Capacity study for existing and potential future users at Myrtle Pond Water System

Date: September 09, 2021

Prepared by:

MSR Solutions Inc.
125-662 Goldstream Avenue
Victoria, BC V9B 0N8
Phone: 1+(250)-479-5164
Fax: 1+(888)-277-2816

Submitted to:

Patrick Devereaux
Manager of Operational Services
qathet Regional District,
Phone: +1 (604) 487-1380
Email: pdevereaux@qathet.ca

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

TABLE OF ABBREVIATION

Abbreviation	Explanation
ADD	Average Daily Demand
AO	Aesthetic Objectives Concentrations
AWWA	American Water Works Association
BU	Bed Units
CRD	Capital Regional District
EPA	Environmental Protection Agency
FH	Fire Hydrant
FUS	Fire Underwriters Survey
GPM	Gallon Per Minutes
ha	Hectares
IWA	International Water Association
KWL	Kerr Wood Leidal Associates Ltd.
LPCD	Litres per Capita per Day
LPM	Liters per Minutes
MAC	Maximum Acceptable Concentrations
MDD	Maximum Daily Demand
NFPA	National Fire Protection Association
PHD	Peak Hour Demand
qRD	qathet Regional District
SFE	Conversion to Single Family Equivalent

1. Introduction

qathet Regional District (qRD) currently owns and operates one Residential Water System, the Myrtle Pond Water System. The Myrtle Pond Water Service is located approximately two kilometers south of the City of Powell River. The service supplies 79 developed lots and 5 undeveloped lots with a total of 84 lots. The existing boundary of the water system includes 79 developed lots (101 Single Family Equivalent and a population of 222) that are already connected to the system and 5 undeveloped lots (47 Single Family Equivalent and a population of 104) that will connect to the existing system. The expanded boundary of the water system will include 172 lots with a total of 236 Single Family Equivalent and a population of 519.

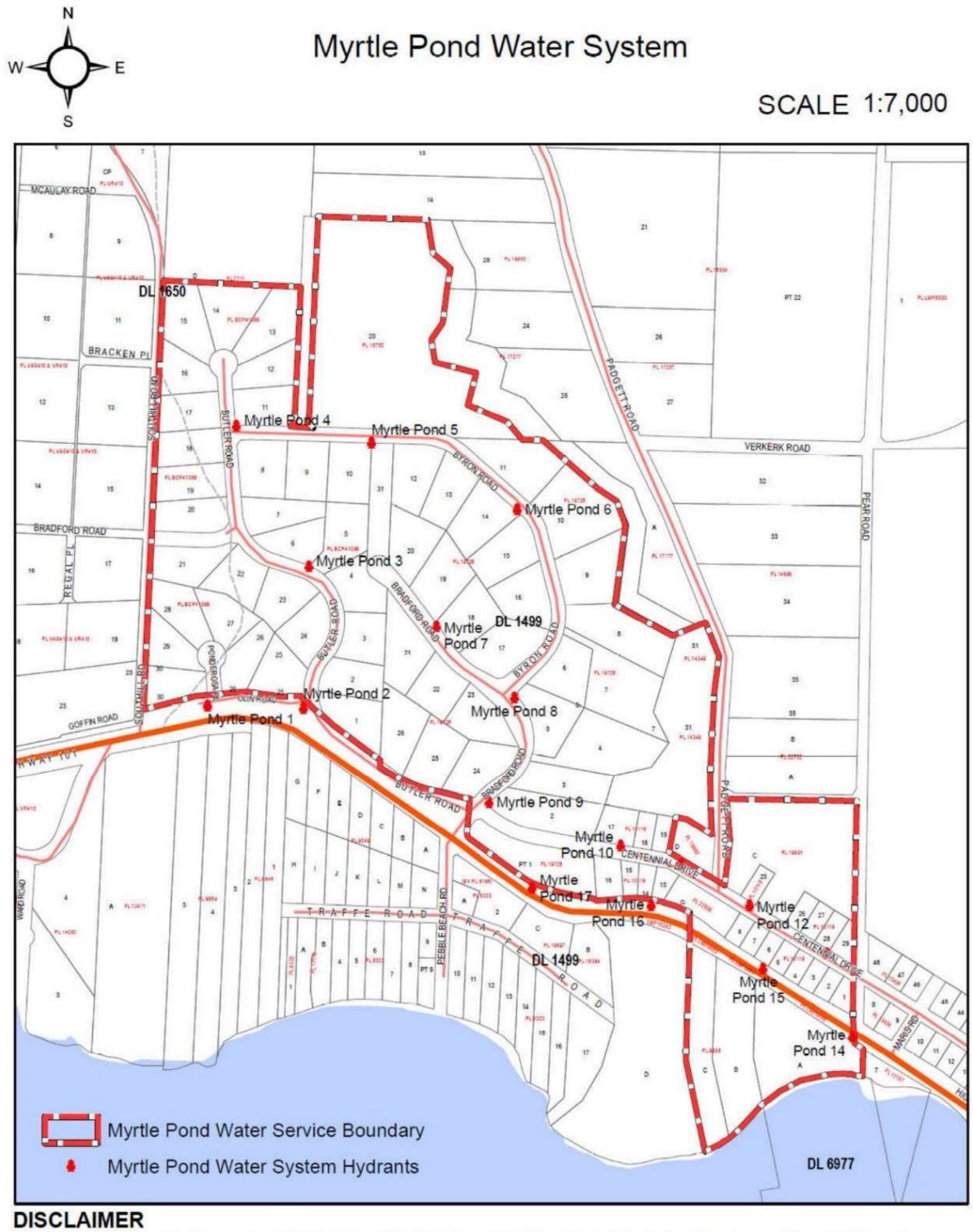
A new treatment facility was built in 2014 and delivered and commissioned in January 2015. The system is governed by a Permit to Operate from Vancouver Coastal Health. A new water reservoir has been constructed and is now operational.

2. Background

MSR Solutions was retained for the Water System Capacity Assessment of the Myrtle Pond Water System. The goal of this study is to define the capacity of the system's wells; treatment plant; and infrastructure to enable the qathet Regional District (qRD) to better forecast capital planning and to assess any proposed expansion of the service area.

The qRD Myrtle Pond water service area, is located approximately 3km southeast of Powell River on the Sunshine Coast Highway. Figure 1 shows the existing water service boundary.

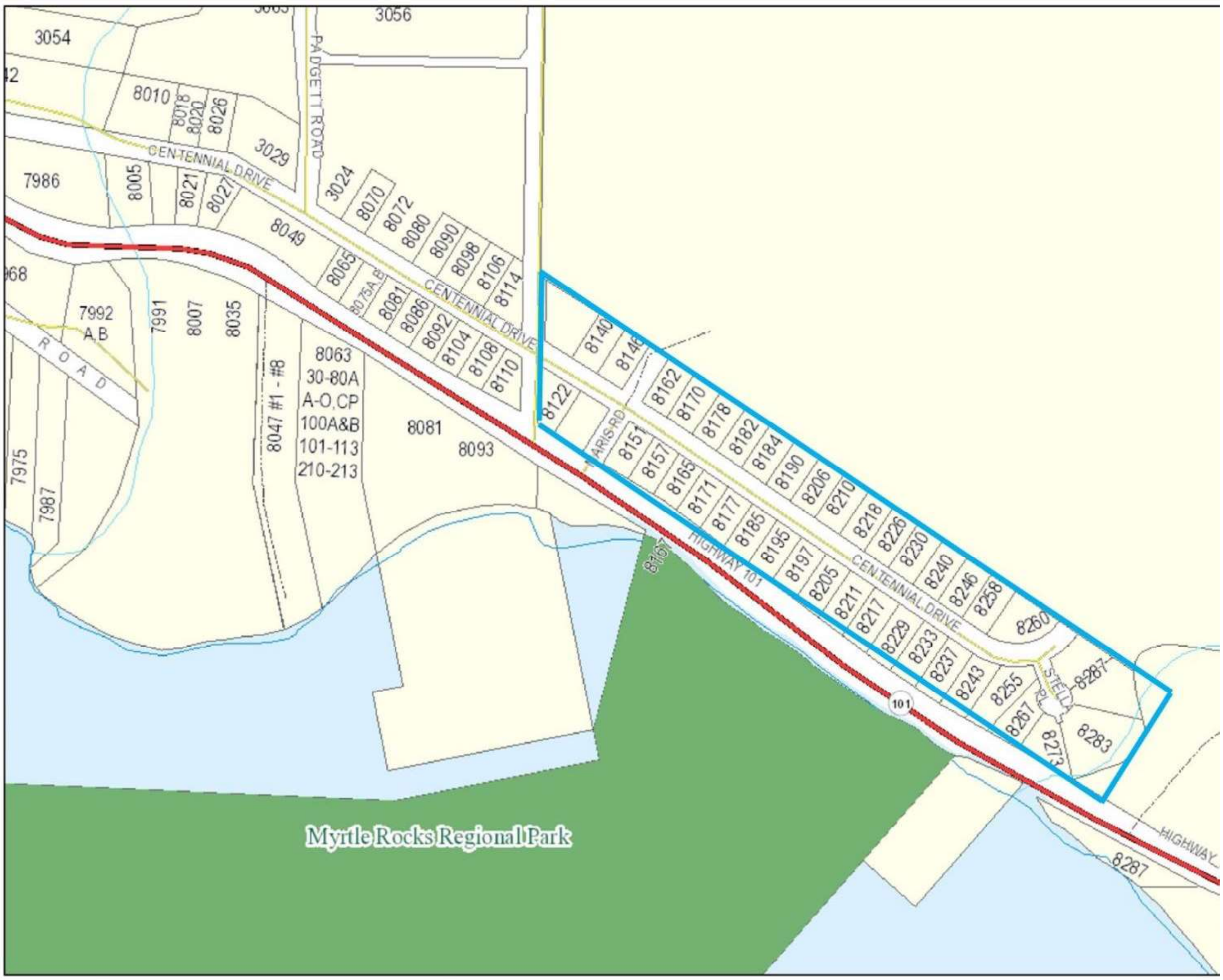
There is high potential demand for servicing lands adjacent to the Myrtle Pond Water Service Area, which include both existing homes at densities similar to those in the service area, and undeveloped land. These areas have potential to be included in the service area with watermain extensions on Centennial Drive (east of service area), as show in Figure 2. The water for this area is supplied by well and pumped to a storage tank. On Pebble Beach and Traffe Road (south of service area), Figure 3, the users are supplied with water from private wells.



DISCLAIMER
This mapping data has been compiled by the qathet Regional District using data derived from a number of different sources with varying levels of accuracy. The qathet Regional District disclaims all responsibility for the accuracy or completeness of this information.

Figure 1- Existing water service area

The current boundary of the existing Myrtle Pond Water System is 84 lots which includes 79 developed and 5 undeveloped lots. The current 79 developed lots contain 72 single-family and 7 multiple-family units. Lot 8063 (Commercial recreation) is considered as a part of undeveloped lands in this study. All 84 lots either developed or undeveloped are considered in the existing water network.



Copyright qRD
This mapping data has been compiled by qathet Regional District using data derived from a number of different sources with

Figure 2- Potential expansion on Centennial Drive

Copyright qRD
This mapping data has been compiled by qathet Regional District using data derived from a number of different sources with

Figure 3- Potential expansion on Pebble Beach and Traffe Road

In the future, 88 single-family lots could be connected to the 84 existing lots with a total of 172 lots that are described in Table 1. Therefore, 172 lots are considered in the potential water boundary network for the purpose of this report.

3. Definition

3.1. Zoning

As it has been defined in qRD Bylaw No. 117.20, the following definitions are used in this study.

Commercial Recreation: includes a use providing overnight accommodation and recreational opportunities and includes the following uses:

a) campground and cabins providing temporary overnight accommodation;
b) an office, restaurant, laundry facility, and playground accessory to use in a);
c) a swimming pool.

Dwelling unit: means a self-contained unit used as a residence for a single household and containing a single set of facilities for food preparation and eating, sleeping, and living area.

Residential: includes parcels used for residential purposes and that contain only one dwelling.

Multiple Residential: includes parcels used for residential purposes and that contain more than one dwelling unit.

Existing water system boundary: includes the connection of LOT 8063 to the current water system and full development on the current boundary.

Expanded water system boundary: includes the existing water system boundary, as defined, and the further connection of Centennial Drive east of the service area, and on Pebble Beach and Traffe Roads south of the service area.

3.2. Conversion to Single Family Equivalent (SFE)

SFE means a building that possesses the average characteristics of a home of a single-family in a permanent residence in the district. For the purpose of this report, the number of SFEs associated with all buildings is based on their type of use. The average occupancy for a single-family house by Canadian census profile in 2016 for Powell River is presented at 2.1. The conversion values of 1 are subjected to the building type with an average occupancy of 2.2 people to convert the residential, single-family, and multi-family, and commercial lots to an equivalent unit. The conversion to SFE can allow for a better understanding of capacity assessment for the service area.

Table 1- Lot occupation of existing and expanded boundary for Myrtle Pond Water System

Form of accommodation			Number of units	Single Family Equivalent (SFE)	Lots address	Population
Existing boundary	Developed	Single-family	72	72	N/A	222
		Multiple family units	7	a) 2 b) 2 c) 2 d) 11 e) 8 f) 2 g) 2	a) 3130 Butler Rd b) 3139 A, B Byron Rd c) 8075 A, B Centennial Rd d) 8104 HWY 101 e) 8047 #1-8 HWY 101 f) 3066 Bradford g) 8013Centennial Rd	
	Undeveloped	Single-family	4	4	N/A	104
		Commercial Recreation	1	43	8063 Highway 101	
Total SFE			148*			
Expanded boundary	Single-family		164	164	N/A	519
	Multiple family units		7	a) 2 b) 2 c) 2 d) 11 e) 8 f) 2 g) 2	a) 3130 Butler Rd b) 3139 A, B Byron Rd c) 8075 A, B Centennial Rd d) 8104 HWY 101 e) 8047 #1-8 HWY 101 f) 3066 Bradford g) 8013Centennial Rd	
	Commercial recreation		1	43	8063 Highway 101	
Total SFE			236**			

* Include 101 connected SFE, and 47 not connected SFE
** Include 101 connected SFE, and 135 not connected SFE

4. Existing Infrastructure

The Myrtle Pond water system consists of three supply wells, a filtration treatment plant, a 444 m^3 (98,000 gal) reservoir, distribution mains, pressure reducing stations, line valves, hydrants, and customer service connections with pit meters. The supply and treatment system are designed for a maximum day demand of 286 m^3 (52 USGPM). The well 93 with safe yields of 155 m^3/day (28 USGPM) is not in service, but well 1-05 and well 2-08 with safe yields of production at 60 m^3/day (11 USGPM) and 436 m^3/day (80 USGPM), respectively, are the two current water sources in the Myrtle Pond water system, for a total of 496 m^3/day.

5. Water Demand for Determination of System Capacity and Sizing

5.1. General

The amount of water used in a community will vary over the course of the day and throughout the year as a result of differences in instantaneous water use among users over time. Most communities will exhibit a repeated pattern of increased water consumption.

All water transmission and distribution pipes, including service connections, should be sized according to flow demands and pressure requirements. The distribution system should be designed to convey domestic, irrigation, and fire flows.

On existing systems, the water demand should be preferably established from reliable water consumption records such as metering data and pumping records. When reliable records are not available or the project is a new water system, the design engineer shall calculate the critical demands based on guidelines and regulations methods.

The main design parameters used for sizing the water system are the average day demand (ADD) and the maximum day demand (MDD).

5.2. Average Daily Demand (ADD) – Using Water Consumption Report

The ADD represents the total water demand that is exerted on the system by all users on a normal day. It is recommended that historical water use records be used to determine the ADD of a community.

If insufficient data is available in the community, a published average per capita water demand may be used instead and can be beneficial in forecasting the capacity of a service area. However, the published per capita demands often fail to take into account the individual water use patterns found in smaller communities and are not relied upon for safe estimations.

The three years water consumption history provided by the qRD to MSR has been used to determine the ADD of the existing water service area. In this report, 79 lots are considered already connected to this system, but the water consumption of 77 lots has been reported from January 2018 to December 2020. The address of these 77 lots is checked and the single-family equivalent (unit) for these 77 lots is calculated at 97. By considering 2.2 ppu (people per unit), the population of reported consumption is calculated at 214.

According to the water consumption report, the total pumped water and the metered consumption in three years was 60,195 and 53,327 m^3, respectively. By considering population at 214, the average consumption including water loss of connected lots to the service area is calculated at 280 (60,195 ÷214) Liters per Capita per Day (LPCD). The water loss is determined at 30 LPCD, which is about 12% of the total average demand. Therefore, the average daily demand including water loss is considered at 280 LPCD.

5.3. Maximum Daily Demand (MDD)

5.3.1. Using Water Consumption Report - Practical

The MDD is the maximum water demand that can be expected from the community on any given day occurring over a one-year period. The MDD is a critical design parameter for sizing reservoirs, pumps and treatment works between source and balancing storage. Like ADD, it can be determined based on historical water use data. However, it is rarely feasible unless the water users are metered. Thus, engineers and utilities frequently rely on hourly peaking factors. If representative water use data is not available, peaking factors can be used to predict MDD.

Different guidelines and literature are recommending methods to determine the peak factors. A study shows when the population is very small, the peak flows predicted by many of the calculation methods converge. For the determination of the maximum daily demand and peak hour demand, the peak factors from BC Design Guidelines have been considered. The Myrtle Pond Water Service counts as small community with less than 5,000 people. The BC Design Guidelines for Rural Residential recommended the daily peak factor of 2.5 and hourly peak factor of 4 where the area is less than 5,000people, therefore these factors will be used for the purpose of this report.

The current water boundary can have 148 SFE (See Table 1) and by considering 2.2 people per unit, the population is estimated at 326. As explained in the last section, 280 LPCD is calculated as an Average Daily Demand for each person. By considering 2.5 daily peak factors respectively, the Maximum Daily Demand (MDD) for the entire area will be 228 m3/day (44 USGPM). By considering 4 the hourly peak factor, the Peak Hour Demand (PHD) of the entire service area is calculated at 364 m3/day (44 USGPM). Table 2 and *326 population, based on recorded water consumption

The expanded system will have 236 SFE (See Table 1). By considering 2.2 ppu, the population is estimated at 519 for an expanded system. By considering 280 LPCD water consumption, the ADD, MDD, and PHD are calculated in Table 3.

Table 3 show the calculated ADD, MDD, and PHD for existing and expanded water service areas, respectively.

*Table 2- Practical ADD, MDD, and PHD– Existing water system**

	Unit	Total	Per Single Family Equivalent (SFE)
Average Daily Demand (ADD)	m^3/day	91	0.6
Maximum Daily Demand (MDD)	m^3/day	228	1.5
Peak Hour Demand (PHD)	m^3/day	364	2.5

**326 population, based on recorded water consumption*

The expanded system will have 236 SFE (See Table 1). By considering 2.2 ppu, the population is estimated at 519 for an expanded system. By considering 280 LPCD water consumption, the ADD, MDD, and PHD are calculated in Table 3.

*Table 3- Practical ADD, MDD, and PHD – Expanded water system**

	Unit	Total	Per Single Family Equivalent (SFE)
Average Daily Demand (ADD)	m^3/day	145	0.6
Maximum daily Demand (MDD)	m^3/day	362	1.5
Peak Hour Demand (PHD)	m^3/day	580	2.5

**519 population, based on recorded water consumption*

5.3.2. Using Rural Residential Guideline - Theoretical

5.3.2.1. Indoor Demand

This indoor usage considers a typical application of standard low flow fixtures and appliances in modern subdivisions. According to Design Guidelines for Rural Residential Community Water Systems (2012), indoor demand shall be based on a water use rate of 230 LPCD with the following typical occupancy rates:

a) 3.5 persons per single detached dwelling and duplexes.
b) 2.5 persons per multifamily residential.
c) 4 persons per commercial recreation on lakes, golf courses, and other recreational destinations.

Recreational resorts typically incorporate a water utility providing water service to several properties and facilities. The BC Design Guidelines for Rural Residential Community Water Systems (2012) recommends the MDD criterion for indoor usage at 230 L/day/BU. Typically, a room at recreational resorts is assigned two (2) bed units each.

The theoretical indoor water demand is calculated for both existing and expanded lots in the water system. Based on B.C. Design Guidelines for Rural Residential Community Water Systems, 3.5 people per unit is considered for a single-family house and 2.5 people per unit for multiple family units. Table 4 and Table 5 and show the calculated theoretical indoor water demand for existing and expanded water systems.

Table 4- Theoretical indoor water demand for existing water system boundary

Form of accommodation		Number of dwellings	Person per unit	Water demand (LPCD)	Indoor water demand (L/Day)
Developed	Single family	72	3.5	230	58,000
	Multiple family unit	29	2.5	230	16,700
Undeveloped	Single family	4	3.5	230	3,200
	Commercial recreation*	43	2	230	19,800
Entire network					**97,700**

*It consists of 43 units and 2 beds per unit with a total of 86 people at full occupancy (Design Guidelines for Rural Residential Community Water Systems).

Table 5- Theoretical indoor water demand for expanded water system boundary

Form of accommodation	Number of dwellings	Person per unit	Water demand (LPCD)	Indoor water demand (L/Day)
Single family unit	164	3.5	230	132,000
Multiple family unit	29	2.5	230	16,700
Commercial*	43	2	230	19,800
Entire network				**168,500**

*It consists of 43 units and 2 beds per unit with a total of 86 people at full occupancy (Design Guidelines for Rural Residential Community Water Systems).

5.3.2.2. Irrigation Demand

The irrigation demand is dependent on several parameters such as evapotranspiration, type of crop, size of the area, soil types, and irrigation efficiency. British Columbia can be subdivided into 6 main climatic zones according to specific evapotranspiration rates.

The peak demand period for summer use resorts typically falls into the summer season. Therefore, irrigation demands for golf courses, park facilities, and other irrigable areas need to be superimposed upon indoor demands to derive design parameters. A number of B.C. municipalities have adopted topsoil bylaws to preserve and enhance existing topsoil thickness within new developments. An absorbent topsoil layer requires less irrigation, stays green longer during a drought, and contributes to the sustainability of the water supply. Typically, a 30 cm topsoil layer maximizes the soil's water storage capacity, thus resulting in a decrease in the number of irrigation days required per week. A 10% reduction in lawn and garden irrigation can be applied to the above calculations.

The qathet Regional District is located in the Northern / West Coastal climate zone with an irrigation rate of 28 m^3/ha/day. The land use of most single-family houses is estimated at >1,600 m^2/lot, so the irrigated area is calculated at 800 m^2 per single-family unit. Based on the evapotranspiration rate and assuming grass as the typically irrigated crop in residential subdivisions and using the metered rate, the irrigation demand for existing and expanded development are described in Table 6 and Table 7.

Table 6- Irrigation demand in existing water system boundary

Accommodation's type	Number of units	Lot number	Irrigated area per unit (ha)	Total irrigated area (ha)	Irrigation rate (m^3/ha/day)	Total irrigation demand (m^3/day)
Single-family	76	N/A	0.08 ha	6.24	20	121.6
Multiple family*	7	3130	40% x 0.45	0.18	20	3.6
		3139	40% x 0.58	0.23	20	4.6
		8075	40% x 0.1	0.04	20	0.8
		8104	40% x 0.1	0.04	20	0.8
		8047	40% x 1.01	0.40	20	8.1
		3066	40% x 0.51	0.21	20	4.2
		8013	40% x 0.1	0.04	20	0.8
Commercial**	1	8063	0.12 ha	1.22	20	2.4
Total						146.9

* The actual area of each multiple family unit is determined by the qathet Regional District's interactive map.
** The total irrigated area is determined at 0.12 ha based on the qathet Regional District's interactive map.

Table 7- Irrigation Demand in expanded water system boundary

Accommodation's type	Number of units	Lot number	Irrigated area per unit (ha)	Total irrigated area (ha)	Irrigation rate m^3/ha/day	Total irrigation demand m^3/day
Single-family	164	N/A	0.08 ha	13.12	20	262.4
Multiple family*	7	3130	40% x 0.45	0.18	20	3.6
		3139	40% x 0.58	0.23	20	4.6
		8075	40% x 0.1	0.04	20	0.8
		8104	40% x 0.1	0.04	20	0.8
		8047	40% x 1.01	0.40	20	8.1
		3066	40% x 0.51	0.21	20	4.2
		8013	40% x 0.1	0.04	20	0.8
Commercial**	1	8063	0.12 ha	0.12	20	2.4
Total						287.7

* The actual area of each multiple family unit is determined by the qathet Regional District's interactive map.
** The total irrigated area is determined at 0.12 ha based on the qathet Regional District's interactive map.

5.3.2.3. Water Loss

The approach to quantify water loss is in accordance with the International Water Association (IWA) and the American Water Works Association (AWWA M36). It is based on physical system parameters including length of mains, number of service connections, and average operating pressure.

The water loss is calculated for both existing and expanded water system boundaries, while 84 service connections are considered for existing and 172 service connections for the expanded water system boundary. The summary of the water loss calculation is described in Table 8.

Table 8- Water loss in existing and expanded water system boundary

	Existing water system boundary	Expanded water system boundary
L_m= main length (km)	3.1	4.3
N_c= # of service connections	84	172
L_c= Total length of service connections (km)	1.68	3.44
P= average system pressure (meter water column)	14	14
Total water loss in the entire network (m^3/day)	**4.1**	**7.6**

As mentioned before, the total theoretical Maximum Daily Demand (MDD) for the entire network is calculated based on the following formulation:

$$MDD = Indoor\ Demand + Water\ Loss\ Allowance + Irrigation\ Demand$$

Table 9 summarized the theoretical MDD for the entire network and each node.

Table 9- The theoretical MDD for the entire network and each node

	Unit	Existing water system boundary	Expanded water system boundary
Indoor demand	m^3/day	97.7	168.5
Water loss allowance	m^3/day	4.1	7.6
Irrigation demand	m^3/day	146.9	287.7
MDD for the entire network	m^3/day	248.7	463.8
Single Family Equivalent (SFE)	-	148	236
MDD for SFE	m^3/day	1.7	2

The calculated theoretical MDD according to the B.C. Design Guidelines for Rural Residential Community Water Systems and considering 2.5 as the daily peak factors, the average consumption per capita for the existing and expanded Myrtle Pond Water Service is estimated at 290 LPCD and 350 LPCD, respectively. The theoretical average water consumption at 290 LPCD is very close to the practical water consumption at 280 LPCD.

5.3.3. Comparison of The Theoretical and Practical MDD

The MDD is calculated with two practical and theoretical methods for existing and expanded water system boundary in Myrtle Pond water. Table 10 compared the MDD results achieved from both theoretical and practical methods. The existing water system is included 326 population with a potential increase to 519 in an expanded system. For more accuracy, it is decided to calculate the MDD for both existing and expanded water systems based on the hybrid method. A hybrid method is a combination of practical and theoretical methods. In this regard, the MDD is calculated based on the practical method for already connected lots and the theoretical method for those lots that will be connected in the future. The calculation of the hybrid method is described for both existing and expanded water system as follow.

MDD calculation for existing water system based on hybrid method:

The population that is already connected to the existing system: 222 ppl

The population that is not connected to the existing system: 104 ppl

The practical water consumption: 280 LPCD

The theoretical water consumption for existing system: 305 LPCD

MDD for existing water system = ((222 ppl x 280 LPCD) + (104 x 305 LPCD)) x 2.5 = 234,700 L/d or 235 m^3/d

Based on above calculated MDD at 235 m^3/d and population of 326, the maximum water consumption will be 720 LPCD for the existing system boundary.

MDD calculation for expanded water system based on hybrid method:

The population that is already connected to the existing system: 222 ppl

The population that will be connected to the expanded system: 297 ppl

The practical water consumption: 280 LPCD

The theoretical water consumption for expanded system: 360 LPCD

MDD for expanded water system = ((222 ppl x 280 LPCD) + (297 ppl x 350 LPCD)) x 2.5 = 422,700 L/d or 423 m^3/d

Based on the above calculated MDD at 423 m^3/d and population of 519, the maximum water consumption will be 815 LPCD for the existing system boundary.

Table 10- Comparison of the theoretical and practical method

	Calculation method	Existing water system boundary	Expanded water system boundary
Maximum Daily Demand (m^3/d)	Practical	228	362
	Theoretical	249	464
	Hybrid	235	423

It is worth noting that most of the guidelines and literature recommend using data records to select the effective water demand when possible. Therefore, it is decided to use the three years water consumption history from January 2018 to December 2020 to determine the ADD, MDD, and PHD of currently connected lots and use the theoretical rates for potential expansion to the service area. However, the practical MDD at 228 m^3/d is very close to the theoretical MDD at 249 m^3/d in the existing water system boundary. For more accuracy, the hybrid method is used to calculate the water demand. Therefore, the practical method is used for already connected lots that there is an actual report and theoretical method for those lots that will be connected to the system. For the rest of this report and doing the hydraulic assessment, the calculated hybrid demand of 235 m^3/d for the existing and 423 m^3/d for the expanded system will be used.

5.4. Further Discussion on Water Demand

MSR Solutions had a site visit at Myrtle Pond Water on July 14th, 2021. Based on the discussion, the client had concerns regarding unusual water demand that happened over the summer of 2021 because of extremely high temperatures. Therefore, additional investigation and analysis have been undertaken by MSR Solutions to make sure that the calculated MDF will correspond with unusual water demand in a condition of unexpected high temperatures. In this regard, MSR Solutions asked the client to report the actual water consumption during summer 2021.

This section aims to analyze the water consumption, rainfall, and temperature in summer 2021. Figure 4 demonstrates the reported daily water consumption, high temperature, and daily rainfall from May 1st to July 13th, 2021. The general analysis of this graph shows that when the rainfall decreases and the temperature increases the water consumption increases. The unexpected water consumption has started from June 22nd to June 29th due to the extremely high temperature. This week counts as an unexpected condition with the unusual water demand. In this section, the calculated MDD is compared to the water consumption from June 22nd to June 29th to make sure that the system can handle this unexpected condition.

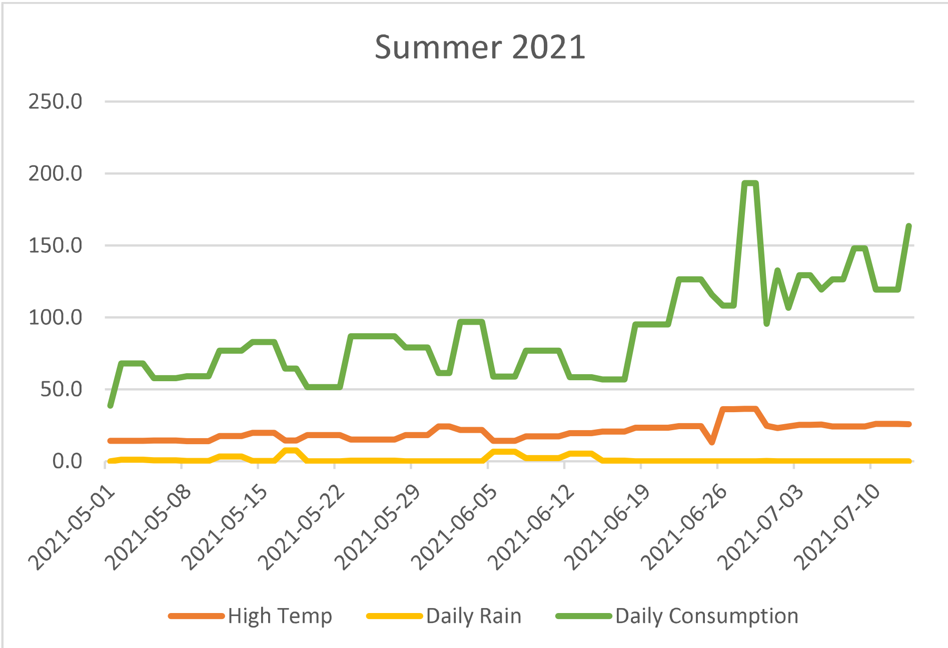


Figure 4- Reported daily water consumption, average temperature, and average rainfall

Table 11 summarizes the daily water consumption, high temperature, and daily rainfall from June 22nd to June 29th. The average water consumption for this week is calculated at 137 m^3.

Table 11- Daily water consumption from June 22nd to June 29th, 2021

Date	High Temperature (°C)	Rainfall (mm)	Daily Water Consumption (m^3)
2021-06-22	24.6	0	127
2021-06-23	24.6	0	127
2021-06-24	24.6	0	127
2021-06-25	31.2	0	116
2021-06-26	36.3	0	108
2021-06-27	36.3	0	108
2021-06-28	36.4	0	193
2021-06-29	36.4	0	193
Week Average Water Consumption			137

In the previous calculation (Section 5.2), the average water demand was calculated at 280 LPCD. Considering 137 m^3/d as an average consumption in this unexpected week and 222 users were connected to the system, the maximum water consumption for each person will be 617 LPCD (137,000 L ÷ 222). Therefore, the considered 720 LPCD as a maximum daily demand is higher than 617 LPCD in an unexpected condition (June 22nd to June 29th). This comparison can validate the calculated maximum water consumption for each person at 720 LPCD.

MSR Solutions also analyzed the water consumption and maximum temperature for the summer season from 2018 to 2021 to have a comprehensive overview of water consumption during warm months. Figure 5 shows the average water consumption and maximum temperature for May, June, and July from 2018-2021. It is clear, whenever the temperature rises, water consumption increases. The maximum water consumption was observed in July 2021 with the average monthly consumption of 131 m^3. Considering 222 users and a 2.5 daily peak factor, the recalculation will be 131,000 L ÷ 222 = 590 LPCD. In this report, the maximum water consumption is considered 720 LPCD which is higher than the 590 LPCD consumption that happened in July 2021.

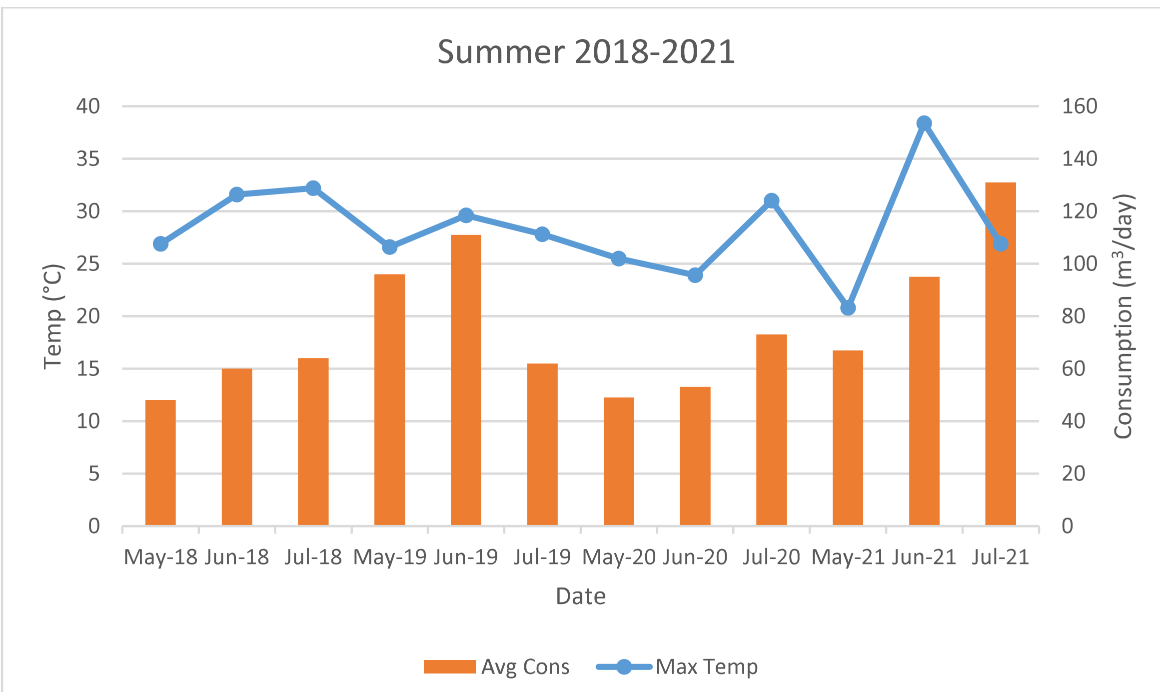


Figure 5- Comparison of the average consumption and maximum temperature in summer 2018-2021

5.5. Summary of Water Demand

The Maximum Daily Demand (MDD) has been calculated with two practical and theoretical methods for existing and expanded water system boundary in Myrtle Pond water. Most guidelines and literature recommend using data records to select the effective water demand when possible. If sufficient data is not available in the community, a published average per capita water demand may be used. The available historical data has been considered to determine the flow for the currently connected houses and the average per capita water demand calculated based on the B.C. Design Guidelines for Rural Residential Community Water Systems has been considered for the potential connections. The important parameters and basis in the hydraulic assessment are summarized in Table 12 that will be used throughout the entire assessment.

Table 12- Hydraulic assessment basis

	Existing network		Expanded network	
	m^3/day	USGPM	m^3/day	USGPM
The Average Daily Demand (ADD)	94	17	169	31
Maximum Daily Demand (MDD)	235	43	423	78
Peak Hourly Demand (PHD)	376	69	677	124

5.6. Required Fire Flow

Fire Underwriters Survey (FUS), Water Supply for Public Fire Protection (1999), includes data on fire flow requirements according to the building size and specific duration. By using the air photos from Google Earth and qathet Regional District's interactive map the space between buildings is generally over 10 meters and less than 30 meters. Therefore, a 3,000 Lpm fire flow for 1.25 hr (75 minutes) has been selected for the required flow based on information from FUS. By considering 3,000 Lpm flow and 75 min fire duration, the total fire consumption is calculated at 225,000 L. Therefore, 225 m^3 fire storage is required to supply 3,000 Lpm fire flow for a 75-minute fire duration.

6. Hydraulic Assessment

6.1. Water Source

The Myrtle Pond water system consists of three wells (two wells in service and one idle), a small treatment plant, a 444 m^3 reservoir, distribution mains, pressure reducing stations, line valves, hydrants, and customer service connections with pit meters. The well 1-05 with 60 m^3/day and the well 2-08 with 436 m^3/day production are the two current water sources in the Myrtle Pond water system for a total of 496 m^3/day.

The MDD for the existing and expanded water system is calculated at 235 and 423 m^3/day. Therefore, the current two wells in service (well 1-05 and well 2-08) with a total of 496 m^3/day production will meet the MDD for both existing and expanded water systems.

6.2. Treatment Assessment

The current treatment system includes sand filtration, primary and secondary chlorine disinfection. The supply and treatment system are designed for a maximum day demand of 286 m^3. Currently, the maximum daily demand of connected houses is estimated at 155 m^3/day. By adding 104 people to the existing system, the MDD is calculated at 235 m^3/day (Section 5.3.3). Therefore, lot 8063 and four other undeveloped lots with a total of 104 people can hook up to the water service, which require about 79 m^3/day.

Moreover, the remaining treatment capacity at 55 m^3 (286–234=52) allows the Myrtle Pond water service to expand the service to 31 more adjacent lots or 68 more people considering consumption at 800 LPCD.

6.3. Reservoir Assessment

6.3.1. Assessment Base on Drinking Water Systems in British Columbia

As defined in the Design Guidelines for Rural Residential Community Water Systems (2012), the required total effective storage should be based on the following formula:

Total Storage Required = A + B + C

A = Equalization storage capacity (25% of Maximum Day Demand)

B = Fire Storage

C = Emergency Storage (25% of A+B)

(A) Equalization Storage

According to the above-mentioned guidelines and standards, the equalization storage capacity is defined as 25% of MDD. Using MDD of 234 m^3/day and 423 m^3/day for the existing and expanded water system, the equalization storage would result in 58 m^3 and 106 m^3 for the existing and expanded water system, respectively.

(B) Fire Storage

For the calculation purposes and in accordance with Fire Underwriters Survey (FUS), the flow rate of 3,000 L/min for 75 min duration in addition to maximum daily domestic demand, delivered with a residual pressure not less than 140 kPa (20 psi) was considered for the required firefighting flow. This flow rate equals a Fire Storage volume of 225 m^3.

(C) Emergency Storage

According to the BC Rural Guidelines and standard, emergency storage is defined as 25% of equalization storage and fire storage. Therefore, the emergency storage volume for the existing and expanded water system would be 71 m^3 and 82 m^3 for the existing and expanded water system, respectively.

Total Storage for the existing water system - BC requirements = 58 m^3 + 225 m^3 + 71 m^3 = **354 m^3**

Total Storage for the expanded water system - BC requirements = 104 m^3 + 225 m^3 + 83 m^3 = **412 m^3**

The current reservoir in the Myrtle Pond Water service is a 444 m^3 (117,000 US gal) tank with 1 m (3.3 ft) freeboard that will meet the total storage requirement for the existing and expanded water system.

6.3.2. Assessment Base on Capital Regional District (CRD) Engineering Specifications

For comparison purposes, MSR Solutions has done the reservoir assessment based on the CRD standard. The CRD specification has a different method for sizing the reservoir, therefore it has been considered as the second benchmark to assess the reservoirs capacity in the service area. The CRD Engineering Specifications require that reservoirs be sized according to the following:

Total Storage Required = A + the greater of B and C

A = Equalization storage capacity (25% of Maximum Day Demand)

B = Fire Storage

C = Emergency Storage (50% of Average Day Demand)

(A) Equalization Storage

According to the CRD engineering specifications and standard, the equalization storage capacity is defined as 25% of MDD. Therefore, the equalization storage would result in 58 m^3 and 106 m^3 for the existing and expanded water system, respectively.

(B) Fire Storage

For the calculation purposes and in accordance with the CRD Engineering Specifications and Fire Underwriters Survey (FUS), the flow rate of 3,000 L/min for 75 min duration in addition to maximum daily domestic demand, delivered with a residual pressure not less than 140 kPa (20 psi) was considered for the required firefighting flow. This flow rate equals a Fire Storage volume of 225 m^3.

(C)Emergency Storage

According to the CRD engineering specifications and standard, emergency storage is defined as 50% of ADD. Using ADD of 92 m^3/day and 166 m^3/day for the existing and expanded water system, the emergency storage would be 46 m^3 and 83 m^3 for the existing and expanded water system, respectively.

Total Storage using the CRD requirements for the existing water system = 58 m^3 + 225 m^3 = **283 m^3**

Total Storage using the CRD requirements for the expanded water system = 106 m^3 + 225 m^3 = **331 m^3**

7. Water Distribution Network Modeling by Using EPANET

7.1. General

Full-featured and accurate hydraulic modeling is a prerequisite for doing effective water network modeling. The modeling is used for pressure-dependent demands in hydraulic analyses. The modeling also includes the head losses and allows for multiple demands and scenarios. The results for hydraulic modeling by EPANET included the pressure for each consumer and also the water velocity in the pipelines. This section focuses on water network analysis to fulfill the water demand of the growing population in the Myrtle Pond Water System. The development includes the 172 lots by extension of the water main on Centennial Drive east of the service area, and on Pebble Beach and Traffe Roads south of the service area. It is required to supply a uniform quantity of water through the network. The water supply network must meet the requirement for residential demand, fire flow, and one commercial unit demand that will be connected to the network. To achieve this goal, the existing water network plus the extended network has been analyzed by using EPANET Software.

7.2. EPANET Background

EPANET is a software application to simulate a water distribution piping system which is developed by the United States Environmental Protection Agency (EPA). A network includes pipes, junctions (nodes), reservoirs, valves, and pumps. The program has some important defaults that should be set containing the head loss equations and units (metrics and US). EPANET tracks the water velocity through the pipe and pressure in each node to meet the requirements.

7.3. Input Data

There are some main input data of pipes, nodes, and reservoirs that are required to begin the water network simulation. The mandatory input data of pipes includes the length, diameter, and roughness. Input data of nodes contains elevation and water demand in each node. The pipe is a link to connect two nodes and each pipe has a start node and end node. The elevation of the start and end node is used in head loss calculations through the pipe.

This analysis uses information provided by the qathet Regional District (qRD). In this analysis, the pipe length and elevation nodes are applied to EPANET based on the AutoCAD drawing provided to MSR Solutions. It should mention that the imported elevation node is not the invert level, and it is the surface elevation as the qRD was not able to provide the invert pipe level at the time of this report.

The network is divided into three sections. One section was the current water network service area which has PVC pipe with a diameter of 150 mm. The second section was the existing pipe on Centennial Drive from

Pear Road to Stella Place, which had an Asbestos Cement pipe of 100 mm diameter. The development on Traffe Roads, south of the service area, didn't have existing water mains, therefore the minimum of 150mm PVC pipe is considered for this section.

7.4. Run Analyses

The Myrtle Pond Water distribution network is analyzed under different scenarios to ensure network reliability. The following sections describe each scenario in detail and achieved results.

7.4.1. Water Network Analysis Based on Maximum Daily Demand (MDD)

As the simplest scenario, the MDD is considered for all nodes, but no fire demand is considered. The pressure range is calculated from 14 m (20 psi) to 60 m (85 psi) and the velocity range from 0.5 to 3 m/s based on BC Design Guidelines for Rural Residential Community Water Systems. This guideline suggested a minimum pressure of 140 kPa (20 psi) in all flow conditions.

Figure 6, Figure 7, and Figure 8 show the pressure and velocity distribution in the network. These are the entire network that is divided into north, south, and east sides. Pressure is the most important criterion in the water distribution network. The result shows that each node will have sufficient pressure to supply the water and the minimum pressure will be 20 m (28 psi) at only a few nodes which is still higher than the suggested minimum pressure. As shown in Figure 7, the pressure reducer chamber on Highway 101 should be located before lot 7989.

The EPANET model also shows that for extension of the service area to the south of the existing water boundary a pressure reducer chamber is required. The proposed location of this chamber is shown in Figure 7 before lot 7917.

The velocity is lower than 0.5 m/s through all pipes and the reason is the large pipe diameter. BC Design Guidelines for Rural Residential Community Water Systems recommended the minimum diameter of distribution pipes be 150 mm (6 inches) to supply water demand in fire conditions. Low velocity is a common issue in the water distribution network which requires regular flushing to minimize sedimentation.

Figure 9 demonstrates the contour plot of pressure through the entire network. It shows most nodes are in the pressure range of 30 to 60 m (43 to 85 psi).

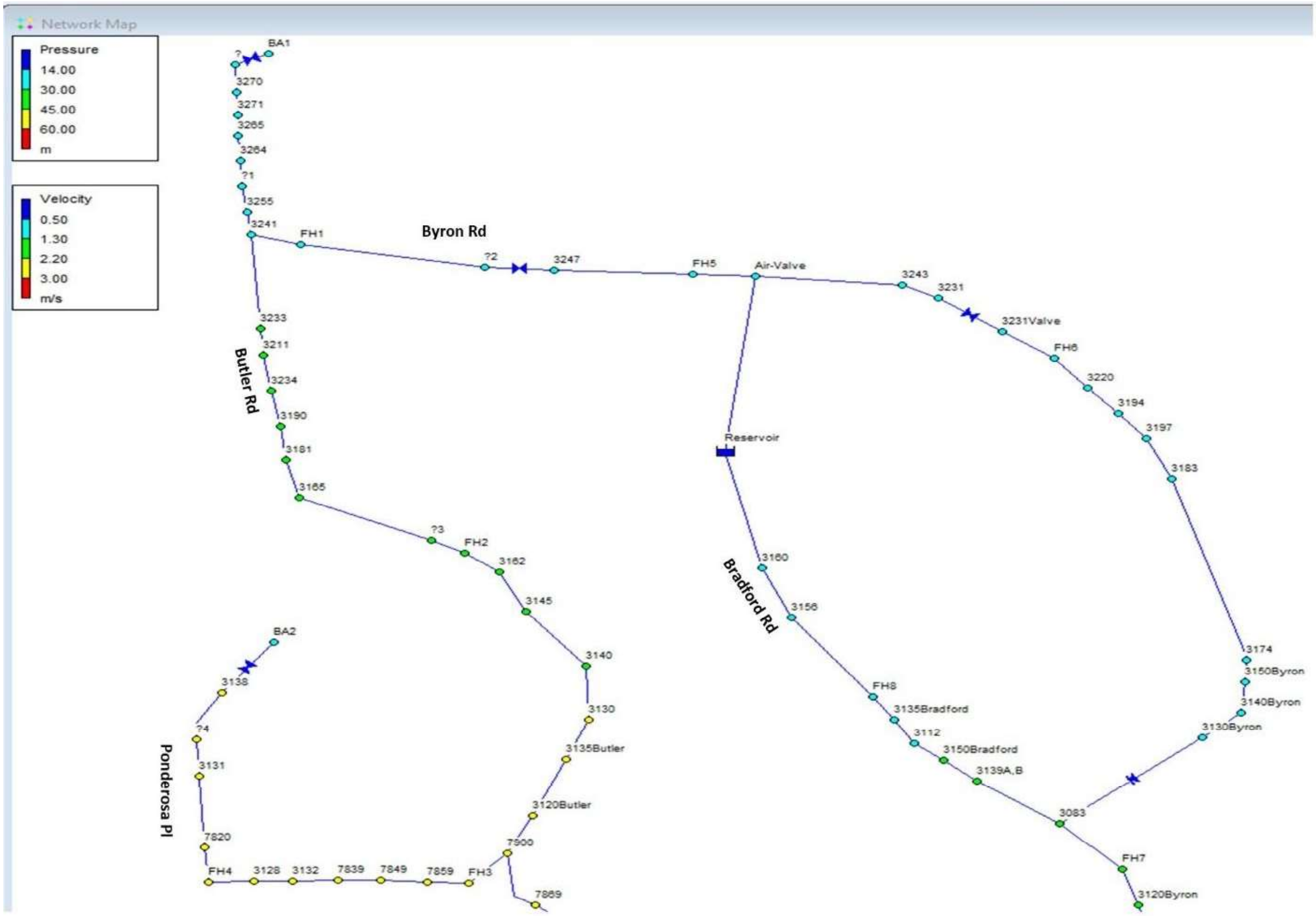


Figure 6- Myrtle Pond Water Network considering MDD (North)

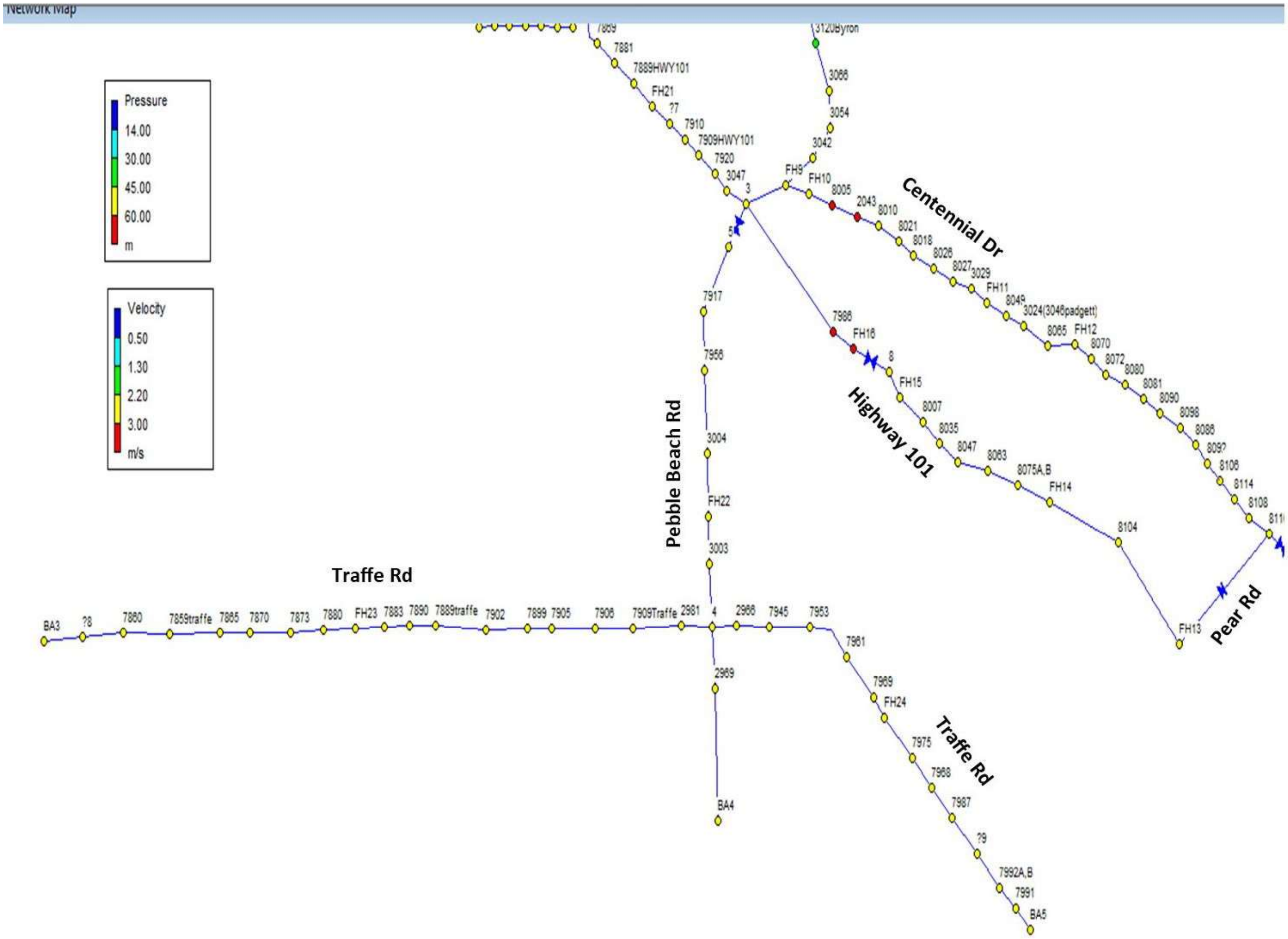


Figure 7- Myrtle Pond Water Network considering MDD (South)

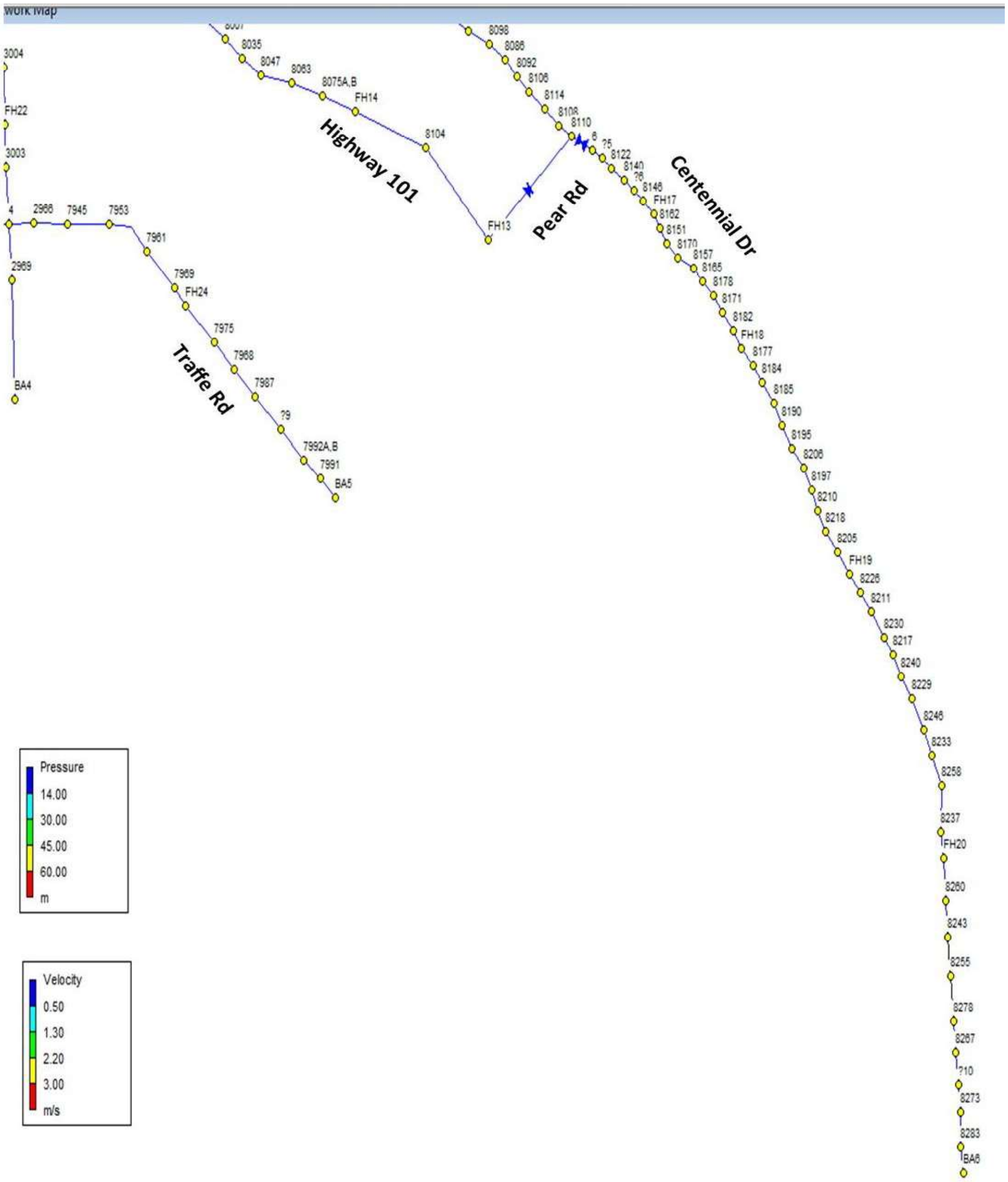


Figure 8- Myrtle Pond Water Network considering MDD (East)

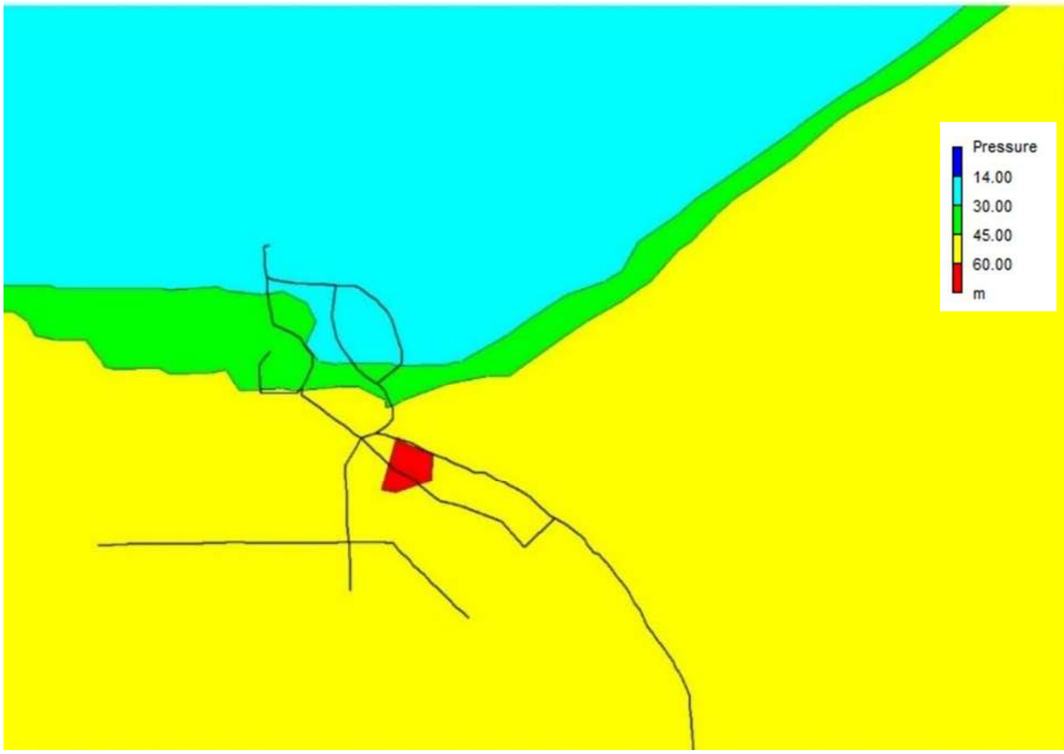


Figure 9- Contour plot of pressure

7.4.2. Water Network Analysis Based on Peak Hour Demand (PHD)

As described before, the peak hourly factor of 4 is considered for Myrtle Pond Water Service based on BC Design Guidelines for Rural Residential. In this scenario, the time consumption pattern is considered based on peak hours demand. To make the distribution network more realistic, the time pattern with variable demands is created for a 24-hour period as shown in Figure 10. Based on this pattern, the maximum hourly demand is from 7 AM to 9 AM and the lowest demand will be at 3 AM. Considering PHD in water network analysis helps to ensure that the network is reliable even at peak hour demand.

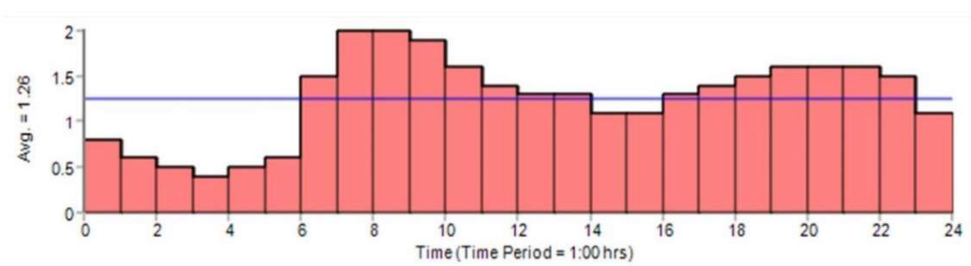


Figure 10- Time pattern demands

Figure 11 shows the velocity and pressure distribution through the water network at the time that the peak hour demand is started. The results show that in peak hours demand the network will have the desired pressure to supply the water. The minimum observed pressure is 20 m (28 psi), and the maximum observed pressure is 59 m (84 psi) which is in a standard range. Due to the higher consumption during the peak hours demand, the velocity through the pipe becomes higher and the low-velocity issues get solved in most pipes.

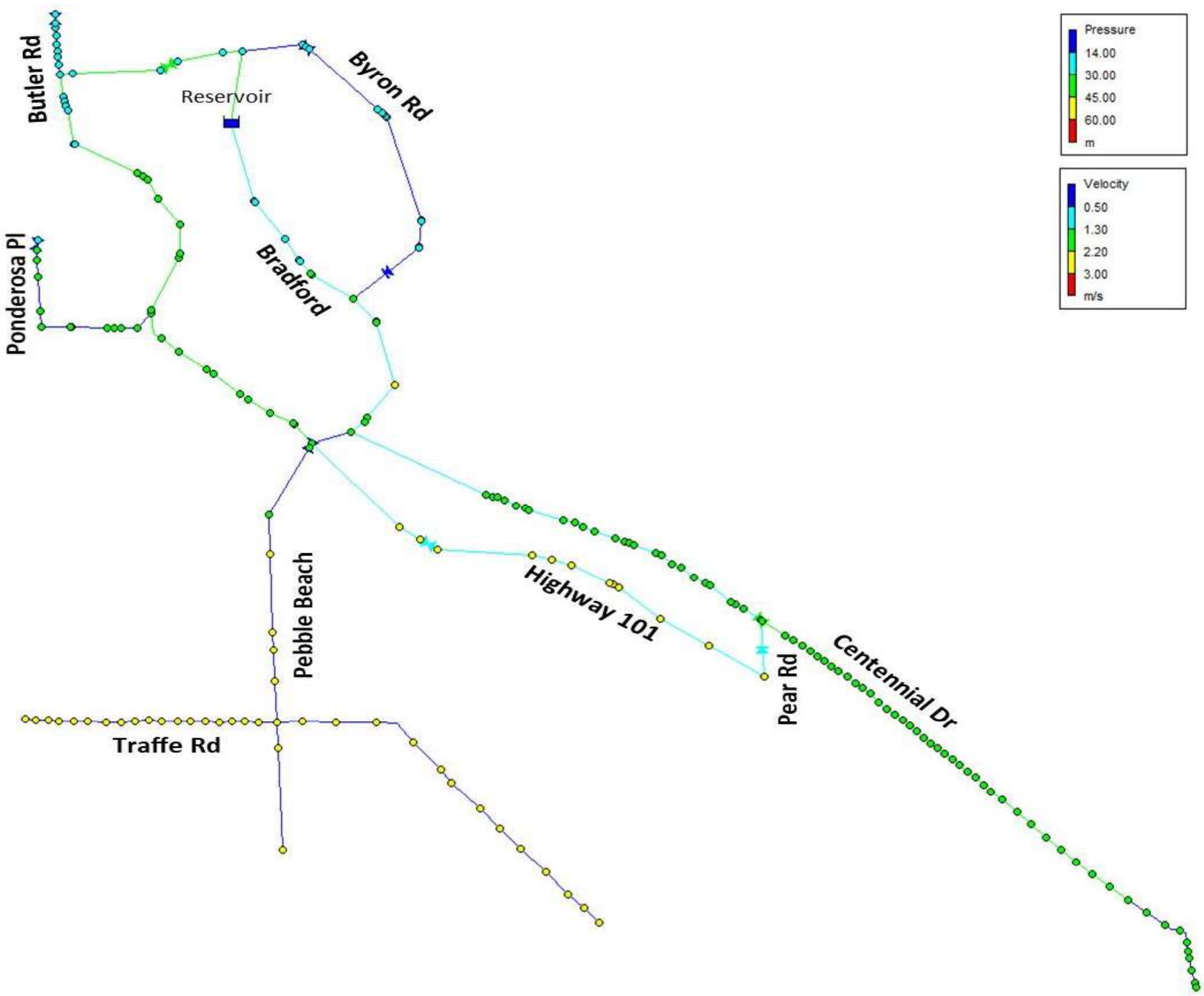


Figure 11- Myrtle Pond Water Network considering time pattern demand

7.4.3. Water Network Analysis Based on Fire and Peak Hour Demand (PHD)

Based on the National Fire Protection Association (NFPA), the fire hydrants are designed to supply fire demand with a minimum flow of 250 GPM (1,637 LPM). To be more conservative as described in section 5.6, the fire flow is calculated at 3,000 LPM (790 GPM). In the water network analysis with considering the fire situation, the worst-case scenario is assumed. In a worst-case scenario, the fire will happen during peak hours (7-9 am) for a period of 75 minutes. In the first fire analysis, flow is assumed at fire hydrant 1 (FH1) at 7 am at 3,000 LPM. This section of the network seems to have the lowest pressure, therefore the fire flow during peak hour has been applied to this hydrant. Figure 12 shows the velocity and pressure distribution through the water network considering a fire at FH1 from 7 to 9 am. The velocity through the pipes from the reservoir to the fire hydrant (FH1) becomes higher at 2.6 m/s, but still meets the velocity requirement as it does not exceed 3 m/s. In some nodes near FH1, the pressure becomes lower compared to the normal condition, and the lowest observed pressure was 20 m (28 psi).

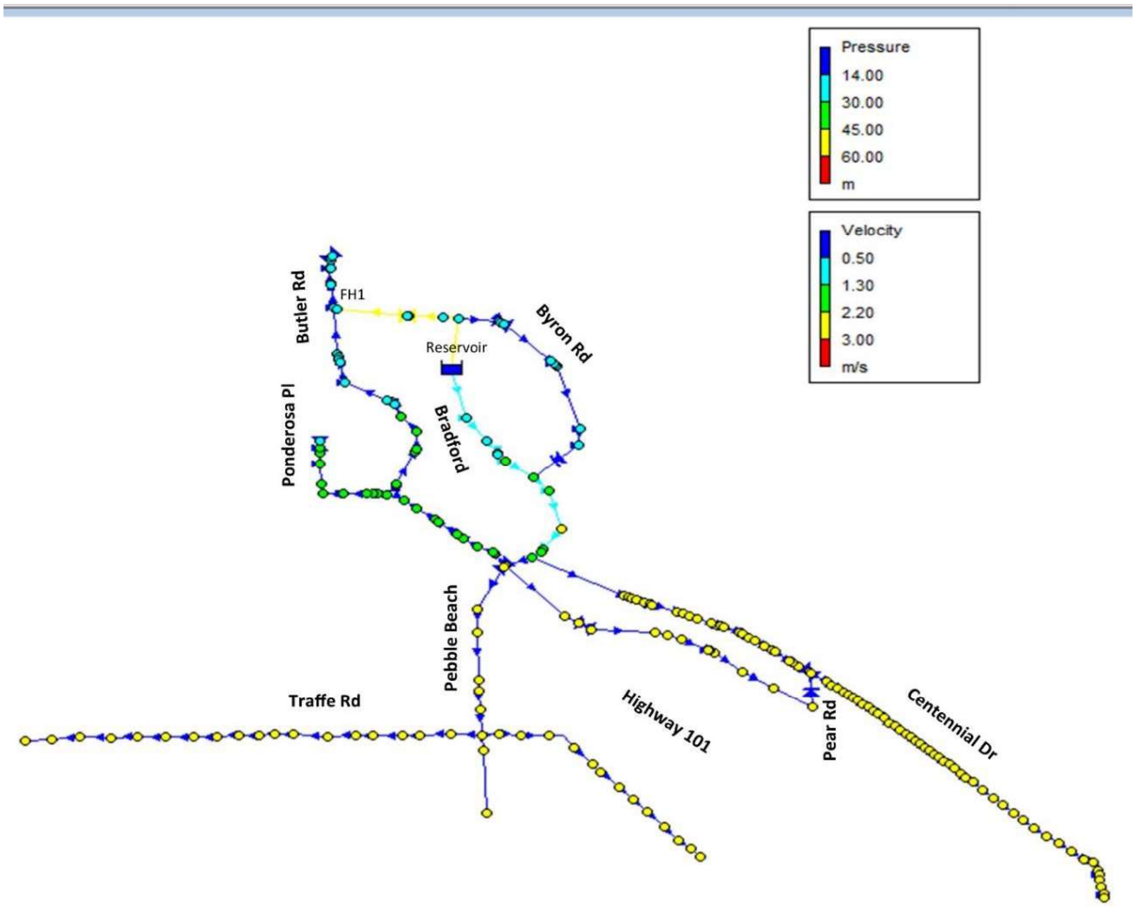


Figure 12- Myrtle Pond Water Network considering fire at FH1

In a second fire scenario, the fire is assumed at fire hydrant 20 (FH20) which will be the last fire hydrant at the bottom of Centennial Drive. The mainline pipes are 100 mm (4 inches) Asbestos Cement through Centennial Drive from Pear Road to Stella Place, which is smaller than the standard suggested diameter. BC

Design Guidelines for Rural Residential Community Water Systems suggests the minimum diameter of distribution pipes should be 150 mm (6 inches) to enable the system conveyance of fire flows to each fire hydrant location. Figure 13 shows the velocity and pressure distribution through the water network considering fire at FH20 from 8 to 9 am. It shows the velocity becoming higher through the pipe in Centennial Drive. The maximum observed velocity was 6.51 m/s which exceeds the allowable maximum velocity (3 m/s) by more than two times. Negative pressure is observed at most nodes in this mainline, therefore; the system will not have sufficient pressure to supply the fire demand at FH20.

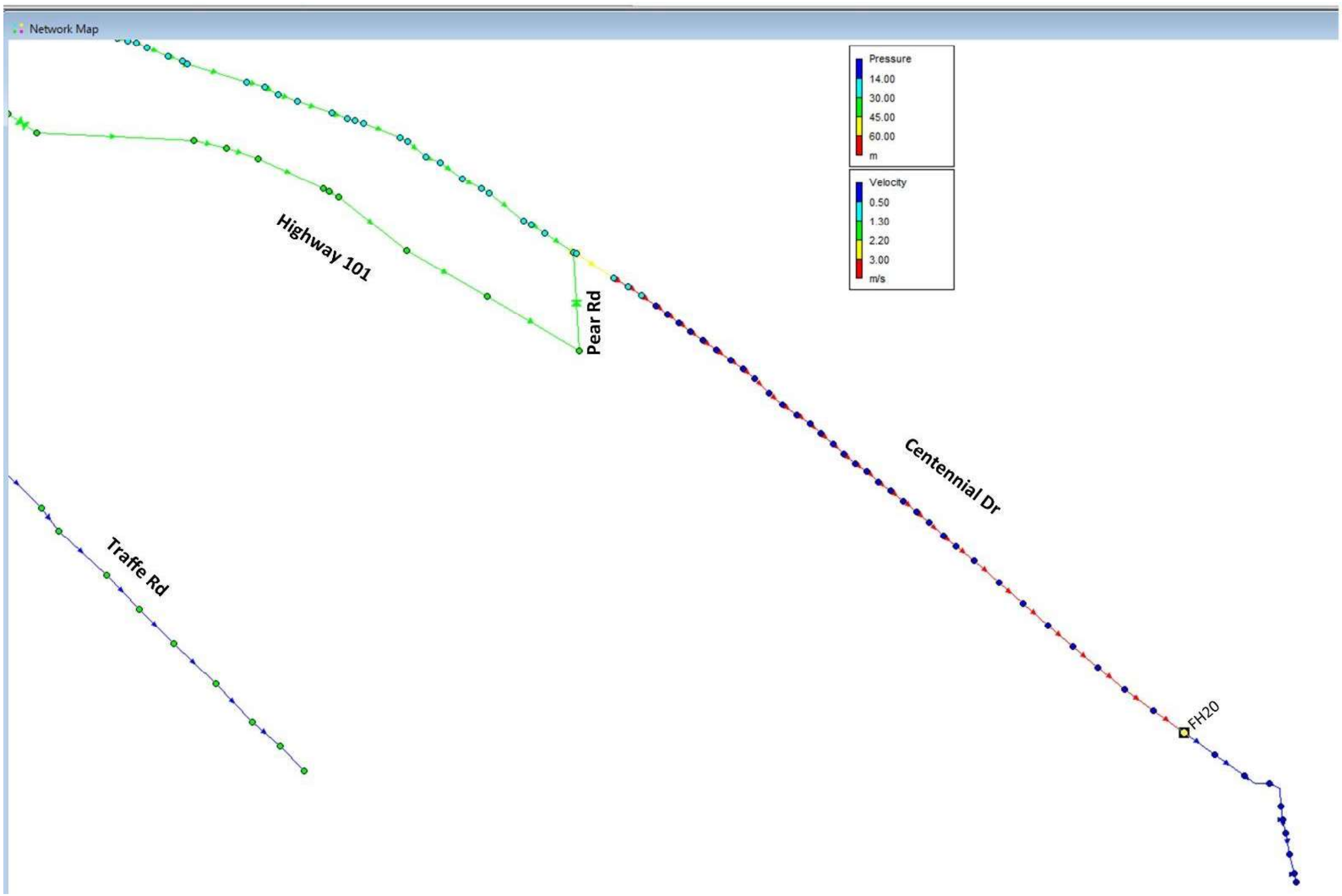


Figure 13- Myrtle Pond Water Network considering fire at FH20 with 4" pipes

In a third fire scenario, the fire is assumed at fire hydrant 20 (FH20) where the main is 150 mm (6 inches) instead of 100 mm (4 inches) in Centennial Drive. The purpose of this scenario is to analyze the effect of the pipe diameter to provide enough pressure in a fire situation. As it shows in Figure 14, the velocity through the pipe at Centennial drive from Pear Rd to the end will be in the desired range and will not exceed 3 m/s.

Also, the pressure drop issue was resolved and the whole node will have pressure in the range of 30 to 45 m (43 to 64 psi). Therefore, based on our analysis, it is highly recommended to replace 100 mm (4 inches) Asbestos Cement pipe through the Centennial Drive from Pear Road to Stella Place with 150 mm (6 inches) PVC to supply fire demand in this area and meet the BC design guidelines. The total length of this replacement is about 700 meters.

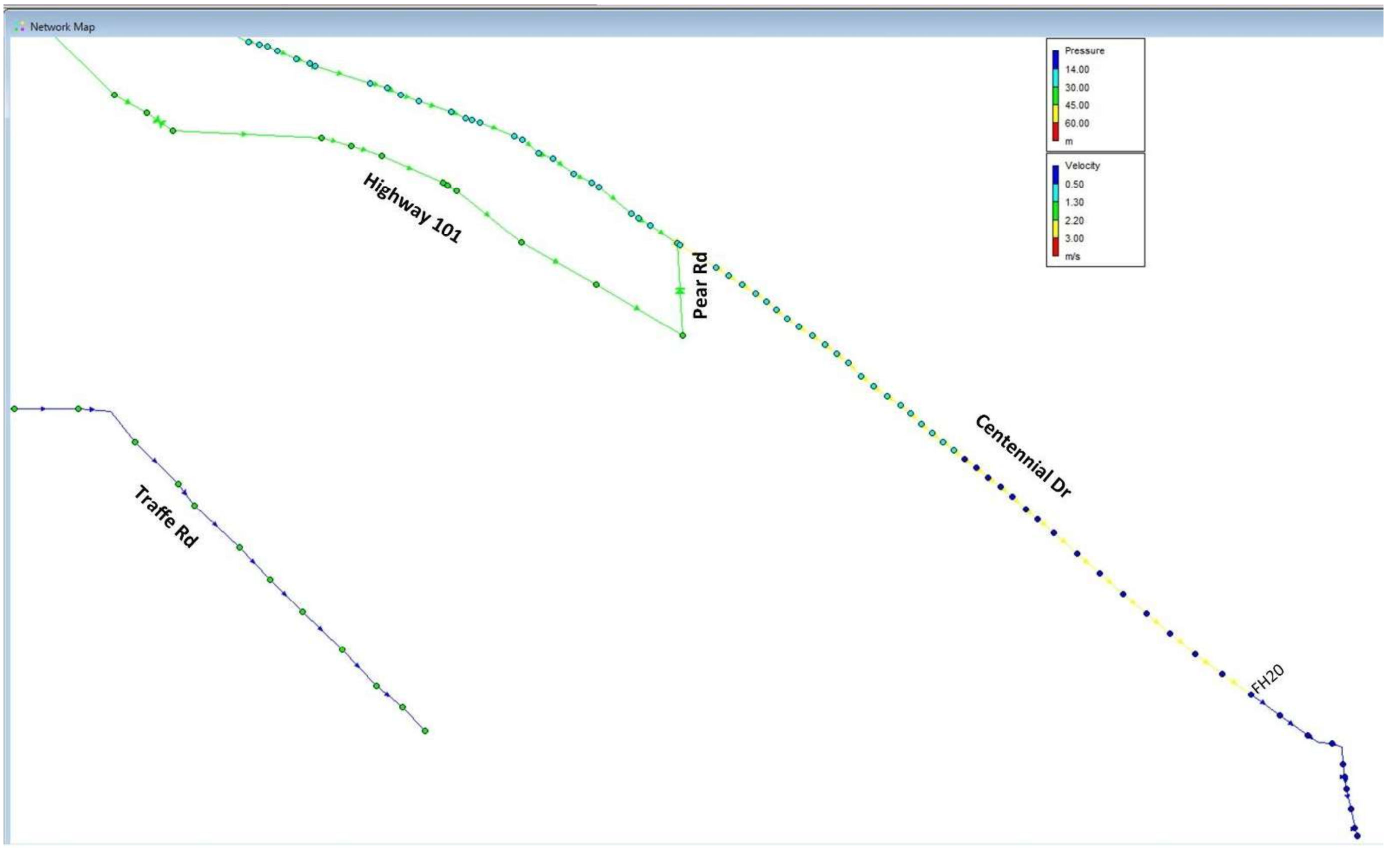


Figure 14- Myrtle Pond Water Network considering fire at FH20 with 6" pipes

The fire scenario was repeated for each fire hydrant location to analyze the pressure and velocity in the entire network. In all scenarios, the pressure shows that the network will meet the minimum acceptable pressure (14 m or 20 psi) and the velocity will not exceed the maximum allowable level (3 m/s). It has been observed that if the existing pipe isn't replaced with 150 mm pipes, during a fire situation at Centennial drive from Pear Rd to the end of the road (at FH17, FH18, FH19, and FH 20 fire hydrant), the pressure will be less than 20 psi and velocity will exceed the 3 m/s thresholds, so it is highly recommended to replace this water mainline. Otherwise, if the water service is expanded to the east of the existing water boundary, it will not provide the fire flow and fire shuttle service most be used.

8. Demand Management

With more frequent readings of customer meters, water utility staff develop a better understanding of water use patterns and are in a better position to manage water demand.

Programs that combine promotions such as rebates for installing low flush toilets with economic incentives created by rate structures are more effective in controlling water demand.

Rate reform is an important tool for water demand management that will help the qRD and its members to achieve their strategic water conservation objectives and better serve the community. The reforms of water rates are expected to reduce overall water demand by up to 10%. This reduction will increase the effective water supply capacity and thus improve system reliability in times of drought. It will also allow additional growth to be serviced without expanding capacity and thus will allow the qRD to defer future capacity investments.

It should be mentioned that the public will often oppose any type of rate reform. An effective communication plan will do much to overcome this opposition. The rate reform will thus lead to a more equitable distribution of costs among customers. Increases in metering and billing costs are minimized and existing billing systems should readily accommodate the proposed changes. The rate reform can be applied based on the discussion in Table 15 to accommodate the expansion of the water service area either by the decrease of demand in the service area or by recovery of the project cost.

9. Cost Estimation

9.1. Expansion Cost for Service Provision

The cost estimation in this section is considered Class "D" with reasonable accuracy to proceed with preliminary or detailed design. These costs should not be used for final budget authorization and construction.

According to the provided information by the operator of *Centennial Drive Water Utilities Society water system* the remaining life of AC pipes are exceeded, and the condition of the existing pump house and storage tank of this section is very poor. Therefore, the extension of the service area to Centennial Drive is recommended as the priority.

The network modeling also shows that the replacement of 100 mm AC pipe to 150 mm PVC pipe is necessary to provide fire protection to this area. Therefore 700 meters replacement of pipe is required to connect this area to the service area.

Figure 15- The storage tank of Centennial Drive Water Utilities

Expanding the service area and connecting additional lots to the Myrtle Pond water system will increase the necessity of a capacity treatment upgrade. Therefore, the treatment upgrade should consider increasing the treatment capacity. In this case, completing more detailed studies is required to determine the cost estimation of treatment upgrades. Expansion of the service area to the south of the existing boundary (Traffe areas), will need 700 meters expansion of water mainline with 150 mm PVC. The expansion can happen when water treatment capacity is increased by completing the upgrade of the water treatment plant to provide sufficient water.

9.2. Other Cost to Be Consider for Water Treatment

The water source of Myrtle Pond Water System is a deep well that has poor quality regarding iron and manganese. The water is pumped out the well and primary chlorination is applied prior to sand filtration. As the final stage of water treatment, the filtrated water is disinfected with secondary chlorination.

According to the 2018-Drinking Water System Annual Report for Myrtle Pond presented on the qRD website, the water system met the bacteriological compliance. No chemical sampling was conducted on that water quality report. During the reporting period in 2018, there were two water quality complaints by the consumers. The first complaint recorded as "smelly water" and the second reported red staining in the toilet and tub. The corrective action that happened for both complaints was flushing the main at hydrant #11 and at the blow-off, respectively. The water quality lab results on March 17th, 2020, reported a high level of Iron and Manganese for the Well 1-05. The aesthetic Objectives (AO) concentrations for Iron and Manganese based on Canadian Drinking Water Guidelines are 0.3 and 0.02 mg/l. Canadian Drinking Water Guidelines define the Maximum Acceptable Concentrations (MAC) for Manganese at 0.12 mg/l. The lab results showed the concentration of iron and manganese at 2.8 and 0.13 mg/L, respectively.

MSR Solutions received a water quality report of treated water. The water was sampled on October 05, 2020, and results show that the Iron and Manganese concentration of treated water were both below the AO concentration of Canadian Drinking Water Guidelines thresholds. The water sampling also did not show any issue regarding the treated water. Therefore, the oxidation of Iron and Manganese by dosing chlorine is effective for treatment purposes. It is recommended to monitor the physical/chemical water properties of raw water and treated water. It is also recommended to upgrade the current water treatment system to a higher treatment capacity with better treatment techniques to remove Iron and Manganese. One option is twinning the current plant with an alternative Iron and Manganese treatment technique. Preliminary and detailed design for this purpose and indicative cost estimate for this project is beyond the scope of this study and should be determined through a "Detailed Design and Life Cycle Cost Analysis for Water Treatment".

9.3. Projected Cost Forecast

The projects recommended for a 20-year forecast period (2021-2041) with a Class "D" cost estimation are summarized in Table 13. The magnitude cost estimation is estimated base on the current year (2021) and it has not included inflation.

As it has been mentioned before, the high concentration of Manganese in a raw water sample in March 2020, raised the concern of treatment effectiveness, but the treated water lab result shows that the treatment is adequate for the removal of Iron and Manganese. However, it is highly recommended to monitor the quality of raw and treated water and to prioritize the projects if required.

The cost per unit of expansion of the service area is assumed based on the full depth of gravel as follow:

Service	Fee Rate
150mm pipe	$250/m
Paving	$72/m
Connection	$14/m
Water service	$2,500/SFE

As per MSR Solutions experience with water treatment that dealing with iron and manganese removal, in 2014 the construction cost of water treatment at 24 USgpm was at about $487,000. With consideration building construction price indexes of Q2 2014 to Q2 2021 at about 25% (Table 18-10-0135-02 Building construction price indexes, percentage change, quarterly) and the average of 1.5% inflation rate, the construction of the same treatment plant is estimated at about $560,000 ($560,000/24Usgpm = $23,300). Adding a new treatment plant to the existing facility will require 30 Usgpm treatment capacity and on the other hand building a new treatment to accommodate the total required maximum daily flow of 78Usgpm. The estimated cost for these option is estimated at $700,000 and $1,500,000, respectively.

Table 13- Identified Projects for a period of 20-year

Project Name	Year	Estimated Cost	Contingency (50%)*	GST (5%)	Total
Expansion of service area to (31 SFE)	2025	$313,000	$156,500	$23,475	$492,975
Twinning Water Treatment	2030	$700,000	$350,000	$52,500	$1,102,500
New Water Treatment		$1,500,500	$750,000	$112,500	$2,362,500
Expansion of service remaining adjacent lots (57 SFE)	2035	$378,000	$189,000	$28,350	$595,350

* According to APEGBC Budget Guidelines for Consulting Engineering Services

Table 14- Projects Inclusion charge

Project Year	Number of Connected Dwellings to Service Area	Total Cost	Recommended inclusion charge
2025	148	$492,975	$3,331
2030	179	$1,102,500*	$6,159
2035	179	$595,350	$3,326

Note: The cost estimation is based on the current year (2021) and does not include inflation.
*Base on twinning the treatment plant

Using Table 14 and Table 1, the inclusion charge for various land use in the service area can be calculated and is summarised in Table 15.

Table 15- Inclusion charge base on land use

Land Use		Inclusion Charge
Projected 2025		
Single-family (One Dwelling)		\$3,300 (at base of 1.5 m^3/d)
Multiple Residential	(Two Dwelling)	\$6,600
	Each additional dwelling	\$3,300
Projected 2030		
Single-family (One Dwelling)		\$6,100 (at base of 1.5 m^3/d)
Multiple Residential	(Two Dwelling)	\$12,200
	Each additional dwelling	\$6,100
Projected 2035		
Single-family (One Dwelling)		\$3,300 (at base of 1.5 m^3/d)
Multiple Residential	(Two Dwelling)	\$6,600
	Each additional dwelling	\$3,300

10. Summary

MSR Solutions was retained for the Water System Capacity Assessment of the Myrtle Pond Water System. The project includes a review of the existing water boundary and potential expansion to the service area to refine the capacity of the system's wells, treatment plant, and water network.

The current boundary of the existing Myrtle Pond Water System is 84 lots which include 79 developed and 5 undeveloped lots. The current 79 developed lots contain 72 single-family and 7 multiple-family units. The 5 undeveloped lots contain 4 single-family houses and 1 commercial recreation (Lot 8063) that will be connected to the existing water network. A potential expansion of 88 single-family lots to the 84 existing lots is forecasted. The average household of the Myrtle Pond Water System has been considered at 2.2 people. The Single-Family Equivalent (SFE) of the existing water system determines 148 with an estimated population of 326. The expansion of the service area will increase the Single-Family Equivalent (SFE) to 236 with a forecasted population of 519.

For the existing water service boundary, it has been considered to hook up 4 undeveloped lots as a single-family house and 1 commercial recreation lot (Lot 8063). The expanding service area is considered 88 single-family houses on the adjacent lots.

The capacity assessment for the existing infrastructure showed that the production wells can provide about a total of 496 m^3/day and the 444 m^3 reservoir will meet the requirement for the expansion of the service area to potential adjacent lots south and east of the water service area. The maximum daily demand of full expanded service area, including hook up of all lots in the current service area and expanding to the east and south of the service area, is estimated at about 423 m^3/day (78 USGPM). Based on the B.C. Design Guidelines for Rural Residential Community Water Systems, maximum required water storage capacity, for the expanded area is calculated at 412 m^3.

The hydraulic assessment of water treatment shows that it does not have sufficient capacity for the full expansion to the south and east of the existing boundary. The treatment plant can provide adequate capacity to hook up 4 undeveloped lots as a single-family house and 1 commercial recreation lot. The remaining capacity of the treatment plant can provide up to 31 more lots or 68 more people to the service area.

The raw water of Myrtle Pond water system has poor water quality regarding Iron and Manganese. The treated water lab result provided to MSR Solutions for assessing the treatment plant shows the effectiveness of the water treatment process. However, it is recommended to monitor the quality of raw and treated water in order to be sure about the priority of required projects in the expansion of the service area.

In order to connect Centennial Drive east of the service area to the existing water service, the 100 mm Asbestos Cement pipe is required to be replaced with a 150mm PVC pipe to provide fire protection in this area.

The connection of Traffe Road south of the service area will require the extension of the water main about 700 meters with a minimum 150 mm PCV pipe with a pressure reducer chamber before lot 7917.

11. Conclusions and Recommendations

- **Water Source:**

The hydraulic assessment for Myrtle Pond Water system shows that the current water source including two wells in service (well 1-05 and well 2-08) with the total of 496 m^3/day production will meet the maximum daily demand for both existing (connecting Lot 8063 and 4 undeveloped lots) and expanded water system (connection of the Centennial and Traffe areas).

- **Water Treatment**

The current water treatment system with 286 m^3/d capacity can provide treatment for the required water demand including connecting Lot 8063 and 4 undeveloped lots. The treatment also can provide up to 31 more SFE connections or 68 people. The water treatment plant will not have enough capacity for a full expansion. Therefore, the current water treatment system is required to be upgraded to reliably supply demands for the expanded water system, or a demand management program can promote efficient water use and decrease the water demand in the service area. The estimated class "D" cost for upgrading the treatment plant by twinning the treatment capacity is anticipated at about $700,000. In this case, completing a preliminary and detailed design for this purpose and indicative cost estimate for this project through a "Detailed Design and Life Cycle Cost Analysis for Water Treatment" will be required.

- **Water Quality**

We recommend more water sampling of raw and treated water. This information can be compared to determine the effectiveness of two-stage chlorination treatment. Moreover, it is recommended to upgrade the current water treatment system to remove Iron and Manganese using a more efficient alternative technique.

- **Reservoir**

The existing reservoir in Myrtle Pond has a 444 m^3 (117,411 US gal) storage capacity. Based on the B.C. Design Guidelines for Rural Residential Community Water Systems, maximum required water storage capacity, for the expanded area is calculated at 412 m^3, therefore the existing reservoir has adequate capacity to meet the total storage requirement for the existing and expanded water system.

- **Infrastructure**

By modeling the water network distribution through EPANET software, a low level of velocity is observed which requires regular flushing to minimize settling through the pipes. This is a usual issue for the water main line that provides sufficient water for fire fighting. The pressure of the system meets the minimum requirement of B.C guidelines for all conditions, including average daily demand, maximum daily demand, peak hourly demand, and fire flows.

The water network will have enough pressure to supply the maximum daily demand but fire flow in Centennial Drive will result in negative pressure. The negative pressure means the water network system can not provide enough pressure to supply water in a case of fire. It is highly recommended to replace the 100 mm (4 inches) Asbestos Cement pipe through Centennial Drive from Pear Road to Stella Place with 150 mm (6 inches) PVC pipe as service areas are expanded to supply fire demand. This will solve the drop in pressures issue and meet the BC design guidelines. The total length of mainline replacement for Centennial Drive is estimated at 700 meters. By reviewing the current Centennial Drive Water Utility Society and the remaining expected lifetime of the pump house and storage tank in this area, it is recommended connecting this area by replacing the 100 mm AC pipe with 150 mm PVC pipe to the Myrtle Pond Water Service Area and extend the service to this area. It is currently anticipated that cost of expansion of the service area to Centennial

Drive would be about $350,000. It should mention that only 31 single-family equivalents can be connected due to the limitation of treatment capacity.

For the Traffe area, the mainline expansion requires 700 meters of 150 mm (6 inches) PVC pipe and a pressure reducer chamber to avoid excess water pressure in this area. The estimated class "D" cost is anticipated at about $350,000 in the current year. The consumers in this area rely on private wells, therefore expanding the service area is beneficial for public health. It should be mentioned again, if the Traffe area is added to the service area first, only 31 single-family equivalents can be connected due to the limitation of treatment capacity.

After expanding the service area to the south (Traffe Rd) or east (Centinennial Dr) of the current boundary, only 31 single-family equivalents can be connected to the existing infrastructures, before further expansion and upgrade of the water treatment would be required to provide sufficient capacity.

Prepared by:

Nazila Shamloo, M.Sc.,

Junior Engineer

Email: nazila@msrsolutions.ca

Prepared by:

Saman Khoddam, M.Sc.,

Lead Design

Email: saman@msrsolutions.ca

Reviewed and Approved by:

Mike Seymour, AScT, P.L.Eng.,

Principal

Email: *mike*@msrsolutions.ca

Association of Professional Engineers and Geoscientists of the Province of British Columbia
M. J. SEYMOUR
ENGINEERING LICENSEE
Limited Licence
125208
2021-09-13