Report on Wires and Non-Wire Solutions to Address Reliability in the Bellows Falls Area - 2022

Docket No. DE 21-004

June 1, 2022

Table of Contents

Section 1: Executive Summary

Liberty Utilities (Granite State Electric) Corp. ("Liberty" or the "Company") completed a solution assessment on one of its worst-performing areas in reliability, Bellows Falls. The purpose of the study was to assess the last five (5) years of outage data and identify potential solutions to improve reliability for our customers in this area.

Because the Company's analysis is based on historical data, the effect of planned improvements in the Bellows Falls area are not captured. As discussed below, the Company has already committed to system hardening investments and changes to our vegetation management strategies that are expected to improve reliability. The solutions described herein are in addition to those enhancements.

One major driver complicating a solution for the reliability issues in the Bellows Falls area is the inability to perform the necessary system reconfiguration to isolate system faults and reduce the number of customers impacted during an event.

The Company undertook analyses of thermal loading, voltage, reliability, asset condition, power quality, environmental, safety, and voltage performance. Six solutions were identified to address the reliability issue, three of which being traditional wires solutions and three being non-wires solutions (NWS).

The table below shows the possible solutions, with a brief description of each option and estimated cost.

Table 1: Potential Solutions

Liberty NWS Evaluation Workbook: Solutions			
Problem	With the loss of the 12L1 and 12L2 or pole top reclosers, downstream customers would be out of power for the duration of the outage.		
Option		Solution	Cost
1	Forrest Road Tie Line	3-phase line extension to provide circuit tie within the 12L1 (3.9 miles)	$1,978,800
2	Prospect Hill Rd Tie Line	3-phase line extension to provide circuit tie within the 12L1 and 12L2 (7.5 miles)	$3,825,000
3	Acworth Rd Tie Line	3-phase line extension to provide circuit tie within the 12L1 and 12L2 (9 miles)	$4,590,000
4	BTM Storage	Behind the meter storage - 2 MW	$4,509,000
5	8MWh Storage	Install battery storage for 12L1 and 12L2	$8,300,000
6	16 MWh Storage	Install battery storage for 12L1 and 12L2	$15,200,000

The cost estimates for battery storage options 5 and 6 were derived through industry data from a consultant the Company engaged for assistance in determining costs associated with these

solution options. The behind the meter battery solution Option 4 cost estimate was calculated using previous cost data the Company had available through the Company's battery pilot program. Solution 4 costs are based on 200 customers and an installation cost of $22,545 per home.

The Company used the evaluation criteria and weighting factors as outlined in the January 14, 2021, LCIRP filing on Bates 318–319 to assess the solutions and a summary of the results is shown in the table below. Each of the options and the detailed analysis is presented later in this report. The report provides the direction in which the Company believes is most viable at this time. Solutions three and four provides the greatest potential for increasing reliability.

Table 2: Evaluation Summary

Evaluation Summary							
Evaluation Criteria	**% Weight Factor**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**
Cost/Benefit Comparison	30%	2	3	4	2	2	1
Reliability Risk	20%	1.50	2.60	3.40	1.20	2.00	2.00
Feasibility Risk	20%	2.35	3.00	3.25	2.35	2.25	2.25
Performance Risk	20%	2.80	3.00	3.20	2.35	2.40	2.40
Environmental Risk	10%	2.25	2.50	2.50	4.00	3.00	3.00
Total Assessment	**100%**	**2.16**	**2.87**	**3.42**	**2.18**	**2.23**	**1.93**

Based on the total assessment scoring results, Option three (3) scored the highest. It is important to note that all of the traditional wires solutions scored higher than any non-wires solution. This is due to the current estimated reliability impact performance that the batteries can potentially provide as opposed to a traditional wires solution.

Option three (3) consists of installation of a nine-mile 3-phase line extension in 2026 with a circuit tie between the 12L1 and 12L2 This solution affords the best opportunities to conduct restoration switching should a permanent upstream fault occur on either circuit breaker or two of the pole-top reclosers on the 12L1 circuit.

Currently, only 19.5% of the 12L1 circuit and 31.2% of the 12L2 circuit have 3-phase primary, as compared to the rest of the Company's circuits average of 49.3%. To provide the most reliable service, creating 3-phase circuit ties is the appropriate course of action. This installation will also provide a greater footprint of 3-phase primary for future distributed generation installations. By the Company's estimation, this will improve circuit outage duration ("Ckaidi") for reportable customer interruptions in this region by approximately 6%. The Company intends to implement

distribution automation once the tie has been constructed to modernize the circuits and greatly improve the customer experience.

Based on the information available at the time of this analysis, the Company has identified the preferred solutions to investigate further to resolve reliability in the Bellows Falls area to Options 3 and 4. The next step of the adjudicative process will be to work with interested parties to further investigate each option.

Section 2: History

In Docket No. DE 19-120, the Settlement Agreement provided that prior to filing its next Least Cost Integrated Resource Plan (LCIRP), the Company was to develop a list of planned capital projects that may be candidates for avoidance and/or deferral through deployment of a non-wires solution ("NWS"). Once the NWS candidates were initially identified by Liberty, the Company agreed to meet with the settling parties to identify an NWS candidate that should be the focus of a more detailed analysis provided within the LCIRP filing. The Settlement Agreement specified the analysis of NWS should consider utility system benefits including, but not limited to, avoided distribution capacity costs, avoided energy costs, and avoided transmission costs. The analysis was to also include an evaluation of the demand reduction potential associated with energy efficiency and load curtailment, as well as other NWSs. The Commission approved the Settlement Agreement in Order No. 26,408 (Sept. 23, 2020).

The Company filed an NWS on January 14, 2021, which included the building of a microgrid to manage the potential loss of supply in the Bellows Falls area with the assumption that the full analysis would be filed on July 14, 2021, or six months after the initial filing, as provided in the Settlement Agreement. On June 15, 2021, the Commission Staff (now Department of Energy) requested the docket be suspended due to the loss of engineering expertise. Subsequently, a new procedural schedule was approved on October 15, 2021, which provided that the Company would file its analysis for the NWS on February 18, 2022.

During the period of October 2021 through February 2022, the Company reviewed its reliability data for the Bellows Falls area and determined more analysis needed to be completed due to the reliability in the area becoming more troubling over the prior twelve months. The NWS proposed on January 14, 2021, would not have addressed reliability issues in the area, it would only have addressed the loss of a supply line from Liberty's transmission provider, National Grid. As such, the Company filed a request to postpone the filing of the NWS. The Commission ordered that the Company file a report on the dire situation in Bellows Falls on May 2, 2022, and to submit its NWS analysis by June 1, 2022.

As described in the Company's May 2, 2022, Bellows Fall Reliability Report, the largest cause of outages for the circuits that serve the Bellows Falls area is vegetation-related (Bates 8). The Company has identified traditional wires solutions to mitigate the reliability issues in its plans for 2022, along with several NWS for future years.

Section 3: Analysis of Utility System Benefits

Utility system benefits for non-wires solutions are qualitative and quantitative in nature. Solution options 1 through 3 that are presented further in this report are traditional wires solutions and as a result, did not include analyses of avoided distribution capacity costs, avoided energy costs, avoided transmission costs, demand reduction associated with energy efficiency and load curtailment. These traditional wires solutions are focused on system reliability given the data presented in the Company's May 2, 2022, report and, since they are wires solutions, there are no avoided costs associated with these projects.

Solutions 4 through 6 are the non-wires solutions and thus may have avoided distribution capacity costs, avoided energy costs, avoided transmission costs, and load curtailment during peak periods. However, the Company did not analyze these cost reductions because the construction costs for solutions 5 and 6 are significantly higher than solutions 1 through 4. Solution 4 is based on the Company's Phase 1 of the battery storage pilot and the analysis of Phase 1 will be completed and filed on August 31, 2022. With regard to demand reduction associated with energy efficiency, the Company did not analyze the impact because the issues in the area are not capacity driven, which could benefit from energy efficiency, but are reliability driven, which energy efficiency cannot solve.

Section 4: Risk Scoring

As part of the Company's capital planning process, a risk score is assigned to determine the prioritization of a project. The Company looks at the following factors when calculating the risk score. The matrix includes the likelihood of an event occurring and the impact of that event. The following types of factors are reviewed:

- Frequency of interruptions or failures;
- Duration of outages;
- Customer count of each outage;
- Cost to repair the outage or failure;
- Whether the failure is at the system level, such as at the substation, or is isolated to a pocket on a circuit.

The Company utilizes the following matrix for risk scoring, with the higher numbers indicating higher risk:

Table 3: Risk Calculation Matrix

Likelihood	>Once in 100 yrs	Once in 20-100 yrs	Once in 10-20 yrs	Once in 5-10 yrs	Once in 3-5 yrs	Once in 1-3 yrs	>Once in 1 yr
Likelihood	1	2	3	4	5	6	7
Impact	Risk Value						
1	1	2	4	7	11	12	13
2	3	6	8	16	18	23	24
3	5	10	14	21	27	30	31
4	9	17	19	28	34	36	37
5	15	22	26	35	39	41	42
6	20	29	33	40	44	45	46
7	25	32	38	43	47	48	49

Section 5: Additional Source Solutions

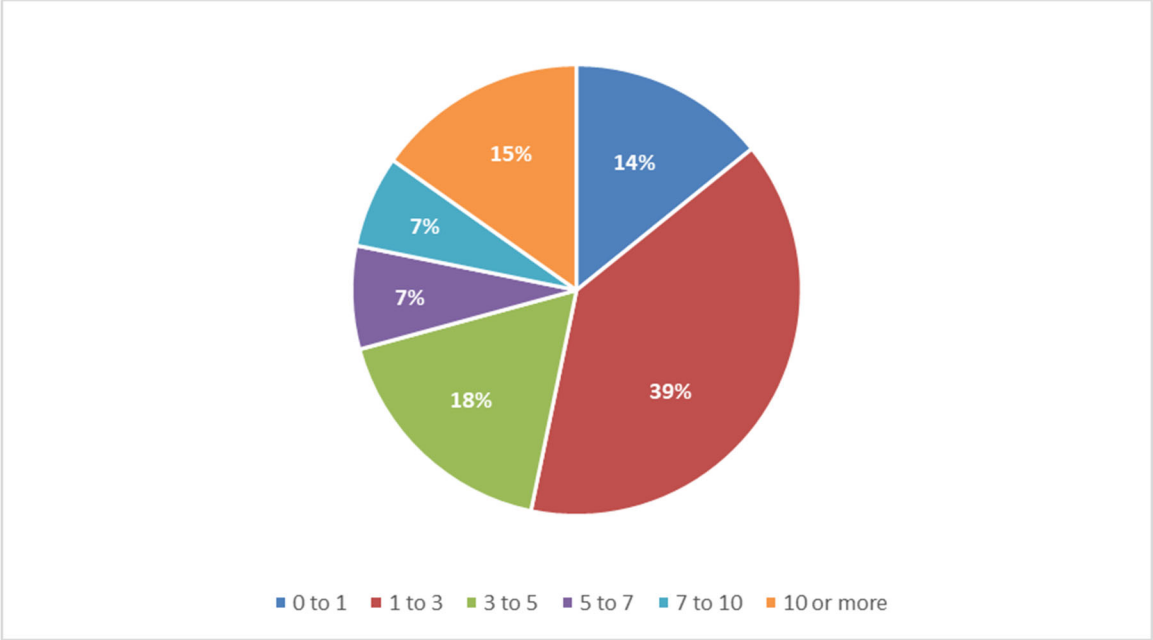
The Bellows Falls Reliability Report filed on May 2, 2022, identified near-term mitigation efforts to address the reliability issues on the 12L1 and 12L2 circuits consisting of vegetation management and reconductoring work. That work will address the frequency of outages resulting in some improvement of reliability in the area. However, it does not address the need for a supplemental supply source to mitigate long-duration outages. This section describes and compares wires and non-wires options necessary to take the next step toward resolving the reliability issues in the Bellows Falls area. That next step in the reliability strategy is to create another source located near the back end of the main line portion of the circuit. Such a new source could come from either battery storage or a 3-phase line extension with circuit tie between the 12L1 and 12L2. The circuit tie would make it possible to conduct restoration switching should an upstream main line fault occur. The battery storage solution – installing a battery toward the end of the circuit of a sufficient size to serve customers while an outage is being repaired – could provide the same benefit as a circuit tie, without the construction of the three-phase line extension.

The primary benefit of battery storage over a line extension would be avoiding the cost of setting new poles and running the new conductor. A secondary benefit, is that the batteries could be dispatched for peak shaving, lowering overall transmission costs. A third benefit could be that the battery storage system would be scheduled to charge overnight when energy costs are cheaper and then dispatched onto the system during high demands when prices of energy are more expensive..

The disadvantage of battery storage is the limited number of hours the supply would be available should a long-term outage occur for a given portion of the circuit, which is a problem that can be exacerbated depending on the state of the battery's charge or discharge when the fault occurred.

The 12L1 and 12L2 circuits tend to have lengthy outages. As depicted in the figure below, approximately 30 percent of the outages which occur on 12L1 and 12L2 are greater than 4 hours in length. Therefore, an NWS at full charge could potentially only resolve approximately 70 percent of customer outages.

Figure 1: 12L1 and 12L2 Outage Durations in Hours from 2017–2021



The Company identified six solutions to address the reliability issues on the 12L1 and 12L2 circuits. Each solution is reviewed in more detail below.

Solution #1: Forrest Road, Acworth - $1,978,000

The first proposed wires solution is to extend the 12L1 approximately 3.9 miles along Forrest Road to create a circuit tie from Forrest Road, Acworth, to Forest Road in Alstead. The benefit of this option would be to provide a tie to two radial sections on the back end of the 12L1 circuit, beyond two pole-top reclosers. This project would provide the ability to conduct switching should either section experience a fault. One disadvantage of this option is that it would not provide a backup source should one of the pole top reclosers upstream, or the 12L1 circuit breaker itself, lock out. Also, there is a portion of this project that would travel through a small area that does not currently

have any poles or wire. The Company would need to obtain the necessary easements and/or licenses to install its equipment in this section.

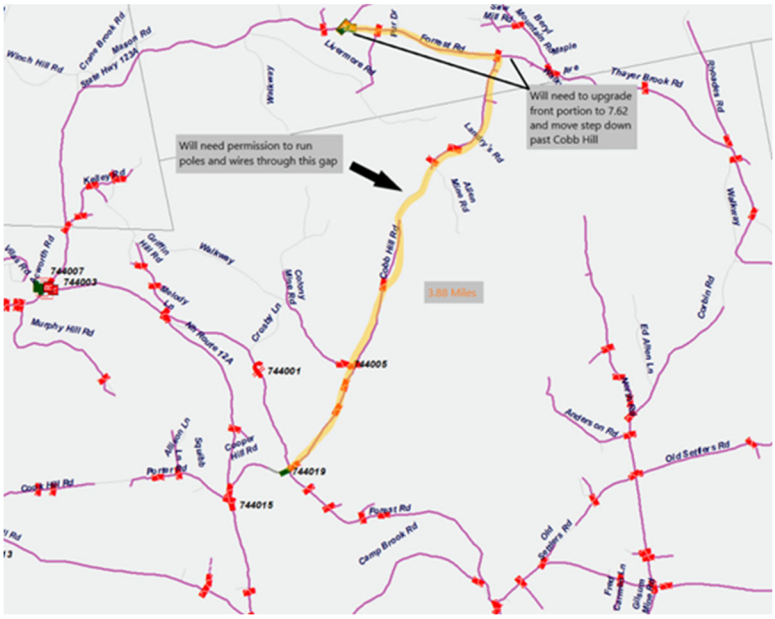
This project would involve reconductoring of approximately 3.9 miles at a cost of approximately $1,978,000, with a risk score of 24. The following table provides estimated increased reliability post-construction. The cost of the project is $15,418 per customer interruption and $69 per customer minute saved.

Table 4: Estimated Reliability Results for Forrest Road

Circuit Reliability Impacts Post Construction		
	No Exclusion	Puc 307.07 Exclusion
Frequency	N/A	N/A
Duration	-3%	-3%
$/dCI	$12,032	$15,418
$/dCMI	$60	$69

Figure 2 below shows the proposed circuit tie between the 12L1 and 12L2 circuits.

Figure 2: Proposed Circuit Tie



Solution #2: Route 123 – Watkins Hill Road - $3,825,000

The second proposed wires solution is to construct a 7.5 mile, 3-phase line extension from the 12L1 circuit at Route 123, Walpole, to the 12L2 circuit at Watkins Hill Road, Walpole. This would create a

circuit tie beyond a pole top recloser for each circuit. The benefit of this option is that it would not only put the tie in a zone not covered by the circuit breaker, but it affords the Company the ability to utilize distribution automation. As it stands now, the circuit breakers at Vilas Bridge are the protective upstream devices for the current tie.

The disadvantage of this option is that it would not affect outage frequency, it would only improve duration.

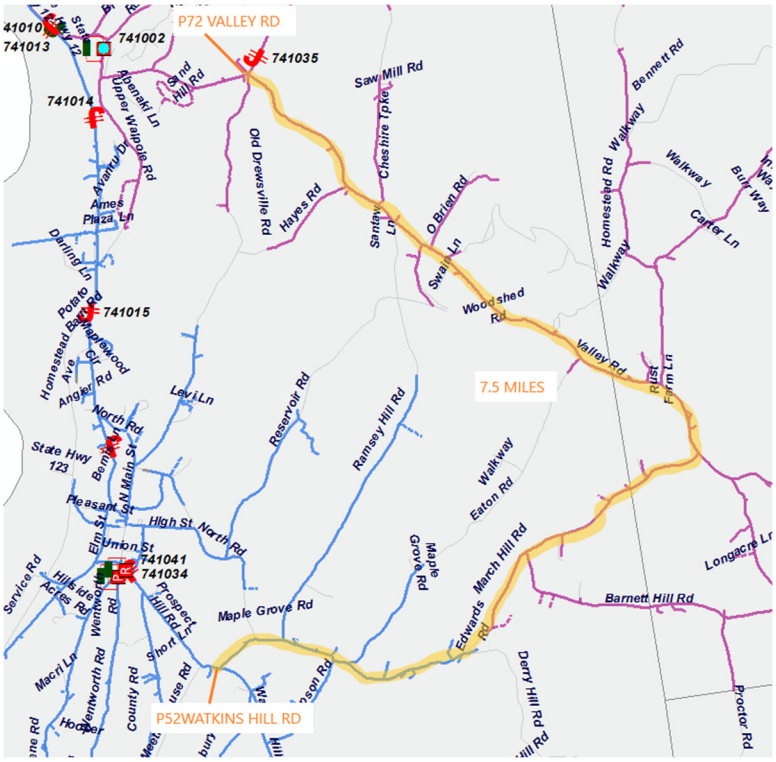
This project would consist of reconductoring approximately 7.5 miles at a cost of $3,825,000, with a risk score of 30. The following table provides estimated increased reliability post-construction and cost per interruption. The cost of the project is $7,889 per customer interruption and $39 per customer minute saved.

Table 5: Estimated Reliability Results for Route 123 – Watkins Hill Road

Circuit Reliability Impacts Post Construction		
	No Exclusion	Puc 307.07 Exclusion
Frequency	N/A	N/A
Duration	-9%	-6%
$/dCI	$4,172	$7,889
$/dCMI	$28	$39

Figure 3 below shows the proposed circuit tie between the 12L1 and 12L2 circuits.

Figure 3: Proposed Circuit Tie



Solution #3: Route 12A – Watkins Hill Road – $4,590,000

The third proposed wires solution is to construct a 9 mile, 3-phase line extension from the 12L1 circuit at Route 12A, Alstead to the 12L2 circuit at Watkins Hill Road in Walpole. The benefits of this option is that it would create a more useful circuit tie in the more rural areas of both the 12L1 and 12L2 circuits and allow the Company to utilize distributed automation for multiple zones. This tie not only is in the optimum location for both circuits but puts 3-phase primary throughout a much larger area which would give more opportunities for future distributed generation interconnection.

This project would reconductor approximately 9 miles at a cost of about $4.6 million, with a risk score of 37.

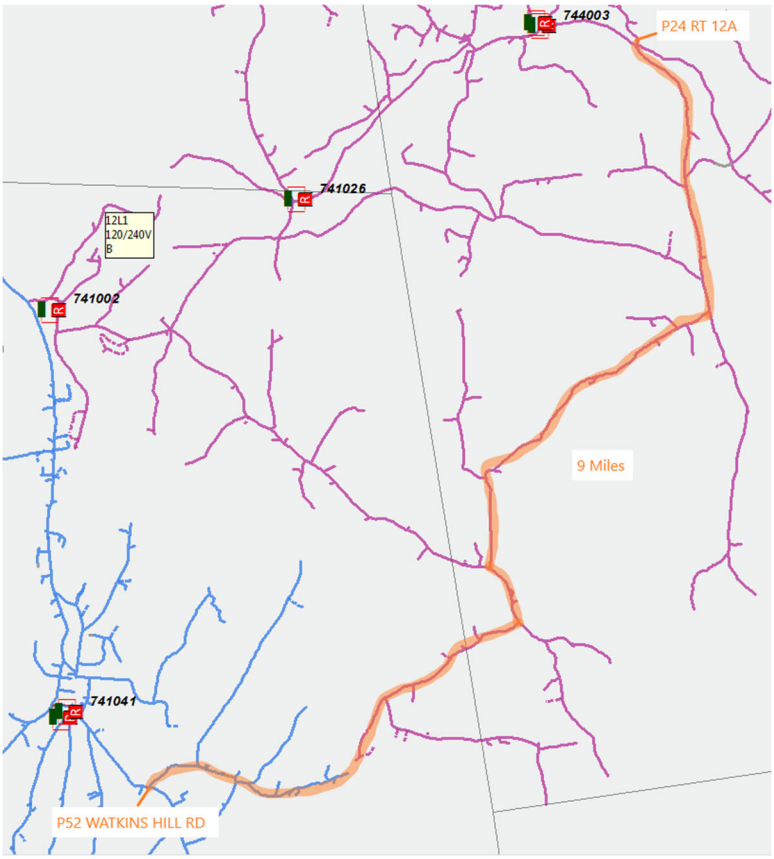
The following table provides estimated increased reliability post-construction and cost per interruption. The cost of the project is $9,467 per customer interruption and $46 per customer minute saved.

Table 6: Estimated Reliability Results for Acworth Road

Circuit Reliability Impacts Post Construction		
	No Exclusion	Puc 307.07 Exclusion
Frequency	N/A	N/A
Duration	-12%	-6%
$/dCI	$3,558	$9,467
$/dCMI	$25	$46

Figure 4 below demonstrates the proposed circuit tie between the 12L1 and 12L2 circuits.

Figure 4: Proposed Circuit Tie



Solution #4: Targeted Battery Storage Implementation

One non-wires solution option to avoid constructing a circuit tie would be to install batteries on every customer downstream of the affected protective device. Similar to the Company's Phase 1 battery storage pilot program, these individual customer batteries could be designed to provide

storage for each home and business on the circuit whereby the customers would participate in the same manner as the Phase 1 battery storage pilot customers.

The benefits of this option is that it would avoid construction of the wires solution and, if successful, would provide back-up power during an outage. The disadvantage is that it would not solve the issue of poor reliability in the area.

Using cost data from the Company's Phase 1 battery storage pilot, for approximately 200 customers the total cost of this project would be $4,509,000. Of this amount, $1,200,000 would be provided by the customers at a cost of $6,000 each. The remaining $3,309,000 would be paid for by Liberty. These estimated costs were derived from the Company's Phase 1 costs for 100 customers participating and tailoring it to 200 customers participating. The Company is still in the initial stages of phase 1 of the battery storage pilot program and will continue to evaluate the costs and benefits of this polit to determine if this non-wires solution is a comparable alternative to a wires solution.

Solution #5: 8MWh Storage

A second non-wires solution option is to provide a backup storage source to one portion of each circuit. A 2 megawatt, 4-hour battery storage system (8 MWh), without the costs to purchase the site and perform site work, is approximately $4,150,000 each, or $8,300,000 for two. Given that this would act as a circuit tie, a battery on each circuit is necessary to feed both circuits.

Given this high cost, the Company did not evaluate this option further. The Company will continue to monitor the commodity pricing for battery storage. If the cost of this option comes down in the coming years, the Company will once again evaluate this solution as an alternative to a wires solution.

Solution #6: 16MWh Storage

A third non-wires solution is to install sufficient battery storage at the end of the 3-phase main line for both circuits, to provide a replacement for a circuit tie. The 12L1 and 12L2 circuits each peak at over four megawatts. A 4 megawatt, 4-hour battery storage system (16 MWh), without the purchase of the site or cost of site work, is approximately $7,600,000 each, or $15,200,000 for two.

Section 6: Evaluation

The following tables show the criteria for the evaluation of the six potential solutions. The Company ranked each solution according to cost, reliability, feasibility, performance, and environmental risks. Each criterion was broken down into multiple components, with weighted percentages, and

scored one through four. These tables were then combined for a total assessment of each solution.

Table 7: Key for Evaluation of Solutions 1 through 6

Project Scope	Option
3-phase line extension to provide circuit tie within the 12L1 (3.9 miles)	1
3-phase line extension to provide circuit tie between 12L1 and 12L2 (7.5 miles)	2
3-phase line extension to provide circuit tie between 12L1 and 12L2 (9 miles)	3
Acquire customer participation in behind the meter battery storage program	4
Install 8 MWh battery storage connected at the far end of 3-phase battery storage for 12L1 and 12L2	5
Install 16 MWh battery storage connected at the far end of 3-phase battery storage for 12L1 and 12L2	6
Scoring Definitions	Values
Marginal with mitigation	1
Marginal without mitigation	2
Acceptable	3
Best Solution	4

Table 8: Summary Evaluation of Solutions 1 through 6 (higher number is better)

Evaluation Summary							
Evaluation Criteria	% Weight Factor	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Cost/Benefit Comparison	30%	2	3	4	2	2	1
Reliability Risk	20%	1.50	2.60	3.40	1.20	2.00	2.00
Feasibility Risk	20%	2.35	3.00	3.25	2.35	2.25	2.25
Performance Risk	20%	2.80	3.00	3.20	2.35	2.40	2.40
Environmental Risk	10%	2.25	2.50	2.50	4.00	3.00	3.00
Total Assessment	**100%**	**2.16**	**2.87**	**3.42**	**2.18**	**2.23**	**1.93**

Table 9: Reliability Risk Evaluation

IDENTIFIED PROBLEM: CONTINGENCY LOSS 12L1 or 12L2							
Reliability Risk	% Weight Factor	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Customer Outage Experience	50%	2	3	4	1	2	2
Automated Restoration	30%	1	3	4	1	2	2
Power Quality	20%	1	1	1	2	2	2
Totals	**100%**	**1.50**	**2.60**	**3.40**	**1.20**	**2.00**	**2.00**

Table 10: Feasibility Risk Evaluation

NWA COST/RISK EVALUATION SUMMARY							
Feasibility Risk	**% Weight Factor**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**
Likelihood of Timely Completion	35%	2	3	3	3	3	3
Predictable Long Term Solution	25%	3	3	4	2	2	2
Historical Field Experience	10%	3	3	3	2	1	1
Operational Uncertainty	30%	2	3	3	2	2	2
Totals	**100%**	**2.35**	**3.00**	**3.25**	**2.35**	**2.25**	**2.25**

Table 11: Performance Risk Evaluation

NWA COST/RISK EVALUATION SUMMARY							
Performance Risk	**% Weight Factor**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**
Availability	35%	3	3	3	3	2	2
Operability	25%	3	3	3	2	2	2
Policy Alignment	20%	3	3	3	3	3	3
DER Integration	20%	2	3	4	1	3	3
Totals	**100%**	**2.80**	**3.00**	**3.20**	**2.35**	**2.40**	**2.40**

Table 12: Environmental Risk Evaluation

NWA COST/RISK EVALUATION SUMMARY							
Environmental Risk	**% Weight Factor**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**
Wetland Impact	25%	2	2	2	4	3	3
Tree Clearing	25%	2	2	2	4	3	3
Community Impacts	25%	3	3	3	4	3	3
Municipal Impacts	25%	2	3	3	4	3	3
Totals	**100%**	**2.25**	**2.50**	**2.50**	**4.00**	**3.00**	**3.00**

Section 7: Findings

This report's key findings can be summarized as follows:

- Of the investments that could be made to mitigate the reliability issues in the Bellows Falls area, the Acworth Rd. Tie Line (Option 3) and BTM Storage (Option 4) have the lowest costs.

- The cost estimates presented herein are based on the best data currently available to the Company but do not reflect actionable quotes from vendors. The actual cost to implement any of the solutions described herein cannot be precisely known at this time.

- The solutions in this report create reliability benefits insofar as they mitigate the service risks to customers in the Bellows Falls area. Many would also create economic benefits by reducing the Company's cost to operate the electric system on customers' behalf. Those benefits have not been evaluated for this report and cannot be known with certainty at this time.

- As described above and in the May 2, 2022, Bellows Falls Reliability Report, the Company has plans to perform tree trimming in 2022 and invest in two near-term future reconductoring projects which are expected to significantly improve reliability in the Bellows Falls area.

The Company intends to continue to monitor the Bellows Falls area with emphasis on understanding the effectiveness of the reconductoring investments and vegetation management plan to improve system reliability. If further enhancements are required, the Company expects to rely on this analysis to guide decision-making regarding next steps.