April 18, 2023

Halfmoon Bay Living Ltd
Truman Road, Sunshine Coast, BC

Re: Square Bay Desktop Site Investigation

1. Introduction

MSR Solutions (MSRS) attended the Square Bay site, located near of Halfmoon Bay, BC, on January 31, 2023 to conduct a preliminary investigation into the requirements for providing wastewater treatment and disposal for a residential multi-family housing project. An existing subdivision in Square Bay consists of 93 parcels, and Halfmoon Bay Living Ltd. proposes the addition of 44 lots subject to the rezoning of the property to allow for the subdivision. The parcel is comprised of forest and is generally sloping south towards Halfmoon Bay. Any property development will require an onsite solution for wastewater treatment and disposal.

During the site visit, MSRS inspected all accessible areas of the property. Previously dug test pits were investigated during the site visit.

2. Site Investigations

The site appeared to have been previously used for logging and as a rock stockpiling area for previous developments. Evidence of rock blasting was observed from piles of rock deposits, similar to Figure 1.

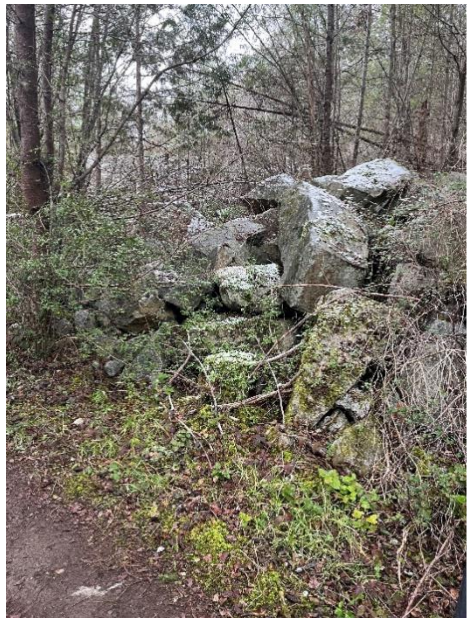

Figure 1: Existing Rock Deposit Pile

In addition to the collections of blasted rocks, bedrock outcrop was observed in areas of the site. The majority of test pits confirmed a minimum 1.2 m of soil to either bedrock or refusal in the area surveyed, which provides a suitable basis for ground disposal. Groundwater was not observed in the test pits during the site investigation, however small amounts of water was noted on the floor of a test pit. It is believed that this water was due to snowmelt and rain at the time of inspection.

Ten test pits were excavated in the potential disposal area location. The soil profile consisted of 0.10-15 m of organics/topsoil followed by 0.8-1.0 m of gravelly sandy loam. Previous percolation tests indicated that the gravelly sandy loam has a percolation rate between 2-4 min/inch (kfs ≈ 2,000 – 4,000 mm/day).

3. Desktop Site Investigation

3.1. Aquifer

The development site at Square Bay is located approximately 1 km south and 0.5 km west of Aquifer No. 558 (Figure 2). The aquifer is approximately 10.3 km^2 in size and comprised of fractured crystalline bedrock. There are

104 wells correlated with this aquifer. The proposed site is not within the boundaries of any formally classified aquifers.

The location of 5 wells in closest proximity to the development site are shown in Figure 2. A high-level summary of the well log data corresponding to the 5 nearby wells is included in Table 1.

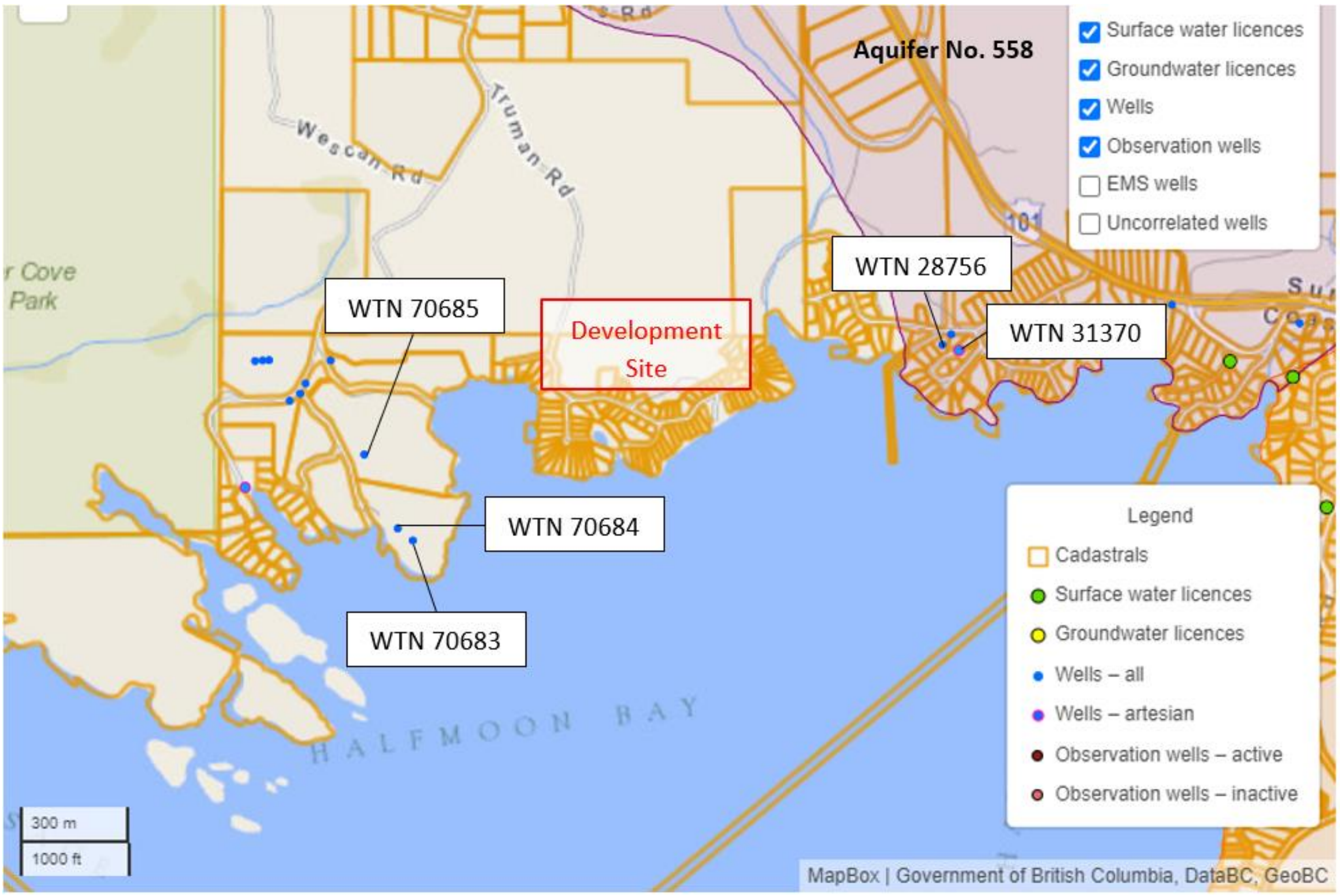

Figure 2: Aquifer and Wells Close to the Development Site

Table 1: Summary of Well Log Data

Well Tag Number (WTN)	Top Soil Layer Description	Depth to Bedrock	Bedrock Description	Finished Well Depth
70685	Silty sand and gravel, and broken rock	5	Green, black, and black & white granite	400
70684	Fill material	2	Grey, black, and green granite	378
70683	Fill material	4	Hard granite	393
28756	Loose soil rock	6	Granite	235
31370	Sandy silt and sandy gravel overlain by organic soil	-	-	16

3.2. Bedrock and Surficial Geology

Due to the absence of B.C. geological survey data from the proposed development site, the bedrock and surficial geology information was inferred based on surrounding geological data. Additional lithology information from nearby well logs (Table 1) and observations from a site visit performed by MSR (Section 2) were used to corroborate the geological data.

The site is underlain by bedrock that is likely between 0.6 – 1.8 m below the ground surface (b.g.l.). The bedrock is igneous and primarily comprised of granite.

The upper 0.6 m of soil is likely Cannell which is common in the region, especially along the coast of both South Thormanby Island and the southeast side of Halfmoon Bay. The soil is comprised primarily of loam which is well drained. Water is removed from the soil readily but not rapidly. Excess water will flow readily downward into underlaying permeable soil or laterally as subsurface flow. Lateral movement will occur when the water reaches the shallow bedrock. The loamy soils have some available water storage capacity (4 – 5 cm). On slopes, subsurface flow may occur for short durations, but inflow is typically equaled by outflow, i.e., daylighting is common on slopes.

The water table is never present in these soils due to the presence of a shallow bedrock restrictive layer.

From the well log data, fractures in the bedrock may be present at a minimum depth of 72 m b.g.l. Furthermore, the groundwater is likely accessible at depths greater than 72 m b.g.l. based on existing well depths. Therefore, land uses on the surface are unlikely to impact the groundwater.

4. Sewage Treatment and Disposal

4.1. Sewage Regulatory Requirements

In the Wastewater Treatment Facility Options Report completed by MSRS in November 2021, the following methods of treatment and disposal were considered:

- Ground disposal under the Municipal Wastewater Regulation (MWR)
- Marine disposal under the MWR
- Ground disposal under the Sewerage System Standard Practice Manual V3 (SPM)

The total anticipated sewage flow from the proposed 44 lots will be about 60 m^3/day, based on an assumed 3-bedroom home producing about 1,360 L/day. Three independent collection systems rated at 22.7 m^3/day, and facilities each with a ground disposal field under the Vancouver Coastal Health (VCH) Subdivision Guideline, and the Sewerage System Regulation (SSR) are proposed for the Square Bay development.

4.2. Proposed Sewage Treatment

The treatment and ground dispersal system will be constructed as a Type 3 system, with an effluent quality having concentrations of biological oxygen demand (BOD_5) and total suspended solids (TSS) less than 10 mg/L, and less than 400 CFU/100mL of fecal coliforms.

Membrane bioreactor (MBR) is an advanced wastewater treatment technology that combines the conventional suspended growth activated sludge process with membrane filtration, performing the critical solids/liquid separation function that is traditionally accomplished by gravity using secondary clarifiers. The difference in biomass concentration leads to much smaller reactor basins for the biological process. When combined with the elimination of secondary clarifiers, the overall footprint of the MBR treatment plant is significantly reduced. The headworks of the plant does not require primary treatment but does include an equalization tank with one-day retentions equipped with 2-mm fine screen. A schematic of a typical MBR treatment system is shown in Figure 3.

The MBR system has the following distinct advantages:

- High Efficiency
- Smaller Footprint
- High Effluent Quality
- Operational Stability
- Less Sludge Production
- Operation Simplicity and Low Maintenance Requirement
- Higher loading rate to ground disposal to reduce that footprint

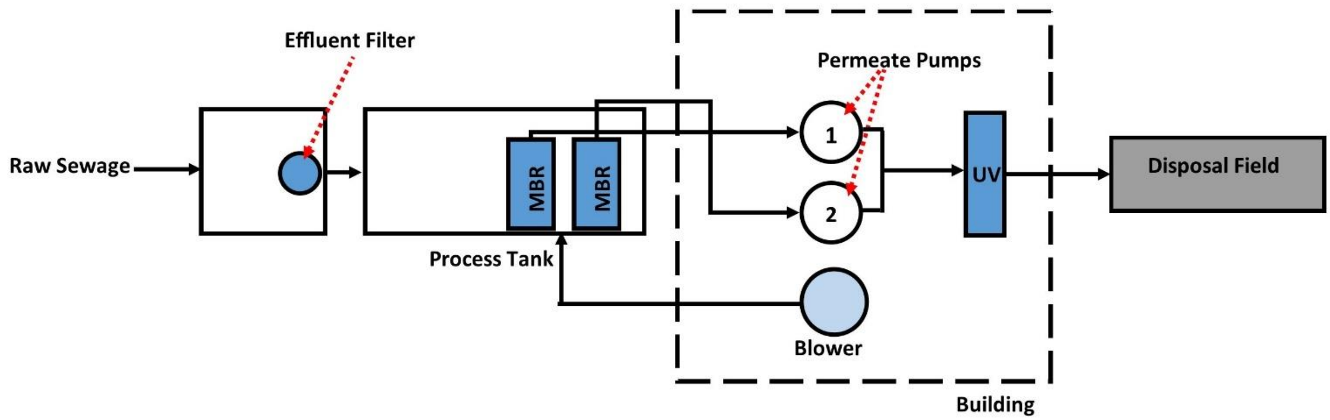

Figure 3: Typical MBR Treatment Schematic

MBR systems typically produce effluent with less than 10 mg/L of BOD_5 and TSS. Therefore, Type 3 effluent will be achieved with an MBR treatment plant. Three identical MBR treatment plants are proposed, each rated for 22 m^3/day.

4.3. Proposed Sewage Disposal

It is proposed that effluent treated to Type 3 standards will be disposed of onsite via six Rapid Infiltration Basins (RIBs). Each system will discharge to two RIBs authorized under the SSR.

RIBs are permeable granular basins, designed and operated to filter and disperse treated effluent. An RIB system is managed by repetitive cycles flooding, infiltration, and drying. This process is successful by alternating each of these cycles across multiple RIBs. The first RIB is flooded and then allowed time to infiltrate and dry. During this time, a second RIB is flooded and allowed time to infiltrate and dry. Cycling between RIBs is done in such a way that while one RIB is infiltrating and drying, the other is being flooded. This ensures that each RIB can cycle through the stages of flooding, infiltration, and drying before receiving another dose of effluent. A fence should be installed around the RIBs to ensure humans or animals cannot enter the disposal area with appropriate signage.

Further treatment and effluent polishing is accomplished as effluent infiltrates through the soil. Under the Sewerage System Regulation, effluent must travel at least 7.5 meters underground prior to reaching a downslope breakout point. Following the 7.5 meters of in-ground travel through soils with sufficient depth and permeability, effluent has been polished to the point that it is now classified as regular stormwater, as discussed in further detail in the following section.

4.4. Subsurface Polishing Treatment

4.4.1. Subsurface Travel Time

To determine a safe distance for effluent disposal from surfaces or property lines, the subsurface travel time can be used. The MWR specifies minimum subsurface travel times for municipal effluent based on the water quality. For Class A or B effluent (i.e., the quality the treatment system will generally produce), the minimum subsurface travel time is 6 days.

Using the hydraulic conductivity (i.e., rate of water transport in the subsurface), porosity of the soil, and hydraulic gradient (i.e., slope of the water table), the minimum safe distance can be calculated. Approximating these parameters from the recent site investigation, the effluent travel velocity can be estimated at 1 m/day. This means that a 6 m offset between the disposal field and the surrounding properties would ensure sufficient subsurface travel time for safe disposal of degraded effluent. As discussed in Section 4.3, the minimum subsurface travel distance for the effluent will be 7.5 m. This provides an additional 1.5 days of subsurface travel time (25% more than required) allowing additional treatment of the effluent.

4.4.2. Contaminant Treatment

Nitrates, phosphates, and coliforms are the main contaminants that are of concern for treated wastewater disposal. The subsurface can provide some treatment of the discharged effluent through chemical, biological, and mechanical processes (e.g., sorption).

Contaminant transport modelling can be used to evaluate the extent of treatment by the subsurface. The results of this modelling can provide further justification for the safe distances between effluent disposal and property lines.

5. Conclusions

An existing subdivision in Square Bay consists of 93 parcels, and Halfmoon Bay Living Ltd is proposing the addition of 44 lots subject to the rezoning of the property to allow for the subdivision. Any property development will require an onsite solution for wastewater treatment and disposal. MSRS has performed a desktop hydrogeological assessment to assist in the conceptual design of sewage treatment and disposal and found the following:

- Existing site conditions imply that subsurface flows are in the direction of downslope properties.
- The native soils on site have adequate permeability and vertical separation for onsite effluent disposal under the Sewerage System Regulation.
- Advanced tertiary treatment is proposed to minimize impacts to the receiving environment.
- The proposed sewage disposal design meets the regulatory requirement of > 7.5 m of subsurface travel as specified under the Sewerage System Regulation.
- The proposed sewage treatment and disposal design exceeds the regulated sub-surface residence time required to ensure that pathogen and nutrient removal is maximized. Following the in-ground stage of treatment, the effluent is no longer classified as sewage and no longer reflects the physical properties of sewage. It can be regarded as no different from regular groundwater.
- Under the Sewerage System Regulation, to ensure in-ground remediation of any remaining nutrient and pathogen contamination, water originating from the effluent must travel greater than 7.5 meters prior to encountering a downslope breakout.

The proposed works will satisfy all regulatory requirements while mitigating environmental risks on the property and surrounding parcels.

Should you have any questions, do not hesitate to contact the undersigned.

Prepared by:

Jeff Brett, E.I.T.
Project Engineer

Prepared by:

Taryn Fournie, Ph.D., E.I.T.
Junior Engineer

Reviewed by:

PROFESSIONAL
PROVINCE OF
K. R. WILLIAUME
46060
BRITISH COLUMBIA
ENGINEER

2023-04-18

Karl Williaume, P. Eng.
Sr. Manager of Engineering