Comox Valley REGIONAL DISTRICT

Staff Report

DATE: May 11, 2023

FILE: 5600-01/BCOB

TO: Chair and Director
Black Creek – Oyster Bay Services Committee

FROM: James Warren
Deputy Chief Administrative Officer

Supported by James Warren
Deputy Chief Administrative Officer

J. Warren

RE: **Black Creek/Oyster Bay Water Master Plan**

Purpose
To provide an overview of the Black Creek/Oyster Bay (BCOB) Water Master Plan.

Recommendation from the Deputy Chief Administrative Officer:
THAT staff develop an implementation strategy for all recommended actions from the Black Creek/Oyster Bay Water Local Service Area Water Master Plan dated May 4, 2023, that includes analysis of timing, water rate implications and costs for consideration as part of the 2024-2028 financial plan for the Black Creek/Oyster Bay Water Local Service Area.

Executive Summary

- A water master plan for the BCOB system was conducted in 2022 and 2023, analyzing the systems current water supply, fire flow capabilities, water demands and requirements for future growth.
- The new groundwater supply well currently under development is anticipated to enable the BCOB system to meet the projected maximum day demand of the BCOB and Watutco water systems (should they choose to join), and improve reservoir recharge performance during fire events.
- Most of the system meets minimum recommended fire flows for residences; however, significant watermain and reservoir upsizing would be required to meet industry standard fire flows for the small amount of Industrial/Commercial/Institutional (ICI) properties.
- Additional analysis of existing fire flows at key properties could reduce future capital cost requirements.
- Several watermain projects and upgrades to the existing watermain reservoirs will be required to service known larger development projects.
- Based on the outcome of the BCOB Water Master Plan an implementation plan should be developed and considered as part of the BCOB financial planning process.

Prepared by:	Concurrence:	Concurrence:
C. Leimert	*K. La Rose*	*M. Rutten*
Caley Leimert, EIT Engineering Analyst	Kris La Rose, P.Eng. Senior Manager of Water/Wastewater Services	Marc Rutten, P.Eng. General Manager of Engineering Services

Government and Community Interests Distribution (Upon Agenda Publication)

Strathcona Regional District	✔
K'ómoks First Nation	✔
Watutco	✔

Background/Current Situation

The Comox Valley Regional District (CVRD) retained Koers and Associates Engineering Ltd. to complete a water master plan for the Black Creek/Oyster Bay Water Local Service Area.

The document contains significant technical detail and its conclusions and recommendations impact multiple services within the CVRD. Staff representatives from Engineering Services, Planning and Development Services and Fire Services have reviewed the key findings and recommendations of the draft versions of the report and considered impacts on the service areas in the future. Engineering Services staff also have had multiple meetings and correspondence with Koers regarding additional water system modeling for fire flows, updated GIS mapping and analysis regarding the significant development potential within the settlement node.

Staff have already been advancing toward the development of a new well for the water system, which is also the principal recommendation of the Water Master Plan. Initial results indicate that Well No. 6 should be sufficient to meet the projected future maximum day demand for the near future and assist with increased capability to refill the reservoirs during significant fire events. Staff anticipate that this could be confirmed as early as fall 2023, allowing for the connection suspension put in place in 2021 to be lifted.

A significant amount of watermains would have to be upsized to provide industry standard fire flow requirements to relatively few ICI zoned properties located at the end of long stretches of watermains. A key recommendation of the BCOB Water Master Plan is confirming the fire flow needs for the existing ICI buildings, as it may be possible to reduce the capital cost requirements benefiting relatively few ICI properties. As detailed in the BCOB Asset Management Plan completed in 2019, watermain replacements are anticipated to start significantly increasing in the mid to late 2030s. By confirming the required sizing of the watermains in advance of the replacements, future watermains can be adequately sized over time as replacement occurs.

Several watermain projects and upgrades to the existing watermain reservoirs will be required to service known larger development projects. CVRD staff will use the findings of this report to support discussions with developers regarding servicing their specific projects. It's important to note that although several of the smaller "Active and Proposed Developments" listed within the plan are no longer under consideration or have changed, the resulting recommendations do not change as most upgrades are overwhelmingly driven by fire flow industry standards for the existing system rather than new development.

Due to the unforeseeable nature of how future development will occur, this plan did not model properties that could rezone and subdivide, which would result in a significant amount of additional connections within the settlement node. For this reason, this Water Master Plan should be updated at regular intervals in the future.

As development occurs, two additional groundwater wells will eventually require implementation to ensure existing well physical and license capacity is not exceeded. Regular updates of the Water Master Plan will help ensure that demand doesn't exceed supply.

Options

The committee has the following options regarding the future level of service of the BCOB Water Local Service Area.

1. Direct staff to implement recommendations in the Water Master Plan where possible with existing staff resources and to begin developing detailed financial plan impacts of full adoption to be included within the 2024-2028 financial plan for the Black Creek/Oyster Bay Water Local Service Area.
2. Direct staff to implement recommendations in the Water Master Plan only where possible with existing staff resources.

For effective use of rate-payer revenue, and to continue planning for significant development within the settlement node, Option 1 is recommended.

Financial Factors

Implementing the report's recommendations comes with significant financial consideration for the service. This staff report recommends utilizing existing resources and funding to begin and continue work on some of the more immediate needs, such as pursuit of the new well and continued discussions with the Fire Service, followed by the development of an implementation strategy for all recommended actions, which includes analysis of timing, water rate implications and costs to be reflected in and considered as part of the 2024-2028 financial plan for the BCOB Water Local Service Area.

Strategic Considerations: Strategic Drivers and Regional Growth Strategy

CVRD Board Strategic Drivers:							
Fiscal Responsibility	✔	Climate Crisis and Environmental Stewardship and Protection	✔	Community Partnerships		Indigenous Relations	✔

The CVRD Board has set four strategic drivers to guide service delivery and the Water Master Plan is in alignment with each of these drivers in the following ways.

Fiscal Responsibility

- By confirming the watermain and reservoir upsizing recommendations of this report through carrying out fire flow calculations, there is the potential to save on watermain replacement costs that may be unnecessary and unequitable.

Climate Crisis and Environmental Stewardship and Protection

- Confirmation of the collective dry season sustainable yield of all wells and investigation into the possibility of setting up emergency temporary low head pump intake in the Oyster River will allow the service to respond better to changes in climate.

Indigenous Relations

- In 2018, the CVRD and K'ómoks First Nation (K'ómoks) signed a Mutual Benefit Agreement confirming cooperation and collaboration in the management of water resources in the region. The CVRD operates under an Indigenous Relations Framework and has adopted a Statement of Reconciliation with Indigenous Peoples that focuses on four main themes: self-determination, shared prosperity, protecting cultural heritage and relationship with land and water. The United Nations Declaration on the Rights of Indigenous Peoples recognizes the right of Indigenous people to connect with, and protect, land and waters in their traditional territories and participate in decision-making that affects their rights.

CVRD Regional Growth Strategy Goals:							
Housing	✔	Ecosystems, Natural Areas and Parks	✔	Local economic development	✔	Transportation	
Infrastructure	✔	Food Systems		Public Health & Safety	✔	Climate Change	✔

Black Creek/Oyster Bay is one of the three settlement nodes identified by the Regional Growth Strategy (RGS) to accommodate compact forms of development. MG Policy 1B-1 of the RGS states that growth in the settlement nodes shall be accommodated through a balance of new development, intensification and improvements to public infrastructure including the provision of appropriate water services.

By increasing the pumping capacity and staging watermain replacements over time, the Water Master Plan will provide affordable, effective and efficient infrastructure in balance with responding to the increased housing demand and local economic development.

By increasing the number of loops in the water system and increasing the available fire flows, the Water Master Plan supports a high quality of life through the protection and enhancement of community health through improved water quality and public safety through improved fire service capability.

By pursuing additional water supplies and water licenses outside of the influence of the Oyster River, the Water Mater Plan supports important aquatic ecosystems and fish habitat.

Intergovernmental Factors

Early on in the development of the BCOB Water Master Plan, CVRD staff reached out to Strathcona Regional District (SRD) planning staff who confirmed that no major developments were currently anticipated in SRD lands within the BCOB Water Local Service Area. As stated above, the majority of watermain upgrades are required to meet existing fire flow industry standards rather than responding to specific developments. Should new significant developments within SRD arise, they can be quickly reassessed using Koers Engineering Ltd.'s updated water model for the water service.

The CVRD recognizes there is nothing more sacred to the K'ómoks people than water. Access to water is critical for the exercise of traditional rights and necessary for the physical, cultural, and spiritual survival of the K'ómoks First Nation. The CVRD also recognizes K'ómoks as an important partner in water management with unique legal status in relation to lands and waters. K'ómoks is not a watershed stakeholder, but rather one of three levels of government, with rights related to land and water protected through the Canadian Constitution. *The Constitution Act, 1982*, which sets the rights and freedoms of Canadians, similarly protects the rights of Indigenous peoples. Indigenous rights include the right to fish, hunt, develop economically, and practice one's own culture. K'ómoks espouses the four pillars: authority, jurisdiction, governance, and management over natural resources within the territory.

The CVRD is seeking direction from K'ómoks Chief and Council to determine if there is an interest in the key findings of this report and how K'ómoks would like to engage with the CVRD as planning for the long-term future of the service continues.

Interdepartmental Involvement
Engineering Services has led this work in consultation with Planning and Development Services and Fire Services to evaluate the broader impacts of the Black Creek/Oyster Bay Water Master Plan's key findings and recommendations.

Citizen/Public Relations
Should the committee approve the recommendations within this report, a press release will be issued and a dedicated web page will be created to inform the public about the key planning process outcomes and current fire flow capabilities of the service

Attachments: Appendix A – Black Creek/Oyster Bay Water Master Plan

Comox Valley
REGIONAL DISTRICT

Black Creek / Oyster Bay Water Local Service Area

Water Master Plan

Final Report (Rev 1)
May 4, 2023

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& ASSOCIATES
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Consulting Engineers

PARKSVILLE, BC

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May 4, 2023
File: 2134-02

Comox Valley Regional District
770 Harmston Avenue
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Attention: **Mr. Kris La Rose, P.Eng.**
Senior Manager of Water/Wastewater Services

Re: Comox Valley Regional District
Black Creek/Oyster Bay Water Local Service Area
Water Master Plan - FINAL REPORT (Rev 1) -

Koers & Associates Engineering Ltd. is pleased to submit a pdf copy of our report entitled: Black Creek/Oyster Bay Water Local Service Area Water Master Plan – Final Report. The comments we received from the CVRD on the Draft Report submission have been incorporated into this final report.

The water modelling analysis performed during this assignment, and the findings presented in this report, are based on water system demand data recorded up to September, 2021.

The principal findings of the report are:

Water Licence & Future Growth

- The water system presently services 975 properties. The BC/OB water system is presently operating well below the authorized limits (maximum day and total annual) of its water licence. It is estimated that the servicing of up to 792 additional properties could be accommodated under the existing authorized limits based on the current average annual demand per water service connection. These 792 additional properties might consist of:
  - i) Properties not yet connected to the system (51 connections)
  - ii) Properties with current zoning subdivision potential (215 connections)
  - iii) Active and proposed developments (526 connections)
- While there is no specify timeframe on when all of the potential 792 additional properties might be connected to the water system, it is estimated that it would take several decades.
- It is estimated that the 129 properties presently serviced by the Watutco water system could be accommodated under the existing BC/OB water licence, with some additional development.

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- It is estimated that the existing BC/OB water licence limits would not be sufficient to service the addition of both the Watutco customers and the estimated 792 future additional properties. If the water licences that are issued to Watutco were transferred to the BC/OB water system, the authorized limit for maximum day under the current licences would be adequate but the total annual limit is projected to be slightly exceeded (by 4%). Future groundwater wells that are proven not to be hydraulically connected to the Oyster River will likely be granted additional water licence capacity, which will cover this shortfall.

Water Supply Capacity

- The pumping capacity of the BC/OB wells reduces during the summer months as the groundwater level drops and the flow in the Oyster River decreases.
- The production capacities of the wells have been published with factors of safety ranging from none to 30%. A combined longterm sustainable yield for the water supply sources has not been developed. For this study, five dry season operational scenarios were considered for varying combinations of pumps operating (or not operating) and with varying factors of safety. The resulting total daily production volume ranged from a low of 2,376 m^3/day (Scenario No. 4) to a high of 3,432 m^3/day (Scenario No. 1). For the purposes of this Water Master Plan, Scenario No. 2 (with a total daily production volume of 3,048 m^3/day) was selected to assess the ability of the water system to meet future maximum day design demands during the dry season.
- The production capacity under Scenario No. 2 (3,048 m^3/day) is estimated to be sufficient to meet the current maximum day demand of the BC/OB water system (2,308 m^3/day) plus the assumed maximum day demand of the Watutco water system (600 m^3/day).
- To meet the projected maximum day demand of the combined BC/OB and Watutco water systems and the future addition of 792 properties, an additional source production capacity of a minimum of 1,000 m^3/day (11.6 L/s) would be required.

New Water Supply Source

- Since the submission of the Draft Report last year, the CVRD has commenced detailed design for the development of a new groundwater supply well. The hydrogeology report for this well (Well No. 6) indicates a calculated sustainable yield of 1,142 m^3/day (approx. 48 m^3/hr) during drought conditions.

Fire Fighting Capabilities

- Computer modelling indicates that the delivery of the land-use based recommended minimum fire flows are available throughout most, but not all, of the distribution system. The delivery of fire flows is limited by pipe diameters, lack of watermain looping, and dead-ended mains. Upsizing of existing mains and the installation of new watermains (totaling more than 15 kms) have been identified as follows:

  i) Current conditions 12,010 m
  ii) Future (build-out) conditions 2,500 m

…/3

Comox Valley Regional District
Mr. Kris La Rose, P.Eng.

iii) Addition of Watutco 850 m

- The delivery of the 150 L/s fire flow demand is responsible for most of the proposed current conditions watermain upgrade projects.
- Computer modelling indicates that a major fire (150 L/s for 2 hours) during the maximum day demand, when the production capacity of the water supply sources is reduced, will have a significant impact on the water storage reservoirs as follows:
  - i) The Macaulay Road Reservoir will be almost completely drained and will not return to a full water level until 62 hours (2.5 days) after the end of the fire flow demand.
  - ii) The Kelland Road Reservoir will be completely drained and remain empty for almost 2 hours. It will return to a full water level in 9 ½ hours.
- The performance of the reservoirs will improve as more supply capacity is added to the system. The reservoir performance would also be improved if a maximum fire flow demand, lower than the current recommended land-use base minimum of 150 L/s for 2 hours, could be established for the water system.

Other Potential Development

Since submission of the Draft Report last year, the CVRD has indicated the potential for additional development applications within the BC/OB water system that would be over and above the 792 additional connections accounted for in this Water Master Plan. The ability to service other potential development should be reviewed and assessed as the applications are made, or in future updates to the Water Master Plan. The review may require additional water modeling as well as an assessment of the capacity of the water supply sources to meet the projected design demand and the ability to service the proposed development within the authorized licenced withdrawal limits.

We have appreciated the opportunity to be of service to the CVRD on this interesting assignment and we would be pleased to assist in the implementation of the recommendations in this report.

Yours truly,

KOERS & ASSOCIATES ENGINEERING LTD.

Chris Holmes, P.Eng.
Project Engineer

Mitch Brook, P.Eng.
Water Modelling Specialist

Matt Palmer, P.Eng.
Project Manager

Permit to Practice No. 1001658
Enclosure

Comox Valley REGIONAL DISTRICT

Black Creek/Oyster Bay Water Local Service Area

Water Master Plan

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APPENDICIES

1 INTRODUCTION

1.1 Authorization

The Comox Valley Regional District (CVRD) authorized Koers & Associates Engineering Ltd to prepare a Water Master Plan for the Black Creek/Oyster Bay Water Local Service Area. The study work was to be carried out in accordance with our proposal dated June 17, 2021.

1.2 Study Need

The CVRD is receiving a significant number of development application proposals for lands within the Black Creek/Oyster Bay Water Local Service Area, which includes the lands contained within the servicing boundary shown in **Figure 1**. The CVRD is concerned about the ability of the existing water supply sources (Oyster River infiltration gallery and groundwater supply wells) to meet current peak demands during very dry summers when the river and groundwater levels are lower. As a result, the CVRD is not considering applications for new connections to the Black Creek/Oyster Bay water system until the current capacity of the water supply has been re-evaluated and the ability of the distribution system to accommodate additional connections is better understood.

At the time this Water Master Plan was being prepared, the CVRD was continuing to pursue options related to:

- The development of additional high-capacity groundwater supplies.
- The interconnection of the Black Creek/Oyster Bay and the WATUTCO water systems, which may provide access to additional licenced capacity on the Oyster River.

1.3 Study Objectives

The primary objectives of this Water Master Plan are to:

- Develop an understanding of the current water supply capacity and need for additional supply,
- Examine historical meter data and compare current system demands to available water supply capacity,
- Review current annual demands, per connection demands and the water system's percentage of non-revenue water, compare them with those of other fully metered water systems on Vancouver Island, and if they are considered to be high, assess potential reduction targets.
- Perform water modelling on the existing system and identify upgrading works necessary to meet current design standards,
- Develop future water demands based on a defined level of growth (provided by the CVRD), and compare future demands to the existing licenced withdrawal limits,
- Perform water modelling and identify upgrading works necessary, if any, to accommodate the future development,

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CLIENT: COMOX VALLEY REGIONAL DISTRICT

PROJECT: BLACK CREEK/OYSTER BAY WATER LOCAL SERVICE AREA WATER MASTER PLAN

TITLE: BLACK CREEK/OYSTER BAY & WATUTCO SERVICE AREAS

APPROVED	
DATE	NOV 2021
PROJECT No.	2134
SCALE	1: 30,000
DWG No.	FIGURE 1

- Consider the addition of the WATUTCO water system and assess the potential impacts to the BC/OB water system.

1.4 Core Tasks

The core tasks carried out during preparation of this Water Master Plan include the following:

1 Water Supply Capacity & System Overview

i) Develop an understanding of the current water supply capacity and potential for additional supply.

ii) Detailed review of the Black Creek/Oyster Bay and WATUTCO surface water supplies, groundwater supplies (existing and potential).

iii) Review of the individual pump curves, and an overview of existing treatment, treated water storage reservoirs, pressure reducing valve, booster pump station, distribution piping, and pressure zones.

2 Current Water Demands (Black Creek/Oyster Bay and WATUTCO)

i) Detailed review of the existing bulk and individual water meter records to establish current demands and estimate the level of system leakage occurring within the distribution system at this time.

ii) Compare current system demands to available water supply capacity.

iii) Review current annual demand per connection demands and the water system percentage of Non-Revenue water, compare them with those of other fully metered water systems on Vancouver Island, and if they are considered to be high, assess potential reduction targets.

iv) Consider the addition of the WATUTCO water system and assess the potential impacts to the BC/OB water system

3 Existing Distribution System Modelling (Black Creek/Oyster Bay and WATUTCO)

i) Update the existing WaterGEMS computer model of the Black Creek/Oyster Bay water system to reflect current conditions.

ii) Perform water modelling and identify upgrading works necessary, if any, for the combined single system to meet current design standards

iii) Calculation of system pressures under peak hour demands, determining available fire flows under maximum day demands, and comparing the current reservoir storage volume with the recommended minimum reservoir storage volume.

iv) Available fire flow and peak hour pressure maps will be produced for the entire water system.

v) A schematic plan showing the proposed improvement works will also be provided.

4 Future Growth & Demand Projections

i) Establish future growth projections associated with infill of existing service areas and any proposed land development projects that are currently known about and may be added to the system in the future.

ii) Estimate where future growth is likely to occur so that additional demands can be distributed throughout the water system as realistically as possible to allow modelling of this future demand condition.

5 Distribution System Modelling Under Future Demands

i) Perform water modelling and identify upgrading works necessary, if any, to accommodate the future development.

ii) Calculation of system pressures under peak hour demands, available fire flows under maximum day demands, and assessment of water storage volume capacity compared to the recommended minimum volume when system demands reach the defined level of growth established in **Task 4**.

iii) Available fire flow and peak hour pressure maps will be produced for this future demand condition. A plan showing the proposed improvement works (if needed) will also be provided.

1.5 Reference Documents

In the preparation of this report, several published documents were utilized, which are listed on the next page in **Table 1**.

1.6 Acknowledgements

Koers & Associates Engineering Ltd. acknowledges with thanks the assistance provided by the following CVRD Staff in the preparing of this report:

- Kris La Rose, P.Eng. Senior Manager of Water/Wastewater Services
- Caley Leimert, EIT Engineering Analyst

Table 1 – Reference Documents

No.	Report Description	Date	Author
Black Creek / Oyster Bay Water Local Service Area			
Water Source Production Capacity			
1	*Production Well No. 5 Development & Yield Rating*	*Jan 2021*	*GW Solutions*
2	*Groundwater Availability Assessment within the Oyster River Nature Park & interactions with Oyster River*	*Dec 2020*	*GW Solutions*
3	*Water Supply System*	*Jan 2020*	*GW Solutions*
4	*Water Infiltration Gallery*	*Mar 2019*	*GW Solutions*
5	*Groundwater Asset Characterization*	*Sep 2015*	*GW Solutions*
Water System			
6	*Technical Memorandum No. 1 BC/OB & Watutco Water Source Review*	*May 2020*	*Koers & Associates Engineering Ltd.*
7	*Water System Update*	*Jul 2010*	*Koers & Associates Engineering Ltd.*
8	*Water System Study of Interconnection with Watutco*	*Dec 1996*	*Koers & Associates Engineering Ltd.*
9	*Water System Study*	*June 1992*	*Koers & Associates Engineering Ltd.*
	Watutco Water System		
10	*Technical Memo, Watutco Water System Assessment, Rev. 4*	*Oct 2018*	*McElhanney Consulting Services Ltd.*
	Water System Design Standards		
11	*MMCD Design Guidelines, 2014*	*2014*	*Master Municipal Construction Documents Association*
12	*Water Supply For Public Protection, A guide to recommended practice in Canada*	*2020*	*Canadian Insurance Industry, OPTA Information Intelligence*

2 WATER SUPPLY & SYSTEM OVERVIEW

2.1 Black Creek/Oyster Bay Water Supply Sources

The Black Creek / Oyster Bay water system obtains water by two means: three groundwater supply wells and an infiltration gallery installed within the river bed of the Oyster River. Submersible well pumps are installed in the groundwater wells and inside pump sumps that were drilled below the wet well that the river infiltration gallery is connected to. The pumped water is treated at the nearby water treatment building before entering the water distribution system. The wells, infiltration gallery and water treatment building are located within the Oyster River Nature Park near the mouth of the Oyster River (on the north side) as shown in **Figure 2**.

2.1.1 Oyster River Infiltration Gallery

The river infiltration gallery system consists of:

- 50 m of 450 mm dia. corrugated HDPE perforated pipe
- 1,800 mm dia. concrete wet well c/w two drilled & cased pump sumps
- two 60 hp submersible well pumps

The steel casings that were drilled in the floor of the wet well act as sumps for the two 60 hp submersible well pumps. One casing is 600 mm dia. and the other is 450 mm dia. The casings extend approximately 3.5 m below the floor of the wet well.

The infiltration gallery, concrete wet well, 600 mm dia. steel casing, and the original 100 hp well pump were installed in 1993; replacing a river infiltration gallery system constructed in 1983 and located approximately 25 m upstream. In 2010, the 450 mm dia. steel casing was added and a 60 hp submersible well pump was installed inside the new casing. The original 100 hp pump inside the 600 mm dia. casing was removed and replaced with a 60 hp submersible pump, identical to the pump in the new casing.

The two well pumps in the infiltration gallery are referred to as Well No. 2A and Well No. 2B. Relevant well characteristics of the infiltration gallery are presented in **Table 2** and the infiltration gallery's location is shown in **Figure 2**.

2.1.2 Groundwater Wells

There are three active groundwater supply wells: Well No. 1, Well No. 4 and Well No. 5. A summary of the characteristics of each well is presented in **Table 2** and the location of each is shown in **Figure 2**.

Base airphoto image from SRD on-line UMapIt GIS (accessed July 16, 2021)

Figure 2 – Black Creek/Oyster Bay Water Supply Sources & Water Treatment Building Location

Table 2 – Water Supply Well Characteristics

Well No. (1)	Tag No. (1)	Identification Plate No. (1)	Year Drilled (1)	Casing Diameter (1) (mm)	Well Depth (1) (m)	Screen Length (2) (m)	Elevation (geodetic) (2)				Aquifer No. (1)
							Top of Casing (m)	Top of Screen (m)	Pump Intake (m)	Lowest Water Level (3) (m)	
Groundwater Supply Wells											
1	39039	14341	1978	250	12.8	3.7	6.47	- 2.64 (1)	-2.50	- 2.0	412
4	85474	14343	2003	300	13.5	3.5	6.13	- 1.34	- 4.46	- 3.3	412
5	122231	61171	2020	500	13.1	3.0	7.46	-3.21 (2)	- 3.15	- 2.8	412
Oyster River Infiltration Gallery Wells											
Wet Well	-	-	1993	1800	3.5	n/a	3.16	n/a	n/a	0.0	Oyster River
2A	-	-	1993	600	± 3.7	n/a	-0.26	n/a	- 1.70	0.0	Oyster River
2B	-	-	2010	450	± 3.5	n/a	-0.16	n/a	- 1.70	0.0	Oyster River

Notes:

1 Data obtained from BC Government Groundwater Wells and Aquifers website https://apps.nrs.gov.bc.ca/gwells

2 Elevations are shown on the following Record Drawings:

Koers & Associates Engineering Ltd.

- Well No. 1 Reconstruction Details dwg no. 0336-216 Rev 4 Jan 15, 2010
- Well No. 2 Reconstruction Details dwg no. 0336-215 Rev 3 Jan 15, 2010
- Well No. 4 Construction Details dwg no. 0336-213 Rev 3 Jan 15, 2010

McElhanney Consulting Services Ltd.

- Well No. 5 Details, New Water Production Well dwg no. 0336-214 Rev 4 Jan 15, 2010

3 The lowest water level elevation is the worst case pumping scenario in which the water in the well casing has dropped down to a level that the well pump is close to shutting down, or the pump needs to be shut off to avoid cavitation. This is the water pumping elevation that has been used when modelling the flow of water between the wells and the reservoirs.

2.1.3 Pump Curves

Based on the information we have in our files, we understand the make/model/horsepower of the five submersible well pumps currently supplying water to the Black Creek/Oyster Bay water system are as listed in **Table 3**.

Table 3 – Black Creek / Oyster Bay Well Pumps & Motor Horsepowers

Well No.	Pump		Motor (hp)
	Manufacturer	Model	
1	Grundfos	300 S 400 - 10	40
4	Grundfos	300 S 400 - 10	40
5	Grundfos	385 S 400 - 5	40
2A	Grundfos	475 S 500 - 6A	60
2B	Grundfos	475 S 500 - 6A	60

The pump curves for these pumps are contained in **Appendix A**. These are the curves that have been input into the updated computer water model for the Black Creek/Oyster Bay water system. When water levels in the well casings start to drop significantly, operators reduce the pump flows by adjusting the variable frequency drives that are used to control each pump motor. When performing extended time modelling, adjustments are made to the curves in the water model as needed to match the dry season rated capacity that is selected for a particular well.

2.2 Black Creek/Oyster Bay Water Licences

The Comox Valley Regional District is the holder of two water licences on the Oyster River. One licence (503625) is issued for the Black Creek / Oyster Bay water system and encompasses all of the existing water supply sources, i.e., Well 1, Well 4, Well 5 and Well 2A/2B (river infiltration gallery). The authorized annual and maximum day withdrawal limits are noted in **Table 4**.

Table 4 – Black Creek / Oyster Bay Water System Water Licence

Licence No.	Priority Date	Licenced Withdrawal Limit		Equivalent Ave Day m^3/day
		Maximum Day m^3/day	Annual m^3/year	
C503625	May 24, 1985	3,637	497,797	1,364

Recent hydrology reports assessing the production capacity of the existing groundwater supply wells in the wellfield indicate that the aquifer they withdraw water from is hydraulically linked to the Oyster River. The CVRD has indicated that the provincial government will be issuing a new water licence for the groundwater supply wells and the withdrawal of water from all the existing wells is to be covered by the CVRD's existing surface water licence.

The CVRD also holds a second water licence (C121084). This licence is issued specifically for the withdrawal of water at Archer Road for fire protection from a river intake and fire hydrant on Archer Road which is located more than 6 kms beyond (west of) the Black Creek / Oyster Bay Local Water Service Area boundary.

2.3 Treatment of Well Supplies

The location of the Oyster Bay/Black Creek water treatment facility is shown in **Figure 2** and **Figure 3**. All water pumped from the groundwater wells and the infiltration gallery is combined together and treated with UV, caustic soda (for pH adjustment), and chlorine prior to entering the distribution system. Currently the CVRD alternates between two independent UV reactors, operating one at a time. Each reactor has a reported minimum and maximum design flow capacity of 23 L/s and 42.1 L/s (1,990m^3/day and 3,637 m^3/day).

All piping between the wells and the outlet of the water treatment plant has been included in the updated water model for the Black Creek/Oyster Bay water system.

2.4 Potable Water Reservoirs

The Black Creek/Oyster Bay water system has two existing potable water reservoirs. These are referred to as the Macaulay Road and Kelland Road Reservoirs. The location of the reservoirs is shown in **Figure 3** and the physical characteristics of each reservoir is shown in **Table 5**.

Table 5 – Water Storage Reservoir Characteristics

Reservoir	Year Built	Shape	Type	Dia. (m)	Height (m)	Volume (m^3)	Top Water El. (m)	Floor El. (m)
Macaulay Rd	2011	Circular	GLBS	11.94	16.35	1,830	86.1	69.75
Kelland Rd	2016	Circular	GLBS	5.11	23.1	475	113.3	90.20
					Total Storage Volume:	2,305		

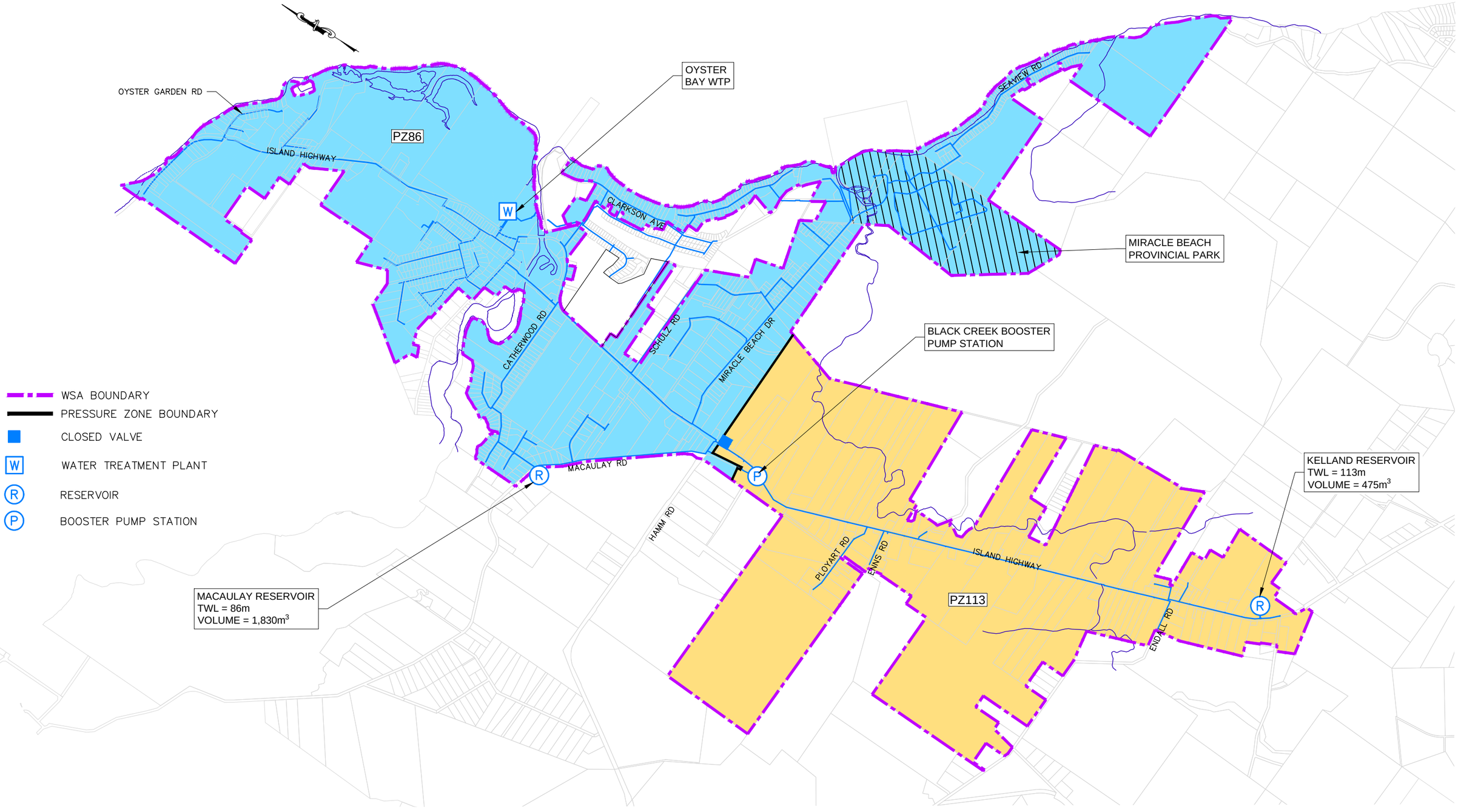
Notes:
GLBS = Glass Lined Bolted Steel

Both reservoirs are included in the updated water model for the Black Creek/Oyster Bay water system. The pumps in the groundwater wells and the infiltration gallery are controlled according to the water levels in the Macaulay Road Reservoir.

2.5 Distribution System

2.5.1 Water Mains

The BC/OB water distribution system consists of approximately 37.8 kms of watermain piping and 975 water service connections. All the water services are metered. A breakdown of the piping by material and diameter is presented in **Table 6**.



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CLIENT: COMOX VALLEY REGIONAL DISTRICT

PROJECT: BLACK CREEK/OYSTER BAY WATER LOCAL SERVICE AREA WATER MASTER PLAN

TITLE: BLACK CREEK/OYSTER BAY EXISTING WATER SYSTEM

APPROVED	
DATE	NOV 2021
PROJECT No.	2134
SCALE	1: 30,000
DWG No.	FIGURE 3

Table 6 – Pipe Lengths by Material and Diameter

Dia. mm	Pipe Length (m)			Total
	PVC	AC	Other	
100	960		25	985
150	1,085	9,100	290	10,475
200	3,300	16,900	1,450	21,650
300	1,610	2,610	360	4,580
400		95	5	100
Total	6,955	28,705	2,130	37,790

Dia. mm	Pipe Length as % of Total			Total AC
	PVC	AC	Other	
100	2 %		> 1 %	3 %
150	3 %	24 %	1 %	28 %
200	9 %	45 %	4 %	57 %
300	4 %	7 %	1 %	12 %
400		> 1 %		> 1 %
Total	18 %	76 %	6 %	100 %

All existing watermain piping has been included in the updated water model for the Black Creek/Oyster Bay water system.

2.5.2 Water System Pressure Zones

The two pressure zones in the Black Creek/Oyster Bay water system are referred to as PZ 86 and PZ 113. The areas covered by each pressure zone are illustrated on **Figure 3**. Water pumped from the groundwater wells and infiltration gallery flows through the distribution system of PZ 86 on its way to fill the Macaulay Road Reservoir. The Black Creek Booster Pump Station transfers water directly from the PZ 86 distribution system into the PZ 113 distribution system, which in turn fills the Kelland Road Reservoir. The pump station is controlled according to the water levels in the Kelland Road Reservoir. The pumping characteristics of the Black Creek Booster Pump Station are shown in **Table 7** and the pump station's location is shown in **Figure 3**.

Table 7 – Pumping Characteristics for the Black Creek Booster Pump Station

Location	Pump				Pump Capacity [1] (L/s @ TDH)
	No. of	Make	Model	Hp	
86 m to 113 m HGL					
8527 Island Hwy (19a)	Two	Grundfos	CR90-1	15	18.9 L/s @ 35 m

Notes:

1 Based on the computer model, one pump provides 18.9 L/s at a Total Dynamic Head (TDH) of 35 m and two pumps provide 25.6 L/s at 40.6 m (TDH) during Maximum Day.

The pump curve for the two booster pumps is contained in **Appendix A**. This is the curve that has been input into the updated computer water model for the Black Creek/Oyster Bay water system. The Total Dynamic Head on the discharge side of the booster pumps will drop during a fire flow condition in PZ 113 and the booster pumps will be able to pump higher flows than are indicated in **Table 7**.

The Black Creek Booster Pump Station also has a pressure sustaining feature that prevents the booster pump(s) from pulling down the hydraulic grade line of PZ 86 below a predetermined set point.

2.6 Water Conservation Initiatives

The following water conservation initiatives are currently in place or promoted within the Black Creek/Oyster Bay water system:

- Watering restrictions take place automatically in the spring according to a four stage watering schedule that is initiated on May 1 each year.
- Micro/drip irrigation is promoted through the four stage watering schedule, which does not limit the use of this type of irrigation during some of the water restriction periods.
- Residential and commercial water meters are currently in place and stepped billing rates are applied to each metered account.
- Low flow fixtures, nature scaping, smart irrigation controllers and leak checking are promoted on a dedicated webpage located on the CVRD's website.

3 DESIGN CRITERIA

In establishing the servicing capabilities of a water supply and distribution system, three levels of water demands are normally considered, in addition to fire flows. These are:

Average Day Demand	=	$\frac{\text{Total annual consumption}}{\text{365 days}}$
Maximum Day Demand	=	Day with highest demand for the year
Peak Hour Demand	=	Highest flow rate maintained for one hour (generally occurring on maximum day of the year)

3.1 Water Supply

The water supply source(s) must be capable of meeting the maximum day demand. Peak hour demands and fire flow demands are to be covered by the emergency storage that is built into the potable water storage reservoirs.

3.2 Water Storage

Water reservoirs perform three functions:

- storage for fire fighting
- storage for emergencies (such as a watermain break)
- storage for equalization to manage hourly peaks in demand

The storage volume requirements will be calculated using the following, generally accepted, formula from the "Design Guideline Manual, 2014" from the Master Municipal Contract Document (MMCD) Association:

Storage Volume = A + B + C

where:

A = Fire Storage	Fire flow from MMCD Design Manual & fire duration from Fire Underwriters Survey Guide
B = Equalization (Peaking) Storage	25% of Maximum Day Demands
C = Emergency Storage	25% of [A + B]

The requirement for Emergency Storage (C) can be reduced or eliminated based on several factors, including: water source dependability, reliability of the supply system (e.g. gravity vs pumped, duplication of mains and treatment, standby emergency power), multiple sources, more than one storage reservoir, and reservoir water circulation needs. It is recommended that the full amount of the emergency storage component be included in the Black Creek/Oyster Bay water storage reservoir volumes.

3.3 Water Distribution System

The water distribution system must be capable of delivering all demands, as well as delivering fire flow demands during maximum day demands, while operating within acceptable pressure ranges.

3.3.1 System Pressures & Watermain Diameters

The adequacy of the distribution system for various demand conditions is judged by the residual pressures available throughout the system and by the maximum velocities in the watermains. The criteria that are typically applied to assess the distribution system are listed in **Table 8**.

Table 8 – Distribution System Design Criteria

Parameter	Value	
Pressures & Velocities		
Under Peak Hour Demand Conditions		
Minimum residual pressure at property line	300 kPa	(44 psi)
Maximum velocity in watermains	2.0 m/s	(6.6 ft/s)
Under Fire Flow Demand Conditions (during Maximum Day Demands)		
Minimum residual pressure at hydrant	150 kPa	(22 psi)
Maximum velocity in watermains	3.5 m/s	(11.5 ft/s)
Minimum residual pressure at property line	35 kPa	(5 psi)
Under Static Conditions		
Maximum service pressure	860 kPa	(125 psi)
Pipe Diameter		
Minimum pipe diameter up to hydrant	150 mm	

3.3.2 Fire Flow Requirements

Fire flow requirements are typically based on guidelines published by MMCD and the "Water Supply for Public Fire Protection" by the Fire Underwriters Survey (FUS).

The FUS fire flow requirements vary depending on building design, floor area, number of stories, construction materials, if a fire sprinkler system is installed, fire break walls, and spacing from adjacent buildings (exposure). The duration for which a fire flow is to be provided increases as the flow increases. For example, a fire flow of 33 L/s (2,000 L/minute) or less is to be sustained for at least 1 hour and a fire flow of 200 L/s (12,000 L/minute) is to be sustained for 2.5 hours, according to FUS. The FUS recommends that a water system be capable of providing the design fire flow during maximum day demands, while maintaining a minimum residual pressure 150 kPa (22 psi) in the watermain.

The application of target fire flows for commercial and industrial applications can vary widely depending on the building's design, age, size, use, exposures, the materials utilized for construction, and whether a sprinkler system has been installed. Typically, the required flow rates are determined using FUS criteria at the time of design, and if necessary, improvements to the municipal system are undertaken by the developer as required to achieve the desired fire flow.

It is challenging to determine a specific target number for commercial and industrial land uses in existing rural areas, as the fire flow requirements for each facility will vary. For the purposes of this report, we have used the MMCD fire flow guidelines according to land-use and the FUS fire flow durations, as presented below in **Table 9**.

Table 9 – Fire Flow Demand by Land-Use

Land-Use	Recommended Minimum Fire Flow & Duration	
	MMCD Fire Flow (L/s)	FUS Fire Duration (hrs)
Single/Two Family Residential	60	1.5
Light Industrial	150	2
Commercial	150	2
Institutional	150	2

4 WATER SUPPLY CAPACITY REVIEW

4.1 Water Supply Capacity Requirement

When considering the capacity of a water supply that provides potable water to a community, one must ensure that maximum day demands can be met under all conditions. On Vancouver Island, maximum day demands usually occur during the summer dry season. These high demands typically occur during periods of low precipitation, lower groundwater levels, and low stream flows.

The Black Creek/Oyster Bay water supply does not have large volumes of surface water storage in the form of dams or natural lakes, and therefore all of the raw water supply must be obtained directly from the local aquifer and the natural flow of surface water available in the Oyster River. Maximum day demands during the dry season have to be met even when groundwater tables are depressed and stream flows are very low.

The amount of water extracted from the existing groundwater wells (Well 1, 4 and 5) and the river infiltration gallery (by Well 2A/2B) must not exceed the CVRD's current water licence. Consequently, until such time as new water supplies are developed that are not hydraulically connected to the Oyster River, development within the Black Creek/Oyster Bay water system has to be controlled according to two water supply criteria:

i) the water supply that is currently available during the dry season must be sufficient to meet maximum day demands, and

ii) maximum day demands must fall within the CVRD's current water licence.

The CVRD is actively working on developing new well supplies that are located far enough away from the river that they will not have to be included under the existing water licence.

4.2 Water Supply Currently Available to Black Creek/Oyster Bay During Dry Season

Table 10 lists the historical well capacity ratings for the five wells that currently supply raw water to the Black Creek/Oyster Bay water system. When reviewing operational well pumping scenarios during the dry season, we considered the following:

- Historical testing and operational experience suggest that running groundwater Well No. 1 and Well No. 4 at the same time should be minimized. If these two wells are operated at the same time during the dry season, the capacities of Wells No. 1 and No. 4 will have to be significantly de-rated.

- During the low river levels experienced in 2014, the water level in Well No. 2A/2B was drawn down to the point where the pumps had to be shut off due to low water levels in the two well casings. Based on observations made in 2014, it has been suggested that alternating between the groundwater supplies and the river infiltration gallery will likely improve this situation. Therefore, operating Wells No. 1, 4 and 5 (in any combination) at

the same time as Well No. 2A/2B (continuously over a long duration) should not be counted on as a reliable operational scenario during an extended dry period.

- During the summer of 2021, the actual flows that could be pumped from Well No. 5 suggest that a rating of 40 m^3/hr may be more appropriate during the dry season.

- It is not uncommon for submersible pumps/motors to breakdown and require replacement. Larger pumps and motors can have significant delivery times and it can take weeks to obtain and replace one of these pumps or motors. In the summer of 2021, there was a significant amount of time that the CVRD had to rely entirely on the groundwater wells while the two pump motors in the infiltration gallery were replaced. Based on this experience, it is good practice to assume one of the higher production wells may be unavailable to operate over an extended period during the dry season. This risk could be mitigated by ensuring sufficient back-up pumps and motors are readily available in storage. Having such a back-up plan in place would reduce the down time should one of the high production wells experience a pump or motor failure. Infiltration Gallery Wells No. 2A/2B are already fully redundant because they have the same pumps and motors, and only one pump is operating at any given time. Redundancy could also be achieved on the groundwater wells by purchasing one 40 hp back-up motor and two separate models of back-up pumps and putting these in storage. Having the replacement pump and/or motor readily available would allow a repair to occur relatively quickly on an individual well during an emergency.

Table 10 – Water Supply Sources Capacity Rating History

No.	Report Date	Well Rating m^3/hr	Well Rating m^3/day	Description	Data Source	Page No.	Author
		Well 1					
1	1978/79	n/a			Well log record (no flow rate listed)		
2	Feb 2004	66	1,572	Summertime, with Well 4 operating	BCOB Water Supply, conclusions	12	EBA Engineering
	Feb 2004	73		Wintertime, with Well 4 operating	BCOB Water Supply, conclusions	12	EBA Engineering
3	Sep 21, 2015	72		No safety factor	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		51		30% safety factor	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		49	1,176	No safety factor, with Well 4 operating	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		34	816	30% safety factor, with Well 4 operating	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		Well 4					
4	1978/79	n/a			Well log record (no flow rate listed)		
5	Oct 16, 2003	30			Well log record		Fyfe's Well Drilling
2	Feb 2004	53		Sustainable yield estimate	BCOB Water Supply, Table 5	8	EBA Engineering
		35	838	Sustainable yield est. with Well 1 operating	BCOB Water Supply, Table 4	8	EBA Engineering
3	Sep 21, 2015	25		No safety factor	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		18		30% safety factor	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		10	240	No safety factor, with Well 1 operating	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		7	168	30% safety factor, with Well 1 operating	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		Summertime, Well 1 & 4 Operating Simultaneously					
2	Feb 2004	100	2,411	Sustainable yield estimate			
3	Sep 21, 2015	59	1,416	No safety factor	Well 4 24 hr pump test report, Table 8	21	GW Solutions
	Sep 21, 2015	41	984	30% safety factor	Well 4 24 hr pump test report, Table 8	21	GW Solutions
		Well 5					
6	Jan 7, 2021	45	1,080	Sustainable yield estimate, during lowest water conditions and 20% safety factor	20" production well & two 6" test wells , Table 7	29	GW Solutions
		57	1,368	Sustainable yield estimate, during lowest water conditions and no safety factor	20" production well & two 6" test wells , Table 7	29	GW Solutions
		73	1,752	Sustainable yield estimate, during highest water conditions and no safety factor	20" production well & two 6" test wells , Table 7	29	GW Solutions
7	Oct 26, 2021	40	960	Summertime Sustainable yield estimate from Summer 2021	Observations by CVRD Operations Staff	-	-
		Well 2a/2b (Infiltration Gallery)					
8	March 2019	128.4		Max Flow, 2016 369,800 m^3/year	CVRD Water Infiltration Gallery	5	GW Solutions
		128.0		Max Flow, 2017 378,500 m^3/year	CVRD Water Infiltration Gallery	5	GW Solutions
		124.4		Max Flow, 2018 368,100 m^3/year	CVRD Water Infiltration Gallery	5	GW Solutions
				It does not appear that capacity has decreased	CVRD Water Infiltration Gallery, Conclusions	9	GW Solutions

Note: During dry season (Jun 1- Nov 1), it is recommended that Well 1 not operate when Well 4 is operating (GW Solutions report dated Sep 21, 2015).

4.3 Selection of Dry Season Well Supply Operational Scenario

Table 11 lists the well supply operational scenarios that may be possible when operating the Black Creek / Oyster Bay water system during the dry season. The total estimated volume of water that could be supplied each day under the five scenarios is also provided in **Table 11**. This information is presented graphically in **Figure 6** (located after page 21).

To plan for future development, it is necessary to select the dry season well supply operational scenario that will have the highest likelihood of producing the volume of water needed to meet the maximum day demands of the water system when all approved service connections are in place. When selecting the water supply scenario that best represents the dry season water supply capacity available in the Black Creek/Oyster Bay water system, we have considered the following:

Operational Scenario No. 1

Scenario No. 1 is the most optimistic of the five dry season water supply options, producing 3,432 m^3/day. This scenario does assume Well No. 1 and Well No. 4 would be operating at the same time, with a 30% safety factor applied to their capacities. However, based on the difficulties experienced in 2014 when Well No. 1 and Well No. 4 were operated at the same time, it may be overly optimistic to assume this method of operation can be sustained during a very dry summer when the new well (Well No. 5) is also operating continuously and the infiltration gallery is operating 50% of the time.

Operational Scenarios No. 3 and No. 4

Scenario No. 3 and No. 4 do not include any contributions from the infiltration gallery. Basing the ultimate water supply capacity on Scenarios No. 3 or No. 4 could be construed as being overly cautious for the following reasons:

- Based on observations made in 2014, resting the infiltration gallery improved the capacity of this water supply and enabled some water to be pumped from Well 2A/2B.
- A more stringent level of watering restrictions can be applied during an extremely dry summer in order to reduce demands.
- As discussed later in the report, water supply capacity is compared to the highest maximum day demand on record. The maximum day demand does not typically repeat itself day after day over long durations, particularly when watering restrictions are in place. **Figure 8**, which is introduced later in the report, shows the monthly average day demands during the 2021 dry season were much lower than the actual Maximum Day.
- Improvements to the existing infiltration gallery could be made to improve the low water conditions experienced in the past.
- During an emergency it may be possible to set-up a temporary low head pump intake directly into the Oyster River and divert surface water into the Well 2A/2B concrete

manhole chamber. A temporary plug could be used to plug off the infiltration gallery piping to prevent pumped surface water from flowing back out into the infiltration gallery piping.

Operational Scenarios No. 2 and No. 5

Scenario No. 2 assumes that Well No. 1 is completely offline and not removing any groundwater from the aquifer. This maximizes the distance between the two groundwater wells that are operating and minimizes well interference. Well No. 4 is operating at less than half of the capacity that was observed this summer when Well No. 1 was shut off. Well 2A/2B is resting 50% of the time, which will help re-saturate the river gravels around the 450 mm dia. perforated gallery piping during low river levels. Scenario No. 5 is considered a much more conservative operational scenario and yet it produces almost the same volume of water as Scenario No. 2.

After reviewing the existing water supplies currently available in the Black Creek/Oyster Bay water system, we recommend basing the maximum number of water connections in this water system according to Dry Season Well Supply Operational Scenario No. 2, until such time as additional water sources can be developed or obtained, or until additional well testing shows otherwise. As the pumping flows observed at Well No. 5 were lower than expected during the summer of 2021, the CVRD should consider having the sustainable yield estimate for this well re-evaluated next time pump testing is carried out in the well field.

Using Dry Season Well Supply Operational Scenario No. 2, extended time modelling of maximum day demands and two fire flow conditions (during maximum day demands) is carried out to see how the existing Macaulay Road and Kelland Road Reservoirs react and recover during these events. This discussion is presented in **7.4 Extended Time Modelling**.

Based on the implementation of Dry Season Well Supply Operational Scenario No. 2, a discussion on the water supply capacity that is available for additional water connections is presented in **10.4.5 Supply Source Capacity** and shown graphically in **Figure 20** and **Figure 21**.

Table 11 – Black Creek / Oyster Bay Dry Season Well Supply Operational Scenarios

Dry Season Operational Scenario	Well No. 1				Well No. 4				Well No. 5			Well No. 2A/2B		Total Daily Volume Available m^3/day
	No Safety Factor	30% Safety Factor	No Safety Factor, with Well 4 On	30% Safety Factor, with Well 4 On	No Safety Factor	30% Safety Factor	No Safety Factor, with Well 1 On	30% Safety Factor, with Well 1 On	No Safety Factor, Lowest Water Conditions	20% Safety Factor, Lowest Water Conditions	Summer 2021 Based on CVRD Flow Observations	Typical River Flow	Year 2014, Wells 2A/2B Operate 50% of the time	
Flow Rate (m^3/hr)	72	51	49	34	25	18	10	7	57	45	40	124	62	
No. 1 (m^3/day)	1,728	1,224	1,176	**816**	600	432	240	**168**	1,368	1,080	**960**	2,986	**1,488**	**3,432**
No. 2 (m^3/day)	1,728	1,224	1,176	816	**600**	432	240	168	1,368	1,080	**960**	2,986	**1,488**	**3,048**
No. 3 (m^3/day)	**1,728**	1,224	1,176	816	600	432	240	168	1,368	1,080	**960**	2,986	1,488	**2,688**
No. 4 (m^3/day)	1,728	1,224	**1,176**	816	600	432	**240**	168	1,368	1,080	**960**	2,986	1,488	**2,376**
No. 5 (m^3/day)	50% Operate **864**	1,224	1,176	816	600	432	240	168	1,368	1,080	50% Operate **480**	2,986	**1,488**	**2,832**

General Notes:

The well capacity ratings in this table are based on the information presented in Table 10.

The highlighted numbers beside each operational scenario represent the well capacity rating that has been included in that particular scenario.

Description of Operational Scenarios:

Scenario No. 1 has Groundwater Wells No. 1 and 4 operating together with the 30% safety factor, the capacity of Well No. 5 is based on the low flows observed in 2021, and the Infiltration Gallery Wells (No. 2A/2B) are operated 50% of the time.

Scenario No. 2 has Well No. 1 out of service, Well No. 4 is operating without the safety factor because Well No. 1 is off, the capacity of Well No. 5 is based on the low flows observed in 2021, and the Infiltration Gallery Wells (No. 2A/2B) are operated 50% of the time.

Scenario No. 3 has Well No. 4 out of service, Well No. 1 is operating without the safety factor (because Well No. 4 is off), the capacity of Well No. 5 is based on the low flows observed in 2021, and the Infiltration Gallery Wells (No. 2A/2B) are shut off due to extreme low river levels.

Scenario No. 4 has Wells No. 1 and 4 operating together at the lower rating without the safety factor (because the Infiltration Gallery Wells are shut off), the capacity of Well No. 5 is based on the low flows observed in 2021, and the Infiltration Gallery Wells (No. 2A/2B) are shut off due to extreme low river levels.

Scenario No. 5 has Wells No. 1 and No. 5 operating 50% of the time without the safety factor (because Well No. 4 is off and the Groundwater Wells are not operating full time), and the Infiltration Gallery Wells (No. 2A/2B) are operated 50% of the time. In this scenario, the groundwater wells are never operating at the same time as the Infiltration Gallery Wells.

5 WATER DEMANDS REVIEW

5.1 Historic Demands

A detailed review of bulk and individual water meter records was carried out to establish historic demands and estimate the amount of non-revenue water in the system.

5.1.1 Total Annual, Average Day & Maximum Day

A review of the daily bulk meter records for Year 2014 to Year 2021 show demands are highest in the summer months and lowest in the late fall/early winter months. Between Year 2014 and 2017, total annual demand rose each year for a cumulative increase of 42,300 m^3 (11%). This was followed over the next three years, to the end of year 2020, by a cumulative decrease of 39,700 m^3 and then by an increase of 43,600 m^3 (13%) for Year 2021. It is noted that Year 2021 experienced lower than average rainfall from February through August (as recorded at the Environment Canada Comox Airport weather station) as well as extreme and sustained day and night-time temperatures during the "heat dome" event from late June to mid July.

Maximum day demand occurred between the end of May to beginning of August, with five of the eight years occurring in July. The highest maximum day demand was this year (July 5, 2021) at 2,308 m^3/day. This occurred just after Stage 2 Water Restrictions were brought into effect. This was well below the maximum day licenced withdrawal limit of 3,637 m^3/day. The highest recorded maximum day demand and the maximum day licenced withdrawal limit are compared to the five dry season well supply operational scenarios in **Figure 6.** Since 2014, the lowest maximum day demand occurred in year 2019 (May 28) and amounted to 1,872 m^3/day.

Total annual, average day, and maximum day demand for each year are presented in **Table 12** and are shown graphically in **Figure 4**. Daily demands from 2014 through 2021 are shown in **Figure 5**.

Table 12 – Black Creek/Oyster Bay Annual, Ave and Max Day Demands, 2014 - 2021

Year	Annual Demand m^3	Average Day m^3/day	Maximum Day		Max Day Ave Day Ratio
			m^3/day	Date	
2014	**337,600**	**925**	2,014	July 9	2.17
2015	350,300	960	1,876	July 4 – 6	1.95
2016	365,900	1,000	2,224	June 29	**2.24**
2017	379,900	1,041	2,080	July 30	2
2018	367,800	1,008	2,014	August 9	2
2019	356,200	976	**1,872**	May 28	**1.92**
2020	340,200	930	1,926	July 27	2.07
2021	**383,700**	**1,051**	**2,308**	July 5	2.20
Licenced Withdrawal Limit (Water Licence C61430)					
-	497,797	-	3,637	-	-

Notes:

1 **Bold red numbers** indicate **highest value** of all of the years
2 **Bold blue numbers** indicate **lowest value** of all of the years

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Black Creek / Oyster Bay
Annual, Average Day, Maximum Day Demands
2014 - 2021

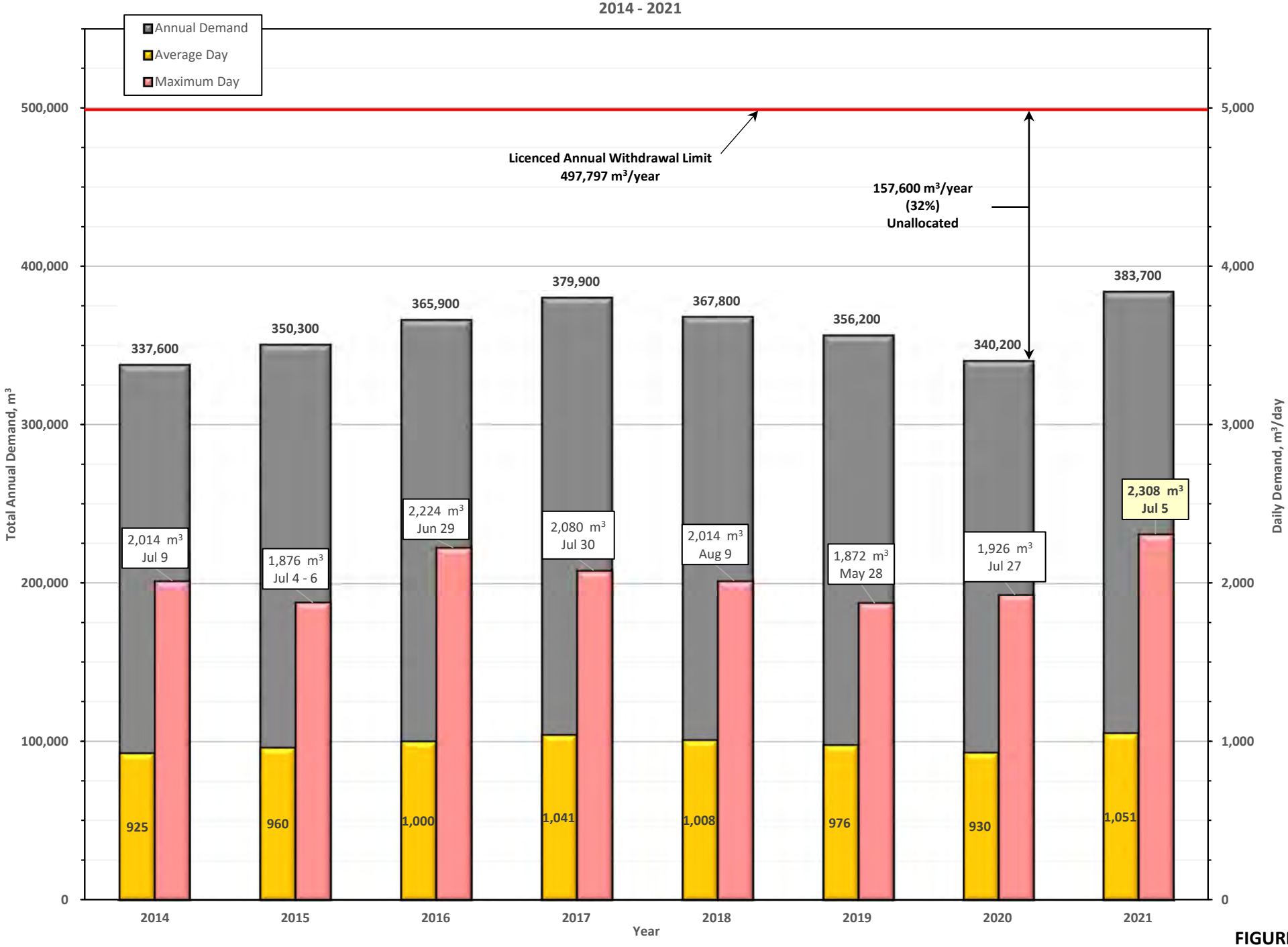

FIGURE 4

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Black Creek / Oyster Bay
Water System Daily Demand
2014 - 2021

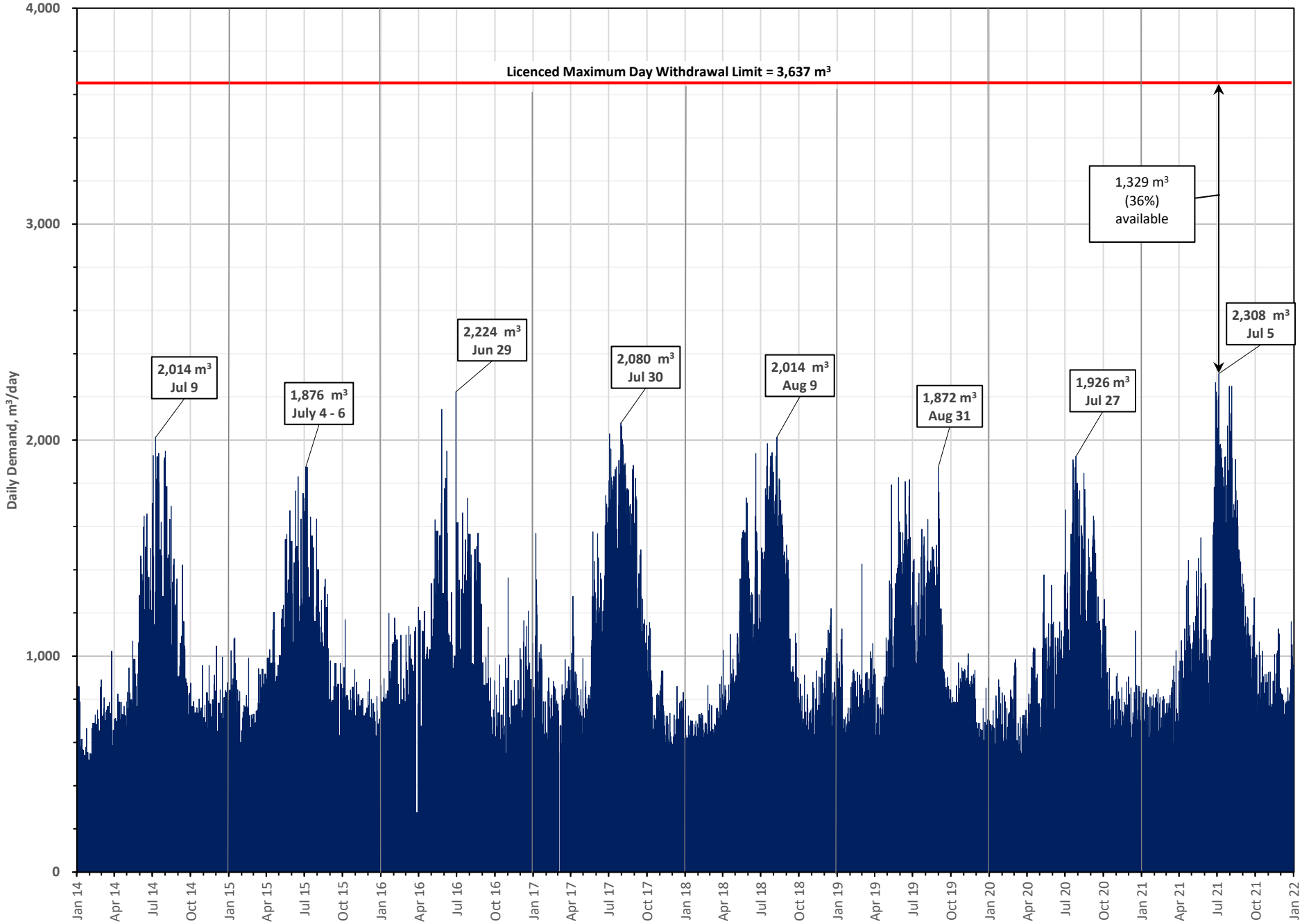

FIGURE 5

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Black Creek / Oyster Bay Water Supply

Comparison of Dry Season Water Supply Operational Scenarios to Maximum Day Demand and Licenced Maximum Day Withdrawal

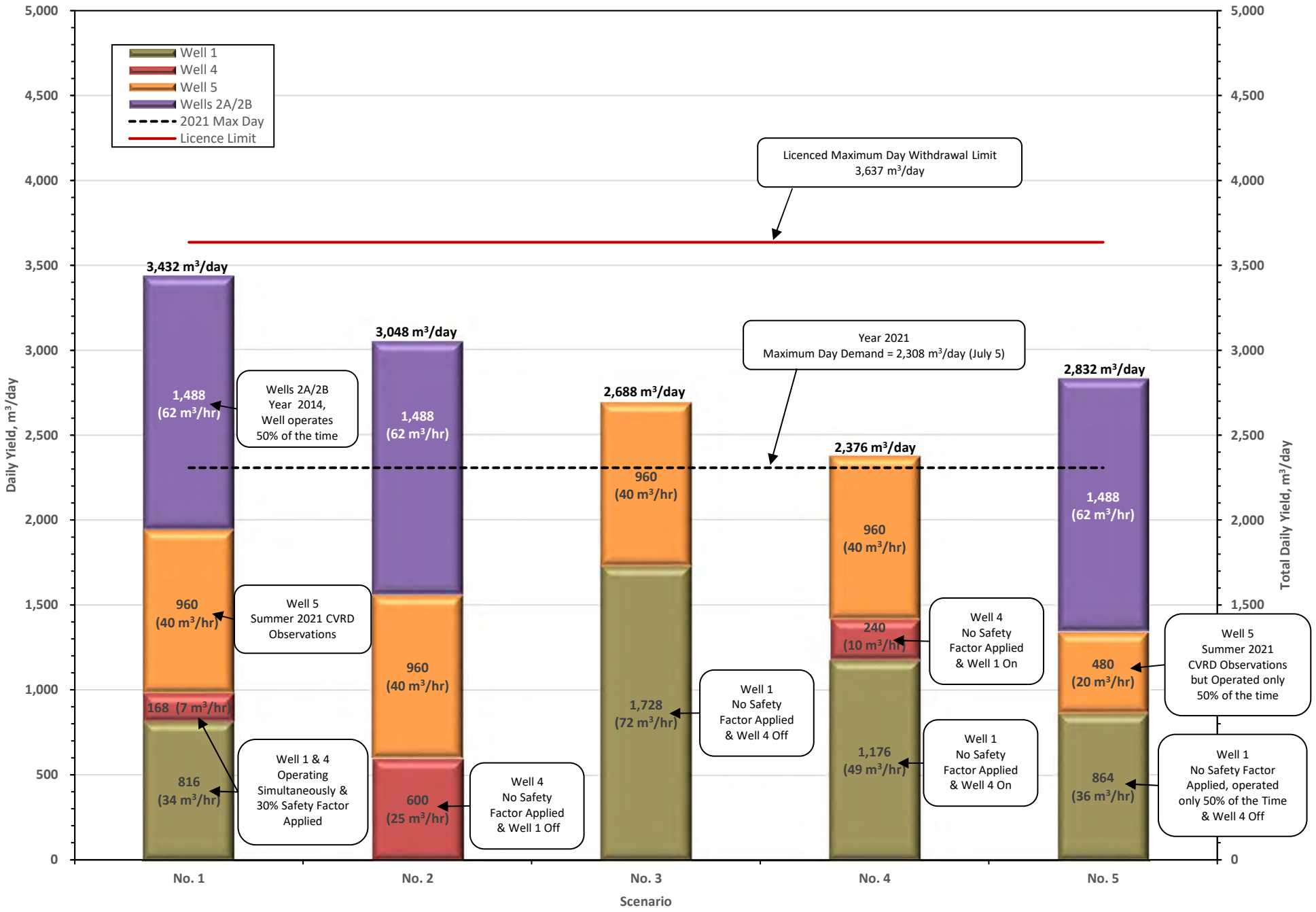

FIGURE 6

5.1.2 Monthly

The highest demand month was most often July for six (6) of the last eight (8) years. The lowest demand month was most often February as it has only 28 or 29 days. When the number of days in each month are accounted for, the lowest monthly average day demand occurred in December and January (three (3) times for each). The monthly total and monthly averaged day demand for the past eight years are presented in **Table 13** and graphically shown in **Figure 7** and **Figure 8**.

Table 13 – Black Creek/Oyster Bay Monthly Demands, 2014 – 2021

Month	Monthly Demand (1), m^3								8 Year Ave
	2014	2015	2016	2017	2018	2019	2020	2021	
Jan	18,800	25,200	25,900	27,500	19,500	23,200	20,700	21,000	22,700
Feb	**18,300**	20,300	25,100	20,600	18,700	21,500	20,000	19,900	20,600
Mar	22,400	24,900	26,100	22,800	21,800	25,800	20,700	22,700	23,400
Apr	21,100	28,300	30,500	24,700	25,100	22,700	24,800	29,300	25,800
May	26,900	39,600	43,000	29,400	39,800	37,800	29,600	34,800	35,100
Jun	41,100	41,800	36,500	40,500	37,900	42,500	29,600	40,000	38,700
Jul	48,700	43,100	41,400	54,500	51,300	38,900	45,700	**57,700**	47,700
Aug	42,500	34,400	40,300	54,200	50,400	42,300	44,500	49,000	44,700
Sep	28,300	23,800	24,000	38,900	29,800	30,100	37,200	32,300	30,600
Oct	22,700	25,100	21,500	25,300	22,500	25,100	24,500	26,900	24,200
Nov	23,000	21,700	23,500	21,100	22,700	26,000	21,000	25,800	23,100
Dec	23,800	22,000	28,100	20, 400	28,100	20,300	21,800	24,300	23,600
Total	337,600	350,200	365,900	379,900	367,600	356,200	340,100	383,700	360,200

Month	Monthly Average Day Demand (2), m^3/day								8 Year Ave
	2014	2015	2016	2017	2018	2019	2020	2021	
Jan	**605**	815	835	890	630	750	670	675	733
Feb	655	725	865	735	670	770	690	685	724
Mar	720	805	840	735	705	830	670	735	755
Apr	705	945	1,015	820	835	760	825	975	861
May	870	1,275	1,390	950	1,285	1,220	955	1,125	1,133
Jun	1,370	1,390	1,215	1,350	1,265	1,415	985	1,335	1,292
Jul	1,570	1,390	1,335	1,760	1,655	1,255	1,475	**1,860**	1,538
Aug	1,370	1,110	1,300	1,745	1,625	1,365	1,435	1,580	1,442
Sep	945	795	800	1,295	995	1,005	1,240	1,075	1,019
Oct	730	810	695	820	725	810	790	865	781
Nov	765	725	785	700	760	865	700	860	770
Dec	770	710	905	660	905	655	705	785	762

Notes:

1 Total monthly demand rounded to nearest 100 m^3

2 Monthly averaged day demand rounded to nearest 10 m^3

3 Orange shading indicate highest value for that year and blue shading indicates lowest value for that year

4 **Bold red number** indicate **highest value** and **bold blue number** indicate **lowest value** of all of the years

5 The Black Creek-Oyster Bay water system has a four stage water restriction schedule with the 1st two stages automatically occurring every year. Stage 1 begins on May 1st as indicated by the light yellow shading of May and June. Stage 2 begins on July 1st as indicated by the bright yellow shading. Stage 3 and Stage 4 are implemented when necessary as noted in the image below (from the CVRD's website):

Black Creek-Oyster Bay Watering Schedule

Residential lawn and garden watering is permitted with a sprinkler during the specified days and hours as follows:

STAGE	STARTS	HOURS	Mon	Tues	Wed	Thu	Fri	Sat	Sun
1	Starting May 1	5-8 am & 7-10 pm	No Watering	Even Address	Odd Address	Even Address	Odd Address	Even Address	Odd Address
2	Starting July 1	6-8 am & 8-10 pm	No Watering	Even Address	Odd Address	No Watering	No Watering	Even Address	Odd Address
3	When Notified	6-8 am & 8-10 pm	HAND WATERING OR MICRO/DRIP IRRIGATION OF TREES, SHRUBS, FLOWERS AND VEGETABLES ONLY						
4	When Notified	N/A	NO WATERING						

Hand watering or micro/drip irrigation of trees, shrubs and vegetables is permitted anytime during Stage 1 and 2.

For the eight year period of 2014 to 2021, the maximum month averaged daily demand was slightly more than double (2.12) the minimum month averaged daily demand (1,538 m^3/day vs 724 m^3/day) as shown in **Table 13**.

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Black Creek / Oyster Bay
Monthly Demands
2014 - 2021

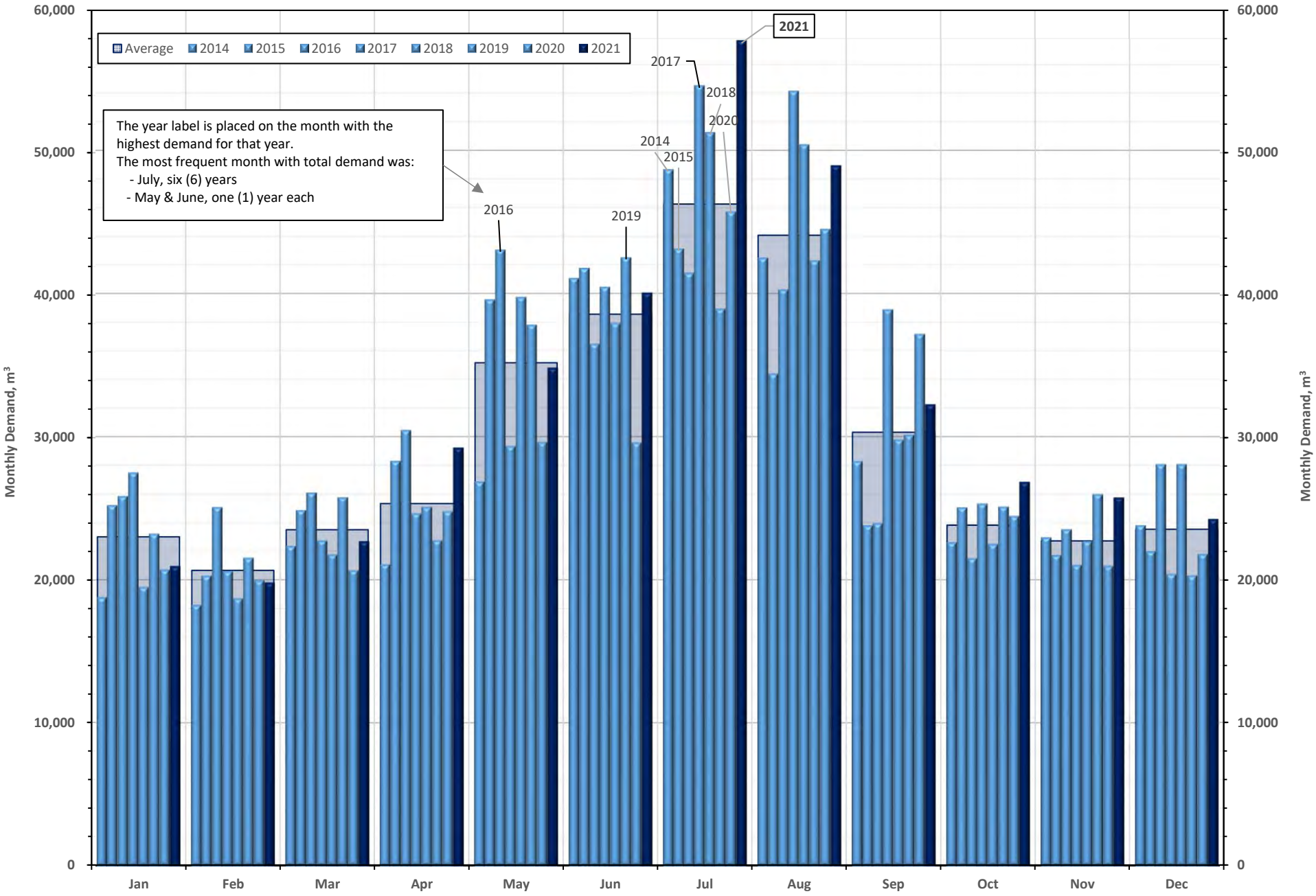

FIGURE 7

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Black Creek / Oyster Bay
Monthly Average Daily Demand
2014 - 2021

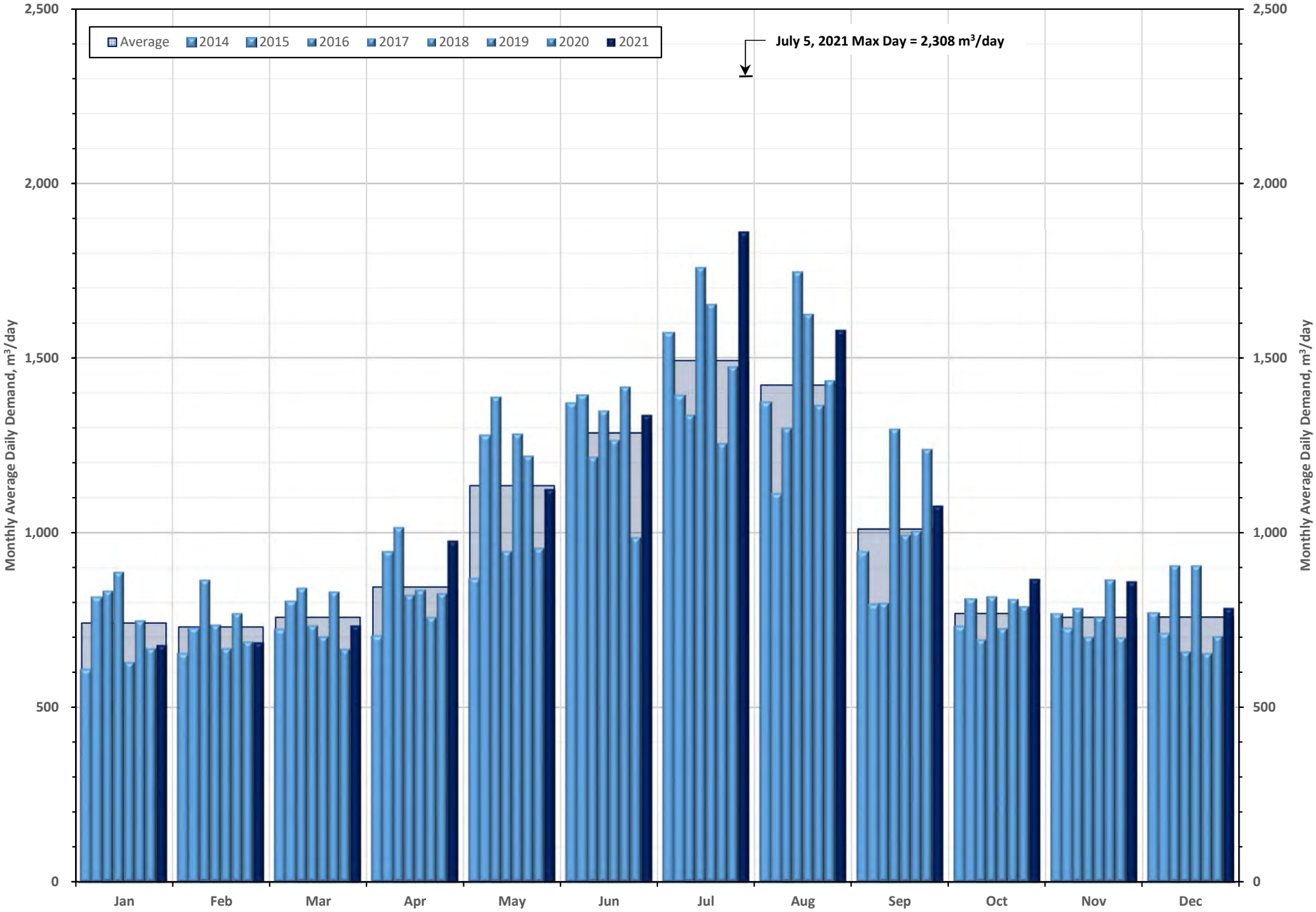

FIGURE 8

5.2 Property Demands

A detailed review of water demands by land-use was carried out using the individual meter reading records. Properties were assigned one of two categories:

- Single Family residential 96% of all properties
- Institutional/Commercial/Industrial (I/C/I 4% of all properties

Individual water meters are read quarterly (once every three months). A comparison of total annual demand, number of connections, and annual demand per connection for the past three years (2018 – 2020) is presented in **Table 14**.

Table 14 – Annual Demands by Land-Use, 2018 - 2020

Description	Year			3 Year Average
	2018	2019	2020	
Total Annual Demand, m^3 (1)				
SF residential (2)	236,500	229,900	242,500	236,300
I/C/I (3)	51,100	46,100	41,000	46,100
Combined Total	287,600	275,000	283,500	282,400
Number of Service Connections				
SF residential	934	934	934	934
I/C/I	41	41	41	41
Combined Total	975	975	975	975
Annual Demand Per Connection, m^3/connection (4)				
SF residential (3)	255	245	260	255
I/C/I (4)	1,245	1,125	1,000	1,125
Combined Total	295	280	290	290

Notes:

1 Rounded to nearest 100 m^3.
2 SF residential = Single Family Residential.
3 I/C/I = Institutional/Commercial/Industrial. This encompasses all properties that are NOT zoned SF residential.
4 Rounded to nearest 5 m^3.

5.2.1 Single Family Residential Properties

The following observations are made regarding metered demand for Single Family Residential properties (**Table 14**) and from a detailed analysis of metered demands for Year 2019 which is graphically shown in **Figure 9**:

- Single Family Residential service connections (934) account for 96% of all service connections (975).

- Single Family Residential demand accounts for approximately 84% of the total annual metered demand.

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Black Creek/Oyster Bay
Single Family Water Meters
Individual Annual Demand, 2019

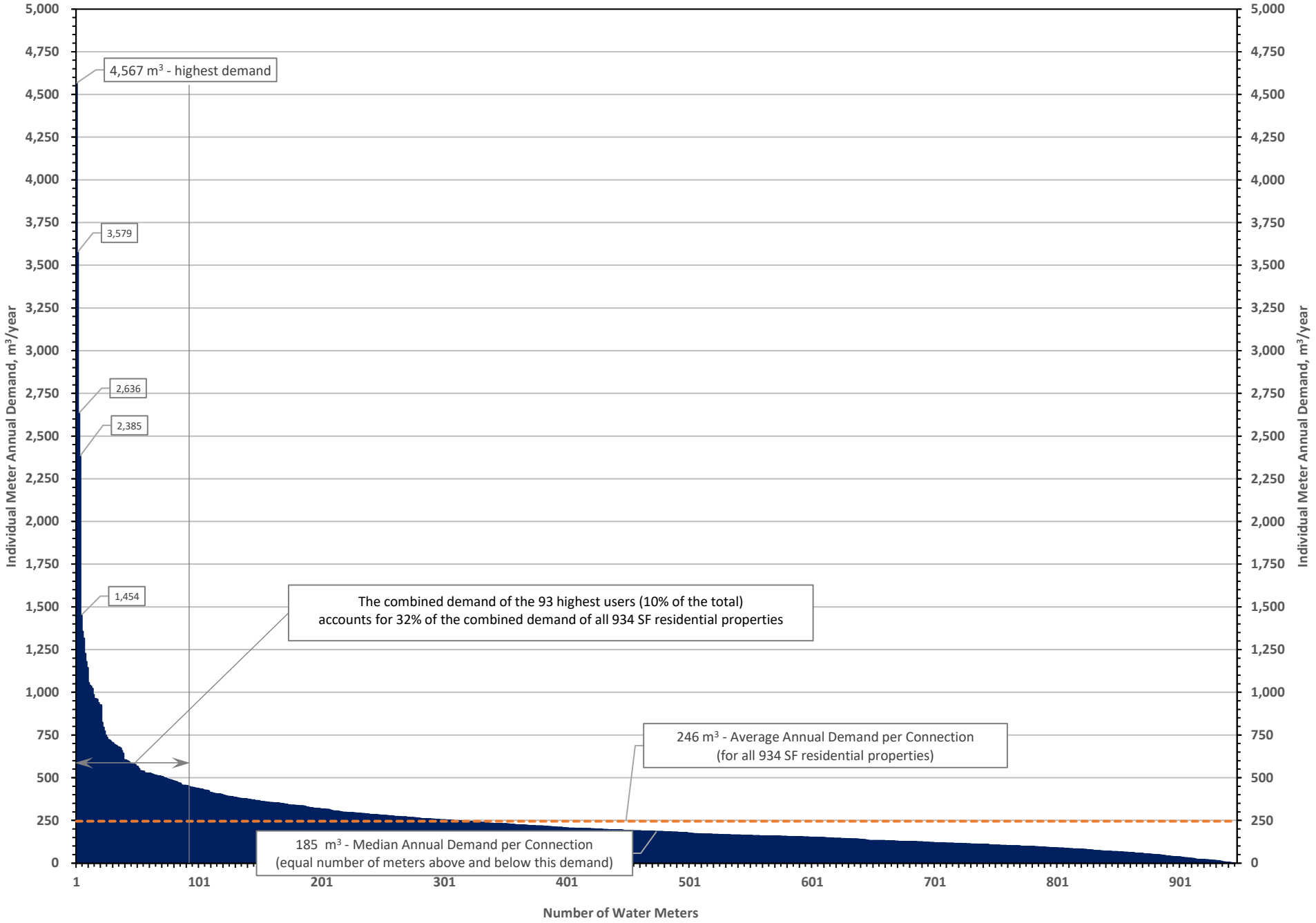

FIGURE 9

- For Year 2019 (**Figure 9**), the following observations were made:

  i) The average annual demand per connection (total demand divided by the number of meters) was 246 m^3/year.

  ii) The median annual demand per connection (equal number of meters above and below the demand) was 185 m^3/year.

  iii) The combined demand of the 93 highest single family residential users (10% of the total) accounted for 32% of the total demand of all single family residential properties. These percentages are not unexpected and are consistent with several other similar (primarily residential) universally metered mid-Vancouver Island water systems.

5.2.2 I/C/I Properties

The following observations are made regarding metered demand for Institutional / Commercial / Industrial properties (**Table 14**):

- I/C/I service connections (41) account for 4% of all service connections (975).
- I/C/I demand accounts for approximately 16% of the total annual metered demand.
- During the past three years, the I/C/I demand decreased by 10% (5,000 m^3) each year.

5.3 Non-Revenue Water

5.3.1 Definition & Calculation

Water usage in a water system can be divided into two categories, Revenue Water and Non-Revenue Water which are defined as:

- Revenue Water: Water that is metered and paid for
- Non-Revenue Water: Water that is used and not paid for

Non-Revenue water is made up of three components:

- *Unbilled Authorized Consumption + Apparent Losses + Real Losses*

The water used in each of these three categories can be partitioned into several sub-categories as noted below:

Unbilled Authorized Consumption

- Watermain flushing
- Sewer main flushing
- Fire department training and fire fighting
- Public boulevard and playfield irrigation

Apparent Losses

- Water theft
- Metering Inaccuracies

Real Losses

- Leakage on transmission mains and distribution mains
- Leakage on service connections before the customer's meter

For a universally metered water system, the Non-Revenue Water Demand can be calculated using the following equation:

Non-Revenue Water = Bulk Meter – All Individual Meters

The amount of Non-Revenue Water averaged 20% over the past three years (2018-2020), ranging from a high of 23% in Year 2019 to a low of 17% last year (2020). This is very similar to the 21% calculated for Year 2015. The Non-Revenue calculation for Year 2015 and Years 2018-2020 is presented in **Table 15** and graphically shown in **Figure 10**.

Table 15 – Non-Revenue Water, 2015 & 2018 - 2020

Description	Year			
	2015	2018	2019	2020
Annual Demand [(1)] (m^3)				
Entire System Demand	350,300	367,800	356,200	340,200
Individual Metered Demand	276,000	287,600	276,000	283,500
Difference (Non-Revenue Water)	74,300	80,200	80,200	56,700
as % of Entire System	21 %	22 %	23 %	17%

Notes:

1 Annual demand rounded to nearest 100 m^3

The sources of Non-Revenue Water cannot be definitively established at this time. Section 5.3.2 (below) compares the amount of Non-Revenue Water in the BC/OB water system to other mid-Vancouver Island water systems.

5.3.2 BC/OB and Other Island Water Systems

A review of ten universally metered water systems located on the east side of Vancouver Island in the mid-island area found the amount of Non-Revenue water ranged from a minimum of 5% to a maximum of 37% of the system's total annual demand. The 5% is on the newest water system and the 37% is on the oldest water system. As water systems age, *Real Losses* (leakage) increase in response to several factors, such as:

- gaskets on old pipe joints hardening and becoming brittle and more susceptible to leakage
- pipe material weakening, notably at direct tap service connections on AC pipe
- loss of pipe wall strength (on AC pipe this occurs in areas where the pipe comes in contact with aggressive water and/or soils, resulting in cement mortar leaching)
- Inadequate or improper bedding material used when the pipe was installed resulting in rocks or trench rock pressing onto the outside of the pipe wall, causing a localized pressure point, that overtime can create a crack in the pipe wall
- Excessive loading and/or settlement, which disturbs the "settled" state of the water system and causes disruption/movement at pipe joints, service connections, tees, valves, fittings and other appurtenances, resulting in a loss of the integrity of the seal of the gasket at these locations

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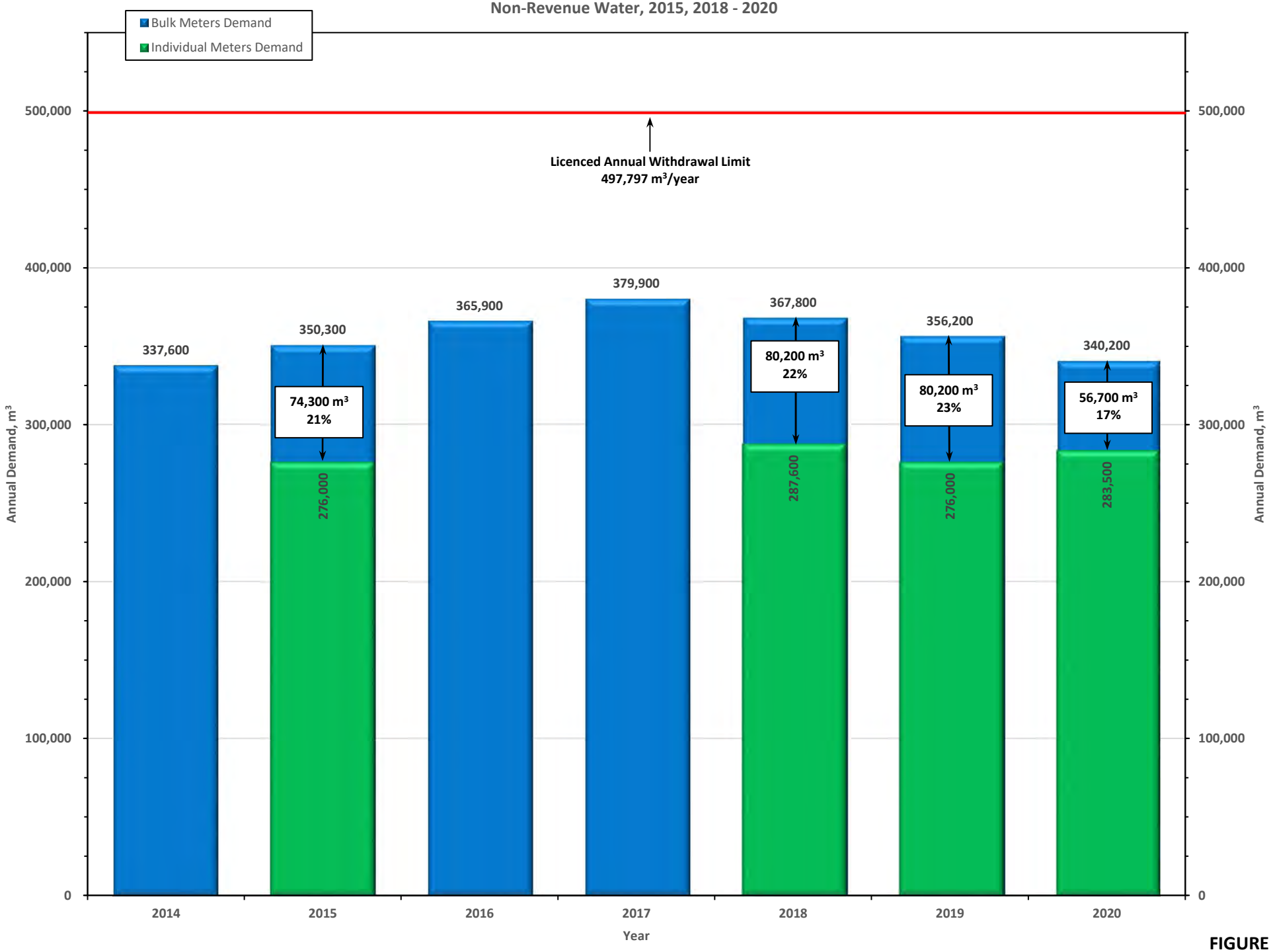


FIGURE 10

The percentage of Non-Revenue Water in some other Vancouver Island water systems is presented in **Table 16**.

Table 16 – Non-Revenue Water for Other Vancouver Island Water Systems

Water System	Year	No of Service Connections #	Annual Demand (1) m^3	Non-Revenue Water %	Demand per Connection(2) m^3
Universally Metered Systems					
Decourcey WSA	2018	5	1,000	10 %	200
Melrose Terrace WSA	2018	28	4,900	21 % (3)	175
Whiskey Creek WSA	2018	124	42,400	35 % (3)	340
Englishman River WSA	2018	151	64,400	5 % (4)	425
French Creek WSA	2018	238	59,000	8 %	250
San Pareil WSA	2018	288	99,100	35 % (5)	345
Union Bay WLSA	2021	691	220,400	41 % (3)	319
Saltair	2016	803	266,000	27 %	330
Lantzville	2014	885	242,200	22 % (6)	275
BC/OB WLSA	**2019**	**975**	**356,200**	**23 % (7)**	**365**
Cumberland	2015	1,616	545,100	37 % (8)	335
Nanoose Bay Peninsula WSA	2018	2,191	725,000	23 % (3)	330
Partially Metered System					
Area D WLSA	2020	1,230	993,400	n/a (9)	805

Notes:

1 Annual demand rounded to nearest 100 m^3/year.

2 Demand per connection rounded to nearest 5 m^3/year.

3 Includes wastewater from the water treatment (filtration system) process.

4 The Englishman River water system is the youngest water system at 18 years old. It consists of 12.6 kms of PVC watermain.

5 The San Pareil water system is around 60 years old. It consists of 8 kms of watermain of which 6.4 kms (82%) is AC pipe.

6 The District of Lantzville water system is around 50 years old. It consists of 27 kms of watermain of which 15 kms (57%) is AC pipe.

7 The BC/OB water system is believed to be around 50 years old. It consists of 38 kms of watermain of which 29 kms (76%) is AC pipe.

8 The Village of Cumberland water system is the oldest water system. Its water licence is almost 125 years old (Year 1897). The distribution system consists of varying pipe materials, such as CI, DI, AC and PVC.

9 The Area D water system is believed to be around 50 years old and is only partially metered; 73 (6%) of service connections were metered (Year 2020). It consists of 36 kms of watermain of which 26 kms (73%) is AC pipe.

The percentage of Non-Revenue Water for the BC / OB water system is within the expected range of 15% to 25% for a water system that is around 50 years old and comprised mostly (76%) of Asbestos Cement watermains that are also around 50 years old.

5.4 Water Demand Reduction

Reducing Revenue (metered) water demands requires a change in human behaviour. A system wide and consistent reduction in metered demand during the dry summer months would provide the ability to service additional properties within the Black Creek/Oyster Bay water system and/or reduce withdrawals from ground and river sources.

5.4.1 Water Conservation Plan

Changing human behavior of water usage during the dry summer months, and year round, will require a **Water Conservation Plan** that is specifically developed for the Black Creek/Oyster Bay water system. The plan would identify water use modification tools which would result in the goal of demand reduction. The plan would assess the potential for reducing both indoor and outdoor water use.

6 WATER MODEL

6.1 Computer Program

Modelling of the water distribution system was carried out utilizing the computer software program WaterGEMS, an enhanced version of WaterCAD. This water distribution modelling and management software is in use throughout North America by engineering consultants, utility companies and municipalities, because of its reliability, versatility, AutoCAD and GIS interface, and support by its creator Bentley Systems Inc.

WaterGEMS is a powerful, easy-to-use program to analyse, design, and optimize water distribution systems. The programs many features include; steady state and extended time modelling, fire flow event modelling while evaluating flows and pressures across the entire system, peak hour pressure analyses, optimization of fixed and variable speed pumps and reservoir storage to minimize energy usage and cost, and automated model calibration. Other analyses features that can be utilized include; system leakage, water loss and unaccounted for water, reservoir mixing, and water-age. The modelling results can be presented in tabular and graphical form.

The WaterGEMS, Connect Edition Update 3 was used for this study.

6.2 Water Model Set-up

6.2.1 Water System

Koers' in-house computer model of the BCOB water system served as the basis for this Water Master Plan. A copy of the CVRD's GIS database of the BCOB water system was obtained and compared to our in-house model. The in-house model of the water supply and distribution system were spatially updated as warranted and a few additions were added, including Water Supply Well No. 5, Oyster River Way subdivision, and the Schulz Road watermain extension project that is presently under construction. The developed model consists of:

- water supply wells
- lengths, diameter and material type of the water supply and distribution mains
- water storage reservoirs
- fire hydrants
- booster pump station

The model is spatially developed, matching the CVRD's and SRD's composite legal plan and the GIS database of the water system, so that the actual lengths of watermains and distances between services connections reflect "on the ground" conditions.

The model was developed to geodetic datum using elevations obtained from record drawings and available 5 m and 20 m contour intervals from the CVRD's and SRD's on-line GIS maps.

The settings for the water storage reservoirs (call for water supply well(s) pump on/pump off), the booster pump station (pump on/pump off) and the Pressure Sustaining Valve (inlet and outlet pressures) were provided by the CVRD water department.

6.2.2 Pipe Friction Factors

A Hazen Williams friction factor was entered in the model for varying pipe materials, as listed in **Table 17**.

Table 17 – Pipe Friction Factors

Pipe Material		Friction Factor C (Hazen Williams)
Name	Abbreviation	
High Density Polyethylene	HDPE	145
Polyvinyl Chloride	PVC	140
Asbestos Cement	AC	130
Ductile Iron	DI	130
Steel with Coating	SC	130
Pre-stressed Concrete	PConc	120
Cast Iron	CI	110

6.2.3 Allocation of Demands

Water demands were distributed evenly throughout the model at nodal points (pipe intersections, end of mains and pipe diameter changes). The maximum day demand was used as the base. Peak hour demand was modelled by multiplying each individual maximum day demand by one and one half (1.5).

7 EXISTING SYSTEM ANALYSIS

The existing conditions computer model was used to assess the ability of the water distribution system to:

- provide adequate pressure during peak hour demands, and
- deliver adequate fire flow during maximum day demands.

The model was also operated in extended time mode in order to assess the ability of the water supply sources to refill the Macaulay Road water storage reservoir during high demands occurring in the dry season. The modelling results are discussed below.

7.1 Peak Hour Pressures

The calculated residual pressures throughout the existing distribution system (during the current peak hour design demand of 40 L/s) are graphically shown in **Figure 11**.

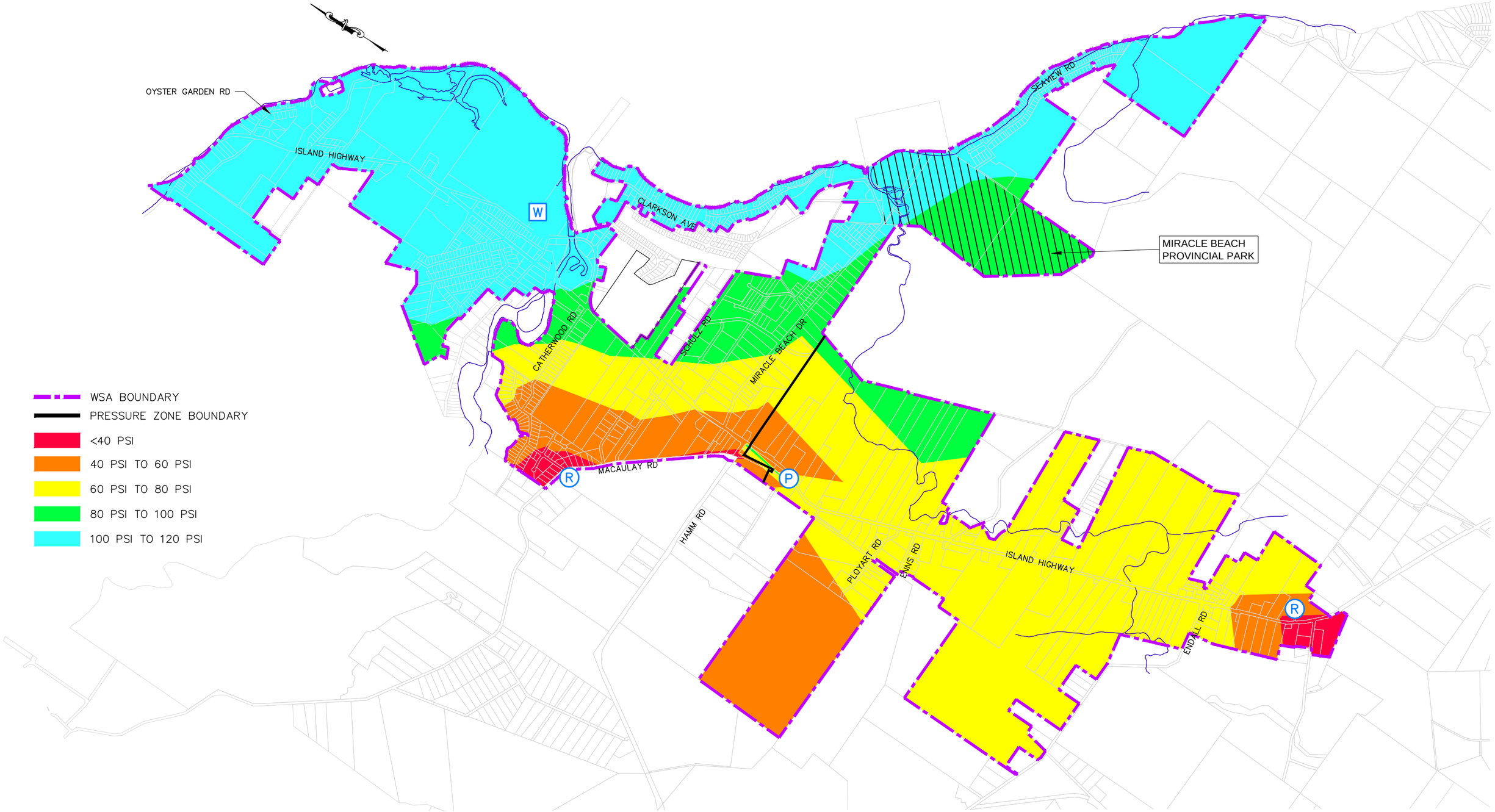
The modelling results indicate the recommended minimum pressure at property line of 300 kPa (44 psi) are provided throughout the existing distribution system with the exception of properties close to the two reservoirs. Around the Kelland Road reservoir (with its top water level of 113.3 m) properties above ±82 m geodetic experience pressures less than the minimum recommended 300 kPa (44 psi). Around the Macaulay Road reservoir (with its top water level of 86.1 m) properties above ±55 m geodetic also experience pressures less than the minimum recommended 300 kPa (44 psi).

7.2 Maximum Day with Design Fire Flow

The calculated maximum available fire flows throughout the existing distribution system (during a maximum day demand of 2,308 m^3/day) are graphically shown in **Figure 12** and are based on allowing a maximum velocity in the watermains of 3.5 m/s (**Table 8**).

The modelling results indicate that the land-use based recommended minimum fire flows (**Table 9**) are available throughout most, but not all, of the existing distribution system. Delivery of the recommended minimum fire flows are limited because of pipe diameters, lack of watermain looping in a number of areas, and dead-ended watermains.

The delivery of 150 L/s to a number of the Institutional/Public Assembly zoned properties (school, church, community hall) and some of the Commercial zoned properties is not currently provided. In addition, the delivery of 60 L/s to residential zoned properties is not currently provided in several areas. Improvements have been identified to increase the available fire flows to these locations. They include replacing existing watermains with larger pipes (up to 300 mm dia.) and looping of dead-ended watermains. Areas with insufficient fire flows are listed in **Table 18** along with the available fire flow, the recommended land-use/zoning based minimum fire flow, and the resulting fire flow after the proposed improvements are implemented. The proposed improvements are discussed later in this report (see **7.5 Proposed Improvements**).



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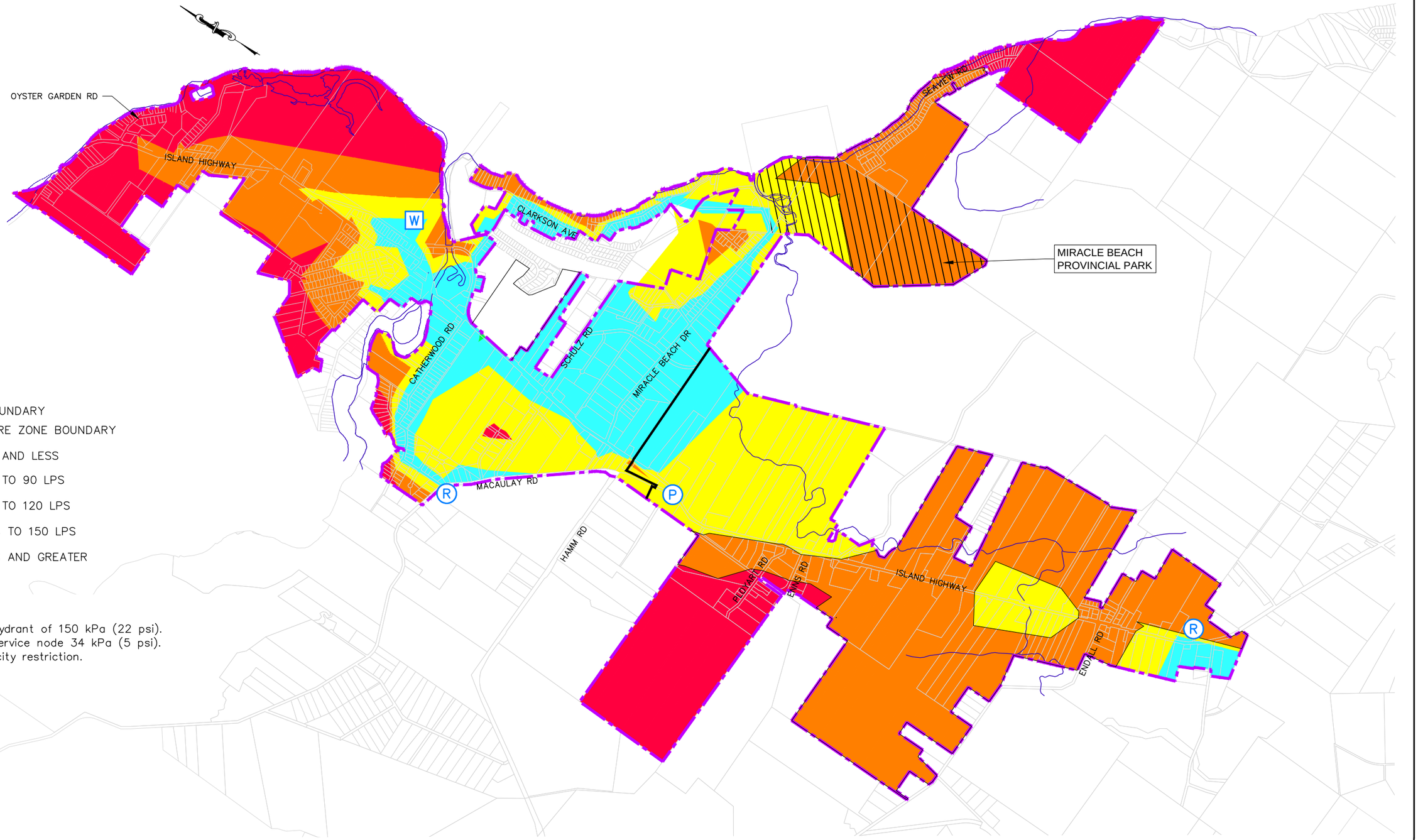
CLIENT COMOX VALLEY REGIONAL DISTRICT

PROJECT BLACK CREEK/OYSTER BAY WATER LOCAL SERVICE AREA WATER MASTER PLAN

TITLE EXISTING CONDITIONS RESIDUAL PEAK HOUR PRESSURES

APPROVED	SCALE 1: 30,000
DATE NOV 2021	DWG No. FIGURE 11
PROJECT No. 2134	



Fire Flow Criteria:

1. Pressure at hydrant of 150 kPa (22 psi).
2. Pressure at service node 34 kPa (5 psi).
3. 3.5 m/s velocity restriction.

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CLIENT: COMOX VALLEY REGIONAL DISTRICT

PROJECT: BLACK CREEK/OYSTER BAY WATER LOCAL SERVICE AREA WATER MASTER PLAN

TITLE: EXISTING CONDITIONS AVAILABLE FIRE FLOWS

APPROVED	
DATE	NOV 2021
PROJECT No.	2134
SCALE	1: 30,000
DWG No.	FIGURE 12

Table 18 – Existing Conditions - Areas with Insufficient Fire Flows

Location	Fire Flow (L/s)		
	Available [1]	Required	With Proposed Improvements [1, 2]
South of Oyster River			
Black Creek Rd	61	150	172
North Island Hwy/Endall Rd	120	150	210
North Island Hwy/Lalum Rd	90	150	163
Enns Rd	56	150	123 [3]
North Island Hwy/Miracle Beach Dr	136	150	166
Paulsen Rd (Miracle Beach Elementary)	120	150	153
Dove Rd	50	60	83
Oakes Rd	50	60	104
Clarkson Ave/Eyre Rd	135	150	150
North of Oyster River			
Terrain Rd (Oyster River Elementary)	62	150	188
Salmon Point Rd	52	150	152
North Island Hwy/Oyster Garden Rd	60	150	158
North Island Hwy (north end of system)	42	150	109 [4]

Notes:

1 Based on a maximum fire flow velocity in the watermains of 3.5 m/s (Table 8).

2 Proposed watermains upgrades will have diameters up to 300 mm.

3 This is close to (but still less than) the recommended minimum 150 L/s fire flow for I/C/I zoned properties. It would be advisable to carry out FUS fire flow calculations on existing and proposed I/C/I buildings in this area.

4 This is significantly less than the recommended minimum fire flow for I/C/I zoned properties. It will be costly to improve fire flows significantly as this area is at the extremities of the distribution system where it is challenging to provide system looping. It would be advisable to carry out FUS fire flow calculations on existing and proposed I/C/I buildings in this area.

7.3 Reservoir Storage Capacity

A comparison of the recommended minimum storage volume requirements to the current storage volume in the distribution system (Macaulay Rd and Kelland Rd reservoirs) indicates the available storage volume is more than the recommended minimum, as shown in Table 19.

Table 19 – Minimum Reservoir Storage Volume - Current Conditions

Description			Volume m^3
A	Fire Storage	FUS Guide	1,080 (1)
B	Equalization	25% of Max Day	575 (2)
C	Emergency	25% of [A+B]	415
		Total:	2,070
		Current Available:	2,305 (3)
		+Surplus/-Shortfall:	+235 +10%

Notes:

1 Fire storage volume based on 150 L/s demand for 2 hours.

2 Current Conditions Maximum Day demand = 2,308 m^3/day (July 5, 2021) as shown in **Table 12** and **Figure 5**.

3 See **Table 5**.

However, while the current storage volume of both reservoir combined meets the recommended minimum requirement, extended time modelling results indicate the fire fighting capabilities in PZ 113 are hindered by the storage volume of the Kelland Rd Reservoir and the pumping capacity of the Black Creek Booster Pump Station, which pumps water from PZ 86 and into PZ 113, and the ability of the Macaulay Rd Reservoir to return to full water level after a major fire may be hindered by the pumping capacity of the water supply during the dry summer months. This is reviewed in more detail below in **7.4 Extended Time Modelling**.

7.4 Extended Time Modelling

Extended time modelling was carried out to assess the ability of the water supply sources to refill the water storage reservoirs for three demand conditions:

- Maximum Day Demand (2,308 m^3/day – July 5, 2021)
- Maximum Day Demand with 60 L/s Fire Flow
- Maximum Day Demand with 150 L/s Fire Flow

For the purposes of this analysis, the Dry Season Well Supply Operational Scenario No. 2 (**Table 11**) was applied to the production capacity of the water supply sources, i.e.,

- Well No. 1 out of service,
- Well No. 4 is operating without a safety factor because Well No. 1 is off,
- Well No. 5 is operating at the capacity observed during the summer of 2021, and
- Wells No. 2A/2B (Oyster River infiltration gallery) are operated 50% of the time.

The modelling results are discussed in the following section.

7.4.1 Macaulay Rd Reservoir

Maximum Day Demand - Extended Time Modelling

The computer modelling results are shown in **Figure 13** and indicate that:

- the Macaulay Reservoir would return to its top water level (full) within 24 hours, and
- the simultaneous operation of all three sources is required to refill the reservoir.

Maximum Day Demand with 60 L/s Fire Flow - Extended Time Modelling

A 60 L/s fire flow demand for 1.5 hours was applied to the maximum day demand (2,308 m^3/day, July 5, 2021). The computer modelling results are shown in **Figure 14** and indicate that:

- the Macaulay Reservoir would return to its top water level (full) within 20 hours after the end of the 60 L/s fire flow demand, and
- the simultaneous operation of all three sources is required to refill the reservoir.

Maximum Day Demand with 150 L/s Fire Flow - Extended Time Modelling

A 150 L/s fire flow demand for 2 hours was applied to the maximum day demand (2,308 m^3/day, July 5, 2021). The computer modelling results are shown in **Figure 15** and indicate that:

- the Macaulay Reservoir is almost completely drained (empty) by the end of the 150 L/s fire flow demand,
- the reservoir does not return to its top water level (full) until 62 hours (2.5 days) after the end of the fire flow demand, and
- the simultaneous and continuous operation of all three sources for 65 hours (2.7 days) is required to refill the reservoir.

The extended time modelling of a 150 L/s fire flow shows the water in the Macaulay Road Reservoir will drop to an unacceptable level and take a significant amount of time to recover after the fire. For this reason, it is very important to secure additional water supplies that will be available during the dry season. Additional water supplies will reduce drawdown in the reservoir during the fire and assist with faster recovery after the fire is over. The extended time modelling for the Macaulay Road Reservoir should be updated after additional water supplies have been developed and connected to the system.

7.4.2 Kelland Rd Reservoir

Water is supplied to the Kelland Rd Reservoir (PZ 113) by the Black Creek Water Booster Pump Station (see **Figure 3**) which has a calculated pumping rate of 18.9 L/s with one pump operating and 25.6 L/s with both pumps operating (**Table 7**).

The extended time modelling results are discussed below.

Maximum Day Demand - Extended Time Modelling

The computer modelling results are shown in **Figure 16** and indicate that:

- the water booster pump station is able to maintain the Kelland Reservoir at full water level during maximum day demand (2,308 m^3/day).

KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

Existing Conditions
Macaulay Rd Reservoir Water Level Extended Time Modelling
Maximum Day Demand
for Dry Season Well Supply Operational Scenario No. 2

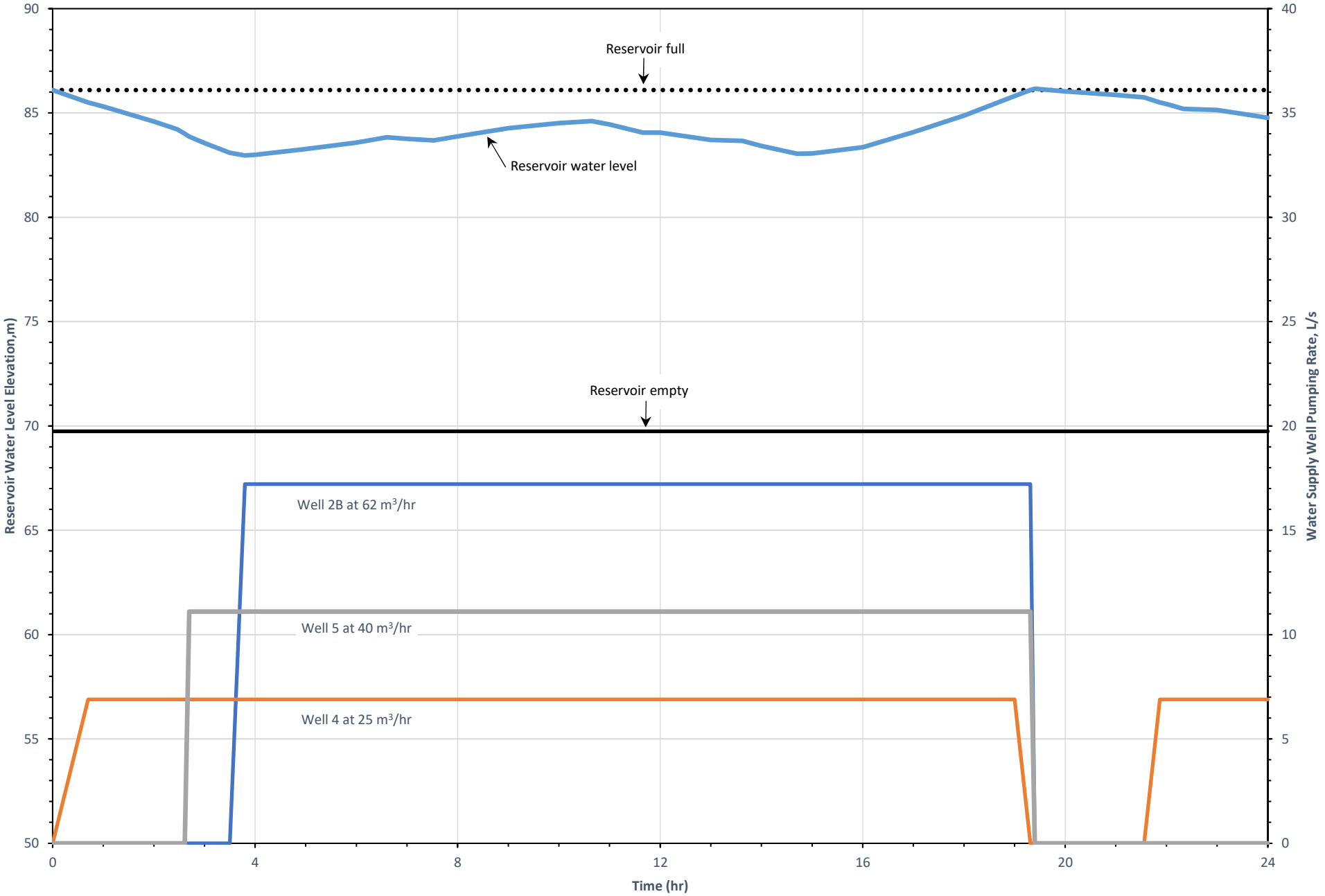

FIGURE 13

KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

Existing Conditions
Macaulay Rd Reservoir Water Level Extended Time Modelling,
Maximum Day + Fire Flow (60 L/s)
for Dry Season Well Supply Operational Scenario No. 2

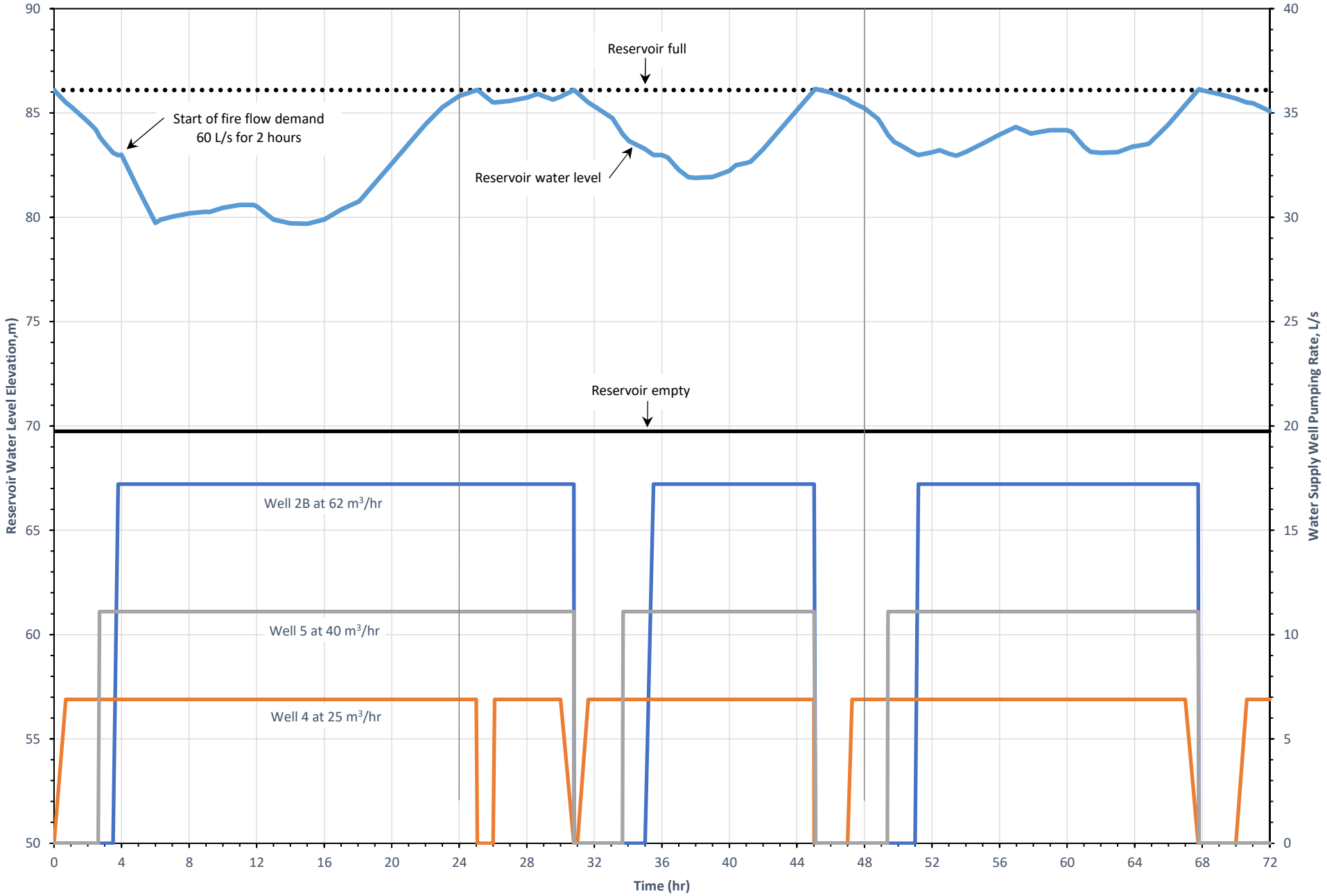

FIGURE 14

KOERS & ASSOCIATES ENGINEERING LTD.
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Existing Conditions
Macaulay Rd Reservoir Water Level Extended Time Modelling
Maximum Day + Fire Flow (150 L/s)
for Dry Season Well Supply Operational Scenario No. 2

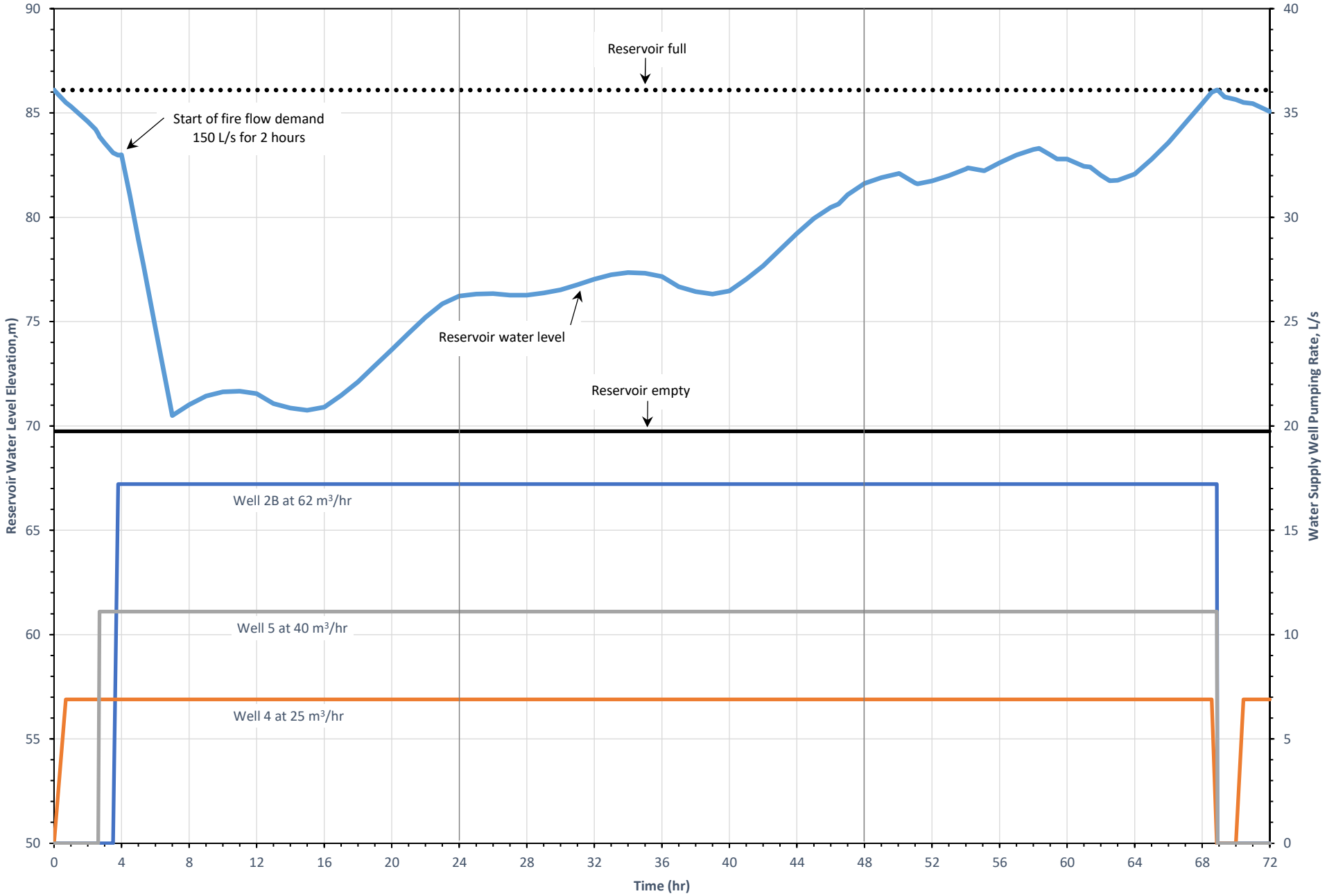

FIGURE 15

KOERS & ASSOCIATES ENGINEERING LTD.
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Existing Conditions
Kelland Rd Reservoir Water Level Extended Time Modelling
Maximum Day + Fire Flows (60 L/s & 150 L/s)
for Water Supply Scenario No. 2

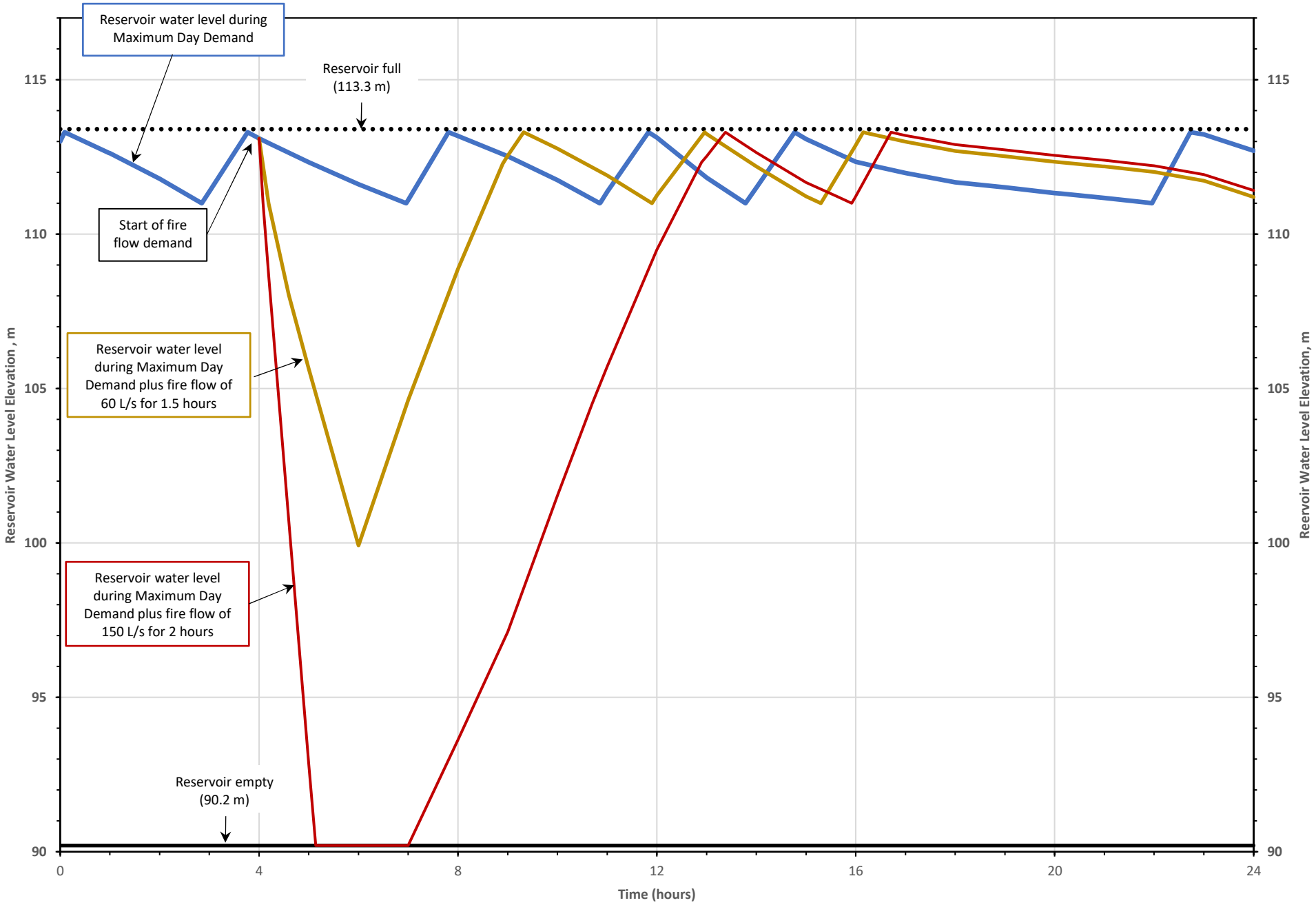

FIGURE 16

Maximum Day Demand with 60 L/s Fire Flow - Extended Time Modelling

A 60 L/s fire flow demand for 1.5 hours was applied to the maximum day demand (2,308 m^3/day, July 5, 2021). The computer modelling results are shown in **Figure 16** and indicate that:

- the water level in the Kelland Reservoir drops by 13.3 m to 100 m geodetic (42% full) by the end of the fire flow demand
- the water booster pump station is able to return the Kelland Reservoir to its top water level (full) within 5½ hours

Maximum Day Demand with 150 L/s Fire Flow - Extended Time Modelling

A 150 L/s fire flow demand for 2 hours was applied to the maximum day demand (2,308 m^3/day, July 5, 2021). The computer modelling results are shown in **Figure 16** and indicate that:

- the Kelland Reservoir is completely drained (empty) and remains empty for almost 2 hours
- the water booster pump station is able to return the Kelland Reservoir to its top water level (full) within 9 ½ hours but we expect the water level in the Macaulay Road Reservoir is impacted significantly in order to achieve this. We have not modelled this simultaneous impact.

The Kelland Road Reservoir is filled by the booster pump station and not directly by the well supplies. Increasing the storage in the Kelland Road Reservoir may be required in order to avoid draining the reservoir during a major fire event. Increasing the capacity of the booster pump station is another option that should be considered. Both of these options should be looked at in greater detail once it is known whether additional water supplies can be developed for this water system and the extended time modelling can be re-evaluated.

7.5 Proposed Improvements

Watermain upgrades are proposed to improve the fire fighting capabilities of the BC/OB water system in order to address the areas with insufficient fire flows as discussed in **7.2 Maximum Day with Design Fire Flow** and listed in **Table 18**. The proposed watermain upgrades are presented in **Table 20** (on the next page) and shown in **Figure 17**.

Table 20 – Proposed Watermain Upgrades (for Fire Flows), Existing Conditions

Location	Dia. mm		Length (m)
	Existing	Proposed	
PZ 86			
Finlay/Shiloh Road, Hwy 19a – west end of Shiloh Rd	-	200	500
Catherwood Road, Hwy 19a – Oakes Rd	250	300	1,000
Oakes Road, Catherwood Rd – Tammy Rd	250	300	300
Oakes Road, Tammy Rd – west end	150	200	200
Tammy Road, Oakes Rd – Macaulay Rd Reservoir	250	300	400
Regent Road, Saratoga Rd – Glenmore Rd	-	200	410
Regent Road, Glenmore Rd – Terrain Rd	-	250	690
Terrain Road, Lambeth Rd – Oyster River Elementary	-	200	200
Regent Road, Terrain Rd – Hwy 19a	200	300	290
Hwy 19a, Regent Rd – Salmon Point Rd	200	300	1,150
Salmon Point Rd, Hwy 19a – 400 m east	150	250	400
SRW (required), Salmon Point Rd – Oyster Garden Rd	-	200	330
Hwy 19a, Salmon Point Rd – Oyster Garden Rd	200	300	500
Hwy 19a, Oyster Garden Rd – 520 m west	150	300	520
Hwy 19a, 520 m west of Oyster Garden Rd – west end	150	200	300
PZ 113			
Hwy 19a, Black Creek Booster Pump Sta. – Kelland Rd Res.	200	300	4,400
Black Creek Road, Hwy 19a to 140 m east	150	250	140
Enns Road, End of existing main to Ployart Rd	-	200	280
		Total:	12,010

Almost all of the proposed watermain upgrades listed in **Table 20** are attributed to the design fire flow of 150 L/s for I/C/I zoned properties. On a smaller water system the size of the BC/OB system, such a magnitude of watermain improvements (more than 30% of the water distribution system mains) will likely have to be carried out over a significant time frame due to the cost of the upgrades. In some areas it may be acceptable to wait until the older piping reaches the end of its operational life, and then replace it with the larger watermains identified above.

The CVRD should share the existing conditions fire flow mapping **(Figure 17)** with the local fire department, so they are aware of the existing fire flow limitations that currently exist throughout the distribution system. It would also be advisable to find out if the local fire department can identify specific areas of concern that may cause challenges from the perspective of fire fighting operations. This type of input will help establish which watermain improvements should be targeted as priorities.

OYSTER GARDEN RD
ISLAND HIGHWAY
CLARKSON AVE
CATHERWOOD RD
SCHULZ RD
MIRACLE BEACH DR
SEAVIEW RD
MACAULAY RD
HAMM RD
PLOVART RD
EVANS RD
ENDALL RD
MIRACLE BEACH PROVINCIAL PARK
PRESSURE ZONE 86
PRESSURE ZONE 113
200ø
250ø
300ø
150ø
W
R
P

WSA BOUNDARY
PRESSURE ZONE BOUNDARY
PROPOSED WATERMAIN REPLACEMENT
PROPOSED WATERMAIN LOOP
PROPOSED WATERMAIN FOR BUILDOUT CONDITIONS
PROPOSED REPLACEMENT WATERMAIN FOR WATUTCO

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CLIENT: COMOX VALLEY REGIONAL DISTRICT

PROJECT: BLACK CREEK/OYSTER BAY WATER LOCAL SERVICE AREA WATER MASTER PLAN

TITLE: PROPOSED WATERMAIN IMPROVEMENTS

APPROVED	
DATE	FEB 2022
PROJECT No.	2134
SCALE	1: 30,000
DWG No.	FIGURE 17

8 FUTURE GROWTH & DEMAND PROJECTIONS

8.1 Future Growth

The Rural Comox Valley Official Community Plan 2014 identifies several settlement nodes which are areas that are planned to receive growth and can accommodate urban forms of development. One of these settlement nodes is Saratoga Miracle Beach which is located within the Black Creek / Oyster Bay Water Local Service Area (BCOB WLSA). In addition, there are properties, both developed and undeveloped that are within the BCOB WLSA but are not yet connected to the water system. There also are properties within the BCOB WLSA that have the potential to be subdivided under the current zoning. A total of 792 water service connections could be added to the water system based on:

- properties not yet connected,
- properties that could be subdivided under the existing zoning, and
- active and proposed developments.

An overview of the potential increase in number of properties that could be serviced is presented below.

8.1.1 Properties Not Yet Connected

The CVRD identified a total of 49 properties within the BCOB WLSA that are not yet connected to the water system. These include vacant properties (29 lots) and developed properties (20 lots) comprised of eighteen (18) properties with one dwelling and two (2) properties with two dwellings. Their locations are shown on **Map 1**.

The 49 properties equate to 51 new water service connections which represents 6% of the total projected 792 additional water service connections. A summary of the potential number of water service connections is presented in **Table 21**.

8.1.2 Existing Zoning Subdividable Properties

The CVRD identified 48 properties that have the ability to subdivide under the existing zoning. Approximately ½ of the properties are located within the Saratoga Miracle Beach settlement note and the ½ are located outside of it. Their locations are shown on **Map 2**.

The 48 subdividable properties could result in up to 215 new water service connections which represents 27% of the total projected 792 additional water service connections. A summary of the potential number of water service connections is presented in **Table 21**.

8.1.3 Active and Proposed Developments

The CVRD has received a number of development inquiries and applications for properties that would be serviced by the BC / OB water system. Presently there are ten (10) applications being processed and all are within the boundaries of the Saratoga Miracle Beach settlement node. Their locations are shown on **Map 3**.

The ten (10) active and proposed developments could result in up to 526 new water service connections which represents 66% of the total projected 792 additional water service connections. A summary of the potential number of water service connections is presented in **Table 21**.

Table 21 – Potential Additional Water Service Connections

Description	Number of Properties, Existing [1]	Potential Number of Water Services Connections [2]
Properties Not Yet Connected		
Vacant Lot	29	29
Developed Lot		
- one dwelling	18	18
- two dwellings	2	4
Subtotal:	49	51
Existing Zoning Subdividable Properties		
Developed & Undeveloped	48	215
Subtotal:	48	215
Active and Proposed Developments		
# 2	1	8
# 3	1	5
# 4	1	4
# 5	1	3
# 6	1	30
# 7	1	2
# 8	3	1
# 9	1	446
# 10	1	27
Subtotal:	11	526
Total:	108	792

Notes:

1 Locations are shown on **Map 1**, **Map 2**, and **Map 3**.

2 Potential number of water service connections based on the estimated number of potential dwelling units as follows:

For Properties Not Yet Connected. Based on the potential number of dwelling units for each property, e.g., one lot with one dwelling = one potential water service connection. One lot with two dwellings = two potential water service connections.

Existing Zoning Subdividable Properties. Based on the size of the property and the minimum lot size permitted by the current zoning, e.g., for a 10.3 ha property zoned CR-1 and a minimum lot size of 2.0 ha, the potential number of water service connections was estimated to be 5 (10.3 ha ÷ 2 ha/property).

Development Applications Instream. As provided by CVRD.

Legend

- Water Service Connection
- Water Main
- Regional District Boundary
- Settlement Node
- Black Creek/Oyster Bay Water Local Service Area (BCOB)

Properties Not Connected to Water System

- Vacant (29 lots)
- One Dwelling (18 lots)
- Two Dwellings (2 lots)

Date of Analysis: July 27, 2021

Active and Proposed Developments

- #1: 20170802 - 04557c17
- #2: 01311 C 21
- #3: 20180607 - RZ4C18
- #4: 20191025 - RZ2C19
- #5: 20200525 - 01760C20
- #6: 20200403 - DP 26C 19
- #7: 20200922 - 04214C20
- #8: 20201222 - RZ2C20
- #9: Saratoga Beach Estates
- #10: Saratoga Cabin Developments

Strathcona Regional District
Comox Valley Regional District

Oyster River
Bear Creek
Black Creek
Miracle Beach Park
Northy Lake
Sayer Creek
19A

MAP 1 Properties Not Connected to BCOB Water System

Legend

- Water Service Connection
- Water Main
- Regional District Boundary
- Settlement Node
- Property has potential to subdivide with current zoning
- Black Creek/Oyster Bay Water Local Service Area (BCOB)

Date of Analysis: July 27, 2021

Active and Proposed Developments

- #1: 20170802 - 04557c17
- #2: 01311 C 21
- #3: 20180607 - RZ4C18
- #4: 20191025 - RZ2C19
- #5: 20200525 - 01760C20
- #6: 20200403 - DP 26C 19
- #7: 20200922 - 04214C20
- #8: 20201222 - RZ2C20
- #9: Saratoga Beach Estates
- #10: Saratoga Cabin Developments

Oyster Bay
Strait of Georgia
Salish Sea
Strathcona Regional District
Comox Valley Regional District
Oyster River
Bear Creek
Elma Bay
Black Creek
Sayer Creek
Northy Lake
Hamm Rd
Miracle Beach Dr
Island Hwy N
Seaview Rd
Miracle Beach Park
Oakes Rd
Catherwood Rd
Regent Rd
McLarey Ave
Henderson Ave
Clarkson Ave
Driftwood Rd
Dove Rd
Macaulay Rd
Schulz Rd
Cedar Ridge Dr
Smooth Rd
Oyster River Way
Hampshire Rd
Reinhold Rd
Enns Rd
Ployart Rd
Lalum Rd
Dzini Rd
Endall Rd
Helm Rd
Gladstone Rd
Surgenor Rd N
Surgenor Rd
Constitution Rd
Larkin Rd
Williams Beach Rd
1
2
3
4
5
6
7
8
9
10

Comox Valley Regional District

MAP 2

BCOB Water System
Subdividable Properties With Current Zone

Legend

- Regional District Boundary
- Settlement Node

Active and Proposed Developments

- #1: 20170802 - 04557c17
- #2: 01311 C 21
- #3: 20180607 - RZ4C18
- #4: 20191025 - RZ2C19
- #5: 20200525 - 01760C20
- #6: 20200403 - DP 26C 19
- #7: 20200922 - 04214C20
- #8: 20201222 - RZ2C20
- #9: Saratoga Beach Estates
- #10: Saratoga Cabin Developments
- Black Creek/Oyster Bay Water Local Service Area

Strait of Georgia
Oyster River
Elma Bay
Black Creek
Miracle Beach Park
Catherwood Rd
Oakes Rd
Emmerson Rd
Tammy Rd
Dove Rd
Hamm Rd
Reinhold Rd
Island Hwy N
19A
B.C.
Ployart Rd
Enns Rd
Macaulay Rd
Regent Rd
Saratoga Rd
McLarey Ave
Henderson Ave
Eyre Rd
Maple Dr
Clarkson Ave
Driftwood Rd
Schulz Rd
Cedar Ridge Dr
Oyster River Way
Smooth Rd
Paulsen Rd
Schiefderup Rd
Hampshire Rd
Miracle Beach Dr
Black Creek
1
2
3
4
5
6
7
8
9
10

Comox Valley Regional District

MAP 3
Active and Proposed Developments in Black Creek/Oyster Bay Area

8.1.4 Strathcona Regional District

All land north of the Oyster River is within the Strathcona Regional District, Electoral Area D (Oyster Bay – Buttle Lake). As no potential future development/increase in water demands was provided for this Water Master Plan no increases were applied.

8.2 Demand Projections

Future demands were developed for Average Day, Maximum Day and Peak Hour based on a per connection design demand and the number of potential service connections.

8.2.1 Per Connection Design Demands

The per connection design demand used for this Water Master Plan are presented in **Table 22** along with an explanation of how they were developed.

Table 22 – Per Connection Design Demand

Description	Per Connection Design Demand m^3/day	L/s	Design Demand Source
Average Day	0.7	-	Based on the annual average demand per connection for single family properties over the past three years (2018-2020). i.e., 255 m^3/year per connection (**Table 14**) = 0.7 m^3/day per single family service connection [(1)].
Maximum Day	1.435	-	A multiplier of 2.05 was applied to the Average Day demand based on the average ratio of Max Day to Ave Day for the past seven years, 2014-2020, (**Table 12**) for the bulk meter recorded data; the only source of daily recorded data.
Peak Hour	-	0.025	Peak hour demands are not recorded by the BCOB water system. In their absence, a typical multiplier of 1.5 was applied to the Max Day demand to generate the peak hour design demand.

Notes:

1 The Average Day demand per connection was based on the metered records for single family properties as the majority of the proposed development will consist of residential dwelling units.

8.2.2 Future Demands

The Average Day demand is projected to increase to 1,530 m^3/day. This is an increase of 555 m^3/day from the existing 975 m^3/day.

The Maximum Day demand is projected to increase to 3,448 m^3/day. This is an increase of 1,140 m^3/day from the 2,308 m^3/day recorded this year (July 5, 2021).

The Peak Hour demand is projected to increase to 59.8 L/s. This is an increase of 19.8 L/s from the existing estimated 40 L/s.

The future Average Day, Maximum Day, and Peak Hour design demands are presented in **Table 23** and are based on the potential number of water service connections (**Table 21**) and the per connection design demands (**Table 22**).

Table 23 – Water Demands, With Development

Description	No. of Service Connections (1)	Ave Day (2) m^3/day	Max Day (3) m^3/day	Peak Hour (4) L/s
Current Conditions	975	975 (1)	2,308 (2)	40 (3)
With Development				
- Not Yet Connected	51	35	70	1.2
- Subdividable Under Existing Zoning	215	150	310	5.4
- Active & Proposed Developments	526	370	760	13.2
With Development Subtotal:	792	555	1,140	19.8
Cumulative Total:	1,767	1,530	3,448	59.8
(m^3/hr)		64 m^3/hr	144 m^3/hr	215 m^3/hr

Notes:

1 See **Table 14** and **Table 21**.

2 Ave Day demand calculation:

Current Conditions

From the bulk metered demand for the past seven years (2014-2020).

With Development

Based on the annual average demand per connection for single family properties over the past three years (2018-2020). i.e., 255 m^3/year per connection (**Table 14**) = 0.7 m^3/day per single family service connection, rounded to the nearest 5 m^3.

3 Max Day demand calculation:

Current Conditions

Bulk meter highest recorded maximum day demand during the past eight years (2014-2021) as noted in **Table 12** and **Figure 5**.

With Development

A multiplier of 2.05 was applied to the Ave Day demand based on the average ratio of max day to ave day for the past seven years, 2014-2020, (see **Table 12**) to generate the max day design demand rounded to the nearest 5 m^3.

Max Day = Ave Day x 2.05

4 Peak Hour demand calculation:

Current Conditions and *With Development*

Peak our demands are not recorded by the BCOB water system. In their absence, the standard multiplier of 1.5 was applied to the Max Day demand to generate the peak hour design demand.

$$\textit{Peak Hour} = \frac{\textit{Max Day x 1.5}}{\textit{86,400 seconds/day}}$$

8.3 Other Potential Developments & New Water Supply Source

Since submission of the Draft Report last year, the CVRD has:

- Indicated the potential for additional development applications within the BC/OB water system that would be over and above the ones listed in **Table 21** and identified in **Map 1**, **Map 2**, and **Map 3**. We understand the number of potential additional connections could be equivalent to approximately 500 lots. The ability to service future developments that are not accounted for in this Water Master Plan should be reviewed and assessed as the applications are made, or in future updates to the Water Master Plan. The review may require additional water modeling as well as an assessment of the capacity of the water supply sources to meet the projected design demand and the ability to service these future developments within the authorized licenced withdrawal limits.

- Commenced detailed design for the development of a new groundwater supply well. The hydrogeology report for this well (Well No. 6), indicates a calculated sustainable yield of 1,142 m^3/day (approx. 48 m^3/hr) during drought conditions.

9 SYSTEM ANALYSIS WITH FUTURE DEMANDS

A future conditions (build-out) computer model was developed and used to assess the ability of the water distribution system to:

- provide adequate pressure during peak hour demands, and
- deliver adequate fire flow during maximum day demands.

The future conditions (build-out) model was developed using the existing conditions model with the following modifications:

i) all of the proposed watermain upgrades listed in **Table 20**,
ii) proposed watermain loop through Saratoga Beach Estates (proposed Development #9) between Regent Road, Schulz Road and McLarey Ave, and
iii) all of the future demands listed in **Table 23** incorporated.

Future demands were added to the model at nodal point(s) located closest to the future development listed in **Table 21** and graphically shown in **Map 1**, **Map 2**, and **Map 3**. The model was then run and ability to provide adequate pressures during peak hour demand and the delivery of the design fire flows during maximum day demand reviewed. Where deficiencies were noted, additional upgrading of mains were incorporated in the model to eliminate the deficiencies. The watermain upgrades to meet the future Build-Out demands as listed in **Table 24** and shown in **Figure 17**.

Table 24 – Proposed Watermain Improvements to Meet Future (Build-Out) Conditions

Location	Dia. mm		Length (m)
	Existing	Proposed	
PZ 86			
Saratoga Rd, Regent Rd – Henderson Rd	200	250	460
SRW (east of Saratoga Rd, Henderson Rd – Clarkson Ave	200	250	140
Saratoga Beach Estates			
- McLarey Ave, existing dead-end to 200 m west	-	150	200
- Future north/south road, Regent Rd to Schulz Rd	-	200	930
PZ 113			
Ployart Rd, Black Creek Rd to 775 m west	150	200	770
		Total:	2,500

The other potential developments discussed in **Section 8.3** are not expected to have significant impacts on the watermain improvements identified in this Water Master Plan because watermain sizing is typically based on fire flow requirements.

9.1 Peak Hour Pressures

The calculated residual pressures throughout the future conditions (build-out) water distribution system for a peak hour design demand of 59.8 L/s (**Table 23**) is graphically shown in **Figure 18**.

The modelling results indicate the recommended minimum pressure at property line of 300 kPa (44 psi) are provided throughout the future conditions distribution system with the exception of properties close to the two reservoirs as follows:

Kelland Road Reservoir (113.3 m top water level)

Available ground elevation contours indicate that there are six (6) properties around the reservoir that have ground elevations above ±82 m geodetic. These properties will experience pressures less than the minimum recommended 300 kPa (44 psi) as shown in **Figure 18**.

Macaulay Road Reservoir (86.1 m top water level)

Available ground elevation contours indicate that there are approximately 20 to 25 properties around the reservoir that have ground elevations above ±55 m geodetic. These properties will experience pressures less than the minimum recommended 300 kPa (44 psi) as shown in **Figure 18**.

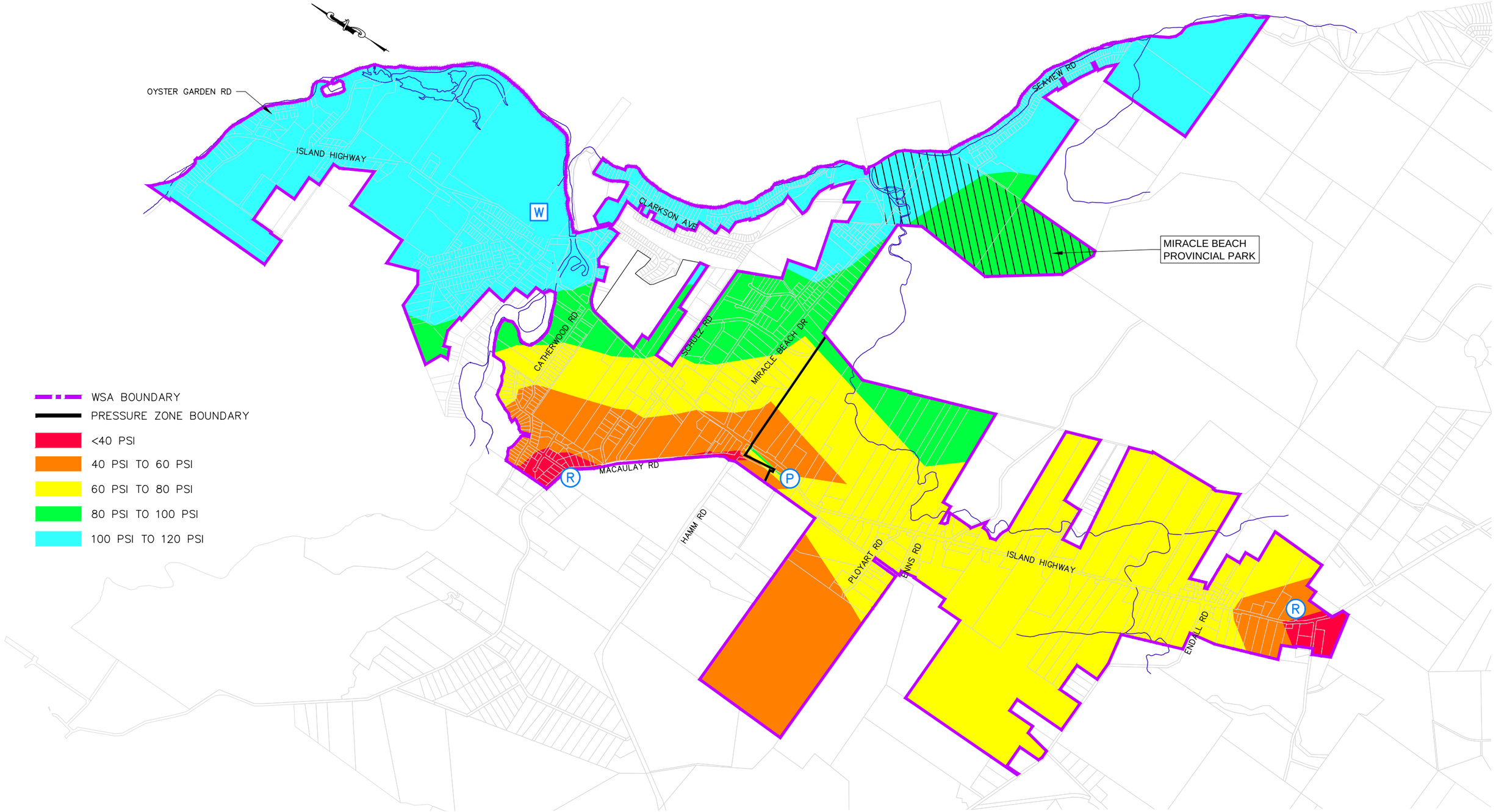
9.2 Maximum Day with Design Fire Flow

The calculated maximum available fire flow throughout the future conditions (build-out) water distribution for a maximum day design demand 3,448 m^3/day (**Table 23**) is graphically shown in **Figure 19** and are based on allowing a maximum velocity in the watermain of 3.5 m/s (**Table 8**).

The modelling results indicate that after the proposed watermain improvement projects as listed in **Table 20** and **Table 24** (and are shown in **Figure 17**) are completed, the land-use based recommended minimum fire flows (**Table 9**) are significantly improved throughout the entire water distribution system.

9.3 Reservoir Storage Requirement

A comparison of the recommended future (build-out) minimum storage volume requirement to the current total storage volume in the distribution system (Macaulay Rd reservoir and Kelland Rd reservoir) indicates the total available storage volume is only slightly less than (5%) of the recommended minimum as shown in **Table 25**.



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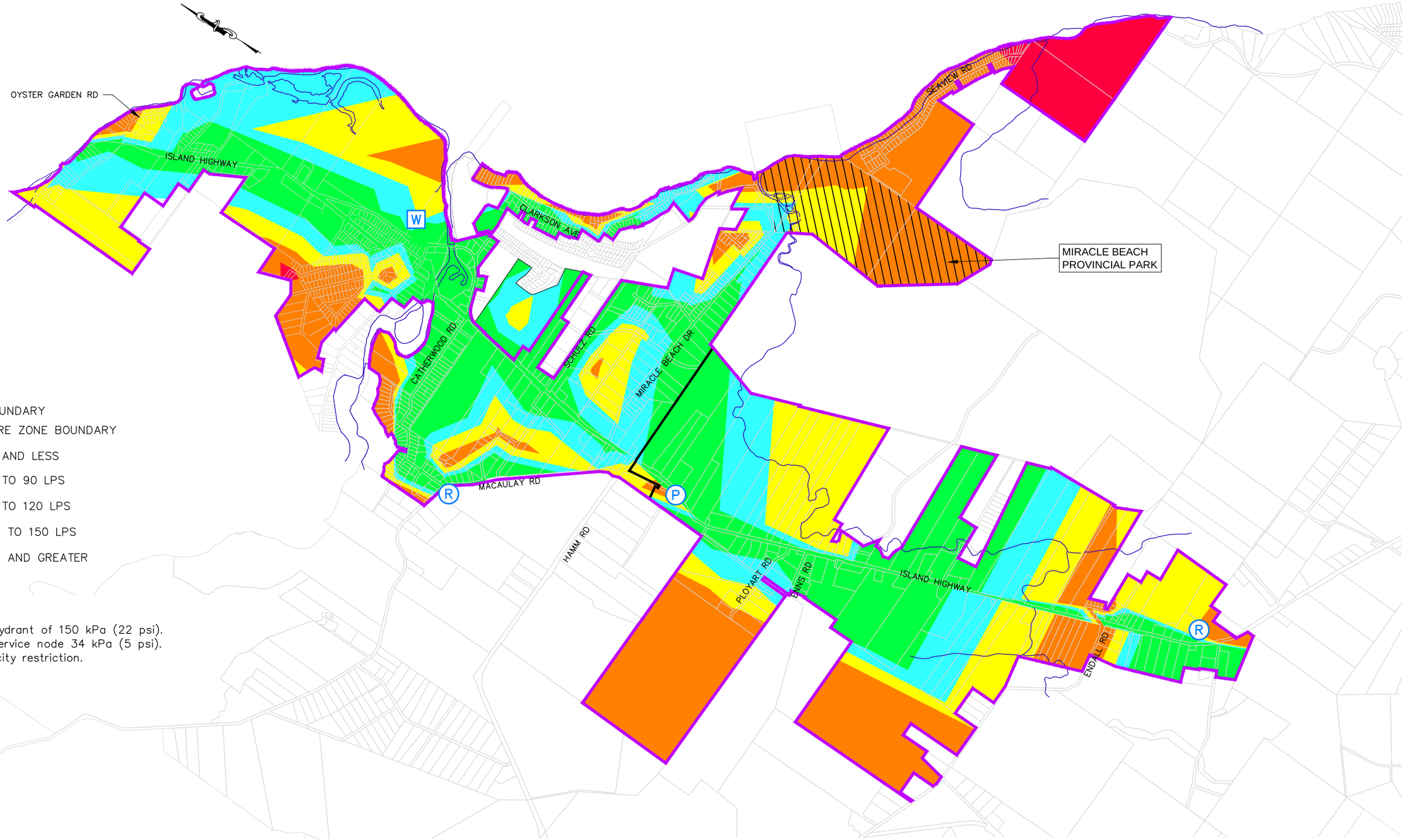
CLIENT COMOX VALLEY REGIONAL DISTRICT

PROJECT BLACK CREEK/OYSTER BAY WATER
LOCAL SERVICE AREA WATER MASTER PLAN

TITLE BUILD OUT CONDITIONS
RESIDUAL PEAK HOUR PRESSURES

APPROVED	SCALE 1: 30,000
DATE NOV 2021	DWG No. FIGURE 18
PROJECT No. 2134	



Fire Flow Criteria:

1. Pressure at hydrant of 150 kPa (22 psi).
2. Pressure at service node 34 kPa (5 psi).
3. 3.5 m/s velocity restriction.

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CLIENT COMOX VALLEY REGIONAL DISTRICT

PROJECT BLACK CREEK/OYSTER BAY WATER LOCAL SERVICE AREA WATER MASTER PLAN

TITLE BUILD OUT CONDITIONS AVAILABLE FIRE FLOWS

APPROVED	SCALE 1: 30,000
DATE NOV 2021	DWG No. FIGURE 19
PROJECT No. 2134	

Table 25 – Reservoir Minimum Storage Requirement, With Development

Description			Volume m^3
A	Fire Storage	FUS Guide	1,080 (1)
B	Equalization	25% of Max Day	860 (2, 3)
C	Emergency	25% of [A+B]	485 (3)
		Total:	2,425
		Current Available:	2,305
		+Surplus/-Shortfall:	-120 -5%

Notes:

1 Fire storage volume based on 150 L/s demand for 2 hours.

2 With Development Maximum Day demand = 3,448 m^3 (**Table 23**). Does not include any demand from Watutco.

3 Rounded to nearest 5 m^3.

However, as previously discussed in **7.4 Extended Time Modelling**, the current fire fighting capabilities in PZ 113 are hindered by the storage volume of the Kelland Rd Reservoir and the pumping capacity of the Black Creek Booster Pump Station, which pumps water from PZ 86 and into PZ 113, and the current ability of the Macaulay Rd Reservoir to return to full water level after a major fire may be hindered by the pumping capacity of the water supply during the dry summer months.

A **Reservoir Optimization Study** is needed to determine the best way to address the reservoir volume shortfall and reduce the length of time it takes to refill the reservoirs following a fire flow event. The optimization study should include additional extended time modelling of fire flow events in both pressure zones. Possible improvements may include:

- Adding reservoir volume at Kelland Road and/or Macaulay Road
- Increasing the combined well capacity that is available during the dry season
- Increasing the pumping capacity of the Black Creek Booster Pump Station
- Adding a standby generator at the Black Creek Booster Pump Station

9.4 Extended Time Modelling

No extended time modelling under future (Build-out) conditions was carried out as the existing conditions extended time modelling results indicate that there are hinderances to the refilling of the Macaulay Rd Reservoir after a major fire during the dry summer months and fire fighting capabilities of the Kelland Road Reservoir are hindered by the storage volume in the reservoir and the pumping capacity of the Black Creek Booster Pump Station (see **7.4 Extended Time Modelling**). Extended time modelling of the reservoirs under future demands should be carried out once the capacity of future water supplies during the dry summer months has been established.

10 WATUTCO WATER SYSTEM

10.1 Water System

The Watutco water system is a privately owned and operated water utility servicing a small area located on the south side of the Oyster River, east of Hwy 19a, and within the boundaries of the Saratoga Miracle Beach settlement node identified in the Rural Comox Valley Official Community Plan 2014. The service area is shown in **Figure 1**. The water system is reported to service 129 properties as noted in **Table 26**.

Table 26 – Watutco Water System Service Connections

Description	Reported Number of Properties Serviced
Residential, Single Family	127
Commercial	
- Pacific Playgrounds Resort & Marina	1
- Saratoga Beach Mobile Home Park	1
Total:	129

Water Supply & Treatment

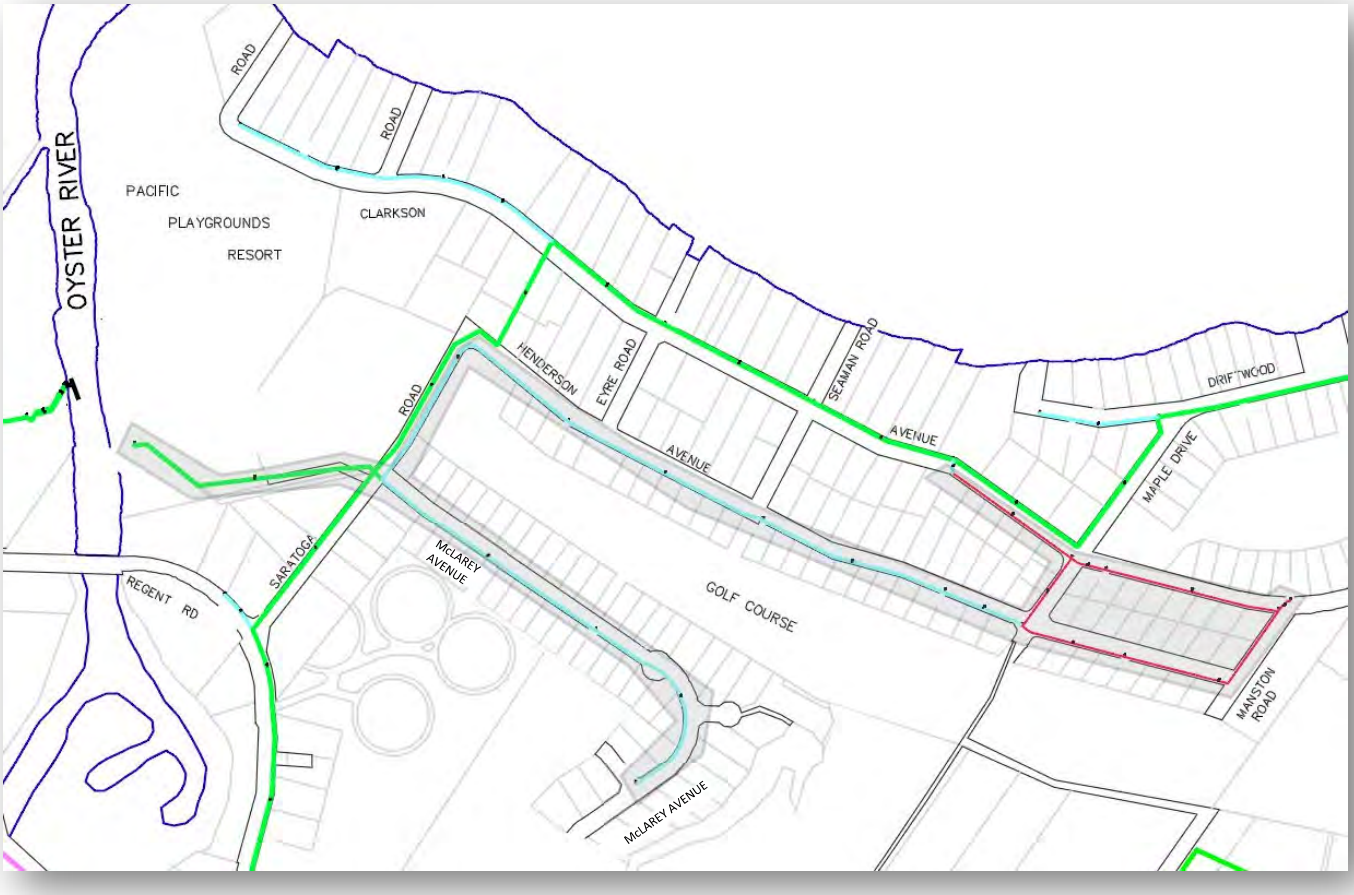
Water is obtained indirectly from the Oyster River via an infiltration gallery situated adjacent to the Oyster River and located within Pacific Playgrounds Resort & Marina. The infiltration gallery is connected to a shallow wet well at the edge of the river. Water that is pumped from the wet well passes through a dual disinfection process (UV followed by chlorination) prior to entering the water distribution system. The pump house is located overtop/adjacent to the wet well and is reported to contain two booster pumps each rated for 15 L/s (1,300 m^3/day).

Distribution System

Distribution mains are located on Saratoga Road, Henderson Avenue, Clarkson Avenue, McLarey Avenue, Maple Drive, and Manston Road, as shown in the image on the following page, and consist of:

- ±850 m of 100 mm dia. watermain pipe
- ±1,600 m of 150 mm dia. watermain pipe

The water system does NOT include a water storage reservoir, which is typically used to meet peak hour demands and provide storage for fire fighting and emergency purposes.



Watutco Water Supply and Distribution System (noted by gray shaded areas)

10.2 Water Licences

Watutco Enterprises Ltd. is the holder of three water licences for the withdrawal of water from the Oyster River. The summary of the authorized annual and maximum day withdrawal limits is presented in **Table 27**.

Table 27 – Watutco Enterprises Ltd. Water Licences

Licence No.	Priority Date	Licenced Withdrawal Limit		Equivalent
		Maximum Day m^3/day	Annual m^3/year	Ave Day m^3/day
C54066	Jan 23, 1975	248	90,431	248
C59087	Nov 9, 1982	45	16,593	45
C118864	Oct 9, 2003	205	37,335	102
	Total:	498	144,359	395

10.3 Water Demands

The most recent water demand data available for this study was contained in the technical memo Watutco Water System Assessment – Rev. 4, October 3, 2018 prepared by McElhanney Consulting Services Ltd. for the CVRD, covering the period of 2004 to 2016 (13 years). Demand data beyond 2016 was not available for Watutco at the time this Water Master Plan was being prepared. The annual, average day, and maximum day demand from 2004 to 2016 are presented in **Table 28** along with the total annual and maximum day licenced withdrawal limits.

Table 28 – Watutco Annual, Ave and Max Day Demands, 2007 - 2016

Year	Annual Demand m^3	Average Day m^3/day	Maximum Day		Max Day Ave Day Ratio
			m^3/day (1)	Date (2)	
2004	**168,318**	446	**903**	-	2.02
2005	129,364	354	**746**	-	2.11
2006	143,850	394	**791**	-	2.01
2007	**144,583**	396	**714**	-	1.80
2008	130,803	357	**762**	-	2.13
2009	118,043	323	**702**	-	2.17
2010	106,843	293	**720**	-	2.46
2011	106,089	290	**629**	-	2.17
2012	95,664	261	**571**	-	2.18
2013 (3)	-	-	-	-	-
2014	**64,364**	**176**	-	-	-
2015	81,763	224	-	-	-
2016	104,963	287	-	-	-
Licenced Withdrawal Limit					
-	144,359	-	498	-	-

Notes:

1 No maximum day demand data was reported after Year 2012.
2 No dates of the maximum day demand were reported.
3 No data for Year 2013 was reported.
4 **Bold red numbers** indicate value exceeds maximum day licenced withdrawal limit.
5 **Bold blue numbers** indicate **lowest value** of all of the years.

The data in **Table 28** shows that after the licenced annual withdrawal limit (144,359 m^3) was exceeded in Year 2017 and there was a steady, year over year decline in total annual demand for the next seven years. In year 2014 the total annual demand was less than ½ of the Year 2007 annual demand (64,364 m^3 vs 144,583 m^3) and well below the licenced withdrawal limit. Over the next two years, the annual demand quickly rose, increasing by 40,599 m^3 (63%) to 104,963 m^3 in Year 2016. There was no explanation for the decline and subsequent increases in the annual demands.

For the nine year period (2004 – 2012) that maximum day demand was reported, there was an overall gradual reduction in demand, resulting in a total decrease of 332 m^3 (37%) for Year 2012 compared to Year 2004 (571 m^3 vs 903 m^3). However, the maximum day demand of every year exceeded the licenced withdrawal limit of 498 m^3. There was no explanation for the decline in the maximum day demands.

10.4 Incorporation into Black Creek / Oyster Bay Water System

In 2020, Koers were retained by the CVRD to carry out a review of the impact of incorporating the Watutco water system into the BC/OB water system. The findings were presented in the Technical Memorandum No. 1 – Rev.1, Black Creek/Oyster Bay and Watutco Water Source Review, May 5, 2020. Relevant findings from that Technical Memorandum are presented below.

10.4.1 Water Supply Interconnection

The 2020 study reviewed three options for connecting the Watutco raw water supply source to BC/OB water supply system for treatment at the BC/OB water treatment building. All three options included the use of the Watutco infiltration gallery. Options 1 and 2 requires the ongoing use of pumps to extract water out of Watutco's existing infiltration gallery. Option 3 includes connecting the Watutco infiltration gallery to the BC/OB infiltration gallery that supplies water to the Well 2A/2B wet well. Under Option 3, the Watutco infiltration gallery wet well and pumphouse would be decommissioned.

10.4.2 Distribution Systems Interconnection

Presently there is an emergency connection between the Watutco and BC/OB distribution systems on Clarkson Avenue in the vicinity of 8889 Clarkson Ave. We understand a short section of 150 mm diameter watermain crosses Clarkson Ave and is connected to the BC/OB watermain (200 mm dia.) and the Watutco watermain (100 mm dia.). There is reported to be two (2) line valves on the existing interconnection main and both are presently closed.

For permanent interconnection of the two water systems, the 2020 Technical Memorandum recommended there be two connection points which would involve:

.1 Opening of the closed valves on the existing interconnection main on Clarkson Ave (in the vicinity of 8889 Clarkson Ave), and
.2 Installation of another interconnection on Saratoga Road and McLarey Avenue.

10.4.3 Design Water Demands, Current & Future

For the purposes of this Water Master Plan, a maximum day demand of 600 m^3/day was used for the Watutco water system. This is slightly higher than the last reported maximum day demand of 571 m^3/day for Year 2012 (see **Table 28**).

The Average Day, Maximum Day, and Peak Hour design demands are presented in **Table 29**.

Table 29 – BC/OB & Watutco Water Demands, Current & Future

Description	No. of Service Connections [1]	Ave Day m^3/day	Max Day m^3/day	Peak Hour L/s
Current Conditions				
BC/OB	975	975 [2]	2,308 [3]	40 [4]
Watutco	129	300 [5]	600 [6]	10.4 [7]
Current Conditions total:	1,104	1,275	2,908	50.4
(m^3/hr)		53 m^3/hr	121 m^3/hr	181 m^3/hr
Future Development [8]				
Development				
- Not Yet Connected	51	35	70	1.2
- Subdividable Under Existing Zoning	215	150	310	5.4
- Proposed Developments	526	370	760	13.2
Future Development total:	792	555	1,140	19.8
Cumulative Total:	1,896	1,830	4,048	70.2
(m^3/hr)		64 m^3/hr	144 m^3/hr	253 m^3/hr

Notes:

1 Number of connections from **Table 14**, **Table 21**, and **Table 26**.

2 BC/OB Ave Day demand, see **Table 23**, note 2.

3 BC/OB Max Day demand, July 5, 2021 (see **Table 12**).

4 BC/OB Peak Hour demand, see **Table 23**, note 4.

5 Watutco Ave Day demand estimated to be ½ maximum day demand.

6 Watutco Max Day demand estimated to be 600 m^3/day.

7 Peak hour demands are not recorded by the Watutco water system. In their absence, the approach used for the BC/OB water system was used, i.e., a multiplier of 1.5 was applied to the Max Day demand to generate the peak hour design demand.

$$\textit{Peak Hour} = \frac{\textit{Max Day x 1.5}}{\textit{86,400 seconds/day}}$$

8 Future development includes the potential development identified by the CVRD for the BC/OB water system as discussed in **8.1 Future Growth** and shown in **Map 1**, **Map 2**, and **Map 3** and summarized in **Table 17**.

10.4.4 Licenced Withdrawal Limits & Design Demands

For the purposes of this Water Master Plan, it has been assumed the incorporation of the Watutco water system into the BC/OB water system will not impact the authorized withdrawal limits of both systems and the Watutco licences would be transferred over to the CVRD for continued use. The resulting combined total of licences is presented in **Table 30**.

Table 30 – BC/OB and Watutco Water Licences Summary

Water System	Licenced Withdrawal Limit		Equivalent Ave Day m^3/day
	Maximum Day m^3/day	Annual m^3/year	
BC/OB	3,637	497,797	1,364
Watutco	498	144,359	395
Total:	4,135	642,156	1,759

A comparison of the combined totals to the projected combined demand of the BC/OB and Watutco system under current conditions and with the addition of future development in the BC/OB water system is presented in **Table 31**.

Table 31 – BC/OB & Watutco Combined Water Demands vs Licenced Withdrawal Limits

Description	Maximum Day m^3/day	Total Annual m^3
Current Conditions		
BC/OB	2,308	355,875
Watutco	600	109,500
Current Conditions Demand:	2,908	465,375
Combined Water Licence Limit:	4,135	642,156
+Surplus/-**Shortfall**:	+1,227	+176,781
	30%	28%
Future Development [8]		
- Not Yet Connected	70	12,775
- Subdividable Under Existing Zoning	310	54750
- Proposed Developments	760	135,050
Future Development Demand:	1,140	202,575
Combined Current & Future Demand:	4,048	667,950
Combined Water Licence Limit:	4,135	642,156
+Surplus/-**Shortfall**:	+87	**-25,794**
	2%	-4%

The data in **Table 31** indicates that:

- the combined licenced withdrawal limits for the two systems can presently meet the current design water demands of the two systems, and
- with the addition of future demands from the potential future development:
  - the combined maximum day licenced withdrawal limit is sufficient (2% surplus)
  - the combined annual licenced withdrawal limit would be exceeded (4% deficiency)

10.4.5 Supply Sources Capacity

The available water supply sources must be able to meet the maximum day demands during the dry season. For the purposes of this Water Master Plan, a comparison of the maximum day design demands and the water supply available, using Dry Season Well Supply Operational Scenario No. 2 (**Table 11**), was carried out for existing conditions demands and with the addition of future development demands. It has been assumed the Watutco demands remain constant at the 2016 estimate.

Existing Conditions Demand, Maximum Day

The estimated current conditions maximum day design demand of the two combined systems (2,908 m^3/day, **Table 29**) is slightly below the combined production capacity of BC/OB water supply wells under Dry Season Well Supply Operational Scenario No. 2 (3,048 m^3/day, **Table 11**) and well below the licenced maximum day withdrawal limit of the BC/OB water system as shown in **Figure 20**.

With Future Development Demands, Maximum Day

With the addition of Watutco's assumed maximum day design demand and the maximum day design demands associated with future development (**Table 29**), the resulting total maximum day (4,048 m^3/day) exceeded the Scenario No. 2 water supply production capacity (3,048 m^3/day) by 1,000 m^3/day, assuming the existing Watutco infiltration gallery intake is not being utilized. The combined demand also exceeds the licenced withdrawal limit of the BC/OB water system (3,637 m^3/day) but is slightly below the combined licenced capacity of the two water systems (4,048 m^3/day) as can be seen in **Figure 21**. This comparison indicates that:

- based on the supply currently available under Dry Season Well Supply Operational Scenario No. 2, an additional water supply source capable of providing a minimum of 1,000 m^3/day (42 m^3/hr) is required to meet the future maximum day demands, and
- the combined maximum day licenced withdrawal limits of the BC/OB and Watutco systems are required under future development demands.

With Future Development Demands, Annual Demand

As shown in **Table 31**, the future total annual design demand resulting from the combining of the two water systems, and with the addition of the demands from projected future development, is slightly more (4% higher) than the combined annual licenced withdrawal limit of the two water systems.

10.4.6 Peak Hour Pressures & Available Fire Flows, Existing Conditions

The BC/OB water system current conditions computer model was expanded to include the Watutco water distribution system, the Watutco system demands, and the two proposed interconnections that are discussed in **10.4.2 Distribution Systems interconnection**. The expanded model was then run under peak hour demand and again under maximum day plus fire flow demands to assess the impact on the BC/OB water system. The results are presented in **Table 32** and indicate the incorporation of the Watutco water system will have minimal impact on the BC/OB water

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Consulting Engineers

Black Creek / Oyster Bay & Watutco Water Systems Combined
Existing Design Demand vs Dry Season Well Supply Operational Scenario No. 2 & Licenced Max Day Withdrawal

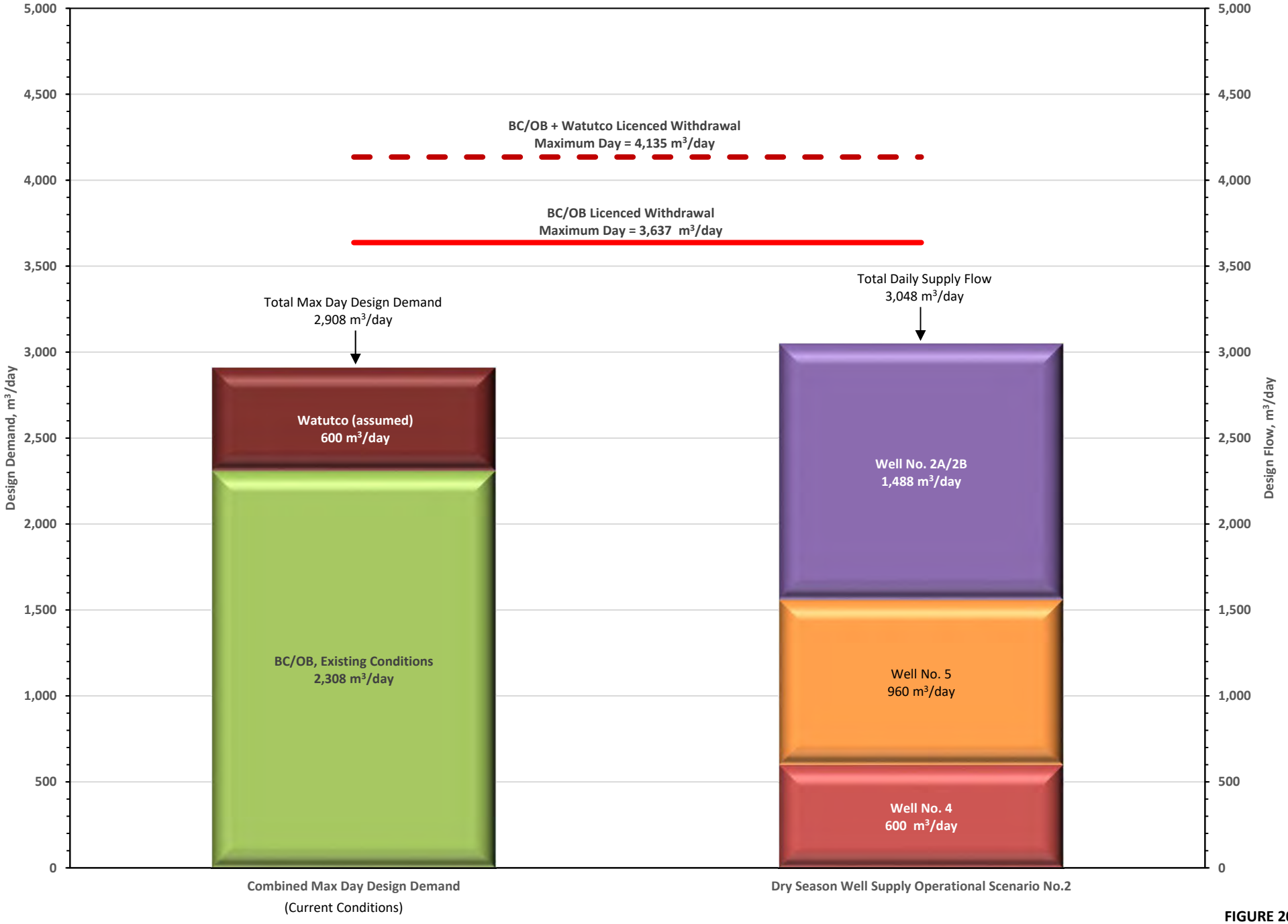

FIGURE 20

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Black Creek / Oyster Bay & Watutco Water Systems Combined
Future Design Demands vs Dry Season Well Supply Operational Scenario No. 2 & Licenced Max Day Withdrawal

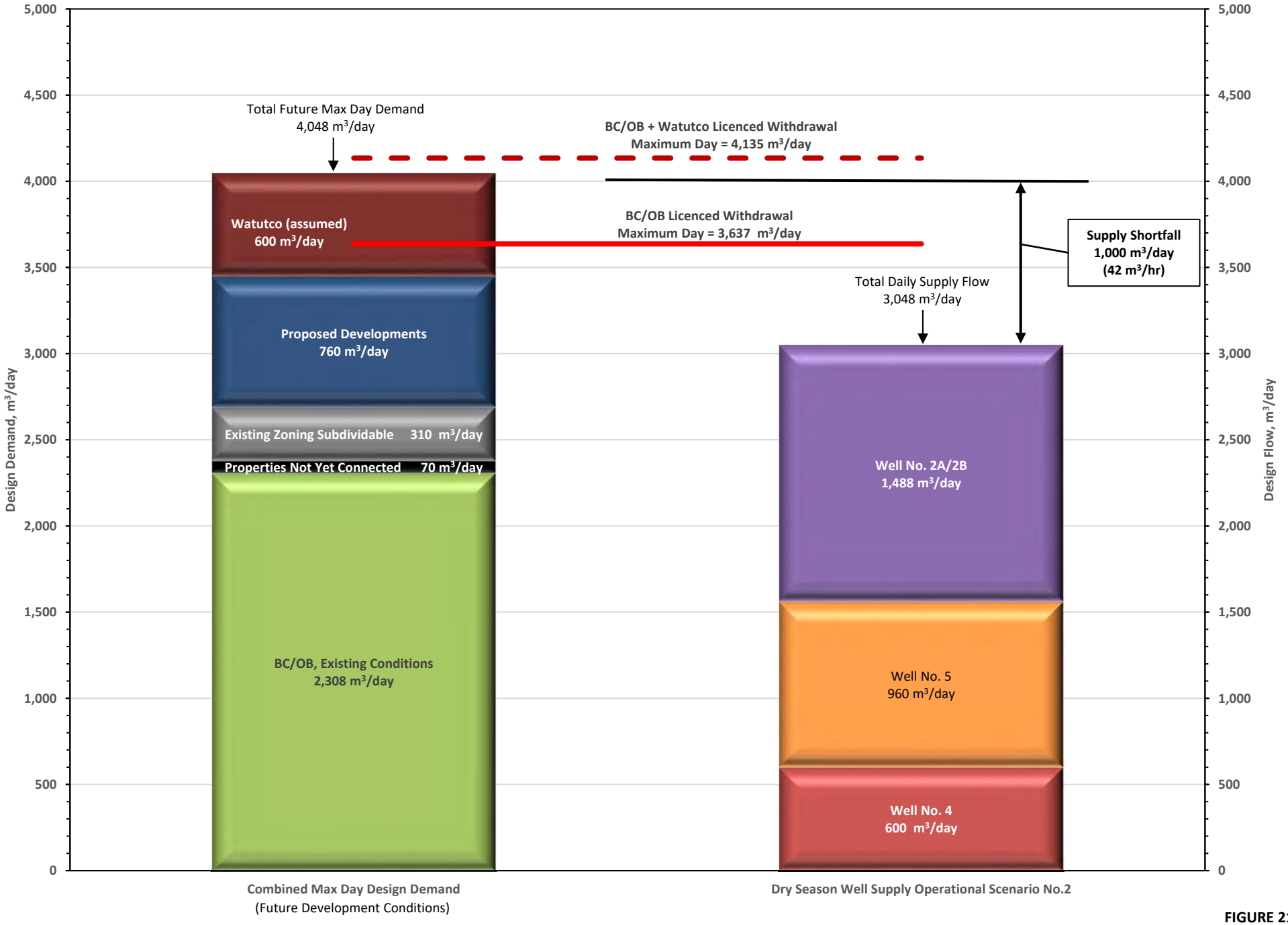


FIGURE 21

distribution system. There would be a slight reduction in the peak hour pressures and available fire flow due to the increase in demand.

Table 32 – BC/OB Peak Hour Pressures & Available Fire Flows With Watutco, Existing Conditions

Description	Peak Hour Pressure (psi)	Maximum Day with Fire Flow (L/s)
Average Change	**- 1.5**	**- 2**
Maximum Change	**- 2.5**	**- 8.3**

Watutco Water System Pressure Increase

With the interconnection of the two systems, the Watutco service area would be serviced by the Macaulay Road reservoir. This will result in an increase in the service pressure to the entire Watutco system (all mains and all properties). As a result, system leakage in the Watutco system may increase because of the higher pressures. All property owners will have to be notified in advance of the pressure increase to ensure that individual pressure reducing valves are installed on their service connections, if not already in place, and that they are rated to handle the pressure increase.

10.4.7 Peak Hour Pressures & Available Fire Flows, Future Conditions

The future conditions (build-out) computer model was expanded to include the Watutco water distribution system, its demands, and the upgrading of the 850 m of 100 mm dia. watermain to 150 mm dia. within the Watutco system (see **Figure 17**). The expanded model was then run under peak hour demands and again under maximum day plus fire flow demands to assess the impact on the BC/OB water system. The modelling results are summarized below.

Peak Hour Pressures, Future (Build-out) Conditions with Watutco

The calculated residual pressures throughout the future distribution system for a peak hour design demand of 70.2 L/s (**Table 29**) are graphically shown in **Figure 22**.

The modelling results indicate the recommended minimum pressure at property line of 300 kPa (44 psi) are provided throughout the distribution system except for properties close to the two reservoirs. Around the Kelland Road reservoir (with its top water level of 113.3 m) properties above ±82 m geodetic experience pressures less than the minimum recommended 300 kPa (44 psi). Around the Macaulay Road reservoir (with its top water level of 86.1 m) properties above ±55 m geodetic also experience pressures less than the minimum recommended 300 kPa (44 psi).

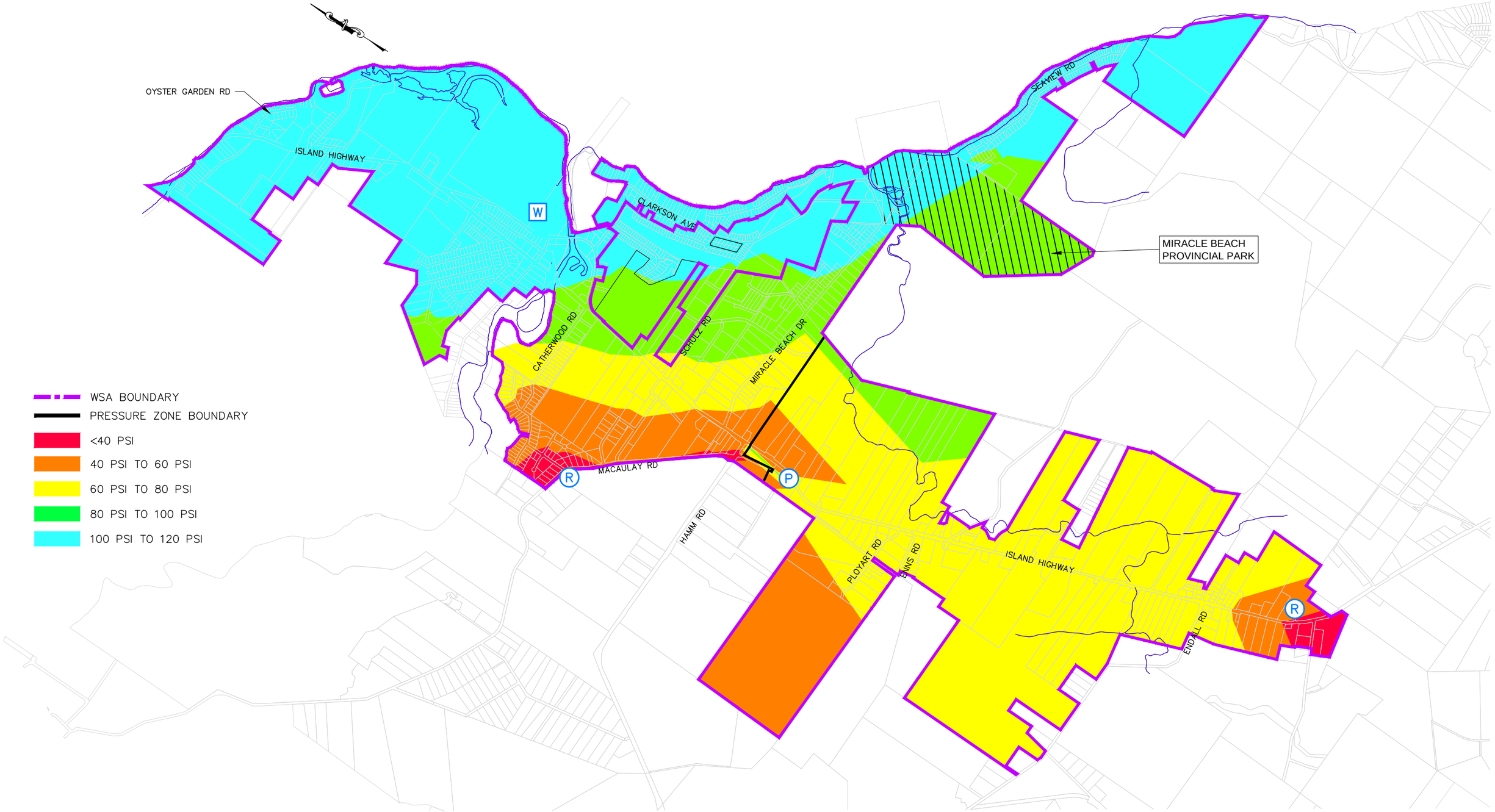
Available Fire Flows, Future (Build-out) Conditions with Watutco

The calculated maximum available fire flow throughout the future conditions (build-out) water distribution for a maximum day design demand 4,048 m^3/day (**Table 29**) is graphically shown in **Figure 23** and are based on allowing a maximum fire flow velocity in the watermain of 3.5 m/s (**Table 8**).

The modelling results indicate that with the interconnection of the BC/OB and Watutco water distribution systems, the land-use based recommended minimum fire flows (**Table 9**) within the Watutco service area are met with almost negligible impact on the available fire flows along Clarkson Avenue and Maple Drive. As previously stated, this assumes the existing 100 mm dia. watermains in Watutco are upsized to 150 mm dia.

10.4.8 Water Conservation, Future Conditions

Water meters are known to reduce water consumption. If the Watutco water system is incorporated into the BC/OB water system, water meters will be installed so that all existing Watutco service connections are metered and billed in the same manner as the other properties within the BC/OB water system.



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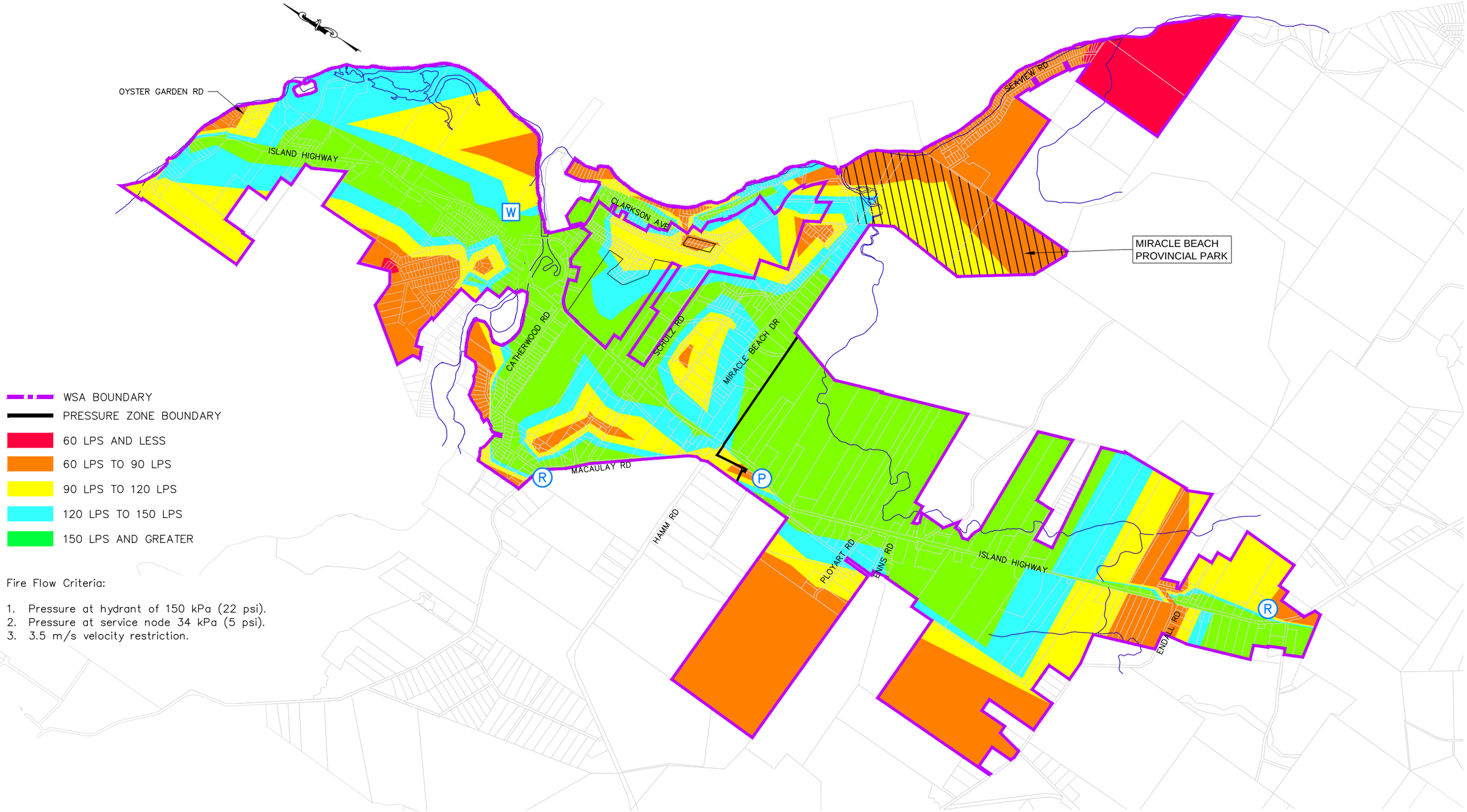
CLIENT COMOX VALLEY REGIONAL DISTRICT

PROJECT BLACK CREEK/OYSTER BAY WATER LOCAL SERVICE AREA WATER MASTER PLAN

TITLE BUILD OUT CONDITIONS WITH WATUTCO RESIDUAL PEAK HOUR PRESSURES

APPROVED	SCALE 1: 30,000
DATE NOV 2021	DWG No. FIGURE 22
PROJECT No. 2134	



Fire Flow Criteria:

1. Pressure at hydrant of 150 kPa (22 psi).
2. Pressure at service node 34 kPa (5 psi).
3. 3.5 m/s velocity restriction.

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CLIENT COMOX VALLEY REGIONAL DISTRICT

PROJECT BLACK CREEK/OYSTER BAY WATER LOCAL SERVICE AREA WATER MASTER PLAN

TITLE BUILD OUT CONDITIONS WITH WATUTCO AVAILABLE FIRE FLOWS

APPROVED	SCALE 1: 30,000
DATE NOV 2021	DWG No. FIGURE 23
PROJECT No. 2134	

CONCLUSIONS

The following are the principal findings of this study:

10.5 Existing Conditions

Water Licence Authorized Withdrawal Limits & Historical Demand

1 The BC/OB water system is authorized to withdraw the following daily maximum and total annual volume under licence no. C503625:

- Maximum Day Withdrawal Limit: 3,637 m^3/day
- Annual Withdrawal Limit: 497,797 m^3/year

2 During the past eight years (2014-2021), the historical demand (Maximum Day and Total Annual) have been well below the licenced withdrawal limits. The highest recorded demands were:

- Highest Maximum Day Demand: 2,308 m^3/day, July 5, 2021 (63% of licence)
- Largest Total Annual Demand: 383,700 m^3/year, Year 2021 (77% of licence)

Water Supply Sources & Production Capacity

3 The BC/OB water system obtains water by two means:

- Three groundwater wells (Well No. 1, Well No. 4 and Well No. 5), and
- An infiltration gallery under the Oyster River (Well 2A/2B)

4 The production capacity of the water supply sources increases and decreases as the groundwater level rises and falls and the flow in the Oyster River fluctuates.

5 The capacity of the water supply sources must be sufficient to meet the maximum day demand. For the BC/OB water system the maximum day demand has historically occurred sometime between the end of May and the beginning of August, with five of the past eight years (2014 – 2021) occurring in July, followed by once in May, June, and August.

6 The production capacity of the water supply sources have been published with factors of safety ranging from none to 30%. A combined longterm sustainable yield for the water supply sources has not been developed. For this study, five dry season operational scenarios were considered for varying combinations of pumps operating (or not operating) and with varying factors of safety. The resulting total daily production volume ranged from a low of 2,376 m^3/day (Scenario No. 4) to a high of 3,432 m^3/day (Scenario No. 1). For the purposes of this Water Master Plan, Scenario No. 2 with a total daily production volume of 3,048 m^3/day was selected to assess the ability to meet future maximum day design demands during the dry season.

Water Treatment

7 All water is treated by UV, caustic soda (for pH adjustment), and chlorine before entering the distribution system.

8 It is understood that there are two UV reactors and they each are rated for a design flow of:

- Minimum Flow: 23 L/s (1,990 m^3/day)
- Maximum Flow: 42.1 L/s (3,637 m^3/day)

Water Storage

9 There are two treated water storage reservoirs in the distribution system with a combined storage volume of 2,305 m^3:

- The Macaulay Rd Reservoir has a storage volume of 1,830 m^3. It has a top water level of 86.1 m geodetic and services Pressure Zone (PZ) 86.
- The Kelland Rd Reservoir has a storage volume of 475 m^3. It has a top water level of 113.3 m geodetic and services PZ 113.

Booster Pump Station

10 The Kelland Rd Reservoir is filled by a booster pump station which pumps water from PZ 86 into PZ 113. The station is equipped with two Grundfos turbine pumps and whose operation is controlled by the water level in the Kelland Rd Reservoir. The operation of one pump is calculated to provide a flow of 18.9 L/s for a Total Dynamic Head (TDH) of 35 m. The operation of both pumps simultaneously is calculated to provide a flow of 25.6 L/s for a TDH of 40.6 m.

11 The booster pump station is equipped with a pressure sustaining feature that prevents the pump(s) from pulling down the hydraulic grade line (HGL) of PZ 86 below a predetermined set point.

Water Distribution

12 The water distribution system consists of almost 38 kms of watermain piping, of which 76% (28.7 kms) is Asbestos Cement material.

13 The majority (57%) of the watermain piping is 200 mm dia., followed by 150 mm dia. at 28%, 300 mm dia. at 12%, 100 mm dia. at 3%, and 400 mm dia. at less than 1%.

14 The majority of the water distribution mains are believed to be around 50 years old.

Water Conservation

15 A number of water conservation initiatives are currently in place or promoted within the Black Creek/Oyster Bay water system. These include:

- Watering restrictions take place automatically in the spring according to a four stage watering schedule that is initiated on May 1 each year.
- Micro/drip irrigation is promoted through the four stage watering schedule, which does not limit the use of this type of irrigation during some of the water restriction periods.
- Residential and commercial water meters are currently in place and stepped billing rates are applied to each metered account.

- Low flow fixtures, nature scaping, smart irrigation controllers, and leak checking are promoted on a dedicated webpage located on the CVRD's website.

Water Demands, Historical

16 The highest maximum day demand recorded over the past eight years (2014 – 2021) was 2,308 m^3/day for July 5, 2021. This was only 63% of the licenced withdrawal limit of 3,637 m^3/day.

17 The largest annual volume recorded over the past eight years (2014 – 2021) was 383,700 m^3 for Year 2021. This equates to 77% of the licenced withdrawal limit of 497,797 m^3/year. It is noted that Year 2021 experienced lower than average rainfall from February through August (as recorded at the Environment Canada Comox Airport weather station) as well as extreme and sustained day and night-time temperatures during the "heat dome" event from late June to mid July.

Demands Per Connection, Historical

18 The BC/OB water system is universally metered. In Year 2019, there were 975 water meters. The majority of the meters (95%) are for single family residential properties. The other 5% are for Institutional, Commercial, or Industrial (I/C/I) properties.

19 For Year 2019, the average demand per connection for the water system was 365 m^3/year per connection based on a total system demand of 356,200 m^3 and 975 connections. This is slightly on the higher side compared to other similar Vancouver Island universally metered water systems (see **Table 16**).

Non-Revenue Water Amount

20 For 2019, the amount of Non-Revenue Water (Water System Bulk Meter minus Sum of all Individual Meters) was 23%. This is within the expected range of 15% to 25% for a water system that is around 50 years old and comprised mostly (76%) of Asbestos Cement watermains that are also around 50 years old.

Revenue Water Demand Reduction

21 Reducing Revenue (metered) demands requires a change in human behavior. If changes can be made and Revenue demands lowered, additional properties could be serviced within the Black Creek/Oyster Bay water system.

22 To help initiate a reduction in Revenue demands it would be beneficial to develop a **Water Conservation Plan** that is specific for the Black Creek/Oyster Bay water system. The plan would identify water use modification tools which would result in the goal of demand reduction during the dry summer months when demand is the highest. The plan would assess the potential for reducing both indoor and outdoor water usage.

System Pressures During Peak Hour Demands, Existing Conditions

23 Computer modelling results indicate that the water system is capable of providing the recommended minimum pressure of 300 kPa (44 psi) at property line throughout the distribution system except for approximately 20 to 25 properties around the Macaulay Rd Reservoir and approximately 6 properties around the Kelland Rd Reservoir.

Available Fire Flows During Maximum Day Demand, Existing Conditions & Proposed Upgrades

24 Computer modelling results indicate that the land-use based recommended minimum fire flows (**Table 19**) are available throughout most, but not all, of the existing distribution system. Delivery of the recommended minimum fire flows are limited because of pipe diameters, lack of watermain looping, and dead-ended mains.

25 The delivery of 150 L/s to a number of the I/C/I zoned properties is currently not provided (see **Table 18**) and is the primary driving factor in the need for most of the 12 kms of proposed watermain upgrades (see **Table 20** and **Figure 17**).

26 On a water system the size of the BC/OB system, the upgrading of 12 kms (more than 30% of the water distribution system mains) will likely have to be carried out over a significant period of time due to the cost of the upgrades. In some areas it may be acceptable to wait until the older piping reaches the end of its operational life, and then replace it with the proposed larger watermains.

Reservoir Performance In Response to Major Fire Flow During Maximum Day Demand, Existing Conditions

27 Extended time computer modelling of the water levels in the water storage reservoirs with a major fire (design flow of 150 L/s for 2 hours) occurring during maximum day demand (2,308 m^3/day) and Dry Season Well Supply Operational Scenario No. 2 (3,048 m^3/day) shows:

Macaulay Rd Reservoir

- the reservoir is almost completely drained (empty) by the end of a 150 L/s fire flow demand within its pressure zone (PZ 86),
- the reservoir does not return to its top water level (full) until 62 hours (2.5 days) after the end of the fire flow demand, and
- the simultaneous and continuous operation of all three sources for 65 hours (2.7 days) is required to refill the reservoir.

Kelland Rd Reservoir

- the reservoir is completely drained (empty) and remains empty for almost 2 hours for a 150 L/s fire flow demand within its pressure zone (PZ 113),
- the reservoir returns to its top water level (full) within 9 ½ hours.

10.6 With Future Development

Future Growth & Demands

28 A potential for 792 water service connections to be added to the water system has been identified (see **Table 21** and **Maps 1**, **Map 2,** and **Map 3**).

29 The single largest proposed development is Saratoga Beach Estates with a potential for 446 connections (56% of potential total future connections).

30 The future maximum day demand, based on the currently anticipated amount of development, is projected to increase to 3,448 m^3/day (see **Table 23**). This design demand is:

- less than: 3,637 m^3/day (existing licenced maximum day withdrawal limit) but
- greater than: 3,048 m^3/day (Dry Season Well Supply Operational Scenario No. 2).

System Pressures During Peak Hour Demands With Future Development

31 Computer modelling results indicate that the water system is capable of providing the recommended minimum pressure of 300 kPa (44 psi) at property line throughout the distribution system except for approximately 20 to 25 properties around the Macaulay Rd Reservoir and approximately 6 properties around the Kelland Rd Reservoir.

Available Fire Flows During Maximum Day Demand With Future Development & Proposed Upgrades

32 Computer modelling results indicate that 2.5 kms of watermain upsizing/new watermains and looping will be required to deliver the land-use based recommended minimum fire flows (**Table 19**). The proposed works are listed in **Table 24** and shown in **Figure 17**.

Reservoir Capacity With Future Development

33 Under future build-out conditions the existing reservoir storage volume will be less than the recommended minimum, as shown in **Table 25.** A **Reservoir Optimization Study** is needed to determine the best way to address the reservoir volume shortfall and reduce the length of time it takes to refill the reservoirs following a fire flow event.

10.7 With Addition of Watutco

Watutco Water Licence Authorized Withdrawal Limits & Historical Demand

34 The Watutco water system is authorized to withdrawal the following daily maximum and total annual volume under three water licences:

- Maximum Day Withdrawal Limit: 498 m^3/day
- Annual Withdrawal Limit: 144,359 m^3/year

35 Only limited historical demand (Maximum Day and Total Annual) was available for this study and no information more recent than Year 2016 was available.

36 For the purposes of this study a maximum day demand of 600 m^3/day was applied to the Watutco water system based on a review of the most recent maximum day demand data (years 2011 and 2012). This is higher than the licenced maximum day withdrawal limit (498 m^3/day).

Water Distribution System Interconnection with BC/OB

37 Incorporating the Watutco water system into the BC/OB water system was modelled by connecting the distribution systems together at two locations:

.1 Opening of the closed valves on the existing interconnection main on Clarkson Ave (in the vicinity of 8889 Clarkson Ave), and

.2 Installation of another interconnection on Saratoga Road and McLarey Avenue.

38 The Watutco water system (consisting of 129 connections) would become part of the BC/OB PZ86 which is serviced by the Macaulay Rd Reservoir.

Watutco Water Supply Intake and Treatment

39 The existing Watutco water supply system consisting of an infiltration gallery under/adjacent to the Oyster River, and its pumping station and water treatment system, would be abandoned.

Watutco Watermain Upgrades

40 The ±850 m of 100 mm dia. watermain piping (see **Figure 17**) will be upgraded to 150 mm dia. to meet the minimum land-use based fire flow demand.

BC/OB & Watutco Combined Water Demands and Licenced Withdrawal Limits

41 With the incorporation of the Watutco water system under current conditions and assuming the Watutco water licences are transferred over to the BC/OB water system, it is anticipated the combined licenced withdrawal limits will be greater than the maximum day and total annual demand (see **Table 31** and **Figure 20**) under existing conditions as shown below:

Maximum Day, Existing

- Combined Systems Anticipated Demand: 2,908 m^3/day
- Combined Licenced Withdrawal Limit: 4,135 m^3/day

Annual Demand, Existing

- Combined Systems Demand: 465,375 m^3/day
- Combined Licenced Withdrawal Limit: 642,156 m^3/day

42 With the incorporation of the Watutco water system under future development conditions and assuming the Watutco water licences are transferred over to the BC/OB water system, it is anticipated the combined maximum day withdrawal limit will be greater than the future maximum day but the future total annual demand would be slightly greater (4% larger) than the combined licenced withdrawal limit (see **Table 31** and **Figure 21**).

BC/OB & Watutco Combined Water Demands and Water Supply Source Production Capacity

43 For existing conditions, it is anticipated the production capacity of 3,048 m^3/day of the BC/OB water system under Dry Season Well Supply Operational Scenario No. 2 will be just adequate

to meet the estimated combined maximum day demand of 2,908 m^3/day of the combined systems (see **Figure 20**).

44 For future development conditions, it is projected that an additional 1,000 m^3/day (minimum) of water supply (in addition to the production capacity of 3,048 m^3/day of the BC/OB water system under Dry Season Well Supply Operational Scenario No. 2) would be required to meet the projected future maximum day design demand of 4,048 m^3/day (see **Figure 21**).

Watutco Water Conservation

45 If the Watutco water system is incorporated into the BC/OB water system, water meters will be installed so that all existing Watutco service connections are metered and billed in the same manner as the other service areas.

11 RECOMMENDATIONS

Based on the conclusions reached in this study, the following actions are recommended:

Water Supply

1 To meet the projected future maximum day design demand in response to the projected future development, and the servicing of the Watutco water system by the BC/OB water supply sources, a minimum additional supply capacity of 1,000 m^3/day (11.6 L/s) should be developed. The CVRD has commenced detailed design for a new water supply well (Well No. 6). The hydrology report indicates Well No. 6 has a calculated sustainable yield of 1,142 m^3/day (approx. 48 m^3/hr).

2 Once new well supplies have been developed, the dry season sustainable yield estimate for each individual well, and operating collectively as a group, should be re-evaluated by a groundwater hydrologist.

3 Because of the significant delivery times that can occur with larger pumps and motors, some spare pumps and motors should be kept in storage to reduce the down time should one of the high production wells experience a pump or motor failure.

Fire Flow Requirements for I/C/I Properties

4 Because of the significant impact on watermain sizing, reservoir storage requirements, and the ability of the water supply sources to restore the reservoirs to full water level after a major fire, it is recommended that fire flow calculations be carried out on a number of I/C/I properties to confirm the watermain upsizing recommendations in this report. These calculations should be based on industry standard design guidelines, such as the ISO equation in the "Water Supply for Public Fire Protection, 2020" by the Fire Underwriters Survey (FUS). As a minimum, the existing developed I/C/I zoned properties that should be reviewed include, but are not limited to:

Pressure Zone 113 (Kelland Rd Reservoir)

- 8074A/8074B Hwy 19a North (Black Creek Dinner/gas station/Farm & Feed Supply)
- 2275/2277 Enns Road (Black Creek United Mennonite Church)
- 2001 Black Creek Road (Black Creek Community Centre)
- 7898 Hwy 19a north (Black Creek Community Church)

Pressure Zone 86 (Macaulay Rd Reservoir)

- 8775 Paulsen Rd (Miracle Beah Elementary)
- 8655 Hwy 19a south (Cedar Sales & Fencing)
- 8667 Hwy 19a south (Miracle Beach Mini Golf)
- 8723 Hwy 19a south/2380 Macaulay Rd (Saratoga Speedway)
- 2222 Regent Rd (Living Waters Fellowship)
- 2200/2212 Regent Rd (metal shop, mini storge, RV repairs)
- 2207 Glenmore Rd (Discovery Foods Plaza)
- 2250 Terrain Rd (Oyster River Elementary)

- 4750 Regent Rd (Shelter Point Distillery)
- 2158/2176 Salmon Point Rd (Salmon Point Resort)
- 4378 Hwy 19a north (Ocean Resort)
- 4357 Hwy 19a south (Oyster Bay Resorts)
- 4329 Hwy 19a south (Driftwood Restaurant)

Treated Water Storage Capacity

5 As additional water supply capacity is added to the system, Dry Season Well Supply Operational Scenarios should be reviewed and modified/updated as warranted. An appropriate Scenario should be selected as a design standard, and extended time modelling of the reservoirs re-evaluated under existing and future demands to assess the time requirements of the reservoirs to refill after the largest design fire flow demand for each pressure zone.

6 A **Reservoir Optimization Study** should be conducted to determine how best to upsize the reservoir storage needed to accommodate future development. Water system improvements that may be recommended include:

- Adding reservoir volume at Kelland Road and/or Macaulay Road
- Increasing the combined well capacity that is available during the dry season
- Increasing the pumping capacity of the Black Creek Booster Pump Station
- Adding a standby generator at the Black Creek Booster Pump Station

Water Distribution System

7 To meet the land-use based recommended minimum fire flows (**Table 19**), projected future growth, and incorporation of Watutco; the upsizing, looping of dead-end mains and installation of new mains shown in **Figure 17** (totalling 15,360 m) be carried out, subject to the findings of recommendation 4.

8 The order in which/prioritization of the watermain upgrading projects shown in **Figure 17** are carried out should be developed base several factors, including but not limited to:

- Input from the Oyster Bay Fire Department following their review of the fire flow mapping (see **Figure 12**)
- Mains with a history of breaks/leaks
- Remaining service life of mains
- Timing of and proposed developments and their fire flow requirements
- Adequate funding

Water Conservation

9 Existing water conservation measures should continue and be expanded where appropriate. The development of a **Water Conservation Plan** should also be considered for the Black Creek/Oyster Bay water system in order to help manage and reduce revenue water demand.

APPENDIX A

-

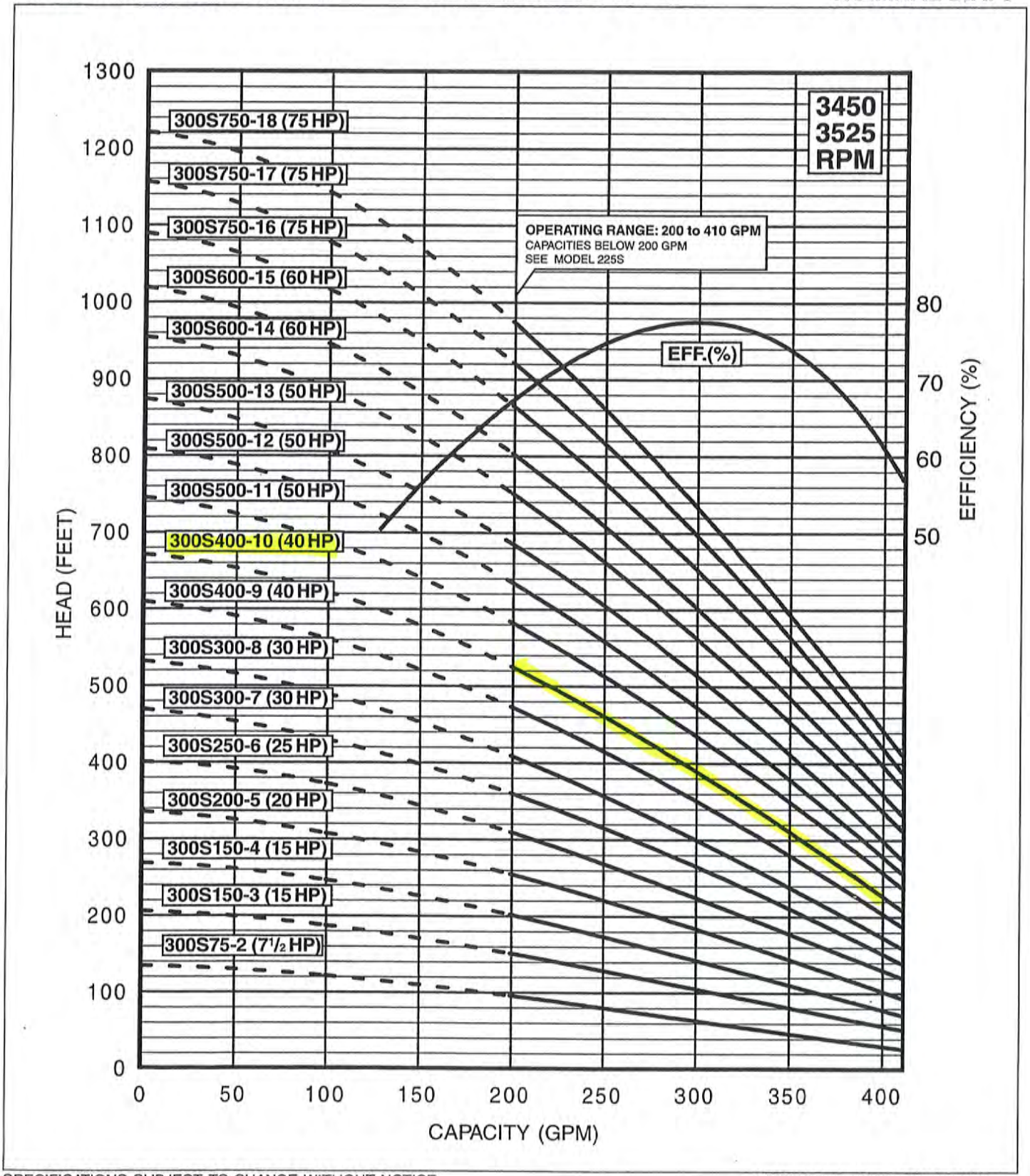
BLACK CREEK / OYSTER BAY WATER SYSTEM

PUMP CURVES
Well No. 1
Well No. 4
Well No. 5
Well No. 2A/2B
Black Creek Booster Pump Station

Well #1 & Well #4

Model 300S 300 GPM Performance Curves

FLOW RANGE: 200 -410 GPM **OUTLET SIZE: 3"& 4" NPT*** **NOMINAL DIA. 6"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 7.5 HP/3450 RPM.
6" MOTOR STANDARD,15-50 HP/3450 RPM.
8" MOTOR STANDARD, 60-75 HP/3525 RPM.
* 3" NPT 2-7 STAGES, 4" NPT 8-18 STAGES.

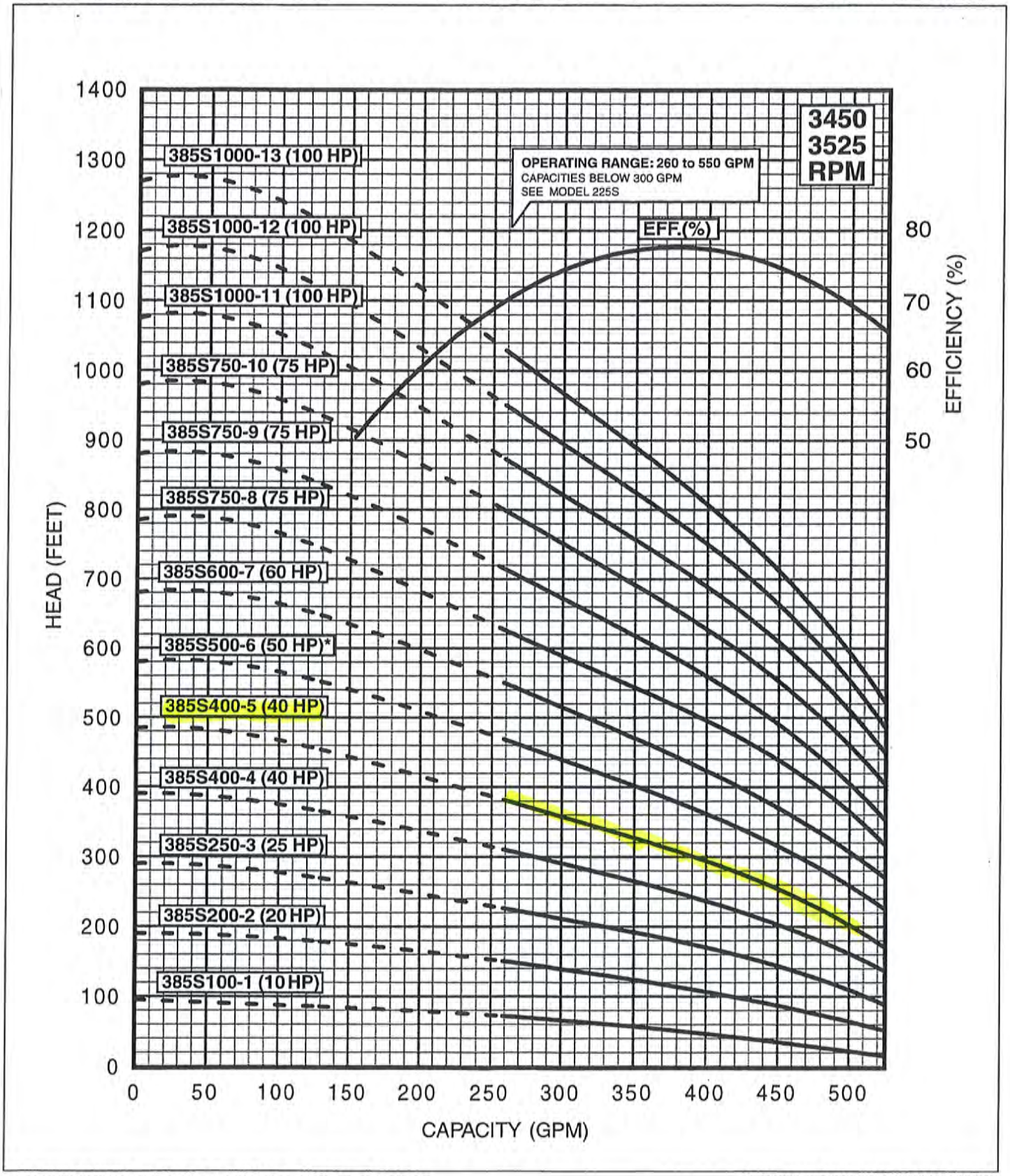
Performance conforms to ISO 2548 Annex B
@ 8 ft. min. submergence.

GRUNDFOS

Well #5

Model 385S 385 GPM Performance Curves

FLOW RANGE: 260 - 550 GPM **OUTLET SIZE: 4" NPT** **NOMINAL DIA. 8"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
6" MOTOR STANDARD, 10-50 HP/3450 RPM.
8" MOTOR STANDARD,60-100 HP/3525 RPM.
* Also available with 8" motor.

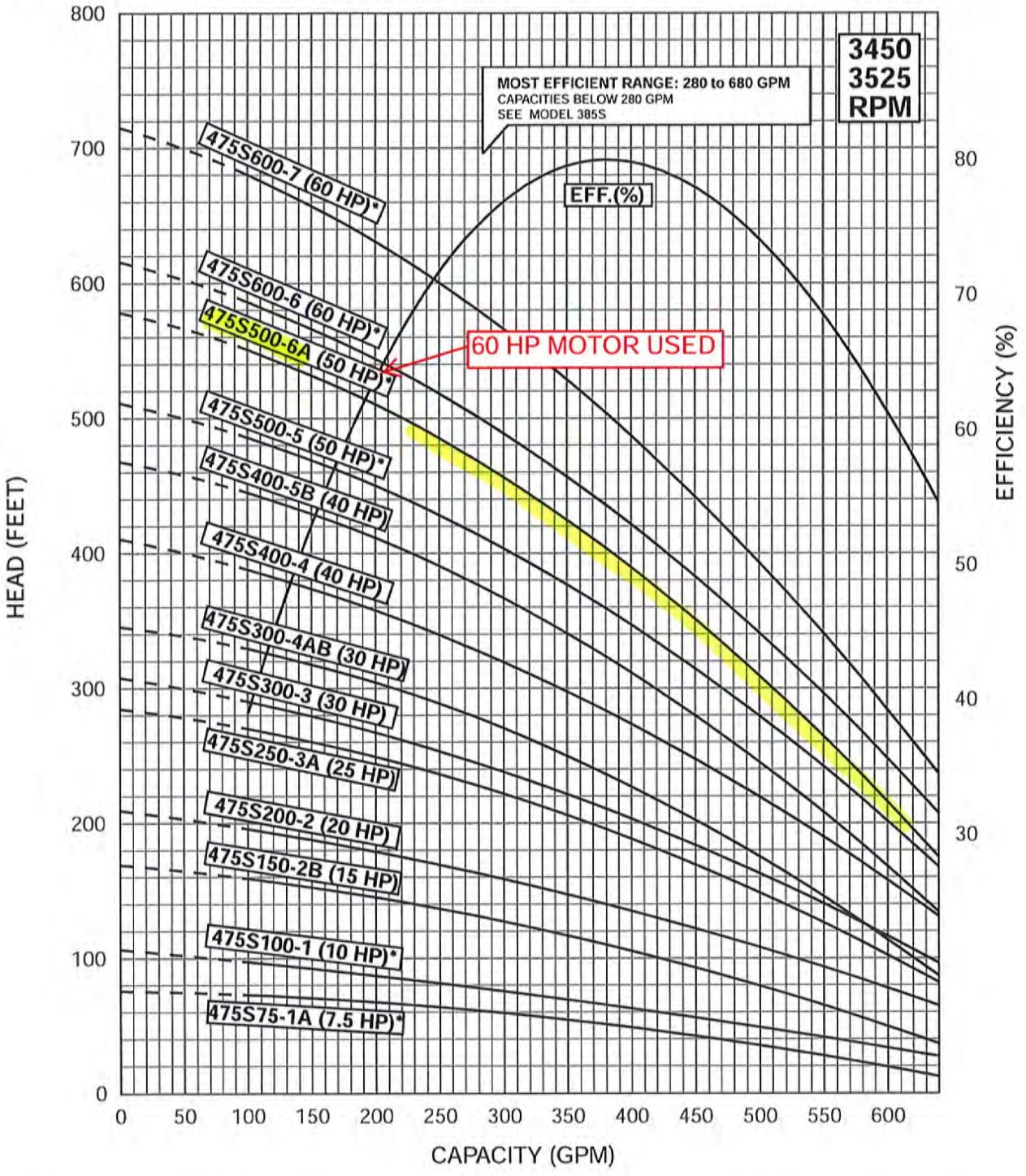
Performance conforms to ISO 2548 Annex B
@ 8 ft. min. submergence.

GRUNDFOS

Well 2A/2B

PERFORMANCE CURVES 475 GPM MODEL 475S

FLOW RANGE: 95 - 680 GPM **OUTLET SIZE: 6" NPT** **NOMINAL DIA. 8"**

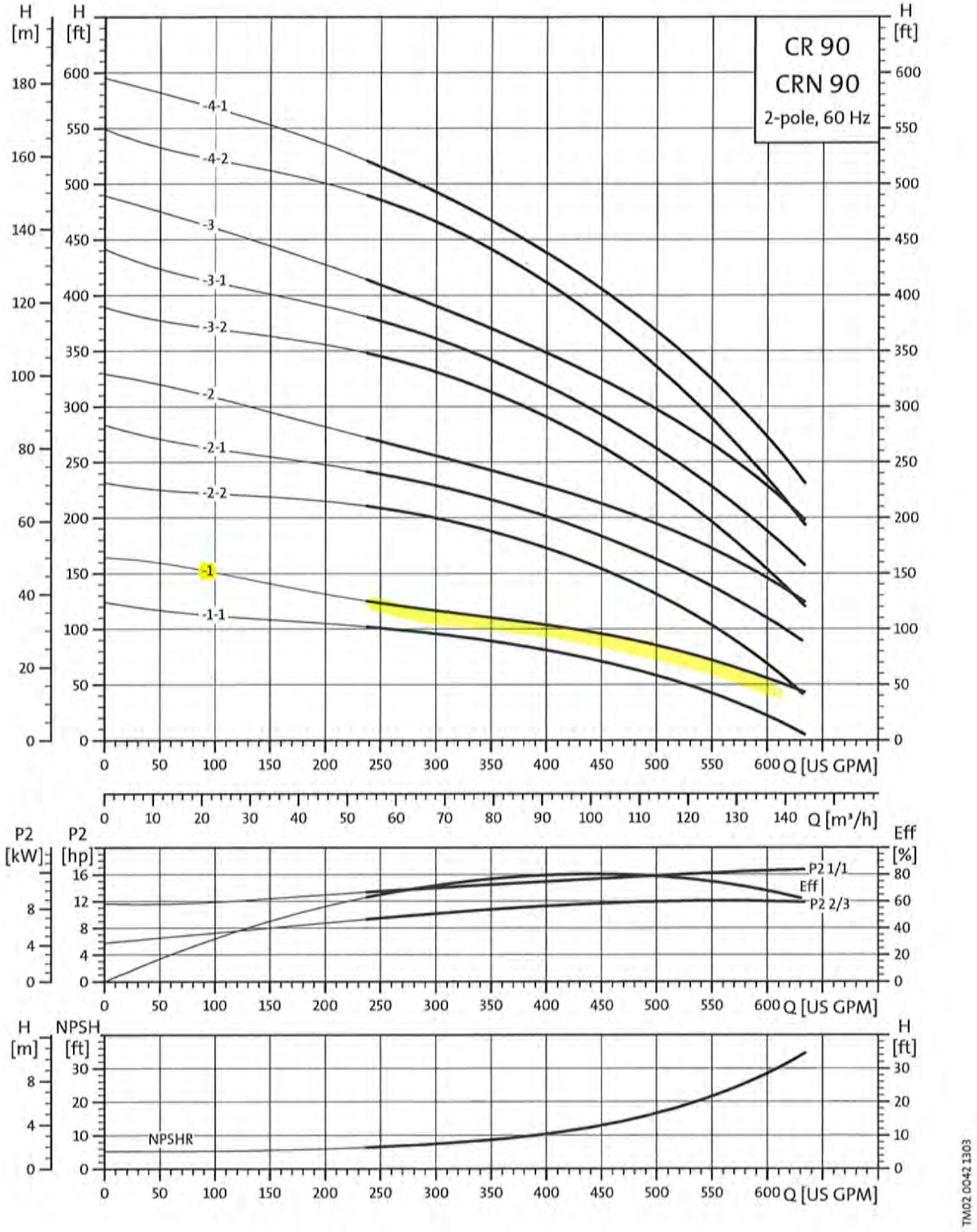


SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
6" MOTOR STANDARD, 10-60 HP/3450 RPM.
8" MOTOR STANDARD,75-125 HP/3525 RPM.
* Alternate motor sizes available.

Performance conforms to ISO 9906 Annex A
@ 8 ft. min. submergence.

Performance curves

Black Creek Water Booster Pump Station



APPENDIX B

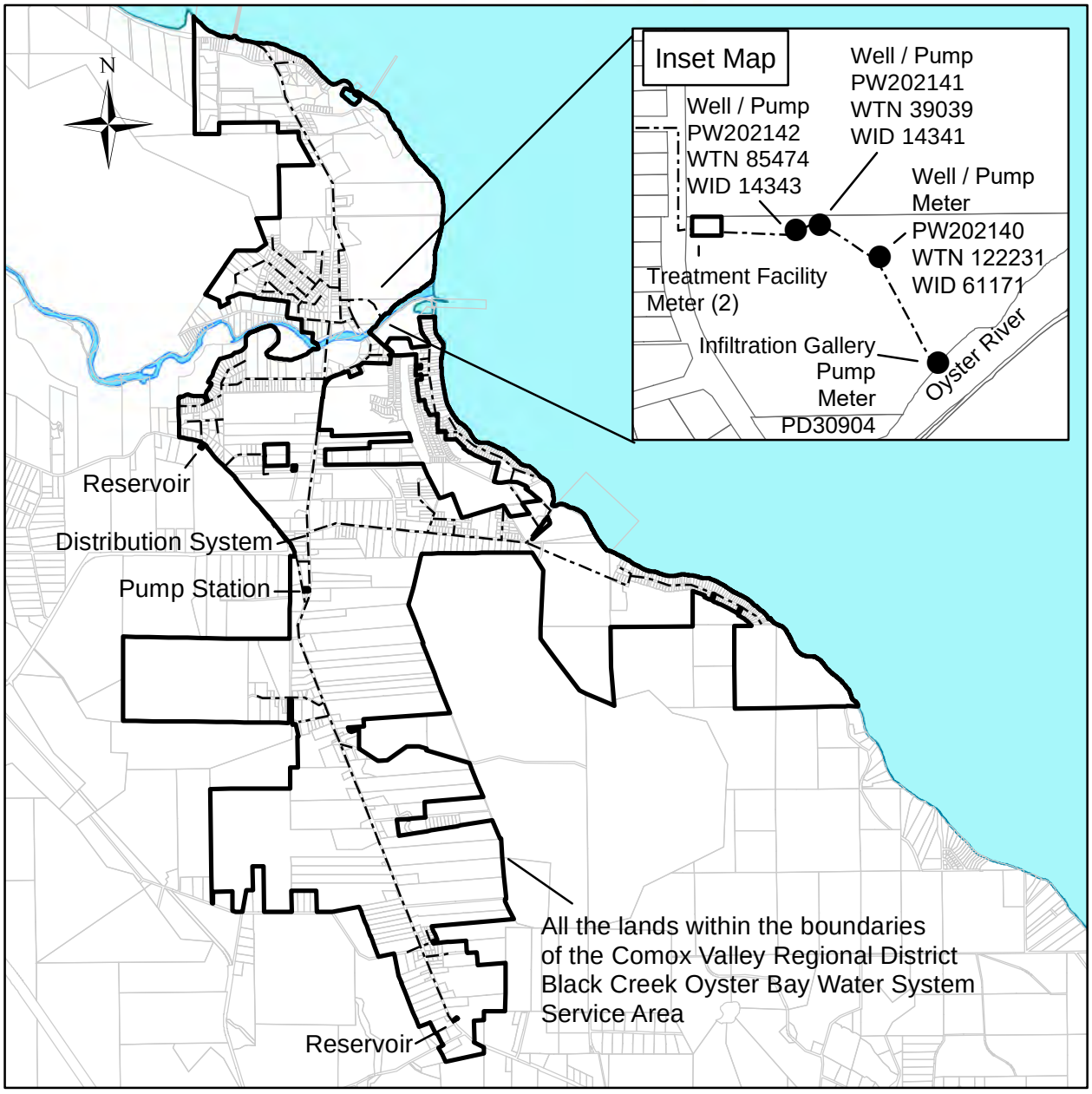
-

WATER SUPPLY LICENCES

Black Creek Water Local Service Area
Licence No. C503625 (and C61430)

Watutco Water System
Licence No. C054066
Licence No. C059087
Licence No. C118864

Black Creek Water Local Service Area
Licence No. C503625 (and C61430)



WATER DISTRICT: Nanaimo
PRECINCT: Courtenay
LAND DISTRICT: Comox
WATERSHED: COMX-Oyster

Signature: Cali Mc
Date: November 5, 2021

LEGEND:

Scale: 1:64,000
Point of Diversion: ●
Map Number: 92.F.085.3.2
Pipe: –·–·–·–·–

C.L.: 503625
FILE: 1000482

The boundaries of the land to which this licence is appurtenant are shown thus: ——————

Province of
British Columbia

Ministry of
Environment

Vancouver Island Region 1
Regional Headquarters
2569 Kenworth Road
Nanaimo
British Columbia
V9T 4P7
Telephone: (604) 758-3951

ORDER

WATER ACT

SECTION 15

File No. 1000482

In the matter of Conditional Water Licence No. 61430, which authorizes diversion and use of water from the Oyster River for Waterworks purpose and is appurtenant to the lands within the boundaries of Black Creek/Oyster Bay Specified Area.

Having received an application for a change to the works authorized under the said licence and being satisfied that no person's rights will be injuriously affected, I hereby amend Clauses (h) and (i) of Conditional Water Licence to read as follows:

(h) The works authorized to be constructed are infiltration gallery, sump, pump, pipe, storage tanks and distribution system.

(i) The construction of the said works shall be completed and the water beneficially used on or before the 31st day of December, 1992.

Dated at Nanaimo, B. C., this 27th day of August, 1991.

J. Card
A/Regional Water Manager

EW/ew

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Regional District of Comox-Strathcona of P.O. Box 3370, Courtenay, B.C. V9N 5N5 is hereby authorized to divert and use water as follows:

(a) The source of the water-supply is Oyster River.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 24th May, 1985.

(d) The purpose for which this licence is issued is waterworks.

497,797 m^3/yr = 1,364 m^3/day

(e) The maximum quantity of water which may be diverted is 109,500,000 gallons per year at a rate not exceeding 800,000 gallons per day.

3,637 m^3/day

(f) The period of the year during which the water may be used is the whole year.

(g) The land upon which the water is to be used and to which this licence is appurtenant is all the lands within the boundaries of Black Creek/Oyster Bay Specified Area.

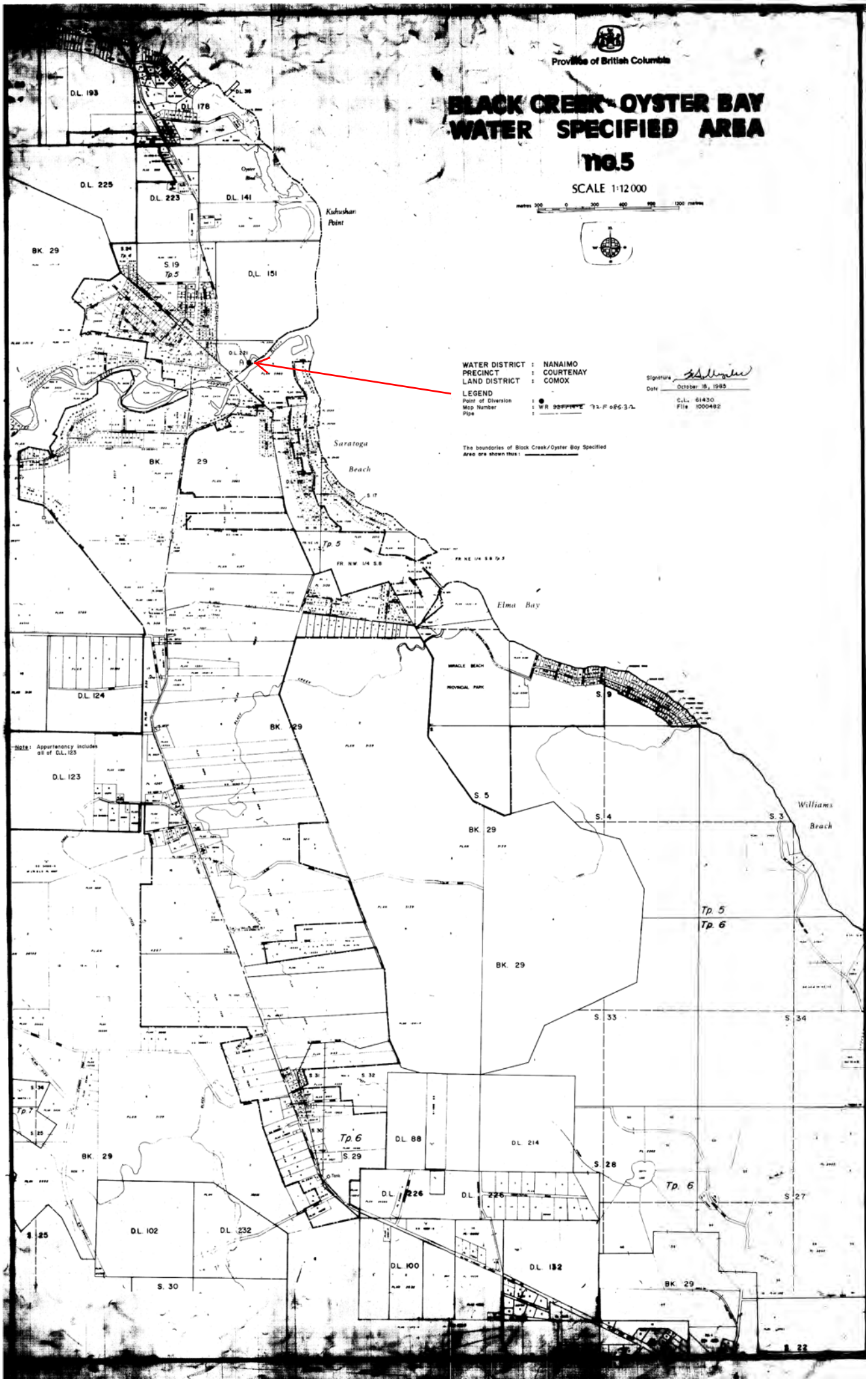
(h) The works authorized to be constructed are sump, pump, pipe, storage tanks and distribution system, which shall be located approximately as shown on the attached plan.

(i) The construction of the said works shall be completed and the water beneficially used on or before the 31st day of December, 1988.

(j) A flow measuring device suitable to an Engineer under the Water Act shall be incorporated into the works at the source.

B. Hollingshead
Regional Water Manager

File No. 1000482 Date issued: 18th October, 1985 Conditional Licence 61430


Province of British Columbia
BLACK CREEK - OYSTER BAY
WATER SPECIFIED AREA
No. 5
SCALE 1:12 000
metres 300 0 300 600 900 1200 metres
WATER DISTRICT : NANAIMO
PRECINCT : COURTENAY
LAND DISTRICT : COMOX
LEGEND
Point of Diversion : ●
Map Number : WR 92-P-085-3-2
Pipe :
The boundaries of Black Creek/Oyster Bay Specified Area are shown thus : ——
Signature
Date October 18, 1985
C.L. 61430
File 1000492
Kuhushan Point
Saratoga Beach
Elma Bay
Miracle Beach Provincial Park
Williams Beach
D.L. 193
D.L. 178
D.L. 225
D.L. 223
D.L. 141
D.L. 151
D.L. 221
D.L. 124
D.L. 123
D.L. 88
D.L. 214
D.L. 226
D.L. 102
D.L. 232
D.L. 100
D.L. 132
BK. 29
S. 19 Tp. 5
S. 17
S. 9
S. 5
S. 4
S. 3
S. 33
S. 34
S. 31
S. 32
S. 30
S. 29
S. 28
S. 27
S. 25
S. 22
Tp. 5
Tp. 6
Tp. 7
FR. NW 1/4 S.8
FR. NE 1/4 S.8 Tp.5
Note: Appurtenancy includes all of D.L. 123

Watutco Water System
Licence No. C054066
Licence No. C059087
Licence No. C118864

LAND AND WATER MANAGEMENT
WATER RIGHTS BRANCH

MINISTRY OF THE ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Watutco Enterprises Limited of P.O. Box 82, Black Creek, B.C. V0R 1C0

is/are hereby authorized to divert and use water as follows:—

(a) The source(s) of the water-supply is/are Oyster River.

(b) The point(s) of diversion is/are located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 23rd January, 1975.

(d) The purpose for which the water is to be used is waterworks.

248 m^3/day = 2.9 L/s

(e) The maximum quantity of water which may be diverted is 54,500 gallons a day,

and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(f) The period of the year during which the water may be used is the whole year.

(g) ~~The [illegible]~~ This licence is appurtenant to the undertaking of the licensee as set out in Certificate of Public Convenience and Necessity No. 62/1975 and any substitution thereof or amendment thereto.

(h) The works authorized to be constructed are diversion structure, pump, tank and pipe,

which shall be located approximately as shown on the attached plan.

(i) The construction of the said works has been completed and the water shall be beneficially used on or before the 31st day of December, 1981.

J.E. Farrell,
Deputy *Comptroller of Water Rights.*

File No. 0328279 Date issued: 8 August, 1980 Conditional Licence No. 54066.

ENTERED ON
Map No. 92F/14-E

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Watutco Enterprises Ltd. of Box 32, Black Creek, B.C. V9N 6V4

is hereby authorized to divert and use water as follows:

(a) The source of the water supply is Oyster River.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 9th November, 1982.

(d) The purpose for which the water is to be used is waterworks.

45 m^3/day = 0.5 L/s

(e) The maximum quantity of water which may be diverted is 10,000 gallons a day, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(f) The period of the year during which the water may be used is the whole year.

(g) This licence is appurtenant to the undertaking of the licensee as set out in Certificate of Public Convenience and Necessity No. 487/1983, and any substitutions thereof or amendment thereto.

(h) The works authorized to be constructed are diversion structure, pump, tank and pipe, which shall be located approximately as shown on the attached plan.

(i) The construction of the said works has been commenced and shall be completed and the water beneficially used on or before the 31st day of December, 1985.

J. E. Farrell,
Deputy Comptroller of Water Rights.

File No. 1000093 Date issued: 29th July, 1983 Conditional Licence 59087

W-183

ENTERED ON
Map No. 92F/4-E

Province of British Columbia
Water Act

CONDITIONAL WATER LICENCE

The holder of the undertaking to which this is appurtenant is hereby authorized to divert and use water as follows:

(a) The stream on which the rights are granted is Oyster River.

(b) The point of diversion on Oyster River is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is January 23, 1975.

(d) The purpose for which this licence is issued is waterworks (local authority).

(e) The maximum quantity of water which may be diverted is 8,212,500 gallons a year provided that the maximum daily diversion does not exceed 45,000 gallons a day. 37,335 m^3/yr

(f) The water may be diverted and used throughout the whole year. 205 m^3/day = 2.4 l/s

(g) This licence is appurtenant to the undertaking of the licensee as set out in *Certificate of Public Convenience and Necessity No. 945/1996* and any substitution thereof or amendment thereto.

(h) The works authorized to be constructed are diversion structure, pump, pipe and distribution system which shall be located as shown on the attached plan.

(i) The construction of said works has been completed and the water is being beneficially used. The licensee shall continue to make a regular beneficial use of the water in the manner authorized herein.

(j) A flow measuring device suitable to the Engineer under the *Water Act* must be incorporated into the works at the source. The flow measuring device must be maintained and operated, and records kept and submitted as directed by the Engineer under the *Water Act*.

(k) This licence is issued in substitution of Conditional Water Licence 54065.

Glen Davidson, P.Eng.
Deputy Comptroller of Water Rights

File No. 0367459 Date issued: October 9, 2003 Conditional Licence 118864

Attachment: plat