Sanitary Master Plan

District of Hope

June 2020

Project No. 1239-181

ENGINEERING ■ PLANNING ■ URBAN DESIGN ■ LAND SURVEYING

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Report Submission

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List of Acronyms

AC	Asbestos Cement
CBD	Central Business District
CPR	Canadian Pacific Railway
FVRD	Fraser Valley Regional District
DFO	Fisheries and Oceans Canada
District	District of Hope
DWF	Dry Weather Flow
FWL	Full Water Level
HDPE	High Density Polyethylene
HMI	Human Machine Interface
I&I	Inflow and Infiltration
ICI	Industrial, Commercial, Institutional
MMCD	Master Municipal Construction Documents
MOE	Ministry of Environment
PCC	Pollution Control Centre
PLC	Programable Logic Controller
PVC	Polyvinyl Chloride
SCADA	Supervisory Control and Data Acquisition
TRUE	TRUE Consulting
UV	Ultra Violet
WTP	Water Treatment Plant
WWF	Wet Weather Flow
WWTP	Wastewater Treatment Plant

Units of Measure

ft	feet
Igpm	Imperial gallons per minute
Ha	Hectares
km	kilometre
L/d	Litres per day
L/m	Litres per minute
L/s	Litres per second
L/ha/d	Litres per hectare per day
L/cap/d	Litres per capita per day
L/mmØ/m/d	Litres per millimetre diameter per metre per day
lpcd	Litres per capita per day
m	metre
m^3/d	cubic metres per day
mg/L	milligrams per Litre
mm	millimetre
NTU	Nephelometric Turbidity Units
Ppl	People
psi	pounds per square inch
USgpm	US gallons per minute

Referenced Reports

1 Dayton & Knight Ltd. Development Cost Charges for Water, Sewerage and Drainage Facilities. 1994.

2 Omega & Associates Engineering Ltd. Condition Assessments of Roadway Structures, Water Mains, Storm Sewers, and Sanitary Sewers. 2016.

3 Urban Systems Ltd. Asset Management Investment Plan. 2016.

4 District of Hope. Integrated Official Community Plan. June 2016

Executive Summary

The purpose of this Sanitary Master Plan is to identify long term servicing strategies for wastewater collection and treatment within the District of Hope to the year 2040. The scope of work for the Master Plan includes:

- Establishing the capacity and shortcomings of existing infrastructure;
- Identifying infrastructure requirements in the future;
- Evaluating alternatives;
- Preparing cost estimates and a phasing plan for the preferred alternatives

The District of Hope collects and treats wastewater from the majority of the developed lots inside the District boundary. A network model has been developed for the analysis of the collection system capacity. The study identified that there is sufficient capacity for existing flows. However, the capacity of sewers in some areas becomes fully utilized under the future growth scenario. These sewers will need to be monitored for surcharging so that upgrades can be planned if needed. The District will continue to use the new sewer model to allow the impact of development proposals to be accurately assessed.

It is recognized that relatively little is known about the condition of buried infrastructure. Much of the network is aging and is allowing inflow and infiltration to occur to a significant degree. Deteriorating infrastructure will be the primary focus of future improvements to the sewer network. Sewers will be replaced or rehabilitated on the basis of condition assessments. These will be informed by ongoing CCTV surveys being undertaken by the District with a view to achieving full system coverage within ten years.

The capabilities and shortcomings of the sanitary system have been used to identify improvements and prepare a sanitary system capital plan. The capital improvements have been prioritized to improve the capacity of the system and meet the projected requirements.

The general improvements required within the next five years are as follows;

- Headworks construction and permanent outfall at the Pollution Control Centre.
- Telemetry and control upgrades for the lift stations and Pollution Control Centre
- Phased replacement of aging sewers to address infiltration.

In the longer term the following work will be likely to occur:

- Network expansion in support of development;
- Replacement of undersized collector mains for future flows;
- New mechanical and electrical infrastructure at older lift stations to replace aging equipment;
- Eventual capacity upgrade at the Pollution Control Centre.

1.0 Introduction

1.1 Background

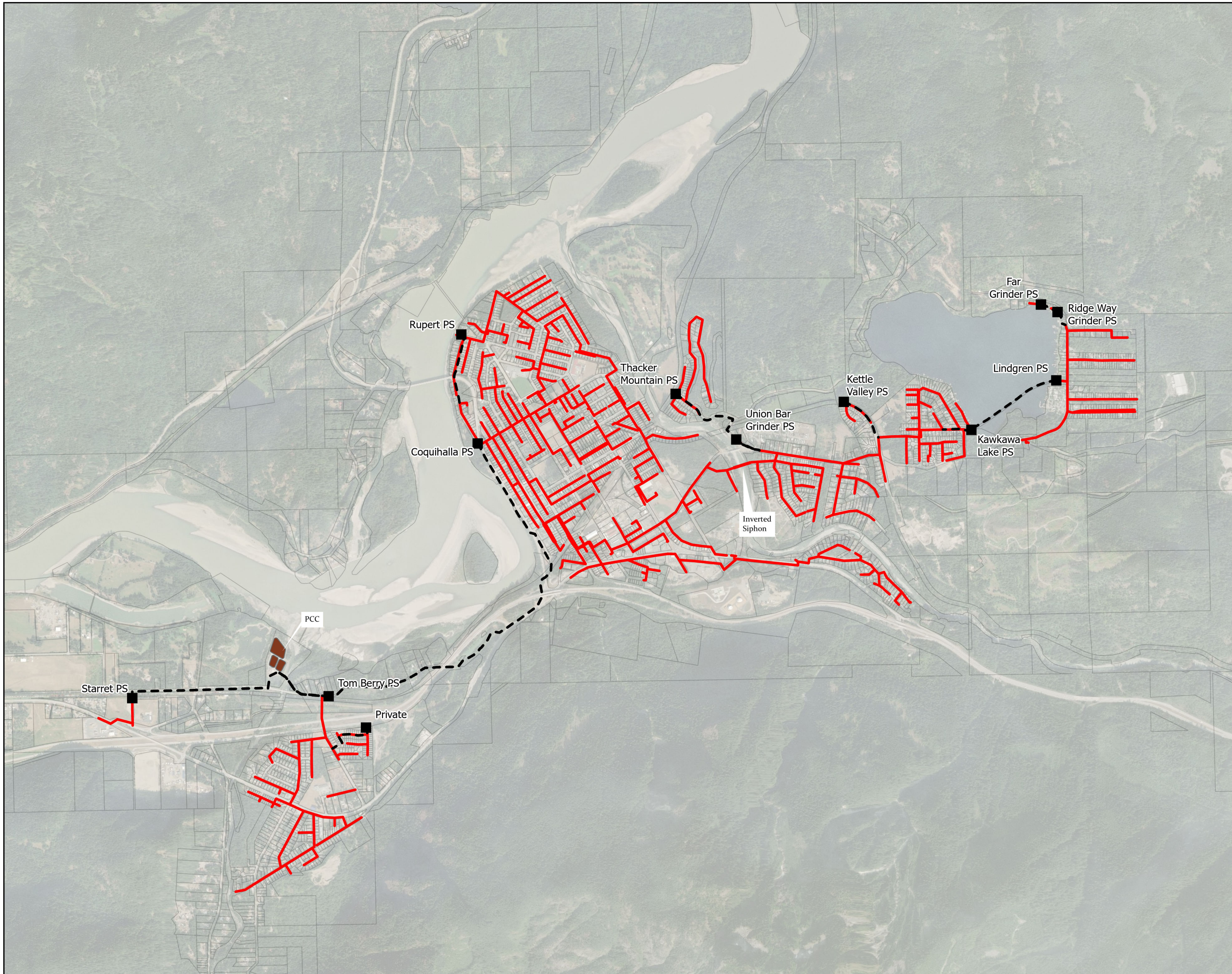
The District of Hope has called for the preparation of a Sanitary Master Plan in order to provide guidance and direction regarding future capital expenditures, long term financial planning and to understand system constraints and challenges associated with population growth and development initiatives.

The objective of the report is to provide the District with clear direction on the status of the wastewater utility and to recommend system improvements to address deficiencies. As such, this study has the following objectives;

- Prepare a summary of wastewater flows and service capacity of the sanitary sewer system by sewer modelling.
- Evaluate and assess the performance of the treatment system.
- Identify and prioritize capital improvement projects to service projected short, medium- and long-term growth conditions and service extensions.

The District took over the responsibility for the sewage treatment works from the Fraser Cheam Regional District In 1993. In 1994 the District undertook a Development Cost Charge study to review water, sanitary and drainage infrastructure. The DCC study found that all pipelines and pumping stations had adequate capacity for flows. A Sewage Treatment Study was also completed in 1994, as the lagoon effluent exceeded the permit limits on several occasions in 1992 and 1993. The Pollution Control Centre was upgraded in 1999 and again in 2017–19.

The capacity requirements described in the DCC study were based on a future population of 10,000 people. As there appears to be significant time remaining before this population benchmark is reached, the findings of the DCC study in relation to the sanitary collection system are generally still relevant. Many of those proposed improvements have been included in this Master Plan.



DISTRICT OF HOPE

Sanitary Sewer System Overview

- Lift Station
- Forcemain
- Gravity Main
- Parcel Fabric

0 500 1,000 1,500 m

N

Datum: North American 1983
Projection: Transverse Mercator (Zone 10)

Scale:	1:25,000
Issued for:	Draft Report
Drawn by:	RK
Date:	6/15/2020
Project Ref No.	1239-181

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Figure 1-1

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1.2 Official Community Plan

The District's planning in relation to sanitary sewer infrastructure is guided by the Official Community Plan. Specific objectives related to general infrastructure and to the sewer system are listed in the following tables.

TABLE 1-1: OCP OBJECTIVES AND POLICIES - GENERAL INFRASTRUCTURE SYSTEMS

Objective 9.1	**To encourage an orderly pattern of development in order to reduce construction, operations and maintenance costs of infrastructure systems while meeting current and future needs.**
Policy 9.1.1	The District will identify the extent, location, and phasing of development for infrastructure, including municipal water and sanitary sewer trunk lines.
Policy 9.1.2	The District does not support the extension of municipal services outside of its municipal boundary.
Policy 9.1.3	Ensure the District's Development Cost Charges Bylaw supports future planned infrastructure upgrades to support economic development.
Policy 9.1.4	Apply a comprehensive and integrated approach to asset management, including the development and ongoing use of an Asset Management Plan.
Objective 9.2	**To require that the costs of upgrading infrastructure and servicing new development are borne by those who benefit.**
Policy 9.2.1	When feasible, the District will enter into latecomer agreements to require benefitting parcels to pay their proportionate share of infrastructure costs when connecting to the extended service.
Policy 9.2.2	Support infrastructure improvements that benefit the municipality as a whole. Where possible, seek provincial cost sharing to reduce the financial impact on ratepayers.
Policy 9.2.3	The costs of upgrading services will be borne primarily by the property owners who benefit. A variety of tools may be used including but not limited to: local service areas, utility charges, and development works service agreements.
Policy 9.2.4	Continue to require new development to contribute to the costs of infrastructure capacity improvements that benefit the entire community. A variety of tools may be used including but not limited to: development works servicing agreements, amenity negotiations, and comprehensive development agreements.
Policy 9.2.5	Support innovative methods for servicing developments that encourage economic growth and environmental sustainability.

TABLE 1-2: OCP OBJECTIVES AND POLICIES – SANITARY SEWER INFRASTRUCTURE

Objective 9.6	**To provide sufficient capacity for municipal sanitary sewer collection and treatment facilities**
Policy 9.6.1	Upgrade the existing sewage treatment plant to accommodate future growth and meet higher effluent standards.
Policy 9.6.2	Update the District's Subdivision Servicing Bylaw to allow for environmentally sustainable wastewater alternatives that reduce infrastructure, operations, and maintenance costs and make Hope more resilient to climate change.

The Official Community Plan also identifies areas for community expansion which are shown on OCP mapping. These have been considered in this plan for the identification of new service areas.

2.0 Description of Existing System

The existing wastewater collection and treatment system has been constructed in the period since the early 1960's. Some key dates in the development of the system are as follows;

1960s	First sewers constructed in the Town of Hope.
1970s	Trunk sewer constructed to a new treatment plant in Silver Creek. Sewers constructed in the Kawkawa Lake area.
1980s	Sewers constructed in Silver Creek.
1980	Construction of original Pollution Control Centre and outfall.
1993	District takes responsibility for the Pollution Control Centre.
1999	Third treatment cell added at the Pollution Control Centre.
2017	Pollution Control Centre lagoons re-configured and aeration replaced.
2018	Dissolved air flotation system constructed at Pollution Control Centre.

The existing network is illustrated on Figure 1-1.

2.1 Gravity Mains and Force Mains

A total length of 50 km of gravity sewer main is recorded in the District's database. It is mostly comprised of asbestos cement and PVC materials. The force mains are largely constructed in ductile iron and HDPE. Figure 2-1 and Figure 2-2 show the relative rates of network construction based on length of pipe and decade. They show how the system has grown with the community over time.

The gravity collection system pipe diameter and material makeup is illustrated in Figure 2-3. The figure demonstrates that the greatest part of the network is 150mm to 300mm pipe with the highest proportion being 200mm diameter. The majority of the pipe in those sizes is asbestos cement and PVC.

Force mains in sizes greater than 100mm diameter are predominantly ductile iron and HDPE. The mix of force main materials is shown by Figure 2-4.

FIGURE 2-1: AGE OF GRAVITY COLLECTION SYSTEM BY MATERIAL

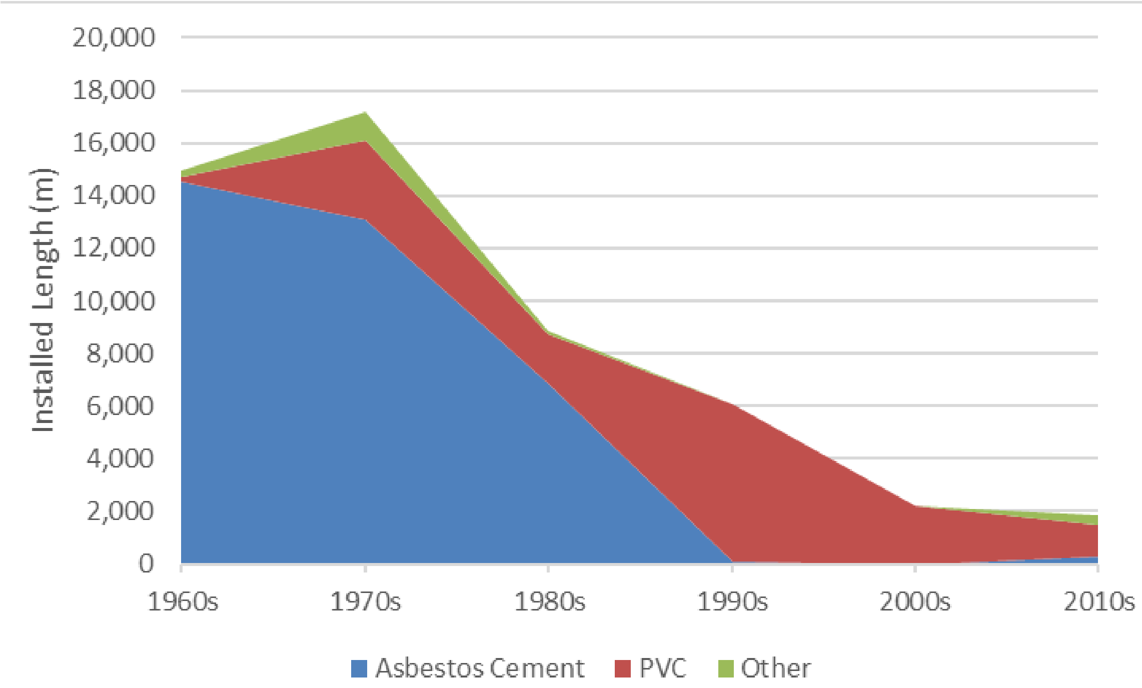


FIGURE 2-2: AGE OF FORCE MAINS BY MATERIAL

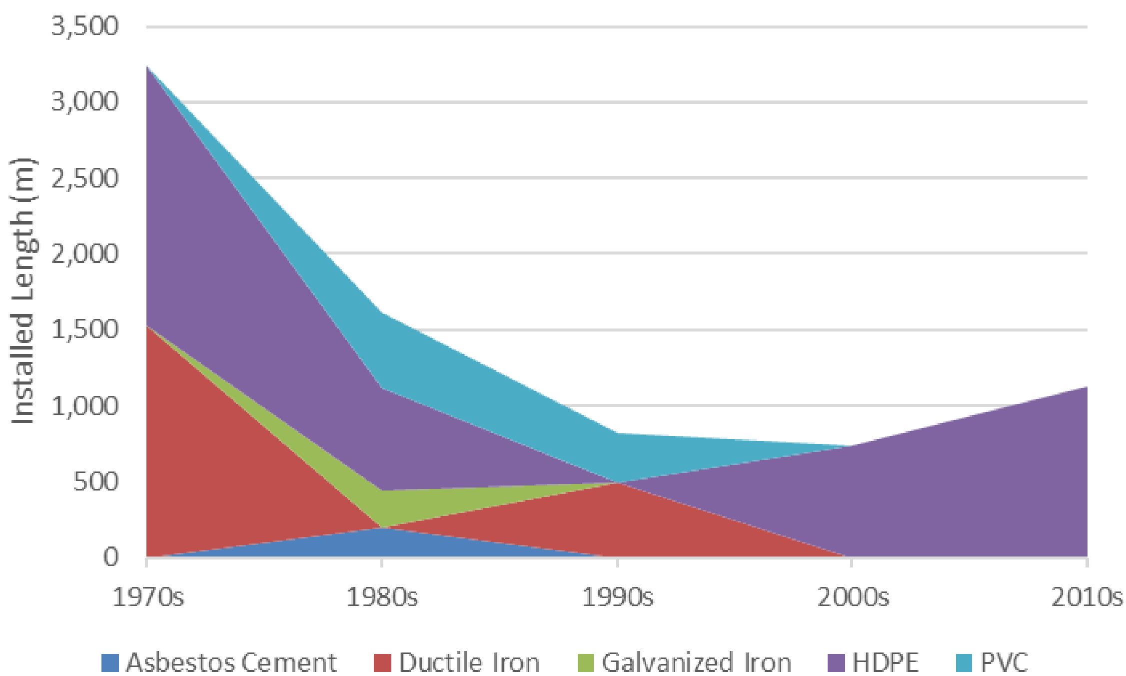


FIGURE 2-3: DIAMETER OF GRAVITY COLLECTION SYSTEM PIPES BY MATERIAL

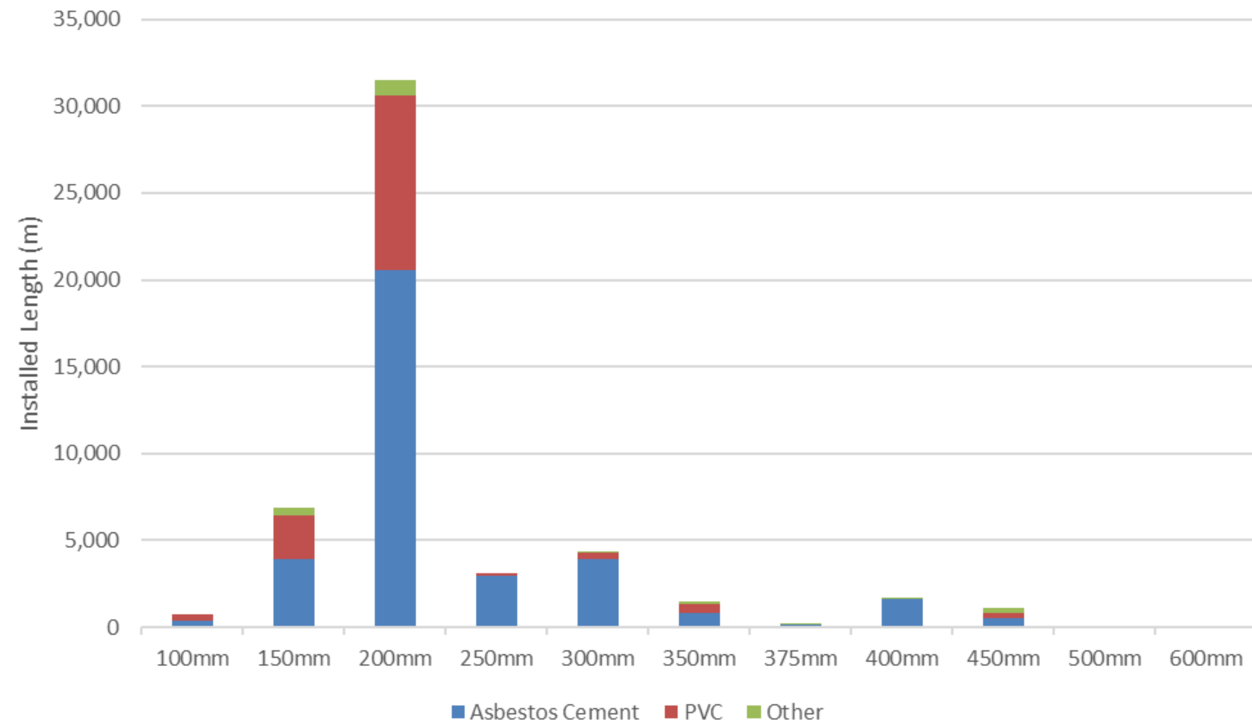
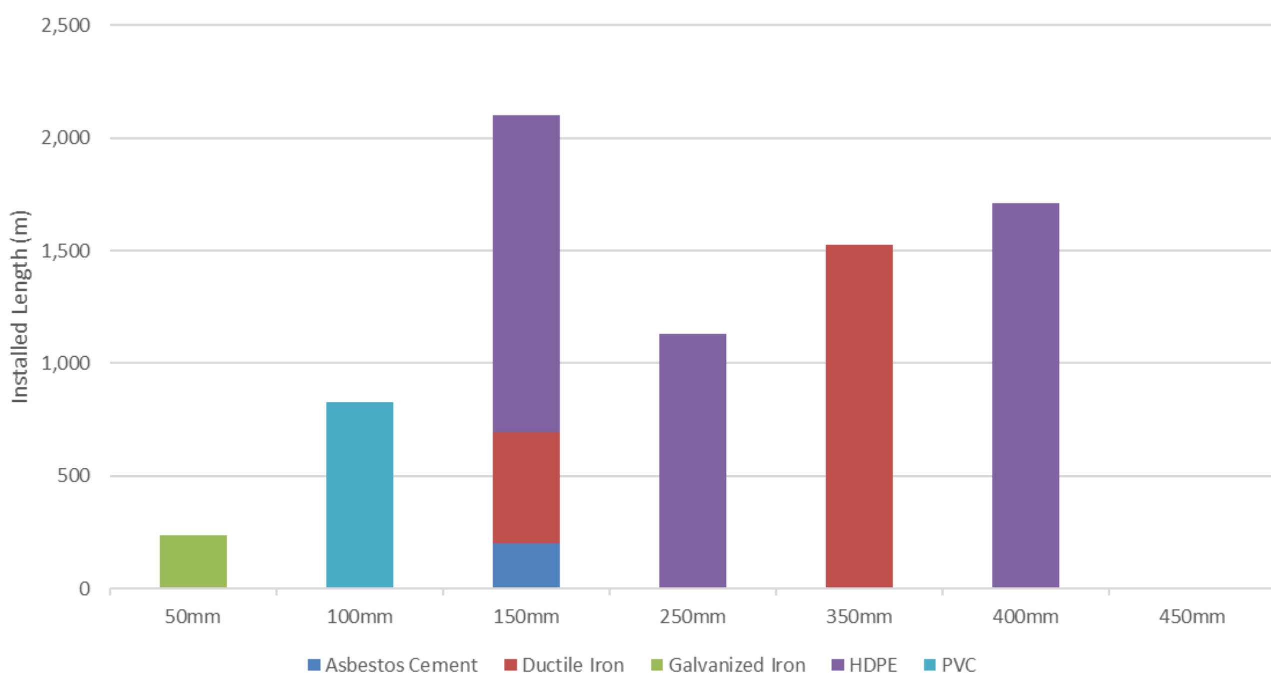


FIGURE 2-4: DIAMETER OF FORCE MAIN PIPES BY MATERIAL



2.1 Lift Stations

The layout of the sewer system means that it is necessary to pump the sewage to the treatment plant. There are eleven municipal lift stations in the collection system. These are summarised in Table 2-1. Their locations are shown on Figure 1-1.

There are also private lift stations pumping to the collection system (e.g. Crystal River Court trailer park and Silver Valley Estates lift stations). These lift stations are not owned or maintained by the District.

FIGURE 2-5: STARRET LIFT STATION

TABLE 2-1: LIFT STATION SUMMARY

	Kaw Rd (Lindgren)	Boat Launch (Kawkawa Lake)	Kettle Valley	Thacker Mountain	Rupert	Starret	Tom Berry	Coquihalla
Asset No	SST0003	SST0004	SST0008	SST0009	SST0013	SST0010	SST0015	SST0001
Year of Construction	1980	1980	2006	1981	1960	2012	1978	1960
Pump	Flygt 3127-181-1595	Flygt 3153-181-3337	Flygt 3127-181-0119	Flygt 3102-181-1360	Flygt 3101-180	Flygt 3153-181-1043	Flygt 3126-180	Flygt 3300-181-2125
Impeller	439	462	489	256	432	436	422	466
Pump Power (hp)	7.5	20	7.5	6.5	5	15	9.4	88
Phases / Volts / Amps	1 / 230 / 30	3 / 600 / 26	3 / 208 / 21	3 / 230 / 16	3 / 600 / 5.7	3 / 600 / 15	3 / 600 / 11	3 / 600 / 82
Pump speed (rpm)	1745	1755	1745	3440	1755	1760	1800	1770
Total Pump Hours (2019)	7,506 /7,845	21,719 /20,483	426 /389	11,791 /11,360	22,250 /22,354	89/89	4,609 /6,043	36,816 /35,285 /13,561
Average Hours Per Day	5.1	3.5	0.3	12	3.7	0.2	0.9	7
Number of Pumps	2	2	2	2	2	2 (can take 3)	2	3
Flush valve	No	No	Yes	Yes	Yes	Yes	Yes	No
Level Instrument	Ultrasonic	Floats	Ultrasonic	Ultrasonic	Ultrasonic	Ultrasonic	Floats	Ultrasonic
Capacity (L/s)	28	42	-	20	12	-	40	110
Standby Power	Transfer Switch	Genset	Transfer Switch	Transfer Switch	Genset	Genset	Genset	Genset
Chamber Diameter (m)	2.1	2.4	1.8	1.8	1.8	3.0	1.4	3.7
Chamber Depth (m)	4.5	4.3	4.6	4.9	4.9	7.0	5.6	6.7
Pump Level Range (m)	0.7	1.0	1.0	1.0	1.0	1.1	1.0	2.1
Storage Capacity (m^3)	2.6	4.7	2.6	2.6	2.6	8.0	1.5	21.5

Table excludes the following minor lift stations: Far Grinder pump station (SST0002) built 1980, Ridge Way Grinder pump station (SST0014) built 1980, Union Bar Grinder pump station (SST0005) built 1981.

2.2 Pollution Control Centre

The District of Hope Pollution Control Centre provides sewage treatment for the Hope township. The plant is located adjacent to both the Fraser River and Silverhope Creek and discharges into the Fraser River. The treatment process is partial mix aerated lagoons with four treatment cells. The hydraulic retention time totals approximately 20 days at average flow.

The original facility was constructed in 1980. At that time, it consisted of two lagoons cells with coarse bubble aeration and an effluent outfall to the Fraser River. The initial design population was 5,000. The operational permit stipulated that the effluent samples not exceed 100 mg/L for five-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) concentrations.

The District took over control of the plant in 1993. By 1999, the serviced population exceeded 5,000 and the plant was upgraded for a design population of 8,400 (Stage Two expansion). The Stage Two expansion added a third lagoon cell with a settling zone, a third blower, and upgraded the aeration to fine bubble diffusers. The discharge permit was amended with $CBOD_5$[1] not to exceed 45 mg/L and TSS not to exceed 60 mg/L. By 2017 the fine bubble diffuser system was failing, and the flow control structures (which direct the flow path through the three lagoon cells) were no longer functional.

In 2017-2018 the aeration diffusers were replaced, the larger treatment cell was partitioned and the plant configuration was changed to series flow to improve BOD removal performance. The accumulated sludge was removed to free up treatment volume and a dissolved air flotation process was installed to reduce suspended solids concentrations that occur in summer due to accelerated algae growth.

The lagoons are currently operated as partial mix aerated lagoons. They are filled to a depth of 3.8m to give a total treatment volume of 46,500m^3. The lagoons have concrete side slopes and an asphalt floor. Wastewater flows through the treatment cells one after the other (in series) with wastewater quality gradually improving in each cell. The aeration intensity decreases as the wastewater progresses from Cell 1 to Cell 3. By Cell 3, very little aeration is required. Cell 3 includes a settling zone.

Three 75 horsepower Hoffman multistage blowers are installed in the blower room. Generally, one blower runs, with a second blower operating during summer peak air demand periods. The third blower acts as a stand-by unit. Two of the three multistage blowers are approximately 35 years old, while the third is approximately 15 years old. While the blowers are old, their design is reliable and they can be expected to continue to operate with regular maintenance.

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[1] BCMOE have confirmed that the BOD_5 referred to in the permit is $CBOD_5$, consistent with the BC Municipal Wastewater Regulation definition.

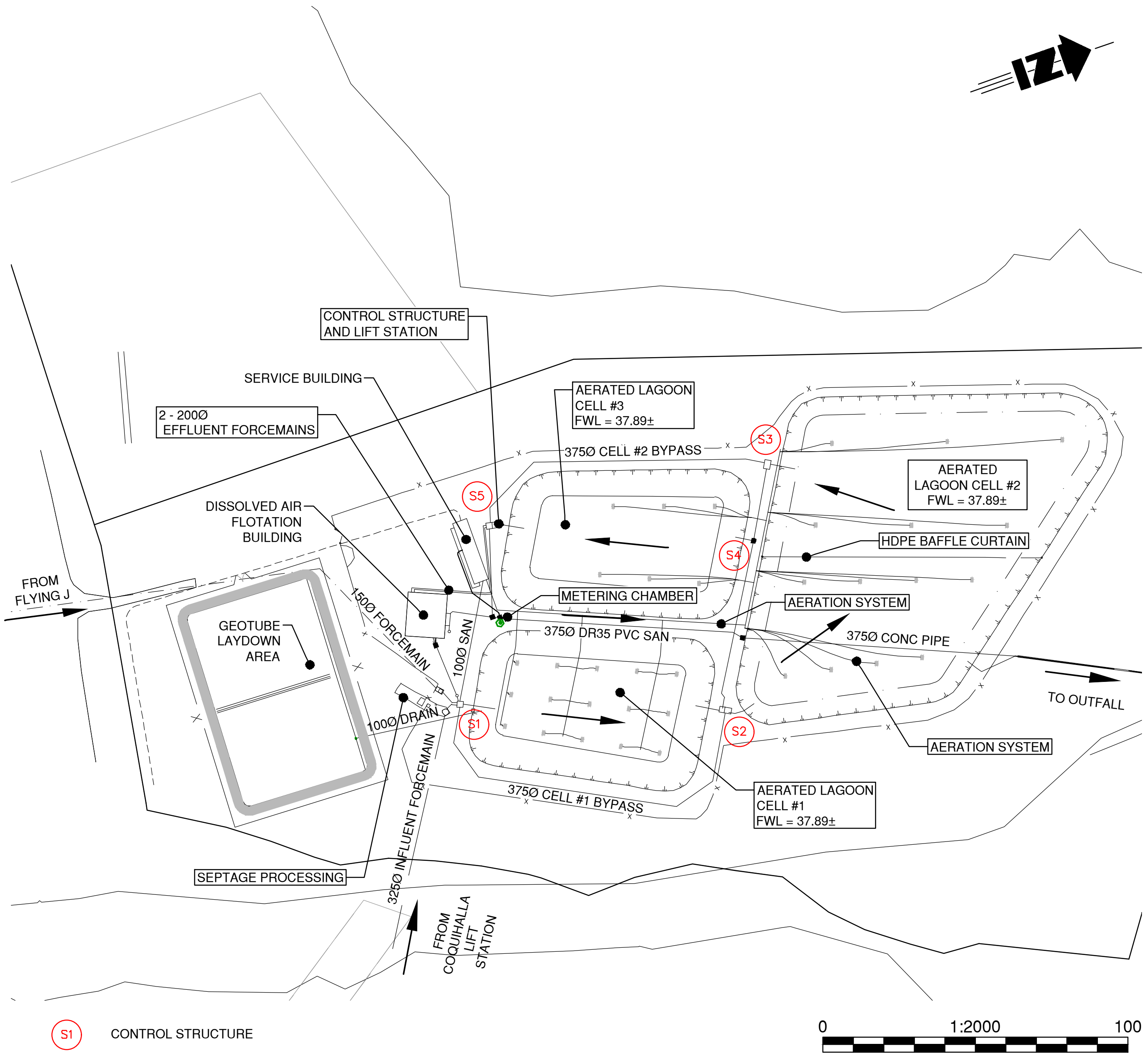
While there is no backup generator for use in the event of a power outage, a transfer switch would allow a portable generator to be connected.

In summary, the treatment process is simple and relatively inexpensive to operate and is capable of meeting effluent targets with current flows and loads.

TABLE 2-2: LAGOON WORKING VOLUME

Feature	Working Volume (m^3)	Retention Time - days (Avg flow)
Cell 1	9,000	4.5
Cell 2a	12,000	6
Cell 2b	15,000	7.5
Cell 3	9,000	4.5

FIGURE 2-6: INSTALLATION OF NEW AERATION SYSTEM INTO CELL #1 (MAY 2018)



DISTRICT OF HOPE

POLLUTION CONTROL CENTRE SITE PLAN

TRUE CONSULTING

DSGN. BY: RW

SCALE: 1:2000 (8x11)

DWG. NO.:

Fig 2-7

1239-181

DWN. BY: DL

DATE: Dec 2019

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2.3 Outfall

A 350m long 350/375mm diameter pipeline extends from the plant to an outfall in the bed of the main channel in the Fraser River. The 1979 record drawings show four vertical rubber hose diffuser ports rising upwards above the river bottom to discharge into the river. The riverbed has migrated over the ports and they are now completely buried. This caused effluent to back up into the plant during high water periods in the Fraser River, and when plant flows were high.

A temporary outlet structure has recently been installed at the river's edge until a permanent outfall can be built. The temporary outfall is generally fully submerged. It is only exposed during winter when Fraser River flows are below average. There have been no issues with backing up of flows since the temporary outfall went into service.

FIGURE 2-8: OUTFALL LOCATION ON FRASER RIVER (FEBRUARY 2017)

3.0 Infrastructure Assessment

3.1 Sewer Assessment

3.1.1 Sewer Condition Assessments

A study of road, watermain, storm and sanitary sewer assets was completed in 2016 (Omega and Associates). They carried out a CCTV investigation limited to the sewer assets on 6th Avenue, Coquihalla St and Rupert St. The survey included sections of vitrified clay and concrete pipe ranging from 150mm to 400mm in diameter. Omega and Associates found a number of problems, including longitudinal cracking, circumferential cracking, gravel deposits and root intrusion. Evidence of water infiltration into the collection system was also seen. Based on District records, the sewers that were examined date from the 1960s and 1970s, making them among the oldest of the District sewers. This limited survey indicates that sewer repairs will be necessary in many of the old AC mains as the system continues to age.

The District has extended the scope of sewer flushing / CCTV surveys to the full gravity network since the 2016 study. The District plans to complete this work gradually over the next five to ten years.

3.1.2 Inflow and Infiltration

Inflow of rainwater (or snow melt) and infiltration of groundwater into the sewer system can add significantly to the flows that must be transported and treated. Inflow and infiltration (I&I) is a problem because it;

- Takes capacity from the system that could be used for sewage.
- Makes sewage treatment less efficient and more expensive to build and operate.
- May overwhelm sewers or treatment plants leading to health risks and property / environmental damage.

Information about the status of the sewer system can also be gleaned from infiltration rates. At present it appears that the wastewater flow from the community can double or triple during periods of sustained wet weather. While flows are safely within the permit flow of 8,820 m^3/d, there would be value in identifying the source of the flows in order to make system operation easier. It would also ease the load on trunk sewers that are reaching capacity. This issue is further discussed in Section 5.3 Inflow and Infiltration.

If the maximum average daily flow exceeds double the average dry weather flow during storm or snowmelt events, section 95 of the BC Municipal Wastewater Regulation requires that a liquid waste management plan or a specific study be conducted to identify how inflow and infiltration can be reduced. Measures to reduce inflow and infiltration should then be developed and implemented.

3.1.3 Corrosion

When gravity mains receive sewage from longer force mains, there can be a significant amount of hydrogen sulphide (H_2S) generated in the anaerobic environment of the lift station and forcemain. When the wastewater arrives at a gravity sewer the H_2S is released to the atmosphere above the wastewater. It reacts with water in the air and on the walls to form sulphuric acid, which is corrosive to concrete and metals. Modern plastic pipe materials are impervious to this corrosion, but the older pipes and the concrete access chambers can be badly affected.

A cured in place lining was added to a concrete section of the force main that carries sewage from the Coquihalla Lift Station to the Pollution Control Centre in 2017. This main had been affected by sulphide generated under anaerobic conditions in the main.

FIGURE 3-1: FRESHLY LINED FORCEMAIN

3.2 Lift Station Assessment

Physical condition assessments of the lift stations were completed in 2019. The lift stations were found to be in good condition apart from some small package lift stations. In general, there does not appear to be serious attack by corrosive atmospheres in the lift stations themselves. In addition, odour does not appear to be unusually strong at any of the lift stations, although the Tom Berry Pump Station is in a sheltered area with limited natural air flow, and would benefit from an odour control system.

The mechanical and electrical condition of the lift stations is generally as would be expected for the age of the systems. Various upgrades were made to mechanical and electrical components at the Kaw Road Sewage Pump Station in East Kawkawa Lake in 2017. It is recommended that the pump run status and operating level be monitored at this lift station to determine whether there is sufficient installed pump capacity.

The small package lift stations of metal construction are suffering from non-structural corrosion. While they remain functional, they will continue to deteriorate. As rehabilitation in place would be difficult and relatively expensive, it is recommended that they be replaced with FRP lift stations when this becomes necessary.

FIGURE 3-2: UNION BAR LIFT STATION

3.3 Pollution Control Centre Assessment

3.3.1 Component Age and Condition

The Pollution Control Centre (PCC) has recently been upgraded, meaning that many parts of the plant are in new condition. The control building and lagoons are forty years old but there are no significant improvements required in the near term. The installation dates for the major system components were as follows;

TABLE 3-1: PCC COMPONENT CONSTRUCTION

Feature	Date of Construction
Cell 1	1980
Cell 2	1999
Cell 3	1980
Control building	1980
Flow control structures and pipework	2017
Aeration diffusers	2017
Flow meter structure	2017
Dissolved air flotation system	2018

FIGURE 3-3: DISSOLVED AIR FLOTATION BUILDING, BLOWER BUILDING AND LAGOONS

3.3.2 Existing Bar Screens

The wastewater treatment plant is currently equipped with a bar screen with a coarse 25mm spacing. This screen is not very effective at removing rag, such as 'flushable' wipes and smaller items arriving at the plant. As a consequence of this, the treatment cells accumulate floating debris that forms large mats and snags on aeration diffusers and their floats. This has already resulted in a float breaking, which means that the retrieval of the aeration diffuser for maintenance becomes very difficult. Entangled debris will also have a detrimental effect on aeration performance, and hence treatment performance and energy costs.

A longer-term consequence of the lack of screening is that the accumulating sludge will contain various non-degradable items that will limit beneficial reuse options for the sludge. This issue is discussed in the next section.

FIGURE 3-4: EXISTING BAR SCREEN

FIGURE 3-5: RAFT OF FLOATING DEBRIS IN CELL 1

FIGURE 3-6: EXAMPLE OF AN AERATION DIFFUSER FOULED WITH RAG

3.3.3 Sludge Requiring Disposal

Sludge was removed from all of the treatment cells in 2017. The solids are being stored in geotube bags which allow the water entrained with the solids to drain away. The sludge volume remaining after dewatering has been estimated as follows;

Approximate Sludge Volume:	12,200 m^3
Mass Dry Solids:	710 tonne
Expected Mass for Disposal @ 20% solids:	3,600 tonne

Because the wastewater entering the plant is unscreened, the sludge contains non-biodegradable debris and personal items entering the plant with the wastewater. This narrows the options for disposal.

Sludge acceptance at landfills is declining rapidly, and BC municipalities are struggling to find viable options for sludge disposal. As time passes, landfill disposal may no longer be available as an option. If a beneficial reuse option cannot be developed, then it is likely that unscreened sewage sludge will have to be dried and incinerated. A suitable incineration facility would need to be identified. The financial and environmental costs of trucking a long distance to an incineration facility would be higher than beneficial reuse.

In 2012, the Canadian Council of Ministers (CCME) of the Environment published the report "Canada-Wide Approach for the Management of Wastewater Biosolids". The CCME recommends against disposal of sludge or biosolids to landfill as it wastes resources and increases greenhouse gas emissions. As a result, the Province is pushing for beneficial reuse of biosolids.

The Organic Matter Recycling Regulation (2002) sets standards and requirements that must be met before organic matter can be recycled. The OMRR was developed to facilitate the recycling of organic material while protecting human health and the environment. While the sludge can be treated to meet Class A or B criteria, the inorganic litter content will remain at the disposal site after the organic content has gone. This makes public acceptance of this material significantly less likely and contributes to plastics / micro-plastics pollution.

The ministry is currently working on revising the OMRR. An Organic Matter Recycling Regulation policy intentions paper was issued 2018, with the consultation period completed in November of that year. At this stage, it is not clear how changes to the Regulation will affect the District's disposal options.

Other municipalities have attempted beneficial reuse of biosolids by application to agricultural land and been met with significant public backlash. It is not expected that this would be an easy option for the District of Hope, particularly given the lack of initial screening.

As an example, Metro Vancouver produces most of the sewage sludge in BC. They mix their biosolids with sawdust and sand to produce 'Nutrifor'. This is used as a fertilizer for regional facilities and parks, rangeland, hayfields, forests and tree farms; a landscaping topsoil. It is also used as a soil placed on landfills to absorb methane, and to rebuild soil at mine sites and gravel pits.

Failing beneficial reuse and landfill, the sludge could be disposed of by combustion. The combustion-based disposal options for biosolids include incineration, gasification and pyrolysis.

FIGURE 3-7: GEOTUBE BAGS CONTAINING SLUDGE REMOVED IN 2017.

The Metro Vancouver waste to energy facility burns approximately 25% of Metro Vancouver garbage to power 16,000 homes. Sludge is not accepted from outside the Metro Vancouver area. Nevertheless, assuming an approximate cost per m^3 for sludge disposal of $250/tonne (based on the Metro Vancouver special waste tipping fee – waste to energy facility) the District would need to budget around $900,000 for sludge disposal, plus costs for transportation to the disposal destination.

In Hope's case, this service, including the necessary pre-processing, would need to be provided by an outside party, such as a private provider.

It may be that the District's best option is to continue to store the sludge until a feasible option for the disposal of sludge by small municipalities in BC is established, or an opportunity presents itself, such as a mine needing biological material for remediation. In the meantime, further dewatering of sludge could be undertaken on the same site by laying new bags over the existing ones.

Long term, the District should consider ways to improve biosolids quality, such as introducing screening of the incoming sewage and making efforts to divert metals from the sewage flow. Common problematic metals are mercury from Dental practices and copper from copper pipe corrosion.

3.4 Outfall Assessment

As discussed in Section 2.3, the original outfall structure is no longer operating effectively and has been bypassed with a temporary structure. The structure was installed in March 2017 when the Fraser River level was at an elevation of 28.5m. The Hope River gauge was reading 3.43m on that day (EL 31.36m) which lies at about the lower quartile for winter flows.

FIGURE 3-8: TEMPORARY OUTFALL AT TIME OF CONSTRUCTION

The temporary outfall is located in an active riverbed and can quickly become covered in sediment. An inspection undertaken in January 2020 found the temporary outfall to be in good condition and exposed. The outfall was buried in sediment during a significant winter rain storm a few weeks later (see Figure 3-9).

FIGURE 3-9: TEMPORARY OUTFALL JANUARY 23, 2020 (LEFT) AND FEB 13, 2020 (RIGHT)

The District plans to replace the temporary outfall with a permanent structure placed below the minimum water level (EL 27.62m). This work will need to occur when river levels are low. The pattern for periods with low river level does not coincide well with the reduced risk timing window for fish & wildlife for the Lower Mainland Region.

4.0 SCADA Network Assessment

4.1 Communications

4.1.1 Existing Communications

The District's SCADA systems have been upgraded in a piecemeal fashion as the District has grown. Communications throughout the District include wireless radios of different frequencies as well as phone modem connections. The lack of uniformity has made the existing system difficult to service.

The mountainous topography and even the climate can also make radio links difficult to maintain reliably. Many parts of the radio communication system are subject to fading, which means that various radio links will fail in a communication outage condition. Off the shelf equipment has been installed without specifically planning for the addition of future channels or performance in adverse weather conditions.

The District's sewage lift station communications are stand-alone and do not communicate with a central monitoring system. Each kiosk is fitted with an alarm dialer that calls the operators when a problem arises. An alarm requires an immediate site visit to investigate.

4.1.2 Proposed Communications

A radio path study has been conducted to determine where radios should be aimed and how antennas should be sized and selected for optimal performance. The path study found that the District requires 900 MHz radio links on a licensed frequency band for reliable communications. The annual fee for licences is $100 with a cap of $1,200 per user.

It is recommended that a cellular gateway be added to each station for status monitoring. Since the link would not be used to control the lift station, its reliability does not have to meet utility standards and could be achieved with a cellular device and a small data plan costing less than $10/month. Link reliability can be improved using a second SIM card to allow two networks to be used for backup (eg. Telus and Rogers).

It is proposed that a radio link should be installed for the Pollution Control Centre due to the need for regular two-way communication.

TABLE 4-1: EXISTING AND PROPOSED COMMUNICATION LINKS

Link Location		Infrastructure	
From	**To**	**Existing**	**Proposed**
Pollution Control Centre	Public Works	-	900 MHz licensed frequency radio / Cellular Backup
Coquihalla PS	Public Works	Autodialler	Cellular modem
Far Grinder PS	Public Works	Autodialler	Cellular modem
Kettle Valley PS	Public Works	Autodialler	Cellular modem
Lindgren PS	Public Works	Autodialler	Cellular modem
Ridge Way Grinder PS	Public Works	Autodialler	Cellular modem
Rupert PS	Public Works	Autodialler	Cellular modem
SST0007 PS	Public Works	Autodialler	Cellular modem
Starret PS	Public Works	Autodialler	Cellular modem
Thacker Mountain PS	Public Works	Autodialler	Cellular modem
Tom Berry PS	Public Works	Autodialler	Cellular modem
Union Bar Grinder PS	Public Works	Autodialler	Cellular modem

4.2 HMI System

4.2.1 Existing HMI

Data collected from the network is ultimately received at the Public Works Yard where the control system generates alarms and records system data. Presently the SCADA system is based on Schneider Electric ClearSCADA. This was installed as an interim platform and has limited functionality. The system is also relatively old and lacks important features including;

- Access to SCADA system using portable devices
- Ability to control equipment remotely
- Ability to acknowledge alarms
- Automatic generation of daily status reports
- Ability to export long term trend data
- Modern cyber security

4.2.2 Proposed HMI

A central SCADA monitoring system would permit alarms and process variables to be monitored remotely. The operator can determine whether, or how soon, physical intervention is required. This reduces the frequency and cost of call-outs.

It is proposed that a modern PC based HMI system be installed to improve the ability of the District to monitor and manage the water and the wastewater systems. An HMI upgrade would cost around $80,000 including software licenses, hardware, programming and engineering.

4.3 Local Control

The lift station control is mostly configured using basic relay logic instead of programmable logic controllers (PLC). An upgrade to PLC control is proposed. The benefits of PLC control are:

- Increased process control functionality, with the ability to dynamically change level setpoints by operators. For example, lift pump start/stop setpoints and alarm conditions may have to be adjusted. Under the current conditions, adjusting set points requires an electrician to make physical changes to the instrumentation.
- Alarm handling – generating specific alarms to alert of problem conditions
- Remote monitoring and control (via cellphone/SCADA PC)
- Increased reliability as problematic mechanical relays would be removed

A PLC retrofit would cost approximately $30,000 per lift station depending on the instrumentation and site requirements.

The Pollution Control Centre was recently upgraded with PLC based control systems. No further improvements are proposed at that site.

5.0 Hydraulic Modeling

5.1 General

A functional sewer model of the sanitary sewer system had never been developed for the District's network. As a result, a hydraulic model of the gravity collection network was prepared for this master plan. The functional sewer model created for this study uses the latest version of PCSWMM to model the sanitary sewers and lift stations up to the PCC.

This modeling predicts the flow capacity of the network based on existing and future flows and identifies existing system deficiencies. It can then be used to assess system improvement options to resolve these deficiencies. The sewer model will continue to be useful to the District as a tool to assess the system's capacity to service new developments.

5.2 Sewer Model Development

5.2.1 Data Collection

The base data for the sanitary network came from the District's GIS data of the sanitary system. This GIS data included general attributes (diameter, length, direction) of each conduit, but lacked elevation data.

The elevation information was collected by TRUE survey crews to ensure that the PCSWMM model uses the best geometric information available. In total, approximately 1000 sanitary and storm manholes were surveyed. The accuracy of the District records was checked at the same time, including access chamber locations, pipe diameter and pipe material. Photos inside the manholes were also uploaded onto the GIS system as a record of their condition.

5.2.2 Development of Average and Peak Flows

Average daily flows have been developed for all scenarios based on land use, population densities and typical wastewater generation rates. The flows were then spatially distributed through the model based on the spatial proximity of each parcel to the sanitary network.

The average flows are then used to calculate a peak flowrate for each part of the network. One approach to calculating the peak flow is to use a relationship called the Harmon's peaking factor. The District design criteria reference the Harmon's peaking factor for estimating sanitary peak flows. While it is appropriate for subdivision design, Harmon's peaking factor has been found to be too conservative for modeling. In addition, it does not allow a model to be calibrated to real world conditions.

Because of the daily routines of households and businesses, the flows in a sewer network vary in a regular pattern through the day. This daily routine leads to peaks in flow in the morning and evening. The daily pattern is referred to as the diurnal flow curve. The PCSWMM model uses a diurnal curve to model the time dependent flows generated by the users connected to the sanitary system. These diurnal curves can be developed to accurately represent peak flows in a network.

In general, diurnal curves are developed from flow meter data recorded at lift stations. Unfortunately, the District's lift stations do not record flow. As a result, a system specific and localized diurnal curve could not be developed. TRUE selected a typical diurnal curve based on work in similar sized communities and applied a 25% safety factor to the peak flow.

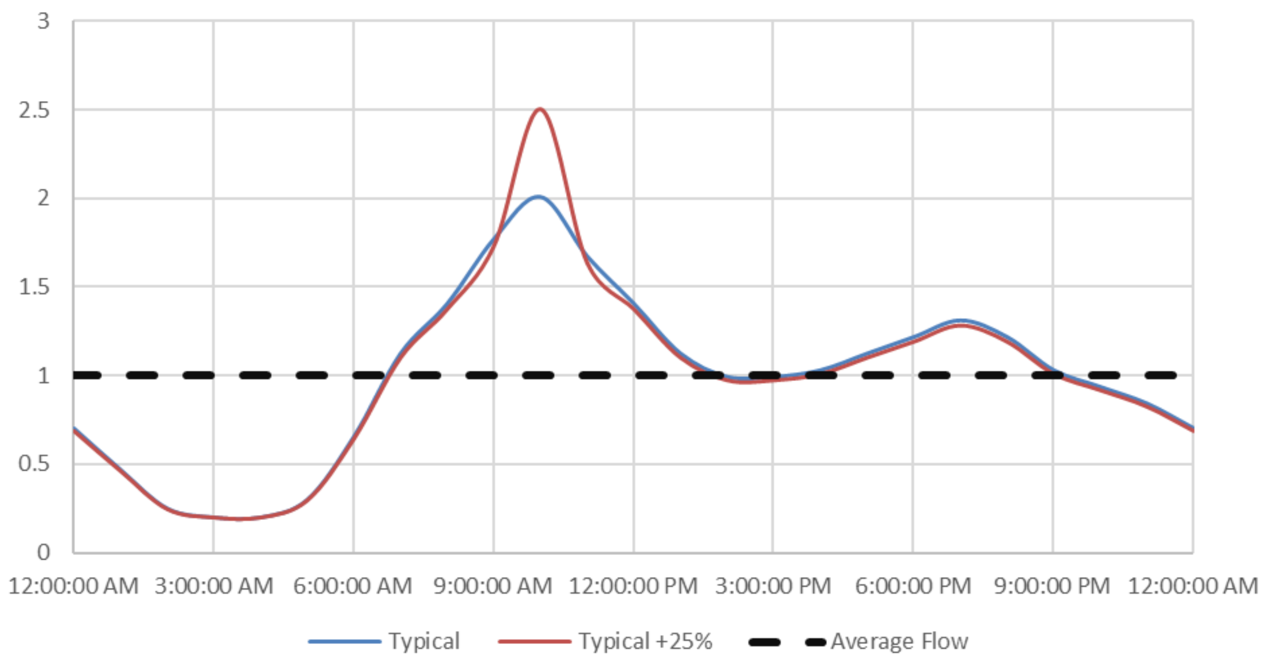


FIGURE 5-1: MODEL DIURNAL CURVES

The PCSWMM model calculates the peak flow for each pipe segment by applying the diurnal curve to the average daily flow of each parcel, routing the flows through the system, and applying inflow and infiltration (I&I) parameters to develop a peak flow estimate for each model element. Inflow and infiltration modeling is described in Section 5.2.3.

Since PCSWMM uses the GIS based pipe network, a relatively detailed allocation of flows can be applied to the model. The parcels connected to the sanitary system were identified and linked to the sanitary network using geospatial analysis tools. Current land use was then applied to the parcels, separating them into residential and Institutional-Commercial-Industrial (ICI) use, as well as vacant parcels. Table 5-1 provides a summary of the dry weather flows (DWF) applied to the model.

TABLE 5-1: EXISTING DWF SUMMARY

LAND USE	POPULATION/AREA	GENERATION RATE	AVERAGE DAILY FLOW	NORMALIZED TOTAL FLOW[2]
Residential	5,408 ppl[1]	280 l/cap/d	1,496 m^3/d	406 l/cap/d
ICI	120 ha	7,500 l/ha/d	697 m^3/d	
Total Flow			2,193 m^3/d	

1. 2575 residential units x 2.1 ppl/unit
2. Total flow/serviced population

The generation rates for the model listed in Table 5-1 were determined based on the total DWF measured at the PCC. Based on both the area and connected population, the model wastewater generation rates were calibrated to be in line with the total DWF volume measured at the PCC of 2,000 m^3/d. The resulting model flows are approximately 10% higher with approximately 2,200 m^3/d.

As a check, the total modeled volume was compared to the per capita flow based on total population. This resulted in a value of 406 l/cap/d. This value is similar to the District's Design Criteria Manual value of 410 l/cap/d, which adds support to the model inputs that have been used[2].

5.2.3 Modeling of Inflow and Infiltration

Flow data from the PCC was analyzed for evidence of Inflow and Infiltration (I&I) during rain events. Unfortunately, the flow monitoring at the PCC only measures outflow. Due to the attenuating nature of the treatment lagoons the outflow measurement cannot be used to determine a peak I&I inflow for the model. Further discussion on I&I can be found in Section 5.3.

For the purposes of modelling I&I, the District Design Criteria rate of 0.283 l/mmØ/m/d for each pipe segment was applied at a constant rate. Table 5-2 provides a summary of the I&I flows applied.

TABLE 5-2: SUMMARY OF EXISTING WET WEATHER FLOW

TOTAL SEWER LENGTH	AVG DIAMETER	RATE	TOTAL I&I VOLUME	DWF VOLUME	WWF VOLUME
51,070 m	230 mm	0.283 l/mmØ/m/d	3,321 m^3/d	2,193 m^3/d	5,621 m^3/d

[2] Design average daily flows are listed in the District's Design Criteria Manual as follows:
Residential = 410 l/cap/day
ICI = 30,000 – 40,000 l/d/ha

Based on the most recent flow monitoring at the PCC, the peak WWF is in the order of 6,000 m^3/d. This indicates that the design criteria as applied for I&I is generally in accordance with system performance over a daily timestep.

More data and analysis is recommended to determine the sub-daily peak flow impacts of I&I. This is further discussed in Section 5.3.

5.3 Capacity Assessment for Existing Sewers

The PCSWMM model was used to calculate both the percent full and the percentage of capacity used for each segment of the sewer network. Percentage capacity is an estimate based on Manning's equation while percentage full is the depth of flow in a pipe relative to its diameter.

Because the Manning's equation underestimates the true capacity of a pipe segment in very flat pipe segments, the percent full has also been presented. A pipe that is relatively full should be interpreted as a bottleneck in the system, even if the '% of capacity' figure is low. This is evident in some of the pipe segments listed in Table 5-3, which are showing they are reaching capacity, but are not that full.

The performance of the five most critical bottlenecks in the system has been summarized in Table 5-3. Both SGM0196 and SGM0186 are reaching capacity with a relatively high 'percent full' figure. This part of the network is further discussed in the discussion of pipe capacity under future conditions in Section 5.4.

Taken as a whole, the gravity system performs well under existing conditions[3] with only a few pipes approaching capacity. This is supported by anecdotal reports.

TABLE 5-3: EXISTING GRAVITY SEWER PERFORMANCE SUMMARY

SEGMENT	LOCATION	DIAMETER (MM)	% OF CAPACITY	% FULL
SGM0196	Coquihalla St (4th to 5th)	200	98%	67%
SGM0186	Coquihalla St (4th to 5th)	200	86%	77%
SGM0091	Allison Ave (near Hazel)	200	82%	42%
SGM0593	Skylark (u/s of Siphon)	350	59%	64%
SGM0172	Alley (King to Stuart)	200	56%	52%

[3] Inclusive of inflow and infiltration (I&I)

An unusual feature of the network is an inverted siphon under the Coquihalla River, located adjacent to Skylark Drive. The siphon services a sewer-shed east of the Coquihalla river. The siphon system consists of a screening chamber, inlet / outlet chambers and three parallel connecting pipes (1 x 150mm and 2 x 200mm). Table 5-4 summarizes the performance of the siphon system under existing wet weather conditions.

TABLE 5-4: EXISTING COQUIHALLA RIVER SIPHON PERFORMANCE

CAPACITY (L/S)	PEAK FLOW (L/S)	% OF CAPACITY
55	28	51%

The performance of the major lift stations has also been analyzed. Their performance based on current data is summarized by Table 5-5 below.

TABLE 5-5: EXISTING LIFT STATION PERFORMANCE SUMMARY

STATION	CAPACITY (L/S)	PEAK FLOW (L/S)	% OF CAPACITY
Kawkawa Lake Rd (Lindgren)	28	9.5	34%
Boat Launch (Kawkawa Lake)	42	12	29%
Kettle Valley	-	0.8	-
Thacker Mountain	20	2.4	12%
Rupert	12	6.9	58%
Starret	-	2.7	-
Tom Berry	40	14.5	36%
Coquihalla	110	80	73%

It can be seen that the main lift station (Coquihalla) is close to full capacity. This is discussed further in Section 5.4.

The capacity indicted for the Boat Launch (Kawkawa Lake) Lift Station appears to be more than adequate. However, it has been observed that the lift station is running for a considerable amount of time when the Nestle property is discharging flows. Dedicated flow monitoring of the Nestle Waters discharge is recommended as a basis for flow-based charging and to ensure that the capacity of the downstream system is not at risk of being exceeded. In the meantime, a peak flow of 3.5 L/s was used in the PCSWMM model (from an average flow of 120 m^3/d).

5.4 Future Capacity Assessment

5.4.1 Model Development for Future Flows

Future development areas were identified, along with anticipated land use and development potential, in order to model the performance of the system under future conditions. This development was generally based on the District's IOCP.

The estimated growth areas are shown on Figure 5-2 and the resulting flows are summarized in Table 5-6.

TABLE 5-6: FUTURE DWF SUMMARY

LAND USE	ADDITIONAL POPULATION/AREA	GENERATION RATE	ADDITIONAL DAILY FLOW
Residential	2,964 ppl	280 l/cap/d	830 m^3/d
ICI	24.2 ha	7,500 l/ha/d	184 m^3/d
Total Flow			1,014 m^3/d

The relative change in flow by sector between the existing and future scenarios are laid out below.

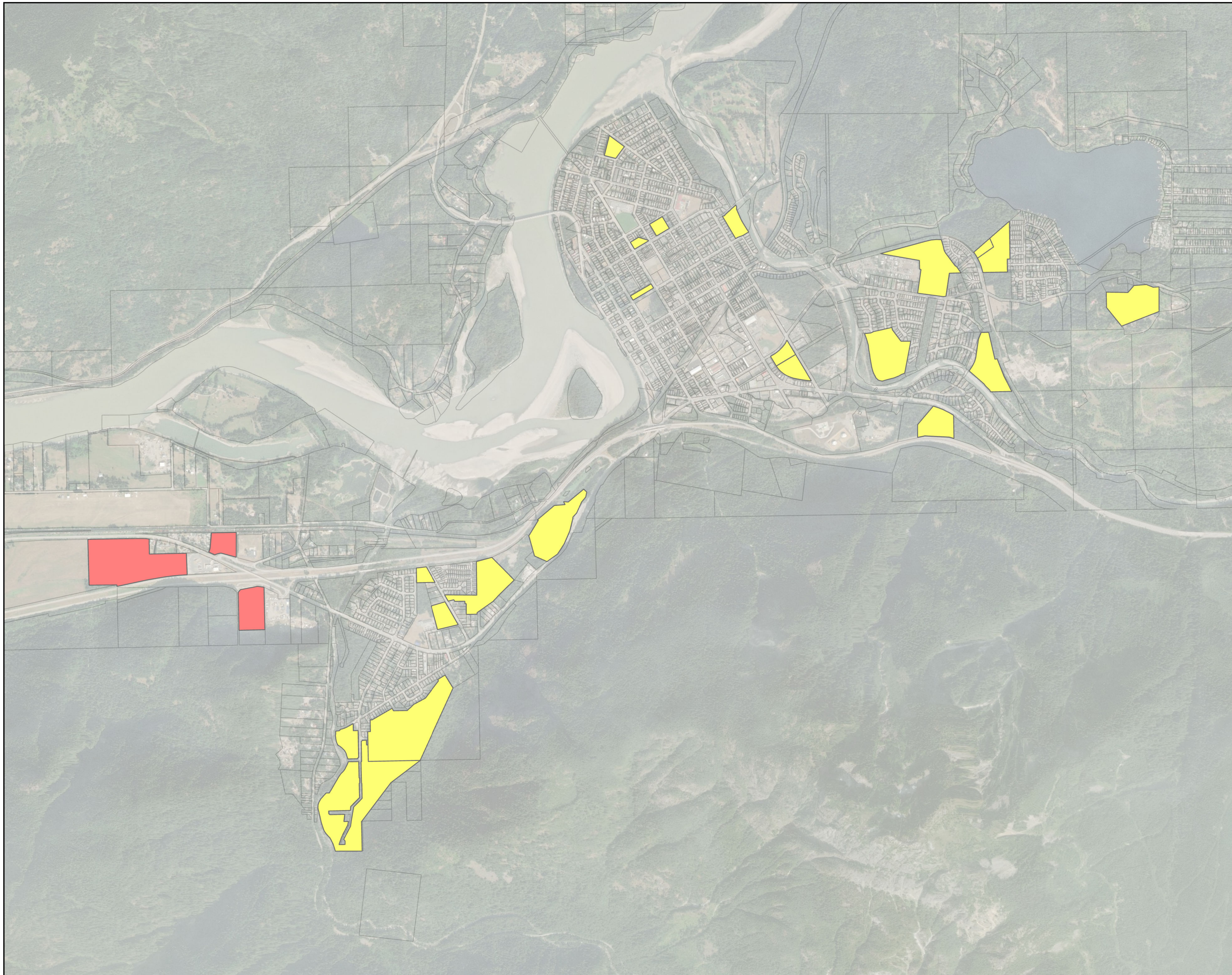
TABLE 5-7: EXISTING AND FUTURE DWF COMPARISON

LAND USE	EXISTING DWF	GROWTH DWF	FUTURE DWF	INCREASE
Residential	1,496 m^3/d	830 m^3/d	2,326 m^3/d	55%
ICI	697 m^3/d	184 m^3/d	881 m^3/d	26%
Total	2,193 m^3/d	1,014 m^3/d	3,207 m^3/d	46%

Table 5-7 shows that the IOCP growth scenario developed in the sanitary sewer model projects a 46% increase in flows. Based on a 1% growth rate, it would take 40 to 50 years to reach the flows indicated. Put another way, the modeling indicates system capacity approximated to the year 2060.

DISTRICT OF HOPE

Future Growth Areas



Land Use

- Commercial
- Residential
- Parcel Fabric

0 500 1,000 1,500 m

N

Datum: North American 1983
Projection: Transverse Mercator (Zone 10)

Scale:	1:25,000
Issued for:	Draft Report
Drawn by:	RK
Date:	6/15/2020
Project Ref No.	1239-181

TRUE

Figure 5-2

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5.4.2 Future Capacity Assessment

Future network flow capacity is presented graphically by Figure 5-3. The green lines represent gravity mains that are flowing at up to 50% capacity. These comprise the vast majority of the network. There are a small number of yellow segments (50 – 75% of capacity). The District's design criteria sets a performance criteria that sanitary sewers should flow at less than 75% full. Pipe segments exceeding this criterion are labelled red on the figure. Only three areas exceed this limit.

Table 5-8 summarizes the segments that are approaching, or exceeding, the 75% capacity performance limit.

TABLE 5-8: FUTURE CONDITIONS GRAVITY SEWER PERFORMANCE SUMMARY

SEGMENT	LOCATION	DIAMETER (MM)	% OF CAPACITY	% FULL	% CAPACITY CHANGE FROM EXISTING
SGM0196	Coquihalla St (4th to 5th)	200	104%	70%	+6%
SGM0186	Coquihalla St (4th to 5th)	200	92%	81%	+6%
SGM0091	Allison Ave (near Hazel)	200	92%	45%	+10%
SGM0593	Skylark (u/s Siphon)	350	76%	74%	+17%
SGM0592	Alley (King to Stuart)	200	67%	45%	+22%

Overall, the gravity system performs well under future conditions[4], with only a few pipes approaching capacity. Considering the conservative inputs incorporated into the model, upgrades of those segments is not recommended at this time. Rather, additional flow monitoring and I&I analysis should be completed to verify and adapt the model inputs as required before completing upgrades to the gravity system.

Table 5-9 summarizes the performance of the Coquihalla River siphon under future wet weather conditions. Modeling shows that the existing siphon will have sufficient hydraulic capacity for the anticipated future growth, however the contribution from Nestle should be confirmed.

TABLE 5-9: SIPHON PERFORMANCE UNDER FUTURE CONDITIONS

CAPACITY (L/S)	PEAK FLOW (L/S)	% OF CAPACITY	CAPACITY USE CHANGE FROM EXISTING
55	39.4	72	+21%

[4] Inclusive of inflow and infiltration (I&I)

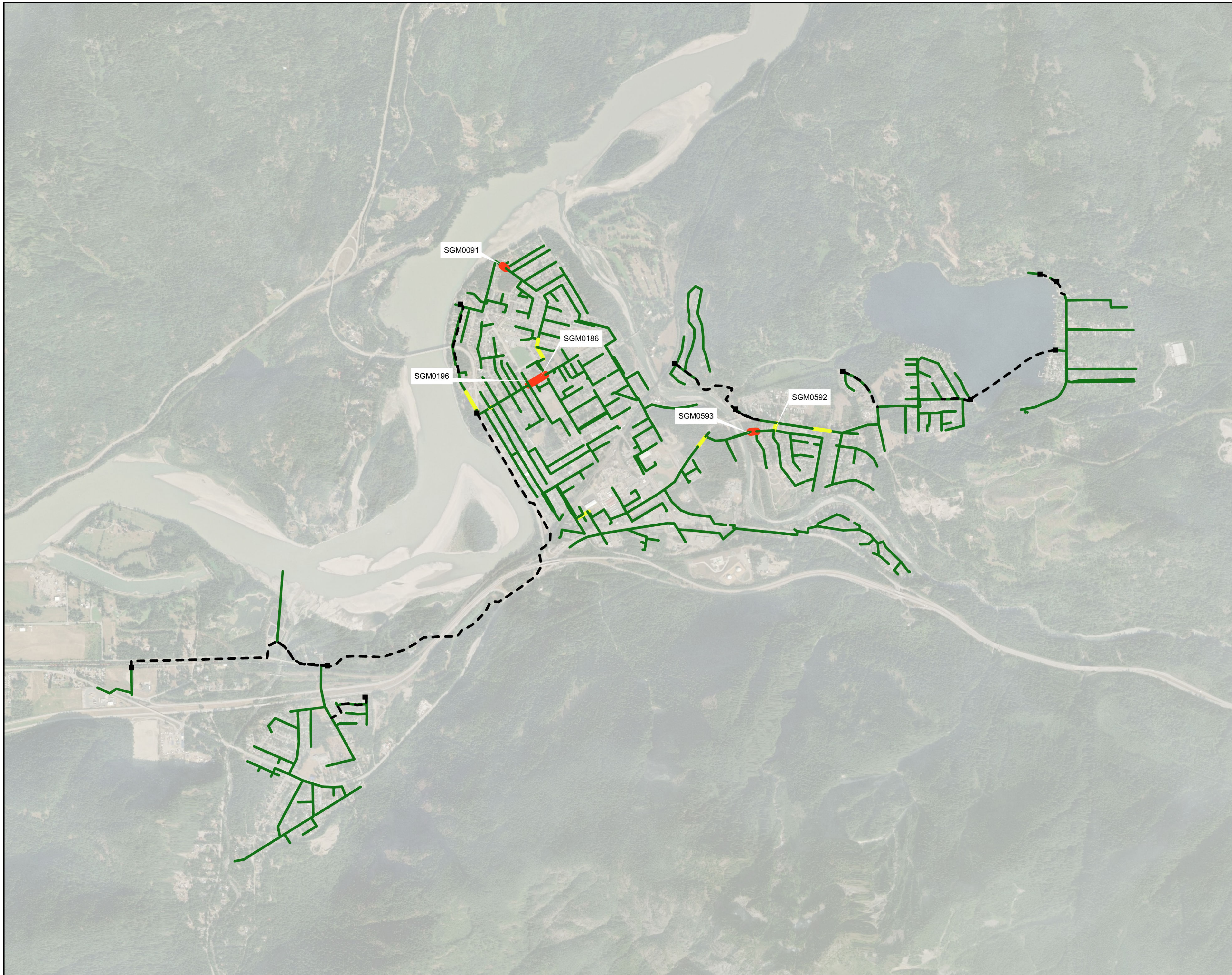
Table 5-10 summarizes performance of the major lift stations. The capacity of the Coquihalla lift station remains near to fully utilized under future conditions. It is recommended that additional flow monitoring should be completed to confirm the estimated flows prior to planning capital upgrades. Daily pump hours could also be recorded automatically if PLC control is installed at this lift station.

TABLE 5-10: FUTURE CONDITIONS LIFT STATION PERFORMANCE SUMMARY

STATION	CAPACITY (L/S)	PEAK FLOW (L/S)	% OF CAPACITY	% CAPACITY CHANGE FROM EXISTING
Kawkawa Lake Rd (Lindgren)	28	13.4	48%	+14%
Boat Launch (Kawkawa Lake)	42	15.9	38%	+9%
Kettle Valley	-	1.0	-	-
Thacker Mountain	20	2.4	12%	0%
Rupert	12	7.4	62%	+4%
Starret	-	7.92	-	-
Tom Berry	40	22.8	57%	+21%
Coquihalla	110	97	88%	+15%

DISTRICT OF HOPE

Future Sewer Network Capacity



Forcemain
Gravity Main
% Flow
< 50 %
50 - 75 %
>75 %
Lift Station

0 500 1,000 1,500 m

N

Datum: North American 1983
Projection: Transverse Mercator (Zone 10)

Scale:	1:25,000
Issued for:	Draft Report
Drawn by:	RK
Date:	6/15/2020
Project Ref No.	1239-181

TRUE

Figure 5-3

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5.5 Sewer Condition Assessment

5.5.1 Sewer Surveys

The District undertook a sewer condition assessment in 2016 on sample sewer mains in older parts of the network. This was based on CCTV inspection of the infrastructure. Staining around existing cracks in many locations was determined to be evidence of infiltration. There was also evidence of root intrusion and other deficiencies. This and other surveys completed by the District indicate that older concrete sewer mains are deteriorating as they age. Deteriorating infrastructure can contribute heavily to infiltration into a sewer network. Infiltration appears to be widely dispersed, making repair expensive and disruptive.

The condition assessment consultant recommended trenchless point repair for many of the issues identified in the older sewers with their full replacement planned to occur within 5 years. Full sewer lining may be appropriate instead, which would add 50 years to the useful life of a sewer main. Relining costs are significantly less than full conventional sewer replacement. Nevertheless, new PVC pipe has a life expectancy measured in hundreds of years, which can make it a more cost-effective choice. The programmed replacement of sewer and water pipelines should occur when general road reconstruction becomes necessary.

The District has completed CCTV inspection of over 6,000m of sewer mains in the period from 2015. The older concrete mains have a range of issues such as cracking and root intrusion. The newer PVC sewers remain in good condition. The Coquihalla force main was fitted with a cured in place liner in 2017 to address corrosion of the original pipe material. A similar approach may be used with many of the gravity mains in the District.

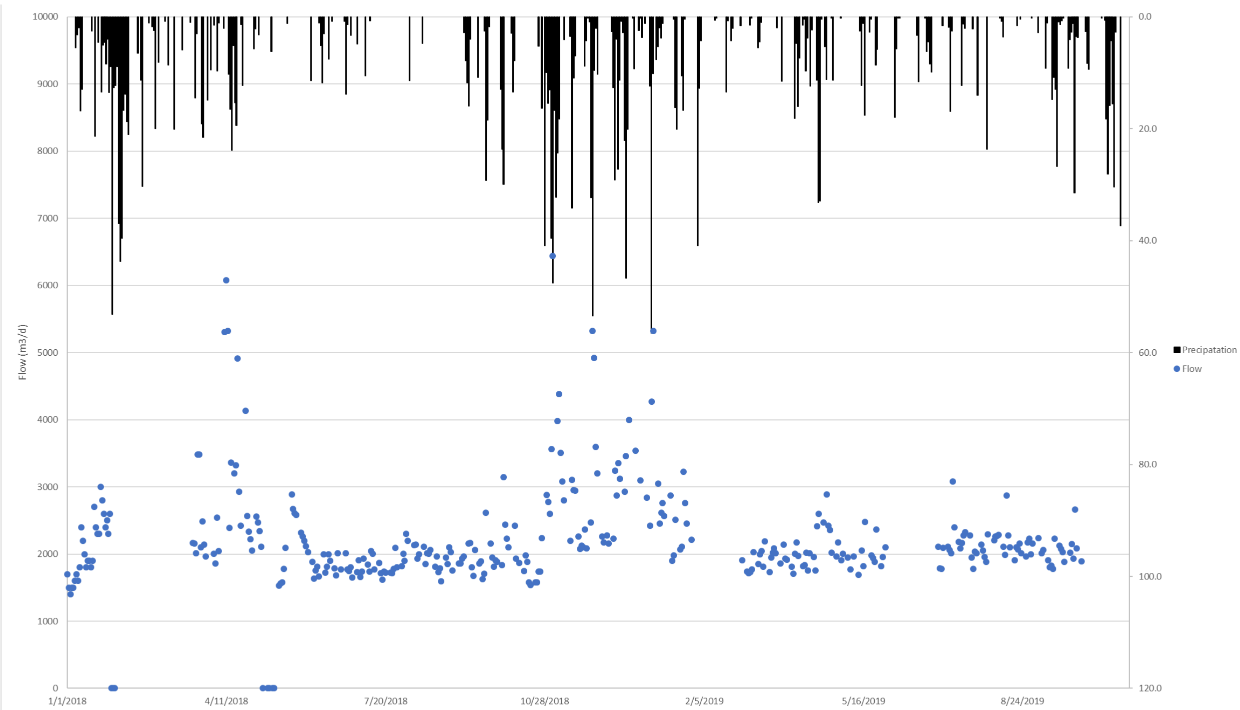
Based on the assessed condition of the sewer mains, inflow and infiltration is expected to correlate with sewer age. Older concrete sewers are more prone to leakage than newer PVC sewers. Private sewer laterals and cross-connections built before the 1970s are also likely to be contributing significant I&I.

There are no combined storm and sanitary sewers in Hope. Therefore, stormwater separation is not required, aside from illegal connections on private property. The extent of these connections is currently unknown. To date, no smoke surveys have been completed to locate illegal connections. During these surveys, smoke is pumped into sewer lines and would be expected to appear at illegal storm inlets. P-traps prevent the smoke escaping from sewers, although dry traps can lead to smoke appearing in homes. As a result, the proper notification of homeowners in the survey area is important.

5.5.2 Inflow and Infiltration Analysis

The only measurement of flow in the District's sanitary system is at the PCC as it leaves the facility. The daily flow has been compared with Environment Canada rainfall records to assess the quantity of I&I at a cursory level and the results are presented in Figure 5-4: District of Hope – WWTP Outflow vs Precipitation

FIGURE 5-4: DISTRICT OF HOPE – WWTP OUTFLOW VS PRECIPITATION



As can be seen in the figure, there is a strong relationship between higher than normal rainfall and significant increases in plant outflow. Outflow can increase to two to three times average flow during rainfall events.

Additional analysis was completed using the plant outflow meter to examine the sewage system response to rainfall on a sub-daily level. However, since the treatment lagoons are large, they have an attenuation affect on flows, which distorts the hydrograph response to rainfall. Inflow metering to the PCC would be needed in order to complete a more detailed analysis. This would be combined with flow monitoring of other parts of the system.

5.5.3 Inflow and Infiltration Reduction Program

The information available indicates that I&I is a concern for the District. A formal I&I reduction program is recommended. The general steps are as follows:

- Data collection and analysis to determine more specific impacts, priority areas, and priority actions.
- Set I&I reduction targets, timelines and prioritize catchments
- Undertake I&I reduction actions such as sewer replacement or lining.
- Progressively re-assess and adapt the program over time.

The first step is to gather more detailed data to quantify the impacts of I&I on different parts of the system. This data gathering should include the following:

- Upgrade the major lift stations with SCADA capabilities so that pump run time and station performance data is recorded for future analysis
- Consider installing permanent flow meters on all lift stations to provide more accurate and long-term data for various parts of the system. Alternatively, temporary flow meters could be installed for short term data.
- Develop an annual flow monitoring program to gather data in gravity sewer areas.

The network can then be analysed using the Envelope method or the RTK method to quantify the system performance in relation to I&I. At this point a more detailed and targeted I&I reduction program can be developed. This program would also be informed by subjective analysis of CCTV records.

6.0 Treatment Assessment

6.1 Regulatory Requirements

The wastewater treatment plant is regulated under the BC Municipal Wastewater Regulations (MWR), as well as the Federal Wastewater Systems Effluent Regulations (WSER). The relevant regulatory criteria are listed below;

TABLE 6-1: COMPARISON OF APPLICABLE EFFLUENT QUALITY STANDARDS

Quality Parameters	Hope PCC Effluent Permit No. PE-042125	Provincial Municipal Wastewater Regulation[5]	Federal Wastewater Systems Effluent Regulations
Carbonaceous Biochemical Oxygen Demand (mg/L)	45 max	45 max	25 avg
Total Suspended Solids (mg/L)	60 max	60 max	25 avg
Un-ionized ammonia, NH_3-N (mg/L)	-		1.25 max
Total Phosphorus as P (mg/L)	-	1 max	-
Orthophosphate, as P (mg/L)	-	0.5 max	-
pH	-	6 – 9	-
Acute lethality of effluent to rainbow trout[6]		Non-lethal	Non-lethal

Wastewater Systems Effluent Regulations (WSER)

The federal WSER effluent criteria are as follows;

- The effluent is not acutely lethal
- Average CBOD $\leqslant$ 25 mg/L
- Average TSS $\leqslant$ 25 mg/L
- Average total residual chlorine $\leqslant$ 0.02 mg/L
- Maximum unionized ammonia at 15°C < 1.25 mg/L (as N)

The WSER criteria use average values for many parameters, including CBOD. Flow records for 2015 – 2019 are listed as follows;

[5] Where discharge > 50m^3/d and effluent dilution >40:1.
[6] Reference Method EPS 1/RM/13. Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout (EPS 1/RM/13 Second Edition), December 2000 with May 2007 amendments, published by the Department of the Environment, as amended from time to time.

Year	Average Flow (m^3/d)
2015	2427
2016	2319
2017	2378
2018	2226
2019	2151

Based on average plant flow being less than 2,500 m^3/d, the averaging period should be annual.

For a continuous wastewater system with a hydraulic retention time of five or more days, the determination of the average suspended solids does not take into account the result of any determination of the concentration of suspended solids in a sample taken during the month of July, August, September or October, if that result is greater than 25 mg/L (WSER Part 1 sec 6.5). This is intended to take account of the regular proliferation of algal growth in the lagoons in the warmer months. The weather in Hope can be warm in June, which can lead to algal proliferation prior to the period allowed for. A dissolved air flotation system has been installed for the purpose of removing algae.

Table 6-2 indicates the level of compliance in the period 2016 – 2019. The lagoons were upgraded in 2017 with completion in early 2018. After the lagoons were upgraded, the Hope PCC generally achieved the WSER effluent quality criteria with the results averaged on an annual basis (average flow < 2500m^3/d). Unfortunately, a high TSS result on June 7, 2019 caused the average TSS for 2019 to exceed 25mg/L.

TABLE 6-2: HOPE PCC ANNUAL AVERAGE CBOD / TSS RESULTS

Year	CBOD (mg/L)	TSS (mg/L)
2016	16	**32**
2017	19	**37**
2018	21	24
2019	10	**30**

Note: Excludes TSS Results >25mg/L from July – October.

The WSER requires that the effluent must not be acutely lethal to fish. The acute lethality of the effluent is commonly related to the unionized ammonia concentration, for which the WSER has a limit of 1.25mg/L as N at 15°C. While the total ammonia concentration varies seasonally between 0.1 and 41 mg/L, the average unionized ammonia concentration has remained consistently below this limit.

Despite the low unionized ammonia concentration, there have been regular failures on the acute lethality test in the summer (September) samples. The winter samples typically pass. Total and unionized ammonia levels are low in September due to the higher summer biological activity.

Recent testing indicates that the acute lethality is likely to be a result of elevated nitrite in the effluent. This nitrite appears to be a result of incomplete nitrification. Evidence suggests that nitrification is being inhibited by a lack of alkalinity in the wastewater. Hope water is soft by provincial standards. This issue can be corrected by dosing alkalinity during the period when nitrification inhibition occurs.

Expectations for Compliance if Flows Increase Above 2500m^3/d

If plant flow was to increase above 2,500 m^3/d then the results would be averaged on a quarterly basis. Quarterly average effluent CBOD results have remained below the target average of 25 mg/L since the lagoons were upgraded (from Q2 of 2018) and would be expected to continue to meet this benchmark.

TABLE 6-3: HOPE PCC QUARTERLY CBOD RESULTS

	2016	2017	2018	2019
Q1	21	21	**29**	11
Q2	13	19	21	9
Q3	11	17	7	7
Q4	17	15	7	12

The historical quarterly average effluent TSS results have frequently exceeded the 25mg/L benchmark. Since the plant was upgraded and fully commissioned (the third quarter of 2018) the plant has generally complied with WSER standards. High TSS values were recorded in the second quarter of 2019, but this may be corrected with an increase to aeration rates. In addition, the District can reduce effluent TSS by operating the dissolved air flotation process.

TABLE 6-4: HOPE PCC QUARTERLY AVERAGE TSS RESULTS[7]

	2012	2013	2014	2015	2016	2017	2018	2019
Q1	16	**31**	15	18	**40**	25	**29**	21
Q2	-	23	12	**31**	**27**	**44**	**27**	**46**
Q3	-	20	14	18	-	-	10	24
Q4	15	16	21	**36**	**29**	**43**	12	14

Treatment Performance Compared to the Discharge Permit

The Hope PCC Discharge Permit PE-04125 dates from 1999 and sets limits of 60mg/L on TSS and 45mg/L on $CBOD_5$. The maximum authorized rate of discharge is 8,820 m^3/d.

[7] TSS results over 25mg/L in the months of July, August, September and October were excluded (as is permitted by the Regulation).

Treatment performance has typically achieved these values since the 2017/18 upgrade. The plant consistently achieved the CBOD limit. There have been occasions with TSS values exceeding 60mg/L in the warmer months as a result of algal growth in the lagoons. The dissolved air flotation system will address this issue once it is fully optimised.

Plant Reliability Criteria (MWR)

The MWR specifies levels of infrastructure duplication in order to allow for plant maintenance and for failure of plant components. The WWTP reliability category has been assumed to be 'II', whereby permanent or unacceptable damage to the receiving environment would not be caused by a short-term effluent degradation, but would be caused by a long term effluent degradation. Equipment duplication meets the reliability requirements.

TABLE 6-5: RELIABILITY REQUIREMENTS CATEGORY II PLANT

Components	**Minimum Redundancy Requirement**	**Backup Power Source**	**Compliance Status**
Blowers or mechanical aerators	Multiple units	Optional	Yes
Aerated Lagoons	2 cells	Optional	Yes
Chemical Flash Mixer	No backup	Optional	Yes
Flocculation	No backup	Optional	Yes
Final Sedimentation	2 minimum. Plant capable of 50% of design max flow with largest unit out of service.	Optional	Yes

Summary

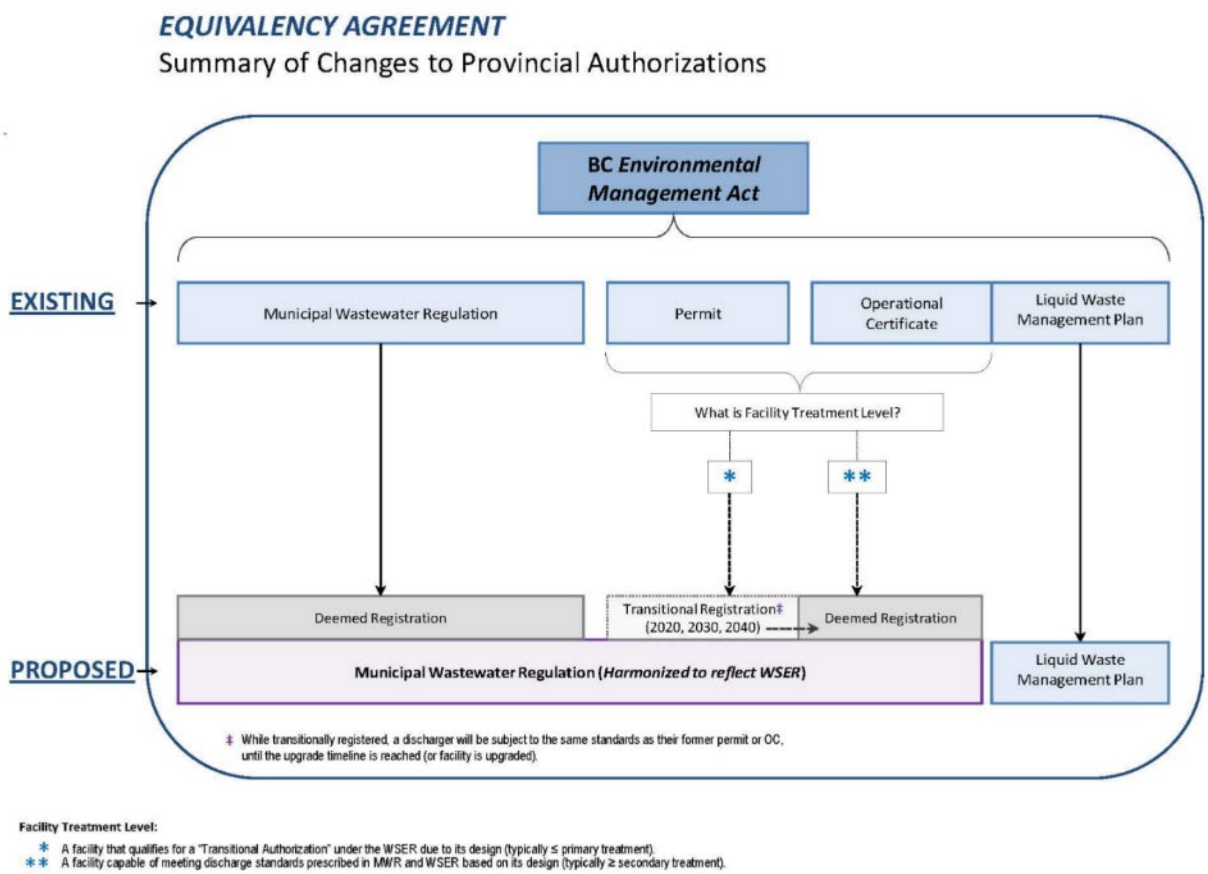
The existing plant infrastructure is sufficient to meet all relevant regulatory requirements.

WSER Harmonization

A regulation harmonization process is being undertaken in order to enable dischargers to meet provincial requirements only, standing down the Wastewater Systems Effluent Regulations (WSER) in BC. The harmonization process will involve migrating permit holders to authorizations under the MWR. It is understood that harmonization discussions between the governments of BC and Canada have been postponed until further notice.

Updating the discharge permit to an MWR authorization would be part of the harmonization process. At that time, the District would need to meet total phosphorus and orthophosphate levels specified by the MWR. The plant could meet these criteria if the coagulation / dissolved air flotation process were to be operated year-round. Operating this part of the plant year-round would increase plant operating costs. Alkalinity dosing is likely to be required in order to successfully use the coagulants most commonly used for phosphorus removal.

FIGURE 6-1: MOE FIGURE EXPLAINING TRANSITION PROCESS



6.2 Options for Improved Treatment

Future upgrades may be needed for population growth, operational improvements and for changes in regulatory requirements. Examples of these improvements are described in this section.

6.2.1 Headworks Structure

In order to effectively remove inorganic litter that arrives with the sewage, it is recommended that a mechanical fine screen system be installed at the headworks.

A 6mm screen would be appropriate for this application. This is a reasonable compromise between effective solids removal and acceptable screen flow capacity. As all flows arrive by force main it would be feasible to install the screen either above or below grade. The structure should have a screened bypass available to enable maintenance. The bypass screen can be cleaned manually. A macerator is commonly installed upstream of the screen unit to reduce the likelihood of jamming of the solids handling equipment. A screenings washer/compactor system would remove faecal matter and organic materials minimizing odours and waste quantity.

An outdoor installation is proposed in order to avoid costs associated with a building and electrical equipment rated for explosive atmosphere compliance. These cost savings will be significant. The operating costs will also be reduced through the deletion of high capacity heating and ventilation for the required 12 air changes per hour. While the outdoor configuration gives the operators and equipment less protection from the elements, it is feasible to add a carport style roof without compromising on explosive gas safety. The equipment can also be fitted with heated covers as protection against freezing. This has been done successfully in much colder locations.

6.2.2 Blower Control to Reduce Aeration Energy Consumption

At present there are three aeration blowers that can only be turned on or off. Their speed cannot be adjusted. This means that the quantity of air delivered to the aerated lagoons can only be adjusted by throttling valves.

The blowers themselves are a very robust design that can be expected to operate for many more years with normal maintenance. It is not likely that the cost of replacing the blowers with more efficient units would be recovered in energy savings.

Therefore, in order to improve plant energy efficiency, it is suggested that one of the blowers could be equipped with a variable speed drive. At present, only the blower equipped with a relatively new motor should be upgraded in this way. The older blower motors are not thought to be compatible with variable speed operation, although a reactor could be used. The variable speed blower would be used to trim the air flow, with the other blowers turned on and off as necessary.

BC Hydro are understood to have a capacity issue in their local network and may give financial assistance to this upgrade.

6.2.3 Treatment Cell Capacity

The first treatment cell is highly loaded. Although negligible dissolved oxygen levels can be achieved in the first cell, at present the loading rate is not sufficient to cause odour that exceeds a normal level for this form of treatment. If these issues reach a point where treatment performance is compromised, or plant odour increases, then additional aeration diffusers should be installed in Cell 1.

6.2.4 Dissolved Air Flotation

The manufacturer of the dissolved air flotation equipment is still working to successfully commission and optimize it. The combination of poor equipment performance and dosing that cannot be fully optimized has led to increased floating debris in Cell 1 from the polymer coated sludge waste from the DAF. This issue must be resolved which may require the replacement of certain process elements with equipment from another manufacturer.

6.2.5 Effluent Disinfection

Because the immediate area of the outfall is not accessible for bathing, and the flow of the Fraser River massively dilutes the effluent, there has not been a historical need for effluent disinfection at the Hope PCC. Nevertheless, future regulations may make it necessary to install an effluent disinfection system. Effluent disinfection would most likely take the form of an open channel ultraviolet disinfection system downstream of the treatment process. An alternative technology that is applied at many sites is peracetic acid dosing. Effluent would then flow by gravity to the outfall. A disinfection system should only be considered if it becomes a requirement for compliance.

6.2.6 Capacity and Treatment Performance Upgrades

In time, as the population of Hope increases and the required treatment standards change, the capacity and treatment performance of the plant may need to be upgraded. There are many alternative approaches to upgrading aerated lagoon treatment systems. These range from simply increasing the aeration intensity (complete mix reactors) to relatively compact, high rate, treatment processes. It would be most likely that the District would choose to increase treatment capacity in an incremental fashion, which may favour processes such as moving bed bioreactors, which are operated in a very similar way to the existing plant, but have a small foot print.

At present there is no requirement to remove total nitrogen or phosphorus in order to comply with regulations. Of course, there is a possibility that these requirements could change. Ammonia removal is currently negligible in winter and this plant is not specifically designed for phosphorus removal. Processes are available which are designed for nitrification of aerated lagoon effluent under winter conditions, including aerated rock filters. Aerated rock filters would have a modest impact on the plant hydraulic profile, but they have a large footprint. The existing site would need to be expanded to allow for this technology. Other, more compact technologies are available that could achieve year-round nitrification. Phosphorus removal would be most likely to be undertaken by coagulation and separation using the dissolved air flotation system.

6.2.7 Outfall Improvements

The District plans to replace the temporary outfall diffuser with a permanent outfall in the near future. This will address the potential for health impacts from an above-ground sewage outfall discharging at the shore of the river during the winter months. The outfall is also achieving less dilution than would be expected in a faster flowing part of the river.

It is recommended that the permanent structure be designed to be advanced into the main channel using trenchless methods suitable for a high percentage of large gravel to cobble sized material. The proposed design incorporates a 600mm diameter high strength steel casing advanced at a downward angle to the main river channel. A 350mm diameter butt-welded high density polyethylene wastewater pipe with a duckbill type check valve at the end would be inserted through the casing to the discharge location. In order to adjust the casing position in the channel, a drilling/tunneling company would return to site to advance or withdraw the casing.

The permanent repair works should be timed to coincide with the annual low-flow period December – March to allow for practicality of installation.

6.3 Natural Hazards

6.3.1 Earthquake Resiliency

Based on hazard mapping, the Hope area appears to be at moderate risk of a damaging earthquake. A major earthquake can be expected to affect the wastewater system. There may be damage to above ground structures such as buildings and treatment lagoons, as well as widespread failure of pipelines underground. Failure modes can include pipe breaks, changes to pipe grade and intrusion by debris. Lift stations in areas subject to liquefaction can fail as a result of uplift. Initially, the main concern would be with loss of power. This is already protected against by the provision of standby power at the critical stations. It is recommended that recovery of service after a major earthquake is included in the planning of future improvements to Pollution Control Centre and lift stations.

6.3.2 Flooding and Geotechnical Hazards

General: The District's Official Community Plan includes maps showing areas of the community that are at risk of flooding and erosion (District of Hope Floodplain and Erosion Areas – Maps 1 – 5) and geotechnical hazards (District of Hope Geotechnical Hazards – Maps 1 – 5).

The maps indicate known natural hazards affecting the wastewater system. The most significant among these are flooding and landslides. The District should consider specific analysis of the hazards affecting wastewater infrastructure in order to mitigate any impacts.

Sewers can be inundated in the event of flooding, but this issue is temporary and would be expected to be localized.

Pollution Control Centre: There is a risk of flooding at the Pollution Control Centre. The original control building floor and the treatment lagoons are set above the estimated local 200 year flood level based on the Fraser River. The provincial flood plain mapping for the Fraser River indicates a 200-year flood level for the area of the PCC at 38.5m. The ground level around the plant was originally constructed on this basis and is generally around 38.8 - 39.3m.

There should not be significant damage to the lagoons from inundation by slow moving flood water, but it is possible that the older electrical equipment in the control building would be affected. The plant may need to be shut down for safety in the event of this scale of flooding. The District may consider raising the blowers onto higher supports to provide additional flood protection.

The District has identified Flood Construction Levels in the 2016 Official Community Plan (District of Hope Floodplain and Erosion Areas – Map 2). The recommended construction elevation at the plant site is identified as being 40.1m. The new DAF building floor is constructed at this level, with most equipment being higher still. The floor elevation of the original control building is at

39.5m, with the blower motors being around 40.0m in elevation. New electrical panels in the building are also raised above the floor level as protection.

It should be noted that there is a steep drop in hydraulic grade on Silverhope Creek through the Tom Berry bridge (41.5m to 40.1m). This indicates that the bridge is a constriction in the creek and would be prone to overtopping, especially under debris events. A site-specific flood assessment would be needed to determine where the water would go during such an event.

7.0 Recommendations

7.1 Introduction

The recommendations described in the Master Plan have been summarized in this section. The improvements listed may be categorized as;

- Projects to improve the level of service within the existing service area
- Projects triggered by new development, and
- Administrative improvements, including continuation of existing programs.

7.2 Administrative Recommendations

7.2.1 Sewer Connection Bylaw

The District is aware of the potential impact of new and existing commercial and industrial wastes on sewers and wastewater treatment plant capacity. The District wishes to be proactive in providing regulation and 'best practice' guidelines to dischargers to curb this impact.

The District is in the process of implementing a Sewer Connection Bylaw, which will include basic conditions for discharge to the municipal sewer. The bylaw will require the pH of wastewater disposed of to the to be within the range 6 – 10.5 in order to protect the sewer network from corrosion, as well as to protect workers in case of accidental contact.

Certain discharges will need to be monitored for the purpose of determining compliance and potentially as a basis for setting user charges. Most discharges in Hope are small and do not warrant the effort of regular monitoring. An exception is the Nestle Waters facility. The following recommendations apply to the monitoring of this discharge;

- The effluent flow should be metered
- A composite sampler linked to the flow meter should be used to collect samples
- These samples should be analysed for BOD, TSS and pH initially, with other parameters added based on expectations for impact on treatment.

7.2.2 Update DCC Bylaw

The improvements described in this Master Plan should be appropriately considered by the provisions of the Development Cost Charge bylaw. The District should review the bylaw and make appropriate changes. This is also described in the following section (7.5 Financing).

7.2.3 Asset Management Plan

Asset management planning represents a commitment to recording and evaluating asset information in order to develop informed plans for the operation, upkeep, replacement, and financing of community infrastructure. Asset management gives a community tools for efficiently managing assets as well as planning for the costs associated with owning them. Due to the benefits of asset management, adequate asset management planning is increasingly becoming a condition of senior government grants.

An Asset Management Plan (AMP) document describes;

- what information should be recorded,
- where it will be kept,
- who is responsible for the information,
- defines tools to record and manipulate the data, and
- what the information developed from the data will be used for.

An AMP generally results in the creation of a data registry (a location for storing asset data). Along with a registry, tools for analyzing the data are often developed.

The data registry may include the following basic information; Identification, location, age, life expectancy, replacement value. The following additional information is also useful; condition, actual level of service and target level of service.

As an example, asset management planning will be a key tool in scheduling pipeline replacement or renewal. To assist in the development of the sewer main replacement program, the District's mains have been inventoried on a segment basis. Each segment represents a length of main between two manholes which therefore would represent a logical stand-alone replacement project. As part of an asset management plan the District would prioritize the replacement of sewer mains based on selection criteria. Likely criteria to be used in the replacement of the various segments are briefly described as follows;

Pipe age: Pipe age in relation to the anticipated service life based on pipe type is not a particularly useful prioritization factor for sewers. Pipe age would suggest that the oldest sewer mains be replaced first but the pipe condition can be strongly influenced by factors such as H_2S corrosion and issues like root intrusion. The age distribution of the District's sewer mains is illustrated in Figure 2-2.

Asset condition: Relatively little has been known about the condition of the sewer system assets in the past. The District has been working to address this knowledge gap with annual CCTV surveys of sections of the sewer network. In addition, the report "Condition Assessments of Roadway Structures, Water Mains, Storm Sewers, and Sanitary Sewers" prepared by Omega & Associates Engineering Ltd in 2015 incorporated a condition assessment of road, water storm and sanitary sewer assets. The study noted some issues with the condition of sewer utilities. Based on the findings it is likely to be common for storm / sewer utility assets to require replacement. When this work is undertaken the cast iron and AC water pipes should also be replaced. Afterwards, a full width road restoration can be completed.

Level of Service: Because there is currently surplus capacity in the network, the business case for sewer replacement for capacity enhancement is relatively weak in comparison with other District priorities.

As a result, the sewer replacement work is to be limited to areas where infiltration is severe and there is a risk of pipe failure and consequently loss of service. Measures that are commonly taken to address these issues are the sealing or raising of manhole lids, repairing broken sewers and requiring the disconnection of illegal stormwater connections to the sanitary sewer.

7.3 Short Term Capital Improvements

It is recommended that a number of lower cost improvements are made in the short term to improve sewer network serviceability and reliability.

TABLE 7-1: SHORT TERM IMPROVEMENTS

Project	Est. Cost
Pollution Control Centre Headworks and Influent Flow Meter	$650,000
Pollution Control Centre Permanent Outfall	$690,000
Lift Station and PCC SCADA Improvements	$600,000
Nestle wastewater flow meter	$20,000
Annual sewer lining / rehabilitation budget.	~$100,000 /year
Annual Flow Monitoring Program and Reporting	~$40,000 /year
Extension of sewer service within Silver Creek	TBD

In addition, a number of investigations and studies are proposed, including;

- Monitoring to identify the main sources of inflow and infiltration. This would start with the installation of an ultrasonic flow meter upstream of the Coquihalla Lift Station. The monitoring equipment would be moved from location to location to gather the necessary data. A permanent flow meter could also be considered for the Coquihalla Lift Station if the recommended PCC headworks project is delayed.
- Periodic review of sewer model findings / conclusions. Update the Subdivision and Development Servicing Bylaw based on review of the sewer model.
- Ongoing CCTV surveys of the sewer network (general data collection as well as review of sewer condition in specific locations prior to road or water upgrade projects).
- Commence regular sampling and flow monitoring of industrial discharges.
- Review asset financial investment plan.

7.4 Financing

Sewer system capital improvements are typically financed from any or combinations of the following:

- User fee / sewer tax revenue
- Borrowing (Municipal Finance Authority debentures)
- Development cost charges
- Developer contributions

- Grants from senior governments

7.4.1 User Fees

Some portion of the capital improvement program is likely to have to be financed by increasing the user fee rate structure. The District's annual 2020 utilities budget is summarized as follows;

Revenue	
Parcel taxes	91,000
Sales of Services	460,000
Transfers from other governments	975,000
Development Cost Charges	177,500
Total Revenues	**1,703,500**
Expenses	
Wages and benefits	135,000
Insurance	19,400
Office and administration	11,600
Contracts, Materials and supplies	177,000
Utilities	106,300
Vehicles	50,000
Total expenses	**499,300**
Subtotal Expenses	
Interest	**19,900**
Amortization	**365,000**
Operating Budget Surplus	**819,300**

In the above summary, amortization is a non-cash expense and largely represents depreciation of the value of the sewer infrastructure. To a degree, the allowance for depreciation could be "used" to replace aging infrastructure such as sewer mains approaching the end of their service life. Recognizing amortization as a non-cash expense, the District's 2020 wastewater utility has a budgeted annual surplus of $1,184,300 before capital expenditures and reserve transfers. The operating surplus is expected to be allocated to I&I program implementation, replacement of aging infrastructure as well as improvements to the sewer system.

Depending on the planned capital works program, the District may choose to set a new funding target and adopt a series of user fee rate structure increases, to eventually reach this goal.

7.4.2 Development Cost Charges

Capital projects having the objective of providing additional capacity and/or improving system reliability are typically eligible projects for a development cost charge bylaw. A report was prepared in 1994 calculating development cost charges for water, sewerage and drainage facilities, this report has not been updated to reflect current projects, although this will be an outcome of this master plan.

The District does not currently have a stand-alone development cost charge bylaw. Development Cost Charges are authorized under the Fees and Charges Bylaw No. 1363.

7.4.3 Gas Tax revenue

Annual Gas Tax revenue can be used for wastewater system rehabilitation projects. The District will need to determine what projects are a priority for use of the Gas Tax revenue.

7.4.4 Senior Government Grants

These projects can be eligible for grants from senior governments if a significant benefit, particularly water quality improvements, can be demonstrated. Senior Government Grant programs attach a higher priority to wastewater projects that would have environmental benefits.

APPENDIX A

Capital Cost Estimates

DISTRICT OF HOPE
PCC UPGRADES

DESCRIPTION	UNIT OF MEASURE	ESTIMATED QUANTITY	UNIT PRICE	TOTAL
PCC Headworks				
TABLE 9-1:				
Plug and bypass	LS	1	20,000	20,000
Control chamber c/w gate	LS	1	70,000	70,000
Remove forcemain and replace with gravity main	LS	1	20,000	20,000
Tie-in to existing at bar screen	LS	1	5,000	5,000
Channel excavation	LS	1	10,000	10,000
Concrete channel	cu.m.	17.5	2,000	35,000
Slide gates	LS	1	40,000	40,000
1500Ø FRP lined manhole	LS	1	20,000	20,000
Interconnect piping	LS	1	5,000	5,000
Supply grinder, screen, auger	LS	1	175,000	175,000
Install grinder, screen, auger	LS	1	30,000	30,000
Power supply and appurtenances	LS	1	15,000	15,000
Backfill / restoration	LS	1	5,000	5,000
Commissioning	LS	1	5,000	5,000
Subtotal				**455,000**
+ Eng and Contingency				**191,000**
Total				**646,000**
PCC Permanent Outfall				
TABLE 9-1:				
Insurance and bonding	LS	1	30,000	30,000
Mobilization	LS	1	20,000	20,000
Environmental protection	LS	1	100,000	100,000
Augering pit	LS	1	20,000	20,000
600Ø casing	LS	1	205,000	205,000
350Ø HDPE outfall pipeline	LS	1	70,000	70,000
Check valve	LS	1	10,000	10,000
Tie-in to existing	LS	1	10,000	10,000
De-mobilization	LS	1	20,000	20,000
Subtotal				**485,000**
+ Eng and Contingency				**204,000**
Total				**689,000**

DISTRICT OF HOPE
ELECTRICAL UPGRADES

DESCRIPTION	UNIT OF MEASURE	ESTIMATED QUANTITY	UNIT PRICE	TOTAL
Telemetry / SCADA upgrades				
TABLE 9-1:				
5.8 GHz Radio / Cellular Backup	ea.	1	10,000	10,000
Convert autodialler to cellular modem	ea.	11	5,000	55,000
Convert hardwired control to PLC	ea.	11	30,000	330,000
Win911 Alarming Licenses & Hardware	LS	1	10,000	10,000
Upgrade existing SCADA system (Server & Software)	LS	1	60,000	60,000
Subtotal				**465,000**
+ Eng and Contingency			30%	**140,000**
Total				**605,000**

APPENDIX B

Sewer Asset Summary

Summary of Sewers by Decade and Material

	Asbestos Cement	Cast Iron	CIPP	Clay	CP	Ductile Iron	Galvanized	HDPE	PVC	Reinforced Concrete	Steel	Vitreous Clay	
Forcemain													
1970s						1526		1711					3237
1980s	200						238	674	506				1618
1990s						492			323				816
2000s								732					732
2010s			139					1131					1270
Sub Total	**200**		**139**			**2019**	**238**	**4248**	**829**				**7672**
Gravity main													
1960s	14530			227					176			33	14966
1970s	13105	152			276	49			3009	94	74	443	17203
1980s	6874					131			1851				8855
1990s	69					29			5980				6078
2000s									2177				2177
2010s	280							366	1225				1871
Sub Total	**34859**	**152**		**227**	**276**	**209**		**366**	**14418**	**94**	**74**	**476**	**51150**
Grand Total	**35059**	**152**	**139**	**227**	**276**	**2227**	**238**	**4614**	**15248**	**94**	**74**	**476**	**58823**

Summary of Sewers by Diameter and Material

	Asbestos Cement	Cast Iron	CIPP	Clay	CP	Ductile Iron	Galvanized	HDPE	PVC	Reinforced Concrete	Steel	Vitreous Clay	Grand Total
Force Main													
50							237.6						238
100									829.3				829
150	200.1					492.4		1406.3					2099
250								1131.3					1131
350						1526.1							1526
400								1710.8					1711
450			138.5										139
Sub-Total	**200.1**		**138.5**			**2018.5**	**237.6**	**4248.4**	**829.3**				**7672**
Gravity Main													
100	386.3								365.9				752
150	3937.6					130.9		239.4	2529.5			33.1	6871
200	20532.8	97.6		227				119.7	10109			442.5	31529
250	2929.9								172.6				3103
300	3923.2	54.4							359.7				4337
350	783.5					49		6.4	549.3		74		1462
375	121.8									94.2			216
400	1645.1					28.8							1674
450	522.8				276.4				332.4				1132
500	56.7												57
600	18.9												19
Sub-Total	**34859**	**152**		**227**	**276.4**	**208.6**		**365.5**	**14418.3**	**94.2**	**74**	**475.6**	**51150**
Grand Total	**35059**	**152**	**138.5**	**227**	**276.4**	**2227.2**	**237.6**	**4613.9**	**15247.6**	**94.2**	**74**	**475.6**	**58823**