

**PUBLIC SERVICE COMMISSION  
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**SIERRA CLUB EXHIBIT 10**

**WECC Path Reports, 10-Year Regional  
Transmission Plan**



# 10-Year Regional Transmission Plan

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## **WECC Path Reports**

September 2011



# WECC Path Reports

## *Introduction*

This document is for technical review purposes only. It has not been endorsed or approved by the WECC Board of Directors, its Transmission Expansion Planning Policy Committee (TEPPC), the TEPPC Scenario Planning Steering Group (SPSG), or WECC Management.

*This section provides observations for each WECC Path drawn from current project development, historical information, and forward looking congestion analysis.*

WECC Paths are defined in nearly every portion of the Western Interconnection and are generally understood by power industry professionals. As such, they provide a comprehensive and effective medium for congestion and transmission expansion related discussions. Introductory material is provided in this section to familiarize readers with specific terminology used, and assumptions made in forming the observations that are presented for each WECC Path. These observations draw from current project development, historical information, and forward looking congestion analysis. Paths that met any one of the following criteria are discussed individually in the subsequent briefings.

- Analyzed in any one of the past three TEPPC Path Utilization Studies.
- Identified as highly utilized<sup>1</sup> in any one of the 15 study cases used to inform the 10-Year Plan.

There are 66 WECC Paths defined in the WECC 2011 Path Rating Catalog.<sup>2</sup> Forty of these paths met at least one of the aforementioned criteria and are discussed individually in this section. The other 26 paths not meeting either of the criteria are listed in this section.

The following material is a guide to the information presented for each WECC path and should be reviewed before reading the individual path discussions.

| Section Title in Path Discussions | Explanation of Material and Terminology  |
|-----------------------------------|--|
| <b>Observations</b>               | A high level summary of the conclusions and findings resulting from project development information, historical data, and forward looking congestion analysis. |
| <b>Description</b>                | Information taken from the WECC 2011 Path Rating Catalog. Path characteristics and a map illustrating the path definition are included.                        |

<sup>1</sup> As defined by the congestion dashboard utilization screening test

<sup>2</sup> WECC 2011 Path Rating Catalog: [Link](#) (link only available to WECC members).

| Section Title in Path Discussions | Explanation of Material and Terminology |
|-----------------------------------|---|
|-----------------------------------|---|

**Historical Congestion** The TEPPC Transmission Path Utilization Studies quantify the historical utilization of major transmission paths in the Western Interconnection and provide insight to where transmission congestion may have occurred during the study year. Information from the 2009, 2008, and 2007 studies is available for a number of WECC paths. Included in the path utilization studies is a list of the most heavily utilized/congested paths in the Interconnection for that year. This analysis and final ranking was based on the consideration of a number of metrics. If a path made it on this list of “most heavily utilized/congested paths” in the Interconnection in any of the three studies, then that path is termed “historically congested” and is reported as such in this section, and in the context of the 10-Year Plan. For clarity, the metric that resulted in the path being listed in the ranking is identified. Furthermore, a duration plot is presented showing how path flows fluctuate over the historical study years. Although informative, the plot does not necessarily reflect the metrics that support or refute the path as being historically congested. Detailed charts and specific results pertaining to the studied metrics from all the studies can be found by following the links below.

*2009 Path Utilization Study*

- Data: 2008 and 2009 flow, schedule, and ATC data analyzed
- Metrics analyzed for congestion/utilization ranking:
  - Actual flow
  - Maximum actual flow
  - Net Schedule
  - Maximum directional schedule
  - Block hour net schedule
  - Block hour max directional schedule.

*2008 Path Utilization Study*

- Data: 2007 flow and schedule data analyzed
- Metrics analyzed for congestion/utilization ranking:
  - Actual flow
  - Maximum actual flow
  - Net schedule
  - Maximum directional schedule

*2007 Path Utilization Study*

- Data: Winter 1998/99 – Summer 2005 data analyzed
- Metrics analyzed for congestion/utilization ranking:
  - Actual flow

Additionally, transmission providers and path operators were asked to comment on the 2008 Path Utilization Study and its findings. Many of these comments provide greater insight into how exactly the metrics used in the historical analysis do, or do not, apply to a particular path.

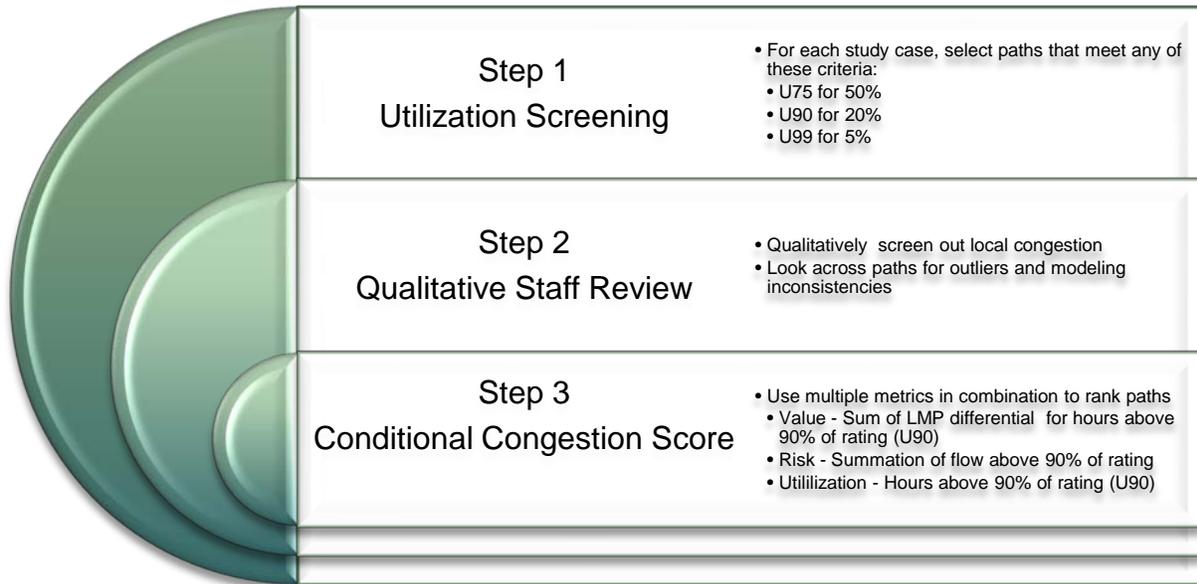
| Section Title in Path Discussions | Explanation of Material and Terminology   |
|-----------------------------------|---|
| <b>Project Development</b>        | <p>A list of transmission projects under development in the Western Interconnection was constructed by combining those projects listed on the WECC Transmission Project Information Portal, SCG Foundational Projects List, and SCG Potential List. Projects that either directly cross, run parallel to, or could potentially impact a path are listed for each path. Stakeholder input was solicited to review the information gathered and to ensure the impact of the transmission projects on the paths was accurately noted. Some projects under development are SCG Foundational Projects, indicating they have a “high probability” of being built, and were subsequently included in the 2020 dataset. These projects are denoted as appropriate in the path briefings. Also identified are projects that were run as expansion cases as a part of the 2010 Study Program. Notably, not all projects identified by stakeholders in the Project Development section were studied in the 2010 Study Program or were included in the SCG Foundational Projects list.</p> <p><a href="#">SCG Foundation Projects Report</a><br/><a href="#">WECC Project Portal</a></p>  |
| <b>Future Congestion Analysis</b> | <p>The forward looking congestion analysis draws upon study case results from production cost model (PCM) runs based on 2019 and 2020 TEPPC datasets. This work was done as a part of the TEPPC 2010 Study Program. Results from the TEPPC studies are broken down into the following categories.</p> <p><u>Expected Future:</u> The expected future represents a set of load, resource, and transmission assumptions obtained through TEPPCs stakeholder-based planning process. This expected future is defined by the 2020 SPSC Reference Case.</p> <p><u>Alternative Futures:</u> There were 15 study cases used to inform the 10-Year Plan; six 2020 cases and nine 2019 cases. Each case represents a set of load and/or resource assumptions. For each study case a utilization screening, designed to select highly utilized paths, was applied. This section identifies how many times the path in question passed the utilization screening. A path that consistently passes the utilization screening, regardless of the set of assumptions used to form the study case, would be of great concern.</p> <p><u>Conditional Congestion:</u> Congestion that is contingent on a specific future (e.g. related to resource location or load level) is termed conditional congestion. The conditional congestion score is calculated for paths that are highly utilized in a case. By looking across a number of conditional congestion scores for a particular path, we can identify which, if any, cases cause excessive congestion along a path.</p> |

| Section Title in Path Discussions | Explanation of Material and Terminology   |
|-----------------------------------|---|
|                                   | <p><u>Project Development Impact:</u> As a part of the TEPPC 2010 Study Program transmission expansion cases were implemented in various cases. For the 2019 cases, stakeholders selected certain transmission projects to be implemented concurrently with state resource relocation scenarios. For the 2020 cases, transmission projects were added to the two resource relocations (MT, WY), as well as to the 2020 SPSC Reference Case and the study cases were re-run to determine what impact the project had on transmission utilization. If a path had a particular transmission project in “Project Development” that was studied in the study program, that project’s impact on the path, in terms of utilization, is outlined in this section. Not all projects identified by stakeholders in the “Project Development” section were studied in the 2010 Study Program, thereby making congestion results available for only certain potential projects.</p> |
| <b>Other Observations</b>         | <p>If necessary, additional information not pertaining to any of the previous sections is presented. Path operators were given the opportunity to comment on actual path operation. Appropriate comments received by these experts are included in this section.</p>  |

Information on future path utilization and congestion<sup>3</sup> emanated from the TEPPC study case results is featured in the “**Future Congestion Analysis**” section of the path discussions. Each of the 2010 TEPPC study cases used to inform the 10-Year Plan was evaluated through a three-step process that brings quantitative value, risk, and utilization indicators together with qualitative staff and stakeholder review to indicate highly utilized or congested paths for each study case. This allows for a breakdown from the path perspective where the method reveals study cases that cause a specific path to be highly utilized or congested. This information is displayed on the Congestion Dashboard for 40 of the 65 WECC paths. The other 25 paths did not meet the utilization screening for any of the study cases. The process is outlined in Figure 1, and explained in detail below.

<sup>3</sup> In previous discussions there has been significant dialogue around the use of the terms “utilization” and “congestion.” Utilization is a term that describes the extent that the transmission line (path) is used. Congestion is a word to describe when a transmission line may be over utilized. For purposes of this communication, high utilization is defined as times path flows are above 75 percent of the path rating (U75). Congestion is occurring when the path flows are above 90 percent of the path rating (U90).

Figure 1: Congestion Analysis Process



### Step 1 – Utilization Screening

The utilization screening intends to capture any highly utilized or potentially congested paths in the TEPPC study cases. Any path with a U75<sup>4</sup> for 50 percent of the year, U90<sup>5</sup> for 20 percent of the year, or U99<sup>6</sup> for 5 percent of the year is analyzed further. A path is defined as being “highly utilized” if it met any one of these screening criteria.

### Step 2 – Qualitative Staff Review

The qualitative staff and stakeholder review screened out paths that showed congestion based on how the modeling was performed (i.e. localized congestion due to how new generation was added to the model which would not occur in actuality). Paths that were screened out were not analyzed further, but were tracked throughout the process and provided for stakeholder review. To date, the only paths screened out in this step were the SDG&E-CFE and Intermountain to Mona 345-kV paths.

### Step 3 – Conditional Congestion Score

The remaining paths were scored using three normalized metrics that quantify value, risk, and utilization. The sum of the normalized metrics makes up the Conditional Congestion Score on the Main View of the [congestion dashboard](#). If a path passed the Utilization Screening for a particular case, it was given a Conditional Congestion Score.

<sup>4</sup> U75 is the number of hours when flows are greater than 75 percent of the path’s rated capacity.

<sup>5</sup> U90 is the number of hours when flows are greater than 90 percent of the path’s rated capacity.

<sup>6</sup> U99 is the number of hours when flows are at the path’s rated capacity.

- The Value metric is the sum of the hourly LMP<sup>7</sup> difference across the path for hours above U90. This metric is an indicator of the relative value of the transmission congestion across the path. This metric is shown on the Value View of the dashboard.
- The Risk metric is a summation of the flow along a path for all hours above U90 and is an indicator of how often the path is heavily loaded and how much energy could be at risk. This metric is shown on the Risk View of the dashboard.
- The Utilization metric is simply U90 and provides a way to compare the utilization of paths regardless of size. This metric is shown on the Utilization View of the dashboard.

The dashboard uses this “results synthesizing methodology” in order to present congestion information that can be viewed either from the perspective of the study case, or that of the individual path.

<sup>7</sup> Locational Marginal Price (LMP) difference is the price differential between generation in two areas.

The following paths are featured in individual path discussions.

| Path #    | Path Name                      |
|-----------|--------------------------------|
| <b>1</b>  | ALBERTA - BRITISH COLUMBIA     |
| <b>3</b>  | NORTHWEST - CANADA             |
| <b>8</b>  | MONTANA - NORTHWEST            |
| <b>9</b>  | WEST OF BROADVIEW              |
| <b>10</b> | WEST OF COLSTRIP               |
| <b>11</b> | WEST OF CROSSOVER              |
| <b>14</b> | IDAHO - NORTHWEST              |
| <b>16</b> | IDAHO - SIERRA                 |
| <b>17</b> | BORAH WEST                     |
| <b>18</b> | IDAHO - MONTANA                |
| <b>19</b> | BRIDGER WEST                   |
| <b>20</b> | PATH C                         |
| <b>22</b> | SOUTHWEST OF FOUR CORNERS      |
| <b>23</b> | FOUR CORNERS 345/500           |
| <b>27</b> | IPP DC LINE                    |
| <b>29</b> | INTERMOUNTAIN - GONDER 230 KV  |
| <b>30</b> | TOT 1A                         |
| <b>31</b> | TOT 2A                         |
| <b>32</b> | PAVANT INTRMTN - GONDER 230 KV |
| <b>33</b> | BONANZA WEST                   |
| <b>34</b> | TOT 2B                         |

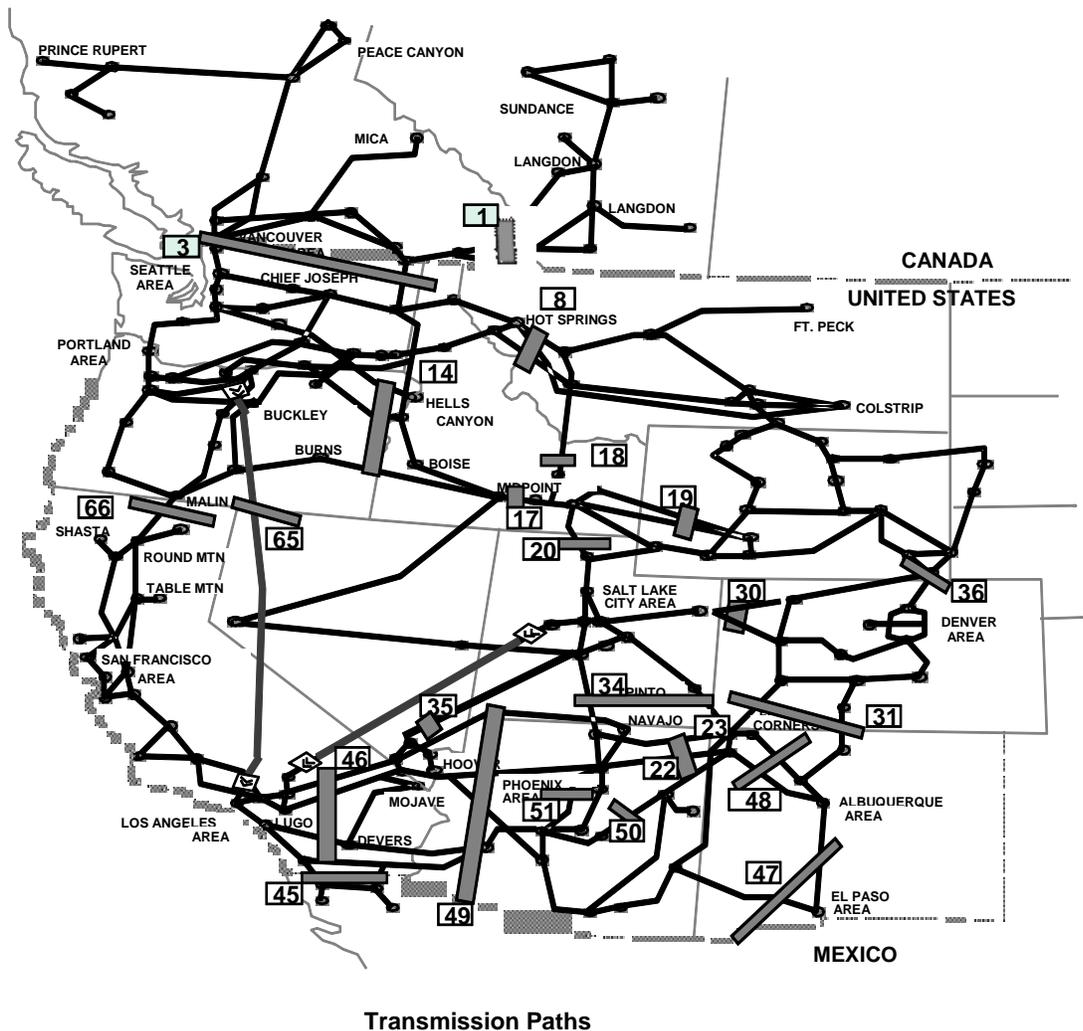
| Path #    | Path Name                      |
|-----------|--------------------------------|
| <b>35</b> | TOT 2C                         |
| <b>36</b> | TOT 3                          |
| <b>42</b> | IID – SCE                      |
| <b>43</b> | NORTH OF SAN ONOFRE            |
| <b>46</b> | WEST OF COLORADO RIVER (WOR)   |
| <b>47</b> | SOUTHERN NEW MEXICO (NM1)      |
| <b>48</b> | NORTHERN NEW MEXICO (NM2)      |
| <b>49</b> | EAST OF COLORADO RIVER (EOR)   |
| <b>50</b> | CHOLLA - PINNACLE PEAK         |
| <b>51</b> | SOUTHERN NAVAJO                |
| <b>52</b> | SILVER PEAK - CONTROL 55 KV    |
| <b>60</b> | INYO - CONTROL 115 KV TIE      |
| <b>61</b> | LUGO - VICTORVILLE 500 KV LINE |
| <b>65</b> | PACIFIC DC INTERTIE            |
| <b>66</b> | COI                            |
| <b>75</b> | MIDPOINT - SUMMER LAKE         |
| <b>76</b> | ALTURAS PROJECT                |
| <b>78</b> | TOT 2B1                        |
| <b>80</b> | MONTANA SOUTHEAST              |

The following paths are not analyzed separately because they were not analyzed in any of the past three TEPPC Path Utilization Studies, and/or were not identified as highly utilized in any of the 15 study cases used to inform the 10-Year Plan.

| <b>Path #</b> | <b>Path Name</b>             |
|---------------|------------------------------|
| <b>2</b>      | Alberta-Saskatchewan         |
| <b>4</b>      | West of Cascades (North)     |
| <b>5</b>      | West of Cascades (South)     |
| <b>6</b>      | West of Hawaii               |
| <b>15</b>     | Midway-Los Banos             |
| <b>24</b>     | PG&E-Sierra                  |
| <b>25</b>     | PacifiCorp/PG&E 115 kV       |
| <b>26</b>     | Northern-Southern California |
| <b>28</b>     | Intermountain-Mona 345 kV    |
| <b>37</b>     | TOT 4A                       |
| <b>38</b>     | TOT 4B                       |
| <b>39</b>     | TOT 5                        |
| <b>40</b>     | TOT 7                        |
| <b>41</b>     | Sylmar to SCE                |
| <b>44</b>     | South of San Onofre          |
| <b>45</b>     | SDG&E-CFE                    |
| <b>54</b>     | Coronado West                |
| <b>55</b>     | Brownlee East                |
| <b>58</b>     | Eldorado-Mead 230 kV         |
| <b>59</b>     | WALC Blythe, SCE Blythe      |
| <b>62</b>     | Eldorado-McCullough 500 kV   |
| <b>71</b>     | South of Allston             |
| <b>73</b>     | North of John Day            |
| <b>77</b>     | Crystal-Allen                |
| <b>81</b>     | Centennial                   |

Figure 2 presents a partial list of the WECC paths. A complete list is available [here](#).

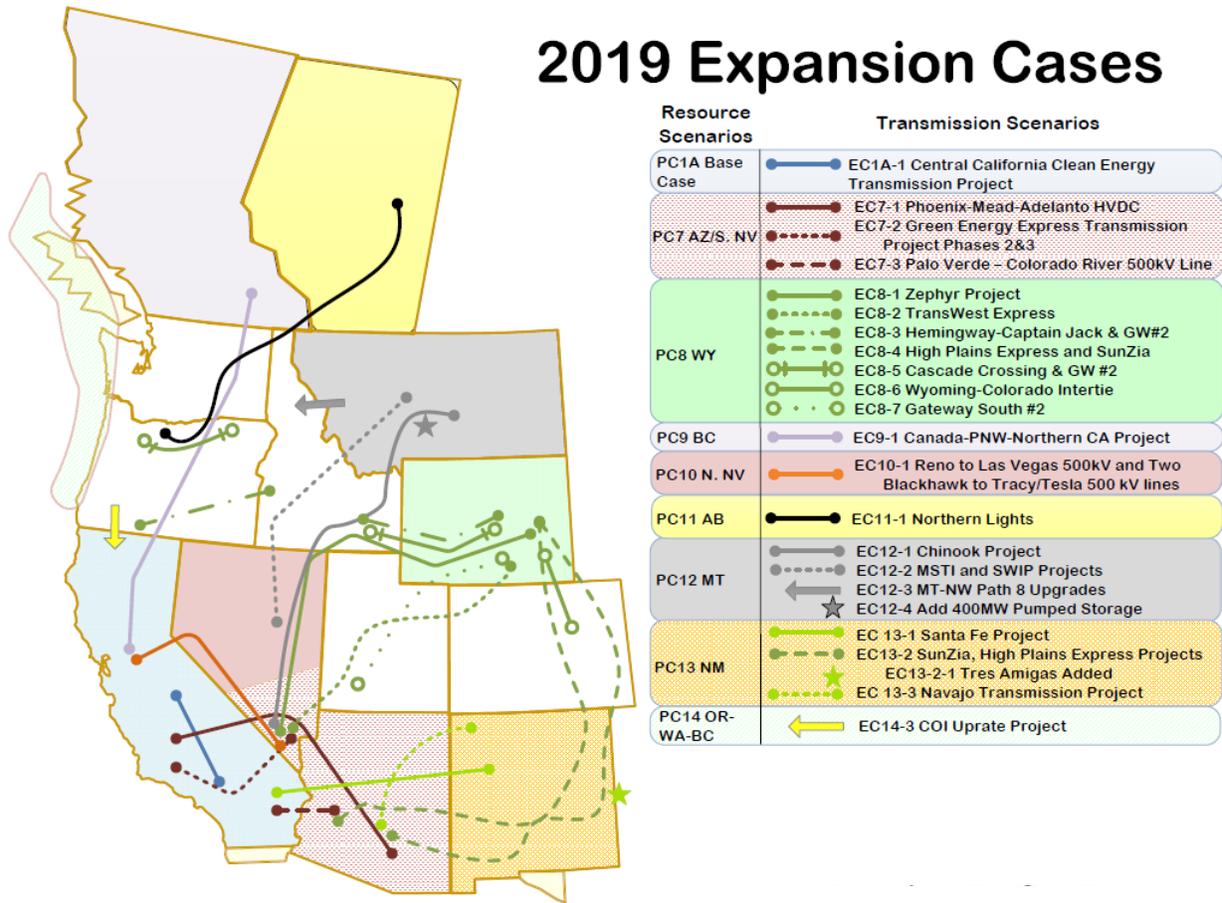
Figure 2: Map of Select WECC Paths



|         |                        |         |                           |
|---------|------------------------|---------|---------------------------|
| Path 1  | Alberta to BC          | Path 34 | TOT 2B                    |
| Path 3  | Northwest to Canada    | Path 35 | TOT 2C                    |
| Path 8  | Montana to Northwest   | Path 36 | TOT 3                     |
| Path 14 | Idaho to Northwest     | Path 45 | CISO to CFE               |
| Path 17 | West of Borah          | Path 46 | West of Colorado River    |
| Path 18 | Montana to Idaho       | Path 47 | Southern New Mexico       |
| Path 19 | Bridger West           | Path 48 | Northern New Mexico       |
| Path 20 | Path C                 | Path 49 | East of Colorado River    |
| Path 22 | Southwest of 4 Corners | Path 50 | Cholla - Pinnacle Peak    |
| Path 23 | 4 Corners Transformer  | Path 51 | Southern Navajo           |
| Path 30 | TOT 1A                 | Path 65 | Pacific DC Intertie       |
| Path 31 | TOT 2A                 | Path 66 | Pacific AC Intertie (COI) |

Figure 3 is a map of the transmission projects evaluated as a part of the 2010 Study Program.

Figure 2: Project Map





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*This brief provides observations regarding the Alberta – British Columbia WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## **Observations**

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 1.

- Path 1 is historically congested based on the 2009 Path Utilization Study block hour net schedule and block hour maximum directional schedule metrics. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their future path utilization reports.
- There are a number of projects under development that could directly impact Alberta – British Columbia path flows.
- Path 1 is not congested or highly utilized in the expected future study case. However, it was congested in the 2019 studies. In part, this is caused by the economic dispatch using abundant and inexpensive hydro resources located in British Columbia to displace the mostly coal and natural gas resource portfolio modeled in Alberta.
- The inclusion of the Montana Alberta Tie Line (MATL) project, a SCG Foundational Project in the 2020 dataset, appears to have a noticeable impact on the level of congestion observed along Path 1 in the TEPPC congestion studies.

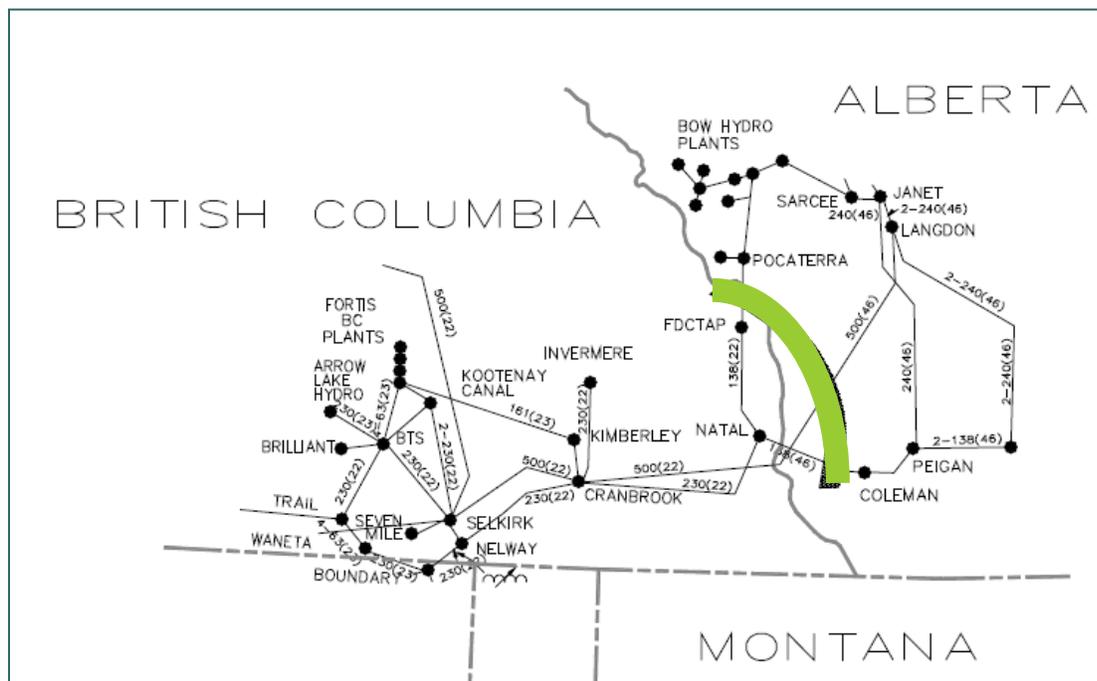
## **Description**

The Alberta – British Columbia path serves as the sole link between Alberta and the remainder of the Western Interconnection. The path consists of the constituent of lines spanning southern Alberta to southern British Columbia. East to West flows are typically 0 to 400 MW and usually occur during light load hours. West to East flows are usually 0 to 400 MW, can be as high as 800 MW, and generally occur during peak load hours. Key characteristics of the path as defined by the 2011 WECC Path Rating Catalog can be found in Table 1, on the next page. Figure 1, shows the physical cut plane that forms the Alberta – British Columbia path.

Table 1: Path 1 Characteristics

| Path Characteristics |         |
|----------------------|---------|
| Rating E to W        | 1000 MW |
| Rating W to E        | 1200 MW |
| Max Voltage          | 500 kV  |

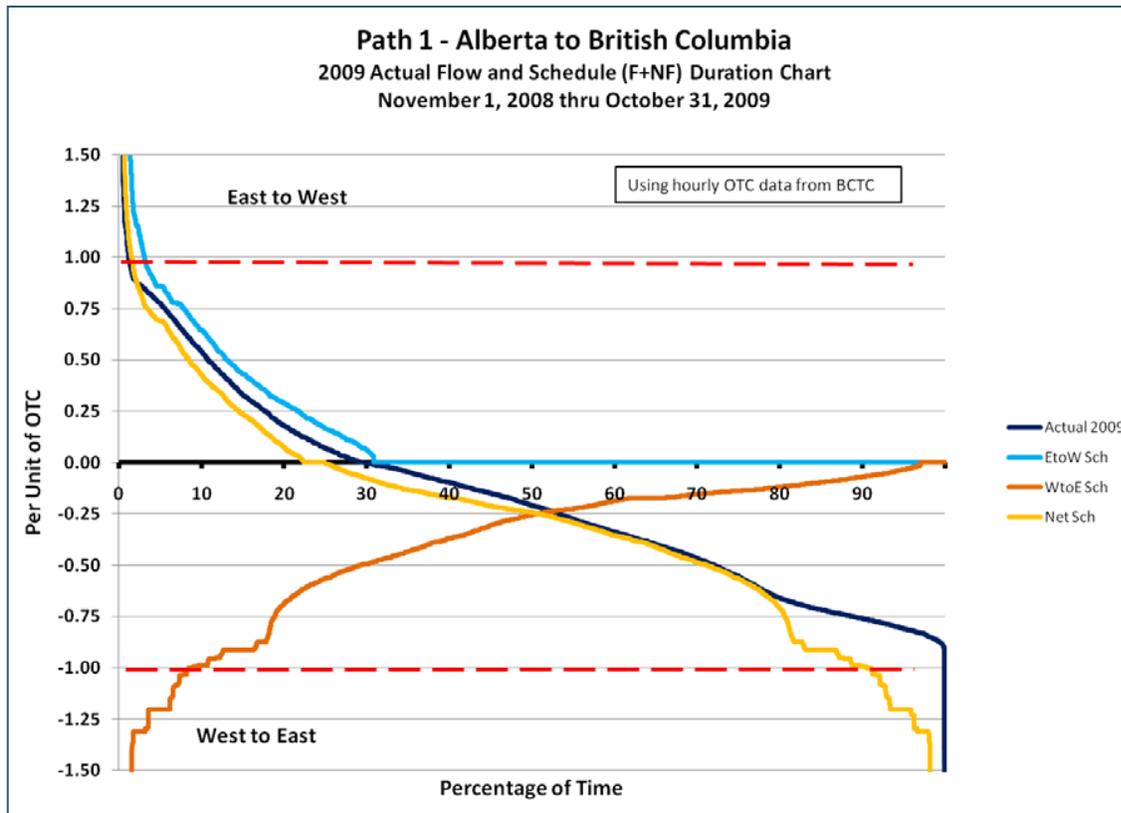
Figure 1: Path 1 Definition



### Historical Congestion

Path 1 is historically congested as demonstrated by the block hour net schedule and block hour maximum schedule analysis conducted in part of the 2009 TEPPC Transmission Path Utilization Study. Alberta – British Columbia was identified as the 10<sup>th</sup> most heavily used path in the Western Interconnection in the 2009 study. Actual flow and schedule data can be found in the duration plot in Figure 2. Although informative, the plot does not necessarily reflect the metrics that support the path as historically congested. Path 1 was not analyzed in the 2008 and 2007 TEPPC Transmission Path Utilization Studies.

Figure 2: Path 1 Actual Flow Duration Plot



## Project Development

The following four projects were determined by stakeholders to be the most likely to have an impact on Path 1.

- MATL (SCG Foundational Project)
- NorthernLights (Studied in 2010 Study Program)
- Triton HVDC Sea Cable Project
- West Coast Cable

Because the MATL project was included in the 2020 dataset, but not the 2019 dataset, some of the reduced congestion along Path 1 observed in the 2020 cases can be attributed to the utilization of the MATL project. This is further explained in the following sections. Additionally, the NorthernLights project was implemented with the 2019 Alberta Resource Relocation case as part of the 2010 Study Program. Congestion impacts on Path 1 from this study case are presented in the "Future Congestion Analysis" under "Project Development Impact".

## Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

In the 2020 expected future study case, Path 1 operated at U99 and U90 for only 2.57 percent and 3.61 percent of the year, respectively. Path 1 was not highly utilized in this study case and there was no congestion on Path 1 contingent on the assumptions used to develop the 2020 Reference Case.

### Alternative Futures

Of all 15 study cases used to inform the 10-Year Plan, the Alberta – British Columbia path passed the utilization screening eight times. All eight of these cases were based on the 2019 dataset. The path was not highly utilized in any of the 2020 study cases, including the reference case, as previously mentioned. The MATL project was included in the 2020 dataset and not the 2019 dataset. The implementation of the MATL project reduced congestion along Path 1. In addition, Alberta generation was increased to ensure load-gen balance. The need for Alberta to import fewer resources may have contributed to the decrease in utilization of Path 1 from the 2019 to the 2020 studies.

### Conditional Congestion

Conditional congestion along Path 1 is dependent strictly on 2019 study cases. Conditional congestion scores were calculated for those study cases in which Path 1 was highly utilized (i.e. passed the utilization screening). The conditional congestion scores for Path 1 and the associated study cases in which the scores were calculated are listed in Table 2.

**Table 2: Path 1 Conditional Congestion**

| Study Case                    | Conditional Congestion Score <sup>1</sup> |
|-------------------------------|---|
| <b>2019 Base Case</b>         | 0.52                                      |
| <b>2019 Arizona/S. Nevada</b> | 0.49                                      |
| <b>2019 Wyoming</b>           | 0.48                                      |
| <b>2019 British Columbia</b>  | 0.92                                      |
| <b>2019 N. Nevada</b>         | 0.47                                      |
| <b>2019 Montana</b>           | 0.52                                      |
| <b>2019 New Mexico</b>        | 0.48                                      |
| <b>2019 Northwest Coastal</b> | 0.67                                      |

High levels of congestion along Path 1 appear to be most contingent on a future featuring a large build out of renewable resources in British Columbia, as indicated by the high conditional congestion score for Path 1 in the 2019 British Columbia resource relocation case.

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

### **Project Development Impact**

The NorthernLights project was added to the relocation of 12,000 GWh of renewable resources from California to Alberta in a 2019 transmission expansion study. The intention was to compare congestion results from the transmission expansion case with that of the base case, and the resource relocation case without transmission to better understand how Path 1 behaves under varying assumptions. However, because of DC line modeling issues, Alberta's modeled resource portfolio, and results from the economic dispatch of the system, the impact of the NorthernLights project on Path 1 was inconclusive and should not be compared to the congestion results observed in the base case or resource relocation cases. Model results aside, we do know that with the implementation of NorthernLights would result in almost no impact to Path 1 flow. If operated properly, the NorthernLights DC line could transfer all relocated resource out of Alberta, leaving no residual impact on Path 1.

### **Other Observations**

The analysis identified the Alberta – British Columbia path as being particularly sensitive to changes in dataset input assumptions. Specifically, the inclusion of the MATL project in the 2020 dataset appears to have mitigated congestion identified along Path 1 in the 2019 cases. Some of this mitigation may also be due to the modified resource portfolio modeled in Alberta, as previously mentioned. Path 1 is a radial path, which makes it particularly sensitive in production cost model studies to adjustments in transmission and resource assumptions; therefore, it is reasonable to predict that the utilization of the path may be sensitive to load adjustments as well.



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*This brief provides observations regarding the Northwest to Canada WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## **Observations**

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 3.

- Path 3 is historically congested based on the 2009 Path Utilization Study actual flow and block hour schedule metrics. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their future path utilization reports.
- There are a large number of projects under development that could directly impact Northwest to Canada path flows.
- Path 3 was not congested in the 2020 expected future. However, futures featuring WECC-wide load and carbon reductions appear to cause congestion along the path.

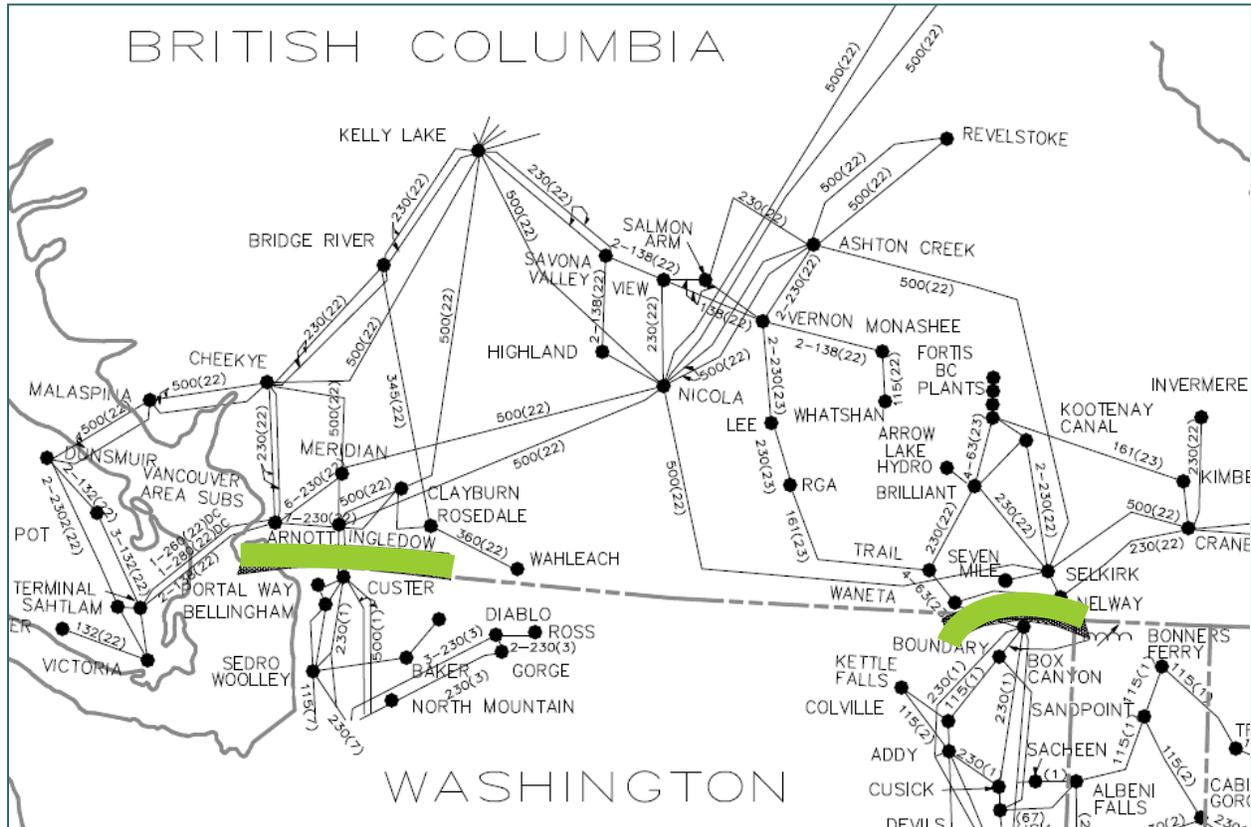
## **Description**

Path 3 serves as the only transmission intertie between British Columbia and the northwestern U.S. The path is composed of two interties, the Westside Intertie and the Eastside Intertie. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in Table 1, on the next page. The Westside Intertie has substantially higher ratings than the Eastern Intertie. Figure 1, on the next page as well, shows the physical cut plane that forms the Northwest to Canada path. Although Path 3 has a north to south rating of 3150 MW, it is important to note that operating constraints in the Puget Sound Area reduce capacity on the line from north to south so that it rarely operates at its path rating. It is often limited to 2400 MW or less.

Table 1: Path 3 Characteristics

| Path Characteristics |         |
|----------------------|---------|
| Rating N to S        | 3150 MW |
| Rating S to N        | 2000 MW |
| Max Voltage          | 500 kV  |

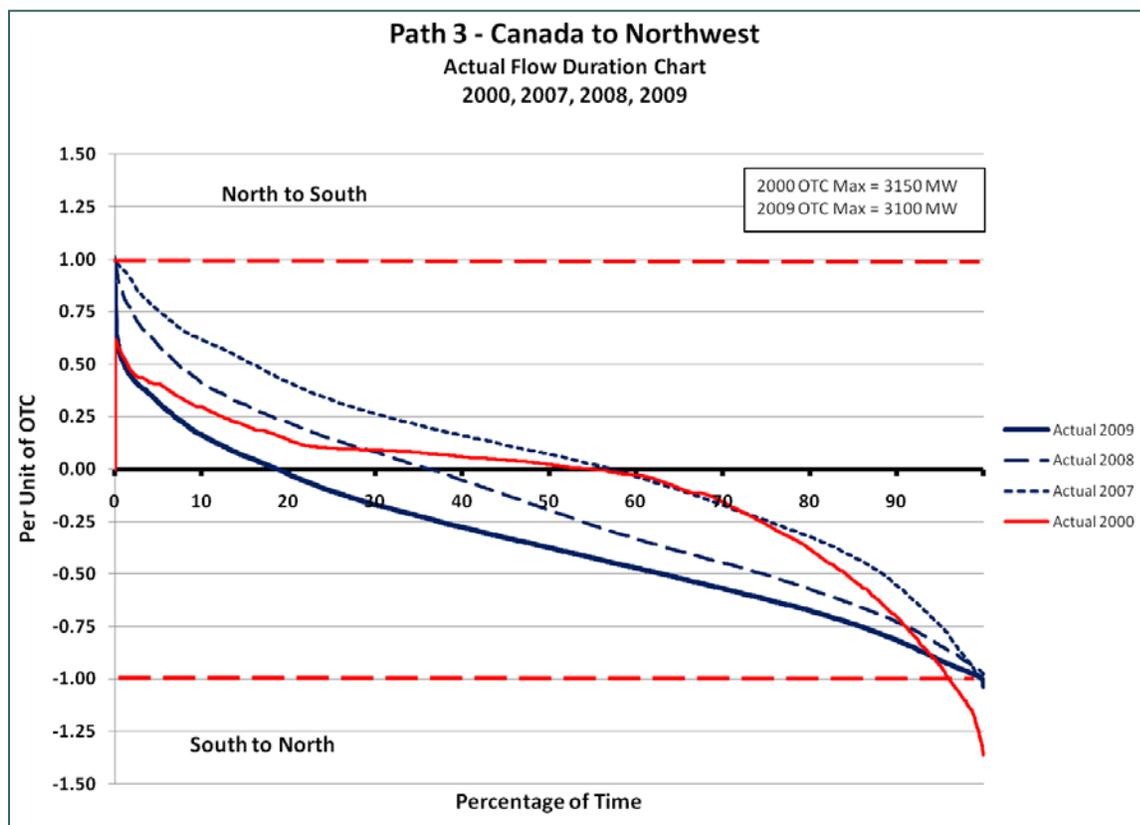
Figure 1: Path 3 Definition



### Historical Congestion

Path 3 is historically congested based on actual flow and block hour schedule metrics resulting from the 2009 Path Utilization Study. It was identified as the 9<sup>th</sup> most congested path in the Western Interconnection in the 2009 report. U75 for Path 3 was 14 percent of the year, with the winter U75 equaling 22.3 percent. Additionally, 257 MW of firm ATC were reported at least 95 percent of the year in the north to south direction in the study period. The 2007 and 2008 Path Utilization Studies did not list Path 3 as one of the most heavily utilized paths. The 2008 Path Utilization Study reported Path 3 U75 and U90 values to be 10 percent and 4 percent, respectively. Actual flow data can be found in the duration plot in Figure 2. As evident in the figure, north to south and especially south to north flows in 2008 and 2009 have increased substantially since 2000. Although informative, the plot does not necessarily reflect the metrics that support the path as historically congested.

Figure 2: Path 3 Actual Flow Duration Plot



## Project Development

The following four projects were determined by stakeholders to be the most likely to have an impact on Path 3.

- BC-US Intertie Upgrade (SCG Foundational Project)
- Canada/Pacific Northwest – Northern California HVDC (CNC) (Studied in 2010 Study Program)
- Juan de Fuca cable #1
- Juan de Fuca cable #2

The BC-US Intertie Upgrade project was included in the 2020 dataset, but not the 2019 dataset. The inclusion of this upgrade project in the 2020 dataset helps to account for Path 3 not being congested in the 2020 expected future, which is contrary to recent historical behavior. Additionally, the CNC project was implemented with the 2019 British Columbia Resource Relocation study case as part of the 2010 Study Program. Congestion impacts on Path 3 from this case are presented in the “Future Congestion Analysis” under “Project Development Impact”.

## Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

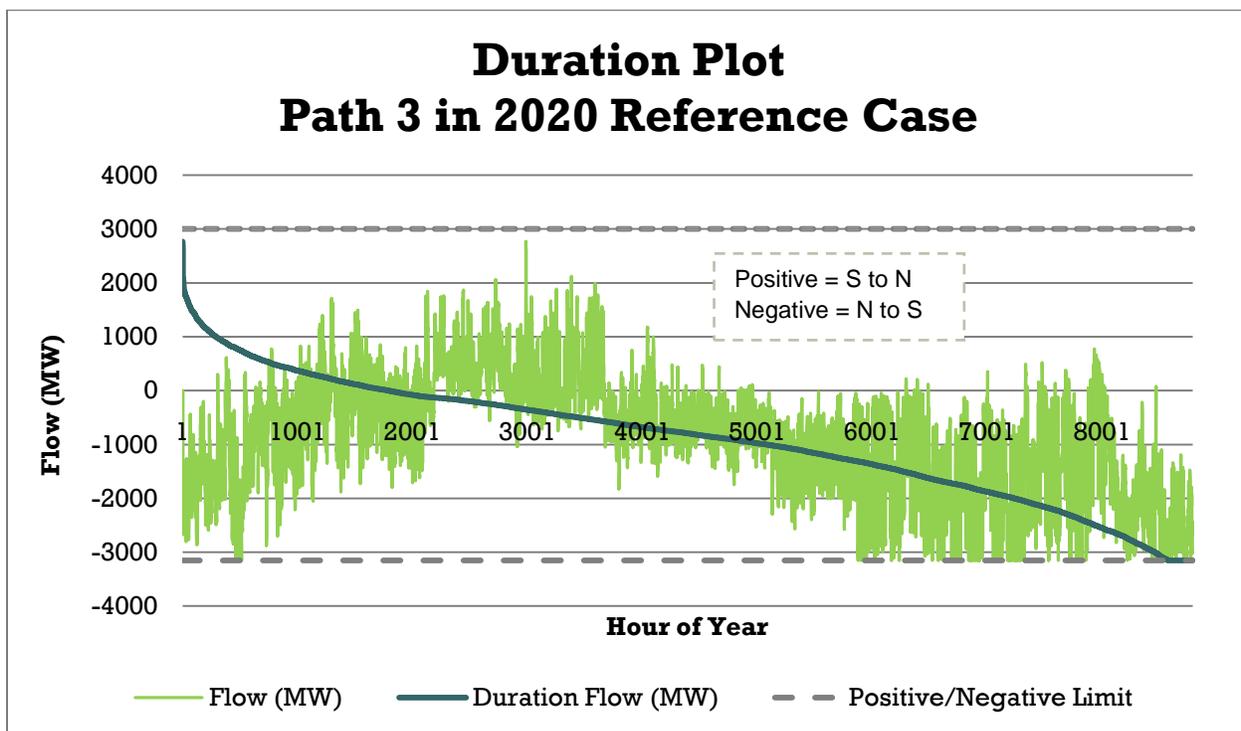
As previously noted, Path 3 has a north to south rating of 3150 MW; however operating constraints in the Puget Sound Area reduce capacity on the line from north to south so that it rarely operates at its path rating and is often limited to 2400 MW or less. Given this operating reality, it is likely that congestion on the path would be greater than portrayed in the future congestion analysis, particularly as the majority of flow in these cases is from north to south.

## Expected Future

Path 3 did not meet the definition of being highly utilized in the expected future. Therefore, the path received a conditional congestion score of zero for the 2020 SPSC Reference Case. It was utilized at the U75 level for 11.44 percent of the year, placing it as the 20<sup>th</sup> most utilized path in the expected future, according to this metric. The path was at U99 for 2.74 percent of the year. As shown in Figure 3, flow was in the north to south direction for the majority of the year. The chronological plot in the same figure shows the seasonality of the flows. The switch in the predominant flow direction between historical operation and results from the 2020 congestion studies is due to the inclusion of a significant amount of new resources, primarily hydro, in British Columbia in the 2020 studies to reflect BC Hydro's planned compliance with the provisions in the Clean Energy Act<sup>1</sup>.

<sup>1</sup> The Clean Energy Act was passed into law by the British Columbia legislature on June 3, 2010. The Act includes provisions for: the development of significant provincially-owned large hydro generation resources; the provincial utility to hold several calls for power from Independent Power Producers; and a requirement for the provincial utility to have a reserve of 3000 GWh of energy surplus to supply obligations by 2020 with the capacity needed to integrate that energy.

Figure 3: Path 3 2020 Duration Plot



**Alternative Futures**

Of all 15 of the study cases used to inform the 10-Year Plan, the Northwest to Canada path passed the utilization screening only three times. The path was highly utilized in the 2019 British Columbia Resource Relocation, 2020 High DSM, and 2020 Carbon Reduction study cases.

**Conditional Congestion**

Conditional congestion along Path 3 is strictly contingent on certain 2019 and 2020 study cases. The congested cases and their conditional congestion scores are listed in Table 2.

Table 2: Path 3 Conditional Congestion

| Study Case                                | Conditional Congestion Score <sup>2</sup> |
|---|---|
| 2019 British Columbia Resource Relocation | 0.47                                      |
| 2020 High DSM                             | 0.85                                      |
| 2020 Carbon Reduction                     | 0.79                                      |

High levels of congestion along Path 3 appear to be most contingent on a future featuring High DSM or Carbon Reduction policy. Congestion also exists when 12,000 GWh of renewable

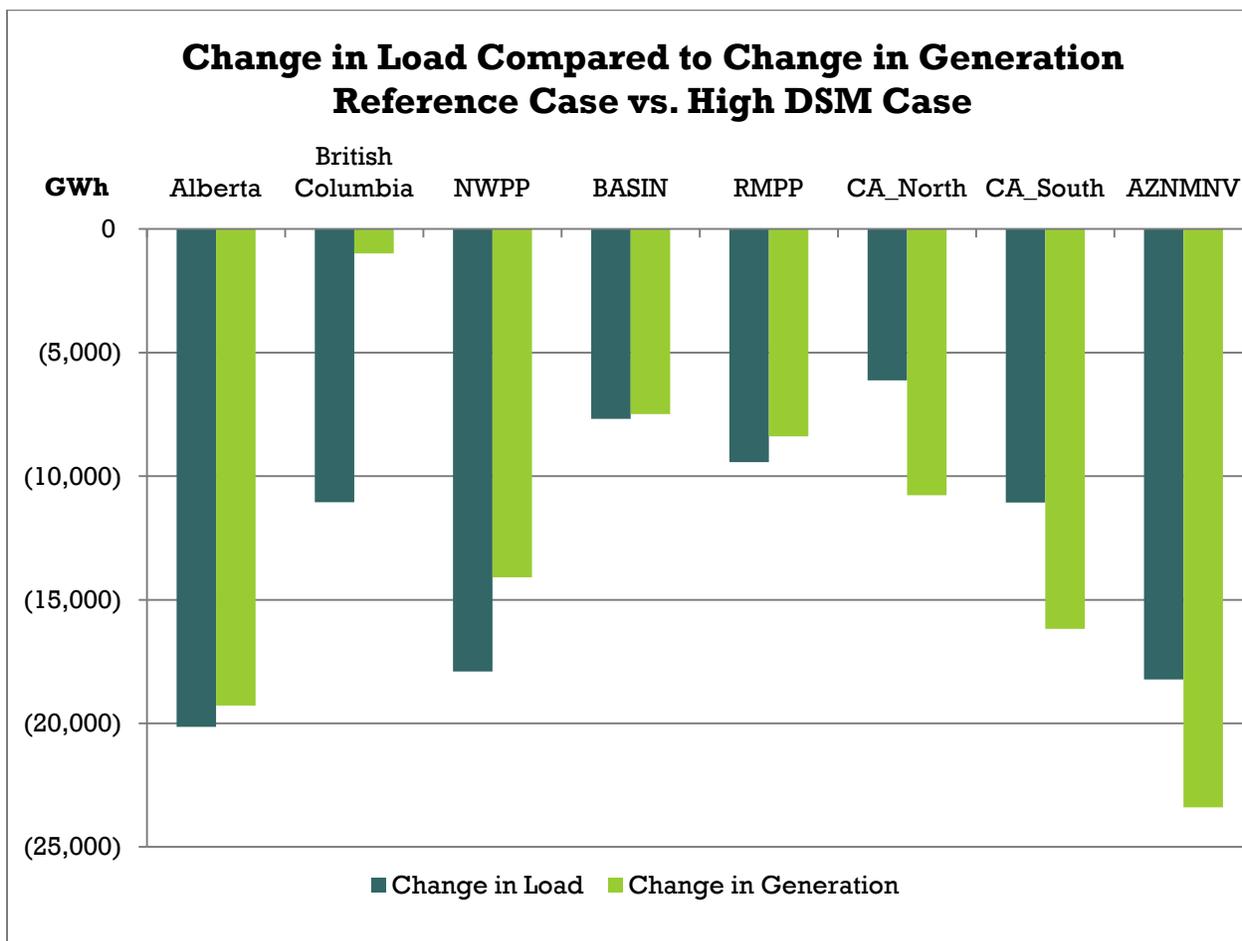
<sup>2</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

resources were removed from California and relocated to British Columbia in the form of wind resources shaped by hydro generation. The congestion is the result of generation from the incremental resources trying to reach load centers outside the province.

The congestion caused by the High DSM case is not as easily explained. Of all the paths in the Western Interconnection, the High DSM case caused the greatest increase in U90 (relative to the Reference Case) on the Northwest to Canada path. The case featured a decrease to state-adjusted loads in order to reflect achievement of the full economic energy efficiency potential throughout the West. Generation was modified only slightly to reflect RPS targets based on these lower load forecasts. Essentially, this resulted in a 10,000 GWh decrease in British Columbia load, while generation saw only a small drop<sup>3</sup>. This small decrease is shown in Figure 4. British Columbia is the exception rather than the rule, as most regions featured drops in generation on par with their load decrease. With decreased loads throughout the Interconnection due to DSM, inexpensive hydro generation from British Columbia was made available for export. This, in turn, caused considerable congestion along Path 3.

<sup>3</sup> The 2020 expected future case included British Columbia's DSM and energy efficiency targets mandated in the Clean Energy Act, therefore, the High DSM case does not result in additional decreases to load in the province.

Figure 4: Change in Load vs. Change in Generation



Although less severe, the Carbon Reduction case also caused congestion along Path 3. This case featured the same assumptions as the High DSM study case with the exception of a carbon adder that was applied to achieve a 17 percent reduction in CO<sub>2</sub> emissions, relative to 2005 levels. As a consequence, gas units were dispatched in favor of coal. This generation shift had little impact on Path 3, and because of reasons previously mentioned, congestion along the path was similar to that in the High DSM case.

It is worth noting that both the High DSM and Carbon Reduction cases produce concurrent congestion on Path 65, the Pacific DC Intertie and Path 66, the California-Oregon Intertie. Both of these paths are most heavily congested in study cases in which Path 3 is also congested.

**Project Development Impact**

The CNC project was assumed constructed and 12,000 GWh of renewable resources were relocated from California to British Columbia in a 2019 resource relocation and transmission expansion study. By comparing congestion results from the expansion study with that of the base case, and the resource relocation (without incremental transmission) we can better

understand how Path 3 behaves under varying assumptions. Table 3 shows the U90 for each of the above mentioned study cases.

**Table 3: Project Development Impact on Path 3**

| <b>Study Case</b>                                | <b>U90</b> |
|--|------------|
| <b>Base Case</b>                                 | 1.76%      |
| <b>2019 BC Resource Relocation</b>               | 17.15%     |
| <b>2019 BC Resource Relocation + CNC Project</b> | 2.41%      |

Path 3 utilization increased greatly from the base case to the British Columbia Resource Relocation. With the implementation of the CNC Project into the model, utilization of Path 3 dropped significantly as it provides a direct connection between resources in British Columbia and loads in California. These production cost model results suggest that BC resource development combined with the CNC Project would only have a minor increase on Path 3 utilization.



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*This brief provides observations regarding the Montana to Northwest WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## **Observations**

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 8.

- Path 8 is historically congested based on actual flow metrics from the 2008 Path Utilization Report, and actual flow, path schedule and block hour schedule metrics from the 2009 Path Utilization Report. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their future path utilization reports.
- There are a number of projects in development that could directly impact Montana to Northwest path flows.
- Path 8 was congested in the 2020 expected future case, and significant future resource additions modeled in Montana further increased congestion along Path 8.
- The Montana to Northwest path is a WECC Area of Concern. {LINK TO SECTION}.

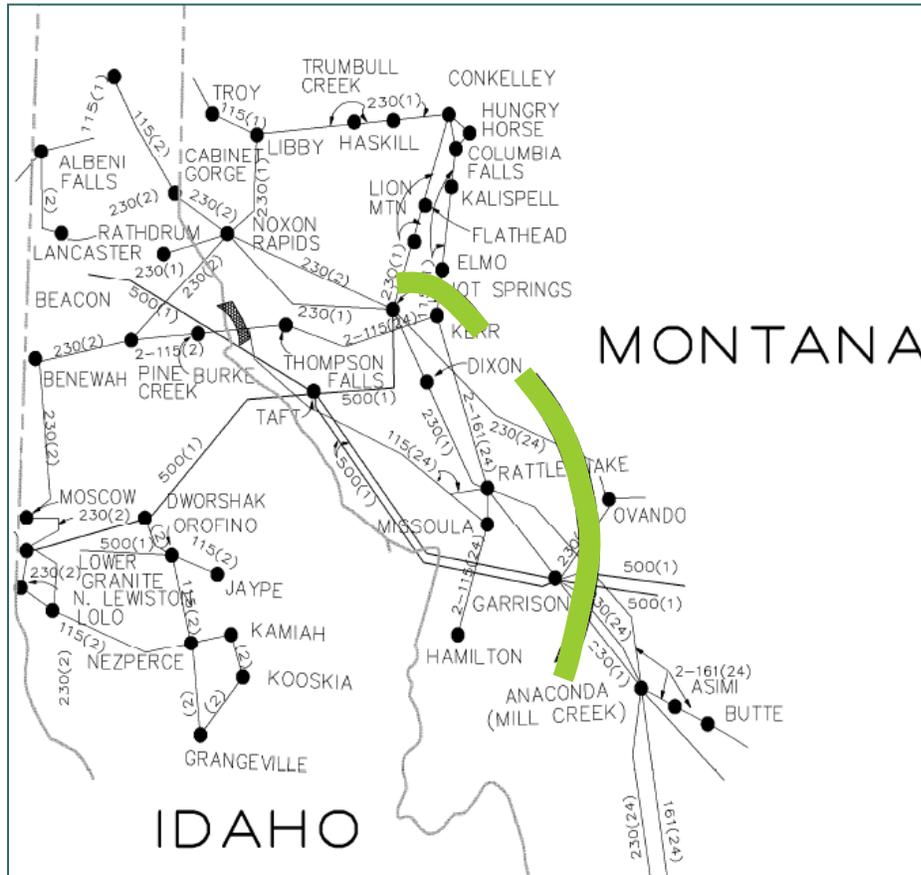
## **Description**

Path 8, the largest of the Montana export paths, consists of the lines running between western Montana and northwest US. It is the only major WECC Path available to export resource out of the state. The lines are the metered tie lines between NorthWestern Energy (NWMT) and Bonneville Power Administration (BPA), plus the tie lines between NWMT and Avista Corp. (AVA). Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Montana to Northwest path.

Table 1: Path 8 Characteristics

| Path Characteristics |         |
|----------------------|---------|
| Rating E to W        | 2200 MW |
| Rating W to E        | 1350 MW |
| Max Voltage          | 500 kV  |

Figure 1: Path 8 Definition

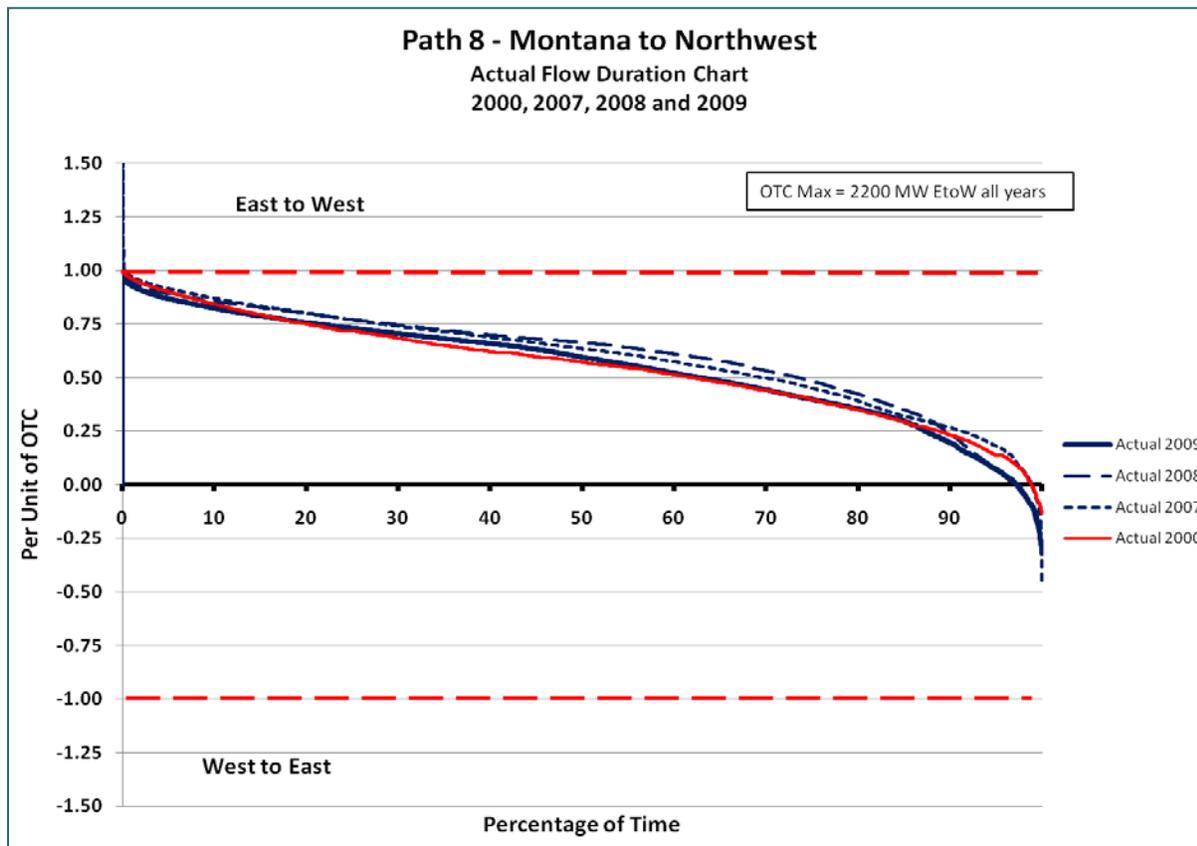


### Historical Congestion

Path 8 is historically congested based on actual flow metrics in the 2008 Path Utilization Report, and actual flow, path schedule and block hour schedule metrics in the 2009 Path Utilization Report. The 2008 Study reported Path 8 as the 3<sup>rd</sup> and 4<sup>th</sup> most heavily utilized based on flow metrics and maximum directional schedule data, respectively. Overall, the path was one of the top 10 most heavily used in the Western Interconnection in the 2008 Study. The 2009 Study identified Path 8 as the 5<sup>th</sup> most heavily used path in the Western Interconnection relative to its capacity. Path 8 was also analyzed in the 2007 Transmission Path Utilization Study where it operated above 75 percent of its limit for 25 to 50 percent of the year in the highest load year from 1999 to 2005. Actual flow data for historic years can be found in the duration plot in Figure 2. Although informative, this plot does not necessarily reflect the metrics that support the path

as historically congested. It is worth noting that the path was designed to operate at a high utilization in order to transfer power from Colstrip generation to the Northwest. Additional generation in Montana will be problematic for this path.

Figure 2: Path 8 Actual Flow Duration Plot



## Project Development

The following four projects were determined by stakeholders to be the most likely to have an impact on Path 8. In this specific case, it is likely that the projects would reduce flow along Path 8 when the projects export energy out of Montana.

- Mountain States Intertie (MSTI) (Studied in 2010 Study Program)
- Colstrip Upgrade
- Chinook (Studied in 2010 Study Program)
- MATL (SCG Foundational Project)

The MATL project was the only project assumed constructed in the 2020 datasets.

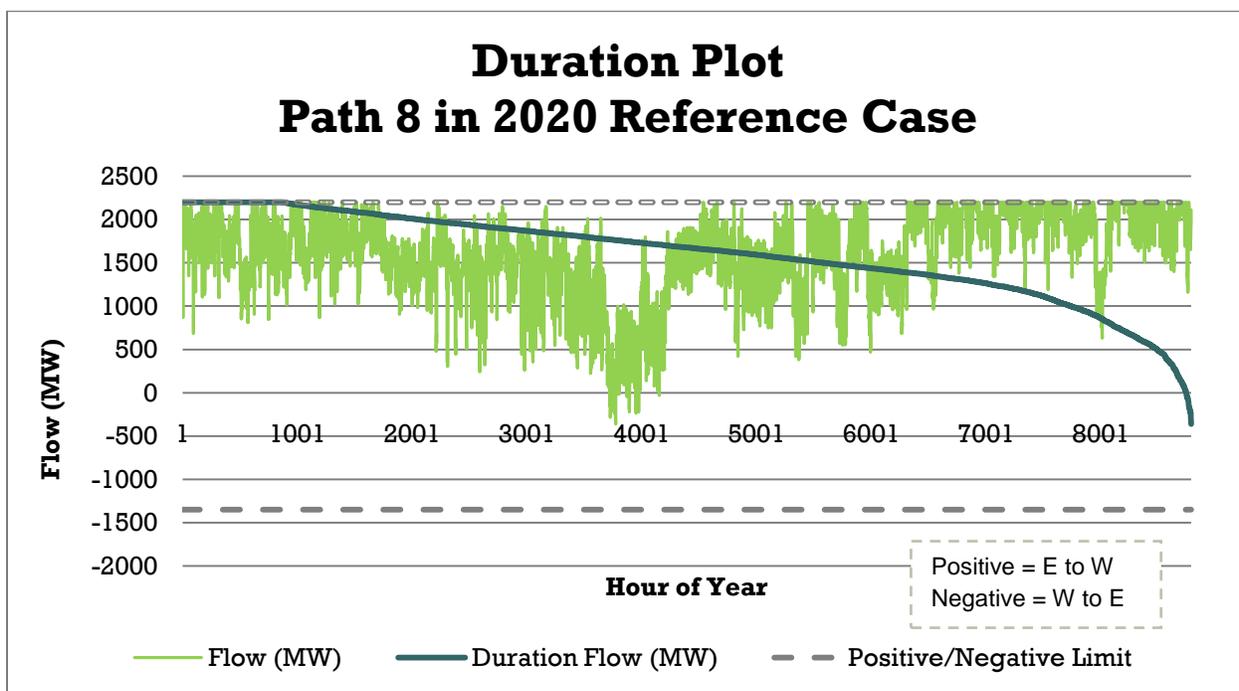
## Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Relative to the other paths in the Western Interconnection, Path 8 was heavily congested in the expected future case. Montana to Northwest operated at U99 for over 10 percent of the year, and at U90 for nearly 25 percent of the year. The duration plot in Figure 3 shows this heavy utilization. The chronological plot in the same figure shows the seasonality of the flows. Aside from the California-Oregon Intertie (COI), Path 8 was the most heavily utilized 500 kV path in the expected future case because it supplies the only major export path out of Montana, which is home to large amounts of base load and variable resources.

Figure 3: Path 8 2020 Duration Plot



### Alternative Futures

Of all 15 study cases used to inform the 10-Year Plan, Path 8 passed the utilization screening 14 times, indicating that the path was highly utilized in all study cases except the 2020 Carbon Reduction study case. According to the production cost model, utilization of Path 8 can be expected to be extremely high in 2020, regardless of the assumptions used to form the case. Only the carbon reduction case induces a relatively lower level of utilization along Path 8.

### Conditional Congestion

Conditional congestion along Path 8 is contingent on a variety of cases. Specifically, cases featuring incremental generation in Montana cause the greatest amount of conditional congestion. The congested study cases and their conditional congestion scores are listed in Table 2.

**Table 2: Path 8 Conditional Congestion**

| <b>Study Case</b>                                 | <b>Conditional Congestion Score<sup>1</sup></b> |
|---|---|
| <b>2019 Base Case</b>                             | 0.37  |
| <b>2019 Arizona/S. Nevada Resource Relocation</b> | 0.38  |
| <b>2019 Wyoming Resource Relocation</b>           | 0.49  |
| <b>2019 British Columbia Resource Relocation</b>  | 0.32  |
| <b>2019 N. Nevada Resource Relocation</b>         | 0.30  |
| <b>2019 Alberta Resource Relocation</b>           | 0.38  |
| <b>2019 Montana Resource Relocation</b>           | 1.63  |
| <b>2019 New Mexico Resource Relocation</b>        | 0.41  |
| <b>2019 Northwest Coastal Resource Relocation</b> | 0.31  |
| <b>2020 SPSC Reference Case</b>                   | 0.55  |
| <b>2020 High Load</b>                             | 0.45  |
| <b>2020 High DSM (Low Load)</b>                   | 0.44  |
| <b>2020 Aggressive MT Wind</b>                    | 2.11  |
| <b>2020 Aggressive WY Wind</b>                    | 0.85  |

As indicated by high conditional congestion scores, Path 8 is not only highly utilized in nearly every case but congested as well. Extreme levels of congestion were observed in three cases: 2020 Aggressive Wyoming Wind, 2019 Wyoming Resource Relocation, and 2020 Aggressive Montana Wind. The 2020 Aggressive Wyoming Wind study case, featuring the relocation of 25,000 GWh of resources to Wyoming, caused extensive congestion along the path. This is due to the large quantity of relocated resources coupled with the existing systems inability to handle this incremental generation. Wyoming export paths are highly constrained in this study case, resulting in flow northward into Montana, and consequently onto the Montana to Northwest path.

Considering all paths and all cases, the 2020 Aggressive Montana Wind case and the 2019 Montana Resource Relocation caused two of the highest conditional congestion scores on Path 8. The 2020 Aggressive Montana Wind case features 25,000 GWh of wind resources relocated to Montana while the 2019 Montana Resource Relocation case consisted of the relocation of 12,000 GWh of wind. Neither of the study cases features added transmission and, as predicted, the incremental generation heavily constrained Path 8. With existing generation already causing congestion along Path 8, as shown by the historical analysis, any incremental resources added within Montana further constrain the path.

### **Project Development Impact**

There is extensive congestion analysis on Path 8 available in the {Path/Region of Concern} portion of the report. The congestion impacts on Path 8 caused by the MSTI project, Chinook Project, and others, are presented in that section.

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).



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*This brief provides observations regarding the West of Broadview WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 9.

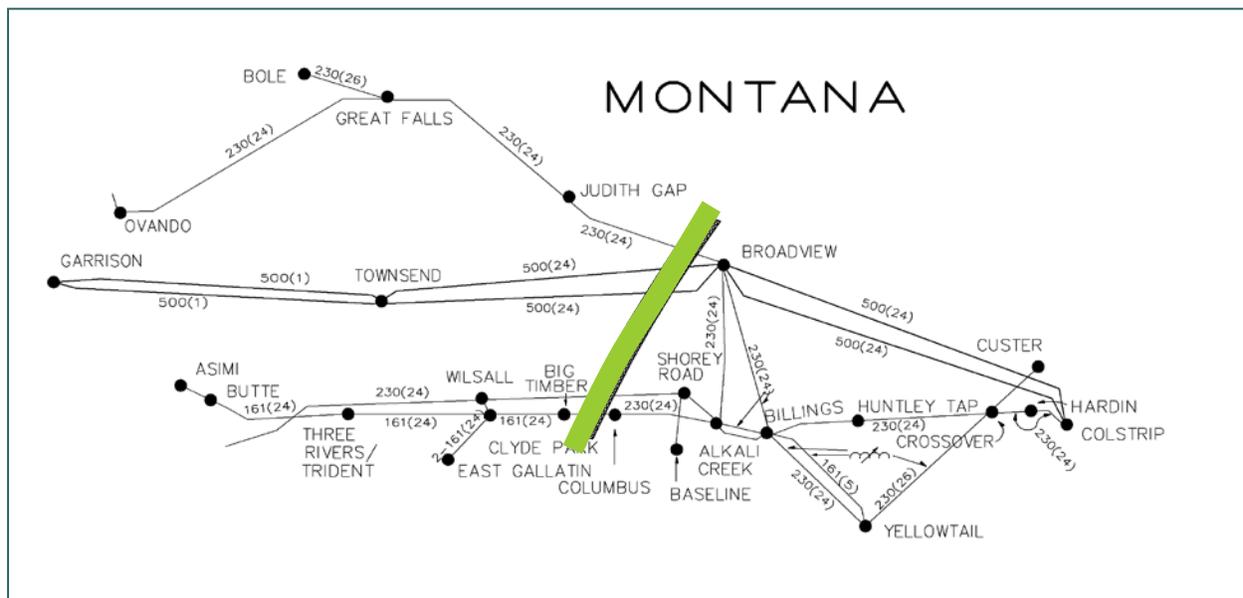
- There are few transmission projects in development that could directly impact West of Broadview path flows.
- Path 9 was not congested in the 2020 expected future study case.

Path 9 is located in central Montana and includes all lines proceeding west from the Billings area. Flow on this path is generally east to west. When flow is west to east, the magnitude is minimal and because of this, no effort has been made to apply a west to east rating. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the West of Broadview path.

**Table 1: Path 9 Characteristics**

| Path Characteristics |           |
|----------------------|-----------|
| <b>Rating E to W</b> | 2573 MW   |
| <b>Rating W to E</b> | Undefined |
| <b>Max Voltage</b>   | 500 kV    |

Figure 1: Path 9 Definition



### Historical Congestion

Path 9 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

The Colstrip Upgrade Project was determined by stakeholders to be the most likely to have an impact on Path 9. This project was not assumed constructed in either the 2019 or 2020 datasets.

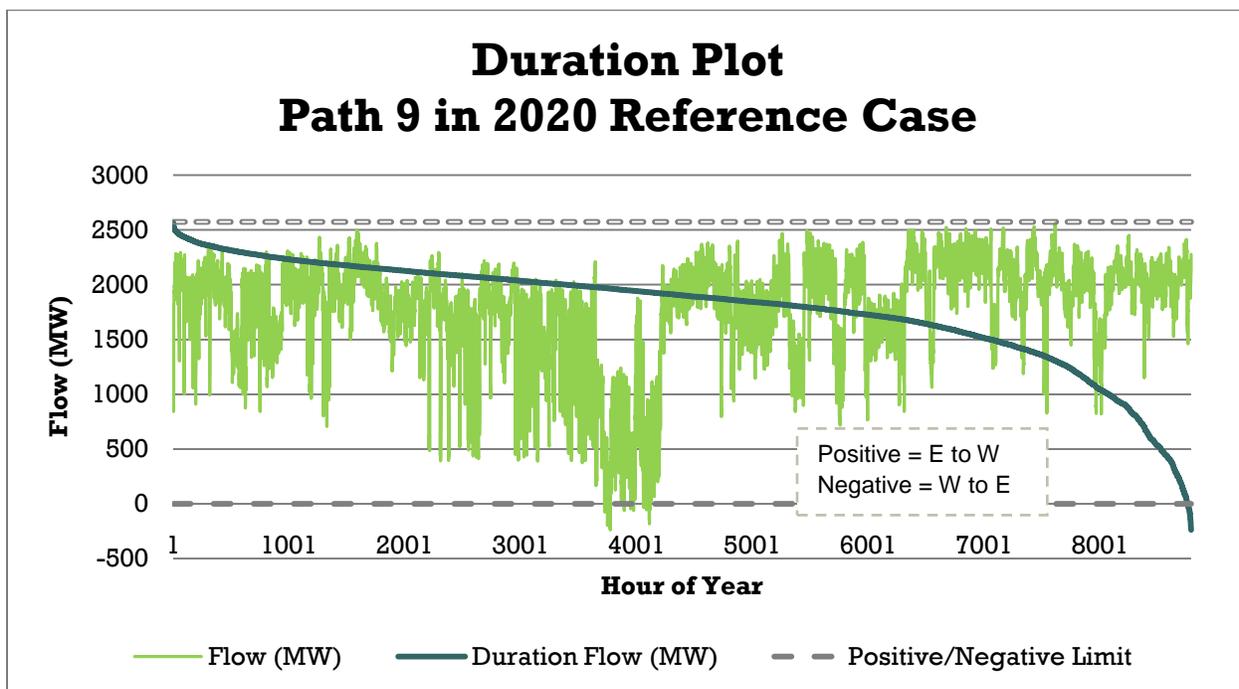
### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

The utilization screening and congestion metrics advocate that Path 9 is not heavily utilized or congested in the 2020 expected future case. The U90 and U99 levels were only 5.51 percent and 0.01 percent, respectively. However, U75 levels were significantly higher at 46.74 percent. The duration plot in Figure 3 shows this utilization at the 75 percent level. The chronological plot in the same figure shows the seasonality of the flows. Although Path 9 experienced significant use in the expected future study case, it is not heavily utilized or congested. The path has a high U75 by design as it is intended to transmit base load Colstrip generation.

Figure 2: Path 9 2020 Duration Plot



### Alternative Futures

Of the 15 study cases used to inform the 10-Year Plan, Path 9 passed the utilization screening one time. This indicates that the path was highly utilized in a very specific case, the 2020 Aggressive Montana Wind case. According to the production cost model, utilization of Path 9 can be expected to be extremely high under a future involving drastic resource addition in Montana, without the addition of transmission.

### Conditional Congestion

Path 9 congestion is contingent only on the Aggressive Montana Wind case. The case and its conditional congestion score is presented in Table 2.

Table 2: Path 9 Conditional Congestion

| Study Case                   | Conditional Congestion Score <sup>1</sup> |
|------------------------------|---|
| 2020 Reference Case          | 0.00                                      |
| 2020 Aggressive Montana Wind | 0.35                                      |

As shown in the table above, congestion along Path 9 only occurs when large amounts of renewable resources are added to Montana in the absence of incremental transmission. In the Aggressive Montana Wind study case Path 9 was at U90 and U75 for 16.83 percent and 59.67

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all study cases and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

percent of the year, respectively. Increased utilization of Path 9 due to the installation of wind generation facilities is likely contingent on those generators being located east of the path.



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*This brief provides observations regarding the West of Colstrip WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 10.

- There are few transmission projects in development that could directly impact West of Colstrip path flow.
- Path 10 was highly utilized, but not congested, in the 2020 expected future study case.
- TEPPC Study results show that significant resource additions in Montana decrease the utilization of Path 10.

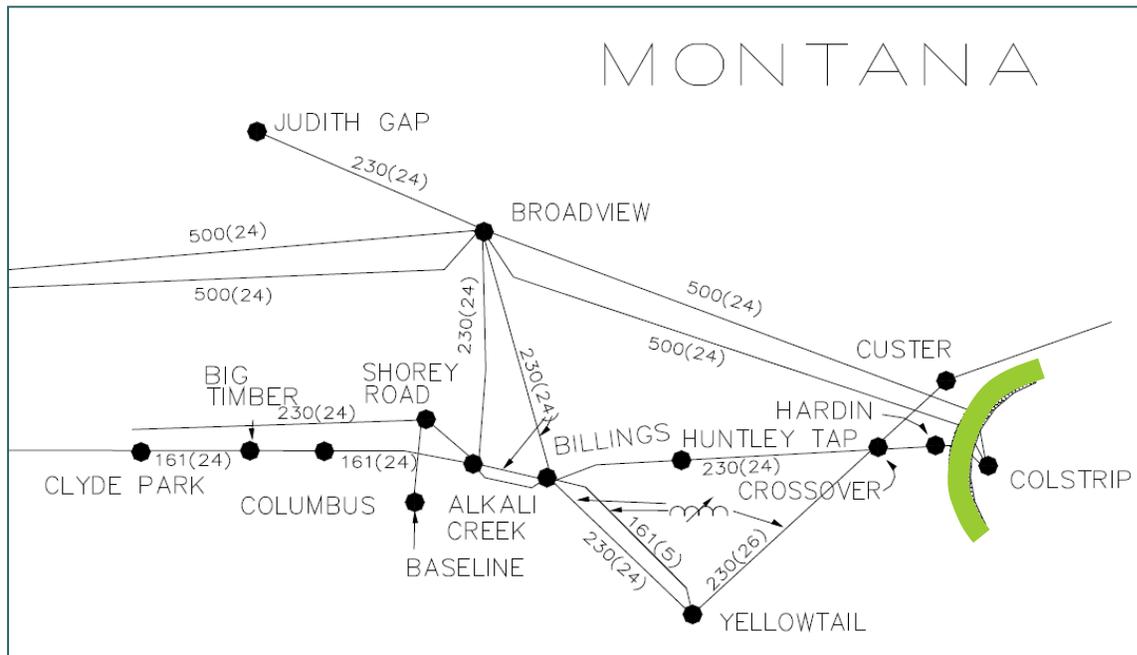
## Description

Path 10 is located in southeastern Montana and consists of three lines connecting to the Colstrip generators. Flow is always east to west since the path was constructed to integrate the Colstrip generation project into the Montana system. As a result, no effort has been made to determine the west to east capacity. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the West of Colstrip path.

Table 1: Path 10 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating E to W        | 2598 MW   |
| Rating W to E        | Undefined |
| Max Voltage          | 500 kV    |

Figure 1: Path 10 Definition



### Historical Congestion

Path 10 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

The Colstrip Upgrade Project was determined by stakeholders to be the most likely to have an impact on Path 10. This project was not assumed constructed in the 2019 or 2020 dataset.

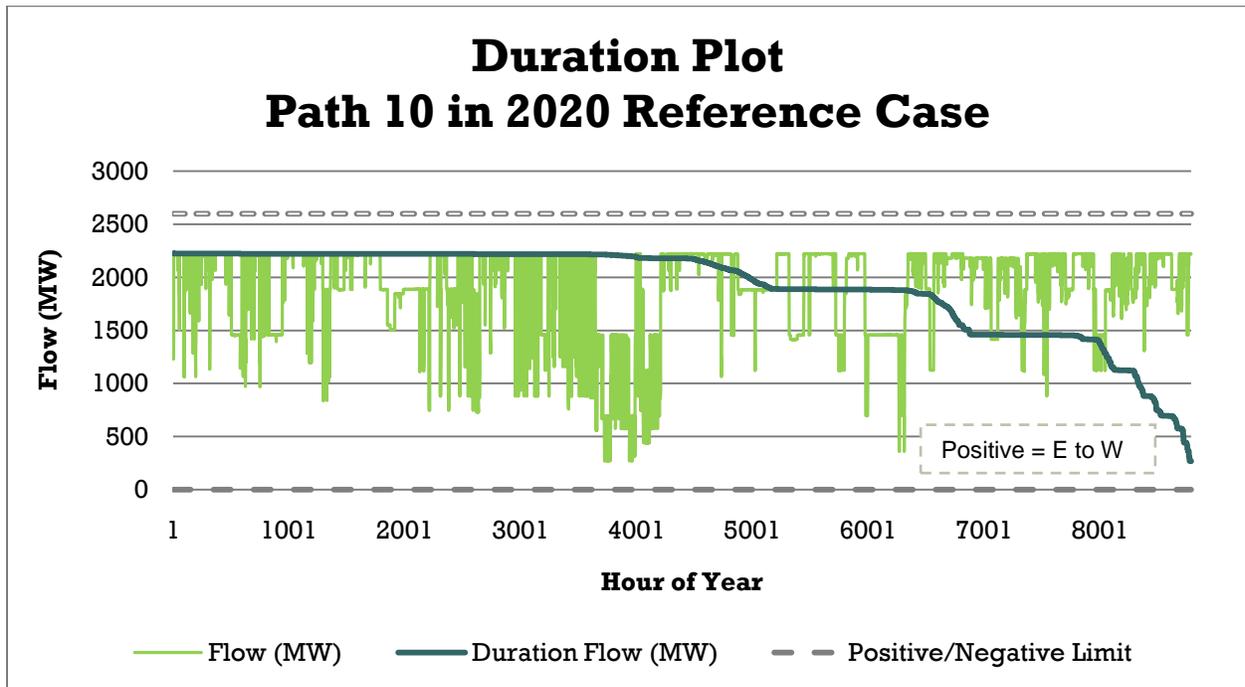
### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

In the expected future study case Path 10 was heavily utilized, but not congested according to the utilization screening and the congestion metrics used to evaluate PCM results. The path operated at or above U75 for 57.32 percent of the year and passed the utilization screening based on this metric. However, Path 10 had zero hours with flow greater than 90 percent of the path limit. This resulted in a conditional congestion score of zero for this case. The duration plot in Figure 3 shows heavy utilization but zero congested hours. The chronological plot in the same figure shows ramping experienced by the Colstrip units due to Montana wind resources being a “must take” resource.

Figure 2: Path 10 2020 Duration Plot



High utilization is expected for this path. It was constructed to integrate base load Colstrip generation; therefore, the flows on the path are dependent on Colstrip generation.

### Alternative Futures

Of the 15 study cases used to inform the 10-Year Plan, Path 10 passed the utilization screening 10 times, indicating that the path was highly utilized in a variety of cases. This is to be expected, as the path was constructed with the intent that it be highly utilized. The path passed the screening in all 2019 Study Cases, except the Montana Resource Relocation case. The path also was highly utilized in the 2020 SPCS Reference Case (expected future), and the 2020 High Load case. Not surprisingly, the path was not highly utilized in futures that resulted in a decrease of Colstrip generation. These cases were High DSM, Carbon Reduction, Aggressive Wind (MT/WY), and Montana Resource Relocation.

### Conditional Congestion

There is no congestion contingent on any specific study case for Path 10. Although highly utilized in numerous cases, as described above, the path received conditional congestion scores of zero in all study cases. The conditional congestion score is based on three metrics that all use the number of hours for which path flow was greater than 90 percent of the path's limit. In all cases, Path 10's flow never surpassed 90 percent of the path's limit. Thereby, the conditional congestion score was zero for all cases. However, as previously noted, the path still passed the utilization screening and was highly utilized in 10 cases.



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*This brief provides observations regarding the West of Crossover WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 11.

- Path 11 was congested in the 2020 expected future case. Furthermore, the most extreme congestion on Path 11 was observed in the 2020 High Load case.

## Description

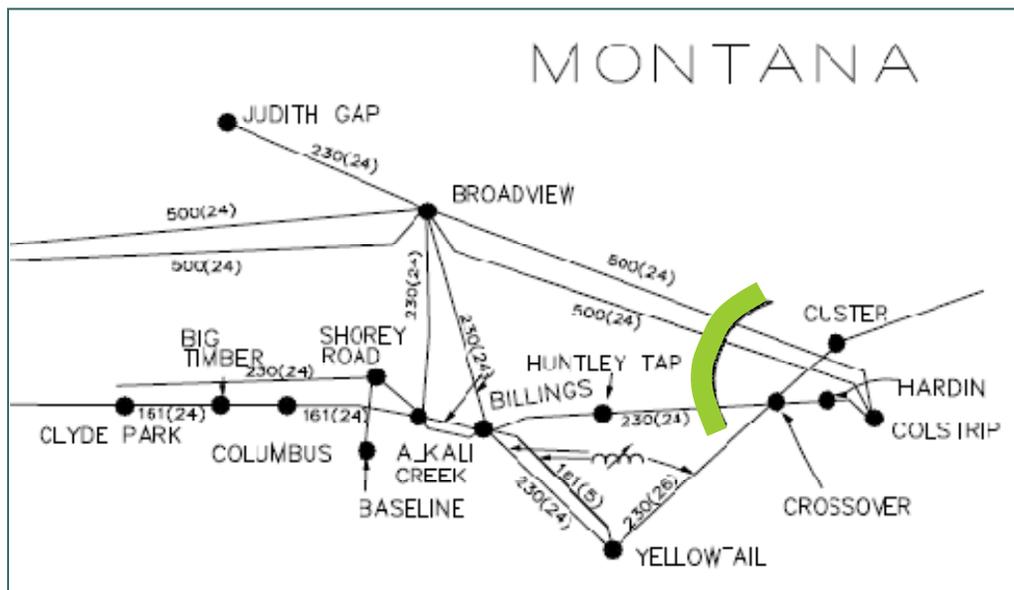
Path 11, located in southeastern Montana, consists of two 500 kV lines west of the Colstrip bus and a single 230 kV line west of the Crossover bus. Flow is generally in the east to west direction. Since the path integrates Colstrip generation and the Miles City DC tie into the system, no effort has been made to determine the west to east capacity. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the West of Crossover path.

Table 1: Path 11 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating E to W        | 2598 MW   |
| Rating W to E        | Undefined |
| Max Voltage          | 500 kV    |

WECC Path Reports  
West of Crossover - Path 11

Figure 1: Path 11 Definition



### Historical Congestion

Path 11 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

Stakeholders did not identify any specific potential projects that may have a direct impact on Path 11 flows.

### Future Congestion Analysis

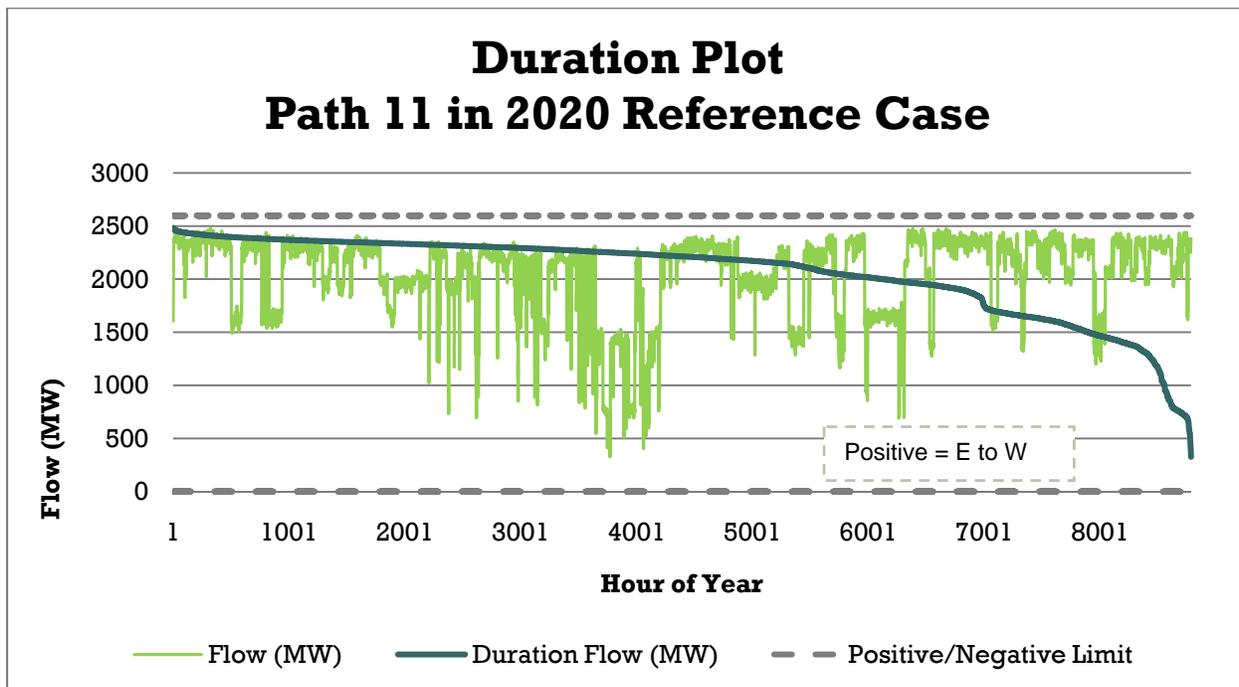
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 11 was congested in the expected future study case, as defined by the congestion metrics. West of Crossover operated at or above U75 and U90 for 70 percent and 9.47 percent of the year, respectively. The duration plot in Figure 3 shows this heavy utilization. The chronological plot in the same figure shows the seasonality of the flows. This high level of utilization is normal for Path 11 as it is intended to integrate Colstrip base load generation.

WECC Path Reports  
West of Crossover - Path 11

Figure 2: Path 11 2020 Duration Plot



**Alternative Futures**

Of 15 study cases used to inform the 10-Year Plan, Path 11 passed the utilization screening 12 times, indicating that the path was highly utilized in almost all study cases. According to the production cost model, utilization of Path 11 was high in every 2019 case except the 2019 Montana Resource Relocation study. The utilization of Path 11 decreases when resources are relocated to Montana because a large influx on wind generation into the state over constrains the transmission system, causing base load units like Colstrip to either back down or ramp excessively. Colstrip generation is directly tied to Path 11; therefore increased renewable penetration into Montana causes Path 11 utilization to decrease.

**Conditional Congestion**

Path 11 conditional congestion is contingent on a variety of cases. The congested cases and their conditional congestion scores are listed in Table 2. Study cases not listed are those in which Path 11 was not highly utilized.

Table 2: Path 11 Conditional Congestion

| Study Case                                 | Conditional Congestion Score <sup>1</sup> |
|--|---|
| 2019 Base Case                             | 0.15                                      |
| 2019 Arizona/S. Nevada Resource Relocation | 0.14                                      |

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

WECC Path Reports  
 West of Crossover - Path 11

| Study Case  | Conditional Congestion Score <sup>1</sup> |
|---|---|
| <b>2019 Wyoming Resource Relocation</b>           | 0.30                                      |
| <b>2019 British Columbia Resource Relocation</b>  | 0.10                                      |
| <b>2019 N. Nevada Resource Relocation</b>         | 0.08                                      |
| <b>2019 Alberta Resource Relocation</b>           | 0.16                                      |
| <b>2019 New Mexico Resource Relocation</b>        | 0.16                                      |
| <b>2019 Northwest Coastal Resource Relocation</b> | 0.08                                      |
| <b>2020 SPSC Reference Case</b>                   | 0.19                                      |
| <b>2020 High Load</b>                             | 0.42                                      |
| <b>2020 High DSM (Low Load)</b>                   | 0.11                                      |
| <b>2020 Aggressive WY Wind</b>                    | 0.63                                      |

The highest levels of congestion were contingent on the assumptions that formed two study cases: Aggressive Wyoming Wind, and High Load. The Aggressive Wyoming Wind case, featuring the relocation of 25,000 GWh of resources to Wyoming, caused congestion along the path. Increased penetration of Wyoming resources caused Wyoming coal units to back down due to transmission constraints. As a consequence, Montana coal resources were utilized further; thereby increasing flows on the West of Crossover path.

The High Load study case caused high levels of congestion along Path 11 as well. In this case, increased load requirements throughout the Western Interconnection results in increased base load generation. This increase in generation caused flows along Path 11 to exceed 90 percent of the path's limit for over 20 percent of the year.



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*This brief provides observations regarding the Idaho to Northwest WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 14.

- Path 14 is not historically congested according to metrics used in past TEPPC path utilization studies. However, congestion may exist in a capacity that cannot be identified by historical analysis due to the bidirectional nature of Path 14 flow. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are few projects in development that could directly impact Idaho to Northwest path flows.
- Path 14 was not heavily utilized or congested in the 2020 expected future study case, or any other study cases included in the 2010 Study Program.

## Description

Path 14 is composed of a number of lines located in southwest Idaho, northern Idaho, eastern Oregon, and eastern Washington. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Idaho to Northwest path.

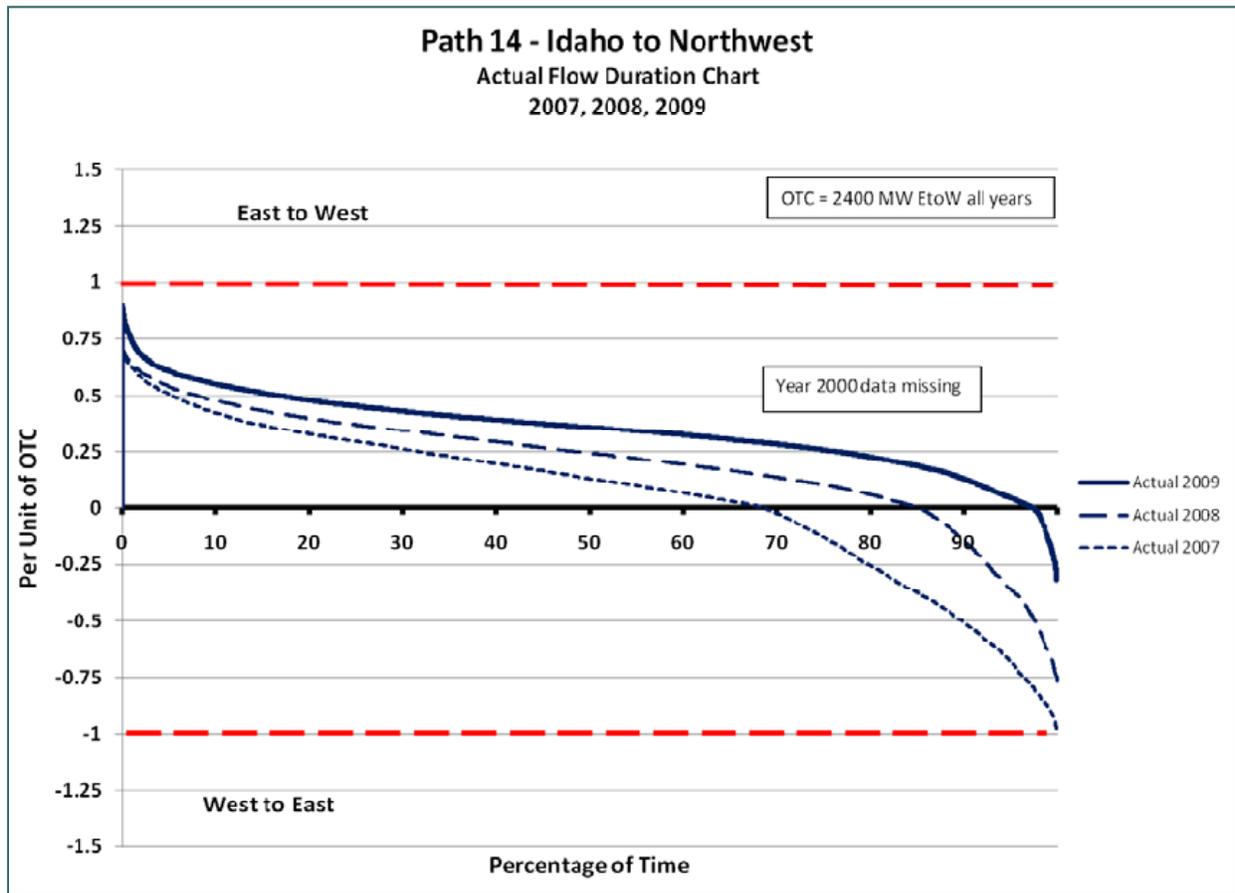
Table 1: Path 14 Characteristics

| Path Characteristics |         |
|----------------------|---------|
| Rating E to W        | 2400 MW |
| Rating W to E        | 1200 MW |
| Max Voltage          | 500 kV  |



WECC Path Reports  
 Idaho to Northwest - Path 14

Figure 2: Path 14 Actual Flow Duration Plot



**Project Development**

The following two projects were determined by stakeholders to be the most likely to have an impact on Path 14.

- Boardman – Hemingway (SCG Foundational Project)
- Hemingway – Captain Jack (Studied in 2010 Study Program)

The Boardman – Hemingway project was assumed constructed in both the 2019 and 2020 datasets.

**Future Congestion Analysis**

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

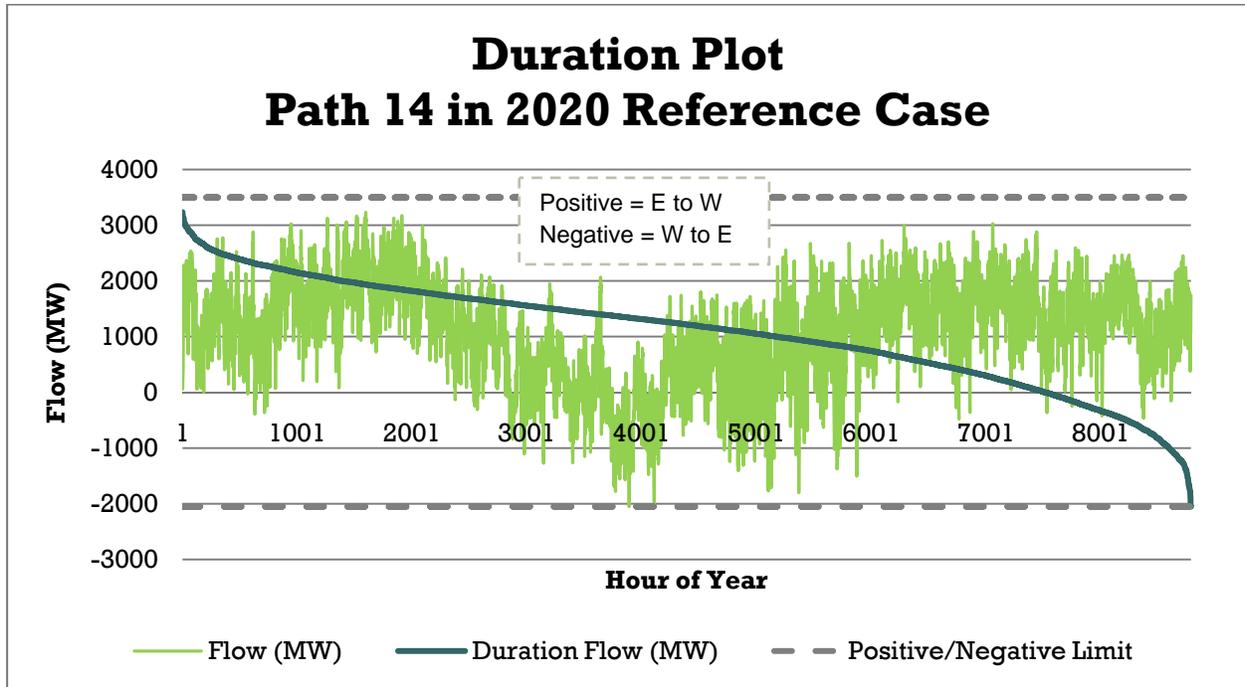
**Expected Future**

Path 14 was not heavily utilized or congested in the 2020 expected future study case. However, it is worth noting that the uni-directional operation of the path observed in the PCM does not align with actual operation (and therefore perceived congestion) of the path. Over the study year, U75 and U90 levels were at 2.58 percent and 0.11 percent, respectively. It is worth noting

WECC Path Reports  
 Idaho to Northwest - Path 14

that because the Boardman – Hemingway project and the Gateway West Phase 1 project were included in the 2020 dataset, the Path 14 rating increased from 2400 MW to 3500 MW in the east to west direction, and from 1200 MW to 2050 MW in the west to east direction. Without this rating increase the path may have been congested in the 2020 expected future, and the decrease in path utilization appears to coincide with the planned rating increase. The duration plot in Figure 3 shows low utilization of the path with the 2020 rating. The chronological plot in the same figure shows the seasonality of the flows.

Figure 3: Path 14 2020 Duration Plot



**Alternative Futures**

Path 14 did not pass the utilization screening in any of the 15 study cases used to inform the 10-Year Plan. No set of assumptions in the 2010 Study Program caused significant utilization of the path.

**Conditional Congestion**

Path 14 did not display any congestion the 2019 or 2020 study cases. Once again, the increased capacity provided by the Boardman – Hemingway project caused the lack of congestion along the path as a whole, in part.

**Project Development Impact**

The proposed Hemingway – Captain Jack project was assumed constructed in an addition to 12,000 GWh being relocated to Wyoming. This study provided information on the project’s ability to relieve congestion, relative to the base case and resource relocation case level of congestion. The implementation of the Hemingway – Captain Jack project decreased the utilization of Path 14, as shown in Table 2.

WECC Path Reports  
Idaho to Northwest - Path 14

Table 2: Project Development Impact on Path 14

| <b>Study Cases</b>  | <b>U75</b> |
|---|------------|
| <b>2019 Base Case</b>   | 4.10%      |
| <b>2019 Wyoming Resource Relocation</b>   | 8.47%      |
| <b>2019 WY Resource Relocation + Hemingway – Captain Jack and Gateway West #2</b> | 4.47%      |



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*This brief provides observations regarding the Idaho-Sierra WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 16.

- There are few projects in development that could directly impact Idaho-Sierra path flows.
- Path 16 was not congested or heavily utilized in the 2020 expected future case.

## Description

Path 16 consists of a single 345 kV line connecting southern Idaho and northern Nevada. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

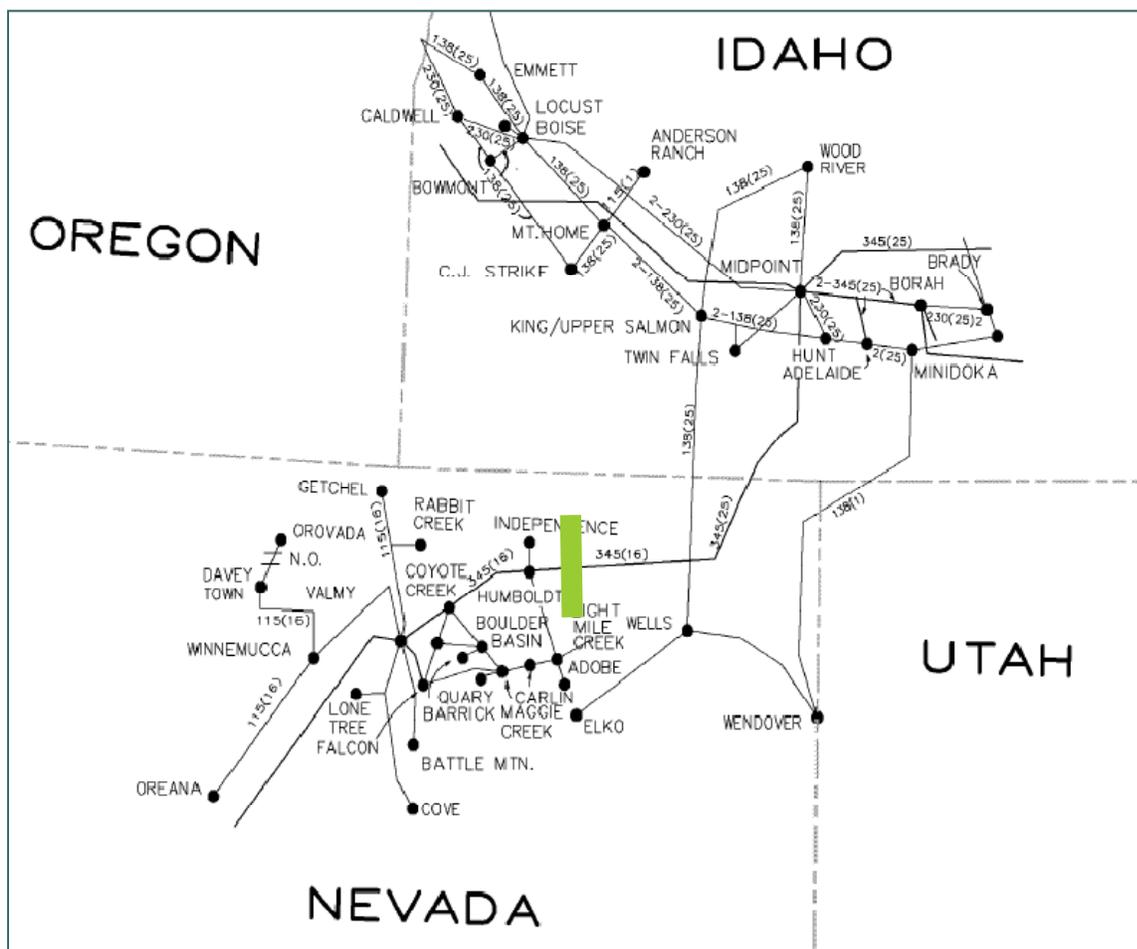
Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Idaho-Sierra path.

**Table 1: Path 16 Characteristics**

| Path Characteristics |        |
|----------------------|--------|
| <b>Rating N to S</b> | 500 MW |
| <b>Rating S to N</b> | 360 MW |
| <b>Max Voltage</b>   | 345 kV |

## WECC Path Reports Idaho-Sierra - Path 16

Figure 1: Path 16 Definition



### Historical Congestion

Path 16 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

The TransWest Express Project, studied in the 2010 Study Program, was determined by stakeholders to be the most likely to have an impact on Path 16. The TransWest Express project was studied as part of the 2010 Study Program. Congestion impacts on Path 16 from these study cases are presented in the “Future Congestion Analysis” under “Project Development Impact” {LINK}.

### Future Congestion Analysis

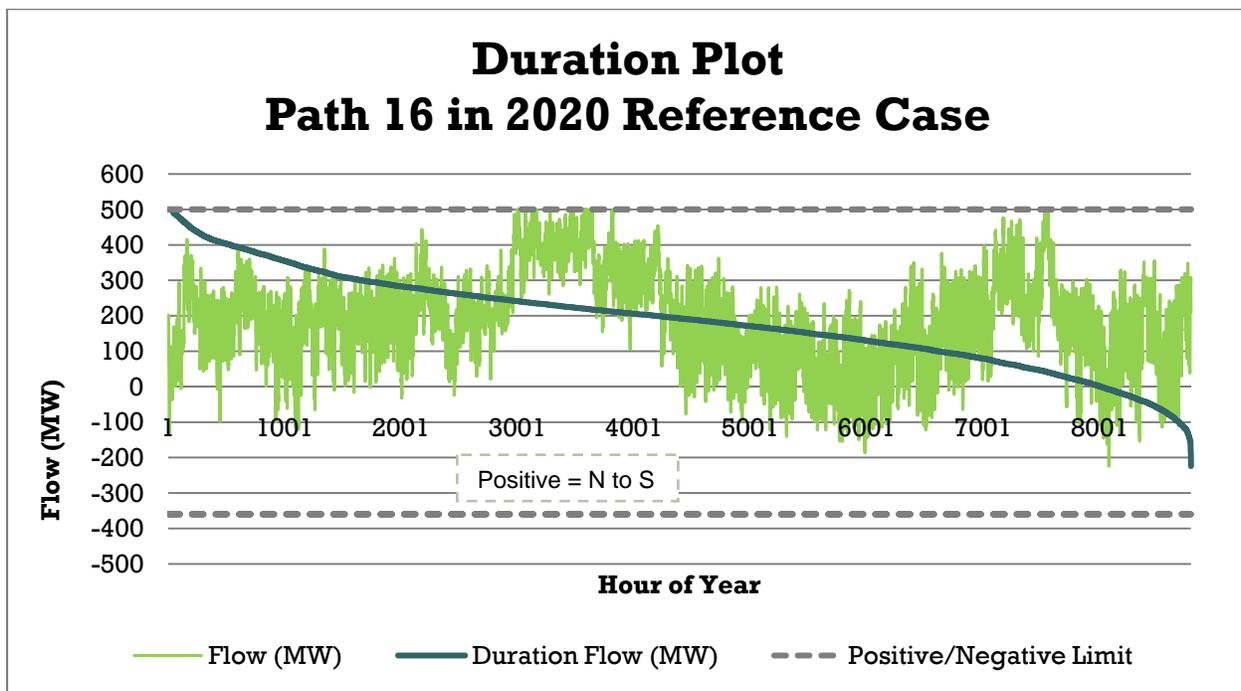
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

WECC Path Reports  
 Idaho-Sierra - Path 16

**Expected Future**

Path 16 did not meet the definition of being highly utilized in the expected future case. Furthermore, the path was not congested and received a conditional congestion score of zero in the expected future. It was utilized at the U75 level for only 8.94 percent of the year, placing it as the 24<sup>th</sup> most utilized path in the expected future, according to this metric. The path was at or above U90 for 2.14 percent of the year. As shown in Figure 2, flow was in the north to south direction for the majority of the year. The chronological plot in the same figure shows the seasonality of the flows.

**Figure 2: Path 16 2020 Duration Plot**



**Alternative Futures**

Of 15 study cases used to inform the 10-Year Plan, Path 16 passed the utilization screening twice, indicating that the path was highly utilized in specific study cases. According to the production cost model, utilization of Path 16 was high in the 2019 Northern Nevada Resource Relocation and the 2020 High DSM case.

**Conditional Congestion**

Path 16 conditional congestion is contingent on the same study cases in which it was highly utilized. The congested study cases and their conditional congestion scores are listed in Table 2.



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*This brief provides observations regarding the Borah West WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 17.

- Path 17 is historically congested based on net schedule analysis from the 2008 Path Utilization Study and from schedule and block schedule analysis in the 2009 Path Utilization Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are a number of projects in development that could directly impact Borah West path flows. However, those projects modeled in the 2010 Study Program did not have a significant impact on Path 17 due to an assumed increase in its path rating.
- Path 17 was not congested in the 2020 expected future case, or any of the other study cases.

## Description

Path 17 is located in southeast Idaho and is composed of five lines ranging in size from 138 kV to 345 kV. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

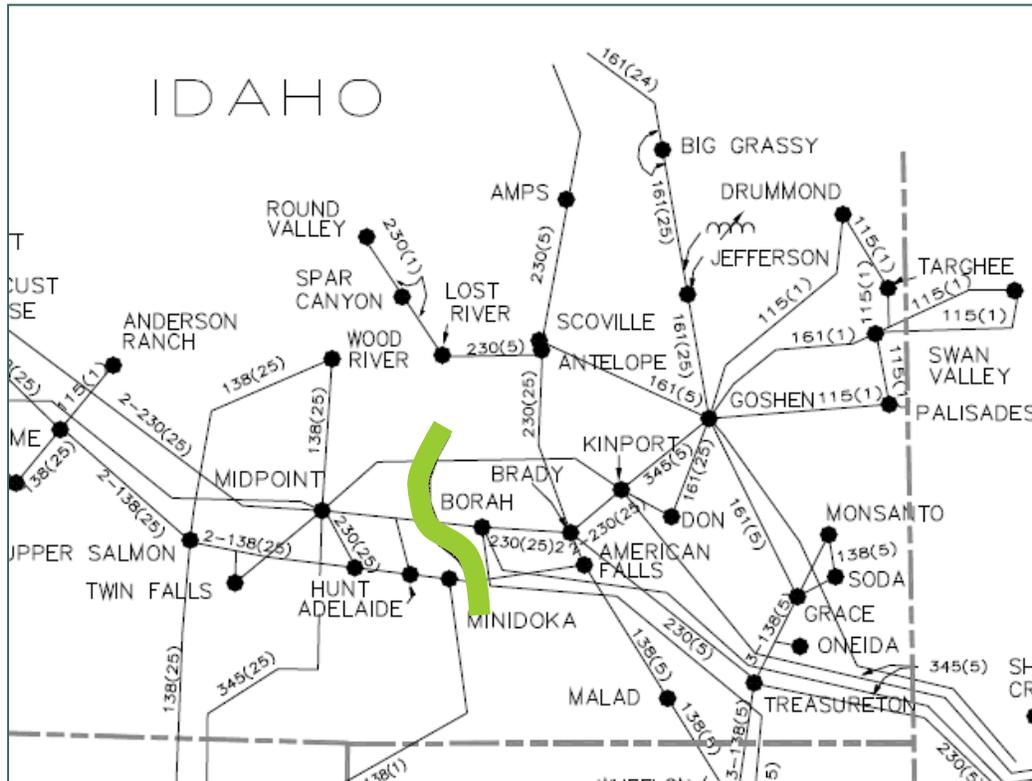
Table 1. The transfer capacity listed is the rating assigned following the completion of the Borah West 250 MW upgrade project. Figure 1, on the next page, shows the physical cut plane that forms the Borah West path.

**Table 1: Path 17 Characteristics**

| Path Characteristics |           |
|----------------------|-----------|
| <b>Rating E to W</b> | 2557 MW   |
| <b>Rating W to E</b> | Undefined |
| <b>Max Voltage</b>   | 345 kV    |

WECC Path Reports  
Borah West - Path 17

Figure 1: Path 17 Definition

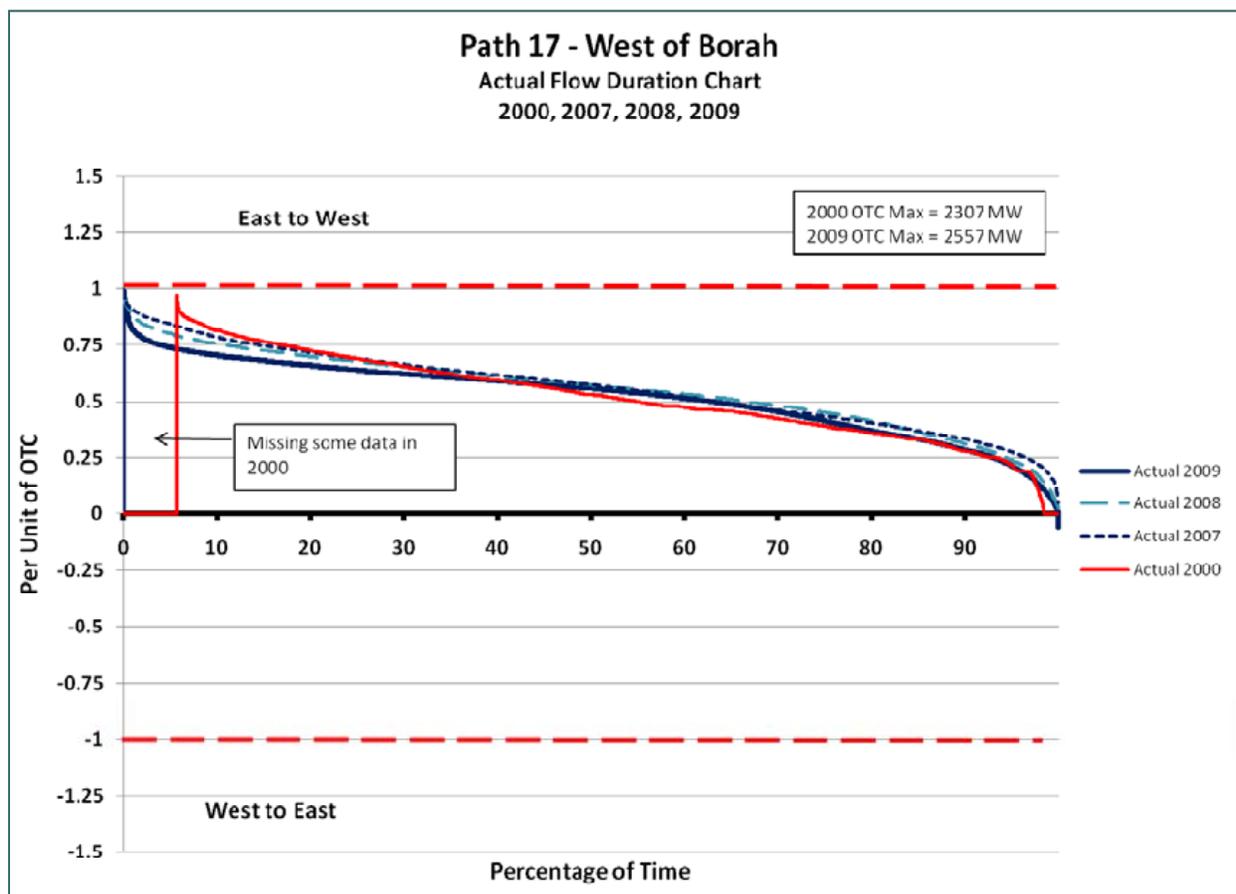


### Historical Congestion

Path 17 is historically congested based on net schedule metrics from the 2008 Path Utilization Study, as well as schedule and block schedule metrics from the 2009 Path Utilization Study. In 2008, actual flow was at U75 for 14 percent of the year. Based on the net schedule ranking, Path 17 was the 2<sup>nd</sup> most congested path in the Western Interconnection in the 2008 Study. It was also listed as one of the most heavily used or congested paths based upon flow and schedule data. In the 2009 Study Borah West had no firm ATC available for at least 95 percent of the year. The path was listed as the 4<sup>th</sup> most heavily used or congested path based on 2009 historical flow and schedule data. The path was analyzed in the 2007 report as well, where during spring, summer, and fall seasons Path 17 had actual flow greater than 75 percent of OTC between 25 percent and 50 percent of the time, based on the heaviest loading year from 1998 to 2005. Actual flow data for historic years can be found in the duration plot in Figure 2. Although informative, this plot does not necessarily reflect the metrics that support the path as historically congested.

WECC Path Reports  
Borah West - Path 17

Figure 2: Path 17 Actual Flow Duration Plot



### Project Development

The following projects were determined by stakeholders to be the most likely to have an impact on Path 17.

- Chinook (Studied in 2010 Study Program)
- Gateway West Phase 2 (Studied in 2010 Study Program)
- Overland
- TransWest Express (Studied in 2010 Study Program)

Congestion impacts on Path 17 resulting from the three projects included in the 2010 Study Program are presented in the "Future Congestion Analysis" under "Project Development Impact".

### Future Congestion Analysis

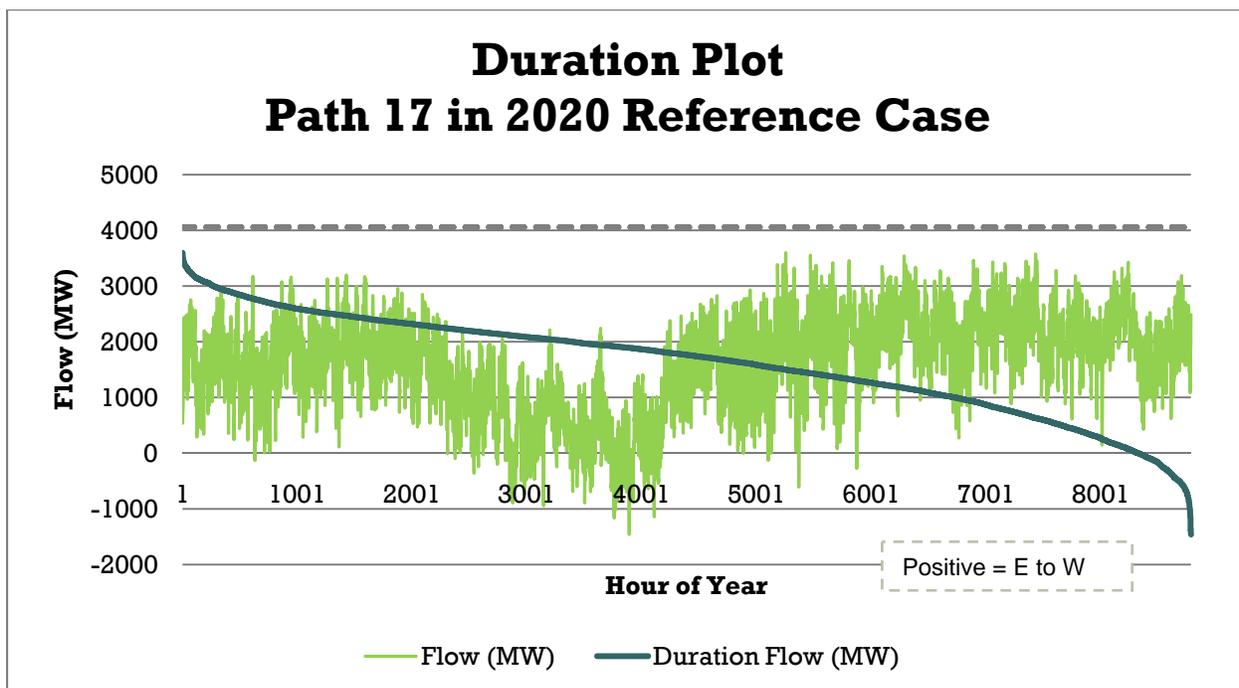
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

WECC Path Reports  
 Borah West - Path 17

**Expected Future**

Path 17 was not congested or highly utilized in the expected future case as defined by the utilization screening and congestion metrics. Borah West operated at or above U75 for less than three percent of the year and flow never reached 90 percent of the path's limit. The duration plot in Figure 3 shows this light utilization in the expected future case. The increase from the current east to west rating of 2,557 MW to the 4,057 MW modeled in the 2020 expected future is due to the inclusion of the Gateway West project. Without this project and the subsequent path rating increase, it is likely that Borah West would have been congested in the expected future case. The chronological plot in Figure 3 shows the seasonality of the flows as well.

**Figure 3: Path 17 2020 Duration Plot**



**Alternative Futures**

Path 17 failed to pass the utilization screening in all 15 study cases used to inform the 10-Year Plan. No combination of assumptions used to form the study cases caused Path 17 to be highly utilized as defined by the utilization screening.

**Conditional Congestion**

There is no congestion on Path 17 contingent on any study case in the study program.

**Project Development Impact**

There were three projects evaluated in the study program that could potentially have an impact on Path 17 flow. The first of which was the Chinook project, which was run both on the 2020 Reference Case and on the 2019 Montana Resource Relocation. The Chinook project connects energy rich Montana with the Las Vegas load center. The second project, Gateway West Phase 2, was run on the 2019 Wyoming Resource Relocation in conjunction with multiple projects. Lastly, the TransWest Express project connects Wyoming to the Las Vegas area. This project

WECC Path Reports  
 Borah West - Path 17

was run on the 2019 Wyoming Resource Relocation study case. Table 2 presents a comparison of the Borah West utilization in the 2020 Reference Case, 2019 Base Case, and transmission expansion cases. As shown, the path was not highly utilized in any of the study cases.

**Table 2: Project Development Impact on Path 17**

| Study Cases   | Borah West U75 (% of year) |
|---|----------------------------|
| <b>2019 Base Case</b>   | 0.00%                      |
| <b>2019 Montana Resource Relocation</b>   | 0.00%                      |
| <b>2019 MT Resource Relocation + Chinook Project</b>                                    | 0.00%                      |
| <b>2019 Wyoming Resource Relocation</b>   | 0.00%                      |
| <b>2019 WY Resource Relocation + TransWest Express</b>                                  | 0.00%                      |
| <b>2019 WY Resource Relocation + Gateway West Phase 2 (w/ Cascade Crossing)</b>         | 0.00%                      |
| <b>2019 WY Resource Relocation + Gateway West Phase 2 (w/ Hemingway – Captain Jack)</b> | 0.00%                      |



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*This brief provides observations regarding the Montana-Idaho WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 18.

- Path 18 is not historically congested according to the metrics used in past TEPPC Path Utilization Studies. However, the path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are few projects in development that could directly impact Montana-Idaho path flows.
- Path 18 was not congested in the 2020 expected future study case. However, there was congestion along the path contingent on the development of renewables in Montana.
- Path 18 forms a portion of the Montana Region of Concern {Link}.

## Description

Path 18 is located in eastern Idaho and western Montana. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Montana-Idaho path.

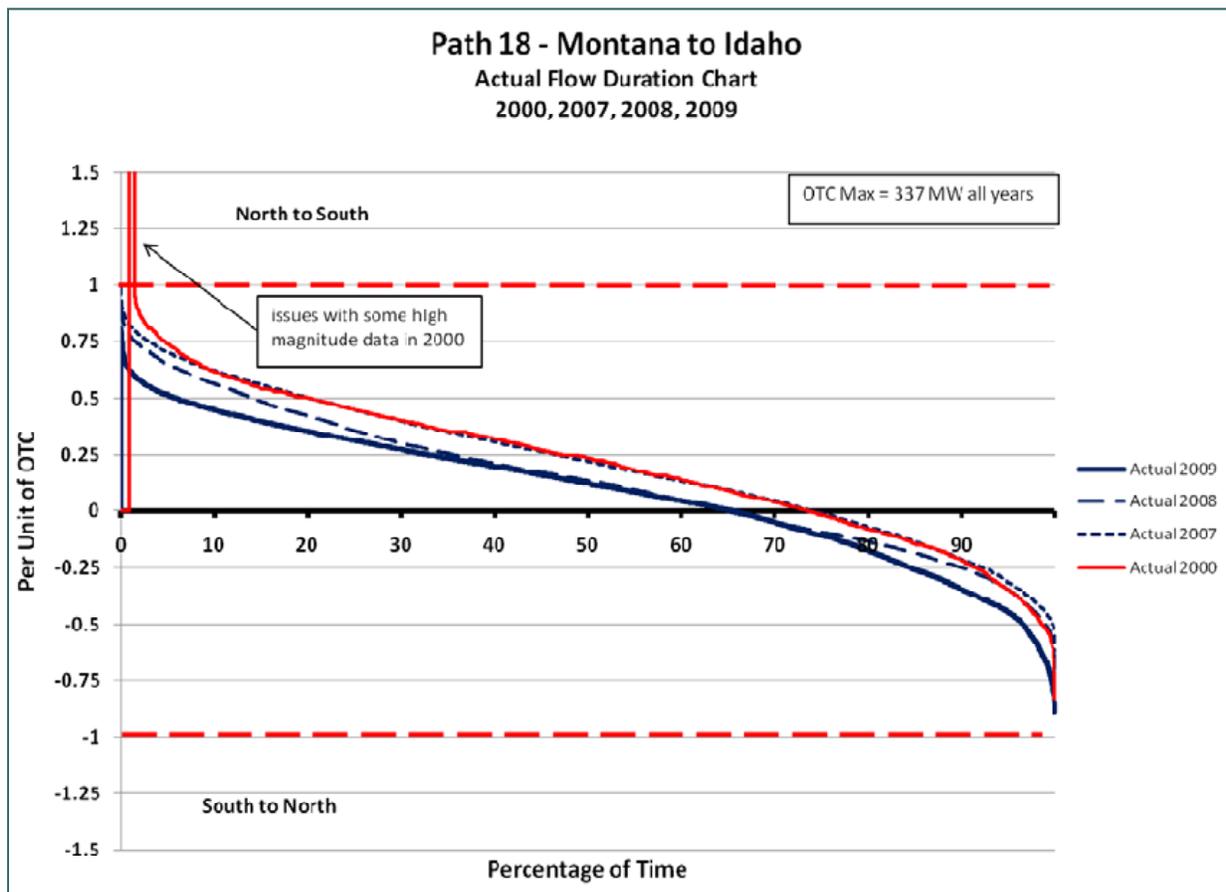
Table 1: Path 18 Characteristics

| Path Characteristics |        |
|----------------------|--------|
| Rating N to S        | 337 MW |
| Rating S to N        | 256 MW |
| Max Voltage          | 230 kV |



WECC Path Reports  
 Montana-Idaho - Path 18

Figure 2: Path 18 Actual Flow Duration Plot



**Project Development**

The Chinook and Mountain States Intertie (MSTI) projects, both studied in the 2010 Study Program, were determined by stakeholders to be the most likely to have an impact on Path 18. Neither of these projects was included in the 2019 or 2020 datasets.

**Future Congestion Analysis**

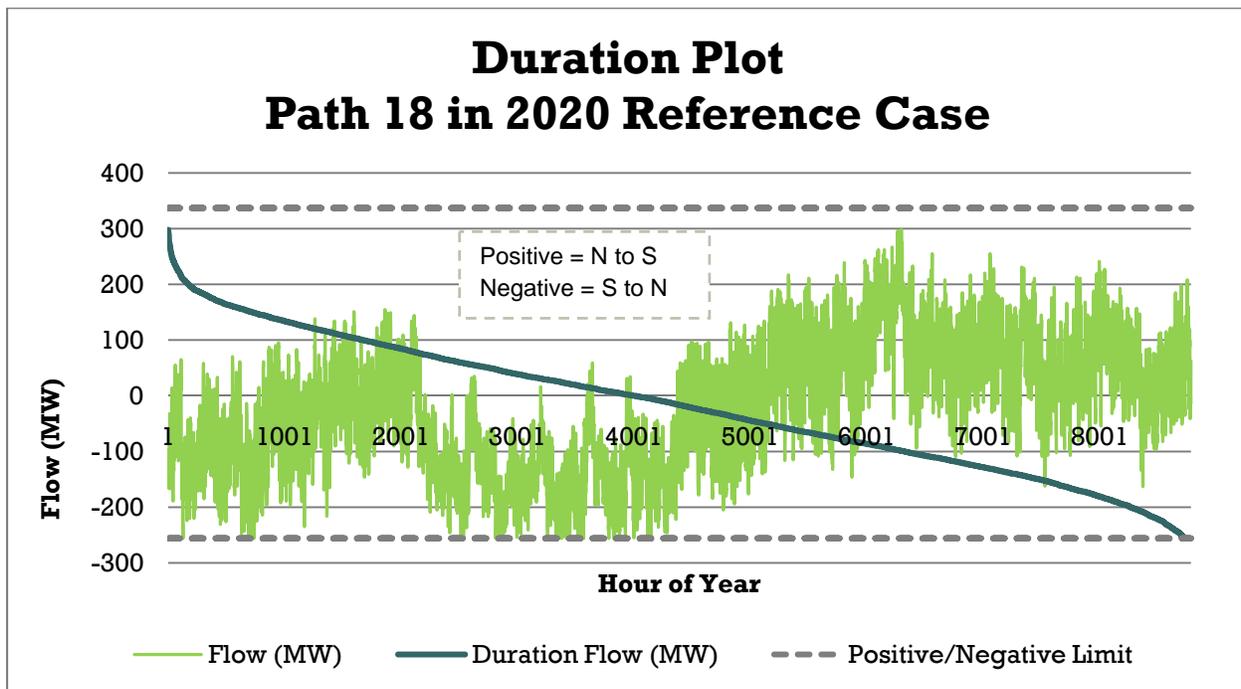
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

**Expected Future**

Path 18 was not heavily utilized or congested in the expected future case. Montana-Idaho operated at U75 for only 7.38 percent of the year, and at U90 for only 2.42 percent of the year. The duration plot in Figure 3 shows this relatively low utilization. The chronological plot in the same figure shows the seasonality of the flows.

WECC Path Reports  
Montana-Idaho - Path 18

Figure 3: Path 18 2020 Duration Plot



**Alternative Futures**

Of 15 study cases used to inform the 10-Year Plan, Path 18 passed the utilization screening two times, indicating that high utilization of the path is dependent on specific assumptions. According to the production cost model, utilization of Path 18 can be expected to be high in cases featuring an increase of Montana renewables without added transmission.

**Conditional Congestion**

Path 18 conditional congestion was contingent on study cases featuring increased renewable penetration into Montana. The congested cases and their conditional congestion scores are presented in Table 2. Idaho-Montana flow was at or above U90 for over 38 percent of the year in the Aggressive Montana Wind case. In the Montana Resource Relocation case, the path was at U90 for nearly 25 percent of the year. Congestion along Path 18, in both cases, was caused by placing large amounts of renewable generation in Montana without adding transmission. The entire Montana system, including Path 18, was congested as a result.

Table 2: Path 18 Conditional Congestion

| Study Case                       | Conditional Congestion Score <sup>1</sup> |
|----------------------------------|---|
| 2019 Montana Resource Relocation | 0.87                                      |
| 2020 Aggressive Montana Wind     | 1.54                                      |

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all study cases and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Case). The minimum was 0 (multiple occurrences).

WECC Path Reports  
 Montana-Idaho - Path 18

**Project Development Impact**

There are two projects in development that could have a direct impact on Path 18 utilization. The impacts on Path 18 utilization as a result of project development in the region are presented in Table 3. In the table, U90 values are reported for the 2019 Base Case, Montana Resource Relocation Case, and the resource case with added transmission (transmission expansion cases). Each set of assumptions has a different impact on Path 18 operation.

**Table 3: Project Development Impact on Path 18**

| <b>Study Cases</b>                                      | <b>U90<br/>(% of year)</b> |
|---|----------------------------|
| <b>2019 Base Case</b>                                   | 5.63%                      |
| <b>2019 Montana Resource Relocation</b>                 | 25.54%                     |
| <b>2019 MT Resource Relocation + Chinook</b>            | 6.660%                     |
| <b>2019 MT Resource Relocation + MSTI (and SWIP N.)</b> | 8.64%                      |

As shown in the table, U90 along Path 18 increases greatly when resources are relocated to Montana without added transmission. However, it appears that most projects listed are effective at reducing the utilization of Path 18 down to the levels observed in the 2019 Base Case.



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*This brief provides observations regarding the Bridger West WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 19.

- Path 19 is historically congested based on flow metrics from the 2007 Path Utilization Study, flow metrics from the 2008 Study, and flow, schedule, and block hour schedule metrics from the 2009 Study. However, the path was constructed with the intent that it be highly utilized. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are projects in development that could directly impact Bridger West path flow.
- Path 19 was not heavily utilized or congested in the 2020 expected future study case.

## Description

Path 19 is located along the boarder of southeast Idaho and southwest Wyoming. It is composed of three 345 kV lines, all of which originate at the Jim Bridger Generation Station. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Bridger West path.

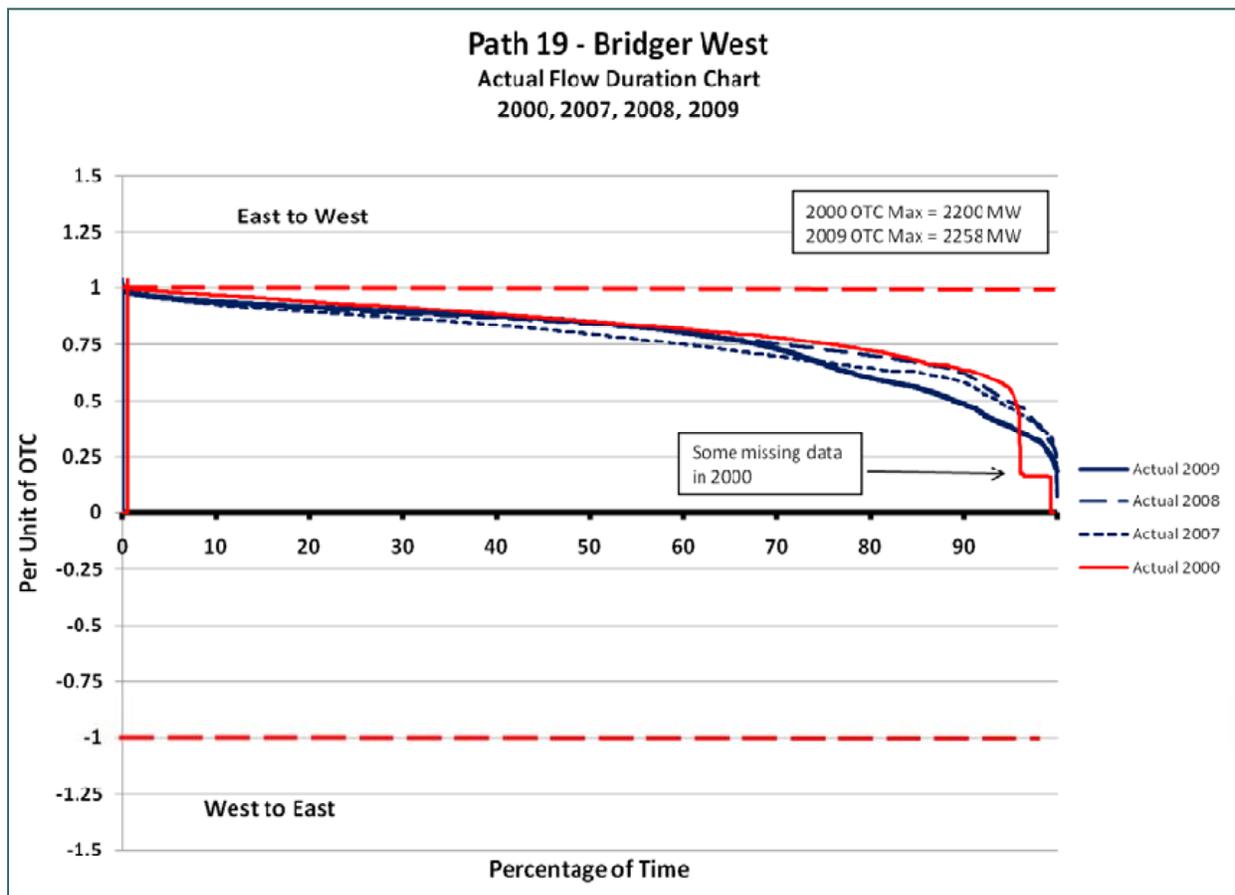
Table 1: Path 19 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating E to W        | 2200 MW   |
| Rating W to E        | Undefined |
| Max Voltage          | 345 kV    |



WECC Path Reports  
 Bridger West - Path 19

Figure 2: Path 19 Actual Flow Duration Plot



### Project Development

The following four projects were determined by stakeholders to be the most likely to have an impact on Path 19.

- Gateway West Phase 1 (SCG Foundational Project)
- Overland
- TransWest Express (Studied in 2010 Study Program)
- Zephyr (Studied in 2010 Study Program)

The Gateway West Phase 1 project was assumed constructed in the 2020 database. Both the TransWest Express and Zephyr projects were evaluated as expansion cases and their impacts on Path 19, in terms of utilization, are presented in the “Future Congestion Analysis” under “Project Development Impact.”

### Future Congestion Analysis

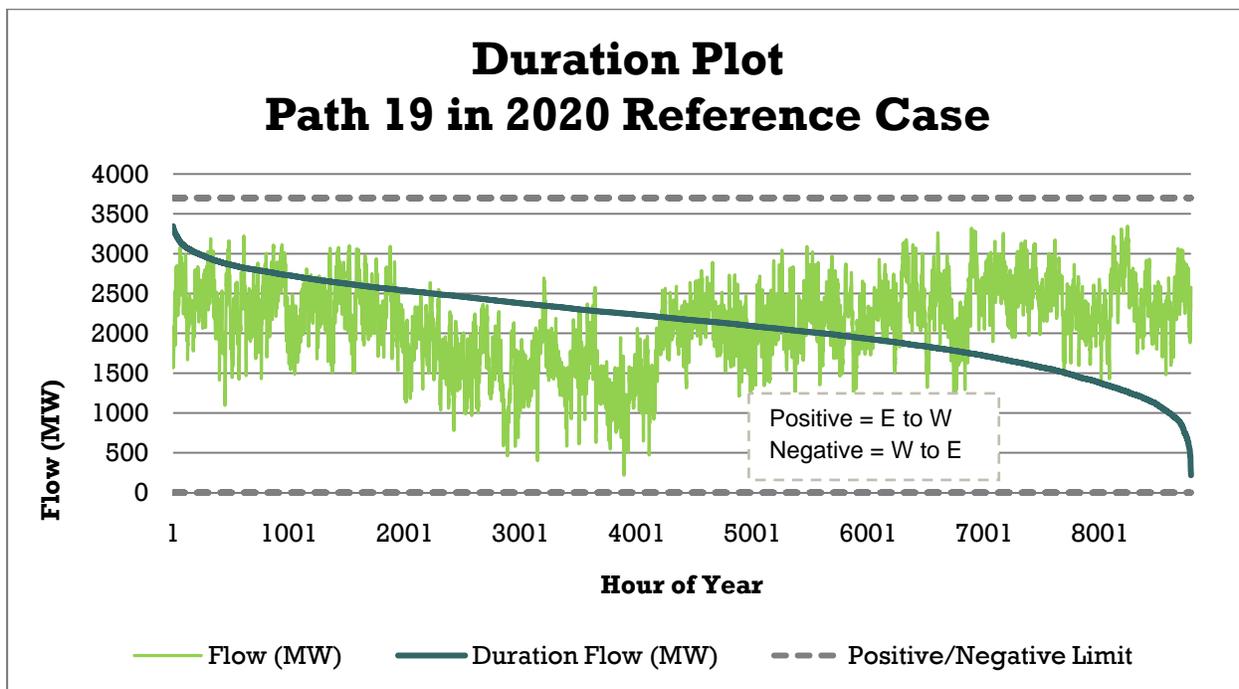
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

WECC Path Reports  
Bridger West - Path 19

### Expected Future

Path 19 was not heavily utilized or congested in the 2020 expected future case. Over the study year, the path operated at or above U75 for only 2.71 percent of the year. It is worth noting that because the Gateway West Phase 1 project was included in the 2020 dataset, the Path 19 rating increased from its current 2,200 MW rating to 3,700 MW in the east to west direction. Without this rating increase the path may have been congested in the 2020 expected future. The duration plot in Figure 3 shows low utilization of the path with the 2020 rating. The chronological plot in the same figure shows the seasonality of the flows.

Figure 3: Path 19 2020 Duration Plot



### Alternative Futures

Path 19 passed the utilization screening in only one of the 15 study cases used to inform the 10-Year Plan. The set of assumptions used to form the Aggressive Wyoming Wind case, featuring 25,000 GWh of relocated wind resources, caused Path 19 to be highly utilized as defined by the utilization screening.

### Conditional Congestion

Path 19 displayed a significant amount of congestion in the Aggressive Wyoming Wind case. This set of assumptions caused Bridger West to operate at U75 for over 50 percent of the year, U90 for nearly 30 percent of the year, and at U99 (i.e. fully constrained) for 13 percent of the year. Large amounts of renewable energy modeled in Wyoming, without incremental transmission, appear to have caused high levels of congestion along Path 19 in the PCM.

WECC Path Reports  
 Bridger West - Path 19

**Project Development Impact**

The TransWest Express and Zephyr projects were evaluated as expansion cases in the 2010 Study Program. The expansion cases were evaluated by running the 2019 Wyoming Resource Relocation case with the added transmission.

**Table 2: Project Development Impact on Path 19**

| <b>Study Cases</b>                      | <b>Path 19 U75<br/>(% of year)</b> |
|---|------------------------------------|
| <b>2019 Base Case</b>                   | 12.50%                             |
| <b>2019 Wyoming Resource Relocation</b> | 33.50%                             |
| <b>2019 Wyoming + TransWest Express</b> | 28.12%                             |
| <b>2019 Wyoming + Zephyr</b>            | 13.06%                             |

As shown in the table, the U75 levels of Path 19 decreased from the 2019 Wyoming Resource Relocation in both expansion cases. Both projects were able to transfer resource out of Wyoming and deliver the energy to load centers, thereby reducing congestion along Path 19. However, due to DC line modeling issues associated with the PCM, both the TransWest Express and Zephyr lines were underutilized in the model. If this modeling inconsistency were corrected, it is likely that a substantial decrease in Path 19 utilization would be observed after implementing the DC lines into the model. Both projects provide sufficient capacity to transfer the resources relocated to Wyoming to load centers without impacting intermediate transmission.



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*This brief provides observations regarding the Path C WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path C.

- Path C is historically congested based on schedule and block hour schedule metrics from the 2009 Path Utilization Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are a number of projects in development that could directly impact Path C flows. However, TEPPC congestion analysis show only minor changes in Path C utilization.
- Path C was not congested in the 2020 expected future study case, or any other study case in the 2010 Study Program.

## Description

Path C consists of six transmission lines located in northern Utah and southern Idaho. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

**Table 1. The stated ratings are a function of load and generation in northern Utah and southeastern Idaho.**

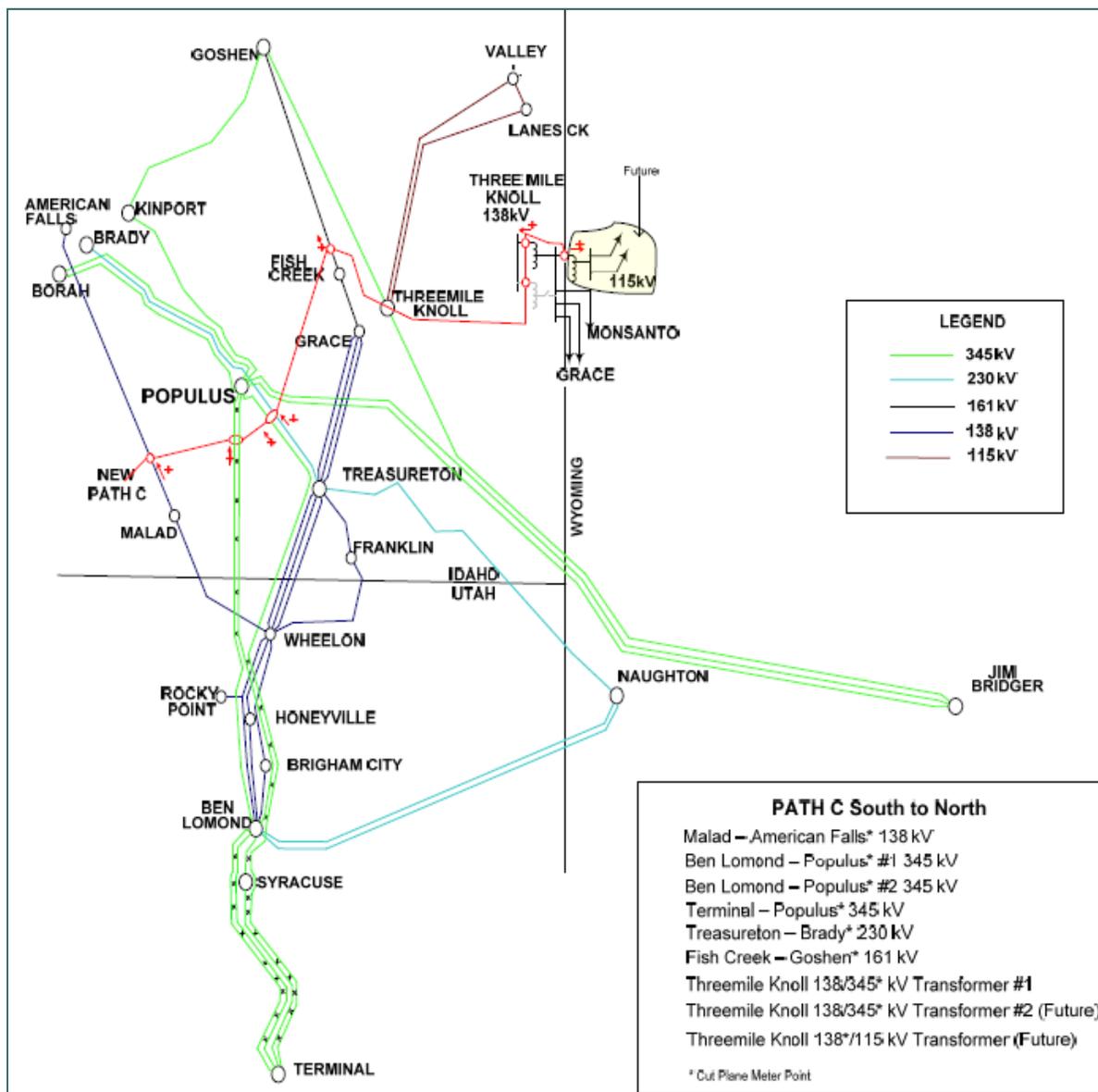
Figure 1, on the next page, shows the physical cut plane that forms Path C.

**Table 1: Path C Characteristics**

| Path Characteristics |         |
|----------------------|---------|
| <b>Rating N to S</b> | 1600 MW |
| <b>Rating S to N</b> | 1250 MW |
| <b>Max Voltage</b>   | 345 kV  |

WECC Path Reports  
 Path C - Path 20

Figure 1: Path C Definition



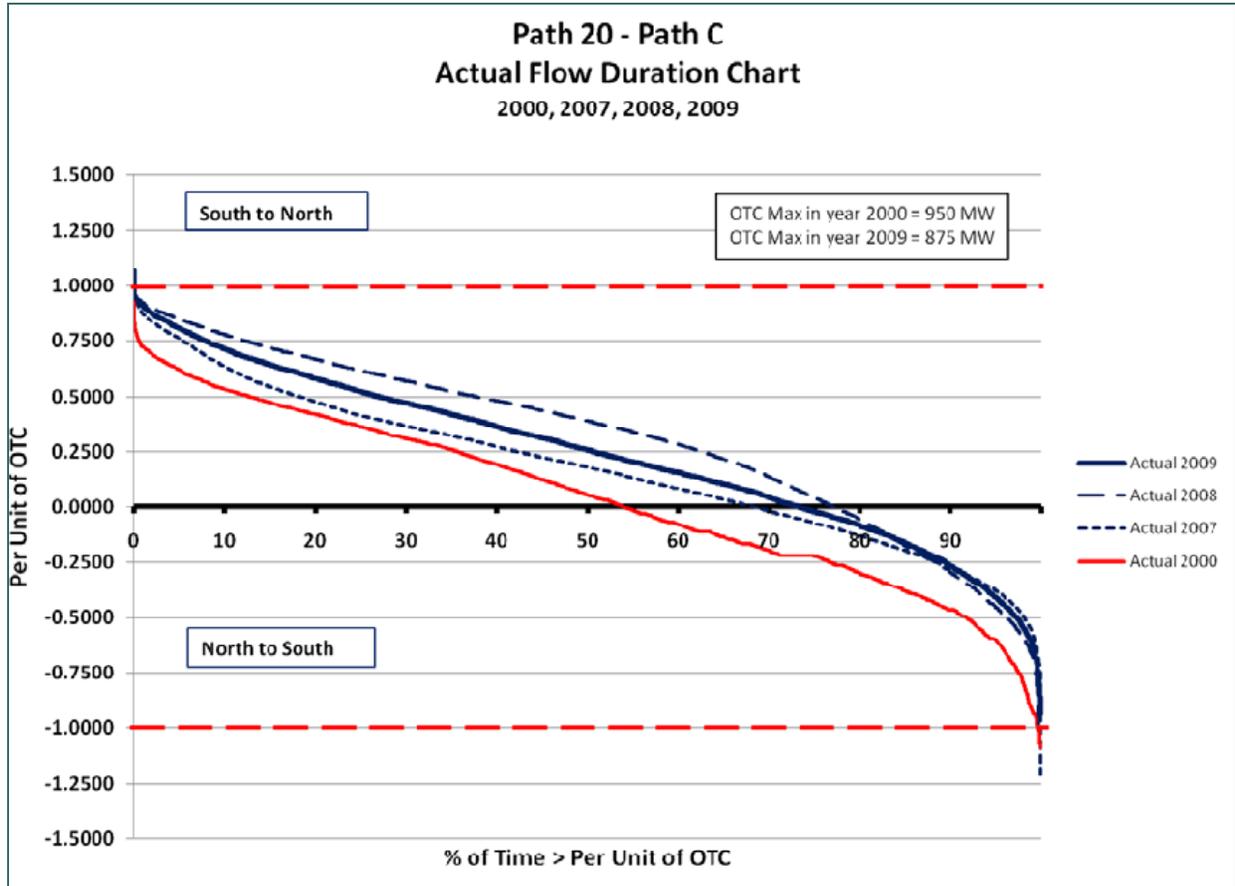
**Historical Congestion**

Path C was analyzed in the 2009, 2008, and 2007 Transmission Path Utilization Studies and is historically congested based on schedule metrics and block hour schedule metrics from the 2009 Study. Unused capacity was calculated to be 104 MW available for 95 percent of the year in the 2009 Study. Based on net schedule data, the 2009 Study reported Path C operated at U75 for nearly 23 percent of the year. Path C was listed as the 6<sup>th</sup> most congested or highly utilized path. There was no ATC data available for analysis in the 2009 Study. The 2008 Study reported Path C as operating at or above U90 for one percent of the year. Actual flow data for

WECC Path Reports  
 Path C - Path 20

historic years can be found in the duration plot in Figure 2. Although informative, this plot does not necessarily reflect the metrics that support the path as historically congested.

Figure 2: Path C Actual Flow Duration Plot



## Project Development

The following projects were determined by stakeholders to be the most likely to have an impact on Path C.

- Chinook (Studied in 2010 Study Program)
- Gateway Central Phase 1 (SCG Foundational Project)
- SWIP North (Studied in 2010 Study Program)
- TransWest Express (Studied in 2010 Study Program)
- Zephyr (Studied in 2010 Study Program)

The Gateway Central Phase 1 project was assumed constructed in the 2019 and 2020 datasets. The other projects were studied as part of the 2010 Study Program and their impact on Path C utilization is presented in the “Future Congestion Analysis” under “Project Development Impact”.

WECC Path Reports  
 Path C - Path 20

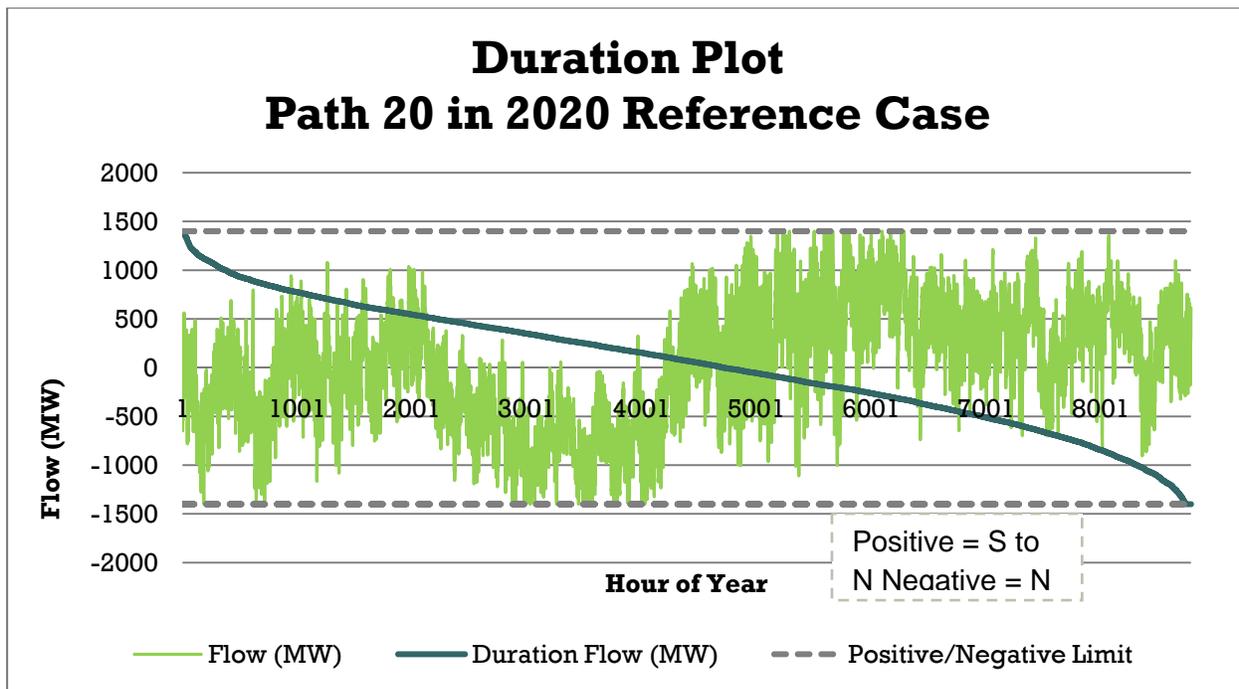
### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

#### Expected Future

Path C did not pass the utilization screening and was not congested in the 2020 expected future case. Flows were in the south to north direction for the majority of the study year. Moreover, the path exceeded U75 for only 7.82 percent of the study year. In part, this relatively low utilization can be attributed to the modeled increase of the path limit. TEPPC used the 2010 Path Rating Catalog as a starting point for implementing path limits. Path C had limits of 1,000 MW in both directions in 2010. The 2020 dataset assumed the construction of the Gateway Central Phase 1 project, which increased the path limits to 1,400 MW in both directions. This increase in capacity resulted in decreased utilization of the line and mitigated any potential congestion in the expected future case. Had the limit been the original 1,000 MW, it is likely that Path C would have been congested in the expected future. The duration plot in Figure 3 shows the light utilization of the path. The chronological plot in the same figure shows the seasonality of the flows.

Figure 3: Path C 2020 Duration Plot



#### Alternative Futures

Of the 15 study cases used to inform the 10-Year Plan, Path C never passed the utilization screening. No set of assumptions in the 2010 Study Program caused the path to be highly utilized.

WECC Path Reports  
 Path C - Path 20

**Conditional Congestion**

Path C did not display any congestion in any of the 2019 or 2020 study cases.

**Project Development Impact**

There were four projects evaluated in the 2010 Study Program that could have an impact on Path C flow. Table 2 **Error! Reference source not found.** shows a comparison of Path C utilization in the 2019 Base Case, and several different combinations of transmission projects and resource relocations. Due to the path rating increases along Path C associated with the inclusion of the Gateway Central Phase 1, project development had little impact on Path C utilization.

**Table 2: Project Development on Path C**

| Study Cases                             | Path C U75<br>(% of year) |
|---|---------------------------|
| <b>2019 Base Case</b>                   | 0.00%                     |
| <b>2019 Montana Resource Relocation</b> | 0.09%                     |
| <b>2019 Montana + MSTI/SWIP N.</b>      | 0.53%                     |
| <b>2019 Montana + Chinook Project</b>   | 0.50%                     |
| <b>2019 Wyoming Resource Relocation</b> | 0.35%                     |
| <b>2019 Wyoming + TransWest Express</b> | 0.22%                     |
| <b>2019 Wyoming + Zephyr</b>            | 0.74%                     |

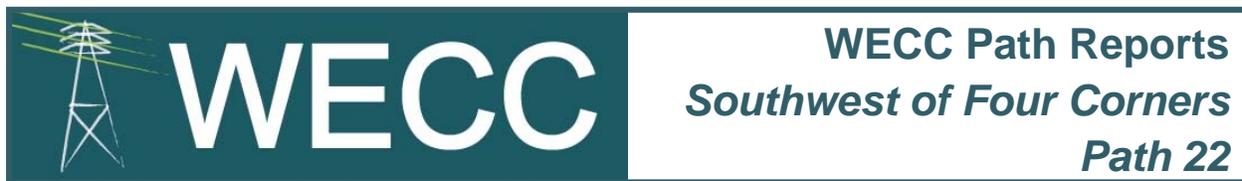
**Other Observations**

General observations from PacifiCorp regarding Path 20's 2008 historical analysis, as taken from Appendix I of the 2008 TEPPC Transmission Path Utilization Study, are as follows:

“Path C is the primary path used for reserves under the Northwest Power Pool's reserve sharing programs. Reserve use is not scheduled; however firm rights holders do not schedule their full capacity in an effort to assure that reserve capacity is available for use. Reserve benefits claimed on the path range from 100 – 200 MW.

Path C's operating limits have fallen significantly over the past year as PacifiCorp studies have shown that credible N-2 outages must be taken into account. The current operating limits in both S to N and N to S directions are much lower than the limits in during 2007. The current OTC limit is a function of loads (on both ends of the path) and temperature. The net effect is to reduce the historic TTC by 100 MW to as much as 400 MW based upon actual conditions each operating day.

The same facilities are used to provide both the northbound and the southbound service. If either direction is at the limit, the "path" is a constraint. In some ways taking the maximum of the southbound or northbound use ratio for each hour might be a better measure of the "path" use than a southbound chart and a northbound chart.”



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*This brief provides observations regarding the Southwest of Four Corners WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 22.

- Path 22 is historically congested based on actual flow metrics from the 2007 Path Utilization Study, actual flow metrics from the 2008 Study, and actual flow, schedule, and block hour schedule metrics from the 2009 Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are a number of projects under development that could directly impact Southwest of Four Corners path flow.
- Path 22 is not heavily utilized or congested in the expected future study case.

## Description

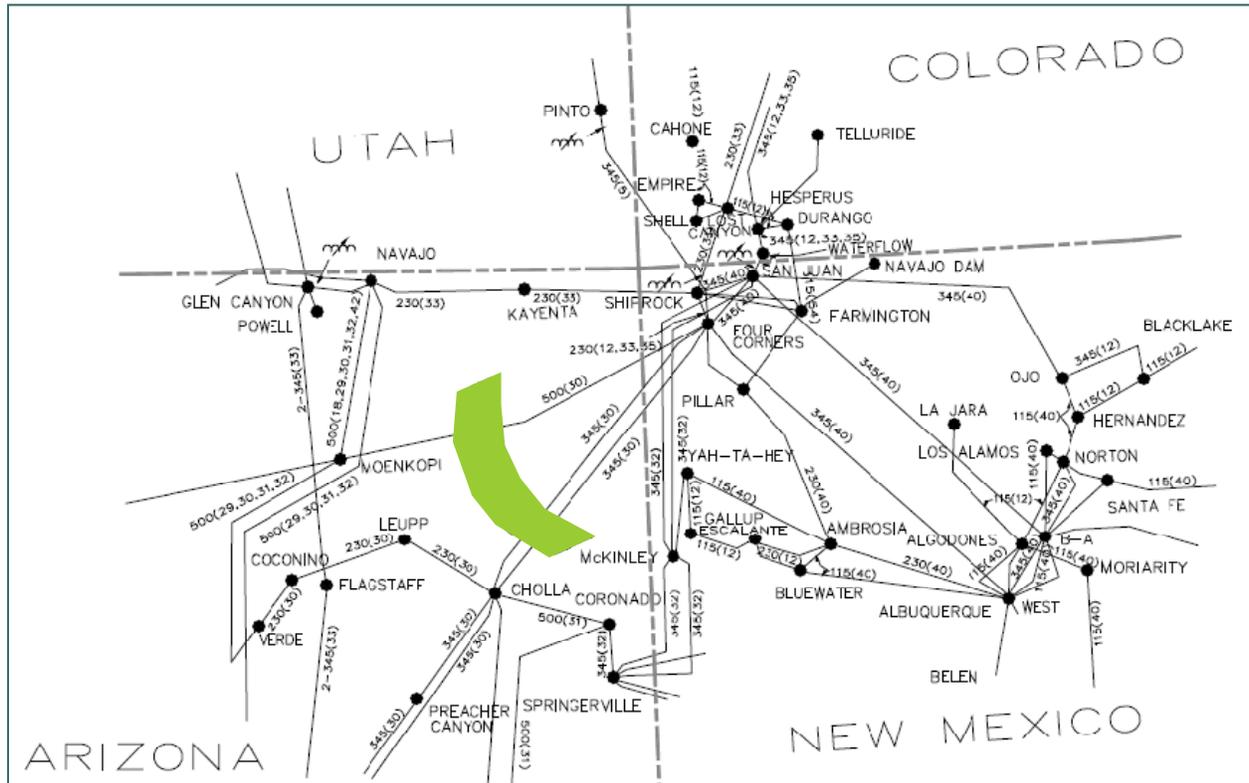
The Southwest of Four Corners path is located in northeastern Arizona. The path consists of three lines, one 500 kV line and two 245kV lines, all of which are connected to the Four Corners station. Historically, flows have been generally east to west due to the large amount of generation located in northwestern New Mexico. This generation is partly owned by entities west of the Arizona – New Mexico border. Key characteristics of the path as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Southwest of Four Corners path.

**Table 1: Path 22 Characteristics**

| Path Characteristics |           |
|----------------------|-----------|
| <b>Rating E to W</b> | 2325 MW   |
| <b>Rating W to E</b> | Undefined |
| <b>Max Voltage</b>   | 500 kV    |

WECC Path Reports  
Southwest of Four Corners - Path 22

Figure 1: Path 22 Definition

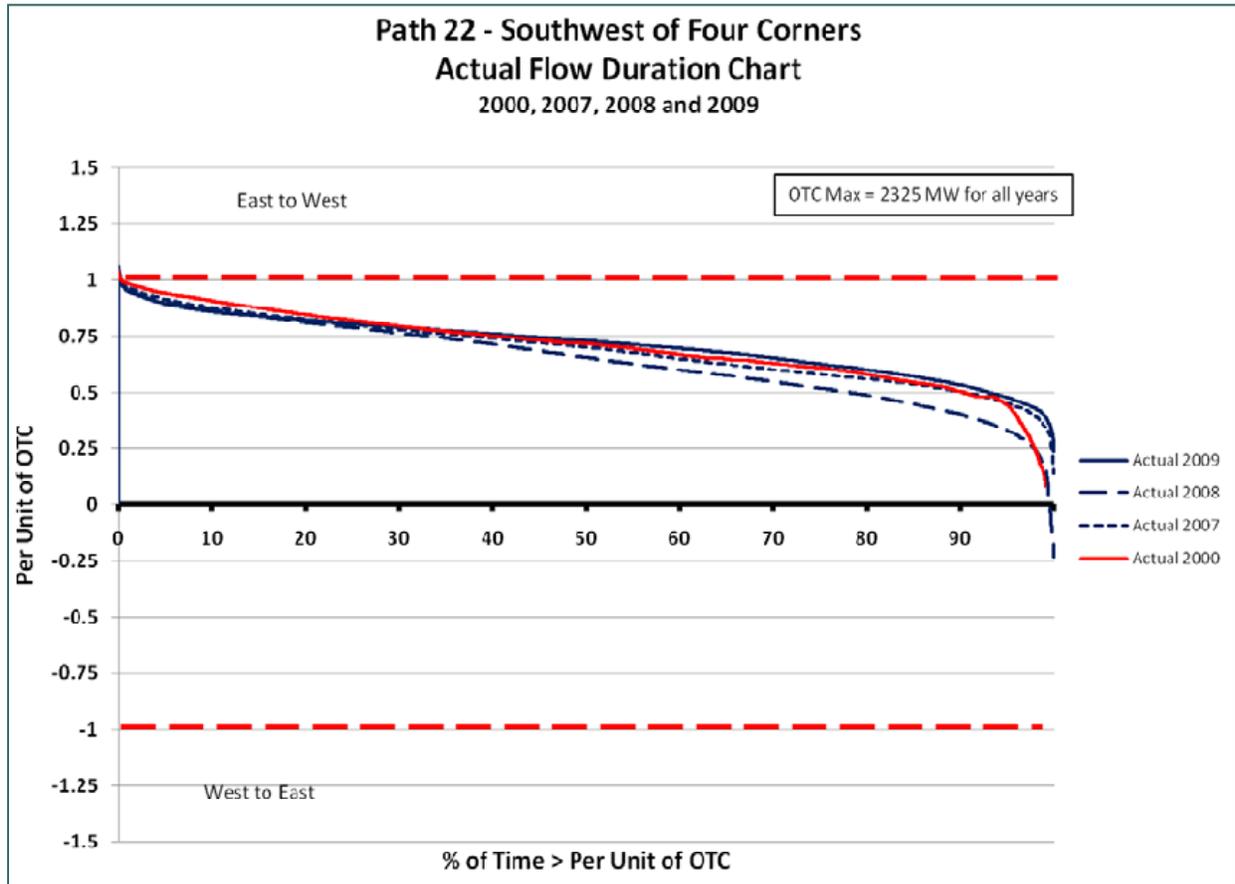


### Historical Congestion

The 2007, 2008, and 2009 TEPPC Transmission Path Utilization Studies analyzed data for Path 22 and it is historically congested based on actual flow metrics from the 2007 and 2008 Studies, and actual flow, schedule, and block hour schedule metrics from the 2009 Study. The 2007 Study reported that Path 22 had at least one season over the study period in which the seasonal loading exceeded 75 percent of OTC 50 percent of the time or more. This constituted the inclusion of Path 22 on the list of heavily utilized paths in the 2007 Study. Path 22 made the list again in the 2008 Study, with flow exceeding 90 percent of the path limit for nearly 7 percent of the year. The 2009 Study ranked Southwest of Four Corners as the 3<sup>rd</sup> most heavily utilized or congested path based on flow and schedule data. Additionally, the path had zero firm ATC offerings in the east to west direction during the study year. Actual flow data can be found in the duration plot in Figure 2. Although informative, the plot does not necessarily reflect the metrics that support the path as historically congested.

WECC Path Reports  
 Southwest of Four Corners - Path 22

Figure 2: Path 22 Actual Flow Duration Plot



### Project Development

The following two projects were determined by stakeholders to be the most likely to have an impact on Path 22.

- Centennial West Clean Line (Studied in 2010 Study Program)
- Navajo Transmission Project (Studied in 2010 Study Program)

Congestion impacts on Path 22 from those projects included in the 2010 Study Program are presented in the “Future Congestion Analysis” under “Project Development Impact”.

### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

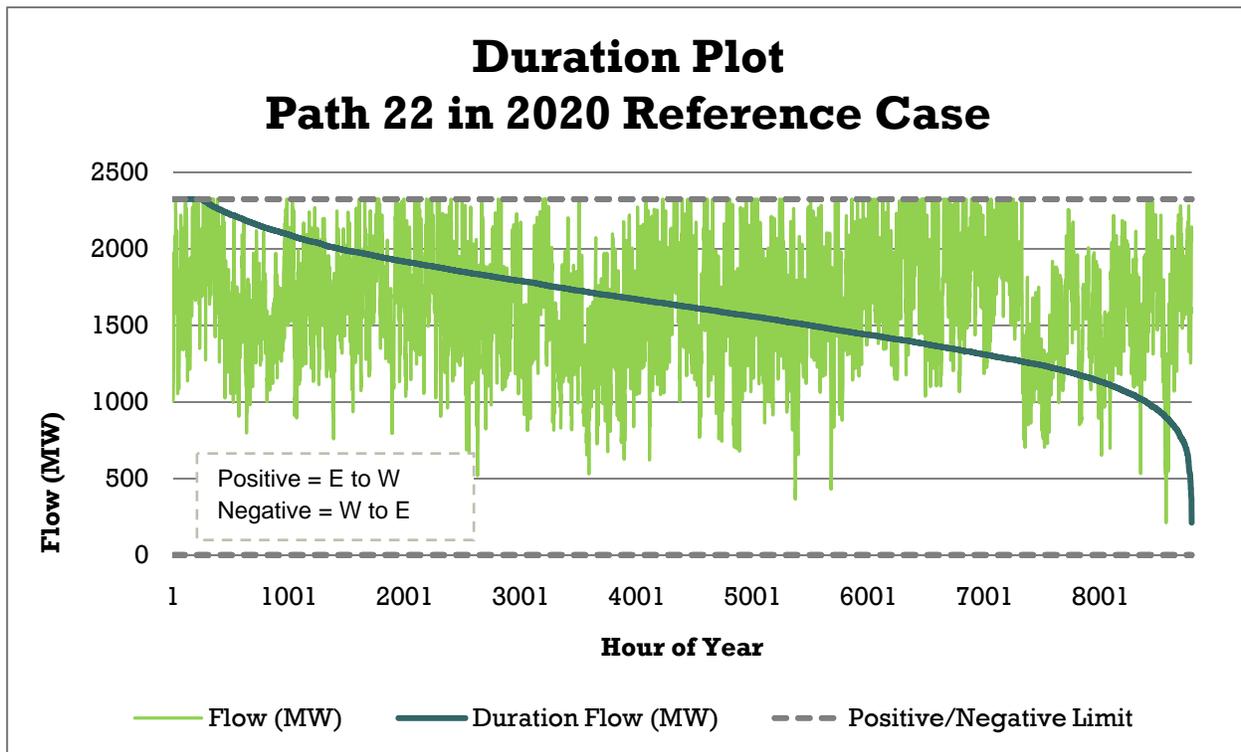
### Expected Future

In the 2020 expected future case, Path 22 operated at U99 and U90 for 38 percent and 11 percent of the year, respectively. It did not pass the utilization screening based on any of the metrics, thereby it was not highly utilized in the expected future study case and there was no

WECC Path Reports  
 Southwest of Four Corners - Path 22

congestion on Path 22 contingent on the assumptions used to develop the 2020 Reference Case. As shown in Figure 3, flow was in the east to west direction for the majority of the year. The chronological plot in the same figure shows path flow above 1500 MW for the majority of the year. In part, this is due to the path's connection to the Four Corners coal generation, which is utilized as a base load resource.

Figure 3: Path 22 2020 Duration Plot



**Alternative Futures**

Of 15 study cases used to inform the 10-Year Plan, the Southwest of Four Corners path passed the utilization screening three times. Path 22 was highly utilized in the 2019 Wyoming Resource Relocation, 2019 New Mexico Resource Relocation, and 2020 Aggressive Wyoming Wind cases.

**Conditional Congestion**

Conditional congestion along Path 22 in the PCM is contingent on resources being relocated to Wyoming or New Mexico (without the addition of transmission). Conditional congestion scores were calculated for those study cases in which Path 22 was highly utilized (i.e. passed the utilization screening). The conditional congestion scores for Path 22 and the associated study cases in which the scores were calculated are listed in Table 2.

WECC Path Reports  
Southwest of Four Corners - Path 22

**Table 2: Path 22 Conditional Congestion**

| Study Case                                 | Conditional Congestion Score <sup>1</sup> |
|--|---|
| <b>2019 Wyoming Resource Relocation</b>    | 0.57                                      |
| <b>2019 New Mexico Resource Relocation</b> | 1.02                                      |
| <b>2020 Aggressive Wyoming Wind</b>        | 0.67                                      |

High levels of congestion along Path 22 appear to be most contingent on a future featuring a large build out of renewable resources in New Mexico, as indicated by the high conditional congestion score in that study case. This congestion is likely caused by incremental transmission not being included in that particular study case, which in turn resulted in the southeast portion of the Western Interconnection, which includes Path 22, becoming heavily constrained.

**Project Development Impact**

Centennial West Clean Line and the Navajo Transmission projects were added, separately, to the 2019 New Mexico Resource Relocation case in order to form transmission expansion study cases. These expansion case congestion results were compared with the base case and the resource relocation without incremental transmission to better understand how Path 22 behaves under varying assumptions. Impacts on Path 22 utilization are shown in Table 3.

**Table 3: Project Development Impact on Path 22**

| Study Cases  | U90    |
|--|--------|
| <b>Base Case</b>   | 12.85% |
| <b>2019 New Mexico Resource Relocation</b>                       | 41.23% |
| <b>2019 NM Resource Relocation + Centennial West Clean Line</b>  | 49.92% |
| <b>2019 NM Resource Relocation + Navajo Transmission Project</b> | 2.35%  |

As previously discussed, Path 22 became heavily congested in the 2019 New Mexico Resource Relocation case. The Navajo Transmission Project appears to reduce U90 levels along Path 22 below the base case level. The Centennial West Clean Line project is a DC line that is underutilized in the PCM, and as a consequence Path 22 utilization did not decrease with the implementation of that line.

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<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).



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*This brief provides observations regarding the Four Corners 345/500 WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 23.

- Path 23 is not historically congested based on the metrics used in previous TEPPC Path Utilization Studies. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their future path utilization reports.
- There are few projects in development that could directly impact Four Corners 345/500 flows.
- Path 23 was not congested in the 2020 expected future, or in any other study case in the 2010 Study Program.

## Description

Path 23 is located in northwestern New Mexico and is defined as the flow on the 345/500 kV transformer. Flows in the area are generally from east to west due to the large amount of generation in the Four Corners area. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical location of the Four Corners 345/500 path.

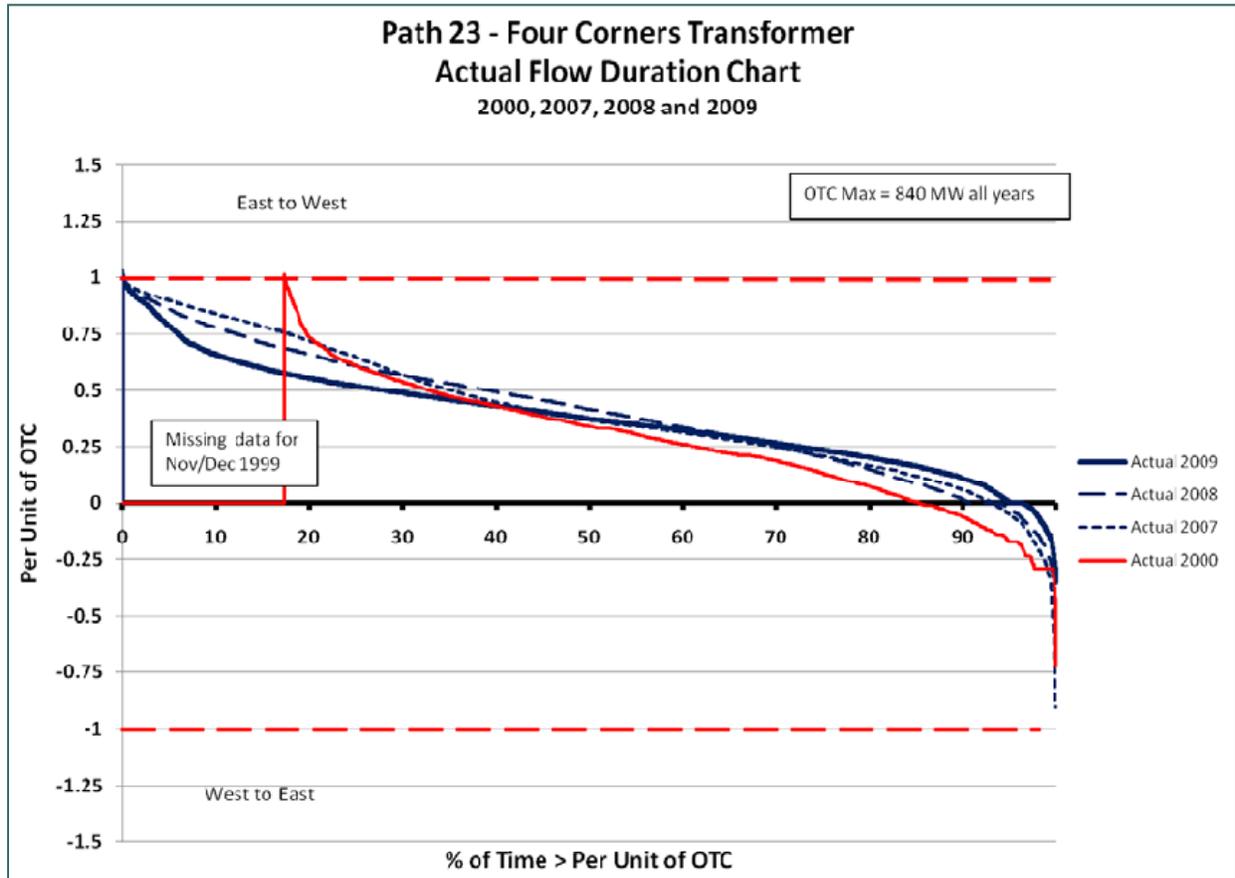
**Table 1: Path 23 Characteristics**

| Path Characteristics  |  |
|-----------------------|--|
| <b>Transfer Limit</b> | 345 to 500 kV: 840 MVA<br>500 to 345 kV: 840 MVA |
| <b>Max Voltage</b>    | 500 kV   |



WECC Path Reports  
 Four Corners 345/500 - Path 23

Figure 2: Path 23 Actual Flow Duration Plot



### Project Development

Stakeholder determined that the Navajo Transmission Project (Studied in 2010 Study Program) as a potential project likely to have an impact on Path 23. The project was not assumed built in the 2019 or 2020 datasets. The Navajo Transmission Project was studied as an expansion case in the 2010 Study Program. Congestion related impacts on Path 23 from the project are presented in the “Future Congestion Analysis” under “Project Development Impact” {LINK}.

### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

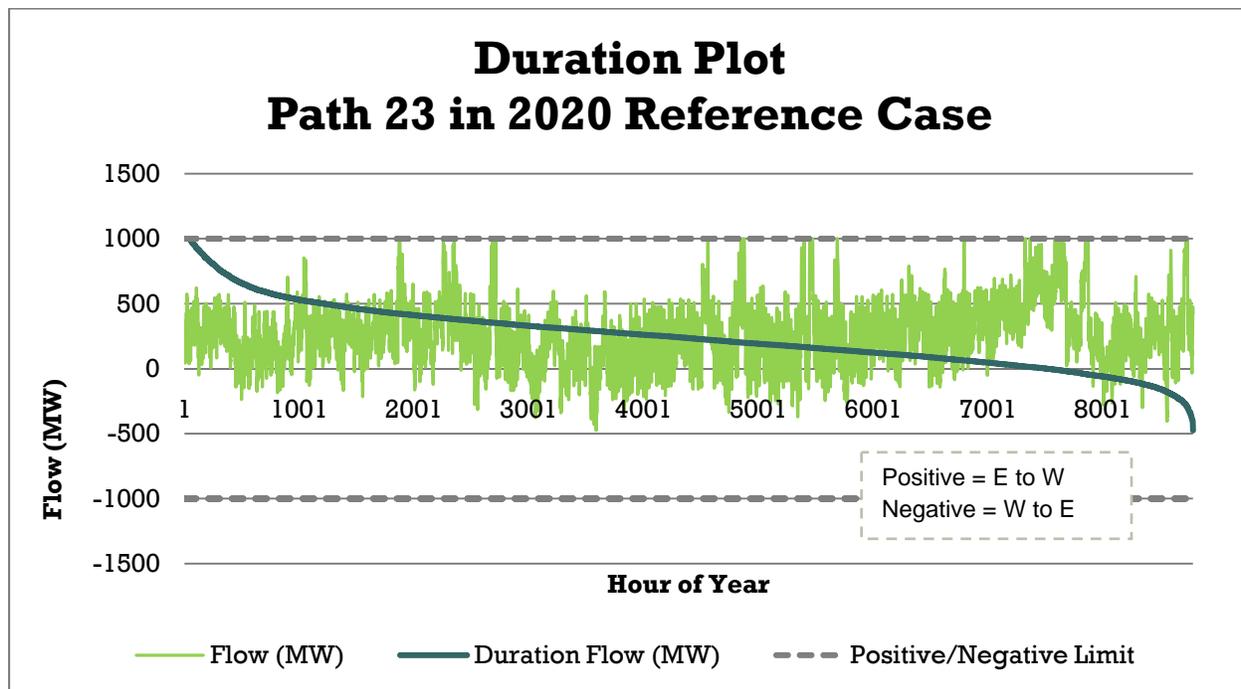
Path 23 was not congested or heavily utilized in the expected future study case. The path operated at U75 for only 3.63 percent of the study year. This low utilization is due to an increase in the path limit implemented in the 2020 dataset. At the request of the owner, Four Corners 345/500 limit was increased from 840 MW to 1,000 MW in the dataset<sup>1</sup>. In previous TEPPC studies, Path 23 was one of the most congested paths. By assuming the construction of a

<sup>1</sup> In the PCM unity power factor is assumed for the transformer. This assumption is based on the premise that reactive power issues would be dealt with locally.

WECC Path Reports  
 Four Corners 345/500 - Path 23

higher rated transformer, the path was no longer congested. The duration plot in Figure 3 shows this light utilization. The chronological plot in the same figure shows the seasonality of the flows.

Figure 3: Path 23 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 23 never passed the utilization screening. No set of assumptions in the 2010 Study Program caused the path to be highly utilized.

**Conditional Congestion**

Path 23 did not display any congestion in any of the 2019 or 2020 study cases.

**Project Development Impact**

There was one project evaluated in the 2010 Study Program that could potentially have an impact on Path 23 flow. **Error! Reference source not found.** shows a comparison of Path 23 utilization in the 2019 Base Case, 2019 New Mexico Resource Relocation, and the 2019 New Mexico Resource Relocation with the Navajo Transmission Project.

| Study Cases                                   | Path 23 U75 (% of year) |
|---|-------------------------|
| 2019 Base Case                                | 3.26%                   |
| 2019 New Mexico Resource Relocation           | 9.22%                   |
| 2019 New Mexico + Navajo Transmission Project | 19.11%                  |

Utilization of Path 23 increased after 12,000 GWh of renewable resources were relocated to New Mexico without added transmission. Utilization of the path increased further once the Navajo Transmission Project was added to the case. With added export capacity in the form of



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*This brief provides observations regarding the Intermountain Power Project DC Line (IPPDC) WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 27.

- Path 27 was constructed with the intent that it be highly utilized. This statement is consistent with the results of the historical congestion analysis. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their future path utilization reports.
- There are projects in development that could directly impact IPPDC path flows.
- Path 27 was congested in the 2020 expected future case. A number of future resource and load assumptions also resulted in congestion along Path 27.

## Description

Path 27 is a +/- 500 kV DC bipole line that runs from the Intermountain station in central Utah to the Adelanto substation in southern California. The path is often referred to as IPPDC. Nearly 60 percent of the path’s capacity is allocated to LADWP. The remaining 40 percent is split between five southern California municipalities. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the IPPDC path.

**Table 1: Path 27 Characteristics**

| Path Characteristics |           |
|----------------------|-----------|
| <b>Rating E to W</b> | 2400 MW   |
| <b>Rating W to E</b> | 1400 MW   |
| <b>Max Voltage</b>   | 500 kV DC |

WECC Path Reports  
IPP DC Line - Path 27

Figure 1: Path 27 Definition

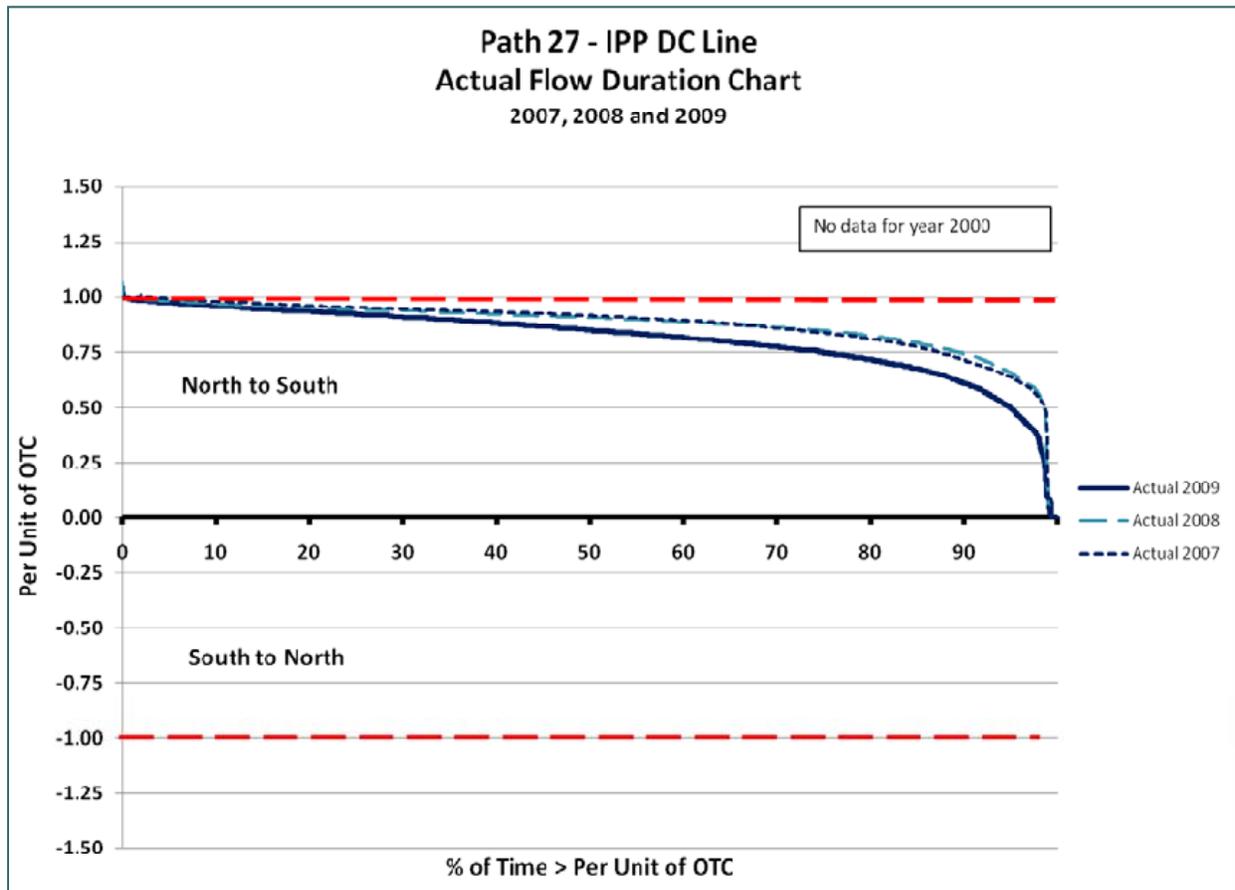


**Historical Congestion**

Path 27 was analyzed in the 2009 Transmission Path Utilization Study where it was ranked as the most heavily congested/utilized path in the Western Interconnection based on flow, schedule, and block hour schedule metrics. In the 2009 study year, Path 27 operated at or above U75 for nearly 75 percent of the year. The path as most heavily utilized in the winter months. The 2007 Study did not evaluate Path 27, although it was listed as one of the most heavily used paths in the 2007 Study based off of previous study results. The 2008 Study did not evaluate Path 27. Actual flow data for historic years can be found in the duration plot in Figure 2. Although informative, the plot does not necessarily reflect all metrics that support the path as being heavily utilized.

WECC Path Reports  
 IPP DC Line - Path 27

Figure 2: Path 27 Actual Flow Duration Plot



### Project Development

The following two projects were determined by stakeholders to be the most likely to have an impact on Path 27.

- Path 27 Upgrade Project
- TransWest Express (Studied in 2010 Study Program)

The Path 27 project was assumed completed in the 2019 and 2020 datasets. This translated to a capacity increase from 1,920 MW (as given by the 2010 Path Rating Catalog) to 2,400 MW, which is also the value in the 2011 Path Rating Catalog.

### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

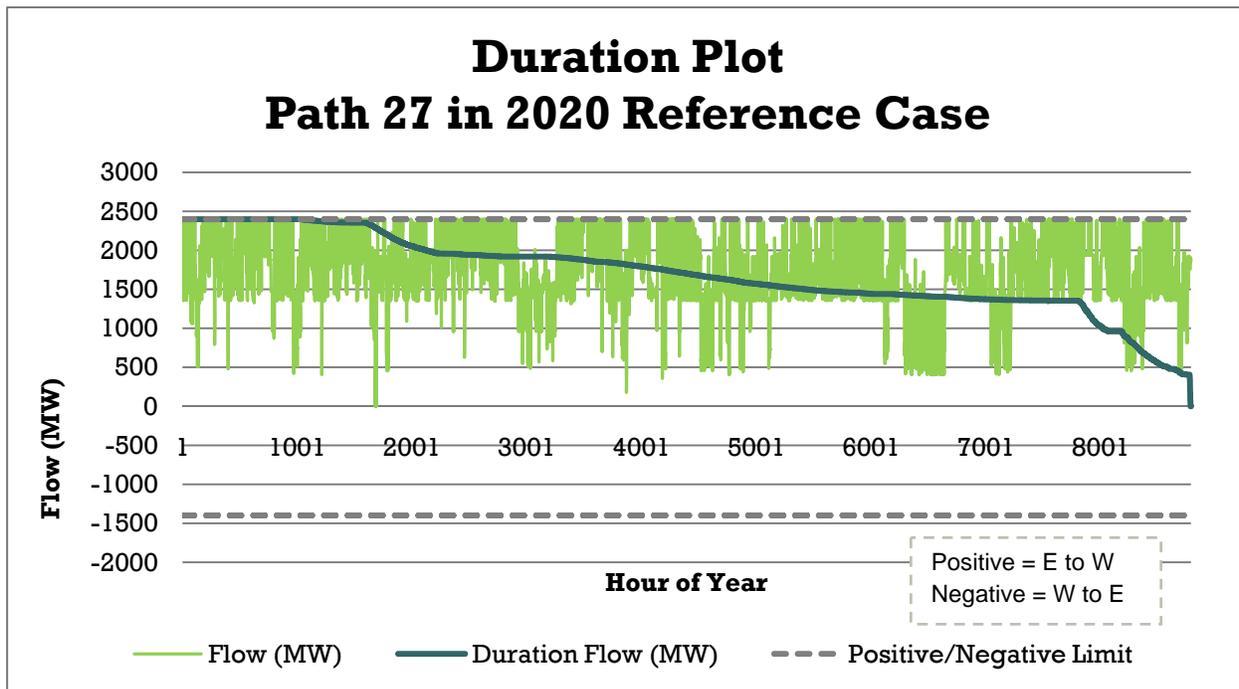
### Expected Future

Relative to the other paths in the Western Interconnection, Path 27 was heavily congested in the expected future case. IPPDC operated at U99 for over 13 percent of the year, and at U90 for nearly 21 percent of the year. The duration plot in Figure 3 shows this heavy utilization. The

WECC Path Reports  
 IPP DC Line - Path 27

chronological plot in the same figure shows the seasonality of the flows. Although the path was heavily utilized and congested throughout the year, this result was expected as the line is intended to deliver inexpensive coal generation from the Intermountain Power Project to the southern California load center. The high flow along Path 27 in the expected future is considered normal operation for that path.

Figure 3: Path 27 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 27 passed the utilization screening 13 times, indicating that the path was highly utilized in all study cases except the 2019 Base Case and the 2019 Arizona/S. Nevada Resource Relocation. According to the production cost model, utilization of Path 27 can be expected to be extremely high in 2020, regardless of the assumptions used to form the case. Surprisingly, Path 27 maintained a high utilization in the 2020 Carbon Reduction Case where a \$30/ton carbon adder was implemented in order to reduce WECC-wide carbon emissions 17 percent from 2005 levels.

**Conditional Congestion**

Conditional congestion along Path 27 is contingent on a variety of cases. The congested study cases and their conditional congestion scores are listed in Table 2.



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*This brief provides observations regarding the Intermountain-Gonder 230 kV WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 29.

- There are projects in development that could directly impact Intermountain-Gonder 230 kV path flows.
- Path 29 was congested in the 2020 expected future case. A number of future resource and load assumptions also caused congestion along Path 29.

## Description

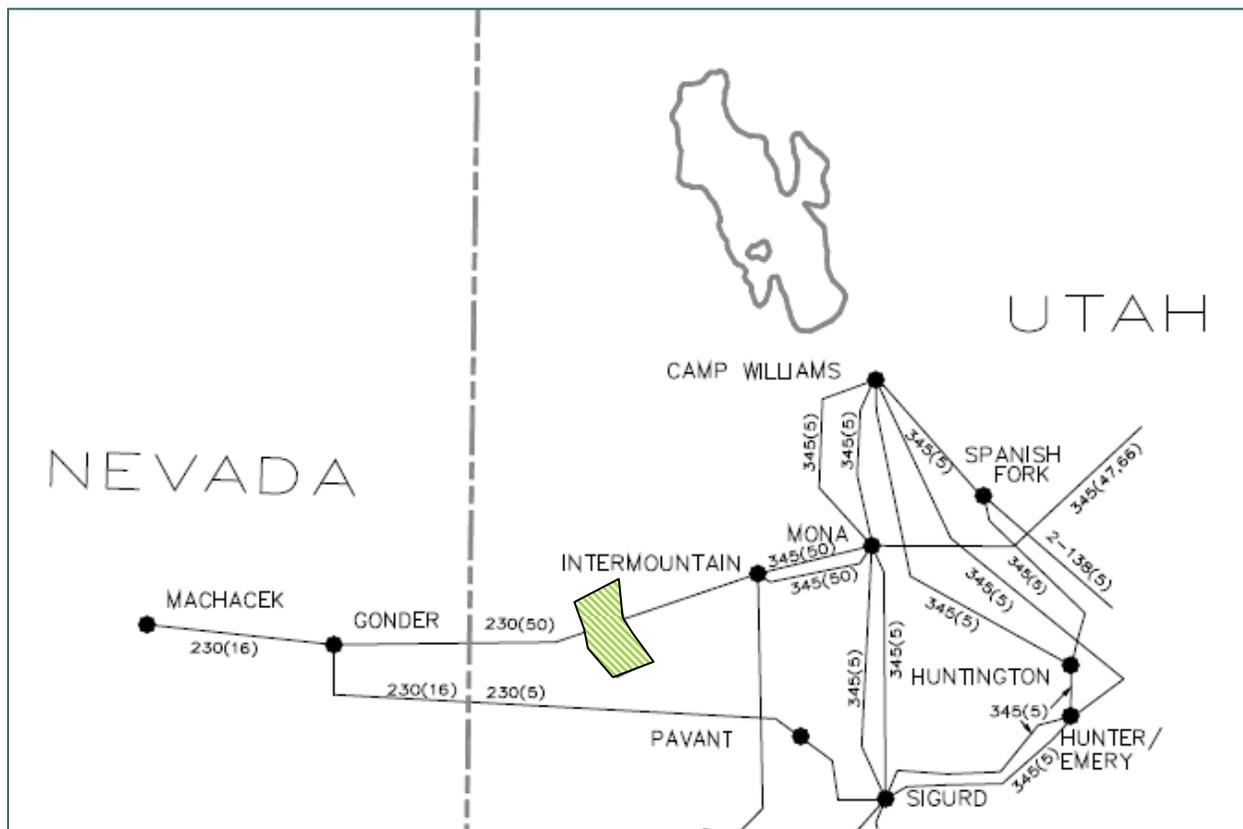
Path 29 is a single 230 kV line that runs from the Intermountain bus near Delta, Utah to the Gonder substation in eastern Nevada. The line is connected to the Intermountain Power Project generation through a 300 MV regulating transformer. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Intermountain-Gonder path.

Table 1: Path 29 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating E to W        | 200 MW    |
| Rating W to E        | Undefined |
| Max Voltage          | 230 kV    |

WECC Path Reports  
Intermountain-Gonder 230 kV - Path 29

Figure 1: Path 29 Definition



### Historical Congestion

Path 29 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

The TransWest Express Project, studied in the 2010 Study Program, was determined by stakeholders to be the most likely to have an impact on Path 29. The congestion impact on Path 29 from this expansion case is presented in the “Future Congestion Analysis” under “Project Development Impact” {LINK}.

### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

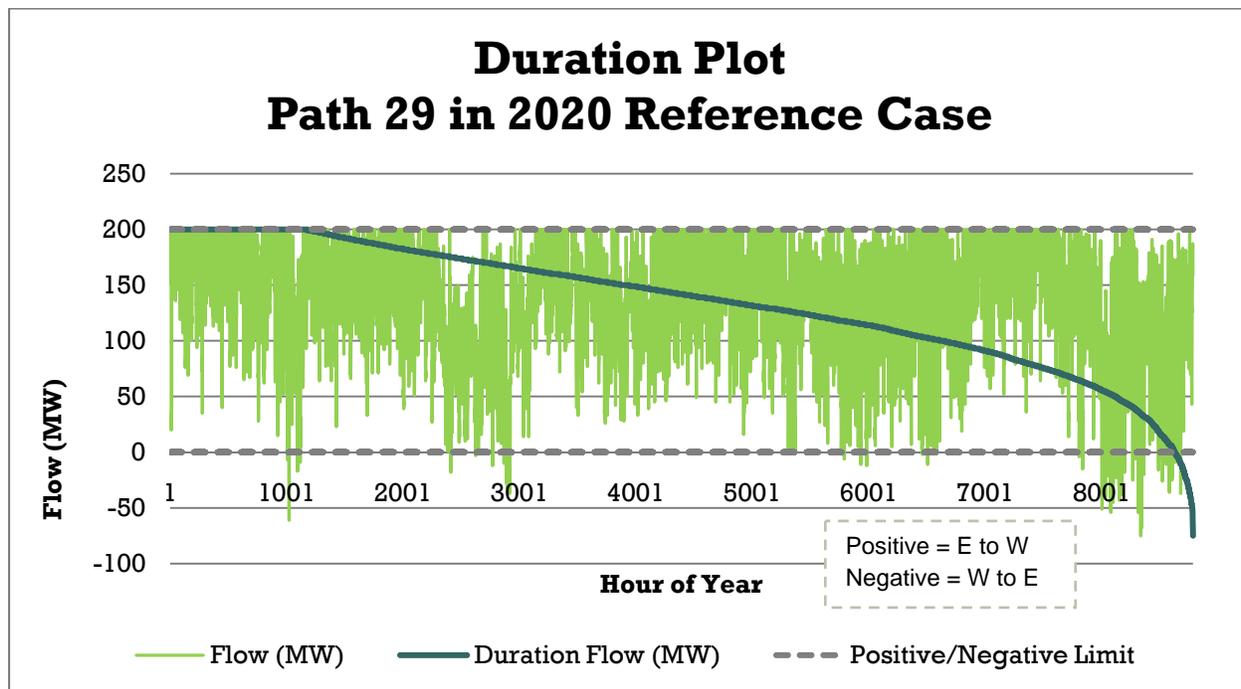
### Expected Future

Relative to the other paths in the Western Interconnection, Path 29 was heavily congested in the expected future case. Intermountain – Gonder 230 kV operated at U99 for almost 14 percent of the year, and at U90 for nearly 24 percent of the year. The duration plot in Figure 2 shows this heavy utilization. The chronological plot in the same figure shows the seasonality of

WECC Path Reports  
 Intermountain-Gonder 230 kV - Path 29

the flows. Although the path was heavily utilized and congested throughout the year, this result was expected as the line is tied to generation from the Intermountain Power Project.

Figure 2: Path 29 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 29 passed the utilization screening nine times, indicating that the path was highly utilized in a variety of study cases. Surprisingly, Path 29 maintained a high utilization in the 2020 Carbon Reduction Case where a \$30/ton carbon adder was implemented in order to reduce WECC-wide carbon emissions 17 percent from 2005 levels. This drastically reduced IPP coal generation, however wind resources and gas generation continued to utilize the line.

**Conditional Congestion**

Conditional congestion along Path 29 is contingent on a variety of cases. The congested study cases and their conditional congestion scores are listed in Table 2.

Table 2: Path 29 Conditional Congestion

| Study Case                                 | Conditional Congestion Score <sup>1</sup> |
|--|---|
| 2019 Base Case                             | 0.19                                      |
| 2019 Arizona/S. Nevada Resource Relocation | 0.18                                      |

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

WECC Path Reports  
 Intermountain-Gonder 230 kV - Path 29

| Study Case                                 | Conditional Congestion Score <sup>1</sup> |
|--|---|
| <b>2019 Wyoming Resource Relocation</b>    | 0.21                                      |
| <b>2019 Alberta Resource Relocation</b>    | 0.18                                      |
| <b>2019 New Mexico Resource Relocation</b> | 0.18                                      |
| <b>2020 SPSC Reference Case</b>            | 0.35                                      |
| <b>2020 High DSM (Low Load)</b>            | 0.54                                      |
| <b>2020 Carbon Reduction</b>               | 0.22                                      |
| <b>2020 Aggressive WY Wind</b>             | 0.29                                      |

As indicated by low conditional congestion scores, Path 29 was highly utilized in a number of study cases, but congestion levels remained low. The highest levels of congestion along Path 29 were observed in the 2020 High DSM (Low Load) study case. The study case featured a decrease to state-adjusted loads in order to reflect achievement of the full economic energy efficiency potential throughout the West. Generation was modified only slightly to reflect RPS targets based on these lower load forecasts. With decreased loads throughout the Interconnection due to DSM, inexpensive coal generation from the IPP plants was relied upon heavily to meet the remaining load at least cost. This, in turn, caused considerable congestion along Path 29.

**Project Development Impact**

The TransWest Express project was studied as a part of the 2019 expansion cases. The 2019 Wyoming Resource Relocation resulted in Path 29 being utilized at the U90 level for nearly 15 percent of the year. After the TransWest Express project was introduced into the Wyoming Resource Relocation study case, Path 29 utilization at the U90 level dropped to 9.55 percent of the year. The TransWest Express project was able to deliver Wyoming resources to southern California and Las Vegas load areas, thereby reducing the need for Path 29 to transfer the incremental resources.



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*This brief provides observations regarding the TOT 1A WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 30.

- Path 30 is historically congested based on flow metrics from the 2007 Path Utilization Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- Stakeholders did not identify any projects in development that could directly impact TOT 1A path flows.
- Path 30 was not congested in the 2020 expected future study case. Congestion along the path was strictly contingent on the case where a large build out of Wyoming wind was assumed (without added transmission).

## Description

Path 30 is located in northwest Colorado and consists of one 345 kV line, and two 138 kV lines. Historically, the flows have been predominatnly east to west. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

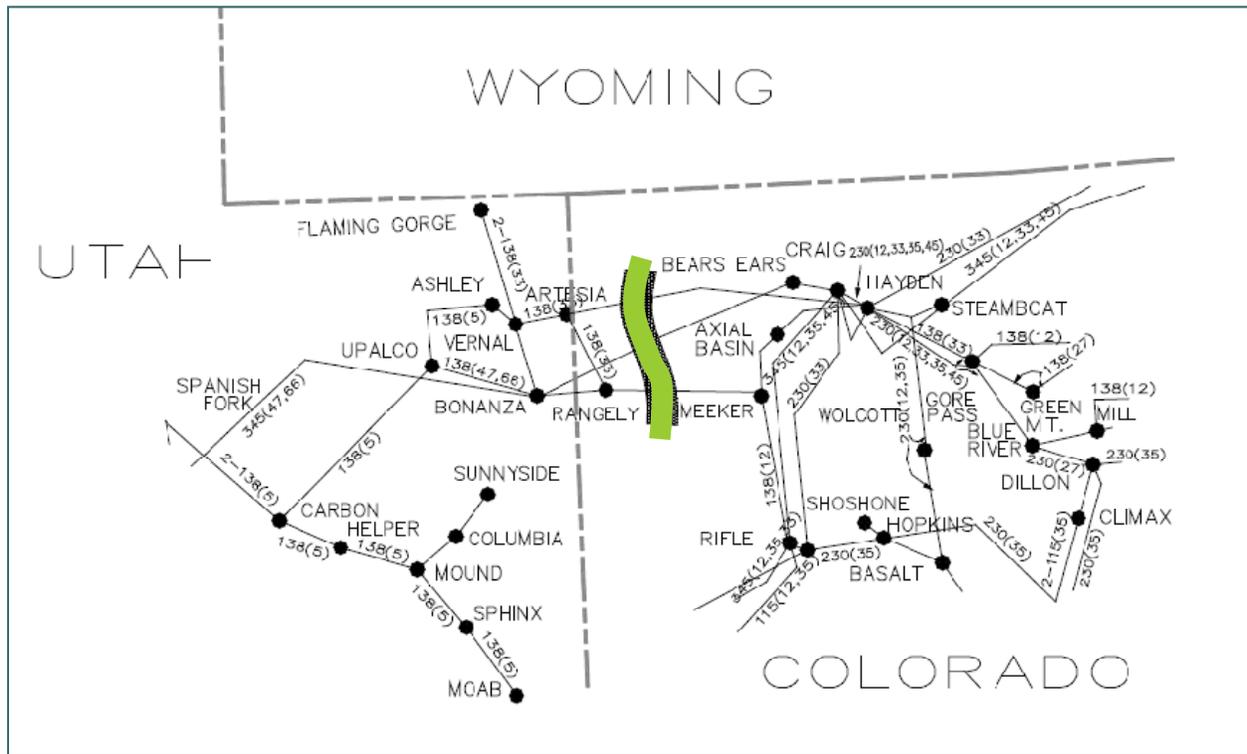
Table 1. Figure 1, on the next page, shows the physical cut plane that forms the TOT 1A path.

**Table 1: Path 30 Characteristics**

| Path Characteristics |           |
|----------------------|-----------|
| <b>Rating E to W</b> | 650 MW    |
| <b>Rating W to E</b> | Undefined |
| <b>Max Voltage</b>   | 345 kV    |

WECC Path Reports  
 TOT 1A - Path 30

Figure 1: Path 30 Definition



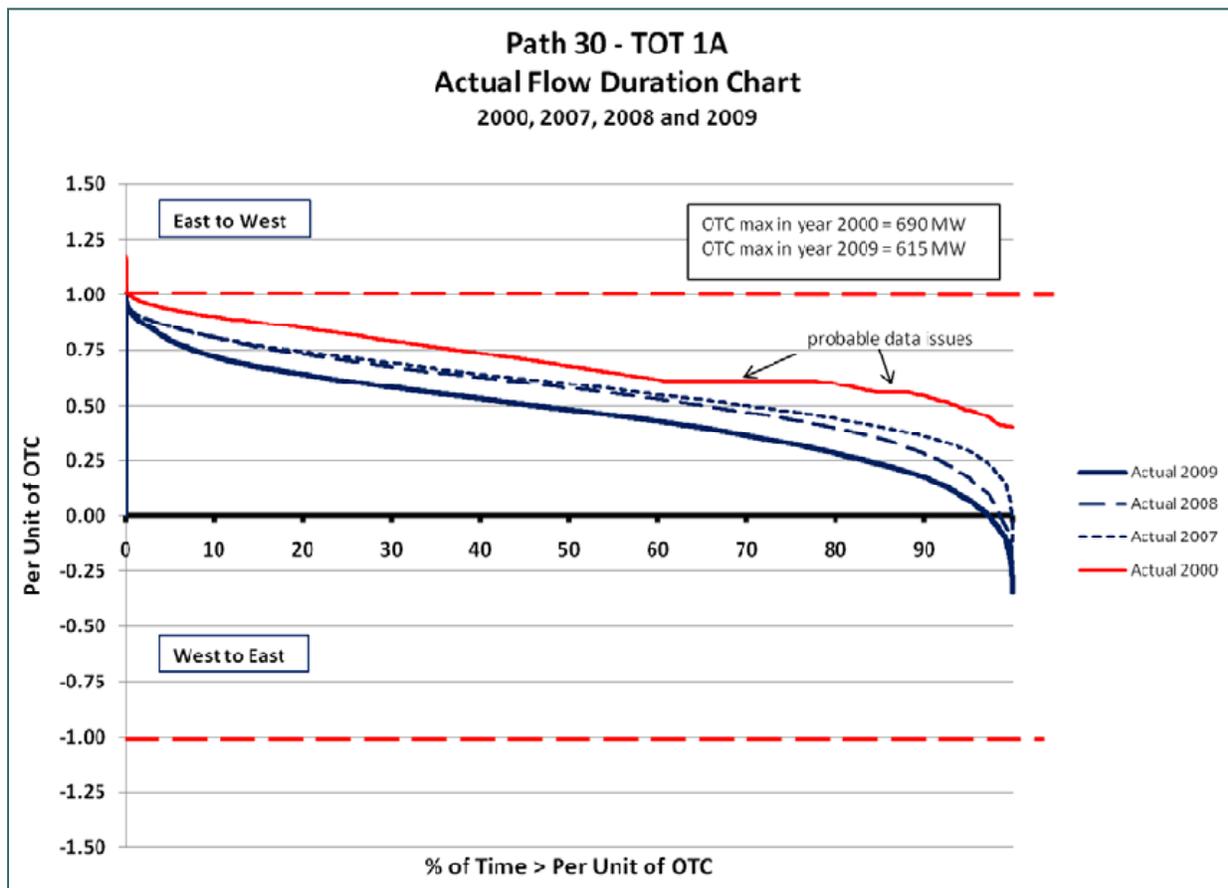
**Historical Congestion**

The 2009, 2008, and 2007 Transmission Path Utilization Studies include analysis on Path 30. Path 30 is historically congested based on flow metrics from the 2007 Path Utilization Study. There was at least one season analyzed in the 2007 Study period where Path 30 seasonal loading exceeding 75 percent of operating transfer capacity 50 percent of the time or more. This qualified Path 30 as one of the most heavily utilized paths in the Interconnection according to the 2007 Study. The 2008 Study reported Path 30 operating at or above U75 for 19 percent of the study year. However, it was not named as one of the Western Interconnection’s most heavily utilized paths in that study. The 2009 Study cited decreased flow from 2008 levels as Path 30 operated at U75 for eight percent of the year. Path 30 had 80 MW of firm ATC available for 95 percent of the study year, and did not make the final list as one of the most heavily utilized paths in the 2009 Study. Actual flow data can be found in the duration plot in flow in recent years has decreased relative to 2000 levels. Although informative, the plot does not necessarily reflect the metrics that support the path as historically congested.

Figure 2. As evident in the figure, flow in recent years has decreased relative to 2000 levels. Although informative, the plot does not necessarily reflect the metrics that support the path as historically congested.

WECC Path Reports  
 TOT 1A - Path 30

Figure 2: Path 30 Actual Flow Duration Plot



**Project Development**

Stakeholders did not identify any specific potential projects that may have a direct impact on Path 30 flows.

**Future Congestion Analysis**

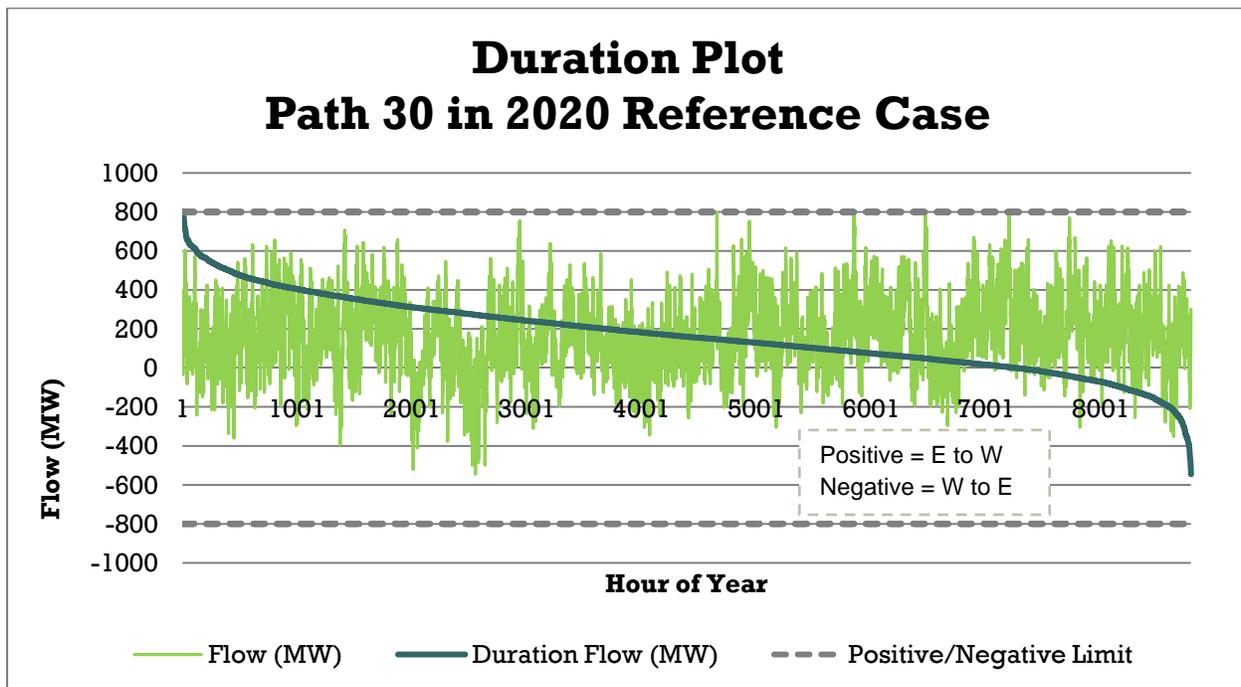
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

**Expected Future**

Path 30 was not heavily utilized or congested in the expected future case. TOT 1A operated at U75 for only 1.38 percent of the year, and at U90 for only 0.23 percent of the year. The duration plot in Figure 3 shows this relatively low utilization. The chronological plot in the same figure shows the seasonality of the flows. It is worth noting that the 2019 and 2020 datasets assumed an increase in Path 30 capacity from 650 MW to 800 MW. Without this increase the utilization of the path could have been higher in the expected future scenario.

WECC Path Reports  
 TOT 1A - Path 30

Figure 3: Path 30 2020 Duration Plot



**Alternative Futures**

Of 15 study cases used to inform the 10-Year Plan, Path 30 passed the utilization screening one time, indicating that high utilization of the path is dependent on a specific set of assumptions. Path 30 was highly utilized in the study case featuring the relocation of 25,000 GWh of wind resources to Wyoming. With no added transmission in the study, Path 30 became heavily utilized as the incremental renewable resources in Wyoming flooded the northeastern portion of the transmission system.

**Conditional Congestion**

Path 30 congestion in the PCM is contingent on the same study case for which the path was heavily utilized, the Aggressive Wyoming Wind case. As previously described, the large increase in Wyoming resources without added transmission overloaded the northeast portion of the Interconnection. This caused the congestion on Path 30 as it operated at or above U90 for nearly 13 percent of the study year.



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*This brief provides observations regarding the TOT 2A WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 31.

- Path 31 is historically congested based on maximum schedule metrics from the 2008 Path Utilization Study, and schedule and block hour schedule metrics from the 2009 Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- Stakeholders did not identify any projects in development that could directly impact TOT 2A path flows.
- Path 31 was not congested in the 2020 expected future.

## Description

Path 31 is located in southwest Colorado. The path includes one 345 kV line, one 115 kV line, and one 230 kV line. Historically, flows have been north to south across the path, although south to north flows have been more frequent in recent years, typically during the heavy winter load season. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms Path 31.

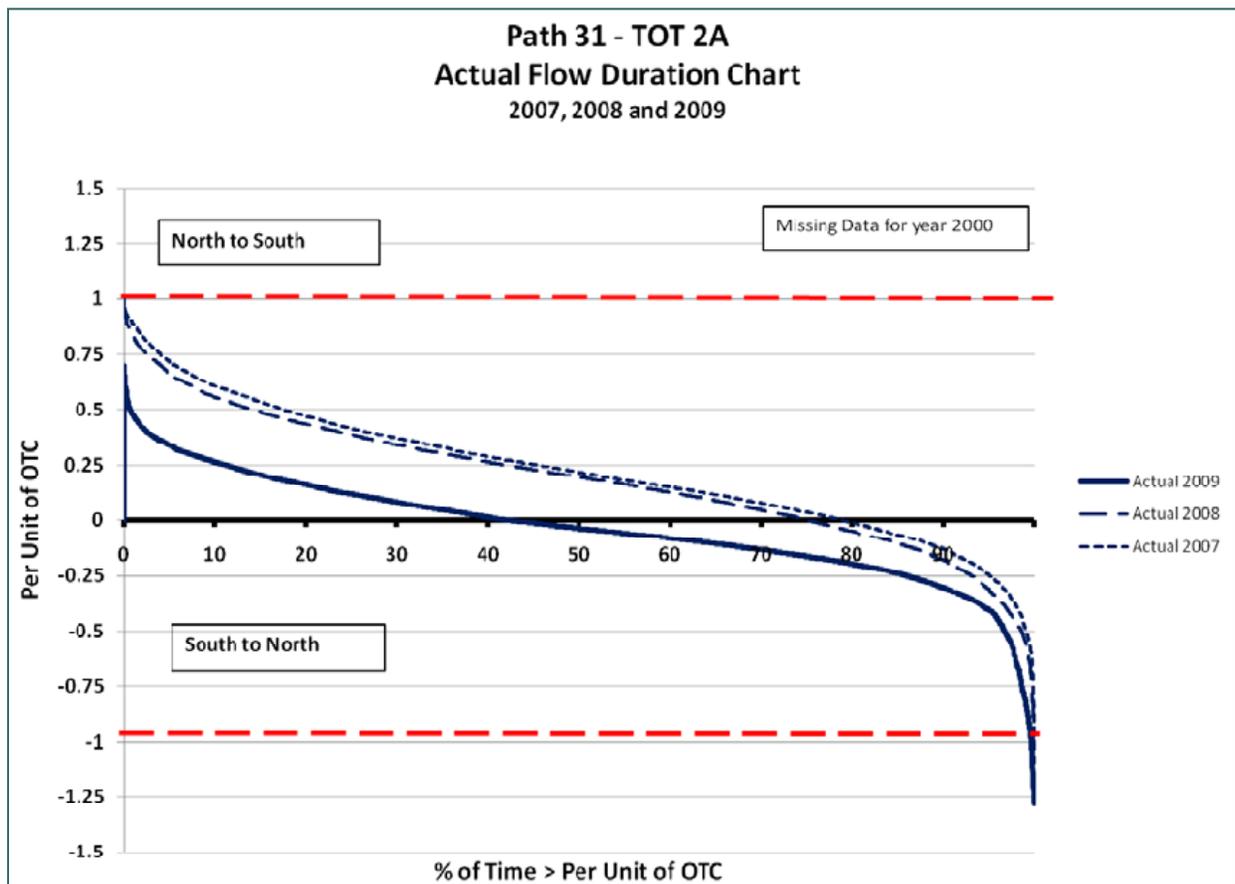
Table 1: Path 31 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating N to S        | 690 MW    |
| Rating S to N        | Undefined |
| Max Voltage          | 345 kV    |



WECC Path Reports  
TOT 2A - Path 31

Figure 2: Path 31 Actual Flow Duration Plot



### Project Development

Stakeholders did not identify any specific potential projects that may have a direct impact on Path 31 flows.

### Future Congestion Analysis

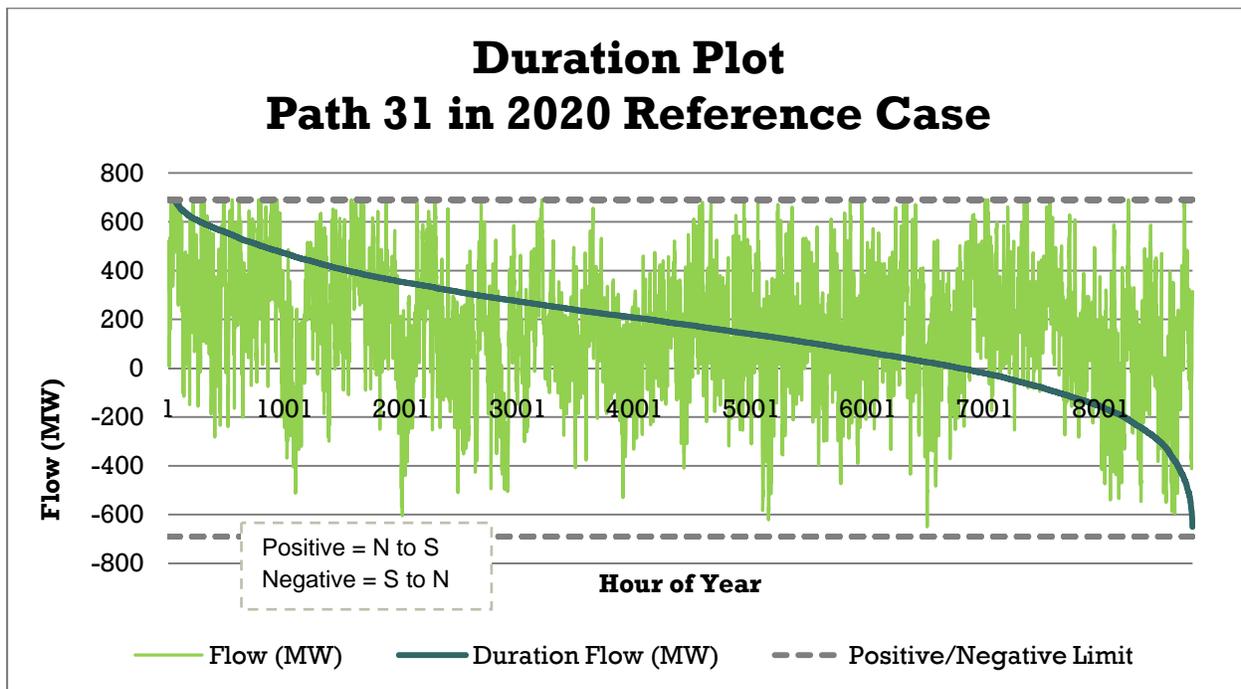
The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 31 did not meet the definition of being highly utilized or congested in the expected future study case. It was utilized at the U75 level for 8.29 percent of the year and path flows reached 90 percent of the path limit for only 2.19 percent of the year. As shown in Figure 3, flow was in the north to south direction for the majority of the year. The chronological plot in the same figure shows the seasonality of the flow.

WECC Path Reports  
 TOT 2A - Path 31

Figure 3: Path 31 2020 Duration Plot



**Alternative Futures**

Of 15 the study cases used to inform the 10-Year Plan, Path 31 passed the utilization screening only twice. The path was highly utilized in both the 2019 Wyoming Nevada Resource Relocation and the 2020 Aggressive Wyoming Wind study cases.

**Conditional Congestion**

Conditional congestion along Path 31 is contingent on study cases featuring renewable resources relocated to Wyoming without added transmission. Path 31 conditional congestion scores are reported with their appropriate study case in Table 2. In the 2019 Wyoming Resource Relocation Path 31 operated at or above U90 for 12.31 percent of the year. In the 2020 Aggressive Wyoming Wind case TOT 2A flow surpassed U90 for almost 21 percent of the year. In both of the study cases, congestion and high utilization along TOT 2A is the direct result of the existing system not being able to effectively transmit (i.e. without congestion) the relocated resources.

Table 2: Path 31 Conditional Congestion

| Study Case                       | Conditional Congestion Score <sup>1</sup> |
|----------------------------------|---|
| 2019 Wyoming Resource Relocation | 0.24                                      |
| 2020 Aggressive Wyoming Wind     | 0.39                                      |

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).



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*This brief provides observations regarding the Pavant/Intermountain-Gonder 230 kV WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 32.

- There are few projects under development that could directly impact Pavant/Intermountain-Gonder 230 kV flow.
- Path 32 was not congested in the 2020 expected future.

## Description

Path 32 is located in central eastern Nevada and central western Utah. The path includes two 230 kV lines; the Gonder-Pavant line and the Gonder-Intermountain line. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in

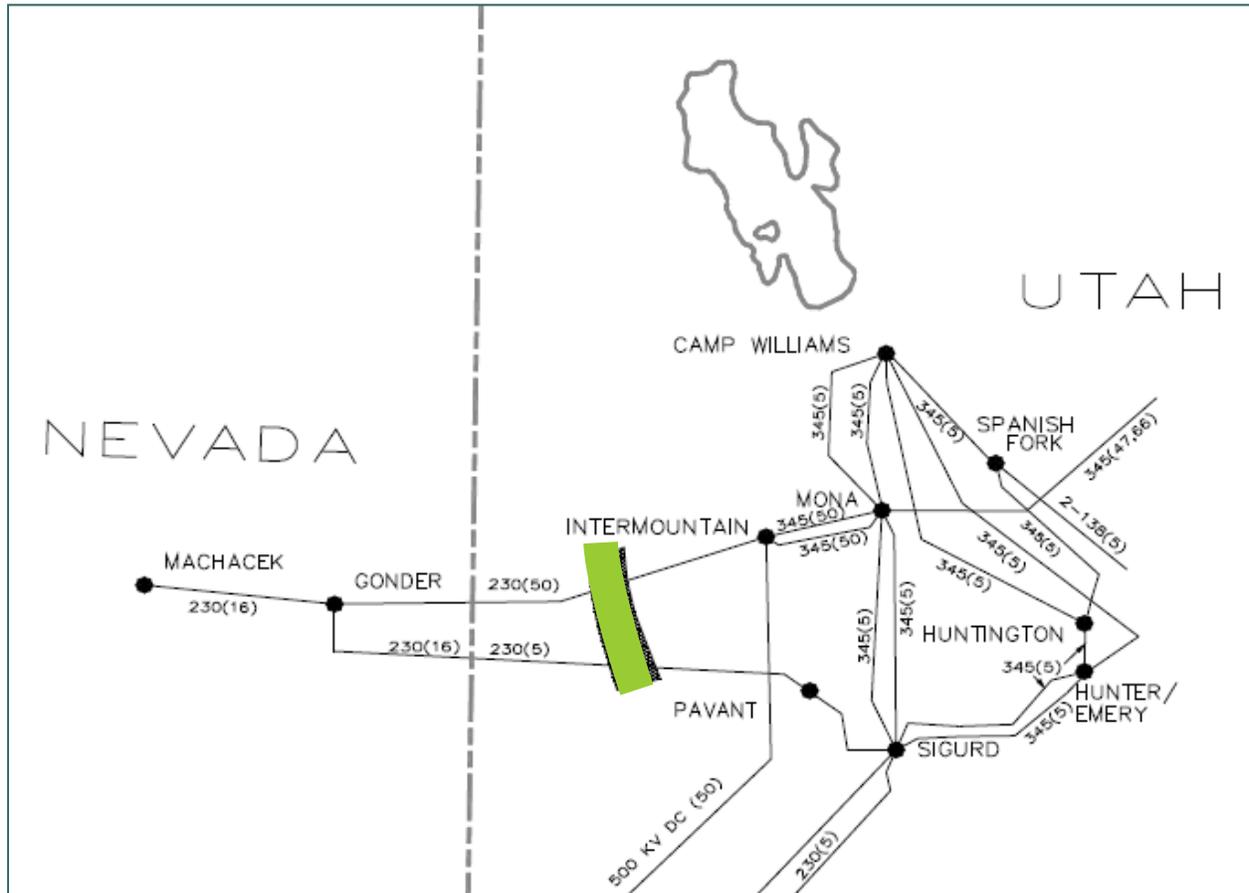
Table 1. Figure 1, on the next page, shows the physical cut plane that forms Path 32.

Table 1: Path 32 Characteristics

| Path Characteristics |        |
|----------------------|--------|
| Rating E to W        | 440 MW |
| Rating W to E        | 235 MW |
| Max Voltage          | 230 kV |

WECC Path Reports  
Pavant/Intermountain – Gonder 230 kV - Path 32

Figure 1: Path 32 Definition



### Historical Congestion

Path 32 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

The TransWest Express project, which was studied in the 2010 Study Program, was the only project determined by stakeholders that would likely have an impact on Path 32. Congestion impacts on Path 32 from this expansion case are presented in the “Future Congestion Analysis” under “Project Development Impact”.

### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

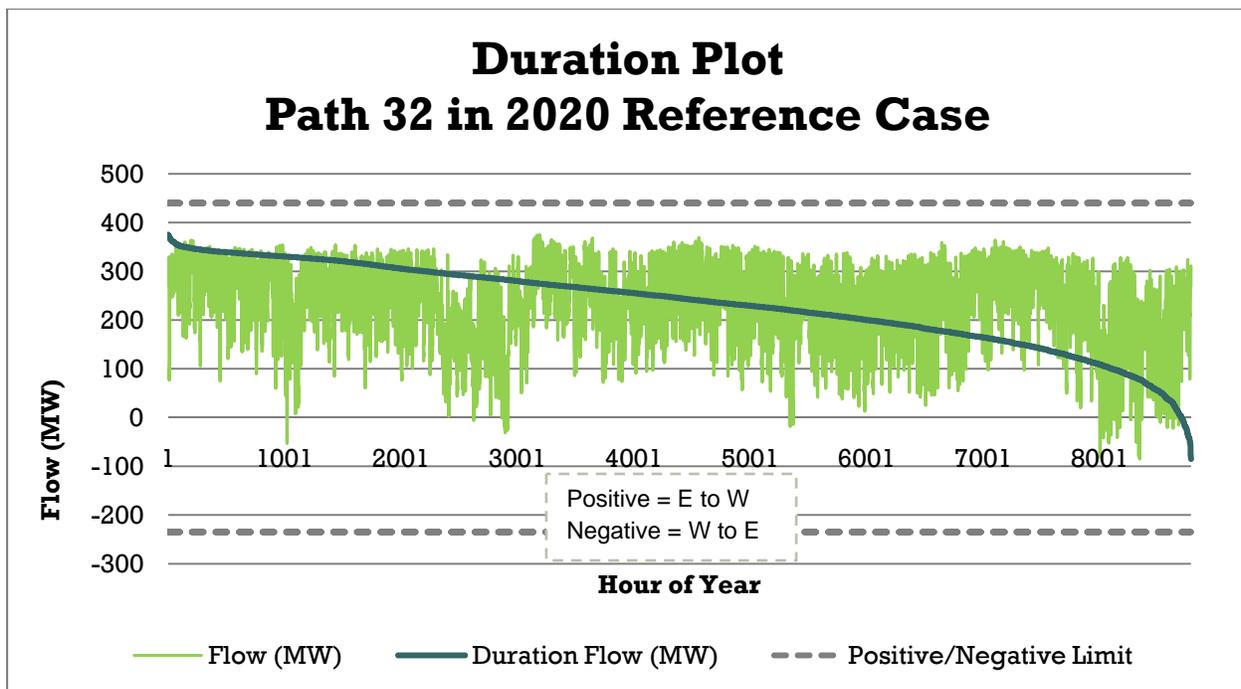
### Expected Future

Path 32 did not meet the definition of being highly utilized or congested in the expected future. It was utilized at the U75 level for 11.22 percent of the year placing and path flows never reached

WECC Path Reports  
 Pavant/Intermountain – Gonder 230 kV - Path 32

90 percent of the path limit. As shown in Figure 2, flow was in the east to west direction for the majority of the year. The chronological plot in the same figure shows the lack of seasonality in regard to flow. Rather consistent flow along the path is expected due to the paths proximity to the Intermountain Power Project (IPP) coal plant.

Figure 2: Path 32 2020 Duration Plot



**Alternative Futures**

Of 15 of the study cases used to inform the 10-Year Plan, Path 32 passed the utilization screening only once. The path was highly utilized in the 2019 Northern Nevada Resource Relocation.

**Conditional Congestion**

Congestion along Path 32 is strictly contingent on the set of assumptions used to form the 2019 Northern Nevada Resource Relocation, where 12,000 GWh of resources were removed from California and placed in northern Nevada without added transmission. Path 32 had a conditional congestion score of 1.10 in this study case. Flow exceeded 90 percent of the path limit for 41 percent of the year and Path 32 was the second most congested path in this study case. It is important to note that the majority of flow, and thereby congestion, occurred in the direction opposite of what is normally considered the predominate direction of flow for this path. Due to the massive influx of resource into northern Nevada, the transmission system was heavily constrained and the resources had trouble reaching loads. As a consequence, flow on Path 32 was west to east for the majority of the year. This allowed for energy to reach large lines that would in turn deliver the resources to the Las Vegas load area. Notably, the rating in the west to east direction is less than that in the east to west direction.

WECC Path Reports  
Pavant/Intermountain – Gonder 230 kV - Path 32

**Project Development Impact**

The TransWest Express project was studied in conjunction with the 2019 Wyoming Resource Relocation. In the 2019 Base Case, Path 32 operated at or above U75 for only 0.19 percent of the year. The 2019 Wyoming Resource Relocation caused this to increase only to 0.35 percent of the year. After the TransWest Express project was added to the 2019 Wyoming Resource Relocation, Path 32 operated at U75 for only 0.02 percent, which proves that the project had very little impact on Path 32 flow.



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*This brief provides observations regarding the Bonanza West WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 33.

- There are projects in development that could directly impact Bonanza West path flow.
- Path 33 was not congested in the 2020 expected future case.

## Description

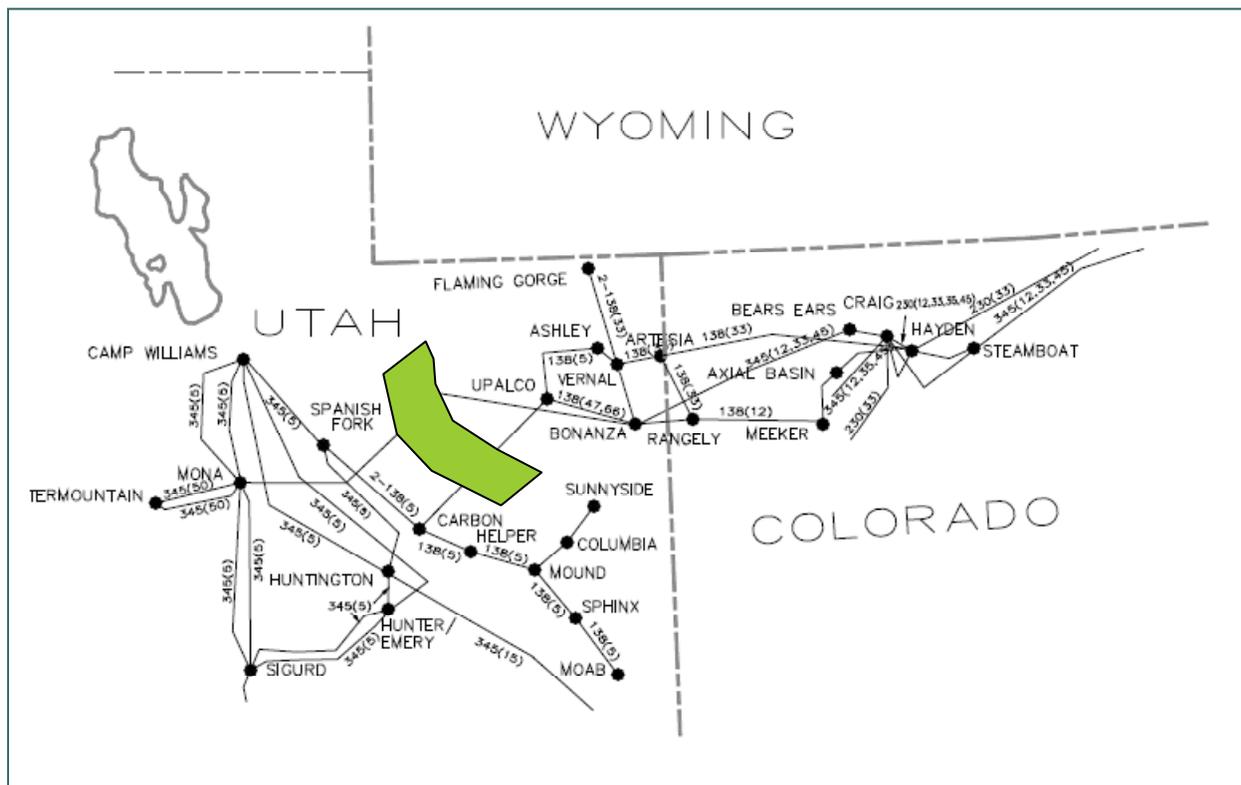
Path 33 consists of a 230 kV line and a 138 kV line, which run from northwest Utah to central Utah. In part, the path is used to integrate Bonanza coal generation (470 MW maximum capacity) into the system. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Intermountain-Gonder path.

**Table 1: Path 33 Characteristics**

| Path Characteristics |           |
|----------------------|-----------|
| <b>Rating E to W</b> | 785 MW    |
| <b>Rating W to E</b> | Undefined |
| <b>Max Voltage</b>   | 345 kV    |

## WECC Path Reports Bonanza West - Path 33

Figure 1: Path 33 Definition



### Historical Congestion

Path 33 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

The TransWest Express project, studied in the 2010 Study Program, was determined by stakeholders to be the most likely to have an impact on Path 33. The TransWest Express project was studied as part of the 2010 Study Program. Congestion impacts on Path 33 from these study cases are presented in the “Future Congestion Analysis” under “Project Development Impact.” The Gateway South Phase 1 project was also determined to likely have an impact on Path 33. This path was assumed constructed in the 2020 dataset.

### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

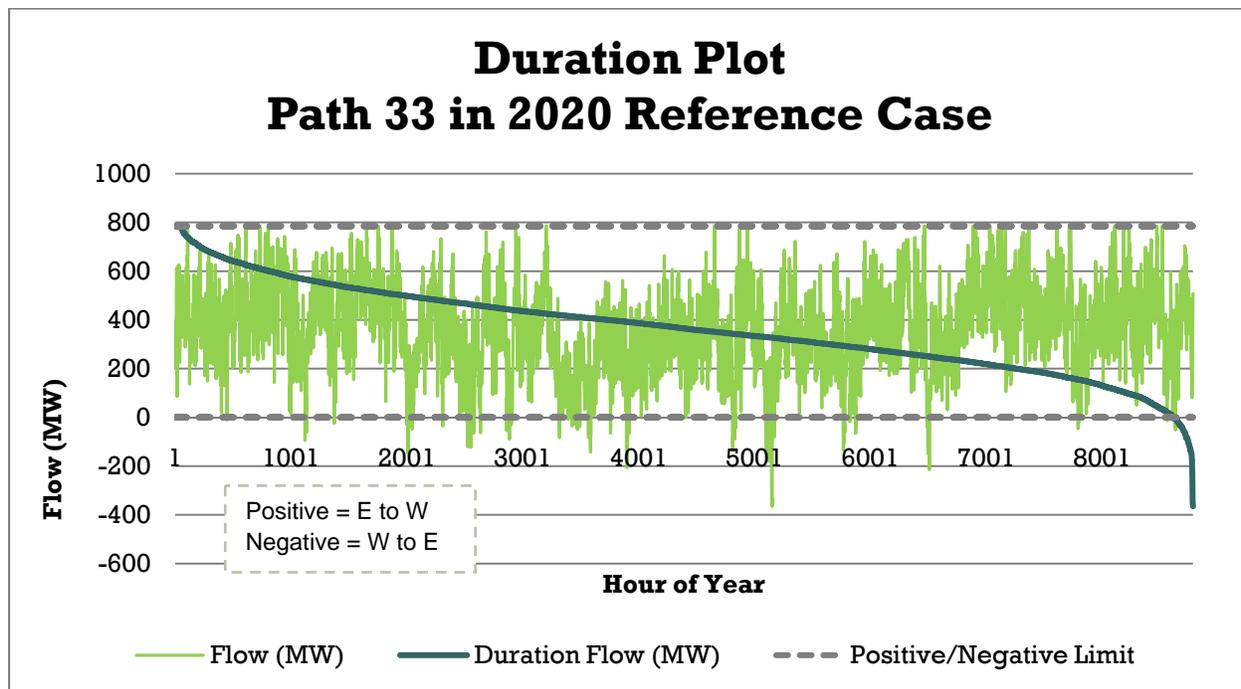
### Expected Future

Path 33 was not congested or heavily utilized in the expected future case. Bonanza West operated at U90 for only two percent of the year, and at U75 for only 10 percent of the year. The

WECC Path Reports  
 Bonanza West - Path 33

duration plot in Figure 2 shows this light utilization. The chronological plot in the same figure shows the seasonality of the flows.

Figure 2: Path 33 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 33 passed the utilization screening two times. Bonanza West was highly utilized in both the 2019 Wyoming Resource Relocation and the 2020 Aggressive Wyoming Wind study cases. Both study cases feature an increase in Wyoming renewable generation without added transmission. These resource additions without added transmission resulted in high utilization along Path 33.

**Conditional Congestion**

Conditional congestion along Path 33 is contingent on a variety of cases. The congested study cases and their conditional congestion scores are listed in Table 2.

Table 2: Path 33 Conditional Congestion

| Study Case                       | Conditional Congestion Score <sup>1</sup> |
|----------------------------------|---|
| 2019 Wyoming Resource Relocation | 0.27                                      |
| 2020 Aggressive WY Wind          | 0.78                                      |

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

WECC Path Reports  
Bonanza West - Path 33

In the 2019 Wyoming Resource Relocation and 2020 Aggressive Wyoming Wind study cases, 12,000 GWh and 25,000 GWh of renewable energy were removed from the assumed California RPS resources and placed in Wyoming. Due to Path 33's close proximity to Wyoming, these incremental resources and the lack of added transmission caused the path to become highly congested in these two study cases.

**Project Development Impact**

The TransWest Express project was studied as a part of the 2019 Resource Relocation study cases. The 2019 Wyoming Resource Relocation resulted in Path 33 being utilized at the U90 level for nearly 15 percent of the year. After the TransWest Express project was introduced into the Wyoming Resource Relocation study case Path 33 utilization at the U90 level dropped to 8.58 percent. The TransWest Express project was able to deliver Wyoming resources to southern California and Las Vegas load areas, effectively bypassing Path 33 and reducing its utilization.



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*This brief provides observations regarding the TOT 2B WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 34.

- Path 34 is not historically congested based on the metrics used in previous path utilization studies. However, the path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their biannual path utilization report.
- There are no projects in development that could directly impact TOT 2B path flows.
- Path 34 was not congested in the 2020 expected future case, or any of the other cases in the 2010 Study Program.

## Description

Path 78 (TOT 2B1) and Path 79 (TOT 2B2) combine to form Path 34. The path is now operated as two separate paths, TOT 2B1 and TOT 2B2. However, the combined Path 34 remains as a constraint in the PCM. The PCM also defined TOT 2B1 and TOT 2B2 as separate paths. Path ratings as defined by the PCM for Path 34 can be found in

Table 1.

**Table 1: Path 34 Characteristics as Defined in PCM**

| Path Characteristics |        |
|----------------------|--------|
| Rating N to S        | 780 MW |
| Rating S to N        | 850 MW |

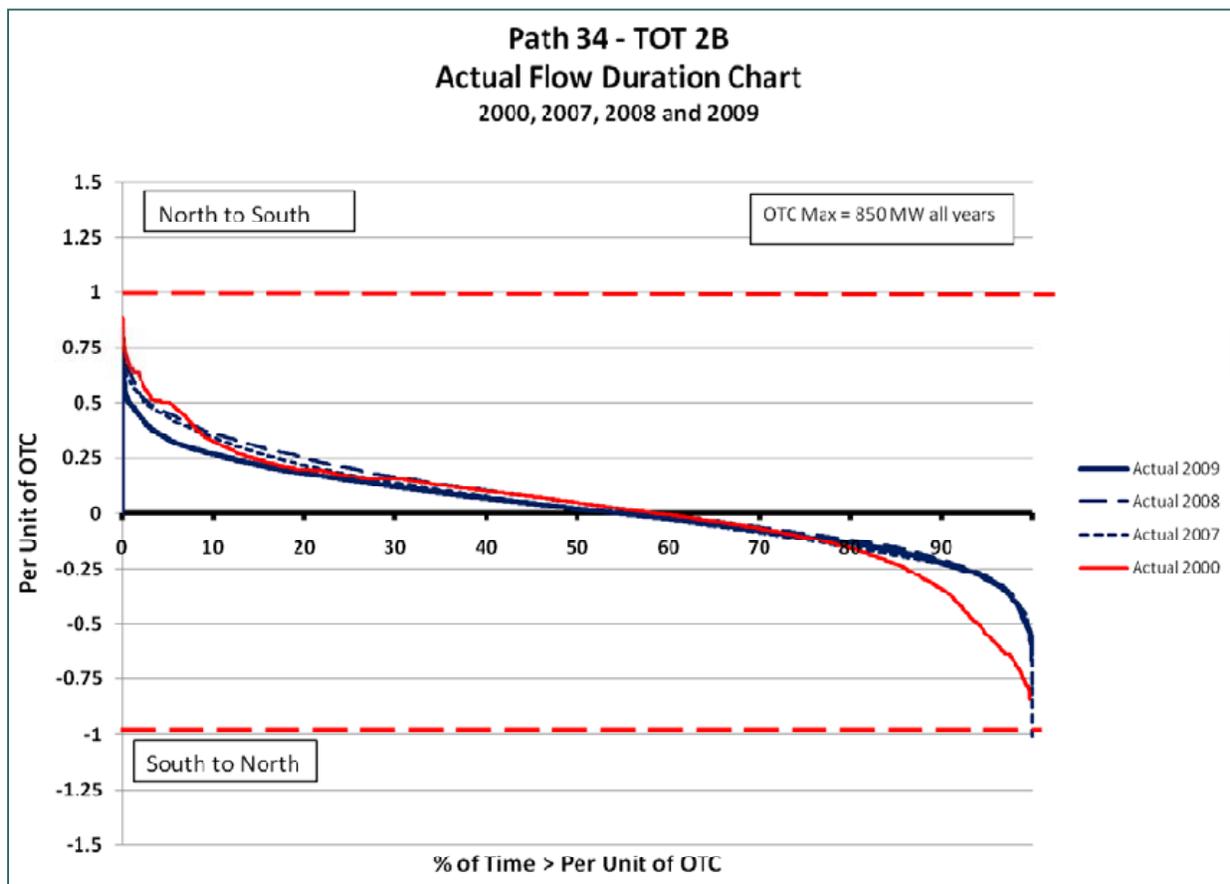
## Historical Congestion

Path 34 was analyzed in the 2009, 2008, and 2007 Transmission Path Utilization Studies, and was not historically congested in any study year based on the metrics used in the analysis. The 2009 Study calculated 292 MW of unused capacity (non-firm) along Path 34. It did not rank higher than 13<sup>th</sup> in any of the metrics used to determine the list of most heavily used paths in the 2009 Study. Actual flow data for historic years can be found in the duration plot in Figure 1.

WECC Path Reports  
 TOT 2B - Path 34

Although informative, the plot does not necessarily reflect all of the metrics used to inform the historical analysis.

Figure 1: Path 34 Actual Flow Duration Plot



### Project Development

Stakeholders did not identify any projects in development that are likely to have an impact on Path 34 flow.

### Future Congestion Analysis

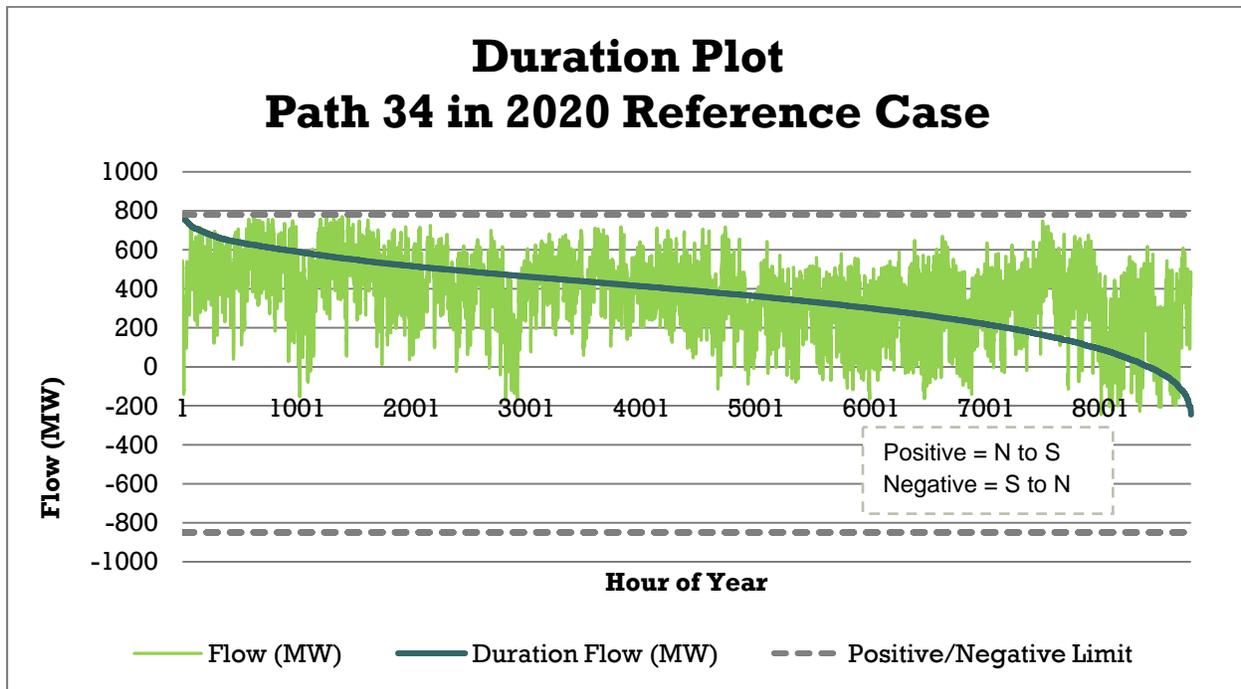
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 34 was not heavily utilized or congested in the expected future study case. TOT 2B operated at U75 and U90 for only 11.95 percent and 1.66 percent of the year, respectively. The duration plot in Figure 2 shows this light utilization. The chronological plot in the same figure shows the seasonality of the flows.

WECC Path Reports  
TOT 2B - Path 34

Figure 2: Path 34 2020 Duration Plot



**Alternative Futures**

Of all 15 study cases used to inform the 10-Year Plan, Path 34 never passed the utilization screening. No set of assumptions used to form a study case in the 2010 Study Program caused the path to be highly utilized.

**Conditional Congestion**

Path 34 did not display any congestion contingent on a specific set of assumptions.



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*This brief provides observations regarding the TOT 2C WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 35.

- Path 35 is historically congested based on the net schedule metric from the 2008 Path Utilization. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are projects in development that could directly impact TOT 2C path flows.
- Path 35 was congested in the 2020 expected future case. Nearly all study cases used to inform the 10-Year Plan also caused congestion along Path 35

## Description

Path 35 consists of a single 345 kV line connecting the Red Butte bus in southwestern Utah to the Harry Allen substation in southeastern Nevada. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the TOT 2C path. The path rating will increase from 300 MW bidirectional to 600 MW (bidirectional in summer 2011).

Table 1: Path 35 Characteristics

| Path Characteristics |        |
|----------------------|--------|
| Rating N to S        | 300 MW |
| Rating S to N        | 300 MW |
| Max Voltage          | 345 kV |

WECC Path Reports  
TOT 2C - Path 35

Figure 1: Path 35 Definition

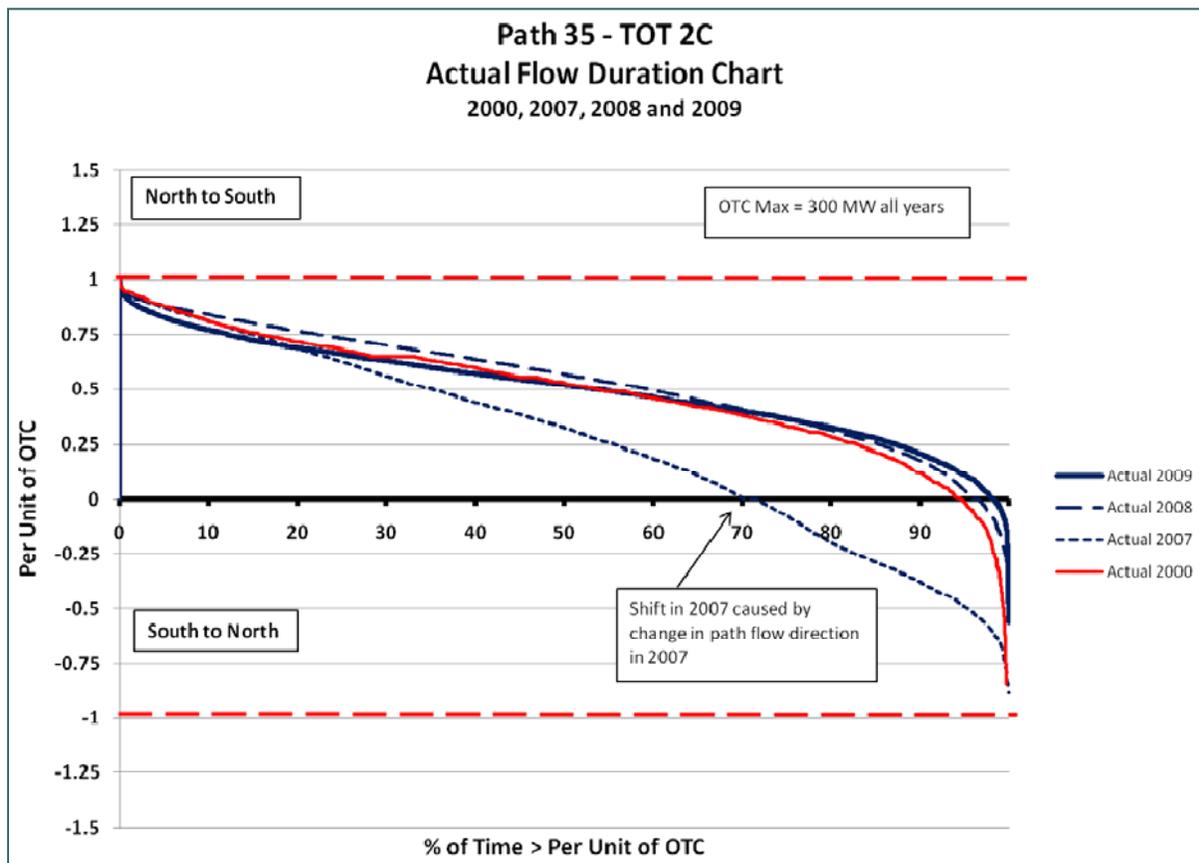


### Historical Congestion

The 2007, 2008, and 2009 Transmission Path Utilization Studies provide relevant congestion information for Path 35, which is historically congested based on net schedule metrics from the 2008 Study. The 2008 Study reported Path 35 having flow above 75 percent of its OTC for 15 percent of the year, and flow above 90 percent of its OTC for three percent of the year. Overall, Path 35 was ranked as the 3<sup>rd</sup> and 8<sup>th</sup> most congested of Western Interconnection paths based on net schedule and actual flows/max flows in 2008. Flow, schedule, and ATC data from 2009 and partial 2008 were analyzed for Path 35 in the 2009 TEPPC Transmission Path Utilization Study. Based on flow, Path 35 was the 11<sup>th</sup> most utilized path in the Western Interconnection. It was at or above 75 percent of its Operational Transmission Capacity (OTC) for 12 percent of the study year. Actual flow data for historic years can be found in the duration plot in Figure 2. Although informative, the plot does not necessarily reflect the metrics that support the path as historically congested.

WECC Path Reports  
 TOT 2C - Path 35

Figure 2: Path 35 Actual Flow Duration Plot



### Project Development

The following projects were determined by stakeholders to be the most likely to have an impact on Path 35.

- Chinook (Studied in 2010 Study Program)
- Gateway South Phase 2 (Studied in 2010 Study Program)
- SWIP South (SCG Foundational Project)
- TransWest Express (Studied in 2010 Study Program)
- Zephyr (Studied in 2010 Study Program)

Congestion impacts on Path 35 from those projects in the 2010 Study Program are presented in the “Future Congestion Analysis” under “Project Development Impact” {LINK}.

### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program. The change in assumptions on the modeled limit of TOT 2C from one study year to another is worth noting as this had an impact on the PCM results. In the 2019 studies, the TOT 2C limit was modeled to be 600 MW and a nomogram was not used to force IPP resources to flow down the IPPDC Line (Path 27). In the 2020 dataset these assumptions

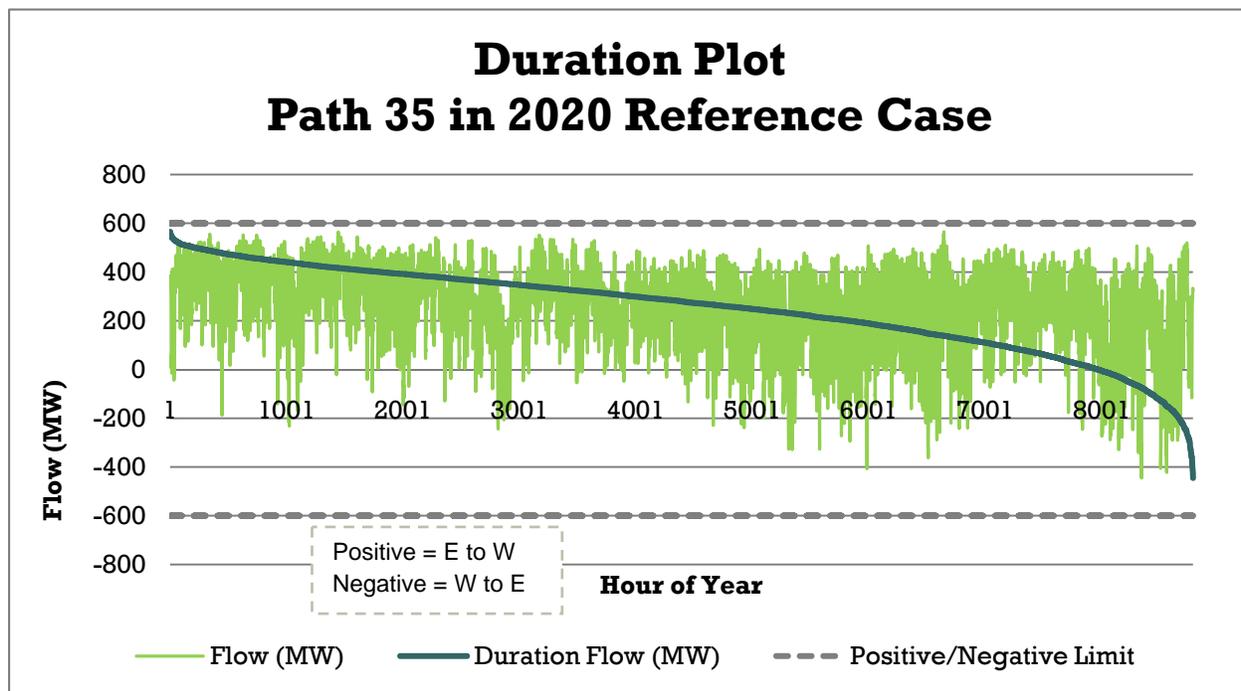
WECC Path Reports  
 TOT 2C - Path 35

changed. The TOT 2C limit was modeled to be 300 MW and the IPPDC nomogram was implemented. Congestion apparent in the 2019 studies is likely overstated because without the IPPDC nomogram the AC system in the vicinity of the DC line is over utilized by the PCM. Congestion in the 2020 studies may be overstated as well because the 300 MW limit is modeled with the inclusion of Gateway South Phase 1<sup>1</sup> which brings more energy to TOT 2C, even with the IPPDC nomogram in place. The variance in assumptions should be taken into account when reviewing the PCM results.

**Expected Future**

Relative to the other paths in the Western Interconnection, Path 35 was heavily congested in the 2020 expected future case. TOT 2C operated at U99 for over eight percent of the year, and at U90 for nearly 13 percent of the year. The duration plot in Figure 3 shows this heavy utilization. The chronological plot in the same figure shows the seasonality of the flows. In the 2020 dataset, the Path limit for TOT 2C was assumed to be 300 MW. In the 2019 dataset, the limit was assumed to be 600 MW.

Figure 3: Path 35 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 35 passed the utilization screening 14 times, indicating that the path was highly utilized in a variety of study cases. The only study case that TOT 2C was not highly utilized in was the 2019 Wyoming Resource Relocation.

<sup>1</sup> It was reported after the completion of the 2010 PCM studies that Gateway Phase 1 will likely increase the rating of TOT 2C

WECC Path Reports  
 TOT 2C - Path 35

**Conditional Congestion**

Conditional congestion along Path 35 is contingent on a variety of assumptions. The congested study cases and their conditional congestion scores are listed in Table 2.

**Table 2: Path 35 Conditional Congestion**

| Study Case                      | Conditional Congestion Score <sup>2</sup> |
|---------------------------------|---|
| <b>2019 Base Case</b>           | 0.34                                      |
| <b>2019 Arizona/S. Nevada</b>   | 0.31                                      |
| <b>2019 British Columbia</b>    | 0.41                                      |
| <b>2019 N. Nevada</b>           | 0.58                                      |
| <b>2019 Alberta</b>             | 0.36                                      |
| <b>2019 Montana</b>             | 0.27                                      |
| <b>2019 New Mexico</b>          | 0.32                                      |
| <b>2019 Northwest Coastal</b>   | 0.39                                      |
| <b>2020 SPSC Reference Case</b> | 0.20                                      |
| <b>2020 High Load</b>           | 0.30                                      |
| <b>2020 High DSM (Low Load)</b> | 0.29                                      |
| <b>2020 Carbon Reduction</b>    | 0.22                                      |
| <b>2020 Aggressive MT Wind</b>  | 0.16                                      |
| <b>2020 Aggressive WY Wind</b>  | 0.22                                      |

Congestion along TOT 2C was most contingent on the assumptions that formed the 12,000 GWh Northern Nevada Resource Relocation study case. The relocated resources caused flow along Path 32 and Path 29 to occur west to east, into southwestern Utah. TOT 2C connects to the Red Butte bus in southwestern Utah and was then able to transfer the resources to the Las Vegas load center.

**Project Development Impact**

There were four projects studied as a part of the 2019 Resource Relocation study cases, which were predicted to have an impact on TOT 2C path flow. Changes in TOT 2C utilization as a result of these study cases are presented in Table 3, below.

---

<sup>2</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

WECC Path Reports  
 TOT 2C - Path 35

**Table 3: Project Development Impact on Path 35**

| <b>Study Cases</b>                      | <b>U90</b> |
|---|------------|
| <b>2019 Base Case</b>                   | 18.73%     |
| <b>2019 Wyoming Resource Relocation</b> | 11.27%     |
| <b>2019 Wyoming + Zephyr</b>            | 40.05%     |
| <b>2019 Wyoming + TransWest Express</b> | 36.18%     |
| <b>2019 Wyoming + Gateway South #2</b>  | 20.76%     |
| <b>2019 Montana Resource Relocation</b> | 13.48%     |
| <b>2019 Montana + Chinook</b>           | 41.35%     |

TOT 2C utilization increased substantially from the resource relocation cases to the transmission expansion cases. This result is less than intuitive and can be explained by two separate, but highly related, DC line modeling issues. The first issue lies in the IPP DC line modeling and is observed in all of the transmission expansion cases. IPP coal generation increased substantially from the base case and resource relocation cases to each of the transmission expansion cases. Not all of this new coal generation was transferred on the IPP line in the model (unlike in reality). Much of the generation ended up on TOT 2C and the AC system. This accounts for some of the increase in utilization observed along TOT 2C in the expansion cases.

The second factor that accounts for the unexpected increase in TOT 2C utilization is again related to DC line modeling, but in this case it applies to the transmission expansion projects themselves. The incremental DC lines were underutilized by the model and they failed to transfer the relocated resources back to California, where the resources were removed. This likely caused the relocated renewables to flow on the AC system to load centers, which increased TOT 2C utilization. Furthermore, this probably enhanced the first modeling issue related to the IPP line as the resources were not able to reach California so IPP generation was dispatched and consequently flooded the local AC system, including TOT 2C, as previously explained.

If the PCM operated properly, we would expect to see all of the Montana Resources and Wyoming Resources transferred to load centers via the DC lines. As a result, TOT 2C utilization would likely decrease from the levels observed in the resource relocations.

**Other Observations**

General observations from PacifiCorp regarding Path 35's 2008 historical analysis, as taken from Appendix I of the 2008 TEPPC Transmission Path Utilization Study, are as follows:

“The same facilities are used to provide the service in both directions. If either direction is at the limit, the "path" is a constraint. Again, in some ways taking the maximum of the southbound or northbound use ratio for each hour might be a better measure of the "path" use than a westbound chart and an eastbound chart.”



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*This brief provides observations regarding the TOT 3 WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 36.

- Path 36 is historically congested based on actual flow metrics from the 2007 Path Utilization Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are projects under development that could directly impact TOT 3 path flows.
- Path 36 was not congested in the 2020 expected future. However, futures featuring incremental Wyoming renewable resources (without transmission) induce congestion.

## Description

Path 36 serves as the transmission intertie between northeast Colorado and southeast Wyoming. Historically, flow is north to south across the path. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms the TOT 3 path.<sup>1</sup>

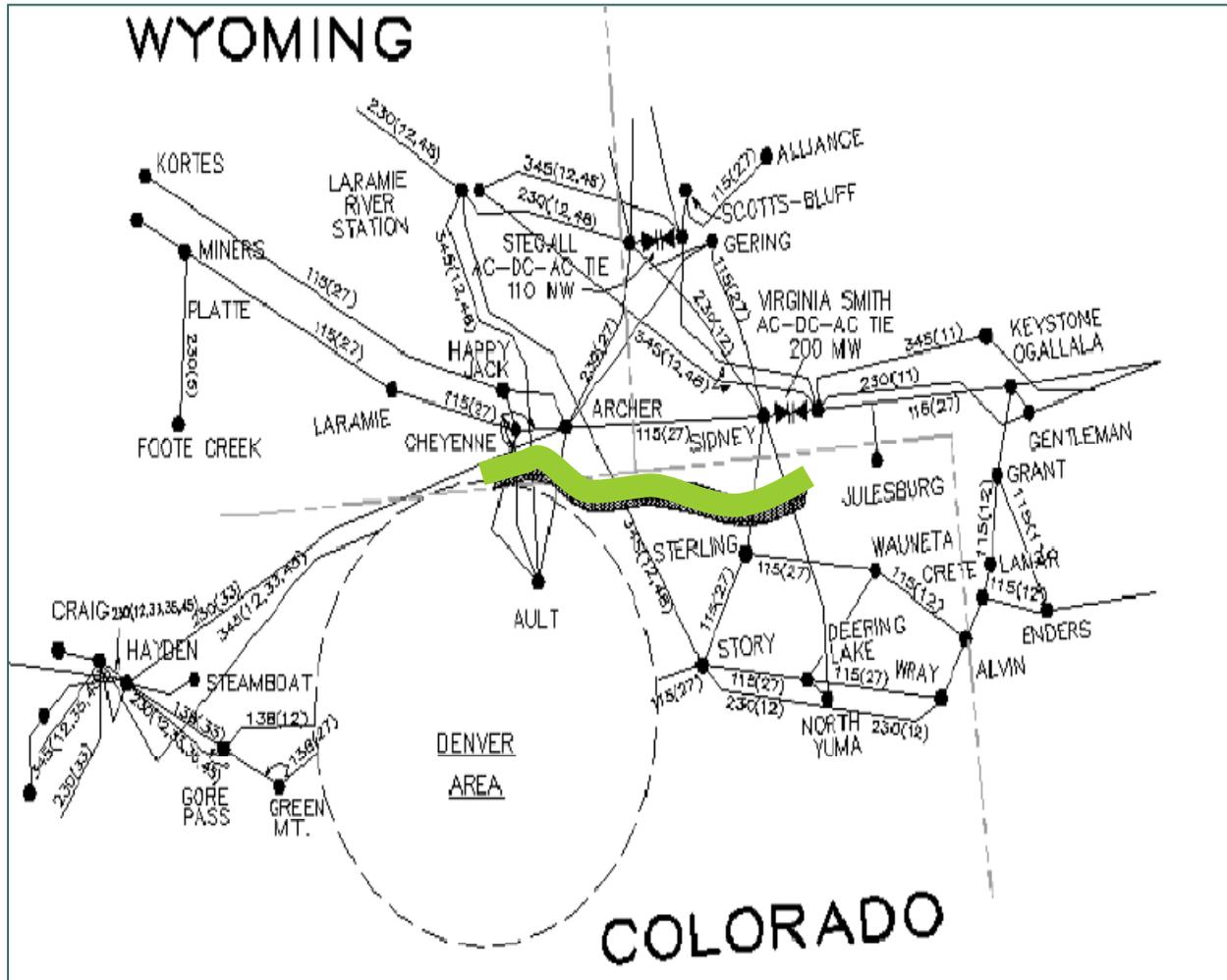
Table 1: Path 36 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating N to S        | 1680 MW   |
| Rating S to N        | Undefined |
| Max Voltage          | 345 kV    |

<sup>1</sup> Information from WECC 2011 Path Rating Catalog: [Link](#)

Discussion of WECC Paths  
TOT 3 - Path 36

Figure 1: Path 36 Definition

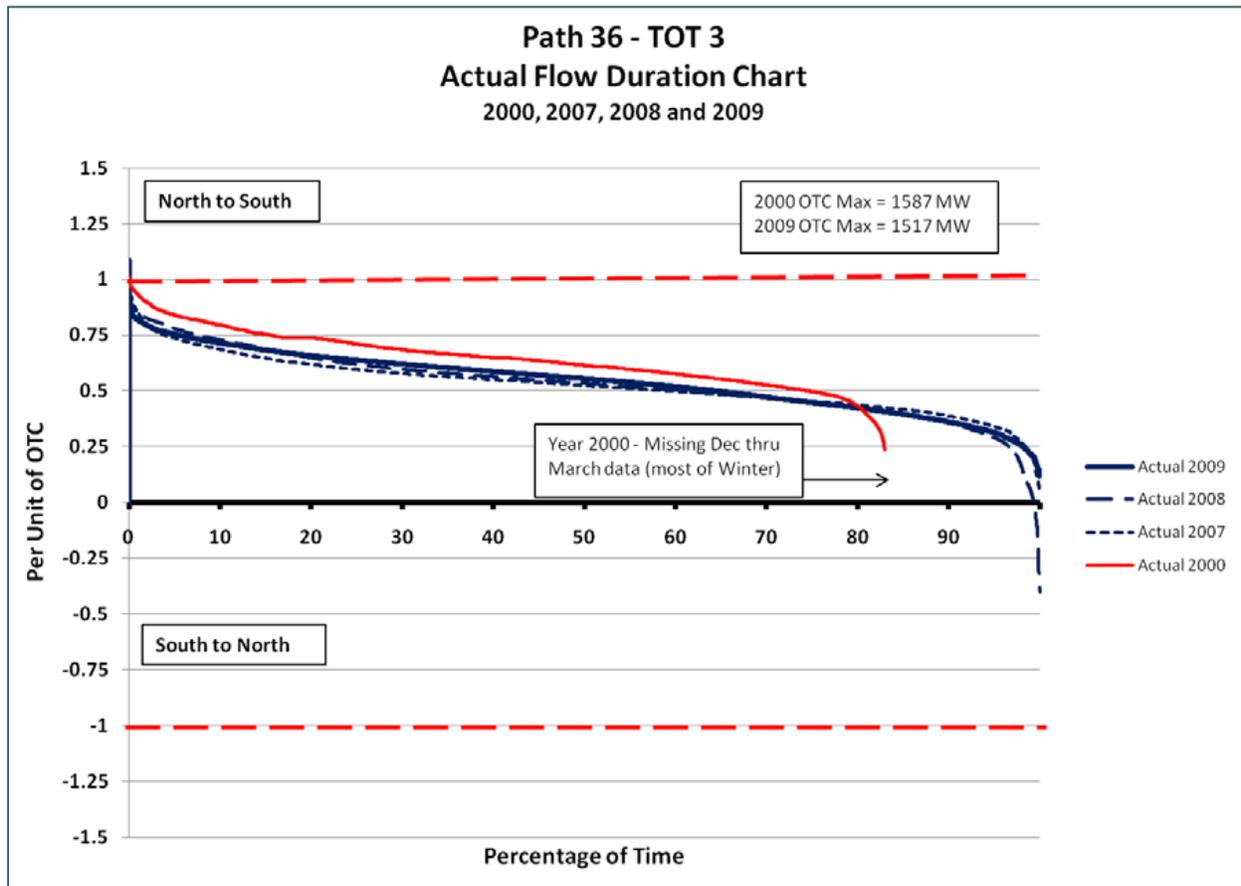


**Historical Congestion**

Path 36 was analyzed in the 2009, 2008, and 2007 Transmission Path Utilization Studies and is historically congested based on actual flow metrics from the 2007 Study. There was at least one season analyzed in the 2007 Study period where Path 36 seasonal loading exceeding 75 percent of operating transfer capacity 50 percent of the time or more. According to the study, this qualified Path 36 as one of the most heavily utilized paths in the Interconnection. The 2008 Path Utilization Study showed U75 and U90 values to be four percent and zero percent, respectively. The path was not listed as one of the Western Interconnection's most heavily used paths in the 2008 Study. In the 2009 Study, U75 for Path 36 was six percent of the year. Additionally, 0 MW of firm ATC were reported at least 95 percent of the year in the north to south direction. However, the 2009 Study did not list Path 36 as one of the most heavily used and congested path based on 2009 historical flow and schedule data. Actual flow data for multiple years can be found in the duration plot in Figure 2. As evident in the figure, flow is typically north to south and 2007, 2008, and 2009 flows were very similar in terms of MW transferred. It is worth noting that although informative, the plot does not necessarily reflect all of the metrics that support the path as historically congested.

Discussion of WECC Paths  
 TOT 3 - Path 36

Figure 2: Path 36 Actual Flow Duration Plot



**Project Development**

The following five projects were determined by stakeholders to be the most likely to have an impact on Path 36.

- Archer Interconnection (SCG Foundational Project)
- High Plains Express (Studied in 2010 Study Program)
- Zephyr (Studied in 2010 Study Program)
- TransWest Express (Studied in 2010 Study Program)
- Wyoming – Colorado Intertie (Studied in 2010 Study Program)

The Archer Interconnection project was included in the 2020 and 2019 datasets. Congestion impacts on Path 36 from the other projects studied in the 2010 Study Program are presented in the “Future Congestion Analysis” under “Project Development Impact”.

**Future Congestion Analysis**

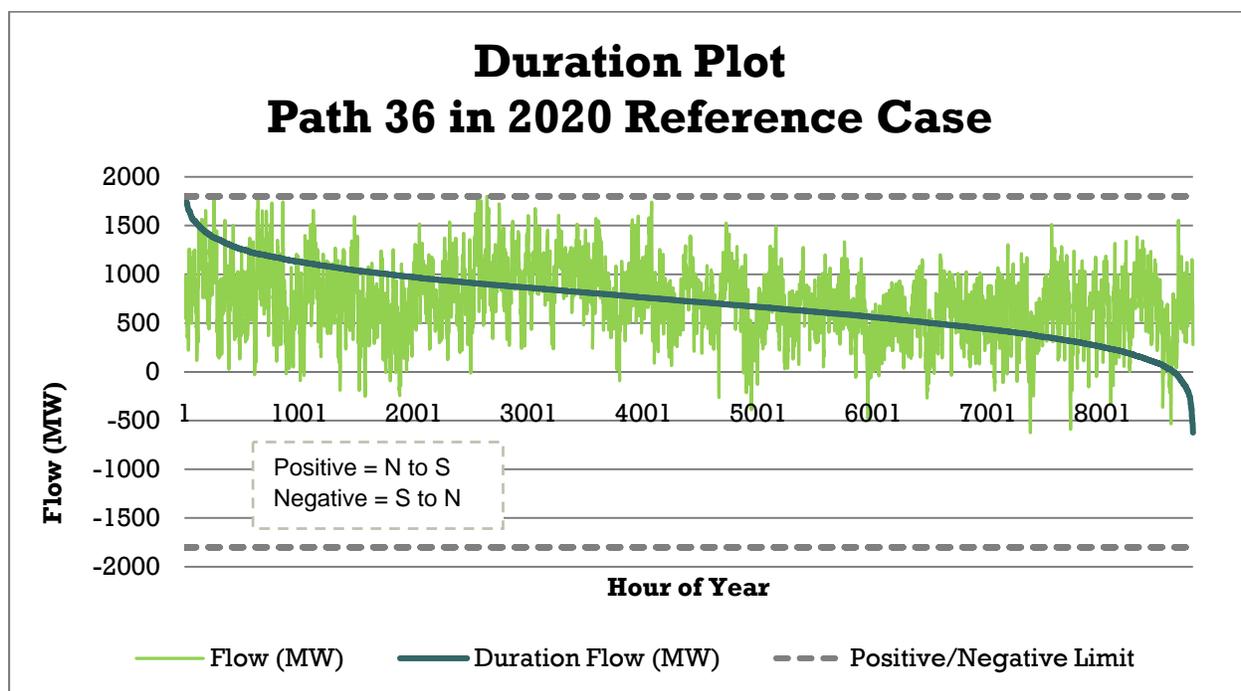
The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

Discussion of WECC Paths  
 TOT 3 - Path 36

**Expected Future**

Path 36 did not meet the definition of being highly utilized in the expected future. It was utilized at the U75 level for 3.54 percent of the year, and at U99 for only 0.59 percent of the year. As shown in Figure 3, flow was in the north to south direction for the majority of the year. The chronological plot in the same figure shows the seasonality of the flows. The increase from the north to south rating of 1,680 MW defined in the 2010 Path Rating Catalog to the 1,800 MW modeled in the 2020 expected future (and all other 2019 and 2020 study cases) is due to the inclusion of the TOT3 Archer Interconnection project. This project was an SCG Foundational Project and was assumed constructed in the datasets. Without this project and the subsequent path rating increase it is likely that Path 36 would have displayed higher utilization in the expected future case.

Figure 3: Path 36 2020 Duration Plot



**Alternative Futures**

Of 15 of the study cases used to inform the 10-Year Plan, TOT 3 path passed the utilization screening only twice. The path was highly utilized in the 2019 Wyoming Resource Relocation and the 2020 Aggressive Wyoming Wind cases.

**Conditional Congestion**

Congestion along Path 36 is contingent on certain 2019 and 2020 study cases. Moreover, the congestion appears to be dependent on resources being located in Wyoming. The congested cases and their conditional congestion scores are listed in Table 2.

Discussion of WECC Paths  
TOT 3 - Path 36

**Table 2: Path 36 Conditional Congestion**

| Study Case                              | Conditional Congestion Score <sup>2</sup> |
|---|---|
| <b>2019 Wyoming Resource Relocation</b> | 0.61                                      |
| <b>2020 Aggressive Wyoming Wind</b>     | 1.84                                      |

High levels of congestion along Path 36 appear to be most contingent on a future featuring increased renewable penetration into Wyoming. The 12,000 GWh of relocated resource in the 2019 Wyoming study case caused Path 36 to operate at U90 for almost 30 percent of the year, resulting in the second highest conditional congestion score in that case. The 25,000 GWh of wind energy in the 2020 Aggressive Wyoming Wind study case caused Path 36 flows to exceed U90 for nearly 46 percent of the year. Overall, Path 36 is extremely sensitive, in terms of congestion, to futures featuring renewable resource implementation in Wyoming without the addition of transmission. The congestion in these studies is caused by the lack of added transmission in the resource scenarios. With no incremental transmission, the added resources over-constrain the existing system.

**Project Development Impact**

The four projects identified in the “Project Development” section were studied in concurrence with the 12,000 GWh Wyoming Resource Relocation. By comparing congestion results from the expansion studies with that of the base case, and the resource relocation (without incremental transmission) we can better understand how Path 36 behaves under varying assumptions. Table 3 shows the U90 for each of the study cases.

**Table 3: Project Development Impact on Path 36**

| Study Cases  | U90    |
|--|--------|
| <b>2019 Base Case</b>  | 0.07%  |
| <b>2019 Wyoming Resource Relocation</b>                        | 29.18% |
| <b>2019 WY Resource Relocation + High Plains Express</b>       | 0.80%  |
| <b>2019 WY Resource Relocation + TransWest Express</b>         | 22.44% |
| <b>2019 WY Resource Relocation + Zephyr</b>                    | 24.49% |
| <b>2019 WY Resource Relocation + Wyoming-Colorado Intertie</b> | 11.79% |

Path 36 utilization increased greatly from the 2019 Base Case to the 2019 Wyoming Resource Relocation. With the implementation of the High Plains Express project and Wyoming-Colorado Intertie projects into the model, utilization of Path 36 dropped significantly. The Zephyr and TransWest Express projects were less effective at relieving Path 36 congestion because the projects are DC lines and subsequently fell subject to modeling issues that resulted in the

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<sup>2</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

Discussion of WECC Paths  
TOT 3 - Path 36

underutilization of the line. In all expansion cases the utilization of Path 36 decreased because the added transmission provided additional capacity for Wyoming exports.



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*This brief provides observations regarding the West of Colorado River WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 46.

- Path 46 is not historically congested according to the metrics used in previous path utilization studies. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their biannual path utilization report.
- There are many projects in development that could directly impact Path 46 flows.
- Path 46 was not congested in the 2020 expected future study case, or any other cases in the 2010 Study Program.

## Description

The largest WECC path in terms of transfer capacity, Path 46 consists of numerous lines interconnecting southern Nevada and Arizona to southern California. Operation of the path is maintained within the boundaries of the Southern California Import Transmission (SCIT) nomogram, which is not included in the production cost model (PCM). Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms the WOR path.

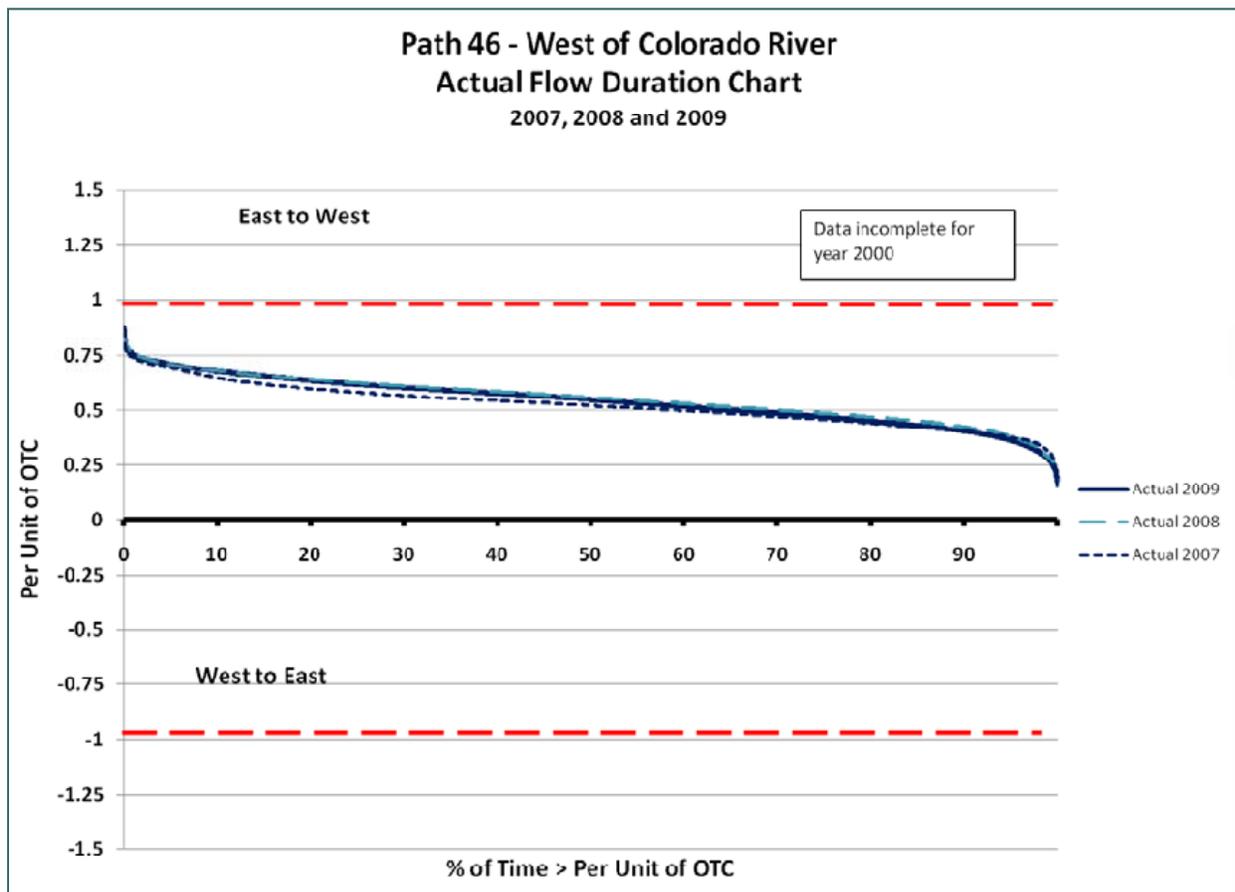
Table 1: Path 46 Characteristics

| Path Characteristics |          |
|----------------------|----------|
| Rating E to W        | 10623 MW |
| Rating W to E        | None     |
| Max Voltage          | 500 kV   |



WECC Path Reports  
West of Colorado River - Path 46

Figure 2: Path 46 Actual Flow Duration Plot



### Project Development

The following projects were determined by stakeholders to be the most likely to have an impact on Path 46.

- Blythe – Devers (SCG Foundational Project)
- Centennial West Clean Line (Studied in 2010 Study Program)
- Chinook (Studied in 2010 Study Program)
- Harcuvar Transmission Project
- High Plains Express (Studied in 2010 Study Program)
- Navajo Transmission Project (Studied in 2010 Study Program)
- Palo Verde – Blythe
- Palo Verde – N. Gila #2 (SCG Foundational Project)
- Southline Project
- SunZia (Studied in 2010 Study Program)
- TCP (Harry Allen to Eldorado/Mead)
- TransWest Express (Studied in 2010 Study Program)
- Zephyr (Studied in 2010 Study Program)

WECC Path Reports  
West of Colorado River - Path 46

The projects identified as an SCG Foundational Project were assumed constructed in the 2020 dataset.

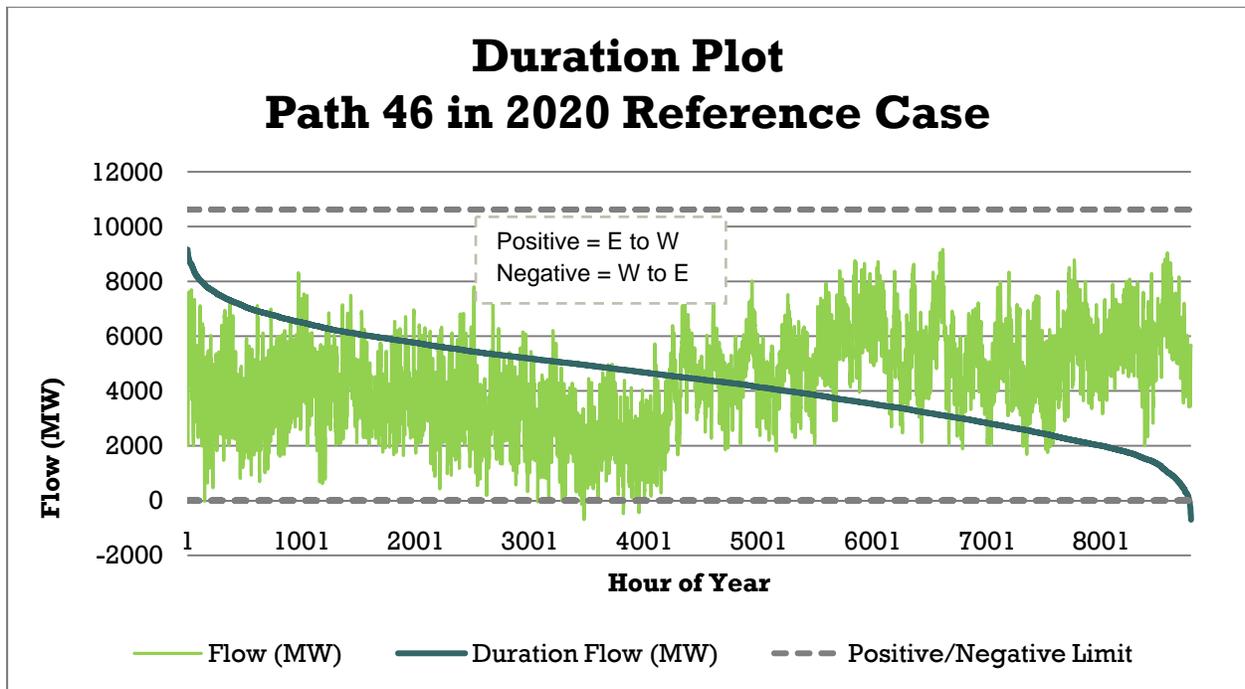
### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 46 was not heavily utilized or congested in the expected future case. The path never exceeded U90 and operated at or above U75 for only 1.48 percent of the year. The duration plot in Figure 3 shows this light utilization. The chronological plot in the same figure shows the seasonality of the flows.

Figure 3: Path 46 2020 Duration Plot



### Alternative Futures

Path 46 did not pass the utilization screening in any of the 15 cases used to inform the 10-Year Plan. There was no combination of assumptions that caused the path to be highly utilized.

### Conditional Congestion

Congestion along Path 46 is not contingent on any future evaluated in the 2010 Study Program.

### Project Development Impact

There is extensive project development that could potentially impact Path 46 flows. Seven of these projects were evaluated as a part of the 2010 Study Program. Each transmission expansion case includes 12,000 GWh of resource relocation and incremental transmission infrastructure. The impacts on Path 46 U90 are reported in Table 2.



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*This brief provides observations regarding the IID-SCE WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 42.

- There are a number of projects under development that could directly impact IID-SCE path flows.
- Path 42 was congested and heavily utilized in the 2020 expected future case in TEPPCs production cost model studies.

## Description

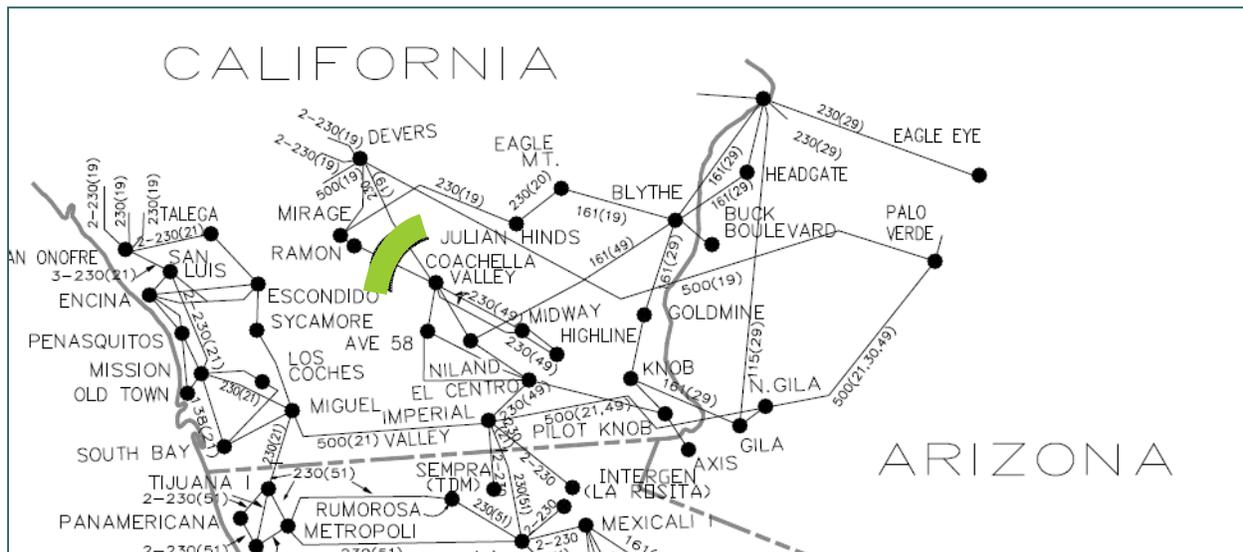
IID – SCE includes the flows on two 230 kV transmission lines in Riverside County, California. Flows have historically been east to west. Key characteristics of the path as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the IID-SCE path.

Table 1: Path 42 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating E to W        | 600 MW    |
| Rating W to E        | Undefined |
| Max Voltage          | 230 kV    |

WECC Path Reports  
IID – SCE - Path 42

Figure 1: Path 42 Definition



### Historical Congestion

Path 42 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

The Blythe – Devers and Sunrise projects were determined by stakeholders to be the most likely to have an impact on Path 42. Both projects were SCG Foundational Projects and were assumed constructed in the 2020 dataset.

### Future Congestion Analysis

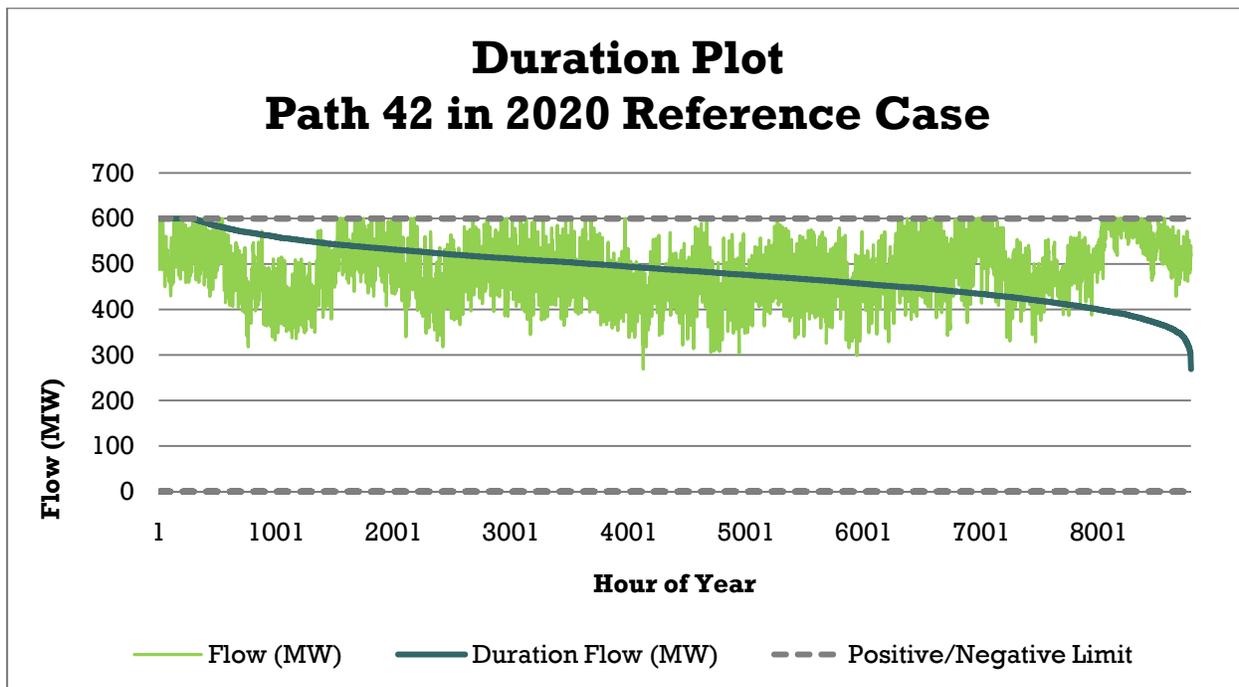
The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 42 was heavily utilized and congested in the expected future study case. The path passed the utilization screening based on the U75 metric, where it operated at or above for 71.51 percent of the year. Additionally, flow was at or above U90 for 18.42 percent of the year. The duration plot in **Error! Not a valid bookmark self-reference.** shows this heavy utilization. The chronological plot in the same figure shows the seasonality of the flows. Path 42 was only one of 9 paths that had congestion in the expected future study case.

WECC Path Reports  
 IID – SCE - Path 42

Figure 2: Path 42 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, IID-SCE path passed the utilization screening five times. All five of these cases were based on the 2020 dataset. The path was not highly utilized in any of the 2019 study cases, including the base case.

**Conditional Congestion**

Conditional congestion along Path 42 is dependent strictly on 2020 study cases. Conditional congestion scores were calculated for those study cases in which Path 42 was highly utilized (i.e. passed the utilization screening). The conditional congestion scores for Path 42 and the associated study cases in which the scores were calculated are listed in Table 2.

Table 2: Path 42 Conditional Congestion

| Study Case               | Conditional Congestion Score <sup>1</sup> |
|--------------------------|---|
| 2020 Reference Case      | 0.31                                      |
| 2020 High Load           | 0.48                                      |
| 2020 High DSM (low load) | 0.16                                      |
| 2020 Carbon Reduction    | 0.12                                      |
| 2020 Aggressive WY Wind  | 0.14                                      |

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

WECC Path Reports  
IID – SCE - Path 42

High levels of congestion along Path 42 appear to be most contingent on the study case featuring high load assumptions. This high level of congestion, represented by a U90 of nearly 28 percent of the year, is likely due to the increase in load in the southern California load center. Flow along Path 42 increased to meet this new level of load concentrated on one side of the IID-SCE path.



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*This brief provides observations regarding the Southern New Mexico (NM1) WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 47.

- Path 47 is historically congested based on actual flow metrics from the 2007 Path Utilization Study, and maximum schedule metrics from the 2008 Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their biannual path utilization report. It is likely that Path 47 will have reduced flow in future historical analysis because of new generation located in southern New Mexico.
- There are a number of projects in development that could directly impact Southern New Mexico (NM1) path flows. Further development in the region will require more research as to future expectations on path flow.
- Path 47 was not congested in the 2020 expected future study case, or any other cases in the 2010 Study Program.

## Description

Path 47 is defined as the sum of flows on four lines in southern New Mexico. The lines range in size from 115 kV to 345 kV. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

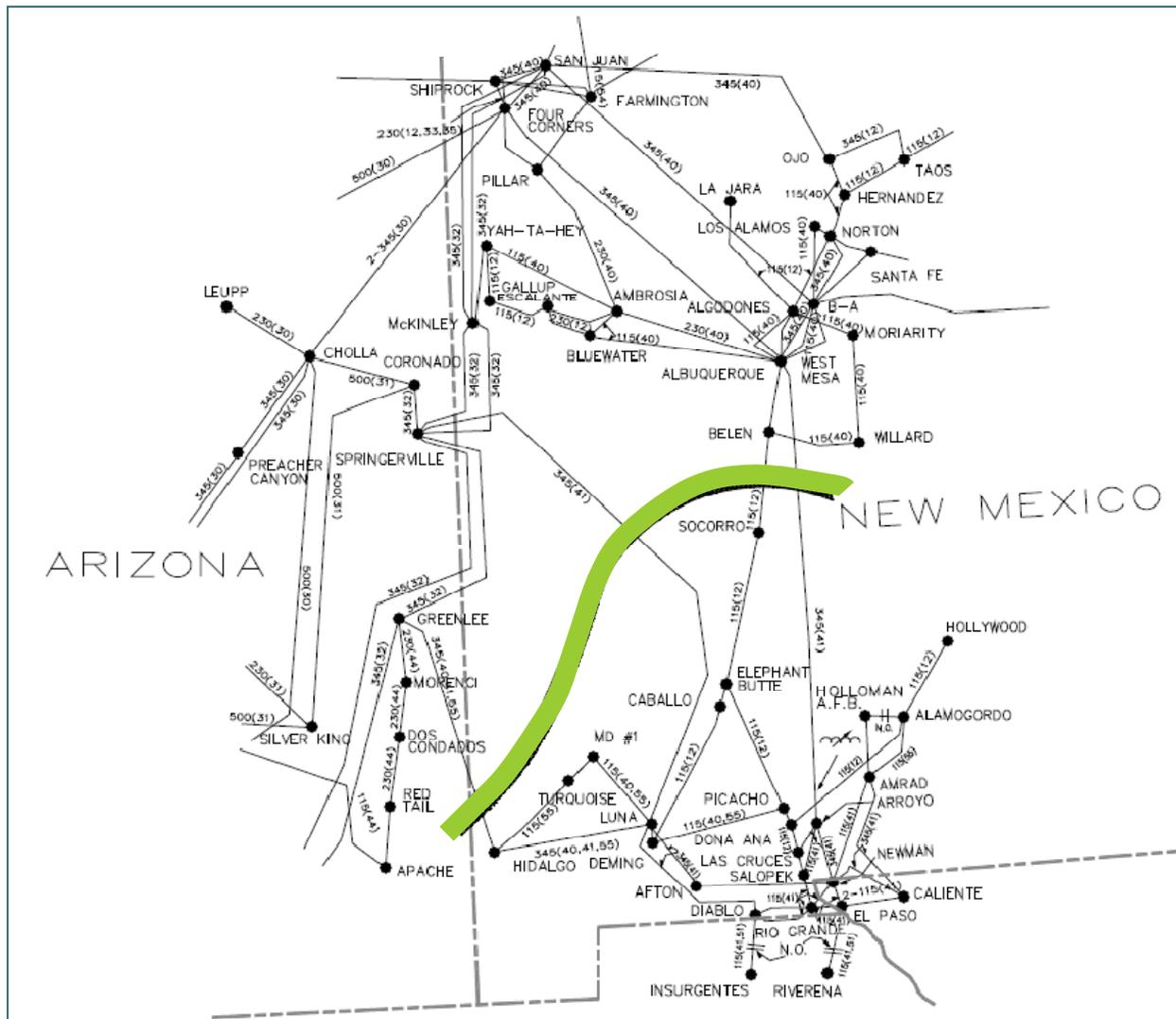
Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Southern New Mexico path.

Table 1: Path 47 Characteristics

| Path Characteristics |  |
|----------------------|--|
| <b>Rating W to E</b> | 940 MW (simultaneous firm)<br>1048 MW (non-simultaneous) |
| <b>Max Voltage</b>   | 345 kV   |

WECC Path Reports  
Southern New Mexico (NM1) - Path 47

Figure 1: Path 47 Definition

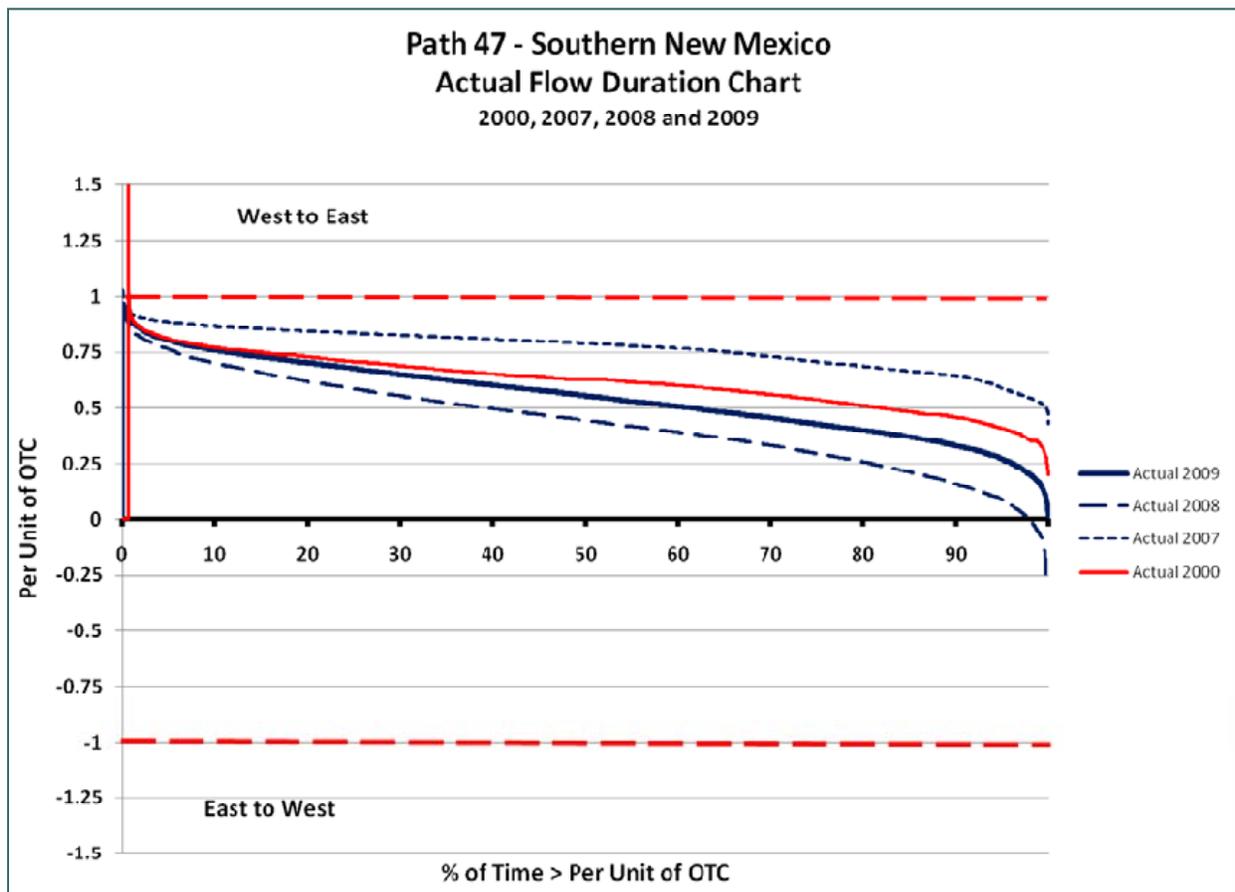


**Historical Congestion**

Path 47 was analyzed in the 2009, 2008, and 2007 Transmission Path Utilization Studies, and was historically congested based on actual flow metrics from the 2007 Study, as well as maximum schedule metrics from the 2008 Study. The 2009 Study did not identify Path 47 as one of the most congested paths. Actual flow data for historic years can be found in the duration plot in Figure 2. Although informative, the plot does not necessarily reflect the metrics that support the path as historically congested.

WECC Path Reports  
 Southern New Mexico (NM1) - Path 47

Figure 2: Path 47 Actual Flow Duration Plot



### Project Development

The following projects were determined by stakeholders to be the most likely to have an impact on Path 47.

- Centennial West Clean Line (Studied in 2010 Study Program)
- High Plains Express (Studied in 2010 Study Program)
- SunZia (Studied in 2010 Study Program)

None of these projects was included in the 2019 or 2020 datasets.

### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

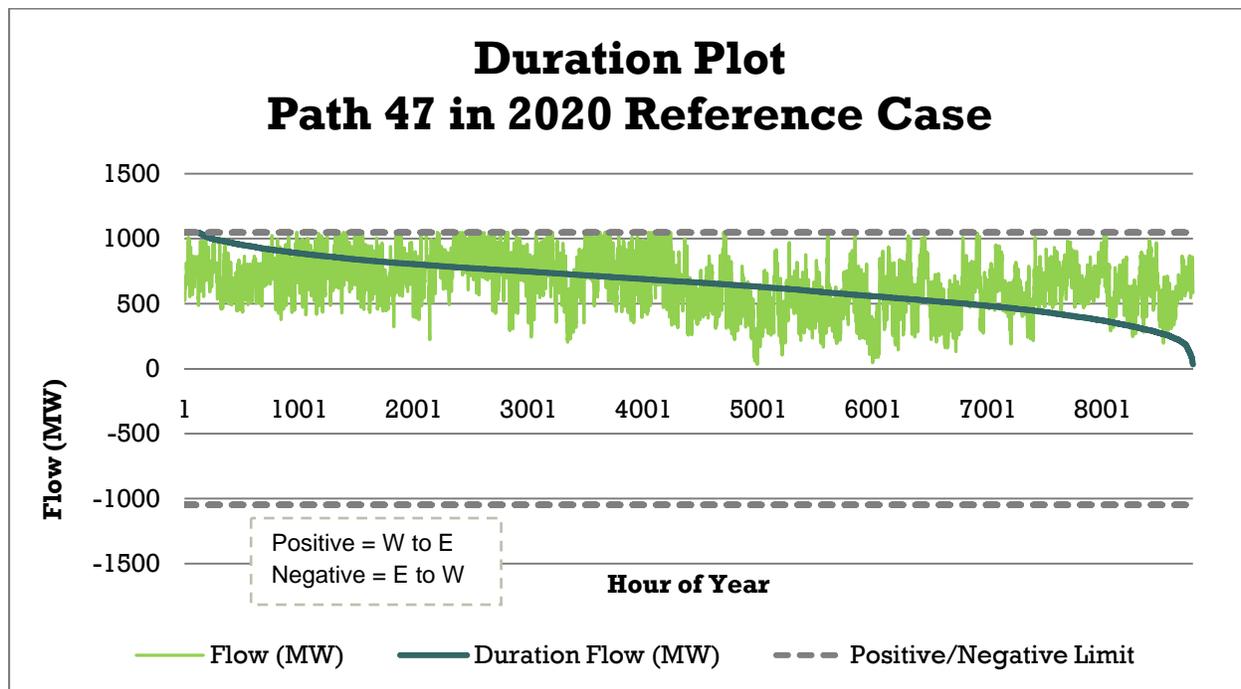
### Expected Future

Path 47 was not heavily utilized or congested in the expected future case. The path exceeded U90 and U75 for 6.44 percent and 25.85 percent of the year, respectively. Neither of these values surpasses the utilization screening requirement. The duration plot in **Error! Not a valid**

WECC Path Reports  
Southern New Mexico (NM1) - Path 47

**bookmark self-reference.** shows this light utilization. The chronological plot in the same figure shows the seasonality of the flows. Note the higher flows in spring and early summer.

Figure 3: Path 47 2020 Duration Plot



**Alternative Futures**

Path 47 did not pass the utilization screening in any of the 15 cases used to inform the 10-Year Plan. There was no combination of assumptions that caused the path to be highly utilized.

**Conditional Congestion**

Congestion on Path 47 is not contingent on any future evaluated in the 2010 Study Program.

**Project Development Impact**

By comparing congestion results from the expansion studies with that of the base case, and the resource relocation (without incremental transmission) we can better understand how Path 47 behaves under varying assumptions. Path 47 U75 values are presented in Table 2.

Table 2: Project Development Impact on Path 47

| Study Cases                         | Path 47 U75 (% of year) |
|-------------------------------------|-------------------------|
| 2019 Base Case                      | 2.43%                   |
| 2019 New Mexico Resource Relocation | 6.19%                   |

WECC Path Reports  
Southern New Mexico (NM1) - Path 47

|   |       |
|---|-------|
| <b>2019 New Mexico + Centennial West Clean Line Project</b> | 2.88% |
| <b>2019 New Mexico + High Plains Express/Sun Zia</b>        | 0.00% |

Path 47 is not heavily utilized in the base case or the resource relocation case. Change in flows caused by the implementation of the incremental transmission was not significant. Both projects were effective at transporting resources out of New Mexico, thereby leaving fewer resources to flow on Path 47, which decreased its utilization as an effect. It is worth noting that the Centennial West Clean Line Project is a DC line that if contracted to specific generation would have little to no effect on Path 47 in terms of its actual loading.

### Other Observations

The path operator provided the following comments on Path 47 in response to this write-up:

“Congestion on Path 47 has been reduced due to the addition of the Luna Energy Facility (LEF) generating station owned by Phelps Dodge Energy, PNM, and TEP. The LEF generation output flows in an east to west direction which counter flows the natural flow of Path 47.”

PNM provided the following recommendation for Path 47 regarding future TEPPC studies:

“Path 47 is only rated West to East and does not have an accepted East to West rating. As such Public Service Company of New Mexico (PNM) recommends for the purpose of TEPPC studies use the West to East simultaneous firm limit of 940 MW as a proxy. Allowing the limit to be undefined in TEPPC studies allows conclusions to be made that might not otherwise be drawn if there was an East to West simultaneous firm limit established.”



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*This brief provides observations regarding the East of Colorado River (EOR) WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 49.

- Path 49 is historically congested based on actual flow and schedule metrics analyzed as a part of the 2009 Path Utilization Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are many projects in development that could directly impact East of Colorado River flows.
- Path 49 was not congested in the 2020 expected future study case, or any other cases in the 2010 Study Program.

## Description

Path 49 is the 2<sup>nd</sup> largest WECC path in terms of transfer capacity, and is composed of numerous lines in western Arizona. Operation of the path is maintained within the boundaries of the Southern California Import Transmission (SCIT) nomogram, which is not included in the production cost model (PCM). Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

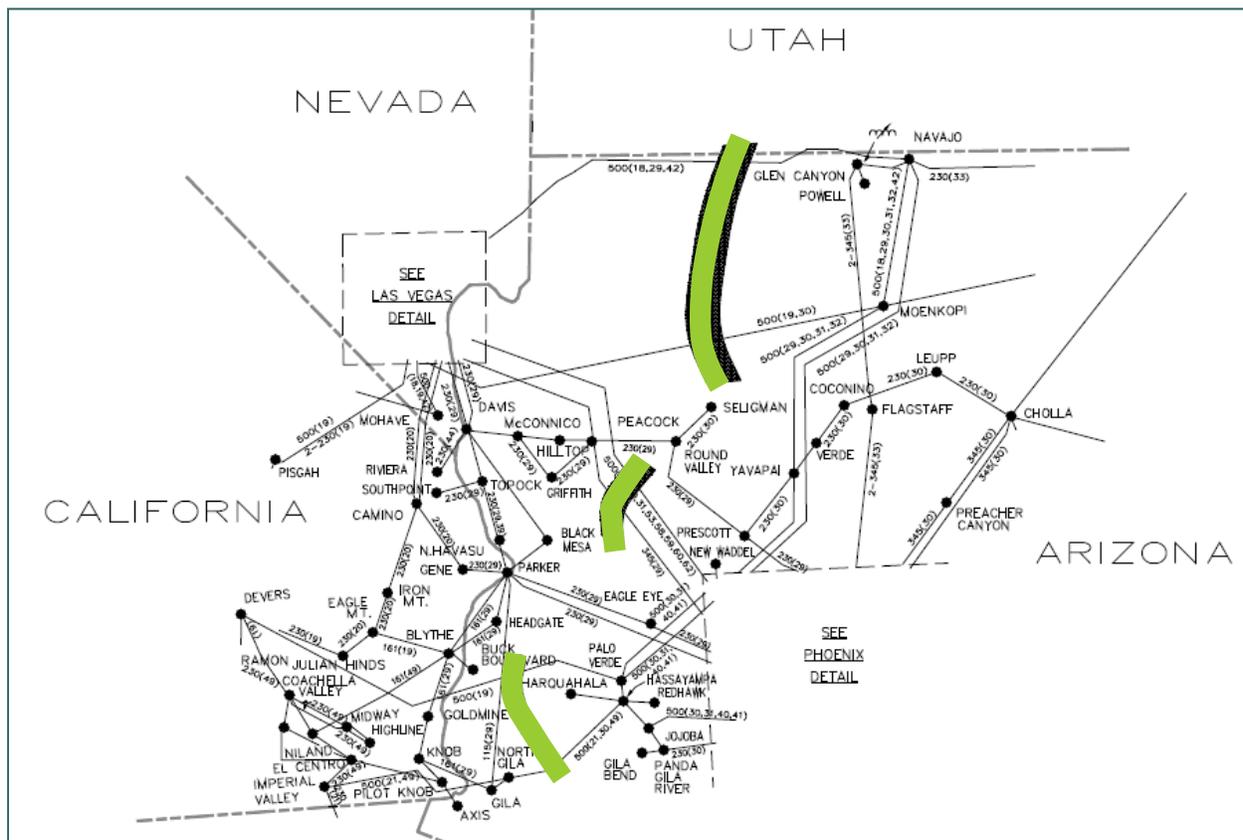
Table 1. Figure 1, on the next page, shows the physical cut plane that forms the East of Colorado River (EOR) path.

Table 1: Path 49 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating E to W        | 9300 MW   |
| Rating W to E        | Undefined |
| Max Voltage          | 500 kV    |

WECC Path Reports  
 East of Colorado River (EOR) - Path 49

Figure 1: Path 49 Definition

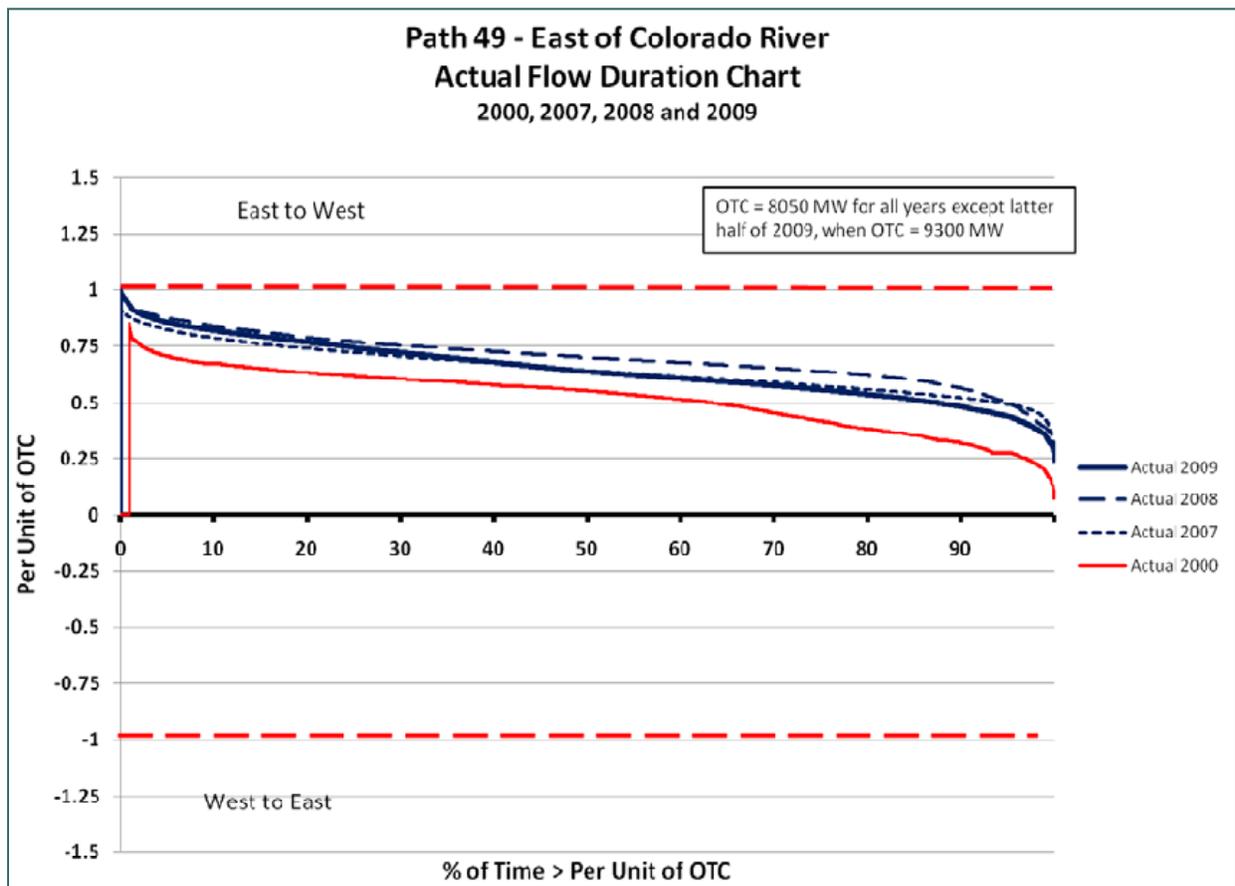


**Historical Congestion**

Path 49 was analyzed in the 2007, 2008 and 2009 Transmission Path Utilization Studies, and is historically congested based on actual flow and schedule metrics from the 2009 Study. The 2009 Study listed Path 49 as the 6<sup>th</sup> most heavily used path in the Interconnection. It was at or above U75 for 24 percent of the year. However, Path 49 did have 1,090 MW, or 13 percent of its total transfer capacity, of unused capacity available 90 percent of the year. There was 271 MW of firm ATC available for 95 percent of the year as well. In the 2008 Study Path 49 operated at U75 for 17 percent of the year. The path never reached U90 and was not listed as one of the most utilized paths in the Western Interconnection. Actual flow data for historic years can be found in the duration plot in Figure 2. The increase in Path 49 flow since 2000 is visible in this figure. Although informative, the plot does not necessarily reflect all metrics that support the path as being historically congested.

WECC Path Reports  
 East of Colorado River (EOR) - Path 49

Figure 2: Path 49 Actual Flow Duration Plot



**Project Development**

The following projects were determined by stakeholders to be the most likely to have an impact on Path 49.

- Blythe – Devers (SCG Foundational Project)
- Centennial West Clean Line (Studied in 2010 Study Program)
- Chinook (Studied in 2010 Study Program)
- Harcuvar Transmission Project
- High Plains Express (Studied in 2010 Study Program)
- Navajo Transmission Project (Studied in 2010 Study Program)
- Palo Verde – Morgan (SCG Foundational Project)
- Palo Verde – Blythe
- Palo Verde – N. Gila #2 (SCG Foundational Project)
- Southline Project
- SunZia (Studied in 2010 Study Program)
- TCP (Harry Allen to Eldorado/Mead)
- TransWest Express (Studied in 2010 Study Program)

WECC Path Reports  
 East of Colorado River (EOR) - Path 49

The projects identified as SCG Foundational Projects were assumed constructed in the 2020 dataset.

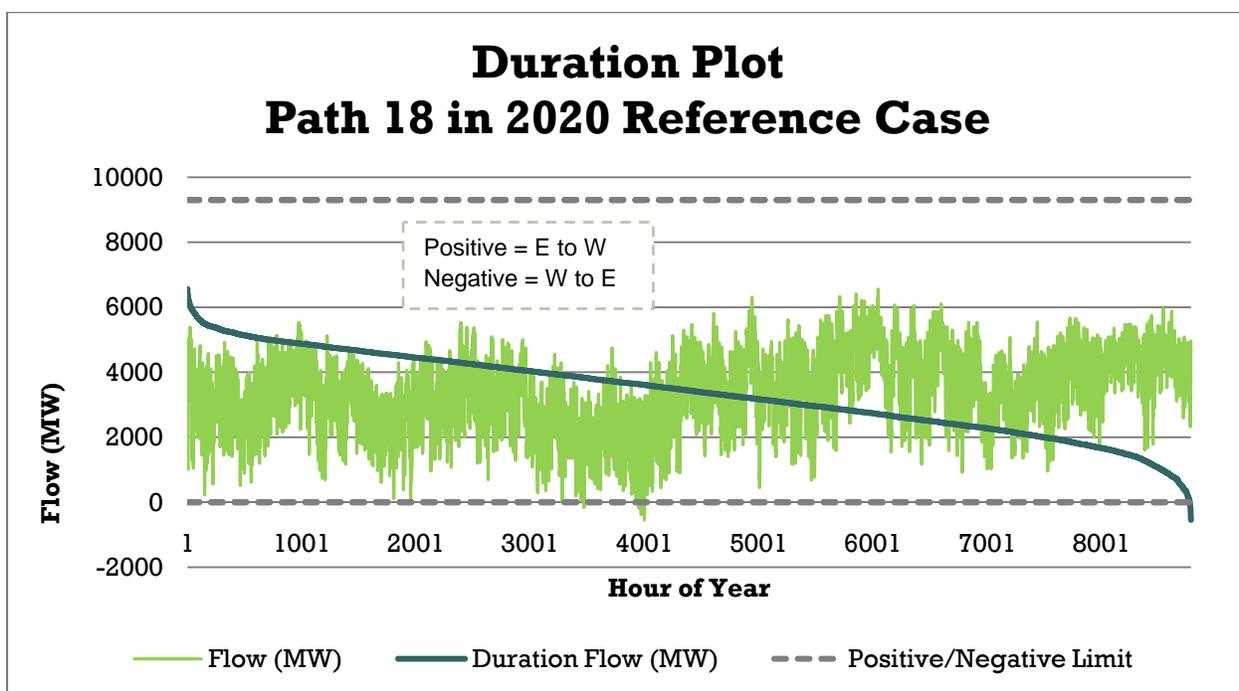
### Future Congestion Analysis

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 49 was not heavily utilized or congested in the expected future case. The path never exceeded 90 percent or 75 percent of the path limit. The duration plot in Figure 3 shows this light utilization. The chronological plot in the same figure shows the seasonality of the flows.

Figure 3: Path 49 2020 Duration Plot



### Alternative Futures

Path 49 did not pass the utilization screening in any of the 15 cases used to inform the 10-Year Plan. There was not a combination of assumptions that caused the path to be highly utilized.

### Conditional Congestion

Congestion along Path 49 is not contingent on any future evaluated in the 2010 Study Program.

### Project Development Impact

There is extensive project development that could potentially impact Path 49 flow. Six of these projects were evaluated in five different combinations as a part of the 2010 Study Program. Each transmission expansion case includes 12,000 GWh of resource relocation and incremental transmission infrastructure. The impacts on Path 49 U75 are reported in Table 2.

WECC Path Reports  
 East of Colorado River (EOR) - Path 49

**Table 2: Project Development Impact on Path 46**

| <b>Study Cases</b>                                | <b>U75</b> |
|---|------------|
| <b>2019 Base Case</b>                             | 2.44%      |
| <b>2019 New Mexico Resource Relocation</b>        | 7.44%      |
| <b>2019 NM + Centennial West Clean Line</b>       | 2.57%      |
| <b>2019 NM + Navajo Transmission Project</b>      | 0.00%      |
| <b>2019 NM + High Plains Express &amp; SunZia</b> | 12.11%     |
| <b>2019 Wyoming Resource Relocation</b>           | 4.67%      |
| <b>2019 WY + TransWest Express</b>                | 1.54%      |
| <b>2019 Montana Resource Relocation</b>           | 3.01%      |
| <b>2019 MT + Chinook</b>                          | 0.99%      |

The majority of projects reduce Path 49 U75 levels from that of their respective resource relocation case. Every project that terminated west of Path 49 caused the utilization to decrease because the added line decreased the reliance on Path 49 to deliver the added resources. Notably, the only project that terminates east of Path 49, the High Plains Express/SunZia project, caused Path 49 flow to increase because once the PCM delivered the relocated resources east of Path 49 the utilization of the path increased as the resources attempted move further west into California.



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*This brief provides observations regarding the Cholla-Pinnacle Peak WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

### Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 50.

- Path 50 is historically congested based on actual flow metrics from the 2007 Path Utilization Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are projects in development that could directly impact Cholla-Pinnacle Peak path flow.
- Path 50 was not heavily utilized or congested in the 2020 expected future case.

### Description

Path 50 is located in eastern Arizona and is composed of the flow on two 345 kV transmission lines. Historically, flows on this path have been east to west due to the large amount of generation located in northwestern New Mexico and eastern Arizona. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Cholla-Pinnacle Peak path.

**Table 1: Path 50 Characteristics**

| Path Characteristics |           |
|----------------------|-----------|
| <b>Rating E to W</b> | 1200 MW   |
| <b>Rating W to W</b> | Undefined |
| <b>Max Voltage</b>   | 345 kV    |

WECC Path Reports  
 Cholla – Pinnacle Peak - Path 50

Figure 1: Path 50 Definition



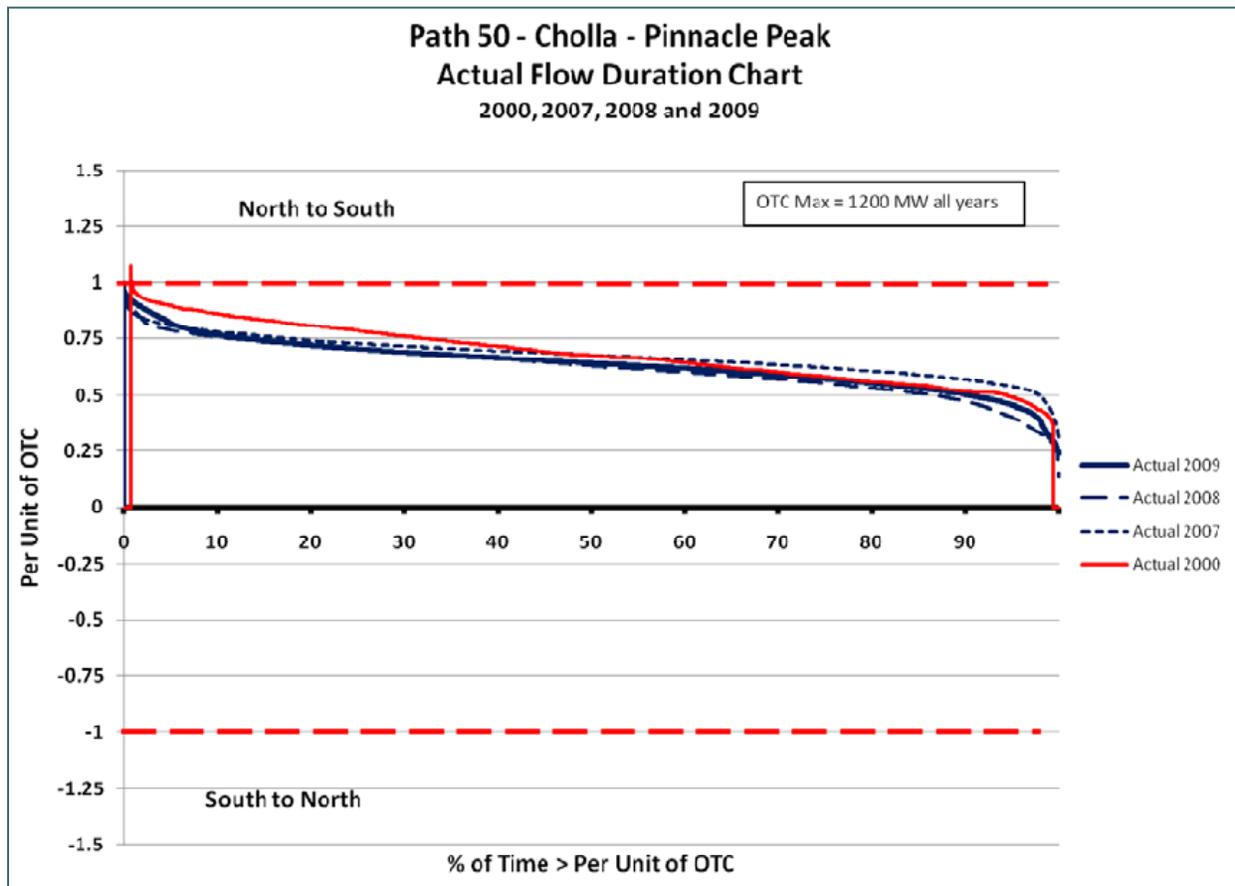
**Historical Congestion**

The 2009, 2008, and 2007 Transmission Path Utilization Studies analyzed Path 50, which is historically congested based on actual flow metrics from the 2007 Study. The 2007 Study identified Path 50 as having at least one season in the study period in which the seasonal loading exceeded 75 percent of operating transfer capacity 50 percent of the time or more. Path 50 was considered one of the most heavily utilized paths in the 2007 Study. The 2008 Study reported Path 50 operating at or above U75 for 17.4 percent of the year, and it was not identified as one of the most heavily utilized paths. Path 50 was the 9<sup>th</sup> most utilized path in the 2009 Study, based on actual flow. The path had 73 MW of firm ATC available 95 percent of the time, and did not make the list as one of the most heavily used WECC paths in the 2009 Study. Actual flow data for historic years can be found in the duration plot in Figure 2. Although

WECC Path Reports  
 Cholla – Pinnacle Peak - Path 50

informative, the plot does not necessarily reflect the metrics that support the path as historically congested. The figure shows that Path 50 flows were highest in 2000.

Figure 2: Path 50 Actual Flow Duration Plot



**Project Development**

Stakeholders did not identify any projects likely to have an impact on Path 50.

**Future Congestion Analysis**

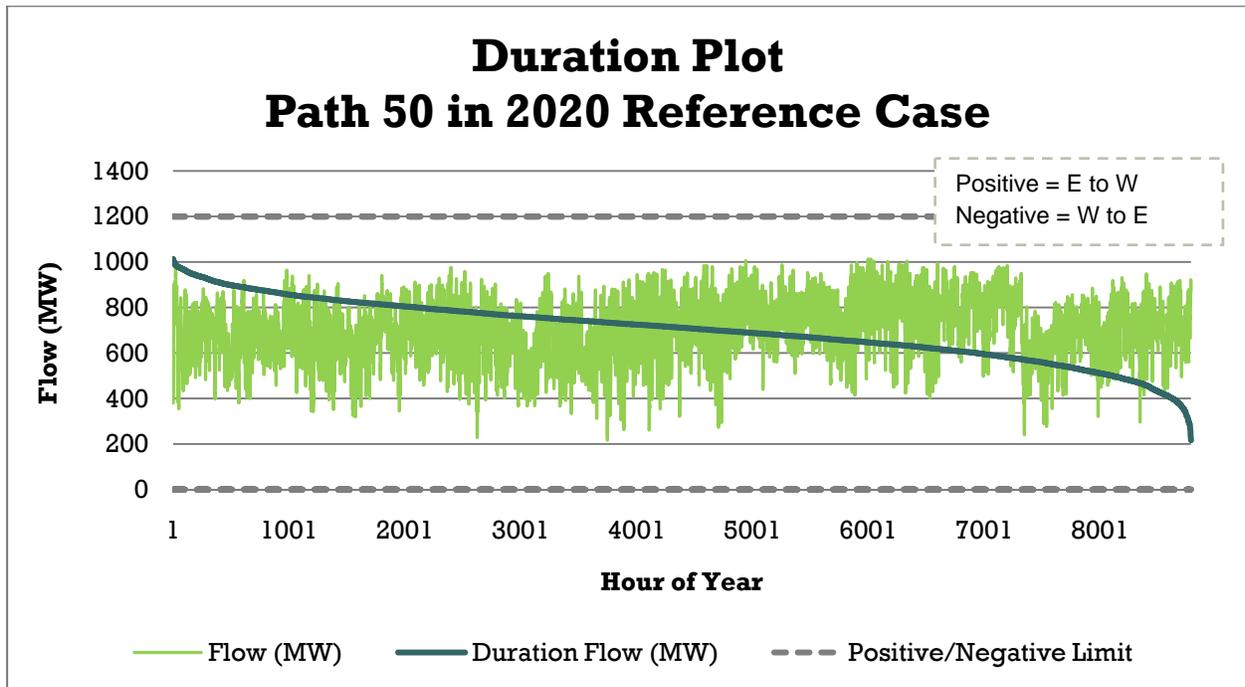
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

**Expected Future**

Path 50 was not heavily utilized or congested in the 2020 expected future study case. Flow equaled or surpassed U75 for only 5.44 percent of the study year, and never exceeded U90. The duration plot in Figure 3 shows the low utilization of the path. The chronological plot in the same figure shows the seasonality of the flows.

WECC Path Reports  
 Cholla – Pinnacle Peak - Path 50

Figure 3: Path 50 2020 Duration Plot



**Alternative Futures**

Of 15 study cases used to inform the 10-Year Plan, Path 50 passed the utilization screening in only one case, the 2019 New Mexico Resource Relocation. Due to the increase in New Mexico generation in this case, Path 50 was heavily utilized in order to deliver those incremental resources to load centers west of New Mexico.

**Conditional Congestion**

There was a small amount of congestion along Path 50 contingent on the set of assumptions used to form the 2019 New Mexico Resource Relocation. As previously mentioned, the path was highly utilized in the same scenario. However, the path passed the utilization screening based on the U75 metric, where it operated at or above for 52 percent of the year. The congestion scores are based on the U90 metric, where the path operated at for less than four percent of the year. This difference between the number of hours at U75 versus the number of hours at U90 explain why the path was heavily utilized, but rarely congested in New Mexico Resource Relocation case.

**Other Observations**

The path operator submitted the following comments in response to this write-up:

“In actual operation Path 50 flow is generally kept lower to account of the loss of the parallel line to avoid overloading the remaining circuit.”



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*This brief provides observations regarding the Southern Navajo WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 51.

- Path 51 is not historically congested according to the metrics in previous path utilization studies. However, the path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in future path utilization reports.
- There are projects in development that could directly impact Southern Navajo path flows.
- Path 51 was not heavily utilized or congested in the 2020 expected future case, or any other cases in the 2010 Study Program.

## Description

Path 51 is located in northern Arizona and consists of the flow on two 500 kV lines. Flows on the path have historically been north to south due to the generation of the Navajo power plant and other resources east and west of the plant. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Southern Navajo path.

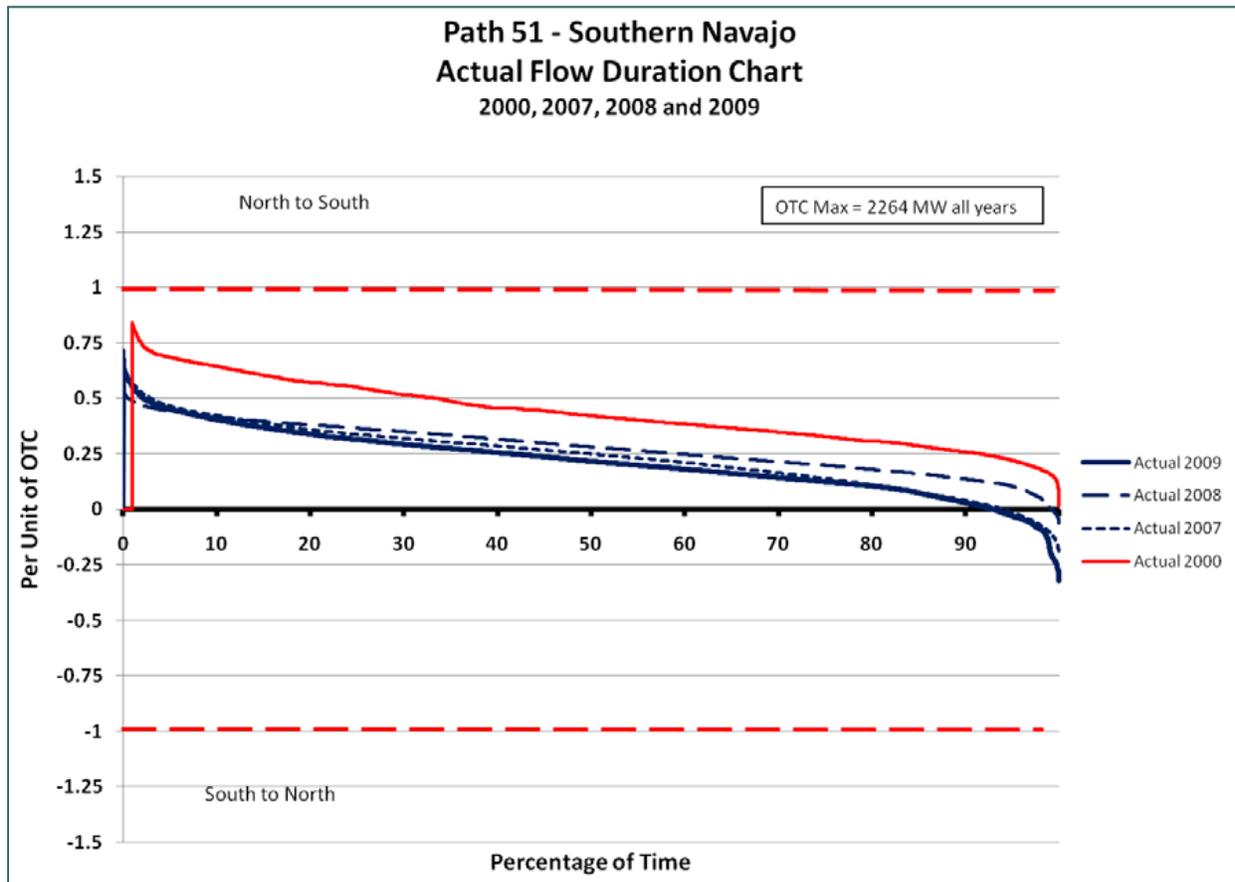
Table 1: Path 51 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating N to S        | 2800 MW   |
| Rating S to N        | Undefined |
| Max Voltage          | 500 kV    |



WECC Path Reports  
 Southern Navajo - Path 51

Figure 2: Path 51 Actual Flow Duration Plot



### Project Development

The following two projects were determined by stakeholders to be the most likely to have an impact on Path 51.

- Centennial West Clean Line (Studied in 2010 Study Program)
- Navajo Transmission Project (Studied in 2010 Study Program)

### Future Congestion Analysis

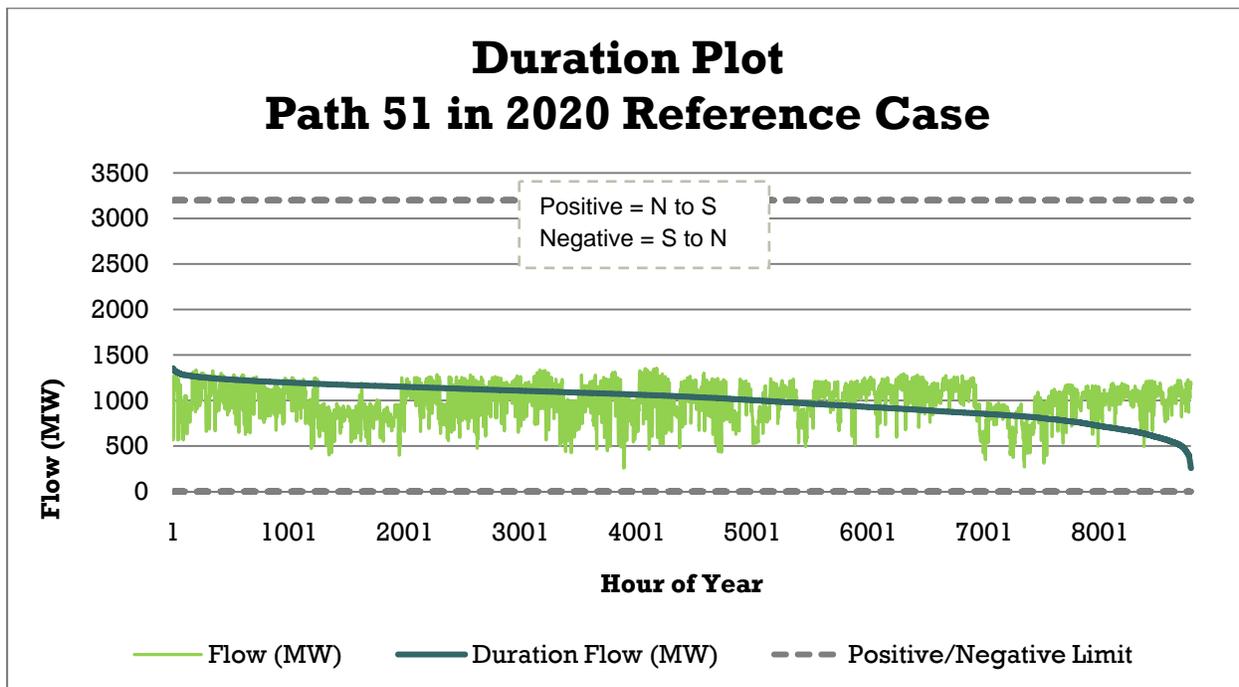
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 51 was not heavily utilized or congested in the 2020 expected future study case. Over the study year, flow never surpassed 75 percent of the path's limit. The duration plot in Figure 3 shows low utilization of the path with the 2020 rating. The chronological plot in the same figure shows the seasonality of the flows. It is worth noting that Path 51's planned rating increase to 3,200 MW is assumed in the studies. Without this higher rating it is likely that the calculated path utilization metrics would have indicated heavier utilization.

WECC Path Reports  
 Southern Navajo - Path 51

Figure 3: Path 51 2020 Duration Plot



**Alternative Futures**

Path 51 did not pass the utilization screening in any of the 15 study cases used to inform the 10-Year Plan. No set of assumptions in the 2010 Study Program caused significant utilization of the path. As previously mentioned, this relatively low utilization is partially due to the path rating increase to 3200 MW.

**Conditional Congestion**

Path 51 did not display any congestion in either the 2019 or 2020 study cases.

**Project Development Impact**

Both the Centennial West and the Navajo Transmission projects were studied in the 2010 Study Program. Both projects were implemented in separate studies that featured a 12,000 GWh resource relocation to New Mexico. However, Path 51 did not become highly utilized or congested when the resources were relocated without added transmission. With the added transmission of Centennial West and the Navajo Transmission project, Path 51 continued to display lower utilization and flows did not surpass 75 percent of the path’s limit in either of the expansion cases.



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*This brief provides observations regarding the Silver Peak-Control 55 kV WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 52.

- There are no projects in development that could directly impact Silver Peak-Control 55 kV path flow.
- Path 52 was not heavily utilized or congested in the 2020 expected future case.

## Description

Path 52 is located along the boarder of southwestern Nevada and central eastern California. Historically, during peak loading cvonditions, flows on the intertie have been limited to 14 MW. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

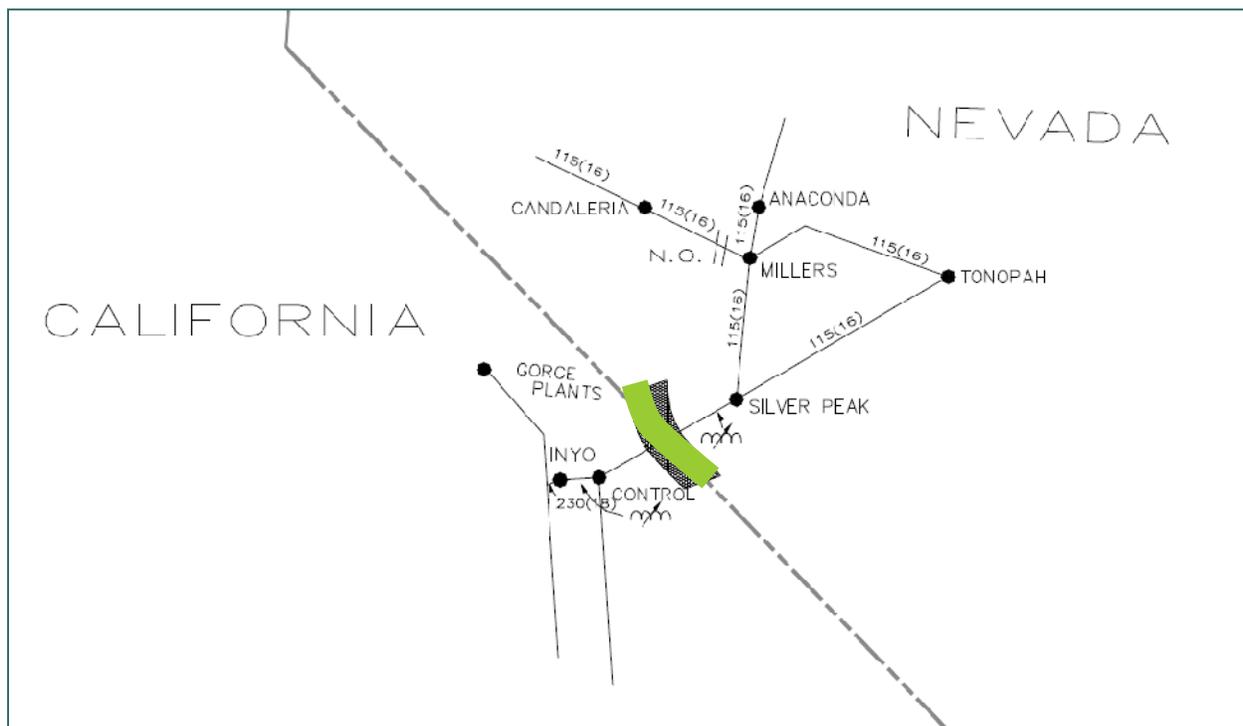
Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Silver Peak-Control 55 kV path.

Table 1: Path 52 Characteristics

| Path Characteristics |       |
|----------------------|-------|
| Rating W to E        | 17 MW |
| Rating E to W        | 17 MW |
| Max Voltage          | 55 kV |

WECC Path Reports  
Silver Peak-Control 55 kV - Path 52

Figure 1: Path 52 Definition



### Historical Congestion

Path 52 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

Stakeholders did not identify any specific potential projects that may have a direct impact on Path 52 flow.

### Future Congestion Analysis

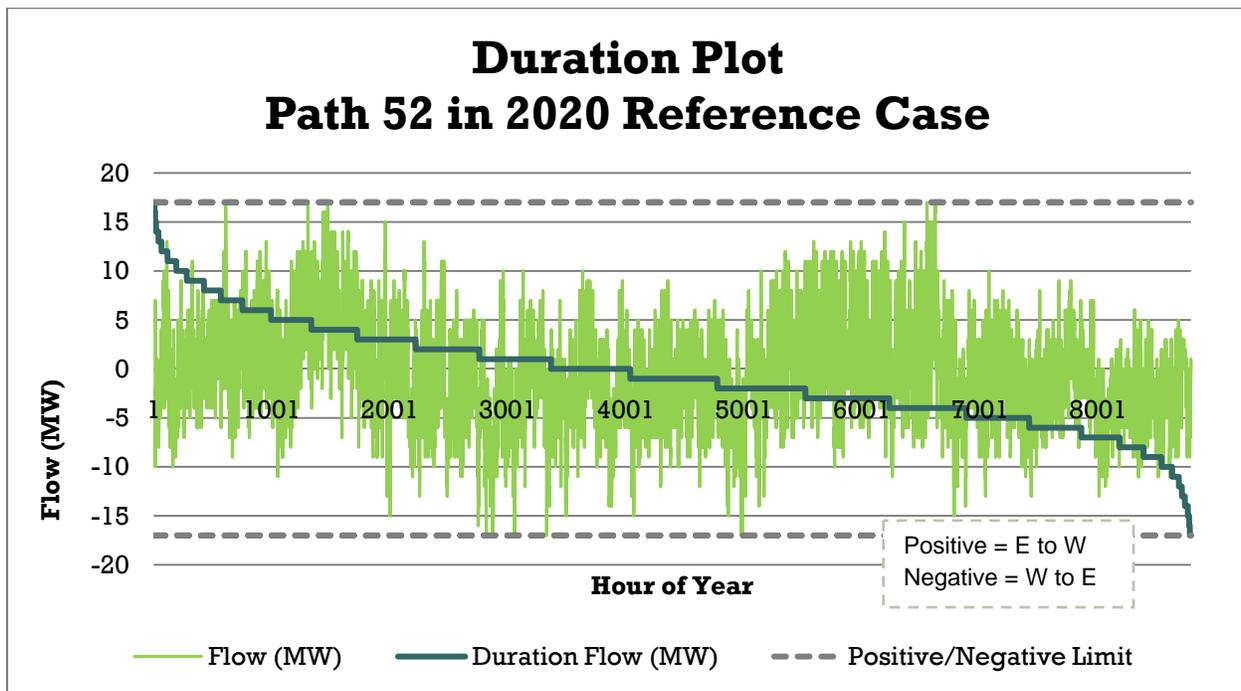
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 52 was not heavily utilized or congested in the 2020 expected future study case. Flow equaled or surpassed U75 and U90 for only 1.18 percent and 0.28 percent of the year, respectively. The duration plot in Figure 2 shows the low utilization of the path. The chronological plot in the same figure shows the seasonality of the flows.

WECC Path Reports  
 Silver Peak-Control 55 kV - Path 52

Figure 2: Path 52 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 52 passed the utilization screening in only one case, the 2019 Northern Nevada Resource Relocation. Path 52 was heavily utilized in this study case because the PCM attempted to meet California load with Northern Nevada resources without any added transmission. Path 52 provides an obvious link between these two areas.

**Conditional Congestion**

There was a large amount of congestion along Path 52 contingent on the set of assumptions used to form the 2019 Northern Nevada Resource Relocation. As previously mentioned, the path was highly utilized in the same scenario. Although the Silver Peak-Control 55 kV path was not designed to transfer large amounts of resources, the PCM still used it for this purpose. The result was an extremely high U90 of 55.26 percent of the year for this very small 17 MW path. In actual operation the path would be better served ensuring reliability and making use of the phase shifters, rather than transferring bulk resources like a typical AC line.



**WECC Path Reports**  
*Inyo-Control 115 kV Tie Path*  
**60**

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*This brief provides observations regarding the Inyo-Control 115 kV Tie WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

### Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 60.

- There are no projects in development that could directly impact Inyo-Control 115 kV Tie path flow.
- Path 60 was heavily utilized and congested in the 2020 expected future study case.

### Description

The Inyo-Control 115 kV Tie is located in eastern central California, near the town of Bishop. The path rating is limited by the continuous rating of the 56 MVA phase shifter. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

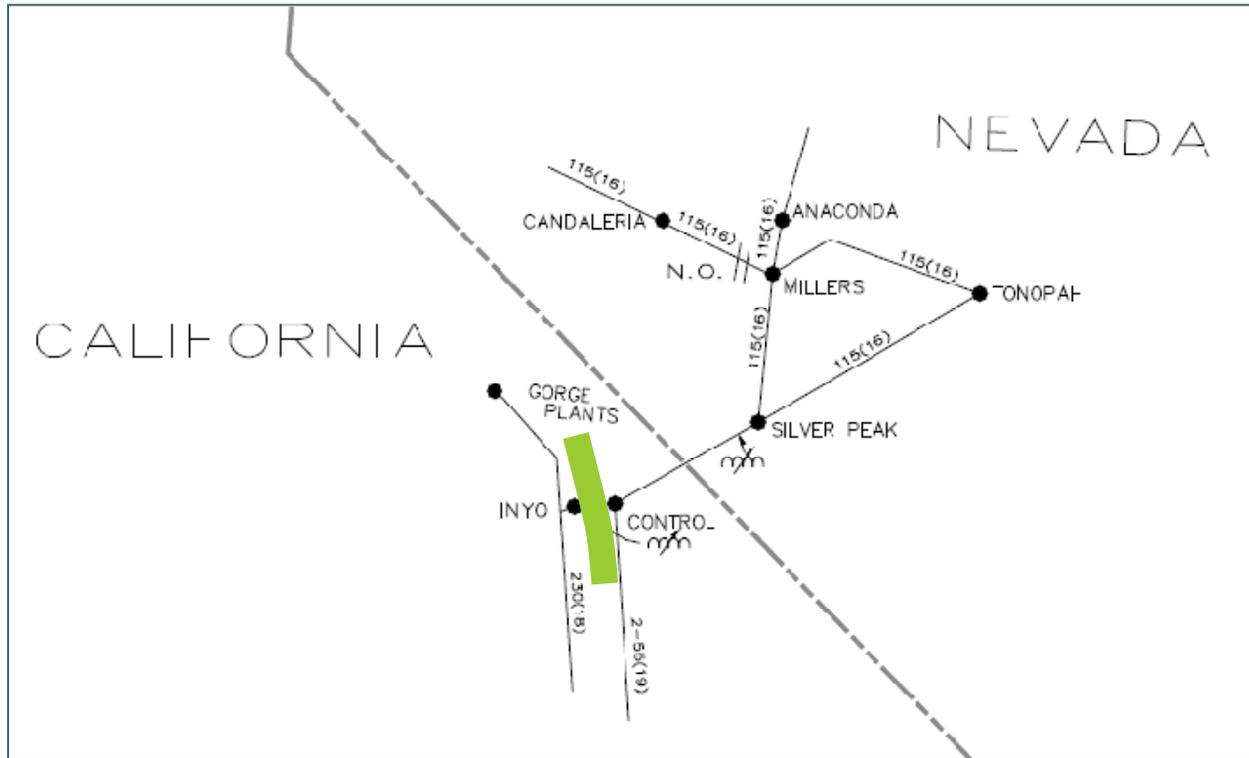
Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Inyo-Control 115 kV Tie path.

Table 1: Path 60 Characteristics

| Path Characteristics |        |
|----------------------|--------|
| Rating W to E        | 56 MW  |
| Rating E to W        | 56 MW  |
| Max Voltage          | 115 kV |

WECC Path Reports  
Inyo-Control 115 kV Tie - Path 60

Figure 1: Path 60 Definition



### Historical Congestion

Path 60 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

Stakeholders did not identify any specific potential projects that may have a direct impact on Path 60 flow.

### Future Congestion Analysis

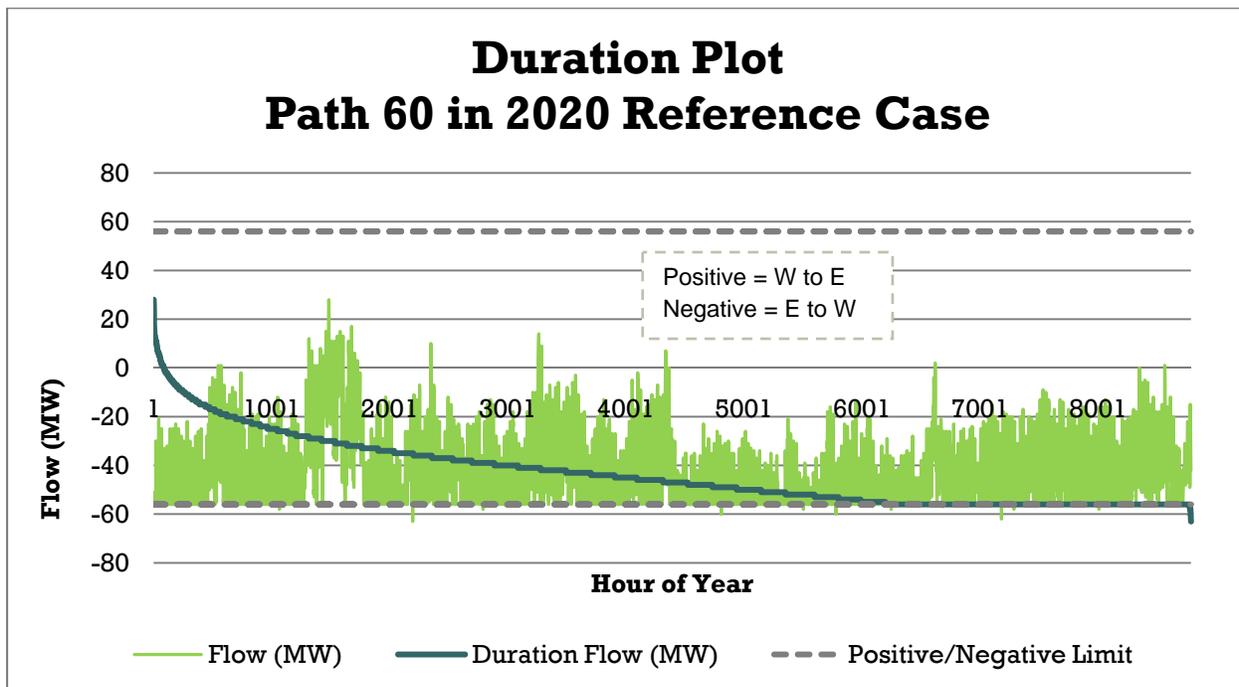
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 60 was heavily utilized and congested in the 2020 expected future study case. Flow equaled or surpassed U75 and U90 for 60.26 percent and 40.52 percent of the year, respectively. The duration plot in Figure 2 shows the high utilization of the path in the east to west direction. The chronological plot in the same figure shows the seasonality of the flows.

WECC Path Reports  
Inyo-Control 115 kV Tie - Path 60

Figure 2: Path 60 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 60 passed the utilization screening in all six of the 2020 study cases. It was not heavily utilized in any of the 2019 studies.

**Conditional Congestion**

Congestion along Path 60 is contingent on a variety of study cases. Path 60 conditional congestion scores are reported with their appropriate study case in Table 2.

Table 2: Path 60 Conditional Congestion

| Study Case                   | Conditional Congestion Score <sup>1</sup> |
|------------------------------|---|
| 2020 Reference Case          | 0.65                                      |
| 2020 High Load               | 0.70                                      |
| 2020 High DSM                | 0.68                                      |
| 2020 Carbon Reduction        | 0.56                                      |
| 2020 Aggressive Montana Wind | 0.55                                      |
| 2020 Aggressive Wyoming Wind | 0.91                                      |

Congestion along Path 60 appears to be most contingent on the set of assumptions used to form the 2020 Aggressive Wyoming Wind study case. In this study case 25,000 GWh of

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

WECC Path Reports  
Inyo-Control 115 kV Tie - Path 60

renewable energy were removed from California in and out of state RPS resources, and placed in Wyoming in the form of wind energy without added transmission. This influx of energy flooded the northeast, and as the energy made its way to southern California load centers Path 60 became congested in the east to west directions. In actual operation the path would be better served ensuring reliability and making use of the phase shifters, rather than transferring bulk resources like a typical AC line.



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*This brief provides observations regarding the Lugo-Victorville 500 kV WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 61.

- There are no projects in development that could directly impact Lugo-Victorville 500 kV path flow.
- Path 61 was not heavily utilized or congested in the 2020 expected future case. However, it was congested in the 2019 Base Case.

## Description

Path 61 is a 500 kV transmission line from Victorville substation in LDWPs service area to Lugo substation in SCEs service area. Historically, Victorville to Lugo flows are high during times with high IPPDC (Path 27), East of Colorado River (EOR) and West of Colorado River (WOR) flows. Lugo to Victorville flows are highest when flows on IPPDC, East of Colorado River, and West of Colorado River are low. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Lugo-Victorville 500 kV path.

**Table 1: Path 61 Characteristics**

| Path Characteristics |         |
|----------------------|---------|
| <b>Rating N to S</b> | 2400 MW |
| <b>Rating S to N</b> | 900 MW  |
| <b>Max Voltage</b>   | 500 kV  |

WECC Path Reports  
Lugo – Victorville 500 kV - Path 61

Figure 1: Path 61 Definition



**Historical Congestion**

Path 61 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

**Project Development**

Stakeholders did not identify any specific potential projects that may have a direct impact on Path 61 flow.

**Future Congestion Analysis**

The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

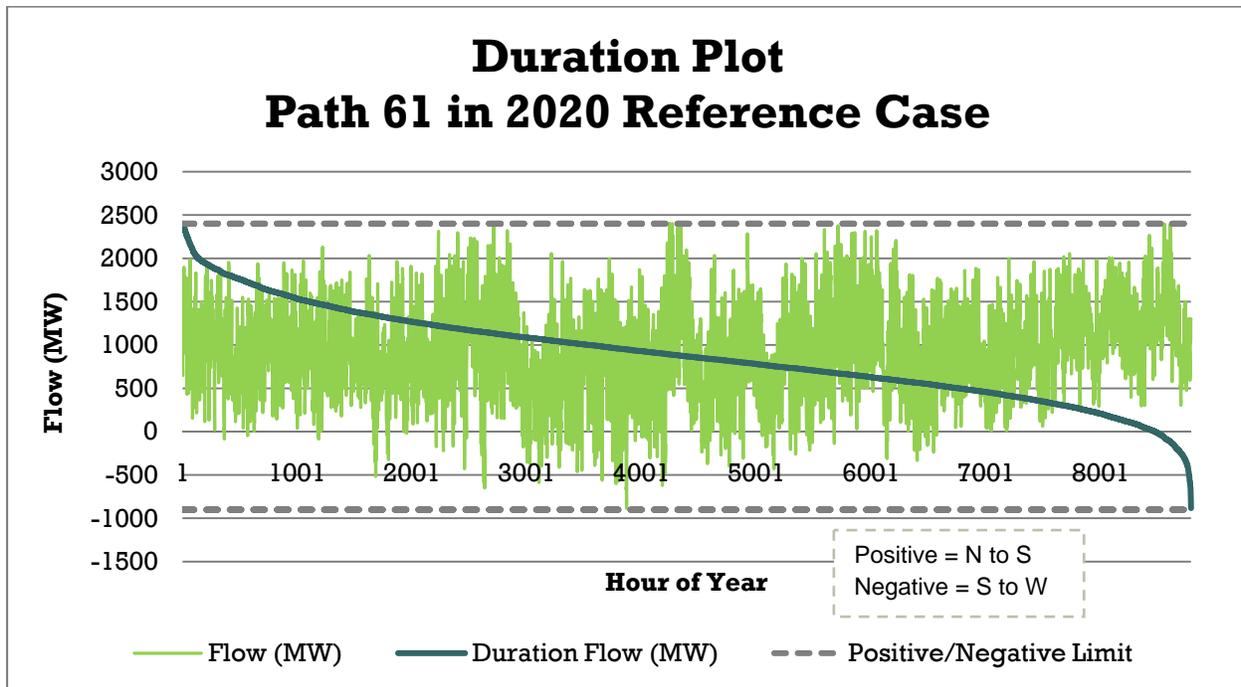
**Expected Future**

Path 61 was not heavily utilized or congested in the 2020 expected future study case. Flow equaled or surpassed U75 and U90 for only 4.76 percent and 0.77 percent of the year,

WECC Path Reports  
Lugo – Victorville 500 kV - Path 61

respectively. The duration plot in Figure 2 shows the low utilization of the path. The chronological plot in the same figure shows rather consistent path flows throughout the year.

Figure 2: Path 61 2020 Duration Plot



### Alternative Futures

Of the 15 study cases used to inform the 10-Year Plan, Path 61 passed the utilization screening in only one case, the 2019 Base Case. Path 61 was heavily utilized in this study case based on the U99 criteria, which the path operated at for 10.55 percent of the year. This high utilization is likely dependant on assumptions made regarding placement of California renewable resources. Had the resources been placed at different locations, like in the 2020 Reference Case, utilization on Path 61 could have been lower (or higher).

### Conditional Congestion

There was congestion along Path 61 contingent on the set of assumptions used to form the 2019 Base Case. As previously mentioned, the path was highly utilized in the same study case. It operated at or above U90 for nearly 12.60 percent of the year. Path 61 was one of the 8 paths that displayed congestion in the 2019 Base Case. This congestion is likely a function of where resource placement assumptions within California.



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*This brief provides observations regarding the Pacific DC Intertie (PDCI) WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 65.

- Path 65 is not historically congested according to the metrics used in previous path utilization studies. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their future path utilization reports.
- There are projects in development that could directly impact PDCI path flows.
- Path 65 was congested in the 2020 expected future case. A number of future resource and load assumptions also resulted in congestion along Path 65.

## Description

Path 65 is a +/- 500 kV DC multi-terminal system stretching from the Celilo station (Big Eddy area) in northern Oregon to the Sylmar station in southern California. The system is divided into northern and southern systems, with the demarcation point at the Nevada-Oregon state border. Transfer limits for the path are based on sending end measured power. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the PDCI path.

Table 1: Path 65 Characteristics

| Path Characteristics |           |
|----------------------|-----------|
| Rating N to S        | 3100 MW   |
| Rating S to N        | 3100 MW   |
| Max Voltage          | 500 kV DC |

WECC Path Reports  
PDCI Line - Path 65

Figure 1: Path 65 Definition

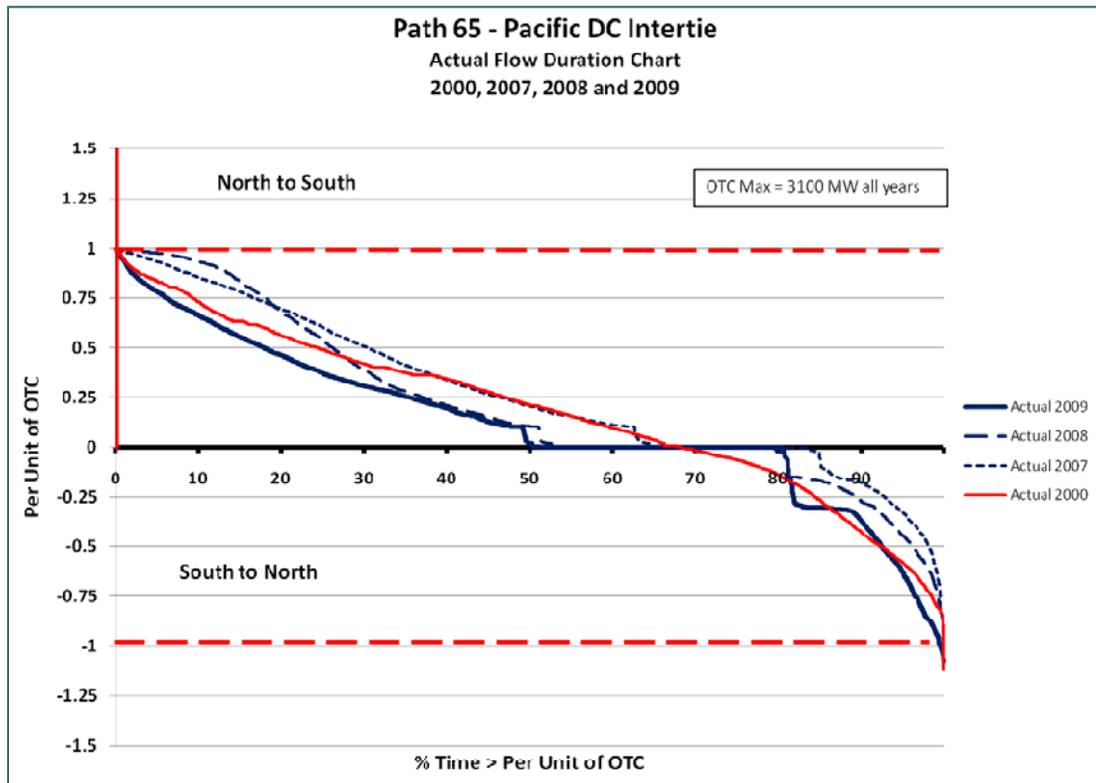


### Historical Congestion

Path 65 was analyzed in the 2007, 2008, and 2009 Transmission Path Utilization Studies, and was not historically congested according to the metrics used in the studies. The 2007 Study analyzed data from 1999-2005, where PDCI experienced a maximum summer U75 greater than 30 percent of the season. The 2008 Study reported Path 65 flow to have exceeded 90 percent of the path limit for seven percent of the year. PDCI was listed as one of the six most heavily utilized paths in the study. The 2009 Study did not list PDCI as one of the most heavily used paths in the study year. The 2009 Study reported that Path 65 had 537 MW of capacity available 95 percent of the year. Actual flow data for historic years can be found in the duration plot in Figure 2. Although informative, the plot does not necessarily reflect the metrics that support or refute the path as being historically congested.

WECC Path Reports  
 PDCI Line - Path 65

Figure 2: Path 65 Actual Flow Duration Plot



**Project Development**

The following two projects were determined by stakeholders to be the most likely to have an impact on Path 65.

- Canada/Pacific Northwest-Northern California (Studied in 2010 Study Program)
- Chinook (Studied in 2010 Study Program)
- TransWest Express (Studied in 2010 Study Program)
- Triton HVDC Sea Cable Project
- West Coast Cable

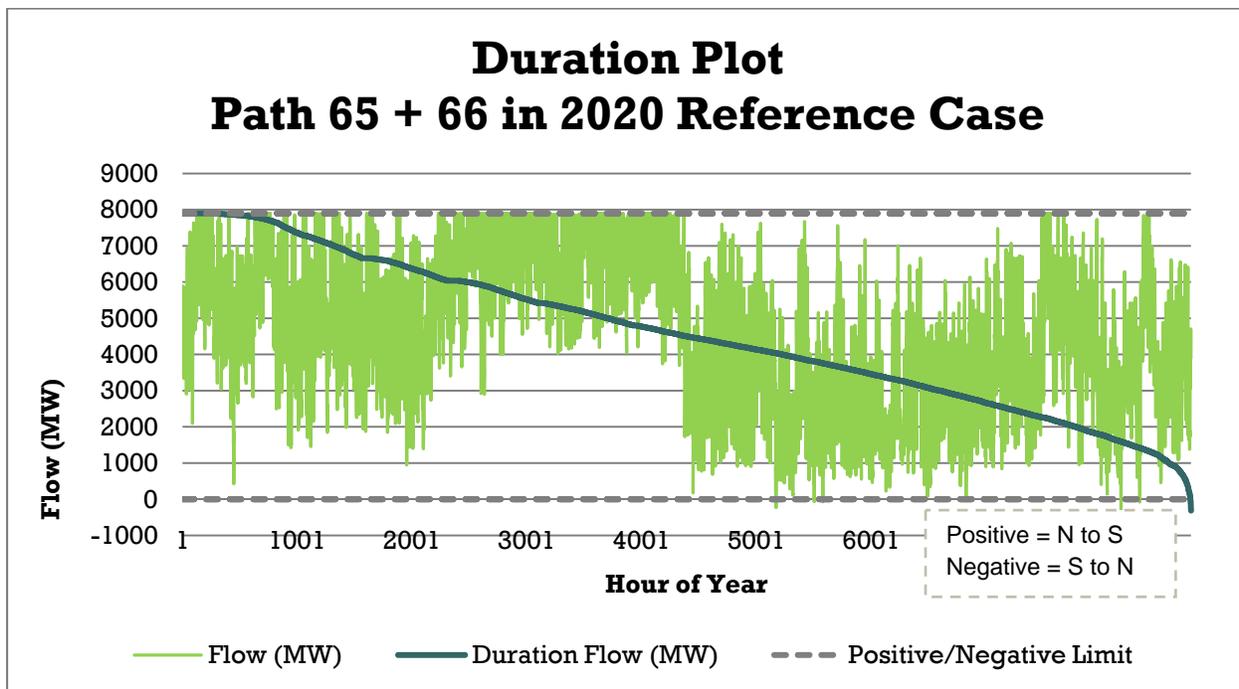
**Future Congestion Analysis**

The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program. However, due to DC line modeling issues associated with the production cost model, the model tends to use AC lines (Path 66 - COI) before utilizing DC lines (PDCI). Because of this, congestion metrics for the COI and PDCI were calculated by summing the flows of the two paths and using their combined limit. By combining the two paths we can more accurately evaluate the amount of congestion when electricity is transferred from the northwest to California. Although the forward looking congestion analysis doesn't focus explicitly on Path 65, the combined Path 65 and Path 66 analysis provides useful insight on how northwest – California transfers behave under a variety of assumptions.

**Expected Future**

Path 65/66 was highly utilized and congested in the expected future case. The combined path operated at U90 for over 14 percent of the year. The duration plot in Figure 3 shows this heavy utilization. The chronological plot in the same figure shows the seasonality of the flows. Especially high flows are experienced in the spring to early summer months, between hours 2000 and 4000. The COI/PDCI combined path had the highest conditional congestion score of all paths in the 2020 Reference Case.

Figure 3: Path 65/66 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 65/66 passed the utilization screening five times. The combined path was highly utilized and congested in all 2020 study cases excluding the 2020 High Load case. The path was not highly utilized in any of the 2019 study cases. In part, the low utilization observed in the 2020 High Load scenario is due to increased loads in the northwest. It is likely that northwest hydro resources were used to meet local load, as opposed to southern California load. As a result, Path 65/66 flows decreased in the study year.

**Conditional Congestion**

{See Path of Concern COI/PDCI Section - LINK}

**Project Development Impact**

{See Path of Concern COI/PDCI Section - LINK}



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*This brief provides observations regarding the California-Oregon Intertie (COI) WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development, historical congestion analysis, and forward looking congestion analysis were used to form the following observations concerning Path 66.

- Path 66 is historically congested based on actual flow metrics from the 2008 Path Utilization Study. The path should continue to be evaluated by the TEPPC Historical Analysis Work Group (HAWG) in their future path utilization reports.
- There are projects in development that could directly impact COI path flows.
- Path 66 was congested in the 2020 expected future case. A number of future resource and load assumptions also resulted in congestion along Path 66.

## Description

Path 66 is an AC intertie composed of three 500 kV lines between Oregon and northern California. Key path characteristics as defined by the 2010 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms the COI path.

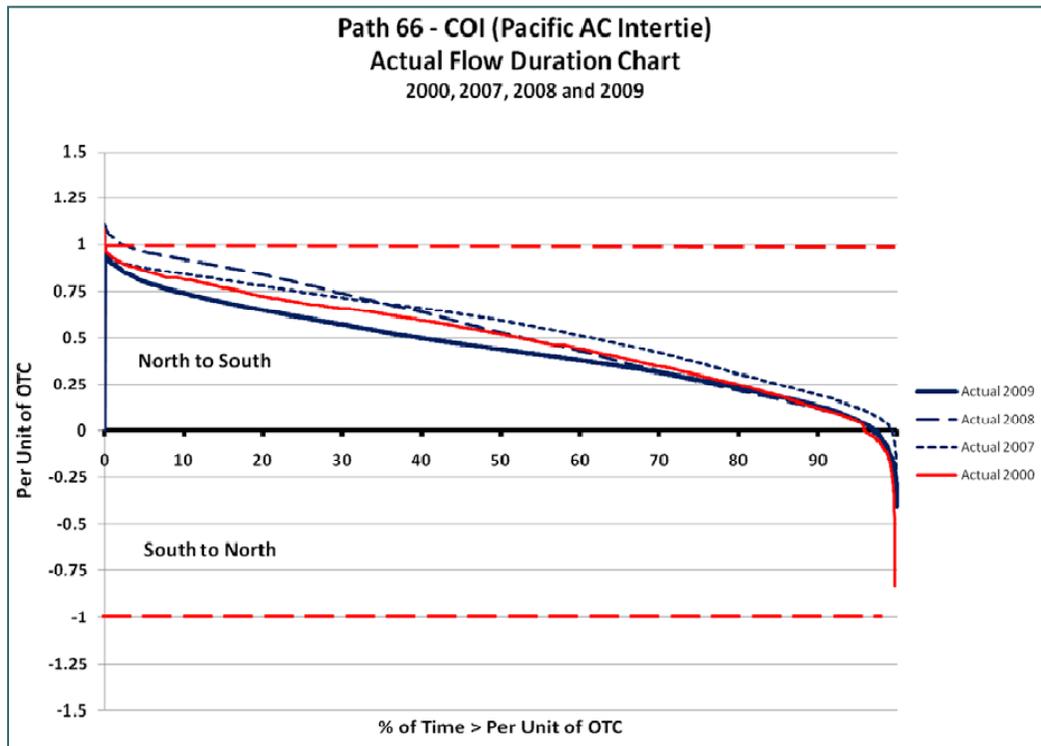
**Table 1: Path 66 Characteristics**

| Path Characteristics |           |
|----------------------|-----------|
| <b>Rating N to S</b> | 4800 MW   |
| <b>Rating S to N</b> | 3675 MW   |
| <b>Max Voltage</b>   | 500 kV AC |



WECC Path Reports  
 California-Oregon Intertie - Path 66

Figure 2: Path 66 Actual Flow Duration Plot



## Project Development

The following projects were determined by stakeholders to be the most likely to have an impact on Path 66.

- Canada/Pacific Northwest-Northern California (Studied in 2010 Study Program)
- Chinook (Studied in 2010 Study Program)
- TransWest Express (Studied in 2010 Study Program)
- Triton HVDC Sea Cable Project
- West Coast Cable

## Future Congestion Analysis

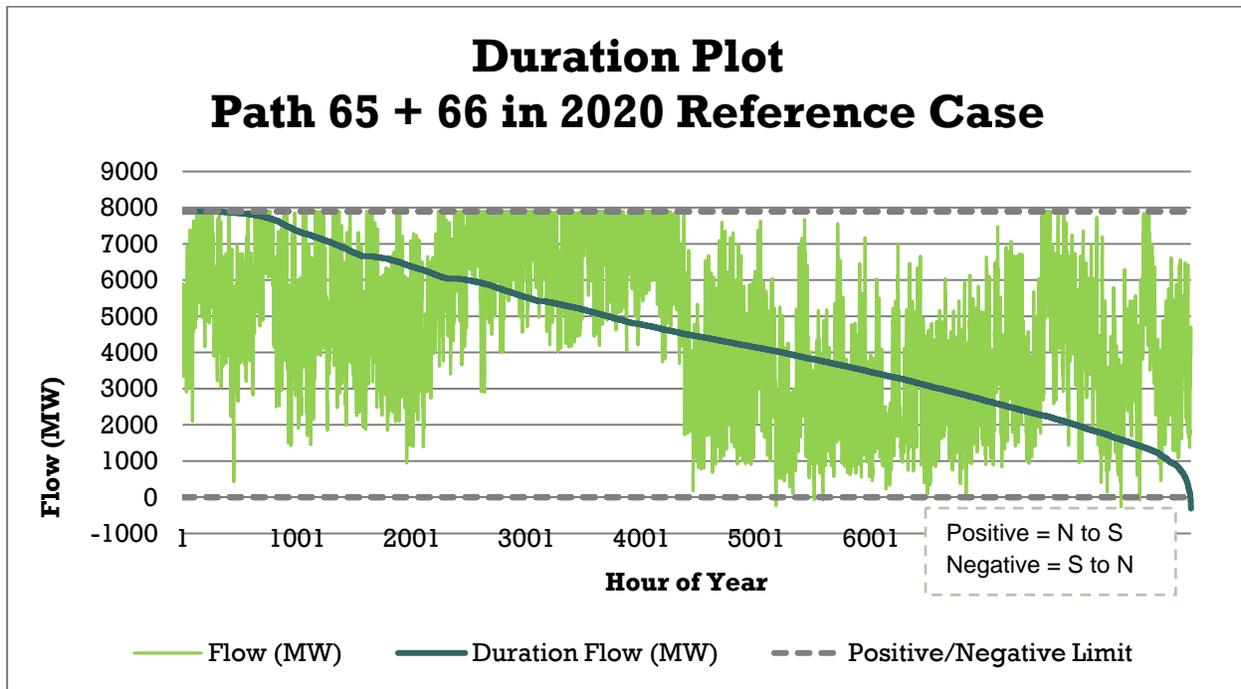
The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program. However, due to DC line modeling issues associated with the production cost model, the model tends to use AC lines (Path 66 - COI) before utilizing DC lines (PDCI). Because of this, congestion metrics for the COI and PDCI were calculated by summing the flows of the two paths and using their combined limit. By combining the two paths we can more accurately evaluate the amount of congestion when electricity is transferred from the northwest to California. Although the forward looking congestion analysis doesn't focus explicitly on Path 66, the combined Path 65 and Path 66 analysis provides useful insight on how Northwest – California transfers behave under a variety of assumptions.

WECC Path Reports  
 California-Oregon Intertie - Path 66

**Expected Future**

Path 65/66 was highly utilized and congested in the expected future case. The combined path operated at U90 for over 14 percent of the year. The duration plot in Figure 3 shows this heavy utilization. The chronological plot in the same figure shows the seasonality of the flows. Especially high flows are experienced in the spring to early summer months, between hours 2000 and 4000. The COI/PDCI combined path had the highest conditional congestion score of all paths in the 2020 Reference Case.

Figure 3: Path 65/66 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 65/66 passed the utilization screening five times. The combined path was highly utilized and congested in all 2020 study cases, except the 2020 High Load case. The path was not highly utilized in any of the 2019 study cases. In part, the low utilization observed in the 2020 High Load scenario is due to increased loads in the northwest. It is likely that northwest hydro resources were used to meet local load, as opposed to southern California load. As a result, Path 65/66 flows decreased in the study year.

**Conditional Congestion**

{See Path of Concern COI/PDCI Section - LINK}

**Project Development Impact**

{See Path of Concern COI/PDCI Section - LINK}



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*This brief provides observations regarding the Midpoint-Summer Lake WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 75.

- There are projects in development that could directly impact Midpoint-Summer Lake path flows.
- Path 75 was not congested in the 2020 expected future case.
- The Hemingway-Boardman line was assumed constructed in the 2020 dataset and not the 2019 dataset. As a consequence, the path was highly congested in 2019 and not in 2020.

## Description

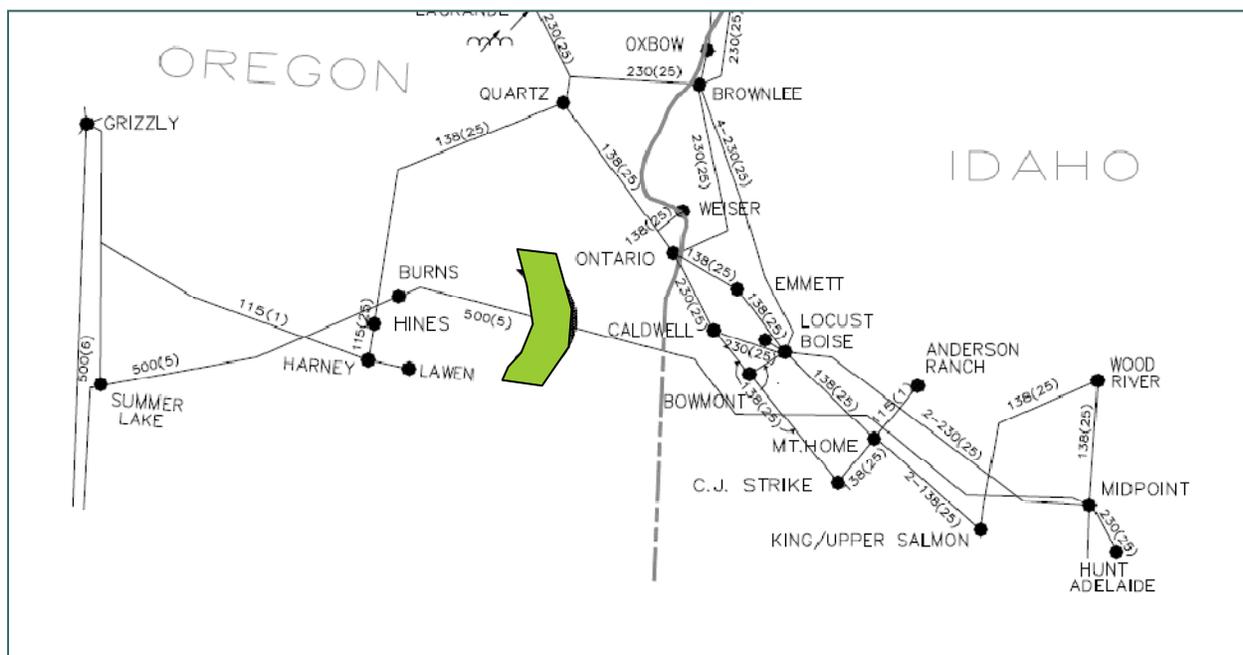
Path 75 has recently been renamed Hemingway-Summer Lake, instead of Midpoint-Summer Lake. It is located in southwest Idaho and eastern Oregon and consists of one 500 kV line. Key path characteristics as defined by the 2011 WECC Path Rating Catalog can be found in Table 1. Figure 1, on the next page, shows the physical cut plane that forms Path 75.

**Table 1: Path 75 Characteristics**

| Path Characteristics |         |
|----------------------|---------|
| <b>Rating E to W</b> | 1500 MW |
| <b>Rating W to E</b> | 400 MW  |
| <b>Max Voltage</b>   | 500 kV  |

## WECC Path Reports Midpoint-Summer Lake - Path 75

Figure 1: Path 75 Definition



### Historical Congestion

Path 75 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

### Project Development

The Hemingway-Captain Jack and TransWest Express projects, studied in the 2010 Study Program, were determined by stakeholders to be the most likely to have an impact on Path 75. Congestion impacts on Path 75 from these study cases are presented in the “Future Congestion Analysis” under “Project Development Impact” {LINK}.

### Future Congestion Analysis

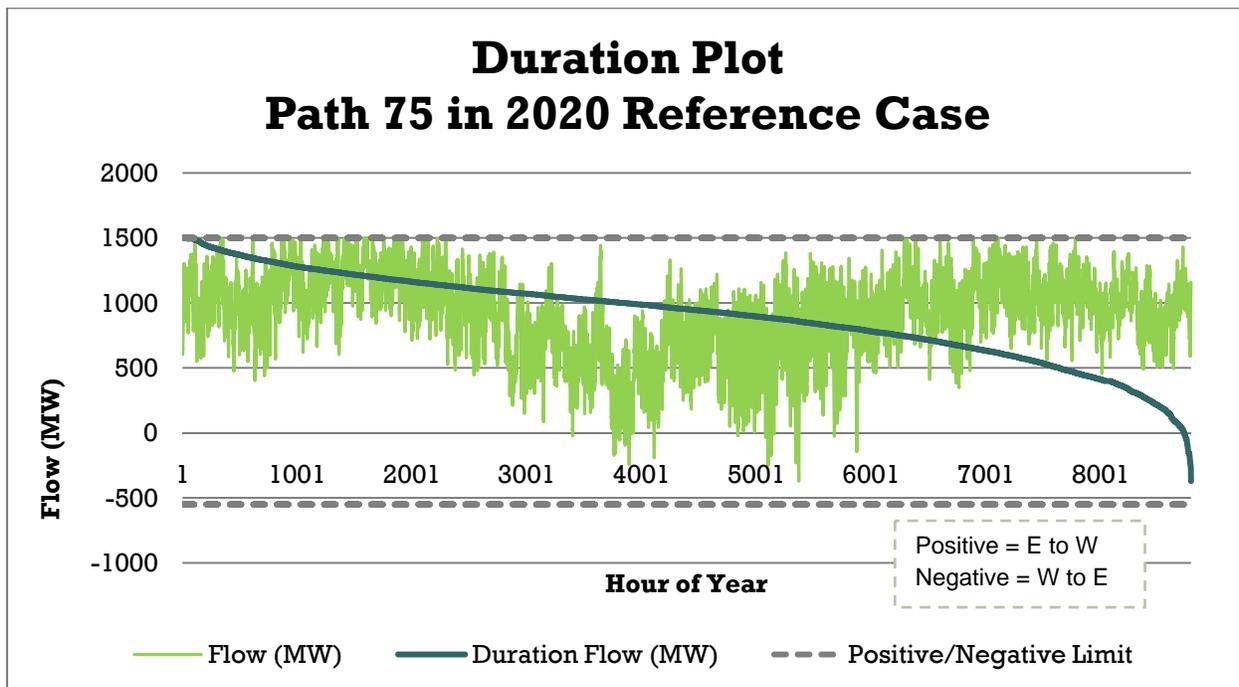
The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

### Expected Future

Path 75 was not congested or heavily utilized in the expected future case, or any other study cases run on the 2020 dataset. Midpoint-Summer Lake operated at U90 for 6.64 percent of the year, and at U75 for only 27 percent of the year. The duration plot in Figure 2 shows this rather typical level of utilization. The chronological plot in the same figure shows the seasonality of the flows. Notice the highest level of flows occurring near the beginning and end of the year.

WECC Path Reports  
Midpoint-Summer Lake - Path 75

Figure 2: Path 75 2020 Duration Plot



**Alternative Futures**

Of the 15 study cases used to inform the 10-Year Plan, Path 75 passed the utilization screening eight times. However, all cases where Path 75 was highly utilized were 2019 studies. It did not pass the utilization screening in any 2020 studies. This is likely due to the inclusion of the Hemingway-Boardman line in the 2020 dataset, and not the 2019 dataset.

**Conditional Congestion**

Conditional congestion along Path 75 is contingent on strictly the set of assumptions used to form 2019 studies, where Hemingway-Boardman was not assumed built. The congested study cases and their conditional congestion scores are listed in Table 2.

Table 2: Path 75 Conditional Congestion

| Study Case                                 | Conditional Congestion Score <sup>1</sup> |
|--|---|
| 2019 Base Case                             | 0.40                                      |
| 2019 Arizona/S. Nevada Resource Relocation | 0.47                                      |
| 2019 Wyoming Resource Relocation           | 0.94                                      |
| 2019 British Columbia Resource Relocation  | 0.40                                      |
| 2019 Alberta Resource Relocation           | 0.44                                      |
| 2019 Montana Resource Relocation           | 0.33                                      |

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

WECC Path Reports  
 Midpoint-Summer Lake - Path 75

| Study Case  | Conditional Congestion Score <sup>1</sup> |
|---|---|
| <b>2019 New Mexico Resource Relocation</b>        | 0.49                                      |
| <b>2019 Northwest Coastal Resource Relocation</b> | 0.32                                      |

Congestion along Path 75 appears to be most contingent on the set of assumptions used to form the 2019 Wyoming Resource Relocation study case. In this study Path 75 operated at or above U90 and U99 for almost 44 percent and 30 percent of the year, respectively. Although extreme congestion is contingent on this specific study, nearly all 2019 study cases induce congestion regardless of what assumptions formed the study cases. More importantly, the congestion apparent in the 2019 studies did cease after the Hemingway-Boardman project was implemented in the 2020 studies.

**Project Development Impact**

The projects that were anticipated to have an impact on Path 75 flow are listed in Table 3 with their corresponding Path 75 U90 values.

**Table 3: Project Development Impact on Path 75**

| Study Cases  | U90    |
|--|--------|
| <b>2019 Base Case</b>                                    | 21.73% |
| <b>2019 Wyoming Resource Relocation</b>                  | 24.74% |
| <b>2019 Wyoming + TransWest Express</b>                  | 32.23% |
| <b>2019 Wyoming + Cascade Crossing + Gateway West #2</b> | 40.17% |

Both transmission expansion cases increased Path 75 U90 over its level in the 2019 Wyoming Resource Relocation case (with no added transmission). The Gateway West #2 project terminates at the Hemingway station, likely allowing for resource to flow from Wyoming and onto Path 75, which accounts for the increase in utilization on Midpoint-Summer Lake. The increase in Path 75 utilization observed in the TransWest Express expansion was caused by coal generation in Wyoming increasing due to the capacity provided by the added DC line. Due to minimum run times, much of this coal ended up on the AC system, and caused Path 75 to be congested.



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*This brief provides observations regarding the TOT 2B1 WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 78.

- There are a number of projects under development that could directly impact TOT 2B1 path flows.
- Path 78 was not congested in the 2020 expected future, or any other 2020 study cases.

## Description

Path 78 is located in southeastern Utah and northwestern New Mexico. The path includes one 345 kV line that runs from the Pinto to Four Corners substations. This line, combined with the Sigurd-Glen Canyon 230 kV line (TOT 2B2), make up the TOT 2B Path. Key path characteristics as defined by the 2010 WECC Path Rating Catalog can be found in

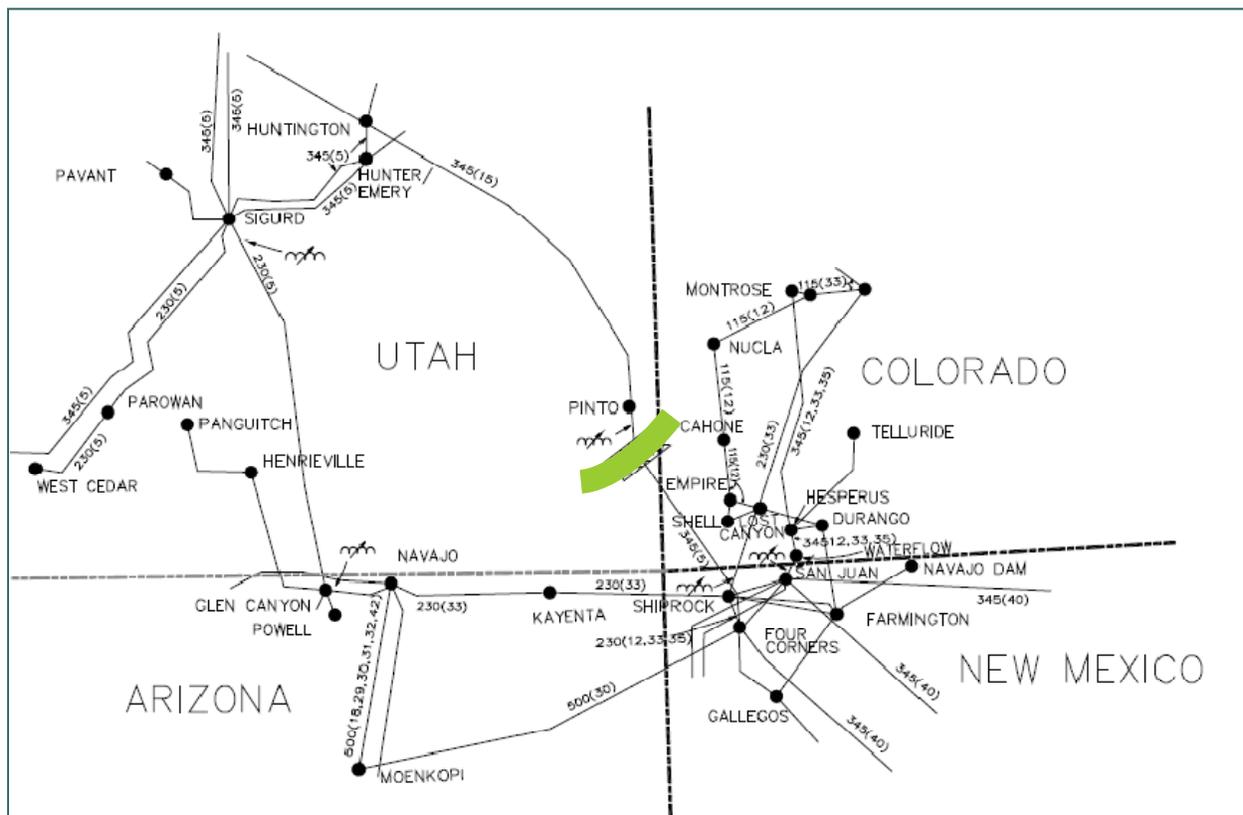
Table 1. Figure 1, on the next page, shows the physical cut plane that forms Path 78.

Table 1: Path 78 Characteristics

| Path Characteristics |        |
|----------------------|--------|
| Rating N to S        | 530 MW |
| Rating S to N        | 600    |
| Max Voltage          | 345 kV |

WECC Path Reports  
 TOT 2B1 - Path 78

Figure 1: Path 78 Definition



**Historical Congestion**

Path 78 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report.

**Project Development**

Stakeholders identified Gateway South #2 and the TransWest Express as two projects that may have a direct impact on Path 78 flows.

**Future Congestion Analysis**

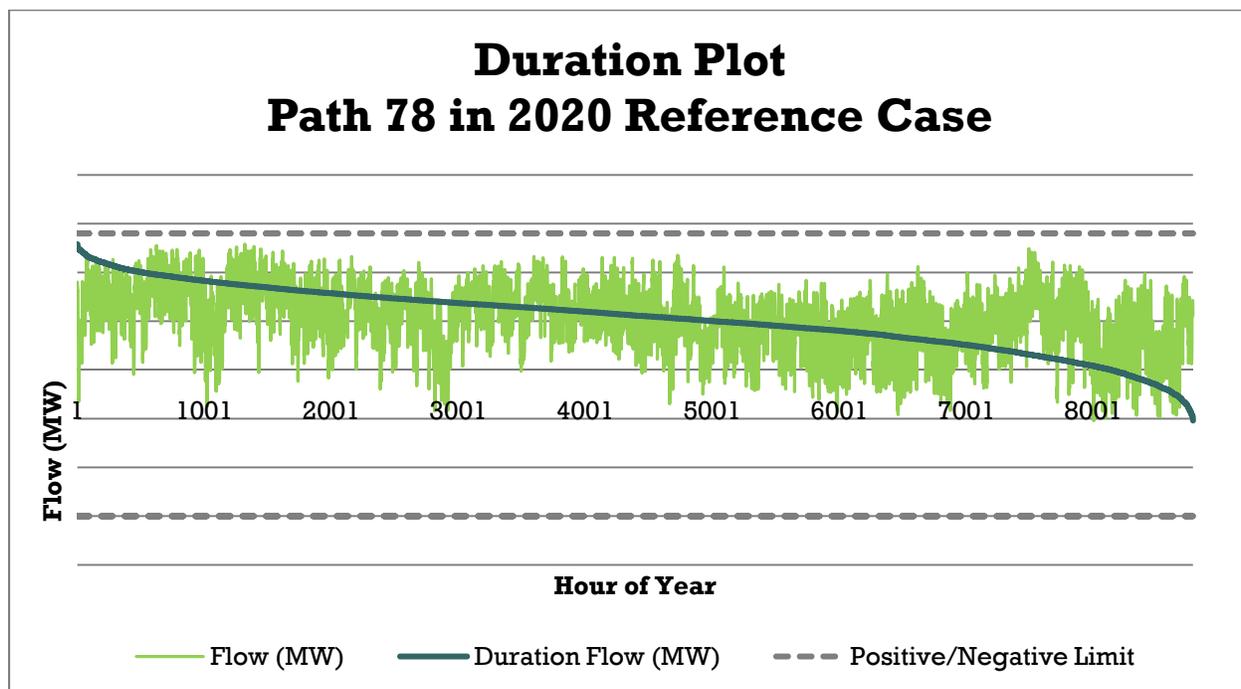
The forward looking congestion analysis draws upon study case results from production cost model runs using TEPPCs 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

**Expected Future**

Path 78 did not meet the definition of being highly utilized or congested in the expected future study case. It was utilized at the U75 level for only 3.73 percent of the year and path flows reached 90 percent of the path limit for only 0.05 percent of the year. As shown in Figure 2, flow was in the north to south direction for the majority of the year. The chronological plot in the same figure shows the seasonality of the flow.

WECC Path Reports  
 TOT 2B1 - Path 78

Figure 2: Path 78 2020 Duration Plot



**Alternative Futures**

Of 15 the study cases used to inform the 10-Year Plan, Path 78 passed the utilization screening only three times. The path was highly utilized in the 2019 Wyoming Resource Relocation, 2019 N. Nevada Resource Relocation, and the 2019 New Mexico Resource Relocation. The path was not highly utilized in any of the 2020 study cases.

**Conditional Congestion**

Congestion along Path 78 is contingent on the same study cases for which the path was highly utilized. Path 78 conditional congestion scores are reported with their appropriate study case in Table 2.

Table 2: Path 78 Conditional Congestion

| Study Case                          | Conditional Congestion Score <sup>1</sup> |
|-------------------------------------|---|
| 2019 Wyoming Resource Relocation    | 0.22                                      |
| 2019 N. Nevada Resource Relocation  | 0.22                                      |
| 2019 New Mexico Resource Relocation | 0.16                                      |

The 2019 Northern Nevada and 2019 Wyoming resource relocation cases caused the most congestion along TOT 2B1. In the Northern Nevada and Wyoming cases, without added

<sup>1</sup> Score is comprised of Risk, Value, and Utilization congestion components. The maximum conditional congestion score across all scenarios and all paths was 2.11 (Path 8 in 2020 Aggressive WY Wind Scenario). The minimum was 0 (multiple occurrences).

WECC Path Reports  
 TOT 2B1 - Path 78

transmission, TOT 2B1 operated at or above U90 for 13.87 percent and 12.85 percent of the year, respectively. It is important to note that TOT 2B1 was not highly utilized or congested in any of the 2020 study cases. This includes the 2020 Aggressive Wyoming Wind study where 25,000 GWh of wind resources were relocated to Wyoming, which is a large resource increase compared to the 2019 Wyoming Resource Relocation, where only 12,000 GWh were relocated. It is likely that TOT 2B1 was not highly utilized or congested in the 2020 studies because those studies feature a different set of base case assumptions than those used to form the 2019 studies.

**Project Development Impact**

Gateway South #2 and the TransWest Express were identified as two projects that may have a direct impact on Path 78 flows. As shown in the Table 3, below, both projects decreased the utilization of Path 78 from the level observed in the 2019 Wyoming Resource Relocation.

**Table 3: Project Development on Path 78**

| <b>Study Cases</b>                      | <b>U90<br/>(% of year)</b> |
|---|----------------------------|
| <b>2019 Base Case</b>                   | 7.02%                      |
| <b>2019 Wyoming Resource Relocation</b> | 12.85%                     |
| <b>2019 Wyoming + TransWest Express</b> | 8.85%                      |
| <b>2019 Wyoming + Gateway South #2</b>  | 3.86%                      |

The decrease in Path 78 utilization from the resource relocation to the expansion cases was caused by the projects ability to deliver the incremental resources to load centers efficiently. This relieved the existing system, and Path 78 was utilized less often as a consequence.



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*This brief provides observations regarding the Montana Southeast WECC path. These observations draw from current project development information, historical data, and forward looking congestion analysis. Readers should review the “Discussion of WECC Paths – Introduction” with this document.*

## Observations

Transmission project development and forward looking congestion analysis were used to form the following observations concerning Path 80.

- Stakeholders did not identify any projects in development that could directly impact Montana Southeast path flows.
- Path 80 was not congested in the 2020 expected future study case. Congestion along the path was strictly contingent on a large build out of Montana renewables (without added transmission).
- Path 80 forms a portion of the Montana Region of Concern {Link}.

## Description

Path 80 is located in southeast Montana and is the second largest Montana export path. Key path characteristics defined by the 2011 WECC Path Rating Catalog can be found in

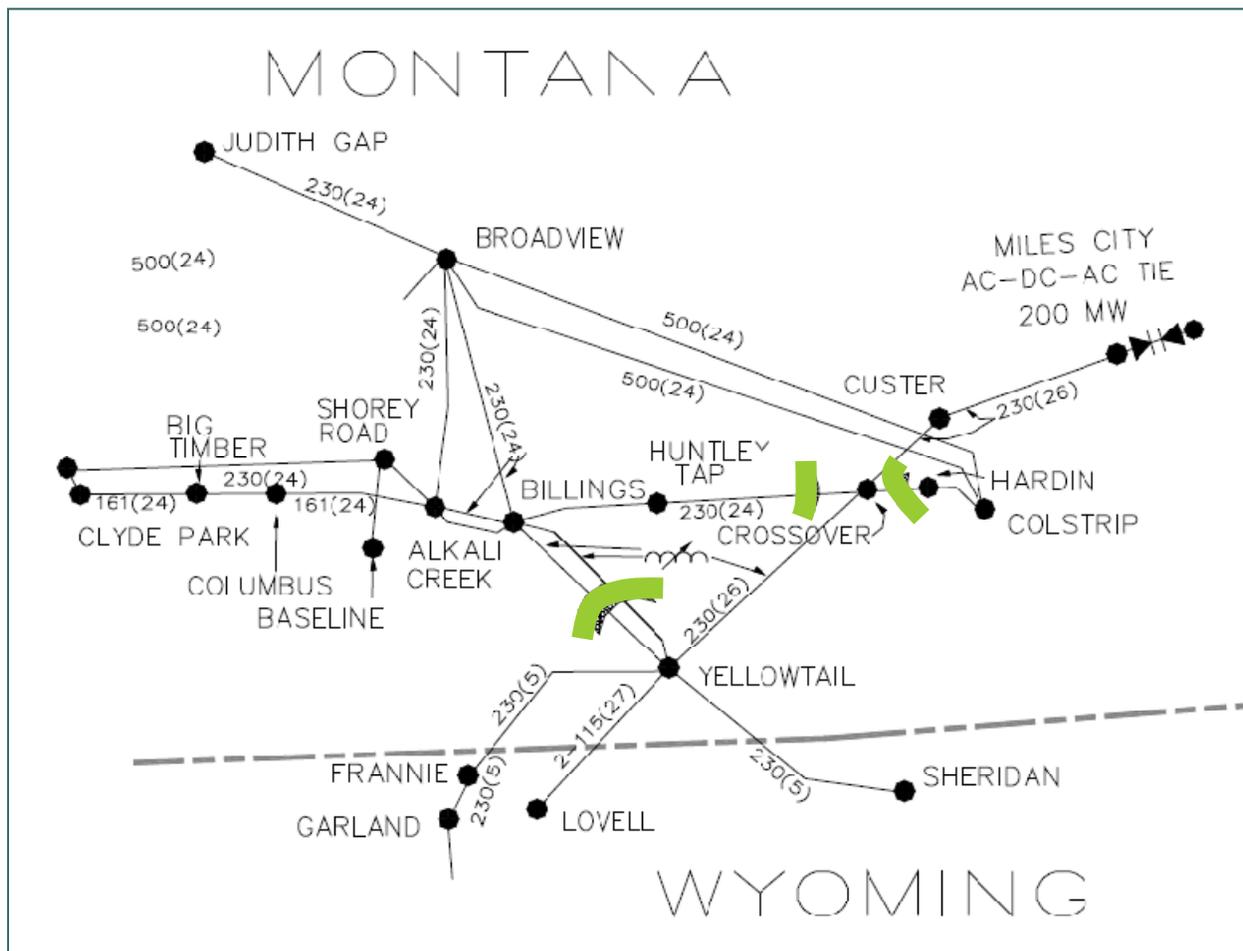
Table 1. Figure 1, on the next page, shows the physical cut plane that forms the Southeast Montana path.

**Table 1: Path 80 Characteristics**

| Path Characteristics |        |
|----------------------|--------|
| <b>Rating N to S</b> | 600 MW |
| <b>Rating S to N</b> | 600 MW |
| <b>Max Voltage</b>   | 230 kV |

WECC Path Reports  
Montana Southeast - Path 80

Figure 1: Path 80 Definition



### Historical Congestion

Path 80 was not analyzed in any of the past Transmission Path Utilization Studies. The path was not selected by the TEPPC Historical Analysis Working Group (HAWG) to be included in the studies, and consequently no historical data is available for this report. Stakeholder experience suggests that historically Path 80 can become congested when large market forces drive power prices high on the west coast.

### Project Development

Stakeholders did not identify any specific potential projects that may have a direct impact on Path 80 flows.

### Future Congestion Analysis

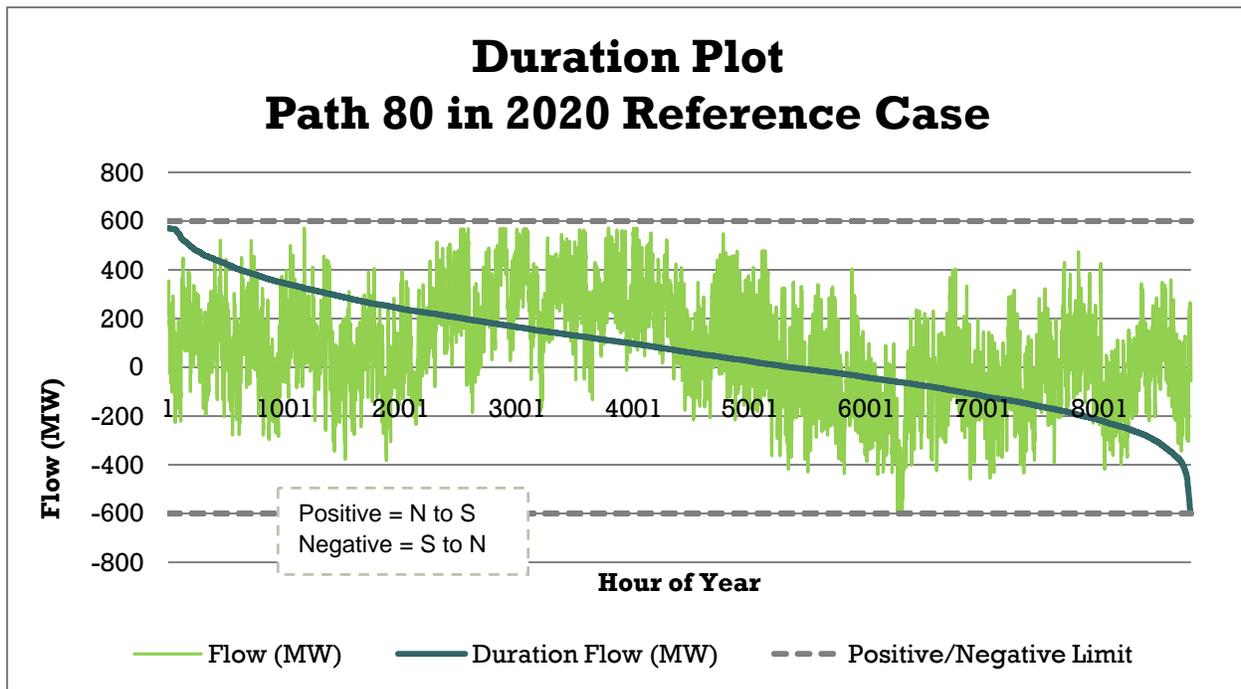
The forward looking congestion analysis draws upon study case results from production cost model runs based on 2019 and 2020 datasets. This work was done as a part of the 2010 Study Program.

WECC Path Reports  
 Montana Southeast - Path 80

**Expected Future**

Path 80 was not heavily utilized or congested in the expected future case. Montana Southeast operated at U75 for only 4.53 percent of the year, and at U90 for only 1.35 percent of the year. The duration plot in Figure 2 shows this relatively low utilization. The chronological plot in the same figure shows the seasonality of the flows.

Figure 2: Path 80 2020 Duration Plot



**Alternative Futures**

Of 15 study cases used to inform the 10-Year Plan, Path 80 passed the utilization screening one time, indicating that high utilization of the path is dependent on specific assumptions. Path 80 was highly utilized in the study case featuring an increase of 25,000 GWh of wind resource in Montana. With no added transmission in the study, Path 80 became heavily utilized as the renewable resources tried to reach load. It appears that a large build out of renewable resources in Wyoming, without added transmission, could induce congestion along Path 80.

**Conditional Congestion**

Path 80 congestion is contingent on the same study case for which the path was heavily utilized, the Aggressive Montana Wind case. According to the conditional congestion score, Path 80 was the 2<sup>nd</sup> most congested path in this case. As previously described, the large increase in Montana resources without added transmission overloaded the Montana transmission system. This caused the excessive congestion on Path 80.