Yukon Diverse Fibre Link Project

Dempster Route

Total Cost of Services (TCOS) Executive Summary

Final

Prepared for:
Government of Yukon
Economic Development
Corporate Services

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Sign-off Sheet

This Report entitled Yukon Diverse Fibre Link Project; Dempster Route Total Cost of Services (TCOS) Report was prepared by Stantec for the account of Government of Yukon, Economic Development, Corporate Services (the "Client").

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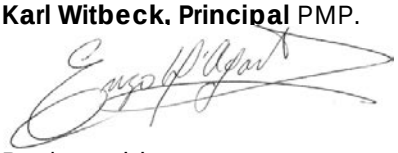

Reviewed by _

Enzo D'Agostini, P. Eng

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Abbreviations

ACS	Alaska Communications
AP&T	Alaska Power and Telephone Company
AT&T	American Telephone & Telegraph
AVG	Average
BER	Bit Error Rate
BGP	Border Gate Protocol
CDN	Canadian Dollars
CSA	Canadian Standards Association
DWDM	Dense Wave Division Multiplex
E&Y	Ernst and Young Corporation
FOSC	Fibre Optic Splice Case
Gbps	Giga-bits per second
GCI	General Communications Inc.
HDPE	High Density Poly Ethylene
IXP	Internet Exchange Point
IRU	Indefeasible Right of Use
MTTR	Mean Time To Repair
MVFL	Mackenzie Valley Fibre Line
NOC	Network Operations Center
NWTEL	Northwestel Inc.
NPV	Net Present Value
NZ-DSF	Non Zero – Dispersion Shifted Fibre
O&M	Operations and Maintenance
RFI	Request For Information
SLA	Service Level Agreement
VDC	Volts Direct Current
VFM	Value For Money
W	Watts
YDFL	Yukon Diverse Fibre Link
YG	Government of Yukon

Revision History

Revision No.	Date	Description	Author
0	September, 2015	Draft Executive Summary for Review	KW, ED
1	September, 2015	Final Executive Summary for Distribution	KW

1.0 EXECUTIVE SUMMARY

Stantec was engaged by the Government of Yukon to provide preliminary Engineering services and analysis to develop a Total Cost of Services estimate for the Dempster route in order to understand in more detail what this alternate route would cost and its technical viability. The engineering services provided by Stantec primarily included conceptual schematic design in support of developing cost estimates, so that programmatic decisions can be made regarding the implementation of the proposed Dempster fibre optic route and to understand how this project compares to the Juneau route project studied separately.

The premise of the 1,309 km Dempster route, as defined below is to provide a second route out of Yukon for telecommunications services. In the event of a failure, telecommunications services would be maintained with minimal disruption.

The following provides an overview of the costs associated with this proposed route and a comparison to the Juneau Route.

1.1 PURPOSE

This executive summary is provided to inform the general public of the Yukon Territory regarding the status and preliminary cost data developed for the proposed Dempster fibre optic route that is currently under consideration by the Government of Yukon.

1.2 BACKGROUND

It is an objective of the Government of the Yukon (YG) to provide its citizens, businesses, government operations, and visitors, access to fast, affordable, and reliable broadband and telecommunications services for the Yukon's social and economic prosperity. Improving the existing telecommunications infrastructure with a second fibre optic route has been a long standing objective of the Yukon Government to ensure reliable and effective services to support public services and private enterprise.

The YG's goals and objectives for the YDFL include, but are not limited to, providing long-term benefits to the users, future proofing of the communications infrastructure, and supporting effective competition among a wide range of service providers.

Two routes have been proposed for the second data path: a route between Whitehorse and Lena Point (near Juneau, Alaska); and along the Dempster highway from Whitehorse to Inuvik. These will be referred to as the Juneau Route and the Dempster route respectively.

1.3 APPROACH

The approach to the analysis of the Dempster route was to leverage the preliminary work done by Stantec in the prior phases and carry forward those assumptions that were determined to still be applicable. This data was then developed further so that conceptual network design and high level cost estimates could be established. The conceptual network developed for this analysis is proposed to be economical, highly reliable, servicable and sustainable.

1.4 DEMPSTER ROUTE DEFINITION

The proposed Dempster route provides a new 72 strand fibre optic cable between Whitehorse, YT and Inuvik, NWT and consists of Yukon Territory and Northwest Territory Segments as depicted in the figure below.

Figure 1 Dempster Route Map

1.4.1 Route Segments

For the purpose of cost estimating, four (4) route segments (A thru D) are proposed for the Dempster route as indicated in the following table. Data Traffic originating at Whitehorse would be terminated at Inuvik for handoff to the Mackenzie Valley Fibre Link Network (MVFL).

Table 1 Route Segments Lengths

Segment	Estimated Length (km)	Notes
A: Whitehorse to Carmacks	175	72-strand underground fibre in conduit
B. Carmacks to Stewart Crossing	177	72-strand underground fibre in conduit
C: Stewart Crossing to Dawson City	180	72-strand underground fibre in conduit
C: Dawson City to Chapman Lake, YT	163	72-strand underground fibre in conduit
C: Chapman Lake to Village, YT	73	72-strand underground fibre in conduit
C: Village to Ft. Eagle Plains, YT	174	72-strand underground fibre in conduit
C: Ft. Eagle Plains to YT/NWT Border	97	72-strand underground fibre in conduit
Subtotal Yukon Segment	**1,039**	
D: YT/NWT Border to Ft McPherson, NWT	85	72-strand underground fibre in conduit
D: Ft McPherson to Inuvik, NWT	185	72-strand underground fibre in conduit
Subtotal NWT Segment	**270**	
Totals	**1,309**	

1.4.2 Assumptions

The following assumptions were used to define the Dempster route.

- The fibre for the entire route would be installed within the existing highway right-of-way to the extent feasible.
- New network assets will be owned by the Government of Yukon and operations and maintenance would be provided by a third party operator yet to be determined.
- The planned Life cycle of the network shall be twenty (20) years
- Traffic will be switched/routed to/from the NWTEL network at Whitehorse and at Fort Simpson at facilities to be determined.
- We have defined the existing NWTEL network connection at Whitehorse as the primary path to the outside world. This network approach was adopted due to the massive distance difference to the outside world from the MVFL route side. The shorter path will always provide a higher level of network reliability. The Ft Simpson NWTEL network connection will be defined as the secondary or back-up path to the outside world. Both paths are assumed to ultimately end up connecting to separate IXP networks in Edmonton and/or Calgary, Alberta.
- Yukon Enterprise end user services would be the responsibility of a third party operator yet to be determined.
- All electronic equipment considered in the cost estimate will only be provisioned for termination/routing of traffic at Whitehorse and Inuvik and regeneration/breakout of data traffic along the way where needed.

1.5 SERVICE BANDWIDTH ESTIMATE

The following twenty (20) year bandwidth projection was derived based on a ten (10) year market demand analysis performed by Planetworks in 2013. The results of the Planetworks study were updated and projected out to twenty (20) years and then used in our analysis as the expected forecast for traffic over the network. It is also noted that the service bandwidth in the network does not include handling or terminating of any analog telephone traffic. The following table provides a Traffic Bandwidth summary for the 20 year projection.

Table 2 Twenty Year Service Bandwidth Projection

20 YEAR BANDWIDTH PROJECTION (Gbps)									
Year 1-2	**Year 3-4**	**Year 5-11**	**Year 12-13**	**Year 14**	**Year 15-16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
10	20	30	40	50	60	80	90	100	120

1.6 DEMPSTER ROUTE TOTAL COST OF SERVICES ESTIMATE

The total cost of services for the proposed Dempster route network were derived from knowledge and experience in the construction and operation of high capacity fibre networks of similar scope and complexity in the North American Telecom industry.

Our approach was to use industry best practices and network operational metrics which have been used successfully throughout the Telecom industry. The high reliability network is proposed to be implemented to ensure proper and reliable operations throughout the outside plant and inside equipment life cycles; and was the basis for developing an accurate operational cost model. Our model consisted of the following component estimates.

Construction Cost Estimate

A detailed construction estimate was prepared based on the concept of operations, length of the cable installation and equipment needed. Assumptions in the following categories were used to develop the construction cost estimate.

- Schedule Assumptions
    - The proposed schedule for the Dempster route is assumed to be over a thirty-six (36) month construction cycle. The total distances involved and number of crossings will require a multiple year schedule to complete all the required construction.
- Construction Approach and Methods
    - All construction activity and material shall be in accordance with the national standards applicable to the region.
    - In North America these include the Canadian Standards Association (CSA), the American National Standards Institute (ANSI); the American Society for Testing and Materials (ASTM), the National Fire Protection Association (NFPA), Rural Utilities Services (RUS) and Telecommunications Industry Association (TIA)

- Technology Assumptions
    - The proposed network will require a number of intermediate repeater and breakout sites located within the 1309 km route. These breakout sites will require secured and fully environmentally controlled shelters to house the transport optical equipment as well as the breakout network equipment.
- Materials and Quantity Estimates
    - Detailed estimating methods were used to develop preliminary material costs.
- Contractor Related Costs
    - In addition to the material costs, cost related to labor, equipment, insurance and other expenses were estimated.

Table 3 below provides a summary of the estimated construction costs (un-escalated $).

Table 3 Total Capital Construction Costs

CONSTRUCTION SPREAD	A	B	C	D	TOTAL
Route Distance (Km)	352	180	592	185	1,309
Total Material $:	$6,930,000	$3,450,000	$11,440,000	$3,930,000	
Total Labour $:	$3,230,000	$1,350,000	$5,730,000	$1,220,000	
Total Contractor Support Costs $:	$4,020,000	$2,130,000	$15,680,000	$2,380,000	
Total Capital $ per SPREAD:	$14,160,000	$6,920,000	$32,840,000	$7,510,000	
TOTAL Capital Construction Costs:	$61,420,000				
Material $/km:	$19,700	$19,200	$19,400	$21,300	
Labour $/km:	$20,600	$19,300	$36,200	$19,400	
OVERALL $/km:	$40,300	$38,500	$55,500	$40,600	
TOTAL OVERALL CONSTRUCTION $/km:	$47,000				

Whitehorse to Stewart Crossing - SPREAD A

Stewart Crossing to Dawson - SPREAD B

Dawson to Ft McPherson - SPREAD C

Ft McPherson to Inuvik - SPREAD D

Life Cycle Cost Estimate

A detailed lifecycle cost estimate was developed for the operations and maintenance of the proposed network over the twenty (20) year life cycle. The following table provides a summary of the operational costs.

Table 4 Operating Expenses

OPERATING EXPENSES SUMMARY	PROJECT TOTALS
GENERAL Office Expenses	$4,100,000
Network Back Office Expenses	$9,300,000
Head End and Outside Plant Equipment - Maintenance	$3,600,000
Network - Maintenance	$23,000,000

OPERATING CAPITAL SUMMARY	PROJECT TOTALS
Network Back-Office	$6,800,000
Head End/Outside Plant Equipment Maintenance	$900,000
Network Maintenance	$2,400,000
Lifecycle - Technology Refresh	$30,500,000
Total Operating Capital Expenses:	$40,600,000

Cost of Services Estimate

Considering the construction, operational, life cycle and revenue projections over the twenty (20) year period, a total net cost of services estimate was developed.

These costs include an adjustment for inflation of 2% per year. In the column labelled "NPV" the same nominal dollars are discounted back to year 2015 at a discount rate of 3.0%.

Table 5 Dempster Route – Total Net Cost of Services Estimate

Cash Outflow/(Inflow)	NPV TOTAL @ 3.0%	PROJECT TOTALS
Initial Capital Costs	$60,900,000	$62,700,000
Annual Owner's Costs	$5,300,000	$6,100,000
Annual Operating Costs	$28,000,000	$39,800,000
Annual Capital Renewal Costs	$28,200,000	$40,500,000
Total IP Transit BW Required(by year 20)	120 Gbps	

1.7 COST OF SERVICES COMPARISON

The following table provides a side-by-side comparison of the Dempster and Juneau project estimates.

Table 6 Comparison Between Dempster and Juneau Routes

	DEMPSTER ROUTE	JUNEAU ROUTE
PROJECT CAPITAL CONSTRUCTION COSTS	**PROJECT TOTALS**	**PROJECT TOTALS**
Route Distance (Km):	1,309	154
Total Material $:	$25,750,000	$3,990,000
Total Labour $:	$11,530,000	$2,500,000
Total Contractor Support Costs $:	$24,210,000	$3,950,000
Total Capital $:	$61,490,000	$10,440,000
Material $/m:	$19.70	$26.00
Labour $/m:	$27.40	$41.90
OVERALL $/m:	$47.10	$67.90
OPERATING EXPENSES SUMMARY	**PROJECT TOTALS**	**PROJECT TOTALS**
GENERAL Office Expenses	$4,100,000	$1,700,000
Network Back Office Expenses	$9,300,000	$4,700,000
Head End and Outside Plant Equipment - Maintenance	$3,600,000	$600,000
Network - Maintenance	$23,000,000	$6,300,000
OPERATING CAPITAL SUMMARY	**PROJECT TOTALS**	**PROJECT TOTALS**
Network Back-Office	$6,800,000	$1,800,000
Head End/Outside Plant Equipment Maintenance	$900,000	$140,000
Network Maintenance	$2,400,000	$1,100,000
Lifecycle - Technology Refresh	$30,500,000	$4,200,000
Total Operating Capital Expenses:	$40,600,000	$7,240,000

CASH OUTFLOW/(INFLOW)	NPV TOTAL @ 3.00%	PROJECT TOTAL TOTAL	NPV TOTAL @ 3.00%	PROJECT TOTAL TOTAL
Initial Capital Costs	$60,900,000	$62,700,000	$10,400,000	$10,700,000
Annual Owner's Costs	$5,300,000	$6,100,000	$3,600,000	$4,300,000
Annual Operating Costs	$28,000,000	$39,800,000	$29,400,000	$41,400,000
Annual Capital Renewal Costs	$28,200,000	$40,500,000	$6,200,000	$9,000,000

Notes: Discount rate is based on approximated long term (20 year) Government of Yukon borrowing
NPV Total and Project Total reflect net costs for initial construction plus twenty years of
Costs are escalated at 2% per annum. Revenues are adjusted for both growth and price changes.

	DEMPSTER - PROPOSED CONSTRUCTION SCHEDULE				JUNEAU - PROPOSED CONSTRUCTION SCHEDULE	
	Pre-Construction	Construction YR-1	Construction YR-2	Construction YR-3	Pre-Construction	Construction YR-1
		33%	33%	33%		100%
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2
Owner Costs (Technical)	$2,281,000	$420,000	$420,000	$420,000	$1,150,000	$630,000
Fibre Cable and Conduit		$ 7,600,000	$ 7,600,000	$ 7,600,000		$ 2,900,000
Shelter Sites		$ 1,200,000	$ 1,200,000	$ 1,200,000		$ 610,000
Transport Optronics		$ 670,000	$ 670,000	$ 670,000		$ 830,000
Outside Plant Infrastructure		$ 2,900,000	$ 2,900,000	$ 2,900,000		$ 1,700,000
Contractor Related Project Costs		$ 4,100,000	$ 4,100,000	$ 4,100,000		$ 1,900,000
Contractor Equipment Support Costs		$ 3,400,000	$ 3,400,000	$ 3,400,000		$ 1,600,000
Customer Connections		$ 184,000	$ 184,000	$ 184,000		$ 560,000
Contingency (@ 10% Spread C Labour Only!)		$ 650,000	$ 650,000	$ 650,000	(@20% Spread C Labour Only!)	$ 570,000
TOTAL ANNUAL CONSTRUCTION COSTS:		$ 20,704,000	$ 20,704,000	$ 20,704,000		
OVERALL PROJECT (NON-Escalated):		$62,112,000				$ 10,670,000