Sub Regional RTEP Committee
PJM West

November 2, 2017

Second Review
Baseline Reliability and Supplemental Projects

Baseline Reliability –Project Additional Scope

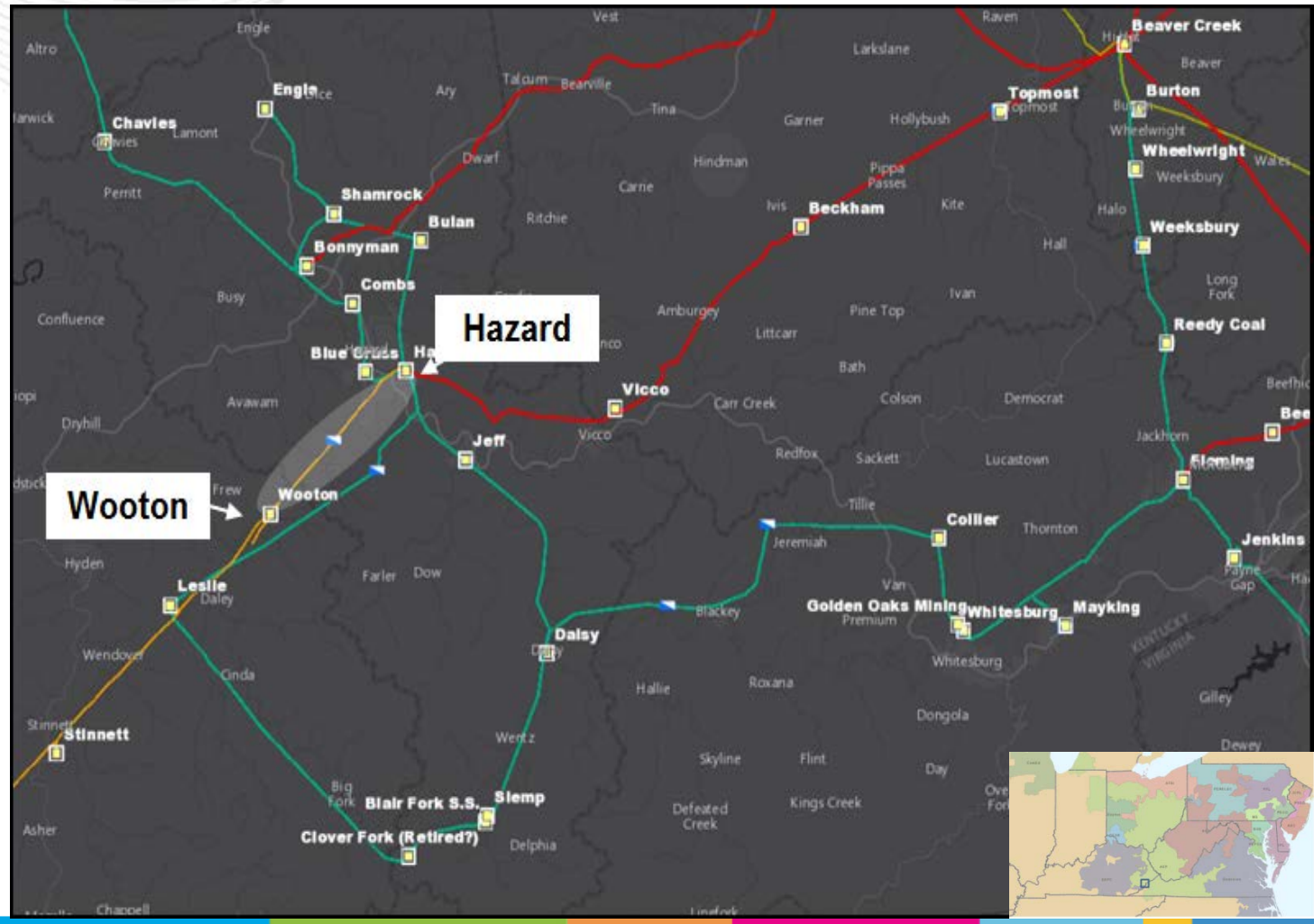
Previously Presented: 9/11/2017 SRTEAC

Problem Statement: The Hazard – Wooton 161 kV line overloads under summer and winter peak conditions during generation deliverability analysis performed as part of the 2016 PJM RTEP Window 2. During the 2016 PJM RTEP Window 2, the recommended solution is "Perform a Sag Study of the Hazard – Wooten 161 kV line to increase the thermal rating of the line" (B2761.2, presented on 10/6/2016 TEAC). The results of the sag study determined that 40 of the 45 structures which comprise the line would need to be replaced due to sag clearance issues. Additionally, approximately 6.3 of the 6.5 mile Hazard – Wooton 161 kV line utilizes wood structures from 1943. There are currently a total of 52 category A open conditions along the 6.5 mile long line which is comprised of 45 structures. These open conditions include damaged/rotted poles and damaged guy wires, shield wire, conductor, insulators, and cross arms. Therefore, the conclusion of the sag study is to rebuild the line.

Recommended Solution: Rebuild the Hazard – Wooton 161 kV line utilizing 795 26/7 ACSR conductor (300 MVA rating). (B2761.3)

Estimated Cost: $16.48M

Expected In-service: 6/1/2021



ComEd Transmission Zone: Baseline
Schauff Road – Rock Falls 138KV Circuit

Baseline Reliability – Light Load Deliverability Violation

Previously presented: 9/11/2017 SRTEAC

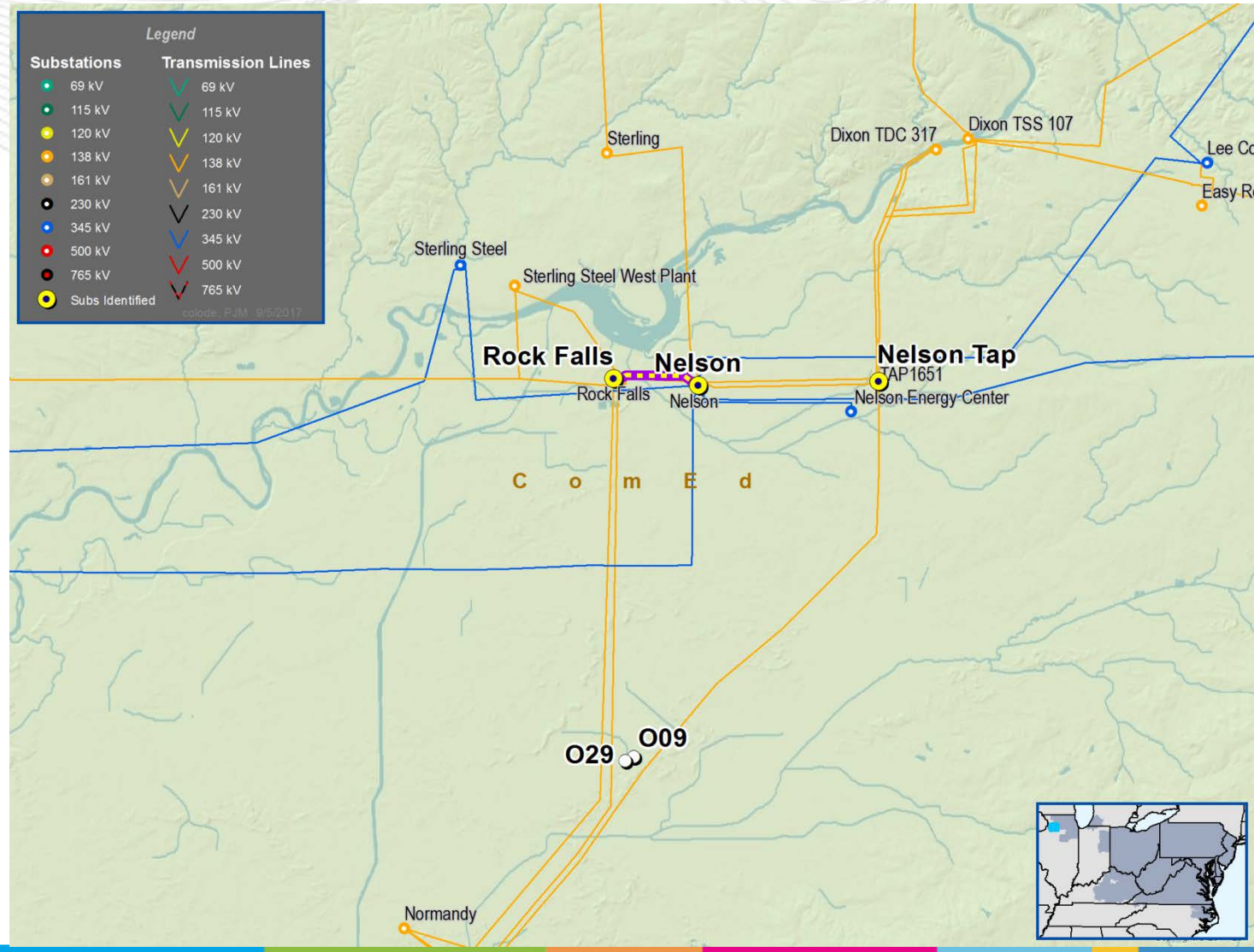
Problem Statement: Queue O-09 and O-29 are back to active from suspension. Rock Falls – Nelson 138KV Red line, Schauff Road (O09&O29) – Nelson Tap 138kV Red line and Schauff Road(O9&O29) – Rock Falls 138kV Red line are overload in base case and multiple single contingencies.

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

Recommended Solution: Install a new 138kV circuit 18702 from Schauff Road to Rock Falls and install a fourth breaker and a half run at Schauff Road. (B2959)

Estimated Cost: $20M

Expected In-service: 11/1/2019



AEP Transmission Zone: Supplemental
Pigeon River Station

Convert Baseline to Supplemental

Previously Presented: 8/30/2017 9/11/2017 SRTEAC

Cancel b2936.2: Pigeon River Station: Replace existing MOAB Sw. 'W' with a new 69kV 3000 A 40 kA breaker, and upgrade existing relays towards HMD station. Replace CB H with a 3000 A 40 kA breaker.

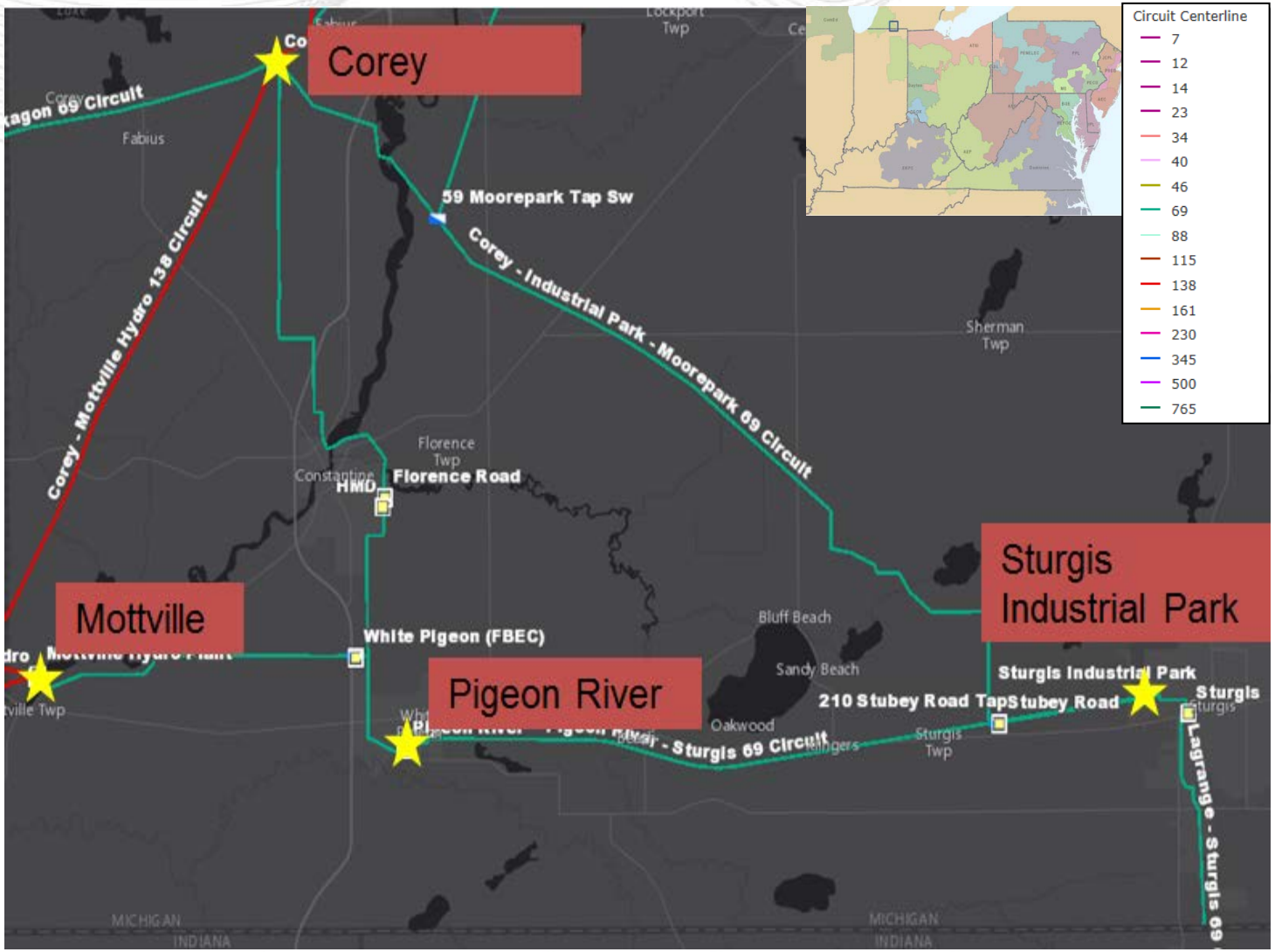
Reason: This project is not currently needed for any reliability violation. It is driven by the equipment material/Condition: The existing 69kV CB H at Pigeon River station is a 1200 A 19 kA oil filled breaker that was manufactured in 1969. This breaker has had 89 fault operations, exceeding the manufacturer limit of 10. Oil samples on this breaker indicate a large concentration of PCB. Oil spills are frequent with breaker failures and routine maintenance can become an environmental hazard.

Covert it to Supplemental: Pigeon River Station: Replace existing MOAB Sw. 'W' with a new 69kV 3000 A 40 kA breaker, and upgrade existing relays towards HMD station. Replace CB H with a 3000 A 40 kA breaker. (s1403)

Estimated Project Cost: $1.5M

Projected ISD: 6/1/2020

Status: Scoping



First Preliminary Review
Baseline Reliability and Supplemental Projects

AEP Transmission Zone: Baseline Reliability
Sand Hill 138kV Ring Bus Expansion

Problem Statement: TO Criteria violation

Customer Service: The MarkWest Customer is increasing the peak demand of its Warton Hill & Calis Switch delivery points significantly (60 MW addition, 144 MW total) over the next couple of years. This load increase drives planning criteria violations on the surrounding 138kV system.

Planning Criteria Violations: Due to major load increases at MarkWest's Majorsville, WV facilities (served via Calis SW & Warton Hill), the following thermal capacity and voltage violations are observed :

- For loss of the Brues-Sand Hill & Tidd-Sand Hill 138kV lines or Sand Hill breaker 'A' failure:
  - Kammer-Aston 138kV line overload (556 ACSR conductor, 284 MVA rating)
  - Calis SW 138kV area low voltages (voltage-collapse)
- For loss of the Brues - Sand Hill & Big Grave Creek - Kammer 138kV lines:
  - Tidd-Sand Hill 138kV overload (556 ACSR conductor, 284 MVA rating)

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

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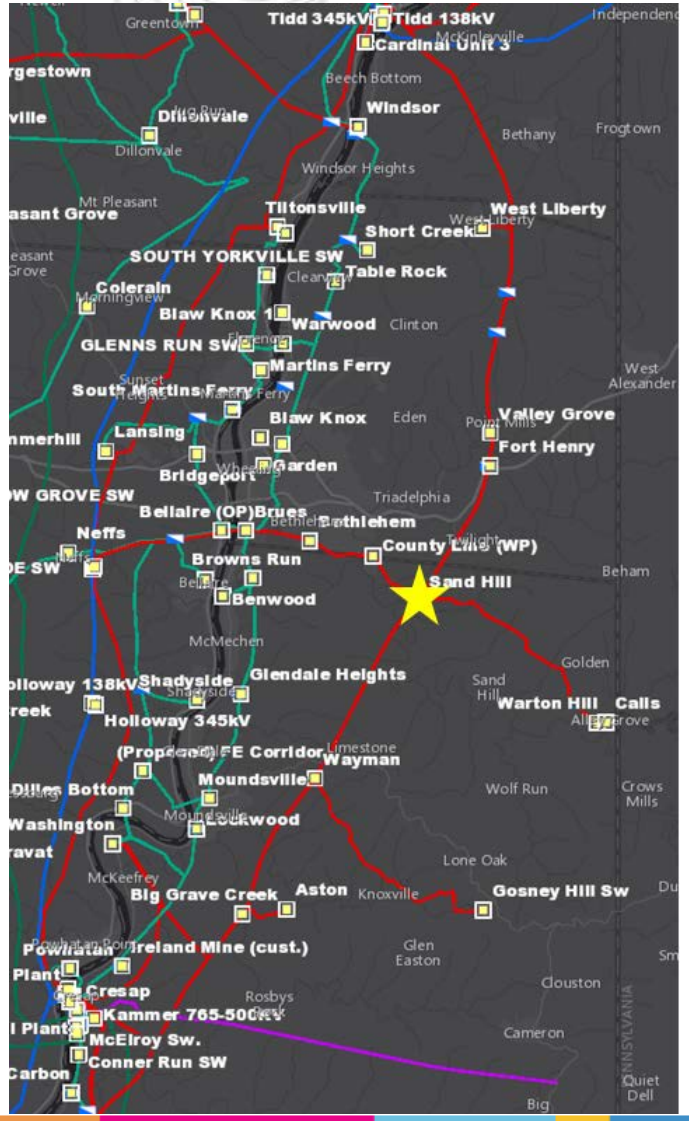

AEP Transmission Zone: Baseline Reliability
Sand Hill 138kV Ring Bus Expansion

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Recommended Solution:
Cut George Washington – Tidd 138kV circuit into Sand Hill and reconfigure Brues & Warton Hill line entrances. ($2.19M) (B2958.1)
Add 2 138kV 3000 A 40 kA breakers, disconnect switches, and update relaying at Sand Hill station. ($5.06M) (B2958.2)

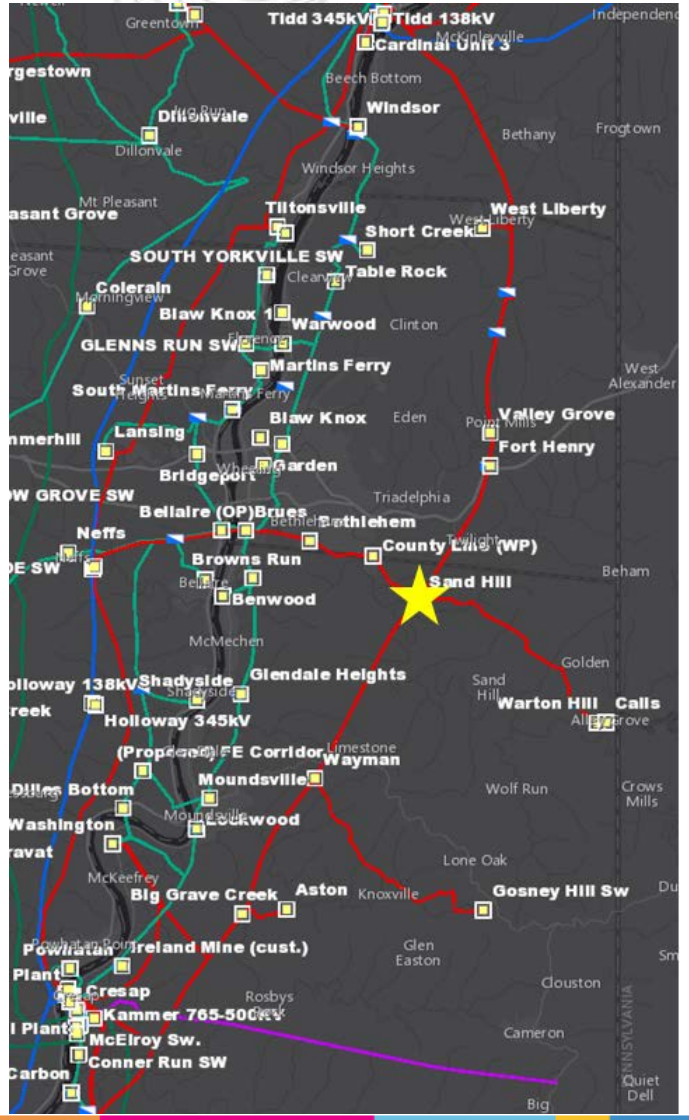
Alternatives: Re-conductor the area's overloaded 138kV circuits:
Kammer-Aston 138kV (9.3 miles) and Tidd-Sand Hill 138kV (19.3 miles). This would be an expensive endeavor due to the long mileage and challenging terrain. In addition, the criticality of these circuits would make outage-scheduling very difficult. Plus, they are built as double-circuit tower-lines.
To resolve the low voltage constraints, install additional 138kV capacitor banks, for area voltage support. The grid in the area already has substantial capacitor bank penetration and this addition is expected to saturate switchable capacitor banks thus resulting in poor coordination and mis-operations.

Alternative Cost: $35-50M

Estimated Project Cost: $7.25M

Expected ISD: 7/1/2017

Projected ISD: 12/1/2018



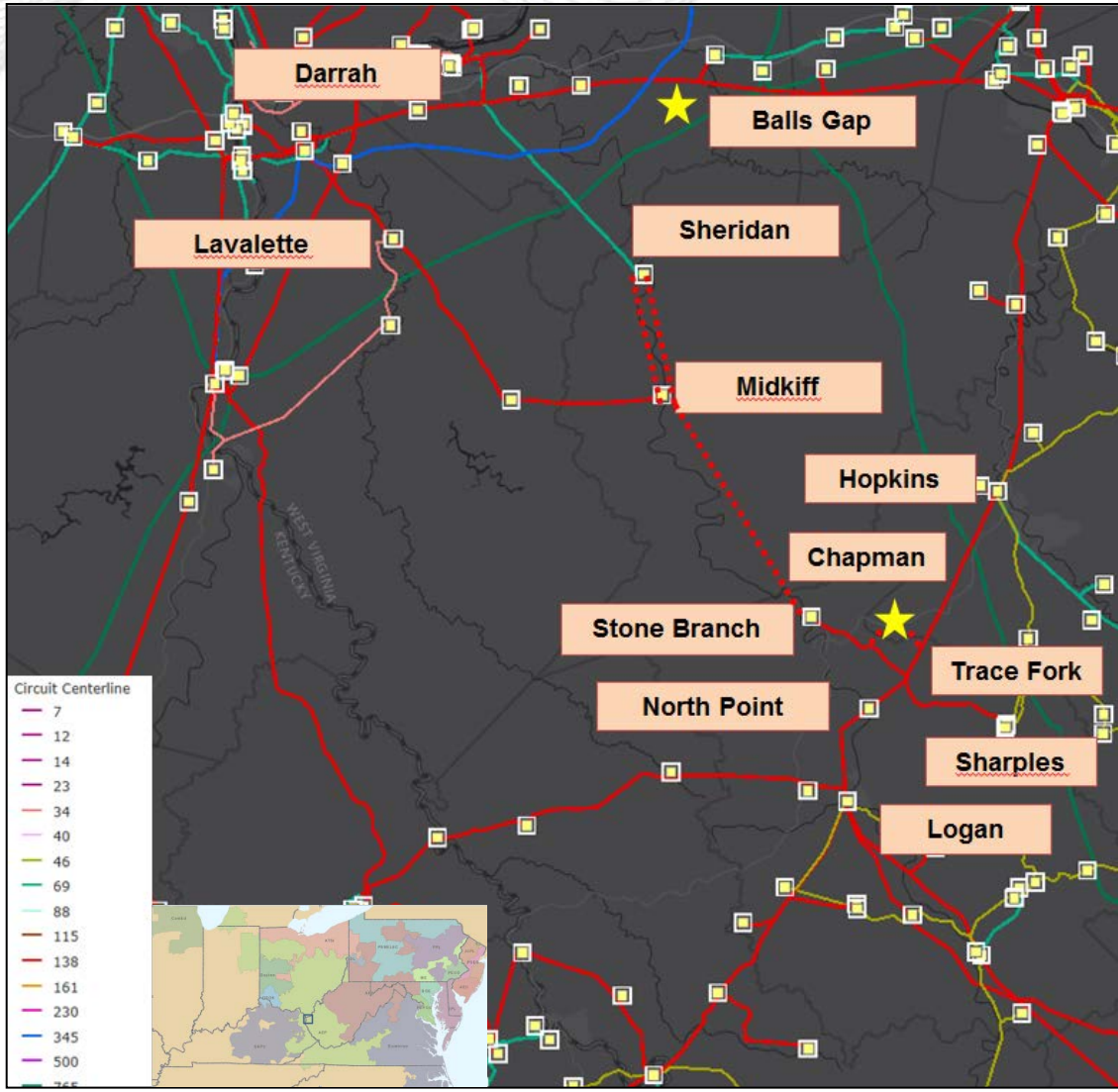
AEP Transmission Zone: Supplemental Sheridan Area Improvements

Problem Statement:

Equipment Material/Condition/Performance/Risk: The Darrah – Sheridan 69kV line has experienced approximately 8 million customer minutes of interruption between 2013-2016, including 19 momentary and 7 permanent outages. Darrah – Sheridan 69kV line was originally built in the 1920s with 4/0 ACSR conductor (63/83 MVA winter ratings). The majority of the structures on the line are 1950s wood pole. The 17 mile long circuit currently has 45 open category A conditions associated with it.

The Hopkins – Logan 138kV line has experienced approximately 2.6 million customer minutes of interruption between 2013-2016, including 15 momentary and 3 permanent outages. The new Chapman station will replace the existing 4-way switching structure at Trace Fork that exposes North Point, Stone Branch and Sharples to any outage on the ~20 mile Hopkins – Logan 138kV circuit. MPOI calculation performed on Hopkins – Logan 138kV circuit supports installing breakers to the line at Chapman station.

Operational Flexibility and Efficiency: Sheridan 69kV station, with a projected load of 19 MVA, is currently being served radially on a 17 mile long line. Stone Branch 138kV station, with a projected load of 40 MVA, is currently being served radially on a 6 mile long line. Midkiff 138kV station, with a projected load of 17 MVA, is currently being served radially on a 27 mile long line.



AEP Transmission Zone: Supplemental Sheridan Area Improvements

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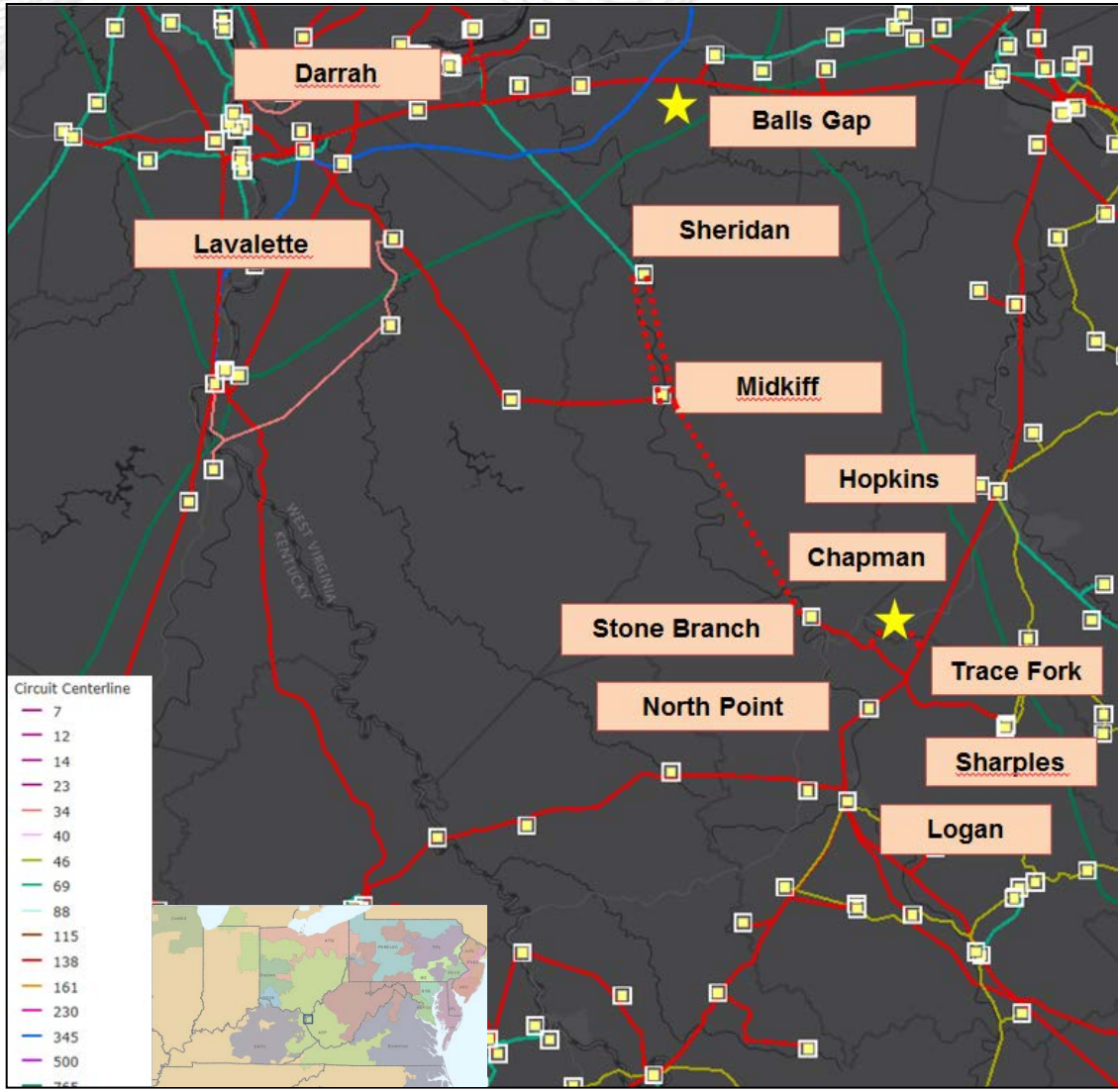
Potential Solution:

- Sheridan: Retire 69/12kV Sheridan station. Rebuild Sheridan on property near existing Sheridan station as 138/34.5kV in and out station. Install two 138kV line circuit breakers, one 138/34.5kV 30 MVA XFR, one 138kV circuit switcher, one 138kV cap bank, and distribution line exits with breakers.
  Estimated Trans. Cost: $7.1M
- Midkiff: Install a motorized phase-over-phase switch outside Midkiff Station to maintain 138kV service.
  Estimated Trans. Cost: $0.7M
- Lavalette: Install 138kV MOAB facing West Huntington. Replace high-speed ground switch/MOAB combo on XFR #1 with a circuit switcher. Estimated Trans. Cost: $0.1M
- Stone Branch: Replace high-speed ground switch/MOAB combo on XFRs #1 and #2 with circuit switchers. Install 138kV MOABs facing Midkiff and Chapman. Estimated Trans. Cost: $0.2M
- Chapman: Retire Trace Fork S.S. and 4-way switch and replace with Chapman Switching Station located ~1 mile away. Install 4 138kV 3000 A 40 kA CB ring bus at new Chapman.
  Estimated Trans. Cost: $5.7M
- Darrah: Retire 69kV CBs H and M. Estimated Trans. Cost: $0.1M
- Construct an 8 mile 138kV double circuit line between Sheridan and Midkiff utilizing 1033.5 ACSR (375/464 MVA winter ratings) and OPGW. Estimated Trans. Cost: $25.7M
- Construct a 17 mile 138kV line between Midkiff and Stone Branch utilizing 1033.5 ACSR (375/464 MVA winter ratings) and OPGW. Estimated Trans. Cost: $28.1M
- Construct 138kV double circuit line from Chapman to existing 138kV Stone Branch – Trace Fork line utilizing 1033.5 ACSR (375/464 MVA winter ratings). Install OPGW on new line sections.
  Estimated Trans. Cost: $5.5M
- Construct 138kV double circuit line from Chapman to existing 138kV Logan – Hopkins line utilizing 1590 ACSR (493/624 MVA winter ratings) to match the existing Logan-Hopkins line capabilities. Install OPGW on new line sections. Estimated Trans. Cost: $5.7M
- Retire Darrah – Sheridan 69kV line. Estimated Trans. Cost: $9.2M



AEP Transmission Zone: Supplemental Sheridan Area Improvements

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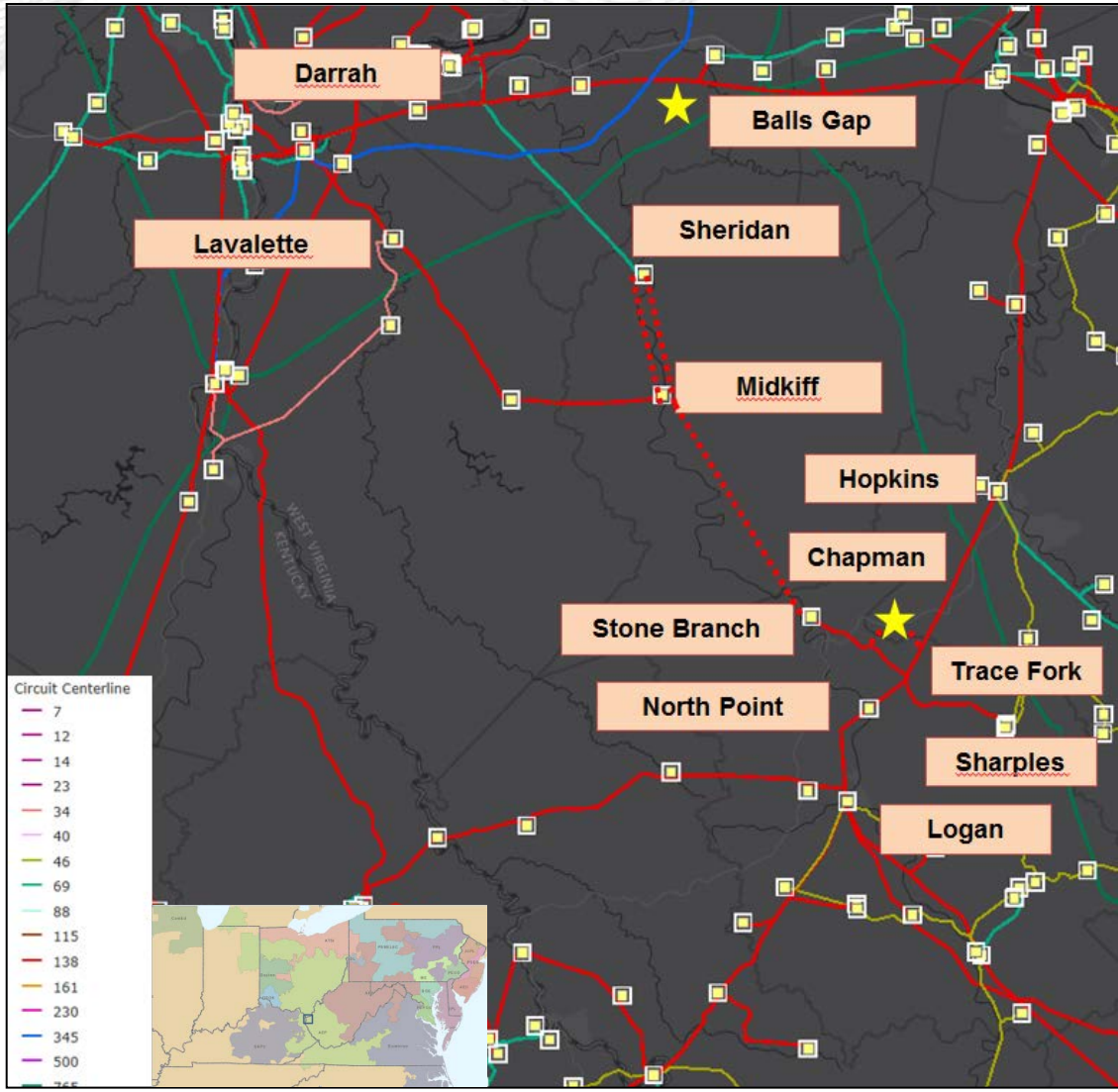
Alternatives:

- Construct approximately 10 miles of new 138kV line to new 138kV Balls Gap Station. Convert Sheridan Station to 138kV and construct single circuit from Sheridan to Midkiff, approximately 8 miles. Construct new 138kV Chapman Station. Build a new circuit, approximately 7 miles from Chapman to Stone Branch Station. Retire Trace Fork Switching Station and connect Chapman to both Logan – Hopkins 138kV and Sharples – Stone Branch 138kV in/out.

  Estimated Cost: $90M

Projected In-service: 12/01/2020

Project Status: Scoping



AEP Transmission Zone: Supplemental
Jay Breaker Replacement

Problem Statement:

Equipment Material/Condition/Performance/Risk: Breakers 'J' and 'H' at Jay station are vintage 1967 1200 A 21 kA oil medium models with fault counts of 16 and 100 respectively. 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. The drivers for replacement of these breakers are age, number of fault operations, a lack of available repair parts, and PCB content.

Potential Solution:
At Jay station, replace 69kV breaker 'J' and 'H' with 3000A 40KV breakers and associated equipment.

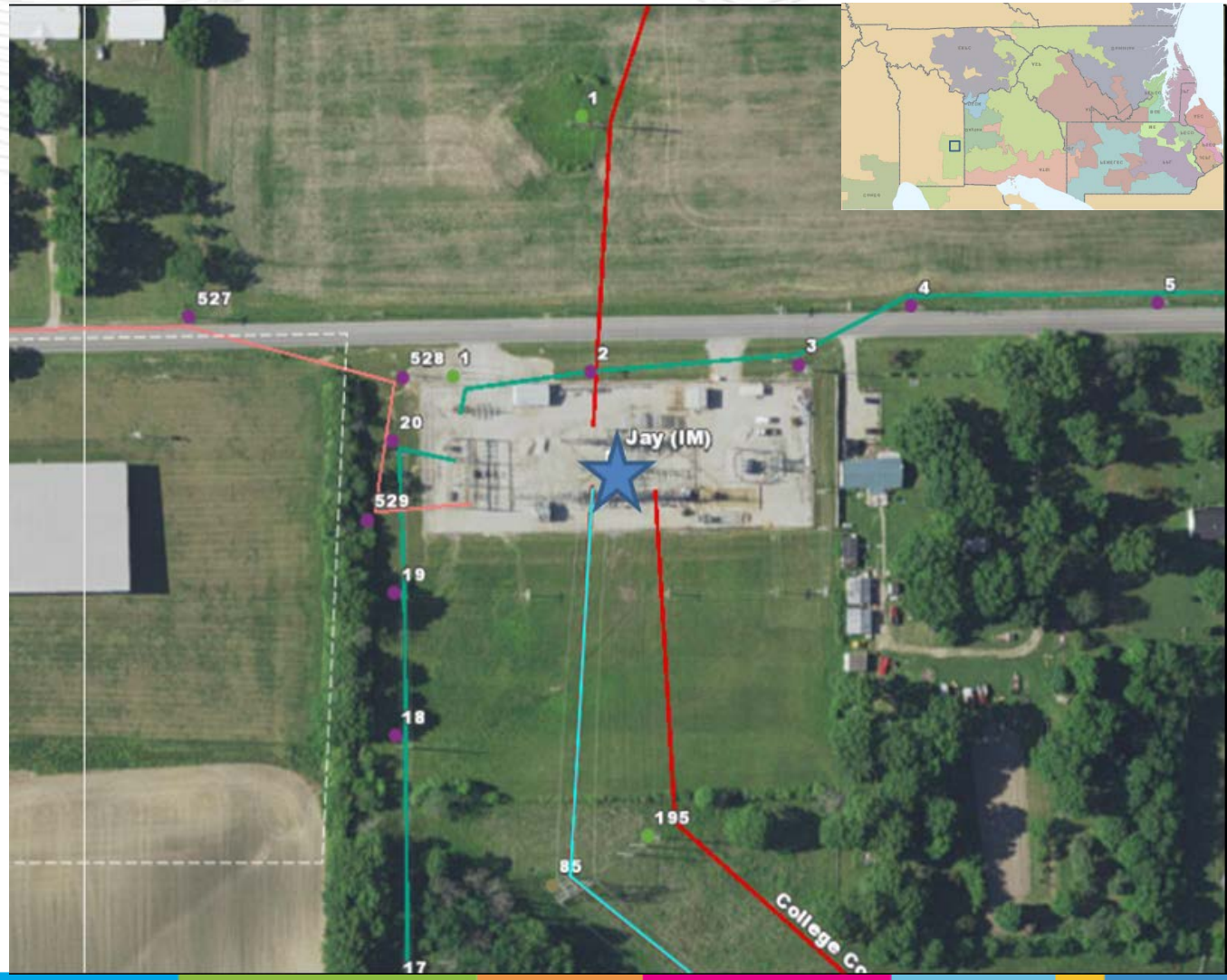
Estimated Cost: $1.97M

Alternatives:

- No viable cost alternatives identified

Projected In-service: 4/30/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Anaconda Station Rebuild

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The 1957 vintage 4kV circuit breaker A at Anaconda Substation is an oil filled breaker without oil containment. Additionally, the foundation of the unit is poor and should be addressed. AEP recommends the replacement of this circuit breaker due to the mentioned notices.

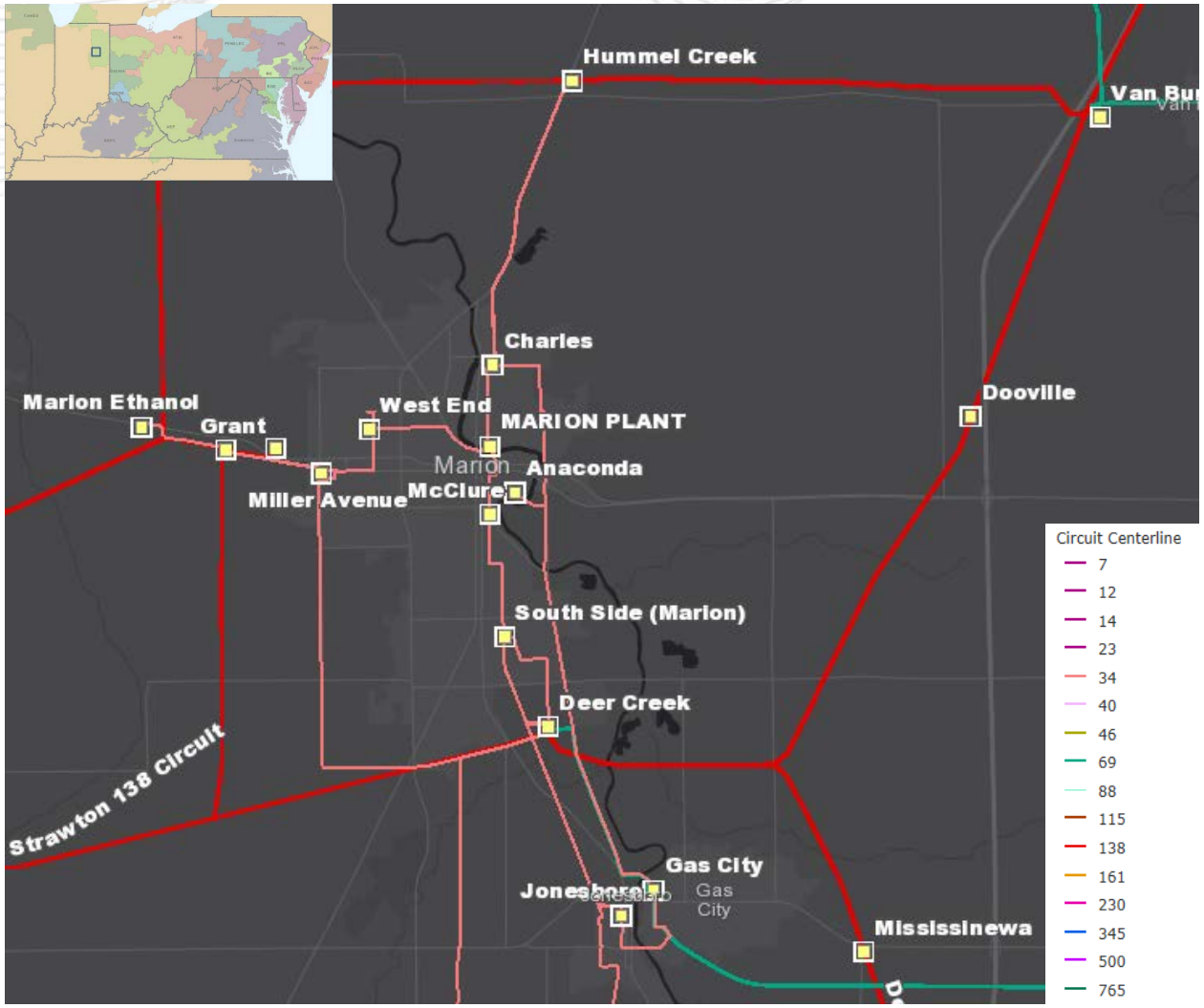
The 1950 vintage transformer 1 at Anaconda Substation was oil processed but the combustible gases continued to rise even after the processing. The CO/CO2 ratio is above the warning threshold and the interfacial tension is below the acceptable limit. This data shows that the units insulation is nearing end of life and should be addressed. Additionally, the foundation of the unit is poor and should be addressed. Due to the mentioned notices, AEP recommends the replacement of this transformer.

Anaconda substation currently deploys 3 relays, implemented to ensure the adequate protection and operation of the substation. Currently all of the relays are of the electromechanical type which have significant limitations with regards to fault data collection and retention. All relays should be replaced. The metering and battery enclosures also need replaced due to rust on the enclosure and the general status of the wood structure they are installed on. A new DICM should be considered in this replacement to reduce the duration of construction outages as well as reduce the overall project cost associated with P&C crew labor.

Anaconda substation is supported primarily by deteriorating wood structures that should be replaced. Additionally, Transformer 1 and Circuit Breaker A are both mounted on wood tie structures that should be replaced. Lastly, the battery and metering enclosures are rusted and mounted on wood structures and should be replaced.

Currently in Anaconda station, there is no separation between customer and I&M owned equipment. In order to bring station to current standards, Anaconda station will need to be rebuilt in the clear with no customer equipment in the AEP fence.

The current Anaconda Tap has two unique structures with open conditions across its 8 total structures.



AEP Transmission Zone: Supplemental Anaconda Station Rebuild

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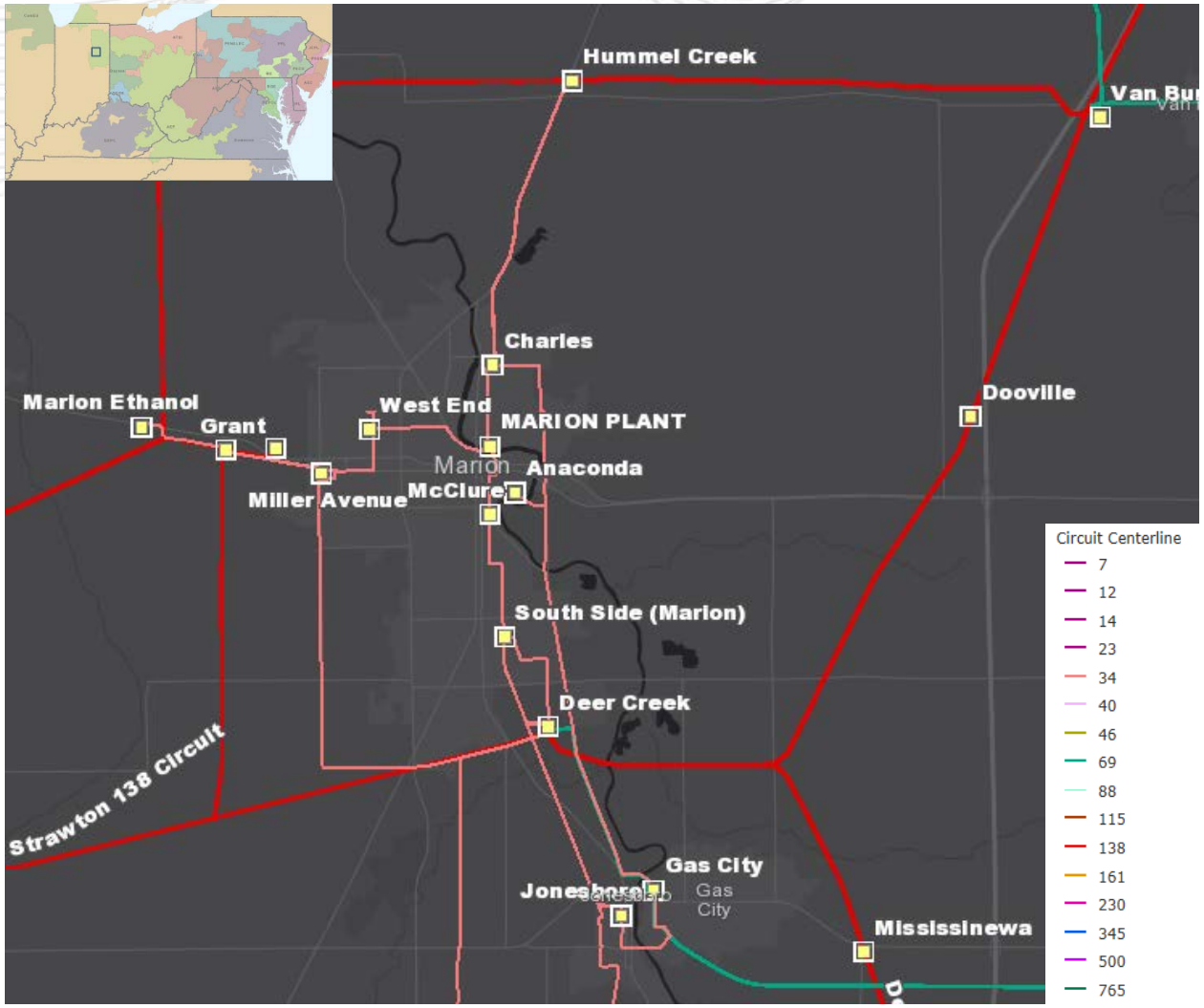
Potential Solution:

- Anaconda: Retire the current Anaconda 34.5 kV station. No transmission costs.
- Anaconda Tap switch : Retire Anaconda Tap and reconnect Hummel Creek – Deer Creek 34.5 kV circuit. Estimated Transmission Cost: $0.2M
- Wire Mill Station – No transmission costs
  - Install a 4kV bus built to 12kV standards with a 1200A 25kA CB protecting the Anaconda load.
  - Install a 34.5kV bus built at 69kV standards.
  - Install a 6.25MVA 69/34.5/4kV non-LTC transformer to connect the 4kV and 34.5kV busses.
  - Install a 2000A 25kA circuit switcher on the high side of the transformer rated at 69kV but operated at 34.5kV
- Shunk Street 34.5 kV Switch: Install a new 1200A 3 way PoP ground operated switching structure. Estimated Transmission Cost: $0.45M
- Fifth Street 34.5 kV Extension: Install roughly .5 miles of 556.5 ACSR (WE: 80MVA) from Shunk Street Switch to the new station location. This line will be built to 69kV but operated at 34.5kV. Estimated Transmission Cost: $0.8M
- Anaconda Tap: Retire the Anaconda - Anaconda Tap 34.5kV line. Estimated Transmission Cost: $0.04M

Total Estimated Transmission Cost: $1.49M



AEP Transmission Zone: Supplemental Anaconda Station Rebuild

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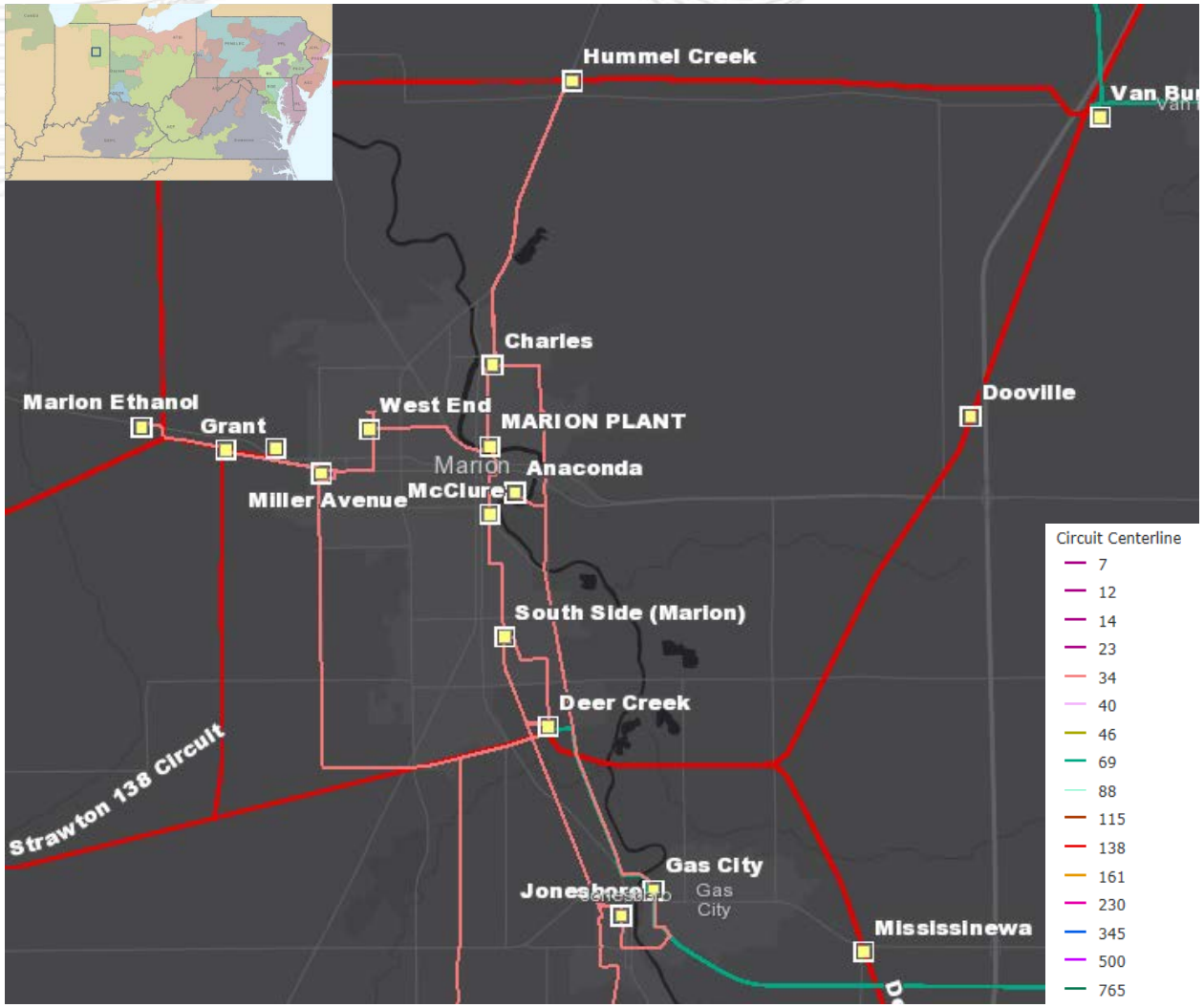
Alternatives:

- Keep station connected to the Hummel Creek – Deer Creek line:
  In order to connect Wire Mill to this line, AEP would have to build additional poles across a customers property in addition to replacing two existing condition afflicted poles. Since the Deer Creek – Marion line is in close proximity to the proposed Wire Mill station, it would only require ten poles to be constructed and so is the preferred option. In addition to this, the Deer Creek – Hummel Creek line was originally constructed in the 1930s and is currently in a deteriorating state with 44 open conditions and will need to be addressed in the near future. However, this line only serves two stations; Gas City and Anaconda. By moving Anaconda's load to the Deer Creek – Marion line, AEP will have the option in the future to retire this line instead of rebuilding it for one station. Due to these reasons, it is inadvisable to leave the Anaconda load connected to the Hummel Creek – Deer Creek line.
  Estimated Cost: $1M

Projected In-service: 7/27/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Hazard Station

Problem Statement:

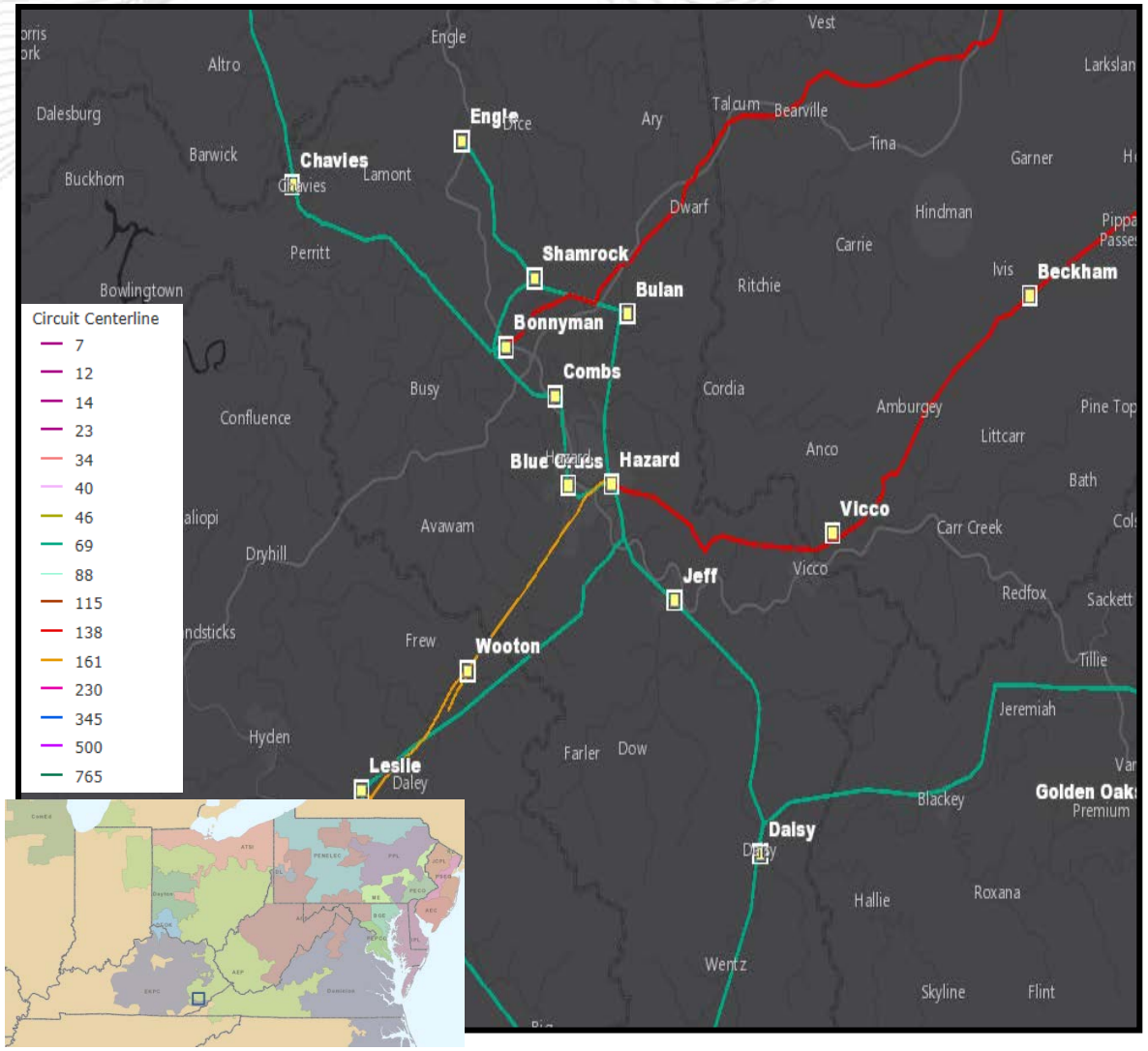
Equipment Material/Condition/Performance/Risk:

Circuit breakers S (1100A, 11.3kA) and E (1800A, 27kA) at Hazard station are FK type breakers all over 40 years old. Circuit breaker F at Hazard is a 1200A, 31.5kA CG type breaker. These are oil breakers that have come more difficult to maintain due to the required oil handling. In general, oil spills occur often during routine maintenance and failures with these types of breakers. Other drivers include PCB content, damage to bushings and number of fault operations exceeding the recommendations of the manufacturer. Breakers S, E, and F have experienced 82, 184, and 193 fault operations respectively, well above the manufactures recommendation of 10.

Circuit breaker M (2000A, 40kA) will need to be relocated in association with the baseline project to replace the existing 161/138 kV transformer at Hazard station (b2761) in order to limit outage times. The breaker is an SF6-gas breaker, 29 years old and has experienced 21 fault operations, which exceeds the manufacturer recommendation of 10.

Transformer #1 (1974 vintage, 50 MVA) and #2 (1973 vintage, 130 MVA) show dielectric breakdown (insulation), accessory damage (bushings/windings) and short circuit breakdown (due to amount of through faults). Transformer #1 also shows signs of corrosion on radiators as well as oil leaks.

Circuit Switcher BB a MARK V unit which have presented AEP with a large amount of failures and mis-operations. AEP has determined that all MARK V's will be replaced and upgraded with the latest AEP cap-switcher design standard. Capacitor bank BB will need to be relocated in association with the baseline project to replace the existing 161/138 kV transformer at Hazard station (b2761).



AEP Transmission Zone: Supplemental Hazard Station

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Capacitor switcher CC has oil leaks on all three phases and cannot be repaired. Capacitor bank CC was a non standard design and its components (fuses and cans) have begun to fail.

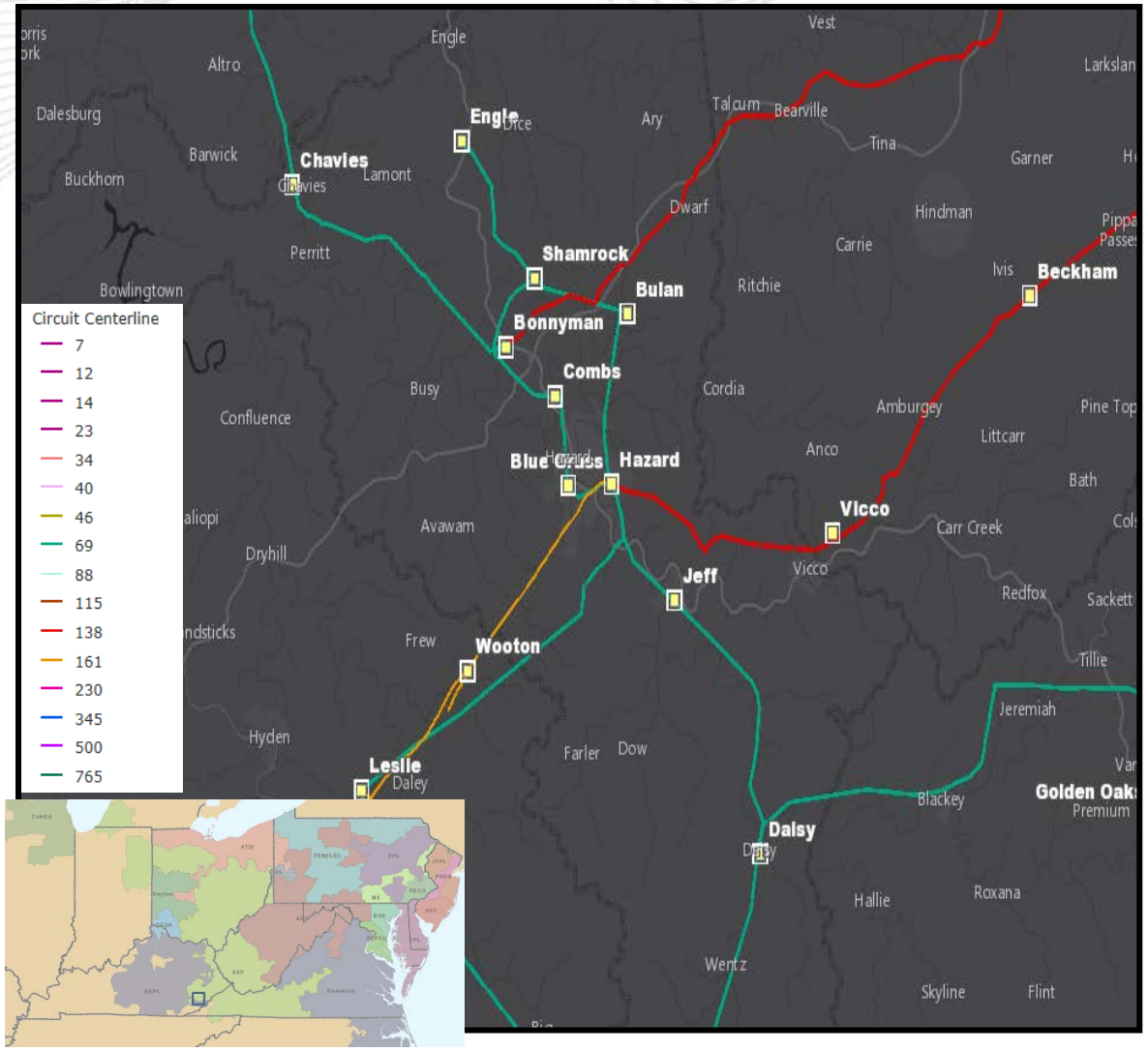
Safety concerns associated with existing equipment platforms at the station will also be addressed. The majority of the platforms at the station were field designed with thought of access, not safety, adequate clearances, or structural integrity in mind. Drainage issues at the station will also be addressed. Water from an adjacent parking lot and an incorrectly sloped 69 kV yard is causing water to pool on the fence line at Hazard Station.

<u>Operational Flexibility and Efficiency</u>

A 138 kV circuit breaker will be added at Hazard station on the line exit towards Beckham station, along with a circuit switcher and low side breaker on transformer #1 to separate three dissimilar zones of protection. The 138 kV bus, the Hazard – Beckham 138 kV line, and the 138/69 kV transformer #1 are all on the same protection zone. This can lead to mis-operations and over tripping.

138 kV circuit switchers will be added to transformer #2 and #4, as well as low side breakers on transformer #2, #3, and #4 to separate four dissimilar zones of protection.

Transmission Operations has requested a 69 KV bus tie circuit breaker be installed to improve operational flexibility to the 69 kV networks served out of Hazard. The 69 kV tie breaker will also help facilitate the retirement of Capacitor AA which is currently located off the line to Bonnyman, is beginning to show issues, and requires its VBM type cap switcher replaced. Tying the 69 kV buses together requires the 138/69 kV transformers to be the same size to avoid circulating currents and to be able to serve the 69 kV area independently for loss of one.



AEP Transmission Zone: Supplemental Hazard Station

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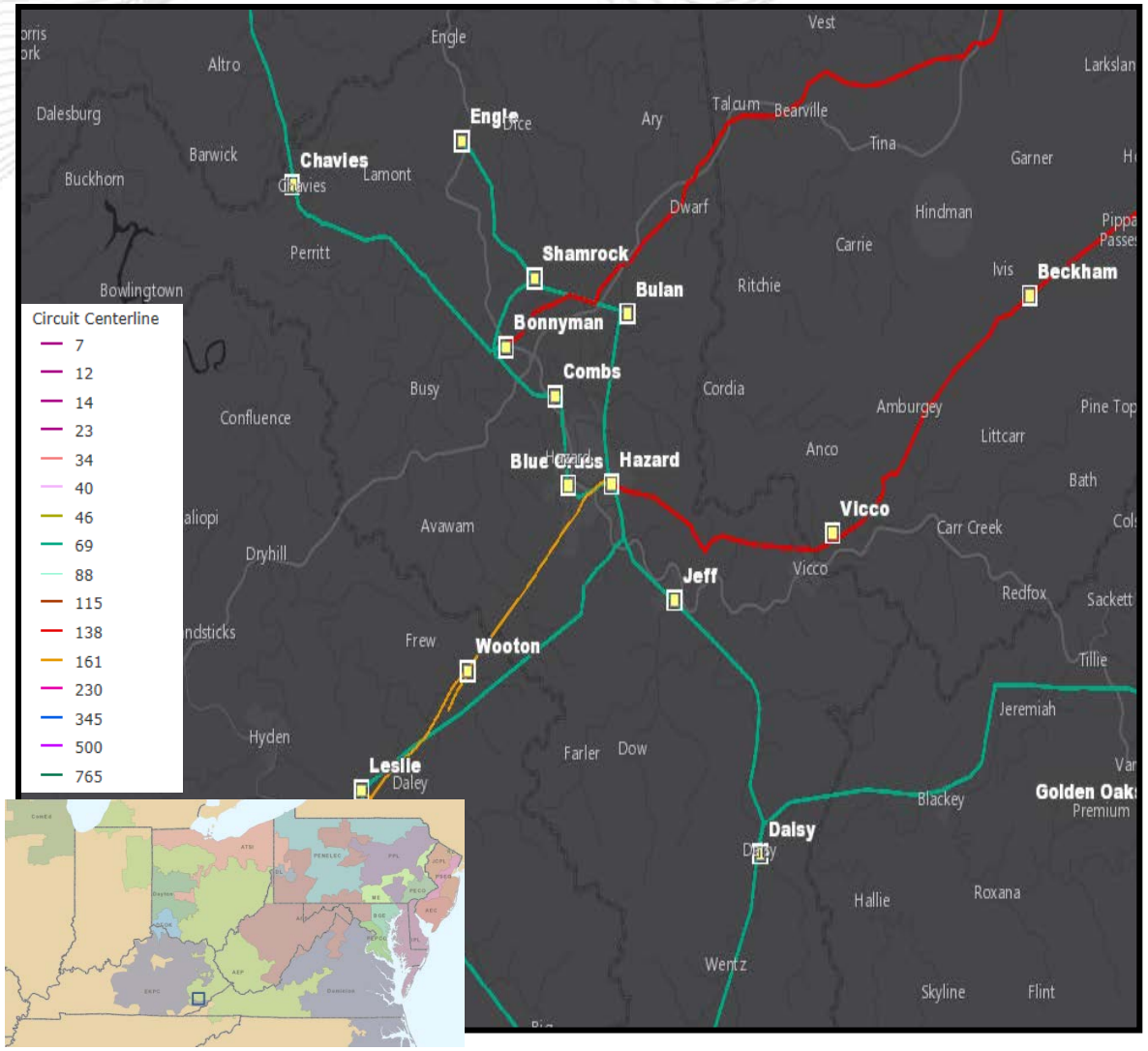
Potential Solution:
Install a new 3000A 40 kA 138 kV circuit breaker at Hazard station on the line exit towards Beckham station. A 138 kV circuit switcher will be added to the high side of transformer #4. 138 kV capacitor bank and switcher BB will be replaced with a new switcher and 43.2 MVAR capacitor bank. 138/69 kV transformers #1 and #2 will be replaced by new 138/69 kV 130 MVA transformers with 138 kV circuit switchers on the high side and 3000A 40 kA 69 kV breakers on the low side. 69 kV circuit breakers S, E, and F will be replaced with 3000A 40 kA 69 kV circuit breakers with a bus tie 3000A 69 kV circuit breaker being installed between the existing 69 kV box bays. 69 kV capacitor bank and switcher CC will be replaced with a new switcher and 28.8 MVAR capacitor bank. 69 kV capacitor bank and switcher AA will be retired. 161 kV circuit breaker M towards Wooton will be replaced by a 161 kV 3000 A 40 kA breaker. A 3000A 40 kA 138 kV circuit breaker will be added to the low side of 161/138 kV transformer #3. Safety and access issues associated with existing equipment platforms and drainage issues at the station will also be addressed.

Estimated Transmission Cost: $20.0M



AEP Transmission Zone: Supplemental Hazard Station

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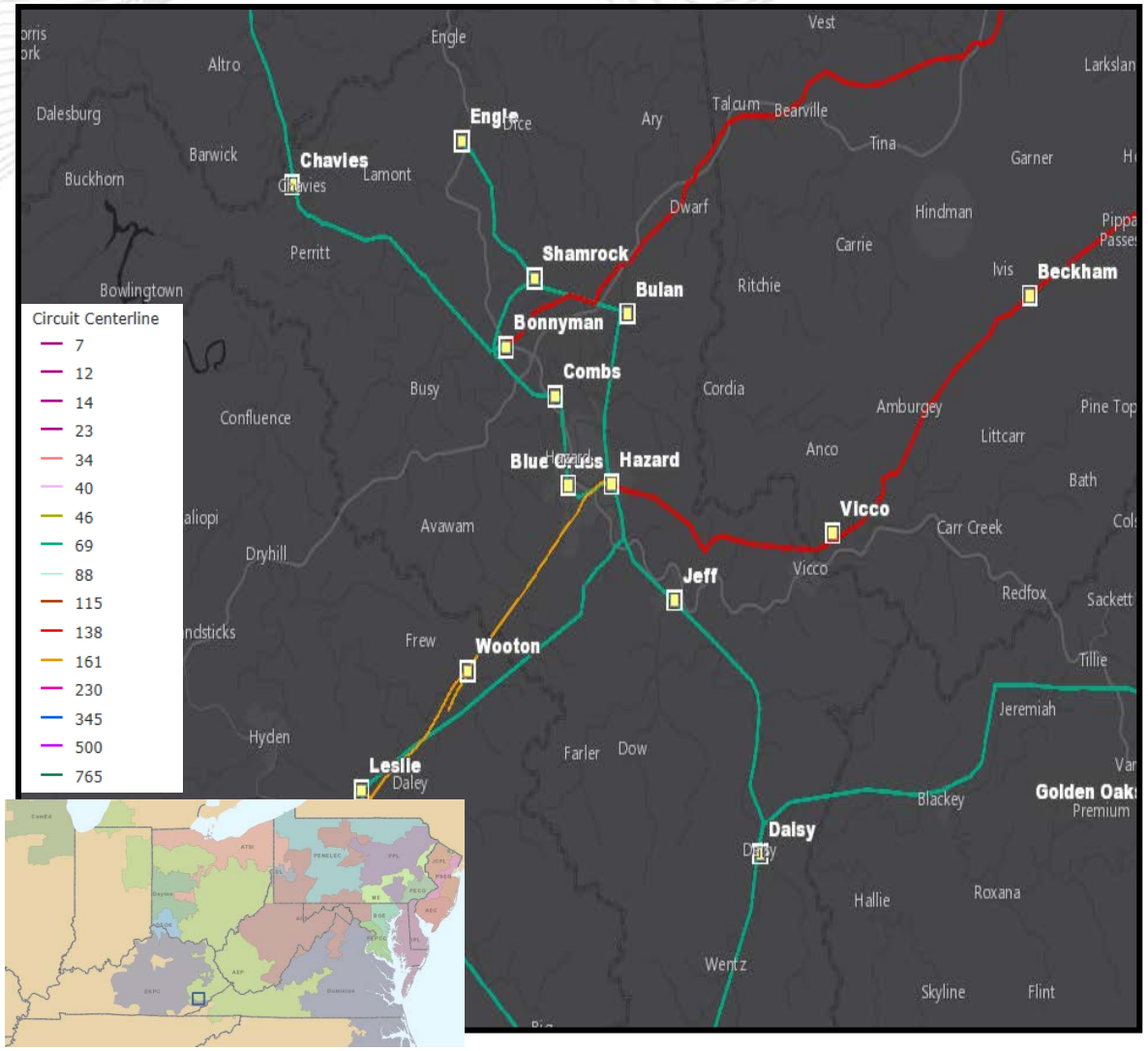
Alternatives:

- Rebuilding the station in the clear was evaluated. Lack of a suitable site in close proximity to the station due to the mountainous terrain and nearby population would have resulted in significant rerouting of the six transmission circuits and the four distribution circuits located within the existing station. It was determined that this would not be a cost effective alternative. Beyond the cost implications, relocation of the circuits and station would have been extremely challenging from a siting perspective. Estimated Cost: $35M
- Constructing the 69 kV portion of the yard into a 69 kV ring bus was evaluated. It was determined that this alternative was not physically possible at the existing station site without extended outages. This alternative was determined to be not feasible due to constructability aspects.

Projected In-service: 12/31/2019

Project Status: Scoping



Shoals Station

Problem Statement:

Customer Service:

Obligation to serve customer request. The Lavalette 138/34.5 kV, 30 MVA #1 transformer is projected to exceed it's rated capability (45 MVA) during the winter of 2018/2019 season. The West Huntington Station transformer is going to exceed its rated capability in 2020. To alleviate these two transformer overloads, Shoals Station is being constructed. Shoals will serve 15 MVA peak in summer and 16 MVA peak in winter.

Potential Solution:

Construct a new 138/34.5 kV Station (Shoals Station). Install a 138 kV line breaker and 138 kV MOAB's. Tap the Midkiff-West Huntington 138 kV line into the new station.

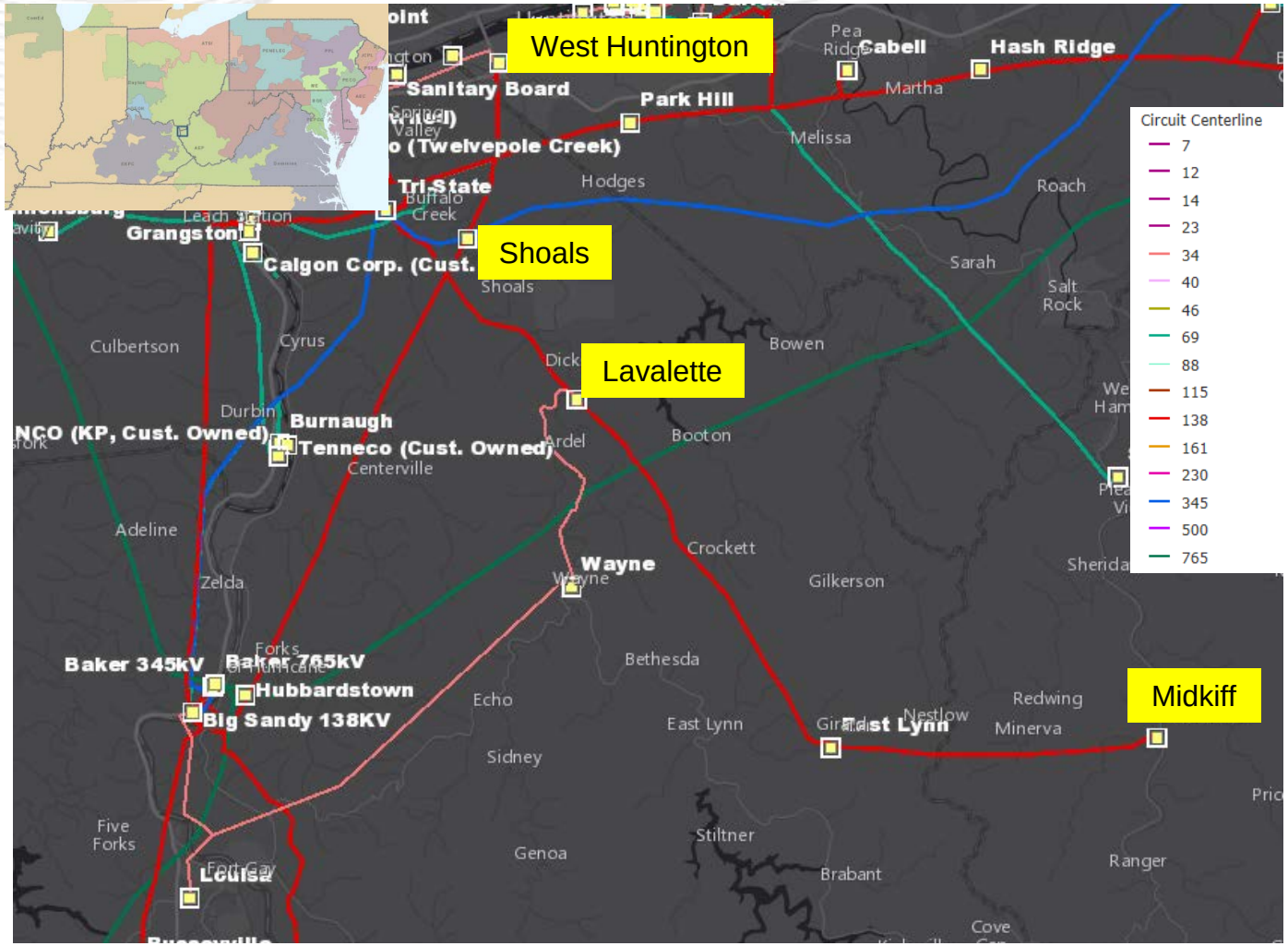
Estimated Transmission Cost: $1.27M

Alternatives:

- Construct 3 miles of new 138 kV circuit in and out to the existing Wayne 138 kV station. Establish a 138 kV bus and install a new 138/34.5 kV XF. Estimated Cost: $12M
- Rebuild approximately 7 miles and convert Lavalette – Wayne from 34.5 kV to 138 kV. Rebuild approximately 16 miles and convert Big Sandy – Wayne from 34.5 kV to 138 kV. Establish a 138 kV bus and install a new 138/34.5 XF at Wayne Station. Estimated Cost: $50M

Projected In-service: 12/1/2017

Project Status: Construction



AEP Transmission Zone: Supplemental
Balls Gap Station Construction

Problem Statement:

Customer Service:

Obligation to serve customer delivery point. Future load at the station is estimated to be approximately 10 MVA during Summer Peak and 16 MVA during Winter Peak. Load will be partially transferred from Milton, Hash Ridge, and Grassy Fork. MPOI calculations justify the installation of breakers at Balls Gap (804, above the 200 threshold).

Potential Solution:

Tap the Amos - West Huntington 138 kV line utilizing 1033.5 ACSR conductor (167 MVA rating) and extend 3.6 miles in and out of the new Balls Gap Station. Estimated Transmission Cost: $9.6M

Construct a new 138-34.5 kV Station. Install a 138/34.5 kV 30 MVA transformer, high side circuit switcher and two 138 kV 40 kA CBs. Estimated Transmission Cost: $2.5M

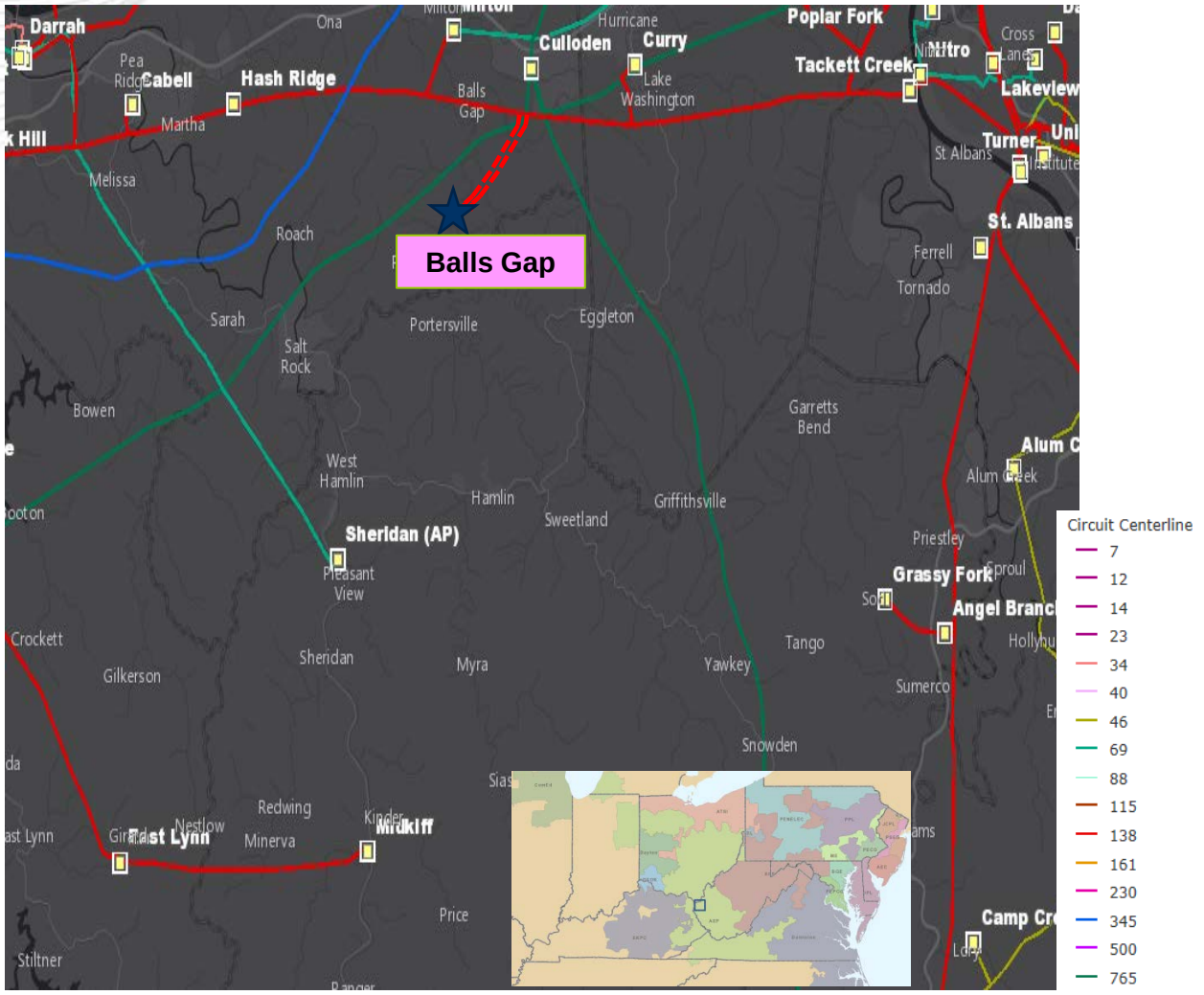
Total Estimated Transmission Cost: $12.1M

Alternatives:

- No viable cost-effective alternatives identified

Projected In-service: 12/1/2017

Project Status: Construction



AEP Transmission Zone: Supplemental Beckham Breaker Addition

Problem Statement:

Operational Flexibility and Efficiency:

The MPOI calculation (score of 203) performed on Beaver Creek - Hazard 138 kV circuit exceeds the threshold of 200, which supports installing breakers on the line at Beckham station per AEP guidelines. Additionally, the load in this area is non-transferrable and cannot be picked up in case of a line outage. Therefore, installing two breakers to protect both sides of the lengthy line is recommended.

Potential Solution:

Install two new 3000 A 40 kA 138 kV circuit breakers at Beckham station. The circuit breakers will be placed on the line exists towards Hazard and Beaver Creek stations. The existing ground MOAB scheme on the high side of the distribution transformer at Beckham will be replaced by a 138 kV circuit switcher.

Estimated Transmission Cost: $1.2M

Alternatives:

- No viable cost-effective alternatives identified

Projected In-service: 12/1/2017

Project Status: Construction

AEP Transmission Zone: Supplemental Bass Breaker Replacement

Problem Statement:
Equipment Material/Condition/Performance/Risk:
Breaker B at Bass station is a GE FK-339-1000-2 1200A 17kA model manufactured in 1947 that has experienced 24 fault operations, exceeding the manufacturer's recommendation of 10. Factors contributing to the replacement recommendation are age, bushing maintenance issues, no repair part availability and the amount of fault operations. Additionally, the installation of new IEDs would provide increased protection reliability and enhanced oscillography capabilities for fault analysis.

Potential Solution:
At Bass station, replace 34kV CB "B" with a 1200A 25kA model.

Estimated Transmission Cost: $1M

Alternatives:
- No viable cost-effective alternatives identified

Projected In-service: 9/1/2018

Project Status: Construction

AEP Transmission Zone: Supplemental
Fall Creek Breaker Replacement

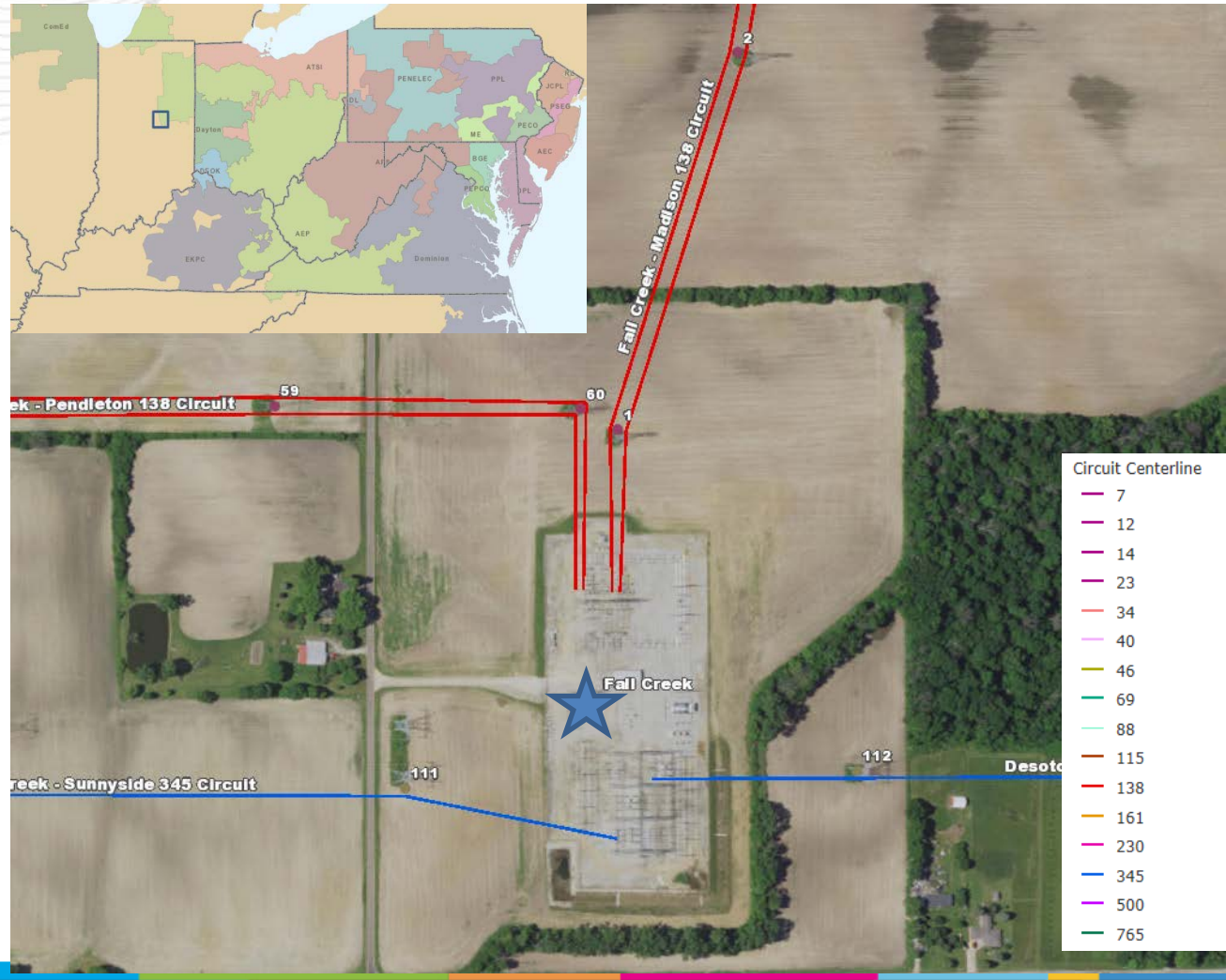
Problem Statement:

Equipment Material/Condition/Performance/Risk:

Breakers 'C', 'C2', 'E', and 'E2' are from vintage PK style 3000A 50 kA air blast breakers from 1973. The PK air blast medium breakers have a documented history of exploding violently upon failure and are an identified safety hazard. These breakers have been subject to a large amount of fault operations with Breaker C experiencing 15 operations, C2 experiencing 26 operations, breaker E experiencing 36 operations and breaker E2 experiencing 35 operations. Due to the age, number of operations and condition of these breakers, replacement is required.

Operational Flexibility and Efficiency:

Currently the Fall Creek busses are exposed to 6.7 miles of line fault through the Delco Remy 1949 line and 7.5 miles of line fault through the Madison 1940 line. In order to provide the busses protection from these 70+ year old lines breakers are needed. Currently a fault on the Delco Remy or the line requires 5 breakers to operate to clear the fault. The high number of breaker operations required significantly increases the complexity of the protection circuits and increases the likelihood of misoperations and human error.



AEP Transmission Zone: Supplemental
Fall Creek Breaker Replacement

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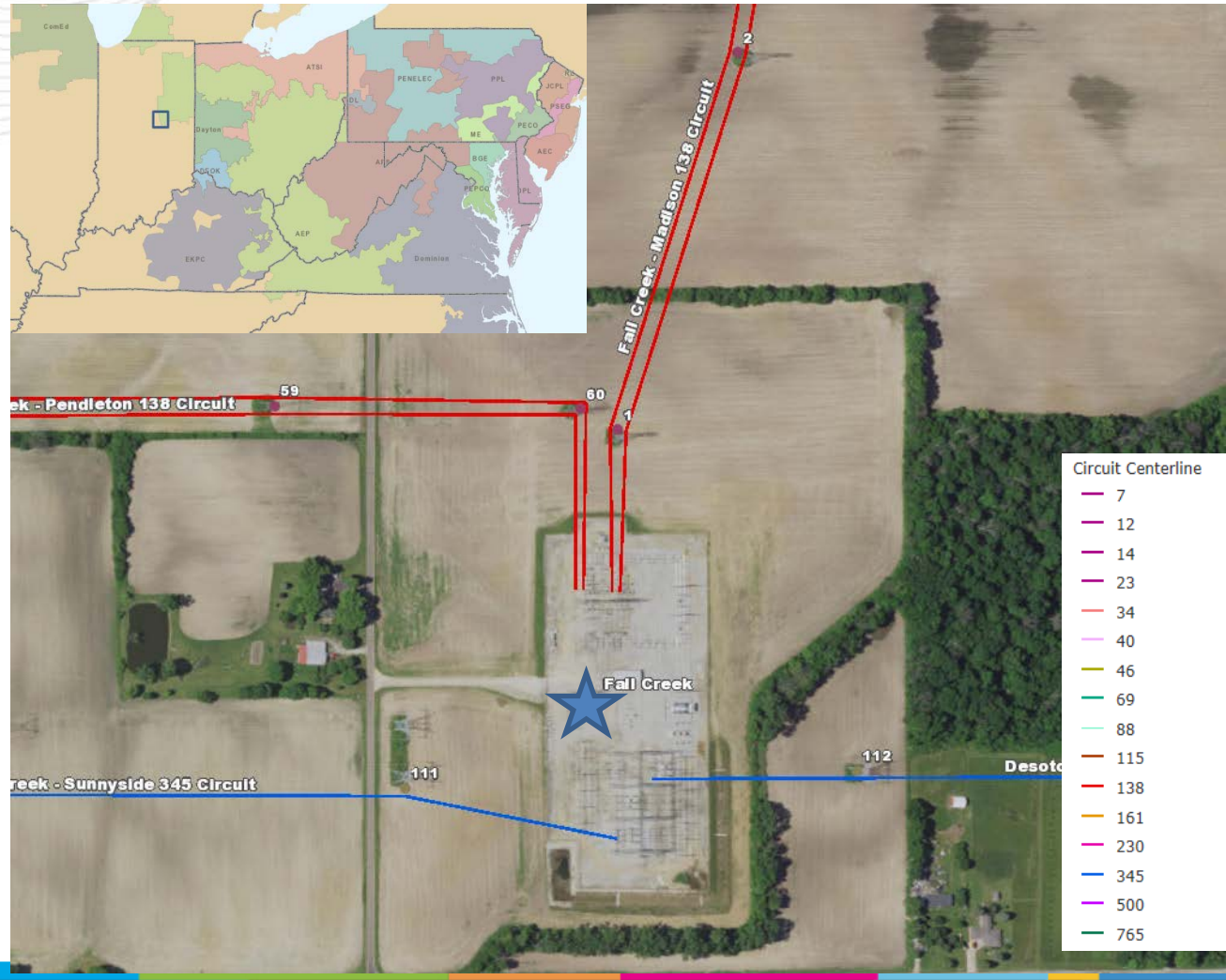
Potential Solution:
At Fall Creek station, install six 138 kV 3000 A 63 kA breakers at Fall Creek station to complete a breaker-and-a-half arrangement for all line exits at the station. Replace associated relaying and equipment in the existing control house.
Estimated Transmission Cost: $6.5M
Reroute and terminate the Delco and Pendleton lines to new station exit locations.
Estimated Transmission Cost: $0.6M
Reroute and terminate the Madison and New Castle lines to new station exit locations.
Estimated Transmission Cost: $0.6M

Total Estimated Transmission Cost: $7.68M

Alternatives:
Replace breakers in place. This would require longer outages, pose increased safety risks and would require more construction equipment and so is not recommended. Estimated Cost: $3.0M

Projected In-service: 12/31/2017

Project Status: Construction



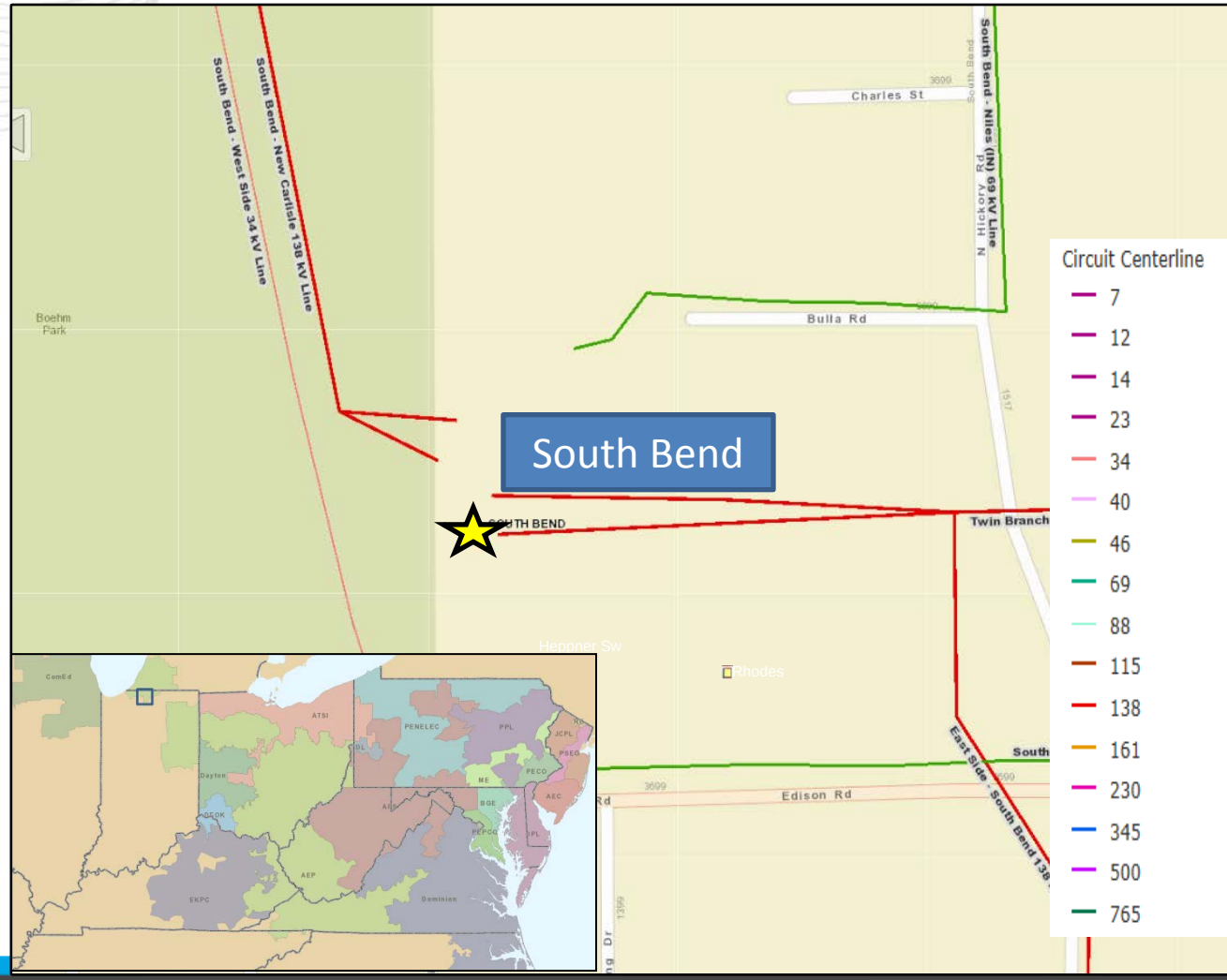
AEP Transmission Zone: Supplemental
South Bend Station Upgrades

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Transformer #1 is showing signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings). Transformer #1 is a 1961 vintage and has high levels of Ethane and Hydrogen. For transformer 1, Asset Health Center shows a reading of 125 PPM for Ethane (at Condition 3 of 101-150) and 1,122 for Hydrogen (at IEEE Condition 3 of 701-1,800). Gas formation within an operating transformer are caused by electrical disturbances and thermal decomposition. All transformers generate gases to some extent at normal operating temperatures. Utilities abide by the IEEE Conditions, with 4 being the worst and 1 being normal, to assess transformer health.

Transformer #2 is a 1966 vintage 75MVA bank that is no longer needed at this station. By removing this bank and connecting the 34.5 winding of existing transformer 5 to the 34.5kV network, the reliability of the 34.5kV network is maintained. Transformer 5 was manufactured in 1992.



AEP Transmission Zone: Supplemental
South Bend Station Upgrades

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Potential Solution

At South Bend station, retire 138/34kV transformer #2. Replace transformer #1 with a 138/69-34.5kV 78/104/130MVA transformer. Transformer #1 will feed the 34.5kV bus through the 34.5 kV winding until the station is upgraded to 69kV. Connect the 34.5 kV winding of transformer #5 to the 34.5kV bus 2. Install high side circuit switchers on both transformer #1 and #5. Reroute the South Bend – West Side, South Bend – Colfax and South Bend – Dragoon line to the new station exits.

Estimated Transmission Cost $1.15M

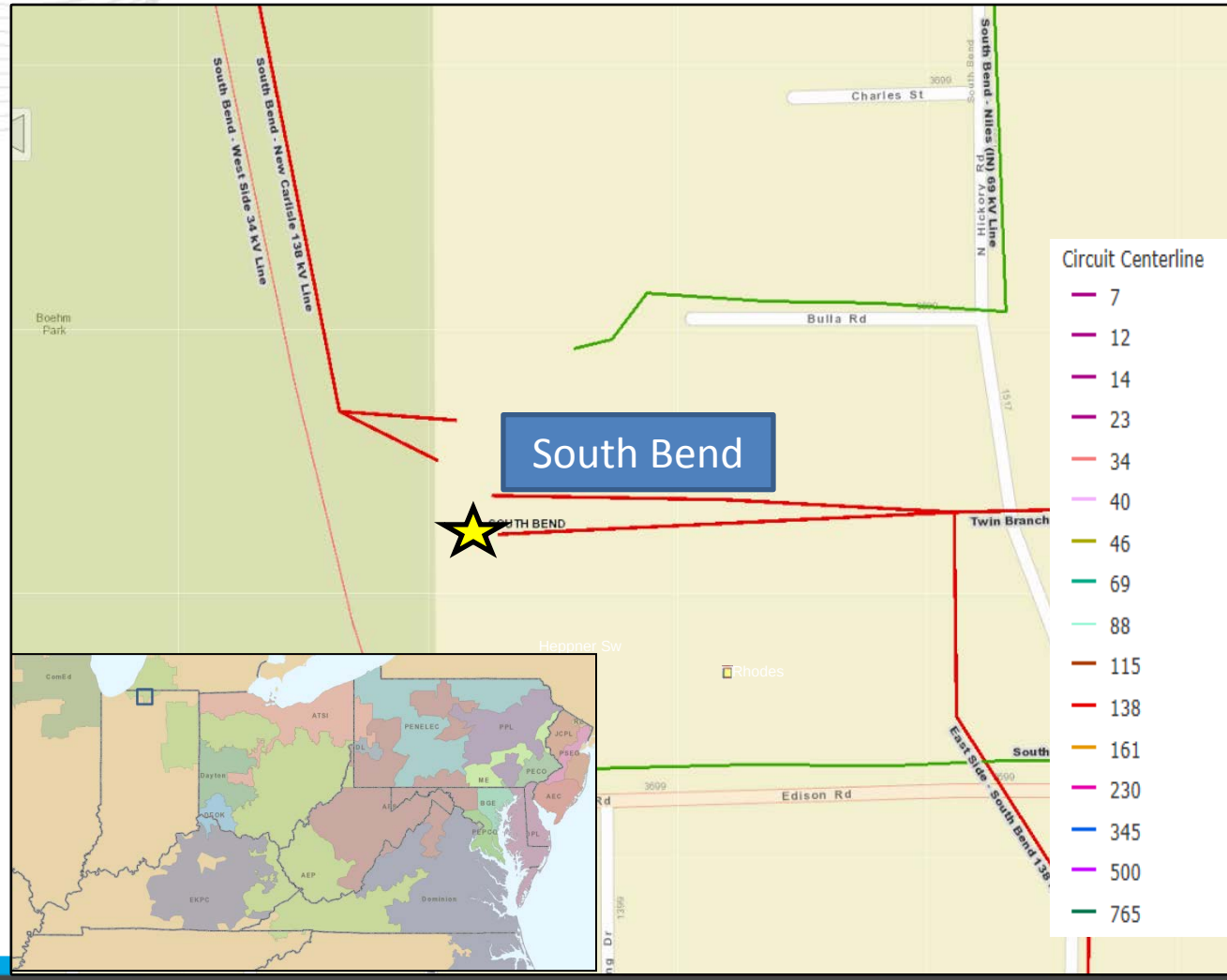
Alternative:

Replace both 138/34.5 kV TXs with 138/34 kV TXs and not with a single 138/69-34.5 kV transformer. Due to future plans to convert portions of the 34.5kV network to 69kV, it is not recommended to install a 138/34.5kV transformer. The conversion project will be submitted in a separate supplemental submittal.

If only the existing unit were connected to the 34.5 kV bus without the installation of the second unit, the Dragoon-Railroad and Liberty Tap-Russ Street lines would overload under N-1-1 conditions.

Projected In-service: 12/01/2017

Project Status: Construction



AEP Transmission Zone: Supplemental
Axton Breaker Replacement

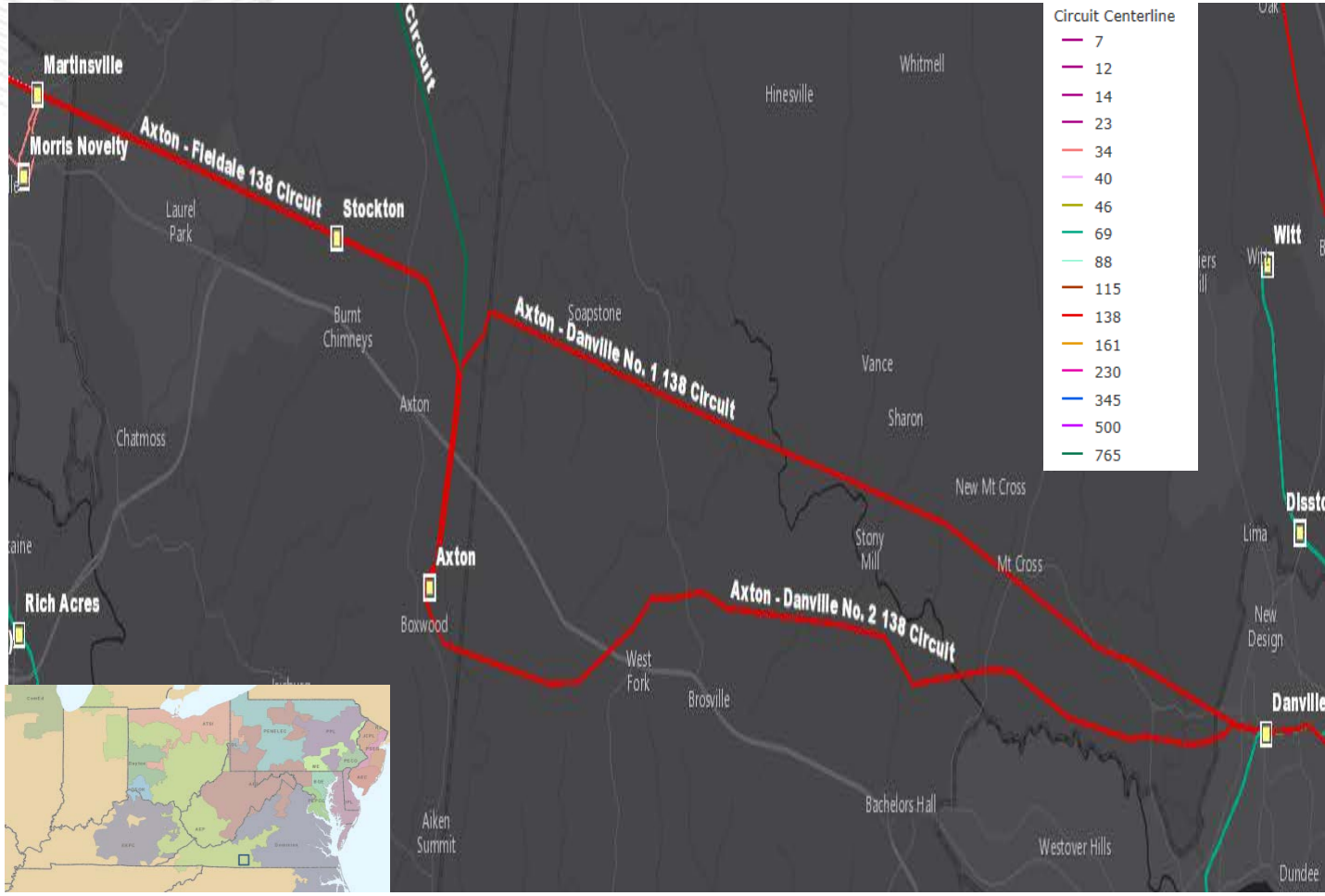
Problem Statement:

Equipment Material/Condition/Performance/Risk:

At Axton station, 138kV circuit breakers H, H1, H2 and G are Delle PK-28 50kA type Air Blast breakers. Air blast breakers are being replaced across the AEP system due to reliability concerns, intensive maintenance, and their tendency to catastrophically fail. During failures, sharps pieces of porcelain from their bushings are typically expelled, which, can be a potential safety hazard to field personnel. In addition, the ability to get spare parts for these breakers is becoming increasingly difficult. The Manufacturers recommended number of fault operations is 10. Breaker H has experienced 85 fault operations, breaker H1 has experienced 45 fault operations, breaker H2 has experienced 69 fault operations, and breaker G has experienced 32 fault operations. Presently, the backup station service is provided by the City of Danville. This makes us dependent on another utility for reliable station service which is not the best situation. In addition, the station service transformers has begun to show high levels of deterioration and will be replaced with like kind units.

Operational Flexibility and Efficiency:

The 138kV Martinsville line breaker(CB - J2) at Axton is being added to prevent the loss of the 138kV Bus #2 due to a fault on the line. This 138kV breaker will also separate two zones of protection for the bus and the line. CB - G1 is being added to prevent the loss of 138kV Danville #2 line and 138kV Fieldale line for a breaker failure (CB - H1).



AEP Transmission Zone: Supplemental
Axton Breaker Replacement

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Potential Solution:
Axton Station ($3.79M):

- Replace 138kV PK breakers with new 3000A, 145/170kV, 63kA circuit breakers and install new control relays.
- Install a new 3000A, 145/170kV, 63kA circuit breaker on the Martinsville line and install new line relays.
- Install a new 3000A, 145/170kV, 63kA circuit breaker to complete 138kV G string for Danville 32 138kV line and install new line relays.
- Install new relays for 138kV Danville #1 line, 138kV Danville #2 line, 138kV Fieldale line, 138kV Bus #1 and 138kV Bus #2.

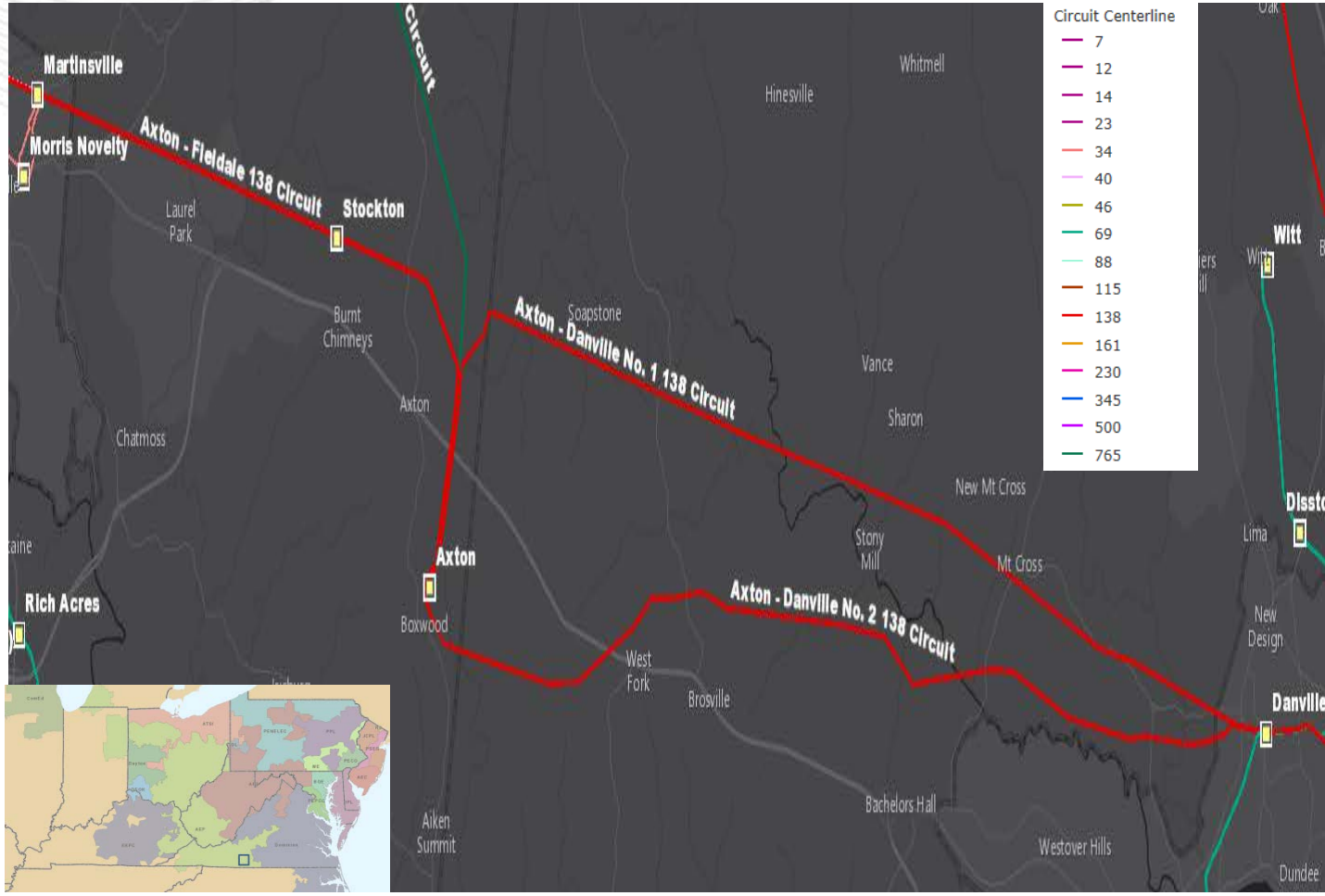
Estimated Transmission Cost: $3.79M

Alternatives:

- No viable cost alternatives identified

Projected In-service: 11/1/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Berne and Adams Breaker Replacements

Problem Statement:

Equipment Material/Condition/Performance/Risk:

CB's A, B, and C at Berne and Breaker E at Adams are oil type breakers. Oil breakers, in general, have become more difficult to maintain due to the required oil handling. Oil spills occur often during routine maintenance and failures, which can become an environmental concern. Other drivers include age, bushing damage, and number of fault operations.

69kV breakers 'A' and 'B' at Berne are Penn CF 1200A 23kA models manufactured in 1967 and have experienced 16 and 79 fault operations respectively. 69kV breaker 'C' at Berne is a McG CF 1200A 23kA breaker model manufactured in 1970 and has experienced 121 fault operations. 69kV circuit switcher 'AA' being replaced is a S&C model 400A 20kA. 69kV breaker 'E' at Adams is a P.T.CO CF 1200A 21kA model manufactured in 1966 and has experienced 12 fault operations.

AEP Transmission Zone: Supplemental
Berne and Adams Breaker Replacements

Continued from previous slide…

Potential Solution:
At Berne station, retire 69 kV CB's "A","B","C", foundations and associated disconnects and replace them with 69kV 3000A 40kA CB's. Replace Cap Switcher "AA" along with its foundation and controls with a 69kV 420A 18kA cap switcher.

Estimated Transmission Cost: $2.6M

At Adams Station, replace breaker 'E' with a 69kV 3000A 40kA breaker.

Estimated Transmission Cost: $0.7M

Total Estimated Transmission Cost: $3.3M

Alternatives:
Rebuild Berne station in the clear. Due to the distribution equipment being less than 30 years old and having no outstanding asset health concerns, there is not adequate justification for rebuilding in the clear.

Estimated Cost: $5.5M

Projected In-service: 12/31/2018

Project Status: Engineering

AEP Transmission Zone: Supplemental
Bosman-Hartford City Rebuild

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Delaware – Hartford City line is constructed of wooden poles from 1950 and is currently subject to 75 open conditions including elongated crossarm bolt holes; heart rotted, top rotted and split crossarms; broken and missing ground lead wires; broken insulators; and heart rotted, top rotted and split poles. The existing conductor is 3/0 copper (23 MVA rating).

Potential Solution:

Rebuild the 17.6 mile Bosman – Hartford City 34.5 kV line utilizing 795 ACSR 26/7 (64 MVA rating). This line will be built to 69kV standards but operated at 34.5kV

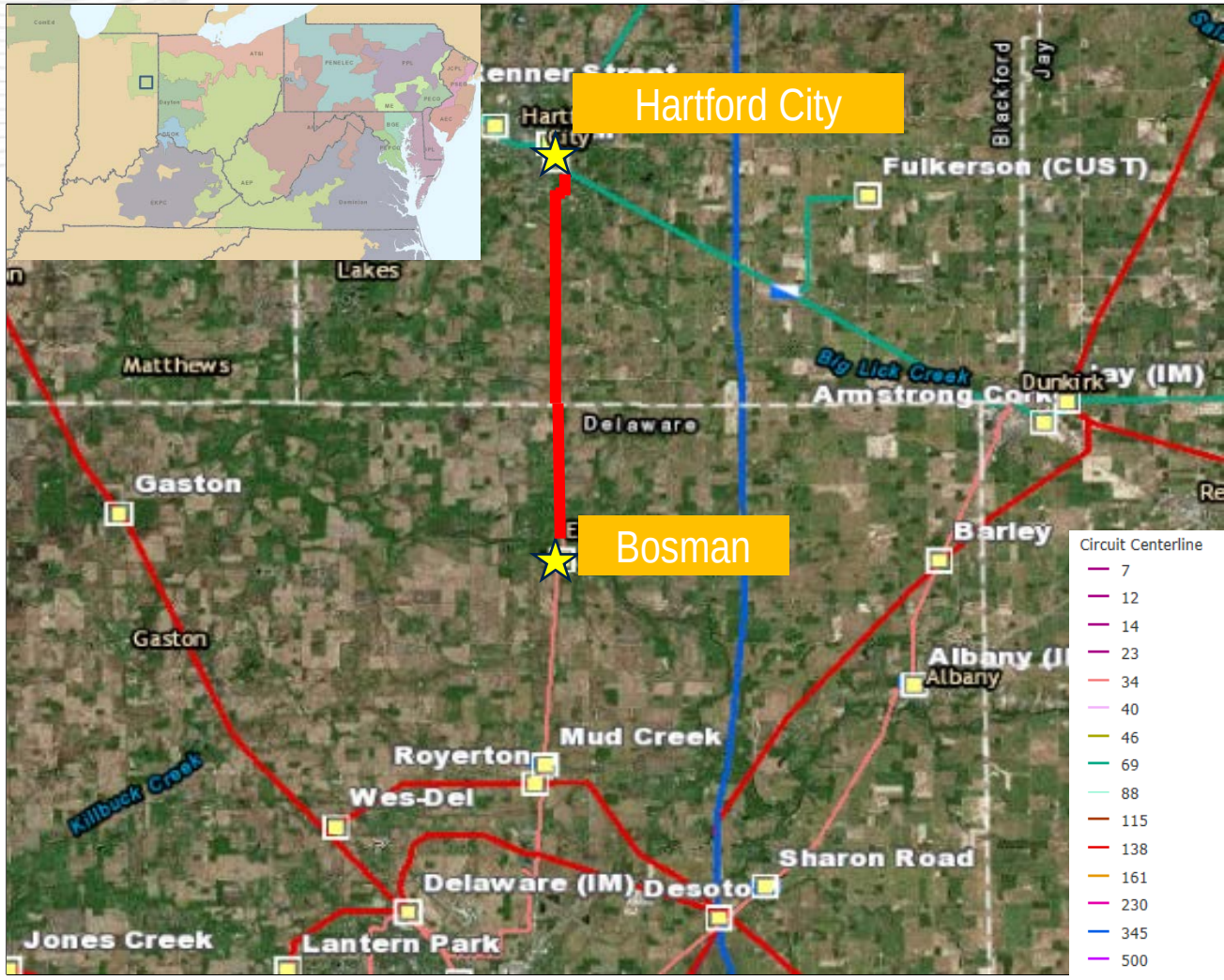
Estimated Transmission Cost: $13.6M

Alternatives:

- Rebuild line in the clear to avoid lengthy outages. Due to feasibility of outages on the existing line and increased cost, building on new ROW is not recommended. Estimated cost: $19M

Projected In-service: 8/31/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental
Buckhorn Station Expansion

Problem Statement:

Customer Service:

Obligation to serve customer. Future load at the station is estimated to be approximately 7 MVA during Summer Peak and 15 MVA during Winter Peak.

Potential Solution:

At Buckhorn station, split the existing bus and install a new 3000A 120kA MOAB between Bus #1 and Bus #2. Replace the existing switch facing Tazewell with a new 2000A 100kA MOAB (non-auto sectionalizing). Install a 20 MVA 138/12 kV transformer on the newly established Bus #2. Install two 3000A 40kA circuit switchers on the high side of XF #1 and the new XF #2.

Estimated Transmission Cost: $0M

Line work to accommodate a second transformer at the station.

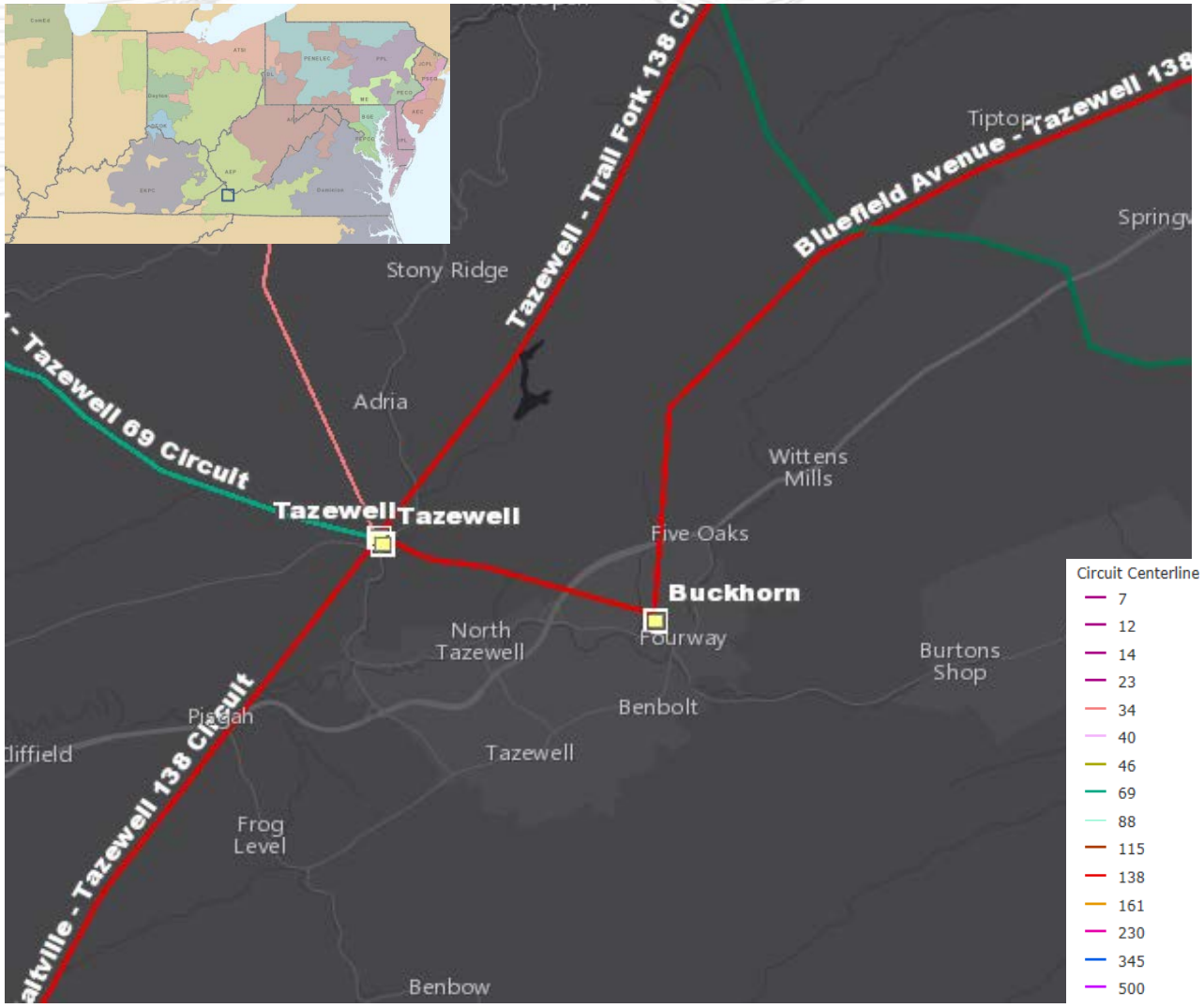
Total Estimated Transmission Cost: $0.1M

Alternatives:

- No viable cost-effective alternatives identified

Projected In-service: 12/1/2018

Project Status: Engineering



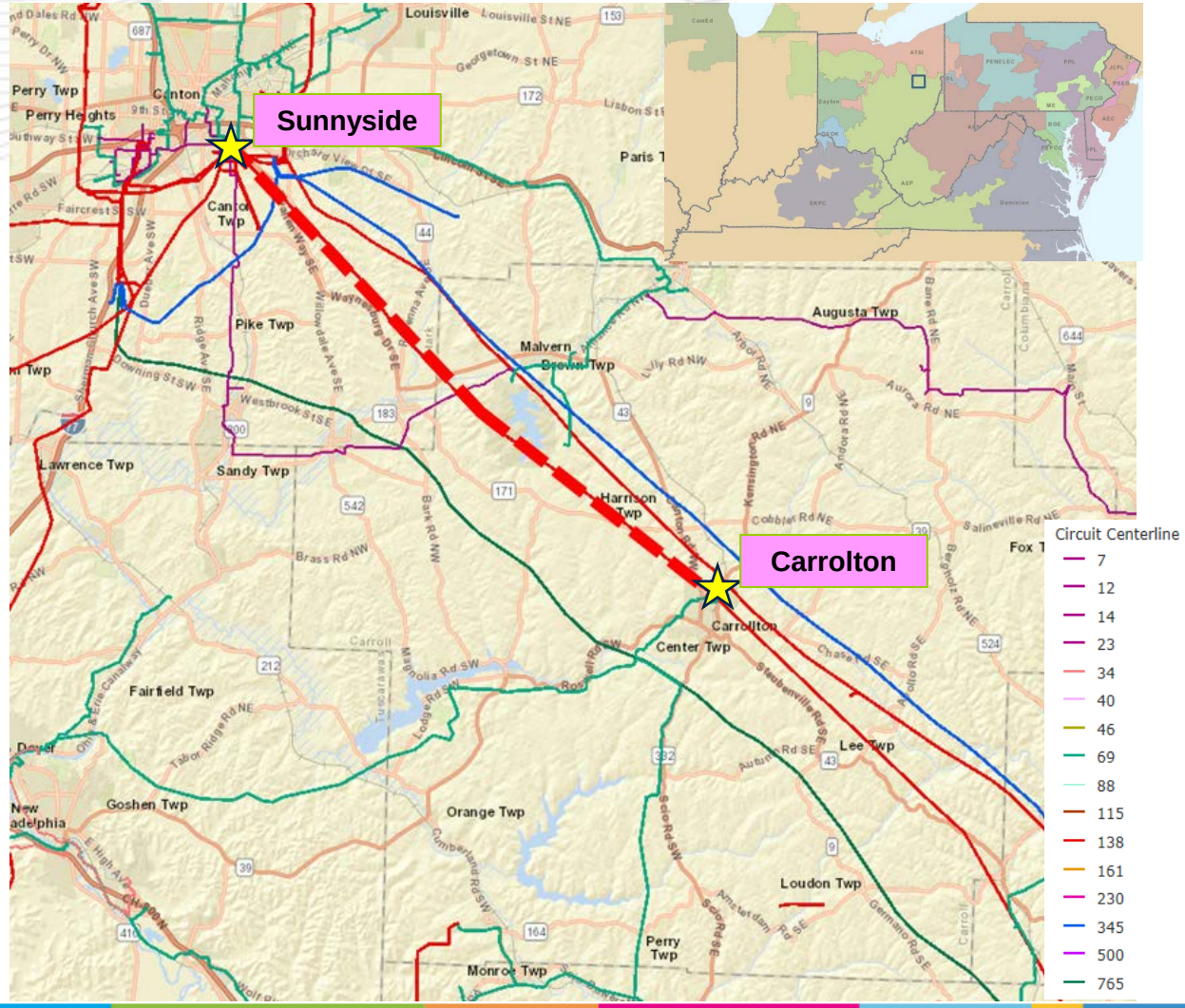
AEP Transmission Zone: Supplemental Carrolton-Sunnyside Rebuild

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The existing 19.8-mile, 138 kV line section between Carrollton and Sunnyside stations was constructed in 1916 using lattice towers and 6-wired 200 kcmil copper conductor (221 MVA summer rating). There are numerous condition concerns on this line, including rusting towers on 60% of the line, worn insulators and hardware. The copper conductor has become very brittle after 100 years in the field and is difficult for crews to repair. Some towers are sitting in water. Many tower legs under ground have been found to be significantly deteriorated.

The circuit has experienced zero minutes of customer interruption, due to not directly serving customers. However, it does serve as an important pathway in transporting power from south to north, from the Ohio River generation to the load center in northeast Ohio. This area also has high load growth potential due to shale loads in the area. Keeping the existing ROW and line is advantageous to maintaining future flexibility in the area.



AEP Transmission Zone: Supplemental Carrolton-Sunnyside Rebuild

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Potential Solution:

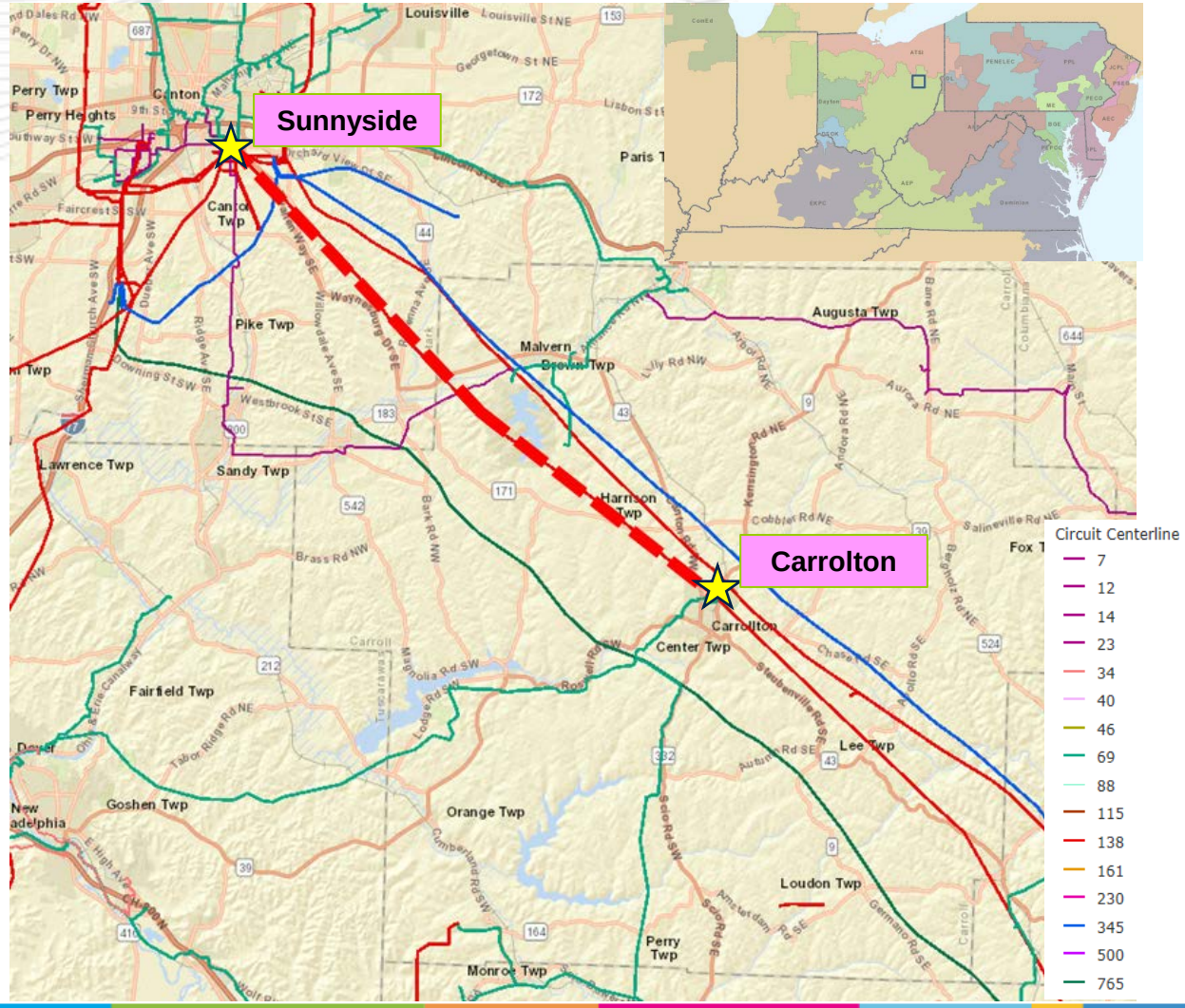
Rebuild the Carrollton-Sunnyside 138kV circuit. Install double-circuit steel poles with 6-wired 1234 ACSS/TW Yukon conductor. Future circuit rating = 335 MVA SN / 392 MVA SE (non-conductor limited).
Estimated Transmission Cost: $50.4M

Alternatives:

- No viable cost-effective transmission alternative was identified. The problematic transmission line could not be retired in place, due to serving as an important power pathway on the AEP transmission grid. Retiring it would have left the Carrollton 138/69kV station radial from Tidd station, and removed a strong 138kV power source to Sunnyside station in Canton. Both of these changes would have resulted in a less reliable transmission system and could have adverse impact on customers.

Projected In-service: 12/1/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental College Corner Rebuild

Problem Statement:

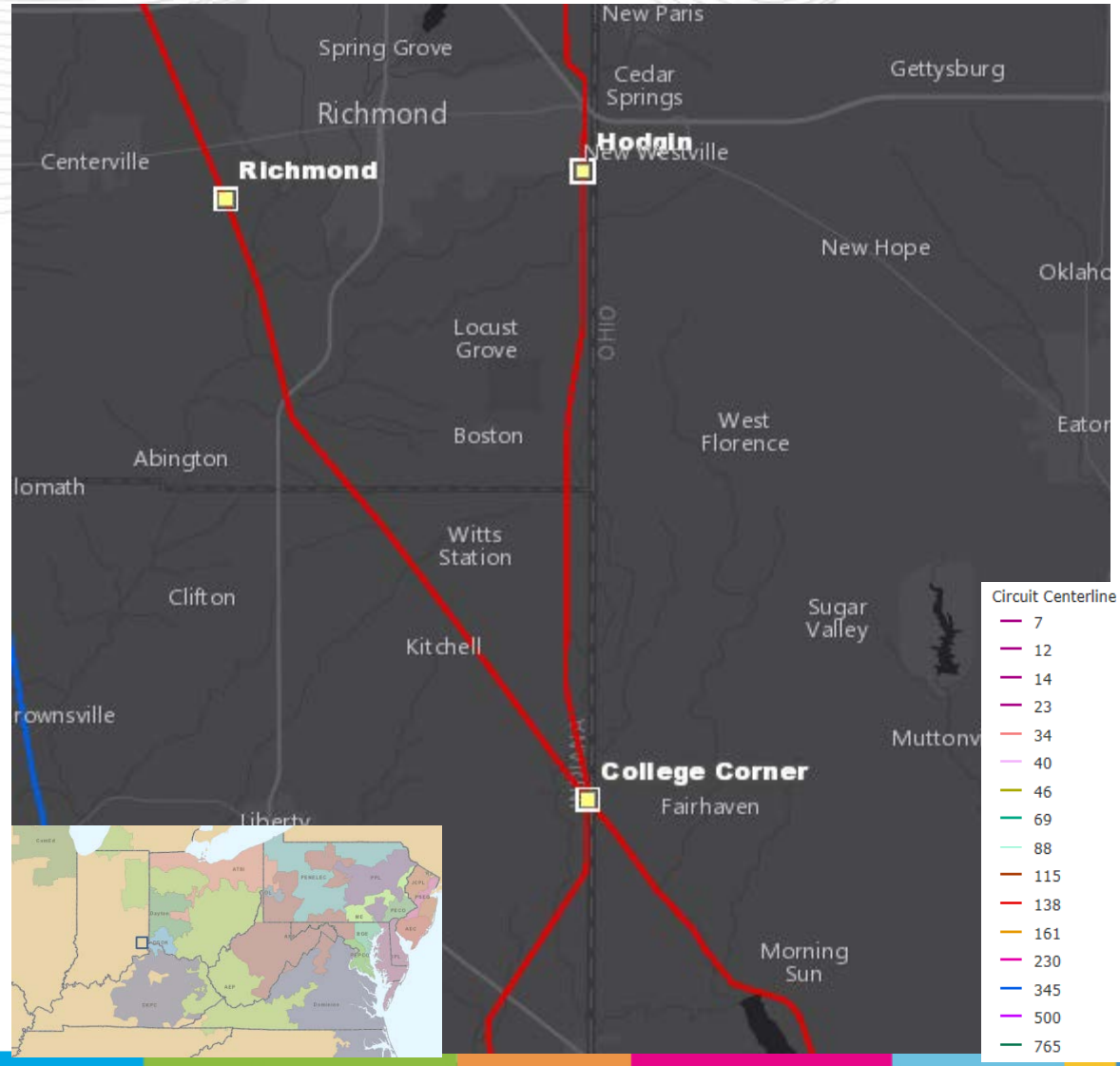
Equipment Material/Condition/Performance/Risk:

The College Corner station breakers are 1950 manufactured FK-439 type Oil breakers. These breakers are currently experiencing leaking bushings, bushings leaking into the breaker tank, high C2 PF and steadily increasing contact resistance. Each breaker contains 2,400 gallons of oil for a total of 16,800 gallons and must be toped off twice a year. In addition to this, the breaker bushings are likely PCB and create a potential risk to the local environment. The leaking air tanks are resulting in high compressor run time which, in conjunction with the oil breaker maintenance, is causing higher O&M costs. The breaker switches are obsolete models with breaded shunts and cap and pin insulators. The current breaker switch and station service transformer bus selector switches are mechanically difficult to operate and need to be replaced.

The relay equipment with the exception of the Ohio line exits are electromechanical. The carrier protection schemes are now starting to exhibit repetitive problems.

The stations RTU is a legacy model that is no longer supported by our vendor which means if an issue would occur, repairs would be costly and timely if possible.

The control house is in very poor condition and needs replaced. The roof currently needs to be patched periodically to stop leaks that spring up, the walls are deteriorated to the point that wildlife is entering the control house, and current cable exits are full and have no room for expansion. In addition to this many of the yard cabinets are in very deteriorated condition and need replacement.



AEP Transmission Zone: Supplemental College Corner Rebuild

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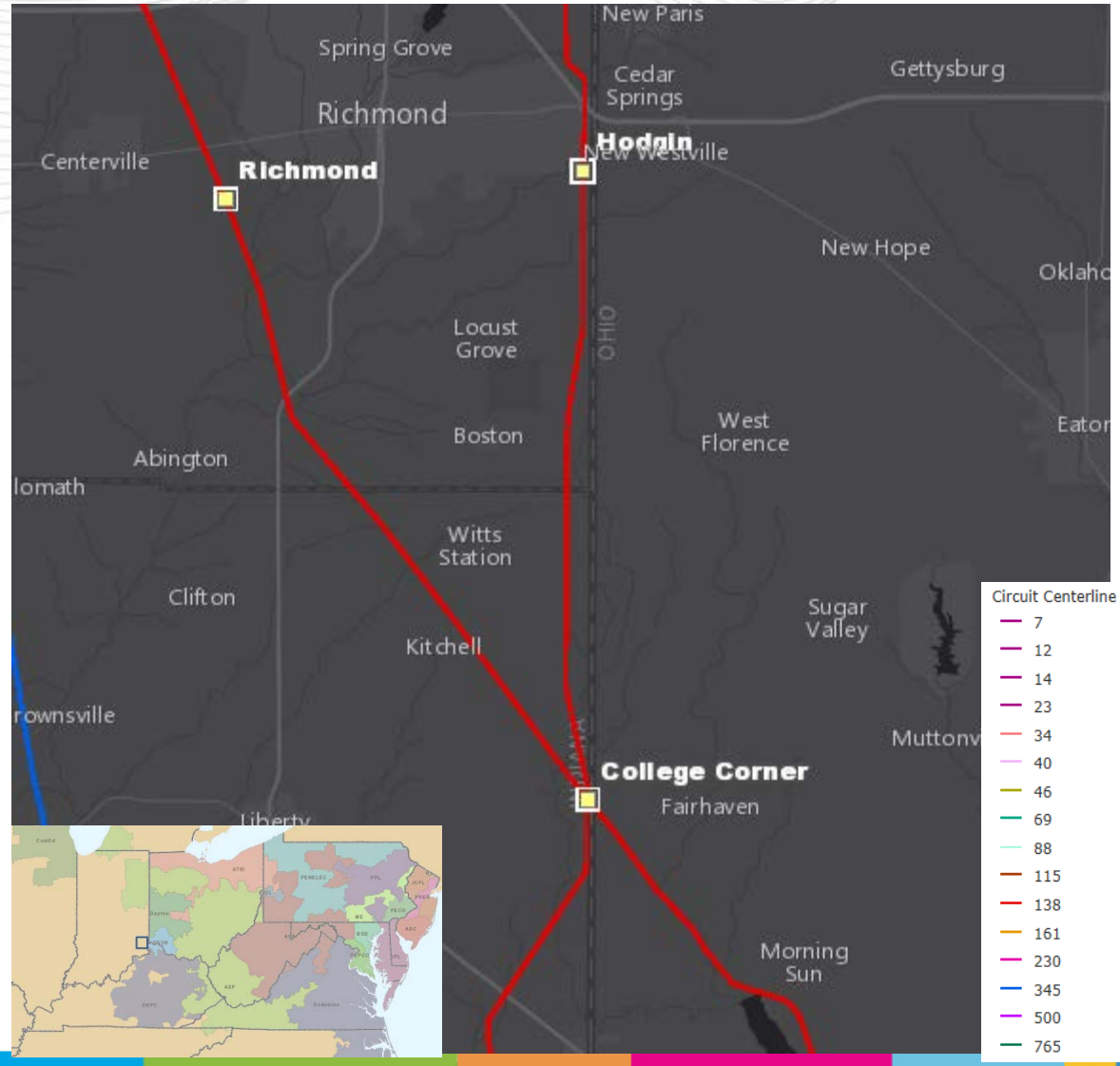
Equipment Material/Condition/Performance/Risk:

From 2002-2012 there have been 6 relay miss-operations which can be linked to either the age of the equipment or the poor protection scheme.
Breakers ‘A’, ‘B’, ‘D’, ‘E’, ‘F’ and ‘G’ are FK-439 1200A 17.5kA models
Breakers ‘A’, ‘E’, ‘F’, ‘G’, and ‘H’ are all above the recommended fault limit of 10 with the following amount of fault operations; A: 24 E: 88 F: 47 G: 37 H: 19

Breaker ‘C’ is a 140SFMT 3000A 40kA model and recently failed in the field.

Breaker ‘H’ is a HVB HS170 3000A 40kA model and recently failed in the field.

At Richmond station, the vintage 1959, 138kV circuit breaker C is a GE, FK Type oil filled breaker without oil containment that has had 91 fault operations which significantly exceeded the designed number of fault operations.
Breaker ‘C’ is a FK 439-138-5-3Y 1200A 50000MVA model.
The Richmond MOAB’s are in deteriorated condition and have vintage delta star mechanisms. In addition to this, the MOAB toward College Corner is no longer operational and the MOAB toward Selma Parker requires a mobile transformer to operate.



AEP Transmission Zone: Supplemental College Corner Rebuild

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Potential Solution:

Rebuild College Corner 138 kV station in the clear at the existing station site with ten 3000A 40 kA circuit breakers in a breaker and a half arrangement to terminate seven line positions. Replace the control house with a new DICM.
Estimated Transmission Cost: $12.3M
At Richmond station, replace 138 kV Breaker C with a 3000A 40kA model and replace MOAB's U, V, W, and Y with 3000A MOAB switches
Estimated Transmission Cost: $1.5

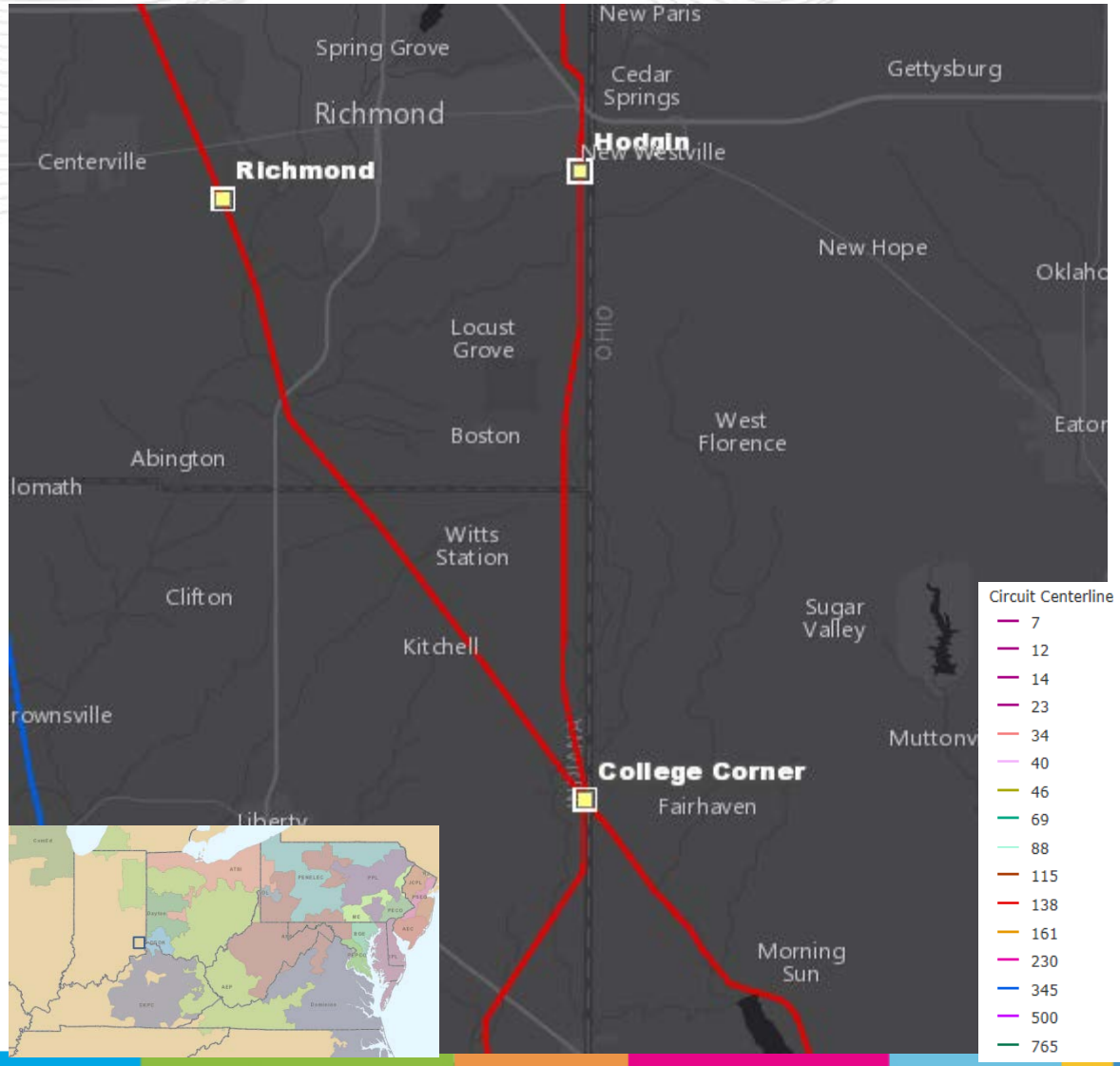
Total Estimated Transmission Cost: $13.8M

Alternatives:

- Replace in the current position. College Corner supports delivery to the City of Richmond and Drewersburg in Indiana and it provides interconnections with two utilities in Ohio. Due to the criticality of the station and the inability to take extended outages here, this is not a recommended option. Estimated Cost: $10M

Projected In-service: 11/30/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental
Moccasin Gap Station Construction

Problem Statement:

Customer Service:

Appalachian Power distribution has requested a new point of service in Scott County, VA to replace the existing Weber City delivery point. Future load at the station is estimated to be approximately 15 MVA during Summer Peak and 25 MVA during Winter Peak.

Potential Solution:

This project will construct a short single span 69 kV line extension from the existing Fort Robinson – Hill 69 kV transmission line to a new 69/12 kV Appalachian Power distribution station in Scott County, VA. The line extension will utilize 556 ACSR conductor (102 MVA rating). The new Moccasin Gap station will replace the existing Weber City station.

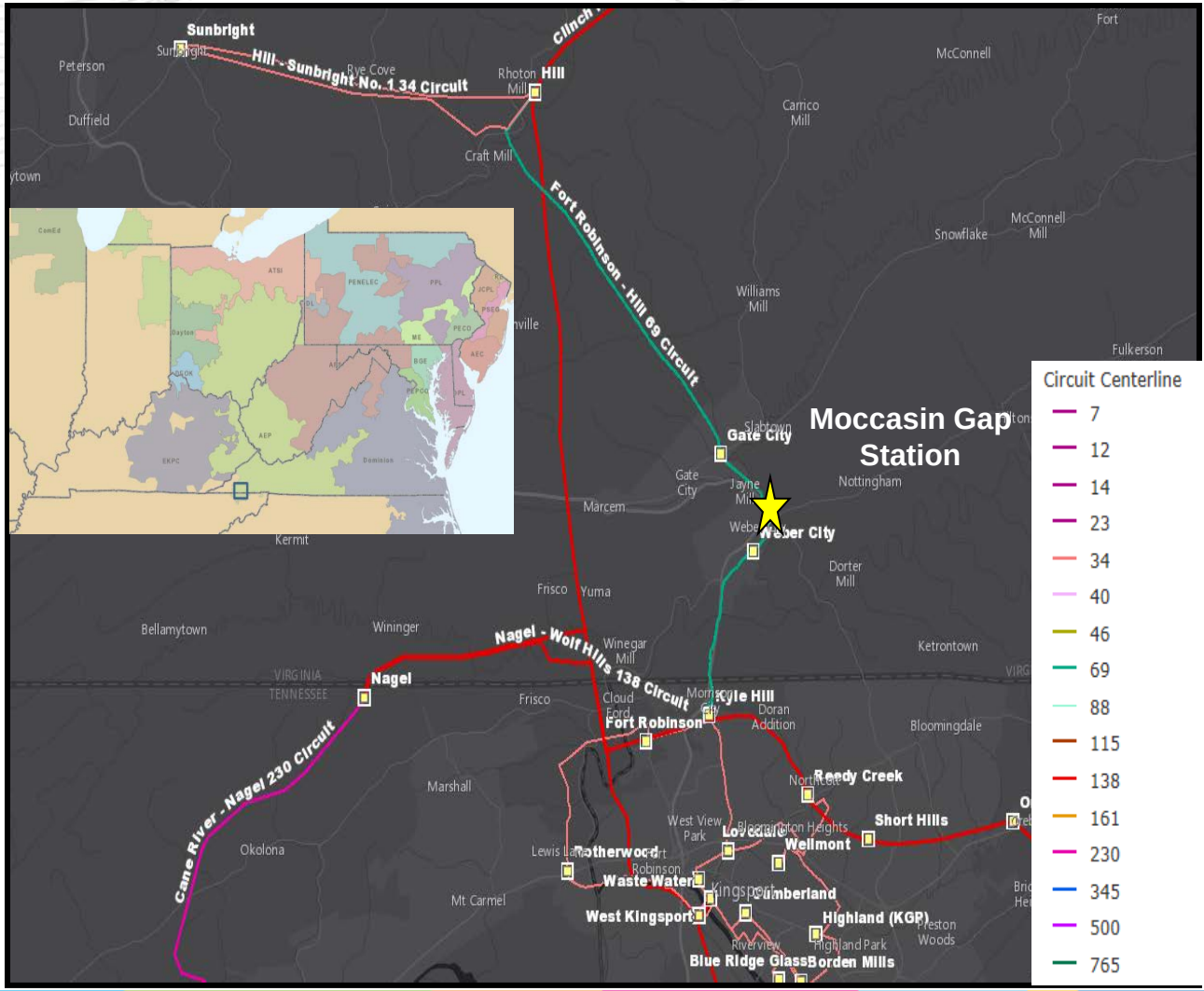
Estimated Transmission Cost: $0.2M

Alternatives:

- No viable cost-effective alternatives identified

Projected In-service: 12/01/2018

Project Status: Engineering

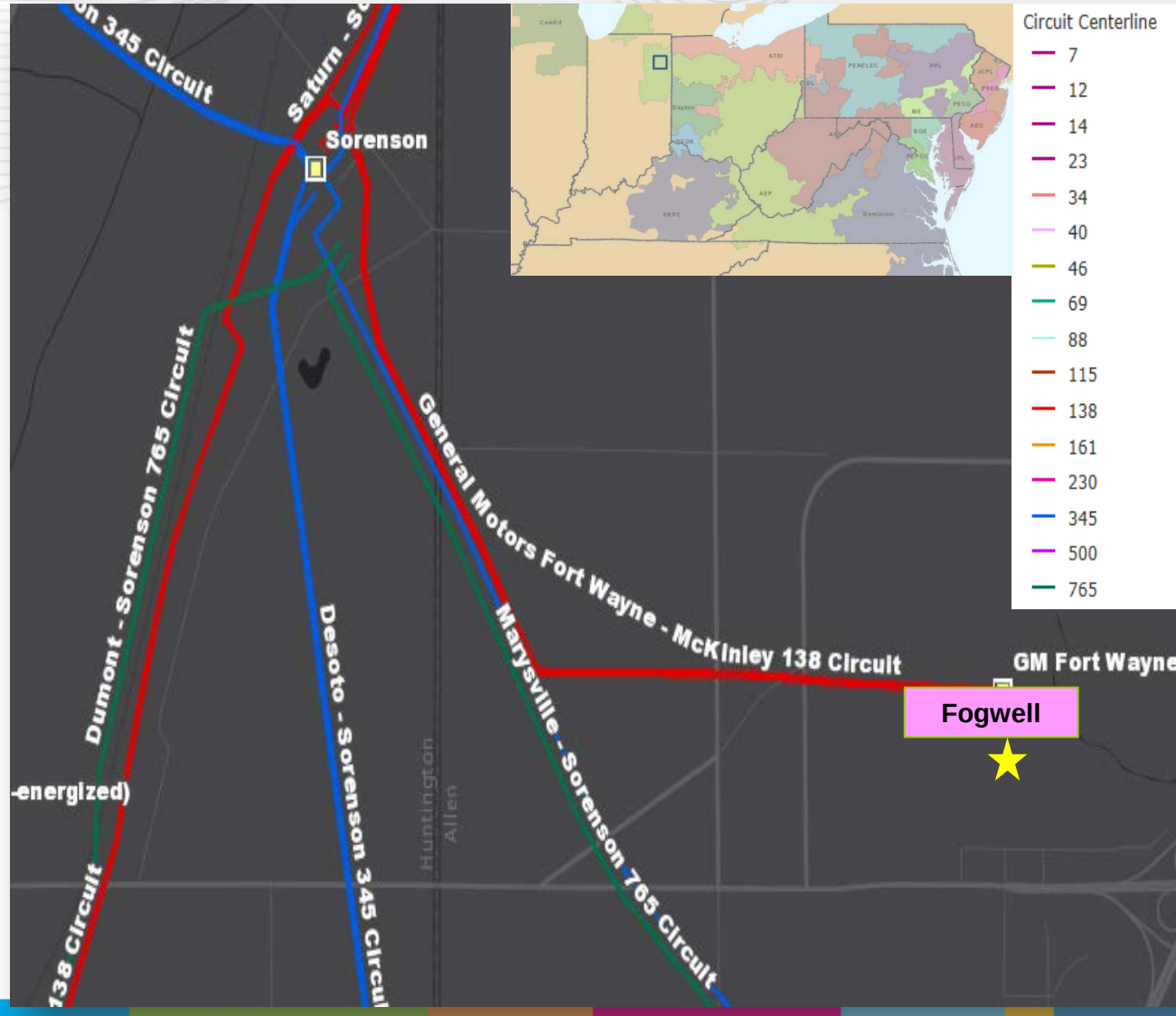


AEP Transmission Zone: Supplemental
Fogwell Station

Problem Statement:

Customer Service:

General Motors has set in motion a plan to increase production capabilities at their Fort Wayne Truck Plant by adding new facilities and therefore additional load. The existing peak load at the plant is approximately 28 MVA, with a new projected peak load of 45 MVA. This significant increase in load has required Wabash Valley Power Authority (WVPA), who owns the transformers serving the GM Truck Plant, to add a third transformer in order to support the new load and maintain reliability. In order to provide reliable service off the 138kV AEP facilities serving WVPA and GM going forward, a new AEP 138kV yard (Fogwell Station), will be established directly adjacent to the existing station facilities.



AEP Transmission Zone: Supplemental
Fogwell Station

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Potential Solution:

Build new 138kV station in the clear near existing GM Fort Wayne station. Station configuration will consist of two breaker and a half strings, totaling six 138kV, 3000 A, 40 kA circuit breakers. Transmission line and transformer positions will be configured such that at least one 138kV line and two transformers will be in-service in the event of a breaker failure..

Estimated Cost: $5.9 M

Install metering for GM tie line 3.

Estimated Cost: $0.27 M

Reroute 0.25 miles of the Sorenson line to the F-F1 Fogwell breaker position.

Estimated Cost: $0.8M

Reroute 0.1 miles of the GM 1 tie line to terminate at 138kV bus 1.

Estimated Cost: $0.56M

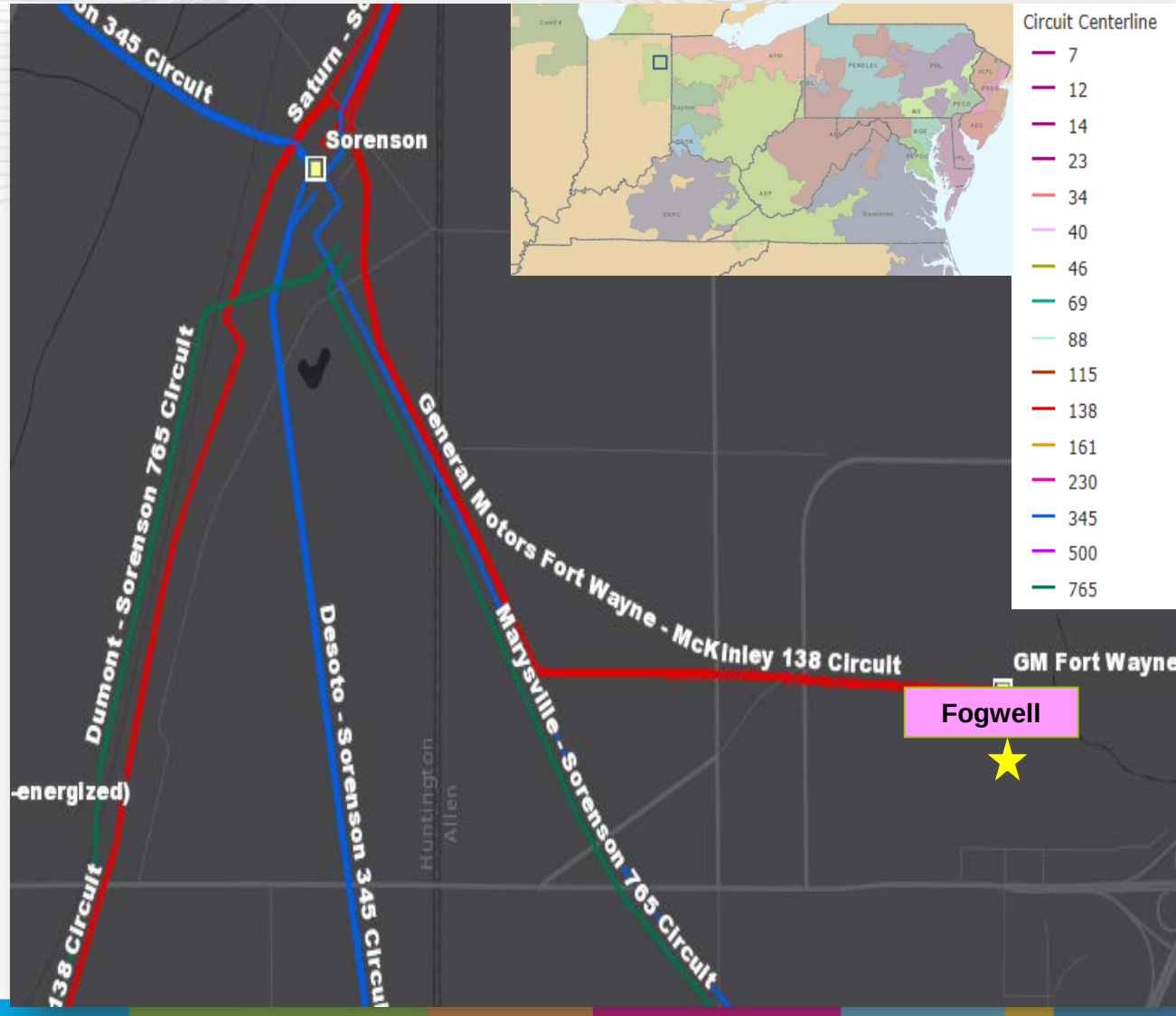
Reroute 0.1 miles of the GM 2 line to the F-F2 Fogwell breaker position.

Estimated Cost: $0.56M

Reroute 0.1 miles of the GM 3 line to the G-G2 Fogwell breaker position.

Estimated Cost: $0.26M

Total Estimated Transmission Cost: $8.4M



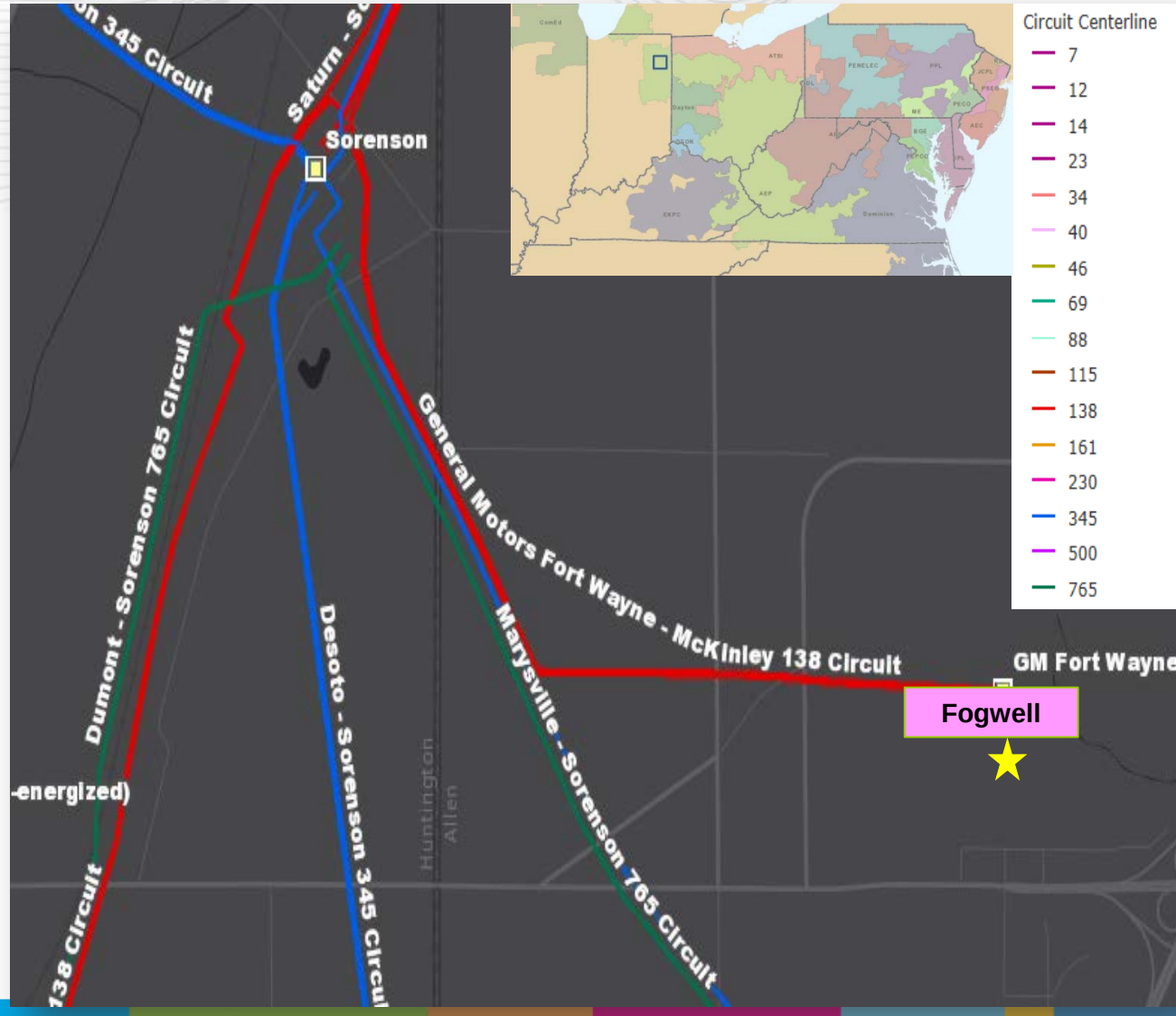
AEP Transmission Zone: Supplemental
Fogwell Station

Continued from previous slide…

Alternatives:
Connect the new Wabash Valley Power Authority (WVPA) transformer to existing 138kV AEP facilities (GM Fort Wayne Station). With existing configuration and limited room for expansion, a decrease in reliability would occur due to the addition of the new transformer. A new 138kV yard will improve reliability while serving the increase in load.

Projected In-service: 6/01/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Harrison-Parsons-Marion 40 kV

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Marion-Parsons 40kV line is 1926 vintage and in poor condition and in need of a complete rebuild. It has 38 A conditions along the 5 mile length. Due to the fact that this is a double circuit line and the only source to Parsons station, a planned outage cannot be taken to rebuild the line. The 636 AAC & 636 ACSR conductors are rated for SN/SE=62/62 MVA.

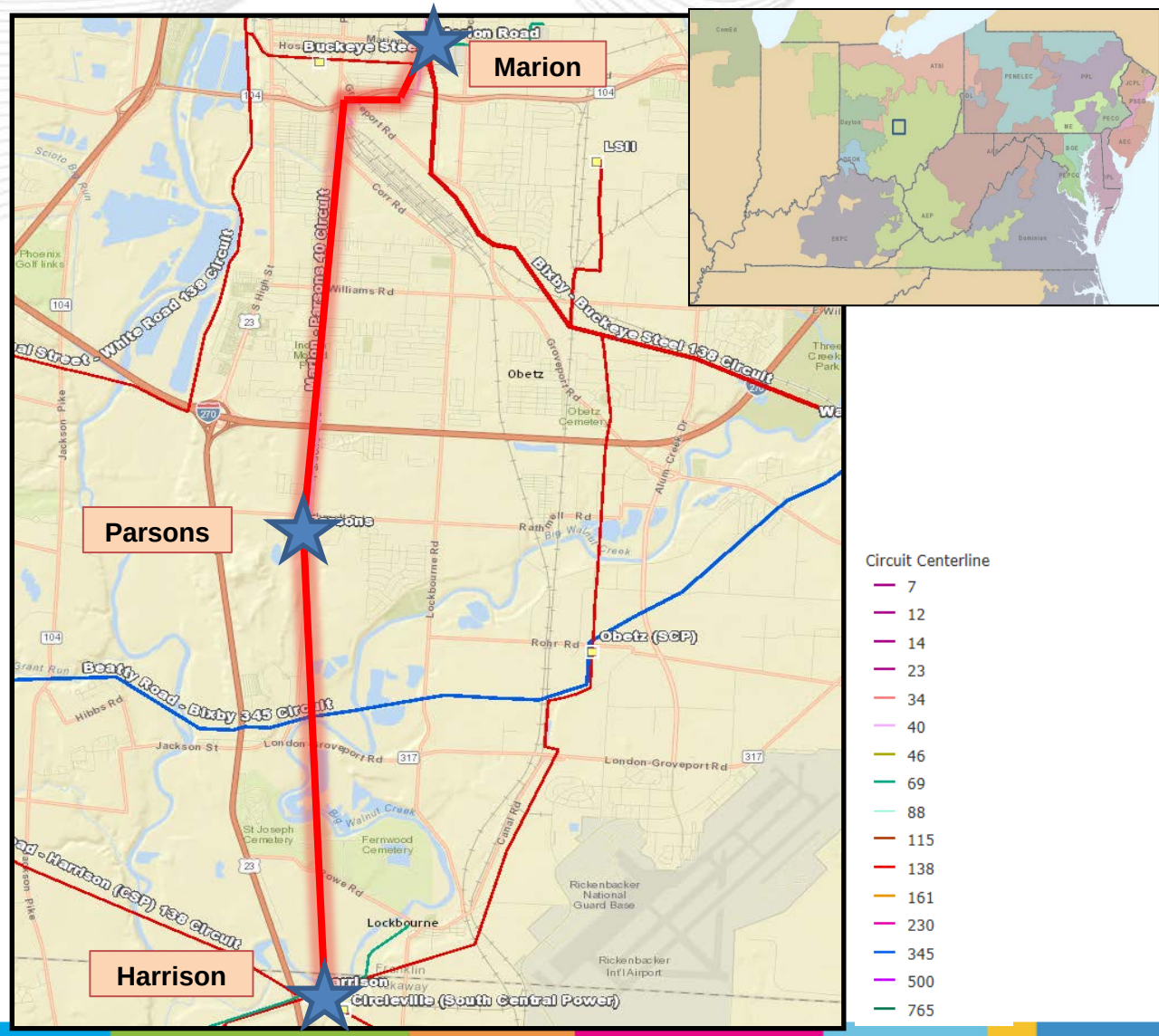
Parsons records show 25 fault operations on CB 42 and 11 fault operations on CB 44. The manufacturer recommends a limit of 10 fault operations.

Parsons circuit breakers #42 & #44 are showing signs of deterioration and use oil as the interrupting medium. 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 can become an environmental hazard.

The drivers for replacement of these breakers are age, bushing damage, no repair part availability, amount of fault operations and PCB content. PCBs have been used as coolants and lubricants in transformers, breakers, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effect.

Operational Flexibility and Efficiency:

Due to the fact that the Marion-Parsons 40kV line is the only source to Parsons station, it cannot be taken out of service for basic maintenance or to facilitate future conversion from the obsolete 40kV system to 69kV.



AEP Transmission Zone: Supplemental Harrison-Parsons-Marion 40 kV

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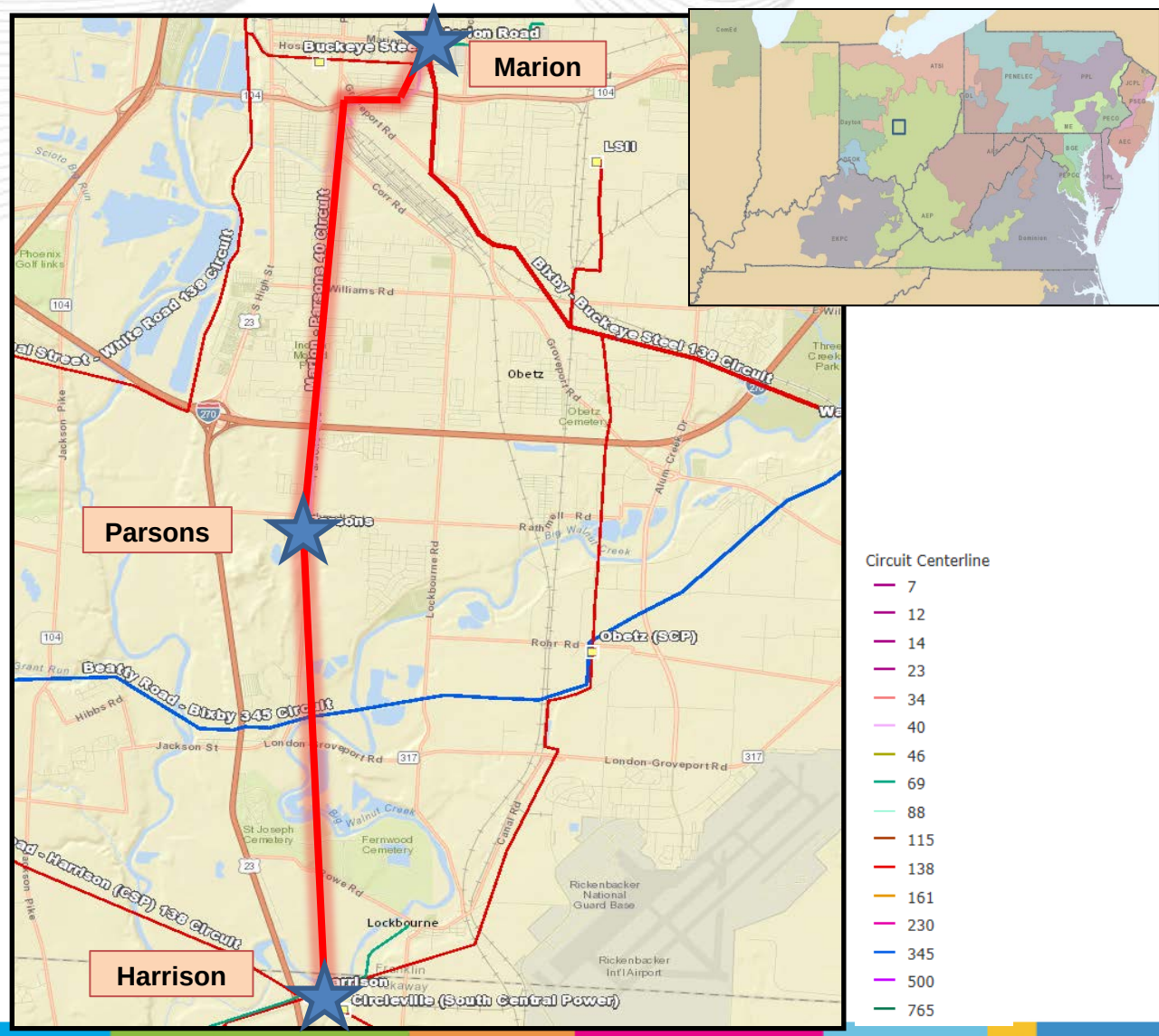
Potential Solution:
Construct a new Harrison-Parsons 69kV Line (energized @40kV), New 795 ACSR Drake in new ROW, SN/SE = 73 MVA
Estimated Transmission Cost: $7.7M
Rebuild the Marion-Parson double circuit 40kV Line as single circuit 69kV (energized @40kV), SN/SE = 73 MVA,
Estimated Transmission Cost: $14.0M
Harrison station, Relocate and install existing spare 138/40kV 46MVA transformer, 3,000A 138kV CB, & 2,000A 69kV CB
Estimated Transmission Cost: $2.0M
Parsons station, Replace 2-40kV CB's with 2-2,000A 69KV CB's, install 9.4MVAr capacitor bank
Estimated Transmission Cost: $1.0M
Marion station, Install 9.4 MVAr capacitor bank and retire unused equipment.
Estimated Transmission Cost: $0.3M.

Total Estimated Transmission Cost: $25.0M



AEP Transmission Zone: Supplemental Harrison-Parsons-Marion 40 kV

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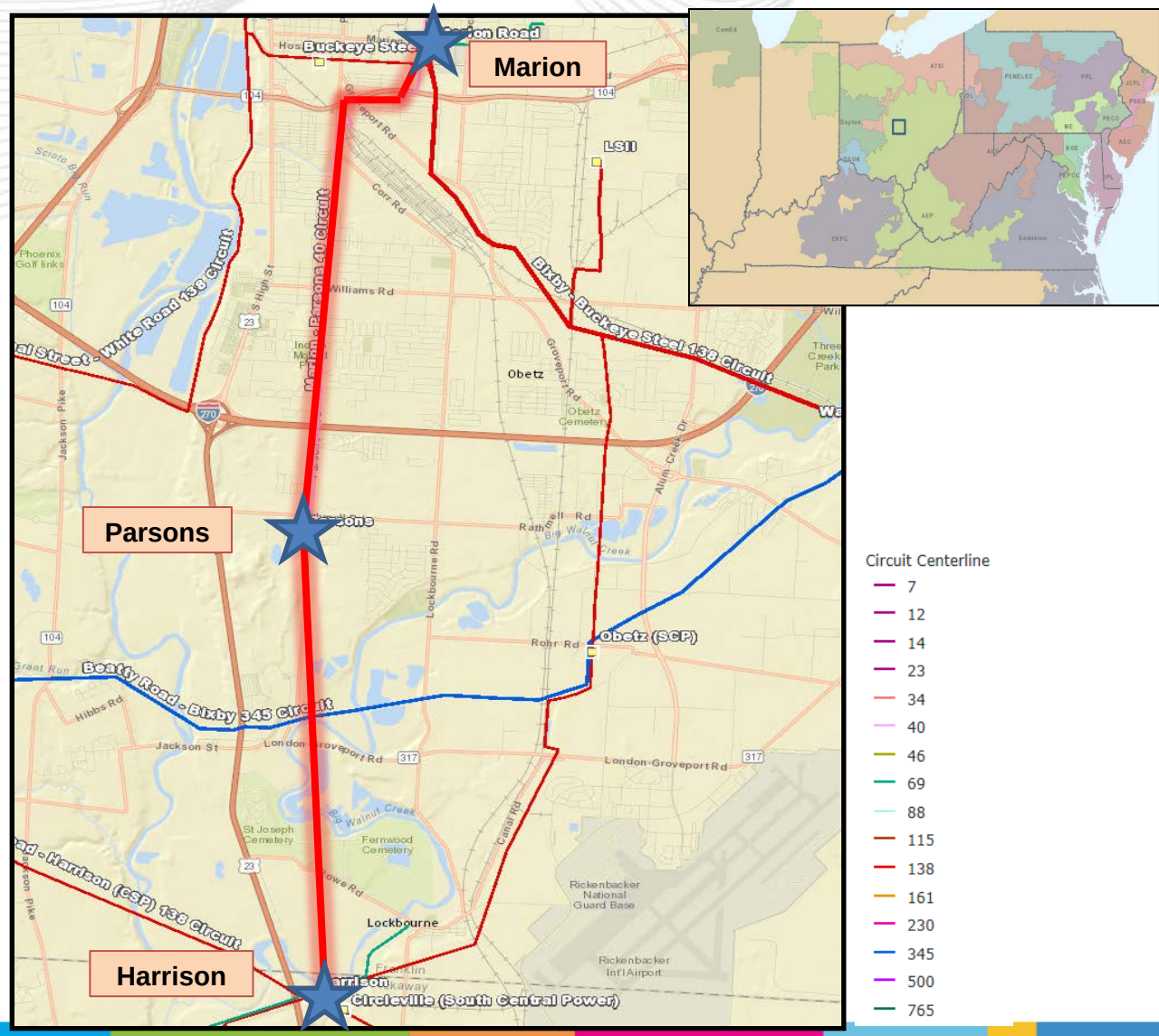
Alternatives:

- Rebuild Marion-Parsons 40kV line as a double circuit similar to existing configuration within the existing ROW. Given the physicality of the double circuit construction and the fact that no other circuits connect to Parsons, the required outage window cannot be obtained. Energized construction techniques were considered to rebuild this line while avoiding the need for significant outages but safety concerns ruled out this approach. Estimated Cost: $14M
- Build a new double circuit line from Harrison to Parsons and remove the Marion-Parsons line. This type of construction would put AEP in a similar position in the future when the double circuit line needs to be maintained or rebuilt in the future where Parsons would be taken out of service to perform maintenance or rebuild activities. Estimated Cost: $14M
- Rebuild double circuit line in the clear. Due to the proximity of nearby homes, businesses, railroad crossings, and major highway crossings, this option is not feasible. This line closely follows Parsons Ave., such that centerline averages approximately 50 feet from center of road. Estimated Cost: $30M
- Rebuilding to 138 kV was not considered in this area due to ROW concerns. This area is mostly urban, so the ROW constraints and construction challenges rendered the 138 kV option unsuitable.

Projected In-service: 12/01/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental
Hartford City – Montpelier 69 kV Line Rebuild

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Hartford City – Montpelier 69 kV line is constructed using wooden poles from 1963 with 4/0 ACSR conductor (50 MVA rating) and is subject to 24 open conditions. The line currently is suffering from multiple tree hazards, stolen ground lead wires, broken and burnt insulators, and woodpecker afflicted poles. From 2012-2016, this line has experienced 13 momentary outages and 3 permanent outages. In the time from 2013-2015 this 8.5 mile line alone contributed to 500,333 minutes of customer interruption.

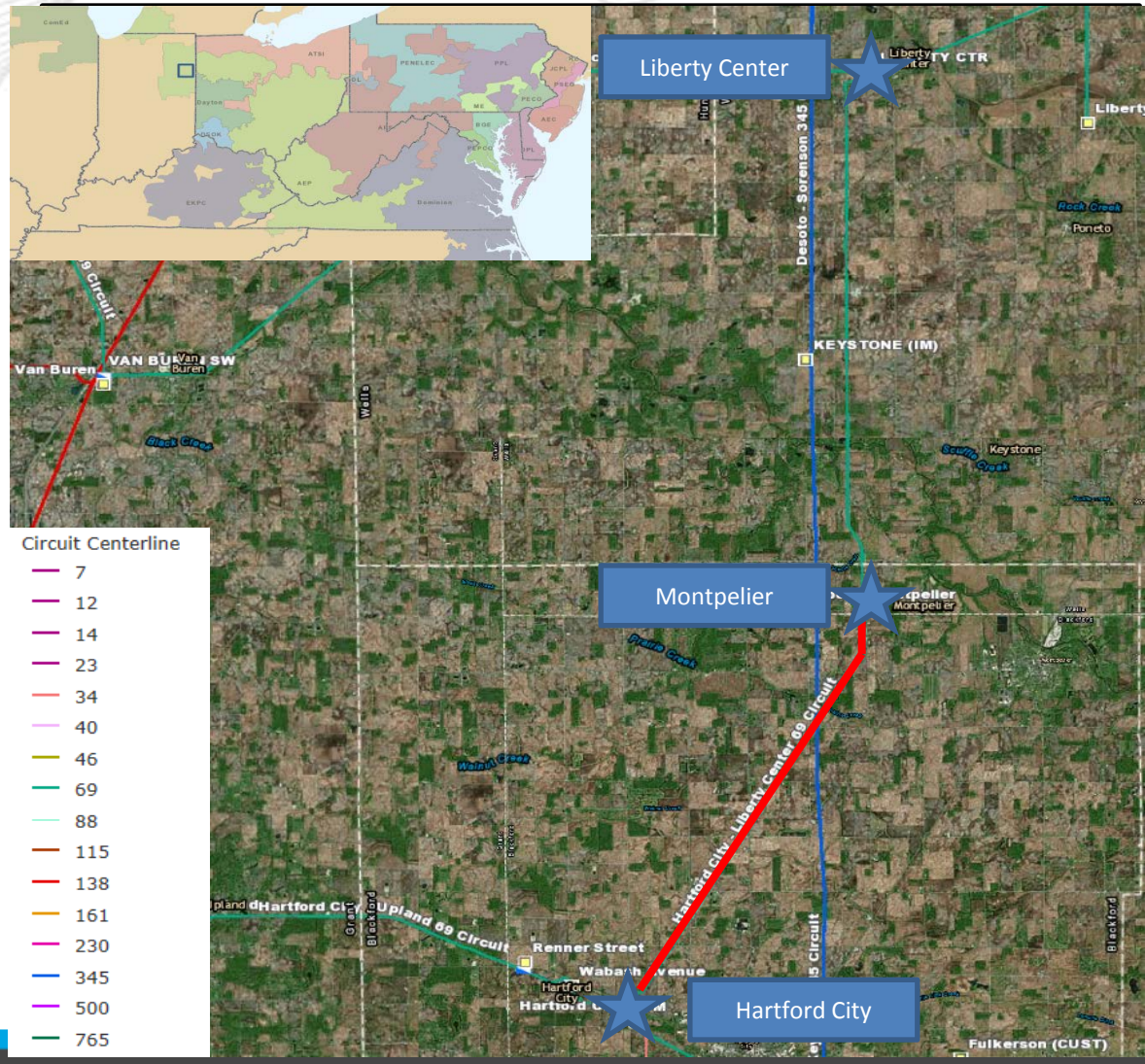
Liberty Center CB's A and C are McGraw Edison CF oil type breakers. Oil breakers, in general, have become more difficult to maintain due to the required oil handling. Oil spills occur often during routine maintenance and failures, which can become an environmental concern. Other drivers include age, bushing damage, and number of fault operations. Liberty Center breakers C and A are CF 1200A 21kA models with 143 and 126 fault operations respectively.

Liberty Center Transformers #1 is showing signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings). Hartford City CB's O, P, and Q are FK oil type breakers. Oil breakers, in general, have become more difficult to maintain due to the required oil handling. Oil spills occur often during routine maintenance and failures, which can become an environmental concern. Other drivers include age, bushing damage, number of fault operations, and a lack of available repair parts.

Hartford City breakers Q, O and P are FK 1200A 21kA models with 20, 59 and 170 fault operations respectively.

Hartford City CB's O, P, and Q are FK oil type breakers. Oil breakers, in general, have become more difficult to maintain due to the required oil handling. Oil spills occur often during routine maintenance and failures, which can become an environmental concern. Other drivers include age, bushing damage, number of fault operations, and a lack of available repair parts.

Hartford City breakers Q, O and P are FK 1200A 21kA models with 20, 59 and 170 fault operations respectively.



AEP Transmission Zone: Supplemental
Hartford City – Montpelier 69 kV Line Rebuild

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Potential Solution:
Replace circuit breakers F and E at Liberty Center and install a new high side 69kV circuit switcher. Replace circuit breakers A and C at Liberty Center with 3000A 40kA models. ~~Replace the current 69/12 kV transformer at Liberty Center with a new model.~~ Estimated Cost: $1.0M

Replace circuit breakers Q, O and P at Hartford City with 3000A 40kA models
Estimated Cost: $0.9M

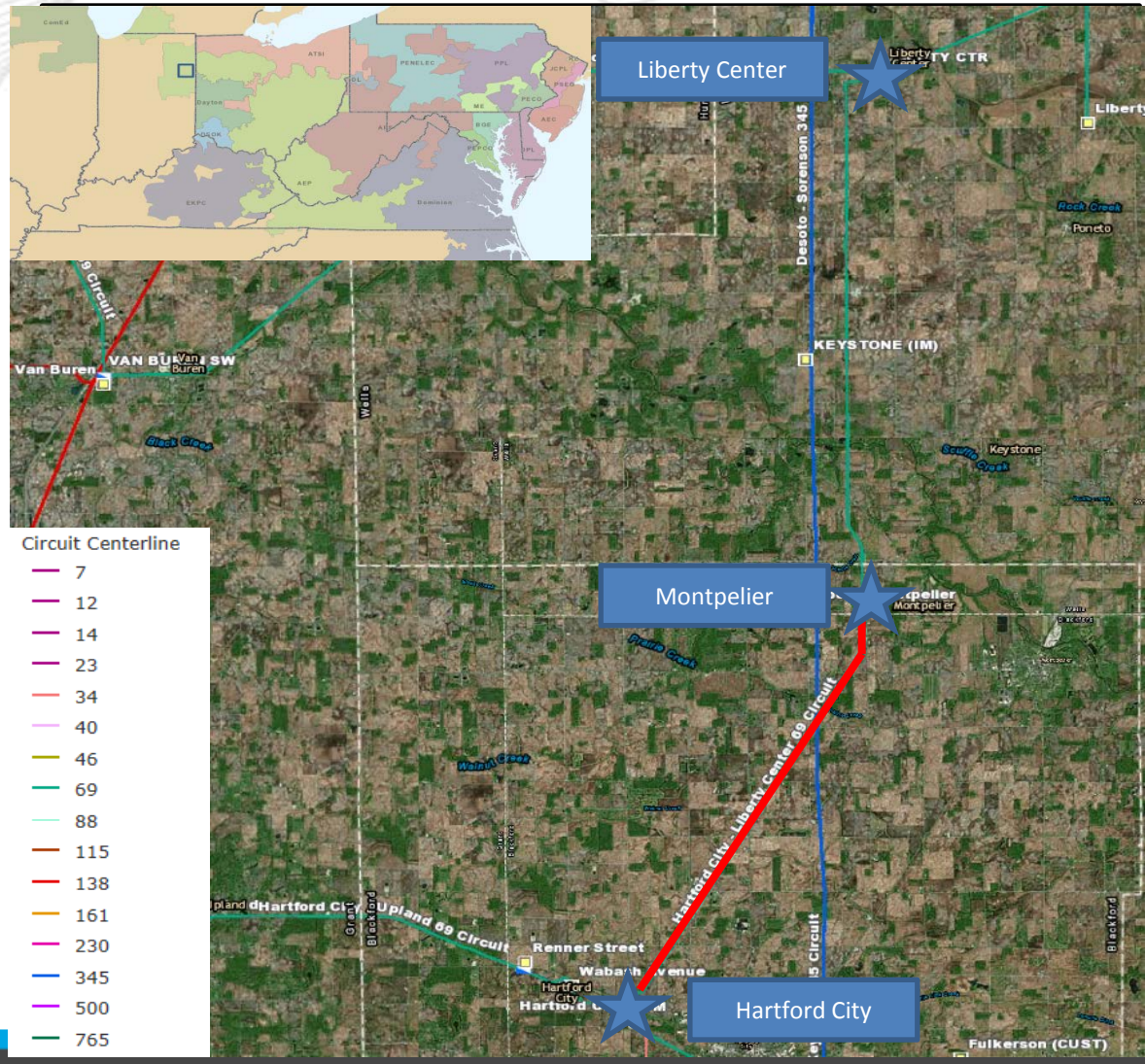
Rebuild the ~8.5 miles of the Hartford City – Montpelier 69 kV line utilizing 556.5 ACSR (68 MVA rating, non-conductor limited) Estimated Cost: $13.4M

Total Estimated Transmission Cost: $15.3M

Alternatives:
Retire existing line and build a new greenfield line in new right of way in order to limit outages. Due to feasibility of outages on the existing line and increased cost, building on new ROW is not recommended. Estimated cost: $18M

Projected In-service: 04/01/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental
Hopkins – Sharples Line Rebuild

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Hopkins – Sharples 46 kV circuit has had 8 permanent and 9 momentary forced outages resulting in over 1 million customer minutes of interruption from 2013 - 2015. There are currently 101 open A conditions along the 11-mile length of the circuit. The conditions include damaged poles/crossarms/shield wire/conductor and rotted poles/crossarms The majority of the line is constructed with 1960s wood structures with 4/0 ACSR and 1/0 copper conductor (23 MVA rating).

Potential Solution:

Rebuild ~11 miles of the Hopkins – Sharples circuit (designed to 69 kV standards, operated at 46 kV) with single circuit 795 26/7 ACSR (62 MVA rating, non-conductor limited) including ~2.6 miles of the Hopkins – Bim line that is double circuited with Hopkins – Sharples. Replace switches at Hewett station with 1200A 3-way Phase Over Phase (POP) switch. On all lines, install OPGW.

Total Estimated Transmission Cost: $23.7M

Alternative:

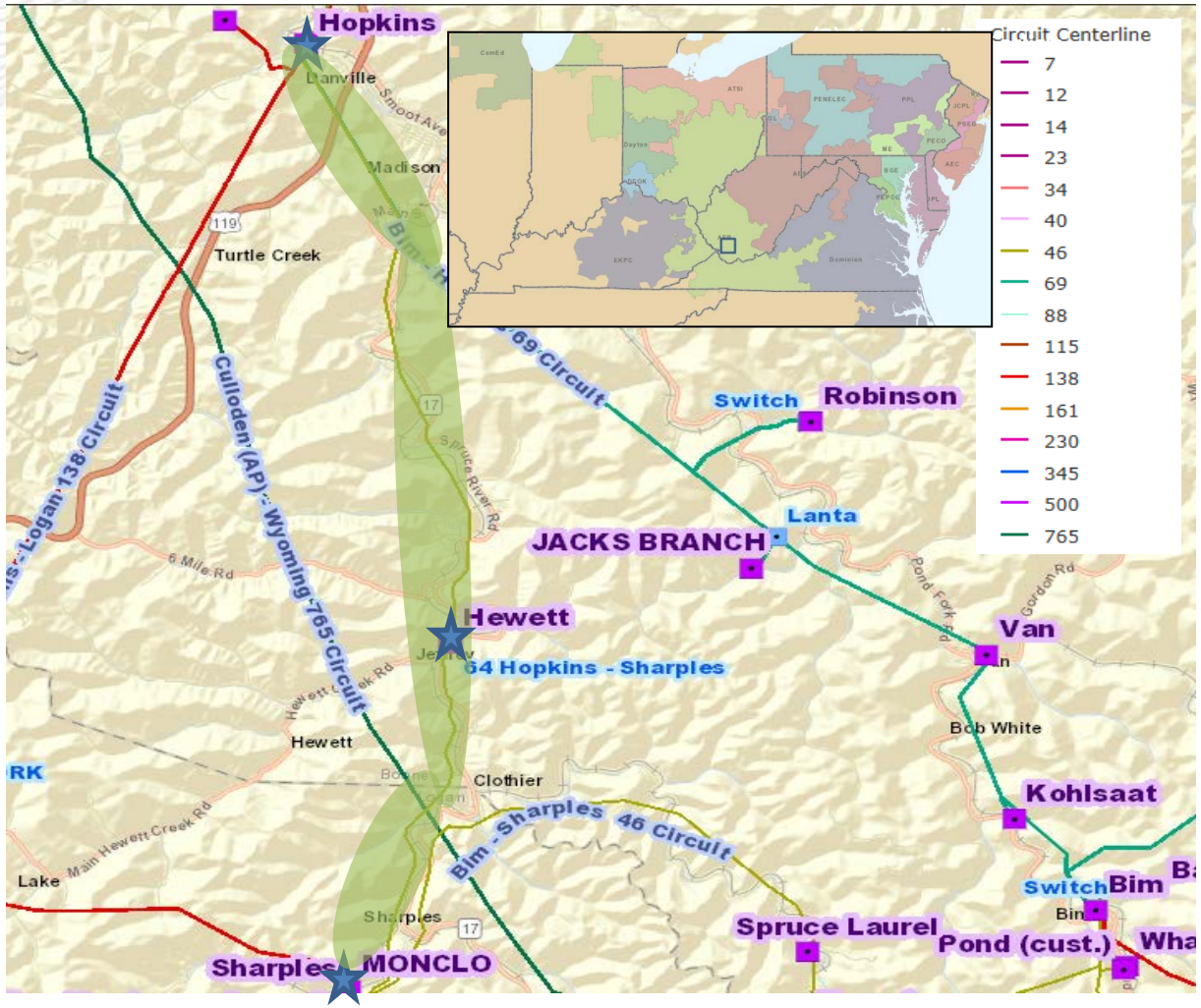
Retire Hopkins – Sharples 46 kV circuit. Build a new 69 kV line from Bim – Hopkins 69 kV circuit to Hewett Station (approx. 5 miles). Install 69/12 kV transformer at Hewett Station. Also, rebuild portions of Bim-Hopkins 46 kV line. Retirement of Hopkins- Sharples 46 kV line would result in radializing Bim-Sharples 46 kV line, requiring the need to add 138/46 kV Transformer at Sharples station.

Alternative Estimated Cost: $29M

Cut into the Bim – Sharples and extend a double circuit line to Hewett station. Retire the Hewett – Hopkins line section. Install a new 138/46 kV transformer and station expansion at Sharples station. This option was evaluated and eliminated because the Sharples 46 kV lines are not tied into the 138 kV system at Sharples Station. Installing a 138/46 kV transformer at Sharples significantly increases the cost of this alternative.

Projected In-service: 12/01/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental Lick – Ross Line Rebuild

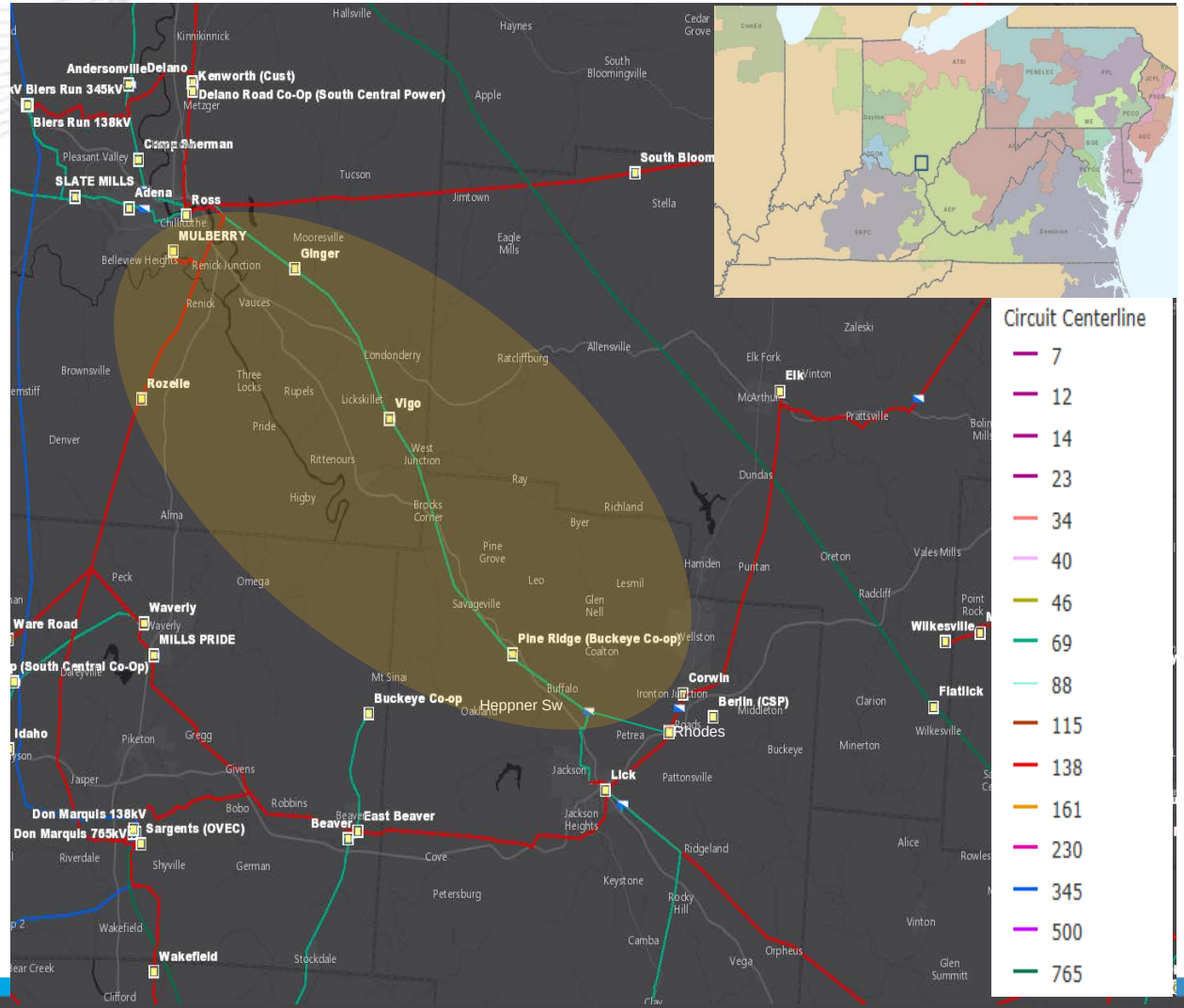
Problem Statement:

Equipment Material/Condition/Performance/Risk:

Of the 37+ miles of conductor on the entire circuit, 88% (32.96 miles) is original from the 1926 line construction – mostly 4/0 ACSR Penguin (50 MVA rating). Of the 275 structures, 98% (269) are wood and 43% (119) are older than 1960. There are 241 open conditions on the line (109 A & 132 B conditions), including issues with conductor, structures, and ROW encroachments. The line has been responsible for 1.4M CMI from 2013-2015, including over 12.5k customer interruptions. Every switch on the line is currently inoperable, lengthening all sustained outages because we have to dispatch personnel to each site and cut the line in order to restore customers. This has led to an average circuit restore time due to transmission outages of over 30 hours.

Operational Flexibility and Efficiency:

AEP's FOI calculations support the addition of MOABs on this circuit. However, considering the length of the line, rough terrain, and remote locations, breakers will be added at Vigo Station and MOABs at both Ginger and Pine Ridge Sw. The added sectionalizing will heavily reduce CMI for all customers attached to this circuit, which currently see average restore times of consistently over 30 hours to resolve issues on the transmission system.



AEP Transmission Zone: Supplemental Lick – Ross Line Rebuild

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Potential Solution:

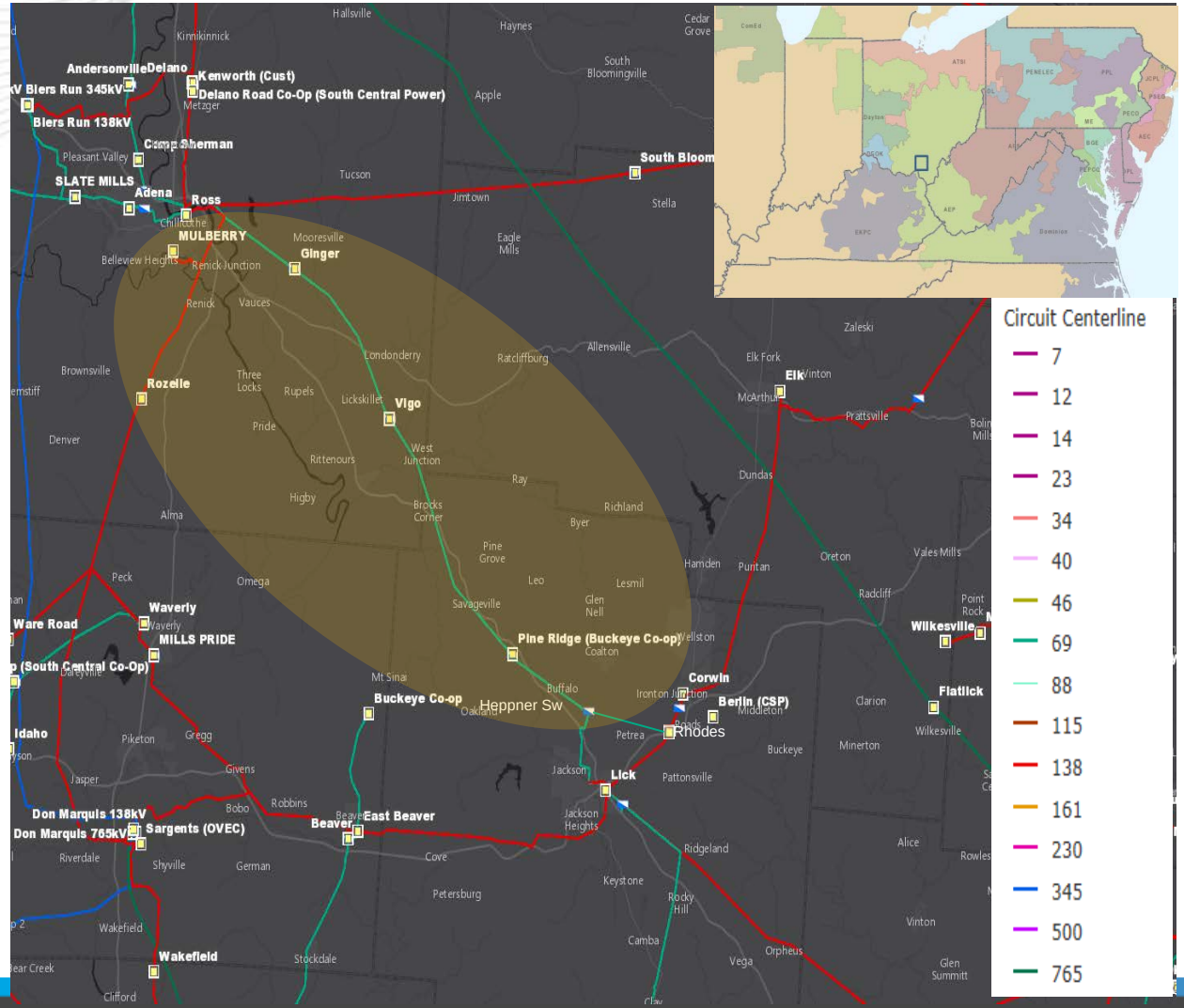
Rebuild from Ross to Heppner Sw (formerly Coalton Sw). Single Circuit 138kV Rebuild (Energized at 69kV) with 1033 ACSR Curlew Conductor (148 MVA SN rating)

Estimated Cost: $46.2M

Replace switches at Ginger with a new 138kV, 2000A phase-over-phase switch with MOABs. Replace switches at Vigo with a new box bay and 138kV, 3000A breakers. Replace Pine Ridge Switch with a new 138kV, 2000A phase-over-phase switch with MOABs.

Estimated Cost: $4.1M

Total Estimated Transmission Cost: $50.3M



AEP Transmission Zone: Supplemental
Lick – Ross Line Rebuild

Continued from previous slide…

Alternative:
Construct the line to 69 kV standards. While this is a feasible alternative, constructing to 138kV standards will allow for an additional 138kV path to support Ross Station, as there is currently only one 138kV source that currently feeds Ross Station from the South (via Waverly Station) and that circuit is loaded to ~90% of its conductor rating (636 ACSR, 310 MVA rating) under N-1-1. The additional source will relieve the Waverly source and allow future operational and construction flexibility.

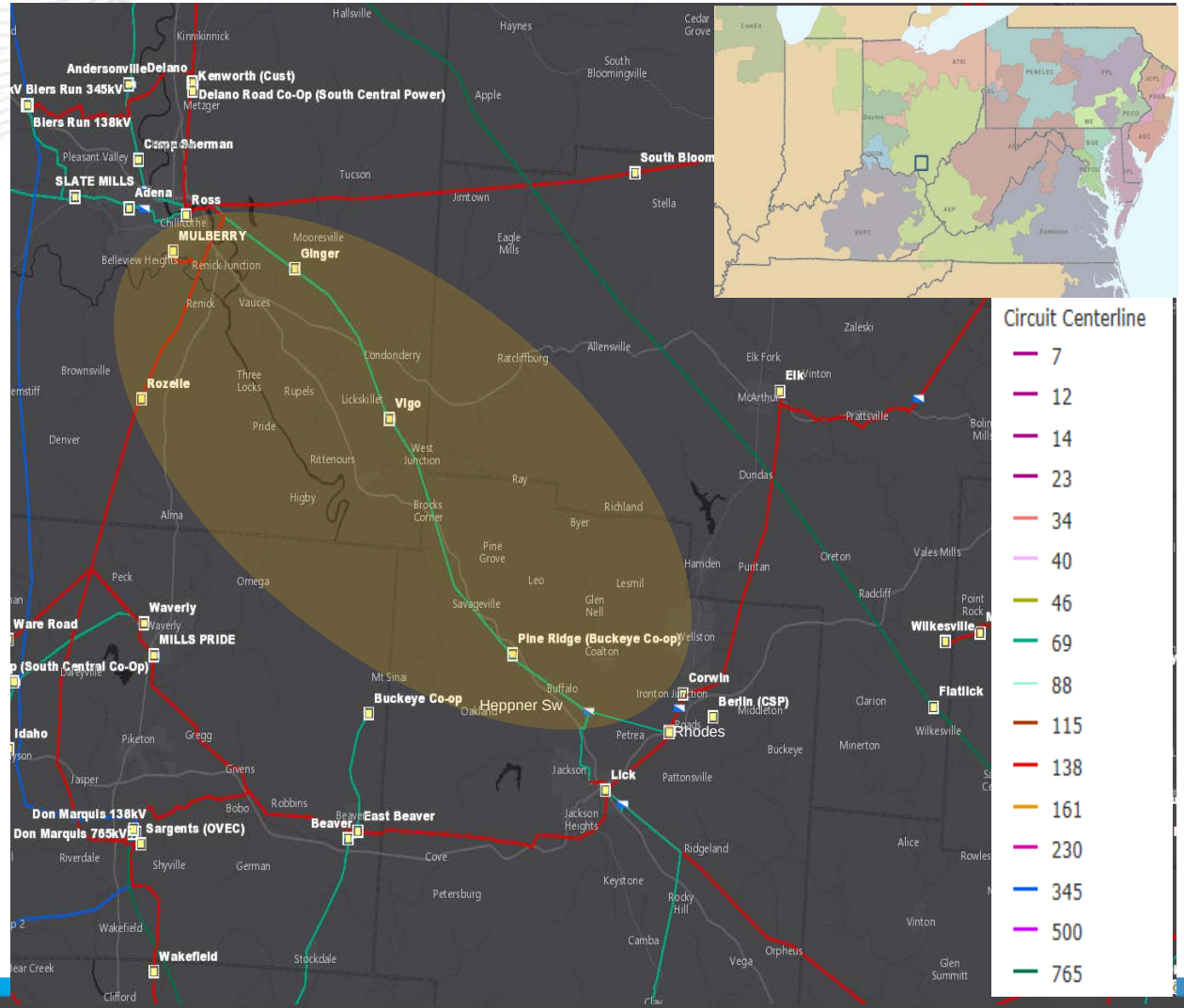
Since the existing Lick-Ross line was constructed in 1926, most of the easements are blanket easements, so as part of the project defined Right-of-Way widths will be obtained, resulting in the same ROW costs for the alternate. Construction and material costs would have a maximum increase of around 10%, yielding an approximate cost increase to construct to 138kV standards of $3M or an approximate 6% project cost increase.

The actual conversion of the line to 138kV will take some time due to there being 2-AEP and 1-Co-Op stations being served from this line, and is not anticipated for 5-10 years.

Estimated cost: $46M

Projected In-service: 12/31/2021

Project Status: Scoping



AEP Transmission Zone: Supplemental Midway Breaker Replacement

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Midway 69 kV circuit breaker A is an FK 25 kA 1200 A oil-filled breaker manufactured in 1965. In general, oil breakers have become increasingly difficult to maintain due to the oil handling associated with them. Oil spills occur frequently with failures and while performing routine maintenance, which, is an environmental hazard.

Potential Solution:

Replace Midway's existing 69 kV circuit breaker A with a new 69 kV 40kA 3000A circuit breaker. Line relays at remote ends will be upgraded.

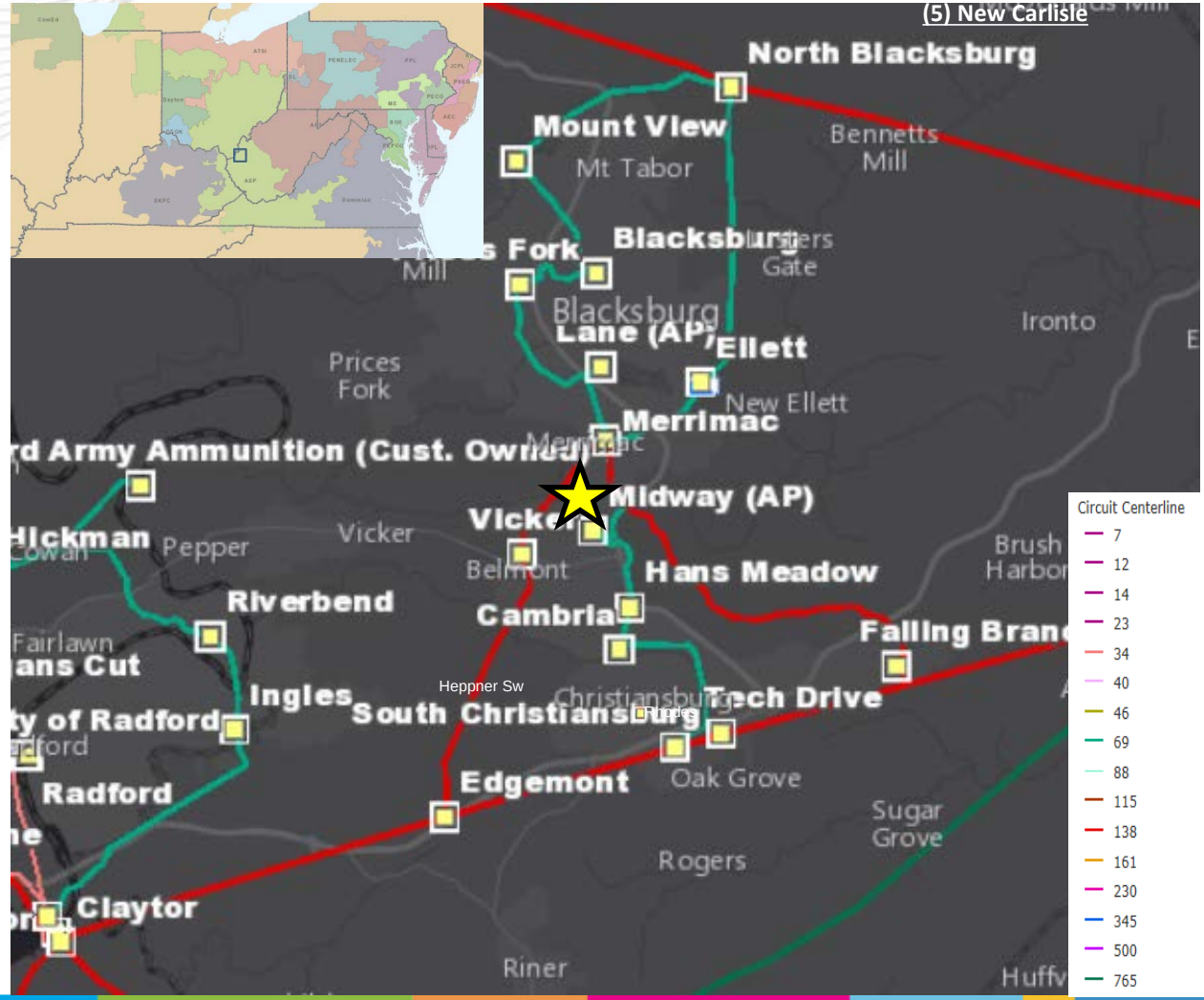
Estimated Transmission Cost $0.52M

Alternative:

- No viable cost-effective alternatives identified

Projected In-service: 05/25/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental Monroe Station Line MOAB Replacement

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The wood pole structure supporting the line MOAB switches outside Monroe Station is decaying due to heart rot. The pole base will eventually collapse and render the switches inoperable. This will cause Monroe stations load to be dropped. Currently there are 4 in line Motor Operated Air Break Switches (MOABs) on the Berne – Decatur line. Having more than 3 MOABs in line leads to increased chances of misoperations and increases the complexity of the protection scheme. AEP guidelines recommend a maximum of three Motor Operated Air Break Switches (MOABs) in series based on experience with mis-operations in applications with more than three MOABs. In order to increase the reliability of this circuit and to reduce the chances of a mis-operation, a breaker will be added at Monroe station.

Operational Flexibility and Efficiency:

Ground switching MOABs have been identified by AEP as a reliability concern due to the PQ issues that result upon operation and due to the absence of bus 1-shot capability for distribution bus faults. Replacing this switch with a circuit switcher will fix both of these reliability issues.

A second distribution transformer will be needed at this station in the future. Rebuilding the station entrance and upgrading its protection allows for that future expansion to take place.

Potential Solution:

At Monroe station, install a 2000A circuit switcher on the high side of the transformer. Install a 69kV 3000A 40kA circuit breaker on the Decatur line. Install a 2000A MOAB on the Berne line. Retire entrance structure and span, replace with two exit spans.

Estimated Transmission Cost: $1.9M

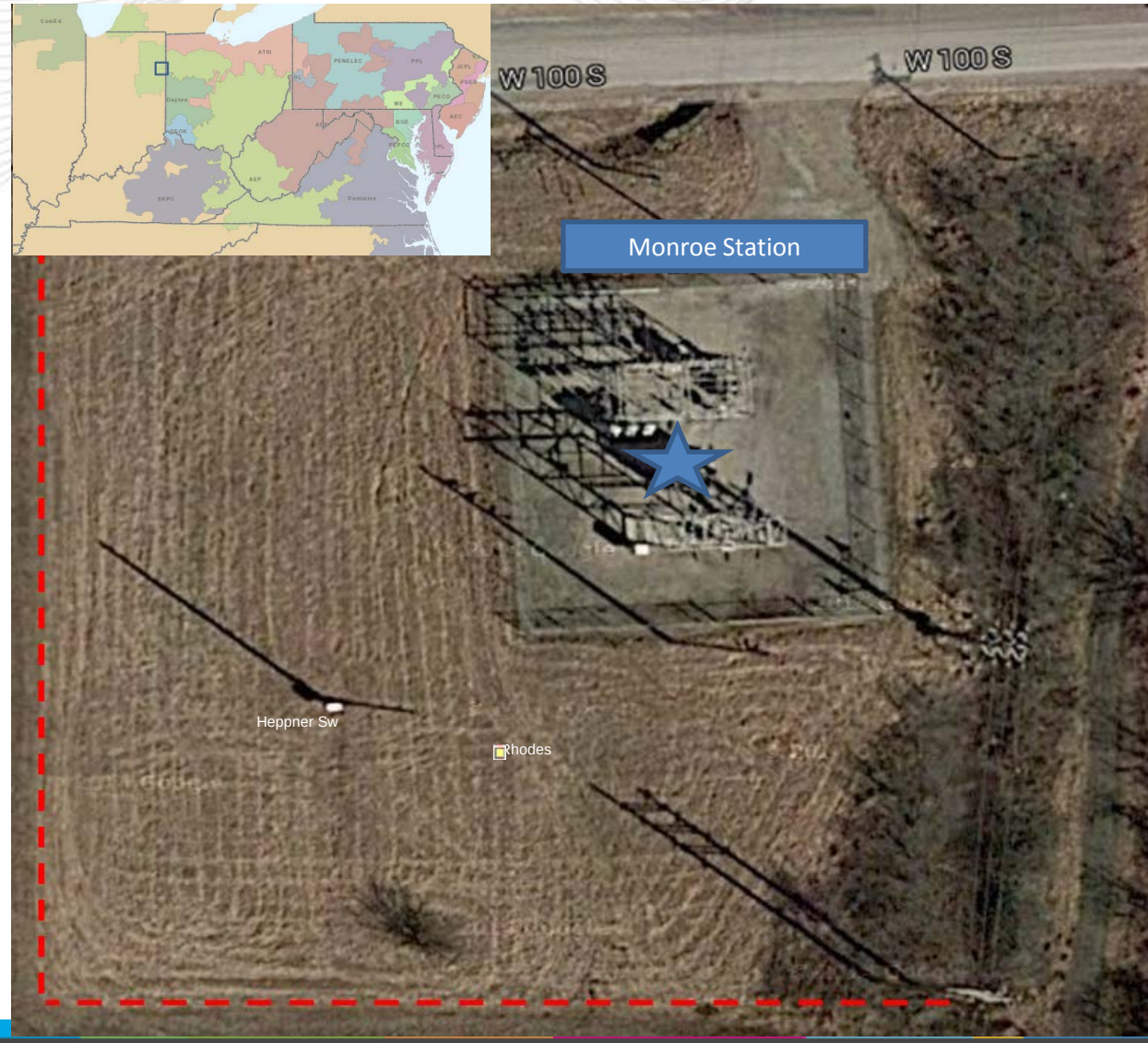
Alternative:

Install a breaker towards Berne instead of Monroe. This would not sectionalize the Monroe and South Decatur loads since both would be dropped due to a line fault without the breaker present.

Estimated cost: $2M

Projected In-service: 3/01/2018

Project Status: Construction



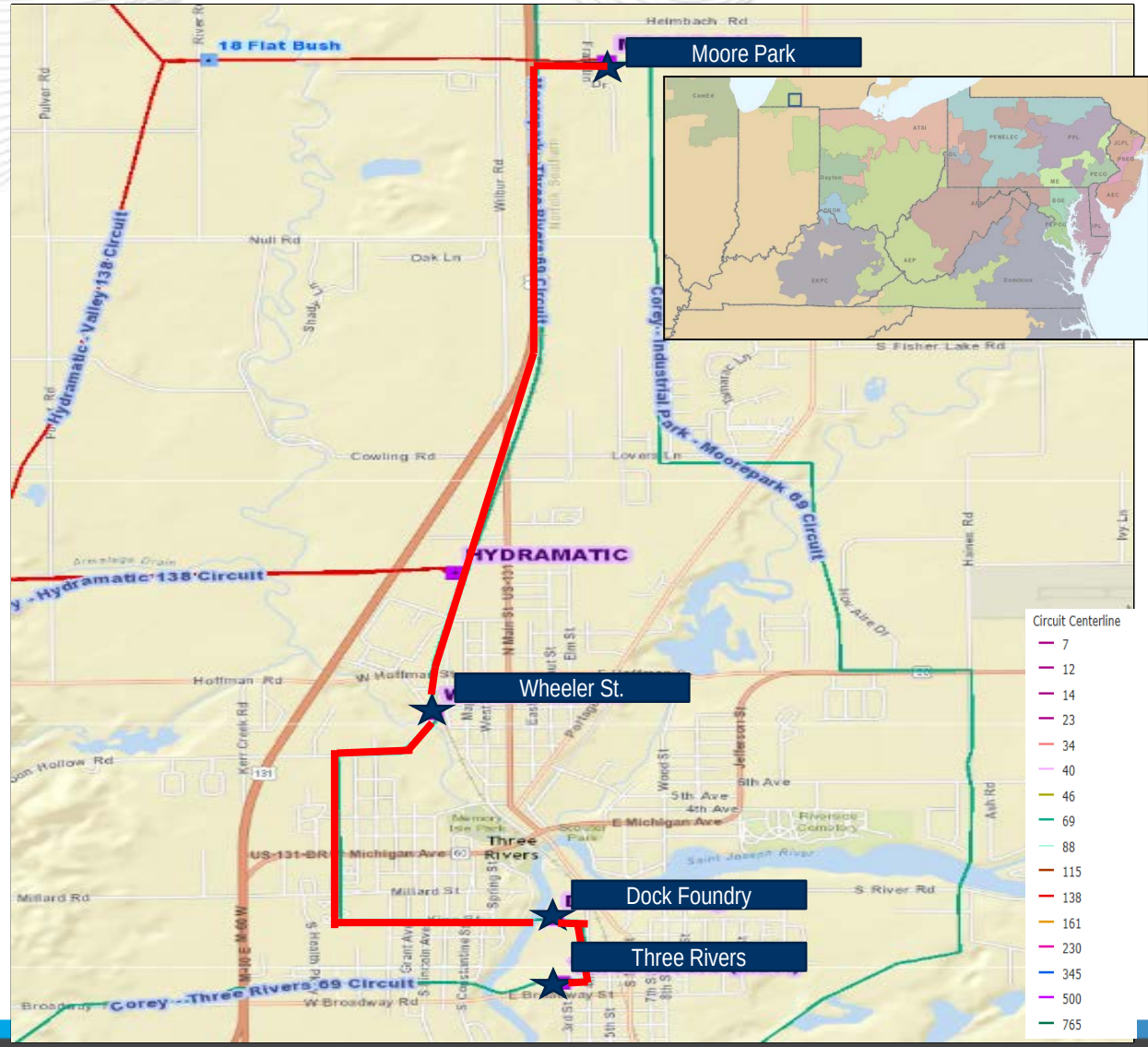
AEP Transmission Zone: Supplemental
Moore Park – Three River Rebuild

Problem Statement:

Equipment Material/Condition/Performance/Risk:

24% of the wood poles used for the Moore Park – Three Rivers 69 kV line were installed in the 1950's and the remaining 76% were installed in the 1960's. This 5.7 mile line currently has 55 open conditions, which include rotten poles, broken insulators, cracked poles, and broken cross-arms.

Circuit breakers A and B at Moore Park station are 1960s vintage oil type (1200A 19kA CF) breakers. CB A has a total of 115 fault operations and CB A has a total of 210 fault operations. Both breakers have exceeded the maximum number of fault operations recommended by the manufacturer. Oil breakers, in general, have become more difficult to maintain due to the required oil handling. Oil spills occur often during routine maintenance and failures, which can become an environmental concern. Other drivers include age, number of fault operations, and PCB content. PCBs have been used as coolants and lubricants in transformers, breakers, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and may have a negative health effect.



AEP Transmission Zone: Supplemental
Moore Park – Three River Rebuild

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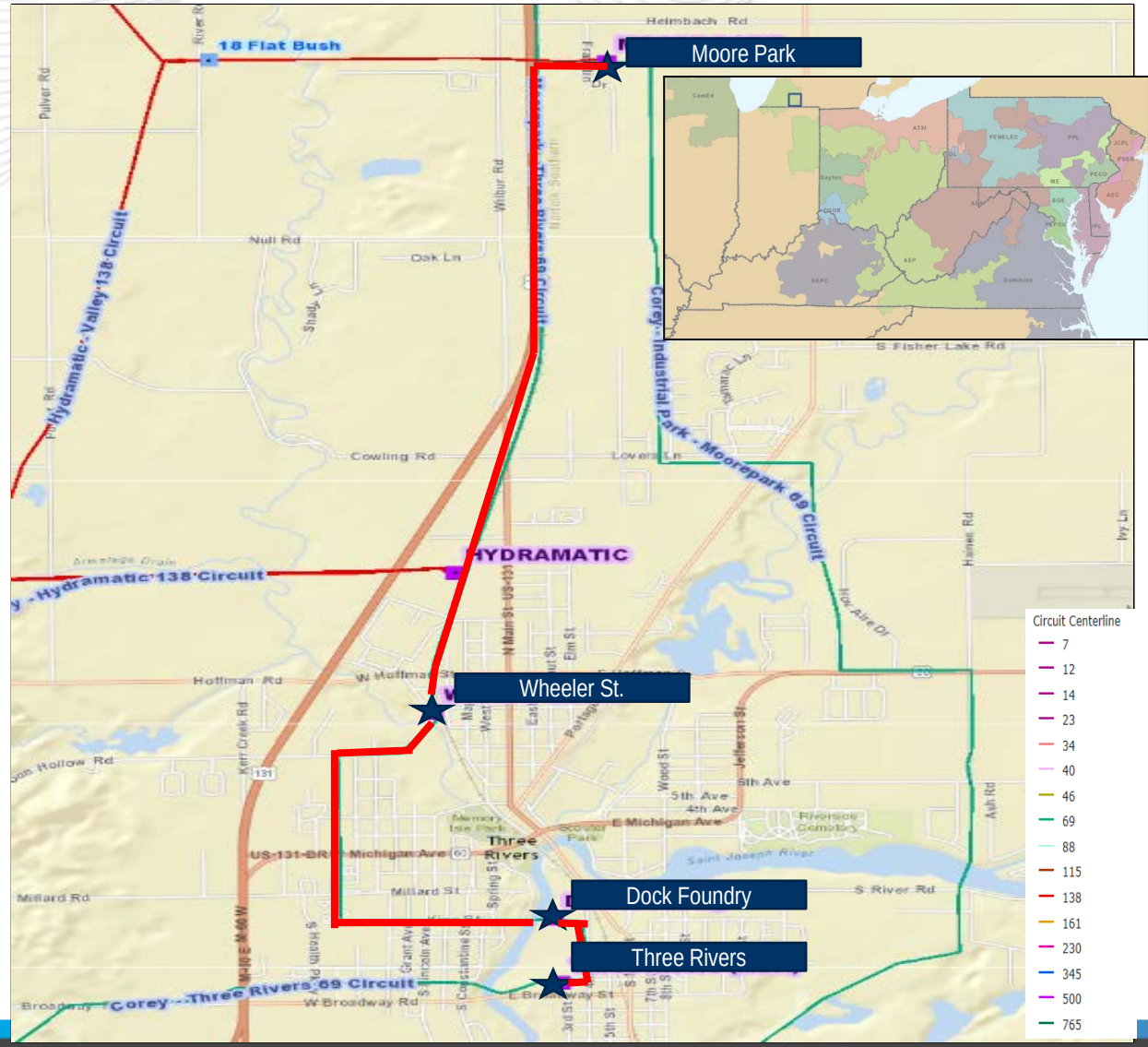
69 kV circuit breakers A, C, D and E at Three Rivers are 1950/60s vintage and are all showing signs of deterioration. CB A, C, and D have fault operations of 148, 161, 71, respectively. The drivers for replacement of these breakers are age, number of fault operations, and PCB content. At Three Rivers, transformer 1 is also showing significant signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings). Transformer 1 also has high levels of Carbon Dioxide dissolved in the oil. Asset Health Center shows a reading of 13,265 PPM (above IEEE Condition 4 of >10,000). Gas formation within an operating transformer are caused by electrical disturbances and thermal decomposition. All transformers generate gases to some extent at normal operating temperatures. Utilities abide by the IEEE Conditions, with 4 being the worst and 1 being normal, to assess transformer health.

<u>Operational Flexibility and Efficiency:</u>

Moore Park – Three Rivers 69kV line has a 22MVA load during normal conditions with a 3 year CMI of 742,950 minutes of interruption affecting close to 1271 customers. All of the outages associated to this line were caused by failed T line equipment (insulators, and poles).

The P&C coordination at Three Rivers is currently being through pilot wire communication, using a leased line. This lease is about to expire and AEP has not upgraded the station relays to support the fiber that is currently being built to the station. Therefore, Three Rivers is currently at risk of losing P&C coordination to its remote end stations. This will severely impact the protection of this station and the 2,937 customers currently served from Three Rivers.



AEP Transmission Zone: Supplemental
Moore Park – Three River Rebuild

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Potential Solution:
Rebuild 69kV Three Rivers station in the clear. New station name will be Ripple Station.
Estimated Transmission Cost $2.3M

Replace CB A and B 1200A 19kA at Moore Park with new 3000A, 40kA breakers.
Estimated Transmission Cost $1.4M

Add 1200A line MOAB switch at Dock Foundry station towards Wheeler Station.
Estimated Transmission Cost $0.5M

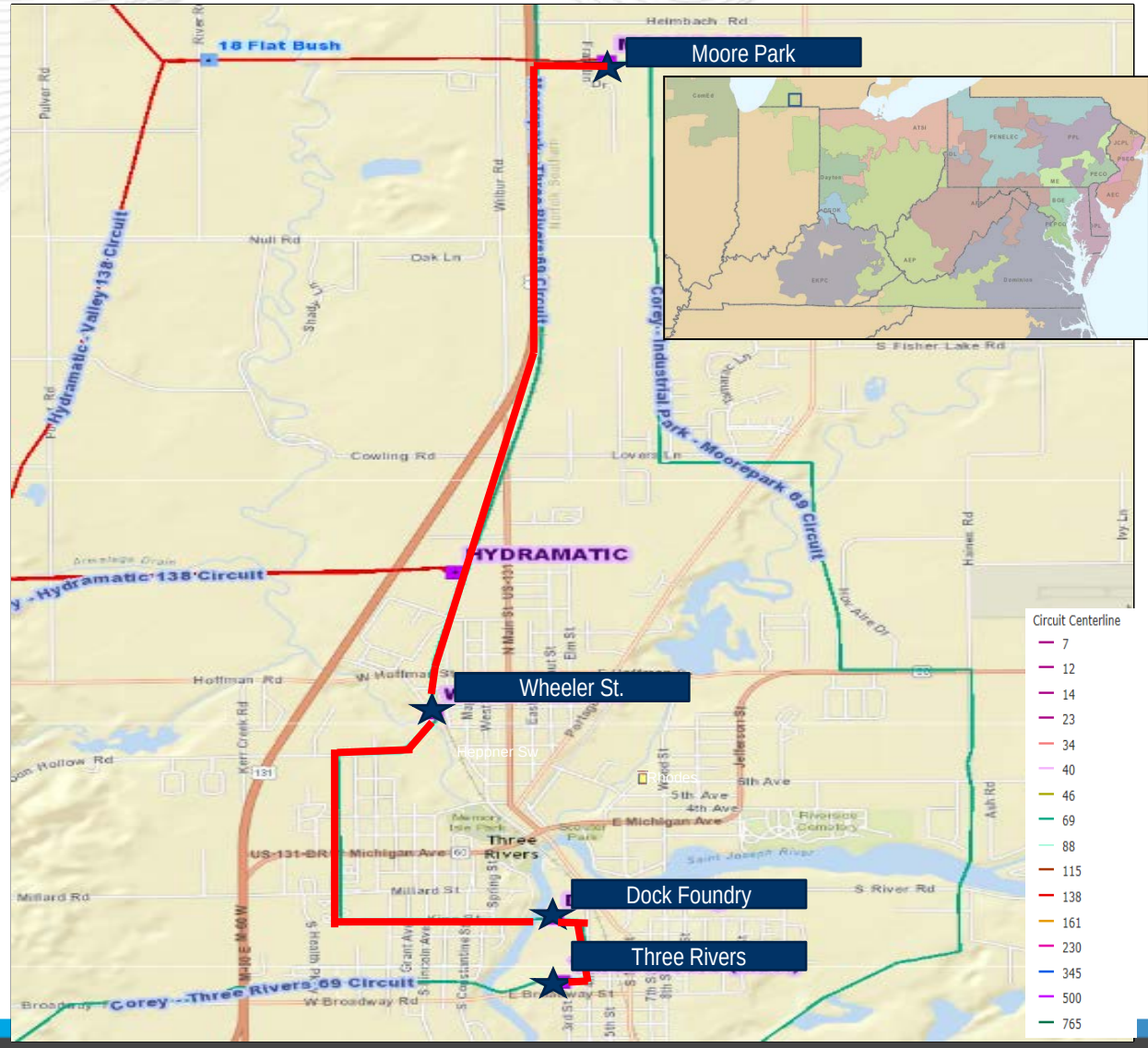
Rebuild approximately 5.7 miles of 69kV line between Moore Park and Three Rivers using 795 ACSR conductor (129 MVA rating). Upgrade line relaying and extension towards Corey and towards Three Rivers.
Estimated Transmission Cost $16.1M

Total Estimated Transmission Cost $20.3M

Alternative:
Three Rivers station brownfield expansion. This option required additional land purchase adjacent to the existing Three Rivers station site. But due to lack of willingness to sell from the owner, AEP had to move forward with a greenfield construction.

Projected In-service: 8/22/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental
North Portland Station

Problem Statement:

Equipment Material/Condition/Performance/Risk:

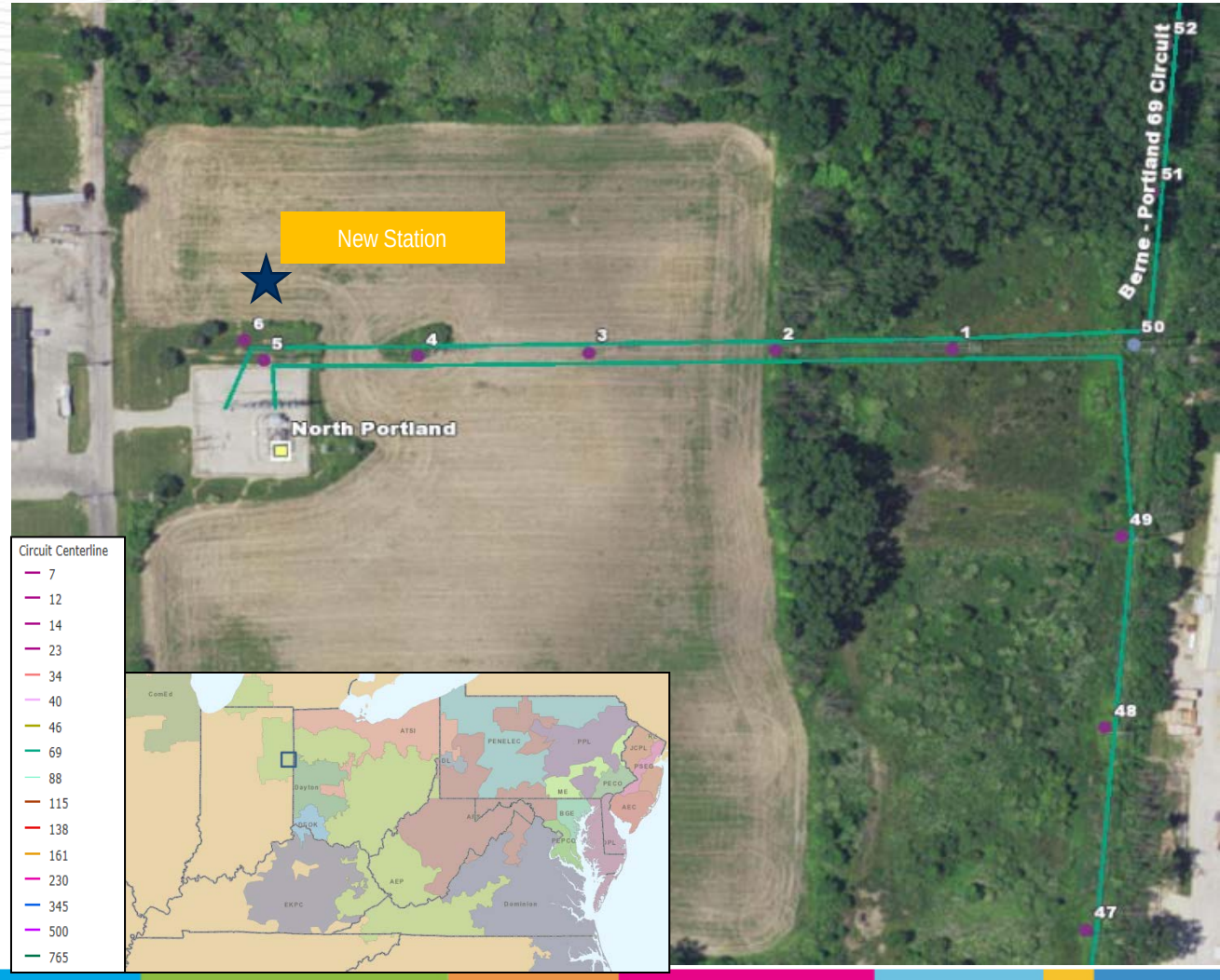
The Portland area is non-recoverable in case of a failure. Load growth is slow but steady and transformer maintenance is restricted to only a few weeks per year. A transformer failure recovery has to be by a mobile transformer. To mitigate this, there needs to be a second distribution feeder at North Portland.

There currently are four Motor Operated Air Break Switches (MOABs) in series on the Portland – Berne circuit. Having more than three MOABs in series on a circuit introduces increased chance of mis-operation and requires complex protection schemes. It is AEP current standard to not allow more than 3-MOABs in series. To mitigate this, a line breaker is required at a new station.

Transformer #1 at North Portland is beginning to show signs of deterioration. Drivers for replacement include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings).

Operational Flexibility and Efficiency:

The Berne – Portland line has experienced 39 momentary forced outages over the past 10 years and has a CMI of 1,040,639 over the last 3 years. 69% of this CMI value was triggered by the multiple unprotected stations on this line. Installing a breaker will effectively separate the City of Portland from the REMC owned Trinity Tap as well as 14.3 miles of exposure and will significantly improve the area system performance and overall reliability.



AEP Transmission Zone: Supplemental
North Portland Station

Potential Solution:
Retire North Portland Station. Install 2 69kV busses separated by a 2000A switch. At the 69kV bus 1, install a 69kV 3000A 40kA circuit breaker 'D'. Install two 20MVA 69/12kV transformers with high side 2000A circuit switcher and low side 12kV 2000A circuit breakers. Install 2 15kV main and transfer buses separated by a 2000A circuit breaker. Install 6 1200A circuit breakers on the 6 12kV station exits. Rebuild the Portland Extension portion of the Berne – Portland 69kV circuit to the new station utilizing 556.5 ACSR (102 MVA rating).
Estimated Transmission Cost $3.5M

Alternative:
Replace station components in place. This would require longer outages, pose increased safety risks and would require more construction equipment. Since the Portland area is non-recoverable during an outage, this is not recommended.
Estimated Cost: $1.5

Projected In-service: 12/03/2018

Project Status: Engineering

AEP Transmission Zone: Supplemental North Wellsville 69 kV Station Upgrades

Problem Statement:

Equipment Material/Condition/Performance/Risk:

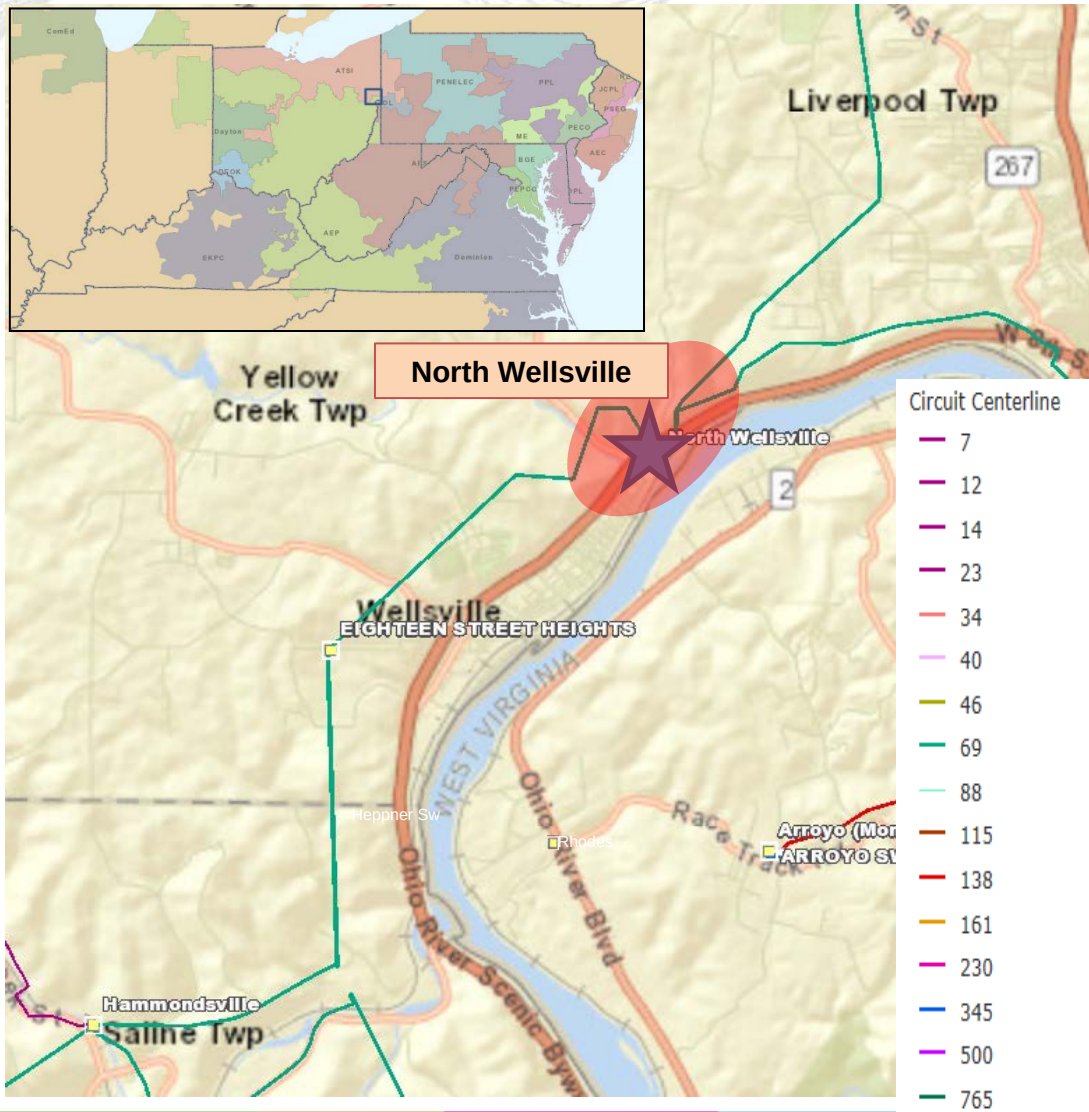
North Wellsville 69kV breakers L & M are GE 'FK' 600 A 8kA oil-filled breakers made in 1951. They have operated for 74 and 43 faults respectively, above the manufacturer recommendation of 10. These breakers have had problems with oil leaks in recent years. The breaker foundations have deteriorated significantly. Finding spare repair parts for these breakers is very challenging. There are 6- 69kV 600-amp switches in need of replacement. The 69kV circuits utilize electromechanical relays which are recommended for an upgrade. Pilot wire relaying is used on the circuit to Hammondsville, which has been unreliable. The 69kV bus CCVT's are also in poor condition.

Of the 40 protective relays in the control house, 36 are electromechanical and 2 are solid-state units which are recommended for replacement due to poor performance, high maintenance costs, and lack of fault event recording capabilities. Due to the extent of protection upgrades needed, a prefabricated drop-in-control-module (DICM) will be utilized, as the station can't be completely taken out of service during construction.

Operational Flexibility and Efficiency:

The 69-12kV distribution transformer lacks a high-side protective device, so the entire 69kV bus is tripped for a distribution transformer fault or 12kV bus fault (opens 3- 69kV circuits plus a 69kV cap bank). There are three overlapping zones of protection (69kV bus, 69-12kV transformer, 12kV bus). This arrangement reduces the life of the transmission breakers by tripping for faults in any zone. Installing a 69kV circuit switcher for the transformer will address these problems.

The existing AEP fiber-optic telecom network in the area will be extended into North Wellsville and 69kV remote terminals, to improve the capability of EMS, SCADA, and system protection equipment.



AEP Transmission Zone: Supplemental North Wellsville 69 kV Station Upgrades

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Potential Solution:
At North Wellsville station, replace 69kV oil breakers L & M with new 3000A 40 kA breakers; replace all 69kV disconnect switches; add 69kV transformer protection with circuit switcher & relaying; install distribution DICM to house new 69 & 12kV protection/communications; replace 12kV bus voltage regulator; replace both 12kV feeder breakers and protection/controls.

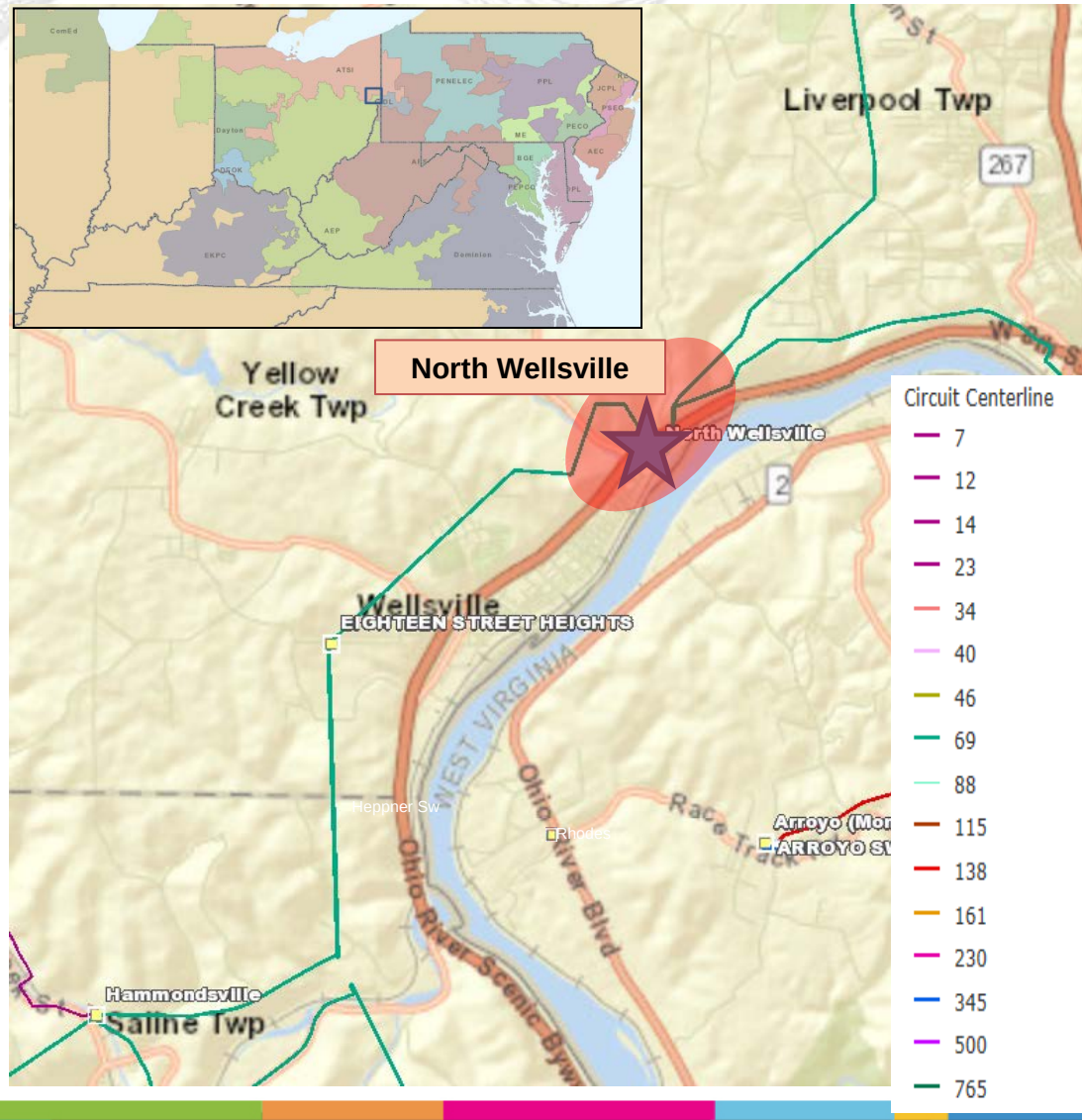
Estimated Transmission Cost $1.3M

Alternatives:

- Purchase new property in the area (3-5 acres at least) to facilitate a greenfield 69-12kV station to replace North Wellsville, with ample space for a future 138-69kV source. This option was investigated, but ultimately was ruled out due to: hilly terrain, proximity to Ohio River, lack of suitable land, and the need to keep the 12kV distribution source close to the city of Wellsville. This option would have been simpler from an engineering & construction standpoint, and made outage-scheduling easier. However, it would have been several times more expensive.
  Estimated Cost: $12-$15M
- Build a separate green-field 138kV station in the area and add a new 138-69kV source, while keeping the existing North Wellsville station in-service. The area's transmission infrastructure is entirely 69kV, including a newly rebuilt 69kV circuit (to East Liverpool). Based on the area's load growth characteristics, a 138-69kV station should not be needed for some time, and would be overly expensive. In addition, we'd still have the risk of equipment failures from the aging breakers & relays at North Wellsville. Estimated Cost: $30M

Projected In-service: 12/1/2019

Project Status: Scoping



AEP Transmission Zone: Supplemental Opossum Creek Condenser

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The synchronous condenser at Opossum Creek station is a 1972 vintage model with multiple concerns involving the cooling and control systems. The control system has been replaced within the last 20 years but has never worked correctly. Currently, every time the condenser experiences an abnormal system event, it will go offline. Once the unit is back online, an engineer must monitor its controls or it will go offline again. This control system issue has lead to decreased reliability and performance of a critical system asset. The breakers for this machine are “rack in – rack out” breakers that are two of a kind in AEP’s system; when they fail they need to be shipped to G.E. to get fixed. These breakers have also led to prolonged outages for the condenser. AEP’s main issue is that the water in the cooling system is acidic and is continually causing corrosion. The cooling towers and the cooling system are in a state where new leaks are appearing constantly. Additional leaks are being addressed, but this is a costly procedure that involves taking the condenser offline for an extended period of time. In addition, we cannot find all the leaks at the rate they are appearing, so we are having to refill the cooling system frequently which is costly. We can address the exterior corrosion, but we cannot see what the acidic water is doing to the inside of the condenser. To inspect and repair the internal corrosion, we would have to take this critical asset offline for a significant period. The breakers at Opossum Creek are 1970’s PK type air blast breakers which, have a tendency to explode upon failure and are therefore a safety hazard. Transformers 1, 2, 3 and 5 are all from the 1970’s and are becoming a liability to system performance due to their condition.

AEP Transmission Zone: Supplemental Opossum Creek Condenser

Continued from previous slide…

Operational Flexibility and Efficiency:

The existing 250 MVAR synchronous condenser at Opossum Creek Station plays an important role in the Lynchburg area by providing voltage support and voltage stability during contingent conditions or planned outages. Past operational experience has shown that when the area load is above 550 MW and an outage on the EHV system occurs in combination with a 138kV outage, voltage violations result in real time. Any of these EHV outages:

- Joshua Falls 765/138kV transformer
- Cloverdale – Joshua Falls 756 kV
- A simultaneous outage of both Cloverdale – Jacksons Ferry 765kV and Cloverdale – Lexington 500kV circuits.

Paired with these 138kV outages:

- Cloverdale – Reusens 138kV
- Moseley – Reusens 138kV
- Opossum Creek – Smith Mountain 138kV
- Altavista – New London 138kV
- Bremo – Scottsville 138kV circuit.

This is the PJM and SCC operational study basis for post contingency responses. As a result, most 138kV planned work in the Lynchburg area is restricted to off peak periods. Additionally, N-1-1 contingency planning requires fractionalizing during Summer peak periods for a system normal configuration. The availability of the 250 MVAR synchronous condenser at Opossum Creek becomes a critical element with regard to minimizing fractionalization of the Lynchburg area 138kV system. Furthermore, the Lynchburg area is remote from any generation which causes a condition where dynamic responses are slow and any system changes (load changes or static capacitor bank adjustments) can cause large voltage spikes. The synchronous condenser frequently reaches maximum reactive output in both summer and winter peak conditions.

Moving the existing South Lynchburg 138kV line into a breaker and half string, currently connected to the bus with a manual disconnect switch, will improve reliability to the system and will provide its own zone of protection for both the bus and line. Adding the line breaker will also reduce the outage impact during maintenance of the line and bus.

AEP Transmission Zone: Supplemental Opossum Creek Condenser

Continued from previous slide…

Potential Solution:

Install a new 138kV 3000A bus (3 & 4) at Opossum Creek and the replacement condenser units. Replace 138kV breakers A, A1, A2, B1, C, C1 and D1 with 138kV 40kA breakers at Opossum Creek. Using 138kV 40kA breakers, complete the breaker string B for the East Lynchburg exit and the new condenser #1 unit. Using 138kV 40kA breakers, complete the breaker string D for the Smith Mountain and Reusens lines. Replace Circuit switchers AA & BB with 138kV 40kA circuit switchers. Create a new 138kV bus 3 for the new condenser unit #2. Create a new 138kV bus 4 for the new condenser unit #1. In between the two GSU banks, install a spare transformer that will be separated by normally open switches. Remove both 34.5kV busses and their associated transformers. Install primary and secondary station service off of the 138kV bus 1&2 respectively. At South Lynchburg and Joshua Falls, relay settings will have to be changed. At East Lynchburg, Smith Mountain and Peaksview, relay work will be needed.

Estimated Transmission Cost $65.5M

Alternative:

Install a SVC, StatCom or another dynamic VAR Compensating device. Synchronous condenser was deemed as a better option due to similar initial, the absence of harmonics, less physical space requirements, short term overload capability (2x's rating for 10 seconds), twice the expected life span, and overall better system dynamic voltage recovery due to the additional system inertia.

Estimated Cost: $37M (for the SVC or StatCom only)

Projected In-service: 12/31/2018

Project Status: Engineering

AEP Transmission Zone: Supplemental Pendleton Breaker and Relay Replacement

Problem Statement:

Equipment Material/Condition/Performance/Risk/Operational Flexibility:

The 34.5 kV oil breakers E, F, G, H, and K at Pendleton station are 2000 A 36 kA FK and CF type breakers manufactured between 1952 and 1971. Oil breakers, in general, have become more difficult to maintain due to the required oil handling. Oil spills occur often during routine maintenance and failures, which can become an environmental concern. Other drivers include age, bushing damage, number of fault operations, and a lack of available repair parts. Breaker G has experienced 30 fault operations. Breaker E has experienced 42 fault operations. Breaker F has experienced 36 fault operations. The manufacturer recommendation for fault interruptions is 10.

138kV breakers M and N at Pendleton station are 1200A 17.5kA models from 1951 and have had 18 and 13 fault operations respectively, which is higher than the manufacturer recommendation of 10. 138kV Breaker P being replaced is a 800A 17.5A model manufactured in 1946.

Operational Flexibility and Efficiency:

Currently a fault from transformer 2 requires 3 138kV breakers to operate in order to clear. Adding a circuit switcher is recommended to prolong the life of the new 138kV breakers.

AEP Transmission Zone: Supplemental Pendleton Breaker and Relay Replacement

Continued from previous slide…

Potential Solution

At Pendleton station, replace 34kV CBs “H”, “F”, “E”, “G”, and “K” with 2000A 38kV 25kA breakers. Replace 138kV CB’s “M”, “P”, and “N” with 3000A 40kA breakers. Install a 3000A 40kA circuit switcher on the high side of transformer #2.

Estimated Transmission Cost $6.1M

Alternative:

Replace breakers with 69kV rated equipment and operate them at 34.5kV.
The 34.5kV network fed off of Pendleton station is owned by IMPA and is not controlled by AEP. Since IMPA’s network is operated at 34.5kV, installing 69kV rated equipment would not offer the system any added flexibility and so is not advisable.

Projected In-service: 2/09/2018

Project Status: Construction

AEP Transmission Zone: Supplemental
Tiffin Center Breaker Replacements

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Breakers 'A' and 'B' at Tiffin Center station are 1200A 21 kA oil medium breakers manufactured in 1965 with fault counts of 149 and 73 respectively. 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. The drivers for replacement of these breakers are age, number of fault operations, a lack of available repair parts, and PCB content.

Potential Solution:

At Tiffin Center station, replace 69kV breaker 'A' and 'B' with 3000A 40kA breakers and associated equipment.

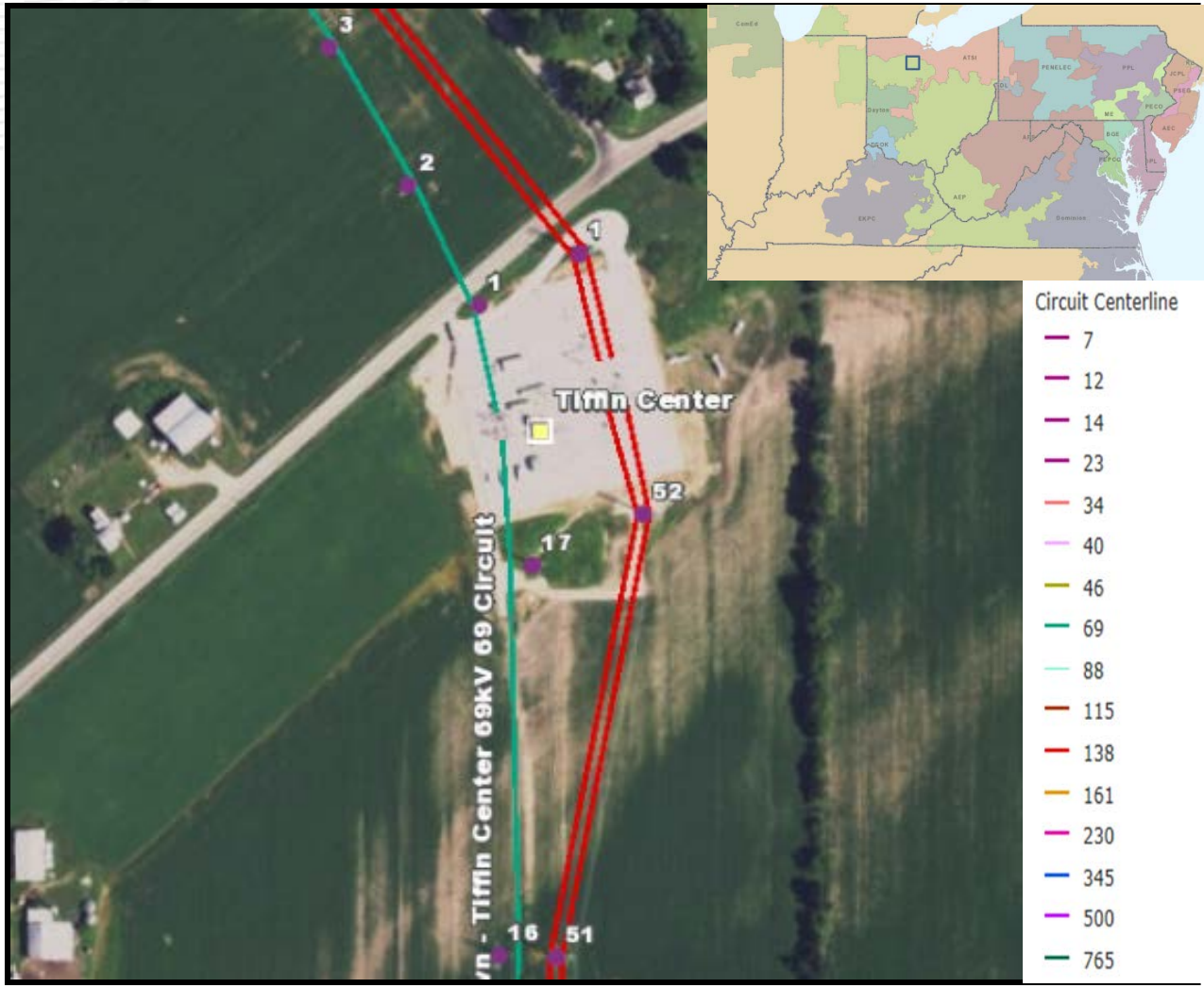
Estimated Transmission Cost: $1.24M

Alternative:

- No viable cost-effective alternatives identified

Projected In-service: 03/16/2018

Project Status: Engineering



AEP Transmission Zone: Supplemental
Wharncliffe CB Replacement

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Wharncliffe 46 kV circuit breakers “A”, “B”, & ”C” have all significantly exceeded (A = 228 operations , B = 175 operations , C = 60 operations) the manufacturer’s designed number of fault operations of 10. In addition, all three breakers are ME Type EPB 1200 A 20 kA breakers and are on the obsolete breakers list. This type of breaker has very few parts for repairs and AEP has been working towards eliminating these breakers from the system

Potential Solution:

Replace existing Wharncliffe circuit breakers A, B, and C with 3000 A 40 kA circuit breakers.

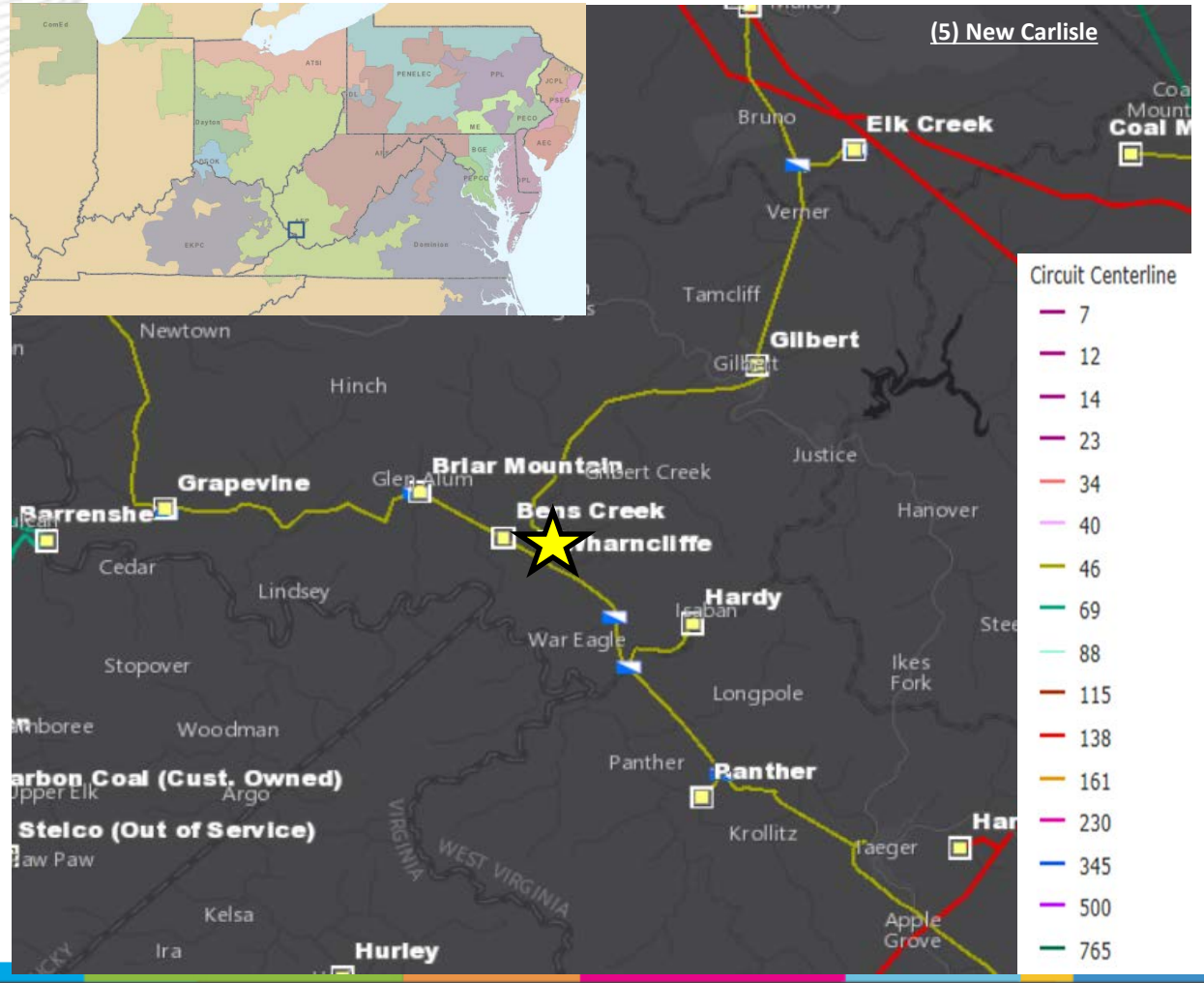
Estimated Transmission Cost $ 3.41M

Alternative:

- No viable cost-effective alternatives identified

Projected In-service: 06/01/2018

Project Status: Scoping



AEP Transmission Zone: Supplemental Madison 69 kV Loop

Problem Statement:

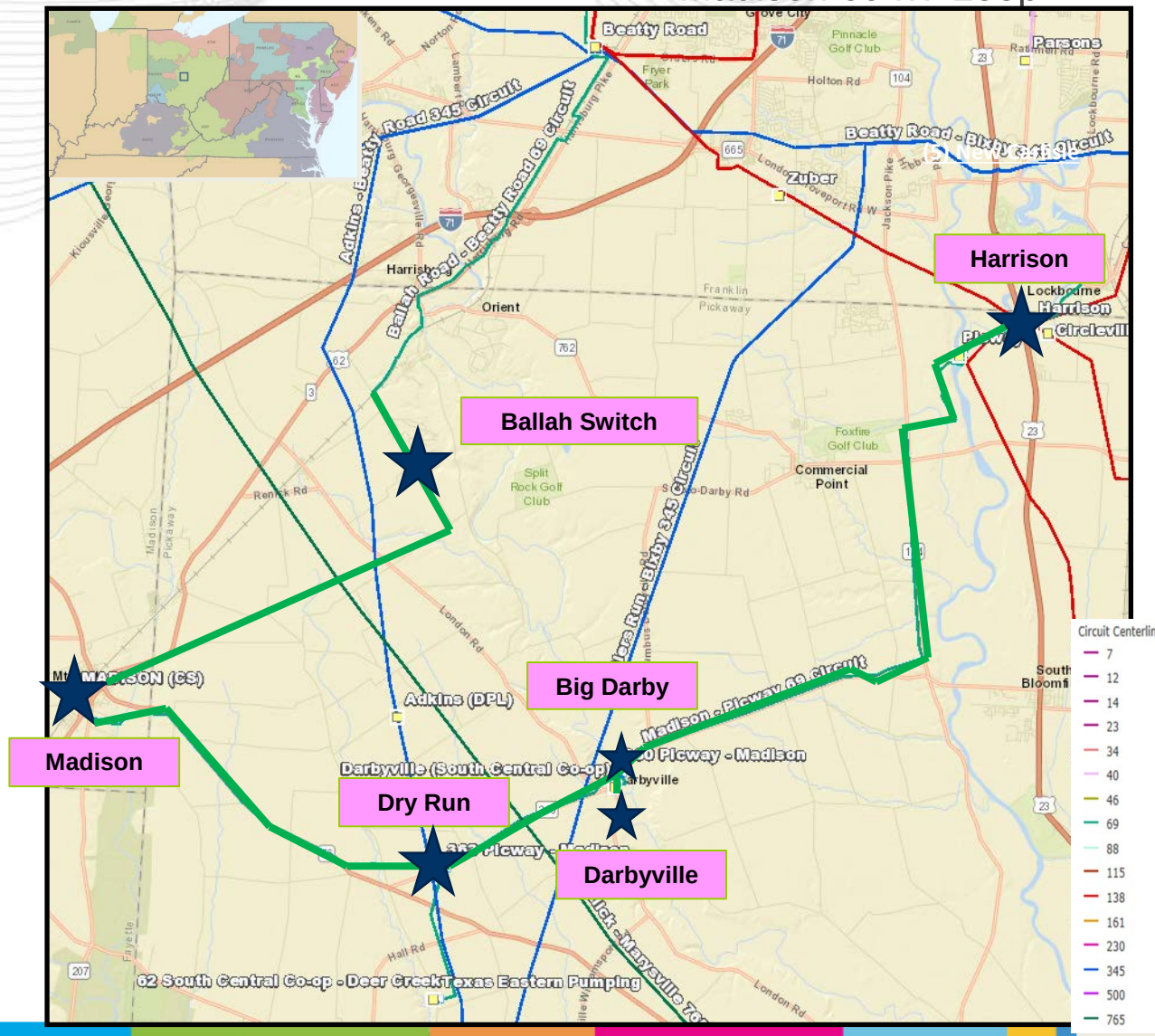
Equipment Material/Condition/Performance/Risk:

The Harrison-Madison 69kV circuit (made up of Picway-Madison, vintage 1944 & Picway Harrison, vintage 1969) is in very poor condition and in need of rebuild. 15.29 miles of the 24.2 mile line is 73 years old and 16.4 miles of it is comprised of copper conductor (25 MVA rating). There are 248 known conditions as of the last inspection. Due to the radial nature of the line, it cannot be rebuilt without first completing and closing the loop at Madison station in order to avoid extensive customer outages.

The transmission line operations crew receives multiple call outs on this line, and it's construction makes it difficult to repair. There are also co-op customers and a pipeline customer served off this line that are affected when the line is outaged.

Four circuit breakers at Harrison station are showing signs of deterioration. These breakers were installed in the late 1960's and early 1970's and use oil as the interrupting medium. 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. The drivers for replacement of these breakers are age, bushing damage, no repair part availability, amount of fault operations and PCB content. Fault operation counts at Harrison include 13 on 69kV CB 61, 58 on 69kV CB 62, and 23 on 69kV CB 63, which exceed the manufacturer's recommended limit of 10.

Harrison 138/69kV transformer 1 is also showing signs deterioration. Drivers for transformer replacement include age, dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events) and accessory damage (bushings).



AEP Transmission Zone: Supplemental Madison 69 kV Loop

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Operational Flexibility and Efficiency:

A normally opened configuration at Str. 280 (near the Darbyville tap location) allows for limited temporary recovery of loads at Deer Creek, Darbyville, Clark Lakes, Texas Eastern Co., and Madison stations for outages involving Str. 280 to Harrison branch. This configuration depends on utilizing normally radial customer owned 69kV transmission line. However, there are not recovery options if the outages involve Str. 280 to Madison branch. Existing small conductors also limit the load recovery options in this configuration.

Customer Service:

SCP has approached AEP to help address numerous outages affecting customers in this area.

Potential Solution:

Build a new Beatty-Madison 69 kV line utilizing 795 ACSR (129MVA rating) in new ROW. Acquire existing 636 ACSR & 336 ACSR (73 MVA rating) in existing ROW.

Estimated Transmission Cost: $16.2M

Rebuild single circuit 69kV line from Harrison to Madison with 795 ACSR (129 MVA rating), mostly in existing ROW. Estimated Transmission Cost: $23.4M

Rebuild tap to Darbyville as double circuit 795 ACSR (129 MVA rating).

Estimated Transmission Cost: $0.9M

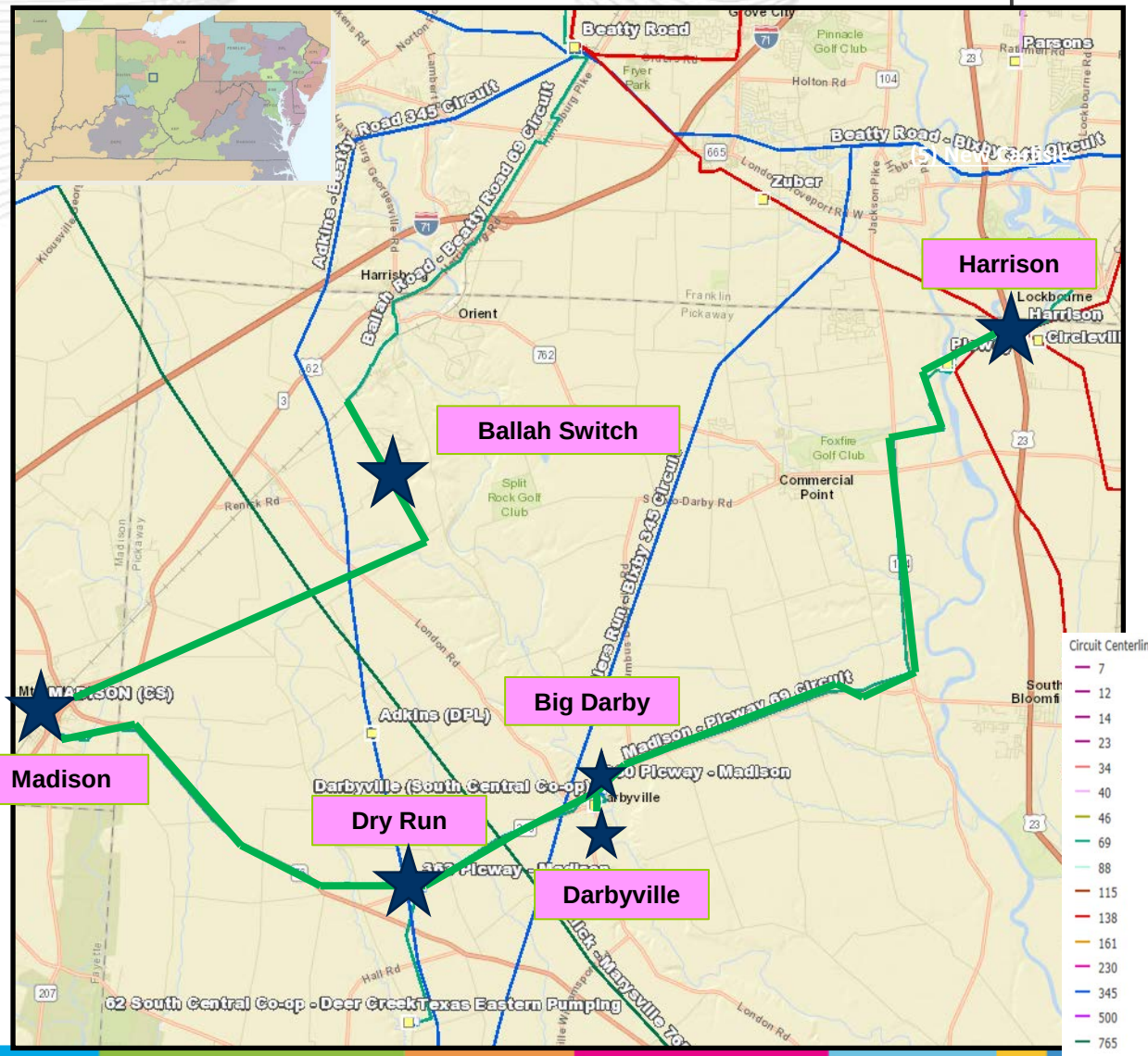
At Harrison station, replace the 138/69kV transformer with a 90 MVA. Install 3-69kV CB's with 2,000A 40kA breakers. Install 1-138kV CB with a 3,000A 63kA breaker. Install a 14.4 MVAr 69kV capacitor. Estimated Transmission Cost: $5.8M

At Madison station, install 2 new 69kV 2,000A 40kA CB's and 1 600A 40kA ckt switcher.

Estimated Transmission Cost: $3.0M

At Big Darby Switch, Dry Run Switch, and Ballah Switch, upgrade with 2000A switches at new locations. Retire old switches. Estimated Transmission Cost: $1.3M

Total Estimated Transmission Cost: $50.6M



AEP Transmission Zone: Supplemental Madison 69 kV Loop

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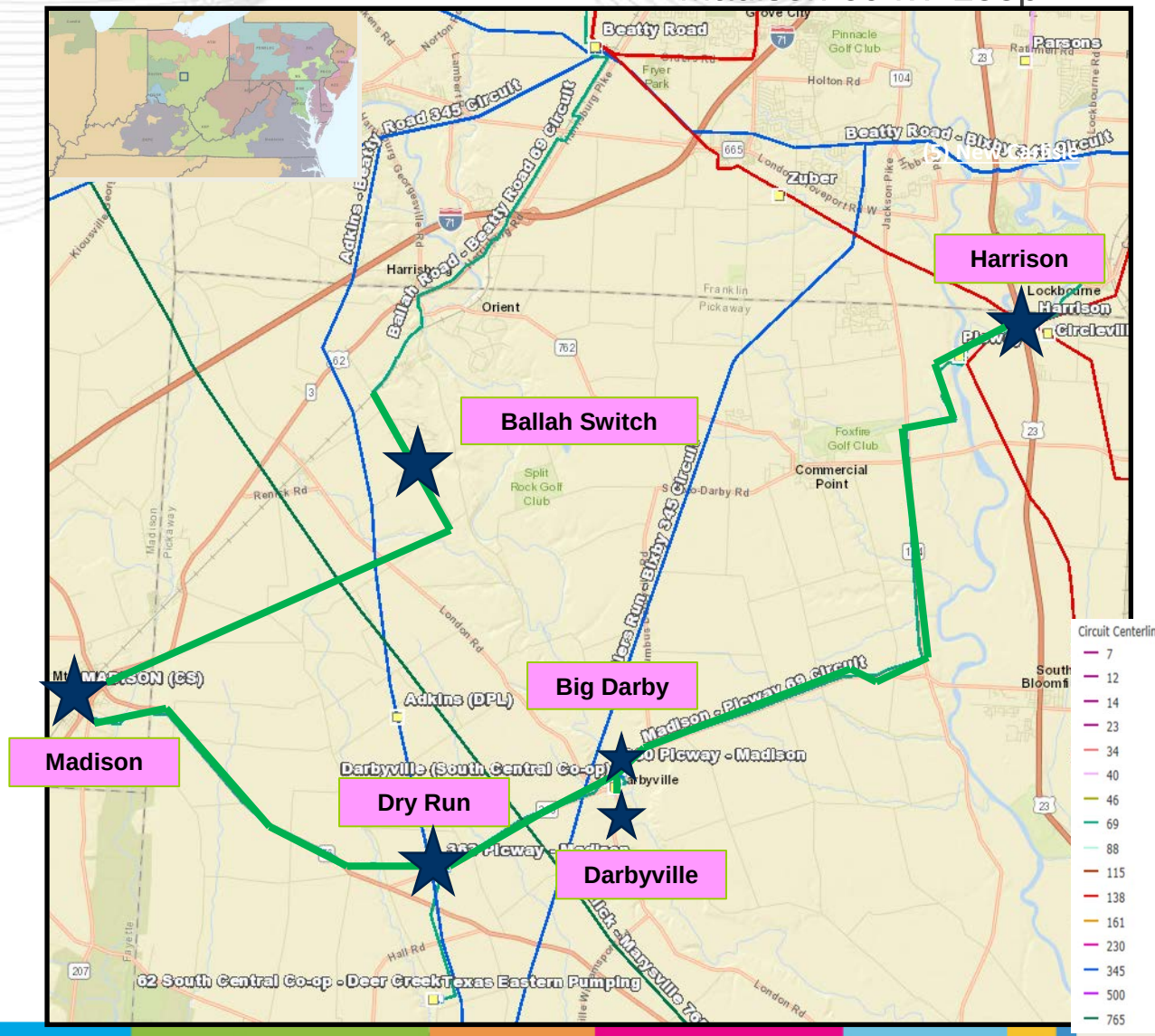
Alternatives:

- Rebuild Harrison-Madison line, offset from centerline. This would require extensive new ROW, could pose severe challenges with encroachments and/or existing structures, and would leave the line radially fed from Harrison. Estimated Cost: $45M
- Construct a 345/69kV step down station to close the 69kV loop and back feed loads while line rebuild is occurring. This would solve the immediate problem but at excessive cost. Additional 69kV line construction would still be required if the radial line is to be fully addressed. Estimated Cost: $60M

Projected In-service: 12/1/2019

Project Status: Engineering



AEP Transmission Zone: Supplemental
Meadowbrook Station

Problem Statement:

Equipment Material/Condition/Performance/Risk:

Breakers C and D are currently not in use and are accruing yearly O&M costs. Due to the cost, retirement is recommended.

Operational Flexibility and Efficiency

Currently there are three overlapping zones of protection at Meadowbrook station: the 34.5kV bus, the 138/34.5kV transformer and the Pendleton – Madison line. It is AEP's current standard to not allow for an overlap of more than two protection zones. The configuration at Meadowbrook does not meet AEP's current standards as three protection zones share the same relays thus increasing the probability of mis-operations. Also, a transformer protection zone overlapping with a bus and line protection zones does not allow for bus one-shot and high-speed reclosing schemes, respectively. This adds restoration delays and significantly reduces reliability. Also, this arrangement reduces the life of breakers by tripping them for events in any of the three protection zones.

Potential Solution:

Retire out of service breakers "C" and "D" and install a high side 138kV 3000A 40kA breaker for transformer protection.

Estimated Transmission Cost: $2.5M

Alternative:

- Install the breaker on the low side of the transformer instead of the high side. While this would protect the 34.5kV bus from a transformer fault, it would leave the transformer exposed to a line fault. Since line faults are a more common occurrence, protecting the station equipment from a line fault was chosen as the optimal solution. Estimated Cost: $2M

Projected In-service: 4/16/2018

Project Status: Scoping

AEP Transmission Zone: Supplemental
Deer Creek-Sorenson Rebuild

Problem Statement:

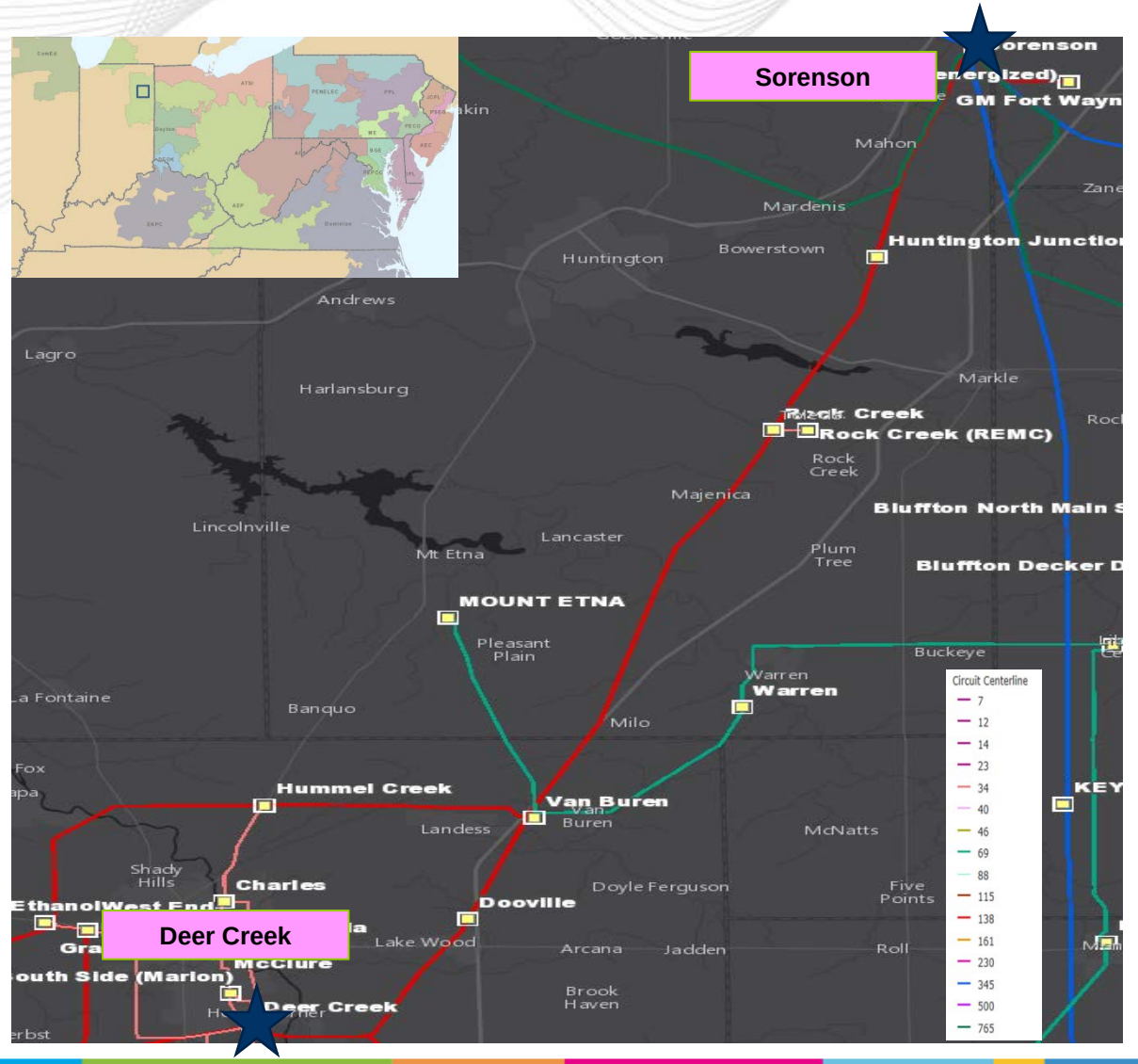
Equipment Material/Condition/Performance/Risk:

The Deer Creek – Sorenson double circuit line has 236 open conditions and is comprised of conductor and towers from 1928 with mostly 397 ACSR conductor (167 MVA rating) along the 36 mile length. It is currently subject to corroded towers; broken clamps; broken dampers; burnt insulators; vine hazards and broken shield wire.

Design standards from the 1920s do not meet modern standards for strength, resilience, and horizontal and vertical clearances for safety. Underlying land rights secured prior to the line's original construction do not contain modern protective language which would provide the ability to properly manage non-conforming land uses. The ability to control building encroachments and intrusive vegetation were often not included in the language of the original easements. This transmission line has exceeded its original life expectancy. Age and normal deterioration of the line, now over ninety (90) years old, warrants its complete replacement.

Operational Flexibility and Efficiency

Due to the relative length of the line, wind exposure, and perpendicularity of this line to the prevailing winds, the Deer Creek – Sorenson circuit has had a history of "galloping" which has led to 30 momentary interruptions across the Deer Creek – Hummel Creek – Sorenson circuit and 43 momentary interruptions on the Delaware – Sorenson circuit in the last 10 years alone. Rebuilding this line with structures and configurations more suited for high wind environments is required.



AEP Transmission Zone: Supplemental
Deer Creek-Sorenson Rebuild

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Potential Solution:

Rebuild ~32 miles of the Delaware – Sorenson & Sorenson – Deer Creek 138kV double circuit line using 795ACSR (257 MVA rating).

Estimated Transmission Cost: $82.6M

Rebuild ~3 miles of the Deer Creek 138kV double circuit extension using 795 ACSR (257 MVA rating). Estimated Transmission Cost: $1.7M

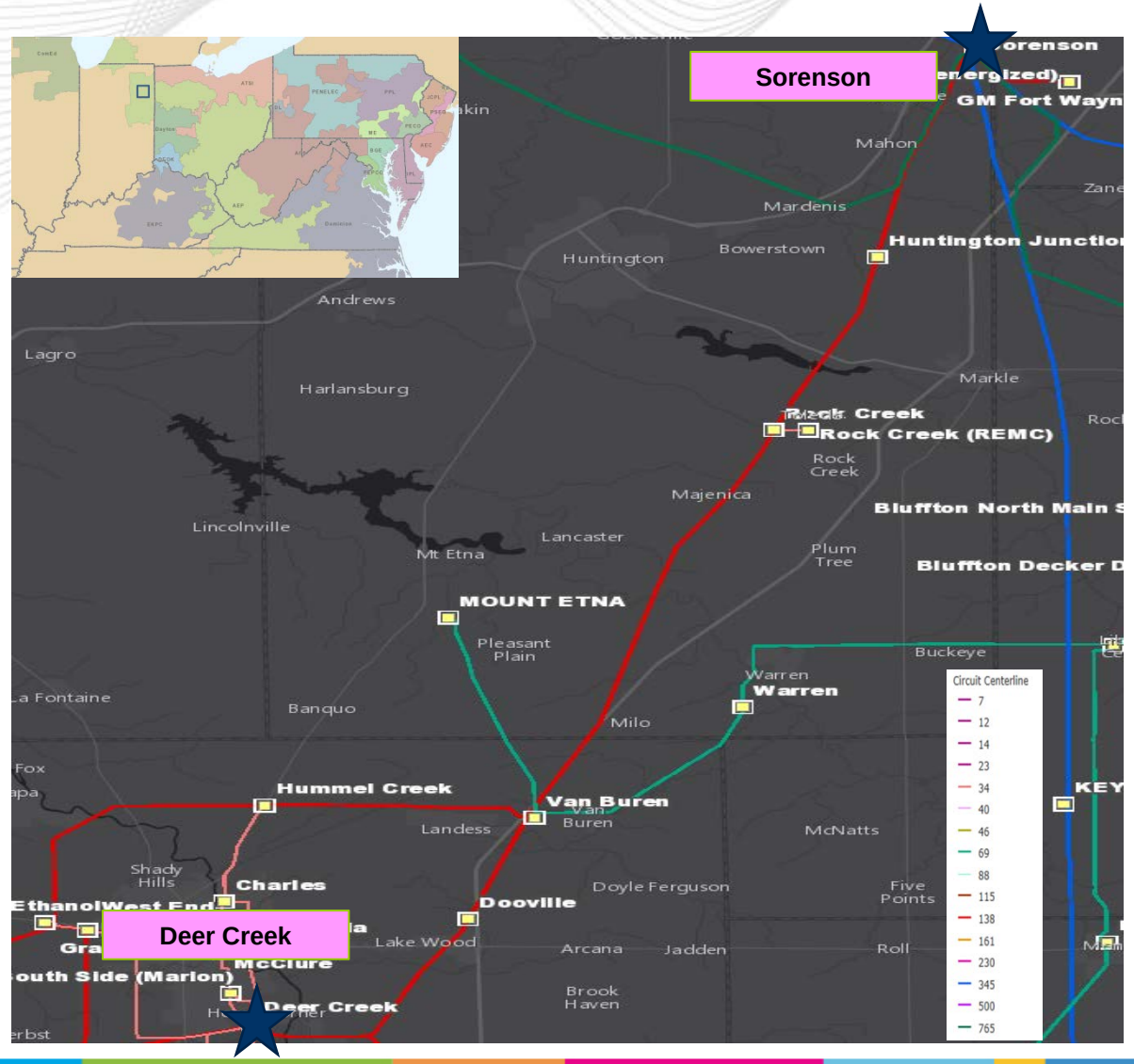
Total Estimated Transmission Cost: $84.3M

Alternative:

- Retire existing line and build a new greenfield line in new right of way to reduce outage time. However, outages on this line have not been difficult to secure in the past. Estimated Cost: $90M

Projected In-service: 12/2/2019

Project Status: Engineering



ComEd Transmission Zone: Supplemental QTS Data Center Interconnection at Fisk

Problem Statement:
New customer requesting to interconnect near Fisk station at 138kV in Chicago January of 2019.
Initial 2019 load of approximately 11 MW expected to grow to 110 MW by 2030.
The distribution system does not have enough capacity to meet the customer's future needs.

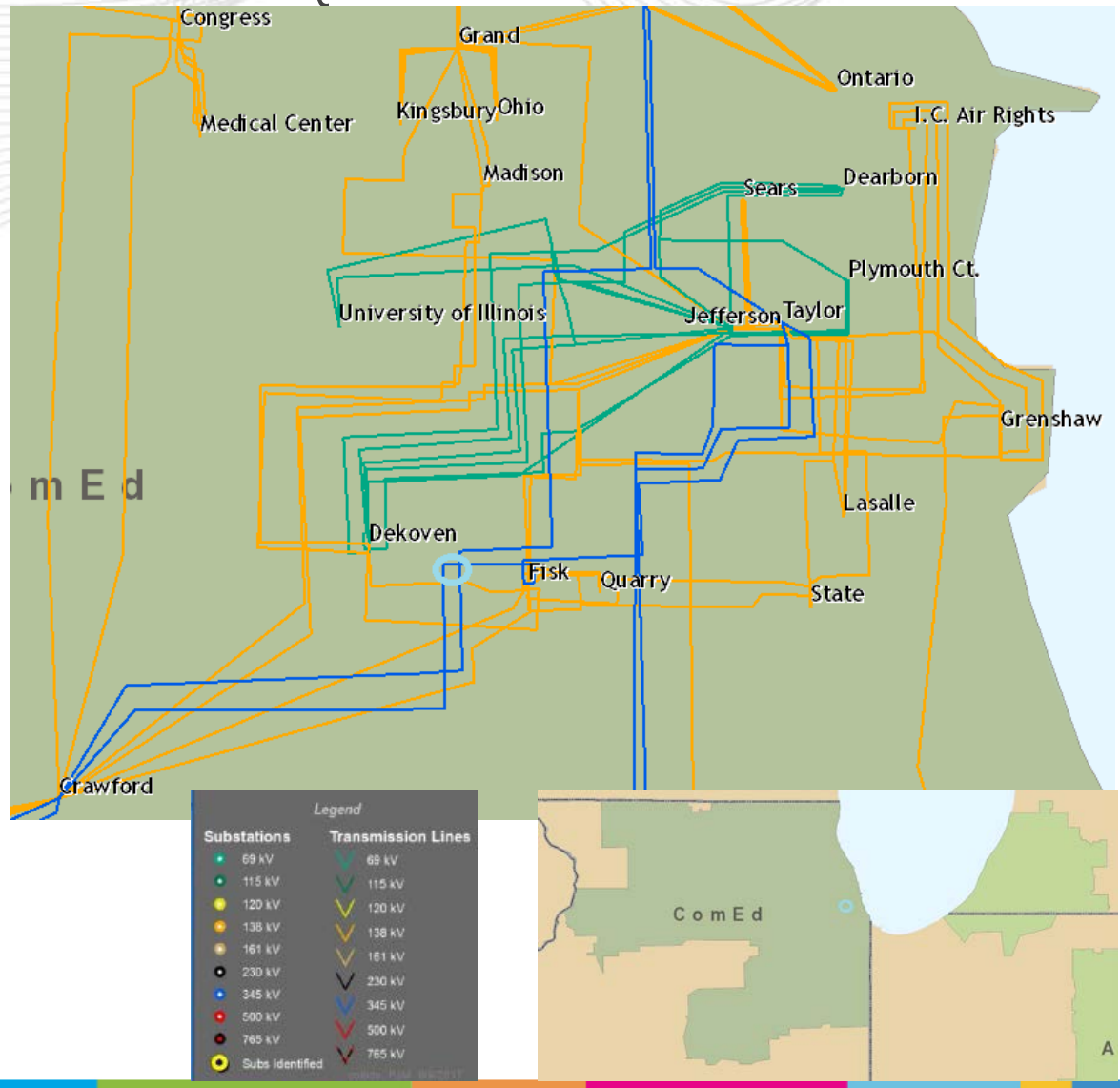
Potential Solutions:
Install 2 circuit breakers at Fisk 138KV substation and extend two 138kV lines from Fisk for 0.3 miles to a new customer substation.

Alternative:
No existing 138kV transmission lines in the area
Expected load level is too large for the distribution system
No viable cost-effective alternatives identified

Estimated Cost: $3.8M

Projected In-service: 1/1/2019

Status: Engineering



ComEd Transmission Zone: Supplemental Digital Realty Data Center Interconnection

Problem Statement:
Existing distribution customer in Franklin Park 34KV requesting to interconnect to transmission system in December 2018.
Current load of approximately 20 MW expected to grow to 88 MW by 2024.
The distribution system does not have enough capacity to meet the future customer needs.

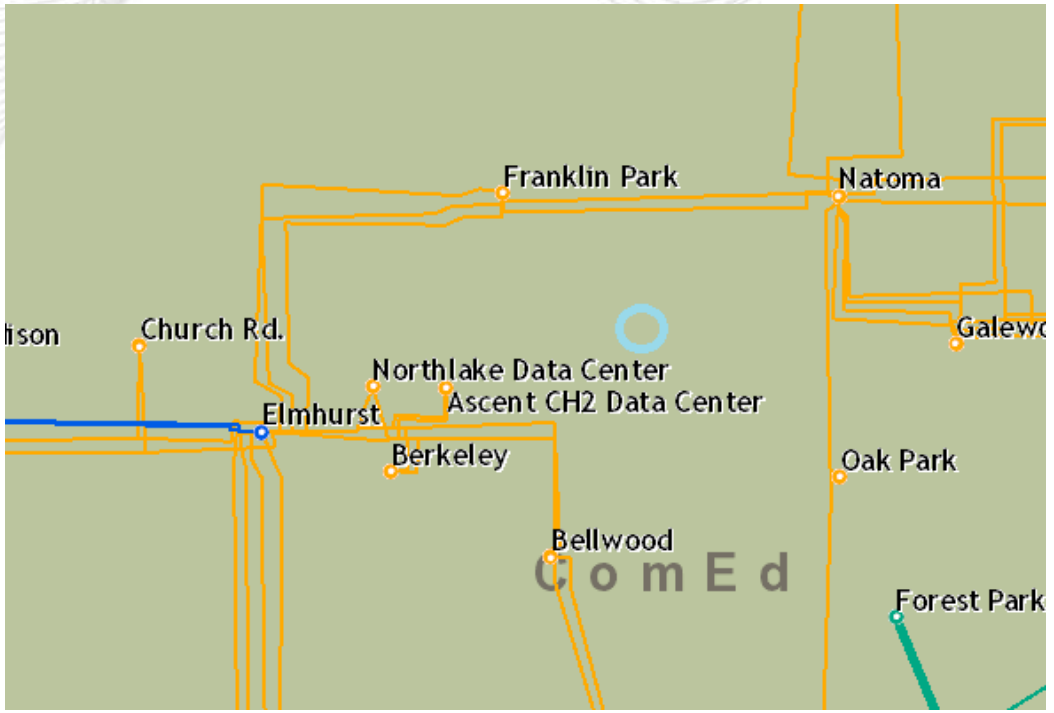
Potential Solutions:
Add 5 138kV CB's and reconfigure Bellwood 138kV substation bus from a straight bus to a ring bus to create 2 new line bays. Extend two new 138kV lines from Bellwood for 3.3 miles to a new customer substation.

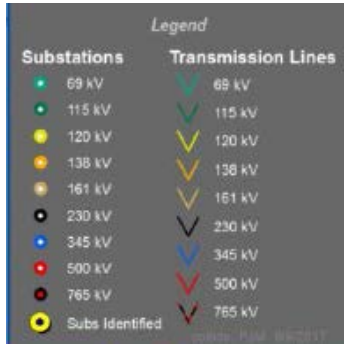
Alternative:
No existing 138kV transmission lines can handle the increased loading.
Expected load level is too large to remain on the distribution system
No viable cost-effective alternatives identified

Estimated Cost: $12M

Projected In-service: 12/1/2018

Status: Engineering





ComEd Transmission Zone: Supplemental
Blue Island Transformer 82

Problem Statement:
48 year old Blue Island ASEA 345/138KV transformer that cannot be re-blocked
Acoustic testing shows high vibration and an unexpected increase in frequencies associated with looseness in core assembly
Low ability to withstand a through fault.

Tertiary cap banks no longer allowed per ComEd standards. Tertiary cap bank failures stress the 345/138kV transformers and have caused transformer failures in the past.

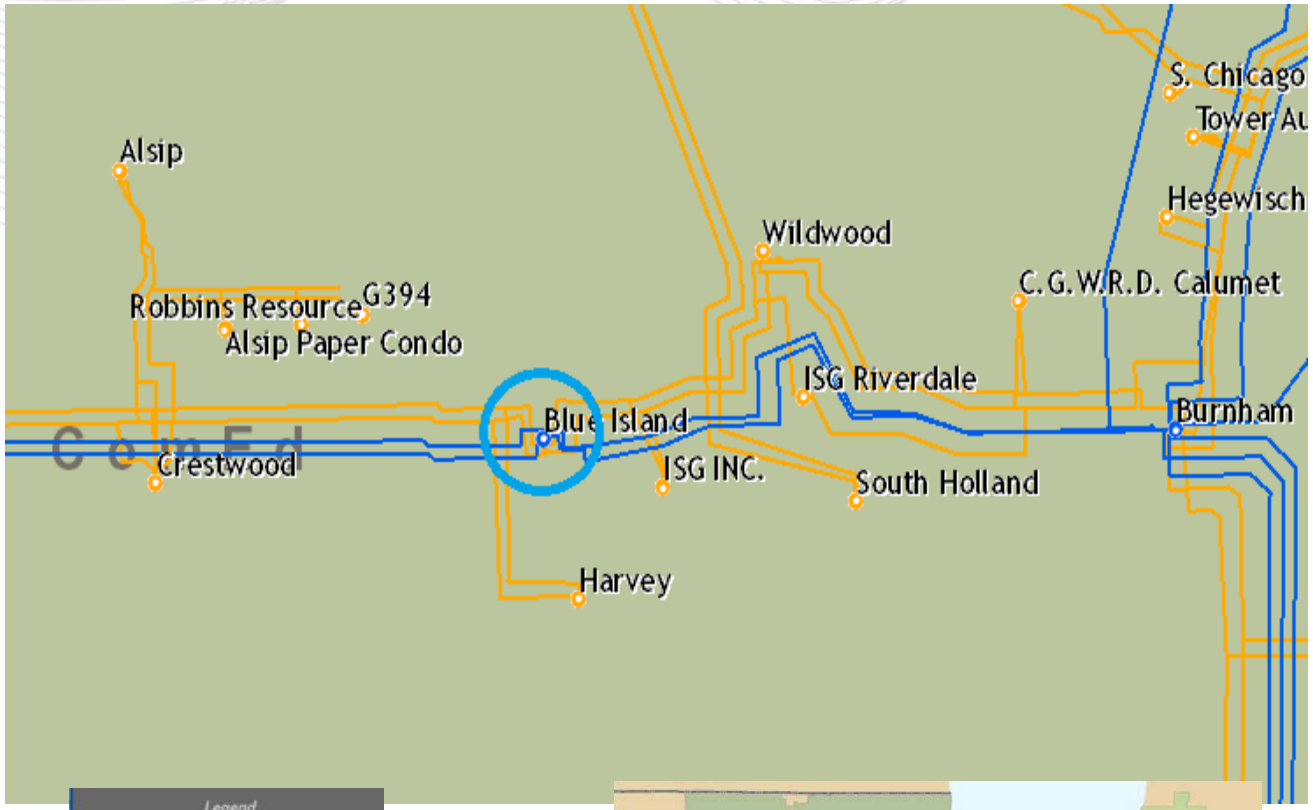
Potential Solutions:
Replace Blue Island 345/138kV transformer 82. Remove tertiary cap bank and install 115MVAr 138kV bus cap.

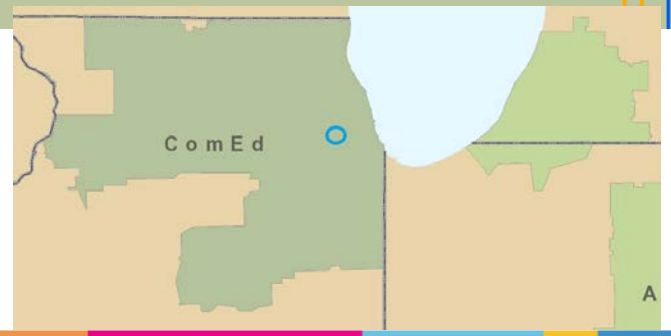
Alternative:
No viable cost-effective alternatives identified

Estimated Cost: $12M

Projected In-service: 12/1/2018

Status: Engineering





ComEd Transmission Zone: Supplemental Elmhurst – Franklin Park138kV line (ACOP)

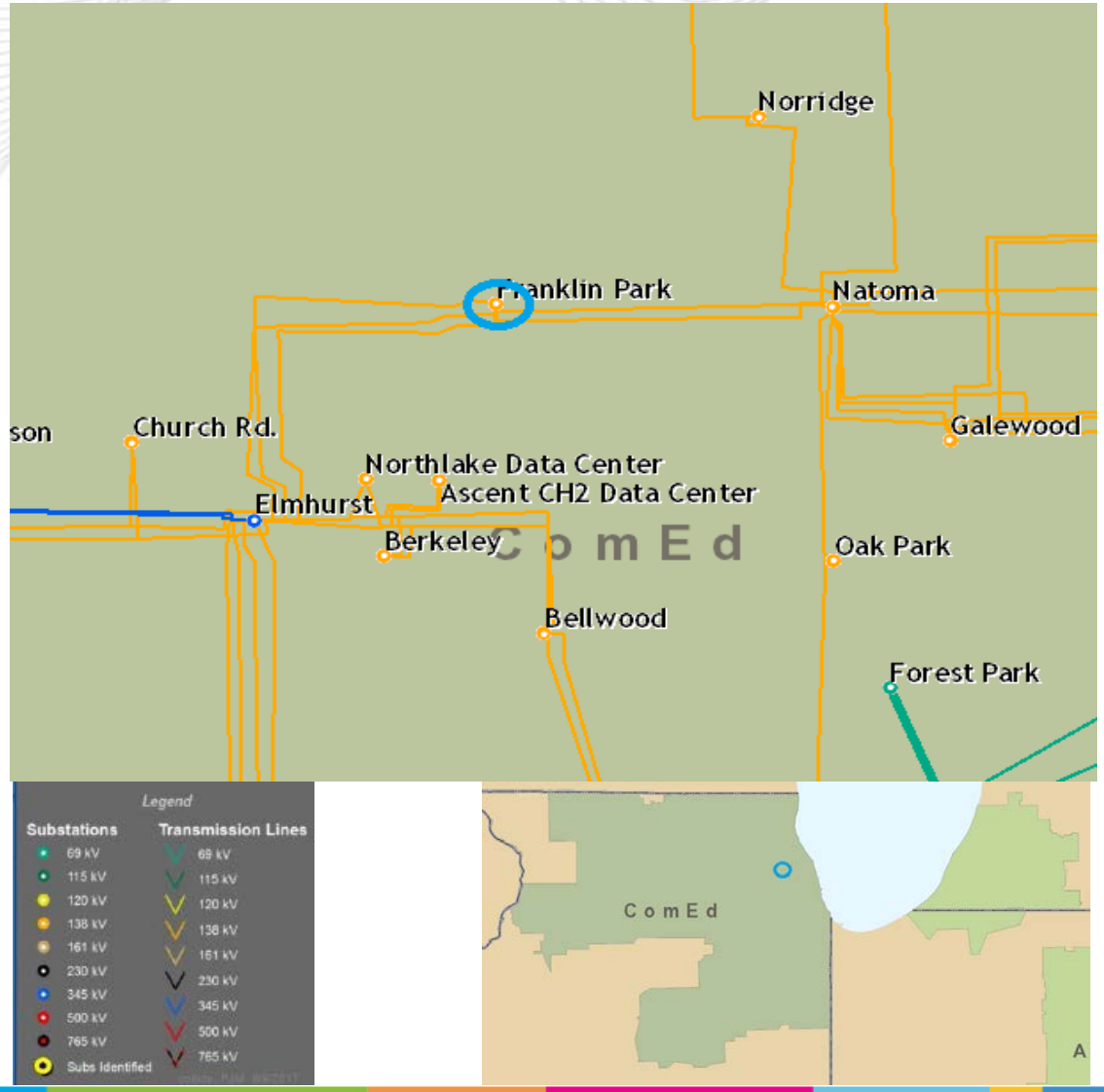
Problem Statement:
Forced Cooling equipment on the Elmhurst – Franlin Park138kV line was installed in 1970. Availability of replacement parts is diminishing
O&M costs are increasing

Potential Solutions:
Replace forced cooling equipment that is at end of life for the Elmhurst – Franlin Park138kV line; Install additional cooling equipment to increase thermal capability of 138kV line
Estimated Cost: $3.5M

Alternative:
Re-conductor underground cables with XLPE and retire forced cooling equipment
Estimated Cost: $30-40M

Projected In-service: 12/1/2019

Status: Engineering



ComEd Transmission Zone: Supplemental McCook TR 84 Cap Bank

Problem Statement:
McCook Tertiary cap banks no longer allowed per ComEd standards.
Tertiary cap bank failures stress the 345-138kV transformers and have caused transformer failures in the past.
Increased load levels at Bellwood substation are increasing the loading of the McCook 345-138kV auto-transformers and reducing the phase shifter adjustability

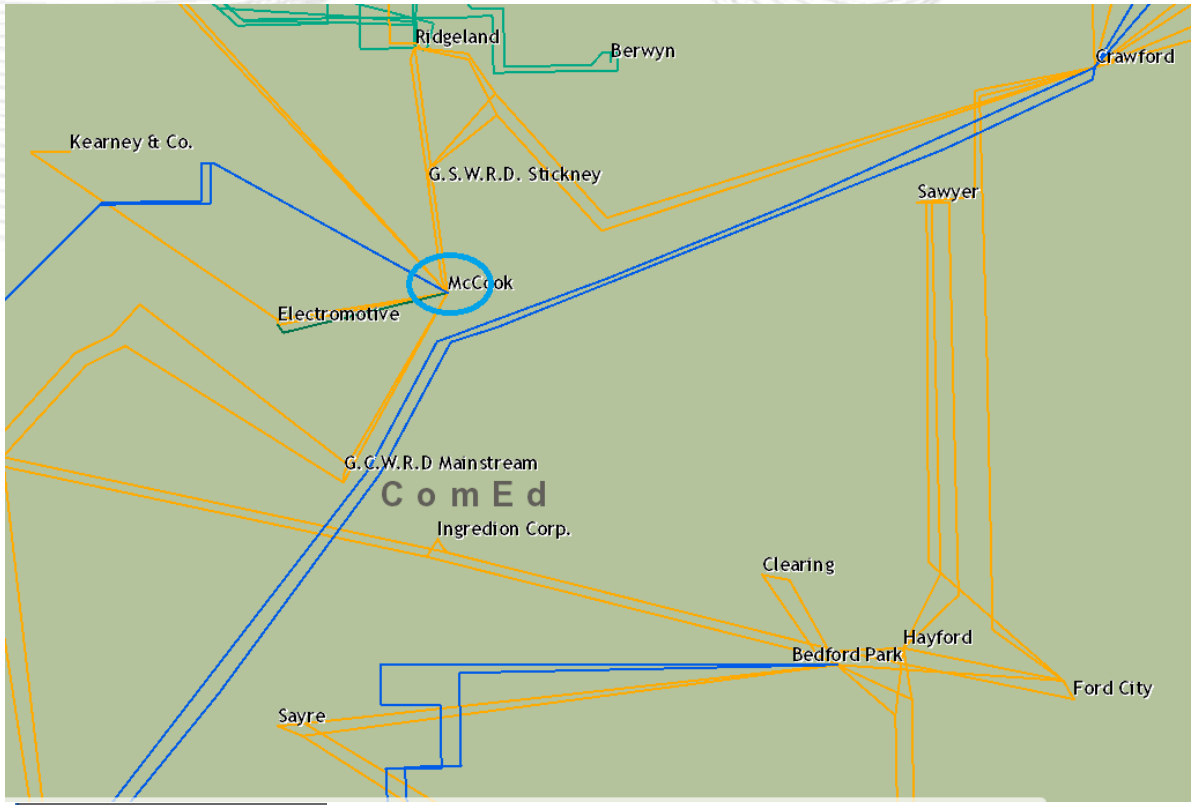
Potential Solutions:
Remove McCook Transformer 84 tertiary capacitor banks and install 138kV 115MVar capacitor banks
Increase the thermal capability of the 345-138kV autotransformer
Increase operational flexibility in the Chicago phase shifter zone
TR 82 tertiary cap bank has already been removed

Alternative:
Do nothing and risk losing one of the highest loaded auto-transformers to a capacitor bank failure. Continue to loss phase shifting operability as data center load continues to grow

Estimated Cost: $6.0M

Projected In-service: 12/1/2018

Status: Engineering



Next Steps

Upcoming Western SRTEAC Dates

West	Start	End
12/18/2017	12:30	3:30
1/30/2018	12:00	4:00
3/27/2018	12:00	4:00
5/30/2018	12:00	4:00
7/27/2018	12:00	4:00
9/28/2018	12:00	4:00
11/29/2018	12:00	4:00

Questions?

or

RTEP@pjm.com

Revision History

10/26/2017 – V1 – Original version posted to PJM.com

10/30/2017 – V2 – Slides #60, Updated Projected IS date

– Slides #80, Updated future SRTEAC dates

– Slides #8, Add projected IS dates

4/18/2018 – V3 – Updated slides to reflect stakeholder feedback (changes in red)

- Slides 13 – 27: Anaconda, Hazard, Shoals, Balls Gap, Beckham, Fall Creek, and South Bend
- Slides 33 – 38: Buckhorn, Carlton-Sunnyside, College Corner
- Slides 43 – 51: Harrison-Parsons-Marion, Hartford City-Montpelier, Hopkins-Sharples, and Lick-Ross