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Comox No.2 Pump Station

Groundwater Risk Assessment

Prepared for:

Comox Valley Regional District

Prepared by:

GW Solutions Inc.

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1 BACKGROUND

The Comox Valley Regional District (CVRD) is proposing to construct a new wastewater pump station, called the Comox No.2 Pump Station, to circumvent the deteriorating forcemain that skirts the coast beneath the Willemar bluffs. The proposed site is located within Area B of the CVRD in the said Croteau Road – Balmoral Beach neighbourhood (hereafter referred to as the study area) (Figure 1).

Residents within the study area have raised concern about the siting of a wastewater pump station, especially as it relates to the future supply and quality of groundwater for their properties, both during construction and over the long-term.

The objective of GW Solutions' work has been to assess the risk of negative impacts to groundwater in case of an accidental release of sewer from the pump station or forcemain during construction and operation.

2 SCOPE

This report describes the hydrogeological study conducted for the risk assessment in the area of the pump station.

As part of GW Solutions' assessment, the following tasks have been completed:

- Review of background information on wells and aquifers from the BCMoE database;
- Geophysical investigation (Ground Penetrating Radar);
- Well survey among residents of the neighborhood: collection of well information including lithology, water level, water quality, and presence/state of surface seals;
- Completion of monitoring wells at key locations;
- Building of a 3D conceptual model;
- Reporting (intermediate report on the geophysical investigation and this report).

Figure 1. Location of study area and proposed Comox No. 2 Pump Station

3 METHODOLOGY

To determine the risk of negative impacts to groundwater in case of an accidental release of sewer from the pump station or forcemain, several criteria have been assessed, including:

- **Presence of a low permeability layer** (clay, silt, or dense till) between the aquifer and the sewer main:
  - Degree of permeability of this layer. The higher the clay content, the more contaminants are adsorbed (sorption capacity) and the less they will migrate;
  - Thickness of the low permeability layer;
  - Continuity of the low permeability layer.
- **Depth of the pump station and forcemain** compared to the depth of the low permeability layer, if any;
- **Piezometric conditions and hydraulic gradient**, determining how high the water table is and the groundwater flow direction;
- **Distance from domestic wells;**
- **Well integrity,** investigating the presence of surface seal.

GW Solutions assigned a rating (i.e., low, moderate or high) to the above criteria and a resulting global level of risk was estimated by integrating all criteria. [KLR1]

The travel time of a potential accidental release of contaminants from the forcemain and pump station [KLR2]to the well screen was estimated based on simple advection principles.

Finally, water samples were collected from domestic wells and submitted to Maxxam laboratory for chemical analyses. The purpose of the samples was to generate a baseline of what the water quality is prior the commissioning of the pump station, particularly focusing on elements that would be indicative of sewage contamination such as Chloride, Total Dissolved Solids, Nutrients (Ammonia, Nitrate), Sulfate, Sulphide and Bacteria. For informational purposes, the results were also compared to the Canadian Drinking Water Quality Guidelines.

4 HYDROGEOLOGICAL SETTING

4.1 Geological Model

Information collected during the well survey was combined to publicly available information on lithology (provincial WELLS database for the building of a 3D hydrogeological model of the study area and a better understanding of the groundwater regimes.

Two geotechnical wells were drilled by EXP, the company responsible for the geotechnical aspect of the pump station project. The geotechnical borehole at the pump station site was converted into a monitoring well to follow the trend of water level over time and collect water samples. The second geotechnical borehole located at the corner of Young Street and Beech Street was decommissioned after drilling. Well logs are available in Appendix 3.

Four additional monitoring wells were completed by Drillwell and supervised by GW Solutions on June 19th and 20th, 2017. These additional wells were drilled to confirm the soil stratigraphy between the domestic wells and the proposed project footprint at locations where data was missing. The depth of the monitoring wells ranged between 4 and 10.5 m.

Locations with information that allowed the construction of the 3D model are shown in Figure 2.

The geology of the study area can be summarized as follows (Figure 3 and Figure 4):

- An upper sand and gravel unit (till-like) encountered near the ground surface up to depths of 15 m. This unit appears as interplays of compact and loose till sub-layers. Dug wells in the study area are installed in this unit, which is considered as an unconfined aquifer.
- Underlying this surface sand and gravel is a low permeability till layer, present throughout the study area and usually described as “hardpan” on the well logs. It starts at depths ranging from 2 to 15 m below ground level. This layer likely constitutes an aquitard.
- Significant sand and gravel lenses occur at depths ranging from 10 to 30 m below ground surface. The saturated sand and gravel lenses have a range in thickness from under a metre to over 17 m, and an average thickness of approximately 5 m. Most drilled wells are completed in this layer (generally 20 m deep) that we will refer to as an intermediate aquifer.
- Pre-Quadra sand unit is found, within the neighborhood, at a depth of 30 m below the ground surface. A few drilled wells are completed in this deep aquifer.

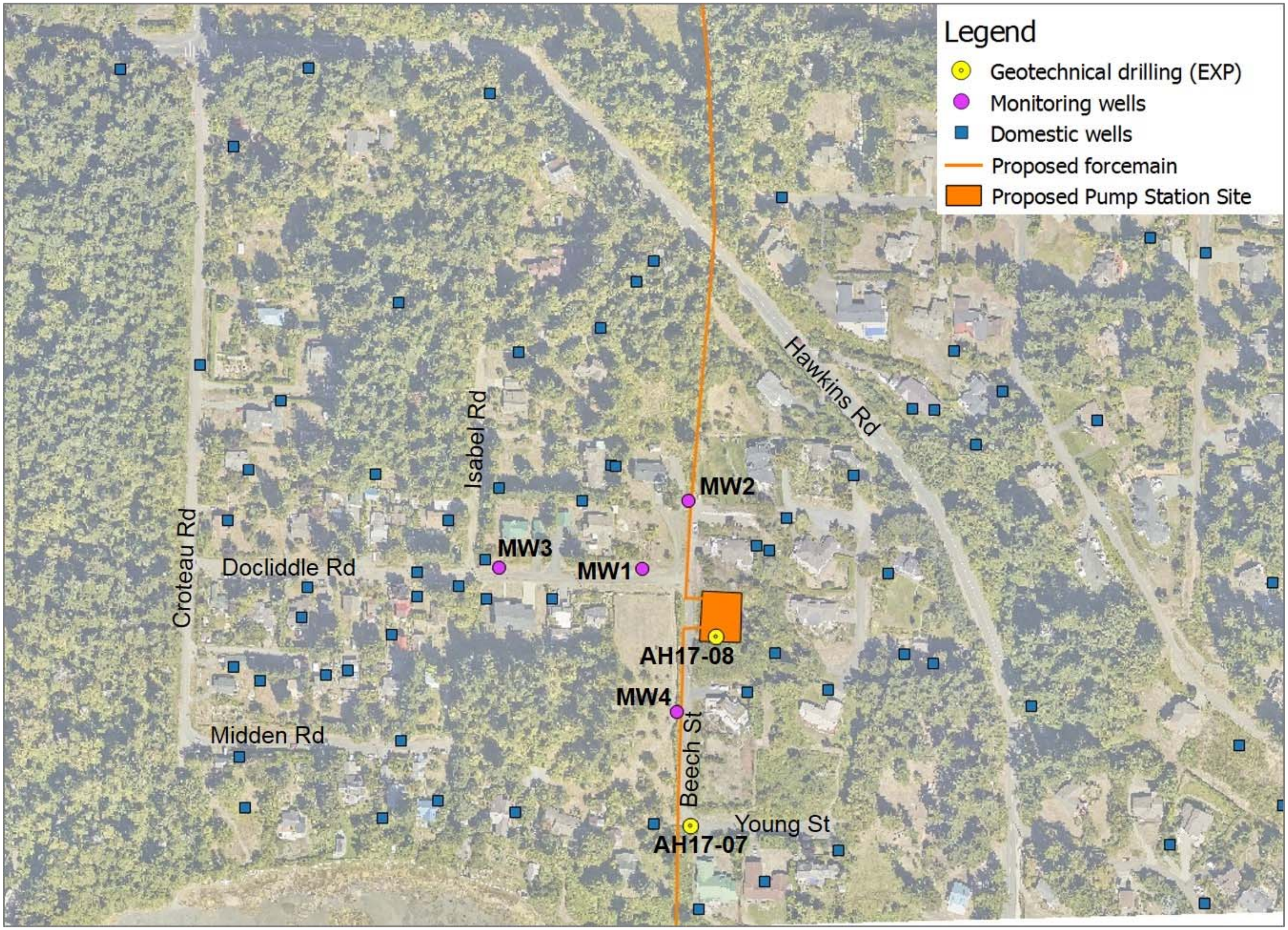

Figure 2. Location of monitoring wells, geotechnical holes and domestic wells used for building the 3D model

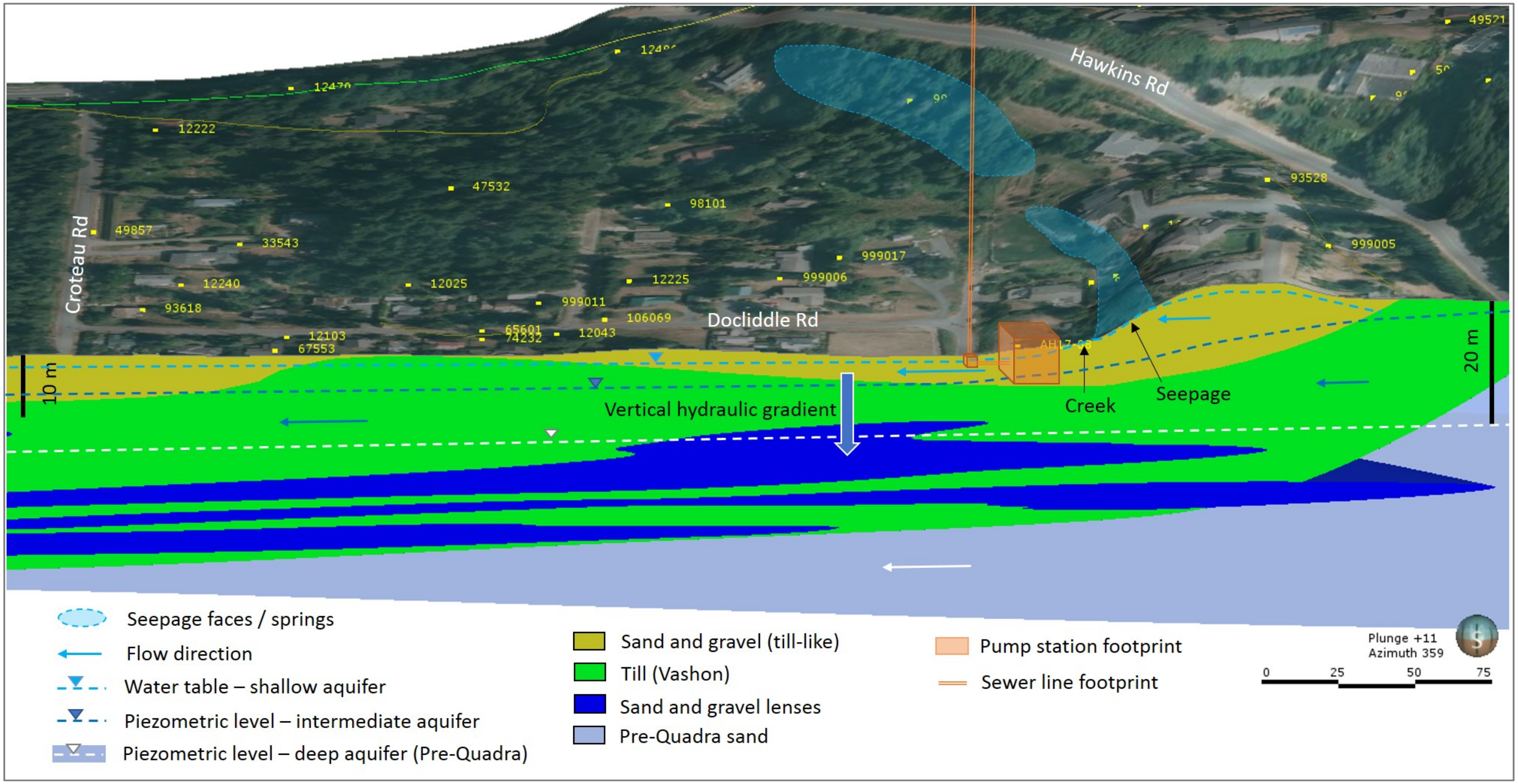

Figure 3. 3D model showing geological layers and water levels – looking north

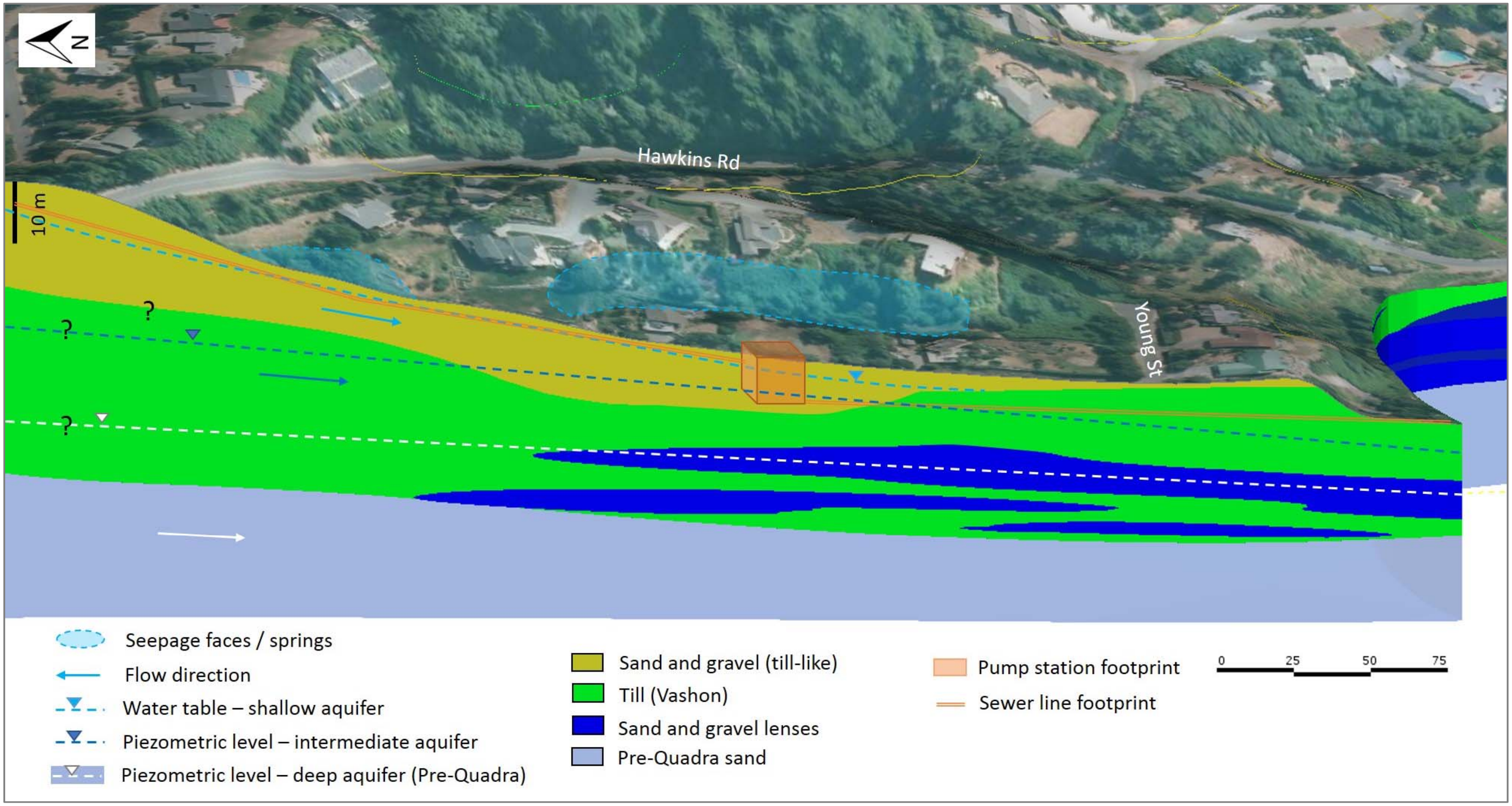

Figure 4. 3D model showing geological layers and water levels – looking east

4.2 Fine Content of the Soil

The presence of fines (silts and clays) in the soil will play an important role in the potential migration of pathogens and contaminants, preventing or reducing vertical seepage by several mechanisms such as sorption and microbiological degradation. The fines also allow for most pollutants to be adsorbed, except Cl, NO_3, and SO_4 to a lesser extent.

The lithological description of the soil within the first 10 m varies across the study area. Hard silty-clay till was found close to the shore and up to MW4; this provides a good protection against potential sewer contamination. Most wells in this area are drilled wells, deeper than this silty-clay layer.

At the pump station site (AH17-08), the proportion of fine content appeared to be very low from the core logging (sieve analysis pending). The same observation was made at MW1, MW2 and MW3. A dense silty till is found at a depth ranging between 1 and 2 m in AH17-08 and MW1. Within the footprint of the proposed forcemain and pump station (i.e., between 3 to 7.5 m), the soil consisted of interplays of loose sand and gravel (till-like) and hard sand and gravel (till-like) (Figure 5).

At MW2, a layer of uniform saturated fine sand was found between 3 and 4 m deep, which likely constitutes a preferential pathway to groundwater.

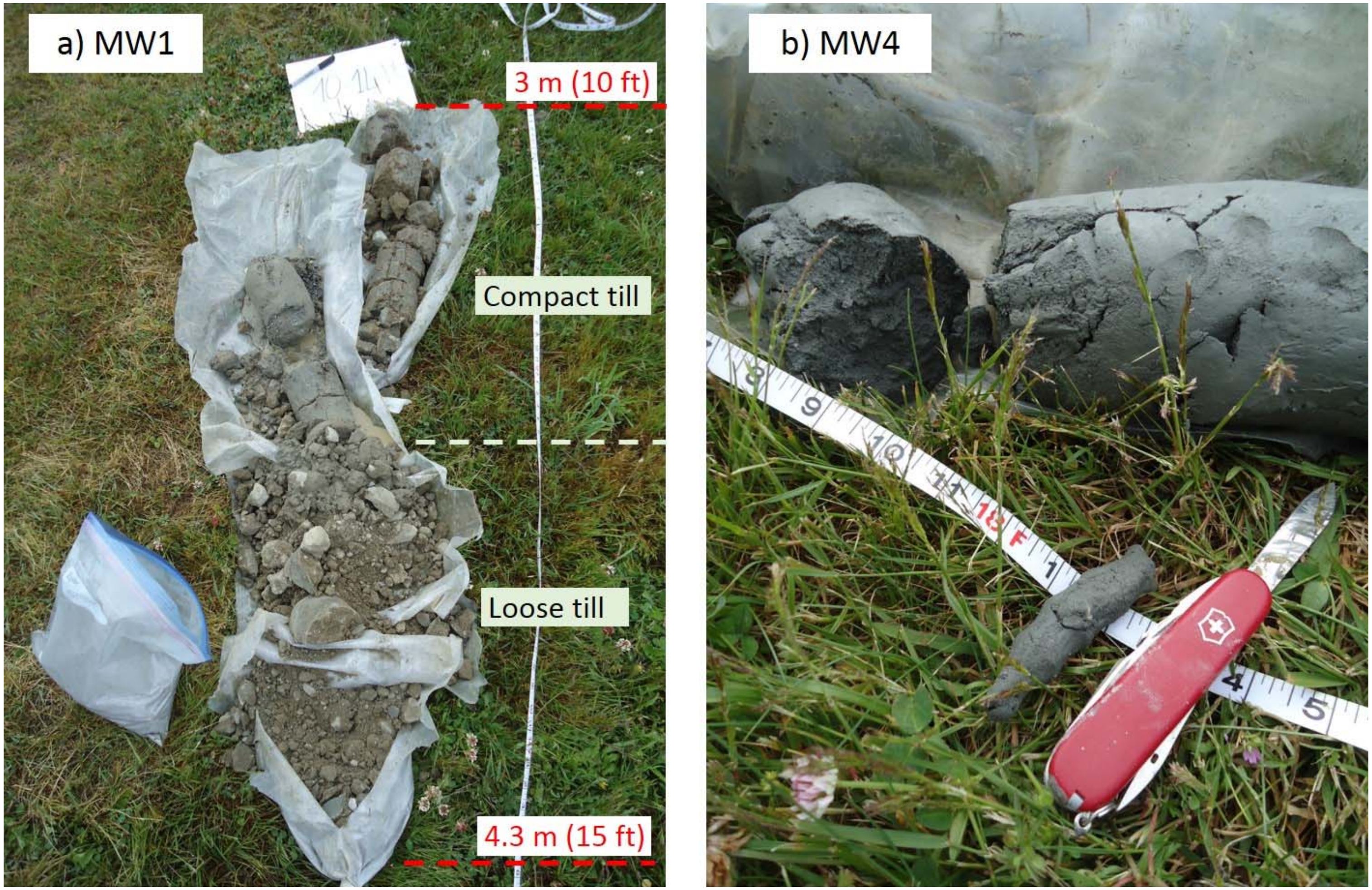

Figure 5. Illustration showing core samples from sonic drill for a) MW1 and b) MW4

4.3 Water Levels and Hydraulic Gradients

Shallow aquifer (sand and gravel - till-like sand and gravel)

The shallow aquifer is recharged by precipitation. Springs and seepage, observed almost all year, are the result of natural discharge of groundwater caused by topography (Figure 3). The water table is relatively close to the surface (1 to 3 meters). Groundwater flows southwest.

Intermediate aquifer (sand and gravel lenses)

Water levels within the intermediate confined aquifer are likely to fluctuate between depths of 5 to 7 m. Groundwater flows southwest. Due to the low permeability of the till layer (aquitard) separating the shallow and the intermediate aquifer, downward vertical flow may exist, but will be negligible.

Deep aquifer (Pre-Quadra)

Water levels in the deep aquifer are approximately 20 m deep near the pump station. Groundwater flows southwest. The hydraulic gradient between the intermediate and the deep aquifer is downward.

Groundwater flows southwest from the proposed forcemain and pump station site. The water table within the unconfined aquifer is within 1 to 3 m from ground. Vertical flow, if any, is downgradient toward deeper units.

5 HAZARD CHARACTERIZATION: PUMP STATION AND FORCEMAIN

The following hazard factors were evaluated:

5.1 Pump Station Location and Depth

The proposed pump station is located at 98 Beech Street (Figure 2). The base of the deeper structure (wet well) will be between 4.3 m and 7.7 m deep, according to the Opus building profile (Appendix 2).

The proposed forcemain will reach the pump station starting from the existing wastewater sewer main in the bay and via Beech Street. The forcemain will leave the pump station via Beech street to the north and cross Hawkins Road. The depth of excavation will be 3 to 4 m.

The footprint of the pump station and forcemain is within the shallow aquifer and partially penetrates the saturated zone (Figure 3 and Figure 4).

5.2 Release of Sewer Contaminants: Chemical Indicators

The proposed forcemain and pump station will service Courtenay and the Town of Comox. It will carry mostly domestic wastewater, but will also include some wastewater from industries, hospitals and other medical clinics.

Pollutants commonly found in domestic wastewater include bacteria and pathogens as well as elevated levels of chloride, ammonia, nitrate, sulphate, and sulphide (as H_2S). Wastewater contains high concentrations of total dissolved solids (TDS).

These various elements have different physicochemical properties. As a result, they have different adsorption, degradation, and migration processes. Chloride is considered the most conservative parameter because it will barely be absorbed when seeping through soils; therefore, chloride is a good chemical indicator of potential groundwater contamination resulting from the release of sewage associated with a potential forcemain or pump station failure. Bacteria and viruses are usually degraded in the biologically active zone before reaching the water table. The presence of pathogens is considered unlikely when groundwater must flow through over 1 m of silts and clays.

Pharmaceuticals (e.g. antibiotics, anti-depressants and anti-inflammatories) and endocrine disruptors (such as estrogens from birth control) can be present in domestic wastewater. Effects on human health are not well known, yet could include drug resistance and hormone disruption. Once in the ground, the sorption and degradation capacity of these molecules depends on their physiochemical properties, soil characteristics, and chemical properties of the groundwater (Sui et al. 2015[1]). GW Solutions considers the concentration of pharmaceuticals in the wastewater as a concern.

Wastewater from industries would generally carry high concentrations of common metals such as cadmium, chromium, copper, lead, mercury, nickel, silver and zinc and other organic contaminants (e.g., polycyclic aromatic hydrocarbons, volatile organic compounds). [KLR3]However, the ratio of discharge of industrial effluents compared to domestic effluents is low; the resulting combined wastewater therefore shows low concentrations of metals and organic contaminants (as confirmed by results of chemical analyses, CVRD personal communication).

The risk of contamination of the groundwater supply by the above contaminants depends on the chemical constituents of the wastewater itself, the groundwater regime and the physical/chemical soil characteristics near the domestic wells.

[1] Sui, Q., Cao, X., Lu, S., Zhao, W., Qiu, Z., Yu, G., 2015. Occurrence, sources and fate of pharmaceuticals and personal care products in the groundwater: A review. Emerging Contaminants 1: 14-24.

5.3 Contamination Spill

If there is a breach in the forcemain or pump station, it will create a continuous contaminant input (until fixed). The amplitude of the contamination (extent) will depend on the size of the breach (outflow).

Each pollutant has different attenuation rates; therefore, the distance at which pollutants travel varies with each pollutant's characteristics.

For non-reactive parameters (e.g., chloride), advection is the governing process for contaminant transport; this means that the contaminant is transported by natural groundwater flow velocity.

Sieve analysis are not presently available; therefore, a value of hydraulic conductivity cannot be estimated other than using literature values. Within the loose till-like soils, where the pump station and forcemain are sited, we can assume a hydraulic conductivity value *K* of maximum 10^{-4} m/s. In this condition, assuming an effective porosity value n_e of 25 % and with a hydraulic gradient *i* of 0.5%, the pore velocity (average linear velocity) using Darcy's law is:

$$v_l = \frac{Ki}{n_e} = 2.10^{-5} m/s \approx 1\ m/yr$$

5.4 Barrier for Groundwater Flow

Construction details of the sewer trenches and foundations of the pump station are not known at this stage.

Considering the shallow water table, construction will likely involve dewatering. This will create a drop in the water level near the pump station and sewer main, and may affect the water supply of shallow wells nearby. Detailed construction planning and mitigation measures must be implemented by the CVRD.

Regarding the very local recharge area of the shallow aquifer, it is likely that the presence of the foremain crossing along Beech Street will act as a barrier for shallow groundwater flow (springs)[KLR4]. In the absence of construction details (e.g. bedding material, placement of low permeability backfill material to create local barrier to groundwater flow) and hydrogeological data in the northern part of the study area (where shallow wells are present), the scale of change in flow input cannot be assessed at this stage.

6 VULNERABILITY: DOMESTIC WATER SUPPLY WELLS

The following vulnerability factors were evaluated:

6.1 Well Completion

Wells in the study area are either dug in the shallow aquifer, or drilled in the deeper aquifer system (sand and gravel lenses + deep aquifer), as shown in Figure 6. Shallow dug wells are generally between 5 and 8 m deep. Wells completed in the intermediate aquifer (sand and gravel lenses) are generally 20 m deep.

At least 20 wells are completed in the shallow aquifer, where the pump station and forcemain are proposed to be sited.

6.2 Proximity to Forcemain and Capture Zone

Six (6) dug wells are located within 50 m of the pump station and forcemain, including 4 dug wells to the west side and 2 dug wells to the east side. The other dug wells are located more than 100 m away from the pump station and forcemain (Figure 6).

The capture zone of domestic wells does not usually exceed a few meters; therefore, even if they locally modify hydraulic gradients and flow directions, the effect over the overall study area is negligible.

The wells identified as being most at risk of being negatively impacted, should there be a release of sewage effluent from the forcemain or the pump station, are shown in Figure 6.

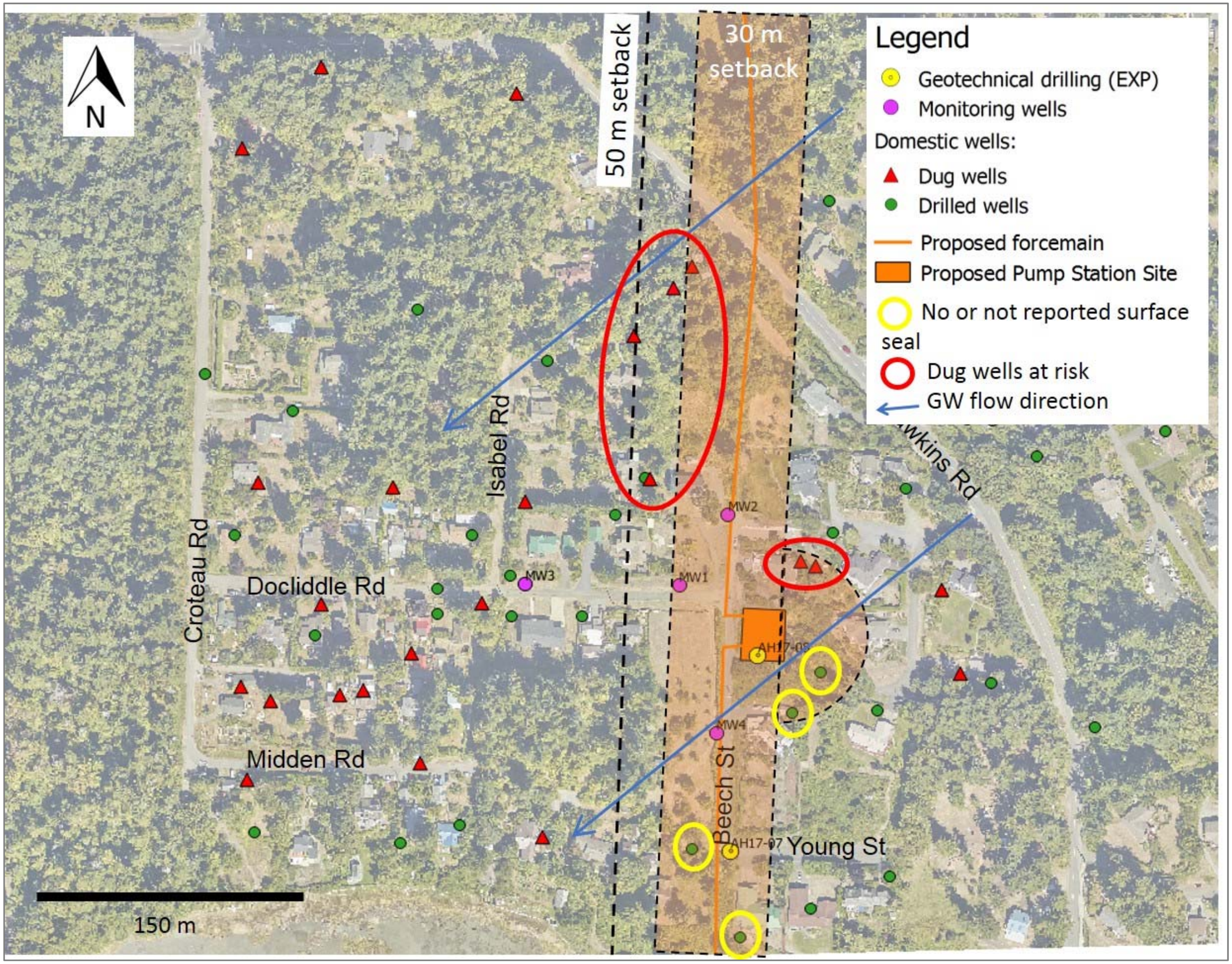

Figure 6. Domestic wells location in the study area

6.3 Well Integrity: Surface Seal

The information provided by the well logs and the well survey completed by GW Solutions in the study area provide the following conclusions:

- Some wells, including drilled wells, do not have a surface seal or the surface seal is not reported.
- No annular spaces were visible around the visited wells. However, the integrity of the surface seal cannot be guaranteed without conducting a specific investigation.

Domestic wells with no or impaired surface seals have a higher risk of contamination due to the potential for sub-surface contaminants to travel along unsealed concrete, steal well casings, or PVC pipes to reach the well screen.

Four (4) drilled wells within 20 meters of the pump station or sewer main do not have surface seals, or no surface seal is reported (Figure 6**). In this situation, wastewater has a potential to travel along the casing and reach the well screen.**

GW Solutions also noted that the length of stick-up was not respected for some wells, and that setbacks from potential source of contamination (e.g., septic field, compost, animal manure, liquid waste, storage) were not respected. These wells may be at risk of contamination from surface sources (other than the pump station or forcemain).

7 RISK ASSESSMENT

Risk for shallow / dug wells in case of a sewer breach (Table 1 and Figure 6):

- The proposed pump station and forcemain are located within the shallow sand and gravel aquifer (till-like). The proportion of fine particles in this layer (silts and clays) appeared to be very low, providing low pollution abatement (by sorption and microbiological decomposition). The fine content close to the shore is larger and would provide a better pollution attenuation.
- The water table is relatively close to the surface (1 to 3 m). The proposed pump station and forcemain penetrate into the saturated zone. This also provides less chance of pollution attenuation, by sorption and microbiological decomposition processes, that are effective when a significant distance to the water table is present. Pollution attenuation within the saturated zone occurs more slowly, with dilution being the predominant attenuation process. In this situation, contamination will be transported by the natural groundwater flow velocity (advection) at approximately 1 m/year[KLR5][SR6] in the upper aquifer layer and towards the southwest.

- Four (4) dug wells are located between 30 and 50 m to the west side of the pump station and forcemain (Figure 6). If a sewer breach were to occur, contamination will take several decades to reach the wells. [KLR7][Office8]
- The two dug wells, less than 30 m northeast of the pump station, are considered at a moderate to low risk of negative impact in case of a pump station or forcemain failure.
- Some shallow wells may experience a drop of water level due to the dewatering of the ground at the location of the deep excavation and trenches, during construction.
- The presence of the trench containing the forcemain, may intercept groundwater seepage observed at the toe of the slope; therefore, shallow wells adjacent west of the forcemain may experience a change of groundwater flow input. Although, it is not possible at this stage to determine if this effect will be significant or not (applies to 4 wells); this risk is considered to be low.

Table 1. Summary of criteria for the risk assessment for dug wells

Criteria	**PS and forcemain position**	**Fine content at proposed site footprint**	**Proximity to PS / forcemain**	**Water level**		**Well integrity**
Parameter	Depth of invert or excavation	Permeability/clay content	Distance	Water table	Horizontal hydraulic gradient	Surface seal
Description	Within shallow aquifer	Little fine close to PS and above north. More fine content south of PS	6 wells ≤ 50 m from PS or forcemain. Other wells ≥ 100 m	Shallow (1 to 3m deep)	To South-West of PS/forcemain	Reported present in minority of wells
Risk of contamination	*High*	*High*	*High for closest wells. Low for wells ≥ 100 m*	*High*	*High for wells located on West side. Moderate for wells located on East side*	*High*

note: PS = Pump Station

Risk for drilled wells in the intermediate and deep unit in case of a sewer breach (Table 2 and Figure 6):

- Drilled wells are naturally protected from subsurface contamination by the overlying till layer (or hardpan) which is continuously present over the study area with thickness greater than 5 m.
- However, some wells do not have a surface seal or no surface seal is reported. In this situation, wastewater has a potential to enter deeper aquifers by traveling along the casing, as the hydraulic gradient is downward from the shallow to the deeper aquifer system. This is likely to happen for wells located very close to the pump station or sewer main (e.g. approx. 10 m). GW Solutions has identified four wells between 10 m and 30 m from the pump station or forcemain. The risk is considered moderate for these wells.

Table 2. Summary of criteria for the risk assessment for drilled wells

Criteria	**PS and forcemain position**	**Till or low permeability layer**			**Proximity to PS / forcemain**	**Water level**	**Well integrity**
Parameter	Depth of invert or excavation	Permeability / clay content	Continuity	Thickness	Distance	Vertical hydraulic gradient	Surface seal
Description	Within shallow aquifer	“Hardpan”	Yes	> 5 m	4 wells between 10 and 30 m from PS or forcemain	Downward	Absent or not reported for the 4 closest wells
Risk of contamination	*Low*	*Low*	*Low*	*Low*	*NA (depends on other criteria)*	*High*	*High to moderate*

8 WATER QUALITY BASELINE

As part of the water quality baseline study, 12 water samples were collected in residential wells between April and June 2017. Samples were collected before any water treatment from an outside tap (if accessible), or the kitchen tap if no outside tap was available.

Figure 7 shows the baseline average concentrations of elements that would be used to monitor any impact due to a sewage leakage: chloride (Cl), total dissolved solids (TDS), nitrate (NO_3), ammonia (NH_4), sulfate (SO_4), and sulphide (H_2S). Note that the presence of one or more of these parameters can have different origins and may not only be attributed to sewer contamination. In case of a significant difference of one of the indicators parameters before and after commissioning of the pump station, a detailed study must be undertaken to determine the source of contamination.

Samples were grouped according to the type of wells they were collected from (e.g., shallow and intermediate/deep wells).

TDS is on average 1.7 times lower for shallow wells that for deep wells. A lower TDS generally indicates a younger water, that has travelled less time within the ground from the recharge area. The two sets of TDS values confirm the presence of two aquifer systems (shallow and intermediate).

Logically following the trend of the TDS, the concentrations of chloride and sulphate are 1.7 to 2 times lower on average for shallow wells than for deep wells.

Nitrate and ammonia concentrations are around 2 times higher for shallow wells than for deep wells. Nitrate (or nitrogen elements) in shallow groundwater is common and is explained by the presence of organic matter, surface input from fertilizers, or slight impacts from local septic fields.

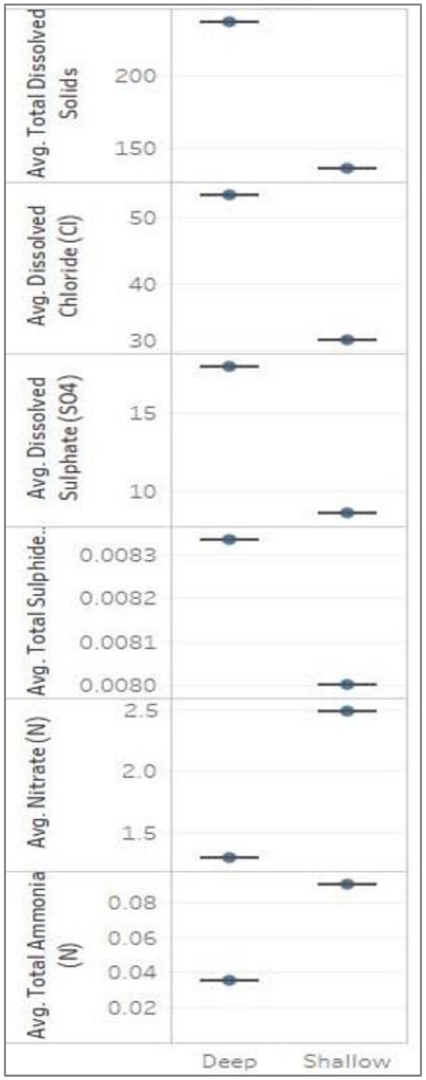

Figure 7. Average concentration values for indicators elements (in mg/l)

Table 3 shows that the concentration of iron (Fe) exceeds the Aesthetics Objective (AO) of the Canadian Drinking Water Quality Guidelines (CDWQG). Total coliforms exceeded the Maximum Admissible Concentration (MAC) for the CDWQG. It is recommended that another sample be taken for bacteria only where total coliforms have been detected. Total coliforms can have various origins such as a septic field, compost, garbage, manure, organic material, etc. Number of total coliforms present can be highly variable depending on season or surrounding environmental conditions. Total coliforms were found in shallow wells, but also in deep wells at depths where they are unexpected. This suggests preferential vertical transport pathways caused by the defective installation of water wells (impaired or absent surface seal).

Table 3. Elements exceeding the CDWQG

Parameter exceeding	MAC, AO	Number of samples exceeding guideline
Iron	AO	1
Total Coliforms	MAC	6[KLR9][SR10]

9 CONCLUSIONS[KLR11][SR12]

Based on available information and field work completed for this study, GW Solutions draws the following conclusions:

1. The four dug wells located between 30 m and 50 m west of the pump station and forcemain are considered at high risk of negative impact (Figure 6), should sewer accidentally be released.

2. The two dug wells less than 30 m northeast of the pump station are considered at moderate to low risk of negative impact, should sewer accidentally be released.

3. Drilled wells are naturally protected by a low permeability layer; however, the absence of surface seals may create preferential pathways along the casing for wastewater contamination. This might be the case for the four wells located within 30 m from the pump station or forcemain. These drilled wells are considered at moderate risk of negative impact, should sewer accidentally be released.

4. Some shallow wells may experience a drop of water level due to the dewatering of the ground at the location of the deep excavation and trenches, during construction.

5. Some shallow dug wells located west of the forcemain may experience a change of groundwater flow input due to the presence of the forcemain. Although, in the absence of relevant data, it is not possible at this stage to determine if this effect will be significant or not.

6. Pharmaceutical and Personal Care Products: untreated sewer effluents contain Pharmaceutical and Personal Care Products (PPCP); therefore, there is a risk of contamination by these products of wells identified at risk, should there by an accidental release of sewage at the pump station or forcemain. The impact on health should be considered high because the effects these products have on humans (hormone disruptors, effects on nervous and cardiac systems, etc.) are not well known, and some molecules can travel long distances (10s to 100s of meters) in the subsurface.

7. Sampling in the residential wells provided a water quality baseline before the possible commissioning of the pump station. Water quality is good, except for the presence of total coliforms in half of the analyzed samples.

10 RECOMMENDATIONS[KLR13][SR14]

GW Solutions makes the following recommendations:

1. A detailed construction plan should be completed by OPUS (e.g., profile and elevation of sewer main invert, bedding material), and the impact construction of the trench may have on the drainage of shallow groundwater should be further investigated.

2. Mitigation measures must be implemented by the CVRD for wells that may experience negative impact on water quantity and quality during construction and after the commissioning of the pump station.

3. Should the project proceed, a water quality monitoring program must be designed and implemented to detect any release of sewage from the pump station or forcemain, and its potential impact on groundwater quality. This program may include regular sampling of the monitoring wells and /or wells that were considered at risk of contamination in case of a sewer breach.

4. According to the maps provided by the CVRD, the forcemain continues up to the treatment station in a zone where residents also rely on individual wells for water supply. GW Solutions recommends that the risk assessment be extended up along the forcemain, should this alignment of the project proceed.

11 CLOSURE

Conclusions and recommendations presented herein are based on available information at the time of the study. The work has been carried out in accordance with generally accepted engineering practice. No other warranty is made, either expressed or implied. Engineering judgement has been applied in producing this letter-report.

This letter report was prepared by personnel with professional experience in the fields covered. Reference should be made to the General Conditions and Limitations attached in Appendix 1.

GW Solutions was pleased to produce this document. If you have any questions, please contact me.

Yours truly,

GW Solutions Inc.

Prepared by: Sandra RICHARD, Ph.D.
Hydrogeologist

Reviewed by: Gilles WENDLING, Ph.D., P.Eng.
President

APPENDIX 1
GW SOLUTIONS INC. GENERAL CONDITIONS AND LIMITATIONS

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During the performance of the work and the preparation of this report, GW SOLUTIONS may have relied on information provided by persons other than the client. While GW SOLUTIONS endeavours to verify the accuracy of such information when instructed to do so by the client, GW SOLUTIONS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

3.0 LIMITATION OF LIABILITY

The client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising out of the presence of those materials. In consideration of these risks, and in consideration of GW SOLUTIONS providing the services requested, the client agrees that GW SOLUTIONS's liability to the client, with respect to any issues relating to contaminants or other hazardous wastes located on the subject site shall be limited as follows:

(1) With respect to any claims brought against GW SOLUTIONS by the client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the client to GW SOLUTIONS under this Agreement, whether the action is based on breach of contract or tort;

(2) With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the client agrees to indemnify, defend and hold harmless GW SOLUTIONS from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by GW SOLUTIONS, whether the claim be brought against GW SOLUTIONS for breach of contract or tort.

4.0 JOB SITE SAFETY

GW SOLUTIONS is only responsible for the activities of its employees on the job site and is not responsible for the supervision of any other persons whatsoever. The presence of GW SOLUTIONS personnel on site shall not be construed in any way to relieve the client or any other persons on site from their responsibility for job site safety.

5.0 DISCLOSURE OF INFORMATION BY CLIENT
The client agrees to fully cooperate with GW SOLUTIONS with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The client acknowledges that in order for GW SOLUTIONS to properly provide the service, GW SOLUTIONS is relying upon the full disclosure and accuracy of any such information.

6.0 STANDARD OF CARE
Services performed by GW SOLUTIONS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

7.0 EMERGENCY PROCEDURES
The client undertakes to inform GW SOLUTIONS of all hazardous conditions, or possible hazardous conditions which are known to it. The client recognizes that the activities of GW SOLUTIONS may uncover previously unknown hazardous materials or conditions and that such discovery may result in the necessity to undertake emergency procedures to protect GW SOLUTIONS employees, other persons and the environment. These procedures may involve additional costs outside of any budgets previously agreed upon. The client agrees to pay GW SOLUTIONS for any expenses incurred as a result of such discoveries and to compensate GW SOLUTIONS through payment of additional fees and expenses for time spent by GW SOLUTIONS to deal with the consequences of such discoveries.

8.0 NOTIFICATION OF AUTHORITIES
The client acknowledges that in certain instances the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by GW SOLUTIONS in its reasonably exercised discretion.

9.0 OWNERSHIP OF INSTRUMENTS OF SERVICE
The client acknowledges that all reports, plans, and data generated by GW SOLUTIONS during the performance of the work and other documents prepared by GW SOLUTIONS are considered its professional work product and shall remain the copyright property of GW SOLUTIONS.

10.0 ALTERNATE REPORT FORMAT
Where GW SOLUTIONS submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed GW SOLUTIONS's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by GW SOLUTIONS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by GW SOLUTIONS shall be deemed to be the overall original for the Project. The Client agrees that both electronic file and hard copy versions of GW SOLUTIONS's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except GW SOLUTIONS. The Client warrants that GW SOLUTIONS's instruments of professional service will be used only and exactly as submitted by GW SOLUTIONS. The Client recognizes and agrees that electronic files submitted by GW SOLUTIONS have been prepared and submitted using specific software and hardware systems. GW SOLUTIONS makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

APPENDIX 2

GW SOLUTIONS INC. GENERAL CONDITIONS AND LIMITATIONS

APPENDIX 3
WELL LOGS