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# Gillies Bay Master Water Plan

**Final Report**
**July 2016**
**KWL Project No. 3458.002-300**

**Prepared for:**

**Gillies Bay Improvement District**

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# Executive Summary

Gillies Bay is a small residential community of approximately 550 people located on the northwest coast of Texada Island in the Powell River Regional District. The water system is owned and operated by the Gillies Bay Improvement District (GBID). The system draws water from Cranby Lake and is comprised of the following:

- 4,000 m of 100 mm dia. AC pipe;
- 5,000 m of 150 mm dia. AC pipe;
- 300 m of 300 mm dia. C900 PVC pipe;
- a pump station with four hydro-pneumatic tanks;
- 33 fire hydrants;
- 27 150 mm dia. valves; and
- 15 100 mm dia. valves.

Previous reports about the GBID water system raised the following concerns.

- The demand exceeds the amount of water allowed by the existing water licences.
- The water treatment process is inadequate given the raw water quality.
- The storage tank volume is undersized for fire flow, emergency and balancing storage and is at insufficient elevation to provide adequate pressure across the distribution system.
- The distribution system is undersized for fire protection and has not been expanded based on a structured plan.

The GBID retained Kerr Wood Leidal Associates Ltd. (KWL) to develop a Master Water Plan to improve the water treatment, storage and water distribution system as funding becomes available over the next 20 years. The objectives of the Master Water Plan were to:

- ensure proper treatment and optimized disinfection;
- ensure sufficient storage for fire flows, balancing, and emergency storage;
- increase system capacity and pressure;
- reduce water wastage and operating costs; and
- provide the GBID with a “road map” that will assist them in setting budgets for priority improvement projects, and to get the best value for money during emergency expenditures through reference to the master plan.

The Master Water Plan was developed in consultation with GBID staff. This report first identified the basis for design with relevant design criteria then identified recommendations to allow the GBID water system to address existing system deficiencies and meet the identified criteria. Finally, it summarized the identified recommended improvements in a concise manner that can be readily used by the GBID in the planning, design and construction of water system upgrades. Over the next 20-years, it was recommended that the GBID budget the following:

- $6,279,000 for high priority items (to be completed within 5-year timeframe);
- $1,727,000 for medium priority items (to be completed within 10-year timeframe); and
- $1,987,000 for low priority items (to be completed within 20-year timeframe).

This budget was based around water system improvements to improve drinking water quality, increase fire protection capabilities, and decrease water loss.

# 1. Introduction

Gillies Bay is a small residential community located on the northwest coast of Texada Island in the Powell River Regional District. The water system is owned and operated by the Gillies Bay Improvement District (GBID). Water is supplied from Cranby Lake, a shallow surface water source with colour, organic content and turbidity. Lake water is siphoned over the impoundment dam and through approximately 560 m of 150 mm supply main to a chlorination station where hypochlorite is added. It then flows downhill another 1,200 m to the distribution system. A small bolted steel tank reservoir with an altitude valve is located in this section of the supply line. The altitude valve has been adjusted so that the tank continuously overflows to maintain a chlorine residual. The excess treated water is returned overland to a ditch. Under normal operating conditions, the reservoir is “off-line” and system pressures are based on the elevation of the lake. During fire flows, the reservoir comes “on-line” and its lower Top Water Level (TWL) controls the pressure in the system. The system has a pressure booster station (hydro-pneumatic tanks) to increase pressure in the far reaches of the system. Refer to Figure 2-1 for a plan of the existing system.

Since 1988 there have been several studies completed on various aspects on the water system. The two key reference reports are:

1. Water Treatment Strategy, Final Report (Anderson Civil, 2007); and
2. Water Treatment Strategy, Final Report (Anderson Civil, 2015).

These reports raised the following concerns about the current water system:

- The demand exceeds the amount of water allowed by the existing water licences.
- The water treatment process is inadequate given the raw water quality.
- The storage tank volume is undersized for fire flow, emergency and balancing storage and is at insufficient elevation to provide adequate pressure across the distribution system.
- The distribution system is undersized for fire protection and has not been expanded based on a structured plan.

The GBID retained Kerr Wood Leidal Associates Ltd. (KWL) to develop a Master Water Plan to improve the water treatment, storage and water distribution system, as funding becomes available.

## 1.1 Project Objectives

The main objectives of the Master Water Plan are to:

- Ensure proper treatment and optimized disinfection;
- Ensure sufficient storage for fire flows, balancing, and emergency storage;
- Increase system capacity and pressure;
- Reduce water wastage and operating costs; and
- Provide the GBID with a “road map” that will assist them in setting budgets for priority improvement projects, and to get the best value for money during emergency expenditures through reference to the master plan.

# 2. Basis for Design

This section outlines the design criteria upon which the Master Water Plan is based. This includes the geographical study area, design horizon, population projections, supply characteristics and constraints, current and future water demand, fire protection requirements, storage requirements, distribution system pressures and arrangement, and treatment requirements.

## 2.1 Study Area

The existing Gillies Bay service area is identified in Figure 2-1. The geographical scope of the Master Water Plan is expanded from the existing Gillies Bay service area to include the potential of servicing the Shelter Point system which has another 42 lots located approximately 1 km south of Gillies Bay (refer to Figures 2-1 and 2-2).


**Figure 2-1: Existing GBID Service Area**

**Figure 2-2: GBID and Shelter Point Service Areas**

The water systems at Shelter Point are privately owned and operated. In 2008 they were issued a directive by Vancouver Coastal Health (VCH) requiring them to take steps to improve their systems to meet the requirements of the *Drinking Water Protection Act* and *Drinking Water Protection Regulation*. The GBID identified a potential to connect the Shelter Point system to Gillies Bay system and deliver water to the residents of Shelter Point and potentially recoup any additional costs through any one of a number of opportunities yet to be determined.

## 2.2 Design Horizon

This Master Water Plan is based on a 20-year design horizon. The planning periods for this project have been set to:

- 5-year Plan: Urgent or high-priority tasks;
- 10-year Plan: Medium-priority tasks; and
- 20-year Plan: Low-priority tasks.

For modelling purposes the potential future connection of Shelter Point was assumed to occur at the 10-year (and beyond) planning horizon after the main supply line along Gillies Bay Road has been upgraded. The plan however is sufficiently flexible to allow for connection of the Shelter Point at any time after completion of the new reservoir and water treatment system.

## 2.3 Population

From previous reports, the existing population of Gillies Bay was estimated at approximately 544 people based on 259 current connections (occupancy of 2.1 people per connection). The Shelter Point area was assumed to be fully built out with 42 connections and a total connected population of 105 people. These estimates for the current population are summarized in the following Table 2-1.

**Table 2-1: Existing Population**

| Community | Number of Connections | Current Population |
|---|---|---|
| Gillies Bay | 259[1] | 544[2] |
| Shelter Point | 42[3] | 105[3] |
| **TOTAL** | **301** | **649** |

1. Provided by GBID staff.
2. Based on occupancy of 2.1 people per connection from 2007 Anderson Civil Report.
3. KWL 2014 Water Treatment and Distribution Concept Technical Memorandum. Assumes that Shelter Point is fully built-out.

Based on discussions with GBID staff, the population of Gillies Bay has fallen by approximately 30% in the last 15 years as commercial activities have declined in the area. Given the reduction in population, it was determined that utilizing a percent annual growth rate (or decline) was not appropriate to project the population for the 20 year master planning period. Instead, the population was projected assuming that all lots within the GBID service area will be connected at the end of the study period. Additionally, the GBID identified lots which have potential for development were assumed to be subdivided and connected by the end of the study period. Figure 2-3 provides an overview of the current and future connections as well as potential future development lots where more connections will exist in the future within the same lot boundaries (i.e. a large lot that currently has one house, but could support three is assumed to have three connections in the future case). The future population was then determined assuming the same occupancy of 2.1 people per connection.

A review of available lots in Gillies Bay suggests that build out for the design horizon could add approximately 95 connections to the current inventory. The total number of future connections was used to determine the future population projections, which are presented in the following Table 2-2.

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**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Reservoir
- Booster Pump
- Hydrant
- Contour Index (10m)
- Contour Intermediate (2m)

**Existing Water Mains**

- 100 mm dia
- 150 mm dia
- 300 mm dia

**Service Connections**

- Existing Connections
- Potential Future Lot Division
- Potential Future New Connections

**Note**: Potential future lot division (dark green) represents lots that may be developed to have multiple connections (houses) in the future.

**Reference**: Orthophoto provided by Powell River Regional District.

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# Existing and Future Serviced Lots

**Figure 2-3**

**Table 2-2: Future Population Projections**

| Community | Number of Future Connections | Future Population |
|---|---|---|
| Gillies Bay | 354 | 758[1] |
| Shelter Point | 42 | 105[2] |
| **TOTAL** | **396** | **863** |

1. Assumes all parcels are connected and lots which have potential for development have been subdivided.
2. KWL 2014 Water Treatment and Distribution Concept Technical Memorandum. Assumes that Shelter Point is fully built-out.

Accordingly, the design horizon population used for the master plan will be 863.

## 2.4 Supply

### Surface Water

#### Water Licences

The GBID currently owns three diversion water licences and one storage licence; details are summarized in the following Table 2-3.

**Table 2-3: GBID Water Licence Summary**

| Licence Number | Type of Licence | Source | Date Issued | Volume Allowed | Status |
|---|---|---|---|---|---|
| 27762 | Diversion | Cranby Lake | Jan. 28, 1963 | 30,000 gal/d (113.6 m³/d) | In use |
| 24579 | Diversion | Ball Park Creek | Feb. 2, 1959 | 500 gal/d (1.9 m³/d) | Not in use |
| ? | Diversion | Halley Creek | ? | 20,000 gal/d (77.8m³/d) | Not in use |
| 120005 | Storage | Cranby Lake | Oct. 14, 2004 | 310 acre feet per annum (382,379 m³/year) | Issued in substitution of Licence 27763 |

The GBID is currently only using the Cranby Lake storage and diversion licences. From previous flow records, it appears that the GBID is using more water than allowed by their licence (113.6 $m^3$/d) and, on occasion, up to 925 m³/d. A report by the B.C. Department of Lands, Forests and Water Resources from 1965 indicated that Cranby Lake has a storage capacity of 200 million gallons and a 1988 Report by John Motherwell & Associates indicated that the lake has ample supply, but no value was quantified. In 2000, a watershed assessment was completed for Priest Lake, Cranby Creek, and Ballpark Creek; however this assessment did not identify a safe yield for Cranby Lake. A watershed supply analysis will need to be completed to determine the safe yield. Prior to system upgrades the GBID should complete this watershed analysis to determine the safe yield from the lake and apply for an additional Cranby Lake water diversion licence to support current and future demand.

Detailed information about water quality is provided in Section 2.10, but the water quality of Cranby Lake can be generally described as having high total organic carbon, colour and turbidity.

## Groundwater

Given the high total organic carbon, colour and turbidity in the Cranby Lake water, the GBID has considered developing a groundwater source in the area.

In 1989 Pacific Hydrology Consultants (PHC) was retained to conduct an evaluation of the feasibility of developing a groundwater source to supply the community of Gillies Bay. In their report, PHC noted that well records for seven wells in the area indicated estimated individual capacities between 1.5 gpm and 5 gpm (2,200 to 7,200 gal/d or 8 to 27 m³/d). Based on their investigations, PHC concluded that any wells drilled in the bedrock would have very low capacities (insufficient to supply the Gillies Bay community). However, in their review of the local geology, they identified an area northwest of Gillies Bay which is described in geological terms as Quadra Sand. This sand is thought to have been deposited as an outwash blanket in front of glaciers advancing from the southern coastal mountains on the Mainland into the Georgia Depression during late Wisconsin time. PHC felt that this Quadra Sand constituted a potential source of groundwater that warranted further investigation. They recommended a three-hole test-production drilling program with a total cost of $39,180 (approximately $68,000 in 2016 dollars) with a total risk cost $28,000 (approximately $50,000 in 2016 dollars) and an estimated chance of success of 40%.

In 2014, a proposal was submitted to the GBID by Kalwij Water Dynamics (KWD) which also proposed a test-well drilling program in the Quadra Sand area northwest of Gillies Bay. This area is directly below Cranby Lake. As such, there may be more water available than from rock wells, but the quality is not expected to differ significantly from that of Cranby Lake. The total cost estimate for their proposed program ranged from $98,705 to $169,842 (approximately $101,000 to $174,000 in 2016 dollars).


**Test Well Area Recommended by KWD**

Both of these proposals suggested that sufficient groundwater might be present, but it would cost between $70,000 and $174,000 to confirm. This money could be spent on a drilling program without finding water. Additionally, the proposed work programs focused on available water quantity and not on water quality. The quality of groundwater must also be considered when determining the most appropriate water supply because if the groundwater is not of sufficient quality or considered to be under the influence of surface water, filtration and disinfection would likely be required to meet the *Guidelines for Canadian Drinking Water Quality Guidelines* (GCDWQ).

The water quality of Cranby Lake has been extensively monitored over a 40 year period so the water quality is well understood (refer to Section 2.10). To gain an understanding of the potential water quality of available groundwater, GBID staff contacted Vancouver Coastal Health to inquire about water quality from private wells in the area. Their Environmental Health Officer noted that while some wells have acceptable water quality, others in the area have elevated levels of antimony, arsenic, selenium and uranium. The Shelter Point area also has several wells. One drilled well in the Shelter Point area was over-pumped leading to saltwater intrusion and others have elevated levels of metals (aluminum, iron, manganese, sodium, arsenic, and fluoride). The majority of other wells on Texada island have been dug instead of drilled which means that they typically don't have elevated levels of metals, but they would be considered a surface water source which can have bacteriological issues.

Table 2-4 presents a summary of the potential benefits and risks of groundwater investigations.

**Table 2-4: Groundwater Investigation Benefits and Risks**

| Pros/Opportunities |
|---|
| Groundwater could be better quality than Cranby Lake water. If the water quality is adequate and consistent, treatment requirements could be less onerous to meet requirements acceptable to the health authority. |
| **Cons/Risks** |
| The GBID could spend $70,000 - $175,000 and not find water. Pacific Hydrology Consultants estimated a possible 40% success rate with a test well drilling program in 1989. |
| The quantity of available groundwater could be insufficient to supply the Gillies Bay community. |
| The quality of available groundwater could not be sufficient to avoid filtration and disinfection. |
| Given the sandy nature of the proposed drilling area, the well could be considered to be under the influence of surface water (Groundwater Under Direct Influence of Surface Water - GUDI or Groundwater at Risk of Containing Pathogens - GARP). |
| If groundwater were to be considered GUDI/GARP a long term water quality monitoring program would be required to determine if the source would be eligible for filtration exemption/deferral. Organic carbon levels would also likely remain elevated which could lead to high levels of disinfection by-products in water supplied to the community. |
| A licence for groundwater would be required under the new Water Sustainability Act. |

Given the high cost and risks along with the limited potential for savings with a groundwater source, it is recommended that the GBID continue to rely on Cranby Lake as its water supply.

## 2.5 Demand

The GBID provided historical water consumption data from 2006 to 2014. The 2010 and 2011 data was excluded from analysis based on measurement errors. With the 2010/2011 data excluded, the average maximum day demand (MDD) for this period was determined to be 703 m³/d. No historical flow data was available for the Shelter Point area. The current MDD was compared to the volume expected from the 2012 Design Guidelines for Rural Residential Community Water Systems (DGRRCWS) and found to be significantly (11%) higher than expected. Based on discussions with GBID staff, it is anticipated that there is a significant leakage within the distribution system. In addition, the MDD numbers are somewhat skewed by the current practice of regular flushing to maintain water quality. Flushing records were provided and a flushing allowance has been added to the MDD calculation to achieve better alignment with the guidelines.

From previous reports, the historical consumption of Gillies Bay was estimated as high as 925 m³/d. The MDD for the Shelter Point area was calculated using the DGRRCWS to be 160 m³/d. As the Shelter Point area is assumed to be fully built out, the present MDD will remain unchanged for the remainder of the design horizon. These estimates for the current MDD are summarized in the following Table 2-5.

**Table 2-5: Current Maximum Day Demand**

| Community | Historical | Report |
|---|---|---|
| Gillies Bay | 703 $m^3$/d [1] | 925 $m^3$/d [2] |
| Shelter Point | Not supplied by GBID | 160 $m^3$/d [3] |
| **TOTAL** | | **1,085 $m^3$/d** |

1. Based on flow records provided by GBID for 2006 – 2014 period excluding 2010 and 2011.
2. McElhanney 2006 Water Supply System Upgrading Options Report.
3. KWL 2014 Water Treatment and Distribution Concept Technical Memorandum.

The existing system was modelled with 703 $m^3$/d demand divided evenly between 259 service connections.

The future MDD was calculated based on the DGRRCWS utilizing the same irrigable area, the future projected population identified in Section 2.3 (utilizes the same occupancy of 2.1 people per connection) and 50% of the current flushing allowance. It was also assumed that most if not all of the existing pipes will be replaced over the study period; therefore for the future case, the leakage coefficient was reduced from 12 to 5 which is typical for a newer system. This calculation methodology yielded a projected future MDD for the Gillies Bay community of 633 $m^3$/d. Demand calculation details are provided in Appendix A.

Given that the projected MDD for Gillies Bay (633 $m^3$/d) is lower than the current (703 $m^3$/d) and historical (925 $m^3$/d) MDD an intermediate MDD of 870 $m^3$/d was chosen to be conservative and allow for a future Shelter Point connection.

**Table 2-6: Future Maximum Day Demand**

| Community | Prior Reports | Rural Design Guidelines | Selected MDD |
|---|---|---|---|
| Gillies Bay | 1,260 $m^3$/d [1] | 633 $m^3$/d | 870 $m^3$/d [3] |
| Shelter Point | 160 $m^3$/d [2] | 160 $m^3$/d [2] | |
| **TOTAL** | **1,420 $m^3$/d** | **793 $m^3$/d** | |

1. Anderson Civil 2007 Water Treatment Strategy Final Report.
2. KWL 2014 Water Treatment and Distribution Concept Technical Memorandum. Assumes that Shelter Point is fully built-out.
3. Selected MDD balances historical, current and future demands and allows for future Shelter Point connection. Also, when required balancing flow is combined with emergency and fire storage this MDD yields a standard tank size which optimizes the cost of the storage tank.

The future system was modelled with a 710 $m^3$/d (i.e. 870-160) demand distributed evenly between 354 future service connections in the GBID service area. Within the model the Shelter Point demand of 160 $m^3$/d was included as a point demand at the end of the GBID pipe on Gillies Bay Road which extends towards the Shelter Point community. Combined, the total system MDD was 870 $m^3$/d as identified above. It should be noted that the distribution network naturally will have a much larger capacity than required to convey the future MDD because it is designed to accommodate a fire flow of 60 L/s (5,200 $m^3$/d) which allows greater flexibility in the future system.

## 2.6 System Pressures

In accordance with the 2012 DGRRCWS, all watermains must be designed so that system pressures remain above 140 kPa (20 psi) during simultaneous maximum day and fire flow demands. In addition, the pressure in a distribution system during peak hour demand (assumed to be 1.5 x MDD) should not be generally greater than 700 kPa (100 psi) nor less than 280 kPa (40 psi).

## 2.7 Fire Protection

### Fire Flow Delivery Requirements

Water system infrastructure must be designed to protect the community in the case of fire. There needs to be sufficient volume of water for fighting fires, and it must be delivered from a suitable elevation to maintain system pressures to all residents during such an event. Infrastructure has to be adequately sized to deliver fire flows to hydrants, and hydrants must be appropriately spaced to ensure adequate coverage.

The GBID did not provide a local design criteria guideline for fire protection. Based on the size and number of connections in the system, KWL has chosen to use the 2012 DGRRCWS.

Available information indicates that Gillies Bay does not have any large Industrial, Commercial or Institutional (ICI) buildings that would require a fire flow of 150 L/s available for two hours. The largest commercial building in the community is a wood frame building no larger than 2,000 sq ft. Based on the foregoing, the fire protection standard for the design horizon has been selected in consultation with the GBID Fire Chief, as follows.

**Residential:** A fire flow of 60 L/s with a residual pressure of 140 kPa (20 psi) available for an hour and a half (90 min). This aligns with the MMCD requirements for residential construction and conforms to the Fire Underwriter's Survey of Canada fire protection guidelines.

**ICI Buildings:** New ICI buildings are to be constructed with sprinkler systems capable of delivering 25 L/s (plus simultaneous MDD demand) at a residual pressure of 240 kPa (35 psi) for 30 minutes.

### Fire Flow Coverage

Typical system planning guidelines call for 150 m spacing of hydrants, although a maximum spacing of 180 m is often used in rural areas. This will result in a maximum coverage for each individual hydrant of 75 m or 90 m radius, respectively. A 75 m radius was used in the development of this Master Water Plan.

## 2.8 Storage

The existing reservoir is a bolted steel tank with a volume of 26,700 imperial gallons (121.4 m³). It is located off the Airport Road approximately 300 m west from the intersection of Airport Road and Pine Street. Elevations were estimated based on contour information and measurements by the water system operator. The tank has a bottom water level (BWL) of 52.1 m and a Top Water Level (TWL) of 56.9 m elevation. Water does not flow through the reservoir en route to the water distribution system, but instead draws and overflows a small volume of water to maintain adequate chlorine residual. The tank only comes online when there is a fire flow level of water demand in the system.

## Storage Requirements

Reservoirs store water for three purposes:

- fire protection (required fire storage for this project is 60 L/s for 90 minutes, for a total of 324 $m^3$);
- meeting consumer demands during peak usage times over the day (required balancing storage is calculated as 25% of MDD); and
- redundancy of supply (emergency storage is calculated as 25% of fire plus balancing storage).

The following Table 2-7 shows calculations in accordance with applicable standards.[1]

**Table 2-7: Required Reservoir Storage**

| A. Fire Storage | Current | Future |
|---|---|---|
| Required Flow Rate | 60 L/s | 60 L/s |
| Duration | 90 min | 90 min |
| **Fire Storage Volume Required (A)** | **324 $m^3$** | **324 $m^3$** |
| **B. Balancing Storage = 25% MDD** | **Current** | **Future** |
| MDD | 703 $m^3$/d [1] | 870 $m^3$/d [2] |
| Balancing Volume Ratio | 25% | 25% |
| **Balancing Volume Required (B)** | **176 $m^3$** | **218 $m^3$** |
| **C. Emergency Storage = 25% (A + B)** | **Current** | **Future** |
| Balancing + Fire Storage | 500 $m^3$/d | 542 $m^3$/d [3] |
| Emergency Volume Ratio | 25% | 25% |
| **Balancing Volume Required (A)** | **125 $m^3$** | **135 $m^3$** |
| **TOTAL (A + B + C)** | **625 $m^3$** | **677 $m^3$** |

1. Based on 2006 -2009 and 2012-2014 historical flows provided by GBID.
2. Assumes Shelter Point Connection (refer to Section 2.5).

The existing storage tank is not sufficient to provide fire, balancing and emergency storage. It is recommended that the storage tank be replaced with a new bolted steel reservoir with an operating volume of at least 677 $m^3$. Given standard tank sizes available and the variability in historical MDD, a 678 $m^3$ reservoir is recommended.

[1] *BC Design Guidelines for Rural Residential Community Water Systems*, 2012.

## Storage Location

To supply the GBID system by gravity, it is recommended that the storage tank be installed at a much higher elevation than the existing reservoir. There is a fundamental relationship between the elevation of a reservoir, and its ability to service a community both in terms of system pressures and fireflows. The optimum elevation for a reservoir is as high as possible without exceeding the static elevation requirements for a single zone system. The maximum reservoir elevation is governed by ensuring that static pressures in a system do not exceed 120 psi (830 kPa or 83 m of head), and the lowest elevation is restricted to ensuring that the static elevation is greater than 40 psi (280 kPa or 28 m of head). With the highest building elevation in Gillies Bay at approximately 52 m above sea level (asl), and the lowest elevation building at approximately 10 m asl, the top water level in the reservoir should not be greater than 93 m asl (i.e. 84 m plus 10 m), nor less than 80 m (i.e. 52 plus 28 m). Assuming that the reservoir height would be 5 m, the search range was for a location with a ground elevation range of approximately 75 m to 90 m. Refer to Figure 2-4 which highlights the areas that are within the required elevation range for reservoir siting (highlighted in green).

The two best site location options identified were flat areas with a ground elevation of about 82 m asl:

**Option 1:** The first location is adjacent to Airport Road approximately 1.5 km northwest from the intersection of Airport Road and Pine Street. This location would require the acquisition, lease or land use agreement for the reservoir location and supply main. Based on discussions with GBID staff, this is considered the preferred location.

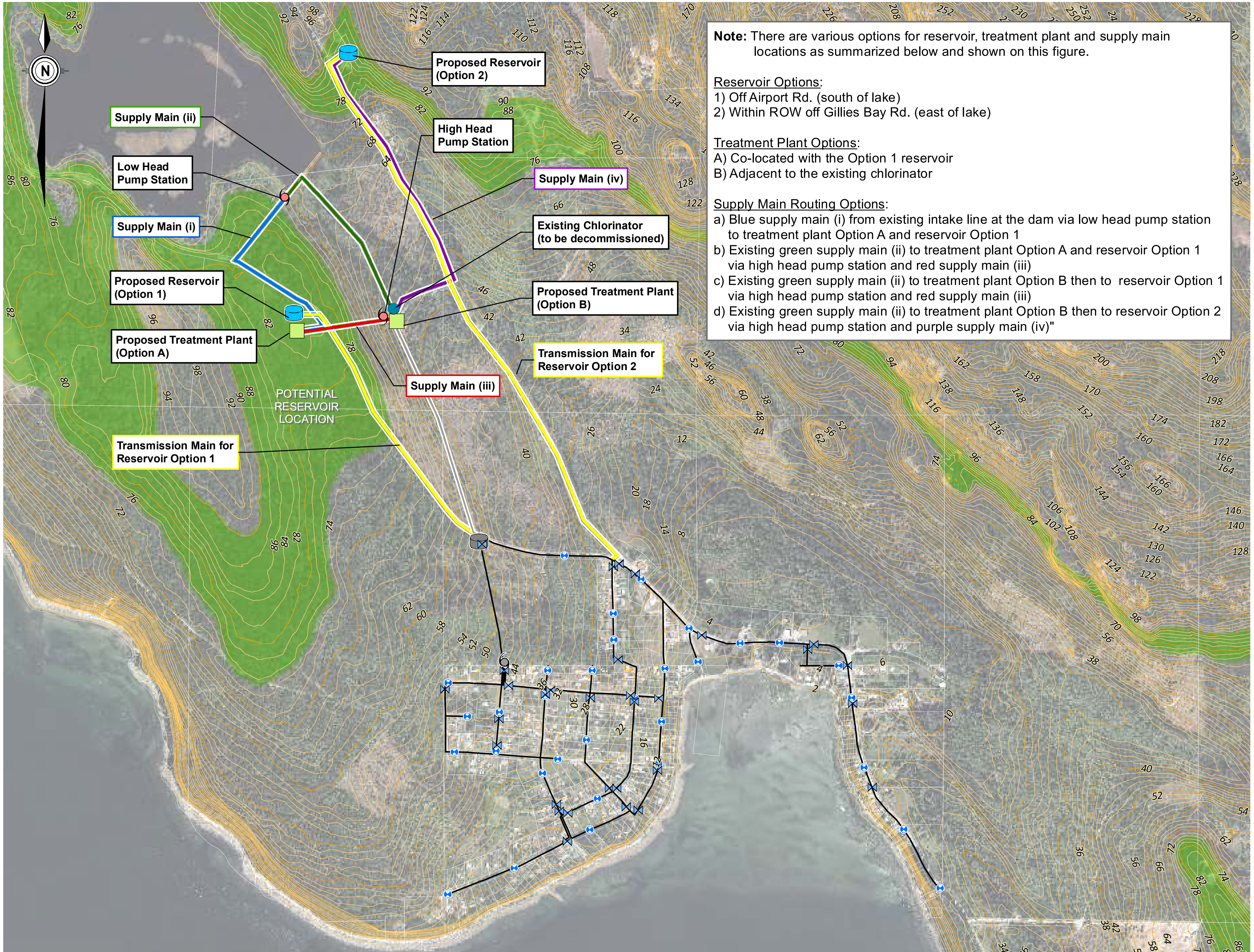
**Option 2:** The second location is within a right-of-way off Gillies Bay Road between two lots approximately 2 km north of the intersection of Gillies Bay Road and Airport Road. While this option would not require land acquisition/lease/agreement, it is not preferred because the houses on the adjacent lots are located close to the property lines. As a result, the tank would either need to be installed below ground or on the other side of the road in an area levelled by blasting. Both of these installation methodologies would increase the capital cost therefore this option is not preferred.

The two proposed reservoir locations are identified in Figure 2-4.

It is a welcome coincidence that the preferred reservoir location (Option 1) will provide flexibility in long term planning; it will also be able to supply the Shelter Point community. This may represent an opportunity for cost recovery in the future should Shelter Point decide to connect to the GBID system. The impact of the Shelter Point community on reservoir storage, treatment plant size and pipe sizes selected is negligible. However, if the Shelter Point Community should decide to connect to the GBID system, then an agreement on some funding formula can be developed in future without any new capital outlay.

It should also be noted that even if the reservoir were to be located at the existing chlorinator site (at an elevation that is well below the elevation range for an optimum reservoir site), land would need to be acquired. The reservoir and treatment plant/disposal pond have estimated land requirements of 35 m x 35 m and 40 m x 65 m respectively (or 40 m x 100 m if combined) which is larger than the existing ROW at the chlorinator site.

The preferred Option 1 reservoir location is flat and partially cleared which would reduce construction costs. Also, locating storage and treatment infrastructure at the Option 1 site moves it away from the debris flow path from a potential dam breach which would have higher risk and insurance implications.




**Note:** There are various options for reservoir, treatment plant and supply main locations as summarized below and shown on this figure.

Reservoir Options:
1) Off Airport Rd. (south of lake)
2) Within ROW off Gillies Bay Rd. (east of lake)

Treatment Plant Options:
A) Co-located with the Option 1 reservoir
B) Adjacent to the existing chlorinator

Supply Main Routing Options:
a) Blue supply main (i) from existing intake line at the dam via low head pump station to treatment plant Option A and reservoir Option 1
b) Existing green supply main (ii) to treatment plant Option A and reservoir Option 1 via high head pump station and red supply main (iii)
c) Existing green supply main (ii) to treatment plant Option B then to reservoir Option 1 via high head pump station and red supply main (iii)
d) Existing green supply main (ii) to treatment plant Option B then to reservoir Option 2 via high head pump station and purple supply main (iv)"

**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Reservoir (Existing)
- Pump Station (Existing)
- Reservoir (Proposed)
- Existing Chlorinator
- Treatment Plant (Proposed)
- Pump Station (Proposed)
- Hydrant (Existing)
- Valve (Existing)
- Contour Index (10m)
- Contour Intermediate (2m)
- Water Main (Existing)
- Abandoned Water Main (Existing)

**Water Main**

- Supply Main (i)
- Supply Main (ii)
- Supply Main (iii)
- Supply Main (iv)
- Transmission Main (Various Options)

**Potential Reservoir Zone**

- 75m-90m (Potential Reservoir Location)

**Reference**: Orthophoto provided by Powell River Regional District.

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| 3458-002 | July 2016 |

**Reservoir Siting Analysis with Proposed Reservoir, Pump Station, and Treatment Plant Location Options**

**Figure 2-4**

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## 2.9 Distribution System

The existing distribution system includes approximately:

- 4,000 m of 100 mm dia. AC pipe;
- 5,000 m of 150 mm dia. AC pipe;
- 300 m of 300 mm dia. C900 PVC pipe;
- a pump station with four hydro-pneumatic tanks;
- 33 fire hydrants;
- 27 150 mm dia. valves; and
- 15 100 mm dia. valves.

### Water Model

A WaterCAD hydraulic model was developed for Gillies Bay which includes all major transmission mains originating from the lake source, and terminating at system dead-ends, hydrant laterals, and water services. Each water service is represented by a connection and per-connection demand within the model.

**Current System**

The current distribution system was modeled based on scanned maps provided by GBID staff and data available in the water system Operations and Maintenance manual. The location and diameter of each watermain was transcribed to GIS and the resulting map (refer to Figure 2-5) was reviewed and approved by GBID staff. The existing system was modelled with a 703 m³/d demand divided evenly between the 259 service connections. The operation of the system was validated by comparing to pressures identified in the Operations and Maintenance manual (refer to Figure 2-6).

The modelled boundary conditions for the current system include the lake source with a design water level of 73.1 m elevation (Low Water Level). Given that the reservoir is on a side branch, the reservoir elevation does not control the available flow rate or pressure in the system.

The existing system is limited by available pressures and fire flow supply to the entire network. For convenience, it has been divided into two pressure zones: the ‘Low Zone’ and ‘High Zone’. The Low Zone is fed by a gravity supply along Airport road from the lake source and includes most of Gilles Bay residents. The High Zone is a pumped zone from Ash Street to Oak Street between Elm Street and Cedar Street. It is connected to the low zone by watermains on Oak Street and Cedar Street, but the connection is limited by partially closed valves in these watermains. This configuration provides redundancy, allowing the High Zone and Low Zone to supply each other if the pressure drops on either side, but not in the event of a large demand, such as fire flow.

The existing pump station servicing the “Low Zone” and located on Dogwood Ave. includes three (3) pumps for domestic water supply:

- 0.75 hp duty pump (also referred to as the ‘night pump’). This pump is always on and maintains 65 - 70 psi in the High Zone.
- Two 4 hp booster pumps. These pumps activate when downstream pressures drop below 50 psi.

These pump models do not have published performance data readily available, so KWL estimated pump curves and efficiency based on comparable models and observed system pressures.

# GILLIES BAY IMPROVEMENT DISTRICT
## Gillies Bay Master Water Plan

**Legend**

- Reservoir
- Chlorination Facility
- Booster Pump
- Existing Hydrant

**Valve**

- 100 mm dia
- 150 mm dia

**Existing Water Main**

- 100 mm dia
- 150 mm dia
- 300 mm dia

Note: Valve locations and sizes are approximate as supplied by the Gillies Bay Improvement District

**Reference**: Orthophoto provided by Powell River Regional District.

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# Existing Water System

**Figure 2-5**

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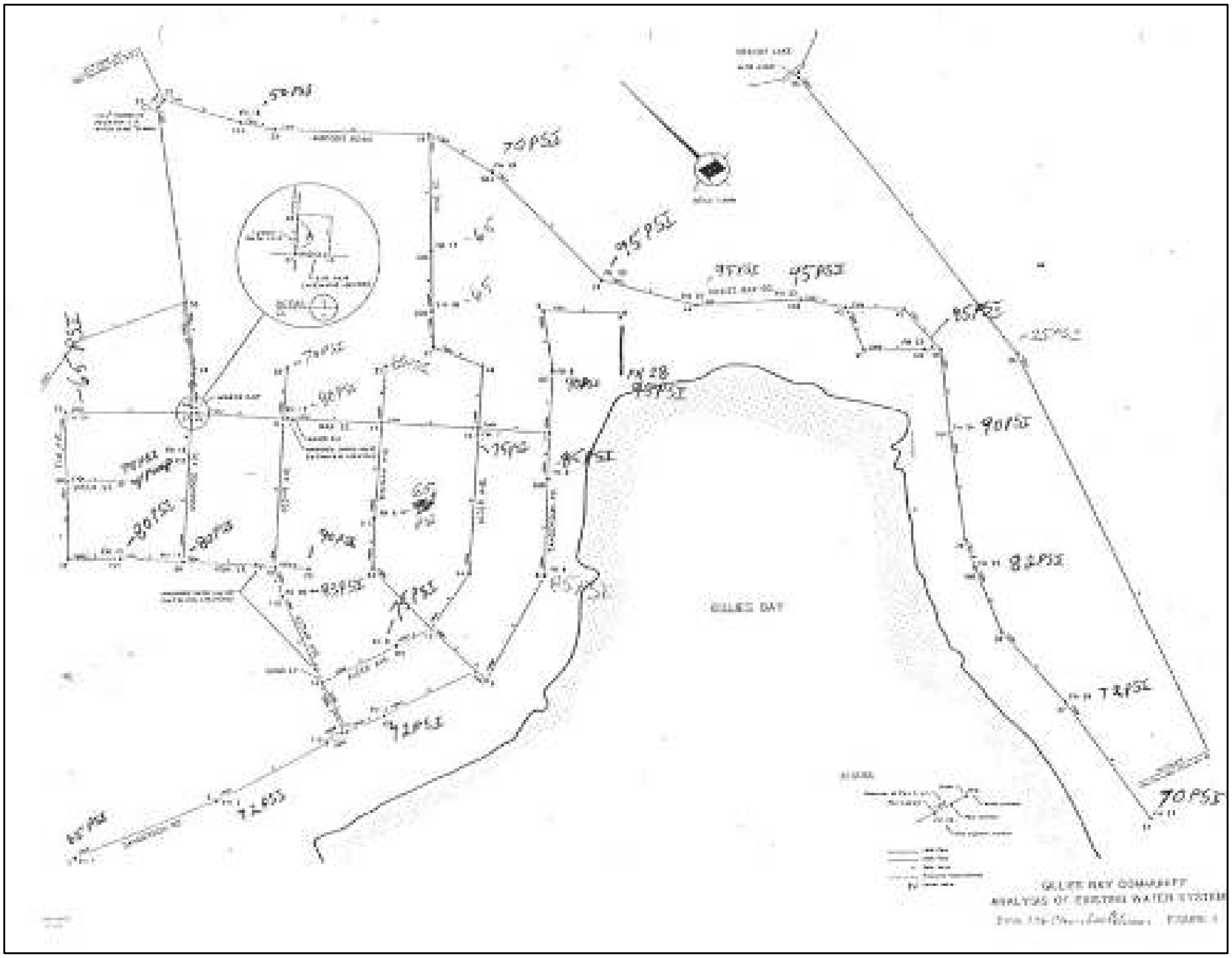



**Figure 2-6: Operating Pressures of Existing System**

**Future System**

Future scenarios (5-yr, 10-yr, 20-yr) were developed based on a new reservoir elevation of approximately 85 m as described in Section 2.8. The hydraulic model assumes water supply to the proposed reservoir equal to or greater than MDD and the future system was modelled as a single pressure zone with 710 $m^3$/d demand distributed evenly between 354 future service connections. The 160 $m^3$/d MDD for shelter point was assigned as a single demand at the end of Gillies Bay Road.

## System Pressure Design Criteria

Required minimum pressures for the assessment of the water system are outlined in Table 2-8.

**Table 2-8: System Pressures**

| Design Case | Pressure |
|---|---|
| MDD plus Fire Flow | 20 psi (140 kPa) |
| Peak Hour Demand | 40 psi (280 kPa) |
| Maximum Allowable | 120 psi (830 kPa) |
| Sprinkler System | 40 psi (275 kPa) |

## Current System Fire Protection Criteria

The hydraulic model includes a hydrant element at each existing hydrant location within the system. In addition, hydrants were added to future scenarios to satisfy the recommended fire protection levels. In order to calculate the available fireflow, the model calculated the maximum flow that can be drawn at each hydrant without causing supply pressure to drop below 140 kPa (20 psi) at any location in the network.

The timeline and criteria for fire protection have been established as follows:

- 5-yr Plan (urgent or high-priority tasks):
  - Provide 30 L/s available fireflow everywhere within the water network;
- 10-yr Plan (medium-priority tasks):
  - Provide 60 L/s available fireflow to all major intersections/primary hydrants within the system; and
- 20-yr Plan (low-priority tasks):
  - Provide 60 L/s to all hydrants within the network.

The Gillies Bay Fire Department (GBFD) was consulted regarding current and future hydrant locations and priority. Five high priority hydrants were identified by the GBFD, these hydrants are included in the five year plan. All remaining hydrants will be replaced (or installed) when the watermain they are (or will be) supplied from is upgraded in the locations approved by the GBFD.

It should be noted that all watermain sizes are governed by fire flows requirements not domestic supply (to GBID and Shelter Point). This is because the required fire flow rate is 60 L/s while the combined MDD for GBID and Shelter Point is only 3.7 L/s (6% of fire flow). Pipes are sized for the 60 L/s to minimize headlosses, which would necessitate a higher reservoir elevation.

## 2.10 Treatment

### Regulatory Requirements

Domestic water systems such as the Gillies Bay Water System are required to comply with *the Drinking Water Protection Act* and *Drinking Water Protection Regulation*. The Regulation stipulates that potable water must be free of total coliforms and *E.coli*. The Act requires that all domestic water systems hold a valid Operating Permit at all times and a valid Construction Permit when making changes to a domestic system. In the Act and Regulation, the Drinking Water Officer is given the authority to grant and enforce water systems. In practice, the Drinking Water Officer is an agent of the regional health authority, which on Texada Island is the Vancouver Coastal Health Authority (VCH).

The *Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia* are a province-wide guideline adopted by all health authorities, some of which previously named these guidelines the "4-3-2-1-0 Requirements". The requirements of these objectives are as follows:

- 4-log reduction (99.99%) of viruses;
- 3-log inactivation (99.9%) of *Cryptosporidium* and *Giardia*;
- at least 2 barriers of treatment;
- less than 1 NTU turbidity in finished water at all times; and
- no total coliforms or *E. coli* in treated water.

The *Guidelines for Canadian Drinking Water Quality* provide guidelines for chemical and physical parameters based on health impacts (maximum acceptable concentrations), aesthetic considerations (aesthetic objectives), and operational considerations (operational guidance).

### Raw Water Quality

Raw water quality information was reviewed and summarized from the historical reports provided by GBID staff. A water summary table is included in Appendix B.

The water quality of Cranby Lake can be described as having high total organic carbon, colour and turbidity. According to prior reports, raw water quality may be improved by extending the intake further into the lake with a floating header to control the level from which raw water is drawn.

### Treatment Process Requirements

The treatment process must remove:

- organics (dissolved and suspended);
- colour;
- cryptosporidium and giardia (oocysts);
- algae; and
- pathogens (bacteria and viruses).

The largest constraint for this system is the organics in the raw water which limits the number of appropriate treatment technologies. The selected process must address the high organic content, provide two barriers of treatment, and include chlorination for secondary disinfection.

## Treatment Plant Location

Two potential locations were identified for a treatment plant (refer to Figure 2-4):

- **Option A:** co-located with the Option 1 reservoir off Airport Road; and
- **Option B:** adjacent to the existing chlorinator.

The treatment plant location is a relatively complex issue because it tries to resolve the question of risk versus opportunity. It would be possible to have the treatment plant located at the existing chlorinator building, complete with a pump station delivering flows to the reservoir (Option B). This approach would require land acquisition for the treatment plant, the deflector berm, rights-of-way for supply forcemains, and reservoir site if Option 1 is selected. The amount of land required may be smaller (i.e. opportunity), but it must be compared to potential risk of dam breach. A catastrophic breach has the potential to damage infrastructure at the chlorinator site including the power that supplies it. A minor breach may be deflected by a berm, but even a small breach event has the potential to compromise the power lines that feed the site. The alternative is to reduce risk by locating treatment infrastructure adjacent to the reservoir and including chlorination as part of the treatment process (Option A). The risk with Option A is that it may be difficult to acquire the necessary land adjacent to Airport Road. The advantages and disadvantages for the two treatment plant location options are summarized in Table 2-9.

**Table 2-9: Treatment Plant Location Summary**

| Location Option | Pros/Advantages | Cons/Disadvantages |
|---|---|---|
| Option A<br>(Co-located with Reservoir Option 1 by Airport Rd.) | • Co-locating treatment plant and reservoir has the potential to reduce pumping costs (can avoid breaking head at existing chlorinator location before pumping up to treatment plant/reservoir or supply directly from the lake via the dam access and airport roads).<br>• Treatment plant and power supply would be out of the flow path in the event of a dam breach.<br>• Site is close to Airport Road (easy access).<br>• Site has been previously cleared and historical satellite photos indicate poor growing conditions on the site.<br>• GBID is less likely to need to pay high insurance premiums because infrastructure is not in the debris flow path. | • Site does not have an established access.<br>• Site is not currently serviced by power.<br>• ROW's and easements from the dam to the site need to be confirmed. Will require land acquisition.<br>• Requires a new chlorinator. |
| Option B<br>(Existing Chlorinator Location) | • Site is already in use for the chlorinator, this has the potential to simplify land occupancy/acquisition.<br>• Site has an established access.<br>• Site is serviced by power.<br>• Some chlorinator infrastructure may be salvageable. | • Treatment plant and power supply may be in the flow path if the dam were to breach (this would require the installation of a deflection berm).<br>• Site is much lower than for Option A, and will require higher capital and O&M costs to deliver water to the reservoir.<br>• GBID may need to pay high insurance premiums to cover infrastructure in the debris flow path. |

### Power Supply Routing

The question of power supply routing is intrinsically connected with the treatment plant location. Given the reservoir and treatment plant considerations noted above, the 'worst case' connection scenario from the intersection of Airport Road and Gillies Bay Road has been included in Section 4 for budgetary purposes. Selecting the worst case power routing minimizes risk by identifying the maximum anticipated cost to allow the GBID to set aside enough money to complete the work. The actual power routing would be considered at the detailed design stage and if these power poles were to be run along the road, it is possible that BC Hydro would cover or contribute to the cost of their construction. Additionally, installing power along airport road would increase the value of TIFR land which may serve useful in land acquisition negotiations.

### Reservoir Supply

The transfer of water from the treatment plant to the reservoir will be via a dedicated supply main. Adequate contact time (CT) will be provided either in this dedicated supply main or in the reservoir. Given the relative locations and elevation differences of the proposed treatment plant and reservoir sites, high head duplex pumps will be required. These pumps will need to be specially selected to meet the site constraint of single phase power on Texada Island.

## Treatment Capacity Requirements

It is anticipated that once Gillies Bay has implemented the majority of system improvements outlined in this Master Water Plan, the system demand will drop from current levels and future predictions. This will occur because of a number of factors including, reduction in leakage, reduction in flushing requirements, and the result of public education about the benefits of water conservation. Accordingly, the treatment plant will be designed in modular form, initially to treat an MDD of 600 m³/d, with flexibility to add a further third train of 300 m³/d for an ultimate capacity of 900 m³/d. This last train can be employed to allow for greater demand than anticipated, or for connection of Shelter Point.

## Emergency Power Supply

The GBID currently has an 8 kW Generac backup generator that automatically switches on upon power loss to provide power to the chlorination station. It is fueled by a 420 lb propane tank and is capable of running approximately 125 hours. There is an additional 100 lb tank on standby.

The capacity of the existing generator should be reviewed at the detailed design stage to determine if it sufficient to ensure continuous water treatment or supply to the reservoir. All distribution following the reservoir will be by gravity and will not require backup power.

**Figure 2-7: Existing Generator at Chlorinator**

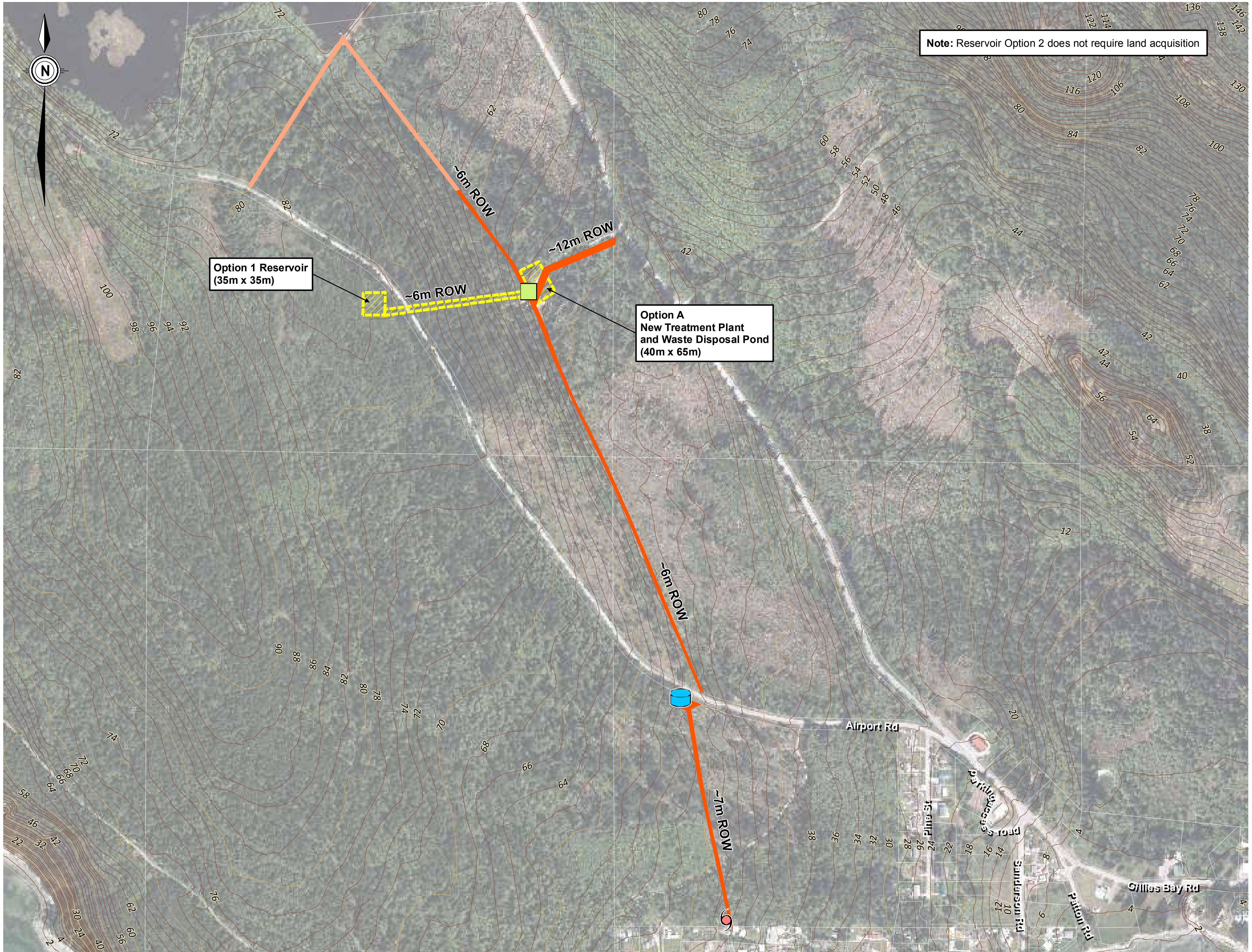
The need for backup power for the pump station is unclear at this stage. The requirement for backup power is a function of how long power outages typically last. With a new reservoir there will be adequate storage to provide fire, balancing and emergency storage for a given period of time. Based on discussions with GBID, it is understood that power outages have not historically lasted any longer than three days. Given the potential power outage duration, the need for emergency power should be reviewed during detailed design to ensure the community has adequate water during a power outage.

## 2.11 Land Requirements

The land surrounding the community of Gillies Bay is largely owned by the Texada Island Forestry Reserve (TIFR). The GBID communicated with the TIFR property manager and obtained ROW information from the Land Title Office to determine what established easements/rights-of-way exist for the water system infrastructure. The established easements/rights-of-way are summarized below:

- dam (and access road);
- chlorinator (and access road);
- chlorinator supply line (from the dam); and
- community supply line (from the chlorinator).

The land requirements for the two different proposed treatment plant location options (A & B) and reservoir location options (1 & 2) are identified in Figure 2-8 and Figure 2-9.




**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Contour Index (10m)
- Contour Intermediate (2m)
- Existng Chlorination Facility
- Existing Reservoir
- Existing Booster Pump
- Existing ROW
- Assumed Existing ROW
- Proposed Land Acquisition

**Reference**: Orthophoto provided by Powell River Regional District.

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**Existing and Proposed Rights-of-Way (Reservoir Option 1 and Treatment Plant Option A)**

**Figure 2-8**

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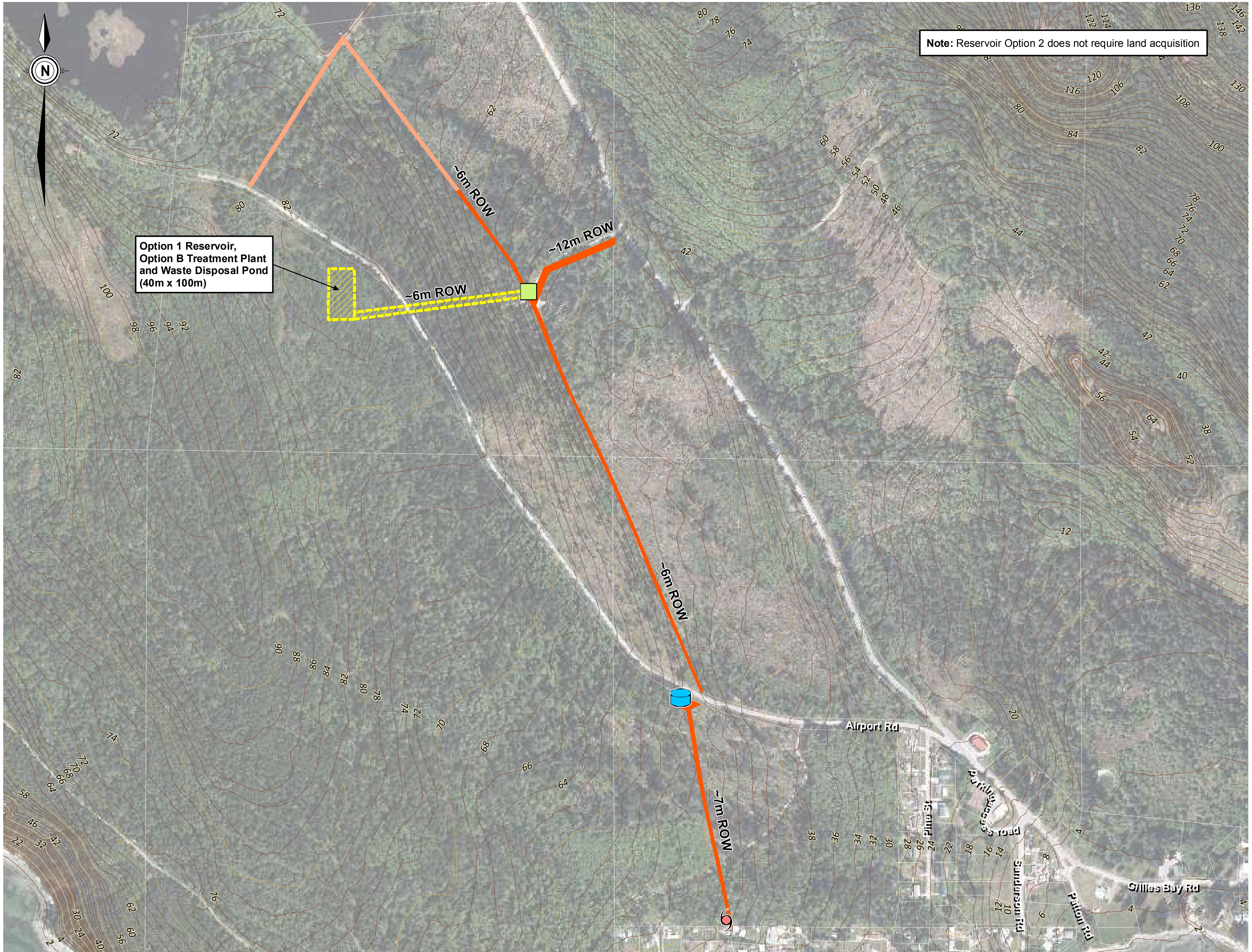


**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

**Legend**

- Contour Index (10m)
- Contour Intermediate (2m)
- Existng Chlorination Facility
- Existing Reservoir
- Existing Booster Pump
- Existing ROW
- Assumed Existing ROW
- Proposed Land Acquisition

**Reference**: Orthophoto provided by Powell River Regional District.

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**Existing and Proposed Rights-of-Way (Reservoir Option 1 and Treatment Plant Option B)**

**Figure 2-9**


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# 3. Recommended Upgrades

This section includes a list of deficiencies for the existing water system. It then identifies recommended improvements that:

- address deficiencies;
- ensure sufficient storage for fire flows, balancing, and emergency storage;
- increase system capacity and pressure;
- ensure proper treatment and optimized disinfection; and
- reduce waste and costs.

These recommendations are then summarized in Section 4 with an estimated implementation schedule and cost.

## 3.1 Existing System Deficiencies

A list of existing water system deficiencies was developed based on findings of prior reports and input from GBID staff. This list identifies the drivers and priority for each entry which have been summarized in order of descending priority.

**Table 3-1: Water System Deficiencies**

| Entry # | Description | Driver | Priority |
|---|---|---|---|
| 1 | Insufficient fire flow is available across the service area | Fire Protection | High |
| 2 | Fire department cannot use hydrants without pulling material through the system. This potentially requires the health officer to place the community on a boil water advisory due to inadequate contact time or high turbidity. | Fire Protection / Water Quality | High |
| 3 | Insufficient fire coverage based on existing fire hydrants. | Fire Protection | High |
| 4 | Current Vancouver Coastal Health Authority (VCHA) hazard rating for GBID water system is moderate. Raw water has high total organic carbon, colour and turbidity and the existing treatment system does not meet VCHA requirements or Canadian Drinking Water Quality Guidelines. | Water Quality | High |
| 5 | Customers have aesthetic concerns with the current raw water associated with taste, odour, and appearance. | Water Quality / Customer Relations | Medium |
| 6 | Frequent system flushing is required to maintain water quality. Total flushing volume was 29,101 $m^3$ in 2015. | Water Quality / Environmental | Medium |
| 7 | GBID is currently drawing more water than allowed under the conditions of its water licence. Total water use for 2015 was 109,789 $m^3$ (300.8 $m^3/d$) and the licence allows 41,464 $m^3$ (113.6 $m^3/d$). | System Capacity / Environmental | Medium |
| 8 | A section of pipe on Shelter Point Rd. crosses a creek bed. The pipe is visible and the creek is fish bearing. | Environmental | Medium |
| 9 | The dam's spillway/weir has reached the end of its service life. A mechanically operable gate would also be useful for releasing high water accumulation and flushing debris collected near the intake. | Lifecycle | Medium |
| 10 | The private power pole and electrical mast for the chlorinator is nearing the end of its service life. | Lifecycle | Low |
| 11 | The 6" pumper ports on fire hydrants have not been used (2.5" typically used) and at least three of them have seized. | Lifecycle / Fire Protection | Low |
| 12 | The hydrant at the end of Gillies Bay Road needs to be moved to the ditch side of road to facilitate flushing operations. | Water Quality | Low |
| 13 | Homes may not have PRVs. Pressure adjustments may impact pressure in customer homes. | Customer Relations | Low |

## 3.2 Fire Protection

### Hydrant Coverage

As noted in Section 2.7, typical system planning guidelines call for 150 m spacing of hydrants. The Gillies Bay Fire Department (GBFD) was consulted regarding current and future hydrant locations and priority. Five high priority hydrants were identified by the GBFD, these hydrants are included in the five year plan. All remaining hydrants will be replaced (or installed) when the hydrant they are (or will be) supplied from is upgraded in the locations approved by the GBFD. The future hydrant locations were selected to minimize unserved properties (i.e. outside 75 m radius) within the Gillies Bay service area. Refer to Figure 3-1 and Figure 3-2 for current and proposed hydrant coverage.

### Storage

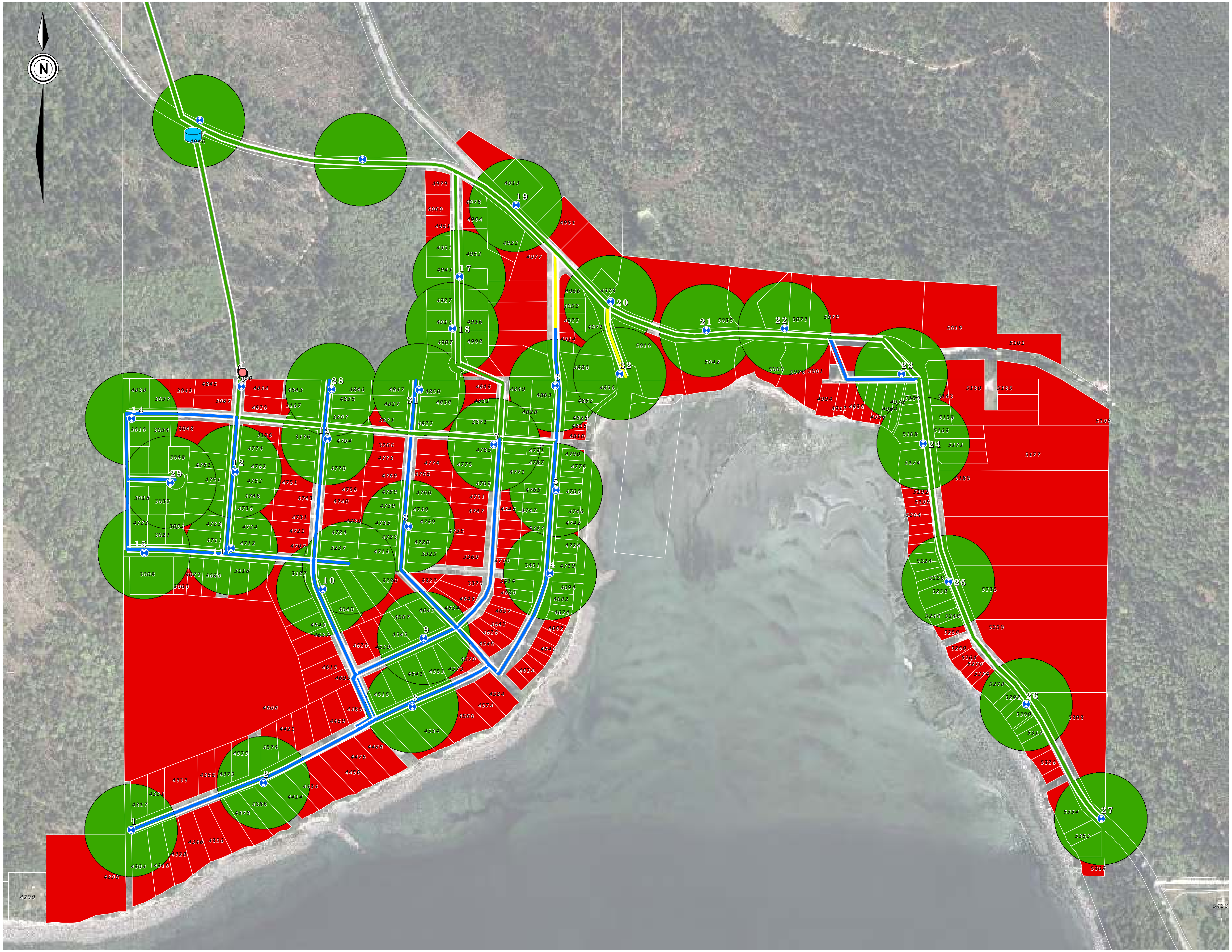
As noted in Section 2.8, the existing storage tank is not sufficient to provide fire, balancing and emergency storage. It is recommended that the storage tank be replaced with a new reservoir with an operating volume of at least 678 m³. It is recommended that this new reservoir be installed with a top water level (TWL) of 85 m at one of the two locations identified in Figure 2-4 and fed by a 150 mm diameter supply main either from the existing chlorinator location (proposed future treatment plant location B) or directly from the dam via a low-head pump station and supply main that runs along the dam access road then down Airport Road.

Installing this new reservoir will have two significant impacts on the GBID water system:

1. It will provide adequate fire flow storage, balancing and emergency water supply.
2. It will increase the pressure and available fire flow within the service area.

It was noted in Table 3-1 that there is insufficient fire flow available across the service area due to pipe capacity constraints. This was confirmed using the water model which showed that the available fire flow is less than the minimum FUS standard of 30 L/s (refer to Figure 3-3). The model showed that installing a new reservoir and supply main either on Airport Rd (Option 1) or off Gillies Bay Road (Option 2), without any pipe upgrades in the distribution system itself increases the available fire flow for more than 50% of the service area above 30 L/s and a portion above 60 L/s (refer to Figure 3-4 and Figure 3-5 for Options 1 and 2 respectively). The installation of a new reservoir, pump station, supply main, and transmission main will provide excellent value to the GBID by providing adequate storage capacity and improving water protection capabilities without replacing any piping within the distribution system.

**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**



## Legend

- Reservoir
- Booster Pump
- Hydrant (Existing)
- Hydrant Radius of 75m (Recommended Hydrant Coverage)
- Lots Lacking Hydrant Coverage

**Existing Water Main**

- 100 mm dia
- 150 mm dia
- 300 mm dia

**Reference:** Imagery from the Powell River Regional District.

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# Existing Water System Hydrant Coverage

**Figure 3-1**

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**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Hydrant (Existing)
- Hydrant (Proposed)
- Hydrant Radius of 75m
- Lots Lacking Hydrant Coverage

**Future Water Main**

- 100 mm dia
- 150 mm dia
- 200 mm dia
- 250 mm dia
- 300 mm dia

**Reference**: Orthophoto provided by Powell River Regional District.

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# Future Water System and Proposed Hydrant Coverage

**Figure 3-2**

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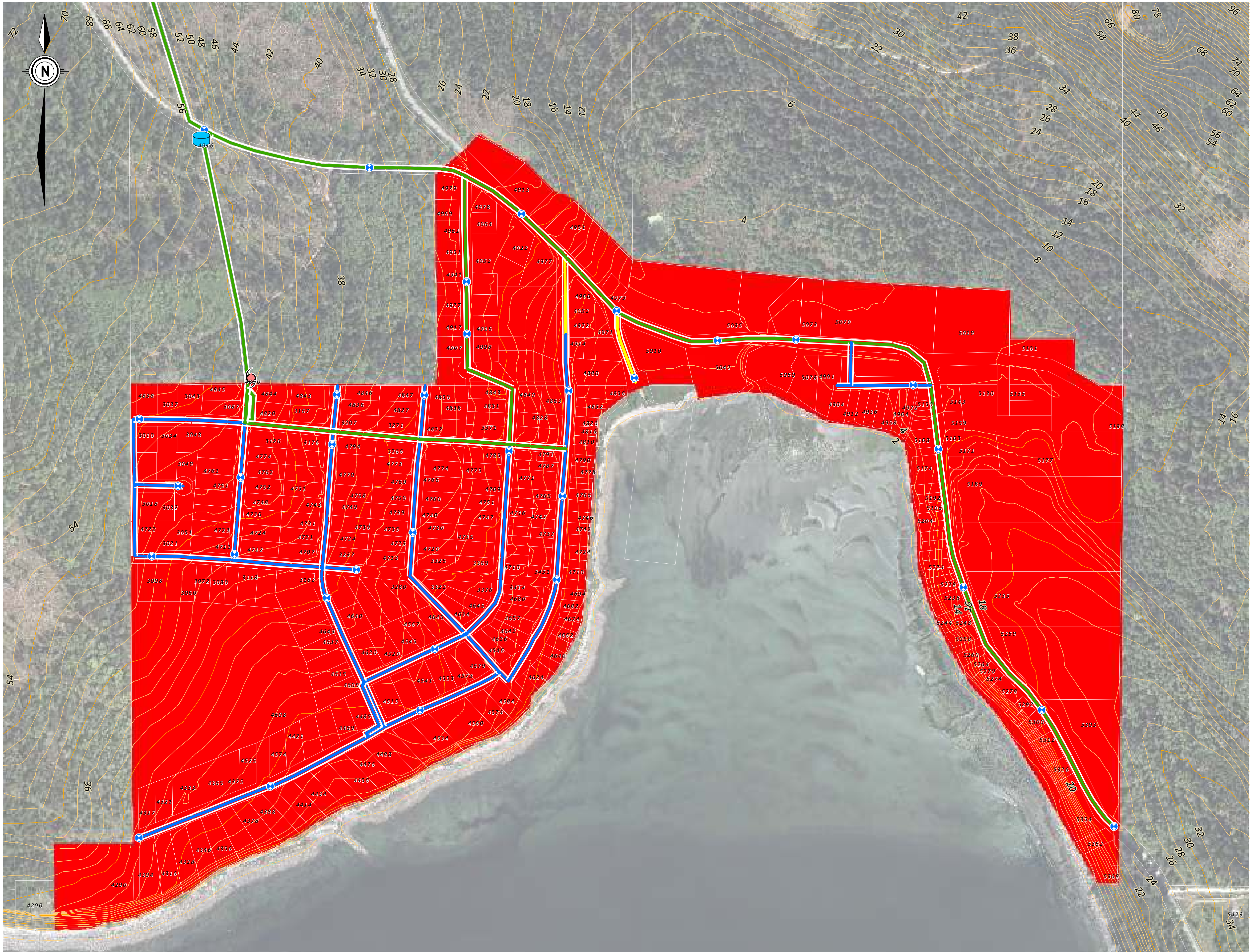

**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

Reservoir

Booster Pump

Hydrant (Existing)

**Water Main**

100 mm dia

150 mm dia

300 mm dia

**Available Fire Flow**

<30 L/s

30 - 60 L/s

>60 L/s

**Reference**: Orthophoto provided by Powell River Regional District.

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# Existing System Available Fire Flow

**Figure 3-3**

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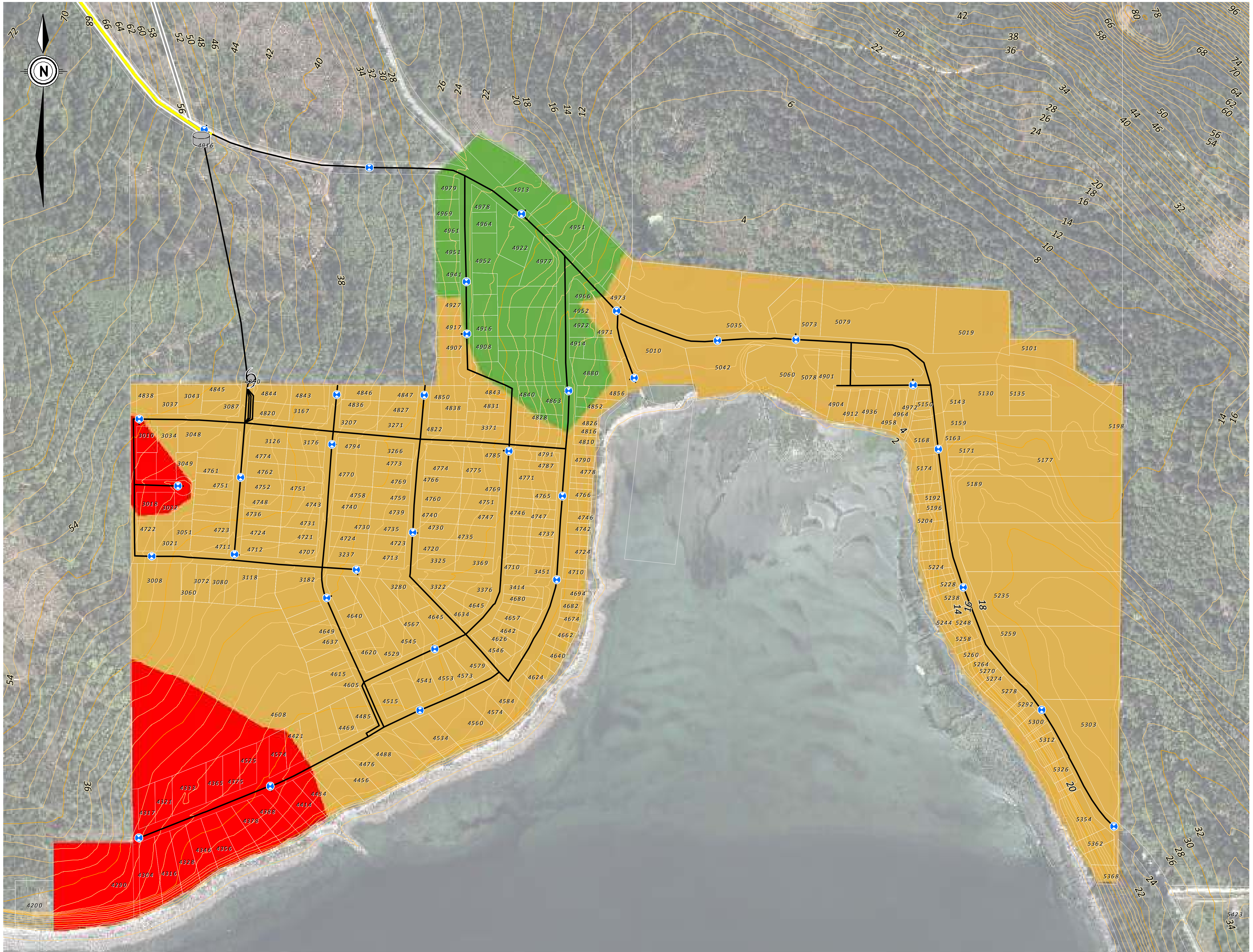

**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Hydrant (Existing)
- Water Main (Existing)
- Abandoned Water Main (Existing)

**Water Main Upgrade (mm) 1-Year**

- 100 mm dia
- 150 mm dia
- 200 mm dia
- 250 mm dia
- 300 mm dia

**Available Fire Flow**

- <30 L/s
- 30 - 60 L/s
- >60 L/s

**Reference**: Orthophoto provided by Powell River Regional District.

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# New Reservoir Available Fire Flow (Reservoir Option 1)

**Figure 3-4**

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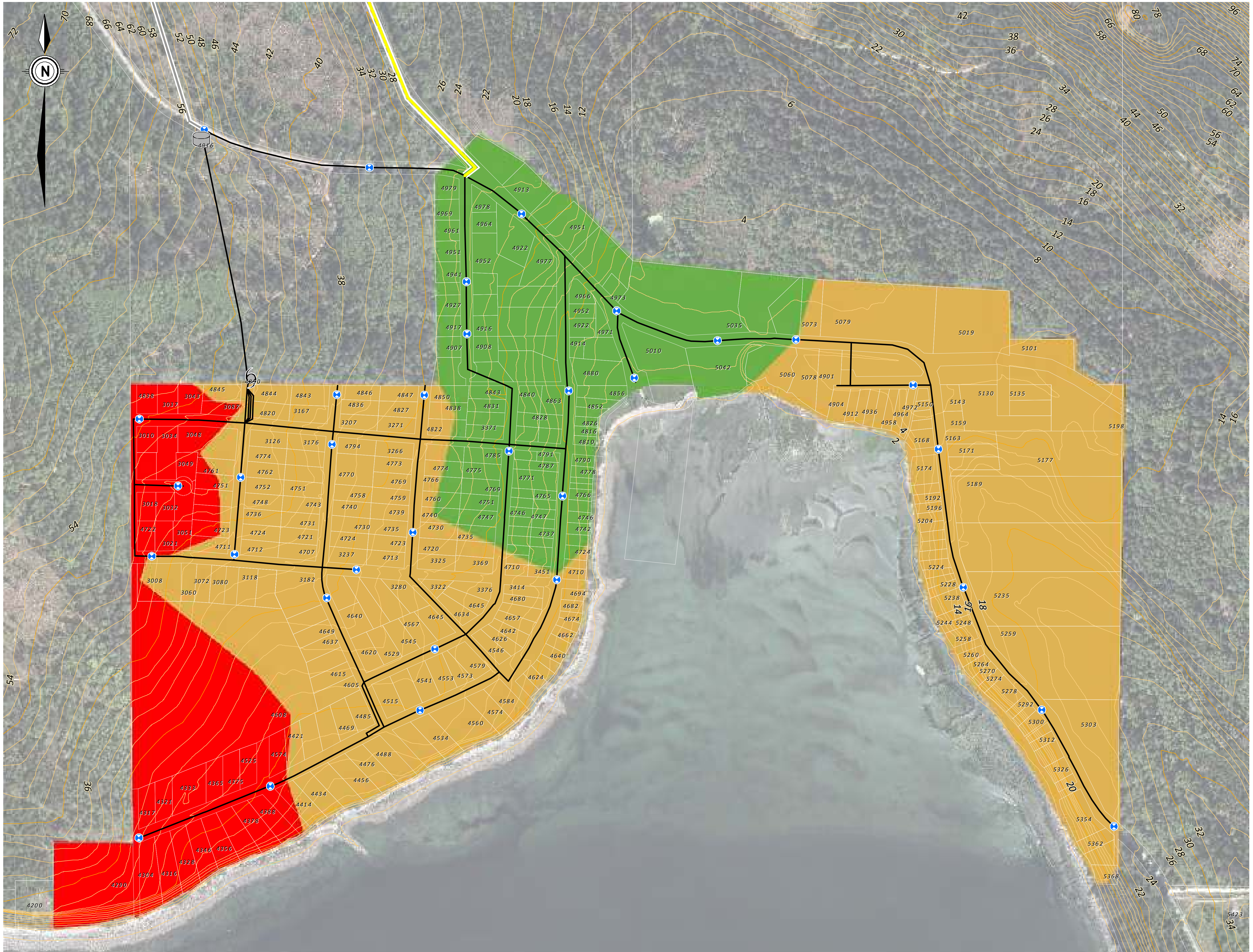
**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**



## Legend

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Hydrant (Existing)
- Water Main (Existing)
- Abandoned Water Main (Existing)

**Water Main Upgrade**

- 100 mm dia
- 150 mm dia
- 200 mm dia
- 250 mm dia
- 300 mm dia

**Available Fire Flow**

- <30 L/s
- 30 - 60 L/s
- >60 L/s

**Reference**: Orthophoto provided by Powell River Regional District.

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# New Reservoir Available Fire Flow (Reservoir Option 2)

**Figure 3-5**

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## Watermain Upgrades

When the reservoir is installed, the available fire flow in the system will be dramatically improved, but not to the extent of supplying the design fire flow requirement of 60 L/s across the entire distribution system. This can only occur with a planned implementation strategy. Accordingly, watermain upgrades are recommended following the timeline and criteria for fire protection established in Section 2.9, and summarized as follows:

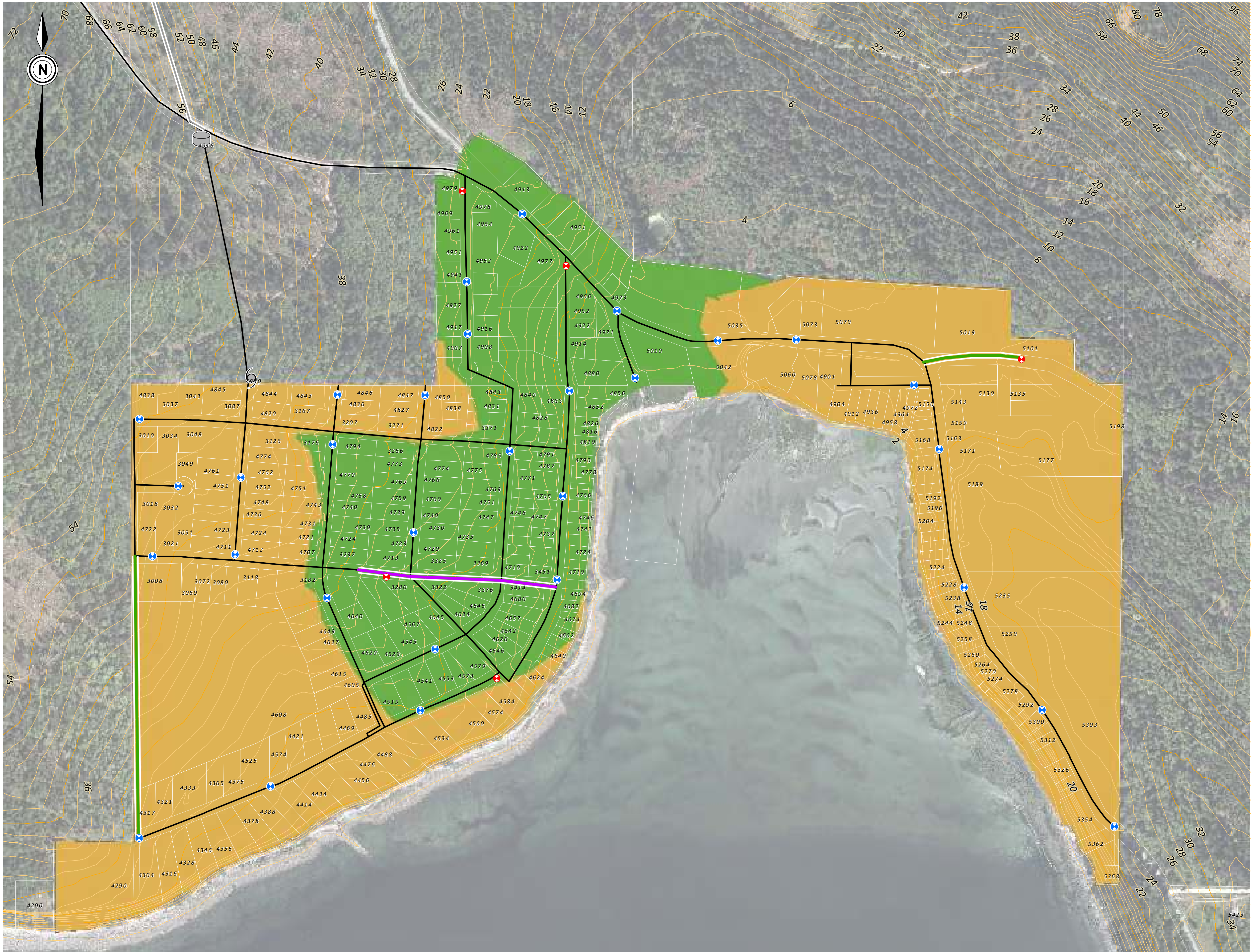
- 5-yr Plan (urgent or high-priority tasks):
  - Provide 30 L/s available fireflow everywhere within the water network;
- 10-yr Plan (medium-priority tasks):
  - Provide 60 L/s available fireflow to all major intersections/primary hydrants within the system; and
- 20-yr Plan (low-priority tasks):
  - Provide 60 L/s to all hydrants within the network.

As noted in Section 2.9, hydrants will be replaced (or installed) when the watermain they are (or will be) fed from is upgraded in the locations approved by the GBFD. Refer to Figures 3-6 and 3-7 for 5-year recommended fire protection upgrades, Figures 3-8 and 3-9 for 10-year recommended fire protection upgrades, and Figures 3-10 and 3-11 for 20-year recommended fire protection upgrades. In these figures:

- The coloured lines represent the recommended watermain upgrades for the given period. The colour of the lines identifies the recommended upgrade size.
- The black lines represent watermains that either exist at the beginning of the study period or were installed in previous time period(s) (i.e. pipes installed in the 5-year period are shown as black in the 10-year and 20-year period figures). Grey pipes represent pipes that have been abandoned as part of the upgrade work.
- The coloured background identifies the available fire flow in the area identified from the water model. In the 20-year figures, the light green area represents the possible growth area for the community that could support a 60 L/s fire flow if the areas are serviced with appropriately sized watermains (this is governed by ground elevation).
- The circles with alternating blue and white sectors represent existing hydrants and those that were installed in previous time period(s) (i.e. hydrants installed in the 5-year period are shown as blue in the 10 and 20-year period figures).
- The circles with alternating red and white sectors represent hydrants that are recommended to be installed in the given period.

In reviewing Figures 3-4 through 3-12 it will be noted that the existing Dogwood Pump Station is to be decommissioned. It is understood that there is often sensitivity around decommissioning infrastructure before it has reached its end of life. However, based on photos of the installation, it has been assumed that there is very little residual value in the Dogwood Pumping Station. Any value that does exist will be depreciation over time and offset by the cost to dismantle and repurpose the installation. In the scenarios identified in the Master Water Plan the pump station would no longer be required to service the GBID service area which will minimize ongoing operation and maintenance costs and simplify operation.

However, should GBID wish to reuse this asset it would be possible to reconfigure the pump station in its current location to supply water (not fire protection) to future development to the west of the existing service area (at an elevation above 52 m asl).



**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Hydrant (Existing)
- Hydrant (Proposed)
- Water Main (Existing)
- Abandoned Water Main (Existing)

**Water Main Upgrade**

- 100 mm dia
- 150 mm dia
- 200 mm dia
- 250 mm dia
- 300 mm dia

**Available Fire Flow**

- <30 L/s
- 30 - 60 L/s
- >60 L/s

**Reference**: Orthophoto provided by Powell River Regional District.

KERR WOOD LEIDAL
consulting engineers



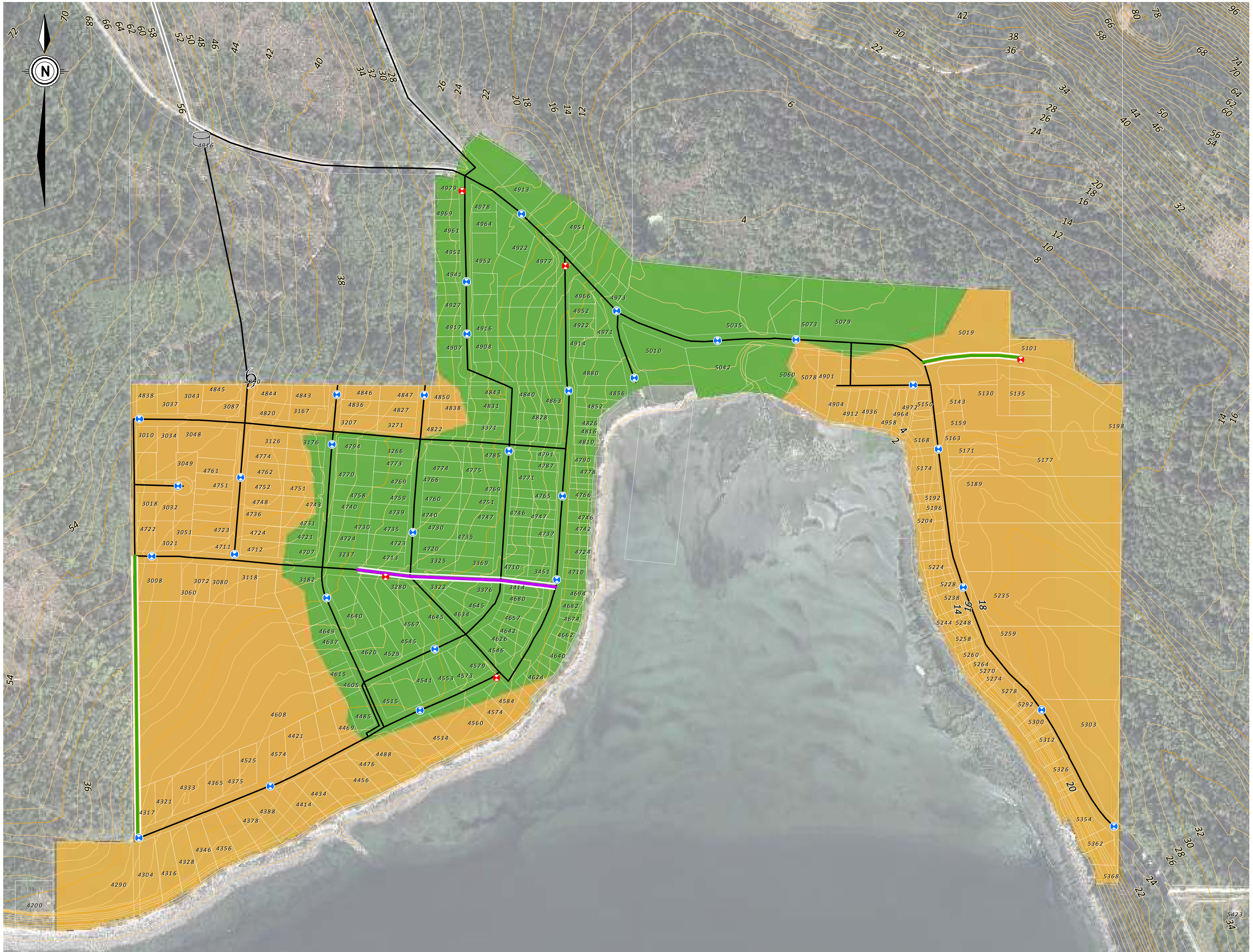
100 0 100
(m)

| Project No. | Date |
|---|---|
| 3458-002 | July 2016 |

# 5-Year System Available Fire Flow (Reservoir Option 1)

**Figure 3-6**

Path: R:\3400-3499\3458-002\430-GIS\MXD-Rp\3458002_Fig3-6_5yrSystemAvailableFireflow_Option1.mxd Date Saved: 7/18/2016 4:30:00 PM
Author: TSoh



**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Hydrant (Existing)
- Hydrant (Proposed)
- Water Main (Existing)
- Abandoned Water Main (Existing)

**Water Main Upgrade**

- 100 mm dia
- 150 mm dia
- 200 mm dia
- 250 mm dia
- 300 mm dia

**Available Fire Flow**

- <30 L/s
- 30 - 60 L/s
- >60 L/s

**Reference**: Orthophoto provided by Powell River Regional District.

KERR WOOD LEIDAL
consulting engineers



100 0 100
(m)

| Project No. | Date |
|---|---|
| 3458-002 | July 2016 |

# 5-Year System Available Fire Flow (Reservoir Option 2)

**Figure 3-7**

Path: R:\3400-3499\3458-002\430-GIS\MXD-Rp\3458002_Fig3-7_5yrSystemAvailableFireflow_Option2.mxd Date Saved: 7/18/2016 4:31:08 PM
Author: TSoh

**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

Reservoir (Decommissioned)

Booster Pump (Decommissioned)

Hydrant (Existing and installed prior to 10-year)

Hydrant (Proposed)

Water Main (Existing)

Abandoned Water Main (Existing)

**Water Main Upgrade**

100 mm dia

150 mm dia

200 mm dia

250 mm dia

300 mm dia

**Available Fire Flow**

<30 L/s

30 - 60 L/s

>60 L/s

**Reference**: Orthophoto provided by Powell River Regional District.

KERR WOOD LEIDAL
consulting engineers



100 0 100
(m)

| Project No. | Date |
|---|---|
| 3458-002 | July 2016 |

# 10-Year System Available Fire Flow (Reservoir Option 1)

**Figure 3-8**

Path: R:\3400-3499\3458-002\430-GIS\MXD-Rp\3458002_Fig3-8_10yrSystemAvailableFireflow_Option1.mxd Date Saved: 7/18/2016 4:29:03 PM
Author: TSoh

**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Hydrant (Existing and installed prior to 10-year)
- Hydrant (Proposed)
- Water Main (Existing)
- Abandoned Water Main (Existing)

**Water Main Upgrade**

- 100 mm dia
- 150 mm dia
- 200 mm dia
- 250 mm dia
- 300 mm dia

**Available Fire Flow**

- <30 L/s
- 30 - 60 L/s
- >60 L/s

**Reference**: Orthophoto provided by Powell River Regional District.

KERR WOOD LEIDAL
consulting engineers



100 0 100
(m)

| Project No. | Date |
| --- | --- |
| 3458-002 | July 2016 |

# 10-Year System Available Fire Flow (Reservoir Option 2)

**Figure 3-9**


**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Hydrant (Existing and installed prior to 20-year)
- Hydrant (Proposed)
- Water Main (Existing)
- Abandoned Water Main (Existing)

**Water Main Upgrade**

- 100 mm dia
- 150 mm dia
- 200 mm dia
- 250 mm dia
- 300 mm dia

**Available Fire Flow**

- <30 L/s
- 30 - 60 L/s
- >60 L/s
- Possible Growth Area (>60 L/s)

**Reference**: Orthophoto provided by Powell River Regional District.

KERR WOOD LEIDAL
consulting engineers



100 0 100
(m)

| Project No. | Date |
|---|---|
| 3458-002 | July 2016 |

**20-Year System Fire Flow Upgrades Available Fire Flow (Reservoir Option 1)**

**Figure 3-10**

Path: R:\3400-3499\3458-002\430-GIS\MXD-Rpt\3458002_Fig3-10_20yrSystemAvailableFireflow_Option1.mxd Date Saved: 7/18/2016 4:31:24 PM
Author: TSoh


**GILLIES BAY IMPROVEMENT DISTRICT**
**Gillies Bay Master Water Plan**

## Legend

Reservoir (Decommissioned)

Booster Pump (Decommissioned)

Hydrant (Existing and installed prior to 20-year)

Hydrant (Proposed)

Water Main (Existing)

Abandoned Water Main (Existing)

**Water Main Upgrade**

100 mm dia

150 mm dia

200 mm dia

250 mm dia

300 mm dia

**Available Fire Flow**

<30 L/s

30 - 60 L/s

>60 L/s

Possible Growth Area (>60 L/s)

**Reference**: Orthophoto provided by Powell River Regional District.

KERR WOOD LEIDAL
consulting engineers



100 0 100
(m)

| Project No. | Date |
|---|---|
| 3458-002 | July 2016 |

**20-Year System Fire Flow Upgrades Available Fire Flow (Reservoir Option 2)**

**Figure 3-11**

Path: R:\3400-3499\3458-002\430-GIS\MXD-Rp\3458002_Fig3-11_20yrSystemAvailableFireflow_Option2.mxd Date Saved: 7/18/2016 4:28:37 PM
Author: TSoh

## 3.3 Water Treatment and Quality

GBID staff requested that the future water treatment design include:

- a concrete apron to receive bulk delivery;
- a roll up garage door to fit a pallet through with a hand truck;
- interior storage space to allow for bulk orders and product easily utilised from storage to mixing chambers, drainage for clean up; and
- exterior power sources.

These elements of the design should be considered in the detailed design of the treatment plant facility. At this stage, the land requirements identified in Section 2.11 allow enough space to incorporate all of these design elements along with a waste disposal pond for backwash from the sand filters.

Several treatment processes were considered during the Master Water Plan:

- ion exchange process which uses a strong base anion exchange resin with brine as the regenerant;
- sand filter with and without ozone pre-treatment; and
- conventional coagulation/flocculation followed by filtration.

For Cranby Lake water, the critical component that requires treatment is organics. If not adequately removed, these organics react with the chlorine used for disinfection to create Trihalomethanes (disinfection by-products) at levels above the GCDWQ.

The ion exchange process can remove organics, but it produces a brine waste solution which would need to be disposed. This disposal would be costly and has the potential to require environmental approvals. The coagulation/flocculation process is operationally intensive (a higher level of operator certification is required), uses chemicals, and produces chemically laden waste products. A sand filter without pre-treatment was tested by Anderson Civil in 2014. This test showed that a sand filter by itself cannot remove enough organics to eliminate the disinfection by-product issue. Given these constraints, a sand filter with ozone pre-treatment is recommended as a preferred treatment process. Given the high levels of organics in the source water it is recommended that the GBID pilot an ozone pre-treatment system upstream of a sand filter to confirm that this technology can meet the treatment process requirements identified in Section 2.10.

## 3.4 Life-cycle and Water Loss

Through water modelling, it was determined that several pipes across the distribution system are of sufficient size to convey fire flows, however these pipes are AC and were installed many years ago. As there are limited record drawings it is difficult to determine how old these pipe are, but AC was most commonly installed between 1940 and 1960 so they are likely 50 – 75 years old. Additionally, the condition of these pipes is unknown. AC pipe has a typical design life of 50 years. Over time, AC pipe undergoes gradual degradation in the form of corrosion (i.e., calcium leaching). This leaching reduces the pipe's effective cross-section, which results in pipe softening and loss of mechanical strength. These failures can be catastrophic or result in increased leakage. To reduce risks of catastrophic failure and decrease leakage across the system it is recommended that all AC pipes be replace within the 20-year planning period. As in Section 3.2 it is recommended that the hydrants on these lines be replaced as part of the watermain construction work. Refer to Figure 3-12 for a summary of the recommended lifecycle replacements.


GILLIES BAY IMPROVEMENT DISTRICT
Gillies Bay Master Water Plan

**Legend**

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Hydrant (Existing and installed prior to 20-year)
- Hydrant (Proposed)
- Water Main (Existing)
- Abandoned Water Main (Existing)

**Water Main Upgrade**

- 100 mm dia
- 150 mm dia
- 200 mm dia
- 250 mm dia
- 300 mm dia

**Reference**: Orthophoto provided by Powell River Regional District.

KERR WOOD LEIDAL
consulting engineers



100 0 100
(m)

| Project No. | Date |
|---|---|
| 3458-002 | July 2016 |

# 20-Year System Lifecycle Replacements

**Figure 3-12**

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Author: TSoh

## 3.5 Water Conservation and Environmental Considerations

The current system layout and treatment infrastructure requires substantial system flushing to maintain chlorine residual to the far reaches of the system. The upgraded system will include better looping to keep water fresh and the treatment process will decrease the rate that the chlorine residual declines in the system. These upgrades are projected to decrease the system flushing requirements to the levels of regular O&M activities for well-designed systems.

The reduction of flushing will result in water conservation by the GBID. To address water conservation across the system (including the customer side) it is recommended that the GBID develop a water conservation plan which considers water conservation strategies like: education programs, water metering, and use-based water rates. It should be noted that any water metering strategy should be driven by water conservation not cost recovery as this is often not feasible for small communities.

## 3.6 Customer Relations

The two primary customer relations opportunities for the upgrade of the water system are related to the aesthetics of water supplied to customers and the pressure at which it is supplied.

### Aesthetic Concerns

Residents of Gillies Bay have aesthetic concerns with the current raw water associated with taste, odour and appearance. Cranby Lake is relatively shallow and warms significantly in the summer which creates favourable conditions for algae growth. In 1975 Dr. R. J. Buchanan prepared a memorandum which reviewed this algal growth and its impacts on the taste and odour of Cranby Lake water. He found a large number of blue-green algae bodies which are usually associated with foul odours and tastes in water. Additionally, he hypothesized that at the end of their life cycle these algal bodies fall to the bottom of the lake where they are not only used as food for the next generation of algae, but also deplete oxygen as they decompose. The anaerobic conditions lead to the production of hydrogen sulfide and other products which result in foul-tasting and foul smelling water. Dr. Buchanan suggested that the level at which water is drawn from the lake can critically impact the aesthetic quality of the water. He suggested installing an intake that could be adjusted to varying intake points would enable better-quality waters to be obtained. John Motherwell & Associates agreed with Dr. Buchanan’s findings and recommendations in their 1988 report.

This Master Water Plan proposes the installation of an adjustable intake to reduce the contribution of taste and odour sources described above. The proposed treatment process will also reduce the colour, organics and turbidity in the treated water, which will have both health and aesthetic impacts.

### Pressure Concerns

When the new reservoir is installed the system pressure will increase. This has the potential to impact customers who do not have pressure reducing valves (PRVs) on their domestic service. It is recommended that the GBID communicate the advantages and proper installation of PRVs to residents in advance of the installation of the reservoir. Customers need to be advised that residential PRV’s factory pre-set need to be installed to reduce the risk of overpressures within their buildings. This could result in pipe failure and cause inundation together with attendant water damage. If desired, the GBID could contract for a bulk installation and bill customers who request/require it.

# 4. Master Water Plan

Overall, the Master Water Plan aimed to identify recommended improvements in a concise manner that can be readily used by the GBID in the planning, design and construction of water system upgrades. These recommended updates are intended to:

- address deficiencies;
- ensure sufficient storage for fire flows, balancing, and emergency storage;
- increase system capacity and pressure;
- ensure proper treatment and optimized disinfection; and
- reduce water wastage and operating costs.

A description of how each of the deficiencies identified in Section 3-1 is addressed in the plan is included in Table 4-1.

A central objective of the Master Water Plan was to provide the GBID with a “road map” that will assist them in setting budgets for priority improvement projects, and to get the best value for money during emergency expenditures through reference to the master plan. This objective has been achieved by grouping related tasks that are recommended to be completed together or within the same timeframe to address specific system deficiencies. This project grouping also aims to group projects that could be procured and constructed as packages to make the work attractive to skilled contractors and encourage competitive bidding. Engineering, contingency and general costs (mobilization, demobilization, insurance, and bonding) are included within each project to allow the GBID to budget appropriately as they move forward with their water system upgrades. The projects are summarized concisely in Table 4-2.

The second portion of the above objective references emergency expenditures. Should there be a watermain, valve, or fitting failure it is beneficial for the GBID to replace or repair the associated infrastructure with the size identified in the Master Water Plan instead of the existing size. To simplify this process the final pipe sizes and hydrant locations are summarized in Figure 4-1.

**Table 4-1: Summary of How Water System Deficiencies are Addressed in the Master Water Plan**

| Entry # | Description | How Deficiency is Addressed |
|---|---|---|
| 1 | Insufficient fire flow is available across the service area. | The new reservoir location and recommended pipe upgrades lead to 60 L/s available fire flow across the distribution system at the end of the 20-year period. |
| 2 | Fire department cannot use hydrants without pulling material through the system. This potentially puts the community on a boil water advisory due to inadequate contact time or high turbidity. | During fire scenarios, water is drawn rapidly from the lake which pulls material into the system. The new reservoir will have adequate fire storage of treated water for firefighting. |
| 3 | Insufficient fire coverage based on existing fire hydrants. | New hydrant locations are identified in the report which maximizes fire coverage over the 20-year period. |
| 4 | Current Vancouver Coastal Health Authority (VCHA) hazard rating for GBID water system is moderate. Raw water has high total organic carbon, colour and turbidity and the existing treatment system does not meet VCHA requirements. | Proposed treatment plant (5-year upgrade) will improve the water quality in the Gillies Bay water distribution system. The system looping will also maintain a higher water quality across the system. |
| 5 | Customers have aesthetic concerns with the current raw water associated with taste, odour and appearance. | Proposed treatment plant (5-year upgrade) will address aesthetic concerns in the treated water. |
| 6 | Frequent system flushing is required to maintain water quality. Total flushing volume was 29,101 $m^3$ in 2015. | Proposed system looping will reduce system flushing requirements. Also residual will last longer in treated water which will reduce flushing required to maintain chlorine residual. |
| 7 | Currently drawing more than water licence. Total water use for 2015 was 109,789 $m^3$ and licence allows 41,464 $m^3$ (113.6 $m^3$/d). | Recommended watershed assessment and water licence renewal. |
| 8 | Section of pipe on Shelter Point Rd crosses a creek bed. Pipe is visible and the creek is fish bearing. | Modelling confirmed that this pipe is not necessary for fire protection. Plan proposes to abandon the line in the 20-year timeframe. |
| 9 | Spillway/weir has reached the end of its service life. It could also use a mechanically operable gate for release of high water accumulation and flushing debris collected near intake. | Spillway/weir upgrade is included as a medium priority (10-year) project. |
| 10 | Private power pole and electrical mast for chlorinator is nearing the end of its service life. | Estimate includes replacement of power pole at chlorinator location. |
| 11 | 6" pumper ports on fire hydrants have not been used (2.5" typically used) and three of them have seized. | All hydrants will be replaced within the 20-year period. |
| 12 | Hydrant at the end of Gillies Bay Road needs to be moved to the ditch side of road to facilitate flushing operations. | All hydrants will be replaced within the 20-year period in conjunction with watermain replacement/upgrade. This hydrant can be relocated as part of this work. |
| 13 | Homes may not have PRVs. Pressure adjustments may impact pressure in customer homes. | Recommended communication with customers in advance of reservoir installation. |

**Table 4-2: Class 'D' Cost Opinion for Master Water Plan Capital Works Projects**

| Item | Description | Unit | Estimated Quantity | Unit Rate $/unit | TOTAL PRICE $ | Comment |
|---|---|---|---|---|---|---|
| 1 | **STORAGE & SUPPLY MAINS (HIGH PRIORITY)** | | | | | |
| 1.01 | Site Preparation | ha | 0.15 | 50,000 | 7,500 | The land requirement for the reservoir is estimated at 35m x 35m (0.12ha). |
| 1.02 | 678 m³ Bolted Steel Reservoir | each | 1 | 450,000 | 450,000 | Installation of one 678 m³ bolted steel tank, including gravel retaining ring foundation, overflow and piping connections. Price ($310,120) provided by Western Tank & Lining Ltd. |
| 1.03 | Pump Station from Treatment Plant to Reservoir | each | 1 | 100,000 | 100,000 | Supply of 2 – Cornell model 1.5WH-CC-10-2 close coupled horizontal end suction pumps supplied in standard cast iron construction, bronze fitted with Cycloseal shaft seal, 10 HP, 3600 RPM, 230/1//60Hz, ODP, standard efficiency motor was quoted at $8,800 for supply only without tax. This estimate includes housing, controls and installation. |
| 1.04 | BC Hydro Connection and Power Pole Replacement | L.S. | 1 | 17,500 | 17,500 | GBID staff noted that power pole at chlorinator is in disrepair and needs to be replaced. This is estimated at $10,000. The BC Hydro service connection is assumed to be $7,500 for the pump station and assumes that BC Hydro would supply the service transformer. |
| 1.05 | 150mm Diameter Feeder Main and Signal Cables | m | 350 | 200 | 70,000 | **Option 1 Only.** 150 mm diameter |
| 1.06 | 150mm Diameter Feeder Main and Signal Cables | m | 1,100 | 200 | 220,000 | **Option 2 Only.** 150 mm diameter |
| 1.07 | New 300mm Diameter Supply Main - New Reservoir to Old Tank | m | 990 | 350 | 346,500 | **Option 1 Only.** 300 mm diameter (70% driven by fireflow requirements, 30% by redundancy) |
| 1.08 | New Transmission Main - Reservoir to Airport Rd. & Pine St. | m | 1,920 | 350 | 672,000 | **Option 2 Only.** 300 mm diameter (70% driven by fireflow requirements, 30% by redundancy) |
| 1.09 | Locate and Open Partially Closed Valves on Ash & Oak | | | | | Reminder (no cost). |
| 1.10 | Decommission and Dispose of Existing Reservoir | L.S. | 1 | 10,000 | 10,000 | Beneficial reuse of this reservoir may be possible (i.e. fire department may use it for training purposes). |
| 1.11 | Decommission and Dispose of Existing Pump Station | L.S. | 1 | 10,000 | 10,000 | Beneficial reuse of the pump station (or its components) may be possible. |
| 1.12 | Treatment Pilot | L.S. | 1 | 55,000 | 55,000 | Treatment pilot to confirm process selection. |
| 1.13 | General (Bonding and Insurance, Mobilization and Demobilization) - 7% | L.S. | | | 74,655 | |
| 1.14 | Engineering & Construction Management - 20% | L.S. | | | 228,231 | |
| 1.15 | Contingency - 30% | L.S. | | | 342,347 | |
| | **SUBTOTAL FOR PROJECT 1 (ROUNDED)** | | | | **1,712,000** | |
| 2 | **TREATMENT PLANT (HIGH PRIORITY)** | | | | | |
| 2.01 | Site Preparation | ha | 0.30 | 50,000 | 15,000 | The land requirement for the water treatment plant and waste disposal pond is estimated at 40mx 65m (0.26ha). |
| 2.02 | Supply and Installation of Intake Extension with Two 6" Branches with Floating Headers & Intake Screens | each | 1 | 50,000 | 50,000 | Will result in improved control over intake level and avoid taking water from below thermocline during the summer months (associated with taste and odour issues). |
| 2.03 | Supply and Installation of Treatment Plant Equipment | each | 1 | 1,600,000 | 1,600,000 | Based on quote provided by MS Filter Inc. and tender prices from Cowan Point WTP. |
| 2.04 | Supply and Installation of Pre-engineered Steel Building and Foundation | L.S. | 1 | 300,000 | 300,000 | |
| 2.05 | Electrical and Mechanical Works (15%) | L.S. | 1 | 240,000 | 240,000 | Private power pole at chlorinator must be replaced. |
| 2.06 | Demolition of Existing Chlorinator | L.S. | 1 | 10,000 | 10,000 | |
| 2.07 | Civil Works (10%) | L.S. | 1 | 160,000 | 160,000 | |
| 2.08 | Waste Disposal Pond (earthworks) | m² | 420 | 50 | 21,000 | Annual wastewater volume of 420m³. Pond assumed to be full volume of annual wastewater. To be installed in the existing chlorinator location. |
| 2.09 | BC Hydro Upgrade to Supply Power to Treatment Plant Location Option B (Airport Road). | LS | 1 | 175,000 | 175,000 | Assumes $10,000 per pole and pole spacing of 100m. This estimate also assumes connection from Airport Road/Gillies Bay Road intersection with a total length of 1.6km. Alternate electrical routes are from the existing chlorinator location directly to the site (350 m), from Gillies Bay Rd via the access road and dam (800m), and from the airport via Airport Rd (1.6km). The estimate also includes a $15,000 BC Hydro connection fee, and assumes that service transformers are provided by BC Hydro. |
| 2.10 | General (Bonding and Insurance, Mobilization and Demobilization) - 7% | L.S. | | | 167,720 | |
| 2.11 | Engineering & Construction Management - 20% | L.S. | | | 547,744 | |
| 2.12 | Contingency - 30% | L.S. | | | 821,616 | |
| | **SUBTOTAL FOR PROJECT 2 (ROUNDED)** | | | | **4,108,000** | |
| 3 | **HIGH PRIORITY (5-YEAR) DISTRIBUTION SYSTEM UPGRADES** | | | | | |
| 3.01 | Abandon Existing Pump Station. Bypass with 250 mm Diameter Distribution Main | m | 60 | 300 | 18,000 | Driven by fireflow requirements. |
| 3.02a | New 150mm Diameter Distribution Main - Elm, from Ash to Sanderson | m | 455 | 200 | 91,000 | Driven by fireflow requirements. |
| 3.02b | Replacement of Fire Hydrant on Ash between Cedar and Balsam | each | 1 | 6,000 | 6,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 3.03 | New 200mm Diameter Distribution Main - Ash, from Cedar to Sanderson | m | 460 | 250 | 115,000 | Driven by fireflow requirements. |
| 3.04a | New 150mm Diameter Distribution Main - School Rd. Extension Past Gillies Bay Rd. and School Rd. | m | 160 | 200 | 32,000 | Driven by fire protection coverage. |
| 3.04b | Install High Priority Hydrants at Airport Rd. and Pine St., Gillies Bay Rd. and Sanderson Rd., 4584 Sanderson Road and on School Rd. Extension | each | 4 | 6,000 | 24,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 3.05 | General (Bonding and Insurance, Mobilization and Demobilization) - 7% | L.S. | | | 20,020 | |
| 3.06 | Engineering & Construction Management - 20% | L.S. | | | 61,204 | |
| 3.07 | Contingency - 30% | L.S. | | | 91,806 | |
| | **SUBTOTAL FOR PROJECT 3 (ROUNDED)** | | | | **459,000** | |
| 4 | **MEDIUM PRIORITY (10-YEAR) DISTRIBUTION SYSTEM UPGRADES** | | | | | |
| 54.01a | Upgrade Airport Rd. from Existing Tank to Gillies Bay Rd. to 250mm Diameter | m | 420 | 300 | 126,000 | Driven by fireflow requirements. |
| 4.01b | Replace Fire Hydrants on Airport Rd. between Existing Tank to Gillies Bay Rd | each | 2 | 6,000 | 12,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 4.02 | Upgrade Pump Station. Supply Main from Airport Rd. to Pump Station to 250mm Diameter | m | 420 | 300 | 126,000 | Driven by fireflow requirements. |
| 4.03a | Upgrade Gillies Bay Rd. from Airport Rd. to Patton Rd. to 250mm Diameter | m | 330 | 300 | 99,000 | Driven by fireflow requirements. |
| 4.03b | Replacement of Fire Hydrants on Gillies Bay Rd. between Airport Rd. and Patton Rd. and Move New Hydrant at Gillies Bay Rd. and Sanderson Rd. to New Watermain | each | 3 | 6,000 | 18,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 4.04a | Upgrade Gillies Bay Rd. from Patton Rd. to School Rd. to 250mm Diameter | m | 540 | 300 | 162,000 | Driven by fireflow requirements. |
| 4.04b | Replace fire hydrants on Gillies Bay Rd. between Patton Rd. and School Rd. | each | 2 | 6,000 | 12,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 4.05a | Upgrade Sanderson Rd. from Gillies Bay Rd. to Ash St. to 250mm Diameter | m | 410 | 300 | 123,000 | Driven by fireflow requirements. |
| 4.05b | Replace Fire Hydrants on Sanderson Rd. between Gillies Bay Rd. and Ash St. | each | 3 | 6,000 | 18,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 4.06a | Upgrade Dogwood Ave. from Oak St. to Ash St. to 200mm Diameter | m | 220 | 250 | 55,000 | Driven by fireflow requirements. |
| 4.06b | Replace Fire Hydrants on Dogwood Ave. between Oak St. and Ash St. | each | 2 | 6,000 | 12,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 4.07a | Upgrade Ash St. from Elm St. to Hydrant between Cedar St. & Balsam Ave. to 200mm Diameter | m | 360 | 250 | 90,000 | Driven by fireflow requirements. |
| 4.07b | Replace Fire Hydrant on Ash St. between Elm St. and Hydrant between Cedar St. & Balsam Ave. | each | 1 | 6,000 | 6,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 4.08a | Upgrade Elm St. from Oak St. to Ash St. to 150mm Diameter | m | 220 | 200 | 44,000 | Driven by fireflow requirements. |
| 4.08b | Replace Fire Hydrant on Elm St. at Corner of Oak St. and Elm St. | each | 1 | 6,000 | 6,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 4.09a | Upgrade Oak from Dogwood Ave. to Elm St. to 150mm Diameter | m | 180 | 200 | 36,000 | Driven by fireflow requirements. |
| 4.09b | Replace Fire Hydrant on Oak St. at Corner of Oak St. and Dogwood Ave. | each | 1 | 6,000 | 6,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 4.10 | Optional: New Transmission Main to Shelter Point | m | 2,200 | 200 | 440,000 | 150mm diameter to connect Shelter Point. |
| 4.11 | Spillway/Weir Repair and Installation of Mechanically Operable Gate | L.S. | 1 | 125,000 | 125,000 | Allowance for installation of concrete spillway with mechanically operable gate. Includes allowance for geotechnical and dam safety assessments. |
| 4.12 | General (Bonding and Insurance, Mobilization and Demobilization) - 7% | | | | 75,320 | |
| 4.13 | Engineering & Construction Management - 20% | | | | 230,264 | |
| 4.14 | Contingency - 30% | | | | 345,396 | |
| | **SUBTOTAL FOR PROJECT 4 (ROUNDED)** | | | | **1,727,000** | |
| 5 | **LOW PRIORITY (20-YEAR) DISTRIBUTION SYSTEM UPGRADES** | | | | | |
| 5.01a | Upgrade Gilles Bay Rd. from School Rd. to 5262 Gillies Bay Rd. to 200mm Diameter | m | 450 | 250 | 112,500 | Driven by fireflow requirements. |
| 5.01b | Replace Fire Hydrants on Gilles Bay Rd. between School Rd. and 5362 Gillies Bay Rd. Install Two New Hydrants at 5204 and 5264 Gillies Bay Rd. | each | 4 | 6,000 | 24,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.02a | Upgrade Sanderson Rd. from Ash St. to Cul de Sac to 150mm Diameter | m | 830 | 200 | 166,000 | Driven by fireflow requirements. |
| 5.02b | Replace Fire Hydrants on Sanderson Rd. between Ash St. and Cul de Sac. Install Four New Hydrants at 4657, 4476 and 4356 Sanderson Rd. | each | 7 | 6,000 | 42,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.03a | Upgrade Birch St. from Elm St. to Cul de Sac to 150mm Diameter | m | 80 | 200 | 16,000 | Driven by fireflow requirements. |
| 5.03b | Replace Fire Hydrant at End of Birch St. | each | 1 | 6,000 | 6,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.04a | Upgrade Cedar St. from Oak St. to Cul de Sac to 150mm Diameter | m | 70 | 200 | 14,000 | Driven by fireflow requirements. |
| 5.04b | Replace Fire Hydrant at end of Cedar St. | each | 1 | 6,000 | 6,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.05a | Upgrade Balsam Ave. from Oak St. to Cul de Sac to 150mm Diameter | m | 90 | 200 | 18,000 | Driven by fireflow requirements. |
| 5.05b | Replace Fire Hydrant at End of Balsam Ave. | each | 1 | 6,000 | 6,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.06 | Upgrade WTP Supply from Lake to WTP to 150mm Diameter | m | 540 | 200 | 108,000 | Driven by lifecycle and water loss. |
| 5.07a | Upgrade Cedar St. from Oak St. to Sanderson Rd. to 150mm Diameter | m | 500 | 200 | 100,000 | Driven by lifecycle and water loss. |
| 5.07b | Replace Fire Hydrants on Cedar St. between Oak St. and Sanderson Rd. Install New Hydrant at 4731 Cedar St. | each | 3 | 6,000 | 18,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.08a | Upgrade Balsam Ave. from Oak St. to Sanderson Rd. to 150mm Diameter | m | 430 | 200 | 86,000 | Driven by lifecycle and water loss. |
| 5.08b | Replace Fire Hydrant on Balsam Ave. between Oak St. and Sanderson Rd. Install New Hydrant at 4730 Balsam Ave. | each | 2 | 6,000 | 12,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.09a | Upgrade Alder Ave. from Oak St. to Cedar St. to 150mm Diameter | m | 510 | 200 | 102,000 | Driven by lifecycle and water loss. |
| 5.09b | Replace Fire Hydrants on Alder Ave. between Oak St. and Cedar St. Install New Hydrants at 4747, 3375 and 4620 Alder Ave. | each | 5 | 6,000 | 30,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.10a | Replace Pine St. from Airport Rd. to Alder Ave. to 150mm Diameter | m | 480 | 200 | 96,000 | Driven by lifecycle and water loss. |
| 5.10b | Replace Fire Hydrants on Pine St. between Airport Rd. and Alder Ave. Install New Hydrant at Intersection of Pine St. and Alder Ave. | each | 3 | 6,000 | 18,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.11 | Replace Oak St. from Dogwood Ave. to Sanderson Rd. to 150mm Diameter | m | 520 | 200 | 104,000 | Driven by lifecycle and water loss. |
| 5.12a | Upgrade Gilles Bay Post Office Loop to 150mm Diameter. Cap and Abandon Main with Pipe Crossing | m | 150 | 200 | 30,000 | Driven by lifecycle and water loss. |
| 5.12b | Replace Fire Hydrant on Post Office Loop and Install New Hydrant at the End of the Main. | each | 2 | 6,000 | 12,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.13a | Upgrade Gilles Bay Rd from 5262 Gillies Bay Rd. to 5362 Gillies Bay Rd. to 200mm Diameter | m | 350 | 250 | 87,500 | Driven by lifecycle and water loss. |
| 5.13b | Replace Fire Hydrants on Gilles Bay Rd between 5262 and 5362 Gillies Bay Rd. Install Hydrant at 5326 Gillies Bay Rd. | each | 3 | 6,000 | 18,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.14 | Install Fire Hydrant at the End of Patton Rd. | each | 1 | 6,000 | 6,000 | Driven by fire protection coverage. Includes lead, hydrant and 6" gate valve. |
| 5.15 | General (Bonding and Insurance, Mobilization and Demobilization) - 7% | L.S. | | | 86,660 | |
| 5.16 | Engineering & Construction Management - 20% | L.S. | | | 264,932 | |
| 5.17 | Contingency - 30% | L.S. | | | 397,398 | |
| | **SUBTOTAL FOR PROJECT 5 (ROUNDED)** | | | | **1,987,000** | |
| 7 | **Task** | | | | | |
| 7.01 | | each | | | 0 | |
| 7.02 | | days | | | 0 | |
| 7.03 | | allow | | | 0 | |
| 7.04 | | days | | | 0 | |
| 7.05 | | days | | | 0 | |
| 7.06 | | days | | | 0 | |
| | **SUBTOTAL FOR TASK** | | | | **0** | |
| | **TOTAL AMOUNT (excl. GST)** | | | | **9,993,000** | |

*Note: Estimates have been prepared with little or no site information and as such indicates the approximate magnitude of the cost of the capital tasks, for project planning purposes only. The estimate has been derived from unit costs for similar projects.*

Notes:

***Prepared by:***

*Seal*

1. Grey line items are provided for information, but not included in the cost estimate.
2. Land acquisition has not been included in this cost estimate.


## GILLIES BAY IMPROVEMENT DISTRICT
### Gillies Bay Master Water Plan

**Legend**

- Reservoir (Decommissioned)
- Booster Pump (Decommissioned)
- Water Main (Existing)
- Abandoned Water Main

**Hydrant Upgrade**

- 5-Year
- 10-Year
- 20-Year

**Water Main Upgrade**

- New Reservoir
- 5-Year
- 10-Year
- 20-Year

**Reference**: Orthophoto provided by Powell River Regional District.

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100 0 100
(m)

| Project No. | Date |
|---|---|
| 3458-002 | July 2016 |

# 20-Year System Upgrade Timeline

**Figure 4-1**

Path: R:\3400-3499\3458-002\430-GIS\MXD-Rpt\3458002_Fig4-1_UpgradeTimeline.mxd Date Saved: 7/18/2016 4:45:46 PM
Author: TSoh

# 5. Closing

We trust that this report meets the requirements of the GBID. If you have any further questions, please do not hesitate to contact Siobhan Robinson at 604-293-3218.

## 5.1 Report Submission

Prepared by:

**KERR WOOD LEIDAL ASSOCIATES LTD.**

PROFESSIONAL ENGINEER S. M. ROBINSON BRITISH COLUMBIA
July 21, 2016

Siobhan Robinson, M.A.Sc., P.Eng.
Project Engineer

Reviewed by:

Jurek Janota-Bzowski, P.Eng.
Project Manager

Irfan Gehlen, P.Eng.
Sr. Water Treatment Specialist

This document is a copy of the sealed and signed original retained on file.
The content of the electronically transmitted document can be confirmed by referring to the filed original.

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This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of GILLIES BAY IMPROVEMENT DISTRICT for the Gillies Bay Master Water Plan. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

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## Revision History

| Revision # | Date | Status | Revision | Author |
|---|---|---|---|---|
| 0 | July 21, 2016 | Final | Final report. | SMR |
| A | May 31, 2016 | Draft | Draft for client review. | SMR |

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Appendix A

# Demand Calculation Details

| Water Demand Calculation | Gillies Bay Improvement District |
|---|---|
| Current Gillies Bay Domestic Water Servicing | July 2016 |

## Water Demand Calculation

$$MDD = Indoor\ Usage + Water\ Loss\ Allowance + Irrigation + \mathbf{Flushing\ Allowance}$$

Flushing Allowance is based on Historical water use

*Note: From Design Guidelines for Rural Residential Community Water Systems (2012).*

| | | | | | | |
|---|---|---|---|---|---|---|
| **Indoor Usage** | | | | | | |
| Number of Homes | 259 | | | | | |
| Population per Home | 2.10 | people | | | Used assumption from Anderson Civil Consultants-Shelter Point Water Service Area Servcing Plan. |
| Population Serviced by System | 544 | | | | |
| Per Capita Water Demand | 230 | L/p/d | | | Recommended indoor use per capita value from Rural Design Guidelines. |
| Indoor Usage Subtotal | 125.097 | $m^3/d$ | 125,097 | L/d | |
| **Water Loss Allowance (System Leakage)** | | | | | |
| $12 \times ((0.4704 \times L_m) + (0.0303 \times N_c) + (0.8 \times L_c)) \times \left(\frac{P}{49.26}\right)^{1.5}$ | | | | | Design Guidelines for Rural Residential Community Water Systems (2012). Increased first coefficient to account for the age and maintenance of the GBID system. |
| Length of mains ($L_m$) | 9.5 | km | | | Based on tracing of mains in GIS |
| Number of Connections ($N_c$) | 259 | | | | |
| Total Length of connections ($L_c$) | 0.25 | km | | | Assumed average 6 m per connection, multiplied by # of connections (6m x 42)= 0.252 |
| System Pressure (P) | 56 | m water column | 80 | psi | Based on pressure map in O&M Plan provided by GBID pressures range from 50psi to 95 psi. Assumed an average pressure of 80 psi |
| Water Loss Subtotal | 181.50298 | $m^3/d$ | 181,503 | L/d | |
| **Irrigation Contingency Allowance** | | | | | |
| Number of Homes | 259 | | | | |
| Area Per Property to be Irrigated | 140 | $m^2$ | | | Shelter Point area was 700. Refer to "RDG-ShelterPointWaterDemand". Operations staff suggested 100m², but indicated that additional water is taken from the system for use outside the service area in summer months. |
| Total Area to be Irrigated | 36,260 | $m^2$ | 3.626 | ha | |
| Peak Daily Evapotranspiration Rate | 4.5 | mm/d | | | Based on Comox max. daily evapotranspiration rate. See Evapotranspiration Rates for Turf Grass in British Columbia - Water Conservation Factsheet |
| Irrigation Rate | 63 | $m^3$/ha /d | | | |
| Irrigation Contingency Allowance Subtotal | 228 | $m^3/d$ | 228438 | L/d | |
| **Flushing Allowance** | | | | | |
| Maximum daily flushing volume | 169 | m³/d | | | Based on historical water use and discussions with |
| **Maximum Day Demand** | **704** | **$m^3/d$** | 8.15 | L/s | |

## Water Demand Calculation

$$MDD = Indoor\ Usage + Water\ Loss\ Allowance + Irrigation + \mathbf{Flushing\ Allowance}$$

*Note: From Design Guidelines for Rural Residential Community Water Systems (2012).*

| | | | | | | |
|---|---|---|---|---|---|---|
| **Indoor Usage** | | | | | | Assumes that flushing will be 50% of current |
| Number of Homes | 354 | | | | | |
| Population per Home | 2.10 | people | | | | Used assumption from Anderson Civil Consultants-Shelter Point Water Service Area Servcing Plan. |
| Population Serviced by System | 743 | | | | | |
| Per Capita Water Demand | 230 | L/p/d | | | | Recommended indoor use per capita value from Rural Design Guidelines. |
| Indoor Usage Subtotal | 170.982 | $m^3/d$ | 170,982 | L/d | | |
| **Water Loss Allowance (Leakage)** | | | | | | |
| $5 \times ((0.4704 \times L_m) + (0.0303 \times N_c) + (0.8 \times L_c)) \times \left(\frac{P}{49.26}\right)^{1.5}$ | | | | | | Design Guidelines for Rural Residential Community Water Systems (2012). |
| Length of mains ($L_m$) | 10.7 | km | | | | Option 2 - East Reservoir. New watermain accounts for 2,698m. |
| Number of Connections ($N_c$) | 354 | | | | | |
| Total Length of connections ($L_c$) | 0.25 | km | | | | Assumed average 6 m per connection, multiplied by # of connections (6m x 42)= 0.252 |
| System Pressure (P) | 64 | m water column | 91 | psi | | If you ignore all nodes above Airport Rd. & Pine St. (i.e. review serviced properties only), the average pressure is 89 psi. Median is 91 psi. |
| Water Loss Subtotal | 117.167 | $m^3/d$ | 117,167 | L/d | | |
| **Irrigation Contingency Allowance** | | | | | | |
| Number of Homes | 354 | | | | | |
| Area Per Property to be Irrigated | 140 | $m^2$ | | | | Assumed to be same as current. |
| Total Area to be Irrigated | 49,560 | $m^2$ | 4.956 | ha | | |
| Peak Daily Evapotranspiration Rate | 4.5 | mm/d | | | | Based on Comox max. daily evapotranspiration rate. See Evapotranspiration Rates for Turf Grass in British Columbia - Water Conservation Factsheet |
| Irrigation Rate | 52.5 | $m^3$/ha /d | | | | Assumes water meters will be installed, but irrigation systems will be varied on customer properties. |
| Irrigation Contingency Allowance Subtotal | 260 | $m^3/d$ | 260190 | L/d | | |
| **Flushing Allowance** | | | | | | |
| Maximum daily flushing volume | 84 | $m^3/d$ | | | | 50% of original flushing allowance |
| **Maximum Day Demand** | **633** | **$m^3/d$** | 7.32 | L/s | | |
| Peaking Factor | 2.5 | | | | | Recommended peaking factor for communities less than 5000 people from Rural Design Guidelines. |
| **Average Day Demand** | **253** | **$m^3/d$** | 2.93 | L/s | | |

## Water Demand Calculation

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

*Note: From Design Guidelines for Rural Residential Community Water Systems (2012).*

| | | | | | |
|---|---|---|---|---|---|
| **Indoor Usage** | | | | | |
| Number of Homes | 42 | | | | |
| Population per Home | 2.5 | people | | | Used assumption from Anderson Civil Consultants-Shelter Point Water Service Area Servcing Plan. |
| Population Serviced by System | 105 | | | | |
| Per Capita Water Demand | 230 | L/p/d | | | Recommended indoor use per capita value from Rural Design Guidelines. |
| Indoor Usage Subtotal | 24.15 | $m^3/d$ | 24,150 | L/d | |
| **Water Loss Allowance (Leakage)** | | | | | |
| $2 \times ((0.4704 \times L_m) + (0.0303 \times N_c) + (0.8 \times L_c)) \times \left(\frac{P}{49.26}\right)^{1.5}$ | | | | | Design Guidelines for Rural Residential Community Water Systems (2012). Reduced from 5 to 2 as the system will be new. |
| Length of mains ($L_m$) | 1.8 | km | | | assumed for drawing |
| Number of Connections ($N_c$) | 42 | | | | |
| Total Length of connections ($L_c$) | 0.25 | km | | | Assumed average 6 m per connection, multiplied by # of connections (6m x 42)= 0.252 |
| System Pressure (P) | 40 | m water column | 57 | psi | Assumed location of reservior will be located at a site between 70 and 80 m elevation. From Drawing I looks like elevation of lots are near the 40 m elevation. |
| Water Loss Subtotal | 3.39421 | $m^3/d$ | 3,394 | L/d | |
| **Irrigation Contingency Allowance** | | | | | |
| Number of Homes | 42 | | | | |
| Area Per Property to be Irrigated | 700 | $m^2$ | | | Used assumption from Anderson Civil Consultants-Shelter Point Water Service Area Servcing Plan. |
| Total Area to be Irrigated | 29,400 | $m^2$ | 2.94 | ha | |
| Peak Daily Evapotranspiration Rate | 4.5 | mm/d | | | Based on Comox max. daily evapotranspiration rate. See Evapotranspiration Rates for Turf Grass in British Columbia - Water Conservation Factsheet |
| Irrigation Rate | 45 | $m^3/ha\ /d$ | | | |
| Irrigation Contingency Allowance Subtotal | 132 | $m^3/d$ | 132300 | L/d | |
| **Maximum Day Demand** | **160** | **$m^3/d$** | 1.85 | L/s | |
| Peaking Factor | 2.5 | | | | Recommended peaking factor for communities less than 5000 people from Rural Design Guidelines. |
| **Average Day Demand** | **64** | **$m^3/d$** | 0.74 | L/s | |

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Appendix B

# Water Quality Summary Table

**Gillies Bay Master Water Plan**

Water Quality Summary

*File: 3458.002*

| | Value | | | CDWG MAC | | | |
|---|---|---|---|---|---|---|---|
| **Water Quality Parameter** | **MAX** | **MIN** | **AVG** | | **Date of Sample** | **Reference** | **Notes** |
| **Organic Carbon (TOC, DOC)**<br>**Units: mg/L** | 8.5 | 6.7 | 7.5 | 4 | July 2014 - January 2015 | Anderson - Slow Sand Filter Pilot Test - Final Report | TOC recommended guideline from MoE Ambient Water Quality Guidelines |
| | 12 | 9 | 10.5 | 4 | 1973 | Terms of Reference 1987 Report | TOC; this data may be unreliable |
| | | | 8.5 | 4 | 1990 | McElhanney 2006 Draft Report | |
| | | | 8 | 4 | 2000 | Alluvia Environmental Services Report | |
| | 8.5 | 2 | 5.25 | 4 | 1990-2000 | EBA Engineering Report | |
| | | | 8 | 4 | 19-Nov-14 | Exova Test Results - Raw from Pilot Testing | |
| | | | 8.1 | 4 | 21-Nov-14 | Exova Test Results - Raw from Pilot Testing | |
| | | | 7.7 | 4 | 24-Nov-14 | Exova Test Results - Raw from Pilot Testing | |
| | | | 8.5 | 4 | 13-Dec-14 | Exova Test Results - Raw from Pilot Testing | |
| **AVERAGING CARBON ACROSS DIFFERENT SOURCES** | | | 8.01 | 4 | | | |
| **Colour**<br>**Units: CU** | 37 | 14 | 25.5 | 15 (AO) | July 2014 - January 2015 | Anderson - Slow Sand Filter Pilot Test - Final Report | 15 is aesthetic objective |
| | | | 20 | 15 (AO) | 2007 | Anderson - Final Report (2007) | |
| | | | 15 | 15 (AO) | 1986 | 1986 Report | Depth range - surface to 1.0m |
| | | | 50 | 15 (AO) | 1986 | 1986 Report | Depth range - to 7.0m |
| | | | 20 | 15 (AO) | 1987 | 1987 Report | |
| | 30 | 20 | 25 | 15 (AO) | 1973 | Terms of Reference 1987 Report | This data may be unreliable |
| | 25 | 15 | 20 | 15 (AO) | 1978 through 2004 | McElhanney 2006 Draft Report | |
| | | | 20 | 15 (AO) | 2000 | Alluvia Environmental Services Report | |
| | | | 20 | 15 (AO) | 2000 | EBA Engineering Report | |
| | | | 19 | 15 (AO) | November-19-14 | Exova Test Results - Raw from Pilot Testing | |
| | | | 18 | 15 (AO) | November-21-14 | Exova Test Results - Raw from Pilot Testing | |
| | | | 19 | 15 (AO) | November-24-14 | Exova Test Results - Raw from Pilot Testing | |
| | | | 27 | 15 (AO) | December-13-14 | Exova Test Results - Raw from Pilot Testing | |
| | | | 20 | 15 (AO) | 17-Nov-14 | Exova Test Results - Annual Baseline Sample (Raw) | |
| **AVERGAGE COLOUR ACROSS DIFFERENT SOURCES** | | | 22.8 | 15 (AO) | | | |
| **Turbidity**<br>**Units: NTU** | 1.2 | 0.7 | 0.7 | 1 | July 2014 - January 2015 | Anderson - Slow Sand Filter Pilot Test - Final Report | Treatment limits for individual filters or units<br>Conventional and direct filtration: ≤ 0.3 NTU<br>slow sand and diatomaceous earth filtration: ≤ 1.0 NTU<br>membrane filtration: ≤ 0.1 NTU |
| | | | 1.2 | 1 | 1986 | 1986 Report | Depth range - surface to 1.0m |
| | | | 5.5 | 1 | 1986 | 1986 Report | Depth range - to 7.0m |
| | | | 1 | 1 | 1987 | 1987 Report | |
| | 3.5 | 0.44 | 1.97 | 1 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| | 3.5 | 0.3 | 1.9 | 1 | 2001 | Alluvia Environmental Services Report | |
| | | | 2 | 1 | 1987 | 1987 Report | This data may be unreliable |
| | | | 0.25 | 1 | 1992 | Ministry of Health and Minstry responsible for seniors report | |
| | | | 0.8 | 1 | November-17-14 | Exova Test Results - Annual Baseline Sample (Raw) | |
| **AVERAGING TURBIDITY ACROSS DIFFERENT SOURCES** | | | 1.7 | 1 | | | |
| **Phosphorous**<br>**Units: ppm** | 0.586 | 0.135 | 0.3605 | | 1984 through 2004 | 2006 McElhanney Report | Orthophosphate max of 3.92 ug/L |
| | 0.09 | 0.004 | 0.03 | | 1973 | 1987 Terms of Reference | Average soluble is 0.0095 |
| **AVERAGING PHOSPHOROUS ACROSS DIFFERENT SOURCES** | | | 0.20 | | | | |
| **Nitrate**<br>**Units: mg/L** | | | <0.02 | 45 | 1986 | 1986 Report | ($NO_3$ and $NO_2$) Depth range - surface to 1.0m |
| | | | <0.02 | 45 | 1986 | 1986 Report | ($NO_3$ and $NO_2$) Depth range - to 7.0m |
| | | | 0.39 | 45 | 1973 | 1987 Terms of Reference | |
| | 0.77 | 0.06 | 0.334 | 45 | 1984 through 2000 | McElhanney 2006 Draft Report | |
| **AVERAGING ACROSS DIFFERENT SOURCES** | | | 0.39 | 45 | | | |
| **Solids (Suspended/Dissolved/Total/Filterable Residue)**<br>**Units: mg/L** | | | 2.7 | 500 (AO) | 1987 | 1987 Report | Suspended |
| | | | 90 | 500 (AO) | 1987 | 1987 Report | Dissolved |
| | 65 | 91 | 74.1 | 500 (AO) | 1984 through 2004 | McElhanney 2006 Draft Report | Dissolved |
| **AVERAGING SOLIDS ACROSS DIFFERENT SOURCES** | | | 82.05 | 500 (AO) | | | Dissolved |
| **Hardness ($CaCO_3$) Units: mg/L** | 70.8 | 37.4 | 45.9 | 0-75 = soft | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Alkalinity ($CaCO_3$) Units: mg/L** | 46.1 | 33 | 39.6 | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| | 43.1 | 38.5 | 41.1 | | 1973 | 1987 Terms of Reference | |
| **AVERAGING ALKALINITY ACROSS DIFFERENT SOURCES** | | | 42.16 | | | | |
| **Sulfate Units: mg/L** | 5 | 3 | 3.8 | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Chloride Units: mg/L** | 7 | 4.3 | 3.8 | 250 (AO) | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Fluoride Units: mg/L** | 0.1 | 0.02 | 0.1 | 1.5 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Conductivity Units: uS/com** | 113 | 95 | 101.5 | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Bromide Units: mg/L** | 0.1 | 0.07 | 0.1 | 0.01 (Bromate) | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Aluminum Units: mg/L** | 0.024 | 0.007 | 0.0 | 0.1 (OG) | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Antimony Units: ug/L** | | <1 | | 6 | 1984 through 2004 | McElhanney 2006 Draft Report | One reading of 94. Seems anomalous |
| **Arsenic Units: ug/L** | 4 | 0.5 | 2.3 | 10 | 1984 through 2004 | McElhanney 2006 Draft Report | Most readings below 1 or below 0.5 |
| **Barium Units: mg/L** | 1 | 0.005 | 0.003 | 1 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Beryllium Units: mg/L** | <0.003 | <0.001 | | | 1984 through 2004 | McElhanney 2006 Draft Report | All readings below 0.003 |
| **Bismuth Units: mg/L** | | | <0.05 | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Boron Units: mg/L** | 0.526 | 0.03 | 0.3 | 5 | 1984 through 2004 | McElhanney 2006 Draft Report | Most readings below 0.01 |
| **Cadmium Units: ug/L** | <1 | <0.02 | | 5 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Calcium Units: mg/L** | 20.9 | 11.7 | 16.3 | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Chromium Units: mg/L** | <0.01 | <0.001 | | 0.05 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Cobalt Units: mg/L** | 0.21 | <0.002 | | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Copper Units: mg/L** | 0.156 | 0.003 | 0.1 | 1 (AO) | 1984 through 2004 | McElhanney 2006 Draft Report | Half of the readings below 0.01 |
| **Gold Units: mg/L** | <0.04 | <0.004 | | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Iron Units: mg/L** | 0.2 | 0.59 | 0.4 | 0.03 (AO) | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Lanthanum Units: mg/L** | <0.02 | <0.002 | | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Lead Units: ug/L** | 0.009 | <0.001 | | 10 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Magnesium Units: mg/L** | 4.53 | 1.7 | 2.3 | 50 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Manganese Units: ug/L** | 0.026 | 0.002 | 0.0 | 50 (AO) | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Mercury Units: mg/L** | | <0.02 | | 0.001 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Molydbenum Units: mg/L** | 0.087 | <0.003 | | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Nickel Units: mg/L** | <0.0.5 | <0.005 | | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Potassium Units: mg/L** | 3.7 | 0.219 | 0.9 | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Scandium Units: mg/L** | 0.059 | <0.05 | | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Selenium Units: mg/L** | <0.001 | <0.0005 | | 0.05 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Silicon Units: mg/L** | 2.98 | 0.26 | 1.3 | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Silver Units: mg/L** | <0.01 | <0.003 | | 0.05 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Sodium Units: mg/L** | 8.7 | 3.1 | 4.6 | 200 (AO) | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Strontium Units: mg/L** | 0.078 | 0.048 | 0.1 | | 1984 through 2004 | McElhanney 2006 Draft Report | Radiological limit is 5 Bq/L. |
| **Titanium Units: mg/L** | 0.071 | 0.003 | | | 1984 through 2004 | McElhanney 2006 Draft Report | Most readings below 0.002 |
| **Tungsten Units: mg/L** | 0.174 | <0.03 | | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Uranium Units: mg/L** | | <0.0005 | | 0.02 | 2000 | McElhanney 2006 Draft Report | |
| **Vanadium Units: mg/L** | <0.05 | <0.01 | | | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Zinc Units: mg/L** | 0.11 | 0.004 | 0.0 | 5 (AO) | 1984 through 2004 | McElhanney 2006 Draft Report | |
| **Algae**<br>**Units: cells/100mL** | | | 374000 | | 1973 | Terms of Reference Report | at 1.0m depth; data may be unreliable |
| | | | 292000 | | 1973 | Terms of Reference Report | at 3.0m depth; data may be unreliable |
| | | | 928000 | | 1973 | Terms of Reference Report | at 6.0m depth; data may be unreliable |
| | 1E+10 | 2600 | 2470053075 | | 2000 through 2004 | McElhanney 2006 Draft Report | |
| **AVERAGING ALGAE ACROSS DIFFERENT SOURCES** | | | 617911769 | | | | |
| **Temperature**<br>**Units: °C** | 18.3 | 12 | 15.15 | | 1986 | 1986 Report | At the HWM of 72.7m |
| | | | 20 | | 1973 | 1987 Report | In the top 4.0m of lake |
| | 20.2 | 10.3 | 15.25 | | 1973 | Terms of Reference 1987 Report | |
| **AVERAGING TEMPERATURE ACROSS DIFFERENT SOURCES** | | | 16.8 | | | | |
| **Trihalomethanes (THM) - in treated water**<br>**Units: µg/L** | 220 | 26 | 94.5 | 100 | 1984 through 2004 | McElhanney 2006 Draft Report | |
| | 227 | 115.1 | 171.05 | 100 | 2000 | Alluvia Environmental Services Report | |
| | 51 | 48 | 49.5 | 100 | 1992 | Ministry of Health and Ministry Responsible for Seniors Report | |
| **AVERAGING THMs ACROSS DIFFERENT SOURCES** | | | 105.0 | 100 | | | |

**Notes:**
- MAC = Maximum allowable concentration
- AO = aesthetic objective
- OG = operational guidance value

**Legend:**

(shaded cell) = Exceeds Canadian Drinking Water Quality Guidelines

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