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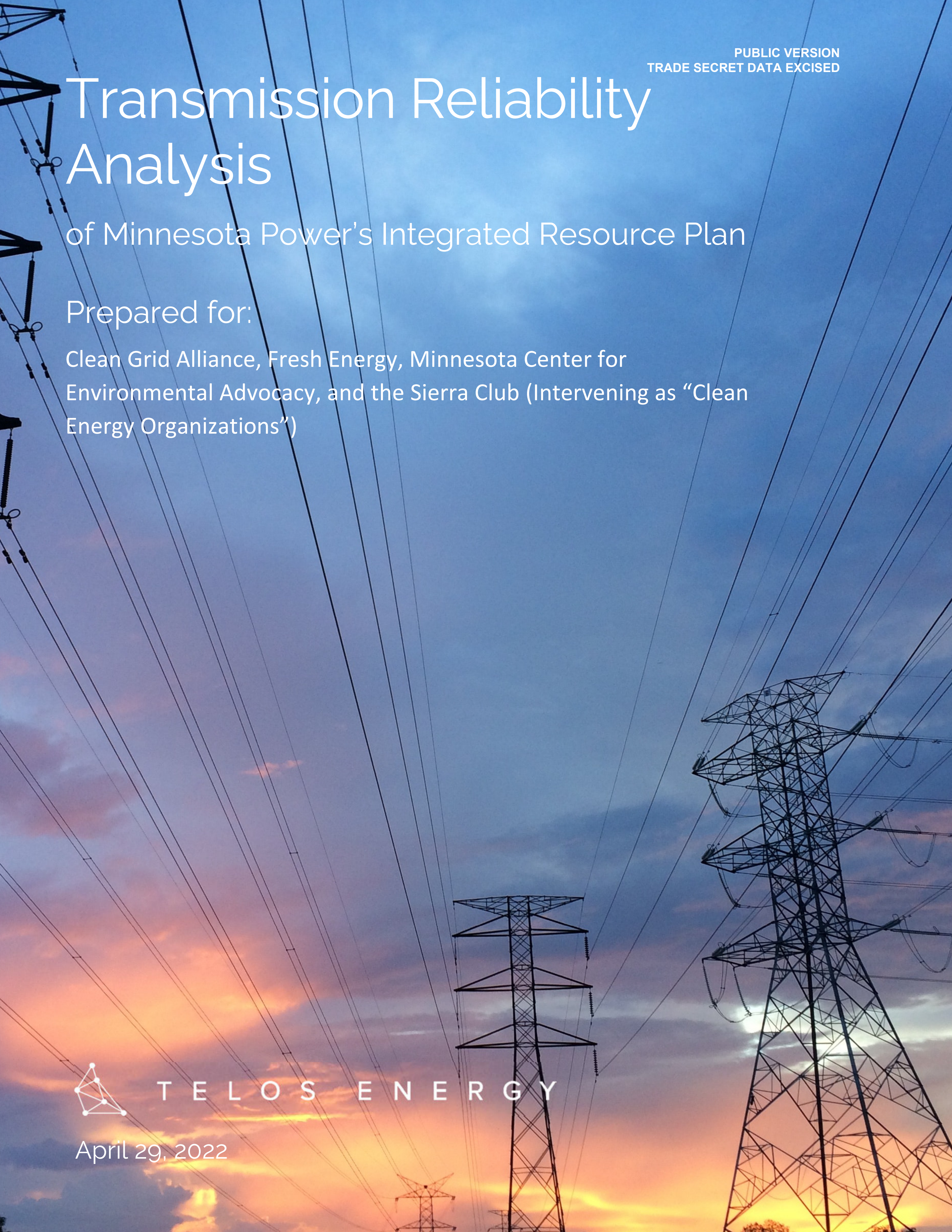

Transmission Reliability Analysis

of Minnesota Power's Integrated Resource Plan

Prepared for:

Clean Grid Alliance, Fresh Energy, Minnesota Center for Environmental Advocacy, and the Sierra Club (Intervening as "Clean Energy Organizations")

TELOS ENERGY

April 29, 2022

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1 Executive Summary

Telos Energy (Telos) performed an analysis of the transmission system in and around the Minnesota Power (MP) service territory for several scenarios, which included different assumptions around generation resource mixes and different transmission upgrades. Underpinning the analysis is the industry standard steady-state transmission system model[1] that included not only Minnesota Power's territory but the entire Midcontinent Independent System Operator (MISO) territory because of the numerous transmission connections to neighboring utilities, particularly to Xcel Energy (Xcel) and Manitoba Hydro. The starting point for all modeling and analysis is the MISO Transmission Expansion Plan 2020 (MTEP20) database. This transmission reliability modeling approach, software type, and MISO database are the same as those used by MISO in its Attachment Y reliability analyses, which Minnesota Power relies on for much of its own reliability analysis.[2]

A total of six scenarios have been developed for analysis. The first scenario is representative of the Utilities' Preferred Plan, the second scenario is representative of the CEOs' Preferred Plan, and the remaining four scenarios are variations or sensitivities to the CEOs' Preferred Plan. The approach used for the quantitative analysis is intended to provide a relative comparison among the scenarios from the standpoint of transmission planning, and by extension, the relative costs of mitigations that would need to be applied to meet NERC planning criteria under different generation mixes.

Overall, the results of our analysis indicate that CEOs' Preferred Plan scenario is as reliable or more reliable than the Utilities' Preferred Plan scenario. Moreover, we find that the NTEC combined-cycle gas plant does not provide a material or necessary reliability benefit when the Boswell 3 coal unit is retired. In addition, we find that when both Boswell units are retired, mitigations will be required. However, MP's estimates of the necessary transmission mitigations when both Boswell units are retired is based on an aggressive and mostly unexplained assumption regarding power flows between MP and Manitoba, which results in a much higher cost estimate than one would find using MISO's base assumptions consistent with historical data. Based on the finding that some transmission mitigations will be needed, our recommendation is that MP begin planning for Boswell 4 mitigations in order to meet its stated retirement timeline or earlier retirement dates that may be considered or required in the future.

[1] PowerGEM's Transmission and Reliability Assessment (TARA) software
[2] Final Attachment Y2 Study Scope, Minnesota Power Boswell Units 3 & 4: 959 MW, MISO. April 4, 2019. Attained through CEO IR-62, PUC Docket No. E015/RP-15-690.

2 Introduction

Telos Energy ("Telos") performed an analysis of the transmission system in and around the Minnesota Power (MP) service territory for several scenarios, which included different assumptions around generation resource mixes and different transmission upgrades. Underpinning the analysis is the industry standard steady-state transmission system model[3] that included not only Minnesota Power's territory but the entire Midcontinent Independent System Operator (MISO) territory because of the numerous transmission connections to neighboring utilities, particularly to Xcel Energy ("Xcel") and Manitoba Hydro. The starting point for all modeling and analysis is the MISO Transmission Expansion Plan 2020 (MTEP20) database. This transmission reliability modeling approach, software type, and MISO database are the same as those used by MISO in its Attachment Y reliability analyses, which Minnesota Power relies on for much of its own reliability analysis.[4]

Beginning with the MTEP20 Winter Peak 2030 transmission planning case, Telos modified the case to reflect a set of scenarios of future grid operations. An AC contingency analysis was then performed on each scenario, and the results of the AC contingency analysis are summarized using several metrics for each scenario. These metrics are then able to be compared across the scenarios to assess the reliability impact of the changes from scenario to scenario.

This analysis focused on the 2030 study year for all scenarios. Within any given study year, there are several different cases like "summer peak," "shoulder light load," and "winter peak," which are snapshots of grid operating conditions that are determined by MISO and the member utilities to be representative of a challenging operating condition for given season. This analysis focused on the "winter peak" 2030 case for all scenarios, which has been identified in prior reports including the MISO Y-2[5] and MP's Beyond Boswell Study[6] as the most challenging of the seasonal cases, given that MP typically experiences the highest demand for electric power during the winter.

The transmission planning process is mandated by the North American Electric Reliability Council (NERC) Standard TPL-001[7], which specifies the evaluations and types of contingencies (equipment outages) that must be considered. This analysis is referred to as an AC contingency analysis, which is the same type of analysis and performed with the same software tool (PowerGEM's TARA) utilized across the industry, including by MISO.

An AC contingency analysis is an evaluation of a grid operating condition against two different types of design criteria: a thermal loading criterion and a voltage tolerance criterion, both of which are discussed further in Appendix A. The analysis begins with a power flow base case, which is a model of a specific

[3] PowerGEM's Transmission and Reliability Assessment (TARA) software
[4] Final Attachment Y2 Study Scope, Minnesota Power Boswell Units 3 & 4: 959 MW, MISO. April 4, 2019. Attained through CEO IR-62, PUC Docket No. E015/RP-15-690.
[5] Final Attachment Y2 Study Scope, Minnesota Power Boswell Units 3 & 4: 959 MW, MISO. April 4, 2019. Attained through CEO IR-62, PUC Docket No. E015/RP-15-690.
[6] Beyond Boswell, Prepared for Minnesota Power, Siemens PTI Report R009-17. November 11, 2020. Attained through CEO IR-008, PUC Docket No. E015/RP-21-33.
[7] Reliability Standards for the Bulk Electric Systems of North America, North American Electric Reliability Corporation. Standard TPL-001-4 – Transmission System Planning Performance Requirements.

grid condition that shows the power flows on all transmission lines and the voltages at every substation contained within the model. Included in every power flow case is an assumption of demand (load) across the grid, assumed interchanges with neighboring utilities, and an assumed commitment and dispatch of all generating resources across the system. The assumptions in the power flow base case are those originally made by MISO as part of their process in developing the MTEP20 database.

In this analysis, the power flow base case from MTEP20 is altered in ways specified below to create six different scenarios, in order to test the impact on system reliability of certain proposed resource changes or the impact of a particular modeling assumption. For each scenario, the starting point is a power flow case that includes all parts of the grid (transmission lines, generation resources, etc.) in service and operating normally. Then one-by-one, a series of 6,570 unique contingencies is applied to the grid model for each scenario from the MTEP20 list of credible contingencies in the region, including those from MP, Xcel, Great River Energy, and Ottertail Power territories.

A contingency is an unplanned loss of one or more elements of the grid, like a loss of a power plant due to a breakdown or the loss of a transmission line, for instance, due to a storm. The result of applying a contingency is a new power flow solution that shows the redistributed power flows across the grid and altered voltages at each substation. These flows and voltages must remain within their specified planning design limits in order for the initial grid operating condition (or scenario) to be considered acceptable for planning purposes.

If any planning limits are violated when applying a contingency, then each violation must be addressed before the case can be considered acceptable. There are typically many ways that a violation can be addressed depending on the location and severity of the violation, ranging from a simple re-dispatch of generation to a solution as complex and costly as building new transmission. This report measures the amount and severity of the two types of violations – thermal loading violations and voltage tolerance violations – for each scenario. The amount and severity of violations revealed by a contingency analysis are metrics that allow planners to assess how grid change would affect a system's ability to respond to credible contingencies. In this analysis, the amount and severity of violations allows us to compare the relative impact on transmission-level reliability across the six scenarios analyzed. Additional explanation of the approach used here is provided in Part 4 ("Analysis Approach").

The following example in Figure 1 illustrates a thermal loading violation on the portion of a transmission system. Below is a stable transmission system where power is flowing through several transmission lines from left to right.

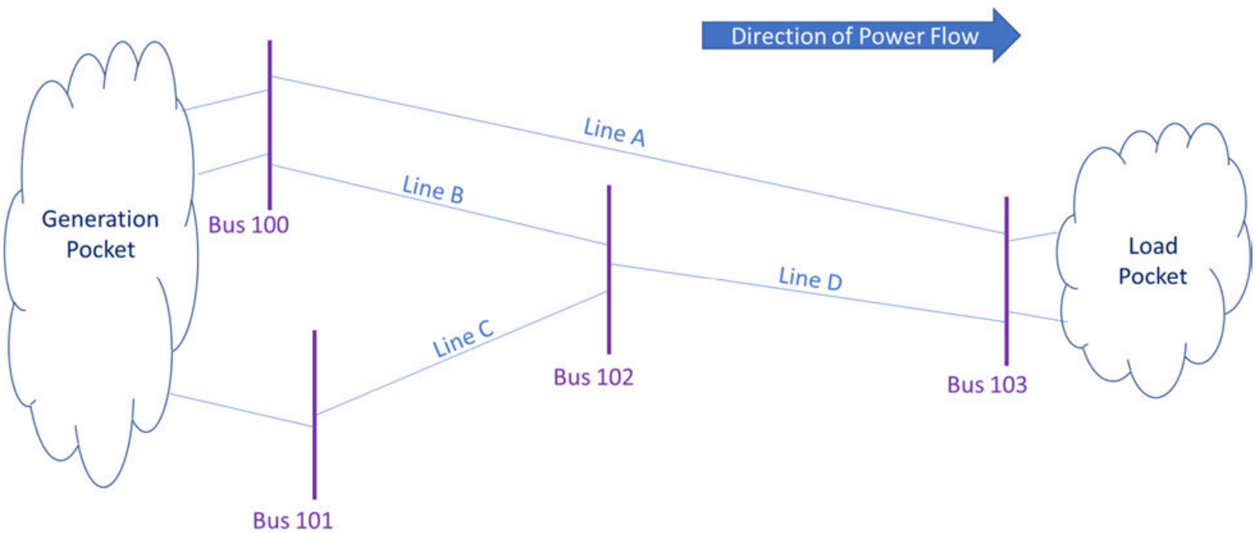

Figure 1: Example of a Portion of a Fictitious Grid Model

Using this same example portion of a grid, consider a contingency in which line C is taken out-of-service, as shown below in Figure 2. The resulting impact is that the power flowing on lines A, B, and D is increased. In this example, it is assumed that lines A and B have a contingency rating of 120 MW and 40 MW, and that they are now overloaded by 30 MW and 10 MW above their ratings, respectively. Therefore, the contingency considering a loss of Line C results in a power flow case with two thermal loading violations.

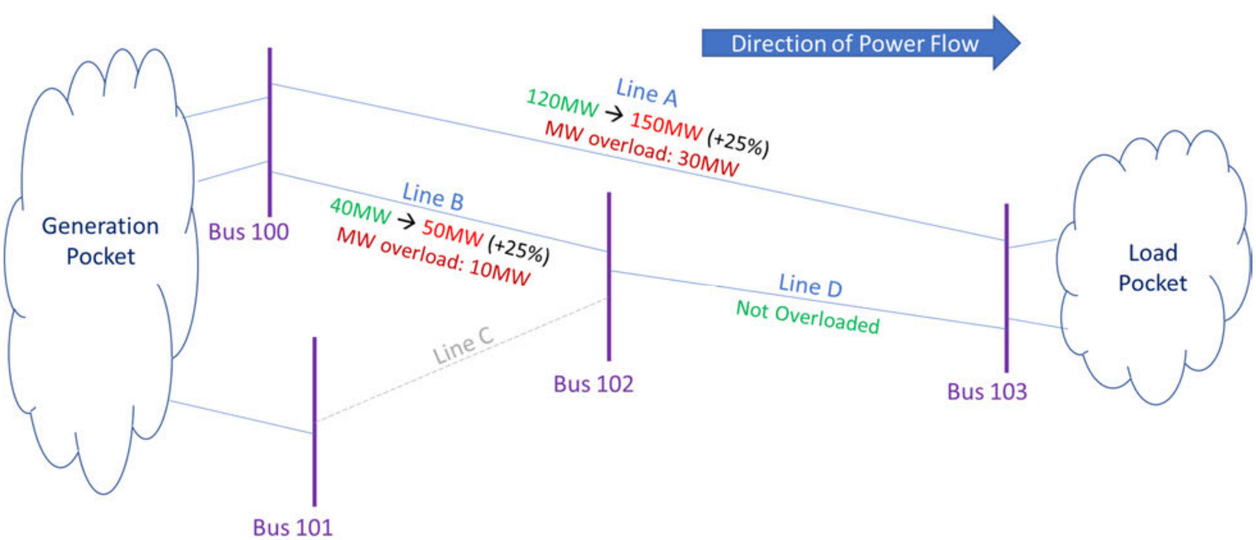

Figure 2: Example of the Thermal Loading Impact of a Contingency on a Fictitious Grid

3 Model and Scenario Development

This section describes the development of the six different scenarios Telos analyzed. All scenarios are based on the same MTEP20 Winter Peak 2030 transmission planning power flow base case, which has then been modified to reflect the six scenarios described below. The 2030 planning year was selected for study because 2030 would include both a significant set of retirements of the regional coal fleet as well as a significant set of renewable generation and energy storage additions to the regional grid.

A summary of all scenarios developed is shown in Table 1. A description of the modifications made for each scenario is described in detail in the sections below.

Table 1: Summary of Scenarios Developed for Evaluation

Scenario	
Reference Case	**Sensitivities**
Utilities' Preferred Plan	
CEO's Preferred Plan	
CEO's Preferred Plan	NTEC In Service
CEO's Preferred Plan	Boswell 3 converted to a synchronous condenser
CEO's Preferred Plan	Boswell 4 Retired
CEO's Preferred Plan	Maximum MHEX Flow North (US --> Manitoba)

3.1 Utilities' Preferred Plan Reference Case Scenario

First, the Utilities' Preferred Plan reference case scenario is developed from the MISO MTEP 2030 Winter Peak power flow base case by adding the generating resources proposed by MP's Preferred Plan, as well as new Xcel resources proposed in its June 2020 Supplement Plan[8]. In addition, this scenario also included the transmission upgrades and investments proposed by MP for 2030. The intent is to develop a reference case as closely reflecting MP's Preferred Plan as possible to which the other scenarios can be compared. The specific changes to resources, transmission investments, and dispatch are explicitly described in the tables in this section.

Table 2 shows the changes to generating resources made from the MTEP 2030 Winter Peak power flow base case to arrive at the Utilities' Preferred Plan. The values in blue indicate that the status of the asset has changed. For context, the status of some additional assets are included, though they are not changed.

[8] "Supplement, 2020-2034 Upper Midwest Integrated Resource Plan," Northern States Power Company. Section 3: Supplement Preferred Plan. Docket No. E002/RP-19-368. June 30, 2020.

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Table 2: Summary of Modeled Generation Changes Between MTEP and the Utilities' Preferred Plan Reference Case Scenario

Generating Resource Changes	MISO MTEP 2030 Winter	Utilities' Preferred Plan
Boswell 3	In	Out
Boswell 4	In	In
Nemadji CC (NTEC)	Not included	In
Sherco CC	Not included	In
Sherco 1&2	In	Out
Sherco 3	In	Out
AS King	In	Out
Laskin Energy Center	In	In
Taconite Harbor 1 & 2	In	Out
Coal Creek Units 1 & 2	In	In
Milton Young Units 1 & 2	In	In
Monticello	In	In
Prairie Island 1&2	In	In
Xcel preferred plan 2500MW PV over 5 sites	Not included	In at 50% CF
MP preferred plan 200MW PV at Boswell	Not included	In at 50% CF

The scenario modeling the Utilities' Preferred Plan leaves Boswell 4, the Laskin Energy Center, and the two nuclear-fired power plants of Monticello and Prairie Island in-service and at the same level of dispatch as the MTEP20 database.

The scenario reflecting Utilities' Preferred Plan includes the retirement of Boswell 3, which MP has stated that it intends to retire in 2029 in its Integrated Resource Plan[9]. The Nemadji Trail Energy Center Combined Cycle (Nemadji CC / NTEC) power plant is proposed with an in-service before 2030, and therefore it is modeled as a "one-by-one" combined cycle plant with a 350 MW combustion turbine and a 200MW heat-recovery steam turbine generator connected at the Arrowhead 345kV bus[10]. The two remaining Taconite Harbor coal-fired units 1 and 2 have been idled since the fall of 2016 and are assumed in this analysis to be retired by 2030.[11]

The MP grid is highly interconnected with Xcel's grid to the south by several high-voltage transmission lines, meaning that major changes to Xcel's transmission and resource plans may be relevant for MP's transmission and resource plans. Therefore, this analysis also includes Xcel's territory, where major

[9] Minnesota Power's 2021 Integrated Resource Plan, Appendix C: Existing Power Supply, Page 12. CEO IR-002, PUC Docket No. E015/RP-21-33.

[10] MISO DPP August 2017 Wisconsin Area Phase 1 System Impact Study Report, J732, Nemadji Trail Energy Center (NTEC), Issued Dec 13, 2018. https://cdn.misoenergy.org/GI-DPP-2017-AUG-ATC-WI-Phase1_SIS_Report_PUBLIC_Final302792.pdf

[11] Minnesota Power's 2021 Integrated Resource Plan, Appendix C: Existing Power Supply, Page 17. CEO IR-002, PUC Docket No. E015/RP-21-33.

changes proposed in Xcel's territory are reflected in the model used for this analysis. These include the retirement of all Sherbourne County coal-fired units and the AS King coal-fired unit by 2030.[12]

Also in the Xcel territory, a combined-cycle power plant was initially proposed at the Sherburne County site (Sherco CC) as replacement generation, a 780 MW resource planned to be in-service by 2030. At the time this scenario was developed Xcel had not submitted its Alternate Plan, which does not include the Sherco CC plant, and so this analysis included the Sherco CC in-service as part of the Utilities' Preferred Plan scenario.[13]

The two large coal-fired plants in North Dakota, Coal Creek and Milton Young, deliver power via HVDC links to the Xcel and MP service territories, and for that reason are relevant for consideration in this analysis. While the fuel source for the power transmitted over the HVDC systems is likely to change by 2030, it is assumed in this analysis that power from North Dakota will continue to be available. Therefore, both HVDC systems that are injecting power at Dickinson and Arrowhead are assumed to remain in-service, even if the coal plants retire, because it is assumed that the generation will be replaced by other sources and that power will continue to be transmitted West to East into the region up to the current ratings of the HVDC systems.

To make up for the coal-fired retirements, replacement generation is included that is consistent with the preferred plans of Xcel and MP at the time the scenarios were developed. In the MP service territory, this includes the 200 MW Boswell solar PV facility, which is expected to be in-service by 2030.[14] All solar PV resources are dispatched at 50% of their installed capacity rating, consistent with MISO's latest assumptions for PV plants in the region for Winter Peak cases.[15]

To capture the solar PV project additions from the Xcel IRP Supplement[16] preferred expansion plan, each solar plant was modeled in an industry-standard fashion: as an aggregate generator with a lumped step-up transformer and a 0.95PF reactive capability range. Each solar plant was modeled as regulating voltage at its low-voltage bus. The interconnection locations were selected on the 345kV transmission system at locations not directly within the metropolitan area, which is assumed to be land-constrained,

[12] Upper Midwest Integrated Resource Plan 2020-2034 Reply Comments, Xcel Energy, Page 7. Docket No. E002/RP-19-368.

[13] Upper Midwest Integrated Resource Plan 2020-2034 Reply Comments, Xcel Energy, Page 4. Docket No. E002/RP-19-368. Inclusion of the Sherco CC plant in the Utilities' Preferred Plan Scenario is a conservative assumption because having the plant in the Utilities' scenario would tend to marginally improve reliability metrics. However, the Sherco CC does not materially impact reliability due to its location relative to other generation, as seen in the CEO scenarios as well as Telos Energy's report, "Sherco & A.S. King Retirement Bulk Transmission Reliability Analysis," prepared for the CEOs January 27, 2021.

[14] Minnesota Power's 2021 Integrated Resource Plan, Appendix M: Socioeconomic Impacts, Page 1. CEO IR-002, PUC Docket No. E015/RP-21-33.

[15] "Wind / Solar Generation Dispatch Assumptions In The Reliability Planning Models," MISO Planning Subcommittee, June 23, 2020. https://cdn.misoenergy.org/20200623%20PSC%20Item%2004c%20Wind%20Solar%20Gen%20Dispatch%20Assumptions453933.pdf Retrieved September 23, 2020.

[16] "Supplement, 2020-2034 Upper Midwest Integrated Resource Plan," Northern States Power Company. Section 3: Supplement Preferred Plan. Docket No. E002/RP-19-368. Page 62. June 30, 2020.

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but at locations that are less populated. Xcel has since released its Alternate Plan[17] calling for renewable resources to be built in outlying areas and connected to the system at the Sherco 345kV substation via a generation tie-line, as well as solar connected to the King plant and other new solar in its footprint. Because of the existing robust 345kV transmission backbone in the Twin Cities region, it is expected that the addition of the Alternate Plan renewables as proposed by Xcel and the addition of renewables at five 345kV substations in the Twin Cities region are essentially equivalent from the perspective of the AC contingency analysis. Each of the new solar PV plants were dispatched at 50% of their rated capacity. The 50% power production assumption for solar PV plants in 2029 is derived from MISO practice,[18] and is consistent with the dispatch of the other solar PV plants in the summer and shoulder cases from the MISO MTEP19 database. Telos modeled generic solar PV plants as presented in Table 3.[19]

Table 3: Solar PV Resource Additions in Xcel for the Utilities' Preferred Plan Scenario

Generic PV Plant Name	AC Inverter Rating	Interconnection Bus	Dispatch (Capacity Factor)
PV1	500 MW	Sherco 345kV	50 %
PV2	500 MW	Chisago 345kV	50 %
PV3	500 MW	Scott County 345kV	50 %
PV4	500 MW	Benton 345kV	50 %
PV5	500 MW	Alexandria 345kV	50 %

In addition, several transmission upgrades proposed by MP in its resource plan are included in the Utilities' Preferred Plan scenario, summarized in Table 4.[20] Reconductoring was modeled as a 25% increase in thermal limits for normal and contingency conditions.

Table 4: Summary of Modeled Transmission Changes between MTEP and the Utilities' Preferred Plan Scenario

Transmission Resource Changes	MTEP 2030 Winter	Utilities' Preferred Plan
IronRng-Blackberry 230 reconductor	Not included	In
Uprate one of Forbes 500-230 transformer	Not included	In
New Forbes-Minntac 230kV line	Not included	In
Reconductor MudLake-Brainerd 115kV	Not included	In
Reconductor Brainerd-Riverton 115kV	Not included	In

[17] Upper Midwest Integrated Resource Plan 2020-2034 Reply Comments, Xcel Energy
[18] MISO Planning Subcommittee meeting on Wind and Solar Dispatch Assumptions held in June 2020. https://cdn.misoenergy.org/20200623%20PSC%20Item%2004c%20Wind%20Solar%20Gen%20Dispatch%20Assumptions453933.pdf
[19] The quantity of new solar modeled is consistent with the amounts approved in Xcel's 2020-2034 Resource Plan. Xcel Energy Jan. 26, 2022, Letter, Re: Alternate Plan Clarifications, Follow-Ups, and Revised Decision Options at 2.
[20] Minnesota Power's 2021 Integrated Resource Plan, Appendix F: Transmission Planning Activities, Local Power Delivery beginning page 58. CEO IR-002, PUC Docket No. E015/RP-21-33.

The flows to the Arrowhead HVDC terminal are adjusted from 60MW to 550MW, which is the current maximum rating of the HVDC link.[21] It is assumed that the HVDC line was designed to be fully utilized, and therefore, generation in North Dakota supplying the HVDC link is assumed sufficient to maximize power transfer on the HVDC line. No changes to the overall generation across the MP or Xcel territory were made.

3.2 CEOs' Preferred Plan Reference Case Scenario

The second reference case scenario, representing the CEOs' Preferred Plan, is built from the Utilities' Preferred Plan with the changes summarized in this section, beginning with the changes to generation resources, shown in Table 5.

The NTEC power plant currently proposed in the MP service territory is placed out of service and the proposed Sherco CC is placed out of service in the Xcel territory. The reduction of about 1330MW of power is replaced with a combination of 1990 MW (AC nameplate installed) of solar photovoltaic (PV) generation and 1775 MW (by inverter nameplate) of energy storage resources, in addition to the PV in the Utilities Preferred Plan. These additions are based on CEO EnCompass modeling for both MP and Xcel and are reasonable proxies for the amount and location of incremental new resources added by all Minnesota utilities or Independent Power Producers by 2030. This PV is dispatched at 50% capacity factor per MISO's practice for winter peak cases.[22] The energy storage is also dispatched at 50% capacity factor, a relatively conservative assumption that considers that the energy storage resource may not be fully charged at the time but would be able to continue supplying power to the grid for a reasonable period of time.

Table 5: Summary of Modeled Generation Changes between Utilities' and CEOs' Preferred Plans Reference Case Scenarios

Generating Resource Changes	Utilities' Preferred Plan	CEOs' Preferred Plan
Nemadji CC (NTEC)	In	Out
Sherco CC	In	Out
Proxy additional MN PV resources, 1990MW	Not included	In at 50% CF
Proxy additional MN storage, 1775MW	Not included	In at 50% CF

The additional PV and storage resources are modeled as inverter-based resources behind a plant step-up transformer with a +/- 0.95 power factor capability at the transmission bus, which is consistent with FERC Order 827 reactive capability requirements for all large resources. The ratings and location for these resources modeled in the CEOs' Preferred Plan scenario is shown in Table 6 and in Table 7.

[21] Minnesota Power's 2021 Integrated Resource Plan, Appendix F: Transmission Planning Activities, Page 11. CEO IR-002, PUC Docket No. E015/RP-21-33.
[22] "Wind / Solar Generation Dispatch Assumptions In The Reliability Planning Models," MISO Planning Subcommittee, June 23, 2020.
https://cdn.misoenergy.org/20200623%20PSC%20Item%2004c%20Wind%20Solar%20Gen%20Dispatch%20Assumptions453933.pdf Retrieved September 23, 2020.

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Table 6: Modeled Rating and Location of Additional PV Resources in the CEOs Preferred Plan Scenario

Generic PV Plant Name	AC Inverter Rating	Interconnection Bus	Dispatch (Capacity Factor)
PV6	500 MW	Forbes 230kV	50 %
PV7	500 MW	Hampton 345kV	50 %
PV8	500 MW	Cedar Mountain 345kV	50 %
PV9	490 MW	Prairie Island 345kV	50 %

Table 7: Modeled Rating and Location of Energy Storage Resources in the CEO's' Preferred Plan Scenario

Generic Energy Storage Plant Name	AC Inverter Rating	Interconnection Bus	Dispatch (Capacity Factor)
ESS1	450 MW	Forbes 230kV	50 %
ESS2	450 MW	Chisago 345kV	50 %
ESS3	450 MW	Coon Creek 345kV	50 %
ESS4	425 MW	Parkers Lake 345kV	50 %

The combination of replacement resources is a net increase of about 550 MW compared to the Utilities' Preferred Plan. However, the load for this case is unchanged, and so to balance the generation with load and losses, the generating resources across the MP service territory is scaled down by 150 MW, or approximately 6%. This means that each resource's power dispatch is reduced by about 6%, unless it reaches its minimum power limit, in which case it may be held at its minimum power level or placed out of service. The same is done in Xcel's service territory at 4%, based on a 400MW aggregate generation reduction. This scaling method is a standard approach and is used by MISO in the creation of Y-2 power flow cases.[23] These adjustments are summarized in Table 8.

Table 8: Summary of Modeled Dispatch Changes between Utilities' and CEOs' Preferred Plan Scenarios

Dispatch Changes	Utilities' Preferred Plan	CEOs' Preferred Plan
MP Generation scaling	From MTEP20	Scaled down 150 MW (-6%)
Xcel Generation scaling	From MTEP20	Scaled down 400 MW (-4%)

The CEOs' Preferred Plan scenario also includes only one of the "Local" and "Regional" power delivery transmission upgrades that MP included and describes in the Transmission Planning Activities section of its IRP. [24] Minnesota Power included five "Local/Regional Power Delivery" transmission upgrades as

[23] MISO Business Practices Manual, Transmission Planning Manual No. 020. Revision 22. Section 6.2.4. May 1, 2020.
[24] Minnesota Power's 2021 Integrated Resource Plan, Appendix F: Transmission Planning Activities, Part 8, Local Power Delivery and Table 9. CEO IR-002, PUC Docket No. E015/RP-21-33.

reliability mitigations for Boswell 3's retirement. However, four of these upgrades were not included in the CEOs' Preferred Plan scenario because they were either described as "proxy" upgrades or determined to be less impactful to the system during the Winter Peak season. The **[TRADE SECRET BEGINS … … TRADE SECRET ENDS]** was included as a transmission upgrade for its ability to avoid thermal overloads in the nearby 115kV transmission system for many different contingencies during the Winter Peak case. The cost of **[TRADE SECRET BEGINS …** the new **… TRADE SECRET ENDS]** is estimated to be $25 million dollars, which is estimated as roughly one third of $61MM cost of all Local Power Delivery upgrades identified in Table 11 from the MP IRP Appendix F[25]. This transmission resource upgrade and this cost estimate was also included in the EnCompass modeling of the CEOs' Preferred Plan as a mitigation for the retirement of Boswell 3.

Table 9: Summary of Modeled Transmission Changes between Utilities' and CEOs' Preferred Plan Scenarios

Transmission Resource Changes	Utilities' Preferred Plan	CEOs' Preferred Plan
[TRADE SECRET BEGINS… …TRADE SECRET ENDS]	In	Not included
[TRADE SECRET BEGINS… …TRADE SECRET ENDS]	In	Not included
[TRADE SECRET BEGINS… …TRADE SECRET ENDS]	In	In
[TRADE SECRET BEGINS… …TRADE SECRET ENDS]	In	Not included
[TRADE SECRET BEGINS… …TRADE SECRET ENDS]	In	Not included

3.3 Sensitivity Scenarios

The following sections describe the six sensitivity scenarios analyzed in this report. Each is based on the CEOs' Preferred Plan reference scenario and includes limited changes, or "sensitivities", to analyze impacts from those single or limited changes. Table 1 is provided again below for ease of reference.

25 Minnesota Power's 2021 Integrated Resource Plan, Appendix F: Transmission Planning Activities, Tables 8, 11. CEO IR-002, PUC Docket No. E015/RP-21-33.

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Table 10: Summary of Scenarios Developed for Evaluation

Scenario	
Reference Case	**Sensitivities**
Utilities' Preferred Plan	
CEO's Preferred Plan	
CEO's Preferred Plan	NTEC In Service
CEO's Preferred Plan	Boswell 3 converted to a synchronous condenser
CEO's Preferred Plan	Boswell 4 Retired
CEO's Preferred Plan	Maximum MHEX Flow North (US --> Manitoba)

3.3.1 NTEC In-Service

This sensitivity scenario was developed to isolate and assess NTEC's impact on the AC contingency analysis. It is built from the CEOs' Preferred Plan reference scenario with the following changes:

- NTEC, which is modeled as two generator units connecting at the 345kV Arrowhead bus, is placed **in service** and fully dispatched at 550MW
- Generation resources across MP's territory are dispatched down by an aggregate 150MW
- Generation resources across Xcel's territory are dispatched down by an aggregate 350MW[26]

3.3.2 Boswell 3 Converted to a Synchronous Condenser

This scenario was developed to assess the impact of Boswell 3 being converted to a synchronous condenser, which is considered a cost-effective way for the Boswell 3 unit to continue to provide voltage support and grid strength services to the grid. MP has noted in its IRP that these grid services are in demand in its territory, and MP has studied construction of new synchronous condensers, but not studied conversion of existing equipment[27].

A synchronous condenser is a grid-supporting asset that provides reactive power to the grid, which is useful for supporting grid voltage (akin to the services provided by a STATCOM, which was selected for supporting voltage in the North Shore Loop).[28] While synchronous condensers also provide other useful services like inertia, grid strength, and short-circuit current, these services are not the focus of this analysis. Physically, a synchronous condenser is a large electric generator connected to the grid but not connected to a turbine. This means that a synchronous condenser is able to provide reactive power but it is not able to provide sustained active power (energy) to the grid.

Synchronous condensers can be commissioned in two ways; one is by installing new units, which is an option considered by MP in its IRP.[29] A second is to convert existing or recently retired power plant equipment to operate as a synchronous condenser by disconnecting the turbine from the generator and modifying auxiliary equipment at the plant. FirstEnergy of Ohio converted its coal-fired Eastlake and

[26] These changes are to balance generation and load as described above in Section 3.2.
[27] Minnesota Power's 2021 Integrated Resource Plan, Appendix F: Transmission Planning Activities, Page 57. CEO IR-002, PUC Docket No. E015/RP-21-33.
[28] Minnesota Power's 2021 Integrated Resource Plan, Appendix F: Transmission Planning Activities, Page 20. CEO IR-002, PUC Docket No. E015/RP-21-33.
[29] Minnesota Power's 2021 Integrated Resource Plan, Appendix F: Transmission Planning Activities, Page 57. CEO IR-002, PUC Docket No. E015/RP-21-33.

Lakeshore power plants to synchronous condensers between 2013 and 2015.[30] For an existing power plant where the generator's useful life extends (or can be refurbished to extend it) beyond its retirement date, conversions can be a cost-effective[31] way to continue supplying useful services to the grid from the existing equipment.[32]

The sensitivity case is built from the scenario reflecting the CEOs' Preferred Plan but with the Boswell 3 unit set to in-service with its active power limited to zero MW so that it can provide reactive power up to its limits, but not active power.

3.3.3 Boswell 4 Retired

While MP has not proposed the retirement of Boswell 4 by the 2030 time horizon in this analysis, evolving decarbonization policies could plausibly lead to its retirement in that timeframe. Such a major change to MP's generating fleet requires a significant amount of advance planning, warranting consideration in this docket of the impact of that retirement on the transmission system. To that end, three additional scenarios have been prepared considering a retirement of both Boswell 3 and 4.

To the CEOs' Preferred Plan reference scenario, Telos added the retirement of Boswell 4, constituting a 580 MW reduction in generating power. This power was in part replaced by power from the modeled proposed future energy storage assets, where an additional 400 MW of energy storage was dispatched and in part by existing generation, where the remaining MP generating fleet was scaled up by 180 MW. The selection of replacement generation is a compromise between utilizing the existing MP generation fleet and utilizing the proposed battery resources, where both are intended to retain a degree of "headroom" or reserves for responding to contingency events.

Of the 400MW additional power dispatched from storage, 200MW was assumed to be located at the Sherco site and 200 MW was assumed to be located at the AS King site. Of the total 1775 MW of installed (inverter nameplate) energy storage, the total dispatch is assumed to be 1287.5 MW or 72.5% capacity factor for the energy storage.

It is acknowledged that the industry is still gaining experience and developing transmission planning methods that consider the operational flexibility but energy-limited nature of battery storage technologies. While more detailed, chronological analysis considering operational rules for battery scheduling is warranted, the assumption of 1287.5MW or 72.5% capacity factor is considered

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[30] FERC approves conversion of Eastlake, Lakeshore coal units, TransmissionHub. December 20, 2012. Retrieved December 23, 2021. https://www.transmissionhub.com/articles/2012/12/ferc-approves-conversion-of-eastlake-lakeshore-coal-units.html

[31] A synchronous condenser conversion of the 405MVA Boswell 3 unit is estimated to cost $8MM to $20MM USD according to the Synchronous Condenser Market by Cooling Type (Hydrogen, Air, Water),Type (New & Refurbished), Starting Method (Static Frequency Converter, Pony Motor), End User (Electrical Utilities & Industries), Reactive Power Rating, and Region-Global Forecast to 2025, Markets and Markets, https://www.marketsandmarkets.com/Market-Reports/synchronous-condenser-market-189197147.html

[32] C.R. Slattery, J.M. Fogarty, Synchronous Condenser Conversions at FirstEnergy Eastlake Plant. CIGRE US National Committee 2015 Grid of the Future Symposium. http://cigre-usnc.org/wp-content/uploads/2015/10/Slattery.pdf

reasonable because neither the battery systems (about 500 MW of headroom) nor the remaining conventional generating resources (about 200MW of online headroom) on the MP system are at their limits; there is still headroom and flexibility in the dispatch condition to account for the uncertainty around the batteries' operating state at the time of high grid stress. Finally, the assumption of 1775 MW of installed battery energy storage AC power capacity is considered conservative for a 2030 planning year, and any additional battery capacity will offer increased flexibility to relieve the grid during high-stress periods.

In summary:

- Boswell 4 is retired (Boswell 3 is retired and is not converted to a synchronous condenser as per CEOs' Preferred Plan reference scenario)
- Dispatch of storage is increased
- MP and Xcel generation dispatch is adjusted within operating limits to balance generation and load

3.3.4 MISO Exporting Power to Manitoba

This scenario was developed to assess the impact of a certain critical assumption in MP's Y-2 and Beyond Boswell studies regarding the export of power north to Manitoba. This assumption – that MP would be exporting electricity to its full capacity north to Manitoba during the most challenging winter conditions – was a change to MISO's base MTEP models that was specifically requested by MP for MISO to use in its Attachment Y-2 analysis and used by MP in its Beyond Boswell study.

MISO is connected to Manitoba through five separate transmission lines; three are 230kV lines and two are 500kV lines, which collectively comprise the Manitoba Hydro Export (MHEX) interface. The power-carrying capability of this interface is dominated by the two 500kV lines (line 604, also known as the Great Northern Transmission Line, and line 602), both of which start in southern Manitoba and terminate in northern Minnesota at Iron Range (line 604) and Forbes (line 602) substations. Approximately 70% of the MHEX power interchange flows on the two 500kV lines. Because of the very high power-carrying capability of these two lines and because they terminate in or very close to MP's service territory, the flows on these lines deserve special attention when analyzing MP's grid.

The maximum flows on the MHEX are determined through studies of AC contingency analysis, voltage stability analysis and dynamic stability, in addition to the ratings of the lines and associated equipment. The limits[33] currently enforced are: **[TRADE SECRET BEGINS …**

… TRADE SECRET ENDS]

The power-carrying capability in the north-to-south direction is nearly twice that of the south-to-north direction. This is consistent with the vast majority of operations where actual power flow is in the north-to-south direction with the US importing power generated by Manitoba's hydro resources. Over the

[33] CEO IR-006, PUC Docket No. E015/RP-21-33.

period from March 2018 to March 2021, 94.9% of all hours showed power flowing north-to-south and 5.1% of these hours showed power flowing south-to-north, which is shown graphically in Figure 3.[34]

In the prior-mentioned studies conducted by MP[35] and MISO (at MP's direction)[36], the Winter Peak power flow cases assumed that the MHEX power flows were at their maximum limit of **[TRADE SECRET BEGINS …** … **TRADE SECRET ENDS]** flowing south-to-north. MISO's MTEP model assumes MHEX flows north-to-south from Manitoba to MISO, consistent with historical power flow; however, MP specifically asked MISO to change this assumption in its Y-2 study to reflect substantial MISO to Manitoba south-to-north flows.[37] Approximately 70% of the MHEX flow for this south-to-north power flow condition is carried on the two 500kV lines. This value is overplotted in Figure 3 with three years of historical data showing the combined power flows of the two 500kV lines, ordered as a duration curve.

[TRADE SECRET BEGINS …

… **TRADE SECRET ENDS]**

The large power flow to the north assumed by MP is in stark contrast with the MTEP20 2030 Winter Peak case, which shows the MHEX power flowing north to south at 450 MW. This constitutes a difference in MHEX flow of **[TRADE SECRET BEGINS … … TRADE SECRET ENDS]**, a very large difference that is not explained or justified in either study. The MISO Y-2 Study appears to use this unsupported assumption, which reverses the direction of historical energy flow during the winter peak

[34] CEO IR-006, PUC Docket No. E015/RP-21-33.
[35] Beyond Boswell, Prepared for Minnesota Power, Siemens PTI Report R009-17. November 11, 2020. Attained through CEO IR-008, PUC Docket No. E015/RP-21-33.
[36] Final Attachment Y2 Study Scope, Minnesota Power Boswell Units 3 & 4: 959 MW, MISO. April 4, 2019. Attained through CEO IR-62, PUC Docket No. E015/RP-15-690.
[37] Final Attachment Y2 Study Scope, Minnesota Power Boswell Units 3 & 4: 959 MW, MISO. Footnote 2. April 4, 2019. Attained through CEO IR-62, PUC Docket No. E015/RP-15-690.

case, because MP requested it to do so. The Y-2 Study included a footnote stating "2030 Winter peak scenario was later added as per customer and impacted transmission owner request. The Manitoba Hydro (MH) interface in this study modeled at ~1400MW import (instead of MH exporting 1000 MW as in the MMWG/ERAG 2028 Winter 2018 series)".[38]

In searching for a reason for the large difference assumed in MHEX flows between the MTEP database and the MP-directed study work, MP was asked to describe all non-market constraints and agreements relevant to the power flows on the MHEX. MP revealed nothing that would require studying such a significant flow of power to the north.[39] The actual historical flows were also analyzed to check for high south-to-north flows. However, there is no recent history showing a south-to-north flow at the technical limit, as shown in Figure 3. The highest flow from MISO to Manitoba Hydro (MH) between March 2018 and March 2021 was 960 MW, which occurred for one hour. There was a total of 75 hours over the course of the three years for which data was provided (March 2018 – March 2021) where flows from MISO to MH exceeded 500 MW.

The purpose of this scenario is to assess the impact of assuming an MHEX power flow of **[TRADE SECRET BEGINS … … TRADE SECRET ENDS]** from south to north, as MP and MISO assumed in the previous studies, versus assuming a power flow of 450 MW from north to south, as assumed in the MTEP20 database and in our other scenarios. This sensitivity was applied to:

1. the CEOs' Preferred Plan reference scenario, where Boswell 3 was retired but Boswell 4 remained in-service, as well as
2. to a supplemental sensitivity based on the CEOs' Preferred Plan but where both Boswell 3 and 4 were retired.

To prepare these scenarios that essentially duplicate MP's assumption of large amounts of power flowing north to Manitoba, the following changes are made to the starting point scenarios (CEOs' Preferred Plan reference scenario and CEOs' Preferred Plan with Boswell 4 Retired sensitivity scenario):

- Aggregate generation in MP territory is scaled up 350 MW
- Aggregate generation in Xcel territory is scaled up 800 MW
- Aggregate generation in OTP territory is scale up 250 MW
- Aggregate generation in MH territory is scaled down by 1400 MW in a manner performed for creating the other sensitivity cases. The scaling includes the reduction of MH generation and DC link flows within Manitoba. These dispatch changes are largely confined to the MH system due to the topology of the grid in the region, where MH is not strongly connected to other states or provinces except through the MHEX.

[38] Final Attachment Y2 Study Scope, Minnesota Power Boswell Units 3 & 4: 959 MW, MISO. Footnote 2. April 4, 2019. Attained through CEO IR-62, PUC Docket No. E015/RP-15-690.
[39] CEO IR-034, PUC Docket No. E015/RP-21-33.

4 Analysis Approach

As noted in the Introduction, for each scenario, an AC contingency analysis was performed to identify thermal and voltage violations for the set of NERC TPL001-4 Planning Contingencies as part of the MTEP database.

The approach taken is intended to provide a relative comparison among the scenarios from the standpoint of transmission planning, and by extension, the relative costs of mitigations that would need to be applied to meet NERC planning criteria.

A large set of contingencies from the MISO MTEP20 dataset was evaluated for each scenario. This contingency set includes over one thousand individual contingencies or combinations of contingencies that need to be evaluated to verify that the grid is secure after each contingency event. Therefore, there is often a large resulting data set where, for each planning criteria violation found, the magnitude of violation and the attributed contingency are reported.

To compare reliability across scenarios, several summary metrics have been calculated for each scenario. One set of summary metrics reflects the total number and magnitude of thermal overload violations for the scenario, and another set of summary metrics reflects the total number and magnitude of voltage violations for the scenario.

4.1 Thermal Violation Summary Metrics

The thermal violation summary metrics identified for each scenario reflect the following:

- The **number of distinct elements overloaded** (note that multiple different contingencies can result in overloading of any given element);
- The **number of distinct contingencies** contributing to at least one overload; and
- The **total MW overload**, which is the sum of the MW overload (delta MW from the maximum contingency rating) for every overloaded element resulting from the entire contingency set. This metric is selected for the following indicative properties:
  - This approach captures that small overloads are counted less than large overloads.
  - It implicitly considers that many small overloads are equivalent to a few large overloads.
  - This approach also considers that the same element may be overloaded by multiple different contingencies, which is worse than one element being overloaded by only one contingency.
  - By summing MW overloads rather than % overloads, it considers that a 1% overload on a 230kV line is generally more severe than a 1% overload on a 115kV line.
  - However, this metric does not consider the length of lines, where it is acknowledged that the same MW overload metric for two lines of different lengths will likely have different mitigation costs.
- The **greatest percent loading of all elements**, which is used as a check for outliers that could skew the summary metrics

Returning to the example contingency shown in Figure 2, the contribution to the total MW overload metric is 10 MW + 30 MW = 40 MW for the contingency of losing Line C. This process is repeated for all contingencies, where the MW overloads from all elements are summed.

4.2 Voltage Violation Summary Metrics

In a manner similar to the thermal violation summary metrics, a set of voltage violation metrics are computed and reported. The reporting is for low-voltage violations, which indicate a need for more voltage-supporting assets (like shunt capacitors, STATCOMs, synchronous condensers, etc), where there is a significant cost of mitigation[40].

The voltage violation summary metrics reflect the following:

- The **number of distinct buses under-voltaged** (substations experiencing a low-voltage violation);
- The **number of distinct contingencies** contributing to one or more low-voltage violations;
- The **greatest per-unit under-voltage violation of all buses**, which is used as a check for outliers that could skew the summary metrics; and
- The **total kV under-voltage**, which is the sum of kV violations (delta of bus voltage from the minimum contingency voltage rating) for every under-voltage bus resulting from the entire contingency set. This metric is selected because it has the following properties:
    - It captures that small violations are counted less than large ones.
    - It implicitly considers that many small violations are equivalent to a few large violations.
    - It considers that the same bus may be under-voltages due to more than one different contingency, which is worse than one element being under-voltages by only one contingency.
    - By summing kV violations rather than % voltage violations, it considers that a 1% violation on a 230kV bus is generally more severe than a 1% violation on a 115kV bus.
    - However, this metric does not consider the grid strength of buses, where it is acknowledged that the same kV violation metric for two buses of the same voltage rating will likely have different voltage support needs, and therefore, different mitigation costs.

From the example, we again consider a contingency in which line C is taken out of service, and where the change in power flows results in the voltage at buses 102 and 103 to drop below their contingency planning criteria, which in this example is assumed to be 95% of nominal voltage (109.25kV for a 115kV nominal line). For this contingency, the contribution to the total kV under-voltage metric is 3.25kV + 4.25kV = 7.5kV. This process is repeated for all contingencies, where the kV under-voltages from all buses are summed.

[40] By contrast, high-voltage violations can generally be resolved operationally through switching, tapping, or adjusting control setpoints of existing assets. Given how relatively easy and inexpensive it is to resolve high-voltage violations, they are not included in the voltage violation summary metrics presented here.

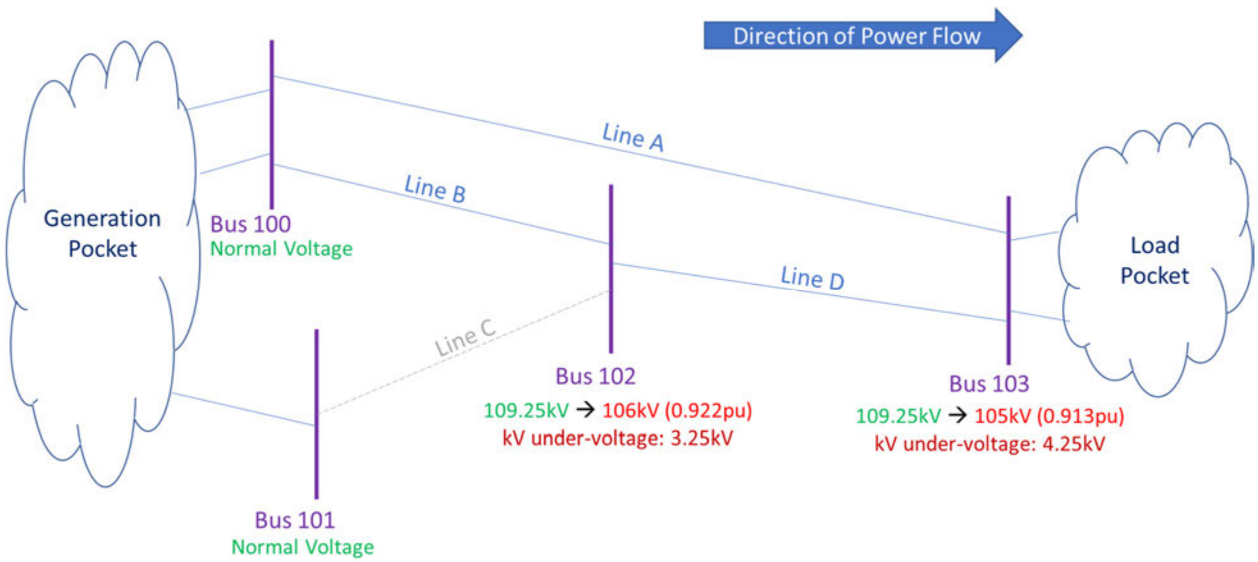

Figure 4: Example of the Voltage Impact of a Contingency on a Fictitious Grid

For each scenario, there are a certain number of contingency cases that do not solve, which is referred to as a non-converged case. Often, a case will not solve because the contingency is so severe that the grid operating condition is infeasible. In each scenario, the non-converged cases are monitored, and the total number is reported in the summary metrics.

Other approaches to comparing alternative scenarios were considered, including the use of security-constrained reliability redispatch (SCRD). SCRD is another method used to operationally resolve violations by making adjustments to the system, in which the impact to the system is reported as shadow prices and/or load reduction. While it is expected that such a SCRD approach would result in similar conclusions, the violation metric approach was adopted because it provides a more direct indicator of planning criteria violations by reporting the number of violations and the aggregate severity of the violations with the “total MW thermal overload” and “total kV under-voltage” metrics. In this way, the violation metric approach was chosen as the preferred method to compare aggregate reliability outcomes across many different scenarios in the resource planning context.

These metrics, particularly the **total MW thermal overload** and **total kV under-voltage** metrics, are intended to provide a relative comparison of expected mitigation costs for achieving a reliable grid according to NERC planning criteria for the different scenarios evaluated. The metrics are not intended to provide an absolute cost of mitigations.

5 Results

This section contains the thermal and voltage violation summary metrics resulting from the AC contingency analysis for each scenario, where the analysis was performed in the same way with the same contingency list and limits for each scenario to enable comparisons across scenarios. It is acknowledged and expected that every scenario has some level of pre-existing violations because mitigations like redispatch, uprating, or adding of equipment has not been performed. Therefore, the comparisons here are relative comparisons only.

5.1 Comparison of CEOs' and Utilities' Preferred Plan Reference Case Scenarios

The first comparison is between the two reference case scenarios – the Utilities' Preferred Plan and CEOs' Preferred Plan. The different generation resources in each scenario are summarized again in Table 11 for reference.

Table 11: Summary of Modeled Generation Changes between Utilities' and CEOs' Preferred Plans Reference Case Scenarios

Generating Resource Changes	Utilities' Preferred Plan	CEOs' Preferred Plan
Nemadji CC (NTEC)	In	Out
Sherco CC	In	Out
CEO's additional PV resources, 1990MW	Not included	In at 50% CF
CEO's storage, 1775MW	Not included	In at 50% CF

The results of the comparison are presented in Table 12 and show the metrics for the Utilities' Preferred Plan and the CEOs' Preferred Plan scenarios. Overall, across metrics the CEOs' Preferred Plan results in essentially equal, and often, better reliability than the Utilities' Preferred Plan. The thermal violation summary metrics generally show significantly better performance by the CEOs' Preferred Plan than by the Utilities' Preferred Plan. Specifically, the number and severity of overloaded elements are 26% lower under the CEOs' Preferred Plan, as indicated by the lower Total MW Thermal Overload. The CEOs' Preferred Plan also shows 17% fewer distinct elements thermally overloaded. While there is one additional contingency that triggers a thermal violation and the highest thermal overload is 1% increased, these differences are minor.

The number and magnitude of low voltage violations of the CEOs' Preferred Plan is slightly higher than that of the Utilities' Preferred Plan. The difference is relatively small, though, and such low voltage violations can often be corrected relatively quickly and inexpensively by improving the voltage regulation characteristics of the new inverter-based resources. For example, voltage improvements could be obtained with line-drop compensation to compensate for the impedance of the plant step-up transformer, with adjustments of existing tap and shunt capacitor switching controls, and with augmentation with additional shunt capacitor banks in the grid.

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Table 12: Comparison of Analysis Metrics between Utilities' and CEOs' Preferred plans

Reference Case Scenario:	Utilities' Preferred Plan	CEOs' Preferred Plan
Total MW Thermal Overload	5466	4058
Number of Distinct Elements Thermally Overloaded	65	54
Number of Distinct Contingencies Causing Thermal Overloads	141	142
Highest Thermal Overload of all Elements	188%	189%
Total kV Under-Voltage	5637	5889
Number of Distinct Buses with Under-Voltage	179	185
Number of Distinct Contingencies Causing Under-Voltage	188	190
Greatest Under-Voltage Deviation	45%	44%
Number of Non-Converged Cases	32	32

From an AC contingency analysis perspective, the CEOs' Preferred Plan is advantageous in comparison to the Utilities' Preferred Plan through reduction of thermal loading. This is a reasonable result given that the CEOs' Plan generally locates the new generation resources in the region to supply power closer to where it is consumed. While the Utilities' Plan shows modest advantages over the CEOs' plan for voltage violations, there are often more mitigations available for voltage violations, and those mitigations are typically less costly and faster to commission.

In addition, the AC contingency results demonstrate that the CEOs' Preferred Plan scenario that only includes one additional transmission upgrade when Boswell 3 retires – as opposed to the five included in MP's analysis – successfully provides equivalent reliability.

5.2 Sensitivity Analysis focusing on reliability benefits from NTEC

The comparison of thermal and voltage violation metrics between the CEOs' Preferred Plan with and without the NTEC plant in service shows a slight increase in thermal violations and a slight decrease in voltage violations with NTEC in service, as shown in Table 13. Specifically, with NTEC in service, the Total MW Thermal Overload metric is 10% higher than without NTEC, while the Total kV Under-Voltage metric is 1% lower. On the whole, these results indicate that NTEC would not provide significant reliability benefits to the transmission system, and that it is likely to increase the thermal stress on the system for some elements near to its point of interconnection.

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Table 13: Comparison of Analysis Metrics Considering NTEC In-Service

Reference Case Scenario:	CEO's Preferred Plan	CEO's Preferred Plan
Sensitivity:		NTEC In Service
Total MW Thermal Overload	4058	4483
Number of Distinct Elements Thermally Overloaded	54	60
Number of Distinct Contingencies Causing Thermal Overloads	142	144
Highest Thermal Overload of all Elements	189%	186%
Total kV Under-Voltage	5889	5827
Number of Distinct Buses with Under-Voltage	185	182
Number of Distinct Contingencies Causing Under-Voltage	190	174
Greatest Under-Voltage Deviation	44%	45%
Number of Non-Converged Cases	32	31

5.3 Sensitivity Analysis Focusing on Boswell 3 Conversion to a Synchronous Condenser

Table 14 compares the results for the two reference case scenarios with a sensitivity converting Boswell 3 to a synchronous condenser rather than retiring it completely. With Boswell 3 as a synchronous condenser, the significantly lower level of total thermal overloading of the grid seen in the CEOs' Plan is preserved. In addition, Boswell 3 as a synchronous condenser brings benefits in terms of additional voltage support to the region, which is reflected in the results as a significant reduction in the number and severity of low voltage violations. In fact, the scenario of converting Boswell 3 to a synchronous condenser has advantages over both the Utilities' and the CEOs' Preferred Plans.

Table 14: Comparison of Analysis Metrics Considering Boswell 3 as a Synchronous Condenser

Reference Case Scenario:	Utilities' Preferred Plan	CEO's Preferred Plan	CEO's Preferred Plan
Plan Sensitivity:			B3 Sync. Condenser
Total MW Thermal Overload	5466	4058	4039
Number of Distinct Elements Thermally Overloaded	65	54	53
Number of Distinct Contingencies Causing Thermal Overloads	141	142	142
Highest Thermal Overload of all Elements	188%	189%	189%
Total kV Under-Voltage	5637	5889	5587
Number of Distinct Buses with Under-Voltage	179	185	168
Number of Distinct Contingencies Causing Under-Voltage	188	190	189
Greatest Under-Voltage Deviation	45%	44%	45%
Number of Non-Converged Cases	32	32	32

5.4 Boswell 4 Retirement Sensitivity

The retirement of Boswell 4 in addition to the changes proposed in the CEOs' Preferred Plan is expected to significantly challenge steady-state grid operations, as indicated by the increase in the number and severity of thermal violations and low voltage violations as summarized by the metrics in Table 15.

Table 15: Comparison of Analysis Metrics Considering the Retirement of Boswell 4

Reference Case Scenario:	Utilities' Preferred Plan	CEO's Preferred Plan	CEO's Preferred Plan
Sensitivity:			B4 Retired
Total MW Thermal Overload	5466	4058	7792
Number of Distinct Elements Thermally Overloaded	65	54	65
Number of Distinct Contingencies Causing Thermal Overloads	141	142	179
Highest Thermal Overload of all Elements	188%	189%	190%
Total kV Under-Voltage	5637	5889	8519
Number of Distinct Buses with Under-Voltage	179	185	190
Number of Distinct Contingencies Causing Under-Voltage	188	190	223
Greatest Under-Voltage Deviation	45%	44%	45%
Number of Non-Converged Cases	32	32	35

In comparing the results in Table 15, it is clear that the grid is significantly more stressed without active power from Boswell 4. This result illustrates that additional transmission system upgrades will be required to facilitate Boswell 4's retirement.

MP's scenario "S3" for the retirement of Boswell units 3 and 4 includes three new synchronous condensers at 300MVA[41] each and a major new transmission project described as a series-compensated line for a mid-level cost estimate of $803MM with a lower estimate of $523MM and an upper estimate of $1.326B[42]. These estimates span an enormous range, which indicates that the scenario and its costs have not been studied closely. Furthermore, MP's estimates are likely overstated, considering that their analysis:

- Has not considered synchronous condenser conversions of the Boswell units, and only considered preliminary concepts for new synchronous condensers, which are substantially more expensive than conversions[43];

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41 CEO IR-008, PUC Docket No. E015/RP-21-33.
42 Minnesota Power's 2021 Integrated Resource Plan, Appendix F: Transmission Planning Activities, Table 11 and Figure 20. CEO IR-002, PUC Docket No. E015/RP-21-33.
43 Synchronous Condenser Market by Cooling Type (Hydrogen, Air, Water),Type (New & Refurbished), Starting Method (Static Frequency Converter, Pony Motor), End User (Electrical Utilities & Industries), Reactive Power Rating, and Region-Global Forecast to 2025, Markets and Markets, https://www.marketsandmarkets.com/Market-Reports/synchronous-condenser-market-189197147.html

- Is based on the severe assumption that MHEX is flowing south-to-north at its maximum technical limit, contrary to historical experience and MTEP assumptions and has not considered contractual or operational solutions to minimize or prevent south-to-north flows during times of peak grid stress (as described in detail below in Section 6);
- Has not studied the benefit of upgrading the Square Butte – Arrowhead HVDC link for importing power the region;
- Has not studied siting of energy storage resources at critical locations to help mitigate short-duration, high-demand events; and
- Has not studied a combination of solutions that could maximize the cost-effectiveness and flexibility of the future grid infrastructure.

Furthermore, MISO's Long Range Transmission Planning (LRTP) process has proposed a new 345kV transmission line as part of its Tranche 1 Portfolio, running from Iron Range to Benton to Cassie's Crossing. This newly proposed line substantially augments the major north-south power flow corridor between MP's territory and the Twin Cities and would alleviate many of the same thermal and voltage violations identified in Northern Minnesota during winter peak conditions[44]. If the new Iron-Range-Benton-Cassie's Crossing transmission line is approved in the LRTP process, it is expected to significantly reduce the cost and extent of additional mitigations required for the retirement of Boswell 4.

6 Impact of Assumed Manitoba-Minnesota Flows on Transmission Reliability

The direction of the assumed power flows between MP/MISO and Manitoba – or the "MHEX interface" – has a massive impact on the number and severity of thermal and voltage violations on the grid in the region. As described in more detail above, MISO's base assumption is that power flows are north-to-south, which is consistent with actual historical flows. However, MP has assumed maximum power flows from MP/MISO to Manitoba (south-to-north). When MP's south-to-north flow is modeled, it significantly stresses the grid in northern Minnesota. The impact of the assumed power flows on the MHEX interface between MISO and Manitoba on thermal and voltage violations is shown in Table 16 for the cases with Boswell 4 in service and retired. The dramatic increase in stress on the grid for a south-to-north flow is reflected in every metric computed.

[44] MISO, LRTP Tranche 1 Portfolio Detailed Business Case, LRTP Workshop, March 29, 2022, p. 13. https://cdn.misoenergy.org/20220329%20LRTP%20Workshop%20Item%2002%20Detailed%20Business%20Case623671.pdf

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Table 16: Comparison of Analysis Metrics Considering Maximum Flow from MISO to MH

Reference Case Scenario:	CEO's Preferred Plan	CEO's Preferred Plan	CEO's Preferred Plan	CEO's Preferred Plan
Sensitivity:		Max MHEX Flow North	B4 Retired	Max MHEX Flow North + B4 Retired
Total MW Thermal Overload	4058	34905	7792	86613
Number of Distinct Elements Thermally Overloaded	54	113	65	153
Number of Distinct Contingencies Causing Thermal Overloads	142	228	179	301
Highest Thermal Overload of all Elements	189%	198%	190%	212%
Total kV Under-Voltage	5889	187977	8519	614546
Number of Distinct Buses with Under-Voltage	185	333	190	426
Number of Distinct Contingencies Causing Under-Voltage	190	613	223	718
Greatest Under-Voltage Deviation	44%	49%	45%	49%
Number of Non-Converged Cases	32	42	35	55

These results show that Minnesota Power's assumption in its studies of a maximum south-to-north flow during Minnesota Power's winter peak significantly increases the perceived reliability impacts from the retirement of the Boswell units. Therefore, we consider this to be a critical and pessimistic base assumption.

In addition, Minnesota Power's estimate of the mitigations, largely in the form of transmission upgrades needed to retire Boswell 4, is based on analyses that incorporate this assumption of a large power flow to the north during the winter peak. Table 17 shows that using MISO's base assumption about winter peak power flows (north-to-south) greatly reduces the violations associated with retiring Boswell 4. This suggests that Minnesota Power's estimate of the scale and cost of the transmission upgrades needed to facilitate Boswell 4's retirement are materially increased by this single assumption.

Furthermore, it is noted that:

- MISO has the legal authority to limit the MHEX flow[45];
- MISO has the technological ability to limit interface flows, which it has been doing already to respect the existing flow limits on the MHEX;
- the MHEX flow historically has been much smaller than assumed in the studies, as shown in Figure 3.

[45] Coordination Agreement By And Between Midcontinent Independent System Operator Inc. and Manitoba Hydro. Rate Schedule 2. Version 32.0.0. Effective On: June 1, 2014.

- there is no valid reason to assume large power flows to the north in the future, except for slightly higher market prices. However, a market incentive would be washed out by the costly reliability problems in Minnesota caused by the stress of large exports of power north.

Therefore, a modified south-to-north power flow limit on the MHEX is a powerful lever for mitigating the stress on the grid in Northern Minnesota and should be considered a mitigation option for the retirement of the Boswell 4 unit.

7 Key Findings and Conclusions

Overall, the results of our analysis indicate that based on a transmission system-level power flow analysis, CEOs' Preferred Plan is as reliable or more reliable than the Utilities' Preferred Plan. Moreover, the NTEC plant does not provide a material or necessary reliability benefit when Boswell 3 is retired, even with fewer transmission mitigations than MP proposed. In addition, we find that mitigations will be required when both Boswell units are retired. However, MP's estimates of the necessary transmission mitigations, based on an aggressive and mostly unexplained assumption regarding power flows between MP and Manitoba, results in a much higher cost estimate than one would find using MISO's base assumptions consistent with historical data. Based on our finding that some transmission mitigations will be needed, we recommend that MP begin planning for Boswell 4 mitigations in order to meet its stated retirement timeline or earlier retirement dates that may be considered or required in the future.

7.1 NTEC Findings

- The NTEC plant does not provide a material transmission system-level reliability mitigation benefit and, in fact, creates thermal and voltage issues on MP's system in the vicinity of NTEC[46] in the scenarios analyzed.

7.2 Boswell 3 Findings

- Retirement of Boswell 3 will require some transmission reinforcements, but probably fewer than MP has proposed. Our analysis finds that MP's proposed transmission upgrades like the **[TRADE SECRET BEGINS… … TRADE SECRET ENDS]** would be sufficient mitigation when applied in conjunction with the CEO's Preferred Plan generation additions[47].
- The conversion of Boswell 3 to a synchronous condenser would improve voltage support and voltage stability and is a recommended solution.

[46] MISO DPP Aug 2017 Wisconsin Phase 1 System Impact Study, American Transmission Company. Section 2.3.6, Additional Studies for J732. Issue Date: 12-13-2018

[47] Based on Telos' analysis, Energy Futures Group used MP's proposed proxy **[TRADE SECRET BEGINS … …TRADE SECRET ENDS]** as the mitigation for Boswell 3's retirement in its EnCompass modeling for CEOs.

7.3 Boswell 4 Findings

- The retirement of Boswell 4, in addition to the retirement of Boswell 3, will increase the stress on the system.
- Planning for mitigations and/or other solutions needs to start now, even to prepare for retirement of Boswell 4 in 2035, and certainly to preserve the option of earlier retirement.

7.4 Manitoba – Minnesota Interchange Findings

- Assuming a maximum power flow from south to north during the winter peak, as was done by MP or at MP's request in the reliability studies it cites, is a critical and pessimistic initial condition. This assumption deviates from historical flow patterns and from the flows assumed MTEP20 winter peak base case, and no justification has been provided for the difference in the assumption.
- Use of this unsupported assumption greatly increases the perceived reliability issues associated with retiring both Boswell units, and therefore likely overestimates the scale and cost of the transmission upgrades needed to facilitate that retirement; and therefore, requires more analysis as a mitigation solution.
- A modified south-to-north power flow limit on the MHEX is a powerful lever for mitigating the stress on the grid in Northern Minnesota and should be considered a mitigation option for the retirement of the Boswell 4 unit.

Appendix A: Thermal and Voltage Planning Criteria

Each power-carrying component in a grid has a limit to its ability to handle the power flowing through it, which is called a thermal limit. The major pieces of power-carrying equipment are transmission lines and power transformers. Engineers must respect the design limits of this equipment to avoid overheating of transformers, which can reduce lifetime, and overheating of lines, which can lead to excessive sag and increased risk of short-circuits through contact with vegetation. While NERC specifies the evaluations and types of contingencies required, it leaves the acceptance criteria up to the individual transmission system operator (TSO). The equipment thermal limits used throughout this analysis come from the MISO MTEP20 database, which is a compilation of limits submitted by each TSO. Power flows that exceed the thermal limits of a piece of equipment are referred to as thermal violations.

Maintaining close control over voltages in the system, especially at major substations, is critical to the ability to transfer power reliably across transmission lines. The voltages in a grid are impacted by many factors, including the number of generators on the system, how those generators are configured to control their local voltage, the load and its characteristics, the topology of the grid, and the power flow through the grid. A voltage violation is the condition where the voltage at a particular substation exceeds the limits of voltage established by the transmission system operators, where the voltage limits are reflected in the MISO MTEP20 database. This analysis focuses exclusively on low voltage violations, which are generally indicative of insufficient reactive power resources where hardware mitigations are often necessary.

Appendix B: Detailed Results

Thermal Overloads, parsed by Element

Monitored Facility	Utilities' Preferred Plan	CEO's Preferred Plan	CEO w/ NTEC In Service	CEO w/ B3 Sync. Condenser	CEO w/ B4 Retired	CEO w/ Full MHEX Flow North	CEO w/ B4 Retired + Full MHEX Flow North	Utilities' Preferred Plan	CEO's Preferred Plan	CEO w/ NTEC In Service	CEO w/ B3 Sync. Condenser	CEO w/ B4 Retired	CEO w/ Full MHEX Flow North	CEO w/ B4 Retired + Full MHEX Flow North
	MWoverload							Case Count						
620233 EDGETAP7 115 620234 PEL RPD7 115 1	1100.3	1070.2	1074.3	6000.2	2206.7	2181.7	1625.8	148	136	123	136	142	245	253
620362 OAKES 4 230 661098 ELLENDL345 4 230 1	53.9	101.4	102.0	4223.2	550.3	549.6	327.3	12	16	5	16	38	84	98
608617 MUDLAKE4 230 615319 GRE-BENTON 4 230 1	0.0	0.0	0.0	89.5	0.0	0.0	0.0	0	0	0	0	0	2	125
620204 PELICN N T7 115 620234 PEL RPD7 115 1	233.9	256.5	261.4	4062.1	1032.6	1023.1	482.3	40	44	19	44	128	213	230
608642 VERNDLE7 115 615567 GRE-WINGRIV7 115 1	0.0	0.0	0.0	1570.9	160.6	160.0	21.7	0	0	0	0	30	164	271
617054 GRE-MILACA 8 69.0 618624 GRE-RUMRVTP8 69.0 1	7.2	5.0	5.0	1648.1	92.5	91.5	23.7	3	1	1	1	41	204	359
620325 BROWNSV4 230 620328 NEW EFFNGTN4 230 1	0.0	0.0	0.0	1993.5	44.3	44.1	2.1	0	0	0	0	7	52	75
617000 GRE-LANGLTP7 115 619412 GRE-STSTPHT7 115 1	0.0	0.0	0.0	443.5	0.0	0.0	0.0	0	0	0	0	0	22	148
620223 HOOT LK7 115 620233 EDGETAP7 115 1	61.6	70.8	70.9	1580.4	164.1	161.1	91.6	4	4	4	4	17	148	162
602037 ROCKCR 4 230 615460 GRE-RUSH CY4 230 1	0.0	0.0	0.0	98.2	0.0	0.0	0.0	0	0	0	0	0	4	66
620327 HANKSON4 230 620328 NEW EFFNGTN4 230 1	0.0	0.0	0.0	1634.5	3.6	3.6	0.0	0	0	0	0	3	50	59
608650 LITTLEF7 115 617000 GRE-LANGLTP7 115 1	0.0	0.0	0.0	315.4	0.0	0.0	0.0	0	0	0	0	0	12	105
608644 DOGLAKE7 115 619700 GRE-THMSTWN7 115 1	0.0	0.0	0.0	499.7	17.2	17.8	0.0	0	0	0	0	7	56	198
615560 GRE-WST CLD7 115 619410 GRE-LSAUKTP7 115 1	0.0	0.0	0.0	255.0	0.0	0.0	0.0	0	0	0	0	0	12	89
620314 BIGSTON4 230 620325 BROWNSV4 230 1	0.0	0.0	0.0	489.2	0.0	0.0	0.0	0	0	0	0	0	31	44
603027 DGLASCO7 115 619405 GRE-LTLSKTP7 115 1	0.0	0.0	0.0	232.4	0.0	0.0	0.0	0	0	0	0	0	32	66
608612 RIVERTN4 230 618604 GRE-SWTRX3A4 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	14
608612 RIVERTN4 230 608617 MUDLAKE4 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	26
620263 FORMN 7 115 652438 FORMAN 7 115 1	181.9	194.4	194.3	930.4	288.7	288.7	272.0	15	15	16	15	19	32	31
608625 BLCKBRY4 230 618604 GRE-SWTRX3A4 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	14
619407 GRE-FSCHRHL7 115 619412 GRE-STSTPHT7 115 1	0.0	0.0	0.0	173.6	0.0	0.0	0.0	0	0	0	0	0	10	60
608647 LONG PR7 115 619405 GRE-LTLSKTP7 115 1	0.0	0.0	0.0	110.9	0.0	0.0	0.0	0	0	0	0	0	22	43
608642 VERNDLE7 115 619701 GRE-ALDRICH7 115 1	0.0	0.0	0.0	101.2	0.0	0.0	0.0	0	0	0	0	0	15	69
619407 GRE-FSCHRHL7 115 619410 GRE-LSAUKTP7 115 1	0.0	0.0	0.0	140.6	0.0	0.0	0.0	0	0	0	0	0	10	52
615461 GRE-RUSH CY8 69.0 617052 GRE-ADRIANR8 69.0 1	0.0	0.0	0.0	265.7	0.0	0.0	0.0	0	0	0	0	0	13	91
605089 ARLNGTN8 69.0 605091 NE ARLNGTM8 69.0 1	112.6	63.7	63.2	564.6	88.3	88.3	88.1	14	12	14	12	15	51	56
620361 MAPLE R3 345 997193 MAPLE R #2 230 2	30.4	0.0	0.0	391.3	99.6	103.6	29.8	4	0	0	0	6	10	10

620361 MAPLE R3 345 997194 MAPLE R #1 230 1	28.5	0.0	0.0	386.3	96.8	100.8	27.3	4	0	0	0	6	10	10
617030 GRE-PINECTY8 69.0 617057 GRE-HNCKLEY8 69.0 1	0.0	0.0	0.0	299.6	0.0	0.0	0.0	0	0	0	0	0	10	12
608615 ARROWHD4 230 997294 ARD7 115 2	438.7	105.1	105.4	287.9	232.5	231.9	626.3	12	3	5	3	3	3	5
657754 MAPLE R4 230 997193 MAPLE R #2 230 2	32.2	0.0	0.0	361.0	101.6	106.5	30.5	4	0	0	0	6	10	10
657754 MAPLE R4 230 997194 MAPLE R #1 230 1	30.3	0.0	0.0	356.0	98.7	103.7	28.0	4	0	0	0	6	10	10
608615 ARROWHD4 230 997295 ARD6 115 1	399.2	96.3	96.6	277.8	226.8	226.2	573.3	7	3	5	3	3	3	5
608673 ARROWHD7 115 997294 ARD7 115 2	389.6	90.8	91.1	276.6	207.0	206.4	569.5	7	3	5	3	3	3	5
608617 MUDLAKE4 230 997292 MLS1 115 1	0.0	0.0	0.0	183.5	0.0	0.0	0.0	0	0	0	0	0	4	20
608639 MNP-STP7 115 619701 GRE-ALDRICH7 115 1	0.0	0.0	0.0	59.4	0.0	0.0	0.0	0	0	0	0	0	6	54
608673 ARROWHD7 115 997295 ARD6 115 1	361.3	81.7	82.0	266.2	199.4	198.8	516.8	7	3	5	3	3	3	3
608651 MUDLAKE7 115 997292 MLS1 115 1	0.0	0.0	0.0	177.7	0.0	0.0	0.0	0	0	0	0	0	4	20
619101 GRE-MLTN TP7 115 620221 PARKERS OTP7 115 1	0.0	0.0	0.0	86.2	0.0	0.0	0.0	0	0	0	0	0	10	19
601001 FORBES 2 500 997377 FBS7ABC 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
608624 FORBES 4 230 997377 FBS7ABC 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
608652 BRAINRD7 115 608657 RVT1BUS7 115 1	0.0	0.0	0.0	95.8	0.0	0.0	0.0	0	0	0	0	0	4	13
608640 BADOURA7 115 997299 BAH5 115 1	118.1	113.7	113.5	227.5	169.6	169.5	146.8	8	5	8	5	6	9	24
602037 ROCKCR 4 230 615466 GRE-BEARCK 4 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	18
617057 GRE-HNCKLEY8 69.0 617064 GRE-HINCKTP8 69.0 1	0.0	0.0	0.0	35.7	0.0	0.0	0.0	0	0	0	0	0	8	10
608651 MUDLAKE7 115 608652 BRAINRD7 115 1	0.0	0.0	0.0	24.8	0.0	0.0	0.0	0	0	0	0	0	2	4
618209 GRE-PRKRPTP7 115 620221 PARKERS OTP7 115 1	0.0	0.0	0.0	36.7	0.0	0.0	0.0	0	0	0	0	0	10	19
608610 BADOURA4 230 997299 BAH5 115 1	108.2	104.8	104.7	211.3	157.6	157.4	135.1	5	5	5	5	6	10	22
617059 GRE-HARRY M8 69.0 617060 GRE-DENHAM 8 69.0 1	0.0	0.0	0.0	74.0	0.0	0.0	0.0	0	0	0	0	0	8	78
618203 GRE-TAMARAC7 115 618207 GRE-CORMRNT7 115 1	0.0	0.0	0.0	62.7	0.0	0.0	0.0	0	0	0	0	0	12	18
608676 HIBBARD7 115 608680 WNTR ST7 115 1	262.6	244.3	246.1	122.9	169.1	169.0	241.6	9	10	9	10	8	5	5
608639 MNP-STP7 115 619700 GRE-THMSTWN7 115 1	0.0	0.0	0.0	29.7	0.0	0.0	0.0	0	0	0	0	0	5	23
608722 FORBES 7 115 608725 44L TAP7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	18
618203 GRE-TAMARAC7 115 620204 PELICN N T7 115 1	0.0	0.0	0.0	75.9	9.7	9.7	0.0	0	0	0	0	3	8	18
605110 SAUKCMU8 69.0 619427 GRE-KANDTTP8 69.0 1	0.0	0.0	0.0	64.5	0.0	0.0	0.0	0	0	0	0	0	24	32
615428 GRE-RIVTON 8 69.0 616734 GRE-OKLWNTP8 69.0 1	0.0	0.0	0.0	25.5	0.0	0.0	0.0	0	0	0	0	0	8	27
615318 GRE-BENTON 3 345 997271 345/230 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	4
608650 LITTLEF7 115 616700 GRE-DEWING 7 115 1	0.0	0.0	0.0	100.1	0.0	0.0	0.0	0	0	0	0	0	4	28
602013 ROSEAU 4 230 657757 MORANVI4 230 1	0.0	0.0	0.0	238.9	0.0	0.0	0.0	0	0	0	0	0	8	4
608673 ARROWHD7 115 618001 GRE-BERGNTP7 115 1	0.0	0.0	0.0	7.8	0.0	0.0	0.0	0	0	0	0	0	2	14
615318 GRE-BENTON 3 345 997270 345/230 _1 230 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	4
605488 GETWAY 8 69.0 657904 PRAIRIE8 69.0 1	28.5	29.2	29.3	34.7	52.8	52.7	28.7	3	3	4	3	5	3	12
618204 GRE-CMRTJCT7 115 618207 GRE-CORMRNT7 115 1	0.0	0.0	0.0	38.0	0.0	0.0	0.0	0	0	0	0	0	4	15
615300 GRE-INMAN 4 230 615566 GRE-WINGRIV4 230 1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0	0	0	0	0	1	14
608614 98L TAP4 230 608615 ARROWHD4 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	4
615317 GRE-BENTONX4 230 997271 345/230 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	4
620263 FORMN 7 115 997192 FORMAN 230 115 1	0.0	0.0	0.0	186.1	0.0	0.0	0.0	0	0	0	0	0	16	16
617029 GRE-RUSHCYD8 69.0 617052 GRE-ADRIANR8 69.0 1	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0	0	0	0	0	2	10

617060 GRE-DENHAM 8 69.0 618049 GRE-KETTLER8 69.0 1	0.0	0.0	0.0	58.9	0.0	0.0	0.0	0	0	0	0	0	4	20
605257 FRMNGTN8 69.0 615443 GRE-LKMARNS8 69.0 1	120.6	161.6	161.6	149.1	164.2	164.2	146.0	15	29	28	29	30	35	32
615317 GRE-BENTONX4 230 997270 345/230 _1 230 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	4
620329 WAHPETN4 230 620829 WAHPETON XF4 230 Z	0.0	0.0	0.0	87.4	0.0	0.0	0.0	0	0	0	0	0	4	27
617062 GRE-SAND SW8 69.0 617064 GRE-HINCKTP8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	10
605166 EAGLELK8 69.0 617243 GRE-EAGLELK8 69.0 1	48.6	34.3	34.3	142.6	51.3	51.4	46.0	4	3	3	3	5	10	10
605083 HENDRSN8 69.0 605223 KELSO SS 8 69.0 1	55.9	16.7	16.5	129.4	22.7	22.7	27.1	11	4	5	4	4	12	12
620285 SOLWAY 7 115 657434 WILT TAP 115 1	110.3	111.6	110.9	119.5	116.7	116.1	112.6	2	3	2	3	4	4	6
608697 TAC HBR7 115 608698 MESABA 7 115 2	83.6	101.3	83.2	26.9	99.9	83.3	101.2	2	2	2	2	2	3	3
608720 COTTNTP7 115 618001 GRE-BERGNTP7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	6
608718 16L TAP7 115 608720 COTTNTP7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	4
605152 MORISTN8 69.0 605164 WATRVIL8 69.0 1	10.2	9.9	9.9	21.9	10.1	10.1	9.5	1	1	1	1	1	7	12
605083 HENDRSN8 69.0 618723 GRE-JSNLDTP8 69.0 1	41.7	11.2	11.0	113.0	17.2	17.2	18.9	9	4	4	4	4	12	12
620238 WINGER 7 115 620239 BAGLEY 7 115 1	96.5	97.8	97.6	89.6	101.1	100.8	98.4	3	3	2	3	4	4	6
608660 BIGROCK7 115 608661 TWOHBRS7 115 1	36.2	21.3	21.8	101.8	26.5	25.5	36.5	4	4	4	4	4	2	2
605166 EAGLELK8 69.0 605569 JAMESTP8 69.0 1	36.6	24.0	23.9	109.4	36.9	37.0	48.6	3	3	3	3	4	9	9
617030 GRE-PINECTY8 69.0 617046 GRE-GRASTON8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	10
615466 GRE-BEARCK 4 230 997242 BRC230-69-1 69.0 1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0	0	0	0	0	1	4
608673 ARROWHD7 115 608688 COLBYVL7 115 1	59.1	53.6	53.7	42.1	53.7	53.3	53.7	3	1	1	1	1	1	3
608653 RIVERTN7 115 997249 RVT115-69-1 69.0 1	16.5	16.4	16.4	14.6	15.7	16.6	16.6	2	2	2	2	2	2	2
615080 GRE-ROCKLK1G 69.0 617040 GRE-RUSH SW8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	10
608633 FAIRMPK7 115 608680 WNTR ST7 115 1	69.4	5.5	6.3	0.0	0.0	0.0	56.3	2	3	2	3	0	0	0
615080 GRE-ROCKLK1G 69.0 617030 GRE-PINECTY8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	10
608657 RVT1BUS7 115 618015 GRE-HILLCTP7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	6
617029 GRE-RUSHCYD8 69.0 617040 GRE-RUSH SW8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	10
615467 GRE-BEAR CK8 69.0 997242 BRC230-69-1 69.0 1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0	0	0	0	0	1	4
615536 GRE-WILSONL8 69.0 616735 GRE-PINCTRT8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
605089 ARLNGTN8 69.0 618723 GRE-JSNLDTP8 69.0 1	24.5	1.1	0.8	78.8	5.8	5.8	3.0	6	3	0	3	4	12	12
608651 MUDLAKE7 115 616700 GRE-DEWING 7 115 1	0.0	0.0	0.0	72.3	0.0	0.0	0.0	0	0	0	0	0	4	12
608660 BIGROCK7 115 608691 SLVRBYH7 115 1	0.0	0.0	0.0	56.8	0.0	0.0	0.0	0	0	0	0	0	2	2
608640 BADOURA7 115 608941 BAD2SUB7 115 1	0.0	0.0	0.0	11.4	0.0	0.0	0.0	0	0	0	0	0	3	5
608941 BAD2SUB7 115 617705 GRE-SHNGOTP7 115 1	65.0	65.5	64.8	94.1	64.9	65.6	64.2	2	2	2	2	2	4	6
615428 GRE-RIVTON 8 69.0 997249 RVT115-69-1 69.0 1	11.1	11.0	11.1	9.8	10.1	11.1	11.3	2	2	2	2	1	1	1
618009 GRE-POKEGMT7 115 618015 GRE-HILLCTP7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	6
615478 GRE-SPRGCK25 161 997239 161/69 _3 69.0 2	31.3	94.0	94.0	29.1	38.4	38.4	66.7	7	7	7	7	3	3	7
620855 DONALDS CAP7 115 657718 HALMA 7 115 1	65.0	65.9	66.0	31.1	62.2	62.4	64.8	3	3	3	3	3	3	3
608691 SLVRBYH7 115 608915 N_SHORE7 115 1	0.0	0.0	0.0	50.1	0.0	0.0	0.0	0	0	0	0	0	2	2
615518 GRE-4CORNRS8 69.0 997233 115/69 _12 69.0 1	3.4	0.0	0.0	0.0	0.0	0.0	4.6	1	0	1	0	0	0	0
657810 HENSELU8 69.0 997205 HENSEL #1 69.0 1	9.4	10.1	10.3	0.0	7.2	7.6	10.5	5	5	25	5	4	0	0
608638 AKELEY7 115 617705 GRE-SHNGOTP7 115 1	59.2	59.4	59.0	81.7	59.1	59.8	58.3	2	2	2	2	2	4	6
615479 GRE-SPRNGCK8 69.0 997239 161/69 _3 69.0 2	24.7	87.5	87.6	26.7	35.8	35.7	60.1	7	7	7	7	3	3	7

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608673 ARROWHD7 115 608674 HANESRD7 115 1	45.1	43.9	44.0	30.7	44.0	43.9	41.6	3	1	1	1	1	1	3
608674 HANESRD7 115 608685 SWAN LK7 115 1	35.3	37.5	37.6	24.6	37.6	37.5	35.5	1	1	1	1	1	1	1
605164 WATRVIL8 69.0 618728 GRE-ELYSNTP8 69.0 1	6.4	6.1	6.1	8.2	6.3	6.3	5.7	1	1	1	1	1	1	1
615467 GRE-BEAR CK8 69.0 617062 GRE-SAND SW8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	10
620149 KARLSTA7 115 657718 HALMA 7 115 1	56.1	57.0	56.9	22.4	53.1	53.5	55.8	3	3	3	3	3	3	3
608694 FINLND_7 115 608697 TAC HBR7 115 1	11.0	11.0	5.4	28.5	6.2	11.0	6.0	1	1	1	1	1	1	1
615517 GRE-4CORNRS7 115 997233 115/69 _12 69.0 1	2.9	0.0	0.0	0.0	0.0	0.0	4.2	1	0	1	0	0	0	0
620255 DONALDS7 115 620855 DONALDS CAP7 115 Z	53.2	54.0	53.8	19.8	49.9	50.6	52.9	3	3	3	3	3	3	3
620223 HOOT LK7 115 658110 FERGSFL7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	10
620255 DONALDS7 115 657705 DRAYTON7 115 1	38.8	38.7	38.7	17.7	37.1	37.2	38.6	1	1	1	1	1	1	1
620255 DONALDS7 115 657714 WARSAW 7 115 1	9.4	9.1	9.1	43.8	8.3	8.4	9.0	1	1	1	1	1	7	7
608740 GR RPDS7 115 618009 GRE-POKEGMT7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
608694 FINLND_7 115 608915 N_SHORE7 115 1	4.7	4.6	0.0	23.2	0.8	4.7	0.6	1	1	1	0	1	1	1
605110 SAUKCMU8 69.0 619425 GRE-W UNION8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	8
605119 PAYNES 8 69.0 619440 GRE-ROSCOTP8 69.0 1	0.0	0.0	0.0	69.5	0.0	0.0	0.0	0	0	0	0	0	19	19
620245 WILTON 7 115 657711 SCRIBNR7 115 1	36.8	37.9	36.7	25.5	35.5	35.6	36.5	2	2	2	2	2	2	2
608661 TWOHBRS7 115 616677 GRE-CLVRVLY7 115 1	0.0	0.0	0.0	39.7	0.0	0.0	0.0	0	0	0	0	0	2	2
620238 WINGER 7 115 620251 PLUMTAP7 115 1	23.7	23.6	23.6	23.5	23.5	23.5	23.9	1	1	1	1	1	1	1
617237 GRE-NWSWDTP8 69.0 617246 GRE-TRAVERS8 69.0 1	1.2	0.0	0.0	27.4	0.0	0.0	0.0	3	0	0	0	0	6	6
605090 GRENISL8 69.0 605091 NE ARLNGTM8 69.0 1	0.0	0.0	0.0	37.0	0.0	0.0	0.0	0	0	0	0	0	11	14
615428 GRE-RIVTON 8 69.0 616727 GRE-CROSSLK8 69.0 1	1.7	1.1	1.2	5.3	3.7	3.8	3.5	1	1	1	1	1	1	1
619427 GRE-KANDTTP8 69.0 619452 GRE-GROVE 8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	8
605084 WINTHRP8 69.0 618415 GRE-WINTHRP8 69.0 1	0.0	0.0	0.0	10.3	0.0	0.0	0.0	0	0	0	0	0	7	14
617237 GRE-NWSWDTP8 69.0 617245 GRE-RUSHRVR8 69.0 1	0.0	0.0	0.0	11.1	0.0	0.0	0.0	0	0	0	0	0	6	6
617247 GRE-JMSTWTP8 69.0 618730 GRE-CLVLAND8 69.0 1	0.0	0.0	0.0	7.8	0.0	0.0	0.0	0	0	0	0	0	6	6
608633 FAIRMPK7 115 608683 STIN-MN7 115 1	7.7	0.0	0.0	0.0	0.0	0.0	1.2	1	0	1	0	0	0	0
620149 KARLSTA7 115 620254 VIKING 7 115 1	14.5	15.4	15.2	0.0	12.2	12.6	14.0	2	2	2	2	2	0	0
605073 ANNDALE8 69.0 619831 GRE-MAPLELK8 69.0 1	9.7	9.5	9.6	9.5	9.6	9.6	9.5	4	4	4	4	4	4	4
618730 GRE-CLVLAND8 69.0 630136 LECENTR8 69.0 1	0.0	0.0	0.0	4.9	0.0	0.0	0.0	0	0	0	0	0	4	4
601001 FORBES 2 500 997376 FBS8ABC 230 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
608624 FORBES 4 230 997376 FBS8ABC 230 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
608632 DAHLBRG7 115 608684 STIN-WI7 115 1	2.5	1.2	1.2	0.0	0.3	0.3	4.7	1	1	1	1	1	0	0
608615 ARROWHD4 230 608624 FORBES 4 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
694075 STONE LK B1 345 996688 STONE LK B1 161 9	12.6	0.0	0.0	0.0	0.0	0.0	11.0	1	0	2	0	0	0	0
602013 ROSEAU 4 230 667046 RICHER 4 230 1	0.0	0.0	0.0	99.2	0.0	0.0	0.0	0	0	0	0	0	8	2
605111 BLCKOAK8 69.0 619452 GRE-GROVE 8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	8
608673 ARROWHD7 115 608686 15TH AV7 115 1	4.3	0.0	0.0	0.0	0.0	0.0	26.4	4	0	4	0	0	0	1
605119 PAYNES 8 69.0 603034 PYNSVIL7 115 2	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0	0	0	0	0	1	1
605223 KELSO SS 8 69.0 617245 GRE-RUSHRVR8 69.0 1	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0	0	0	0	0	3	4
602017 ST LAKE5 161 996688 STONE LK B1 161 9	9.1	0.0	0.0	0.0	0.0	0.0	7.9	1	0	2	0	0	0	0
657712 PRAIRIE7 115 996805 PRAIRIE #2 69.0 2	6.4	6.9	6.9	0.0	4.7	4.7	6.2	2	2	2	2	2	0	0

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608654 AITKNMN7 115 608659 RVT2BUS7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
617034 GRE-BRAHAM 8 69.0 617046 GRE-GRASTON8 69.0 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	8
608615 ARROWHD4 230 615466 GRE-BEARCK 4 230 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	4
608638 AKELEY7 115 657716 LAPORTE7 115 1	12.3	12.3	12.1	9.2	12.2	13.1	11.4	2	2	2	2	2	2	2
608698 MESABA 7 115 608722 FORBES 7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	1	0	0	0	0
615335 GRE-RAMSEY 4 230 997264 RAM230-115-1 115 1	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0	0	0	0	0	4	6
608752 I.FALLS7 118 608784 INTPHAS7 118 1	2.3	0.0	0.0	3.7	4.5	4.5	5.7	1	0	1	0	1	1	1
608722 FORBES 7 115 608730 78L TAP7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	10
620266 RAMSEY 7 115 997264 RAM230-115-1 115 1	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0	0	0	0	0	2	2
608644 DOGLAKE7 115 616715 GRE-FISHTTP7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1
657758 WINGER 4 230 996785 WINGER 230-2 115 1	0.0	0.0	0.0	6.8	0.0	0.0	0.0	0	0	0	0	0	2	2
618202 GRE-ELMO 7 115 618209 GRE-PRKRPTP7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	4
608675 RIDGEVW7 115 608685 SWAN LK7 115 1	0.0	1.0	1.0	0.0	1.0	1.0	0.0	0	1	0	1	1	0	0
657754 MAPLE R4 230 996793 MAPL RIV TR5 115 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2
608673 ARROWHD7 115 608676 HIBBARD7 115 1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0	0	0	0	0	0	0
657904 PRAIRIE8 69.0 657712 PRAIRIE7 115 3	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0	0	0	0	1	0	0
608751 LTLFRK 7 118 657753 LTLFRK 4 230 1	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0	0	0	0	1	0	1

Low Voltage Violations, parsed by Element

Monitored Facility	Utilities' Preferred Plan	CEO's Preferred Plan	CEO w/ NTEC In Service	CEO w/ B3 Sync. Condenser	CEO w/ B4 Retired	CEO w/ Full MHEX Flow North	CEO w/ B4 Retired + Full MHEX Flow North	Utilities' Preferred Plan	CEO's Preferred Plan	CEO w/ NTEC In Service	CEO w/ B3 Sync. Condenser	CEO w/ B4 Retired	CEO w/ Full MHEX Flow North	CEO w/ B4 Retired + Full MHEX Flow North
	kV Overload, Low Voltage							Case Count						
620254_VIKING 7 _115.0_620	317.0	307.4	290.2	308.0	405.9	9580.7	16177.2	34	33	29	32	59	1054	1070
620284_OSLO TN7 _115.0_620	244.3	235.6	219.6	237.3	399.7	9741.2	16105.0	40	29	27	33	108	1048	1050
620253_PLUMPIP7 _115.0_620	358.2	347.4	325.2	347.2	450.4	8727.9	15249.6	40	32	29	32	71	1058	1075
620252_PLUMMER7 _115.0_620	357.4	346.8	324.6	346.7	447.3	8621.8	15125.2	35	31	29	30	71	1058	1075
620251_PLUMTAP7 _115.0_620	356.3	345.8	323.7	345.7	445.2	8587.3	15089.4	34	31	29	30	70	1058	1075
620149_KARLSTA7 _115.0_620	231.6	224.3	215.7	225.6	269.9	7524.7	13607.7	20	20	14	20	39	1033	1030
620855_DONALDS CAP7_115.0_620	197.7	196.8	199.2	196.5	238.4	7592.3	13028.3	21	20	14	19	38	993	968
620256_DONDPIP7 _115.0_620	106.4	104.9	112.1	105.5	149.4	7528.6	12999.0	20	18	13	17	37	992	968
620255_DONALDS7 _115.0_620	125.2	124.5	130.9	123.9	167.6	7527.1	12993.5	19	18	13	17	37	991	968
620249_CRKSTON7 _115.0_620	46.3	45.3	20.6	36.0	68.9	6191.0	12131.9	31	36	19	31	57	1034	1046
620326_ERIEJCT _230.0_620	115.3	133.1	91.4	119.1	189.7	4551.0	11502.9	110	138	87	117	144	756	820

620337_LAKE PARK T4_230.0_620	2.1	2.3	2.0	2.3	41.4	4315.9	10540.5	2	2	2	2	76	778	751
620250_FERTILE7 _115.0_620	5.8	4.8	9.5	4.9	10.5	4354.8	9983.7	5	5	9	5	8	1048	1037
620361_MAPLE R3 _345.0_620	224.0	245.3	140.1	238.6	528.9	6413.2	9825.0	128	153	84	147	213	568	492
620257_HENSEL 7 _115.0_620	21.2	20.0	17.2	20.2	29.1	4395.4	8939.5	16	17	15	17	26	628	685
620238_WINGER 7 _115.0_620	0.6	0.4	0.1	0.5	2.3	2993.0	8476.5	1	1	1	1	6	781	1011
620829_WAHPETON XF4_230.0_620	109.1	134.3	63.8	130.1	444.2	4687.7	7811.4	102	121	66	117	251	576	520
620329_WAHPETN4 _230.0_620	107.3	131.5	62.5	127.3	438.7	4675.1	7798.9	99	121	64	117	251	576	520
603025_NORDIC 7 _115.0_600	0.0	0.0	0.0	0.0	12.0	2864.6	7467.9	0	0	0	0	13	614	952
620242_CLBKPIP7 _115.0_620	48.5	46.8	46.4	47.7	54.8	2308.6	7334.5	9	7	9	7	14	794	1009
620240_MN PIPE7 _115.0_620	48.4	46.7	46.3	47.6	54.7	2299.9	7323.4	8	7	9	7	14	791	1010
620241_CLEARBR7 _115.0_620	48.1	46.5	45.9	47.3	54.2	2276.1	7290.3	8	7	9	7	13	785	1015
620237_MAHNOMN7 _115.0_620	0.0	0.0	0.0	0.0	0.6	2119.6	6707.7	0	0	0	0	1	646	982
620358_BUFFALO3 _345.0_620	103.3	138.5	69.4	117.6	301.0	4253.2	6440.0	61	67	35	61	167	464	378
620239_BAGLEY 7 _115.0_620	42.9	42.0	41.5	42.7	46.9	1891.6	6431.9	5	4	4	4	9	700	1004
657712_PRAIRIE7 _115.0_600	0.0	0.0	0.0	0.0	0.0	1642.0	6200.4	0	0	0	0	0	449	643
603007_PRASWCP7 _115.0_600	0.0	0.0	0.0	0.0	4.0	1500.1	6136.6	0	0	0	0	7	439	599
620336_AUDUBON4 _230.0_620	0.0	0.0	0.0	0.0	0.0	508.2	5638.7	0	0	0	0	0	65	325
620447_CASS LK4 _230.0_620	13.9	10.1	28.9	13.5	9.8	1164.0	5296.6	5	4	9	6	5	173	390
615341_GRE-HUBBARD4_230.0_608	0.0	0.0	0.0	0.0	0.0	332.3	5288.6	0	0	0	0	0	49	273
620244_ITASCA 7 _115.0_620	52.9	52.1	51.8	52.1	57.5	1253.9	5234.0	6	7	10	5	11	543	870
620282_NWOOD 7 _115.0_620	49.5	48.4	47.9	49.2	52.8	1011.5	4782.4	5	5	5	5	8	452	668
620327_HANKSON4 _230.0_620	50.7	69.3	21.1	75.3	282.2	2768.6	4757.5	60	90	32	86	185	381	418
608610_BADOURA4 _230.0_608	0.0	0.0	0.0	0.0	0.0	269.4	4739.4	0	0	0	0	0	37	244
620243_SHEVLIN7 _115.0_620	49.1	47.9	47.4	48.7	52.1	979.2	4722.5	5	5	5	5	8	442	650
620285_SOLWAY 7 _115.0_620	50.0	48.8	48.4	49.7	52.4	731.8	4106.7	5	5	5	5	8	190	534
615566_GRE-WINGRIV4_230.0_608	0.0	0.0	0.0	0.0	0.0	240.4	3961.5	0	0	0	0	0	36	235
620246_BEMIDJI7 _115.0_620	115.3	112.6	124.9	114.1	109.9	795.1	3825.1	16	12	39	14	11	313	547
620245_WILTON 7 _115.0_620	62.0	60.2	73.4	61.9	62.4	744.9	3748.4	10	7	36	9	8	319	527
605488_GETWAY 8 _69.0_600	0.0	0.0	0.0	0.0	0.0	773.6	3615.0	0	0	0	0	0	249	571
620328_NEW EFFNGTN4_230.0_620	19.5	25.3	8.9	26.4	149.9	2035.2	3591.3	27	32	16	33	122	311	366
620207_DL OTP 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	378.6	3517.9	0	0	0	0	0	109	447
620227_FAIRMNT7 _115.0_620	8.3	10.2	5.0	10.5	42.1	1771.3	3493.4	13	15	10	15	89	565	528
620248_CASS N 7 _115.0_620	94.6	93.2	104.1	94.1	83.0	787.8	3460.0	26	24	28	25	17	332	481
620247_CASS LK7 _115.0_620	94.2	92.8	103.6	93.6	82.7	782.6	3451.0	26	24	28	25	17	332	480
620228_TYLER 7 _115.0_620	6.7	8.3	3.9	8.5	30.3	1720.2	3413.1	11	12	3	12	69	682	522
620236_PERHAM SE 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	509.7	3384.6	0	0	0	0	0	316	491
620177_PERHAM SE T7_115.0_620	0.0	0.0	0.0	0.0	0.0	503.5	3375.5	0	0	0	0	0	314	490
620235_PERHAM 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	494.3	3374.4	0	0	0	0	0	310	488
620286_QUADRNT7 _115.0_620	0.0	0.0	0.0	0.0	0.0	499.2	3374.4	0	0	0	0	0	312	490
620226_ERIEJCT _115.0_620	0.0	0.0	0.0	0.0	0.0	294.6	3248.1	0	0	0	0	0	76	348
608612_RIVERTN4 _230.0_608	0.0	0.0	0.0	0.0	0.0	130.8	3196.0	0	0	0	0	0	22	172

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620229_WAHPETN7 _115.0_620	4.2	4.8	2.6	4.9	11.6	1417.9	3180.4	4	6	3	6	23	576	509
620369_JAMESTN3 _345.0_620	27.0	32.2	22.7	36.4	76.0	1839.5	3162.8	19	18	19	21	44	377	230
608617_MUDLAKE4 _230.0_608	0.0	0.0	0.0	0.0	0.0	128.8	3066.3	0	0	0	0	0	22	169
607805_HATTON 8 _69.0_620	0.0	0.0	0.0	0.0	0.0	462.5	2938.5	0	0	0	0	0	110	418
602006_SHEYNNE4 _230.0_600	0.0	0.0	0.0	0.0	0.0	260.6	2909.0	0	0	0	0	0	34	217
607804_MAYVILLE 8 _69.0_620	0.0	0.0	0.0	0.0	0.0	427.4	2838.6	0	0	0	0	0	104	403
601067_BISON 3 _345.0_600	0.0	0.0	0.0	0.0	0.0	340.3	2799.4	0	0	0	0	0	71	194
615300_GRE-INMAN 4_230.0_620	0.0	0.0	0.0	0.0	0.0	161.2	2783.3	0	0	0	0	0	22	176
615902_GRE-HENNING4_230.0_620	0.0	0.0	0.0	0.0	0.0	161.6	2729.3	0	0	0	0	0	22	171
617710_GRE-2NLTX1A7_115.0_608	0.0	0.0	0.0	0.0	0.0	157.0	2696.8	0	0	0	0	0	48	272
607800_THOMPSON 8 _69.0_620	0.0	0.0	0.0	0.0	0.0	401.1	2654.2	0	0	0	0	0	100	386
617712_GRE-ELISHA 7_115.0_608	0.0	0.0	0.0	0.0	0.0	149.6	2653.7	0	0	0	0	0	44	268
617708_GRE-POTATLK7_115.0_608	0.0	0.0	0.0	0.0	0.0	146.2	2633.8	0	0	0	0	0	43	265
607801_REYNOLDS 8 _69.0_620	0.0	0.0	0.0	0.0	0.0	376.9	2621.9	0	0	0	0	0	97	382
619703_GRE-REDEYE 7_115.0_608	0.0	0.0	0.0	0.0	0.0	138.4	2584.9	0	0	0	0	0	37	261
617706_GRE-MANTRAP7_115.0_608	0.0	0.0	0.0	0.0	0.0	135.3	2554.9	0	0	0	0	0	33	256
619704_GRE-BLUBRYD7_115.0_608	0.0	0.0	0.0	0.0	0.0	133.4	2533.8	0	0	0	0	0	32	253
608638_AKELEY7 _115.0_608	14.3	13.9	12.8	14.0	12.5	186.8	2533.0	4	4	2	4	2	45	258
620133_PELICN N7 _115.0_620	0.0	0.0	0.0	0.0	0.0	222.4	2512.9	0	0	0	0	0	56	294
620204_PELICN N T7 _115.0_620	0.0	0.0	0.0	0.0	0.0	220.6	2503.3	0	0	0	0	0	56	292
620268_DEVIL S7 _115.0_620	0.0	0.0	0.0	0.0	0.0	679.8	2501.4	0	0	0	0	0	213	430
607802_SOUTH 8 _69.0_620	0.0	0.0	0.0	0.0	0.0	328.0	2501.4	0	0	0	0	0	87	373
620265_DEVILSE7 _115.0_620	0.0	0.0	0.0	0.0	0.0	666.0	2492.3	0	0	0	0	0	209	416
620266_RAMSEY 7 _115.0_615	0.0	0.0	0.0	0.0	0.0	665.6	2492.2	0	0	0	0	0	209	416
620267_DEVIL J7 _115.0_620	0.0	0.0	0.0	0.0	0.0	680.7	2488.9	0	0	0	0	0	213	427
617704_GRE-SHINGOB7_115.0_608	11.6	11.8	11.5	11.7	11.1	173.0	2480.4	2	2	2	2	2	43	254
620234_PEL RPD7 _115.0_620	0.0	0.0	0.0	0.0	0.0	215.8	2465.3	0	0	0	0	0	56	284
608951_STRTRVR7 _115.0_608	0.0	0.0	0.0	0.0	0.0	121.9	2429.5	0	0	0	0	0	32	242
617702_GRE-RDO 7_115.0_608	0.0	0.0	0.0	0.0	0.0	117.2	2408.5	0	0	0	0	0	32	231
615637_GRE-SILVRLK4_230.0_620	0.0	0.0	0.0	0.0	0.0	161.8	2399.1	0	0	0	0	0	22	161
608641_PINERVR7 _115.0_608	15.7	15.9	16.2	15.9	15.8	147.6	2326.9	1	1	1	1	1	43	242
615342_GRE-HUBBARD7_115.0_608	0.0	0.0	0.0	0.0	0.0	106.0	2326.4	0	0	0	0	0	32	223
616718_GRE-BKUSX2A7_115.0_608	0.0	0.0	0.0	0.0	0.0	120.5	2303.0	0	0	0	0	0	32	224
617700_GRE-PALMRLK7_115.0_608	0.0	0.0	0.0	0.0	0.0	104.7	2301.3	0	0	0	0	0	32	221
608648_PEQUOT 7 _115.0_608	26.1	26.0	26.3	26.1	26.1	163.0	2266.3	2	2	2	2	2	52	240
608640_BADOURA7 _115.0_608	0.0	0.0	0.0	0.0	0.0	106.2	2264.8	0	0	0	0	0	32	216
608639_MNP-STP7 _115.0_608	0.0	0.0	0.0	0.0	0.0	132.5	2256.5	0	0	0	0	0	43	246
619700_GRE-THMSTWN7_115.0_608	0.0	0.0	0.0	0.0	0.0	129.0	2246.5	0	0	0	0	0	42	246
617725_GRE-TRIPPLK7_115.0_608	0.0	0.0	0.0	0.0	0.0	103.2	2238.5	0	0	0	0	0	32	215
607807_TRAIL CO 8 _69.0_620	0.0	0.0	0.0	0.0	0.0	252.8	2230.3	0	0	0	0	0	71	344
607803_HILLSBORO 8 _69.0_620	0.0	0.0	0.0	0.0	0.0	248.8	2220.2	0	0	0	0	0	71	342

608941_BAD2SUB7 _115.0_608	0.0	0.0	0.0	0.0	0.0	101.7	2218.4	0	0	0	0	0	30	212
608940_BAD1SUB7 _115.0_608	0.0	0.0	0.0	0.0	0.0	101.6	2218.3	0	0	0	0	0	30	212
619701_GRE-ALDRICH7_115.0_608	0.0	0.0	0.0	0.0	0.0	129.0	2173.0	0	0	0	0	0	42	245
608644_DOGLAKE7 _115.0_608	0.0	0.0	0.0	0.0	0.0	112.6	2154.2	0	0	0	0	0	32	222
657429_TRAIL J8 _69.0_620	0.0	0.0	0.0	0.0	0.0	235.2	2150.3	0	0	0	0	0	71	327
608642_VERNDLE7 _115.0_608	1.4	1.6	1.2	1.6	2.1	129.0	2131.7	1	1	1	1	1	45	246
620325_BROWNSV4 _230.0_620	6.8	8.0	2.3	8.1	23.7	1089.6	2098.5	8	6	4	6	16	260	277
615567_GRE-WINGRIV7_115.0_608	1.4	1.5	1.1	1.5	2.1	125.1	2076.0	1	1	1	1	1	39	242
617707_GRE-POTATTP7_115.0_608	0.0	0.0	0.0	0.0	0.0	84.2	2028.9	0	0	0	0	0	22	205
616717_GRE-FISHTRP7_115.0_608	0.0	0.0	0.0	0.0	0.0	96.5	2024.7	0	0	0	0	0	28	199
619702_GRE-BLUEBRY7_115.0_608	0.0	0.0	0.0	0.0	0.0	84.8	2021.2	0	0	0	0	0	22	205
616716_GRE-MOTLEY 7_115.0_608	0.0	0.0	0.0	0.0	0.0	91.2	1989.1	0	0	0	0	0	24	195
617705_GRE-SHNGOTP7_115.0_608	7.0	7.2	6.9	7.1	6.5	104.1	1987.5	2	2	2	2	2	34	191
617701_GRE-LONG LK7_115.0_608	0.0	0.0	0.0	0.0	0.0	84.1	1962.0	0	0	0	0	0	22	203
620260_ENDERLN7 _115.0_620	50.8	65.1	32.0	63.1	117.7	1273.2	1958.7	126	147	71	138	205	522	354
618210_GRE-LKEUNIC7_115.0_620	0.0	0.0	0.0	0.0	0.0	107.8	1905.8	0	0	0	0	0	22	226
617703_GRE-RDO TAP7_115.0_608	0.0	0.0	0.0	0.0	0.0	81.3	1902.2	0	0	0	0	0	22	201
618207_GRE-CORMRNT7_115.0_620	0.0	0.0	0.0	0.0	0.0	102.9	1838.6	0	0	0	0	0	22	214
616719_GRE-BULMSTP7_115.0_608	0.0	0.0	0.0	0.0	0.0	76.9	1814.0	0	0	0	0	0	22	191
615421_GRE-BIRCHLK7_115.0_608	0.0	0.0	0.0	0.0	0.0	75.8	1799.8	0	0	0	0	0	20	193
616701_GRE-MERRFLD7_115.0_608	26.7	26.5	26.9	26.6	26.7	100.6	1792.1	2	2	2	2	2	26	192
620259_ALICE 7 _115.0_620	21.1	21.5	14.1	22.6	51.5	1051.5	1786.5	47	61	27	50	128	677	345
608655_SCRCYVL7 _115.0_608	0.0	0.0	0.0	0.0	0.0	72.2	1672.5	0	0	0	0	0	22	182
616704_GRE-STHDALE7_115.0_608	0.0	0.0	0.0	0.0	0.0	71.7	1664.0	0	0	0	0	0	22	183
608651_MUDLAKE7 _115.0_608	0.0	0.0	0.0	0.0	0.0	71.1	1642.5	0	0	0	0	0	22	184
616702_GRE-NOKAY 7_115.0_608	0.0	0.0	0.0	0.0	0.0	69.8	1630.5	0	0	0	0	0	22	184
608652_BRAINRD7 _115.0_608	0.0	0.0	0.0	0.0	0.0	69.2	1607.4	0	0	0	0	0	22	183
620258_BUFFALO7 _115.0_620	8.2	6.3	4.9	8.0	15.9	771.2	1595.0	16	18	13	18	37	480	319
620221_PARKERS OTP7_115.0_620	0.0	0.0	0.0	0.0	0.0	209.9	1571.9	0	0	0	0	0	97	303
608645_BAXTER_7 _115.0_608	0.0	0.0	0.0	0.0	0.0	66.7	1564.2	0	0	0	0	0	22	180
616703_GRE-BAXTER 7_115.0_608	0.0	0.0	0.0	0.0	0.0	66.2	1559.2	0	0	0	0	0	22	179
615908_GRE-RMSYCB24_230.0_615	0.0	0.0	0.0	0.0	0.0	277.0	1559.1	0	0	0	0	0	32	201
615907_GRE-RMSYCB14_230.0_615	0.0	0.0	0.0	0.0	0.0	276.4	1555.4	0	0	0	0	0	32	201
615335_GRE-RAMSEY 4_230.0_615	0.0	0.0	0.0	0.0	0.0	276.0	1552.9	0	0	0	0	0	32	201
616715_GRE-FISHTTP7_115.0_608	0.0	0.0	0.0	0.0	0.0	68.1	1524.5	0	0	0	0	0	22	186
608653_RIVERTN7 _115.0_608	0.0	0.0	0.0	0.0	0.0	61.3	1517.1	0	0	0	0	0	22	180
608657_RVT1BUS7 _115.0_608	0.0	0.0	0.0	0.0	0.0	59.7	1506.7	0	0	0	0	0	22	181
608658_60L TAP7 _115.0_608	0.0	0.0	0.0	0.0	0.0	59.7	1500.0	0	0	0	0	0	22	180
608643_EAGLVLY7 _115.0_608	0.0	0.0	0.0	0.0	0.0	80.6	1490.0	0	0	0	0	0	22	188
620363_FORMAN 4 _230.0_620	0.0	0.0	0.0	0.0	0.0	591.7	1483.8	0	0	0	0	0	213	258
608659_RVT2BUS7 _115.0_608	0.0	0.0	0.0	0.0	0.0	58.5	1467.7	0	0	0	0	0	22	177

618211_GRE-LKENCTP7_115.0_620	0.0	0.0	0.0	0.0	0.0	85.1	1455.4	0	0	0	0	0	20	187
615631_GRE-SCHSTLK7_115.0_620	0.0	0.0	0.0	0.0	0.0	88.5	1443.5	0	0	0	0	0	20	180
618205_GRE-FRAZEE 7_115.0_620	0.0	0.0	0.0	0.0	0.0	81.4	1440.4	0	0	0	0	0	20	188
618204_GRE-CMRTJCT7_115.0_620	0.0	0.0	0.0	0.0	0.0	83.7	1440.0	0	0	0	0	0	20	187
616700_GRE-DEWING 7_115.0_608	0.0	0.0	0.0	0.0	0.0	65.4	1419.9	0	0	0	0	0	22	184
620180_CSLTNET7 _115.0_620	23.2	31.6	19.8	28.6	39.8	469.1	1382.2	17	20	11	20	42	326	332
620232_EDGETWN7 _115.0_620	0.0	0.0	0.0	0.0	0.0	92.8	1308.7	0	0	0	0	0	22	200
615535_GRE-WILSNLK7_115.0_615	1.7	2.0	1.5	2.1	2.6	57.4	1299.2	1	2	2	2	2	31	187
620233_EDGETAP7 _115.0_620	0.0	0.0	0.0	0.0	0.0	89.5	1251.8	0	0	0	0	0	22	192
616713_GRE-STHDALT7_115.0_608	0.0	0.0	0.0	0.0	0.0	46.1	1235.8	0	0	0	0	0	20	183
620223_HOOT LK7 _115.0_620	0.0	0.0	0.0	0.0	0.0	87.8	1222.7	0	0	0	0	0	22	191
620170_EFERGUS7 _115.0_620	0.0	0.0	0.0	0.0	0.0	86.6	1209.9	0	0	0	0	0	22	193
618201_GRE-RUSH LK7_115.0_620	0.0	0.0	0.0	0.0	0.0	72.5	1206.3	0	0	0	0	0	20	177
618202_GRE-ELMO 7_115.0_620	0.0	0.0	0.0	0.0	0.0	74.2	1134.4	0	0	0	0	0	22	162
608654_AITKNMN7 _115.0_608	0.0	0.0	0.0	0.0	0.0	43.3	1124.7	0	0	0	0	0	20	174
618203_GRE-TAMARAC7_115.0_620	0.0	0.0	0.0	0.0	0.0	86.6	1094.9	0	0	0	0	0	20	180
615135_G619TAM7 _115.0_620	0.0	0.0	0.0	0.0	0.0	85.7	1087.0	0	0	0	0	0	20	180
618602_GRE-AITKIN 7_115.0_608	0.0	0.0	0.0	0.0	0.0	39.5	1056.9	0	0	0	0	0	21	173
615301_GRE-INMAN 7_115.0_620	0.0	0.0	0.0	0.0	0.0	64.5	1030.4	0	0	0	0	0	22	165
608647_LONG PR7 _115.0_608	0.0	0.0	0.0	0.0	0.0	52.0	860.2	0	0	0	0	0	22	152
608636_PEPINLK7 _115.0_608	0.0	0.0	0.0	0.0	0.0	46.2	818.6	0	0	0	0	0	22	152
618601_GRE-PORTGLK7_115.0_608	0.0	0.0	0.0	0.0	0.5	30.1	804.1	0	1	0	1	2	22	171
620203_MAPLTN 7 _115.0_620	2.7	2.6	2.7	1.9	3.7	113.2	771.7	4	4	3	4	13	75	214
620370_NORCROSS 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	85.7	749.9	0	0	0	0	0	37	185
608649_BLNCHRD7 _115.0_608	0.0	0.0	0.0	0.0	0.0	33.9	710.4	0	0	0	0	0	24	156
616710_GRE-BELLEVU7_115.0_608	0.0	0.0	0.0	0.0	0.0	41.7	698.9	0	0	0	0	0	24	157
616714_GRE-LTTLFLS7_115.0_608	0.0	0.0	0.0	0.0	0.0	35.2	666.5	0	0	0	0	0	20	153
608650_LITTLEF7 _115.0_608	0.0	0.0	0.0	0.0	0.1	38.7	666.2	0	0	0	0	2	23	156
616733_GRE-WABEDO 8_69.0_615	29.2	31.9	27.7	69.5	65.1	49.7	657.1	11	12	10	29	29	23	195
616743_GRE-LONGVLL8_69.0_615	14.4	15.8	14.2	30.8	25.2	35.8	650.3	11	12	10	29	27	23	193
620261_LISBON 7 _115.0_620	1.0	0.2	1.0	0.1	5.2	154.3	640.9	3	2	3	2	31	124	223
618208_GRE-PRKR PR7_115.0_620	0.0	0.0	0.0	0.0	0.0	49.1	633.7	0	0	0	0	0	20	139
618600_GRE-MCGREGR7_115.0_608	1.4	1.6	1.4	1.7	2.4	23.0	620.0	1	2	1	2	2	17	166
618604_GRE-SWTRX3A4_230.0_608	0.0	0.0	0.0	0.0	0.0	7.6	575.6	0	0	0	0	0	2	148
616728_GRE-EMILY 8_69.0_615	0.0	0.0	0.0	0.0	0.0	12.2	572.1	0	0	0	0	0	10	188
620263_FORMN 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	125.6	569.8	0	0	0	0	0	76	217
620262_GWINNER7 _115.0_620	0.0	0.0	0.0	0.0	0.0	109.0	542.9	0	0	0	0	1	57	206
616729_GRE-OX LAKE8_69.0_615	0.0	0.0	0.0	0.0	0.0	8.6	483.3	0	0	0	0	0	6	183
620269_JAMSTWN7 _115.0_620	0.0	0.0	0.0	0.0	0.3	128.1	473.1	0	0	0	0	3	108	172
618017_GRE-HINGX4A7_115.0_608	60.8	66.0	56.5	66.4	79.4	117.6	472.3	33	35	36	35	37	38	182
616744_GRE-PLSNTLK8_69.0_615	56.3	61.5	52.4	140.5	140.4	66.8	440.9	11	12	10	29	30	15	200

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616741_GRE-CRSSLKC8_69.0_615	0.0	0.0	0.0	0.0	0.0	7.6	433.9	0	0	0	0	0	4	186
618206_GRE-FERGUS 7_115.0_620	0.0	0.0	0.0	0.0	0.0	35.5	417.1	0	0	0	0	0	16	145
619406_GRE-LTLSAUK7_115.0_600	0.0	0.0	0.0	0.0	0.0	18.6	397.9	0	0	0	0	0	11	140
616727_GRE-CROSSLK8_69.0_615	0.0	0.0	0.0	0.0	0.0	6.5	376.5	0	0	0	0	0	4	186
620222_ALEXAND7 _115.0_620	0.0	0.0	0.0	0.0	0.0	26.0	372.1	0	0	0	0	0	20	108
616732_GRE-STONYBK8_69.0_615	2.3	2.4	2.6	2.4	2.3	8.5	368.4	1	1	1	1	1	5	190
616731_GRE-BREZYPT8_69.0_615	0.8	0.9	1.1	0.9	0.8	6.9	357.6	1	1	1	1	1	5	188
620362_OAKES 4 _230.0_620	0.0	0.0	0.0	0.0	0.0	73.9	335.9	0	0	0	0	0	28	129
608611_ZEMPLE 4 _230.0_608	70.4	35.6	35.9	69.0	68.7	193.4	334.3	2	1	1	2	2	11	13
608637_PLATTRV7 _115.0_608	0.0	0.0	0.0	0.0	0.0	11.3	333.4	0	0	0	0	0	5	131
617001_GRE-LANGOLA7_115.0_600	0.0	0.0	0.0	0.0	0.0	11.2	333.3	0	0	0	0	0	5	131
608669_FLDWOOD7 _115.0_608	74.4	75.3	72.7	75.8	89.4	117.5	329.1	31	32	35	32	32	30	108
618209_GRE-PRKRPTP7_115.0_620	0.0	0.0	0.0	0.0	0.0	17.9	313.5	0	0	0	0	0	10	139
616742_GRE-LNGVLLT8_69.0_615	2.3	2.2	2.4	2.4	2.3	9.0	313.1	3	3	3	3	3	8	181
608662_SAVANNA7 _115.0_608	67.2	67.6	64.3	68.2	82.3	111.8	308.6	32	32	36	33	33	31	87
620275_NJAMES 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	39.5	289.5	0	0	0	0	0	58	118
608656_MAHTOWA7 _115.0_608	5.4	4.2	3.8	4.7	9.1	25.8	279.8	8	8	8	8	8	13	153
620175_JAMESTN W7 _115.0_620	0.0	0.0	0.0	0.0	0.0	36.8	278.5	0	0	0	0	0	58	118
620274_JAMSDTN7 _115.0_620	0.0	0.0	0.0	0.0	0.0	33.7	273.0	0	0	0	0	0	41	112
620273_JAMETAP7 _115.0_620	0.0	0.0	0.0	0.0	0.0	32.6	270.0	0	0	0	0	0	40	108
616738_GRE-FFTYLKS8_69.0_615	0.0	0.0	0.0	0.0	0.0	3.5	252.1	0	0	0	0	0	3	120
620272_JAMESPK7 _115.0_620	0.0	0.0	0.0	0.0	0.0	26.6	248.8	0	0	0	0	0	31	95
620225_WHEATNS7 _115.0_620	0.0	0.0	0.0	0.0	0.0	76.3	238.3	0	0	0	0	0	93	178
620271_AVIKO 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	22.1	228.7	0	0	0	0	0	33	89
603020_MAPLE R7 _115.0_600	0.0	0.0	0.0	0.0	0.0	23.8	227.3	0	0	0	0	0	6	32
616739_GRE-BLINDLK8_69.0_615	0.0	0.0	0.0	0.0	0.0	2.7	223.4	0	0	0	0	0	2	95
616725_GRE-OAKLAWN8_69.0_615	0.0	0.0	0.0	0.0	0.0	5.2	221.5	0	0	0	0	0	4	124
620224_DUMONT 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	63.0	215.0	0	0	0	0	0	77	168
603021_REDRIVR7 _115.0_600	0.0	0.0	0.0	0.0	0.0	20.4	211.9	0	0	0	0	0	6	31
616730_GRE-THUN LK8_69.0_615	2.1	1.6	1.7	1.8	2.0	4.3	206.6	4	3	3	4	4	7	92
615422_GRE-BIRCHLK8_69.0_615	45.9	50.2	43.0	113.1	112.0	50.6	205.1	11	12	10	29	30	13	54
620381_UNDERWD4 _230.0_620	0.0	0.0	0.1	0.0	0.0	31.2	190.2	0	0	1	0	0	20	87
616736_GRE-MISSION8_69.0_615	0.0	0.0	0.0	0.0	0.0	1.8	189.7	0	0	0	0	0	2	56
618618_GRE-SPIRITL8_69.0_615	0.0	0.0	0.0	0.0	0.0	6.6	182.7	0	0	0	0	0	4	99
603019_CASS CO7 _115.0_600	0.0	0.0	0.0	0.0	0.0	11.6	179.8	0	0	0	0	0	6	25
616737_GRE-BRZYPTS8_69.0_615	0.0	0.0	0.0	0.0	0.0	1.3	177.1	0	0	0	0	0	2	48
602037_ROCKCR 4 _230.0_600	11.4	10.7	12.8	10.8	9.9	9.0	174.3	3	3	3	3	3	3	31
620276_NHARVEY7 _115.0_620	0.0	0.0	0.0	0.0	0.0	40.5	163.7	0	0	0	0	0	22	101
608791_LAKEHD 7 _115.0_608	37.1	18.7	18.9	36.4	36.2	92.1	162.3	2	1	1	2	2	11	13
608785_ZEMPLES7 _115.0_608	37.0	18.7	18.8	36.3	36.1	91.8	162.0	2	1	1	2	2	11	13
615536_GRE-WILSONL8_69.0_615	0.0	0.0	0.0	0.0	0.0	4.5	159.3	0	0	0	0	0	4	66

615416_GRE-PQUOTLK8_69.0_615	0.3	0.4	0.6	0.4	0.3	1.0	158.5	1	1	1	1	1	3	47
603047_SHYSWCP7 _115.0_600	0.0	0.0	0.0	0.0	0.0	2.2	157.9	0	0	0	0	0	6	25
620270_SPIRITWD 7 _115.0_620	0.0	0.0	0.2	0.0	0.0	9.6	157.4	0	0	2	0	0	16	73
603018_SHEYNNE7 _115.0_600	0.0	0.0	0.0	0.0	0.0	2.5	157.2	0	0	0	0	0	6	25
619405_GRE-LTLSKTP7_115.0_600	0.0	0.0	0.0	0.0	0.0	3.0	155.7	0	0	0	0	0	4	46
608780_ZEMPLEN7 _115.0_608	34.0	18.0	18.5	34.0	32.8	85.7	149.5	4	3	3	4	4	11	13
615466_GRE-BEARCK 4_230.0_608	4.4	3.3	4.7	3.4	3.5	5.0	146.4	3	3	3	3	3	3	27
618002_GRE-HILLCTY7_115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	137.3	0	0	0	0	0	0	38
618015_GRE-HILLCTP7_115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	137.1	0	0	0	0	0	0	38
616726_GRE-PINECTR8_69.0_615	0.0	0.0	0.0	0.0	0.0	3.9	135.0	0	0	0	0	0	4	46
615428_GRE-RIVTON 8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	134.8	0	0	0	0	0	0	42
616734_GRE-OKLWNTP8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.2	131.8	0	0	0	0	0	2	38
620217_LUVERNE 4 _230.0_620	0.0	0.0	0.0	0.0	0.0	0.0	122.6	0	0	0	0	0	0	15
619102_GRE-MILTONA7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	116.3	0	0	0	0	0	0	32
617000_GRE-LANGLTP7_115.0_600	0.0	0.0	0.0	0.0	0.0	1.7	115.0	0	0	0	0	0	3	34
619101_GRE-MLTN TP7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	115.0	0	0	0	0	0	0	32
618066_GRE-REMER 8_69.0_615	3.7	2.0	2.1	3.3	3.4	3.8	113.2	2	3	3	4	2	3	51
619438_GRE-STSTPHN7_115.0_600	0.0	0.0	0.0	0.0	0.0	2.5	111.0	0	0	0	0	0	4	46
615493_GRE-CROMWLL7_115.0_615	3.0	3.1	3.1	3.1	3.6	5.4	108.8	1	1	1	1	1	1	29
616735_GRE-PINCTRT8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.4	106.3	0	0	0	0	0	1	32
602013_ROSEAU 4 _230.0_600	0.0	0.0	0.0	0.0	0.0	103.3	25.0	0	0	0	0	0	8	4
602012_ROSSWCP4 _230.0_600	0.0	0.0	0.0	0.0	0.0	103.1	24.9	0	0	0	0	0	8	4
620218_MORRIS T 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	20.6	102.9	0	0	0	0	0	16	35
618619_GRE-SPRTLKS8_69.0_615	0.0	0.0	0.0	0.0	0.0	1.4	100.9	0	0	0	0	0	2	32
608616_HILLTOP4 _230.0_608	0.0	0.0	0.0	0.0	0.0	0.0	97.0	0	0	0	0	0	0	20
608596_ARDP1DC4 _230.0_608	0.0	0.0	0.0	0.0	0.0	0.0	95.7	0	0	0	0	0	0	20
608598_ARDP2DC4 _230.0_608	0.0	0.0	0.0	0.0	0.0	0.0	95.7	0	0	0	0	0	0	20
608615_ARROWHD4 _230.0_608	0.0	0.0	0.0	0.0	0.0	0.0	95.6	0	0	0	0	0	0	20
618044_GRE-CEDARVL7_115.0_608	12.8	13.0	12.4	13.1	14.6	23.0	94.7	4	4	4	4	4	13	47
618622_GRE-VINELND8_69.0_615	0.0	0.0	0.0	0.0	0.0	2.2	91.1	0	0	0	0	0	2	34
608696_TAC HBR6 _138.0_608	27.5	48.0	90.9	7.6	28.2	0.0	0.0	3	3	4	3	2	0	0
620290_HARVEY 4 _230.0_620	0.0	0.0	0.0	0.0	0.0	12.7	90.4	0	0	0	0	0	5	21
608614_98L TAP4 _230.0_608	0.0	0.0	0.0	0.0	0.0	0.0	90.4	0	0	0	0	0	0	20
618016_GRE-CRMWLLD7_115.0_615	3.8	3.8	3.9	3.9	4.3	6.2	88.2	1	1	1	1	1	1	29
615523_GRE-DEER RV7_115.0_615	21.6	11.0	11.1	20.8	20.7	31.1	87.2	2	1	1	2	2	7	10
603027_DGLASCO7 _115.0_600	0.0	0.0	0.0	0.0	0.0	0.0	85.0	0	0	0	0	0	0	22
603254_DGLASCO CAP7_115.0_600	0.0	0.0	0.0	0.0	0.0	0.0	84.9	0	0	0	0	0	0	22
618617_GRE-GLEN 8_69.0_615	0.0	0.0	0.0	0.0	0.0	1.8	84.7	0	0	0	0	0	2	32
618623_GRE-VINLDTP8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.4	84.2	0	0	0	0	0	1	30
608674_HANESRD7 _115.0_608	22.9	17.4	18.6	18.9	20.9	23.2	82.9	25	27	25	27	27	20	33
608685_SWAN LK7 _115.0_608	19.7	14.3	15.3	15.4	17.5	20.6	81.6	25	25	25	27	27	20	34

615517_GRE-4CORNRS7_115.0_608	19.1	30.2	29.7	30.3	40.7	43.8	79.8	2	3	3	3	4	4	8
608675_RIDGEVW7 _115.0_608	10.7	7.9	9.5	8.1	9.6	13.0	77.5	25	12	8	16	17	20	33
608660_BIGROCK7 _115.0_608	23.5	44.0	75.8	0.0	24.2	0.0	3.5	1	2	3	0	2	0	2
608697_TAC HBR7 _115.0_608	22.9	40.0	75.8	6.4	23.5	0.0	0.0	3	3	4	3	2	0	0
615619_GRE-ORTMN 4 _230.0_608	0.0	0.0	0.0	0.0	0.0	75.1	15.9	0	0	0	0	0	8	4
618060_GRE-BOY RIV8_69.0_615	6.4	3.2	3.4	5.9	6.0	7.2	74.8	2	3	3	4	2	3	37
608664_WRENSHL7 _115.0_608	5.8	4.5	4.5	5.0	8.9	19.8	74.3	5	5	5	5	5	6	26
608694_FINLND_7 _115.0_608	18.4	38.9	70.0	2.1	20.8	0.0	0.0	5	5	6	4	5	0	0
618621_GRE-PALISAD8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	69.2	0	0	0	0	0	0	26
608670_MDWLNDS7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	68.6	0	0	0	0	0	0	27
608663_FLDWDTP7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	68.6	0	0	0	0	0	0	27
608690_SBY2BUS7 _115.0_608	20.8	38.7	67.6	5.1	21.8	0.0	0.0	4	5	6	3	4	0	0
608692_SBY1BUS7 _115.0_608	20.8	38.7	67.6	5.1	21.8	0.0	0.0	4	5	6	3	4	0	0
608691_SLVRBYH7 _115.0_608	20.1	37.9	66.9	4.4	21.1	0.0	0.0	4	5	6	3	4	0	0
608915_N_SHORE7 _115.0_608	20.1	37.9	66.7	4.6	21.1	0.0	0.0	4	5	6	3	4	0	0
620379_RUGBY 4 _230.0_620	0.0	0.0	0.0	0.0	0.0	0.0	66.5	0	0	0	0	0	0	20
616675_GRE-WALDO 7_115.0_608	20.1	37.1	65.5	0.0	20.1	0.0	0.0	1	2	3	0	1	0	0
608914_NTS1BUS7 _115.0_608	15.9	33.4	63.0	0.0	16.0	0.0	0.0	1	2	3	0	1	0	0
618616_GRE-OPSTEAD8_69.0_615	0.0	0.0	0.0	0.0	0.0	1.5	60.6	0	0	0	0	0	2	25
616676_GRE-FINLAND7_115.0_608	13.8	30.3	59.2	0.0	13.9	0.0	0.0	1	2	3	0	1	0	0
619112_GRE-HUDSON 7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	58.0	0	0	0	0	0	0	22
605521_ROCKCRK8 _69.0_600	3.9	3.7	4.3	3.7	3.4	3.1	56.6	3	3	3	3	3	3	31
618080_GRE-BIGSAND8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	56.6	0	0	0	0	0	0	22
608679_GARY 7 _115.0_608	16.1	17.2	17.3	17.2	16.5	16.7	55.5	2	2	2	2	2	2	22
618083_GRE-MOOSNTP8_69.0_615	0.2	0.0	0.0	0.0	0.2	0.5	54.9	1	0	0	0	1	5	25
602011_LFSWCP 4 _230.0_608	27.1	30.2	3.4	30.2	0.0	54.1	3.9	1	1	1	1	0	8	2
618625_GRE-PORTGLK8_69.0_608	0.0	0.0	0.0	0.0	0.0	0.0	52.0	0	0	0	0	0	0	22
618050_GRE-STURGEN8_69.0_615	0.4	0.1	0.1	0.1	1.1	1.5	51.7	1	1	1	1	5	5	27
617120_GRE-CARLTON7_115.0_608	0.0	0.0	0.0	0.0	0.0	1.5	51.7	0	0	0	0	0	5	25
608680_WNTR ST7 _115.0_608	10.1	12.0	10.6	12.1	11.7	12.1	50.9	1	1	1	1	1	2	22
608633_FAIRMPK7 _115.0_608	15.4	16.5	16.6	16.5	15.8	16.2	50.8	2	2	2	2	2	3	22
618049_GRE-KETTLER8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	50.3	0	0	0	0	0	0	22
620278_ESMDOTP7 _115.0_620	0.0	0.0	0.0	0.0	0.0	2.7	49.2	0	0	0	0	0	5	20
608671_BURNETT7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	48.9	0	0	0	0	0	0	21
619111_GRE-LK MINA7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	48.6	0	0	0	0	0	0	22
620277_SELZ 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	2.5	48.3	0	0	0	0	0	5	20
608686_15TH AV7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	47.2	0	0	0	0	0	0	20
618042_GRE-ROUNDLK8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	47.2	0	0	0	0	0	0	22
608668_CLOQUET7 _115.0_608	0.2	0.1	0.1	0.2	0.7	1.6	45.2	1	1	1	1	1	1	21
608688_COLBYVL7 _115.0_608	25.6	25.9	28.3	0.5	25.8	0.7	45.1	2	2	2	1	2	1	21
608661_TWOHBRS7 _115.0_608	23.7	44.3	44.4	0.0	24.4	0.0	5.2	1	2	3	0	2	0	5

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608931_ENBEAST7 _115.0_608	15.0	16.0	16.1	16.1	15.4	15.5	44.4	2	2	2	2	2	2	18
608932_ENBNTH7 _115.0_608	14.9	16.0	16.1	16.1	15.4	15.5	44.3	2	2	2	2	2	2	18
608916_CANOSIA7 _115.0_608	0.3	0.2	0.1	0.3	0.7	1.7	44.2	1	1	1	1	1	1	21
608930_ENBSTH7 _115.0_608	14.9	16.0	16.1	16.0	15.3	15.5	43.8	2	2	2	2	2	2	18
608678_NEMADJI7 _115.0_608	14.8	15.9	16.0	16.0	15.2	15.4	43.4	2	2	2	2	2	2	18
618059_GRE-BENA 8_69.0_615	9.1	4.6	4.7	8.5	8.6	11.4	42.7	2	1	1	2	2	5	28
608883_TOWERMP7 _115.0_608	21.7	21.7	21.7	21.8	21.8	21.7	42.7	3	3	3	3	3	3	6
608672_HILLTOP7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	42.6	0	0	0	0	0	0	20
619114_GRE-LK MARY7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	42.4	0	0	0	0	0	0	22
608665_THOMSON7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	42.0	0	0	0	0	0	0	20
619412_GRE-STSTPHT7_115.0_600	0.0	0.0	0.0	0.0	0.0	0.0	41.9	0	0	0	0	0	0	20
608681_LSPI 7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	41.4	0	0	0	0	0	0	20
608683_STIN-MN7 _115.0_608	14.5	15.6	15.8	15.7	15.0	15.1	41.2	2	2	2	2	2	2	18
618010_GRE-POKEGMA7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	41.2	0	0	0	0	0	0	22
608673_ARROWHD7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	41.0	0	0	0	0	0	0	20
615460_GRE-RUSH CY4_230.0_600	0.0	0.0	0.0	0.0	0.0	0.0	41.0	0	0	0	0	0	0	17
617055_GRE-ISLE 8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.7	41.0	0	0	0	0	0	2	24
615463_GRE-RUSHCYX4_230.0_615	0.0	0.0	0.0	0.0	0.0	0.0	40.9	0	0	0	0	0	0	17
608676_HIBBARD7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	40.6	0	0	0	0	0	0	20
608666_FONDULAC _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	40.2	0	0	0	0	0	0	20
617066_GRE-GRNDSTN8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	39.6	0	0	0	0	0	0	12
608667_POTLTCH7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	39.5	0	0	0	0	0	0	20
618858_GRE-EVENSON8_69.0_615	12.6	6.4	6.5	12.1	12.0	17.9	38.7	2	1	1	2	2	5	10
618079_GRE-BIGSANDT_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	38.0	0	0	0	0	0	0	20
618857_GRE-WIRT 8_69.0_615	12.5	6.3	6.4	11.9	11.8	17.5	38.0	2	1	1	2	2	5	10
608742_TAFT 7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	37.7	0	0	0	0	0	0	17
618052_GRE-MOOSSTP8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	36.7	0	0	0	0	0	0	22
617057_GRE-HNCKLEY8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	35.5	0	0	0	0	0	0	11
618061_GRE-SALEMSW8_69.0_615	2.4	1.3	1.3	1.9	2.1	2.3	34.1	2	1	1	2	2	2	27
619110_GRE-LKMINAT7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	33.8	0	0	0	0	0	0	20
618855_GRE-JESS LK8_69.0_615	11.5	5.9	5.9	10.9	10.8	15.3	33.8	2	1	1	2	2	5	9
608705_BABBITT7 _115.0_608	33.2	5.9	6.9	11.8	18.4	2.3	7.6	7	1	2	2	4	2	8
616202_GRE-MAPLE H8_69.0_615	5.3	15.4	33.2	0.0	5.3	0.0	0.0	1	2	3	0	1	0	0
608684_STIN-WI7 _115.0_608	14.6	15.6	15.8	15.7	15.0	15.1	33.2	2	2	2	2	2	2	15
616206_GRE-CASCADE8_69.0_615	5.1	15.0	32.6	0.0	5.1	0.0	0.0	1	2	3	0	1	0	0
616204_GRE-COLVILL8_69.0_615	5.1	15.0	32.4	0.0	5.1	0.0	0.0	1	2	3	0	1	0	0
618620_GRE-OPSTDTP8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	32.2	0	0	0	0	0	0	20
618041_GRE-WRIGHT 8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	32.2	0	0	0	0	0	0	20
608570_STINSJCT _115.0_608	14.4	15.5	15.6	15.5	14.8	15.0	32.2	2	2	2	2	2	2	13
605108_DGLAS C8 _69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	31.6	0	0	0	0	0	0	20
618615_GRE-ONAMIA 8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.2	29.7	0	0	0	0	0	1	22

616203_GRE-GNDMRTP8_69.0_615	4.0	12.8	29.3	0.0	4.0	0.0	0.0	1	2	3	0	1	0	0
616205_GRE-MPLHLTP8_69.0_615	3.9	12.7	29.1	0.0	4.0	0.0	0.0	1	2	3	0	1	0	0
608716_HOYT LK7 _115.0_608	1.2	1.5	28.7	0.0	1.3	0.0	0.0	1	2	3	0	1	0	0
616201_GRE-LUTSEN 8_69.0_615	3.8	12.2	28.7	0.0	3.9	0.0	0.0	1	2	3	0	1	0	0
608698_MESABA 7 _115.0_608	1.1	1.3	28.5	0.0	1.2	0.0	0.0	1	2	3	0	1	0	0
615090_GRE-ARROWHD8_69.0_615	3.7	12.2	28.3	0.0	3.8	0.0	0.0	1	2	3	0	1	0	0
618058_GRE-BALLCLB8_69.0_615	9.0	4.6	4.6	8.5	8.5	10.6	28.1	2	1	1	2	2	5	8
608689_FRNCHRV7 _115.0_608	24.7	24.8	27.0	0.0	24.8	0.0	27.0	1	1	2	1	1	0	15
608630_STINSON5 _161.0_608	21.4	22.7	23.2	22.7	21.7	21.8	26.7	2	2	2	2	2	2	8
620368_RGBYWND4 _230.0_620	0.0	0.0	0.0	0.0	0.0	0.0	26.5	0	0	0	0	0	0	16
619113_GRE-LKMARYT7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	24.9	0	0	0	0	0	0	20
618859_GRE-WIRTTPS8_69.0_615	9.2	4.7	4.8	8.7	8.6	9.8	24.3	2	1	1	2	2	4	8
617065_GRE-HINCKMP8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	24.2	0	0	0	0	0	0	8
616200_GRE-SCHRDER8_69.0_615	1.5	7.3	21.6	0.0	1.5	0.0	0.0	1	2	3	0	1	0	0
616677_GRE-CLVRVLY7_115.0_608	21.1	21.1	21.2	0.0	21.1	0.0	1.9	1	1	1	0	1	0	2
617064_GRE-HINCKTP8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	21.0	0	0	0	0	0	0	8
618048_GRE-SOLWAY 8_69.0_615	2.3	4.4	4.1	4.5	6.1	8.1	20.6	2	3	3	3	4	4	7
615390_GRE-LINWOOD4_230.0_615	0.0	0.0	0.0	0.0	0.0	0.0	19.8	0	0	0	0	0	0	4
618624_GRE-RUMRVTP8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	15.8	0	0	0	0	0	0	19
615524_GRE-DEER RV8_69.0_615	7.6	3.9	4.0	7.2	7.1	7.5	18.7	2	1	1	2	2	3	7
608632_DAHLBRG7 _115.0_608	9.6	10.6	10.6	10.7	10.1	10.6	18.5	2	2	2	2	2	3	10
619407_GRE-FSCHRHL7_115.0_600	0.0	0.0	0.0	0.0	0.0	0.0	11.0	0	0	0	0	0	0	18
617069_GRE-SUMMIT 8_69.0_615	7.9	8.6	8.7	8.6	8.2	8.3	17.5	2	2	2	2	2	2	11
619425_GRE-W UNION8_69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	17.0	0	0	0	0	0	0	15
618062_GRE-BENA TP8_69.0_615	5.4	2.8	2.8	4.9	5.0	5.0	16.3	2	1	1	2	2	3	7
615372_GRE-TAC HAR8_69.0_615	0.0	3.9	16.3	0.0	0.0	0.0	0.0	0	1	2	0	0	0	0
617068_GRE-AMNICON8_69.0_615	7.5	8.2	8.3	8.2	7.8	7.9	15.5	2	2	2	2	2	2	10
617060_GRE-DENHAM 8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	15.3	0	0	0	0	0	0	15
608919_HAWTHRN5 _161.0_608	13.0	13.9	14.6	13.9	12.9	13.1	10.9	2	2	2	2	2	2	2
618053_GRE-ARBO 8_69.0_615	6.2	3.2	3.4	5.8	5.6	6.0	13.3	2	1	1	2	2	3	7
617058_GRE-SANDSTN8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	13.1	0	0	0	0	0	0	10
618047_GRE-GRANDLK8_69.0_615	0.0	0.8	0.4	0.8	1.2	3.2	13.1	0	3	1	3	4	4	7
615518_GRE-4CORNRS8_69.0_615	0.0	0.7	0.4	0.8	2.6	3.2	12.6	0	3	1	3	12	4	6
618009_GRE-POKEGMT7_115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	12.3	0	0	0	0	0	0	2
615377_GRE-BLAINE 4_230.0_615	0.0	0.0	0.0	0.0	0.0	0.0	11.7	0	0	0	0	0	0	2
617067_GRE-BARDON 8_69.0_615	6.6	7.3	7.3	7.3	6.9	7.0	11.4	2	2	2	2	2	2	8
603267_KERKHOVENTP7_115.0_600	7.9	0.6	1.2	0.6	9.3	10.5	1.4	2	2	2	2	2	2	2
605107_WESTPRT8 _69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	9.9	0	0	0	0	0	0	10
619123_GRE-OMMENTP8_69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	9.7	0	0	0	0	0	0	8
620289_CORRELL7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	9.5	0	0	0	0	0	0	8
620288_ODESSA 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	9.3	0	0	0	0	0	0	8

617030_GRE-PINECTY8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0	0	0	0	0	0	8
618020_GRE-KNIFEFL7_115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0	0	0	0	0	0	5
619120_GRE-OMMEN 8_69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	8.9	0	0	0	0	0	0	8
620287_ORTQUAR7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	8.8	0	0	0	0	0	0	8
620216_ORTONVL7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	8.4	0	0	0	0	0	0	8
605106_VILLARD8 _69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0	0	0	0	0	0	8
620206_LOUSBRG7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0	0	0	0	0	0	8
619121_GRE-LEVEN 8_69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0	0	0	0	0	0	8
605004_LOWRY _69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0	0	0	0	0	0	8
608720_COTTNTP7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0	0	0	0	0	0	6
608918_GORDON 5 _161.0_608	5.9	6.7	7.5	6.7	6.0	6.3	4.0	2	2	2	2	1	1	2
602019_GINGLES5 _161.0_600	5.4	6.6	7.2	6.7	6.3	5.2	3.6	2	2	3	2	2	2	2
618040_GRE-PALTAP 8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0	0	0	0	0	0	7
615494_GRE-CROMWLL8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0	0	0	0	0	0	7
608631_MINONG 5 _161.0_608	4.7	5.5	6.2	5.5	5.1	5.4	2.8	2	1	2	1	1	1	2
618000_GRE-BERGNLK7_115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0	0	0	0	0	0	2
617072_GRE-BARDNSW8_69.0_615	4.8	5.5	5.5	5.5	5.1	5.2	5.7	2	2	2	2	2	2	4
617073_GRE-AMNCNTP8_69.0_615	4.5	5.2	5.3	5.2	4.8	4.9	5.2	2	2	2	2	2	2	4
605366_PINE LK8 _69.0_600	4.4	4.5	4.4	4.6	4.8	4.9	5.1	2	2	2	2	2	2	2
617059_GRE-HARRY M8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0	0	0	0	0	0	5
615467_GRE-BEAR CK8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0	0	0	0	0	0	5
617062_GRE-SAND SW8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0	0	0	0	0	0	5
618063_GRE-ARBO TP8_69.0_615	3.3	1.8	1.9	2.9	2.7	2.4	3.2	2	1	1	2	2	2	5
608751_LTLFRK 7 _118.0_608	3.2	4.9	0.0	4.9	0.0	0.0	0.0	1	1	0	1	0	0	0
620215_HIWY12 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0	0	0	0	0	0	2
605003_LOWRYTP8 _69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0	0	0	0	0	0	4
605105_GLENWD 8 _69.0_600	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0	0	0	0	0	0	4
603286_COURTENAY W7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0	0	0	0	0	0	2
603306_CRTENAY CAP7_115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0	0	0	0	0	0	2
615473_GRE-STINSON8_69.0_615	2.4	3.6	3.0	3.6	3.4	3.5	2.1	1	1	2	1	1	1	1
602018_FRMSINN5 _161.0_600	3.0	2.9	3.5	2.9	2.9	1.7	1.9	1	1	1	1	1	1	1
618046_GRE-BRNDNRD8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0	0	0	0	0	0	3
618043_GRE-GOWAN 8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0	0	0	0	0	0	3
605151_WFARBLT8 _69.0_600	2.6	2.5	2.5	2.5	2.5	2.6	2.7	1	1	1	1	1	1	1
605150_FARIBLT8 _69.0_600	2.5	2.4	2.4	2.4	2.4	2.5	2.6	1	1	1	1	1	1	1
619625_GRE-WALCOTT8_69.0_600	2.4	2.3	2.3	2.3	2.3	2.4	2.5	1	1	1	1	1	1	1
605149_FAIRPRK8 _69.0_600	2.3	2.2	2.2	2.2	2.2	2.3	2.4	1	1	1	1	1	1	1
615601_GRE-COAL FM8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.9	2.2	0	0	0	0	0	1	2
619628_GRE-CIRCLEL8_69.0_600	2.0	2.0	2.0	2.0	2.0	2.0	2.1	1	1	1	1	1	1	1
620174_DAWSON 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0	0	0	0	0	0	2
620173_DAWS TP7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0	0	0	0	0	0	2

618019_GRE-KNFFLTP7_115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0	0	0	0	0	0	2
617075_GRE-FOND DU8_69.0_608	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0	0	0	0	0	0	2
618045_GRE-LKHD GW8_69.0_615	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0	0	0	0	0	0	2
618001_GRE-BERGNTP7_115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0	0	0	0	0	0	2
603283_FISHCREEK7 _115.0_600	0.9	0.9	0.5	0.9	0.9	1.6	1.5	1	2	2	2	2	2	2
619632_GRE-WARSAW 8_69.0_600	1.8	1.7	1.6	1.7	1.7	1.8	1.9	1	1	1	1	1	1	1
619629_GRE-FARIBLT8_69.0_600	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1	1	1	1	1	1	1
608700_43L_TAP7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	1	0	0
608695_NUGGET 7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	1	0	0
608599_SQBP2DC4 _230.0_608	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0	0	0	0	0	0	1
608597_SQBP1DC4 _230.0_608	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0	0	0	0	0	0	1
608602_SQBEAST4 _230.0_608	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0	0	0	0	0	0	1
605148_CIRCLTP8 _69.0_600	1.3	1.2	1.2	1.2	1.2	1.2	1.3	1	1	1	1	1	1	1
619627_GRE-VLLYGRV8_69.0_600	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1	1	1	1	1	1	1
605147_VALLYTP8 _69.0_600	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1	1	1	1	1	1	1
619626_GRE-WALCTTP8_69.0_600	0.9	0.8	0.8	0.8	0.9	0.9	1.0	1	1	1	1	1	1	1
617036_GRE-MAYHEW 8_69.0_615	0.8	0.8	0.7	0.8	0.9	1.0	1.0	1	1	1	1	1	1	1
605458_T SPRBR8 _69.0_600	0.8	0.7	1.0	0.8	0.8	0.2	0.3	1	1	1	1	1	1	1
605457_T RNDLK8 _69.0_600	0.8	0.7	1.0	0.7	0.7	0.2	0.3	1	1	1	1	1	1	1
617042_GRE-OAKPARK8_69.0_615	0.2	0.2	0.1	0.2	0.3	0.4	0.4	1	1	1	1	1	1	1
608727_HTC PMP7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0	0	0	0	0	1	0
608728_HIBBTAC7 _115.0_608	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0	0	0	0	0	1	0
605152_MORISTN8 _69.0_600	0.6	0.5	0.5	0.5	0.6	0.6	0.7	1	1	1	1	1	1	1
602052_MAGIC CITY 4_230.0_600	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0	0	0	0	0	0	1
608784_INTPHAS7 _118.0_608	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0	0	0	0	0	1	0
605435_HAYWAR G _69.0_600	0.8	0.7	1.0	0.7	0.7	0.2	0.3	1	1	1	1	1	1	1
605153_NRSTRND8 _69.0_600	0.2	0.1	0.1	0.1	0.1	0.1	0.2	1	1	1	1	1	1	1
620200_LK NORDEN 7 _115.0_620	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0	0	0	0	0	1	1
617071_GRE-WASCOTT8_69.0_608	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0	1	0	1	0	1	0
605145_DUNDAS 8 _69.0_600	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1	1	1	1	1	1
605026_FRMRSIN8 _69.0_600	0.7	0.6	0.9	0.7	0.7	0.1	0.2	1	1	1	1	1	1	1
617053_GRE-MINDEN 8_69.0_615	0.7	0.7	0.6	0.7	0.8	0.9	0.9	1	1	1	1	1	1	1
617074_GRE-CRYSTLK8_69.0_608	0.0	0.2	0.0	0.3	0.1	0.2	0.0	0	1	0	1	1	1	0
617044_GRE-PIPE 2 8_69.0_615	0.3	0.3	0.2	0.3	0.4	0.5	0.5	1	1	1	1	1	1	1
617070_GRE-DAIRYLD8_69.0_608	0.0	0.3	0.0	0.4	0.2	0.3	0.0	0	1	0	1	1	1	0