DISTRICT OF UCLUELET

- FINAL REPORT -

JULY 2017

KOERS
& ASSOCIATES
ENGINEERING LTD.
Consulting Engineers

Parksville, BC

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July 7, 2017
1581-01 (Final Report)

District of Ucluelet
PO Box 999 – 200 Main Street
Ucluelet, BC V0R 3A0

Attention: **Mr. Warren Cannon**
Superintendent of Public Works

Re: DISTRICT OF UCLUELET - WATER MASTER PLAN, Final Report

We are pleased to submit three bound copies and a digital pdf copy of the final report entitled "District of Ucluelet – Water Master Plan."

This report presents a Water Master Plan, which will allow the District to: Plan and Manage Strategies; Develop Long – Term Economical and Social Benefits; maintain a sustainable Water System. The report reviewed existing System Operations and Water Sources as well as the potential for a new water source.

The plan entailed a detailed review of the water system from its inception to its current condition. The existing surface source Mercantile Creek and groundwater source Lost Shoe Creek Aquifer were reviewed considering their current quantity, quality and level of treatment. Island Health Permit requirements were review noting the surface water source policy adopted in 2012. The report reviewed alternate sources of water including Kennedy Lake and commented on the quantity, quality and treatment required.

The report studied current and future population projections identifying that the District's total and maximum day water demands have decreased dramatically for year 2003 compared to 2013. This significant reduction is in large part in response to the decline in fish processing demands. Metered demands account for around 25% of system demands. Water Conservation was reviewed and it was noted that efforts in Ucluelet will have the most effect if they are directed at reducing non-metered water demands which count for more than 70% of water demand. This is a significant change from 10 years ago, when metered demands accounted for more than 50% of system demands and fish processing demand made up more than 80% of the metered demands, or 40% of the system demands.

1. The District operates two water supply sources:

   i. **Mercantile Creek**, a surface source on the east side of Ucluelet Inlet

   ii. **Lost Shoe Creek Well field**, a groundwater source at the junction of Hwy 4A and Pacific Rim Hwy

2. The LSCA well field acts as the primary source. Mercantile is brought on-line to meet large fish processing demands and the seasonal (summertime) demand increase. The two water supply sources are currently isolated from each other with the manual closing of valves at ten (10) road intersections, which we understand are:

   a. Peninsula Rd at Pacific Crescent
   b. Seaplane Base Rd at Peninsula Rd

c. Norah St at Peninsula Rd
d. Hemlock St near Peninsula Rd
e. Marine Dr at Matterson Dr
f. Victoria Rd at Marine Dr
g. Edward Pl at Peninsula Rd
h. Marine Dr at Peninsula Rd
i. Cedar Rd &d Park Ln
j. Cedar Rd at Main St

3. Water is spilled at the Matterson Reservoir when the Mercantile Creek source is not running and the reservoir is supplied by the Highway Zone.

4. Water treatment consists of the following:

   Mercantile Creek
   Raw water passes through a course screen to catch larger debris prior to being withdrawn from the Creek. At the Bay Street water treatment pump station, the water is treated by Ultra Violet lights followed by disinfection using a sodium hypochlorite solution (NaClO).

   Lost Shoe Creek Well field
   The water is treated by the addition of sodium hypochlorite solution (NaClO).

5. Water quality issues for the water sources consist of the following:

   Mercantile Creek: elevated turbidity levels during the winter months and periods of heavy rainfall

   Lost Shoe Creek Well field: elevated levels of manganese

6. Mercantile Creek source cannot accommodate an increase in withdrawal limits.

7. LSCA recharge rate is influenced by rainfall as shown in **Figure 4**.

8. LSCA Well Number 2 is not operated in summer months due to low water levels.

9. Kennedy Lake is considered a suitable source option for the District.

10. The minimum peak hour pressure is 234 kPa (34 psi) at Athlone Road (elevation 40 m).

11. The areas that do not meet the fire flow requirements for the zoning serviced are listed in **Table 17**.

We thank you for the opportunity to be of service the District of Ucluelet on this interesting assignment. We have enjoyed working with you and your staff and would be pleased to assist in implementation of the report's recommendations.

Please do not hesitate to contact us to discuss the findings in greater detail and we look forward to your response.

Yours truly,

KOERS & ASSOCIATES ENGINEERING LTD.

Jul. 7 2017

Chris Downey P.Eng
Project Manager

DISTRICT OF UCLUELET

WATER MASTER PLAN
- Final Report -

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TABLES

FIGURES **after page**

1 INTRODUCTION

1.1 Authorization

On October 28, 2015, the District of Ucluelet authorized Koers & Associates Engineering Ltd. to carry out a water master plan study for the District of Ucluelet. The study is to allow the District to plan and manage strategies, develop long-term economic and social benefits and maintain a sustainable water system. The study was to be carried out in accordance with Koers' proposal dated October 22, 2015.

1.2 Study Objectives

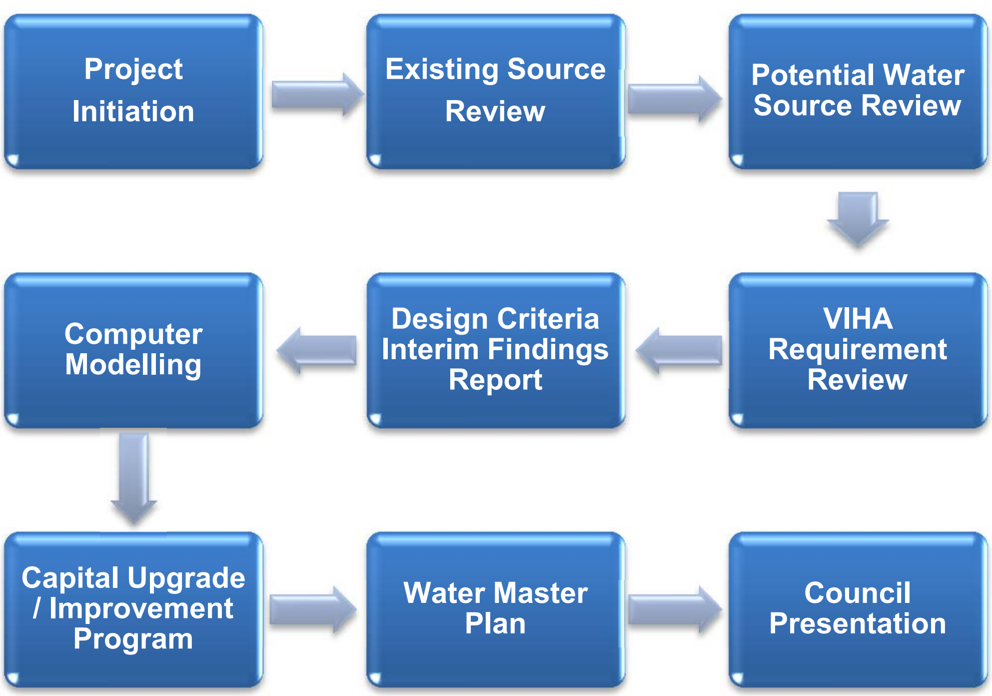
The District is seeking to develop a Water Master Plan which will allow it to:

- Plan and Manage Strategies
- Develop Long-term Economical & Social Benefits
- Maintain a Sustainable Water System

1.3 Scope of Work

To meet the study objectives, a detailed work plan was established as shown in the flow chart below. A detailed description of the work to be carried out with each task is presented after the flow chart.

Work Plan Flow Chart



Task 1 - Project Kick-off Meeting, Data Collection & Review, Site Visit

- Obtain copies of reports and studies including: record drawings; daily bulk water meter records; individual water meter records.
- Obtain copies of: DCC Bylaw; OCP and planning documents; Vancouver Island Health Association's (VIHA) water system operating permits; and pertinent correspondence relating to surface water treatment requirements.
- Obtain digital copy of the District's cadastral, water infrastructure map & zoning maps.
- Visit the water supply sources.

Task 2 - Existing System Operational Review

- Meet with the District's Superintendent and Publics work staff to review the system operation and identify known areas of concern within the water supply and distribution networks.
- Review types of tasks that are carried out daily, weekly, monthly, seasonally, and annually.
- Review known issues with the system, such as: areas with water quality issues, low pressures and flows; watermains with a large amount of sediment; valving concerns; reservoir access, inlet/outlet piping and controls.
- Review Bay Street turbidity meter & U/V system operation.
- Review Lost Shoe Creek Aquifer (LSCA) water quality (Iron & Manganese).
- Review annual watermain flushing program and line pigging procedures.

Task 3 - Existing Water Sources Review

- The two existing water sources to be reviewed in detail and operating conditions and concerns discussed with District Staff.
- Review source quantity, quality, treatment, licencing and observations in source water availability during dryer summers and if there have been noticeable changes/trends in water levels water level year over year.

Task 4 - Potential Water Source Review

- Develop recommendations for a long term water supply strategy to meet the forecasted growth.
- Assess the District's current groundwater (Lost Shoe Creek Wellfield) and surface (Mercantile Creek) supply sources.
- Review of a third source. Location of the third water source (Kennedy Lake, a new groundwater source, or other), will be discussed with staff during the project initiation meeting and a consensus reached prior to advancing the report.

Task 5 - VIHA Permit Review

- Review the District's VIHA permit regulations.
- Provide recommendations and timelines for implementation of the requirements outlined by VIHA.

Task 6 - Design Criteria

- Establish design service population and the timeframe to reach it (rate of growth).

- Establish type of development to occur and where it will occur such as: anticipated land development projects (Weyerhaeuser Lands, Wynd & Sea development); new business development (economic development strategies); tourism; Industry (fishing, logging, mining, energy); First Nations business; Regional airport upgrade/expansion, West Coast Multiplex.
- Analyse average day, maximum day and peak hour water demands from past studies and for the past three years.
- Review annual metered demands for typical land-uses (such as hotel, restaurant, school, service commercial) from the Institutional/Commercial/Industrial metered data.
- Assess potential reductions in residential (per capita) and business (commercial, industrial and institutional) demands in response to varying conservation programs.
- Developed three growth projections (low, medium, and high) for assessing the ability of a water supply source(s) to meet the projected long-term demands, and the ability of the water distribution system to the demands to where the growth is expected to occur.
- Confirm fire flow requirements for the various land use categories. Fire flows will be based on Fire Underwriters Survey and Master Municipal Contract Documents requirements and will be reviewed with the District prior to completion of the computer modelling.

Task 7 - Interim Findings Report

- Interim report will be prepared for the findings of Task 1 to 5. The purpose of this interim report is to assist the District in selecting a long-term water supply source(s) as well as determining the future demand and population conditions for water modelling purposes.
- The report will be presented in a technical memorandum format and will be incorporated into the Water Master Plan document.
- Upon acceptance of the interim report and selection by the District of the long-term water supply source(s), the computer model will be developed.

Task 8 - Computer Modelling

- Update Koers in-house water model of the District's system incorporating capital and new development work that has been carried out since the model was last updated.
- The integrity of the water model will be checked with record drawing information and actual system pressures.
- Wellfield pump curves provided by the District will be compared and updated in the computer model. Modelled pipe diameters and material will be checked in each pressure zone against available information provided by the District.
- Individual demands that are metered in the District (Institutional, Commercial, and Industrial properties) will be added to the model based on their physical locations. Residential demands, which are not metered, will be applied spatially in the model based on residential development densities.

- Review and confirm water distribution system design criteria with District staff.
- Run model under existing and future conditions, identify upgrading works required.

Task 9 - Capital Upgrade / Improvement Program

- Findings of the computer modelling will be combined with the growth projection information to develop a capital upgrade/improvement program complete with Class D (order of magnitude) construction cost estimates.
- A brief summary discussion of each project will be included.
- Each project identified for the capital upgrade/improvement program will be reviewed for eligibility as a DCC project and a tabular list created.

Task 10 - Water Master Plan

- The study work will culminate in the development of the Water Master Plan document. This document will be designed to serve as the guiding plan for capital works and long-term planning.
- The document will include:
    - study findings
    - discussion
    - plans and illustrations
    - graphs and tables
    - project cost estimates
    - conclusions and recommendations
    - A coloured plan drawing showing the District's water system and proposed works
- A draft report will be issued. Koers will meet with staff to discuss the report findings, recommendations and confirm any proposed modifications or additions.
- The report shall be finalized upon receipt of District comments. A digital (pdf) copy and three bound copies will be provided.

Task 11 - Council Presentation

- A PowerPoint will be developed an overview of the Water Master Plan for presentation to Council by Koers.

1.4 Acknowledgements

Koers & Associates Engineering Ltd. acknowledges with thanks the assistance provided by the following District staff during the course of this study:

- Mr. Warren Cannon – Superintendent of Public Works

2 WATER SYSTEM

2.1 Historical & Current Settlement Area

Prior to the arrival of the first European settlers in the early 1870's, the area was inhabited by the Nuu-Chah-Nulth First Nations. Ucluelet or "safe harbour" as named by the Nuu-Chah-Nulth First Nations is situated on the West Coast of Vancouver Island at the south end of the Pacific Rim National Park.

The Village of Ucluelet was incorporated in 1952. Its status changed to a District in 1997, in part to reflect the growing population. The municipal boundaries encompass the entire Ucluth Peninsula, covering an area of more than 1,100 ha.

Ucluelet was established around the logging and fishing industry, but has become known as an eco-tourism based resort area. Development is concentrated on the southern half of the peninsula where there is a municipal sewer collection system. Development on the northern half consists mostly of undeveloped lands with some rural residential properties on larger parcels, and a few industrial and commercial businesses. The northern developed lands are serviced by on-site septic fields. A total of 283 ha of land in the northern west half of the municipality were taken out of the Forest Land Reserve in the early 2000's. Partial development of these lands has started but has been significantly hampered by the economic downturn in 2008. The three largest employment industries are reported to be Hospitality, Fishing, and Logging.

2.2 Supply Source & System Storage

The District operates two water supply sources:

i) **Mercantile Creek**, a surface source on the east side of Ucluelet Inlet, and

ii) **Lost Shoe Creek Wellfield**, a groundwater source at the junction of Hwy 4A and Pacific Rim Hwy.

Both sources are located outside of the District's municipal boundaries.

A discussion of each source is presented below.

2.2.1 Mercantile Creek

Water Licences

The District has been granted five water licences by the provincial government for the diversion of water from Mercantile Creek for the operation of a local water system. The first was granted in January 1958 and the most recent was granted in June 1992. There is also two other water licence holders on Mercantile Creek: Ucluelet Indian Band, and a numbered company. The first licence is for a local water system, the second is for ice making. A list of the water licences is presented in **Table 2** under Section **3.1 Water Quantity**.

Intake Structure

Water is withdrawn from the Creek via an intake structure, the location of which was moved in 1972 to a slightly higher elevation than the original. It is now at an elevation of approximatley 40 m geodetic and has a catchment area of approximately 11.5 km^2. A small 3.3 m high concrete dam with removable stop logs was constructed creating an inmpoundment area. A 9.1 m long by 1.5 m wide covered concrete channel, located just upstream of the dam, conveys water through a course screen before entering a 250 mm diameter intake.

The water is transported approximately 2.5 kms down the hill and under the inlet to the Bay Street water treatment building and pump station. The supply line is reported to consist of 520 m of 350 mm diameter pipe connected to 1,300 m of 250 mm diameter pipe which connects to 690 m of 300 mm diameter High Density Polyethylene (HDPE) submarine pipeline.

Bay Street Water Treatment Plant

The Bay Street water treatment and pump station building, located at the foot of Bay Street, was constructed around 1985. The water treatment system is presently being upgraded to become compliant with the Vancouver Island Health Authority's 4-3-2-1 surface water source treatment policy. This includes replacement of the sand filters with Ultra Violet light and an on-line turbidity meter which automatically stops the supply when the turbidity levels exceed 1 NTU.

Matterson Drive Reservoir

Treated water is pumped into the distribution system by one of two variable speed 40 hp centrifugal vertical pumps and fills the 1,200 m^3 (250,000 ig) bolted steel water storage reservoir on a local high spot off of Matterson Drive.

Constructed in 1983, the Matterson Drive Reservoir is 8.8m in diameter and 19.8 m tall. Its top water level of 57 m geodetic generates a static pressure of 560 kPa (81 psi) at sea level. The exterior of the reservoir was repainted (recoated) in 2000.

Mercantile Creek Usage

Mercantile Creek operated as the District's water source until the development of the Loss Shoe Creek Wellfield, which came on line in 1997. From 1997 to 2002, and from 2005 to 2008 Mercantile Creek acted as an emergency source due to turbidity issues attributed to active logging in the watershed.

In 2014, the Mercantile Creek water treatment process at the Bay Street pump station was upgraded to include Ultra Violet lights in addition to the existing sodium hypochlorite disinfection. This was done as Stage 1 of compliance with the Island Health 4-3-2-1-surface water treatment policy. An on-line turbidity meter was also added as an interim step to full compliance.

2.2.2 Lost Shoe Creek Aquifer

In 1996, an additional water supply was developed using groundwater wells in the Lost Shoe Creek Aquifer (LSCA). The wellfield is located at the junction of Highway 4A and Pacific Rim Highway, approximately 3 kms north of the District's municipal boundary.

Wellfield Pumping Capacity

The District operates four wells at the wellfield. There is allowance for the installation of a 5th well, which has not yet been developed. The original design capacities of the wells are presented in **Table 3** under Section **4 Lost Shoe Creek Wellfield**.

Highway Reservoir

The LSCA wellfield pumps into the 1,400 m^3 (300,000 ig) bolted steel water storage reservoir (Hwy Reservoir) located along Peninsula Road approximately 3 kms south of the wellfield. Constructed in 1997, the reservoir is 12.5 m in diameter and 11.6 m tall. Its top water level of 64.8 m generates a static pressure of 635 kPa (92 psi) at sea level.

The wellfield water source was developed to meet the very large demand from the growing fish process industry, as the Mercantile Creek source capacity was insufficient.

Need for Lost Shoe Creek Source

From 1997 through 2003, the operation of the wellfield at full capacity was required to keep up with the fish processing industry demands. During this time, the capacity of the wells declined significantly due to biofouling of the well screens and the immediately surrounding aquifer materials from iron and sulphur bacteria. In 2002, chemical re-development of the wells resulted in significant recovery, estimated at 90%, of the original design capacity.

The fish processing industry began to decline starting in 2004; resulting in a notable drop in water demands. Up to 2003, the maximum month water demand was as high as 250,000 m^3. From 2004 to present, the maximum month demand ranges from 100,000 m^3 to 130,000 m^3.

During the 2002 well redevelopment program, the Mercantile Creek source was put back on line in mid-August to meet the summertime demand increase. Water quality had improved in the watershed with the cessation of logging activity. Near the end of January 2005, Mercantile Creek was taken off-line in response to a landslide in the watershed. It was not brought back on-line until three years later, in January 2008.

2.3 Treatment

Mercantile Creek
Raw water passes through a course screen to catch larger debris prior to being withdrawn from the Creek. At the Bay Street water treatment pump station, the water is treated by Ultra Violet lights followed by disinfection using a sodium hypochlorite solution (NaClO).

Lost Shoe Creek Wellfield
The water is treated by the addition of sodium hypochlorite solution (NaClO).

2.4 Distribution System

The distribution system contains 35 kms of pipe ranging in diameter from 100 mm to 450 mm of various material types. **Table 1** lists the lengths of pipe for various materials and diameters.

Table 1 – Water Distribution System Pipe Material, Diameters & Lengths

Pipe Diameter (mm)	Length of Pipe (m)				
	Asbestos Cement, AC	Polyvinyl Chloride, PVC	High Density Polyethylene, HDPE	Steel	Total Length (m)
100	425	65			490
150	6,165	3,900		10	10,075
200	1,485	8,540	125	7	10,157
250		3,105		10	3,115
300		1,085	2,630		3,715
350		1,445		5	1,450
400			4,370		4,370
450			1,670	15	1,685
900				25	25
Total:	8,075	18,140	8,795	72	35,082
% of Total	23%	52%	25%	-	100%

A plan drawing of the District's water supply and distribution system is located in the pocket at the end of this report.

2.5 Current System Operation

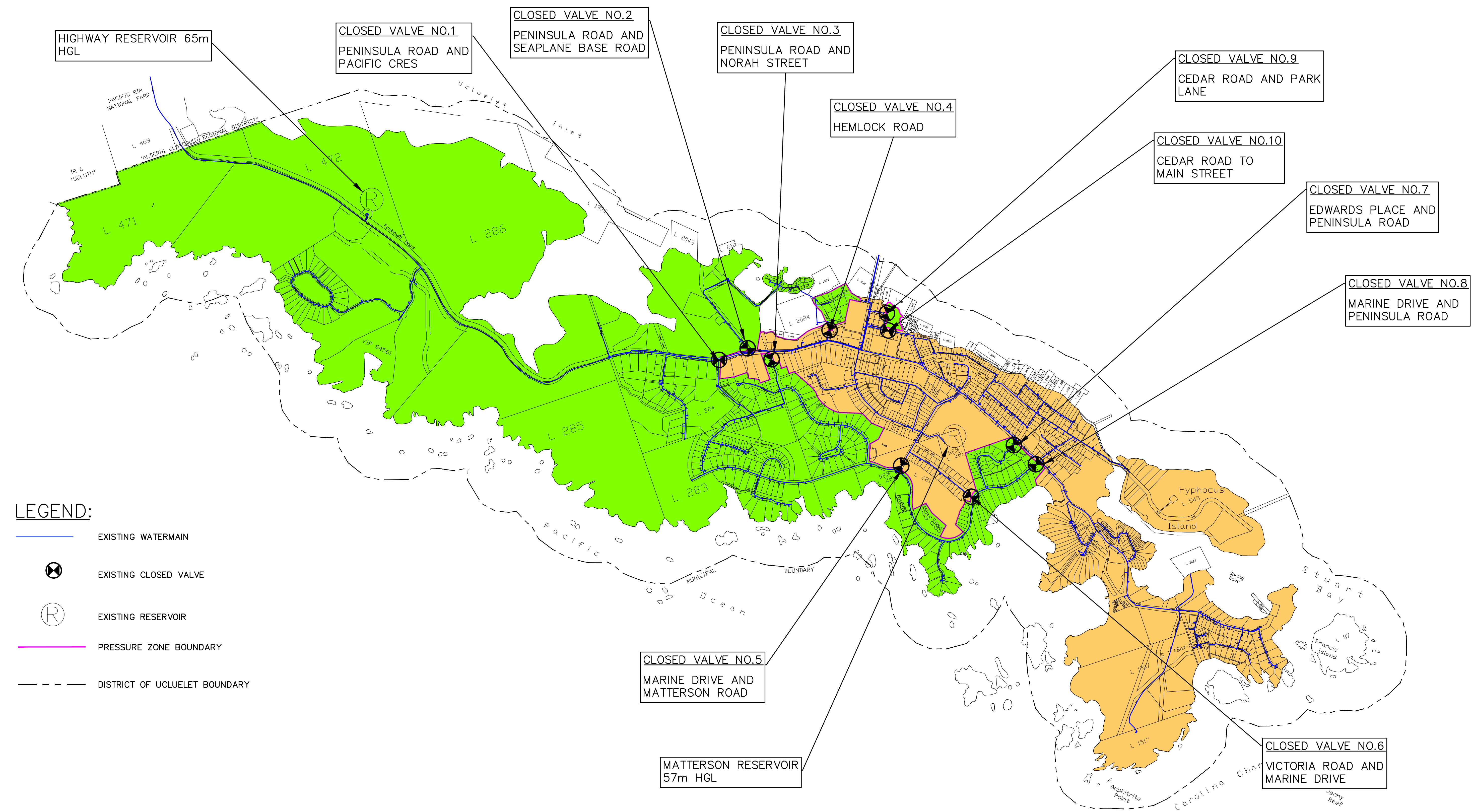
The LSCA well field acts as the primary source. Mercantile is brought on-line to meet large fish processing demands and the seasonal (summertime) demand increase.

The two water supply sources are currently isolated from each other with the manual closing of valves at ten (10) road intersections, which we understand are:

1) Peninsula Rd at Pacific Crescent
2) Seaplane Base Rd at Peninsula Rd
3) Norah St at Peninsula Rd
4) Hemlock St near Peninsula Rd

5)	Marine Dr	at	Matterson Dr
6)	Victoria Rd	at	Marine Dr
7)	Edward Pl	at	Peninsula Rd
8)	Marine Dr	at	Peninsula Rd
9)	Cedar Rd	at	Park Ln
10)	Cedar Rd	at	Main St

When these 10 valves are closed, the LSCA services the northern end customers southwest of Rainforest Drive utilizing the Highway Reservoir. Mercantile Creek services the remainder of the District utilizing the Matterson Drive Reservoir. When the Mercantile source is not available, water is supplied from the Highway Reservoir to the Mercantile Zone through a throttled valve (no.9 in the list above) at the intersection of Cedar Rd at Park Lane. The existing water supply and distribution system is shown on **Figure 1.**



File: H:\8250 Ucluelet District\1581 Water Master Plan\03 Drawings\Figures.dwg Plot Time: Jul 07, 2017 – 12:40pm User: mbrook

KOERS & ASSOCIATES ENGINEERING LTD. Consulting Engineers

CLIENT	DISTRICT OF UCLUELET	TITLE	EXISTING PRESSURE ZONES
PROJECT	WATER MASTER PLAN	APPROVED	SCALE 1: 20,000
		DATE	DWG No. FIGURE 1
		PROJECT No. 1581	

3 MERCANTILE CREEK

3.1 Water Quantity

The District has been granted five water licences by the provincial government for the diversion of water from Mercantile Creek for the operation of a local water system. The first was granted in January 1958 and the most recent was granted in June 1992. There is also two other water licence holders on Mercantile Creek: Ucluelet Indian Band, and a numbered company. The first licence is for a local water system, the second is for ice making. A list of the water licences is presented in **Table 2**.

Table 2 – Mercantile Creek Water Licences

Licence No. & Priority Date		Amount, m^3	
		Average Day	**Maximum Day**
District of Ucluelet			
C 024206	January 1958	113.65	113.65
C 026923	March 1961	113.65	113.65
C 029963	January 1965	113.65	113.65
C 035653	June 1969	2,273.00	2,273.00
C 104912	June 1992	625.23	1,250.15
	District of Ucluelet Total	**3,239.18**	**3,864.10**
Ucluelet First Nation			
C 061385	October 1982	227.30	454.60
	District & First Nation Total	**3,466.48**	**4,318.70**
465792 BC Ltd.			
C 109594	January 1941		327.31

At the point of the District's withdrawal, the creeks upstream catchment area is approximately 11.5 km^2.

<u>Mercantile Creek Low Flow Review</u>
Water Survey of Canada recorded flows in Mercantile Creek during the months of May through November from 1979 to 1984. The minimum, average and maximum recorded flows were reported as follows in the report *<u>Water Quality Assessment & Objectives for Mercantile Creek Community Watershed</u>*, Technical Report, Ministry of Environment, Water Stewardship Division, 2007±:

Water Survey of Canada Mercantile Creek Flows, May to November, 1979 - 1984

- minimum day flow 9,100 m^3/day (0.106 m^3/s)
- maximum day flow 1,753,900 m^3/day (20.30 m^3/s)

The creek's recorded minimum day flow equals 2.1 times the licenced maximum day withdrawal limit.

The Ministry of Environment report further noted that Triton Environmental Consultants Ltd. in 1996 used hydrometric measurements from nearby watersheds to estimate flows in Mercantile Creek. The calculated mean annual and 7 day low flows were reported to be:

Mercantile Creek Flow Based on Nearby Watershed Hydrometric Measurements

- mean annual flow 103,700 m^3/day (1.20 m^3/s)
- mean summer 7 day low flow 11,200 m^3/day (0.13 m^3/s)
- mean winter 7 day low flow 19,000 m^3/day (0.22 m^3/s)

The estimated summer 7 day low flow is 2.6 times the licence max day withdrawal limit.

Additional Licenced Withdrawal Availability

The availability to withdraw/allocate additional water from Mercantile Creek was assessed and the findings presented in the Long Beach Water Allocation Plan, November 1997 by the Ministry of Environment, Lands and Parks, Regional Water Management, Vancouver Island Region.

In determining water availability, the reported noted that the ability to “maintain the natural stream environment and instream uses are of paramount importance for present and future generations” (page 11). In creeks where fish are present, minimum flows required to sustain spawning, as well as rearing habitat, was based on 10% of the Mean Annual Discharge (MAD). If the average 7 day low flow falls below 10% of the MAD, the withdrawal licenced demands should only be allowed for the period when the monthly average flows is greater than 60% of the MAD. Mercantile Creek is a salmon bearing and salmon rearing watercourse with documented escapements of Chinook, Chum, Coho and Sockeye salmon as reported on the BC Ministry of Environment Fisheries Information Summary System on-line database (www.env.gov.bc.ca/fish/fiss).

Because the summer 7 day low flow (11,200 m^3/day) is less than the fisheries resources minimum instream flow requirement of 10% of the MAD (10,370 m^3/day) plus existing licenced withdrawal limits (4,320 m^3/day), there is no additional water available for licenced withdrawal during the months of May through September as shown in **Figure 2**.

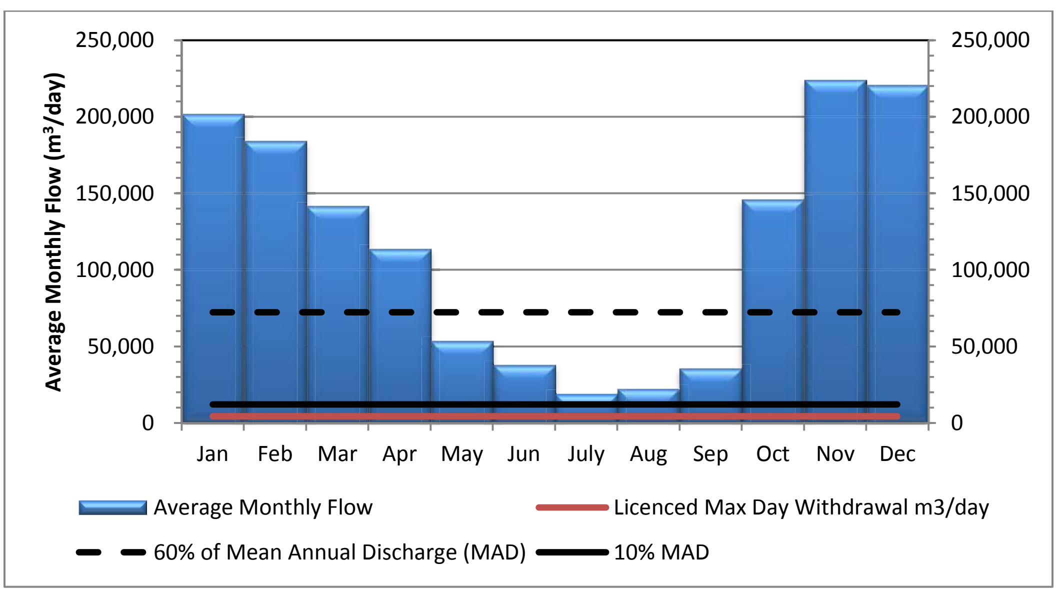


Figure 2 – Mercantile Creek Monthly Average Flow

3.2 Water Quality

Mercantile Creek operated as the District's water source until the development of the Lost Shoe Creek Wellfield, which came on line in 1997. From 1997 to 2002, and from 2005 to 2008 Mercantile Creek acted as an emergency source due to turbidity issues attributed to active logging in the watershed.

The Island Health 4-3-2-1 surface water treatment policy requires a turbidity level of less than 1 NTU. The guidelines for Canadian Drinking Water Quality requires average turbidity levels of less than 1 NTU and no more than two events over 5 NTU in one calendar year.

The source is also affected by organics in the water which can cause disinfection by products (THM's) when mixed with chlorination.

Figure 3 graphs turbidity readings on Mercantile Creek from 2010 to mid-2012.

3.3 Treatment

Water treatment begins with the raw water passing through a course screen at the intake structure on Mercantile Creek. This water is conveyed to the water treatment building at the foot of Bay Street. This building was constructed around 1985 with a treatment process consisting of two large cylindrical steel vessels containing green sand which filtered the water. The filtered water was then disinfected by the injection of chlorine gas prior to discharge into a wet well (constructed underneath the floor of the building) which provided contact time. Water was then pumped out of the wet well and into the distribution system.

In the early 1990's, the green sand was removed from the steel vessels but not replaced; the exact reason for its removal is not known. Water continued to flow through the steel vessels and disinfected by the injection of chlorine gas.

In 2014, the steel vessels were removed and Ultra Violet disinfection was installed as part of becoming compliant with the Island Health authority's 4-3-2-1 surface water treatment policy. After UV, sodium hypochlorite (NaCLO) is injected for disinfection. The section of piping immediately after the injection point was enlarged to 900 mm diameter to provide contact time for disinfection. An on-line turbidity meter was added as an interim step to full compliance. The turbidity meter automatically stops the use of the water when the turbidity levels exceed 1 NTU.

Treated water is pumped into the distribution system by one of two in-line variable speed 40 hp pumps. The pumps are controlled by the water level of the Matterson Drive reservoir.

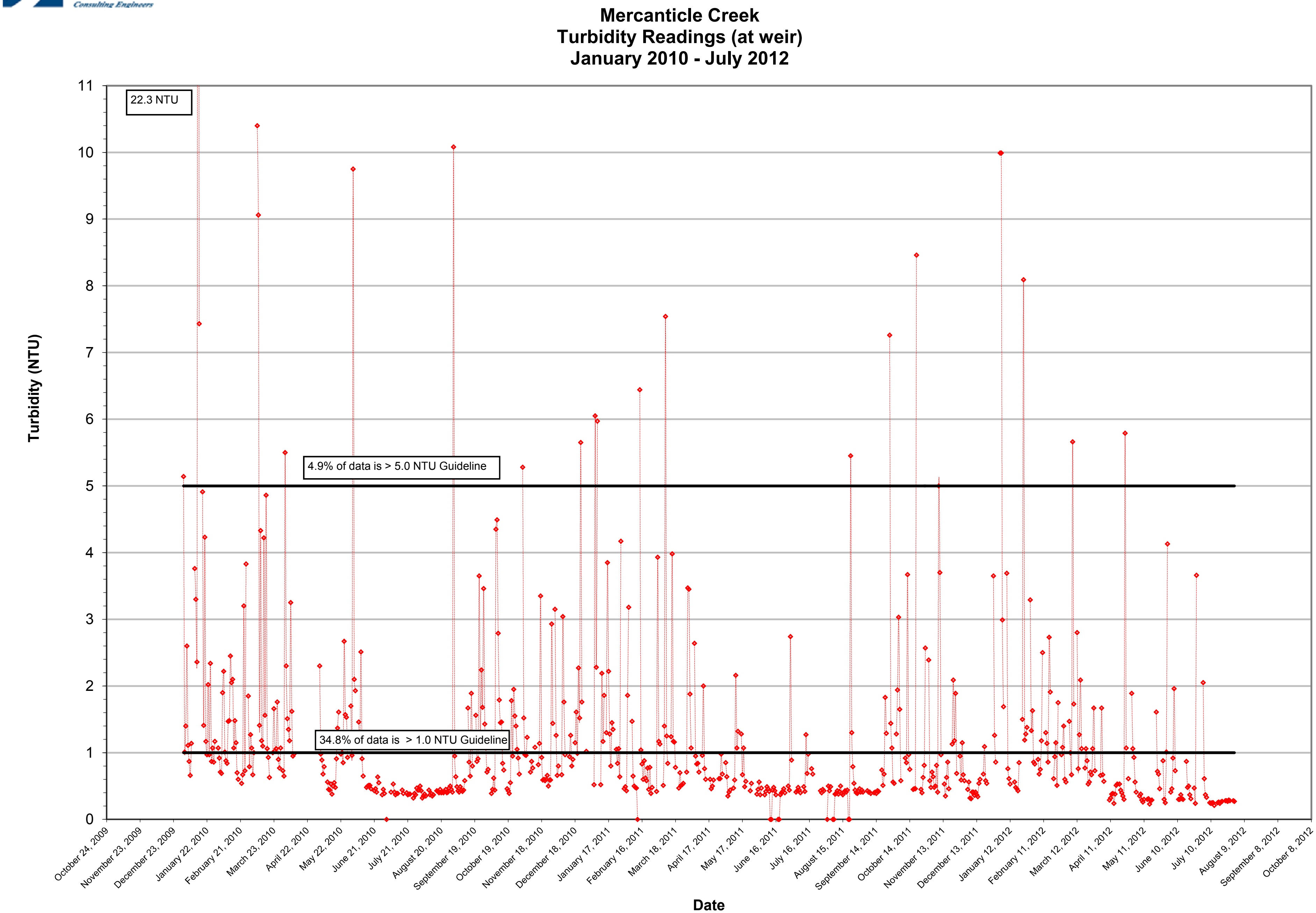

Mercanticle Creek
Turbidity Readings (at weir)
January 2010 - July 2012
22.3 NTU
4.9% of data is > 5.0 NTU Guideline
34.8% of data is > 1.0 NTU Guideline
Turbidity (NTU)
Date
0
1
2
3
4
5
6
7
8
9
10
11
October 24, 2009
November 23, 2009
December 23, 2009
January 22, 2010
February 21, 2010
March 23, 2010
April 22, 2010
May 22, 2010
June 21, 2010
July 21, 2010
August 20, 2010
September 19, 2010
October 19, 2010
November 18, 2010
December 18, 2010
January 17, 2011
February 16, 2011
March 18, 2011
April 17, 2011
May 17, 2011
June 16, 2011
July 16, 2011
August 15, 2011
September 14, 2011
October 14, 2011
November 13, 2011
December 13, 2011
January 12, 2012
February 11, 2012
March 12, 2012
April 11, 2012
May 11, 2012
June 10, 2012
July 10, 2012
August 9, 2012
September 8, 2012
October 8, 2012

FIGURE 3

4 LOST SHOE CREEK WELLFIELD

In 1996, an additional water supply was developed using groundwater wells in the Lost Shoe Creek Aquifer (LSCA). The wellfield is located at the junction of Highway 4 and Pacific Rim Highway, approximately 3 kms north of the District's municipal boundary.

The wellfield was developed to meet the very large demand from the growing fish process industry, as the Mercantile Creek source was insufficient.

<u>Wellfield Pumping Capacity</u>
The District operates four wells at the wellfield. There is allowance for the installation of a 5th well, which has not yet been developed. When developed in 1997, the pumping capacity of the four wells totalled 10,497 m^3/day. Over the next five years, the capacity of the wells declined significantly due to biofouling of the well screens and the immediately surrounding aquifer materials from iron and sulphur bacteria. In 2002, chemical re-development of the wells resulted in significant recovery, estimated at 90%, of the original design capacity.

Well No. 3 pump motor reduction

In 2015, the 60 hp motor in Well No. 3 was replaced with a 40 hp motor due to ongoing issues of the operation of the pump triggering low water level alarms during the summer months requiring the shutdown of the pump each time the alarm was triggered. The alarm may be in response to decline in the opening area of the well screen and plugging of the surrounding gravels. This would restrict the flow of water into the well casing. The reduced flow would result in a lowering of the water level in the casing until it reached the low level alarm sensor.

Well No. 2 Seasonal Shutdown

During the summer months, District staff does not operate Well No. 2 due to low level alarm issues. This well has its well screen set slightly higher than the three other wells as follows:

- Well No. 1 top of screen set 0.7 m below Well No. 2 top of screen
- Well No. 3 top of screen set 3.3 m below Well No. 2 top of screen
- Well No. 4 top of screen set 0.9 m below Well No. 2 top of screen

District staff monitors the groundwater level of the provincial government monitoring well No. 329 during the spring and into the summer as the groundwater level falls in response to less rainfall and warmer weather. The well is located in the Emcon Service Ltd. works yard approximately 600 m northwest just off of the Pacific Rim Highway (Hwy 4). When the groundwater level drops to 8 m below the surface, staff turns off Well No. 2. As a result, staff has indicated that Well No. 2 is generally not in use for approximately three continuous months each year and most often for the period of August through November.

In order to optimize the well field operation it is recommended that variable frequency drives (VFDs) be installed on the existing pumps. The VFDs will adjust the pump motors to run at a lower frequency, allowing the pumps to operate at a range of flows on the pump curve depending on the well level. Pressure transducers should also be installed in the well casings to provide accurate drawdown levels and adjustment of the pump shutdown alarms.

Table 3 presents a summary of the design capacity of each well and the estimated current seasonal capacity for each for the 9 month period when all four pumps are available for use and for the 3 month period Well No. 2 is not in use due the (low) level of the groundwater.

Table 3 – Lost Shoe Creek Aquifer Well Pump Design Capacities

Well No.	Design Capacity		Estimated Current Seasonal Capacity	
	(L/s)	(m^3/day)	Nov - July (m^3/day)	Aug - Oct (m^3/day)
1	25.2	2,177	1,960 (1)	1,960 (1)
2	28.4	2,454	2,200 (1)	- (2)
3	44.2	3,818	2,100 (3)	2,100 (3)
4	23.7	2,048	1,840 (1)	1,840 (1)
5	Undeveloped	-	-	-
Total	121.5	10,497	8,100	5,900

Note:

(1) Capacity estimated at 90% of design capacity to allow reduction over time before well cleaning/redevelopment is carried out.

(2) Well No. 2 is turned off when the low water level alarm is activated. District staff has indicated that this generally occurs for three months starting in August as the groundwater level continues to drop.

(3) In 2015, the 60 hp pump in well number was replaced with a smaller 40 hp and a lower pumping rate (385 usgpm). This was done in response to the drawdown from the 60 hp pump during the summer months triggering the low water level alarm and shutting down.

4.1 Water Quantity

The provincial government operates and monitors groundwater levels in the Lost Shoe Creek Aquifer

Figure 4 graphs groundwater levels readings at the provincial government Observation Well No. 329 for the past 12 years (Dec 2003 to Feb 2016). The well is located approximately 600 m northwest of the Lost Shoe Creek Aquifer Wellfield, just off of the Pacific Rim Highway (Hwy 4) and within the works yard of Emcon Services Ltd. As shown in the figure the water levels in the well follow a cyclical pattern with the water level being the lowest in late September early October and the highest in February and March.

Figure 5 graphs the groundwater level readings and rainfall data from 2014 to March 2016. As shown in the graph the aquifer level is at its lowest levels during periods of high demand and low rainfall in the summer months. As the rainfall levels increase in September, and the system demands decrease, the aquifer level increases

It should be noted that during the fall of 2013 and winter of 2014 the recorded rainfall was the lowest on record, which resulted in the lowest aquifer level during the winter months.

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BC Government Observation Well No. 329
(located 600 m Northwest of Ucluelet Lost Shoe Creek Wellfield)
Hourly Groundwater Level, Dec 2003 - June 20, 2017

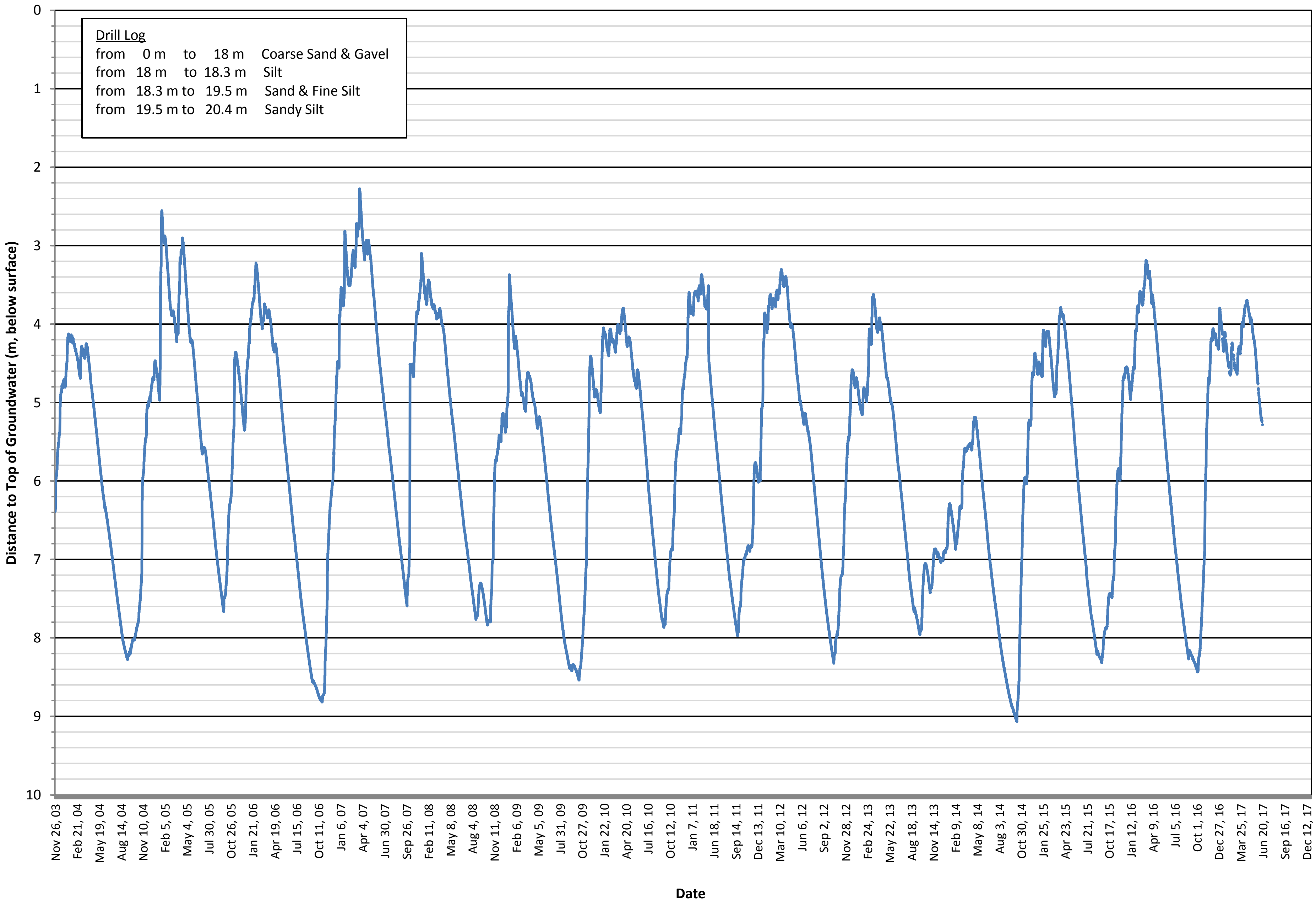

FIGURE 4

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Observation Well No, 329
(located 600 m Northwest of Ucluelet Lost Shoe Creek Wellfield)
Groundwater Depth vs Rainfall, 2014 - June 20, 2017

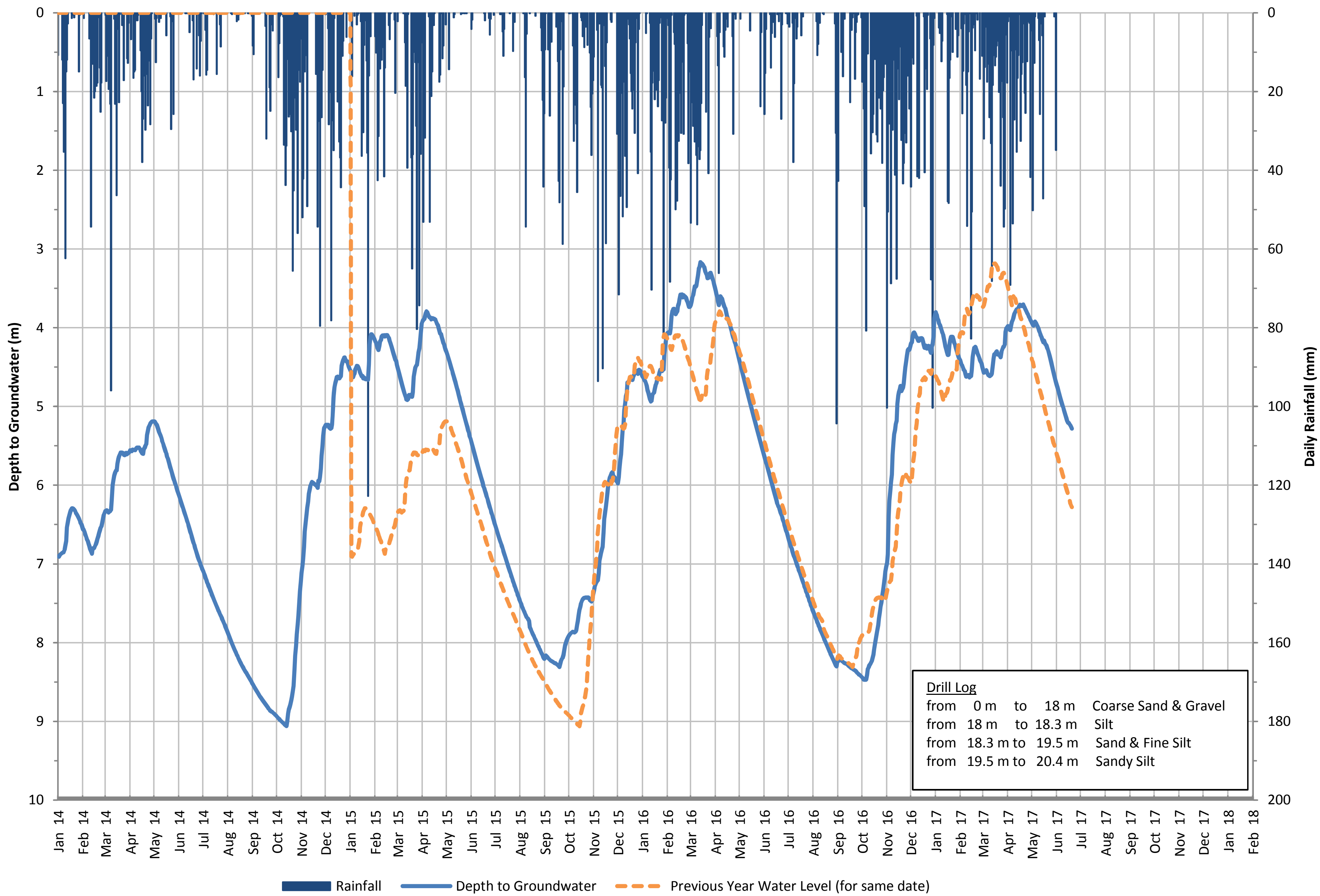

FIGURE 5

The aquifer catchment area boundary as delineated by the provincial government and the location of wells within the catchment is shown on **Figure 6**.

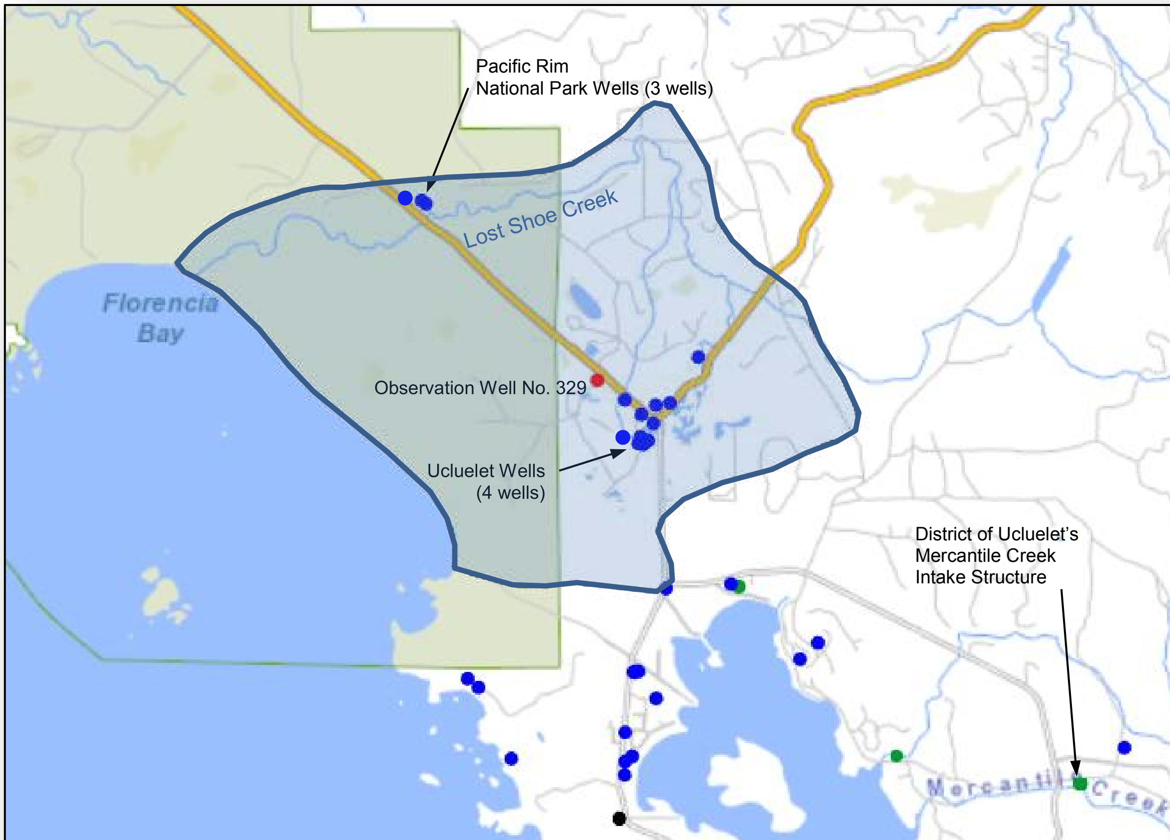

Figure 6 – Lost Shoe Creek Aquifer Boundary

The BC Water Resource Atlas identifies this as Aquifer No. 159. It is reported to be Sand & Gravel with high productivity, high vulnerability and high demand. The catchment area is approximately 3.5 km wide by 3.5 km long; covering 12.5 km^2.

It should be noted that three new wells have been developed in the Pacific Rim National Park at the northwestern edge of the Lost Show Creek Aquifer, as shown in **Figure 6.** Based on discussions with the National Park, it is understood that the wells are groundwater under direct influence of surface water (GUDI) and will have negligible impact on the Lost Shoe Creek Aquifer.

4.2 Water Quality

The groundwater has concentrations of manganese above the Aesthetic Objective (AO) limits of 0.05 mg/L recommended by the Canadian Drinking Water Guidelines. At concentrations above 0.15 mg/L, manganese stains plumbing fixtures and laundry and produces undesirable tastes in beverages. As with iron, the presence of manganese in water may lead to the accumulation of microbial growths in the distribution system. Even at concentrations below 0.05 mg/L, manganese may form coatings on water distribution pipes that may slough off as yellowish brown to black precipitates.

A review of laboratory water quality testing results spanning from Year 1995 to Year 2014 showed manganese concentrations varied from year to year and from well to well. A summary of the findings is shown in **Table 4** and presented in **Figure 7**.

Table 4 – LSCA Wellfield Manganese Concentrations (1995 – 2014)

Description	Manganese Concentration Range (mg/L)
Well No. 1	0.074 – 1.38 mg/L
Well No. 2	0.164 – 1.27 mg/L
Well No. 3	0.039 – 0.15 mg/L
Well No. 4	No data available
Distribution System	0.019 – 0.310 mg/L
CDWQG - AO limit [(1)]	≤ 0.05 mg/L

Note:

(1) Canadian Drinking Water Quality Guidelines (CDQWG) - Aesthetic Objectives (AO).

4.3 Treatment

The water from the Lost Shoe Creek Wellfield is treated by the addition of sodium hypochlorite solution (NaCLO) at the well pump house building.

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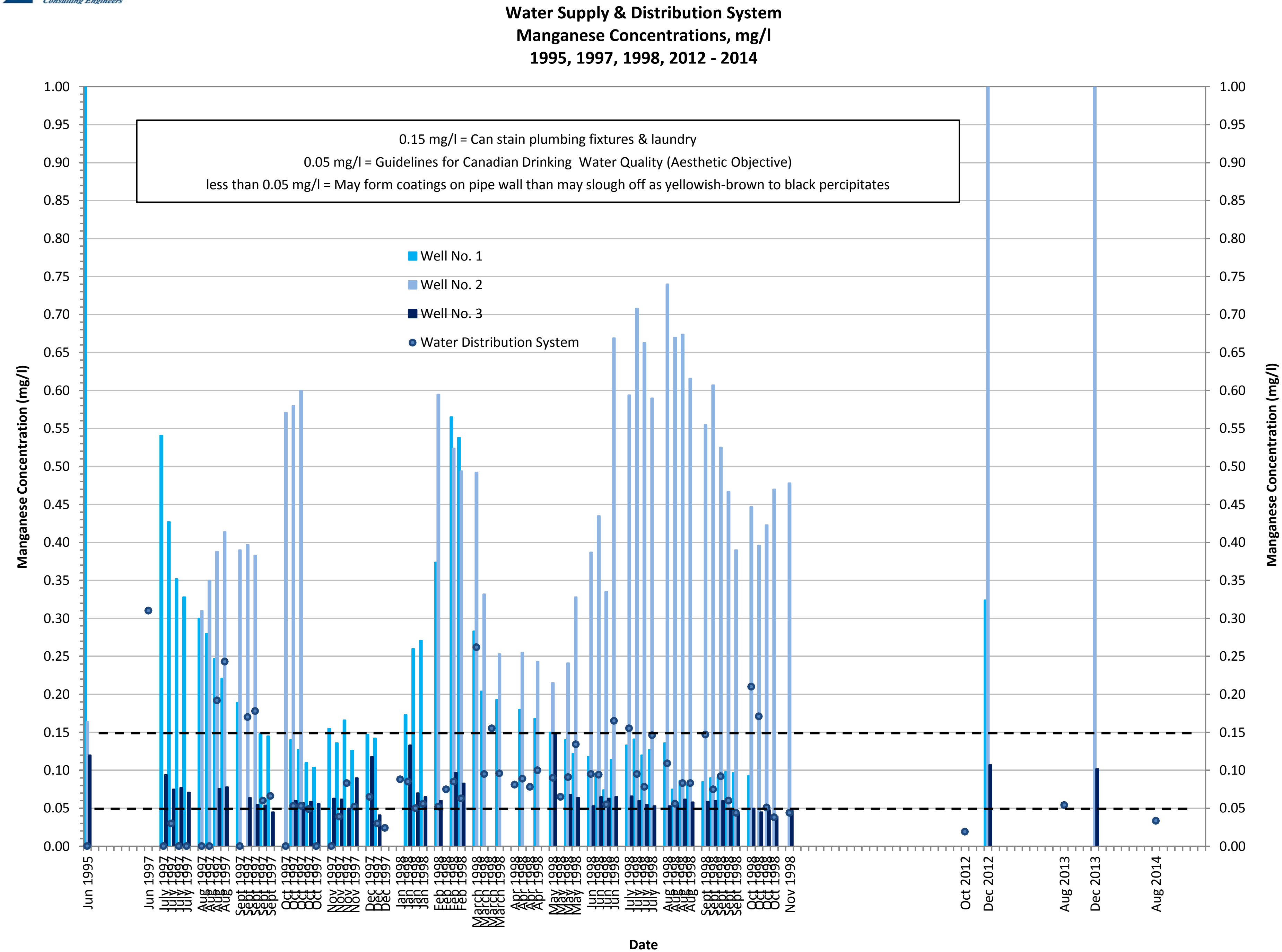

FIGURE 7

5 KENNEDY LAKE

Kennedy Lake is approximately 7 m above sea level and is the largest freshwater lake on Vancouver Island which lies approximately 7.5 km east along Highway 4 from the Lost Creek Wellfield. Kennedy Lake is supplied by two main sources of water the Clayoquot and Kennedy Rivers and discharges through the Kennedy River into the Tofino Inlet.

5.1 Water Quantity

The catchment area of Kennedy Lake is shown in **Figure 8** and is approximately 457 km^2 (121 km^2 Clayoquot River and 336 km^2 Kennedy River) which receives an average of 3,020 mm of precipitation each year. The lake has an estimated volume of 2,136,000,000 m^3 and an average water residence time of 1.22 years. The District's current annual demand of 900,000 m^3 represents 0.0004% of the water within the lake.

Figure 8 – Kennedy Lake Catchment Area

5.2 Water Quality

Metal Concentrations

In 2001 water samples were taken on the main body of Kennedy Lake and in the Clayoquot Arm of Kennedy Lake on May 28, Aug 9, and Nov 5. Water was collected from the surface and at a depth of 20 m at each site during each sampling date. The approximate location of the two sites is shown in **Figure 9** below.

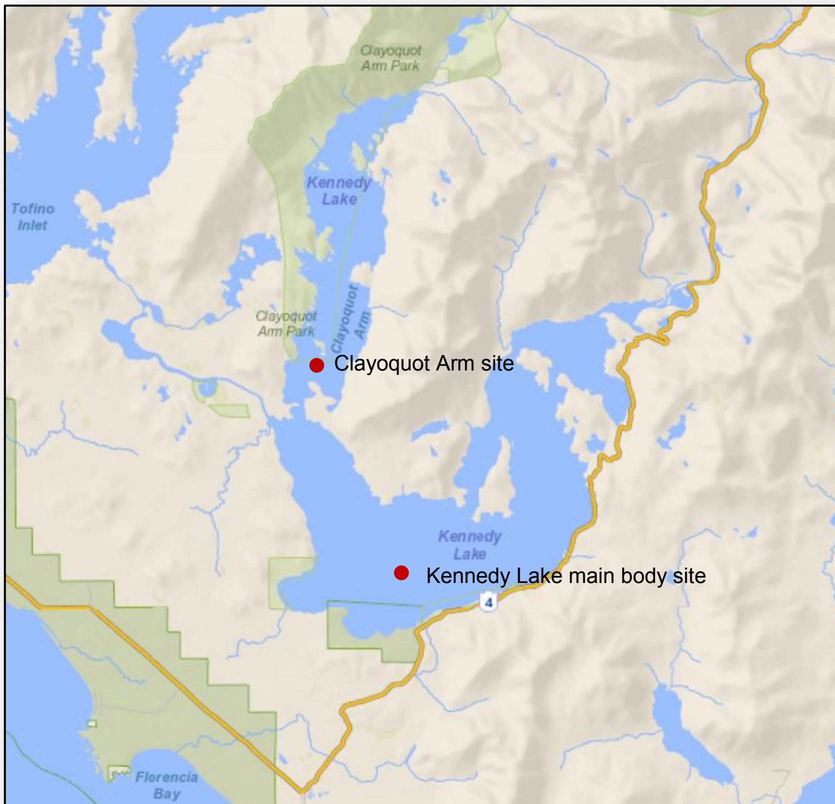

Figure 9 – Kennedy Lake Water Quality Sampling Sites, 2001

The concentrations of the samples were below the current drinking water guideline criteria.

Total Organic Carbon

The concentration of total organic carbon is one indicator of the level of disinfection that may be required.

A criterion of 4.0 mg/L of Total Organic Carbon in source water has been recommended in the BC Water Quality Criteria. This level was exceeded in one sample collected on November 5th from the surface of the main body of Kennedy Lake. All other samples contained levels of Total Organic Carbon ranging from 1.9 to 2.9 mg/L.

Microbiological (Total & Fecal Coliform)
Microbiological analysis reported measurable levels of Total Coliform and Fecal Coliform in the water samples collected from Kennedy Lake.

The Total Coliform counts that ranged from 2 to 6 colonies per 100 mL are within the warning levels.

Fecal Coliform was present at detectable levels only in the November samples that were collected after a period of heavy rain. However, any measure of Fecal Coliform is unacceptable and the only site with Fecal Coliform counts below detection was at the 20 m depth at the main body of Kennedy Lake site.

These test results indicate that the raw water will have to be treated to neutralize coliform presence. Total and fecal coliforms naturally occur in surface waters and all surface waters require disinfection to remove coliform presence.

Trihalomethanes
Trihalomethanes (THM) are formed in drinking water primarily as a result of the interaction between chlorine and organic matter in the raw water. THM formation potential was determined following methods prescribed by the United States Environmental Protection Agency (US EPA).

The formation potential ranged from 0.12 to 0.51 mg/L of total THM. Generally, the formation potential of the samples from Clayoquot Arm were lower than those from the main body of Kennedy Lake site. The results indicate that applying chlorine disinfection to Kennedy Lake water has the potential to produce total THM in excess of the 0.1 mg/L criterion set by the Canadian Drinking Water Guidelines.

Cryptosporidium & Giardia
Samples were collected once on August 9, 2001 and tested for Cryptosporidium and Giardia. There were no detectable levels of either protozoa was found in the water samples from either site.

5.3 Treatment

The results of the January 2002 study by Gartner Lee Limited show that the Kennedy Lake water to be pristine and suitable for public consumption with some treatment, particularly for microbiological parameters thought to be of natural origin. The level of natural contaminants and those introduced from human sources, present in raw Kennedy Lake water were very low.

The trihalomethane formation potential of Kennedy Lake water is related to the organic content that is often measured by the concentration of total organic carbon (TOC). The comparison of TOC and the results of THM formation potential support the relationship between TOC and THM. The elevated levels of THM formation potential indicates that development of the water treatment process should address the levels of organic matter and disinfection options to minimize the formation of THM.

The results of the seasonal water sampling provided a general indication of the water treatment that a water supply system would have to include. Should Kennedy Lake be considered as a water source for the District, then further water sampling and analysis would be required as well as a pilot study during the preliminary design stage of water treatment.

6 LICENCING/PERMITTING

6.1 Island Health 4-3-2-1 Surface Water Source Policy

Water suppliers are required to provide potable water to all users of their system. The 4-3-2-1 surface water treatment policy is a performance target for water suppliers to ensure the provision of microbiological safe drinking water. Vancouver Island Health Authority (VIHA) supports water suppliers to meet this objective. All existing water suppliers serving populations greater than 500 people/day should have an implementation plan to meet this policy.

This policy will also be applied as a performance target for all new surface water systems, regardless of size. Many existing water systems already meet most of this standard. Risk to human health is substantially reduced when water suppliers meet this goal.

Surface water suppliers will be required to provide long term plans to reach the goals of:

- **4 log inactivation** of viruses
- **3 log removal** or inactivation of Giardia cysts and Cryptosporidium oocysts
- **2 treatment processes** for all surface drinking water systems
- **Less than 1 NTU** of turbidity in finished water

<u>4 log inactivation of viruses</u>
Viruses are easily inactivated by the use of chlorine. Achieving a 0.5 mg/L residual of free chlorine for 30 minutes is adequate in most cases.

<u>3 log removal or inactivation of Giardia cysts and Cryptosporidium oocysts</u>
Giardia cysts may be inactivated by large doses of free chlorine, ultraviolet light, ozone and chlorine dioxide, or removed by filtration.

Health Canada has developed design guidelines to determine that the proposed treatment will provide the inactivation desired. For example, chemically assisted rapid sand filtration with sedimentation is given a credit of 3.0 log inactivation. Log inactivation credits of 3.0 for slow sand filtration and 2.5 for direct filtration are given. The remaining credit must be accomplished by another means such as ultraviolet disinfection or free chlorine with a long contact time.

Health Canada has also developed guidelines for Cryptosporidium oocyst removal that outline treatment methods, which will provide the inactivation, desired. Systems with optimized conventional rapid sand filtration are given a credit of 3.0 logs. Membrane filtration may be required to demonstrate removal efficiency through challenge testing and verified by direct integrity testing. Ultraviolet disinfection is given a credit of 3.0 logs if the dose is a minimum of 42mJ/cm2.

<u>2 treatment processes are a minimum for all surface water sources. A dual disinfection approach to water treatment is associated with providing potable water</u>
The main risk to water quality is from microbiological agents. Some of these microbial risks are more resistant to some forms of treatment than others. It is recognized that effective treatment for all microbial risks by a single treatment process is not effective.

Dual treatment processes are required for all surface water to reduce the risk of microbial or health threats to drinking water. Water filtration and disinfection will become the norm for many surface water supplies in order to meet the 4-3-2-1 policy objectives. For other sources where the filtration waiver can be met, dual treatment may mean two forms of disinfection, usually chlorination and UV light disinfection. It may also include watershed protection measures to ensure good raw water quality.

Less than 1 NTU in Turbidity

Events such as sedimentation from road surfaces, higher surface runoff peak flows, landslides and debris flows increase a condition commonly referred to as "turbidity." Turbidity in water is caused by suspended organic and colloidal matter, such as clay, silt, finely divided organic and inorganic matter, bacteria, protozoa and other microscopic organisms. It is measured in nephelometric turbidity units (NTU) and is generally acceptable when less than 1 NTU, and becomes visible when above 5 NTU.

A surface water supply system may be permitted to operate without filtration if the conditions for exclusion of filtration listed in **Table 5** are met or a timetable to implement filtration has been agreed to by the drinking water officer:

Table 5 – Conditions for Surface Water Source Filtration Waiver

Condition No.	Description
1	Overall inactivation is met using a minimum of two disinfections, providing: • 4 log reduction of viruses, and • 3 log reduction of Cryptosporidium and Giardia
2	The number of E. coli in raw water does not exceed: • 20/100 mL, or • if E. coli data are not available, less than 100/100 mL of total coliform in at least 90% of the weekly samples from the previous six months. The treatment target for all water systems is to contain no detectable: • E. coli, or • fecal coliform per 100 ml. Total coliform objectives are also zero based on one sample in a 30-day period. When more than one sample taken in a 30-day period: • at least 90% of the samples should have no detectable total coliform bacteria per 100 ml, and • no sample should have more than 10 total coliform bacteria per 100 ml.
3	Average daily turbidity levels measured at equal intervals (at least every four hours) immediately before the disinfectant is applied are to be: • around 1 NTU, but • do not exceed 5 NTU for more than two days in a 12-month period.
4	A watershed control program is maintained that: • minimizes the potential for fecal contamination in the source water. (Health Canada, 2003)

Applying the exclusion of filtration criteria listed in **Table 5** does not mean filtration will never be needed in the future. A consistent supply of good source water quality is critical to the approach, but source quality can change. Therefore, the exclusion of filtration must be supported by continuous assessment of water supply conditions. Changing source water quality can occur with changes in watershed conditions. Increased threats identified through ongoing assessment and monitoring may necessitate filtration. Maintaining the exclusion condition relies on known current and historic source water conditions, and provides some level of assurance to water suppliers that a filtration system may not be necessary unless the risk of adverse source water quality increases.

6.2 Mercantile Creek

The Mercantile Creek Surface Water Supply meets the first three requirements for Island Health surface water, however it does not meet the <1 NTU and will require filtration in order to become compliant with the Island Health Policy.

6.3 Lost Shoe Creek Wellfield

The Lost Shoe Creek Wellfield is a groundwater source and that does not fall under the Island Health surface water treatment objectives, however the water must be disinfected with chlorine to maintain a chlorine residual within the system.

6.3.1 Water Sustainability Act – Groundwater Licencing

Recently the Provincial Government passed the Water Sustainability Act. This act manages surface and groundwater as a single resource, whereas the previous Water Act managed only surface water. The regulation of groundwater will result in groundwater users having the same rights and responsibilities, including priority rights. In return, the user will be required to obtain a water licence which will require payment of an application fee and an annual water rental fee. The fees vary depending on how the water is being used and who the user (consumer) is. Domestic properties that use groundwater for household needs will be exempt from licensing and fees. Municipalities, like the DoU, will be required to obtain a licence and pay the fees.

A review of the application and annual water rental fee rates for 2016 indicate the estimated costs for the DoU for registration of their wells could consist of:

- One Time Application Fee: $5,000 (for 100,000 m^3/yr. to < 5,000,000 m^3/yr.)
- Annual Rental Fee: $2,000± ($2.25 per 1,000 m^3)

A copy of the Water Sustainability Act and Table of Fees can be found on the BC Government web site.

6.4 Kennedy Lake

Preliminary information shows that the Kennedy Lake water would be pristine and suitable for public consumption with treatment. Should Kennedy Lake be considered as a water source for the District, then further water sampling and analysis would be required as well as a pilot study during the preliminary design stage of water treatment.

7 DESIGN CRITERIA

7.1 Current & Future Population Projection

District of Ucluelet

Ucluelet has seen population fluctuations over the years peaking at 1,760 in Year 1995, followed by a gradual decline to 1,463 by Year 2003. The District's population experienced steady between 2003 and 2011, averaging 1.32% per year. Since 2011, BC Stats has estimated the District's population has declined and as of July 2015, was estimated to be 1,515.

In the fall of 2011 with the passing of Bylaw No. 1140, 2011, Council adopted the Official Community Plan 2011. The OCP projects population growth over 25 years to average 0.60% per year. This would result in the population increasing to 1,928, a 16% increase, by Year 2036 based on Stats BC's Year 2011 population estimate of 1,660.

Ittatsoo 1, IRI

The residents and businesses located within the Ittatsoo 1, IRI of the Yuulu-it-ath First Nation (YFN) obtain potable water from the District of Ucluelet.

A review of Stats Canada population data revealed the population has fluctuation over the past two decade from a low of 191 in Year 1996 to a high of 240 in Year 2011. These counts do not include the YFC members that live off of YFN lands, which in Year 2012 was estimated to be just under 430, for a combined total of 633.

In October 2013 the YFN published their OCP covering all of their lands and foreshore. The OCP included population projections to Year 2042 people based on four different constant annual rates of growth; 0.5%, 1.0%, 1.5% and 2.0%. Applying the lowest and highest growth rate to the Year 2011 on lands population count of 240, results in the service population increasing to between 280 to 443 by Year 2042; a 17% to 85% increase; respectively. When the growth rates are applied to all of the YFN peoples, the total population increases to between 728 and 1,103 by Year 2042.

50 Year Population Projections (Year 2066)

Population projections for both communities have been developed for the next 50 years (to year 2066) for three separate growth rates (low, medium and high) based on the information in their OCP's and extrapolation of historical growth rates. **Table 6** presents the growth rates separately and combined for each community in 10 year increments to Year 2066.

Table 6 – DOU & Ittatsoo Past and Projected Populations (to Year 2065)

Year	DoU	Ittatsoo 1	Combined
2001	1,559	208	1,367
2006	1,487	200	1,687
2011	1,627	240	1,867
2015	1,515	245	1,760
	Slow Growth		
	0.44% to 0.23%	**0.5%**	
2025	1,580	260	1,840
2035	1,630	270	1,900
2045	1,670	285	1,955
2055	1,700	230	2,030
2065	1,740	315	2,055
50 Year Increase (%)	225 15%	70 28%	315 17%
	Moderate Growth		
	0.6%	**1.52%**	
2025	1,800	295	2,095
2035	1,920	345	2,265
2045	2,030	400	2,430
2055	2,160	465	2,625
2065	2,290	540	2,830
50 Year Increase (%)	550 51%	295 121%	1,070 61%
	High Growth		
	1.32%	**2.0%**	
2025	1,950	320	2,270
2035	2,230	385	2,615
2045	2,540	470	3,010
2055	2,890	575	3,465
2065	3,300	700	4,000
50 Year Increase (%)	1,785 118%	455 186%	2,240 127%

The information in **Table 6** is graphically presented in **Figure 10** for the District of Ucluelet, **Figure 11** for Ittatsoo 1, and **Figure 12** for the two communities combined.

7.2 Water Demands

7.2.1 Design Criteria

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

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District of Ucluelet
Population, Historic & Projected

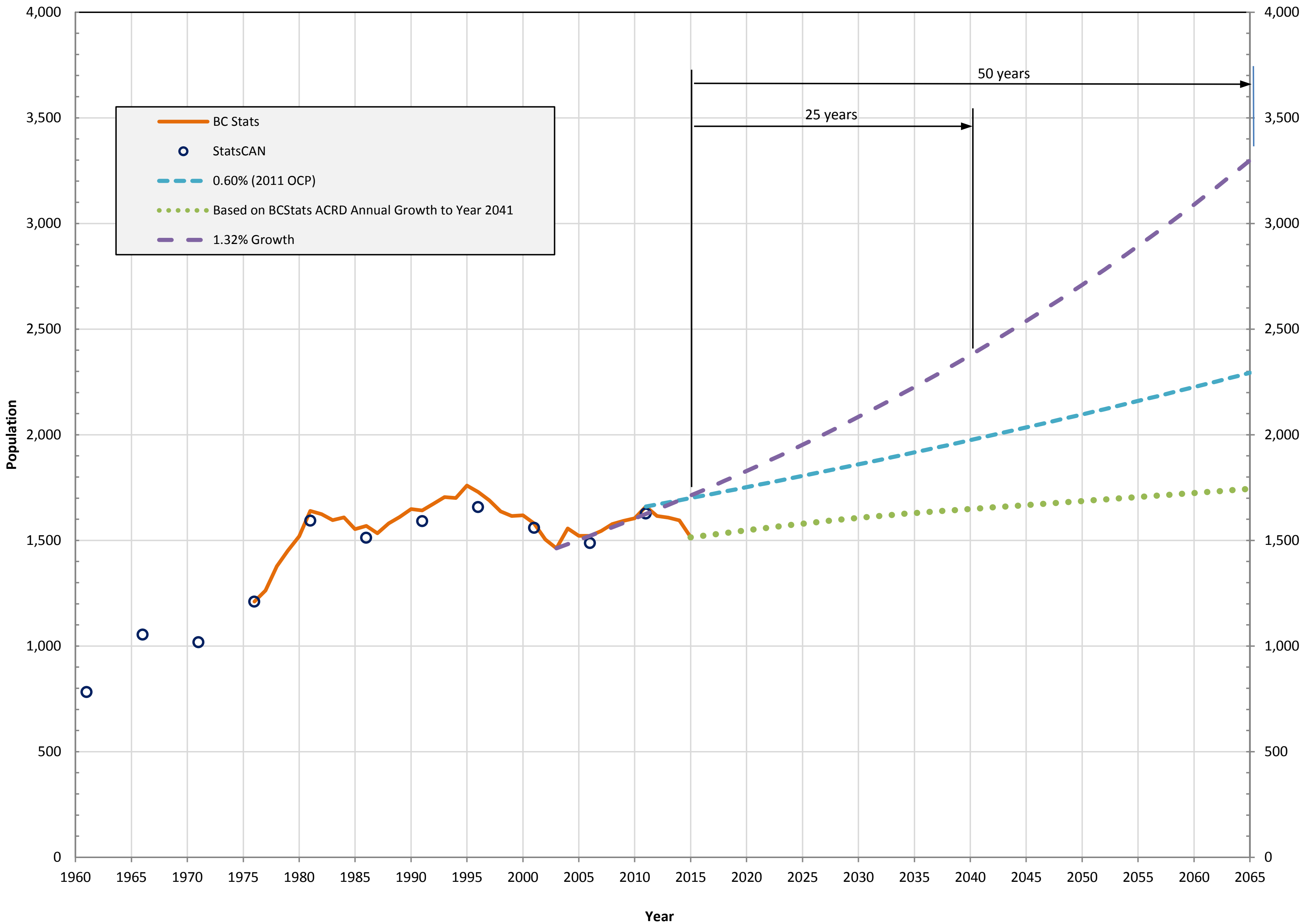

FIGURE 10

Ittatsoo 1
Population, Historic & Projected

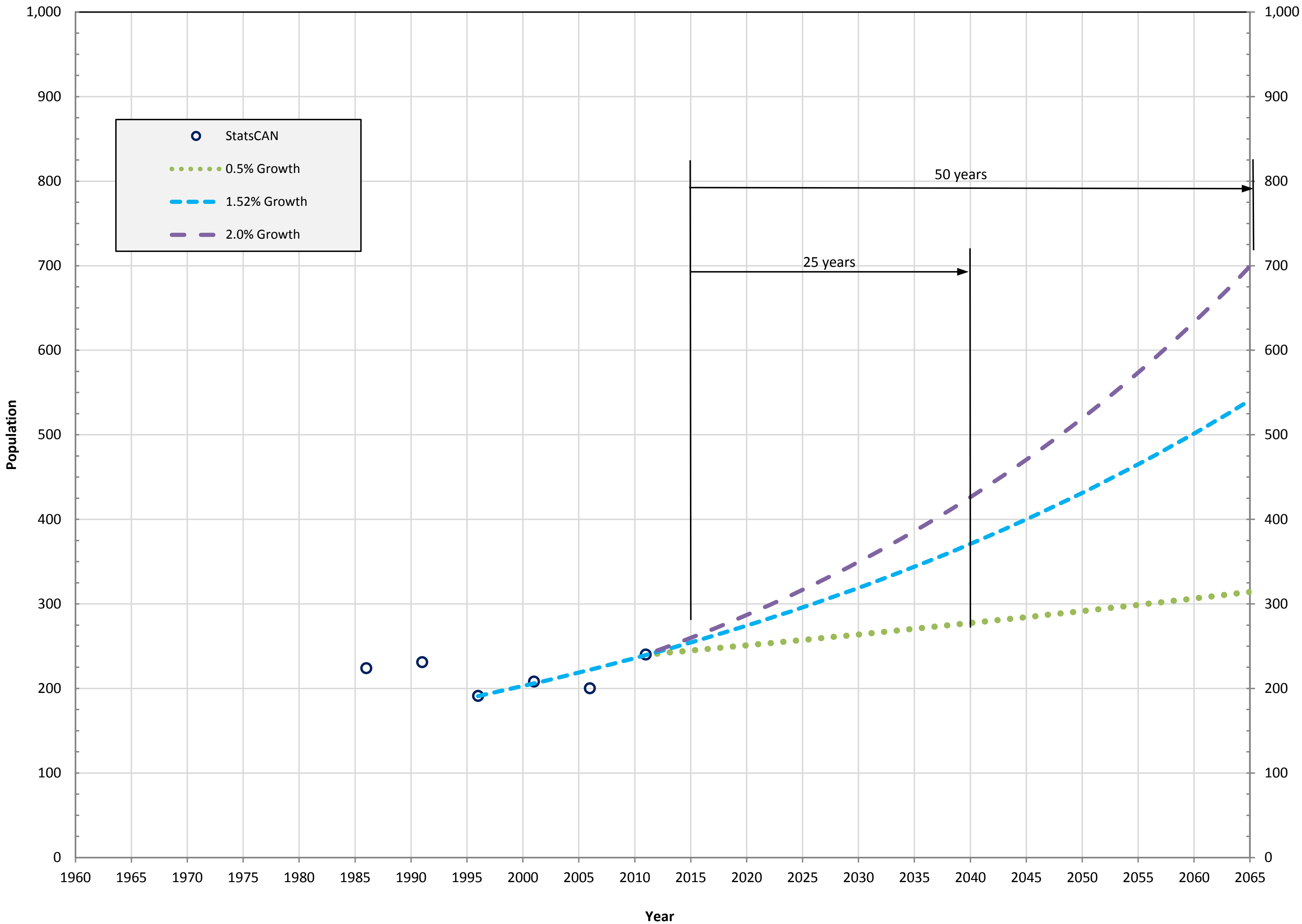

FIGURE 11

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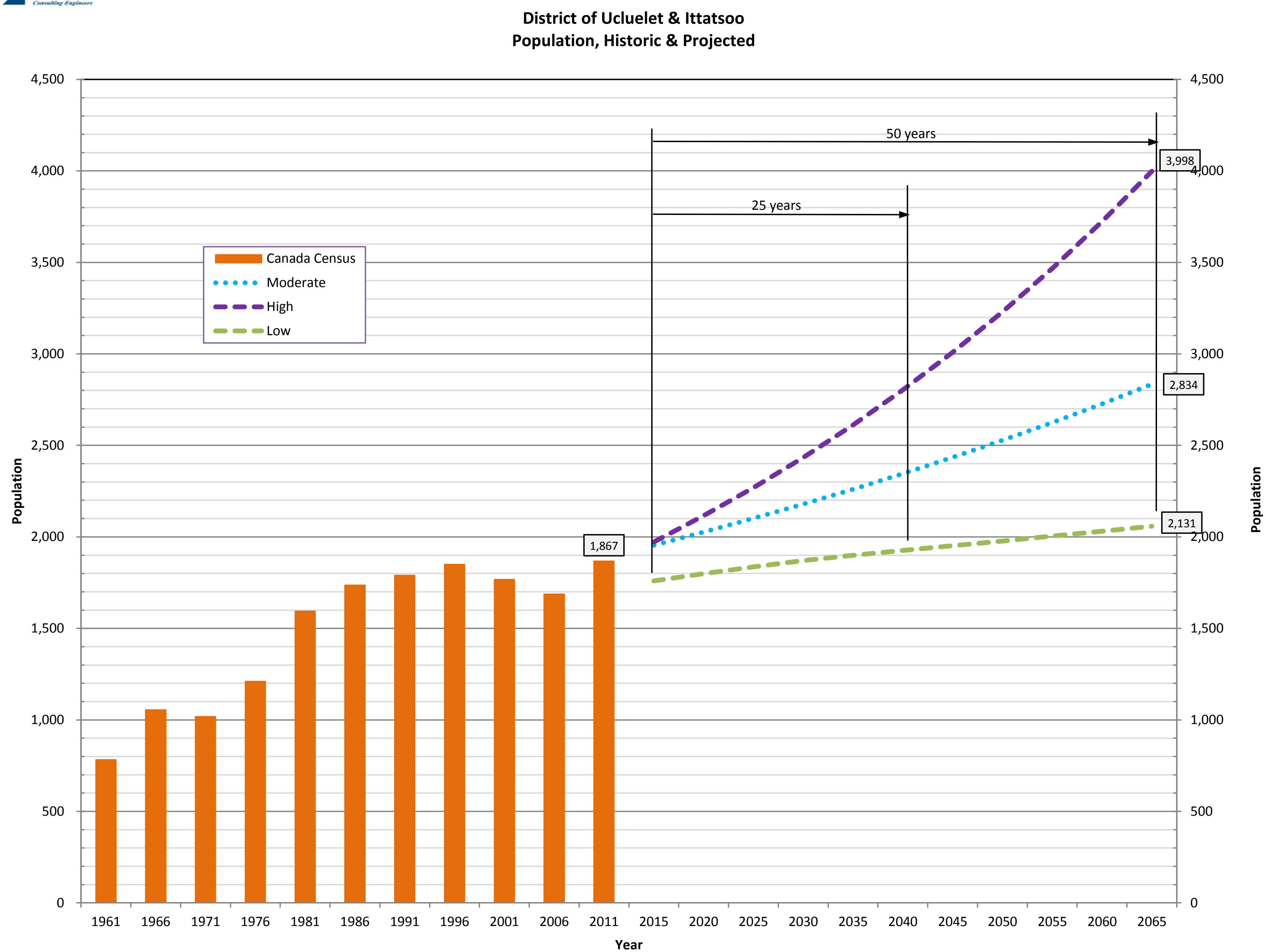


FIGURE 12

Average Day Demand	=	Total annual consumption / 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)

The system must also be capable of delivering fire flow demands during maximum day demands.

7.2.2 Current Demands

Annual Demands

A review of the water system total annual water usage for the past 24 years (1991 to 2015) was carried out along with the total metered demand (commercial and industrial properties) for the two five year periods 2000 to 2004 and 2008 to 2012. This data is graphically presented in **Figure 13** along with the total annual demand for the Ittatsoo 1.

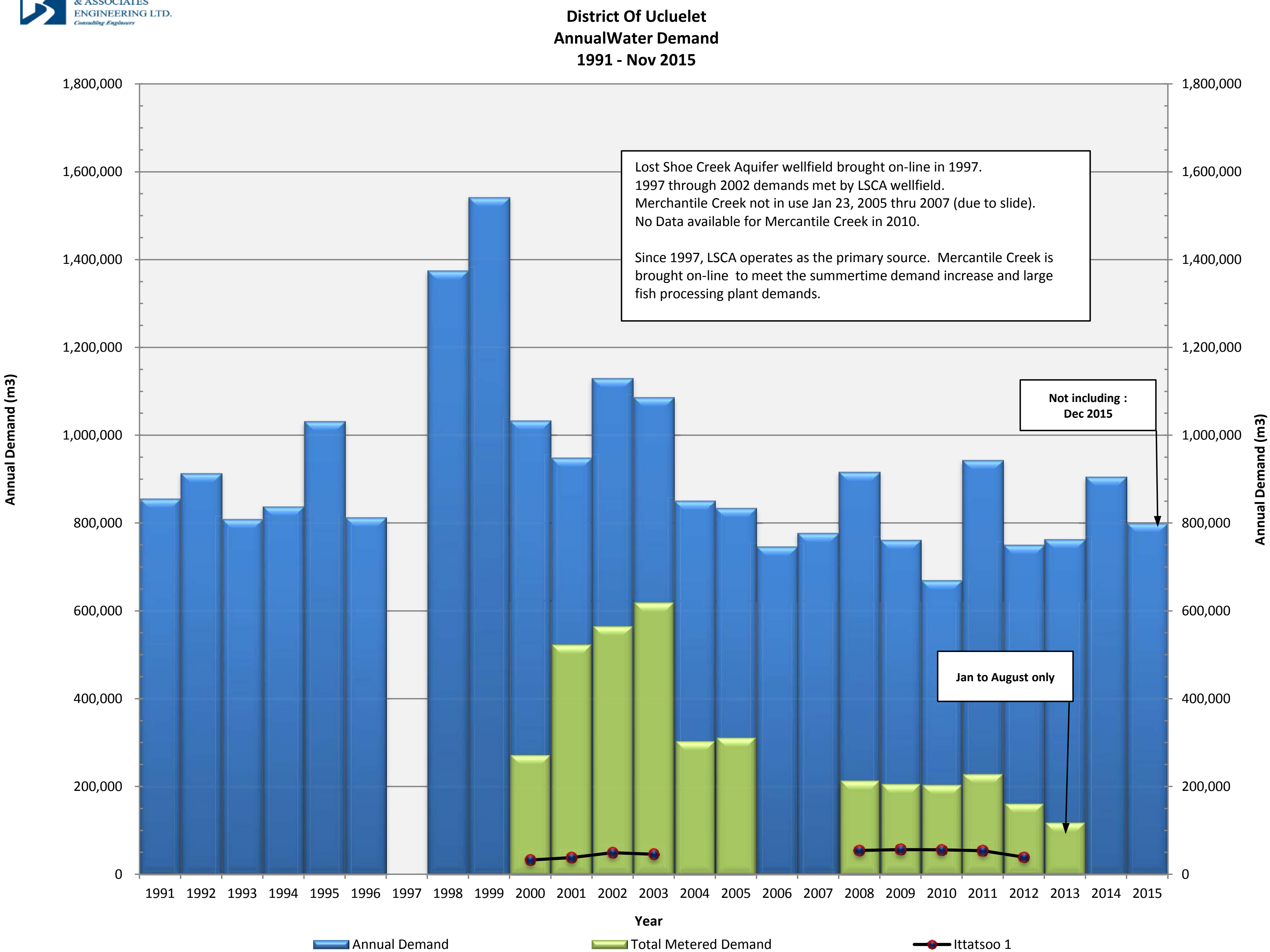
Since 2004, total annual water usage has averaged between 750,000 m^3 and 950,000 m^3. Since 2008 total metered demand has been stable with a slight downward trend. Demand by the Ittatsoo 1 has relatively stable and was the single largest user during the five year period of 2008 to 2012.

Monthly Demands

Figure 14 presents the monthly total demand and metered (commercial and industrial properties) demands from January 2008 to present. Metered data after August 2012 was not available. As can been seen, demands increase in the summer and decrease in the fall. The peak summer demand has steadily decreased since reaching a high in October 2011 while fall demand has steadily increased. The reason for the increase in fall demands is not known. It is suspected that more frequent spillage at the Matterson Reservoir may be the cause. This spillage is the result of the winter supply from the Highway Reservoir through a throttled gate valve that provides continuous supply to the Matterson Reservoir. **Table 7** presents annual system demand vs metered demand from the past eight years.

Table 7 – Annual Demand vs Metered Demands, 2008 to 2015

Year	System Demand	Metered Demand			
		All meters		Ittatsoo 1, IRI	
	m^3	m^3	(%)	m^3	(%)
2008	916,612	214,754	23	54,219	6
2009	761,780	206,951	27	56,425	7
2010	669,747	205,034	31	55,708	8
2011	943,527	229,290	24	53,868	6
2012	750,887	162,365	22	39,080	5
2013	762,992	189,173	25	42,437	6
2014	905,251	213,112	24	55,838	6
2015	861,892	193,379	22	51,336	6



District Of Ucluelet
AnnualWater Demand
1991 - Nov 2015
Lost Shoe Creek Aquifer wellfield brought on-line in 1997.
1997 through 2002 demands met by LSCA wellfield.
Merchantile Creek not in use Jan 23, 2005 thru 2007 (due to slide).
No Data available for Mercantile Creek in 2010.
Since 1997, LSCA operates as the primary source. Mercantile Creek is brought on-line to meet the summertime demand increase and large fish processing plant demands.
Not including : Dec 2015
Jan to August only
Annual Demand (m3)
Year
1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
0 200,000 400,000 600,000 800,000 1,000,000 1,200,000 1,400,000 1,600,000 1,800,000
Annual Demand
Total Metered Demand
Ittatsoo 1

FIGURE 13

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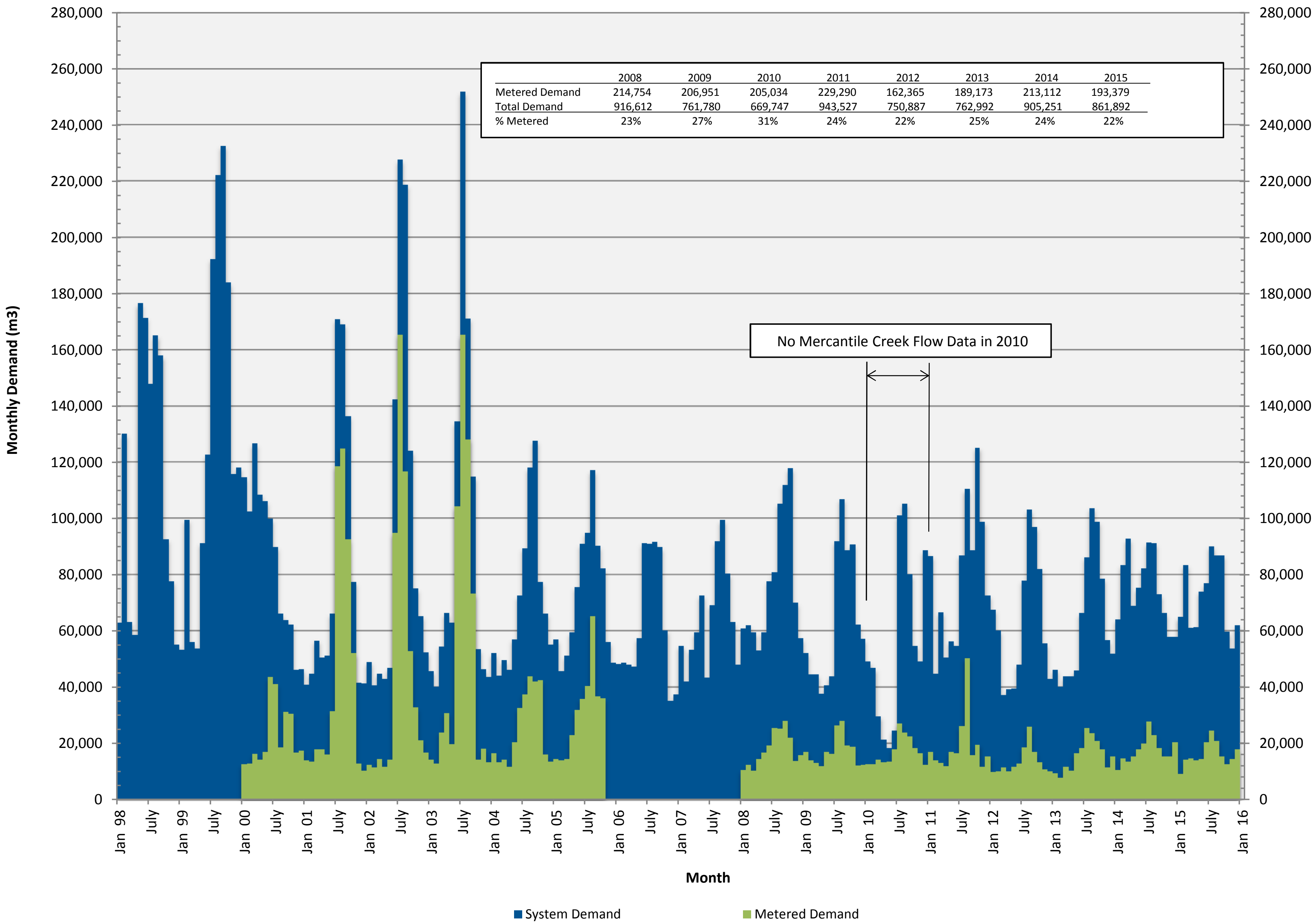
District of Ucluelet
Monthly Demands
1998 to 2015



	2008	2009	2010	2011	2012	2013	2014	2015
Metered Demand	214,754	206,951	205,034	229,290	162,365	189,173	213,112	193,379
Total Demand	916,612	761,780	669,747	943,527	750,887	762,992	905,251	861,892
% Metered	23%	27%	31%	24%	22%	25%	24%	22%

FIGURE 14

Daily Demands

Figure 15 presents daily demands for the period 1998 to 2005 and 2013 to present. No daily flow data from 2006 through 2012 was available. During the early 2000's when fish processing was very active, with up to 4 processing plants operating, both of the District's water supply sources (Mercantile Creek and LSCA) were required to meet maximum day demands. While the decline in the fish processing demands is clearly evident, demands in the summer months continue to exceed the Mercantile Creek water licence maximum withdrawal limits. The data shows that the pumping capacity of the wellfield is well (approximately 9,400 m^3/day) is well below the maximum day demands which have been less than 5,000 m^3/day for the past three years as well as in 2005. No flow data was available from 2006 through 2012.

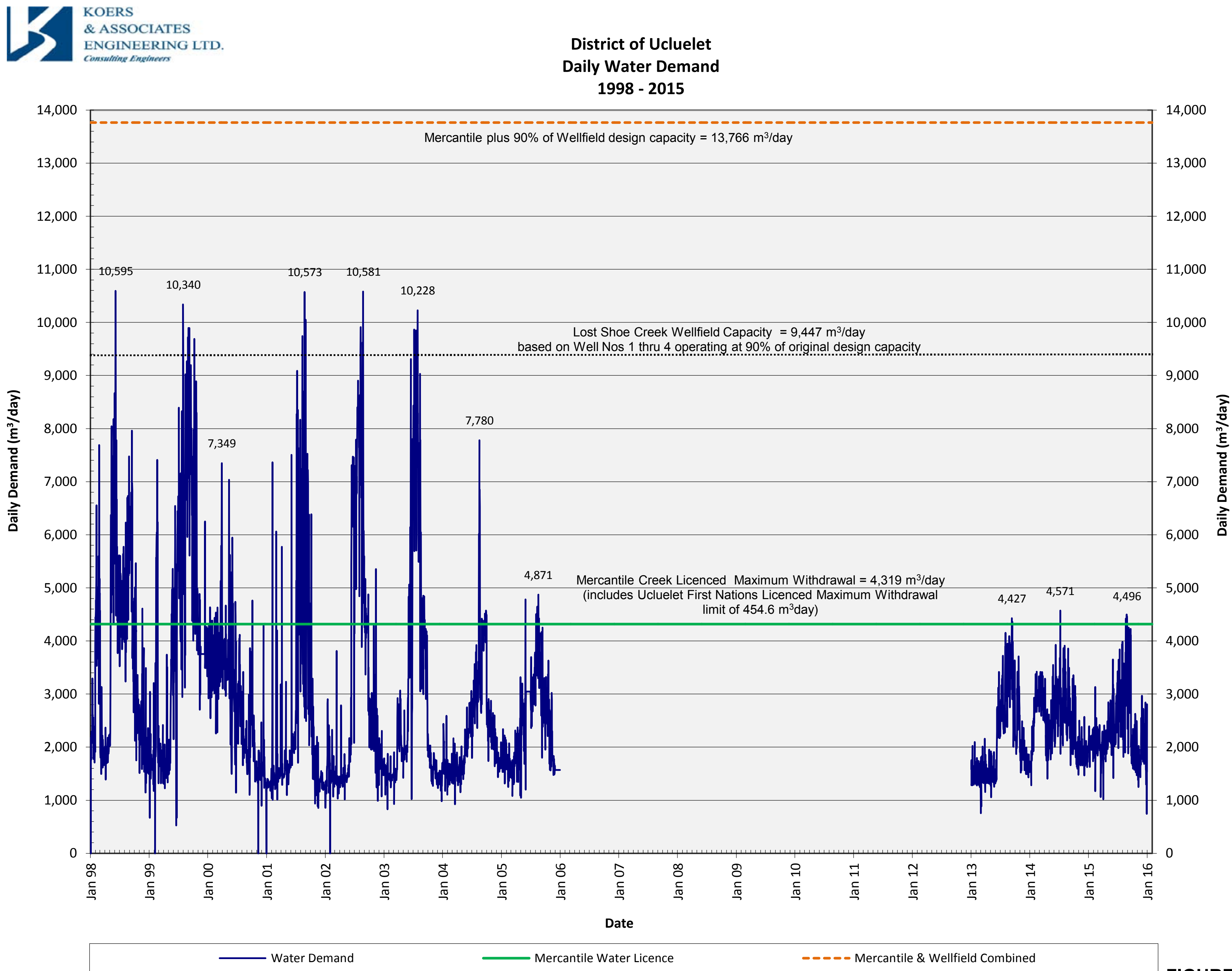
Table 8 presents the total system average and maximum day demands for the past 18 years along with the calculated per capita demand based on the BCStats published population estimates for the District of Ucluelet.

Table 8 – Average and Maximum Day Demands, 1998 – 2015

	Average Day		Maximum Day			Max Day
Year	(m^3/day)	(lpcd)	Month	(m^3/day)	(lpcd)	Ave Day
1998	3,758	2,260	June	10,595	6,370	2.8
1999	4,237	2,680	July	10,340	6,290	2.4
2000	2,848	1,720	March	7,349	4,440	2.6
2001	2,612	1,610	August	10,573	6,500	4.0
2002	3,105	1,900	August	10,581	6,480	3.4
2003	2,976	1,780	July	10,228	6,110	3.4
2004	2,339	1,260	August	7,780	4,200	3.3
2005	2,383	1,250	August	4,871	2,560	2.0
2006	2,047	1,350		-	-	-
2007	2,131	1,380		-	-	-
2008	2,504	1,590		-	-	-
2009	2,087	1,310		-	-	-
2010	1,835	1,140		-	-	-
2011	2,585	1,560		-	-	-
2012	2,052	1,270		-	-	-
2013	2,102	1,310	Sept	4,427	2,755	2.1
2014	2,480	1,555	July	4,571	2,865	1.8
2015	2,409	1,535	August	4,496	2,970	1.9

Figure 16 graphically presents the average and maximum per capita day demands listed in **Table 8** but spanning the 24 year period of 1991 to 2015 and includes the calculated non-metered average day demand per capita. The non-metered demand was calculated as the difference between the total system demand and the metered (commercial and Industrial) demand for each year that data was available.

A Max Day vs Ave Day ratio of 2 is typical for water systems with a service population of the District's size. Peak hour demand data is not available. In general, peak hour demands can be expected to be in the range of 1.5 to 2 times the maximum day demands for a water system with a service population of the District's size.



KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers
District of Ucluelet
Daily Water Demand
1998 - 2015
Mercantile plus 90% of Wellfield design capacity = 13,766 m³/day
Lost Shoe Creek Wellfield Capacity = 9,447 m³/day
based on Well Nos 1 thru 4 operating at 90% of original design capacity
Mercantile Creek Licenced Maximum Withdrawal = 4,319 m³/day
(includes Ucluelet First Nations Licenced Maximum Withdrawal
limit of 454.6 m³day)
10,595
10,340
7,349
10,573
10,581
10,228
7,780
4,871
4,427
4,571
4,496
Daily Demand (m³/day)
Date
Jan 98
Jan 99
Jan 00
Jan 01
Jan 02
Jan 03
Jan 04
Jan 05
Jan 06
Jan 07
Jan 08
Jan 09
Jan 10
Jan 11
Jan 12
Jan 13
Jan 14
Jan 15
Jan 16
Water Demand
Mercantile Water Licence
Mercantile & Wellfield Combined

FIGURE 15

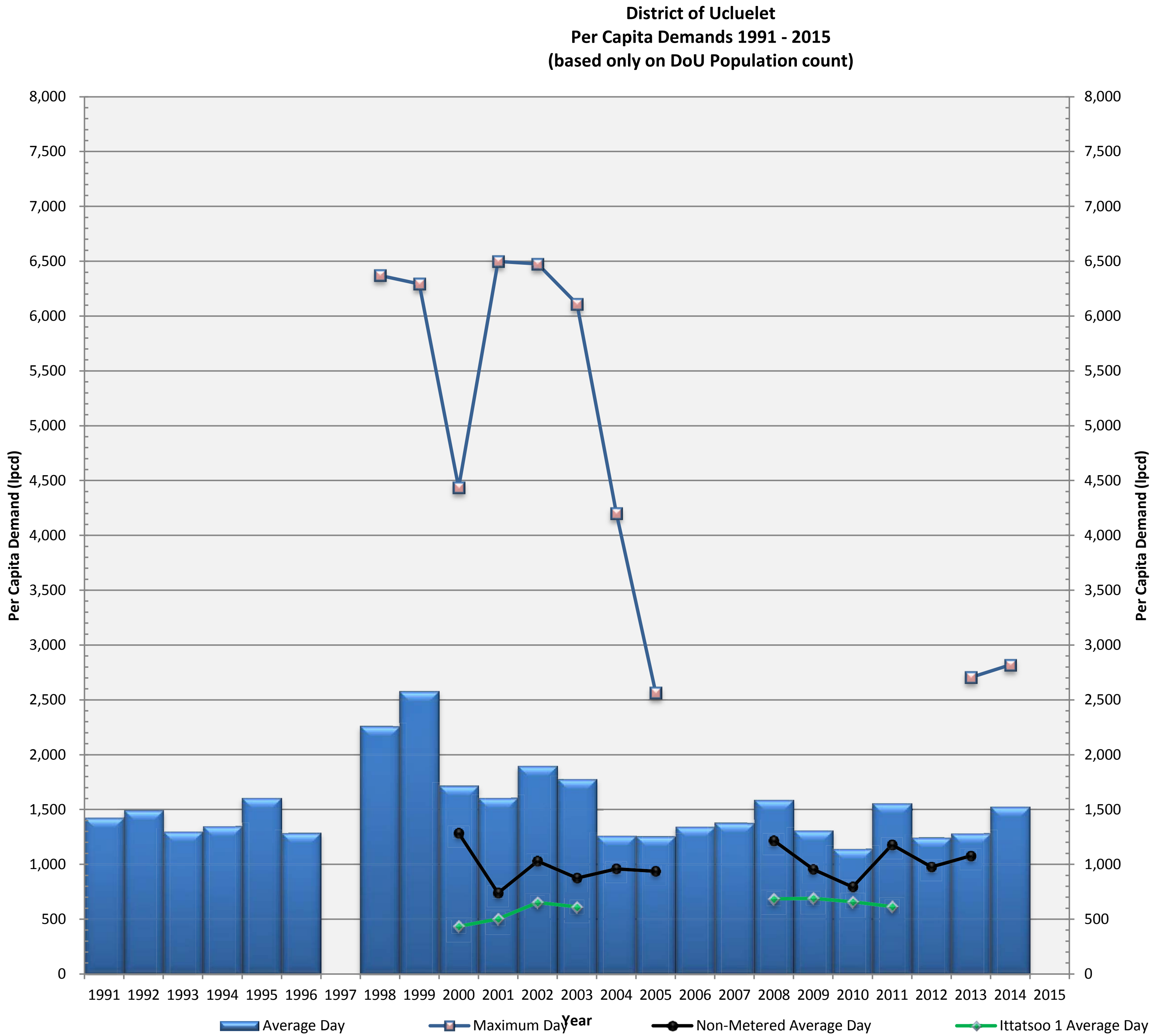

District of Ucluelet
Per Capita Demands 1991 - 2015
(based only on DoU Population count)
Per Capita Demand (lpcd)
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Year
Average Day
Maximum Day
Non-Metered Average Day
Ittatsoo 1 Average Day

FIGURE 16

7.2.3 Future Demands

The District of Ucluelet's Subdivision Servicing Bylaw does not include design water demand criteria. An average day and maximum day per capita design demand have been established based on a review of the calculated per capita demands in **Table 8** and are presented in **Table 9**.

Table 9 – Per Capita Design Demands

Description (Demand)		Per Capita Design Demand (lpcd)		
		District of Ucluelet (1)	Ittatsoo First Nation (2)	District of Ucluelet & Ittatsoo First Nation (3)
Average Day	(ADD)	1,550	700	1,350
Maximum Day	(MDD)	3,100	-	2,700
Peak Hour (4)	(PHD)	6,200	-	5,400

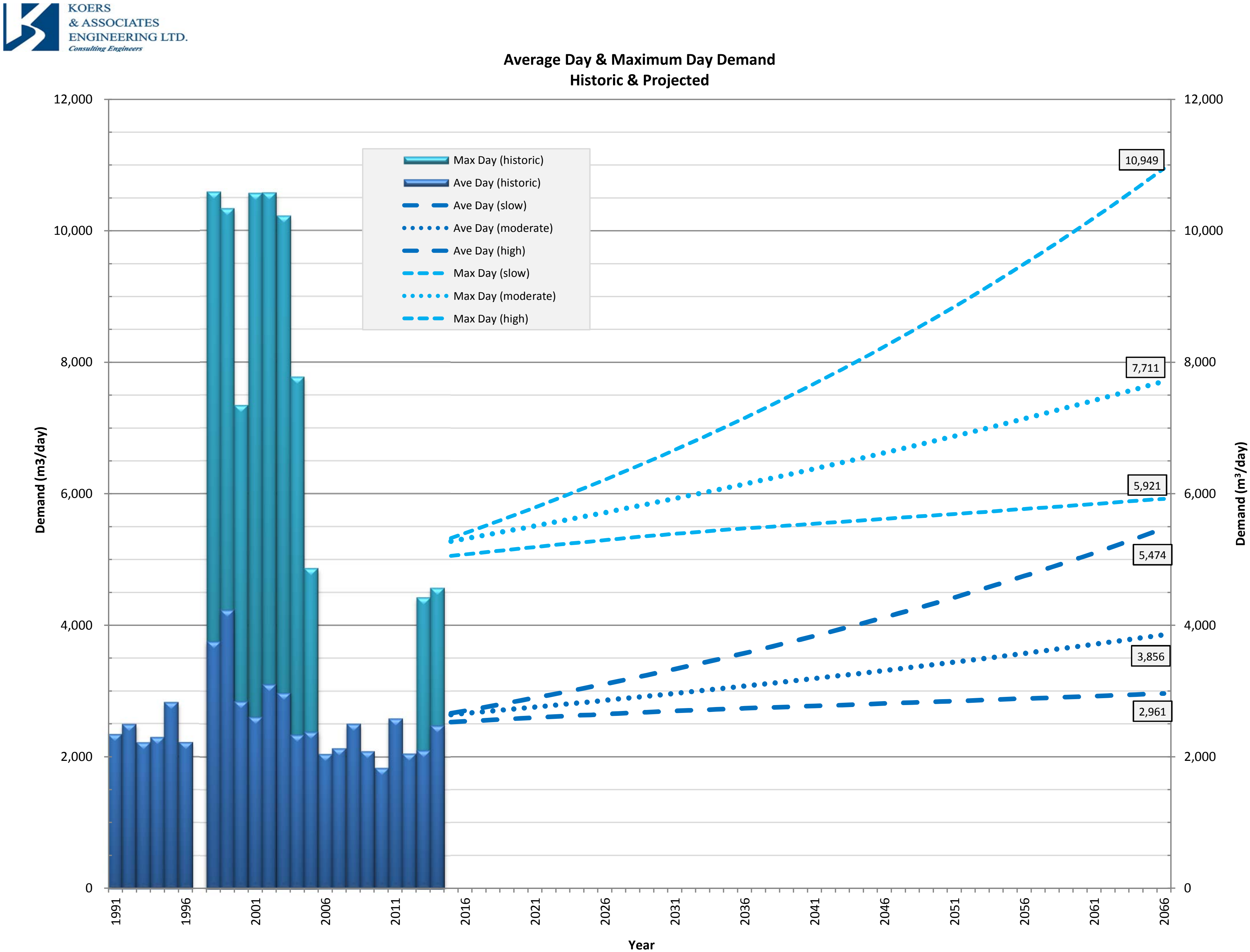
Notes:
(1) Based on total system demand, including Ittatsoo First Nation, divided by only the District of Ucluelet's population estimate.
(2) Based on Ittatsoo First Nation demand divided by its population estimate.
(3) Based on total system demand divided by the District's & Ittatsoo's combined population estimate.
(4) Peak hour demands are not recorded. They are based on 2 times the maximum day demand.

Based on a review of other municipalities on Vancouver Island, including Tofino and Port Alberni, the per capita demands for the District are between 2 to 2.5 times higher. This can be attributed to the fact that the District does not have residential metering in place and that the setup of the current supply and distribution system results in the wasting of water at the Matterson Reservoir when the Mercantile Creek source is not available.

Utilizing the per capita design demands of **Table 9** and the population projections in Table **5**, the average and maximum day demands to Year 2065 for the three growth rates are presented in **Table 10** and are graphically shown in **Figure 17**.

Table 10 – Average and Maximum Day Demands to Year 2065

Year	Average Day Demand (m^3/day)			Maximum Day Demand (m^3/day)		
2015	2,324			4,496		
Year	For Rate of Growth of			For Rate of Growth of		
	Low	Moderate	High	Low	Moderate	High
2025	2,640	2,840	3,060	5,270	5,670	6,130
2035	2,730	3,050	3,530	5,460	6,100	7,050
2045	2,800	3,290	4,060	5,600	6,570	8,120
2055	2,880	3,540	4,680	5,750	7,090	9,360
2065	2,950	3,830	5,400	5,910	7,650	10,800
50 Yr. Increase	540	1,420	2,990	1,410	3,150	6,300
(%)	22%	59%	124%	31%	70%	140%



KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers
Average Day & Maximum Day Demand
Historic & Projected
Max Day (historic)
Ave Day (historic)
Ave Day (slow)
Ave Day (moderate)
Ave Day (high)
Max Day (slow)
Max Day (moderate)
Max Day (high)
10,949
7,711
5,921
5,474
3,856
2,961
Demand (m3/day)
Demand (m³/day)
Year
0
2,000
4,000
6,000
8,000
10,000
12,000
1991
1996
2001
2006
2011
2016
2021
2026
2031
2036
2041
2046
2051
2056
2061
2066

FIGURE 17

7.2.4 Fire Flow Requirements

The ability to provide adequate fire flow is an important feature of a properly designed water distribution system. 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 District does not have a fire flow design standard. Most municipalities are or have adopted the requirement that fire flow demands are to be calculated in accordance with the most recent version of the “Water Supply for Public Fire Protection” by the Fire Underwriters Survey (FUS), for existing and anticipated land use and in general require the system to be capable of providing not less than 60 l/s and not exceed 300 l/s except in the case of an unusual risk. For 60 l/s to 300 l/s, the design duration is 1.75 hours and 4 hours. **Figure 18** below presents the FUS time requirements for varying fire flows. Note 60 L/s and 300 L/s equate to 3,600 L/minute and 18,000 L/min; respectively.

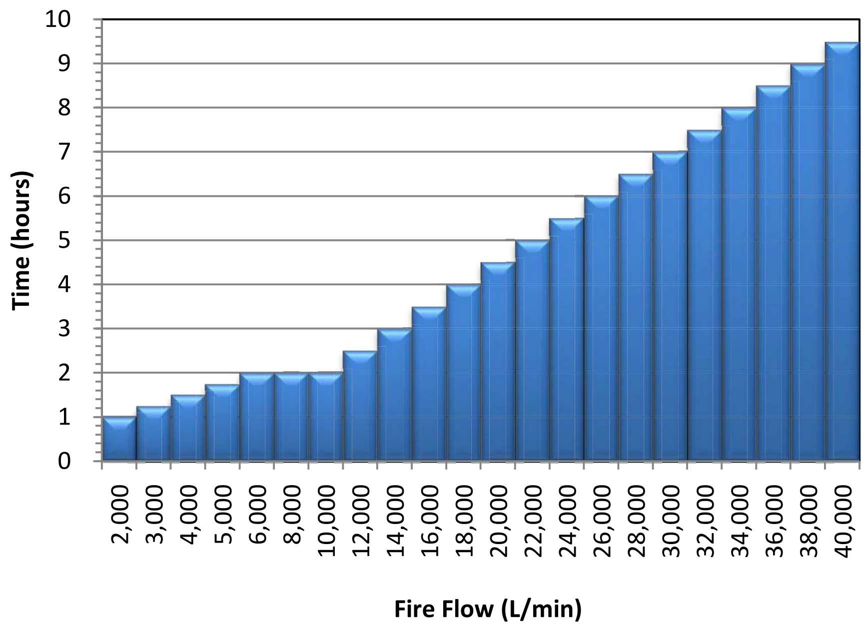


Figure 18 – Fire Underwriters’ Survey Fire Flow vs Time

Using the Master Municipal Contract Documents (MMCD) as a design standard the MMCD – Design Guideline Manual notes fire flows are to be determined in accordance with FUS. The minimum requirements noted in the MMCD – Design Guideline Manual for developments without sprinklers is presented in **Table 11**.

Table 11 – Fire Flow Demands

Land Use	Assumed Minimum Required Fire Flow		Volume (m^3)
	Demand (L/s)	Duration (hrs)	
Single Family	60	1.5	324
Apartments, Townhouses	90	1.75	567
Commercial	150	2	1,080
Institutional	150	2	1,080
Industrial	225	3	2,430

There are several larger wood frame institutional structures and industrial businesses in Ucluelet. The fire flow demands for these structures may be higher than the minimum flows listed in **Table 11.**

7.3 Water Conservation

In 2008, the provincial government launched the Living Water Smart program emphasizing water conservation. This program requires 50% of new municipal water needs to be acquired through conservation by Year 2020.

A water conservation study was recently carried out for the District and the findings were presented in the District of Ucluelet Water Conservation Study, March 2014 by Koers & Associates Engineering Ltd. The principle findings of the study were:

- Conservation efforts in Ucluelet will have the most effect if they are directed at reducing non-metered water demands which count for more than 70% of water demand. This is a significant change from 10 years ago, when metered demands accounted for more than 50% of system demands and fish processing demand made up more than 80% of the metered demands, or 40% of the system demands.
- The motivation for conservation of water use is immediate reduction in O&M costs and the future postponement of major capital expenditures for water supply and distribution.
- It is believed the most appropriate starting point for a successful water conservation program is the elimination of overflows at the Matterson Reservoir with the installation of pressure control valves. This will create two pressure zones; the Highway Reservoir zone and the Matterson Reservoir zone.
- The second step would be an emphasis on understanding non-metered water demand usage and the causes for the large summertime demand increases and/or a concerted effort on leak detection, with initial emphasis on the 23% of the water system with AC mains.
- It is believed that a successful water conservation\leak reduction program in Ucluelet may result in a 27% or greater reduction in water as noted in **Table 12**.

Table 12 – Potential Demand Reduction through Water Conservation Program

Description	Potential Annual Demand Reduction
50% reduction in loss/unaccounted water	15 %
20% reduction in indoor residential use	5%
25% reduction in non-metered summertime demand (July/Aug/Sept/Oct)	8 – 10 %
Total Reduction:	28 – 30 %

For the purposes of this Water Master Plan, water conservation has not been included in the demand projections, as it provided a more conservative approach for the purposes of assessing the capability of the long range water supply source and infrastructure sizing.

8 LONG RANGE SUPPLY

Table 13 presents a summary of the issues related to each of the three water supply sources.

Table 13 – Water Supply Source Issues

Description	Mercantile Creek	Lost Shoe Creek Aquifer Wellfield	Kennedy Lake
Quantity			
Daily Withdrawal Limit (m^3/day)	4,319 m^3 **(1)**	10,497 m^3 **(2)**	TBD
Can Meet Year 2015 Demands			
Ave Day (2,409 m^3/day)	**Yes**	**Yes**	**Yes**
Max Day (4,496 m^3/day)	**No**	**Yes**	**Yes**
Can Meet Year 2065 Demands			
Ave Day (2,950 – 5,400 m^3/day)	**Yes - No**	**Yes**	**Yes**
Max Day (5,910 – 10,800 m^3/day)	**No**	**Yes**	**Yes**
Quality			
Source Type	Surface Water	Ground Water (GUDI)	Surface Water
Filtration Exempt	**No (3)**	**No (4)**	unknown **(5)**
(Reason)	(Turbidity)	(Fe & Mn)	(Surface Source)
Disinfectant Required	UV & Chlorine	Chlorine	UV & Chlorine
Water Licences			
Licenced Volume Sufficient	**No (6)**	**Yes**	**No**
Infrastructure			
Infrastructure In Place			
Water Withdrawal	**Yes**	**Yes**	**No**
Complete Water Treatment System	**No (3)**	**No (4)**	**No**
Supply Main	**Yes**	**Yes**	**No**
Timeline			
Source Approval	-	**(7)**	3 – 4 yrs. ±
Treatment Approval/Detail Design	1 – 2 yrs.	1 – 2 yrs.	2 – 4 yrs. ±
Construction	1 yr.	1 yr.	2 yrs. ±
Total	**2 – 3 yrs.**	**2 – 3 yrs.**	**7 – 10 yrs.**

Notes:

(1) Based on combined licenced daily maximum withdrawal limits for the District of Ucluelet and the Ucluelet First Nations (3,864 + 454.6 = 4,319 m^3/day).

(2) Daily pumping capacity of 10,497 m^3/day based on the four wells operating at 90% of the original design capacity.

(3) The water system operating permit issued by Island Health to the District of Ucluelet for Mercantile Creek requires implementation of a treatment system to ensure turbidity levels are less than 1 NTU in the treated water as previously discussed in **3.2 Water Quality**. This will require installation of a filtration system.

(4) It is assumed the District will institute a process to remove Iron & Manganese (Fe & Mn) from the well field water in response to water quality complaints from the consumers and businesses, as discussed in **4.2 Water Quality**.

(5) Water quality sampling will be required to determine the treatment requirements required for water withdrawn from Kennedy Lake in order to comply with Island Health treatment policy for surface water source (4-3-2-1).

(6) The licenced maximum withdrawal limit is not sufficient to meet current maximum day demand and projected Year 2065 demands. As per the discussion in Section **3.2 Water Quantity** and **Figure 2**, there is no additional capacity on Mercantile Creek to permit additional licenced withdrawals.

(7) As part of the recently passed provincial Water Sustainability Act, water licences are required for the extraction of groundwater. The District must apply for a licence(s) for the LSCA wellfield wells as discussed in **6.3 Lost Shoe Creek Wellfield**.

8.1 Long Term Supply Cost Estimates

Table 14 presents a summary of the costs associated with each long term water supply option.

Table 14 – Long Term Water Supply Cost Estimates

Description	Mercantile Creek	Lost Shoe Creek Aquifer Wellfield	Kennedy Lake
Capital Costs			
Intake	Existing Intake Upgrades **$150,000**	N/A	New intake in Lake **$1,000,000**
Pump Station	N/A	N/A	New Pump Station and wet well **$1,000,000**
Supply Main	Access Road to main **$300,000**	N/A	Construct new **400** mm dia. supply main (8,000 m) **$8,000,000**
Treatment Plant	Existing Cl_2 and UV Required Filtration for Surface Water **$1,200,000**	Existing Cl_2 Required Iron and Manganese **$3,000,000**	Required UV and Cl_2 for Surface Water **$2,500,000**(1)
Total Capital Costs	**$1,650,000**	**$3,000,000**	**$12,500,000**

Operation and Maintenance Costs (per year)			
Intake Maintenance	$2,500	N/A	$2,500
Supply Main Pigging	$7,000	$7,000	$7,000
Pump Maintenance	$5,000	$20,000	$5,000
Well Rehabilitation	N/A	$15,000	N/A
Treatment Plant Maintenance and operation	$120,000	$120,000	$120,000
Water Quality Testing	$3,000	$3,000	$3,000
Permitting Costs			
Consultation with Government Agencies	$5,000	$10,000	$50,000

Notes:

(1) Based on water quality information available the Kennedy Lake source could qualify for a filtration deferral. For the purposes of this report it has been assumed that filtration will not be required at Kennedy Lake.

8.2 Climate Change Impact

As outlined in **Sections 3.1** and **4.1** the impact of the drier periods of weather is evident on the quantity of source water available at Mercantile Creek and the LSCA.

Figure 2 shows that the Mercantile Creek flow rates are lower in the summertime during periods of high demand in the system. Based on the MoE requirements to maintain adequate fish habitat, additional withdrawal from the creek is not available to service future demands. In addition future climate change resulting in a 20% decrease in creek flow would reduce the available water in the creek below the 10% of MAD requirement for fisheries resources. This would result in a potential reduction of the allowable withdrawal from the source to 3,450 m^3, and would shift the demand requirements to the LSCA.

Figures 4 and **5** show that the LSCA is dependent on rainfall to recharge the water levels of the aquifer during the lower demand periods in the winter months. A decrease of the water level in the aquifer of 20% would result in a reduction of the overall well field capacity to 7,200 m^3. In order to operate the well field at the lower capacity VFDs would be required to adjust the pump frequency to provide the required flows at the resulting water levels.

In order to ensure that the District has a reliable source of water to accommodate future growth, it is recommended that the Kennedy Lake source option be pursued and the District proceed with the initial planning stage for the project.

9 WATER MODEL

9.1 Computer Program

Modelling of the Dsitrict's 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, municipalities, and utility companies and is used by Koers 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 include; system leakage, water loss and unaccounted for water, reservoir mixing, and water-age. The modelling results are presented in tabular and graphical form.

9.2 Allocation of Demands

9.2.1 Existing Conditions

Water demands were distributed evenly throughout the model at nodal points (pipe intersections, end of mains and pipe diameter changes). The average day demand was used as the base. Maximum day demands were modelled by multiplying each individual demand by the appropriate ratio (maximum day to average day).

9.2.2 Future Conditions

Future demands were added to the model to the various future development areas in accordance with the District's OCP. This permitted identifying improvements required to service the additional population growth where it is designated to occur. The demands for each area were calculated based on the land-use designation and the associated population density. Long term improvements required to service the future demand conditions are identified in **Section 11.3**.

9.3 Analysis Design Standards

9.3.1 Reservoir Sizing

Reservoirs perform three functions:

- Storage for fire fighting
- Storage for equalization to manage hourly peaks in demand
- Storage for emergencies, such as a watermain break

The storage volume requirement for the District was assessed using the following formula listed in the Master Municipal Contract Document (MMCD) Association Design Guideline Manual:

Storage Volume = A + B + C

Where:

A = Fire Storage	(from Fire Underwriters Survey Guide)
B = Equalization (Peaking) Storage	(25% of Maximum Day Demands)
C = Emergency Storage	(25% of A + B)

Emergency storage requirement 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. For the District, no allowance for a reduction in emergency storage volume requirements was made.

9.3.2 Distribution System

The adequacy of the distribution system for various demand conditions is judged by the residual pressure available throughout the system and by the maximum velocity in the mains. The criteria applied to assess the District's distribution system are as shown in **Table 15**.

Table 15 – Distribution System Design Criteria Example

Under Peak Hour Demand Conditions		
Minimum residual pressure at property line	305 kPa	(44 psi)
Maximum velocity in mains	1.5 m/s	(5 ft./s)
Under Fire Flow Demand Conditions (during Maximum Day Demands)		
Minimum residual pressure at hydrant	138 kPa	(20 psi)
Minimum residual pressure at property line	105 kPa	(15 psi)
Under Static Conditions		
Maximum service pressure – ideal	700 kPa	(101 psi)
Maximum service pressure – absolute	770 kPa	(112 psi)

9.3.3 Pipe Friction Factors

A Hazen Williams friction factor was entered in the model for varying pipe materials, as listed in **Table 16**.

Table 16 – Pipe Friction Factors

Pipe Material		**Friction Factor, "C" (Hazen Williams formula)**
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

To better calibrate the friction factors in the water system, controlled field testing would be required during times of peak hour flows, where pressure losses in the various pipe types and sizes could be determined.

Flow testing was not included in the scope of work for this study and due to the significant system operators' time required to conduct flow tests, no specific flow testing was carried out.

Flow rate and pressure loss determinations along typical sections of the larger supply mains should be carried out when possible, for comparison with the assumed pipe friction values used in this analysis. In general, except for the oldest pipe sections, the pipe friction values listed are believed to be conservative

10 SYSTEM ANALYSIS

10.1 Modelling of Peak Hour & Maximum Day plus Fire Flow

The water system was evaluated under steady state conditions to determine the system pressures under peak hour conditions and during maximum day demands plus fire flows for existing and future conditions.

The modeling analyses are discussed below:

10.1.1 Peak Hour Demand Pressures

The distribution system is capable of meeting current peak hour demands and maintaining pressures greater than the minimum design standard of 280 kPa (40 psi) with the exception of at the top end of Athlone Rd (elevation 40 m). The calculated pressure at this location is 234 kPa (34 psi).

The highest pressures in the water distribution system are along Park Lane at the intersection of Cypress Road where the pressure is approximately 614 kPa (89 psi).

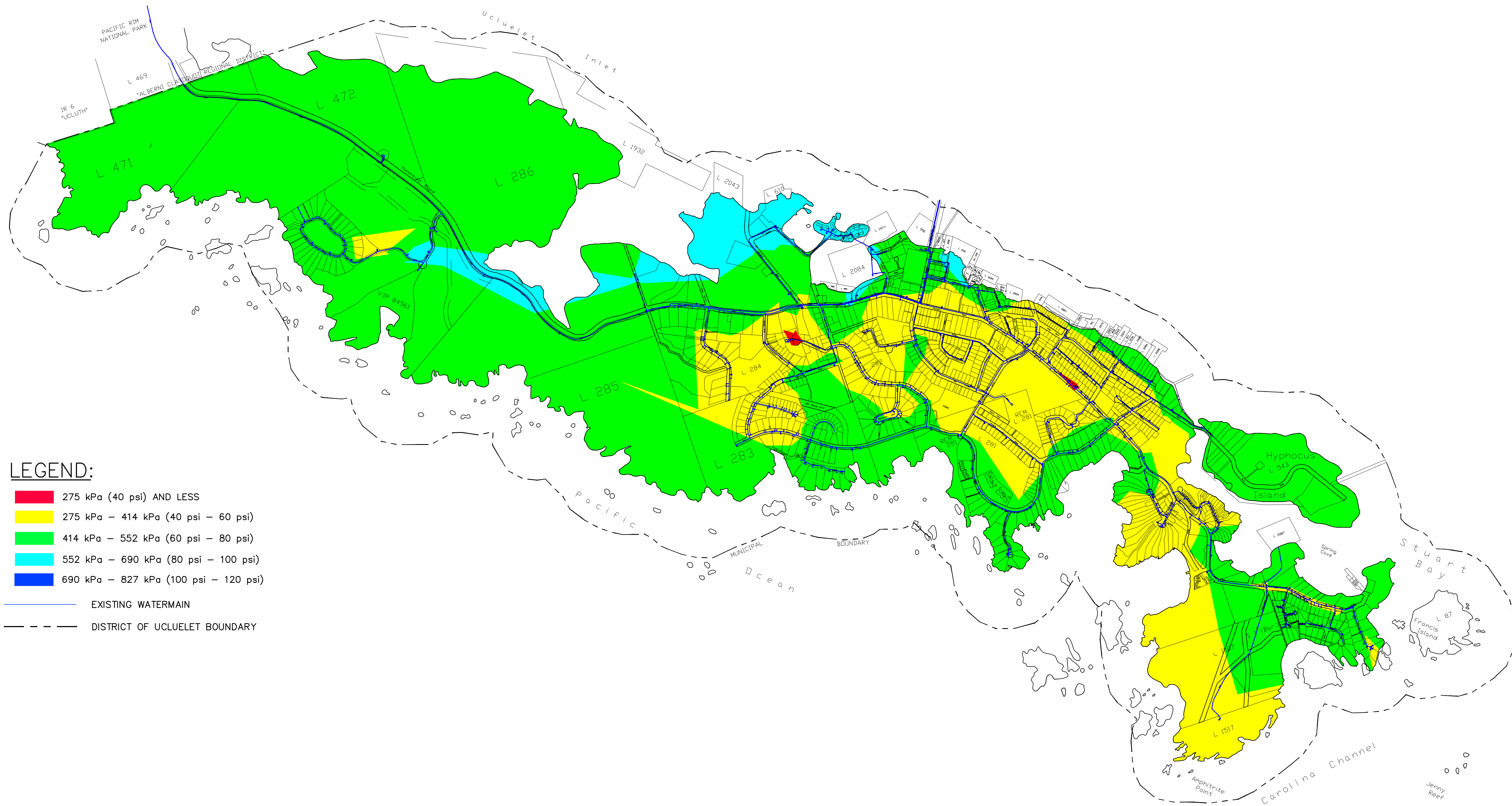
The calculated residual pressures in the water distribution system during peak hour demands under existing conditions are shown in **Figure 19**.

10.1.2 Maximum Day Plus Fire Flow

The available fire flows during maximum day demand for the current conditions is shown in **Figure 20**. The areas that do not meet the fire flow requirements for the zoning serviced are listed in **Table 17**.

Table 17 – Areas with Fire Flow Below Zoning Requirements

Land Use	Fire Flow (lps)		Location
	Available	Required By Zoning	
P-1	36	150	End of Coast Guard Drive
CD-2A	49	150	Marine Dr & Sunset Point Rd
CS-2	50	150	Peninsula Rd & Norah St
CD-2B	51	150	Marine Dr & Rainforest Dre
CD-2A	51	150	Marine Dr & Matterson Rd
CS-3	60	150	Peninsula Rd & Pacific Cres
CD-2A	67	150	Marine Dr & Matterson Road
CS-5	69	150	Peninsula Rd & Seaplane Base Rd
P-1	31	60	Athlone Rd
R-1	33	60	Edwards Place
CS-1	83	150	1728 Peninsula Rd
CS-6	86	150	Hemlock St & Lyche Rd
CS-5	88	150	Peninsula Rd & Hemlock St
MH	53	90	Cynamocka Rd & Norah St
CD-1	90	150	342 Forbes Rd



LEGEND:

- 275 kPa (40 psi) AND LESS
- 275 kPa – 414 kPa (40 psi – 60 psi)
- 414 kPa – 552 kPa (60 psi – 80 psi)
- 552 kPa – 690 kPa (80 psi – 100 psi)
- 690 kPa – 827 kPa (100 psi – 120 psi)
- EXISTING WATERMAIN
- DISTRICT OF UCLUELET BOUNDARY

KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

CLIENT	DISTRICT OF UCLUELET
PROJECT	WATER MASTER PLAN

TITLE	PEAK HOUR PRESSURES EXISTING CONDITIONS		
APPROVED		SCALE	1:20,000
DATE		DWG No.	FIGURE 19
PROJECT No.	1581		

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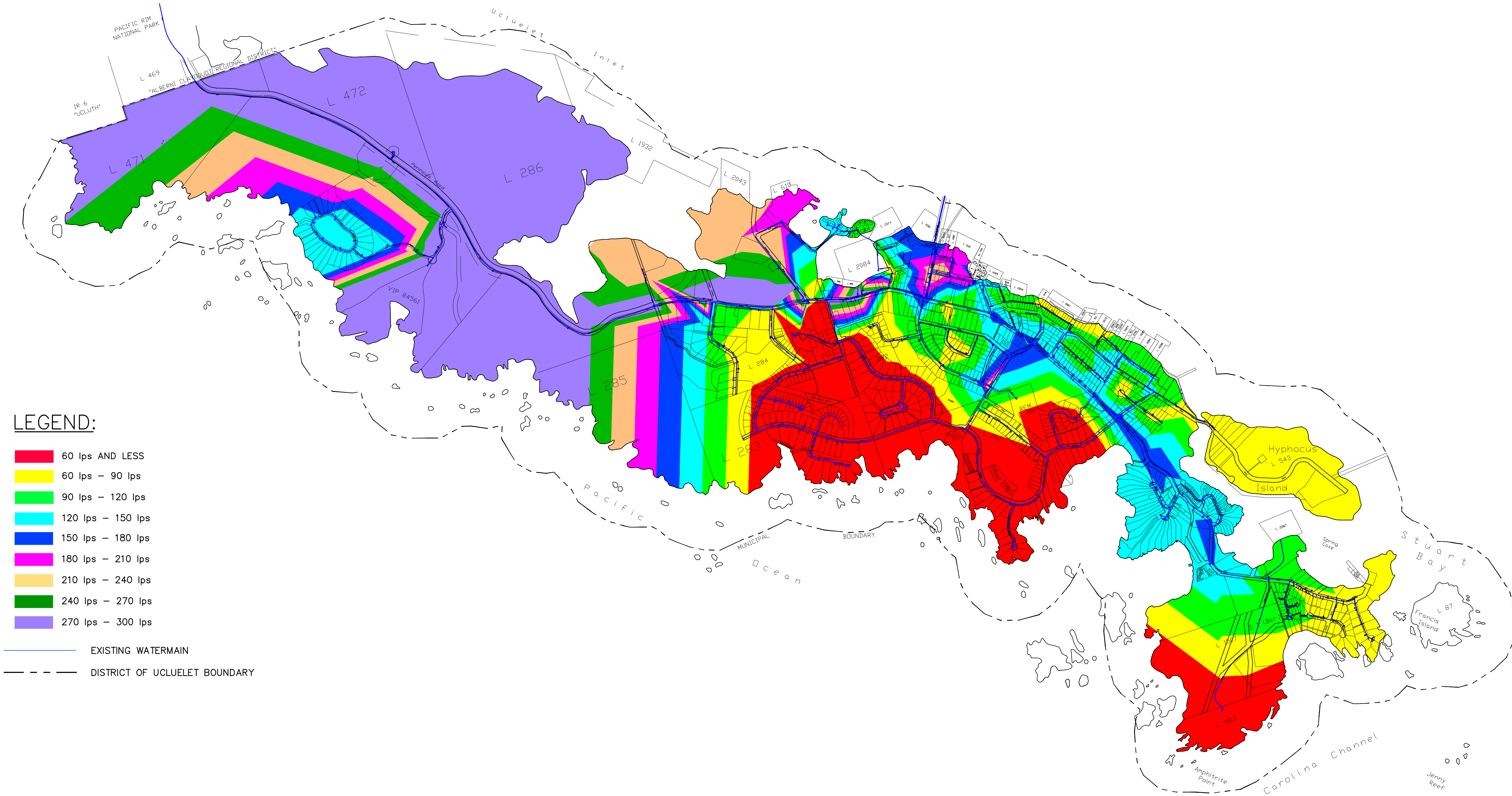

LEGEND:

- 60 lps AND LESS
- 60 lps – 90 lps
- 90 lps – 120 lps
- 120 lps – 150 lps
- 150 lps – 180 lps
- 180 lps – 210 lps
- 210 lps – 240 lps
- 240 lps – 270 lps
- 270 lps – 300 lps
- EXISTING WATERMAIN
- DISTRICT OF UCLUELET BOUNDARY

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KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

CLIENT	DISTRICT OF UCLUELET
PROJECT	WATER MASTER PLAN

TITLE	AVIALBLE FIRE FLOWS EXISTING CONDITIONS		
APPROVED		SCALE	1:20,000
DATE		DWG No.	FIGURE 20
PROJECT No.	1581		

Table 17 – Areas with Fire Flow Below Zoning Requirements

Land Use	Fire Flow (lps)		Location
	Available	Required By Zoning	
CD-1	91	150	368 Forbes Rd
R-1	38	60	Edwards Place
P-1	96	150	Victoria Rd & Matterson Rd
CD-3 MF	97	150	St Jacques Blvd & Bay St
CS-1	101	150	Fraser Lane & Imperial Lane
CD-5	40	60	835 Marine Dr
CS-5	104	150	Hemlock St & Waterfront Dr
R-1	43	60	Marine Dr & Edwards Place
R-1	43	60	350 Marine Dr
CD-5	46	60	2036 Cynamocka Rd
R-1	46	60	Victoria Rd & Marine Dr
CS-2	117	150	Peninsula Rd & Forbes St
CD-1	117	150	310 Forbes St
CD-2A	47	60	End of Sunset Point Rd
M-1	118	150	Multi-family at end of Harbor Cres
GH	47	60	470 Marine Dr
CD-5	48	60	841 Marine Dr
R-1	50	60	Athlone Rd & Norah St
CS-1	124	150	Main St & Cedar Rd
CS-5	125	150	277 Boardwalk Blvd
CD-3	50	60	812 Rainforest Dr
CD-3	51	60	764 Rainforest Dr
CD-3	51	60	1701 Rainforest Lane
CD-3	51	60	Rainforest Drive & Rainforest Lane
CD-3	51	60	1768 Rainforest Lane
CD-3	51	60	636 Rainforest Dr
R-1	52	60	Cynamocka Rd & Norah St
CD-5	52	60	835 Marine Dr
CD-5	52	60	720 Marine Dr
CD-5	52	60	760 Marine Dr
CD-5	53	60	Cynamocka Rd & Marine Dr
CD-5	53	60	End of Odyssey Lane
CD-5	53	60	812 Odyssey Lane
CD-5	53	60	Odyssey Lane & Marine Dr
R-2	80	90	1633 Holly Crescent
R-3	133	150	Yew St & Larch Rd

10.1.3 Reservoir Storage

The water storage requirements within the distribution system are based on the formula from the MMCD Design Guideline Manual, which is:

Water Storage Volume = A + B + C

Where:

A = Fire Storage (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. The calculated storage volume for the District of Ucluelet is shown in **Table 18** for Year 2065.

Table 18 – Reservoir Storage Volume Requirements

Reservoir	Storage Volume				
	Required (m^3)			Existing (m^3)	Shortfall (m^3)
	Equalization	Fire Flow	Total		
Matterson	742 (1)	1,080 (3)	1,822	1,200	**622**
Highway	1,170 (2)	1,080 (3)	2,250	1,400	**850**
Total	**1,912**	**2,160**	**4,072**	**2,600**	**1,472**

(1) Based on a 2065 Maximum Day outflow of 34.3 lps at the reservoir

(2) Based on a 2065 Maximum Day outflow of 54.2 lps at the reservoir

(3) Based on a 150 lps fire flow

It should be noted that with the construction of the Cedar Road Altitude Valve will allow the Highway Reservoir to supplement the Matterson Reservoir. Therefore the future additional storage requirements can be consolidated at the Highway Reservoir site.

The additional storage at the Highway Reservoir should be added when the reservoir outflow reaches 14.8 lps, or 80% of the equalization storage capacity of the reservoir.

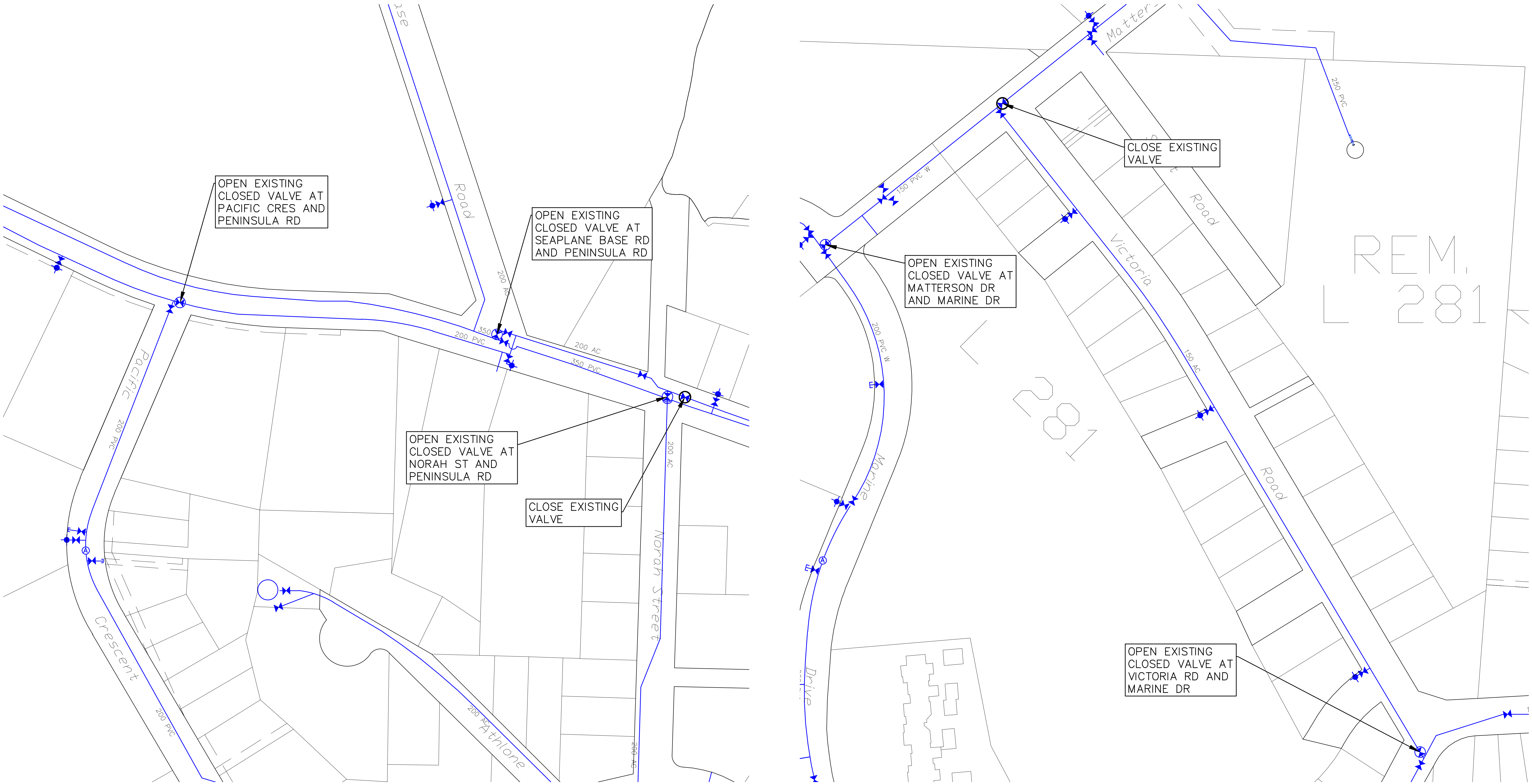
11 PROPOSED WORKS

11.1 Short Term Improvements

The improvements required in order for the system to operate within the distribution system design requirements (**Table 15**) and provide the recommended minimum fire flow are presented in **Table 19** and shown on **Figures 21 to 23**.

Table 19 – Interim Works

Project No.	Location	Description
ST-1	Cedar Road Altitude Valve	Install a new above ground altitude valve station on Cedar Road to interconnect the Highway and Matterson Pressure Zones. The altitude valve will be controlled by the top water level of the Matterson Reservoir and will allow flow between the two pressure zones
ST-2	Pressure Zone Boundary Modifications	Open the following Closed Valves: - Pacific Crescent and Peninsula Road - Seaplane Base Road and Peninsula Road - Norah Street and Peninsula Road - Matterson Drive and Marine Drive - Victoria Road and Marine Drive Close the following valves: - East valve at Norah Street and Peninsula Road - North valve at Matterson Drive and Victoria Road
ST-3	Matterson Reservoir Valve Chamber Modifications	Remove the interconnecting spool pieces in the altitude valve chamber and install blind flanges
ST-4	Well field VFD and pressure transducer installation	Install VFDs on the existing LSCA wells and install pressure transduces in the well casings.
ST-5	Highway Reservoir Check Valve	Install check valve at highway reservoir outlet to prevent water from Mercantile Creek to flow through outlet piping.



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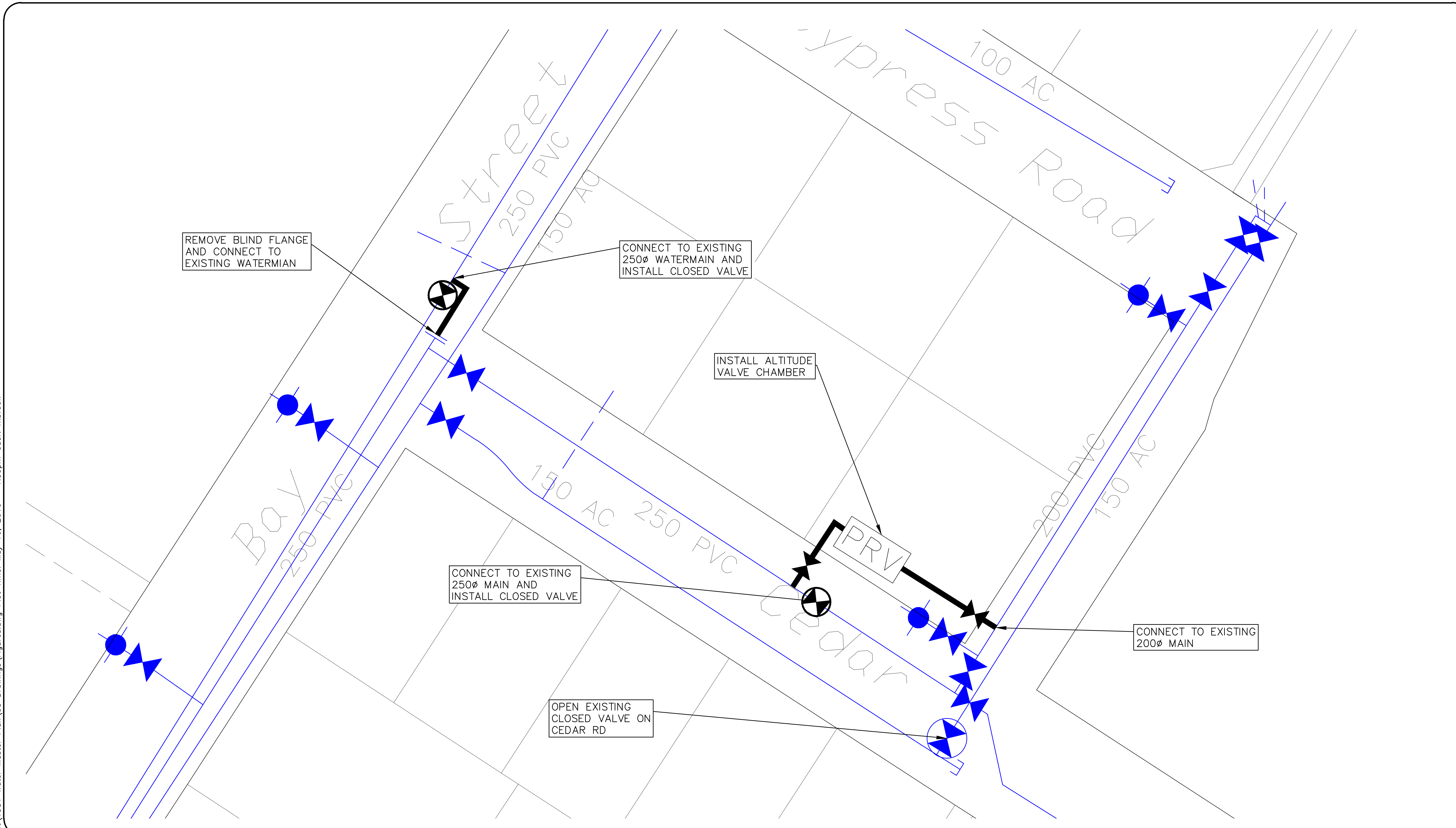
KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

CLIENT	DISTRICT OF UCLUELET
PROJECT	WATER MASTER PLAN

TITLE	PRESSURE ZONE BOUNDARY MODIFICATIONS		
APPROVED		SCALE	1:500
DATE		DWG No.	FIGURE 21
PROJECT No.	1581		



KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

CLIENT	DISTRICT OF UCLUELET
PROJECT	WATER MASTER PLAN

TITLE	ALTITUDE VALVE CHAMBER INSTALLATION
APPROVED	SCALE 1:50
DATE	DWG No. FIGURE 22
PROJECT No. 1581	

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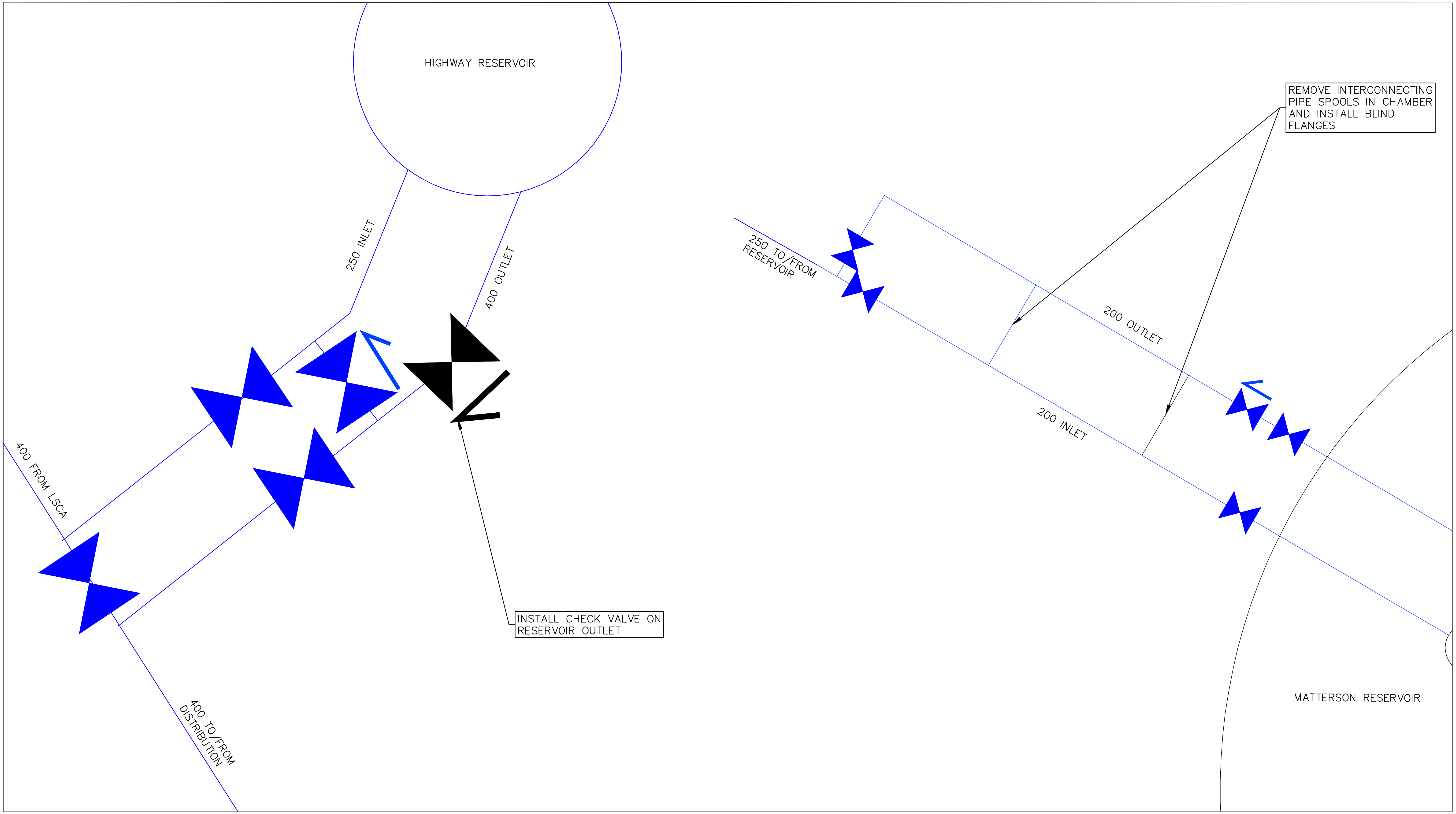

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CLIENT	DISTRICT OF UCLUELET
PROJECT	WATER MASTER PLAN

TITLE: MATTERSON AND HIGHWAY RESERVOIR PIPING IMPROVEMENTS

APPROVED		SCALE	NTS
DATE		DWG No.	FIGURE 23
PROJECT No.	1581		

11.2 Fire Flow Improvements

Listed in **Table 20** and shown on **Figure 24**, below are the following improvements that are required to improve the fire flows in the District's distribution system:

Table 20 – Required Fire Flow Improvement Works

Project No.	Location	Diameter (mm)		Length (m)
		Existing	Proposed	
FF - 1	Check Valve installation on Matterson Dr at Victoria Rd	-	-	-
FF - 2	Hemlock Rd: Lyche Rd to Peninsula Rd. Connect to existing 300 mm dia. main on Peninsula Rd	150	200	70
FF - 3	Peninsula Rd: Bay St to Main St	150	200	350
FF - 4	Bay St: Peninsula Rd to St. Jacques Blvd	150	200	190
FF - 5	Garden St & Eber Rd: Helen Rd to Alder St	100	150	165
		Total Length:		**775**

11.3 Long Term Improvements

Listed in **Table 21**, and shown on **Figure 25**, below are the following improvements that are required to improve the fire flows in the District's distribution system:

Table 21 – Long-Term Works

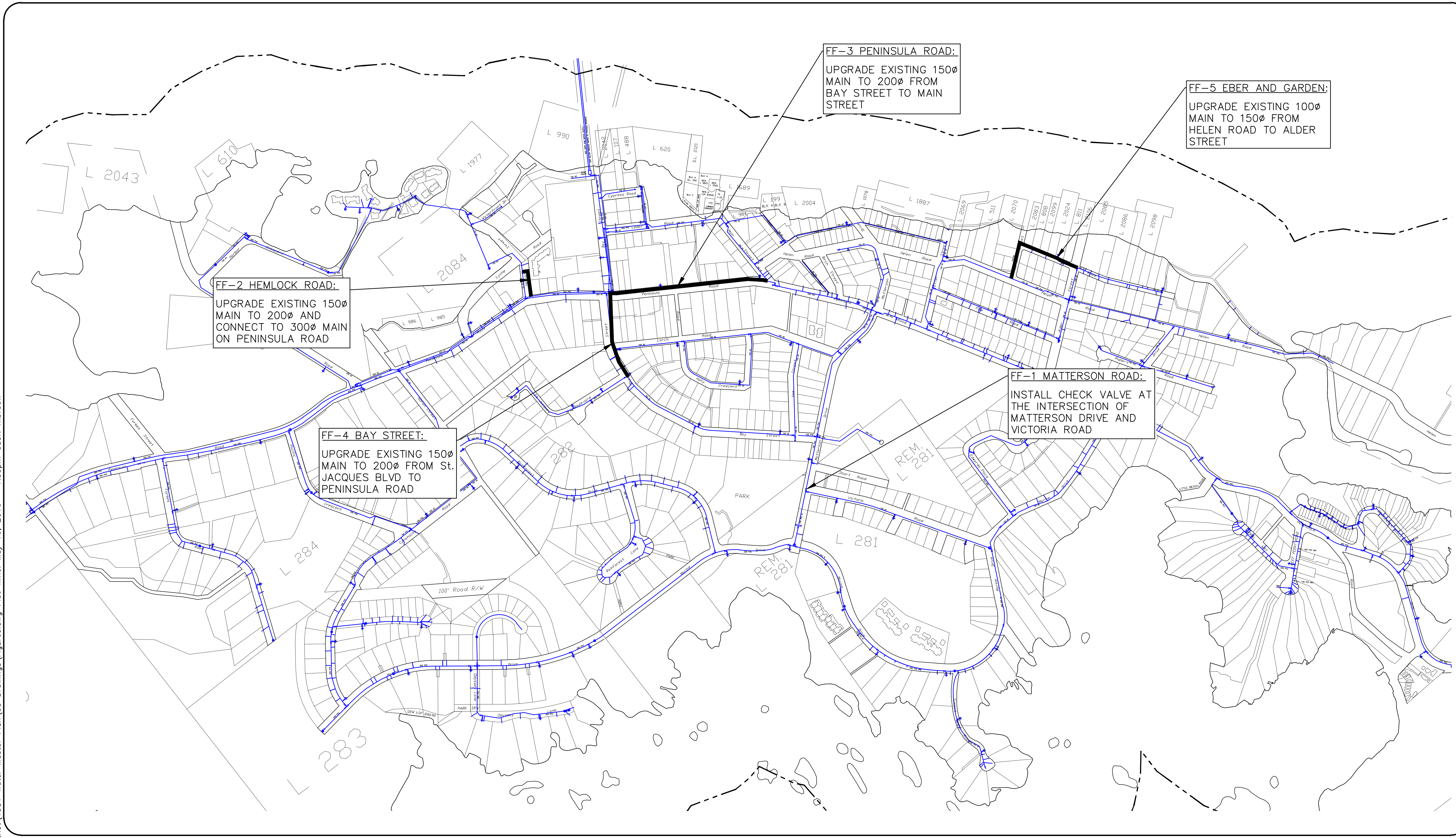
Project No.	Location	Diameter (mm)		Length (m)
		Existing	Proposed	
LT - 1	Construct a duplicate 1,400 m^3 reservoir at the Hwy Reservoir site	-	-	-
LT - 2	Victoria Rd: Matterson Dr to Marine Dr	150	200	415
LT - 3	Marine Dr: Victoria Rd to Edwards Place	150	200	90
LT - 4	Forbes Rd: 371 Forbes Rd to Marine Dr	-	200	370
LT - 5	Watermains for future development in the DL 281 & 282 and Former Forest Land Reserve	-	200	TBD(1)
		Total Length:		**875**

(1) Final piping configuration and requirements to be determined by the developer. Based on a preliminary alignment the minimum pipe size for the supply piping in this area should be 200 mm diameter.

11.4 AC Mains

There are approximately 35 kilometers of watermain in the District, of which approximately 8 kilometers are AC piping. The majority of these mains are more than 40 years old.

The life span of AC mains ranges from 30 to 90 years, depending on many factors, such as water quality, type of soils, groundwater levels, pipe manufacturer, quality of



KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

CLIENT	DISTRICT OF UCLUELET
PROJECT	WATER MASTER PLAN

TITLE	FIRE FLOW WATERMAIN IMPROVEMENTS		
APPROVED		SCALE	1:7500
DATE		DWG No.	FIGURE 24
PROJECT No.	1581		

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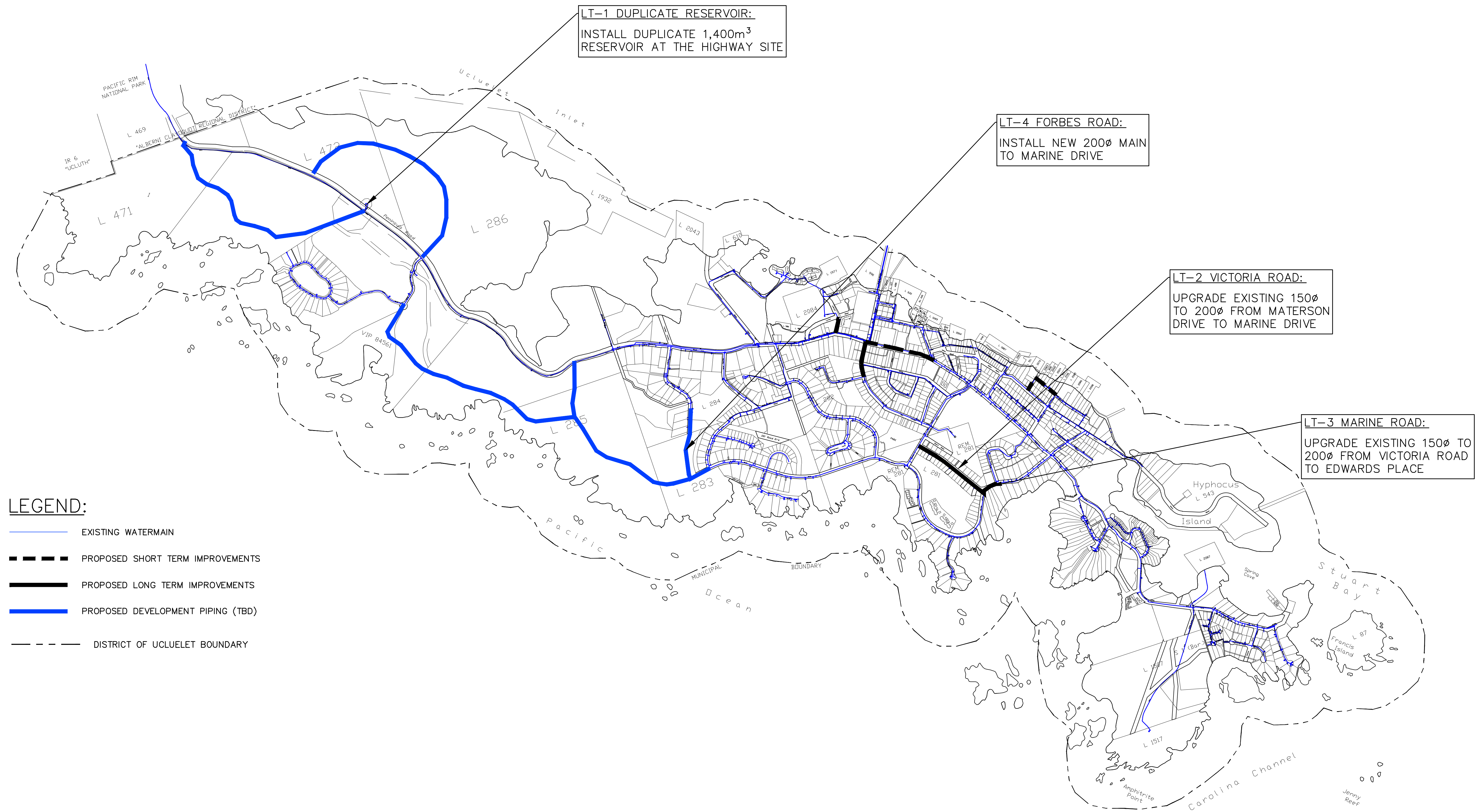

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Consulting Engineers

CLIENT	DISTRICT OF UCLUELET
PROJECT	WATER MASTER PLAN

TITLE	PROPOSED IMPROVEMENTS LONG TERM		
APPROVED		SCALE	1: 20,000
DATE		DWG No.	FIGURE 25
PROJECT No.	1581		

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installation, depth of bury, and traffic loading. The major problem experienced with AC pipe, other than wall fractures, is the leaching of the cement mortar binder out of the pipe. This can occur on the internal and the external surfaces, severely weakening the pipe strength. The rate of leaching depends on the aggressiveness of the groundwater and potable water in contact with the AC pipe. Leaching can be highly localized, and vary from pipe to pipe.

The remaining service life in an AC main can be estimated by a series of laboratory tests, requiring removal of a section of the watermain. Records of main and service connection repairs would aide in identifying known problem areas.

It is recommended that the District review the option of completing an asset management plan for the existing AC watermain infrastructure, to assist in planning and funding future AC watermain replacement projects.

11.5 Uni-directional Flushing Program

It is recommended that the District work to develop and implement a uni-direction flushing program in an effort to minimize the amount of sediment in the distribution system, particularly as the presence of iron and manganese has led to water quality complaints from some residents and businesses in the past. The flushing program should be completed at a minimum of once per year.

12 COST ESTIMATES

The cost estimates in this report are based on Class 'D' (feasibility study) estimates, made without preliminary design input. The estimates include a 30% allowance for construction and engineering costs. No allowance has been made for interim financing or administrative costs. The estimates are exclusive of GST.

Cost estimates are derived from our in-house construction cost data of watermain construction projects in the mid-Vancouver Island area.

A comparison of the estimated total capital cost and operating cost for each water supply source is presented in **Table 22.**

Table 22 – Project Cost Estimates

Project No.	Location	Length (m)	Dia. (mm)	Unit Price	Extension
ST - 1	Cedar Road Altitude Valve	-	-	-	$200,000
ST - 2	Pressure Zone Boundary Modifications	-	-	-	$5,000
ST - 3	Matterson Reservoir Valve Chamber Modifications	-	-	-	$46,000
ST - 4	Well field VFD and pressure transducer installation	-	-	-	$200,000
ST - 5	Highway Reservoir Check Valve	-	-	-	$35,000
FF - 1	Check Valve installation on Matterson Dr at Victoria Rd	-	-	-	$100,000
FF - 2	Hemlock Road: Lyche Road to Peninsula Rd. Connect to existing 300 mm dia. main on Peninsula Rd	70	200	$600	$42,000
FF - 3	Peninsula Road: Bay St to Main St	350	200	$600	$210,000
FF - 4	Bay Street: Peninsula Rd to St. Jacques Blvd	190	200	$600	$114,000
FF - 5	Garden Street and Eber Rd: Helen Rd to Alder St	165	150	$550	$90,750
LT - 1	Construct a duplicate 1,400 m^3 reservoir at the Hwy Reservoir site	-	-	-	$1,250,000
LT - 2	Victoria Rd: Matterson Dr to Marine D	415	200	$600	$249,000
LT - 3	Marine Dr: Victoria Rd to Edwards Place	90	200	$600	$54,000
LT - 4	Forbes Rd: 371 Forbes Rd to Marine Dre	370	200	$600	$222,000
			Total:		**$2,817,750**

13 CONCLUSIONS

Based on the findings of this interim study, the following conclusions are made:

1. The District operates two water supply sources:

    i. **Mercantile Creek**, a surface source on the east side of Ucluelet Inlet

    ii. **Lost Shoe Creek Well field**, a groundwater source at the junction of Hwy 4A and Pacific Rim Hwy

2. The LSCA well field acts as the primary source. Mercantile is brought on-line to meet large fish processing demands and the seasonal (summertime) demand increase. The two water supply sources are currently isolated from each other with the manual closing of valves at ten (10) road intersections, which we understand are:

.1	Peninsula Rd	at	Pacific Cres
.2	Seaplane Base Rd	at	Peninsula Rd
.3	Norah St	at	Peninsula Rd
.4	Hemlock St	near	Peninsula Rd
.5	Marine Dr	at	Matterson Dr
.6	Victoria Rd	at	Marine Dr
.7	Edward Pl	at	Peninsula Rd
.8	Marine Dr	at	Peninsula Rd
.9	Cedar Rd	at	Park Ln
.10	Cedar Rd	at	Main St

3. Water is spilled at the Matterson Reservoir when it is supplied by the Lost Shoe Creek Well field (via the highway reservoir). This occurs when the Mercantile Creek source is not in use.

4. Water treatment consists of the following:

    Mercantile Creek
    Raw water passes through a course screen to catch larger debris prior to being withdrawn from the Creek. At the Bay Street water treatment pump station, the water is treated by Ultra Violet lights followed the addition of liquid sodium hypochlorite (NaClO).

    Lost Shoe Creek Well field
    The water is treated by the addition of liquid sodium hypochlorite (NaClO).

5. Water quality issues for the water sources consist of the following:

    Mercantile Creek:
    Elevated turbidity levels during the winter months and periods of heavy rainfall.

    Lost Shoe Creek Well field:
    Elevated levels of manganese.

6. Mercantile Creek source cannot accommodate an increase in withdrawal limits.

7. LSCA recharge rate is influenced by rainfall as shown in **Figure 4** and **Figure 5**.

8. LSCA Well Number 2 is generally not operated from mid-August to the end of September in response to the seasonal decline in the groundwater level.
9. Kennedy Lake is considered a suitable water supply source option for the District.
10. During current peak hour demands, the water distribution system is capable of maintaining pressures greater than the minimum design standard of 280 kPa (40 psi) with the exception of at the top end of Athlone Rd (elevation 40 m). The calculated pressure at this location is 234 kPa (34 psi). This area is serviced from the highway reservoir with its top water level elevation of 68.4 m geodetic.
11. The areas that do not meet the fire flow requirements for the zoning serviced are listed in **Table 17**.

14 RECOMMENDATIONS

Based on the conclusions listed in this interim report, it is recommended that the District:

1. Implement the improvements listed in **11 Proposed Works**. These works will improve available fire flow and peak hour pressures in the distribution system.
2. Comply with the provincial govermnent's new Water Act and apply for a groundwater licence(s) for the LSCA well field wells as discussed in **6.3 Lost Shoe Creek Well field**.
3. Proceed with the planning stage development of the Kennedy Lake source in order to ensure a reliable long term water supply for the District.
4. Review the option of completing a infrastructure assessment for the existing AC watermains in the distribution system to assist with the planning and funding of the future AC watermain replacement.
5. Develop a uni-directional flushing plan as part of the District's on going supply and distribution system maintenance program.