

Pawnee – Smoky Hill 345kV Transmission Project

**Transmission Study Report
Exhibit No. GMS-1**

**Public Service Company of Colorado
Transmission Reliability & Assessment**

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Appendix A Energy Resource Zones

I. Executive Summary

On March 5, 2007, the General Assembly of Colorado passed Senate Bill 07-100 (SB07-100) upon recommendation by the 2006 Transmission Task Force on Reliable Electricity Infrastructure. In its November 1, 2006 Report, the Task Force recognized that “Colorado’s ability to ensure continued affordable, reliable electricity and to build a vibrant economy depends on sufficient transmission capability...and, if current trends continue, there will not be adequate transmission to meet the needs.” Part of the SB07-100 directive is for Public Service Company of Colorado (PSCo) to develop plans for the construction or expansion of transmission facilities necessary to deliver electric power consistent with the timing of the development of beneficial energy resources, and to submit applications for certificates of public convenience and necessity for those plans.

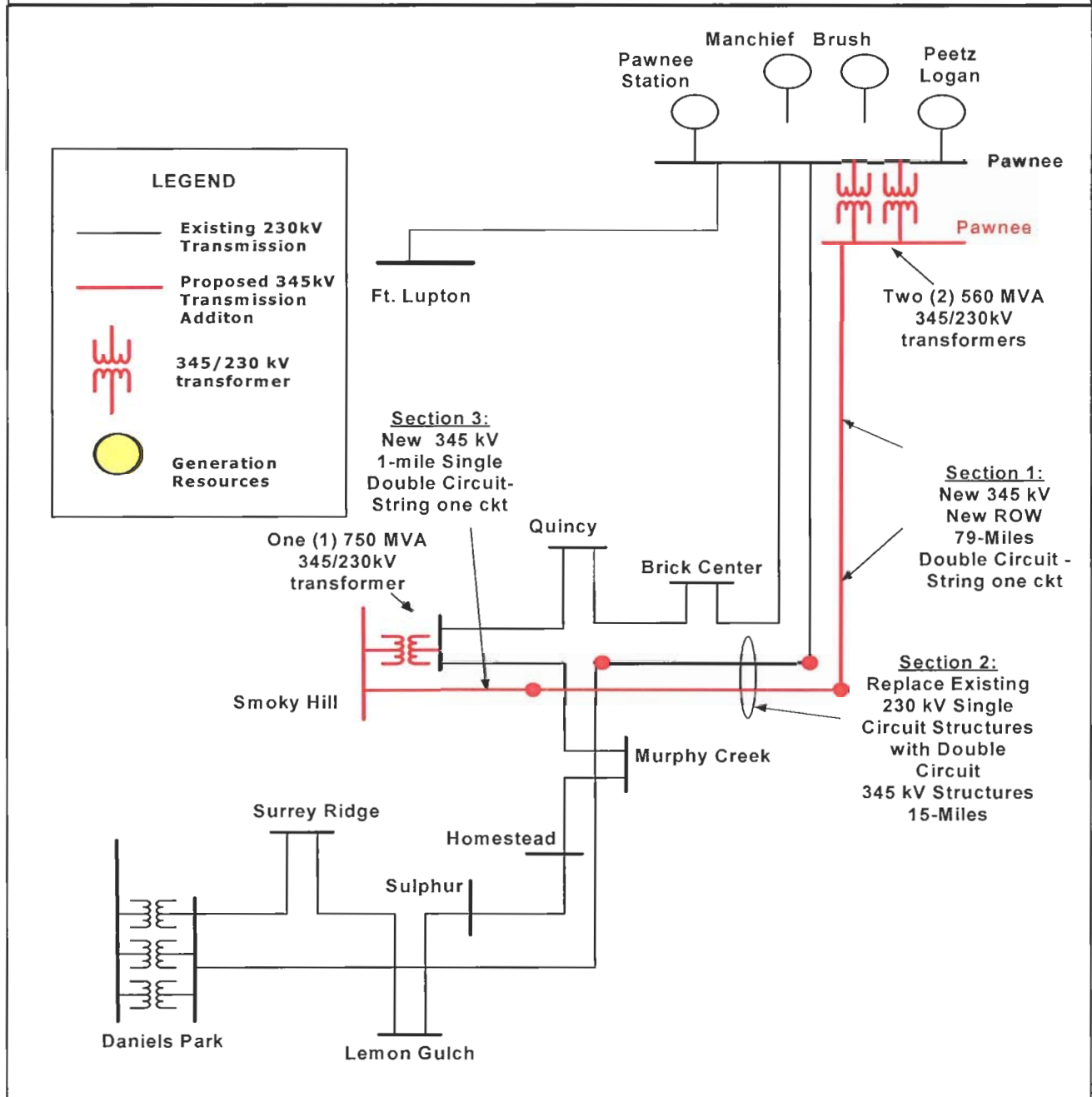
One of the areas that PSCo has identified to be constrained in terms of transmission is the northeast corner of the state. This area is referred to in SB07-100 filings as Energy Resource Zone #1 or simply Zone 1¹. PSCo Transmission Reliability and Assessment has verified that Zone 1 is constrained in terms of transmission. Based on generator and transmission interconnection requests, there is a high probability that future resource development in Zone 1 will occur at or near the Pawnee Substation. Since Pawnee Substation is the primary transmission hub, resource development in other regions of Zone 1 would also likely include a transmission connection to Pawnee in order to facilitate the flow of electricity to the Denver-metro load center. Therefore, this study was performed to evaluate transmission upgrades that would be necessary to allow delivery of additional generation resources from the Pawnee Substation to customer loads in the Denver-metro area.

The transmission project proposed in this report is referred to as the Pawnee – Smoky Hill 345kV Transmission Project (Project). The Project consists of creating a 345kV transmission circuit between the Pawnee Substation, near Brush, Colorado, and the Smoky Hill Substation, southeast of Denver. The 345kV transmission will connect the Pawnee and Smoky Hill Substations using 345/230kV autotransformers at Smoky Hill and at the Pawnee Substation. Figure 1 shows the proposed Pawnee – Smoky Hill 345kV Transmission Project.

Studies show that the proposed Project will enhance the reliability of the transmission system between Pawnee and metro-Denver. It will allow for additional power transfers from Pawnee to regional loads, and therefore be a logical step towards the development of transmission plans for Zone 1. The Project will have no significant impact on the neighboring electrical systems including the Tri-State Generation and Transmission (TSG&T), Intermountain Rural Electric Association (IREA), and Western Area Power Administration (WAPA).

¹ A map showing the Energy Resource Zones is included as Appendix A. Other transmission-related materials regarding Senate Bill 100 can be found at <http://www.rmao.com/wtpp/SB100.html>

Figure 1 Pawnee – Smoky Hill 345kV Transmission Project



Proposed Transmission

The Project can be described in three basic sections as shown in Figure 1:

- Section 1 consists of approximately 79 miles of new 345kV transmission. The transmission would be built to allow for double-circuit capability.
- Section 2 consists of rebuilding approximately 15 miles of existing 230kV wood-pole transmission to double-circuit, 345kV-capable steel-pole transmission. One side of the double-circuit towers would carry the existing 230kV circuit (that runs from Pawnee to Smoky Hill). The other side would carry the newly created Pawnee – Smoky Hill 345kV circuit.
- Section 3 is the last mile of transmission into the Smoky Hill Substation, and consists of approximately one mile of new 345kV transmission. This section would also be built to allow for double-circuit 345kV capability.
- The Pawnee – Smoky Hill 345kV transmission will connect to the Pawnee and Smoky Hill substations using two (2) 560 MVA 345/230kV autotransformers at the Pawnee Substation and one (1) 750 MVA 345/230kV autotransformer at the Smoky Hill Substation.

The Project develops 345kV transmission between Pawnee and the Denver-metro load center by prudent use of existing corridors, and acquiring new right-of-way where appropriate. Section 1 requires acquisition of new right-of-way in rural, mostly open prairie rangeland, minimizing the impacts to residential type land uses. In Section 2, which has significant residential development, the Project would utilize existing transmission corridors by converting an existing single-circuit 230kV transmission line to a double-circuit 345kV capable transmission to minimize impacts to the residential areas.

Total cost of this project is estimated to be \$120 million² with an estimated in-service date of summer 2013.

Other alternatives that were studied, but are not proposed, are discussed in the Studies Section.

² The level of accuracy for the cost estimates in this study is considered to be $\pm 30\%$, which is typical for a project at this budgetary stage in the process. This estimate is based on cost per mile indicators of past projects, average unit costs, and 2007 overhead and labor rates. This estimate is in 2007-year dollars, and it includes all appropriate overheads including AFUDC. At this stage of the project, these are high level, scoping estimates, which are the best estimates that the Company is able to provide prior to detailed engineering of the Transmission Project.

II. Background

In response to recommendations by the 2006 Transmission Task Force on Reliable Electricity Infrastructure the Colorado General Assembly passed SB07-100, a measure designed to ensure the adequacy of Colorado's electric transmission infrastructure. SB07-100, codified, in relevant part, at C.R.S. § 40-2-126, requires rate-regulated electric utilities, on or before October 31 of each odd-numbered year, to do the following:

1. Designate "Energy Resource Zones";
2. Develop plans for the construction or expansion of transmission facilities necessary to deliver electric power consistent with the timing of the development of beneficial energy resources located in or near such zones;
3. Consider how transmission can be provided to encourage local ownership of renewable energy facilities, whether through renewable energy cooperatives as provided in section 7-56-210, C.R.S., or otherwise; and
4. Submit proposed plans, designations, and applications for certificates of public convenience and necessity to the commission for simultaneous review.

In an effort to satisfy the CPCN requirement for SB07-100 the present transmission study addresses existing transmission constraints in Zone 1, and recommends transmission plans to reliably bring potential generation resources from the Pawnee area Zone 1 to Denver-metro area electrical loads. Appendix A is a map showing all of the zones as defined in the SB07-100 process.

The proposed project is consistent with previous studies performed for Generator interconnection requests. It is also consistent with recommendations that came from long-range studies done through the Colorado Coordinated Planning Group. Almost every study has recommended the establishment of a 345kV transmission system between Pawnee and the Denver-metro area to accommodate resource additions in the Pawnee region.

III. Objectives

PSCo adheres to Reliability Criteria published by the North American Electric Reliability Council (NERC) and the Western Electricity Coordinating Council (WECC). In addition, the following objectives were used to develop transmission alternatives:

- Reliably increase the ability to transfer additional power from the Pawnee Substation to PSCo customer loads.
- Allow for future expansion to accommodate future generation and transmission needs. This includes implementing higher-voltage projects, maximizing power carrying capability, and multi-circuit capable transmission.
- Avoid impacts to neighboring electric systems.
- Make practical use of existing transmission facilities and corridors.

IV. Methodology

The transmission studies were conducted in a stepped or phased approach. Since new transmission development can be a multi-year process, the study evaluated both short-term and long-term transmission development. Short-term plans would consist of transmission upgrades that could be implemented within one or two years at relatively low cost. The nature of the short-term transmission plans considered was such that they would not require the filing of an application for CPCN because under Rule 3206 such modifications to existing transmission facilities are deemed to be in the ordinary course of business. The goal of the short-term studies was to recommend upgrades that could allow all existing generation resources at Pawnee to simultaneously deliver maximum power to the Denver-metro area loads. The longer-term plan would allow for increasing the generation resource capacity in the Pawnee region by building new transmission. Therefore, models that represented both 2008 and 2015 system conditions were used for developing transmission plans.

A. Study Models

The 2008 and 2015 models were developed from Western Electricity Coordinating Council (WECC) approved cases. All planned transmission projects were represented. Cases were adjusted to create heavy north to south regional power transfers by reducing generation south of the Denver-metro area.

1. 2008 HS Powerflow Base Case

The 2008 case models peak summer loads and generation in the PSCo powerflow area, and has moderate transfer levels from Wyoming into Colorado across TOT3 of approximately 1,050 MW. Table 1 shows the output of generating facilities in the Pawnee region. The PSCo transmission projects modeled in the benchmark case that weren't in the WECC case include:

- a) Smoky Hill – Spruce 230kV double circuit transmission line uprated from 478 to 800MVA.
- b) Smoky Hill – Jordan Rd 230kV transmission line uprated from 326 to 525MVA.

Table 1 2008 Pawnee Area Generation Dispatch

Base Case	Generation Resources	Output (MW)
2008 HS	Pawnee	530
	Manchief	280
	Brush	260
	Peetz Logan	40
	Total Generation on-line at Pawnee	1,110
	Colorado – Wyoming transfer	Level (MW)
	TOT3	1,050

2. 2015 HS Powerflow Base Case

The 2015 benchmark case models forecasted peak summer loads and generation. It included the 2008 topology and transmission projects planned to be in service by

2015. The planned Comanche – Daniels Park 345kV and the Midway – Waterton 345kV transmission projects are included. Other significant transmission projects modeled include:

- a) Intermountain Rural Electric Association (IREA) Smoky Hill – Castle Rock 115kV transmission line upgrade to achieve a continuous rating of 239 MVA.
- b) IREA Brick Center – Kiowa 115kV transmission line.
- c) Western Area Power Association (WAPA) Story – Beaver Creek – Hoyt 230kV transmission line.

The 2015 case also modeled additional short-term transmission upgrades that would allow the maximum simultaneous Pawnee regional generation. The recommended short-term upgrade is to increase the power-carrying capability of both the Pawnee – Smoky Hill and Pawnee – Daniels Park 230kV lines to have a continuous rating of approximately 735 MVA. The short-term upgrade is described in more detail in the Results section.

Table 2 shows the generation dispatch in the 2015 base case and approximate TOT3 transfer levels. The higher TOT3 level was modeled to overcome the energy resource deficiency in the 2015 powerflow models.

Table 2 Base Case 2015 Generation Dispatch around Pawnee

Base Case	Generation Resources	Output (MW)
2015 HS	Pawnee	530
	Manchief	280
	Brush	260
	Peetz Logan	400
	Total Generation on-line at or near Pawnee:	1,470
	Colorado – Wyoming transfer	Level (MW)
	TOT3	1,450

B. Contingencies

These studies monitored the regional transmission system. Single contingencies (N-1) were performed for elements that were 69kV and above, including transformers with high-side voltages of 230kV. The contingency tables depicted in this report show the most significant N-1 results.

V. Results

A. Benchmark Analyses

The Pawnee area generation in the 2008 HS-A base case was increased to model simultaneous maximum by increasing wind generation. The powerflow case

2008HS-B models approximately 1,470 MW of Pawnee area generation, which is approximately 400 MW higher than in the 2008 HS-A powerflow case. Studies show that if the existing generation in the Pawnee area is at maximum output there is inadequate transmission to reliably deliver the generation resources to the Denver-metro area electric loads. Table 3 shows that the 230kV transmission lines south of Pawnee have the potential for contingency overloads. The Pawnee – Brick Center 230kV transmission line has the potential to overload up to 115% of its 478 MVA rating with the Pawnee – Daniels Park 230kV transmission line outage. The Pawnee – Daniels Park 230kV transmission line has the potential to overload up to 146% of its 326 MVA rating. Therefore, as a short-term measure, it is recommended to increase the continuous rating of the Pawnee to Smoky/Daniels Park 230kV transmission to 735 MVA.

Table 3 2008 Bench Mark Results

Benchmark Results			Contingency / Loaded Element					
Description	Pawnee Gen:	Case		MVA Rating →	Ft. Lupton – Henry Lake 230kV Ft. Lupton – JL Green 230kV	Brick Center – Quincy 230kV Smoky Hill – Strasburg 115kV	Spruce – Smoky #1 230kV Spruce – Smoky #2 230kV	Pawnee – Daniels Park 230kV Pawnee Brick Center 230kV
2008 Benchmark Without Pawnee – Smoky/Daniels Park 230kV uprate	1,170MW	2008HS-A		96%	87%	97%	94%	119%
2008 Benchmark Without Pawnee – Smoky/Daniels Park 230kV uprate	1,470MW	2008HS-B		102%	106%	103%	115%	146%
2008 Benchmark With Pawnee – Smoky/Daniels Park 230kV uprate	1,470MW	2008HS		102%	106%	103%	75%	65%

The Pawnee to Smoky/Daniels Park 230kV transmission line uprate to 735 MVA can be implemented with minimal cost and in a short time frame. It will enhance the reliability of the PSCo transmission system until additional transmission can be built.

This short-term transmission uprate allows for simultaneous generation of up to 1,470 MW in the Pawnee region. Once the Pawnee – Smoky Hills and Pawnee – Daniels Park lines are uprated, the system still has the potential for limiting contingency loadings in the 100% range. The loadings can occur on the 230kV lines south of Ft. Lupton, the Spruce – Smoky Hill 230kV lines, and the 115kV system between Smoky Hill and Strasburg. For the Ft. Lupton – Henry Lake 230kV transmission outage the Ft. Lupton – JL Green 230kV transmission line has the potential to overload up to 102% of its 495MVA rating. The Spruce – Smoky Hill 230kV transmission lines also have the potential to overload up to 104% with the loss of the parallel circuit.

Due to the several contingency loading conditions that were around the 100% limit, additional transmission will need to be developed to accommodate any additional generation resources in the Pawnee area.

B. 2015 Benchmark studies

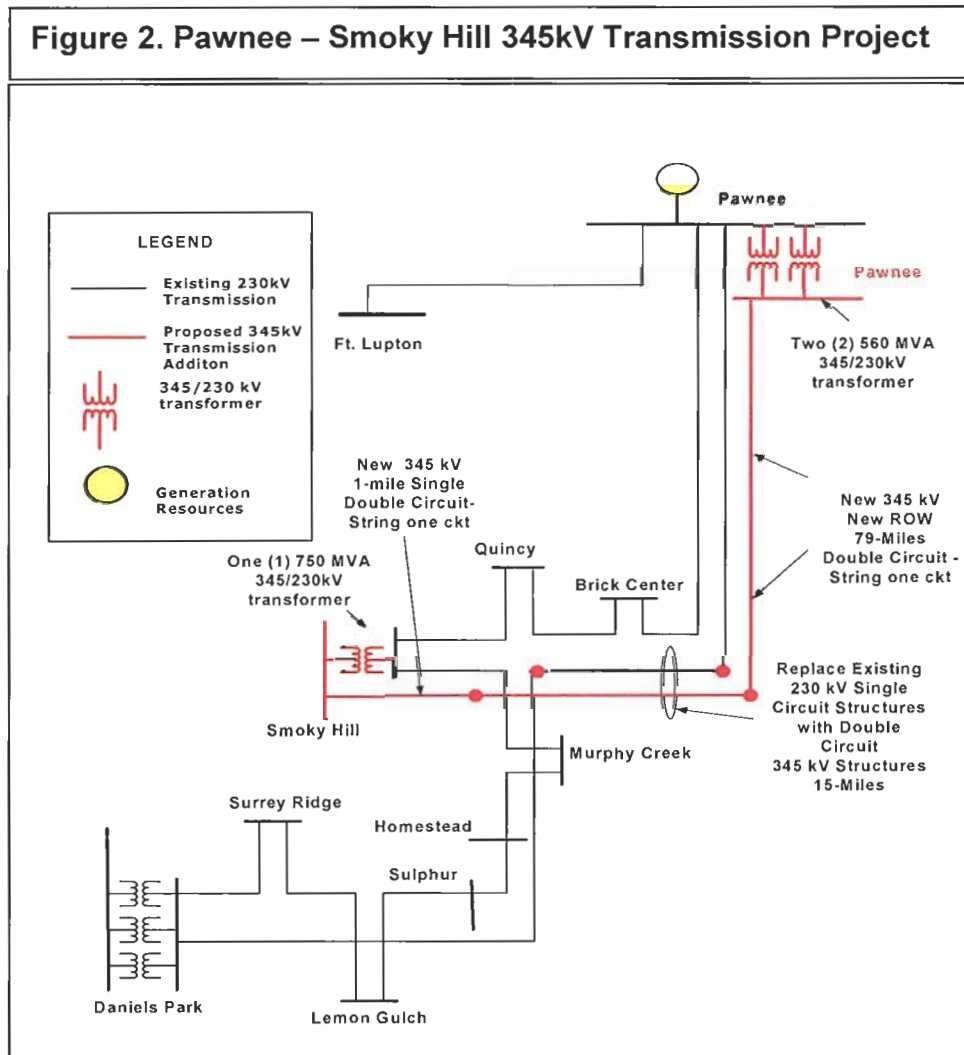
To evaluate longer-term transmission alternatives, cases that modeled 2015 conditions were developed. These cases included the recommended uprate of the Pawnee – Smoky / Daniels Park transmission to 735 MVA. The benchmark transmission studies included models of all planned transmission projects.

VI. Alternative Analyses

From the benchmark analysis, it was clear that the enhancement of any significant injection capacity at the Pawnee Substation would require additional high-voltage transmission. Several different alternatives were evaluated and are described in the following sections. For each alternative, Pawnee area generation was increased beyond the 1470 MW level in the benchmark until contingency limits were reached.

A. Proposed Alternative: Pawnee – Smoky Hill 345kV Transmission

The proposed alternative consists of adding a new 345kV transmission line between Pawnee Substation and Smoky Hill Substation. The alternative is shown in Figure 2



The transmission alternative was added to the benchmark powerflow case, and then generation at Pawnee was increased until contingency limits were reached.

Table 4 Pawnee – Smoky Hill 345kV Contingency Results

Benchmark Results				Contingency / Loaded Element			
Description	Pawnee Gen:	Case	MVA Rating →	Quincy – Brick Center 230kV Brick Center 230/115 kV auto	Valmont – Spindle 230kV Ft. Lupton 230/115kV auto	Pawnee – Smoky 345kV Pawnee – Daniels Park 230kV	Pawnee – Smoky 345kV Pawnee – Brick Center 230kV
2015 Bench Mark Case	1,470 MW	2015HS		124%	106%	N/A	N/A
2015 Single 345kV Pawnee to SH	1,970 MW	2015HS (P-SH)		107%	103%	65%	74%

The incremental injection capacity of generation resources at the Pawnee Substation for this alternative is approximately 500 MW. This limit of 500 MW was determined by two critical contingency overloads around the Denver-metro area. With the Pawnee – Smoky Hill 345kV Transmission Project in place and approximately 1,970 MW of generation feeding into Pawnee, the Brick Center 230/115kV autotransformer has the potential to overload up to 107% of its 200 MVA rating with the Brick Center – Quincy 230kV transmission line outage. In addition, other contingencies in the Denver-metro region exhibited loadings above their 100% rating.

The estimated cost for the proposed alternative is approximately \$120 Million with a time frame of approximately 60 months for completion. Therefore, the Project could not to be implemented before the summer of 2013.

B. Pawnee – Daniels Park 345kV Transmission Alternative

This alternative consists of a new single-circuit 345kV transmission system from Pawnee Substation to Daniels Park Substation. This alternative is depicted in Figure 3. Once the alternative transmission was added to the benchmark case, the Pawnee generation was increased until contingency limits were reached. For this alternative, the contingency limit was approximately 500 MW higher than the 1470 MW level in the benchmark.

Table 5 shows the contingency results for the Pawnee – Daniels Park 345kV Transmission Alternative. The estimated cost for the basic transmission alternative is approximately \$125 Million. However, as seen in the table, the Brick Center 230/115kV autotransformer may also need to be replaced. The Brick Center transformer replacement is estimated to be approximately \$4 million in addition to the \$125 Million.

Figure 3. Pawnee – Daniels 345kV Transmission

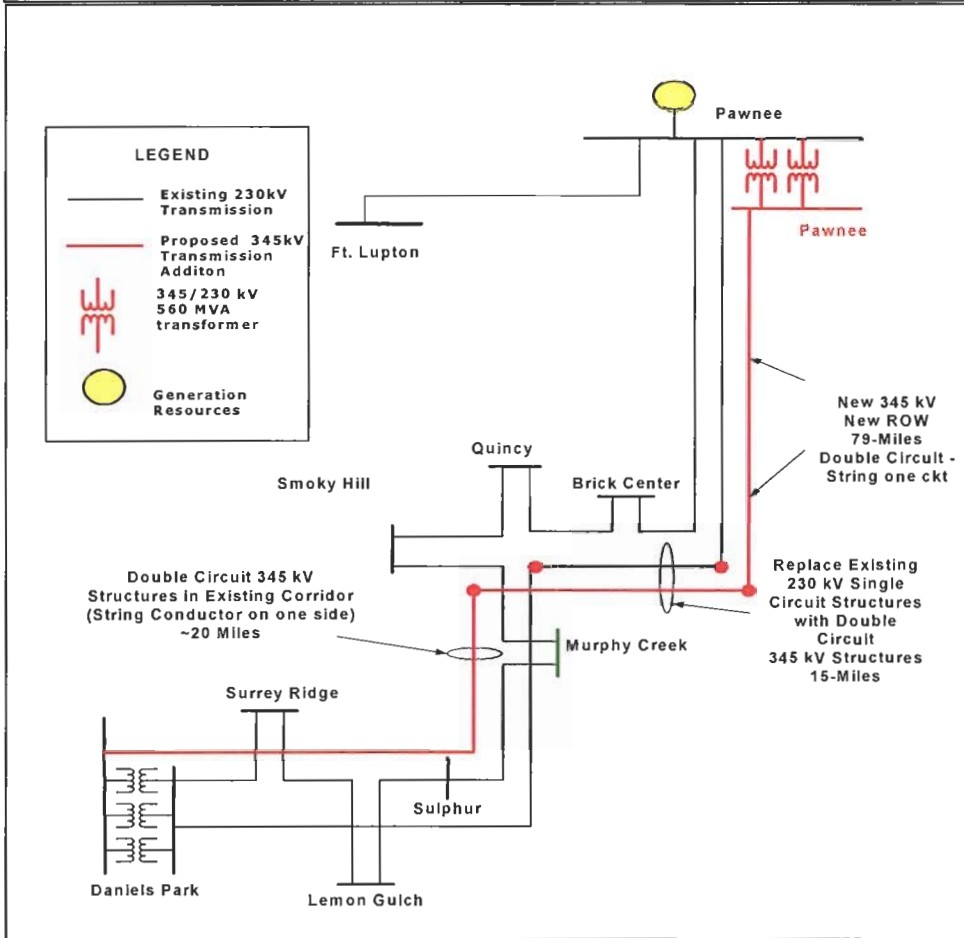


Table 5 Pawnee – Daniels Park 345kV Contingency Table

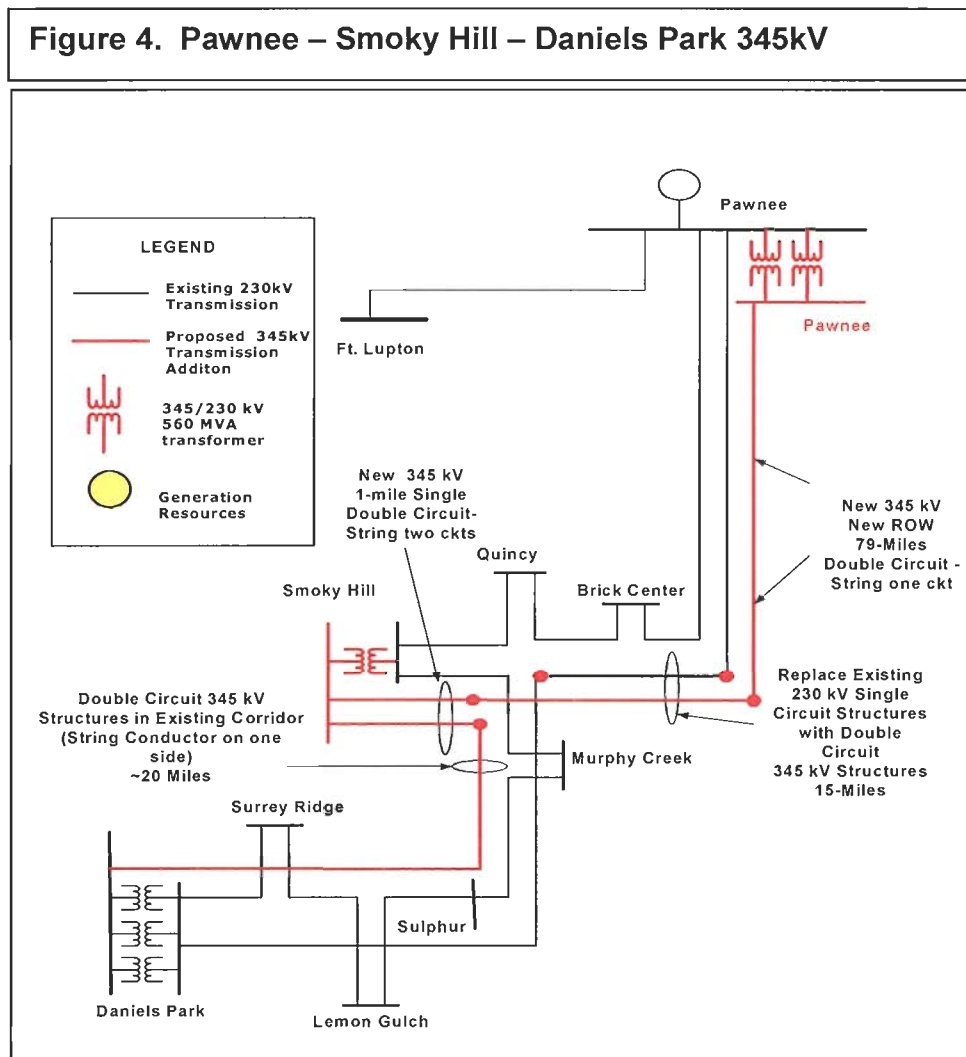
Benchmark Results			Contingency / Loaded Element	Contingency / Loaded Element			
Description	Pawnee Gen:	Case		MVA Rating	200	280	560
2015 Single 345kV Pawnee to SH	1,970 MW	2015HS (P-SH)		107%	103%	<90%	<95%
2015 Single 345kV Pawnee to DP	1,970 MW	2015HS (P-DP)		115%	103%	101%	102%

Table 5 also shows the existing Daniels Park 345/230kV transformers are beginning to exhibit overloads greater than 100% at the 500 MW incremental level. Similarly, for the loss of the Waterton – Roxborough 115kV transmission line the Daniels Park – Castle Rock 115kV transmission line begins to overload marginally. Increasing the generation resources at Pawnee would cause these overloads to increase and have the potential to create undesirable system operation.

This alternative has a higher cost for the same amount of increased generation capability at Pawnee. It would also require additional time for permitting and construction activities, due to the greater length. Therefore, this alternative is not recommended.

C. Pawnee – Smoky Hill – Daniels Park 345kV Transmission

This alternative consists of 345kV transmission originating at Pawnee and terminating at both the Smoky Hill and the Daniels Park substations. Figure 4 shows the alternative.



Once the alternative was added to the benchmark case, generation at Pawnee was increased until contingency limits were reached. Table 6 shows the results of the contingency analysis. For this alternative the generation at Pawnee could be increased by approximately 800 MW above the 1470 MW benchmark level.

Table 6 Pawnee – Smoky Hill – Daniels Park 345kV Contingency Results

Benchmark Results			Contingency / Loaded Element	200	280
Description	Pawnee Gen:	Case			
2015 HS Single 345kV Pawnee to SH	1,970 MW	2015HS (P-SH)	107%	103%	
2015 HS Single 345kV Pawnee to SH to DP	2,270 MW	2015HS (P-SH-DP)	110%	105%	

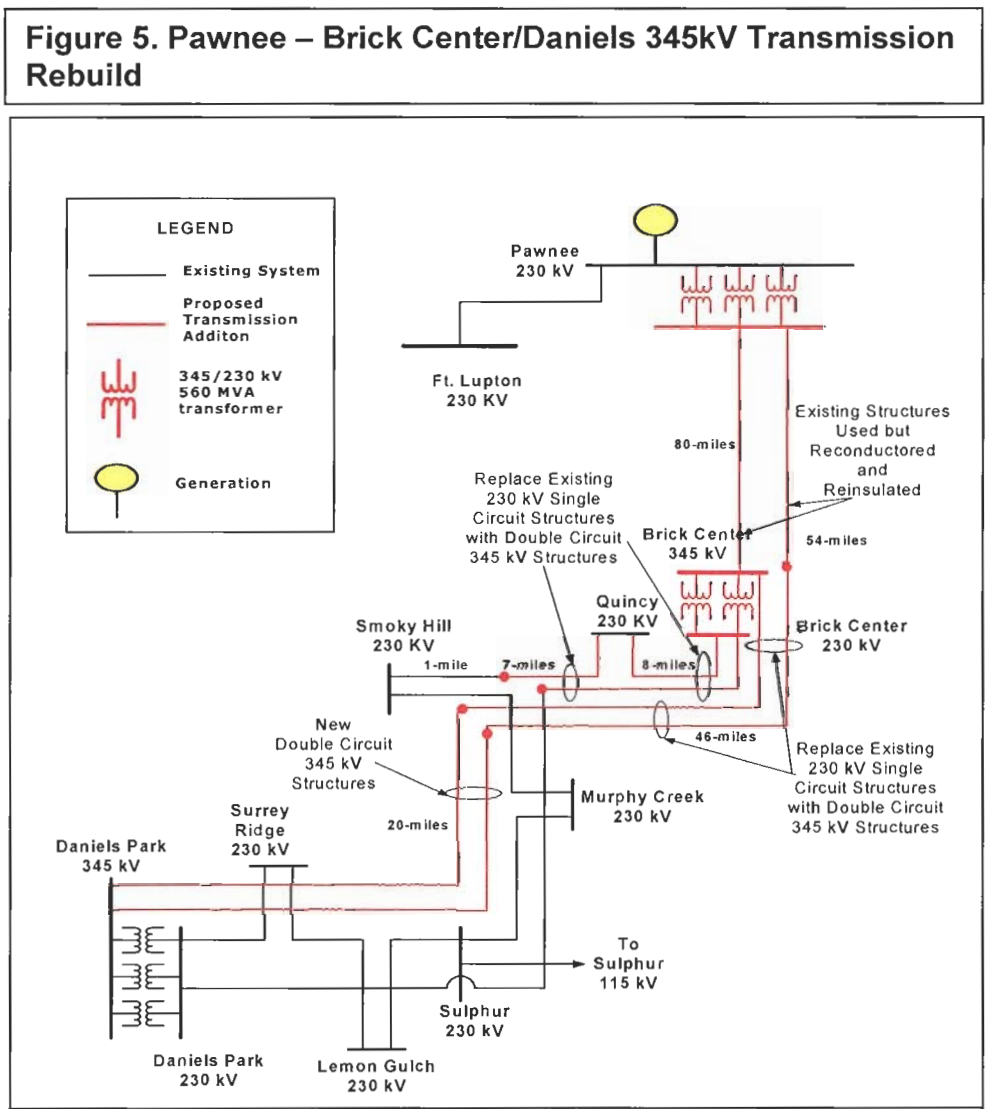
At the 800 MW level, the 230kV and 115kV transmission system south of Ft. Lupton started to exhibit contingency overloads. Since the Brick Center 230/115kV autotransformer also exhibited contingency loadings of 110%, it may also need to be replaced. This project has been previously identified in the internal PSCo budget cycle for an additional cost of \$4 Million.

The total cost for this alternative is approximately \$148 Million (\$152 Million with Brick Center). Due to higher cost of this alternative and the longer time for construction and permitting, it is not recommended. However, the proposed alternative would allow for this “expanded” alternative to be implemented in the future by building 345kV transmission between Smoky Hill and Daniels Park.

D. Pawnee – Smoky Hill / Daniels Park 345kV Rebuild

This alternative consists of rebuilding the existing 230kV lines south of Pawnee (towards Brick Center and Smoky Hill) to 345kV operation. This alternative would utilize existing right-of-way.

Figure 5 shows the alternative. This alternative in essence would provide a Pawnee – Brick Center/Daniels Park 345kV transmission line and a Brick Center – Smoky Hill/Daniels Park 230kV transmission line. This alternative was evaluated in previous studies, including CCPG long-range studies. However, during discussions with PSCo Operations and Engineering, it was determined that this alternative may not be feasible to construct due to operational limitations. The rebuild of lengthy existing 230kV lines to 345kV would require prolonged transmission system outages and has the potential to create undesirable system conditions. To reduce the risk associated with the conversion project additional transmission would have to be developed first. Previous studies indicated that additional transmission would have to be built between Pawnee and Ft. Lupton at an estimated cost of approximately \$50 Million. The total project cost for this alternative is estimated to be at least \$195 Million.



Due to the higher cost and the questionable feasibility of this alternative, it is not recommended.

E. Other Alternatives

Several other alternatives have been evaluated in studies performed for Generator Interconnection requests. Both 230kV and 345kV transmission alternatives were evaluated, using existing and new corridors. However, none of the alternatives were able to mitigate unacceptable contingency overloads that resulted from adding generation at Pawnee. Some of these alternatives can be found in previous Generation Interconnection studies.

Transmission alternatives were also evaluated on a high level that proposed a transmission system from Pawnee to Ft. Lupton. Those studies determined that significant upgrades would be required to terminate at Ft. Lupton. Both transmission alternatives created the potential for severe contingency overloads on the 230kV and 115kV transmission system south of Ft. Lupton and the 230/115kV autotransformer at Ft. Lupton. The 345kV alternative caused higher overloads and also required significant upgrades at the Ft. Lupton Substation. Since a 230kV or 345kV termination at Ft. Lupton would require extensive transmission upgrades south of Ft. Lupton, and cause potential overloads out of Cherokee, these alternatives were not considered any further.

Other transmission alternatives originating at Pawnee were evaluated at a cursory level. These include:

5. 345kV termination at the new Keenesburg Substation, east of the Rocky Mountain Energy Center (RMEC),
6. 345kV terminations at Keenesburg and Ft. Lupton Substations, and
7. 345kV terminations points at Keenesburg and Ft. St. Vrain Substation.

The studies showed that each of these alternatives would require significant transmission system upgrades beyond the terminal point to sustain and maintain system integrity and reliability under contingency conditions.

Due to the significant regional impacts and the need to build more transmission infrastructure beyond the terminal point to sustain transmission integrity and reliability these alternatives were not considered further.

F. Summary of Alternative Analyses

The Pawnee – Smoky Hill 345kV Transmission Project is the recommended high-voltage transmission alternative to increase the generation injection capacity at the Pawnee Substation to deliver generation resources to the Denver-metro area electrical loads. The proposed project provides an incremental generation injection capacity of approximately 500 MW. The Project allows for future expansion of the 345kV network to Daniels Park, which was shown to accommodate an additional 300 MW of generation capability at Pawnee.

Alternatives that terminated at points other than Smoky Hill or Daniels Park were shown to require significant system upgrades beyond the termination point and result in significantly higher costs. Table 7 summarizes the costs of the alternatives evaluated.

Table 7 Alternative Summary

345kV High-Voltage Transmission	Pawnee Simultaneous Generation Level (Approximate)	Cost (\$ Million)
Pawnee – Smoky Hill 345kV Transmission	1,970 MW	120
Pawnee – Daniels Park 345kV Transmission	1,970 MW	125
Pawnee – Smoky Hill – Daniels Park 345kV Transmission	2,270 MW	148
Pawnee – Brick Center/Daniels Park 345kV Transmission	1,970 MW	195

VII. Stability Analysis

PSCo has conducted transient stability studies in the region during the course of numerous Generator Interconnection Studies. These studies have shown that under very similar generation injection level at Pawnee with higher transmission built into the Denver-metro area loads the transmission system exhibits acceptable transient and voltage stability.

VIII. Final Conclusions

The proposed project is the preferred transmission alternative to accommodate additional injection generation capacity at Pawnee. The Project:

Accommodates additional generation:

The Project allows an additional 500 MW of generation resources to be added at Pawnee.

Allows for future expansion:

The proposed project establishes 345kV transmission between Pawnee and Smoky Hill. It allows for future expansion of 345kV transmission to Daniels Park, which would complete a 345kV system from Pawnee to Comanche.

Does not interfere with neighboring electric systems:

The proposed project does not have any adverse impact on neighboring utilities' systems.

Makes practical use of existing facilities and corridors:

The proposed project recommends new right-of-way acquisition in rural areas, and rebuilding transmission in existing easements in areas of urban development.

IX. Study Criteria

A. NERC/WECC Criteria

As a member of WECC, PSCo adheres to the WECC and NERC Reliability Criteria. The complete Reliability Criteria document can be found on the WECC web site at www.wecc.biz.

B. System Normal Condition:

- Line loadings must be limited to 100 percent of the continuous seasonal rating, the established equipment rating, or applicable operating limits.
- Transformer loadings must be limited to 100 percent of the highest nameplate rating or appropriate owner's top rating.
- Transmission bus voltages maintained between 0.95 p.u. and 1.05 p.u. of nominal system voltage³.

C. Contingency Conditions

- PSCo considers 110% as the maximum allowed contingency loading for operational studies, but for planning studies such as this, 100% loading was used to establish system limits.
- Transformer loadings must remain within 115% of the system normal rating or an established emergency rating. However, 100% loading was used to establish limits for this study.
- Transmission bus voltages maintained between 0.90 p.u. and 1.10 p.u. of nominal system voltage.

³ In the benchmark and alternative analyses there were many bus voltages outside the normal range of accepted voltage for both system intact and contingency conditions. Most of the voltage violations were determined to be due to load patterns and the uncertainties with future generation resources, which could be a source of voltage support. This study focused on the development of transmission infrastructure based on system element loadings. Voltage issues will be dealt with in the normal course of business and alleviated with capacitor additions, load shifting, and generation additions.

Appendix A

Colorado Energy Resource Zones

