FORTIS ALBERTA

Need for Development

For the Okotoks-Black Diamond Area

July 18, 2016

	Name	Signature	Date
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Executive Summary

This project is required to provide additional capacity and reliability for the growing distribution load in the towns of Okotoks and Black Diamond and the surrounding area.

Load studies indicate that under N-1 contingency the unsupplied load at the Okotoks 678S substation was predicted to be 13.9 MVA in 2016, increasing to 27.7 MVA by 2025. Under N-1 contingency the unsupplied load at the Black Diamond 392S substation was predicted to be 5.3 MVA in 2016, increasing to 8.8 MVA by 2025. This exceeds FortisAlberta planning criteria for electrical load restoration.

Additionally, there are capacity concerns for the distribution system supplied by the Okotoks 678S, High River 65S and Black Diamond 392S substations:

- the load on 25 kV distribution feeder 65S-16LE is predicted to be in excess of the normal feeder maximum load of 13 MVA starting in 2019;
- the load on 25 kV distribution feeder 65S-63LS is predicted to be in excess of the normal feeder maximum load of 13 MVA starting in 2024;
- the load on 25 kV distribution feeder 392S-219LS is predicted to be in excess of the normal feeder maximum load of 13 MVA starting in 2019;
- 25 kV distribution feeder 678S-349LN has a peak load in excess of the normal feeder maximum load of 13 MVA;
- the load on 25 kV distribution feeder 678S-2181L is predicted to be in excess of the normal feeder maximum load of 13 MVA starting in 2016;
- the load on 25 kV distribution feeder 678S-81LE is predicted to be in excess of the normal feeder maximum of 13 MVA starting in 2016; and
- the load on the Okotoks 678S T1 transformer is predicted to exceed the transformer's rated capacity in 2024.

A distribution study was performed to identify and assess potential solutions for these distribution service concerns. Based on technical and economic merit, the preferred solution requires transmission upgrades at the Okotoks 678S and High River 65S substations. This involves the addition of one 138/25 kV 25/33/42 MVA LTC source transformer and two 25 kV feeder breakers at the Okotoks 678S substation to address the capacity and reliability concerns at the Okotoks 678S substation. The addition of two 25 kV feeder breakers at the High River 65S substation will address the reliability concerns at the Black Diamond 392S substation.

Screening estimates were prepared to assist with the determination of the optimal solution. The estimated transmission cost for the preferred alternative is $14.77 (2017$, ±50%). AltaLink will prepare a Proposal to Provide Service for the required transmission upgrades.

The estimated distribution capital costs associated with this proposal is $14.93M (2017$, ±30%): $5.49M for the distribution work associated with the transmission upgrades at the Okotoks 678S

substation and $9.44M for the distribution work associated with the transmission upgrades at the High River 65S substation.

The requested completion date for the proposed transmission facility upgrades is October 1, 2017.

FortisAlberta is prepared to execute DTS contracts for 49.3 MW for the Okotoks 678S substation and 55.7 MW for the High River 65S substation upon completion of the transmission system upgrades.

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1. Project Description

1.1 Background

The Okotoks 678S substation is located at LSD 04 SEC 25 TWP 20 RGE 29 W of 4, approximately 20 kilometers south of the City of Calgary. The substation has one 138/25 kV 15/20/25/28.1 MVA OCTC source transformer paired with a 25 kV 18.75/25/28.1 MVA voltage regulator supplying two 25 kV distribution feeders and one 138/25 kV 25/32/42 MVA LTC source transformer supplying two 25 kV distribution feeders.

The Black Diamond 392S substation is located at LSD 03 SEC 17 TWP 20 RGE 2 W of 5, approximately 25 kilometers west of the Town of Okotoks. The substation has one 69/25 kV 15/20/25 MVA LTC source transformer supplying two 25 kV distribution feeders and one 138/25 kV 15/20/25 MVA DETC source transformer paired with a 15/20/25 MVA 25 kV voltage regulator supplying two 25 kV distribution feeders. Both 25 kV busses have a 22.5 MVA capacity rating. Transmission line 158L/13L supplying the 66/25 kV transformer has a 16/20 MVA summer/winter capacity rating.

The High River 65S substation is located at LSD 16 SEC 11 TWP 19 RGE 29 W of 4, approximately 20 km of the Town of Okotoks. The substation has two 138/25 kV 25/33/42 LTC source transformers supplying six 25 kV distribution feeders.

The distribution system supplied by the Okotoks 678S substation serves the Town of Okotoks (2014 population: 27, 500) and the surrounding rural residential, farm, small commercial and industrial customers. The distribution system supplied by the High River 65S substation serves the Town of High River (2011 population: 13,000) and the surrounding rural residential, farm, small commercial and industrial customers. The Black Diamond 398S substation serves the towns of Black Diamond and Turner Valley and the surrounding area with farm, rural residential, small commercial and light industrial services.

The distribution system supplied by the Okotoks 678S substation is connected by Normally Open (N.O.) points to adjacent distribution systems supplied by the High River 65S and Black Diamond 392S substations. The distribution system supplied by the Black Diamond 392S substation is connected by N.O. points to the Okotoks 678S, High River 65S and Springbank 272S substations.

Load studies indicate that under N-1 contingency unsupplied load is predicted:

- at Okotoks 678S, 13.9.6 MVA in 2016, increasing to 27.7 MVA by 2025;
- at Black Diamond 392S, 5.3 MVA in 2016, increasing to 8.8 MVA by 2025.

This exceeds FortisAlberta planning criteria for electrical load restoration.

Additionally, there are capacity concerns for the distribution system supplied by the Okotoks 678S, Black Diamond 392S, and High River 65S substations:

- the load on 25 kV distribution feeder 65S-16LE is predicted to be in excess of the normal feeder maximum load of 13 MVA starting in 2019;

- the load on 25 kV distribution feeder 65S-63LS is predicted to be in excess of the normal feeder maximum load of 13 MVA starting in 2024;
- the load on 25 kV distribution feeder 392S-219LS is predicted to be in excess of the normal feeder maximum load of 13 MVA starting in 2019;
- 25 kV distribution feeder 678S-349LN has a peak load in excess of the normal feeder maximum load of 13 MVA;
- the load on 25 kV distribution feeder 678S-2181L is predicted to be in excess of the normal feeder maximum load of 13 MVA starting in 2016;
- the load on 25 kV distribution feeder 678S-81LE is predicted to be in excess of the normal feeder maximum of 13 MVA starting in 2016; and
- the load on the Okotoks 678S T1 transformer is predicted to exceed the transformer's rated capacity in 2024.

1.2 Proposal

Potential solutions for these capacity and reliability concerns were assessed. Based on technical and economic merit, the requested solution involves transmission upgrades at the Okotoks 678S and High River 65S substations. This involves the addition of one 138/25 kV 25/33/42 MVA LTC source transformer and two 25 kV feeder breakers at the Okotoks 678S substation to address the capacity and reliability concerns at the Okotoks 678S substation. The addition of two 25 kV feeder breakers at the High River 65S substation will address the reliability concerns at the Black Diamond 392S substation.

Screening estimates were prepared to assist with the determination of the optimal solution. The estimated transmission cost for the preferred alternative is $14.77M (2017$, ±50%). AltaLink will prepare a Proposal to Provide Service for the required transmission upgrades.

The estimated distribution capital costs associated with this proposal is $14.93M (2017$, ±30%): $5.49M for the distribution work associated with the transmission upgrades at the Okotoks 678S substation and $9.44M for the distribution work associated with the transmission upgrades at the High River 65S substation.

The requested completion date for the proposed transmission facility upgrades is October 1, 2017.

Upon completion of these transmission system upgrades, FortisAlberta is prepared to execute DTS contracts for 55.7 MW for the Okotoks 678S substation and 49.3 MW for the High River 65S substation.

2. Criteria and Assumptions

The analysis for the requested development has been conducted based upon the following criteria and assumptions:

2.1 Criteria

The normal maximum loading of FortisAlberta 25 kV distribution feeders is 13.0 MVA.

FortisAlberta restoration criteria require that back-up supply for contingency situations be available subject only to switching time.

Transmission equipment must not be operated at load levels in excess of the equipment ratings.

2.2 Load Forecast

Table 2-1 provides FortisAlberta historical and forecast peak load levels for the substations and feeders in the subject area. The load forecast is based on historical data, expected development trends and contracted new loads. This load forecast was used to assess all the alternatives presented in this Need for Development document.

Table 2-1: FortisAlberta Load Forecast: Existing System

SUB No	Feeder	CAPACITY T/R	MVA	W or S	MVA LOADING - RECORDED 2011 Peak MVA	2012 Peak MVA	2013 Peak MVA	2014 Peak MVA	2015 Peak MVA	PF	PREDICTED - MVA LOADING 2016 Year 1 MVA	2017 Year 2 MVA	2018 Year 3 MVA	2019 Year 4 MVA	2020 Year 5 MVA	2021 Year 6 MVA	2022 Year 7 MVA	2023 Year 8 MVA	2024 Year 9 MVA	2025 Year 10 MVA
065S	High River (T2)	T2	25/33// 42	W	**25.9**	**25.3**	**27.1**	**26.6**	**25.7**	**95%**	**30.5**	**30.7**	**31.0**	**31.3**	**31.5**	**31.7**	**31.9**	**32.2**	**32.4**	**32.6**
065S	14LS			W	7.9	7.6	8.0	8.0	7.4	100%	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0
065S	37LW			W	2.3	2.5	2.4	2.6	2.2	100%	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
065S	2213L*			W	13.5	14.5	15.7	15.6	15.3	86%	16.9	16.9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7
065S	2088L Total Load			W	16.9	16.5	16.3	15.8	16.6	85%	18.1	18.1	18.2	18.2	18.3	18.3	18.4	18.4	18.5	18.5
065S	2088L			W	3.8	3.4	3.2	2.7	3.5	97%	5.0	5.0	5.1	5.1	5.2	5.2	5.3	5.3	5.4	5.4
065S	2088L Auto Transfer (65S-2213L) Cargill			W	13.10	13.10	13.10	13.10	13.10	86%	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1
065S	High River (T3)	T3	25/33// 42	W	**16.9**	**17.0**	**17.0**	**15.3**	**13.0**	**99%**	**23.5**	**23.9**	**24.2**	**24.6**	**25.0**	**25.3**	**25.7**	**26.1**	**26.5**	**26.9**
065S	16LE			W	7.6	7.8	7.8	6.6	4.3	95%	12.7	12.8	12.9	13.0	13.2	13.3	13.4	13.6	13.7	13.8
065S	63LS			W	9.5	9.5	9.2	9.0	9.2	100%	11.1	11.3	11.6	11.8	12.0	12.3	12.5	12.8	13.0	13.3
065S	Total Station			W	**42.0**	**41.5**	**42.8**	**41.8**	**38.1**	**97%**	**53.5**	**54.1**	**54.7**	**55.3**	**55.9**	**56.5**	**57.1**	**57.7**	**58.3**	**58.9**
272S	Springbank	T1	15/20// 25	W	**15.8**	**13.9**	**13.7**	**12.8**	**12.3**	**100%**	**16.4**	**16.5**	**16.7**	**16.9**	**17.0**	**17.2**	**17.4**	**17.5**	**17.7**	**17.9**
272S	2044L Total Load				12.6	10.1	10.0	10.6	9.1	100%	11.8	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6
272S	2044L Base Load			W	9.4	6.9	6.8	7.4	5.9	100%	8.6	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4
272S	2044L Auto Transfer (272s236LS)				3.20	3.20	3.20	3.20	3.20	100%	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
272S	236LN			W	3.1	3.4	3.3	3.6	2.8	100%	4.5	4.5	4.6	4.6	4.7	4.7	4.8	4.8	4.9	4.9
272S	236LS			W	3.9	4.0	4.0	3.9	3.8	100%	5.0	5.0	5.0	5.1	5.1	5.1	5.2	5.2	5.2	5.2
392S	Black Diamond (T2)	T2	15/20// 25	W	**12.4**	**13.2**	**12.2**	**12.4**	**12.6**	**99%**	**14.6**	**14.7**	**14.9**	**15.0**	**15.2**	**15.3**	**15.5**	**15.6**	**15.8**	**15.9**
392S	121LW Total Load	Bus Rating 22.5 MVA			7.4	7.3	7.3	7.6	7.3	97%	7.9	7.9	8.0	8.0	8.1	8.2	8.2	8.3	8.3	8.4
392S	121LW Base Load	Line rating 16/20 MVA		W	5.4	5.3	5.3	5.6	5.3	99%	5.9	5.9	6.0	6.0	6.1	6.2	6.2	6.3	6.3	6.4
392S	121LW Auto Transfer (392s240LW)				2.00	2.00	2.00	2.00	2.00	90%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
392S	240LW			W	7.1	8.0	7.6	7.7	7.6	99%	9.0	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8
392S	Black Diamond (T3)	T3	15/20// 25							96%										
392S		VR4	15/20// 25	W	**13.3**	**13.3**	**15.3**	**16.0**	**13.4**	**96%**	**17.1**	**17.5**	**17.8**	**18.0**	**18.3**	**18.5**	**18.8**	**19.1**	**19.3**	**19.6**
392S	219LS	Bus Rating 22.5 MVA		W	9.1	9.5	11.4	12.0	10.3	94%	12.7	12.8	12.9	13.1	13.2	13.3	13.5	13.6	13.7	13.9
392S	2154L			W	4.2	4.0	4.4	4.2	4.0	99%	4.8	5.0	5.2	5.3	5.5	5.6	5.7	5.9	6.0	6.2
392S	Total Station			W	**25.7**	**26.0**	**27.4**	**28.6**	**25.7**	**97%**	**31.4**	**31.8**	**32.3**	**32.7**	**33.1**	**33.5**	**33.9**	**34.3**	**34.7**	**35.2**
678S	Okotoks	T1	15/20/25// 28.1	W	**18.7**	**20.9**	**20.1**	**21.5**	**19.5**	**100%**	**24.2**	**24.7**	**25.2**	**25.7**	**26.2**	**26.7**	**27.2**	**27.8**	**28.3**	**28.9**
678S	Okotoks	VR1	18.75/25// 28.1																	
678S	393LW			W	9.2	9.9	10.6	10.8	9.7	100%	11.1	11.2	11.3	11.3	11.4	11.4	11.5	11.6	11.6	11.7
678S	81LE			W	9.7	11.1	9.5	10.9	10.6	99%	13.2	13.6	14.1	14.5	15.0	15.5	16.0	16.5	17.0	17.6
678S	Okotoks	T2	25/32// 42.0	W	**25.3**	**24.1**	**26.8**	**26.3**	**25.9**	**99%**	**28.7**	**29.9**	**31.2**	**32.2**	**33.0**	**33.8**	**34.7**	**35.5**	**36.4**	**37.3**
678S	349LN			W	14.5	13.5	15.8	14.7	13.7	100%	15.6	16.0	16.4	16.8	17.2	17.7	18.1	18.5	19.0	19.5
678S	2181L			W	10.9	10.6	11.3	12.2	12.0	99%	13.2	14.1	15.0	15.6	16.0	16.4	16.8	17.2	17.6	18.1
678S	Total Station			W	**44.0**	**44.7**	**46.5**	**47.4**	**45.2**	**99%**	**52.4**	**54.1**	**55.8**	**57.3**	**58.6**	**59.9**	**61.3**	**62.7**	**64.1**	**65.6**
Total Area Load:					**127.5**	**126.1**	**130.4**	**130.6**	**121.3**		**153.6**	**156.5**	**159.5**	**162.2**	**164.6**	**167.1**	**169.6**	**172.2**	**174.9**	**177.6**
					392S Total Load				25.7		31.4	31.8	32.3	32.7	33.1	33.5	33.9	34.3	34.7	35.2
					N-1 392S				16		16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
					Back up from 272S				3.4		3.5	3.6	3.6	3.7	3.8	3.9	3.9	4.0	4.1	4.1
					Back up from 678S				0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
					Back up from 65S				6.6		6.6	6.6	6.5	6.5	6.5	6.5	6.4	6.4	6.4	6.3
					N-1 Unsupplied Load				0		**5.3**	**5.7**	**6.1**	**6.5**	**6.8**	**7.2**	**7.5**	**7.9**	**8.2**	**8.8**
					678S Total Load				45.2		52.4	54.1	55.8	57.3	58.6	59.9	61.3	62.7	64.1	65.6
					N-1 Capacity 678S				28.1		28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1
					Back up from 392S				2.3		2.4	2.4	2.5	2.5	2.6	2.6	2.5	2.4	2.3	2.2
					Back up from 65S				8.9		8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6
					N-1 Unsupplied Load				**5.9**		**13.9**	**15.6**	**17.3**	**18.8**	**20.1**	**21.4**	**23.0**	**24.5**	**26.1**	**27.7**

2016 Load additions (MVA)
- Add 0.1 MVA to 65S-14LS
- Add 1.4 MVA to 65S-2213L
- Add 1.4 MVA to 65S-2088L
- Add 5.9 MVA to 65S-16LE
- Add 1.6 MVA to 65S-63LS
- Add 1.2 MVA to 272S-2044L
- Add 0.8 MVA to 272S-236LN
- Add 0.9 MVA to 392S-240LW
- Add 2.3 MVA to 392S-219LS
- Add 0.1 MVA to 392S-2154L
- Add 0.6 MVA to 678S-393LW
- Add 1.0 MVA to 678S-81LE
- Add 1.1 MVA to 678S-2181L

2017 Load additions (MVA)
- Add 0.1 MVA to 65S-14LS
- Add 0.1 MVA to 392S-2154L
- Add 0.5 MVA to 678S-2181L

2018 Load additions (MVA)
- Add 0.1 MVA to 65S-14LS
- Add 0.1 MVA to 392S-2154L
- Add 0.5 MVA to 678S-2181L

2019 Load additions (MVA)
- Add 0.1 MVA to 65S-14LS
- Add 0.2 MVA to 678S-2181L

* Large industrial customer >13 MVA

3. Existing System Assessment

The existing substations and distribution systems in the subject area are shown in Figure A-1 in Appendix A. Table 2-1 provides historical and predicted load data. Table 3-1 provides an overview of the existing facilities and capacities for the area substations.

Table 3-1: Overview of Existing Substation Facilities

Substation	Okotoks 678S	Black Diamond 392S	High River 65S	Springbank 272S
Transformation Installed Capacity	T1: 138/25 kV 15/20/25/28.1 MVA OCTC Transformer paired with VR1: 25 kV 18.75/25/28.1 MVA Regulator T2: 138/25 kV 25/32/42 MVA LTC Transformer	T2: 69/25 kV 15/20/25 MVA LTC Transformer *Limited by 69kV supply line summer capacity rating to 16 MVA. 69 kV source transformer rating: 18.75 MVA.25 kV bus capacity: 22.5 MVA* T3: 138/25 kV 15/20/25 MVA OCTC Transformer paired with VR4: 25 kV 15/20/25 MVA Regulator *Limited by secondary bus capacity to 22.5 MVA*	T2: 138/25 kV 25/33/42 MVA LTC Transformer T3: 138/25 kV 25/33/42 MVA LTC Transformer	T1: 138/25 kV 15/20/25 MVA LTC Transformer
Peak Station Load (2015/16 winter peak)	45.2 MVA	25.7 MVA	38.1 MVA	12.3 MVA
Available Capacity (N-0)	70.1 MVA	38.5 MVA	84 MVA	25 MVA
Firm Transformation Capacity (N-1)	28.1 MVA	16 MVA	42 MVA	0 MVA
25 kV Feeders	T1 393LW 81LE T2 349LN 2181L	T2 121LW 240LW T3 219LS 2154L	T2 14LS 37LW 2088L 2213L T3 16LE 63LS	T1 236LN 236LS 2044L

Studies indicate that during the 10 year planning horizon six of the 25 kV feeders supplied by the Okotoks 678S, High River 65S, and Black Diamond 392S substations are already or are predicted to carry peak load in excess of the normal feeder maximum load of 13 MVA: 678S-349LN, 678S-2181L,687S-81LE, 65S-16LE, 65S-63LS, and 392S-219LS. The T1 transformer at Okotoks 678S is predicted to carry a peak load in excess of the transformer's capacity rating.

The existing and predicted unsupplied load under N-1 contingency at the Okotoks 678S substation violates FortisAlberta reliability criteria. The unsupplied load under N-1 contingency at the Black Diamond 392S substation is predicted to violate FortisAlberta reliability criteria.

4. Alternatives Analysis

The following alternatives were considered:

Alternative 1 Distribution Upgrades and Load Shifting

Alternative 2 Upgrades at the Okotoks 678S Substation

Alternative 3 Upgrades at the Okotoks 678S and High River 65S Substations

Alternative 4 New substation in the Okotoks Area

Alternative 5 New substation in the Okotoks Area and Upgrades at the Black Diamond 392S Substation

4.1 Alternative 1: Distribution Upgrades and Load Shifting

4.1.1 Description

Distribution upgrades and load shifting cannot mitigate the existing and predicted capacity and reliability issues at the Okotoks 678S and Black Diamond 392S substations. This is due to the existing and predicted feeder load levels and the distances involved. System models indicate the resultant distribution service would have violations of voltage and motor starting criteria, as part of the FortisAlberta distribution planning criteria. This alternative is not technically acceptable.

4.2 Alternative 2: Upgrades at the Okotoks 678S Substation

4.2.1 Description

2017 at the Okotoks 678S substation:

- **Add one 138/25 kV 25/33/42 MVA LTC source transformer**
- **Add four 25 kV feeder breakers**

Refer to Appendix B, Figure B-1 showing the proposed system development. Two of the proposed four new feeders, 104L and 529L, would address the capacity and reliability

concerns in the area supplied by the Okotoks 678S substation. The other two new feeders, 2361L and 2362L, would provide back-up support for the Black Diamond 392S substation.

All 25 kV overhead conductors, new and existing, exiting the substation and distribution feeder ties shall be 477 MCM. All underground feeder cables, new and existing, shall be 750 MCM. All transmission components on the secondary side of the 25 kV source transformers, new and existing, shall be sized to enable the feeders to simultaneously supply 26 MVA per feeder. Provisions should be made for interconnecting the substation transformer neutrals with the distribution line neutrals as per the TFO standard.

Transmission facilities must be equipped with the appropriate equipment for interconnection with FortisAlberta's Automated Metering system.

All 25 kV feeder breakers shall be equipped with associated equipment to enable under-frequency load shedding.

All 138 kV and 25 kV buses shall have adequate switch points and protection to minimize frequency and duration of outages associated with the maintenance or failure of substation components upstream of the 25 kV bus. Failure of such upstream components must not result in a total substation outage.

4.2.2 Load Forecast

The load forecast resulting from this alternative is provided in Table 4-1.

Table 4-1: FortisAlberta Load Forecast for Alternative 2 – Upgrades at the Okotoks 678S substation

SUB No	Feeder	CAPACITY T/R	MVA	Loading	W or S	MVA LOADING - RECORDED 2011 Peak MVA	2012 Peak MVA	2013 Peak MVA	2014 Peak MVA	2015 Peak MVA	PF	PREDICTED - MVA LOADING 2016 Year 1 MVA	2017 Year 2 MVA	2018 Year 3 MVA	2019 Year 4 MVA	2020 Year 5 MVA	2021 Year 6 MVA	2022 Year 7 MVA	2023 Year 8 MVA	2024 Year 9 MVA	2025 Year 10 MVA
065S	High River (T2)	T2	25/33/ 42	73%	W	**25.9**	**25.3**	**27.1**	**26.6**	**25.7**	95%	**30.5**	**30.3**	**30.5**	**30.8**	**31.0**	**31.2**	**31.4**	**31.7**	**32.4**	**32.6**
065S	14LS				W	7.9	7.6	8.0	8.0	7.4	100%	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.4	9.5
065S	37LW				W	2.3	2.5	2.4	2.6	2.2	100%	2.5	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
065S	2213L				W	13.5	14.5	15.7	15.6	15.3	86%	16.9	16.9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7
065S	2088L Total Load					16.9	16.5	16.3	15.8	16.6	85%	18.1	18.1	18.2	18.2	18.3	18.3	18.4	18.4	18.5	18.5
065S	2088L				W	3.8	3.4	3.2	2.7	3.5	97%	5.0	5.0	5.1	5.1	5.2	5.2	5.3	5.3	5.4	5.4
065S	2088L Auto Transfer (65S-2213L) Cargill				W	13.10	13.10	13.10	13.10	13.10	86%	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1
065S	High River (T3)	T3	25/33/ 42	56%	W	**16.9**	**17.0**	**17.0**	**15.3**	**13.0**	99%	**23.5**	**23.9**	**24.2**	**23.6**	**23.9**	**24.3**	**24.7**	**25.0**	**24.9**	**25.3**
065S	16LE				W	7.6	7.8	7.8	6.6	4.3	95%	12.7	12.8	12.9	12.0	12.2	12.3	12.4	12.5	12.7	12.8
065S	63LS				W	9.5	9.5	9.2	9.0	9.2	100%	11.1	11.3	11.6	11.8	12.0	12.3	12.5	12.8	12.5	12.8
065S	Total Station				W	**42.0**	**41.5**	**42.8**	**41.8**	**38.1**	97%	**53.5**	**53.6**	**54.2**	**53.8**	**54.4**	**55.0**	**55.5**	**56.1**	**56.7**	**57.3**
272S	Springbank	T1	15/20// 25	65%	W	**15.8**	**13.9**	**13.7**	**12.8**	**12.3**	100%	**16.4**	**16.5**	**16.7**	**16.9**	**17.0**	**17.2**	**17.4**	**17.5**	**17.7**	**17.9**
272S	2044L Total Load					12.6	10.1	10.0	10.6	9.1	100%	11.8	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6
272S	2044L Base Load				W	9.4	6.9	6.8	7.4	5.9	100%	8.6	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4
272S	2044L Auto Transfer (272s236LS)					3.20	3.20	3.20	3.20	3.20	100%	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
272S	236LN				W	3.1	3.4	3.3	3.6	2.8	100%	4.5	4.5	4.6	4.6	4.7	4.7	4.8	4.8	4.9	4.9
272S	236LS				W	3.9	4.0	4.0	3.9	3.8	100%	5.0	5.0	5.0	5.1	5.1	5.1	5.2	5.2	5.2	5.2
392S	Black Diamond (T2)	T2	15/20 25	58%	W	**12.4**	**13.2**	**12.2**	**12.4**	**12.6**	99%	**14.6**	**14.7**	**14.9**	**15.0**	**16.2**	**16.3**	**16.5**	**16.6**	**16.8**	**17.0**
392S	121LW Total Load	Bus Rating 22.5 MVA				7.4	7.3	7.3	7.6	7.3	97%	7.9	7.9	8.0	8.0	9.1	9.2	9.2	9.3	9.4	9.5
392S	121LW Base Load	Line rating 16/20 MVA			W	5.4	5.3	5.3	5.6	5.3	99%	5.9	5.9	6.0	6.0	7.1	7.2	7.2	7.3	7.4	7.5
392S	121LW Auto Transfer (392s240LW)					2.00	2.00	2.00	2.00	2.00	90%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
392S	240LW				W	7.1	8.0	7.6	7.7	7.6	99%	9.0	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8
392S	Black Diamond (T3)	T3	15/20/ 25	69%																	
392S		VR4	15/20/ 25	69%	W	**13.3**	**13.3**	**15.3**	**16.0**	**13.4**	96%	**17.1**	**15.7**	**16.0**	**16.2**	**15.4**	**15.6**	**15.8**	**16.0**	**16.2**	**16.5**
392S	219LS	Bus Rating 22.5 MVA			W	9.1	9.5	11.4	12.0	10.3	94%	12.7	12.7	12.8	13.0	12.1	12.2	12.3	12.5	12.6	12.7
392S	2154L				W	4.2	4.0	4.4	4.2	4.0	99%	4.8	3.3	3.5	3.5	3.6	3.7	3.8	3.9	4.0	4.1
392S	Total Station				W	**25.7**	**26.0**	**27.4**	**28.6**	**25.7**	97%	**31.4**	**30.1**	**30.5**	**30.9**	**31.3**	**31.6**	**32.0**	**32.3**	**32.7**	**33.1**
678S	Okotoks	T1	15/20/25// 28.1	86%	W	**18.7**	**20.9**	**20.1**	**21.5**	**19.5**	100%	**24.2**	**20.1**	**20.7**	**21.3**	**21.9**	**22.5**	**23.2**	**23.9**	**24.5**	**25.2**
678S	393LW (MOVE TO T3 IIN 2017)				W	9.2	9.9	10.6	10.8	9.7	100%	11.1									
678S	81LE				W	9.7	11.1	9.5	10.9	10.6	99%	13.2	9.8	10.2	10.5	10.8	11.2	11.5	11.9	12.3	12.7
678S	104L				W						99%		10.5	10.8	11.0	11.3	11.6	11.9	12.2	12.5	12.8
678S	Okotoks	T2	25/32// 42.0	68%	W	**25.3**	**24.1**	**26.8**	**26.3**	**25.9**	99%	**28.7**	**17.3**	**18.3**	**18.9**	**19.4**	**19.9**	**20.4**	**20.9**	**21.4**	**22.0**
678S	349LN				W	14.5	13.5	15.8	14.7	13.7	100%	15.6	9.5	9.7	10.0	10.2	10.5	10.7	11.0	11.3	11.6
678S	2181L				W	10.9	10.6	11.3	12.2	12.0	99%	13.2	6.6	7.3	7.7	7.9	8.1	8.3	8.5	8.7	8.9
678S	2361L				W						99%		1.4	1.4	1.5	1.5	1.5	1.6	1.6	1.7	1.7
678S	Okotoks	T3 NEW	25/32// 42								99%		**19.2**	**19.5**	**19.7**	**20.0**	**20.3**	**20.6**	**20.9**	**21.2**	**21.5**
678S	393LW (MOVE TO T3 IIN 2017)				W	9.2	9.9	10.6	10.8	9.7	100%	11.1	11.2	11.3	11.3	11.4	11.4	11.5	11.6	11.6	11.7
678S	529L				W						100%		7.3	7.5	7.7	7.9	8.1	8.3	8.5	8.7	8.9
678S	2362L				W						100%		0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.1	1.1
678S	Total Station				W	**44.0**	**44.7**	**46.5**	**47.4**	**45.2**	99%	**52.4**	**56.1**	**57.9**	**59.3**	**60.7**	**62.1**	**63.5**	**64.9**	**66.4**	**67.9**

Total Area Load:	**127.5**	**126.1**	**130.4**	**130.6**	**121.3**	**153.6**	**156.3**	**159.2**	**160.9**	**163.4**	**165.8**	**168.4**	**170.9**	**173.6**	**176.2**

2017 Load transfers

3.0 MVA from 678S-81LE to 678S-104L
0.8 MVA from 678S-81LE to 678S-349LN
7.3 MVA from 678S-349LN to 678S-529L
7.9 MVA from 678S-2181L to 678S-104L
1.4 MVA from 392S-2154L to 678S-2361L
0.5 MVA from 65S-37LW to 678S-2632L
0.1 MVA from 392S-219LS to 678S-2632L
0.3 MVA from 392S-2154LE to 678S-2362L

2019 Load transfers

1.0 MVA from 65S-16LE to 255S-16LN

2020 Load transfers

1.0 MVA from 392S-219LS to 392S-121LW

2024 Load transfers

0.5 MVA from 65s-63LS to 65S-14LS

392S Total Load	25.7	31.4	30.1	30.5	30.9	31.3	31.6	32.0	32.3	32.7	33.1
N-1 392S	16	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Back up from 272S	3.4	3.5	3.6	3.6	3.7	3.8	3.9	3.9	4.0	4.1	4.1
Back up from 678S	0	0.0	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3
Back up from 65S	6.6	6.6	6.6	6.5	6.5	6.5	6.5	6.4	6.4	6.4	6.3
N-1 Unsupplied Load	0	**5.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
678S Total Load	45.2	52.4	56.1	57.9	59.3	60.7	62.1	63.5	64.9	66.4	67.9
N-1 Capacity 678S	28.1	28.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1
Back up from 392S	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.5	2.4	2.3	2.2
Back up from 65S	8.9	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6
N-1 Unsupplied Load	**5.9**	**13.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

4.2.3 Cost Estimate

The transmission capital cost for Alternative 2 will be provided by AltaLink. The screening estimate for the transmission costs associated with this alternative is $13.59 million (2017$, ±50%).

The estimated distribution capital cost for Alternative 2 is **$**16.13 million (2017$, ±30%).

4.3 Alternative 3: Upgrades at the Okotoks 678S and High River 65S Substations

4.3.1 Description

2017 at the Okotoks 678S substation:

- **Add one 138/25 kV 25/33/42 MVA LTC source transformer**
- **Add two 25 kV feeder breakers**

2017 at the High River 65S substation:

- **Add two 25 kV feeder breakers**

Refer to Appendix C, Figure C-1 showing the proposed system development. The two new feeders proposed for the Okotoks 678S substation, 104L and 529L, will address the capacity and reliability concerns in the Okotoks area. The two new feeders proposed for the High River 65S substation, 2361L and 2362L, will provide back-up support for the Black Diamond 392S substation.

All 25 kV overhead conductors, new and existing, exiting the substation and distribution feeder ties shall be 477 MCM. All underground feeder cables, new and existing, shall be 750 MCM. All transmission components on the secondary side of the 25 kV source transformers, new and existing, shall be sized to enable the feeders to simultaneously supply 26 MVA per feeder. Provisions should be made for interconnecting the substation transformer neutrals with the distribution line neutrals as per the TFO standard.

Transmission facilities must be equipped with the appropriate equipment for interconnection with FortisAlberta's Automated Metering system.

All 25 kV feeder breakers shall be equipped with associated equipment to enable under-frequency load shedding.

All 138 kV and 25 kV buses shall have adequate switch points and protection to minimize frequency and duration of outages associated with the maintenance or failure of substation components upstream of the 25 kV bus. Failure of such upstream components must not result in a total substation outage.

4.3.2 Load Forecast

The load forecast resulting from this alternative is provided in Table 4-2.

Table 4-2: FortisAlberta Load Forecast for Alternative 3 – Upgrades at the Okotoks 678S and High River 65S substations

SUB No	Feeder	CAPACITY T/R	MVA	W or S	MVA LOADING - RECORDED 2011 Peak MVA	2012 Peak MVA	2013 Peak MVA	2014 Peak MVA	2015 Peak MVA	PF	PREDICTED - MVA LOADING 2016 Year 1 MVA	2017 Year 2 MVA	2018 Year 3 MVA	2019 Year 4 MVA	2020 Year 5 MVA	2021 Year 6 MVA	2022 Year 7 MVA	2023 Year 8 MVA	2024 Year 9 MVA	2025 Year 10 MVA
065S	High River (T2)	T2	25/33/ 42	W	**25.9**	**25.3**	**27.1**	**26.6**	**25.7**	95%	**30.5**	**29.8**	**30.0**	**30.3**	**30.5**	**30.8**	**31.0**	**31.2**	**31.9**	**32.1**
065S	14LS			W	7.9	7.6	8.0	8.0	7.4	100%	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	9.4	9.5
065S	37LW			W	2.3	2.5	2.4	2.6	2.2	100%	2.5	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
065S	2213L			W	13.5	14.5	15.7	15.6	15.3	86%	16.9	16.9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7
065S	2088L Total Load			W	16.9	16.5	16.3	15.8	16.6	85%	18.1	17.7	17.8	17.8	17.9	17.9	18.0	18.0	18.1	18.1
065S	2088L			W	3.8	3.4	3.2	2.7	3.5	97%	5.0	4.6	4.7	4.7	4.8	4.8	4.9	4.9	5.0	5.0
065S	2088L Auto Transfer (65S-2213L)	Cargill		W	13.10	13.10	13.10	13.10	13.10	86%	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1
065S	High River (T3)	T3	25/33/ 42	W	**16.9**	**17.0**	**17.0**	**15.3**	**13.0**	99%	**23.5**	**25.3**	**25.6**	**25.0**	**25.4**	**25.8**	**26.2**	**26.6**	**26.5**	**26.9**
065S	16LE			W	7.6	7.8	7.8	6.6	4.3	95%	12.7	12.8	12.9	12.0	12.2	12.3	12.4	12.5	12.7	12.8
065S	63LS			W	9.5	9.5	9.2	9.0	9.2	100%	11.1	11.3	11.6	11.8	12.0	12.3	12.5	12.8	12.5	12.8
065S	2361L			W						97%		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
065S	2362L			W						97%		1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2
065S	Total Station			W	**42.0**	**41.5**	**42.8**	**41.8**	**38.1**	97%	**53.5**	**54.5**	**55.1**	**54.8**	**55.3**	**56.0**	**56.6**	**57.2**	**57.8**	**58.4**
272S	Springbank	T1	15/20// 25	W	**15.8**	**13.9**	**13.7**	**12.8**	**12.3**	100%	**16.4**	**16.5**	**16.7**	**16.9**	**17.0**	**17.2**	**17.4**	**17.5**	**17.7**	**17.9**
272S	2044L Total Load			W	12.6	10.1	10.0	10.6	9.1	100%	11.8	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6
272S	2044L Base Load			W	9.4	6.9	6.8	7.4	5.9	100%	8.6	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4
272S	2044L Auto Transfer (272s236LS)			W	3.20	3.20	3.20	3.20	3.20	100%	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
272S	236LN			W	3.1	3.4	3.3	3.6	2.8	100%	4.5	4.5	4.6	4.6	4.7	4.7	4.8	4.8	4.9	4.9
272S	236LS			W	3.9	4.0	4.0	3.9	3.8	100%	5.0	5.0	5.0	5.1	5.1	5.1	5.2	5.2	5.2	5.2
392S	Black Diamond (T2)	T2	15/20 25	W	**12.4**	**13.2**	**12.2**	**12.4**	**12.6**	99%	**14.6**	**15.6**	**15.8**	**16.0**	**16.1**	**16.3**	**16.4**	**16.6**	**16.8**	**16.9**
392S	121LW Total Load	Bus Rating 22.5 MVA		W	7.4	7.3	7.3	7.6	7.3	97%	7.9	8.9	9.0	9.1	9.1	9.2	9.3	9.3	9.4	9.5
392S	121LW Base Load	Line rating 16/20 MVA		W	5.4	5.3	5.3	5.6	5.3	99%	5.9	6.9	7.0	7.1	7.1	7.2	7.3	7.3	7.4	7.5
392S	121LW Auto Transfer (392s240LW)			W	2.00	2.00	2.00	2.00	2.00	90%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
392S	240LW			W	7.1	8.0	7.6	7.7	7.6	99%	9.0	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8
392S	Black Diamond (T3)	T3	15/20/ 25							96%										
392S		VR4	15/20/ 25	W	**13.3**	**13.3**	**15.3**	**16.0**	**13.4**	96%	**17.1**	**16.1**	**16.4**	**16.6**	**16.9**	**17.1**	**17.3**	**17.6**	**17.8**	**18.1**
392S	219LS	Bus Rating 22.5 MVA		W	9.1	9.5	11.4	12.0	10.3	94%	12.7	11.8	11.9	12.1	12.2	12.3	12.4	12.5	12.7	12.8
392S	2154L			W	4.2	4.0	4.4	4.2	4.0	99%	4.8	4.6	4.8	4.9	5.0	5.1	5.3	5.4	5.5	5.7
392S	Total Station			W	**25.7**	**26.0**	**27.4**	**28.6**	**25.7**	97%	**31.4**	**31.4**	**31.9**	**32.2**	**32.6**	**33.0**	**33.4**	**33.8**	**34.2**	**34.6**
678S	Okotoks	T1	15/20/25// 28.1	W	**18.7**	**20.9**	**20.1**	**21.5**	**19.5**	100%	**24.2**	**20.1**	**20.7**	**21.3**	**21.9**	**22.5**	**23.2**	**23.9**	**24.5**	**25.2**
678S	393LW (MOVED TO T3 IN 2017)			W	9.2	9.9	10.6	10.8	9.7	100%	11.1									
678S	81LE			W	9.7	11.1	9.5	10.9	10.6	99%	13.2	9.8	10.2	10.5	10.8	11.2	11.5	11.9	12.3	12.7
678S	104L			W						100%		10.5	10.8	11.0	11.3	11.6	11.9	12.2	12.5	12.8
678S	Okotoks	T2	25/32// 42.0	W	**25.3**	**24.1**	**26.8**	**26.3**	**25.9**	99%	**28.7**	**15.9**	**16.8**	**17.5**	**17.9**	**18.4**	**18.8**	**19.3**	**19.8**	**20.3**
678S	349LN			W	14.5	13.5	15.8	14.7	13.7	100%	15.6	9.5	9.7	10.0	10.2	10.5	10.7	11.0	11.3	11.6
678S	2181L			W	10.9	10.6	11.3	12.2	12.0	99%	13.2	6.6	7.3	7.7	7.9	8.1	8.3	8.5	8.7	8.9
678S	Okotoks	T3	25/32// 42	W						100%		**18.3**	**18.6**	**18.8**	**19.1**	**19.3**	**19.6**	**19.8**	**20.1**	**20.4**
678S	393LW			W	9.2	9.9	10.6	10.8	9.7	100%	11.1	11.2	11.3	11.3	11.4	11.4	11.5	11.6	11.6	11.7
678S	529L			W						100%		7.3	7.5	7.7	7.9	8.1	8.3	8.5	8.7	8.9
678S	Total Station			W	**44.0**	**44.7**	**46.5**	**47.4**	**45.2**	99%	**52.4**	**53.8**	**55.5**	**57.0**	**58.3**	**59.6**	**60.9**	**62.3**	**63.8**	**65.2**
Total Area Load:					**127.5**	**126.1**	**130.4**	**130.6**	**121.3**		**153.6**	**156.3**	**159.2**	**160.8**	**163.3**	**165.8**	**168.3**	**170.9**	**173.5**	**176.2**
								392S Total Load	25.7		31.4	31.4	31.9	32.2	32.6	33.0	33.4	33.8	34.2	34.6
2017 Load transfers (MVA)								N-1 392S	16		16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
3.0 MVA from 678S-81LE to 678S-104L								Back up from 272S	3.4		3.5	3.6	3.6	3.7	3.8	3.9	3.9	4.0	4.1	4.1
0.8 MVA from 678S-81LE to 678S-349LN								Back up from 678S	0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.5 MVA from 678S-2181L to 678S-104L								Back up from 65S	6.6		6.6	16.0	16.3	16.5	16.8	17.1	17.4	17.6	17.9	17.9
7.3 MVA from 678S-349LN to 678S-529L								N-1 Unsupplied Load	**0**		**5.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
0.4 MVA from 392S-2154L to 65S-2362L																				
0.6 MVA from 65S-37LW to 65S-2362L								678S Total Load	45.2		52.4	53.8	55.5	57.0	58.3	59.6	60.9	62.3	63.8	65.2
0.4 MVA from 65S-2088L to 65S-2361L								N-1 Capacity 678S	28.1		28.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1
1.0 MVA from 392S-219LS to 392S-121LW								Back up from 392S	2.3		2.4	2.4	2.5	2.5	2.6	2.6	2.5	2.4	2.3	2.2
2019 Load transfers (MVA)								Back up from 65S	8.9		8.0	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0
1.0 MVA from 65S-16LE to 255S-16LN								N-1 Unsupplied Load	**5.9**		**13.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
2024 Load transfers (MVA)																				
0.5 MVA from 65s-63LS to 65S-14LS																				

4.3.3 Cost Estimate

The transmission capital cost for Alternative 3 will be provided by AltaLink. The screening estimate for the transmission costs associated with this alternative was $14.77 million (2017$, ±50%).

The distribution capital cost for Alternative 3 is estimated at **$**14.93 million (2017$, ±30%). This is based on estimated costs for the associated distribution upgrades of $5.49M at the Okotoks 678S substation and $9.44M at the High River 65S substation.

4.4 Alternative 4: New substation in the Okotoks area.

Prior applications by FortisAlberta (AESO projects 934, 1218 and 1232) sought to address the current concerns in the Okotoks/Black Diamond area. These applications did not proceed to NID applications due to evolving project developments. In the course of these applications a number of transmission system upgrade options were considered. To assist in the determination of the preferred alternative, AltaLink produced screening estimates for a number of the alternatives. The two most likely options are presented in sections 4.4.1 and 4.5.1.

4.4.1 Description

Install a new substation at, or near, SW-24-20-1-W5 complete with:

- **one 138/25 kV 25/33/42 MVA LTC source transformer**
- **four 25 kV feeder breakers**

The new substation would be served by an in-out double-circuit 138 kV transmission line created by cutting into 727L. Two of the 25 kV feeders would address the capacity and reliability issues at the Okotoks 678S substation. The other two would address the reliability issues at the Black Diamond 392S substation. See Appendix D, Figure D-1.

The transmission capital cost screening estimate was $39.43M (2017$, ±30%). The estimate for the distribution work associated with this alternative, updated for current unit pricing, was $5.86M (2017$, ±30%).

4.5 Alternative 5: New substation in the Okotoks area and upgrades at the Black Diamond 392S substation.

4.5.1 Description

Install a new substation at, or near, SW-24-20-1-W5 complete with:

- **one 138/25 kV 25/33/42 MVA LTC source transformer**
- **two 25 kV feeder breakers**

Replace the existing 69/25 kV 15/20/25 MVA source transformer at the Black Diamond 392S substation with a 138/25 kV 25/33/42 MVA source transformer.

This alternative includes a different proposal for the 138 kV supply to the new substation. Rather than having two 25 kV feeders from the new substation providing back-up support for the Black Diamond 392S substation, the transmission lines supplying the Okotoks/Black Diamond/High River area would be modified so that the Black Diamond 392S substation would be able to provide its own n-1 contingency support.

The Black Diamond 392S substation currently receives 138 kV supply, 812L, from the High River 65S substation. See Appendix A, Figure A-2. This supplies a 138kV bus, a 138/25 kV 25 MVA transformer, a 25 kV 25 MVA regulator and two 25 kV feeders at the Black Diamond 392S substation. The Black Diamond 392S substation also receives 69 kV supply, 13L/158L, from the High River 65S substation. This supplies a 69kV bus, a 69/25 kV 25 MVA transformer and two 25 kV feeders. The 138kV supply travels west from the High River 65S substation, supplying the Hartell 512S substation, then turns north to reach the Black Diamond 392S substation. The 69 kV supply travels north from the High River substation before turning west at the Town of Okotoks to connect to the Black Diamond 392S substation. The two circuits make a loop however an outage on either loop takes the associated transformer out of service due to the different primary voltages.

While both distribution source transformers at the Black Diamond 392S substation are rated at 25 MVA, the capacities are limited by other elements. The 69 kV source is limited by the 69kV line rating of 16/20 MVA (summer/winter). The 138 kV source is limited by the 25 kV bus capacity of 22.5 MVA.

This alternative proposes replacing the 69 kV supply to the Black Diamond 392S substation with a 138 kV line. As part of replacing the 69 kV supply to the Black Diamond 392S substation, the 69/25 kV source transformer at the substation would be replaced with a 138/25 kV source transformer. See Appendix D, Figure D-1, for a sketch of this alternative. This would increase the capacity and reliability at the substation. A 138 kV line would have a higher line rating than the current 69 kV line increasing the substation capacity. A 138 kV line, and the associated transformer, would enable load shifting between transformers at the Black Diamond 392S substation in the event of an outage of either transmission line supplying the substation.

The proposed 138 kV line supplying the Black Diamond 392S substation would come from the proposed new substation just west of the Town of Okotoks, not from the High River 65S substation. And the proposed new substation would be supplied by a 138 kV line from the Okotoks 678S substation. This would establish a 138 kV loop from the High River 65S substation to Okotoks 678S, to the new sub, on to Black Diamond 392S and back via the Hartell 512S substation to High River 65S. This would improve the reliability for all five substations.

The transmission capital cost screening estimate for this alternative was $72.26 M (2017$, ±30%). The estimate for the distribution work associated with this alternative, updated for current unit pricing, was $1.76M (2017$, ±30%).

5. Alternatives Assessment

The following section presents the technical and economic analysis of the alternatives considered in this Need for Development.

5.1 Technical Analysis

5.1.1 Alternative 1 – Distribution Upgrades and Load Shifting

As per section 4.1.1, distribution upgrades and load shifting could not eliminate the predicted capacity and reliability concern at the Okotoks 678S and Black Diamond 392S substations. This is not a technically acceptable alternative.

5.1.2 Alternative 2– Upgrades at the Okotoks 678S Substation

The addition of a 42 MVA source transformer and four 25 kV feeder breakers at the Okotoks 678S substation, coupled with the associated distribution system upgrades, addresses the reliability and capacity concerns for the distribution systems connected to the Okotoks 678S and Black Diamond 392S substations. This alternative is technically acceptable.

5.1.3 Alternative 3 - Upgrades at the Okotoks 678S and High River 65S Substations

The addition of a 42 MVA source transformer and two 25 kV feeder breakers at the Okotoks 678S substation and the addition of two 25 kV feeder breakers at the High River 65S substation, coupled with the associated distribution system upgrades, address the reliability and capacity concerns for the distribution systems connected to the Okotoks 678S and Black Diamond 392S substations. This alternative is technically acceptable.

By limiting the feeder additions at the Okotoks 678S substation this alternative supports future system upgrades at the Okotoks 678S substation to address anticipated load growth and feeder additions. Alternative 2 would restrict the possibility of addition of the distribution system feeders at the Okotoks 678S substation in the future. Due to the higher growth in the Okotoks area it is preferable to maintain the ability to add new distribution feeders at the Okotoks 678S substation. In addition, the distribution upgrades associated with this alternative result in a more reliable distribution system than those proposed for Alternative 2. Therefore, this is the preferred alternative.

5.1.4 Alternative 4 – New substation in the Okotoks area.

Establishing a new source substation as proposed, with one 42 MVA source transformer and four 25 kV feeders, coupled with the associated distribution system upgrades, addresses the reliability and capacity concerns for the distribution systems connected to the Okotoks 678S and Black Diamond 392S substations. This alternative is technically acceptable.

5.1.5 Alternative 5 – New substation in the Okotoks area and upgrades at the Black Diamond 392S substation.

Establishing a new source substation as proposed, with one 42 MVA source transformer and two 25 kV feeders and upgrading the 69 kV supply to the Black Diamond 392S substation to 138 kV, coupled with the associated distribution system upgrades, addresses the reliability and capacity concerns for the distribution systems connected to the Okotoks 678S and Black Diamond 392S substations. This alternative is technically acceptable.

5.2 Economic Analysis

The cost estimates for the alternatives considered are presented in Table 5-1.

Table 5-1: Capital Cost Estimates of Alternatives Considered

Alternative	Transmission Screening Estimate	Distribution Estimate (2017$, ±30%)
1. Distribution Upgrades and Load Shifting	n/a	n/a
2. Upgrades at the Okotoks 678S Substation	$13.59 (2017$, ±50%)	$16.13
3. Upgrades at the Okotoks 678S Substation and High River 65S Substations	$14.77 (2017$, ±50%)	$14.93
4. New Substation in the Okotoks Area	$39.43 (2017$, ±30%)	$5.86
5. New Substation in the Okotoks Area and Upgrades at the Black Diamond 392S Substation	$72.26 (2017$, ±30%)	$1.76

6. Conclusion/Recommendations

After considering the alternatives to address the predicted concerns for distribution service at the Okotoks 678S and Black Diamond 392S substations, the preferred solution requires transmission upgrades at the Okotoks 678S and High River 65S substations. This involves the addition of one 138/25 kV 25/33/42 MVA LTC source transformer and two 25 kV feeder breakers at the Okotoks 678S substation to address the capacity and reliability concerns at the Okotoks 678S substation. The addition of two 25 kV feeder breakers at the High River 65S substation will address the reliability concerns at the Black Diamond 392S substation.

The distribution upgrades associated with this alternative support future system upgrades at the Okotoks 678S substation to address anticipated load growth in the Okotoks area and result in a more reliable distribution system than those proposed for Alternative 2.

AltaLink will prepare a Proposal to Provide Service for the required transmission upgrades. This will include an estimate for the transmission capital cost.

The estimated distribution capital costs associated with this proposal is $14.93 million (±30%, 2017$): $5.49M for the distribution work associated with the transmission upgrades at the Okotoks 678S substation and $9.44M for the distribution work associated with the transmission upgrades at the High River 65S substation.

The requested completion date for the proposed transmission facility upgrades is October 1, 2017.

Upon completion of these transmission system upgrades, FortisAlberta is prepared to execute DTS contracts for 49.3 MW for the Okotoks 678S substation and 55.7 MW for the High River 65S substation.

Appendix A – Existing System

Figure A-1: Existing Substations and Distribution Feeders in the Okotoks/Black Diamond Area

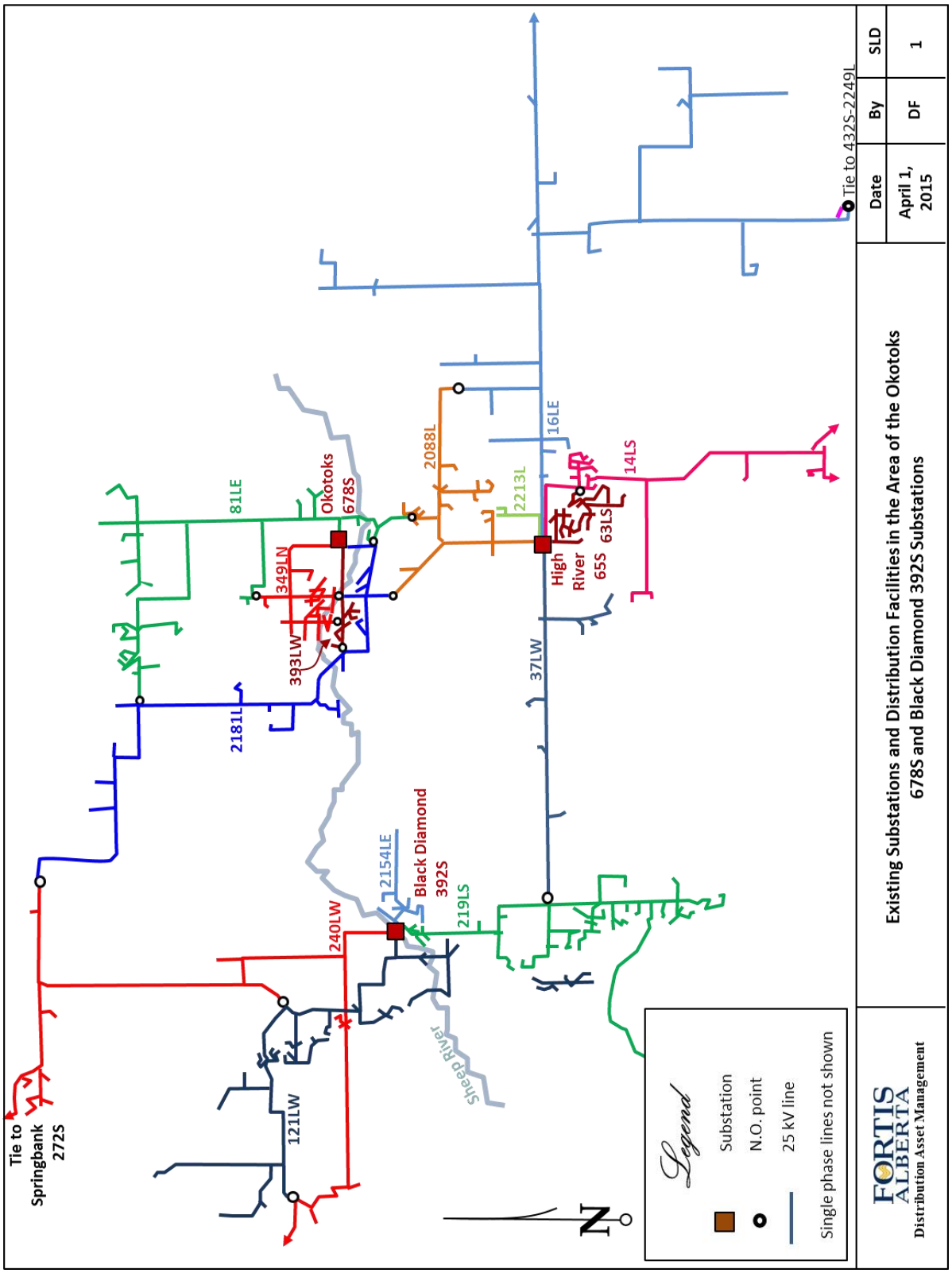
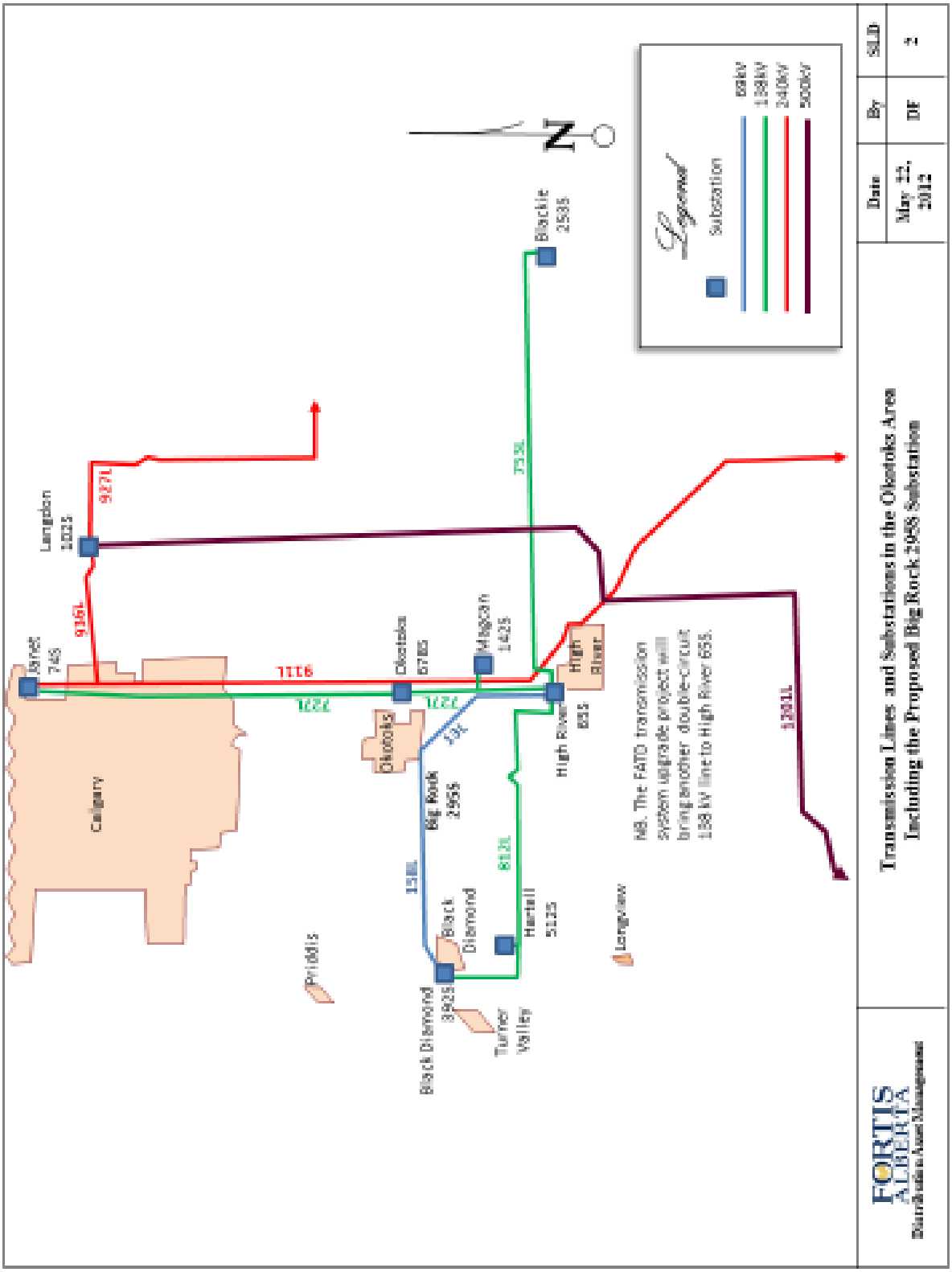
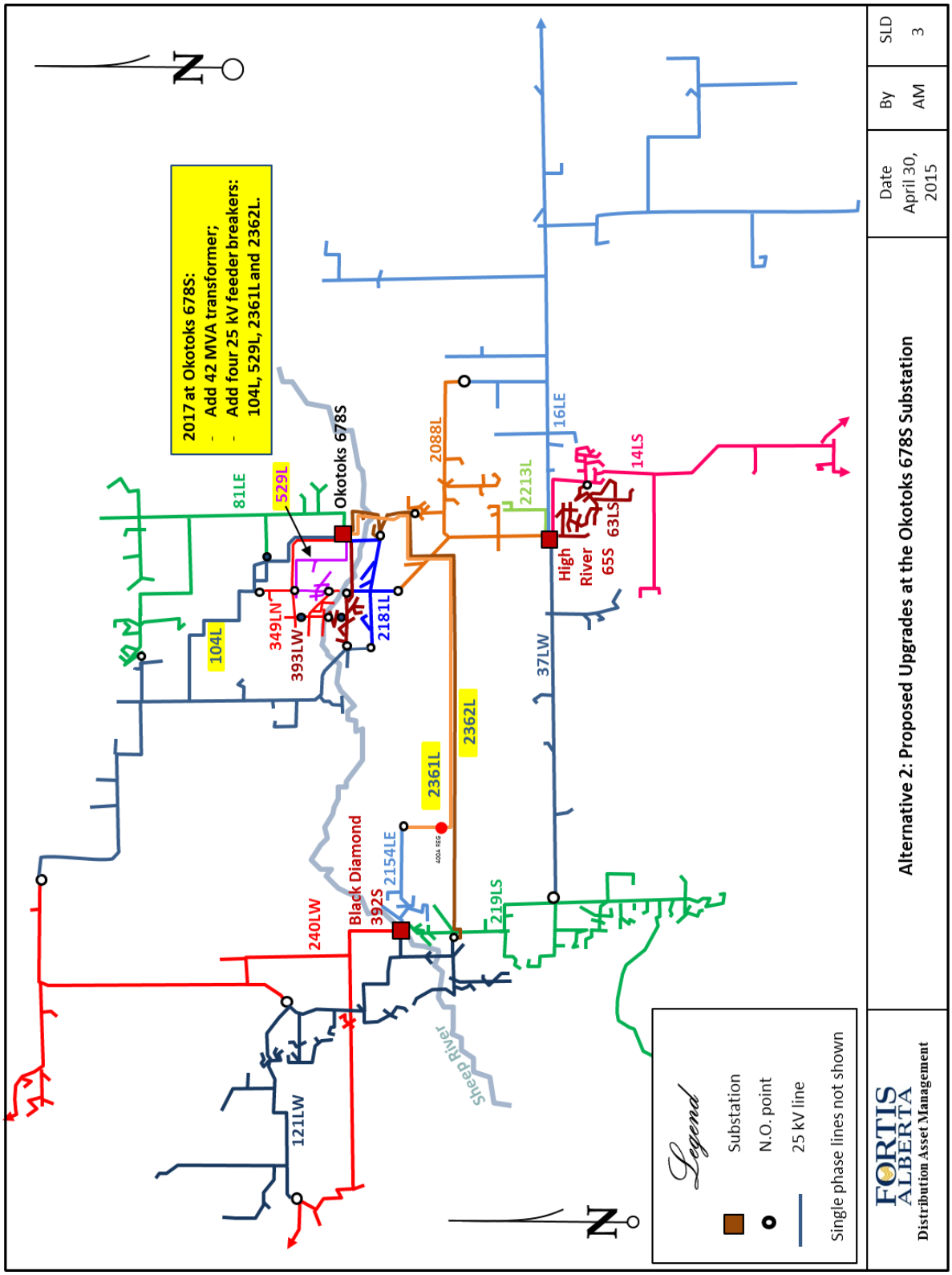


Figure A-2: Existing Transmission System in the Okotoks/Black Diamond area.



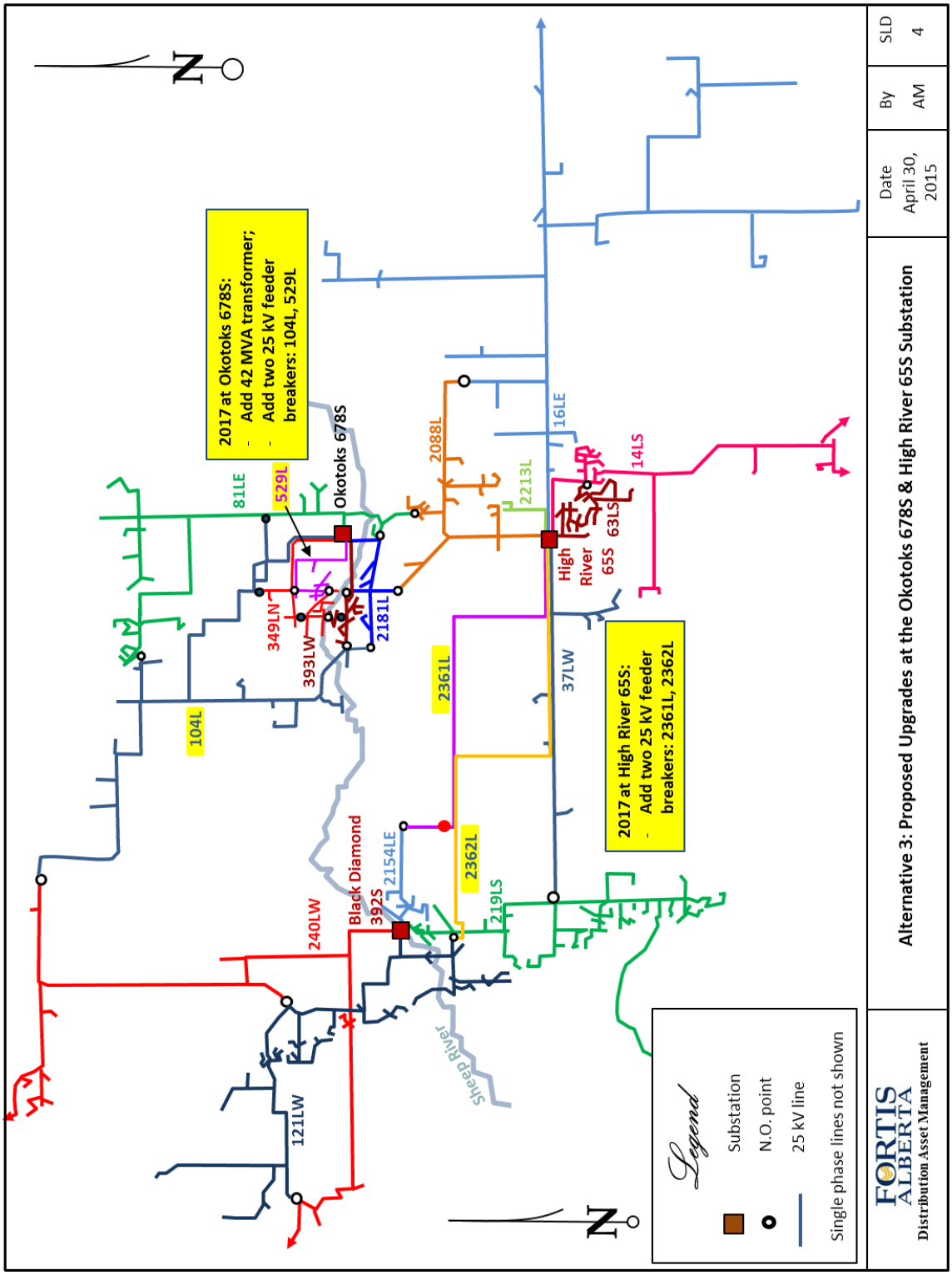
Appendix B – Alternative 2 – Upgrades at the Okotoks 678S Substation

Figure B-1: Alternative 2: Upgrades at the Okotoks 678S Substation



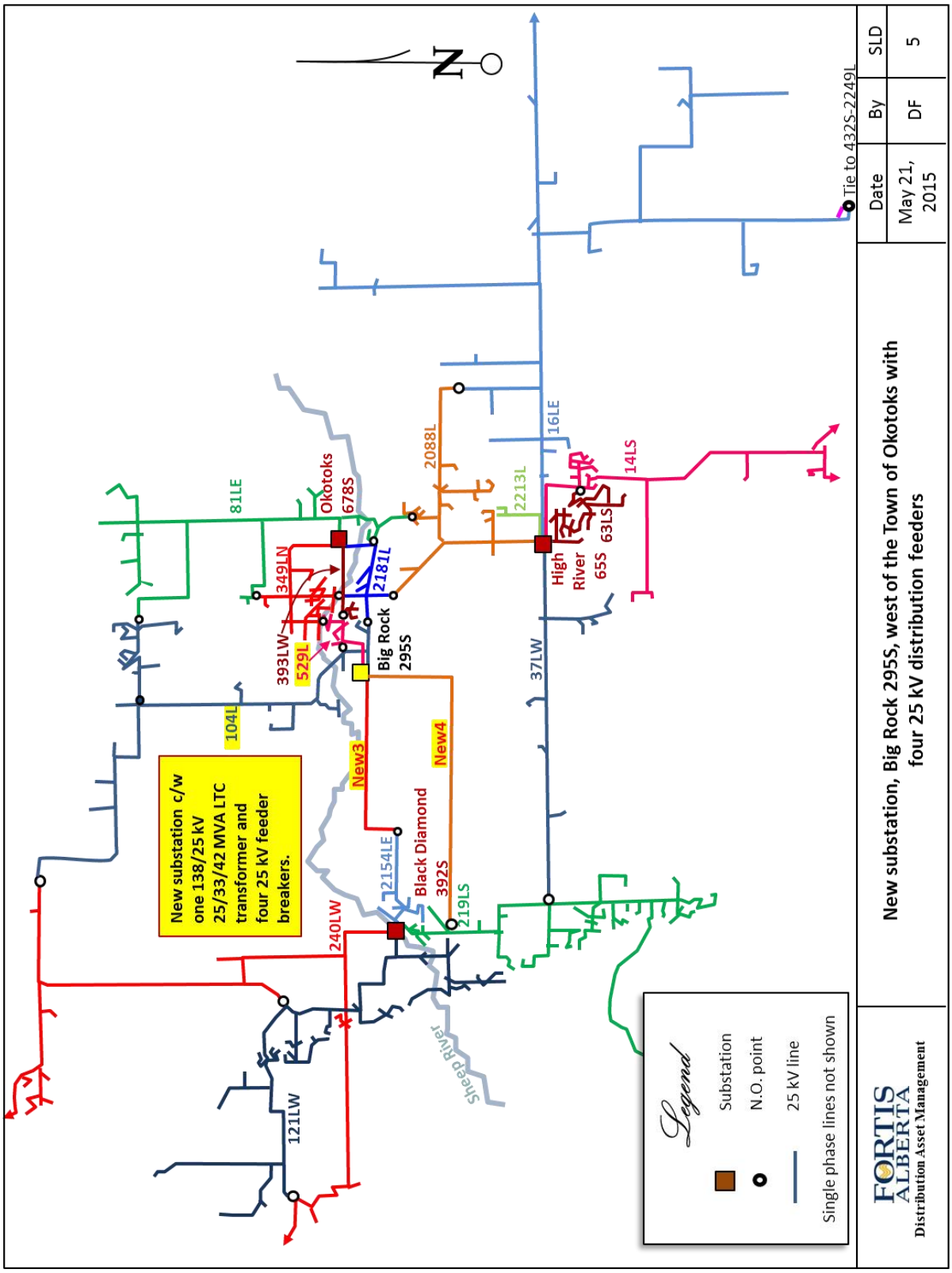
Appendix C – Alternative 3 – Upgrades at the Okotoks 678S and High River 65S Substations

Figure C-1: Alternative 3: Upgrades at the Okotoks 678S and High River 65S Substations



Appendix D – Alternative 4 – New Substation in the Okotoks Area

Figure D-1: Alternative 4: New Substation in the Okotoks Area



Appendix E – Alternative 5 – New Substation in the Okotoks Area and Upgrades at the Black Diamond 392S Substation

Figure E-1: Alternative 5: New Substation in the Okotoks Area and Upgrades at the Black Diamond 392S Substation