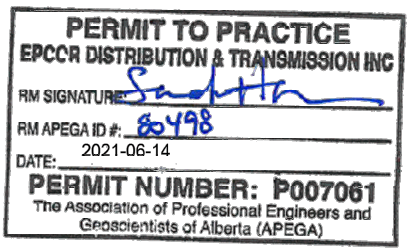
APPENDIX D Distribution Deficiency Report

EPCOR DISTRIBUTION & TRANSMISSION INC.

Distribution Deficiency Report (DDR) for Air Products

Revision 0

Company	Role	Name	Signature
EDTI	Prepared	Gene Liu, P. Eng.	 2021-06-14
EDTI	Approved	Sarah Hanson, P.Eng.	

Abbreviations

AESO: Alberta Electric System Operator

AUC: Alberta Utilities Commission

EDTI: EPCOR Distribution & Transmission Inc.

DDR: Distribution Deficiency Report

ISD: In Service Date

N-0: All elements in service (normal state)

N-1: Failure of a single element (emergency state)

PF: Power factor = MW/MVA

POD: Point of Delivery

SASR: System Access Service Request

TUC: Transportation/Utility Corridor

1.0 EXECUTIVE SUMMARY

EPCOR Distribution & Transmission Inc. (EDTI) is requesting system access service from the Alberta Electric System Operator (AESO) to address capacity and reliability concerns in North East Edmonton, specifically the Clover Bar substation due to the connection of a large industrial customer (Edmonton 3 H2 Plant) to the Alberta Interconnected Electric System (AIES) within the Edmonton city limits north of Sherwood Park.

The plant load is approximately 80 MW with a co-generation facility of approximately 100 MW, including several large motors (up to 25,000 HP). This Plant will require 40 MW of load service in the event of a co-gen shut down and would normally operate in the export mode varying from 5 to 20 MW based on seasonal conditions.

EDTI forecasts that under existing growth rates (not considering the new connection), there will be insufficient distribution capacity on the Clover Bar 25 kV distribution circuits by 2025 and at the substation level by summer of 2044. This is based upon EDTI's planning criteria for circuit and substation loading which states:

1. All 25 kV distribution circuits should operate at or below a design load rating of 12 MVA under N-0.
2. All 25 kV distribution circuits should operate at or below an emergency load rating of 18 MVA under N-1.
3. Circuit lengths should not impose any technical challenges on the distribution system.
4. A substation's firm supply capability is the maximum load a substation can supply without overloading any transmission equipment under an N-1 contingency. N-1 contingencies include but are not limited to:
   - Loss of a single transmission line supply to a substation
   - Loss of a single transformer at a substation

The existing distribution circuits, 12C and 13C are located north and south of the proposed development, are not suitable to service the new load given the above criteria.

In order to supply the Customer's Connection request in the Clover Bar area, the following alternatives were considered:

Distribution supply solutions

1. Using existing distribution circuits

Transmission supply solutions

2. New 25 kV supply from existing Clover Bar (987S) substation, which would include one new 240/25 kV transformer and two new 25 kV distribution circuits in 2023.
3. New 138 kV supply from 700L, which would include four new 138/13.8 kV transformers in 2023.
4. New 240 kV supply from 921L, which would include four new 240/13.8 kV transformers in 2023.

After reviewing these alternatives, EDTI does not currently have a preferred alternative. Additional power system studies, feasibility assessments and estimating are required to identify a preferred alternative. EDTI are submitting a connection project SASR to the AESO and will work with the AESO through the connection process to evaluated alternatives and identify a preferred alternative. . The ISD for the proposed development is September, 2023. EDTI will be requesting a DTS contract capacity of 40 MW for the new development.

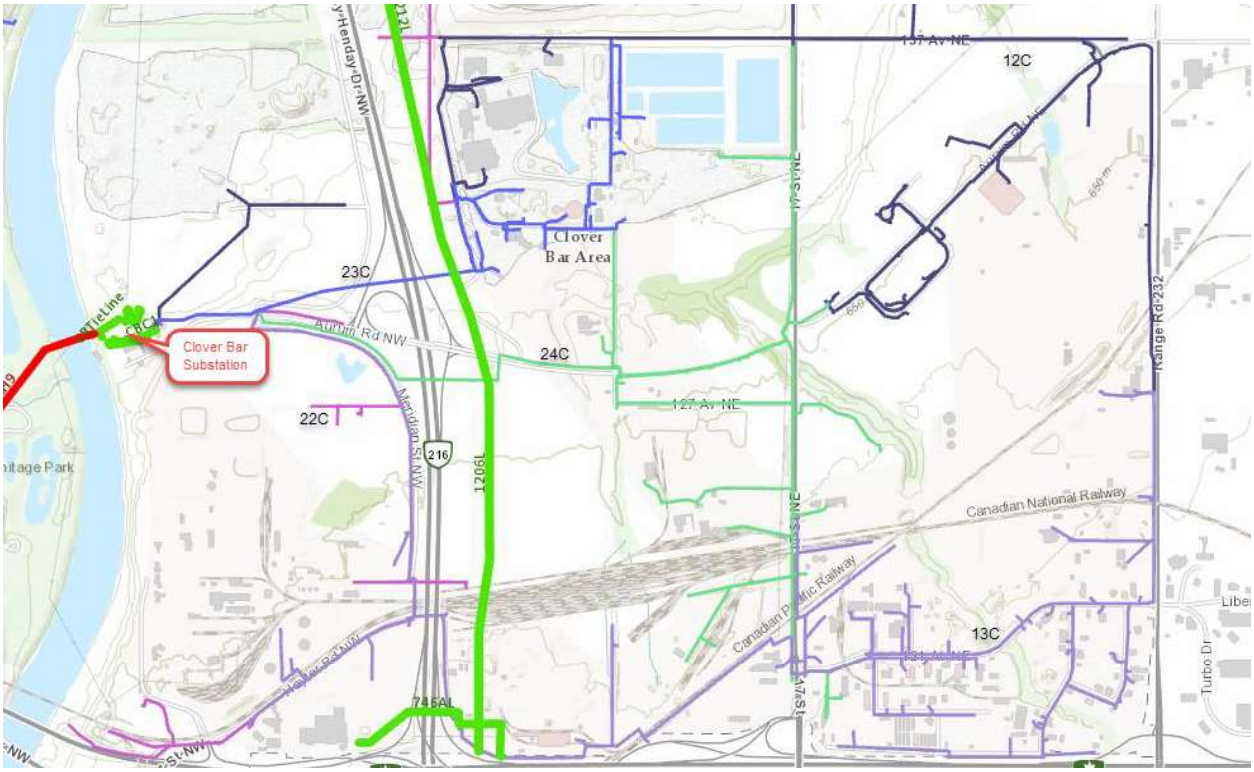
2.0 EXISTING SYSTEM DESRIPTION

The geographic study area discussed in this Distribution Deficiency Report (DDR) is depicted in Figure 2.1-1 on the following page.

2.1 Clover Bar Study Area

The Clover Bar study area is restricted to 12C, 13C, 22C, 23C, and 24C because they are the closest circuits to the Point of Connection (PoC) in Clover Bar.

Figure 2.1-1
Clover Bar Study Area



The Clover Bar area is one of the fastest growing areas in Edmonton with forecasted 3.5% compound annual load growth rate. Growth is expected to result in new demand for electricity from new residential, commercial, and large industrial customers in the area. This area is currently served by 25 kV distribution circuits 12C, 13C, 22C, 23C and 24C from the Clover Bar substation. EDTI planning criteria states that all 25 kV distribution circuits should operate at or below the design load rating of 12 MVA. The design load rating is the maximum load that EDTI plans to operate a circuit under normal operating conditions (N-0). This provides the circuit with some reserve capacity to pick up load from other circuits in outage contingency situations without overloading the circuit. The historical and forecasted winter peak load for Clover Bar circuits are shown in Table 2.1-1.

Table 2.1-1
Clover Bar Circuits 12C, 13C, 22C, 23C and 24C Historical & Forecast Winter Peak Loads (MVA)

CCTNAME	2015A	2016A	2017A	2018A	2019A	2020F	2021F	2022F	2023F	2024F	2025F	2026F	2027F	2028F	2029F
12C	0.0	0.0	6.4	7.5	6.8	7.7	8.6	9.5	10.5	11.4	**12.3**	**13.2**	**14.1**	**15.1**	**15.9**
13C	10.5	0.0	6.0	6.9	7.0	7.2	7.4	7.5	7.7	7.8	8.0	8.1	8.3	8.4	8.6
14C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22C	7.0	0.0	4.6	6.4	6.4	6.6	6.7	6.9	7.1	7.2	7.4	7.5	7.7	7.8	8.0
23C	3.8	0.0	9.1	7.1	10.6	10.8	10.9	11.1	11.2	11.4	11.5	11.7	11.8	12.0	**12.1**
24C	0.0	0.0	0.0	5.6	5.6	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.8	7.0	7.1

Notes:

1. **Red** indicates load is above the 12 MVA circuit design load rating.

As Table 2.1-1 demonstrates, Circuit 12C is forecasted to exceed its design load rating of 12 MVA by winter of 2025. Moreover, the addition of 40 MW of load will exceed the design load rating of 12 MVA, and will require new dedicated feeders from 987S to the proposed development.

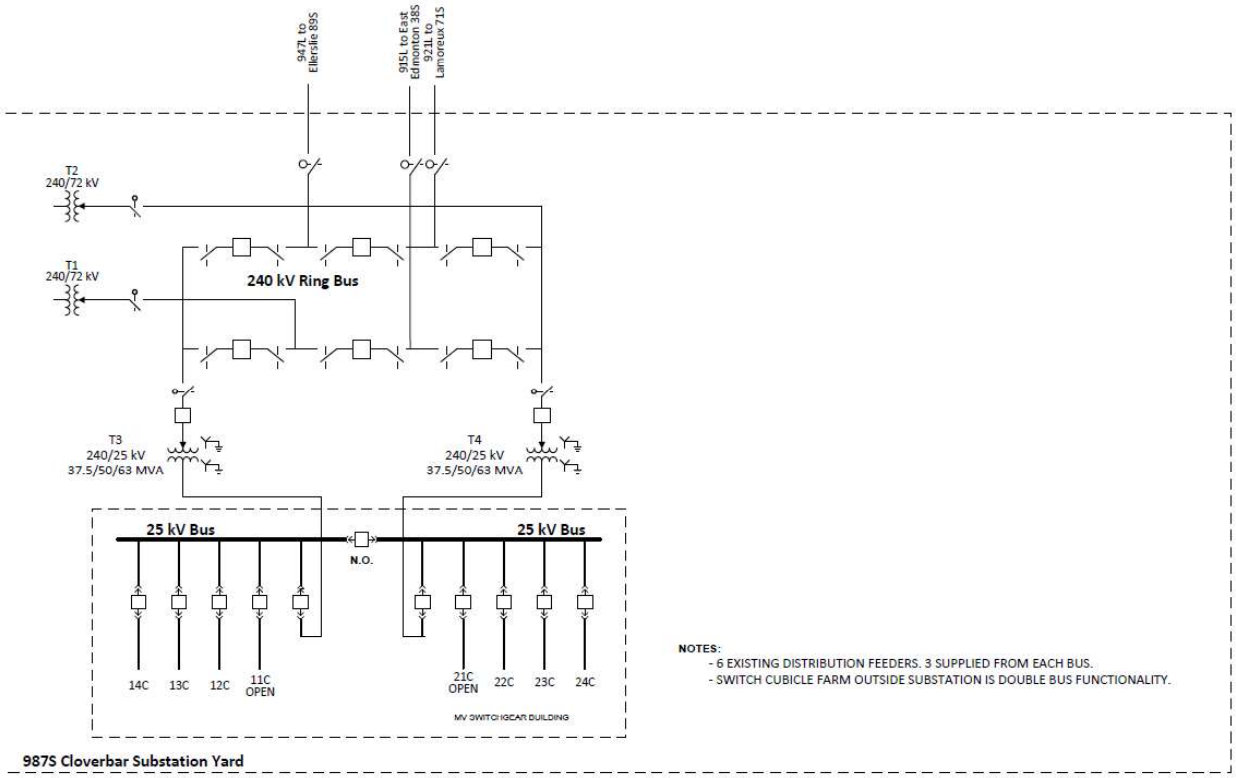
EDTI's transmission planning criteria is to limit the load at a substation to a level at or below the substation's firm supply capability. EDTI defines a substation's firm supply capability as the maximum load a substation can supply without overloading any transmission equipment under an N-1 contingency. N-1 contingencies include but are not limited to:

- Loss of a transmission line supply to a substation
- Loss of a transformer at a substation

Clover Bar substation has two 37.5/50/63 MVA transformers. The nameplate rating at 0 degrees C is 46.8/74.3 MVA. The firm supply capability for Clover Bar substation is then 63 MVA in the summer and 74 MVA in the winter for the loss of one transformer.

2.2 Existing Clover Bar Configuration

Figure 2.2-1
Clover Bar Single Line Diagram



2.2.1 Forecast Summary

Clover Bar Substation

By the winter of 2025, one circuit is forecasted to exceed its 12 MVA design load rating increasing to two circuits exceeding their 12 MVA design load rating by the winter of 2029. Clover Bar substation is not forecasted to exceed its N-1 transformer supply capability within the ten-year time period.

3.0 ALTERNATIVES

The following alternatives were considered to address the deficiencies identified above:

Alternative 1: Distribution Solution
Alternative 2: New 25 kV supply from existing Clover Bar (987S) substation, which would include one new 240/25 kV transformer and two new dedicated 25 kV distribution circuits in 2023.
Alternative 3: New 138 kV supply from 700L, which would include four new 138/13.8 kV transformers in 2023.
Alternative 4: New 240 kV supply from 921L, which would include four new 240/13.8 kV transformers in 2023.

3.1 Alternative 1: Distribution Solution

There is insufficient N-1 transformation at Clover Bar for the addition of the requested 40MW load. This alternative is not viable.

3.2 Alternative 2: New 25 kV supply from existing Clover Bar (987S) substation

Under this alternative, EDTI would create new 25kV supply from the existing Clover Bar substation. This new supply would include one 240/25 kV transformer, and two dedicated distribution circuits that would be in-service in 2023.

This alternative requires long distribution circuits in the order of approximately 6 km each to be constructed due to the distance of the customer site from the Clover Bar substation. Table 3.2-1 summarizes the transmission and distribution requirements and concerns for this alternative. The list of facilities was completed in consultation with EDTI TFO.

Figure 3.2-1
Alternative 2 Single Line Diagram

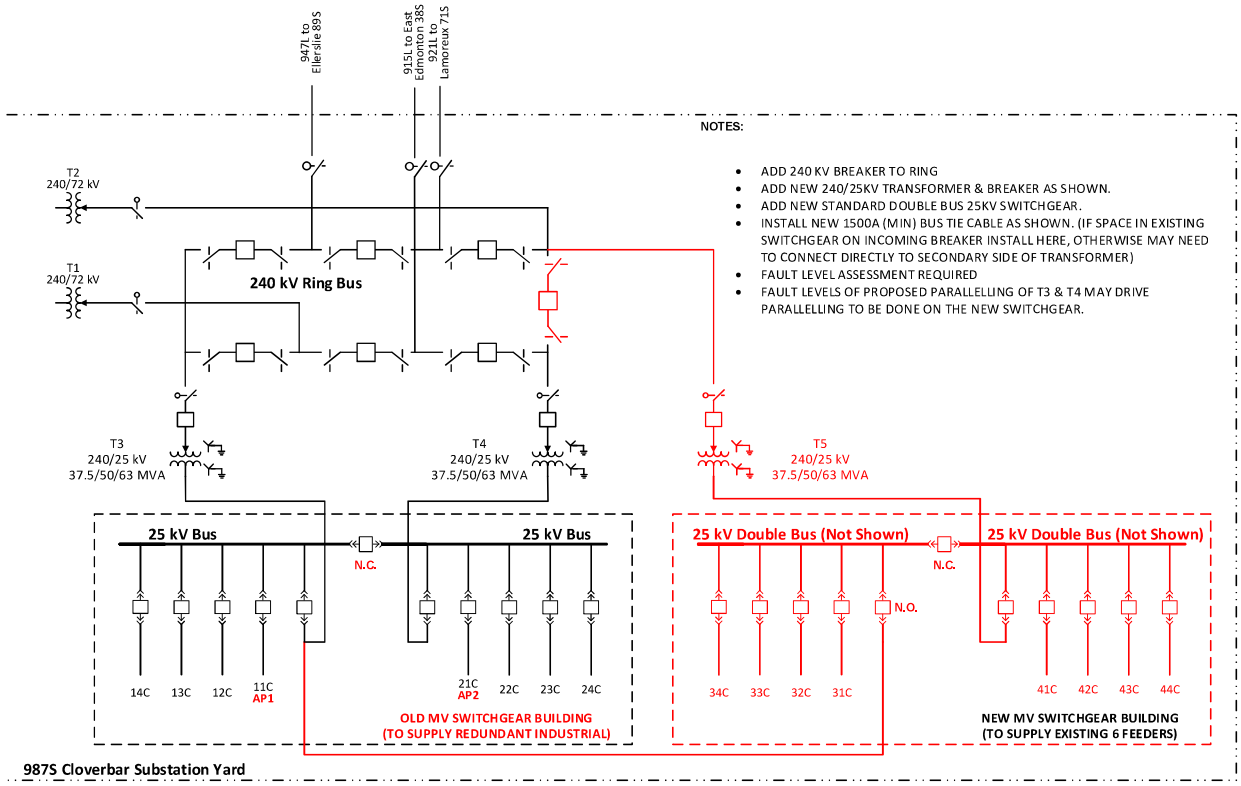


Table 3.2-1

Alternative 2 - Summary of Transmission and Distribution Requirements and Concerns

Alternative #2: New 25 kV Supply	
Transmission	
Transformers	
Description	**Number**
37.5/50/63 MVA 240/25 kV LTC transformer	1
Transmission lines	
Description	**Length (km)**
N/A	0
Breakers	
Description	**Number**
240 kV bus-tie breaker	1
240 kV transformer breaker	1
25 kV transformer breaker	2
25 kV feeder breaker	8
25 kV bus-tie breaker	2
25 kV substation breakers	6
Distribution	
Circuits	
Number & Description	**Total Length (km)**
Two underground 25 kV circuits	6
Operational/construction/other limitations	
1. Additional land may be required for substation extension. It is not likely that EPCOR would be able to secure the necessary land at a reasonable cost. 2. A new 25 kV medium voltage switchgear building is required. 3. Construction feasibility is uncertain: finding alignments for 2 new circuits running through a utility congested area with multiple pipeline crossings would be extremely challenging and costly.	

3.3 Alternative 3: New 138 kV Supply from 700L

700L is a 138 kV line between 746L and 746S Sherwood Park. Under this alternative, four new 138/25 kV transformers would need to be installed as well as breaker additions to the 138 kV bus. This alternative requires transmission circuit(s) in the order of 3 km to be constructed due to the distance from 700L.

Figure 3.3-1
Alternative 3 Single Line Diagram

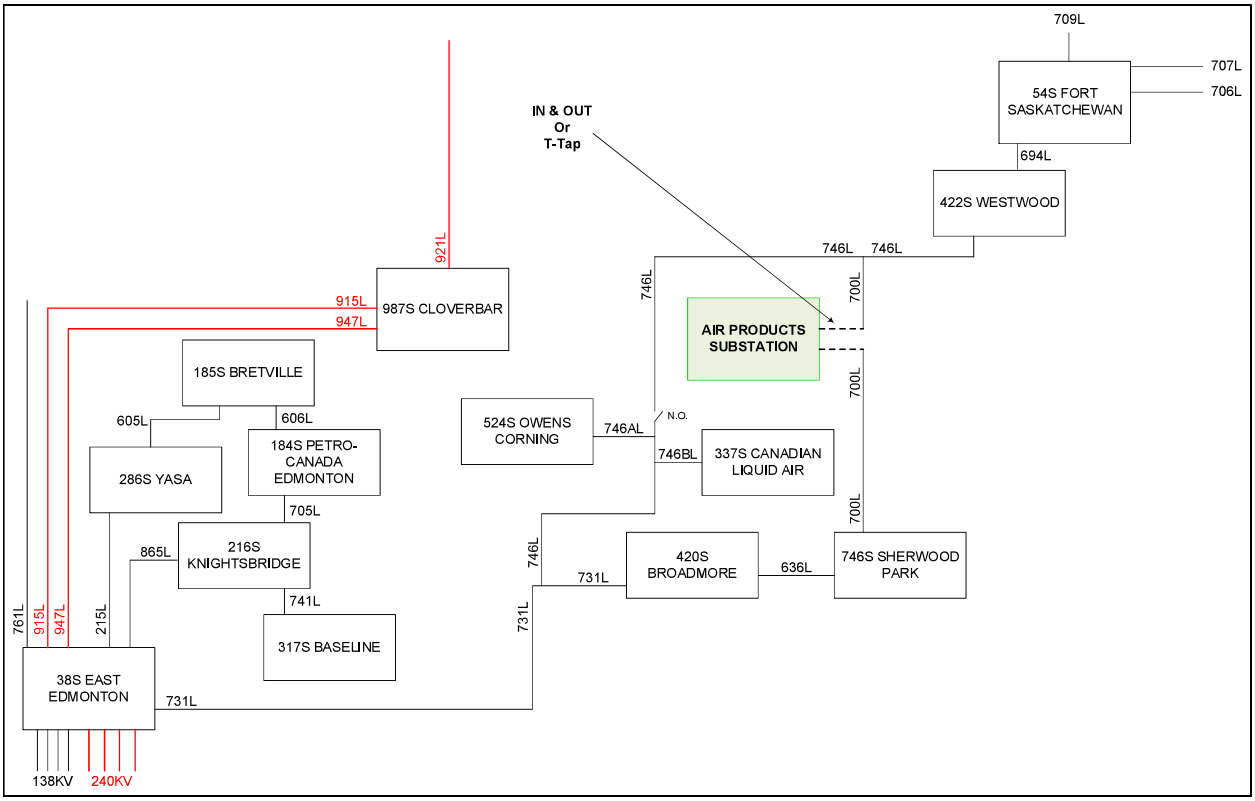


Table 3.3-1 summarizes the transmission and distribution requirements and concerns for this alternative. The list of facilities was completed in consultation with EDTI TFO.

Table 3.3-1
Alternative 3 - Summary of Transmission Requirements and Concerns

Alternative #3: 700L 138 kV Supply	
Transmission	
Transformers	
Description	***Number***
70 MVA 138/13.8 kV LTC transformer	2
50 MVA 138/13.8 kV LTC transformer	1
25 MVA 138/13.8 kV LTC transformer	1
Transmission lines	
Description	***Length (km)***
Double or Single circuit 138 kV line	3
Breakers	
Description	***Number***
138 kV bus-tie breaker	1
138 kV line breaker	2
138 kV transformer breaker	4
Distribution	
Circuits	
Number & Description	***Total Length (km)***
N/A	0
Operational/construction/other limitations	

3.4 Alternative 4: New 240 kV supply from 921L

921L is a 240 kV line between 71S Lamoureux and 987S Clover Bar. Under this alternative, four new 240/25 kV transformers would need to be installed as well as breaker additions to the 240 kV bus. This alternative requires transmission circuit(s) in the order of 5 km each to be constructed due to the distance from 921L.

Figure 3.3-1
Alternative 3 Single Line Diagram

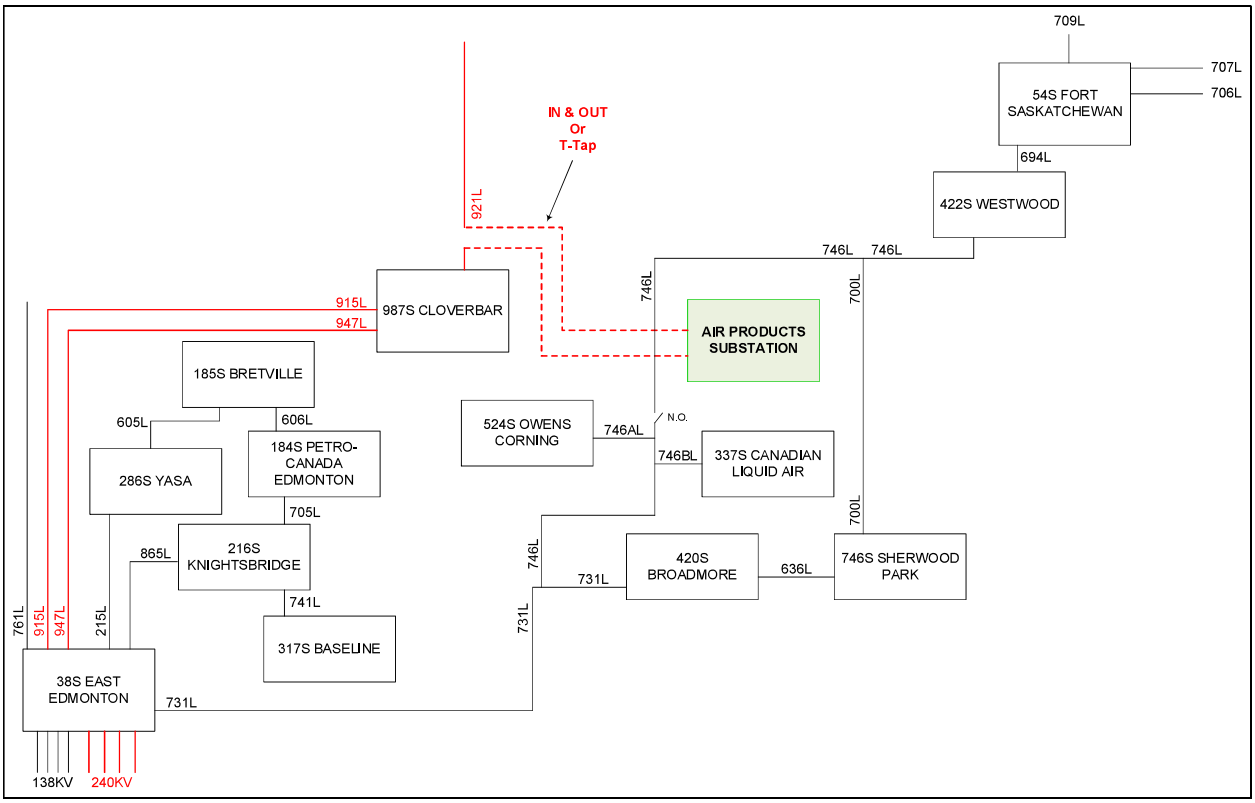


Table 3.4-1 summarizes the transmission and distribution requirements and concerns for this alternative. The list of facilities was completed in consultation with EDTI TFO.

Table 3.4-1

Alternative 4 - Summary of Transmission and Distribution Requirements and Concerns

Alternative #4: 921L 240 kV Supply	
Transmission	
Transformers	
Description	***Number***
70 MVA 240/13.8 kV LTC transformer	2
50 MVA 240/13.8 kV LTC transformer	1
25 MVA 240/13.8 kV LTC transformer	1
Transmission lines	
Description	***Length (km)***
Double or Single circuit 240 kV line	5
Breakers	
Description	***Number***
240 kV bus-tie breaker	1
240 kV line breaker	2
240 kV transformer breaker	4
Distribution	
Circuits	
Number & Description	***Total Length (km)***
N/A	0
Operational/construction/other limitations	
1. 500kV Crossing and urban routing constraints for new transmission line.	

4.0 ALTERNATIVE ANALYSIS

The following section presents the technical, land impact and environmental analysis for the alternatives considered in this Distribution Deficiency Report.

4.1 Technical, Land Impact, and Environmental Analysis

4.1.1 Alternative 1: Distribution Solution

There is insufficient N-1 transformation at Clover Bar for the addition of the requested 40MW load. The proposed development area is presently supplied from 25 kV circuits the Clover Bar substation. Specifically, the circuits are 12C and 13C out of Clover Bar. The existing circuits do not have available capacity to meet the requested DTS of 40 MW.

4.1.2 Alternative 2: New 25 kV Supply from existing Clover Bar (987S) substation

The area surrounding Clover Bar substation to the Northeast is highly congested with high pressure pipelines. This makes it very difficult to find routes for distribution circuits to egress out of this substation. EDTI estimates distribution circuits for Alternative 2 would be 1 km longer than the transmission circuits required for Alternative 4.

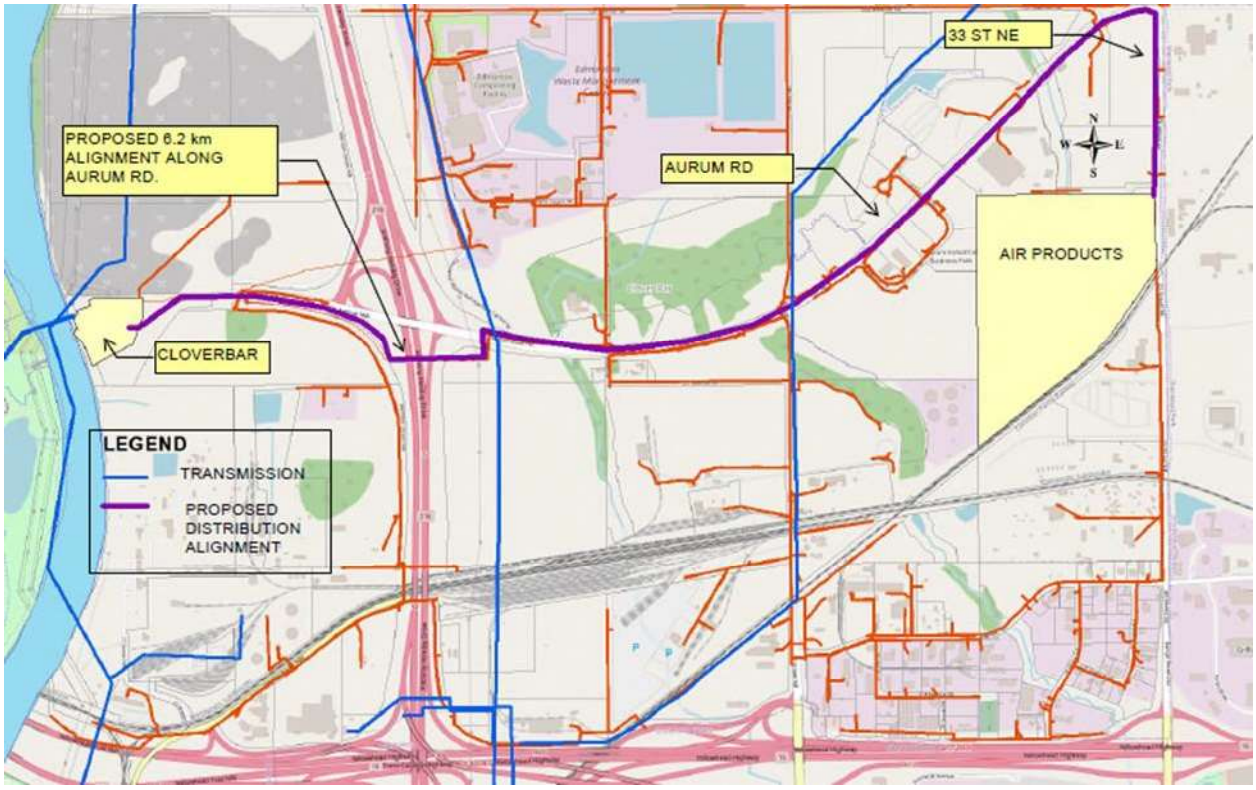
There are environmental and potential stakeholder concerns with this alternative:

- Crossing of the Anthony Henday highway will be required
- Crossing the Heartland 500 kV will be required.
- An alignment down Aurum Road may require crossing a deep and narrow ravine.

This alternative presents the highest reliability option with parallel substation transformers, bus and feeders dedicated to the customer. This option may have issues with the large motor starting required for the facility.

Significant upgrades to Clover Bar are required, and space limitations in the existing site will drive costs higher than a greenfield option.

Figure 4.1.2
Distribution Solution



4.1.3 Alternative 3: New 138 kV Supply from 700L

The 138 kV system surrounding the proposed development area is highly congested with five existing industrial customers already connected and may not have the existing capacity for the requested DTS for the proposed development. System upgrades to the 138 kV system may be required to support the proposed development if identified.

This alternative presents lower reliability with the primary source of grid supply being the 3 km double circuit line.

This alternative has the closest grid point of connection, and may have a lower overall public impact with less infrastructure required to connect to the grid.

4.1.4 Alternative 4: New 240 kV Supply from 921L

The 240 kV system surrounding the proposed development area has a higher degree of strength than the 138 kV system, and would have to satisfy the higher design criteria required for 240 kV transmission.

The new 240 kV double circuit (or single circuit if a tap connection is selected) will have to cross the Anthony Henday and Heartland 500 kV circuits. Underground circuits may be required for the portion of line crossing 500 kV circuits, and concerns about high pressure pipelines in the area still exist.

This alternative presents a high level of reliability with a strong grid source at 240 kV.

The customer has also expressed a preference for Alternative 4.

4.2 Economic Analysis

The cost comparison of each of these alternatives is shown in Table 4.2-1 below:

Table 4.2-1 Cost Comparison
($ Millions)

Alternative	Description	Costs (+/- 50%)
1	**Distribution Solution** Not technically feasible	-
	Total for Alternative 1	**-**
2	**New 25 kV supply from Existing Clover Bar Substation** Distribution Circuit Costs Transmission Costs	 TBD TBD
	Total for Alternative 2	**TBD**
3	**New 138 kV supply from Existing 700L** Distribution Circuit Costs Transmission Costs	 0 TBD
	Total for Alternative 3	**TBD**
4	**New 240 kV supply from Existing 921L** Distribution Circuit Costs Transmission Costs	 0 TBD
	Total for Alternative 4	**TBD**

Note: Transmission costs to be determined during the AESO connection process

5.0 RECOMMENDATION

Alternative 1 is not technically feasible.

Alternative 2 has concerns related to large motor starting, the constructability of the circuits, environmental concerns and land issues.

Alternative 3 has concerns related to capacity on the 138 kV system and lower reliability.

Alternative 4 does not have the same degree of concerns as Alternative 2, and does not have the capacity concerns of Alternative 3.

Revision History

Revision	Issue Date	Author	Change Tracking
1	Jun. 11, 2021	Christopher Wan	