

Transmission Expansion Advisory Committee

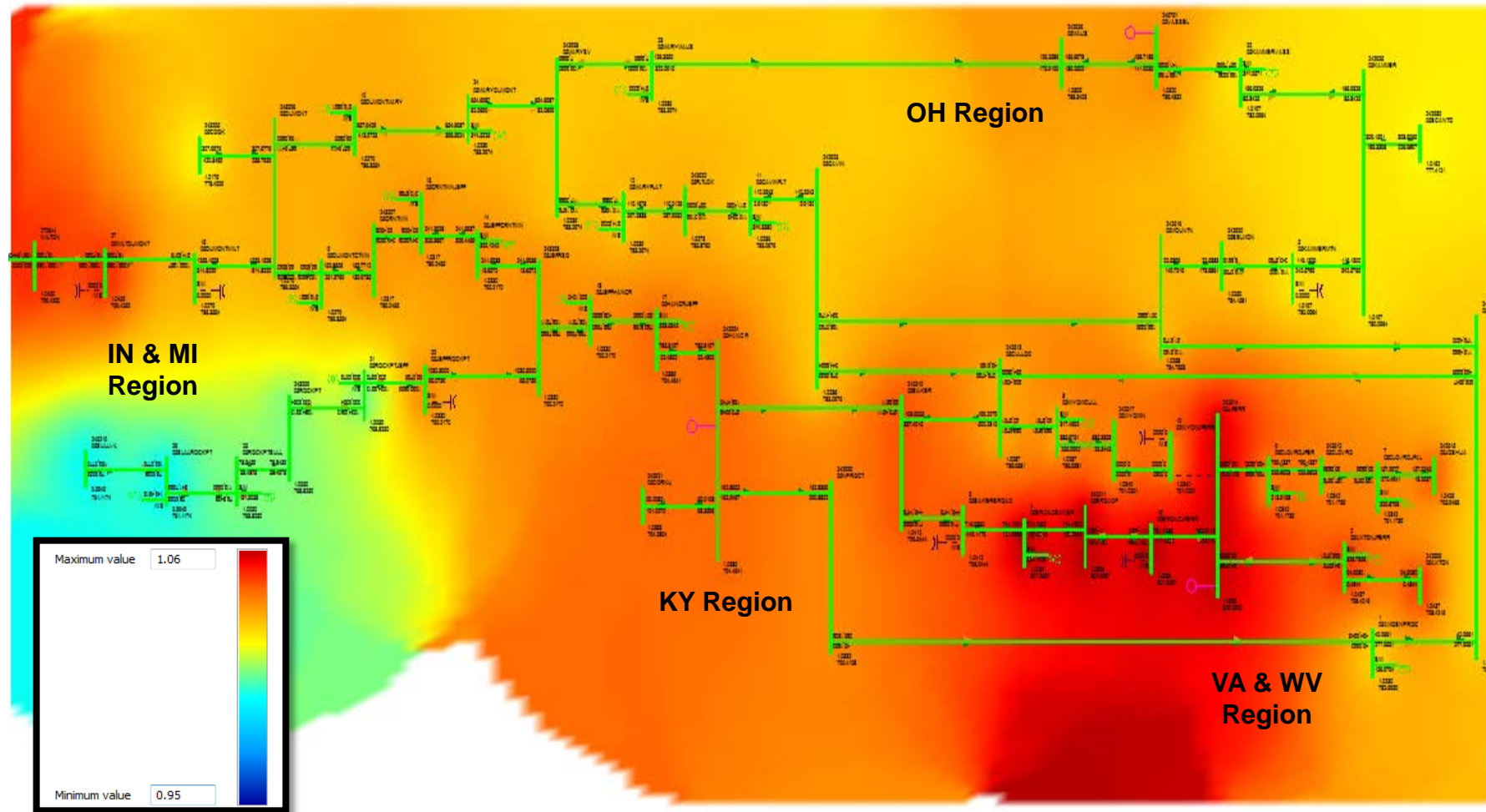
Reliability Analysis Update

August 13, 2015

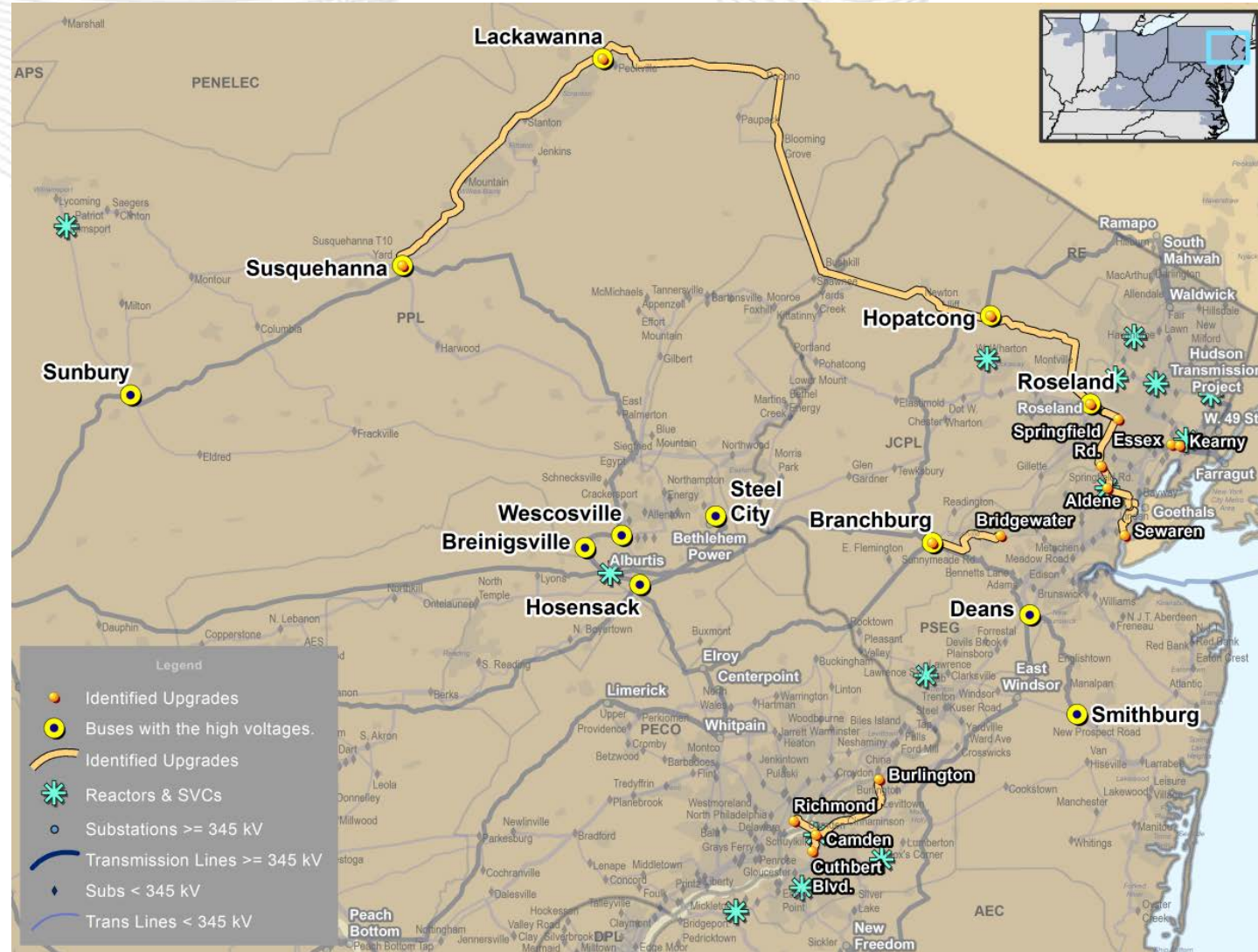
High Voltage in PJM Operations

- In PJM Operations, the AEP and northeastern Mid-Atlantic regions have experienced a large increase in high voltage warnings over the past year
- Drivers are various and include changes in dispatch, reactive support deficiencies and increased line charging from new transmission facilities
- Conditions generally occur during light load periods
- Approved RTEP reactive devices planned to come online over the next couple of years will help lower the voltages to some extent, but expected deactivations and line charging from planned transmission facilities will further aggravate the problem

- Large increase in number high voltage alarms over the past year
- Operating conditions have required 765 kV circuits to be taken out of service to manage high voltages
- Over 5,000 MW of deactivations in 2015
 - Large reduction in dynamic reactive support
- Large increase in amount of switching of existing reactors resulting in multiple failed reactors and reduced life expectancy.
- Preliminary simulations show a potential solution that will involve new SVCs, replenishing the existing reactors and inclusion of circuit breakers for enhanced switching capability



- Operations observes high voltages mainly on the 500 kV system (Map shows recent high voltage locations)
- Largest driver is increased line charging due to new RTEP upgrades located mostly in the PSEG area coupled with loss of dynamic MVAR due to generation deactivations
- On the order of 1,500 MVARs of approved reactors and SVCs planned to go in service in 2015 and 2016 in this region – greatly reduces (improves) the voltage profile
- Future planned transmission in the region may reduce the effectiveness of these reactive devices
- Ongoing studies to determine whether additional reactive devices are required



- Continue to refine cases for simulation
- For violations in the immediate need timeframe, develop upgrade alternatives
- Review with the PJM TEAC

Winter Peak Study Update

- 2020 Winter Reliability Criteria Development
 - Generator Deliverability, Common Mode Outage test and Basecase N-1 Analysis thermal results update
 - Basecase N-1 Analysis voltage results
 - Gas/Electric system interface (Gas Contingency) results
 - Load Deliverability



Winter Generator Deliverability & Basecase Analysis Thermal Results Update

Potential overloaded branches in each zone not including the issues caused by deactivation generation and FSA units

	Potential Thermal Overloads							Total by TO
	138/69KV	138KV	161/138KV	161KV	230KV	345KV	765KV	
APS		1*						1
ATSI		1						1
AEP		16	1	1		1	1	20
ComEd		4						4
PSEG		2				1		3
DPL	1							1
DOM					1			1
Total	1	24	1	1	1	2	1	31

* The violation shows in the 2020 summer analysis and will be fixed by proposals in 2015 Window I

Potential voltage violations in each zone

	Voltage Mag High			Voltage Mag Low		Voltage Drop				Total by TO
	115KV	138KV	345KV	115kV	138KV	115KV	115KV	138KV	230KV	
AEP		3			14			19		36
DPL		2								2
EKPC								1		1
METED	6									6
PN				1*		4	1*			6
PPL									2	2
PSEG			2							2
Total	6	5	2	1*	14	4	1*	20	2	55

* The violation is present in the 2020 summer analysis and is anticipated to be fixed by proposals in 2015 RTEP Proposal Window #1

- **Pipeline outages or compressor failure gas contingencies** (26 contingencies)
 - A complete set of PJM gas pipeline contingencies that results in 1000 MW or more of generation loss
 - Assume all gas generation downstream of the gas contingency on the same gas infrastructure is lost
 - Assume that all gas generation is lost, regardless of dual fuel status
- **Temperature threshold gas contingencies** (4 contingencies)
 - At a pre-determined temperature threshold, assume that non-firm customers (i.e. non-heating demand and 100% of natural gas generation customers in that zone) will be interrupted

Simulated 30 gas pipeline and compressor failure contingencies:

- No Thermal Violation identified
- Voltage Magnitude Test
 - All contingencies converged
 - Low voltage at two 500KV Dominion buses for a natural gas pipeline contingency outage in EMAAC with a consequential loss of more than 11,000MW generation
 - High voltage violations at two 345kV buses for the weather related pipe line outage in PSEG & JCPL to lose more than 7,000MW generation
- Voltage Drop Test
 - Two contingencies are not converged. Both are pipeline outages in EMAAC with one for losing more than 11,000MW generation and the other for losing more than 10,000MW generation
 - Another two contingencies causing voltage drop violations at multiple 500KV and 230KV buses in EMMAC. One contingency is weather related and loses more than 7,000MW generation and the other one is pipeline outage related and loses more than 8,000 MW generation.

- Use 2020 RTEP winter power flow case
- Examine LDAs that have a significant share of their annual loss of load risk in the winter
- Examine LDAs that could potentially be impacted by gas pipeline contingencies

LDA	LOLE Risk in Winter	Gas Contingency Affected Area?
AE	0%	Yes
AEP	45%	Yes
APS	49%	Yes
ATSI	0%	Yes
BGE	0%	Yes
CL	0%	Yes
COMED	0%	Yes
DAY	7%	Yes
DQE	29%	No
VEPO	1%	Yes
DPL	0%	Yes
DPLS	0%	Yes
DUKE	0%	Yes
EKPC	94%	No
JCPL	0%	Yes
METED	12%	Yes
PECO	0%	Yes
PEPCO	0%	Yes
PLGRP	53%	Yes
PN	41%	No
PS	0%	Yes
PSN	0%	Yes
SPJMMA	0%	Yes
WPJMMA	46%	Yes
EPJMMA	0%	Yes
PJMMA	0%	Yes
PJMWEST	0%	Yes

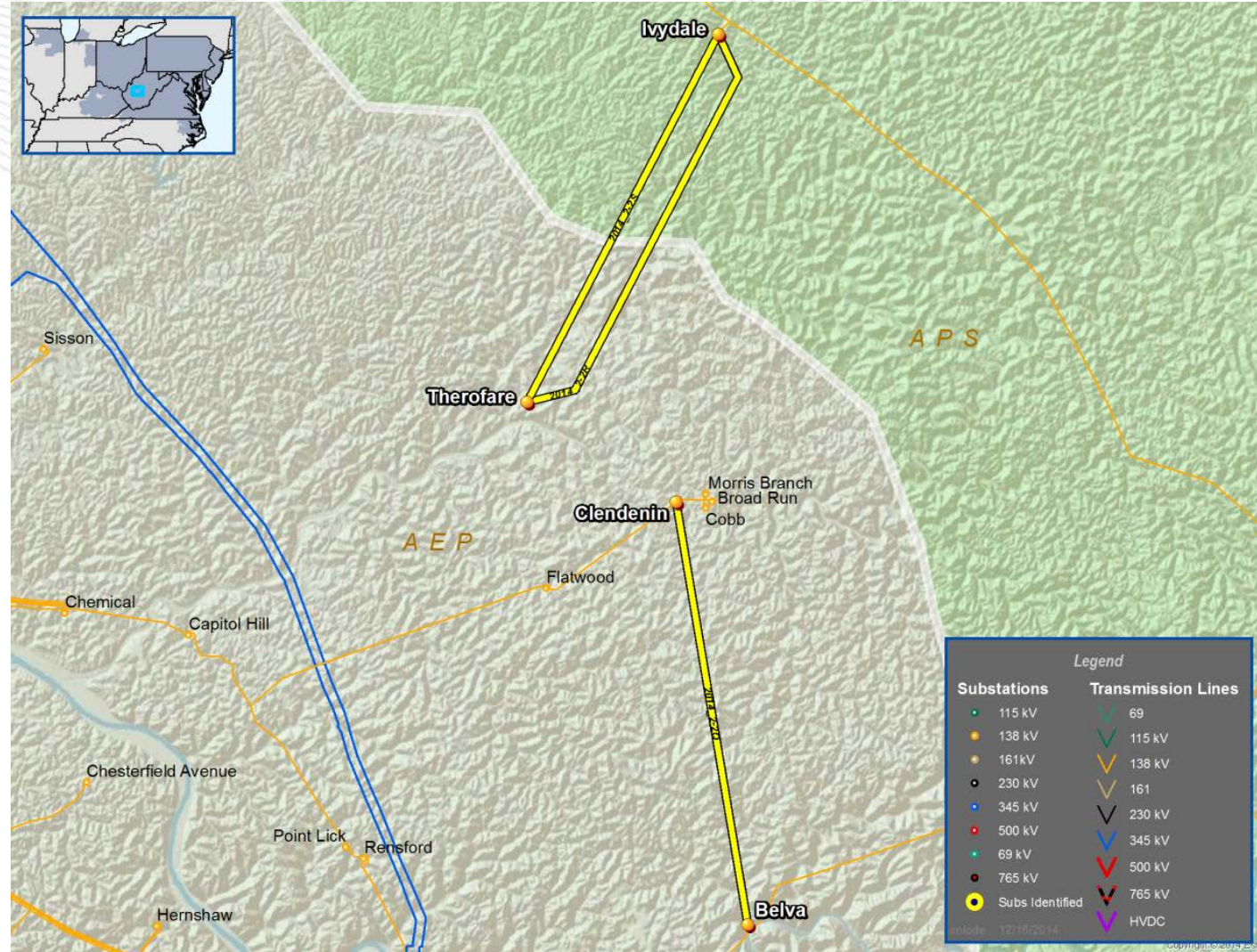
- Finalize Load Deliverability CETO calculations and LDA study cases
- Initiate and review N-1-1 analysis
- Planning Committee & Markets and Reliability Committee
 - Review and endorse Manual 14B language to support the criterion
 - See the Planning Committee materials for the Manual 14B language and overall schedule

Reliability Analysis Update

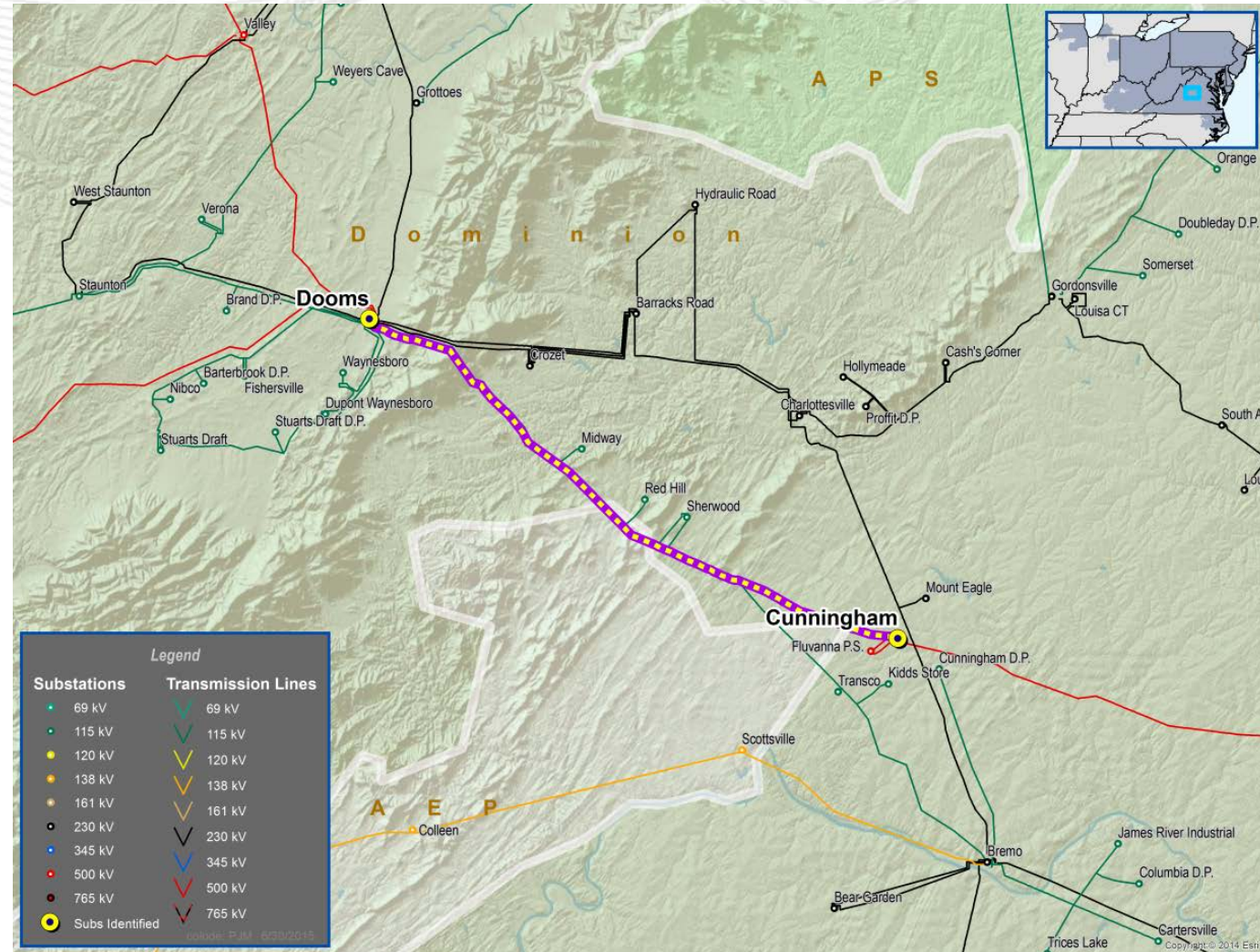
Cost Change & Breakdown of b2609.1, b2609.3, b2609.4, and b2609.5

Updated Cost Breakdown:

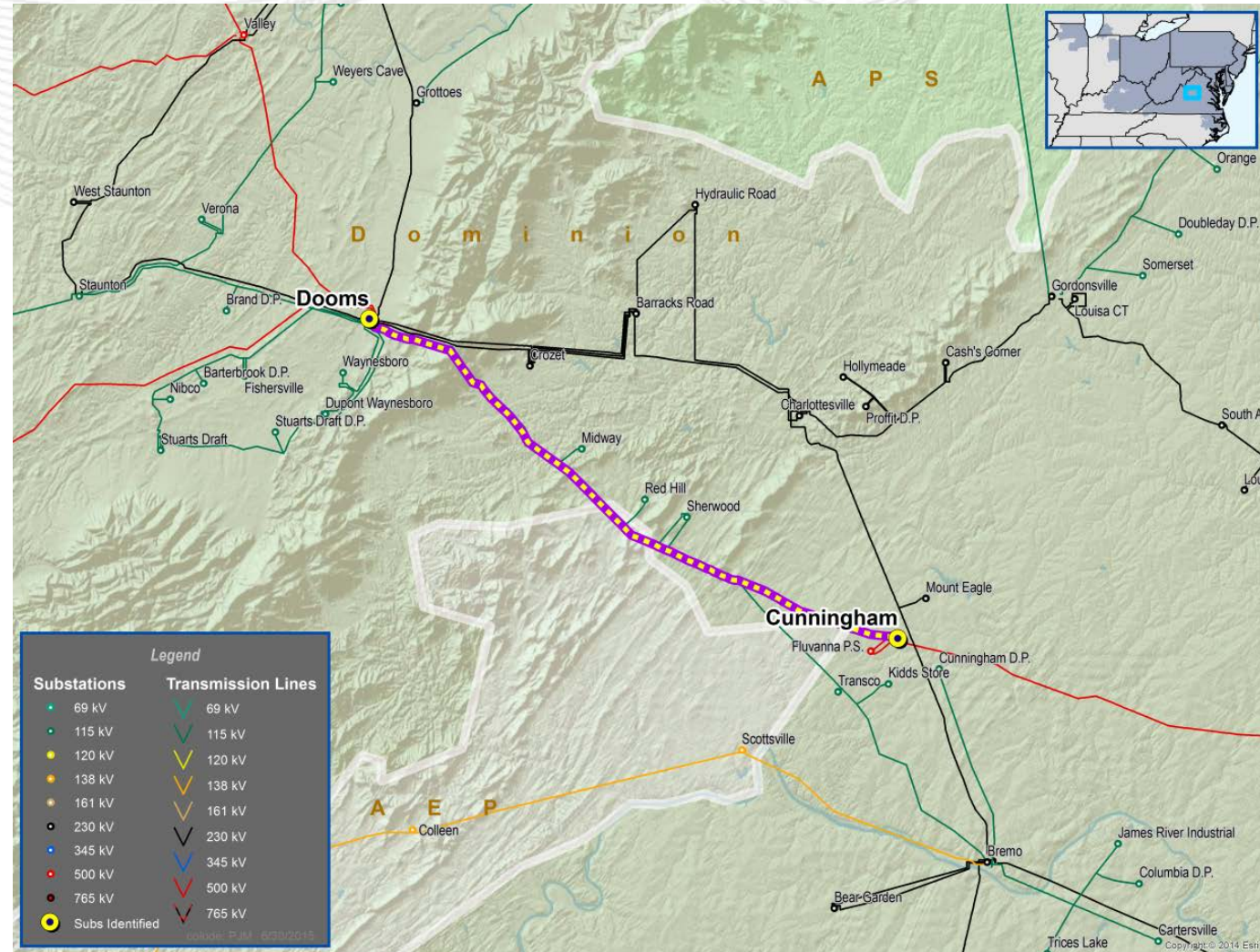
- b2609.1: Install two 138 kV MOAB switches at Thorofare Creek substation
 - Transmission Owner: AEP
 - Updated Cost: \$1.0 M
- b2609.3: Terminate the Flatwood, Kanawha and Capital Hill lines into the new Rutledge substation
 - Transmission Owner: AEP
 - Updated Cost: \$2.1 M
- b2609.4: Establish new 138 kV tap substation on Powell Mountain - Goff Run, construct 15 miles of new 138 kV line from Thorofare Creek to the new 138 kV tap substation, establish Rutledge 138 kV substation
 - Transmission Owner: Transource
 - Updated Cost: \$59.5 M
- b2609.5: Terminate the Powell Mountain and Goff Run lines into new substation and perform any associated relay upgrades or modifications required at Powell Mountain and Goff run to accommodate new substation
 - Transmission Owner: APS
 - Updated Cost: TBD
- Required IS Date: 6/1/2019



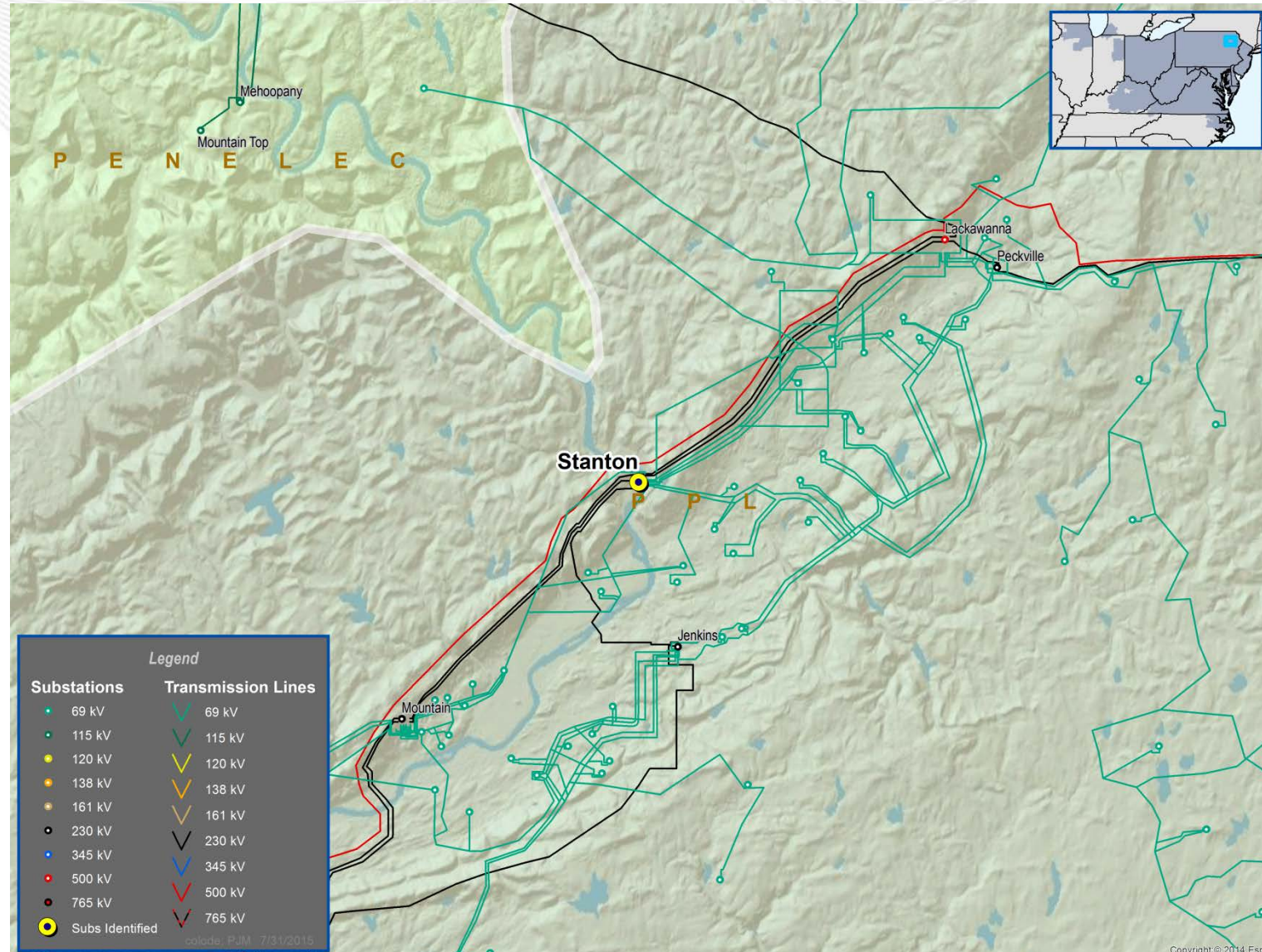
- Dominion End of Life Criteria Violation on the Cunningham to Dooms 500 kV Line
 - Third party evaluation:
 - Confirmed the Cunningham to Dooms 500 kV is nearing or has reached its End of Life
 - Performed a Risk Assessment
 - Reliability Assessments without the line result in Criteria violations:
 - PJM validated the following violations
 - NERC B “N-1” (New NERC TPL-001-4 P3) Violations:
 - Initial Loss of Front Royal generation followed by loss of Mt Storm- Valley 500kV line
 - Overload of Edinburg - Strasburg 138 Kv
- Continued on the next slide



- Continued from previous slide
- NERC C3 “N-1-1” (New NERC TPL-001-4 P6)
 - Loss of Lexington – Cloverdale 500kV and Bath County – Valley 500kV lines:
 - Low voltage and voltage drop in the 500kV area of Bath County, Dooms, Lexington, and Valley
 - Voltage drop in the 230kV area of Lexington Low Moor, and Clifton
- Recommended Solution: Rebuild the Cunningham – Dooms 500 kV line as a PJM baseline upgrade
- Estimated Cost: \$67.95 M
- Projected In Service Date: June 2020



- B2406.8 - Rebuild the Stanton 230 kV yard
- The B2406.8 upgrade is no longer required due to other projects in the area.
- Cancel the B2406.8 (Rebuild Stanton 230 kV yard)





2015 RTEP Baseline Analysis Update

- RTEP Proposal Window #1
 - Closed, scope included baseline N-1 thermal and voltage, generator deliverability and common mode outage, load deliverability thermal and voltage, N-1-1 thermal and voltage
 - Recommend solutions in September & October 2015
- RTEP Proposal Window #2
 - Scope includes Transmission Owner Criteria and Light Load analysis violations
 - Recommend solutions later in 2015
- Anticipated PJM Board Approval of 2015 RTEP

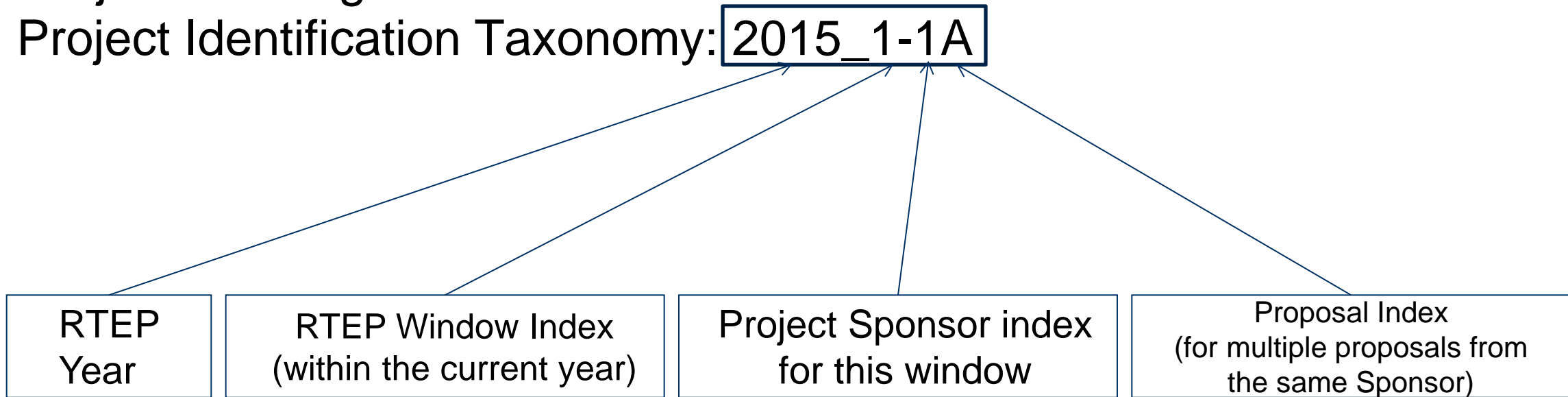


2015 RTEP Proposal Window #1

- Window opened on 6/18/2015
- Closed on 7/20/2015*
 - *All final cost estimates and greenfield proposals due 8/4/2015

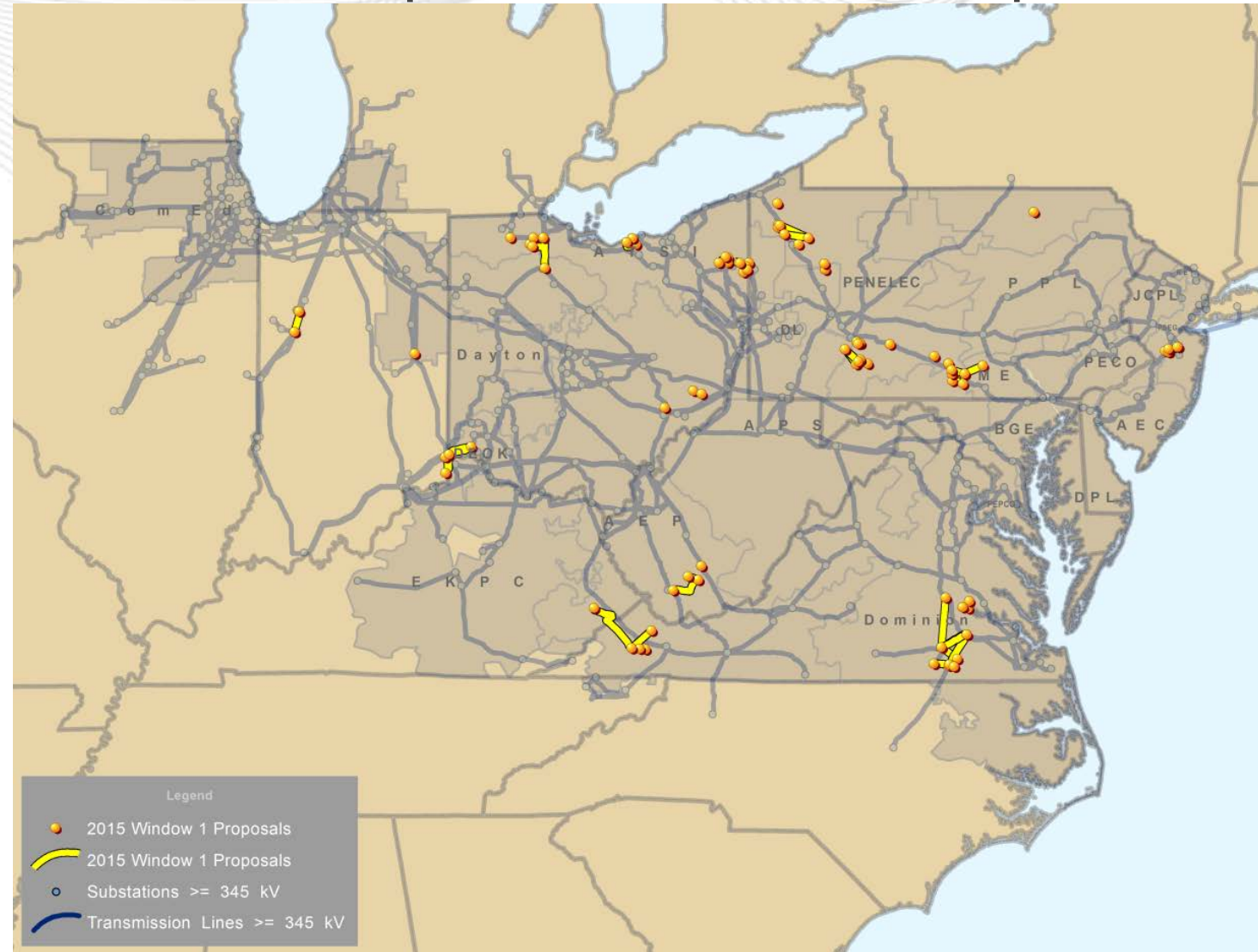
- Project Naming Convention

- Project Identification Taxonomy: **2015_1-1A**



- Transmission Owner Upgrade is a Defined Term
- *“Transmission Owner Upgrade” shall mean an upgrade to a Transmission Owner’s own transmission facilities, which is an improvement to, addition to, or replacement of a part of, an existing facility and is not an entirely new transmission facility.*

- 292 flow gates addressed
- 9 proposing entities
- 91 proposals
 - 26 Transmission Owner Upgrades
 - Cost range of \$0.013M to \$73M
 - 64 Greenfield Projects
 - Cost range of \$6M to \$167.1M
 - 1 Modeling Correction
- 6 target zones



Greenfield Projects

- Proposing Entity: AEP
 - P2015_1-2D: Construct 22 miles of new 1033 ACSR line between Clinch River and Keen Mtn 138kV stations (\$38.5M)
- Proposing Entity: AEP
 - P2015_1-2E: Construct 43 miles of new 1033 ACSR line between Clinch River and Beaver Creek 138kV stations (\$95M)
- Proposing Entity: AEP
 - P2015_1-2G: Construct Dequine-Meadow Lake 345 kV ckt #3. Install a 3000 A (cont. current) 63 kA (intr. current) 345 kV circuit breaker at Dequine station to complete breaker and half string “A”. Swing Fowler Ridge (IPP), Meadow Lake #1, and Meadow Lake #2 to new positions. Terminate Meadow Lake #3 between breaker C1 and C. Install a 3000 A (cont. current) 63 kA (intr. current) 345 kV circuit breaker at Meadow Lake station to complete breaker and half string “D”. Swing Dequine #1 and #2 to new positions. Terminate Dequine #3 between breaker C and C1. Dequine-Meadow Lake ckt #1 and ckt #2 will continue to be on carrier communications whereas; ckt #3 will be on fiber communications. (\$25.6M)

Greenfield Projects

- Proposing Entity: AEP
 - P2015_1-2L: Construct Herlan station as breaker and a half configuration with 9-138kV CB's on 4 strings and with 2-28.8 MVAR capacitor banks. (\$25.82M)
- Proposing Entity: Transource
 - P2015_1-5A: Construct new greenfield 345kV Switch Station to be called Anson Station. The existing Tanners Creek-East Bend 345kV, East Bend-Terminal 345kV and Miami Fort-Terminal 345kV circuits will all be looped in and out of this station. The station will consist of six new 345kV breakers and will be configured in a ring bus. (\$15.3M)
- Proposing Entity: Transource
 - P2015_1-5G: Construct new greenfield 345kV line between Tanners Creek and Miami Fort substations effectively creating Tanners Creek-Miami Fort 345kV Circuit #2. Install two 345kV breakers at Tanners Creek to accommodate proposed line. Install one 345kV breaker at Miami Fort to accommodate new line. (\$19.3M)

Greenfield Projects

- Proposing Entity: PSEG
 - P2015_1-7A: New 345kV line from Dequine to Meadow Lake(\$34.2M)
- Proposing Entity: PSEG
 - P2015_1-7H: New 138kV line from Guyandotte to Tams Mountain(\$135.8M)
- Proposing Entity: PSEG
 - P2015_1-7I: Tap the existing Kanawha River – Matt Funk 345kV line to Bradley – Poleyard 138kV line at a new substation with a 345/138kV transformer (\$61.6M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8C: Build a new 138 kV line interconnecting the 138 kV Bolt substation to the 138 kV Tams Mountain substation (\$23M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8R: Build a 138 kV switching station ("Grassy Creek") interconnecting the Summerfield-Switzer 138 kV line, the Steamtown Skid-Natrium 138 kV line and the Tap to Somerton 138 kV line(\$7.4M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8Z: Build a 345/138 kV substation (Sand Branch) interconnecting the Kanawha River-Matt Funk 345 kV line, the Bradley-Dameron 138 kV line and the Bradley-Pole Yard 138 kV line(\$19.2M)

Transmission Owner Upgrades

- Proposing Entity: AEP
 - P2015_1-2A: Tams Mountain Area Upgrades (\$5.36M)
- Proposing Entity: AEP
 - P2015_1-2B: Lebanon, Elk Garden Switch Replacements (\$1.25M)
- Proposing Entity: AEP
 - P2015_1-2C: Clinch River Area Ratings Upgrades (\$2.5M)
- Proposing Entity: AEP
 - P2015_1-2F: Replace the Muskingum 138 kV bus #1 and bus #2 (\$0.144M)
- Proposing Entity: AEP
 - P2015_1-2H: Install a second 345/138kV, 675 MVA Transformer at Desoto. The new transformer will be connected to the 345kV bus via a new motorized switch while two breakers will be used to connect it to the 138kV. (\$10.6M)

Transmission Owner Upgrades

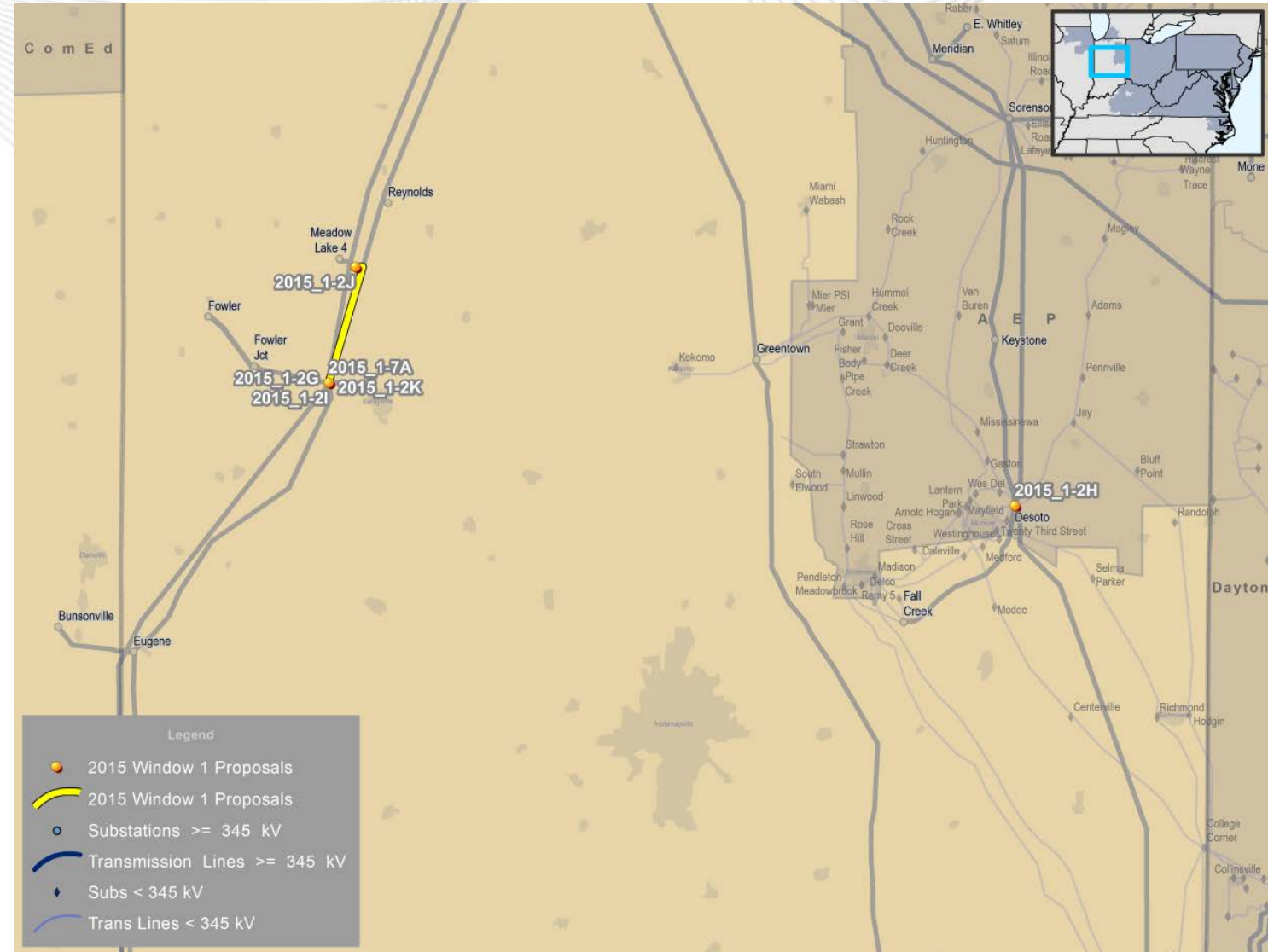
- Proposing Entity: AEP
 - P2015_1-2I: Rebuild Dequine-Meadow Lake 345 kV ckt 1 and ckt 2 using two (2) bundled 954 ACSR 54/7 Cardinal conductor. (\$27.5M)
- Proposing Entity: AEP
 - P2015_1-2J: Rebuild dequine-Meadow Lake 345 kV ckt 1 and ckt 2 using three (3) bundled 954 ACSR 54/7 Cardinal conductor. (\$26.6M)
- Proposing Entity: AEP
 - P2015_1-2K: Reconductor Dequine-Meadow Lake 345 kV ckt 1 utilizing dual 954 ACSR 54/7 Cardinal conductor. (\$5.1M)

Transmission Owner Upgrades

- Proposing Entity: AEP/DEOK
 - P2015_1-3A: This is a joint proposal between AEP and Duke Energy, Ohio & Kentucky. Perform a sag study to include LiDAR survey on AEP portion (0.36 miles) of the Tanners Creek to Miami Fort 345kV Circuit. A successful sag study will allow AEP's conductor to be operated at its Maximum Operating Temperature and thus increase the Summer Emergency rating from 1409 MVA to 1956 MVA on AEP's side of the tie line. If the sag study determines the tie line cannot be operated at its MOT without additional improvements, in the worst case scenario, AEP would need to re-conductor their portion of the line; which is expected to cost approximately \$400K. Replace the DEO&K portion (3.4 miles) of the Tanners Creek to Miami Fort 345kV circuit with two different types of conductor. Aluminum Conductor Composite Reinforced will be used for the Ohio River crossing with the balance of the circuit using Aluminum Conductor, Steel Supported. The rating for the Duke portion of the circuit will increase to 2151MVA. (\$5.95M)

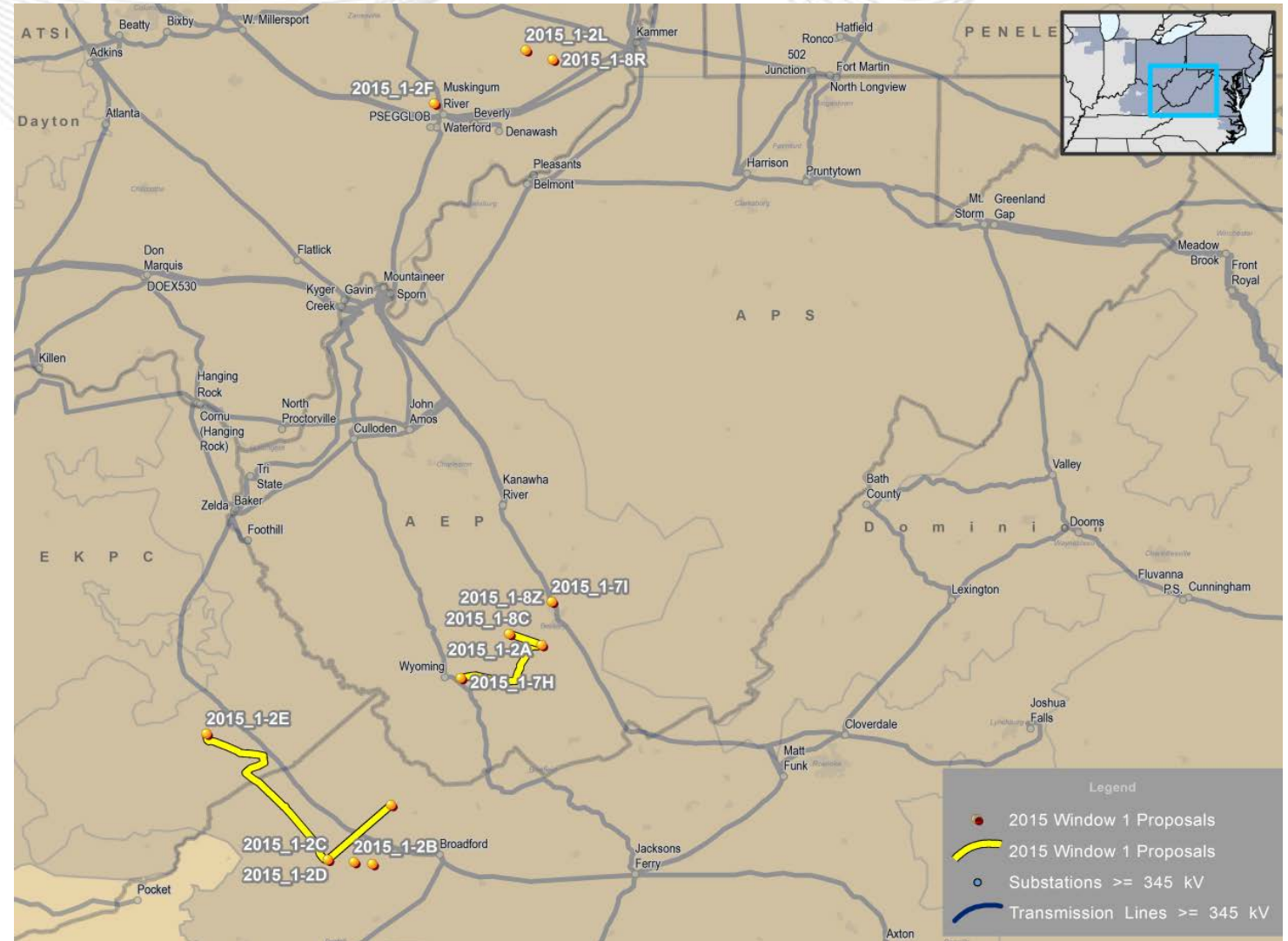
- Proposals:
 - 12 Greenfield Projects
 - 9 Transmission Owner Upgrades

- Next Steps
 - Continue Analysis of proposals



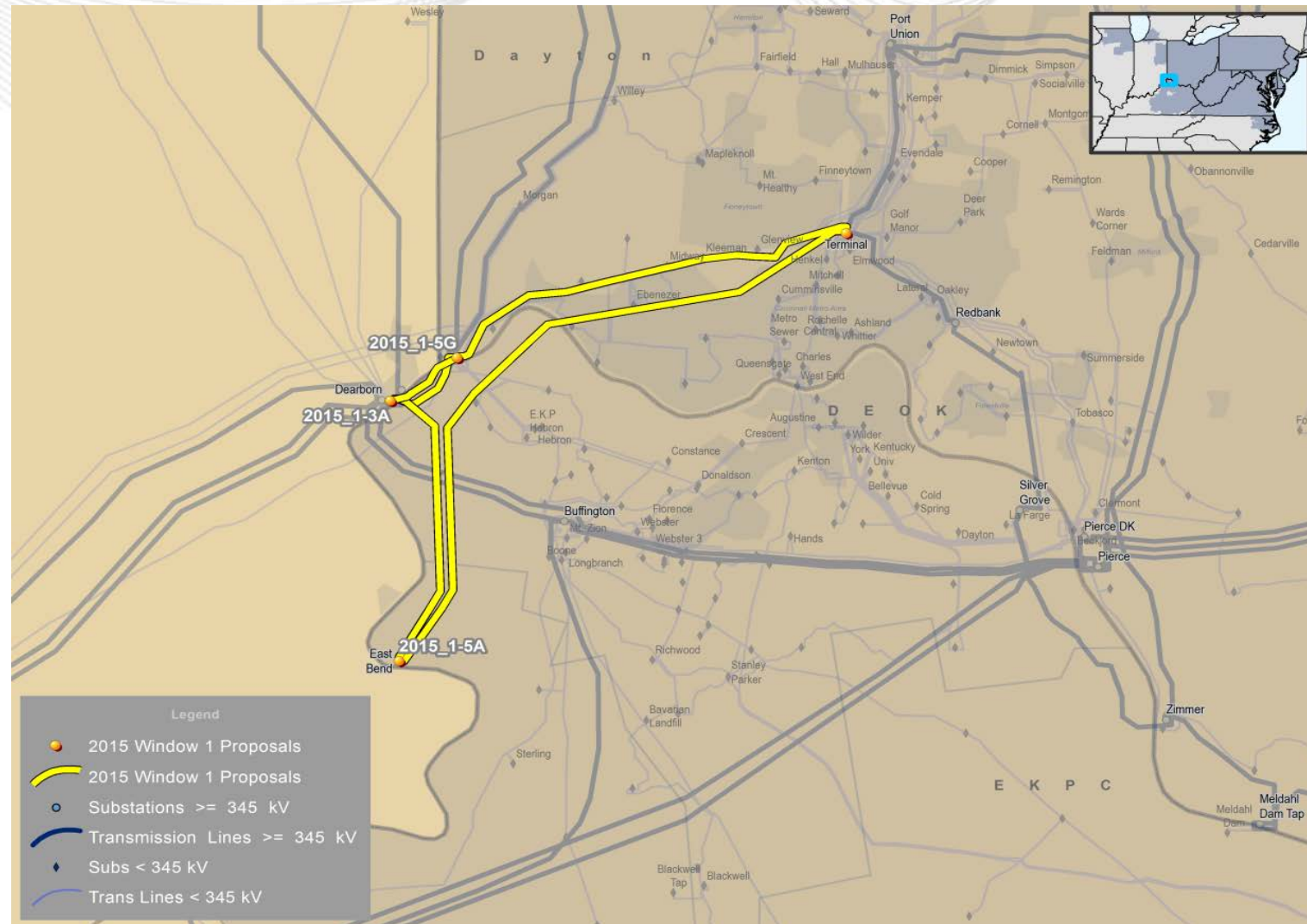
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- Proposals:
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Penelec Transmission Zone – Greenfield Projects

Greenfield Projects

- Proposing Entity: Transource
 - P2015_1-5C: Construct a new 500/115kV Station referred to as Cambria Station by tapping the existing Conemaugh-Hunterstown 500kV Line. The proposed station will cut into the existing Claysburg-Salix (via Krayn) 115kV line. Additionally, install a 24.4 Capacitor Bank at Hooversville station with SCADA control. Additional SCADA upgrades at Saxton and Somerset. (\$21.4M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8A: Build a 138 kV line from the 138 kV Bethlen substation to a new 138/115 kV substation ("Ralphton 138 kV") interconnecting to the 115 kV Ralphton substation. Build a 115 kV line from the 115 kV Ralphton substation to the 115 kV Statler Hill substation (\$59.4M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8B: Build a 138 kV line from the 138 kV Bethlen substation to a new 138/115 kV substation ("Stonycreek") interconnecting the Hooversville-Ralphton 115 kV line and the Hooversville-Somerset 115 kV line. Build a 115 kV line from the new 115 kV Stonycreek substation to the 115 kV Statler Hill substation (\$58.1M)

Greenfield Projects

- Proposing Entity: Northeast Transmission Development
 - P2015_1-8F: Build a new 115 kV line interconnecting a new 115 kV switching station ("CherryTree") to a new 115 kV switching station ("Franklin") (\$45.3M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8G: Build a new 115 kV line interconnecting a new 115 kV switching station ("CherryTree") to the 115 kV Morgan Street substation (\$45.3M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8H: Build a new 115 kV line interconnecting a new 115 kV switching station ("CherryTree") to the 115 kV Wayne substation (\$29.9M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8K: Build a 115 kV line from the existing 138 kV Grand Point substation to the existing 115 kV Carlisle Pike substation (\$21.5M)

Greenfield Projects

- Proposing Entity: Northeast Transmission Development
 - P2015_1-8L: Build a 138 kV line from the existing 138 kV Grand Point substation to the existing 115 kV Carlisle Pike substation (\$22.2M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8M: Build a 115 kV line from the existing 138 kV Grand Point substation to the existing 115 kV Roxbury substation (\$21.7M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8N: Build a 138 kV line from the existing 138 kV Grand Point substation to the existing 115 kV Roxbury substation (\$22.3M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8O: Build a new 115 kV line interconnecting the 115 kV Grandview substation to a new 115 kV switching station ("Franklin") (\$45.3M)

Greenfield Projects

- Proposing Entity: Northeast Transmission Development
 - P2015_1-8P: Build a new 115 kV line interconnecting the 115 kV Grandview substation to the 115 kV Morgan Street substation (\$45.4M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8Q: Build a new 115 kV line interconnecting the 115 kV Grandview substation to the 115 kV Wayne substation (\$30M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8T: Build a 115 kV line from the proposed 500/138 kV Green Ridge substation to the existing 115 kV Carlisle Pike substation (\$16.9M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8U: Build a 115 kV line from the existing 115 kV Mountain substation to the existing 115 kV Carlisle Pike substation (\$32.3M)



Transmission Owner Upgrades

- Proposing Entity: First Energy
 - P2015_1-4H: Install two 23.8 MVAR 120.8kV nameplate (21.6 MVAR 115kV effective) capacitors at Shade Gap. (\$2.5M)
- Proposing Entity: First Energy
 - P2015_1-4I: Install a 115kV breaker on the Hooversville #1 Transformer (\$0.725M)
- Proposing Entity: First Energy
 - P2015_1-4J: Install a 115kV breaker on the Eclipse #2 115/34.5kV transformer. (\$0.383M)
- Proposing Entity: First Energy
 - P2015_1-4K: Install a 39.7 MVAR 120.8kV capacitor (115kV 36.0MVAR effective) at Central City West substation, one capacitor switcher, and capacitor protection relays. (\$1.5M)
- Proposing Entity: First Energy
 - P2015_1-4L: Install a 39.7 MVAR 120.8kV (36 MVAR 115kV effective) capacitor bank and associated facilities at Morgan Street Substation (\$1.518M)



Transmission Owner Upgrades

- Proposing Entity: First Energy
 - P2015_1-4M: Install 115kV Venango Jct. line breaker at Edinboro South. (\$2.066M)
- Proposing Entity: First Energy
 - P2015_1-4N: Install a second 115kV 3000A 40kA bus tie breaker at Hooversville substation (\$1.419M)
- Proposing Entity: First Energy
 - P2015_1-4O: Convert East Towanda to a 115kV breaker and a half layout and upgrade remote terminal relaying. (\$13.25M)
- Proposing Entity: First Energy
 - P2015_1-4P: Replace wave trap, bus conductor and relay at Hilltop substation. Replace remote end relays at Prospect and Cooper substations. New rating of line will be SN: 249 MVA SE: 300 MVA (\$0.6M)

Greenfield Projects

- Proposing Entity: Transource
 - P2015_1-5B: Establish a new 115kV circuit from Burma station (APS) to Piney station (PENELEC). This plan will require the installation of a second 138/115kV transformer at Burma, installed on the #2 138kV bus, to serve the new line. This new circuit will eliminate the voltage drop violations caused by N-1-1 contingency combinations which involve the loss of the existing Burma - Piney 115kV circuit as well as the existing Burma 138/115kV transformer. (\$11.4M)
- Proposing Entity: Transource
 - P2015_1-5D: Construct new greenfield 138kV line (approximately 11.7 miles) between Carlisle Pike and Fayetteville substations. Install 138/115kV transformer at Carlisle Pike to accommodate new 138kV line. Install 4 138kV breakers at Fayetteville for reliability and contingency purposes. Install four 115kV breakers and a high side 138kV breaker for the proposed transformer at Carlisle Pike for reliability and contingency purposes. (\$22.9M)
- Proposing Entity: Transource
 - P2015_1-5E: Install a new 230/115kV Transformer at Rice Station (proposed as part of the PJM 2014 LTW, Proposal 1-9A) and construct a new greenfield 115kV line from Rice to Carlisle Pike. Install additional 115kV breakers at Carlisle Pike to reduce exposure and increase reliability. (\$16.8M)

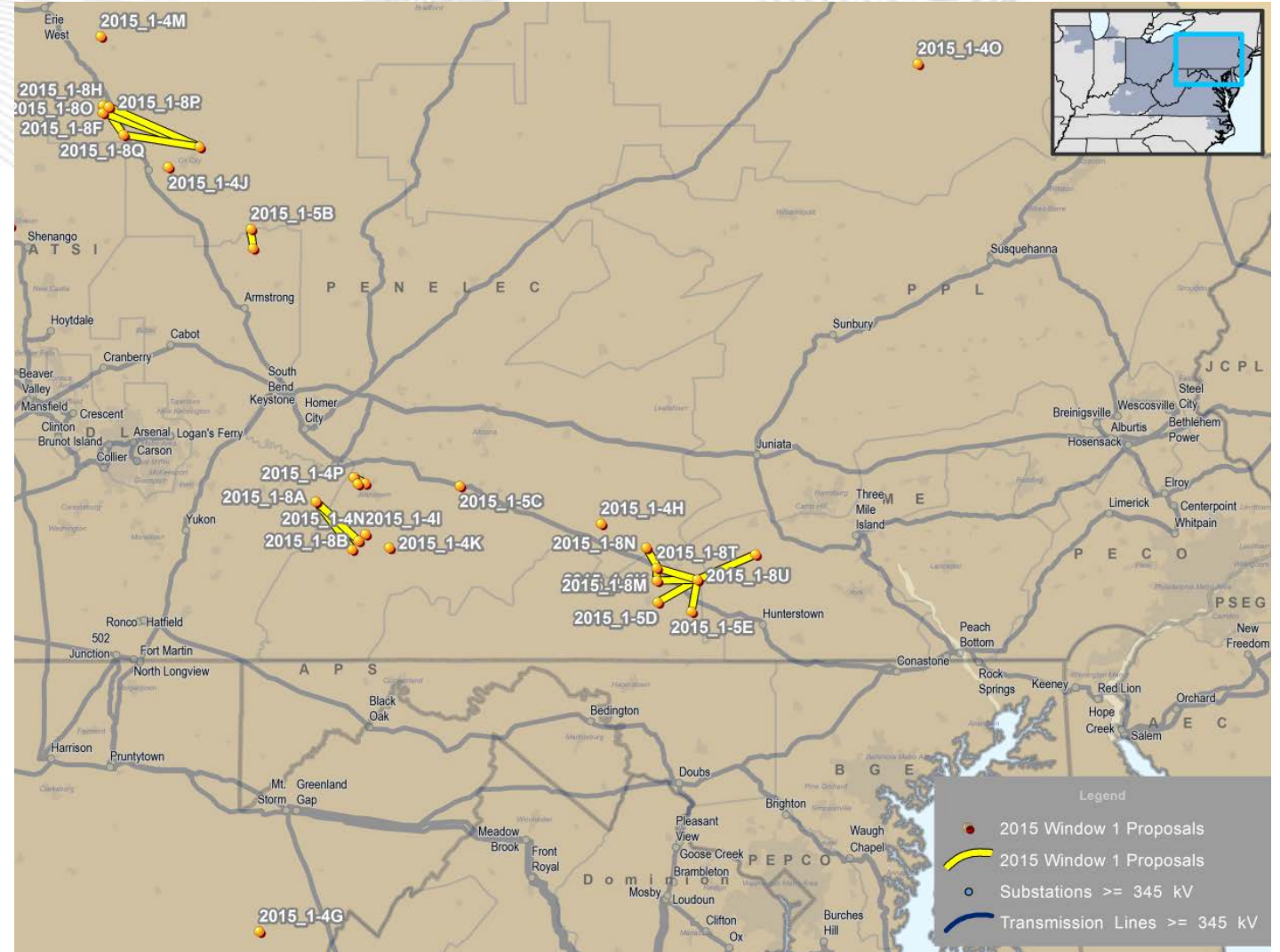


Transmission Owner Upgrades

- Proposing Entity: First Energy
 - P2015_1-4G: Change the CT Ratio at Seneca Caverns from 120/1 to 160/1 and adjust relay settings accordingly. The rating of all equipment not explicitly listed shall exceed: SN: 152 MVA, SE: 152 MVA, WN: 152 MVA, and WE: 152 MVA (\$0.013M)

- Proposals:
 - 18 Greenfield Projects
 - 10 Transmission Owner Upgrade

- Next Steps
 - Continue Analysis of proposals





Greenfield Projects

- Proposing Entity: PSEG
 - P2015_1-7E: New 138kV line from Beaver to Black River (\$16.5M)
- Proposing Entity: PSEG
 - P2015_1-7F: New 138kV line from Beaver to Lake Ave. (\$19.1M)
- Proposing Entity: PSEG
 - P2015_1-7G: Build new 138kV Sheffield station that taps Beaver to Johnson 138kV line. Build a new overhead 138kV line from Black River to new Sheffield station. Install a new 138kV breaker at Black River. Construct new 138/69kV station that taps the Baumhart to Elyria 69kV line. Construct new 138kV line from Beaver to new 138/69kV station. Install a new 138kV breaker at Beaver station. (\$39M)
- Proposing Entity: PSEG
 - P2015_1-7J: Build new 138kV line between Crossland and Elwood (\$18.5M)

Greenfield Projects

- Proposing Entity: PSEG
 - P2015_1-7K: This project consists of building a 138kV line from Dowling 138kV to Bowling Green 5. At Bowling Green 5 69kV, a 138/69 kV transformer shall be built in order to interconnect the 138kV circuit to Bowling Green 69kV (\$17.9M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8D: Build a double circuit 138 kV line from the Lemoyne-West End Fostoria 138 kV line to a new 138/69 kV substation ("Bowling Green 4 138 kV") and interconnecting to the Bowling Green 4 69 kV substation (\$20.6M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8E: Build a 138 kV line from the Lemoyne-West End Fostoria 138 kV line to a new 138/69 kV substation ("Bowling Green 4 138 kV") and interconnecting to the Bowling Green 4 69 kV substation (\$13.2M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8V: Build a 138 kV line from the existing 138 kV Newton Falls substation to the existing 138 kV Franklin substation (\$19.6M)

Greenfield Projects

- Proposing Entity: Northeast Transmission Development
 - P2015_1-8AA: Build a 138 kV switching station ("Stony Hill") interconnecting the Shenango-Masury 138 kV line, the Shenango-LTV Steel 138 kV line and the Lincoln Park-Elwood 138 kV line (\$12M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8AB: Build a 138 kV switching station ("Stony Hill") interconnecting the Shenango-Masury 138 kV line and the Lincoln Park-Elwood 138 kV line (\$6M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8AC: Build a 138 kV switching station ("Stony Hill") interconnecting the Shenango-LTV Steel 138 kV line and the Lincoln Park-Elwood 138 kV line (\$6M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8AD: Build a double circuit 138 kV line from the Central Niles-Garden 138 kV line to a new switching station ("Wick") on the Masury-Salt Springs 138 kV line (\$19.4M)



ATSI Transmission Zone – Transmission Owner Upgrades

Transmission Owner Upgrades

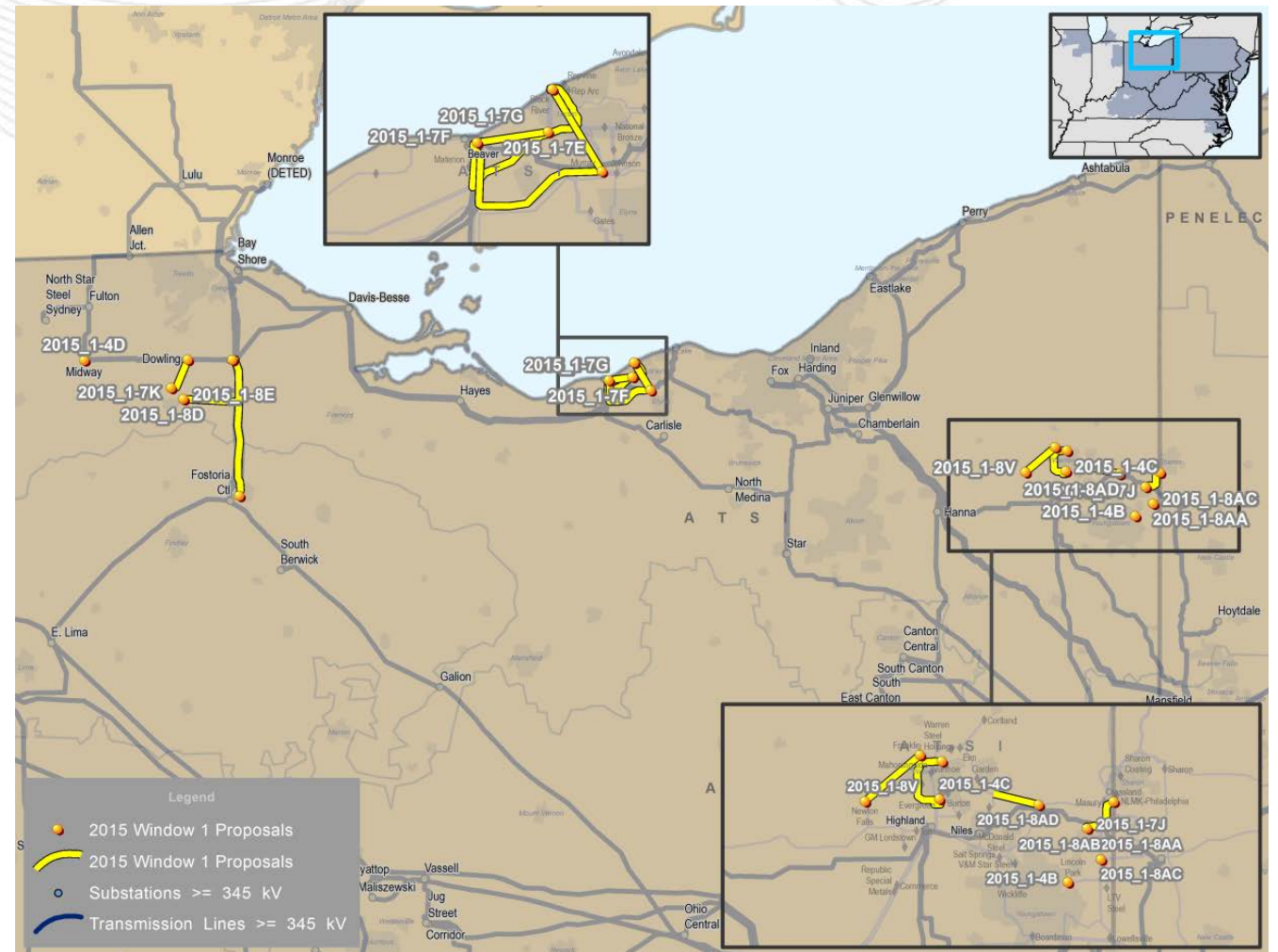
- Proposing Entity: First Energy
 - P2015_1-4A: Rebuild the existing double-circuit tower line section from Beaver Substation to Brownhelm Jct, approx. 2.8 miles, to reconductor with new 954 kcmil ACSS. (\$5.1M)
- Proposing Entity: First Energy
 - P2015_1-4B: Add a 138kV 36 MVar Capacitor Bank and associated capacitor switcher at Lincoln Park Substation. Extend the 138kV Bus in order to accommodate the Capacitor Bank. (\$1.015M)
- Proposing Entity: First Energy
 - P2015_1-4C: Rebuild the 6.6 mi 477 ACSR Evergreen to Ivanhoe 138 kV line to 477 ACSS. (\$4.6M)

Modeling Correction

- Proposing Entity: First Energy
 - P2015_1-4D: Modeling Corrections: A combination of transformer modeling corrections at Midway Substation due to impending transformer replacements, and energizing the capacitor bank at Pemberville Substation pre-contingency eliminates these violations (\$N/A)

- Proposals:
 - 12 Greenfield Projects
 - 3 Transmission Owner Upgrades
 - 1 Modeling Correction

- Next Steps
 - Continue Analysis of proposals



Greenfield Projects

- Proposing Entity: Dominion
 - P2015_1-1C: New 32 miles long 500kV line from Carson - Rogers Rd(\$106.3M)
- Proposing Entity: Dominion
 - P2015_1-1D: 23 miles of new 500kV line from Carson - Rawlings(\$78.9M)
- Proposing Entity: Dominion
 - P2015_1-1E: A short 500kV line from Rogers Rd substation to new substation called Maclins. A 500/230kV TX at Maclins and a 4 mile 230kV line from Maclins to Clubhouse.(\$53.4M)
- Proposing Entity: Dominion
 - P2015_1-1F: A 500/230kV TX at Rawlings and a new 230kV line from Rawlings to new 230kV station at Purdy. Purdy cuts into the existing Carson - Clubhouse 230kV (238 line) line approximately 8.7 miles from Clubhouse.(\$67M)

Greenfield Projects

- Proposing Entity: Transource
 - P2015_1-5F: Establish a new 500kV circuit from Carson station to Rawlings station. This new circuit will eliminate the violation for the generation deliverability flowgate involving Carson - Rodgers Road 500kV Circuit for the loss of the existing Carson - Rawlings 500kV Circuit. (\$65.3M)
- Proposing Entity: Nextera
 - P2015_1-6A: New Pleasant Shade 500/230 kV substation, New 4.2 mile 500 kV transmission line connecting Pleasant Shade to Rogers Road, and New 22-mile 500 kV transmission line connecting Carson to Rawlings.(\$105M)
- Proposing Entity: Nextera
 - P2015_1-6B: New 22 mile transmission line from Carson - Rawlings 500 kV(\$51M)
- Proposing Entity: Nextera
 - P2015_1-6C: New 28 mile transmission line from Rogers Road - Carson 500 kV(\$61.8M)



Greenfield Projects

- Proposing Entity: PSEG
 - P2015_1-7D: Build a three (3) breaker 500kV ring bus on Brunswick to Wake 500kV line. Add one (1) transformer and 230kV circuit from ring bus to Clubhouse 230kV station.(\$47.5M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8S: Build a 230 kV switching station ("Great Branch") interconnecting the Chesterfield-Iron Bridge 230 kV line, the Chesterfield-Basin 230 kV line and the Iron Bridge-Spruance 230 kV line(\$15.6M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8W: Build a 230 kV switching station (Great Branch) interconnecting the Chesterfield-Iron Bridge 230 kV line, the Chesterfield-Basin 230 kV line and the Iron Bridge-Spruance 230 kV line. Build a 230 kV switching station (Reedy Creek) interconnecting the Iron Bridge-Southwest 230 kV line, the Iron Bridge-Hull Street Road 230 kV line and the Hull Street Road-Southwest 230 kV line(\$29.4M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8X: Build a 500 kV line from the 500 kV Rogers Road switching station to the existing 500 kV Carson substation (\$78.7M)

Greenfield Projects

- Proposing Entity: Northeast Transmission Development
 - P2015_1-8Y: Build a 230 kV line from the new 500/230 kV substation (Rogers Road 230 kV) to the existing 230 kV Clubhouse substation (\$27.8M)
- Proposing Entity: ITC
 - P2015_1-9A: Construct a new 500 kV line connecting the existing Rawlings 500 kV switchyard and the existing Midlothian 500 kV substation. Upgrade the existing Rawlings switchyard and Midlothian substation to accommodate the new 500 kV line.(\$167.1M)
- Proposing Entity: ITC
 - P2015_1-9B: Construct a new 500 kV line from the existing Rawlings 500 kV switchyard to a new switchyard (Lakeland) which taps the existing Carson-Midlothian 500 kV line(\$118.9M)
- Proposing Entity: ITC
 - P2015_1-9C: Construct a new 500 kV line from the existing Rawlings 500 kV switchyard to a new switchyard (Steers) which taps the existing Carson-Midlothian 500 kV line(\$105.7M)

Greenfield Projects

- Proposing Entity: ITC
 - P2015_1-9D: Construct a new 500 kV line from the existing Brunswick 500 kV switchyard to the existing Carson 500 kV substation. Upgrade the existing Brunswick Switchyard and Carson Substation to accommodate the new 500 kV line(\$135.2M)
- Proposing Entity: ITC
 - P2015_1-9E: Construct a new 500 kV line from the existing Rawlings 500 kV switchyard to the existing Carson 500 kV substation. Upgrade the existing Rawlings Switchyard and Carson Substation to accommodate the new 500 kV line(\$94.2M)

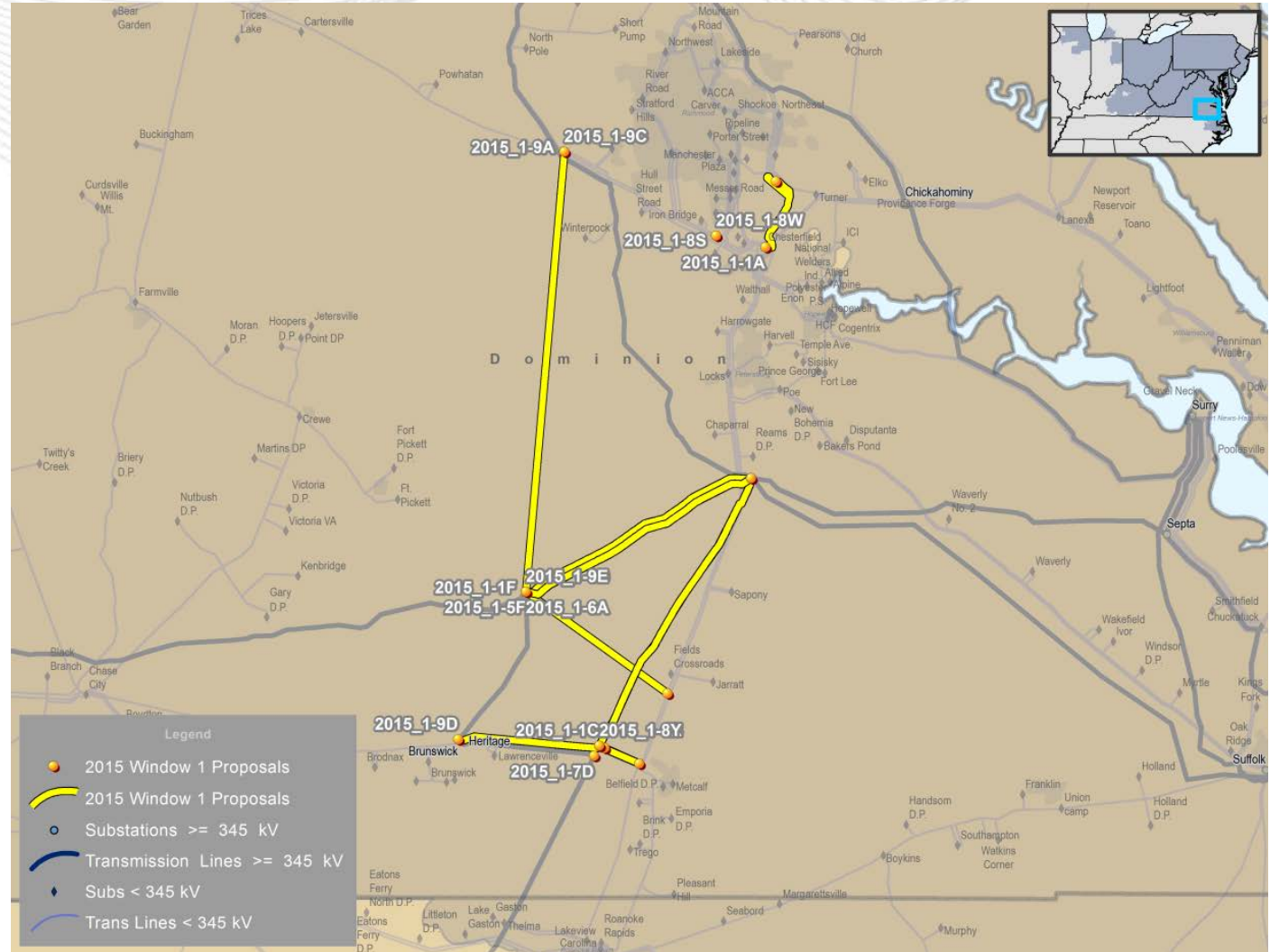
Transmission Owner Upgrades

- Proposing Entity: Dominion
 - P2015_1-1A: Rebuild 11.03 miles of existing line between Chesterfield and Charles City. (\$17.54M)

- Proposing Entity: Dominion
 - P2015_1-1B: Rebuild 500kV line from Rogers Rd - Carson with new structures (\$73M)

- Proposals:
 - 18 Greenfield Projects
 - 2 Transmission Owner Upgrades

- Next Steps
 - Continue Analysis of proposals



Greenfield Projects

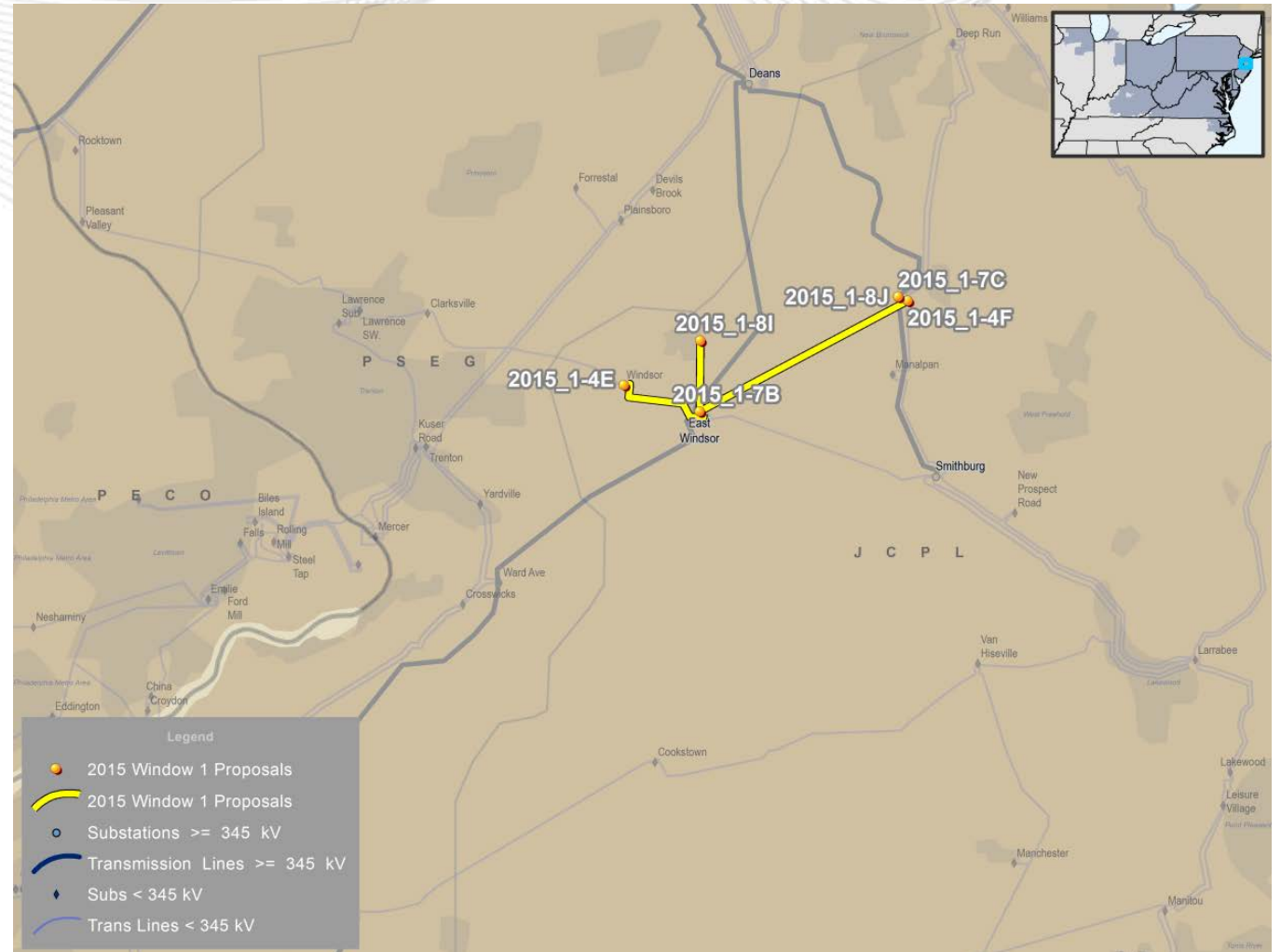
- Proposing Entity: PSEG
 - P2015_1-7B: Build a new 230kV line from East Windsor to Englishtown (\$39.8M)
- Proposing Entity: PSEG
 - P2015_1-7C: Build a new 500-230kV Station on the existing Deans - Smithburg line at Englishtown (\$48.5M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-8I: Build a double circuit 115 kV line from the Wyckoff-Englishtown 115 kV line to a new 230/115 kV substation ("East Windsor 115 kV") and interconnecting to the East Windsor 230 kV substation (\$17.1M)
- Proposing Entity: Northeast Transmission Development
 - P2015_1-9J: Build a 500/230 kV substation ("Englishtown 500 kV") interconnecting the Deans-Smithburg 500 kV line to the Englishtown 230 kV substation (\$26M)

Transmission Owner Upgrades

- Proposing Entity: First Energy
 - P2015_1-4E: Install 1-230 kV breaker at East Windsor and construct new 230 kV line terminal. Install 2-230 kV breakers at Windsor and construct new 230 kV line terminal. Convert the F2006, 230 kV line, East Windsor-Windsor 230 kV from six-wire construction to two 230 kV three-wire circuits. The rating of the new circuit will be: SN: 709 MVA, SE: 869 MVA, WN: 805 MVA, and WE: 1031 MVA (\$5.924M)
- Proposing Entity: First Energy
 - P2015_1-4F: Install 1-230 kV breaker and a 72 Mvar fast-switched capacitor at Englishtown (\$1.5M)

- Proposals:
 - 4 Greenfield Projects
 - 2 Transmission Owner Upgrades

- Next Steps
 - Continue Analysis of proposals

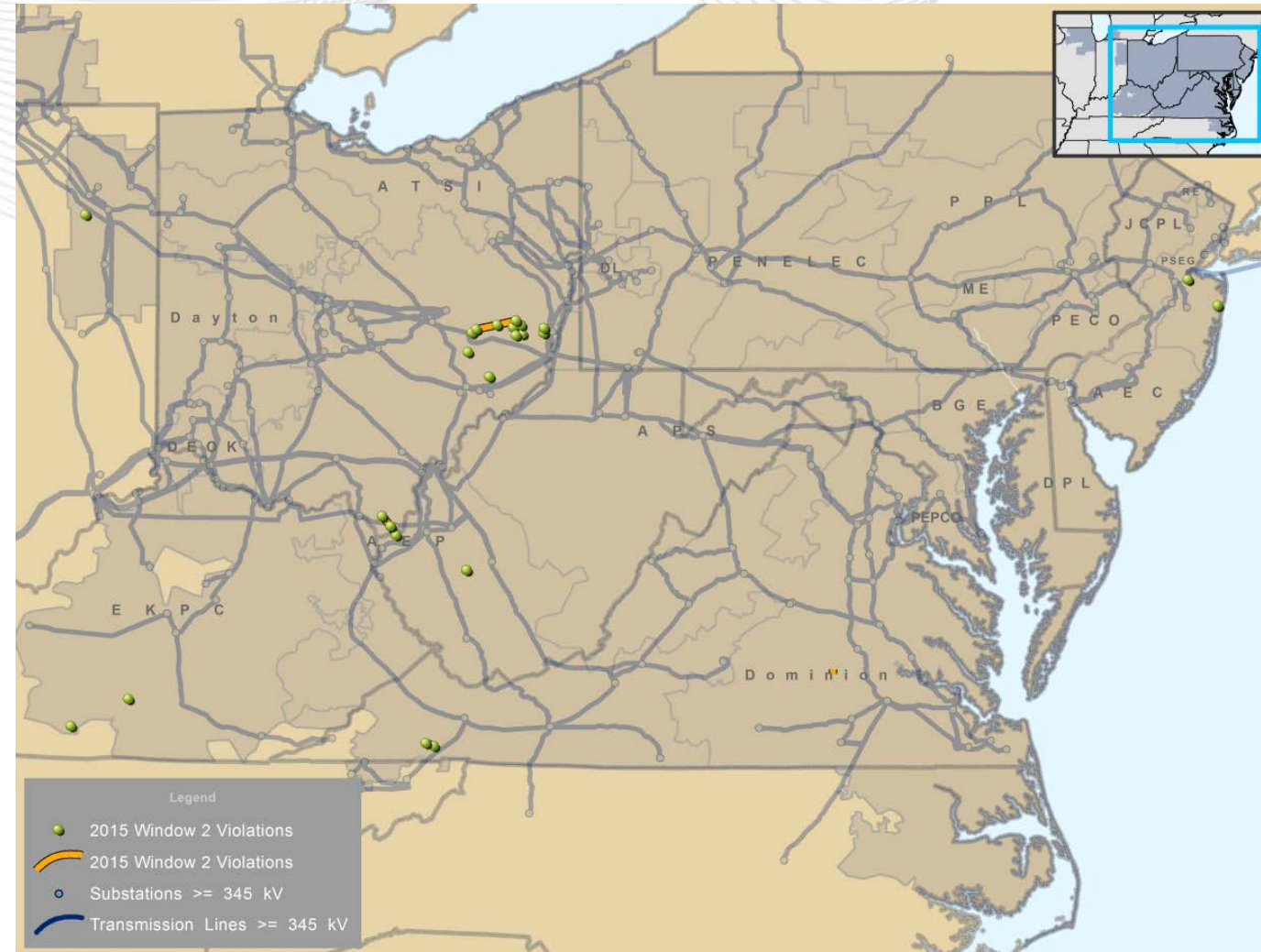


- Next Steps
 - Continue evaluations of proposals
 - Review solution recommendations at September TEAC



2015 RTEP Proposal Window #2

- Scope: Transmission Owner Criteria, Light Load Reliability Criteria Violations
 - Opened Wednesday August 5th, 2015
 - Closes Friday September 4th, 2015*
 - *All final cost estimates and greenfield proposals due 9/21/2015

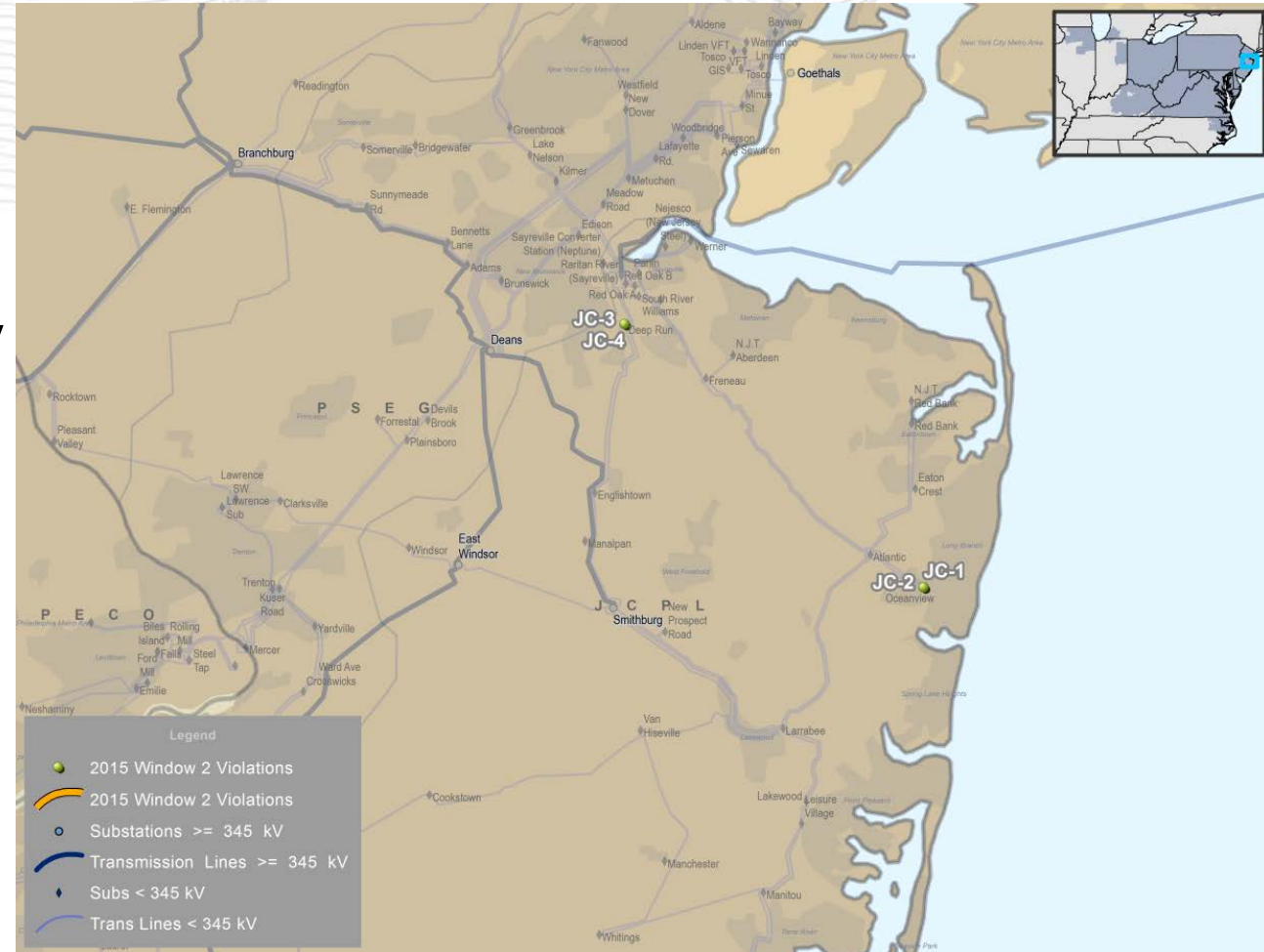


- Transmission Owner Criteria Violations by TO and type

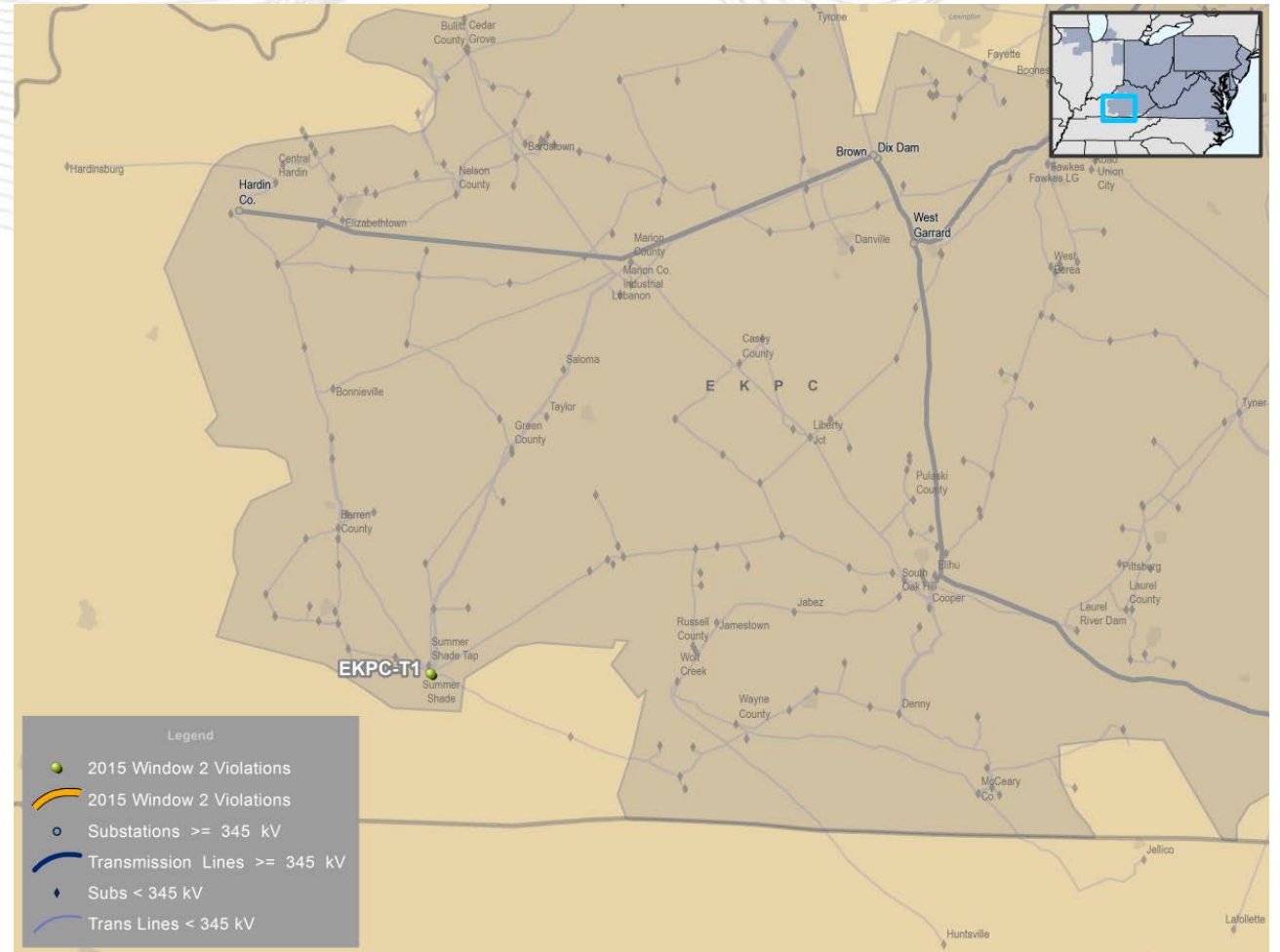
Transmission Owner	Thermal Violations	Voltage Violations
JCPL	4	0
EKPC	1	1
AEP	11	9

- Light Load Reliability Criteria Violations
 - No Light Load Reliability Criteria Violations are identified

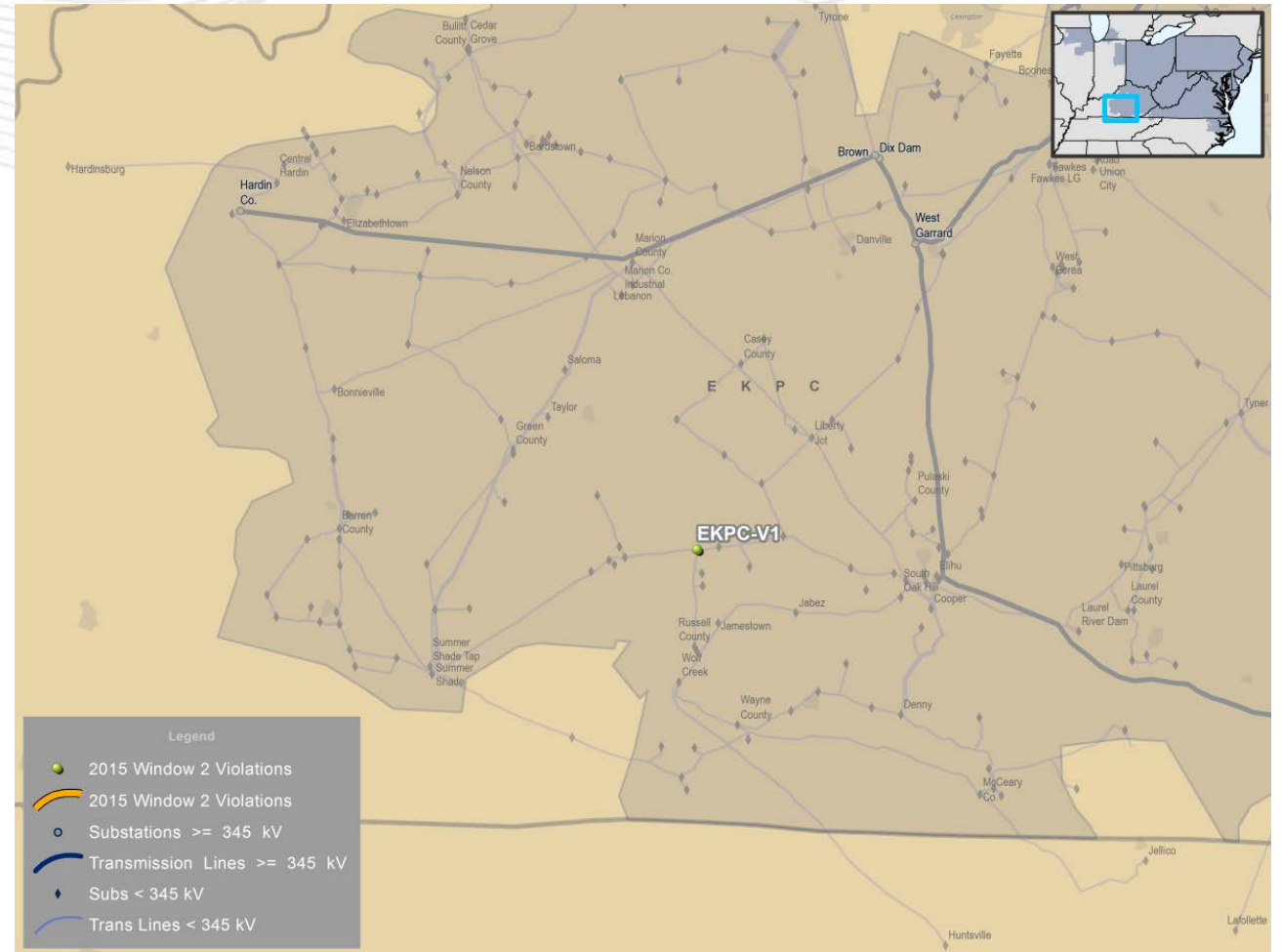
- Transmission Owner Criteria Violation
- N-1 Thermal violation on the Oceanview 230/35 kV XFMR for multiple contingencies
- N-1 Thermal violation on the Deep Run 115/35 kV XFMR for multiple contingencies



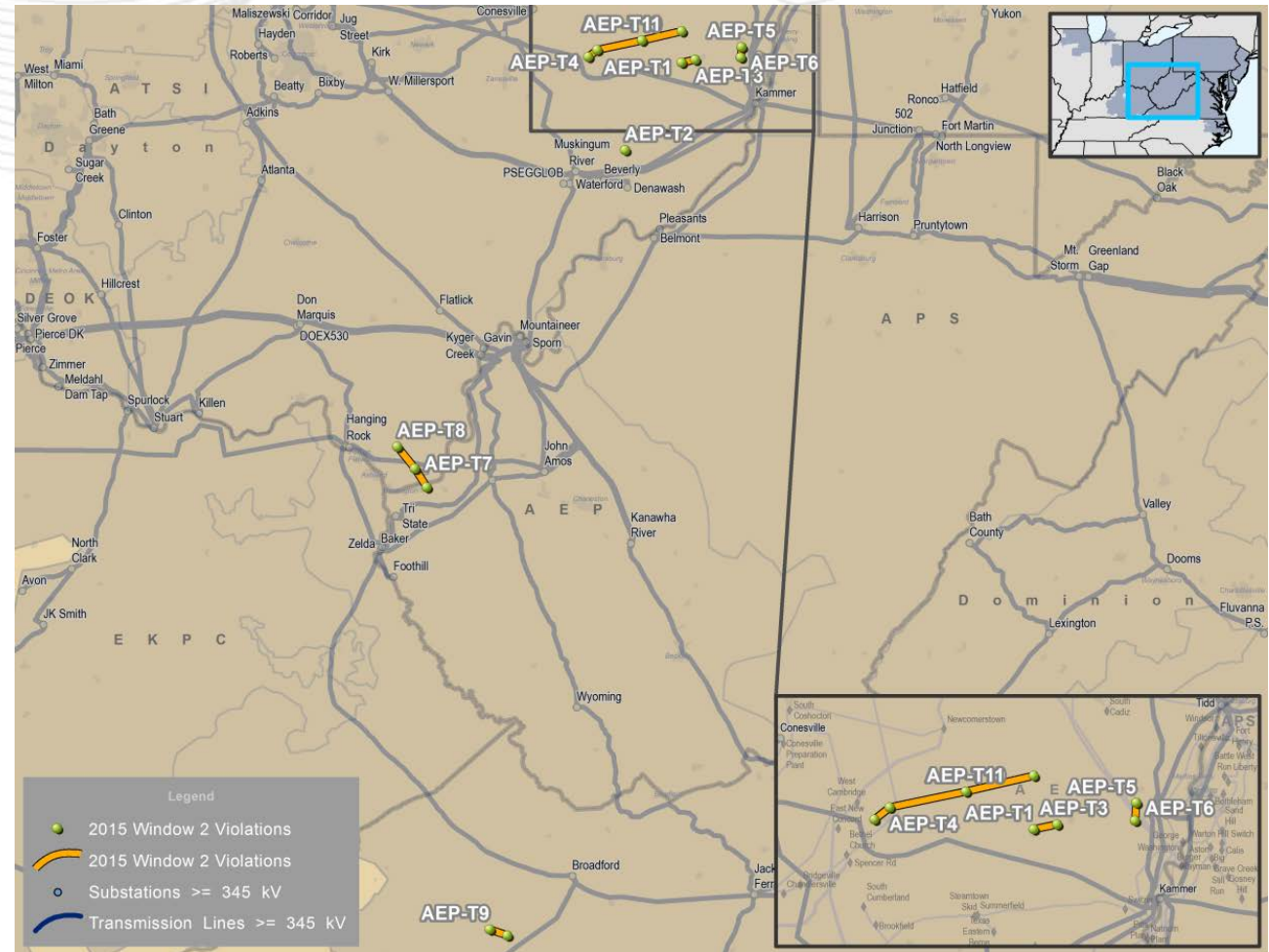
- Transmission Owner Criteria Violation
- N-1 Thermal violation on the Summ Shade 161/69 kV XFMR



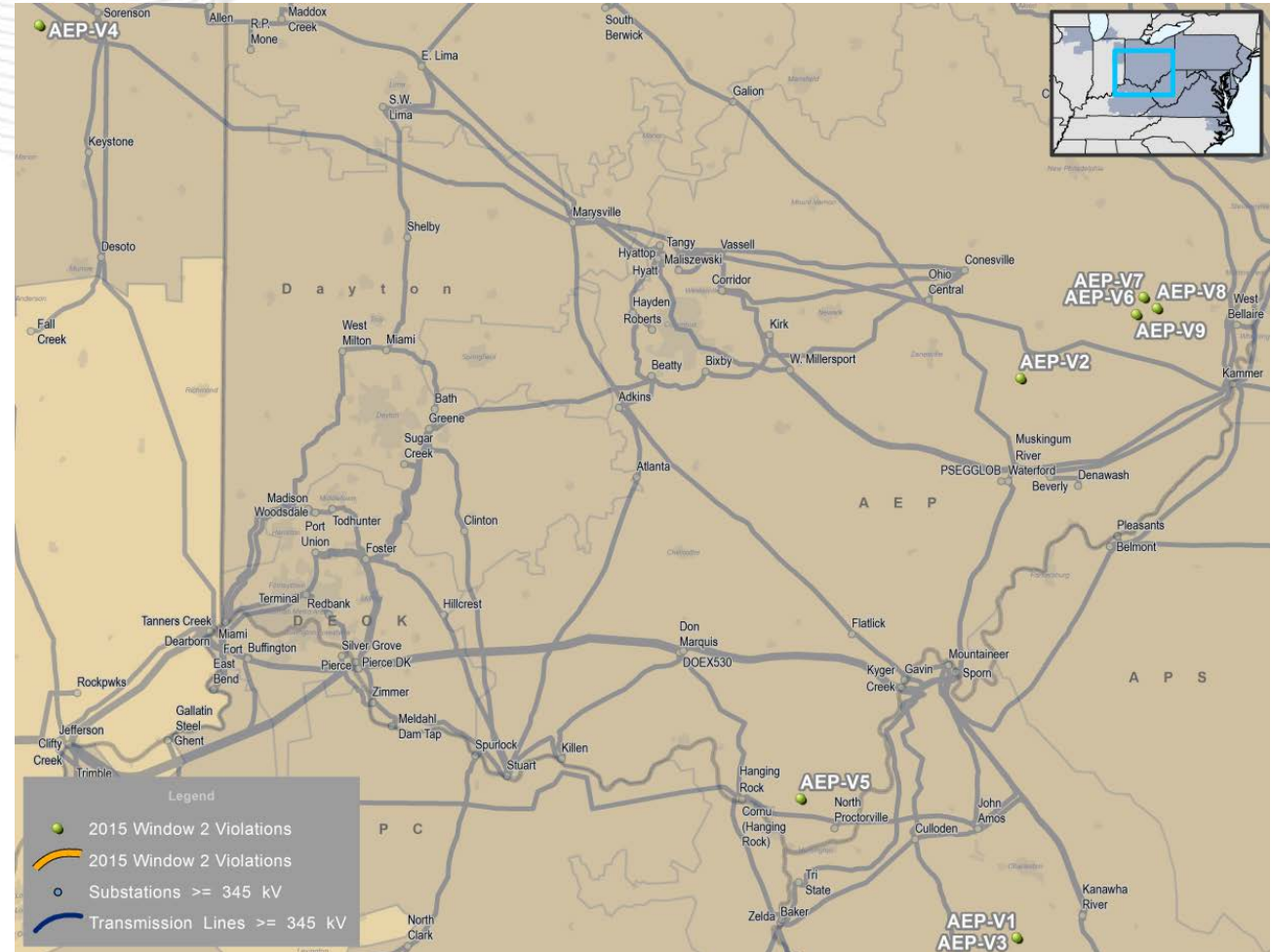
- Transmission Owner Criteria Violation
- Low Voltage violation at Sewellton 69 kV



- Transmission Owner Criteria Violation
- Thermal violations:
 - Barnsville - Speidel 69 kV line
 - Caldwell 138/34.5 kV transformer
 - Fairdale – Camb Rd 69 kV line
 - Darrah – Patsbrnc 34.5 kV line
 - Johnsonl – Patsbrnc 34.5 kV line
 - Abingdon – Hillamn 69 kV line
 - Old Wash – E Cam R 34.5 kV line
 - Old Wash – Antrim 34.5kV line



- Transmission Owner Criteria Violation
- Low Voltage violations:
 - Rondbtm 69 kV
 - Rannel 69 kV
 - Fulks 34.5 kV
 - Johnsonl 34.5 kV
 - Antrim 34.5 kV
 - Antrim 8 34.5 kV
 - Vail 34.5 kV
 - Smyrna 34.5 kV



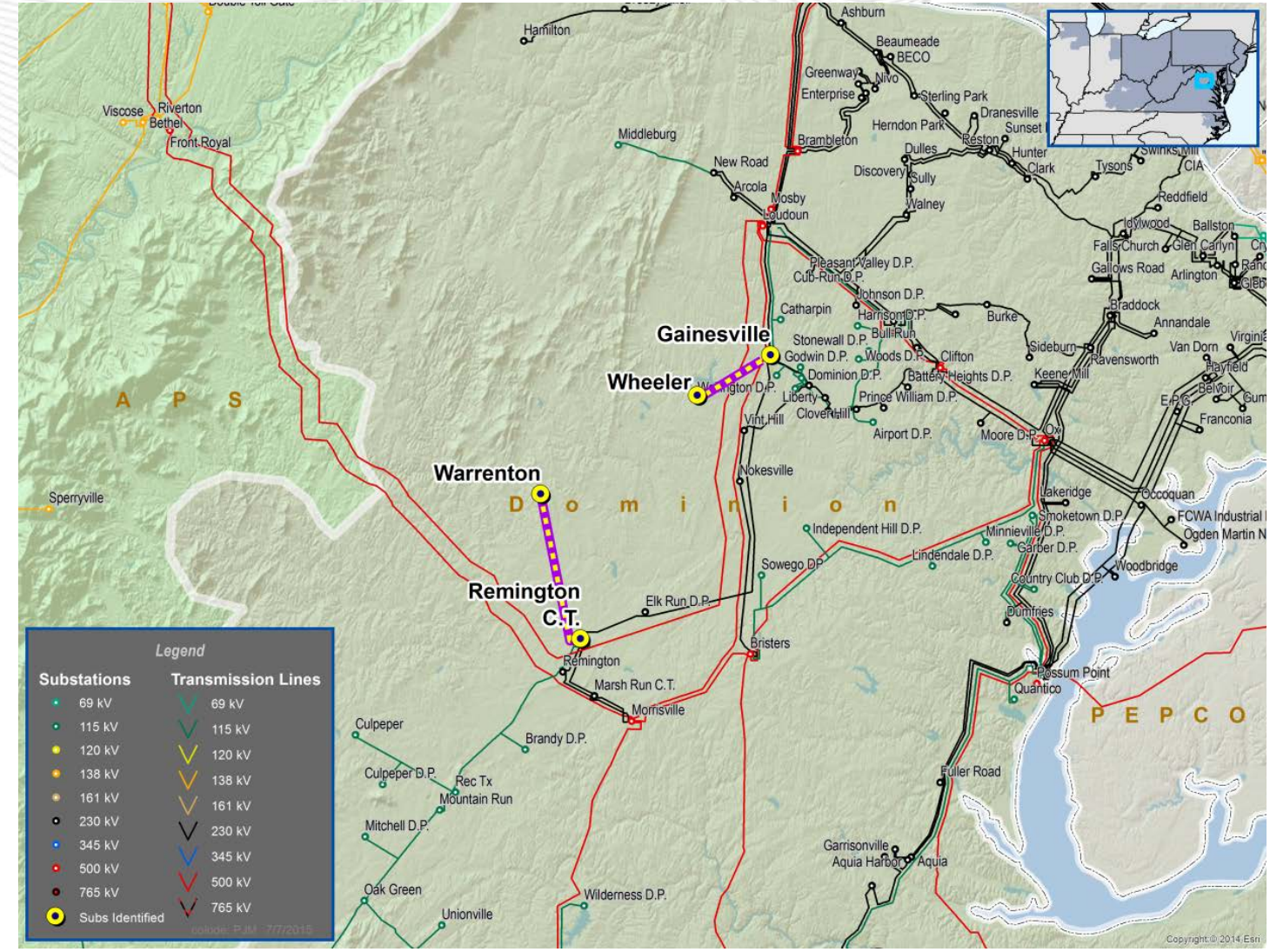


Immediate Need Reliability Projects

- **Dominion local TO criteria - Radial transmission lines**
 - Dominion FERC 715 local planning criteria defines a Radial transmission line is defined as a single line that originates in a substation, serves load and does NOT tie to any other transmission line or substation
- **Loading on single source radial transmission lines will be limited to the following:**
 - 100 MW Maximum
 - 700 MW-Mile Exposure (MW-Mile = Peak MW X Radial Line Length)

Problem: Dominion Radial Line Criteria Violation

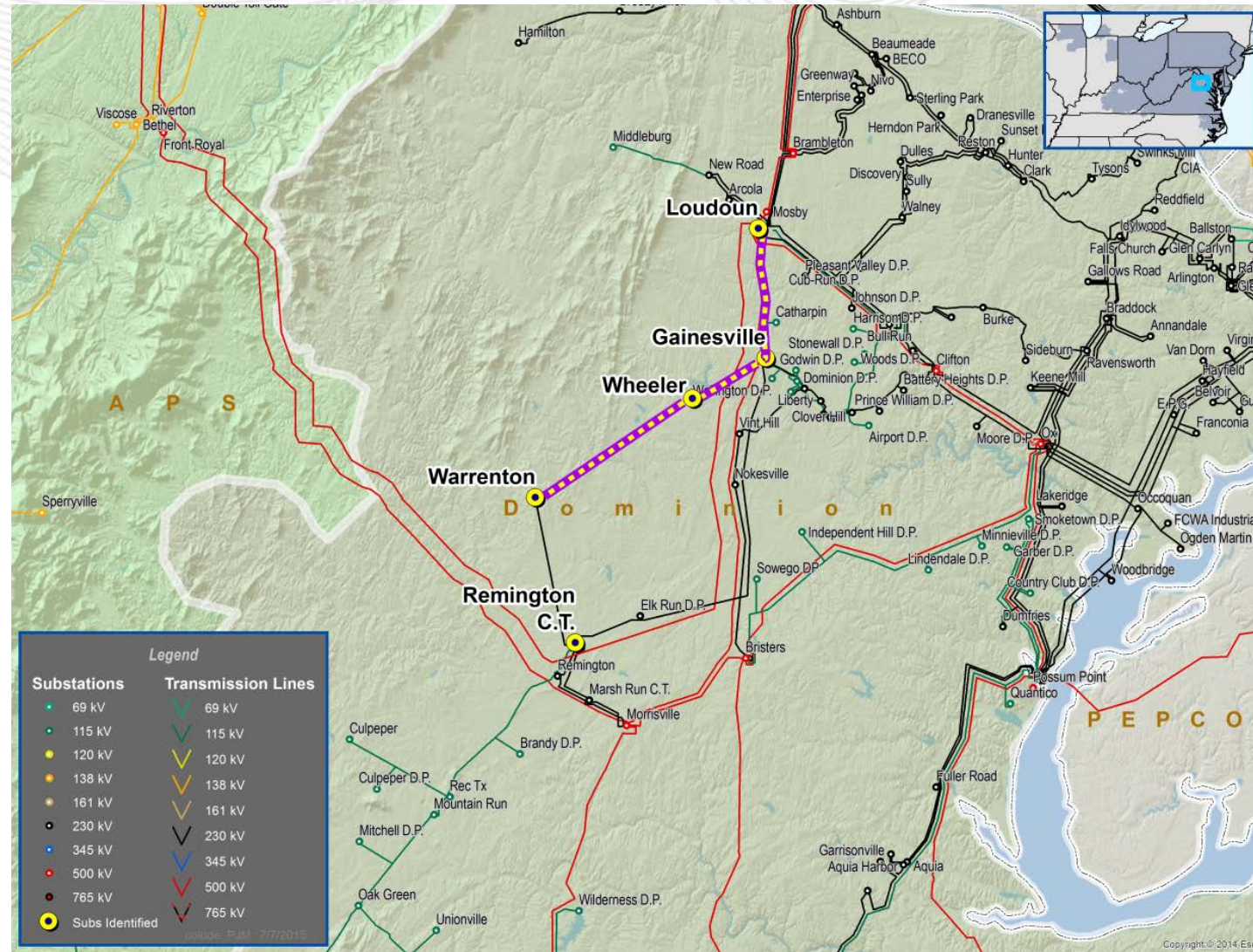
- Loading on radial Remington CT-Warrenton 230 kV is projected to exceed 100 MW by Summer 2017.
- Existing load on NOVEC's radial 115 kV Gainesville-Wheeler line exceeds 110 MW.
- Loss of Gainesville Substation results in over 300 MW being dropped.
- This need is time sensitive due to the criteria violation in the immediate need timeframe.
- When this criteria violation was identified, the need date was already in the immediate need timeframe.
- Previous reliability models did not demonstrate this immediate need violation.



Alternatives Considered

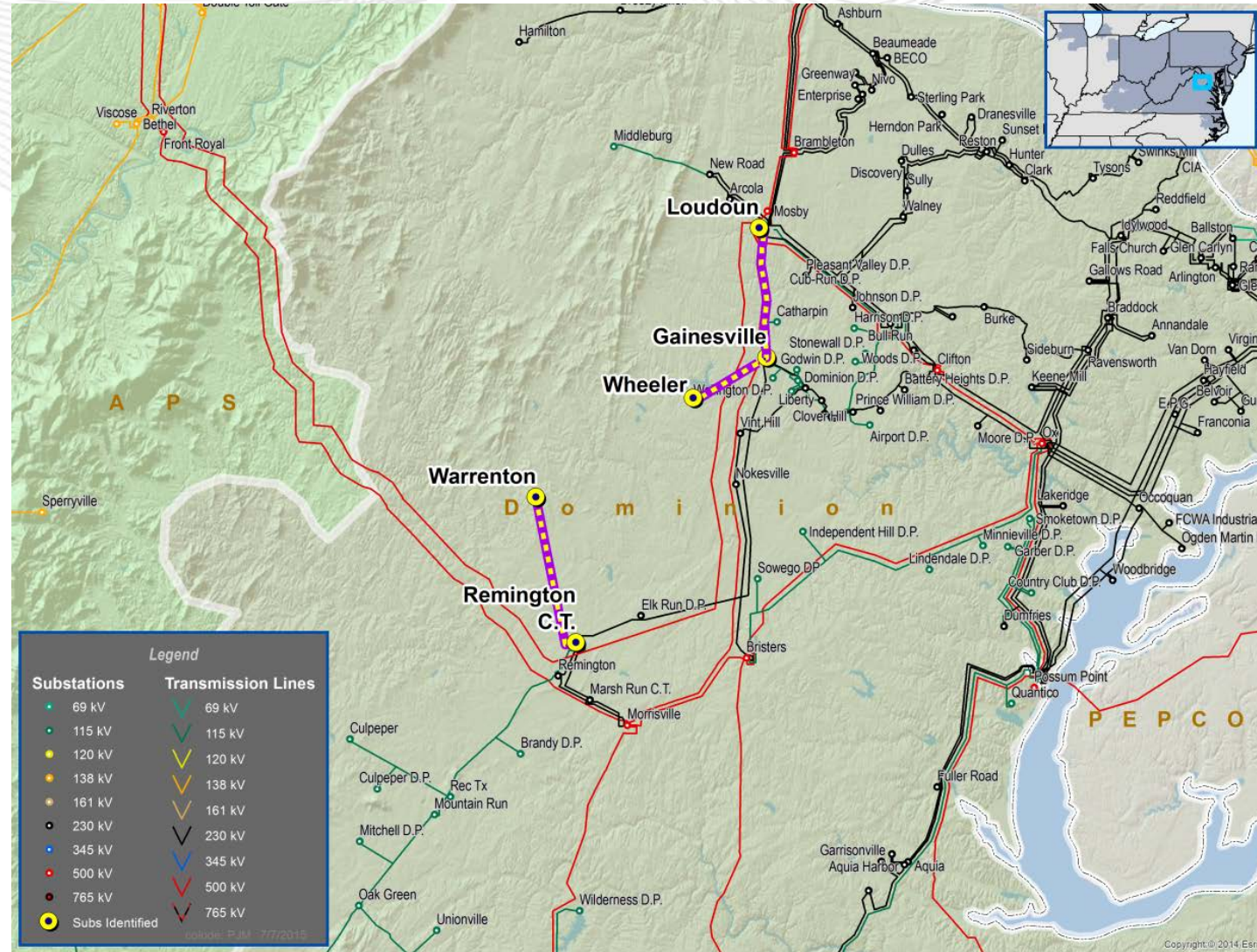
Several other options were considered but concluded would not sufficiently or efficiently address the immediate reliability need,

- A. Construct a 230kV OH line approx. 9 miles from Warrenton to Wheeler Substation. Convert NOVEC's Gainesville-Wheeler line (approx 6 miles) to 230kV. Bypass Gainesville and utilize Gainesville-Loudoun 230kv line to complete a Remington CT-Warrenton-Wheeler-Loudoun networked line. Constructing this Option A underground would be approx 8 miles between Warrenton and Wheeler (\$86 - \$168 M)
- Solution A has permitting constraints associated with OH facilities through historical battlefields, conservation easements, and governmental land along the route. The cost estimate for Solution A is based on the assumption of being able to obtain a "buildable" route.



Alternatives Considered

- B. Wreck-and-rebuild existing Line Remington CT – Warrenton 230 kV (approx. 12 miles)
 Wreck-and-rebuild NOVEC’s Gainesville-Wheeler line (approx. 6 miles) as a double-circuit 230kV line. Terminate one line at Gainesville to create a new Gainesville-Wheeler line. Bypass Gainesville with the other line and utilize Gainesville-Loudoun 230kV to create a 230kV Loudoun-Wheeler line. (\$94 M)
- Solution B is not preferred due to its long-term impact, performance, routing, and permitting constraints compared to the Proposed Solution



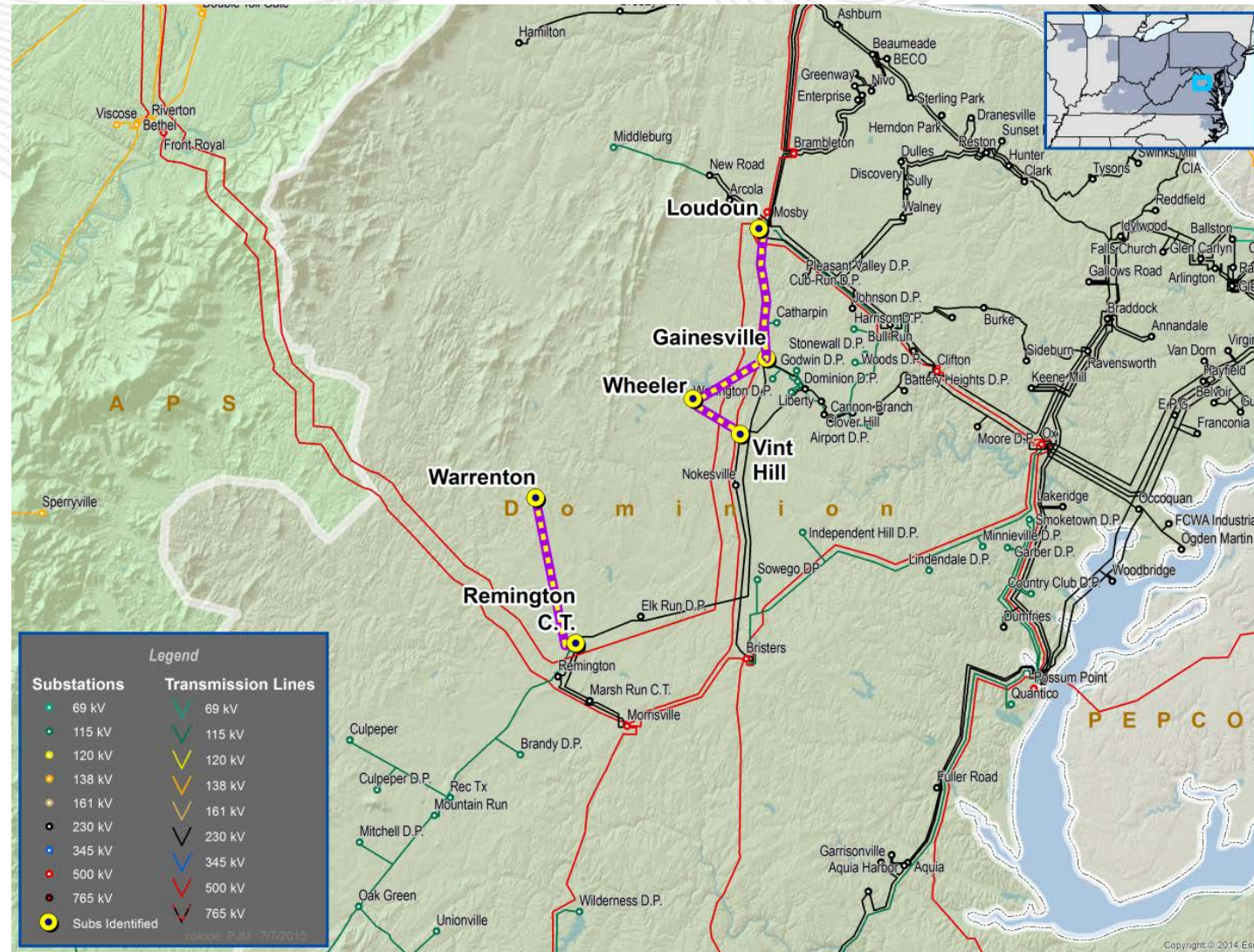
Proposed Immediate Need Solution

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

- Wreck and rebuild existing Remington CT - Warrrenton 230 kV (approx. 12 miles) as a double-circuit 230 kV line (b2461)
- Construct a new 230 kV line approximately 6 miles from NOVEC's Wheeler Substation to new 230 kV switching station in Vint Hill area (b2461.1)
- Convert NOVEC's Gainesville - Wheeler line (approximately 6 miles) to 230 kV (b2461.3)
- Bypass Gainesville and utilize Gainesville - Loudoun 230 kV to complete a Vint Hill - Wheeler - Loudoun 230 kV networked line

Estimated Project Cost: \$105 M

Projected IS Date: 6/1/2017

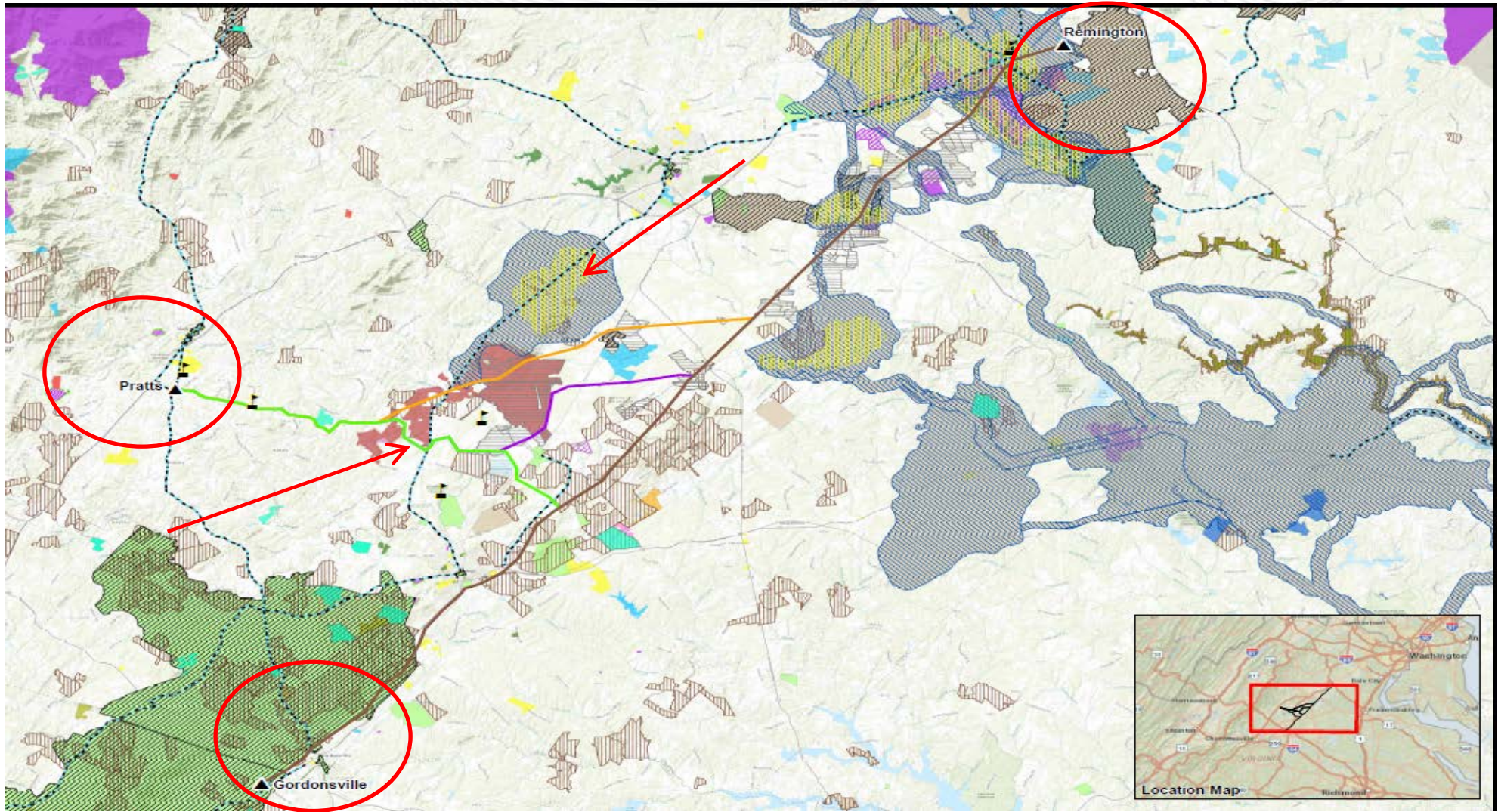




Pratts Area Update

- At the June TEAC
 - Reaffirmed the previous recommendation to implement the 2014_2-13A proposal from Gordonsville – Pratts - Remington and assign construction responsibility to First Energy and Dominion.
 - This recommendation was not yet reviewed by the PJM Board
- In the previous evaluation process, new ROW was recognized as an important issue and an element of risk “common to all new ROW proposals.”
- Further routing analysis indicates that the total length of potential new ROW is 15-18 mi.
- Virginia SCC Guidelines of Minimum Requirements for Transmission Line Applications

- **Virginia State Corporation (SCC)**
 - COMMONWEALTH OF VIRGINIA STATE CORPORATION COMMISSION, DIVISION OF ENERGY REGULATION
 - Guidelines of Minimum Requirements for Transmission Line Applications Filed Under Virginia Code Section 56-46.1 and The Utility Facilities Act
 - To the extent permitted by the property interest involved rights-of-way should be selected with the purpose of minimizing, conflict between; the rights-of-way and present and prospective uses of the land on which they are to be located. To this end, existing rights-of-way should be given priority as the locations for additions to existing transmission facilities, and the joint use of existing rights-of-way by different kinds of utility services should be considered.
 - <https://www.scc.virginia.gov/pue/docs/trans.pdf>

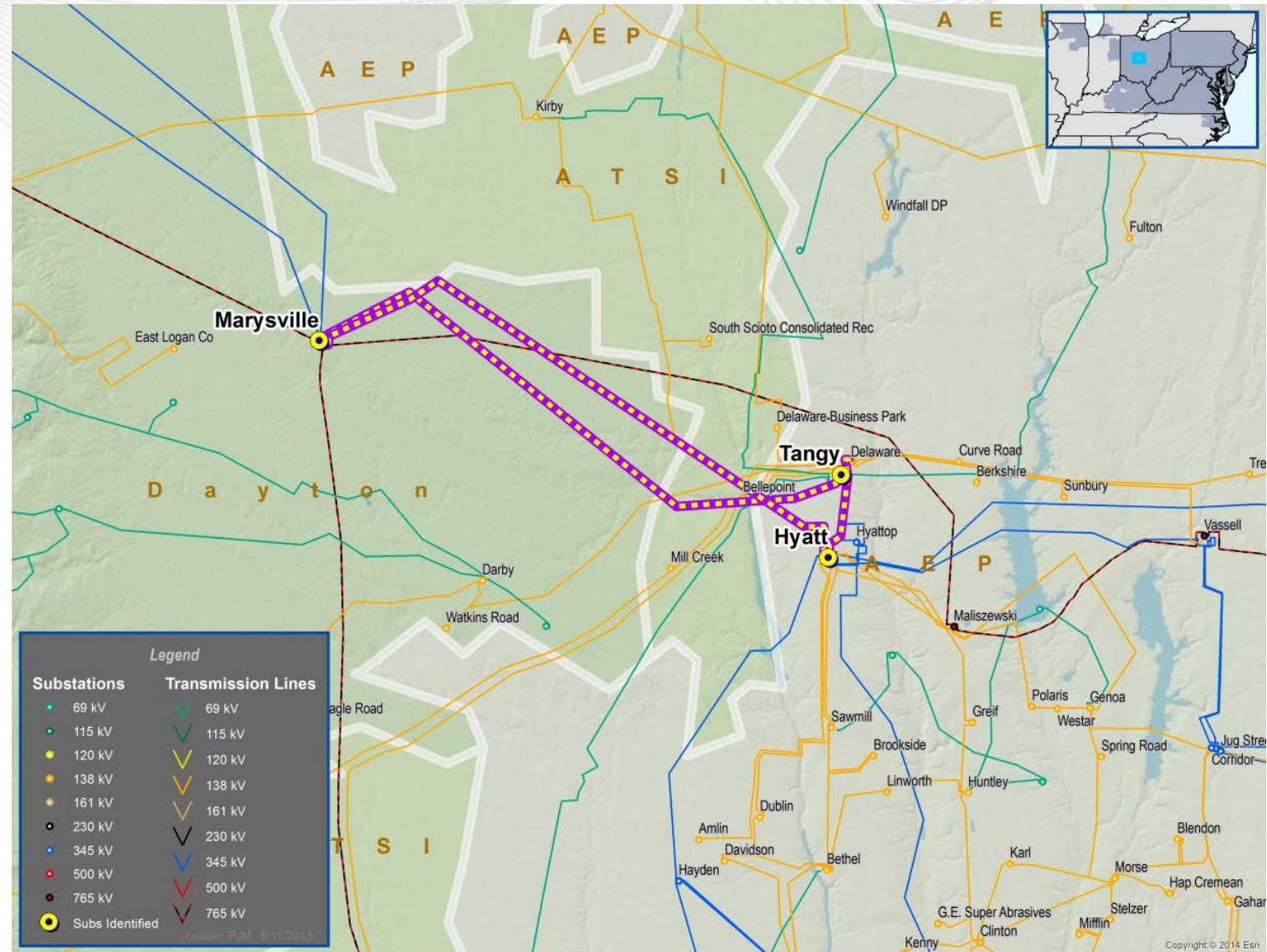


- Identified Routing Constraints:
 - City Land
 - VDHR Historic District
 - VA Scenic Bayways
 - VA Outdoors Foundation Easements
 - National Register of Historic Places and VA Landmarks Register
 - Pending VOF easements
 - Culpeper County Agricultural/Forestal Districts
 - ABPP Battlefield Study Areas
 - ABPP Core Area
 - VA Department of Historic Resources Easements

- Continue to investigate ROW and siting issues
- Reconsider relative merits and concerns related to the two options
 - September 2015
- Recommend the Pratts area solution to the PJM Board
 - October 2015

Supplemental Projects

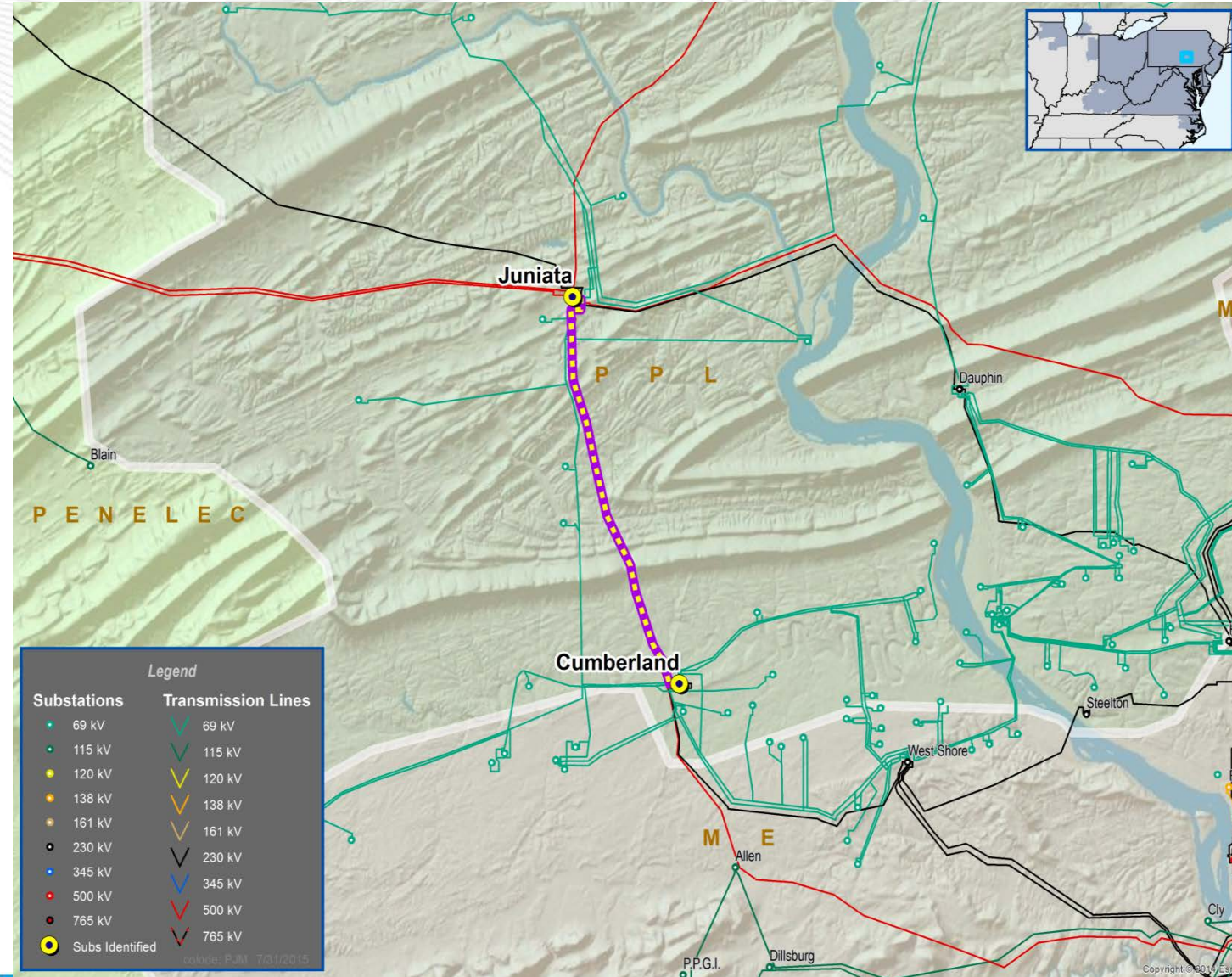
- **Supplemental Project**
- Operation Performance
- Perform a clearance study on the Marysville-Tangy 345 kV circuit, as well as, the Hyatt (OP)-Marysville 345 kV and Hyatt – Tangy 345kV circuits(S1006)
- Estimated Cost: \$0.036
- Projected IS Date: 10/31/2015



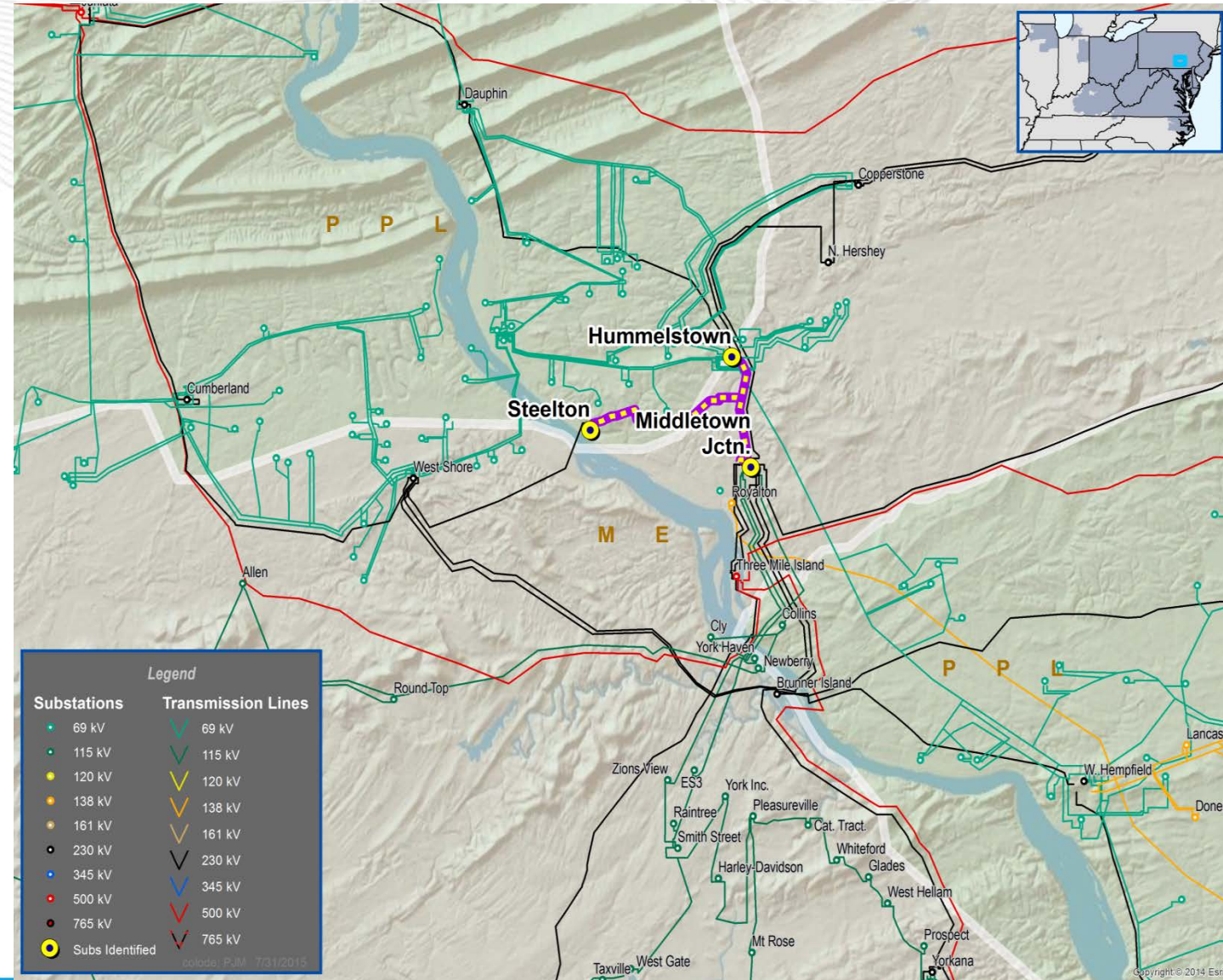
- Development of the PPL Electric Utility 10 year plan: 2015-2024
- Aging Infrastructure
 - A majority of PPL EU's transmission system was installed during expansion periods and it is now approaching the time where structures should be replaced to maintain integrity.
- Increase system reliability
 - Using latest PPL specifications in rebuilds will decrease the frequency and duration of outages due to failed components, lightning, and other weather-related events.
 - Rebuilding facilities to current standard designs will eliminate line tapped transformers at regional substations.
- Reduction in Maintenance Costs
- Combat specific line failure concerns
 - Particular assets though the industry standard at the time, such as cellon treated poles, wood upswept arms, conductor splices, were prone to increase in degradation.

- **Address Worst Performing Circuits**
 - PPL has identified worst performing circuits which increase customer outages. Improvement on these lines will improve quality of service
- **Increase in capabilities of equipment**
 - Rebuilds utilizing new technology will provide better communication, analytics and operations that will restore customers in shorter periods of time.
- **Work Efficiency**
 - Bundling of work together will reduce outage impact to customers
- **Relays and Control Houses**
 - Reduced maintenance, remote monitoring, improved data recording, supports PPL EU fiber, upgrades, and upgraded battery systems.

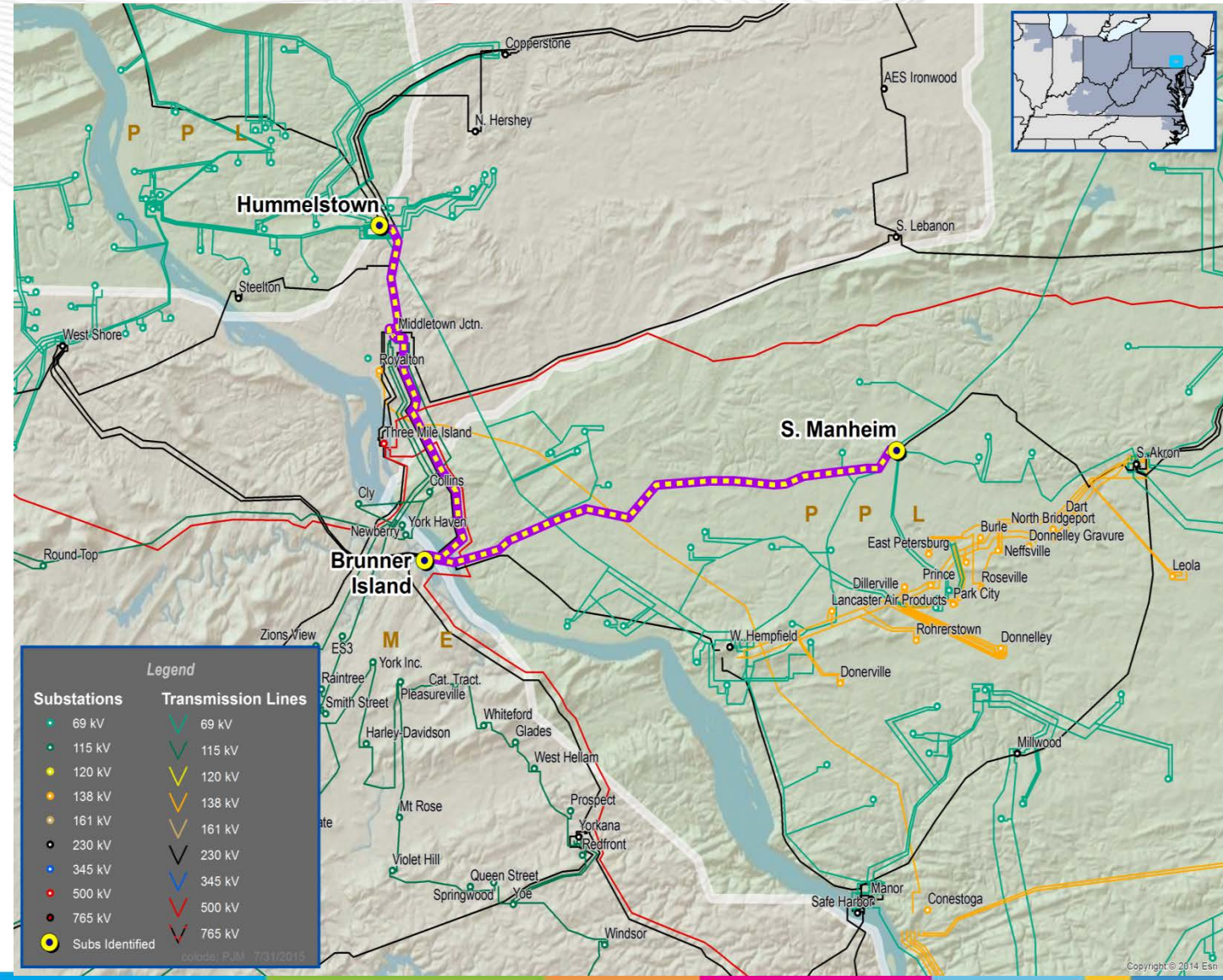
- Supplemental Upgrade:
 - Rebuild the Juniata - Cumberland 230 kV Line (14.2 mi). (S0945.8)
- Estimated Project Cost: \$ 30.6 M
- Projected IS Date: 12/31/2021



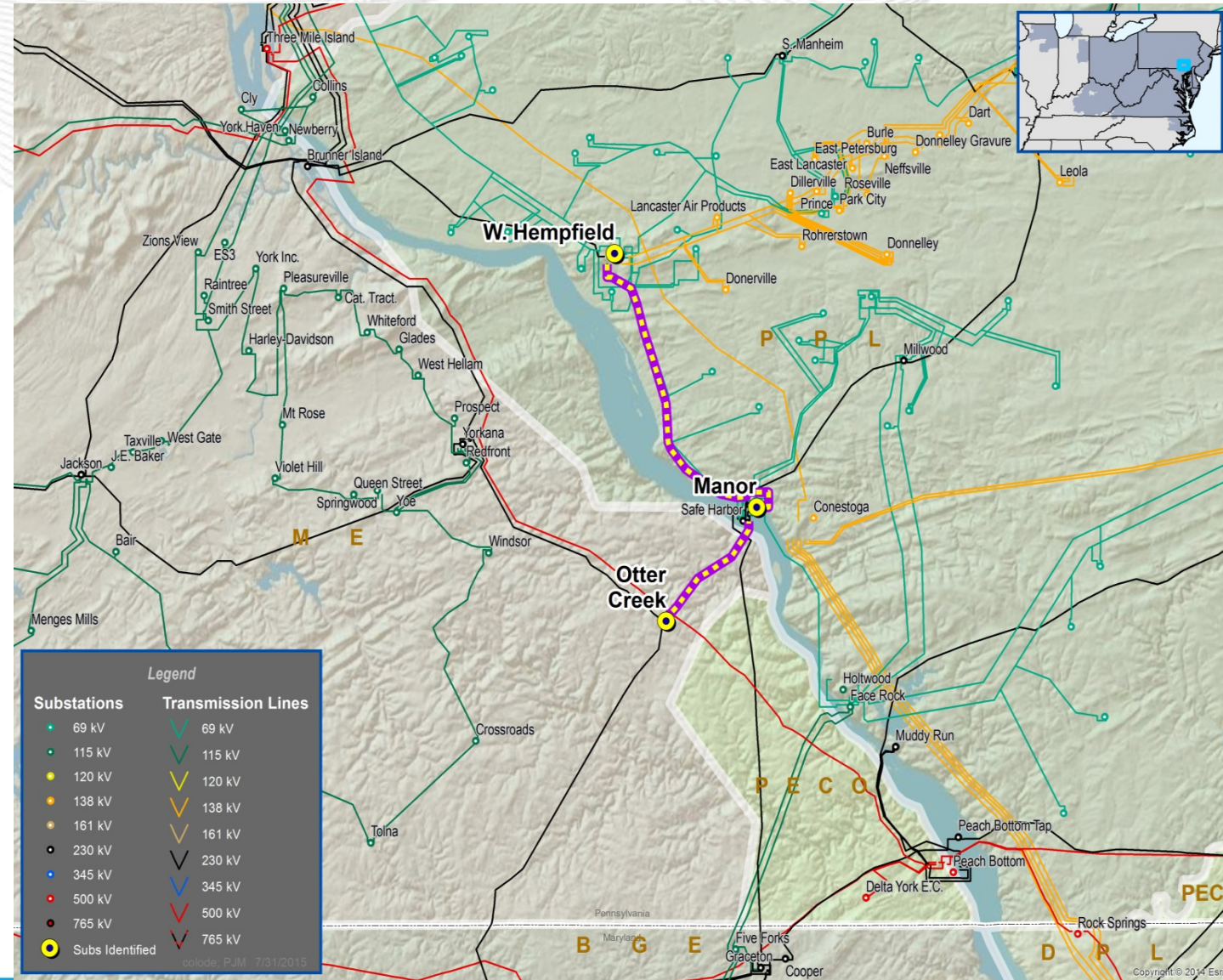
- Supplemental Upgrade:
 - Rebuild Hummelstown - Middletown Junction #1 230 kV line (7 mi). (S0948.1)
 - Rebuild Hummelstown - Steelton 230 kV line (6.8 mi). (S0948.2)
- Estimated Project Cost: \$ 37 M
- Projected IS Date: 12/31/2018



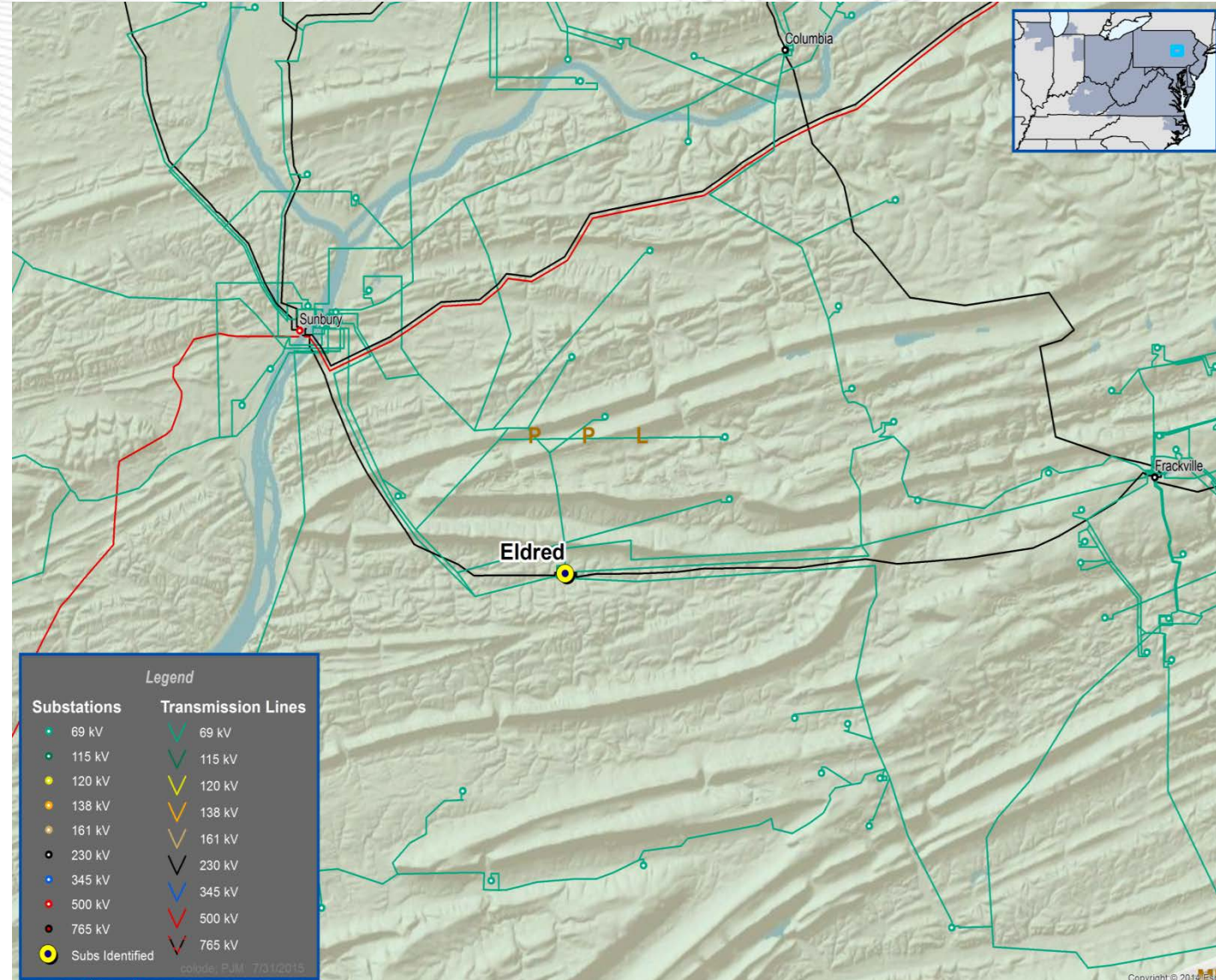
- **Supplemental Upgrade:**
 - Rebuild Brunner Island - South Manheim 230 kV (17.8 mi). (S0951.2)
 - Upgrade Brunner Island 230 kV Switchyard. (S0951.3)
 - Rebuild South Manheim 230 kV yard. (S0951.4)
- **Estimated Project Cost:**
\$ 52 M
- **Projected IS Date:**
12/31/2021



- Supplemental Upgrade:
 - Rebuild West Hempfield - Manor 2 230 kV line (9.1 mi). (S0955.5)
 - Rebuild Manor - Otter Creek 230 kV line (5.9 mi). (S0955.6)
- Estimated Project Cost: \$ 28.1 M
- Projected IS Date: 11/30/2023



- Supplemental Upgrade:
 - Rebuild the Eldred 230 kV Yard. (S0965.7)
- Estimated Project Cost: \$ 9.1 M
- Projected IS Date: 2/28/2022





Board White Paper Summary



RTEP Next Steps

Questions?

Email: RTEP@pjm.com

- Revision History
 - Original version distributed to the PJM TEAC