COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

Electronic Application Of Kentucky Power Company For A Certificate Of Public Convenience And Necessity To Construct A 138 kV Transmission Line And Associated Facilities In Pike And Floyd Counties (Kewanee-Enterprise Park 138 kV Transmission Project)	)	Case No. 2020-00062

DIRECT TESTIMONY OF

NICOLAS C. KOEHLER

ON BEHALF OF KENTUCKY POWER COMPANY

September 2020

DIRECT TESTIMONY OF
NICOLAS C. KOEHLER, ON BEHALF OF
KENTUCKY POWER COMPANY
BEFORE THE PUBLIC SERVICE COMMISSION OF KENTUCKY

CASE NO. 2020-00062

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DIRECT TESTIMONY OF

NICOLAS C. KOEHLER

ON BEHALF OF KENTUCKY POWER COMPANY

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME, POSITION AND BUSINESS ADDRESS.

A. My name is Nicolas C. Koehler. My position is Director, East Transmission Planning for American Electric Power Service Corporation ("AEPSC"). AEPSC supplies engineering, financing, accounting, planning, advisory, and other services to the subsidiaries of the American Electric Power ("AEP") system, one of which is Kentucky Power Company ("the Company"). My business address is 8600 Smiths Mill Road, New Albany, Ohio 43054.

II. BACKGROUND

Q. PLEASE SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND BUSINESS EXPERIENCE.

A. I received a Bachelor of Science – Electrical Engineering degree from Ohio Northern University in Ada, Ohio. In 2008, I joined AEP as a Planning Engineer where I advanced through increasing levels of responsibility. I received my Professional Engineer license in the state of Ohio in 2012 (license number 76967). In May 2019, I assumed my current position.

Q. WHAT ARE YOUR RESPONSIBILITIES AS DIRECTOR OF EAST TRANSMISSION PLANNING?

A. My role includes organizing and managing all activities related to assessing the adequacy of AEP's transmission network to meet the needs of its customers in a reliable, cost

effective, and environmentally compatible manner. I participate in planning activities with Kentucky Power to address overall system performance.

III. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I am testifying in support of Kentucky Power's application for a Certificate of Public Convenience and Necessity authorizing Kentucky Power to construct the Kewanee-Enterprise Park 138 kV Transmission Project (the "Project"). I will provide information related to the need for the Project.

Q. ARE YOU SPONSORING ANY EXHIBITS TO YOUR TESTIMONY?

A. Yes, I am sponsoring Exhibits NCK-1, NCK-2 and NCK-3 which contain copies of PJM Interconnection LLC ("PJM") Subregional Reliability Transmission Expansion Plan ("RTEP") Committee meeting slides for the proposed Project.

IV. PROJECT NEED.

Q. PLEASE DESCRIBE THE NEED DRIVING THE PROJECT.

A. The Project is required to address PJM Baseline thermal and voltage criteria violations on the Company's existing 46 kV Pikeville area subtransmission network. Several criteria violations were identified in the Winter 2023 RTEP for the loss of various combinations of lines and transformers serving the area. These criteria violations include the following:

1. For the loss of the Cedar Creek 138/69/46 kV transformer or the Cedar Creek-Fords Branch 46 kV line:
    - Voltage magnitude issues are experienced at Fords Branch 46 kV Substation.
2. For the loss of the Cedar Creek 138/69/46 kV transformer and the Beaver Creek-Elwood 46 kV line:

- The Dorton 138/46 kV transformer will load to 103% of its winter emergency rating;
- The Breaks 69/46 kV transformer will load to 104% of its winter emergency rating;
- The Henry Clay-Elwood 46 kV line section (~5.8 miles) will load to 125% of its winter emergency rating; and
- Voltage deviation and magnitude issues are experienced at Fords Branch, Pike 29, Elwood, Henry Clay, Draffin, and Burdine 46 kV substations.

3. For the loss of the Cedar Creek 138/69/46 kV transformer and the Dorton 138/46 kV transformer:

- Voltage deviation and magnitude issues are experienced at Fords Branch, Pike 29, Elwood, Henry Clay, and Burdine 46 kV substations.

4. For the loss of the Cedar Creek 138/69/46 kV transformer and Dorton-Elwood-Breaks 46 kV circuit:

- The Burton-Elwood 46 kV line section (~8.3 miles) loads to 130% of its winter emergency rating;
- The Burton-Beaver Creek 46 kV line section (~2.2 miles) loads to 119% of its winter emergency rating;
- The Beaver Creek 138/69/46 kV transformer #1 will load to 103% of its winter emergency rating;
- Voltage magnitude issues are experienced at Fords Branch, Pike 29, and Elwood 46 kV substations; and
- Voltage deviation issues are experienced at Fords Branch, Pike 29, Elwood, and Burton 46 kV substations.

5. For the loss of the Dorton 138/46 kV and Breaks 69/46 kV transformers:

- Voltage magnitude and deviation issues are experienced at Henry Clay, Draffin, and Burdine 46 kV substations.

The Project was assigned baseline ID b3087.1 through b3087.4 and reviewed with stakeholders at the November 11, 2018, October 25, 2019, and April 20, 2020 Sub-Regional RTEP-Western meetings hosted by PJM.

Q. ARE THERE ADDITIONAL BENEFITS THAT THE PROJECT WILL PROVIDE?

A. Yes. In addition to being necessary to resolve the Baseline criteria violations described above, the Project addresses the aging infrastructure needs at the Fords Branch 46 kV Substation. The existing Fords Branch 46/34.5 kV transformer has condition and performance issues that necessitate its replacement. In addition, various switches and circuit breakers are inoperable or have experienced significantly higher fault operations than the manufacturer's recommendations.

The Project also will provide additional capacity (through the 138 kV transmission system) for the Pikeville area's 34.5 kV and 12 kV distribution system. As presently configured, the two planned Kewanee 138 kV Substation 30 MVA transformers, one 138/34.5 kV and one 138/12 kV, will serve four distribution circuits; two distribution circuits will be served by each transformer. The two 12 kV circuits to be served from the Kewanee Substation 138/12 kV transformer will be connected to the existing South Pikeville-Island Creek and South Pikeville-Hospital 12 kV circuits. The two 34.5 kV circuits to be served from 138/34.5 kV transformer will pick up all the load from the existing Fords Branch-Robinson Creek and Fords Branch-Shelby 34.5 kV circuits. The Pikeville Medical Center, which is presently served from the South Pikeville-Hospital 12 kV circuit, is expected to add 2 MVA of load in 2021. With the new capacity at the proposed Kewanee 138 kV Substation, loads can be balanced among the distribution

circuits to accommodate known and future load growth. Also, the additional distribution circuits will enhance reliability by providing additional routes to feed customers during planned and unplanned outages.

Q. PLEASE DESCRIBE HOW THE PROJECT ADDRESSES THE NEEDS YOU IDENTIFY ABOVE.

A. The Baseline planning criteria violations arise because the load being served by the 46 kV network exceeds the network's capacity under certain system conditions. The Project removes the load that is currently served through the Fords Branch 46 kV Substation from the 46 kV network and transfers it to the Kewanee 138 kV Substation where it will be served through the higher capacity 138 kV transmission system.

Q. IS THE PROJECT REQUIRED FOLLOWING THE CANCELLATION OF THE PROPOSED ENERBLU FACILITY?

A. Yes. The Baseline thermal and voltage criteria violations identified in the 2023 RTEP analysis to be addressed by the Project exist even without the addition of new load in the area such as the cancelled EnerBlu facility. The EnerBlu addition would have further exacerbated these otherwise existing issues.

Q. PLEASE PROVIDE AN OVERVIEW OF THE LOCAL DISTRIBUTION NETWORK AND THE LOAD SERVED BY THIS SYSTEM?

A. The existing distribution grid in the Project area is served by the South Pikeville 69 kV Substation and the Fords Branch 46 kV Substation. The South Pikeville 69 kV Substation feeds three 12 kV distribution circuits that serve over 1,700 customers and spans approximately 62 miles. The peak load on this substation is about 22.6 MVA. The Fords Branch 46 kV Substation feeds two 34.5 kV distribution circuits that serve nearly 3,000

customers and spans roughly 111 miles. The peak load on this substation is about 29.5 MVA.

V. PROJECT DESCRIPTION.

Q. PLEASE PROVIDE AN OVERVIEW OF THE PROPOSED PROJECT.

A. The Project consists of three components to address the Baseline planning criteria violations discussed above: (1) the construction of approximately five miles of new double circuit 138 kV transmission line in Floyd and Pike counties, Kentucky (the "Kewanee 138 kV Transmission Line Extension"); (2) the construction of a new greenfield 138 kV substation in the Kentucky Enterprise Industrial Park (the "Kewanee 138 kV Substation"); and (3) the retirement of the existing Fords Branch 46 kV Substation. See **EXHIBIT 5** to the Application (Present System and Project Components).

The double-circuit line will permit the Company to provide looped service to Kewanee 138 kV Substation to be located adjacent to the Kentucky Enterprise Industrial Park. The substation will serve the load currently served by the existing Fords Branch 46 kV Substation, and thereby address the identified Baseline planning criteria violations. Company Witness Larson supports the location of the substation and the Kewanee 138 kV Transmission Line Extension in her direct testimony.

Q. WHAT DOES KENTUCKY POWER PROPOSE TO INSTALL AT THE PROPOSED KEWANEE 138 kV SUBSTATION?

A. The new Kewanee 138 kV Substation will consist of two 30 MVA transformers, one 138/34.5 kV and one 138/12 kV. Each transformer will serve two distribution feeder exits. The substation will also include all of the necessary control, protection and communication equipment that is required for safe and reliable operation of the network. The proposed

layout drawing and location map for the Kewanee 138 kV Substation is included as **EXHIBIT 10** to the Application.

Q. HOW HAS THE STATION CONFIGURATION CHANGED SINCE THE COMPANY'S PREVIOUS FILING IN 2018 (CASE NO. 2018-00209)?

A. The original station configuration included two 138/12 kV transformers and two 138/34.5 kV transformers, each with standard rural distribution structures with three distribution feeder positions in each bay. As a result of the cancellation of the EnerBlu facility, the current design eliminates one 138/12 kV transformer and one 138/34.5 kV transformer, reducing the total number of transformers from four to two. Correspondingly, the number of rural distribution structures is reduced from four to two. In addition, the station ring bus configuration has been changed from six breaker ring bus configuration to a four breaker ring bus configuration with an additional breaker for a new capacitor bank. However, the station circuit breakers will be constructed and owned by AEP Kentucky Transmission Company, Inc. ("Kentucky Transco"). Finally, a 28.8 MVAR capacitor bank will be installed at the new Kewanee 138 kV Substation to help support 138 kV voltages in the area after the load is moved from the 46 kV network to the 138 kV network. This capacitor bank will similarly be constructed and owned by Kentucky Transco.

Q. PLEASE EXPLAIN WHY KENTUCKY POWER IS PROPOSING TO RETIRE THE FORDS BRANCH 46 kV SUBSTATION?

A. The proposed Kewanee 138 kV Substation addresses the baseline violations identified in the 2023 RTEP analysis while also allowing Kentucky Power to address the aging infrastructure needs at the existing Fords Branch 46 kV Substation by transferring the Fords

Branch distribution load to the Kewanee 138 kV Substation and retiring the Fords Branch 46 kV Substation. This retirement is important for several reasons.

First, removing the load from the 46 kV network and moving it to the 138 kV system at Kewanee 138 kV Substation addresses the identified baseline criteria violations by reducing the amount of load served directly from the 46 kV network. Once this load is transferred to the 138 kV system at the Kewanee 138 kV Substation, the existing Fords Branch 46 kV Substation will no longer serve any electrical purpose and can be retired.

Second, the substation's existing equipment and infrastructure are deteriorating or otherwise inadequate and must be addressed. The 46/34.5 kV transformer at Fords Branch 46 kV Substation is showing signs of dielectric breakdown due to deteriorating insulation, accessory damage on the bushings and windings of the transformer, and short circuit breakdown due to the number of through faults experienced. The wood pole phase-over-phase switch that currently serves the Fords Branch 46 kV Substation is inoperable and in need of replacement. The 34.5 kV circuit breakers "A" & "B" at the Fords Branch 46 kV Substation are oil-type breakers that are being replaced across the AEP footprint due to a history of failure associated with this specific type of breaker. In addition, breakers "A" & "B" have experienced 262 and 333 fault operations, respectively, well above the manufacturer recommendation of ten.

Finally, replacing or upgrading of existing equipment in place would be both impracticable and ineffective. The footprint of the Fords Branch 46 kV Substation is constrained by a nearby neighborhood and the adjacent Fords Branch waterway.

Additionally, the small footprint of the Fords Branch 46 kV Substation does not allow for adequate access to equipment for routine maintenance. This increases safety

risks to personnel performing work at the substation. Further, the small county road that provides access the site has limited room to maneuver a mobile transformer. As a result, a mobile transformer must be backed in approximately 0.25 miles up the county road when needed.

EXHIBIT 3 illustrates the layout of the work to be performed and the location of the Fords Branch 46 kV Substation.

Q. HOW WILL THE FORDS BRANCH 46 kV SUBSTATION BE RETIRED?

A. Current plans provide for the removal of the existing 30 MVA 46/34.5 kV transformer, the 46 kV 7.2 MVAR capacitor bank, the 34.5 kV distribution bay structure, the two 34.5 kV distribution feeder circuit breakers and other associated equipment once the entire Fords Branch distribution load is transferred to the Kewanee 138 kV Substation. The load transfer will be accomplished by constructing new 34.5 kV distribution circuit ties from the new proposed Kewanee 138 kV Substation to existing distribution circuits served from the Fords Branch 46 kV Substation. The existing inoperable 46 kV high side motor operated switches "W" and "Y" will be permanently bolted in the closed position and the motor operators for the switches will be removed. The only equipment that will remain following retirement of the substation will be the 46 kV structure that will allow the existing Elwood–Cedar Creek 46 kV subtransmission line to pass through the former Fords Branch Substation site.

Q. DOES KENTUCKY POWER PLAN TO PERFORM WORK ANY OTHER WORK IN CONNECTION WITH THIS PROJECT?

A. Kentucky Power plans to replace an existing relay panel at the Cedar Creek 138 kV Substation with an upgraded version of the relay panel. This routine remote end work is

being undertaken in the normal course of operating and maintaining the Company's transmission facilities. This work will be performed in conjunction with the installation of new breakers and relaying at the Kewanee 138 kV Substation. **EXHIBIT 4** illustrates the layout of the work to be performed and the location of the Cedar Creek 138 kV Substation.

Q. COULD THE SERVICE TO BE FURNISHED BY THE PROJECT BE REASONABLY PROVIDED BY REBUILDING AN EXISTING TRANSMISSION LINE OR EXTENDING SERVICE FROM AN EXISTING SUBSTATION?

A. No. Although generally the Company prefers to rebuild or upgrade an existing transmission line when practicable, in this instance there are no existing transmission lines in the vicinity of the proposed route that can be rebuilt or upgraded to meet the needs addressed by the Project. In addition, the existing Fords Branch 46 kV Substation cannot be upgraded or expanded to address the Baseline thermal and voltage violations.

VI. ALTERNATIVES TO THE PROJECT.

Q. WHAT ELECTRICAL ALTERNATIVES WERE EVALUATED BY THE COMPANY?

A. Kentucky Power considered two alternatives. The first alternative involved rebuilding approximately 16.3 miles of overloaded 46 kV sections of the Burton–Beaver Creek, Burton–Elwood and Henry Clay–Elwood circuits. This alternative solution would also include replacing the overloaded Beaver Creek 138/69/46 kV and Breaks 69/46 kV transformers along with the installation of an additional 14.4 MVAR capacitor bank at the Elwood Substation. While this solution would resolve the identified thermal overloads and voltage violations, it would create voltage coordination and capacitor bank switching issues due to low short circuit strength on the 46 kV system and the existing capacitor banks at

the Elwood, Henry Clay, and Fords Branch stations. Coordinating the settings and voltage setpoints on multiple capacitor banks in such a small area could potentially result in conflicting operation or "hunting". This alternative solution, which would not permit the retirement of the Fords Branch 46 kV Substation, also would not address the aging and inadequate infrastructure needs and safety concerns at that substation.

Q. IS THIS FIRST ALTERNATIVE LESS EXPENSIVE THAN THE COMPANY'S PROPOSAL?

A. No. The total estimated transmission cost of the first alternative was $52 million, which is considerably higher than the $35.2 million estimate presented in the Company's proposal. Because of this and the other disadvantages, the first alternative was not considered to be a reasonable alternative to the Project.

Q. WHAT WAS THE SECOND ALTERNATIVE INVESTIGATED BY THE COMPANY?

A. A second alternative would be to upgrade and expand the existing Cedar Creek 138 kV Substation by installing a redundant 138/46 kV transformer, reconfiguring the existing 138 kV bus into a five breaker ring bus, installing three new 138 kV breakers, and installing two new 46 kV breakers. In addition, a second 14.4 MVAR capacitor bank would need to be added to at Elwood Substation. While this second alternative solution would resolve the identified thermal overloads and voltage violations, it would create voltage coordination and capacitor bank switching issues similar to the first alternative due to low short circuit strength on the 46 kV system and the existing capacitor banks at the Elwood, Henry Clay, and Fords Branch stations. Further, this alternative, like the first, would not

permit the retirement of the Fords Branch 46 kV Substation, and would fail to address the aging and inadequate infrastructure needs and safety concerns at that substation.

Q. ARE THERE ADDITIONAL DISADVANTAGES TO THE SECOND ALTERNATIVE CONSIDERED BY KENTUCKY POWER?

A. Yes. Fords Branch 46 kV Substation is landlocked, surrounded by residences, mountains, and a floodplain. These constraints prevent Kentucky Power from sectionalizing to the station and improving service to customers served out of Fords Branch 46 kV Substation. There are also supplemental needs identified on the Cedar Creek–Elwood 46 kV circuit that, in order to continue serving the Fords Branch Substation at 46 kV, would require a rebuild of this line at an additional cost of approximately $55 million. Conversely, the Project as proposed provides Kentucky Power with the opportunity to potentially retire the Cedar Creek–Elwood 46 kV circuit in the future and avoid these rebuild costs. Given all of these disadvantages, and an estimated cost of $70 million, this second alternative is not a reasonable alternative.

VII. PJM REVIEW.

Q. IS THE PROJECT DESIGNATED AS SUPPLEMENTAL OR BASELINE BY PJM?

A. It is a Baseline Project. PJM has assigned the Project the designation of b3087. More specifically:

b3087.1: Kewanee 138 kV Substation and Retirement of Fords Branch 46 kV Substation

b3087.2: Transmission Line Extension

b3087.3: Remote End Work at Cedar Creek 138 kV Substation

b3087.4: Kewanee 138 kV Substation Capacitor Bank Addition

Q. ARE ANY ASPECTS OF THE PROJECT PRESENTED AS SUPPLEMENTAL WORK?

A. No. Both the line and station work have been approved by PJM as Baseline Project components.

Q. PLEASE PROVIDE A SUMMARY OF THE PROJECT'S ADVANCEMENT THROUGH THE PJM PROCESS?

A. The Project was first submitted at the Subregional Reliability Transmission Expansion Plan Committee meeting held on November 29, 2018. The slide presented at the RTEP meeting is provided as Exhibit NCK-1. Next, an update on the Project was brought back to the Committee on October 25, 2019. This update included the removal of the EnerBlu facility and described the associated changes to the substation. This RTEP slide is provided as Exhibit NCK-2. Finally, a last project update was submitted on April 20, 2020. This update included the addition of the capacitor bank at the Kewanee 138 kV Substation. This RTEP slide is provided as Exhibit NCK-3. The Project was approved by the PJM Board and included in the December 2019 and July 2020 PJM Transmission Enhancement Advisory Committee White Papers. These White Papers are provided as Exhibit NCK-4. The required in-service date for the Project is December 1, 2023.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Sub Regional RTEP Committee
PJM West

November 29, 2018

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

AEP TO Criteria Violation (Immediate Need)
Problem Statement:

Planning Criteria Violations:

In 2023 RTEP winter case:
For the loss of the Cedar Creek – Fords Branch 46 kV line section or Cedar Creek 138/69/46 kV transformer:
-Voltage Magnitude issues are experienced at Fords Branch(.87pu) station.

For the loss of the Cedar Creek 138/69/46 kV transformer and Beaver Creek – Elwood 46 kV circuit:
-The Dorton 138/46 kV transformer will load to 103% of its winter emergency rating (65 MVA, capabilities study pending)
-The Breaks 69/46 kV transformer will load to 104% of its winter emergency rating (50 MVA, capabilities study pending)
-The Henry Clay – Elwood 46 kV line section (~5.8 mi.) loads to 125% of its conductor's winter emergency rating (63 MVA).
-The Pike 29 S.S – Elwood 46 kV line section (~2.8 mi.) loads to 95% of its conductor's winter emergency rating (61 MVA).
-Voltage Magnitude issues are experienced at Fords Branch(.57pu),Pike29 (.66pu), Henry Clay (.80pu), Draffin (.89pu), Burdine (.91pu), and Elwood (.71pu) stations.
-Voltage Deviation issues are experienced at Fords Branch(33%), Pike29 (29%), Elwood (27%), Henry Clay (19%), Burdine (11%), and Draffin(12%) stations.

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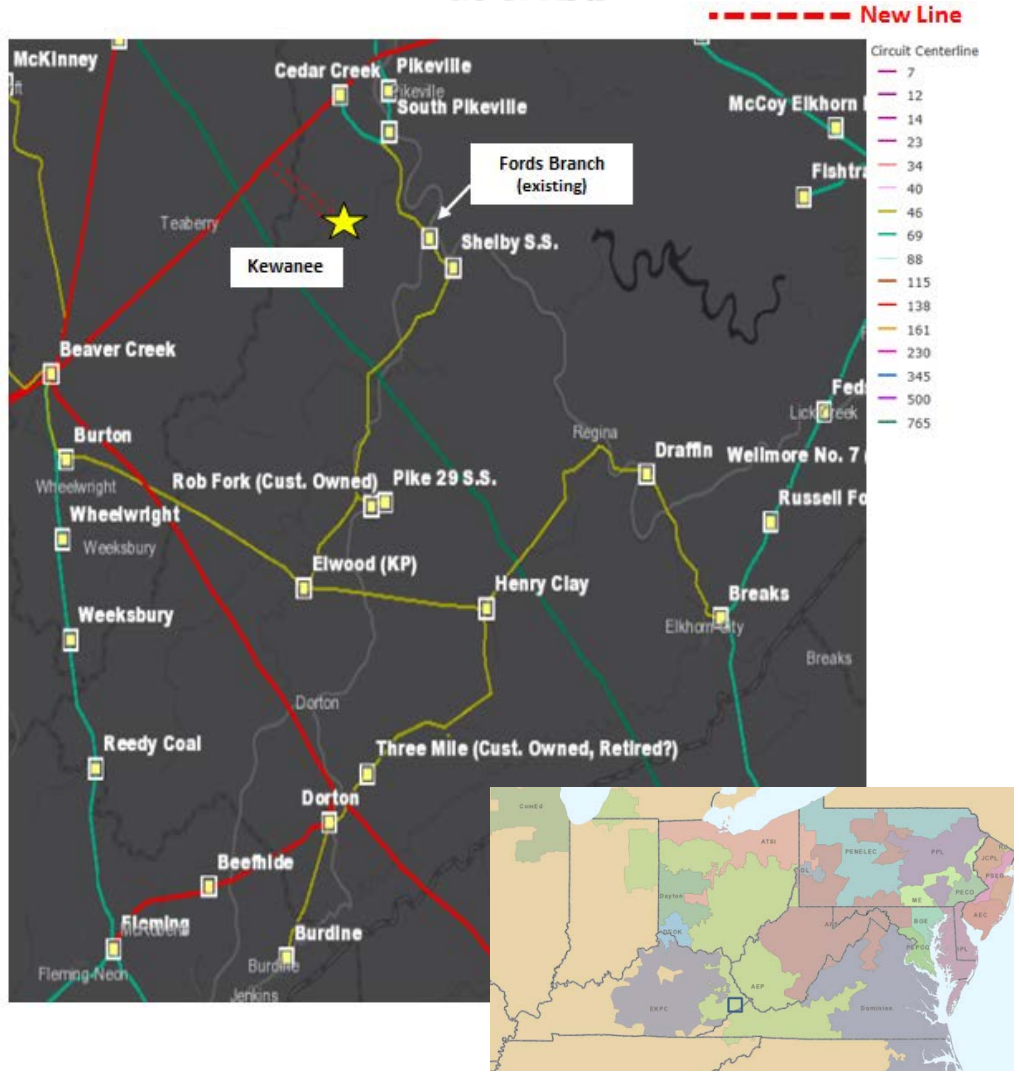

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

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Planning Criteria Violations:

For the loss of the Cedar Creek 138/69/46 kV transformer and Dorton – 138/46 kV transformer:
-The Burton – Elwood 46 kV line section (~8.3 mi.) loads to 98 % of its winter emergency rating (55 MVA).
-Voltage Magnitude issues are experienced at Fords Branch(.80pu),Pike29 (.86pu), Henry Clay (.90pu), Burdine (.89pu), and Elwood (.89pu) stations.
-Voltage Deviation issues are experienced at Fords Branch(9%), Pike29 (8%), Elwood (8%), Henry Clay (9%), and Burdine (12%) stations.

For the loss of the Cedar Creek 138/69/46 kV transformer and Dorton – Elwood – Breaks 46 kV circuit:
-The Burton – Elwood 46 kV line section (~8.3 mi.) loads to 113 % of its conductor's winter emergency rating (63 MVA).
-The Burton – Beaver Creek 46 kV line section (~2.2 mi.) loads to 119 % of its conductor's winter emergency rating (63 MVA).
-The Beaver Creek 138/69/46 kV transformer #1 will load to 103% of its winter emergency rating (58 MVA) .
-Voltage Magnitude issues are experienced at Fords Branch(.67pu),Pike29 (.75pu), and Elwood (.79pu) stations.
-Voltage Deviation issues are experienced at Fords Branch(25%), Pike29 (21%), Elwood (19%), and Burton (9%) stations.

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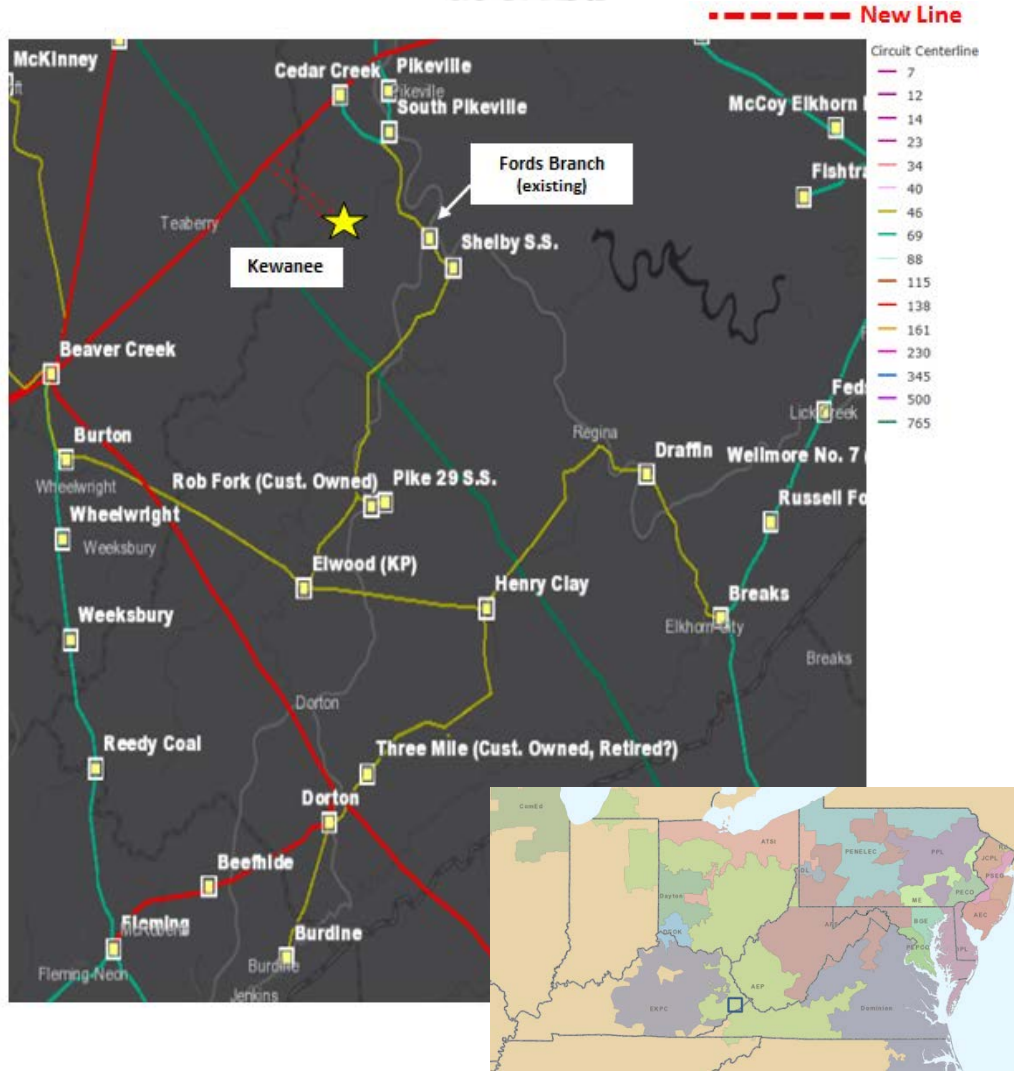

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

<u>Customer Service:</u>
Kentucky Power Distribution has requested an additional 40 MW of capacity to serve distribution customers at the Kentucky Enterprise Industrial Park, Projected IS date: 12/1/2019

<u>Planning Criteria Violations with the additional 40MW load:</u>
Base Case voltage violation (.89pu) at Fords Branch

For the loss of the Cedar Creek – Fords Branch 46 kV line section or Cedar Creek 138/69/46 kV transformer:
-The Elwood 46 kV network becomes non convergent due to a voltage collapse.

For the loss of the Henry Clay – Elwood 46 kV line section:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 103% of its conductor's winter emergency rating (61 MVA)
-Voltage Magnitude issues are experienced at Fords Branch(.87pu),Pike29 (.90pu), and Elwood (.91pu) stations.

A bus outage at Elwood Station results in:
-The Cedar Creek - Fords Branch 46 kV line section (~4.9 mi.) will load to 139% of its largest conductor's winter emergency rating (84 MVA).
-The Cedar Creek 138/69/46 kV transformer will load to 146% of its 46 windings winter emergency rating (80 MVA)
-Voltage Magnitude issues are experienced at Fords Branch(.66pu) and Pike29 (.63pu) stations.
-Voltage Magnitude issues are experienced at Fords Branch(.30%) and Pike29 (37%) stations.

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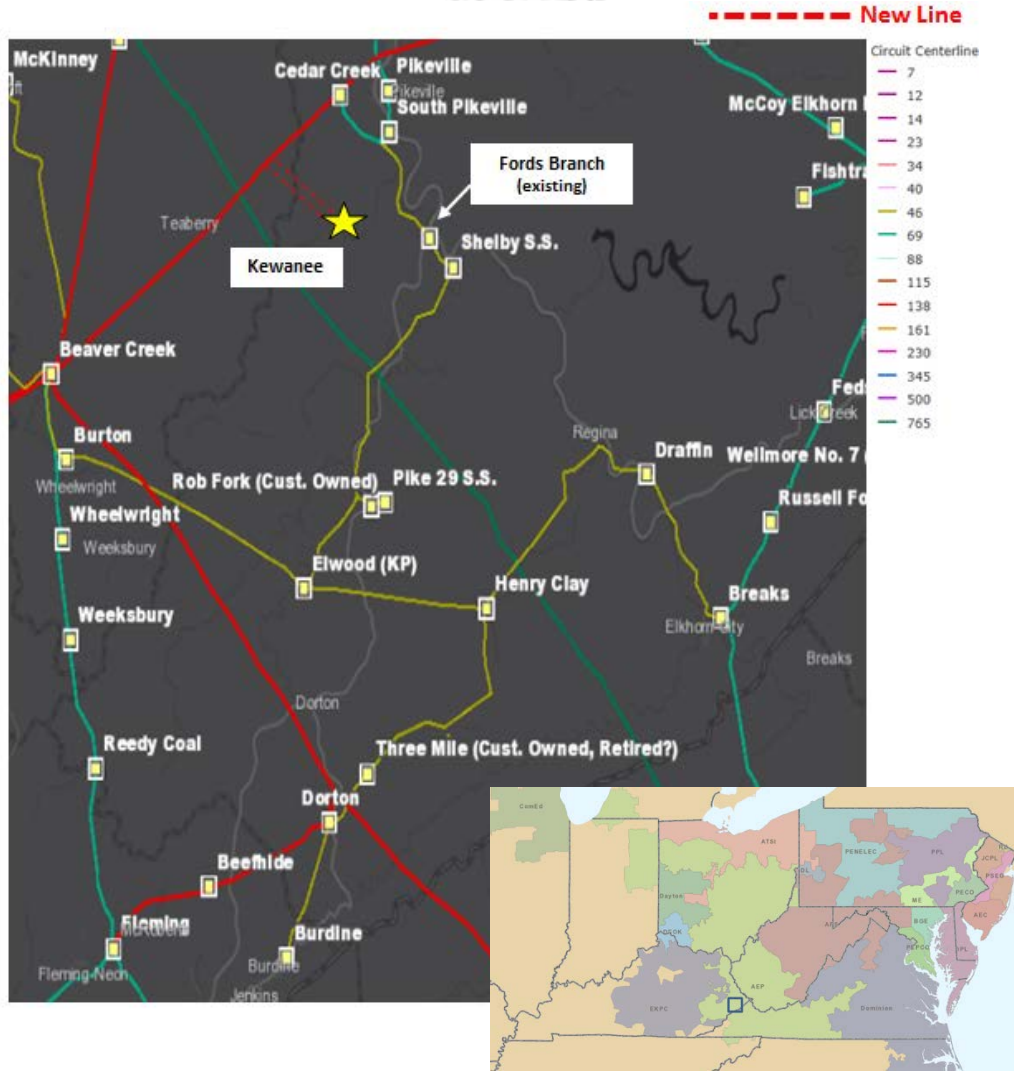

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

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<u>Planning Criteria Violations with the additional 40MW load:</u>

For the loss of the Beaver Creek – Burton 46 kV line section:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 109% of its conductor's winter emergency rating (61 MVA)
-Voltage Magnitude issues are experienced at Fords Branch(.88pu) and Pike29 (.91pu) stations.

For the loss of the Beaver Creek – Elwood 46 kV line circuit:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 105% of its conductor's winter emergency rating (61 MVA)
-Voltage Magnitude issues are experienced at Fords Branch(.89pu) station

For the loss of the Dorton 138/46 kV transformer:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 100% of its conductor's winter emergency rating (61 MVA)
-Voltage Magnitude issues are experienced at Fords Branch(.88pu) and Pike29 (.91pu) stations.

For the loss of the Breaks 69/46 kV transformer:
-Voltage Magnitude issues are experienced at Fords Branch(.89pu) station.

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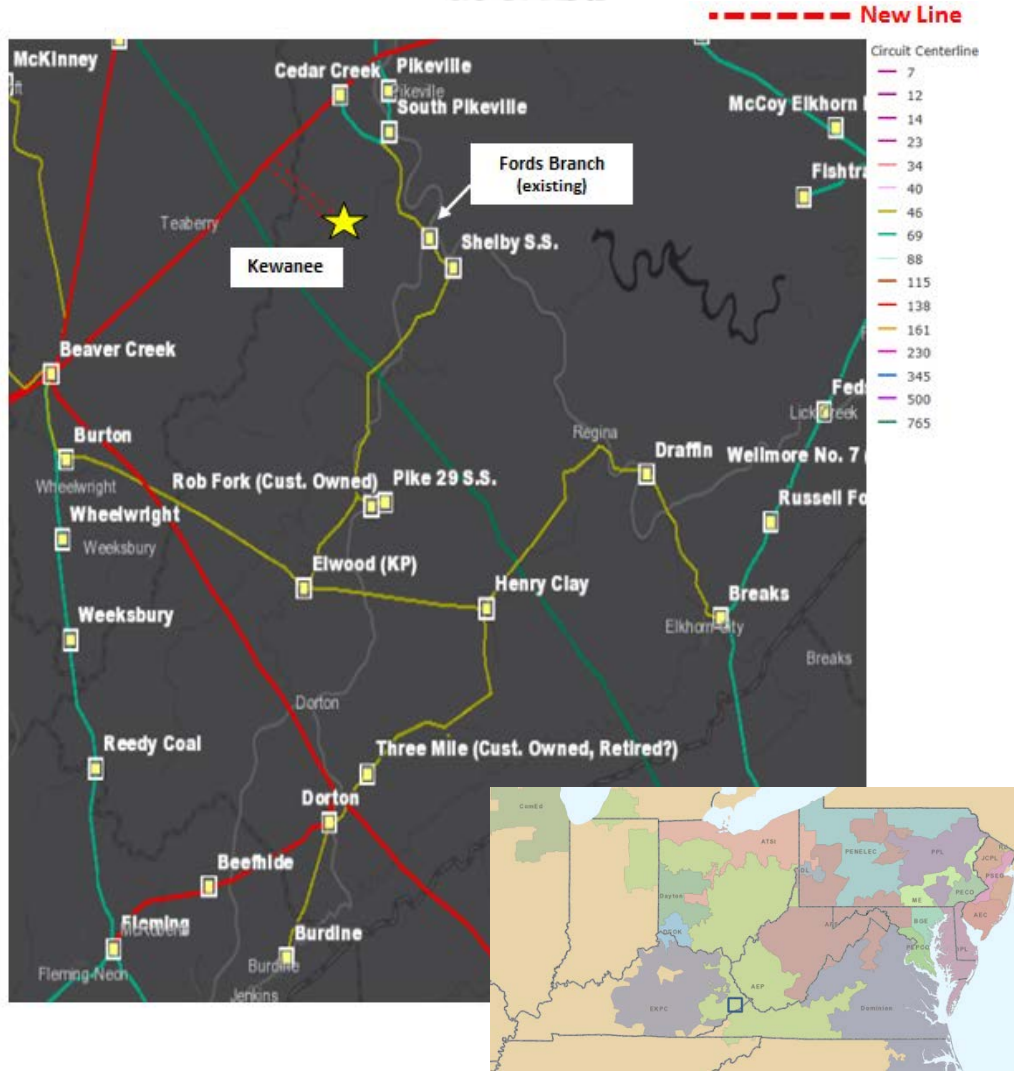

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

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<u>Planning Criteria Violations with the additional 40MW load:</u>

For loss of the Beaver Creek – Elwood 46 kV circuit and Dorton 138/46 kV transformer:
-The Cedar Creek - Fords Branch 46 kV line section (~4.9 mi.) will load to 115% of its largest conductor's winter emergency rating (84 MVA).
-The Cedar Creek 138/69/46 kV transformer will load to 121% of the transformer's 46 kV windings winter emergency rating (80 MVA).
-The Breaks 69/46 kV transformer will load to 134% of the transformers winter emergency rating (50 MVA).
-The Breaks – Draffin 46 kV line section (~4.5 mi.) will load to 102% of its conductor's winter emergency rating (63 MVA).
-The Draffin – Henry Clay 46 kV line section (~7.33 mi.) will load to 105% (92% of its conductor's winter emergency rating (63 MVA)) (55 MVA).
-Voltage magnitude issues are experienced at Fords Branch(.77pu), Pike29 (.77pu), Elwood (.78pu), Henry Clay (.80pu), Draffin (.88pu), and Burdine (.78pu) stations.
-Voltage Deviation issues are experienced at Fords Branch (15%), Pike29 (17%), Elwood (18%), Henry Clay (20%), Draffin (14%), and Burdine (25%) stations.

For loss of the Beaver Creek – Elwood 46 kV circuit and Breaks 69/46 kV transformer:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 141% of its conductor's winter emergency rating (61MVA) and 102% of the line's largest conductor winter emergency rating (84 MVA).
-The Cedar Creek 138/69/46 kV transformer will load to 107% of the transformer's 46 kV windings winter emergency rating (80 MVA).
-A portion of the Dorton – Henry Clay 46 kV circuit (~6 mi.) will load to 98% of its conductor's winter emergency rating (63 MVA).
-The Dorton 138/46 kV transformer will load to 110% of its winter emergency rating (65 MVA, capabilities study pending) .
-Voltage magnitude issues are experienced at Fords Branch(.79pu), Pike29 (.80pu), Elwood (.82pu), Henry Clay (.84pu), and Draffin (.83pu) stations.
-Voltage Deviation issues are experienced at Fords Branch (8%), Pike29 (11%), Elwood (11%), Henry Clay (11%),and Draffin (15%) stations.

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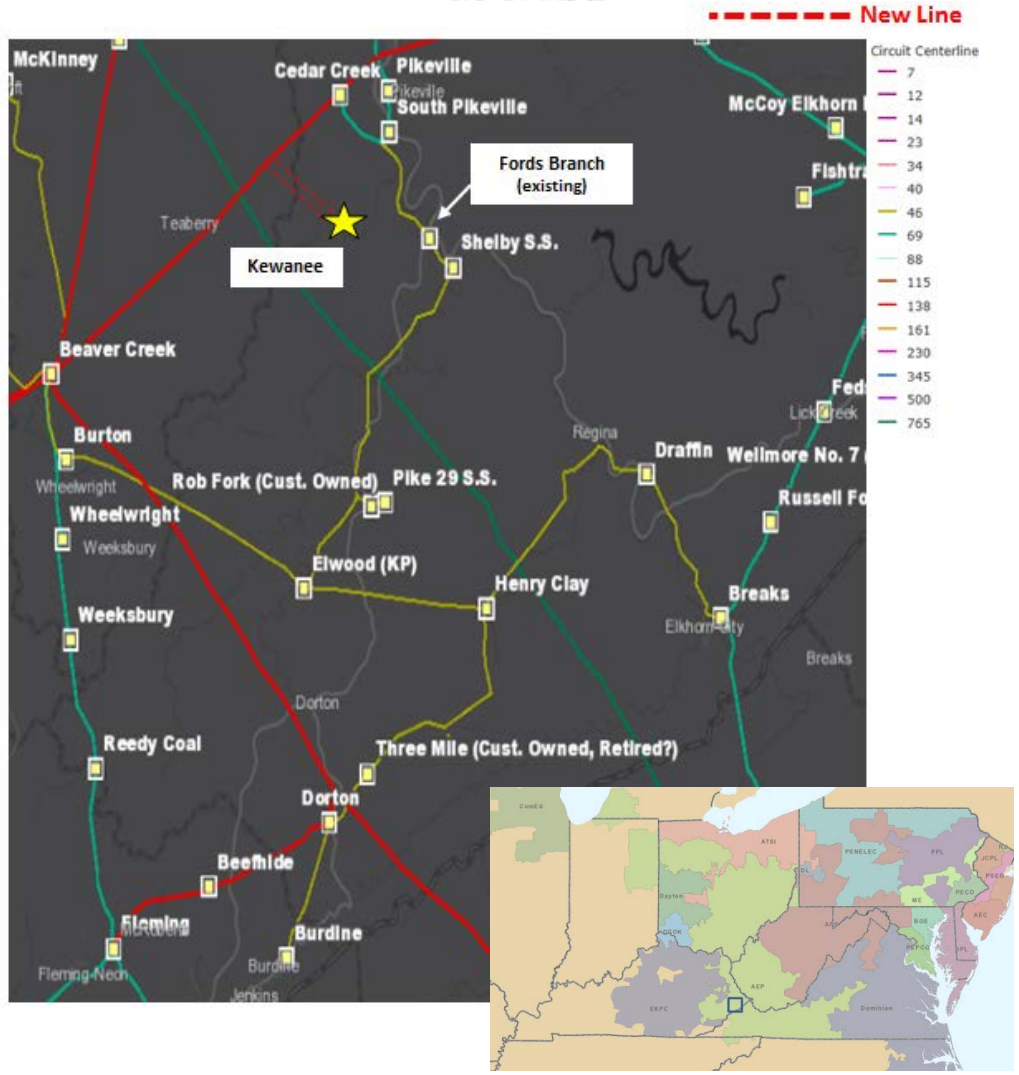

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

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<u>Planning Criteria Violations with the additional 40MW load:</u>

For loss of the Dorton 138/46 kV and Breaks 69/46 kV transformers:
-The Cedar Creek - Fords Branch 46 kV line section (~4.9 mi.) will load to 100% of its largest conductor's winter emergency rating (84 MVA).
-The Cedar Creek 138/69/46 kV transformer will load to 105% of the transformer's 46 kV windings winter emergency rating (80 MVA).
-The Beaver Creek – Burton 46 kV line section (~2.2 mi.) will load to 125% of its conductor's winter emergency rating (63 MVA).
-The Burton – Elwood 46 kV line section (~8.25 mi.) will load to 120% of its conductor's winter emergency rating (63 MVA).
-The Beaver Creek 138/69/46 kV transformer #1 will load to 105% of its winter emergency rating (58 MVA) .
-Voltage magnitude issues are experienced at Fords Branch(.79pu), Pike29 (.80pu), Elwood (.81pu), Henry Clay (.77pu), Draffin (.76pu), and Burdine (.75pu) stations.
-Voltage Deviation issues are experienced at Fords Branch (13%), Pike29 (16%), Elwood (17%), Henry Clay (22%), Burdine (23%), Burton (9%), and Draffin (27%) stations.

For loss of the Beaver 138/69/46 kV transformer #2 and Dorton 138/46 kV transformer:
-The Beaver Creek 138/69/46 kV transformer #1 will load to 104% of its winter emergency rating (58 MVA) .
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 104% of its conductor's winter emergency rating (61MVA)
-Voltage magnitude issues are experienced at Fords Branch(.87pu), Pike29 (.90pu), and Burdine (.91pu) stations.
-Voltage Deviation issues are experienced at Burdine (9%) station.

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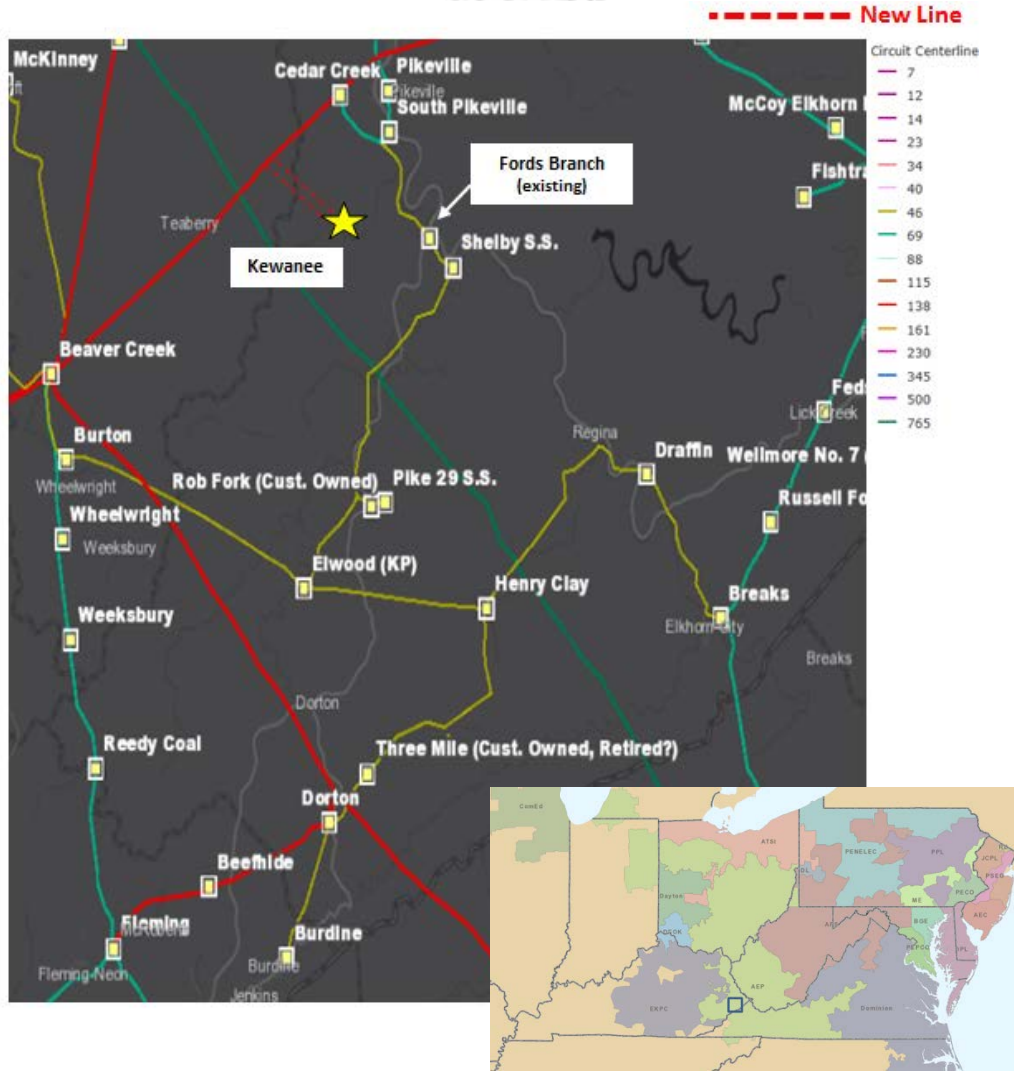

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

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Equipment Material/Condition/Performance/Risk:

The 46/34.5 kV transformer (vintage 1992) at Fords Branch Station is showing signs of dielectric breakdown (insulation), accessory damage (bushings/windings) and short circuit breakdown (due to amount of through faults). The wood pole Phase over Phase switch that currently serves Fords is inoperable and in need of replacement. The 34.5 kV circuit breakers "A" & "B" at Fords Branch are ESV type breakers manufactured in 1992, which are an oil type breaker that are being replaced across the AEP footprint due to their history of violent failures. In addition, breakers "A" & "B" have experienced 262 and 333 fault operations, exceeding the manufacture recommendation of 10.

Operational Flexibility and Efficiency

The 46/34.5 kV transformer at Fords Branch Station utilizes a ground switch MOAB scheme as part of the high side transformer protection.

The proposed 138/12 kV transformer at Kewanee station will allow for load to be transferred away from the existing Betsy Layne – Cedar Creek 69 kV circuit which has historical seen flows close to its 91 MVA conductor winter emergency rating.

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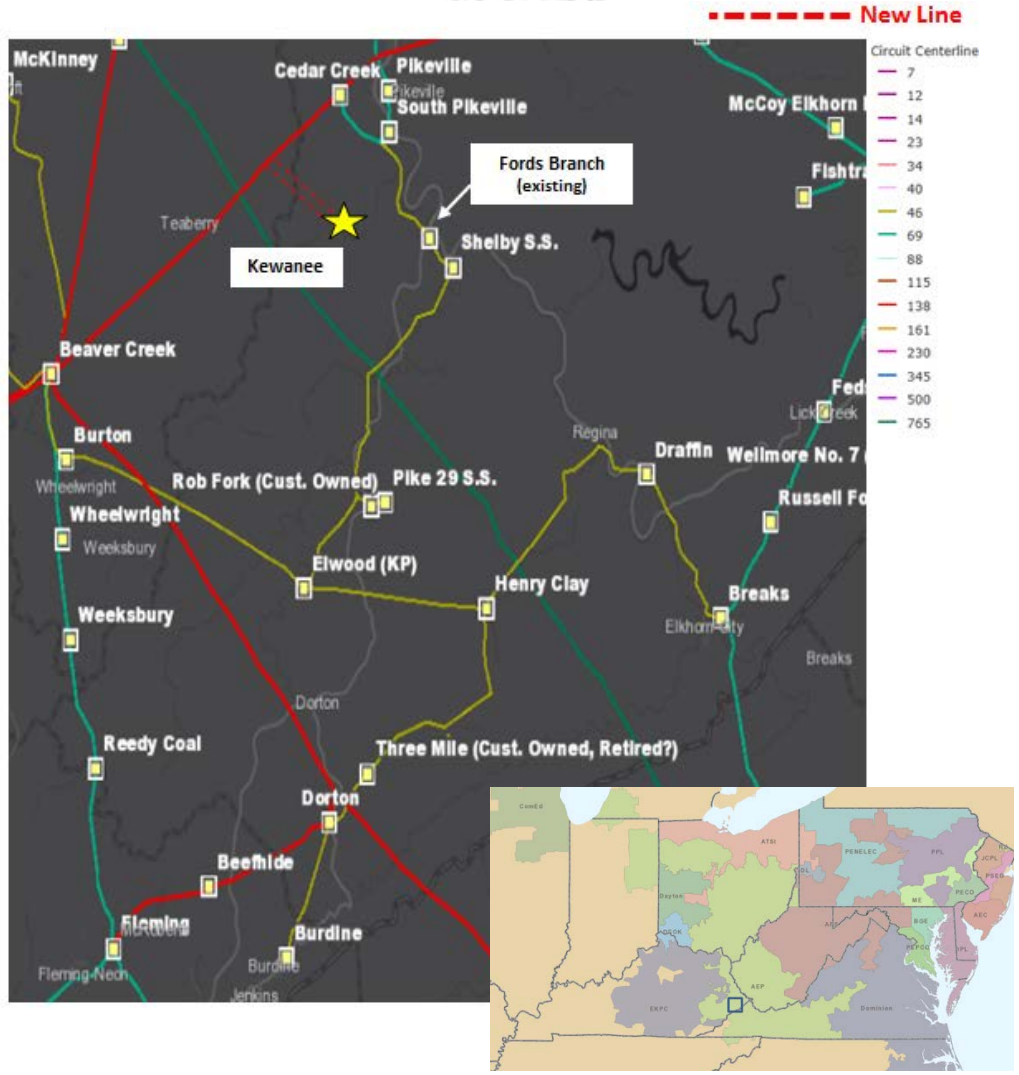

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

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Selected Solution

Construct a new greenfield station to the west (~1.5 mi.) of the existing Fords Branch Station in the new Kentucky Enterprise Industrial Park. This station will consist of six 3000A 40kA 138 kV breakers laid out in a ring arrangement, two 30 MVA 138/34.5 kV transformers, and two 30 MVA 138/12 kV transformers. The existing Fords Branch Station will be retired. (B3087.1) Estimated Cost: $ 3.4 M

Construct approximately 5 miles of new double circuit 138 kV line in order to loop the new Kewanee station into the existing Beaver Creek – Cedar Creek 138 kV circuit. (B3087.2) Estimated Cost: $ 19.9 M

Remote end work will be required at Cedar Creek Station. (B3087.3) Estimated Cost: $ 0.5 M

Total Estimated Transmission Cost: $23.8M

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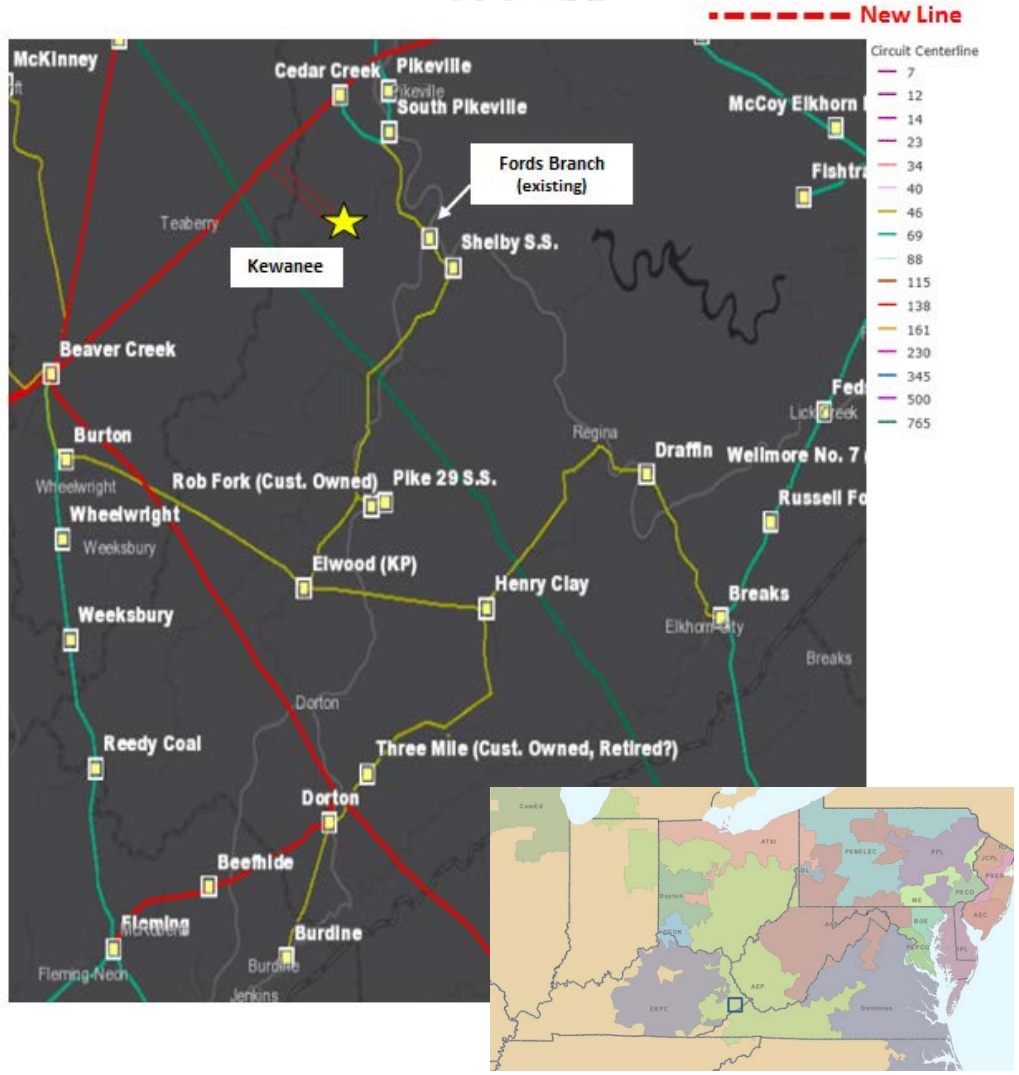

AEP Transmission Zone: Baseline
Enterprise Park Economic and Area Improvements

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Alternate #1

Rebuild the overloaded 46 kV circuit sections (~45 miles). Replace the overloaded Beaver Creek 138/69/46 kV and Breaks 69/46 kV transformers. While this may resolve the identified thermal overloads. This alternative may not solve the identified voltage violations. This alternative would also not address the additional system needs specified in the Project Justification.

This alternative was deemed to not be cost effective.

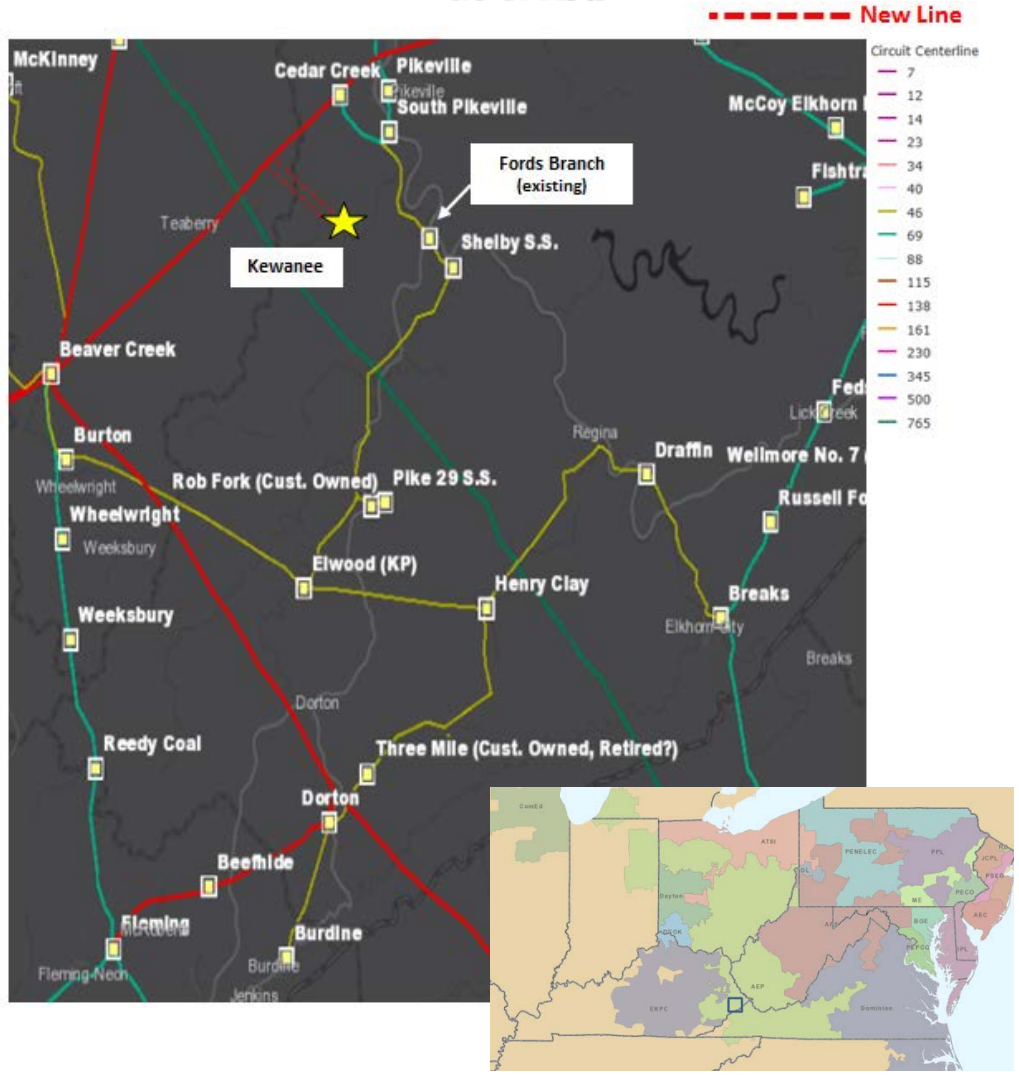
Alternate #2

Install two additional transformers at Cedar Creek station. This would require an expansion at Cedar Creek station. Construct approximately 5 miles of new double circuit 46 kV line from Cedar Creek to Fords Branch Stations. This would require a significant expansion of Fords Branch station which is not feasible due to the land locked nature of that station being surrounded by residences, mountains, and the flood plain. Because of this, Fords Branch would need to be relocated and constructed as a greenfield station, likely at the Enterprise Industrial Park due to lack of suitable sites nearby. The relocation would require an additional 2 miles of double circuit and single circuit 46 kV line to be constructed to connect the station to the existing 46 kV circuits that currently terminate at Fords Branch. 46 kV circuit breakers would be required at the new Fords Branch station.
Estimated Cost: ~$35M

Required In-service: 12/1/2019

Projected In-service: 11/30/2019

Project Status: Scoping



Sub Regional RTEP Committee
PJM West

October 25, 2019

Project Updates

Baseline Reliability Projects

AEP Transmission Zone: Baseline
Pike County, KY

Previously presented: 11/29/2018 SRRTEP
Criteria: Planning Criteria Violation
Assumption Reference: FERC 715
Model Used for Analysis: 2023 Winter RTEP
Proposal Window Exclusion: FERC 715 (TO Criteria)

Problem Statement:
Planning Criteria Violations:

In 2023 RTEP winter case:
For the loss of the Cedar Creek – Fords Branch 46 kV line section or Cedar Creek 138/69/46 kV transformer:
-Voltage Magnitude issues are experienced at Fords Branch (.88pu) station.

For the loss of the Cedar Creek 138/69/46 kV transformer and Beaver Creek – Elwood 46 kV circuit:
-The Dorton 138/46 kV transformer will load to 103% of its winter emergency rating (65 MVA, capabilities study pending)
-The Breaks 69/46 kV transformer will load to 104% of its winter emergency rating (50 MVA, capabilities study pending).
-The Henry Clay – Elwood 46 kV line section (~5.8 mi.) loads to 125% of its conductor's winter emergency rating (63 MVA).
-The Pike 29 S.S – Elwood 46 kV line section (~2.8 mi.) loads to 95% of its conductor's winter emergency rating (61 MVA).
-Voltage Magnitude issues are experienced at Fords Branch(.57 pu), Pike29 (.66 pu), Henry Clay (.80 pu), Draffin (.89 pu.), Burdine (.91pu), and Elwood (.71pu) stations.
-Voltage Deviation issues are experienced at Fords Branch(33%), Pike29 (29%), Elwood (27%), Henry Clay (19%), Burdine (11%), and Draffin(12%) stations.

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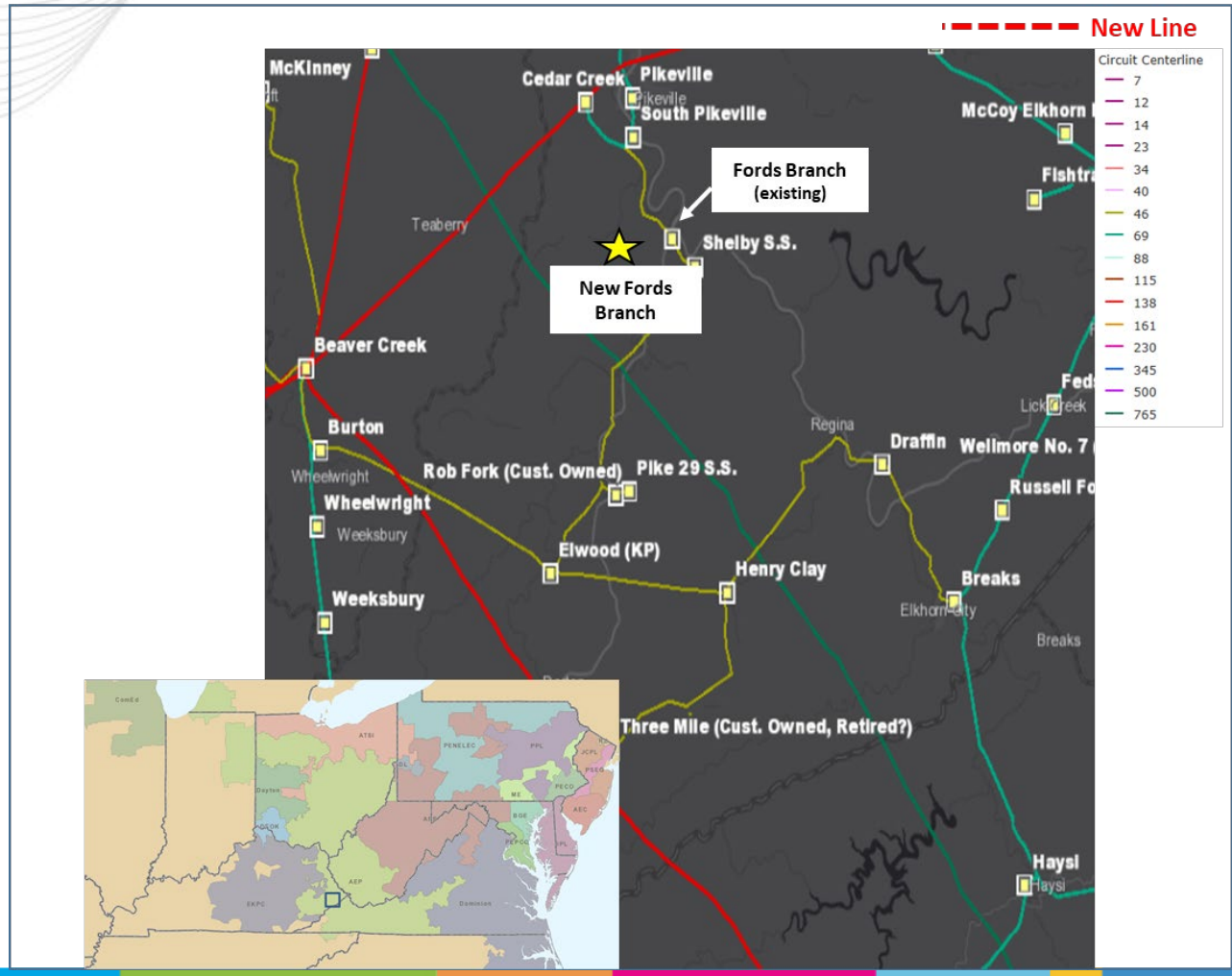

AEP Transmission Zone: Baseline
Pike County, KY

Continued from previous slide…

Planning Criteria Violations:

For the loss of the Cedar Creek 138/69/46 kV transformer and Dorton – 138/46 kV transformer:
-The Burton – Elwood 46 kV line section (~8.3 mi.) loads to 98 % of its winter emergency rating (55 MVA), Voltage Magnitude issues are experienced at Fords Branch(.80pu), Pike29 (.86pu), Henry Clay (.90pu), Burdine (.89pu), and Elwood (.89pu) stations.
-Voltage Deviation issues are experienced at Fords Branch(9%), Pike29 (8% 18%), Elwood (8%), Henry Clay (9%), and Burdine (12%) stations.

For the loss of the Cedar Creek 138/69/46 kV transformer and Dorton – Elwood – Breaks 46 kV circuit:
-The Burton – Elwood 46 kV line section (~8.3 mi.) loads to ~~113%~~ 130% of its ~~conductor's~~ winter emergency rating (~~63 MVA~~ 55MVA).
-The Burton – Beaver Creek 46 kV line section (~2.2 mi.) loads to 119 % of its conductor's winter emergency rating (63 MVA).
-The Beaver Creek 138/69/46 kV transformer #1 will load to 103% of its winter emergency rating (58 MVA) .
-Voltage Magnitude issues are experienced at Fords Branch(.67pu),Pike29 (.75pu), and Elwood (.79pu) stations.
-Voltage Deviation issues are experienced at Fords Branch(25%), Pike29 (21%), Elwood (19%), and Burton (9%) stations.

For loss of the Dorton 138/46 kV and Breaks 69/46 kV transformers:
- Voltage magnitude issues are experienced at Henry Clay (0.89pu), Draffin (0.88pu) and Burdine (0.87) stations.
- Voltage Deviation issues are experienced at Henry Clay (8%), Draffin (%10) and Burdine (9%) stations.

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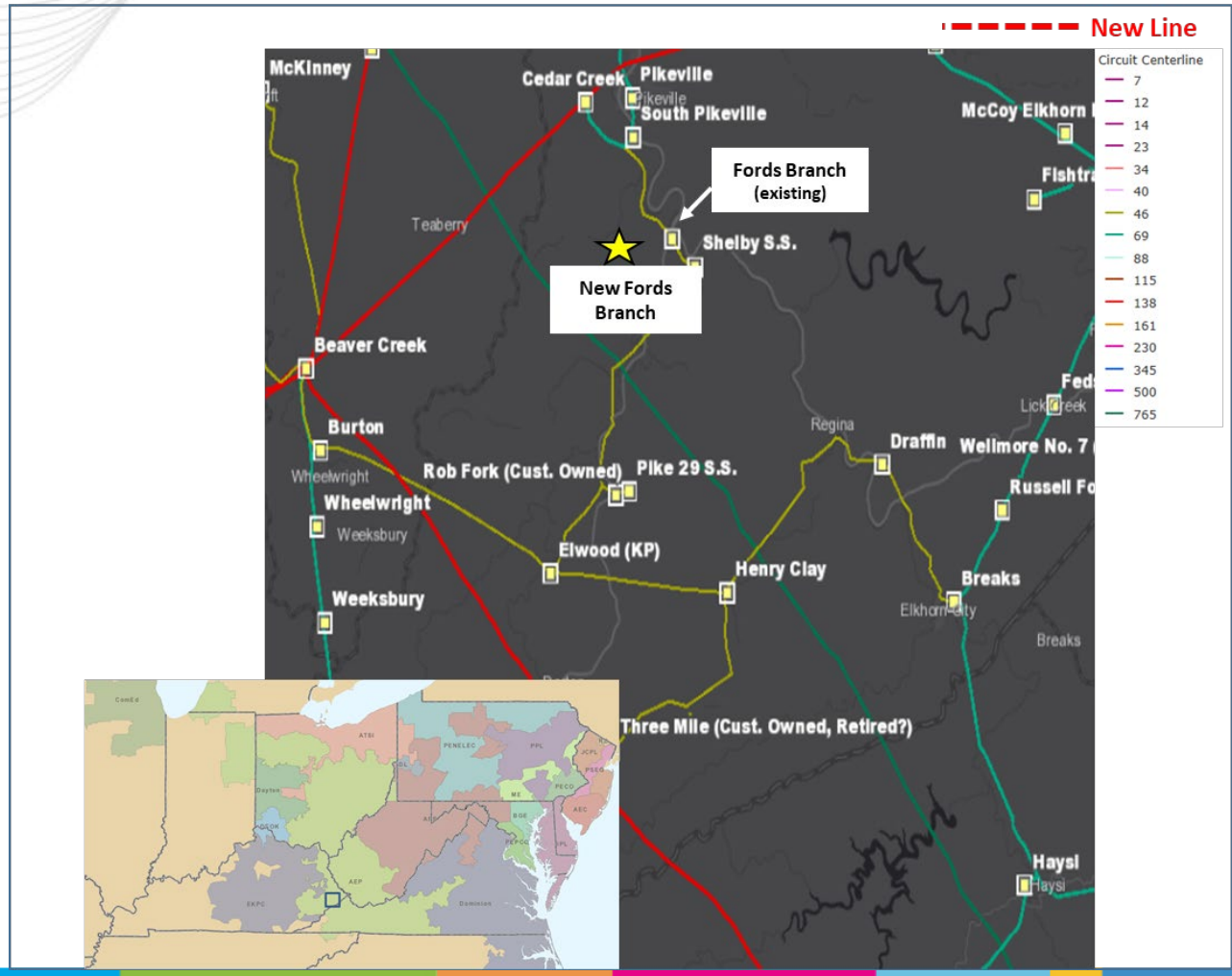

AEP Transmission Zone: Baseline
Pike County, KY

Customer Service:

~~Kentucky Power Distribution has requested an additional 40 MW of capacity to serve distribution customers at the Kentucky Enterprise Industrial Park, Projected IS date: 12/1/2019~~

Planning Criteria Violations with the additional 40MW load:

~~Base Case voltage violation (.89pu) at Fords Branch~~

~~For the loss of the Cedar Creek – Fords Branch 46 kV line section or Cedar Creek 138/69/46 kV transformer:~~

~~-The Elwood 46 kV network becomes non convergent due to a voltage collapse.~~

~~For the loss of the Henry Clay – Elwood 46 kV line section:~~

~~-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 103% of its conductor's winter emergency rating (61 MVA)~~

~~-Voltage Magnitude issues are experienced at Fords Branch(.87pu),Pike29 (.90pu), and Elwood (.91pu) stations.~~

~~A bus outage at Elwood Station results in:~~

~~-The Cedar Creek - Fords Branch 46 kV line section (~4.9 mi.) will load to 139% of its largest conductor's winter emergency rating (84 MVA).~~

~~-The Cedar Creek 138/69/46 kV transformer will load to 146% of its 46 windings winter emergency rating (80 MVA)~~

~~-Voltage Magnitude issues are experienced at Fords Branch(.66pu) and Pike29 (.63pu) stations.~~

~~-Voltage Magnitude issues are experienced at Fords Branch(.30%) and Pike29 (37%) stations.~~

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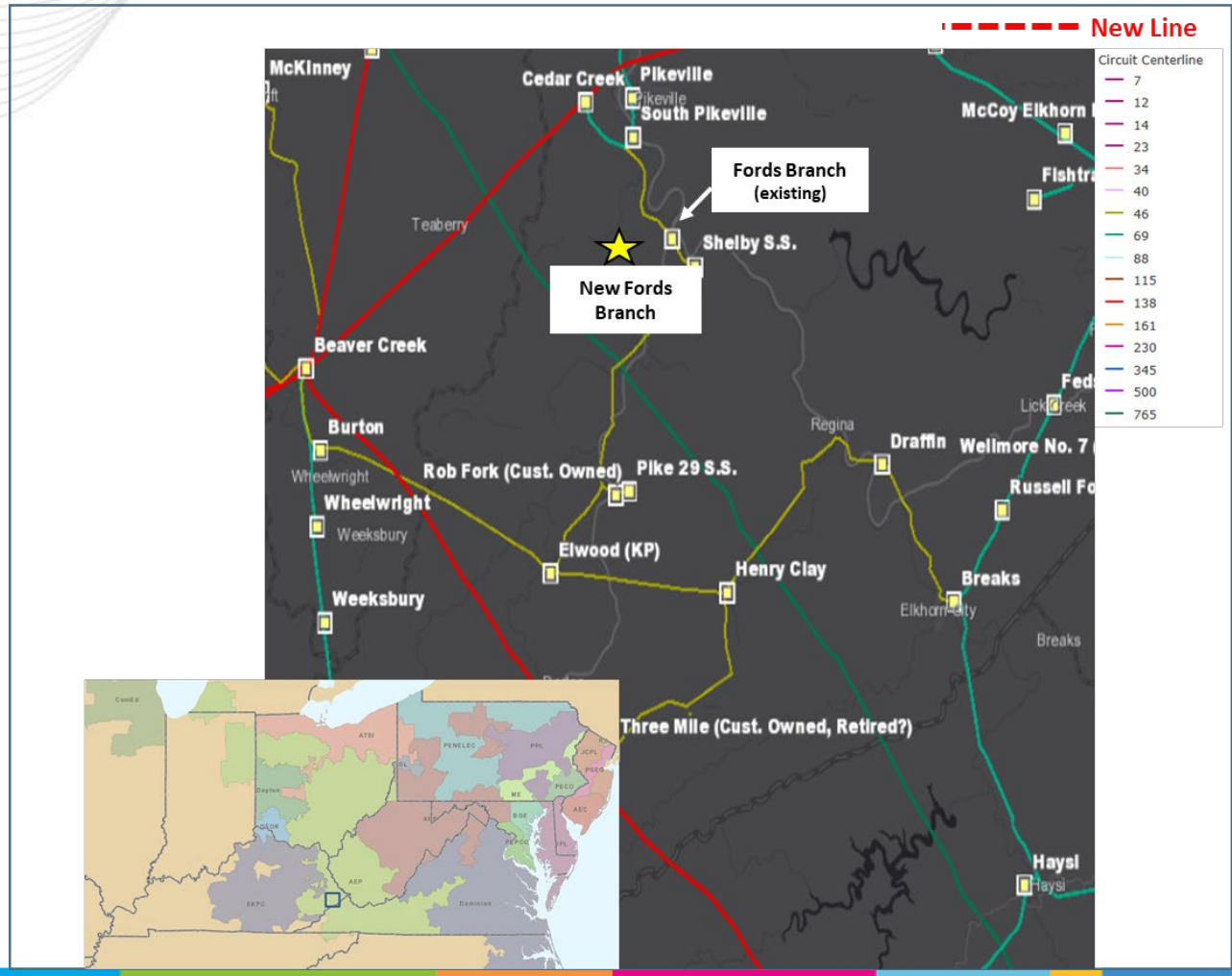

AEP Transmission Zone: Baseline
Pike County, KY

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Planning Criteria Violations with the additional 40MW load:

For the loss of the Beaver Creek – Burton 46 kV line section:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 109% of its conductor's winter emergency rating (61 MVA)
-Voltage Magnitude issues are experienced at Fords Branch(.88pu) and Pike29 (.91pu) stations.

For the loss of the Beaver Creek – Elwood 46 kV line circuit:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 105% of its conductor's winter emergency rating (61 MVA)
-Voltage Magnitude issues are experienced at Fords Branch(.89pu) station

For the loss of the Dorton 138/46 kV transformer:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 100% of its conductor's winter emergency rating (61 MVA)
-Voltage Magnitude issues are experienced at Fords Branch(.88pu) and Pike29 (.91pu) stations.

For the loss of the Breaks 69/46 kV transformer:
-Voltage Magnitude issues are experienced at Fords Branch(.89pu) station.

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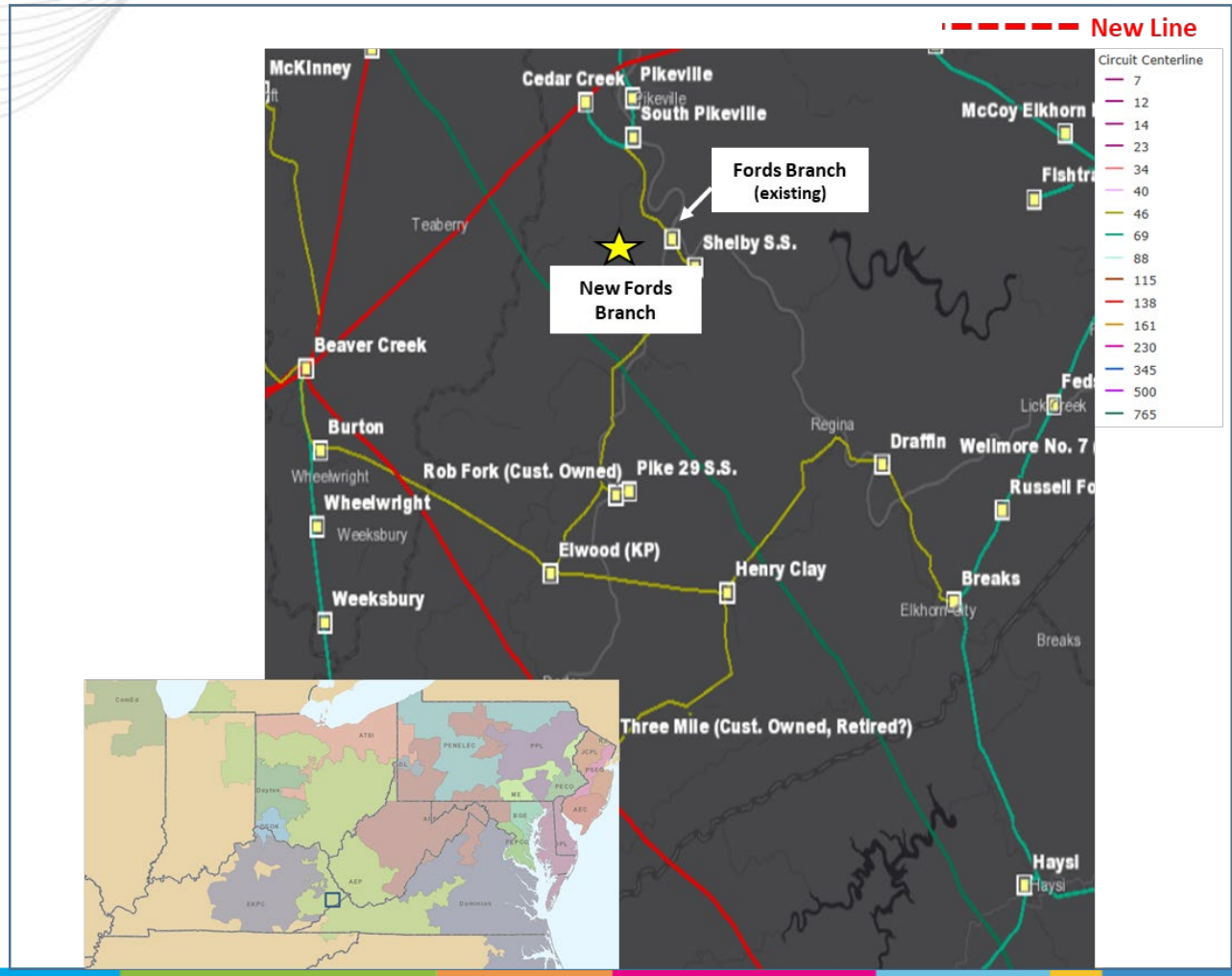

AEP Transmission Zone: Baseline
Pike County, KY

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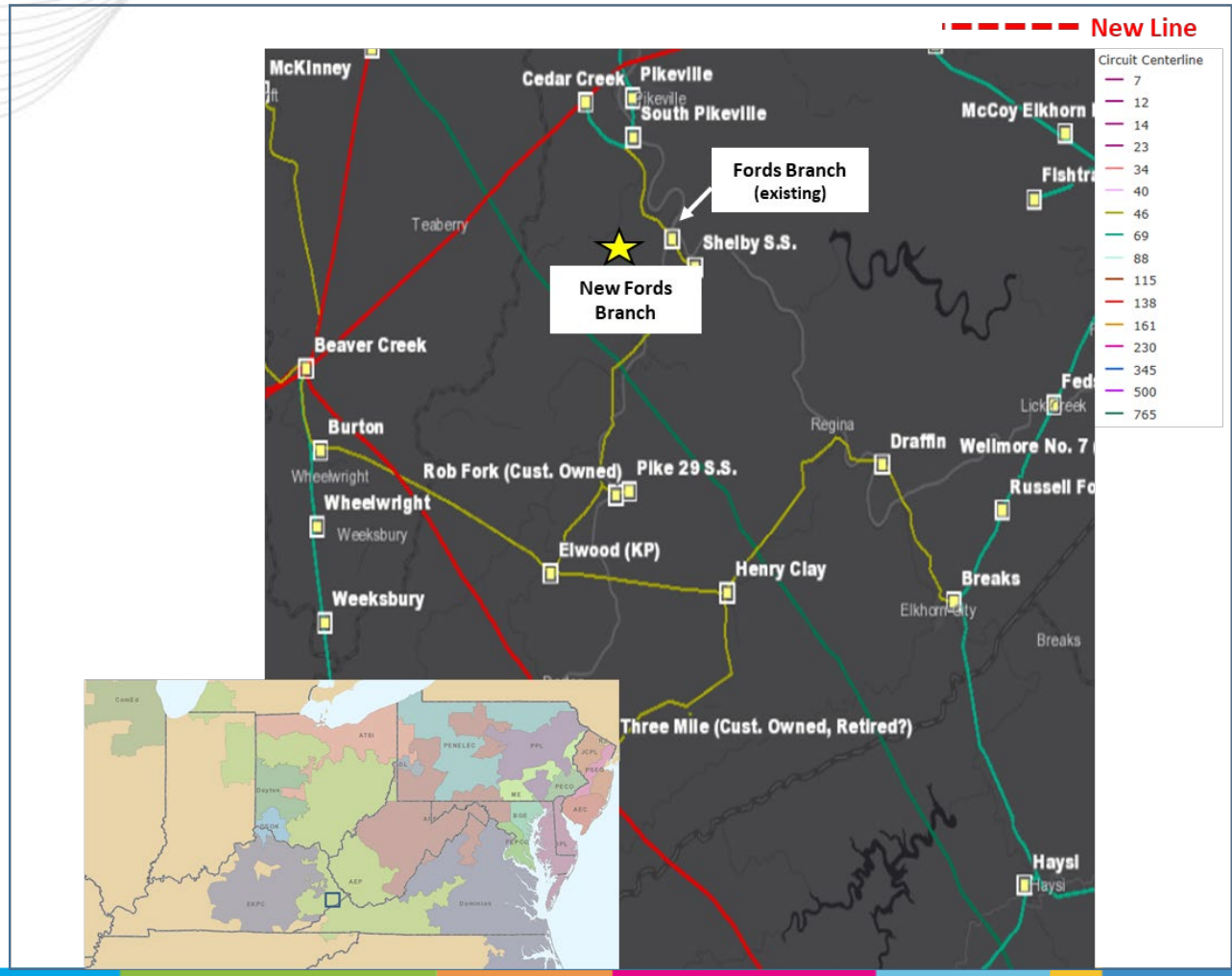
Planning Criteria Violations with the additional 40MW load:

For loss of the Beaver Creek – Elwood 46 kV circuit and Dorton 138/46 kV transformer:
-The Cedar Creek - Fords Branch 46 kV line section (~4.9 mi.) will load to 115% of its largest conductor's winter emergency rating (84 MVA).
-The Cedar Creek 138/69/46 kV transformer will load to 121% of the transformer's 46 kV windings winter emergency rating (80 MVA).
-The Breaks 69/46 kV transformer will load to 134% of the transformers winter emergency rating (50 MVA).
-The Breaks – Draffin 46 kV line section (~4.5 mi.) will load to 102% of its conductor's winter emergency rating (63 MVA).
-The Draffin – Henry Clay 46 kV line section (~7.33 mi.) will load to 105% (92% of its conductor's winter emergency rating (63 MVA)) (55 MVA).
-Voltage magnitude issues are experienced at Fords Branch(.77pu), Pike29 (.77pu), Elwood (.78pu), Henry Clay (.80pu), Draffin (.88pu), and Burdine (.78pu) stations.
-Voltage Deviation issues are experienced at Fords Branch (15%), Pike29 (17%), Elwood (18%), Henry Clay (20%), Draffin (14%), and Burdine (25%) stations.

For loss of the Beaver Creek – Elwood 46 kV circuit and Breaks 69/46 kV transformer:
-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 141% of its conductor's winter emergency rating (61MVA) and 102% of the line's largest conductor winter emergency rating (84 MVA).
-The Cedar Creek 138/69/46 kV transformer will load to 107% of the transformer's 46 kV windings winter emergency rating (80 MVA).
-A portion of the Dorton – Henry Clay 46 kV circuit (~6 mi.) will load to 98% of its conductor's winter emergency rating (63 MVA).
-The Dorton 138/46 kV transformer will load to 110% of its winter emergency rating (65 MVA, capabilities study pending) .
-Voltage magnitude issues are experienced at Fords Branch(.79pu), Pike29 (.80pu), Elwood (.82pu), Henry Clay (.84pu), and Draffin (.83pu) stations.
-Voltage Deviation issues are experienced at Fords Branch (8%), Pike29 (11%), Elwood (11%), Henry Clay (11%),and Draffin (15%) stations.



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AEP Transmission Zone: Baseline
Pike County, KY

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~~Planning Criteria Violations with the additional 40MW load:~~

~~For loss of the Dorton 138/46 kV and Breaks 69/46 kV transformers:~~
~~-The Cedar Creek - Fords Branch 46 kV line section (~4.9 mi.) will load to 100% of its largest conductor's winter emergency rating (84 MVA).~~
~~-The Cedar Creek 138/69/46 kV transformer will load to 105% of the transformer's 46 kV windings winter emergency rating (80 MVA).~~
~~-The Beaver Creek – Burton 46 kV line section (~2.2 mi.) will load to 125% of its conductor's winter emergency rating (63 MVA).~~
~~-The Burton – Elwood 46 kV line section (~8.25 mi.) will load to 120% of its conductor's winter emergency rating (63 MVA).~~
~~-The Beaver Creek 138/69/46 kV transformer #1 will load to 105% of its winter emergency rating (58 MVA) .~~
~~-Voltage magnitude issues are experienced at Fords Branch(.79pu), Pike29 (.80pu), Elwood (.81pu), Henry Clay (.77pu), Draffin (.76pu), and Burdine (.75pu) stations.~~
~~-Voltage Deviation issues are experienced at Fords Branch (13%), Pike29 (16%), Elwood (17%), Henry Clay (22%), Burdine (23%), Burton (9%), and Draffin (27%) stations.~~

~~For loss of the Beaver 138/69/46 kV transformer #2 and Dorton 138/46 kV transformer:~~
~~-The Beaver Creek 138/69/46 kV transformer #1 will load to 104% of its winter emergency rating (58 MVA) .~~
~~-A portion of the Cedar Creek - Fords Branch 46 kV line section (~3 mi.) will load to 104% of its conductor's winter emergency rating (61MVA)~~
~~-Voltage magnitude issues are experienced at Fords Branch(.87pu), Pike29 (.90pu), and Burdine (.91pu) stations.~~
~~-Voltage Deviation issues are experienced at Burdine (9%) station.~~

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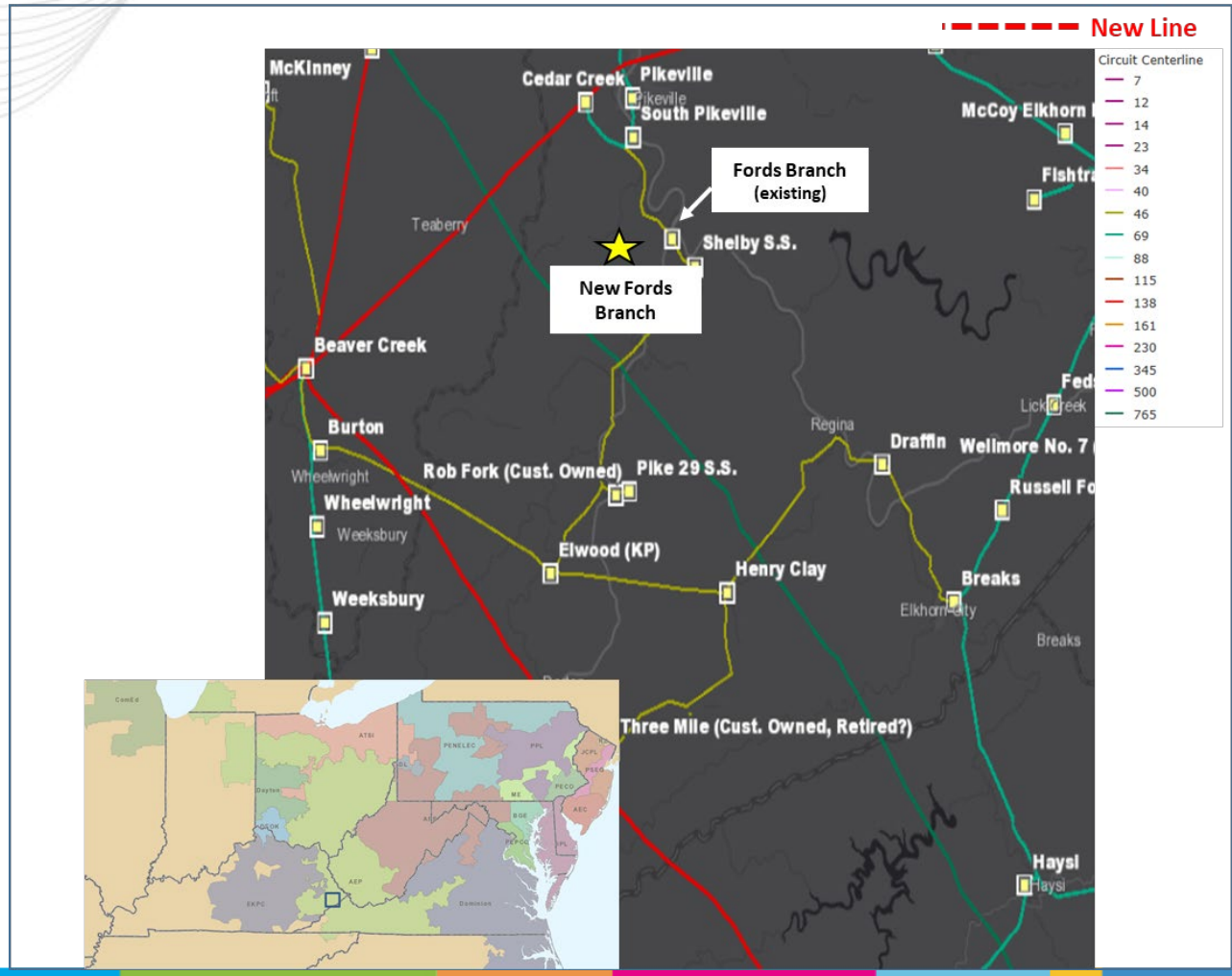

AEP Transmission Zone: Baseline
Pike County, KY

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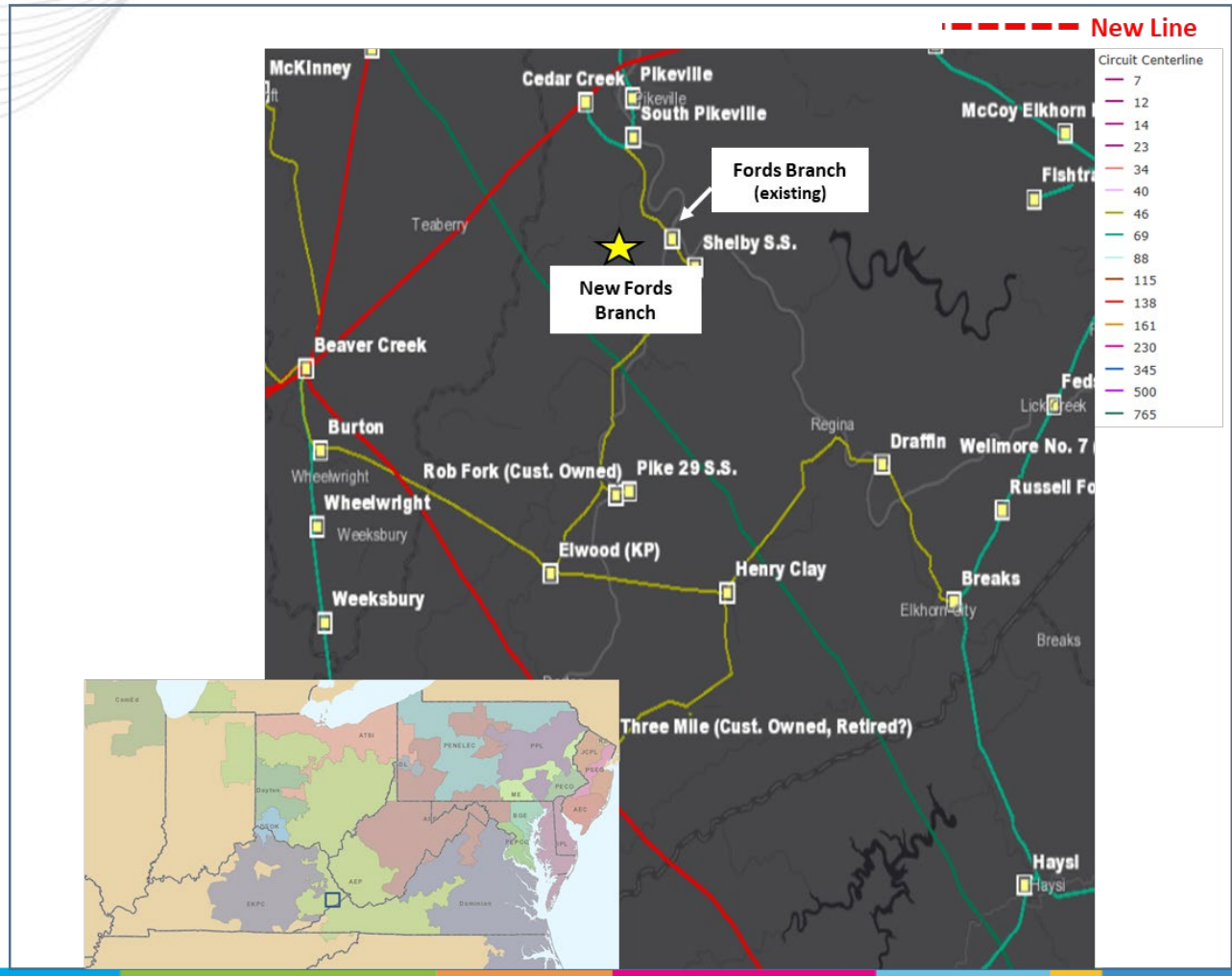
Equipment Material/Condition/Performance/Risk:

- The 46/34.5 kV transformer (vintage 1992) at Fords Branch Station is showing signs of dielectric breakdown (insulation), accessory damage (bushings/windings) and short circuit breakdown (due to amount of through faults).
- The wood pole Phase over Phase switch that currently serves Fords is inoperable and in need of replacement.
- The 34.5 kV circuit breakers "A" & "B" at Fords Branch are ESV type breakers manufactured in 1992, which are an oil type breaker that are being replaced across the AEP footprint due to their history of violent failures. In addition, breakers "A" & "B" have experienced 262 and 333 fault operations, exceeding the manufacturer recommendation of 10.
- The existing station equipment restricts adequate access within the station for normal maintenance activity due to small station footprint, increasing safety risks.
- The small county road needed to access the site has limited room to maneuver a mobile transformer. A mobile must be backed in from highway approximately 0.25mile up county road.

Operational Flexibility and Efficiency

The 46/34.5 kV transformer at Fords Branch Station utilizes a ground switch MOAB scheme as part of the high side transformer protection. ~~The proposed 138/12 kV transformer at Kewanee station will allow for load to be transferred away from the existing Betsy Layne – Cedar Creek 69 kV circuit which has historical seen flows close to its 91 MVA conductor winter emergency rating~~



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AEP Transmission Zone: Baseline
Pike County, KY

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Selected Solution

Construct a new greenfield station to the west (~1.5 mi.) of the existing Fords Branch Station, potentially in/near the new Kentucky Enterprise Industrial Park. ~~This station will consist of six 3000A 40kA 138 kV breakers laid out in a ring arrangement, two 30 MVA 138/34.5 kV transformers, and two 30 MVA 138/12 kV transformers.~~ This new station will consist of 4 -138 kV breaker ring bus and two 30 MVA 138/34.5 kV transformers. The existing Fords Branch Station will be retired. (**B3087.1**) **Estimated Cost: ~~$3.4 M~~ $2.8 M**

Construct approximately 5 miles of new double circuit 138 kV line in order to loop the ~~new Kewanee station~~ New Fords Branch station into the existing Beaver Creek – Cedar Creek 138 kV circuit. (**B3087.2**)
Estimated Cost: $ 19.9 M

Remote end work will be required at Cedar Creek Station. (**B3087.3**)
Estimated Cost: $ 0.5 M

Total Estimated Transmission Cost: ~~$23.8M~~ $23.2 M

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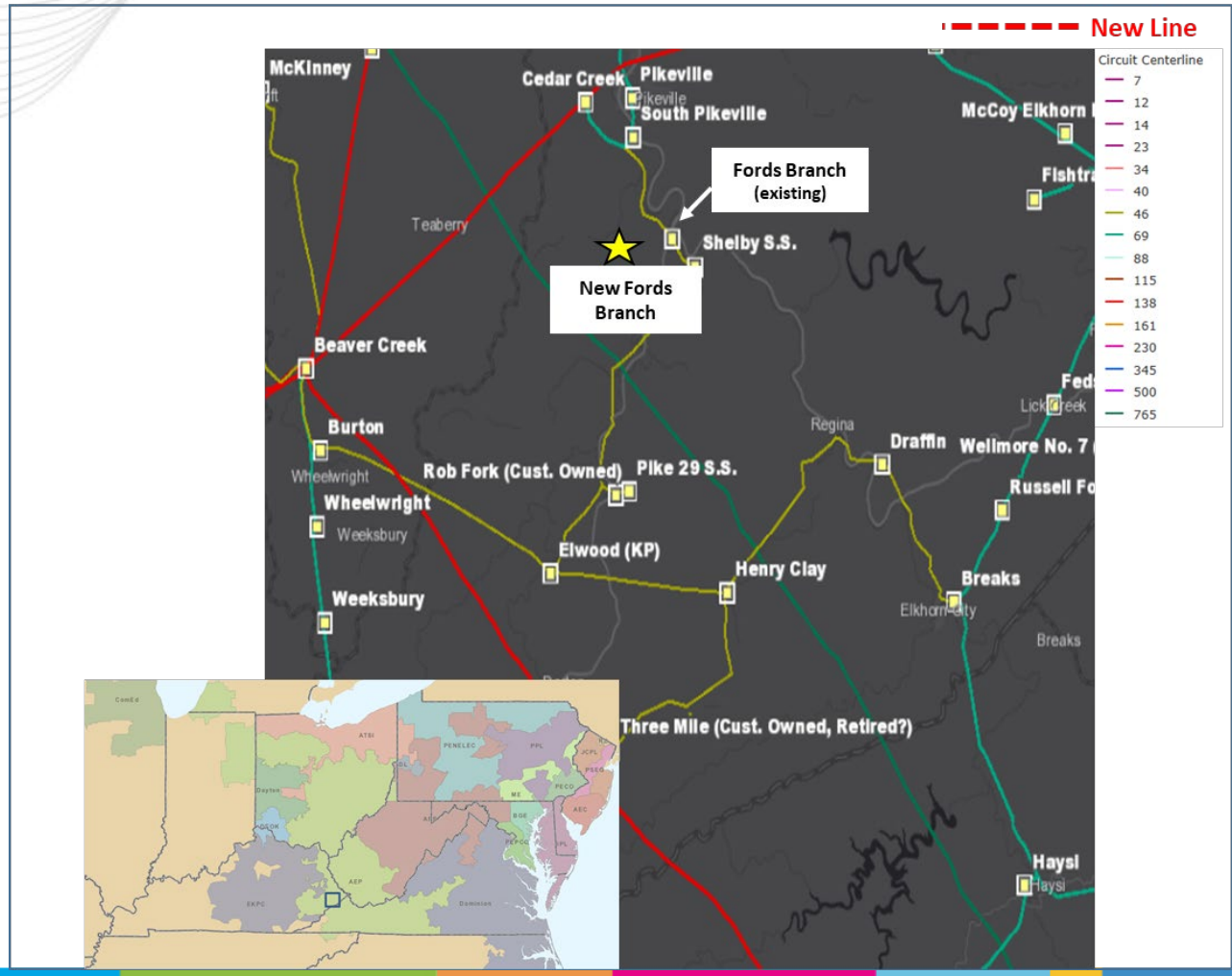

AEP Transmission Zone: Baseline
Pike County, KY

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Alternate #1

Rebuild the overloaded 46 kV circuit sections: Burton – Beaver Creek, Burton – Elwood and Henry Clay – Elwood ~~(~45 miles~~ **~16.3 miles**). Replace the overloaded Beaver Creek 138/69/46 kV and Breaks 69/46 kV transformers. Install ~~total 28.8MVAR~~ an additional 14.4 MVAR cap bank at the Elwood substation (14.4MVAR existing). While this will resolve the identified thermal overloads and ~~this alternative not solve~~ the identified voltage violations, it will create voltage rise issues with an additional cap bank at the Elwood substation due to low short circuit strength on the 46 kV system. Installation of the additional cap bank also increases operational complexity as the new cap bank on the same 46kV bus at Elwood would be switched post contingency whereas the existing 14.4MVAR cap bank is switched normally. There are also existing cap banks at Henry Clay and Fords Branch stations. Coordinating the settings and voltage set points on multiple cap banks in a small area could potentially result in hunting. This alternative would also not address the additional system needs at Fords Branch specified in the Project Justification. **Estimated Cost:** $52 M

~~**This alternative was deemed to not be cost effective.**~~

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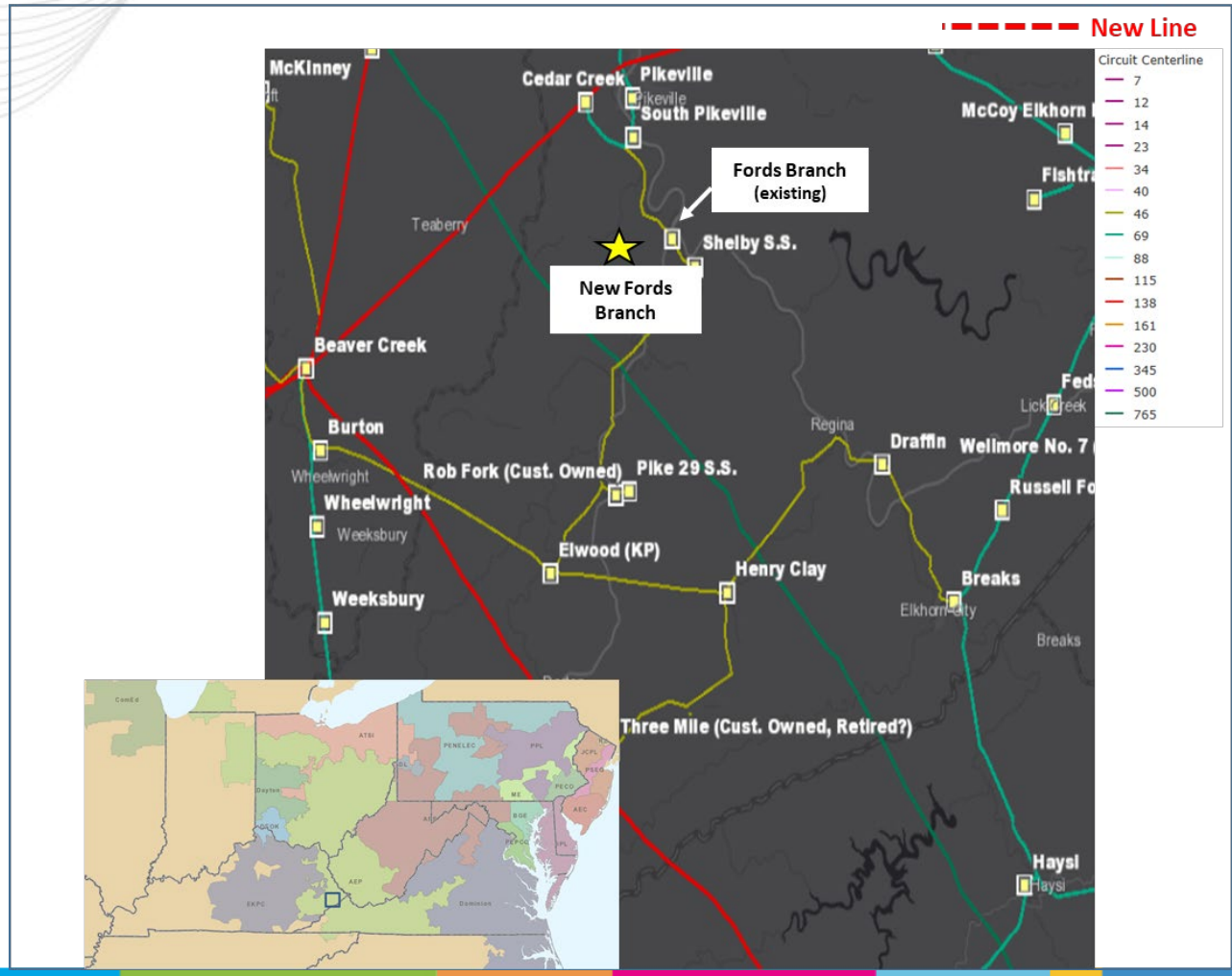

AEP Transmission Zone: Baseline
Pike County, KY

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~~Alternate #2~~

~~Install two additional transformers at Cedar Creek station. This would require an expansion at Cedar Creek station. Construct approximately 5 miles of new double circuit 46 kV line from Cedar Creek to Fords Branch Stations. This would require a significant expansion of Fords Branch station which is not feasible due to the land locked nature of that station being surrounded by residences, mountains, and the flood plain. Because of this, Fords Branch would need to be relocated and constructed as a greenfield station, likely at the Enterprise Industrial Park due to lack of suitable sites nearby. The relocation would require an additional 2 miles of double circuit and single circuit 46 kV line to be constructed to connect the station to the existing 46 kV circuits that currently terminate at Fords Branch. 46 kV circuit breakers would be required at the new Fords Branch station. Estimated Cost: ~$35M~~

Alternate #3

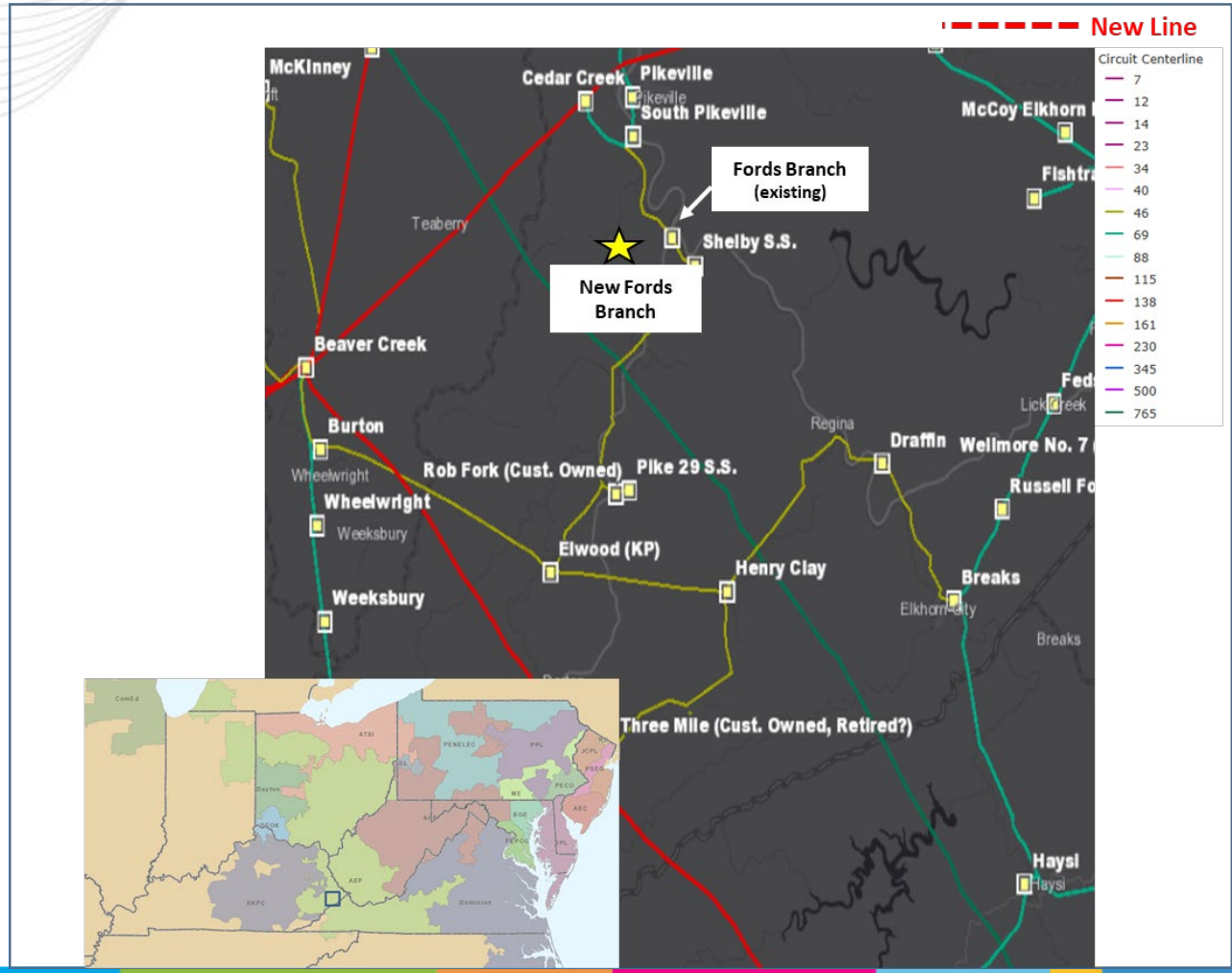
Install a redundant 138/46kV transformer at Cedar Creek station. Reconfigure the existing 138kV bus into a 5 breaker ring bus, Install three new 138kV breakers and install two new 46kV breakers. This would require an expansion and significant station work at Cedar Creek station. Install and additional 14.4 MVAR capacitor bank (14.4 MVAR Existing) at Elwood substation. While this will resolve the low voltage and voltage deviation issues, this alternative will not address voltage rise issue caused by the additional cap bank at the Elwood station. This alternative does not support any future needs at Enterprise Industrial Park. Also, this alternative does not address the additional system needs specified in the Project Justification at Fords Branch and limits the ability to add additional sectionalizing to improve service for the customers served out of the station in the future. The existing station is land locked, surrounded by residences, mountains, and a flood plain. Because of this, Fords Branch would need to be relocated and built in the clear to address the supplemental need, along with new 46 kV line to connect to the new station site. There are also supplemental needs identified on the Cedar Creek – Elwood 46kV circuit, which were presented in the August 2019 SRTEP meeting, need number AEP-2019-AP032. A solution has not been reviewed for this need yet. However, in order to continue to serve Fords Branch at 46 kV, this line would need to be rebuilt at an additional cost of approximately $55M. The selected baseline solution allows AEP to potentially retire the 46 kV line in the future.

Estimated Cost: $70M

Required In-service: ~~12/1/2019~~12/1/2023

Projected In-service: ~~11/30/2019~~09/31/2022

Project Status: Scoping



Sub Regional RTEP Committee
PJM West

April 20, 2020

Project Update

AEP Transmission Zone: Baseline
Pike County, KY

Additional Scope for Project B3087
Criteria: FERC 715 Planning Criteria Violation
Model Used for Analysis: 2023 Winter RTEP

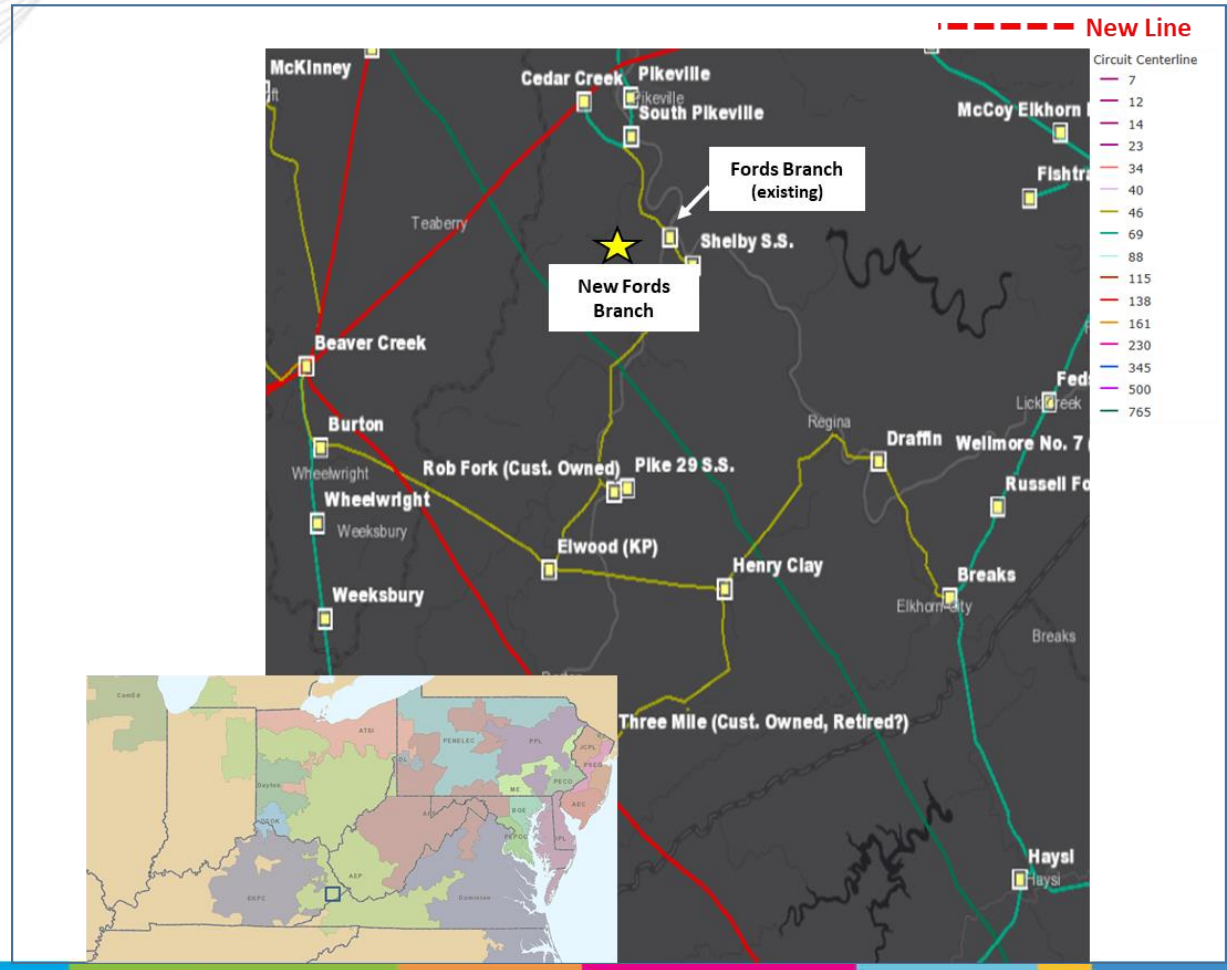
Existing Scope: (Presented: 11/29/2018, 10/25/2019 SRRTEP):
Construct a new greenfield station to the west (~1.5 mi.) of the existing Fords Branch Station, potentially in/near the new Kentucky Enterprise Industrial Park. This new station will consist of 4 -138 kV breaker ring bus and two 30 MVA 138/34.5 kV transformers. The existing Fords Branch Station will be retired. (**B3087.1**)
Estimated Cost: $2.8 M
Construct approximately 5 miles of new double circuit 138 kV line in order to loop the New Fords Branch station into the existing Beaver Creek – Cedar Creek 138 kV circuit. (**B3087.2**) **Estimated Cost: $19.9 M**
Remote end work will be required at Cedar Creek Station. (**B3087.3**) **Estimated Cost: $ 0.5 M**

Additional Scope: Install a 28.8MVar switching shunt at the new Fords Branch substation (**B3087.4**)
Estimated Cost: $ 0.5 M

Reason for the additional scope:

- For the N-1-1 Loss of Beaver Creek Transformer #1 and the loss of Cedar Creek – Johns Creek 138kV line, voltage magnitude violations are identified at New Fords Branch substation (0.90 pu), Cedar Creek 138kV (0.90 pu).
- For the N-1-1 Loss of Beaver Creek – Kewanee (New Fords Branch) 138kV and Cedar Creek – Johns Creek 138kV line, voltage magnitude violations issues are identified at the new Fords Branch substation (0.87 pu), Cedar Creek 138kV (0.87pu), Cedar Creek 69kV (0.90 pu).

Required In-service: 12/1/2023
Projected In-service: 09/31/2022
Project Status: Scoping



Questions?

Revision History

- V1 – 4/13/2020 – Original slides posted

Transmission Expansion Advisory Committee (TEAC) Recommendations to the PJM Board

PJM Staff White Paper

PJM Interconnection

July 2020

For Public Use

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Contents

I. Executive Summary

On April 20, 2020, the PJM Board of Managers approved changes to the Regional Transmission Expansion Plan (RTEP), totaling $64.55 million, primarily to resolve baseline reliability criteria violations.

Since then, PJM has identified additional baseline reliability criteria violations and the transmission system enhancements needed to solve them, at an estimated cost of $58.72 million. Scope changes to existing projects will result in a net increase of $58.18 million, and project cancellations will result in a decrease of $3.85 million. This yields an overall RTEP net increase of $113.05 million, for which PJM recommended Board approval. With these changes, RTEP projects will total $38,348.74 million since the first Board approvals in 2000.

PJM sought Reliability and Security Committee consideration and full Board approval of the additional RTEP baseline projects summarized in this white paper. On July 28, 2020, the Board approved the addition of RTEP baseline projects as well as other changes to the RTEP as summarized in this paper.

II. Baseline Reliability Recommendations

A key dimension of PJM's RTEP process is baseline reliability evaluation, necessary before subsequent interconnection requests can be analyzed. Baseline analysis identifies system violations to reliability criteria and standards. PJM then develops transmission system enhancements to solve identified violations and reviews them with stakeholders through the Transmission Expansion Advisory Committee (TEAC) and Subregional RTEP Committees prior to recommendation to the Board. Baseline reliability transmission enhancement costs are allocated to PJM load.

III. Baseline Reliability Projects Summary

A summary of baseline projects with estimated costs equal to or greater than $5 million is provided below. A complete listing of all recommended projects and their associated cost allocations is included in Attachment A (for allocation to a single zone) and Attachment B (for allocation to multiple zones). Projects with estimated costs less than $5 million typically include transformer replacements, line reconductoring, breaker replacements and upgrades to terminal equipment, including relay and wave trap replacements.

1. **Dominion Transmission Zone**
   - Install a second Chickahominy 500/230 kV transformer: $22 million
2. **APS Transmission Zone**
   - Reconductor Yukon-Smithton-Shepler Hill Jct 138 kV. Upgrade terminal equipment at Yukon 138 kV and replace line relaying at Mitchell and Charleroi 138 kV: $21.4 million
3. **DLCO Transmission Zone**
   - Reconductor the DLCO portion (4.2 miles) of Wilson-Mitchell 138 kV: $7.5 million

4. **AMPT Transmission Zone**
   - Establish a new 138/69 kV substation with one 138 kV circuit breaker, one 138/69 kV 130 MVA transformer and three 69 kV circuit breakers. Construct a 0.15 mile 138 kV 795 ACSR transmission line between Brim 138/69 kV substation (First Energy) and the newly proposed AMPT substation. Loop the Bowling Green Sub No. 5-Bowling Green Sub No. 2 69 kV line in and out of the newly established substation: $5.7 million

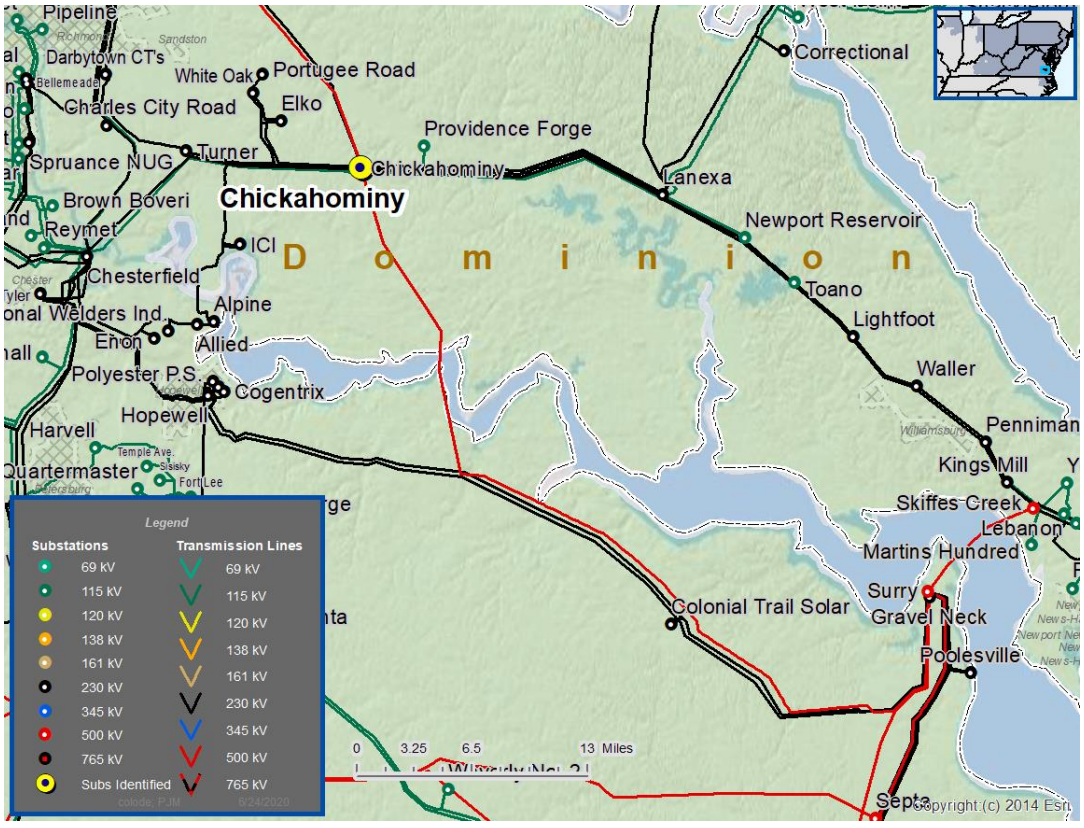
PJM also recommended projects totaling $2.12 million that include terminal equipment replacements whose individual cost estimates were less than $5 million. A more detailed description of the larger-scope projects that PJM recommended to the Board are provided below:

Baseline Project b3213: Second Chickahominy 500/230 kV Transformer

Dominion Transmission Zone

Due to the deactivation of the Chesterfield 5 and 6 units, the Chickahominy 500/230 kV transformer is overloaded for the loss of Chickahominy-Surry 500 kV circuit.

Map 1. **Chickahominy 500/230 kV Transformer**



The recommended solution is to install a second Chickahominy 500/230 kV transformer. The estimated cost for this project is $22 million, with a required and projected in-service date of June 2023. The local transmission owner, Dominion, will be designated to complete this work.

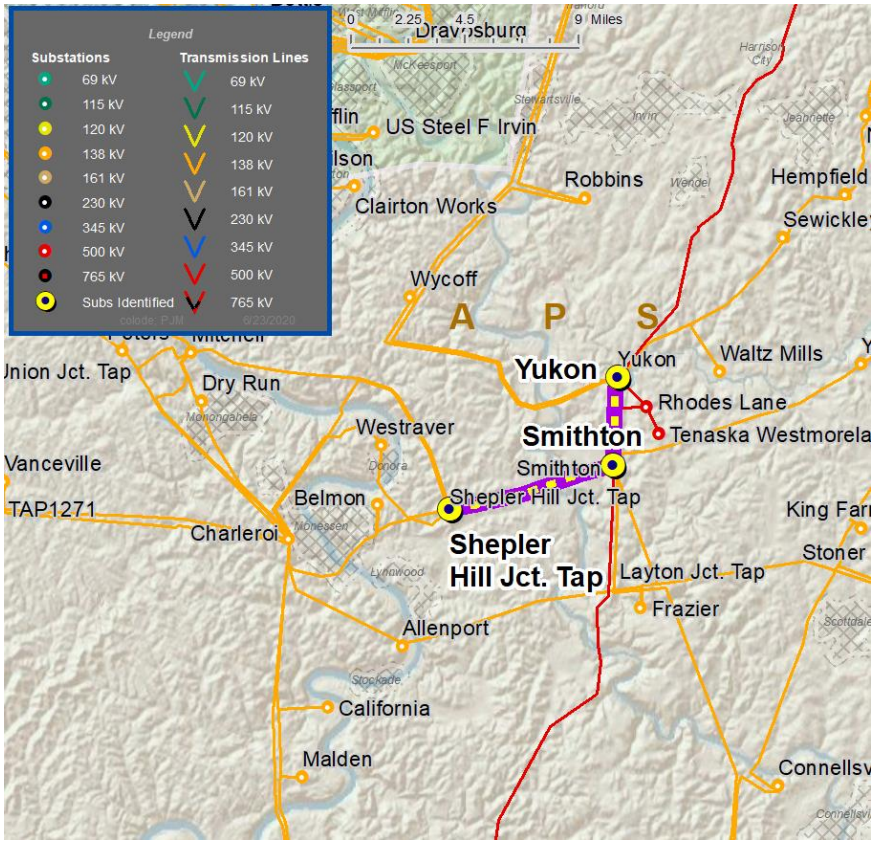
Beaver Valley Reinstatement Baselines

The Beaver Valley nuclear units, totaling 1,811 MW capacity, withdrew their deactivation request in March 2020. The reinstatement study has determined that the following scope of work is either still needed to maintain reliability or will be completed due to work progression.

APS Transmission Zone

The original project scope for baseline b2966 was previously canceled due to the scope change for baseline b3012 (driven by the Beaver Valley, Davis Besse and Perry nuclear deactivation notifications), which eliminated the need for the project. However, the Beaver Valley reinstatement study determined the scope of work is still needed to maintain reliability, and so the scope of work was reassigned to a new baseline b3214. The Yukon-Smithton and Smithton-Shepler Hill Jct 138 kV circuits are overloaded as a result of multiple tower contingencies.

Map 2. **Yukon-Smithton-Shepler Hill Jct 138 kV**

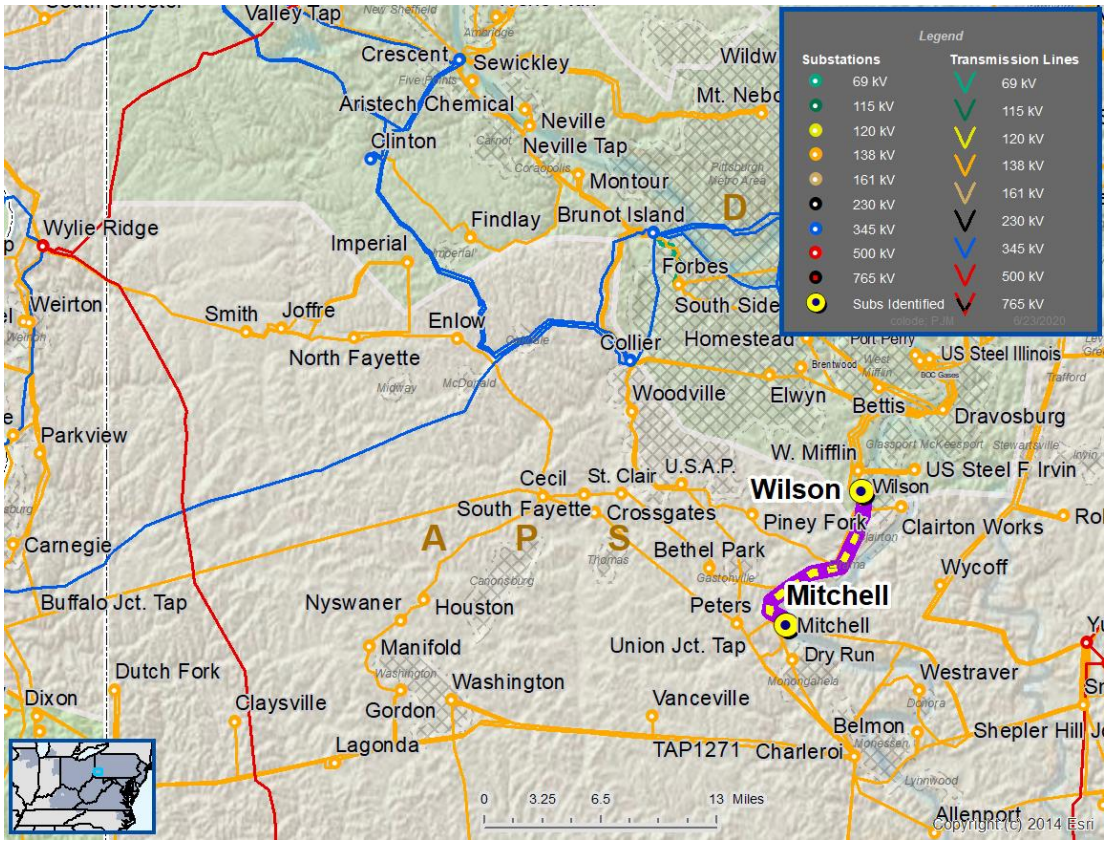


The recommended solution is to reconductor Yukon-Smithton-Shepler Hill Jct 138 kV, upgrade the terminal equipment at Yukon 138 kV, and replace line relaying at Mitchell and Charleroi 138 kV. The estimated cost for this project is $21.4 million, with a required and projected in-service date of June 2023. The local transmission owner, APS, will be designated to complete this work.

DLCO Transmission Zone

The Beaver Valley reinstatement study determined that several baseline projects will remain due to work progression, and baseline b3015.5 project scope is one such upgrade. However, due to a component of the overall upgrade no longer being required, and its potential impact on cost allocation, the baseline was reassigned to the new baseline b3217. The Wylie Ridge 500/345 kV transformer and multiple 138 kV facilities in APS and DLCO transmission zones are overloaded for various contingencies in the zones.

Map 3. **Wilson-Mitchell 138 kV**



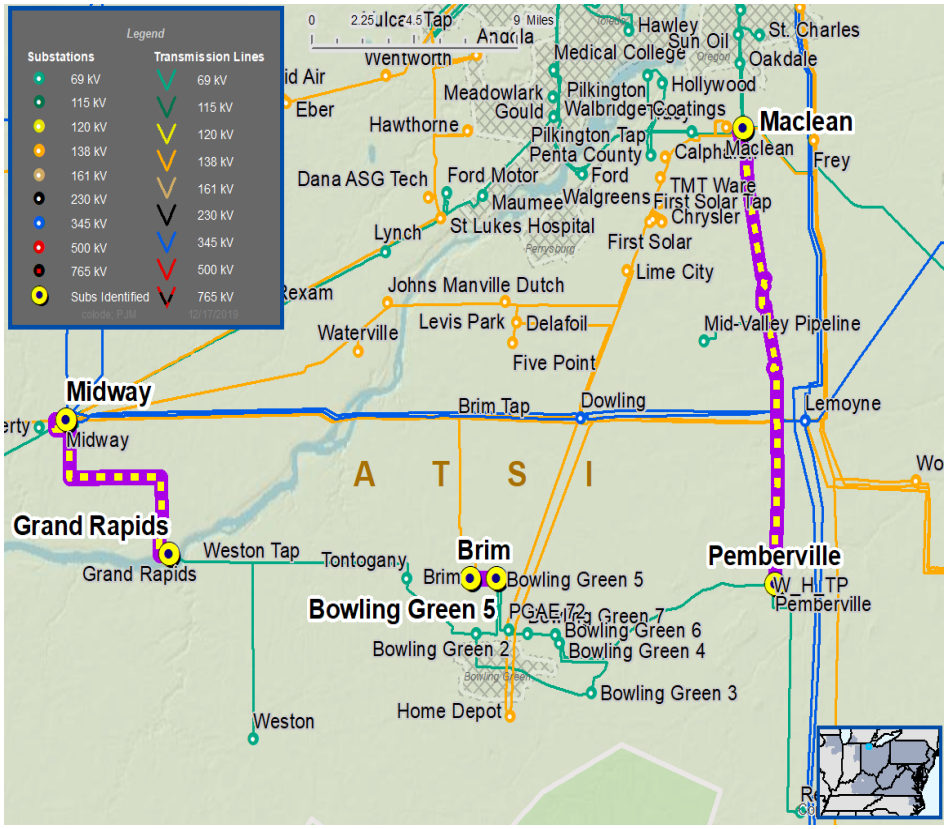
The recommended solution is to reconductor the DLCO portion (4.2 miles) of the Wilson-Mitchell 138 kV circuit. The total estimated cost for this project is $7.5 million, with a required and projected in-service date of June 2021. The local transmission owner, DLCO, will be designated to complete this work.

Baseline Project b3159: New AMPT 138/69 kV Substation in Bowling Green Area

AMPT Transmission Zone

There are multiple AMP Transmission FERC Form 715 Transmission Owner Planning Criteria thermal overloads and voltage violations on the 69 kV system in the Bowling Green and Pemberville area for the N-1-1 loss of Brim-Bowling Green substation No. 5 69 kV, combined with either the loss of the Midway-Grand Rapids or Maclean-Pemberville 69 kV.

Map 4. **Bowling Green and Pemberville Area**



The recommended solution is to establish a new 138/69 kV substation with one 138 kV circuit breaker, one 138/69 kV 130 MVA transformer, and three 69 kV circuit breakers. The project will also construct a 0.15 mile 138 kV 795 ACSR transmission line between Brim 138/69 kV substation (First Energy) and the newly proposed AMPT substation. The Bowling Green Sub No. 5-Bowling Green Sub No. 2 69 kV line will be looped in and out of the newly established substation. The total estimated cost for this project is $5.7 million, with a required and projected in-service date of June 2024. The transmission owner, AMPT, will be designated to complete this work.

IV. Transmission Owner Criteria Projects

Of the $58.72 million of the new recommended baseline transmission system enhancements, approximately $5.7 million is driven by transmission owner planning criteria (as discussed above for the b3159 AMPT project), which makes up 9.7 percent of the new project cost estimates.

V. Changes to Previously Approved Projects

PJM recommends the cancellation of the following projects:

- Baseline b3011.3 (upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #1 138 kV line) is recommended for cancellation. The Beaver Valley reinstatement study determined the scope of work is still needed, but it is being reassigned to new baseline b3215 with updated description and cost.
- Baseline b3011.4 (upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #2 138 kV line) is recommended for cancellation. The Beaver Valley reinstatement study determined the scope of work is still needed, but it is being reassigned to new baseline b3216 with updated description and cost.
- Baseline b3015.5 (reconductor Elrama-Mitchell 138 kV line, 4.2 miles of DLCO portion) is recommended for cancellation. The Beaver Valley reinstatement study determined that a portion of the scope is near completion, but it is being reassigned to new baseline b3217 with updated description and cost.

These changes yield a net RTEP decrease of $3.85 million.

PJM recommends modifying the scope/cost of the following projects:

- Baseline b3098 (rebuild 9.2 miles of Balcony Falls-Skimmer 115 kV and 3.8 miles of Balcony Falls-Cushaw 115 kV to current standards with a minimum rating of 261 MVA) requires additional scope. The additional scope is to rebuild Balcony Falls 115 kV substation and is due to Dominion's acquisition of the substation from Appalachian Power and Light (APL). The lattice structure on the property that all four lines and the cross bus terminates on was built in 1926, and visual inspection shows that the galvanizing is moderately to severely worn along large portions of the structure. There could also be space issues at the station. The additional scope has increased the total cost of the project from $20 million to $29 million. This change yields a net RTEP increase of $9 million.
- Baseline b3130 (Monmouth County 34.5 kV solution) has undergone a scope change after significant discussions with the New Jersey Board of Public Utilities. The previous scope included the conversion of approximately 44.1 miles of existing single circuit to double circuit 34.5 kV construction and 9.4 miles of additional 34.5 kV circuit to existing distribution pole lines. The revised scope converts approximately 52.4 miles of existing single circuit to double circuit 34.5 kV construction, 2.3 miles of additional 34.5 kV circuit to existing distribution pole lines, and 2.1 miles of new 34.5 underground cables. The scope change has increased the total cost of the project from $175 million to $223 million. This change yields a net RTEP increase of $48 million.

- Baseline b3087 (construct a new greenfield station to the west of the existing Fords Branch station, construct approximately 5 miles of new double circuit 138 kV line to loop in new station into the existing 138 kV circuit and remote end work at Cedar Creek station) requires additional scope. The additional scope is to install a 28.8 MVAR switching shunt capacitor at the new Fords Branch 138 kV station. Voltage magnitude violations were identified at the new Fords Branch substation and Cedar Creek substation for the N-1-1 loss of either Beaver Creek transformer #1 and Cedar Creek-Johns Creek 138 kV, or Beaver Creek-Kewanee (New Fords Branch) 138 kV and Cedar Creek-Johns Creek 138kV. The scope addition has increased the total cost of the project from $23.2 million to $23.7 million. This change yields a net RTEP increase of $0.5 million.
- Baseline b3099 (install a 138 kV 3000A 40 kA circuit switcher on the high side of the existing 138/34.5 kV transformer #5 at Holston station) requires additional scope. The additional scope is to install a 138 kV 3000A 40 kA circuit switcher for transformer #7 at Holston station. Transformer #7 serves distribution customers but is located in a transmission station, and after investigating the initial cost responsibility for the switcher installation with distribution, it was determined that the cost should be assigned to transmission. The scope addition has increased the total cost of the project from $0.7 million to $1.4 million. This change yields a net RTEP increase of $0.7 million.
- Baseline b3131 (at East Lima and Haviland 138 kV stations, replace line relays and wave trap on the East Lima-Haviland 138 kV facility) requires additional scope. The additional scope is to replace 500 MCM Cu Risers and bus conductors at Haviland 138 kV. These conductors were identified as elements with ratings between the existing ratings and the desired ratings for this facility during the course of scoping the solution. The scope addition does not impact the total cost for this project, and so the cost remains $1.5 million.
- The required in-service date for baseline b2753.9 (remove/open Kammer 345/138 kV transformer #301) has changed from May 31, 2020, to September 13, 2021. The opening of the circuit breakers to the Kammer 345/138 kV transformer #301 address the overdutied breakers at Kammer 138 kV. Due to the withdrawn queue of Y3-068, the re-study shows the breakers are overduty only after AB2-093, which has an in-service date of September 13, 2021. The cost for this project has decreased by $0.02 million.

These changes yield a net RTEP increase of $58.18 million.

VI. Review by the Transmission Expansion Advisory Committee (TEAC)

Project needs and recommended solutions as discussed in this report were reviewed with stakeholders during 2020, most recently at the June 2020 TEAC and Subregional RTEP Committee meetings. Written comments were requested to be submitted to PJM to communicate any concerns with project recommendations. No comments have been received as of this white paper publication date.

VII. Cost Allocation

Cost allocations for recommended projects are shown in Attachment A (for allocation to a single zone) and Attachment B (for allocation to multiple zones).

Cost allocations were calculated in accordance with Schedule 12 of the Open Access Transmission Tariff (OATT). Baseline reliability project allocations are calculated using a distribution factor methodology that allocates cost to the load zones that contribute to the loading on the new facility. The allocations will be filed at FERC 30 days following approval by the Board.

VIII. Board Approval

The PJM Reliability and Security Committee was requested to endorse the new baseline reliability projects and associated cost allocations, and recommend to the full Board, approval of the projects in this white paper to be included in PJM's RTEP. On July 28, 2020, the Board approved the addition of RTEP baseline projects as well as other changes to the RTEP as summarized in this paper. The RTEP will be published on PJM's website.

Attachment A – Reliability Project Single-Zone Allocations

Upgrade ID	Description	Cost Estimate ($M)	TO	Cost Responsibility	Required In-Service Date
b3087.4	Install 28.8 MVAR switching shunt at the new Fords Branch substation	$0.50	AEP	AEP	12/1/2023
b3098.1	Rebuild Balcony Falls substation	$9.00	Dominion	Dominion	6/1/2019
b3156	Replace line relaying and fault detector on the Wylie Ridge terminal at Smith 138 kV substation	$0.85	APS	APS	6/1/2024
b3157	Replace line relaying and fault detector relaying at Messick Rd. and Morgan 138 kV substations; Replace wave trap at Morgan 138 kV substation	$0.23	APS	APS	12/1/2024
b3158	Replace line relays on the Ridgeley line terminal at Messick Rd. 138 kV substation	$0.14	APS	APS	12/1/2024
b3159	Build a new 138/69 kV substation; Install one (1) 138 kV circuit breaker, one (1) 138/69 kV 130 MVA transformer, three (3) 69 kV circuit breakers; Build a 0.15 mile 138 kV 795 ACSR transmission line between the FE Brim 138/69 kV substation and the newly proposed AMPT substation (three steel poles); Loop the Bowling Green Sub No.5 – Bowling Green Sub No. 2 69 kV lines in and out of the newly established substation	$5.70	AMPT	ATSI	6/1/2024
b3213	Install 2nd Chickahominy 500/230 kV transformer for single contingency loss of Chickahominy-Surry 500 kV line	$22.00	Dominion	Dominion	6/1/2023
b3214	Reconductor the Yukon-Smithton-Shepler Hill Jct 138 kV Line. Upgrade terminal equipment at Yukon and replace line relaying at Mitchell and Charleroi	$21.40	APS	DL	6/1/2023
b3215	Upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #1 138 kV line	$0.40	APS	APS	6/1/2021
b3216	Upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #2 138 kV line	$0.50	APS	APS	6/1/2021
b3217	Reconductor Wilson to Mitchell 138 kV line – DL portion. 4.2 miles total. 2x795 ACSS/TW 20/7	$7.50	DL	DL	6/1/2021

Attachment B – Reliability Project Multi-Zone Allocations

None

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E-Signature 1: Nicolas C Koehler (NCK)
September 02, 2020 11:03:24 -8:00 [09A4F7769EF5] [167.239.221.81]
nckoehler@aep.com (Principal) (Personally Known)

E-Signature Notary: Brenda Williamson (BW)
September 02, 2020 11:03:24 -8:00 [1DA90C8A3203] [167.239.221.81]
bgwilliamson@aep.com
I, Brenda Williamson, did witness the participants named above electronically sign this document.

VERIFICATION

The undersigned, Nicolas C. Koehler, being duly sworn, deposes and says he is the Director of Transmission Planning, American Electric Power Service Corporation, that he has personal knowledge of the matters set forth in the foregoing responses and the information contained therein is true and correct to the best of his information, knowledge, and belief.

Nicolas C Koehler
Signed on 2020/09/02 11:03:24 -8:00

Nicolas C. Koehler

State of Ohio)
) Case No. 2020-00062
County of Franklin)

Subscribed and sworn before me, a Notary Public, by Nicolas C. Koehler this 09/02/2020 ___ day of September, 2020.

Brenda G. Williamson
Signed on 2020/09/02 11:03:24 -8:00

Notary Public

Brenda G. Williamson
Commission # 2016-RE-579446
Electronic Notary Public
State of Ohio
My Comm Exp. Apr 25, 2021

Notary Stamp 2020/09/02 11:03:24 PST 1DA90C8A3203

My Commission Expires _____