MEMORANDUM

To	From
Ms. Judy Stafford Executive Director Cowichan Green Community	Curtis St. Cyr, Project Engineer Our File: 2233-02074-00
Re	**Date**
Cowichan Green Kitchen, 2431 Beverly St, Duncan B.C. – Stormwater Management Plan	September 19, 2023

1.0 INTRODUCTION

McElhanney Ltd. was retained by Cowichan Green Kitchen (the Client) to assist with the development of a proposed commercial kitchen warehouse at 2431 Beverly Street, Duncan BC.

This storm management design report provides a summary of the stormwater analyses and stormwater attenuation recommendations. To address the design goals, the management of stormwater will need to include site-specific Best Management Practices (BMPs) to create a Low Impact Development (LID) scheme. The intent of LID techniques is to mimic the natural hydrologic regime of the site through infiltration and retention of runoff onsite. To analyze the performance of the proposed LID schemes, a series of calculations and continuous flow modelling software (PCSWMM, which is based on the EPA SWMM hydraulic modelling software) were utilized.

2.0 SITE DESCRIPTION AND EXISTING DRAINAGE

The subject site, as shown in **Figure 1**, is located at 2431 Beverly Street in Duncan, BC. It is triangular, with frontage along Beverly St. on the south, and a dyke along the northeast property line. The west of the site is neighboured by a public school. It falls within the jurisdictional limits of the Municipality of North Cowichan (The Municipality). The site currently consists of two greenhouses, one portable structure, and three various sized sheds/structures. The existing site covers approximately 1.373ha.

The site's ground surface is planar to gently undulating, with some low points in the middle of the site. The site drains via overland swales in the north towards the dyke, at which point stormwater is conveyed through a culvert into Somenos Creek. The southern portion of the site drains southeast along the base of the dyke and northeast property line via an overland swale, ultimately flowing into MNC's stormwater sewer along Beverly Street.

The sites proposed development plan does not impact legal boundaries, resulting in one overall catchment area. It includes the addition of a commercial kitchen warehouse which will impact the overall impervious area of the site. Proposed Development Site Plan can be found in attached **Appendix A**.

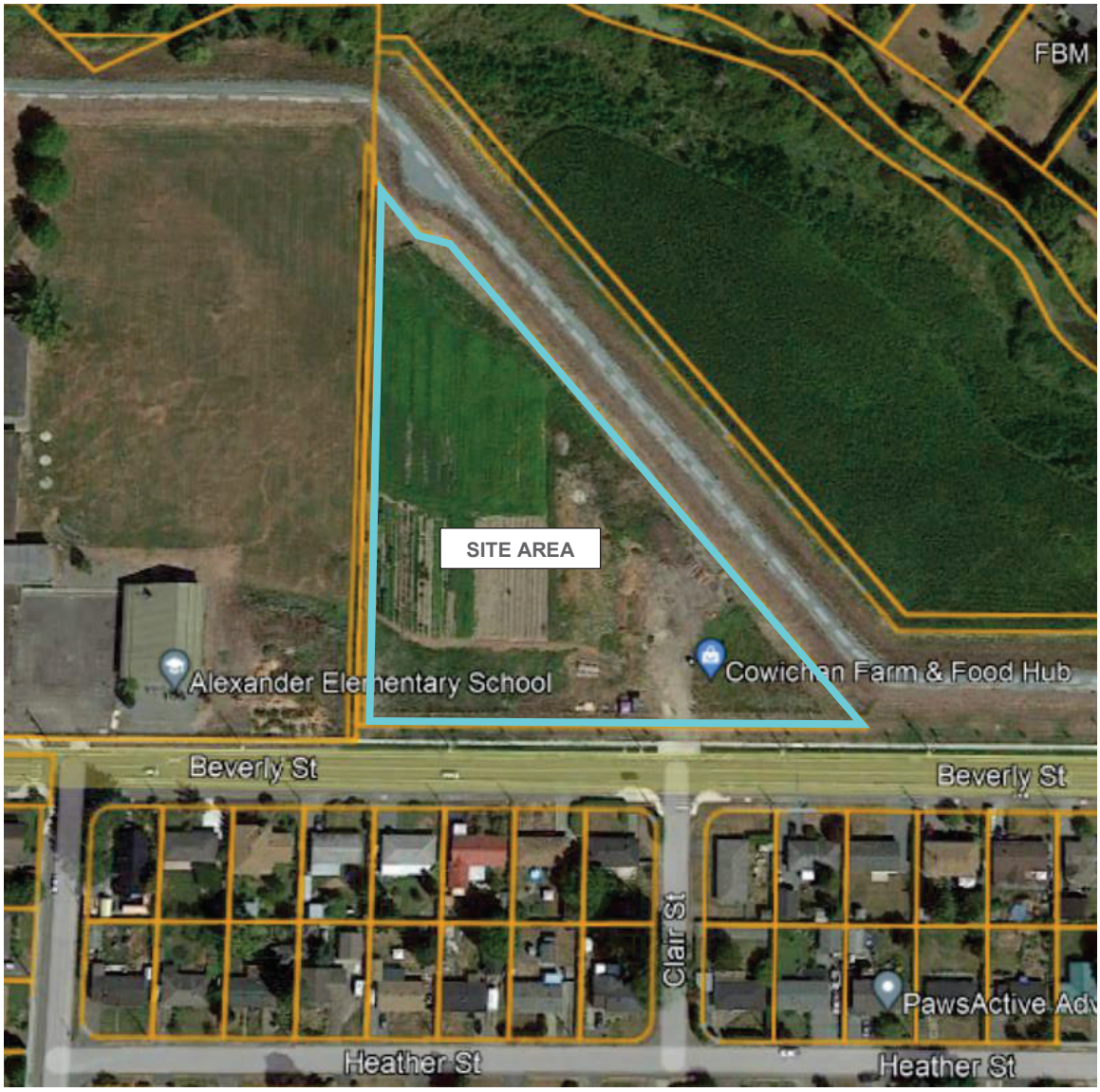

Figure 1: Approximate Site Location

2.1 Catchment Areas

The site is approximately 1.373ha with an existing gravel driveway providing access from Beverly Street. It currently drains north to Somenos Creek and south into MNC's stormwater sewer system on Beverly Street. The proposed development includes the addition of a commercial kitchen warehouse and an increased gravel area to serve as parking and loading.

To determine the effective change in runoff and peak runoff rates, the site's property boundaries were used to define the catchment area. **Figure 2** shows the catchment area boundaries.

Figure 2: Catchment area

2.2 Design Objectives

To meet the requirements of the Municipality's Stormwater and Rainwater Design Guidelines, the stormwater management for this site will aim to achieve the following objectives:

- Rainwater Management Design Criteria (Source Control Objectives)
    - Design source control works (rain gardens/rock pits, bioswales) to handle runoff from on-site impervious surfaces using on-site infiltration and detention as appropriate; and
    - Design of source control works shall be based on 50% of the Mean Annual Rainfall (MAR) 24-hour event. For the Municipality of North Cowichan, an MAR of 48mm shall be assumed, resulting in a 24-hour design rainfall of 24mm, or an average rate of 1.0mm/hr. The intention is that the source control works shall be designed to handle this rainfall amount through a combination of infiltration and detention.
    - Source control works shall include a detention component sized to provide a minimum storage volume based on 25% of the MAR, or 12mm, over the impermeable areas, assuming no infiltration or outflow. This equates to a storage volume of 1.2m^3 for every 100m^2 of impervious

area. For a typical residential lot with 200m^2 of impervious area, the works shall provide a minimum storage volume of 2.4m^3.
    - Source control works shall be installed on all sites regardless of soil conditions, unless otherwise approved. It is recognized that where sites have soils that drain poorly, the effectiveness of infiltration systems will be limited, particularly during winter months. This is acceptable because it mimics the pre-development conditions of sites with soils that drain poorly.
    - The requirement for a flow-controlled outlet may be waived upon submission of evidence by a Geotechnical Engineer that subsurface soil infiltration rates are adequate to handle the full design flow of 24mm of rainfall from onsite impervious surfaces over a 48-hour period.

- Storm Water Management Design Criteria (Capacity and Conveyance Objectives)
    - Limit the on-site post-development peak flow rate to pre-development rate for the 5-year peak flow event;
    - Design minor drainage systems (pipes, swales, ditches) for the 10-year event;
    - Design major drainage systems (overland flow routes) for the 200-year event;
    - Size culverts for the 10-year event with HW/D = 1.0 (no surcharge) and 200-year event with maximum surcharge of HW/D = 2.0 (surcharge of one pipe diameter) if site conditions permit;
    - Use Rational Method to calculate peak flows to size pipes and culverts for basic conveyance systems for drainage areas of 20 ha or less.

- Water Quality Objectives
    - Design water quality treatment works to meet the following:
    - Treat 90% of the annual runoff of the catchment areas; and
    - Meet removal targets of 80% TSS and 95% oil.

- Climate Change
    - A climate change adjustment factor of 20% is to be added to all storm intensities.

2.3 References

The following government publications were reference guidelines in the development of the SWMP:

- Engineering Standards, Schedule B, By-Law 1851, Municipality of North Cowichan, 1993
- Zoning Bylaw 1997 No. 2950, Municipality of North Cowichan
- Storm Water and Rain Water Design Guidelines, Municipality of North Cowichan
- Land Development Guidelines for the Protection of Aquatic Habitat, Fisheries and Oceans, 1993; and
- IDF Curve - Atmospheric Environment Service for North Cowichan (1973-1998).
- SCS Urban Hydrology for Small Watersheds, 2nd Ed
- Hydrology National Engineering Handbook, chapter 7, Natural Resources Conservations Service, U.S. department of Agriculture, January 2009
- Aquifer Impact Assessment, McElhanney, September 2023

3.0 SWMP HYDROLOGIC AND HYDRAULIC ASSESSMENT

This section relates the site assessment to the design criteria to derive a LID that meets the required design objectives. The goal of this analysis and design is to ensure the post development runoff from the site does not exceed pre-development targets. For this development, it is proposed that the LID utilizes an infiltration rock pit (or similar method providing the same storage volume) to mimic the pre-development condition. In this case, 'pre-development' refers to the site conditions prior to when any building or driveway construction took place.

Rock pits provide the ability to utilize more of the site's surface since the rock pit is buried underground. The principal advantage of this option is that the useful surface area of the site is not reduced by the stormwater management facility and may be used for storage or parking for future development.

3.1 Rainwater Analysis for Source Control Objectives

The rainwater analysis was completed using the design criteria described in section 2.2. This process involves:

- Defining the drainage area;
- Selecting design storm frequency and duration;
- Determining impervious areas for post-development conditions; and
- Calculating source control works based on the MAR.

Table 1 shows the relevant source control parameters required to complete the calculations as per the rainwater design guideline.

Table 1: Source Control Parameters

Parameter	Catchment
Site Area (ha)	1.373
Impervious Area (ha)	0.228
Imperviousness (%)	16.6%
Infiltration Rate (mm/day)	0
50% MAR Rainfall (mm)	24

The required infiltration volume is based on 50% of the MAR rainfall depth in a 24-hour period and the impervious area. Therefore, the required infiltration volume is 0.228 ha multiplied by 24mm, which yields approximately 54.72m^3. This infiltration volume is then divided by the assumed infiltration rate to determine the required source control area, but as it is assumed that the infiltration rate for the site is negligible, this is not possible. Ultimately it is practically unfeasible to meet this performance standard and flow control is required. It is also therefore concluded that the intent of the LID is to mimic the pre-development condition.

Source control is also required to provide a minimum storage volume of 25% of the MAR distributed over the impervious area. Therefore, the required storage volume is 0.228ha multiplied by 12mm, which yields approximately 27.36m^3.

Based on the rainwater design criteria, the stormwater detention features are required to mimic the pre-development condition and have a minimum storage volume of 27.36m^3. In addition, since the assumed infiltration

rate is expected to be negligible for portions of the year, the requirement for flow control to meet the source control objectives cannot be waived.

3.2 Storm Water Analysis for Capacity and Conveyance Objectives

The storm water analysis focuses on larger storm events, the available capacity of the downstream drainage system and major overland flood paths.

3.2.1 Pre and Post Development Runoff

To determine the peak runoff for the 5-year design storm event and estimate an LID so that post-development runoff does not exceed pre-development levels, a continuous hydraulic model was utilized. Since this development does not propose to construct a detention pond, the proposed detention facilities are required to limit post development runoff to pre-development levels up to the 5-year design storm event. The sizing of each detention facility will then be compared to that required, to meet the rainwater design criteria and to determine which governs.

Rainfall data is supplied by Environment Canada as “Short Duration Rainfall Intensity-Duration-Frequency Data” (IDF Data) and the IDF data referenced for this project is from the North Cowichan station, updated in 2019.

Since rainfall events tend to be long in duration but relatively low in intensity, which is typical for areas within coastal British Columbia, a SCS Type 1A 24-hour design storm was used in the continuous modelling to derive the LID for the 5-year design storm event. The 5-year design storm event produces 70.8mm of rainfall within the 24-hour period which equates to 85.0mm of rainfall when applying a climate change adjustment factor of 20%. The hydraulic model catchment parameters are shown below in **Table 2**.

Table 2: Hydraulic Model Catchment Parameters

Parameter	Pre-Development	Post Development
Site Area (ha)	1.373	
Impervious Area (ha)	0	0.228
Imperviousness (%)	0	16.6
Land Cover – Soil Group	Open Spaces – Poor - Fair Condition – Group D	Open Spaces – Good Condition – Group D
SCS Curve Number	84	80

The assumed SCS Curve Number is based on the SCS Urban Hydrology for Small Watersheds, 2nd Ed, for soils that are determined to have high runoff potential (hydrologic soil group D) when thoroughly wetted. The reason for a slight decrease in Curve Number for post development is due to the assumption that the landscaped area will be well maintained post construction.

Group D soils, as defined by the Hydrology National Engineering Handbook, chapter 7, Natural Resources Conservations Service, U.S. department of Agriculture, January 2009, are soils that have high runoff potential when thoroughly wetted, with water transmission through the soil being restricted or very restricted. Group D soils

typically have greater than 40% clay and less than 50% sand. A soil is automatically classified as group D if the depth to the water impermeable layer is less than 50 cm.

Figures 3 shows the change in runoff for pre and post development (without a LID) due to the proposed development.

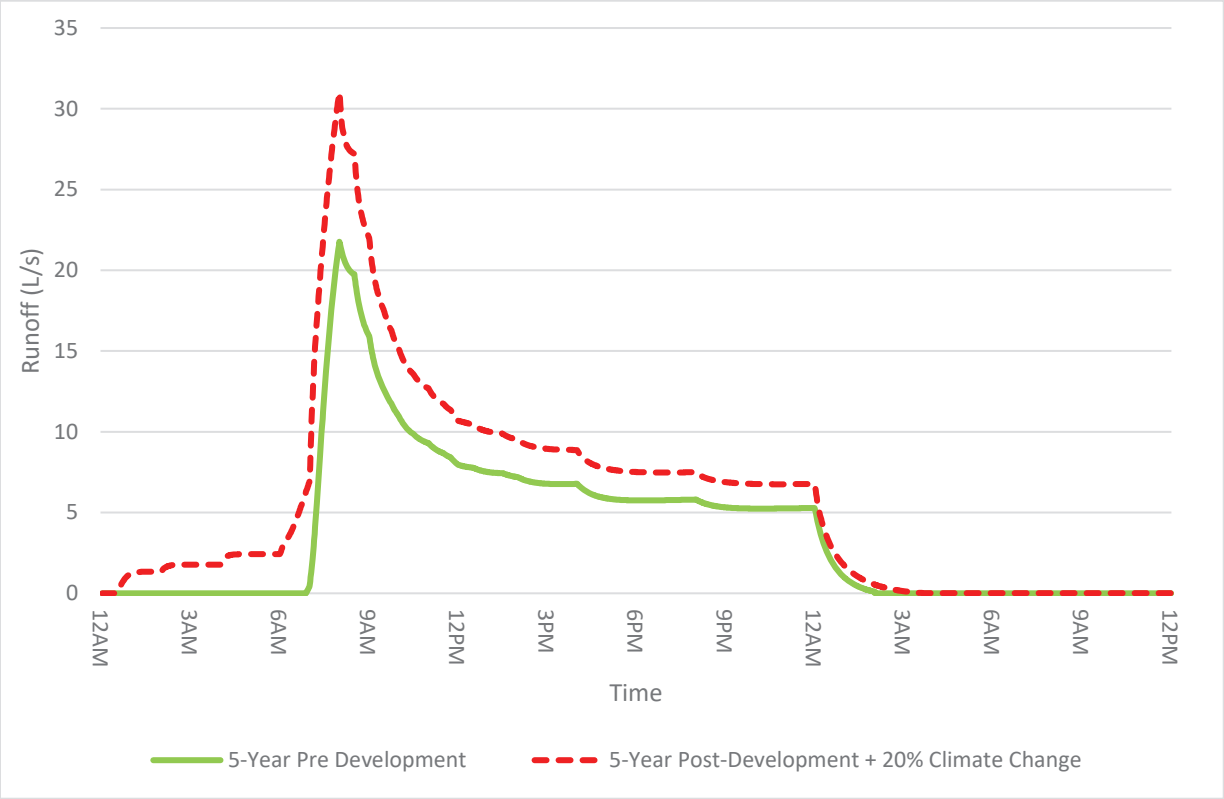

Figure 3: Pre and Post (Future) Development without LID Runoff Hydrographs

3.2.2 Peak Runoff Control

The proposed development includes a multistage approach to control the peak runoff. These stages include:

- Landscaping;
- Rock Pits / Underground Stormwater Detention Chambers; and
- Flow control structures.

Landscaping as a source control measure not only retains rainfall but also reduces stormwater runoff generation. A small allowance has been provided to account for the runoff which is intercepted by the addition of topsoil to landscaped areas on the new development. This consists of the first 5mm of rainfall on pervious areas being stored within the topsoil/landscaping, which is equivalent to approximately 25 to 50mm of topsoil.

The rock pits or underground detention chambers will capture, infiltrate, and retain surface runoff. Additionally, strategically placed orifices shall be installed in the rock pits or chambers to regulate the discharge rates to pre-development levels. The orifices' details will be provided in the detailed design stage.

As discussed throughout the report, the alternative to rock pits are underground detention chambers (such as Stormtech units or similar) which may be utilized to reduce the total footprint but provide the same level of total storage volume.

The proposed storage facility must be designed to store an effective storage volume of 35.76m^3, which would equate to a rock pit volume of 89.4m^3. As per the hydraulic model to derive the post-development with LID scenario, the flow control structure must be fitted with a 25mm orifice set art the outlet invert of the storm service connection, another orifice of 38mm offset 0.75m above the 25mm orifice and an overflow of 200mm (full diameter of the service connection) offset 1.6 m above the 25mm orifice. The intent of the flow control structure is to allow the detention facilities to store and infiltrate as much rainwater as feasibly possible during the 24-hour design storm event.

The proposed stormwater management elements were included in the hydraulic model to derive the post development LID scenario. **Figure 4** shows the change in runoff for pre and post development, with proposed LID implementations.

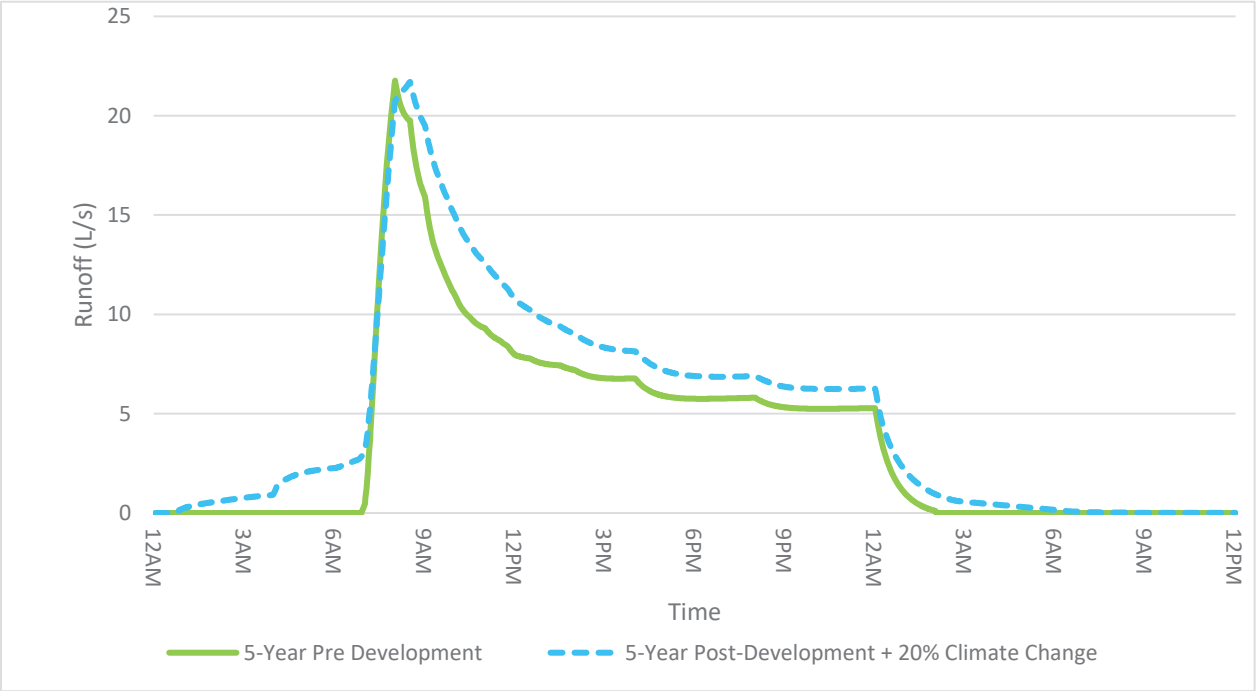

Figure 4: Pre-Development and Post-Development with LID Runoff Hydrographs

As a rainwater design check, the 50% MAR, SCS Type 1A 24-hour design storm event was also simulated in the hydraulic model and the results from the 2 design storms are shown in **Table 3.**

Table 3: Pre-and Post-Development Peak Runoff

Design Storm	Pre-Development	Post Development + 20% Climate Change	Post Development with LID + 20% Climate Change
5-Year	21.77 L/s	31.02 L/s	21.70 L/s
50% MAR	1.22 L/s	2.39 L/s	1.00 L/s

As shown in **Table 3**, the storage facility had a significant impact on the post development runoff for both the 5-year and 50% MAR design storm event and retained stormwater runoff back to the pre-development level. During 50% MAR design storm the storage utilizes only the 25mm orifice to release the runoff.

3.2.3 Onsite Flows

All onsite flows are directed north into Somenos Creek and south to the stormwater system along Beverly Street. The property will be graded to direct stormwater away from the proposed structures and all roof leaders and catch basins will direct the runoff to the detention facility prior to entering the municipality's stormwater drainage system. The major overland flood route runs to the east along Beverly Street and Somenos Creek, as per the pre-development condition. The proposed works do not significantly change the pre-development runoff scheme.

3.2.4 Offsite Flows

The are no significant upstream catchment areas that contribute to the onsite flows. Offsite flows are conveyed through the existing stormwater drainage system and Somenos Creek, and do not impact the proposed LID. The offsite flows are independent from onsite flows.

3.3 Water Quality Control

Rock pits are designed to store and infiltrate as much stormwater as feasibly possible. The spaces between the rocks in the pit provide room for water to be stored. The stormwater gets channelled into the rock pit where it percolates into the ground. The rate of release is managed by the control structure which is fitted with an orifice set at the invert of the rock pit. Water quality, and in turn the characteristics of the soil, are also improved since any impurities in the water is captured by the rock pits non-woven geotextile fabric.

Additionally, as per recommendations in the Aquifer Impact Assessment, the runoff collected in the parking area will be treated by oil/grit/water separator prior to its release to the rock pit to enhance stormwater quality.

4.0 FLOOD RISK AND DOWNSTREAM DRAINAGE REVIEW

The Municipality of North Cowichan's Stormwater Management-Design Guidelines also requires a review of the downstream capacity and flood risk for 10-year, 25-year and 200-year events. The results are summarized below in **Table 4.**

Table 4: Comparison of Peak Runoff Flow Rates

Storm Events	Rainfall Depth + Climate Change (mm)	Pre-Development (L/s)	Post Development + Climate Change (L/s)	Post Development + Climate Change with LID (L/s)
10-Year	95.3	27.43 L/s	38.63 L/s	30.89 L/s
25-Year	108.4	34.09 L/s	46.71 L/s	38.79 L/s
200-Year	172.8	66.78 L/s	86.67 L/s	77.02 L/s

Based on the available topographic and record information, we have confirmed that the stormwater sewer on Beverly Street is adequately sized to manage the proposed flows from the 10-year and 25-year storm events with the climate change adjustments.

The 25-year flow is conveyed east through the stormwater sewer on Beverly Street, and north into Somenos Creek. This will need to be confirmed with the MNC's stormwater system model. The property will be graded such that the overland flows will be directed to the adjacent roadways during major storm events.

Beverly Street is the ultimate major overland flood route for the area, which will manage the proposed flows for the 200-year storm events with the climate change adjustment. Some overland flows will be directed into Somenos Creek via an overland swale. Since the site's grading will direct overland flows away from buildings into overland swales, no additional flood risks are expected.

5.0 EROSION AND SEDIMENT CONTROL

Erosion and Sediment Control (ESC) measures should be installed on-site before and during construction activities. ESC plans deal with site specific conditions to avoid erosion and associated impacts.

ESC measures and best management practices (BMPs) are to ensure that potential sediment-laden runoff stays on site during the construction period. The proposed ESC BMPs may include:

1) Source Erosion Control:

- Limit excavation and fill operations to dry-weather periods;
- Stabilize slopes as required; and
- Minimize the extent of disturbed areas and protect exposed soil surfaces with appropriate ESC measures.

2) Runoff Control:

- Install diversion swales that collect and direct sheet runoff into on-site drainage systems; and
- Provide groundwater control by applying a drainage blanket of coarse material to stabilize slopes and excavations.

3) Sediment Control:

- Construct and maintain on-site haul roads and gravel access pads and restrict vehicle movements to these areas;
- Limit stockpile storage locations to designated areas only;
- Material and soil stockpiles should be covered with polyethylene sheeting or contained with silt fencing. Control silt movement if any, using drainage swales, check dams, and natural ponds;
- Install and maintain sediment fencing and/or interceptor ditches around the northeast perimeter of the site throughout the duration of construction; and
- Protect catch basin inlets with non-woven geotextile (if applicable).

These ESC measures should be installed prior to any on-site construction activities.

To ensure that the ESC BMPs are implemented and functional, it is recommended to inspect and monitor their conditions and performance on a weekly basis throughout the duration of the construction period, and during significant rainfall events. The owner or contractor should retain a Qualified Environmental Professional (QEP) to inspect the installation and operation of these works throughout construction.

6.0 CONCLUSION

The proposed development of this property can result in minimal or no significant impacts to the stormwater drainage patterns if constructed in accordance with the recommendations presented in this report. The stormwater analysis showed that the intent of the Municipality of North Cowichan's Storm Water and Rainwater Design Guidelines, and Engineering Standards, can be achieved, with the intent of the design being to mimic the assumed pre-development condition. On this basis, the proposed design is submitted for preliminary approval. Additional investigations may be recommended to identify downstream capacity or flooding issues, if deemed necessary by Municipality of North Cowichan staff.

Sincerely,

McElhanney Ltd.

Prepared by

Curtis St. Cyr, EIT

Project Engineer

Reviewed by

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
L. BREZINA
55462
2023-09-19

Lukas Brezina, P. Eng.

Project Manager

APPENDIX A

Rev	Date	Description	Drawn	Design	Appd
PB	2022-11-18	ISSUED FOR DEVELOPMENT PERMIT	MR	LB	JI
PA	2022-09-23	ISSUED FOR COORDINATION	MR	LB	JI
PA	2022-03-24	ISSUED FOR DISCUSSION ONLY	LB	LB	JI

0 1:250 10

ORIGINAL DWG SIZE: ANSI D (22" x 34")

McElhanney
Suite 107
225 Canada Avenue
Duncan BC
Canada V9L 1T6
T 250 748 3335

PRELIMINARY NOT FOR CONSTRUCTION

THIS DRAWING HAS NOT BEEN APPROVED AND MAY CONTAIN ERRORS AND OMISSIONS

COWICHAN GREEN KITCHEN

360 DUNCAN STREET ,DUNCAN, BC V9L 3W4

COWICHAN GREEN COMMERCIAL KITCHEN SITE PLAN

Drawing No. 101

Project Number 2233-02074-00

Rev. PB