



Reliability Analysis Update



Transmission Expansion Advisory
Committee

September 14, 2017



2017 RTEP Analysis Update



Anticipated Ohio Valley Electric Corporation (OVEC) Integration Analysis Results

- Anticipated Integration Date
 - 3/1/2018
- Generation
 - Clifty Creek ~1.3 GW coal fired generation
 - Kyger Creek ~1.1 GW coal fired generation
- Transmission
 - 345 kV transmission
- Load
 - Less than 50 MW

- Baseline RTEP integration analysis performed
 - Thermal & Voltage
 - N-1
 - Generator Deliverability
 - Short Circuit
 - Dynamic Stability

Baseline Reliability – Generator Deliverability and Common Mode Violation (pending OVEC integration into PJM)

Problem Statement: The Dearborn – Clifty 345KV line is overloaded for the loss of either the JK Smith – Dale 138kV line or the Jefferson – Greentown 765kV line fault with a stuck breaker at the Jefferson 765kV.

Immediate Need Solution:

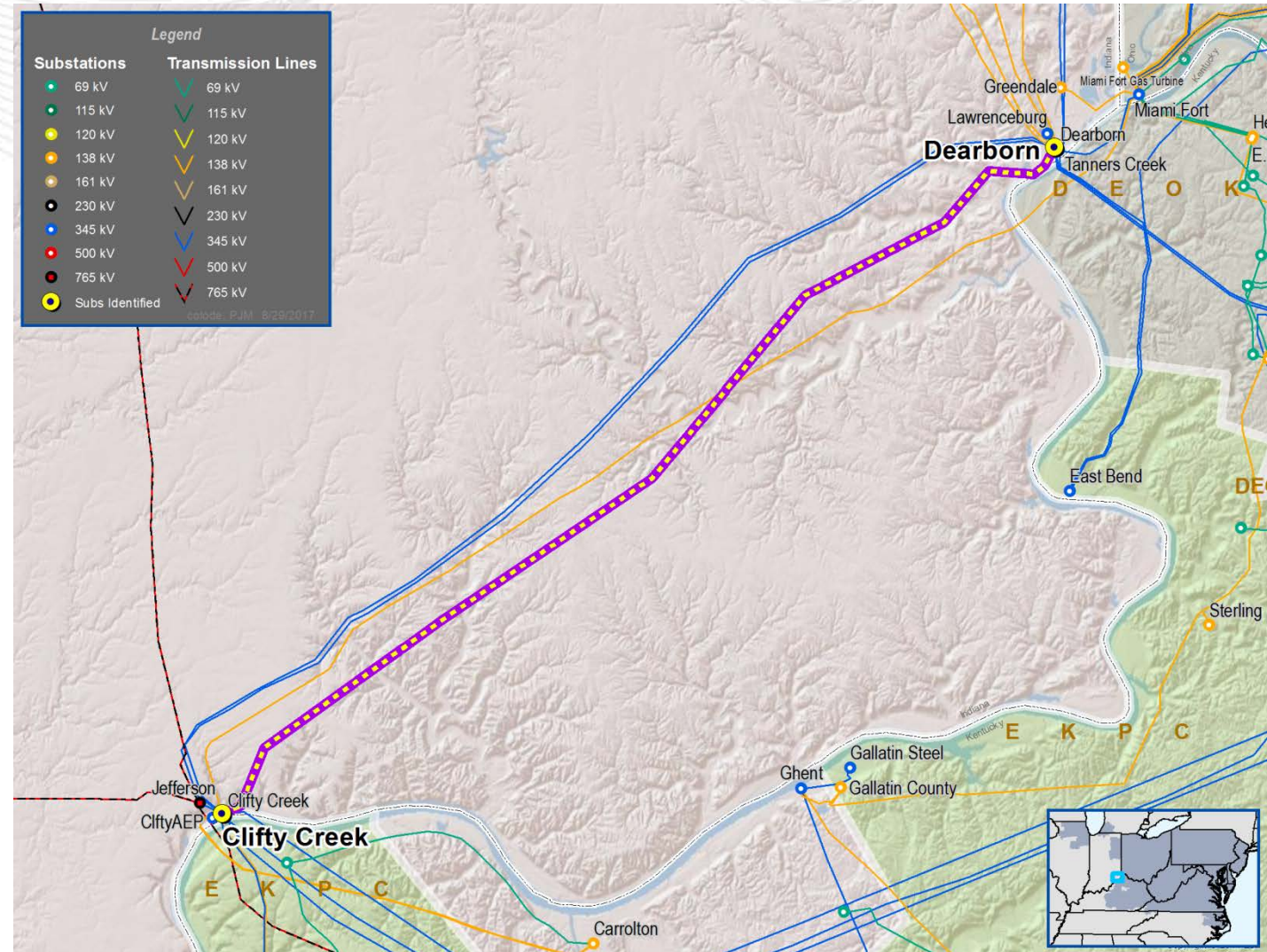
Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

Recommended Solution:

Perform a LIDAR study on the Clifty Creek - Dearborn 345 kV line to increase the Summer Emergency rating above 1023MVA). (B2943)

Estimated Project Cost: \$0.168 M

Required IS Date: 6/1/2018



Natural Gas Contingency Scenario Analysis Results

- **Study cases:** 2022 Winter Peak case and Summer Peak case
- **Study type:** N-1, N-1-1 thermal, N-1-1 voltage and Load deliverability voltage
 - In the N-1-1 test, Gas contingencies were studied as the first contingency with the second contingency being the loss of another single system element
 - In Load Deliverability voltage test, the gas event is applied as an N-1 single contingency
- **Study focus:** Voltage collapse or system cascading
- **Gas contingencies:**
 - 26 PJM gas pipeline outage / compressor contingencies that result in 1000 MW or more of generation loss (Assume that all gas generation downstream is lost, regardless of dual fuel status)
 - 4 temperature threshold contingencies (Assume that non-firm customers will be interrupted at a pre-determined threshold) which are only applied to winter case
 - 8 gas contingencies defined and identified by PJM Operation as impactful in their EMS analysis (5 for gas compressor failure and 3 for gas LDC failure).

- **2022 Winter Results:**

- N-1:

- Thermal: No overload identified
 - Voltage Magnitude:
 - All 38 contingencies converge;
 - High Voltage at 345KV and 230KV buses in Eastern Mid-Atlantic PJM (EMAAC) are observed for 6 gas contingencies
 - No low voltage issue
 - Voltage Drop: No issue identified

- N-1-1:

- Thermal: No overload identified
 - Voltage Magnitude
 - All contingency pairs converge;
 - High Voltage at 138KV and 230KV buses in EMAAC are observed for 11 gas contingencies (paired with another single contingency)
 - No low voltage issue
 - Voltage Drop
 - All contingency pairs converge;
 - All voltage drop are within Emergency limits

- Load Deliverability Voltage:

- All gas contingencies converge
 - No voltage issue identified

- **2022 Summer Results:**

- N-1:

- Thermal: No issue
- Voltage Magnitude: No issue
- Voltage Drop:

- 3 of the 34 gas contingencies (the low temperature threshold contingencies were not applied due to summer conditions) studied show voltage collapse. Two of them 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 one is LDC failure contingency in EMAAC.
- 3 other pipeline outages show voltage drop violations at several 500kV buses in EMAAC

- **2022 Summer Results:**

- N-1-1:
 - Thermal
 - 3 gas contingencies (paired with another single contingency) result in thermal overloads in ComEd and 8 gas contingencies (paired with another single contingency) result in overloads in EMAAC. None have cascading consequences.
 - Voltage Magnitude
 - All contingency pairs converge
 - Low Voltage at 500KV and 230KV buses in EMAAC are observed for 8 gas contingencies (paired with another single contingency) . Among these 8 gas contingencies, the majority result in mild voltage magnitude violations at a limited number of locations. Two of the 8 gas contingencies result in low voltage in a large area. Both are pipeline outages in EMAAC with one losing more than 11,000MW generation and the other losing more than 10,000MW generation
 - Voltage Drop
 - In addition to the 3 contingencies not converged in N-1 voltage drop test, 5 more gas contingencies do not converge after paired with several specific single contingencies; All these contingencies are in EMAAC
 - Voltage Drop violations at several 500KV and 230KV buses in EMAAC are observed for 8 gas contingencies (paired with another single contingency)
 - One gas contingency paired with another specific single contingency results in mild voltage drop violations at several 500kV buses in EMAAC. Two of the 8 gas contingencies causes low voltage in large area.
- Load Deliverability Voltage: LDAs EMAAC, SWMAAC, MAAC, PSGE, PSNORTH, BGE, and ComEd show not converged for multiple gas contingencies

- **Observations:**

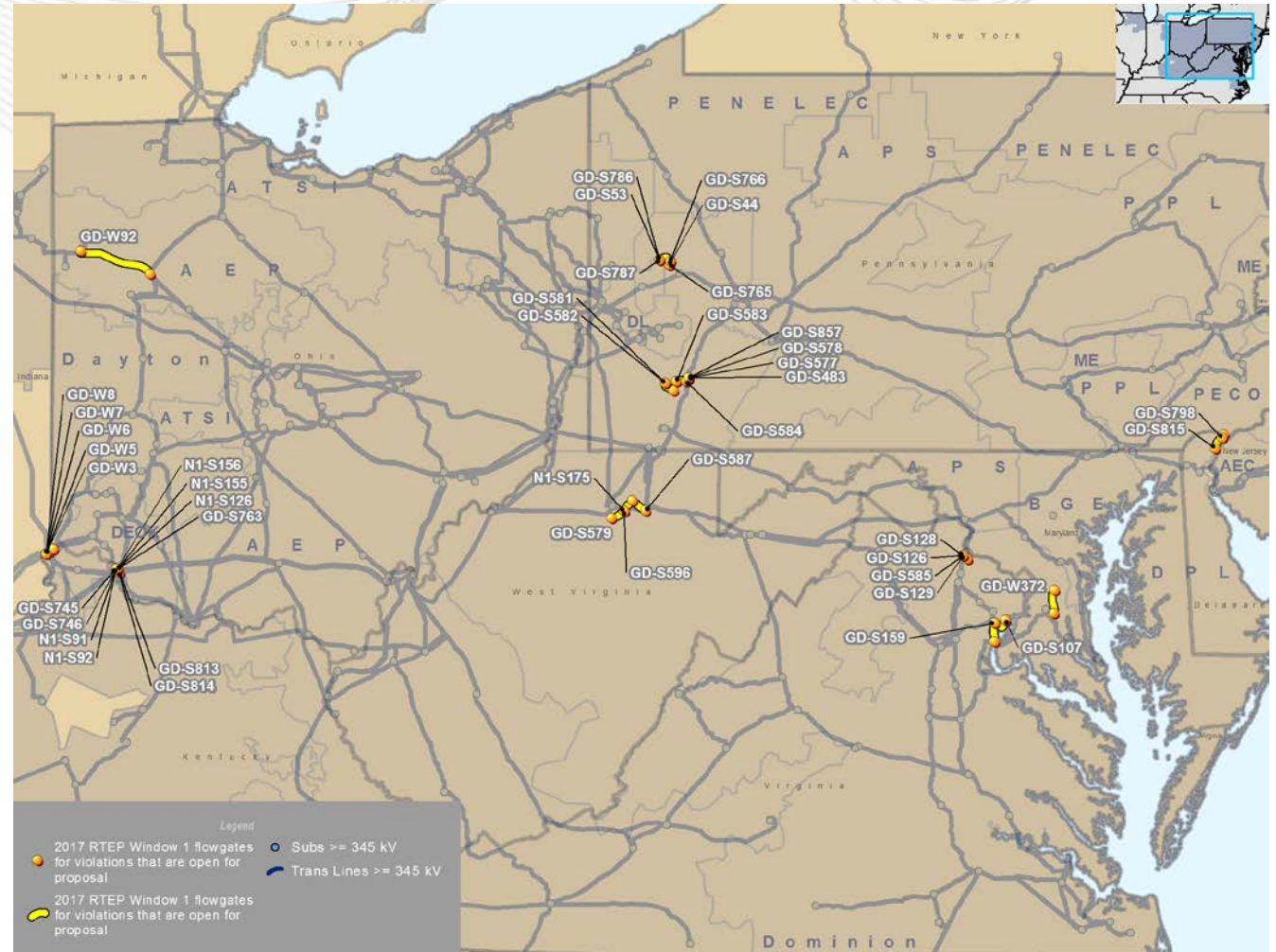
- The current study procedure is conservative
 - In this analysis, the simultaneous and instantaneous loss of power plants for gas contingency events is assumed. If there were actual failure of a compressor station or pipeline, the actual impact to the power plants is the loss of gas pressure which may take minutes or hours.
 - In this analysis, the loss of the gas plant is assumed regardless of dual fuel capability. In actual operations, plants with dual gas sources may be less impacted. Dual fuel units may also take hours or days to switch to an alternate fuel.
 - The probability of a gas LDC failure is very low since there may be more than one source of supply. In our study, we treat all the gas contingencies the same
- In general, our system is robust for gas contingencies
 - No voltage collapse or cascading result was demonstrated in the winter study simulation
 - In summer, using the current methodology, there is potential for voltage collapse for 3 of the gas contingencies or combinations of some gas contingencies with specific single contingencies. The issues are mainly in EMAAC. There are several LDAs may also have potential voltage collapses with system generation and load emergency condition plus gas contingency at the same time

- **Suggestions for next step:**

- Refine gas contingency definitions to considering the benefit of dual fuel.

2017 Proposal Window Update

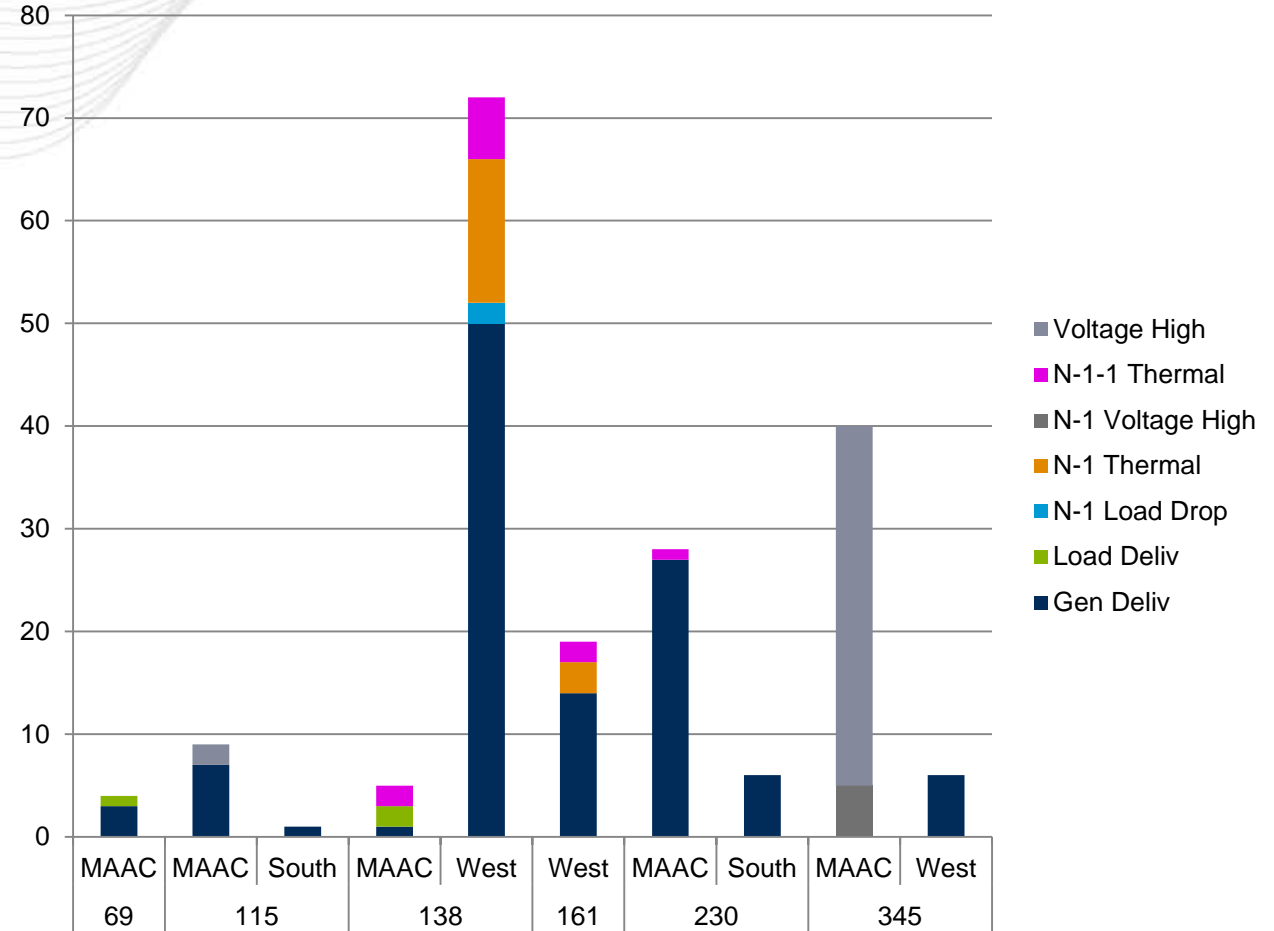
- 190 flowgates
- 2022 conditions
- Summer, Winter & Light Load
- Includes both voltage and thermal violations





2022 Analysis Violations

Count of FG #	Gen Deliv	Load Deliv	N-1 Load Drop	N-1 Thermal	N-1 Voltage High	N-1-1 Thermal	Voltage High	Grand Total
69	3	1						4
MAAC	3	1						4
South								0
115	8						2	10
MAAC	7						2	9
South	1							1
138	51	2	2	14		8		77
MAAC	1	2				2		5
West	50		2	14		6		72
161	14			3		2		19
West	14			3		2		19
230	33					1		34
MAAC	27					1		28
South	6							6
345	6				5		35	46
MAAC					5		35	40
West	6							6
Grand Total	115	3	2	17	5	11	37	190



Overview of 2022 Results

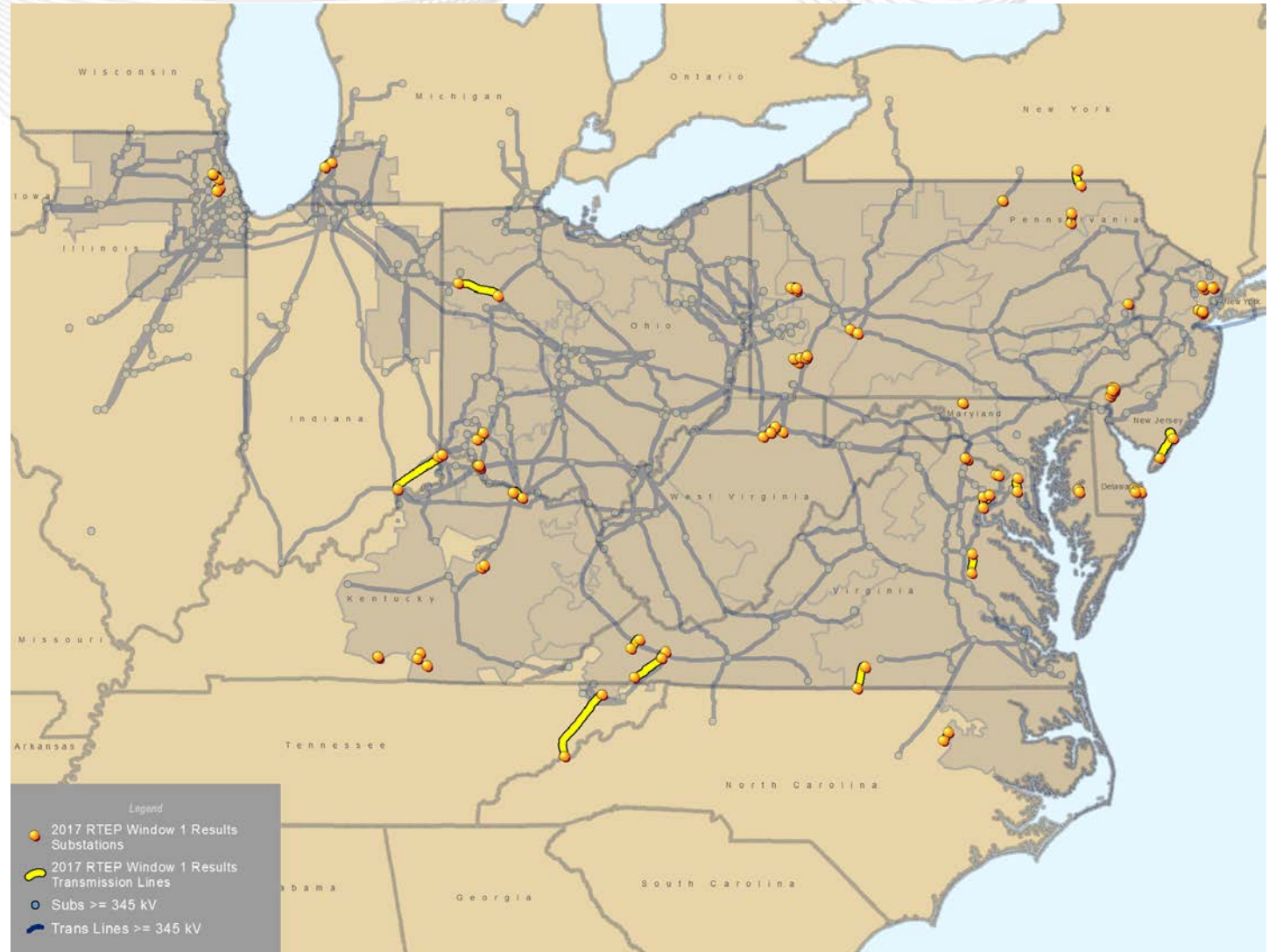
Total of 190 flowgates identified

- 40 included in the window
 - 32 in West region
 - 5 in the South region
 - 3 in the MAAC region

- 150 flowgates excluded
 - Immediate need (PJM OA 1.5.8(m)) (Includes Generator Deactivation related)
 - < 200kV (PJM OA 1.5.8(n))

2017 RTEP Proposal Window 1 - Violations

- 40 flowgates are window eligible
- Includes both voltage and thermal violations



- Timeline
 - Window Opened: July 11th, 2017
 - Window Closed: August 25th, 2017
 - Proposal definitions, simulation data and detailed cost data all due at this time
- PJM requested proposals for 40 reliability violation flowgates
- 51 Proposals received from 10 entities addressing 9 target zones
 - 29 Greenfield
 - 22 Transmission Owner Upgrade

Immediate Need Baseline Upgrades



Baseline Analysis Voltage (Summer, Winter and Light Load) and Operational High Voltage Issue:

Problem Statement:

- The Mainesburg 345 kV station has been experiencing a high voltage issue in the last couple of years. In addition, the 2022 RTEP analysis shows high voltage issue for several contingencies, for all seasonal basecases.

Immediate Need:

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

Recommended Solution:

- Install two 345 kV 80 MVAR shunt reactors at Mainesburg station. (B2944)
 - Estimated Project Cost: \$11.493 M

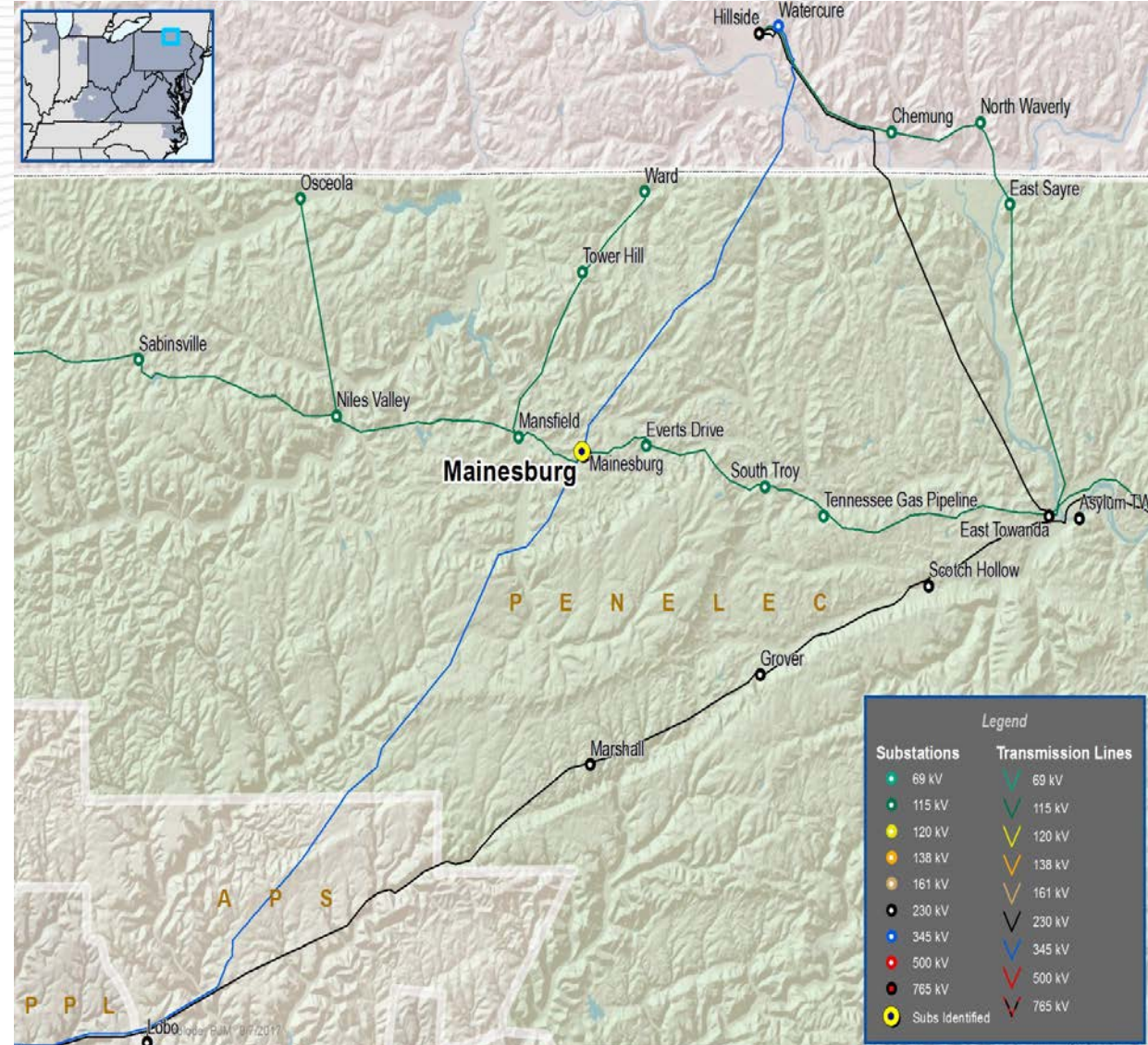
Alternative Solution:

- No alternative considered

Required IS date: 6/1/2017

Expected IS date: 10/1/2019

Project Status: Engineering





PSEG Transmission Zone Baseline Project

Generation Deliverability and N-1-1 (Summer):

Problem Statement:

- Bergen 138kV station has series reactors installed on the two (2) 138kV underground circuits leaving the station, one on the M-1339 (Bergen – Fair Lawn) and one on the R-1344 (Bergen – East Rutherford).
- The M-1339 reactor is 46 years old, installed in 1971
- The R-1344 reactor is also 46 years old, installed in 1971
- Both reactors have the ability to be shunted.
- Failure of the M-1339 reactor overloads the Bergen – Fair Lawn 138 kV circuit and/or failure of the R-1344 reactor overloads the Bergen – East Rutherford 138 kV circuit.

Immediate Need:

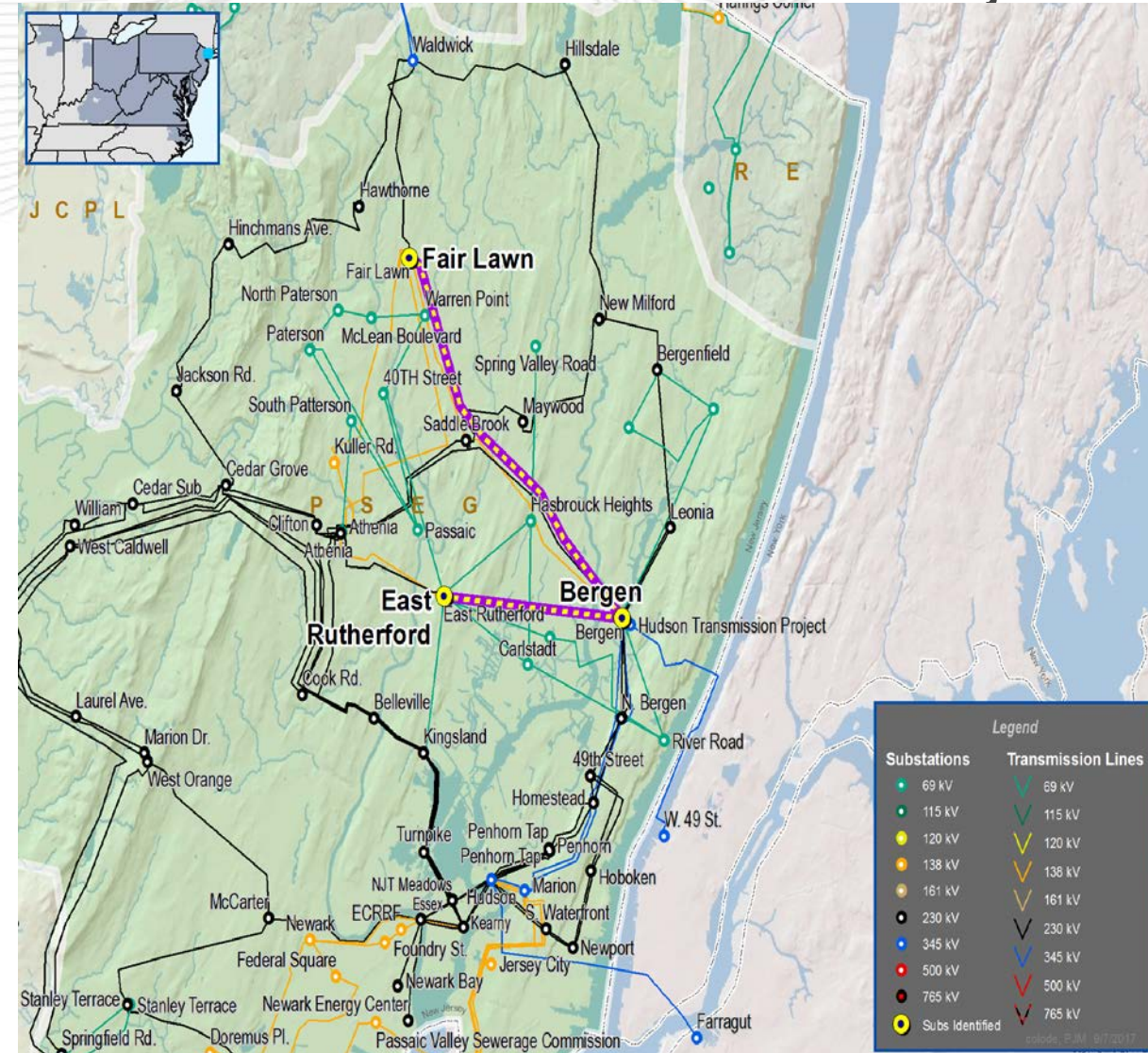
- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

Alternative solutions under consideration:

- Retirement of circuits - Not viable because of the need to supply load. Limits generation output at Bergen. Removes two supplies to load pocket.
- Replace with 138kV XLPE type cable - Maintains same voltage. Eliminates need for stop joints. Lower O&M. Resolves thermal issues.
- Conversion to 230kV - Potential short-circuit issues being studied. Utilizes existing 3000kcmil conductors. Resolves thermal issues.
- Conversion to 345kV - Provides higher capacity. Addresses any potential short-circuit issues. Resolves thermal issues.

Required IS date: 6/1/2018

Project Status: Conceptual





PSEG Transmission Zone

Generation Deliverability (Summer and Winter):

Problem Statement:

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

Immediate Need:

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

Potential Solution:

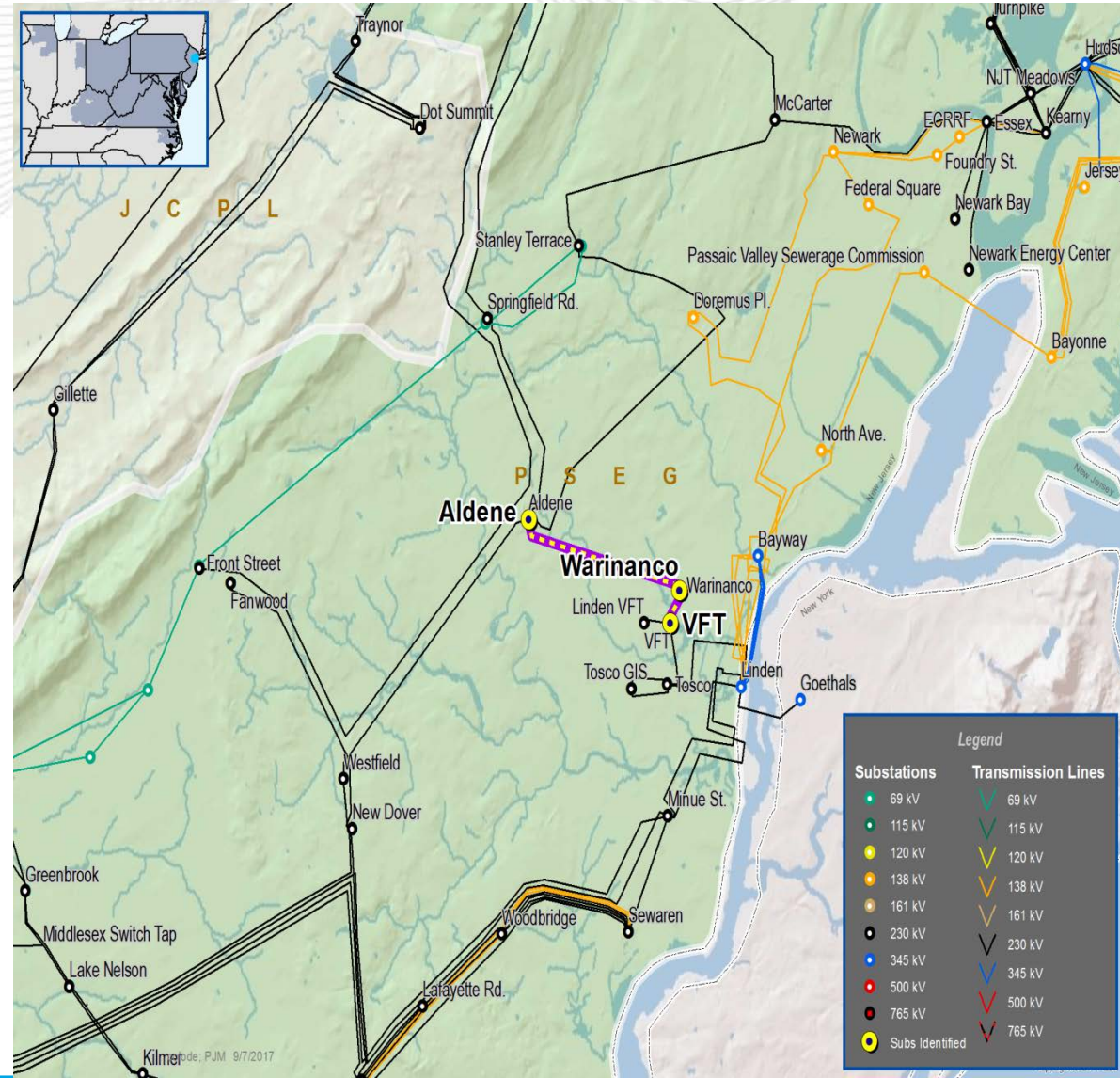
- Wreck and re-build the VFT – Warinanco – Aldene 230 kV circuit with paired conductor. Addresses tower age. Does not require new right of way. Paired conductor can address load requirement with room for future growth.

Alternative Solutions:

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

Required IS date: 6/1/2018

Project Status: Conceptual



Generation Deliverability (Summer):

Problem Statement:

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

Immediate Need:

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

Potential Solution:

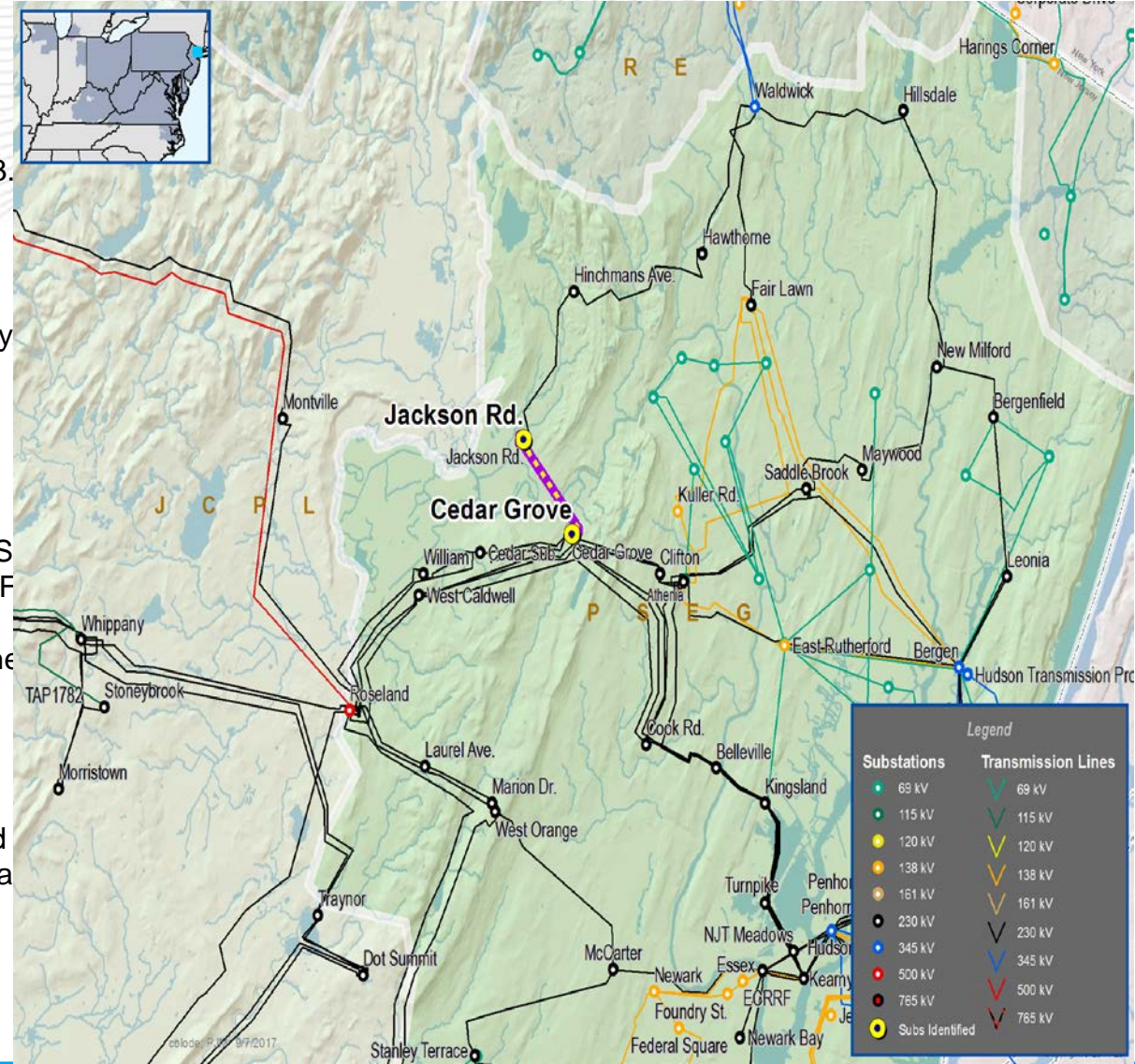
- Reconductor 3.85 miles of the Cedar Grove – Jackson Rd. 230 kV circuit with 3500 kcmil underground, pipe-type cable.

Alternative Solution:

- Install parallel XLPE cable - Requires opening the street, two river crossing, and two US highway crossings. Would result in an impedance imbalance between the existing HPFF and new XLPE. Does not address age of the existing cable. Per mile cost is over twice that of reconductoring HPFF. Requires two new terminations, which will further add to the alternative cost.
- Replace existing cable with XLPE cable - Requires opening the street, two river crossing, and two US highway crossings. Per mile cost is approximately twice that of reconductoring HPFF.
- Replace with overhead construction - Need right of way. Surrounding area is developed and densely populated. Requires two river crossings, interstate highway crossing, and a U.S. route crossing. Airport nearby. The construction of this alternative is not feasible.

Required IS date: 6/1/2018

Project Status: Conceptual





PSEG Transmission Zone

N-1-1 Thermal (Summer):

Problem Statement:

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

Immediate Need:

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

Potential Solution:

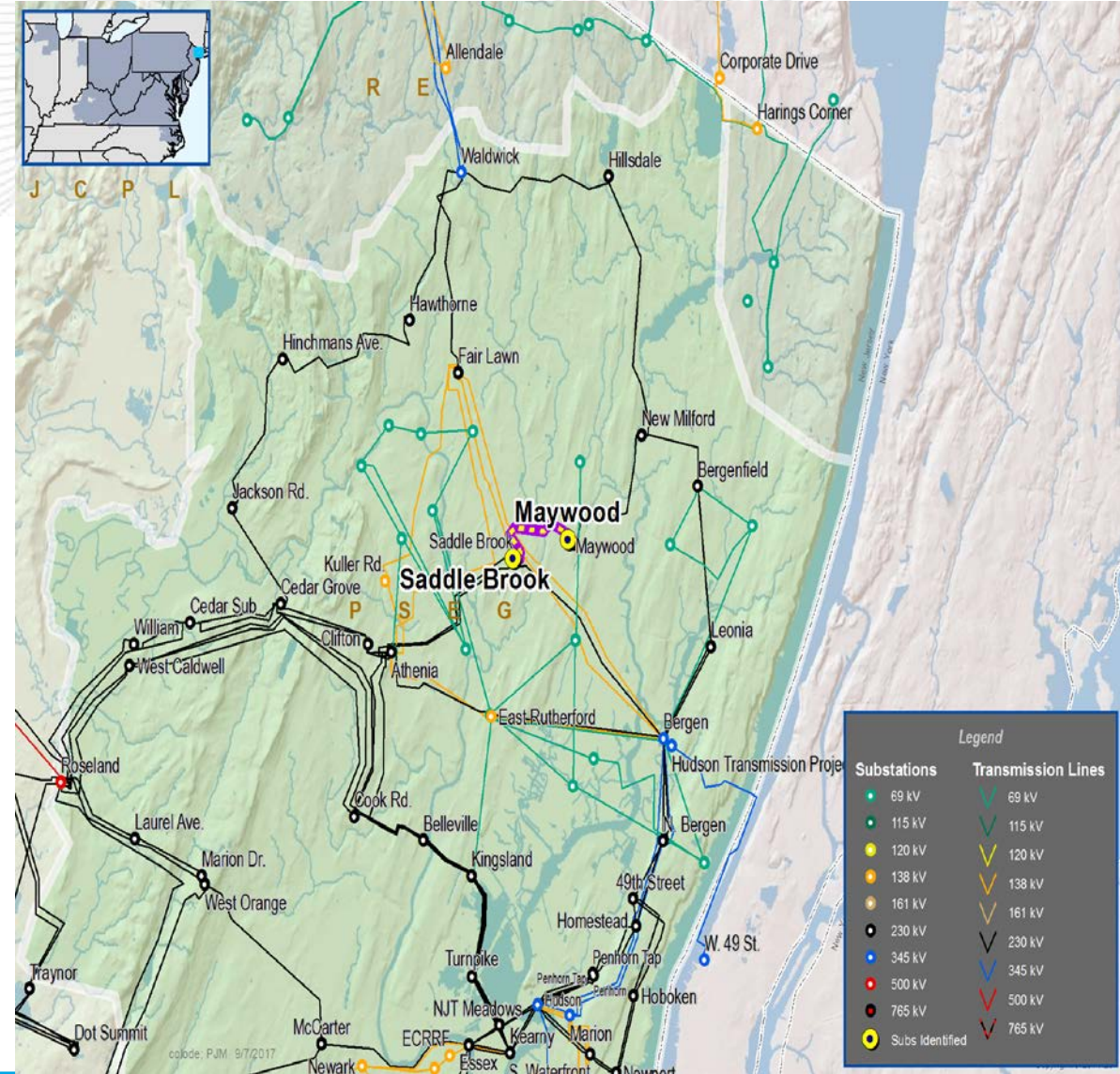
- Reconductor 2.71 miles of the Maywood – Saddle Brook 230 kV circuit with 3500 kcmil underground, pipe-type cable.

Alternative Solution:

- Install parallel XLPE cable - Requires opening the street, a river crossing, and three US highway crossings. Would result in an impedance imbalance between the existing HPFF and new XLPE. Does not address age of the existing cable. Per mile cost is over twice that of reconductoring HPFF. Requires two new terminations, which will further add to the alternative cost.
- Replace existing cable with XLPE cable - Requires opening the street, a river crossing, and three US highway crossings. Per mile cost is approximately twice that of reconductoring HPFF.
- Replace with overhead construction - Need right of way. Surrounding area is developed and densely populated. Requires a river crossing, interstate highway crossing, and U.S. route crossings. Airport nearby. The construction of this alternative is not feasible.

Required IS date: 6/1/2018

Project Status: Conceptual



Operational Performance

Baseline Reliability – Operational Performance High Voltage at Davis Besse

Problem Statement:

Over the past year, Transmission Operations and the Davis Besse nuclear power plant have experienced high voltage operational alerts and warnings due to transmission system voltages that have exceeded the power plants technical specification limits under system light load conditions.

Immediate Need:

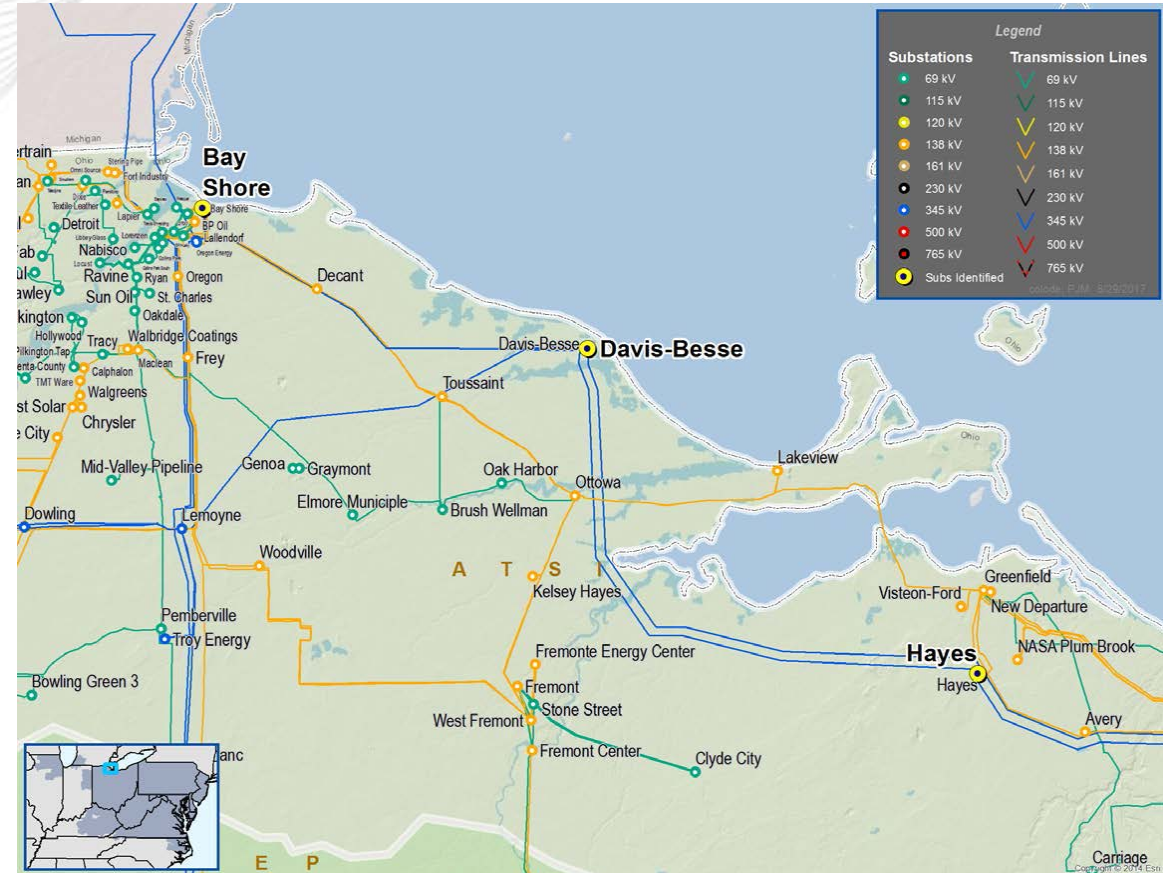
Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner (TO) will be the Designated Entity.

Recommended Solution:

- Install a 100MVAR 345kV shunt reactor at Hayes substation (B2942.1)
- Install a 200MVAR 345kV shunt reactor at Bayshore substation (B2942.2)

NOTE: An existing operational switching solution has been implemented in the past to assist with in the mitigation of the high system voltage until a solution is fully implemented.

Continued on next slide...



Baseline Reliability – Operational Performance High Voltage at Davis Besse

...Continued from previous slide

Estimated Project Costs:

Hayes substation reactor (B2942.1) - \$5.7M

Bayshore substation reactor (B2942.2) - \$5.0M

Required IS Date: Now

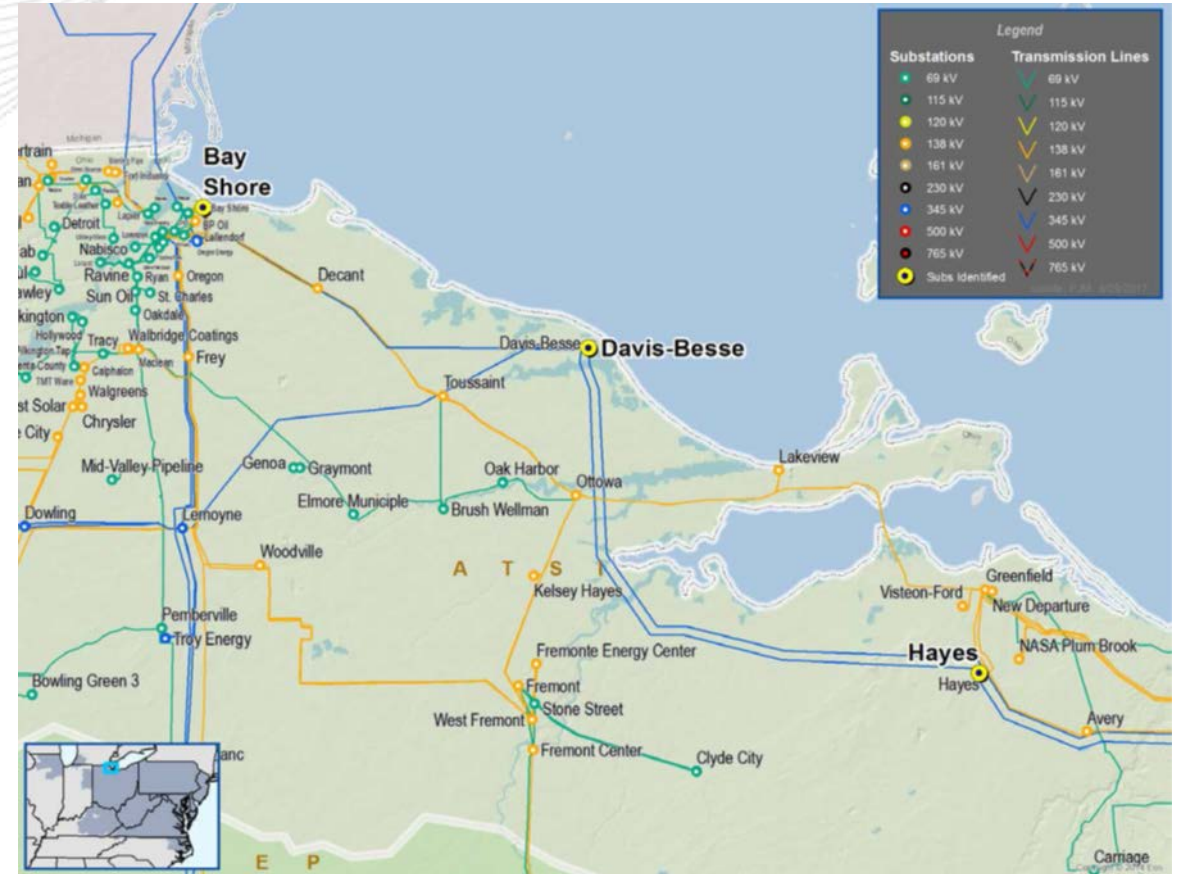
Projected IS Date:

10/31/2017 for Hayes substation reactor (B2942.1)

10/31/2018 for Bayshore substation reactor (B2942.2)

Benefit:

Operational flexibility to adjust the system voltage at the Davis Besse 345kV bus under light conditions with both reactors on-line.



Dominion Update End of Life Criteria



Dominion Transmission Zone Baseline Project

Baseline Reliability - TO Criteria Violation

Line #2144 Winfall to Swamp is at its End of Life

Date Project Last Presented: 8/10/2017 TEAC

Problem Statement: Dominion “End of Life Criteria”

- 230kV Line #2144 Winfall - Swamp was constructed mostly on wood H frames in 1968. This line needs to be rebuilt to current standards based on Dominion’s “End of Life” criteria. The existing summer emergency rating of this line is 478 MVA. The existing conductor is 1109 ACAR (24/13).
- Rebuild is needed because:
 - Permanent retirement of Line #2144 changes 230kV Line #247 Suffolk - Swamp from a 230kV network line to a 31 mile long radial line serving 3900 customers.
 - The MW-mile for Line #247 Suffolk - Swamp would be 685 MW-mile based on the Winter 2025/26 projection. Dominion’s 700 MW-mile radial line criteria would be violated if 0.5 MW or more of new load were added in the future.
 - Contingencies result in reliability violations (low voltage) under stress case conditions (solar generation off line)

Recommended Solution:

- Rebuild 230kV Line #2144 from Winfall to Swamp (4.3 miles) to current standards with a standard conductor (bundled 636 ACSR) having a summer emergency rating of 1047 MVA at 230kV (**b2929**).

Estimated Project Cost: \$6 M

Required IS Date: Immediate

Projected IS Date: 12/30/2022

Project Status: Conceptual



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





Dominion Transmission Zone Baseline Project

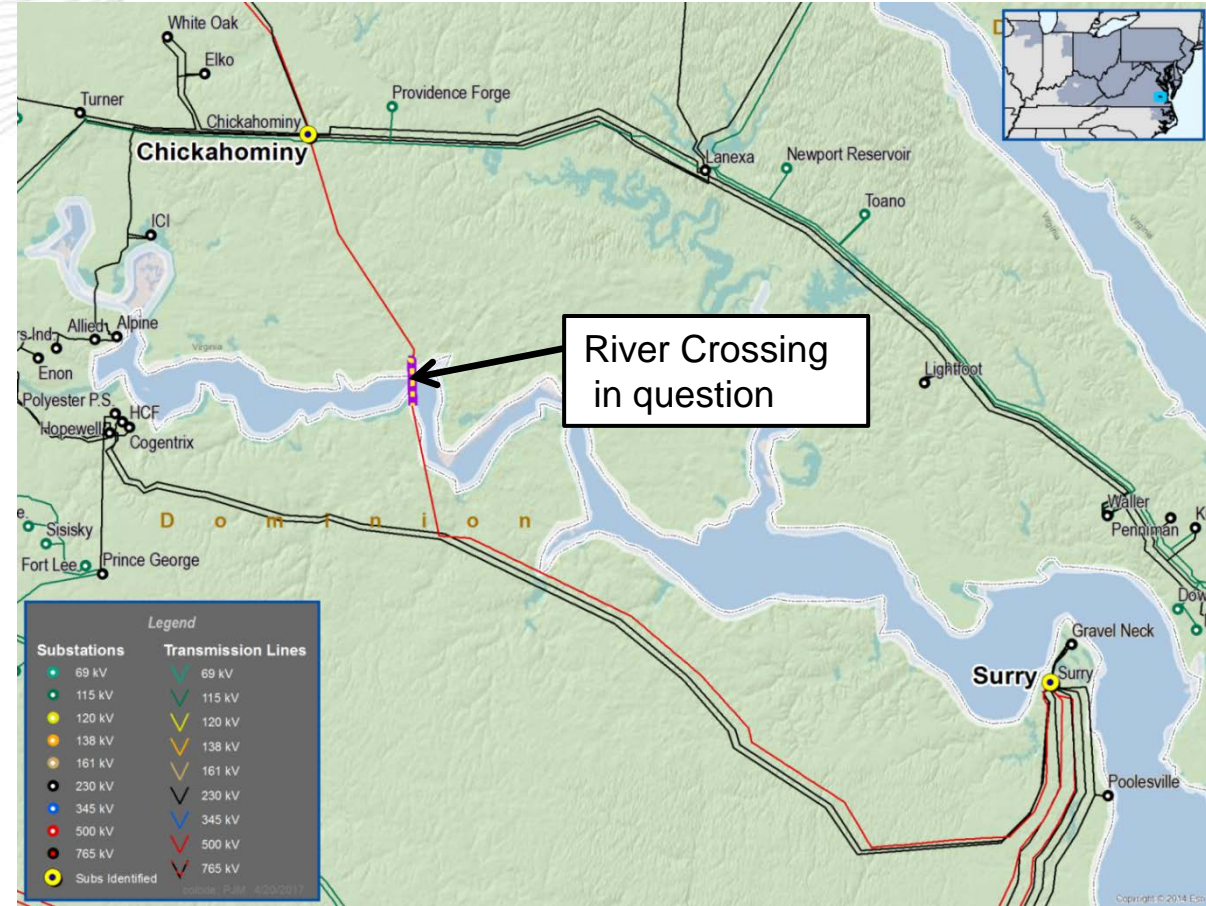
Baseline Reliability - TO Criteria Violation

Line #567 River Crossing Rebuild

Date Project Last Presented: 4/25/2017 SRTEP, 8/10/2017 TEAC

Problem Statement: Dominion “End of Life Criteria”

- This project was previously presented as a Supplemental Project (**s1280**)
- Baseline project classification due to characteristics of the problem
- Dominion filed an application with the Virginia SCC in December of 2016 to replace four structures of 500kV Line #567 (Chickahominy – Surry PS).
- Two of these structures are located in the James River and are approximately 400 feet tall and the other two structures are located on the rivers edge.
- These structures have deteriorated to a point that they need to be replaced. A specialized conductor was used in the construction of the river crossing which limits the line to 1954 MVA.
- This is the only location on Dominion's system that this conductor is used.
- Loss of Line #567 results in multiple Generation Deliverability violations:
 - 230kV Line #259 Chesterfield – Basin is overloaded for the loss of Line #563 Carson – Midlothian or the loss of 230kV Line #217 Chesterfield – Lakeside
 - 230 kV Line #2154 Skiffes Creek – Kings Mill is overloaded for the loss of Line # 563 Carson – Midlothian
 - 230kV Line #2154 Skiffes Creek – Kings Mill – Penniman – Waller is overloaded for stuck breaker 56372 at Carson
 - 500kV – 230 kV Transformer at Carson is overloaded for stuck breaker 562T563 at Carson
 - 230kV Line #259 Chesterfield – Basin is overloaded for stuck breaker 205T217 at Chesterfield



Continued on next slide...

Continued from previous slide...

Recommended Immediate Need Solution:

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

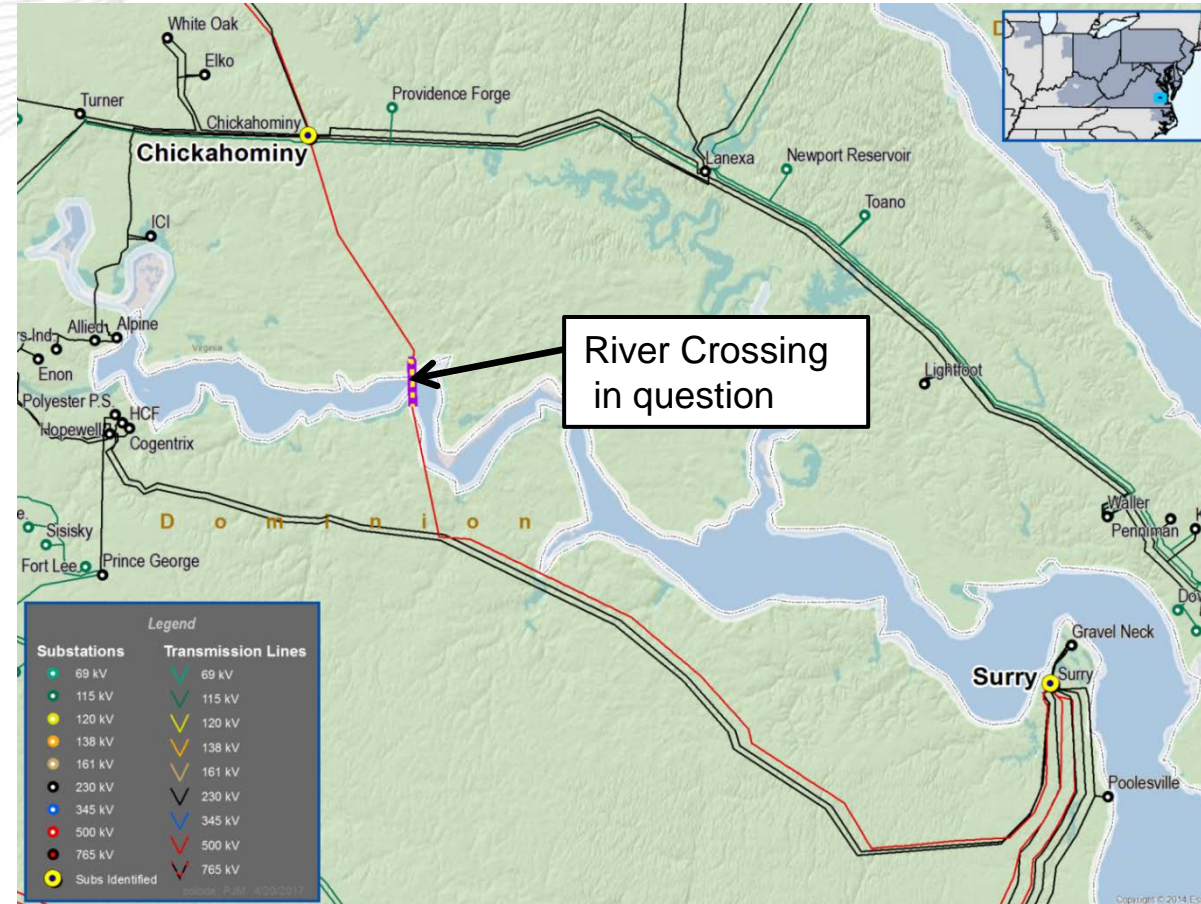
- Rebuild the four structures using galvanized steel and replace the river crossing conductor with 3-1534 ACSR.
- This will increase the 500kV Line #567 line rating from 1954 MVA to 2600 MVA (**b2928**).

Estimated Project Cost: \$41 M

Required IS Date: Immediate

Projected IS Date: 12/30/2017

Project Status: Engineering



Short Circuit Projects

Supplemental Projects

Supplemental Project: Broadford 765 kV CB-Q1 Replacement

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Broadford 765kV Q1 is a 50 kA air blast breaker type PK10D that will be replaced. PK's have historically presented a safety concern for field personnel in general. From experience, PK's are prone to catastrophic bushing failures (shards of porcelain are usually violently expelled from the bushing) and can result in injury to anyone inside the station. Additional drivers include age (1969 Mfg. year), number of fault operations (32; Mfg. recommendation is 10) and lack of available repair parts.

Potential Solution:

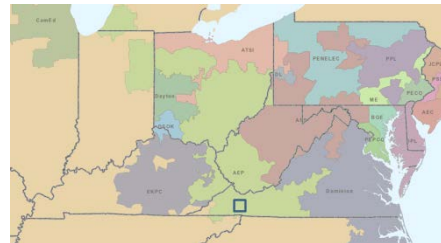
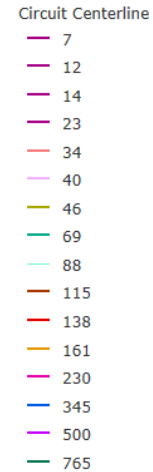
- Replace the 765kV Q1 Circuit Breaker with a new 4000A, 63KA breaker.

Alternatives: No feasible alternatives

Estimated Project Cost: \$3.3 M

Projected IS Date: 3/31/2019

Project Status: Engineering



Supplemental Project: Jacksons Ferry 765/500 XFR Replacement

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Several circuit breakers at Jacksons Ferry station are showing signs of deterioration. These breakers are 3000 A 50 kA air blast PK breakers, which present a significant safety concern for individuals entering the station. From historical experience AEP has determined that PK breakers are prone to catastrophic bushing failures which could result in injury to anyone inside the substation fence. The drivers for replacement of these breakers are age, potential bushing damage, number of fault operations, and a lack of available repair parts.

Transformer 1 phase 1 is showing significant signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings). All three phases of Transformer 1 will be replaced with 500 MVA units.

Potential Solution:

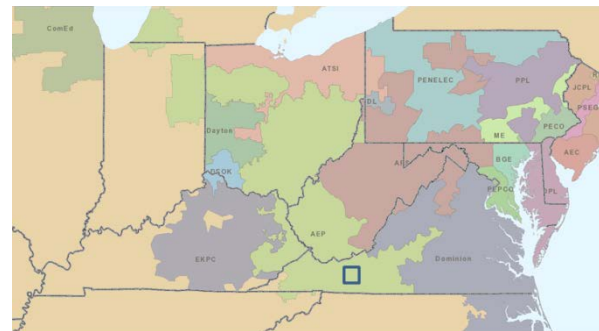
- Replace Jacksons Ferry 765/500 kV 500 MVA Transformer #1 and 138kV Circuit Breaker 'R1', 'P', and 'P2' with 3000A 63kA Circuit Breakers.

Alternatives: No feasible alternatives

Estimated Project Cost: \$27 M

Projected IS Date: 12/01/2020

Project Status: Scoping





Dominion Transmission Zone Supplemental Project

Supplemental Project: Allied 230kV Line #2049 and #2050 Terminal Equipment Replacement

Problem Statement:

- Allied substation 230kV Line #2049 and #2050 terminal equipment needs to be replaced due to age and operational issues.

Potential Solution:

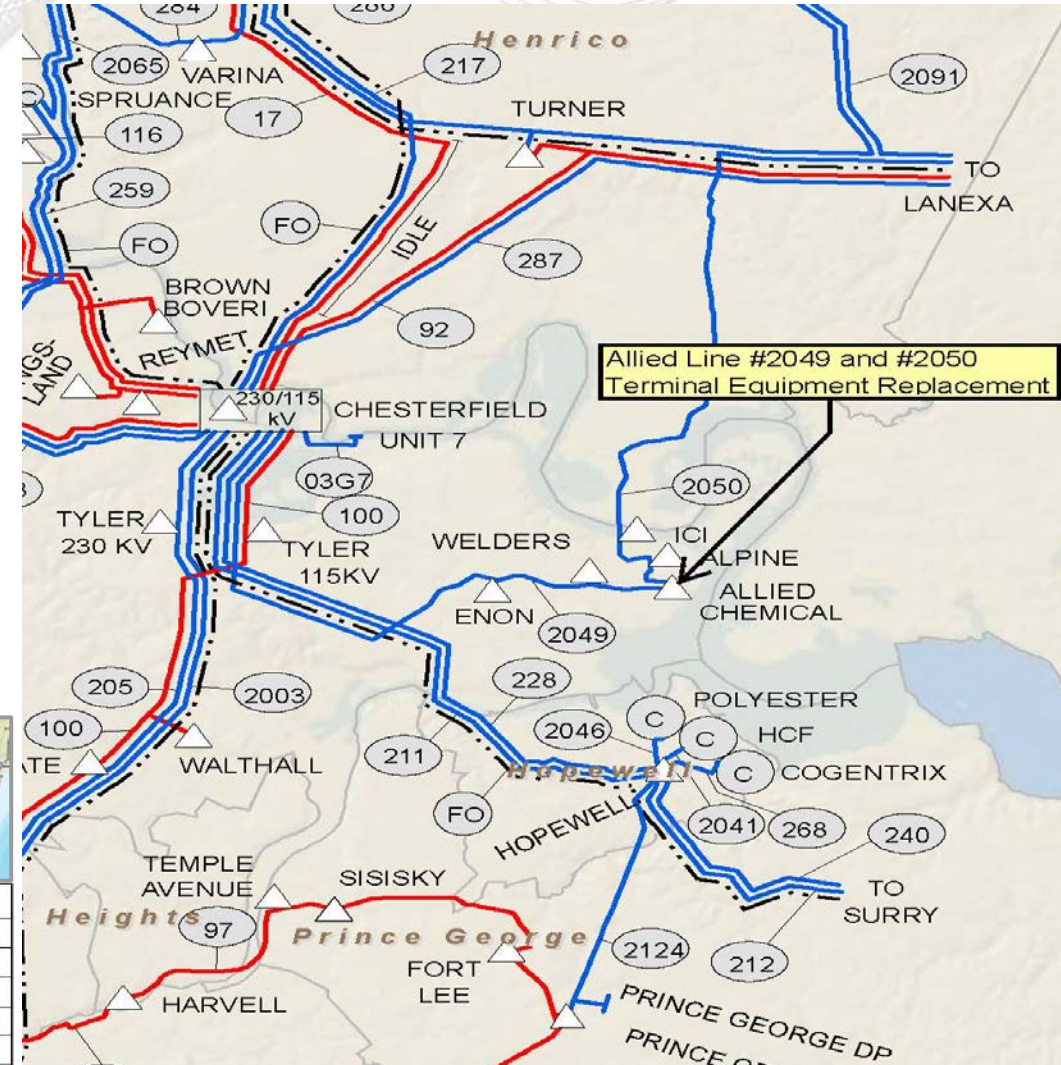
- Replace three 230kV breakers, two line wave traps, and associated line terminal equipment.
- The two new 3000A wave traps increase the summer emergency rating of the National Welders – Allied segment of Line #2049, and the Alpine – Allied segment of Line #2050 from 797MVA to 956MVA.

Alternatives: No feasible alternatives

Estimated Project Cost: \$2.2 M

Possible IS Date: 11/30/2017

Project Status: Engineering





Dominion Transmission Zone Supplemental Project

Supplemental Project: Chesterfield 230kV Line #2049 Wave Trap Replacement

Problem Statement:

- Chesterfield 230kV Line #2049 wave trap and associated line terminal equipment needs to be replaced.

Potential Solution:

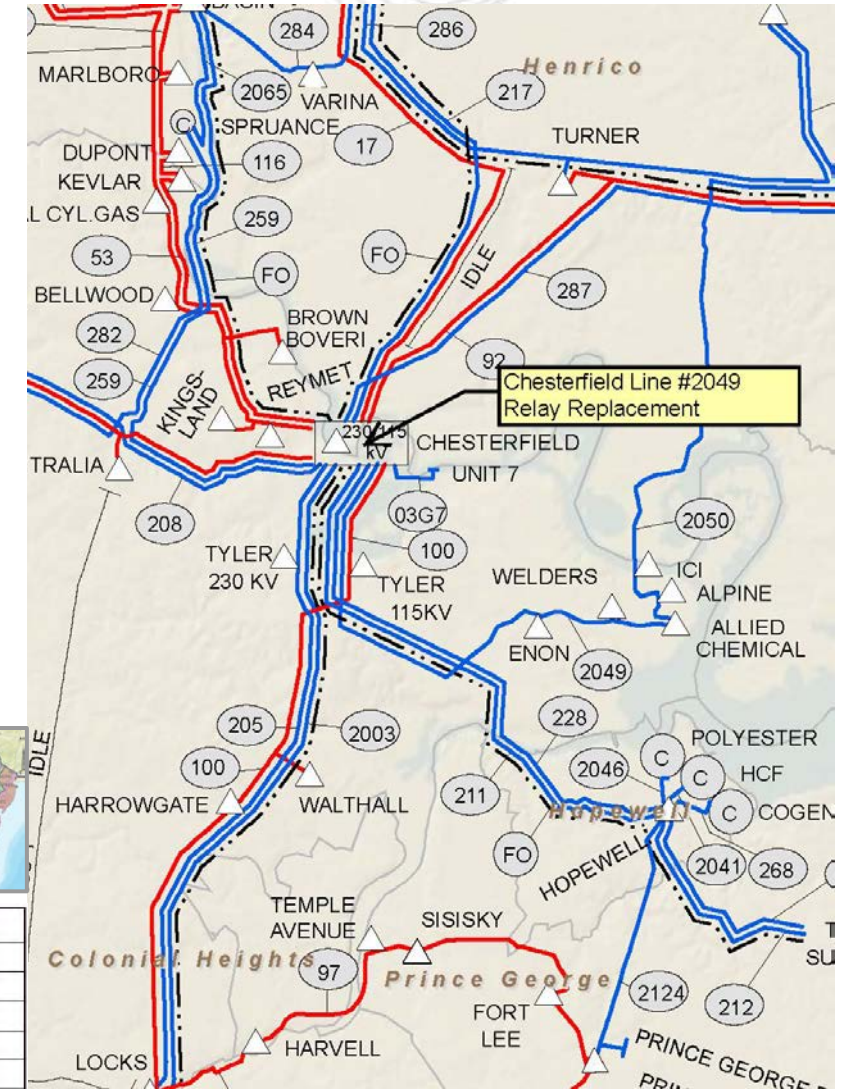
- Replace existing Line #2049 2000A wave trap with a 3000A wave trap. Chesterfield – Enon line segment summer emergency rating will be increased from 797MVA to 927MVA due to wave trap replacement.

Alternatives: No feasible alternatives

Estimated Project Cost: \$0.5 M

Possible IS Date: 11/30/2017

Project Status: Engineering



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



Dominion Transmission Zone Supplemental Project

Supplemental Project: Line #238 Wave Trap and Line Terminal Equipment

Problem Statement:

- Clubhouse line #238 wave trap, Carson line #238 breaker and associated line terminal equipment need to be replaced due to age.

Potential Solution:

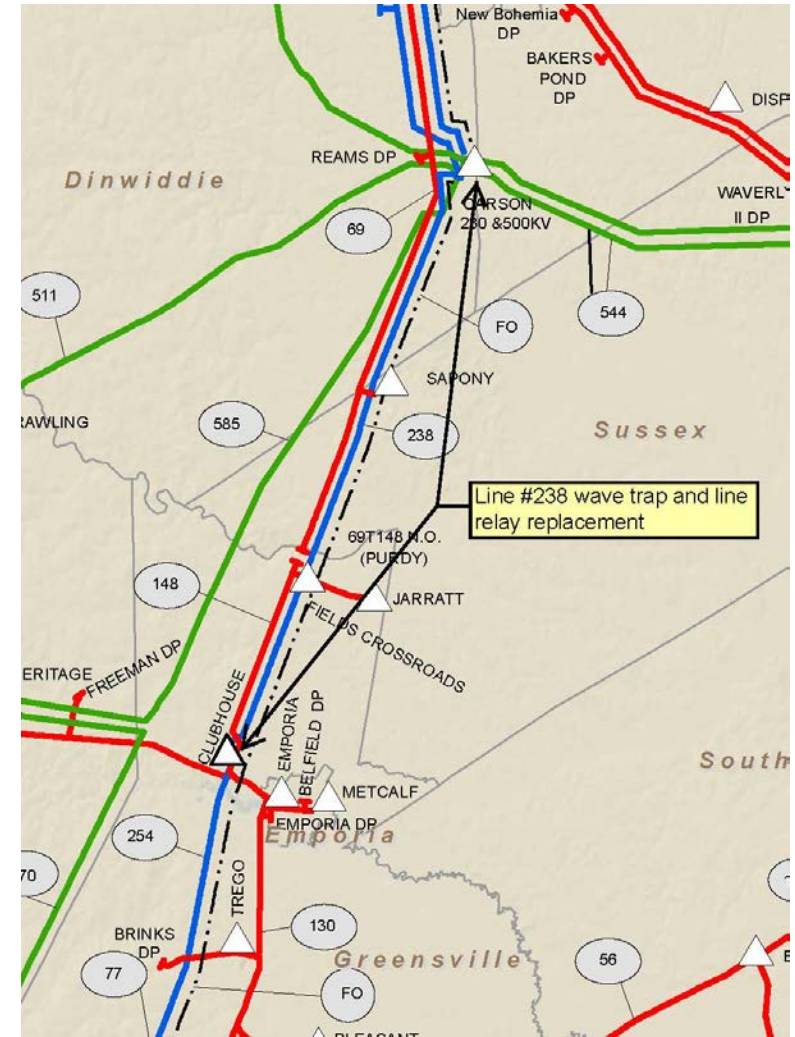
- Replace one 230kV breaker and #238 line relay at Carson. Replace existing line #238 1600A wave trap at Clubhouse with a 3000A wave trap. Spony – Clubhouse segment summer emergency rating will be increased from 637MVA to 722MVA.

Alternatives: No feasible alternatives

Estimated Project Cost: \$1.2 M

Possible IS Date: 11/15/2017

Project Status: Engineering



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



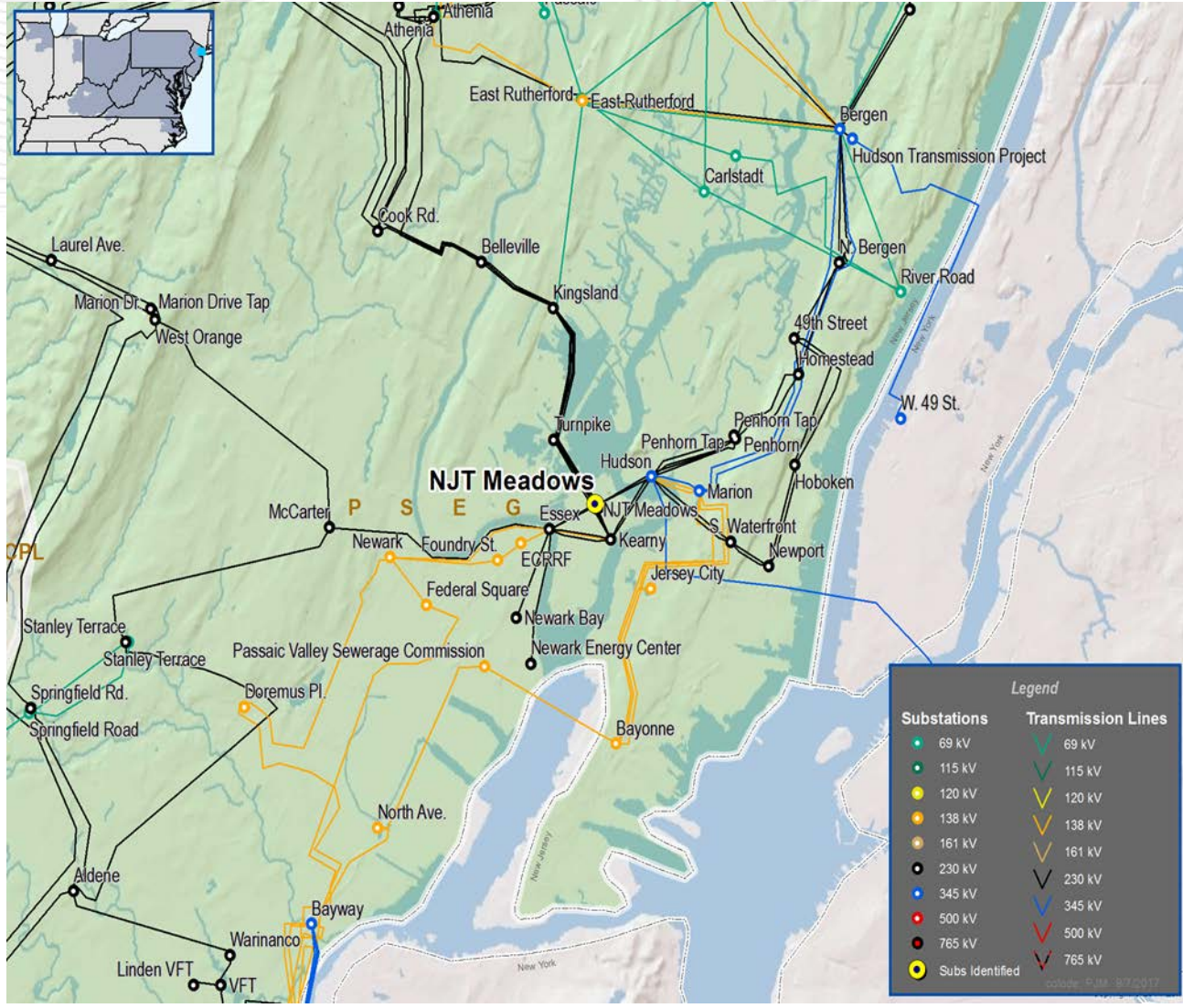
NJ Transit Mason Station Rebuild Supplemental Project



PSEG Transmission Zone Supplemental Project

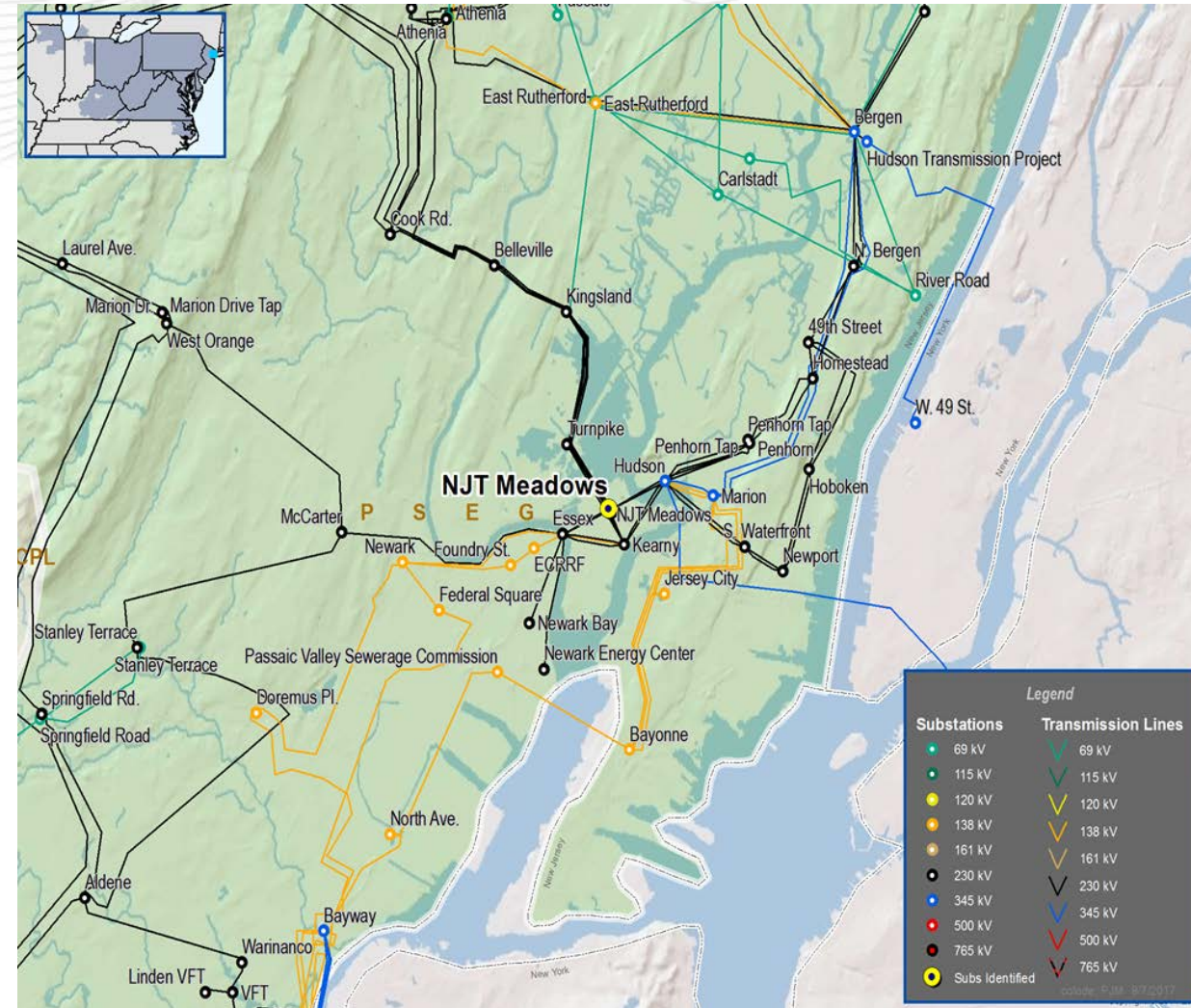
Background:

- The Mason Substation (also known as NJT Meadows) consists of two parallel 230kV feeds that provide power to critical NJ Transit rail facilities in Northern New Jersey, including power for train tunnels connecting New York City and New Jersey.
- The Mason Substation is a “pass-through” substation for the PSE&G 230kV Northern New Jersey Athenia - Essex transmission line. The majority of the power flowing through the Mason Substation is not consumed by NJ Transit.
- The Mason Substation is owned by NJ Transit and was severely damaged due to Superstorm Sandy flooding. The Substation needs to be rebuilt.



Background:

- The operation of the substation impacts PSE&G's ability to deliver power to customers throughout its Northern New Jersey service area, by agreement, PSE&G has the right to operate, test, and adjust certain elements of the Existing Substation.
- The existing equipment configuration and current operational constraints preclude outages necessary to accomplish routine maintenance and repairs.
- The current arrangement has proven to limit PSE&G's ability to promptly access the Existing Substation to expeditiously perform necessary repairs.

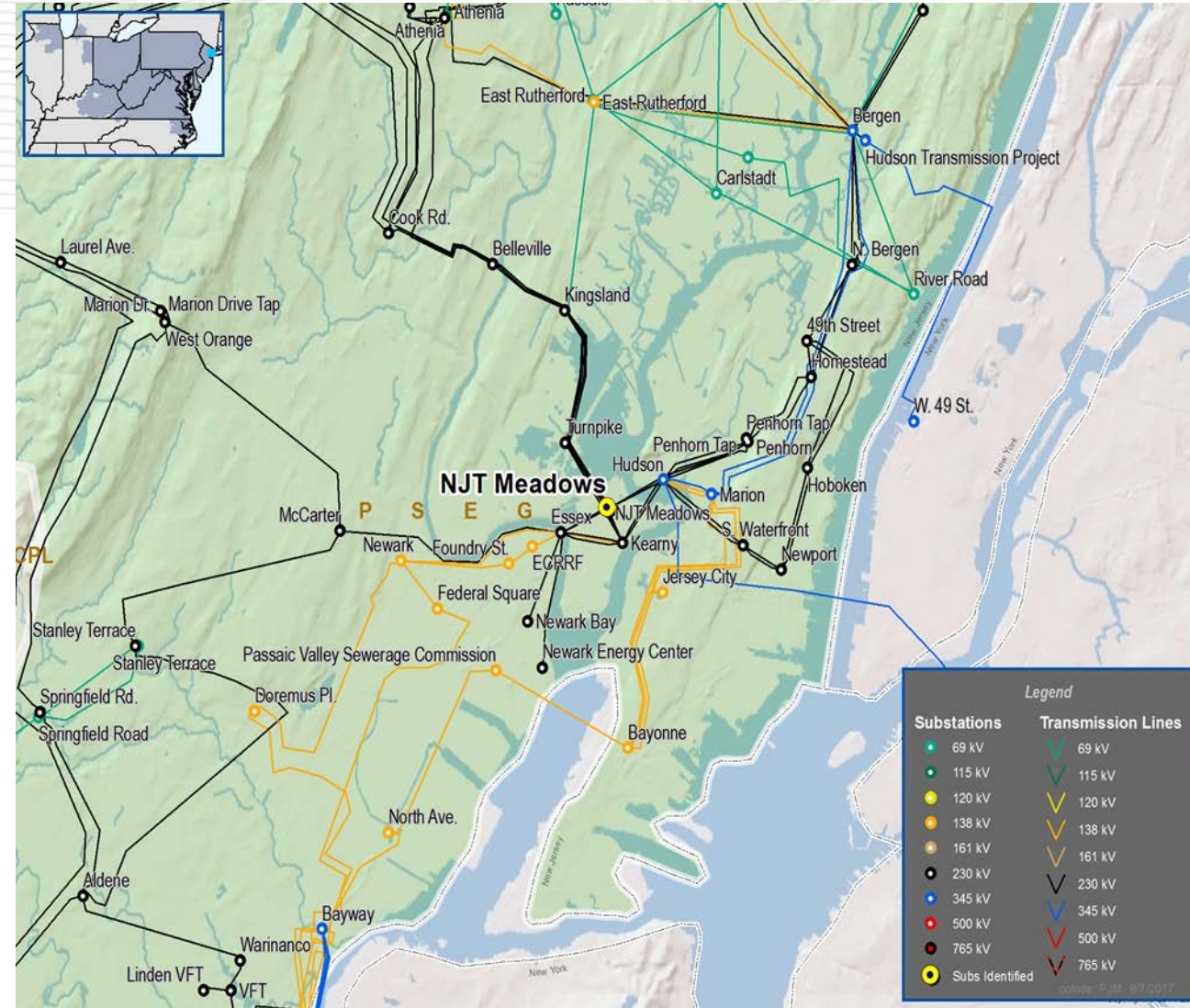


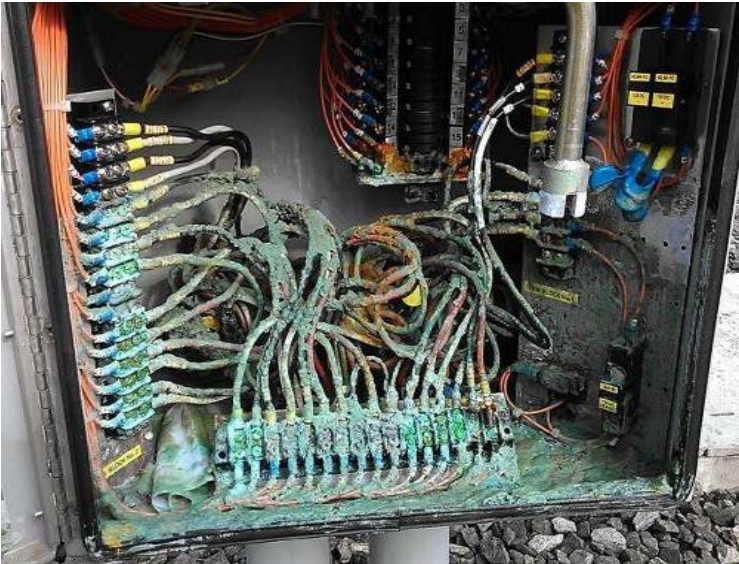
Proposed Supplemental Project

- The New Jersey BPU, NJ Rate Counsel, PSE&G and NJ Transit are in the process of entering into an agreement supporting PSE&G's ownership and operation of the entire Substation.
- Costs for the project will not be recovered through transmission rates. Estimated cost for the 230 kV substation is \$127 million with Risk & Contingency.

Status: Conceptual

Expected IS Date: Under Development





MASON AND BUILDING 9 SUBSTATION DAMAGE – Super Storm Sandy

- The initial Sandy storm surge, estimated to be as high as 7 feet, inundated the Mason Substation and control building. The equipment, wiring, raceways, and structures were submerged in contaminated salt water for an extended period at elevations of 4 to 5 feet.
- Pressurized surge waters also penetrated the control building and equipment cabinets through underground conduits, causing damage to devices located above the flood elevation.

Overview of proposed 230 kV Portion of Substation (“High Side”)

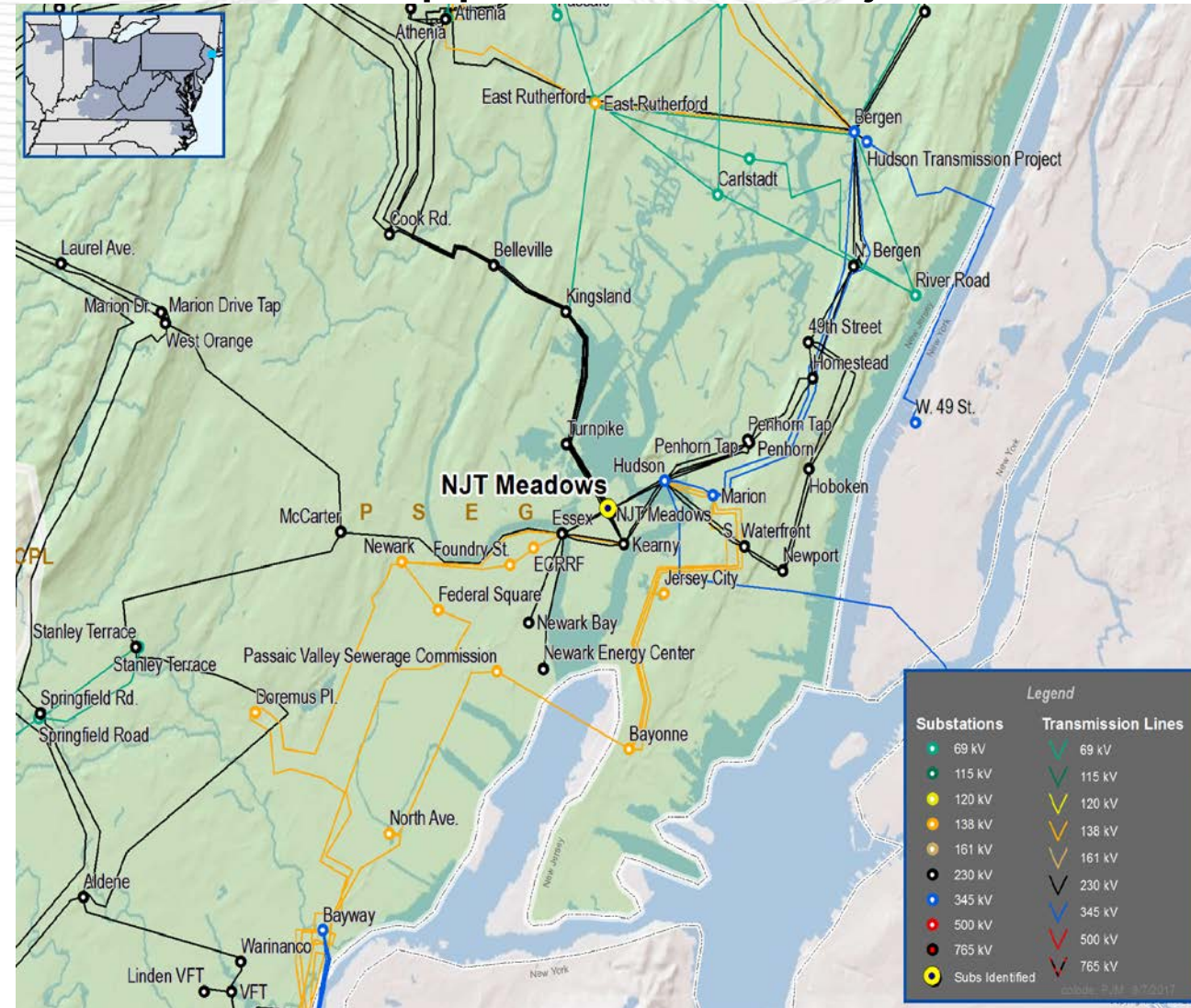
- Two existing 230kV high voltage transmission circuits will be connected to a 230kV breaker-and-a-half design gas-insulated switchgear (GIS) switching station in place of the existing 230kV straight bus design.
- The GIS facility will be comprised of four (4) bays including three (3) breakers and two (2) line positions each, totaling 12 breakers and 8 line positions of GIS equipment as well as a protective GIS hall building, control room, station light and power transformers, and a backup generator.
- The entire 230kV yard will be raised to required 500 year flood elevations to mitigate damage from future storms.
- The Substation will have line capacity of 735 MVA summer normal rating (estimated peak load of NJ Transit at the Substation will be approximately 30 MVA).

Operational Benefits of proposed New Substation & future PSE&G Ownership

- PSE&G's ownership of the Substation will ensure that PSE&G has control of the station to properly effectuate maintenance and repairs that will greatly reduce the likelihood of outages and the duration of outages.
- Reconstruction of the station will also improve reliability of two adjacent substations in Kearny serving the PSE&G system, and serving NJ Transit.
- The current 230kV bus configuration provides limited system reliability due to the existence of a single point of failure. Modification of the Substation from a straight-bus design to a breaker-and-a-half design will result in increased system reliability benefits to PSE&G customers.

About NJ Transit

- NJ Transit is the nation's largest statewide public transportation system.
- The Substation is the source of traction power for a 14.5 mile segment of NJ Transit's Morris & Essex Lines between Maplewood and Hoboken, including critical connection points for travel into and out of New York City.
- The Substation provides traction power for approximately 74,200 weekday passenger trips and supports either a large portion, or all, of the power necessary to facilitate approximately 5,000,000 annual passenger boardings.
- The Substation provides power to NJ Transit's Regional Operations Center and primary Maintenance Center.
- The Substation is located very short distances from both the Hackensack River and the Passaic River.



October 2017 Recommendations to the PJM Board

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

2017 RTEP Next Steps

- Anticipate recommendations contained in this presentation to the PJM Board Reliability Committee on October 17, 2017
- Continue to evaluate 2017 RTEP Window #1 submissions and develop recommendations
- Prepare for 2018 RTEP Assumptions Review



Upcoming TEAC Meetings and anticipated PJM Board Review

10/12 – TEAC Reliability Analysis Update

10/17 – PJM Board of Managers Review

11/9 – TEAC Reliability Analysis Update

12/4 – PJM Board of Managers Review

(If necessary, additional online/teleconference meetings to be held to review potential and recommended solutions)

Questions?

Email: RTEP@pjm.com

Appendix

Previously Reviewed Baseline Upgrades for the October 2017 PJM Board Recommendation

Mid Atlantic Region

Short Circuit Violation

Presented: 8/10/2017 TEAC

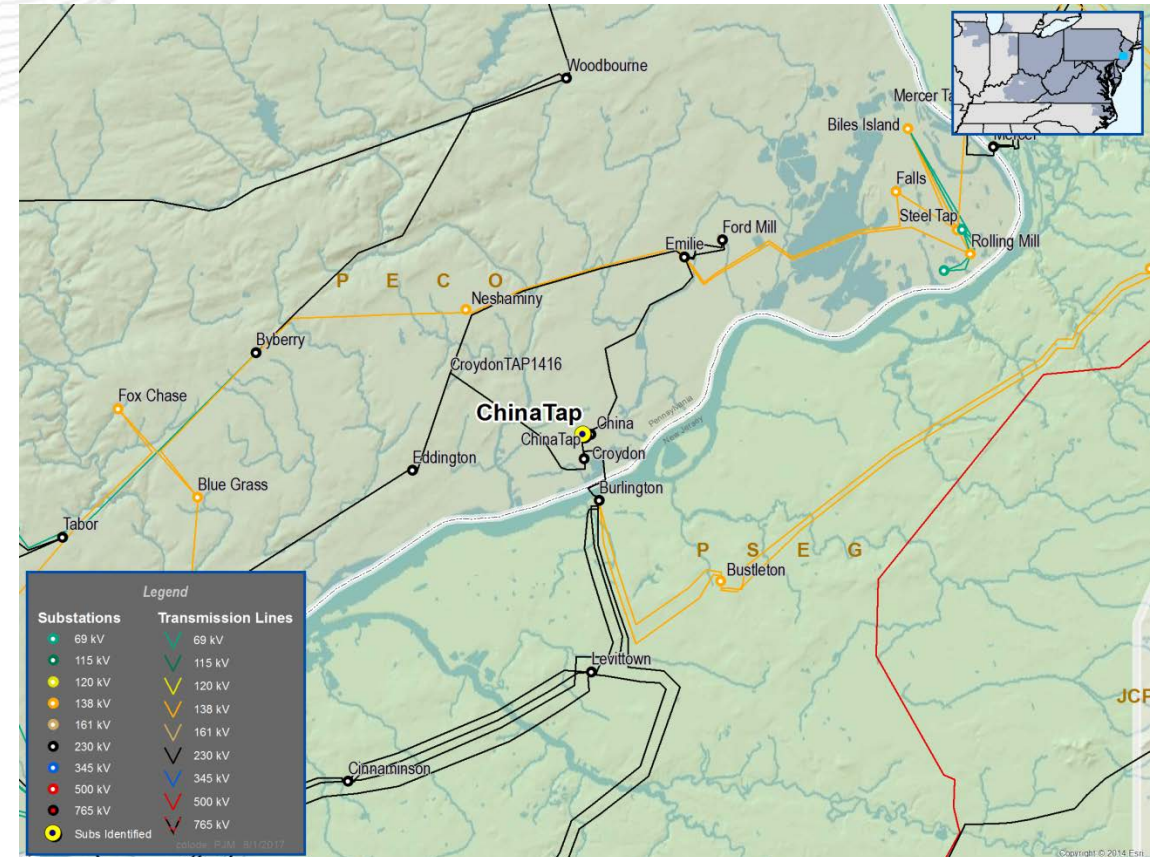
Problem Statement: The China Tap 230kV breaker 'CS15' is overstressed

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

Recommended Solution: Replace China Tap 230kV breaker 'CS15' with a 63kA breaker (b2923)

Estimated Project Cost: \$603 K

Required In Service Date: 6/1/2019



Short Circuit Violation

Presented: 8/10/2017 TEAC

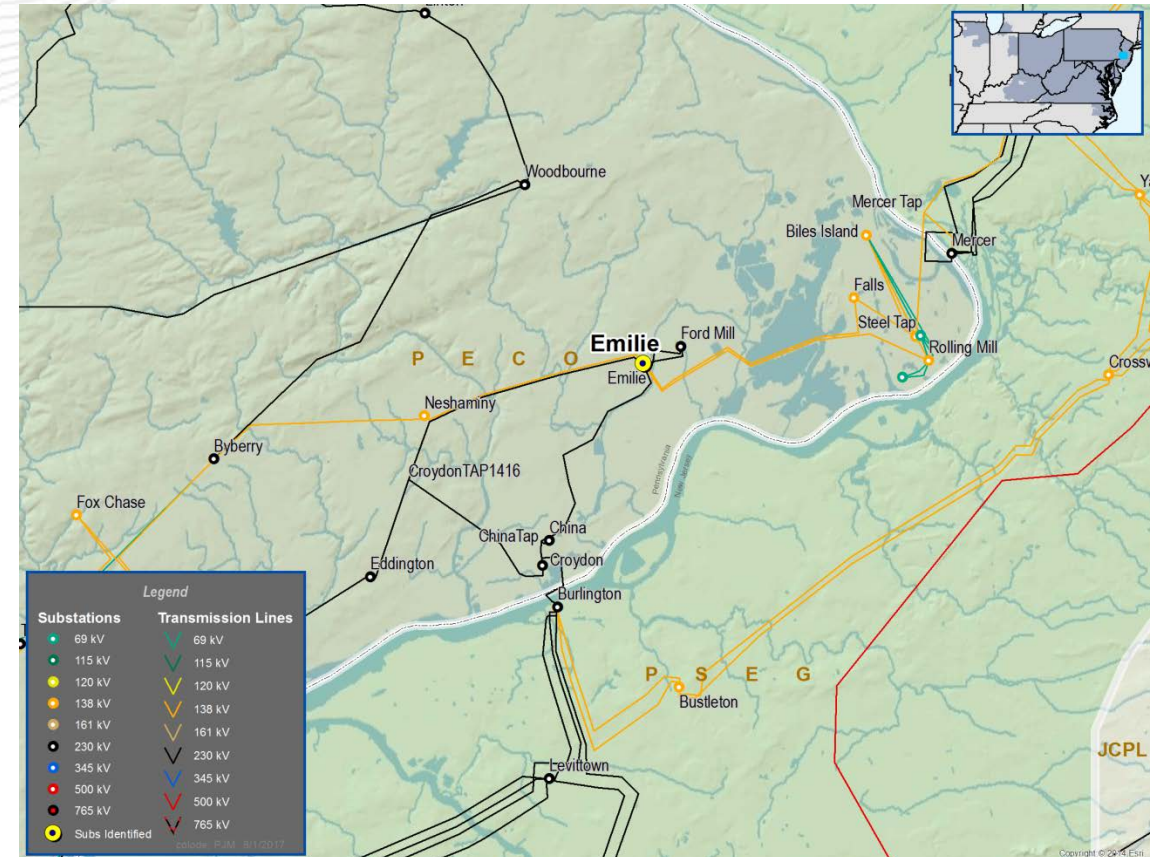
Problem Statement: The Emilie 230kV breakers 'CS15' and 'CS25' are overstressed

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

Recommended Solution: Replace Emilie 230kV breakers 'CS15' and 'CS25' with 63kA breakers (b2924 & b2925)

Estimated Project Cost: \$603 K

Required In Service Date: 6/1/2019



Short Circuit Violation

Presented: 8/10/2017 TEAC

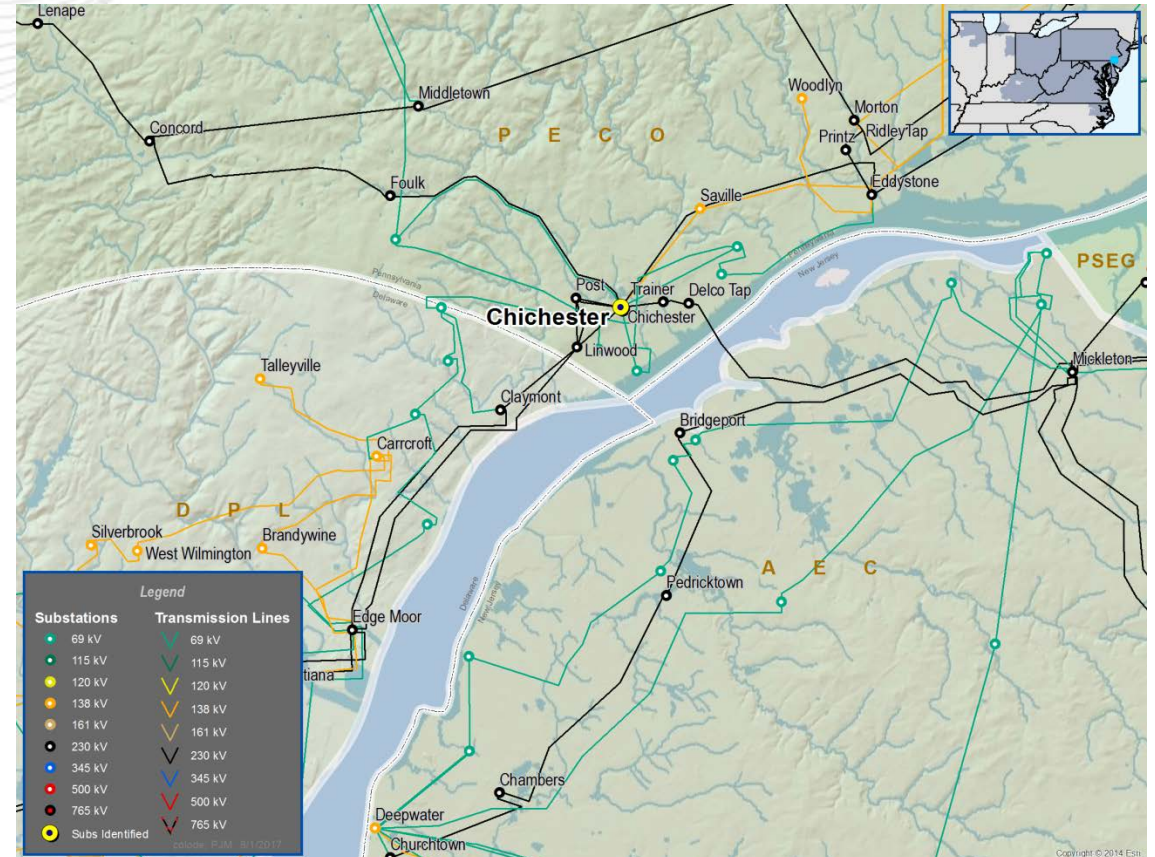
Problem Statement: The Chichester 230kV breaker '215' is overstressed

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

Recommended Solution: Replace Chichester 230kV breaker '215' with a 63kA breaker (b2926)

Estimated Project Cost: \$342 K

Required In Service Date: 6/1/2019



Short Circuit Violation

Presented: 8/10/2017 TEAC

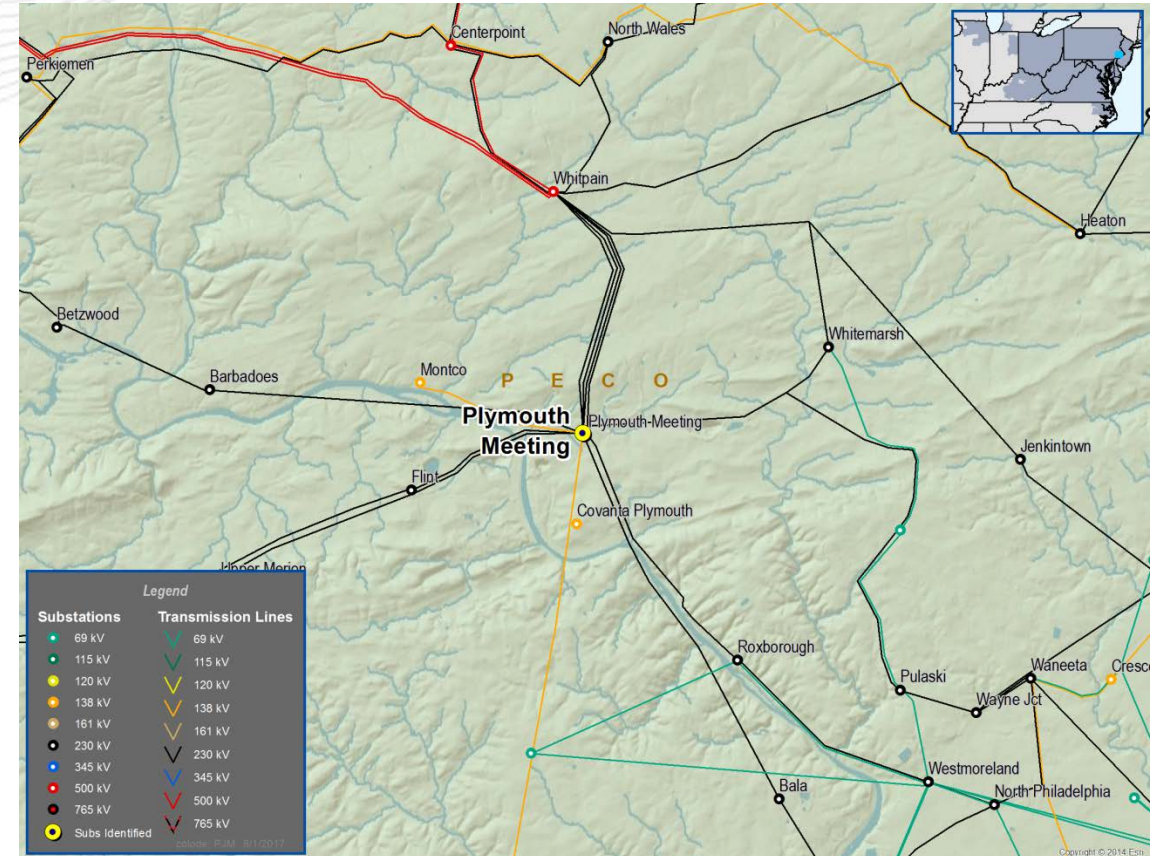
Problem Statement: The Plymouth Meeting 230kV breaker '125' is overstressed

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

Recommended Solution: Replace Plymouth Meeting 230kV breaker '125' with a 63kA breakers (b2927)

Estimated Project Cost: \$342 K

Required In Service Date: 6/1/2019



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

Presented: 8/31/2017 Mid-Atlantic Subregional TEAC

Problem Statement: Springfield Substation is supplied by two 230kV underground lines. Springfield supplies more than 10,000 customers with load in excess of 80MVA. An N-1-1 event would result in a complete loss of electric supply to the station for more than 24 hrs.

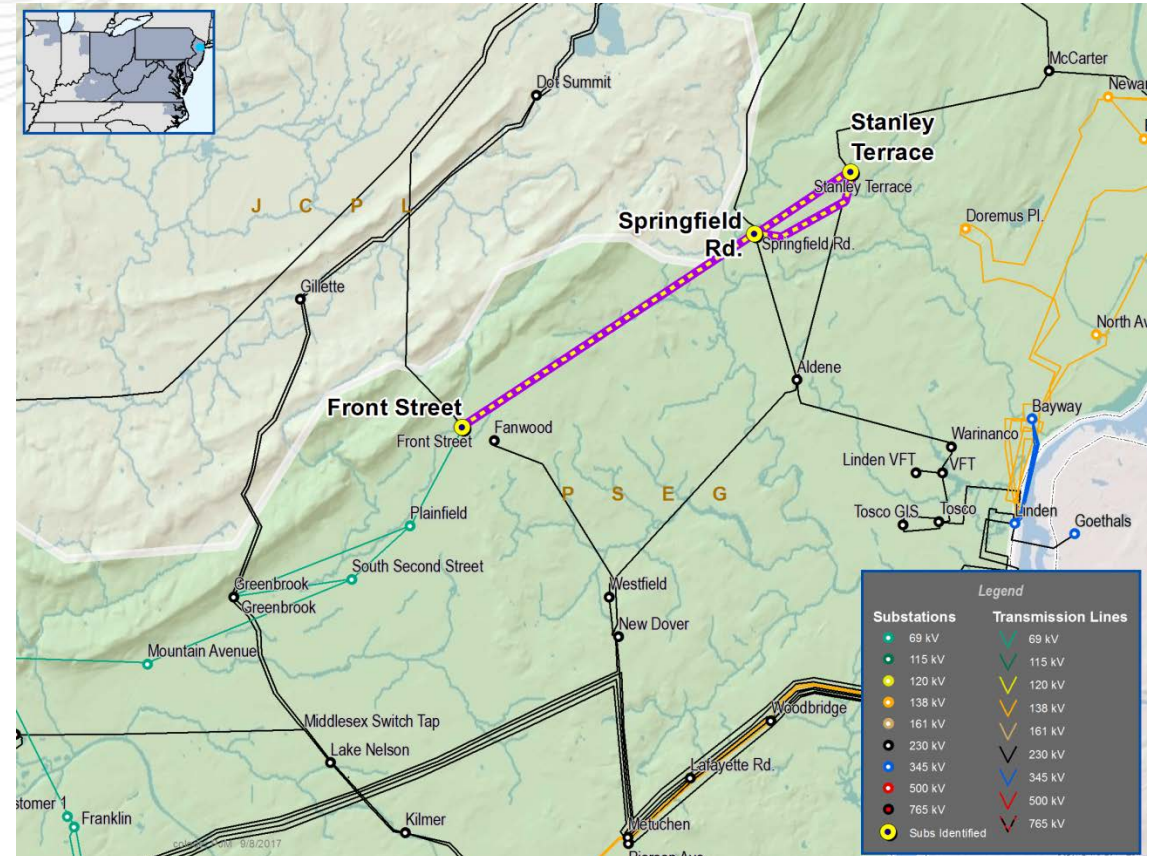
Stanley Terrace is supplied by two 230kV underground lines. Stanley Terrace will supply more than 5,000 customers with an anticipated load in excess of 37MVA. An N-1-1 event would result in a complete loss of electric supply to the station.

Recommended Solution:

- Construct a 230/69 kV station at Springfield. (B2933.1)
- Construct a 230/69 kV station at Stanley Terrace. (B2933.2)
- Construct a 69 kV network between Front Street, Springfield and Stanley Terrace. (B2933.3)

Estimated Project Cost: \$197M

Required In Service Date: 6/1/2018



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

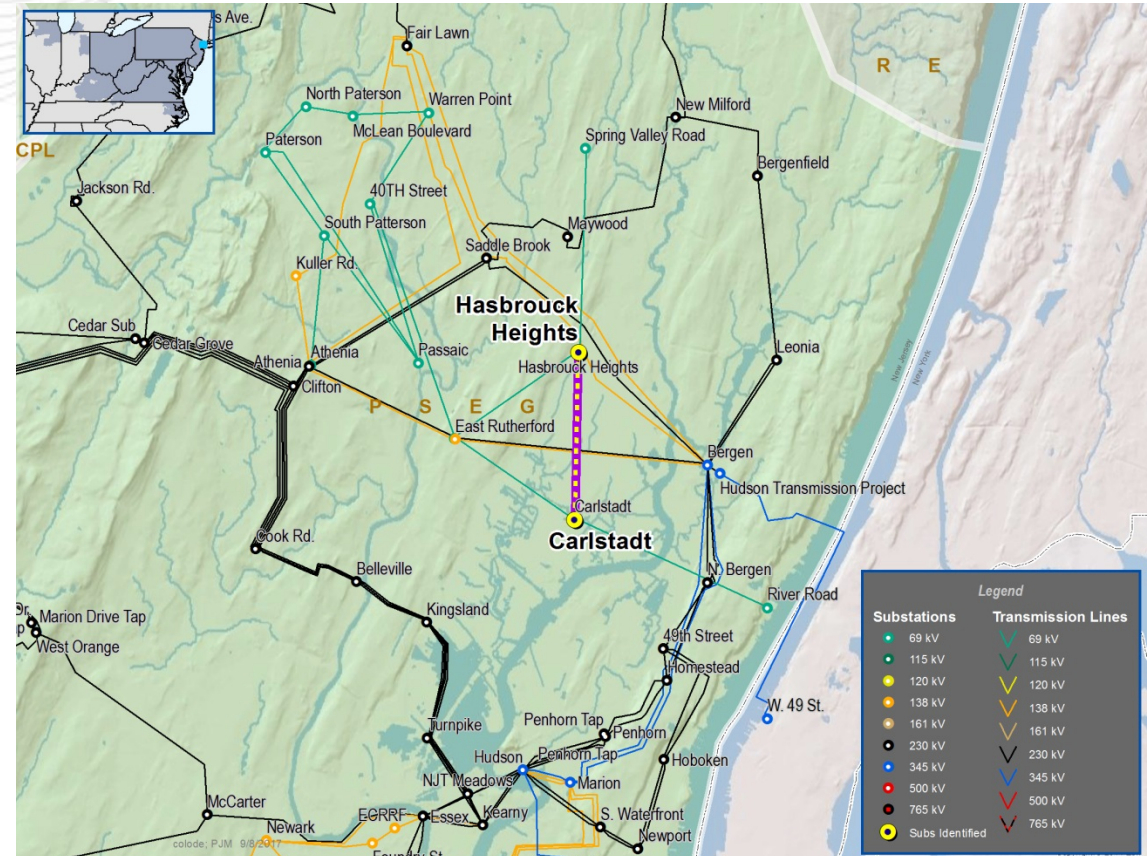
Presented: 8/31/2017 Mid-Atlantic Subregional TEAC

Problem Statement: The Carlstadt 69kV Substation is supplied by two partially underground 69kV circuits. Carlstadt supplies more than 1,400 customers with load in excess of 30 MVA. An N-1-1 event would result in a complete loss of electric supply to the station for more than 24 hrs.

Recommended Solution: Build a new 69kV line between Hasbrouck Heights and Carlstadt. (B2934))

Estimated Project Cost: \$21M

Required In Service Date: 6/1/2018



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

Presented: 8/31/2017 Mid-Atlantic Subregional TEAC

Problem Statement: Runnemedede 69kV Substation is supplied by only two 69kV lines; load exceeds 46MW. One of the lines has portions of the circuit fed by underground cable that would take longer than 24 hours to restore during an outage. In addition, a breaker failure on the Runnemedede 69kV bus would result in the loss of both 69kV supply lines and a complete substation shutdown, interrupting more than 11,000 customers. As a result, there is a need to enhance the station design and provide a 3rd source to Runnemedede 69kV station. The Woodbury station, after conversion to 69kV, will be supplied by two 69kV lines from Gloucester 69kV station with no other 69kV source in the near vicinity to supply the 3rd source, leaving a need to provide a 3rd supply to satisfy FERC Form 715 requirements.

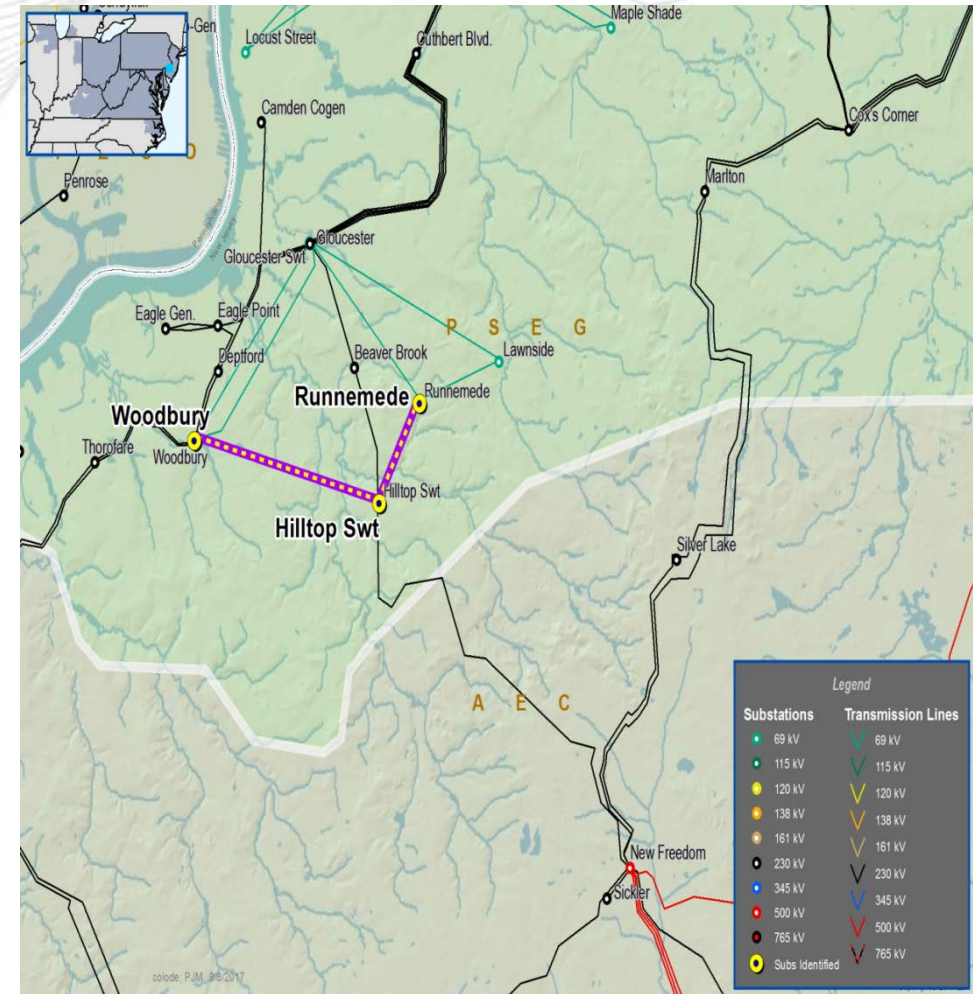
Network Availability: The cost effective solution for the southern area is to convert stations to 69kV. Long term it will be cost effective to supply all PSE&G stations in Gloucester and Camden County from 69kV because there is less infrastructure required and the system benefits from being planned to and operating at higher voltages.

Recommended Solution:

- Build a new 230/69 kV switching substation at Hilltop utilizing the PSE&G property and the K-2237 230 kV line. (B2935.1)
- Build a new line between Hilltop and Woodbury 69 kV providing the 3rd supply (B2935.2).
- Convert Runnemedede's straight bus to a ring bus (eliminating the bus fault violation) and construct a 69 kV line from Hilltop to Runnemedede 69 kV. (B2935.3)

Estimated Project Cost: \$98M

Required In Service Date: 6/1/2018



Southern Region

Existing b2649 Cost Increase and Scope Modification

Presented: 6/9/2017 Southern Subregional TEAC

Problem Statement: DOM “End Of Life Criteria” Violation

End of Life Criteria – The Clubhouse to Carolina 115kV line was constructed on wood H-frames and single poles in 1955. This line serves Mecklenburg delivery points Brink, Belfield and Emporia.

System Impact Assessment – Permanent MW load loss for removal of this line is 42 MW.

When this criteria violation was identified, the need date was already in the immediate timeframe. This is an immediate need project based on “End of Life” criteria.

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

Existing b2649 Cost Increase and Scope Modification

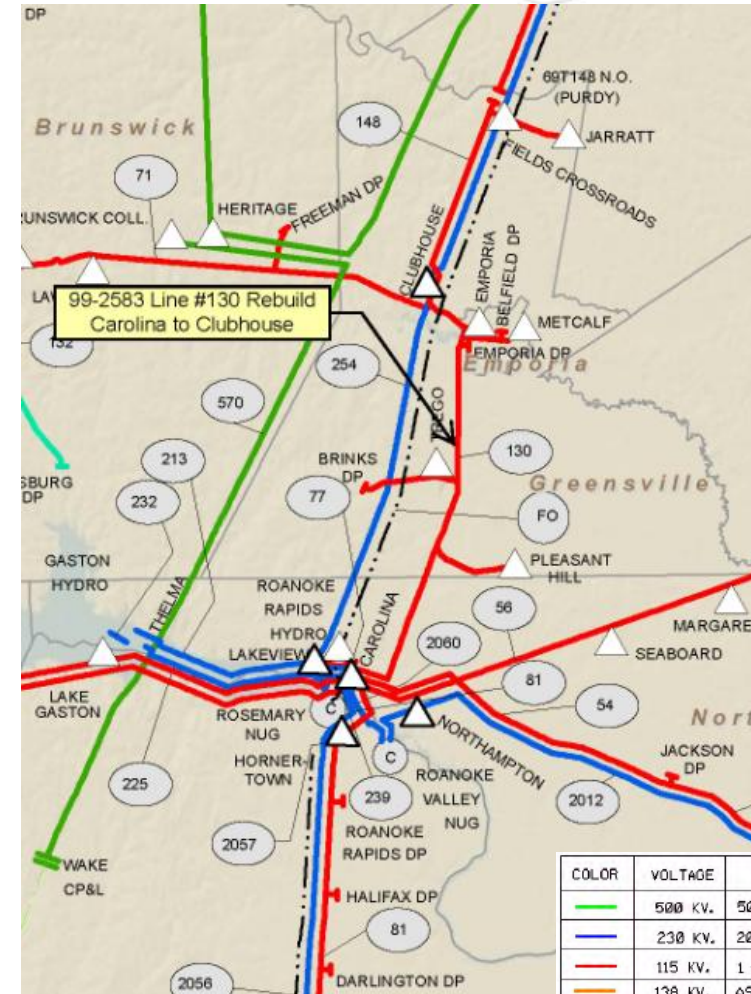
Presented: 6/9/2017 Southern Subregional TEAC

Scope Change & Cost Increase

- Add rebuild of 1.7 mile tap to Metcalf and Belfield DP (MEC) due to poor condition. The existing summer rating of the tap is 48 MVA and existing conductor is 4/0 ACSR on wood H-frames. The proposed new rating is 176 MVA using 636 ACSR conductor. (b2649.1) (\$3,569,000)
- Add rebuild of 4.1 mile tap to Brinks DP (MEC) due to wood poles built in 1962. The existing summer rating of the tap is 48 MVA and existing conductor is 4/0 ACSR and 393.6 ACSR on wood H-frames. The proposed new rating is 176 MVA using 636 ACSR conductor. (b2649.2) (\$8,212,000)
- Both tap rebuilds require a temporary line.
- Proposed permanent construction is steel H-frames.

Estimate Project Cost Increase: \$11.781 M

Required In Service Date: 12/31/2019



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

Dominion Transmission Owner Criteria

Presented: 6/9/2017 Southern Subregional TEAC

Problem Statement: DOM “End of Life Criteria”

A 7 mile segment of 115kV Line #120 located approximately between Dozier and Thompsons Corner Substations was constructed on wood H-frame structures in 1955. The existing summer emergency rating of this line segment is 147 MVA. Current conductor used is 477 ACSR.

This line segment needs to be rebuilt to current standards based on Dominion’s “End of Life” criteria.

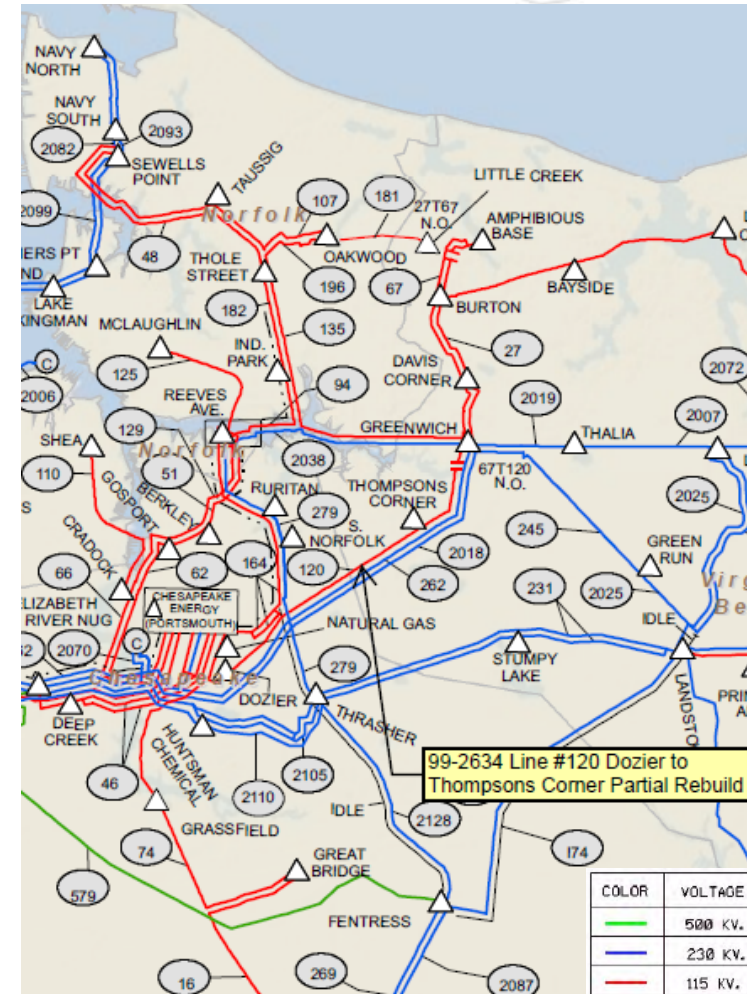
Permanent MW load loss for removal of this line is 100MW.

Recommended Solution: The 7 mile section from Dozier to Thompsons Corner of line #120 will be rebuilt to current standards using 768.2 ACSS conductor with a summer emergency rating of 346 MVA at 115kV. Line is proposed to be rebuilt on single circuit steel monopole structures. (b2800)

Alternatives: No feasible alternatives

Estimated Project Cost: \$6.5 M

Required In Service Date: 12/30/2021



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

Dominion Transmission Owner Criteria

Presented: 6/9/2017 Southern Subregional TEAC

Problem Statement: DOM “End of Life Criteria”

115kV Lines #76 and #79 from Yorktown to Peninsula are 11 miles long and were constructed on double circuit 3 pole wood H-frame structures in 1957. The existing summer emergency rating of these lines are 193 MVA. Current conductor used includes 477 ACSR and 636 ACSR.

This line needs to be rebuilt to current standards based on Dominion’s “End of Life” criteria.

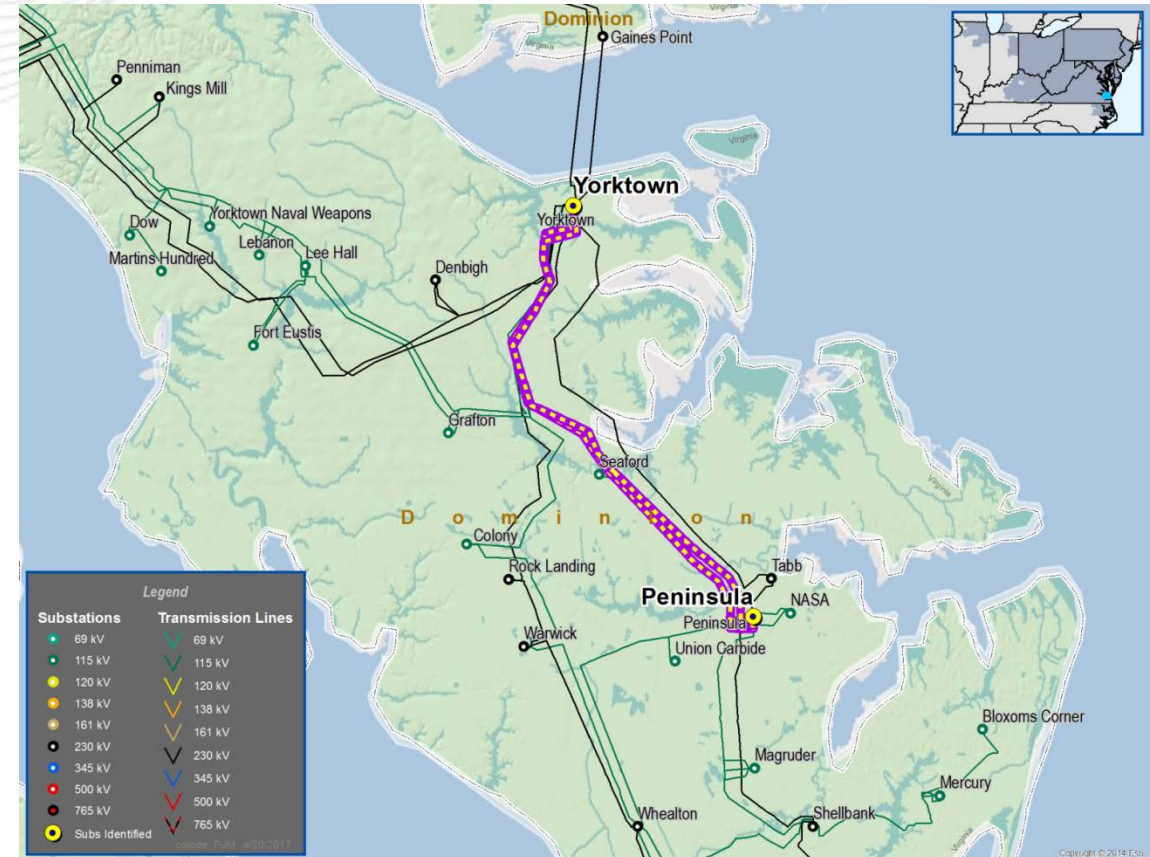
Permanent MW load loss for removal of these lines is 30 MW.

Recommended Solution: Line #76 and #79 will be rebuilt to current standard using 768.2 ACSS conductor with a summer emergency rating of 346 MVA at 115kV. Proposed structure for rebuild is double circuit steel monopole structure. (b2801)

Alternatives: No feasible alternatives

Estimated Project Cost: \$22.0 M

Required In Service Date: 12/30/2020



Dominion Transmission Owner Criteria

Presented: 8/29/2017 Southern Subregional TEAC

Problem Statement: DOM “End of Life Criteria”

115kV Line #101 from Mackeys to Creswell (14 miles) was constructed on wood H-frames in the 1970-1975 timeframe. The conductor has broken stranding consistent across entire line. The existing summer emergency rating of this line is 152 MVA. Current conductor used is 545.6 ACAR (15/7).

This line needs to be rebuilt to current standards based on Dominion’s “End of Life” criteria.

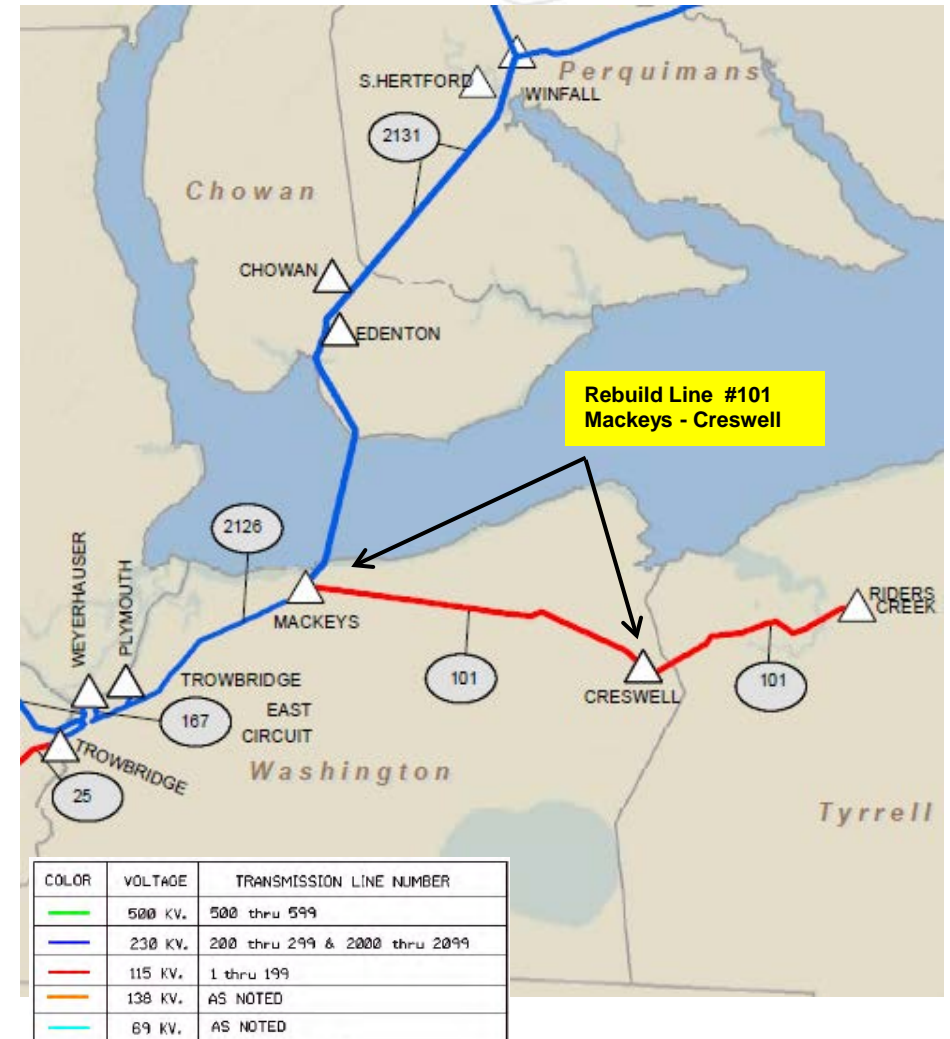
Permanent MW load loss for removal of this line is 21 MW.

The MW-mile for line #101 is 518 MW-mile based on the Winter 2025/26 projection. Dominion’s 700 MW-mile radial line criteria would be violated if 8 MW or more of new load were added in the future.

Recommended Solution: Rebuild Line #101 from Mackeys to Creswell, 14 miles, with double circuit steel structures. Install one circuit with provisions for a second circuit. Provisions for a future second circuit would allow networking of the line (Mackeys – Creswell) if the 700 MW-mile level was exceeded. The conductor used will be at current standards (636 ACSR) with a summer emergency rating of 262 MVA at 115kV. Additional right-of-way is required for the temporary line. (b2876)

Estimated Project Cost: \$40 M

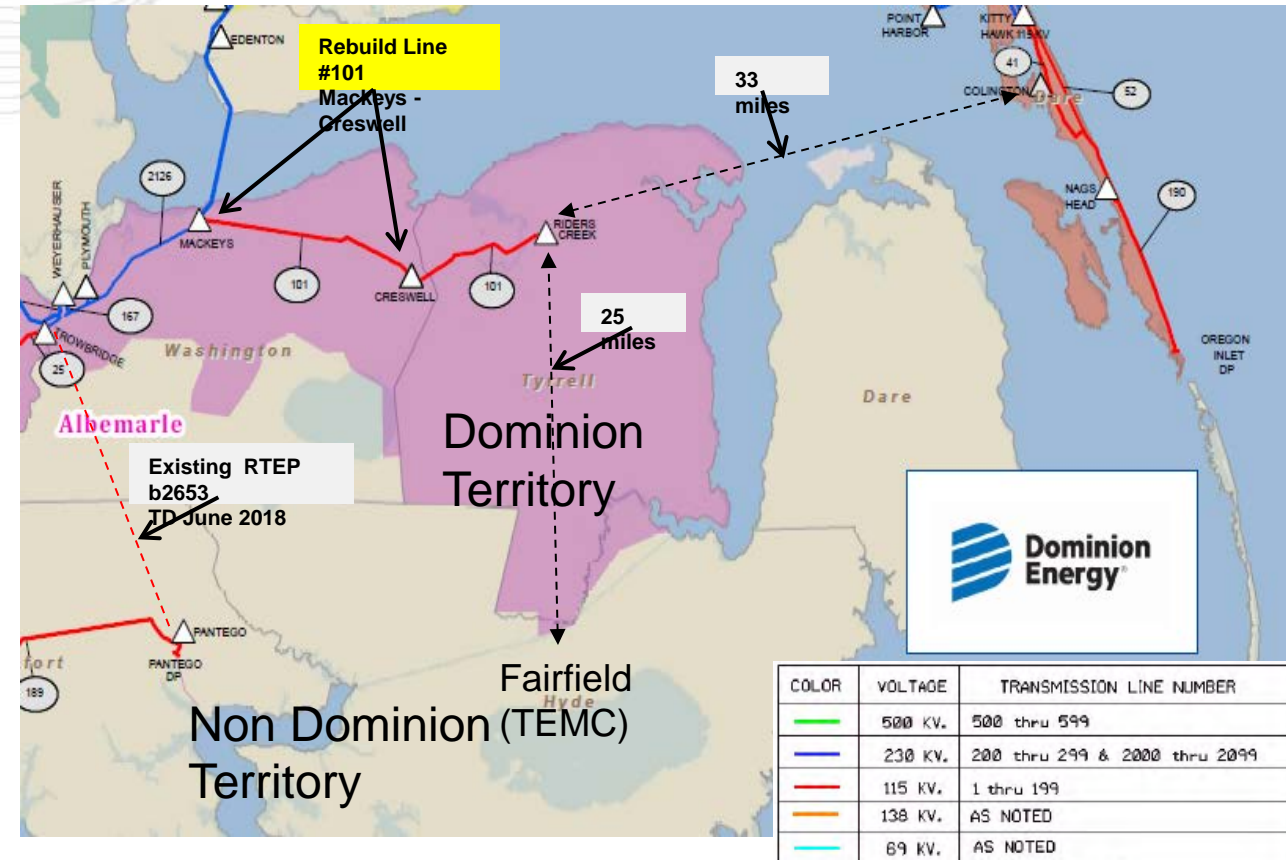
Required In Service Date: 12/30/2022



Continued from previous slide...

Supporting Project Information:

- Radial Line #101 is located in an isolated area with no distribution ties
- Riders Creek to TEMC's Fairfield route was reviewed in 2013 by NRG
- Obtaining right-of-way to network Line #101 to a different source is restricted by wetlands and significant natural heritage areas to the south as well as very long water crossings to the north and to the east
- Riders Creek to Fairfield preliminary route is 25 miles and could become 50 miles if federal and state regulatory agencies are unwilling to approve routing
- Riders Creek to Colington – previous studies have shown this option resulted in voltage collapse for a tower line outage of the two 230kV lines from Shawboro to Kitty Hawk
- Any option to a different source, assuming right-of-way could be obtained, would be much greater than the preferred option cost



Dominion Transmission Owner Criteria

Presented: 6/9/2017 Southern Subregional TEAC

Problem Statement: DOM “End of Life Criteria”

138kV Line #112 from Fudge Hollow to Lowmoor line was constructed in 1929 and includes thirty-three Blaw Knox steel lattice towers that span 5.16 miles. These structures have experienced severe corrosion at grade and their grillage style foundations are no longer considered a dependable system to resist uplift forces that occur during a wind event. The existing summer emergency rating of this line is 207 MVA. Current conductor used for this line includes 4/0 ACSR, 721 ACAR, 336 ACSR, and 1109 ACAR.

Of this distance, a 1.24 mile section includes double circuit towers that are shared with Line #161.

Line #112 serves 9,778 customers including 3,586 fed by Co-op. The loss of a double circuit structure for this line would result in the additional loss of line numbers #161, #109, and #155 along with East Mill, Fudge Hollow, Covington, and Westvaco substations. In 2016 the peak load at Westvaco was 94 MW on August 18th.

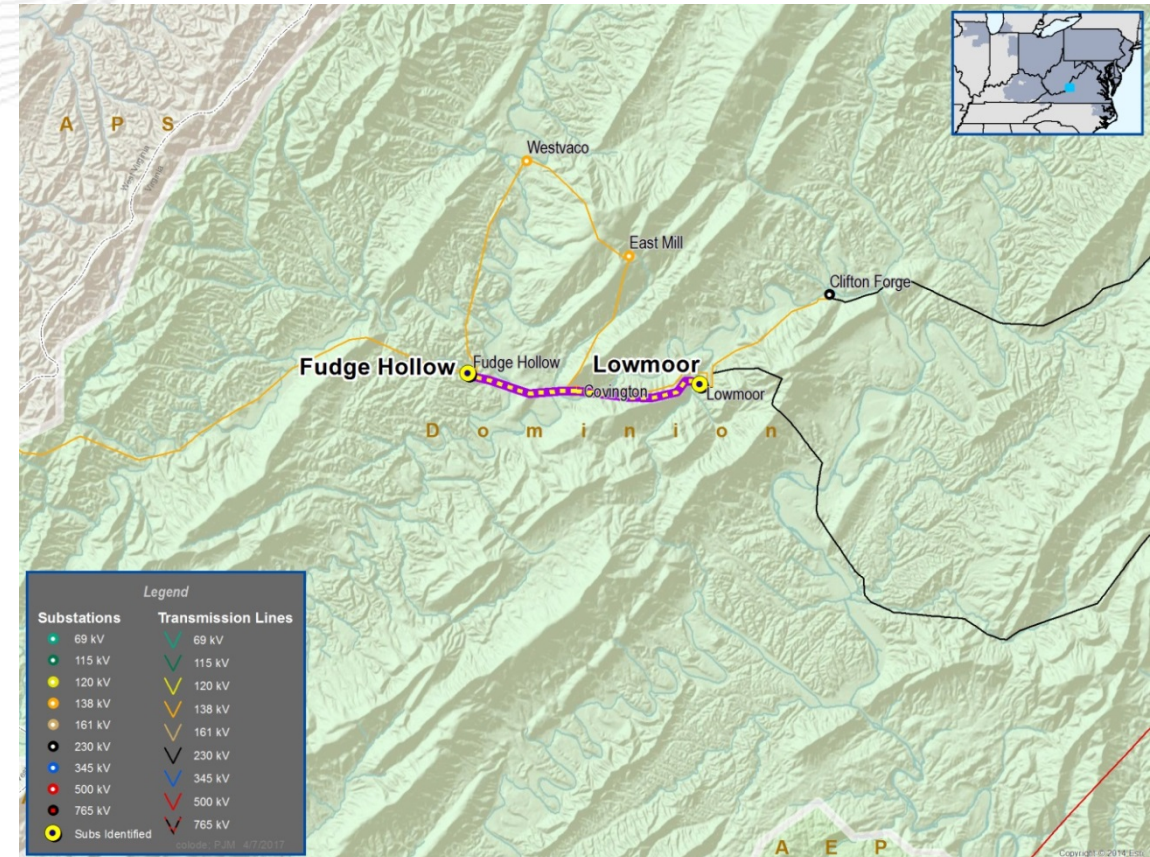
This line is part of the transmission loop between Westvaco and Lexington and needs to be rebuilt to current standards based on Dominion’s “End of Life” criteria.

Recommended Solution: Rebuild Line #112 from Fudge Hollow and Lowmoor (5.16 miles) to current standards (636 ACSR) with a summer emergency rating of 314 MVA at 138kV. Steel tower and double circuit steel monopole replacement structures are being considered. (b2877)

Alternatives: No feasible alternatives

Estimated Project Cost: \$8 M

Required In Service Date: 10/31/2020



Dominion Transmission Owner Criteria

Presented: 7/13/2017 TEAC

Problem Statement: Dominion “End of Life Criteria”

230kV Line #231 from Landstown to Thrasher is 8.5 miles long and was built mostly on double circuit weathering steel (Corten) towers in 1965. The corten structures are in poor condition. The existing summer emergency rating of this line is 955 MVA.

This line needs to be rebuilt to current standards based on Dominion’s “End of Life” criteria.

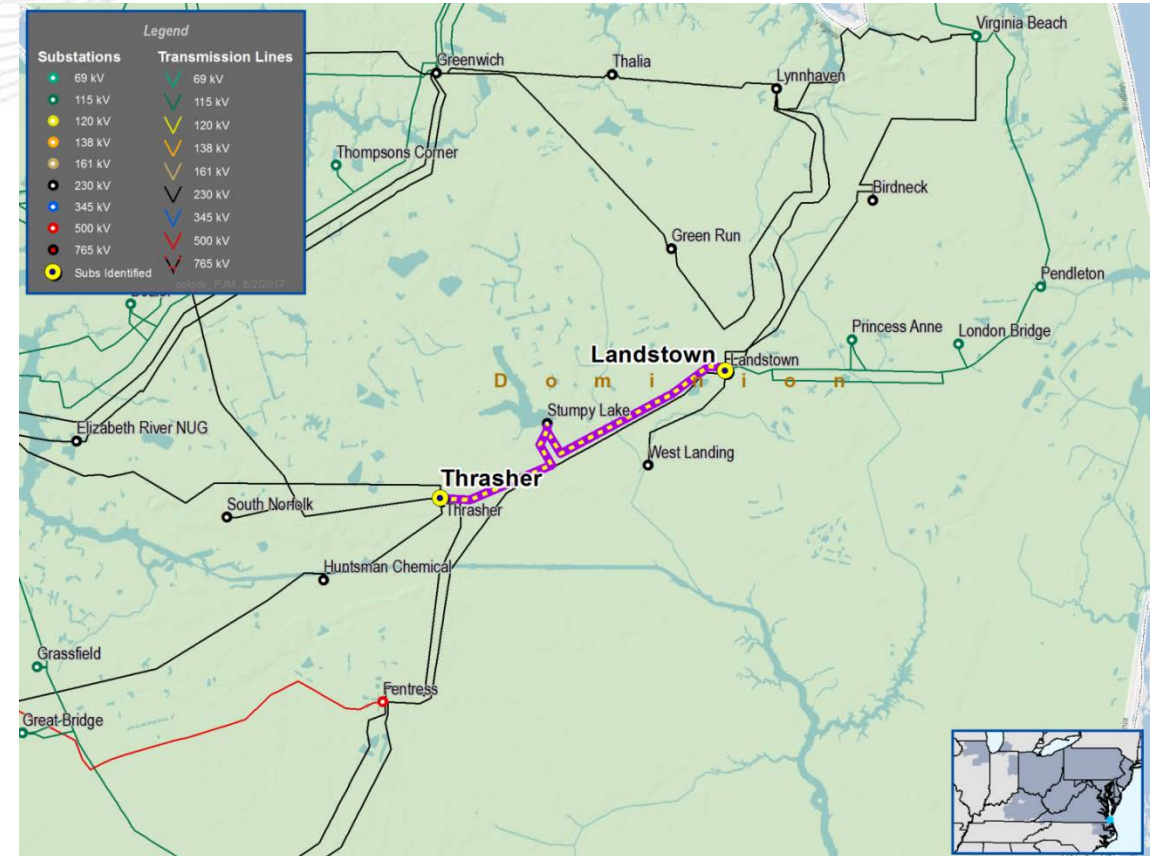
Permanent MW load loss for removal of this line is 89 MW.

Recommended Solution: Line #231 will be rebuilt to current standard with a summer emergency rating of 1046 MVA at 230kV. Proposed conductor is 2-636 ACSR. Structures being considered include double circuit steel pole and double circuit galvanized steel tower. (b2899)

Proposed conductor has a summer load dump rating of 1203 MVA. An N-1-1 study using the 2022 RTEP summer case indicates with the proposed conductor, 48% is the highest loading on the line. Therefore, there is no justification to consider a higher capacity conductor.

Estimated Project Cost: \$22 M

Required In Service Date: 12/1/2020



Dominion Transmission Owner Criteria

Presented: 8/29/2017 Southern Subregional TEAC

Problem Statement: DOM “End of Life Criteria”

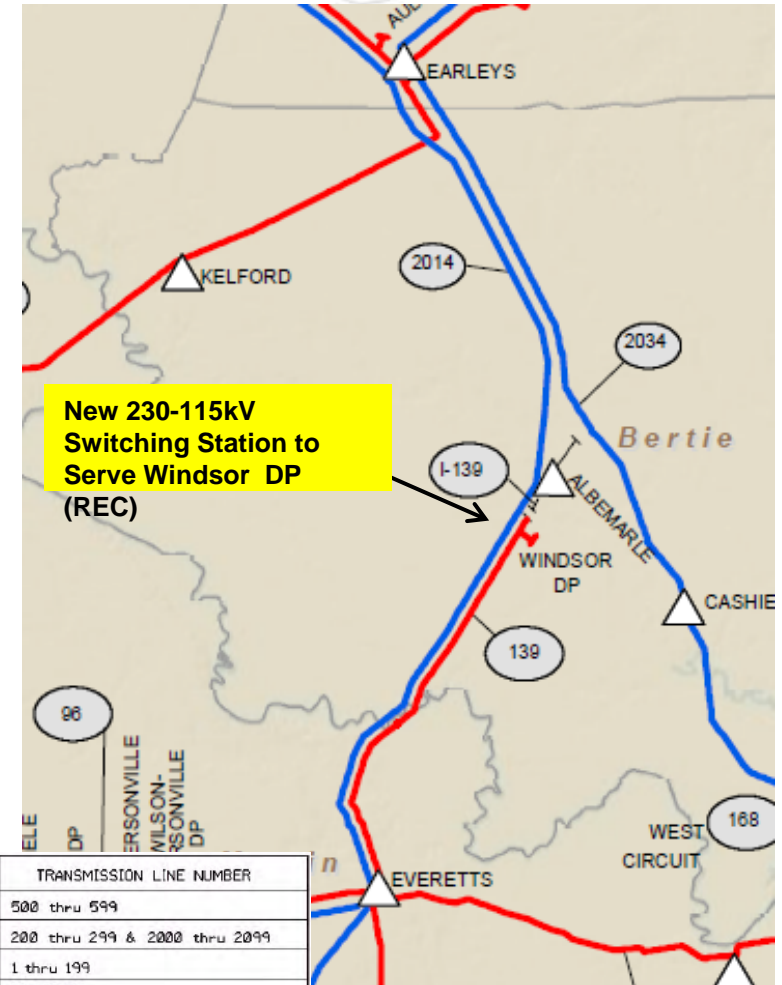
115kV Line #139 Everetts to Windsor has 336 ACSR conductor constructed on wood H-frames in the 1951 timeframe. Line #139 serves one delivery point Windsor DP (Roanoke EC). This line needs to be rebuilt to current standards or provide another source for Windsor DP based on Dominion’s “End of Life” criteria.

Permanent MW load loss for removal of this line is 10 MW.

Recommended Solution: Build a new 230-115kV switching station connecting to 230kV network Line #2014 (Earleys – Everetts). Purchase land and install three single phase 30 MVA 230-115kV transformers (and a spare) with a high and low side breaker. Provide a 115kV source from the new station to serve Windsor DP. Remove Line #139 19.5 miles (15.5 miles Everetts – Windsor, 1.1 mile Windsor to idle line, 2.9 miles idle line). (b2900)

Estimated Project Cost: \$11.5 M

Required In Service Date: 12/30/2022



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

Dominion Transmission Owner Criteria

Presented: 8/10/2017 TEAC

Problem Statement: Dominion “End of Life Criteria”

230kV Lines #211 and #228 run 11 miles from Chesterfield to Hopewell and are double circuit lines

Approximately 8 miles of the lines were built on double circuit weathering steel (Corten) towers in 1969. Field reports and condition assessment indicate the Corten structures are in poor condition. Static fiber is also at end of life.

These lines provide critical outlet for Chesterfield Power station along with HCF and Polyester.

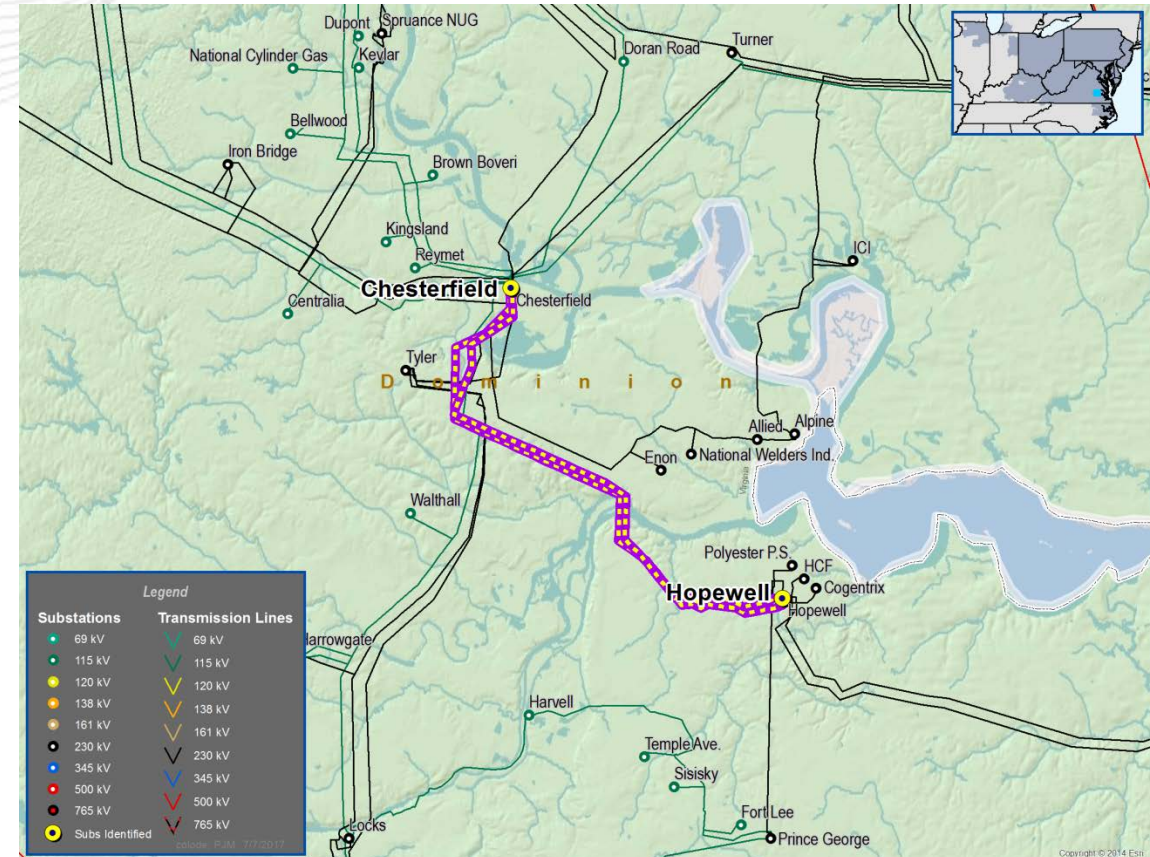
Recommended Solution: Rebuild 8 miles of Line #211 and #228 to current standard. Proposed conductor is 2-636 ACSR. Summer emergency rating of the rebuilt section is 1046 MVA. Summer emergency rating of the entire lines after rebuild is 477 MVA with the remaining 3 mile section being the most limiting conductor. (b2922)

Structures being considered include double circuit steel pole and double circuit galvanized steel tower.

Fiber on the entire line will be replaced.

Estimated Project Cost: \$28.1 M

Required In Service Date: 12/1/2020



Western Region

Baseline Cost Change (B2753.1-10)

Presented: 8/21/2017 Western Subregional TEAC

- N5076.1/B2753.1 - George Washington Station – Replace existing 138kV yard with GIS 138kV breaker and a half yard in existing station footprint. Install 138kV revenue metering for new IPP connection. (AEP)
- N5076.2/B2753.2 - Dilles Bottom Station – Replace Dilles Bottom 69/4kV Distribution station as breaker and a half 138kV yard design including AEP Distribution facilities but initial configuration will constitute a 3 breaker ring bus. (AEP)
- N5076.3/B2753.3 - Holloway Station – Connect two 138kV 6-wired ckts from “Point A” (currently de-energized and owned by First Energy) in ckt positions previously designated Burger #1 & Burger #2. Install interconnection settlement metering on both circuits exiting Holloway station. (AEP)
- N5076.4/B2753.4 - Holloway-”Point A” FE “Burger-Cloverdale No.2” 138kV Line – 6 wire “Burger-Cloverdale No. 2” 138kV Line for double capacity and connect at Holloway and “Point A” (ATSI)
- N5076.5/B2753.5 - Holloway -”Point A” FE “Burger-Longview” 138kV Line – 6 wire “Burger-Longview” 138kV Line for double capacity and connect at Holloway and “Point A” (ATSI)
- N5076.6/B2753.6 - Dilles Bottom -”Point A”138kV Line - Build dbl ckt 138kV line from Dilles Bottom to “Point A”. Tie each new AEP ckt in with a 6 wired line at Point A. This will create a Dilles Bottom-Holloway 138kV ckt and a George Washington-Holloway circuit. (AEP)
- N5076.7/B2753.7 - Dilles Bottom-Bellaire and Moundsville-Dilles Bottom 69kV Lines - Retire line sections south of First Energy 138kV line corridor, near “Point A”. Tie George Washington-Moundsville 69kV ckt to George Washington-West Bellaire 69kV ckt (AEP)
- N5076.8/B2753.8 - Washington-Dilles Bottom 69kV Line – Rebuild existing line as dbl ckt 138kV from George Washington to Dilles Bottom. One circuit will cut into Dilles Bottom initially and the other will go past with future plans to cut in. (AEP)
- N5076.9/B2753.9 - Remove/Open Kammer 345/138 kV transformer #301
- N5076.10/B2753.10 - Complete sag study mitigation on the Muskingum – Natrium 138 kV line

Continued on next slide



Baseline Cost Change (B2753.1-10)

Presented: 8/21/2017 Western Subregional TEAC

Cost Sharing Approach: The interconnection project was to share \$24.5614M of the cost (their ISA commitment) and the Baseline would assume the remainder

Cost Sharing Update: The interconnection project withdrew, the project is still needed. The baseline cost portion will now be 100% of the required project cost.

Required IS Date: 1/1/2019

Original Split Cost	
B2753.1: \$0M	N5076.1: \$24M
B2753.2: \$9M	N5076.2: \$0M
B2753.3: \$2M	N5076.3: \$0M
B2753.4: \$0.25M	N5076.4: \$0M
B2753.5: \$0.25M	N5076.5: \$0M
B2753.6: \$5M	N5076.6: \$0M
B2753.7: \$4.96M	N5076.7: \$0.5614M
B2753.8: \$3.56M	N5076.8: \$0M
B2753.9: \$0M	N5076.9: \$0M
B2753.10: \$2.8M	N5076.10: \$0M

New Split Cost	
B2753.1: \$22.32M	N5076.1: Cancelled
B2753.2: \$9M	N5076.2: Cancelled
B2753.3: \$2M	N5076.3: Cancelled
B2753.4: \$0.25M	N5076.4: Cancelled
B2753.5: \$0.25M	N5076.5: Cancelled
B2753.6: \$5M	N5076.6: Cancelled
B2753.7: \$5.52M	N5076.7: Cancelled
B2753.8: \$3.56M	N5076.8: Cancelled
B2753.9: \$0M	N5076.9: Cancelled
B2753.10: \$2.8M	N5076.10: Cancelled

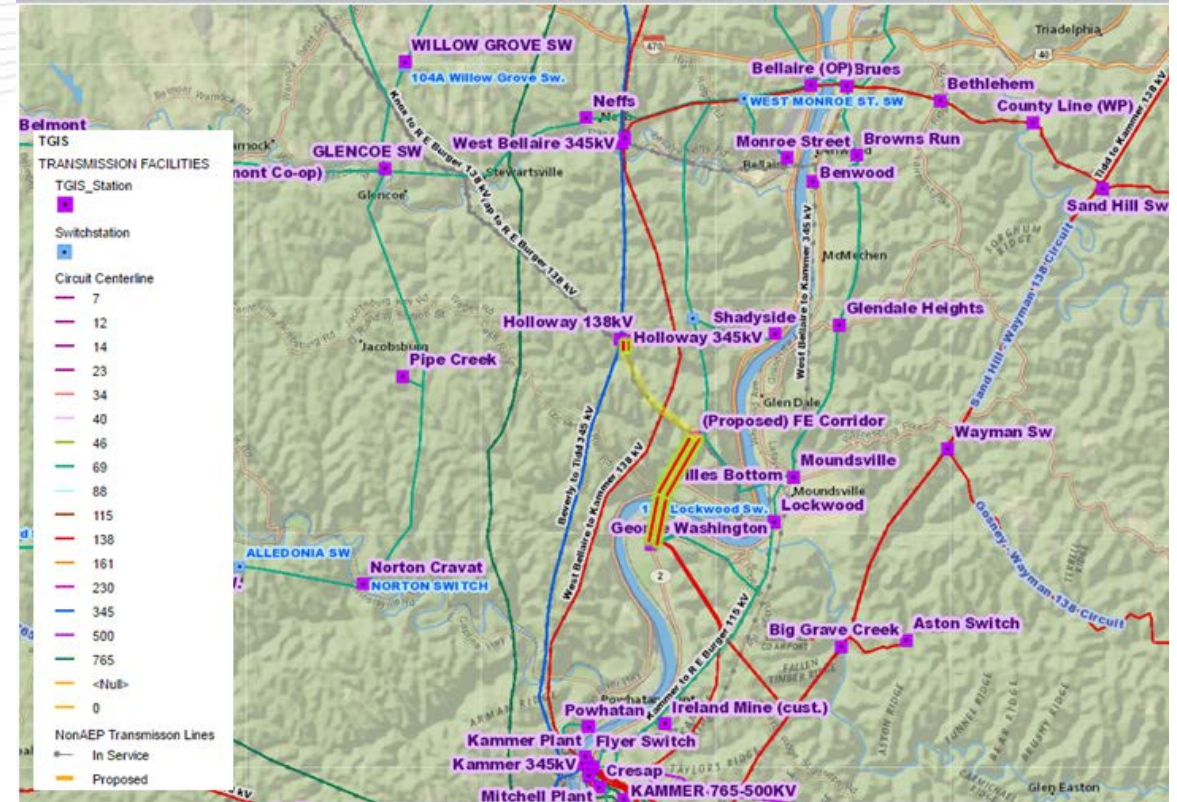
Continued on next slide

Baseline Cost Change (B2753.1-10)

Presented: 8/21/2017 Western Subregional TEAC

Reasons for the Cost Change:

- Queue projects Y3-068 / Z2-048 have been withdrawn. The shared cost of \$24.761M now is transferred to Baseline B2753.1-10.
- B2753.1 New Scope: George Washington Station – Replace existing 138kV yard with GIS 138kV breaker and a half yard in existing station footprint. (Due to the withdrawal of the interconnection request, there is no need for the revenue metering for new IPP connection)
- New Estimated Cost: \$50.7M
- New Required IS Date: 5/31/2020



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Kaiser Jct – Air Force Jct section (3/0 ACSR, 44 MVA rating) of the Kaiser - Heath 69 kV circuit is overloaded (129%) for the failure of the 138/69 kV transformer at West Hebron and subsequent failure of the 138/69 kV transformer at Newark Center in the 2021 RTEP case. –Newark Ohio, Northeast of Columbus

Recommended Solution: Reconductor 0.53 miles (14 spans) of the Kaiser Jct-Air Force Jct Sw section of the Kaiser-Heath 69 kV circuit/line with 336 ACSR to match the rest of the circuit (73 MVA rating, 78% loading). (B2787)

Estimated Project Cost: \$1.096M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Speidel-Barnesville 69kV line section (#1 Copper, 31 MVA rating) is overloaded (117% worst loading) for multiple N-1-1 contingency pairs in the 2021 RTEP case. – Belmont County, Ohio

Recommended Solution: Install a new 3-way 69kV line switch to provide service to AEP's Barnesville distribution station. Remove a portion of the #1 copper T-Line from the 69kV through-path. The Speidel-Summerfield 69 kV line and future bypass route was previously submitted to and reviewed by PJM as s1158. An additional plan of service is being discussed with AEP Ohio.(B2788)

Estimated Project Cost: \$0.35M

Required In Service Date : 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Brues-Glendale Heights 69kV line section (3/0 copper, 46 MVA rating) is overloaded (120% worst loading) for multiple N-1-1 contingency pairs, common towerline, and breaker-failure contingencies in the 2021 RTEP case.

The 5-mile long Brues-Glendale line was built in 1917. 81% of the line is still on the original 1917 wood poles. –Border of Ohio and West Virginia

Recommended Solution: Rebuild the Brues-Glendale Heights 69kV line section (5 miles) with 795 ACSR (128 MVA rating, 43% loading). (B2789)

Estimated Project Cost: \$16.7M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

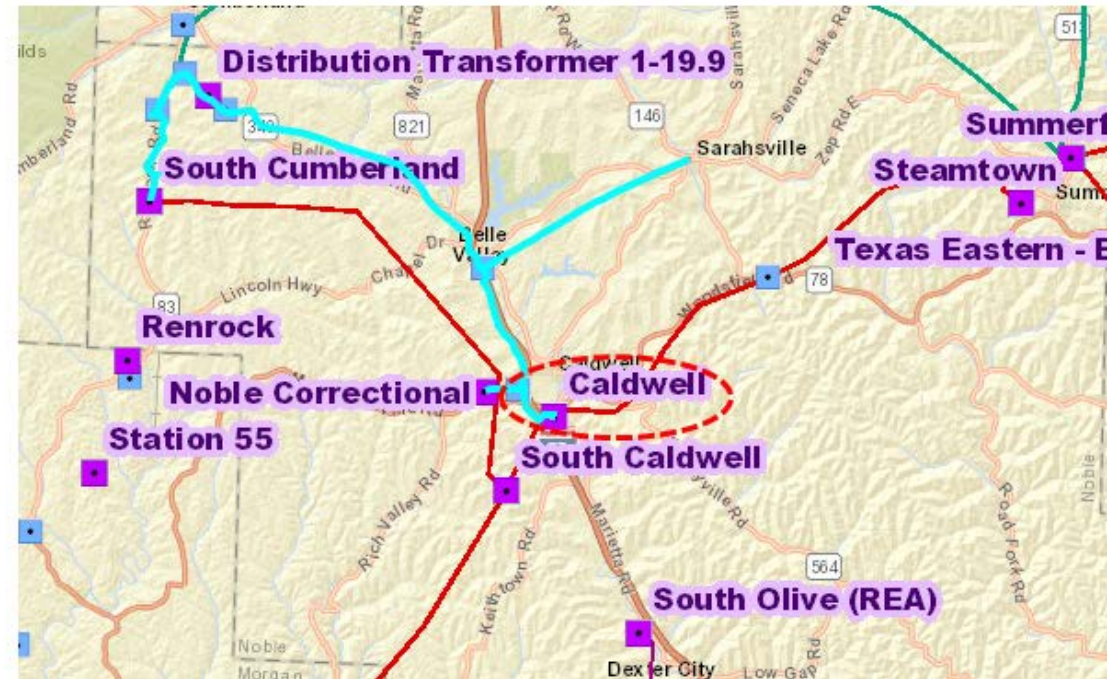
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: Voltage drop violation (0.915 pu) at Sarahsville 34.5 kV bus for a Caldwell 138/34.5kV transformer fault or bus fault contingencies at Caldwell in the 2021 RTEP case. –Noble County, Ohio

Recommended Solution: Install a 3 MVAR, 34.5kV cap bank at Caldwell substation. (B2790)

Estimated Project Cost: \$0.426M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The West Rockaway Switch – East Tiffin 69kV line (#1 Copper, 31 MVA, 203%), the Greenlawn – East Tiffin 69kV line (2/0 ACSR, 39 MVA, 161%), the Chatfield – New Washington Switch 69kV line (#1 Copper, 31 MVA, 112%), the Howard – Willard 69kV line (3/0 ACSR, 44 MVA rating, 101%), the Broken Sword – Nevada Switch 69kV line (#1 Copper, 31 MVA rating, 117%), and the Upper Sandusky – Nevada Switch 69kV line (#1 Copper, 31 MVA rating, 124%) are overloaded for a Chatfield 138-69 kV XFMR fault or similar bus fault contingencies near Chatfield and for multiple N-1-1 contingency pairs in the 2021 RTEP case. Voltage drop (9.6%) and voltage magnitude violation (0.916 pu) at West Shelby, Hinesville and other surrounding 69KV buses for multiple contingencies are also seen in the 2021 RTEP case.

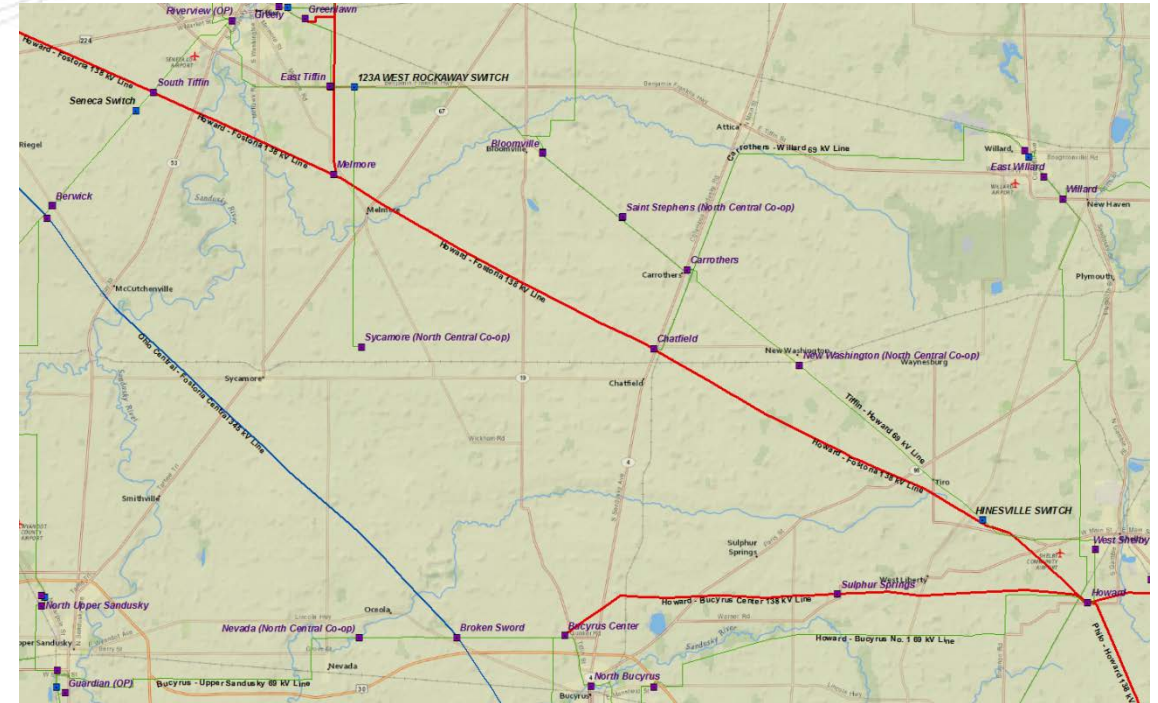
The East Tiffin-Howard 69 kV path was originally constructed in 1918 with wood pole structures utilizing #1 Copper conductor. There are 285 open conditions on the 57-mile long line associated with structure, hardware, and shielding. There has also been increased IPP activity in this area, resulting in increased power flows on lines. –Richland County, Ohio

Recommended Solution:

- Rebuild portions of the East Tiffin-Howard 69kV line from East Tiffin to West Rockaway Switch (0.8 miles) using 795 ACSR Drake conductor (129 MVA rating, 50% loading). (B2791.1)
- Rebuild Tiffin-Howard 69kV line from St. Stephen's Switch to Hinesville (14.7 miles) using 795 ACSR Drake conductor (90 MVA rating, non-conductor limited, 38% loading). (B2791.2)
- New 138/69kV transformer with 138kV & 69kV protection at Chatfield station. (B2791.3)
- New 138kV & 69kV protection at existing Chatfield transformer. (B2791.4)

Estimated Project Cost: \$20.386M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

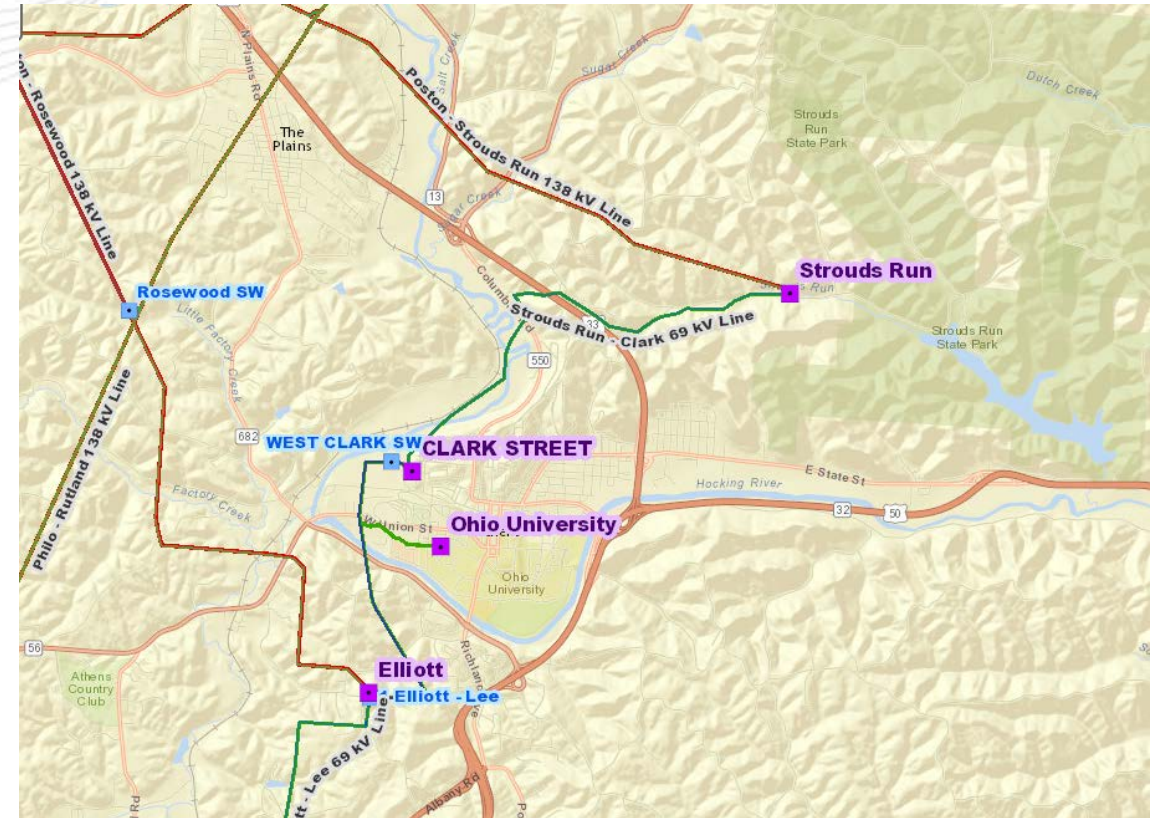
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Elliott 138/69 kV transformer (89 MVA rating) and the Elliott – Ohio University 69 kV line (336 ACSR, 73 MVA rating) are overloaded (108% and 104% respectively) for the loss of the Poston – Strouds Run – Crooksville 138kV Line. The Clark Street – Strouds Run 69 kV line (336 ACSR, 73 MVA rating) is overloaded (107%) for the loss of the Dexter – Elliot – Poston 138kV line in the 2021 RTEP case. –Athens, Ohio

Recommended Solution: Replace the Elliott transformer with a 130 MVA unit. Reconductor 0.42 miles of the Elliott – Ohio University 69 kV line with 556 ACSR to match the rest of the line conductor (102 MVA rating, 73% loading) and rebuild 4 miles of the Clark Street – Strouds Run 69 kV with 556 ACSR conductor (102 MVA rating, 76% loading). (B2792)

Estimated Project Cost: \$5.76M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Fremont Center – Riverview 69 kV circuit is overloaded (118%) for the loss of the Fremont Center 138/69 kV transformer #1 and the Fremont 138/69 kV transformer #1 in the 2021 RTEP case. – Fremont, Ohio.

Recommended Solution: Energize the spare Fremont Center 138/69 kV 130 MVA transformer #3. Reduces overloaded facilities to 46% loading.(B2793)

Estimated Project Cost: \$0.081M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

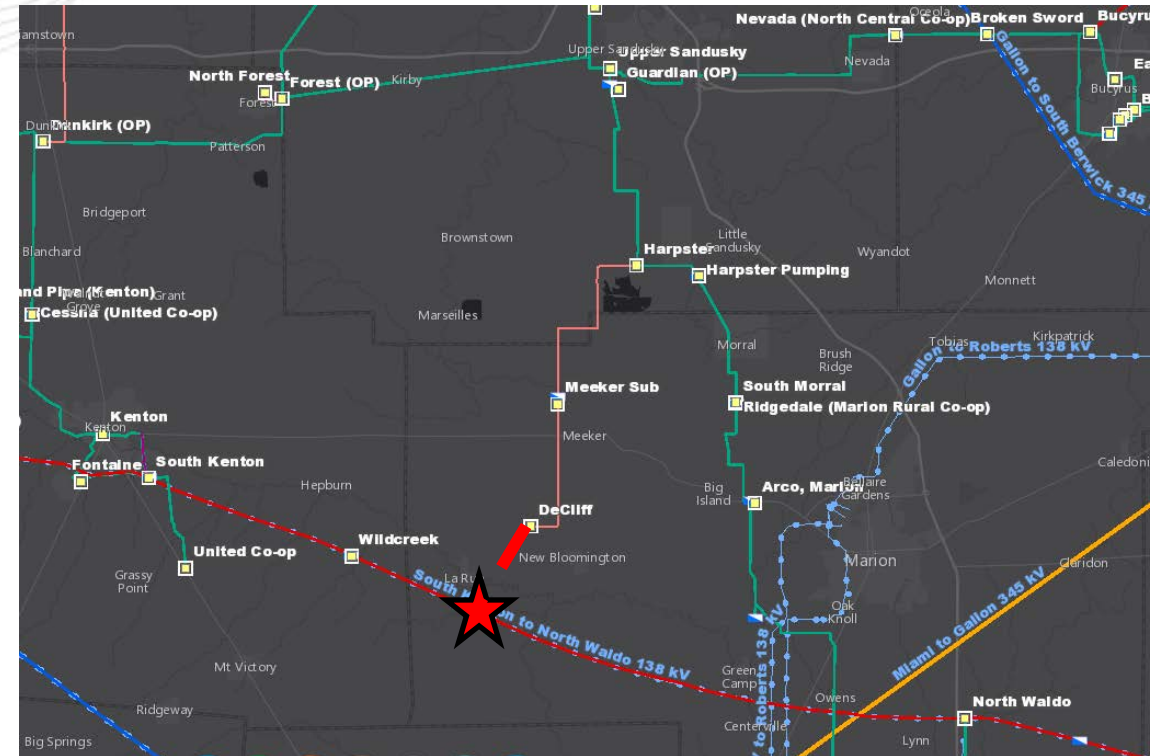
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: Low Voltage (0.883 pu) and voltage drop (17% worst drop) violations at South Upper Sandusky, Harpster, Ridgedale, South Morral, Meeker, and Decliff 69kV buses for the outage of the Upper Sandusky 69kV bus in the 2021 RTEP case. The Harpster area has had over 670,000 customer minutes of interruptions over the past three years, including 360,000 minutes on the Harpster-Decliff line. –Marion, Ohio

Recommended Solution: Construct new 138/69/34kV station and 1-34kV circuit (designed for 69kV) from new station to Decliff station, approximately 4 miles, with 556 ACSR conductor (51 MVA rating). (B2794)

Estimated Project Cost: \$12.65M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

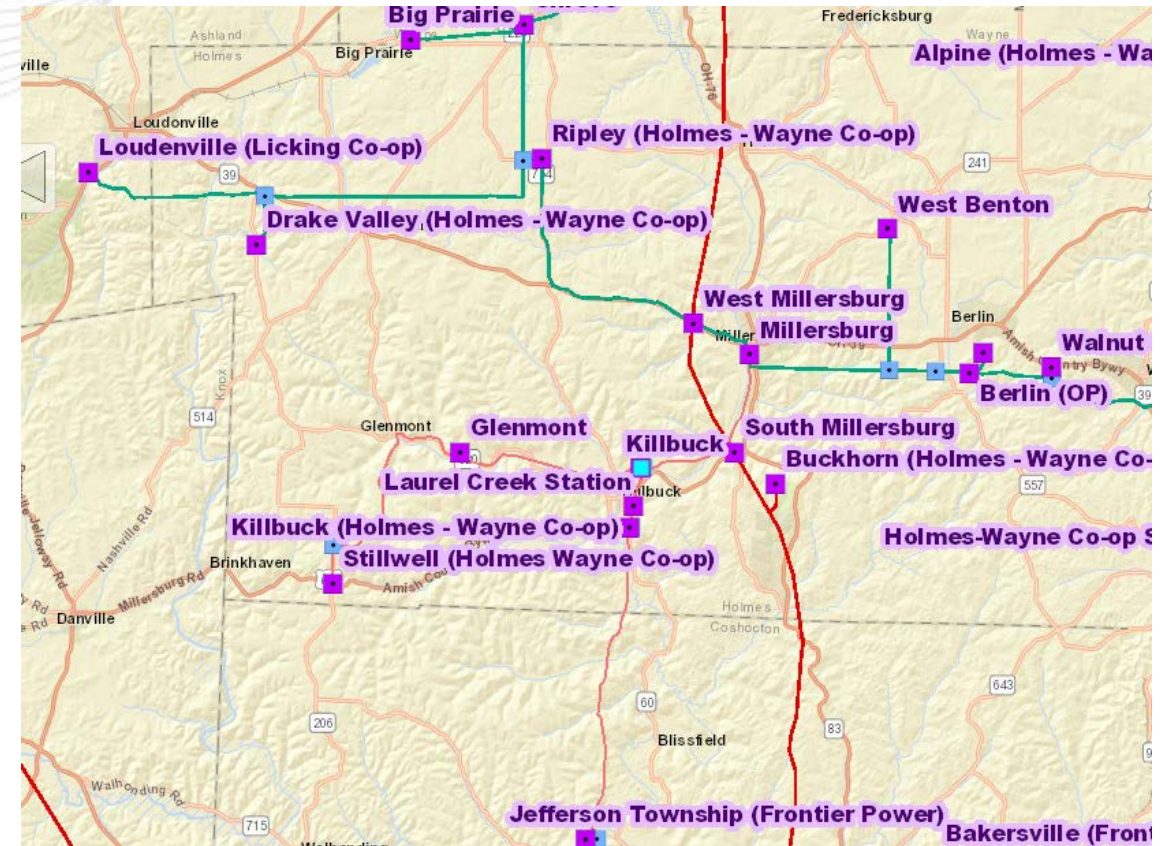
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: Low Voltage (0.916 pu) and voltage drop (10.7% worst drop) violations at Stillwell, Glenmont, and Killbuck 34.5kV buses for the outage of the South Millersburg 34.5kV bus in the 2021 RTEP case. – Holmes County, Ohio

Recommended Solution: Install a 34.5 kV 4.8 MVAR capacitor bank at Killbuck 34.5kV station. (B2795)

Estimated Project Cost: \$0.482M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

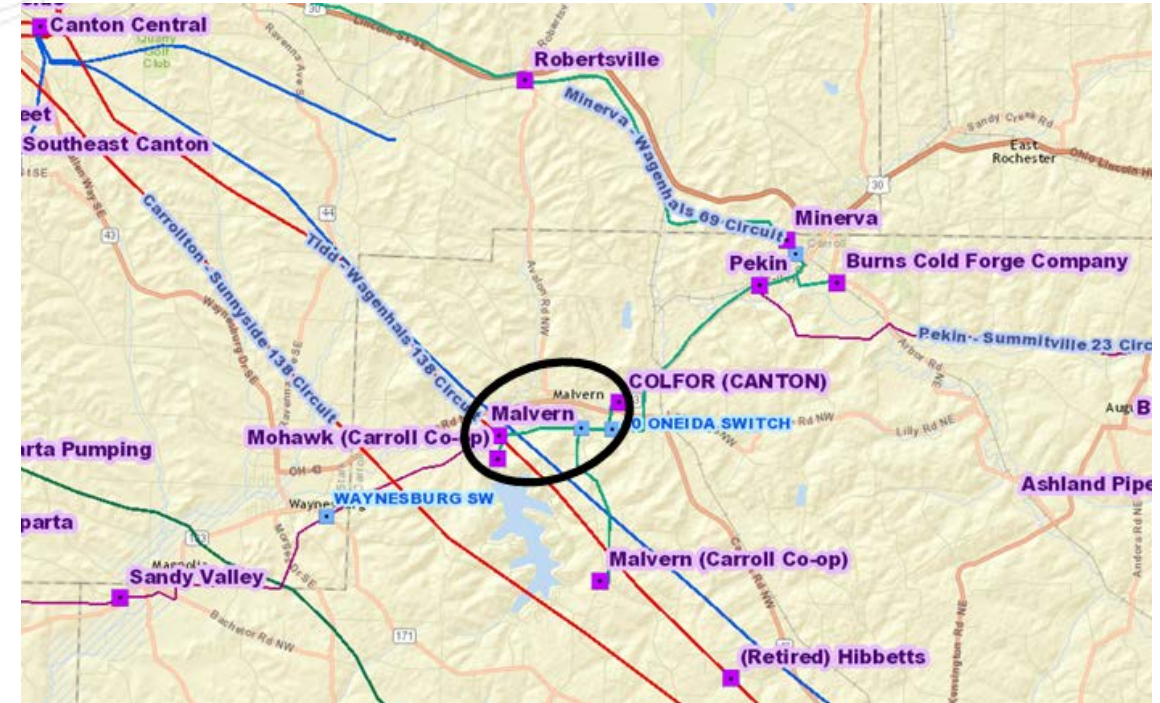
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Malvern - Oneida Switch 69kV line section (4/0 Copper, 54 MVA rating) is overloaded (128% worst loading) for multiple N-1 and N-1-1 contingencies in the 2021 RTEP case. – Carroll County, Ohio

Recommended Solution: Rebuild the Malvern-Oneida Switch 69kV line section with 795 ACSR (1.8 miles, 125 MVA rating, 55% loading). (B2796)

Estimated Project Cost: \$4.1M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

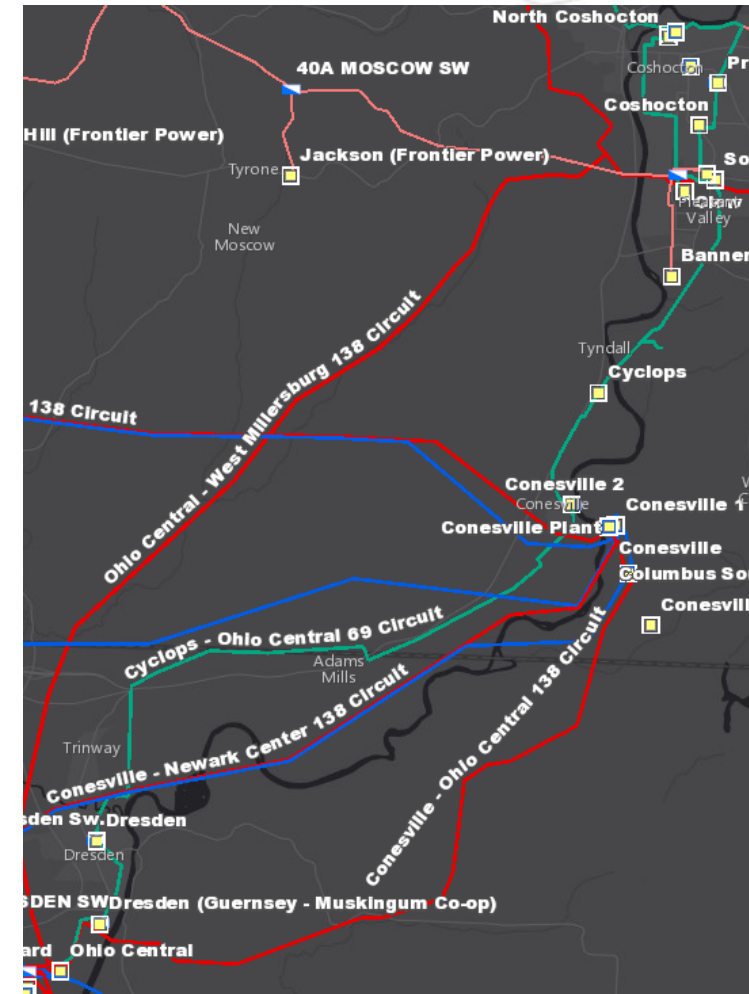
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Ohio Central - Conesville 69kV line section (4/0 Copper and 336 ACSR, 54 MVA rating) and the Ohio Central 138/69 kV transformer (50 MVA rating) are overloaded (135% worst loading) for multiple N-1 and N-1-1 contingencies in the 2021 RTEP case. – Coshocton County, Ohio

Recommended Solution: Rebuild the Ohio Central-Conesville 69kV line section (11.8 miles) with 795 ACSR conductor (128 MVA rating, 57% loading). Replace the 50 MVA Ohio Central 138-69kV XFMR with a 90 MVA unit. (B2797)

Estimated Project Cost: \$20.6M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

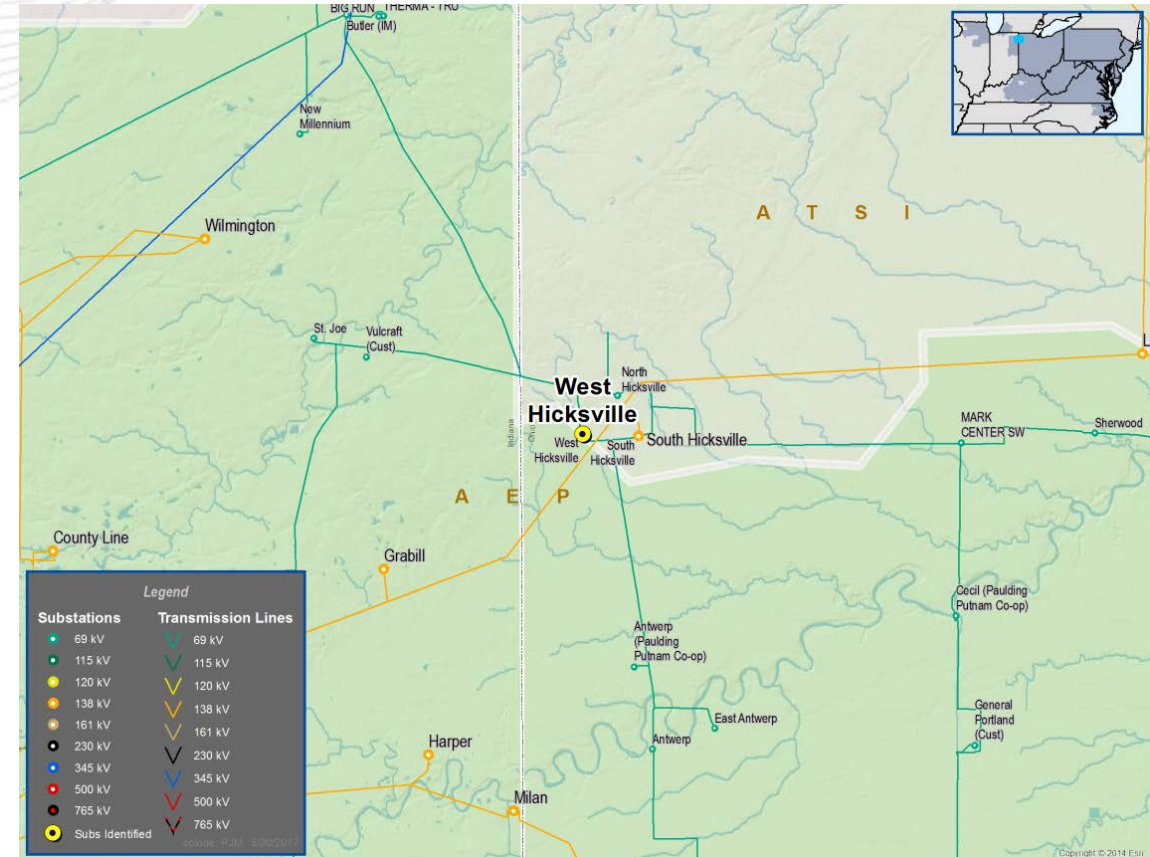
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: Low voltage violation (0.905 pu) at West Hicksville station for loss of the South Hicksville 69 kV bus in the 2021 RTEP case. –Hicksville, Ohio

Recommended Solution: Install a 14.4 MVar capacitor bank at West Hicksville station. Replace ground switch/MOAB at West Hicksville with a circuit switcher (B2798)

Estimated Project Cost: \$1.3 M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement:

Low voltage violations at 19 different stations (0.70 pu voltage and 33% worst drop) were identified, along with thermal violations on the Hartford – Almena (336 ACSR conductor, 73 MVA rating, 141% worst loading), Riverside – South Haven (4/0 Copper conductor, 54 MVA, 142%), and Valley – Almena (556 AAC conductor, 90 MVA, 111%) 69kV lines. Additionally, Valley 138/69 kV transformer 1 (93 MVA, 117%), Riverside 138/69 kV transformer 5 (71 MVA, 111%), and Hartford 138/69 kV transformer 1 (120 MVA, 102%) overload for multiple N-1-1 type contingencies involving the 138/69 kV sources and lines in the area in the 2021 RTEP case.

The Riverside-South Haven 69 kV line was constructed in the 1960s on wood poles with 4/0 Copper conductor (54 MVA rating). This line has experienced over 6,000,000 customer minutes of interruption over the past three years. There are 57 open A conditions along this 24 mile long line, mostly related to rotten wood poles and cross-arms, burnt insulators, and missing ground lead wire. Transmission Operations cannot sectionalize this line without momentarily dropping all customers currently served from this line. AEP's MOAB installation criteria calculations justify the installation of a MOAB at Vector Switch.

The Almena-Hartford 69 kV line was also constructed in the 1960s with 336 ACSR conductor (73 MVA rating). There are 21 open A conditions on this 16 mile long line and has had 34 momentary and 4 permanent outages over the past three years.

The Almena-Valley 69 kV line was built in 1971 with 556 AAC conductor (99 MVA rating). It has 18 open A conditions along the 11 mile long line.

The existing 69kV bus tie CB A at South Haven station is a 1200 A 20 kA GE, FK-type oil filled breaker that was manufactured in 1966. This breaker has a total 265 fault operations, exceeding the manufacturer limit of 10. The current configuration at South Haven station combines more than 3 elements into one protection zone. The existing bus tie protection scheme exposes all three transformers to line faults and increases the probability of relay misoperations. This has been a concern to the customers in the City of South Haven because this is the only transmission source in the area.

At Hickory Creek station, 138 kV breakers L, A and J are 1200 A 20 kA oil filled breakers and 34.5 kV breakers H, G, C, and F are 1200 A 15 kA oil filled breakers. 138 kV circuit breaker B is a 2000 A 40 kA air insulated breaker. During winter conditions, breaker B is at a higher risk of failure than a typical oil filled breaker due to the lack of a dryer system associated with the air system and the loss of heating source. There have been several instances in the past where this breaker has frozen, putting the system at risk of a breaker failure. Additionally, air breakers tend to fail violently and their porcelain bushings disperse particles into the surrounding area, which is a safety concern. Breaker J has had 47 fault operations. Breaker A has had 57 fault operations. Breaker H has had 28 fault operations. Breaker G has had 22 fault operations. Breaker F has had 85 fault operations. All these exceed the manufacturer recommendation of 10. These breakers all have some combination of the following documented conditions: age, bushing damage, number of fault operations, a lack of available repair parts, and PCB contamination. Additionally, 138/34.5 kV 30 MVA transformers 1 and 3 are showing significant signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings).

AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement (continued):

At Main Street station, 138 kV 1200 A 20 kA breaker A and 34.5 kV 1200 A 22 kA breakers B, C, D, and E are all oil filled breakers. Breaker A has had 59 fault operations. Breaker B has had 20 fault operations. Breaker C has had 58 fault operations. Breaker D has had 15 fault operations. Breaker E has had 17 fault operations. All exceed the manufacturer recommendation of 10. These breakers all have some combination of the following documented conditions: age, bushing damage, number of fault operations, and PCB contamination. Additionally, 138/34.5 kV 30 MVA transformer 3 is showing significant signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings).

At Riverside station, 69 kV 1200 A 20 kA breaker L and 138 kV 800 A 15 kA breaker R are oil filled breakers manufactured in 1965 and 1947. Breaker L has had 126 fault operations, exceeding the manufacturer recommendation of 10. These breaker have the following documented conditions: age, number of fault operations, a lack of available repair parts, and PCB content. Additionally, 138/69/34.5 kV 50 MVA Transformer #5 is beginning to show signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), accessory damage (bushings), and high temperature (winding thermal condition). Transformer #5 also has high levels of dissolved Ethylene and Carbon Dioxide in the oil.

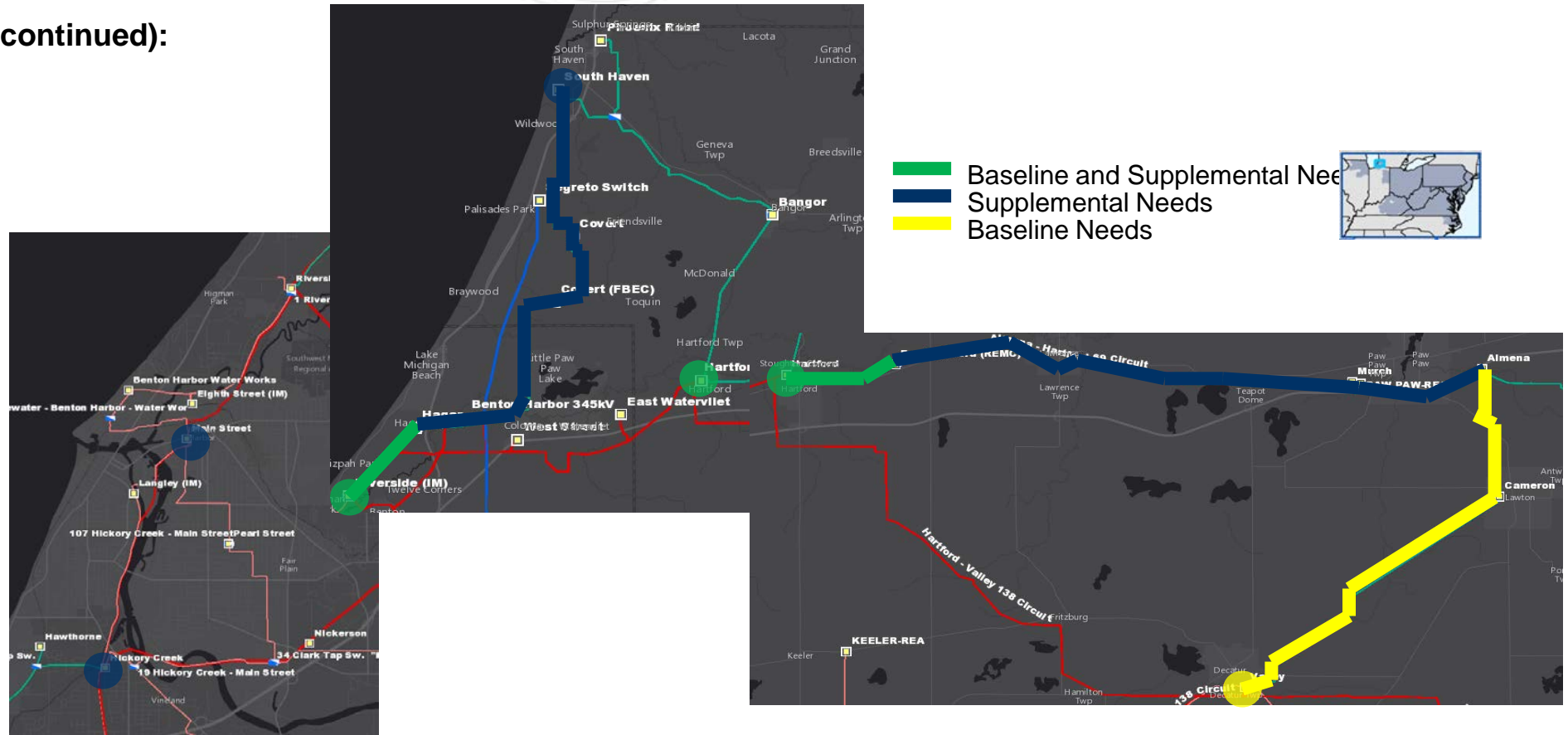
At Hartford station, 69 kV breakers G and H are 1200 A 20 kA oil filled breakers manufactured in 1965 and 1966. Breaker G has had 207 fault operations. Breaker H has had 199 fault operations. Both exceed the manufacturer recommended limit of 10. These breakers have the following documented conditions: age, bushing damage, number of fault operations, and PCB content. Additionally, 138/69/34.5 kV 115 MVA Transformer #1 is showing signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings).

In general, oil breakers have become more difficult to maintain due to the required oil handling. Oil spills occur often during routine maintenance and failures, which can become an environmental concern.

–Kalamazoo, MI

AEP Transmission Owner Criteria Violation Presented: 5/31/2017 Western Subregional TEAC

Problem Statement (continued):



AEP Transmission Owner Criteria Violation

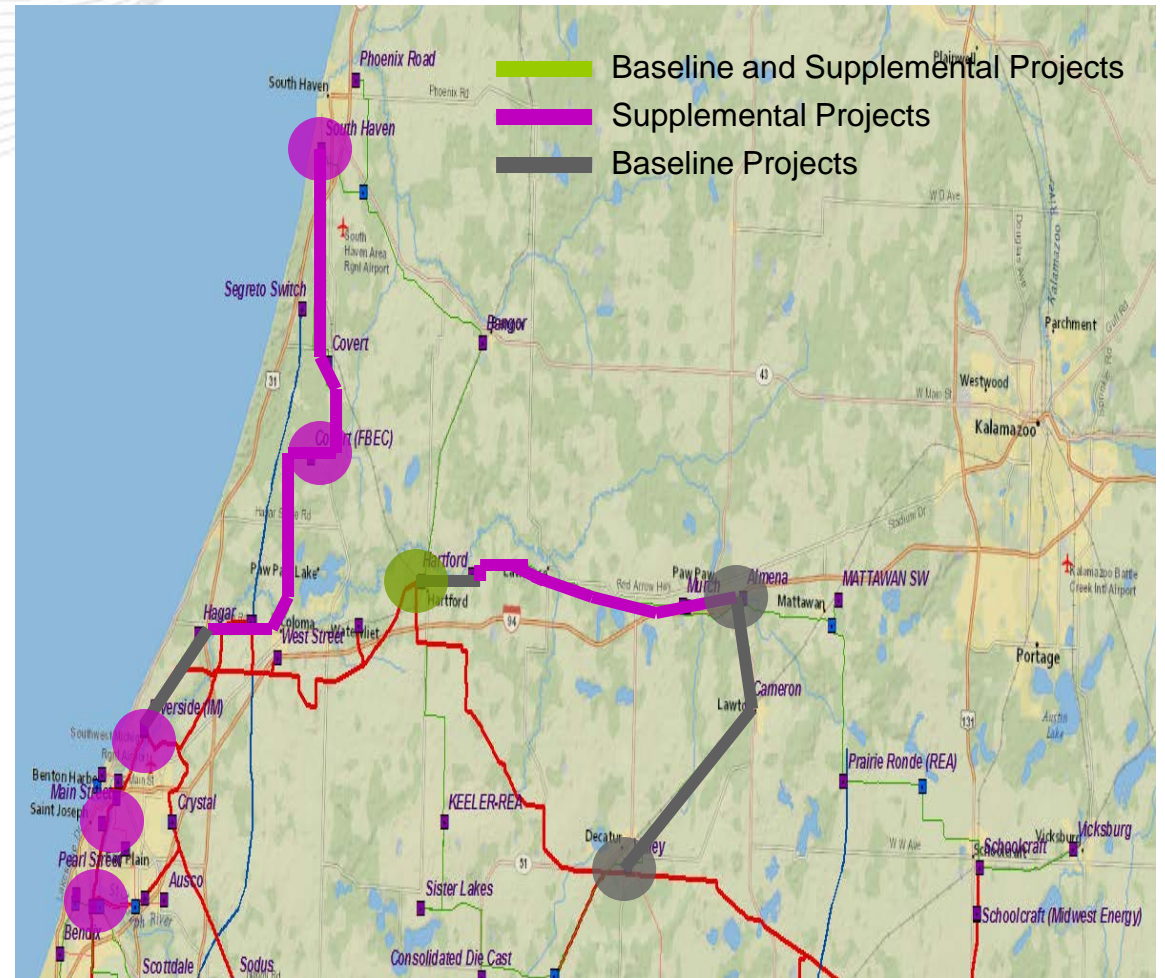
Presented: 5/31/2017 Western Subregional TEAC

Recommended Solution:

- Rebuild 12 miles of Valley – Almena 69kV line as a double circuit 138kV/69kV line using 795 ACSR conductor (360 MVA rating) to introduce a new 138 kV source into the 69 kV load pocket around Almena station. (B2799.1)
- Rebuild 3.2 miles of Almena to Hartford 69kV line using 795 ACSR conductor (90 MVA rating). (B2799.2)
- Rebuild 3.8 miles of Riverside – South Haven 69V line using 795 ACSR conductor (90 MVA rating). (B2799.3)
- At Valley station, add new 138kV line exit with a 3000 A 40 kA breaker for the new 138 kV line to Almena and replace CB D with a 3000 A 40 kA breaker. (B2799.4)
- At Almena station, install a 90MVA 138kV/69kV transformer with low side 3000 A 40 kA breaker and establish a new 138kV line exit towards Valley. (B2799.5)
- At Hartford station, install a second 90MVA 138/69kV transformer with a circuit switcher and 3000 A 40 kA low side breaker. (B2799.6)

Estimated Project Cost: \$53.0 M

Required In Service Date: 6/1/2021



Short Circuit Violation

Presented: 6/30/2017 Western Subregional TEAC

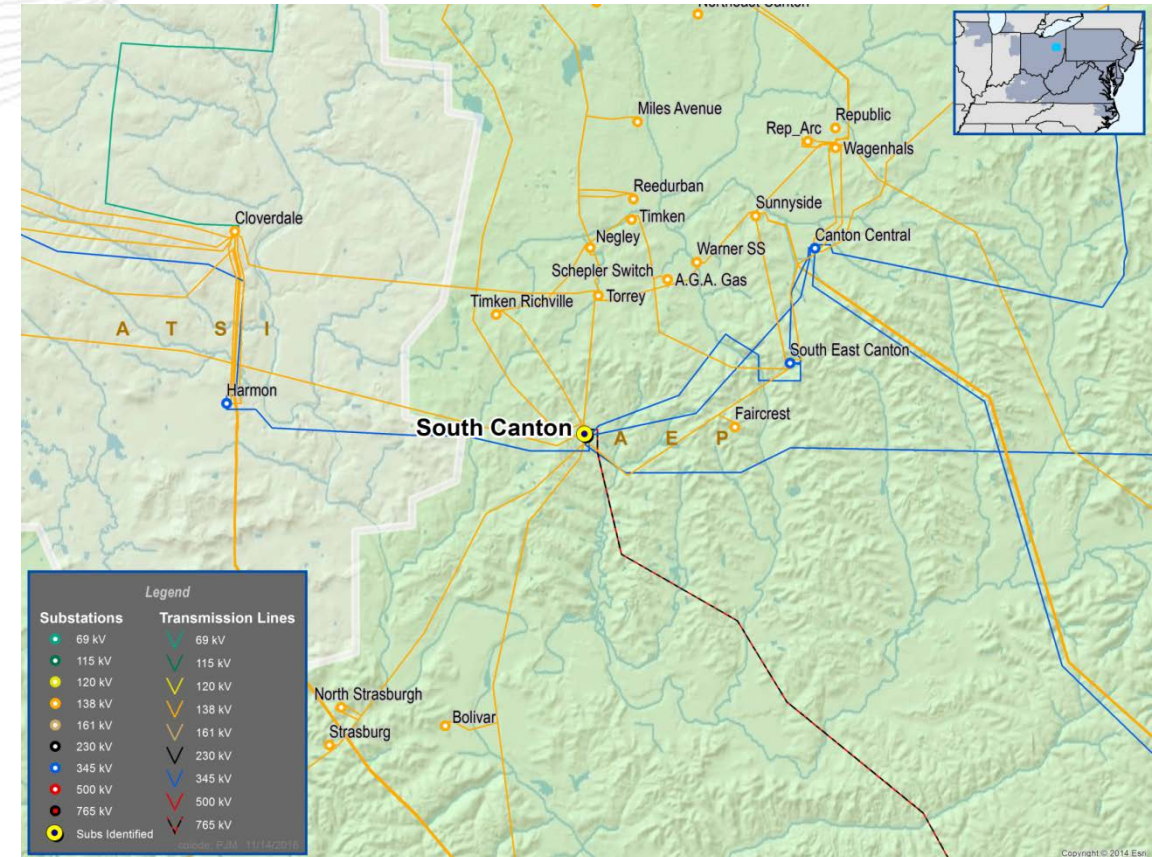
Problem Statement: The South Canton 138 kV breaker 'K2' is overstressed for a fault at South Canton 138 kV.

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

Recommended Solution: Replace the South Canton 138 kV breaker 'K2' with an 80 kA breaker . (b2872)

Estimated Project Cost: \$600 K

Required In Service Date: 6/1/2019



Short Circuit Violation

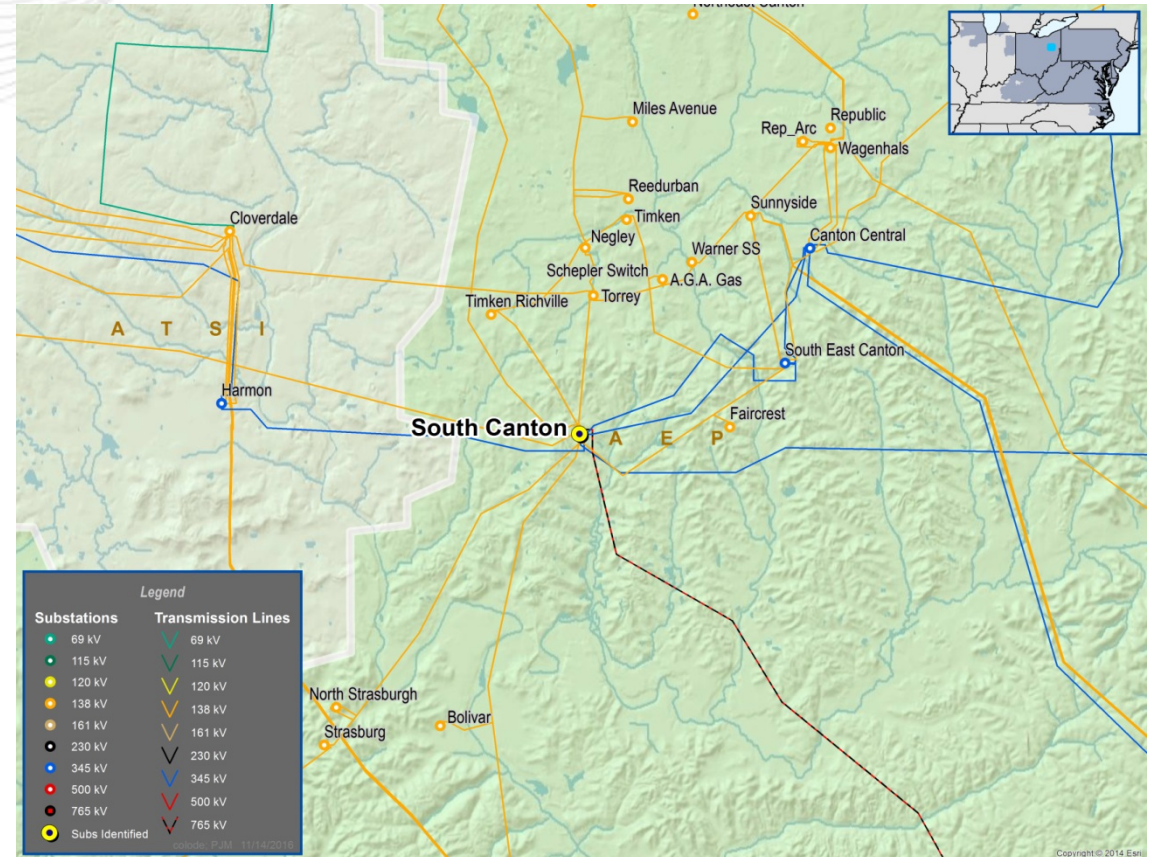
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: The South Canton 138 kV breakers 'M' and 'M2' are overstressed for a fault at South Canton 138 kV.

Recommended Solution: Replace the South Canton 138 kV breakers 'M' and 'M2' with 80 kA breakers. (b2873 and b2874)

Estimated Project Cost: \$600 K per breaker

Required In Service Date: 6/1/2022



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

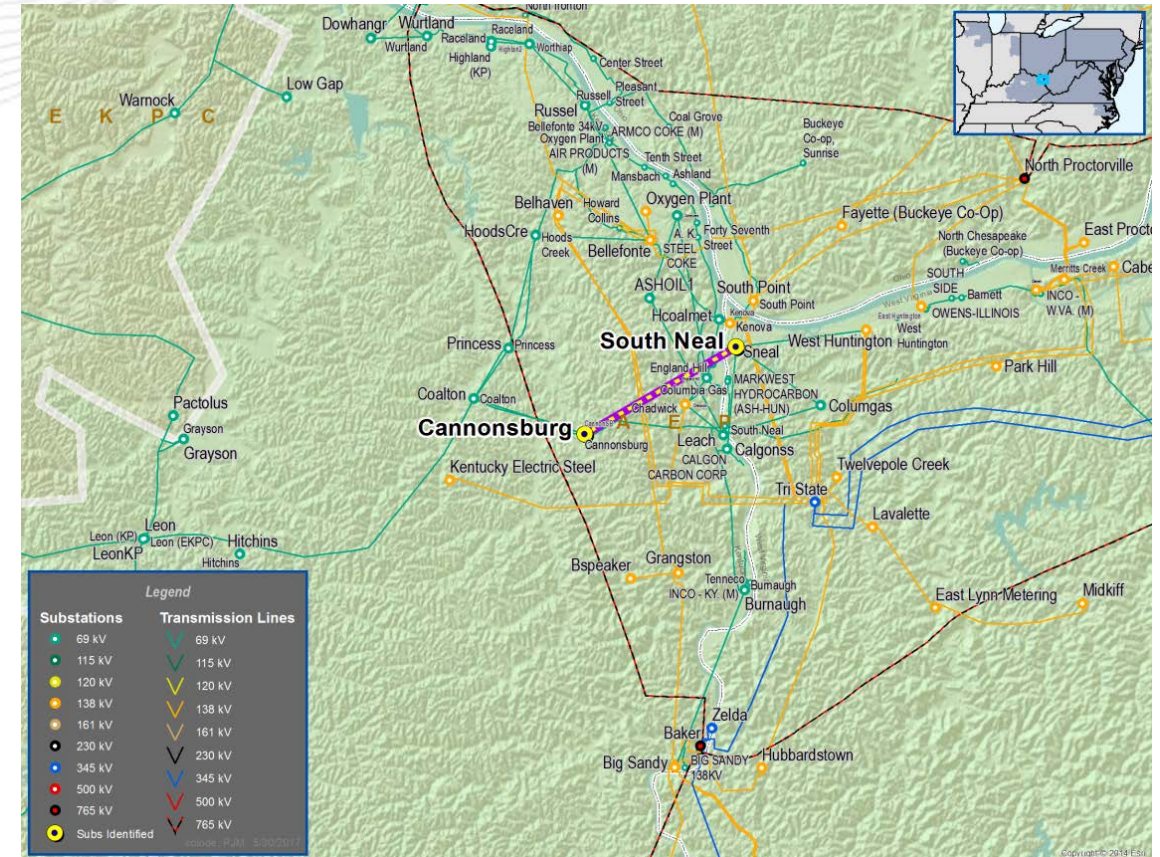
Problem Statement: The Cannonsburg – South Neal 69 kV line section (336 ACSR, 75 MVA rating, 100%) overloads for loss of Bellefonte 69 kV bus #2 or loss of Bellefonte – Hoods Creek 69 kV in the 2021 RTEP case.

In addition to the planning criteria violation, this rebuild will address three open category A conditions on the Cannonsburg – South Neal line section. These conditions include damaged equipment and cross arm. – Ashland, KY

Recommended Solution: Rebuild approximately 4.77 miles of the Cannonsburg – South Neal 69 kV line section utilizing 795 ACSR conductor (90 MVA rating, 83%). (B2880)

Estimated Project Cost: \$12.5M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Dunnhollow – London 69 kV line (3/0 Copper, 31 MVA rating, 103%) overloads for loss of Kanawha River 138 kV Bus #1 or multiple breaker failure contingencies at Kanawha River in the 2021 RTEP case.

In addition to the planning criteria violation, the Carbondale – London 46kV line is a poor performing circuit in the APCo region. From 2013-2016, this circuit has experienced 9 permanent outages and 1,721,181 customer minutes of interruption. Approximately 2.4 miles of this circuit utilizes structures from 1915. There are currently 65 category A open conditions along the 5.9 mile long line. These open conditions include damaged/rotted poles and damaged guy wires, shield wire, conductor, insulator and cross arms. -- Charleston, WV

Recommended Solution: Rebuild ~1.7 miles of the Dunn Hollow – London 46kV line section utilizing 795 26/7 ACSR conductor (58 MVA rating, non-conductor limited, 55%). (B2881)

Estimated Project Cost: \$4.5M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Reusens – Peakland Switch 69 kV line (4/0 Copper, 54 MVA rating, 106%) overloads for loss of the Peaksview 69 kV bus in the 2021 RTEP case.

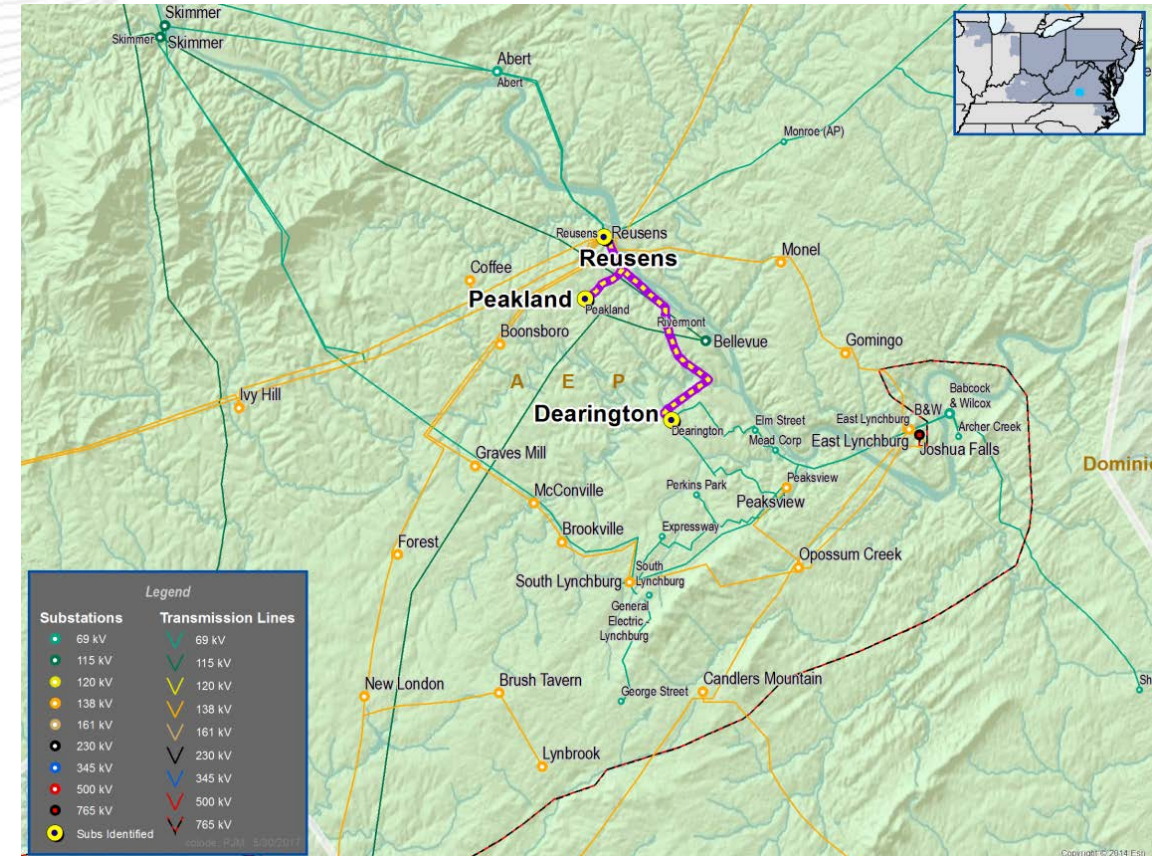
The Dearington – Reusens 69kV is a poor performing circuit in the APCo region. From 2013 – 2016, the circuit has experienced 12 permanent outages with 1,469,505 customer minutes of interruption. Approximately 75% of the structures of this circuit are 1925 vintage. There are currently 60 category A open conditions along the 5.2 mile long line. These conditions include damaged pole/crossarm/shield wire and conductor. – Lynchburg, VA

Recommended Solution:

- Rebuild the Reusens - Peakland Switch 69 kV line (approximately 0.8 miles) utilizing 795 ACSR conductor (86 MVA rating, non-conductor limited, 67%). (B2882.1)
- Replace existing Peakland S.S with new 3 way switch phase over phase structure.(B2882.2)

Estimated Project Cost: \$2.9M

Required In Service Date: 6/1/2021



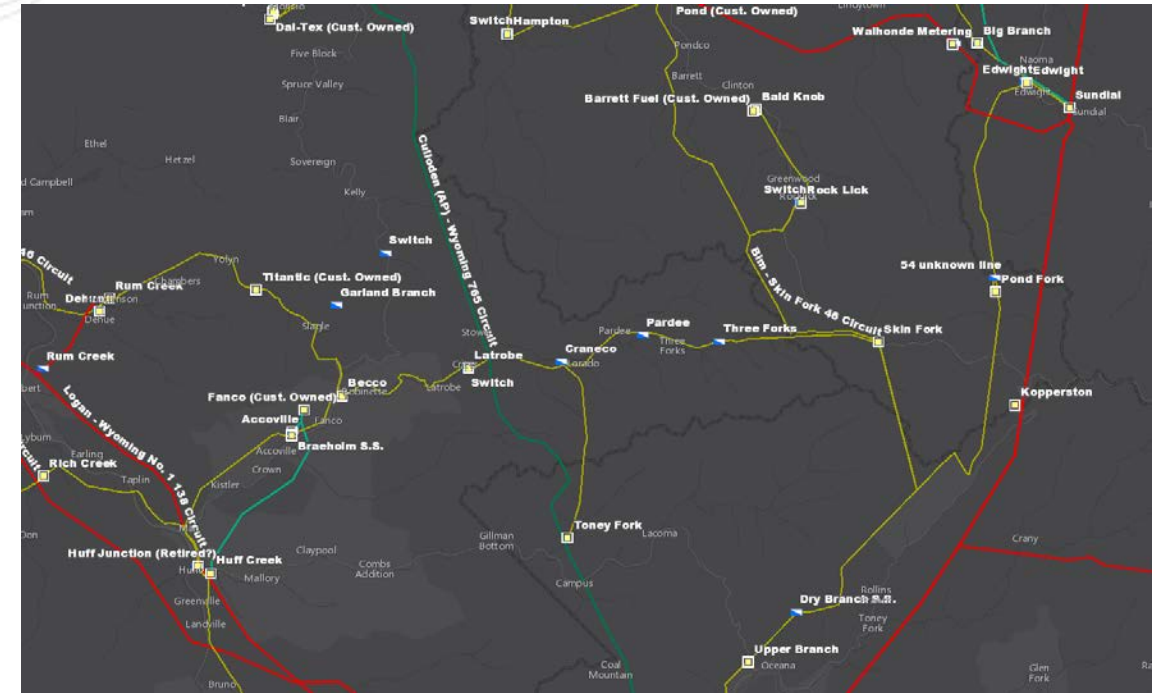
AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Craneco – Pardee – Three Forks – Skin Fork 46kV line (3/0 Copper, 37 MVA rating, 126%) overloads due to the N-1-1 outage of the Huff Creek 138/69/46 kV and Chauncey 138/46 kV transformers in the 2021 RTEP case.

The Becco – Skin Fork circuit is a poor performer in the APCO region. From 2013-2016, the Becco – Skin Fork circuit has experienced 15 permanent outages, resulting in 8,031,079 customer minutes of interruption. Approximately 11.5 miles of the line utilizes 1955 wood structures. There are 78 open category A conditions along the 18 mile long line. These include damaged poles and crossarms, conductor/shield wires, and guy anchor/knee/vee braces. –Logan, WV

Recommended Solution: Rebuild the Craneco – Pardee – Three Forks – Skin Fork 46kV line section (approximately 7.2 miles) utilizing 795 26/7 ACSR conductor (108 MVA rating, 43%). (B2883)



Estimated Project Cost: \$12.2M

Required In Service Date: 6/1/2021

AEP Transmission Owner Criteria Violation

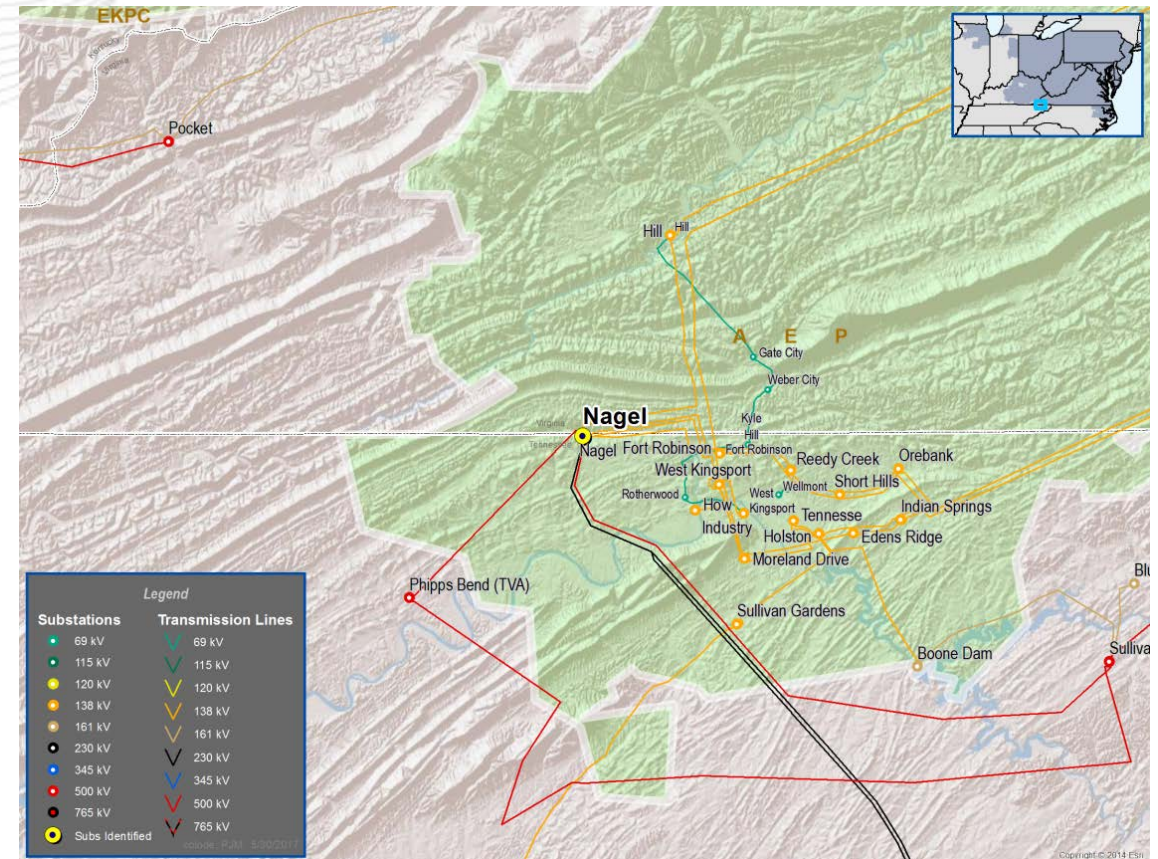
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: Numerous thermal and voltage deviation violations on the Kingsport 34.5 kV sub-transmission system for various N-1 and N-1-1 outages were identified in the 2021 RTEP case.–Kingsport, TN

Recommended Solution: Install a second transformer at Nagel station, comprised of 3 single phase 250MVA 500/138kV transformers. Presently, TVA operates their end of the Boone Dam – Holston 138 kV interconnection as normally open preemptively for the loss of the existing Nagel 500/138 kV XF. By adding a second 500/138 kV transformer at Nagel, TVA will close in the interconnection, providing an additional source to the Kingsport area. (B2884)

Estimated Project Cost: \$13M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement:

The City of Jackson has requested a new 69kV delivery point (Ironman Switch) capable of carrying their entire load, which will be ~37 MW due to a 4 MW load increase by the City. This new delivery point will be redundant with the existing 138kV delivery point out of Lick Station.

After the customer load is connected and is at the full capacity, there is an N-1 violation that drops the voltage at the customer bus to ~65% and thermally overloads the Lick-Ross 69kV Circuit to 130%. To solve this violation, a new 138/69kV station will be established (Rhodes Station), injecting a 3rd source onto the Lick-Ross 69kV circuit. Following the solution, no N-1 or N-1-1 violations appear.

The new City of Jackson delivery point is directly adjacent to the existing Berlin-Lick-Ross 69kV circuit. Of the 37+ miles of conductor on the circuit, 88% (32.96 miles) is original from the 1926 line construction – mostly 4/0 ACSR Penguin (50 MVA rating). Of the 275 structures, 98% (269) are wood and 43% (119) are older than 1960. There are 241 open conditions on the line, including issues with conductor, structures, and ROW encroachments. The line has been responsible for 1.4M CMI from 2013-2015, including over 12.5k customer interruptions. It is recommended that this circuit be rebuilt to 138kV standards in anticipation of a future 138kV conversion to become an additional 138kV path to support Ross Station as there is only one 138 kV source that currently feeds Ross station from the South.

Issues at every switch structure on this circuit (Coalton Sw, Pine Ridge Sw, Vigo, and Ginger) complicates any planned outages as momentary outages are required at all three stations in order to isolate a circuit section. AEP's MPOI calculation justifies the installation of breakers at Heppner station, which will replace Coalton switch. –City of Jackson, Jackson County, OH

AEP Transmission Owner Criteria Violation
Presented: 5/31/2017 Western Subregional TEAC

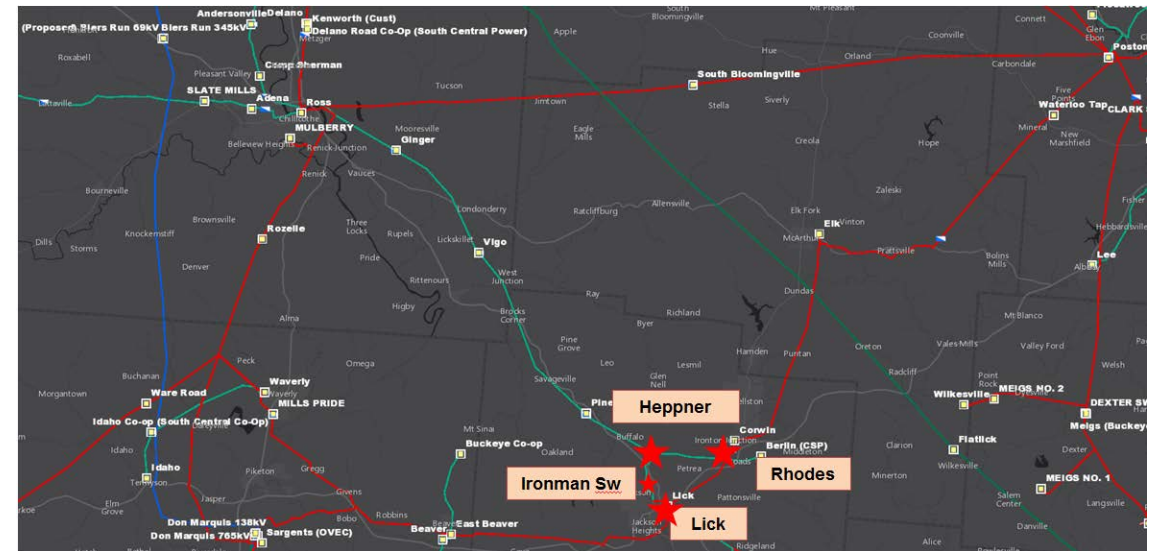
Continued

Recommended Solution:

- Install a new Ironman Switch to serve a new delivery point requested by the City of Jackson for a load increase request. (B2885.1)
- Install a new 138/69 kV station (Rhodes) to serve as a third source to the area to help relieve overloads caused by the customer load increase. (B2885.2)
- Replace Coalton Switch with a new three breaker ring bus (Heppner). (B2885.3)

Estimated Project Cost: \$13M

Required In Service Date: 3/1/2018



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: N-1-1 analysis identified an overload of the East End Fostoria-West End Fostoria 69 kV line and low voltage violations on the 69 kV system for loss of the West End Fostoria 138/69 kV transformer and the Buckley Road 138/69 kV transformer in the 2021 RTEP case.

At West End Fostoria, 69 kV circuit breakers S and BB are vintage GE, FK and Allis-Chalmer, FZO model oil filled circuit breakers manufactured in 1965 and 1961. Furthermore, the maintenance has become difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance and can become an environmental hazard.

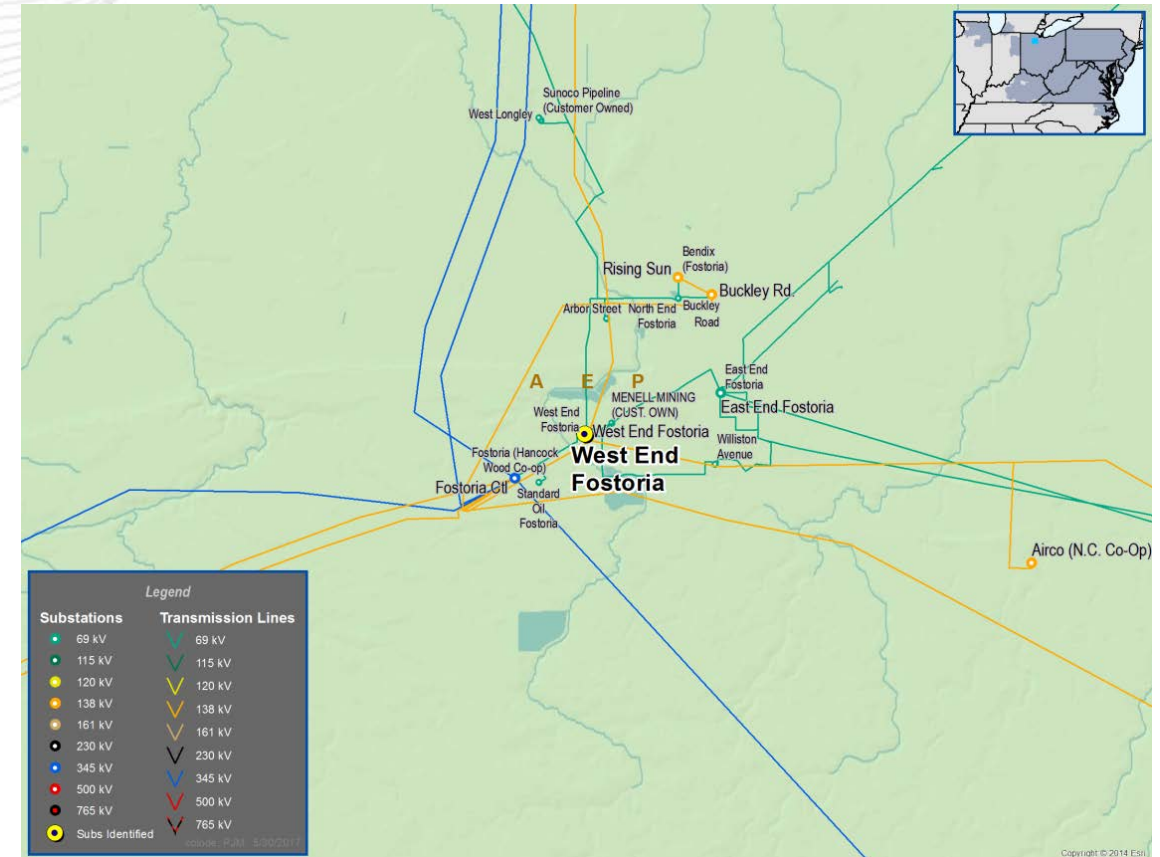
The West End Fostoria breakers have the following documented conditions: unavailability of spare parts, obsolete interrupting medium, PCB content, and age.

The installation of a high side CB to replace the existing transformer #5 MOAB “XX” will eliminate the need to isolate the entire 138 kV bus for a transformer fault. This will ensure the path to Melmore/Chatfield, Lemoyne(FE) and Fostoria Central will remain intact for loss of the existing transformer. –Fostoria, OH

Recommended Solution: Install 90 MVA 138/69 kV transformer, new transformer high and low side 3000 A 40 kA CBs, and a 138 kV 40 kA bus tie breaker at West End Fostoria. (B2886)

Estimated Project Cost: \$3.2M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

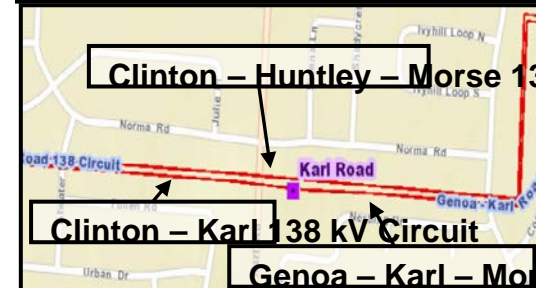
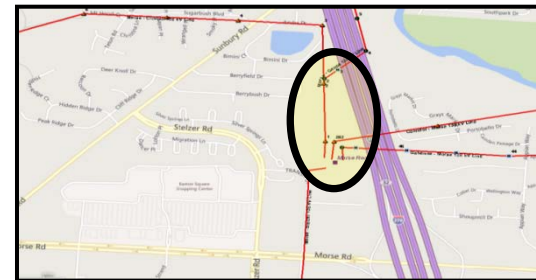
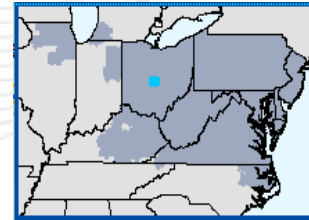
Problem Statement: PJM identified the Mifflin-Stelzer 138kV line overloaded for the loss of the Clinton – Morse Road 138kV line with the stuck breaker at Morse. – East side of Columbus, OH

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

Recommended Solution: Add 2-138kV CB's and relocate 2-138kV circuit exits to different bays at Morse Road. Eliminate 3 terminal line by terminating Genoa-Morse circuit at Morse Road. (B2887)

Estimated Project Cost: \$3.0M

Required In Service Date: 12/31/2019



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: PJM identified the Elliot –Rosewood 138kV line is overloaded for multiple common mode contingencies at Poston 138kV substation

AEP and PJM identified the Elliot – Ohio-U 69KV line and Elliot transformer are overloaded for multiple common mode contingencies at Poston 138kV substation.

PJM identified Low Voltage and Voltage drop violations at Elliot 138kV bus for multiple common mode contingencies at Poston 138kV substation.

The physical equipment at Poston is deteriorated and is mostly over 60 years in age. The bus consists of cap and pin insulators which are a safety concern due to the fact that the mechanical strength of the supports is greatly weakened over time. These cap and pin arrangements have a high tendency to fail during switching and AEP has had multiple instances of cap and pin insulators cracking and breaking while being removed out of service. Additionally, this station has been subject to flooding in the past, making it very difficult to repair or replace existing equipment in place.

All except 1 breaker (138kV & 69kV) at Poston are oil breakers (1200 A 20 kA FK-439's and 600 A 13 kA GO-4Bs types) that were originally installed in the 1940's and 50's. These breaker types are obsolete and do not work well with modern relaying schemes. Oil breakers in general have become difficult to maintain due to the required oil handling. Breaker 552N has had 49 fault operations. Breaker 652S has had 18 fault operations. Breaker 452S has had 178 fault operations. Breaker 252N has had 138 fault operations. Breaker 352N has had 36 fault operations. Breaker 152S has had 82 fault operations. Breaker 152N has had 99 fault operations. Breaker 652 has had 79 fault operations. The manufacturer recommended limit for fault operations for these types of breakers is 10. These breakers have the following documented conditions: age, bushing damage, PCB content, and number of fault operations.

Poston 138/69 kV 47 MVA transformer 2 also needs to be replaced. The drivers for replacement are age, dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings).

The Poston – Trimble 69 kV line was originally built in 1924 utilizing 336 ACSR conductor (75 MVA rating) and currently has 30 open conditions along the 9.7 mile long line. In coordination with AEP Ohio and transmission operations and transmission field services, a plan to replace the existing 69 kV radial line with a new 138 kV tap to serve customers at Trimble station was developed.

–Athens,OH

AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Continued from previous slide

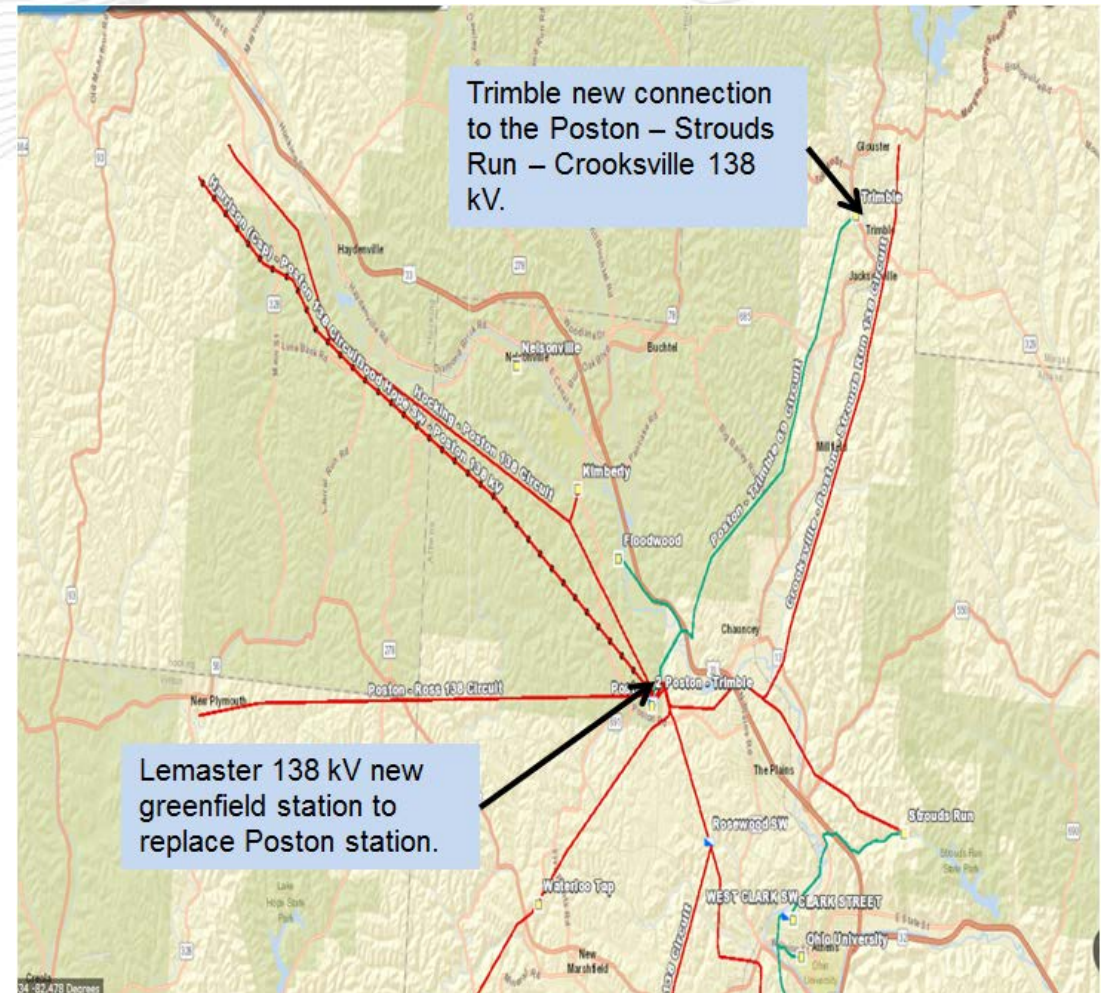
Immediate Need: Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

Recommended Solution:

- Remove and retire the Poston 138kV station (B2888.1)
- Install a new greenfield station, Lemaster 138kV Station, in the clear as a 138 kV switching station utilizing 3000 A 40 kA breakers. (B2888.2)
- Relocate the Trimble 69 kV AEP Ohio radial delivery point to 138 kV, to be served off of the Poston – Strouds Run – Crooksville 138 kV circuit via a new three-way switch. Retire the Poston-Trimble 69kV line. (B2888.3)

Estimated Project Cost: \$26.97M

Projected In Service Date: 12/31/2018



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Cliffview – Lee Highway 69 kV line (1/0 Copper, 48 MVA rating, 139%) overloads for loss of the Jubal Early 138/69 kV transformer in the 2021 RTEP case.

The ~13 mile double circuit line section north of Byllesby (Wythe – Cliffview and Wythe – Byllesby) is approximately 93 years old and has small 1/0 CU conductor. ~4 miles of this double circuit line is also in the national forest near Byllesby.

There is approximately 120 MW of load being served directly off the 138kV system in this area. Under N-1-1 conditions on the 138kV system, this entire load would be dropped. There is no opportunity to sectionalize the 138kV system as this would force the 69kV system to support the existing 90 MW of load plus the 120 MW of load on the 138kV, resulting in the entire 69kV system overloading. –Wytheville, VA



AEP Transmission Owner Criteria Violation
Presented: 5/31/2017 Western Subregional TEAC

Continued

Recommended Solution:

- Cliffview Station: Establish 138kV bus. Install two 138/69kV XFRs (130 MVA), six 138kV CBs (40kA 3000A) and four 69kV CBs (40kA 3000A) .(B2889.1)
- Cliffview Line: Tap the existing Pipers Gap – Jubal Early 138kV line section. Construct double circuit in/out (~2 miles) to newly established 138kV bus, utilizing 795 26/7 ACSR conductor.(B2889.4)
- Byllesby – Wythe 69kV: Retire all 13.77 miles (1/0 CU) of this circuit (~4 miles currently in national forest). (B2889.2)
- Galax – Wythe 69kV: Retire 13.53 miles (1/0 CU section) of line from Lee Highway down to Byllesby. This section is currently double circuited with Byllesby – Wythe 69kV. Terminate the southern 3/0 ACSR section into the newly opened position at Byllesby 69kV, creating a new Galax – Byllesby 69kV circuit..(B2889.3)

Estimated Project Cost: \$30M

Required In Service Date: 6/1/2021



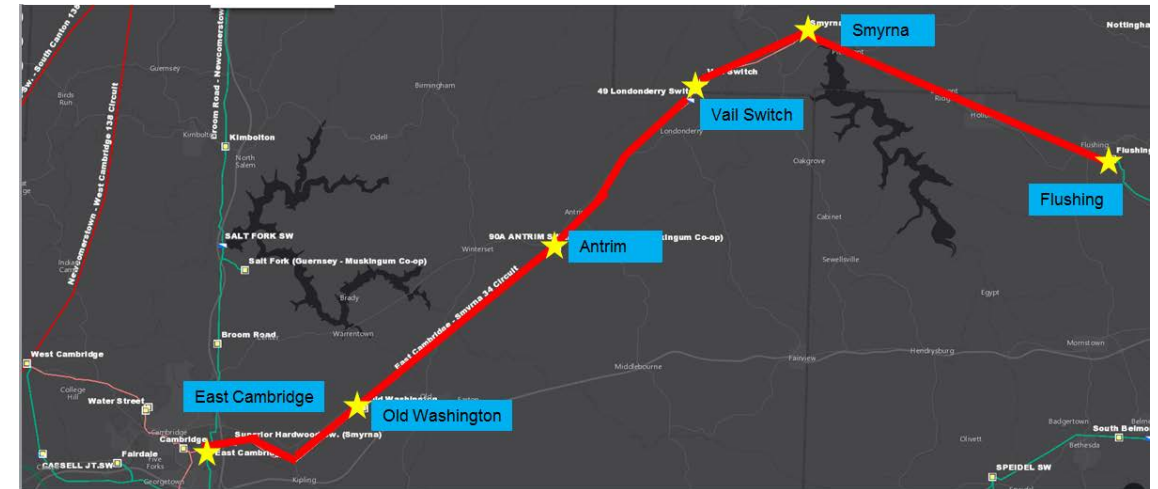
AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Fairdale-Cambridge 69 kV line (266 ACSR, 64 MVA rating), the Summerfield-Derwent 69 kV line (336 ACSR, 75 MVA rating), and the Cambridge-West Cambridge 34.5kV line (4/0 Copper, 27 MVA rating) are overloaded for several combinations of N-1-1 contingencies in the Cambridge area in the 2021 RTEP.

The East Cambridge – Smyrna 34.5 kV circuit was built originally in 1954 and is comprised of mostly 1/0 and 4/0 Copper conductor (17 MVA rating). It presently has 135 open A conditions on the 23.5 mile long line associated with conductor and structure concerns and has resulted in over 3.1M customer minutes of interruption between 2013 and 2016

The East Cambridge-Smyrna lines and associated stations can't be adequately maintained without shutting power off to customers. After significant outreach and discussions with all stakeholders, including AEP Distribution and the Guernsey-Muskingum Co-op, a commitment to the 69kV loop was agreed to. –Cambridge, OH



AEP Transmission Owner Criteria Violation
Presented: 5/31/2017 Western Subregional TEAC

Continued

Recommended Solution:

- Rebuild 23.55 miles of the East Cambridge – Smyrna 34.5 kV circuit with 795 ACSR conductor (128 MVA rating) and convert to 69 kV. Estimated cost: \$34M (B2890.1)
- East Cambridge: Install a 2000 A 69 kV 40 kA circuit breaker for the East Cambridge – Smyrna 69 kV circuit. Estimated cost: \$0.538M (B2890.2)
- Old Washington: Install 69 kV 2000 A two way phase over phase switch. Estimated cost: \$0.512M (B2890.3)
- Antrim Switch: Install 69 kV 2000 A two way phase over phase switch. Estimated cost: \$1.2M (B2890.4)

Estimated Project Cost: \$36.25M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

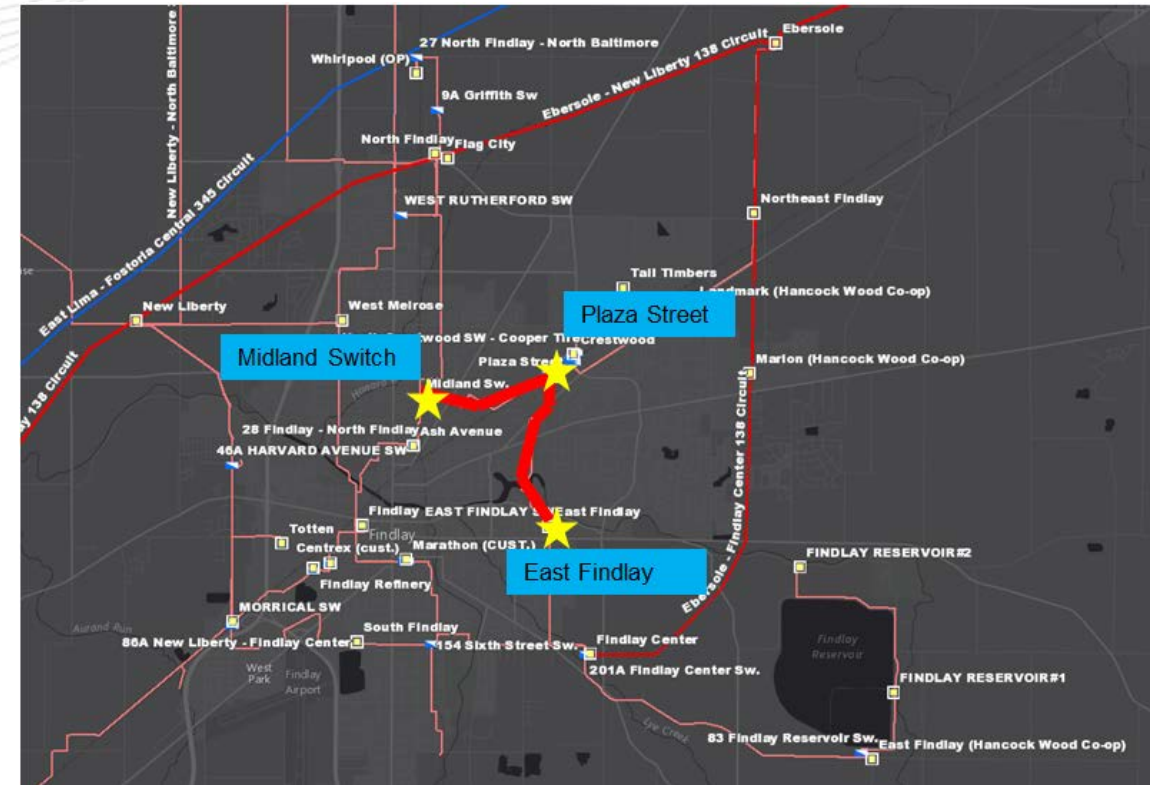
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Midland Switch-East Findlay 34.5 kV line (4/0 ACSR, 25 MVA rating) is overloaded for the N-1-1 loss of the Ebersole 138/34.5 kV transformer and the Findlay Center 138/34.5 kV transformer. –Findlay, OH

Recommended Solution: Rebuild the Midland Switch to East Findlay 34.5 kV line (3.31 miles) with 795 ACSR (63 MVA rating) to match other conductor in the area. (B2891)

Estimated Project Cost: \$4.8M

Required In Service Date: 6/1/2021



AEP Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Leon-Ripley 69kV line (4/0 ACSR, 61 MVA rating, 125%) and 138/69kV transformers #3 at Leon (45 MVA rating, 100%) overload for N-1-1 loss of the Gavin – Meigs 69kV line in conjunction with the Lakin – Racine 69 kV line in the 2021 RTEP case. There are voltage violations (0.90 pu, 12% drop) at the Ripley bus for an N-1 loss of the Leon-Ripley line.

The Leon-Ripley line was constructed in 1957 utilizing 4/0 ACSR conductor on wood H-frame structures and has 209 open A conditions on the 13 mile long line. Most of the structures on this line (77%) are still original from 1957.

Leon 69 kV breaker A is a 1200 A 12 kA FK-type oil breaker manufactured in 1958. Breaker A has had 127 fault operations, exceeding the manufacturer recommended limit of 10. 138/69 kV 25 MVA transformers 1 and 3 at Leon have High concentrations of combustible gases due to Corona Partial Discharges. There is also significant increased trending in oil moisture content which reduces the oil dielectric strength, indicating a breakdown of the paper insulation of the transformer windings. Additionally, there are multiple overlapping zones of protection at Leon (two line exits, two transformers, and bus). The recommended maximum is two overlapping zones.

The Ravenswood 69 kV breakers G and H are 1200 A 20 kA CF-type oil filled breakers manufactured in 1968. Breaker G has had 125 fault operations. Breaker H has had 202 fault operations. Both exceed the manufacturer recommended limit of 10.

In general, oil breakers have become more difficult to maintain due to the required oil handling. Oil spills occur often during routine maintenance and failures, which can become an environmental concern.

– Charleston, WV

AEP Transmission Owner Criteria Violation

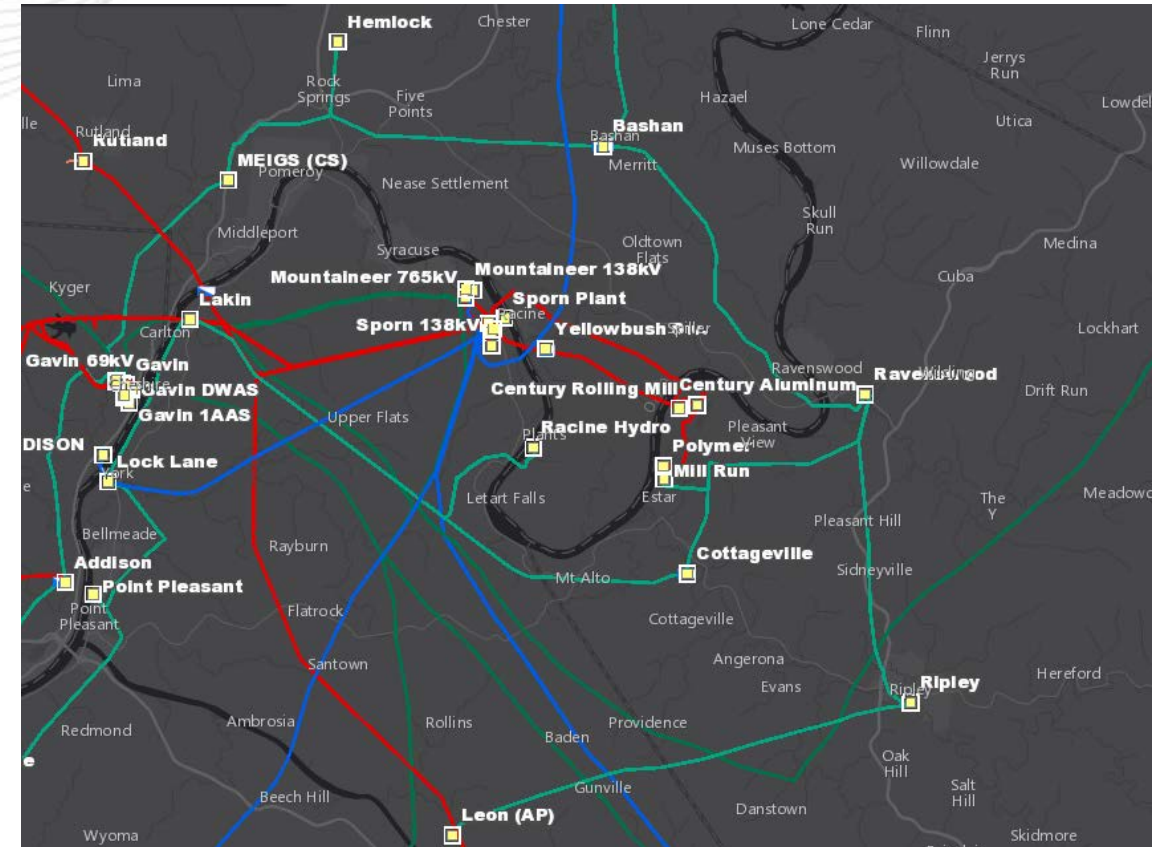
Presented: 5/31/2017 Western Subregional TEAC

Continued

Recommended Solution: Install new 138/12kV transformer with high side circuit switcher at Leon and a new 138 kV line exit towards Ripley. Establish 138kV at Ripley station with a new 138/69 kV 130MVA transformer and move the distribution load to 138 kV service. Rebuild the existing 69kV Leon – Ripley branch with 1033 ACSR and operate at 138kV. Rebuild the Ripley 69 kV bus. (B2892)

Estimated Project Cost: \$27.1M

Required In Service Date: 6/1/2021



Common Mode Violation

Presented: 9/11/2017 Western Subregional TEAC

Problem Statement:

Planning Criteria Violations: The 6.7 miles Mottville – Pigeon River 69kV line is one of the strongest sources at the eastern edge of the Michigan footprint. The total load served from the Mottville – Pigeon River and the Corey – Pigeon River 69kV lines is approximately 74 MVA. AEP Transmission planning has identified multiple N-1-1 contingency scenarios that result in thermal violations on the Mottville – Pigeon River (3/0 ACSR, 44MVA, 115% worst loading) and Corey – Pigeon River (3/0 ACSR, 44MVA, 101% worst loading) 69kV lines for loss of any sources out of Corey station.

Equipment Material/Condition/Performance/Risk: The 6.7 miles Mottville – Pigeon River 69kV line was installed in 1978 and has 23 structures without ground wire and/or with broken ground wire. Transmission line engineering and Transmission Field Services agree that the existing structures will not have the capacity to keep standard clearances if a bigger conductor is installed. There are 10 open A conditions along the line. The existing 69kV CB H at Pigeon River station is a 1200 A 19 kA oil filled breaker that was manufactured in 1969. This breaker has had 89 fault operations, exceeding the manufacturer limit of 10. Oil samples on this breaker indicate a large concentration of PCB. Oil spills are frequent with breaker failures and routine maintenance can become an environmental hazard.

Operational Flexibility and Efficiency: Multiple Post Contingency Local Loading Relief Warnings (PCLLRW's) have been issued in this area as a result of the current 44MVA rating of the line. In order to identify a potential temporary solution to the PCLLRW's, transmission planning performed a LIDAR study on this line to determine the feasibility of operating it at a higher operating temperature. LIDAR study identified clearance constraints across several sections of the line that will prohibit increasing the operating temperature.

Customer Service: The City of Sturgis has requested a study to analyze the impacts of 20 MW demand increase. Planning analysis shows that a 138 kV conversion will be required to mitigate low voltage constraints as result of a 20 MW demand increase in the Sturgis area. Presently, City of Sturgis operates its 69 kV network in radial configuration due to operational constraints on the AEP network. In addition to the 20 MW demand, City of Sturgis is also planning to close the network to improve reliability. By designing the proposed line to 138 kV standards for a future conversion the network is able to meet the 20 MW incremental demand and City's desire to close the network. The incremental cost of 138 kV design is \$0.2M per mile.

Common Mode Violation

Presented: 9/11/2017 Western Subregional TEAC

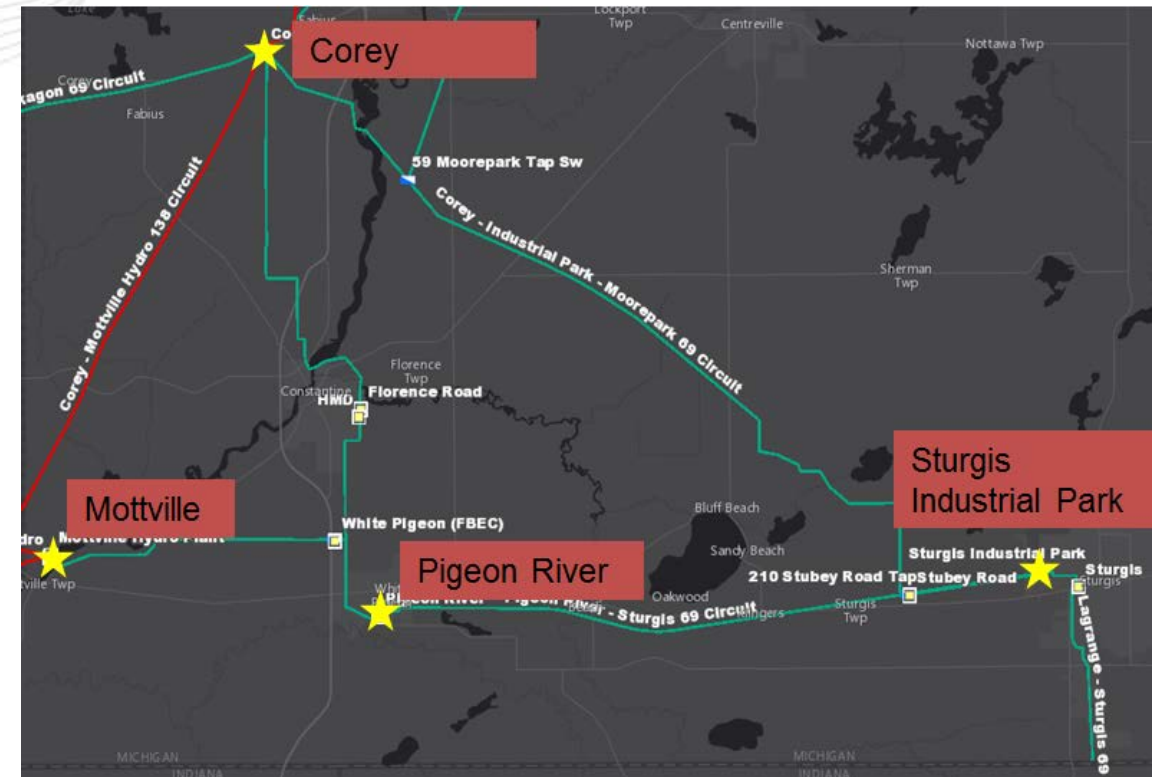
Continued from previous slide

Recommended Solution:

- Rebuild approximately 6.7 miles of 69kV line between Mottville and Pigeon River using 795 ACSR conductor (129 MVA rating). New construction will be designed to 138kV standards but operated at 69kV. (B2936.1)
- Pigeon River Station: Replace existing MOAB Sw. 'W' with a new 69kV 3000 A 40 kA breaker, and upgrade existing relays towards HMD station. Replace CB H with a 3000 A 40 kA breaker. (B2936.2)

Estimated Project Cost: \$12M for rebuilding and \$1.5M for pigeon river station upgrades (Total \$13.5M)

Required In Service Date: 6/1/2020



Common Mode Violation

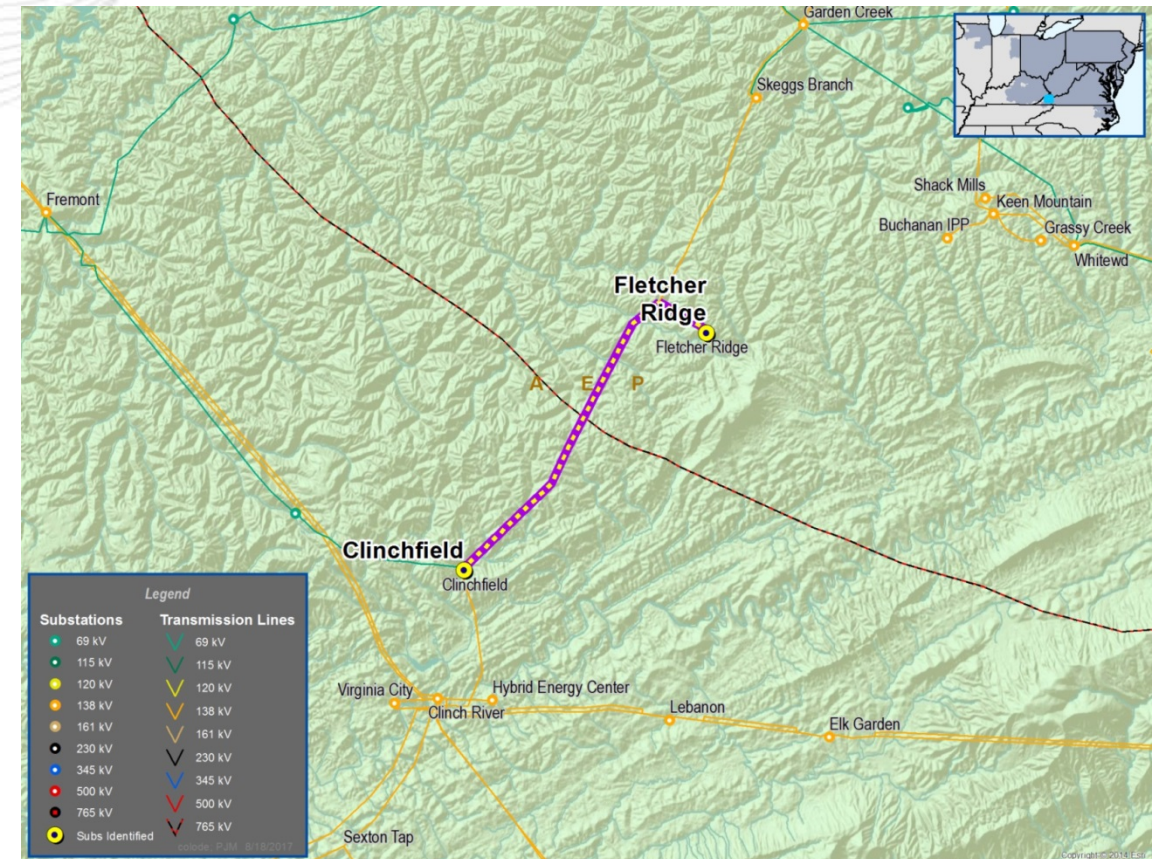
Presented: 9/11/2017 Western Subregional TEAC

Problem Statement: Clinchfield – Fletcher Ridge 138kV line is overloaded for the loss of Broadford – Saltville 138kV line with the stuck breaker at Saltville 138kV (GD-S862)

Recommended Solutions: Replace the existing 636 ACSR 138 kV Bus at Fletchers Ridge with a larger 954 ACSR conductor (B2937)

Estimated Project Cost: \$0.63M

Required In Service Date: 6/1/2022



Common Mode and Generator Deliverability Violation

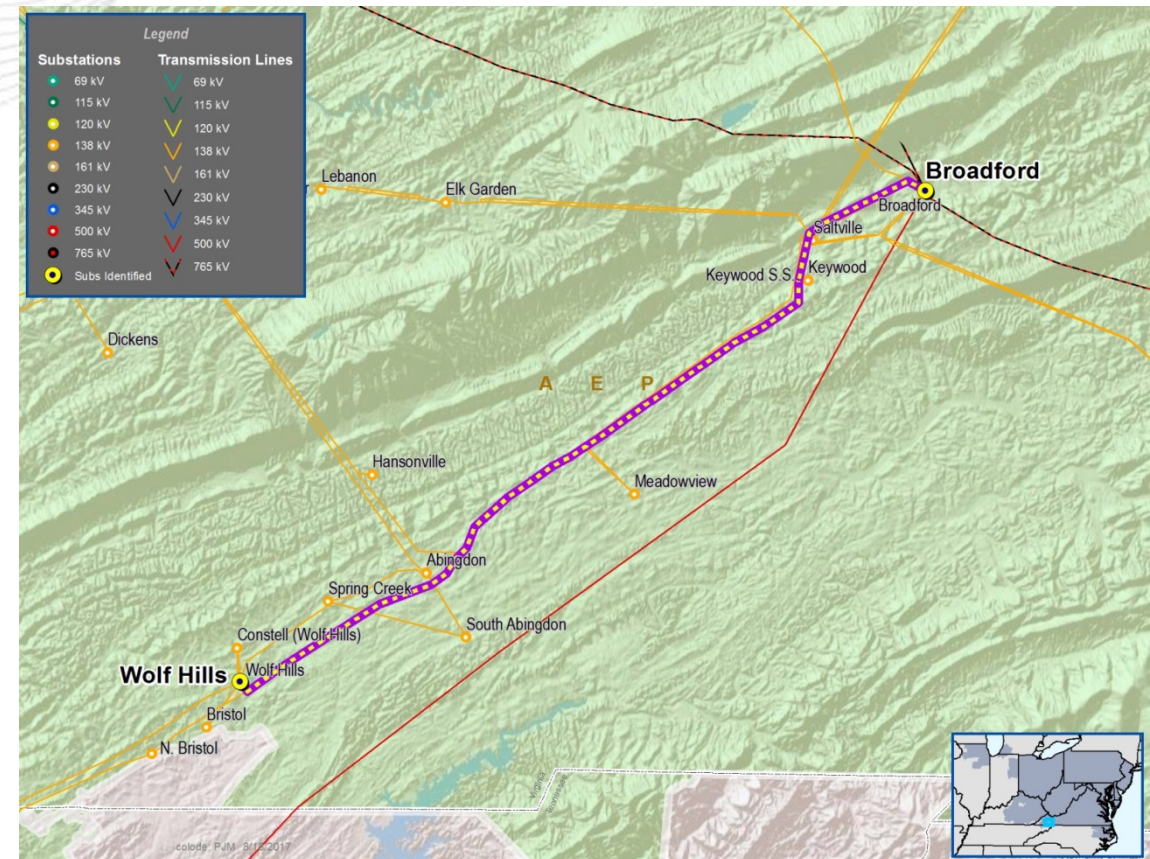
Presented: 9/11/2017 Western Subregional TEAC

Problem Statement: Broadford – Wolf Hills 138kV line is overloaded for the loss of the Boardford – Sullivan 500kV line and the Broadford 765/500kV transformer or the loss of the Broadford – Sullivan 500kV line with the breaker stuck at Broadford 765kV. (GD-S70, GD-S114, GD-S755, GD-S802)

Recommended Solutions: Perform a sag mitigations on the Broadford – Wolf Hills 138kV circuit to allow the line to operate to a higher maximum temperature. (B2938)

Estimated Project Cost: \$2.6M

Required In Service Date: 6/1/2022



Additional Scope for Existing Project B2689

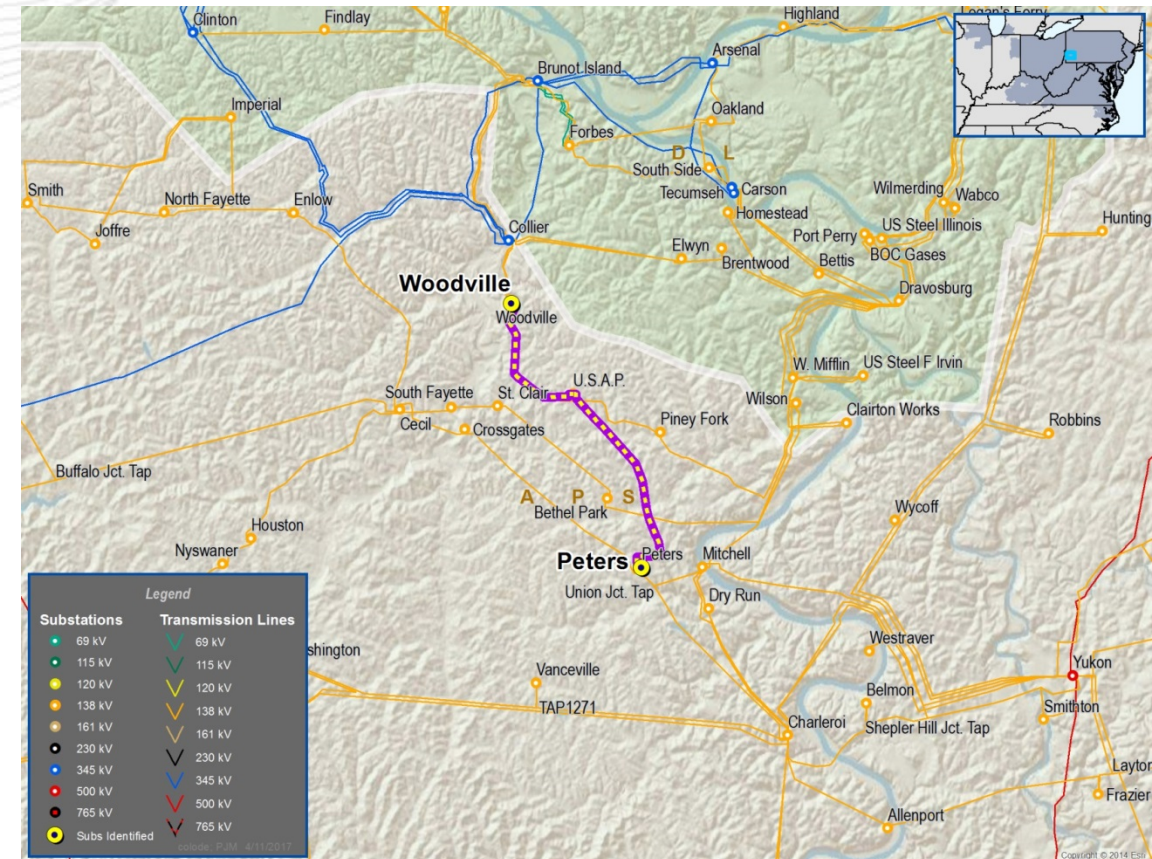
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: Baseline RTEP project b2689.1 (Reconductor approximately 7 miles of the Woodville - Peters (Z-117) 138 kV circuit), assigned to Duquesne Light, reconductors the Woodville-Peters 138 kV line. The existing conductor will be upgraded from 795 ACSR to 795 ACSS. The termination point is located at structure 27A, which is owned and maintained by West Penn Power (WPP), FE. In order to accommodate baseline RTEP project b2689.1, FirstEnergy/WPP will need to upgrade associated facilities (i.e. insulators, clamps, jumpers, etc.).

Recommended Solution: B2689.3 - Upgrade terminal equipment owned by FE related to B2689.1

Estimated Project Cost: \$0.05M

Required In Service Date: 6/1/2018



Short Circuit Violation

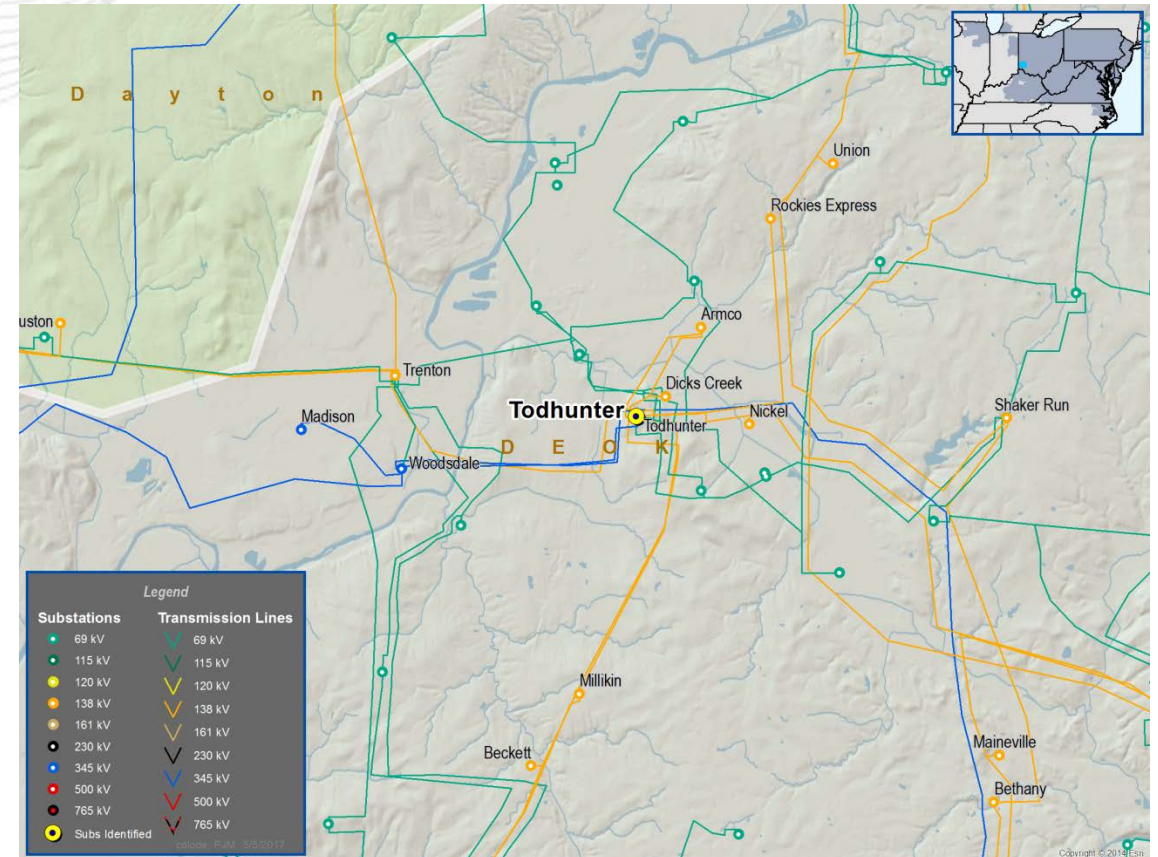
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: The Todhunter 138 kV breakers '931', '919', and '913' are overstressed for a fault at Todhunter 138 kV.

Recommended Solution: Replace Todhunter 138 kV breakers '931', '919', and '913' with 80 kA breakers (B2894)

Estimated Project Cost: \$1.967 M (total)

Required In Service Date: 6/1/2021



Short Circuit Violation

Presented: 6/30/2017 Western Subregional TEAC

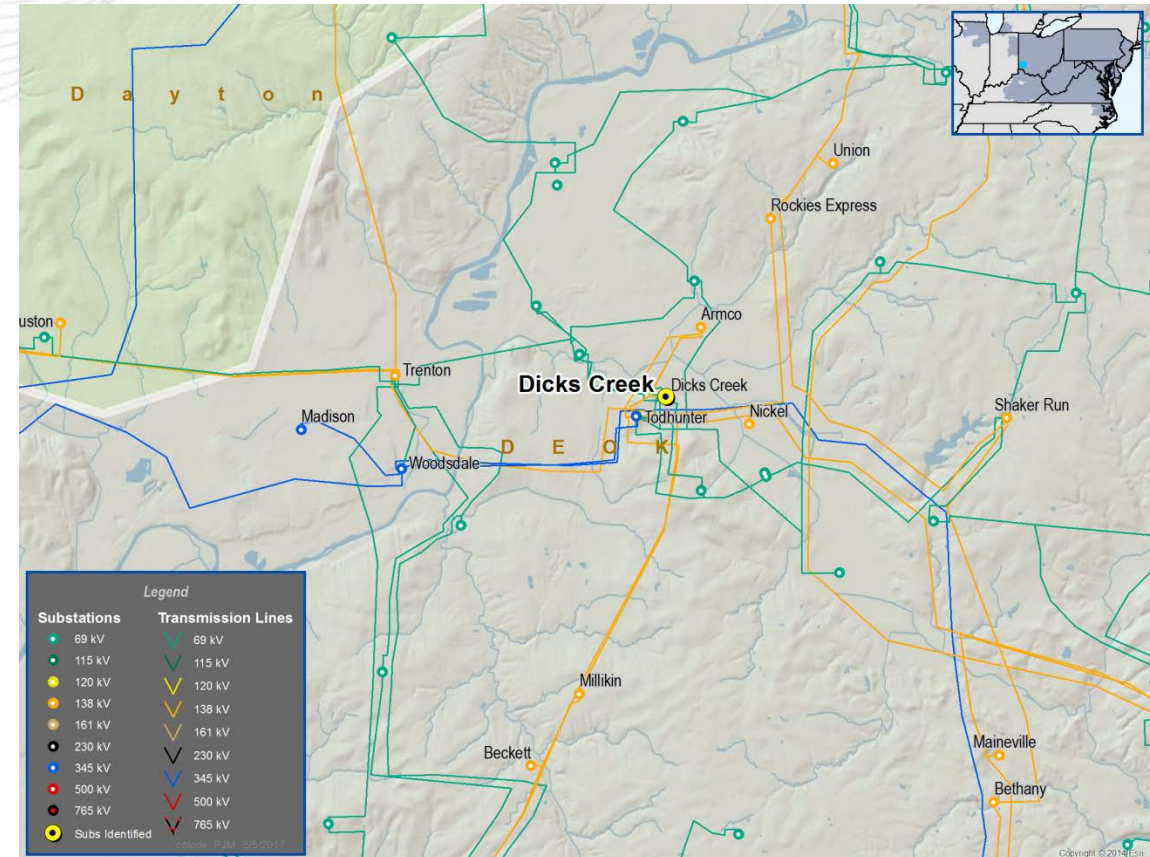
Problem Statement: The Dicks Creek 138kV breaker “963” is overstressed

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

Recommended Solution: Replace the Dicks Creek 138kV breaker “963” with 63kA breaker (B2895)

Estimated Project Cost: \$300 K

Required In Service Date: 6/1/2019



>300 MW Load Loss

Presented: 9/11/2017 Western Subregional TEAC

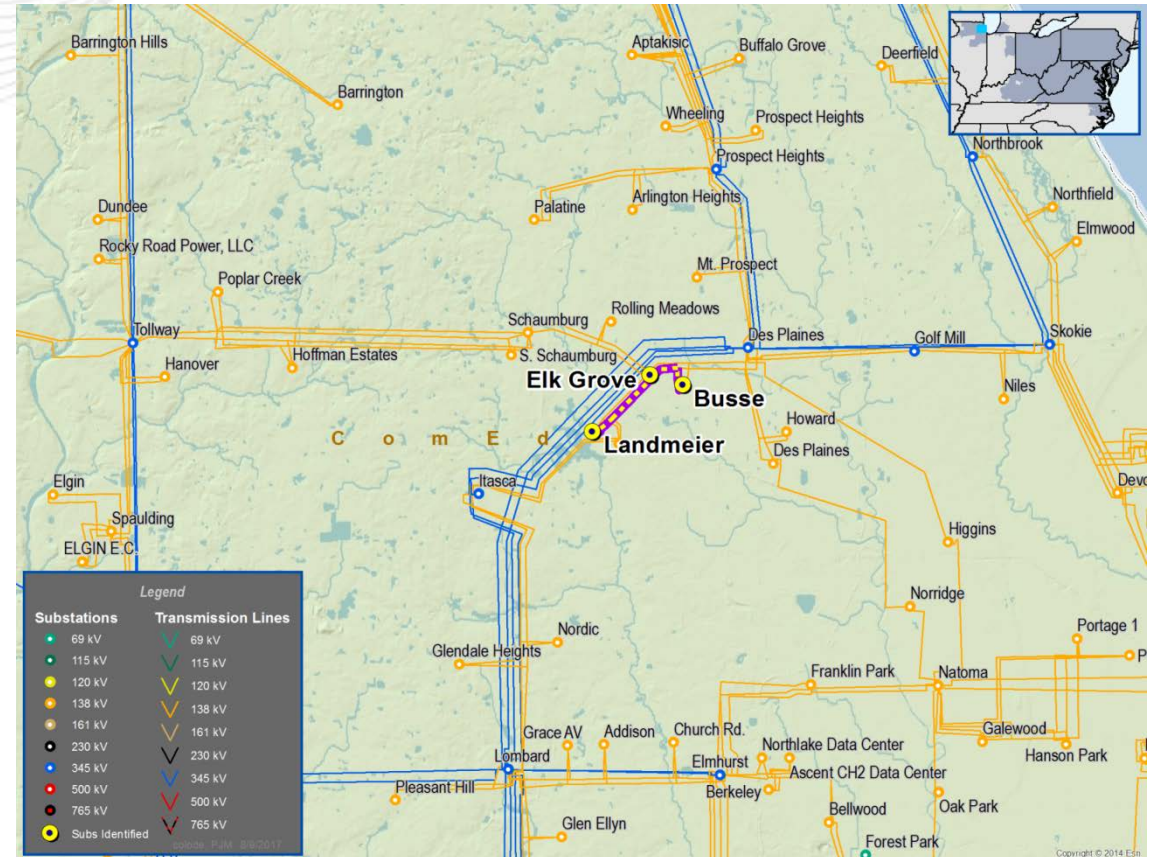
Problem Statement: >300MW load loss for the loss of the 138kV tower lines L4605 (Des Plaines – Busse – Schaumburg – Landmeier – Tonne 138kV “Red” line) and L4606 (Des Plaines – Busse – Schaumburg – Landmeier –Tonne 138kV “Blue” line) (N1-SLD1)

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

Recommended Solution: Build an indoor new Elk Grove 138kV GIS substation at the point where Rolling Meadows & Schaumburg tap off from the main lines, between Landmeier and Busse. The four 345 kV circuits in the ROW will be diverted into Gas Insulated Bus (GIB) and go through the basement of the building to provide clearance for the above ground portion of the building. (B2941)

Estimated Project Cost: \$90M

Projected In Service Date: 6/1/2021



EKPC Transmission Owner Criteria Violation

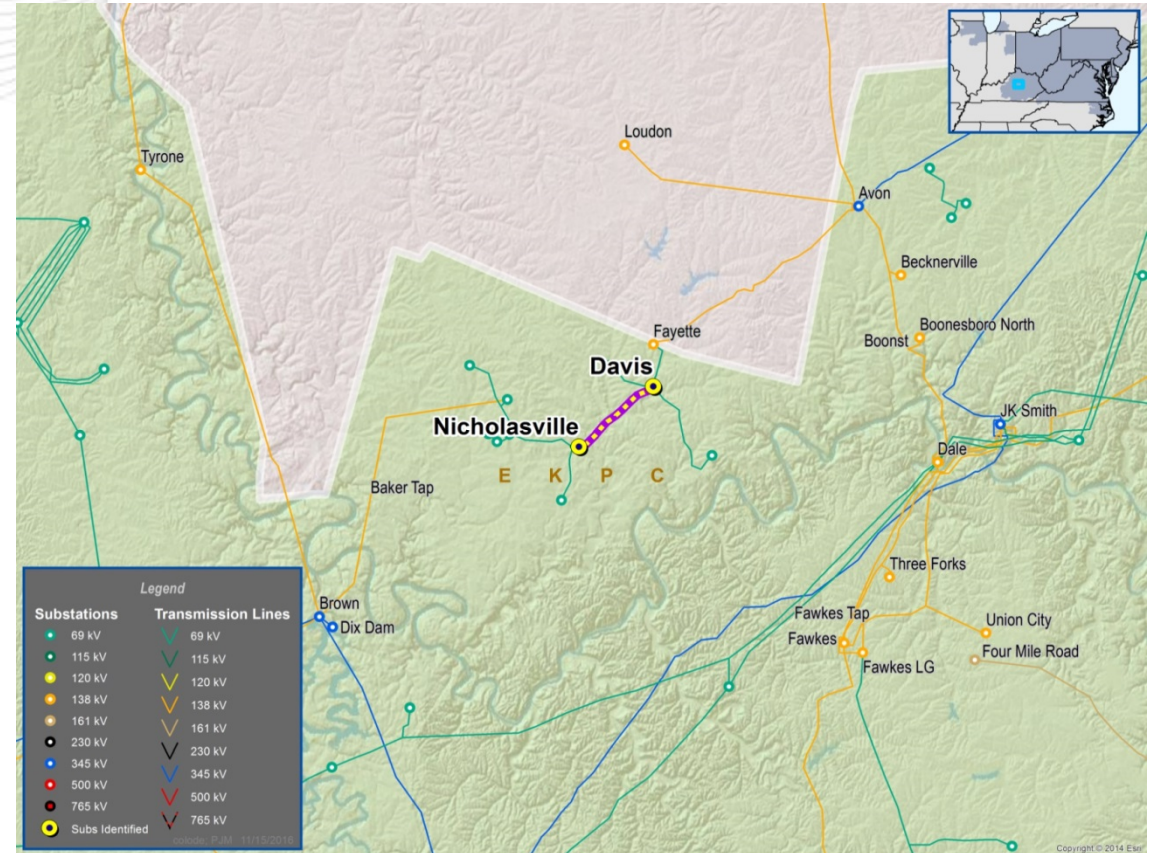
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Davis - Nicholasville 69kV line is overloaded for the loss of the Baker Lane-Baker Lane 138kV line and Trimble unit #2 .

Recommended Solution: Increase Maximum Operating Temperature of Davis - Nicholasville 69kv line section 266.8 MCM conductor to 284°F (LTE of 266°F). (B2781)

Estimated Project Cost: \$0.19M

Required In Service Date: 6/1/2021



EKPC Transmission Owner Criteria Violation

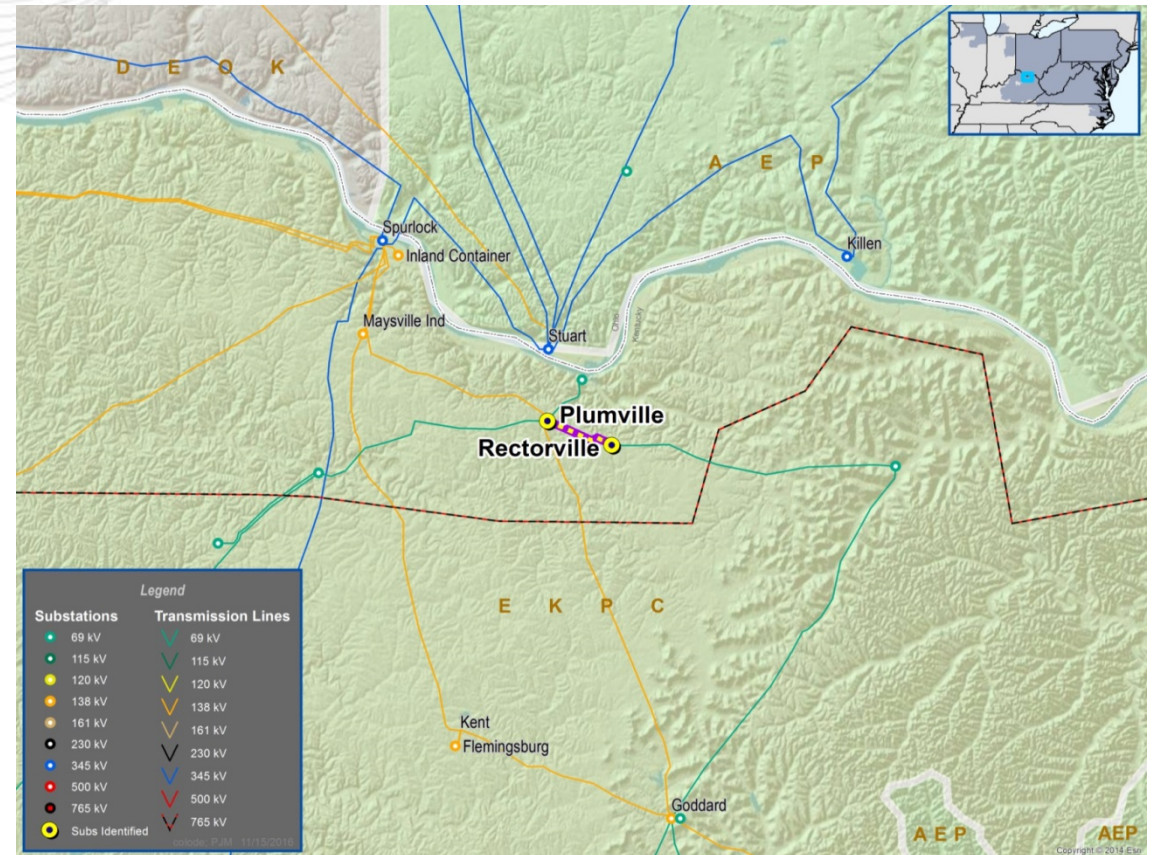
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Plumville - Rectorville 69kV line is overloaded for the loss of the Goddard 138/69KV transformer and Cooper units 1&2.

Recommended Solution: Increase the maximum operating temperature of Plumville - Rectorville 69kV line section 266.8 MCM conductor to 212°F (LTE of 185°F). (B2782)

Estimated Project Cost: \$0.14M

Required In Service Date: 6/1/2021



EKPC Transmission Owner Criteria Violation

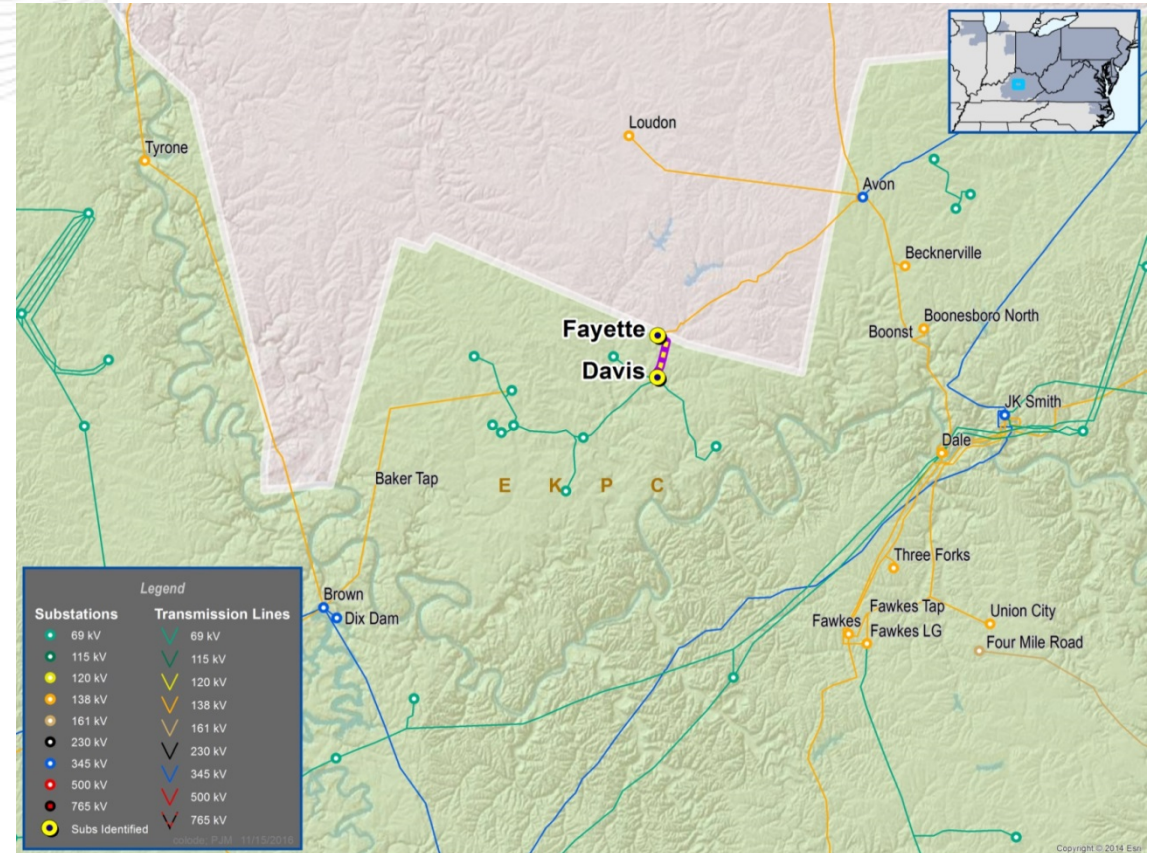
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The Davis - Fayette 69kV line is overloaded for the loss of the Baker Lane-Baker Lane 138KV line and Brown unit #3.

Recommended Solution: Rebuild the Davis - Fayette 69kv line section to 556.5 MCM (3.15 miles) (B2783)

Estimated Project Cost: \$1.3M

Required In Service Date: 12/1/2021



EKPC Transmission Owner Criteria Violation

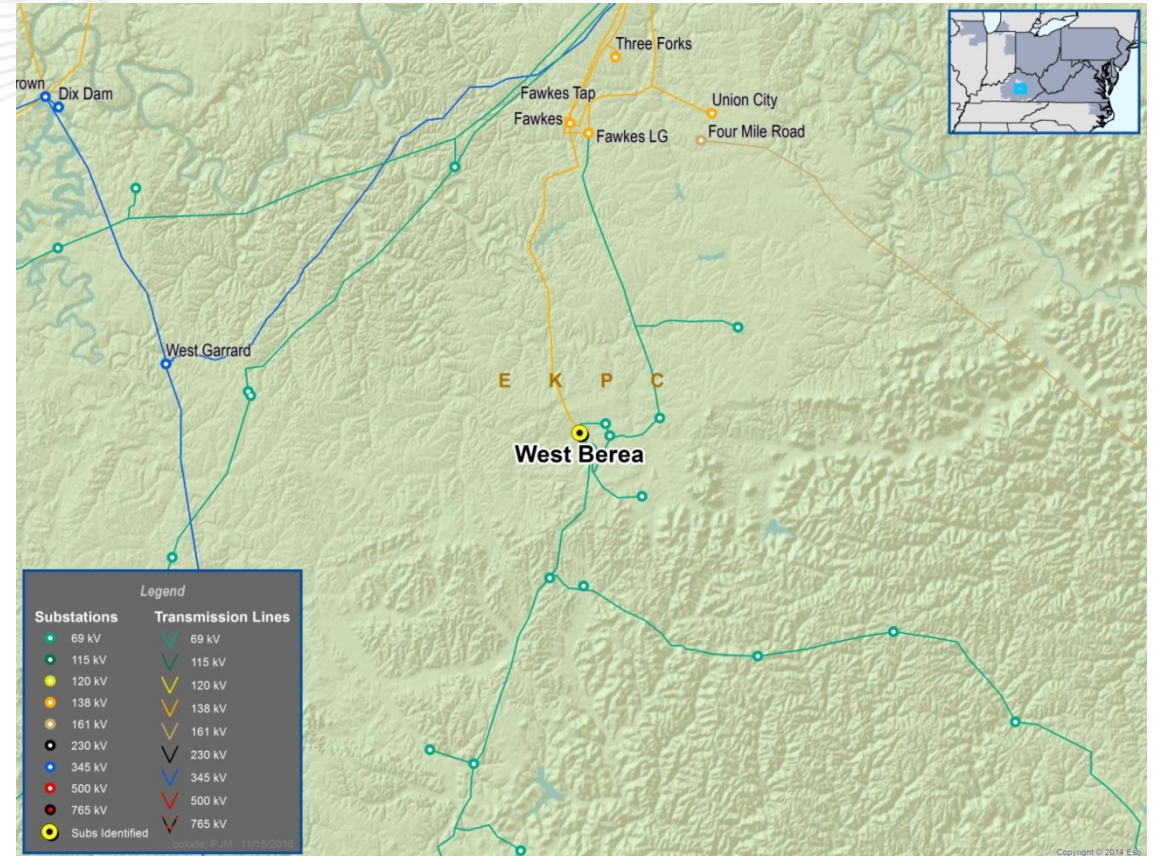
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: The West Berea 138/69kV transformer is overloaded for the loss of the Crooksvil-Fawks 69kV line and Cooper units 1&2.

Recommended Solution: Increase overcurrent relay at West Berea 138/69kV to at least 139 MVA Winter LTE (B2784)

Estimated Project Cost: \$0.0M

Required In Service Date: 12/1/2021



EKPC Transmission Owner Criteria Violation

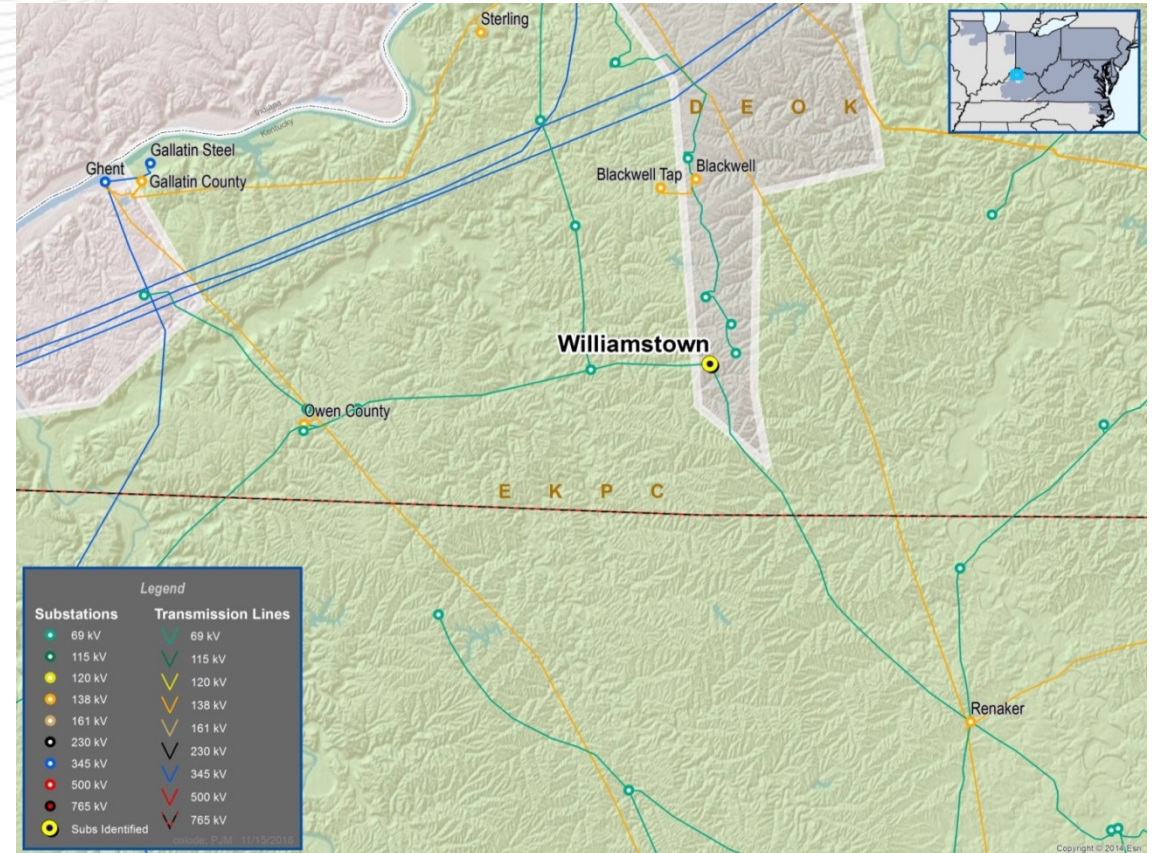
Presented: 5/31/2017 Western Subregional TEAC

Problem Statement: Low voltage at Williamstown 69kV bus for the loss of the Munk Jct.- Williamstown 69kV line and JK Smith Unit 9.

Recommended Solution: Increase Williamstown cap bank to 11.225 MVAR (B2786)

Estimated Cost: \$0.02M

Required In Service Date: 12/1/2021



EKPC Transmission Owner Criteria Violation

Presented: 5/31/2017 Western Subregional TEAC

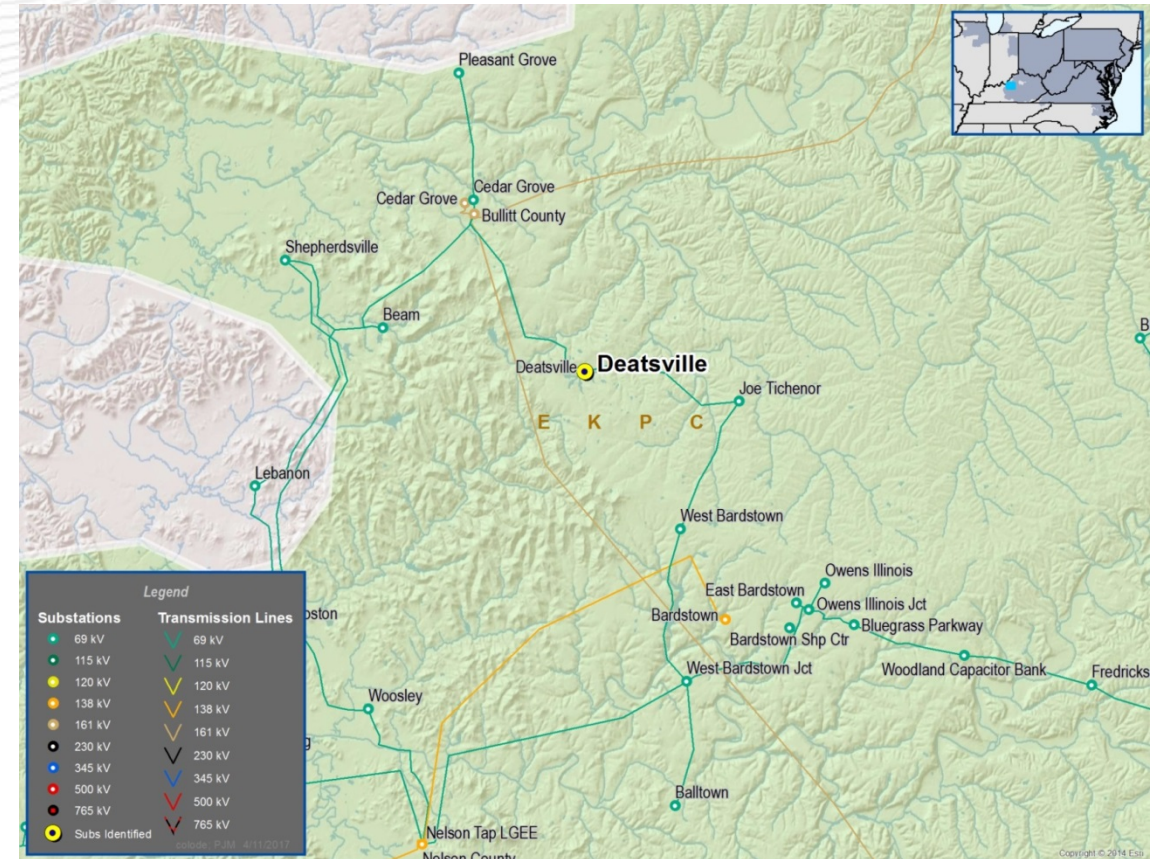
Problem Statement: Low voltage at the Deatsville distribution substation during the loss of the Bullitt County-Deatsville Tap 69 KV line section. Thermal overload of the South Bardstown – West Bardstown Jct. 69kV line during the loss of the Bullitt County 138/69 KV transformer.

Other Considerations: EKPC Reliability Team identified concerns related to the age and condition of this conductor during their conductor assessment. The Reliability Team identified this entire line section as one of the top line sections to be addressed based on condition of the conductor and age of the line.

Recommended Solution: Re-build the existing (1.5 mile), 1/0 MCM ACSR South Bardstown – West Bardstown Jct. 69kV line using 556.5 MCM ACTW conductor. (B2893)

Estimated Cost: \$1.03M

Required In Service Date: 6/1/2017



Baseline Reliability

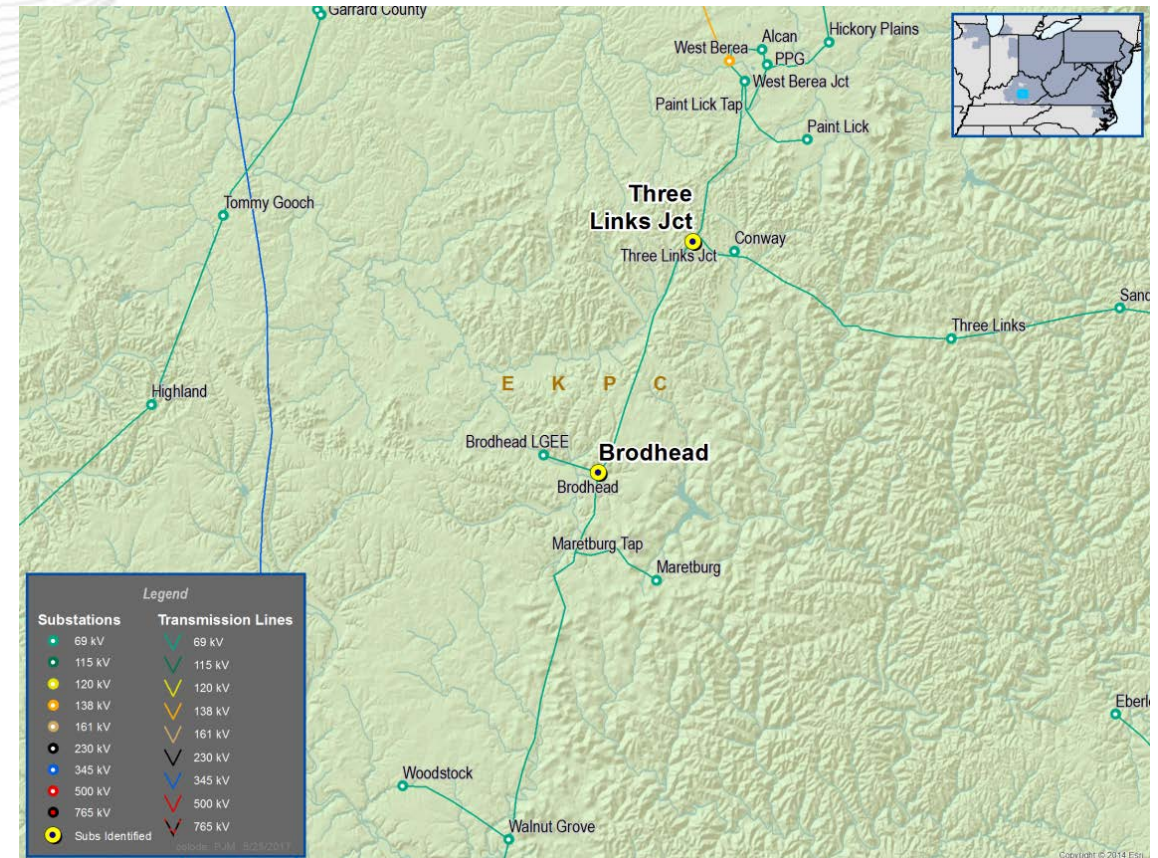
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Potential industrial load continues to grow (2.5MW – 7MW) over the next couple of years at will cause low voltage violations at Asahi, Shopville, and Woodstock substations for the loss of the Norwood-Shopville 69kV line section. The original scope (b2785) provides only a short term solution to the voltage issues in an area overly reliant on capacitor banks for voltage support. A new scope has been created to better serve voltage in the area, as well as serve as a buffer for the future industrial load growth. This low voltage issues now occurs in the 2018/19W, based on new load forecast data.

Recommended Solution: Rebuild the Brodhead - Three Links Jct. 69 kV line section (8.2 miles) using 556.5 MCM ACTW wire. (B2902)

Project Cost Estimate: \$4.715M

Required In Service date: 12/1/2018



EKPC Transmission Owner Criteria Violation

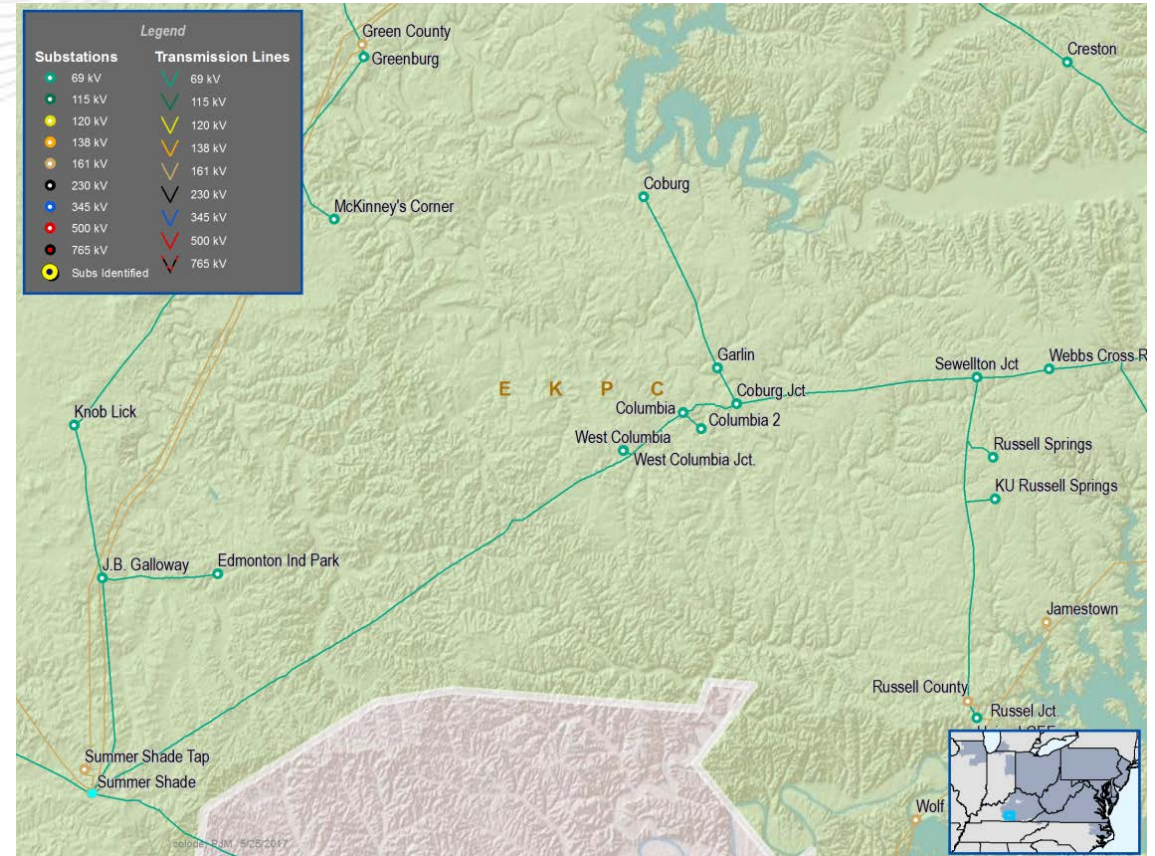
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Low voltage at the Coburg 69 kV station during an outage of the Coburg to Sewellton Jct. 69 kV line section.

Recommended Solution: Raise the V-low setting for Summer Shade 69 kV cap bank to 1.01 pu. (B2903)

Estimated Project Cost: \$0

Required In Service Date: 12/1/2027



EKPC Transmission Owner Criteria Violation

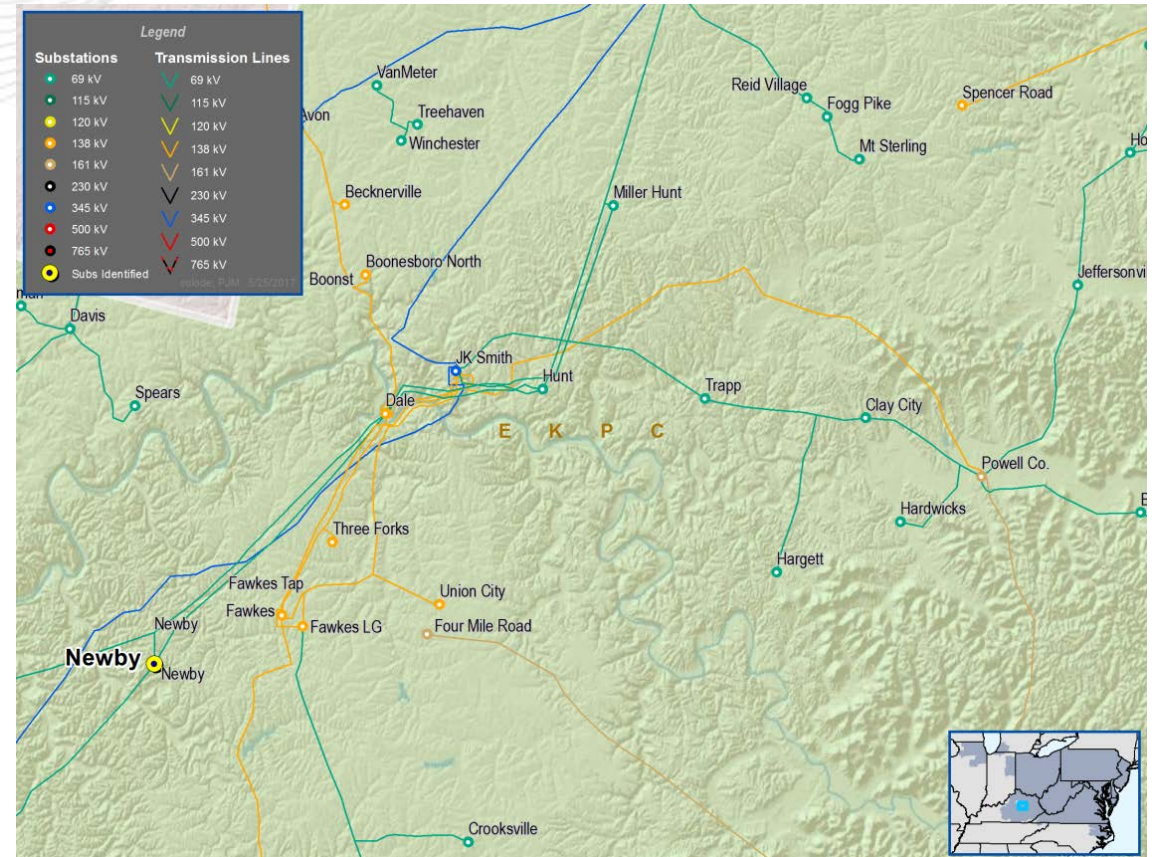
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Low voltage at the Mt. Sterling 69 kV station during the loss of the Dale 138-69 kV transformer.

Recommended Solution: Raise the V-low setting for Newby 69 kV cap bank to 0.955 pu (B2904)

Estimated Project Cost: \$0

Required In Service Date: 12/1/2026



EKPC Transmission Owner Criteria Violation

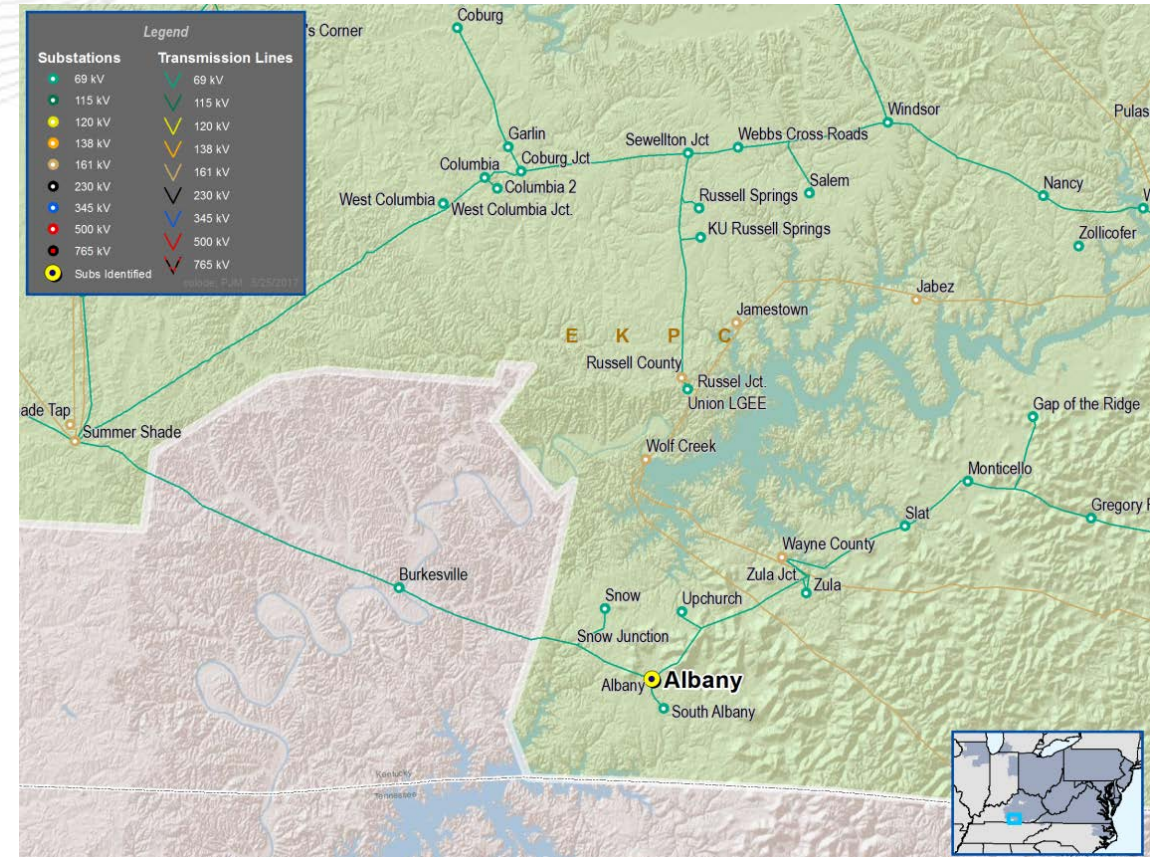
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Low voltage at the Upchurch 69 kV station during the loss of the Zula Jct. – Upchurch Tap 69 kV line section.

Recommended Solution: Resize the Albany 69 KV capacitor bank from 8.4 to 13.776 MVAR. (B2905)

Estimated Project Cost: \$0.09M

Required In Service Date: 6/1/2026



EKPC Transmission Owner Criteria Violation

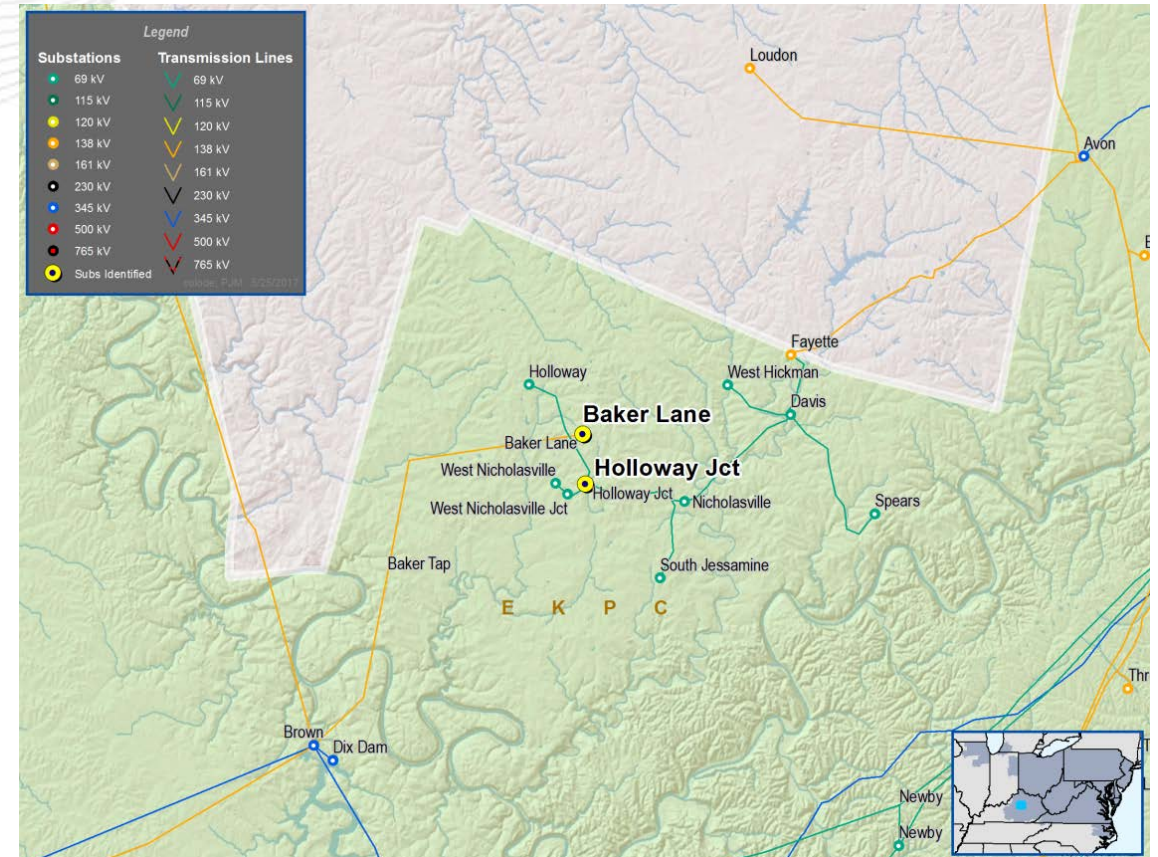
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the Baker Lane-Holloway Jct 69 kV line section during the loss of the Avon - Fayette 138 kV line.

Recommended Solution: Increase the Zone 3 distance relay setting at Baker Lane associated with the Baker Lane-Holloway Jct. 69 kV line to at least 142 MVA LTE Winter. (B2906)

Estimated Project Cost: \$0

Required In Service Date: 12/1/2018



EKPC Transmission Owner Criteria Violation

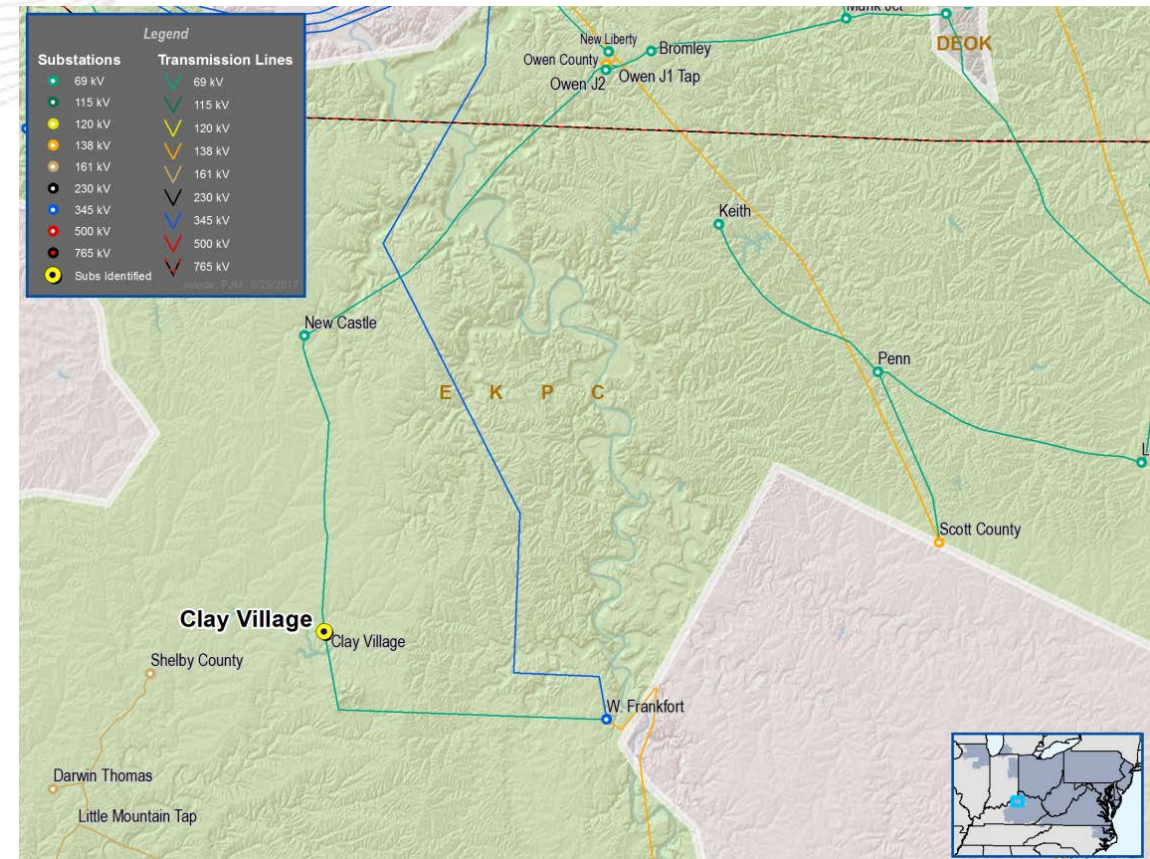
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of Clay Village - KU Clay Village 69 kV Tap during an outage of the KU Ghent – Owen Co- Scott Co 138 kV line section.

Recommended Solution: Upgrade the metering CT associated with the Clay Village - KU Clay Village 69 kV Tap line section to 600 A; at least 64 MVA Winter LTE; Upgrade the distance relay associated with the Clay Village - KU Clay Village 69 kV Tap line section to at least 64 MVA Winter LTE. (B2907)

Estimated Project Cost: \$0.125M

Required In Service Date: 12/1/2024



EKPC Transmission Owner Criteria Violation

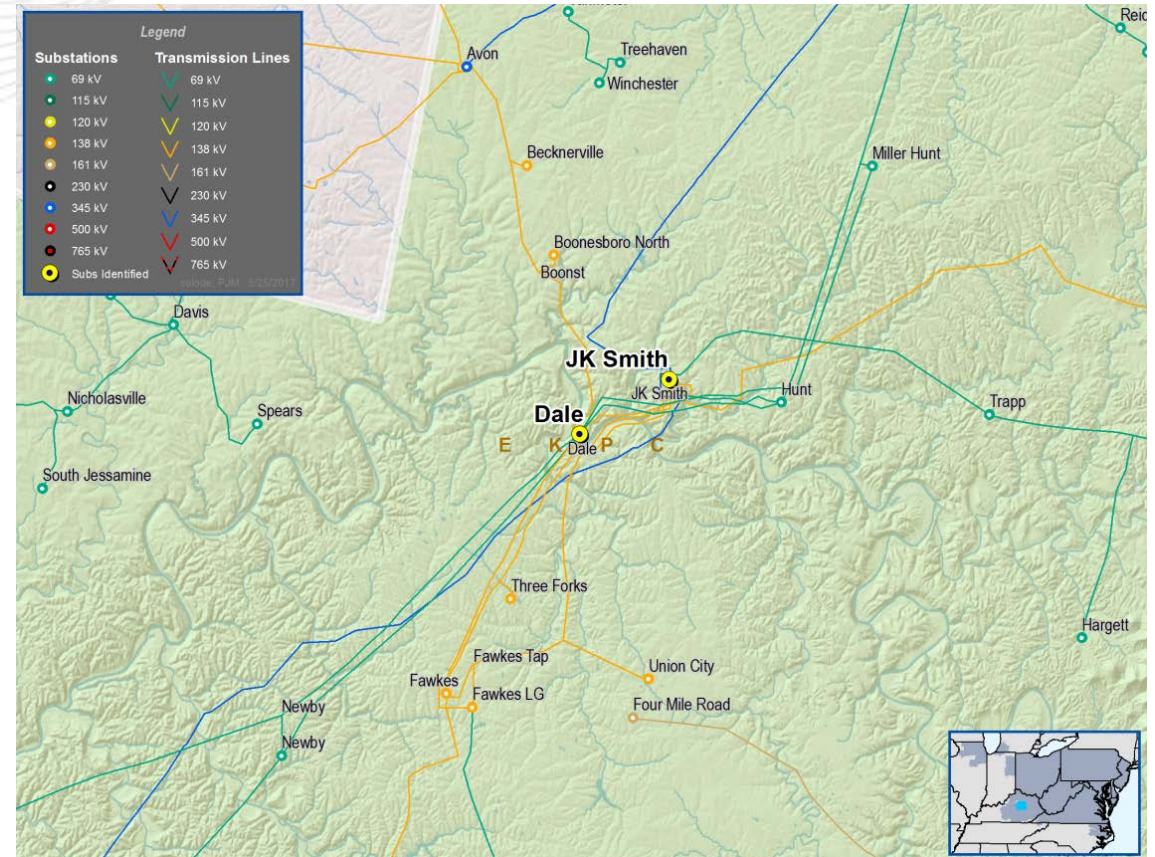
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the Dale - JK Smith 138 kV line section.

Recommended Solution: Upgrade the distance relay associated with Dale-JK Smith 138 kV line section to 362 MVA normal rating. (B2908)

Estimated Project Cost: \$0

Required In Service Date: 12/1/2027



EKPC Transmission Owner Criteria Violation

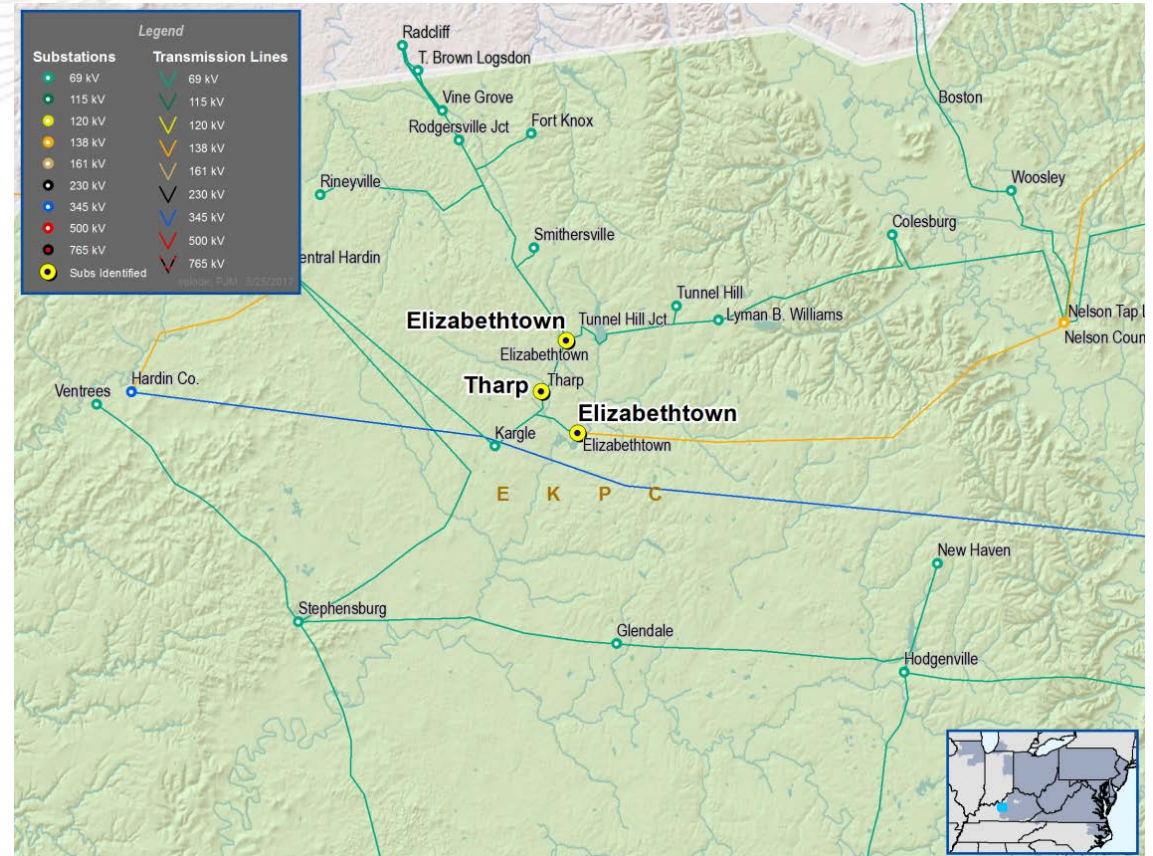
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of Elizabethtown #2 - Tharp 69 kV Tap line section during the loss of KU Rogersville - Rogersville Junction 69 kV line.

Recommended Solution: Increase the MOT of the EKPC Elizabethtown - Tharp Tap 69 kV line section (1.7 miles) to 302°F. (LTE at 284°F) (B2909)

Estimated Project Cost: \$0.2M

Required In Service Date: 12/1/2026



EKPC Transmission Owner Criteria Violation

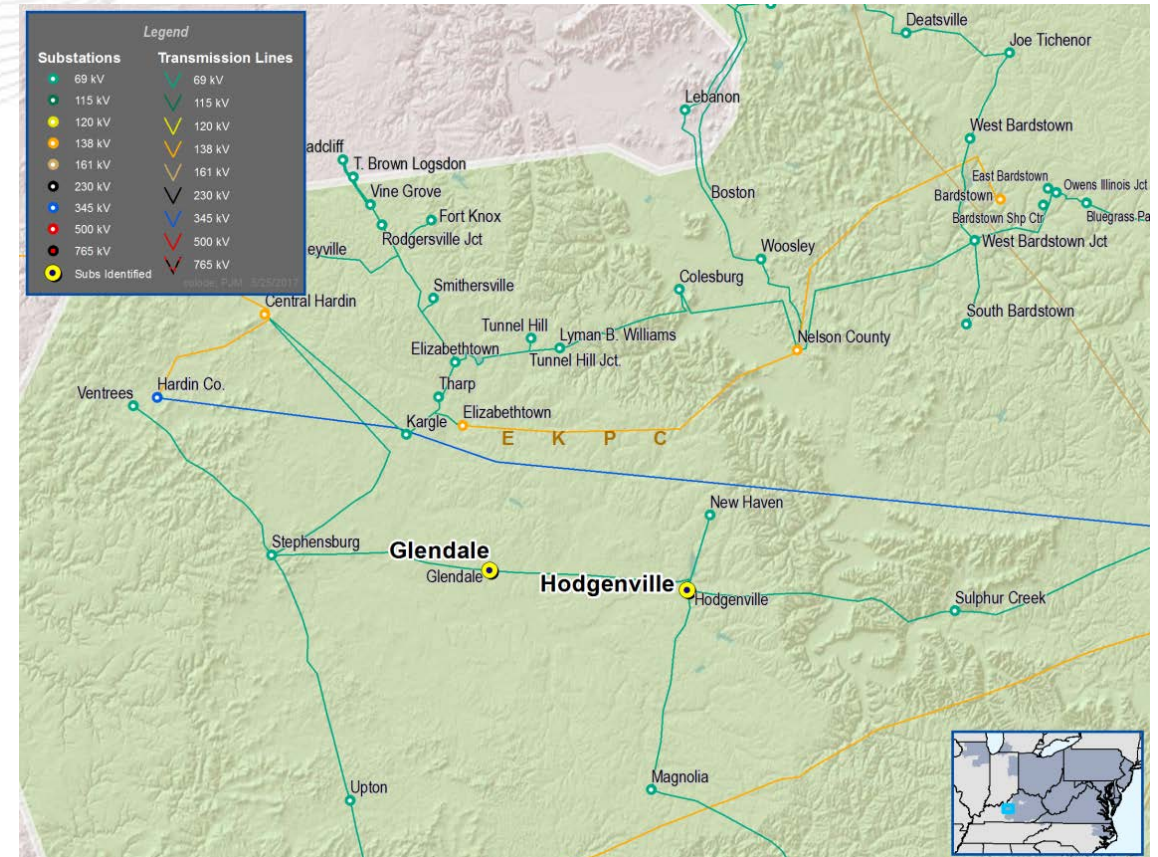
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the Glendale - Hodgenville 69 kV line section during the loss of KU Elizabethtown - KU Elizabethtown #4 69 kV line section.

Recommended Solution: Upgrade the distance relay at the Hodgenville station associated with the Glendale - Hodgenville 69 kV line section to at least 90 MVA Winter LTE. (B2910)

Estimated Project Cost: \$0

Required In Service Date: 12/1/2026



EKPC Transmission Owner Criteria Violation

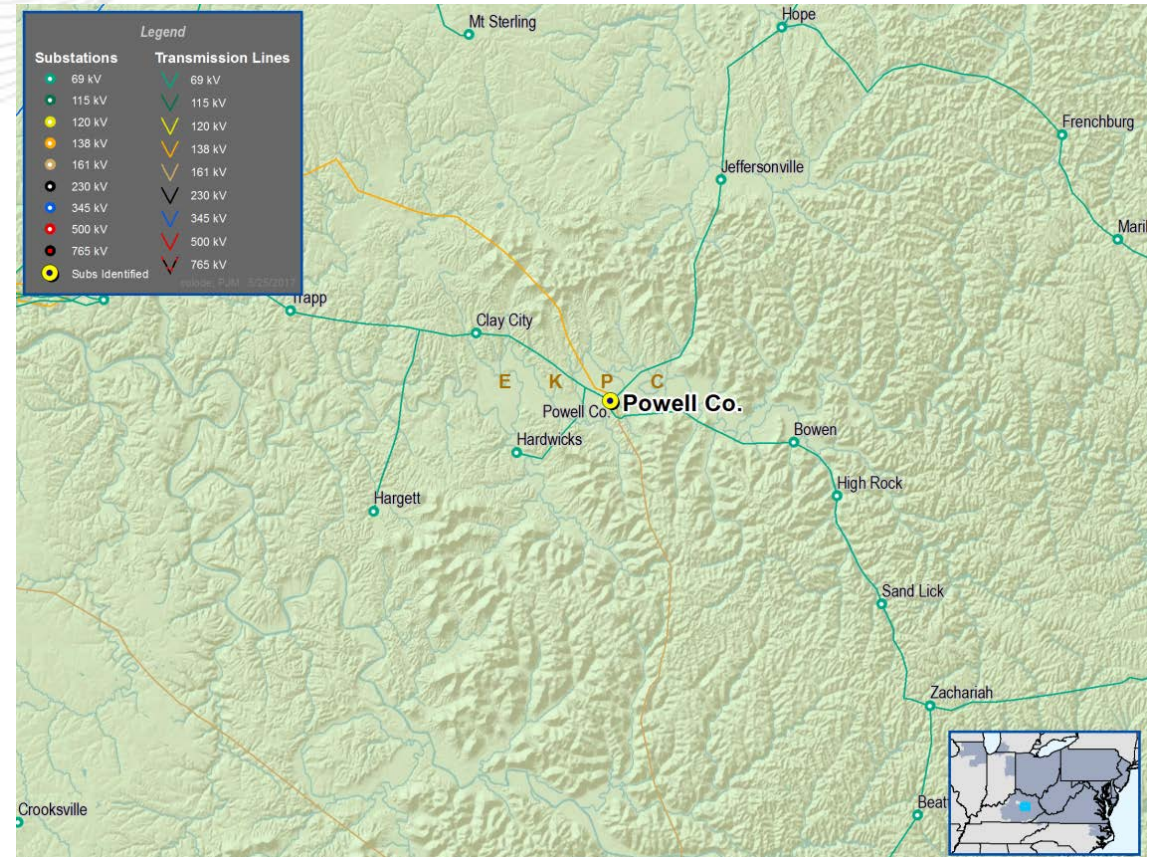
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the Powell County 138-69 kV transformer during the loss of the Powell County – Beattyville 161 kV line section.

Recommended Solution: Upgrade the overcurrent relay setting associated with Powell County 138-69 kV transformer to at least 139 MVA Winter LTE. (B2911)

Estimated Project Cost: \$0

Required In Service Date: 12/1/2025



EKPC Transmission Owner Criteria Violation

Presented: 6/30/2017 Western Subregional TEAC

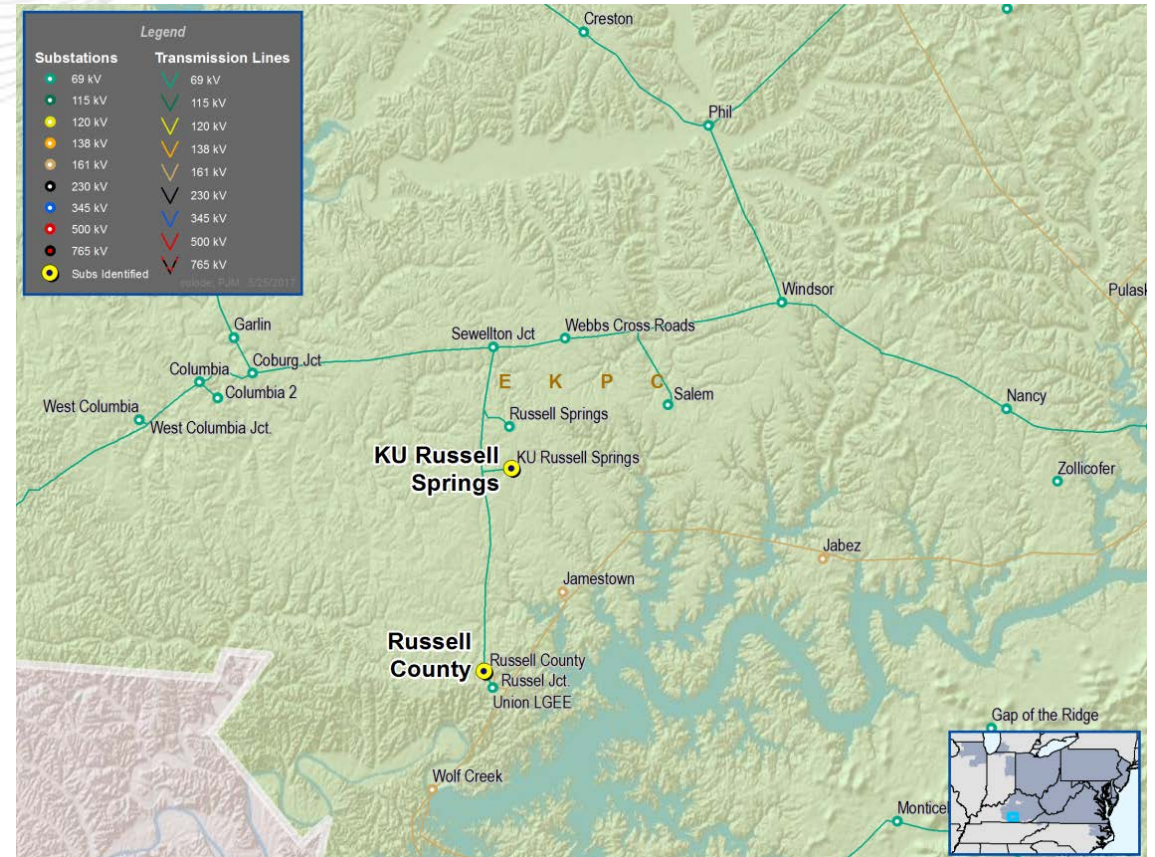
Problem Statement: Overload of the KU Russell Springs-Russell Co 69 kV line section during the loss of the Summer Shade - West Columbia 69 kV line.

Recommended Solution:

Upgrade the existing S408-605, 600 A KU Russell Springs Tap - Russell County 69 kV disconnect switch to 1200 A. (B2912)

Estimated Project Cost: \$0.15M

Required In Service Date: 12/1/2025



EKPC Transmission Owner Criteria Violation

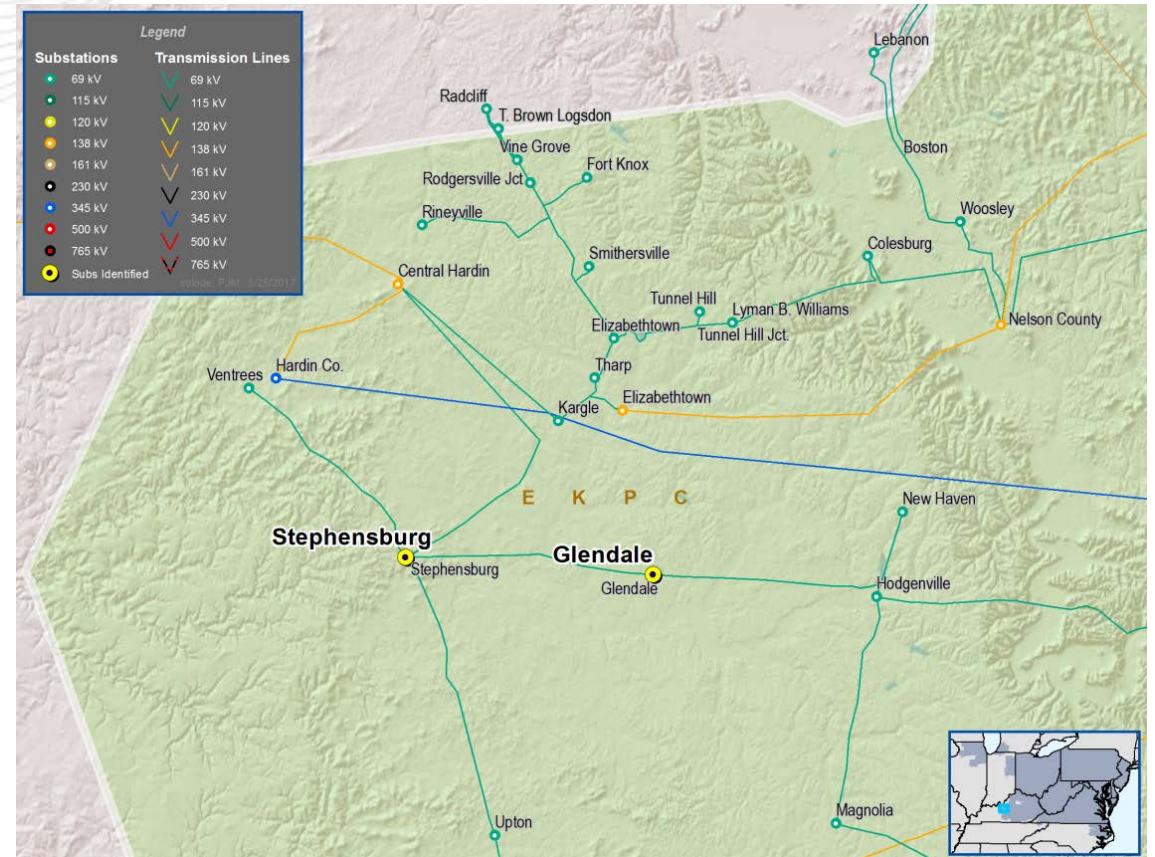
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the Stephensburg-Glendale 69 kV line section during an outage of the KU Elizabethtown - KU Elizabethtown #4 69 kV line section.

Recommended Solution: Upgrade distance relay at the Stephensburg station associated with Stephensburg - Glendale 69kV line section to at least winter LTE 100 MVA. (B2913)

Estimated Project Cost: \$0

Required In Service Date: 12/1/2024



EKPC Transmission Owner Criteria Violation

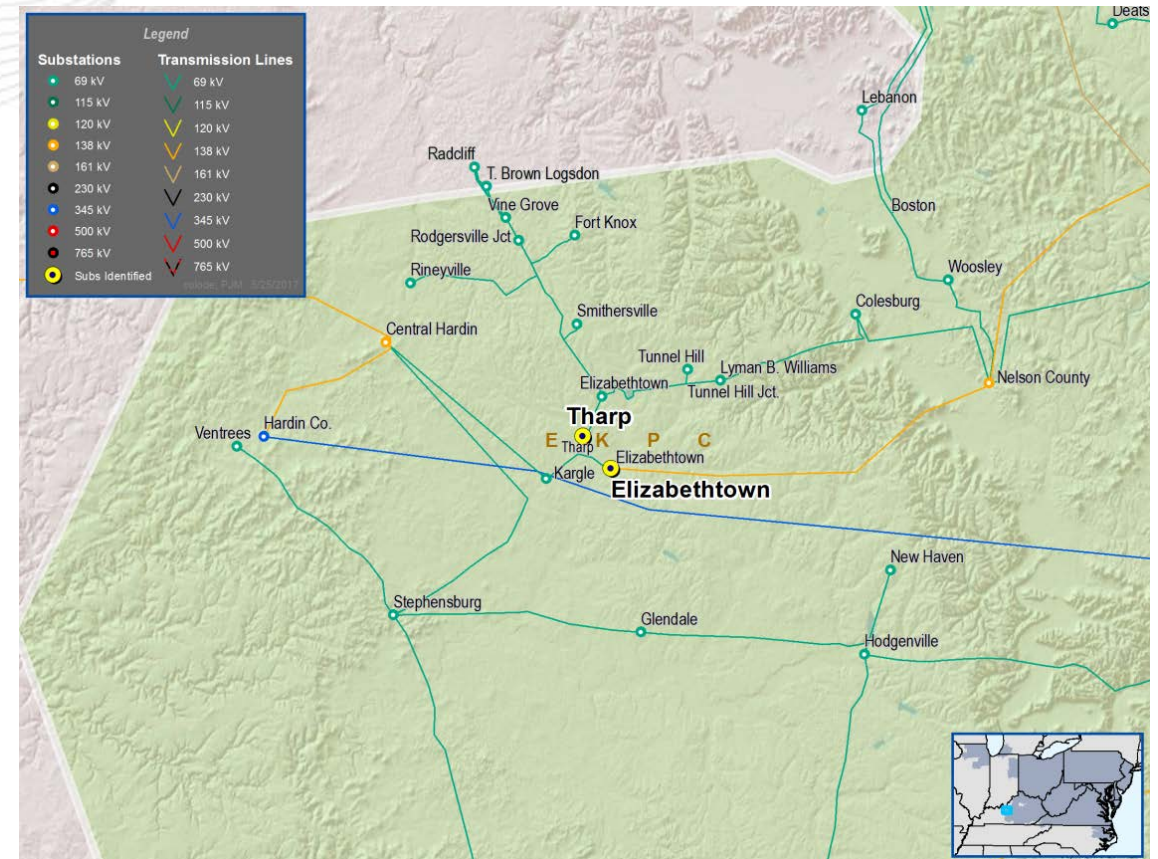
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the Tharp Tap - KU Elizabethtown 69 kV line section during the loss of the Rogersville – Rogersville Jct. 69 kV line section.

Recommended Solution: Rebuild Tharp Tap-KU Elizabethtown 69kV line section to 795 MCM (2.11 miles). (B2914)

Estimated Project Cost: \$1.22M

Required In Service Date: 12/1/2024



EKPC Transmission Owner Criteria Violation

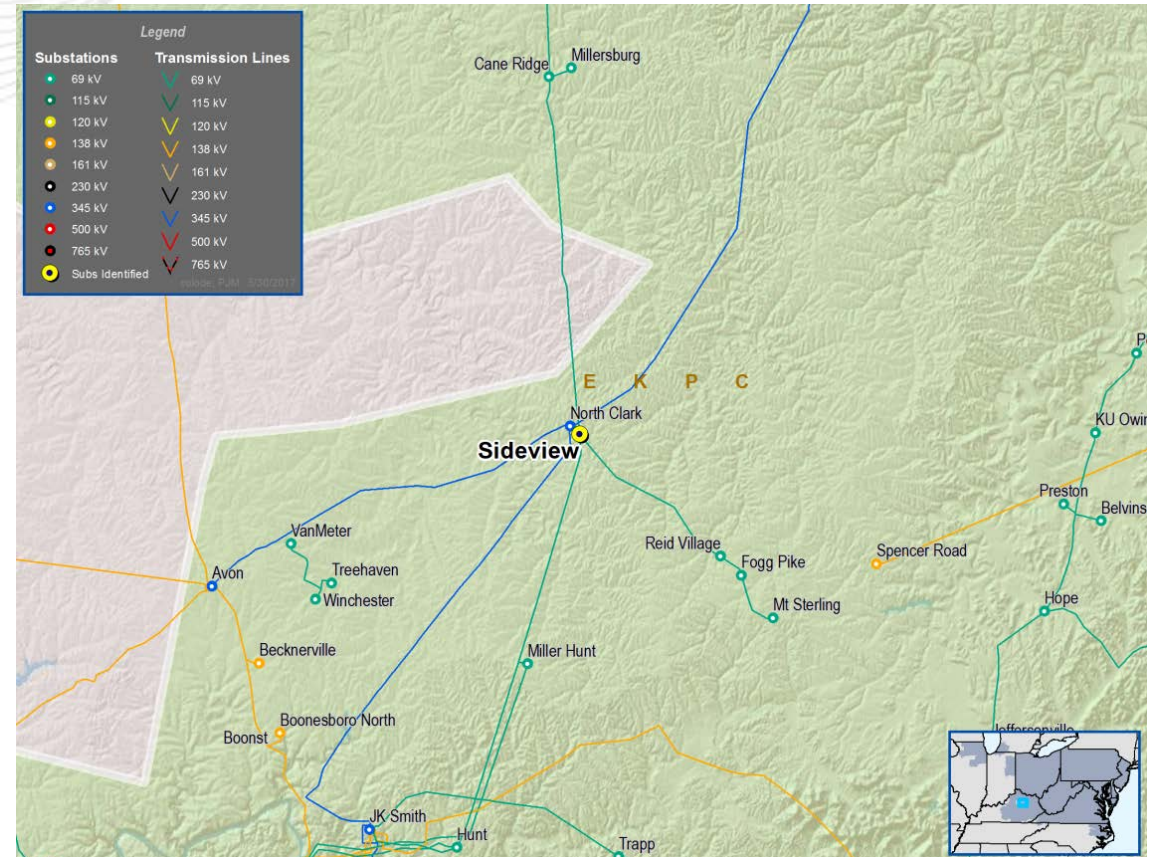
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Low voltage at the Mt. Sterling substation for the loss of the Dale 138-69 kV transformer.

Recommended Solution: Resize the Sideview 69 kV capacitor bank from 6.12 MVAR to 9.18 MVAR. (B2915)

Estimated Project Cost: \$0.07M

Required In Service Date: 12/1/2023



EKPC Transmission Owner Criteria Violation

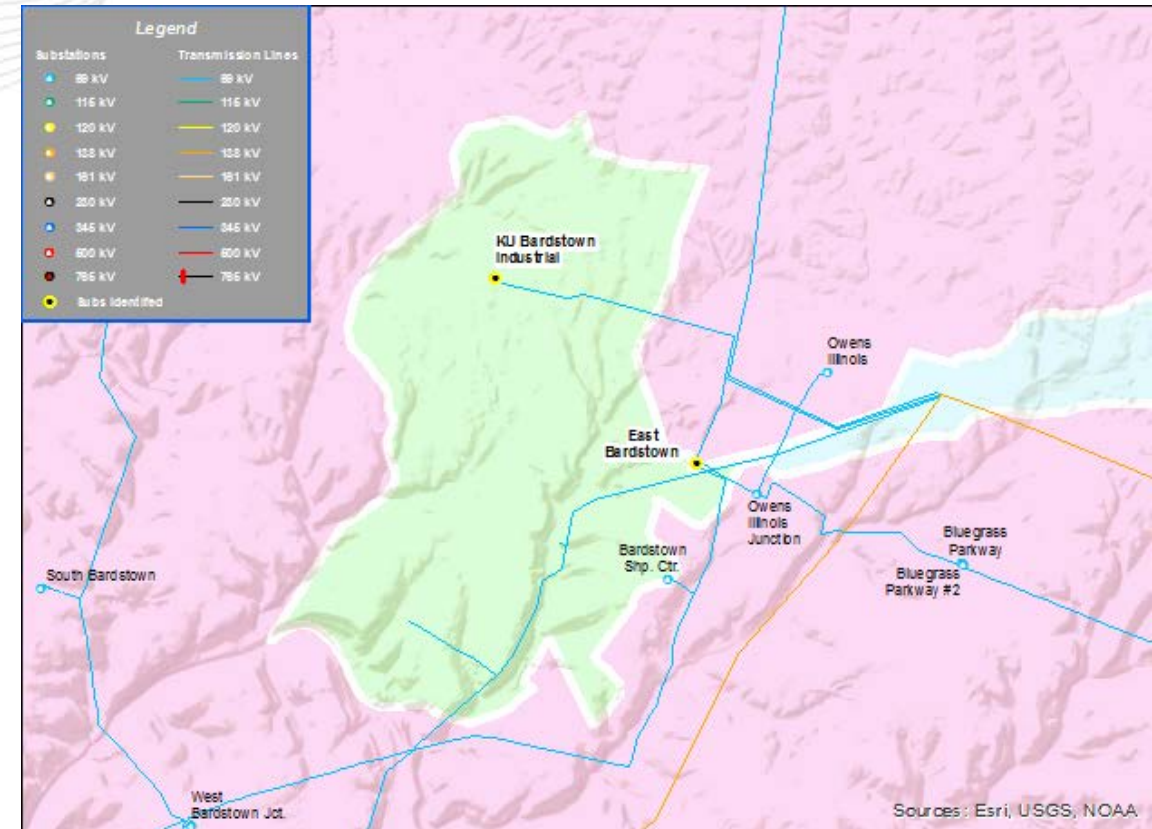
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the East Bardstown - KU Bardstown Industrial 69 kV line section during the loss of the Blue Lick 345-161 kV transformer and associated operating guide

Recommended Solution: Upgrade the existing metering CTs (Quantity of 2) associated with the East Bardstown - KU Bardstown Industrial Tap 69 kV line section to 1200 A, at least 100 MVA Winter LTE; and upgrade the existing East Bardstown bus and jumpers from 4/0 to 500 MCM Copper (B2916)

Estimated Project Cost: \$0.25M

Required In Service Date: 12/1/2023



EKPC Transmission Owner Criteria Violation

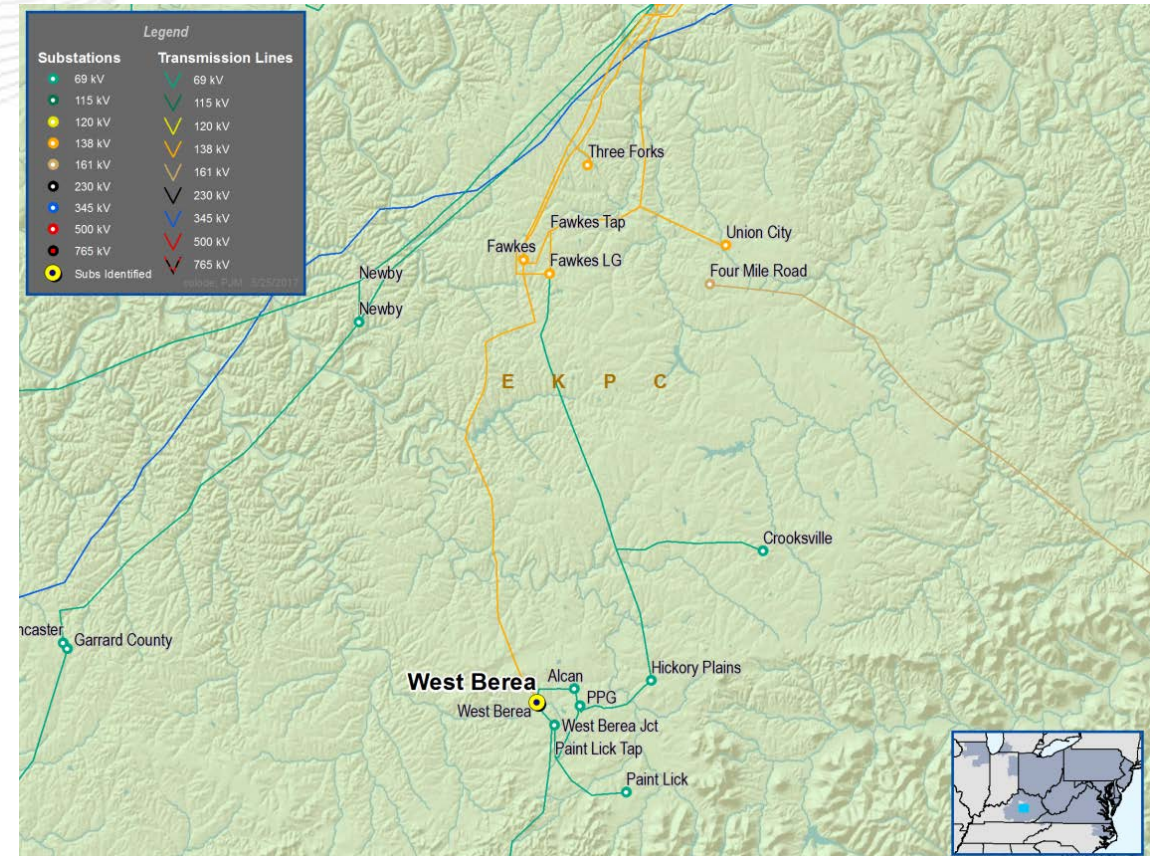
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the West Berea 138-69 kV transformer during the loss of the Crookesville-Fawkes 69kV line.

Recommended Solution: Replace the existing 100 MVA 138-69 kV transformer bank at the West Berea substation with a 150 MVA transformer. (B2917)

Estimated Project Cost: \$1.725M

Required In Service Date: 12/1/2026



EKPC Transmission Owner Criteria Violation

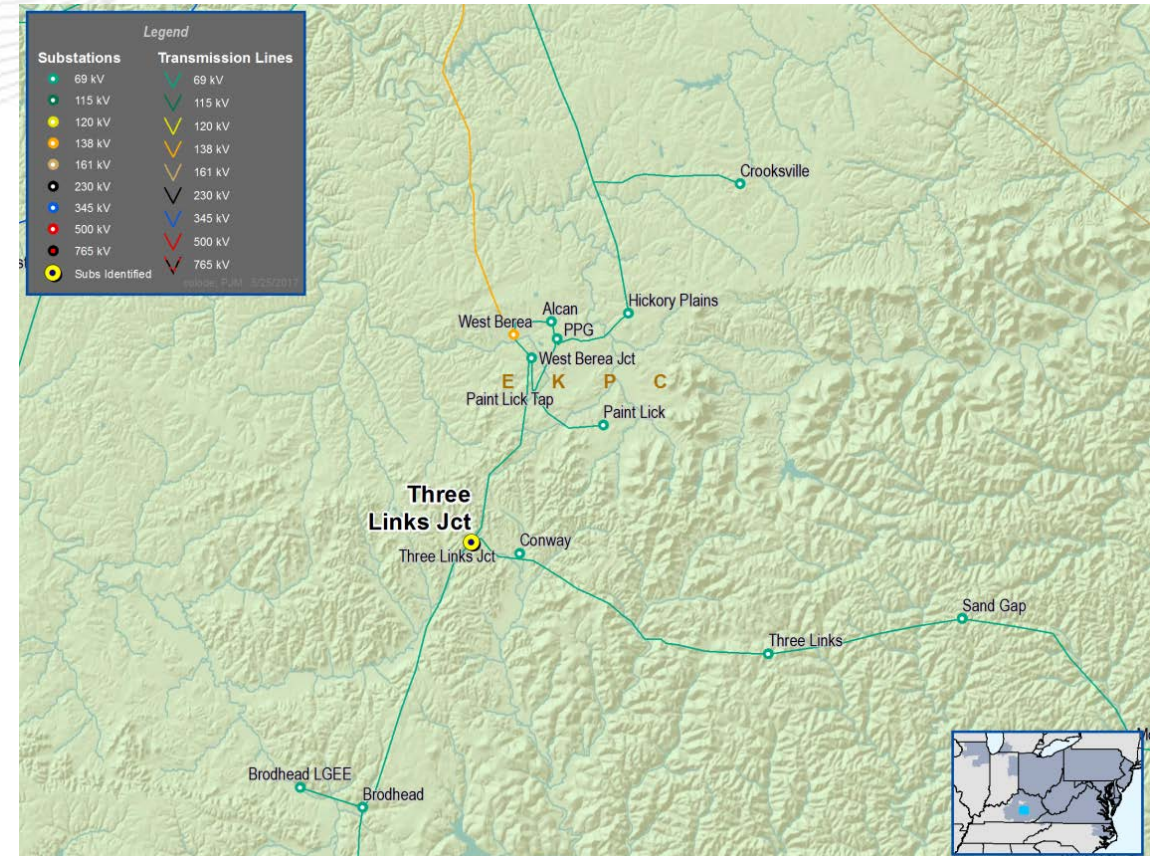
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Overload of the Three Links Jct-West Berea 69 kV line section during the loss of the KU Brown North-Alcalde-Pineville 345kV line section.

Recommended Solution: Upgrade the 4/0 bus and jumpers associated with the West Berea Jct. – Three Links Jct 69 kV line to 500 MCM copper or equivalent equipment at the Three Links Jct. substation. (B2918)

Estimated Project Cost: \$0.15M

Required In Service Date: 12/1/2026



EKPC Transmission Owner Criteria Violation

Presented: 6/30/2017 Western Subregional TEAC

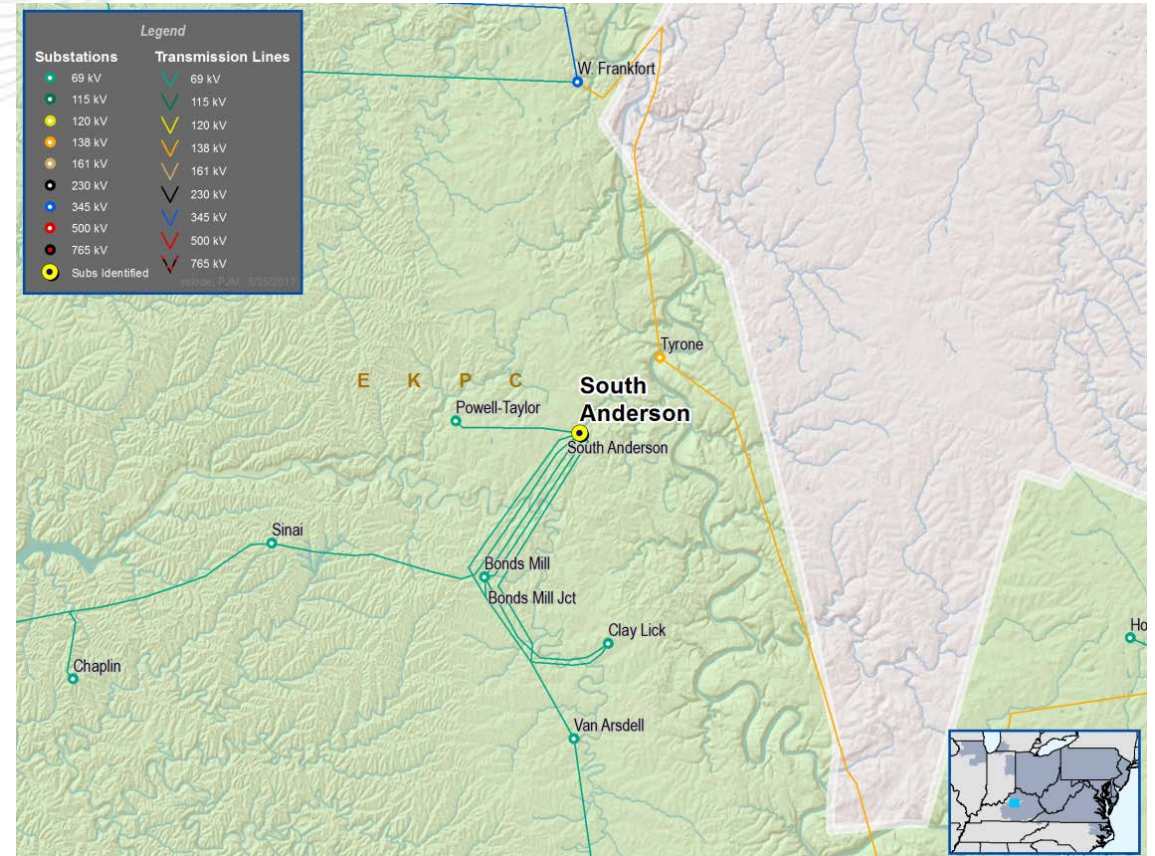
Problem Statement: Low voltage at the Powell Taylor 69 kV station during the loss of the KU Florida Tile Tap-Lawrenceburg 69kV line section.

Recommended Solution:

Install a 69 kV, 15.31 MVAR capacitor bank at South Anderson substation. (B2919)

Estimated Project Cost: \$0.365M

Required In Service Date: 12/1/2026



EKPC Transmission Owner Criteria Violation

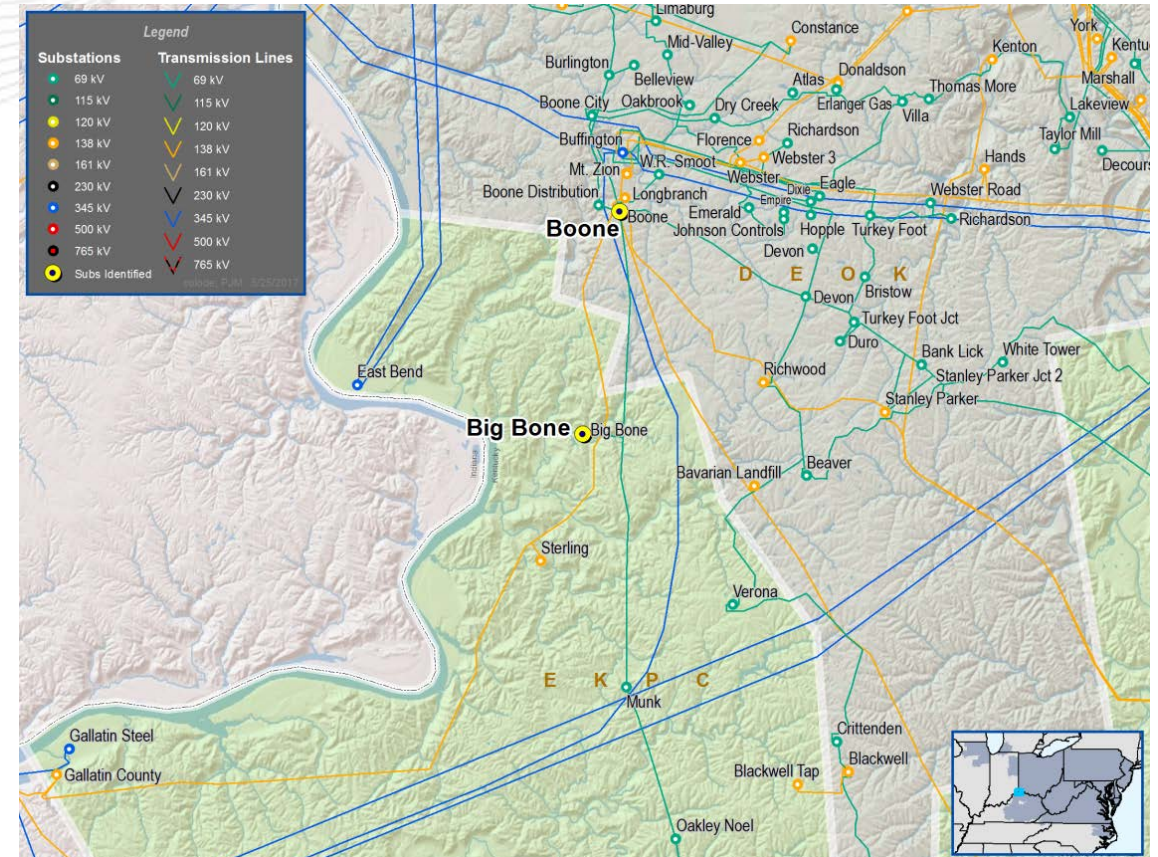
Presented: 6/30/2017 Western Subregional TEAC

Problem Statement: Low voltage on the EK Bromley 69 kV bus during the loss of the Owen County Jct 1 – EK Bromley 69 kV line section.

Recommended Solution: Rebuild Boone - Big Bone Tap 69 kV line section using 556.5 MCM ACTW conductor (6.3 miles). (B2920)

Estimated Project Cost: \$3.625M

Required In Service Date: 12/1/2025





EKPC Transmission Owner Criteria Violation

Presented: 7/21/2017 Western Subregional TEAC

Problem Statement: B2414 (Presented on 11/4/2013 SRTEAC): Build the 2nd Summer Shade EKPC - Summer Shade TVA 161 kV circuit; Required IS Date: 6/1/2018
The original Cost: \$4.6M ; The new cost: \$15.9M - with further evaluation, a new station will need to be built.

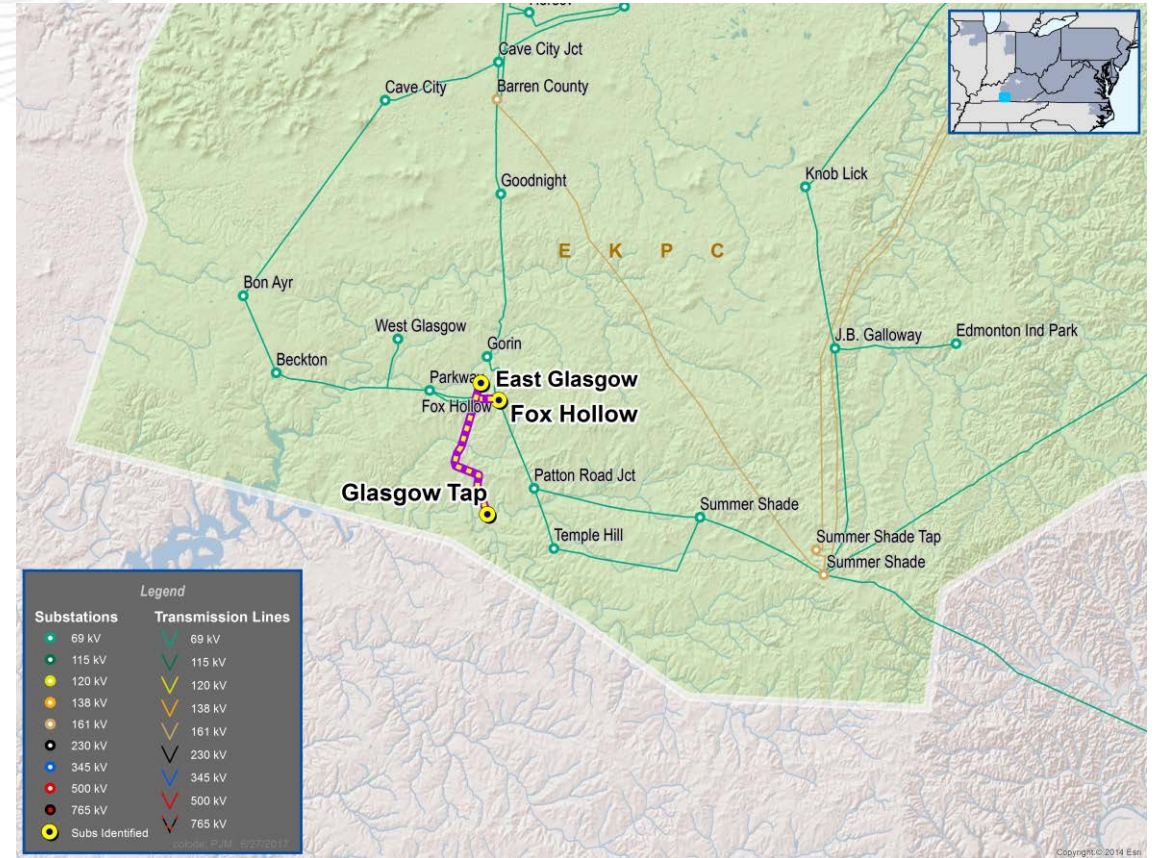
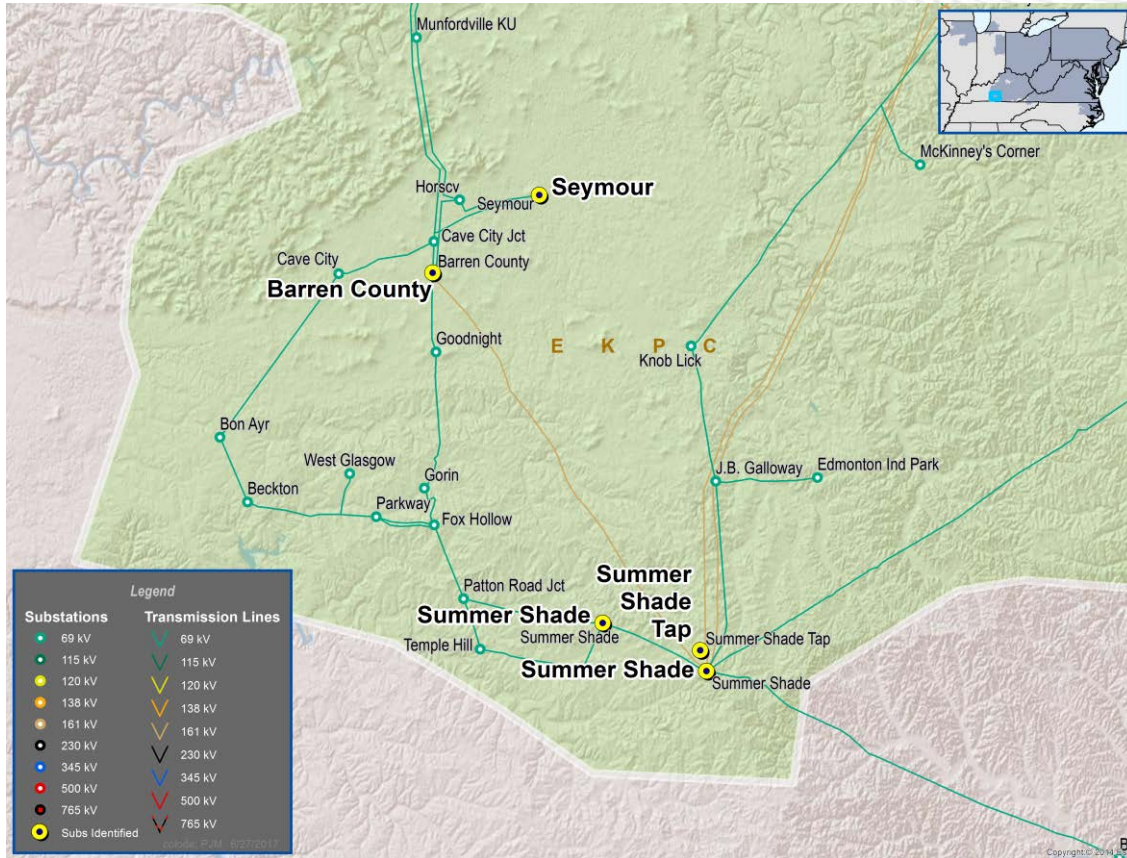
Overload of the Summer Shade 161-69 kV transformer for the loss of the Barren County 161-69 kV transformer in 6/1/2020, which will be solved by baseline project B2710 (Presented 11/5/2015 TEAC): Upgrade the Summer Shade bus and CT associated with the 161/69 kV transformer #1. The Original Cost: \$0.075M
However, the transformer will show up again in 2022 winter. Further upgrades will be needed which include Upgrade CT associated with Summershade 161-69kv transformer to at least 190 MVA Winter LTE; upgrade 1 1/4" IPS bus associated with Summershade 161/69kv transformer to 2" or larger (Estimated Cost of \$0.35M); In 2023 winter, the transformer will be overloaded again. The solution will be to add a second 161-69 kV Transformer at Summer Shade. Estimated Cost - \$1.68 Million

Overload of the Barren county 161-69 kV transformer for the loss of the Summershade - Summershade Jct. 69 kV Line is first identified for 2018 summer. The least cost fix is to replace the Barren County 161-69 kV Xfmr- (Estimated Cost of \$1.6 Million); The transformer will be further overloaded in 12/1/2020, and the fix will be to Increase overcurrent relay at Barren Co 161-69kv transformer to at least 145 MVA Winter LTE (Estimated Cost of \$0). In 2024 winter, the transformer will be overloaded again and the fix will be to upgrade Barren Co 69kv CT associated with 161/69kv transformer from 800/5 CT to 1200/5 CT. (Estimated Cost \$0.01M)

Overload of the Summer Shade Jct. - Summer Shade 69 kV Line for the loss of the Barren County - Summer Shade 161 kV Line is first identified for 2018 summer. The fix is to increase the Maximum Operating Temperature of the Summer Shade Jct. - Summer Shade 69 kV Line to 302°F (Estimated Cost of \$0.1M). The line is further overloaded in 2020 winter and the fix will be to upgrade the Summer Shade 69kV bus and Jumpers Associated with the Summer Shade-Summer Shade Jct 69 KV line section and reconductor the Summer Shade - Summer Shade Jct.69 KV line section (0.15 miles) using 795 MCM ACSR (Estimated Cost of \$0.35M).

Low voltage at Seymour 69KV for the loss of the Barren County 161-69 kV transformer in 2024 winter. The fix is to Install a 20MVAR cap bank at Fox Hollow 69 kV (Estimated Cost -\$0.365M)

Rebuild 9.55 mi Temple Hill - Summershade Jct. 69kV line section 9.55 miles) using 556.6 MCM ACTW. Estimated Cost - \$6M



EKPC Transmission Owner Criteria Violation

Presented: 7/21/2017 Western Subregional TEAC

Recommended Solution:

- New TVA 161kV Interconnection to TVA's East Glasgow Tap-East Glasgow 161 KV line section (~1 mile due West of Fox Hollow). Add Fox Hollow 161/69 KV 150 MVA transformer. Construct new Fox Hollow-Fox Hollow Jct 161 KV line section using 795 MCM ACSR (~1 mile) and new 161kV switching station at point of interconnection with TVA. (B2921)
- Cancel B2414 and B2710

Estimated Cost: \$18.1M

Required In Service Data: 6/1/2018

Summer Generator Deliverability Violation

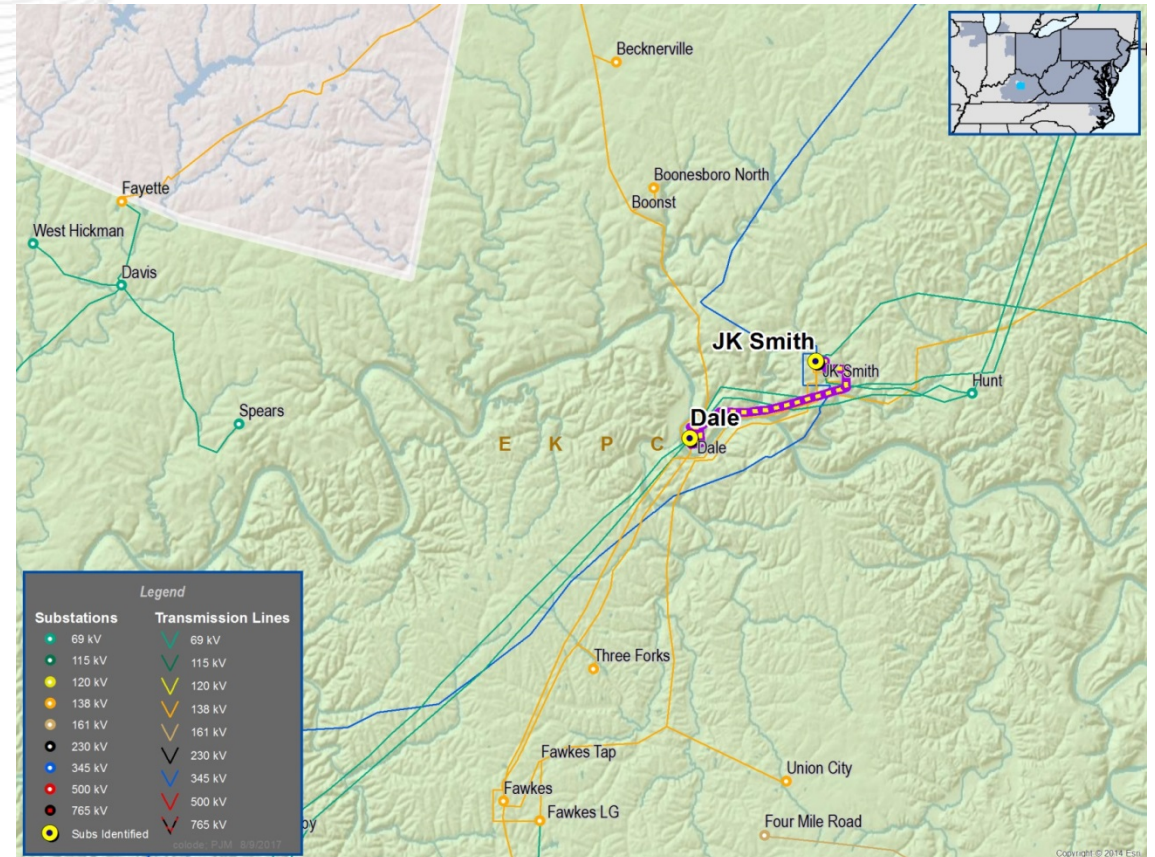
Presented: 9/11/2017 Western Subregional TEAC

Problem Statement: JK Smith – Dale 138kV line is overloaded for the loss of the JK Smith – N Clark 345kV line (GD-S174)

Recommended Solutions: Increase the conductor MOT for the Dale – JK Smith 138kV line to 275°F. The new summer ratings would be 229/296 (B2939)

Estimated Project Cost: \$0.4M

Required In Service Date: 6/1/2022



Winter Generator Deliverability Violation

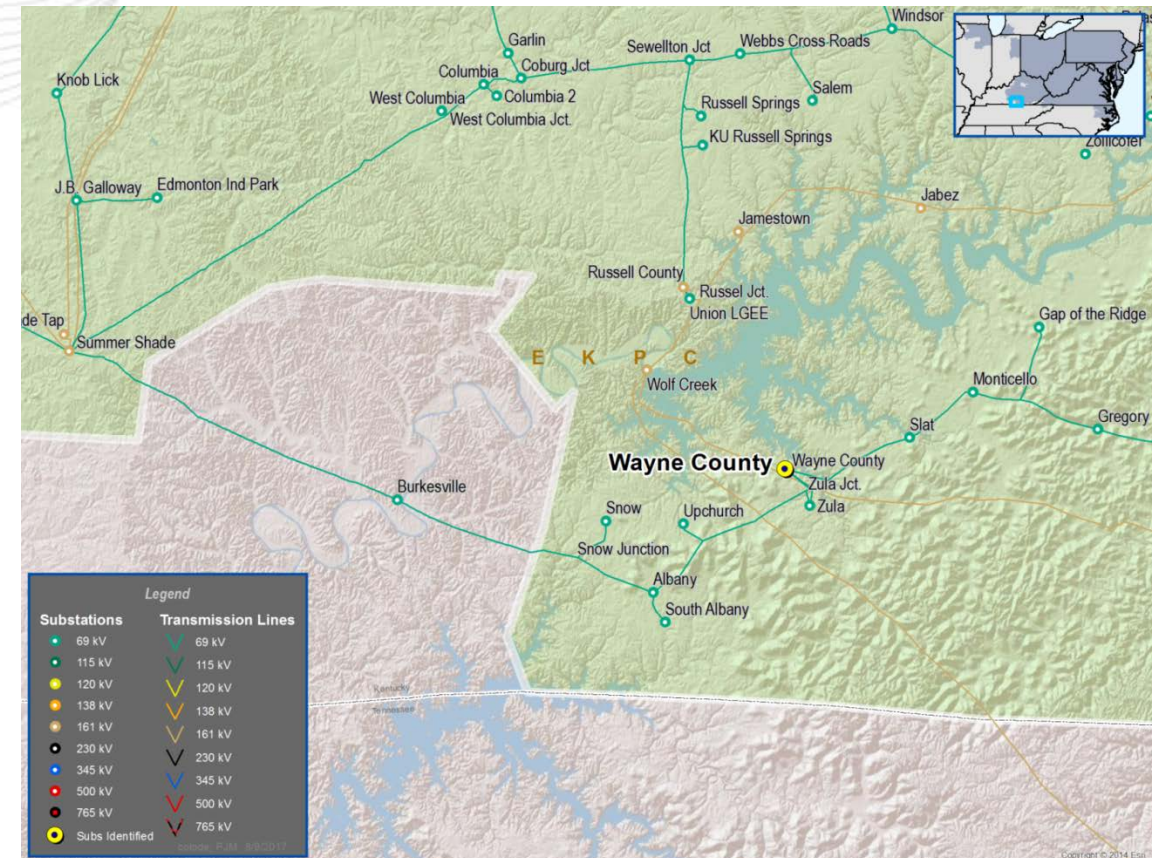
Presented: 9/11/2017 Western Subregional TEAC

Problem Statement: The Wayne Co – Wayne Co KY 161kV line is overloaded for the loss of the Summer Shade 161kV bus section S11-1039. (GD-W314, GD-W483)

Recommended Solutions: Upgrade the distance relay on the Wayne Co – Wayne Co KY 161kV line to increase the line winter rating would be 167/167. (B2940)

Estimated Project Cost: \$0M

Required In Service Date: 6/1/2022



- V1 – 9/8/2017 – Original Slides Posted
- V2 – 9/11/2017
 - Clarified statement on slide 49.
 - Updated the maps for PSEG upgrades in the Appendix (slides 62-64)
 - Added legend Dominion slides in the Appendix (slides 66-75)
- V3 – 9/12/2017
 - Removed Slides 33 and 57
 - Modified slides 26 and 27
- V4- 9/20/2017
 - Corrected OVEC name on Slide 3
 - Removed blank pages from V3