

FINAL

Alternative Evaluation

for the

**Proposed Burlington-Wray 230-kilovolt
Transmission Project**

Prepared by

**Tri-State Generation and Transmission
Association, Inc.**

**1100 W. 116th Avenue
Westminster, Colorado 80234**

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EXHIBITS

Exhibit A	Transmission Study for the Northeast Colorado Area
Exhibit B	Energy Efficiency, Demand Side Management and Distributed Generation Study for the Northeast Colorado Area

ACRONYMS AND ABBREVIATIONS

ACCC	Aluminum Conductor with Composite Core
ACSR	Aluminum Conductor, Steel Reinforced
AE	Alternative Evaluation
ATC	Available Transfer Capability
°C	degrees Celsius
DSM	Demand Side Management
EE	Energy Efficiency
ETC	Existing Transmission Commitments
GDA	Generation Development Areas
K.C.	K.C. Electric Association, Inc.
kcmil	Thousand circular mils
kV	kilovolt
MCS	Macro Corridor Study
MVA	megavolt Amperes
MW	megawatt
NEPA	National Environmental Policy Act
OATT	Open Access Transmission tariff
PSCO	Public Service Company of Colorado
Project	Burlington-Wray 230-kilovolt Transmission Project
RPS	Renewable Portfolio Standard
RUS	Rural Utilities Service
SB 07-091	Colorado Senate Bill 07-091 Renewable Resource Generation Development Areas Task Force Report
TRM	Transmission Reliability Margin
TTC	Total Transmission Capacity
Transmission Study	Transmission Study for the Northeast Colorado Area
Tri-State	Tri-State Generation and Transmission Association, Inc.
Western	Western Area Power Administration
Y-W	Y-W Electric Association, Inc.

1.0 INTRODUCTION

Tri-State Generation and Transmission Association, Inc. (Tri-State) proposes to construct the Burlington-Wray 230-kilovolt (kV) Transmission Project (Project) in eastern Colorado. The Project would include the following components:

1. A new single circuit 230-kV transmission line from the existing Burlington Substation in Kit Carson County, Colorado, to the existing Wray Substation in Yuma County, Colorado.
2. One new 230-kV circuit breaker and associated equipment and buswork at the Burlington Substation to accommodate the new transmission line.
3. Three new 230-kV circuit breakers and associated equipment at the Wray Substation, in a ring bus configuration to accommodate the new transmission line.

The proposed in-service date of the Project is December 2015.

Tri-State is a Colorado cooperative corporation that is owned by 44 rural electric cooperatives. Tri-State provides wholesale electric power to its members, which own and operate distribution systems and provide retail power to farms, homes and businesses in their respective service areas. Tri-State generates and transports power to its members throughout a 250,000-square-mile service territory in Colorado, Wyoming, Nebraska and New Mexico. Tri-State owns, operates, and maintains a transmission system consisting of more than 5,200 miles of transmission lines and 135 substations and switchyards.

Founded in 1952, Tri-State today serves more than 1.4 million consumers in four states. Tri-State's mission is to provide its members a reliable, cost-based supply of electricity while maintaining a sound financial position through effective use of human, capital, and physical resources in accordance with cooperative principles.

1.1 PURPOSE OF THE ALTERNATIVE EVALUATION

The United States Department of Agriculture's Rural Utilities Service (RUS) provides capital loans to electric cooperatives for the upgrade, expansion, maintenance, and replacement of the electric infrastructure in rural areas. Tri-State is pursuing financial support from RUS for the Project.

RUS evaluates environmental impacts of its actions pursuant to the National Environmental Policy Act (NEPA) and the Council on Environmental Quality's implementing regulations (40 Code of Federal Regulations 1500-1508). RUS guidance regarding NEPA implementation (RUS Bulletin 1794A-603) requires that an Alternative Evaluation (AE) and a Macro Corridor Study (MCS) be prepared and accepted by RUS prior to the start of the official NEPA process. This AE considers the system alternatives that would best meet the purpose of and need for the Project. Potential corridor alternatives are discussed in the associated MCS.

1.2 PURPOSE OF AND NEED FOR THE PROJECT

In northeastern Colorado, Tri-State's central transmission path consists of a 230-kV line from Story to North Yuma to Wray, a 115-kV line from Wray to Burlington, and a 230-kV line extending from

Burlington to Big Sandy to Midway (located between Colorado Springs and Pueblo). This is a non-optimal situation because the 230-kV substations at Wray and Burlington are linked only by transformers that step down the voltage from 230-kV to 115-kV and a single-circuit 115-kV line. The Project will increase reliability and capacity of the Tri-State system by providing a 230-kV path between the substations to more fully utilize the 230-kV system that exists on either side of the Project, and address load growth and generation dispatch concerns for Tri-State in this area. The proposed Project will strengthen the power delivery infrastructure and support proposed renewable energy development projects in the region. Fig. 1-1 depicts the Project location and Tri-State's existing transmission system in northeastern Colorado.

FIGURE 1-1: PROJECT AREA MAP



Two of Tri-State's members are located in the vicinity of the Project: K.C. Electric Association, Inc. (K.C.) and Y-W Electric Association, Inc. (Y-W). K.C. serves Kit Carson and Cheyenne Counties and a portion of Lincoln County. Y-W serves members in Yuma and Washington Counties. While the Project geographically affects only these two members, it has far-reaching benefits for other member systems as well, resulting from increased load-serving capabilities across the Tri-State system.

In November, 2010, Tri-State issued a report titled *Transmission Study for the Northeast Colorado Area* (Transmission Study), included as Exhibit A. This Transmission Study identified solutions to mitigate known transmission deficiencies in the region and improve the future reliability, capacity and load serving capability of the system. The Transmission Study identified three existing system deficiencies and recommended the construction of a new Burlington-Wray 230-kV transmission line in order to:

1. Remove operating restrictions relating to the existing Limon and Burlington generation units.
2. Remove operating restrictions relating to the combined Burlington Network Resource generation, including the existing Limon and Burlington generation units in addition to the new 51 megawatt (MW) Kit Carson Windpower Project.
3. Improve present and future deliverability of Tri-State resources to Tri-State native load.

As the first two system deficiencies result from transmission constraints related to existing generation, the Project also considers ways to provide additional generation injection capability beyond this existing amount in the area. These deficiencies and other considerations are discussed in more detail in the Transmission Study (Exhibit A) as well as in the discussion below.

1.2.1 Removal of Operating Restrictions on Network Resources

Tri-State's Open Access Transmission Tariff (OATT) defines a Network Resource as "any designated generating resource owned, purchased, or leased by a Network Customer." In more general terms, these are the electric generation resources that are relied upon to serve end-use customers. In the case of Tri-State, Network Resources serve members such as K.C. and Y-W, who then serve the end-use customers.

Pursuant to Tri-State's OATT, all new Network Resources must meet specified reliability design requirements. Consistent with Tri-State's reliability criteria and procedures, this includes the need for such resources to be able to stay on-line following the most severe single contingency, or N-1 outage, when all generation in the study area is operated at full output.

Tri-State has five Network Resources in the region affected by the Project, including two thermal units with a combined 100-120 MW of generation at the Burlington Generation Station located at the Burlington Substation; two thermal units with a combined 120-140 MW of generation at the Limon Generation Station located at Lincoln Substation near Limon, Colorado; and the Kit Carson 51 MW wind energy generating facility located at the new Landsman Creek Substation west of Burlington. Presently, if a single outage event occurs along the 230-kV Burlington to Big Sandy to Midway transmission path, the existing Burlington-Wray 115-kV line can experience overloads. In addition, an outage event between Lincoln and Midway can cause overloads on the existing Big Sandy to Beaver Creek 115-kV line that is owned by Western Area Power Administration (Western). To prevent excessive flow on the 115-kV system generally, operating procedures limit the total amount of Network Resource generation in the area.

There are operating restrictions on the existing Limon and Burlington generation units that can prevent simultaneous operation of these resources at full output. In addition, a Restricted Operating Procedure imposes dispatch limits for the Burlington area generation, consisting of the Burlington Generation Station and Kit Carson Windpower Project. By adding a 230-kV transmission path that is electrically parallel to the existing Burlington-Wray 115-kV line, the Project will substantially reduce contingency loading on the 115-kV system and eliminate the need for these restrictions.

1.2.2 Capability to Serve Load in Eastern and Southern Colorado

As stated in the Transmission Study, Tri-State needs additional transmission capacity on its southbound path from Story, through North Yuma, Wray, Burlington and Big Sandy, to Midway, to deliver power from some of its most economic Network Resources located in Wyoming and northwestern Colorado.

Tri-State's native load obligation in eastern and southern Colorado includes service to K.C., Mountain View Electric Association, San Isabel Electric Association, San Luis Valley Rural Electric Cooperative, Southeast Colorado Power Association, and Gunnison County Electric Association. In addition to fully utilizing the transmission path that is limited by the 115-kV line segment between Burlington and Wray, Tri-State purchases firm transmission from Western and Public Service Company of Colorado (PSCO) for delivery to these loads.

Tri-State's OATT sets forth the criteria to determine how much transmission capacity is usable for delivery across each of Tri-State's several transmission paths. The transmission capacity owned or purchased by Tri-State comprises the Total Transfer Capability (TTC) that Tri-State has available to serve its native load, meet its other existing transmission commitments, and sell transmission when transmission service is requested by others.

The TTC of the existing Burlington-Wray 115-kV line is based upon Tri-State's *Engineering Standards Bulletin – Reliability Criteria for System Planning and Service Standards*, and is defined as 100 percent of the thermal rating of the line sections in the transmission path. Based on the line size and temperature limits, the maximum rating is 140 MW assuming some relatively minor and lower-cost system improvements are completed. Tri-State also has 193 MW of transmission purchased on other lines owned by Western and PSCO, for a region-wide TTC of 333 MW.

The TTC must be sufficient to cover the Existing Transmission Commitments (ETC) and the Transmission Reliability Margin (TRM). The ETC is defined as the total of Tri-State native load-serving needs and transmission service obligations and commitments for purchase, exchange and delivery. TRM is defined as the amount of transmission transfer capability necessary to provide reasonable assurance that the interconnected transmission network will be secure. TRM accounts for the inherent uncertainty in system conditions and the need for operating flexibility to ensure reliable system operation as system conditions change. For the purpose of the Transmission Study, TRM was estimated at 0 MW on the Burlington-Wray 115-kV line.

To determine the ETC, Tri-State's Power System Planning Department provided a 10-year native load forecast for the several member systems affected by the Project. Tri-State's System Operations Department identified the firm committed uses for the Wray to Burlington transmission path. The ETC consists of 446 MW to cover Tri-State's regional summer peak load, plus 46 MW to cover commitments to serve PSCO delivery to Fountain, PSCO delivery to Las Animas, and Tri-State delivery to the Arkansas River Power Authority, for a total of 492 MW.

This calculation indicates a pre-Project shortfall of 159 MW of TTC, i.e., not enough capacity to serve native load within the 10-year planning horizon. As a consequence, without the Project, Tri-State and its members will be limited to less economical Network Resources or purchases from others that can be dispatched from locations that do not rely on the limited transmission path, if available.

Any other proposed generation in the area will require Available Transfer Capability (ATC), which is calculated as TTC minus ETC, minus TRM. Without the Project, there is presently no ATC for power delivery from proposed generation resources in the region.

With the Project, TTC from Burlington to Wray will increase by the additional thermal rating of the proposed Burlington-Wray 230-kV line. Tri-State proposes to construct the new line with 1272 thousand circular mils (kcmil) “Bittern” aluminum conductor, steel reinforced (ACSR) and a maximum design temperature of 100 degrees Celsius (°C). This will provide an additional capacity of 613 megavolt Amperes (MVA). Adding TTC to the Burlington to Wray section is a first step to increasing the TTC across the complete path that is needed for Tri-State to serve more of or its entire eastern and southern Colorado native load from the economic resources in Wyoming and northwestern Colorado. The Project is intended to complement additional measures to increase the load serving capability on this important path, which consist of a combination of both ongoing projects and projects in planning stages. For example, Tri-State is presently upgrading its Big Sandy to Midway 230-kV line using the same type of conductor and maximum design temperature as the proposed Project. While there is not a timeline for implementation, Tri-State has also identified the next limiting path segment is the Story to North Yuma 230-kV line, which is constrained by its conductor thermal rating and existing committed uses. Tri-State also is considering an upgrade of this line to operate at 100 °C, which would raise the thermal rating of the line to approximately 512 MW and thereby increase the usable 230-kV system capacity from Story to as far as Burlington.

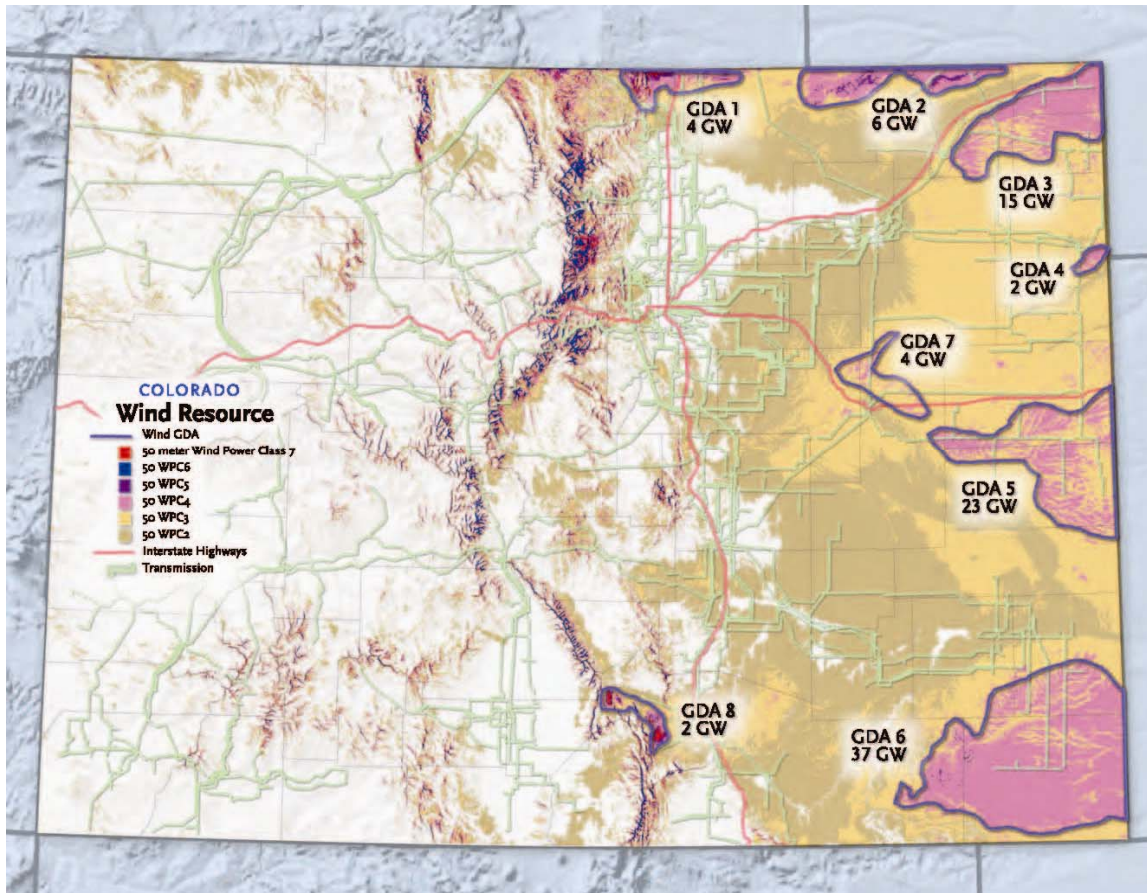
1.2.3 Increased Generation Capability

While there are no specific new generation projects considered in this Project, the proposed Burlington-Wray 230-kV transmission line also will increase the amount of generation that can be injected in the Project area (see pages 14-15 of Exhibit A for more detail). From a transmission planning standpoint, this additional generation capability is not exclusively available to a specific generation technology; however, the area has been shown to have considerable wind generation prospects.

The Report of the Colorado Senate Bill 07-091 Renewable Resource Generation Development Areas Task Force (SB 07-091 Report) identified Generation Development Areas (GDAs) that have significant wind generation potential. The proposed Project will add transmission capacity from GDAs 4 5 near Wray and Burlington, as depicted in Figure 1-2.

Tri-State’s Kit Carson Windpower Project has contributed to the ability of Tri-State’s Colorado Members to meet the renewable portfolio standard (RPS) that will reach 10 percent by the year 2020. While Tri-State has not identified future wind or other generation development projects in this area, the Project will strengthen an important link in the transmission system and improve generation injection capability. As a result, potentially more cost effective resources in this area can be considered when evaluating projects to fulfill the RPS requirements.

FIGURE 1-2: SB07-091 WIND GENERATION DEVELOPMENT AREAS¹



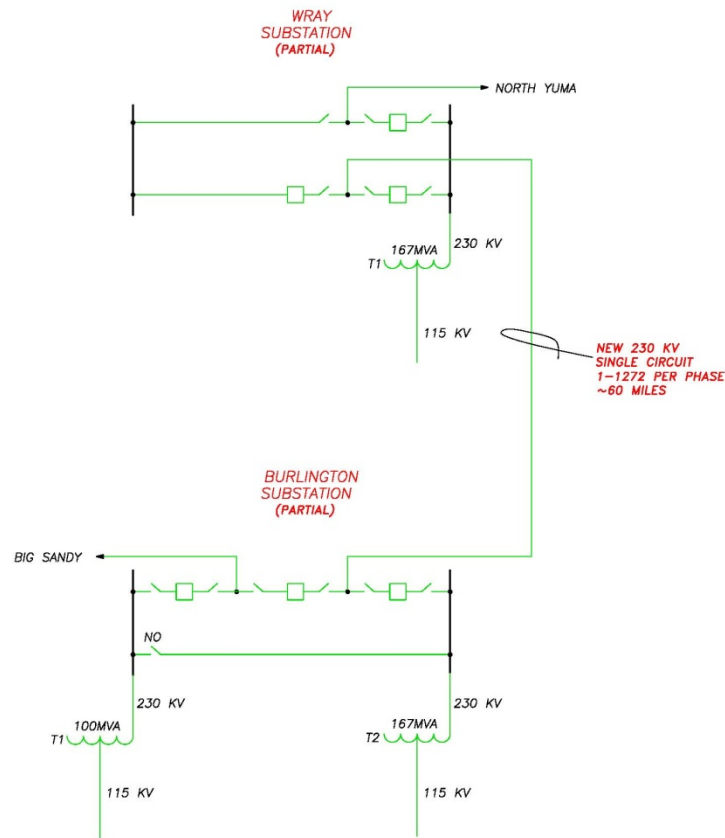
¹ Figure from: "Connecting Colorado's Renewable Resources to the Markets." Report of the Colorado Senate Bill 07-091 Renewable Resource Generation Development Areas Task Force.

2.0 PROJECT DESCRIPTION

2.1 PROPOSED ACTION

The proposed project involves construction of a new 230-kV transmission line between the existing Tri-State Burlington and Wray Substations as depicted on Figure 2-1.

FIGURE 2-1: PROJECT ONE-LINE DIAGRAM



The new single-circuit 230-kV line is approximately 60 miles in length. The conductor will be one 1272 kcmil ACSR per phase with a maximum design temperature of 100°C. The Burlington Substation will be expanded from the existing two breaker arrangement to a three breaker ring bus arrangement to allow for the new 230-kV line bay. The Wray Substation will require a new ring bus configuration with three 230-kV breakers.

After submitting an application in December 2010, Tri-State received a Certificate of Public Convenience and Necessity (CPCN) from the Colorado Public Utilities Commission (CPUC) for this proposed project configuration in January, 2011 (see CPUC docket 10A-906E for more information).

2.1.1 Right-of-Way

The new transmission line is proposed to be constructed within a right-of-way (ROW) that will be typically 150 feet wide. Tri-State representatives will work with the landowners along the selected route to obtain the necessary land rights to allow for access, construction, operation, and maintenance of the new transmission line.

2.1.2 Structures

Table 2-1 summarizes the typical physical design characteristics for the transmission structures.

TABLE 2-1: TYPICAL 230-KV TRANSMISSION LINE CHARACTERISTICS

Description of Design Component	Wood H-Frame or Steel Structures
Voltage	230 kV
ROW Width	150 feet
Average Span	800 feet
Typical Range of Structure Heights	65–110 feet
Number of Structures	6–7 per mile
Minimum Ground Clearance Beneath Conductor	28 feet
Maximum Height of Machinery that can be Operated Safely Under Line	14 feet

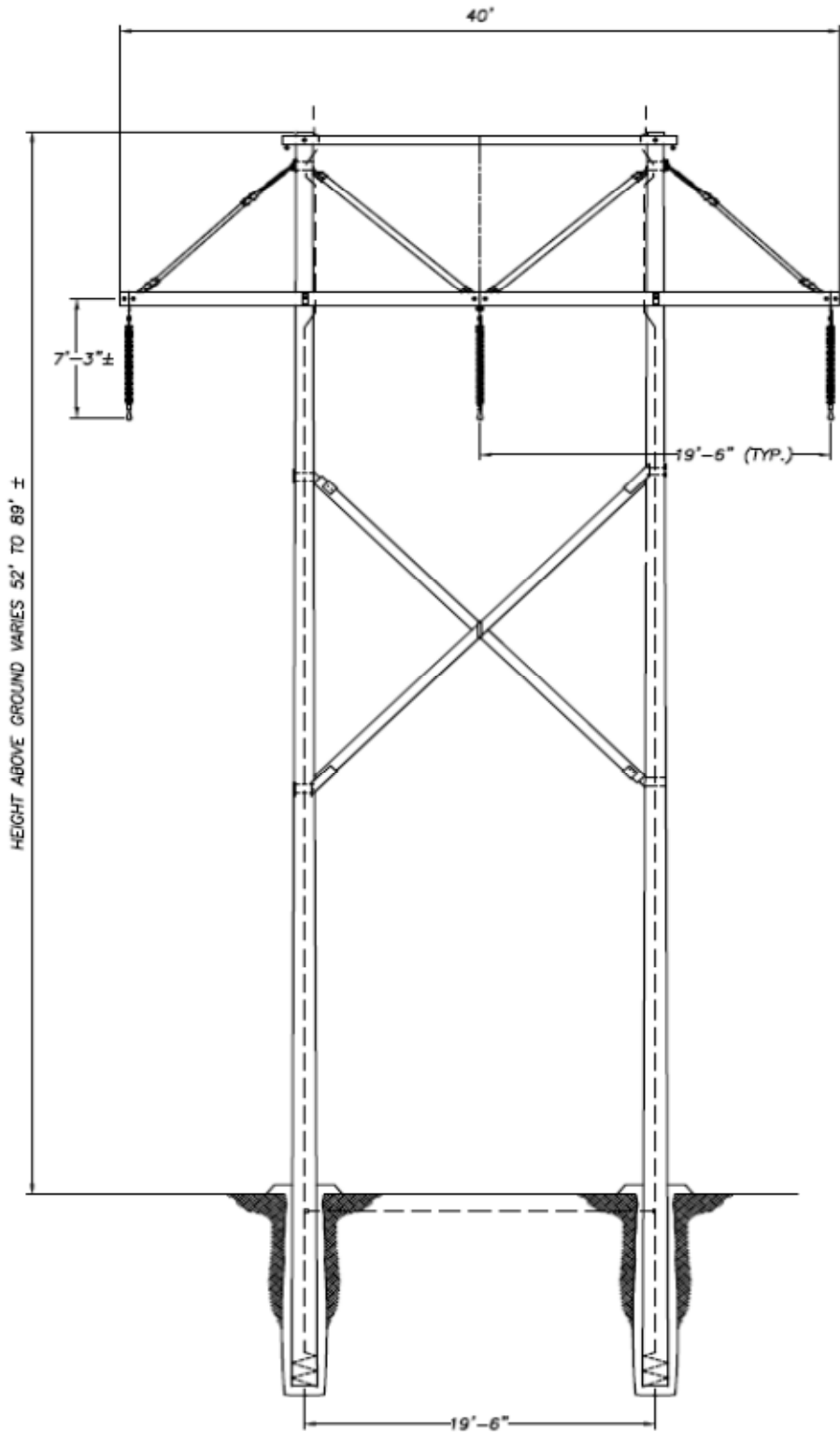
Tri-State proposes to use wood H-frame structures to support the conductors on straight-line sections of the transmission line. These structures typically range in height from approximately 65 to 110 feet, depending on the distance between structures and the area topography. Taller structures may be used for crossing streams, roads, or other transmission lines, or where unusual terrain exists. The distance between structures typically ranges from 650 feet to 1,100 feet, depending on topography.

The H-frame structures are designed to support three conductors on individual insulators located approximately 19 feet from the top. At the top of the structure, two overhead ground wires, or shield wires, will protect the transmission line from lightning strikes. One of the shield wires will contain fiber optics to be used solely by Tri-State for internal (not commercial) communication needs.

Depending on local conditions, other types of structures may be used as well. For example, three-pole wood angle structures with guy wires will be used where the transmission line changes direction. Along sections of the line where the proposed wood H-frame structures are used, three-pole wood dead-end structures with guy wires will be installed every 5 miles to prevent cascading of the structures in the event of storm damage.

Figure 2-2 depicts a representative diagram of the proposed structures.

FIGURE 2-2: PROPOSED 230-KV TRANSMISSION STRUCTURE



3.0 ALTERNATIVE EVALUATION

3.1 ALTERNATIVES CONSIDERED

The following sections consider possible alternatives and the extent to which they address each aspect of the purpose of and need for the Project. These objectives include removal of operating restrictions and improving load serving capability, increasing reliability and economic dispatch that will resolve the three deficiencies outlined in Section 1.2 above, and increasing capacity for new generation projects. All objectives are met by creating a 230-kV link between the existing Burlington and Wray Substations.

Tri-State submitted the Transmission Study included as Exhibit A as part of its application for a CPCN. In addition, an Energy Efficiency, Demand Side Management, and Distributed Generation Study was conducted and submitted as part of the application for a CPCN, and included in this AE as Exhibit B. This report provides a more detailed discussion of the alternatives that were studied.

3.1.1 No Action Alternative

If no action is taken to address the existing deficiencies in the transmission system, none of the objectives of the proposed project will be met. The “no action” alternative would not allow Tri-State to comply with its OATT reliability design requirements, which require Network Resources to be able to stay on-line following the most severe single contingency with all other Network Resources in the area operating at full output. This would result in a continuation of the current operating procedure that limits the use of Network Resources in the Burlington region.

If no action is taken to address the projected shortfall in transmission capacity on the 230-kV path from Story to Wray to Burlington to Big Sandy to Midway, and if the loads continue to grow in the Tri-State member areas south and west of the Burlington area, it will become increasingly difficult for Tri-State to reliably serve those member areas.

The no action alternative also will inhibit new generation projects in the area, including wind generation projects located in or near GDAs 4 and 5. The existing Burlington-Wray 115-kV line is a weak link in the transmission system in eastern Colorado and also has been shown to be a problem in studies for larger future planned transmission projects such as the Lamar-Front Range Transmission Project (currently being developed as a joint project between Tri-State and PSCO), and the High Plains Express transmission project.

3.1.2 Additional Generation

Additional generation would have to be located in some area that is remote from and not dependent upon the already limited transmission path. This would not alleviate the operating constraints that already exist upon Network Resources in the area. Any generation located elsewhere also would not contribute the added benefit of improved capacity to facilitate wind energy generation development in the area, such as from GDAs 4 and 5; therefore, additional generation is not an effective alternative.

3.1.3 Energy Efficiency and Demand Side Management

Energy efficiency (EE) and demand side management (DSM) both generally result in reduced electrical loads. Any measures that reduce loads in the Project area would result in greater need to transmit the local Network Resource generation out of the Project area, which would result in even more restrictive reliability limits. If EE and DSM alternatives are increased in the southeastern and southern Colorado member areas beyond the Burlington area, that would tend to reduce the need for transmission capacity on the path through Wray and Burlington and on to Midway. However, as shown in the Energy Efficiency, Demand Side Management, and Distributed Generation Study (Exhibit B), these alternatives most likely would not have a large enough impact to accommodate the forecasted member loads across the ten year planning horizon. In addition, EE and DSM will not facilitate any new generation in the affected area, including wind generation within GDAs 4 and 5.

3.1.4 Additional Transmission Capacity

The existing 115-kV line connects the 230-kV system to Wray and the 230-kV system from Burlington on a delivery route that serves the Tri-State member load in southeast and southern Colorado. Because of the voltage and size difference, the 115-kV line is the most limiting element on the path. This is true with respect to all of the constraints on reliability, transfer for load service and new generation. A thorough analysis of transmission alternatives (see attached Exhibit A) to resolve the existing system deficiencies was included in the CPCN Application, and partially reproduced here:

Introduction

Transmission line construction to sources other than Burlington and Wray were considered but not studied as a part of this effort, since the transmission limitation being addressed is a path limitation and not a local load-serving limitation. The immediate system need is to increase the capacity of the constrained path and resolve the existing system deficiencies previously described. While some of the transmission deficiencies identified could individually be met with other transmission alternatives, including transmission connections to other stations, these alternatives did not resolve all of the identified deficiencies with a common solution.

In addition, construction of a new 230-kV line between Burlington and Wray will integrate well with future transmission that may interconnect with the 230-kV system. Any new transmission will be able to interconnect to a continuous 230-kV path, thereby providing bi-directional transmission access to loads and resources on the 230-kV system.

To eliminate the existing path limitation, there are a number of possible transmission alternatives between the Burlington and Wray Substations. The alternatives available include variations in line voltage and number of circuits (1 or 2), and consideration of reuse of the existing Burlington-Wray 115-kV transmission line and associated ROW. Following is a discussion of issues associated with line ratings and other criteria applied to analyze various options.

Line Rating Discussion

This section provides a general overview of line ratings by voltage and conductor type. This is not intended to be an exhaustive look at the types of conductors available for use or every option that can be considered, rather this provides overview descriptions related to this Project.

Transmission lines are generally rated using a maximum conductor operating temperature, in °C, and a corresponding amount of current, in Amperes (A) that the line can safely carry. Without considering the effects of outdoor ambient temperature and weather conditions, the conductor temperature will rise as the current level rises. For example, the existing Burlington-Wray 115-kV transmission line utilizes a 477 ACSR “Hawk” conductor and is rated for a maximum conductor operating temperature of 75 °C. Using Tri-State’s methodology for conductor continuous ratings, this line is therefore rated to carry approximately 704 A, equal to 140 MVA at 115-kV, without considering if there are other transmission system elements that could be lower than this conductor rating, such as disconnect switches or instrument transformers in substations included in this path.

Using standard ACSR conductor types, Tri-State utilizes a maximum conductor operating temperature of 100 °C, so there is a possibility the existing line could be upgraded to achieve this rating. This would be accomplished by raising the transmission structures to allow for the additional conductor sag resulting from the higher currents associated with this increased maximum conductor operating temperature of 100 °C. Again using Tri-State’s methodology for conductor continuous ratings, this line rating could then be raised to approximately 166 MVA.

As the existing 477 ACSR “Hawk” type of conductor that is used on the existing Burlington-Wray 115-kV line has a maximum capability of 166 MVA if the line were up-rated to 100 °C, replacing this conductor with a new one, or re-conductoring the existing line is an option to try to raise this thermal rating. The existing line was designed to support the 477 ACSR “Hawk” type of conductor, so attempting to re-conductor with a larger diameter ACSR conductor to try to achieve a higher thermal rating is not appropriate due to the higher structural loadings likely requiring replacement of some or all of the transmission structures.

An additional option is to replace the ACSR type of conductor with a different type that can achieve a higher thermal rating, such as an Aluminum Conductor Steel Supported, Aluminum Conductor Composite Reinforced, or Aluminum Conductor with Composite Core (ACCC) type. These conductors all have higher capacity than the same size ACSR conductor, but the increase in conductor costs can be significant. For example, ACCC conductor costs are 7-8 times as expensive as their standard ACSR size equivalent. With the limitations of the conductor size and voltage that the line was designed for, this was eliminated from further evaluation.

Re-building the line in place of the existing line also was considered. Using the same existing 115-kV line example, an option is to re-build the line with a new 115-kV single circuit line with a higher capacity or possibly replacing with a new 230-kV line. A typical conductor used by Tri-State for a new 115-kV line is a 795 ACSR, which has a thermal rating of 232 MVA using a 100 °C maximum operating temperature. A typical conductor for a new 230 -kV line is a 1272 ACSR, which has a thermal rating of 612 MVA.

The line ratings for these re-building options also would apply to new line options where the existing 115-kV line would remain. For example, a new 115-kV line constructed using a 795 ACSR would have a thermal rating of 232 MVA and a new 230-kV line constructed using a 1272 ACSR has a thermal rating of 612 MVA. There are other conductor types that could be examined, but these show an example of the large difference in ratings when considering a standard 115-kV line and a standard 230-kV line. Extending this to 345-kV options, a common 345-kV line construction utilizes two 1272 ACSR conductors per phase. If this line were operated at 230-kV, this would provide a thermal rating equal to

twice the 612 MVA rating provided by one 1272 ACSR operated at 230-kV, or 1224 MVA. If it were operated at 345-kV, it would then have a thermal rating of 1838 MVA. Considering double-circuit structures, these ratings then apply to each individual circuit.

Transmission alternatives

The following alternatives were analyzed to determine their suitability in resolving the system deficiencies:

1. Existing line and ROW alternatives:
 - a. Thermal upgrade of the existing Burlington-Wray 115-kV line.
 - b. Re-conductor the existing Burlington-Wray 115-kV line.
 - c. Re-build the existing Burlington-Wray 115-kV line.
2. New line using existing right-of-way alternatives (including removal of existing Burlington-Wray 115-kV line):
 - a. New Burlington-Wray 230-kV single-circuit line, operated at 115- or 230-kV.
 - b. New Burlington-Wray 115/230-kV double-circuit line.
3. New line using new right-of-way alternatives (With existing Burlington-Wray 115-kV line staying in service):
 - a. New Burlington-Wray 115-kV single-circuit line.
 - b. New Burlington-Wray 230-kV single-circuit line.
 - c. New Burlington-Wray 230-kV double-circuit line, with either one circuit or two circuits installed.
 - d. New Burlington-Wray 345-kV single- or double-circuit line, considering 230-kV or 345-kV operation and whether one or two circuits are installed on the double-circuit option.

Transmission alternative analysis

Existing line and right-of-way alternatives.

A power flow analysis of the northeastern Colorado system found that under certain system conditions the existing Big Sandy to Beaver Creek 115-kV line overloads. The lighter the load in eastern Colorado and the greater the generation injection in the Burlington area, the greater the potential for overload of the line. For example, the analysis found that with 51 MW of generation in the Burlington area, the overload of the line reaches 120 percent for a loss of the Midway to Lincoln 230-kV line. The overload reaches 127 percent for the same outage with 175 MW of generation modeled in the Burlington area (see Table 1 and Table 2b of the Transmission Study). This overload cannot be mitigated with a rebuild or reconductoring of the Burlington-Wray 115-kV circuit, but can be entirely mitigated with the construction of a second Burlington-Wray circuit.

Considering this fundamental northeastern Colorado 115-kV system overload problem, this first set of transmission alternatives (1.a-1.c) that consider the re-use of the existing 115-kV line and associated ROW were eliminated from further analysis as these resulting overload problems on the Big Sandy to Beaver Creek 115-kV line would be expected to persist with these options. This is in addition to the operational and constructability issues, and limited increase in line rating with these options.

Evaluation criteria.

The remaining transmission alternatives (2.a-2.b and 3.a-3.d) between Burlington and Wray were evaluated using a number of criteria including:

1. Ability to eliminate operating restrictions on Tri-State's existing Limon and Burlington generation facilities, without considering the new Kit Carson Windpower Project generation.
2. Ability to eliminate operating restrictions on Tri-State's Limon, Burlington, and Kit Carson Windpower generation facilities.
3. Ability to eliminate Tri-State's load-serving constraints for southern and eastern Colorado as identified in the Load Serving Analysis in this study, using a 10-year forecast period.
4. Ability to relieve Tri-State's load-serving constraints beyond the 10-year forecasted period for southern and eastern Colorado, including the ability to serve loads bi-directionally (i.e. south to north in addition to identified north to south need).
5. Ability to allow additional generation resource injection in the area.
6. Consistency with transmission system and plans in the area.
7. Other considerations, including constructability, operational and maintenance issues.
8. Estimated cost (A summary of cost considerations including assumptions is included in Exhibit A, Appendix G.)

The first three criteria are the previously mentioned deficiencies in the northeastern Colorado area, and are considered to be the primary criteria in evaluating the alternatives. The remaining five criteria are then considered to be secondary criteria to be used for additional screening.

New line using existing right-of-way alternatives (including removal of the existing Burlington-Wray 115-kV line).

Alternative 2.a was eliminated from further consideration due to a number of factors. First, to allow for 230-kV operation, several distribution substations tapping the existing line (at Bonny Creek, South Fork, Idalia and Vernon Tap) would need to be converted from 115-kV to 230-kV, thereby adding substantial cost to the rebuild of the line. Second, rebuilding the line may be difficult during certain times of the year since each of the substations noted would need to be served radially for extended periods of time during construction. Operating the circuit radially could create further operational issues associated with dispatching the generation in eastern Colorado during the construction period. Third, a loss of the single-circuit between Burlington and Wray interrupts the primary contractual transmission path utilized by Tri-State to serve its native load in eastern Colorado, and this contractual path would be necessarily interrupted during the construction period. Finally, the existing 75-100 foot ROW along the existing line may not be sufficient for 230-kV H-frame construction and operation, and additional easements and new permits would likely be required. The 115-kV operation option of alternative 2.a also would not address the fundamental south to north overloading issue on the combined Big Sandy to Beaver Creek and Burlington to Wray 115-kV lines.

While alternative 2.b would resolve the first three criteria, or primary deficiencies, and would also adequately address criteria four through six, there are significant concerns regarding criteria 7 and 8. Similar to alternative 2.a, rebuilding the line may be difficult during certain times of the year with multiple tap substations that would need to be served radially for extended periods of time during construction. Operating the circuit radially could create further operational issues associated with dispatching the generation in eastern Colorado during the construction period. Also, a loss of the single-circuit between Burlington and Wray interrupts the primary contractual transmission path utilized by Tri-

State to serve its native load in eastern Colorado, and this contractual path would be necessarily interrupted during the construction period. The existing 75-100 foot ROW along the existing line may not be sufficient for 230-kV construction and operation, and additional easements and new permits would likely be required. In addition to these concerns, the cost estimate for this alternative is \$44,040,000 assuming a line length of 51 miles to match the existing line, approximately \$10,000,000 more than constructing a single circuit 230-kV line in a new right-of-way which would provide an electrically equivalent option under normal system operating conditions. It is possible that the line length could be longer depending on siting considerations, which would increase this cost estimate. This option also would introduce an N-2 outage contingency, due to a possible common tower outage.

New line and new right-of-way alternatives (with the existing Burlington-Wray 115-kV line remaining).

A new 115-kV line considered in alternative 3.a may resolve the first two primary deficiencies; however there would be questionable load-serving capability added to address the third primary deficiency. Since the transmission considered in the Story to North Yuma to Wray to Burlington to Big Sandy to Midway path is 230-kV at Burlington and Wray Substations, there would be additional transformer capacity required at both substations to be able to utilize the combined capacity provided by the new 115-kV line (232 MVA) and the existing 115-kV line (140 MVA). Even assuming additional transformers were added to allow for this shortfall, with a combined path rating of approximately 372 MVA in this scenario it would still be below the potential 512 MVA rating mentioned in the Load Serving Analysis for the Story to North Yuma to Wray 230-kV line. Considering these deficiencies, in addition to an estimated cost of \$27,702,000 for a single-circuit 115-kV line versus the estimate of \$34,363,000 for a new single-circuit 230-kV line without considering the additional costs of 230/115-kV transformers at Wray or Burlington, this alternative was eliminated from further consideration.

A new 230-kV line considered in alternative 3.b would resolve the three primary deficiencies. The new 230-kV line would have a thermal rating of 612 MVA, and adding the 140 MVA available on the existing 115-kV line would provide a new load-serving path rating of 752 MVA between Burlington and Wray. This would, therefore, resolve the forecasted load-serving deficit, and would be consistent with the connected 230-kV system at Burlington and Wray to allow for future load-serving support beyond the 10-year forecasted period. In addition, this new 230-kV line removes this northeastern Colorado system limitation and allows for additional generation injection capability in the area.

The remaining alternatives 3.c and 3.d consider double-circuit 230-kV construction alternatives and 345-kV construction alternatives. Similar to the new single-circuit 230-kV line, these alternatives would each be expected to resolve the three primary deficiencies identified. As they would each have a thermal capacity equal to or higher than a single-circuit 230-kV line, each of these also would be expected to provide future load-serving support beyond the 10-year forecasted period identified in the Load Serving Analysis. However, when considering the consistency with the transmission system in the area such as the lack of 345-kV facilities in service today, these options are shown to have deficiencies, especially when considering the significant additional costs of constructing any of these alternatives.

As shown in Appendix G of Exhibit A, the cost estimates for alternatives 3.c and 3.d range from approximately \$51,000,000 to \$82,000,000, which is \$17,000,000 to \$48,000,000 more than the new 230-kV single circuit alternative without considering additional substation equipment costs. As has been stated previously, Tri-State's transmission system connected from the west to east to Tri-State's existing Burlington and Wray Substations consists of a single-circuit 230-kV transmission line. These single-

circuit 230-kV lines serve as the next limit to the Story to North Yuma to Wray to Burlington to Big Sandy to Midway path after the 115-kV Burlington to Wray limitation is addressed. Both of these east-west single-circuit 230-kV transmission lines connected to Burlington and Wray are thermally rated below the new 752 MVA thermal rating that would be provided by a single circuit 230-kV transmission line between Burlington and Wray. This means additional transmission upgrades or new lines must be completed on these east-west sections in order for Tri-State to realize any benefit of constructing a line between Burlington and Wray larger than a single-circuit 230 -V line. Therefore, for Tri-State, the additional costs of these options would be better spent on other transmission upgrades in the area. When considering that no other parties were prepared to financially participate in constructing the line larger than a single-circuit 230-kV line that has been shown to address Tri-State's needs, these options were eliminated from further consideration.

3.2 THE PREFERRED TRANSMISSION SYSTEM ALTERNATIVE

The proposed Project is the preferred transmission alternative. A new Burlington to Wray single-circuit 230-kV line (Alternative 3.1.4) is the best alternative in order to cost effectively:

1. Remove the reliability operating limits that affect existing Tri-State generation in the area;
2. Provide a load-serving path consistent with the long term potential capacity of the existing transmission path in the area and Tri-State's forecasted need for increased use of that path;
3. Facilitate additional generation development in this part of Colorado to access potentially excellent wind energy resources, as illustrated by the Kit Carson Windpower Project; and
4. Anticipate long term plans in the region by providing a 230-kV electrical path between Burlington and Wray and removing the reliability and capacity constraint of the existing 115-kV line.

For further reference, Tri-State has performed complete power flow studies that evaluate the proposed new Burlington-Wray 230-kV transmission line. The study scope, criteria, method, and results are discussed in more detail in the Transmission Study (Exhibit A).

3.3 UNDERGROUND CONSTRUCTION

Underground construction of transmission lines is often perceived as a way to accomplish the electrical objective of the Project while minimizing visual impacts. However, there would be significantly increased costs, technological considerations, and environmental impacts associated with underground construction of a 60-mile transmission line from Burlington to Wray.

Underground construction is frequently used with distribution lines that operate at 34.5-kV or less. At these relatively low voltages, the problems of electrically insulating each phase and of dissipating the heat generated by the conductors are not a concern. With lines of greater voltage, such as the proposed Project, the material costs, construction costs, and the heating of the cable all become a greater concern.

By far the greatest factor to consider when evaluating overhead versus underground transmission is cost. It is estimated that costs for constructing a single-circuit 230-kV underground transmission line in this geographical area could be approximately 5 to 10 times higher than an equivalent overhead line. In addition to the initial installed cost, the life expectancy of an underground transmission line is approximately half that of an overhead line.

The reliability of underground lines is comparable to overhead lines. Although underground lines are immune to the effects of weather or lightning, the duration of an outage on an underground line can be weeks because failures are more difficult to locate and repair. An overhead line can be repaired relatively quickly by Tri-State maintenance crews with standard line materials. An underground line repair would have to be done by skilled contract personnel who may or may not be available. The repair of a failed underground splice or termination would take a significantly greater amount of time during which the circuit would not be available to support loads.

The environmental impacts of underground transmission lines differ from those of overhead lines, and, consequently, the siting considerations also differ. The impacts of underground transmission lines on soils, surface water, vegetation, and wildlife resources are likely to be far greater than those of a similarly located overhead line. This is because any underground technology used would require a continuous trench 4-feet-wide by 5-feet-deep with intermediate vaults 7-feet-wide by 20-feet-long every 2,000 to 2,400 feet.

Given the prohibitive cost, coupled with repair, replacement and maintenance issues and more significant environmental impacts, burying any segment of the transmission line is not considered a viable alternative.

4.0 CONCLUSION

The proposed Project is appropriate and is the best alternative to address the problems and objectives relating to the proposed improvement of Tri-State's system in eastern Colorado. A new Burlington to Wray single-circuit 230-kV line will cost effectively:

1. Remove the reliability operating limits that affect existing Tri-State generation in the area;
2. Provide a load-serving path consistent with the long term potential capacity of the existing transmission path in the area and Tri-State's forecasted need for increased use of that path;
3. Facilitate additional generation development in this part of Colorado to access potentially excellent wind energy resources, as illustrated by the Kit Carson Windpower Project; and
4. Complement long term plans in the region by providing an additional electrical path between Burlington and Wray and removing the limitations of the existing lone 115-kV line.

EXHIBIT A

Transmission Study for the **Northeast Colorado Area**



November, 2010

Prepared by: David Gustad
Mark Stout

Transmission Study for the Northeast Colorado Area

Executive Summary

The northeastern Colorado transmission system was analyzed to determine the preferred alternative to mitigate known transmission system deficiencies, and to evaluate system alternatives to improve the future reliability, and capacity and load serving capability of the system. The study identified contingency loading limitations under light winter and heavy summer conditions with various power injections in the Wray and Burlington areas. The study confirmed the need for additional transmission for certain system contingencies.

The performance of the transmission system was studied for several system conditions and identified the construction of a Burlington to Wray 230 kV line as the best solution to solve several existing transmission system deficiencies. The line would complete a continuous 230 kV path through northeastern Colorado and substantially increase the limit of the load serving path through this area. The proposed line improves the reliability of the transmission system, increases Tri-State's load serving capability, and increases export capability for existing and planned generation.

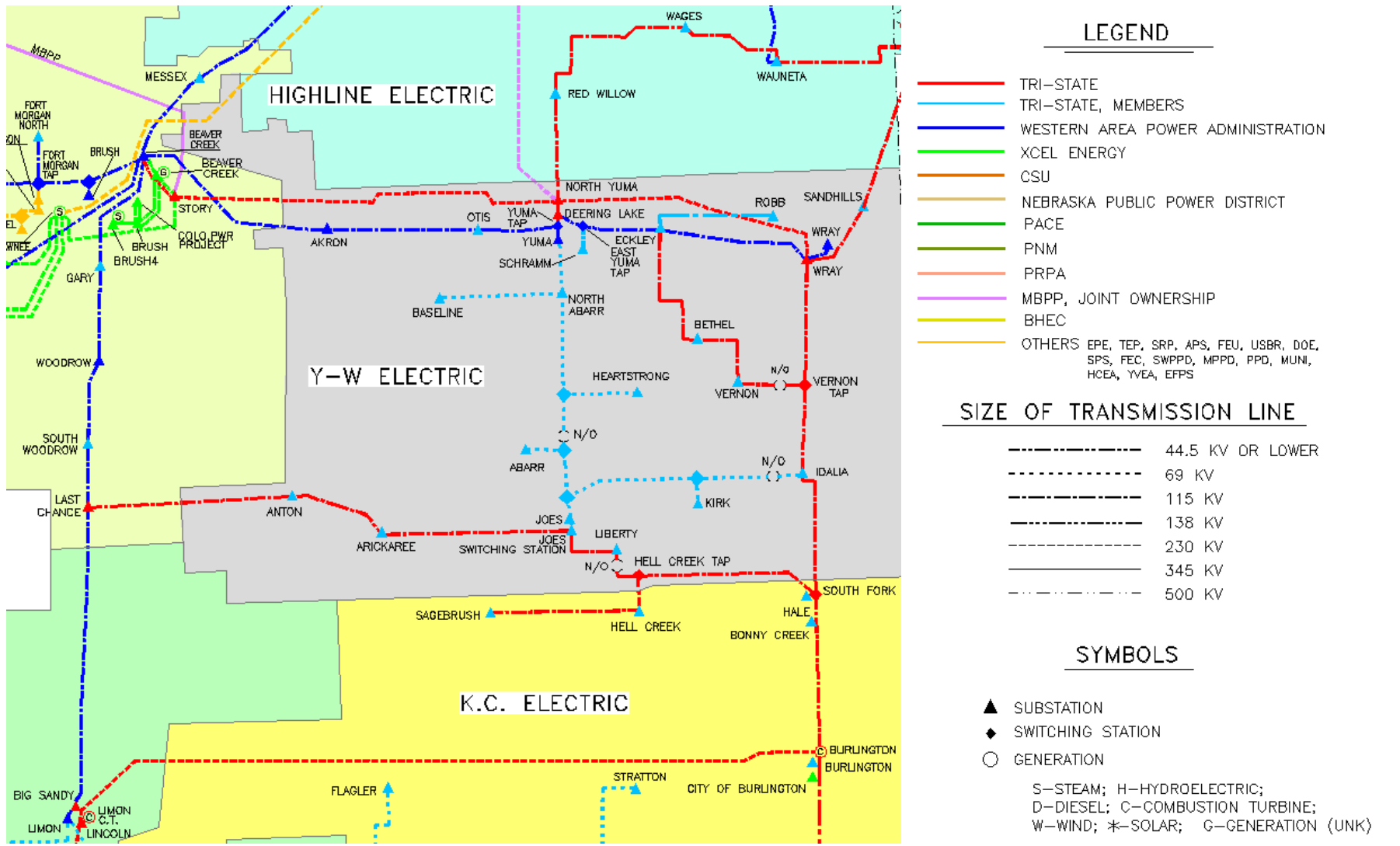


Figure 1: Burlington/Wray Area in Northeastern Colorado

Transmission Study for the Northeast Colorado Area

Background

Load growth and generation additions in northeast Colorado have put a strain on the current 115 kV transmission system. Under certain system conditions, the ability to schedule local generation is limited by overloading conditions on sections of the Burlington – Wray 115 kV line. This 115 kV line is also the limiting element in Tri-State’s load-serving path from Story to Wray to Burlington to Big Sandy to Midway. Additionally, Tri-State has received several third party generation requests for interconnection to the northeast Colorado system that cannot be accommodated with the existing transmission system. Tri-State performed this study to identify system deficiencies in northeast Colorado and to evaluate alternatives for improving the reliability and load serving capability of the transmission system through feasibility and power flow analyses.

Existing Transmission System Deficiencies

1. Operating restrictions on the existing Limon and Burlington generation.

Past study work has identified operating conditions where the existing Burlington to Wray 115 kV line limits Tri-State’s ability to dispatch existing generation resources in eastern Colorado. The most critical single-contingency outage, as identified by previous study work and confirmed by this study, is a loss of the existing Lincoln to Midway 230 kV line. Under this outage, and during light loading conditions, the existing generation resources at Limon and Burlington can be restricted from simultaneously operating at their full output without criteria violations on the existing system. A portion of the Limon and Burlington resources are used to meet Tri-State reserve obligations. The existing Burlington generators have the added operating advantage of quick start capability, that is, they can be called upon, made available and dispatched much faster than typical combustion turbine generation. Therefore, to maximize response capabilities to system conditions and to improve system reliability, it is important that existing operating restrictions on the dispatching of these units be eliminated.

2. Interim Restricted Operating Procedure placed on the 51 MW Kit Carson wind project.

Tri-State Transmission received an application from Tri-State Power Marketing for the designation of the 51 MW Kit Carson wind project as a Network Resource for Tri-State Power Marketing as a part of a Network Service Request dated July 8, 2009. The request was granted conditioned upon an operating restriction applied to the Burlington Network Resources, including the Kit Carson wind project due to overloads on the existing system identified by the System Impact Study performed for the project. A restricted Network

Resource designation was granted for the wind project until such time as network upgrades could be completed. Tri-State Power Marketing and Tri-State Transmission have negotiated an Interim Restricted Operating Procedure¹ to this effect.

Pursuant to Tri-State's Open Access Transmission Tariff (OATT), all new Network Resources must meet specified reliability design requirements. Specifically, Tri-State requires that any new Network Resource must be able to stay on-line at full output and meet all reliability design criteria for the most severe N-1 outages with all existing Network Resources in the study area also operated at full output. The designation of the 51 MW Kit Carson wind project as a Network Resource requires that this reliability design criteria be met. Therefore, construction of network upgrades will be required to 1) eliminate the current operating restrictions, 2) meet the specific reliability design requirement noted above, and 3) meet Tri-State's obligations to its Network Customers under its OATT.

3. Deliverability of Tri-State resources to Tri-State native load.

Tri-State has an existing need for additional or expanded contractual path rights between Wray and Burlington. Tri-State has some of its most economical base-load Network Resources available to serve native loads in southeastern Colorado located in Wyoming and western Colorado. The existing Wray to Burlington 115 kV line constitutes a portion of a primary contractual transmission path utilized by Tri-State to serve its native load in eastern and southern Colorado from these resources and is limited by its current thermal capacity. This study analyzes these load serving and deliverability deficiencies and requirements.

Previous Studies

The Burlington - Bonny Creek – South Fork - Idalia – Vernon Tap - Wray 115 kV line is the common limiting element for each of the existing transmission system deficiencies noted above. The line conductor is Hawk 477 ACSR built for 75 °C and is rated at 120 MVA due to terminal equipment limitations. The thermal capability of this line can be increased from 120 MVA to 140 MVA provided that the terminal equipment is replaced. Previous study work identified this line as a weak link in Tri-State's northeastern Colorado system. That study work included:

- TI-08-0502 Kit Carson 51 MW generation interconnection SIS, FS and Interim Restricted Operating Procedure (November & December 2009, October 2010)
- TI-06-0929A Burlington Area SIS (February 2010)
- TSGT 2010 L&R study (June 2010)
- CLRTPG08 (June 2008)
- TI-04-1103 & TI-06-0223 SIS (December 2007)
- TI-07-0412B Wray Area IFS (August 2007)

¹ The Interim Restricted Operating Procedure applies to the Burlington Network Resources, including the Burlington CT's and the Kit Carson Wind project, accounting for the status of the Limon CT's

Alternative Identification

The existing Tri-State transmission system in the Burlington and Wray areas consists of one 230 kV line extending from Story to North Yuma to Wray and a second 230 kV line extending from Big Sandy to Burlington. The underlying 115 kV system interconnects these 230 kV terminations and serves the Tri-State native load in the region. Since, as noted above, the Burlington - Bonny Creek – South Fork - Idalia – Vernon Tap - Wray 115 kV line is the common limiting element, the first step toward improving the transmission system in eastern Colorado is to increase the transmission capacity of this path.

Various alternatives for alleviating the Burlington – Wray 115 kV path limitation were identified. The alternatives included variations in line voltage and number of circuits to be constructed, and consideration of reuse of the existing Burlington to Wray 115 kV transmission line and associated right-of-way. Those alternatives are discussed in detail in Appendix A. Alternatives that utilized only one circuit between Burlington and Wray, whether trying to upgrade the existing 115 kV line or removing the existing 115 kV line and building a new single circuit line in its place, were eliminated from further consideration since they either cannot solve the transmission system deficiencies identified in this report or do so with significant cost, constructability, operation, and maintenance concerns as discussed in Appendix A.

Another alternative, and one which previous study work had assumed, is the construction of a second transmission line between Burlington and Wray which would electrically parallel the existing 115 kV line. Tri-State's analysis included in this report and from previous studies shows that a project consisting of a new single-circuit 230 kV transmission line between the existing Burlington and Wray Substations, both owned by Tri-State, is the best solution. The choice of 230 kV completes the 230 kV path from Story to North Yuma to Wray to Burlington to Big Sandy through eastern Colorado. There are presently no higher transmission voltages in operation in eastern Colorado with which to interconnect, and the choice of 230 kV integrates well with the existing substations at Wray and Burlington. A 230 kV line constructed with 1272 MCM ASCR conductor at a maximum design temperature of 100 degrees C would have a rating of 612 MVA (1538 amperes), thereby substantially increasing the present 140 MVA rating of the Burlington to Wray path. This added capacity is sufficient to remove the Burlington – Wray path from limiting the Story – Wray – Burlington – Big Sandy – Midway contractual path.

Transmission line construction to sources other than Burlington and Wray were considered but not studied as a part of this effort, since the transmission limitation being addressed by this study is a path limitation and not a local load-serving limitation. As noted above, the immediate system need is to increase the capacity of the constrained path. Construction of a new 230 kV line between Burlington and Wray will integrate well with future transmission that may interconnect with the 230 kV system. Any new transmission will be able to interconnect to a continuous 230 kV path, thereby providing bi-directional transmission access to loads and resources on the 230 kV system.

While some of the transmission deficiencies identified in this report could individually be met with other transmission alternatives, including transmission connections to other stations, these

alternatives did not resolve all of the identified deficiencies with a common solution. Therefore, this report presents the findings of constructing a new single-circuit 230 kV transmission line from the existing Burlington Substation to the existing Wray Substation. The study evaluates the performance of the transmission system with the proposed Burlington to Wray 230 kV line and evaluates design alternatives that may improve the future reliability, capacity and load serving capability of the transmission system in northeastern Colorado. The proposed Burlington to Wray 230 kV line will electrically parallel the existing 115 kV line and is estimated to be approximately 60 miles long. The proposed in-service date (ISD) for the line is December 2015.

Study Scope

A power flow contingency analysis of the northeastern Colorado region was evaluated to determine the system performance both with and without the Burlington – Wray 230 kV line addition. The northeast Colorado system consists of the transmission south of TOT3, east of Pawnee, and north of Midway. The outage list included all single transmission elements in northeastern Colorado (see Appendix B). Any relevant more severe (category C or category D) contingencies were also identified and evaluated. All buses, lines, and transformers in the northeastern Colorado region were monitored for criteria violations, as specified below.

Base Case

An evaluation of 2013 summer and 2013 winter conditions was performed. This case selection was made based on the availability of applicable, trustworthy cases and the original projected in-service date of December 2013, which has since been modified to December 2015. The starting cases were Tri-State's 2013 Heavy Summer (HS) LGIP case and 2013 Light Winter (LW) LGIP case. These cases both originated from the 12hs2ap.sav WECC case, with review and modifications by the CCPG utilities. The major modifications that were made to the starting cases to create the study base cases are in Appendix C.

Criteria

Acceptable voltages for all buses in the study area are between 0.95 and 1.05 per unit under system normal conditions. Acceptable loading on any transmission line is less than 80 percent of its continuous rating, and less than 100 percent of its maximum nameplate rating for transformers. System adjustments during solution were allowed, including shunt capacitor switching and LTC tap adjustments. Area interchanges and phase shifter adjustments were not utilized in order to stress flows north to south, particularly on TOT3.

Tri-State's Engineering Standards Bulletin state's that the 80 percent system normal line loading criteria applies to Tri-State owned transmission lines. This criterion is in recognition of the high losses, high voltage drop, and possible steady-state stability problems associated with a line loaded above 80% of its static thermal rating. For lines owned by other entities, loading above

this limit was noted, but no facility upgrades were required until the loading reached 100 percent of their continuous ratings under system normal conditions.

In the case of single contingency conditions, acceptable voltages for all buses in the study area are between 0.90 and 1.10 per unit. For Platte River Power Authority (PRPA) buses, the acceptable voltage range is 0.92 to 1.07 per unit. Acceptable loading for all transmission lines and transformers is below 100 percent of their continuous ratings or any applicable emergency ratings as specified by the owner of a particular element. However, no applicable emergency ratings were identified for this study beyond a few terminal equipment ratings discussed below. System adjustments during solution were not allowed, including shunt capacitor switching, LTC tap adjustments, area interchanges and phase shifter adjustments.

Study Method

A contingency analysis was performed on the study base cases, both with and without the Burlington – Wray 230 kV line. The results with the line addition were compared to the results without it to determine the effects of the line addition.

The analysis was repeated with additional generation injections modeled, consistent with the general locations of interconnection requests that Tri-State has received in its interconnection queue. In particular, the Kit Carson wind interconnection (DEGS) was modeled at 51 MW approximately 5 miles from the Burlington substation along the Burlington – Big Sandy 230 kV line. Two additional injections were analyzed: one injection of power was modeled at up to 200 MW approximately 30 miles from Burlington along the Burlington – Big Sandy 230 kV line (BurlWInc), and a second injection was modeled at the Wray 230 kV bus at up to 200 MW (WrayWInj). The study results identified the approximate amounts of additional generation at these two locations which the 230 kV line addition could accommodate before additional criteria violations occurred.

First, the system with just the Kit Carson wind injection was analyzed with and without the Burlington – Wray 230 kV line. As noted in the Kit Carson Wind System Impact Study and the associated Operating Agreement, the Kit Carson Wind project and the existing Burlington thermal units currently must coordinate operation in order to avoid overloading the Burlington – Wray 115 kV line before the 230 kV line is built. System analysis was subsequently performed on cases with the Kit Carson wind project plus the generation injection near Burlington, and on cases with the Kit Carson wind project plus the generation injection at Wray. As a result, the analysis identified any additional benefits of the Burlington – Wray 230 kV line to accommodate generation interconnections in northeastern Colorado.

Results

The study results are summarized below and in Table 1. Detailed outage results can be found in Appendix D for the 2013 HS case and Appendix E for the 2013 LW case.

In the study cases, the Burlington - Big Sandy 230 kV line was split into 3 line sections: the Burlington – DEGS line section, the DEGS – BurlWInc line section, and the BurlWInc – Big Sandy line section. DEGS is where the Kit Carson (Duke Energy) wind farm will inject power onto the line, and BurlWInc is where an additional injection of wind power was modeled on the line.

The BurlWInc - Big Sandy 230 kV line is limited to 179 MVA due to terminal equipment at Big Sandy. However, the conductor thermal rating of 284 MVA was used for this study. Terminal equipment was not considered limiting since changes to terminal equipment ratings have relatively low cost and small lead times. Similarly, the Burlington – Wray 115 kV line is limited to 120 MVA due to terminal equipment, but the conductor rating of 140 MVA was used in this study.

For both the light winter and heavy summer cases, there were no criteria violations with the Burlington – Wray 230 kV line addition for cases with no generation injections, including no Kit Carson generation. The same is true for heavy summer conditions with the Kit Carson generation injection of 51 MW. Therefore, while previous studies have found limitations on the existing resources at Burlington and Limon, the dispatch and stressing assumptions used in this study allowed the existing generation to operate to its full capacity under heavy summer conditions.

However, in the light winter case with the Kit Carson generation injection at 51 MW, both the Big Sandy – Beaver Creek 115 kV line and the Burlington – Wray 115 kV line overloaded for several contingencies prior to the 230 kV line addition, at a maximum of 120% and 113% respectively. The overloading on both of these lines is mitigated by the 230 kV line addition for all of the associated contingencies (See Table 1).

This verifies the previously defined need for an interim operating procedure on the Kit Carson Wind facility, and also verifies that the Burlington – Wray 230 kV line addition eliminates the need for that operating procedure.

Table 1: HS and LW Results, Dukeinj at 51 MW

Case	Outage	Monitored Element	Rating (MVA)	Loading w/o Burlington-Wray 230 kV Line (%)	Loading w/ Burlington-Wray 230 kV Line (%)
HS No Injections	No Violations Affected by the Burlington - Wray 230 kV Line Addition				
LW No Injections	No Violations Affected by the Burlington - Wray 230 kV Line Addition				
HS Dukeinj	No Violations Affected by the Burlington - Wray 230 kV Line Addition				
LW Dukeinj	Big Sandy - BurlWInc 230 kV	Bonny Creek - Burlington 115 kV	140	110.6	< 100.0
LW Dukeinj	Big Sandy - BurlWInc 230 kV	Bonny Creek - South Fork 115 kV	140	110.4	< 100.0
LW Dukeinj	Big Sandy - BurlWInc 230 kV	Idalia - South Fork 115 kV	140	108.6	< 100.0
LW Dukeinj	Big Sandy - BurlWInc 230 kV	Idalia - Vernon Tap 115 kV	140	107.6	< 100.0
LW Dukeinj	Big Sandy - BurlWInc 230 kV	Vernon Tap - Wray 115 kV	140	107.3	< 100.0
LW Dukeinj	BurlWInc - DEGS Wind 230 kV	Bonny Creek - Burlington 115 kV	140	110.6	< 100.0
LW Dukeinj	BurlWInc - DEGS Wind 230 kV	Bonny Creek - South Fork 115 kV	140	110.4	< 100.0
LW Dukeinj	BurlWInc - DEGS Wind 230 kV	Idalia - South Fork 115 kV	140	108.6	< 100.0
LW Dukeinj	BurlWInc - DEGS Wind 230 kV	Idalia - Vernon Tap 115 kV	140	107.6	< 100.0
LW Dukeinj	BurlWInc - DEGS Wind 230 kV	Vernon Tap - Wray 115 kV	140	107.3	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Big Sandy - Last Chance 115 kV	109	120.3	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Beaver Creek - Gary 115 kV	109	115.0	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Bonny Creek - Burlngtn 115 kV	140	113.0	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Bonny Creek - South Fork 115 kV	140	112.8	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Gary - Woodrow 115 kV	109	115.6	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Idalia - South Fork 115 kV	140	110.9	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Idalia - Vernon Tap 115 kV	140	109.9	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Last Chance - South Woodrow 115 kV	109	117.2	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	South Woodrow - Woodrow 115 kV	109	116.5	< 100.0
LW Dukeinj	Midway - Lincoln 230 kV	Vernon Tap - Wray 115 kV	140	109.6	< 100.0

Load Serving Analysis

As stated in the Existing Transmission System Deficiencies section of this report, Tri-State has a need for additional contractual path rights between Wray and Burlington. Tri-State's native load obligation in south and eastern Colorado includes service to K.C. Electric Association, Mountain View Electric Association, San Isabel Electric Association, San Luis Valley Rural Electric Cooperative, Southeast Colorado Power Association and Gunnison County Electric Association. In addition to this transmission path, Tri-State purchases firm transmission from CRSP (Western) and Public Service Company of Colorado for service to these loads. These transmission sources owned by or purchased by Tri-State comprise the Total Transfer Capability TTC that Tri-State has available to serve its native load in the south and southeastern Colorado areas and to meet its other existing transmission commitments.

Determining the Available Transmission Capability (ATC) for the existing Wray to Burlington 115 kV line requires an analysis of the Total Transfer Capability (TTC) of the transmission system owned or available to Tri-State to meet its native load-serving needs. A non flow-based analysis of the projected uses of the Wray to Burlington line was conducted. ATC was calculated.

$$\text{ATC} = \text{Total Transfer Capability (TTC)} - \text{Existing Transmission Commitments (ETC)} - \text{Transmission Reliability Margin (TRM)}$$

- TTC was determined in accordance with Tri-State's *Engineering Standards Bulletin – Reliability Criteria for System Planning and Service Standards* which states the maximum loading criteria for transmission lines as a percent of the continuous rating. Based on that criteria, TTC in this study was defined as 100 percent of the thermal rating of the line sections in the transmission path.
- ETC is defined as Tri-State native load-serving needs, existing commitments for transmission service and existing commitments for purchase/exchange/delivery.
- TRM is defined as through flow across the requested path and transfer capability required to ensure reliable system operation as system conditions change. WECC operating practice requires transmission providers to accommodate some through-flow which may decrease ATC. TRM is also utilized to deliver and receive reserve obligations associated with a Reserve Sharing Group.

Tri-State Power System Planning provided a 10 year native load forecast for K.C. Electric Association, Mountain View Electric Association, San Isabel Electric Association, San Luis Valley Rural Electric Cooperative, Southeast Colorado Power Association and Gunnison County Electric Association. Tri-State System Operations provided the firm committed uses for the Story to Wray to Burlington to Big Sandy to Midway transmission path and confirmed Tri-State's reserve obligations with Tri-State Energy Management. These values were used as follows.

TTC is defined as the thermal rating of the Wray to Burlington 115 kV line section. This rating is 140 MVA and is based on 477 ACSR conductor constructed for 75 degrees C operation.

Transmission MW capacity of the Wray to Burlington 115 kV line:	140 MW
Transmission purchased from others by and for Tri-State native loads:	
Firm transmission from CRSP for Tri-State	100 MW
CRSP Preference Power delivered to Midway	43 MW
Firm transmission from PSCo (Ault-Comanche)	<u>50 MW</u>
Total TTC	333 MW

ETC is the sum of native load demand, existing commitments for transmission service and existing commitments for reserves. Tri-State's 10-year projected coincident native load (Total Maximum Coincident Peak, or MCP) for K.C. Electric, San Isabel, San Luis Valley, Mountain View, Gunnison County, and Southeast Colorado Power is as follows: 419 MW winter peak and 446 MW summer peak.

Firm Committed Uses by Others on the Wray to Burlington Line

PSCo delivery to MEAN (City of Fountain)	40 MW
PSCo delivery to ARPA (Las Animas)	3 MW
ARPA existing firm use	<u>3 MW</u>
Total	46 MW

Total ETC = 446 MW (native load summer peak) + 46 MW = 492 MW

No significant variations in firm requirements for transmission capacity (reserve margin) are assumed for the Wray to Burlington path, therefore for purposes of this study the TRM is 0 MW.

Based on the above, the existing ATC for the Wray to Burlington 115 kV line section is calculated as follows:

$$\begin{aligned} \text{ATC} &= \text{TTC} - \text{ETC} - \text{TRM} \\ \text{ATC} &= 333 \text{ MW} - 492 \text{ MW} - 0 \text{ MW} = -159 \text{ MW} \end{aligned}$$

This non flow-based analysis of ATC for the Wray to Burlington 115 kV line demonstrates that Tri-State is presently unable to source its entire south and southeastern Colorado native load via its Story-North Yuma-Wray-Burlington-Big Sandy-Midway path. Therefore, Tri-State is limited to less economical Network Resource dispatch or purchases from others to serve this native load. The above analysis identified committed uses which, together with Tri-State's native load requirements, results in zero ATC available for third party interconnections.

With the construction of the proposed Burlington to Wray 230 kV line, TTC is defined as the thermal rating of the entire Wray to Burlington path, that is, the sum of the 115 kV line thermal rating and the 230 kV line thermal rating. Tri-State is proposing to construct the Burlington to Wray 230 kV line with 1272 MCM ACSR conductor with a maximum design temperature of 100 degrees C (1538 amperes)(612 MVA). Therefore, TTC with the proposed Burlington to Wray 230 kV line becomes:

$$\text{MW capacity of the Wray to Burlington path: } 612 \text{ MW} + 140 \text{ MW} = 752 \text{ MW}$$

Based on the above, the existing TTC for the Wray to Burlington line section, as an element of the Story-North Yuma-Wray-Burlington-Big Sandy-Midway path, increases from 140 MW to 752 MW and removes the most limiting element of this path. It should be noted that increasing the TTC of the Wray to Burlington section, by itself, does not permit Tri-State to source all of its native load-serving needs via the Story-North Yuma-Wray-Burlington-Big Sandy-Midway path. The next most limiting element is the Story to North Yuma 230 kV line, which is limited due to its conductor thermal rating and Existing Committed uses for that line. However, Tri-State is investigating the possibility of upgrading the Story to North Yuma 230 kV line to 100 degrees C operation. That upgrade will raise the thermal rating of the line to approximately 512 MW, greatly increasing Tri-State's contractual load-serving capability over the Story-North Yuma-Wray-Burlington-Big Sandy-Midway path. Therefore, the proposed 230 kV Burlington to Wray line is the first part of a two-part proposal to increase the load serving capability of this contractual path.

Additional Generation

The addition of the Burlington – Wray 230 kV line to the eastern Colorado transmission system provides the added benefit of accommodating some amount of additional power injection. In order to quantify this benefit, the study looked at power injection near Burlington and Wray, incrementing that injection from zero up to 200 MW at each location. System limitations were found when the Kit Carson wind generation was combined with 160 MW of additional generation near Burlington or with 175 MW of additional generation near Wray. Study results are summarized below and in Table 2. Detailed results are in Appendix D for heavy summer conditions and Appendix E for light winter conditions.

In the light winter case with 160 MW of additional generation injections near Burlington, all overloads are mitigated by the 230 kV line addition, except for the Big Sandy – Last Chance 115 kV line loading to 100% of its 109 MVA rating for the Midway – Lincoln 230 kV line outage. This establishes the limitation of the Burlington generation injections for the dispatch assumptions modeled in this study. In addition, instances of voltage instability of the system under outage conditions are mitigated by the Burlington – Wray 230 kV line addition, as seen for both the Big Sandy – BurlWInc 230 kV line outage and the Midway – Lincoln 230 kV line outage, which reach solution only after the 230 kV line addition.

In the light winter case with 175 MW of additional generation injections near Wray, all overloads are mitigated by the 230 kV line addition, except for the Eckley – Wray Tap 115 kV line loading to 101% of its 85 MVA rating for the outage of the North Yuma – Wray 230 kV line. This establishes the limitation of the Wray generation injections for the dispatch assumptions modeled in this study.

In the heavy summer cases with the above generation injections, all pre-project criteria violations are mitigated with the addition of the Burlington – Wray 230 kV line. The instance of voltage instability under outage conditions is also mitigated, as seen for the Big Sandy – BurlWInc 230 kV line outage, which reaches solution only after the 230 kV line addition.

These results do not indicate the exact levels of generation additions that can be expected through a Generation Interconnection (GI) or Transmission Service Request (TSR) study. The assumptions required for those studies may differ from the ones used herein.

Table 2a: LW Results I, Burlinj at 160 MW

Case	Outage	Monitored Element	Rating (MVA)	Loading w/o Burlington-Wray 230 kV Line (%)	Loading w/ Burlington-Wray 230 kV Line (%)
DukeInj + BurlInj	System Normal	Big Sandy - BurlWInc 230 kV	284	80.9	< 80.0
DukeInj + BurlInj	Big Sandy - BurlWInc 230 kV			** Blown Up **	Solved w/ no violations
DukeInj + BurlInj	BurlWInc - DEGS Wind 230 kV	Bonny Creek - Burlington 115 kV	140	110.6	< 100.0
DukeInj + BurlInj	BurlWInc - DEGS Wind 230 kV	Bonny Creek - South Fork 115 kV	140	110.4	< 100.0
DukeInj + BurlInj	BurlWInc - DEGS Wind 230 kV	Idalia - South Fork 115 kV	140	108.6	< 100.0
DukeInj + BurlInj	BurlWInc - DEGS Wind 230 kV	Idalia - Vernon Tap 115 kV	140	107.6	< 100.0
DukeInj + BurlInj	BurlWInc - DEGS Wind 230 kV	Vernon Tap - Wray 115 kV	140	107.4	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Big Sandy - Last Chance 115 kV	109	118.3	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Beaver Creek - Gary 115 kV	109	113.1	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Bonny Creek - Burlngtn 115 kV	140	125.7	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Bonny Creek - South Fork 115 kV	140	125.5	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Gary - Woodrow 115 kV	109	113.8	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Idalia - South Fork 115 kV	140	123.8	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Idalia - Vernon Tap 115 kV	140	122.8	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Last Chance - South Woodrow 115 kV	109	115.4	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	South Woodrow - Woodrow 115 kV	109	114.7	< 100.0
DukeInj + BurlInj	Big Sandy - Lincoln 230 kV	Vernon Tap - Wray 115 kV	140	122.6	< 100.0
DukeInj + BurlInj	Midway - Lincoln 230 kV			** Blown Up **	Solved w/ 1 violation
DukeInj + BurlInj	Midway - Lincoln 230 kV	Big Sandy - Last Chance 115 kV	109	N/A	99.7
DukeInj + BurlInj	Burlington - South Fork 115 kV	Big Sandy - BurlWInc 230 kV	284	114.2	< 100.0
DukeInj + BurlInj	South Fork - Wray 115 kV	Big Sandy - BurlWInc 230 kV	284	113.1	< 100.0

Table 2b: LW Results II, Wrayinj at 175 MW

Case	Outage	Monitored Element	Rating (MVA)	Loading w/o Burlington-Wray 230 kV Line (%)	Loading w/ Burlington-Wray 230 kV Line (%)
Dukelnj + WrayInj	Big Sandy - BurlWInc 230 kV	Bonny Creek - Burlington 115 kV	140	110.4	< 100.0
Dukelnj + WrayInj	Big Sandy - BurlWInc 230 kV	Bonny Creek - South Fork 115 kV	140	110.1	< 100.0
Dukelnj + WrayInj	Big Sandy - BurlWInc 230 kV	Idalia - South Fork 115 kV	140	108.2	< 100.0
Dukelnj + WrayInj	Big Sandy - BurlWInc 230 kV	Idalia - Vernon Tap 115 kV	140	107.1	< 100.0
Dukelnj + WrayInj	Big Sandy - BurlWInc 230 kV	Vernon Tap - Wray 115 kV	140	106.8	< 100.0
Dukelnj + WrayInj	BurlWInc - DEGS Wind 230 kV	Bonny Creek - Burlington 115 kV	140	110.4	< 100.0
Dukelnj + WrayInj	BurlWInc - DEGS Wind 230 kV	Bonny Creek - South Fork 115 kV	140	110.1	< 100.0
Dukelnj + WrayInj	BurlWInc - DEGS Wind 230 kV	Idalia - South Fork 115 kV	140	108.2	< 100.0
Dukelnj + WrayInj	BurlWInc - DEGS Wind 230 kV	Idalia - Vernon Tap 115 kV	140	107.2	< 100.0
Dukelnj + WrayInj	BurlWInc - DEGS Wind 230 kV	Vernon Tap - Wray 115 kV	140	106.9	< 100.0
Dukelnj + WrayInj	North Yuma - Wray 230 kV	East Yuma Tap - Deering Lake 115 kV	84.9	103.4	< 100.0
Dukelnj + WrayInj	North Yuma - Wray 230 kV	East Yuma Tap - Eckley 115 kV	84.9	110.1	< 100.0
Dukelnj + WrayInj	North Yuma - Wray 230 kV	Eckley - Wray Tap 115 kV	84.9	114.9	101.1
Dukelnj + WrayInj	North Yuma - Wray 230 kV	Wray - Wray Tap 115 kV	95	102.7	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Big Sandy - Last Chance 115 kV	109	126.9	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Beaver Creek - Gary 115 kV	109	121.6	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Bonny Creek - Burlngtn 115 kV	140	107.2	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Bonny Creek - South Fork 115 kV	140	106.9	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Gary - Woodrow 115 kV	109	122.2	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Idalia - South Fork 115 kV	140	104.9	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Idalia - Vernon Tap 115 kV	140	103.9	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Last Chance - South Woodrow 115 kV	109	123.9	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	South Woodrow - Woodrow 115 kV	109	123.2	< 100.0
Dukelnj + WrayInj	Midway - Lincoln 230 kV	Vernon Tap - Wray 115 kV	140	103.5	< 100.0
Dukelnj + WrayInj	SpringCanyon-Nyuma-Wray	East Yuma Tap - Deering Lake 115 kV	84.9	100.8	< 100.0
Dukelnj + WrayInj	SpringCanyon-Nyuma-Wray	East Yuma Tap - Eckley 115 kV	84.9	107.7	< 100.0
Dukelnj + WrayInj	SpringCanyon-Nyuma-Wray	Eckley - Wray Tap 115 kV	84.9	112.4	< 100.0
Dukelnj + WrayInj	SpringCanyon-Nyuma-Wray	Wray - Wray Tap 115 kV	95	100.5	< 100.0
Dukelnj + WrayInj	Story-Nyuma-Wray	East Yuma Tap - Eckley 115 kV	84.9	105.4	< 100.0
Dukelnj + WrayInj	Story-Nyuma-Wray	Eckley - Wray Tap 115 kV	84.9	110.2	< 100.0

Table 2c: HS Results, Additional Injections

Case	Outage	Monitored Element	Rating (MVA)	Loading w/o Burlington-Wray 230 kV Line (%)	Loading w/ Burlington-Wray 230 kV Line (%)
Dukelnj + BurlInj	Big Sandy - BurlWInc 230 kV			** Blown Up **	Solved w/ no violations
Dukelnj + BurlInj	Big Sandy - Lincoln 230 kV	Bonny Creek - Burlington 115 kV	140	110.8	< 100.0
Dukelnj + BurlInj	Big Sandy - Lincoln 230 kV	Bonny Creek - South Fork 115 kV	140	104.6	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Big Sandy - Last Chance 115 kV	109	140.5	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Beaver Creek - Gary 115 kV	109	132.2	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Bonny Creek - Burlngtn 115 kV	140	153.0	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Bonny Creek - South Fork 115 kV	140	146.4	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Gary - Woodrow 115 kV	109	133.2	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Idalia - South Fork 115 kV	140	125.6	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Idalia - Vernon Tap 115 kV	140	117.0	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Last Chance - South Woodrow 115 kV	109	135.2	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	South Woodrow - Woodrow 115 kV	109	134.4	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Vernon Tap - Wray 115 kV	140	111.3	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Big Sandy 230/115 kV	167	103.6	< 100.0
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Arickaree 115 kV Voltage		0.899 pu	>0.90 pu
Dukelnj + BurlInj	Midway - Lincoln 230 kV	Joes 115 kV Voltage		0.899 pu	>0.90 pu
Dukelnj + WrayInj	N. Yuma – Story and N. Yuma Xfmr	Wray 230/115 kV	186	111.3	<100.0

Appendix A: Transmission Alternative Analysis

Introduction

To eliminate the existing path limitation, there are a number of possible transmission alternatives between the Burlington and Wray stations. The alternatives available include variations in line voltage and number of circuits (1 or 2), and consideration of reuse of the existing Burlington to Wray 115 kV transmission line and associated right-of-way. This Appendix will discuss issues associated with line ratings and other criteria applied to analyze various options.

Line Rating Discussion

This section provides a general overview of line ratings by voltage and conductor type. This is not intended to be an exhaustive look at the types of conductors available for use or every option that can be considered, rather this provides overview descriptions related to this project.

Transmission lines are generally rated using a maximum conductor operating temperature, in degrees Celsius (C), and a corresponding amount of current, in Amperes (A) that the line can safely carry. Without considering the effects of outdoor ambient temperature and weather conditions, the conductor temperature will rise as the current level rises. For example, the existing Burlington-Wray 115 kV transmission line utilizes a 477 ACSR “Hawk” conductor and is rated for a maximum conductor operating temperature of 75 degrees C. Using Tri-State’s methodology for conductor continuous ratings, this line is therefore rated to carry approximately 704 A, equal to 140 MVA at 115 kV, without considering if there are other transmission system elements that could be lower than this conductor rating, such as disconnect switches or instrument transformers in substations included in this path.

Using standard ACSR conductor types, Tri-State utilizes a maximum conductor operating temperature of 100 degrees C, so there is a possibility the existing line could be upgraded to achieve this rating. This would be accomplished by raising the transmission structures to allow for the additional conductor sag resulting from the higher currents associated with this increased maximum conductor operating temperature of 100 degrees C. Again using Tri-State’s methodology for conductor continuous ratings, this line rating could then be raised to approximately 166 MVA.

As the existing 477 ACSR “Hawk” type of conductor that is used on the existing Burlington-Wray 115 kV line has a maximum capability of 166 MVA, replacing this conductor with a new one, or re-conductoring the existing line is an option to try to raise this thermal rating. The existing line was designed to support the 477 ACSR “Hawk” type of conductor, so attempting to re-conductor with a larger diameter ACSR conductor to try to achieve a higher thermal rating is not appropriate due to the higher structural loadings likely requiring replacement of some or all of the transmission structures.

An additional option is to replace the ACSR type of conductor with a different type that can achieve a higher thermal rating, such as an Aluminum Conductor Steel Supported (ACSS), Aluminum Conductor Composite Reinforced (ACCR), or Aluminum Conductor with Composite Core (ACCC) type. These conductors all have higher capacity than the same size ACSR

conductor, but the increase in conductor costs can be significant. For example, ACCC conductor costs are 7-8 times as expensive as their standard ACSR size equivalent. With the limitations of the conductor size and voltage that the line was designed for, this was eliminated from further evaluation.

Re-building the line in place of the existing line can also be considered as an option. Using the same existing 115 kV line example, an option is to re-build the line with a new 115 kV single circuit line with a higher capacity or possibly replacing with a new 230 kV line. A typical conductor used by Tri-State for a new 115 kV line is a 795 ACSR, which has a thermal rating of 232 MVA using a 100 degrees C maximum operating temperature. A typical conductor for a new 230 kV line is a 1272 ACSR, which has a thermal rating of 612 MVA.

The line ratings for these re-building options would also apply to new line options where the existing 115 kV line would remain. For example, a new 115 kV line constructed using a 795 ACSR would have a thermal rating of 232 MVA and a new 230 kV line constructed using a 1272 ACSR has a thermal rating of 612 MVA. There are other conductor types that could be examined, but these show an example of the large difference in ratings when considering a standard 115 kV line and a standard 230 kV line. Extending this to 345 kV options, a common 345 line construction utilizes two 1272 ACSR conductors per phase. If this line were operated at 230 kV, this would provide a thermal rating equal to twice the 612 MVA rating provided by one 1272 ACSR operated at 230 kV, or 1224 MVA. If it were operated at 345 kV, it would then have a thermal rating of 1838 MVA. Considering double circuit structures, these ratings then apply to each individual circuit.

Transmission alternatives

The following alternatives were analyzed to determine their suitability in resolving the system deficiencies:

1. Existing line and right-of-way alternatives:
 - a. Thermal upgrade of the existing Burlington-Wray 115 kV line.
 - b. Re-conductor the existing Burlington-Wray 115 kV line.
 - c. Re-build the existing Burlington-Wray 115 kV line.
2. New line using existing right-of-way alternatives (including removal of existing Burlington-Wray 115 kV line):
 - a. New Burlington-Wray 230 kV single circuit line, operated at 115 kV or 230 kV.
 - b. New Burlington-Wray 115/230 kV double circuit line.
3. New line using new right-of-way alternatives (With existing Burlington-Wray 115 kV line staying in service):
 - a. New Burlington-Wray 115 kV single circuit line.
 - b. New Burlington-Wray 230 kV single circuit line.
 - c. New Burlington-Wray 230 kV double circuit line, with either one circuit or two circuits installed.

- d. New Burlington-Wray 345 kV single circuit or double circuit line, considering 230 kV or 345 kV operation and whether one or two circuits are installed on the double circuit option.

Transmission alternative analysis

Existing line and right-of-way alternatives.

A power flow analysis of the eastern Colorado system found that under certain system conditions the existing Big Sandy to Beaver Creek 115 kV line overloads. The lighter the load in eastern Colorado and the greater the generation injection in the Burlington area, the greater the potential overload of the line. For example, the analysis found that with 51 MW of generation in the Burlington area, the overload of the line reaches 120% for a loss of the Midway to Lincoln 230 kV line. The overload reaches 127% for the same outage with 175 MW of generation modeled in the Burlington area. (Reference Table 1 and Table 2b of this report.) This overload cannot be mitigated with a rebuild or reconductor of the Burlington – Wray 115 kV circuit, but can be entirely mitigated with the construction of a second Burlington – Wray circuit.

Considering this fundamental northeast Colorado 115 kV system overload problem, this first set of transmission alternatives (1.a-1.c) that consider the re-use of the existing 115 kV line and associated right-of-way were eliminated from further analysis as these resulting overload problems on the Big Sandy to Beaver Creek 115 kV line would be expected to persist with these options. This is in addition to the operational and constructability issues, and limited increase in line rating with these options.

Evaluation criteria.

The remaining transmission alternatives (2.a-2.b and 3.a-3.d) between Burlington and Wray were evaluated using a number of criteria including:

1. Ability to eliminate operating restrictions on Tri-State’s existing Limon and Burlington generation facilities, without considering the new Kit Carson Windpower Project generation.
2. Ability to eliminate operating restrictions on Tri-State’s Limon, Burlington, and Kit Carson Windpower generation facilities.
3. Ability to eliminate Tri-State’s load-serving constraints for southern and eastern Colorado as identified in the Load Serving Analysis in this study, using a 10 year forecast period.
4. Ability to relieve Tri-State’s load-serving constraints beyond the 10 year forecasted period for southern and eastern Colorado, including the ability to serve loads bi-directionally (i.e. south to north in addition to identified north to south need).
5. Ability to allow additional generation resource injection in the area.
6. Consistency with transmission system and plans in the area.
7. Other considerations, including constructability, operational and maintenance issues.
8. Estimated cost (A summary of cost considerations including assumptions is included in Appendix G.)

The first three criteria are the previously mentioned deficiencies in the northeast Colorado area, and are considered to be the primary criteria in evaluating the alternatives. The remaining five criteria are then considered to be secondary criteria to be used for additional screening.

New line using existing right-of-way alternatives (including removal of the existing Burlington-Wray 115 kV line).

Alternative 2.a was eliminated from further consideration due to a number of factors. First, to allow for 230 kV operation, several distribution substations tapping the existing line (at Bonny Creek, South Fork, Idalia and Vernon Tap) would need to be converted from 115 kV to 230 kV, thereby adding substantial cost to the rebuild of the line. Second, rebuilding the line may be difficult during certain times of the year since each of the substations noted would need to be served radially for extended periods of time during construction. Operating the circuit radially could create further operational issues associated with dispatching the generation in eastern Colorado during the construction period. Third, a loss of the single-circuit between Burlington and Wray interrupts the primary contractual transmission path utilized by Tri-State to serve its native load in eastern Colorado, and this contractual path would be necessarily interrupted during the construction period. Finally, the existing 75-100 foot right-of-way along the existing line may not be sufficient for 230 kV H-frame construction and operation, and additional easements and new permits would likely be required. The 115 kV operation option of alternative 2.a would also not address the fundamental south to north overloading issue on the combined Big Sandy to Beaver Creek and Burlington to Wray 115 kV lines.

While alternative 2.b would resolve the first three criteria, or primary deficiencies, and would also adequately address criteria four through six, there are significant concerns regarding criteria 7 and 8. Similar to alternative 2.a, rebuilding the line may be difficult during certain times of the year with multiple tap substations that would need to be served radially for extended periods of time during construction. Operating the circuit radially could create further operational issues associated with dispatching the generation in eastern Colorado during the construction period. Also, a loss of the single-circuit between Burlington and Wray interrupts the primary contractual transmission path utilized by Tri-State to serve its native load in eastern Colorado, and this contractual path would be necessarily interrupted during the construction period. The existing 75-100 foot right-of-way along the existing line may not be sufficient for 230 kV construction and operation, and additional easements and new permits would likely be required. In addition to these concerns, the cost estimate for this alternative is \$44,040,000 assuming a line length of 51 miles to match the existing line, approximately \$10,000,000 more than constructing a single circuit 230 kV line in a new right-of-way which would provide an electrically equivalent option under normal system operating conditions. It is possible that the line length could be longer depending on siting considerations, which would increase this cost estimate. This option would also introduce an n-2 outage contingency, due to a possible common tower outage.

New line and new right-of-way alternatives (with the existing Burlington-Wray 115 kV line remaining).

A new 115 kV line considered in alternative 3.a may resolve the first two primary deficiencies; however there would be questionable load-serving capability added to address the third primary deficiency. Since the transmission considered in the Story to North Yuma to Wray to Burlington to Big Sandy to Midway path is 230 kV at Burlington and Wray substations, there would be additional transformer capacity required at both substations to be able to utilize the combined capacity provided by the new 115 kV line (232 MVA) and the existing 115 kV line (140 MVA). Even assuming additional transformers were added to allow for this shortfall, with a combined path rating of approximately 372 MVA in this scenario it would still be below the potential 512 MVA rating mentioned in the Load Serving Analysis for the Story to North Yuma to Wray 230 kV line. Considering these deficiencies, in addition to an estimated cost of \$27,702,000 for a single circuit 115 kV line versus the estimate of \$34,363,000 for a new single circuit 230 kV line without considering the additional costs of 230/115 kV transformers at Wray or Burlington, this alternative was eliminated from further consideration.

A new 230 kV line considered in alternative 3.b would resolve the three primary deficiencies. The new 230 kV line would have a thermal rating of 612 MVA, and adding the 140 MVA available on the existing 115 kV line would provide a new load-serving path rating of 752 MVA between Burlington and Wray. This would, therefore, resolve the forecasted load-serving deficit, and would be consistent with the connected 230 kV system at Burlington and Wray to allow for future load-serving support beyond the 10 year forecasted period. In addition, this new 230 kV line removes this northeast Colorado system limitation and allows for additional generation injection capability in the area.

The remaining alternatives 3.c and 3.d consider double circuit 230 kV construction alternatives and 345 kV construction alternatives. Similar to the new single circuit 230 kV line, these alternatives would each be expected to resolve the three primary deficiencies identified. As they would each have a thermal capacity equal to or higher than a single circuit 230 kV line, each of these would also be expected to provide future load-serving support beyond the 10 year forecasted period identified in the Load Serving Analysis. However, when considering the consistency with the transmission system in the area such as the lack of 345 kV facilities in service today, these options are shown to have deficiencies, especially when considering the significant additional costs of constructing any of these alternatives.

As shown in Appendix G, the cost estimates for alternatives 3.c and 3.d range from approximately \$51,000,000 to \$82,000,000, which is \$17,000,000 to \$48,000,000 more than the new 230 kV single circuit alternative without considering additional substation equipment costs. As has been stated previously, Tri-State's transmission system connected from the west to east to Tri-State's existing Burlington and Wray Substations consists of a single circuit 230 kV transmission line. These single circuit 230 kV lines serve as the next limit to the Story to North Yuma to Wray to Burlington to Big Sandy to Midway path after the 115 kV Burlington to Wray limitation is addressed. Both of these east-west single circuit 230 kV transmission lines connected to Burlington and Wray are thermally rated below the new 752 MVA thermal rating

that would be provided by a single circuit 230 kV transmission line between Burlington and Wray. This means additional transmission upgrades or new lines must be completed on these east-west sections in order for Tri-State to realize any benefit of constructing a line between Burlington and Wray larger than a single circuit 230 kV line. Therefore, for Tri-State, the additional costs of these options would be better spent on other transmission upgrades in the area. When considering that no other parties were prepared to financially participate in constructing the line larger than a single circuit 230 kV line that has been shown to address Tri-State's needs, these options were eliminated from further consideration.

Conclusion

Based on these analyses, a new Burlington – Wray single-circuit 230 kV line, (Alternative 3.b) is the best alternative in order to cost effectively:

1. Remove the operating limitations of existing Tri-State generation in the area,
2. Provide a load-serving path consistent with Tri-State's forecasted need and also consistent with the long term capability of the path and system in the area,
3. Provide for additional generation development in this area of Colorado that has been identified as having great wind potential, illustrated by the Kit Carson Windpower Project.
4. Complement long term plans in the area, providing an additional electrical path between Burlington and Wray to remove limitations of the existing lone 115 kV Burlington-Wray line.

Alternative Conductors And Loss Analysis

The proposed Burlington – Wray 230 kV line was modeled with 1272 ACSR conductor on wood H frame construction. Other conductor configurations were considered as well, through an economic loss evaluation of different conductor impedances. This included ACSR (954, 1272, and 1590 MCM), and ACSR/TW (1557 MCM) conductors. The loss evaluation is in Appendix F.

As demonstrated in the Conductor Loss Comparison (Appendix F), the differences between the average expected system normal losses on the Burlington – Wray 230 kV line for various conductors are minimal when compared to the additional installation costs. This difference in average expected system normal losses savings compared to installation costs would then be amplified for higher thermal rating conductors such as ACSS, ACCC, and ACCR which have relatively similar impedances and significantly higher costs. This evaluation indicates that a standard 1272 MCM ACSR on wood H-frame construction with a maximum design temperature of 100 degrees C (1538 Amperes) is a good conductor choice for use on the Burlington-Wray 230 kV line from an expected losses standpoint.

Appendix B: Contingency List

Category B Outages

PAWNEE 230.-STORY 230. #1
B.CK PS 115.-BEAVERCK 115. #1
B.CK PS 230.-STORY 230. #1
HENRYLAK 230.-STORY 230. #1
BURLWINC 230.-BURLWINJ 230. #1
BURLWINC 230.-B.SANDY 230. #1
BURLWINC 230.-DEGS WIND 230. #1
WRAYINJ 230.-WRAY 230. #1
B.CK TRI 115.-BEAVERCK 115. #1
B.CK TRI 230.-STORY 230. #1
B.SANDY 115.-LSCHANCE 115. #1
B.SANDY 115.-LIMON 115. #1
B.SANDY 230.-LINCOLNT 230. #1
BURLNGTN 230.-WRAY 230. #1
BURLNGTN 230.-DEGS WIND 230. #1
LAR.RIVR 345.-STORY 345. #1
N.YUMA 230.-STORY 230. #1
N.YUMA 230.-WRAY 230. #1
FRENCHCK 115.-WAUNETA 115. #1
DEERINGL 115.-N.YUMA 115. #1
DEERINGL 115.-YUMA 115. #1
KIOWA CK 115.-ORCHARD 115. #1
ECKLEY 115.-ROBB 115. #1
ECKLEY 115.-BETHELLM 115. #1
VERNONTP 115.-VERNONLM 115. #1
MIDWAYBR 230.-LINCOLNT 230. #1
DEGS WIND 230.-DEGS 230 230. #1
BRUSH SS 115.-B.CK PS 115. #1
BRUSH SS 115.-B.CK PS 115. #2
DANIELPK 230.-PAWNEE 230. #1
FTLUPTON 230.-PAWNEE 230. #1
MIDWAYPS 115.-MIDWAYBR 115. #1
MIDWAYPS 230.-MIDWAYBR 230. #1
MIDWAYPS 230.-FULLER 230. #1
PAWNEE 230.-PTZLOGN 230. #1
MIDWAYPS 345.-WATERTON 345. #1
PAWNEE 345.-SMOKYHIL 345. #1
AULT 345.-LAR.RIVR 345. #1
SIDNEY 230.-SIDNEYDC 230. #1
SIDNEY 230.-STEGALL 230. #1
SIDNEY 230.-SPRNGCAN 230. #1
STEGALDC 230.-STEGALL 230. #1
CHEYENNE 230.-SNOWYRNG 230. #1
PAWNEE 230.-BRICKCTR 230. #1
QUINCY 230.-BRICKCTR 230. #1
MIDWAYBR 230.-RD_NIXON 230. #1
MIDWAYBR 230.-W CANON 230. #1
STERLING 69.-STERLING 115. #1 XFMR

B.CK TRI 115.-B.CK TRI 230. #1 XFMR
B.SANDY 115.-B.SANDY 230. #1 XFMR
BURLNGTN 115.-BURLNGTN 230. #1 XFMR
BURLNGTN 115.-BURLNGTN 230. #2 XFMR
BURLNGTN 115.-BURLNGTN1 13.8 #1 XFMR
BURLNGTN 115.-BURLNGTN2 13.8 #1 XFMR
N.YUMA 115.-N.YUMA 230. #1 XFMR
STORY 230.-STORY 345. #1 XFMR
STORY 230.-STORY 345. #2 XFMR
WRAY 115.-WRAY 230. #1 XFMR
LINCOLNT 230.-LINCOLN1 13.8 #1 XFMR
LINCOLNT 230.-LINCOLN2 13.8 #1 XFMR
DEGS 230 230.-DEGS 34.5 #1 XFMR
PAWNEE 230.-WND_PLN 34.5 #1 XFMR
BRICKCTR 230.-BRICKCTR 115. #T1 XFMR
BRUSH SS 115.-QF BCP2T 13.8 #2T XFMR
BRUSH SS 115.-QF B4-4T 13.8 #4T XFMR
BRUSH SS 115.-QF CPP1T 13.8 #1T XFMR
BRUSH SS 115.-QF CPP3T 13.8 #3T XFMR
BRUSH SS 115.-QF B4D4T 12.5 #4A XFMR
CHEROK1 15.5-CHEROKEE 115. #U1 XFMR
CHEROK2 15.5-CHEROKEE 115. #U2 XFMR
CHEROK3 20.0-CHEROKEE 115. #U3 XFMR
CHEROK4 22.0-CHEROKEE 115. #U4 XFMR
MIDWAYPS 230.-MIDWAYPS 345. #T1 XFMR
PAWNEE 22.0-PAWNEE 230. #1A XFMR
PAWNEE 22.0-PAWNEE 230. #1B XFMR
PAWNEE 230.-MANCHEF1 16.0 #11 XFMR
PAWNEE 230.-MANCHEF2 16.0 #12 XFMR
PAWNEE 230.-PAWNEE 345. #T1 XFMR
PAWNEE 230.-PAWNEE 345. #T2 XFMR
B.CK PS 115.-B.CK PS 230. #T1 XFMR
HENRYLAK 230.-HENRYLAK 115. #1 XFMR
COMANCHE 345.-COMAN 3 24.0 #1 XFMR
PTZLOGN1 34.5-PTZLOGN 230. #1 XFMR
PTZLOGN 230.-PTZLOGN2 34.5 #1 XFMR
PTZLOGN 230.-PTZLOGN3 34.5 #1 XFMR
SPRNGCAN 34.5-SPRNGCAN 230. #1 XFMR
CEDARCRK 230.-CEDARCK1 34.5 #1 XFMR
CEDARCRK 230.-CEDARCK2 34.5 #1 XFMR
LAR.RIVR 230.-LAR.RIVR 345. #1 XFMR
LAR.RIVR 345.-MBPP-1 24.0 #1 XFMR
LAR.RIVR 345.-MBPP-2 24.0 #1 XFMR
SIDNEY 115.-SIDNEY 230. #1 XFMR
MIDWAYBR 115.-MIDWAYBR 230. #1 XFMR
BURLINGTON-BONNY CK-SOFORK 115 kV
SO FORK-IDALIA-VERNON TP-WRAY 115 kV
BRIGHTON-SANDCK-HOYT 115 kV
BCK-AKRON-OTIS-DEERINGLK 115 kV
DEERINGLAKE-E_YUMA_TAP-ECKLEY 115 kV
WRAY-SANDHILL-ALVIN-WAUNETATA 115 kV

LAST CHANCE-ANTON 115 kV
ARICKAREE-SO FORK 115 kV
LAST CHANCE-SWOOD-WOODROW 115 kV
BURLINGTON-BURLKC 115 kV
DALTON-SIDNEY 115.00- 115 kV
JACINTO-SIDNEY 115.00- 115 kV
SIDNEY-PEETZ-STERLING 115 kV
BCK-MESSEX-STERLING 115 kV
STERLING-FRENCHCK 115 kV
WAUNTEA-N.YUMA 115 kV
HOYT-KIOWACK 115 kV
PROSPECT VALLEY TAP OUTAGE
KIOWA CK-FTMORGANWEST 115 kV
ECKLEY-WRAY 115 kV
WRAY-WRAYWAPA 115 kV
SPCN-NYUMA-RAS (NO RUNBACK) 230 kV
BEAVERCK-GARY-WOODROW 115 kV
BC-ADN-HYT 115 kV
BCK-BRUSH-EFM 115 kV
FMWEST-FMS 115 kV

Category C Outages

PROSPECT VALLEY TAP & KIOWA CK-FTMORGANWEST 115
TWO STORY TRANSFORMERS OUTAGE
NYUMA-SPRNGCNYN & NYUMA XFMR OUTAGE
SIDNEY-SPRNGCNYN-NYUMA 230 OUTAGE
SPRNGCNYN-NYUMA-WRAY 230 OUTAGE
DEER LK-NY & NY XFMR OUTAGE
HL-STORY & BC-ADN-HYT
HL-STORY & HYT-SNDCK-BRGHTN
STORY-PAWNEE & STORY XFMR OUTAGE
NYUMA-WAUNETA & NY XFMR OUTAGE
DEERING L-NY-RED WILLOW (WAUNETA) OUTAGE
NYUMA-STORY & NYUMA XFMR OUTAGE
STORY-NYUMA-WRAY 230 OUTAGE
STORY-NORTH YUMA & STORY XFMR 1 OUTAGE
BURL-WRAY 230 & BURLINGTON-BONNY CK-SOFORK
BURL-WRAY 230 & SO FORK-IDALIA-VERNON TP-WRAY

Appendix C: Base Case Modifications

Major Modifications to the Heavy Summer and Light Winter Cases

Both Heavy Summer and Light Winter Cases

- Correct the Last Chance - South Fork 115 kV line impedance and the location of the normally open point. Left as Normally Open between Anton and Arickaree.
- Left Archer Configuration out as this has very little impact to the Burlington/Wray area line loadings.
- Correct configuration in the Ft. Morgan loop.
- Status out the duplicate Duke plant.
- Status out duplicate Erie - Sipres - Henry Lake - Story 230 kV line and correct Sipres load.
- Adjust loads to the appropriate levels for Heavy Summer or Light Winter.
- Adjust the switched shunt settings at Ft.MorganWest, Frenchman Creek, Sidney 115 kV, and Spring Creek Tap.
- Adjust transformer tap settings at Sidney and Sterling.
- Deleted LTC on Wray 230/115 kV transformer as this does not exist.
- Adjust rating of the Burlington - Big Sandy 230 kV line.
- Adjust rating of the Burlington - Wray 115 kV line.
- Add the Burlington - Wray 230 kV line, status off; turned on in appropriate cases.
- Set the existing Burlington generating units to their maximums, 100 MW in the summer and 120 MW in the winter.
- Set the existing Limon (Lincoln) generating units to their maximums, 120 MW in the summer and 136 MW in the winter.
- Add the Duke Wind Plant 5 miles west of Burlington on the 230 kV line to Big Sandy. Status out; turned on at 51 MW in appropriate cases.
- Add a generation injection 30 miles west of Burlington on the 230 kV line to Big Sandy, representing example wind interconnections. Status off; turned on at up to 200 MW in appropriate cases.
- Add a generation injection at Wray, representing example wind interconnections. Status off; turned on at up to 200 MW in appropriate cases.

Heavy Summer Case Only

- Adjust the switched shunt settings at Sterling and Story.
- Left generation at Peetz, Spring Canyon, and Peetz-Logan at 12.5% of maximum (61.5 MW total).

Light Winter Case Only

- Increase wind generation at Peetz, Spring Canyon, and Peetz-Logan to their maximums.

Appendices D and E contain output report data. These appendices are very large, and are contained in separate files. Please contact Tri-State G&T System Planning Department for a copy of these files.

Appendix D: Heavy Summer Results

Appendix E: Light Winter Results

Appendix F: Burlington – Wray 230 kV Loss Calculations

Conductor Loss Comparison

The following losses on the Burlington – Wray 230 kV line were calculated for system normal conditions with alternative conductors in the indicated cases. All cases have the existing generators at Burlington and Limon at full output. Some cases have additional power injections, as indicated by the case title. These load and generation dispatch assumptions produced a maximum loss value for projected system normal line conditions.

Due to seasonal variations in load and in the operation of local generation, the projected system normal line losses vary hour by hour throughout the year and will not remain at the maximum calculated value. Therefore, an average loss value across seasons and generation injection values was used to account for these variations. The average loss values are identified by conductor in the following table 3.

Table 3: Loss evaluation for selected conductors

Case	954 ACSR Losses (MW)	1272 ACSR Losses (MW)	1590 ACSR Losses (MW)	1557 ACSR/TW Losses (MW)
LW_NoInj	0.03089	0.02391	0.01973	0.01974
LW_DukeInj	0.20192	0.15602	0.12865	0.1285
LW_DukeInj+BurlInj	1.23662	0.95704	0.78941	0.78922
LW_DukeInj+WrayInj	0.0074	0.00566	0.00463	0.00461
HS_NoInj	0.08144	0.06293	0.05187	0.05185
HS_DukeInj	0.00401	0.00311	0.00256	0.00256
HS_DukeInj+BurlInj	0.4317	0.33432	0.27595	0.27592
HS_DukeInj+WrayInj	0.14648	0.11352	0.09373	0.09372
Average Losses	0.267558	0.207064	0.170816	0.170765
PWRR of Losses	\$2,937,416	\$2,273,277	\$1,875,329	\$1,874,767
PWRR of Project	\$28,612,265	\$29,361,574	\$30,942,370	\$30,961,003

For each of the above conductor alternatives, annual costs (revenue requirements) for demand and energy losses were calculated. The Present Worth of all future Revenue Requirements (PWRR) for those losses was determined. The PWRR for the total project costs were also determined for each alternative. The PWRR calculations were based on a 30 year project life, 3% per year inflation, an 8% interest rate, a 12% fixed charge rate, 15% planning generation reserve, \$2,100/kW installed generation cost, and \$75/MWh energy generation cost. The PWRR of the project also accounts for differences in major construction costs for the different conductors studied. The following assumptions were made for the major construction costs:

- a. Engineering, ROW, Environmental, and permitting costs are assumed to be the same for any conductor chosen.
- b. Costs are based on construction and major materials only. There will be some minor variances in the construction costs, but not sufficient to change the approximate per mile costs. Costs are based on an assumption of a line length of 60 miles.
- c. All lines were evaluated assuming 10000 pound maximum design tension and 800 foot ruling spans. Structures assumed were wood H-frames. By using the same tensions, the dead end structures and guying were assumed to be the same. The tangent and angle poles would be taller and heavier depending on the varying sag of the line. All other components on the structures including the cross arms and braces would be similar, therefore the cost differential is basically the cost of the conductors and the poles.

Appendix G: Cost Comparisons

Construction Alternatives	Cost² (\$000)
115 kV single circuit wood H-frame design, 60.4 miles, 1-795 ACSR Drake conductor, 100°C design temperature, 100 ft ROW, OPGW	\$27,702
230 kV single circuit wood H-frame design, 60.4 miles, 1272 ACSR Bittern conductor, 100°C design temperature, 150 ft ROW, OPGW	\$34,363
230 kV double circuit steel, 60.4 miles, 1-1272 ACSR Bittern conductor, 100°C design temperature, 150 ft ROW, OPGW, one side strung only	\$51,335
Stringing the other side at a future date ³	\$9,397
230 kV double circuit steel, 60.4 miles, 1-1272 ACSR Bittern conductor, 100°C design temperature, 150 ft ROW, OPGW, both sides strung	\$56,599
230 kV double circuit ⁴ , 51 miles, 1272 ACSR Bittern conductor, 100°C design temperature, 150 ft total ROW, OPGW	\$44,040
345 kV single circuit steel, 60.4 miles, 2-1272 ACSR Bittern conductor, 100°C design temperature, 175 ft ROW, OPGW	\$53,856
345 kV double circuit steel, 60.4 miles, 2-1272 ACSR Bittern conductor, 100°C design temperature, 200 ft ROW, OPGW, one side strung only	\$75,393
Stringing the other side at a future date ⁵	\$12,792
345 kV double circuit steel, 60.4 miles, 2-1272 ACSR Bittern conductor, 100°C design temperature, 200 ft ROW, OPGW, both sides strung	\$81,824

² Costs are for line construction only and do not include associated substation equipment costs.

³ Estimate does not include escalation to any particular future date.

⁴ This option replaces the existing 115 kV line; the status of the taps along this line may be compromised during construction activities.

⁵ Estimate does not include escalation to any particular future date.

EXHIBIT B

**Energy Efficiency, Demand Side
Management, and Distributed
Generation Study**
for the
Northeast Colorado Area



November, 2010

Energy Efficiency, Demand Side Management, and Distributed Generation Study for the Northeast Colorado Area

Introduction

In evaluations of the northeast Colorado electric system, Tri-State's studies have shown the system to have three significant deficiencies that require attention. As part of an alternative evaluation to determine the best way to address these, Tri-State developed this study to determine whether energy efficiency (EE), demand side management (DSM), and distributed generation (DG) alternatives were both appropriate and the optimum solutions to resolve these deficiencies. The three deficiencies are summarized in the following section, and more detail can be found on each of these deficiencies as well as transmission alternatives that are considered in Tri-State's separate Transmission Study for the Northeast Colorado Area.

Identified System Deficiencies

1. Operating restrictions on the existing Lincoln and Burlington generation.

The existing generation resources at Lincoln and Burlington can be restricted from simultaneously operating at their full output without criteria violations on the existing system. This is due to potential overloads on the existing Burlington to Wray 115 kV transmission line limiting Tri-State's ability to economically dispatch these existing generation resources in eastern Colorado.

2. Interim Restricted Operating Procedure placed on the 51 MW Kit Carson wind project.

Similar to the first deficiency summarized above, the combination of the existing generation resources at Lincoln and Burlington and the new Tri-State Kit Carson wind project can be restricted from simultaneously operating at their full output without criteria violations on the existing system. This is again due to potential overloads on the existing Burlington to Wray 115 kV transmission line limiting Tri-State's ability to economically dispatch these existing generation resources in eastern Colorado. An Interim Restricted Operating Procedure has been put in place to account for this operating restriction until network upgrades can be completed.

3. Deliverability of Tri-State resources to Tri-State native load.

The existing Wray to Burlington 115 kV transmission line constitutes a portion of a primary contractual transmission path utilized by Tri-State to serve its native load in eastern and southern Colorado from existing resources and is limited by its current thermal capacity. Tri-State's native load obligation in south and eastern Colorado

includes service to K.C. Electric Association (K.C.), Mountain View Electric Association (Mountain View), San Isabel Electric Association (San Isabel), San Luis Valley Rural Electric Cooperative (San Luis Valley), Southeast Colorado Power Association (Southeast) and Gunnison County Electric Association (Gunnison County). Using Tri-State's Power System Planning 10 year native load forecast for these six member systems, the Load Serving Analysis of the aforementioned Transmission Study for the Northeast Colorado Area concluded that there was a forecasted Available Transmission Capacity (ATC) deficiency of 159 MW in 2020 to serve these members, demonstrating Tri-State's inability to source these loads via its Story-North Yuma-Wray-Burlington-Big Sandy-Midway transmission path.

Energy Efficiency, Demand Side Management, and Local Distributed Generation Alternative Analysis

1. Definitions (from the U.S. Energy Information Administration¹ (EIA)):

Energy Efficiency (EE) – Refers to programs that are aimed at reducing the energy used by specific end-use devices and systems, typically without affecting the services provided. These programs reduce overall electricity consumption (reported in megawatthours), often without explicit consideration for the timing of program-induced savings. Such savings are generally achieved by substituting technologically more advanced equipment to produce the same level of end-use services (e.g. lighting, heating, motor drive) with less electricity. Examples include high-efficiency appliances, efficient lighting programs, high-efficiency heating, ventilating and air conditioning (HVAC) systems or control modifications, efficient building design, advanced electric motor drives, and heat recovery systems.

Demand Side Management (DSM) –The planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand. It refers to only energy and load-shape modifying activities that are undertaken in response to utility-administered programs. It does not refer to energy and load-shaped changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards. Demand-Side Management covers the complete range of load-shape objectives, including strategic conservation and load management, [and demand response] as well as strategic load growth.

Distributed Generation or Distributed Generator (DG) - A generator that is located close to the particular load that it is intended to serve. General, but non-exclusive, characteristics of these generators include: an operating strategy that supports the served load; and interconnection to a distribution or sub-transmission system (138 kV or less).

¹ <http://www.eia.doe.gov/glossary/index.cfm>

2. Overview of Existing Tri-State Programs Systemwide

Programs have already been implemented throughout Tri-State's Member Systems to promote energy conservation, efficiency, demand response and local generation, including small renewable projects. Some of these programs have been in place for more than 20 years and have been successful in helping to minimize the energy used and the maximum coincident peak load and some of these programs are relatively new and have the effect of offsetting against local demand.

Energy Efficiency and Demand Side Management:

Since 1985, Tri-State (through their Member System cooperatives) has been offering financial assistance toward the purchase of high-efficiency motors and pumps to reduce the electrical demand. The cooperatives have had the Energy Efficiency Credits (EEC) Program in place for more than 25 years. This program provides cash rebates to encourage and reward wise use of energy through energy-efficient purchases and practices. Through the EEC Program, Tri-State and the Tri-State Member System cooperatives have already reduced demand by over 75 MW (over the entire system) and saved more than 80,000 MWh of energy through the end of 2009. Tri-State and the Member Systems have expanded the EEC program to make it Energy Star based. Additional measures and programs have also been offered beginning at the first of 2009 and expanded during 2010.

Tri-State also works with each of its Member Systems for appropriate DSM programs, such as time of use rates and load control using time clocks or load signals. During 2009 and 2010, Tri-State conducted a comprehensive system evaluation to understand the technical and practical potential of EE and DSM for each of the regions served by Tri-State's Member Systems. This study is discussed in more detail below as it relates to the Member Systems identified as affected by the current electric system deficiencies, and can be found on the Tri-State website at the following link:

<http://www.tristategt.org/eecPrograms/energy-efficiency-study.cfm>

Distributed Generation:

Distributed generation is built on the concept of installing generation at or near the point of use. Solar, wind, or other alternative types of generation could be installed by the end user to meet the specific needs of the various types of loads, including residential, commercial, industrial, and irrigation. Residential and commercial loads, for example, can be reduced with the application of small solar or wind energy systems. This would tend to reduce the loads in the seven Member Systems and would also reduce the maximum coincident peak (MCP). For the Member Systems with significant amounts of irrigation loads, these represent a scheduled load and are generally not a good candidate for solar- or wind-generated power. However, these irrigation loads could be served with some type of generator located near one or more of the irrigation pumps. Typically, this would need to be powered by gasoline or diesel engines to be available when irrigation was required. The owners and operators of irrigation systems currently have the option of installing local generation; however, the electric cooperative's obligation is to serve the member consumer loads with the best option based on economic and environmental choices.

Tri-State has adopted several Board Policies that enable and provide incentives to Member Systems and their member consumers to participate in and install local renewable projects that can count for renewable portfolio standard (RPS) compliance in Colorado. These policies and the policies of the Member System Boards will provide for net metering at the member-consumer premises and for small community-based projects. Each of the Member Systems offer net metering programs and are evaluating local renewable projects. They also participate through Tri-State in EPRI and CRN research into distributed generation and distributed energy systems. Notwithstanding the attraction of such small distributed generation projects, they remain costly.

3. Application of EE/DSM/DG Programs within the Project Area

DSM/EE programs related to the Burlington-Wray Transmission Project:

The Tri-State Member Systems have different EE/DSM programs they offer. The six Member Systems previously mentioned in the native load serving analysis (deficiency #3 above) in addition to Y-W Electric Association (Y-W) were considered to be member-consumers with load service affected by this project. These seven Member Systems offer consumers appliance use information, energy use information, conservation guides, web-based conservation strategies and links, web-based energy calculators, free energy audits and conservation programs, CFL programs, and time-of-use rates. Each of them has line loss reduction strategies in place and participates through Tri-State in EPRI and CRN research into EE/DSM programs, measures and products.

Tri-State staff has conducted and participated in planning sessions with these Member Systems to expand their programs to include additional demand response through which the load can be shifted. For summer irrigation load, this will require installation of expensive communications and metering equipment, and upgrading their current distribution infrastructure. These investments take time and planning which is well underway. Tri-State is working with one of the Member Systems to support smart grid pilot projects that will support additional demand response. Tri-State is also developing project offering structures through which Member Systems can aggregate load modification activity of their member-owner/consumers to provide products to Tri-State.

As mentioned previously pertaining to EE/DSM, Tri-State has completed a comprehensive end-use energy efficiency/demand side management/demand response study across the entire system. This study examined the technical, economic, and practically achievable energy and demand reduction potential, focusing on program and measure potential in discrete geographic regions, such as those served by the Member Systems with load affected by this Project. There were a total of eight geographic regions analyzed in the study to account for sector diversity and climate. The seven Member Systems identified previously were spread across four of these geographic regions, with K.C., Southeast, and Y-W in the Eastern Colorado region, Mountain View and San Isabel in the Front Range Colorado Region, San Luis Valley in the Western Colorado Region, and Gunnison County in the Mountain Colorado Region. Based on this diversity, individual recommendations by region can be investigated to some extent, but Tri-State felt it was more appropriate to look at the combination of these seven specific Member Systems for the purposes of this study.

For the seven Member Systems, Tri-State determined their cumulative low potential in 2020 is 17,348,018 kWh energy and 3,258kW (3.258 MW) demand savings to a high potential of 30,949,400 kWh energy and 5,833 kW (5.833 MW) demand savings potential and ramping up for years thereafter. Additionally, given the caveats contained in the study about the ability to deploy EE/DSM/DR in rural, low density systems, the low potential is the more likely and planned to amount in considering EE/DSM/DR alternatives. The demand savings potential is more applicable to the purposes of resolving deficiency #3 identified, with a forecasted peak load serving ATC deficit of 159 MW for the six members identified that are affected by the load-serving limitations of the existing Wray to Burlington path. With a 159 MW need by the 2020 forecasted period, and a range of 3.258 to 5.833 MW of demand savings potential identified for the seven member group, the savings represent roughly 2-4% of the forecasted need. Clearly these potential savings do not materially contribute to meeting the purposes of resolving this identified deficiency and are not considered a viable alternative.

While this EE/DSM option has already been shown to be quantitatively insufficient for the purposes of resolving the third deficiency identified, it was also examined in more qualitative terms for resolving the first two deficiencies. As shown in the Transmission Study for the Northeast Colorado Area, these operating restrictions are generally more severe in the Light Winter loading condition rather than the Heavy Summer loading associated with higher system loads. The Eastern Colorado Region, especially in the area around Burlington where the operationally constrained network resources exist, has high amounts of irrigation loads in the summer that make the local loads significantly higher during this season. The Light Winter loading conditions are much lower, which results in higher loads on the transmission system when local generation is operated since there are fewer local loads to serve. With DSM/EE programs having the goal of reducing electrical loads, these lower loads would tend to exacerbate these operating restrictions rather than removing them as exhibited by the Light Winter loading conditions as compared to the Heavy Summer conditions. For this reason, these programs are also not considered a viable alternative.

Distributed generation (DG) programs related to the Burlington-Wray Transmission Project:

As with DSM/EE programs, DG also needs to be analyzed separately for how it relates to the first two operating condition deficiencies compared to how it relates to the third deficiency related to load-serving. With the amount of generation near Burlington already being operationally constrained due to insufficient transmission, additional DG in the same area would be expected to exacerbate the overloads experienced on the transmission system by reducing local loads with DG and increasing the total export of local generation out of the area. Based on this, DG is not considered a viable alternative to solve these first two deficiencies.

When evaluating the impacts of DG with regards to their potential to resolve the remaining third deficiency, the potential of each of the Member Systems affected by the load serving constraints would need to be evaluated. The Member Systems each have the right to meet up to five percent of their member-owner/consumers' needs through local generation projects that the Member Systems own or control. If the seven Member Systems identified installed this entire five percent as local generation projects, the maximum kWh amount that they could deploy is approximately 117,000,000 kWh. However, the more likely amount being experienced is approximately 20% of the total potential for the 10 year future, or approximately 34,000,000 kWh. This figure is

comparable to the high potential of DSM/EE savings, which will have little impact in terms of the total 159 MW forecasted shortfall in load-serving capability and therefore not considered to be a viable alternative to resolve the third deficiency identified. In addition, the type of DG installed would also have to be analyzed for its ability to meet peak demands.

Conclusion

In summary, programs have already been implemented that are designed to be compatible with the primary loads experienced on the Member Systems. These programs are effective in promoting energy conservation and local renewable energy development. Some programs have been in place for more than 25 years, have already been successful in helping to minimize the energy used in the seven Member Systems and should encourage more in the future. However, it takes years to build out EE/DSM and distributed generation/local renewable projects that will have a material impact on local load and energy requirements. In addition, load growth in the area continues to be positive. Based on the evaluations in this study, these programs are not viewed as representing a viable alternative to meet the purposes of the Project.