REPORT

GALIANO GREEN
WATER MANAGEMENT PLAN

Prepared For:

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Date:

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Re:

Water Management Plan

GWAII
ENGINEERING

Contents

1. INTRODUCTION

Gwaii Engineering Ltd. ("Gwaii") has been retained by Mobius Architecture to prepare the following Water Management Plan (WMP) which details the strategies recommended for the proposed 20-unit, multi-family development located at 409 Porlier Pass Road on Galiano Island, BC. This report has been prepared to support an application for Rezoning made to Islands Trust in February 2021.

2. BACKGROUND & SUPPORTING DOCUMENTATION

The proposed development Site is an irregular shaped, undeveloped parcel (totaling approximately 4.04ha) situated between Porlier Pass Road to the north and Georgeson Bay Road along the southern boundary on Galiano Island, BC. The existing legal information for the parcel is described in Table 1 below:

Table 1 - Legal Information

Civic Address	409 Porlier Pass Road, Galiano Island, BC
Legal Description	Lot 1, Plan VIP 29196, District Lot 3, Land District 16, Portion Galiano Island PID: 001-416-987
Zoning	CH1 - Community Housing

This report is intended to support a rezoning application to eventually permit the construction of 20 multi-family units in four proposed blocks accessed through a new development road connecting from Georgeson Bay Road to the south. The Site is located within the *Murchison-Whaler Bay* watershed which forms a Major Groundwater Region as per Schedule C, Land Use Bylaw Water Management Areas and Schedule D, Water Resources Bylaw pursuant to the Galiano Island Official Community Plan Bylaw No. 108. An existing well (WID 23204) located within the central region of the Site (see the attached Site Figure) shall provide potable water to the proposed development for domestic and fire fighting purposes. A pump test and accompanying report prepared by Hy-Geo Consulting dated February 9th, 2020 was completed subsequent to a Water License Application made for WID 23204 at the subject property. The pump test was completed over a 72.5-hour period

between October 16th to October 19th, 2020 and followed previous testing completed in November 2018 by the same firm. The report examined water quantity and quality for WID 23204 and presented the following conclusions:

1. "The well was pump tested for 72.5 hours between October 16th and October 19th, 2020 by Red Williams Well Drilling Ltd., at a constant rate of 12.30 L/min (3.25 USgpm) and water level monitoring was carried out on the nearest neighbouring bedrock well WID 12920 at the Galiano Housing Society complex."
2. "Drawdown in the pumped well at the end of the test was 16.117 m below the non-pumping water level of 32.480 m below ground, utilizing 50% of the available drawdown in the well. The well is more than capable of supplying the estimated demand of the project at 7.99 L/min (2.11 USgpm) with a safety factor >50%."
3. "Although capable of being pumped at rates far in excess of 12.30 L/min (3.25 USgpm) the safe well yield is determined to be 12.30 L/min (3.25 USgpm) at this time."
4. "Interference of approximately 5.41 m was recorded in the nearby observation well WID 12920 during the test. At the demand pumping rate of 7.99 L/min (2.11 USgpm) the potential interference effects on the neighouring well, WID 12920, at the Galiano Housing Society complex would be close to 3.51 m, thereby reducing the available drawdown of 39.62 m in that well by approximately 8.9%."
5. "Based on the laboratory results of the October 19, 2020 sampling, the water quality of the project well met the Guidelines for Canadian Drinking Water (Health Canada, 2019) for all parameters analyzed except for total coliforms at 2 CFU /100mL., and dissolved manganese at 27.7 µg/L. Manganese is ubiquitous in the groundwater of the Gulf Islands and can be treated with appropriate water treatment methods."

Furthermore, the report provided several recommendations that have been considered in this report and have been summarized as follows:

1. "As a precautionary measure against any future potential sources of coliform bacteria, water from the well should be treated with an appropriately designed and maintained ultraviolet irradiation (UV) treatment system."
2. "Elevated levels of manganese may be treated with an appropriately designed and maintained point-of-entry (POE) water treatment system including aeration."

3. "Further examination of the potential water treatment options for the well water should be considered. Hy-Geo Consulting does not design or install water treatment systems."
4. "Consideration should be given to equipping the discharge line from the well with a totalizing water flow meter to monitor and record the well use with time and having a water level sounding tube installed for taking periodic water level measurements in the well."

The report completed by Hy-Geo Consulting has been included as Appendix to the Rezoning application. The existing site topography is highly variable and consists mostly of steep, mountainous terrain which slopes from a central peak (approximate geodetic elevation of 55.0m) down towards the lower-lying western property boundary and a low-lying wetland adjacent to an unnamed tributary of Putter Creek which bisects the northern boundary of the Site. The unnamed watercourse meets the definition of a stream under the Riparian Areas Protection Regulations (RAPR) legislation and has been assigned a Riparian Assessment Area (RAA) setback. The areas adjacent to the unnamed creek and atop the high-lying ridge have been deemed environmentally sensitive and are located within Development Permit Areas as per Schedule F, Development Permit Area 1 – Riparian and Schedule H, Development Permit Area 5, Sensitive Ecosystems pursuant to the Galiano Island Official Community Plan Bylaw No. 108. A Staff Report completed in October 2018 by Island Trust in support of a previous Development Permit application on the property issued the following statements regarding the DP areas:

- **"DPA 2 [SIC] – Riparian Areas** is designated on the property as shown in Attachment 2.3. The riparian area is located around Putter Creek along the northern border of the property. The applicant has provided a RAR Assessment report in support of the application."
- **"DPA 5 – "Sensitive Ecosystems (riparian and wetland)** is designated on the property as shown in Attachment 2.4. The riparian sensitive ecosystem is located in the same location as the riparian area (DPA 1). DPA 5 notes a small wetland sensitive ecosystem in the middle of the property. After a site visit completed by staff and the applicant in early September, staff determined the absence of the wetland. Therefore

the primary focus of DPA 5 will be for the riparian area. The RAR Assessment has been used to address this DPA."

The existing ground cover is densely forested with thick underbrush and natural vegetation that covers most of the property. The natural topography delineates the Site into two subcatchments: 1) a northern catchment that discharges to the unnamed creek which will remain undeveloped, and 2) a southern catchment that discharges towards the west into a low-lying wetland adjacent to the unnamed creek located on the neighbouring property. The development will be located entirely within the southern Site catchment and the natural drainage pattern will be generally maintained following completion of construction. A ***Geotechnical Investigation Report*** was completed for the site by GeoPacific Consultants Ltd. (GP) dated January 19th, 2021. The field investigation included the completion of eight test pits excavated to a maximum depth of 1.5m below existing grade or until practical refusal. The test pits were located within the approximate corridor of the future development road and building site locations. A brief synopsis detailing the results of the subsurface investigation completed by GP has been included below:

- Topsoil/Silty Sand Loam – "Organic topsoil, followed by silty sand loam was noted at the surface of all test hole locations. The silty sand is generally loose, fine-grained, moist and reddish-orange in colour. An approximately 1.50m layer of loose to compact silty sand fill was noted at test hole locations TP21-03 and TP21-08m respectively".
- Weathered Sandstone Bedrock – "...encountered at all test hole locations beneath the topsoil/silty sand loam. Depths to bedrock varied across the site, generally ranging between 0.6 and 1.5m below grade."
- Groundwater - static groundwater was not encountered during the investigation and is estimated to be well below development grades; perched water tables should be expected to form within the topsoil/silty sand which overlies the weathered sandstone.

The Geotechnical Investigation completed by GeoPacific including a Site figure illustrating the approximate test-pit locations has been included as Appendix to the Rezoning application. Review of the Northern Vancouver Island Project geological mapping published by GeoScience BC (Map 2013-NVI-1-1) indicates the Galiano Island region is underlain by the

Upper Cretaceous, Nanaimo Group which includes "boulder, cobble and pebble conglomerate, coarse to fine sandstone, siltstone, shale and coal". A *Galiano Groundwater Study* published by Waterline Resources Inc. in March, 2011 assessed the underlying Geology on Galiano Island. The report identified various publications and determined "quaternary deposits on Galiano Island comprise either thin, compact glacial till or fluvial sands and gravels deposited by meltwater (Mordaunt and Hodge, 1983). Based on provincial soils mapping, more than 60% of the soils on Galiano Island are classified as well drained (Green, et al., 1989) suggesting coarse-grained sediments (eg: sand and gravel). The deposits are typically thin and with poor groundwater potential except in limited, topographic tough areas (Kohut and Johansson, 1997)".

Based on the GeoPacific's field investigation findings and review of the region geological mapping and previous publications, the underlying site soils are likely suitable for full or partial disposal of site generated stormwater runoff. At subsequent Development Permit/Building Permit stage, Gwaii will complete Constant Head Well Permeameter (CHWP) in-situ measurements of existing on-site soils, as necessary, to determine "field-saturated" hydraulic conductivity (Kfs) prior to finalizing site design of stormwater management systems. All permeameter testing analysis shall be completed as per the ETC Pask (Constant Head Well) Permeameter for In-Situ Measurement of Field Saturated Hydraulic Conductivity of Soils published by Engineering Technologies Canada Ltd. (March 2016). Test pitting and permeameter analysis will be completed in strategic locations based on the final development plans.

3. WATER DEMANDS

The Galiano *Groundwater Study* published by Waterline Resources Inc. assessed the unique challenges posed by development on Galiano Island as it relates to the development of freshwater resources and future land-use planning initiatives. Concurrent to the Groundwater Study, the Galiano Local Trust Committee (LTC) reviewed the Galiano Island Official Community Plan with the intent of "balancing the water supply requirements for area growth against environmental needs and future sustainability" (Waterline Resources Inc., 2011). The study examined water demand estimates for Galiano Island based on various

publications and bylaws specifications including requirements stated in the Galiano Island Land Use Bylaw No. 27 and the Galiano Island Official Community Plan Bylaw No. 108. While it was concluded that water volume requirements included in the Galiano Island Land Use Bylaw No. 27 were reasonable, a quantitative approach was recommended to evaluate the water use demands on a development specific basis.

A subsequent report completed by Hy-Geo Consulting in December 2019 reviewed the summation of these previous studies and provided a reasonable estimate of anticipated water demands for rental housing projects in the Gulf Islands of southern British Columbia. The report was intended to provide support for development applications for affordable housing projects on Galiano Island. Indoor water usage for residential water systems was assessed based on the Design Guidelines for Rural Residential Community Water Systems (2012) published by the Ministry of Forests, Lands & Natural Resource Operations. The demands were compared to various publications including a report prepared by the Government of Canada and the rates were considered reasonable. Accordingly, the methodology included in the Design Guidelines for Rural Residential Community Water Systems (2012) has been used in subsequent sections of this report.

4. WATER SYSTEM DESIGN

The potable water system design for domestic and fire systems has been completed in accordance with the design requirements stated in the Galiano Island Land Use Bylaw No. 27, the Galiano Island Official Community Plan Bylaw No. 108, the Design Guidelines for Rural Residential Community Water Systems (2012) and good engineering practice. The demand requirements have been completed based on the conceptual layout prepared by Mobius Architecture and shall be confirmed during the detailed design phase of the project.

4.1 Domestic Demand Requirement

The domestic water demand requirements shall be based on *Section 3.0, Demand Calculations* of the Design Guidelines for Rural Residential Community Water Systems (2012). The proposed development summary has been presented in Table 2 below:

Table 2 – Development Summary

Proposed Dwelling Units	20
Capita Per Dwelling (Multi-Family)	2.5
Design Population	50

4.1.1 Maximum Day Demand (MDD)

As per Section 3.1 of the Design Guidelines: "Maximum Day Demand (MDD) is the single highest total 24-hour daily water consumption occurring over a one-year period". The MDD is based on the following demand components:

MDD = Indoor Demand + Water Loss Allowance + Irrigation Demand

A conceptual layout plan has been illustrated in the attached Site figure and has been used to prepare the following preliminary domestic demands. The Indoor Demand requirement has been presented in Table 3 below:

Table 3 – Indoor Demand

Design Population	50
Water Usage Rate	230 L/cap/day
Indoor Demand	11,500 L/day (7.99 L/min.)

The Water Loss allowance can be neglected from the MDD calculations stated above. An operations and maintenance plan for the on-site water distribution system will include a series of valves on the water piping that will allow for testing of individual sections of the main to determine if there is leakage. As-Built drawings will include detailed locations of each pipe joint where leakage would be expected, and any leaks detected will be easily located and corrected. Furthermore, as per the recommendation provided by Hy-Geo

Consulting: *consideration should be given to equipping the discharge line from the well with a totalizing water flow meter to monitor and record the well use with time and having a water level sounding tube installed for taking periodic water level measurements in the well.* The unit blocks will be provided domestic water meters in addition to this which documents the overall usage for the Development. If discrepancies between measurements are encountered, this could indicate the presence of a leak at which point the Development should take corrective action.

Irrigation demands from the water system can also be considered to be negligible. The unit block designs will not include hose bib or irrigation connections from the development water system. Alternatively, the irrigation demand requirement can be provided with the implementation of rainwater harvesting from a cistern installed adjacent to each unit block. Furthermore, during Building Permit phase, the landscape designer will create a comprehensive water use plan that provides recommendations on irrigation requirements and conservation measures including the restriction of the allowable irrigation area for each unit and promoting the planting of drought tolerant species. These conservation measures will be discussed in further detail in subsequent sections of this report.

Accordingly, the Maximum Day Demand (MDD) has been presented in Table 4 below:

Table 4 – Maximum Daily Demand (MDD)

Indoor Demand	11,500 L/day (7.99 L/min.)
Water Loss Allowance	-
Irrigation Rate	-
Maximum Day Demand (MDD)	11,500 L/day (7.99 L/min.)

Finally, the Average Day Demand (ADD) and Peak Hour Demand (PHD) can be determined based on the following relationships:

$$ADD = MDD/PF_1$$

$$PHD = ADD \times PF_2$$

Where, "Average Day Demand" (ADD) is the average daily use and can be used to derive peak demands from metering data and "Peak Hour Demand" (PHD) represents the maximum volume of water delivered over a single hour throughout the day. The Average Day Demand (ADD) and Peak Hour Demand (PHD) has been presented in Table 5 below:

Table 5 – Average Daily Demand (ADD) & Peak Hour Demand (PHD)

PF_1 & PF_2 (< 5,000 Capita)	2.5 & 4.0
Maximum Day Demand (MDD)	11,500 L/day (7.99 L/min.)
Average Day Demand (ADD)	4,600 L/day (3.19 L/min.)
Peak Hour Demand (PHD)	18,400 L/day (12.78 L/min.)

4.2 Fire Demand Requirement

The fire demand requirements for the proposed development shall be based on the latest edition of the *NFPA 1142 - Standard on Water Supplies for Suburban and Rural Fire Fighting.* The proposed system will likely include a combined domestic/fire or separate on-site fire water gravity system situated directly downstream of the proposed reservoir. The system will include two on-site fire hydrants strategically located to ensure staging areas are located within the allowable distances from proposed dwellings (45m maximum) as per the British Columbia Building Code. During a firefighting scenario, the fire department would pump water from the gravity hydrant system to fight a structure fire. The system should contain a system valve that is normally closed and isolates the fire gravity system from the domestic distribution system. During a fire, the Fire Department would open the valve to the gravity system before fighting drawing water. As per *NFPA 1142, **Section 4.2,*** the minimum water supply requirement for structures without exposure hazards can be calculated based on the following formula:

$$WS_{Min.} = 133.6\ x\ \frac{VS_{Tot}}{OHC}\ (CC)$$

Where,

$WS_{Min.} = Minimum\ water\ supply\ in\ Litres\ (L)$
$VS_{Tot} = Total\ volume\ of\ structure\ in\ m^3$
$OHC = Occupancy\ hazard\ classification\ number$
$CC = Construction\ classification\ number$

As per *Section 5.2.5.1*. the proposed dwellings shall be classified as *Occupancy Hazard Number 7* in which the quantity or combustibility of domestic contents is considered to be relatively light and therefore rates of spread and heat release is low. The construction classification number (CC) for any proposed structure shall be in accordance with *Section 6.3* and shall have a maximum value of 1.0 (Type I-IV as per the table below).

Table 6 – Construction Classification Number (Section 6.2.1)

Type I	0.5
Type II	0.75
Type III	1.0
Type IV	0.75

Classification shall be based on the inclusion of fire walls and structural elements constructed from approved non-combustible or limited-combustible materials in the proposed building plans. Fire resistance ratings for each structural member shall be no less than the values specified in *Section 6.3.1.* The building and structural elements shall be confirmed by the Developer at Building Permit stage. The minimum water supply requirement to the development has been presented in Table 7 below:

Table 7 – Fire Water Demand (Structures without Exposure Hazards)

VS_{Tot}[1]	1,103 m^3
OHC	7
CC[2]	1.0
WS_{Min}	21,052 L (5,291 iGal)

[1] Block C, governing volume of structure
[2] Assume Type III Construction, non-combustible exterior walls

The water supply requirement exceeds the stated minimum of 7600 L for a structure without exposure hazards as per *Section 4.2.2.* A meeting with the Galiano Fire Department determined a minimum 24,000 USGal (±90,850 L) fire volume is required on Galiano Island for insurance purposes. Accordingly, this volume demand will be used to determine the preliminary reservoir storage requirement however, the Developer shall confirm the final volumes during Building Permit stage. For review purposes, detailed *NFPA 1142 - Standard on Water Supplies for Suburban and Rural Fire Fighting* calculations have been provided for each Unit Block in Appendix A. There are also numerous practices which significantly reduce the likelihood and consequence of a structure fire:

- The Development shall complete chimney cleaning on a yearly basis (if applicable).
- The Development shall clean roofs and gutters at least twice a year.
- All dwellings shall have a minimum of 1 smoke alarm on each habitable floor of the house.
- All dwellings shall have a clear and concise evacuation plan complete with safety procedures for exiting and muster area (meeting location).
- All dwellings shall carry a minimum of two (2) 5lb fire extinguishers certified for use on A, B, and C fuels.

4.3 Reservoir Design

The proposed reservoir design shall be based on *Section 4.7, Distribution Storage Reservoirs* of the Design Guidelines for Rural Residential Community Water Systems (2012). As per the

guidelines, the storage reservoir shall be designed to meet the storage requirements for the following purposes:

- **Balancing Storage**: to balance the fluctuations in domestic demands and irrigation (not applicable) and allow for reasonable on/off frequencies of the supply pumps.
- **Fire Storage**: to provide sufficient water for the critical fire flow/duration demands in the system.
- **Emergency Storage**: to provide water in case of power outages and restriction in source supply.

4.3.1 Balancing Storage

As per Section 4.7.1 of the Guidelines, the storage to balance the difference between instantaneous demands and the average demands should be minimum 25% of the MDD (11,500 L/day). Therefore, the volume requirement for balancing storage shall be 2,875 L (632.4 iGal).

4.3.2 Fire Storage

As discussed, the Galiano Fire Department volume requirement of 90,850 L (24,000 USGal) shall supersede the *NFPA 1142 - Standard on Water Supplies for Suburban and Rural Fire Fighting* requirement.

4.3.3 Emergency Storage

As per Section 4.7.3 of the Guidelines, the emergency storage provides water during events such as natural disasters, pump power failure, source failure or watermain breaks. The emergency storage should be calculated based on the following relationship:

Emergency Storage = 0.25 x (Balancing Storage + Fire Storage)

Whereby,

Emergency Storage = 0.25 x (2,875 L + 90,850 L) = <u>23,431 L</u>

4.3.4 Total Reservoir Storage

The total reservoir storage requirement can be determined based on the following relationship:

Total Storage (L) = Balancing Storage + Fire Storage + Emergency Storage

A reservoir volume summary has been included in Table 8 below:

Table 8 – Total Reservoir Storage Summary

Balancing Storage (0.25 x MDD)	2,875 L
Fire Storage	90,850 L
Emergency Storage	23,431 L
Total Reservoir Storage	**117,156 L**

As per Section 4.7.4 of the Guidelines, the structure shall typically be a single cell bolted steel reservoir with a glass lined interior however the eventual design shall be specified and approved by the Developer and Islands Trust. The reservoir will be designed to meet the structural requirements based on the most current version of the British Columbia Building Code (BCBC), National Building Codes and AWWA D-103-09 Specifications.

4.4 Fire Suppression

Should the owner choose to install a fire sprinkler system, the system would likely comprise a separate water tank and pump that bypasses the water treatment system with a backflow prevention valve. The developer has confirmed a dry fire sprinkler system with a pump is the preferable option. During a fire scenario, a system valve is triggered resulting in the operation of one or more sprinklers within the residence. The system shall provide fire suppression measures for 30 minutes with four heads flowing at approximately 60 USGPM or approximately 2000 USGal total (to be confirmed by Avalon Mechanical Engineering during detailed design). The typical response time and proximity of the Fire Department to the proposed development (located directly across the street on Georgeson Bay Road) shall factor into the design volume requirement. The eventual system shall be designed to meet NFPA requirements (or an approved equivalent) and shall be designed by an approved Professional during the Building Permit stage of the project.

4.5 Water Quality (Treatment)

The treatment methodology is outside the scope of this report however water quality analysis and subsequent recommendations stated by Hy-Geo Consulting indicate the need for water quality treatment:

1. "As a precautionary measure against any future potential sources of coliform bacteria, water from the well should be treated with an appropriately designed and maintained ultraviolet irradiation (UV) treatment system."
2. "Elevated levels of manganese may be treated with an appropriately designed and maintained point-of-entry (POE) water treatment system including aeration."

5. WATER CONSERVATION INITIATIVES

The sustainable development of freshwater resources and ongoing conservation efforts are of great importance to the Galiano Island community which is apparent in the Galiano Island Official Community Plan. "Deteriorating water quality is evident in the Galiano Island Local Trust Area generally and the demands on groundwater resources continue to increase"; efforts shall be made to preserve and maintain an adequate fresh water supply. Conservation measures developed by the Capital Regional District (CRD) encourage the sustainable use of regional drinking water sources through education, technology, policy measures and research. Accordingly, the future development shall be encouraged to develop a conservation framework that has been successfully implemented in similar communities. The Water Conservation Guide for British Columbia published in December, 2013 can be used to develop an effective methodology which prioritizes conservation and efficient use. The approach can follow the Conservation Guide's seven-step process for developing a comprehensive Community Water Conservation Plan:

1. Laying the Plan's Foundations
2. Water System Profile
3. Forecast Demand
4. Set Objectives
5. Review Options
6. Select Measures
7. Implementation Strategy

The guide recommends implementing a plan that provides an effective variety of enforceable and voluntary measures based on the following criteria:

- **Legal Measures**
  - Development mandatory water restrictions, planting and irrigation requirements
  - Development bylaws requiring installation of 'low-flow' plumbing fixtures
  - Development restrictions on recreational water usage
- **Operations and Management Measures**
  - Water loss management and leak repair
  - Water meter installation on each Unit
  - Rainwater harvesting programs (see Section 7.0 of this report)
- **Community Engagement Measures**
  - Voluntary restrictions on domestic water usage
  - Education and outreach programs
  - Partnerships and collaborative initiatives

6. STORMWATER DESIGN METHODOLOGY

There is presently no stormwater management design methodology included in the Galiano Island Land Use Bylaw No. 27 or the Official Community Plan Bylaw No. 108. Gwaii has proposed the use of the Master Municipal Construction Documents (MMCD) Design Guidelines (2014) as it pertains to Stormwater Management (Sections 4 and 8 respectively) which provides an acceptable industry standard for development within British Columbia. Given the environmental sensitivity of the Site and surrounding areas, the intention is to develop a Stormwater Management plan that replicates the pre-development hydraulic conditions as closely as possible. The methodology developed in this section is considered conceptual and shall be completed at Development Permit/Building Permit stage based on the final development plans.

6.1 National Resource Conservation Service (NRCS) TR-55 (HydroCAD)

HydroCAD software shall be used to model all infiltration, detention and controlled release requirements for the proposed stormwater detention systems. The design storms used to

complete the HydroCAD analysis are adapted from the Short Duration Rainfall Intensity-Duration Frequency (IDF) Data for the Saturna Capmon, British Columbia Weather Station for 24-hour storm events (Storm Type 1A for the Pacific Northwest) which has been included in Appendix B and summarized in Table 2. The Short Duration rainfall IDF was collected from rain gauge data compiled between 1989-2017 and has been published be Environment Canada. The weather station is the closest Environment Canada published data for the proposed development Site.

Table 9 – 24-Hour Storm (Type 1A), Saturna Capmon

Design Storm	24hr Rate	24hr Total Depth
2-Year	2.0 mm/hr	48.0 mm
5-Year	2.6 mm/hr	62.4 mm
10-Year	2.9 mm/hr	69.6 mm

Analysis of the proposed system is based on NRCS TR-55 criteria (Urban Hydrology for Small Watersheds)—a summary of the model input information has been included,

- Time of Concentration:
  - Sheet Flow (pre-development)
    - Maximum 100m flow length
    - Approximate 13.8% average slope from central, high plateau down to the western property boundary
    - Woods; Light underbrush (Manning's No. = 0.40)
- Storm Type 1A, 24 Hour (Pacific Northwest)
- Curve Numbers (CN):
  - 65 — Woods/grass comb., fair soil, HSG B (Pre-development ground cover)
  - 76 — 50-75% Grass Cover, fair soil, HSG B (Post-development ground cover)
  - 98 — Paved Parking; HSG C
  - 98 — Roofs; HSG C
- 48 Hour Analysis Time Span

6.2 Climate Change Consideration

In accordance with the Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate in BC (APEGBC, 2012) a safety factor of a 10% increase in design peak flow capacity is required to be designed into new minor system infrastructure to account for climate change. The adjusted values are summarized in Table 10:

Table 10 – Adjusted Storm Intensities and rainfall depth as per APEGBC (2012)

Design Storm	24hr Rate	24hr Total Depth
2-Year	2.4 mm/hr	57.6 mm
5-Year	3.1 mm/hr	74.4 mm
10-Year	3.5 mm/hr	84.0 mm

All eventual post-development hydraulic modeling shall include the climate adjusted rates.

6.3 Pre-Development Condition

Pre-development site topography is comprised mostly of steep, mountainous terrain which slopes from a central high-lying ridge down towards a lower-lying western property boundary (southern catchment). The existing ground cover is densely forested with thick underbrush and natural vegetation that covers most of the property. During a typical storm event, runoff sheet flows from the ridge towards the west where it eventually accumulates within the existing wetland northwest of the Site. The wetland areas likely attenuate incoming flows before eventually discharging overland into the unnamed creek along the north side of the property. The Time of Concentration (ToC) is dependent on upstream ground conditions and the effectiveness of the wetland areas to control point source discharge into the creek. Time of concentration and peak flow discharge measured from the central mountain peaks down to the low-lying western boundary (approximated along the longest hydraulic flow path) is determined using HydroCAD. The model approximates the pre-development flows entering the creek from the development Site during the 2-year, 5-year and 10-year storm events. A summary of the predevelopment hydraulic analysis has been presented in Table 11 below:

Table 11 – Pre-Development Site Condition

Design Criteria	Value
Storm Recurrence Interval	2-Year/5-Year/10-Year
Time of Concentration (Tc)	30.2 Min.
Pre-Development CN (Woods/grass comb., Fair soil, HSG B)	60
Inflow Area	1,891 m^2
Pre-Development 2-Year Peak Discharge	0.13 L/s
Pre-Development 2-Year Runoff Volume	5.1 m^3
Pre-Development 5-Year Peak Discharge	0.27 L/s
Pre-Development 5-Year Runoff Volume	13.2 m^3
Pre-Development 10-Year Peak Discharge	0.36 L/s
Pre-Development 10-Year Runoff Volume	19.2 m^3

For the purposes of the pre-development model conditions, a Hydraulic Soil Group (HSG) B was considered: these soils are characterized by "moderate infiltration rates when thoroughly wetted, and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures and a moderate rate of water transmission". The model indicates a modest discharge rate from the Site during significant storm events based on existing soil conditions. The soil characteristics will be confirmed by completing Constant Head Well Permeameter (CHWP) in-situ measurements of existing on-site soils, as necessary, to determine "field-saturated" hydraulic conductivity (Kfs) at Building Permit Stage. The stormwater management strategy shall develop a methodology that imitates the pre-development hydraulic condition as closely as possible.

A pre-development hydraulic model output from HydroCAD has been included in Appendix D.

6.4 Storm Water Quality

During a typical rainfall event, runoff from the proposed structures will discharge directly to rainwater cisterns located adjacent to each building complete with a filter to remove suspended particulate and debris (see Section 7.0). Stormwater discharging from the driveway areas shall flow into shallow grassed swales located on the downstream side of the paved surface. These bioswales provide a "first-flush" treatment of pollutants and other deleterious materials prior to entering a Site drainage system. Lawn basins with open grated lids shall be strategically positioned within the swale with an approximate 50-100mm freeboard to allow for partial surface ponding and infiltration into a bio-retention growing medium along the surface. During typical minor events, the stormwater ponding around the inlet structure will be permitted to infiltrate into underlying site soils. During more significant rainfall events, runoff may exceed the infiltration capacity of the growing medium resulting in surcharge and eventual overflow into the drainage system through the grated lid. Each lawn basin shall have a sump which provides attenuation of incoming flows to permit the settling of the coarse fraction of the sediment (fine to medium sand particles and greater). The drainage system will discharge to a central exfiltration gallery situated in the lower-lying areas south of the proposed dwellings. The gallery will be sized to adequately dispose of site generated stormwater runoff into underlying soils, thereby replicating the pre-development condition.

6.5 On-Site 100 Year Flood Risk

The on-site grading plan shall ensure positive drainage away from all proposed structures towards the central roadways which provides a natural conduit for flood waters during significant storm events. Surface areas that are intended for overland drainage should be hard-surfaced, seeded, planted, or protected with armoring to mitigate potential erosion concerns.

7. STORMWATER COLLECTION

The unit block designs will not include hose bib or irrigation connections from the development water system. Alternatively, the irrigation demand requirement can be provided with the implementation of rainwater harvesting from a cistern installed adjacent to each building. The Mayne Island Integrated Water Systems Society (MIIWSS) recommends the use of Premier Plastics™ polyethylene underground storage cisterns which will be sized based on detailed irrigation demands and proposed roof surface areas for each unit block. The systems will be designed with an overflow to the Site drainage system to dispose of excess stormwater runoff during the wet season. The Premier Plastics™ design software considers monthly precipitation data from Mayne Island, Village Bay. The user inputs rooftop surface areas and irrigation demand and varies the tank volume to provide an Optimal Tank Capacity. The monthly precipitation and rooftop volume requirement based on the proposed block configurations (approximate rooftop area of 1,003 square meters) have been illustrated in the figure below:

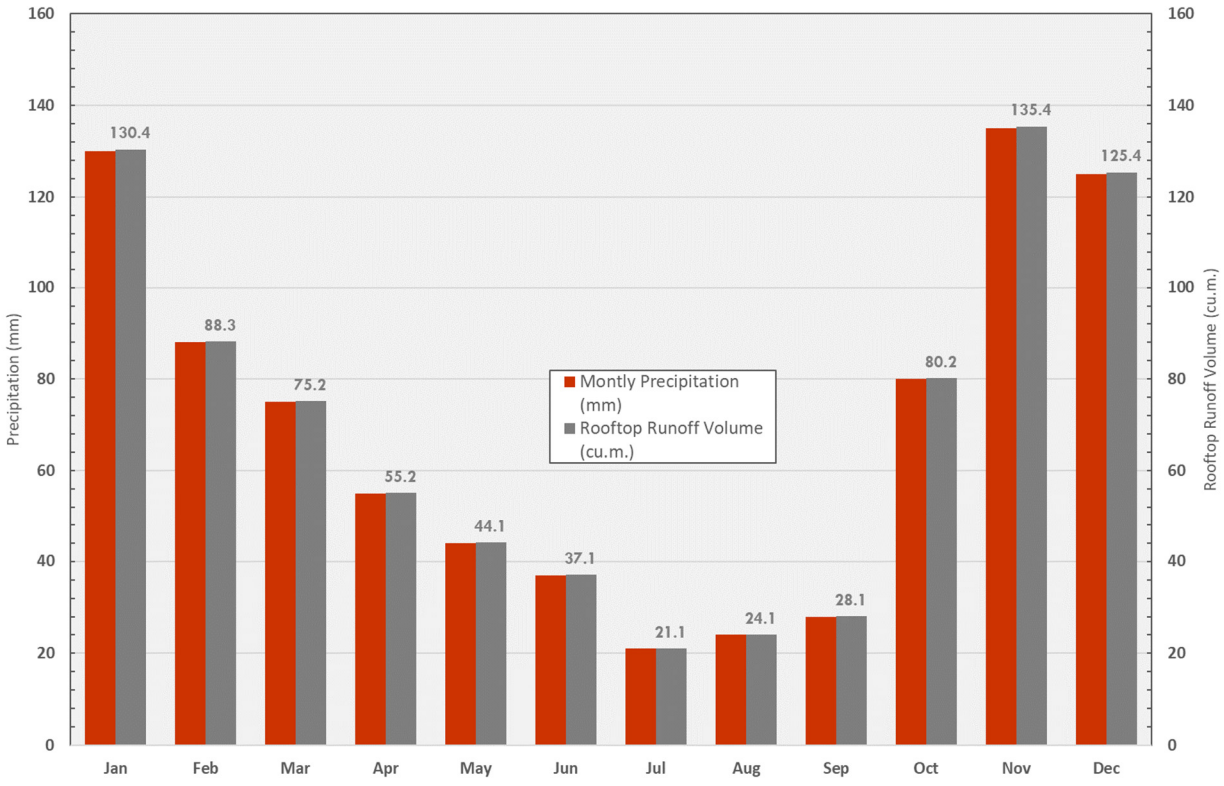

Figure 1 – Precipitation and Rooftop Runoff Volume

The Premier Plastics™ (or an approved equivalent) tank volumes for each unit block shall be completed at Building Permit stage and irrigation demand requirements shall be confirmed by a Landscape Architect or a British Columbia Certified Irrigation Design Professional.

8. SEDIMENT AND EROSION CONTROL

During construction, the contractor is to implement sediment and erosion control procedures to ensure the quality of site run-off is maintained. Controlling erosion and preventing the release of sediments from construction sites is an effective means of minimizing sediment discharge to fish-bearing watercourses and the municipal storm drainage system. Silt fencing and /or drainage swales should be strategically placed to effectively prevent untreated site water from discharging to adjacent properties. These sediment and erosion control measures should be monitored periodically throughout the course of construction and are to remain in place until substantial performance has been verified. An effective erosion and sediment control plan incorporates, but is not limited to the following procedures:

8.1 Layout and Clearing

- Install runoff management systems prior to site disturbance and construction activities;
- Stabilize bare soils the same day that they have been disturbed;
- Avoid clearing vegetation from sites during snowmelt or heavy rains;
- Avoid clearing or grading soils within 15 meters of a stream or ditch;
- Install appropriate measures (straw bales, filter cloth, etc.) to prevent sediment from entering a watercourse;
- Store excavated soils away from watercourses, storm drains and paved surfaces;
- Install a site access pad (crushed gravel before driveway road access) to prevent tracking mud offsite.

8.2 Erosion Control

- Encourage surface water to seep into the soil
- If possible, retain woody debris and organic matter on-site;
- Roughen or terrace slopes to prevent erosion;

- Cover soil stockpiles and bare slopes with mulch, tarps, etc;
- Backfill foundations as soon as possible following approval of perimeter drainage;
- Remove excess soil from the site as soon as possible after backfilling;
- Re-vegetate or landscape the site as soon as possible. If areas of a site must be left incomplete during the rainy season, sow a temporary cover crop, apply mulch or lay geotextile to stabilize exposed soils;
- Keep machinery within specific access areas. Limit the extent of machine access areas to the minimum necessary to complete construction;
- Inspect the construction site daily to ensure erosion control measures are working.

8.3 Drainage and Sediment Control

- Use berms or swales to divert runoff from entering the site;
- Use silt fencing around stockpiled and sloped areas;
- Install filter cloth, drain rock or straw bales to protect ditches and catch basins;
- Collect runoff for treatment in a sediment trap;
- Ensure containment and proper disposal of concrete waste water;
- Properly dispose of construction wastes (build materials, paints, etc.) off-site;
- Do not wash soils or sediments onto the street or into the storm sewer.

Due to the close proximity of the existing unnamed creek to the development, Gwaii will work with the contractor and developer to closely monitor the site and identify where BMPs are best suited during construction.

9. WASTEWATER DESIGN

The wastewater treatment and system design is outside the scope of this report. An *Onsite Wastewater System Site Assessment, New Commons Development* dated February 2021 and completed by BWD Engineering Inc. has been prepared in support of the rezoning application with Islands Trust. All site sanitary design shall be coordinated with BWD Engineering Inc. at Building Permit Stage.

10. CONCLUSIONS

This Water Management Plan (WMP) details the strategies recommended for the proposed 20-unit, multi-family development located at 409 Porlier Pass Road on Galiano Island, BC. This report has been prepared to support an application for Rezoning made to Islands Trust in February 2021.

Yours Truly,

GWAII ENGINEERING LTD.

Prepared by,

Corey Brown, M.Eng., EIT, AScT
Principal, Design Engineer

Reviewed by,

Josh Bartley, P.Eng.
Principal, Review Engineer

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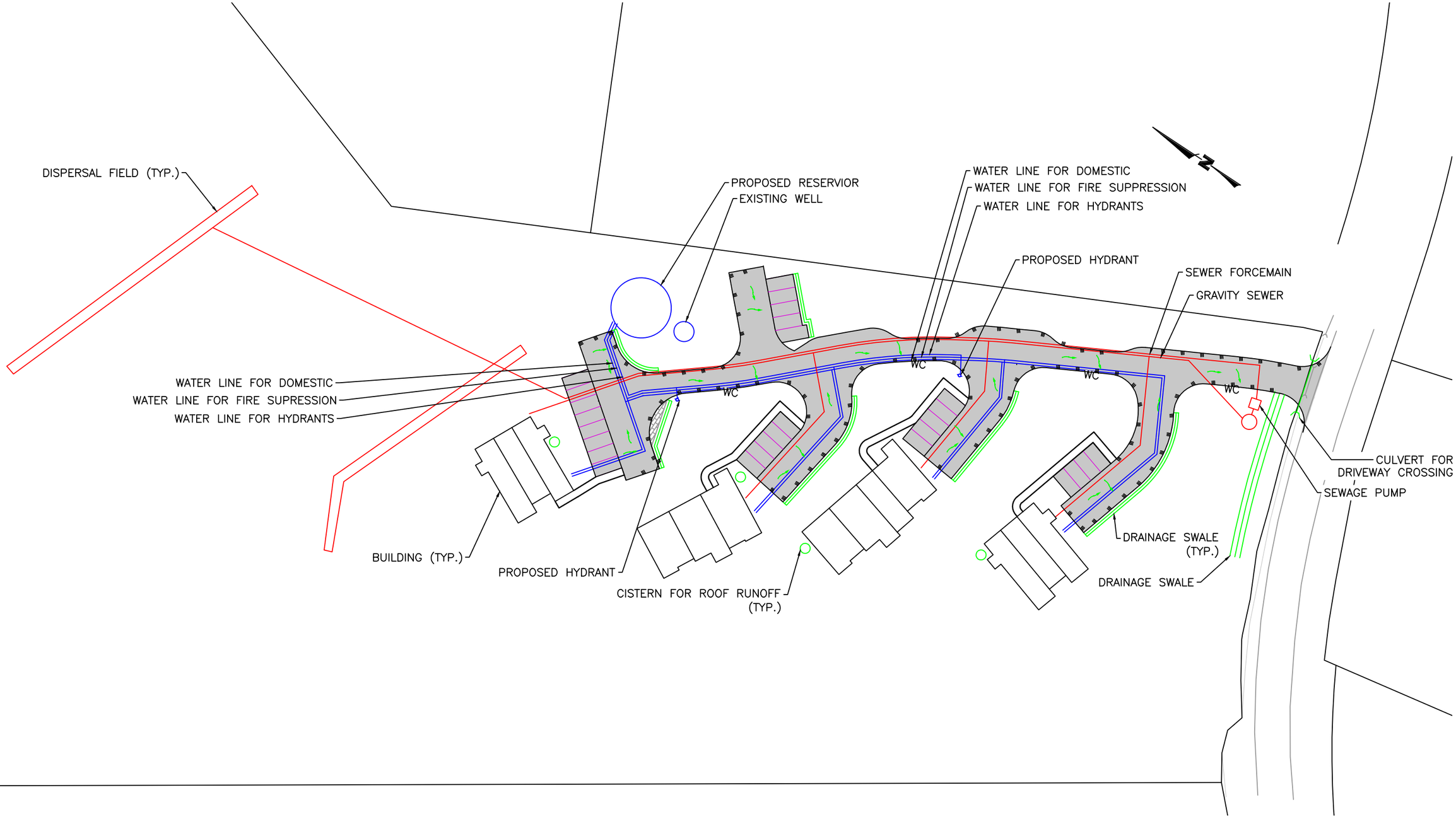
APPENDIX A
Conceptual Servicing Plan



1:500

0 10 30m

GALIANO GREEN
CONCEPTUAL SERVICING PLAN

GALIANO ISLAND

2390	
DATE: 2021-02-26	SHEET NO.: SK1
DRAWN BY: DS	CHECKED BY: CB

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APPENDIX B

NFPA 1142 - Standard on Water Supplies for Suburban and Rural Fire Fighting Calculations

WATER SUPPLY FOR PUBLIC FIRE PROTECTION

Job Name: Galiano Green
Job # 2462G
Date: 18-Feb-21
Name: D. Sessions

Building 1

A. Construction Classification Number

Type	Descr.	CC	
Type I	Approved non-combustible	0.5	*For dwellings maximum CC= 1.0
Type II	Approved non-combustible	0.75	*Refer to NFPA for further classification
Type III	Exterior Walls non-combust.	1	
Type IV	Refer to NFPA	0.75	
Type V	Combustible Materials	1.5	

CC = 1

B. Building Volume

31455 ft3 Type A

C. Occupancy Hazard Classification Number

*Refer to NFPA Building Description: Dwellings

OHC 7

D. Minimum Water Supply

VS 31455 ft3 Minimum Supply 3000 Gal
OHC 7
CC 1

WS	4494	USGal
WS	*17008.2*	L

D. TOTAL FIRE FLOW REQUIREMENT

Min. (Gal)	Max (Gal)	Check	Rate of Water Supply GPM	L/min.	L/sec
0	2500		250	950	15.83
2501	9999	**Use**	500	1900	31.67
10000	19999		750	2850	47.50
20000	99999999		1000	3800	63.33

WATER SUPPLY FOR PUBLIC FIRE PROTECTION

Job Name: Galiano Green
Job # 2462G
Date: 18-Feb-21
Name: D. Sessions

Building 2

A. Construction Classification Number

Type	Descr.	CC	
Type I	Approved non-combustible	0.5	*For dwellings maximum CC= 1.0
Type II	Approved non-combustible	0.75	*Refer to NFPA for further classification
Type III	Exterior Walls non-combust.	1	
Type IV	Refer to NFPA	0.75	
Type V	Combustible Materials	1.5	

CC = 1

B. Building Volume

33084 ft3 Type B

C. Occupancy Hazard Classification Number

*Refer to NFPA Building Description: Dwellings

OHC 7

D. Minimum Water Supply

VS 33084 ft3 Minimum Supply 3000 Gal
OHC 7
CC 1

WS	4726	USGal
WS	*17889.0*	L

D. TOTAL FIRE FLOW REQUIREMENT

Min. (Gal)	Max (Gal)	Check	Rate of Water Supply GPM	L/min.	L/sec
0	2500		250	950	15.83
2501	9999	**Use**	500	1900	31.67
10000	19999		750	2850	47.50
20000	99999999		1000	3800	63.33

WATER SUPPLY FOR PUBLIC FIRE PROTECTION

Job Name: Galiano Green
Job # 2462G
Date: 18-Feb-21
Name: D. Sessions

Building 3

A. Construction Classification Number

Type	Descr.	CC	
Type I	Approved non-combustible	0.5	*For dwellings maximum CC= 1.0
Type II	Approved non-combustible	0.75	*Refer to NFPA for further classification
Type III	Exterior Walls non-combust.	1	
Type IV	Refer to NFPA	0.75	
Type V	Combustible Materials	1.5	

CC = 1.0

B. Building Volume

38934 ft3 Type C

C. Occupancy Hazard Classification Number

*Refer to NFPA Building Description: Dwellings

OHC 7

D. Minimum Water Supply

VS 38934 ft3 Minimum Supply 3000 Gal
OHC 7
CC 1

WS	5562	USGal
WS	*21052.2*	L

D. TOTAL FIRE FLOW REQUIREMENT

Min. (Gal)	Max (Gal)	Check	Rate of Water Supply GPM	L/min.	L/sec
0	2500		250	950	15.83
2501	9999	**Use**	500	1900	31.67
10000	19999		750	2850	47.50
20000	99999999		1000	3800	63.33

WATER SUPPLY FOR PUBLIC FIRE PROTECTION

Job Name: Galiano Green
Job # 2462G
Date: 18-Feb-21
Name: D. Sessions

Building 4

A. Construction Classification Number

Type	Descr.	CC	
Type I	Approved non-combustible	0.5	*For dwellings maximum CC= 1.0
Type II	Approved non-combustible	0.75	*Refer to NFPA for further classification
Type III	Exterior Walls non-combust.	1	
Type IV	Refer to NFPA	0.75	
Type V	Combustible Materials	1.5	

CC = 1

B. Building Volume

31455 ft3 Type A

C. Occupancy Hazard Classification Number

*Refer to NFPA Building Description: Dwellings

OHC 7

D. Minimum Water Supply

VS 31455 ft3 Minimum Supply 3000 Gal
OHC 7
CC 1

WS	4494	USGal
WS	*17008.2*	L

D. TOTAL FIRE FLOW REQUIREMENT

Min. (Gal)	Max (Gal)	Check	Rate of Water Supply GPM	L/min.	L/sec
0	2500		250	950	15.83
2501	9999	**Use**	500	1900	31.67
10000	19999		750	2850	47.50
20000	99999999		1000	3800	63.33

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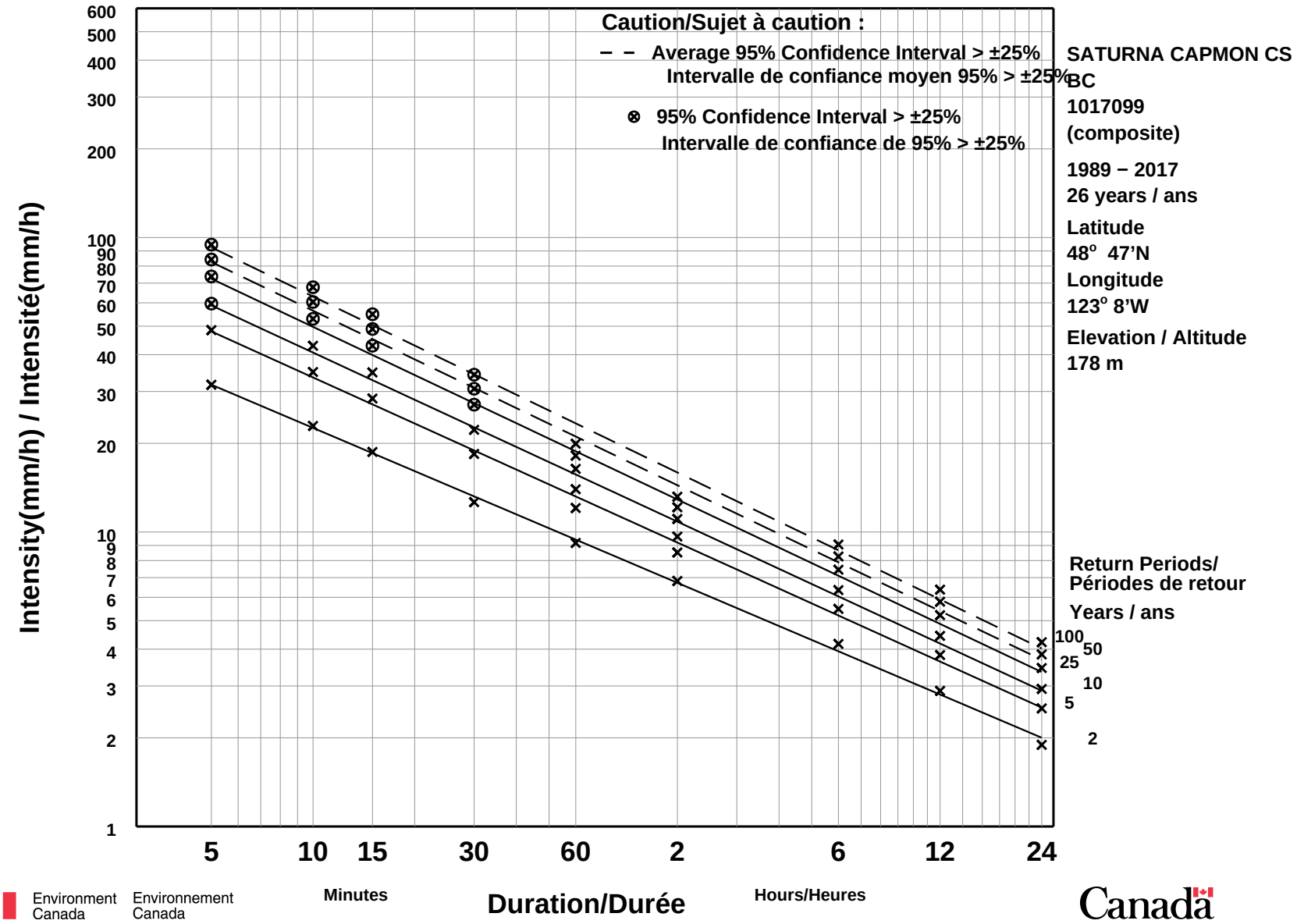
APPENDIX C
Short Duration Rainfall Intensity-Duration Frequency (IDF) Data for the Saturna Capmon, British Columbia

Short Duration Rainfall Intensity−Duration−Frequency Data

2019/02/27

Données sur l’intensité, la durée et la fréquence des chutes de pluie de courte durée



Environment Canada Environnement Canada

Canada

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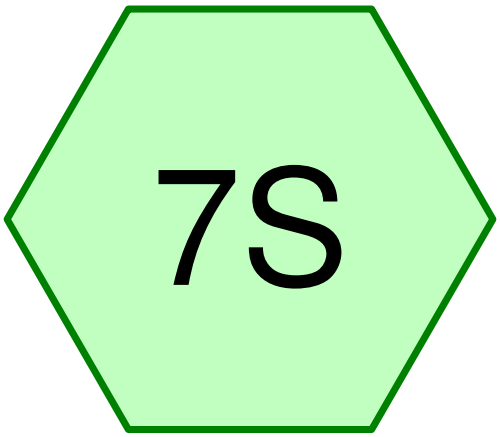
APPENDIX D
Pre-Development HydroCAD Model



Galiano Green Pre-Development (South Catchment)

Subcat Reach Pond Link

Drainage Diagram for 2462G - Galiano Green Pre Development SWMP
Prepared by Gwaii Engineering Ltd., Printed 2/18/2021

Area Listing (all nodes)

Area (sq-meters)	CN	Description (subcatchment-numbers)
1,891.0	65	Woods/grass comb., Fair, HSG B (7S)
1,891.0		**TOTAL AREA**

Summary for Subcatchment 7S: Galiano Green Pre-Development (South Catchment)

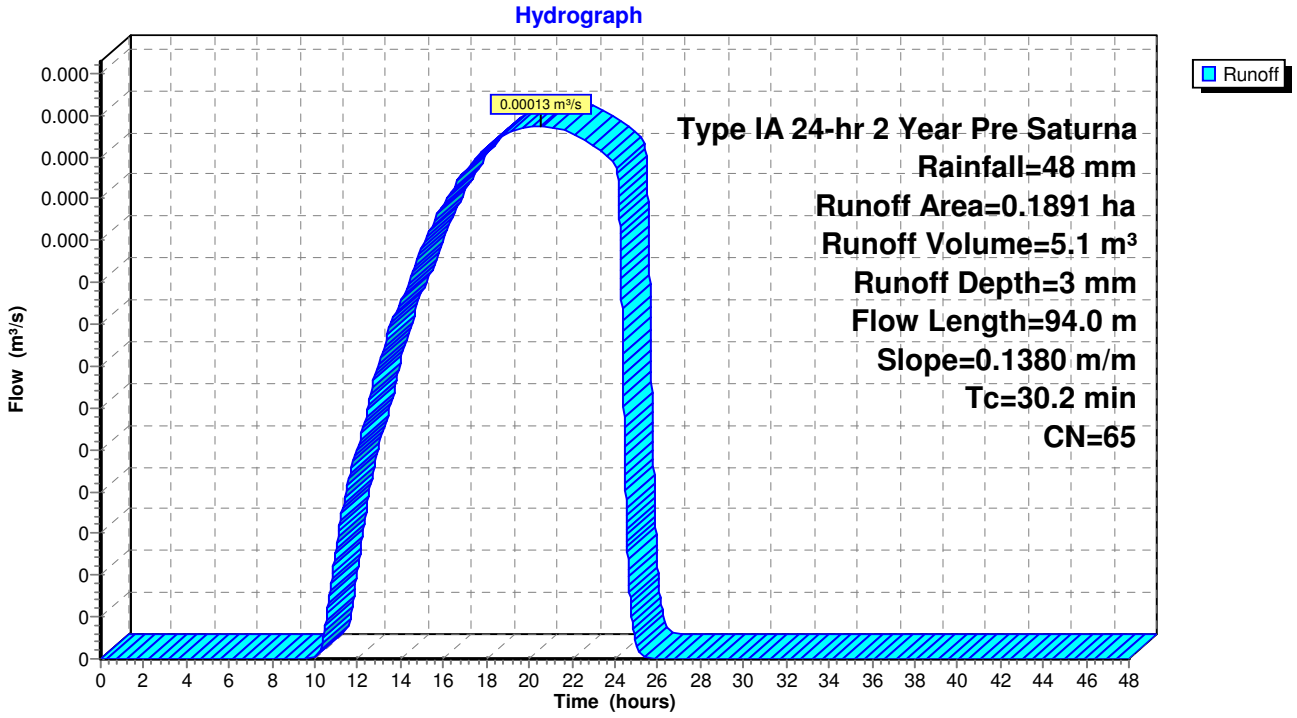
Runoff = 0.00013 m³/s @ 20.50 hrs, Volume= 5.1 m³, Depth= 3 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2 Year Pre Saturna Rainfall=48 mm

Area (ha)	CN	Description
0.1891	65	Woods/grass comb., Fair, HSG B
0.1891		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
30.2	94.0	0.1380	0.05		**Sheet Flow, Overland Sheet Flow** Woods: Light underbrush n= 0.400 P2= 53 mm

Subcatchment 7S: Galiano Green Pre-Development (South Catchment)



Summary for Subcatchment 7S: Galiano Green Pre-Development (South Catchment)

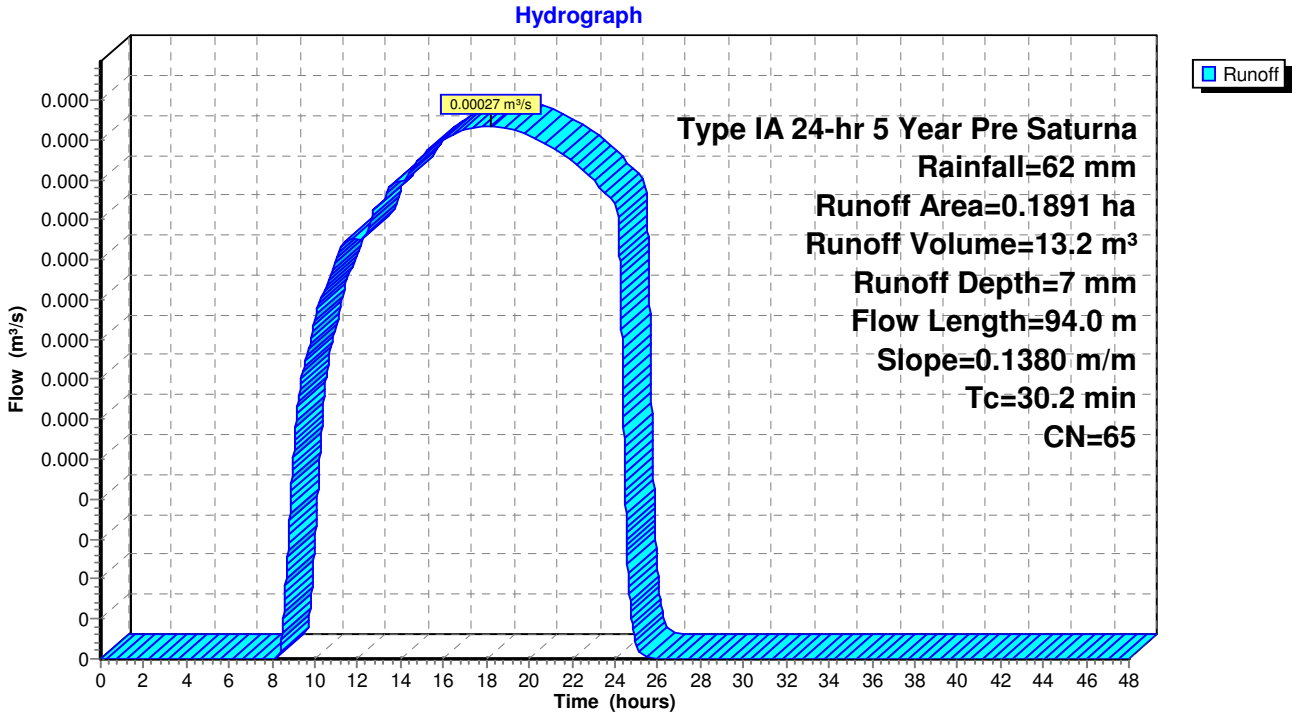
Runoff = 0.00027 m³/s @ 18.22 hrs, Volume= 13.2 m³, Depth= 7 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5 Year Pre Saturna Rainfall=62 mm

Area (ha)	CN	Description
0.1891	65	Woods/grass comb., Fair, HSG B
0.1891		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
30.2	94.0	0.1380	0.05		**Sheet Flow, Overland Sheet Flow** Woods: Light underbrush n= 0.400 P2= 53 mm

Subcatchment 7S: Galiano Green Pre-Development (South Catchment)



Summary for Subcatchment 7S: Galiano Green Pre-Development (South Catchment)

Runoff = 0.00036 m³/s @ 17.28 hrs, Volume= 19.2 m³, Depth= 10 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10 Year Pre Saturna Rainfall=70 mm

Area (ha)	CN	Description
0.1891	65	Woods/grass comb., Fair, HSG B
0.1891		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
30.2	94.0	0.1380	0.05		**Sheet Flow, Overland Sheet Flow** Woods: Light underbrush n= 0.400 P2= 53 mm

Subcatchment 7S: Galiano Green Pre-Development (South Catchment)