SRRTEP Committee: Western AEP Supplemental Projects

June 19, 2020

Needs

Stakeholders must submit any comments within 10 days of this meeting in order to provide time necessary to consider these comments prior to the next phase of the M-3 process

AEP Transmission Zone M-3 Process
Scottsville, VA Area

Need Number: AEP-2020-AP032

Process Stage: Needs Meeting 06/19/2020

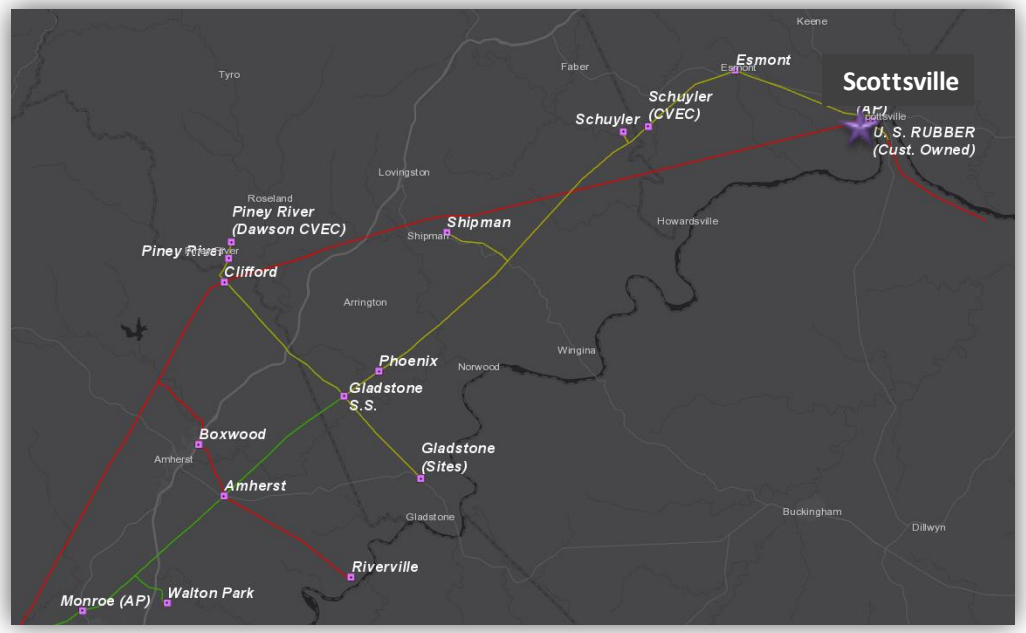
Supplemental Project Driver: Equipment Condition/Performance/Risk

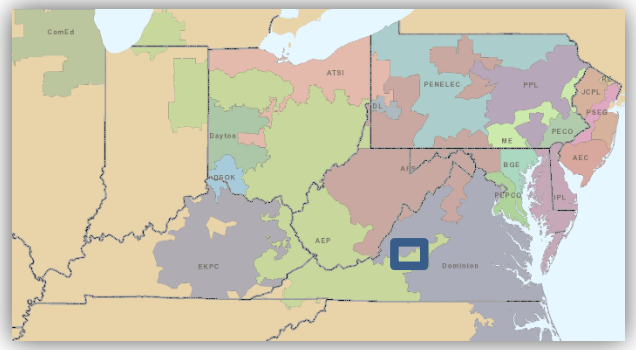
Specific Assumption Reference: AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:

Scottsville Station:

- 138/46 kV Transformer #1 (connected in parallel with T2)
  - 1950 Vintage Transformer
  - Unit has low levels of dielectric strength, indicating an increase in particles within the oil which decreases the ability to withstand fault events, leading to damage to the paper insulation.
  - Observed high oil power factor and low oil dielectric strength are strong indications of elevated moisture in the oil.
- 138/46 kV Transformer #2 (connected in parallel with T1)
  - 1954 Vintage Transformer
  - Elevated levels of carbon dioxide and ethane indicate excessive decomposition of the paper insulating materials.
  - An upward trend in insulation power factor indicates an increase in particles within the oil and the dielectric strength of the insulation system (oil and paper) are in poor condition, impairing the unit's ability to withstand electrical faults.
- 138/46 kV Transformer #5
  - 1950 Vintage Transformer
  - The paper insulating material is deteriorating, reducing the ability of the transformer to withstand through fault events, which could potentially lead to catastrophic failure.





AEP Transmission Zone: Supplemental
Washington, Virginia

Need Number: AEP-2020-AP035
Process Stage: Needs Meeting 06/19/2020

Supplemental Project Driver: Equipment Condition/Performance/Risk

Specific Assumption Reference:

AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

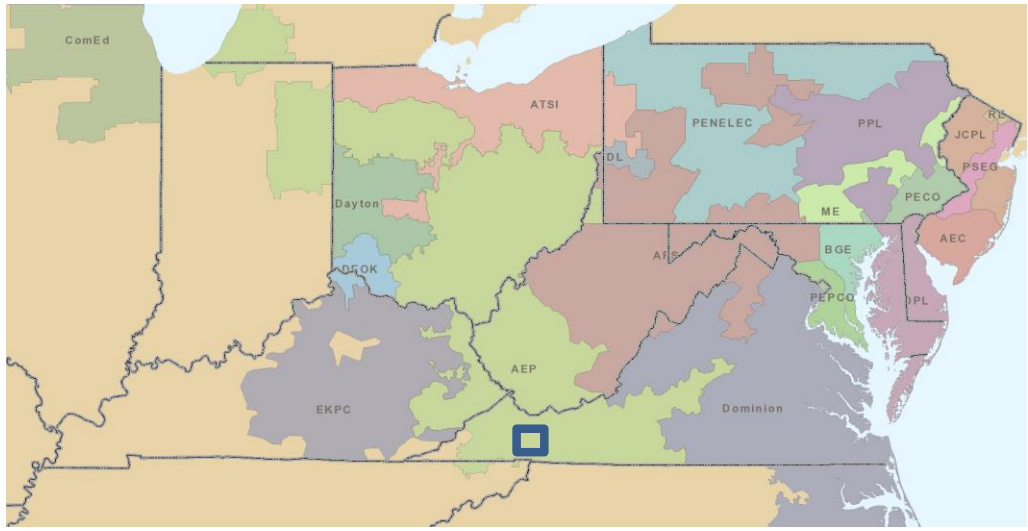
Problem Statement:

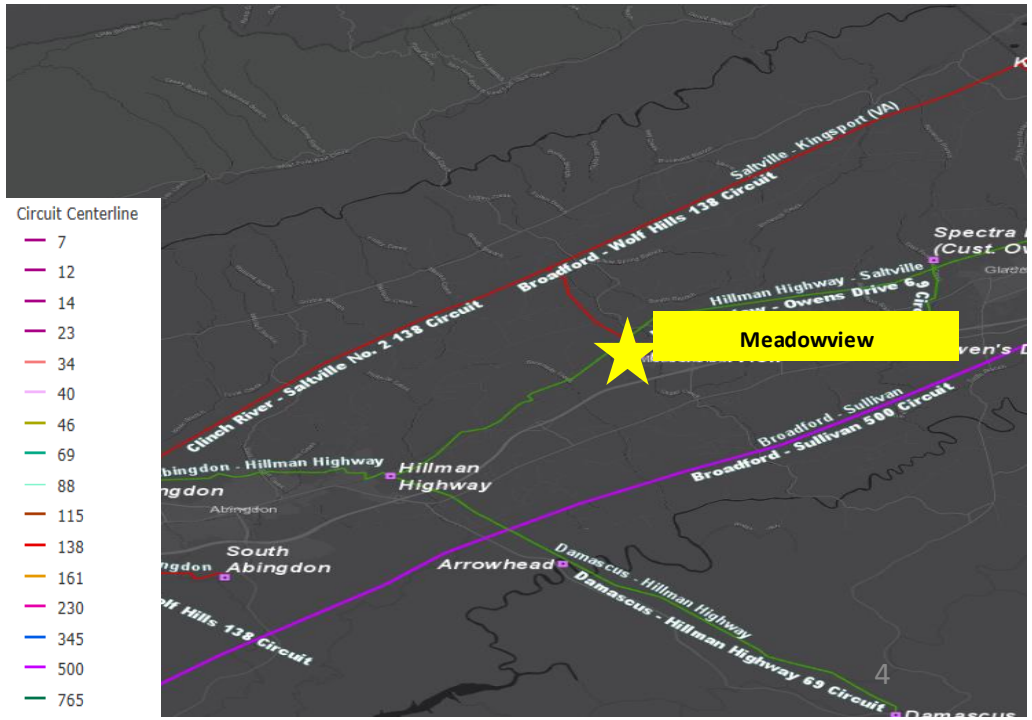
Station

Meadowview Station

Circuit Breakers F&G (69 KV) Concerns:

- Circuit Breakers F and G are 23 years old, 72PM31-20 type, SF6 filled breakers.
- Circuit Breakers F and G have experienced 88 and 72 total fault operations, respectively, exceeding manufacturer's recommended number full fault operations of 6.
- Circuit breakers of this type across the AEP system have had reports of moisture ingress into the breaker tank, which leads to increased maintenance and a higher risk of failure.
- This model type of breakers have experienced five catastrophic failures.
- There are documented issues with failures to close due to burned up coils, and 98 malfunction records related to SF6 gas leaks.





AEP Transmission Zone M-3 Process
Tuscarawas & Carroll County Ohio

Need Number: AEP-2020-OH029

Process Stage: Need Meeting 06/19/2020

Project Driver: Equipment Condition/Performance/Risk

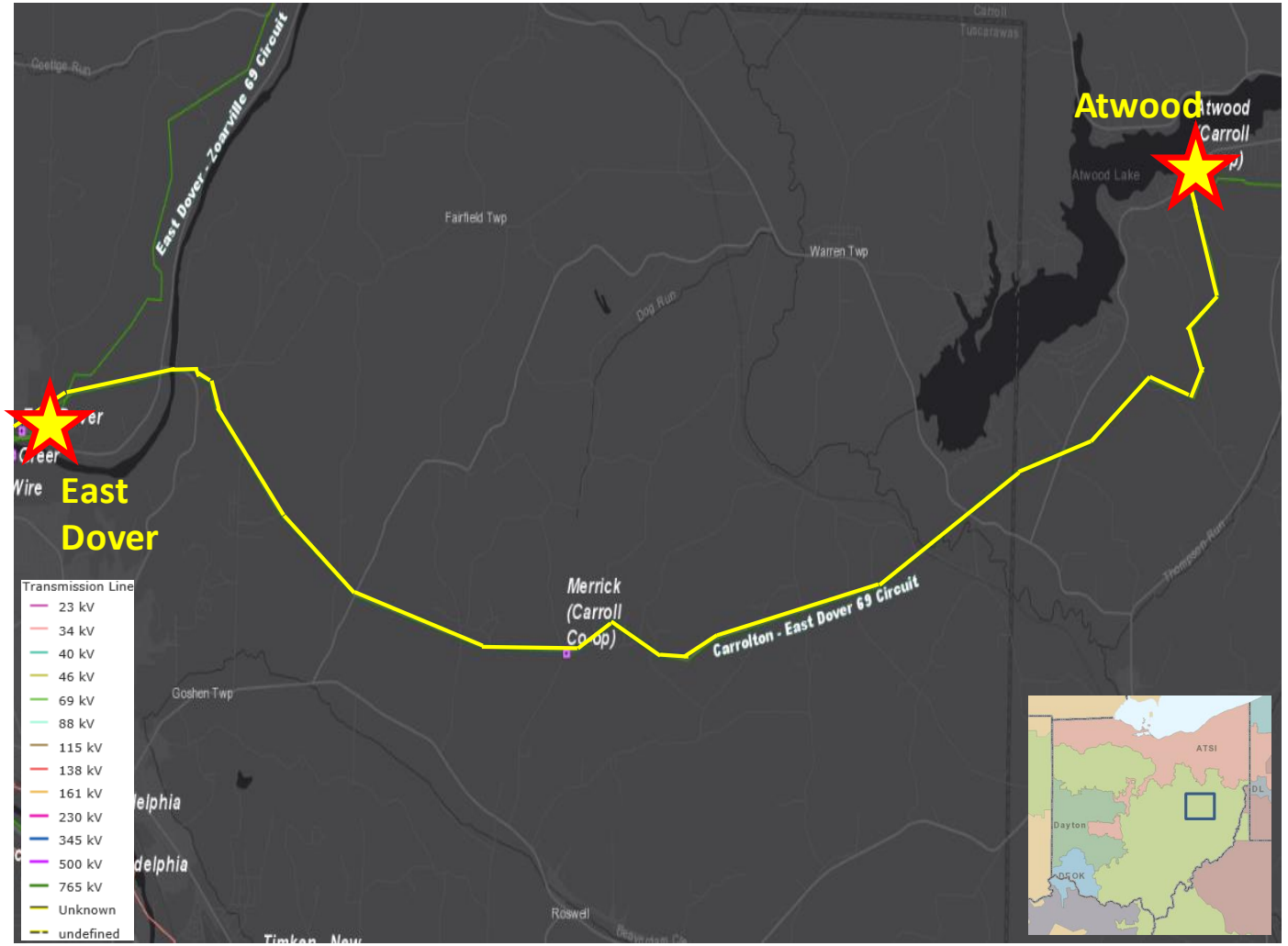
Specific Assumption Reference:

AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:

<u>East Dover Carroll Co-op 69kV (15.30 miles)</u>

- The line consist of wooden monopoles, H-frames and 3 pole structures.
- The line was originally built in 1958 with 4/0 ACSR conductor.
- There are currently 95 structures (55.5% of the line) with at least one open condition.
    - 69 structure with open conditions consisting of insect damage, rot top, rot heart, split crossarms, broken knee brace, rot shell, split poles and woodpecker holes.
    - 7 conductor based open conditions consisting of damaged conductors and malfunctioning splices.
    - 28 hardware based open conditions consisting of loose/broken insulators, burnt insulators, insulators missing bolts and broken/damaged/missing molding.
- For the 2015-2020 time period there have been 13 outage events on the Carrolton – East Dover Circuit. The permanent outages resulted in 2,344,426 minutes of interruption to the 2,643 customers served from the circuit (all Carroll Electric Co-op).



AEP Transmission Zone M-3 Process
Mansfield Ohio

Need Number: AEP-2020-OH034

Process Stage: Need Meeting 6/19/2020

Project Driver:
Equipment Material/Condition/Performance/Risk

Specific Assumption Reference:
AEP Guidelines for Transmission Owner Identified Needs.
Please reference needs materials on pre-1930s era Lattice Lines.

Problem Statement:

Line
Philo – Howard 138kV (vintage 1929):

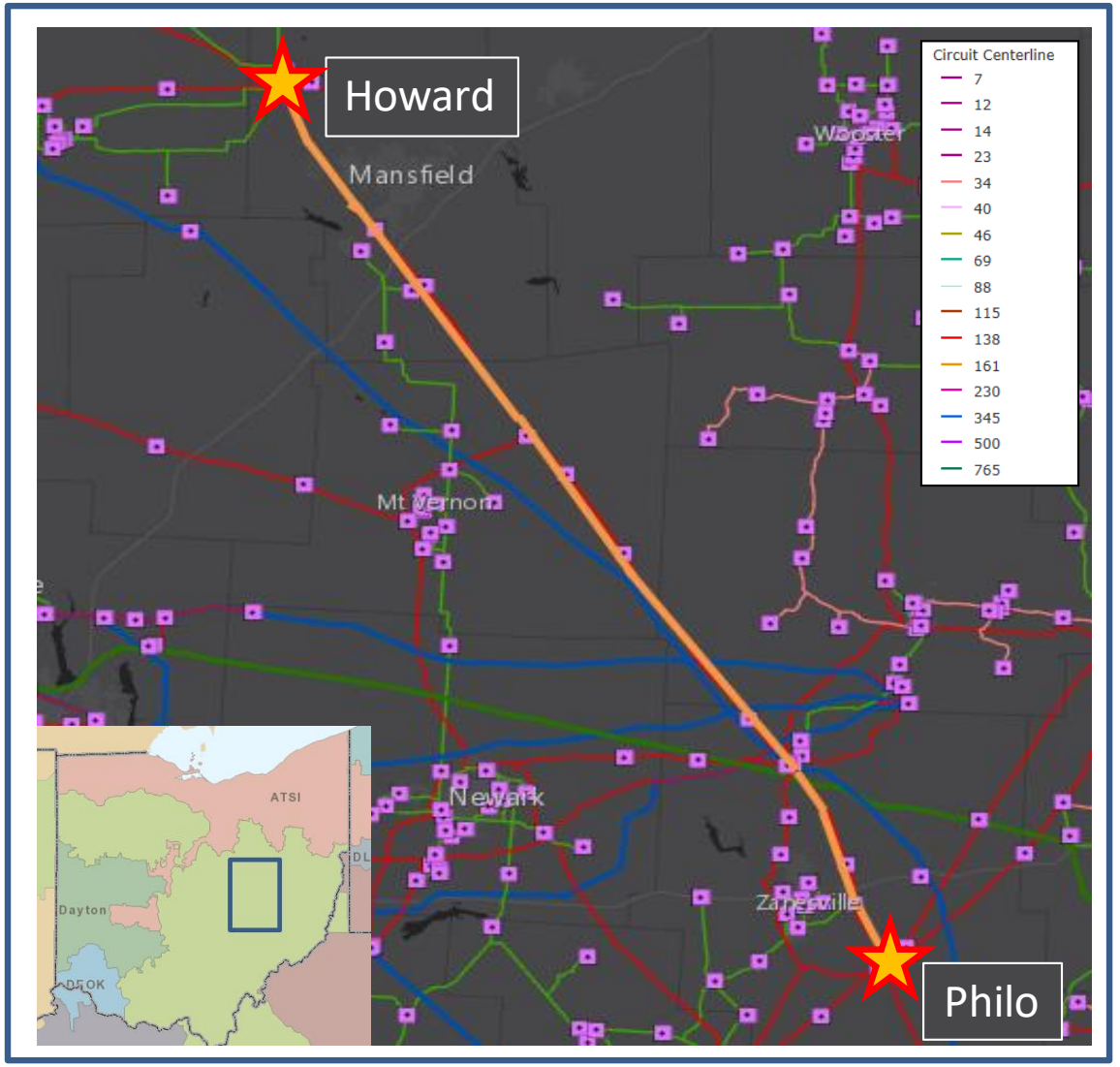
The Philo –Howard 138 kV line serves 60 MVA of load consisting of four AEP substations and three non-AEP substations.

LINE CHARACTERISTICS

- Length of Line: 81.15 Miles
- Original install date: 1929
- Total structure count: 404, 398 dating back to original installation.
- Conductor Type: 556,500 CM ACSR 18/1 (Osprey) and 556,500 CM ACSR 26/7 (Dove)

CONDITION / PERFORMANCE / RISK ASSESSMENT:

- Momentary/Permanent Outages and Duration: 35 total outages: 28 (Momentary), 7 (Permanent).
- 5 Year CMI: 2,667,652
- Number of open Structure, Conductor, and Hardware conditions: 149
    - Conditions include broken conductor strands, burnt insulators, along with broken/damaged lattice members and hardware.
- Structures with at least one open condition: 55
- The line does not meet current grounding and shielding requirements, due to the condition of the obsolete shield wire size (159 ACSR), and the line shielding angle being inadequate. This T-line exhibits similar conditions as the examples listed in AEP's pre-1930's steel lattice tower line presentation.



Solutions

Stakeholders must submit any comments within 10 days of this meeting in order to provide time necessary to consider these comments prior to the next phase of the M-3 process

Need Number: AEP-2018-AP011

Process Stage: Solutions Meeting 06/19/2020

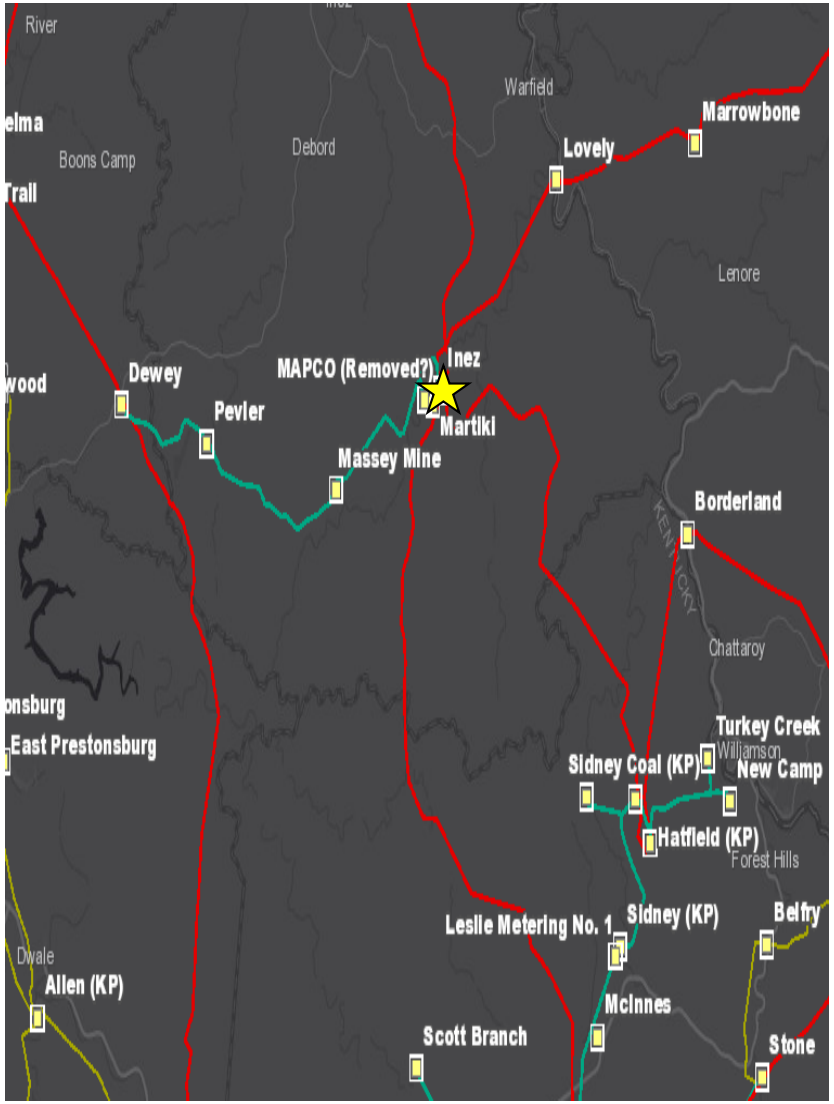
Process Chronology: Needs Meeting 11/29/18

Supplemental Project Driver: Equipment Condition/Performance/Risk

Specific Assumption References: AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:

Capacitor switchers 'BB' and 'CC' at Inez station are Mark V model which no longer support modern relaying packages. Mark V's have been historically prone to mechanism failures and are being replaced system wide where possible. S&C circuit switcher 'AA' at Inez station is an S&C 2030 type with no gas monitor.
The Inez 138 kV yard was designed as a breaker and a half station, but the 'B' string was never completed leaving dissimilar zones of protection between the #1 bus and 20+ mile Inez to Johns Creek 138 kV circuit. Dissimilar zones of protection also exist between the 138 kV bus #2, 138/69 kV transformer #1, and the 138 kV circuit to the Martiki coal service point.



AEP Transmission Zone: Supplemental
Martin County, Kentucky

Need Number: AEP–2019-AP047

Process Stage: Solutions Meeting 06/19/2020

Previously Presented: Needs Meeting 12/18/2019

Supplemental Project Driver: Equipment Material/ Condition/Performance/Risk

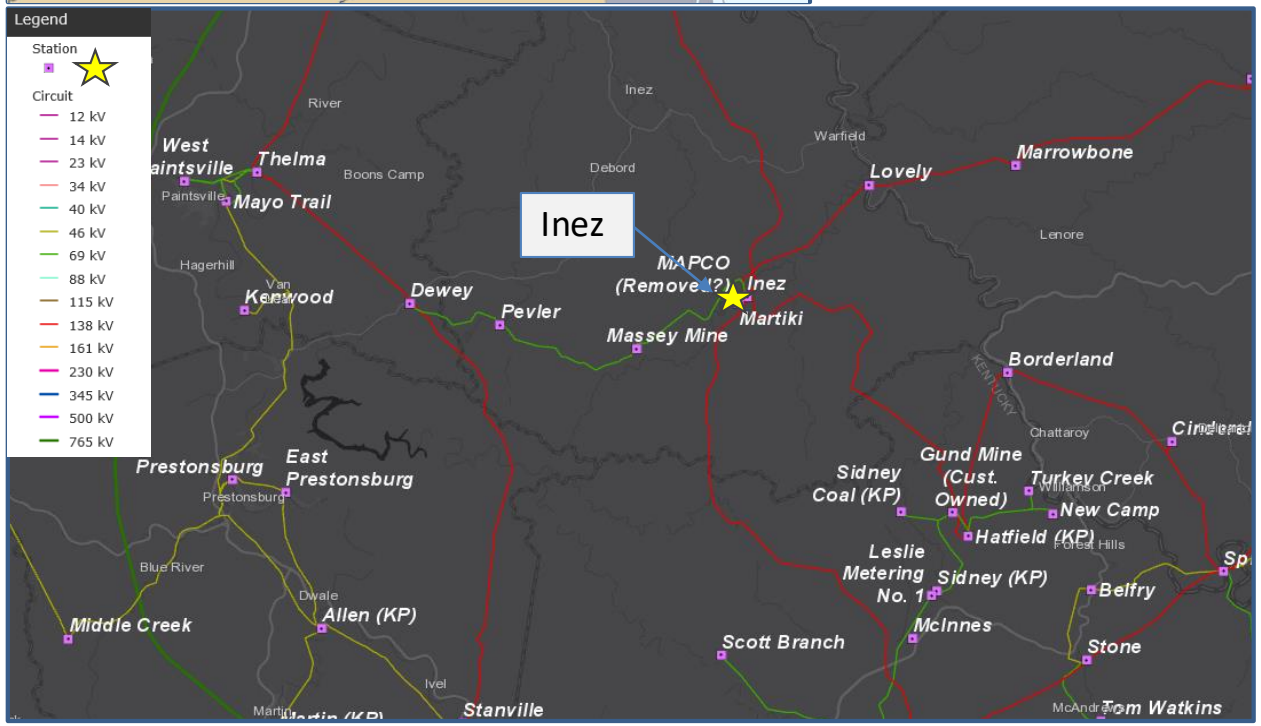
Specific Assumption References:

AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Model: N/A

Problem Statement:

- The 138/69kV-13.09kV TR1 is 1967 vintage and has seen significant increases in moisture levels and power factor which indicate a rise in concentrations of harmful particles within the oil. The Short Circuit strength is decreased due to the age of this unit's insulation materials. As the insulating paper ages, it becomes brittle allowing for increased susceptibility to short circuit faults causing failure of the main tank. The transformer has numerous observed oil leaks including fluid leaking from the internal wiring.
- The four 138kV circuit breakers, B, B2, C and C1, are 1990's vintage SF6, HVB145-40000-A type breakers. The circuit breakers have experienced the following fault operations: CB B (38), B2 (22), C (99), and C1(70). CB-B had 52 leaks reported in malfunction records related to low SF6 gas levels. CB-B2 had 24 and CB-C1 had 10 reported SF6 leaks.
- Inez Substation currently deploys 105 relays to ensure the adequate protection and operation of the substation. Currently, 71 of the 105 relays (68% of all station relays) are in need of replacement due to obsoleteness. 61 are of electromechanical type, six are static type, and four are discontinued microprocessor relays.



AEP Transmission Zone M-3 Process
Martin County, Kentucky

Need Number: AEP-2018-AP011, AEP-2019-AP047
Proposed Solution:

- At Inez station, replace Breakers B, B2, C and C1. Install three new 138kV breakers and create third string in the existing breaker and half configuration. Replace 138/69kV Inez Transformer #1 with a 138/69kV/12kV 90 MVA autotransformer. Move the new Inez 139/69/12kV Transformer #1 and Martiki 138kV feed to the new string. Install Breaker B1 towards Johns Creek to complete the string. Installation of Breaker B1 and the third string addresses dissimilar zones of protection between the #1 bus and 20+ mile Inez to Johns Creek 138 kV circuit and dissimilar zones of protection between the 138 kV bus #2, 138/69 kV transformer #1, and the 138 kV circuit to the Martiki coal service point. Replace Cap bank switchers CS-BB and CS-CC with 138kV circuit breakers. Replace obsolete relays at Inez substation. Retire 69kV Capacitor Bank and the circuit switcher AA. **Estimated Cost: $10.7 M (includes Breaker B1 install cost of $0.8M)**

- Remote end work at Big Sandy, Logan, Sprigg and Dewey substations. **Estimated Cost: $1.7M**

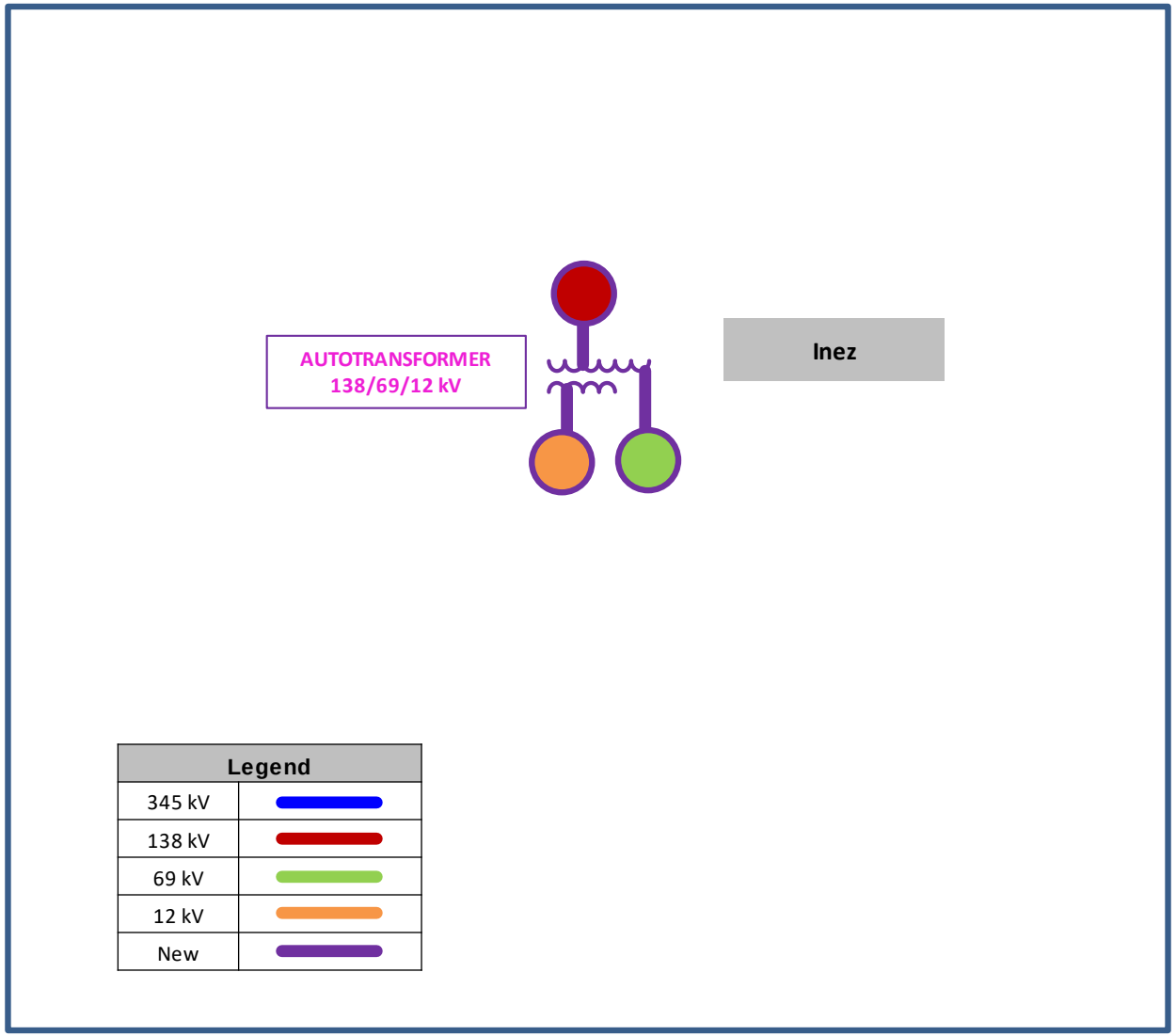
Total Estimated Transmission Cost: $12.4 M

Alternatives considered:

- Rebuild Inez station in the clear. Considering available space, outage availability, and number of lines that would need to be relocated, this option was eliminated. **Total Estimated Cost:** $20M

Projected ISD: 09/01/2022

Project Status: Scoping



AEP Transmission Zone M-3 Process
Columbus, Ohio

Need Number: AEP-2018-OH018

Process Stage: Solutions Meeting 06/19/2020

Previously Presented: Needs Meeting 11/29/18

Supplemental Project Driver: Equipment Material/Condition/Performance/Risk, Operational Flexibility and Efficiency

Specific Assumption References: AEP Guidelines for Transmission Owner Identified Needs

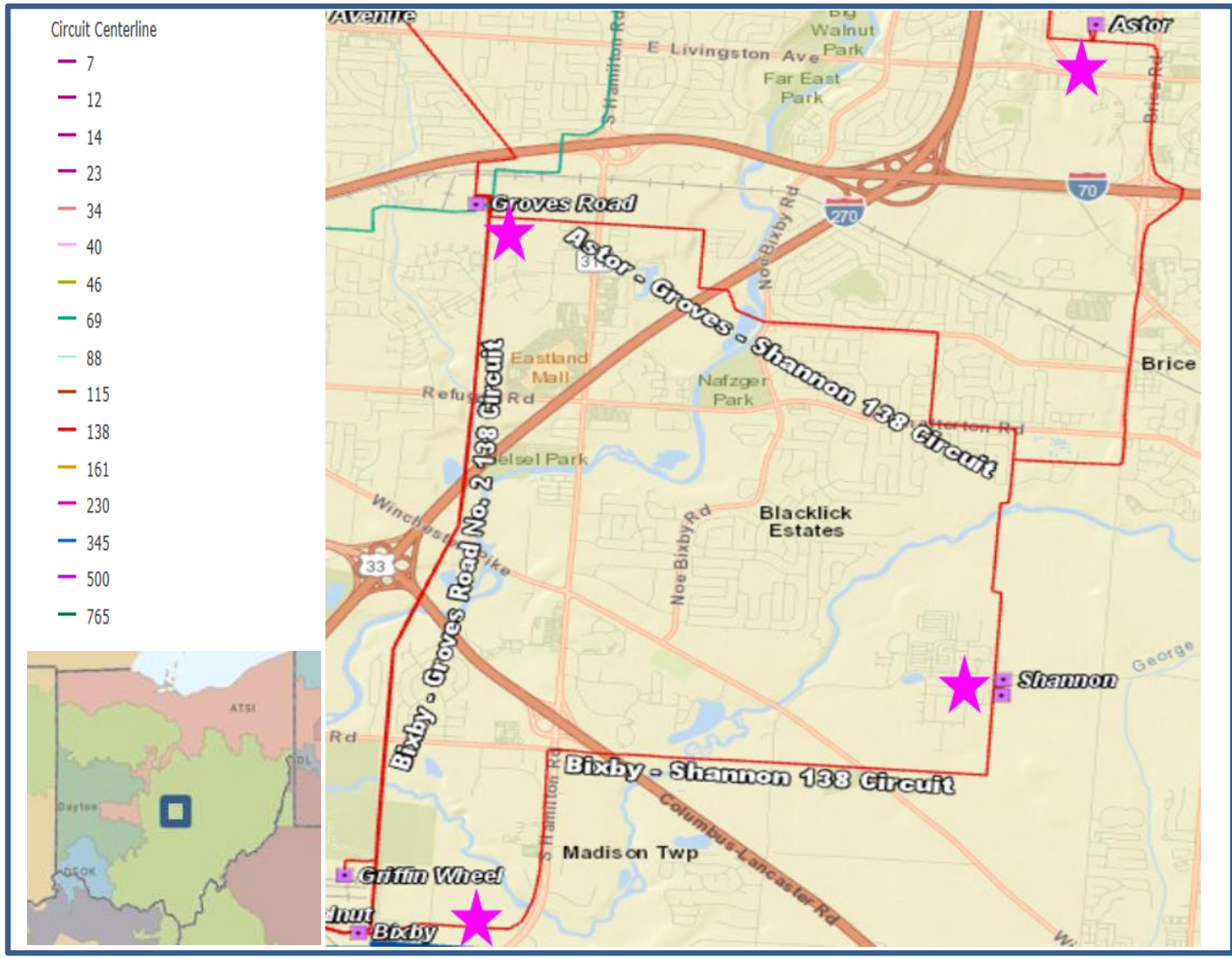
Problem Statement:

- A study of the current physical loading capability of the structures along the Astor-Shannon-Groves & Shannon – Bixby 138 kV circuits revealed that many of the poles are currently overloaded under NESC Heavy Loading Conditions. Additionally, the line structures are unable to handle the addition of telecom fiber, which is needed to improve communications in this area.

Existing NESC Heavy Loading Conditions:

- 36% of poles on the Astor-Bixby 138 kV circuit show overloading.
- 29% of poles on the Bixby – Shannon 138 kV circuit show overloading.
- 20% of the poles on the Shannon – Refugee 138 kV circuit show overloading.
- 58% of poles on the Refugee – (Future) Brice 138 kV circuit show overloading.
- 35% of poles on the (Future) Brice – Astor 138kV circuit show overloading.
- Primarily 1952 wood poles (57% of total line)
- Conductor is all from 1952
- 43 (out of 155) structures on the circuit have at least 1 open condition (28%), with a total count of 63 open conditions.

  23 reported closed conditions – 1 forestry, 4 conductor, 18 structure
- No outage history (0 CMI/CI)
- The Astor-Groves-Shannon 138 kV circuit is a three-terminal line, which limits sectionalizing and can cause mis-operations and over tripping.
- Astor 138 kV Station has ground switch MOAB's on both 138/13 kV transformers. Ground switch MOABs cause intentional high side faults, which can damage nearby equipment.



AEP Transmission Zone M-3 Process
Columbus, Ohio

Need Number: AEP-2018-OH018

Process Stage: Solutions Meeting 06/19/2020

Selected Solution:

- Rebuild ~5.0 miles of 138 kV line between Astor - Shannon. The existing Refugee Switch will be retired. **Cost: $21.8M**
- Rebuild ~0.5 miles and construct ~4.6 miles of greenfield 138 kV line between Groves - Shannon to eliminate the three terminal line. **Cost: $22.0M**
- Rebuild ~4.3 miles of 138 kV line between Bixby – Shannon. **Cost: $15.1M**
- Reconfigure lines at Shannon to accommodate the new 138 kV circuit from Groves. Install two new 138 kV 3000A 40 kA circuit breakers on circuits towards Brice and Bixby to prevent dissimilar zones of protection when bringing the 3rd 138 kV circuit to the station. **Cost: $1.9M**
- **Total Estimated Cost: $60.8M**

Ancillary Benefits: Provides a third transmission source into AEP Ohio's Shannon station (35 MVA/ 90 MVA capacity) that has limited ability to transfer load.

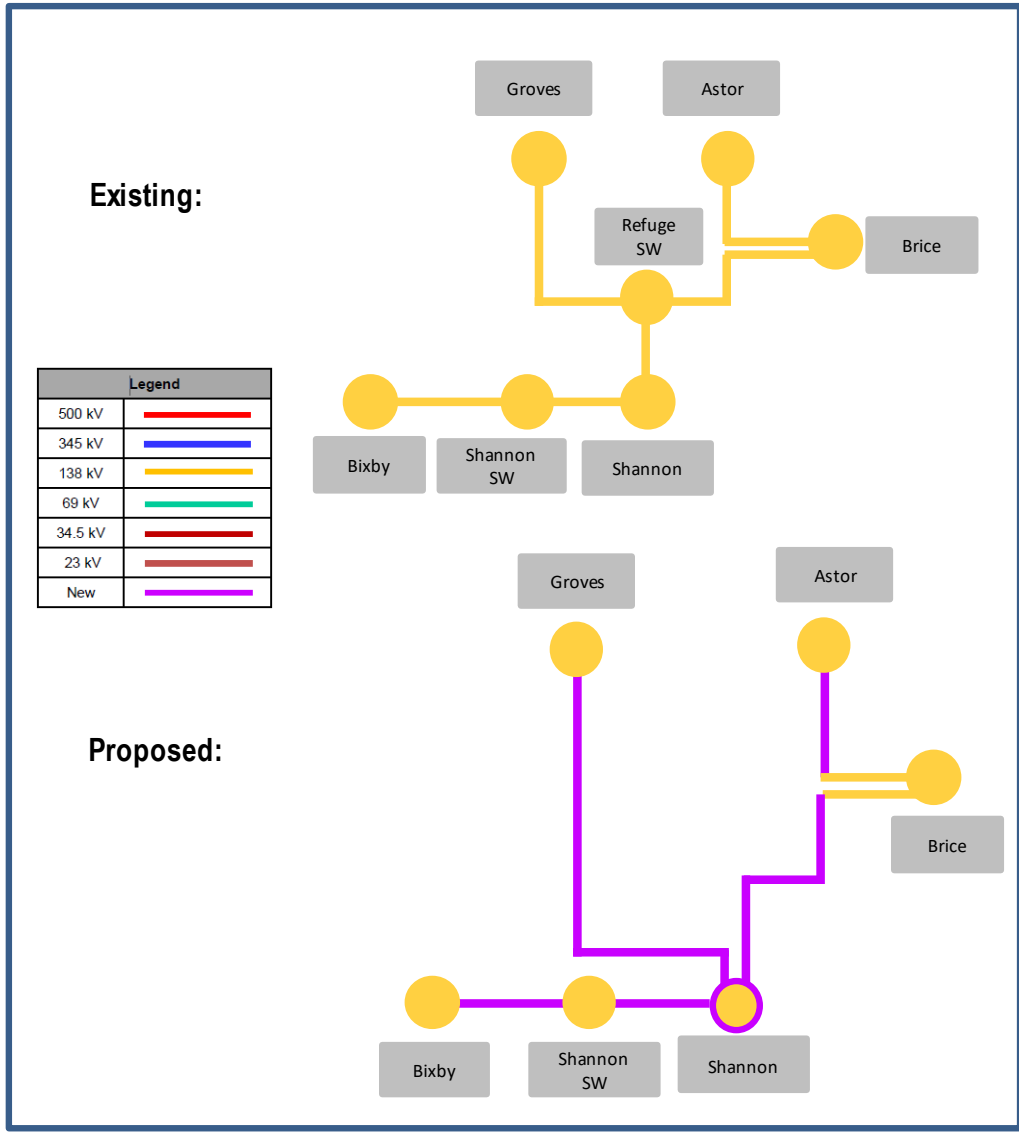
Alternatives Considered:

Rebuild the existing Astor – Refugee (3.5 mi.) and Groves – Refugee (3.9 mi.) line sections as single circuit and rebuilding the Refugee - Shannon line section (1.5 mi.) as double circuit to eliminate the three terminal point at Refugee Switch. Significant ROW and siting concerns were identified on the existing line route between Groves and Refugee. The congested urban environment where these lines are located make any route to get from Groves to Refugee Switch either cost prohibitive or infeasible.

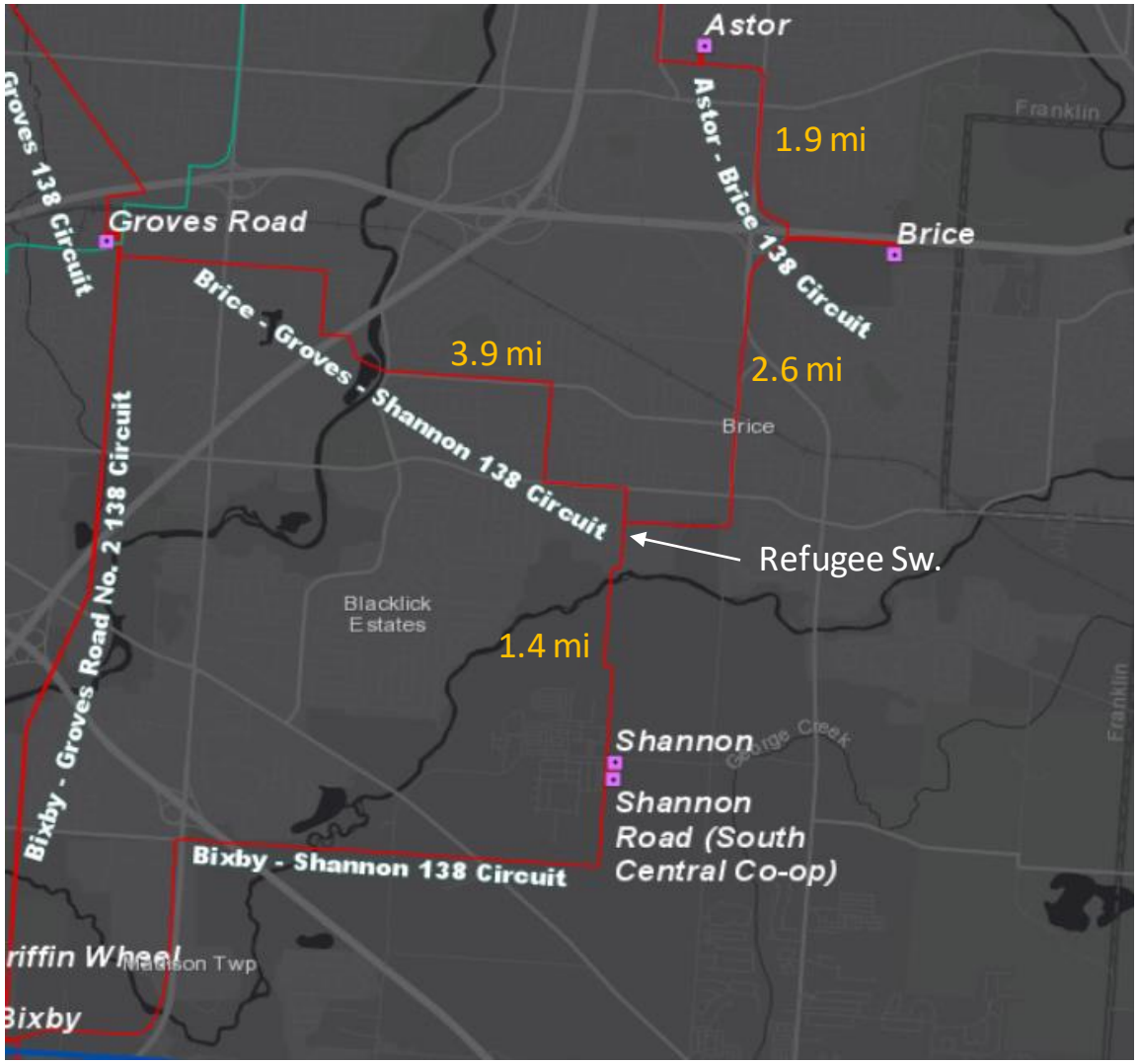
Replacing the existing Refugee Sw with a station to eliminate the three terminal point on the circuit was also considered but the ROW and siting challenges associated the Groves – Refugee line section also eliminated this as a feasible alternative.

Projected In-Service: 11/1/2024

Project Status: Scoping



Before



After

AEP Transmission Zone M-3 Process
Centerburg Area, Ohio

Need Number: AEP-2019-OH039
Process Stage: Solutions Meeting 06/19/2020

Previously Presented: Needs Meeting 06/17/2019

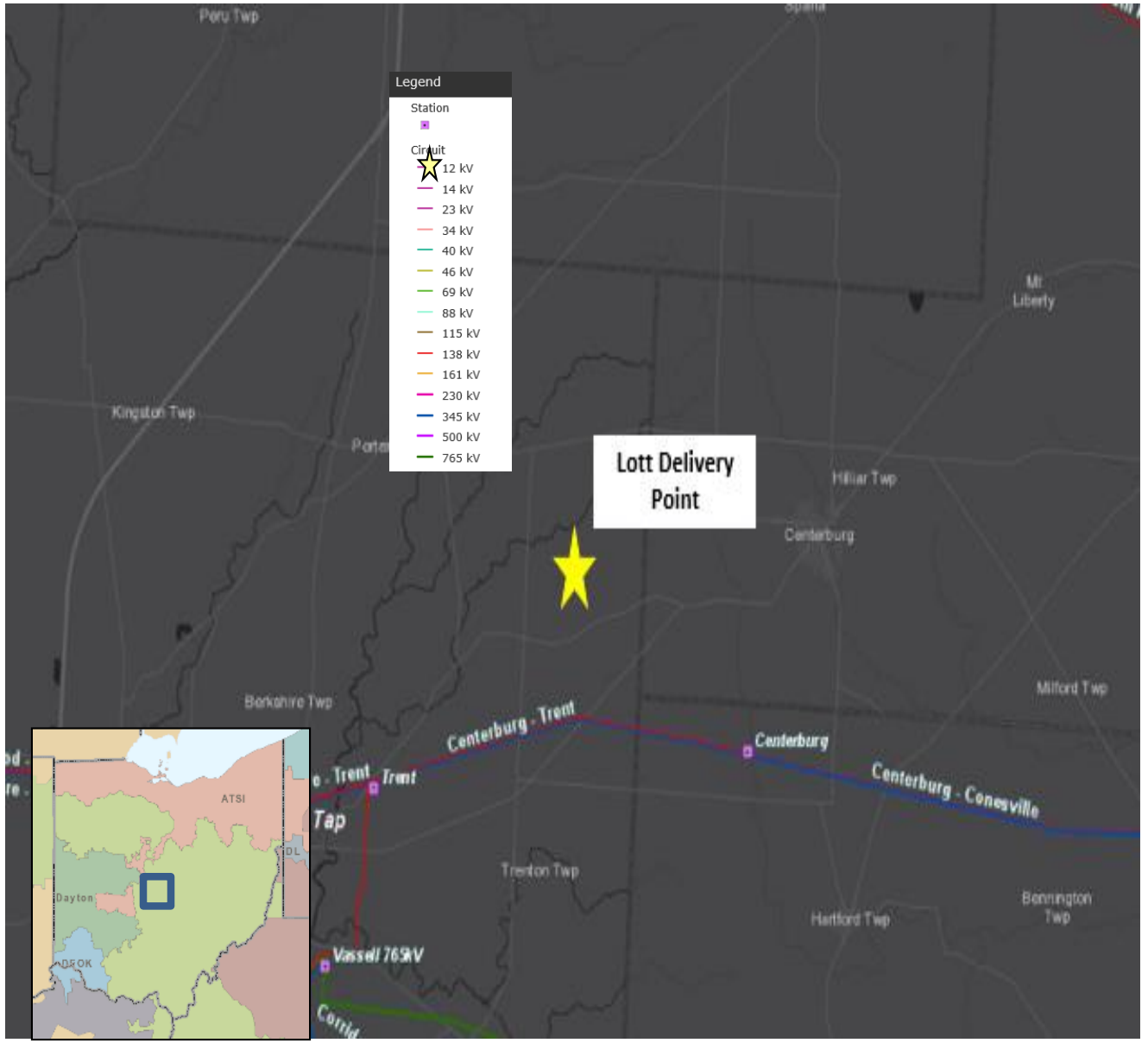
Supplemental Project Driver:
Equipment Condition, Operational Flexibility, and Customer Service

Specific Assumption Reference:
AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions slide 8); AEP Connection Requirements for the AEP Transmission System (AEP Assumptions Slide 7)

Problem Statement:

Lott Delivery Point (CEC):

- Buckeye Power, on behalf of Consolidated Electric Cooperative, has requested transmission service in Delaware County west of Centerburg, Ohio.
- Consolidated Electric Cooperative customers are currently connected to a radial 34.5 kV distribution line from AEP Ohio's Trent station.
- The delivery point has consistently been identified as having poor reliability by Buckeye.
- Consolidated Electric Cooperative has reported approximately 700 thousand customer-outage minutes (CMI) over a three year period (2015-2017).



AEP Transmission Zone M-3 Process
Centerburg Area, Ohio

Need Number: AEP-2019-OH039

Process Stage: Solutions Meeting 6/19/2020

Proposed Solution:

- Build ~ 3.75 miles of single circuit 138kV transmission line from new Condit 3-way MOAB Switch (tapping the Centerburg – Trent 138kV circuit) to Lott station (Consolidated Co-op). **Estimated Cost: $9.86M**
- Build Condit 3-way MOAB 138kV switch **Estimated Cost: $ 0.78M**

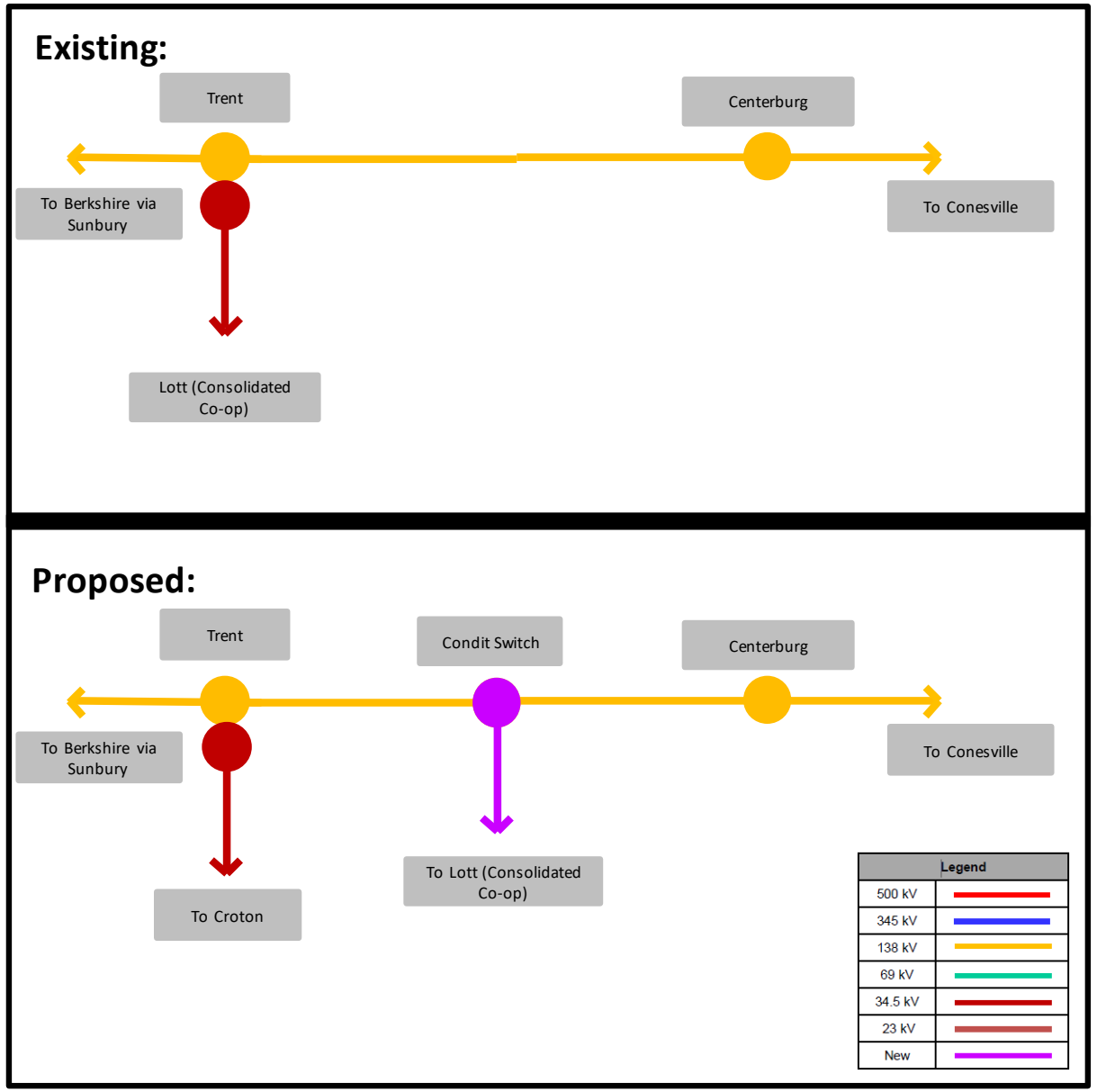
Total Estimated Transmission Cost: $10.64M

Alternatives Considered:

Tap the Centerburg – Trent 138kV circuit and construct approximately 3.75 miles of double circuit 138kV line to a point just outside of the customer's Lott station. Install a new three-way POP MOAB switch at this point just outside of Lott station with a couple spans of single circuit conductor from the switch to the Lott station delivery point. In working with the customer it was determined that given the ability for the load to be transferred elsewhere, a radial service would be adequate for this delivery. **Estimated Cost: $11.63M**

Projected In-Service: 6/1/2024

Project Status: Scoping



AEP Transmission Zone M-3 Process
Columbus, OH

Need Number: AEP-2020-OH013

Process Stage: Solutions Meeting 06/19/2020

Previously Presented: Needs Meeting 02/21/2020

Supplemental Project Driver: Equipment Condition/Performance/Risk

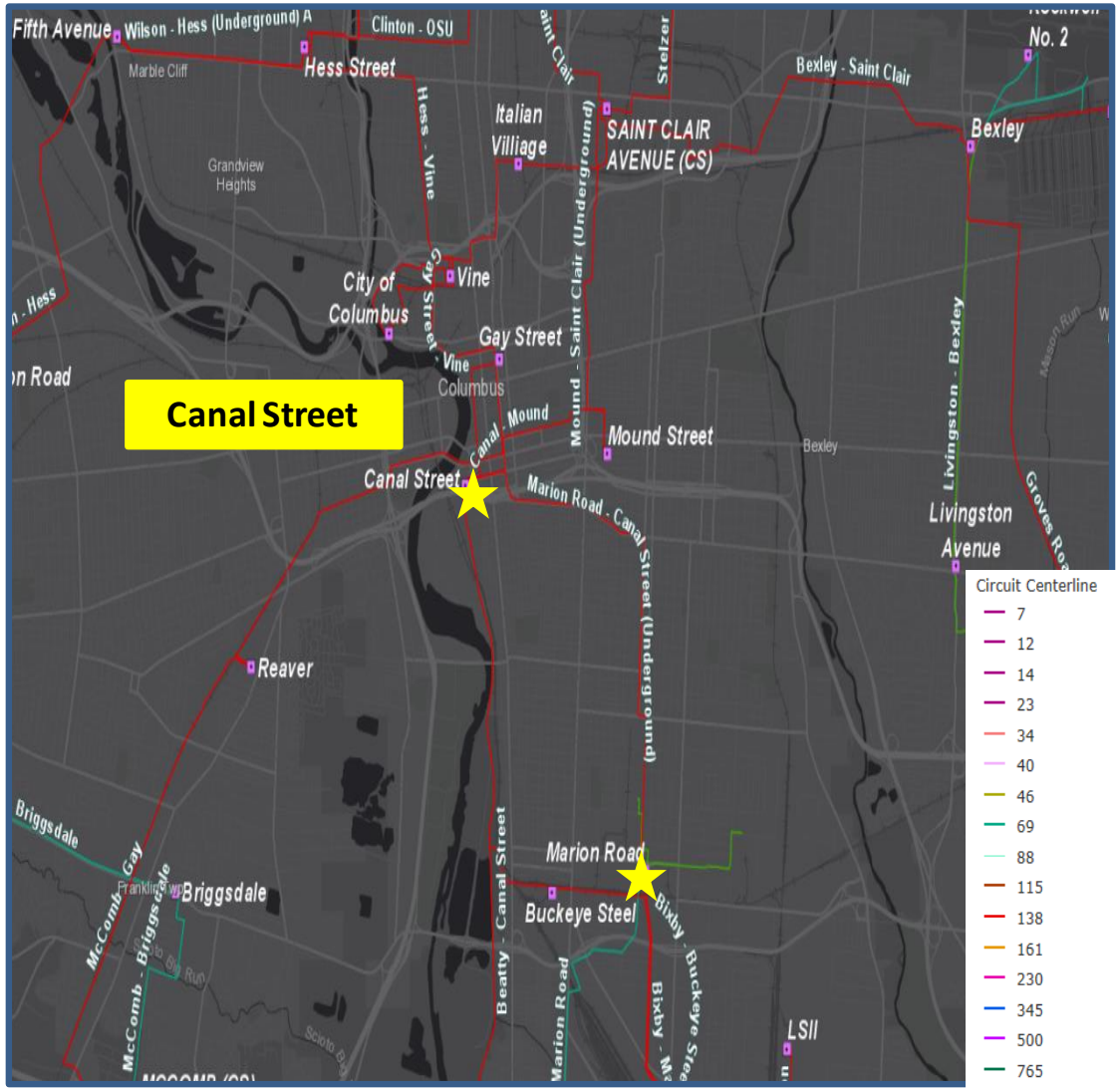
Specific Assumption Reference: AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8), Customer Service

Problem Statement:

Canal Street – Marion Road 138 kV Underground Circuit

- Ohio Department of Transportation (ODOT) has requested that approximately 1500 feet of the existing Canal – Marion 138 kV underground circuit be relocated as part of a planned Interstate improvement project.
- The existing Canal – Marion 138 kV underground circuit is approximately 3.8 miles long and was originally installed in the 1950's.
- The circuit utilizes an underground oil-filled pipe type cable design. Oil-filled pipe type underground cables come with several challenges/risks in densely populated urban areas. Lead times for replacement/repairs from the remaining single vendor can be 6 months to a year. Even minor issues with the cable could result in costly outages over an extended period of time due to this single remaining vendor.

Model: N/A



AEP Transmission Zone M-3 Process
Columbus, OH

Need Number: AEP-2020-OH025

Process Stage: Solutions Meeting 06/19/2020

Previously Presented: Needs Meeting 4/14/2020

Project Driver:

Equipment Material/Condition/Performance/Risk, Operational Flexibility and Efficiency

Specific Assumption Reference:

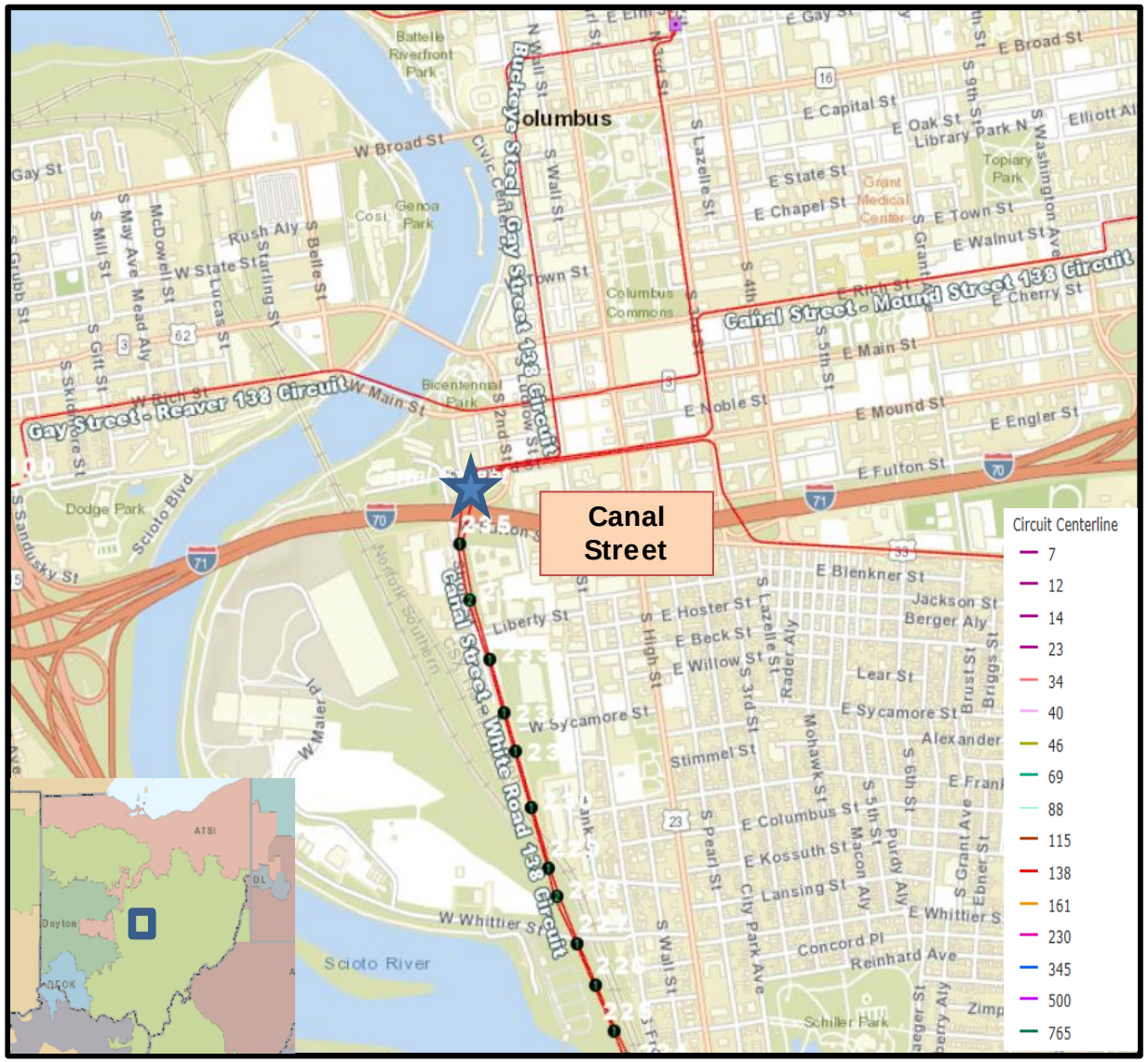
AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:

Canal Street 138kV

Circuit Breaker (4):

- Install Date: 1969
- Interrupting Medium: Oil
- Additional Information:
  - Interrupting Capability: 37kA
  - Fault Operations:
    - Number of Fault Operations: 15
    - Manufacturer recommended Number of Operations: 10
  - Oil breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance and can become an environmental hazard. This is the last remaining oil breaker at Canal Street station.



AEP Transmission Zone M-3 Process
Columbus, OH

Need Number: AEP-2020-OH013 & AEP-2020-OH025

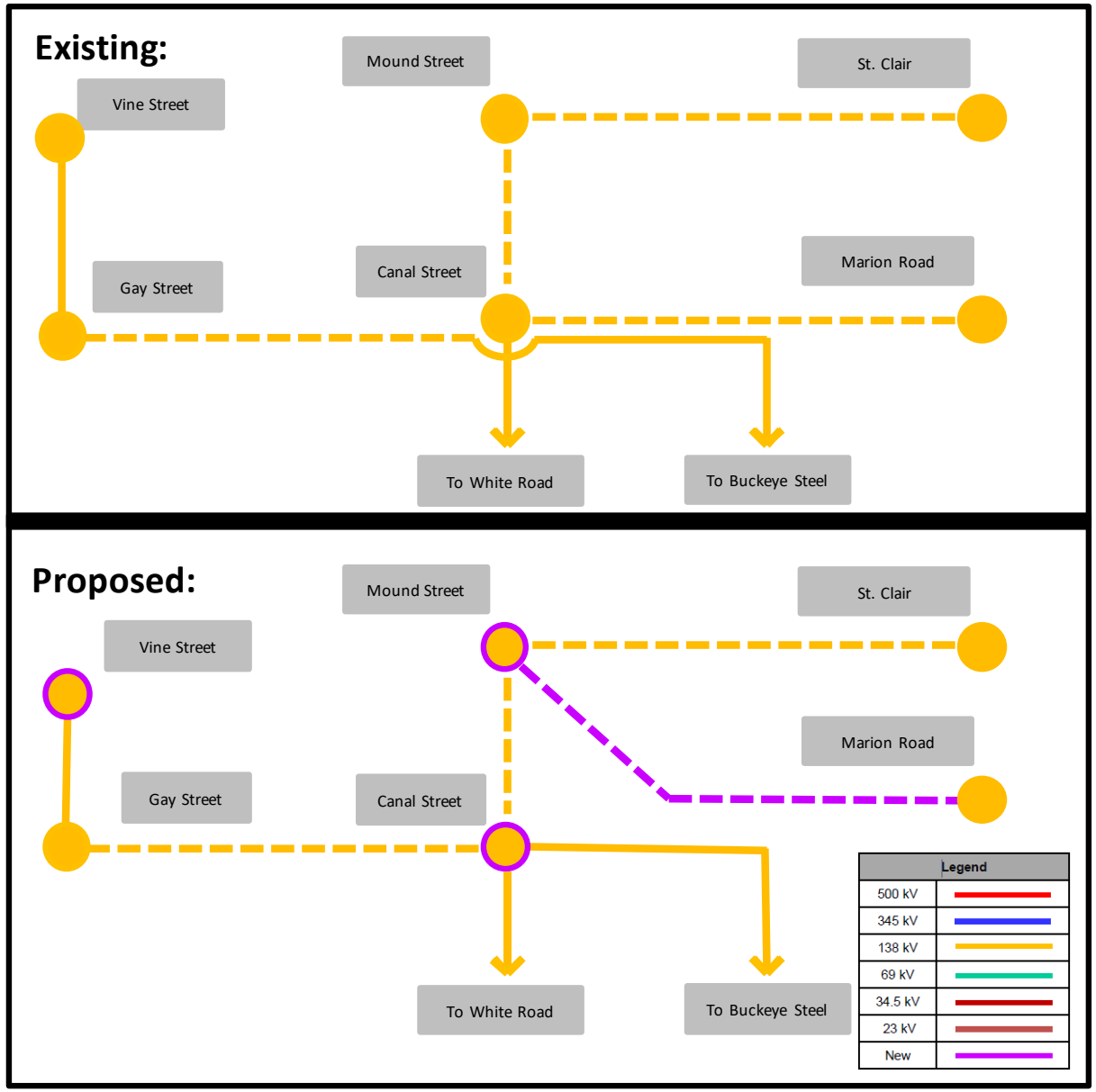
Process Stage: Solutions Meeting 06/19/2020

Proposed Solution:

- Retire ~ 3.8 miles of underground oil filled pipe type 138kV circuit between Canal St. – Marion Rd. **Estimated Cost: $1.6M**
- Build ~ 3.1 miles of underground single circuit 138kV line between Marion Rd. and Mound St. utilizing XLPE cable. **Estimated Cost: $35.8M**
- At Canal Street, install two new 138kV CBs (3000A, 63kA) to electrically terminate the Buckeye Steel – Gay St. 138 kV circuit that already physically runs through the station. Replace breaker '4' with new 138kV CB (3000A, 63kA). **Estimated Cost: $ 3.1M**
- At Mound Street, install new 138kV CB (3000A, 63kA) to accommodate new circuit from Marion Rd. **Estimated Cost: $1.2M**
- At Vine Street, install a 2% series line reactor towards Gay Street station to limit fault contribution increases from reconfigurations of lines in the area. **Estimated Cost: $1.1M**
- Remote end relay work at Gay Street. **Estimated Cost: $0.2M**
- Remote end relay work at Bixby station. **Estimated Cost: $0.6M**
- Relaying upgrades and line termination structure replacement at Marion Road. **Estimated Cost: $1.4M**

Total Estimated Transmission Cost: $45.0M

Ancillary Benefits: The proposed solution will provide a third source into the existing Mound Street station. Mound Street serves a number of critical loads, including the nearby Nationwide Children's Hospital. Ability to transfer load from the station is extremely limited. The station is also 1 of only 2 stations on AEP's footprint solely sourced by underground oil filled pipe type cable. This carries with it inherent reliability concerns associated with the potential risk of extended outages and reliance on one remaining vendor that supports this cable type. Currently, emergency generation has to be brought on site anytime that one of the cables is out to support critical loads from the station. A third source will alleviate the need to bring the generation in for an outage of one of the lines.



AEP Transmission Zone M-3 Process
Columbus, OH

Need Number: AEP-2020-OH013 & AEP-2020-OH025

Process Stage: Solutions Meeting 06/19/2020

Alternatives Considered:

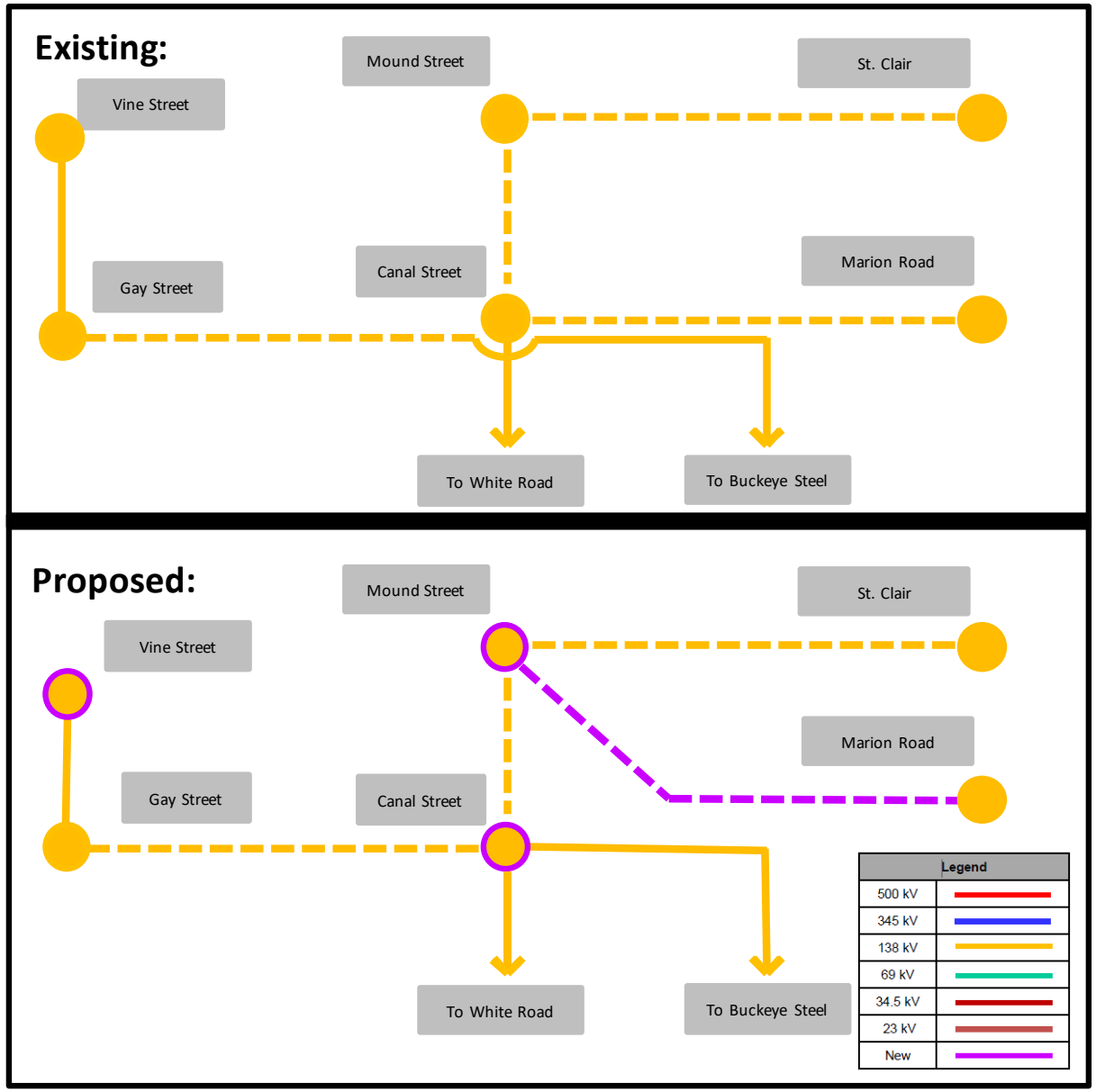
Relocate and replace approximately 1500 feet of the existing Canal St. – Marion Rd. underground oil filled pipe type 138kV circuit as required by ODOT. While this would address the ODOT relocation request it would not address the concerns associated with 1950's era pipe type cable. **Cost: $10M**

Rebuild the entire Canal St. – Marion Rd. underground 138 kV circuit utilizing XLPE cable. Outage constraints would required the line to be rebuilt on a new route. This alternative would not provide the ancillary benefits of a third source to Mound St. station. It also was estimated to be more costly than the proposed solution. **Cost: $48M**

Constructing an overhead line between Marion Rd and Mound St was evaluated, but would have been infeasible given the ROW and siting challenges associated with the location of the line through downtown Columbus.

Projected In-Service: 5/1/2022

Project Status: Scoping



Appendix

High Level M-3 Meeting Schedule

Assumptions

Activity	Timing
Posting of TO Assumptions Meeting information	20 days before Assumptions Meeting
Stakeholder comments	10 days after Assumptions Meeting

Needs

Activity	Timing
TOs and Stakeholders Post Needs Meeting slides	10 days before Needs Meeting
Stakeholder comments	10 days after Needs Meeting

Solutions

Activity	Timing
TOs and Stakeholders Post Solutions Meeting slides	10 days before Solutions Meeting
Stakeholder comments	10 days after Solutions Meeting

Submission of Supplemental Projects & Local Plan

Activity	Timing
Do No Harm (DNH) analysis for selected solution	Prior to posting selected solution
Post selected solution(s)	Following completion of DNH analysis
Stakeholder comments	10 days prior to Local Plan Submission for integration into RTEP
Local Plan submitted to PJM for integration into RTEP	Following review and consideration of comments received after posting of selected solutions

Revision History

6/9/2020 – V1 – Original version posted to pjm.com

6/16/2020 – V2 – Slide #5, Updated the customer count and CMI data