HALFMOON BAY LIVING LTD.

TRUMAN ROAD DEVELOPMENT PROJECT
STORMWATER MANAGEMENT PLAN
FINAL REPORT

Project No: 22-100
April 21, 2023
Aplin & Martin Consultants Ltd.

APLIN MARTIN
ENGINEERING ARCHITECTURE PLANNING SURVEYING

ENGINEERS & GEOSCIENTISTS
BRITISH COLUMBIA
PERMIT TO PRACTICE # 1001018

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1.0 INTRODUCTION

Aplin & Martin Consultants Ltd. (Aplin Martin) has been retained by Halfmoon Bay Living Ltd. (Halfmoon Bay) to develop a Stormwater Management Plan (SWMP) in support of the proposed Truman Road Development Project (Project Site) located on the Truman Road north shore of Halfmoon Bay east of Square Bay, in the Sunshine Coast Regional District (SCRD), BC. This report aims to summarize our understanding of the existing site context and drainage issues, the hydrological and hydraulic analysis in support of the proposed SWMP for the development.

2.0 BACKGROUND

The property is legally described as District Lot 2394 Group 1, Westminster District, PID 013-272-047. The land covers a total area of approximately 15 acres. The Project Site is surrounded by the existing 93 parcel Square Bay Subdivision on the west, south and east. Square Bay and Halfmoon Bay is within 250m beyond the existing residential lots. The hillside on its north belongs to Crown land.

Figure 1 is a location plan of the Project Site.

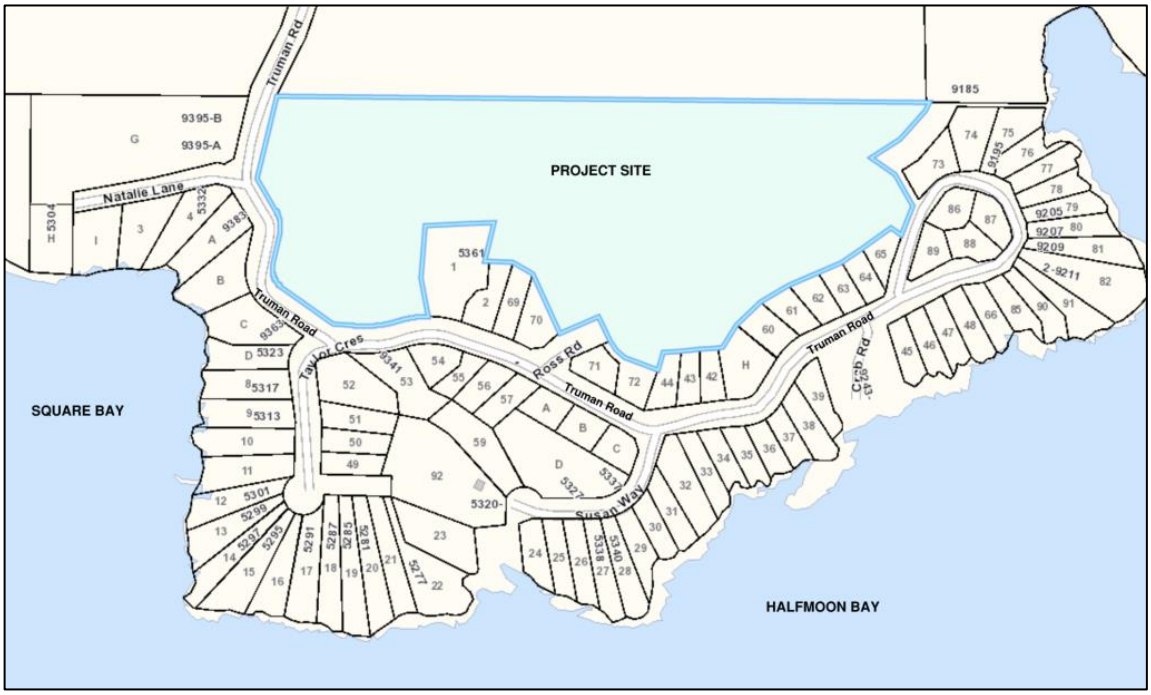


Figure 1: Project Site Location Map

The Project Site is currently undeveloped. An application has been filed with the SCRD for an Official Community Plan (OCP) amendment and a zoning amendment in support of a proposed future subdivision for 44 single family lots. The OCP amendment and rezoning application requires a stormwater management plan to be developed for the Truman Road Development.

3.0 EXISTING SITE CONDITION

The Project Site is presently covered mostly by trees and natural vegetation, except a previously constructed unpaved private road running from west to east via the middle of the property. The site lies on the lower slope of a south facing hillside with elevations ranging from 21 to 70m-geodetic, sloping from northwest to southeast. The average slope is approximately 25%. Steeper slopes are found in small, scattered areas up to 60%.

3.1 GEOTECHNICAL ASSESSMENT

According to the past geological survey conducted for the Sunshine Coast area, (*Surficial Geology and Sand and Gravel Deposits of Sunshine Coast, Powell River, and Campbell River Areas*, by J. W. McCammon, 1977), the Sunshine Coast region is mantled with a variety of unconsolidated materials of glacial, glaciomarine, marine and fluvial origin. Frequent bedrock outcrops suggest that much of the overburden is shallow. The Project Site fits the general geology characteristics of the Sunshine Coast region with large rock outcrops found throughout the land, as shown in Figure 2, the photos taken during Aplin Martin's site visit on April 30, 2022. Sandy gravely soils cover the areas in between the rocks that support the growth of the native vegetations.

Figure 2: Photos of the Project Site (Taken on April 30, 2022)

GES Geotech Inc. conducted two site visits on May 22, 2022 and August 3, 2022. The site generally slopes from mid-north towards the east, south and west. The land is covered

with massive, intact, intrusive rocks which are mainly granite, granodiorite, and diorite. Groundwater was estimated to be about 5-6m below existing ground level. The soil within the project site across several test pits indicated sand, gravel with high infiltration rate. Please see Appendix A for the Geotechnical Reports.

3.2 ENVIRONMENTAL ASSESSMENT

The Project Site lies within the Coastal Douglas-fir (CDF) bio geoclimatic zone. The CDF is limited to a small part of southeastern Vancouver Island, several islands in the Strait of Georgia, and a narrow strip of the Sunshine Coast. It is confined to elevations mostly below 150m. The CDF is in the rain shadow of the Vancouver Island and Olympic mountains. It has warm, dry summers and mild, wet winters. Over the course of a year, the temperature typically varies from 7°C to 20°C, and is rarely below 3°C or above 24°C. The average annual precipitation in Halfmoon Bay is 1028.8mm. More than 40% of the precipitation falls as rainfall in November, December, and January. Very little (less than 5%) falls as snow during the winter months. The snow typically melts within a week of falling.

Triton Environmental Consultants Ltd. was retained to prepare the Environmental Management Plan (EMP) and indicated that one unidentified stream to the east of the Project site occurs and another unidentified lake/lagoon to the southwest of the project site exists and is connected to the Halfmoon Bay by an unidentified stream.

The EMP also identified some large diameter trees to be protected at the northeast corner of the Project Site. The EMP reports can be found in Appendix B.

3.3 EXISTING DRAINAGE CONDITION

No visible drainage watercourses can be found within the Project Site, except ditch sections noted along the existing unpaved road on the property. These ditches were likely formed when the road was constructed. They do not connect to any visible downstream ditches or watercourses but appear being drained via seepage into the subsurface. Rainfall on the site appears mostly infiltrating into the ground and seeping via the shallow soil layer and/or in between rocks. Minor surface runoff may occur during very heavy rain events. A small shallow ditch was found along the northside of Truman Road that collects both surface runoff and seepage water from the hillside including that originated from the project site. The ditch along Truman Road follows the road grades and discharges further downhill via the Square Bay Subdivision area into the ocean. Figure 3 shows the drainage catchments to the section of Truman Road downhill of the Project Site and the existing drainage configuration along Truman Road and downstream.

The total existing catchment area draining to the section of Truman Road that could be impacted by the drainage from the Project Site is 13.8ha. The overall catchment can be subdivided into three catchments based on contours and drainage designation points, including:

- West Catchment
  This catchment covers a drainage area of 5.74ha, draining from the west portion of the project site and the upper hillside area into the north roadside ditch of Truman Road to a local low elevation point on Truman Road at where it intersects with Taylor Crescent. There is a culvert exists at this location conveying the flows collected in the ditch across Truman Road into a well-defined ditch along the

west side of Taylor Crescent that runs fronting the three properties south of Truman Road. The ditch ceases at the driveway on 5317 Taylor Crescent. During our site visit on April 30, 2022, we were able to find an entrance to a culvert on the north side of the driveway. However, the outlet for this culvert was not found on the south side and no further drainage connection could be identified further downstream. Taylor Crescent was found sloping upwards on the south of 5317 Taylor Crescent.

We interviewed the resident of 5317 Taylor Crescent, who informed us that during heavy rainfall conditions, flows in the west roadside ditch of Taylor Road would overflow into their lot and inundate almost the entire front yard of the property. The resident also indicated that during rain events, flow was also observed coming out of the slope on the east side of Taylor Crescent fronting 5314 Taylor Crescent, running overland in between the fence installed along the northern property and the house on 5314 Taylor Crescent. The basement of 5314 Taylor Crescent has been frequently inundated during these events. The overland flow would then discharge into the meshy open water on 5320 Susan Way that connects directly to the ocean (see Figure 3).

- Lower Central Catchment
  This lower central catchment covers a drainage area of 1.58ha. Based on the contour map, this catchment drains to the point where Truman intersects with Susan Way. No culvert was found during our site visit at this location, neither any open channels further downstream along Susan Way. We believe the flow collected in the Truman Road ditch, if any, would drain subsurface via the lands downhill into the ocean.

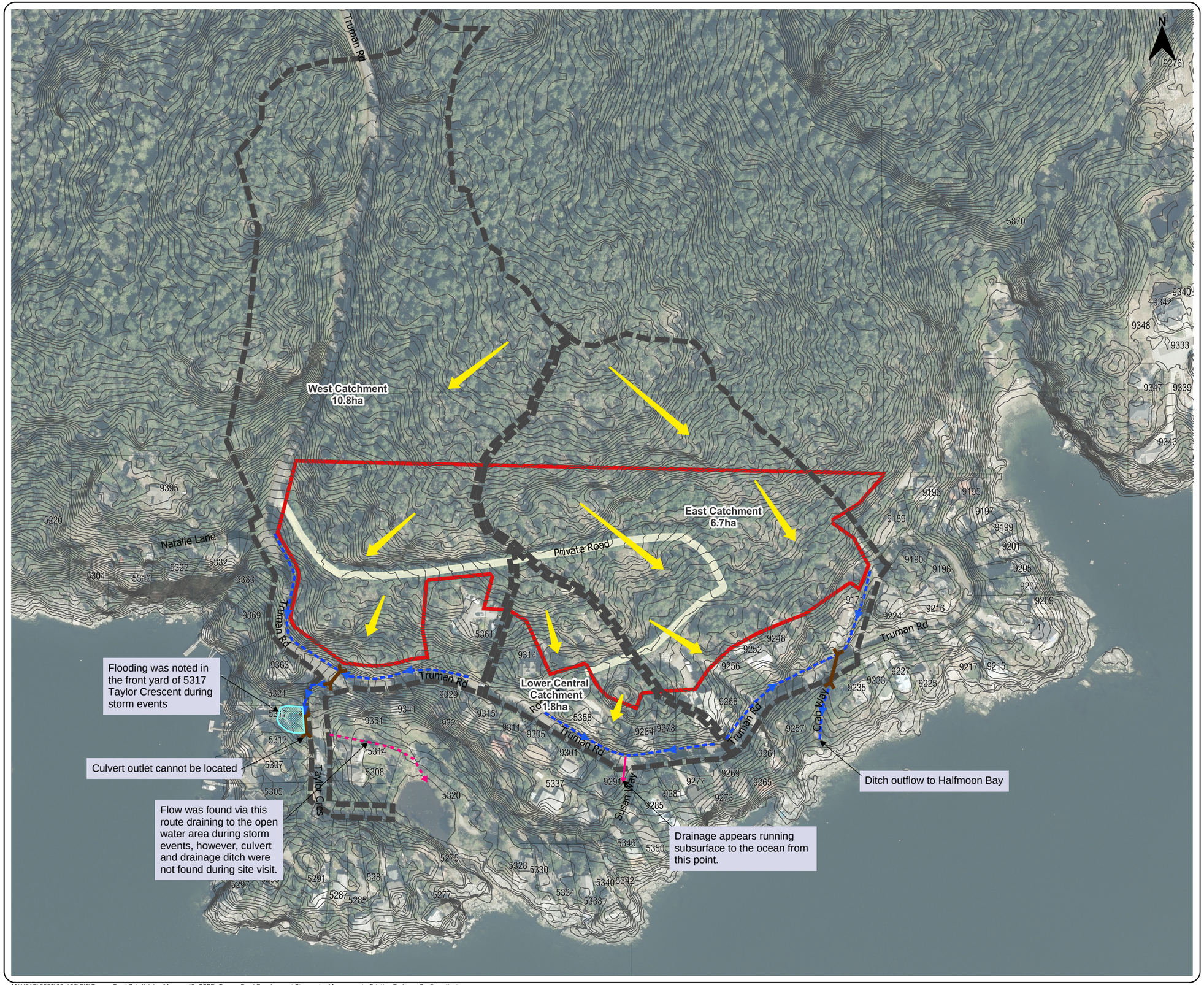
- East Catchment
  The East Catchment covers an area of 6.58ha. Surface runoff or seepage from the hillside is collected in the Truman Road north roadside ditch to where Truman Road intersects with Crab Road. A culvert was found at the location crossing Truman Road that would convey the flow to a ditch along the east side of Crab Road and into the foreshore area of Halfmoon Bay.

According to the site visit conducted on April 30, 2022, the drainage of the Truman Road catchment would mainly run via subsurface into the ocean except two major surface drainage flow routes via culverts crossing Truman Road then ditches on Taylor Crescent and Crab Road, discharging into the ocean. The Key drainage issue was with the surface drainage route via Taylor Crescent. This surface drainage conveyance route does not appear containing the proper drainage infrastructure downstream of Taylor Crescent to allow safe conveyance of the surface runoff generated from the upstream catchment into the ocean, and hence has caused flooding on 5314 and 5317 Taylor Crescent during major storm events in the past.

Truman Road Development Stormwater Management

FIGURE 3

Existing Drainage Configuration



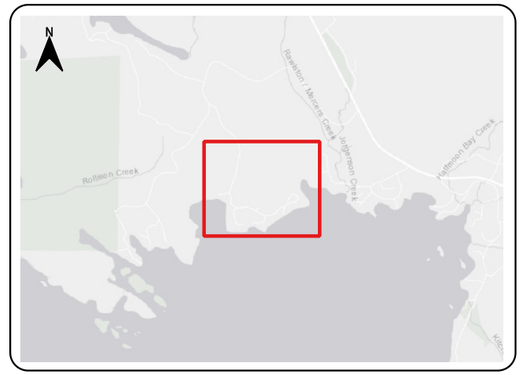
LEGEND

- Contour
- Project Site
- Existing Private Road
- Existing Ditch
- Existing Culvert
- Existing Overland Flow Directions
- Existing Drainage Catchment Boundary

Proj. No:	22-100
Creator:	CYC
Reviewer:	WY
Revision:	A
Date:	2023/04/21

0 25 50 75 m

Scale: 1:3000
Coordinate System:
EPSG:26910 - NAD83 / UTM Zone 10N



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4.0 STORMWATER MANAGEMENT DESIGN CRITERIA

The SCRD does not have a bylaw that stipulates stormwater management/drainage requirements for residential developments in the Regional District. Based on the standard stormwater management/drainage requirements specified in the Master Municipal Construction Documents Association (MMCD) Design Guideline 2014 and specific existing drainage issues noted downstream of the Project Site, Aplin Martin recommends the following stormwater design criteria to be used for the proposed new development on the Project Site:

- Control post-development runoff from the project site to the pre-development level up to 5-year return period to mimic existing runoff condition.
- Drainage conveyance system to contain 1:100-year maximum Hydraulic Grade Line (HGL) without surcharging or causing any flooding and flood damage to the downstream properties.

5.0 STORMWATER MANAGEMENT PLAN

The Project Site is proposed to be subdivided into 44 single family lots, 1 wastewater treatment plant at the lower elevation and 1 park conservation area near the northeast corner of the Project Site. Based on the existing drainage condition, the proposed subdivision plan and the recommended stormwater management design criteria, Aplin Martin has developed a Stormwater Management Plan (SWMP) for the subdivision as shown in Figure 4.

The proposed catchment plan is generally following the existing three major catchments which are serviced by the proposed stormwater facilities that would service the upstream following the existing drainage pattern and discharge to the ocean via three discharge points.

The SWMP is also summarized in Table 1 with the design components and proposed stormwater management targets presented in detail.

Table 1 –Proposed Stormwater Management Concept

Item	Proposed Stormwater Management Plan	Stormwater Management Targets
1.	Onsite Stormwater Control Measures (to be implemented during individual site development and house building): - Disconnected roof leaders - 300mm depth of amended topsoil applied to minimum 50% of the pervious area - No basements or drain tiles for the proposed homes - Impervious areas sloping to pervious area - Rock pit sized and placed in the proposed pervious area	- Promote onsite infiltration to mimic the existing site drainage condition
2.	- Interceptor drainage system around the house buildings to collect runoff from hillside and safely convey to the fronting roadside ditches (to be designed at	- Collect runoff from the hillside to avoid potential drainage from the hillside to cause flooding in the proposed development lots

	individual site development based on the individual lot condition)	
3.	Proposed storm sewer within proposed wastewater treatment facility along the south side adjacent to other properties (to be designed for 100-year flows, and to be constructed during the subdivision development)	- Collect surface runoff from the wastewater facility and convey to downstream drainage system on Truman Road to avoid any surface and subsurface runoff flow into the existing residential properties in the Square Bay Subdivision
4.	Proposed roadside ditches along the proposed new roads and Truman Road (to be designed for 100-year flows, and to be constructed during the subdivision development)	- Collect surface runoff to convey via storm ditches, culverts to avoid potential flooding and flood damage to residential properties
5.	Roadway Stormwater Source Control Measures (to be constructed during the subdivision development): - Bioswale on roadside to provide stormwater quality treatment. - Vegetation amended topsoil with rock bottom for bioswale design.	- Provide stormwater treatment to the runoff from the road surface and promote infiltration into the ground
6.	Proposed storm sewers on Taylor Crescent (to be designed for 100-year flows and built during the subdivision development) and upgrade the culvert and ditch downstream if deems to be necessary	- Contain flows in storm sewers or upgraded culvert to avoid potential flooding and flood damage to the existing residential properties in the Square Bay Subdivision

The proposed preliminary SWMP include a drainage conveyance system with interceptor drainage system, roadside ditch, storm sewers and ditch and culvert upgrades that collects the surface runoff that cannot be retained in ground and convey the flow safely to the ocean.
Since there are existing roadside ditches along the road alignment within the project site under existing condition, it is proposed to use the existing roadside ditches with as the drainage conveyance system to service the project site wherever is feasible.

In addition to the proposed drainage system to service the Project Site, roadside ditches sewers are also proposed on the west section of Truman Road to convey the flow collected from both the West Catchment of the Project Site and the overland flow from upstream catchment area outside of the Project Site, the change to storm sewer running along Taylor Crescent to its south end and then via the ROW on the east of the cul-de-sac to the open water area on 5320 Susan Way that has a direct connection to the ocean.

The culvert and ditch system along Crab Way will also be reviewed and upgraded, if necessary, to allow safe conveyance of the drainage from the East Catchment into the ocean without causing any overflow into the existing private properties along Crab Way.

Truman Road Development Stormwater Management

FIGURE 4

Stormwater Management Plan

LEGEND

- Contour
- Project Site
- Parcel
- Post-Dev Catchment Boundary
- Proposed Overland Flow

Proposed Drainage System

- Proposed Culvert
- Proposed Storm Sewer
- Proposed Trench Drain
- Proposed Ditch and Ditch Upgrades
- Existing Ditch to be kept
- Existing Culvert to be Abandoned
- Existing Ditch to be Abandoned

Land Use

- Forest
- Park
- Proposed Single-Family Residential
- Proposed Wastewater Treatment Facility

Proj. No: 22-100
Creator: CZ
Reviewer: CYC
Revision: A
Date: 2023/04/21

0 25 50 75 m

Scale: 1:3000
Coordinate System:
EPSG:26910 - NAD83 / UTM Zone 10N

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M:\HEAD\2022\22-100\GIS\Truman Road Subdivision Map.qgz "4_SCRD_Truman Road Development Stormwater Management_Stormwater Management Plan"

BMP Measures

In addition to the proposed storm sewer collection surface runoff conveyance system, stormwater source control measures are also proposed that include:

- Onsite Source Control Measures:
  - Where the site is proposed for minimum 50% of pervious area covers, a minimum depth of 300mm amended topsoil is recommended to be placed in the proposed lawn/ vegetation areas. The amended topsoil is essential to support vegetation growth, while it can also be used as a stormwater source control feature to allow absorbance of the rainwater and surface runoff into this soil layer, prior to seeping into the subsurface native soils and/or rocks.
  - Roof leaders shall be disconnected to drain to the lawn/vegetation areas with amended soil cover, or to the native ground.
  - All impervious surfaces (e.g. driveways) shall be sloped to drain to the lawn/vegetation covers or native ground.

Disconnected Roof Leader

The above proposed onsite source control measures are to promote the subsurface drainage as that occurs under the existing onsite drainage conditions. To avoid potential flooding due to the runoff from the upstream north hillside area in Crown land, rock pit on the rear side of the northern properties shall also be installed to intercept and infiltrate the surface runoff, if any, from the hillside area. Interceptor drainage system is to be applied around the building to safely convey the excessive runoff under large storm events. It is recommended that residential buildings to be built shall not have basement and foundation drainage system to avoid any interception to the groundwater flows to increase the runoff flow rates via the proposed drainage conveyance system.

Please note that the above recommended onsite source control measures shall be implemented during the development of individual properties. The individual landowners or developers shall ensure these source control measures to be implemented during the developing and building the single-family homes.

- Offsite Roadway Source Control Measures:
  - Road drainage shall be collected and conveyed via the roadside ditch which bioswale can be incorporated with rock drainage at the bottom to promote infiltration to the native ground while conveying the flows downstream directly.
  - The proposed downstream new storm sewers along the Taylor Crescent shall pick up flow from the upstream bioswales and convey it to the ocean to prevent flooding in the private properties.

Roadway Stormwater Management Concept

6.0 HYDROLOGIC & HYDRAULIC MODELLING

A detailed hydrological and hydraulic model using PCSWMM has been developed based on the post-development condition to support the proposed subdivision plan and preliminary sizing of the proposed drainage system. The model was developed to size the proposed roadside ditch and storm sewer system to meet the servicing requirement according to the proposed stormwater management design criteria. The model also included the major drainage system which is proposed to be retained based on the SWMP to check the required upgrades needed under the post-development condition. Proposed storm sewer system was assumed with minimum 1 m cover generally following the existing topography. The model assumed with free outfall condition as the downstream boundary based on the steep slope topography at the ocean discharge points.

The subcatchments are subdivided mostly on a lot-by-lot basis based on the post-development land uses, road alignment, and allocation to the drainage system, while existing forest area are subdivided and allocated to the same outlet as the immediate downstream residential subcatchments. Both existing and post-development model scenarios were developed to assess the impact from the project site with the proposed stormwater management plan.

6.1 DESIGN STORM

Since there's no existing design storm provided by the SCRD to be used for the study area, Aplin Martin has reviewed the Intensity-Duration-Frequency (IDF) data provided in the District of Sechelt's Subdivision and Development Control Servicing Standards Bylaw No. 430, 2003 (Consolidated July 2019) which is based on the historical rainfall data at Environment Canada (EC) Vancouver UBC climate station. However, upon review of the nearby rain gauge locations and available rainfall data, it is recommended that the IDF data developed based on the 29 years of rainfall record (1983-2021) from the Environmental Canada (EC) station Sechelt Aut to be used to develop design storms for the analysis. The storm hyetograph used in the District of Sechelt Bylaw was adopted for creating the design storms at Sechelt Aut station which is using AES distribution for short-duration storms and SCS distribution for long-duration storms.

Table 2 – Design Storm Rainfall Amount (mm) at Sechelt Aut Station (1983-2021)

Duration	Current Climate Condition	
	5-Year	100-Year
1-hr	12.8	19.8
2-hr	18.2	28.5
6-hr	29.0	42.5
12-hr	41.1	60.0
24-hr	60.1	91.5

Single storm event simulations were performed to determine size requirements for both the existing drainage upgrades and proposed drainage system. Table 3 provides the design storms used for modelling and their respective data source.

Table 3 – Design Storms Used for Modelling

Design Storm Event	Data Source
5-year & 100-year: 1, 2, 6, 12, 24-hour duration events	Historical IDF data based on the Environment Canada rainfall data (1983-2021) at Sechelt Aut station & Storm Hyetographs from the District of Sechelt's Bylaw

6.2 MODEL PARAMETER

Non-Linear Reservoir rainfall/runoff method were applied to the model subcatchments according to the land use types. Considering the steep topography of the study area and high infiltration condition of the subsurface layer, groundwater module was included in the model development to simulate the groundwater seepage through the hillside and contribute to the drainage system.

As field data was not available for model calibration, the modelling parameters were assumed based on our professional judgements and experience on similar projects and site condition. Subcatchment slopes were calculated using the slope tool in PCSWMM based on the available DEM data. Based on the past geological survey and site visits, sandy gravely soil type was identified among the large rock outcrops throughout the study area, therefore, Curve Number (CN) number of 70 was assumed for the existing forest area representing the rocky site condition with some infiltration capacities. To simplify the model process using SWMM engine, the Green-Ampt infiltration parameter and groundwater module parameters applied for the forest area was verified through sensitivity analysis against the Curve Number method.

The hydrological and hydraulic model parameters used for the modelling analysis are summarized in Table 4.

Table 4 - Hydrologic and Hydraulic Modelling Parameters

SWMM Model Parameters		Value
Subcatchment Parameters Based on Various Land Uses	**Forest**	
	Imperviousness (%)	0
	Flow Length (m)	75-240
	Slope (%)	23-35% (Based on DEM Slope)
	Single Family Residential	
	Imperviousness (%)	55
	Flow Length (m)	30-50
	Slope (%)	5% (Based on DEM Slope)
	Subarea Routing, Percent Routed (%)	Pervious, 100%
	Road	
	Imperviousness (%)	75
	Flow Length (m)	10
	Slope (%)	3
	Subarea Routing, Percent Routed (%)	Pervious, 75%
	Depression Storage (mm)	

Global Parameter	- Impervious	1.5
	- Pervious (Road, Lawn)	5
	- Pervious (Forest)	8
	Manning's n	
	- Impervious	0.015
	- Pervious (Forest)	0.4
	- Pervious (Road, Lawn)	0.25
	Green Ampt	
	- Conductivity Rate (mm/hr)	60
	- Suction Head (mm)	61.3
	- Initial Moisture Deficit	0.335
	Roughness Coefficient	
	- Conduit	0.013
	- Culvert	0.024
	- Ditches	0.035

According to the subsurface soil condition, most of the rainfall infiltrated to the ground would likely be discharged into roadside ditches as groundwater inflow. Therefore, the groundwater module was included in the model to account for groundwater inflows. The parameters used for the groundwater module were based on the subsurface soil characteristics and our past groundwater model calibration experience, as shown in Table 5.

Table 5 – Groundwater Parameters

Stormwater Model Parameters		
Groundwater Aquifer Parameters	Porosity (fraction)	0.437
	Wilting Point (fraction)	0.05
	Field Capacity (fraction)	0.12
	Conductivity (mm/hr)	60
	Lower GW Loss Rate (mm/hr)	0.002
	Bottom Elevation (m)	Outlet Invert Elevation
	Initial Water Table Elevation (m)	Outlet Invert Elevation
Groundwater Parameters	Surface Elevation (m)	Outlet Surface Elevation
	Groundwater Flow Coefficient (A1)	0.3
	Groundwater Flow Exponent (B1)	2
	Groundwater Flow Coefficient (A2)	0
	Groundwater Flow Exponent (B2)	0
	Surface Water Depth (m)	Depth from flow routing
	Threshold Water Table Elevation (m)	Outlet Invert Elevation

6.3 MODEL RESULTS

Modelled 5-year peak flow rates under the existing and post-development condition at each discharge point is compared and is summarized in Table 6.

Table 6 –Existing and Post-Development Peak Flow Rate Comparison

Catchment	Existing Condition		Post-Development Condition	
	Contributing Area (ha)	5-Year Peak Flow (L/s)	Contributing Area (ha)	5-Year Peak Flow (L/s)
OF1	10.8	68.3	11.2	47.3
OF2	1.8	11.1	1.2	6.0*
OF3	6.7	42.2	7.5	34.3

*NOTE: * 5-year peak flow is governed by 1-hour duration design storms according to the model results, while the remaining 5-year peak flows shown in the table are governed by 24-hour duration design storm.*

Based on the model results, under 5-year return period, runoff from the project site to the downstream outfalls are all maintained to the existing drainage condition.

7.0 PROPOSED DRAINAGE SYSTEM

Based on the proposed design criteria for sizing the proposed drainage system stated in Section 4.0, under the 100-year design storm events, maximum Hydraulic Grade Lines (HGLs) in the system are to be contained without surcharging.

The model results shows that the 100-year 24-hour storm event governs the peak HGL profile in the drainage system. Proposed drainage system is sized based on the proposed SWMP and the hydraulic modelling results. Additionally, the existing Truman and Crab road's culvert and ditch are proposed to be upgraded. The drainage system for the proposed project site is proposed with slope varying from 1.3% to 17.4% and sizes of 300 mm diameter along Taylor Crescent. Some existing culverts are proposed to be upgraded to safely convey the 100-year peak flow.

The existing ditches along Truman Road are proposed to be retained and has sufficient capacity to service the upstream catchment under post-development condition. To carry the design flows, ditch bottom width and depth are considered as 0.3m wide and 0.5m deep with 1H:1V side slope. Runoff through the ditches along the Truman Road are conveyed as subsurface flow via infiltration towards Susan Way. The culvert size in the Crab Road is upgraded to 450mm to convey the design flows. The proposed sewers and downstream ditches are designed such that runoff can be conveyed through the system without potential flooding and causing damage to residential properties.

The modelled post-development catchment and preliminary drainage system sizing are shown in Figure 5. The Stormwater Control Plan summarized the modelled flows and HGLs for all proposed and existing drainage system under post-development condition in Table 7.

Truman Road Development Stormwater Management

FIGURE 5

Stormwater Control Plan

LEGEND

- Contour
- Parcel
- SWCP Catchment Boundary

Proposed Drainage System

- Existing Ditch
- Proposed Culvert
- Proposed Ditch
- Proposed Storm Sewer
- Outfall
- MH
- Node

Land Use

- Proposed Residential
- Existing Residential
- Roads
- Forest
- Park
- Wastewater Treatment Facility

Proj. No:	22-100
Creator:	CZ
Reviewer:	CYC
Revision:	A
Date:	2023/04/19

0 25 50 75 m

Scale: 1:2000
Coordinate System:
EPSG:26910 - NAD83 / UTM Zone 10N

Typical Roadside Ditch Cross Section

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Preliminary Stormwater Management Plan for the Proposed Truman Road Development in Halfmoon Bay, Sunshine Coast Regional District- PCSWMM RESULTS

Project Title: Truman Road Development

Project Location: East and north side of Truman Road

within the northshore area of Halfmoon Bay in the SCRD

Municipal Proj #:

Client: Halfmoon Bay Living Ltd.

Storm Sewer Design Criteria

Design Return Period: 100 YEAR

MANNINGS "n" 0.013 for PVC and Concrete Pipe
0.024 for CSP
0.035 for Ditches

CONSULTANT APLIN MARTIN

DITCHES AND STORM SEWER SIZED TO CONVEY 100-YEAR DESIGN STORM

APLIN MARTIN
ENGINEERING ARCHITECTURE PLANNING SURVEYING

A&M Proj # 22-100

Page: 1 of 1

Designed by: CZ

Checked by: CYC

Date: 4/18/2023

Locations			Sub-Catchments				Flow	Pipe Parameters							Model results			Pipe Type
Street	Manhole/Junction		Sub-Catchment No.	Tributary Area		Imperv Ratio*	Q_{100}							Pipe Capacity (Max/Full Flow)	Pipe Capacity (Max/Full Depth)	Remarks		
	From	To		ha	Sum ha	%	cms	S %	DIA mm	L m	n	Vfull m/s	Qfull cms	Q_{100}	Dep_{100} %	100 YEAR FLOW ROUTES		
Proposed Road	Node01	Node02	A1	1.43	1.43	31%	0.012	8.36	-	87.90	0.035	3.462	2.164	1.2%	1.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node02	Node03	A2	1.24	2.67	22%	0.022	5.06	-	66.03	0.035	2.694	1.684	2.2%	2.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node03	Node04	A3	0.28	2.95	62%	0.024	0.44	-	48.00	0.035	0.798	0.499	2.4%	8.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node04	Node05	A4	1.46	4.41	9%	0.036	9.38	-	12.96	0.035	3.669	2.293	3.6%	3.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
Truman Road	Node05	Node06	A5	4.60	9.02		0.074	12.89	-	27.75	0.035	4.301	2.688	7.4%	5.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node06	Node07	A6	0.13	9.15	66%	0.075	12.44	-	31.66	0.035	4.224	2.640	7.5%	5.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node07	Node08	A7	0.19	9.34	66%	0.076	10.90	-	52.44	0.035	3.954	2.471	7.6%	5.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node08	Node10	A8	0.45	9.79	62%	0.080	11.73	-	63.65	0.035	4.102	2.564	8.0%	5.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node09	Node10	A9	1.03	1.03	59%	0.008	10.72	-	106.67	0.035	3.921	2.451	0.8%	1.0%	IN DITCH	EXISTING DITCH	
Taylor Crescent	Node10	STMH03			10.82		0.088	18.21	250	33.59	0.024	2.800	0.137	8.8%	64.0%	IN PIPE	PROPOSED CULVERT UPGRADE	
	STMH03	STMH04	A10	0.31	11.13	75%	0.089	2.45	300	85.50	0.013	2.141	0.151	8.9%	59.0%	IN PIPE	PROPOSED SEWER	
	STMH04	OF1			11.13		0.089	13.01	300	55.97	0.013	4.934	0.349	8.9%	25.0%	IN PIPE	PROPOSED SEWER	
Proposed Road	Node11	Node12	A11	1.49	1.49	30%	0.012	6.84	-	95.43	0.035	3.132	1.957	1.2%	3.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node12	Node13	A12	0.93	2.42	29%	0.020	16.62	-	33.51	0.035	4.882	3.051	2.0%	3.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node13	Node14	A13	0.44	2.86	59%	0.023	12.83	-	32.14	0.035	4.290	2.681	2.3%	4.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node14	STMH02	A14	0.11	2.97	55%	0.024	11.14	-	64.96	0.035	3.997	2.498	2.4%	5.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
Easement	Node15	Node16	A15	0.21	0.20	55%	0.002	13.42	-	22.56	0.035	4.387	2.742	0.2%	2.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node16	STMH02	A16	0.20	0.41	55%	0.003	8.81	-	66.12	0.035	3.554	2.221	0.3%	5.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
Easement	Node17	Node18	A17	0.53	0.53	55%	0.004	0.94	-	32.08	0.035	1.158	0.724	0.4%	21.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node18	Node19			0.53		0.004	3.66	-	8.19	0.035	2.293	1.433	0.4%	11.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node19	Node20	A18	0.22	0.75		0.006	0.23	-	43.50	0.035	0.574	0.359	0.6%	60.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	Node20	STMH01			0.75		0.009	1.48	-	20.22	0.035	1.459	0.912	0.9%	33.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
	STMH01	STMH02	A19	0.31	1.06	80%	0.012	10.47	200	50.88	0.013	3.378	0.106	1.2%	11.0%	IN PIPE	PROPOSED SEWER	
	STMH02	Node22	A20	0.09	4.52	80%	0.037	16.58	200	44.37	0.013	4.251	0.134	3.7%	28.0%	IN PIPE	PROPOSED SEWER	
Truman Road	Node21	Node22	A21	0.23	0.23	55%	0.002	11.08	-	28.26	0.035	3.837	2.494	0.2%	0.0%	IN DITCH	PROPOSED ROADSIDE DITCH UPGRADE	
	Node22	HW02	A22	0.29	5.05	64%	0.041	10.11	-	66.85	0.035	3.808	2.380	4.1%	3.0%	IN DITCH	PROPOSED ROADSIDE DITCH UPGRADE	
Truman Road	Node23	Node24	A23	1.97	1.97	21%	0.016	11.25	-	70.02	0.035	4.016	2.510	1.6%	1.0%	IN DITCH	PROPOSED ROADSIDE DITCH UPGRADE	
	Node24	HW02	A24	0.49	2.46	57%	0.020	3.03	-	25.82	0.035	2.084	1.302	2.0%	3.0%	IN DITCH	PROPOSED ROADSIDE DITCH	
Crab Road	HW02	HW03			7.50		0.062	12.27	450	15.34	0.013	6.278	0.999	6.2%	6.0%	IN PIPE	PROPOSED CULVERT UPGRADE	
	HW03	OF3			7.50		0.061	9.32	-	50.98	0.035	3.656	2.285	6.1%	5.0%	IN DITCH	PROPOSED ROADSIDE DITCH UPGRADE	

* Impervious ratio based on area weighted imperviousness as follows:

Imperviousness
- *Residential Lots = 55%*
- *Road ROW = 75%*
- *Park = 20%*
- *Forest = 0%*

Soil Parameters (Green-Ampt)
- *Conductivity Rate= 60mm/hr*
- *Suction Head = 61.3mm*
- *Intial Moisture Deficit = 0.335*

Global Parameters
- *N Imperv = 0.015*
- *N Perv = 0.25*
- *Dstore Imperv = 1.5mm*
- *Dstore Perv (Lawns) = 5mm*
- *Dstore Perv (Forest) = 8mm*

** Ditch: H: the vertical height of the Trapezoidal Channel; W: the bottom width of the Trapezoidal Channel*

8.0 CONCLUSION AND RECOMMENDATION

The proposed SWMP has been developed for Truman Road residential development based on a comprehensive review of the existing condition of the area, the issues with the existing stormwater management system and the potential adverse impacts of the proposed development, a detailed hydraulic analysis conducted for the drainage system. The SWMP include the following storm infrastructures:

1. Proposed ditch system along the new road within the development site.
2. Proposed ditch system along the south property boundary from Ross Road to divert runoff from upper development lots east to the proposed drainage system on Truman Road and discharge to the ocean via ditch along Crab Way.
3. Proposed ditch upgrades along Truman Road and proposed storm sewer on Taylor Crescent.
4. Proposed source control measures for both onsite development lots and the roadways.

According to the modelling analysis results, under post-development condition, the runoff from the Project Site will have no negative impact to the neighbouring properties once proposed SWMP.is implemented. Where flow rates increase, the proposed downstream ditch upgrades along Truman Road and proposed storm sewer system on Taylor Crescent will not only provide safe conveyance of the runoff up to 100-year return period, but also solve the existing flooding issues noticed in the existing neighbourhood. Therefore, detention is not considered necessary for the Project Site.

It is recommended that the SWMP shall be implemented with the proposed development in conjunction with the site development implementation plans.

9.0 CLOSING

We trust the proposed SWMP for the Truman Road Development meets your current need. Please review and let us know if you have any questions and/or comments.

Yours truly,

APLIN & MARTIN CONSULTANTS LTD.

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Reviewed by:

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Senior Project Manager

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22-100 - Truman Road Stormwater Management Plan Report_Final.docx

STATEMENT OF LIMITATIONS

Aplin & Martin Consultants Ltd. prepared this report for Halfmoon Bay Living Ltd.. The material in this report reflects the best judgment of Aplin & Martin Consultants Ltd. in the light of the information available at the time of preparation. Any use of, or reliance placed upon, the material contained in this report by third parties, or decisions based upon this report are the sole responsibility of those third parties. Aplin & Martin Consultants Ltd. accepts no responsibility for damages suffered by any third parties as a result of decisions made, or actions taken, based upon information contained within this technical memorandum.

REVISION HISTORY

Revision	Date	Details	Name	Title
0	14-March-2023	Draft Report	Wendy Yao	Senior Project Manager
1	27-March-2023	1st Revised Draft Report	Wendy Yao	Senior Project Manager
2	06-April-2023	2nd Revised Draft Report	Wendy Yao	Senior Project Manager
3	21-April-2023	Final Report	Wendy Yao	Senior Project Manager

APPENDIX A:

Geotechnical Assessment Report

May 14, 2022 GES Project No. 22011

Attention: Halfmoon Bay Living Ltd

RE: PRELIMINARY GEOTECHNICAL & HAZARD ASSESSMENT REPORT UNDEVELOPED PROPERTY TRUMAN ROAD, HALFMOON BAY, SECHELT, BC

1.0 Introduction

As requested, GES Geotech Inc. (GES) carried out a site reconnaissance site visit on May 2, 2022. GES is providing this report, which includes a summary of the site reconnaissance fieldwork, a desktop review and the results of our subsequent geotechnical assessment, based on analysis of the available information. Our May 2022 site visit was comprised of a visual site investigation inclusive of the topography, vegetation, geomorphology, surficial geology, rocks conditions, water courses and groundwater related features, slope conditions, as well as general geotechnical conditions. The desktop review included the gathering of available information from sources such as Google Maps, geological maps, seismic data and the subsequent execution of slope stability analysis under static and seismic conditions. In preparing this report we had access to a January 1982 report by Golder Associates titled "Geotechnical Appraisal for Proposed Subdivision, Halfmoon Bay, Sechelt, BC" ("the 1982 Golder Report"); we have reviewed the 1982 Golder Report and, where appropriate, have included their findings and recommendations in our report. A copy of the 1982 Golder Report was received from our Client, Halfmoon Bay Living Ltd, whom may be contacted for access to the 1982 Golder Report.

2.0 Site Conditions

The legal description of the property is "Remainder of DL 2394, Group 1, NWD". The subject site is located approximately 18 km west of Sechelt and about 3 km west of Halfmoon Bay. Access to the site is obtained via the Sunshine Coast Road from Halfmoon Bay. The site is bounded to the north by un-surveyed Crown Land, and to the south, east and west by Truman Road; see Figure 1. The subject site is an irregular rectangular-shaped lot, having an average length of approximately 640m and a width of approximately 220m (in plan). The surface area of the site is approximately 140,000m^2 (14 ha). It is estimated

that approximately 50,000m^2 (5 ha) of the land surface is composed of rock scarps, steep slopes, as well as broken rocks, which require further geotechnical investigation prior to development.

The subject property is being proposed by the Client as a 50-lot subdivision, subject to the approval of the Sunshine Coast Regional District (SCRD). The areas located along the south, east and west boundaries of the property have already been developed. For the general layout of the subject site, see Figure 2.

Generally, the site consists of gentle slopes, relatively steep slopes, terraces, low rock scarps, and broken rocks. The ground grades and topographic characteristics of the subject land were established through our site visit, Google Earth data and other available information. The elevation of subject site varies from about 56m above sea level (ASL) at the north side of the property. Generally, the slope direction is from the mid-north towards the east, south and west. Beyond Truman Road towards the east, south and west boundaries of the property lie developments which are waterfront or have a water view of the ocean. The most dominant elevations are in range of 20-45m ASL. In general, the lot is a sloping area. Using Google Earth, we established six (6) cross sections in the north-south direction and several cross sections in the east-west direction for the assessment of slopes; see Figures 3 and 4. Based on our desk study and our May 2, 2022 site visit, the topography of land is dominated by slopes with grades ranging from 10% to almost 60%, with the predominant slope of about 20%. We estimate that more than 50% of the land's surface area has slope grades of about 15%-25%. For the topography of the subject land, see Figures 3 and 4, together with the attached Photos 1-5.

Vegetation at the subject site consisted of Douglas fir, cedar, and pine trees as well as underbrush including shrubs and small trees. Further, dense salal, juniper, ferns and mosses are also among the main vegetation observed. In the previously logged areas, many tree trunks were seen and it was noted that those logged areas are heavily overgrown. For the main vegetation of subject land, see Figure 6 and the photos attached at the back of this report.

3.0 General Geology

The majority of the subject land is covered with massive, intact, intrusive igneous rocks. The rocks are mainly granite, granodiorite and diorite. The representative feature of the subject land is exposed bedrock. Much stress relief joining can be seen in the igneous rocks. The igneous rocks of the site are mostly single-body sound, fissured, multiple-body and very fissured poly-body rocks. The granitic rocks are grey and coarse-grained, with high to very high strengths. In some areas, there are weathered rocks having various thicknesses estimated between 1-2m. The compression strength of the granitic rocks is estimated as about 80-120MPa. There are also sharp rock scarps with heights of about 4-5m. Finally, some few granular soils accumulation can be seen in gullies and depression areas. For the geology of the subject land, see Figure 5 and attached Photos 1-5.

4.0 Geomorphology

Predominantly rock mass and rock exposure, exposed bedrock, rocky terraces having relatively smooth to steep slopes, low rock scarps and broken rocks are among the main geomorphological features of the subject land. Also seen in some locations are irregular blocky ground, locally-broken rounded glacially eroded shoreline, very blocky broken shoreline, and broken gullies between scarps. Blasted rocks along access roads, marginally stable blocks, relatively loose blocks having sliding potential, loose surface rocks at toe of some terraces, rock outcrops, smooth slopes and shallow hollows are also among the geomorphological features of the subject site.

5.0 Groundwater

We estimated the groundwater level as about 5-6 m below existing ground level (BEGL), based on the following considerations:

1. Our site visit that did not observe any evidence of spring or wet areas.
2. Assessment of existing vegetation such as the presence of Douglas fir trees which are associated with deeper groundwater levels.
3. Assessment of conditions of igneous rocks fissures, single-body sound rocks, as well as fissured and multiple-body rocks along with very fissured poly-body rocks within the property.
4. Available information regarding groundwater conditions in the Halfmoon Bay area.

6.0 Geotechnical Site Conditions

From a geotechnical perspective, the site can be divided into five zones:

1. Massive intact rock areas
2. Loose surface rock areas
3. Broken rock areas
4. Terraced areas
5. Rock scarp areas

Zone 1: Massive Intact Igneous Rock Areas

Massive, intact, granitic rocks cover more than 60% of the subject property with a little soil or rock cover. From a geomorphological point of view, the massive intact zone corresponds to the rounded or terraced areas, having smooth surfaces. The slopes in this zone mostly have about 15%-25% grade. However, in some locations there are steeper slopes, up to about 50% or more. In our professional opinion, this zone is developable area with conventional engineering approaches regarding foundations and other geotechnical aspects. For the general conditions of Zone 1, see Photo 1.

Zone 2: Loose Surface Rock (Block) Areas

The second geotechnical feature of land is loose surface, mostly granitic, rock block areas. This geotechnical feature covers about 10%-15% of the land area. From a geomorphological perspective, the Loose Surface Rock (Block) Areas are mostly located

along gullies and also at the foot of some slopes. The slopes' grade in this zone are generally greater than about 20%. In some locations, the slopes are steeper, reaching up to about 40%-60% in this zone. In our professional opinion, this zone is mostly undevelopable, unless measures are taken including the removal of most of the loose rock blocks, and setting the foundations on very stable large rock blocks or on lower intact rocks. For the general conditions of Zone 2, see Photo 2.

Zone 3: Broken Rock Areas

The third geotechnical feature of the subject property is broken, mostly granitic, rock blocks zone. The weight of some rocks in the broken rock zone is more than 3 tonnes, within the range of approximately 3-10 tonnes. This geotechnical feature covers about 5%-10% of the subject property's surface. From a geomorphological point of view, the broken rock zone is situated mostly at the foot of slopes in the lower elevations of the property. The slope grades in this zone are typically more than about 20%. In some locations, steeper slopes up to about 40%-60% can be observed as well. In our professional opinion, this zone is mostly undevelopable land, unless mitigation strategies are undertaken including removing most of the broken rocks, and setting the foundations on very stable large rock blocks or on lower intact rocks. For the general conditions of Zone 3, see Photo 3.

Zone 4: Smooth Surface Terraced Areas

The fourth geotechnical feature within the property is a smooth surface terraced zone. This geotechnical feature covers about 5%-10% of the subject land surface. From a geomorphological point of view, the smooth surface terraced zone is situated along the local trails and in some cases downslope of steep scarps. The slopes in these areas have about 5%-15% grade. In our professional opinion, the smooth surface terraced zone is mostly developable land. For the general conditions of Zone 4, see Photo 4.

Zone 5: Rock Scarps Areas

The fifth geotechnical feature of the subject property is rock scarps some with sliding potential. The weight of some rocks in this zone may reach up to 10 tonnes or more. We estimate that this geotechnical feature covers a maximum of about 5% of the land surface. From a geomorphological point of view, the rock scarps with sliding potential are mostly at the crest of some slopes. The slopes' angle in this zone may reach over 60%. In our professional opinion, this zone is generally undevelopable land, unless there is the removal of the large sliding rock masses or the application of extensive geotechnical mitigation measures such as elaborate rock nailing, anchors and heavy grouting, or similar mitigation techniques which will have to be developed at a later date, in the event that the approved subdivision development includes Zone 5 areas. For the general conditions of Zone 5, see Photo 5.

Entire Property (Zones 1-5)

Other than the areas where we are of the view that development is not deemed generally appropriate from a geotechnical perspective, namely Zones 2, 3 and 5, the majority of the site falls under Zones 1 and 4, which are developable without any mitigation measures

being required. Zones 1 and 4 make up approximately two-thirds of the property. Zones 2, 3 and 5 make up approximately one-third of the site; mitigation measures that would result in enabling development to proceed include rock bolting and rock anchoring, although other appropriate mitigation techniques which are not part of our current scope of work.

7.0 Seismic Considerations

Based on the subject site's latitude and longitude of 49.512 and -123.932 and as per the 2015 National Building Code of Canada for the 2% in 50 years' probability of occurrence (1 in 2,400-year return period), the Peak Ground Acceleration (PGA) and Peak Ground Velocity (PGV) values are as follows:

- PGA = 0.355g
- PGV = 0.551m/s
- Sa (0.2) = 0.808g, Sa (0.5) = 0.735g and Sa (1.0) = 0.443g

Based on the findings from our May 2, 2022 site visit, geology and available geology maps, Soil Class for the subject property, which is underlain by mostly mass granitic rocks, is estimated to be Class A, B and C for different locations. For seismic considerations regarding the subject site, see Figure 7.

8.0 Slope Stability Analysis

Since the subject land is a sloping property, assessment of slope stability and Partial Risk Rating are highly important regarding any further developments at the subject site. In general, the slopes in the subject site are stable. Although we witnessed that there is no considerable previous instability at the site, we also rarely witnessed any small scale localized instabilities either. Due to the importance of slope conditions for future development, we assessed the slope conditions at the subject site within our site visit. Further, we carried out the required desk study work in this regard.

In the absence of legal survey plans for the property at the time of writing this report, we used Google Earth to establish several slope profiles; the representative slopes of the site were derived, and can be seen in Figures 3 and 4. To assess the stability of the existing slopes, we carried out several slope stability analyses under both static and seismic conditions for a number of representative slope cross-sections. For the results of the slope stability analysis under static and seismic conditions for a number of representative slopes across the site, see Figures 8 and 9, and Tables 1 and 2. The results of our slope stability analysis under static conditions show that the factors of safety for the smooth slopes zone, within the range 15%-50%, are more than 2, which is indicative of "very low" Partial Risk Rating under static conditions. For seismic conditions, the Partial Risk Rating for slopes with a grade of 15%-50% is "very low" and for slopes with 60% is "low"; see Figure 9, and Tables 1 and 2.

Table 1: Slopes and Slope Stability Analysis Results under Static and Seismic Conditions

No.	Slope Gradient	Factor of Safety (Static Conditions)	Factor of Safety (Seismic Conditions)	Partial Risk Rating
1	20%	4.77 > 2	3.19	"Very Low" for static and seismic conditions
2	30%	3.41 > 2	2.28	"Very Low" for static and seismic conditions
3	40%	2.49 > 2	1.77	"Very Low" for static and seismic conditions
4	50%	2.10 > 2	1.55	"Very Low" for static and seismic conditions
5	60%	2 > 1.88 > 1.5	1.33 > 1.1	"Low" for static and seismic conditions

Table 2: Partial Risk Rating Table

Definations of the qualitative partial risk ratings in Static Condition

	Rating	Criteria
Partial Risk to Structure under Static Condition P(HA)	Very Low	Fs >= 2.0
	Low	1.5 =< Fs < 2.0
	Moderate	1.3 =< Fs < 1.5
	High	1.1 =< Fs < 1.3
	Very High	Fs < 1.1

Definations of the qualitative partial risk ratings in Seismic Condition

	Rating	Criteria
Partial Risk to Structure under Seismic Condition P (HA)	Low	Fs >= 1.1
	Moderate	1.0 =< Fs < 1.1
	High	0.9 =< Fs < 1.0
	Very High	Fs < 0.90

Specific Risk Matrix based on combined values of Vulnerability and Partial Risk Ratings

		Vulnerability Rating		
		Low	Moderate	High
Partial Risk Rating	Very Low	Very Low	Very Low	Low
	Low	Very Low	Low	Moderate
	Moderate	Low	Moderate	High
	High	Moderate	High	Very High
	Very High	High	Very High	Extreme

9.0 Conclusions and Recommendations

1. From a geotechnical point of view, future residential development in most parts of the subject site would be considered safe.
2. The geotechnically safe areas include the relatively flat terraced areas having relatively smooth bedrock features, and the relatively gentle slopes having grades less than about 50%.

3. The areas having potentially high scarped rock are not recommended for development, unless this is undertaken with extensive geotechnical investigations and correspondingly effective hazard mitigation measures. We understand that during a past public information meeting for the proposed subdivision project, a question was raised that the southwest corner of the property would require a development permit due to the presence of geotechnical hazards. Based on our May 2022 site reconnaissance, we believe that the subject (southwest) corner of the property corresponds to the first two photos that are depicted in Photo 5 of this report. That being the case, we are of the professional opinion that the southwest corner of the property poses a geotechnical hazard due to the orientation of the jointing of the rock, which is inclined with an unfavourable dip towards Truman Road.
4. For each individual lot a separate geotechnical investigation is recommended, and this shall be part of the scope of further geotechnical work once authority(ies) having jurisdiction (AHJ) determine the approval of the number of lots within the proposed 50-lot subdivision.

10.0 Limitations

The recommendations presented in this report are based on GES's interpretation and understanding of the site conditions, our May 2, 2022 site reconnaissance, the desk review, slope stability and partial risk rating analysis results, and other available information. To properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the report in its entirety. We cannot be held responsible for use, by any party, of portions of the report without reference to the whole report.

11.0 Closure

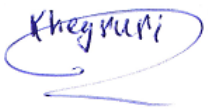
This report has been prepared following generally accepted geotechnical engineering principles and practice. The main purpose of this report was to describe the extent of geotechnical hazards and carry out Slope Stability Analysis and Partial Risk Rating to help ascertain how much of the subject property may be safely developed. This report has been completed for the exclusive use of Halfmoon Bay Living Ltd (c/o Will Dong, PEng) for their project located along Truman Road in Halfmoon Bay, BC. Any use of the information contained in this report by third parties or for other than the intended purpose must *first* be approved in writing by GES.

We trust the information presented in this report meets your immediate requirements. Should you have any questions, please do not hesitate to contact us.

Yours truly,

GES GEOTECH INC – A Slate Holdings Company
EGBC Permit: 1001508

Prepared by:



Z. (Parviz) Kheyruri, MSc
Senior Geotechnical Specialist

Reviewed by:

Mahmoud Mahmoud, PhD, PEng, FEC, FGC (Hon)
President

Attach:

- Figures 1-9
- Photos 1-5

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220514RF Preliminary Geotechnical & Hazard Assessment Report - Truman Road, Halfmoon Bay, BC.docx

Figure 1: Location of Subject Site

Figure 2: Subject Property's Layout

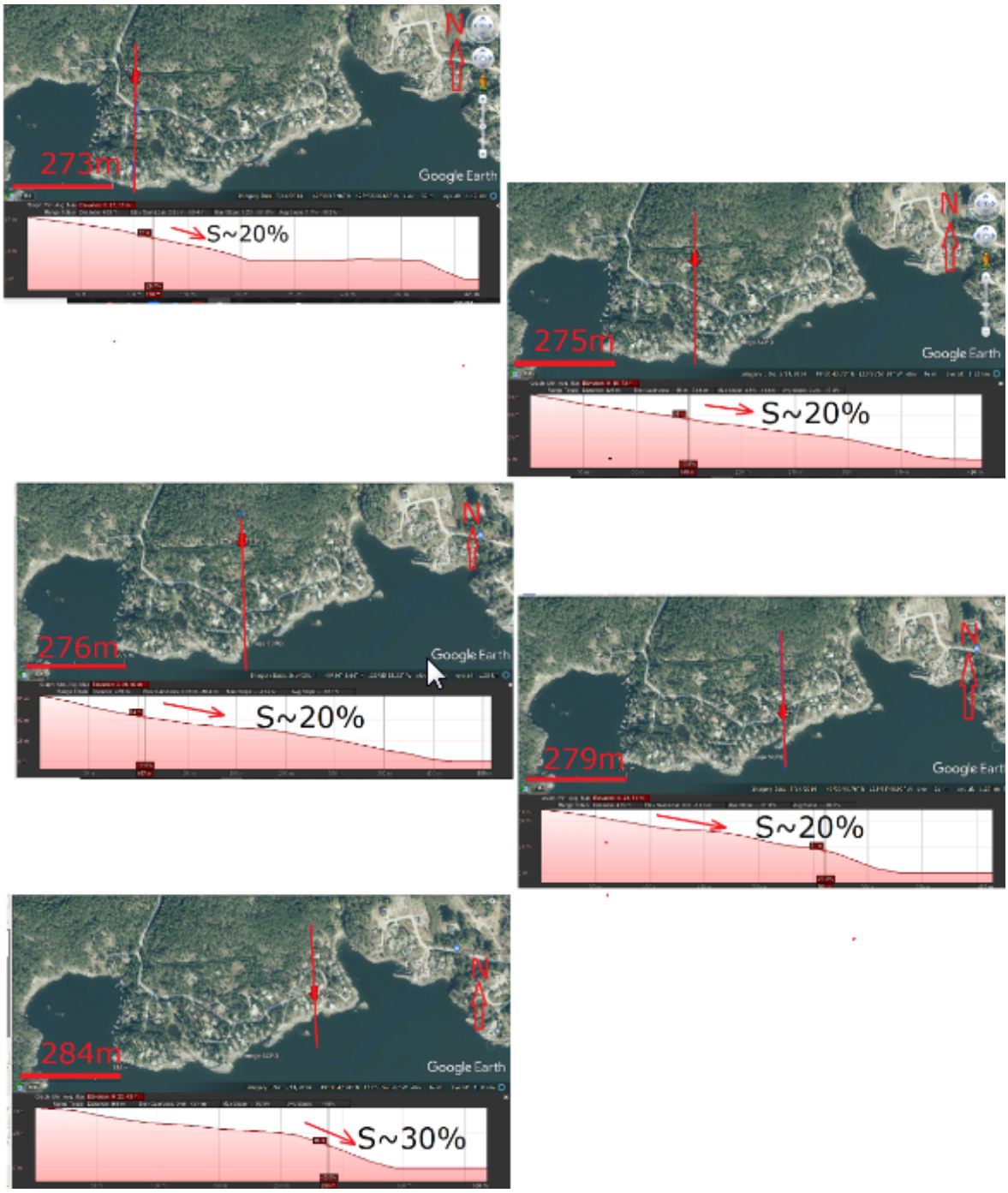


Figure 3: Subject Site's Slope Profiles in North-South Direction, Obtained Using Google Earth

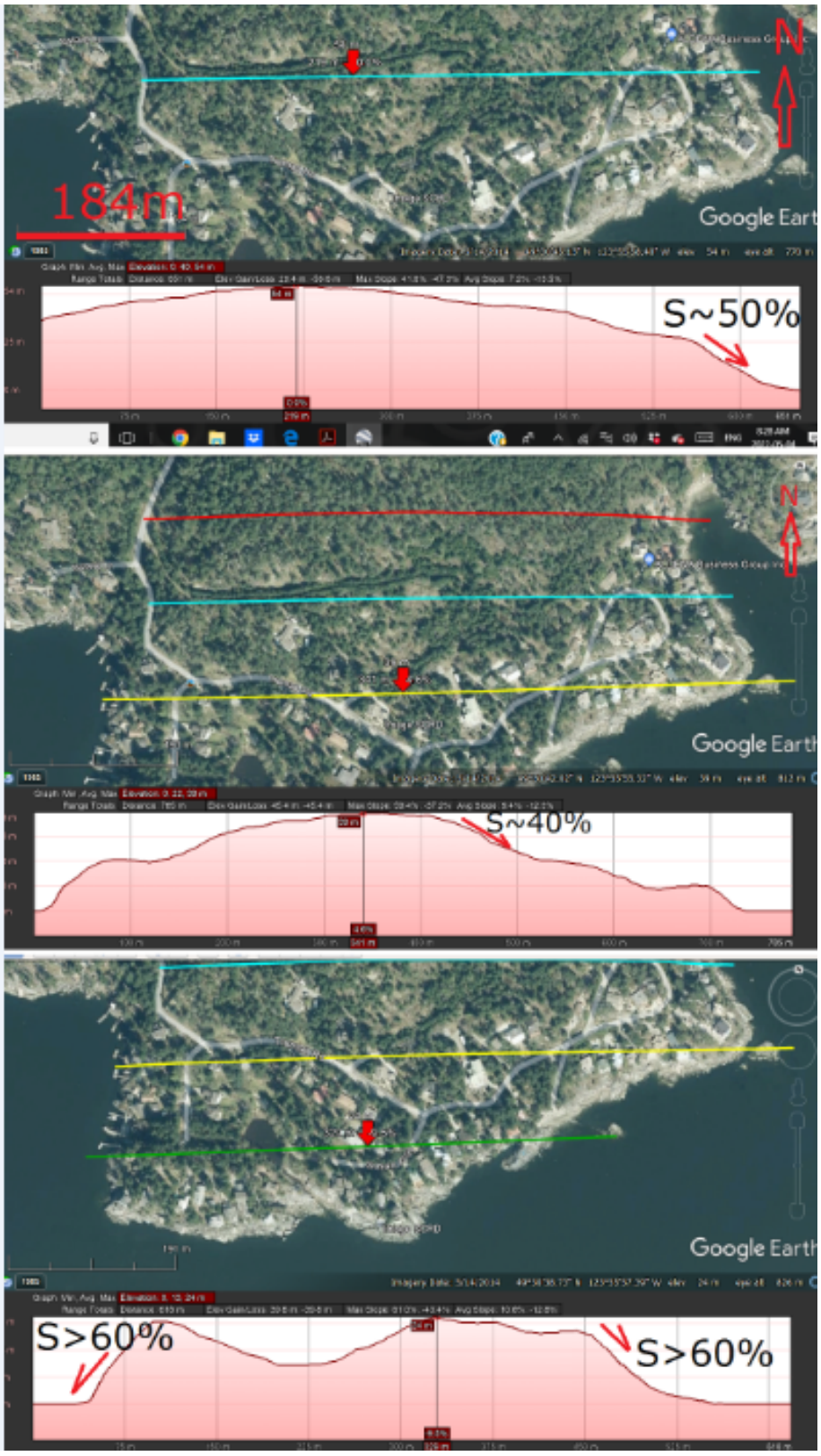


Figure 4: Subject Site's Slope Profiles in West-East Direction, Obtained Using Google Earth

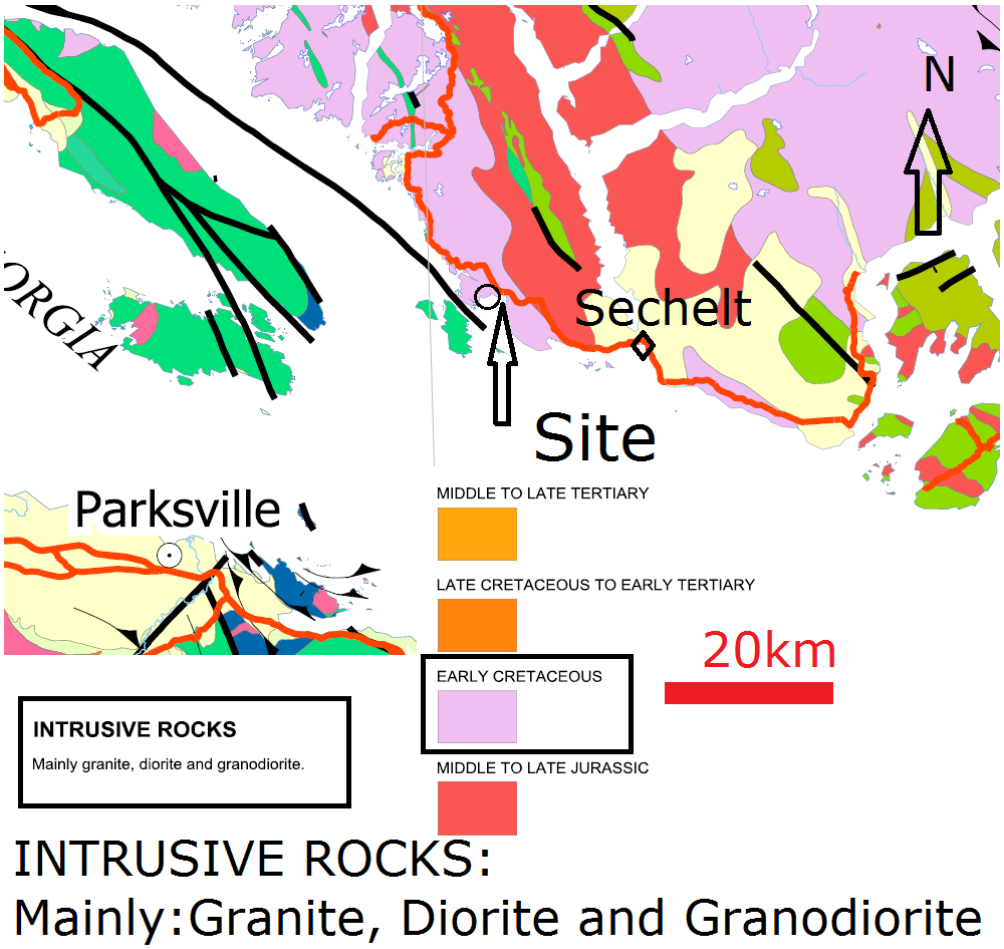
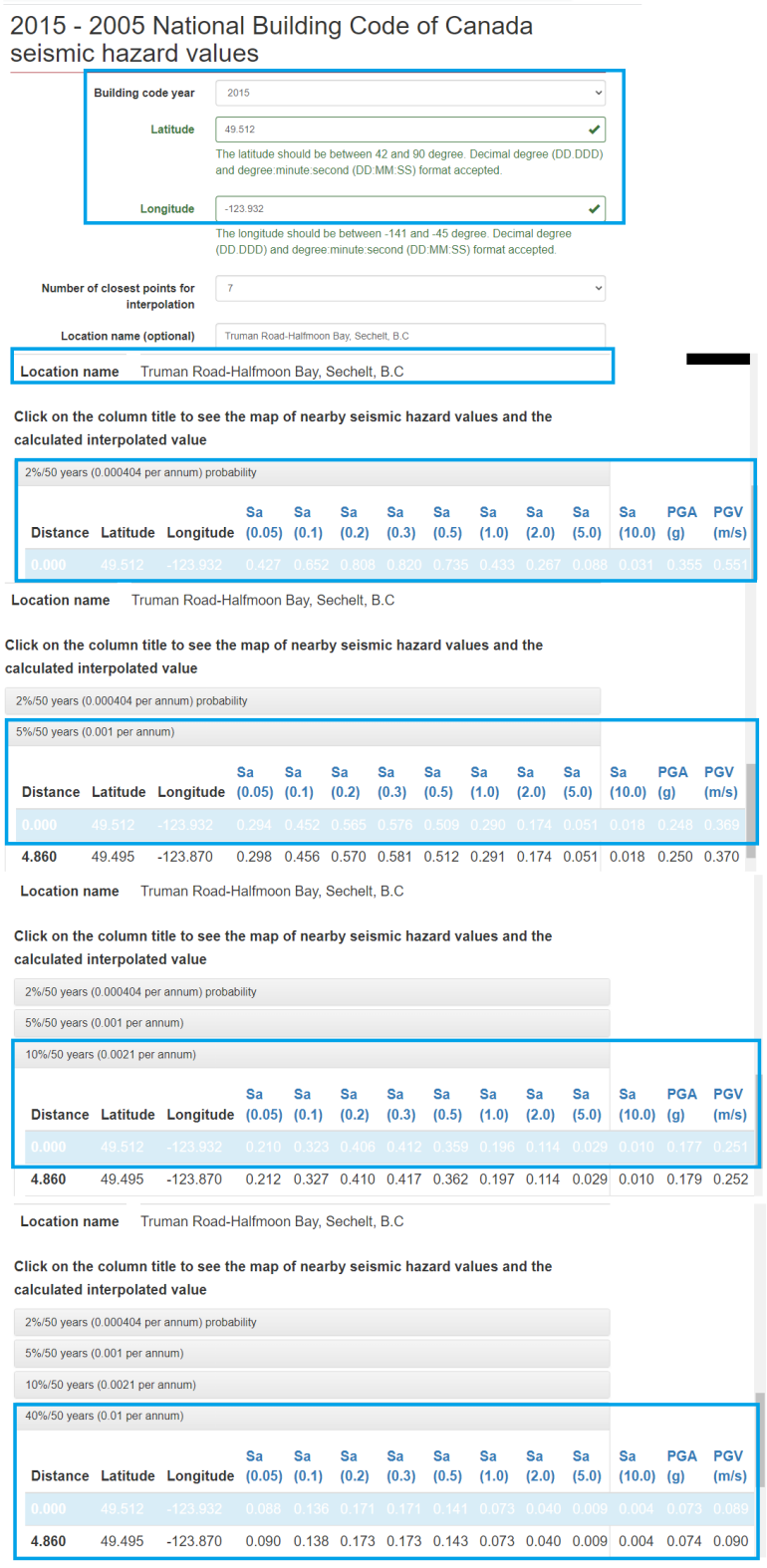


Figure 5: Site's Geology

Figure 6: Site's Vegetation Regarding Douglas Fir Trees



2015 - 2005 National Building Code of Canada seismic hazard values

Building code year: 2015

Latitude: 49.512

The latitude should be between 42 and 90 degree. Decimal degree (DD.DDD) and degree:minute:second (DD:MM:SS) format accepted.

Longitude: -123.932

The longitude should be between -141 and -45 degree. Decimal degree (DD.DDD) and degree:minute:second (DD:MM:SS) format accepted.

Number of closest points for interpolation: 7

Location name (optional): Truman Road-Halfmoon Bay, Sechelt, B.C

Location name Truman Road-Halfmoon Bay, Sechelt, B.C

Click on the column title to see the map of nearby seismic hazard values and the calculated interpolated value

2%/50 years (0.000404 per annum) probability

Distance	Latitude	Longitude	Sa (0.05)	Sa (0.1)	Sa (0.2)	Sa (0.3)	Sa (0.5)	Sa (1.0)	Sa (2.0)	Sa (5.0)	Sa (10.0)	PGA (g)	PGV (m/s)
0.000	49.512	-123.932	0.427	0.652	0.808	0.820	0.735	0.433	0.267	0.088	0.031	0.355	0.551

Location name Truman Road-Halfmoon Bay, Sechelt, B.C

Click on the column title to see the map of nearby seismic hazard values and the calculated interpolated value

2%/50 years (0.000404 per annum) probability

5%/50 years (0.001 per annum)

Distance	Latitude	Longitude	Sa (0.05)	Sa (0.1)	Sa (0.2)	Sa (0.3)	Sa (0.5)	Sa (1.0)	Sa (2.0)	Sa (5.0)	Sa (10.0)	PGA (g)	PGV (m/s)
0.000	49.512	-123.932	0.294	0.452	0.565	0.576	0.509	0.290	0.174	0.051	0.018	0.248	0.369
4.860	49.495	-123.870	0.298	0.456	0.570	0.581	0.512	0.291	0.174	0.051	0.018	0.250	0.370

Location name Truman Road-Halfmoon Bay, Sechelt, B.C

Click on the column title to see the map of nearby seismic hazard values and the calculated interpolated value

2%/50 years (0.000404 per annum) probability

5%/50 years (0.001 per annum)

10%/50 years (0.0021 per annum)

Distance	Latitude	Longitude	Sa (0.05)	Sa (0.1)	Sa (0.2)	Sa (0.3)	Sa (0.5)	Sa (1.0)	Sa (2.0)	Sa (5.0)	Sa (10.0)	PGA (g)	PGV (m/s)
0.000	49.512	-123.932	0.210	0.323	0.406	0.412	0.359	0.196	0.114	0.029	0.010	0.177	0.251
4.860	49.495	-123.870	0.212	0.327	0.410	0.417	0.362	0.197	0.114	0.029	0.010	0.179	0.252

Location name Truman Road-Halfmoon Bay, Sechelt, B.C

Click on the column title to see the map of nearby seismic hazard values and the calculated interpolated value

2%/50 years (0.000404 per annum) probability

5%/50 years (0.001 per annum)

10%/50 years (0.0021 per annum)

40%/50 years (0.01 per annum)

Distance	Latitude	Longitude	Sa (0.05)	Sa (0.1)	Sa (0.2)	Sa (0.3)	Sa (0.5)	Sa (1.0)	Sa (2.0)	Sa (5.0)	Sa (10.0)	PGA (g)	PGV (m/s)
0.000	49.512	-123.932	0.088	0.136	0.171	0.171	0.141	0.073	0.040	0.009	0.004	0.073	0.089
4.860	49.495	-123.870	0.090	0.138	0.173	0.173	0.143	0.073	0.040	0.009	0.004	0.074	0.090

Figure 7: Site's Seismic Conditions

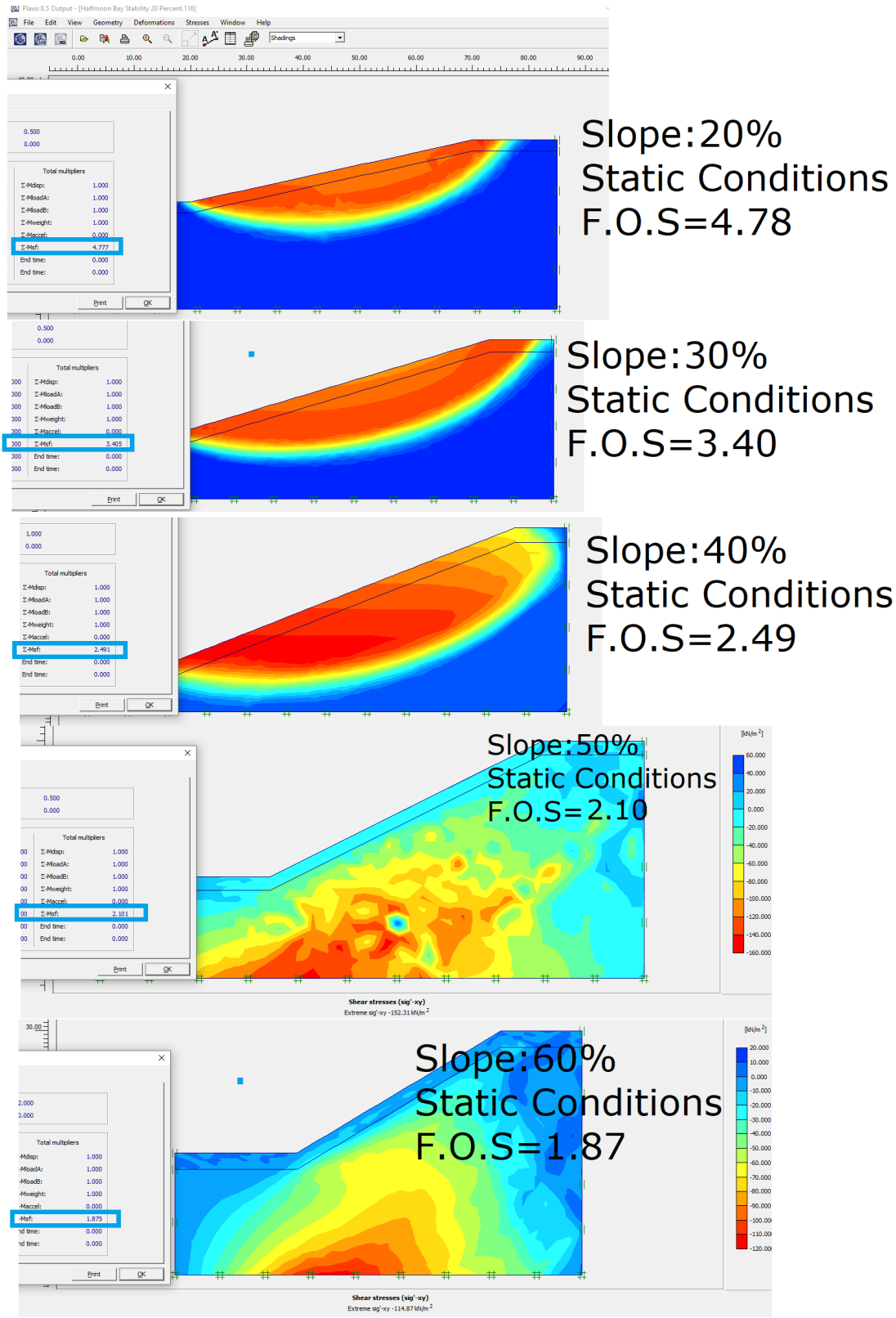


Figure 8: Slope Stability Analysis Results under Static Conditions for Different Slope Gradients

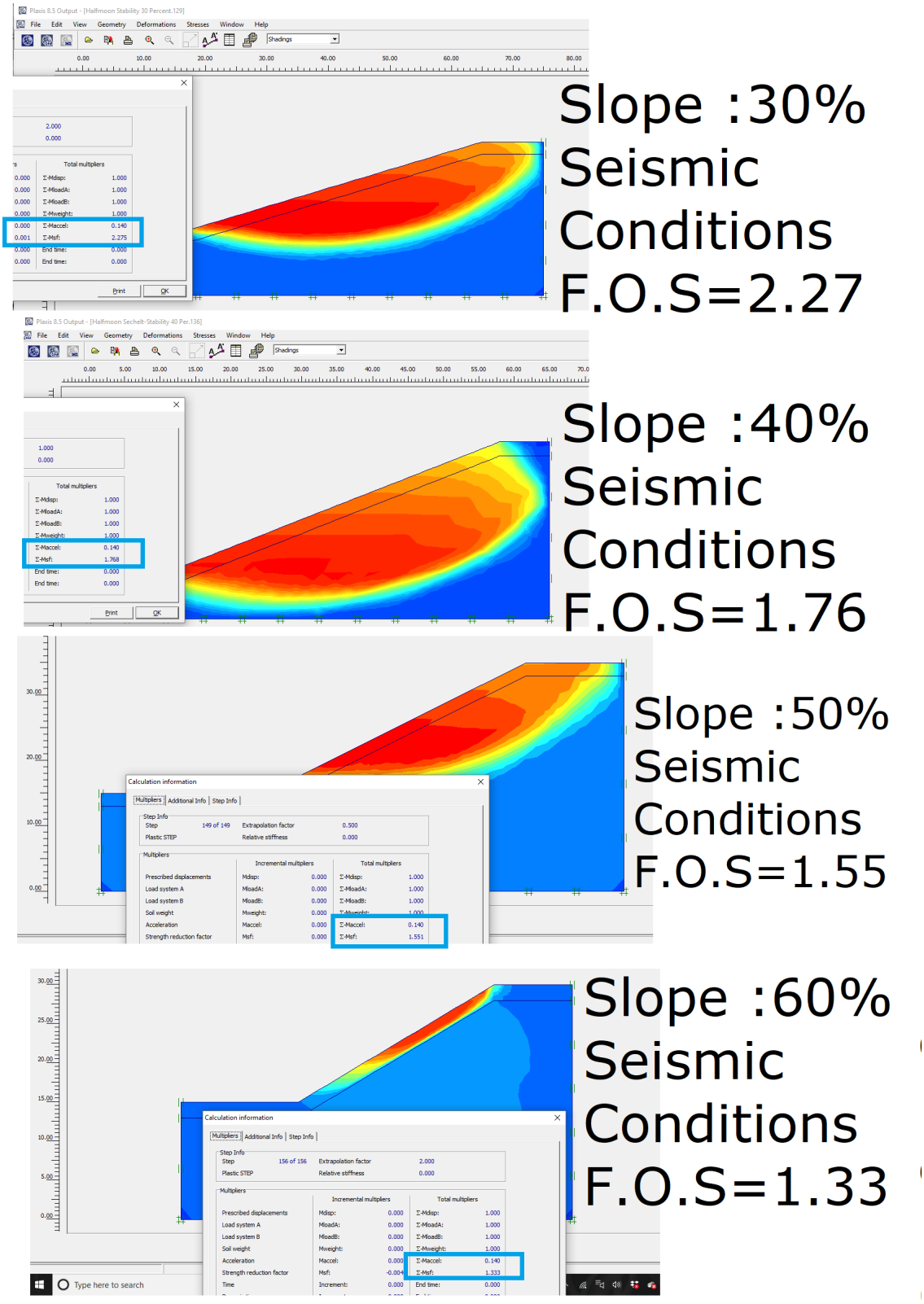


Figure 9: Slope Stability Analysis Results under Seismic Conditions for Different Slope Gradients

Photo 1: Massive Intact Granitic Rock Zone ("Zone 1")

Photo 2: Loose Surface Rock Blocks Zone ("Zone 2")

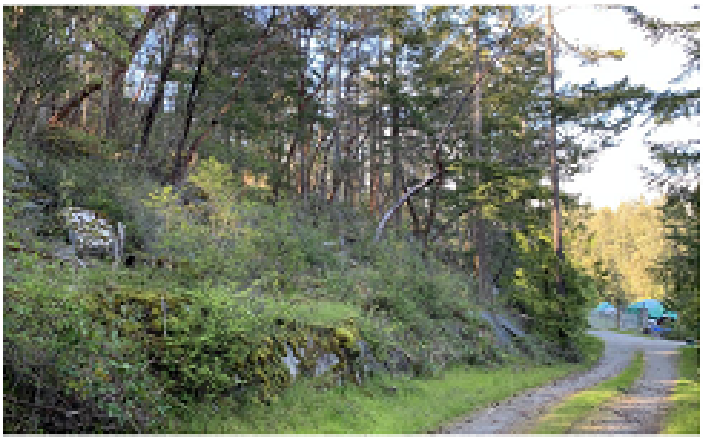


Photo 3: Broken Rock Zone (“Zone 3”)

Photo 4: Smooth Surface Terraced Zone ("Zone 4")

Photo 5: Rock Scarps Zone with Sliding Potential ("Zone 5")

September 10, 2022 GES Project No. 22011

Attention: Will Dong, PEng, Tudor Project Ltd

Re: **FOLLOW-UP GEOTECHNICAL & HAZARD ASSESSMENT REPORT**
UNDEVELOPED PROPERTY
TRUMAN ROAD, HALFMOON BAY, BC

1.0 Introduction

As requested, GES Geotech Inc. (GES) conducted a second (follow-up) site reconnaissance on August 3, 2022. The first site reconnaissance took place on May 2, 2022 and its report has already been issued to the Client. Authorization to Proceed with this second site reconnaissance and reporting was provided by our Client, Will Dong, PEng, via text messages dated August 1, 2022.

2.0 Scope of Work

The second (follow-up) site reconnaissance was carried out by GES on August 3, 2022, to provide more detailed geotechnical information, focusing on lots located on Ross Road. The assessment included a site walkover and site reconnaissance, with particular focus on reviewing the existing site conditions along Ross Road. In addition, the information contained in the 1982 Golder Report was closely scrutinized, and pertinent information has been included in a site plan in this report for the sake of completeness.

3.0 Site Reconnaissance and Findings

We started our August 3 site visit by carrying out a walkover survey along Ross Road; see Figure 2. Once we reached the end of the subject property line, we hiked up to investigate the upper lots; see Figure 3. After that, we went over the lots along Truman Road; see Figure 1. Figure 4 shows the information included in Figures 1, 2 and 3, thus easing reference to all the pertinent geotechnical information collected and summarised from our August 3 detailed site reconnaissance.

During this site reconnaissance, we came across two test pits with a depth of around 3’ below ground surface (BGS) that had been excavated by others in the past, at some point in time prior to our arrival at the site. Neither of these two test pits was excavated by GES. After investigating the subsoils profiles at these two test pits, we found evidence of previous

historical rock sliding and general ground movement. The subsoils of these two test pits consisted of sands, gravels, and cobbles; see Photos 5 and 6 in Figure 2. Later, based on anecdotal information received from Will Dong (PEng), we were made aware that these test pits were dug to complete percolation testing.

Furthermore, on August 25, 2022 we received anecdotal information from Will Dong (PEng) regarding some construction done in the 90s, as well as percolation testing completed by INF Planning and Design Corporations (INF).

INF completed percolation testing on September 16, 2021 with Sunco Civil Consulting Ltd. 11 holes were dug to over 4’ deep. The results of the percolation testing show that the soil found was sandy gravel with a percolation rate of 2” per minute.

Attached herein are also two maps of all the information provided by the map included in the 1982 Golder Report, the details of which were reviewed and verified; see Figures 5 and 6.

4.0 Limitations

The recommendations presented in this report are based on GES's interpretation and understanding of the site conditions, the two test pits that had been excavated by others in the past, and information provided by our Client for the proposed development. To properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the report in its entirety. We cannot be responsible for use, by any party, of portions of the report without reference to the whole report.

5.0 Closure

This report has been prepared following generally accepted geotechnical engineering principles and practice. The main purpose of this report was to describe the subsurface soil and groundwater conditions and to provide Geotechnical Recommendations for the subdivision of the subject lot. This report has been completed for the exclusive use of Tudor Project Ltd for their project located Truman Road, Halfmoon Bay, BC. Any use of the information contained in this report by third parties or for other than the intended purpose must first be approved in writing by GES.

We trust the information presented in this report meets your immediate requirements. Should you have any questions please do not hesitate to contact us.

GES GEOTECH INC – A Slate Holdings Company
EGBC Permit: 1001508

Prepared by: Reviewed by:

Erfan Adeshi

Erfan Adeshi
Engineering Intern

Mahmoud Mahmoud, PhD, PEng, FEC, FGC (Hon.)
President

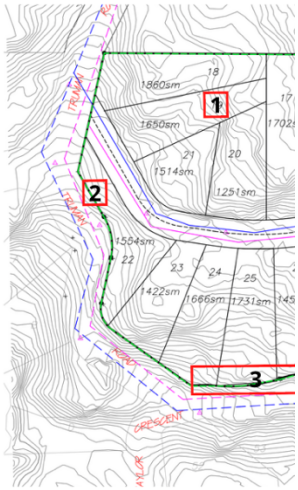
Attach:
- Figures 1-6

EA/MM/ea

20220910R - Tudor Project Ltd - Halfmoon Bay.docx

1 Rock terraces

2 Rock scarps. Evidence of significant potential for a future rock slide.



3 Rock scarps. Evidence of significant potential for a future rock slide. Joints present (Marked pink on the previous plan provided by GES, June 24, 2022)

Figure 1: Map of the subject site, focused on Truman Rd.
Overlay done by GES.

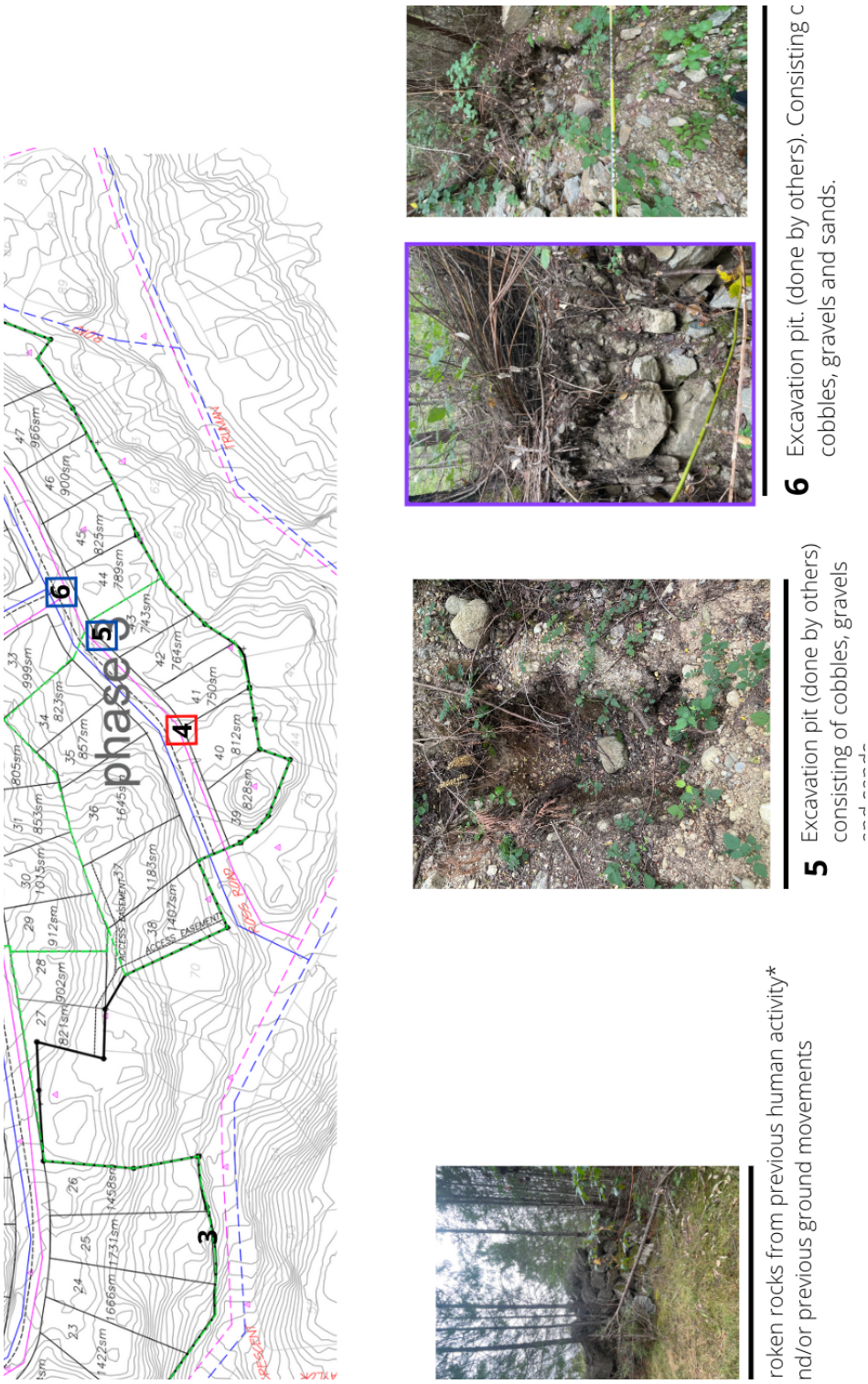


Figure 2: Map of the subject site, focused on Ross Rd.
Overlay done by GES.

Figure 3: Map of the subject site, focused on the upper lots.
Overlay done by GES.

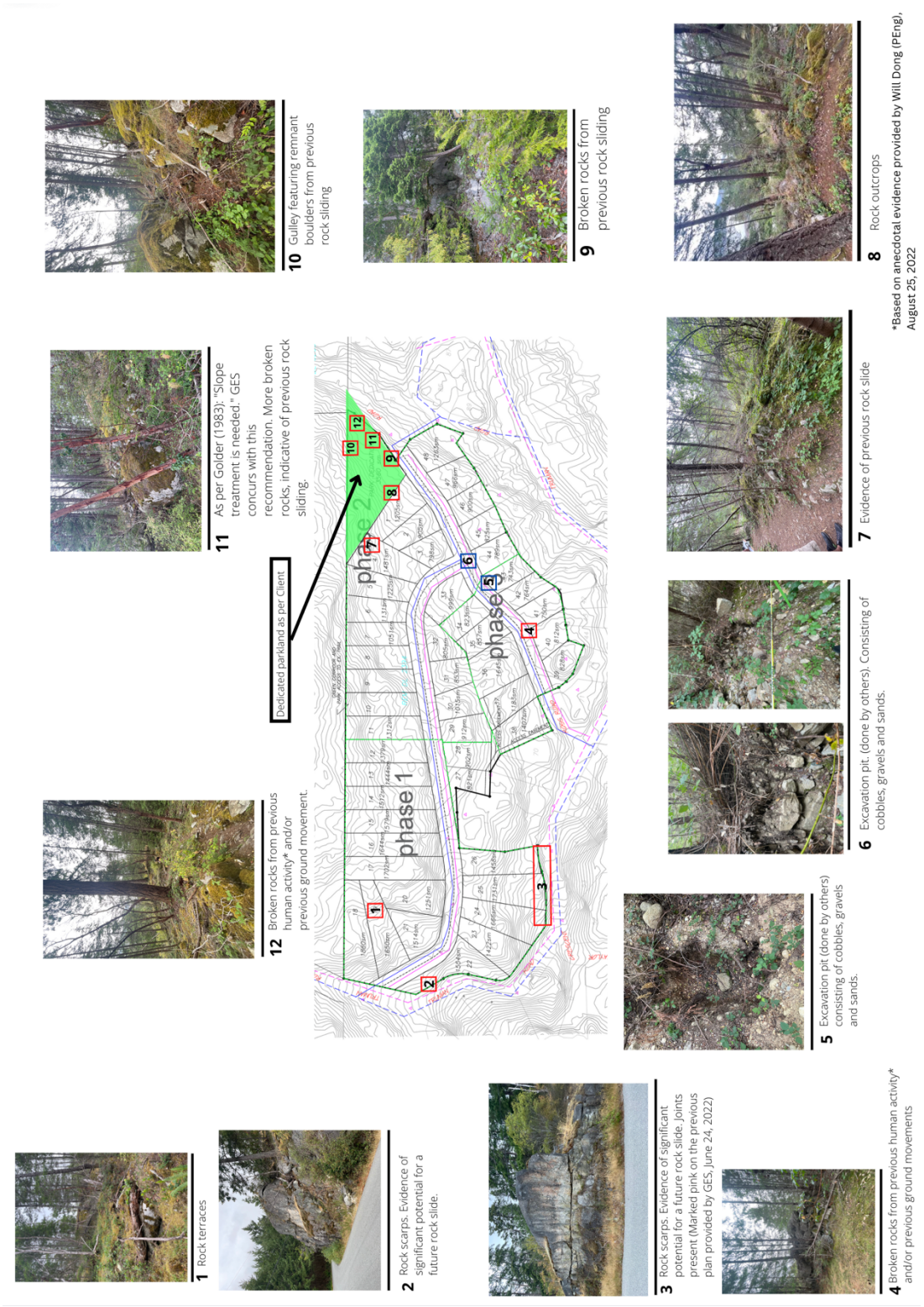


Figure 4: Map of the subject site (incorporating Figures 1-3).
Overlay done by GES.

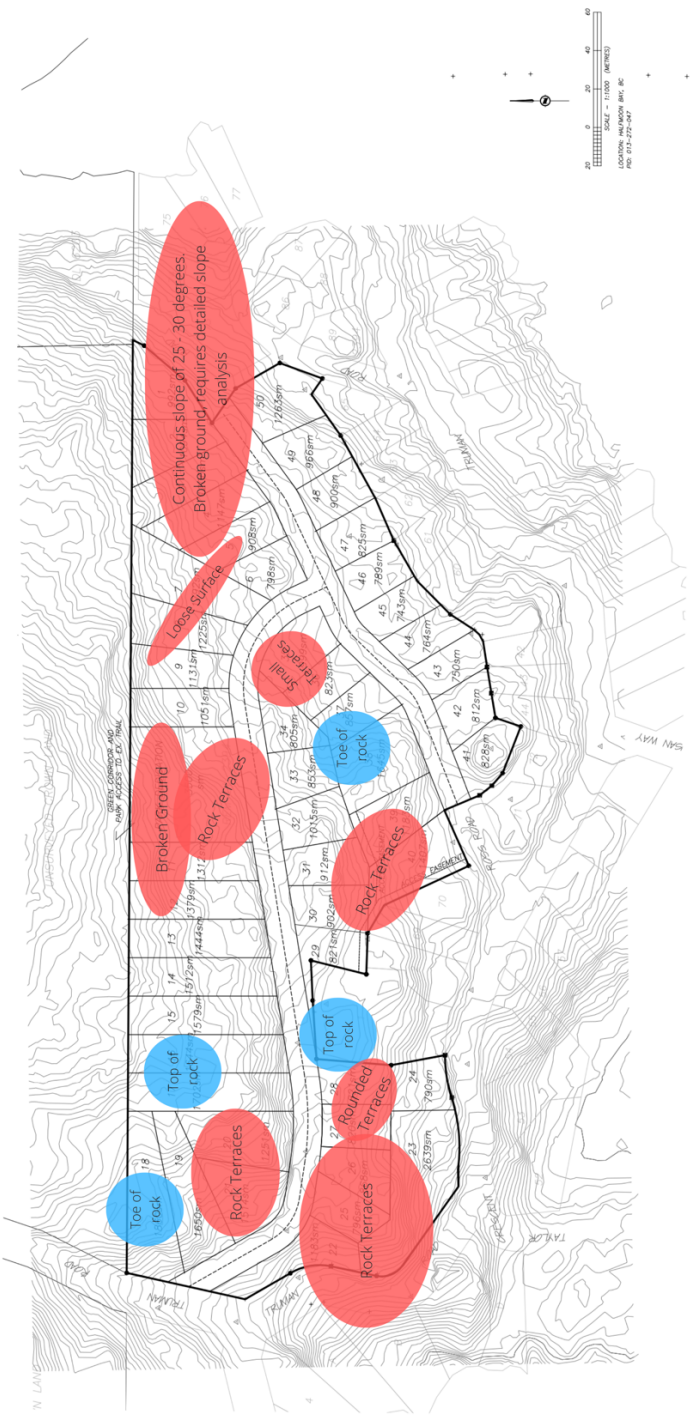


Figure 5: Enhanced version of the 1982 Golder Map, as summarized and verified by GES.

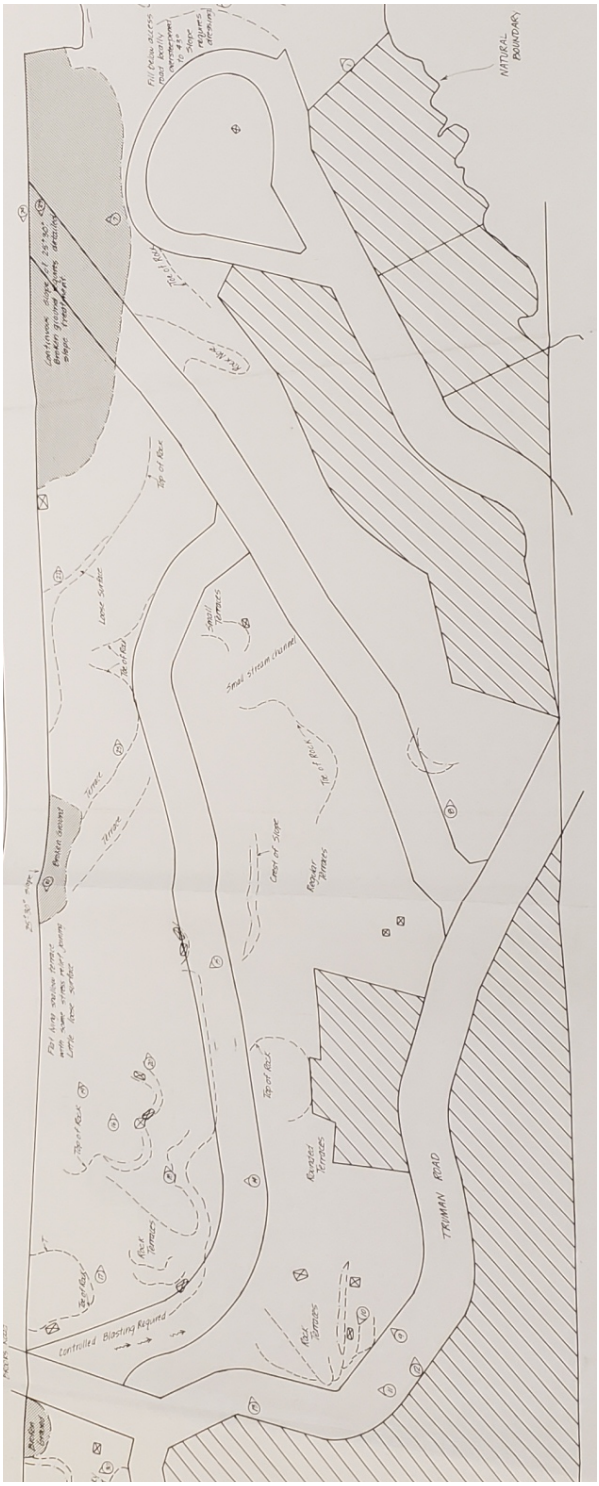


Figure 6: Original Copy of the 1982 Golder Map,
showing Pertinent Geological Features Mapped by Golder.

APPENDIX B:

Environmental Management Report

Truman Road Development Project
Environmental Management Plan

Halfmoon Bay Living Ltd.

TRITON
Environmental Consultants

#650, 1040 West Georgia Street, Vancouver, BC V6E 4H1 | tel 604 631 2211 | fax 604 631 2213 | triton-env.com

Revision History and Approvals			
Project Name		Truman Road Development Project	
Project Number		11471	
Report Title		Environmental Management Plan	
Document #		V5453	
Report Author(s)		Aegean Chan, E.I.T., B.ASc., BC-CESCL	
Date	***Version***	***Review Type***	***Reviewed by***
October 18, 2022	Draft	Peer	Michelle Dobson
October 20, 2022	Draft	Senior	Scott Everett
October 21, 2022	Draft	Document	Marilyn Fransen
October 26, 2022	0	Client	Will Dong

Disclaimer

This report is rendered solely for the use of Halfmoon Bay Living Ltd. (the Owner) in connection with the Truman Road Development Project (the Project), and no person may rely on it for any other purpose without Triton Environmental Consultants Ltd.'s prior written approval. Should a third party use this report without Triton's approval, they may not rely upon it. Triton accepts no responsibility for loss or damages suffered by any third party as a result of decisions made or actions taken based on this report.

This report is based on facts and opinions contained within the referenced documents, including the results of any data collection programs carried out in relation to this report. We have attempted to identify and consider facts and documents relevant to the scope of work, accurate as of the time period during which we conducted this analysis. However, the results, our opinions, or recommendations may change if new information becomes available or if information we have relied on is altered.

We applied accepted professional practices and standards in developing and interpreting data. While we used accepted professional practices in interpreting data provided by the New Owner or third-party sources, we did not verify the accuracy of any such data.

This report must be considered as a whole; selecting only portions of this report may result in a misleading view of the results, our opinions, or recommendations.

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Appendix 1. Tree Location Plan

1.0 Introduction

1.1 Purpose and Contents of the EMP

This Environmental Management Plan (EMP) provides information that outlines environmentally sensitive aspects of the proposed Project and provides mitigation and monitoring measures aimed at reducing or eliminating environmental impact at all levels of the Project or activity.

This EMP outlines the scope of work identified by the Project Owner (the New Owner) and provides an overview of the proposed Project works. A Bio-Assessment Report (Triton 2021a) and a Feasibility Study Report (Triton 2021b) have been completed by a Triton Senior Wildlife Biologist for site visits conducted on August 24, 2021 and October 21, 2021, respectively. A Feasibility Study – Ecological Community Assessment (Triton 2022) was completed by a Triton Vegetation Ecologist on May 17, 2022. The site-specific information and specific environmental mitigation plans for the New Owner in this EMP include:

- A summary of environmental conditions and issues that must be addressed during construction;
- Specific controls/mitigation measures to minimize impact on the environment resulting from activities to be conducted by the New Owner;
- Aquatic Resources Mitigation Plan;
- Vegetation Management Plan; and
- Wildlife Management Plan.

2.0 Project Location and Description

Halfmoon Bay Living Ltd. (the New Owner) is considering the purchase of a partially developed 7.0 hectare property for the purposes of developing a subdivision near Halfmoon Bay on the Sunshine Coast of south coastal British Columbia (BC). The property was initially subdivided in the 1970s with approximately 75 houses constructed on 90 lots throughout the 1970s and 1980s. During this period, plans to construct a road through the proposed subdivision began with clearing and blasting a path through the site (Triton 2021b). This unfinished road exists as a 6-metre wide trail extending east-west from the west side of the property on Truman Road near Natalie Lane for approximately 350 m into the site where it then curves southwest to meet Ross Road. The surrounding property was developed into existing houses during the previous few phases in the 1970s to 1980s after which further development was halted in 1993. The previous owner has now decided to sell the lot. The footprint of the proposed Project runs, generally, west to east between both ends of Truman Road (Rd.) and is bordered on the north side by the forest, while the southern side is bordered by where Truman Rd. meets Natalie Lane, Taylor Crescent, Ross Rd., and Truman Loop.

The New Owner is proposing to subdivide the property into smaller parcels, requiring a rezoning application be submitted to the Sunshine Coast Regional District (SCRD) to amend the Official Community Plan. The site is a second growth forested area within the Coastal Douglas-fir (CDFmm) biogeoclimatic subzone that has been logged multiple times over the years. A geotechnical assessment conducted in 1981 described the site as exposed bedrock consisting of granite and a series of rock terraces formed by erosion during the last glacial period (Golder Associates 1982). There is little accumulation of granular soils anywhere on the property and the vegetation is typically shallow-rooting pines, firs, and underbrush.

Triton Environmental Consultants Ltd. (Triton) was retained by the New Owner for the proposed Project, to prepare this Environmental Management Plan (EMP). This EMP is a dynamic document that may need to be updated throughout the duration of the proposed Project to address the construction activities and environmental mitigations to be implemented.

3.0 Proposed Project Works

Proposed Project activities are expected to occur in the following sequence:

Pre-construction activities:

- Kick-off meeting
- Approval of Project documentation

The proposed Project consists of roadwork, utility placement, surveying, and construction of residential lots. In addition, a functional ditch along the east side of Truman Rd. upslope of the property entrance and a culvert under the property access road were proposed to be installed to reduce erosion. The general nature of the work to be carried out for the development consists of, but is not necessarily limited to, the following:

- Mobilization to site
- Clearing and grubbing
- Surveying
- Grading
- Installation of temporary erosion and sediment control measures
- Excavation earthworks
- Installation of sanitary sewer and waterworks
- Paving
- Traffic management
- Quality management
- Demobilization
- Clean-up and site restoration

4.0 Environmental Sensitivities

4.1 Aquatic Resources

There is one unidentified stream to the east of the Project site which starts just south of the Sunshine Coast Highway and flows southeasterly past Brooks Rd., curves toward the southwest, and passes to the west of Jorgensen Dr. and joins Halfmoon Bay (PoBC 2022). This stream is located approximately 75 m east of the proposed Project boundary. There is an unidentified lake/lagoon to the south/southwest, approximately 120 m from site. An unidentified stream connects this lake with Halfmoon Bay.

Halfmoon Bay is approximately 200 m south of the Project area and 83 m to the east of the Project (PoBC 2022). However, there are no watercourses from the site leading to the water body. On the west side of the Project area, Square Bay is approximately 68 m from the site. Similarly, there are no watercourses leading from the site to Square Bay (PoBC 2022). No other watercourses were noted in the immediate vicinity of the Project area.

4.2 Mammals

During the first two Triton site visits (for the Bio-Assessment and Feasibility Study), only a Douglas Squirrel (*Tamiasciurus douglasii*) was seen, although it is likely that the site is also used or occupied by other rodents, mustelids (weasels, mink), and insectivores such as shrews and bats. Black Bear (*Ursus americanus*) scat was seen within the site at two locations, and a bedding area was also found (Triton 2021a). Scat of Columbian Black-tailed Deer (*Odocoileus hemionus columbianus*) was observed at multiple locations during the Triton May 2022 site visit, and scat of Roosevelt Elk (*Cervus elaphus roosevelti*) was seen in the upper portion of the site (Triton 2022). Discussions with the neighbour indicate that Coyote (*Canis latrans*), and Grey Wolf (*Canis lupus*) have also been observed on the property (Triton 2021a).

4.3 Reptiles and Amphibians

A Northern Alligator Lizard (*Elgaria coerulea*) was seen during the Triton May 2022 site visit, outside the upper eastern property boundary (Triton 2022). While the site occurs within the range of several amphibian species including *Species at Risk Act* (SARA) Special Concern species such as the Western Toad (*Anaxyrus boreas*) and Northern Red-legged Frog (*Rana aurora*), these species would likely only occur randomly while they move through the site, given the lack of any freshwater habitat and proximity to breeding ponds (Triton 2021a). In addition, there is no suitable aquatic habitat beyond the Project site for amphibians to breed, so it is unlikely that other species occurring within the area such as the Rough-skinned Newt (*Taricha granulosa*), Northwestern Salamander (*Ambystoma gracile*), and Long-toed Salamander (*Ambystoma macrodactylum*) are likely to move into the site (Triton 2021b).

Nearby residents have reported seeing gartersnakes, which could be any of BC's three species – Common Gartersnake (*Thamnophis sirtalis)*, Western Gartersnake (*T. elegans)*, or Northwestern Gartersnake (*T. ordinoides*), in the area (Triton 2021b). These species may still occur at the site but should not affect Project development unless a hibernaculum is

discovered, in which case a relocation salvage may be required to avoid contravention of the BC *Wildlife Act*. None of the wildlife species or wildlife signs observed during the Triton Bio-Assessment, Triton Feasibility Study, and Triton Ecological Community Assessment site visits were uncommon for the area and none are considered to be Species at Risk.

4.4 Invertebrates

Triton noted mussels (*Mytilus* sp.), cockles (likely *Clinocardium sp*.), a Dungeness Rock Crab shell (*Cancer magister*), and Acorn Barnacles (*Belanus glandulus*) within the intertidal zone, but an intertidal survey was not conducted (Triton 2021a). There are no Species at Risk invertebrates (e.g., insects, arachnids, crustaceans, mollusks) known to occur at the Site or in close proximity (PoBC 2022).

4.5 Birds

There were 21 bird species detected during the site assessments (Table 1). None of the birds observed indicated any behavioural cues reflective of nesting. No sensitive species or Species at Risk were detected.

Table 1. Bird species detected during the Triton Feasibility Study and Ecological Community Assessment

#	*Common Name*	*Scientific Name*
1	American Robin	*Turdus migratorius*
2	Anna's Hummingbird	*Calypte anna*
3	Canada Goose	*Branta canadensis*
4	California Gull	*Larus californicus*
5	Cedar Waxwing	*Bombycilla cedrorum*
6	Chestnut-backed Chickadee	*Poecile rufescens*
7	Common Raven	*Corvus corax*
8	Dark-eyed Junco	*Junco hyemalis*
9	Golden-crowned Kinglet	*Regulus satrapa*
10	Gull	*Larus* sp.
11	Hairy Woodpecker	*Dryobates villosus*
12	Northern Flicker	*Colaptes auratus*
13	Pacific Slope Flycatcher	*Empidonax difficilis*
14	Pileated Woodpecker	*Dryocopus pileatus*
15	Red-breasted Nuthatch	*Sitta canadensis*
16	Red-tailed Hawk	*Buteo jamaicensis*
17	Spotted Towhee	*Pipilo maculatus*
18	Steller's Jay	*Cyanocitta stelleri*
19	Swainson's Thrush	*Catharus ustulatus*
20	Yellow-rumped Warbler	*Setophaga coronata*
21	Western Tanager	*Piranga ludoviciana*

4.6 Plants

A complete list of plants observed during the Triton Feasibility Study and Ecological Community Assessment site visits is provided in Table 2. The forest along the upper north portion of the property was determined to be made of two community types: (1) a young, closed-canopy forest in the middle of the property, and (2) a more mature, very open forest along the rest of the northern perimeter that is characterized by widely spaced, large diameter Douglas-fir trees, and an open forest canopy with numerous gaps and sub-dominant arbutus and young regenerating western redcedar (Triton 2022).

The Triton Ecological Community Assessment report notes the sizes of large, older Douglas-fir trees observed near the eastern property boundary and at sporadic locations along the northern property boundary (Triton 2022).

Table 2. Plant, moss, and lichen species observed during Triton Feasibility Study and Ecological Community Assessment

Species Type	*Common Name*	*Scientific Name*
Tree	Arbutus	*Arbutus menziesii*
Tree	Bigleaf maple	*Acer macrophyllum*
Tree	Douglas-fir	*Pseudotsuga douglasii*
Tree	Lodgepole pine	*Pinus contorta*
Tree	Red alder	*Alnus rubra*
Tree	Western redcedar	*Thuja plicata*
Shrub	Baldhip rose	*Rosa gymnocarpa*
Shrub	Cotoneaster	*Cotoneaster* sp.
Shrub	Dull Oregon-grape	*Berberis nervosa*
Shrub	Kinnikinnick	*Arctostaphylos uva-ursi*
Shrub	Oceanspray	*Holodiscus discolor*
Shrub	Red huckleberry	*Vaccinium parvifolium*
Shrub	Salal	*Gaultheria shallon*
Shrub	Saskatoon berry	*Amelanchier alnifolia*
Shrub	Scotch broom	*Cytisus scoparius*
Shrub	Snowberry	*Symphoricarpous albus*
Shrub	Trailing blackberry	*Rubus ursinus*
Shrub	Twinflower	*Linnea borealis*
Shrub	Western trumpet honeysuckle	*Lonicera ciliosa*
Forb	Bigrooted geranium	*Geranium macrorhizum*
Forb	Black raspberry	*Rubus leucodermis*
Forb	Bracken fern	*Pteridum aquilinum*
Forb	Chickweed monkeyflower	*Mimulus alsinoides*
Forb	Cleavers	*Gallium aparine*
Forb	Common wood sorrel	*Oxalis acetosella*
Forb	Dandelion	*Taraxicum* spp.
Forb	Dovefoot geranium	*Geranium molle*
Forb	English ivy	*Hedera helix*

Species Type	Common Name	Scientific Name
Forb	Green spleenwort	*Asplenium viride*
Forb	Hairy cat's ear	*Hypochaeris radicata*
Forb	Herb robert	*Geranium robertianum*
Forb	Himalayan blackberry	*Rubus armeniacus*
Forb	Liquorice fern	*Polypodium glycyrrhiza*
Forb	Meadow alumroot	*Heuchera chlorantha*
Forb	Meadow death-camas	*Zigadenus venenosus*
Forb	Northwestern twayblade	*Neottia banksiana*
Forb	Parsley fern	*Cryptogramma crispa*
Forb	Plantain	*Plantago sp.*
Forb	Purple peavine	*Lathyrus nevadensis*
Forb	Rattlesnake plantain	*Goodyera oblongata*
Forb	Sea blush	*Plectritus congesta*
Forb	St. John's wort	*Hypericum* sp.
Forb	Small flowered blue-eyed mary	*Collinsia parvifolium*
Forb	Small-flowered alumroot	*Heuchera micrantha*
Forb	Small-flowered nemophila	*Nemophila parviflora*
Forb	Spikemoss	*Selaginella* sp.
Forb	Sword fern	*Polystichum munitum*
Forb	Wild strawberry	*Fragaria virginiana*
Forb	Yarrow	*Achillea millefolium*
Forb	Yellow monkeyflower	*Mimulus guttatus*
Graminoid	Rush	*Juncus* or *Luzula* sp.
Graminoid	Sedge	*Carex* sp.
Lichen	Reindeer lichen	*Cladina portentosa*
Moss	Fork moss	*Dicranum sp.*
Moss	Haircap moss	*Polytrichum sp.*
Moss	Oregon beaked moss	*Kindbergia oregana*
Moss	Step moss	*Hylocomium splendens*

4.7 Species at Risk

There are several species listed as *at-risk* under Federal (SARA and COSEWIC) or Provincial (BC *Wildlife Act*) legislation that are known to occur within the vicinity of the Project area (Table 3 to Table 5) (PoBC 2022).

Table 3. List of SARA, COSEWIC, and BC *Wildlife Act* Amphibians, Mammals, and Reptiles

Taxa	Scientific Name	COSEWIC	SARA	BC Wildlife Act
Northern Red-legged Frog	*Rana aurora*	Special concern	Special concern	Blue
Western Painted Turtle	*Chrysemys picta*	Threatened/ Special concern	Threatened/ Special concern	-
Western Toad	*Anaxyrus boreas*	Special concern	Special concern	Yellow

A desktop search also noted critical habitat for Western Painted Turtle (*Chrysemys picta*) within 1 km to the northwest at Trout Lake and 400 m to the southwest at the border of Francis Point Provincial Park (Triton 2021a). This species will likely not occur in the Project area due to distance, lack of any freshwater aquatic habitat or other connectivity to the site, and unfavourable terrain (i.e., paved roads) inhibiting overland movement.

Table 4. List of COSEWIC, *SARA*, and *BC Wildlife Act* Birds

Taxa	*Scientific Name*	*COSEWIC*	*SARA*	*BC Wildlife Act*
Marbled Murrelet	*Brachyramphus marmoratus*	Threatened	Threatened	Blue

Table 5. List of COSEWIC, SARA, and BC Wildlife Act Plants

Taxa	*Scientific Name*	*COSEWIC*	*SARA*	*BC Wildlife Act*
Douglas-fir / dull Oregon-grape	*Pseudotsuga menziesii / Mahonia nervosa*	-	-	Red
Grand fir / three-leaved foamflower	*Abies grandis / Tiarella trifoliata*	-	-	Red

4.8 Site History and Contamination

A site visit was conducted by INF Planning and Design Corporation (INF) on November 5, 2021, to confirm site conditions (INF 2021). The property was partially developed and a road approximately 6 m wide with two side ditches was built by the previous developer. The INF report mentioned three main geotechnical conditions on the property which matched the findings in Golder's report. The previous owner confirmed with the New Owner that the site conditions remained the same since the 1980s (INF 2021).

A soil test was conducted by INF with Sunco Civil Consulting Ltd. on September 16, 2021. Eleven test pits were dug to 0.3 m deep, covering an area of approximately 4,046 m^2. The soil was sandy gravel, and no contamination was found. INF (2021) indicates that current site conditions are consistent with assessments conducted by Golder in the 1980s. The findings in the Golder report did not find any site contamination and only noted the area was extensively logged several times, but "…no undue ground disturbance has been effected…" (Golder Associates 1982).

5.0 Environmental Protection and Mitigation Measures

5.1 Aquatic Resources

Since there are no freshwater habitats at the site (e.g., wetlands, streams, ditches), there are no issues associated with freshwater fish or amphibian breeding. There are no mitigation measures recommended at this time.

5.2 Vegetation Management Plan

A tree location plan was prepared by the New Owner, noting large diameter tree locations, and is attached in Appendix 1. The New Owner has indicated that only tree 24 will be removed. All other trees noted in the plan will be protected. In addition, the New Owner has planned to include a 5-m protection setback zone from the north property line from lot 17 to lot 4 (west to east), and protection for the park dedication area. It is recommended that a certified arborist conduct a survey to verify that ample space has been designated for the long-term health of trees planned for protection.

Workers will minimize the potential for negative impacts to native vegetation during construction-related activities through implementation of mitigation measures such as the following:

- Minimize visual impact on existing vegetation to preserve natural landscape features by limiting vegetation clearing.
- No trees should be cut down unless stated in the Tree Clearing Permit. Precautions should be taken to prevent damage to existing trees and shrubs, protect branches, foliage, trunks and stems, and prevent machinery from travelling over roots within the 'dripline' of the trees by placing and maintaining snow fencing around each tree outside of the 'dripline'. Excavated material should not be piled within the dripline of existing trees.

5.2.1 Clearing and Grubbing

The New Owner does not anticipate any clearing or grubbing will take place during the regional bird nesting season. The nesting season for species known to occur in the area is between March 1 and August 30 (Birds Canada, 2022).

Raptors such as Bald Eagle and some owl species may nest prior to this window, so it would be prudent to conduct a raptor nest survey prior to any vegetation clearing occurring from mid-January onward, particularly for Bald Eagles, given the proximity to Gerrans Bay and previous observations of Bald Eagles at the site (Triton 2021a). If a Bald Eagle nest is found, mitigation measures will follow the *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia* (MFLNRO 2013), as raptor nests are protected year-round under Section 34 of the BC *Wildlife Act*, regardless of whether the nest is active (i.e., occupied).

Care must be taken to protect and preserve all vegetation outside of the clearing boundary to reduce the amount of vegetation clearing required for the Project to the greatest extent possible. Trees within SCRD can only be cleared with a Tree Cutting Permit issued by the SCRD. For those trees permitted for removal, and shrubs and grasses to be grubbed within the Project area, the following measures to mitigate these potential impacts will be adhered to:

- All clearing and/or grubbing will extend only to the designated limits defined in the Project.
- Limits of clearing and grubbing will be marked on-site with established flagging tape conventions or barriers, as per the Tree Location Plan, to ensure clarity on 'no-go-zones' to prevent clearing beyond Project limits.
- Prior to the commencement of land clearing activities, construction personnel should familiarize themselves with the environmental requirements and acceptable construction practices associated with the Project.
- Trees cleared or protected will be consistent with the Project's Tree Clearing permit.
    - Trees designated to be protected will be done so in accordance with Tree Cutting Permit Bylaw No. 350.
    - Tree protection will remain in place until the Project clean-up phase or otherwise approved by SCRD.

5.2.2 Invasive Plant Management

Best management practices (BMPs) to ensure that noxious weed and invasive plants are not spread or propagated throughout the construction areas include the following:

- All equipment will be washed clean of soil, seeds, and plant parts prior to entering the site at the start of the Project. All equipment will be inspected for soil/seeds/plant parts when the Project is completed, and any organic material will be removed prior to equipment leaving site.
- Any removed invasive species will be properly transported and disposed of at an approved facility.
- Soil disturbance will be minimized and disturbed areas re-vegetated as quickly as possible.
- If possible, staging and laydown areas will not be located in infested areas.
- Any observation of an invasive plant or noxious weed is to be reported to the designated Project Environmental Monitor (EM). Coordinates will be taken and these sites will be flagged and reported to the Invasive Alien Plant Program (IAPP).
- The Contractor is responsible for inspecting any mulch supplies, should they be used, to ensure they are weed-free.
- Straw (mulch) sources shall be certified weed-free, and visually inspected prior to application to ensure no invasive plant seeds are present. Hay shall not be used as mulch unless it is from a local area demonstrated to be free of invasive species.

5.3 Wildlife Management Plan

Both the Federal *Migratory Bird Convention Act* and BC *Wildlife Act* prohibit the disturbance of birds, nests, or eggs. Work crews should be aware that, except for crows, nests of raptors and herons are protected year-round, active or inactive, under both Acts, and that disturbance to the birds, whether adults, chicks, or eggs, including harassment, flushing, or other stress, is a regulatory violation. Contravention of these acts will be avoided by scheduling clearing outside of sensitive life-history timing periods (e.g., the bird breeding period), or by conducting non-intrusive bird nesting surveys prior to and during construction within the bird breeding period.

It is important that work crews follow general BMPs regarding birds on-site, including the following:

- Be vigilant for birds and bird nests.
- Do not damage, destroy, remove, or disturb any active bird nests.
- Nests under construction (i.e., no eggs or chicks present) are considered to be active and live. If adult birds are present, they cannot be intentionally flushed from the nest. The designated Project Qualified Environmental Professional (QEP) should be contacted about any nests discovered or suspected.

In the absence of a QEP, if any nests, or birds displaying nesting behaviour (e.g., carrying nesting material or food in their mouths), are observed within the site or in close proximity to areas potentially affected by Project activities (i.e., within 30 m), observations should be noted with photo documentation if possible and provided to a QEP to assess status. In such situations, a non-disturbance buffer around a nest is delineated until the nestlings fledge.

If vegetation clearing must occur during the nesting window, it is recommended that at least three nest sweeps be conducted given the size and habitat complexity at the site. Ideally the sweeps are conducted on consecutive days under ideal survey conditions, by an experienced QEP knowledgeable with nesting behaviour of the species known or likely to occur at the site. Clearing or brushing activities should then commence within 72 hours of the nest sweep completion.

Wildlife will likely avoid areas of construction activity; however, if wildlife such as deer are observed near or within the Project site, they will be avoided, and construction will stop in the immediate area until the wildlife leaves the site. If wildlife is observed, the QEP may determine that specific deterrent measures, such as air horns, be used (depending on wildlife species identified).

Wildlife sightings will be reported directly to the QEP. Any aggressive behaviour by wildlife toward the construction crew will result in work shutdown until the wildlife vacates the area, or a Conservation Officer is dispatched to resolve the conflict. Harassment of wildlife is illegal under the BC *Wildlife Act*, and crews will be made aware of this potential during Toolbox Safety meetings.

Apart from some specific non-native species (e.g., Norway Rat, European Starling), most native vertebrate wildlife in BC is also protected under the BC *Wildlife Act*. This includes native small mammals (e.g., rodents, weasels, bats, shrews), amphibians, and reptiles. While a salvage (i.e., relocation) will not be required for these groups prior to habitat alteration, exceptions may be required under rare circumstances such as the discovery of a snake or bat hibernaculum, active den, or similar situation that may arise during clearing or construction activities.

The following general mitigations measures will be applied to Project work to minimize impacts to wildlife at the Project site:

- Work crews will be oriented and aware of work activity restrictions associated with sensitive habitats or known wildlife features.
- A QEP will be consulted as required if wildlife or wildlife features are encountered at the site.
- Crews will take care to scan for wildlife on or near roads when driving to/from site, especially at dusk and dawn when wildlife is most active.
- Domestic animals shall not be brought to the Project site.

Construction works have the potential to increase human-wildlife interactions; therefore, the following measures will be utilized to reduce the likelihood of those interactions:

- Food scraps and garbage will be removed from the site daily.
- When moving off-site, personnel will use as few vehicles as necessary, with multiple people per vehicle to reduce traffic on roads and reduce wildlife collision potential.
- Workers will adhere to posted speed limits.
- Dangerous human-wildlife incidents will be reported to the BC Conservation Service.
- Wildlife vehicle collisions will be immediately reported to the QEP.
- All personnel are prohibited from disturbing, feeding, or harassing wildlife.
- If wildlife is encountered at the site, wildlife will be given the right of way and allowed to pass freely.
- If wildlife does not disperse from the site, crews will contact the QEP for advice.
- Crews shall not relocate or handle wildlife of any kind.

6.0 References

Birds Canada. 2022. Nesting Calendar Query Tool. 2022. Available at: https://naturecounts.ca/apps/rnest/index.jsp?lang=EN. Accessed October 2022.

Golder Associates. 1982. Geotechnical Appraisal for Proposed Subdivision, Halfmoon Bay, Sechelt, BC.

[INF] INF Planning and Design Corporation. 2021. Geotechnical Assessment for Subdivision at Truman Road, SCRD, PID 013-272-047. 6 November 2021.

[MFLNRO] British Columbia Ministry of Forests, Lands and Natural Resource Operations. 2013. Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia, 2nd Ed. (Orig. pub 2005, Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia by M.W. Demarchi and M.D. Bentley).

[PoBC] Province of BC. 2022. Habitat Wizard map of project area. 2022. Accessed October 2022 from https://maps.gov.bc.ca/ess/hm/habwiz/.

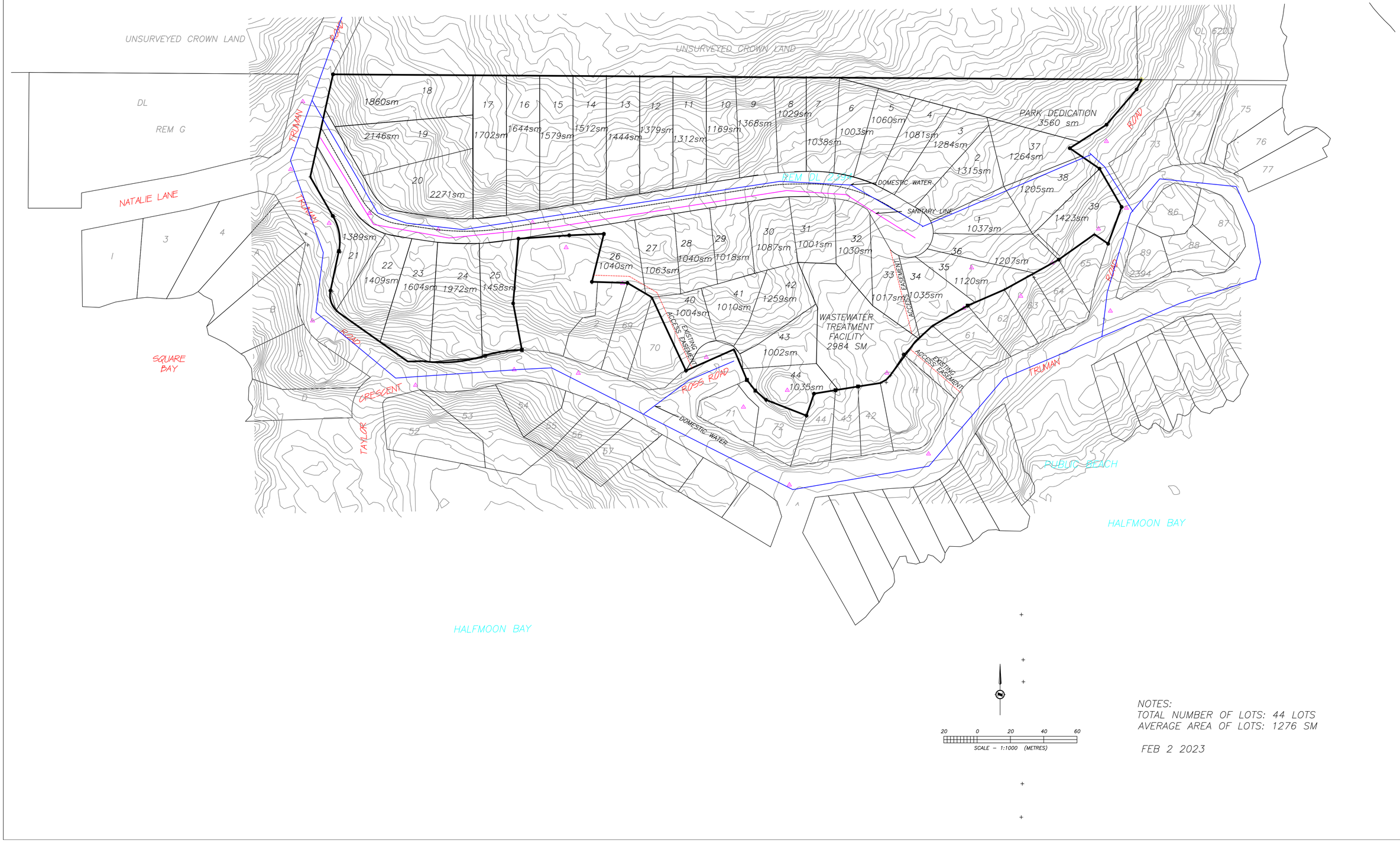
[Triton] Triton Environmental Consultants Ltd. 2021a. Tudor Road Bio-Assessment, Vancouver, BC. October 2021.

[Triton] Triton Environmental Consultants Ltd. 2021b. Truman Road Feasibility Study, Vancouver, BC. November 2021.

[Triton] Triton Environmental Consultants Ltd. 2022. Truman Road Feasibility Study – Ecological Community Assessment, Vancouver, BC. June 2022.

APPENDIX 1

TREE LOCATION PLAN



NOTES:
TOTAL NUMBER OF LOTS: 44 LOTS
AVERAGE AREA OF LOTS: 1276 SM

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