SPP Southwest Power Pool
MARKET MONITORING UNIT

WESTERN ENERGY IMBALANCE SERVICE MARKET

FREQUENTLY CONSTRAINED AREAS 2020 STUDY

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1 EXECUTIVE SUMMARY

The Market Monitor analyzed real-time data from November 1, 2019 through October 31, 2020 for constraints monitored in the Western Interconnection by the SPP Reliability Coordinator. Based on the analysis, the Market Monitor recommends no Frequently Constrained Areas (FCA) prior to the start of the Western Energy Imbalance Services (WEIS) market.

1.1 INTRODUCTION

Frequently Constrained Areas are areas of the market footprint that both experience high levels of congestion and are associated with one or more pivotal suppliers. A supplier is pivotal when some or all of its output is necessary for reliable operation of the electrical system within a defined area. The SPP Western Imbalance Service Tariff[1] defines Frequently Constrained Areas as:

> "an electrical area identified by the Market Monitor that is defined by one or more binding transmission constraints that are expected to be binding for at least five-hundred (500) hours during a given twelve (12)-month period and within which one (1) or more suppliers are pivotal."

The SPP Market Monitor defines and recommends Frequently Constrained Areas to the SPP Board of Directors prior to the start of the WEIS market[2] and reevaluates the designations at least annually.[3]

[1] SPP Western Imbalance Service Tariff Att. B Section 3.1.1 (Frequently Constrained Areas)

[2] SPP Western Imbalance Service Tariff Att. B Section 3.1.1.2 (Initial Designation of Frequently Constrained Areas)

[3] SPP Western Imbalance Service Tariff Att. B Section 3.1.1.3 (Changes to Frequently Constrained Area Designation)

The contents of this report include:

- Executive summary: an executive summary of the findings and proposals
- Methodology: description of the study process or methodology
- Analysis and Results: detailed description of the analysis
- Binding Constraint And Pivotal Supplier Data: list of constraints and paths with corresponding binding and pivotal supplier hours

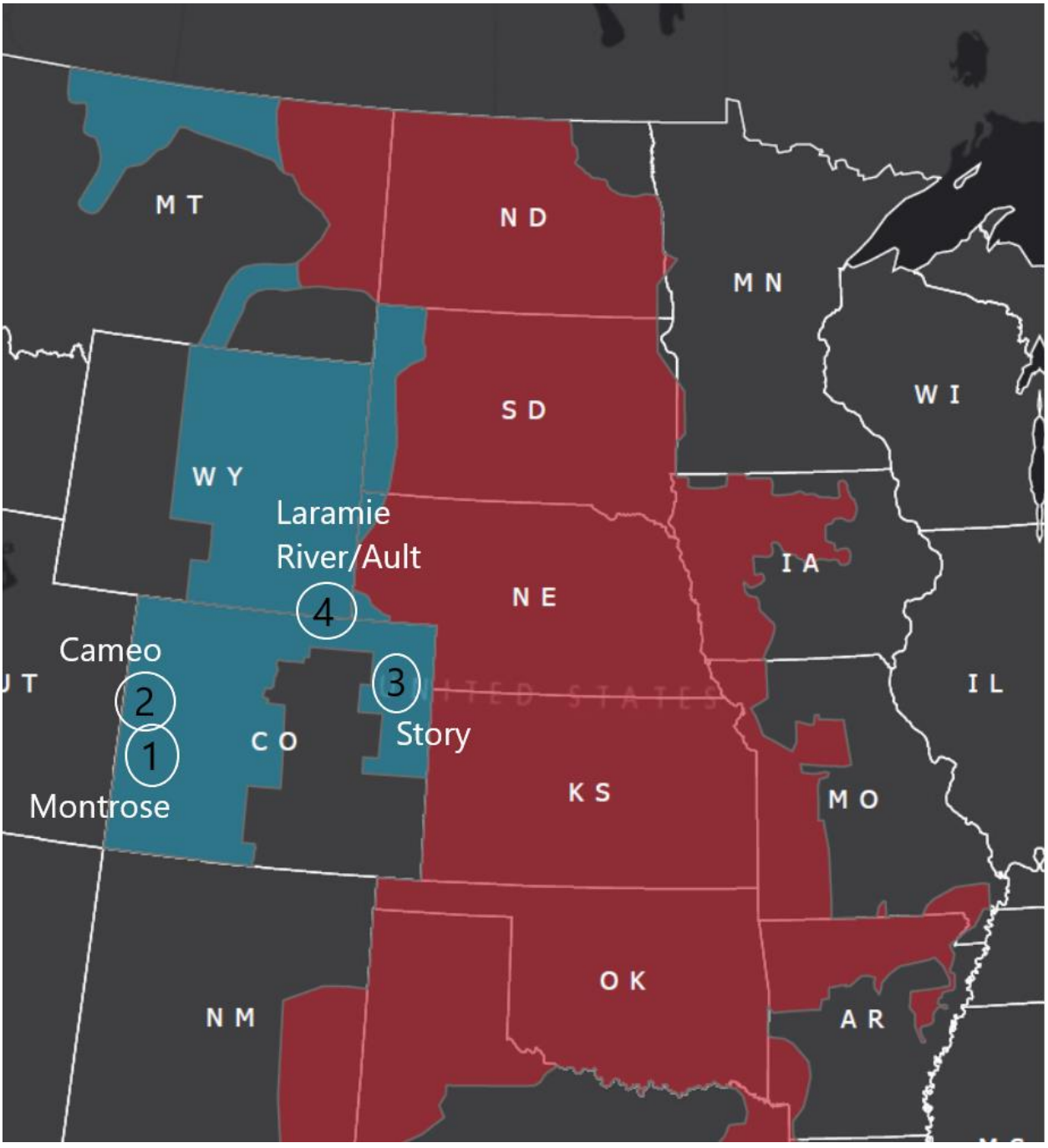
1.2 RESULTS

The MMU analyzed over 15 scenarios with varying primary and secondary constraints as Frequently Constrained Area possibilities in the WEIS market area. The four areas shown in Figure 1–1 are the scenarios resulting in at least 100 binding hours. The remaining preliminary scenarios resulted in insignificant binding and pivotal supplier hours.

Figure 1–1 Frequently Constrained Area Candidate Designations

Map Reference #	Geographical Area	FCA Candidate Name
1	Western Colorado	Montrose
2	Western Colorado	Cameo
3	East of Denver, Colorado	Story
4	North of Denver, Colorado	Laramie/Ault

Figure 1–2 Frequently Constrained Area Candidates



The binding and pivotal supplier analysis (see Study Process) counts the number of hours[4] a constraint is near or above its limit and the number of those hours where at least one supplier is pivotal. Binding and pivotal supplier hours for a candidate area is the summation of all hours for the primary constraint and secondary constraints in that area. Figure 1–3 provides the binding and pivotal supplier analysis results for these four candidate areas and the pivotal supplier hours for each of the six suppliers in the WEIS market.

Figure 1–3 Binding and Pivotal Supplier Analysis Results

FCA Candidate	FCA Candidate Total							
	Binding (Hrs)	Pivotal Supplier (Hrs)	PS 1 (Hrs)	PS 2 (Hrs)	PS 3 (Hrs)	PS 4 (Hrs)	PS 5 (Hrs)	PS 6 (Hrs)
Montrose	**137**	**123**	0	123	0	0	0	0
Cameo	**137**	**123**	0	123	0	0	0	0
Story	**263**	**91**	17	73	11	30	11	16
Laramie/Ault	**103**	**41**	0	41	0	0	0	0

* Pivotal Supplier hours may have multiple pivotal suppliers in an interval

No candidate areas exceeded 500 binding hours where there was at least one pivotal supplier. The Montrose candidate area is in the western Colorado and measured 137 binding hours for the study period. 90 percent of these hours were pivotal with only one supplier being pivotal during these hours. The Cameo candidate area also in western Colorado produced the same results since the area was comprised of the same constraints as the Montrose candidate area but with different primary constraints (see Section 3.1.)

The Story candidate area, east of Denver, produced the most binding hours of all the candidate areas but had the least percentage of pivotal hours. 35 percent of the binding hours were pivotal with all six suppliers pivotal at least one of the hours. The Laramie/Ault candidate area

[4] Count is by interval. In a five minute market a binding interval would count as one-twelfth of an hour.

had the fewest binding and pivotal supplier hours of the candidate areas. 40 percent of the binding hours were pivotal with all the pivotal hours from one supplier.

1.3 PROPOSAL

The MMU recommends adding no Frequently Constrained Areas prior to the start of the Western Energy Imbalance Services market. The results of this analysis indicates no candidate areas that observed constraints at or near their limits for over 500 hours during the study period. The MMU is required to reevaluate the Frequently Constrained Areas annually and may reevaluate more frequently if conditions change. The MMU will monitor for the need to perform another analysis prior to the annual requirement given the probability of congestion pattern changes resulting from a centralized dispatch.

2 METHODOLOGY

2.1 DATA AND STUDY PERIOD

The study period runs from November 1, 2019 through October 31, 2020. Historical real-time constraint and path loading, limits, and resource output used by SPP in its role as a Reliability Coordinator in the Western Interconnection were used in the analysis. Reference levels were used for resource physical parameters and resource shift factors calculated using models for daily contingency analysis. Nameplate capacity was used for the final results of this analysis. A 53 percent cap on hydro resources was also simulated but the difference in results were minimal, therefore not shown.

Future Frequently Constrained Area studies after the start of the WEIS market will use WEIS Real-time Balancing Market (WRTBM) congestion and dispatch data, and resource parameter offers for online resources. Real-time transmission system topography, including but not limited to transmission elements, ratings, effective and termination times, temporary operating conditions, etc., will also be used.

2.2 STUDY PROCESS

The study consists of the following five step process.

1. **Binding Hours Computation**: The number of binding hours is computed for each modeled transmission constraint that is at 90 percent[5] of its limit or greater. A constraint is counted as binding if the loading on the constraint plus the additional loading capability of a supplier is equal to or greater the constraint limit.

[5] A scenario was also simulated at 70 percent that resulted in minimal differences. The FCA analysis in the east Integrated Marketplace uses 90 percent.

2. **Pivotal Supplier Analysis**: The number of pivotal supplier hours is computed for each binding transmission constraint. A constraint is counted as having a pivotal supplier during an interval if the supplier can cause a constraint to exceed the limit by decreasing generation on resources that provide congestion relief and by increasing generation on resources that contribute to congestion. The re-dispatch of the potential pivotal supplier's resources is governed by the resource's ramp rates, and minimum and maximum capabilities. The ability of the market to react to the actions of the potential pivotal supplier is accounted for by allowing a similar re-dispatch of all resources not owned or controlled by the potential pivotal supplier. If the other suppliers cannot offset the additional loading created by the potential pivotal supplier, that supplier is pivotal to that constraint for that interval. There can be multiple pivotal suppliers to a constraint for each interval. Partial Participation Resources (PPR) and DC ties current output were not were not included in the pivotal supplier analysis. Their current output remained unchanged. Wind resources and non-dispatchable resources are not increased in the pivotal supplier analysis but are decreased in the down direction.
3. **Selection of Frequently Constrained Area candidates:** Candidates for designation as a Frequently Constrained Area are chosen based on the binding hours and pivotal supplier analyses. Constraints that are in the same electrical proximity and have the same relieving resources are grouped together. If the aggregate number of binding and pivotal supplier hours is significant, then the area is selected as a Frequently Constrained Area candidate. A primary constraint for the Frequently Constrained Area candidate is generally selected as the constraint with the highest number of binding hours.
4. **Identify the Frequently Constrained Area candidate resources:** A resource is a Frequently Constrained Area candidate resource if its resource-to-load-distribution-factor (RLDF), or shift factor, relative to the Frequently Constrained Area candidate primary constraint is less than or equal to the Frequently Constrained Area candidate shift factor cut-off. To determine the shift factor cut-off, the relief capability of the largest pivotal supplier relative to the primary constraint is computed. The cut-off is then set at the value corresponding to the 90^{th} percentile of the relief capability. In other

words, 90 percent of the largest pivotal supplier's relief capability has a shift factor less than or equal to the Frequently Constrained Area candidate shift factor cut-off. In cases where the shift factor value corresponding to the 90th percentile is less than negative five percent (-5%), the cut-off is set to negative five percent to prevent the application of mitigation to resources with a very small impact on the primary constraint. This cut-off of negative five percent is consistent with the market power test[6] for resources' shift factor relative to binding constraints in a binding non-Frequently Constrained Area.

5. **Identify the Frequently Constrained Area candidate secondary constraints:** A constraint is eligible to be defined as a secondary constraint for a given Frequently Constrained Area candidate if that Frequently Constrained Area candidate resource group (as identified in step four) contributes at least 70 percent of the total relief capability on the constraint. Additional considerations for defining a constraint as a secondary constraint include:
    i. electrical proximity to the candidate resource group identified in step 4;
    ii. an expectation that the constraint is not short-term or temporary; and
    iii. an expectation that the constraint will experience congestion in the upcoming year.

    Frequently Constrained Area candidate areas that are expected to have 500 annual hours with at least one pivotal supplier are recommended to be designated as Frequently Constrained Areas. The resulting, more stringent mitigation applied under the WEIS Tariff[7] prohibits a pivotal supplier from accruing significant benefits by pursuing a withholding strategy in a Frequently Constrained Area.

[6] SPP Western Imbalance Service Tariff Att. B Section 3.1 (Market Power Test)

[7] SPP Western Imbalance Service Tariff Att. B Section 3 (Mitigation Measures for Economic Withholding – Market Power in the Western Energy Imbalance Service Market)

3 ANALYSIS AND RESULTS

3.1 FREQUENTLY CONSTRAINED AREA CANDIDATES

The initial phase of the study identified the following four candidates for the Frequently Constrained Area designation:

(1) Montrose (western CO)

(2) Cameo (western CO)

(3) Story (east of Denver, CO)

(4) Laramie/Ault (north of Denver)

These four areas measured the most binding hours in the SPP Western Interconnection reliability footprint during the study period. Some candidate areas have overlap where secondary constraints and candidate resources may appear in multiple areas. Figure 3–1 lists the top constraints with at least ten binding hours for the study period along with pivotal supplier hours and FCA candidate area.

Figure 3–1 Top Binding Constraints

Constraint Name	Monitored Element or Description	Binding Constraint Hours	Pivotal Supplier Hours	FCA Candidate Area(s) Primary (P) Secondary (S)
WTP098_92098	Story transformer 345/230kV	105	20	Story (P)
WTP100_92100	Laramie River – Ault 345kV	103	41	Story (S) Laramie/Ault (P)
WTP077_92077	Yellowtail – Lovell 115kV	73	73	
WTP008_92008	Meeker – White River City 138kV	66	66	
WTP146_92146	Cherokee – California 115kV	66	66	
WTP050_92050	Cameo – Uintah 230kV	60	51	Cameo (P) Montrose (S)
WTP037_92037	Stegall – Gering 115kV	55	30	Story (S)
WTP041_92041	Meeker – Rifle UTE 138kV	47	43	
WTP066_92066	Montrose transformer 345/115kV	35	35	Cameo (S) Montrose (P)
WTP069_92069	Grand Junction – Starr Nelson 115kV	20	20	Cameo (S) Montrose (S)
WTP038_92038	Glen Canyon – Flagstaff 345kV	20	20	
WTP023_92023	North Fork – Hotchkiss 115kV	16	13	Cameo (S) Montrose (S)
WTP032_92032	Austin – Marlow 115kV	13	13	
WTP150_92150	Kutz Tap – Bergin 115kV	12	12	

The most binding constraint (Story 345/230kV transformer) observed had over 100 binding hours with 20 being pivotal. This low percentage of binding hours indicates there is adequate supply from multiple suppliers to relieve congestion on this constraint in most cases. The Laramie River – Ault 345kV constraint was the only other constraint with over 100 binding hours and also had a lower percentage of pivotal hours than most other constraints.

The Cameo – Uintah 230kV and Montrose 345/115kV transformer constraints are both located in western Colorado and produced the same results regardless of which was designated as the primary constraint. The western Colorado area results in about 90 percent of the binding hours being pivotal indicating some or all of at least one supplier's output is necessary for reliable operation of the electrical system within this area.

Most constraints result in a high percentage of binding hours with at least one of the six suppliers being pivotal. This high percentage may decrease some once market data is available reflecting real-time conditions (ramp rates, minimum/maximum) rather than more optimal reference levels. Constraints in this list without a primary or secondary designation were included in preliminary scenarios but did not result in producing an area with more than 100 binding hours.

This study used defined current constraints and paths in the Western Interconnection defined by the SPP Reliability Coordinator. Figure 3–2 shows the one constraint and four Qualified Paths that were removed from the analysis.

Figure 3–2 Excluded Constraints/Paths

Constraint/Path Name	Monitored Element or Description	Binding Constraint Hours	Pivotal Supplier Hours
WTP014_92014	Skala – Canon City 115kV	1,464*	1,193
WQP_P66_COI	Path 66 California Oregon Intertie	667	626
WQP_P36_TOT3	Path 36 TOT3	127	85
WQP_P31_TOT2	Path 31 TOT2	90	90
WQP_P30_TOT1	Path 30 TOT1	41	41

* Post-contingent flows incorrect

The Skala – Canon City 115kV constraint uses a reconfiguration in over 90 percent of the intervals during the study period. The post-contingent flow is not calculated correctly[8] when this reconfiguration is in place. Therefore, the 1,400 binding hours were not used in this analysis since the recorded loading is not correct and the reconfiguration alleviates the issue with this constraint.

The four Qualified Paths (WQP_P30_TOT1, WQP_P31_TOT2, WQP_P36_TOT3, and WQP_P66_COI) were also not used in this analysis. Mitigation of flow on these paths is administered by the Western Interconnection Unscheduled Flow Mitigation Plan (WIUFMP) and are not expected to appear as binding constraints in the WEIS market. A measured flow on a Qualified Path at or near its provided limit does not automatically trigger mitigation taken under the WIUFMP. The MMU will monitor for congestion on these excluded constraints and paths to determine if another analysis should be performed prior to the annual requirement.

Over 15 scenarios were analyzed in the preliminary screening with differing primary and secondary constraint/path combinations. The candidate areas in this report represent the areas resulting in the most significant binding hours and pivotal supplier hours from the preliminary

[8] Real-time contingency analysis calculates post-contingent flow correctly and will alert with possible overloads. These are not available in the archive.

screening. These scenarios in the preliminary screening will be helpful in identifying changes in congestion patterns impacting the WEIS system over the years.

Figure 3–3 shows the primary constraint and the shift factor cut-off for each Frequently Constrained Area candidate. The primary constraint for each candidate area is typically the constraint with the most binding hours and the cut-off is used to identify the candidate resources associated with the Frequently Constrained Area candidate. If a cut-off is calculated to be greater than negative five percent then the cut-off is capped to negative five percent.

Figure 3–3 Primary Constraints and Shift Factor Cut-Offs

FCA Candidate	Primary Constraint	Binding Hours	Pivotal Supplier Hours	Shift Factor Cut-off
Montrose	WTP066_92066	35	35	-9.6%
Cameo	WTP050_92050	60	51	-7.3%
Story	WTP098_92098	105	20	-9.9%
Laramie/Ault	WTP100_92100	103	41	-16.1%

The shift factor cut-offs are used to identify the candidate resources associated with the Frequently Constrained Area candidates. Any resource with a shift factor that is equal to or less than the cut-off is a Frequently Constrained Area candidate resource. For example, the candidate resource group for the Montrose candidate area consists of all resources that have a shift factor corresponding to the WTP066_92066 constraint that is less than or equal to negative 9.6 percent. Figure 3–4 shows the number of resources included in each Frequently Constrained Area candidate and the corresponding capacity[9] in each candidate area.

[9] Based on registered capacity.

Figure 3–4 Candidate Resource Summary

FCA Candidate	Number of Resources	Total Capacity (MW)
Montrose	8	1,304
Cameo	9	1,316
Story	41	2,586
Laramie/Ault	38	2,335

The next step in the process is to identify the secondary constraints for each Frequently Constrained Area candidate. The identification of secondary constraints is necessary because congestion in tightly constrained areas generally affects a group of constraints. Operators may activate a constraint in close proximity to the designated primary constraint instead of activating the primary constraint due to different loading patterns given varying situations. Without the designation of the secondary constraints, the market power mitigation logic will fail to recognize that the Frequently Constrained Area is binding and may not adequately apply stricter thresholds to resources' offers. For a constraint to be defined as secondary it must be determined that the Frequently Constrained Area candidate resource group makes up more than 70 percent of the total relief capability on the constraint. For example, if the total relief capability on constraint XYZ is 1,000 megawatts and the resource candidate group corresponding to a candidate area contributes 725 relief megawatts, then the 70 percent threshold is exceeded and constraint XYZ may be included as a secondary constraint for that area. Additional considerations for including a constraint as secondary include:

i. electrical proximity to the candidate resource group,
ii. the expectation that the constraint is not a short-term in duration, and
iii. the potential for the constraint to experience significant congestion in the future.

The secondary constraint summary for each Frequently Constrained Area candidate is shown in Figure 3–5.

Figure 3–5 Frequently Constrained Area Candidate Secondary Constraint Summary

FCA Candidate	Number of Secondary Constraints
Montrose	7
Cameo	6
Story	4
Laramie/Ault	2

All candidate areas produced at least one secondary constraint that was active at one time during the study period. This study includes binding hours and pivotal supplier hours for current constraints defined by the SPP Reliability Coordinator in the Western Interconnection. No terminated constraints were present at the onset of the study but future analysis may include terminated constraints. Terminated constraints may be the most limiting constraint in an area during certain outages or loading conditions. The congestion may then resume on other nearby active constraints under normal conditions after the temporary condition ceases. Even though the constraint is terminated, it may still be an indicator of similar congestion patterns in an area.

4 APPENDIX

4.1 BINDING CONSTRAINT AND PIVOTAL SUPPLIER DATA

Constraint/Path Name	Monitored Element(s)	Binding Hours	Pivotal Supplier Hours
WTP014_92014*	Skala – Canon City 115kV	1,464**	1,193
WQP_P66_COI*	Path 66 California Oregon Intertie	667	626
WQP_P36_TOT3*	Path 36 TOT3	127	85
WTP098_92098	Story transformer 345/230kV	105	20
WTP100_92100	Laramie River – Ault 345kV	103	41
WQP_P31_TOT2*	Path 31 TOT2	90	90
WTP077_92077	Yellowtail – Lovell 115kV	73	73
WTP008_92008	Meeker – White River City 138kV	66	66
WTP146_92146	Cherokee – California 115kV	66	66
WTP050_92050	Cameo – Uintah 230kV	60	51
WTP037_92037	Stegall – Gering 115kV	55	30
WTP041_92041	Meeker – Rifle UTE 138kV	47	43
WQP_P30_TOT1*	Path 30 TOT1	41	41
WTP066_92066	Montrose transformer 345/115kV	35	35
WTP069_92069	Grand Junction – Starr Nelson 115kV	20	20
WTP038_92038	Glen Canyon – Flagstaff 345kV	20	20

Constraint/Path Name	Monitored Element(s)	Binding Hours	Pivotal Supplier Hours
WTP023_92023	North Fork – Hotchkiss 115kV	16	13
WTP032_92032	Austin – Marlow 115kV	13	13
WTP150_92150	Kutz Tap – Bergin 115kV	12	12
WTP007_92007	Beaver Creek – Brush Tap 115kV	9	6
WTP053_92053	Belen – Bernardo 115kV	9	9
WTP149_92149	Alcova – Raderville 115kV	7	6
WTP009_92009	Cottonwood – Kettle Creek 115kV	6	2
WTP058_92058	Leetsdale – Monroe 230kV	5	5
WTP085_90285	Bonny Creek – South Fork 115kV	4	0
WTP143_92143	Tamarron – Spring Creek 115kV	4	4
WTP140_92140	Beaver Creek – Akron 115kV	4	4
WTP027_92027	Leetsdale – Harrison 115kV	2	2
WTP018_92018	Meeker – Rifle UTE 138kV	2	2
WTP056_92056	Griffith – McConnic 230kV	2	2
WTP040_92040	Pawnee – Story 230kV	2	1
WTP025_92025	Laramie River – Stegall 230kV	1	1
WTP054_92054	Montrose – Nucla 115kV	1	1
WTP063_92063	Kutz Tap – Bergin 115kV	1	1
WTP068_92068	Monroe – Elati 230kV	1	1
WTP141_92141	Hayden Sub – Axial Basin 138kV	1	0

Constraint/Path Name	Monitored Element(s)	Binding Hours	Pivotal Supplier Hours
WTP062_92062	Hayden Sub – Artesia Tap 138kV	1	1
WTP019_92019	Craig transformer 345/230kV	1	1

* Excluded constraint/path ** Recorded post-contingent flows incorrect

The data and analysis provided in this report are for informational purposes only and shall not be considered or relied upon as market advice or market settlement data. All analysis and opinions contained in this report are solely those of the SPP Market Monitoring Unit (MMU), the independent market monitor for Southwest Power Pool, Inc. (SPP). The MMU and SPP make no representations or warranties of any kind, express or implied, with respect to the accuracy or adequacy of the information contained herein. The MMU and SPP shall have no liability to recipients of this information or third parties for the consequences that may arise from errors or discrepancies in this information, for recipients' or third parties' reliance upon such information, or for any claim, loss, or damage of any kind or nature whatsoever arising out of or in connection with:

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