

# Lower Rio Grande Valley (LRGV) Discussion

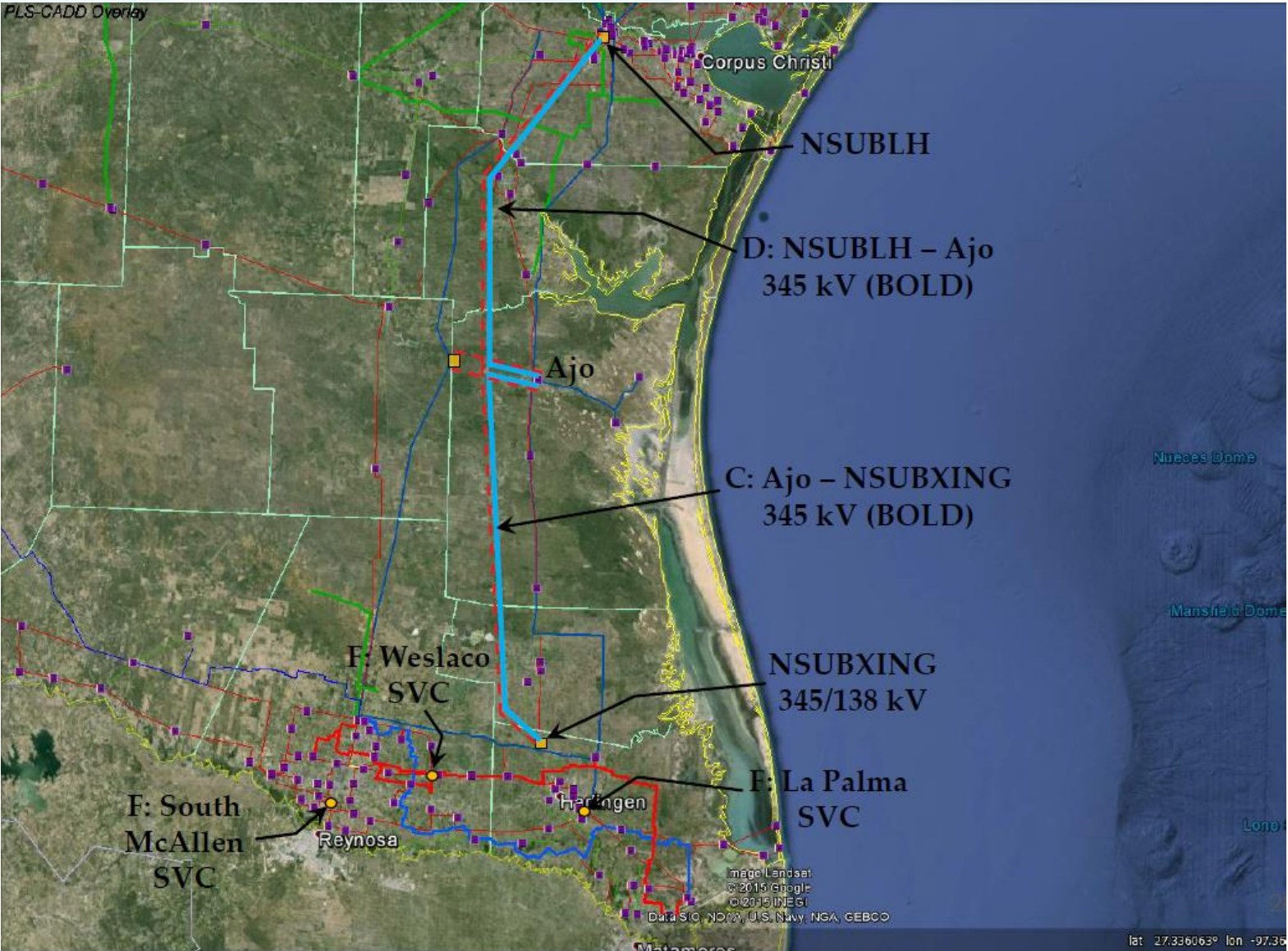
September 15, 2015



# Background

- Historically difficult to serve LRGV load reliably due to the region being remote from the rest of the ERCOT grid
- Sustained high load growth for the LRGV region
- Narrow window to complete transmission and generation clearances
- Multiple ERCOT Regional Planning Group project proposals to address reliability issues
  - Laredo Projects – Submitted as RMR exit strategy for local generation
    - 150 MW DC Tie and Miguel (South of San Antonio) – Lobo (Laredo )
    - Over 100 miles of 345 kV line
    - Estimated at \$200 Million
  - LRGV Project 1 – Submitted March 2011
    - Lobo (Laredo) to N Edinbrough (LRGV)
    - Over 150 miles 345 kV line
    - Estimated at \$525 Million
  - LRGV Project 2 – Submitted April 2015
    - Lon Hill (Corpus Christi) to Rio Hondo (LRGV)
    - Over 100 miles 345 kV line
    - Estimated at \$621.5 Million

# AEP Recommended Option - \$621.5 Million



# Comments on AEP Projects

- Relying on same source/sink combos poses a risk to the LRGV region
  - AEP's project relies heavily on Lon Hill and Rio Hondo
  - Lon Hill (Corpus Christi) is the source for three out of the four major paths into the Valley
  - Rio Hondo (LRGV) is the sink for two out of the four major paths into the Valley.
  
- ERCOT should consider alternative planning options to develop a more reliable project for the LRGV consumers
  - Higher Voltage Classes
  - HVDC technologies
  - Alternative Source/Sink Combinations
    - Prevent Lon Hill, N Edinburg & Rio Hondo from becoming critical stations
    - More diversity in terms of LRGV load serving capability and reliability in the longer run
  
- The identified LRGV Import Project might change the intra-Valley option ERCOT recommends, therefore, ERCOT should consider the intra-Valley upgrades in the context of the recommended LRGV Import Project.

# LRGV Electrical Characteristics

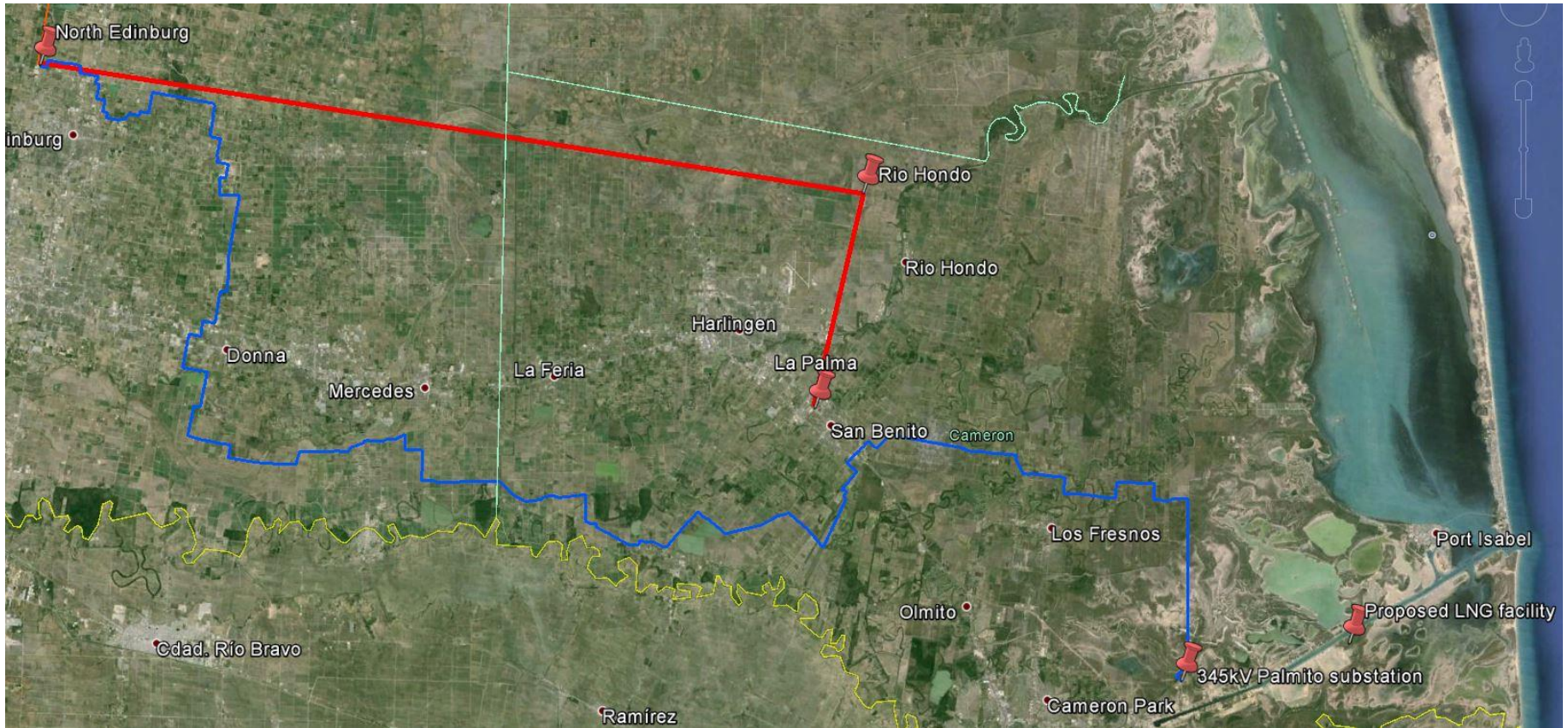
- LGRV is physically and electrically remote from major generation centers.
- Generation within the LRGV is limited
  - Frontera announced it will be switching from the Texas grid to the Mexico grid by 2016.
  - After 2016, the LRGV will only have three thermal generating stations
  - New NERC standards requires the transmission system to maintain reliability after the loss two generation stations (NERC TPL-001-4 P3 events)
- Only two sources into the LRGV
  - Lon Hill (source for 2 out of 3 transmission paths)
  - Miguel (source for 1 out of 3 transmission paths)
- Only two sinks in the LRGV
  - Rio Hondo (sink for 1 out of 3 transmission paths)
  - North Edinburg (sink for 2 out of 3 transmission paths)



# Sharyland/CPS Studies – New Sources/Sinks

- New sources considered by Sharyland/CPS that would diversify the transmission paths into the LRGV
  - Knob Creek
    - New station near Temple
    - 1,400 MW of new generation locating at Knob Creek station
    - Approximately 375 miles from LRGV
  - Tap Station on a new line from Caballo to Ajo
    - New station on a new transmission line
    - Would relieve trapped generation at Ajo
    - Approximately 90 miles from LRGV
  - Elm Creek
    - Existing station near San Antonio
    - Intersection of multiple 345 kV transmission lines
    - Approximately 230 miles from LRGV
- New sink for the LRGV region
  - Palmito Station
    - New sink in LRGV with ability to close LRGV 345kV loop and serve LNG load additions in Brownsville port

# LRGV 345kV Loop & Palmito Vs LNG Facilities



Location of 345kV Palmito station vis-à-vis proposed LNG facility location

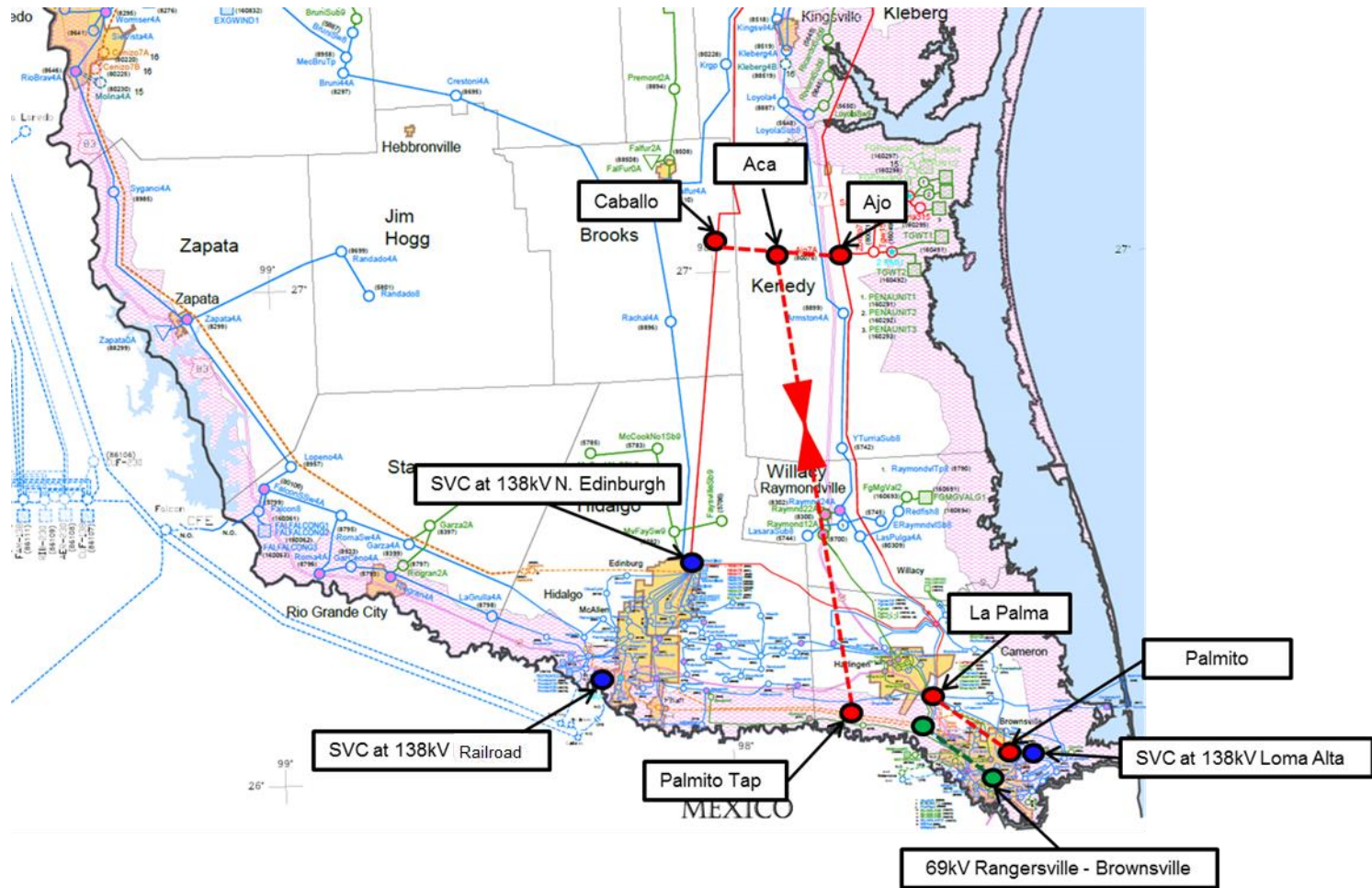
# Alternative Options Considered

## ■ Option 1

- 25 mile 345 kV La Palma – Palmito single circuit line
- 345 kV Palmito Tap switching station on the Cross Valley line approximately 35 miles from the 345 kV Palmito station (6-breaker ring bus)
- 345 kV Caballo switching station on the 345 kV Lon Hill – N. Edinburgh line approximately 65 miles from the 345 kV N. Edinburgh station (6-breaker ring bus)
- 345 kV Aca switching station on the new 345 kV Ajo – Caballo line approximately 7 miles from the 345 kV Ajo station (6-breaker ring bus)
- 7 mile 345 kV Ajo – Aca single circuit line
- 7 mile 345 kV Caballo – Aca single circuit line
- 90 mile 425 kV DC Palmito Tap – Aca single circuit line
- One 1000 MW VSC converter at Aca station
- One 1000 MW VSC converter at Palmito Tap station
- 20 mile 69 kV Rangersville – Brownsville single circuit line
- +600/-200 MVAR SVC at 138 kV Loma Alta
- +600/-200 MVAR SVC at 138 kV Railroad
- +600/-200 MVAR SVC at 138 kV North Edinburgh



# Option 1

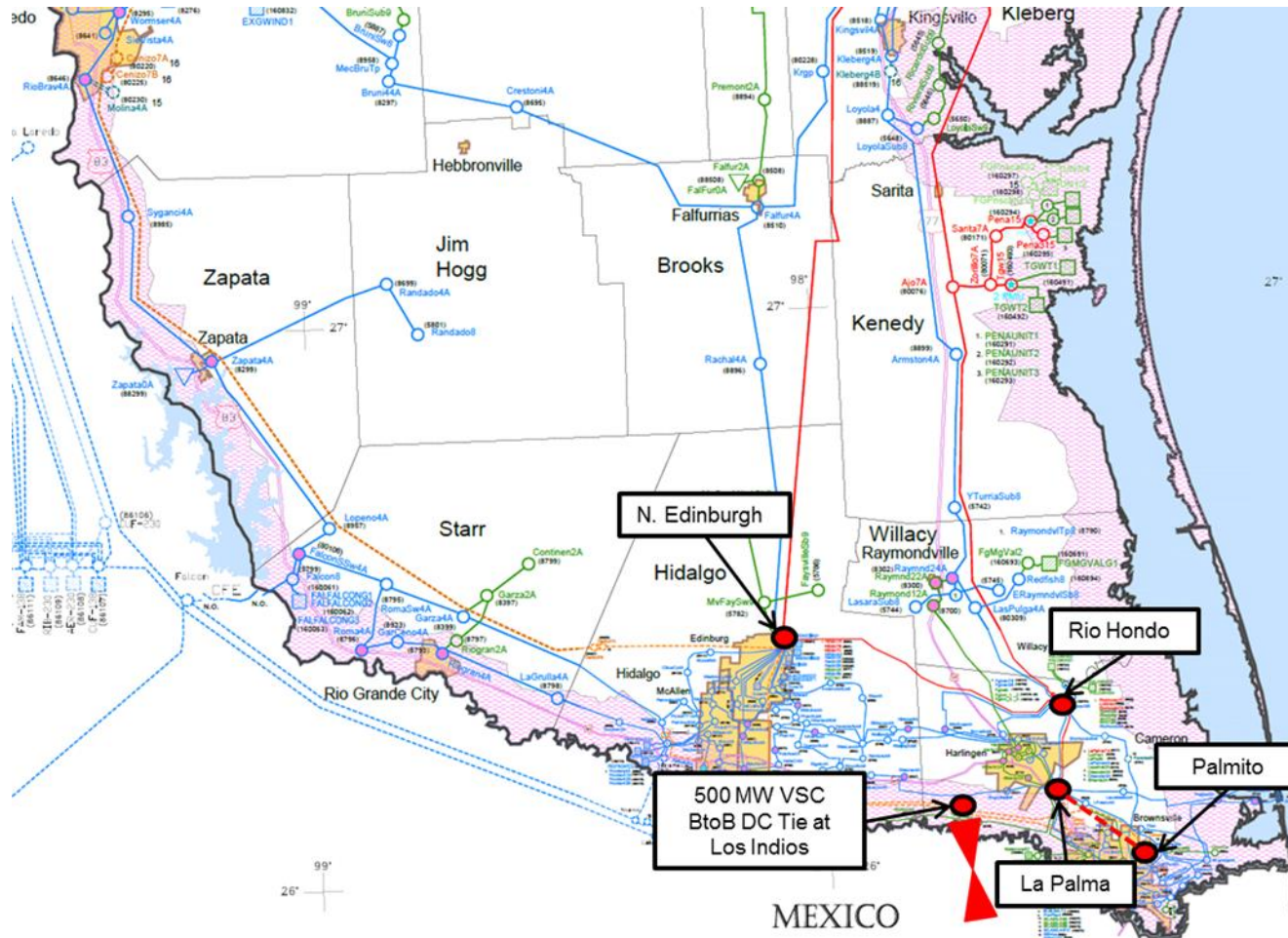


# Alternative Options Considered

## ■ Option 2

- 25 mile 345 kV La Palma – Palmito single circuit line
- 345 kV Los Indios switching station on the Cross Valley line approximately 37 miles from the 345 kV Palmito station (6-breaker ring bus)
- 500 MW VSC BtoB converter at Los Indios station (connected to CFE Grid)

# Option 2



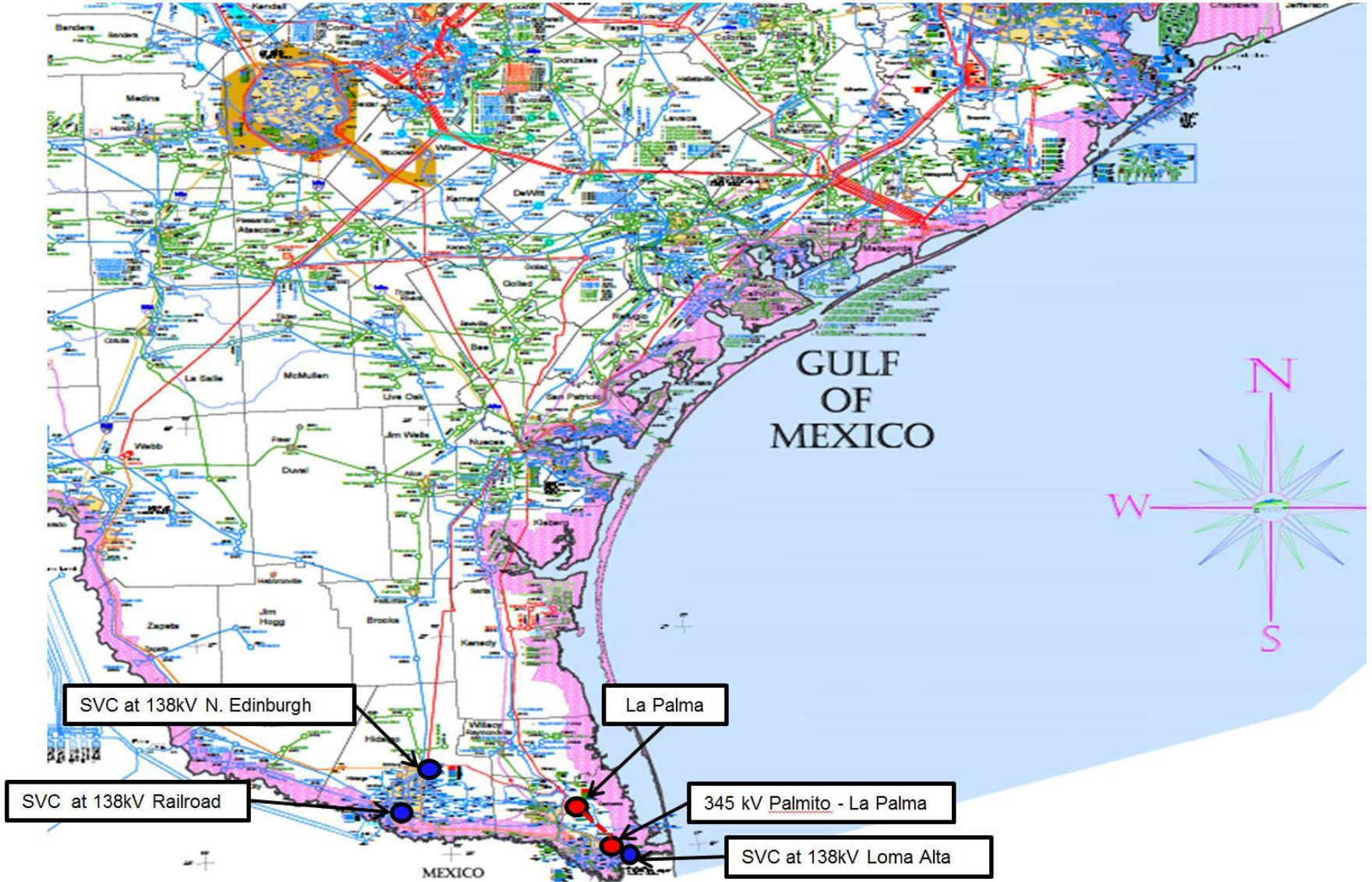
# Alternative Options Considered

## ■ Option 3

- 25 mile 345 kV La Palma – Palmito single circuit line
- +600/-200 MVAR SVC at 138 kV Loma Alta
- +600/-200 MVAR SVC at 138 kV Railroad
- +600/-200 MVAR SVC at 138 kV North Edinburgh



# Option 3



# Alternative Options Considered

## ■ Option 4

- 25 mile 345 kV La Palma – Palmito single circuit line
- 345 kV Palmito Tap switching station on the Cross Valley line approximately 35 miles from the 345 kV Palmito station (6-breaker ring bus)
- 500 kV Palmito Tap switching station (6-Breaker Ring bus)
- 500 kV Elm Creek switching station (6-Breaker Ring bus)
- 270 mile 500 kV Palmito Tap – Elm Creek single circuit
- Two (2) 500/345 kV, 1078 MVA transformer at new 345 kV Palmito Tap
- Two (2) 500/345 kV, 1078 MVA transformer at existing 345 kV Elm Creek
- 200 MVAR reactor at new 500 kV Palmito Tap station
- 200 MVAR reactor at new 500 kV Elm Creek
- 20 mile 69 kV Rangersville – Brownsville single circuit line
- +600/-200 MVAR SVC at 138 kV Loma Alta
- +600/-200 MVAR SVC at 138 kV Railroad
- +600/-200 MVAR SVC at 138 kV North Edinburgh



# Option 4



# Alternative Options Considered

## ■ Option 5

- 25 mile 345kV La Palma – Palmito single circuit line
- 345/138 kV Mehman switching station on the Cross Valley line approximately 30 miles from the 345 kV N. Edinburgh station (6-breaker ring bus) (at the junction of the 345 kV Cross Valley and 138 kV Stewart to Weslaco lines)
- 280 mile 345 kV Palmito – Elm Creek double circuit line
- One (1) 345/138kV 450 MVA transformer at Mehman Substation
- Add second 345/138 kV 450 MVA transformer at 345 kV Palmito
- 20 mile 69 kV Rangersville – Brownsville single circuit line
- 48 MVAR capacitor at 138 kV Yturria
- +400/-100 MVAR SVC at 138kV Loma Alta
- +400/-100 MVAR SVC at 138kV Railroad
- +600/-200 MVAR SVC at 138kV North Edinburgh

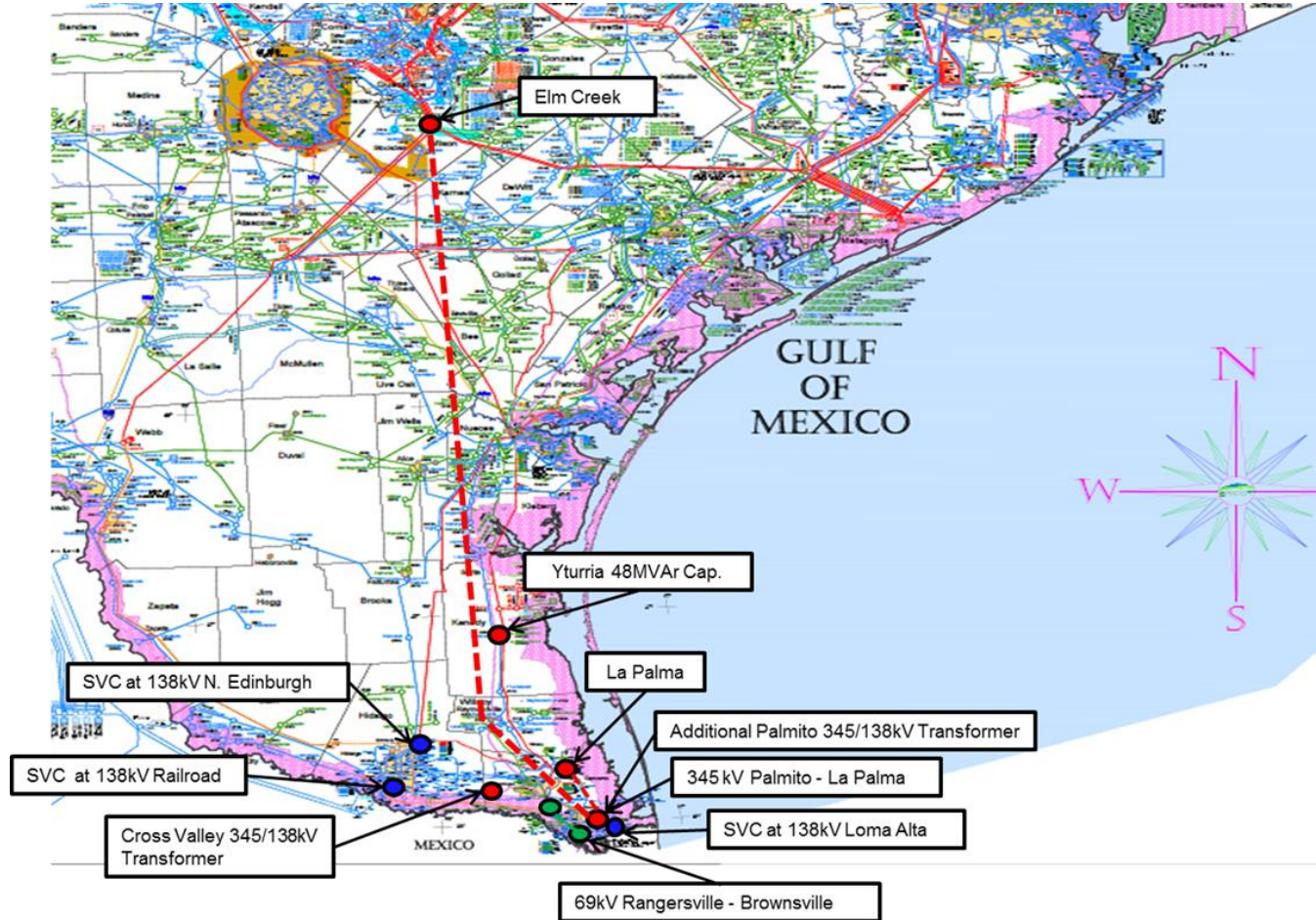


# Alternative Options Considered

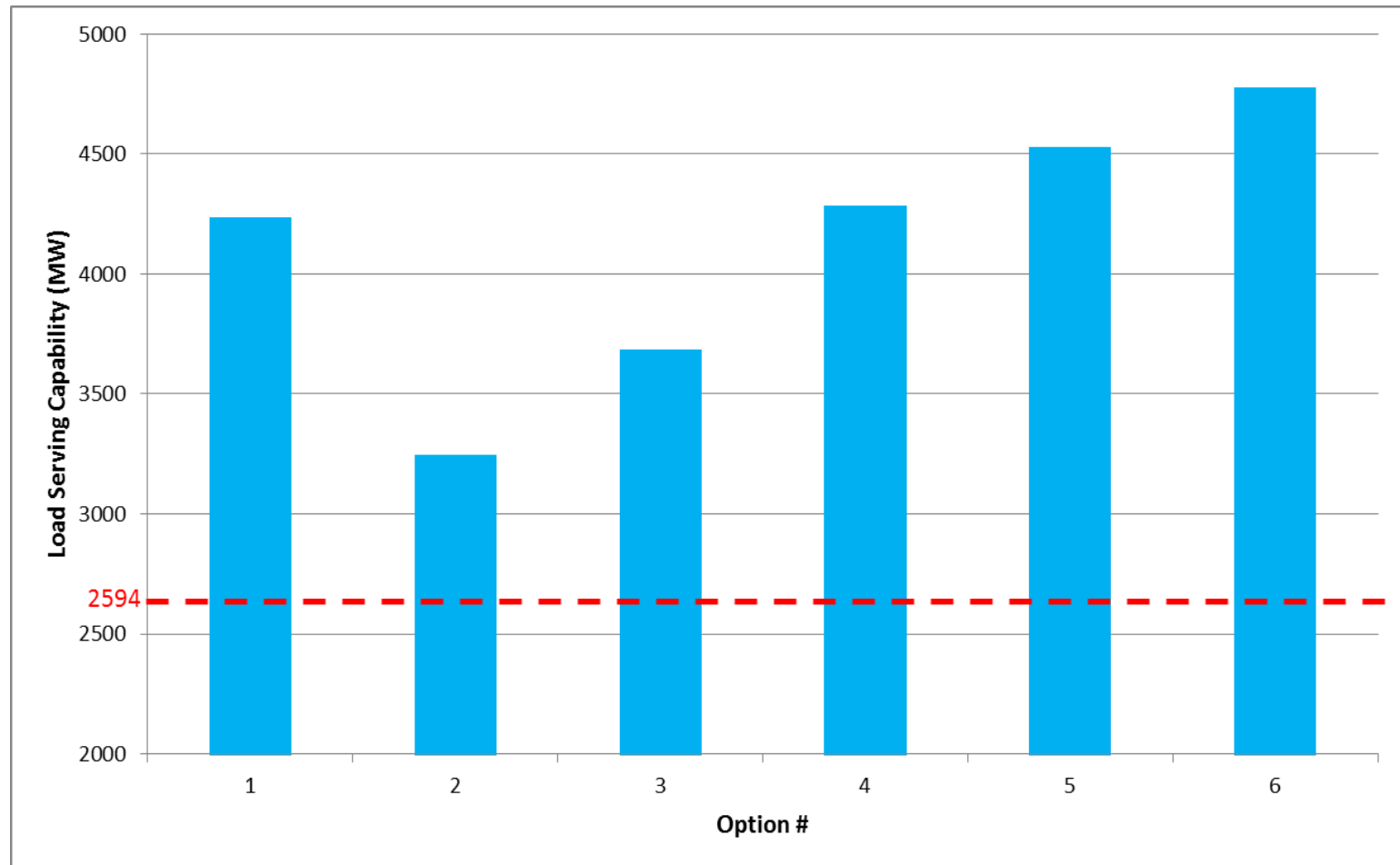
## ■ Option 6

- Option 5 with 50% series compensation on the Elm Creek to Palmito 345 kV line
- Additional +200/-100 MVAR SVC at 138kV Loma Alta
- Additional +200/-100 MVAR SVC at 138kV Railroad

# Options 5 & 6

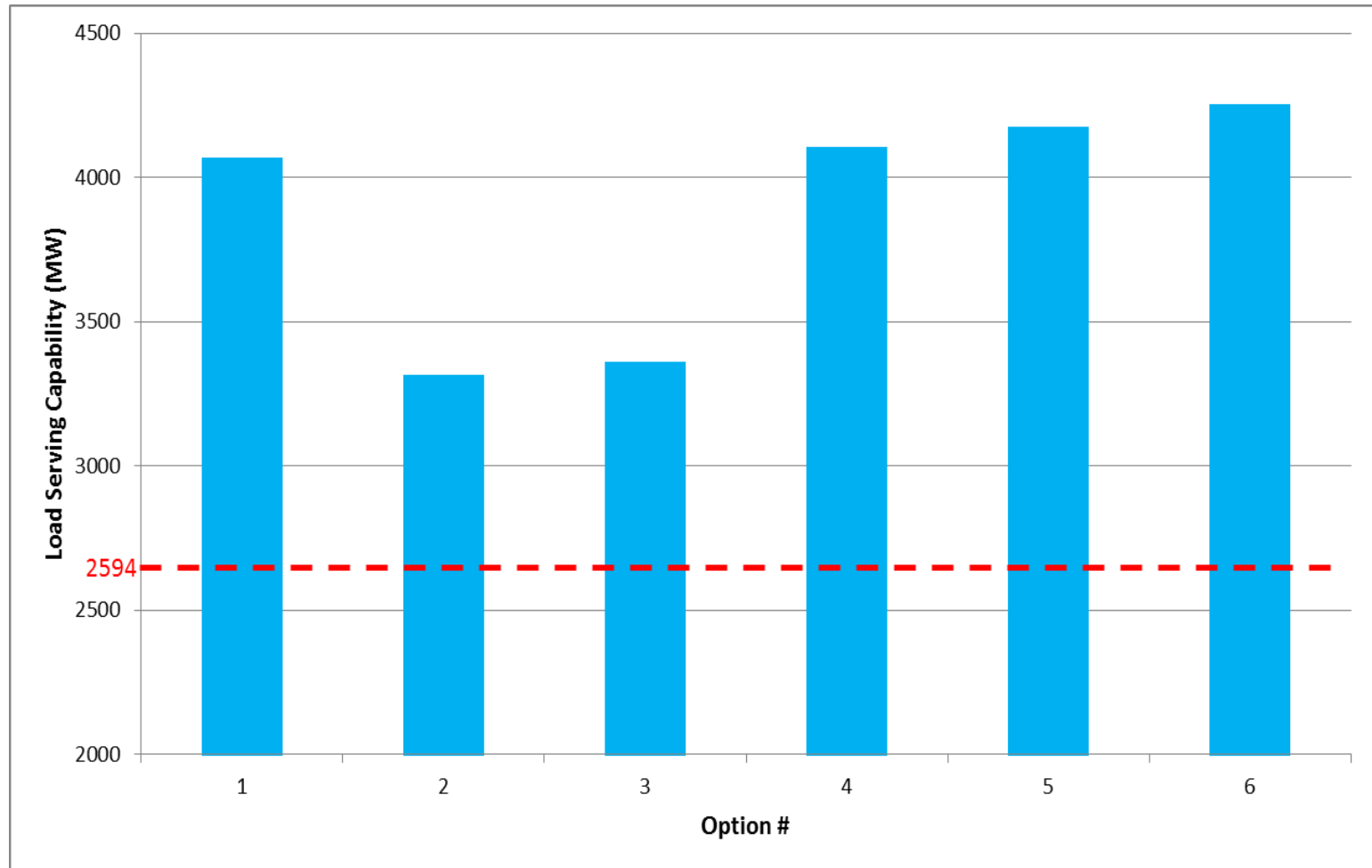


# Steady State Assessment Results



LRGV Load Serving Capability, Steady State Assessment, G-1+G-1

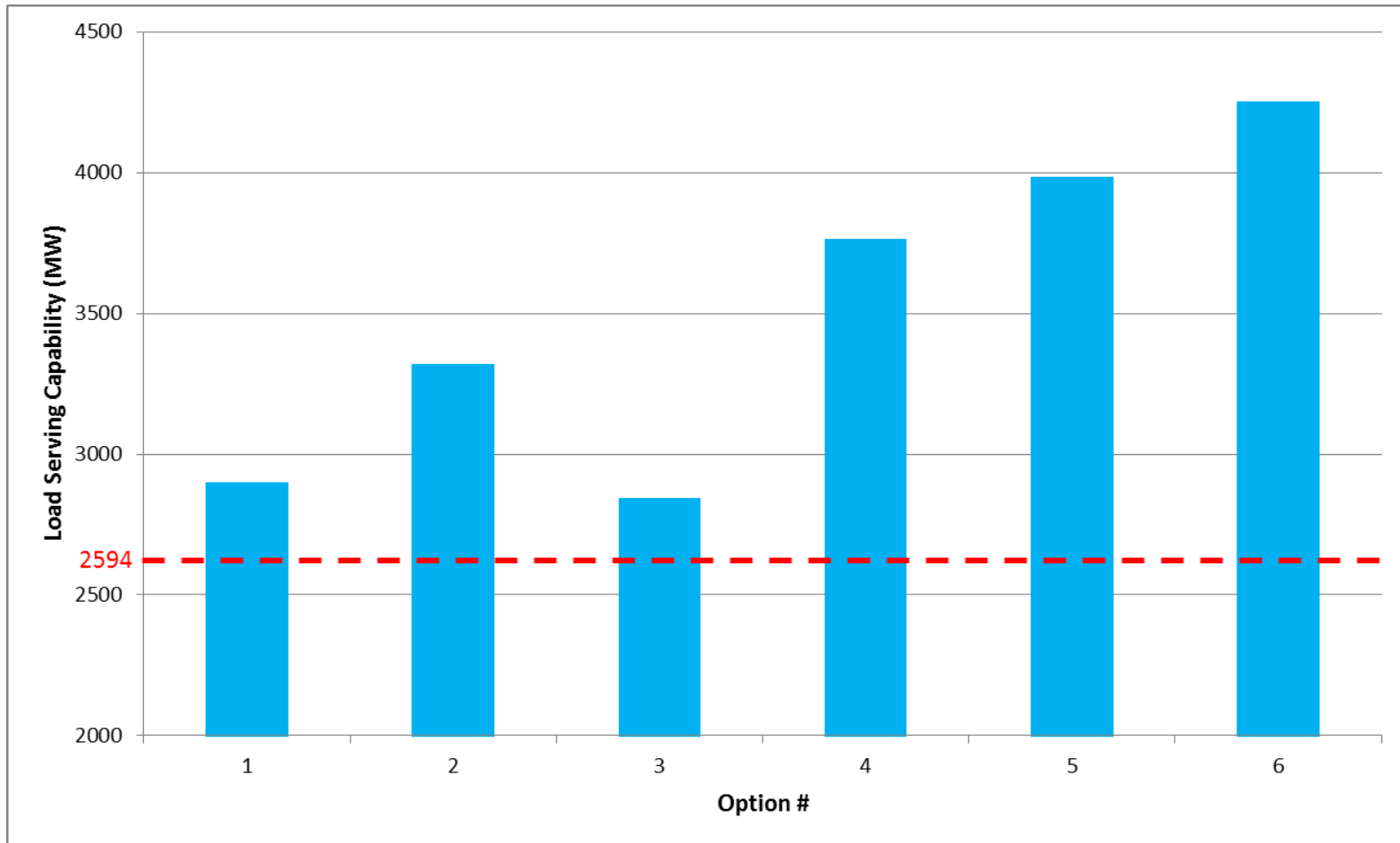
# Steady State Assessment Results



LRGV Load Serving Capability, Steady State Assessment, G-1+N-1



# Steady State Assessment Results



LRGV Load Serving Capability, Steady State Assessment, N-1-1

# Steady State Assessment Key Observations

- Transmission Options shortlisted for dynamic assessment
  - Option #5 – Involves a 345kV double circuit line from Elm Creek – Palmito station
  - Option #6 – Involves a 345kV double circuit series compensated line (50%) from Elm Creek – Palmito station
- Shortlisted options evaluated from a transient stability standpoint in terms of their load serving capability for the LRGV region to recommend final preferred option

Option	Most Limiting LSC (MW)
1	2900
2	3248
3	2844
4	3766
5	<b>3983</b>
6	<b>4252</b>

**Most Limiting Load Serving Capability Levels, Steady State Assessment**

# Lon Hill Vs Elm Creek Evaluation

- Short circuit MVA levels compared between NSUBLH (Lon Hill) & Elm Creek to evaluate the relative strength of the new source into the LRGV
- Elm Creek represents a source that is almost 2 times stronger than NSUBLH (Lon Hill)

Bus #	Bus Name	kV	SC Current (kA)	SC MVA
5133	Elm Creek	345	38.085	22758
80265	NSUBLH	345	19.916	11901

- Effective line reactance compared between AEP recommended option and Sharyland/CPS Options 5 and 6

Option	345 kV LRGV Import Path	% Series Compensation	# of Circuits	Length (miles)	Effective Line Reactance (p.u. on 100 MVA Base)
Sharyland & CPS Energy Option 5	Elm Creek to Palmito	0	2	280	0.06558
Sharyland & CPS Energy Option 6	Elm Creek to Palmito	50	2	280	0.03279
AEP-TCC Recommended Option (Option AEP)	NSUBLH to Ajo to NSUBXING	0	1	132	0.04525
765kV Single Circuit Line	Elm Creek to Palmito	0	1	280	0.0332

- A shorter line does not necessarily imply a better reliability performance

# Source/Sink Combination Evaluation

- Positive impact of the increased source station strength and the effective line reactance on the voltage stability of the valley region was further corroborated by performing a voltage stiffness evaluation for select stations within the valley.
- Nine (9) sample stations were identified, spanning 345, 138 and 69 kV levels, within the valley to perform a volt/var evaluation for Options 5, 6 and Option AEP.
- All transmission line additions associated with each of the above options was included in the evaluation.
- SVC/reactive additions recommended as part of these options were not included in the volt/var evaluation in order to quantify the relative benefit of the import path associated with each option

Scenario	dV/dQ								
	345 kV			138 kV			69 kV		
	Palmito	Rio Hondo	N. Edinburgh	Loma Alta	La Palma	Goodwin	Raymondville	Rangersville	McCook
Option AEP	2.22%	1.06%	0.60%	1.40%	1.25%	3.47%	13.92%	17.47%	35.06%
Option 5	1.24%	1.00%	0.60%	1.19%	1.24%	3.42%	13.99%	14.62%	35.06%
Option 6	1.07%	0.95%	0.60%	1.16%	1.23%	3.41%	13.94%	14.58%	35.06%



# Dynamic Assessment Approach

- All generation units meeting section 6.9 requirements of the ERCOT planning guide in the study region incrementally added
- Results of the steady state assessment utilized to identify the N-1-1, N-1+G-1 and G-1+G-1 events to be analyzed
- Key differences between steady state & dynamic analysis
  - Reactive capability from WGRs within the LRGV meeting Section 6.9 requirements of ERCOT Planning Guide assumed to be zero
  - WGRs in the Ajo region reduced to 10% dispatch
  - Voltages below 0.9 per unit within the LRGV assumed to be unacceptable
- Rotor angle and voltage stability evaluated at the above LRGV load levels
- Dynamic analysis LRGV incremental load serving capability limits:
  - Option 5 – 1389 MW (total LRGV LSC of 3983 MW)
  - Option 6 – 1658 MW (total LRGV LSC of 4252 MW)

# Elm Creek-Palmito Recommended Project

- Elm Creek – Palmito 345 kV line project
  - 280 miles of double-bundled, double circuit 345 kV line
  - Independent new source into the LRGV
  - New sink in the LRGV region
  - Longer term solution for the LRGV
    - Provides comparable or higher incremental transfer capability in comparison to AEPs recommended option
    - Better equipped to serve the LNG facility loads if they were to request connection
      - Options 5 and 6 observed to result in better reliability performance for the Brownsville LNG load addition sensitivity in comparison to terminating at Rio Hondo/North Edinburg
    - Ability to stage future, cost competitive LRGV Upgrades
      - Loop into and out of Ajo
      - Series Compensation
  - Cost competitive with the AEP options
    - Get two new 345 kV circuits at a comparable cost to AEP's single circuit proposal

# Elm Creek-Palmito Project

- Options to further increase the transfer capability into the LRGV
  - Loop-in-loop-out through AEP's Ajo station
    - Option 5 modified to loop in and out of the 345 kV Ajo station is expected to provide additional robustness to the option performance in terms of LRGV import and assist with Ajo region wind export capability
    - Import capability is observed to be at par with Option 6 albeit without series compensation
  - Triple-bundled 345 kV lines
  - Quadruple-bundled 345 kV lines
  - Series Compensation
    - SSR screening evaluation performed for the series compensated option (Option #6)
    - N-x evaluation for all generators in the region performed to quantify any material impact on SSR risk

# Cost Estimate – Option 5

Option 5 - Description	Cost (\$M)	Unit	Quantity	Total Cost (\$M)
280 mile, 345 kV Palmito - Elm Creek double circuit	1.69	\$M/mile	280	473.2
25 mile, 345 kV La Palma - Palmito single circuit line	1.1	\$M/mile	25	27.5
345kV, Ring Bus, Mehman switching station	15.94	\$M	1	15.94
138 kV Mehman switching station	9.05	\$M	1	9.05
345/138kV, 450 MVA Transformer at 345kV Mehman station	7.98	\$M	1	7.98
345/138kV, 450 MVA Transformer at 345kV Palmito station	7.98	\$M	1	7.98
20 mile, 69kV Rangersville - Brownsville single circuit line	0.375	\$M/mile	20	7.5
48 MVAR Capacitor at 138 kV Yturria	0.083	\$M/MVAR	48	4
SVC (+400, -100 MVAR) at 138 kV Loma Alta	0.075	\$M/MVAR	500	37.5
SVC (+400, -100 MVAR) at 138 kV Railroad	0.075	\$M/MVAR	500	37.5
SVC (+600, -200 MVAR) at 138 kV North Edinburgh	0.075	\$M/MVAR	800	60
<b>Total Cost of "Intra-LRGV" Upgrades (\$M)</b>				<b>44.47</b>
<b>Total Cost of Import Project (\$M)</b>				<b>643.68</b>



# Cost Estimate – Option 6

Option 6 - Description	Cost (\$M)	Unit	Quantity	Total Cost (\$M)
Option 5				643.68
Series Compensation at 50% for Palmito - Elm Creek	39	\$M	1	39
Additional SVC (+200, -100 MVAR) at 138kV Loma Alta	0.075	\$M/MVAR	300	22.5
Additional SVC (+200, -100 MVAR) at 138kV Railroad	0.075	\$M/MVAR	300	22.5
<b>Total Cost of "Intra-LRGV" Upgrades (\$M)</b>				<b>44.47</b>
<b>Total Cost of Import Project (\$M)</b>				<b>727.68</b>

Questions?

