

Appendix: Previously Reviewed Baseline Upgrade Recommendations for the December 2019 PJM Board Review



Dominion Transmission Zone: Baseline Line #569 Rebuild (End of Life Criteria)

Process Stage: Recommended Solution – Second Read

Criteria: End of Life

Assumption Reference: FERC 715

Model Used for Analysis: 2019 Series 2024 Summer RTEP

Proposal Window Exclusion: FERC 715 (TO Criteria)

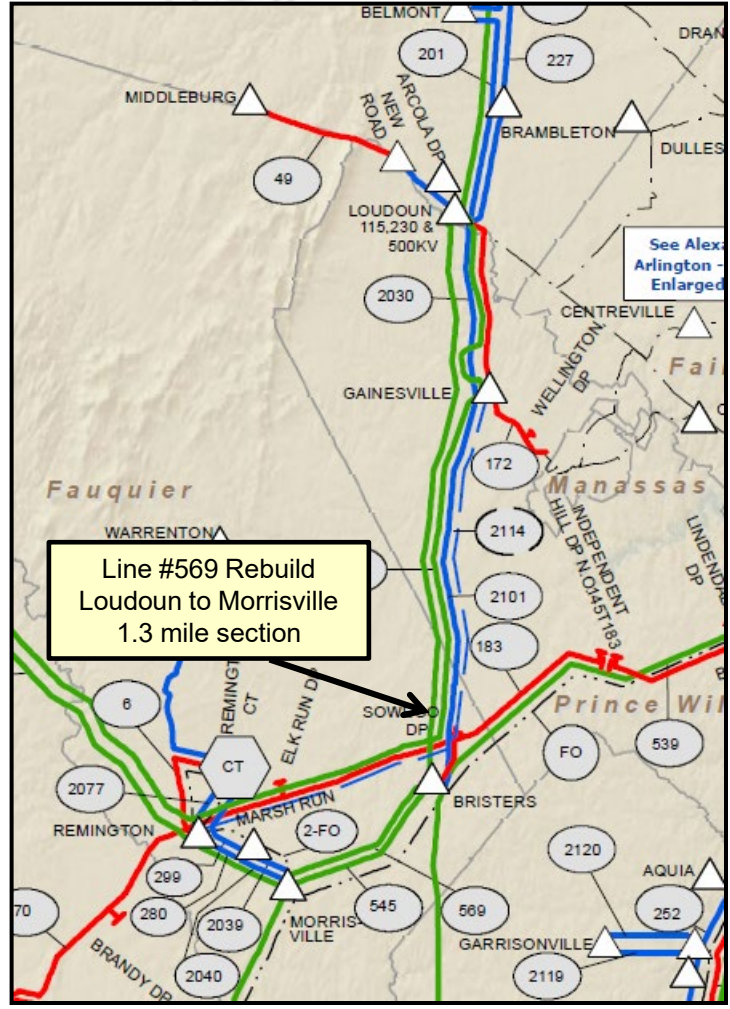
Problem Statement:

The 500 kV Line #569, from Loudoun to Morrisville, is approximately 32 miles long and 1.3 miles of this line is constructed on CORTEN structures. A third party study (Quanta) has determined that these structures are at the end of their useful life.

Reliability studies indicate that retiring Line #569 will result in thermal overloads in accordance with P6 NERC criteria violations.

Existing Facility Rating: 2913 MVA STE
Preliminary Facility Rating: 3424 MVA STE

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



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Dominion Transmission Zone: Baseline Line #569 Rebuild (End of Life Criteria)

Recommended Solution:

Rebuild the 1.3 mile section of Line #569 with single-circuit 500 kV structures at the current 500 kV standard. This will increase the rating of Line #569 to 3424 MVA. **(b3211)**

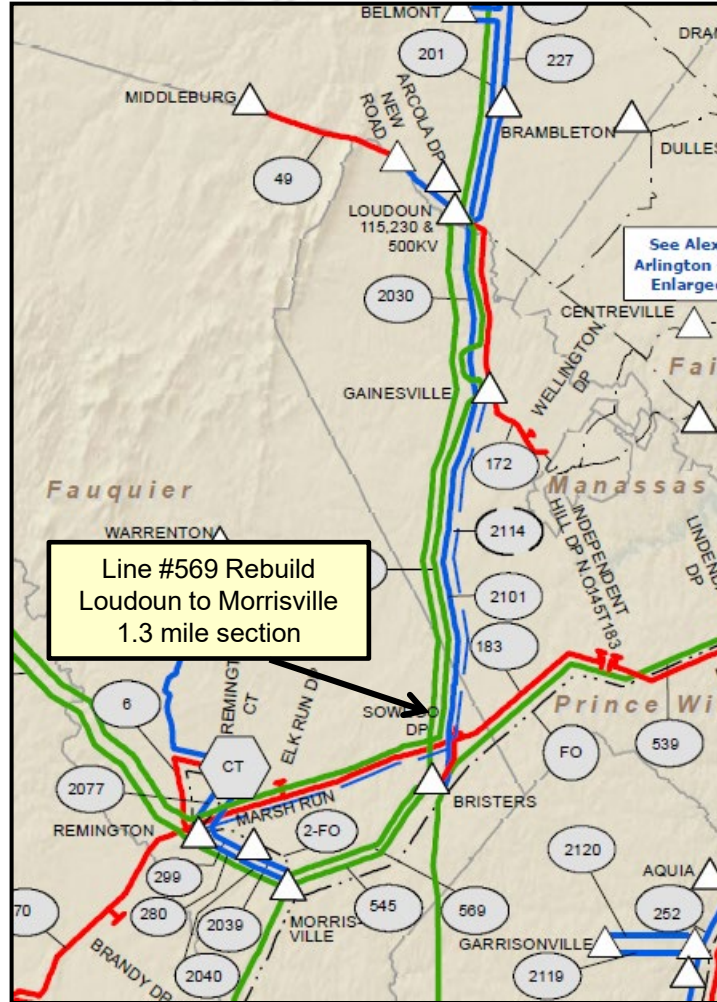
Estimated Project Cost: \$4.5 M

Required In-Service Date: As Soon As Possible

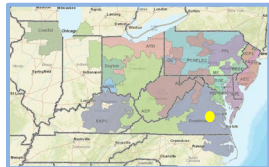
Projected In-Service Date: 12/31/2024

Project Status: Conceptual

Previously Presented: 8/8/2019 TEAC



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



Baseline Reliability: Immediate Need Exclusion – Second Read

Problem Statement: Short Circuit

- The Whitpain 230kV breaker "125" is overdutied.

Significant Driver:

- Case Correction – Whitpain 230kV breaker "125" was incorrectly modeled as a 63kA breaker when it was a 50kA breaker in the field.

Recommended Solution:

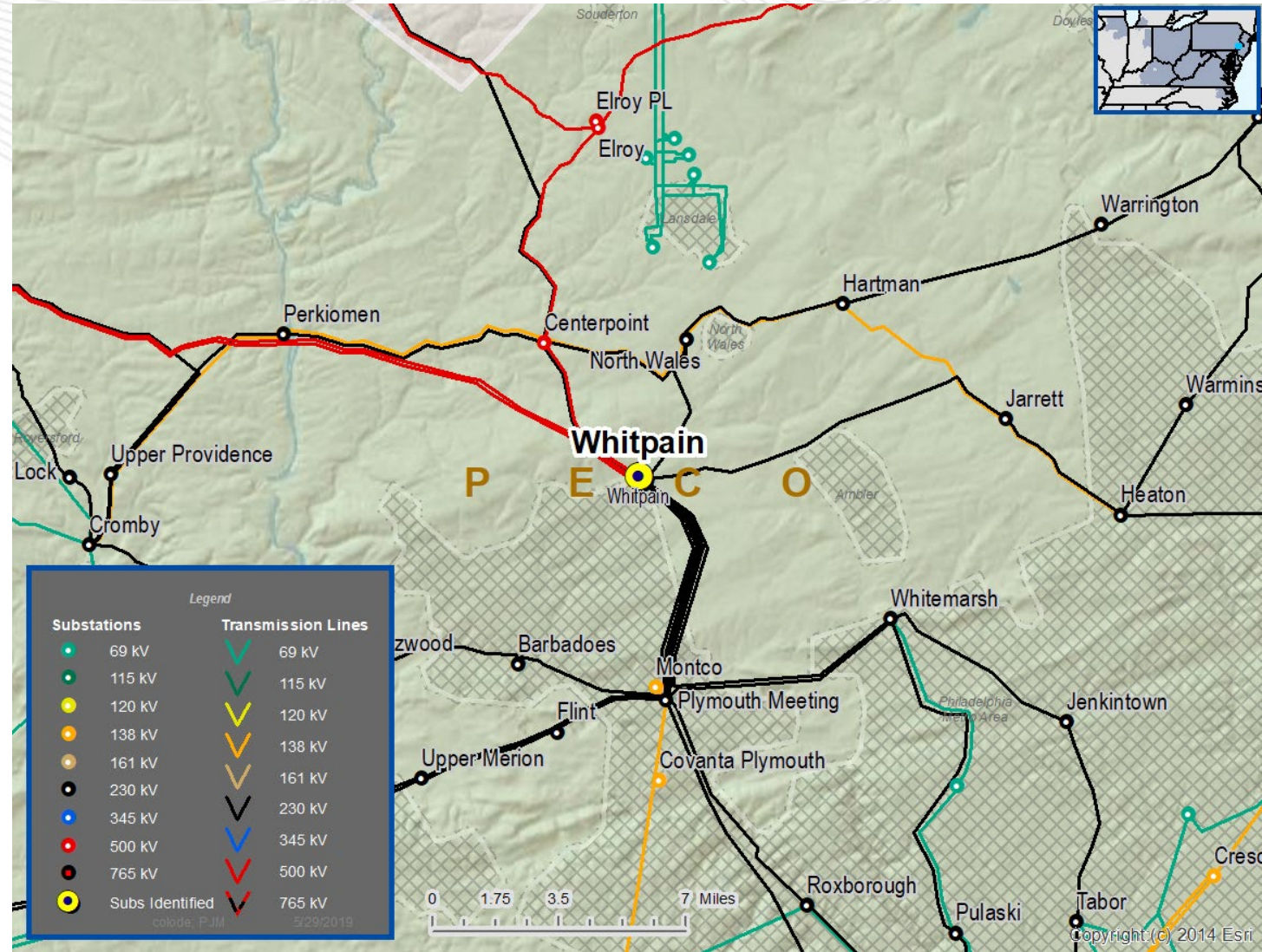
- Replace the Whitpain 230kV breaker "125" with a 63kA breaker (b3120)

Estimated Project Cost: \$0.60 M

Required In-service Date: Immediate Need

Projected In-service Date: 6/1/2021

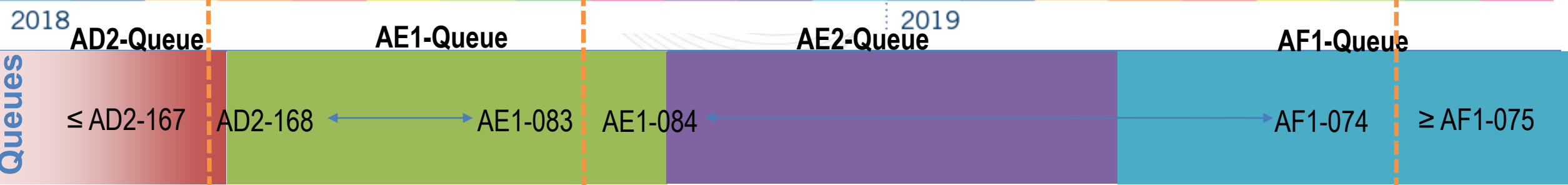
Project Status: Conceptual





FirstEnergy Reinstatement Impact

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep



RTEP

b2965	b3005	b3011.1	b3012.2	b3015.5	b3012.3	b3063	b3065	b3069	b3073	b3077	b3081	b3085
b2967	b3006	b3011.2	b3013	b3015.7	b3012.4	b3064.1	b3066	b3070	b3074	b3078	b3082	
	b3007.1	b3011.3	b3014	b3015.8	b3061	b3064.2	b3067	b3071	b3075	b3079	b3083	
	b3007.2	b3011.4	b3015.1	b3016	b3062	b3064.3	b3068	b3072	b3076	b3080	b3084	
	b3008	b3011.5	b3015.2	b3017								
	b3009	b3011.6	b3015.3	b3024								
	b3010	b3012.1	b3015.4									

- Required for remaining deactivations
- New required for remaining deactivations
- Complete due to progress
- Pending resolution

Notices

03/28/2018: First Energy announces deactivation of **Davis Besse 1, Perry 1, and Beaver Valley 1-2**

08/29/2018 ^{or} First Energy announces deactivation of Eastlake 6, **Sammis 5-7**, Sammis Diesel, and Mansfield 1-3

07/29/2019 First Energy announces reinstatement of Davis Besse 1, Perry 1, and Sammis 5-7

- Baseline projects highlighted in green or red on slide 6-7 remain required.
- Newly identified projects are highlighted in yellow on slide 6-7
- Baseline projects highlighted in white on slide 6-7 are pending.
- All pending baseline projects are on hold.
- Final decision on canceling baseline projects will occur after completion of all required RTEP analysis and execution of ISAs for affected generation queue projects.
- Key Schedule
 - 2024 RTEP retool will be performed in the beginning of October 2020.
 - AE2 System Impact Study results anticipated February 2020.
 - AF1 Feasibility Study results anticipated January 2020.

Newly Identified baseline projects

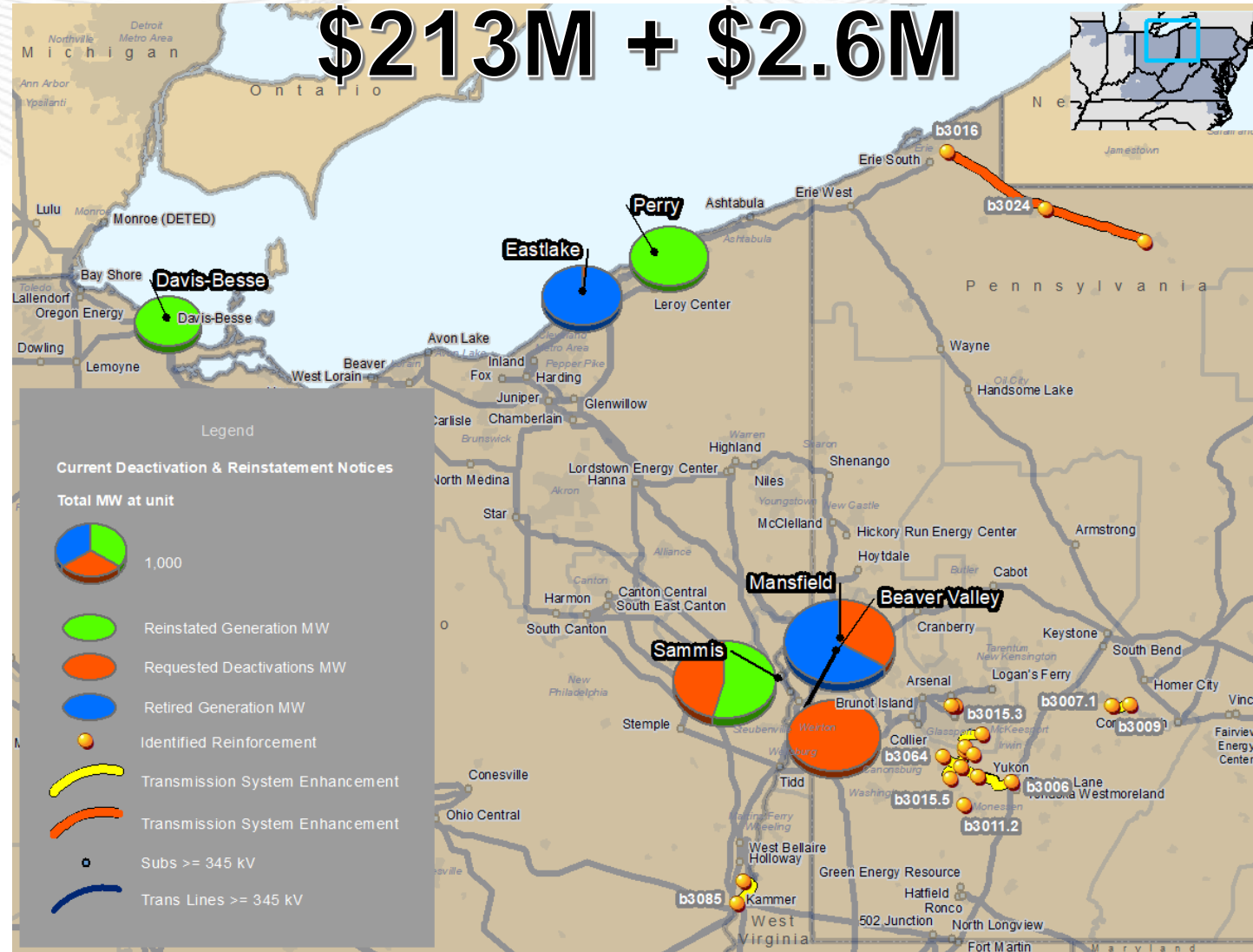
B3064.2, B3064.3 (APS) - Upgrade line relaying at Piney Fork and Bethel Park for Piney Fork – Elrama 138 kV line and Bethel Park – Elrama 138 kV line.

Estimated Project Cost: \$0.6M
Required IS Date: 06/01/2021
Projected IS Date: 06/01/2021

B3015.8 (APS) – Re-establish work of B3015.6 (canceled 2/2019) upgrade terminal equipment at Mitchell for Mitchell – Elrama 138 kV line for required circuit breaker replacement.

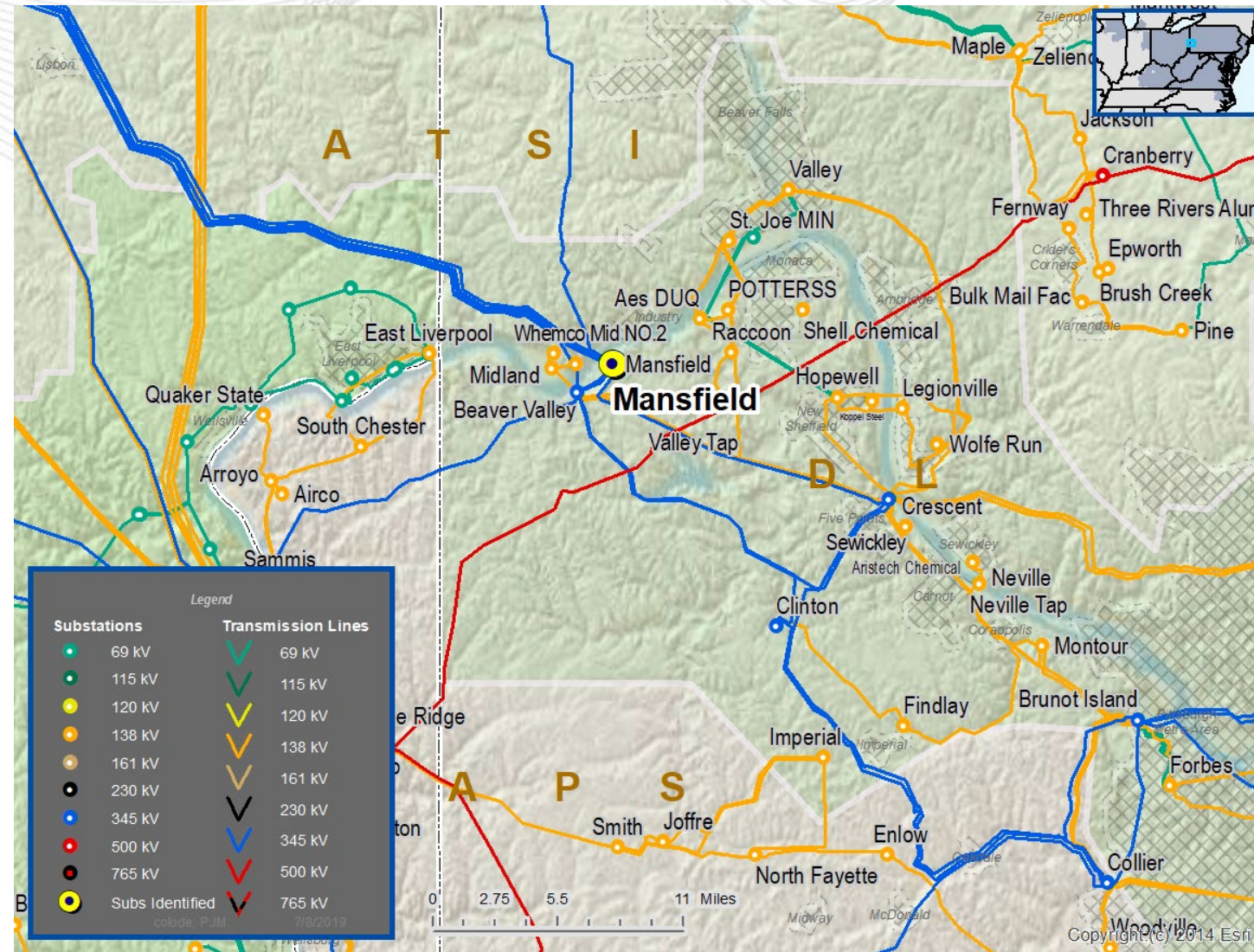
- Existing Scope Rating: SN 498 MVA / SE 600 MVA
- New Scope Rating: SN 790 MVA / SE 838 MVA

Estimated Project Cost: \$2M
Required IS Date: 06/01/2021
Projected IS Date: 06/01/2021



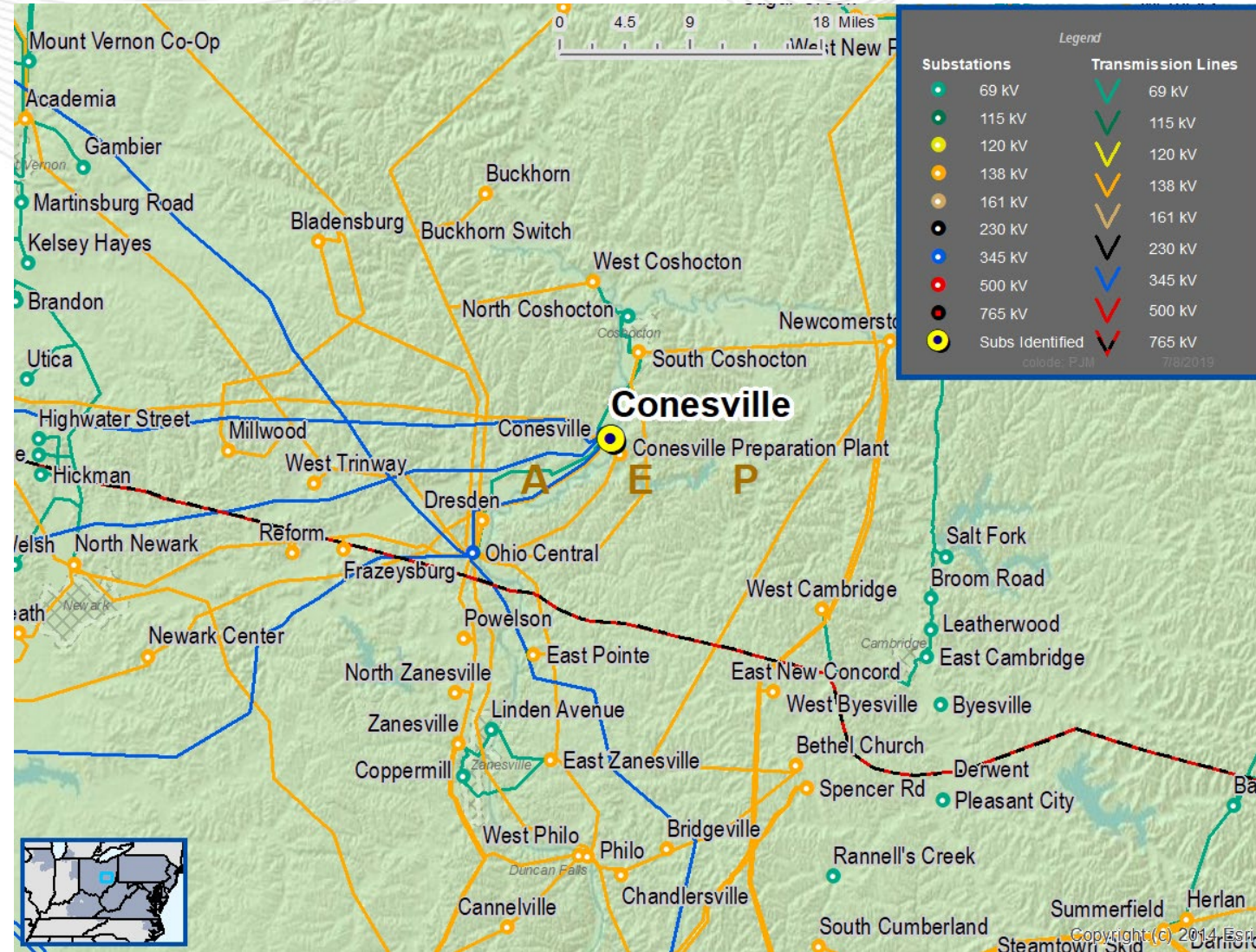
Bruce Mansfield – 1491 MW

- The projected deactivation date **has changed from 06/01/2021 to 11/07/2019**.
 - All impacts and associated baseline projects were presented on 11/08/2018
 - FE recently informed of the necessary substation work associated with deactivating the unit – B3124 for separating metering, station power, and communication.
- **Estimated Cost: \$0.4M**
 - **Projected IS Date: 12/31/2020**
 - **Original TEAC Date: 07/11/2019**



Conesville 4 – 780 MW

- The projected deactivation date is 09/01/2020.
- All impacts and associated baseline projects were presented on 03/07/2019
- AEP recently informed of the necessary substation work associated with deactivating the unit – B3129
 - Remove line leads to generating units
 - Separate and reconfigure protection schemes.
 - Transfer plant AC service to existing station service feeds in the switchyard.
- **Estimated Cost:** \$1.5M
- **Projected IS Date:** 12/31/2020
- **Original TEAC Date:** 07/11/2020



APS Transmission Zone: Baseline Glen Falls 138kV Substation Breakers Upgrade

Process Stage: Second Review

Previously Presented: 6/17/2019

Criteria: Short Circuit

Assumption Reference: PJM Criteria

Model Used for Analysis: Short Circuit 2020/2023 Base cases

Proposal Window Exclusion: Immediate Need, Below 200 kV

Problem Statement:

The “Rider 50” and “No. 1 & No. 4 transf.” 138 kV breakers at Glen Falls 138 kV substation are over-dutied due to generation retirement driven system upgrade b2996.

Existing Facility Rating: 5000 MVA

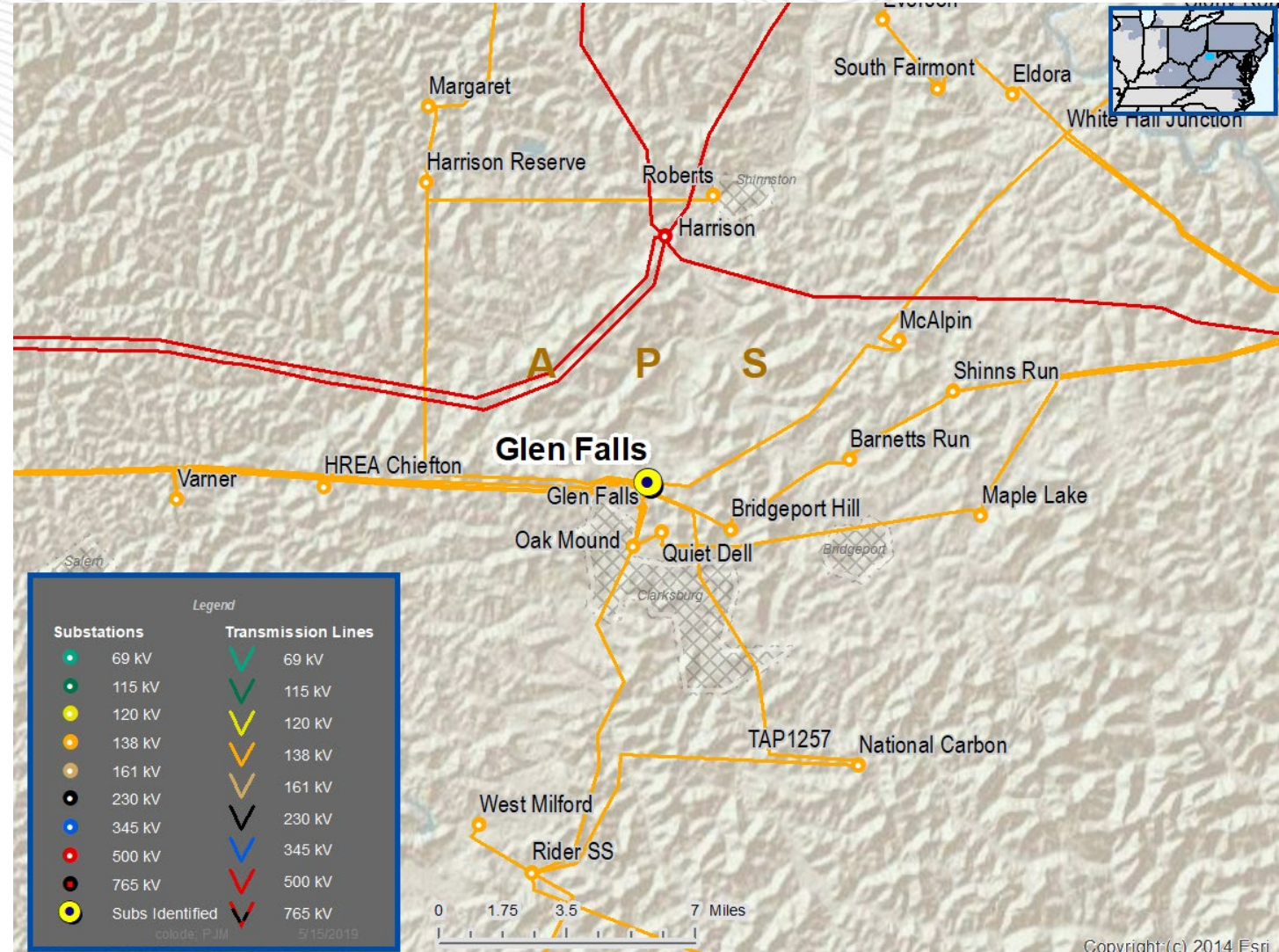
Proposed Solution (b2996.3):

Replace two 138 kV breakers (Rider 50 and #1/4 transformer breaker) at Glen Falls 138 kV substation with 63 kA breakers

Estimated Cost: \$ 487 k

Alternatives: N/A

Required In-Service: 5/31/2020



Process Stage: Second Review

Previously Presented: 5/31/2019 and 9/24/2019

Criteria: ODEC Planning Criteria Violation

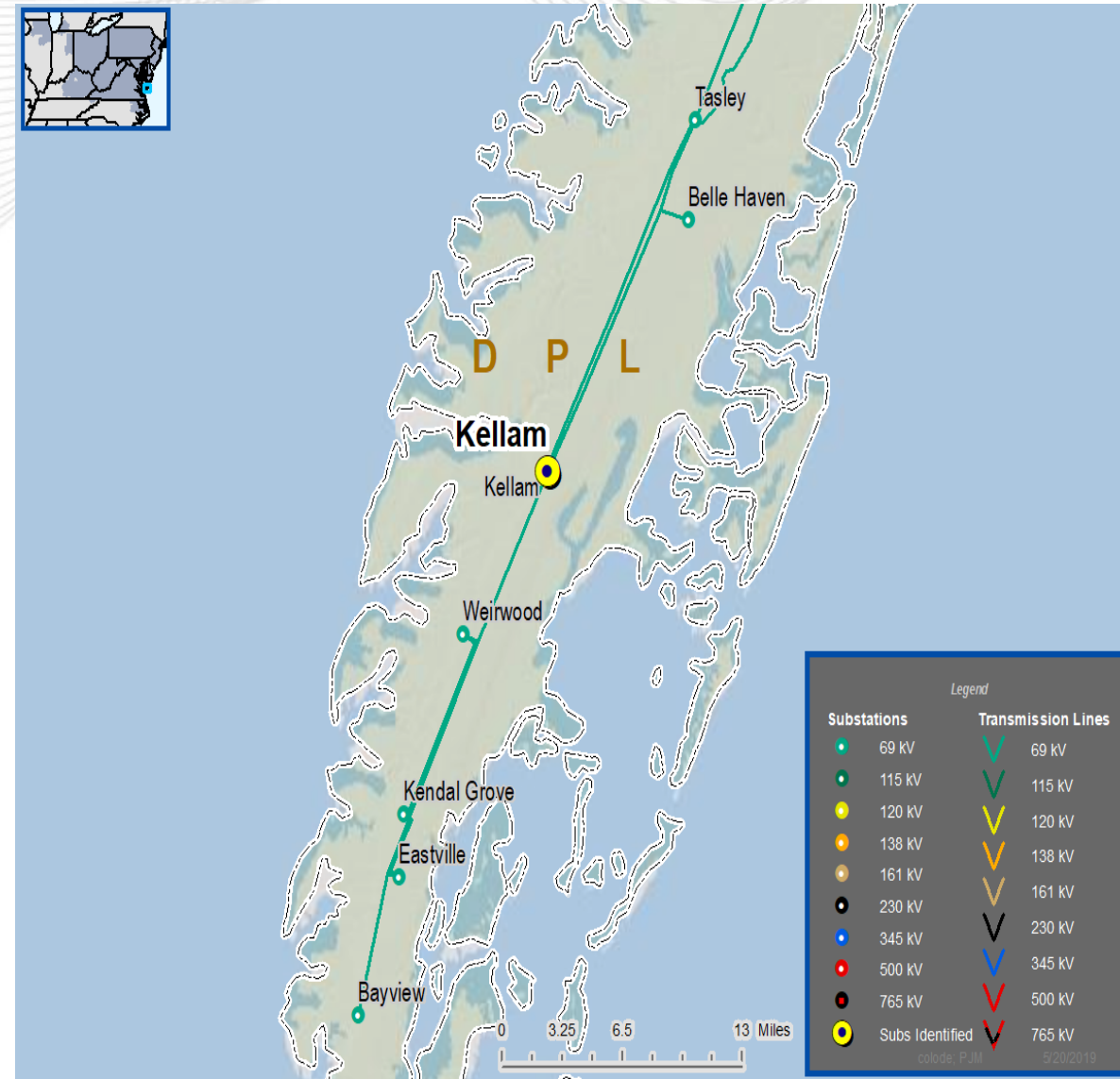
Assumption Reference: ODEC Planning Criteria 6/14/2018

- A radial 69 kV transmission line shall feed no more than 10,000 consumers, 50 megawatts of load, or have more than 700 MW-Miles of exposure (MW-Mile = Peak MW X Radial Line Length) Once a radial loading limit exceeds any of these thresholds, an additional transmission source is required. This may be a separate source, or it may be a loop back to the source of the original radial line

Proposal Window Exclusion: Below 200 kV

Problem Statement:

The load south of Kellam Substation violates the MW-Mile criteria. 21 Miles x 37.2 MW = 781.2 MW-Miles





Recommended Solution:

- Create a line terminal at Belle Haven Delivery Point (three-breaker ring bus) and install a new single circuit 69kV overhead from Kellam sub to new Bayview Substation (21 miles)
- Converting Belle Haven to a terminal substation eliminates sequential tripping for faults near Kellam, and increases system reliability and resilience by avoiding loss of service to points south for a destructive physical event (e.g. fire or tornado) at Kellam. (New rating 55N/55E MVA summer) (B3134)

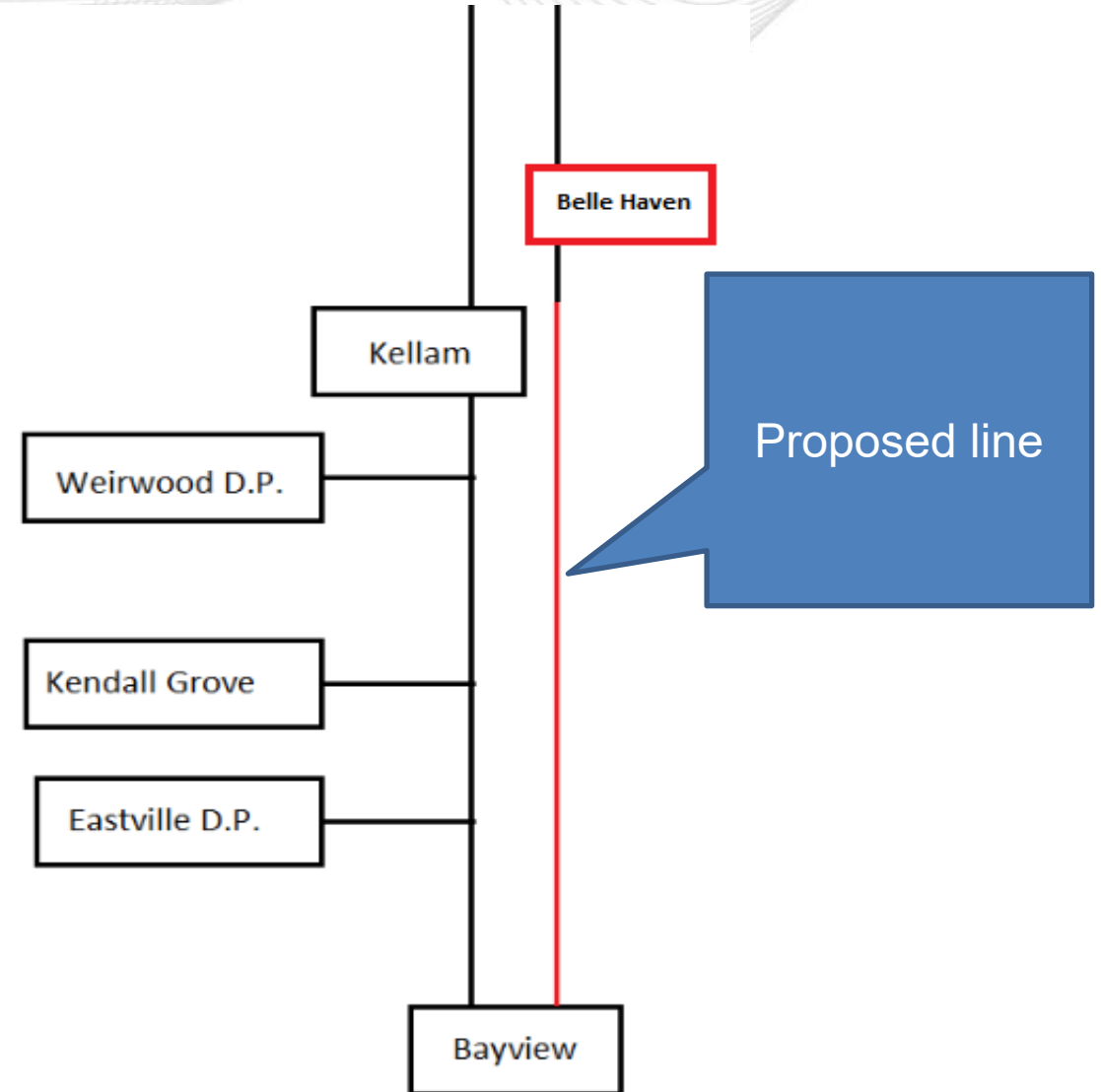
Estimated Cost: \$22 M

Alternative: Rearrange the bus at Kellam and use that substation as the northern terminal for a similar cost.

Required IS date: Immediate

Expected IS date: 6/1/2022

Status : Conceptual





Process Stage: Second Review
Previously Presented: 9/24/2019

Summer and Light Load: (N1-ST17, N1-ST30, N1-ST42), (N1-SVM1 to N1-SVM19), (N1-SVD3, N1-SVD4, N1-SVD29 to N1-SVD48), (N1-LLVD1 to N1-LLVD15)

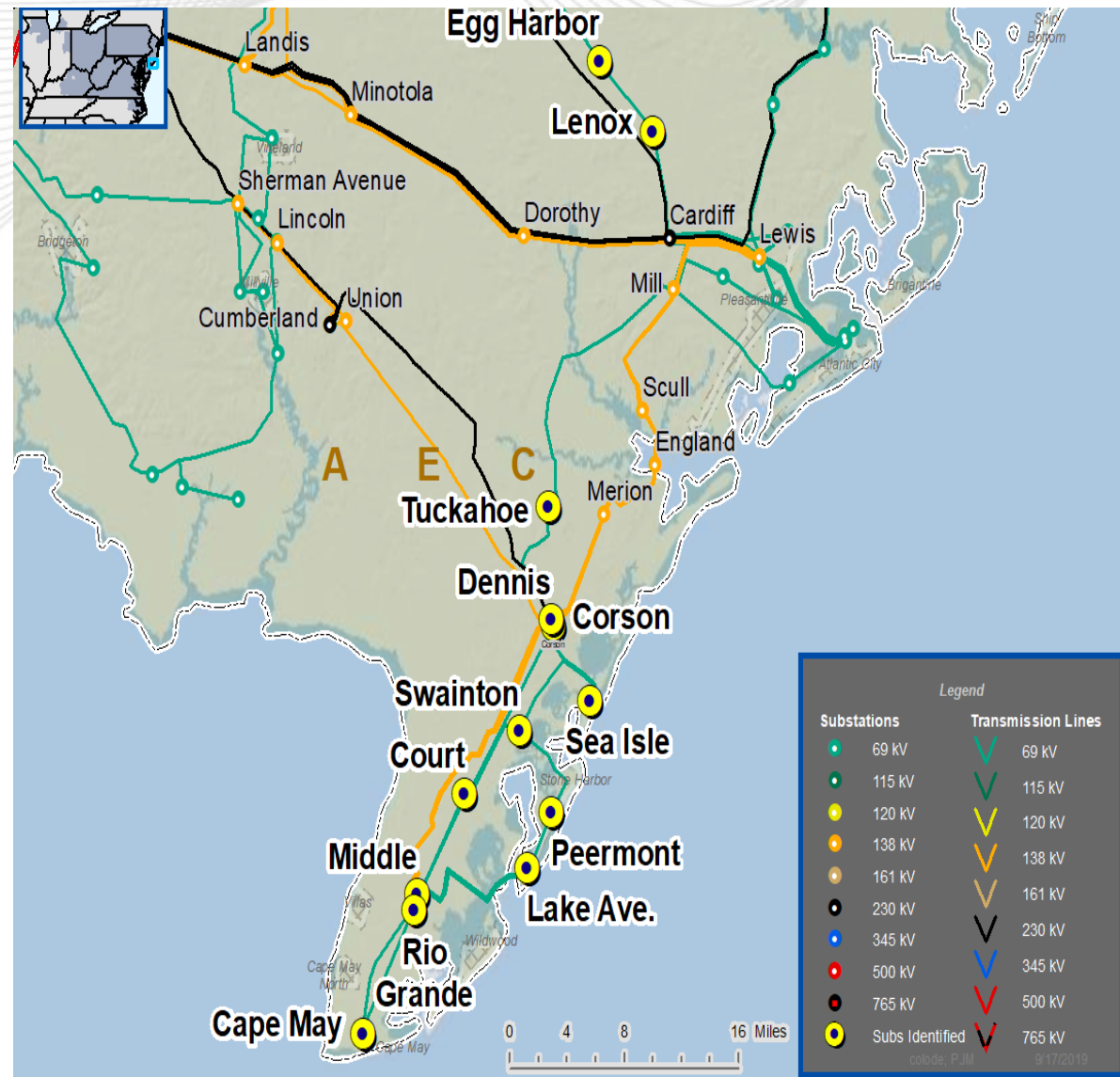
Problem Statement:
Thermal and Low voltage violation at several 138 kV and 69 kV stations in the Atlantic Electric area for loss of Corson 138 kV station due to fault on a line and failure of relay. The violation is identified on Light Load and Summer studies.

Proposal Window Exclusion: Immediate Need

Recommended Solution:
Install back-up relaying on the 138 kV bus at Corson substation. (B3135)

Alternatives Considered:
None

Estimated Project Cost : \$0.3M
Required IS Date: 6/1/2019
Projected IS date: 6/1/2022
Status: Conceptual





Process Stage: Second Review
Previously Presented: 9/24/2019

Summer: N2-ST59 and N2-ST60

Problem Statement:

The Smith Tap – Smith St. 115 kV circuit is overloaded for N-1-1 contingency loss of the Middletown Junction 230/115 kV transformer #2 and #5 in the Summer N-1-1 thermal study. The circuit is rated at 118N/152E summer and 168N/189E Winter.

Proposal Window Exclusion: Substation Equipment

Recommended Solution:

Upgrade limiting bus conductor at the Smith St 115 kV Substation. (B3136)
 (New rating 163N/185E summer 186N/204E winter)

Alternatives Considered:

None

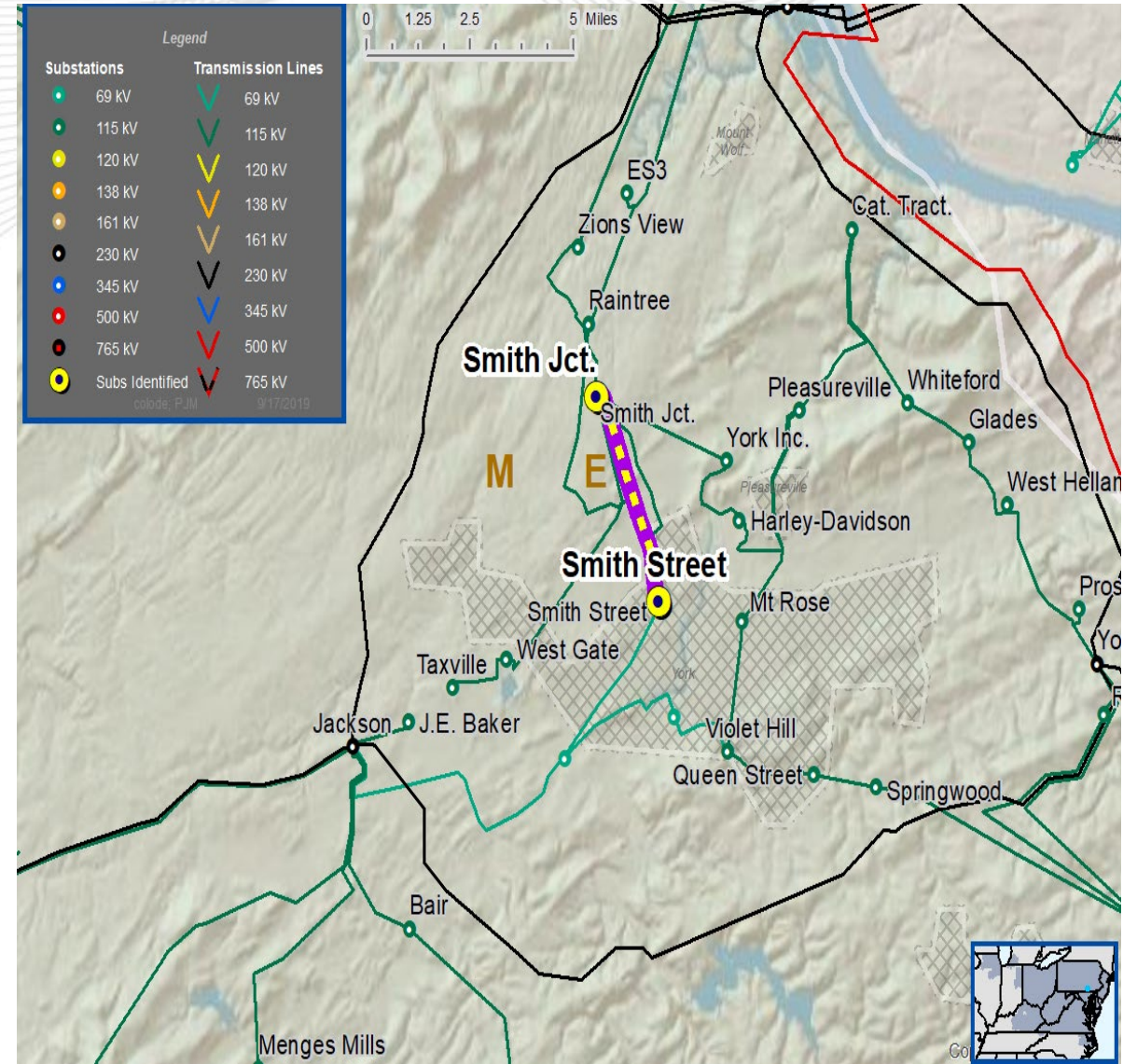
Estimated Project Cost : \$0.153 M

Required IS Date: 6/1/2024

Projected IS date: 6/1/2024

Status: Conceptual

ME Transmission Zone: Baseline





Process Stage: Second Review
Previously Presented: 9/24/2019

Summer: [N1-ST50 and N1-ST51], [GD-S315 and GD-S316]

Problem Statement:

The Master – Westmoreland East – Pencoyd 69 kV is overloaded for line fault stuck breaker contingency loss of Roxborough 230/69 kV transformer and Roxborough – Westmoreland West 69 kV circuit in the summer baseline and generation deliverability studies. The line is rated at 103N/103E Summer and 102N/103E Winter.

Proposal Window Exclusion: Below 200 kV

Recommended Solution:

Move 2 MVA load from the Roxborough to Bala substation. Adjust the tap setting on the Master 138/69 kV transformer #2. (B3138)

Alternatives Considered:

None

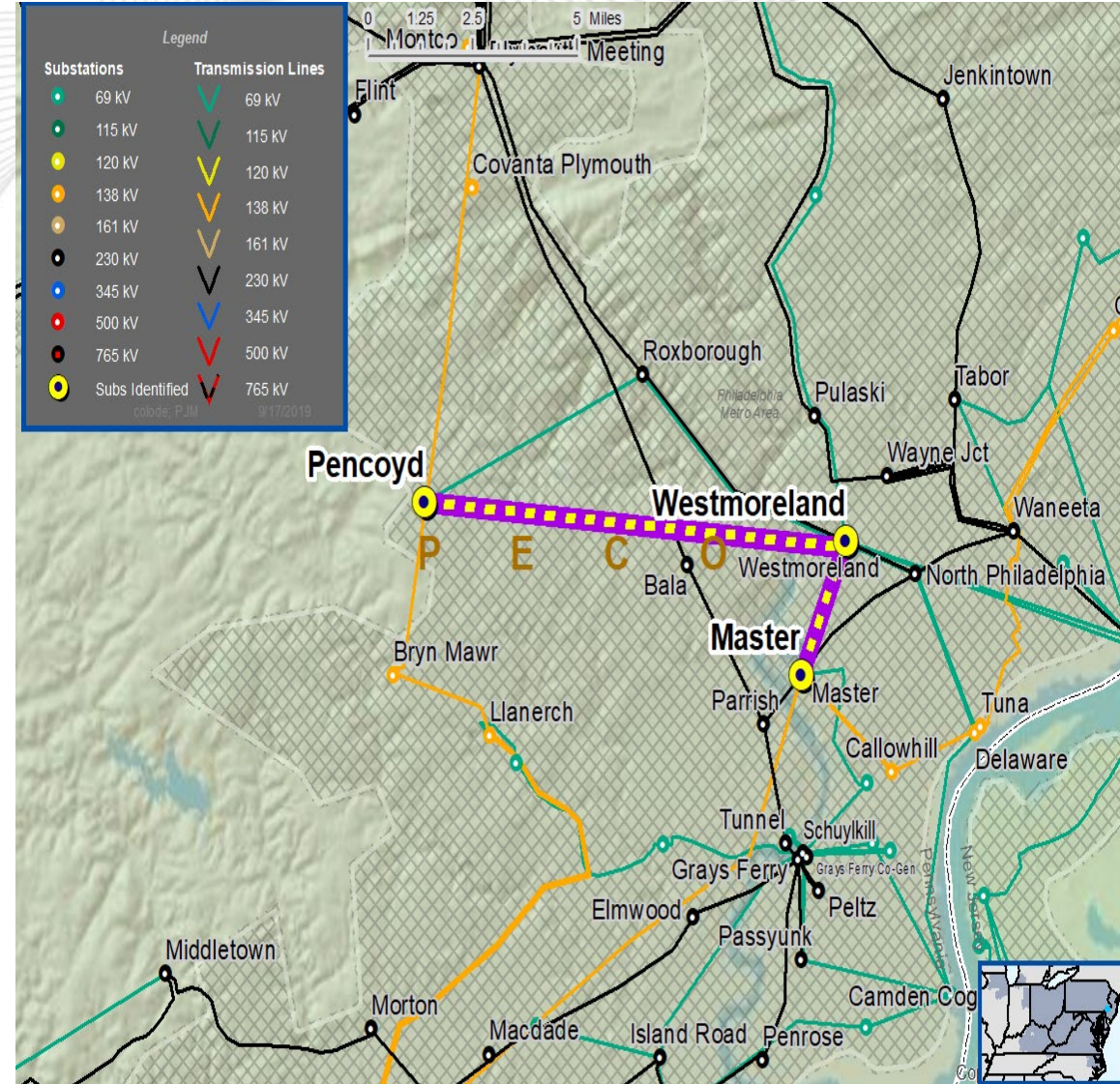
Estimated Project Cost : \$0.015 M

Required IS Date: 6/1/2024

Projected IS date: 6/1/2024

Status: Conceptual

PECO Transmission Zone: Baseline





Process Stage: Second Review
Previously Presented: 9/24/2019

Winter: GD-W18

Problem Statement:

The Towanda – North Meshoppen 115 kV circuit is overloaded for single contingency the loss of the East Towanda – Canyon – North Meshoppen 230 kV circuit in the Winter generation deliverability study. The circuit is rated at 167N/202E Summer and 188N/239W Winter.

Proposal Window Exclusion: Below 200 kV

Recommended Solution:

Rebuild ~20 miles of the East Towanda - North Meshoppen 115 kV line and adjust relay settings at East Towanda and North Meshoppen 115 kV. (B3137)
 (New rating 202N/245E summer 228N/290E winter)

Alternatives Considered:

None

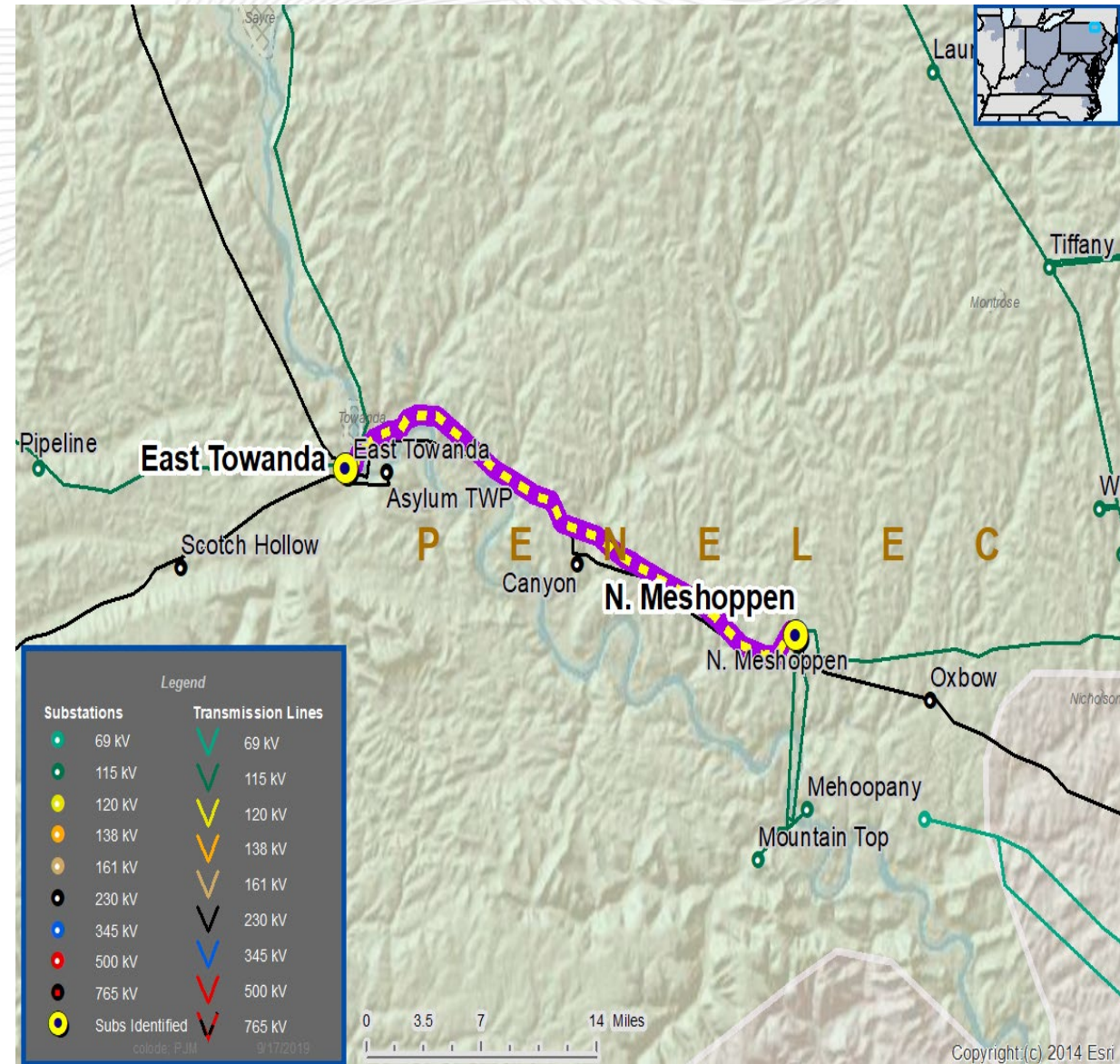
Estimated Project Cost : \$58.6 M

Required IS Date: 6/1/2024

Projected IS date: 6/1/2024

Status: Conceptual

Penelec Transmission Zone: Baseline





Bosserman-Trail Creek Proposal Final Results

Proposal ID	BT_481	BT_129
Proposal Description	Rebuild Michigan City-Trail Creek-Bosserman 138 kV (10.7mi)	New Kuchar station and new Kutchar-Luchtman 138kV line (10.5mi)
Project Type	Upgrade	Greenfield
B/C Ratio Metric	Lower Voltage	Lower Voltage
In-Service Cost (\$MM)*	\$24.69	\$29.51 (Independent Cost Review) \$26.3 (Proposer's Cost Containment)
Cost Containment	No	Yes
In-Service Month	Jan 2023	Dec 2023
% Cong Driver Mitigated	100%	95%
2023 Shifted Cong (\$MM)	\$0.04	-
PJM Benefit Metric (\$MM)	69.16	60.01
PJM Base Case B/C Ratio	2.63	1.91 (with Independent Cost Review) 2.14 (with Proposer's Cost Containment)
PJM Interregional Cost Allocation %**	89.1 %	86.7%

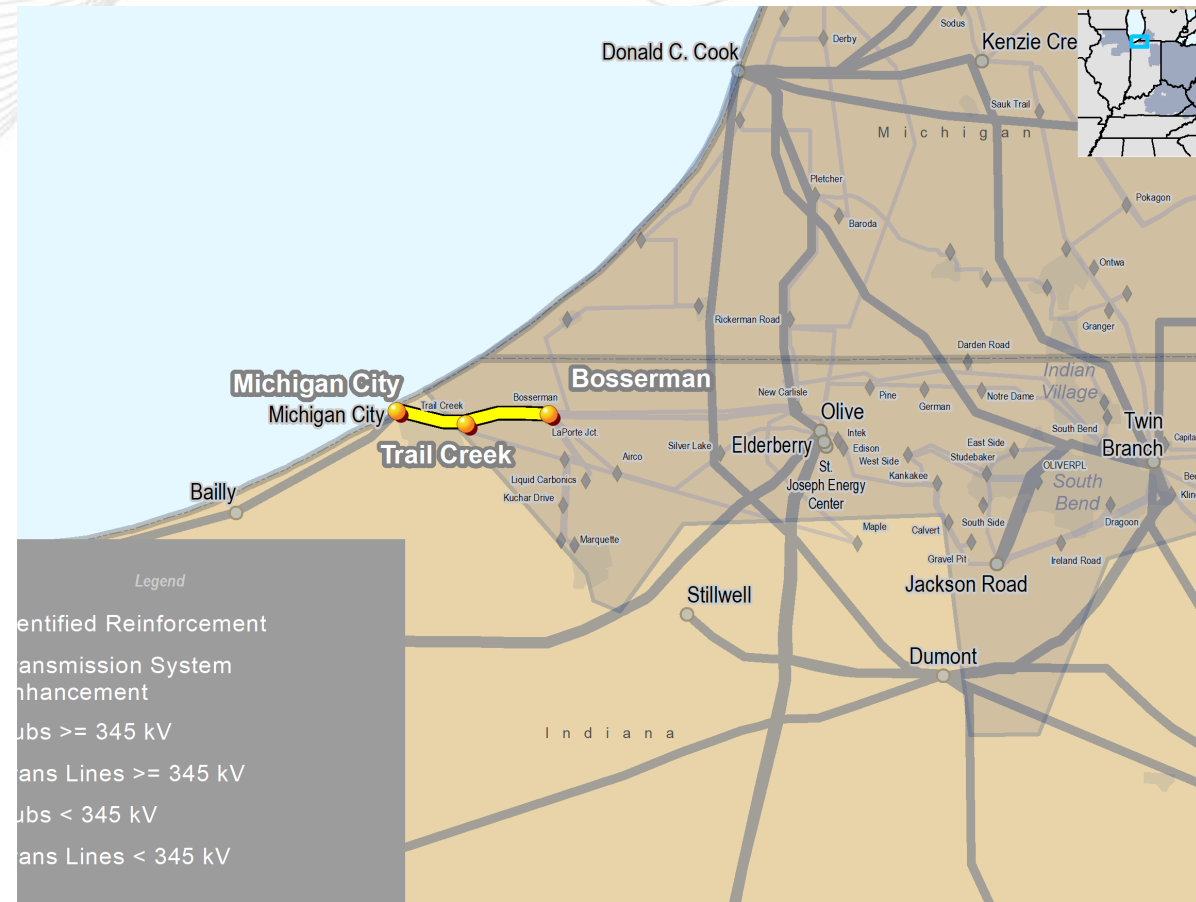
* Costs based on PJM's Independent Cost/Constructability Review

** Cost split based on September 20 IPSAC Presentation :

<https://www.pjm.com/-/media/committees-groups/stakeholder-meetings/ipsac/20190920/20190920-ipsac-presentation.ashx>

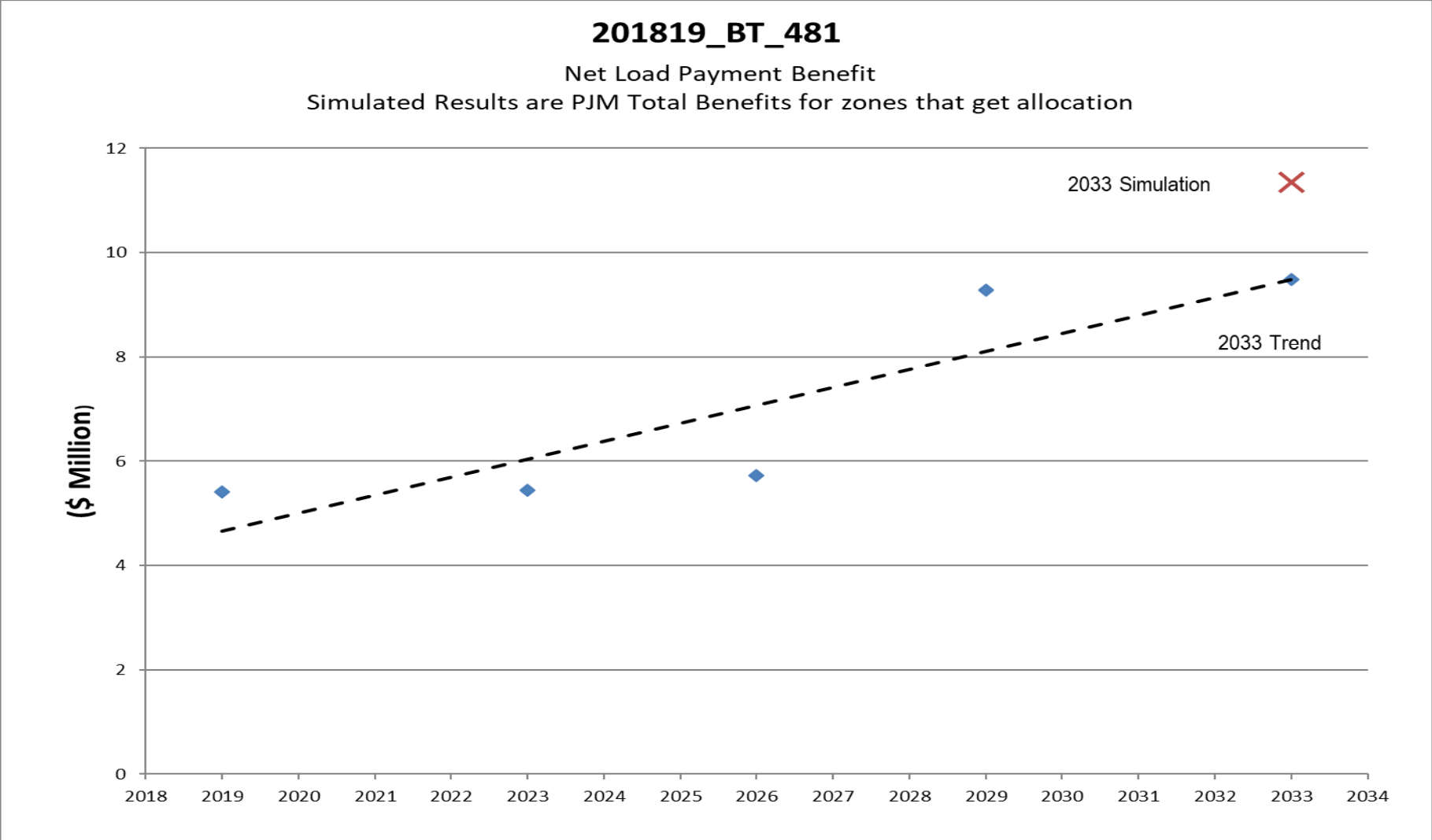
Bosserman –Trail Creek 138 kV

- BT_481, rebuilding Michigan City to Trail Creek to Bosserman 138 kV lines:
 - Highest B/C ratio
 - Robustly addresses congestion on identified issue
 - Passed reliability no-harm test
- Recommended as Interregional Market Efficiency Project
- MISO similarly recommends project





Trend for Net Load Benefits of Proposal BT_481



- 2nd read for proposal BT_481, Bosserman-Trail Creek 138kV, at November TEAC
- Recommend BT_481 for provisional* approval at the December Board meeting
- Continue to coordinate with MISO

**Dependent on MISO Board approval of same project*

Process Stage: Recommended Solution

Criteria: Winter Generator Deliverability and Basecase Analysis

Assumption Reference: PJM RTEP Study

Model Used for Analysis: 2024 RTEP Winter Peak Model

Proposal Window Exclusion: Substation Equipment and Below 200kV

Problem Statement:

The Haviland – East Lima 138kV line is overloaded for multiple contingencies in winter generator deliverability test and basecase analysis test. (N1-WT18, N1-WT19, N1-WT20, N1-WT21, N1-WT22, N1-WT23, N1-WT24, N1-WT25, GD-W244, GD-W3, GD-W4, GD-W5, GD-W7, GD-W8, GD-W19)

Existing Facility Ratings:

From Bus ID	From Bus Name	To Bus ID	To Bus Name	Ckt Id	SN	SE	WN	WE
242989	05E LIMA 138.00	243017	05HAVILAND1 138.00	1	143	143	143	143

Preliminary Facility Ratings:

From Bus ID	From Bus Name	To Bus ID	To Bus Name	Ckt Id	SN	SE	WN	WE
242989	05E LIMA 138.00	243017	05HAVILAND1 138.00	1	167	245	210	271



Proposed Solution:

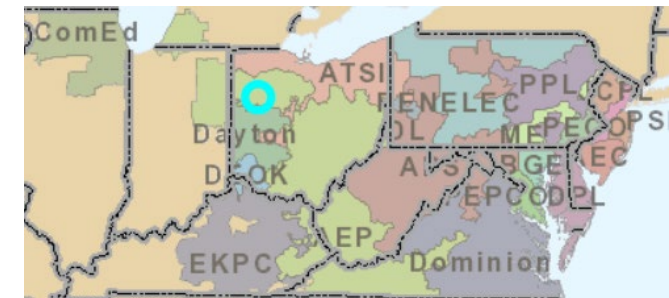
At East Lima and Haviland 138 kV stations, replace line relays and wavetrap on the East Lima-Haviland 138 kV facility. (B3131)

Estimated Cost: \$1.35M

Required In-Service: 12/1/2024

Projected In-Service: 12/1/2024

Previously Presented: 9/25/2019 SRRTEP



Process Stage: Recommended Solution

Criteria: TO Criteria Violation

Assumption Reference: FERC 715

Model Used for Analysis: 2024 RTEP Summer & Winter

Proposal Window Exclusion: Below 200kV

Problem Statement:

The Botkins 69kV bus voltage drops 10.6% for the loss of the Sidney-Botkins 69kV transmission line under N-1 analysis in the 2024 RTEP summer case, and the voltage drops 10.4% for the same contingency in the 2024 RTEP winter case. The Sidney-Botkins contingency also causes the Blue Jacket Tap-Huntsville 69kV line to overload to 101% of its summer emergency rating in the 2024 RTEP summer case.

Existing Facility Rating: Blue Jacket Tap-Huntsville SN/SE 80/98

Preliminary Facility Rating: Blue Jacket Tap-Huntsville SN/SE 80/98

Proposed Solution:

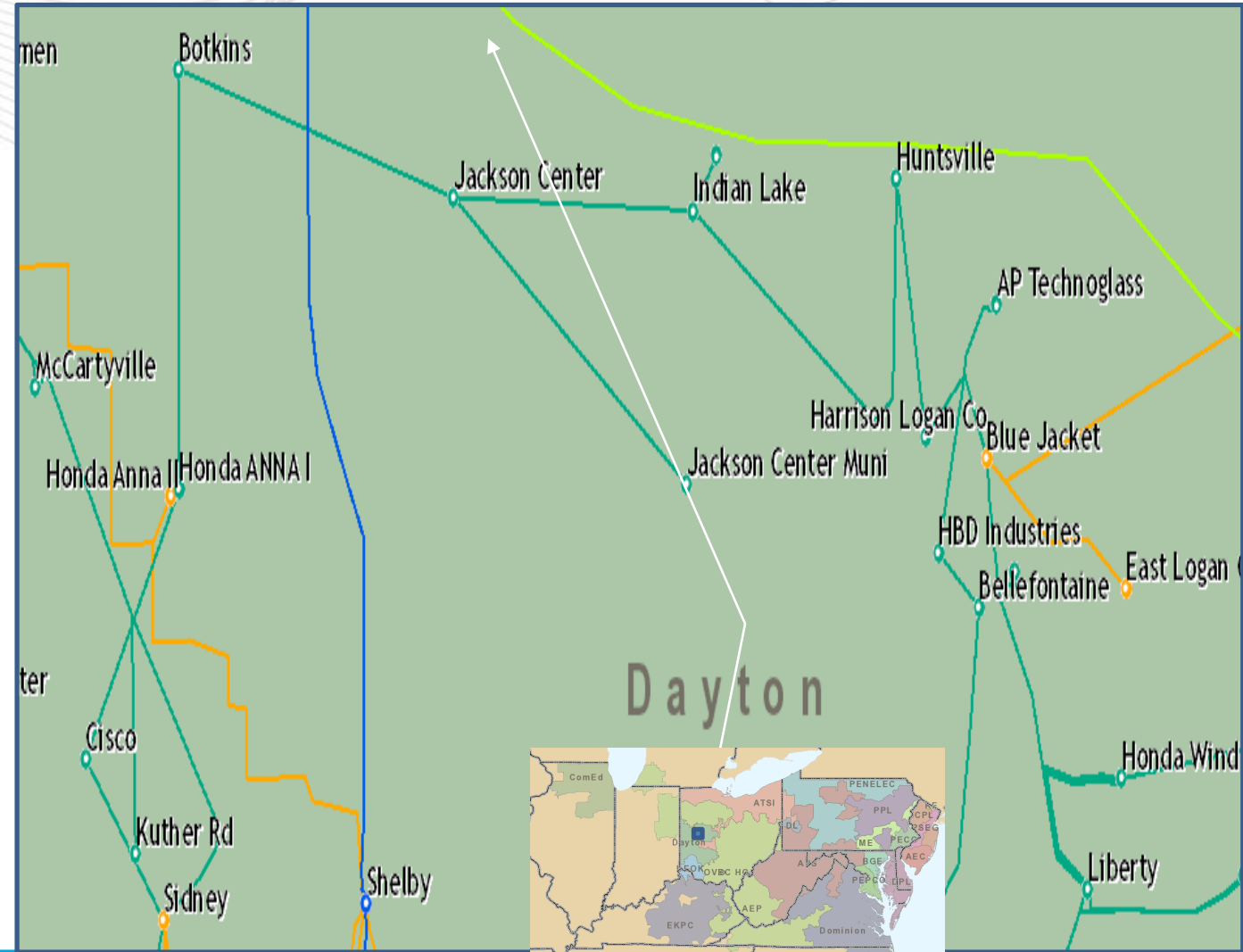
Move the existing Botkins 69kV capacitor from the Sidney-Botkins side of the existing breaker at Botkins to the Botkins-Jackson Center side. This will keep the capacitor in-service for the loss of Sidney-Botkins. This reduces the voltage drop to less than 3% and also resolves the overload on the Blue Jacket Tap-Huntsville 69kV line. (B3133)

Estimated Cost: \$200K

Required In-Service: 6/1/2024

Projected In-Service: 6/1/2024

Previously Presented: 9/25/2019 SRRTEP





AEP Transmission Zone: Baseline New Buffalo Area Improvements

Previously Presented: 6/17/2019 SRRTPEP

Process Stage: Recommended Solution

Criteria: Thermal N-1-1 violation (TO Criteria)

Assumption Reference: FERC 715

Model Used for Analysis: 2022 RTEP Summer

Proposal Window Exclusion: Below 200KV

Problem Statement:

For the N-1-1 loss of

- Derby – Cook Thornton 69kV and Bridgman – Pletcher 69kV
- Bridgman – Cook Thornton 69kV and Bridgman – Pletcher 69kV
- Derby – Cook Thornton 69kV and Pletcher 138/69kV TR#1
- Bridgman – Cook Thornton 69kV and Pletcher 138/69kV TR#1

the following violation occurs in the 2022 RTEP case:

- LaPorte Junction – New Buffalo 69 kV line gets loaded to 128%, 124%, 103%, 102% of its SE ratings (4/0 ACSR, 50MVA rating)

Existing Facility Rating:

246335 05LAPORTE – 246472 05N.BUFFAL 50/50/63/63 for SN/SE/WN/WE

Preliminary Facility Rating:

246335 05LAPORTE – 246472 05N.BUFFAL 64/73/80/87 for SN/SE/WN/WE

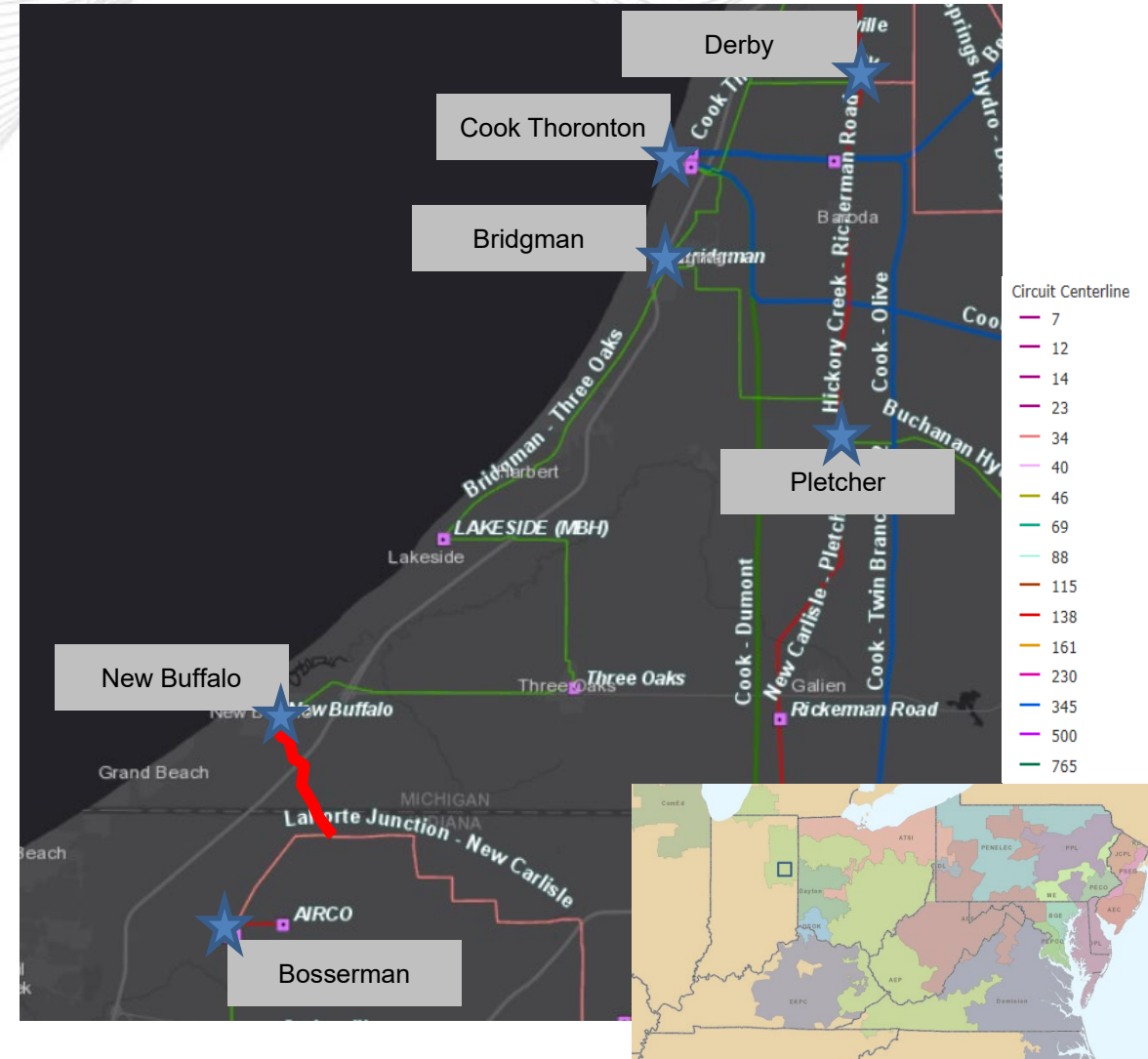
Proposed Solution:

Rebuild 3.11 miles of the LaPorte Junction – New Buffalo 69 kV line with 795 ACSR (**B3132**)

Estimated Cost: \$12.3M

Required IS Date: 06/01/2022

Project IS Date: 12/15/2020





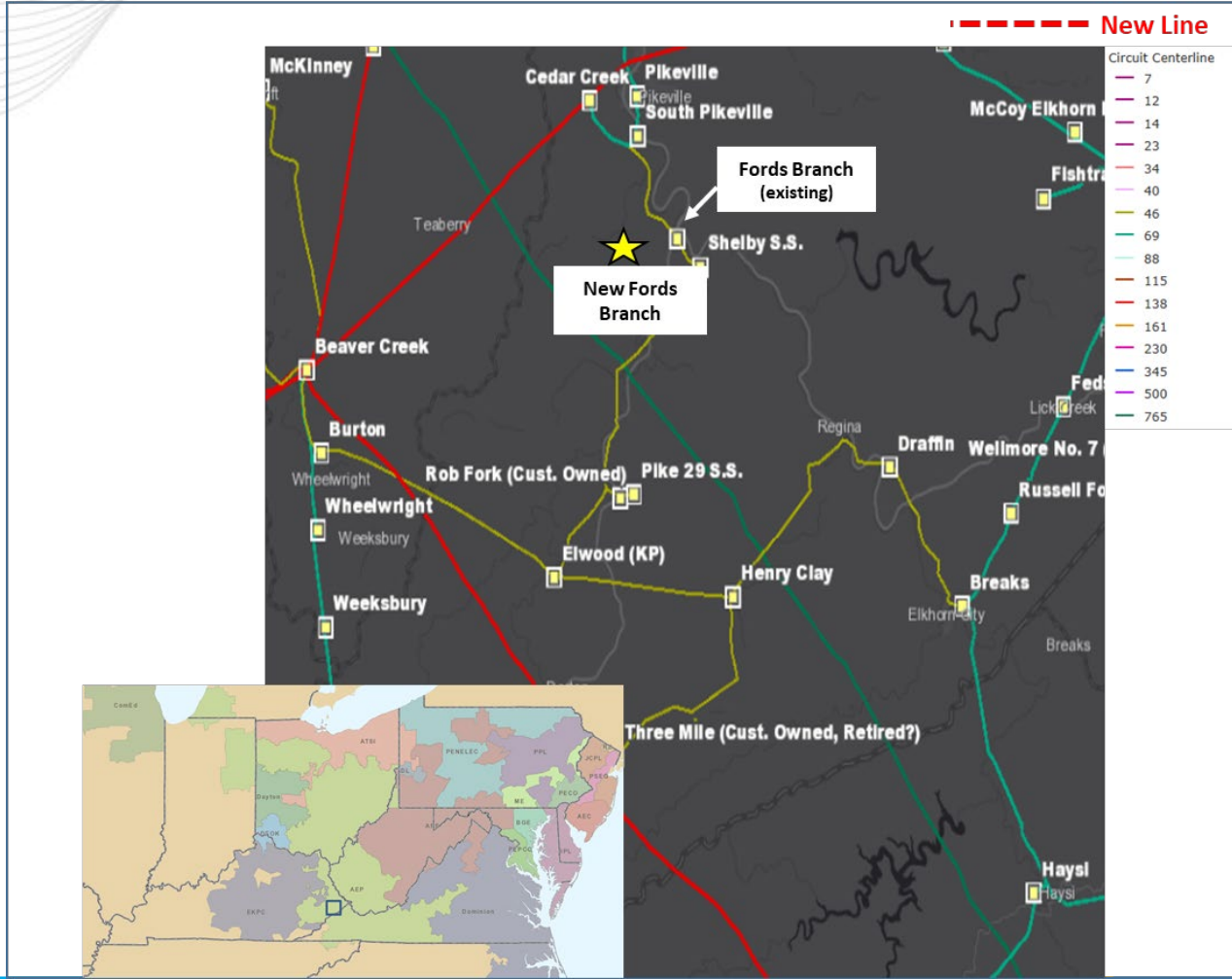
AEP Transmission Zone: Baseline Pike County, KY

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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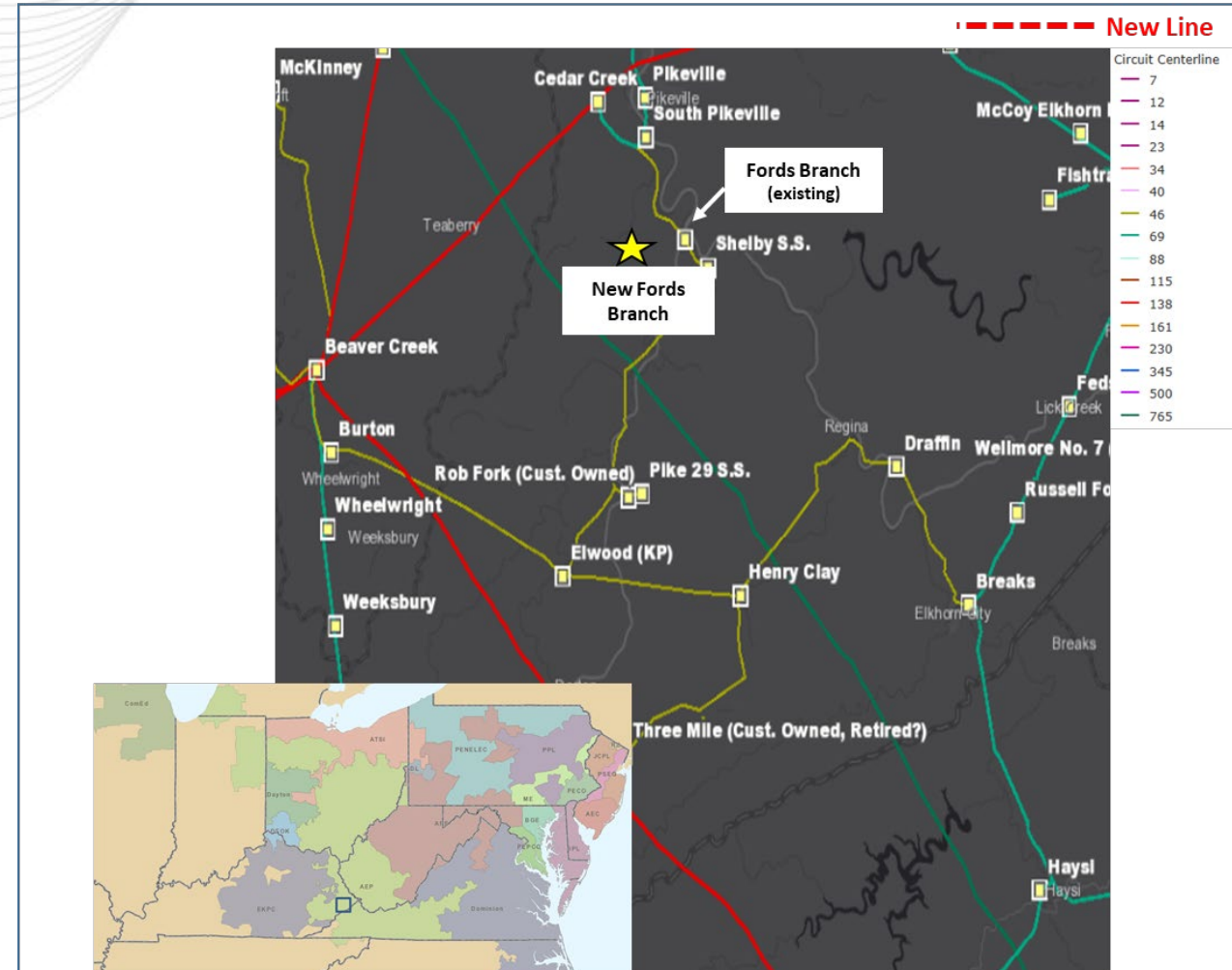
Planning Criteria Violations:

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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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.

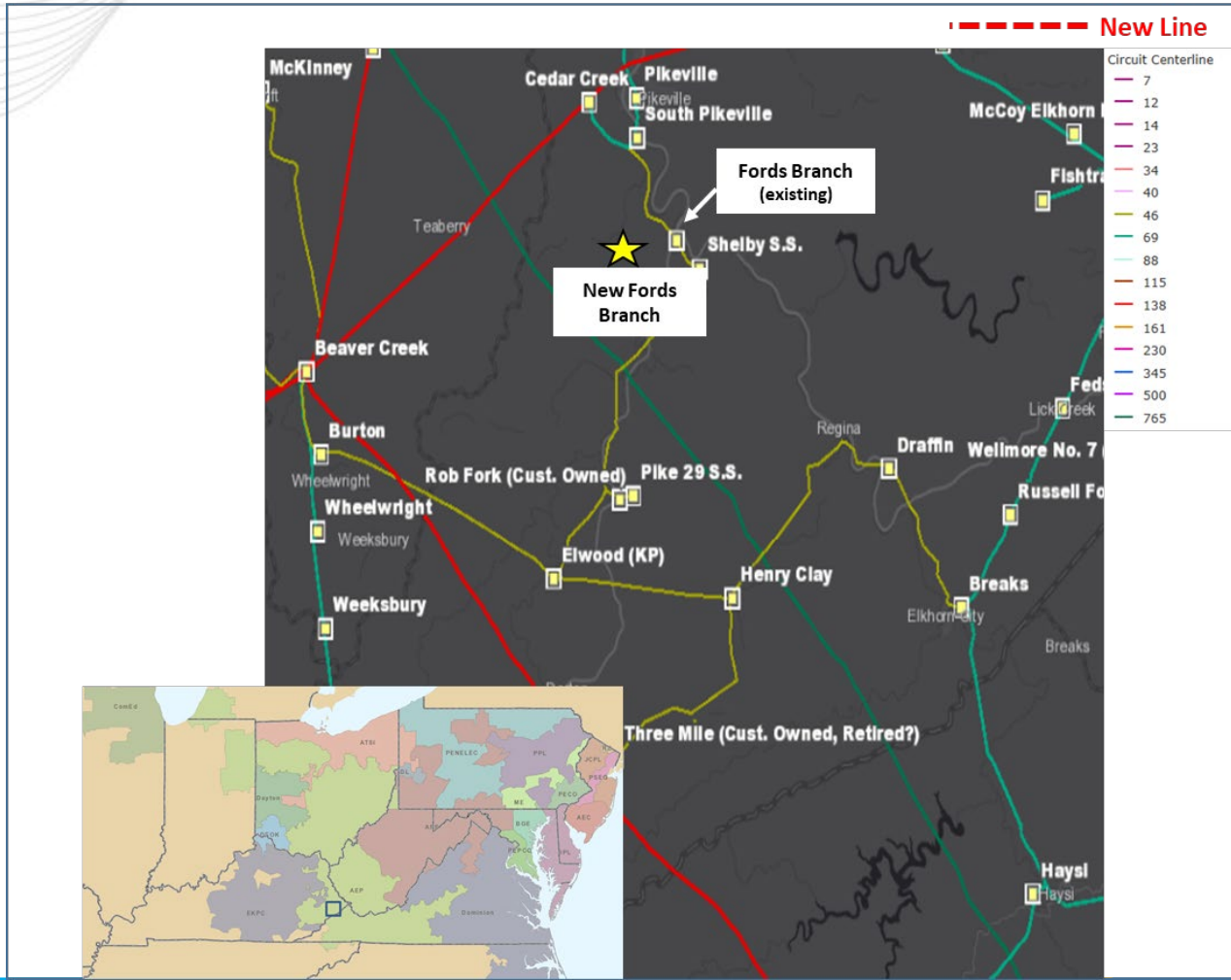
For the loss of the Henry Clay – Elwood 46 kV line section:

- 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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Planning Criteria Violations with the additional 40MW load:

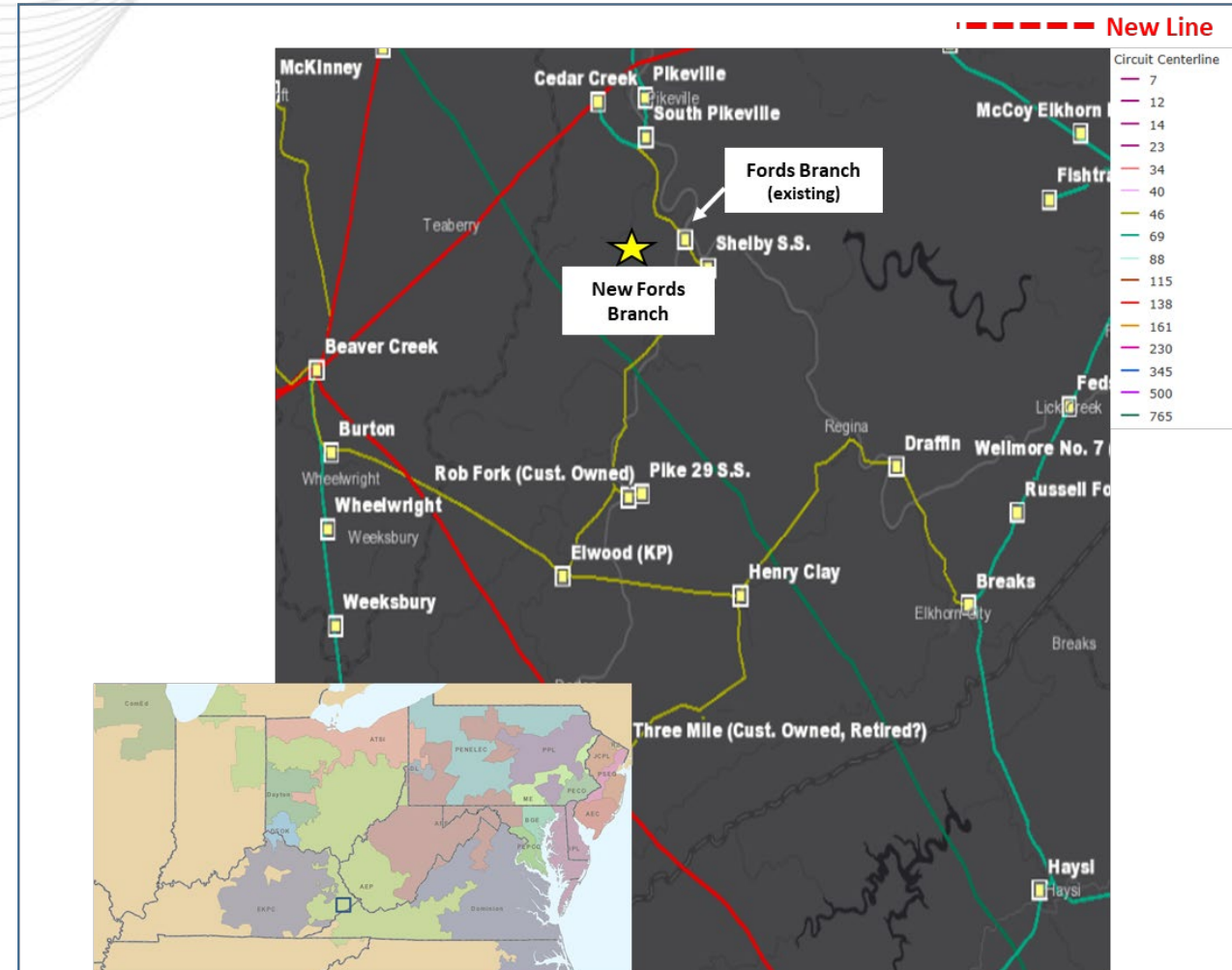
- For the loss of the Beaver Creek — Burton 46 kV line section:
 -A portion of the Cedar Creek — Fords Branch 46 kV line section (~3 mi.) will load to 109% of its conductor's winter emergency rating (61 MVA)
 -Voltage Magnitude issues are experienced at Fords Branch(.88pu) and Pike29 (.91pu) stations.

- 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.

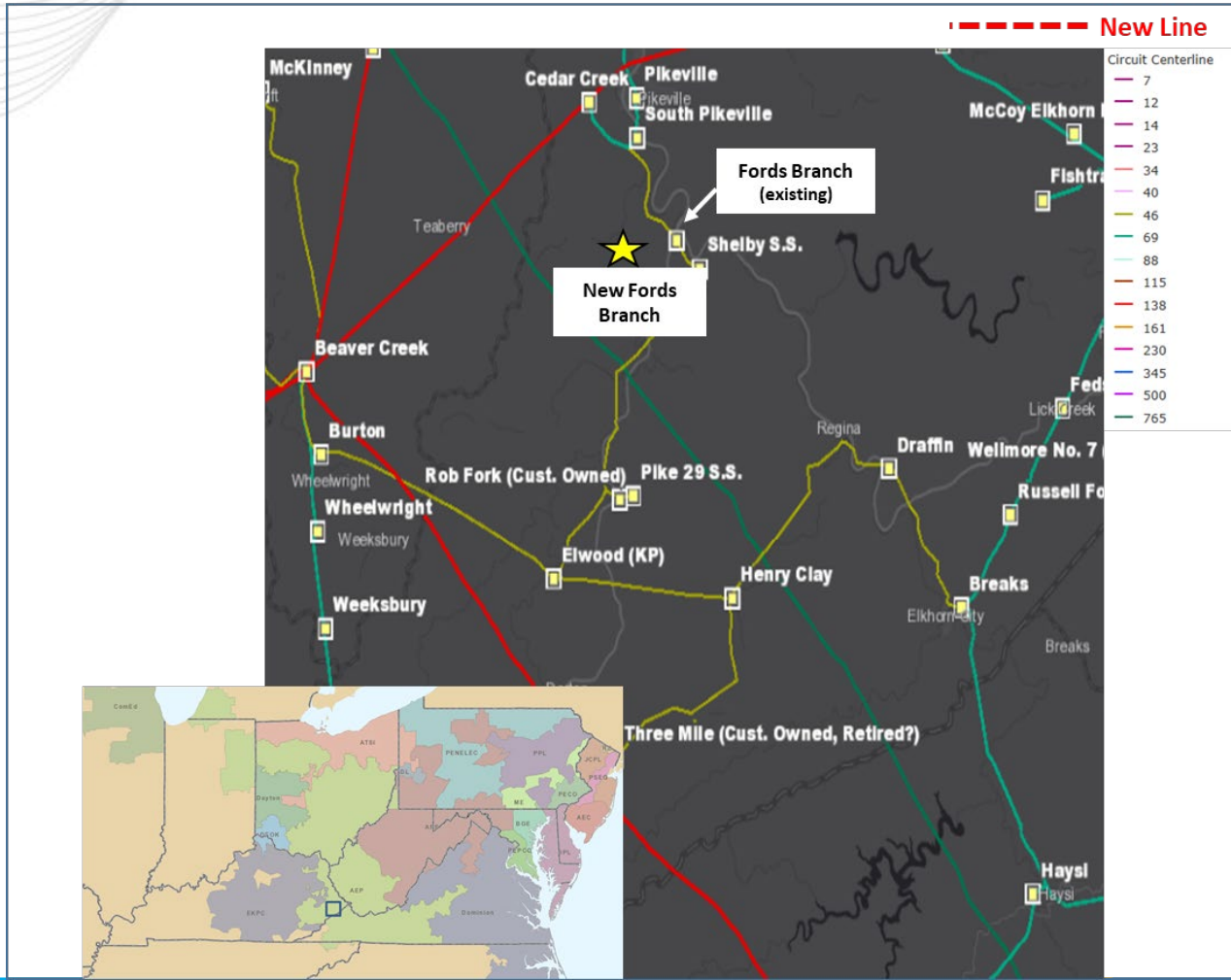
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Planning Criteria Violations with the additional 40MW load:

- 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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Planning Criteria Violations with the additional 40MW load:

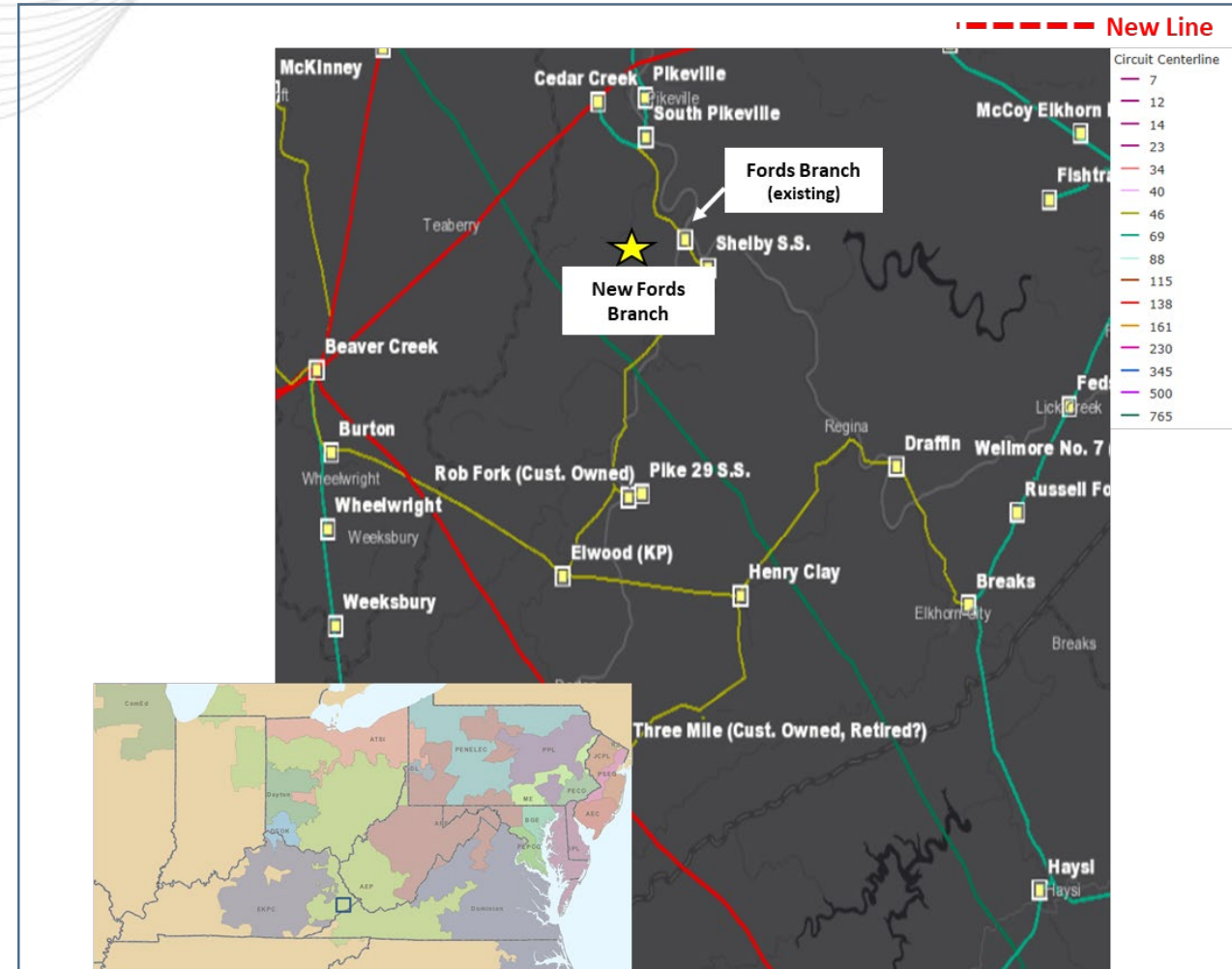
For loss of the Dorton 138/46 kV and Breaks 69/46 kV transformers:

- 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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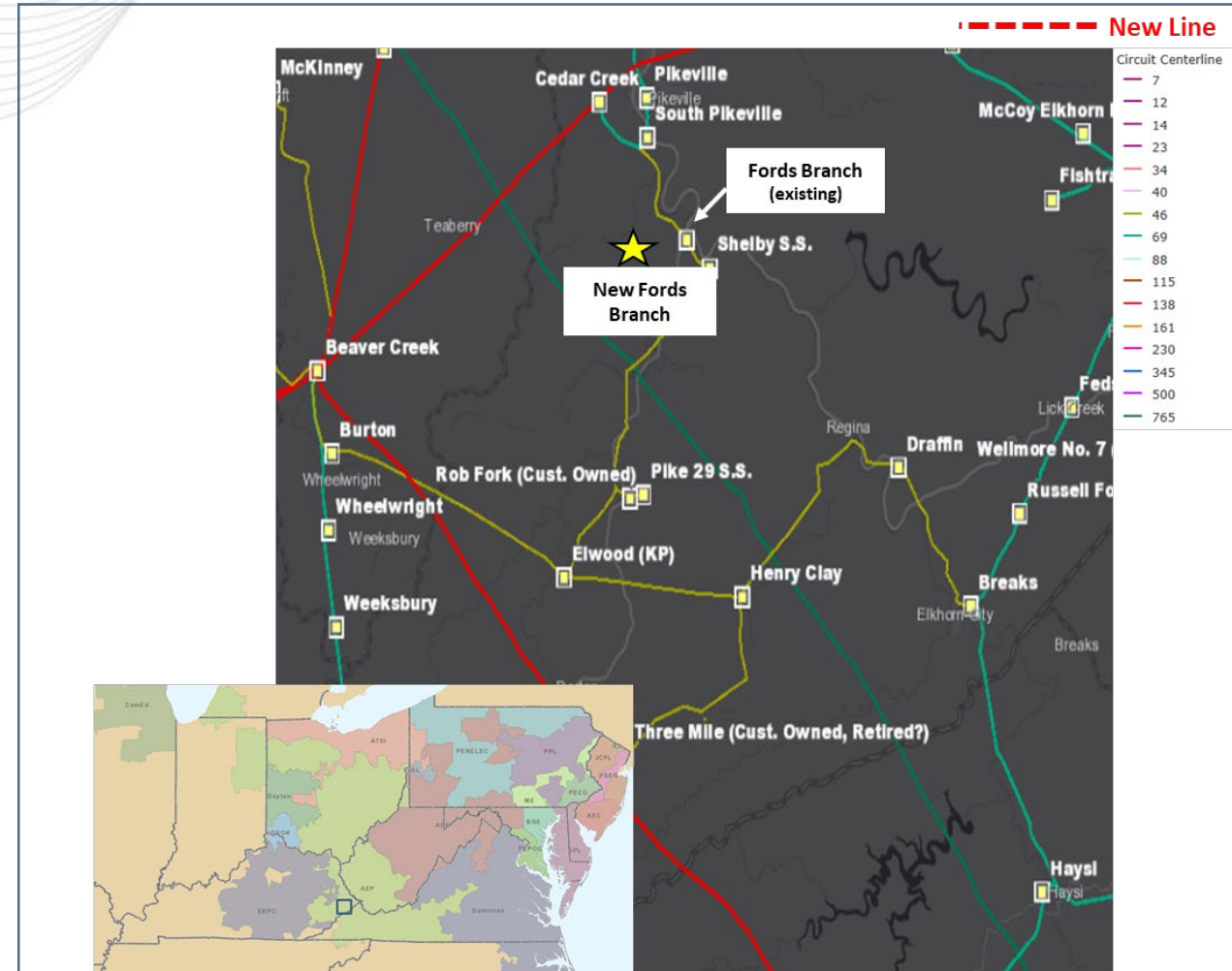
Equipment Material/Condition/Performance/Risk:

- 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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Selected Solution

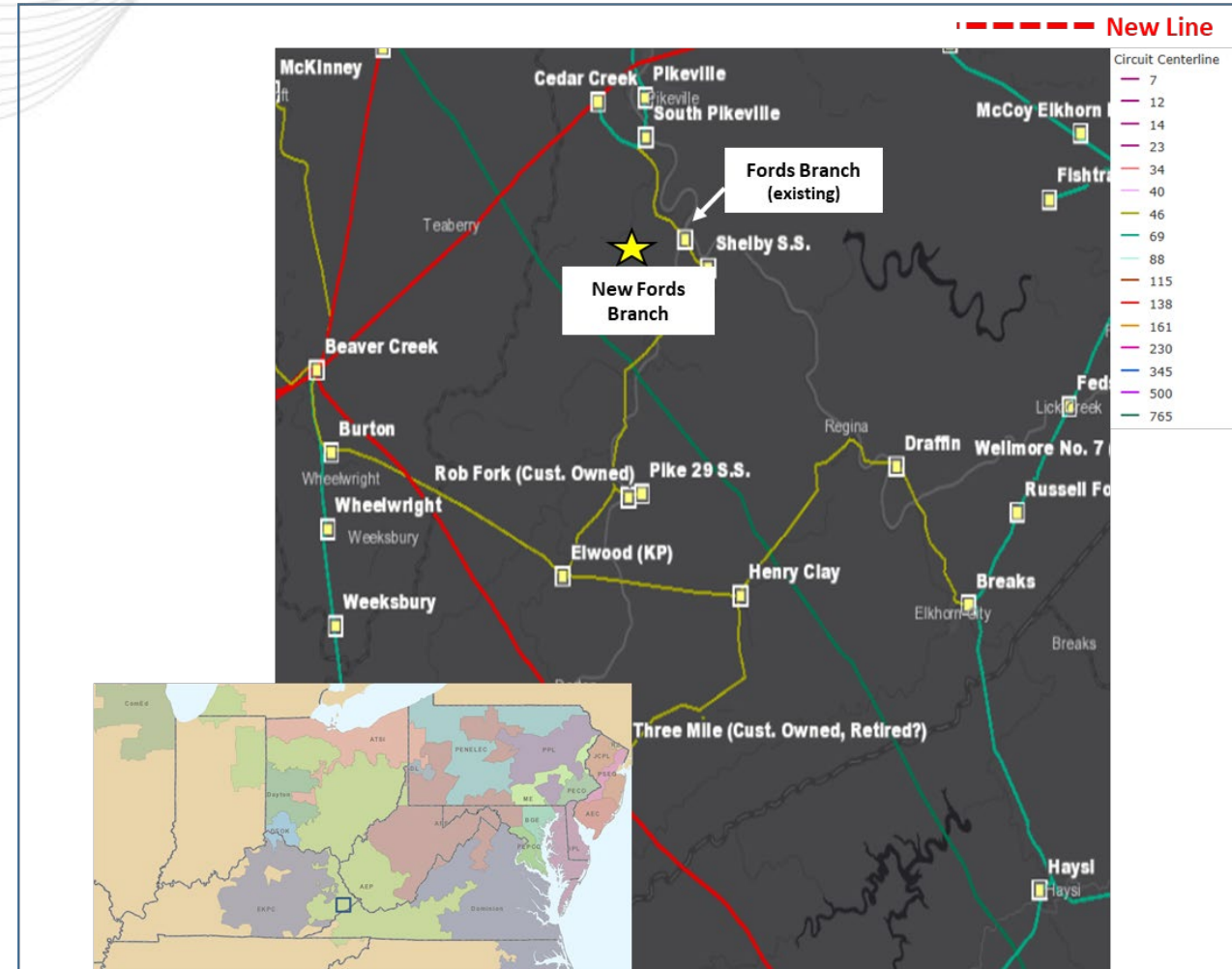
Construct a new greenfield station to the west (~1.5 mi.) of the existing Fords Branch Station, potentially in/near the new Kentucky Enterprise Industrial Park. This station will consist of six 3000A 40kA 138 kV breakers laid out in a ring arrangement, two 30 MVA 138/34.5 kV transformers, and two 30 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: ~~\$23.8 M~~ \$23.2 M

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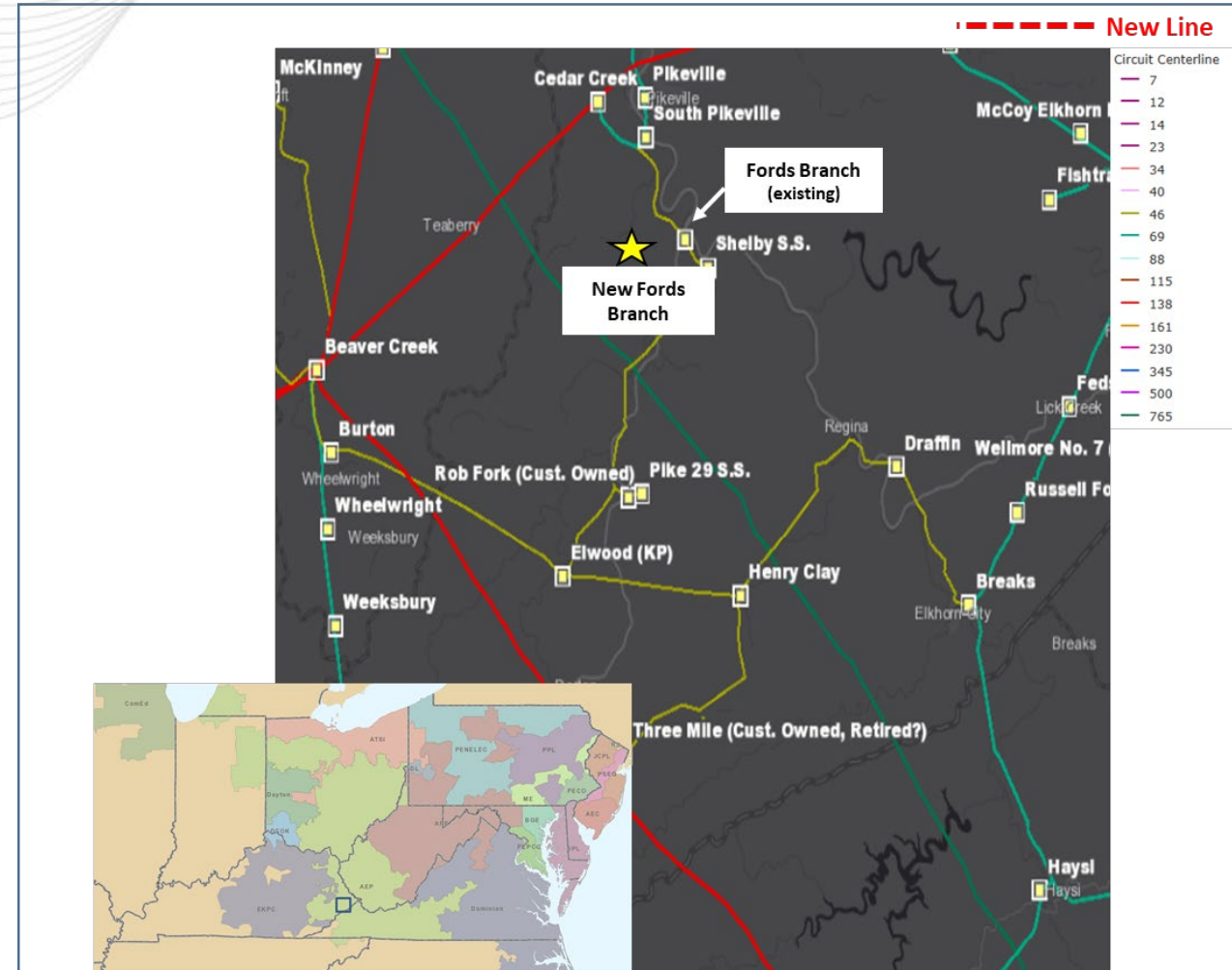
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Alternate #1

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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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 an 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

