TECHNICAL MEMORANDUM

TO: Lorna Dysart, Chief Administrative Officer, Stewart Novak, Public Works & Emergency Preparedness Coordinator

FROM: Clive Leung, P.Eng., Sanwal Gilani, EIT.

SUBJECT: Available Capacity of Pipeline Supply from District of North Vancouver

DATE: March 30, 2022

1 INTRODUCTION AND BACKGROUND

The District of North Vancouver (DNV) has been the primary supplier of potable water for the Village of Belcarra (VoB) since 2011. Water is supplied via two 200mm High Density Polyethylene (HDPE) marine pipelines which are currently located at the bottom of the waterway between the Deep Cove area and Belcarra Pier. These watermains are approximately 1,400m in length and feed potable water from the DNV Pressure Zone S6 at Strathcona Road to the VoB at the intersection of Midden Road and Belcarra Bay Road. This water is then supplied to the Tatlow Road Reservoir through a dedicated ~2,160m long 200mm Ductile Iron watermain.

The original 2008 Water Service Agreement between DNV and VoB stated that a maximum instantaneous flow of 14 L/s can be drawn from the DNV system. This was later updated to a maximum flow instantaneous flow of 20 L/s in 2019. Since then, the VoB has been investigating ways to improve their fire flow capabilities. One such way is to review if additional capacities could be provided from the DNV system. The purpose of this memo is to discuss potential option to improve fire flow provision within VoB by increasing flows from the supply pipeline from DNV.

2 OBJECTIVES

The VoB seeks to understand the maximum available supply capacity of its water supply from the DNV. There are two components to review, namely (1) the ability of DNV's water network to provide this flow, and (2) the theoretical capacity of the pipeline supplying water from DNV to the VoB's Tatlow Reservoir, which consists of two main components, the dual marine pipeline, as well as approximately 2,160m of watermain within the VoB.

3 INFORMATION FROM DNV

A total of four scenarios were evaluated to determine if there is sufficient/additional available supply from the DNV system to be provided to the VoB. The four scenarios are those reviewed by the DNV in their memo entitled "Village of Belcarra Fireflow Increase Analysis – Additional Modelling

Request" dated March 3, 2022, and are described below:

- Scenario 3a: Maximum Day Demand (MDD) + 120 L/s Fire flow (FF) within the DNV system and 20L/s demand from VoB.
- Scenario 3b: MDD + 120 L/s FF within the DNV system and 30L/s demand from VoB.
- Scenario 3c: MDD + 120 L/s FF within the DNV system and 45L/s demand from VoB.
- Scenario 3d: MDD + 120 L/s FF within the DNV system and 60L/s demand from VoB.

The memo concluded that the DNV water network is currently at capacity with the provision of 20 L/s to the VoB. While the DNV's pipelines appear adequately sized, the noted asset which is at capacity is the DNV's Blueridge Pump Station, at as low as 20 L/s of flow to VoB. Scenarios 1 and 2 were captured in a separate memo entitled "Village of Belcarra Fireflow Increase Analysis" dated September 9, 2021, also from the DNV, where Scenario 3 was concluded as the preferred approach to analysis of the water supply.

In addition, the DNV has provided WSP with the modelled Hydraulic Grade Line (HGL) and elevation at the connection point of the pipeline for each of the scenarios listed above. This was requested by WSP in order to determine the starting HGL in the DNV from which the VoB will be drawing from at different flow rates, to then determine if the flow rates would be induce too much headloss in the supply pipeline before being able to reach and fill the VoB's Tatlow Reservoir. The analysis of pipeline supply capacity is presented below.

4 ANALYSIS OF PIPELINE SUPPLY CAPACITY

The pipeline supply capacity is calculated based on the estimated headloss across the marine and VoB pipelines between the DNV connection point and the VoB's Tatlow Reservoir. The capacity assessment is also focused on review of flow capacity across only one of the two marine pipelines, rather than both. While assessment of both marine pipelines would enable additional capacity to be supplied to the VoB, this is not recommended as the original design intent of the two marine pipelines was to provide full redundancy for the marine supply.

Table 1 summarizes the hydraulic calculations performed to compare the maximum allowable headloss vs anticipated headloss at different flow rates under the four scenarios reviewed. Where the anticipated headloss is less than the maximum allowable head loss, this means the pipeline will have sufficient capacity to supply the VoB (by refilling its reservoir).

Table 1 Maximum Allowable and Anticipated Headlosses at Different Flow Rates

Scenario	VoB Flow Rate (L/s)	HGL @ DNV Connection (m)	Maximum Allowable Headloss to Ensure Tatlow Res Fill (m)[1]	Anticipated Headloss at Flow Rate (m)	Within Allowable Headloss?
3a	20	107	18.50	13.42	Yes
3b	30	105	16.50	28.42	No
3c	45	102	13.50	60.23	No
3d	50	98	9.50	102.60	No

[1] calculated by the difference between HGL supplied at DNV connection minus TWL of Tatlow Reservoir at 88.5m geodetic

Appendix A contains a detailed summary of the calculations performed to develop the table above.

5 DISCUSSION

The DNV has indicated that the Blueridge Pump Station is not physically capable of keeping up with VoB demands at 20 L/s and above, even with all pumps running at the station. In order to meet any increase in flow rates to the VoB above 20 L/s, at least two pumps in Blueridge Pump Station would need to be replaced. In addition to this, the DNV would also likely require twinning the unlooped transmission main in their Pressure Zone S5 to accommodate the increased flows. The total estimated costs of both of these potential upgrades was noted at $5,350,000 (in 2021 dollars) for upgrades required up to conveying the 100 L/s flow rate to the VoB. At a flow rate of 20 L/s or even 30 L/s, the cost for improvements was not provided by the DNV, but from WSP's engineering judgement and referencing DNV's report, we believe the cost may likely still be in the range of ~$4,000,000.

Aside from the DNV network being at capacity at 20 L/s, if only focusing on the infrastructure starting from the marine pipeline to the VoB, it may be possible for the VoB to increase their current flow rate from 20 L/s to a maximum of ~23 L/s only, as can be implied from Table 1. Therefore, there will be also significant added costs for pipeline upgrades in addition to DNV's costs should 30 L/s or even 45 L/s be requested. This adds to the costs noted in the paragraph above.

Based on our understanding of the history of the water network design in the VoB, we understand that the marine pipeline crossing was always intended to be a low flow supply, and the Tatlow Reservoir to be the source of fire protection for the VoB. As such, the alternative for increasing fire protection based on reservoir expansion appears still to be a more cost-effective solution for expanding fire protection capabilities. A new reservoir could be constructed within the VoB to either supplement the existing Tatlow Reservoir or to serve as the sole portable water storage tank at a lower cost compared to expanding the water supply pipelines. In the 2017 memo entitled "Potable Water Storage Increase" from Opus International Ltd., both of these options were evaluated. The first option involved constructing a new larger tank to provide both domestic and fire flow protection in addition to the existing Tatlow Reservoir and would eliminate the need for the existing fire pump. This option was estimated to cost between $800,000 and $1,000,000 (in 2017 Dollars). The second option involved constructing a new reservoir to replace the existing Tatlow Reservoir, but at a higher elevation which would eliminate the need for the Tatlow Reservoir and potentially the existing fire pump. This option was estimated to cost between $600,000 and $800,000 (in 2017 Dollars). VoB should note the construction cost for these upgrades will have increased as well with recent inflation and supply chain issues for steel manufacturers (for reservoirs). These costs do not include costs for land acquisition.

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6 CONCLUSION AND RECOMMENDATION

The DNV's current water system does not have the capacity to provide additional flow to the VoB. Increasing the DNV system capacity through upgrades to their water infrastructure appears to be a costly option.

A previously assessed alternative for increasing fire protection based on reservoir expansion appears still to be a more cost-effective solution for expanding VOB's fire protection capabilities.

Sincerely,

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Appendix A: Hydraulic Calculations using Hazen Williams Equation

Hazen-Williams Equation: $V = k\,C\,(D/4)^{0.63}\,S^{0.54}$ where $S = h_f / L$ and $Q = V\,\pi\,D^2/4$

k is a unit conversion factor:
k=1.318 for English units (feet and seconds). k=0.85 for SI units (meters and seconds)
C=Hazen-Williams Coefficient. D=Pipe inside diameter.

Scenario:	1	2	3	4
DNV HGL (m)	107	105	102	98
Tatlow HGL (m)	88.5	88.5	88.5	88.5
Max allowable headloss (m)	**18.5**	**16.5**	**13.5**	**9.5**

Scenario 1: VOB = 20L/s:

Pipe	ID (mm)	Q (L/s)	C	L (m)	A (m2)	V (m/s)	HL (m)	
HDPE	155.45	20	140	1400	0.0190	1.05	9.777	
DI	214.12	20	130	2160	0.0360	0.56	3.638	
					Total Headloss (m)		**13.415**	<18.5

Scenario 2: VOB = 30L/s:

Pipe	ID (mm)	Q (L/s)	C	L (m)	A (m2)	V (m/s)	HL (m)	
HDPE	155.45	30	140	1400	0.0190	1.58	20.716	
DI	214.12	30	130	2160	0.0360	0.83	7.708	
					Total Headloss (m)		**28.424**	>16.5

Scenario 3: VOB = 45L/s:

Pipe	ID (mm)	Q (L/s)	C	L (m)	A (m2)	V (m/s)	HL (m)	
HDPE	155.45	45	140	1400	0.0190	2.37	43.894	
DI	214.12	45	130	2160	0.0360	1.25	16.332	
					Total Headloss (m)		**60.226**	>13.5

Scenario 4: VOB = 60L/s:

Pipe	ID (mm)	Q (L/s)	C	L (m)	A (m2)	V (m/s)	HL (m)	
HDPE	155.45	60	140	1400	0.0190	3.16	74.778	
DI	214.12	60	130	2160	0.0360	1.67	27.822	
					Total Headloss (m)		**102.600**	>9.5