PJM Western SRRTEP Committee
AEP Supplemental Projects

April 23, 2019

Changes to Existing Supplemental Projects Before M-3 Process

AEP Transmission Zone: Supplemental Hazard Station

Previously Presented: 11/2/2017, 12/18/2017 SRRTEP

Problem Statement:

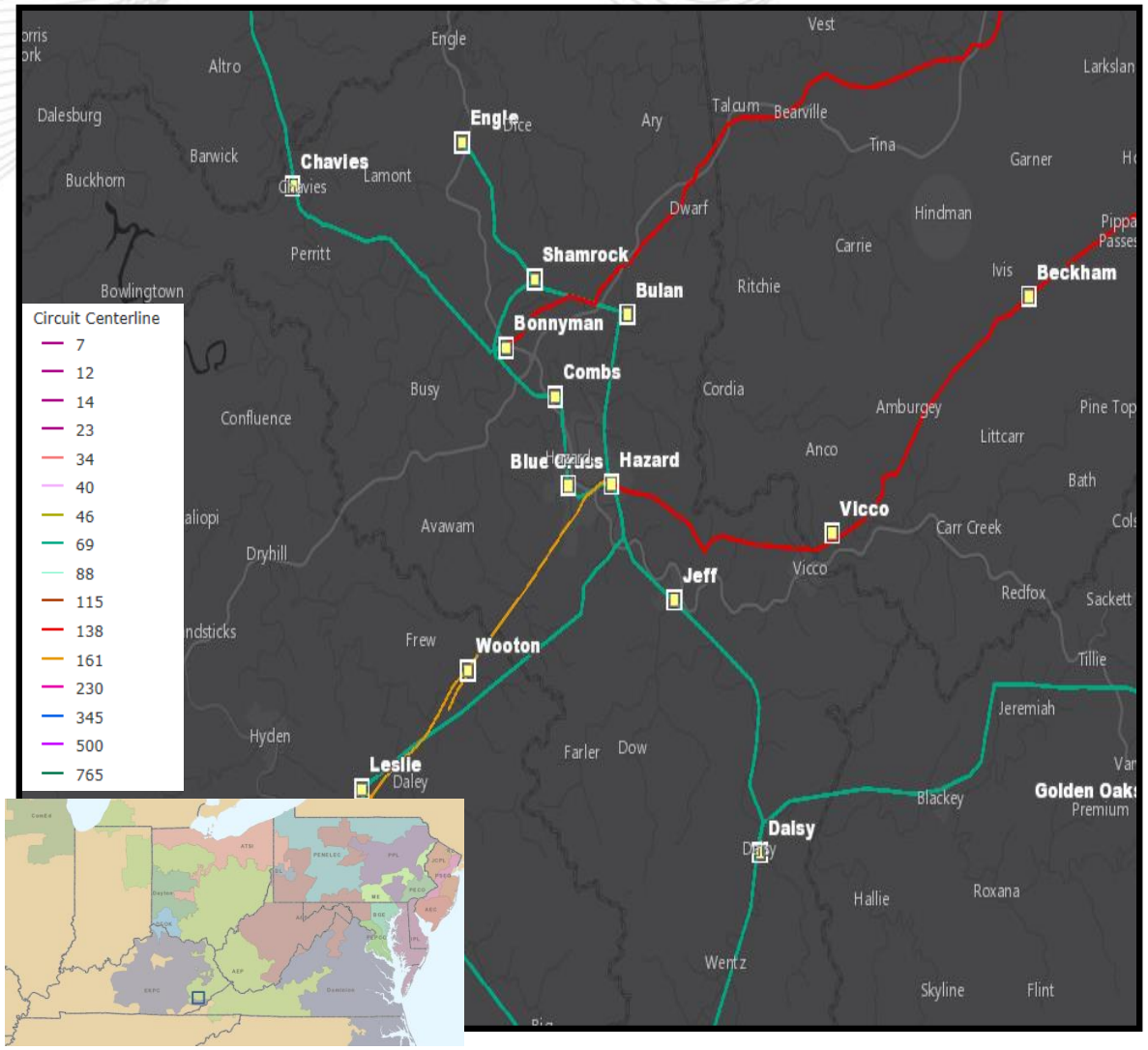
Equipment Material/Condition/Performance/Risk:

Circuit breakers S (1100 A, 11.3 kA) and E (1800 A, 27 kA) at Hazard station are FK type breakers all over 40 years old. Circuit breaker F at Hazard is a 1200 A, 31.5 kA 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 (2000 A, 40 kA) 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).~~ Additional engineering design has indicated that Capacitor bank BB would not need to be relocated to accommodate the baseline 161/138 kV transformer replacement/relocation.



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.

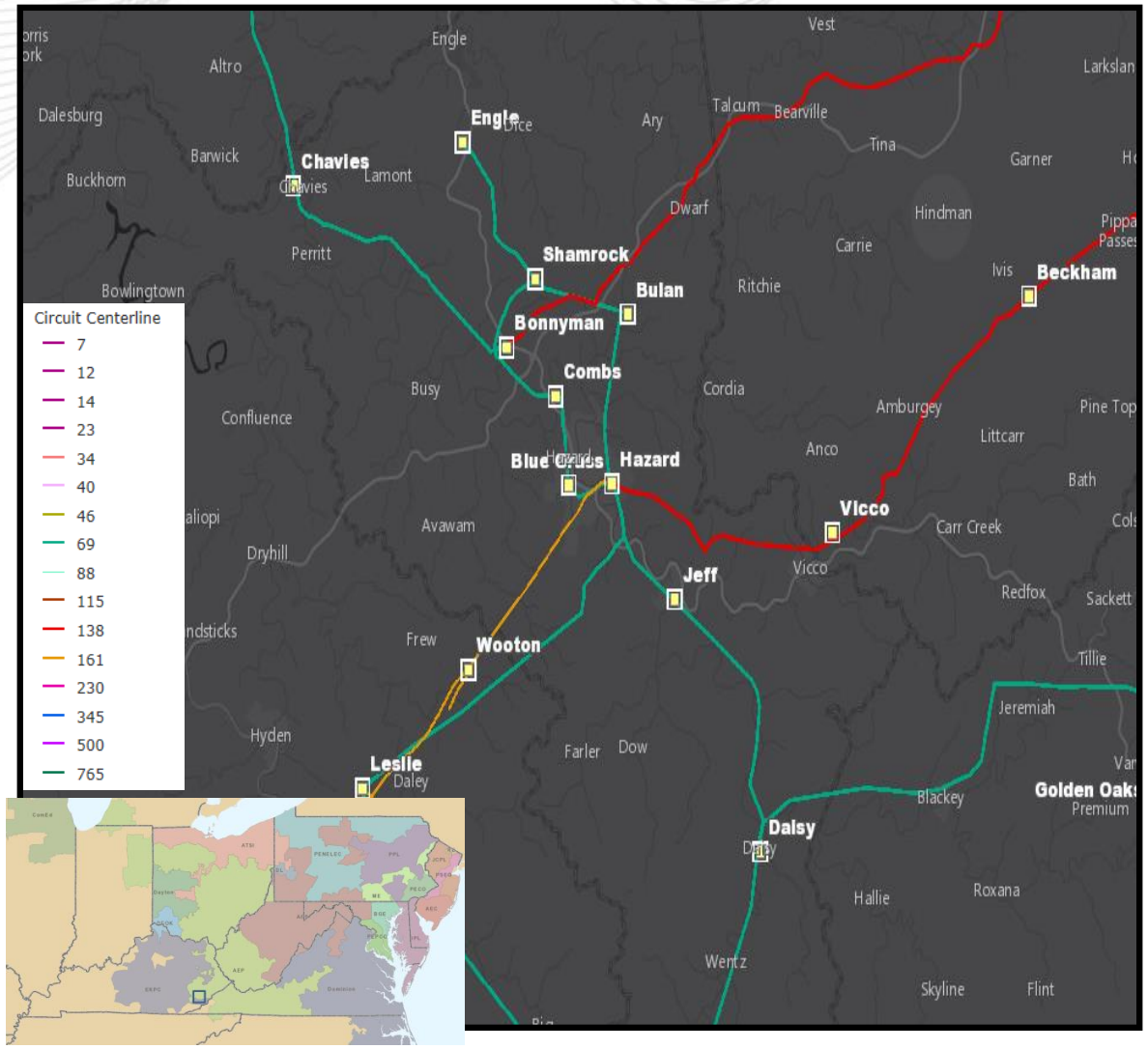
Safety concerns associated with existing equipment platforms at the station will also be addressed. The majority of the platforms at the station were field designed with thought of access, not safety, adequate clearances, or structural integrity in mind. Drainage issues at the station will also be addressed. 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.

Operational Flexibility and Efficiency

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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Selected Solution:

Install a new 3000 A 40 kA 138 kV circuit breaker at Hazard station on the line exit towards Beckham station. **(s1412.1)**

Add a 138 kV circuit switcher to the high side of transformer #4. **(s1412.2)**

Replace 138 kV capacitor bank and switcher BB with a new switcher and 43.2 MVAR capacitor bank. **(s1412.3)**

Replace 138/69 kV transformers #1 and #2 with new 138/69 kV 130 MVA transformers with 138 kV circuit switchers on the high side and 3000 A 40 kA 69 kV breakers on the low side. **(s1412.4)**

Replaces 69 kV circuit breakers S, E, and F with 3000 A 40 kA 69 kV circuit breakers with a bus tie 3000A 69 kV circuit breaker being installed between the existing 69 kV box bays. **(s1412.5)**

Replace 69 kV capacitor bank and switcher CC with a new switcher and 28.8 MVAR capacitor bank. 69 kV capacitor bank and switcher AA will be retired.

Replace 161 kV circuit breaker M towards Wooton with a 161 kV 3000 A 40 kA breaker. ~~**(s1412.6)**~~

This work is already included in the baseline project (b2761).

Add a 3000 A 40 kA 138 kV circuit breaker to the low side of 161/138 kV transformer #3. ~~**(s1412.7)**~~

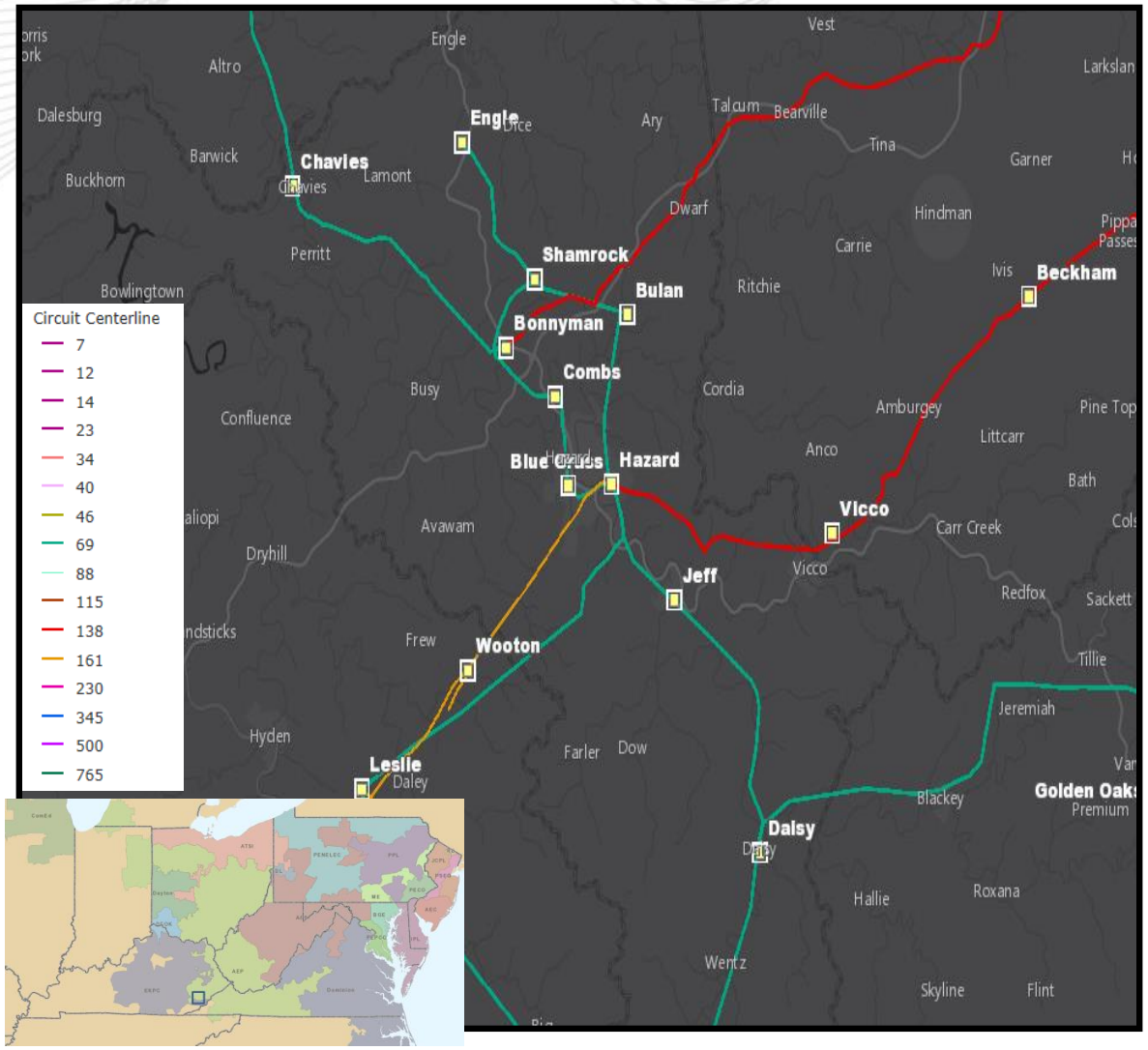
This work is already included in the baseline project (b2761).

Address safety and access issues associated with existing equipment platforms and drainage issues at the station. **(s1412.8)**

Estimated Transmission Cost: ~~**$20.0M**~~ **$23.3 M**

Projected In-service: 12/31/2019

Project Status: Scoping



Needs

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

AEP Transmission Zone M-3 Process
South Charleston, West

Need Number: AEP-2019-AP010

Process Stage: Needs Meeting 4/23/2019

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

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

Problem Statement:
South Charleston 46 kV CBs A and B are 460G-3000 oil filled breakers.

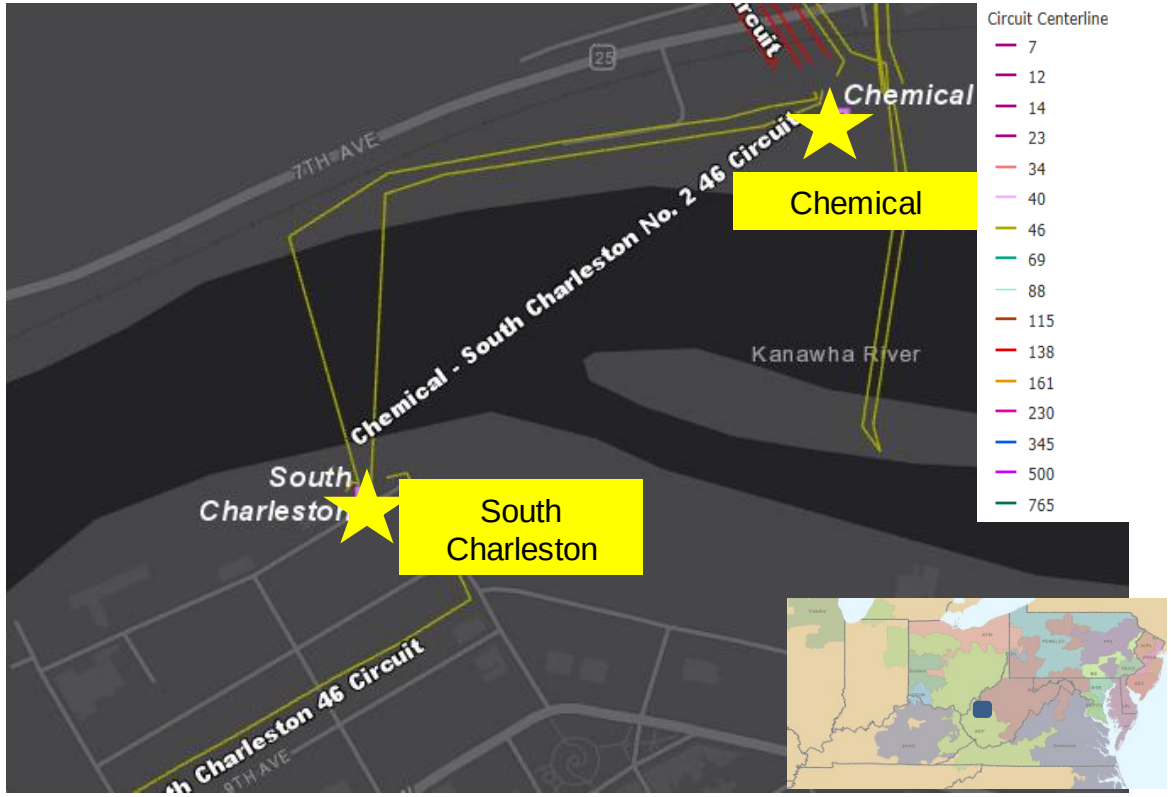
- Oil breakers are more difficult to maintain as oil spills have the potential to occur during maintenance which can be an environmental and safety hazard.
- These are the last 2 circuit breakers in the 460G-3000 CB model family on the AEP system, making spare parts difficult or impossible to obtain.

Chemical – South Charleston 46 kV #1 (~0.5mi) currently has 9 open conditions on 8/8 structures.

- The majority of the circuit is constructed with 1950s wood structures and lattice structures.
- The conditions include rot shell, insect damage and heavy rust.

Chemical – South Charleston 46 kV #2 (~0.5mi) currently has 16 open conditions on 9/9 structures.

- The majority of the circuit is constructed with 1950s lattice and wood structures.
- The conditions include rot and heavy rust and rot shell.



AEP Transmission Zone M-3 Process
Winfield, West Virginia

Need Number: AEP-2019-AP011

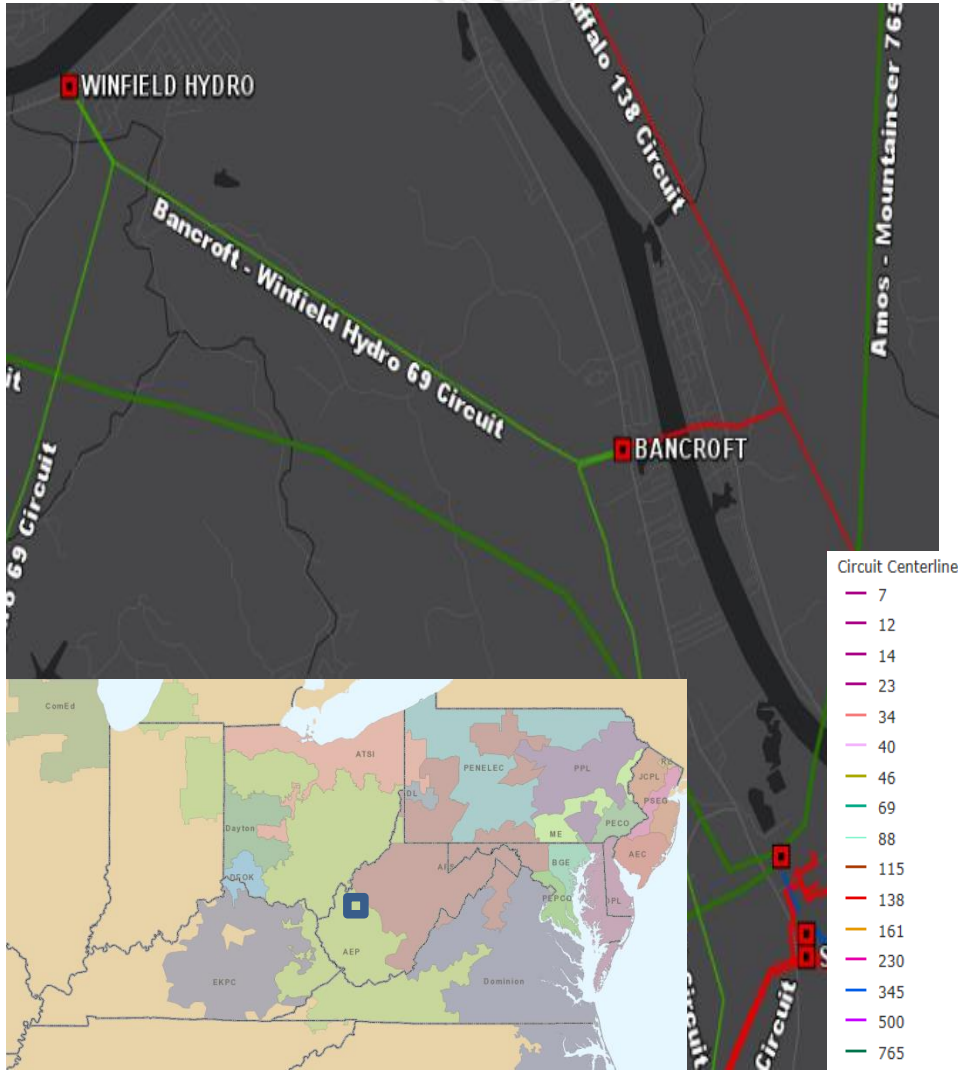
Process Stage: Needs Meeting 4/23/2019

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

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

Problem Statement:
69 kV circuit breakers F and G at Bancroft station are CF-48 oil type breakers that were manufactured in 1965.

- Oil breakers are more difficult to maintain as oil spills have the potential to occur during maintenance which can be an environmental and safety hazard.
- Breakers F and G have experienced 55 and 70 fault operations, exceeding the manufacturer's designed number of fault operations of 10.



AEP Transmission Zone M-3 Process
Indiana & Michigan

Need Number: AEP-2019-IM009

Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:
Equipment Condition/Performance/Risk

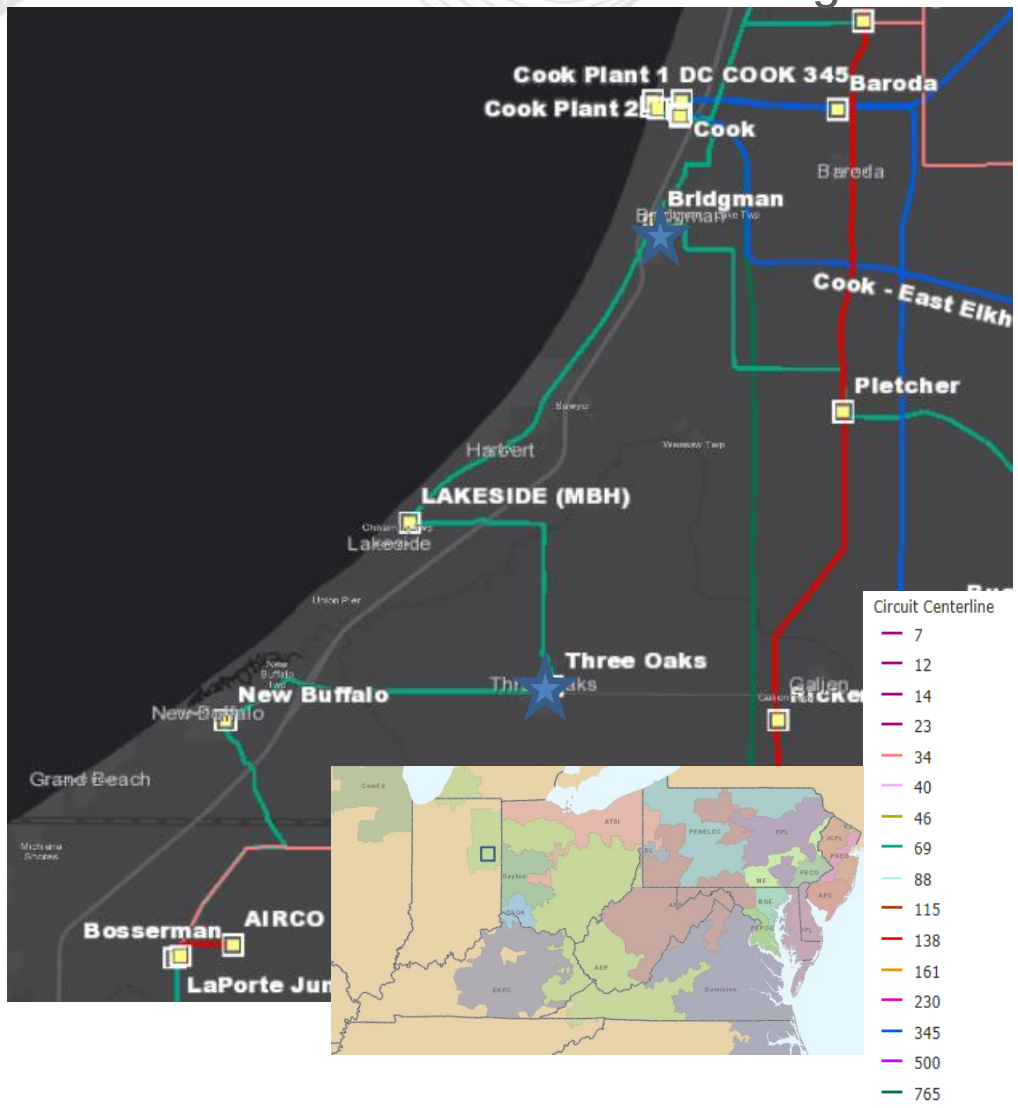
Specific Assumptions Reference:
AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:
Bridgman 69 kV Station
Breakers C, A, & B 69 kV

- 1968 vintage FK Oil breakers
- Fault Operations: C(204), A(48) & B(58) – Recommended(10)
- Oil filled breakers have much more maintenance required due to oil handling that their modern, vacuum counterparts do not require. Finding spare parts for these units is difficult or impossible, and these models are no longer vendor supported

Three Oaks 69 kV Station
Breakers C & B 69 kV

- 1968 vintage FK Oil breakers
- Fault Operations: C(73) & B(63) – Recommended(10)
- Oil filled breakers have much more maintenance required due to oil handling that their modern, vacuum counterparts do not require. Finding spare parts for these units is difficult or impossible, and these models are no longer vendor supported



AEP Transmission Zone M-3 Process
Indiana & Michigan

Need Number: AEP-2019-IM009

Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:
Equipment Condition/Performance/Risk

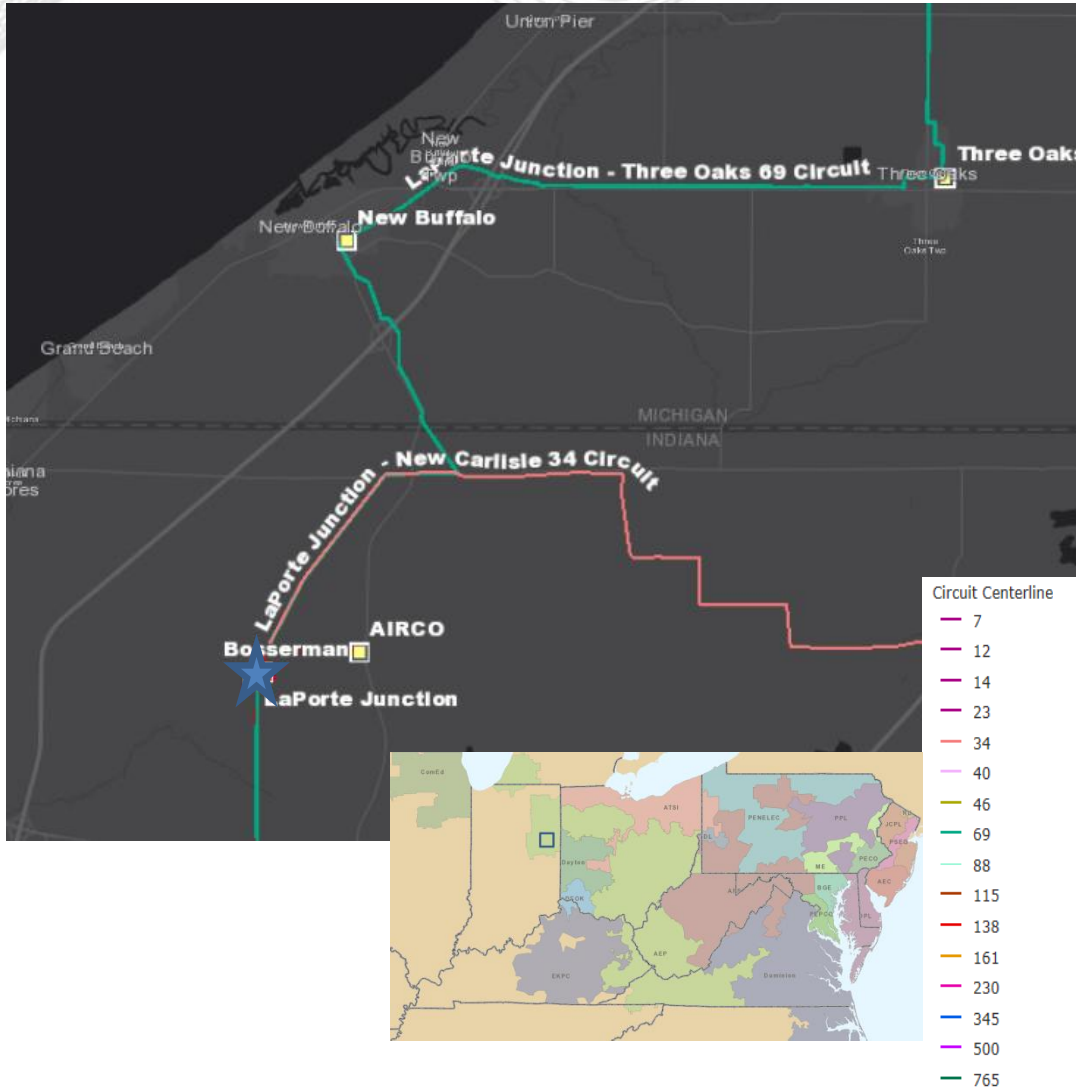
Specific Assumptions Reference:
AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:
<u>LaPorte 69 kV Station</u>
Breakers B 69 kV

- 1968 vintage FK Oil breakers
- Fault Operations: B(62) – Recommended(10)
- Oil filled breakers have much more maintenance required due to oil handling that their modern, vacuum counterparts do not require. Finding spare parts for these units is difficult or impossible, and these models are no longer vendor supported.

Transformer #1 138/69/34 kV

- 1967 vintage
- Its showing significant signs of deterioration and has high levels of Carbon Dioxide dissolved in the oil.
- Equipment condition concerns include dielectric strength breakdown (winding insulation), short circuit strength breakdown (due to the amount of through fault events), and accessory damage (bushings).



AEP Transmission Zone M-3 Process
Indiana & Michigan

Need Number: AEP-2019-IM009

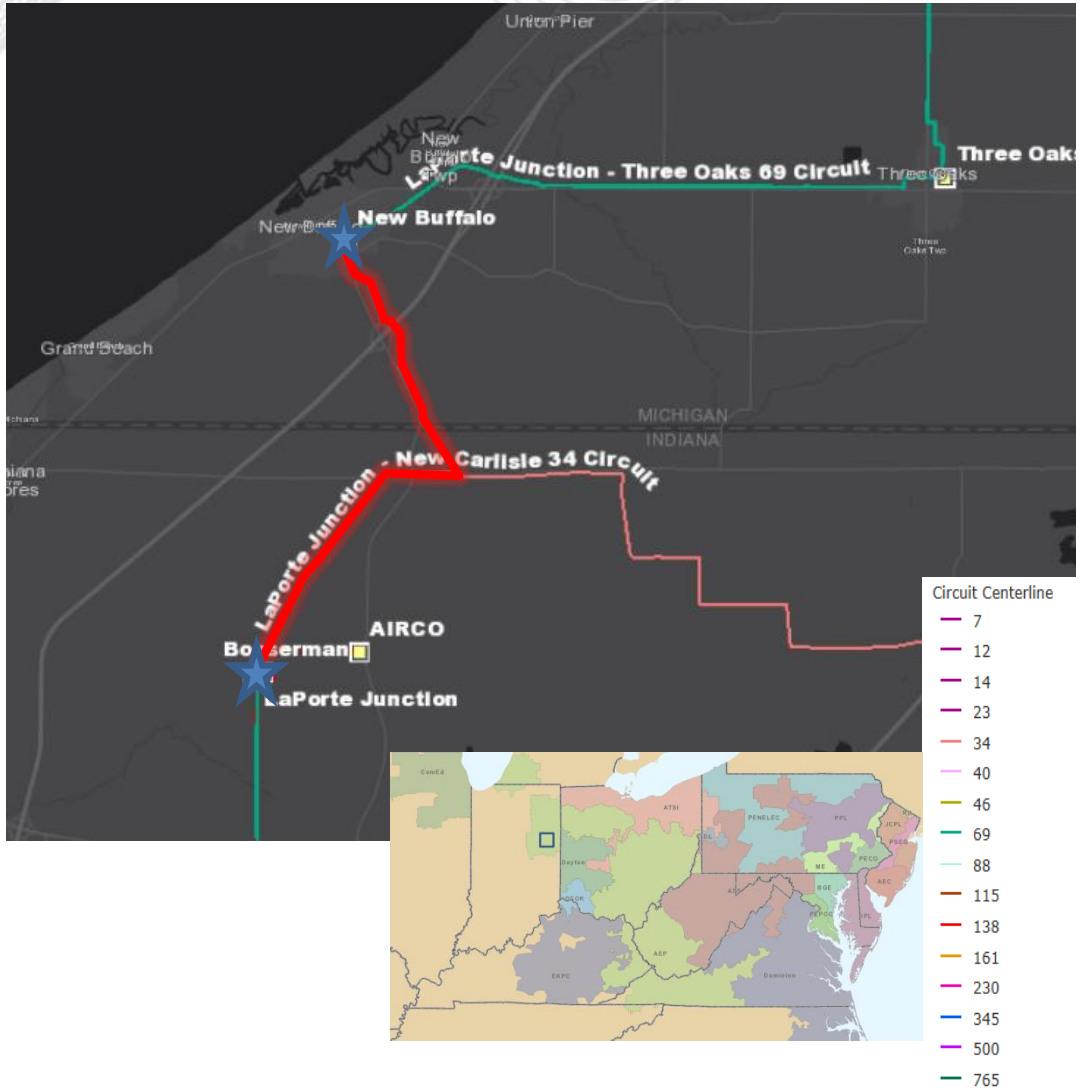
Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:
Equipment Condition/Performance/Risk

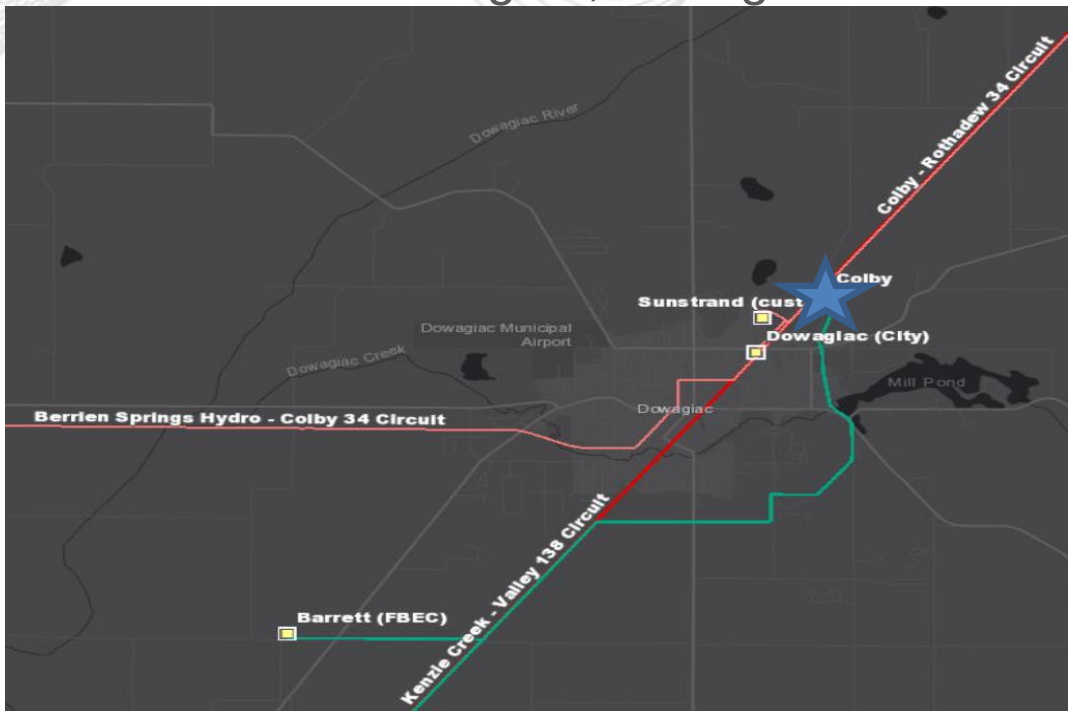
Specific Assumptions Reference:
AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:
Laporte Junction – New Buffalo (IN) 69 kV Line (~4 Miles)

- 1960's vintage wood crossarm construction
- Approximately 78% of the structures have Insect Damage
- There are currently 132 open conditions on this line with majority being structure issues. The O&M cost of the line is expected to increase as the age of the line increases.



AEP Transmission Zone M-3 Process
Dowagiac, Michigan Area



Need Number: AEP-2019-IM010

Process Stage: Needs Meeting 04/23/19

Supplemental Project Driver:
Equipment Condition/Performance & Operational Flexibility

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

Problem Statement:
Colby Station
Breakers A, B, C, D, and E

- 1963-1968 vintage oil breakers
- CB Fault operations: CB A(38), C(67), D(86), E(12) – Recommended(10)
- Breaker B control cabinet has documented corrosion concerns
- Since 2017 breaker D's operation counter hasn't functioned

Currently contains a 3-terminal line within the station.

AEP Transmission Zone M-3 Process
Marion, Indiana

Need Number: AEP-2019-IM011

Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:
Customer Request

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

Problem Statement:
West End 34.5 kV station

- AEP I&M Distribution is rebuilding and reconfiguring their West End Station to address aging equipment and capacity concerns.

AEP Transmission Zone M-3 Process
Ft. Wayne, Indiana

Need Number: AEP-2019-IM012

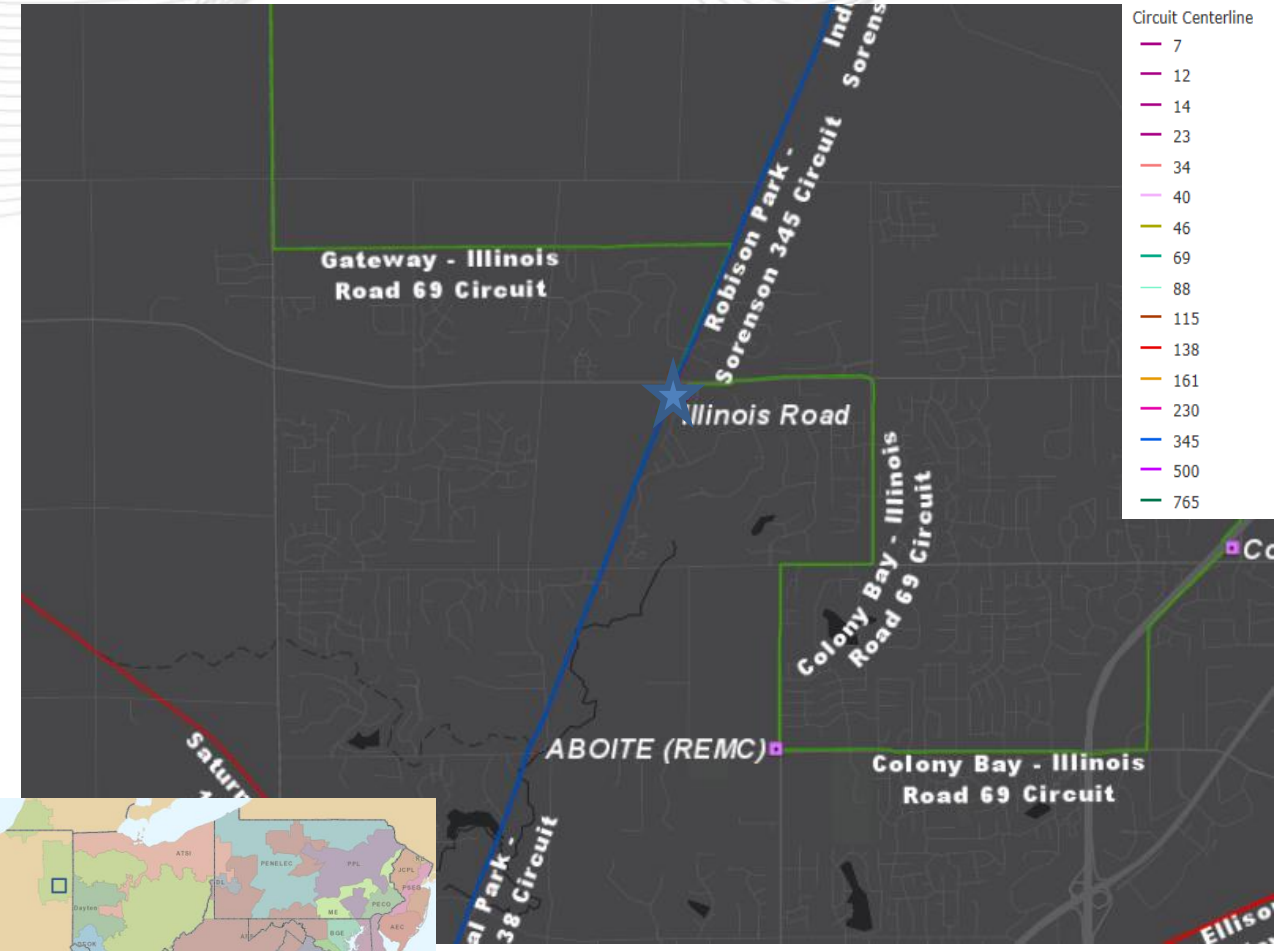
Process Stage: Needs Meeting 04/23/2019

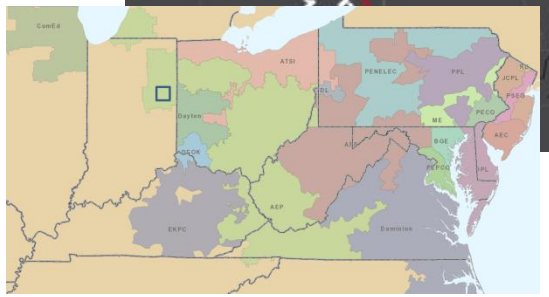
Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

Problem Statement:
<u>Illinois Road 138 kV station</u>
Breakers A & B 69 kV

- 1969 and 1970 vintage Oil breakers
- Fault Operations: A(23) & B(67) – Recommended(10)
- Oil filled breakers have much more maintenance required due to oil handling that their modern, vacuum counterparts do not require. Finding spare parts for these units is difficult or impossible, and these models are no longer vendor supported





AEP Transmission Zone M-3 Process
Ft. Wayne, Indiana

Need Number: AEP-2019-IM013

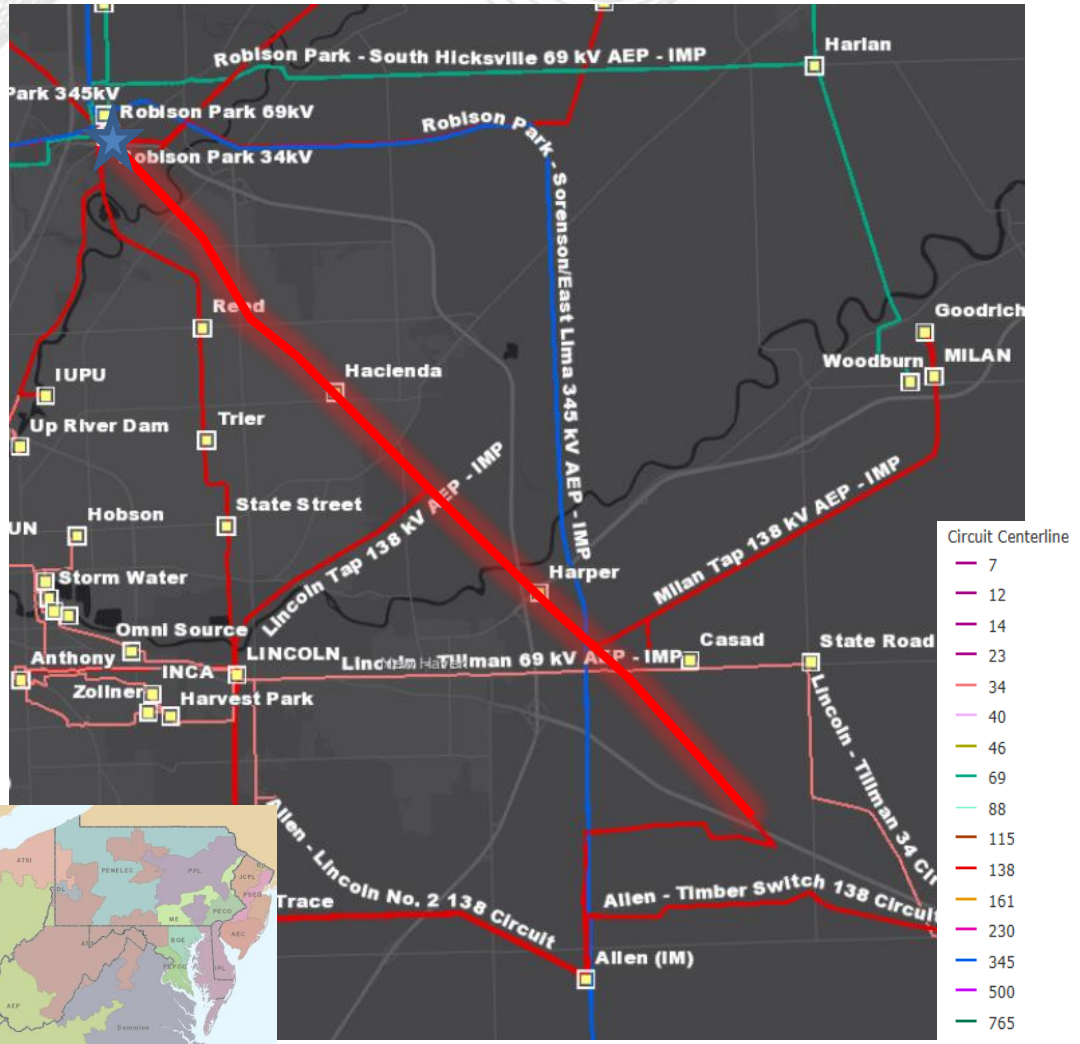
Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

Problem Statement:
Robison Park – Haviland 138 kV Line (~12 Miles)

- 1926 vintage steel lattice line construction
- There are currently 56 open conditions on this line with majority (84%) being structure issues. The O&M cost of the line is expected to increase as the age of the line increases.
- Forced Momentary Outages: 2
- Forced Permanent Outages: 1
- The current line shielding angle on the steel towers is inadequate for current AEP shielding angle requirements.



AEP Transmission Zone M-3 Process
Ft. Wayne, Indiana

Need Number: AEP-2019-IM014

Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

Problem Statement:

Robison Park – South Hicksville 69 kV Line (~27 Miles)

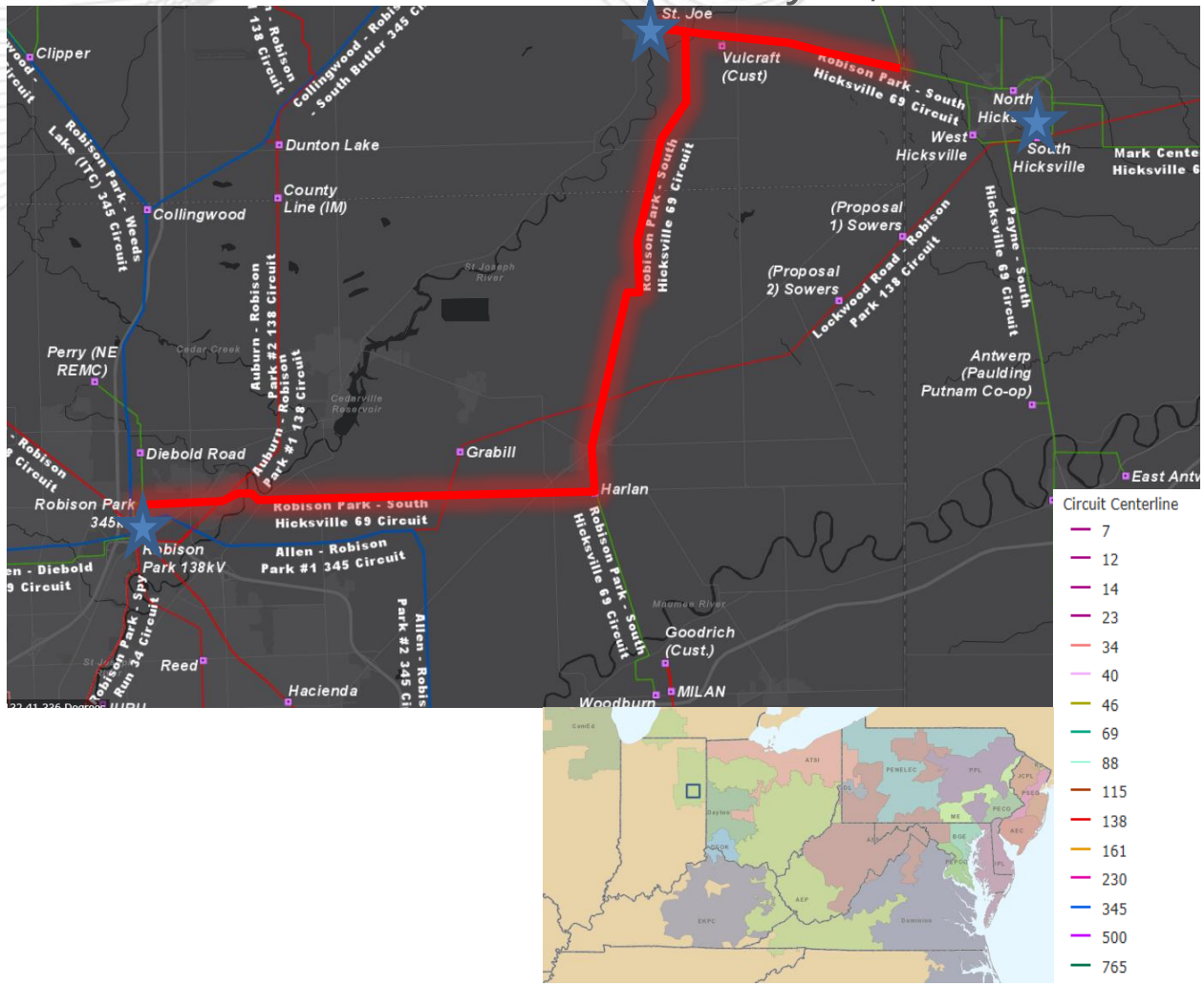
- 1967 vintage wood cross arm construction.
- There are currently 56 open conditions on this line with majority (94%) being structure issues. The O&M cost of the line is expected to increase as the age of the line increases.
- 4/0 ASCR conductor with horizontal post type porcelain insulators.
- CMI: 526,269
- Forced Momentary Outages: 6
- Forced Permanent Outages: 5

St Joe Tap 69 kV Line (~0.6 Miles)

- 1967 vintage wood cross arm construction
- There are currently 3 open conditions on this line. The O&M cost of the line is expected to increase as the age of the line increases.
- St. Joe is radially served out of Robison Park – South Hicksville 69 kV Line and it is susceptible to single event outages.
- It occasional encounter floodwaters of Bear Creek that leave some of the existing poles inaccessible.

St. Joe Tap Switch

- The Switch has accessibility challenges due to St. Joseph River floodwaters.



AEP Transmission Zone M-3 Process
Ft. Wayne, Indiana

Need Number: AEP-2019-IM015

Process Stage: Needs Meeting 04/23/2019

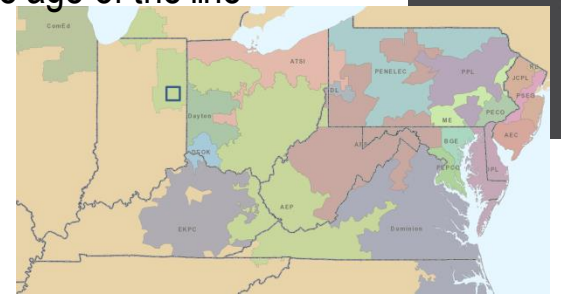
Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

Problem Statement:
The loads at Bixler and North Kendallville are 20.58 MW and 17.13 MW respectively. Bixler is radially served from a 2.89 mile long 138 kV line. North Kendallville is radially served from a 1.79 mile long 69 kV line.

<u>Kendallville – North Kendallville 69 kV Line (~1.7 Miles)</u>

- 1960's vintage wood pole construction
- There are currently 5 open conditions on this line with majority being structure issues. The O&M cost of the line is expected to increase as the age of the line increases.
- CMI: 1,541,297
- Forced Momentary Outages: 1
- Forced Permanent Outages: 9



AEP Transmission Zone M-3 Process
Ft. Wayne, Indiana

Need Number: AEP-2019-IM016

Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:

Equipment Condition/Performance/Risk

Specific Assumptions Reference:

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

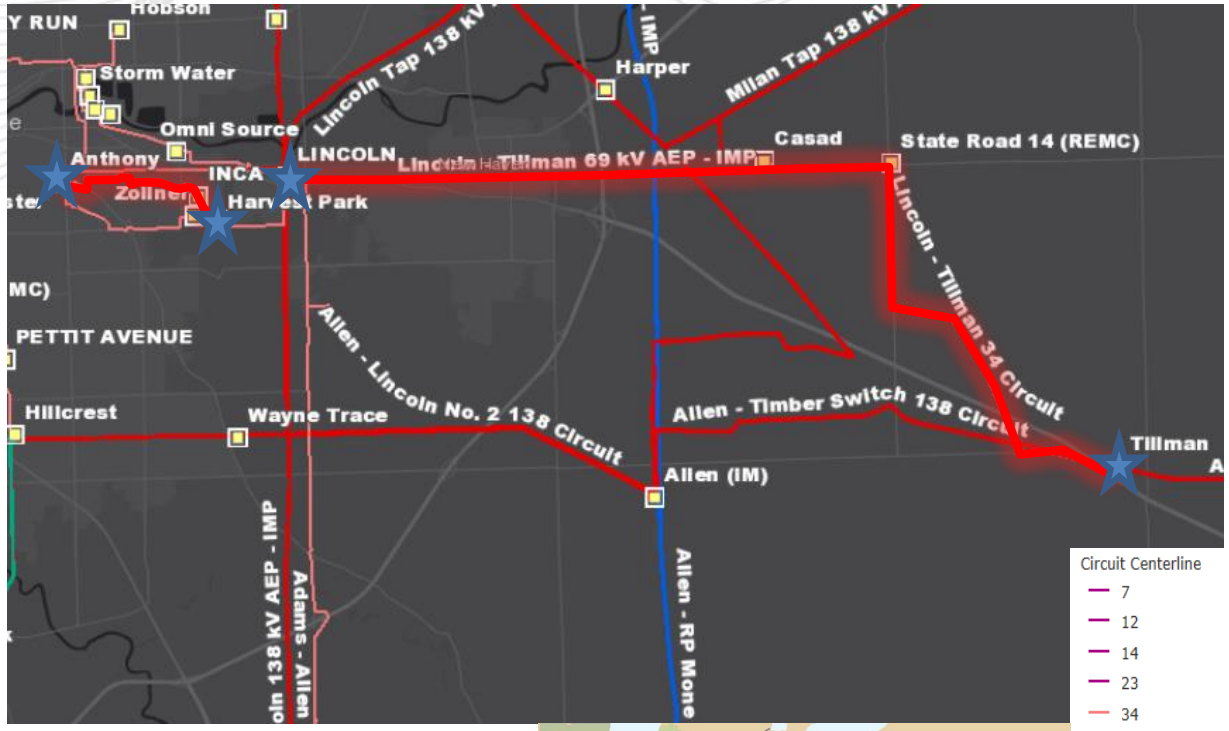
Problem Statement:

Anthony – Harvest Park No.2 34 kV Line (~2.5 Miles)

- 1930's vintage wood crossarm construction
- There are currently 14 open conditions on this line with majority being structure issues. The O&M cost of the line is expected to increase as the age of the line increases.

Lincoln – Tillman 69 kV Line (~13 Miles)

- 1968 vintage wood crossarm construction
- There are currently 24 open conditions on this line with majority being structure issues. The O&M cost of the line is expected to increase as the age of the line increases.



AEP Transmission Zone M-3 Process
Ft. Wayne, Indiana

Need Number: AEP-2019-IM016

Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

Problem Statement:

Anthony 34 kV station

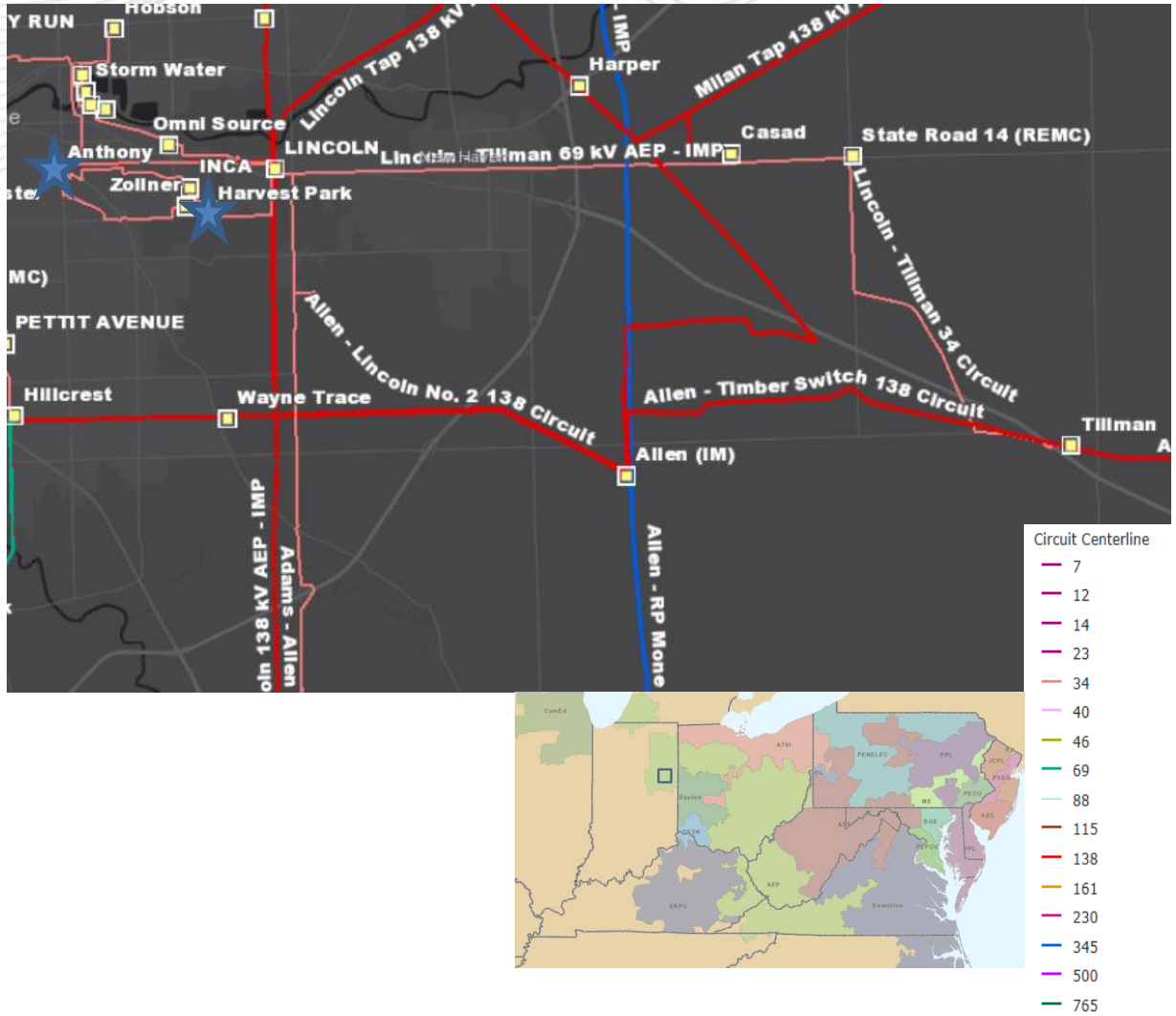
Breakers H, Q, D, C & A 34 kV

- 1970 vintage FK Oil breakers
- Fault Operations: H(21), A(12) – Recommended(10)
- Oil filled breakers have much more maintenance required due to oil handling that their modern, vacuum counterparts do not require. Finding spare parts for these units is difficult or impossible, and these models are no longer vendor supported

Harvest Park 34 kV station

Breakers S, N, A & B 34 kV

- 1962 vintage FK Oil breakers S, N & B
- 1956 vintage FK Oil breakers B
- Fault Operations: A(49) – Recommended(10)
- Oil filled breakers have much more maintenance required due to oil handling that their modern, vacuum counterparts do not require. Finding spare parts for these units is difficult or impossible, and these models are no longer vendor supported



AEP Transmission Zone M-3 Process
Ft. Wayne, Indiana

Need Number: AEP-2019-IM017

Process Stage: Needs Meeting 04/23/2019

Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

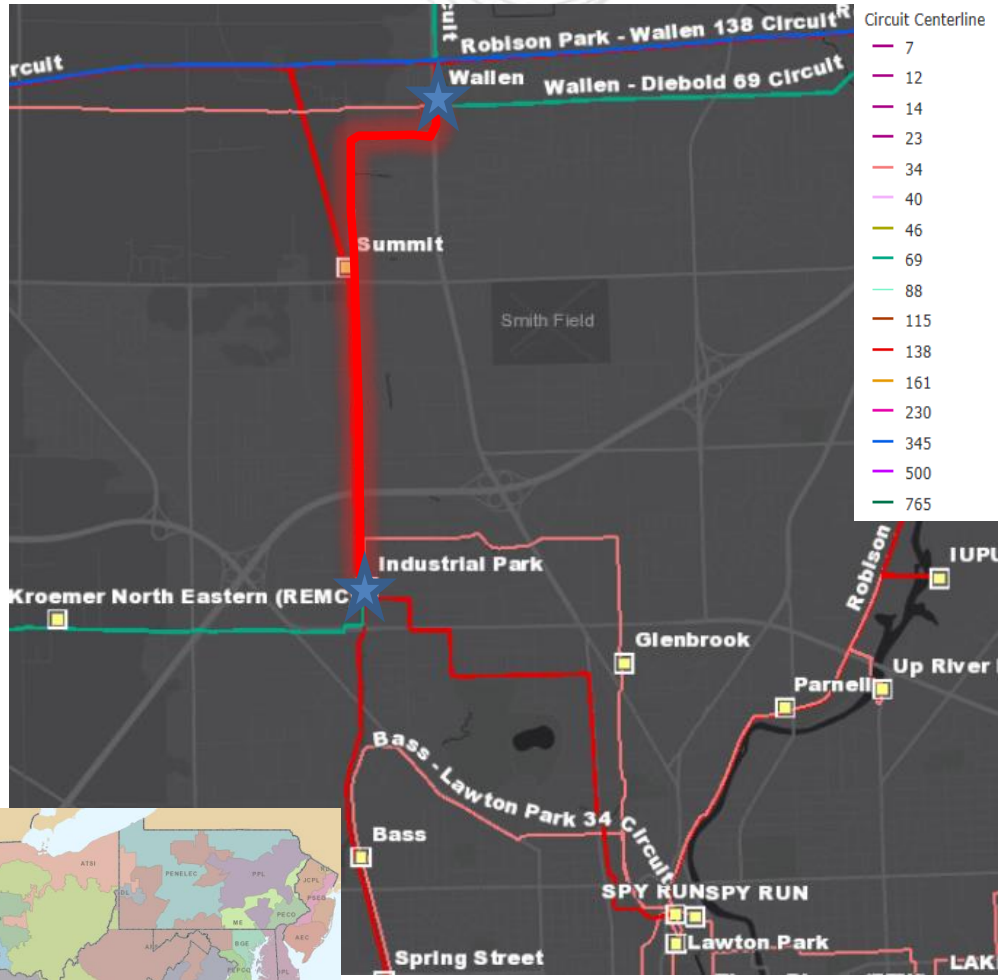
Problem Statement:

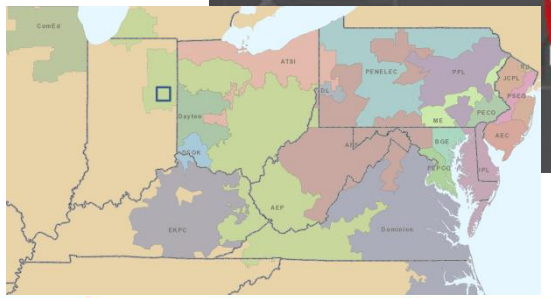
Industrial Park – Wallen 34 kV (~3.3 Miles)

- 1925 vintage steel lattice construction
- There are currently 5 open conditions on this line with majority being structure issues. The O&M cost of the line is expected to increase as the age of the line increases.
- Six wired Copper conductor with copper weld shield wire. Copper conductors become brittle with age and Copper weld conductor has long been obsolete

Industrial Park 138 kV

- Breakers F, D & E 34 kV
  - 1967 vintage Oil breakers
  - Fault Operations: F(18), D(0) & E(14) – Recommended(10)
- Breakers G 69 kV
  - 1967 vintage Oil breakers
  - Fault Operations: G(50) – Recommended(10)
- Oil filled breakers have much more maintenance required due to oil handling that their modern, vacuum counterparts do not require. Finding spare parts for these units is difficult or impossible, and these models are no longer vendor supported.
- Multiple wood pole 138 kV transformer lead support structures inside Industrial Park Station.





AEP Transmission Zone M-3 Process
Franklin County Ohio

Need Number: AEP-2019-OH013

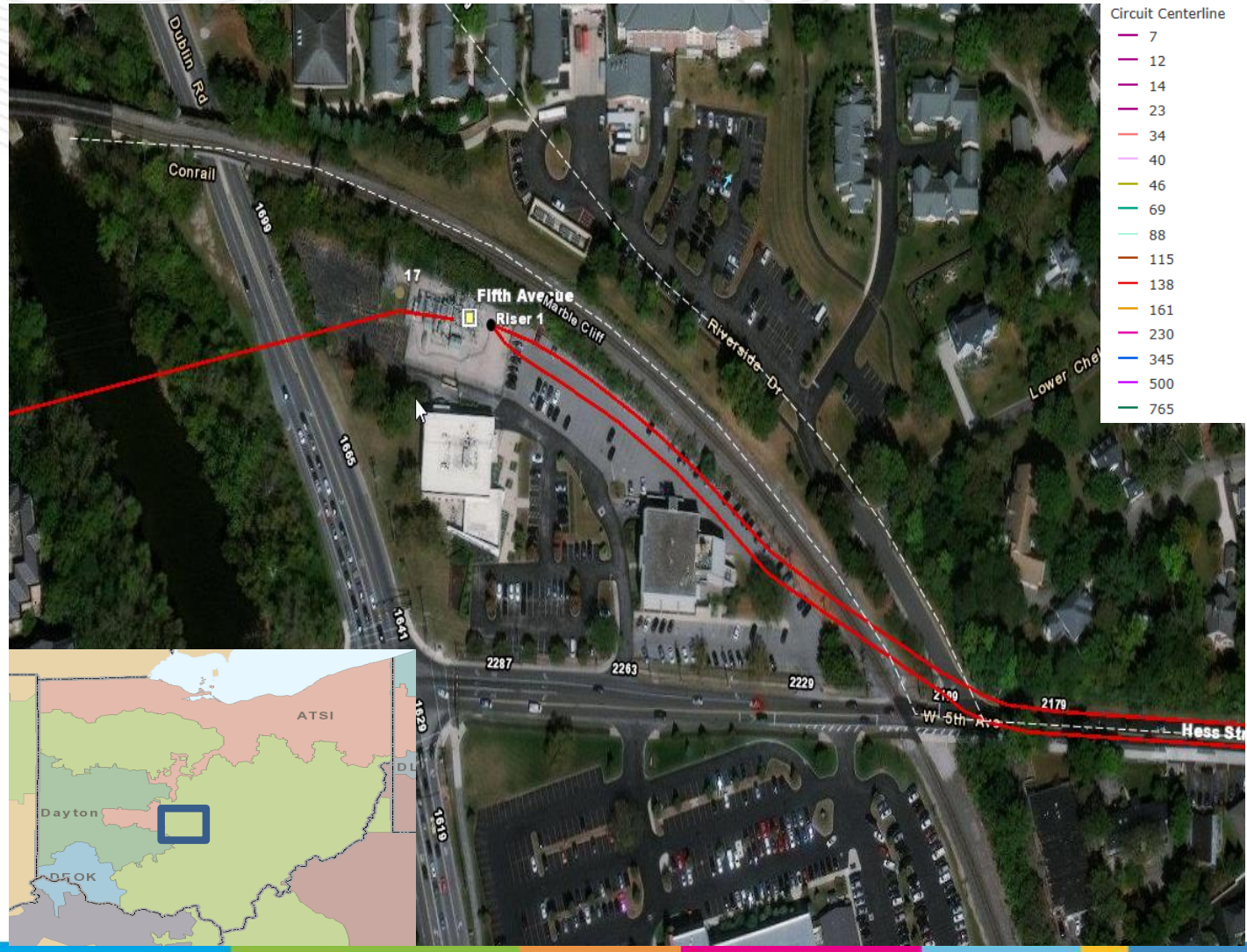
Process Stage: Need Meeting 4/23/2019

Supplemental Project Driver:
Customer Service, Operational Flexibility

Specific Assumptions Reference:
AEP Guidelines for Owner Identified Needs (AEP Assumptions slide 7, 8)

Problem Statement:

- AEP Ohio is requesting a new delivery point next to the existing Fifth Ave Station, which is being retired. This new delivery point will be able to accommodate existing and future expansion.
- The existing Fifth Avenue Station is being removed due to asset renewal conditions and the fact that it cannot be expanded due to being land locked on all sides.
- This station has limited transferability, serves approximately 7,000 customers via a single transformer (22 MVA of load on the tertiary winding), and is located in an urban environment.
- 13/16 relays at Fifth Ave are Electro Mechanical type. These relays have limited spare part availability, lack vendor support, have no SCADA ability, and lack fault data collection.
- The RTU at this Station has a high failure rate, lacks spare parts, and no longer provides load data.
- AEP Ohio has identified several of the feeders served out of this Station that are expected to exceed their capacity with the load growth in the area.



AEP Transmission Zone M-3 Process
Adams County, Ohio

Need Number: AEP-2019-OH014

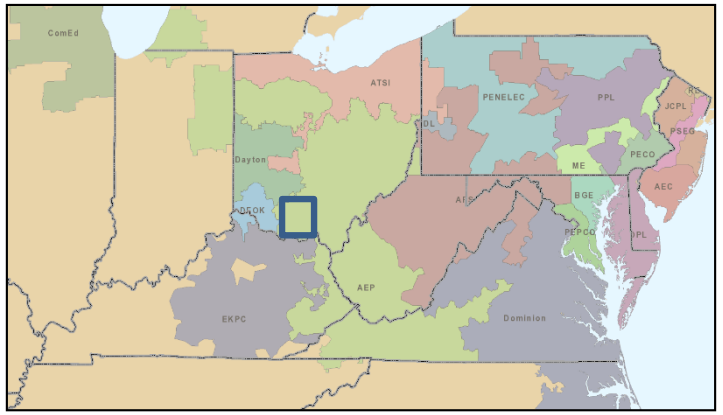
Process Stage: Needs Meeting 04/23/2019

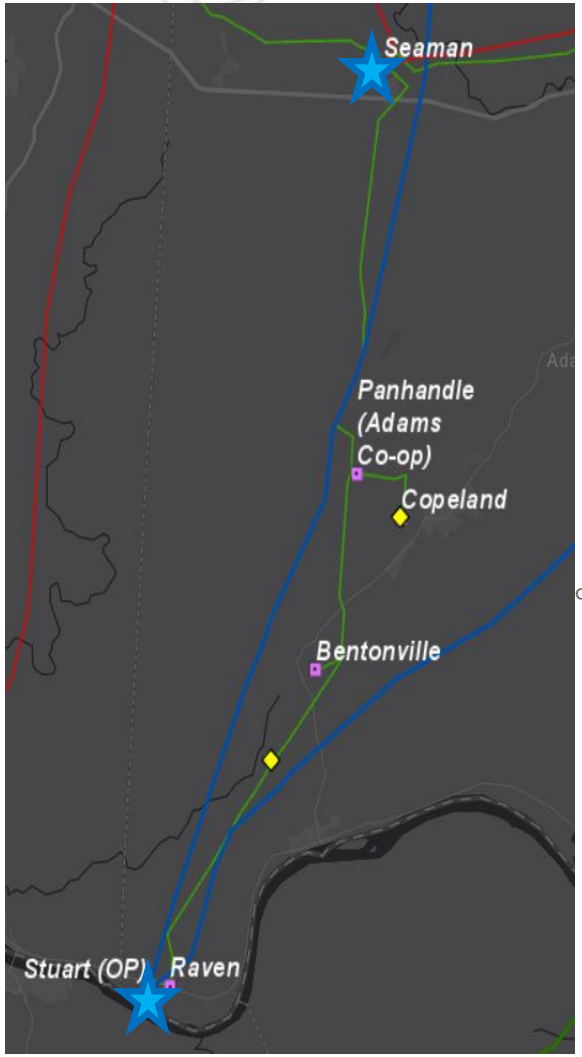
Supplemental Project Driver:
Equipment Material/Condition/ Performance/Risk

Specific Assumptions Reference:
AEP Guidelines for Transmission Owner Identified Needs

Problem Statement:

- The existing 28.5 mile, 69 kV line section between Stuart (DP&L/Duke) and Seaman(AEP) was constructed in 1974 using wood pole structures with 636 ACSR conductor. There are 260 open A conditions distributed across the 170 structures on this line.
- The Stuart-Seaman 69 kV circuit has experienced over 2.2 million customer minutes of interruption in the past three years: 753,716 for AEP and 1,517,618 for Adams Coop.





AEP Transmission Zone M-3 Process
Bucyrus, Ohio

Need Number: AEP-2019-OH016

Process Stage: Need Meeting 04/23/19

Supplemental Project Driver:

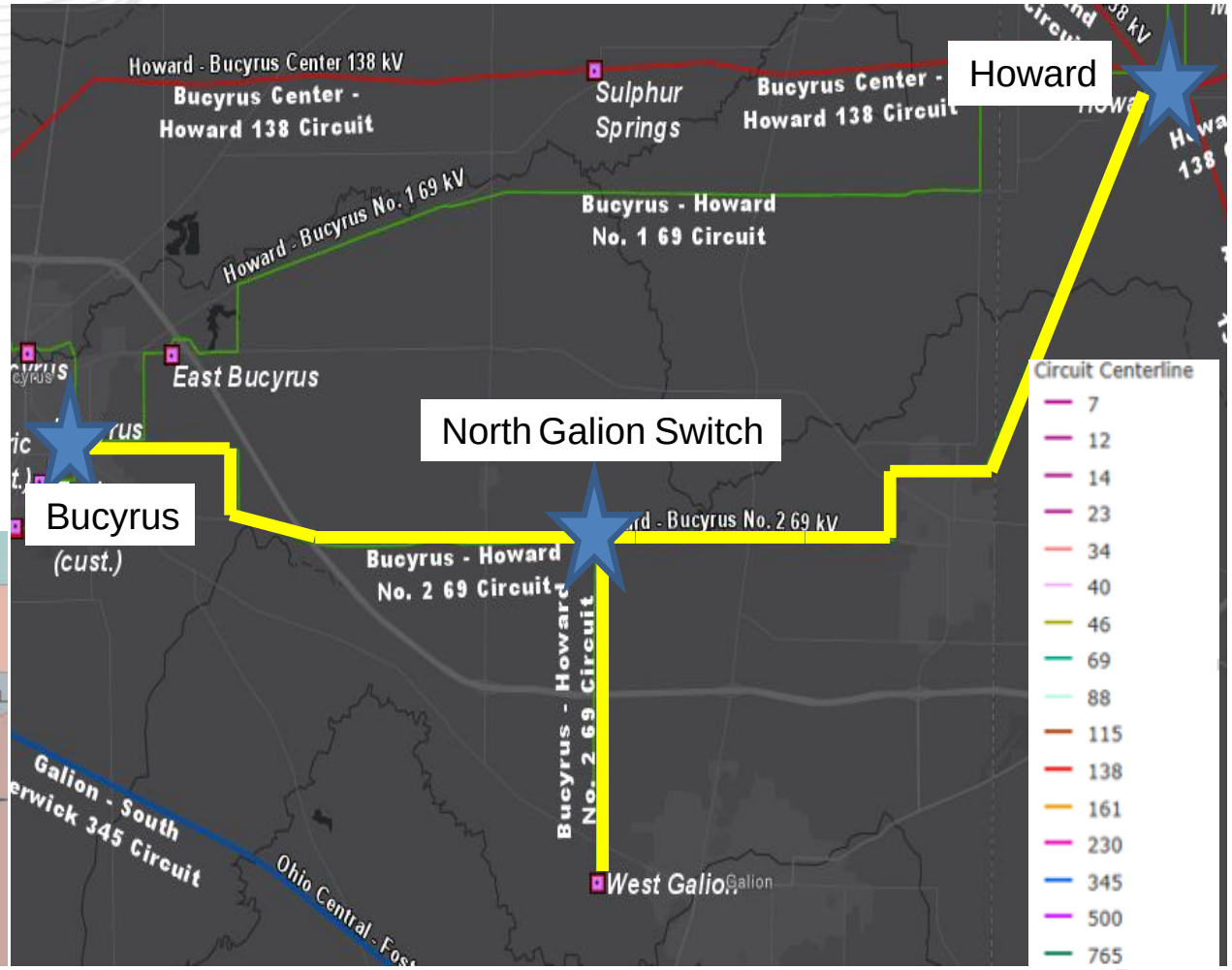
Equipment Material/Condition/Performance/Risk

Specific Assumptions Reference:

AEP Guidelines for Transmission Owner Identified Needs

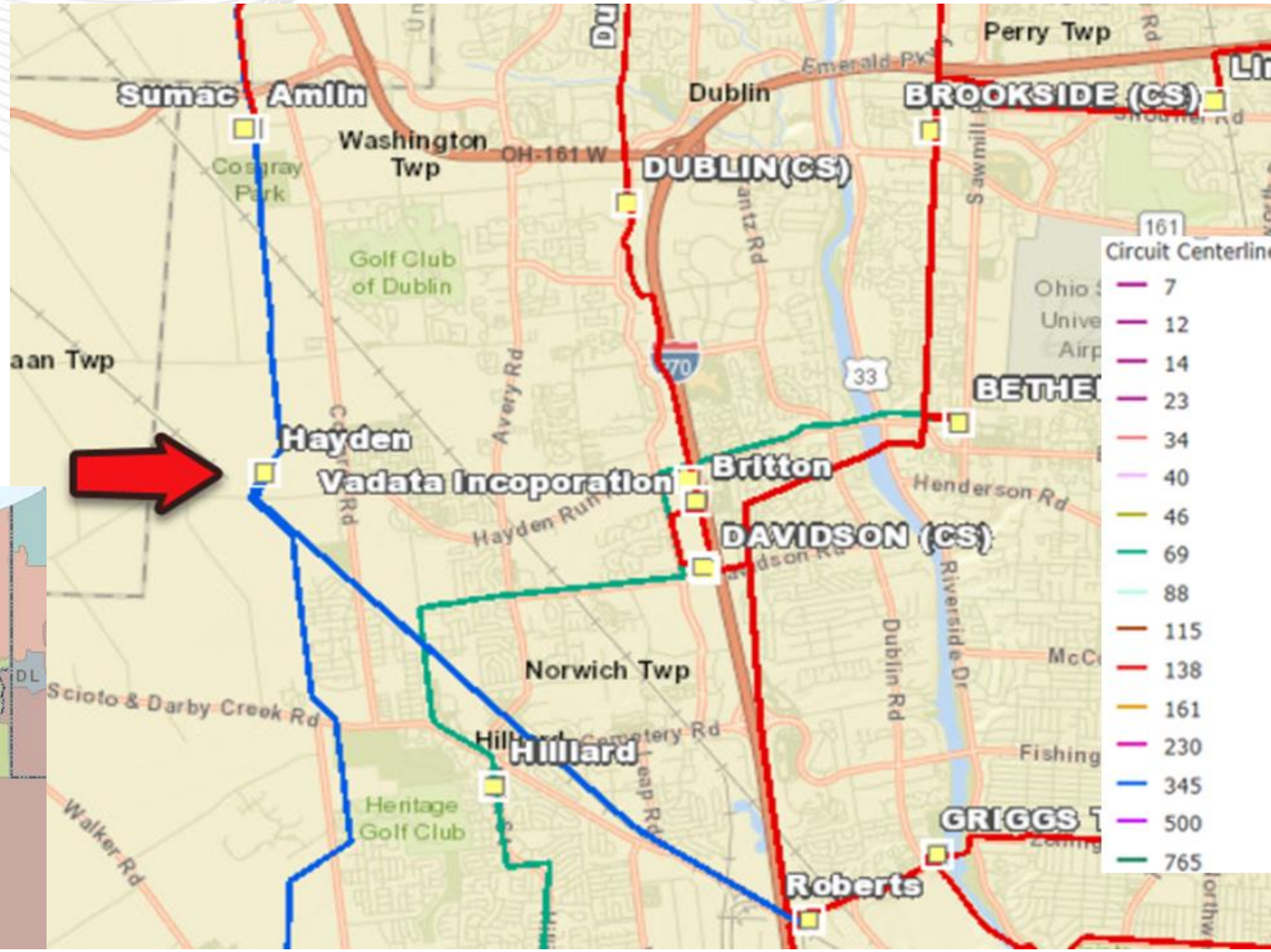
Problem Statement:

- The Bucyrus-Howard No.2 69 kV circuit was originally constructed in 1919 with wood structures and copper conductor (#1 CU and 3/0 CU). 84% of the line still utilizes the original 1919 copper conductor.
- Some structures have been replaced over the years; however, they have been like for like wood pole replacements.
- The circuit has had 38 forced operations in the last 11 years of which 7 have been permanent and resulted in 54 hours of down time. 2 out of the 7 outages have been caused by conductor failures, the most recent of which resulted in 188,000 CMI.
- There are currently 144 open conditions along the 23 mile long line.

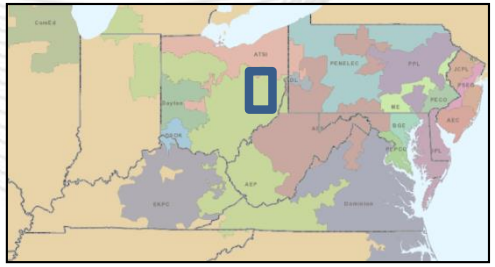


Need Number: AEP-2019-OH017
Process Stage: Needs Meeting 04/23/19
Supplemental Project Driver:
Customer Service
Specific Assumptions Reference:
AEP Guidelines for Transmission Owner Identified Needs
Problem Statement:

- AEP-Ohio is requesting a new 138 kV delivery point at Hayden Station by 6/1/2020.
- There are several highly loaded distribution circuits at Dublin, Davidson, & Hilliard Stations that require a new delivery point.



AEP Transmission Zone M-3 Process
Muskingum to Tuscarawas ~~Stark~~ Counties, Ohio



Need Number: AEP-2019-OH018 (revised)

Process Stage: Need Meeting 4/23/2019

Supplemental Project Driver:

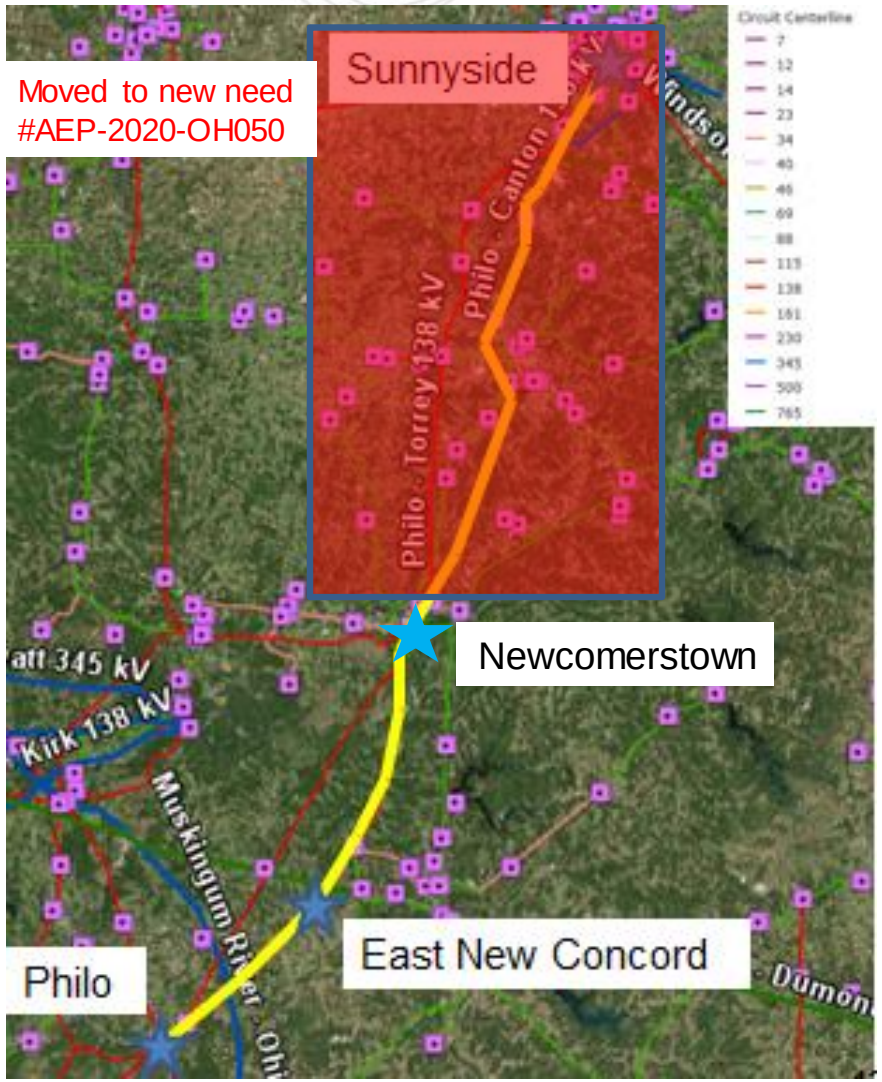
Equipment Material/ Condition/Performance/Risk and Operational Flexibility

Specific Assumption References:

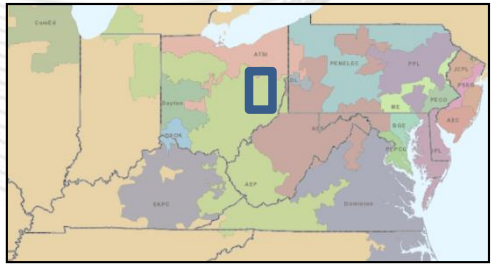
AEP Guidelines for Transmission Owner Identified Needs

Problem Statement:

- The Philo-Newcomerstown ~~Sunnyside~~ 138kV transmission line section is 33 ~~75~~ miles long, originally constructed in 1923. The vast majority of the structures are still original, as well as the six-wired 336 ACSR conductor, insulators, and hardware. This line is made up of several circuits connected between Muskingum River and Newcomerstown ~~Sunnyside~~ stations.
- Insulator assemblies are showing corrosion and deterioration, which could lead to additional failures and safety concerns.
- There have been 1.4 ~~2.1~~ million customer-minutes-of-interruption (CMI) over the 2008-2018 time period.
- This line has experienced 8 ~~44~~ momentary outages and 3 ~~8~~ sustained outages over the past 10 years.
- The East New Concord Station is connected via a hard tap (no sectionalizing switches present). Lack of sectionalizing requires a substation outage whenever maintenance or emergency repairs are performed on either side of the 138kV tap.



AEP Transmission Zone M-3 Process
Muskingum to Tuscarawas ~~Stark~~ Counties, Ohio



Need Number: AEP-2019-OH018 (revised)

Process Stage: Need Meeting 4/23/2019

Supplemental Project Driver:

Equipment Material/ Condition/Performance/Risk and Operational Flexibility

Specific Assumption References:

AEP Guidelines for Transmission Owner Identified Needs

Problem Statement:

- The Philo-Newcomerstown ~~Sunnyside~~ 138kV transmission line section is 33 ~~75~~ miles long, originally constructed in 1923. The vast majority of the structures are still original, as well as the six-wired 336 ACSR conductor, insulators, and hardware. This line is made up of several circuits connected between Muskingum River and Newcomerstown ~~Sunnyside~~ stations.
- Insulator assemblies are showing corrosion and deterioration, which could lead to additional failures and safety concerns.
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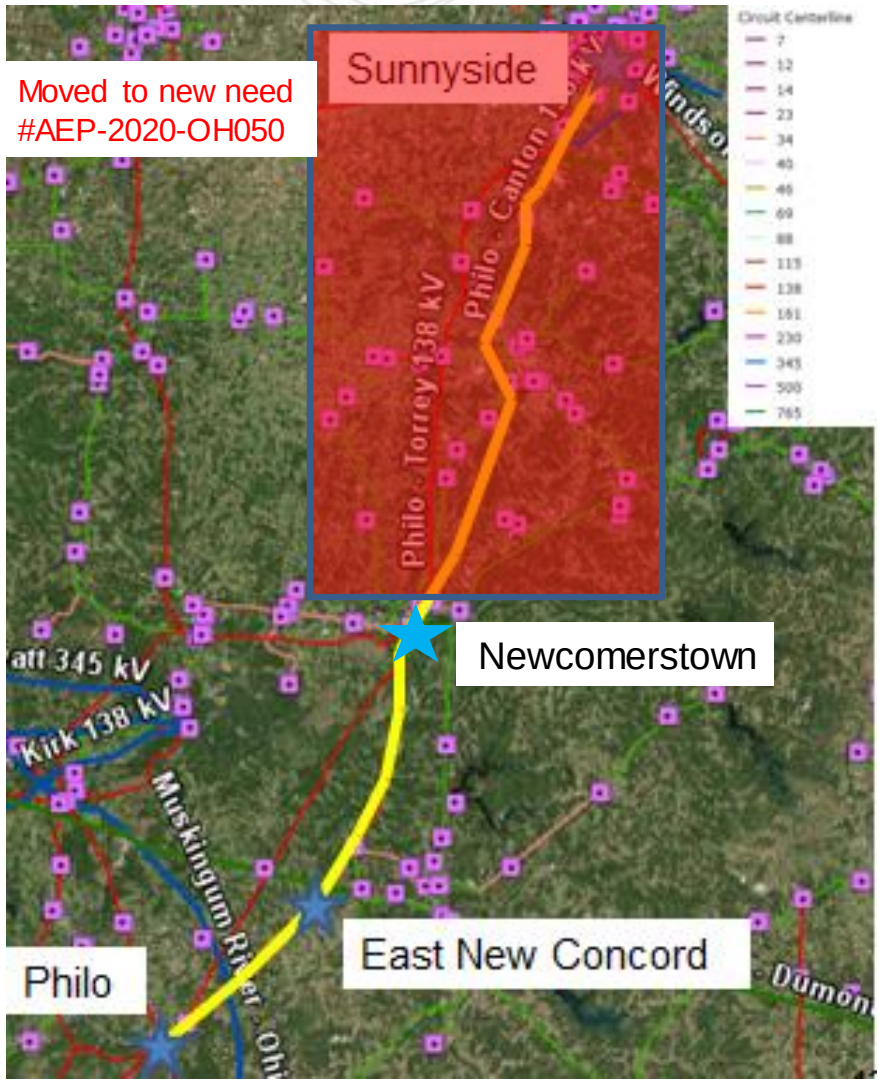
- The East New Concord Station is connected via a hard tap (no sectionalizing switches present). Lack of sectionalizing requires a substation outage whenever maintenance or emergency repairs are performed on either side of the 138kV tap.



AEP Transmission Zone M-3 Process
Belmont / Harrison County, Ohio

Need Number: AEP-2019-OH019

Process Stage: Needs Meeting 04/23/2019

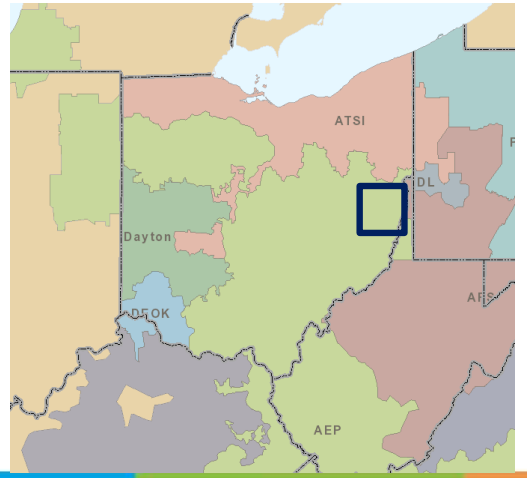
Supplemental Project Driver:

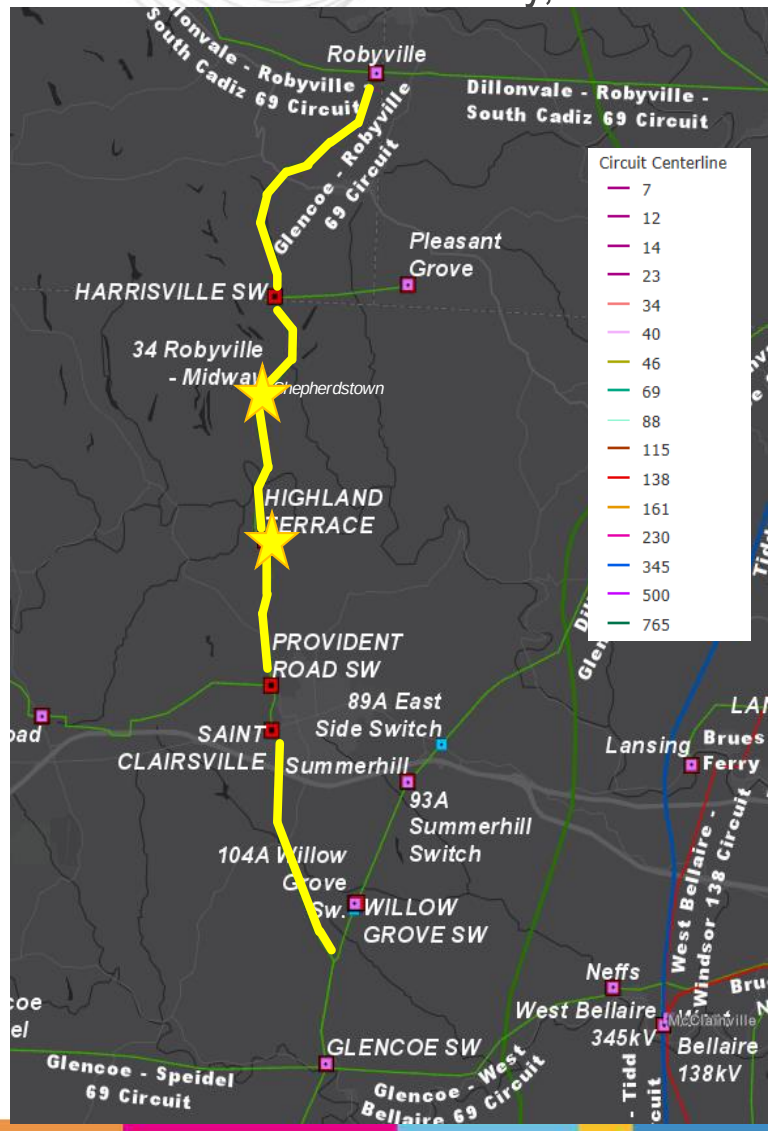
Equipment Material/Condition/Performance/Risk

Specific Assumption References:
AEP Guidelines for Transmission Owner Identified Needs

Problem Statement:

- The Glencoe – Robyville 69 kV circuit is 13.3 miles long and originally constructed in 1915-1925 using wood pole structures. This circuit currently has 556 ACSR 18/1 (Osprey) conductor rated for 126 MVA WE.
- The Glencoe – Robyville 69 kV circuit has 136 open A conditions which includes broken shield/ground wires, heavy structure rot, woodpecker damage, broken insulators, and split cross arms/knee braces.
- This circuit has experienced 789,612 CMI between 2013 – 2018.
- The existing switch at Highland Terrace two-way GOAB that restricts our ability to perform routine maintenance and restoration activities in this remote area of our system.
- The Shepherdstown delivery point is connected via a hard tap which limits operational flexibility, can cause over tripping and relay mis-operations, and restricts restoration activities.





Need Number: AEP-2019-OH020

Process Stage: Need Meeting 04/23/2019

Supplemental Project Driver:

Equipment Condition/Performance, Operational Flexibility and Efficiency, & Customer Service

Specific Assumption References:

AEP Guidelines for Transmission Owner Identified Needs

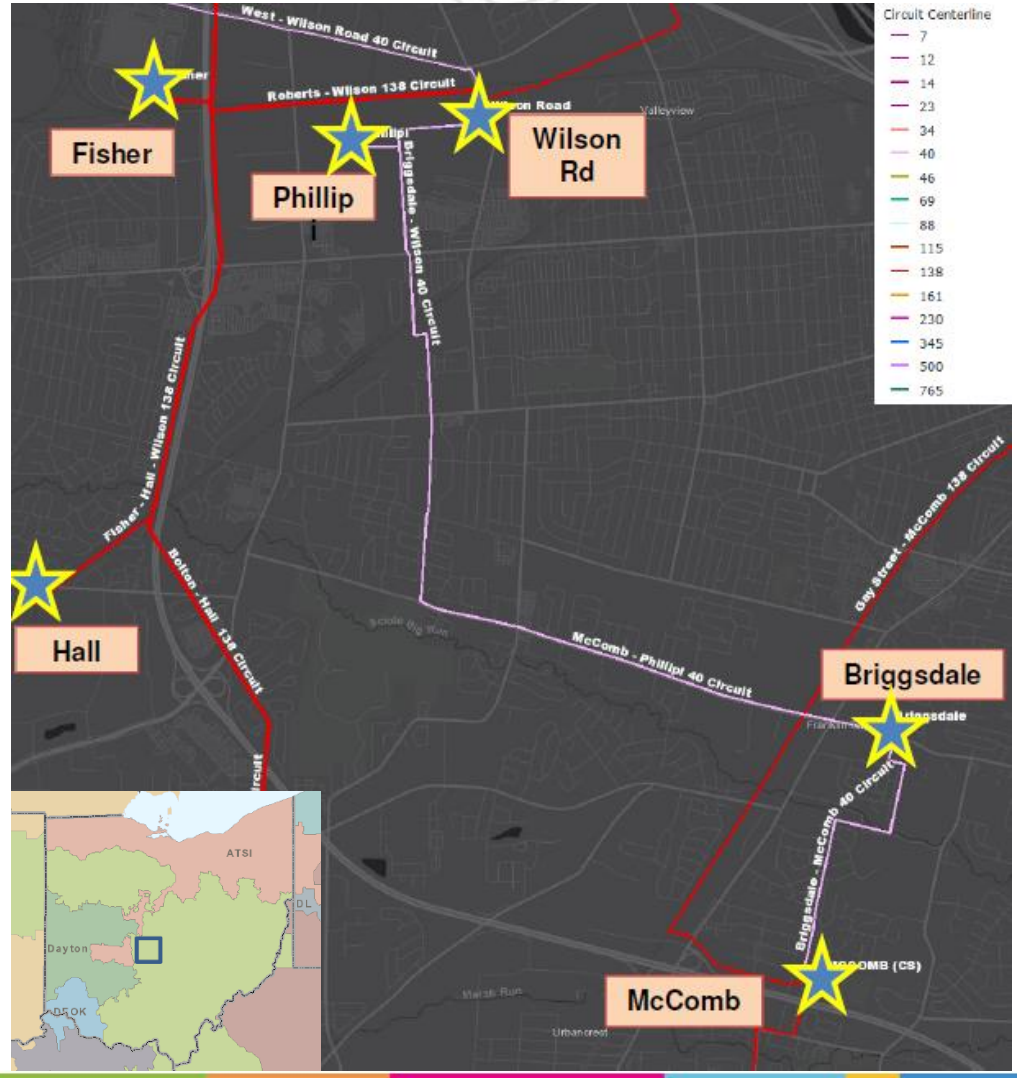
Problem Statement:

Equipment Material/Condition/Performance/Risk:

- The 40 kV system is an obsolete voltage class and as a result is difficult to obtain replacement parts.

Wilson Road Station

- 1 – 40 kV: CB-34 has 55 Fault Operations
- 1 – 40 kV: CS-AA is an SF6 2030-69 model circuit switcher, which has been identified as needing replacement due lack of to spare part availability, historical reliability, and lack of vendor support.
- 3 – 40 kV: (CBs 30,35, & 36) & 8 - 138 kV: (CBs 2-9) are oil type breakers.
  - 7-138 kV: (CBs 2-7) 1974 vintage FK oil breakers.
  - 2-138 kV: (CBs 8 & 9) 1967 & 1968 vintage GM oil breakers.
  - 138 kV CB-4 has 17 Fault Operations.
  - 195 – Electromechanical relays: EM relays have limited spare part availability, a lack vendor support, no SCADA functionality, and no fault data collection ability.



Problem Statement Continued:

Wilson Continued:

- 13 – Microprocessor relays: The identified relays are obsolete, no longer supported, or have been identified as high risk of failures.
- 4 – Static relay: this type of relay has significant limitations with regard to fault data collection and retention.

McComb Station

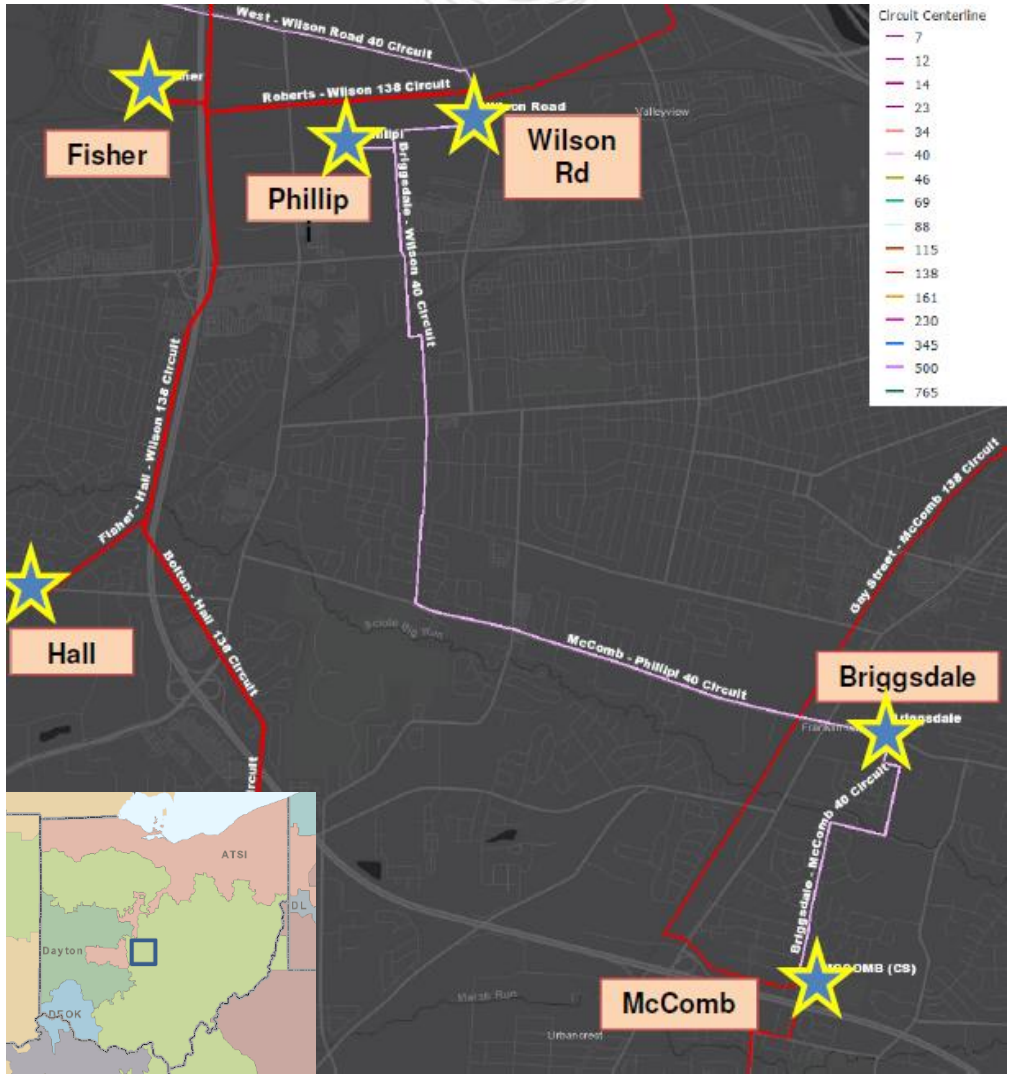
- 5 – 46 kV: (CBs 41-45) oil type breakers
  - Fault Operations: (CB-42 = 15 & CB-43 = 26)
- 1 – 138 kV CS-CC (Mark V): This model of switcher has been identified for replacement due to lack of spare part availability, historical reliability, and lack of vendor support. It also has 16 fault operations.
- 117 – Electromechanical relays: EM relays have limited spare part availability, a lack vendor support, no SCADA functionality, and no fault data collection ability.
- McComb Station utilizes either ground switch/MOAB's or MOAB's for high side transformer protection.

Operational Flexibility and Efficiency:

- There is currently a 3-terminal 138 kV hard tap between Wilson, Fisher Rd, and Hall Stations. 3-terminal lines are problematic because they limit sectionalizing and can cause mis-operations and over tripping. A single breaker failure will result in the loss of 5 transformers.

Customer Service:

- AEP-Ohio plans to replace the Briggsdale 40 kV Station with a new Reaver 138 kV Station (s1606), which eaves Phillipi (customer owned station) on the local 40 kV system.



Need Number: AEP-2019-OH021

Process Stage: Need Meeting 04/23/2019

Supplemental Project Driver:

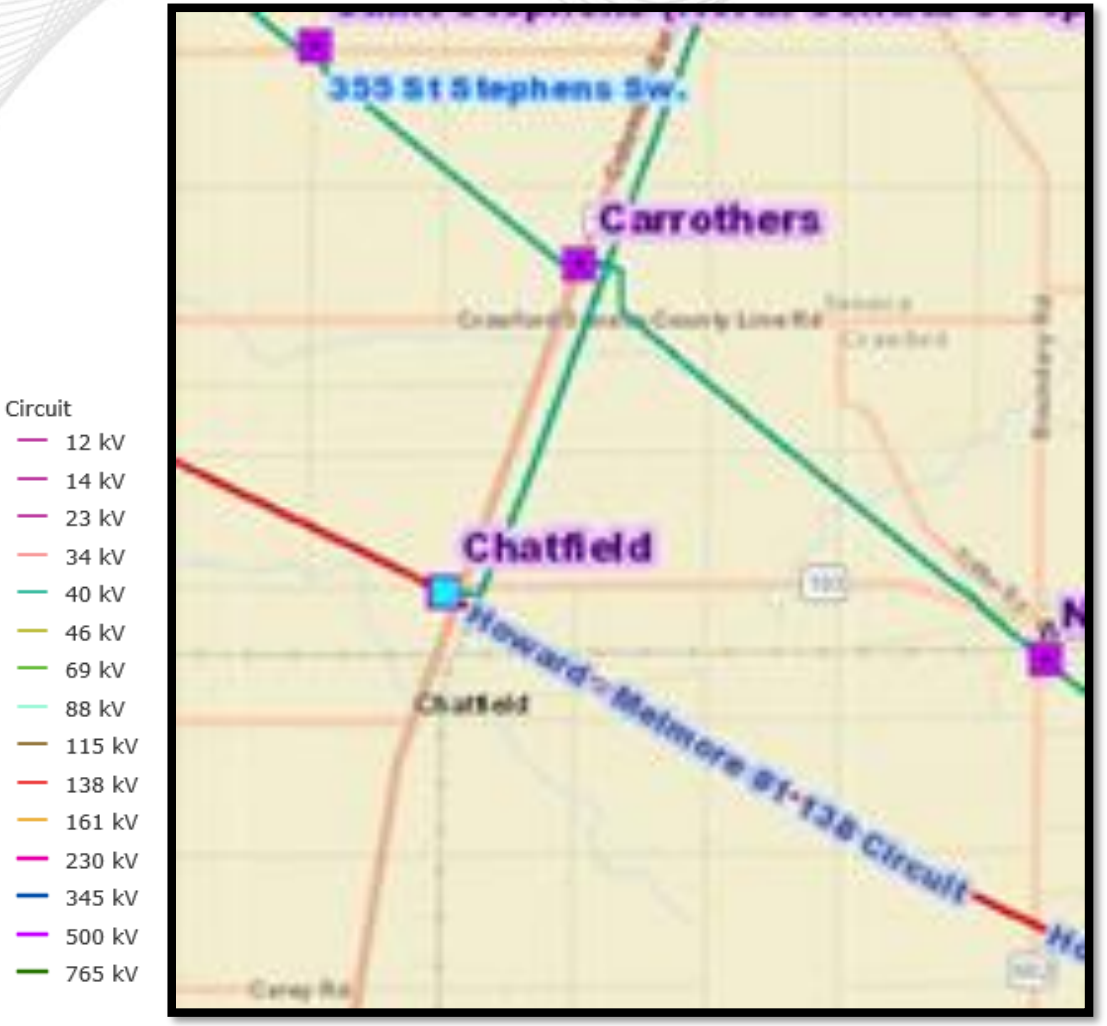
Operational Flexibility and Efficiency

Specific Assumption References:

AEP Guidelines for Owner Identified Needs (AEP Assumptions slide 8)

Problem Statement:

- The Carrothers 69 kV Station has three dissimilar zones of protection (Bus, Transformer, and Line). Dissimilar zones of protection can cause misoperations and over tripping.



Solutions

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

AEP Transmission Zone M-3 Process
Mullensville

Need Number: AEP-2018-AP003

Process Stage: Solutions Meeting 4/23/2019

Previously Presented: Needs Meeting 10/26/18

Supplemental Project Driver:
Equipment Condition/Performance/Risk

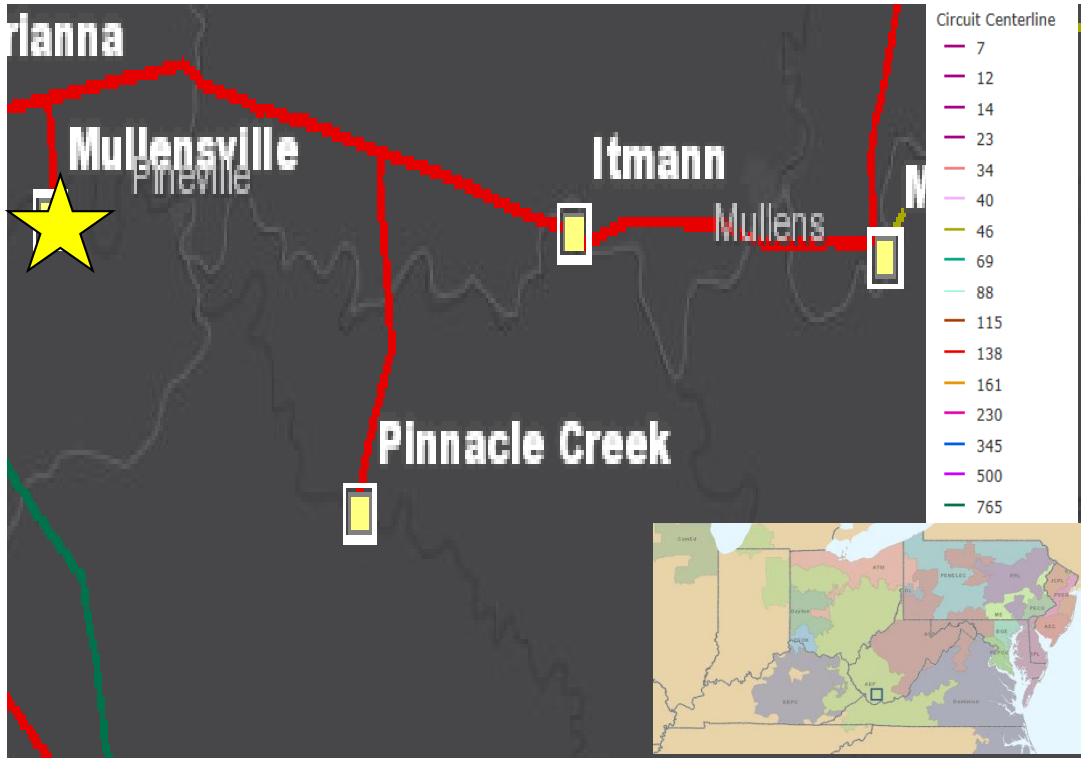
Specific Assumption Reference:
AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:

The need to address Mullensville transformer #1 is driven by the short circuit strength breakdown caused by the amount of electrical discharges of high energy has led to rising gas levels in the tank oil and carbonization of the insulating paper. Acetylene is at IEEE Condition 3 and Ethylene is at IEEE Condition 2 per the latest DGA readings in 2018 which contributes to poor dielectric strength. The rising presence of these hot metal gasses can be caused by poor connections, shorted turns, broken winding strands, or inadvertent core grounding from damage to the core ground insulation during through faults events; all of these are indicative of circulating currents in the core resulting in hotspots of the core and surrounding internal components. High energy discharges can be caused by flashovers, tracking or arcing, or short circuits between a number of internal components.

In addition to the 2018 compressor failure on CB A, IPS malfunction records indicate that the compressor motor burnt up in 2008 and failed again in 2009. There are only 13 of these FK-69-1500-3 types on the AEP system, making replacement parts difficult or impossible to obtain. This oil filled breaker has no oil containment and requires O&M costs to maintain the unit's oil that similar SF6 type breakers do not require.

The Ground-Switch MOAB on the high side of the 138/46 kV transformer at Mullensville are obsolete and create an overlap in the zones of protection.



AEP Transmission Zone M-3 Process
Mullensville

Need Number: AEP-2018-AP003

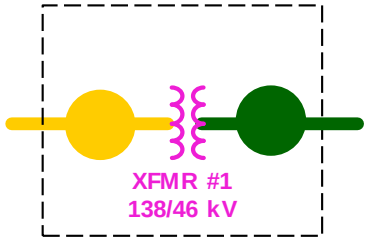
Process Stage: Solutions Meeting 4/23/2019

Potential Solution:
Replace Gr. Sw. MOAB with a new 138 kV circuit switcher. Replace existing 138 kV/46 kV 30 MVA XFR #1 with a new 138/46 kV 30 MVA XFR. Replace 46 kV circuit breaker A with a new 46 kV 3000 A 40 kA circuit breaker.

Estimated Trans. Cost: $5.4M

Alternatives Considered:
No cost effective viable Transmission alternative was identified

Projected In-Service: 4/1/2020



Mullensville Substation

Legend	
345 kV	
138 kV	
69 kV	
46 kV	
New	

AEP Transmission Zone M-3 Process
Huff Creek

Need Number: AEP-2018-AP006

Process Stage: Solutions Meeting 4/23/2019

Previously Presented: Needs Meeting 10/26/18

Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

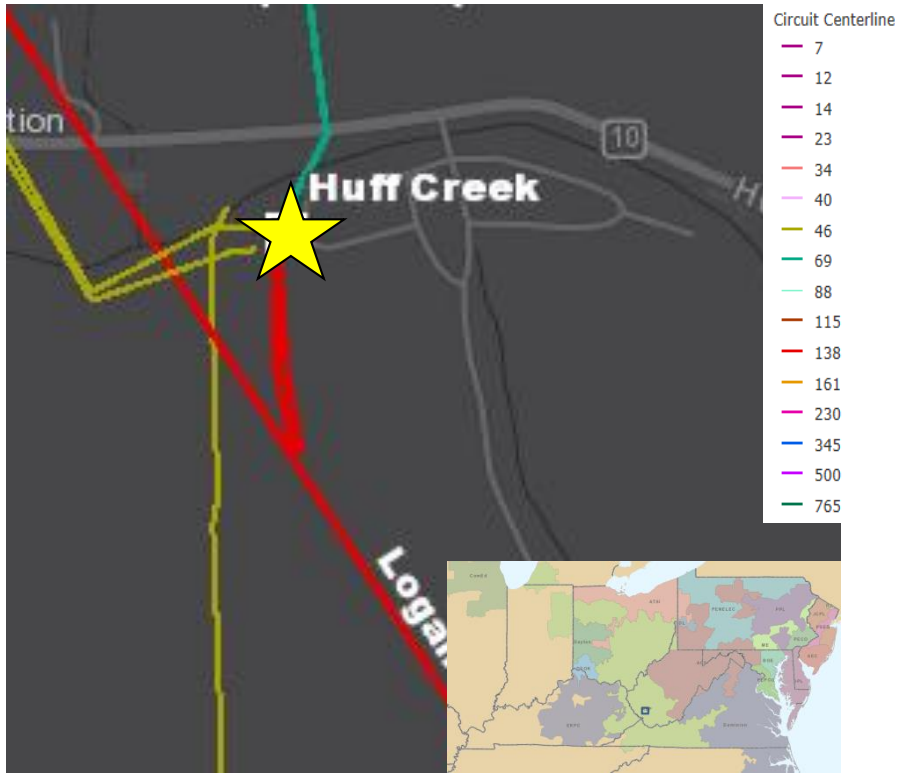
Problem Statement:

The need to address Huff Creek transformer #1 is driven by the oil's interfacial tension, which has been consistently below 30 mN/m (the acceptable limit for this voltage class). This is an indication of sludge beginning to form from oil contaminates, which will lead to accelerated aging of the unit; the sludge will impair oil circulation and lead to more frequent overheating. In addition, the moisture content and CO levels have begun a rapid increase over the past four years. CO is now at IEEE Condition 2 and dielectric strength is trending down. The presence of increased CO and moisture levels occurring over the same span of time is indicative of the cellulose breakdown from the insulating paper; this increases the risk of future shorts in the windings due to decreased insulating material.

The need to address Huff Creek ground transformer #2 is driven by Thermal through fault events, mostly in excess of 700°C, have led to, steady increases in gasses including the now IEEE Condition 3 levels of ethylene in PH A, IEEE Condition 2 levels of carbon monoxide in PH A, methane in PH B, and ethylene and methane in PH C. These faults have also generated carbonization of the insulating paper. In addition, all phases have seen sustained and elevated moisture levels which has resulted in low and decreasing dielectric strength.

The 69 kV circuit breaker D is an FK type oil filled circuit breaker with no oil containment. Oil filled breakers have much more maintenance required due to oil handling that their modern, SF6 counterparts do not require. Circuit breaker D is 1 of the 13 remaining FK-69-1500-3 model family remaining on the AEP system. This circuit breaker family is no longer supported by their original vendor and spare parts are scarce to non-existent. In addition, CB D has seen at least 148 faults; based on the maximum fault current levels available for this circuit breaker location, it has likely exceeded the manufactured life expectancy of cumulative fault current, 113 kA.

Huff Creek Substation currently deploys 74 relays, implemented to ensure the adequate protection and operation of the substation. Currently, all 74 (100% of all station relays) are in need of replacement. There are 60 of the electromechanical and 4 of the static type which have significant limitations with regards to spare part availability and fault data collection and retention in addition to a lack of vendor support. The remaining 10 microprocessor relays were commissioned in 1997 and 2007; the warranties are now expired and the firmware is no longer supported by the vendor. There appears to be little available panel space in the existing control house.



Need Number: AEP-2018-AP006

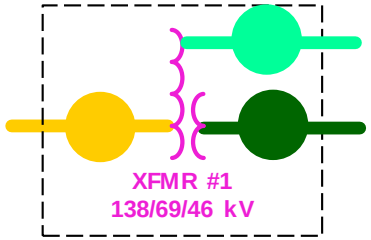
Process Stage: Solutions Meeting 4/23/2019

Potential Solution:
Replace existing 69 kV CB 'D' with a new 3000 A 40 kA 69 kV CB. Replace the existing 90 MVA 138/69/46 kV transformer #1 with a new 90 MVA 138/69/46 kV transformer. Replace the existing 3000 A GR. TRF Bank with a new 3000 A GR. TRF Bank. Replace the relaying at the station.

Estimated Trans. Cost: $6.6M

Alternatives Considered:
No cost effective viable Transmission alternative identified

Projected In-Service: 4/1/2020



Huff Creek Substation

Legend	
345 kV	
138 kV	
69 kV	
46 kV	
New	

Need Number: AEP-2018-IM004

Process Stage: Solution Meeting 4/23/2019

Previously Presented: Needs Meeting 10/26/18

Supplemental Project Driver:

Equipment Condition/Performance/Risk

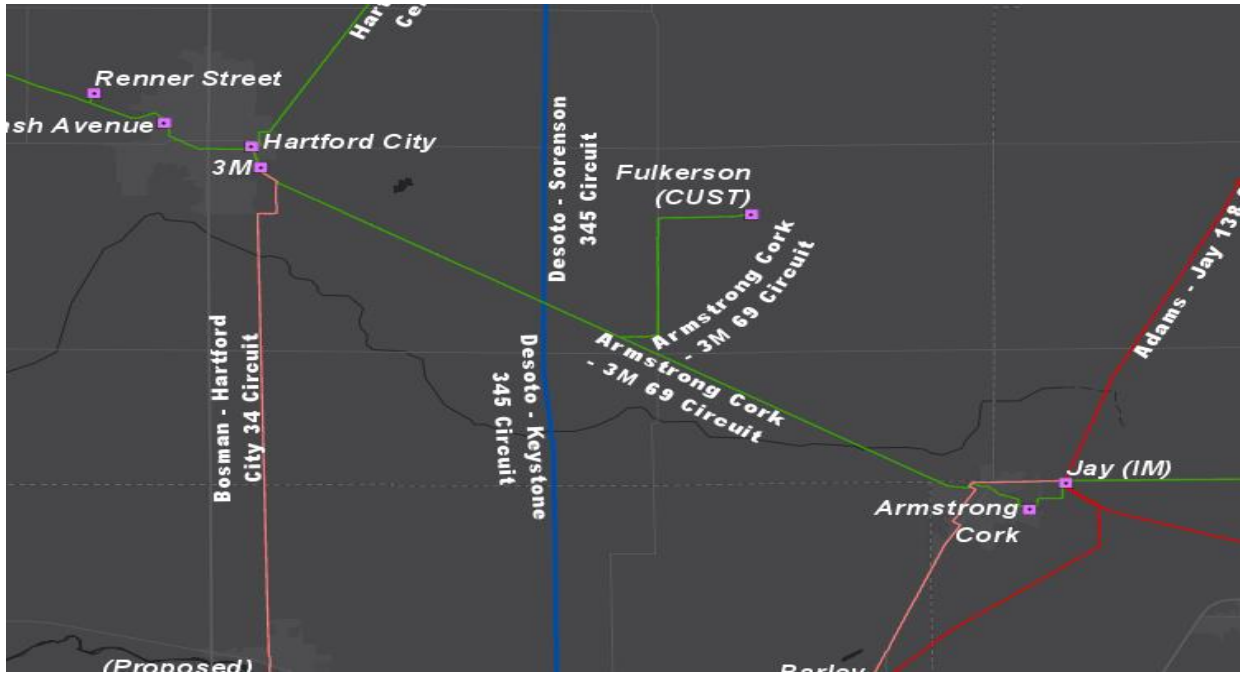
Specific Assumptions Reference:

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

Problem Statement:

3M Station 69 kV Station

- Breaker A
  - 1967 FK oil filled breakers without oil containment.
  - Fault Operations: CB A(23) – Recommended (10)



AEP Transmission Zone M-3 Process
Hartford City, Indiana Area

Need Number: AEP-2018-IM004

Process Stage: Solution Meeting 4/23/2019

Proposed Solution (Supplemental):

3M 69 kV

Transmission will rebuild the full through-path of 3M station in the plot of land directly south of the existing 3M station. This through path includes one 69 kV breaker toward Jay station and a MOAB toward Hartford City station.

Transmission was approached by I&M Distribution with their needs at 3M station after the initial read of the transmission needs. In working with I&M Distribution on the best solution to address both T and D needs at 3M, it was determined the best approach would be to build in the clear at an adjacent site to minimize the outages while addressing both sets of needs.

Alternatives:

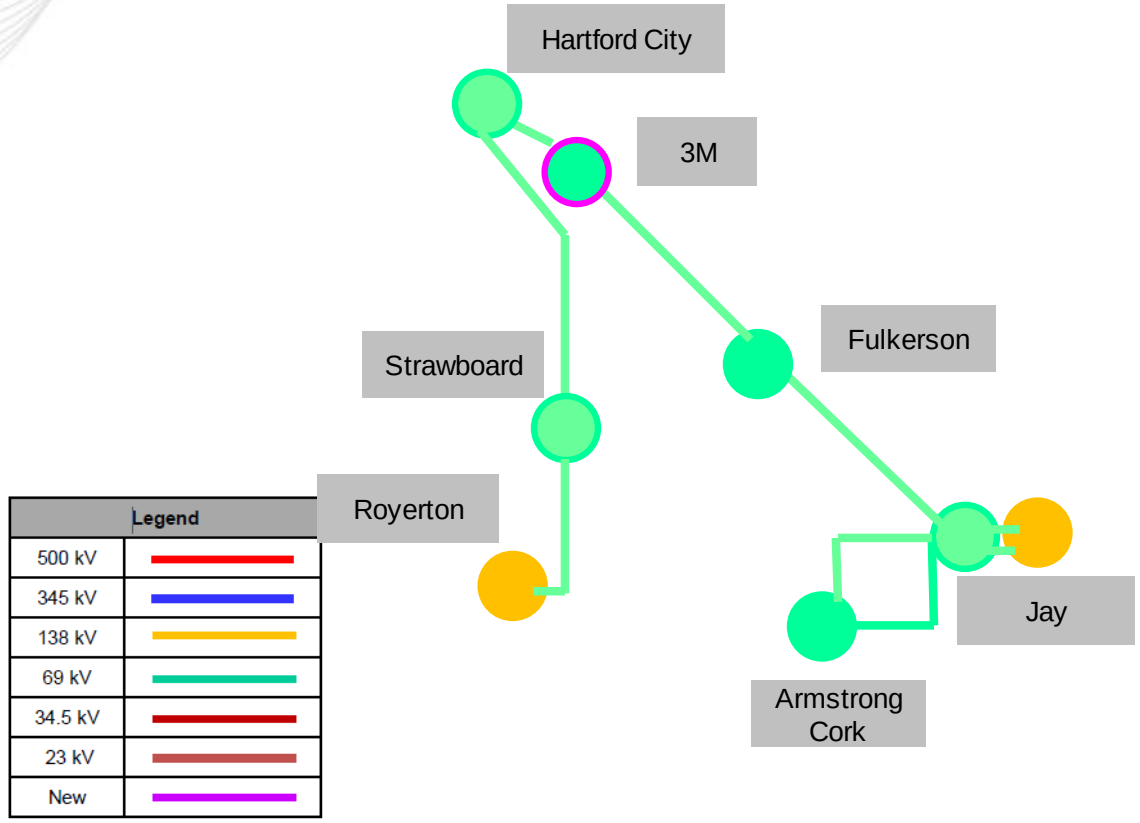
Alternate 1:

Rebuild the station on site. Due to the sensitivity of the customers served by 3M station and their inability to take sustained outages, this was deemed non-viable.

Total Estimated Transmission Cost: $1.35 M

Projected IS Date: 6/1/2022

Project Status: Scoping



AEP Transmission Zone M-3 Process
Tanners Creek, IN

Need Number: AEP-2019-IM003

Process Stage: Solutions Meeting 4/23/2019

Previously Presented: Needs Meeting 2/20/2019

Supplemental Project Driver:
Operational Efficiency & Flexibility

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

Problem Statement:
Tanners Creek 345 kV

- Currently a line fault on the Dearborn circuit causes 5 EHV breakers to open. This is above the AEP max of 4 and must be addressed.
- According to the DEDSTFMRS PJM document, 200 kV+ facilities with 7+ elements are required to be in a complete breaker and a half setup at a minimum. This facility has 9 elements and is currently in an incomplete breaker and a half setup.

AEP Transmission Zone M-3 Process
Tanners Creek, IN

Need Number: AEP-2019-IM003

Process Stage: Solutions Meeting 4/23/2019

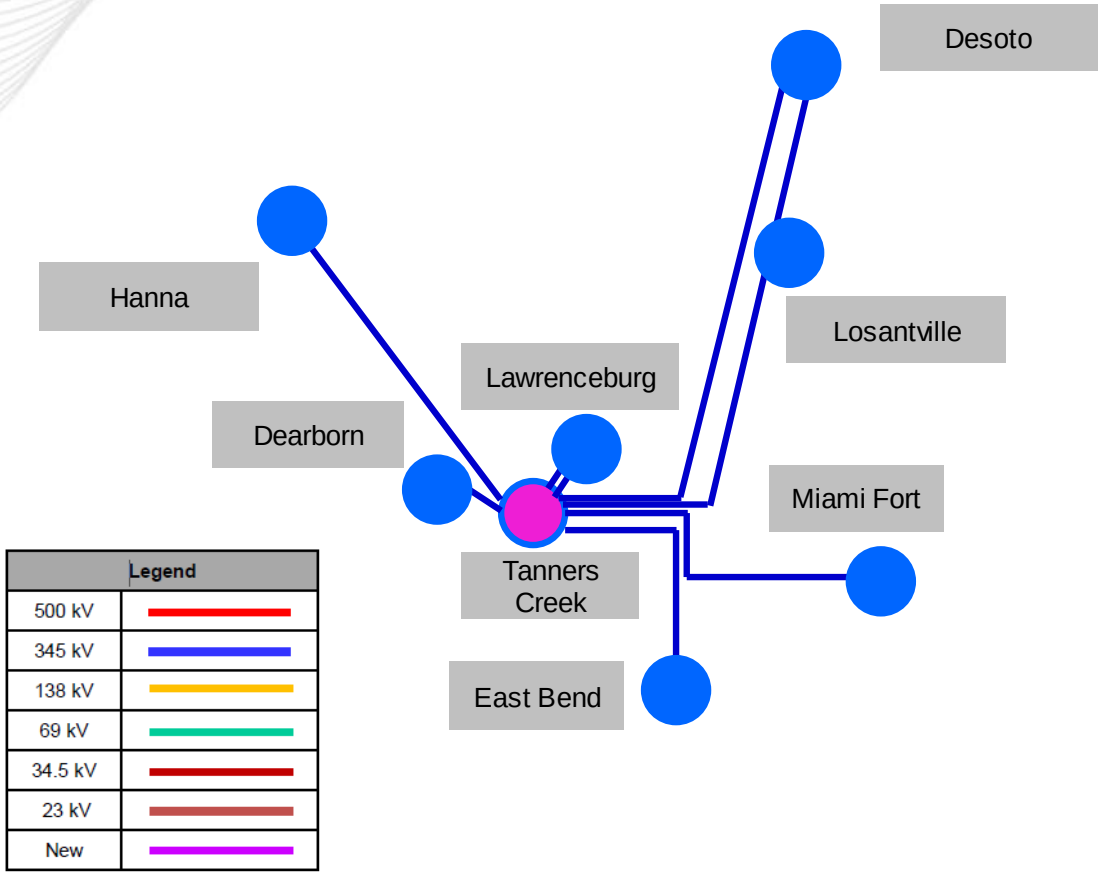
Proposed Solution:
Install 2 new 345 kV breakers and move the existing M2 breaker into the new N string. Terminate the Dearborn line and the transformer into the new N string. Install a new 345 kV breaker "T" to complete the T string.

Alternatives:
Reterminate the 345/138 kV transformer and 345 kV Dearborn line into existing breaker spots. Due to the way the station is laid out, this would require reconfiguring multiple 345 kV lines and would cost more.

Total Estimated Transmission Cost: $5.93 M

Projected IS Date: 6/1/2021

Project Status: Scoping



AEP Transmission Zone M-3 Process
Greentown, IN

Need Number: AEP-2019-IM004

Process Stage: Solutions Meeting 04/23/2019

Previously Presented: Needs Meeting 02/20/2019

Supplemental Project Driver:
Operational Efficiency & Flexibility

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

Problem Statement:

- Greentown
  - According to the DEDSTFMRS PJM document, BES facilities with 7+ elements are recommended to be in a complete breaker and a half setup at a minimum. This facility has 7 elements and is currently in an incomplete breaker and a half setup.

AEP Transmission Zone M-3 Process
Greentown, IN

Need Number: AEP-2019-IM004

Proposed Solution:

Greentown 765/230/138 kV station:

Install two 138 kV breakers to terminate the 765/138 kV Transformer into a breaker and a half string. This work will be done in conjunction with the significant MISO work being planned at this station,

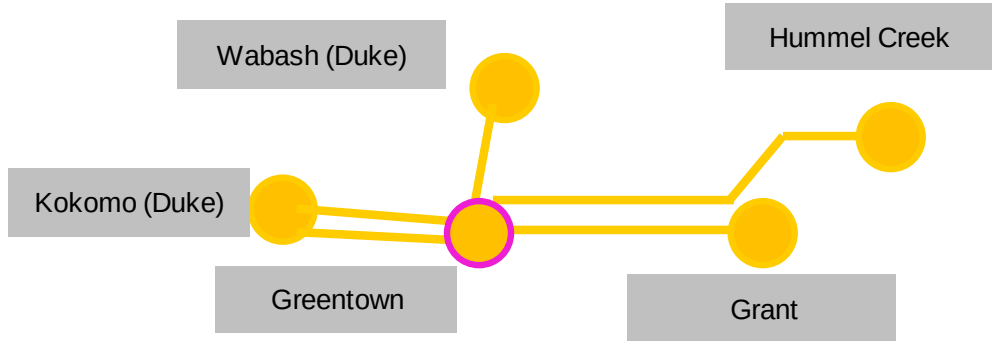
Alternatives:

No cost effective viable alternates were identified.

Total Estimated Transmission Cost: $2.7 M

Projected IS Date: 02/15/2023

Project Status: Scoping



Legend	
500 kV	
345 kV	
138 kV	
69 kV	
34.5 kV	
23 kV	
New	

AEP Transmission Zone M-3 Process
Elwood, Indiana

Need Number: AEP-2018-IM010

Process Stage: Solution Meeting 4/23/2019

Previously Presented: Needs Meeting 10/26/18

Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

Problem Statement:

Jonesboro – South Summitville

- 1930's wood crossarm construction
- #2 copper
- Over the past 10 years this line has had 128 structures require active maintenance with the majority being wood rot. This trend is expected to increase as the line ages.
- 68 structures currently have an open condition

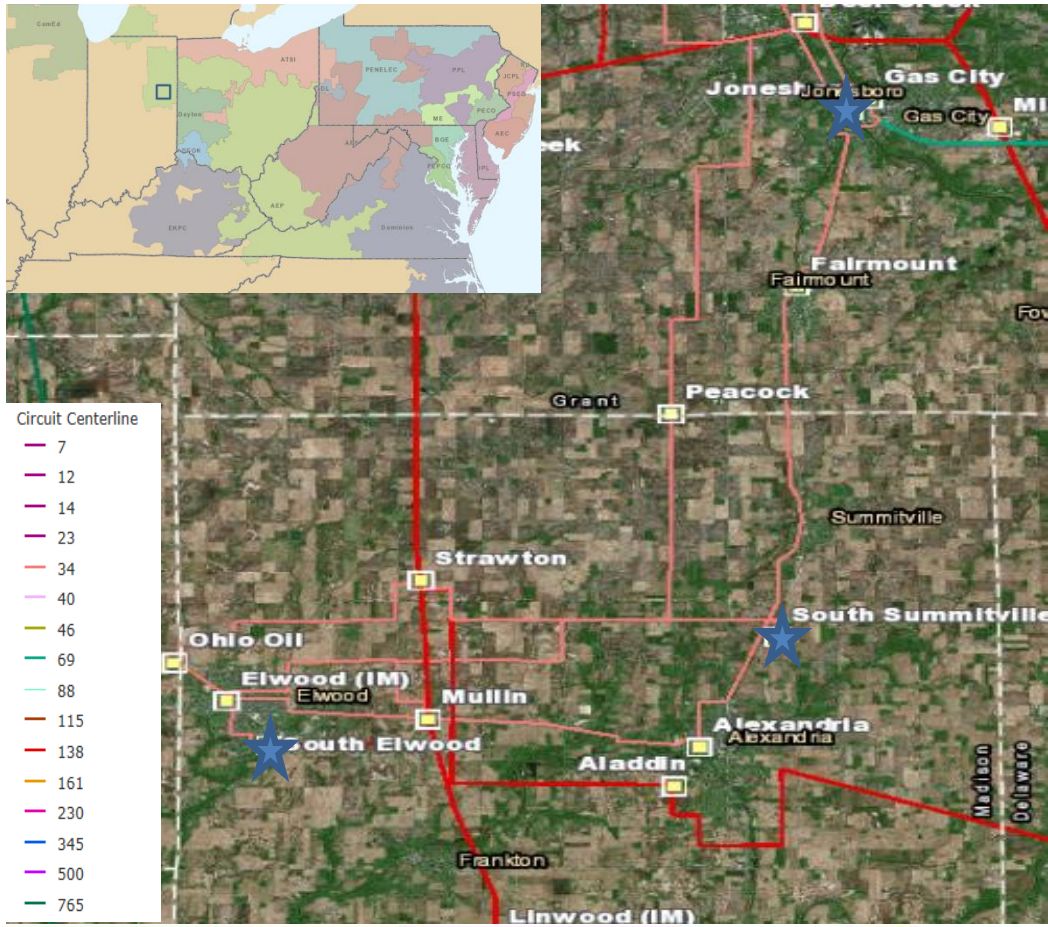
South Elwood

Breaker "C"

- 1951 FK oil type with no oil containment
- Fault Operations: CB C(19) – Recommended (10)

Transformer 1 – 1955 vintage

- Type O Westinghouse bushings
- Increasing power factor
- Increasing Carbon Monoxide
- Failed internal heater circuit.
- Physically obstructs other station assets.



AEP Transmission Zone M-3 Process
Elwood, Indiana

Need Number: AEP-2018-IM010

Process Stage: Solution Meeting 4/23/2019

Process Chronology: Needs Meeting 10/26/18

Supplemental Project Driver:
Equipment Condition/Performance/Risk

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

Problem Statement (continued):

<u>Fairmount</u>

Breakers "A" and "B"

- Fault Operations: A(75) B(99) – Recommended(10)

Transformer 1 – 1972 vintage

- High Carbon Dioxide level
- Dielectric issues

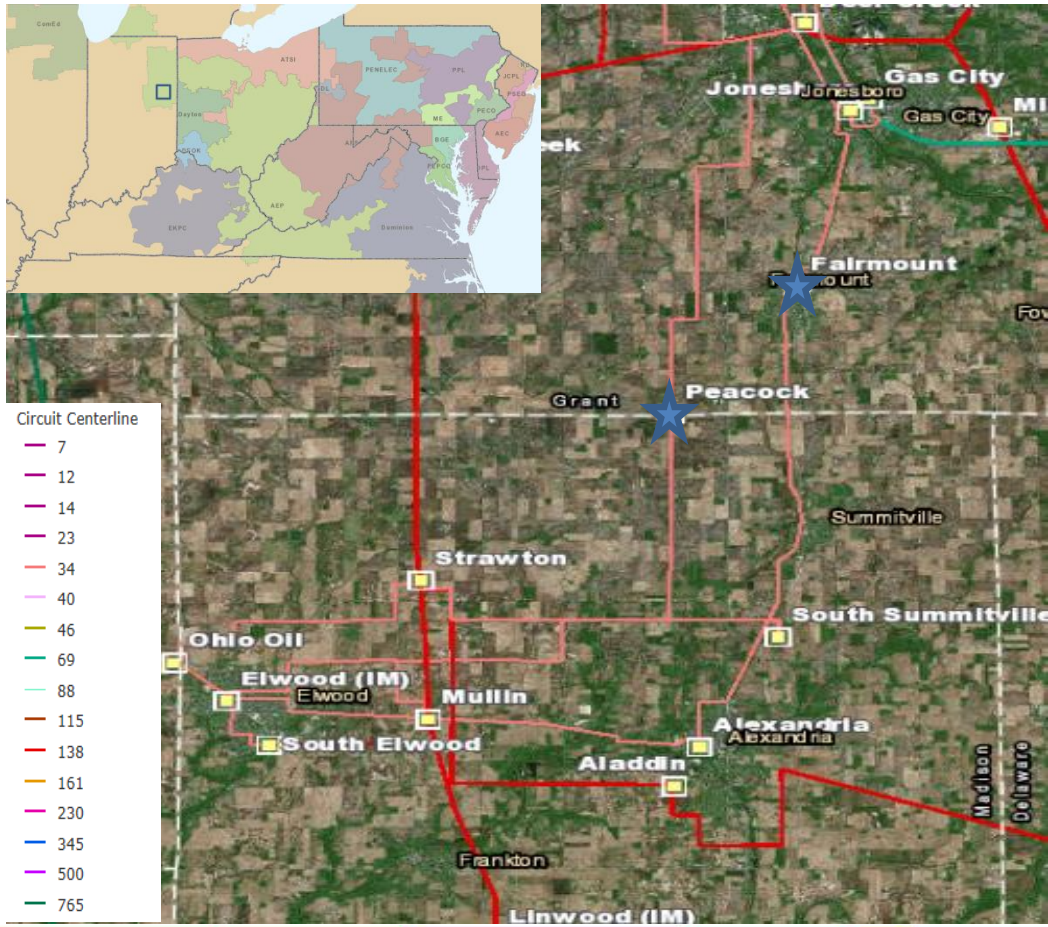
<u>Peacock</u>

Breaker "A"

- 1969 PR Oil breaker without containment
- Fault Operations: A(154) – Recommended(10)

Transformer 1 – 1951 Vintage

- High levels of Ethane, Methane, and CO2.
- Increasing Insulation power factor.



AEP Transmission Zone M-3 Process
Elwood, Indiana

Need Number: AEP-2018-IM010

Process Stage: Solution Meeting 4/23/2019

Process Chronology: Needs Meeting 10/26/18

Supplemental Project Driver:

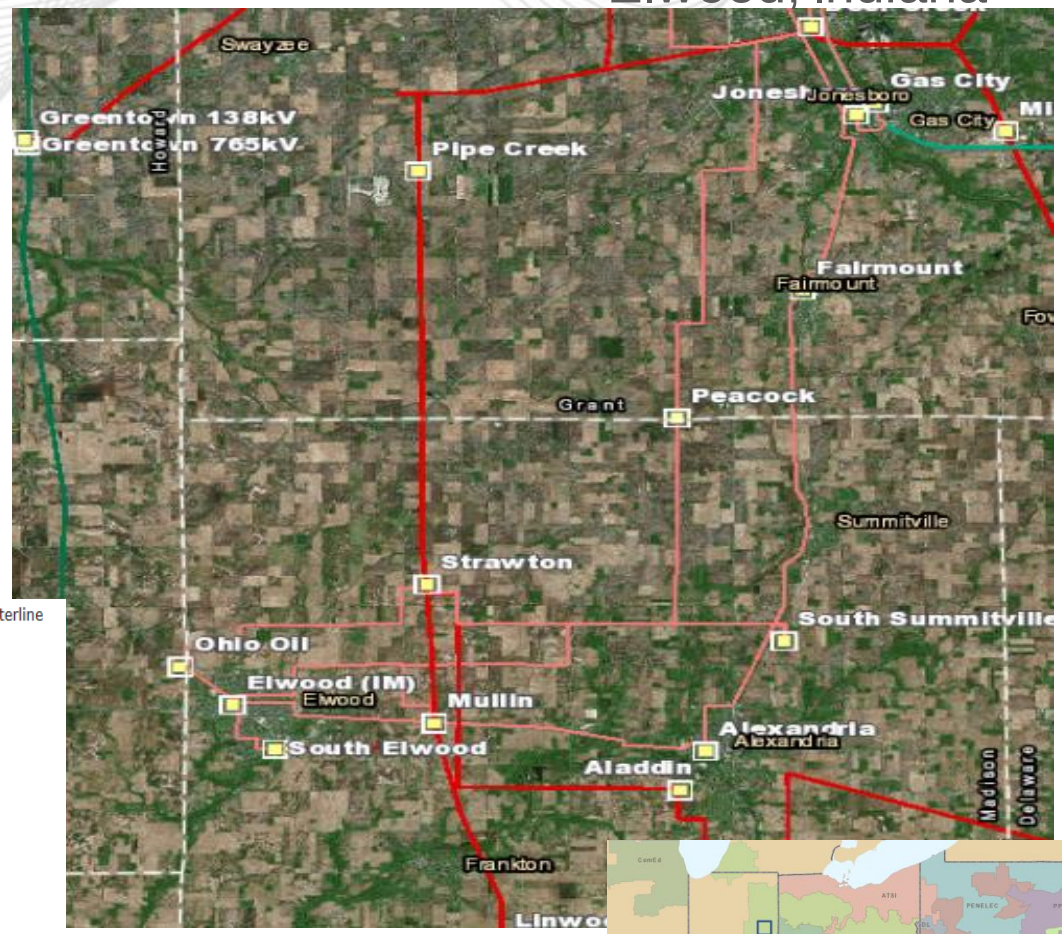
Customer Service/Operational Flexibility & Efficiency

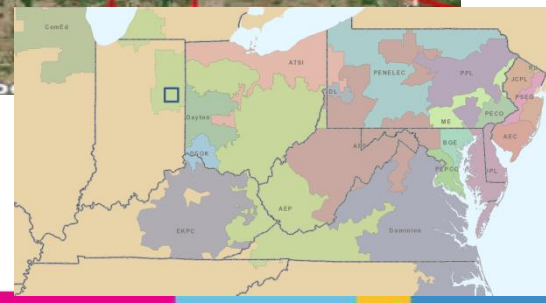
Specific Assumptions Reference:

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

Problem Statement:

- Both AEP Transmission and AEP distribution have received multiple requests for economic development in this area.
- The current system would require significant rework in order to facilitate these requests, and the timeline for those fixes are not conducive to customer timelines.
- The 34.5 kV system is subject to "Drop and Pick" operating procedure. This operating procedure has been an issue for I&M Distribution operations as it results in less reliable service for the customer and causes outages that could otherwise be avoided.





AEP Transmission Zone M-3 Process
Marion, Indiana

Need Number: AEP-2018-IM025

Process Stage: Solution Meeting 4/23/2019

Process Chronology: Needs Meeting 1/11/2019

Supplemental Project Driver:

Equipment Condition/Performance/Risk

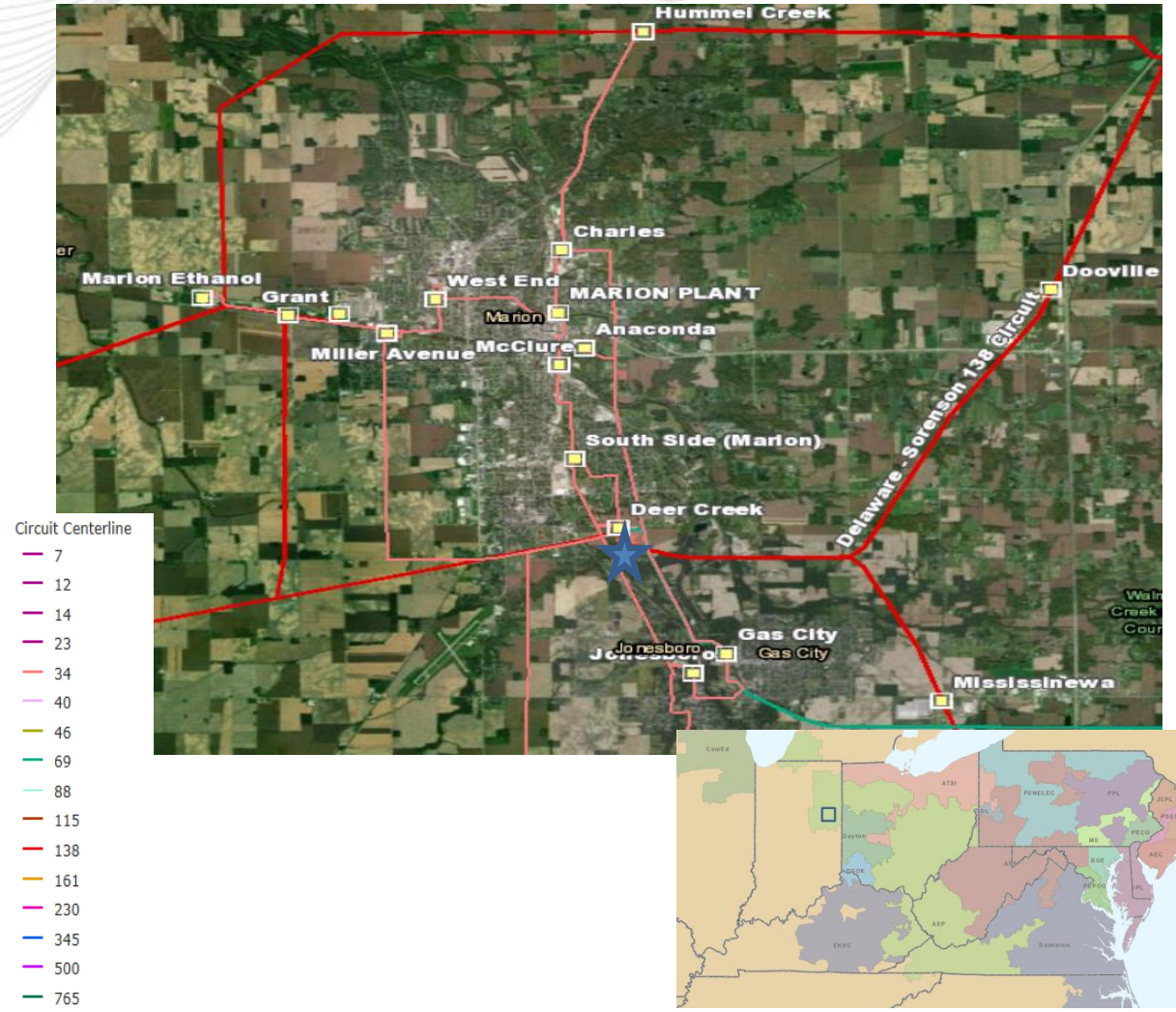
Specific Assumptions Reference:

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

Problem Statement:

Deer Creek 34.5 kV

- Breakers "U"
  - 1950 vintage FK oil breakers without containment
  - Fault Operations: CB U(38)– Recommended(10)



AEP Transmission Zone M-3 Process
Alexandria, Indiana

Need Number: AEP-2019-IM005

Process Stage: Solution Meeting 4/23/2019

Process Chronology: Needs Meeting 02/20/2019

Supplemental Project Driver:
Operational Flexibility and Efficiency

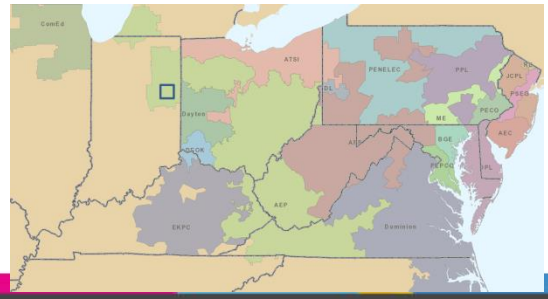
Specific Assumptions Reference:
AEP Guidelines for Transmission Owner Identified Needs (AEP Assumptions Slide 8)

Problem Statement:

Associated Needs: AEP-2018-IM010

Strawton – Arnold Hogan 138 kV

- This line currently has 4 MOABS in series (2 at Aladdin and 2 at Jones Creek) which is above AEP's max of 3.



AEP Transmission Zone M-3 Process
Elwood, Indiana

Need Number: AEP-2018-IM010, AEP-2018-IM025, AEP-2019-IM005

Process Stage: Solutions Meeting 4/23/2019

Proposed Solution:

Jonesboro – South Summitville 34.5 kV line:

Retire the ~10.5 mile South Summitville – Jonesboro 34.5 kV line.

Jonesboro 34.5 kV station:

Retire Jonesboro station

Dean 69 kV station & Fairmount/Peacock 34.5 kV stations:

Install the new 69 kV Dean station with a single bus tie breaker to take replace the 34.5 Fairmount and Peacock stations

South Elwood 138/34.5 kV station:

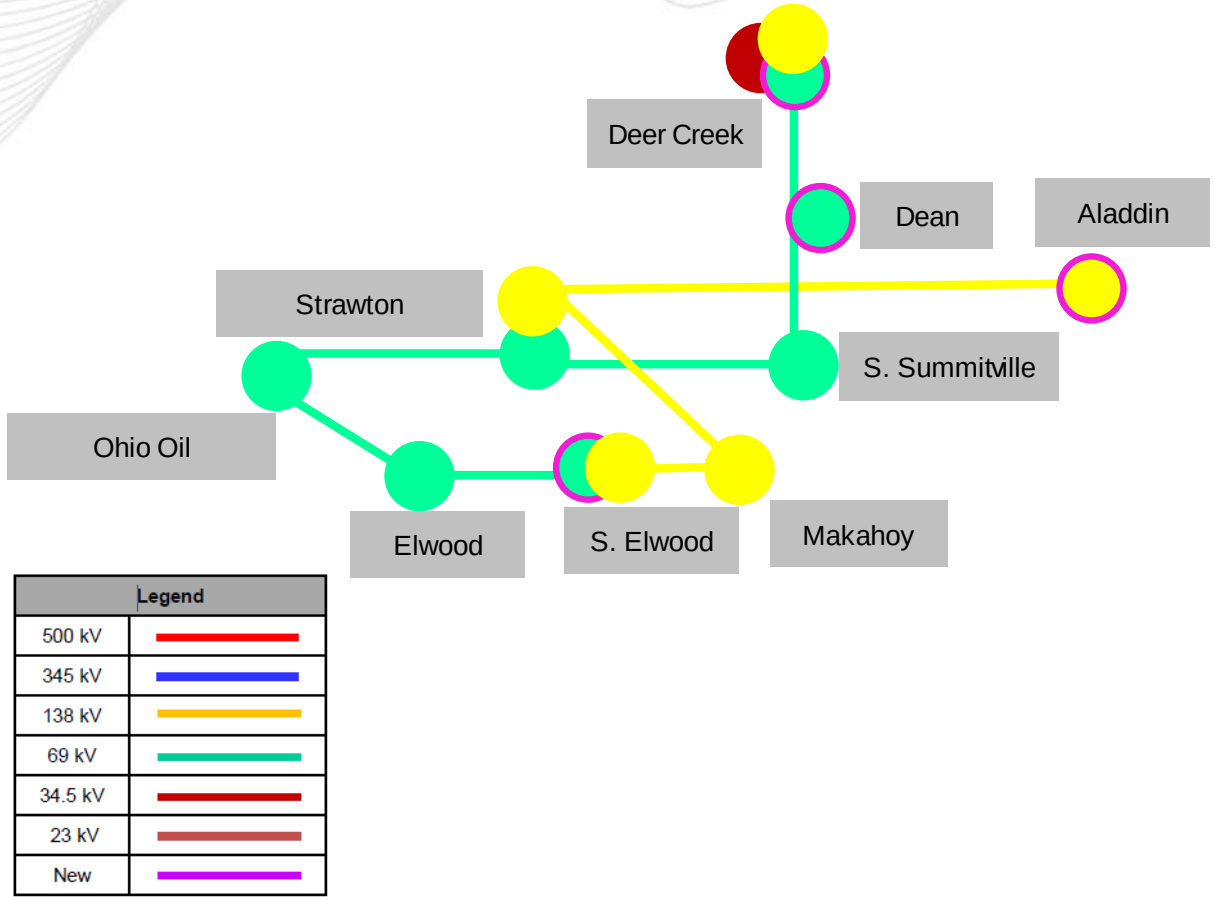
Replace the 138/34.5 kV XFR 1 and the existing 34.5 kV breaker with a 138/69 kV XFR and a 69 kV rated breaker

Deer Creek 138/69/34.5 kV station:

Install a 3 breaker 69 kV ring bus In the clear to enable the connection of the now 69 kV rated South Summitville line. Add a 138 kV breaker to the high side of XFR 1 to replace the moab.

Aladdin 138 kV station:

Install a 138 kV bus tie breaker at Aladdin station to breaker up the 4 MOABS in series



AEP Transmission Zone M-3 Process
Elwood, Indiana

Need Number: AEP-2018-IM010, AEP-2018-IM025, AEP-2019-IM005

Process Stage: Solutions Meeting 4/23/2019

Proposed Solution:

Elwood 34.5 kV station

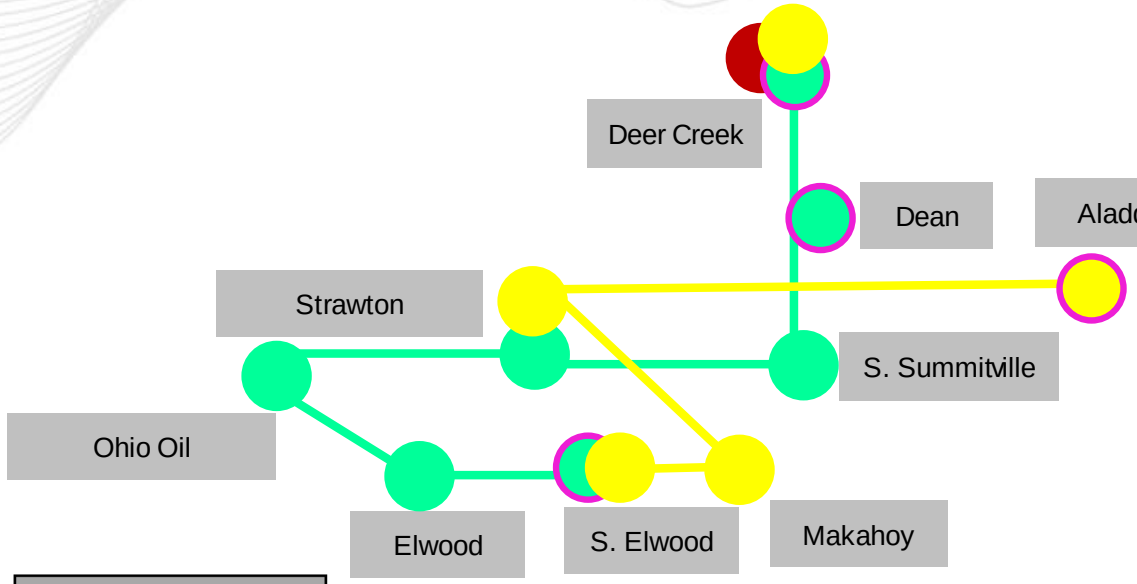
Rebuild Elwood in the clear as an in and out station with a bus tie breaker.

Strawton Area work

Energize Ohio Oil, South Summitville, Strawton and the lines connecting them to 69 kV. These stations and lines are already built to this standard.

Alternatives:

Re-use both breakers at Elwood and keep the original configuration. While this configuration protects Elwood's load from line faults, it doesn't allow for AEP to take bus outages for maintenance. With the removal of the Cap Bank, full line protection becomes no longer needed. Changing the configuration to a single breaker improves distribution's reliability, reduces the station footprint and saves money.



AEP Transmission Zone M-3 Process
Elwood, Indiana

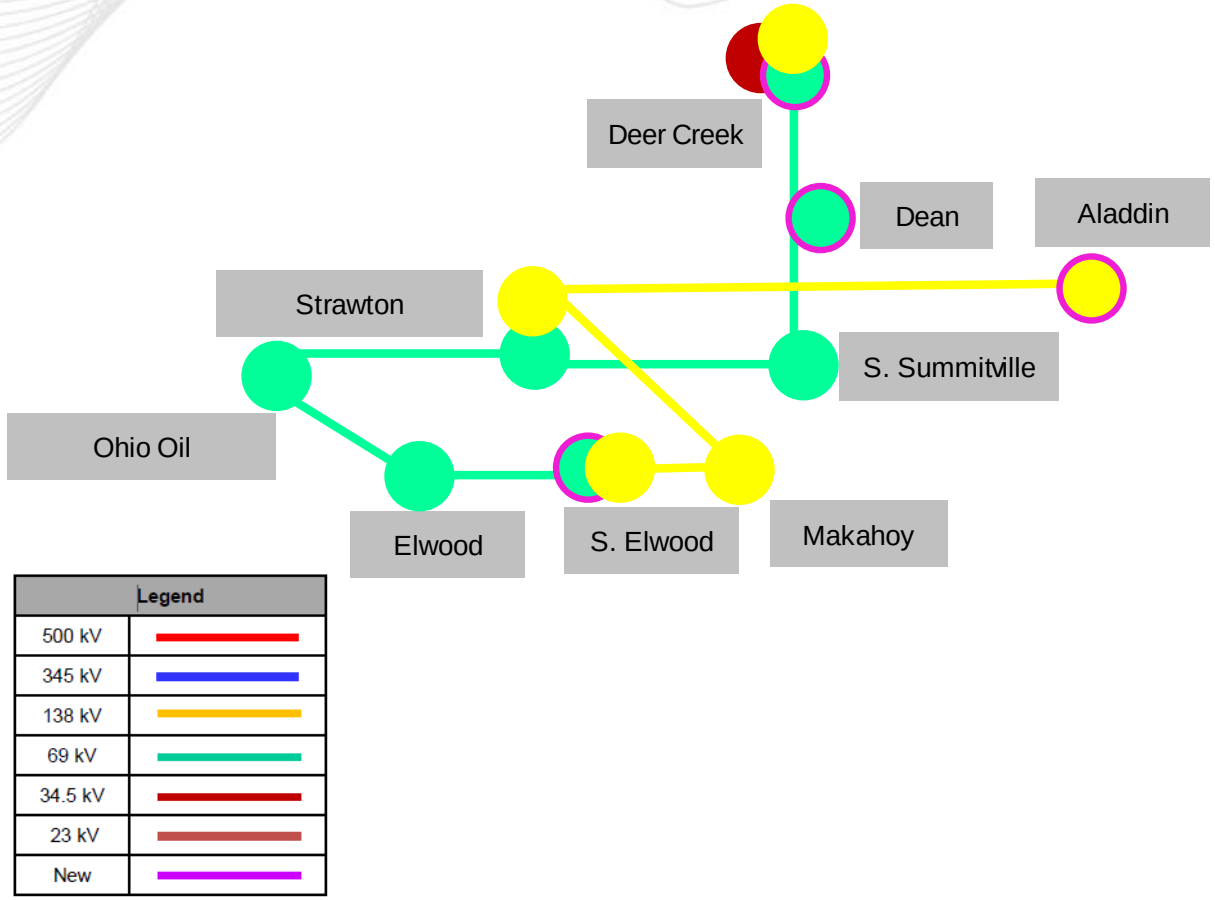
Need Number: AEP-2018-IM010, AEP-2018-IM025, AEP-2019-IM005

Alternatives:
Re-use 69 kV breaker "J" at Deer Creek station in the 69 kV ring bus. Breaker "J" is still in good shape. But in order to minimize outages, it was decided that AEP would use brand new breakers for the 69 kV voltage class and will plan to re-use J when addressing the remaining 34.5 kV needs at this station.

Total Estimated Transmission Cost: $17.4M

Projected IS Date: 10/1/2021

Project Status: Scoping



Appendix

High level M-3 Meeting Schedule

Assumptions

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

Needs

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

Solutions

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

Submission of Supplemental Projects & Local Plan

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

Revision History

4/12/2019 – V1 – Original version posted to pjm.com

4/16/2019 – V2 – Slide #35: Corrected the solution meeting date

Slide #36: Add “Process Stage”

4/16/2019 – V3 – Slides #41 -45: Change Solution meeting date from 4/23/2018 to 4/23/2019

Slide #14, 20: Corrected Need meeting date

4/16/2019 – V4 – Slides #23: Add “open conditions along the 23 mile long line.”

4/26/2019 – V5 – Slides #21: Revise Problem Statement

– Slides #36: Add detailed explanations under in Proposed Solution

5/18/2019 – V6 – Slides #44, #46-48: Change AEP-2018-IM017 to AEP-2018-IM025

2/1/2021 – V7 – Slides #25: Change AEP-2019-OH018