GARP STAGE 1 SCREENING LEVEL ASSESSMENT FOR SOURCE WATER APPROVAL FROM WELL 1 DEEP BAY IMPROVEMENT DISTRICT BOWSER, BRITISH COLUMBIA

Submitted To:

Deep Bay Improvement District
5031 Mountainview Road
Bowser, BC
V0R 1G0

Submitted By:

Waterline Resources Inc.
Nanaimo, BC
September 7, 2023
3534-23-001

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1.0 INTRODUCTION

1.1 Background

Deep Bay Improvement District (DBID) is looking to obtain source water approval from Island Health for resuming operation of their Water Supply Well #1 (Well 1) located at 5031 Mountainview Road in Bowser, BC (the Site; Figure1). Well 1 is currently inactive, unlicensed, and not connected to a treatment system. The DBID would like to connect Well 1 to their community water supply system, which provides domestic potable water to the residents of Deep Bay.

In 2016, Well 1 was included in the *Aquifer and Well Protection Plan for the Deep Bay Improvement District* (the Well Protection Plan; PEG, 2016), which included a Stage 1 Hazard and Screening Assessment for each of the DBID wells in accordance with the *Guidance Document for Determining Groundwater at Risk of Containing Pathogens (GARP) Version 2* (BC Ministry of Health [MoH], 2015). The Well Protection Plan and associated screening assessment identified an onsite septic system within 20 metres (m) of Well 1, which was not in compliance with the BC MoH Health Hazard Regulation (BC MoH, 2020) that requires a 30 m minimum offset distance from a water supply well. Well 1 was considered at low risk of GARP as the septic system was downgradient of the well, outside the calculated capture zone, and the water quality complied with drinking water health protection guidelines (Payne Engineering Geology [PEG], 2016). However, it was recommended that Well 1 not be used as a water supply well until the existing septic system was replaced with a new system that conformed to the applicable setback criteria.

To approve the resumed operation of Well 1, Island Health's Environmental Health Officer (EHO; previously Elizabeth Thompson, now Shuja Awan) requested that a qualified professional hydrogeologist registered in the Province of BC complete an updated Stage 1 Hazard Screening and Assessment in accordance with the latest *Guidance Document for Determining GARP Version 3* (GARP Guidance Document; BC MoH, 2017). The EHO documented this requirement as a condition for approval in a letter of conditions sent to DBID in December 2020 (included in Appendix A). Other action items included on the letter included weekly testing of raw water for bacteriological parameters, a full potability analysis as per Island Health's guidelines, and proof of proper offset distances to a new onsite septic system.

DBID retained a Waterline Resources Inc. (Waterline) to complete the updated GARP Stage 1 screening level assessment.

1.2 Objective and Scope of Work

DBID has requested that Waterline conduct a GARP Stage 1 screening level assessment to satisfy the requirement of the EHO for source water approval. To help meet this objective, Waterline completed the following tasks:

- Reviewed all publicly available data for the Site to conceptualize the hydrogeological regime and risk to groundwater for comparison with the wellhead protection plan developed by PEG (2016);
- Reviewed and compiled relevant Client specific data, including groundwater quality data, sewerage system records, driller logs, well inspection report, and site photographs; and,
- Completed a hydrogeological assessment to determine if groundwater at Well 1 is at "risk", providing all methods, observations, findings, conclusions, and recommendations, as required.

1.3 Groundwater at Risk of Containing Pathogens - Regulatory Considerations

Surface water contaminants such as pathogenic bacteria can be of concern to a community water supply, particularly when aquifers are found to be in direct hydraulic communication with the ground surface. The GARP Guidance Document identifies four main hazard categories to be considered in the assessment that, if present, could increase the risk to groundwater. Within the categories, there are 13 equally weighted hazards that require consideration when determining whether the water supply is at risk of containing pathogens.

The GARP Guidance Document states that if none of the indicated hazards are identified during the Stage 1 screening level assessment, the water source is "at low risk" of containing pathogens. If one or more of the hazards are present, further assessment is needed.

In addition to the GARP Guidance Document, the Engineers, and Geoscientists British Columbia (EGBC) *Professional Practice Guidelines for the Assessment of Groundwater at Risk of Containing Pathogens (GARP), Version 1* (EGBC, 2019) outlines the appropriate standard of practice to be followed during the assessment, including the responsibilities of the DBID, professional of record, and the approving authority.

The Drinking Water Protection Regulation (DWPR) Section 5(2) (BC Government, 2003) indicates water from a drinking water supply system must be disinfected by a water supplier if the water originates from groundwater, that in the opinion of the drinking water officer, is at a risk of containing pathogens.

2.0 METHODOLOGY

Waterline used its proprietary Environmental Web Services (EWS) geodatabase system to obtain local data to support the preliminary hydrogeological assessment. EWS integrates publicly available data including geological, hydrogeological, and hydrological information, among additional datasets, using a Geographic Information Systems (GIS) platform. EWS provides a visual presentation of the searched data relative to the Site and surrounding areas. This allows for the rapid characterization of the local hydrogeological setting and determination of the potential risk to Well 1.

The EWS Hydrachem database was also utilized to compile historical groundwater chemistry data sampled from Well 1, which was provided by DBID. Waterline generated relevant groundwater chemistry trends charts, plots, and data tables to assess changes to groundwater quality with time.

3.0 SETTING

3.1 Physiography

The Site is situated on the east coast of Vancouver Island, approximately 2.5 km northwest of Bowser, BC (Figure 1). The regional topography generally slopes northeast, towards the ocean. Topography at the Site also slopes to the northeast, with topography ranging from 66 to 51 metres above sea level (masl). Surface water drainage follows topography, with surface water flow to the northeast. There is a wetland found 280 m south (upgradient) of Well 1. There are no other mapped surface water bodies within 500 m of the well.

3.2 Site Description

Well 1 is located near the intersection of Mountain View Road and Gainsberg Road, on the north side of Highway 19A (Figure 2). Well 1 is approximately 15 m southeast (upslope) of the DBID office building and Fire Halll as seen in Photograph B1 (see Appendix B). Well 1 is housed in a well pit constructed below ground level (Photograph B1 to B4). The ground elevation at Well 1 is 60.1 masl. The well is currently isolated from the water distribution system but is still capped/covered and connected to the DBID monitoring system (Photograph B4).

The former onsite septic system, which serviced the DBID office building and the adjacent Fire Hall, was removed in 2019 (Don Buchner, pers. comm., August 4, 2023). The septic tank was pumped out and removed. The piping was dug out and recycled. The soil within the septic field was excavated and blended into the foundation of the new Fire Hall.

A new septic system was installed to service the office building and the Fire Hall (see site plan in Appendix C). The new septic tanks are located approximately 45 m north (downslope) of Well 1 and connected to the building with new piping. The septic field is located approximately 90 m north of Well 1. All infrastructure for the new septic system is downslope of Well 1 and meets the 30 m setback criteria (BC MoH, 2020). The record of sewerage system filed with Island Health by the Registered Onsite Wastewater Practitioner (ROWP), including the system design, layout, and onsite investigations (test pitting) is included in Appendix C.

3.3 Surficial and Bedrock Geology

The unconsolidated and bedrock geology on the east coast of Vancouver Island has been extensively mapped. Regionally, the unconsolidated deposits consist of post-glacial marine and fluvial sediments overlying successive intervals of unconsolidated, glacial material (Russell et al, 2016). The unconsolidated sediments are underlain by Upper Cretaceous sedimentary bedrock of the Nanaimo Group (Russell et al, 2016). The regional stratigraphic sequence from youngest to oldest (i.e., in descending order) includes:

- **Capilano sediments** consisting of two complexes:
  - Stratified glaciofluvial outwash and deltaic sands and gravels; and
  - Lower complex of late marine and glacio-marine sediments of stoney, till-like clay. The basal complex is likely an extension of the underlying Vashon Till.
- **Vashon Till** consisting of massive to stratified sandy diamictons with poorly sorted pebbles to boulders, cemented in a fine clay to sand size matrix, originating as ice-proximal morainal to surface tills;
- **Quadra Sand** consisting of pro-glacial, homogenous, stratified, and cross-stratified sand with minor gravel and silt (lower sections contain organic-rich lenses);
- **Dashwood Drift** consisting of cobbles and gravel underlain by glaciomarine silts and stoney clay; and
- **Nanaimo Group** consisting of boulder, cobble and pebble conglomerate, coarse to fine sandstone, siltstone, shale and coal.

A conceptual geological cross-section of the region is included in the Well Protection Plan (PEG, 2016).Well 1 is screened across fine-grained sand from 11.0-15.8 metres below ground level. Well construction details are summarized in Table 1.

Table 1: Well 1 Construction Details

Well Name	Water Supply Well #1
Well Tag Number	28807
Well Identification Number (WID)	13731
Well Completion Date	1973-09-05
Latitude	49.4507
Longitude	-124.7118
Groundwater Elevation (masl)	57.6
Well Casing Diameter (mm)	203
Casing Stick-Up (m)	0.59
Total Depth Drilled (mbgl)	25.0
Well Depth (mbgl)	15.8
Top of Screen Depth (mbgl)	11.0
Top of Screen Elevation (masl)	49.1
Bottom of Screen Depth (mbgl)	15.8
Bottom of Screen Elevation (masl)	44.3
Screen Length (m)	4.8

Notes: mbgl is metres below ground level; mbtoc indicates metres below top of casing; masl indicates metres below sea level.

3.4 Hydrogeology

3.4.1 Unconsolidated Aquifer

Based on regional mapping, the Site is underlain by provincially mapped Aquifer 416 (BC Ministry of Environment Protection and Sustainability [BC ENV], 2023; Figure 3), also referred to as the Quadra Sand Aquifer. A summary of the aquifer description is provided in Table 2.

Table 2: Aquifer 416 Description

Aquifer Name	Aquifer 416 (Thames River to Mapleguard Point)
Aquifer Type/Material	Confined Quadra Sediments (Sand and Gravel)
Aquifer Area (km^2)	13.7
Aquifer Vulnerability	Moderate
Aquifer Productivity	High
Median Depth to Groundwater (mbgl)	5.5
Median Well Completion Depth (mbgl)	21.3
Median Well Yield Estimate (m^3/day)	109
Aquifer Use	Domestic, water works, commercial, industrial and irrigation
Comments	There are 60 wells associated with the aquifer, including the DBID water supply wells

Notes: mbgl is metres below ground level; m^3/day is cubic metres per day

The Well Protection Plan (PEG, 2016) indicates the Vashon Till is discontinuous in the Deep Bay area, and there are parts of Aquifer 416 that are unconfined and more vulnerable to surface contamination. The driller's log for Well 1 (Appendix D) indicates that the screened interval for Well 1 is overlain by a 2 m thick silty sand unit, which is then overlain by 0.9 m of silty sand and gravel. The silty unit overlying the aquifer is expected to provide some level of protection for the aquifer near Well 1 but the permeability and lateral extent of the unit is unknown. The record of sewerage system (Appendix C) indicates that clay was encountered in two of the three test pits at depths of 2.0 mbgl and 2.1 mbgl, respectively. However, the total thickness and extent of the clay units are unknown as the test pits terminated at 2.2 mbgl and clay was not observed in all three test pits. As a result, the thickness and extent of a confining unit in the area surrounding Well 1 cannot be confirmed.

The recharge area for Aquifer 416 is shown on Figure 3, and the capture zone for Well 1 is provided in the Well Protection Plan (PEG, 2016). The capture zone extends below Highway 19A, approximately 860 m south of Well 1 into forested lands. The land use overlying the capture zone was identified in the Well Protection Plan as being a low to negligible risk to the aquifer (PEG, 2016).

Groundwater flow is gravity induced and typically flows from higher elevation to lower elevation northeast towards the ocean (PEG, 2016). Groundwater recharge to Aquifer 416 is predominately from precipitation and infiltration, with a smaller subcomponent potentially flowing up from underlying aquifers. Water levels in Aquifer 416 have been monitored since 1990 at Provincial

Observation Well (OW) 310, located 310 m southwest of the Site (Figure 3). Groundwater level trends for the aquifer are stable over time (BC ENV, 2023), with an average seasonal fluctuation of about 2 m (BC ENV, 2023). The highest groundwater levels occur in late winter (February to March) during the wet season, while the lowest groundwater levels are in late fall (October to November) after the dry season. The static groundwater level at Well 1 was measured to be 2.5 mbgl (57.6 masl) on July 21, 2023.

3.4.2 Groundwater Quality – Well 1

DBID has collected groundwater samples from Well 1 between 1977 and 2021, and again for microbiological parameters from October 2021 to April 2022 as per the Island Health letter of conditions. A summary of the analytical programs is included in Appendix E Table E1.

The groundwater quality results are summarized in Tables E2 to E5 and compared to the Guidelines for Canadian Drinking Water Quality (GCDWQ; Health Canada, 2022), to provide a reference of relative groundwater quality. The GCDWQ sets guidelines based on aesthetic objectives (AO) and maximum acceptable concentrations (MACs). Notable observations include:

- No coliform bacteria or E. Coli have been detected in any of the samples collected over the entire monitoring period (Table E2).
- There have been no exceedances of major ions or nutrients (Table E3), specifically chloride, sulphate, nitrate and nitrite, and their concentrations have remained stable over time, indicating there are no impacts from fertilizers or septic fields (inorganic and organic nitrogen, respectively).
- Turbidity readings were elevated above the aesthetic objective (AO) of 1 Nephelometric Turbidity Unit (NTU) for unfiltered groundwater on multiple occasions, with values as high as 4.5 NTU (Table E4). One of the samples from 2013 also corresponded to a colour of 21 True Colour Units (TCU); the AO is 15 TCU.
- The total dissolved solids (TDS) concentration was less than 75 mg/L, indicating the water is fresh with low mineralization.
- The pH of the groundwater for one sample, collected in 1977, was slightly lower (6.8) than the AO of 7.0 (Table E4). However, pH has been above the lower AO limit in all subsequent samples (Table E4).
- Total iron was elevated above the AO of 0.3 mg/L on November 18, 2013, and December 8, 2015 (Table E5). However, recent sampling for total iron concentrations (2016 to 2019) suggests concentrations are below the AO (Table E5).
- Total manganese was elevated above the AO of 0.02 mg/L June 27, 1977, however all samples since that time have been below guideline levels (Table E5).
- Total lead was elevated above the MAC of 0.005 mg/L December 8, 2015 (Table E5). However, more recent sampling results (2016 to 2019) show total lead concentrations below the AO (Table E5).

4.0 RESULTS OF THE GARP STAGE 1 SCREENING LEVEL ASSESSMENT

A GARP Stage 1 screening level assessment was completed for Well 1, the results are summarized in Table 3

Table 3: GARP Hazard Screening Assessment for Well 1

Hazard Factors and Criteria	Screening		Assessment	
	Not Present	Present	At Risk	At Low Risk
Water Quality Results				
A-1: Exhibits recurring presence of Total coliform bacteria, fecal coliform bacteria, or *Escherichia coli* (*E. coli*).	X			
A-2: Has reported intermittent turbidity or has a history of consistent turbidity greater than 1 Nephelometric Turbidity Units		X		X
Source Type and Location				
B-1: Situated inside setback distances from sources of contamination as per section 8 of the Health Hazards Regulation[1]	X			
B-2: Has an intake depth <15 m below ground surface that is located within a natural boundary of surface water or a flood prone area.	X			
B-3: Has an intake depth between the high-water mark and surface water bottom (or <15 m below the normal water level), **and** located within, or <150 m from the natural boundary of any surface water.	X			
B-4: Located within 300 m of a source of probable enteric viral contamination without a barrier to viral transport.	X			
Well Construction				
C-1 Does not meet GWPR (Part 3 Div.3) for surface sealing.		X		X
C-2: Well does not meet GWPR (Part 4) for well caps and covers.	X			
C-3: Well does not meet GWPR (Section 63) and Drinking Water Protection Act (Section 16) for floodproofing.	X			
C-4: Well does not meet GWPR (Part 3, Division 5, and Part 7) for wellhead protection.	X			
Aquifer Type and Setting				
D-1: Well with intake depth <15 m below ground surface.		X	X	
D-2: Is situated in a highly vulnerable, unconfined, unconsolidated, or fractured bedrock aquifer.		X	X	
D-3: Well, completed in a karst bedrock aquifer, regardless of depth.	X			

Notes: GWPR means Ground Water Protection Regulation (BC Government, 2016). [1]Section 8 Health Hazard Regulation setbacks include: a) 30 m from any probable source of contamination, b) 6 m from any private dwelling; and c) unless contamination of the well would be impossible because of the physical conformation, 120 m from a cemetery or dumping ground (BC MoH, 2020).

The GARP hazard screening assessment indicated the groundwater source at Well 1 is at low risk for two hazard categories, and at risk for two hazard categories. Further explanation of these risks is provided below for consideration by the EHO:

1. ***Hazard category A-2: Has reported intermittent turbidity or has a history of consistent turbidity greater than 1 Nephelometric Turbidity Units.*** Of the 14 samples collected between 1977 and 2021, five samples exceeded the 1 NTU threshold, with a maximum value of 4.5 NTU. PEG (2016) indicates that the elevated turbidity observed at Well 1 occurs when the well is stagnant, causing the inconsistent turbidity readings. The color of the groundwater samples has been below the AO guideline level for all except one sample, indicating the water is typically clear and transparent.

2. **Hazard category C-1: Does not meet GWPR (Part 3 Div.3) for surface sealing.** A well inspection report was completed by the BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO) on July 21, 2022, indicating there was "No" presence of a surface seal during their inspection (see the FLNRO well report in Appendix D). Waterline also confirmed from the driller's log, that a surface seal for a water supply well, as defined by Section 23 of the Groundwater Protection Regulation (GPR; BC Government, 2016) is not present at Well 1. The well was drilled before bentonite surface seals were standard practice in BC's water well drilling industry. However, an intact concrete floor is present around Well 1, providing protection against water at surface migrating down along the well casing. Any surface water that enters the well pit is redirected to a drainage system at the base of the well pit. Additionally, the well casing stick-up is greater than 0.3 m and the well is capped with a secure well lid.

3. **Hazard Category D-1: Well with intake depth <15 m below ground surface.** Well 1 is completed from 11.0 to 15.8 mbgl. As a result of the relatively shallow intake depth, Well 1 is more vulnerable to surface contamination.

4. **Hazard Category D-2: Is situated in a highly vulnerable, unconfined, unconsolidated, or fractured bedrock aquifer.** A water supply well installed in an aquifer without a confining unit is at risk of surface contamination as there is no barrier to viral transport. Aquifer 416 is mapped regionally as having moderate vulnerability to surface contamination based on the discontinuous nature of the Vashon Till confining unit. The silty unit identified in the drillers log may provide some level of protection for the aquifer but the permeability and extent of a confining unit is unknown based on the limited available data.

5.0 CONCLUSIONS

Waterline completed a GARP Stage 1 Screening Level Assessment for Source Water Approval from Well 1 as requested by Island Health's Environmental Health Officer. The assessment followed *Guidance Document for Determining GARP Version 3* guidelines.

Well 1 is considered to be at risk of containing pathogens due to the presence of several GARP hazards, including the following:

- The screen interval for Well 1 is from 11.0 to 15.8 mbgl and does not meet the well intake depth criteria of intake depths greater than 15 m. Due to the relatively shallow intake depth the well is more vulnerable to surface contamination.
- Aquifer 416 is considered to have moderate vulnerability and is therefore “at risk” to surface contamination in the vicinity of Well 1 based on the unknown extent and permeability of a confining unit overlying the aquifer.

The following additional GARP hazards related to Well 1 were identified but deemed to be low risk:

- Elevated and inconsistent turbidity is likely related to the lack of well use rather than an indication of poor subsurface filtration. PEG (2016) noted that during periods of sustained pumping the turbidity decreased below the drinking water guidelines;
- Well 1 does not meet the surface sealing requirements described in the GPR (BC Government, 2016) but it does have an in intact concrete floor and drainage system around the well to protect from surface water contamination.

Additional conclusions related to specific requests from the Island Health’s EHO, as outlined in the letter of conditions for Well 1, are provided below.

- Coliform bacteria and E. Coli have not been detected in any of the samples collected over the monitoring period, including from the eleven samples collected between October 2021 to July 2022.
- In general, the water quality has remained consistent since regular sampling began in 2011. Minimal AO exceedances have occurred and only one MAC exceedance has occurred, indicating a potable water supply.
- The old septic system, which was inside setback distances for sources of contamination, was removed, and the new septic system was installed 45 m downgradient of Well 1, meeting the setback distances for sources of contamination.

6.0 RECOMMENDATIONS

Waterline recommends the following actions be taken to ensure Well 1 is safe for community use:

- Well 1 should be flushed and shock chlorinated with the support of a qualified contractor and resampled for microbiological and chemical water quality, including metals, prior to well use. A guidance document for water well disinfection is provided in Appendix F.
- Biannual potability samples of the raw groundwater should be collected to ensure the water continues to meet the GCDWQ MAC and AO guidelines, and seasonal changes in the groundwater chemistry are monitored.
- Testing for bacteriological parameters in the water distribution system (tap water) should continue at a regular frequency as per the DWO requirements.
- The operator for Well 1 should conduct routine inspections of the well pit to ensure the concrete floor around the well is intact and no pooling of surface water occurs.

- The DBID should discuss proper procedures and operational guidelines for untreated water with the Vancouver Island Health Authority.
- Well 1 should be licensed under the Water Sustainability Act (BC Government, 2014).
- Implementing a well performance monitoring program would help DBID assess the condition and vulnerability of their well and aquifer over time. Routine well performance monitoring includes continuous groundwater level measurements, recording pumping rates/volumes, and collection of biannual groundwater/surface water quality samples. The data should be reviewed annually by a qualified professional in hydrogeology and the results should be used to evaluate and update the Wellhead Protection Plan (Payne, 2016) as needed.

7.0 CERTIFICATIONS

This document was prepared under the direction of a professional geoscientist registered in the Province of British Columbia.

Waterline Resources Inc. trusts that the information provided in this document is sufficient for your requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Respectfully submitted,

Waterline Resources Inc.
EGBC Permit No. 1000669

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9.0 LIMITATIONS AND USE

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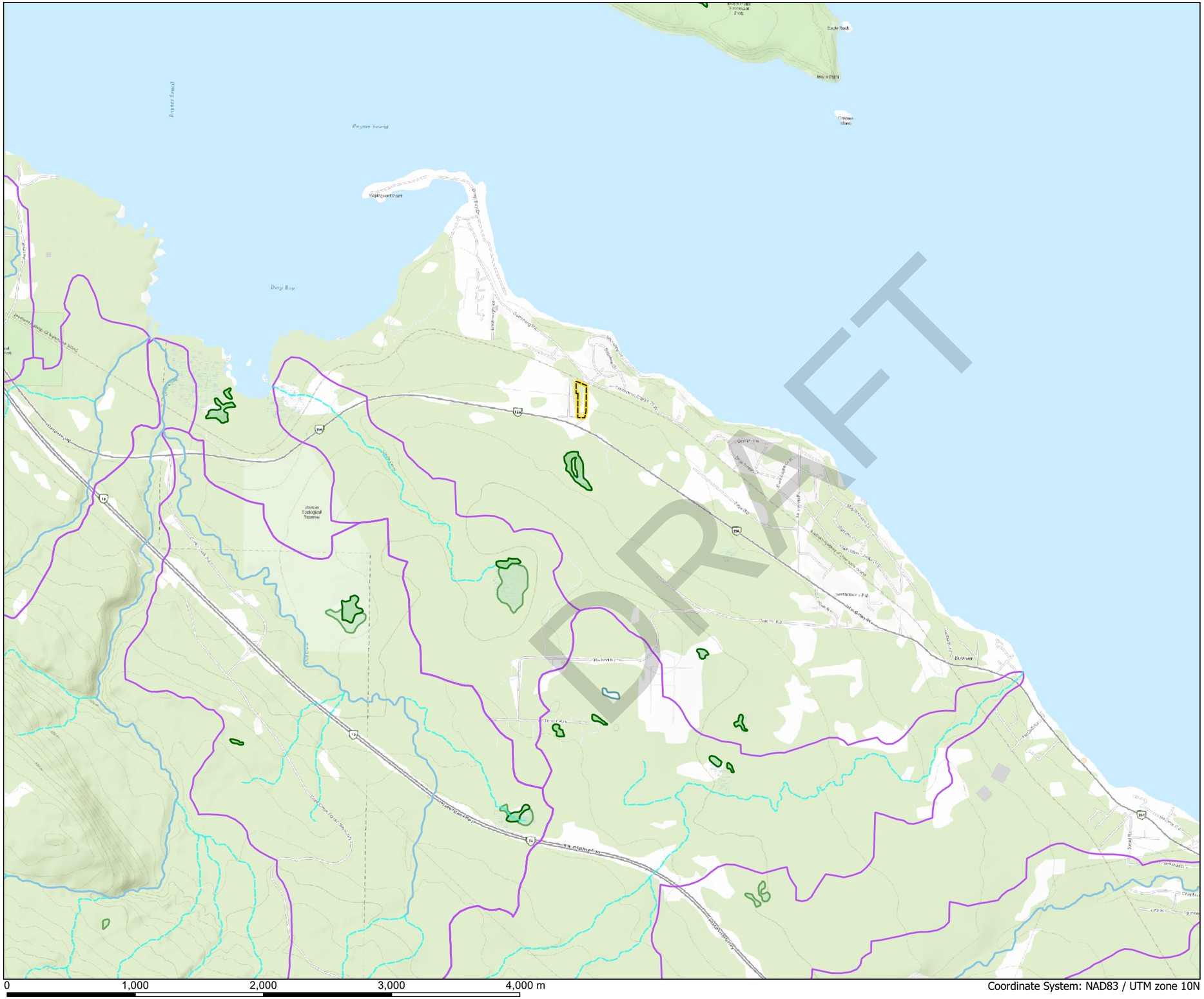
FIGURES



References:

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GARP Stage 1 Screening Level Assessment For Source Water Approval, Bowser, BC, Submitted to Deep Bay Improvement District

LOCATION MAP

Waterline

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Compiled By:	mwine
Date Issued:	2023-Aug-21
Date Revised:	--

FIGURE 1

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Site Boundary

Groundwater Flow Direction

N

Coordinate System: NAD83 / UTM zone 10N

References:

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GARP Stage 1 Screening Level Assessment For Source Water Approval, Deep Bay Improvement District, BC

SITE MAP

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Date Revised:	--

FIGURE 2

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Search Well
MOE Observation Well
Aquifer 416
Groundwater Recharge Area
River/Stream - Definite
River/Stream - Intermittent
Marsh
Swamp
Lake/Reservoir - Definite
Lake/Reservoir - Intermittent

N

Coordinate System: NAD83 / UTM zone 10N

References:

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AQUIFER 416 RECHARGE AREA

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Date Revised:	--

FIGURE 3

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Appendix A

Conditions for Approval Letter from Island Health

December 9, 2020

Deep Bay Improvement District
5031 Mountainview Road
Bowser, BC
V0R 1G0

Dear Deep Bay Improvement District:

Re: Well #1 Groundwater at Risk of Containing Pathogens (GARP)

During the November 2, 2020 drinking water inspection Well #1 was discussed regarding resuming operation as the septic system has been relocated.

The following are to be completed prior to resuming use of well #1 as part of the drinking water system:

1) Well #1 GARP assessment to be updated by a professional
2) Well #1 raw water bacteriological samples to be submitted weekly ongoing, frequency to be assessed after 6 months.
3) Well #1 Chemical analysis to be completed following Island Health's Minimum Untreated Source Water Quality Parameters list.
4) Provide documentation, for septic systems near Well #1, that confirms Health Hazard Regulation, Section 8, Distance of Wells from Possible Source of Contamination is met.

Once all items have been completed, provide supporting documentation to this office for review and discussion prior to bringing the well online as part of the drinking water system.

Wells #2 and Wells #3 were identified as GARP viruses only and GARP respectively, in the October 2016 Well Protection Plan. Wells #2 and #3 must not be used as part of the drinking water system until treatment is in place to meet the *Guidelines for Drinking Water Treatment Objectives for Groundwater Supplies.*

Should you have any questions, I am available by phone at 250-947-8222 or by email: Elizabeth.thomson@viha.ca

Yours Sincerely,

Elizabeth Thomson
Environmental Health Officer, CPHI (C)

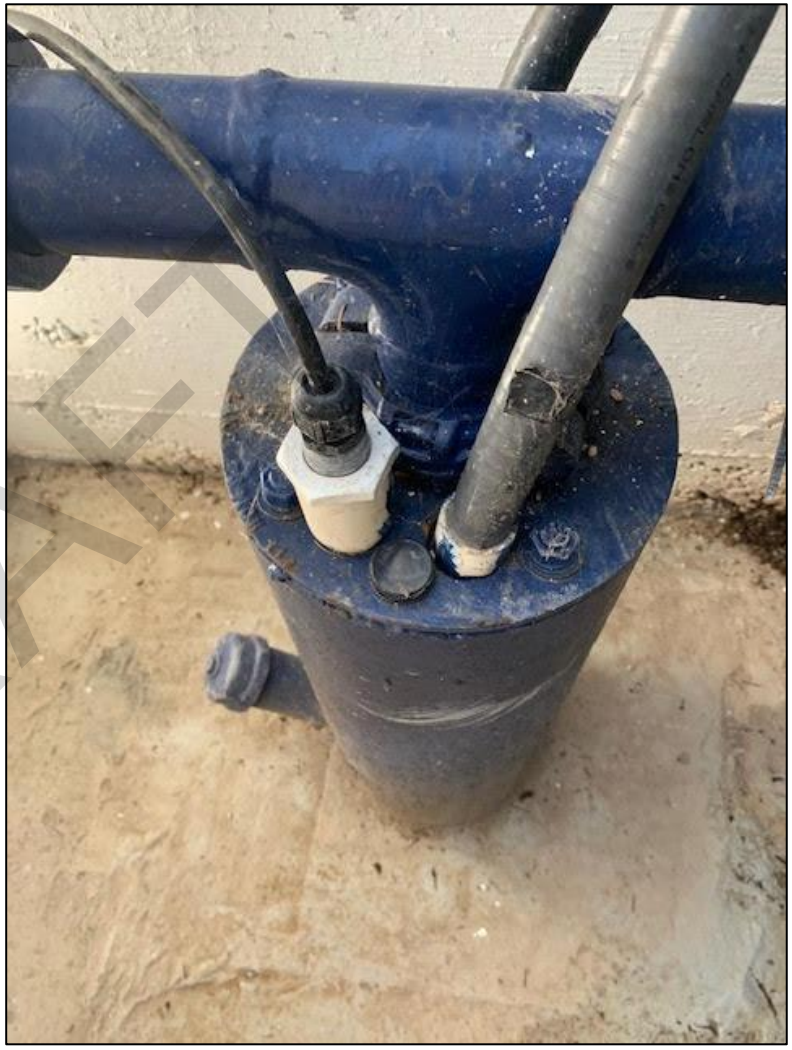
c.c.: Don Buchner, Drinking Water System Operator
Shaun Malakoe, Senior Environmental Health Officer

Health Protection and Environmental Services
489 Alberni Highway, Parksville, BC V9P 1J9
Tel: 250-947-8222 |
Fax: 250-951-9576

Appendix B

Site Photographs

Photograph B1 (LEFT): Exterior view of the well pit, looking northwest, at the office building and firehall. **Photograph B2 (RIGHT):** Exterior view of the well pit, looking southeast, away from the office building and firehall.



Photograph B3 (LEFT): Looking down into the well pit floor, floor drain and the top of the wellhead for Well 1. **Photograph B4 (RIGHT):** Close up view of the well head for Well 1. Visible is the intact concrete floor around the well casing, the well connected to the water distribution system, the electrical line for the well pump and the connection for the pressure transducer.

Appendix C

Record of New Sewerage System

island health

RECORD OF SEWERAGE SYSTEM

Filing # (OFFICE USE ONLY) PK19-166

1. Property Information

☒ New Construction ☐ Alteration ☐ Repair ☐ Amendment – Original Filing #

Tax Assessment Roll #: 769014021.000

PID #: 003-726-452

Legal Description (Plan, Lot, District Lot, Block Numbers): LOT 1, DISTRICT LOT 27, NEWCASTLE DISTRICT, PLAN 19471

Street (Civic) Address or General Location: 5031 MOUNTAINVIEW RD

City: BOWSER

2. Owner Information

Name of Legal Owner: DEEP BAY IMPROVEMENT DISTRICT

Mailing Address: 5031 MOUNTAINVIEW RD

Phone: 250-757-9312

City: BOWSER

Prov: BC

Postal Code: VOR 1G0

3. Authorized Person Information

Name of Authorized Person: JULIAN WRIGHT

Mailing Address: 1154 SMITHERS RD

Phone: 250-240-4824

City: PARKSVILLE

Prov: BC

Postal Code: V9P 2C1

Registration #: OW0734

Email: wwoww@shaw.ca

4. Structure Information

Sewerage System Will Serve:

☐ Single Family Dwelling ☒ Other Structure *(specify)* FIREHALL ☐ Other Dwelling *(specify)*

The sewerage system is designed for an estimated minimum daily domestic sewage flow of *(check one)*

☒ Less than or equal to 9,100 litres ☐ More than 9,100 litres but less than 22,700 litres

5. Site Information

Depth of native soil to seasonal high water table or restrictive layer *(cm)*: 30

Information respecting the type, depth and porosity of the soil is attached ☒ Yes ☐ No

GPS Location of System *(decimal degrees)* Latitude 49.451470 Longitude -124.712049

Horizontal Accuracy *(m)* 5 ☒ Recreational GPS ☐ Differential GPS

6. Drinking Water Protection

Will the sewerage system be located less than 30 m from a well? ☐ Yes ☒ No

If yes, attach a professional's report and specify the intended distance _____ *(m)*

Distance of proposed sewerage system to the closest body of surface water >30 *(m)*

7. System Information

Sewerage treatment method ☒ Type 1 ☐ Type 2 ☐ Type 3

8. Legal or Regulatory Considerations

☒ Construction of the proposed sewerage system will not conflict with legal instruments registered on the property.

Is this filing submitted as the result of an order from the Health Authority? ☐ Yes *(attach a copy of the order)* ☒ No

9. Plot Plan and Specifications

Plot Plan (to scale) and specifications are attached ☒ Yes ☐ No

☒ The plans and specifications are consistent with Standard Practice

Source of Standard Practice: ☒ Ministry of Health Standard Practice Manual ☐ Other

10. Authorized Person's Signature

Signature: [signature]

Date: 27th NOVEMBER 2019

OFFICE USE ONLY

Filing Accepted Date: Nov. 28/19.

Receipt Number: 244131.

Revised August 2015

By Road ✓ By # ✓
HS entered ✓ ~~Reg Dist~~
ROWP ✓

WRIGHTWAY ONSITE WASTEWATER LTD

SEPTIC SYSTEMS
EXCAVATION
DRAINAGE

WRIGHTWAY ONSITE WASTEWATER LTD
1154 SMITHERS RD PARKSVILLE BC V9P2C1

Email: julian@wwoww.ca

ASTTBC: ROWP OW0734 GST# 824277727RT0001 **PH: 1 250 240 4824 Fax: 1 250 586 4480**

VIHA initial filing for construction of sewerage system
Site investigation report, record of design and specs

Date: 27/11/2019

Legal description: LOT 1, DISTRICT LOT 27, NEWCASTLE DISTRICT, PLAN 19471

Address: 5031 MOUNTAINVIEW RD, BOWSER, BC V0R 1G0

GPS location: Lat 49.451470Long -124.712049 (dispersal field)

Property owner: Deep Bay Improvement District

System Summary:

New construction onsite wastewater system for a fire hall & office DDF800 L/day peaking to 1350L/day for 2 days per week

- New 5455 litre 2 compartment concrete septic tank and a 5455 litre pump/equalization chamber with Myers ME45 effluent pump
- Timed micro dosing, 18 doses a day by Sje rhombus EZ control panel, transducer, with alarm and data logging
- Pressure distribution below grade sand lined seepage bed, with pea gravel bed, 3% slope, bed 20.00m x 2.00m
- 6 x 32mm laterals, centre feed manifold

Site information:

Lot size: 1.78 hectare
Potable water source: municipal supply
Building area: 640 m²
Vegetation: none at dispersal field, forest downslope of proposed dispersal field
Topography: 3% slope at dispersal field
Setbacks: all setbacks meet SPM V3 guidelines, no breakout points

Note: This is a new system

Site/soil evaluation:

Refer to site plan, drawing #1 for test pit locations. Tests conducted 15th October 2019

Test pit 1: vegetation none, gravel
Horizon 0
0-170cm, mixed fill
Horizon A
170-205cm, loamy sand, brown, CF 0%, structure 2 SGR loose, roots fine to large - abundant, mottles 0, damp, seepage 0
Horizon B
205- 220cm, clay, brown, CF 0%, structure massive, roots 0 , mottles, damp, seepage 0

220cm bottom of pit

Restrictive layer clay
SHWT @ 210cm below grade
Usable soil depth, VS in native soils = 35cm

Test pit 2: vegetation none, gravel
Horizon 0
0-160cm, mixed fill
Horizon A
160-210cm, loamy sand, brown, CF 0%, structure 2 SGR loose, roots fine to large - abundant, mottles 0, damp, seepage 0

210cm bottom of pit

Restrictive layer SHWT
SHWT @ 210cm below grade
Usable soil depth, VS in native soils = 40cm

Test pit 3: vegetation none, gravel
Horizon 0
0-161cm, mixed fill
Horizon A
161-200cm, loamy sand, brown, CF 0%, structure 2 SGR loose, roots fine to medium - few, mottles 0, damp, seepage 0
Horizon B
200- 220cm, clay, brown, CF 0%, structure massive, roots 0 , mottles, damp, seepage 0

220cm bottom of pit

Restrictive layer clay
SHWT @ 200cm below grade
Usable soil depth, VS in native soils = 39cm

Hydraulic conductivity (kfs) = 5630mm/day taken in horizon A

Constraints and design rational:

The entire useable area has had a fill layer of 130-150cm placed over native soils between 1992 -2003, it consists of approx. 120cm of unsuitable material and is to be removed down to native soils; a 100-120cm layer of mound sand is to be then placed to bring the level to within 35cm of grade giving type 2 effluent at point of application. Seepage bed is most suitable and criteria meets SPM 3 table II-6 type below grade seepage bed with pea gravel dispersal bed. After removing fill layer native soil VS will be minimum 35cm for an LLR45
All setbacks meet or exceed all required standards in SPM 3 vol II table II-20.
Building is a fire hall with a permanent office with a staff of 2 giving DDF200 (2 staff 5 toilet flushes ea per day) Twice a week up to 20 staff in the fire hall are present, toilet and laundry giving a peak DDF1350, to allow for a smaller field area a 5455 litre septic tank to ensure 3 times DDF for adequate retention is to be used along with a 5455 litre equalization/pump chamber with microdosing to spread out the effluent distribution to the field over 3-4 days to prevent overloading and saturation. The equalization volume in the tank is to be set at 2.5 x DDF (3375litres)
Uniform pressure distribution with timed micro dosing is to be used.

Design information and calculations:

Type 1 effluent, (type 2 at point of application) pressurized to sand lined seepage bed with pea gravel dispersal bed atop native loamy sand. Excavate top approx. 150cm of native soils. Basal interface loamy sand, dispersal field constructed on 3% slope, VS in native soils 39cm, as constructed 150cm, exceeds minimum required of 55cm as per SPM V3 Vol II table II-16

Average DDF 800Lpd, municipal fire hall with office
HLR = 40L/day/m^2
LLR = 45L/day/m

5455 litre *septic tank* >3 x DDF
5455 litre *pump chamber* >2 x DDF

AIS native soil basal: DDF/basal HLR = 800/40 = 20m^2, 40m^2 design
Bed length 20.00m
Bed width: AIS/bed length = 2.00m
Timed, micro dosing

Dose frequency = 12 doses per day to ensure 3 day equalization
Dose volume = DDF/no. doses per day = 12.
3375 litre retained volume ÷ 3.75 days = 900 litres ÷ 12 = 75 litres per dose. (16.5igal)
Dose frequency: 24hrs/12 = every 2hr minus the dose time
Pump run time per dose: TBD by timing pump draw down to be viewed by connecting to ez panel
(Overide dose same at DDF peak flow = 75 litres, dose frequency every 30min)
Equalization volume before override = 3375 litres (= 250% DDF)
Alarm reserve volume = 675 litres = 50% DDF SPM V3 vol II table II - 46 (actual reserve =1550 litres)
Pump flow required 96 x 3/16th orifices at .61usgpm =58.56usgpm, System total head requirement = 21ft
Myers ME45 gives 60usgal at 21ft head
Levels above tank floor: pump off = 6", timer enable = 7", alarm on = 39", override = 40"

Dispersal field:

Sand lined seepage bed with pea gravel dispersal field 20.00m x 2.00m
Force main and manifold to be CSA 50mm Sch 40 pvc pipe, manifold length 1.20m, centre feed 6 x 32mm laterals to be CSA S40 pvc pipe, length 10.00m, spaced at 0.60m and 0.40m from edge of bed. Proximal and distal orifices to be minimum 0.30m from end of bed
32mm ball valves at proximal end of each lateral 50mm from manifold and c/w 150mm round irrigation boxes
32mm pvc swept 90's or 2 x45's on distal end of each lateral for cleanout with threaded caps. c/w 150mm round irrigation boxes. Manifold cleanout at end of manifold and c/w 150mm round irrigation box.
Orifice spacing to be 0.60m, total 96 giving 0.417m^2 per infiltrative surface/orifice (exceeds required 0.56m2)
16 orifices per lateral. *orifices to be staggered between laterals*
Orifice size 3/16th inch = minimum squirt height 2' covered with manufactured orifice shields.
System does not drain between doses, freezing in winter not anticipated, check valve placed on force main above pump to prevent drain back to pump chamber, 2 observation ports in bed 3.50m from proximal and distal ends down to native soil interface

Seepage bed construction specifications: see DWG #3 for detail

- Excavate fill layer down to native soil size 20.00m x 2.00m to depth approx. 120-150cm
- Scarify basal infiltrative surface in native soil with excavator bucket teeth depth 5-10cm, place 90-120cm (to within 30cm of grade) of mound sand in 30cm lifts tamping down with excavator bucket level with rake to +/- 1cm from side to side and end to end...use a laser level or transit to ensure accurate grade measurements
- Place 10cm layer of washed 10mm pea gravel 20m x 2m, rake level to +/- 1cm from side to side and end to end...use a laser level or transit to ensure accurate grade measurements
- Install manifold laterals, ball valves, sweeps and flush outs and cover with orifice shields
- Install observation ports as specified above, cover ball valves, flush outs and OP's with lawn boxes
- Place 5cm of pea gravel over laterals, cover with light weight landscape cloth and cover with 5cm of clean coarse sand and cap with 10cm native sandy loam, extend cover soils minimum 60cm past edge of bed, grade sloping from upper to lower edges of bed to ensure water run off
- Rake soil ready for grass seed

Tank and pump chamber

Install new 5455 litre 2 compartment concrete septic tank and 5455 litre equalization/pump chamber from Dan's precast with filter in outlet "T" baffle of septic tank and with handle within 15cm of tank lid. Ensure all access lids are above grade and slope surrounding soil away from lids to mitigate groundwater infiltration.
Install Myers ME45 pump on a 1.5" concrete pad* in pump chamber.
Connect building's sewer pipe outlet to septic tank and install cleanout at the abs to pvc junction.
Use CSA 4" sewer pipe between house sewer pipe and septic tank and between septic tank and pump chamber.
Ensure backfill between tanks is compacted paying particular attention under the pipes to prevent future settling and sagging. Preferred method under pipes is to backfill with pea gravel or compacted sand.

*Install pumps as per SPM V3 with union, swing check valve and ball valve within 15cm of access lid and rope tied to pump for pump removal.
Install a 1.25" check valve upside down between pump outlet and check valve in vertical position by first 90deg bend to prevent air slugs on pump start up.
Install transducer in pump chamber on a 1" float tree attached by "t" saddle to riser within 15cm of access lid for easy removal. Transducer to be located 1" off bottom of tank.
See DWG #4 for pump chamber detail.
Tanks vent back through building plumbing vent stacks.

Control panel and electrical requirements:

Control panel single phase, EZ series, simplex type 4x model 1S1W by SJE rhombus, comes with transducer. Install panel on the side of the house or on a pressure treated post in a visible and audible position, minimum 4ft above ground level.
2 separate electrical circuits with 115v x 15amp breaker for panel/alarm and 115v x 20amp breaker for pump
All electrical connections from house to control panel and control to pumps etc to be installed by a certified electrician.
Ensure wires exiting tank are sealed thru riser and also sealed off from any junction boxes and the control panel so no sewer gas from tank comes into contact with any electrical connections.
Panel to be placed where it can be seen and heard in event of an alarm.

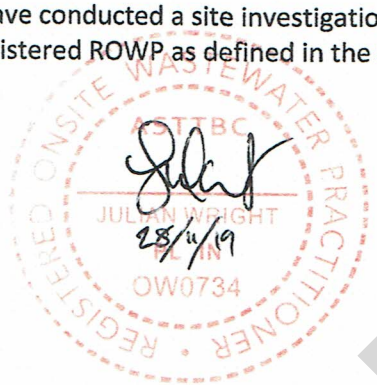
Transducer panel settings:

Pump off: 3"
Timer enable: 4"
Alarm on: 34"
Override: 35"

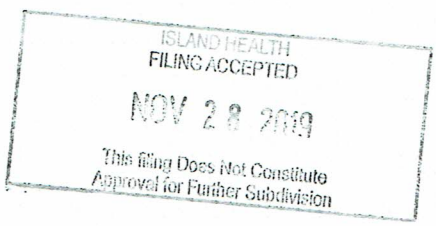
Dose volume 16.5igal, pump chamber gal per inch = 22.86
Drawdown per dose = 0.7"

Declaration:

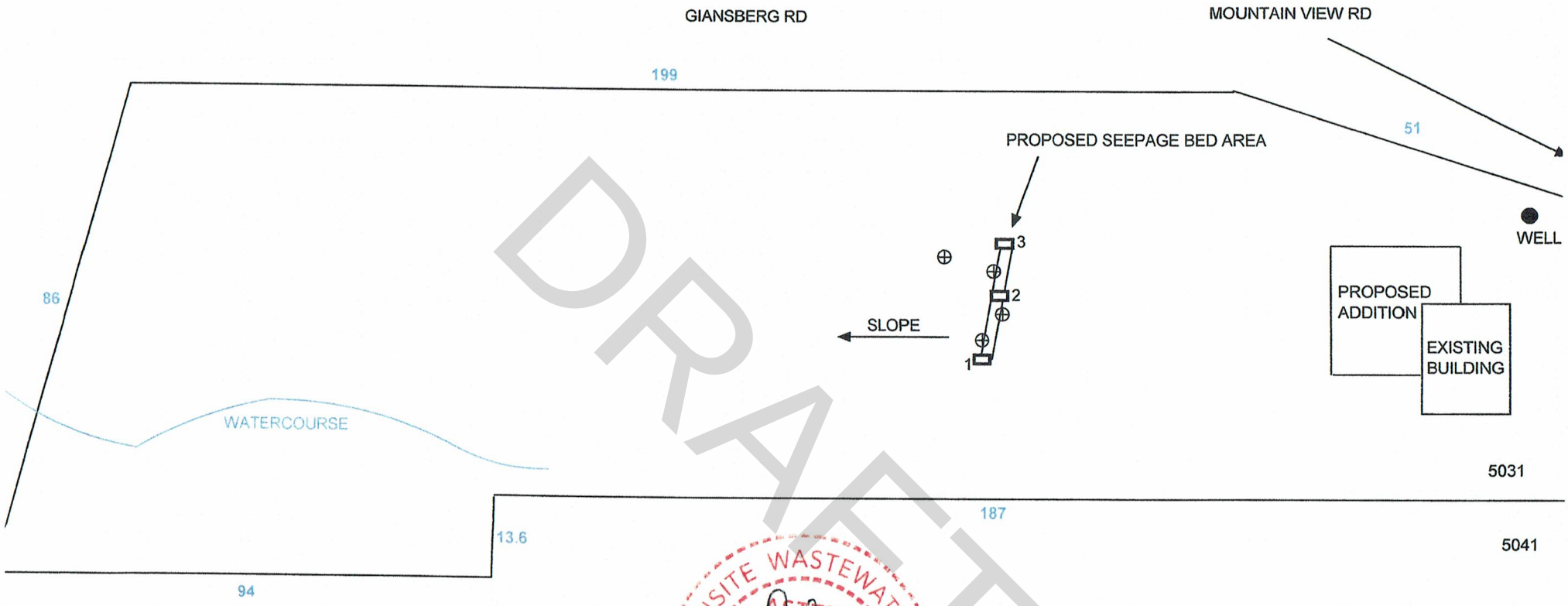
The plans, calculations and specs herein are consistent with standard practice with regard to the SSR 2004 (amended 2010) and the SPM version 3, Sept 2014.
I have conducted a site investigation and evaluation and have exercised due diligence. I am an authorized person (AP) and registered ROWP as defined in the SSR.



Julian Wright ROWP



ISLAND HEALTH
FILING ACCEPTED
DEC 05 2019
This filing Does Not Constitute
Approval for Further Subdivision



REGISTERED ONSITE WASTEWATER PRACTITIONER
ASTTBC
JULIAN WRIGHT
PLY IN
OW0734
5/12/19

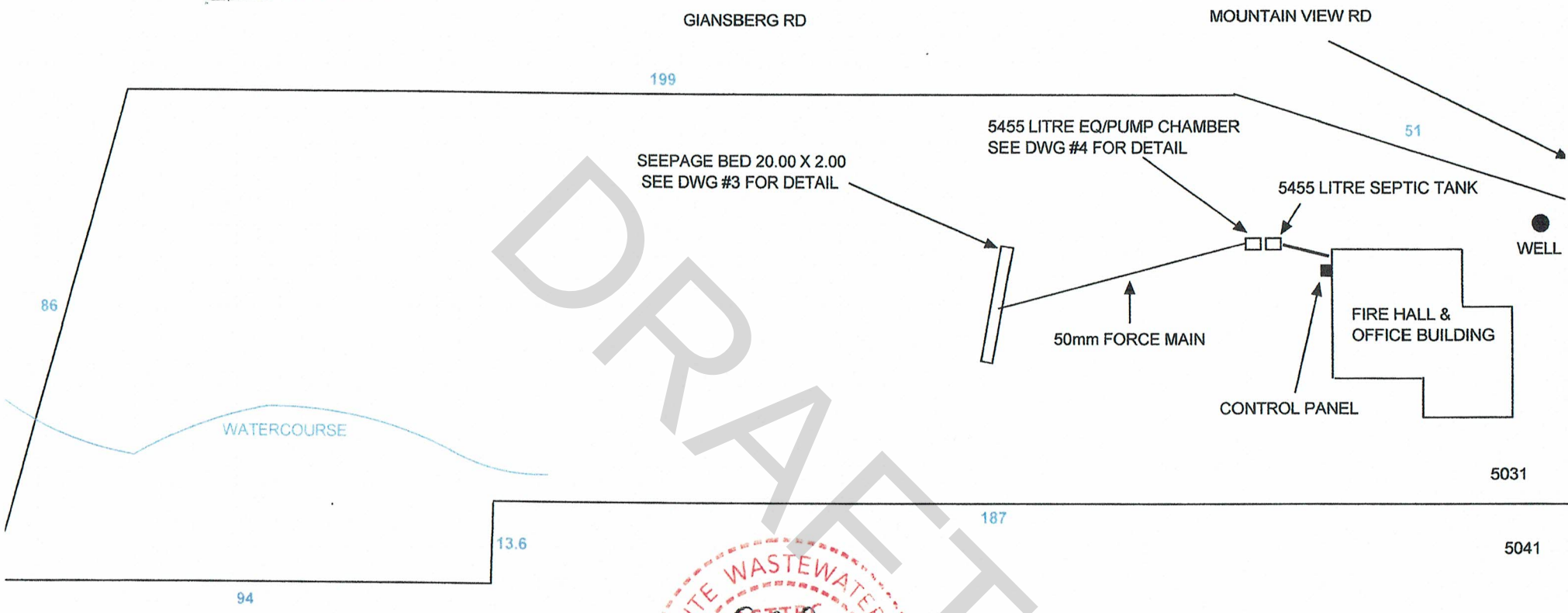
KEY:

- TEST PIT LOCATION
- ⊕ PERMEABILTITY TEST LOCATION

10 0 30

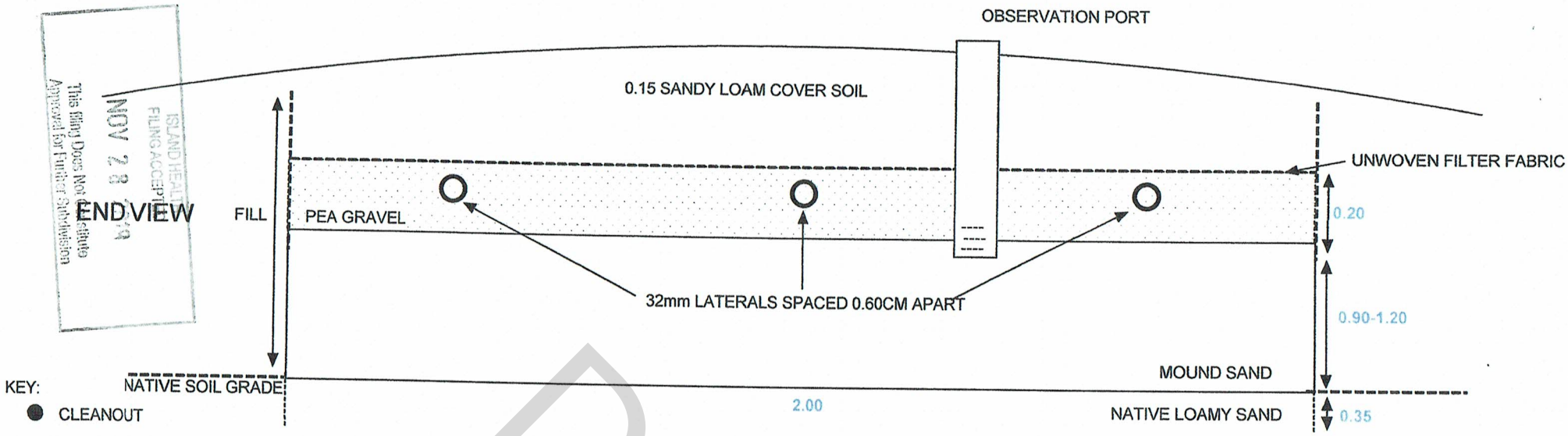
WRIGHTWAY ONSITE WASTEWATER LTD 1154 SMITHERS RD, PARKSVILLE, BC. V9P 2C1	PROJECT: 5031 MOUNTAINVIEW RD
CLIENT: DEEP BAY IMPROVEMENT DISTRICT	TITLE: SITE PLAN WITH FIELD TEST LOCATIONS
	DATE OF ISSUE: 28/11/019 · DRAWING No: 1 · SCALE: 1:1000

ISLAND HEALTH
FILING ACCEPTED
DEC 05 2019
This filing Does Not Constitute
Approval for Further Subdivision



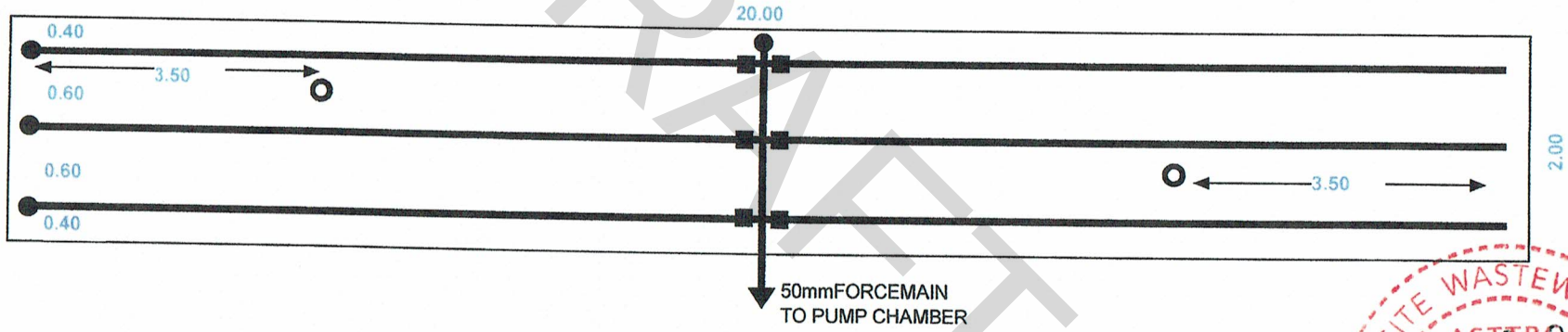
REGISTERED ONSITE WASTEWATER PRACTITIONER
JULIAN WRIGHT
PL IN
OW0734
5/12/19

WRIGHTWAY ONSITE WASTEWATER LTD 1154 SMITHERS RD, PARKSVILLE, BC. V9P 2C1	PROJECT: 5031 MOUNTAINVIEW RD		
CLIENT: DEEP BAY IMPROVEMENT DISTRICT	TITLE: SITE PLAN		
	DATE OF ISSUE: 28/11/019	DRAWING No: 2	SCALE: 1:1000



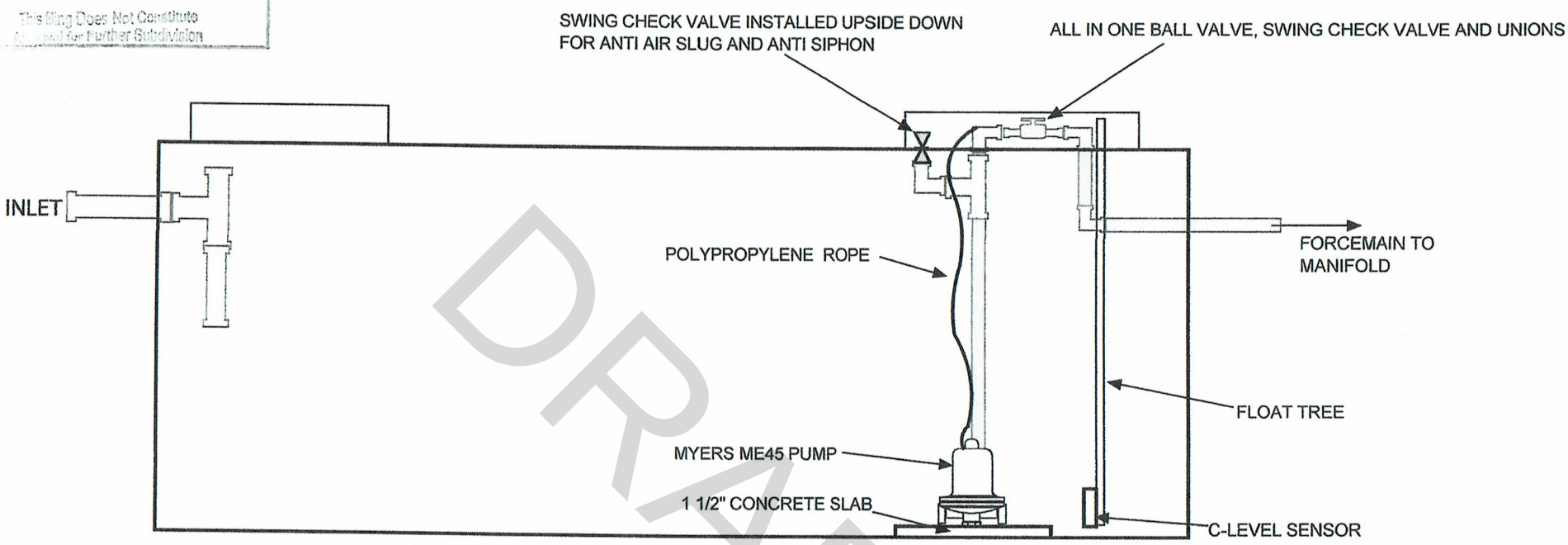
KEY:

- CLEANOUT
- 50mm BALL VALVE
- OBSERVATION PORT



SCH40 50mm MANIFOLD LENGTH 1.20
6 x 32mm SCH40 LATERALS,CENTRE FEED, 16 x 3/16" ORIFICES PER LATERAL, TOTAL 96. ORIFICE SPACING 0.60
PEA GRAVEL BED LAID ON NATIVE SAND, MINIMUM BED THICKNESS UNDER LATERALS 0.15, COVER PIPES WITH 0.05 PEA GRAVEL
ORIFICES COVERED WITH POLYLOK MANUFACTURED SHIELDS. CLEANOUTS AT DISTAL END OF EACH LATERAL WITH 2 X 45 32mm BENDS.
CLEAN OUT ON END OF MANIFOLD. BALL VALVES INSTALLED AT PROXIMAL ENDS. CLEANOUTS, BALL VALVES AND OP'S COVERED WITH 150mm ROUND IRRIGATION BOXES

WRIGHTWAY ONSITE WASTEWATER LTD 1154 SMITHERS RD, PARKSVILLE, BC. V9P 2C1	PROJECT: 5031 MOUNTAINVIEW RD, BOWSER		
CLIENT: DEEP BAY IMPROVEMENT DISTRICT	TITLE: SEEPAGE BED DETAIL		
	DATE OF ISSUE: 28/11/2019	DRAWING No: 3	SCALE: NTS

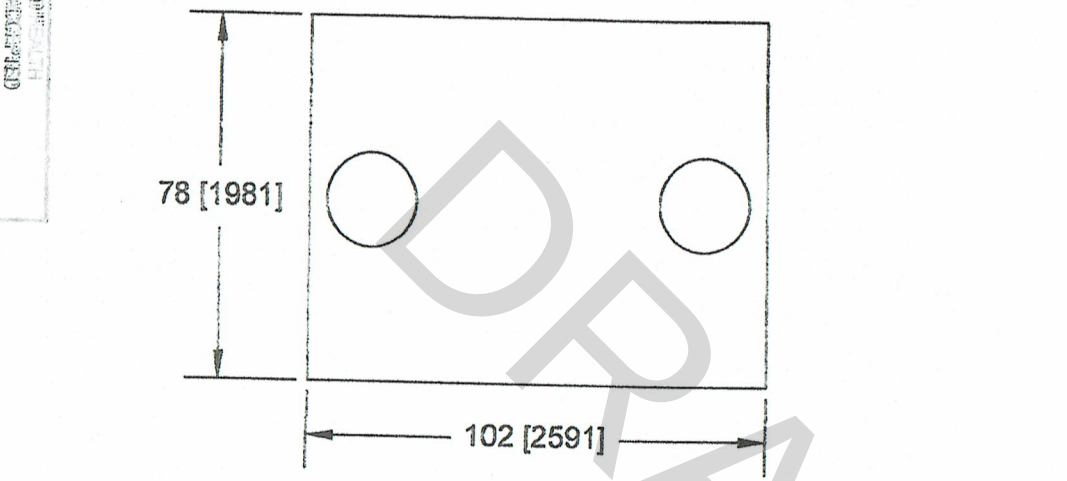


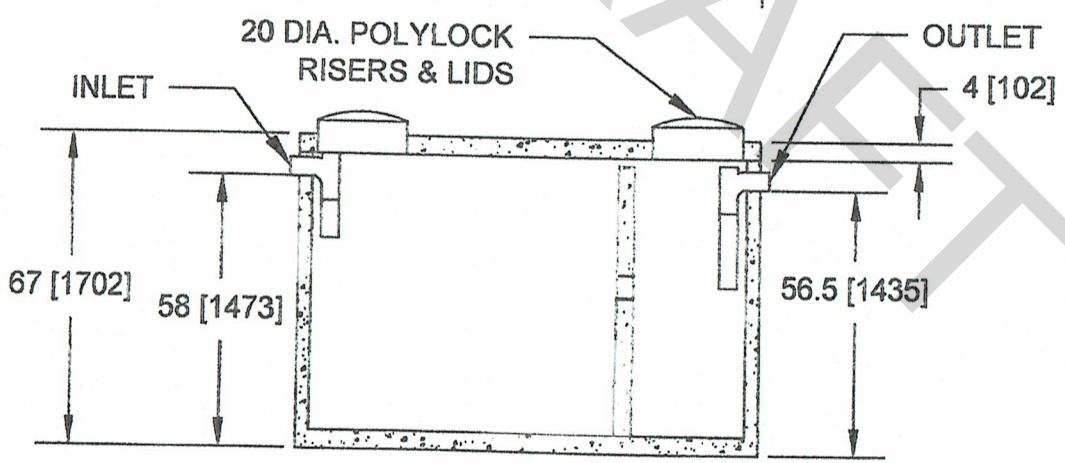
DAN'S PRECAST 5455 LITRE PUMP CHAMBER

WRIGHTWAY ONSITE WASTEWATER LTD 1154 SMITHERS RD, PARKSVILLE, BC. V9P 2C1	PROJECT: 5031 MOUNTAIN VIEW RD, BOWSER		
CLIENT: DEEP BAY IMPROVEMENT DISTRICT	TITLE: PUMP CHAMBER DETAIL		
	DATE OF ISSUE: 28/11/2019	DRAWING No: 4	SCALE: NTS

1200 IMP. GAL. TANK (2 COMPARTMENT)

TOP VIEW





SIDE SECTION VIEW

UNITS IN INCHES [AND MM]

DAN'S Pre-Cast LTD.
6100 SCOTT ROAD, DUNCAN
B.C., V9L 6Y8
TEL. (250) 746-7400
FAX (250) 746-3606

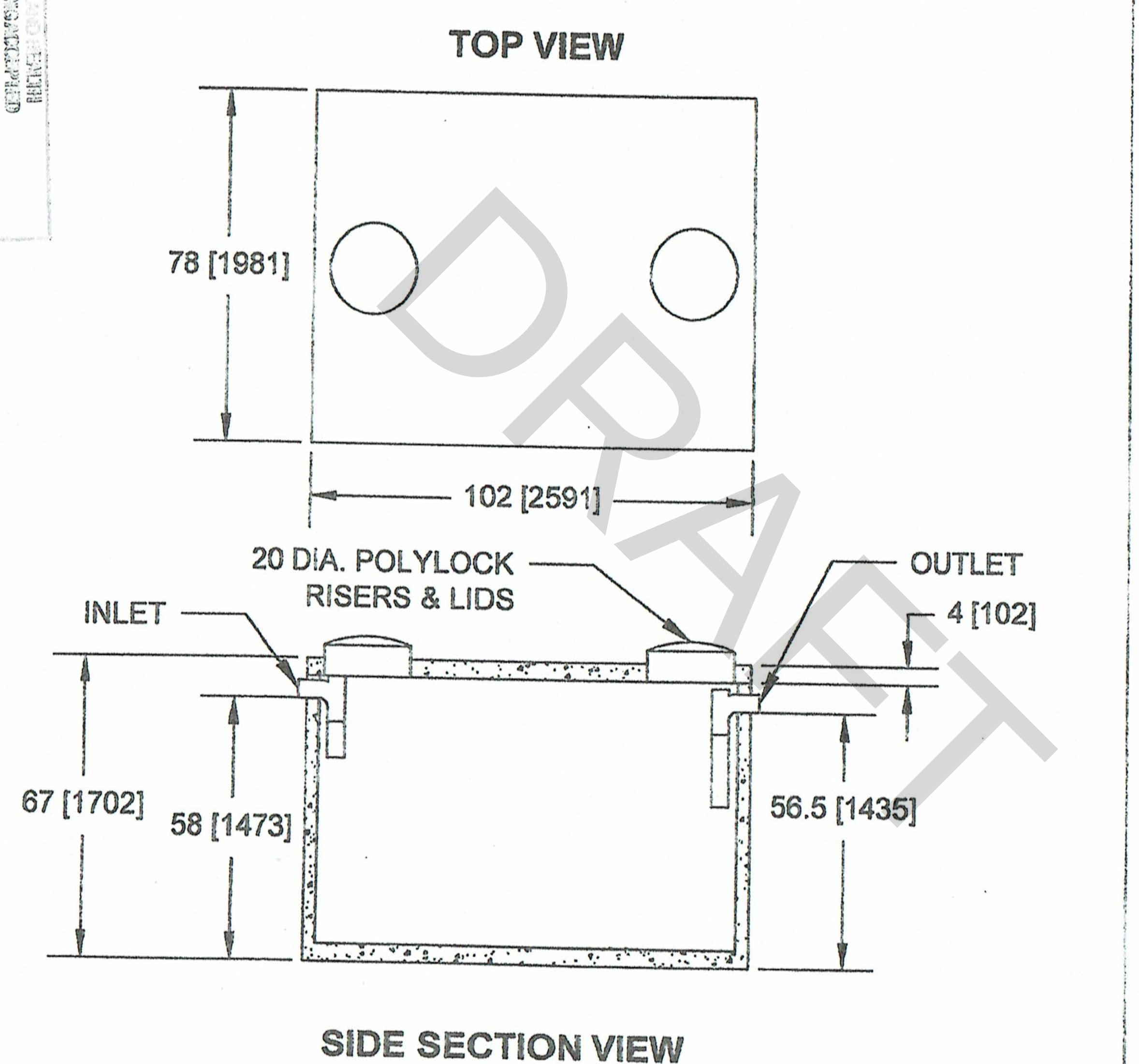
NOTES:

1. COMES WITH:
   - 20 DIA. POLYLOCK RISERS & LIDS
   - 4 DIA. RUBBER INLET AND OUTLET CONNECTORS
   - FILTER ON OUTLET SIDE

REV	DATE
1	AUG 20, 2010

SCALE 1:40

1200 IMP. GAL. TANK (1 COMPARTMENT)



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   - FILTER ON OUTLET SIDE

REV	DATE
1	AUG 20, 2010

UNITS IN INCHES [AND MM]

SCALE 1:40

Appendix D

Field Well Driller's Log and Well Inspection for Well 1

DBI-2

(1)

UTM Zone 10 375,934 E 5,478,965 N +/- 10m

BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 28807

Owner: DEEP BAY WATER DIST

Address: 5031 Mountainview Road, Bowser

Area:

WELL LOCATION:

NEWCASTLE Land District

District Lot: Plan: Lot:

Township: Section: Range:

Indian Reserve: Meridian: Block:

Quarter:

Island:

BCGS Number (NAD 83): 092F047322 Well: 7

Class of Well: WATER SUPPLY.

Subclass of Well: DOMESTIC

Orientation of Well: VERTICAL

Status of Well: New

Licence General Status: UNLICENSED

Well Use: ~~Unknown Well Use~~ MUNICIPAL

Observation Well Number:

Observation Well Status:

Construction Method: Drilled

Diameter: 8.0 inches

Casing drive shoe:

Well Depth: 82 feet

Elevation: 0 feet (ASL)

Final Casing Stick Up: inches

Well Cap Type:

Bedrock Depth: feet

Lithology Info Flag:

File Info Flag: Y

Sieve Info Flag:

Construction Date: 1973-09-05 00:00:00

Driller: Drillwell Enterprises

Well Identification Plate Number: 13731

Plate Attached By:

Where Plate Attached:

PRODUCTION DATA AT TIME OF DRILLING:

Well Yield: 80 ~~66~~ (Driller's Estimate) U.S. Gallons per Minute

Development Method:

Pump Test Info Flag: Y

Artesian Flow:

Artesian Pressure (ft):

Static Level: 7 feet

Info in red provided by Michael Payne of Payne Engineering. March 7, 2016.

WATER QUALITY:

Character:

Colour:

Odour:

Well Disinfected: N

EMS ID:

Water Chemistry Info Flag:

Field Chemistry Info Flag:

Site Info (SEAM):

Water Utility:

Water Supply System Name: ~~BOWSER~~ DEEP BAY

Water Supply System Well Name: #1

SURFACE SEAL:

Flag:

Material:

Method:

Depth (ft):

Thickness (in):

SCREEN DEPTH: 36' - 52'

WELL YIELD: 80 US gpm.

WELL LOG CONSTRUCTION RECORD

OWNER DEEP BAY WATER DIST.

Address

Well Location

Date Started AUG 11. Date Completed SEPT 5 '73

DRILLWELL ENTERPRISES LTD.
KEN SLADE - - Phone: 746-5268
R.R.1, COWICHAN STATION, B.C.

Drilling Method CABLE TOOL

Driller T. STALLYBRASS Helper

File Folio

Signed By

LOG OF FORMATIONS

Depth			Descriptions
		HOLE # 1	
0	to		
	to		11 ft. of 10"
0	to	3	SILTY SAND & GRAVEL
3	to	10	SILTY SAND
10	to	18	SILTY SAND (WB)
18	to	52	FINE SAND BROWN
52	to	82	till CLAYLY
	to		
	to		PULLING BACK 3 HRS.
	to		BACK FILLING
	to		
	to		6 HRS SETTING SCREEN
	to		& DEVELOPING
	to		
	to		TOTAL CASING 38 ft
	to		STICK UP 2 ft 5 inch
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		

GENERAL REMARKS

CASING RECORD

Dia. ins. Wt. #/ft. From to

Dia. ins. Wt #/ft. From to

Dia. ins. Wt. #/ft. From to

Shoe — Welded — Cemented

SCREEN RECORD

Make JOHNSON Material STAINLESS

Slot opening 10 thou Length 16-3

Top 36 ft. Bottom 52 ft.

Fittings Top LEAD Fittings Bottom BAIL

Gravel Pack Natural —

Development Method SURGING & BAILING

ROCK WELL DATA

Open Bore Hole Dia. ins.

From ft. to ft.

PRODUCTION DATA

Static Level 7 ft ft.

Measured from

Pumping Level ft. at GPM

ft. at GPM

Bail Test ft. at GPH

ft. at GPH

Recommended Pump Setting ft.

Recommended Max. Pump Output GPM / GPH

Duration of Test Hrs.

PUMP DATA

Make Type

Model Serial No.

Size HP Drop Pipe ins.

GPM Head ft. RPM

Motor Volts PH

Well Seal

Water Analysis — Hardness PPM

PH Iron PPM

092F · 047 3 2 2 WIN: 3822

WATER INVESTIGATIONS BRANCH, DEPT. OF LANDS, FORESTS, AND WATER RESOURCES, VICTORIA, B.C.

7

LEGAL LOCATION .. .. .. WELL LOCATION MAP COORDINATES

WELL #1 LAND DISTRICT NEWCASTLE

LICENCE NO. DATE LICENCE AMOUNT N.T.S. GRID SHEET

OWNER'S NAME DEEP BAY WATER DIST. ADDRESS % MRS. F.M. PARRY, SECRETARY, R.R.2 QUALICUM BEACH

DRILLER'S NAME DRILWELL ENT. ADDRESS R.R.1 COWICHAN STATION DATE OF COMPLETION SEPT 5/73

DEPTH 82' ELEVATION OF 032 ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 8" 10' OF 10" S. CASING LENGTH TYPE

METHOD OF CONSTRUCTION CABLE TOOL SCREEN ☒ SIZE #10 LENGTH 16.3 TYPE S.S.

LOCATION OF SCREEN TOP 36' BOTTOM 52' DEVELOPED ☒ DESCRIBE SURGE & BAILING

PERFORATED CASING ☐ LENGTH LOCATION OF PERFORATIONS

GRAVEL PACK ☐ LENGTH DIAM. SIZE GRAVEL, ETC.

DISTANCE TO WATER FROM 7.0' ☐ ESTIMATED ☒ MEASURED WATER LEVEL ELEVATION ARTESIAN PRESSURE P.S.I. DATE

WATER USE

PRODUCTION TEST SUMMARY

DATE 4-0

TEST BY AQUA FLOW

BAIL TEST ☐ DURATION OF TEST

PUMP TEST ☒ RATE G.P.M.

WATER LEVEL AT COMPLETION OF TEST

DRAWDOWN AVAILABLE DRAWDOWN 29'

SPECIFIC CAPACITY 3.5 U.S. gpm/ft. dd

PERMEABILITY USgpd/ft² STORAGE COEFF.

TRANSMISSIVITY DRAWDOWN USgpd/ft. RECOVERY USgpd/ft.

REMARKS CAPACITY 66 U.S. gpm

CHEMISTRY

TEST BY DATE

TOTAL DISSOLVED SOLIDS mg/l TEMPERATURE °C pH CONDUCTANCE μmhos/cm AT 25°C

IRON (Fe) mg/l SILICA (SiO_2) mg/l TOTAL HARDNESS ($CaCO_3$) mg/l

TOTAL ALKALINITY ($CaCO_3$) mg/l PHEN. ALKALINITY ($CaCO_3$) mg/l MANGANESE (Mn) mg/l

ANIONS	mg/l	epm	% epm	CATIONS	mg/l	epm	% epm
CARBONATE (CO_3)				CALCIUM (Ca)			
BICARBONATE (AS CO_3)				MAGNESIUM (Mg)			
SULPHATE (SO_4)				SODIUM (Na)			
CHLORIDE (Cl)				POTASSIUM (K)			
NITRATE ($NO_2 + NO_3$)							
* TKN (NO_3)							
PHOSPHORUS (P)							
TOTAL				TOTAL			

* TKN : TOTAL KJELDAHL NITROGEN

CHEMISTRY FIELD TESTS

TEST BY DATE EQUIPMENT USED

LITHOLOGY

FROM	TO	DESCRIPTION
		#1
0	HOLE #1	
		11 FT OF 10"
0	3	SILTY SAND & GRAVEL
3	10	SILTY SAND
10	18	SILTY SAND (WB)
18	52	FINE SAND BROWN
52	82	TILL CLAYEY
		PULLING BACK
		3 HRS BACK FILLING
		6 HR SETTING
		SCREEN & DEVELOPING
		TOTAL CASING 38'
		STICK UP 2' 5"
79 ft depth		Try Robert Parry Deep Bay Rd. 757-8447

CONTENTS OF FOLDER

☒ DRILL LOG ☒ PUMP TEST DATA ☐ CHEMICAL ANALYSIS

☐ SIEVE ANALYSIS ☐ GEOPHYSICAL LOGS ☒ REPORT

OTHER 4092-500

SOURCES OF INFORMATION NOT IN 75 FILES

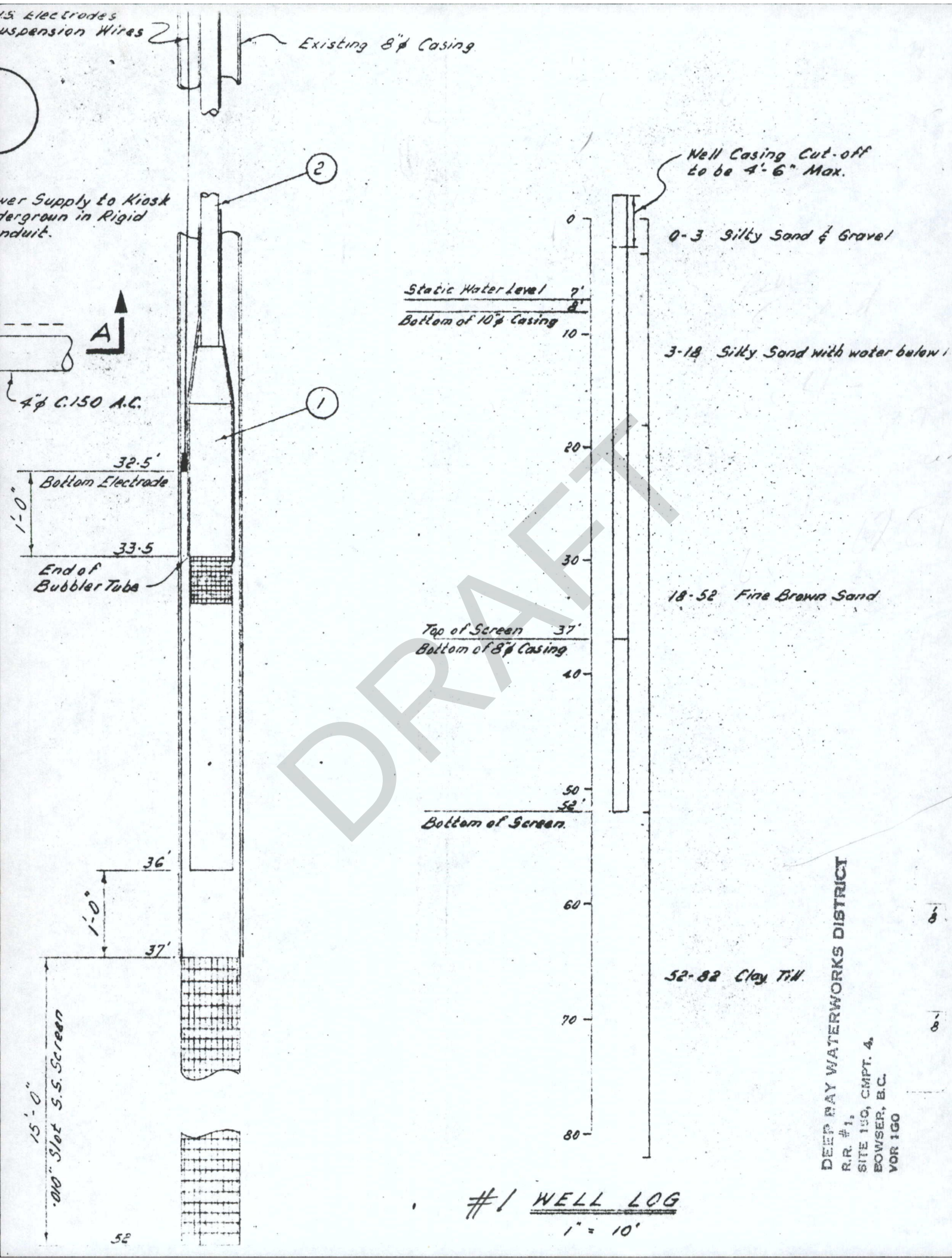
LOT 12, 13 & 14 BLOCK SEC 12 & 13 R9 PL 716A

92 F/7 #3

REMARKS

MFR 79 - INSIDE

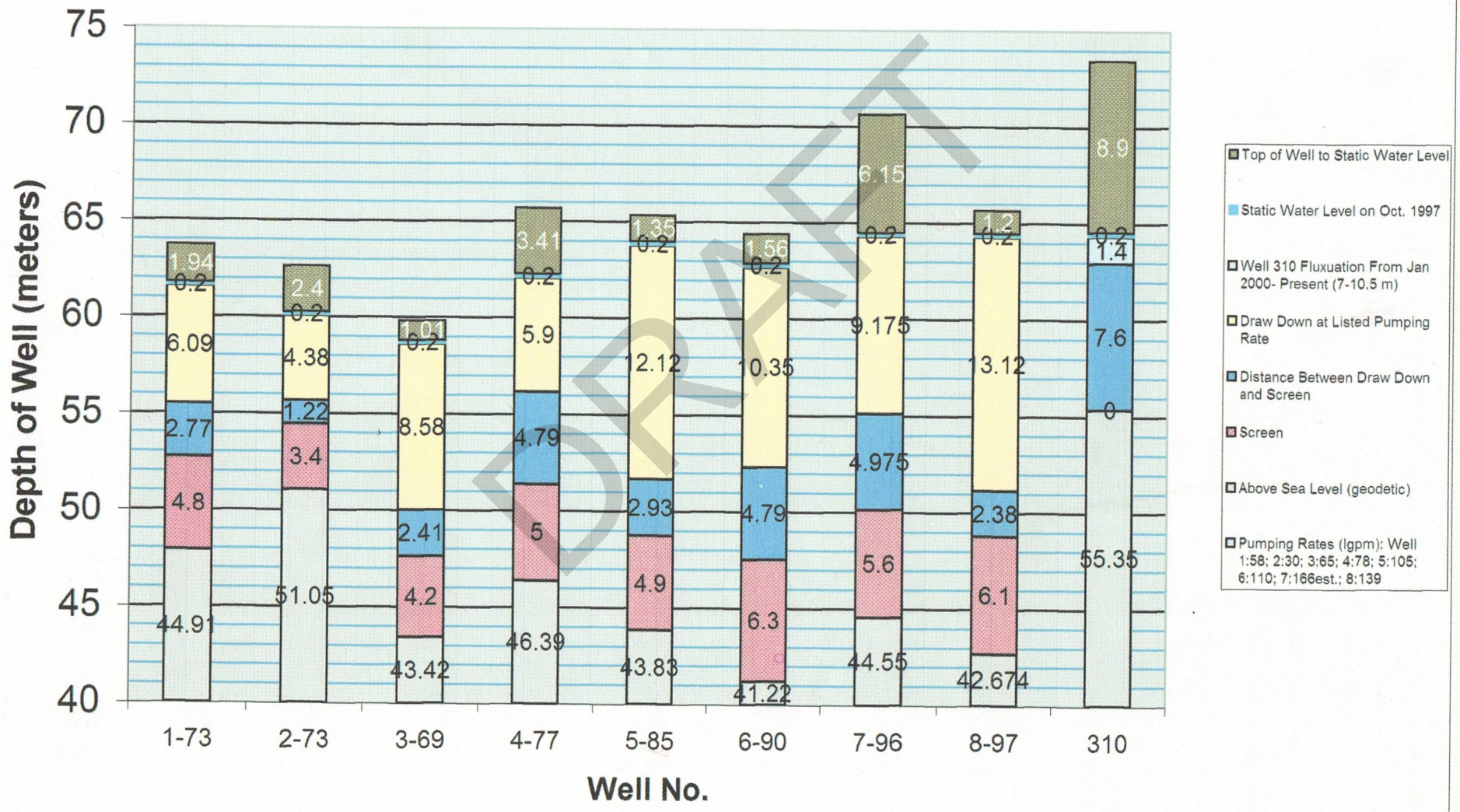
DRAFT


3 Electrodes
uspension Wires
Existing 8"ϕ Casing
2
wer Supply to Kiosk
dergroun in Rigid
nduit.
A
4"ϕ C.150 A.C.
1
32.5'
Bottom Electrode
1'-0"
33.5
End of
Bubbler Tube
36'
1'-0"
37'
15'-0"
.010" Slot S.S. Screen
52
Well Casing Cut-off
to be 4'-6" Max.
0
0-3 Silty Sand & Gravel
Static Water Level 7'
8'
Bottom of 10"ϕ Casing
10
3-18 Silty Sand with water below
20
30
18-52 Fine Brown Sand
Top of Screen 37'
Bottom of 8"ϕ Casing
40
50
52'
Bottom of Screen
60
52-82 Clay Till
70
80
DEEP BAY WATERWORKS DISTRICT
R.R. #1,
SITE 150, CMPT. 4,
BOWSER, B.C.
V0R 1G0
#1 WELL LOG
1" = 10'

WELL INFO # 1-8 incl. #310

Production Wells (depths: metric, geodetic)

(//daily well reading/analysis of production wells)



Preliminary analysis for discussion only

Payne Engineering Geology

Client: Deep Bay Waterworks Distri Date: 29/10/2015

Project: Well protection plan Rev: 1

File: DBI-2-1 By: M.J.Payne

Rev	Date	Note
R1	29/10/2015	Initial data from PHCL (2007) and other reports.

Water Well Summary

Well ID #			Year drilled	UTM coords, ground elev (m)				DIAMETERS (3)				Screen Depth				Length	DEPTHS (3)						ELEVATIONS (metres)					Well Yield (4)			WELL TEST (most recent)								Foot note
								Casing		Screen		Bottom		Top			Pump intake		SWL (1)		Casing		Intake		SWL	Ground	Casing				Start	Duration	Pumping rate		SWL	PWL	DD	T	S	
DBWD	Plate	Tag#		Z	East	North	Elev	in	mm	in	mm	ft	m	ft	m	m	ft	m	ft	m	ft	m	Bottom	Top	m	m	m	US gpm	Lps	cmpd	date	mins[1]	US gpm	Lps	m	m	m	sqm/d		
# 1	13731	28807	1973	10	375,934	5,478,965	60.12	8.0	200			52.0	15.8	36.0	11.0	4.9	0.0	0.0	7.3	2.2	-1.94	-0.59	44.3	49.1	57.9	60.12	60.71	78	4.9	425	24/04/2014	555	68	4.3	2.23	8.36	6.1			
# 2	13732	28811	1973	10	375,170	5,479,092	62.10	8.0	200			38.0	11.6	27.0	8.2	3.4			5.3	1.6	-1.80	-0.55	50.5	53.9	60.5	62.10	62.65	48	3.0	262		955	36	2.3	1.60	5.98	4.4			
# 3	13733	99102	1969	10	376,056	5,478,905	59.54	8.0	200			53.7	16.4	40.0	12.2	4.2			2.7	0.8	-0.92	-0.28	43.2	47.3	58.7	59.54	59.82	90	5.7	491		480	89	5.6	0.81	8.63	7.8			
# 4	13734	95534	1977	10	375,965	5,478,795	65.46					63.5	19.4	47.1	14.4	5.0			14.8	4.5	-0.75	-0.23	46.1	51.1	61.0	65.46	65.69	84	5.3	458		600	107	6.7	4.51	11.53	7.0			
# 5	13735	96930	1985	10	376,292	5,478,609	64.88	8.0	200			70.5	21.5	54.4	16.6	4.9			4.2	1.3	-1.48	-0.45	43.4	48.3	63.6	64.88	65.33	156	9.8	850		1,440	137	8.6	1.26	13.92	12.7			
# 6	13736	102152	1990	10	376,134	5,478,714	64.00	8.0	200			76.0	23.2	53.3	16.2	6.9			2.0	0.6	-1.38	-0.42	40.8	47.8	63.4	64.00	64.42	144	9.1	785		1,408	144	9.1	0.59	9.06	8.5	1,240		
# 7	255	63335	1996	10	376,115	5,478,606	70.05	8.0	200	7.0	180	85.6	26.1	67.3	20.5	5.6			17.9	5.4	-1.97	-0.60	44.0	49.5	64.6	70.05	70.65	0	0.0	0	22/05/1996	195	220	13.9	5.45	16.77	11.3	2,200		2
# 8	13737	74923	1997	10	376,416	5,478,514	65.26	8.0	200			75.4	23.0	58.4	17.8	5.2			4.9	1.5	-1.35	-0.41	42.3	47.5	63.8	65.26	65.67	174	11.0	948	30/10/1997	1,455	244	15.4	1.21	14.33	13.1	1,600		
Minimum:							59.54						11.6			3.4				0.6		-0.60	40.8		57.9			48	3.0	262										
Average:							63.93																																	
Maximum:							70.05						26.1			6.9				5.4		-0.23	50.5		64.6			174	11.0	948										

Footnotes

1) Static Water Level as reported by driller at time of drilling.

2) Provincial Observation Well # 331.

3) Well depths and diameters, and aquifer Transmissivity, from reports by Pacific Hydrology Consultants.

4) Well yield from DBID report (2014)

Preliminary analysis for discussion only

Payne Engineering Geology

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Project: Well protection plan Rev: 1
File: DBI-2-1 By: M.I.Payne

Rev	Date	Note
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								Casing		Screen		Bottom		Top			Pump intake		SWL (1)		Casing		Intake		SWL	Ground	Casing				Start	Duration	Pumping rate		SWL	PWL	DD	T	S	
DBWD	Plate	Tag#		Z	East	North	Elev	in	mm	in	mm	ft	m	ft	m	m	ft	m	ft	m	ft	m	Bottom	Top	m	m	m	US gpm	Lps	cmpd	date	mins	US gpm	Lps	m	m	m	sqm/d		
# 1	13731	28807	1973	10	375,934	5,478,965	60.12	8.0	200			52.0	15.8	36.0	11.0	4.9	0.0	0.0	7.3	2.2	-1.94	-0.59	44.3	49.1	57.9	60.12	60.71	78	4.9	425	24/04/2014	555	68	4.3	2.23	8.36	6.1			
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# 3	13733	99102	1969	10	376,056	5,478,905	59.54	8.0	200			53.7	16.4	40.0	12.2	4.2			2.7	0.8	-0.92	-0.28	43.2	47.3	58.7	59.54	59.82	90	5.7	491		480	89	5.6	0.81	8.63	7.8			
# 4	13734	95534	1977	10	375,965	5,478,795	65.46					63.5	19.4	47.1	14.4	5.0			14.8	4.5	-0.75	-0.23	46.1	51.1	61.0	65.46	65.69	84	5.3	458		600	107	6.7	4.51	11.53	7.0			
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# 6	13736	102152	1990	10	376,134	5,478,714	64.00	8.0	200			76.0	23.2	53.3	16.2	6.9			2.0	0.6	-1.38	-0.42	40.8	47.8	63.4	64.00	64.42	144	9.1	785		1,408	144	9.1	0.59	9.06	8.5	1,240		
# 7	255	63335	1996	10	376,115	5,478,606	70.05	8.0	200	7.0	180	85.6	26.1	67.3	20.5	5.6			17.9	5.4	-1.97	-0.60	44.0	49.5	64.6	70.05	70.65	0	0.0	0	22/05/1996	195	220	13.9	5.45	16.77	11.3	2,200		2
# 8	13737	74923	1997	10	376,416	5,478,514	65.26	8.0	200			75.4	23.0	58.4	17.8	5.2			4.9	1.5	-1.35	-0.41	42.3	47.5	63.8	65.26	65.67	174	11.0	948	30/10/1997	1,455	244	15.4	1.21	14.33	13.1	1,600		
Minimum:							59.54						11.6			3.4				0.6		-0.60	40.8		57.9			48	3.0	262										
Average:							63.93																																	
Maximum:							70.05						26.1			6.9				5.4		-0.23	50.5		64.6			174	11.0	948										

Footnotes

1) Static Water Level as reported by driller at time of drilling.
2) Provincial Observation Well # 331.
3) Well depths and diameters, and aquifer Transmissivity, from reports by Pacific Hydrology Consultants.
4) Well yield from DBID report (2014)

BRITISH COLUMBIA | Ministry of Forests, Lands and Natural Resource Operations

Well Inspection Report

38000-25 / Nanaimo

Inspection Date: 2022-07-21 / Time: 8:50:03 AM

Inspector: Nicole Fulcher

Site or Water System Name: Deep Bay Improvement District #1

Well Owner: Deep Bay Waterworks

Phone No: 250-757-9312

Mailing Address: 5031 Mountainview Road, Bowser, V0G 1G0

Site Contact: Don Buchner (operator)

Phone No: 250-757-8757

Site Coordinates: Longitude Latitude

Manual Coordinates: Longitude 124.71165 Latitude 49.45057

Location Address: 5031 Mountainview Rd, Bowser

Legal Property Description (e.g. PID, lot):

Well Location Description: Southeast of firehall in concrete basin

Well Tag Number: 28807

Well ID Plate Number: 13731

ID Plate Location: Attached to piping

Construction Date: 1973-09-05

Construction Method: Drilled

Class Of Well: Water supply

Subclass Of Well: Municipal

Driller Name: Unknown

Driller Company: Drillwell Enterprises

Driller Registered: Yes

Driller Supervisor:

Driller Class: Water Well

Pump Installer Name: Unknown

Pump Installer Company: Unknown

Pump Installer Registered:

Pump Installer Supervisor:

WELLS Record Data Update: No

Data Field To Update:

Reason For Change:

Well Status: Active

Well Head Location: Well pit

Well Pit Drained: Yes

Estimated Distance To Nearest Water Well: meters

Secure Well Cap Cover: Yes

Type Of Cap: Sanitary seal

	Meters	Feet
Well Depth:	25.0	82.0
	CM	Inches
Well Diameter:	20.3	8.0
Casing Stick Up:	60.0	23.6

Static Water Level:

Measurement Method:

Pumping Rate: M^3 /Day

Notes:

Electrical Conductivity:

Surface Seal: No

Flowing Well: No

Clear Access To Well: Yes

No Foreign Matter Within 3m: Yes

Wellhead Graded: Yes

Well Maintenance: Good

Issues identified for follow up based on *Water Sustainability Act* and *Groundwater Protection Regulation* Requirements: No

Photographs Taken: Yes

Comments And Recommended Actions:

This well is not currently being used until a geotechnical report is done because the nearby septic was recently moved. The well is still pumped monthly pump and discharged to ground with check valve.

No compliance issues were identified during the inspection.

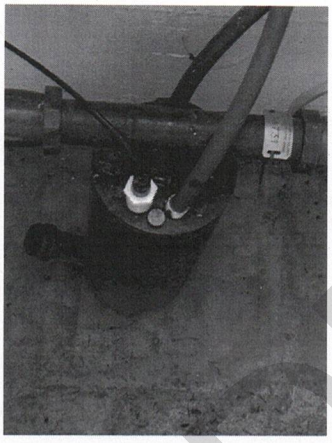
Inspector Signature:

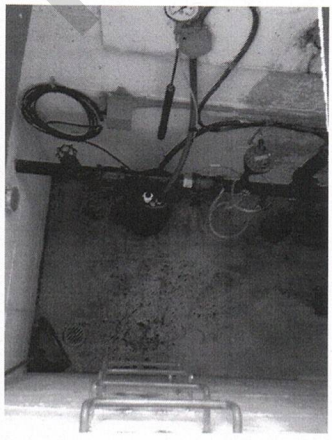
Nicole Fulcher

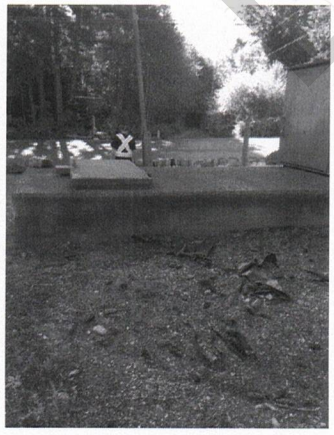
FLNRO Regional Office Contact Info:

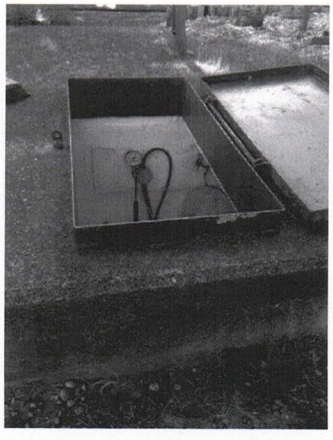
Nicole Fulcher, FOR, West Coast, 2080 Labieux Road, Nanaimo, BC, V9T 6J9 (250)739-8339
Nicole.Fulcher@gov.bc.ca

Site Pictures:









Original to File

Copy Hand Delivered to: ☐ Well Owner ☐ Site Contact ☐ Contractor ☐ Environmental Health Officer

Copy Mailed/Emailed to: ☒ Well Owner ☐ Site Contact ☐ Contractor ☐ Environmental Health Officer

Government of British Columbia Water Website: www.gov.bc.ca/water

Appendix E

Water Quality Results

Table E1: Summary of Analytical Programs

Well Name	Date	Microbiology	Major Ions and Nutrients	General Chemistry	Total Metals
Well #1	1977-06-27		X	X	
Well #1	2003-01-21	X	X	X	X
Well #1	2006-02-15	X	X	X	X
Well #1	2011-05-10	X	X	X	X
Well #1	2012-10-24	X	X	X	X
Well #1	2013-11-18	X	X	X	X
Well #1	2014-11-17	X	X	X	X
Well #1	2015-12-08	X	X	X	X
Well #1	2016-12-06		X	X	X
Well #1	2017-11-08		X	X	X
Well #1	2018-11-15	X	X	X	X
Well #1	2019-11-21		X	X	X
Well #1	2020-11-19		X	X	
Well #1	2021-10-18	X			
Well #1	2021-11-15	X			
Well #1	2021-11-22	X			
Well #1	2021-11-29	X			
Well #1	2021-12-14	X	X	X	
Well #1	2022-01-24	X			
Well #1	2022-02-22	X			
Well #1	2022-03-21	X			
Well #1	2022-04-04	X			
Well #1	2022-04-19	X			
Well #1	2022-07-02	X			

Table E2: Summary of Microbiology Results

Sample Location	Sample Date	E. Coli	Total Coliforms
Guidelines	Units	MPN/100mL	MPN/100mL
	GCDWQ AO	-	-
	GCDWQ MAC	0	0
Well #1	2003-01-21	-	<1
Well #1	2006-02-15	-	0
Well #1	2011-05-10	<1	<1
Well #1	2012-10-24	<1	<1
Well #1	2013-11-18	<1	<1
Well #1	2014-11-17	<1	<1
Well #1	2015-12-08	0	0
Well #1	2018-11-15	<1	<1
Well #1	2021-10-18	<NC	<NC
Well #1	2021-11-15	<NC	<NC
Well #1	2021-11-22	<NC	<NC
Well #1	2021-11-29	<NC	<NC
Well #1	2021-12-14	<1.8	<1.8
Well #1	2022-01-24	<NC	<NC
Well #1	2022-02-22	<NC	<NC
Well #1	2022-03-21	<NC	<NC
Well #1	2022-04-04	<NC	<NC
Well #1	2022-04-19	<NC	<NC
Well #1	2022-07-02	<NC	<NC

Notes:
GCDWQ represents the Guidelines for Canadian Drinking Water Quality, Summary Table (Health Canada, September 2022). Guidelines are health based and listed as maximum acceptable
Laboratory results that were less than detection limits and greater than the applied guidelines are not shown as exceedances.
Violet highlight - Value exceeds the Aesthetic Objectives (AO).
Yellow highlight - Value exceeds the Maximum Allowable Concentration (MAC).
MPN means Most Probable Number, NC means No Count

Table E3: Summary of Major Ion and Nutrient Parameter Concentrations

		Major Ions											Nutrients			
Sample Location	Sample Date	Calcium (Ca)-Dissolved	Chloride (Cl)	Fluoride (F)	Iron (Fe)-Dissolved	Magnesium (Mg)-Dissolved	Manganese (Mn)-Dissolved	Potassium (K)-Dissolved	Sodium (Na)-Dissolved	Sulphate (SO_4)	Sulphide	Ammonia (N)	Nitrate-N	Nitrite-N	Organic Nitrogen-Total (as N)	Phosphorus (P)-Total
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines	GCDWQ AO	-	250	-	0.3	-	0.02	-	200	500	0.05	-	-	-	-	-
	GCDWQ MAC	-	-	1.5	-	-	0.12	-	-	-	-	-	10	1	-	-
Well #1	1977-06-27	6.7	2	0.05	-	1.2	-	0.2	2.7	1.6	-	-	<0.10	-	-	-
Well #1	2003-01-21	-	1.6	0.08	-	-	-	-	-	0.26	-	-	0.07	0.01	-	-
Well #1	2006-02-15	-	2.2	<1.0	-	1.8	-	-	-	<2.0	-	-	<0.1	<0.1	-	-
Well #1	2011-05-10	8.3	2.3	<1.0	-	1.97	-	0.2	2.5	<2.0	<0.005	<0.05	<0.1	<0.1	<0.08	<0.01
Well #1	2012-10-24	9.03	1.6	<0.05	-	2	-	0.2	2.8	0.6	-	0.06	<0.05	<0.05	-	-
Well #1	2013-11-18	4.63	1.6	<0.05	-	0.86	-	0.2	2.1	<0.5	-	<0.02	<0.05	<0.05	-	-
Well #1	2014-11-17	4.63	1.9	<0.05	-	0.86	-	0.2	2.1	0.6	-	<0.02	<0.05	0.09	-	-
Well #1	2015-12-08	9.6	1.8	0.026	-	2.5	-	0.31	3.07	0.69	-	0.018	0.034	<0.0050	-	0.013
Well #1	2016-12-06	-	1.64	<0.02	-	-	-	-	-	0.6	-	<0.01	0.023	<0.005	-	-
Well #1	2017-11-08	-	1.57	<0.02	-	-	-	-	-	0.6	-	<0.01	0.022	<0.005	-	-
Well #1	2018-11-15	8.54	1.5	<0.02	0.01	2.09	<0.001	0.19	2.48	0.7	<0.01	<0.01	0.013	<0.005	<0.05	0.009
Well #1	2019-11-21	8.49	1.32	<0.02	-	1.99	-	-	-	0.7	-	0.02	0.028	<0.005	-	-
Well #1	2020-11-19	-	1.25	<0.02	<0.01	-	-	0.23	-	0.7	-	<0.01	0.025	<0.005	-	-
Well #1	2021-12-14	8.66	1.3	<0.02	0.05	2.03	<0.001	0.3	2.47	0.5	<0.02	<0.05	0.032	<0.005	<0.05	<0.08

Notes:
GCDWQ represents the Guidelines for Canadian Drinking Water Quality, Summary Table (Health Canada, September 2022). Guidelines are health based and listed as maximum acceptable concentrations (MAC), or based on aesthetic considerations and listed as aesthetic objectives (AO).
Violet highlight - Value exceeds the Aesthetic Objectives (AO).
Yellow highlight - Value exceeds the Maximum Allowable Concentration (MAC).
mg/L means milligrams per litre

Table E4: Summary of General Chemistry Parameter Concentrations

Sample Location	Sample Date	Colour	Alkalinity, Total (as $CaCO_3$)	Conductivity (EC)	Hardness (as $CaCO_3$)	Dissolved Organic Carbon (DOC)	Total Dissolved Solids-Calculated	Bromide	Turbidity	UV Transmittance (254nm)	pH
Guidelines	Units	TCU	mg/L	µS/cm	mg/L	mg/L	mg/L	mg/L	NTU	cm-1	-
	GCDWQ AO	15	-	-	-	-	500	-	0.1	-	7-10.5
	GCDWQ MAC	-	-	-	-	-	-	-	-	-	-
Well #1	1977-06-27	<5	33.5	51.5	21.7	-	50	-	0.6	-	6.8
Well #1	2003-01-21	4	36	76.1	28.3	-	53	-	0.0	-	7.02
Well #1	2006-02-15	<5	34	67.2	27	-	73	-	<0.5	-	7.10
Well #1	2011-05-10	<5	31	72.1	29	-	64	-	<0.5	-	7.10
Well #1	2012-10-24	<1	32	-	31	-	49	-	0.7	100	7.00
Well #1	2013-11-18	21	20	-	15	-	28	-	4.5	98.4	7.00
Well #1	2014-11-17	5	20	-	15	-	48	-	4.5	99	7.00
Well #1	2015-12-08	10	36.3	-	34.4	-	40	-	3.5	>97.7	7.70
Well #1	2016-12-06	<5	-	-	29.6	-	-	<0.05	<0.1	-	7.14
Well #1	2017-11-08	<5	-	-	-	-	-	<0.05	0.2	-	7.11
Well #1	2018-11-15	<5	37	74	29.9	0.6	72	<0.05	2.4	-	7.23
Well #1	2019-11-21	<5	-	-	29.4	-	-	<0.05	0.7	-	7.34
Well #1	2020-11-19	<5	-	-	29.8	-	-	<0.05	1.5	-	7.56
Well #1	2021-12-14	-	33	72	30	658.0	75	<0.05	1	-	7.39

Notes:

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Violet highlight - Value exceeds the Aesthetic Objectives (AO).

Yellow highlight - Value exceeds the Maximum Allowable Concentration (MAC).

mg/L means milligrams per litre, µS/cm means micro Siemens per centimeter, °C means degrees celcius, TCU means True Color Unit, NTU means Nephelometric Turbidity Unit, cm-1 means molar absorptivity

Table E5: Summary of Total Metal Concentrations

Sample Location	Sample Date	Aluminum (Al)-Total	Antimony (Sb)-Total	Arsenic (As)-Total	Barium (Ba)-Total	Boron (B)-Total	Cadmium (Cd)-Total	Calcium (Ca)-Total	Chromium (Cr)-Total	Copper (Cu)-Total	Iron (Fe)-Total	Lead (Pb)-Total	Magnesium (Mg)-Total	Manganese (Mn)-Total	Mercury (Hg) - Total	Potassium (K)-Total	Selenium (Se)-Total	Sodium (Na)-Total	Strontium (Sr)-Total	Uranium (U)-Total	Zinc (Zn)-Total
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines	GCDWQ AO	0.1	-	-	-	-	-	-	-	1	0.3	-	-	0.02	-	-	-	200	-	-	5
	GCDWQ MAC	2.9	0.006	0.01	2	5	0.007	-	0.05	2	-	0.005	-	0.12	0.001	-	0.05	-	7	0.02	-
Well #1	1977-06-27	-	-	-	-	-	-	-	-	-	0.012	-	-	0.022	-	-	-	-	-	-	-
Well #1	2003-01-21	0.007	<0.0002	<0.0002	0.001	0.003	<0.00001	8.2	0.0008	<0.001	<0.1	0.0002	1.9	<0.005	<0.0000002	<0.4	<0.0002	2.5	-	<0.0005	0.010
Well #1	2006-02-15	<0.005	<0.0002	<0.0002	<0.001	0.004	<0.00001	8.0	0.0006	<0.001	<0.1	0.0004	1.8	<0.005	<0.0000001	<0.4	<0.0002	2.40	-	<0.0005	0.044
Well #1	2011-05-10	<0.005	<0.0002	0.0002	<0.001	<0.005	<0.00001	8.3	0.0005	<0.001	0.015	0.0003	1.97	<0.005	<0.00000001	0.2	<0.0006	2.5	0.022	<0.0004	0.095
Well #1	2012-10-24	0.006	<0.0001	<0.00005	0.001	0.003	0.00001	9.0	0.0005	0.0008	0.042	0.0003	2	0.0009	-	0.2	<0.0001	2.8	0.0216	<0.00001	0.043
Well #1	2013-11-18	<0.005	<0.0001	<0.00005	0.000	0.002	<0.00001	4.6	0.0005	0.0054	0.358	0.0034	0.86	0.0056	-	0.2	<0.0001	2.1	0.0238	<0.00001	0.016
Well #1	2014-11-17	<0.005	<0.0001	<0.00005	0.006	0.003	<0.00001	9.3	0.0007	0.0018	0.05	0.0018	2	0.0019	-	0.2	<0.0001	2.6	0.0217	<0.00001	0.040
Well #1	2015-12-08	0.038	<0.0005	<0.0001	<0.001	<0.050	0.00003	9.6	<0.001	0.1140	0.442	0.0143	2.5	0.0066	-	0.31	<0.0001	3.07	0.027	<0.0001	0.224
Well #1	2016-12-06	-	-	-	-	-	-	-	-	-	<0.010	0.00015	-	-	-	0.206	-	-	-	-	0.016
Well #1	2017-11-08	-	-	-	-	-	-	-	-	-	0.03	0.00039	-	-	-	0.3	-	-	-	-	0.020
Well #1	2018-11-15	-	-	-	-	-	-	-	-	-	0.03	0.00039	-	-	-	0.3	-	-	-	-	0.020
Well #1	2019-11-21	-	-	-	-	-	-	-	-	-	0.02	0.00007	-	-	-	0.25	-	-	-	-	0.0160
Well #1	2021-12-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
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Violet highlight - Value exceeds the Aesthetic Objectives (AO).
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mg/L means milligrams per litre

Appendix F

Water Well Disinfection

Water Well Disinfection

Using the Simple Chlorination Method

USING THE SIMPLE CHLORINATION METHOD

The Groundwater Protection Regulation (Regulation) requires a well driller to disinfect a water supply well promptly after it has been drilled, altered, developed, or rehabilitated. The Regulation also requires a well pump installer to disinfect a water supply well and well pump promptly after installing the pump in the well. Well disinfection is used to inactivate or control micro-organism populations in a well and the distribution system. A well owner may disinfect their own well; however, care should be exercised to ensure disinfection is effective and safe. There are several methods used to disinfect water wells including simple chlorination, shock chlorination or bulk displacement. This brochure describes the simple chlorination method. For wells that are hard to disinfect, consult a well driller or a well pump installer.

ARE THERE THINGS I NEED TO DO BEFORE DISINFECTING MY WELL?

A well should be tested regularly for water quality. If coliforms or Escherichia coli (E. coli) are repeatedly detected in your well water, the first step to take to eliminate them is to look for the following:

- Are there any potential sewage contamination sources near the well, such as manure or compost piles or septic disposal fields?
- Does the ground slope promote drainage of surface water toward the well or ponding of water around the wellhead?
- Is the well cap missing, cracked or damaged? Does the well cap allow water or vermin to enter into the well?
- Is the well casing stickup less than 30 cm (1 ft) above the ground surface (see Figure 1) or the floor of the pump house? Can surface or standing water easily flood over the top of the well casing?
- Is there a space or gap between the well casing and the ground around the well (see Figure 2) , thus indicating that the surface seal is missing or incomplete? Are there noticeable cracks in the surface seal around the well casing?
- Is the well finished below grade?

If you answered **"YES"** to any of the above questions, fix the problem before proceeding with disinfection. Otherwise the well will continue to be vulnerable to contamination.

FIGURE 1 *Well casing stickup less than 30 cm (1ft) from the ground surface*

FIGURE 2 *Well with gap between casing and ground – no surface seal*

NOTE: A registered well driller or pump installer must be hired to repair or install a surface seal for a well, or to add casing to increase the well stickup.

ARE THERE ANY SAFETY PRECAUTIONS TO TAKE?

Chlorine is volatile so it is dangerous to work with in confined areas where vapours can accumulate such as in pump houses, well pits and crawl spaces. Caution should be used when working in these situations – WorkSafeBC rules for confined spaced entry must be followed.

Prepare the chlorine solution outside in a well-ventilated area and wear appropriate safety clothing and equipment to protect your eyes and skin from splashes and spills.

If you have any concerns or need help with disinfecting your well contact a well driller or a well pump installer.

WHAT ARE THE LIMITATIONS OF THE SIMPLE CHLORINATION METHOD?

Simple chlorination only inactivates or eliminates the micro-organisms present in the well, on the pumping equipment or in the distribution system. It will not kill bacteria in the aquifer beyond the immediate location of the well. If there is some external source of contamination, the problem will only be solved temporarily by disinfecting the well itself. A well must be protected from contamination through proper siting, construction and maintenance and by keeping drainage and foreign matter away from the area around the wellhead.

Nuisance bacteria such as iron-related or sulphate-reducing bacteria are often found in groundwater and water wells. If uncontrolled, these bacteria can colonize the intake area of a well. The colonies form a sticky, slimy substance called biofilm (see Figure 3 below), which can reduce well production and degrade water quality. Also, minerals in groundwater can settle out and accumulate on well screens over time. The simple chlorination method is not effective in penetrating or removing biofilm and mineral build-up. To prevent the accumulation of biofilm and minerals regular disinfection of the well is recommended in cases where bacteria have been detected.

FIGURE 3 *Biofilm on well wiring*

If the well has never or infrequently been disinfected or coliforms or E. coli continue to be detected in the water, hire a registered well driller or well pump installer to remove the pump and clean the casing and screen before repeating disinfection using the shock chlorination method.

WHAT ARE THE STEPS FOR DISINFECTING A WATER WELL?

STEP 1 – BEFORE DISINFECTING THE WELL

Notify all users of the well not to drink the water or bathe in it while the strong solution of chlorine is present in the system and to store sufficient water for use during a 12-hour period.

Bypass or disconnect any carbon filters or water treatment devices before disinfecting. Carbon filters will remove the chlorine from the water – distribution pipes located past these filters will not be disinfected if the filters are not removed.

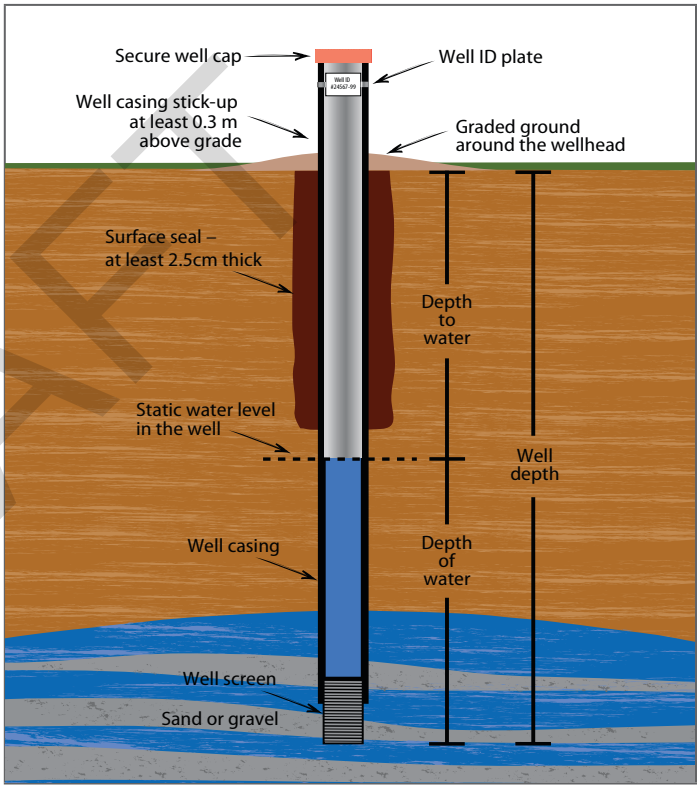

FIGURE 4 *Cross-section of well showing main features and measurements*

STEP 2 – DETERMINE THE VOLUME OF WATER IN THE WELL AND THE PH OF THE WELL WATER

The diameter and depth of the well and the static water level can be found on the driller's well construction report. If this information is not available, contact a registered well driller or well pump installer for help to take measurements. The depth of water = well depth – static water level (see Figure 4).

Test the pH of the well water. Ideally, the pH should be 7 or less. If it is above 7, add one litre of vinegar or citric acid to the well and re-test the pH in the well water before proceeding.

STEP 3 – ADD CHLORINE SOLUTION TO THE WELL

Estimate the amount of domestic bleach (see Table 1) or chlorine tablets or powder (see Table 2) needed. Follow the recommended chlorination guidelines; over chlorination can have a negative effect on the disinfection process.

A. *For wells without a pump (e.g., new well) using domestic bleach*

Mix the volume of bleach needed with at least 45 litres (10 gallons) of water. Pour the solution into the well and leave it for approximately 12 hours. When the pump is installed, pump for at least one hour to remove the chlorine solution.

B. *For wells with a pump using domestic bleach*

Turn off power to the pump. Mix the volume of bleach needed with at least 45 litres (10 gallons) of water. Remove the well cap[1] and lift the wires out and pull to one side. Clean the cap to remove debris, dirt and oil and place in a clean container. Pour or siphon the chlorine solution into the well between the drop pipes (pipes that carry water from a pump in a well to the surface) or pour the solution directly into the well. Some wells have a sanitary seal (see Figure 5) with either an air vent or plug that can be removed to add the chlorine mixture – contact a registered well driller or well pump installer for assistance, if required.

FIGURE 5 *Well with sanitary seal type cap*

FIGURE 6 *Well fitted with pitless adapter, cap has space for wiring*

If possible, mix the water in the well by attaching a clean hose to a nearby water tap or hydrant, place the hose into the top of the well casing, and run the water from the hose, which is sourced from the well, back into the well.

NOTE: The power to the well pump will need to be turned back on. After mixing, let the water stand in the well for two hours before proceeding to the next step.

1 **CAUTION:** *Do not loosen or remove any of the bolts in the top of the sanitary well seal.*

C. *For wells with a pump using chlorine tablets or powder*

Dissolve the required weight of tablets or powder in warm water, remove the well cap, pour the solution into the well, mix if possible and let stand for two hours (see instructions above).

STEP 4 – MOVE THE CHLORINATED WATER INTO THE DISTRIBUTION SYSTEM

Turn the well pump on. Open all taps, one at a time, including outside hose bibs and cold and hot water taps. Flush toilets and fill washing machines and dishwashers. Allow the water to run until a chlorine smell is detected from each faucet or there is a slippery feeling to the water, then turn off each tap. Open the valve or plug at the top of the pressure tank just before stopping the pump to allow the solution to contact the entire inside surface of the tank. Then close the valve or plug. Back flush any water softener devices and all water filters (except carbon filters). Replace carbon filters to avoid reintroducing bacteria into the system. Plumbing grit and solid mineral particles may form during disinfection and may clog faucet aerators, flush valves and equipment using filters. Faucet aerators may need to be removed if clogging occurs. If a strong chlorine odour is not present, return to step 3, add half the amount of chlorine used for the initial treatment to the well and repeat step 4.

Replace the well cap and leave the chlorine solution in the distribution system for at least 12 hours.

STEP 5 – FLUSH THE CHLORINE OUT OF THE WELL AND DISTRIBUTION SYSTEM

Open an outside tap and run the chlorinated water from the well to an area where plants or aquatic areas won't be harmed. Do not run the water into your septic system as the chemicals and the amount of water required to flush the system may overload or damage the septic system. Do not drain the water into a stream, ditch or storm drain that connects with any fish-bearing streams.

When a chlorine smell is no longer present, run the indoor hot and cold water taps to flush out the hot water tank and plumbing (this small amount of chlorine will not harm the septic system). It may take as little as half an hour or as long as four days to completely remove the chlorine odour from the water system.

DO NOT OVERPUMP THE WELL! If the well is low-yielding or pumps silt or sand, slowly flush the well – watch the water coming from the hose to make sure there is no sediment in it. Over-pumping may worsen the sediment problem. It may be necessary to stop and start the pump if it is losing its prime.

STEP 6 – SAMPLE THE WELL WATER

A water sample should be collected for analysis one week after chlorination to verify the water is safe to use. Do not drink the water without boiling it until test results show it is safe to drink. Retest again one month after disinfection to ensure the water is potable.

TABLE 1 *Volumes of domestic bleach* needed for a 200 ppm chlorine solution.*

WELL DIAMETER		DOMESTIC BLEACH* (5-6%) NEEDED PER 3 M (10 FT) OF WATER		
inches	mm	metric	US gallons	other
4	100	100 mL	0.02	5 tbsp
5	130	150 mL	0.04	10 tbsp
6	150	200 mL	0.05	13 tbsp
8	200	360 mL	0.09	1.5 cups
10	250	560 mL	0.15	2.5 cups
12	300	808 mL	0.21	3.5 cups
24	610	3.3 L	0.9	14.6 cups
36	914	7.5 L	2.0	
48	1219	13.3 L	3.5	

***NOTE:** Domestic bleach has an expiry date and should be used before this date for effective disinfection. Purchase only the amount needed and use it all. Use only unscented plain domestic bleach without fabric softeners or other additives.

TABLE 2 *Dry weight of chlorine tablets* needed for a 200 ppm chlorine solution*

WELL DIAMETER		DRY WEIGHT OF CHLORINE TABLETS (65-75%) PER 3 M (10 FT) OF WATER	
inches	mm	oz	grams
4	100	0.3	9
5	130	0.5	15
6	150	0.7	20
8	200	1.3	36
10	250	2.0	57
12	300	2.9	82
24	610	11.9	337
36	914	26.7	758
48	1219	47.4	1347

***NOTE:** Make sure the chlorine tablets are for potable water, e.g. not for swimming pools or hot tubs.

WHEN SHOULD A WELL BE DISINFECTED?

The simple chlorination method is used:

- following construction of a new well,
- following alteration of an existing well,
- following well pump installation, maintenance or repair, or
- when the well has tested positive for coliforms or E. coli.

The micro-organisms found in the soil at or near the well site can be picked up on drilling tools, pipes and well pumps during construction or servicing of a well. If disease-causing organisms are present they may be introduced into the well. Therefore, the Regulation requires that every well, after construction or repair, must be disinfected.

FOR FURTHER INFORMATION

For further information on whether the well water is safe to drink contact your local Health Authority: *look for listings online or in your local phone directory.*

The registers of well drillers and well pump installers in British Columbia can be found at: *http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells/information-for-well-drillers-well-pump-installers*

BRITISH COLUMBIA

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Photos by Sylvia Kenny, Peter Epp and Greg Farley