

APPENDIX E DFO NEED FOR DEVELOPMENT REPORT



Benbow 397S
Need for Development

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Executive Summary

The Benbow 397S substation consists of one 138.0/24.94 kV 25/33/42 MVA source transformer (T2) supplying three 25 kV distribution feeders and one 138.0/24.94 kV 15/20/25 MVA source transformer (T1) supplying two 25 kV distribution feeders.

Load growth in the Benbow area is producing a number of concerns related to the adequacy of the existing transmission and distribution facilities to provide reliability to meet customer needs.

In the event of an N-1 contingency at Benbow 397S substation, the unsupplied load in the area is predicted to exceed 9.0 MVA by 2016. The unsupplied load is predicted to increase to over 13 MVA by 2023. This exceeds FortisAlberta Inc. (FortisAlberta) restoration criteria.

To address the reliability concerns in the area, load shifting and distribution upgrades were investigated and rejected, as it was determined that solely upgrading the distribution facilities, including the distribution facilities out of the proposed DeerHill substation, would not fully resolve the unsupplied load at the Benbow 397S substation. Therefore, FortisAlberta is requesting to replace the existing 138/24.94 kV 15/20/25 MVA transformer-regulator pair (T1) with one (1) 138/25 kV 25/33/42 MVA LTC transformer at the Benbow 397S substation.

AltaLink Management Ltd. (AltaLink) will prepare a proposal for the required transmission upgrades. This will include an estimate for the transmission capital cost.

The requested completion date for the Benbow 397S transformer replacement is December 1, 2016.

FortisAlberta will not require a capacity increase for the Demand Transmission Service (DTS) contract at the Benbow 397S substation.

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1. Project Description

1.1 Background:

The Benbow 397S substation is located approximately 60 km to the North of the town of Edson. It has one 138.0/24.94 kV 25/33/42 MVA source transformer (T2) supplying three 25 kV distribution feeders and one 138.0/24.94 kV 15/20/25 MVA source transformer (T1) supplying two 25 kV distribution feeders.

In a separate application, FortisAlberta applied to construct the new DeerHill substation to the south of the Benbow 397S substation. This Need for Development application is submitted under the assumption that the DeerHill substation will be approved and put in service in 2016.

The distribution load in this area consists mainly of oil and gas loads. Load growth has generally been similar to the system average of 1.5%. See Figure A-1 in Appendix A and Table 3-1 for an overview of the area substations and distribution facilities. Table 2-1 presents substation and feeder load levels and growth rate information.

Based on the historical load levels, forecast growth and committed load additions for the distribution systems supplied by the area substations, reliability concerns are predicted within the 10 year planning horizon. In 2016, the proposed DeerHill substation and associated distribution upgrades will reduce the potential amount of unsupplied load under an N-1 contingency at the Benbow 397S substation from 17.1 MVA to 9 MVA. The unsupplied load is then predicted to grow to over 13 MVA by 2023 if left unaddressed. This violates FortisAlberta restoration criteria.

1.2 Proposal:

After considering the alternatives to address the existing and predicted reliability concerns, a transmission system upgrade is requested. This involves the replacement of the existing 138/24.94 kV 15/20/25 MVA transformer-regulator pair with one (1) 138/25 kV 25/33/42 MVA LTC transformer at the Benbow 397S substation. This will address the reliability concerns at the Benbow 397S substation.

AltaLink Management Ltd. (AltaLink) will prepare a proposal for the required transmission upgrades. This will include an estimate for the transmission capital cost.

The requested completion date for the Benbow 397S transformer upgrade is December 1, 2016.

FortisAlberta will not require a capacity increase for the DTS contract at the Benbow 397S substation.

2. Criteria and Assumptions

The analysis for the requested development at the Benbow 397S substation has been conducted based upon the following criteria and assumptions.

2.1 Criteria

The maximum normal 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 Assumptions

It is assumed that the Alberta Electric System Operator (AESO) project #1515 (new DeerHill substation) would be in service in 2016 as proposed in a separate NID application.

2.3 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 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 (includes DeerHill substation)

						MVA LOADING - RECORDED					PREDICTED - MVA LOADING										
						2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Fore-cast
SUB No	Feeder	CAPACITY T/R	MVA	Loading	PF	Peak MVA	Peak MVA	Peak MVA	Peak MVA	Peak MVA	Year 1 MVA	Year 2 MVA	Year 3 MVA	Year 4 MVA	Year 5 MVA	Year 6 MVA	Year 7 MVA	Year 8 MVA	Year 9 MVA	Year 10 MVA	Growth
058S	Edson (T1)	T1	25/33/ 42	49%	98%	16.1	18.4	18.1	18.0	16.7	20.46	20.81	21.16	21.52	21.89	22.26	22.64	23.02	23.41	23.81	1.7%
058S	334LW				96%	9.6	10.2	10.6	10.5	11.0	13.39	13.68	13.98	14.29	14.60	14.92	15.25	15.59	15.93	16.28	2.2%
058S	377LE				99%	8.2	8.6	8.9	8.2	8.1	9.09	9.18	9.27	9.36	9.45	9.54	9.64	9.74	9.84	9.94	1.0%
058S	Edson (T2)	T2	25/33/ 42	77%	93%	21.1	22.5	22.9	24.7	24.6	32.17	33.28	30.14	30.53	30.93	31.33	31.74	32.15	32.57	32.99	1.3%
058S	153LW (Load)				89%	9.3	9.8	11.1	12.4	12.9	13.85	14.15	10.01	10.23	10.45	10.68	10.91	11.15	11.39	11.64	2.2%
058S	155LE				97%	8.2	8.2	8.6	8.4	8.7	9.81	10.57	11.34	11.45	11.56	11.68	11.80	11.92	12.04	12.16	1.0%
058S	376LS				85%	5.6	5.8	5.5	5.5	6.1	12.54	12.60	12.66	12.72	12.78	12.84	12.90	12.96	13.02	13.09	0.5%
058S	Total Station	Coincident peaks			92%	29.2	37.2	38.6	35.3	39.9	46.84	48.14	45.66	46.32	47.01	47.70	48.40	49.10	49.82	50.55	
207S	Pinedale	T1	15/20/ 25	92%	95%	18.1	17.4	16.9	17.7	16.8	22.92	23.03	23.15	23.27	23.39	23.51	23.63	23.75	23.87	23.99	0.5%
207S	2247L (155L)		LTC		93%	8.0	7.8	8.2	8.1	8.4	11.11	11.17	11.23	11.29	11.35	11.41	11.47	11.53	11.59	11.65	0.5%
207S	2228L (369L)				97%	10.4	10.4	9.6	9.9	9.3	12.52	12.58	12.64	12.70	12.76	12.82	12.88	12.94	13.00	13.07	0.5%
NEW	Deer Hill	T1	25/33/ 42	0%	90%						0.00	0.00	12.89	13.02	13.15	13.28	13.41	13.54	13.68	13.82	1.0%
NEW	4010L				90%						0.00	0.00	5.00	5.05	5.10	5.15	5.20	5.25	5.30	5.35	1.0%
NEW	5200L				90%						0.00	0.00	6.33	6.39	6.45	6.51	6.58	6.65	6.72	6.79	1.0%
NEW	6003L				90%						0.00	0.00	1.60	1.62	1.64	1.66	1.68	1.70	1.72	1.74	1.0%
397S	Benbow	T1	15/20/ 25	87%																	
397S		VR1	15/20/ 25	87%	95%					9.3	20.04	20.26	20.48	20.71	20.94	21.17	21.40	21.64	21.88	22.12	1.1%
397S	2045L				99%					1.1	9.65	9.80	9.96	10.12	10.28	10.44	10.61	10.78	10.95	11.13	1.6%
397S	220LN				94%					8.4	12.12	12.19	12.26	12.33	12.40	12.47	12.54	12.62	12.70	12.78	0.6%
397S	Benbow	T2	25/33/ 42	52%	88%	27.3	29.3	27.7	28.0	20.0	21.84	22.28	14.79	15.09	15.39	15.70	16.01	16.33	16.66	16.99	2.0%
397S	2045L				99%	12.4	9.8	12.4	12.1												
397S	220LN				94%	7.2	7.4	6.9	6.8												
397S	2114L				89%	4.3	6.1	6.7	6.9	14.2	8.03	8.19	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	2.0%
397S	4150L				90%					0.0	9.08	9.26	9.45	9.64	9.83	10.03	10.23	10.43	10.64	10.85	2.0%
397S	2198L				88%	4.8	6.8	6.4	6.1	6.1	6.59	6.72	6.85	6.99	7.13	7.27	7.42	7.57	7.72	7.87	2.0%
397S	Total Station				91%	27.3	29.3	27.7	28.0	28.9	41.46	42.11	34.92	35.44	35.97	36.50	37.04	37.59	38.15	38.72	
406S	Fickle Lake	T1	15/20/ 25.0	46%	97%	7.8	7.6	8.6	8.4	9.2	11.55	11.78	12.02	12.26	12.51	12.76	13.02	13.28	13.55	13.83	2.0%
406S	153L				97%	7.8	7.6	8.6	8.4	9.2	11.55	11.78	12.02	12.26	12.51	12.76	13.02	13.28	13.55	13.83	2.0%

Total Area Load:	82.4	91.5	91.8	89.4	94.8	122.77	125.06	128.64	130.31	132.03	133.75	135.50	137.26	139.07	140.91
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2014 Add 2.7 MVA to 397S-334LW
2014 Add 1.1 MVA to 397S-155LE
2014 Add 6.3 MVA to 397S-376LS
2014 Add 2.5 MVA to 207S-2247L
2014 Add 3.0 MVA to 207S-2228L
2014 Switch 397S-2045L to final configuration
2014 Add 3.7 MVA to 397S-220LN
2014 Switch 397S-2114L to final configuration
2014 Add 9.1 MVA to 397-4150L
2014 Add 2.3 MVA to 406S-153L

397S	Total Load	41.46	42.11	34.92	35.44	35.97	36.50	37.04	37.59	38.15	38.72
	N-1 Capacity	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
	Backup from Deer Hill	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N-1 Unsupplied Load	16.46	17.11	9.92	10.44	10.97	11.50	12.04	12.59	13.15	13.72

2016 Transfer 5 MVA from 397S2114L and 58S153L to DeerHill-4010L
2016 Transfer 6.41 MVA from 397S2114L and 58S153L to DeerHill-5200L
2016 Transfer 1.613 MVA from 58S153L to new DeerHill-6003L

3. Existing System Assessment

The existing distribution systems in the Benbow area are shown in Figure A-1 in Appendix A and Table 3-1 provides an overview of the existing and future facilities and capacities for the area substations.

Table 3-1: Overview of Existing and Future Substation Facilities

Substation	Edson 58S	Pinedale 207S	Benbow 397S	Fickle Lake 406S	DeerHill (in 2016)
Transformation Installed Capacity	T1 138.0/24.94 kV 25/33/42 MVA LTC T2 138.0/24.94 kV 25/33/42 MVA LTC	T1 138.0/26.5 kV 15/20/25 MVA LTC	T1 138.0/24.94 kV 15/20/25 MVA transformer-regulator pair T2 138.0/24.94 kV 25/33/42 MVA LTC	T1 138.0/26.5 kV 15/20/25 MVA LTC	T1 138/25 kV 25/33/42 MVA LTC
Peak Station Load (2013/14 winter peak)	39.9 MVA	16.8 MVA	28.9 MVA	9.2 MVA	12.9 MVA (in 2016)
Available Capacity (N-0)	82.0 MVA	25.0 MVA	67.0 MVA	25.0 MVA	42 MVA
Firm Transformation Capacity (N-1)	42.0 MVA	0	25.0 MVA	0	0
25 kV Feeders	334LW 377LE 153LW 155LE 376LS	2247L 2228L	2045L 220LN 2114L 4150L 2198L	153L	4010L 5200L 6003L

Over the next ten years, the following 25 kV feeders are predicted to carry load levels in excess of the normal feeder load maximum: 58S-334LW and 58S-376LS.

The amount of unsupplied load under N-1 contingency exceeds restoration criteria at the Benbow 397S substation.

4. Alternatives Analysis

The following alternatives were considered:

Alternative 1	Load Shifting and Distribution Upgrades
Alternative 2	Upgrades at the Benbow 397S Substation

4.1 Alternative 1: Load Shifting and Distribution Upgrades

4.1.1 Description

The proposed DeerHill substation would be the closest to the Benbow 397S substation. The distance via roads between the DeerHill and Benbow 397 substations is approximately 47 km. This distance limits the amount of load that can be transferred via the distribution system between these substations under contingency situations. Load shifting on the distribution system that would exist upon the completion of the DeerHill substation cannot mitigate the N-1 unsupplied load at Benbow 397S.

Upgrading approximately 30 km of the proposed DeerHill-4010L feeder, which would connect DeerHill and Benbow substation, to 477 ACSR was investigated to mitigate the unsupplied load at the Benbow 397S substation. This solution would provide full back-up to the 397S-2114L and 397S-2198L feeders, but it would not provide back-up to the 397S-4150L feeder due to even greater distances between the DeerHill substation and the loads served by the 397S-4150L feeder. If this alternative would be implemented, there would be approximately 2.5 MVA of unsupplied load at the Benbow 397S substation in 2016, and the unsupplied load would be projected to grow to over 6.4 MVA by 2023. Additional distribution upgrades would make this alternative the most expensive, compared to other available alternatives, and were not investigated any further.

As a result of this, the load forecast and costs for these alternatives have not been included in this document.

4.2 Alternative 2: Upgrades at the Benbow 397S Substation

4.2.1 Description

At the Benbow 397S substation:

- **Replace the existing 138.0/24.94 kV 15/20/25 MVA transformer-regulator pair with one (1) 138/25 kV 25/33/42 MVA LTC transformer**

This alternative would resolve the unsupplied load at the Benbow 397S substation. Appendix A-2 shows the single line diagram of the system after the upgrade.

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

Transmission facilities must be equipped with the appropriate equipment for interconnection with FortisAlberta's Automated Metering system. Provisions should be made for interconnecting the substation transformer neutrals with the distribution line neutrals as per the transmission facility owner standard.

All 138 kV and 25 kV buses shall have adequate protection to minimize frequency and duration of outages associated with the failure of substation components upstream of the 25 kV bus.

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 Benbow 397S

					MVA LOADING - RECORDED					PREDICTED - MVA LOADING											
SUB	Feeder	CAPACITY			PF	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Forecast
No		T/R	MVA	Loading		Peak	Peak	Peak	Peak	Peak	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Growth
058S	Edson (T1)	T1	25/33/ 42	49%	98%	16.1	18.4	18.1	18.0	16.7	20.46	20.81	21.16	21.52	21.89	22.26	22.64	23.02	23.41	23.81	1.7%
058S	334LW				96%	9.6	10.2	10.6	10.5	11.0	13.39	13.68	13.98	14.29	14.60	14.92	15.25	15.59	15.93	16.28	2.2%
058S	377LE				99%	8.2	8.6	8.9	8.2	8.1	9.09	9.18	9.27	9.36	9.45	9.54	9.64	9.74	9.84	9.94	1.0%
058S	Edson (T2)	T2	25/33/ 42	77%	93%	21.1	22.5	22.9	24.7	24.6	32.17	33.28	30.14	30.53	30.93	31.33	31.74	32.15	32.57	32.99	1.3%
058S	153LW (Load)				89%	9.3	9.8	11.1	12.4	12.9	13.85	14.15	10.01	10.23	10.45	10.68	10.91	11.15	11.39	11.64	2.2%
058S	155LE				97%	8.2	8.2	8.6	8.4	8.7	9.81	10.57	11.34	11.45	11.56	11.68	11.80	11.92	12.04	12.16	1.0%
058S	376LS				85%	5.6	5.8	5.5	5.5	6.1	12.54	12.60	12.66	12.72	12.78	12.84	12.90	12.96	13.02	13.09	0.5%
058S	Total Station	Coincident peaks			92%	29.2	37.2	38.6	35.3	39.9	46.84	48.14	45.66	46.32	47.01	47.70	48.40	49.10	49.82	50.55	
207S	Pinedale	T1	15/20/ 25	92%	95%	18.1	17.4	16.9	17.7	16.8	22.92	23.03	23.15	23.27	23.39	23.51	23.63	23.75	23.87	23.99	0.5%
207S	2247L (155L)			LTC	93%	8.0	7.8	8.2	8.1	8.4	11.11	11.17	11.23	11.29	11.35	11.41	11.47	11.53	11.59	11.65	0.5%
207S	2228L (369L)				97%	10.4	10.4	9.6	9.9	9.3	12.52	12.58	12.64	12.70	12.76	12.82	12.88	12.94	13.00	13.07	0.5%
NEW	Deer Hill	T1	25/33/ 42	0%	90%						0.00	0.00	12.89	13.02	13.15	13.28	13.41	13.54	13.68	13.82	1.0%
NEW	4010L				90%						0.00	0.00	5.00	5.05	5.10	5.15	5.20	5.25	5.30	5.35	1.0%
NEW	5200L				90%						0.00	0.00	6.33	6.39	6.45	6.51	6.58	6.65	6.72	6.79	1.0%
NEW	6003L				90%						0.00	0.00	1.60	1.62	1.64	1.66	1.68	1.70	1.72	1.74	1.0%
397S	Benbow	T1	15/20/ 25	80%	95%					9.3	20.04	20.26									1.1%
397S		VR1	15/20/ 25	80%	95%																
397S		T1 (2016)	25/33/ 42	48%	95%																
397S	2045L				99%					1.1	9.65	9.80	9.96	10.12	10.28	10.44	10.61	10.78	10.95	11.13	1.6%
397S	220LN				94%					8.4	12.12	12.19	12.26	12.33	12.40	12.47	12.54	12.62	12.70	12.78	0.6%
397S	Benbow	T2	25/33/ 42	52%	88%	27.3	29.3	27.7	28.0	20.0	21.84	22.28	14.79	15.09	15.39	15.70	16.01	16.33	16.66	16.99	2.0%
397S	2045L				99%	12.4	9.8	12.4	12.1												
397S	220LN				94%	7.2	7.4	6.9	6.8												
397S	2114L				89%	4.3	6.1	6.7	6.9	14.2	8.03	8.19	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	2.0%
397S	4150L				90%					0.0	9.08	9.26	9.45	9.64	9.83	10.03	10.23	10.43	10.64	10.85	2.0%
397S	2198L				88%	4.8	6.8	6.4	6.1	6.1	6.59	6.72	6.85	6.99	7.13	7.27	7.42	7.57	7.72	7.87	2.0%
397S	Total Station				91%	27.3	29.3	27.7	28.0	28.9	41.46	42.11	34.92	35.44	35.97	36.50	37.04	37.59	38.15	38.72	
406S	Fickle Lake	T1	15/20/ 25.0	46%	97%	7.8	7.6	8.6	8.4	9.2	11.55	11.78	12.02	12.26	12.51	12.76	13.02	13.28	13.55	13.83	2.0%
406S	153L				97%	7.8	7.6	8.6	8.4	9.2	11.55	11.78	12.02	12.26	12.51	12.76	13.02	13.28	13.55	13.83	2.0%

Total Area Load:	82.4	91.5	91.8	89.4	94.8	122.77	125.06	128.64	130.31	132.03	133.75	135.50	137.26	139.07	140.91
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2014 Add 2.7 MVA to 397S-334LW
2014 Add 1.1 MVA to 397S-155LE
2014 Add 6.3 MVA to 397S-376LS
2014 Add 2.5 MVA to 207S-2247L
2014 Add 3.0 MVA to 207S-2228L
2014 Switch 397S-2045L to final configuration
2014 Add 3.7 MVA to 397S-220LN
2014 Switch 397S-2114L to final configuration
2014 Add 9.1 MVA to 397-4150L
2014 Add 2.3 MVA to 406S-153L

397S	Total Load	41.46	42.11	34.92	35.44	35.97	36.50	37.04	37.59	38.15	38.72
	N-1 Capacity	25.00	25.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00
	Backup from Deer Hill	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N-1 Unsupplied Load	16.46	17.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2016 Upgrade 397S T1 transformer to 42 MVA
2016 Transfer 5 MVA from 397S2114L and 58S153L to DeerHill-4010L
2016 Transfer 6.41 MVA from 397S2114L and 58S153L to DeerHill-5200L
2016 Transfer 1.613 MVA from 58S153L to new DeerHill-6003L

-Capacity concerns for the distribution system supplied by the Edson and Fickle Lake substations will be addressed by future distribution upgrades and/or transmission upgrades applications

4.2.3 Cost Estimate

The estimated transmission capital cost for Alternative 2 will be provided by AltaLink.

5. Alternatives Assessment

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

5.1 Technical Analysis

5.1.1 Alternative 1 – Load Shifting and Distribution Upgrades

As discussed in the Alternatives Analysis section above, the distribution system that would exist after the construction of the DeerHill substation is not robust enough to support the required load transfers. Upgrades to the distribution system were investigated and were found incapable to fully resolve the unsupplied load at the Benbow 397S substation. Therefore, these alternatives are not acceptable.

5.1.2 Alternative 2 – Upgrades at the Benbow 397S Substation

Upgrading the 25.0 MVA transformer-regulator pair at the Benbow 397S substation will resolve the reliability concerns in the Benbow area. This is the preferred technical solution because it enables FortisAlberta to provide reliable distribution service to the existing and future customers in the Benbow area.

This alternative is acceptable.

6. Conclusion/Recommendations

After considering the alternatives to address the existing reliability concern for distribution service in the Benbow area, Alternative 2 is preferred. Alternative 2 involves the replacement of the existing 138/24.94 kV 15/20/25 MVA transformer-regulator pair with a 138/25 kV 25/33/42 MVA LTC transformer at the Benbow 397S substation.

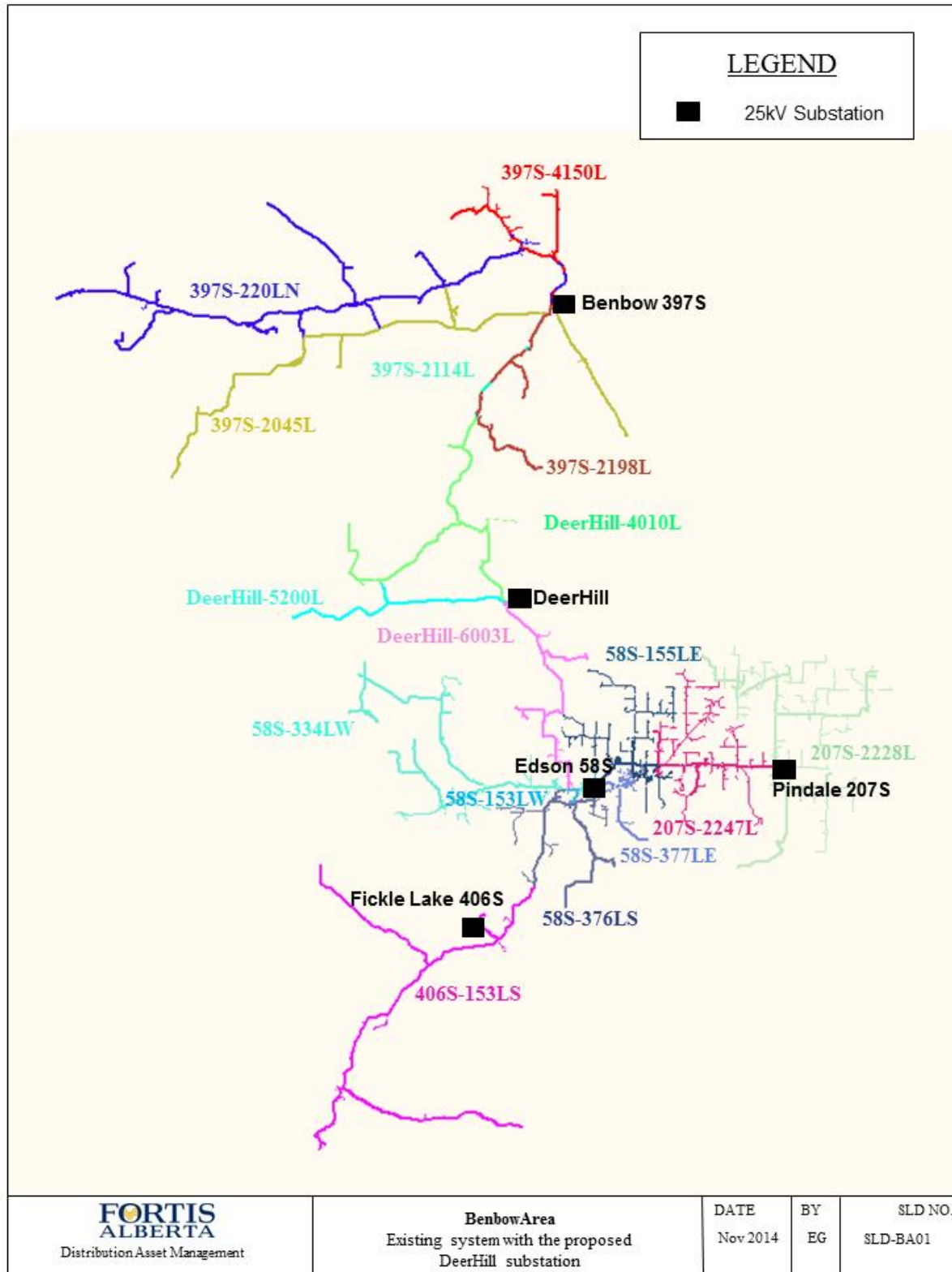
An estimate for the transmission system capital cost will be provided by AltaLink.

The requested completion date for the Benbow 397S transformer upgrade is December 1, 2016.

FortisAlberta will not require a capacity increase for the DTS contract at the Benbow 397S substation.

Appendix A – Existing System

Figure A-1: Existing System



Appendix A – Preferred Alternative

Figure A-2: Preferred Alternative

