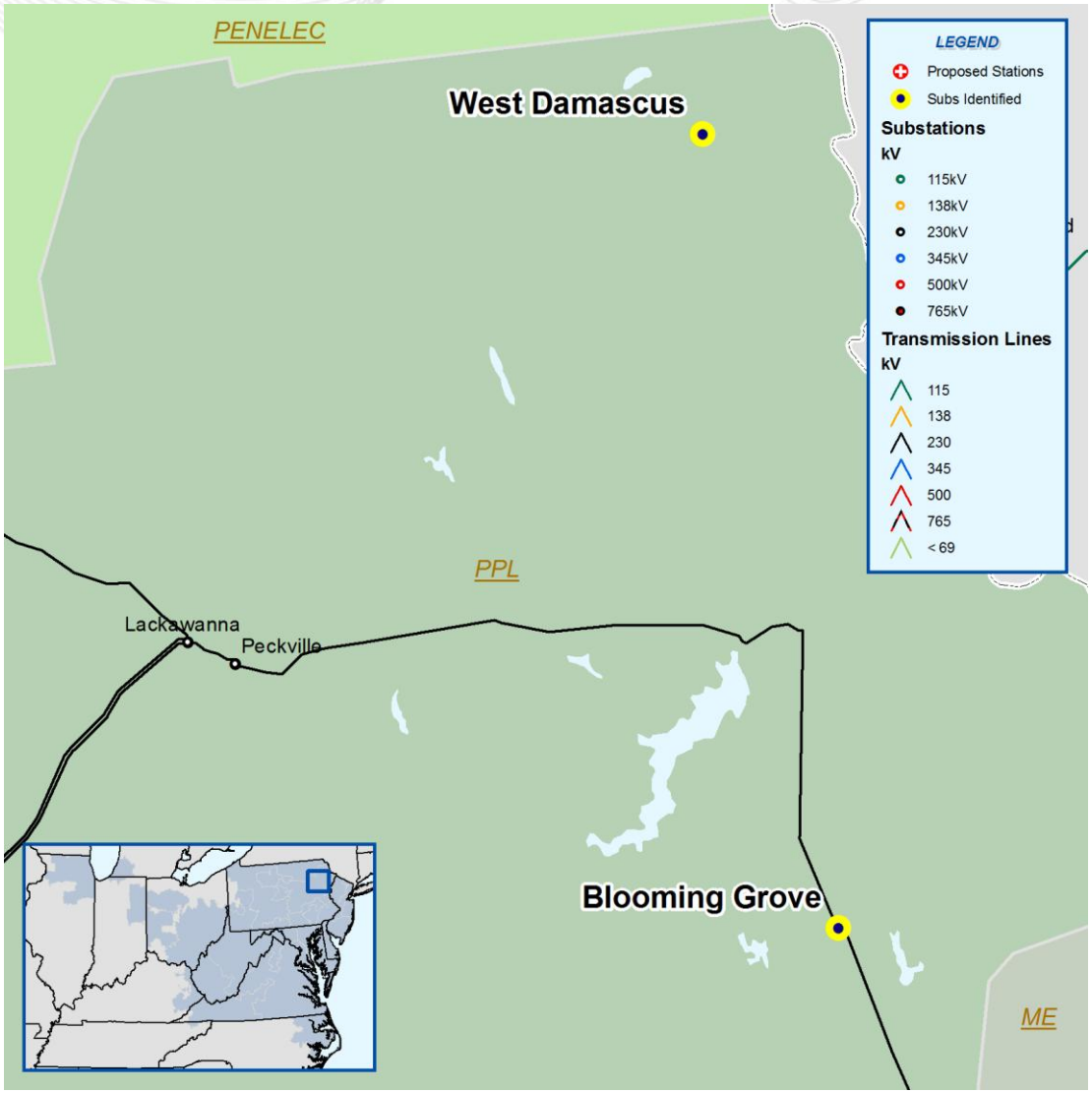
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Blooming Grove - West Damascus 69 kV line exceeds loading guidelines for the loss of Blooming Grove – West Damascus 69 kV line, and overloads Peckville - Varden 69 kV line when load is transferred away
- Proposed Solution:

  Reconductor and rebuild 16 miles of Peckville - Varden 69 kV and 4 miles of Blooming Grove - Honesdale 69 kV (B1215)
- Estimated Project Cost:

  $22.4 M
- Proposed IS Date:

  11/30/2014



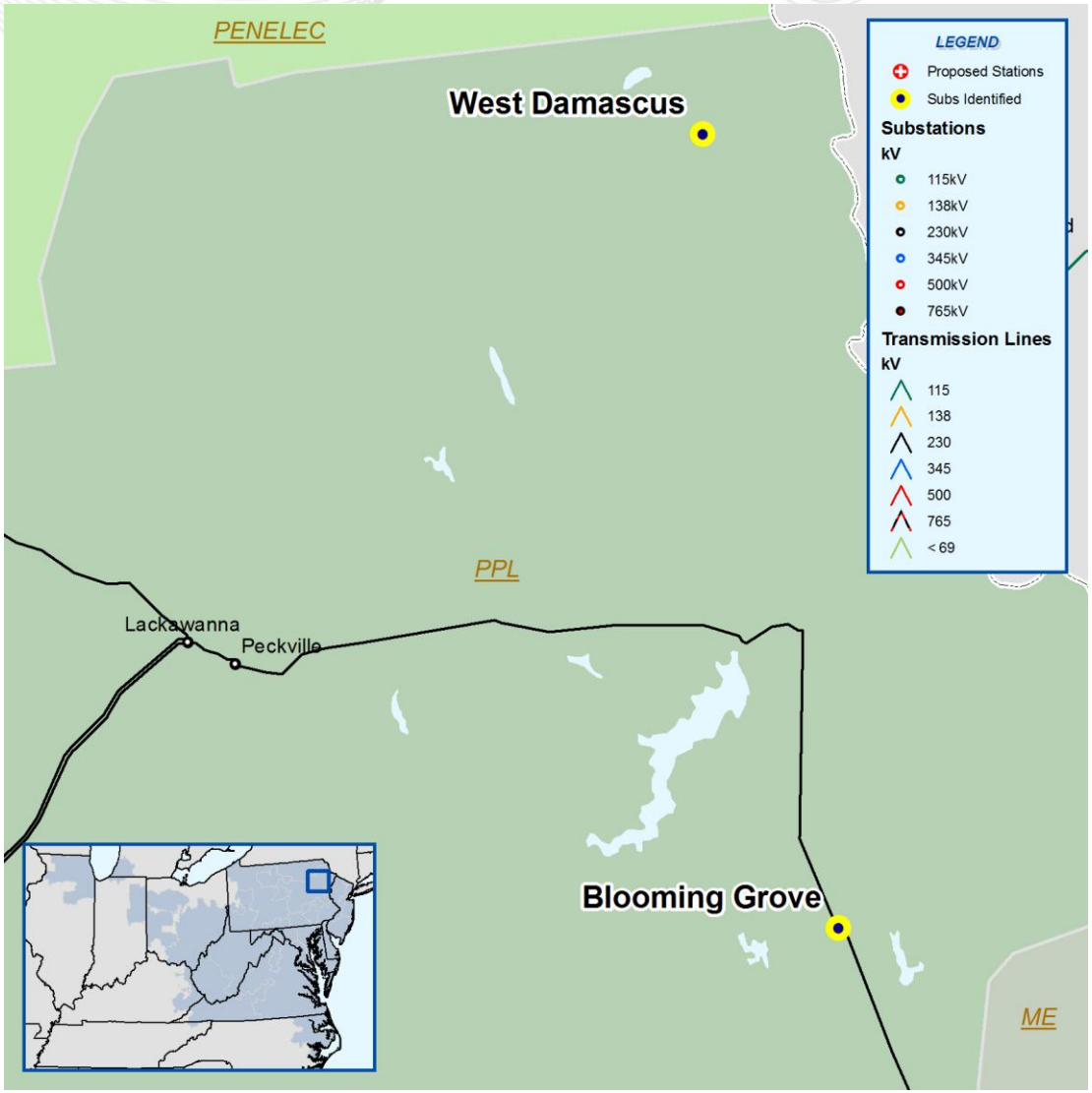
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Blooming Grove - West Damascus 69 kV line exceeds loading guideline for the loss of Blooming Grove – West Damascus 69 kV Line, and overloads Peckville-Varden 69 kV line when load is transferred away
- Proposed Solution:

  Build approximately 2.5 miles of new 69 kV transmission to provide a “double tap – single feed” connection to Kimbles 69/12 kV substation (B1216)
- Estimated Project Cost:

  $2.69 M
- Proposed IS Date:

  11/30/2013



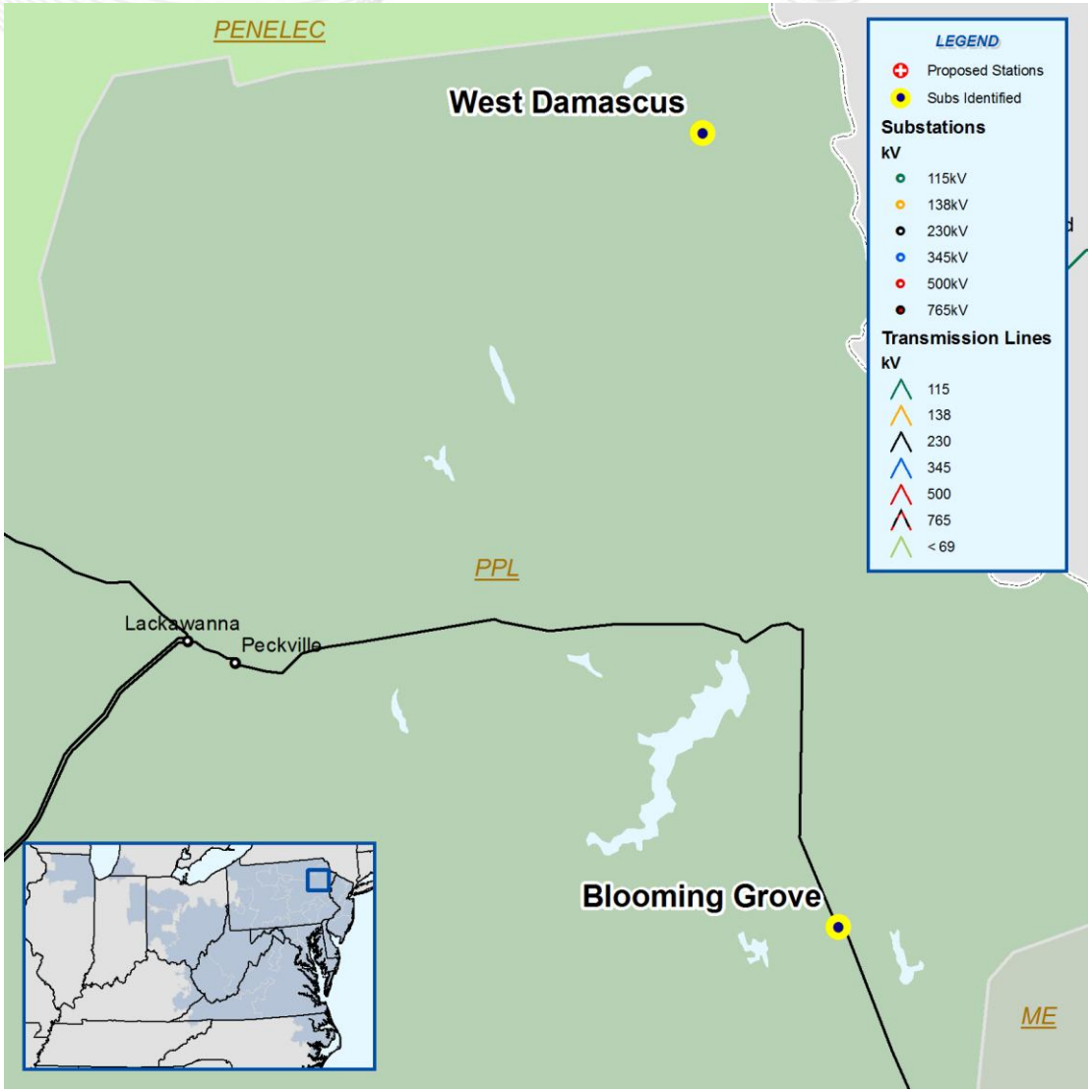
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
- Blooming Grove - West Damascus 69 kV line exceeds loading guideline for the loss of Blooming Grove – West Damascus 69 kV Line, and overloads Peckville-Varden 69 kV line when load is transferred away
- Proposed Solution:

  Provide a “double tap – single feed” connection to Tafton 69/12 kV substation (B1217)
- Estimated Project Cost:

  $2.0 M
- Proposed IS Date:

  11/30/2012



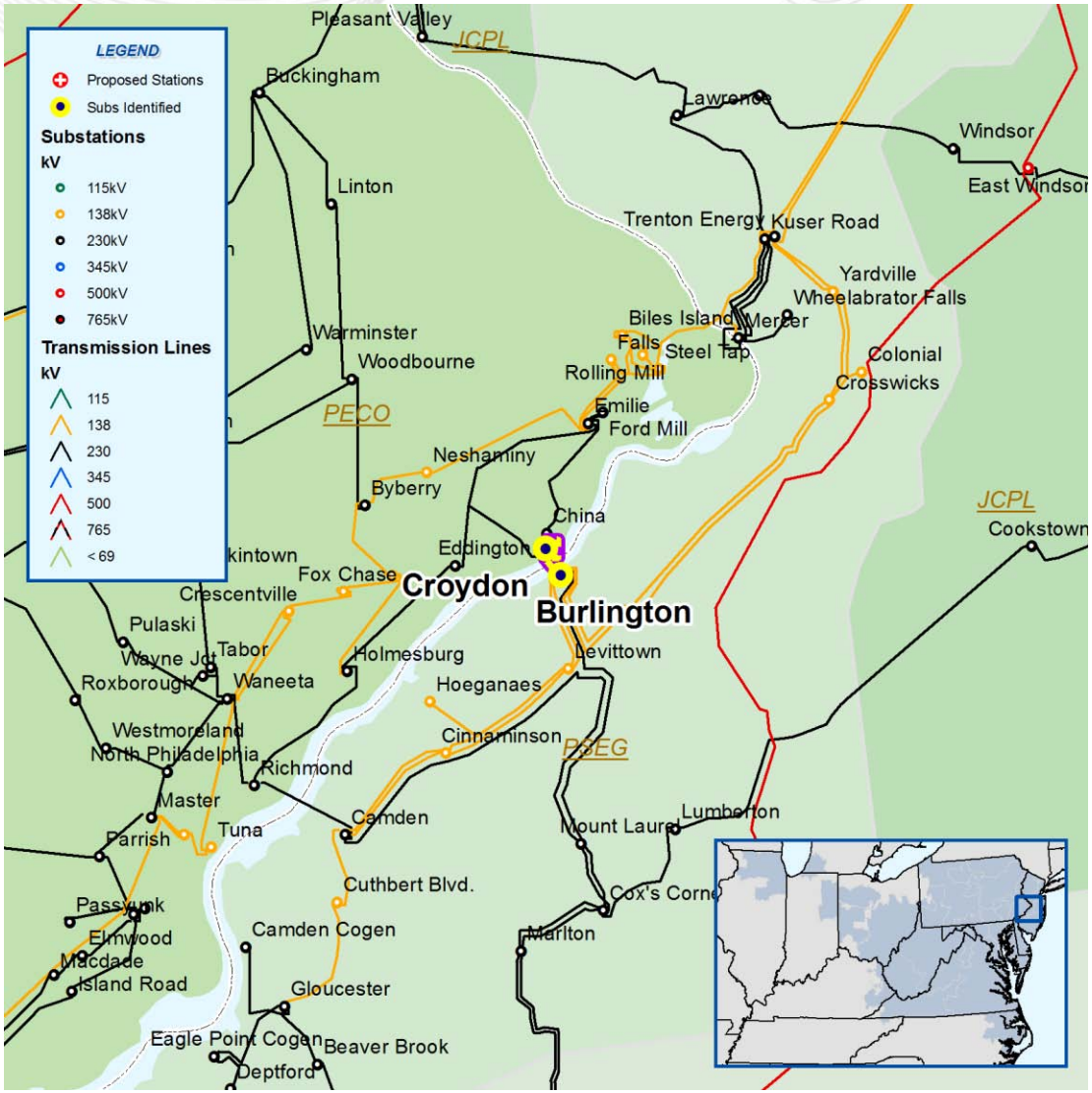
PSEG Transmission Zone

- Generation Deliverability
- Burlington – Croydon 230 kV is overloaded for several contingencies
- Proposed Solution:

  Reconductor the PSEG portion of the Burlington – Croydon circuit with 1590 ACSS (B1197.1)
- Estimated Project Cost:

  $3.0 M
- Expected IS Date:

  6/1/2015



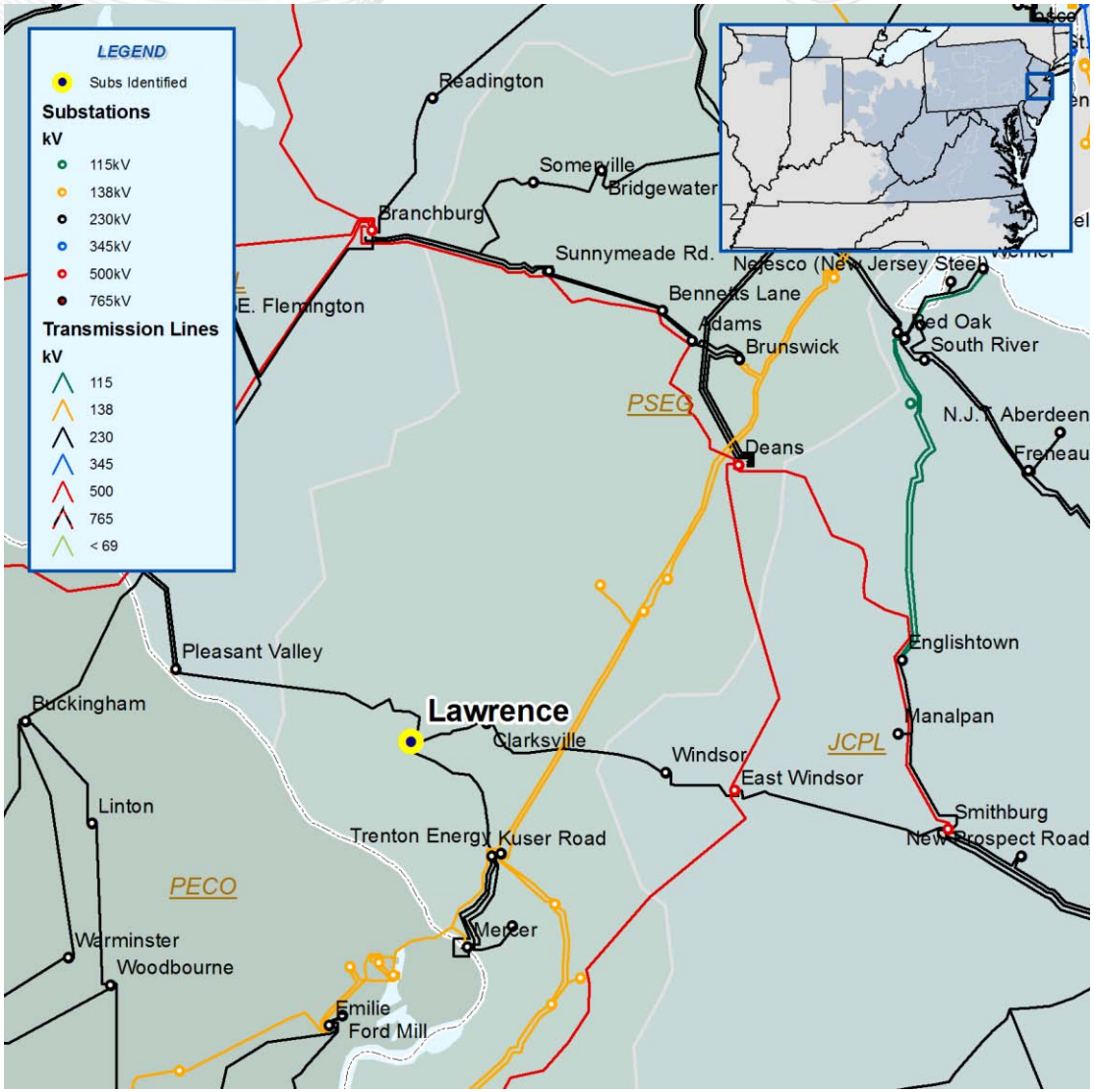
PSEG Transmission Zone

- Generation Deliverability:
- Lawrence - Penns Neck 69 kV is overloaded for multiple line fault with stuck breaker contingencies.
- Proposed Solution:

  Re-configure the Lawrence 230 kV substation (B1228).
- Estimated Project Cost:

  $9.0 M
- Expected IS Date:

  6/1/2014



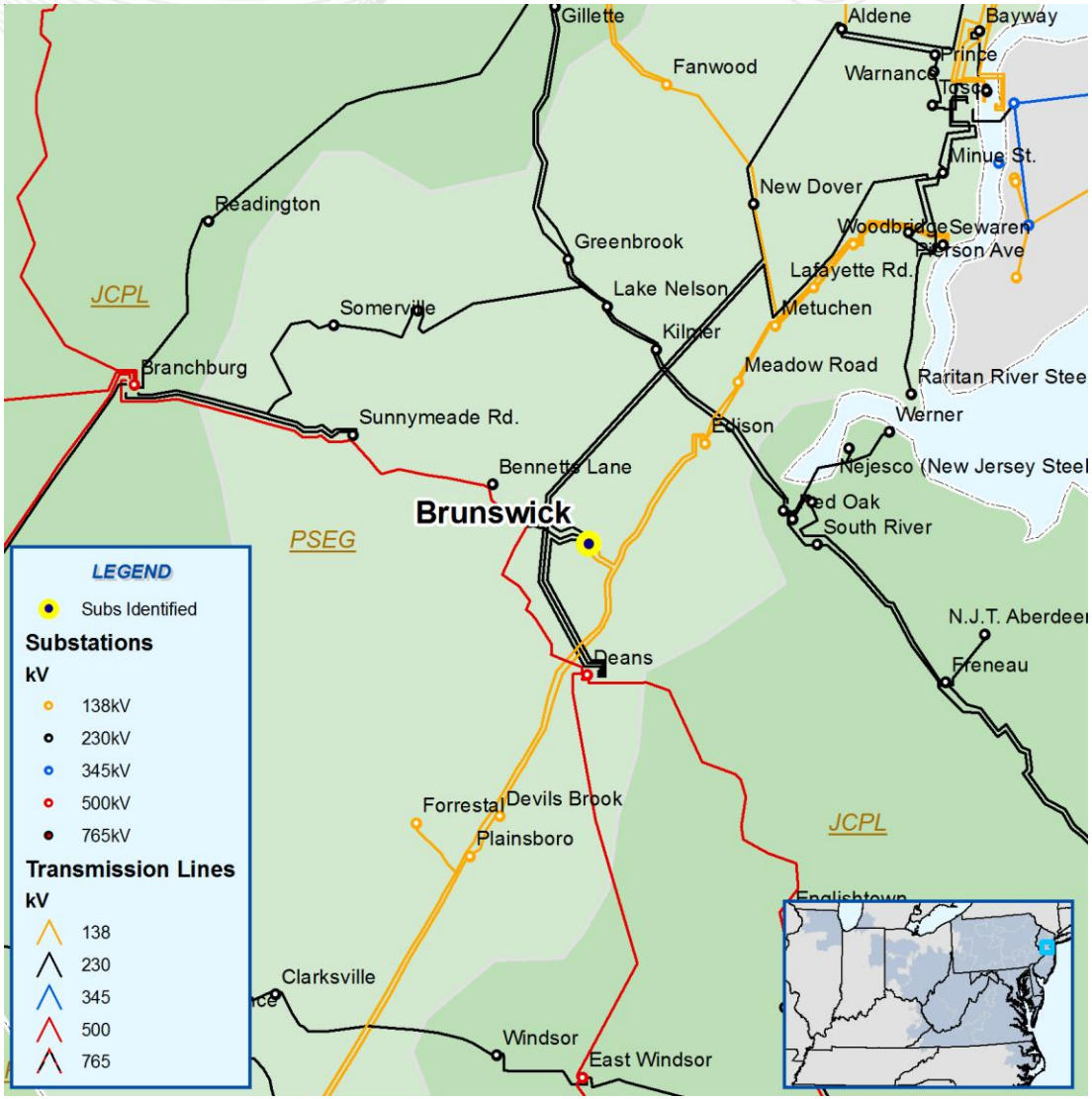
PSEG Transmission Zone

- Baseline Voltage Violation:
- Voltage violation in the Brunswick 69 kV vicinity for several category C contingencies.
- Proposed Solution:

  Build a 69 kV substation (Ridge Road) and build new 69 kV circuits from Montgomery – Ridge Road – Penns Neck/Dow Jones (B1255).
- Estimated Project Cost:

  $22.5 M
- Expected IS Date:

  6/1/2015



Baseline Reliability Summary

- Baseline upgrade solutions in this presentation (with the exception of ATSI) will be Proposed to the PJM Board in October 2010 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

- ATSI 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

Email RTEP@pjm.com with any comments

Next Steps

Review Issues Tracking