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Our File: 241

June 4, 2019

Cortes Island Seniors Society
Manson's Landing
Cortes Island, B.C.
V1M 3G5

Attention: Sandra Wood, Housing Project Coordinator

Dear Sirs:

Re: New Well for Seniors Village, 951 Beasley Road, Cortes Island

Elanco Enterprises Ltd. (Elanco) was retained by the Cortes Island Seniors Society (CISS) to conduct a hydrogeological assessment of the yield sustainability and risk from contamination when a new well on the 951 Beasley Road property (the Property) is placed in production. It is understood that this well would service up to 10 housing units.

Well Information and Location

The new well is located south of the existing Beasley Road health clinic and about 27 meters (m) west of an existing well that serves the clinic and six housing units (see Figures 1 and 2).

The New Well is 82.3m deep and was constructed in late May 2019 (see log on Fig. 3). Soon after construction a 4.5 hour pumping test was conducted on the well and a water sample collected and sent to a laboratory for a complete potability analysis. The results of these tests are provided in the latter part of this report.

Hydrogeological Setting

The sediments underlying the Property are profiled on Figs. 3 and 4. The upper dense silty sand and gravel cobbley unit extends over a wide area and on a regional scale is mapped as being a drift deposit associated with the Fraser Glaciation (Vashon Till). Underlying this unit is the Quadra Sand unit, which is a fine to medium sand of glaciofluvial origin.

According to the Ministry of Environment website there is extensive sand and gravel aquifer present below the Manson's Landing area. This has been designated as Aquifer 0841 and underlies most of the Sutil Peninsula. This 9.5 Km^2 aquifer was rated as having a low vulnerability to contamination from surface sources and the estimated volume of water being abstracted relative to its potential yield volume (the demand) was low.

The test pits dug on the adjacent property (965 Beasley Road) and the presence of a boggy area and many dug wells in the area confirm that an areally extensive hydraulic restrictive layer is present throughout most of the area. This unit is likely comprised of soil derived from the Vashon till unit that typically overlies the Quadra Sand Unit, where the aquifer is present.

Seepage from the south end of Hague Lake recharges the local aquifer which sustains a southwesterly groundwater flow towards Georgia Strait. As the fine to medium sand aquifer unit is very permeable, the gradient is relatively flat as it approaches the ocean.

Well Yield and Sustainability

At the time of construction, the drilling contractor estimated that the short term well yield was about 10 gpm. However, a pump test run on the well showed that the drawdown after 4.5 hours of pumping at this rate was 2.25m. After allowing for long term trends and pump suction, it is estimated that the well is capable of sustaining a yield of about 20 gpm.

The B.C. Department of Highways typically requires proof of a 2.5 cubic metre per day water supply to each residence on a subdivided lot. If this was the requirement for the planned 10 units, the sustainable yield from the well would need to be 3.8 gpm. However, the measured water consumption for a typical Gulf Island property is typically less than half the 2.5 m^3 daily volume, which confirms that the new well can easily supply the water required for the 10 housing units.

During the pump test water levels were monitored in the Clinic well, which is screened in the same aquifer and located about 27m west of the New Well. The measured drawdown was 0.05m, which confirmed that the aquifer is very permeable and that pumping from the New Well will have negligible impact on neighbouring wells.

Water Quality and Potential for Contamination

The results of the laboratory analysis of the New Well water sample are presented on Table I, along with test results from other local area wells and Canadian Drinking Water Quality (CDWQ) guideline for individual parameters. This shows that the New Well has excellent water quality and meets the CDWQ standard. As some of the nearby wells had elevated iron concentrations, the sediment profile in the New Well was carefully assessed during construction to identify the elevation in the aquifer where dissolved iron in the groundwater would potentially have the lowest concentration. As the concentrations of dissolved iron and manganese in groundwater are influenced by oxygen concentrations, migrating plumes of these metals are rare. This leads to the conclusion that the concentrations of these metals are not likely to change with time when the New Well is in operation.

Locations of the nearest septic tank and effluent dispersal field are indicated on Fig. 2 and, as can be seen, these are more than 30m from the New Well. The presence of the 20m thick near-surface Vashon till unit provides an excellent barrier against downward migration of contaminants escaping from these, and any other potential sources, into the underlying aquifer. In addition, the 50m thick fine to medium unsaturated sand unit above the water table provides a very effective contaminant filter.

Conclusions.

- The 82.3 m deep New Well has a sustainable yield that can easily supply the water requirement for the proposed 10 new housing units.
- The well water quality is excellent and meets the Canadian Drinking Water Quality Guideline.

- The 20m thick near surface low permeability till unit and the 50m thick unsaturated sand unit provides a very effective barrier against the migration of surface contaminants into the aquifer which will sustain the New Well.

I trust that this sufficient for your present purposes.

Yours truly,

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Elanco Enterprises Ltd.

R. Allan Dakin, FEC, P. Eng.
(Senior Groundwater Engineer)

Table

Table I
Manson's Landing Area Well Water Quality

Parameter	Detection Limit	Units	Client Sample ID	New Senior's Village Well	Cortes Island Health Center (WTN = 93932)		Cortes Natural Food Coop (Well B)	CDWQ Guideline		
			Date Sampled	14-May-2019	20-Jul-2005	25-Mar-2013	8-Dec-2017	MAC	AO	IMAC
			Time Sampled	7:30 AM			6:45			
			Laboratory	ALS Eviro	CanTest	North Is. Lab	Maxxam			
			Lab Sample ID	L2273086	507220445	101537	08441366			
Physical Tests (Water)										
UV Absorbance (254 nm)	0.001	Abs/cm		0.004	-	-	-	-	-	-
Colour, True	5	CU		<5.0	<5	-	30	-	15.0	-
Conductivity	2	uS/cm		168	-	-	86.5	-	-	-
Hardness (as CaCO3)	0.5	mg/L		7.44	43	55	21.8	-	-	-
pH	0.1	pH		7.91	7.47	7.30	7.57	-	6.5:10	-
Total Suspended Solids	3	mg/L		3.8	-	-	-	-	-	-
Total Dissolved Solids	20	mg/L		134	98	108	48	-	500	-
Turbidity	0.1	NTU		1.1	5.9	-	6.05	-	-	-
Transmittance, UV (254 nm)	1	%T/cm		99.1	-	-	-	-	-	-
Anions and Nutrients (Water)										
Alkalinity, Total (as CaCO3)		mg/L		72.2	57.7	-	27.3	-	-	-
Bircarbonate alkalinity (as HCO3)		mg/L		-	70	-	33.4	-	-	-
Carbonate alkalinity (as CO3)		mg/L		-	<0.5	-	<1	-	-	-
Hydroxide alkalinity (as OH)		mg/L		-	<0.5	-	<1	-	-	-
Bromide (Br)	0.05	mg/L		<0.05	-	-	-	-	-	-
Chloride (Cl)	0.5	mg/L		8.16	9	11	8.0	-	250	-
Fluoride (F)	0.02	mg/L		<0.02	-	<0.05	<0.02	1.5	-	-
Ammonia, Total (as N)	0.0050	mg/L		<0.0050	-	-	<0.02	-	-	-
Nitrate (as N)	0.0050	mg/L		1.27	-	1.43	0.054	10	-	-
Nitrite (as N)	0.0010	mg/L		<0.0010	-	<0.05	<0.005	1	-	-
Sulfate (SO4)	0.30	mg/L		1.54	1.1	1	3.3	-	500	-
Sulphide as S	0.020	mg/L		<0.018	-	-	0.0146	-	-	-
Organic / Inorganic Carbon (Water)										
Dissolved Organic Carbon	0.50	mg/L		<0.50	-	-	-	-	-	-
Total Organic Carbon	0.50	mg/L		<0.50	-	-	1.29	-	-	-
Bacteriological Tests (Water)										
E. coli		MPN/100mL		<1	-	-	1	<1	-	-
Fecal coliform bacteria		MPN/100mL		<1	-	-	-	<1	-	-
Coliform bacteria - Total		MPN/100mL		<1	-	-	7	<1	-	-
Non coliform bacteria - Total		MPN/100mL		-	-	-	-	-	-	-
Heterotropic Plate Count		CFU/mi		9	-	-	220	-	-	-
Iron Bacteria		CFU/mi		-	-	-	<25	-	-	-
Sulphate Reducing Bacteria		CFU/mi		-	-	-	**<25**	-	-	-
Total Metals (Water)										
Aluminum (Al)-Total	0.0030	mg/L		0.0399	<0.005	0.010	<0.003	-	-	0.01
Antimony (Sb)-Total	0.0001	mg/L		0.00012	<0.001	<0.0001	<0.0005	0.006	-	-
Arsenic (As)-Total	0.0001	mg/L		0.00024	<0.001	<0.00005	<0.0001	0.01	-	-
Barium (Ba)-Total	0.000050	mg/L		0.00312	0.009	0.0103	0.0017	1	-	-
Beryllium (Be)-Total	0.00010	mg/L		<0.00010	-	<0.00005	<0.0001	-	-	-
Bismuth (Bi)-Total	0.000050	mg/L		<0.000050	-	<0.0001	<0.0001	-	-	-
Boron (B)-Total	0.010	mg/L		0.042	<0.05	0.007	<0.05	5	-	-
Cadmium (Cd)-Total	0.000005	mg/L		0.0000271	<0.0002	<0.00001	0.000011	0.005	-	-
Calcium (Ca)-Total	0.050	mg/L		2.61	11.40	14.6	6.65	-	-	-
Cesium (Cs)-Total	0.00001	mg/L		<0.000010	-	-	-	-	-	-

Table I
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			Client Sample ID	New Senior's Village Well	Cortes Island Health Center (WTN = 93932)		Cortes Natural Food Coop (Well B)	CDWQ Guideline		
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			Time Sampled	7:30 AM			6:45			
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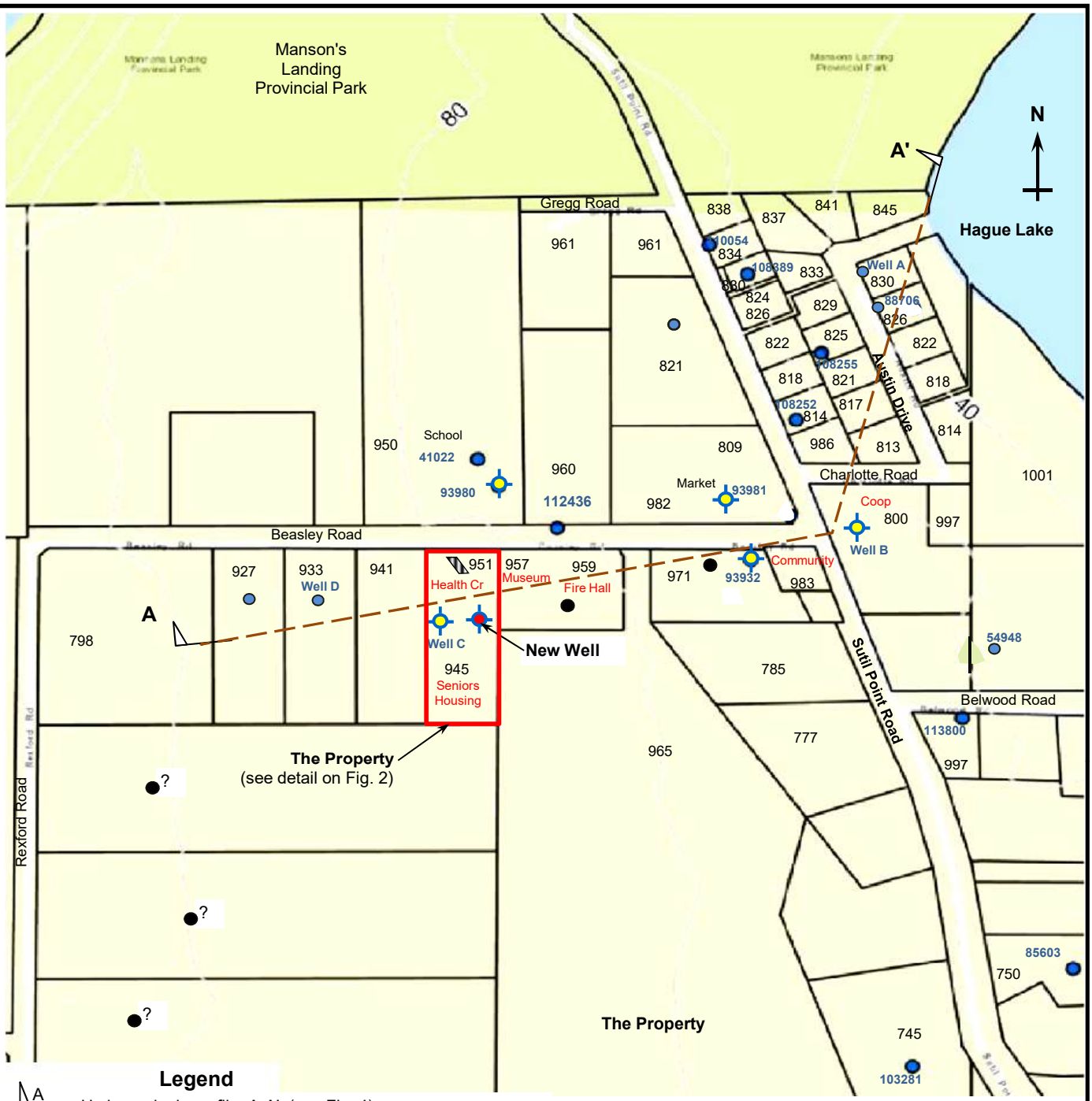
			Lab Sample ID	L2273086	507220445	101537	08441366			
Parameter	Detection Limit	Units								
Chromium (Cr)-Total	0.0001	mg/L		0.00762	<0.001	0.0023	<0.001	0.05	-	-
Cobalt (Co)-Total	0.0001	mg/L		0.00053	-	<0.0001	<0.0002	-	-	-
Copper (Cu)-Total	0.0005	mg/L		0.125	0.005	0.0068	0.0423	-	1	-
Iron (Fe)-Total	0.01	mg/L		0.113	**0.44**	0.174	**0.686**	-	0.3	-
Lead (Pb)-Total	0.00005	mg/L		0.00203	<0.001	0.0006	0.00055	0.01	-	-
Lithium (Li)-Total	0.001	mg/L		<0.0010	-	0.0008	-	-	-	-
Magnesium (Mg)-Total	0.005	mg/L		0.223	3.65	4.42	1.26	-	-	-
Manganese (Mn)-Total	0.0001	mg/L		**0.002**	**0.073**	0.0091	0.0372	-	0.05	-
Mercury (Hg)-Total	0.00001	mg/L		<0.0000050	-		0.00001	-	-	-
Molybdenum (Mo)-Total	0.00005	mg/L		0.000355	-	0.00045	<0.001	-	-	-
Nickel (Ni)-Total	0.0005	mg/L		0.185	-	0.0015	<0.001	-	-	-
Phosphorus (P)-Total	0.05	mg/L		<0.050	-	-	-	-	-	-
Potassium (K)-Total	0.05	mg/L		4.4	1.50	1.80	0.621	-	-	-
Rubidium (Rb)-Total	0.0002	mg/L		0.00138	-	-	-	-	-	-
Selenium (Se)-Total	0.00005	mg/L		<0.000050	<0.001	<0.0001	7.76	0.01	-	-
Silicon (Si)-Total	0.05	mg/L		2.34	-	11.8	-	-	-	-
Silver (Ag)-Total	0.00001	mg/L		0.000024	-	<0.00005	<0.00002	-	-	-
Sodium (Na)-Total	0.05	mg/L		2.11	-	11.4	7.1	-	200	-
Strontium (Sr)-Total	0.0002	mg/L		0.00644	-	0.0900	0.0503			
Sulfur (S)-Total	0.5	mg/L		1.65	-	-	-	-	-	-
Tellurium (Te)-Total	0.0002	mg/L		<0.00020	-	-	-	-	-	-
Thallium (Tl)-Total	0.00001	mg/L		<0.000010	-	<0.00001	<0.00001	-	-	-
Thorium (Th)-Total	0.0001	mg/L		<0.00010	-	-	-	-	-	-
Tin (Sn)-Total	0.0001	mg/L		0.00065	-	0.0002	<0.005	-	-	-
Titanium (Ti)-Total	0.0003	mg/L		0.00044	-	<0.0005	<0.005	-	-	-
Tungsten (W)-Total	0.0001	mg/L		<0.00010	-	-	-	-	-	-
Uranium (U)-Total	0.00001	mg/L		0.000028	<0.0005	0.00016	<0.0001	0.02	-	-
Vanadium (V)-Total	0.0005	mg/L		<0.00050		0.0016	<0.005	-	-	-
Zinc (Zn)-Total	0.003	mg/L		0.021	0.008	0.0054	0.0457	5	-	-
Zirconium (Zr)-Total	0.0003	mg/L		<0.000060	-	-	<0.0001	-	-	-
Dissolved Metals (Water)										
Calcium (Ca)-diss		mg/L		-	11.4	-	-	-	-	-
Iron (Fe)- diss		mg/L		0.1	**0.43**	-	-	-	0.3	-
Magnesium (Mg)-diss		mg/L		-	3.6100	-	-		-	
Manganese (Mn)-diss		mg/L		0.0001	0.070	-	-	-	0.05	-
Potassium (K)-diss		mg/L		-	1.5	-	-	-	-	-
Silicon (Si)-diss		mg/L		-	19.2	-	-	-	-	-
Sodium (Na)-diss		mg/L		-	9.4	-	-	-	-	-
Aggregate Organics (Water)										
Tannin & Lignin (as Tannic Acid)	0.10	mg/L		<0.1	-	-	-	-	-	-

Notes:
1) See locations of wells on Fig. 1.
2) **0.00** = Samples exceeding MAC **0.00** = Samples exceeding AO

Figures

JOB NUMBER: 241



Legend

- A — Hydrogeologic profile A-A' (see Fig. 4)
- Existing Seniors Society effluent dispersal field (see Fig. 2)
- Drilled 150mm diameter steel cased water well. The number is the Provincially assigned Well Tag number.
- Public water supply well
- Dug well with known and speculated locations.

Scale (1:5,000)

0 80 160m

NOTES

1) Base map from BC Ministry of Environment web site.

CORTES ISLAND SENIORS SOCIETY HOUSING COMMITTEE

ELANCO ENTERPRISES LTD.
Victoria, B.C. (250 744-1357)

HYDROGEOLOGICAL ASSESSMENT FOR NEW WELL, 951 BEASLEY ROAD, CORTES ISLAND. B.C.

Water Wells in Village Core

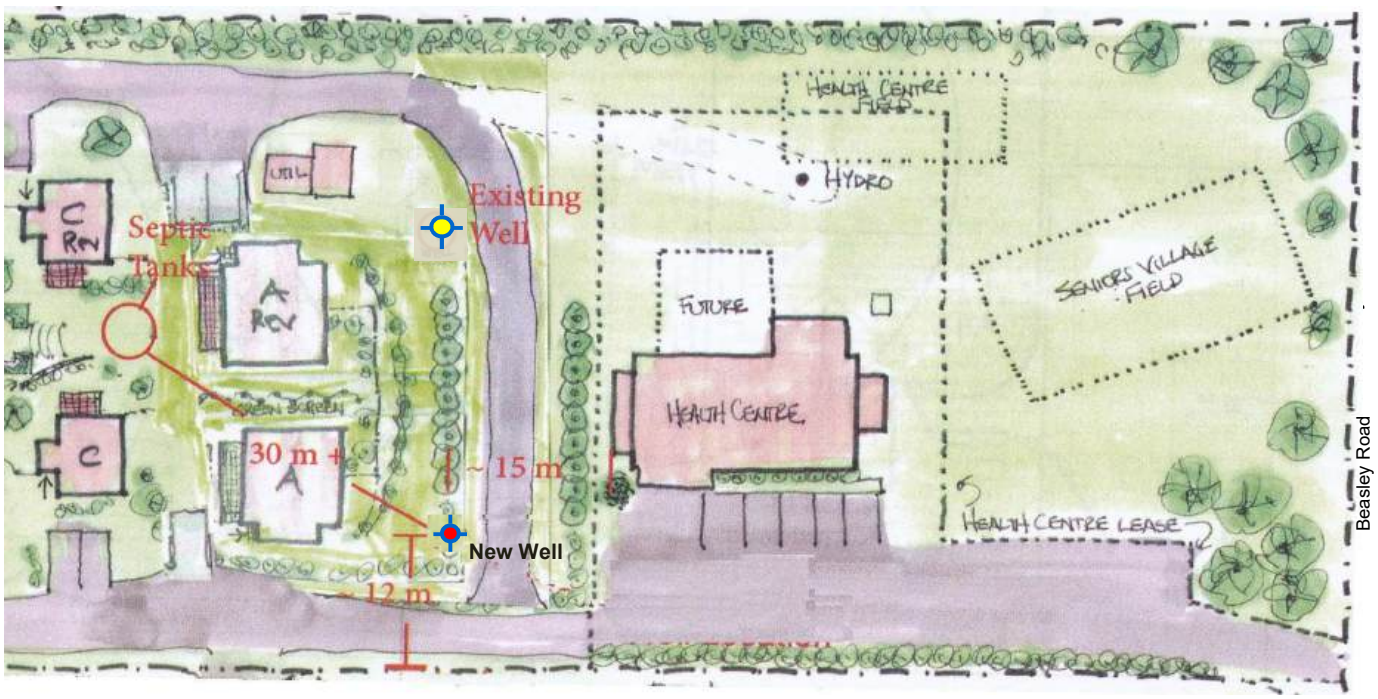
Drawn: RDO

Date: Jun. 2019

Approved:

Fig. **1**

JOB NUMBER: 241



Plan of North End of The Property

Scale (1:700)

0 10 20m

NOTES

1) Base map prepared by Cortes Island Seniors Society Housing Committee.

CORTES ISLAND SENIORS SOCIETY HOUSING COMMITTEE	***ELANCO ENTERPRISES LTD.*** *Victoria, B.C. (250 744-1357)*

HYDROGEOLOGICAL ASSESSMENT FOR NEW WELL, 951 BEASLEY ROAD, CORTES ISLAND. B.C.	**Plan of Northern Part of the Property**	Drawn: RDO	Date Jun. 2019
		Approved:	Fig. **2**

JOB NUMBER : 244

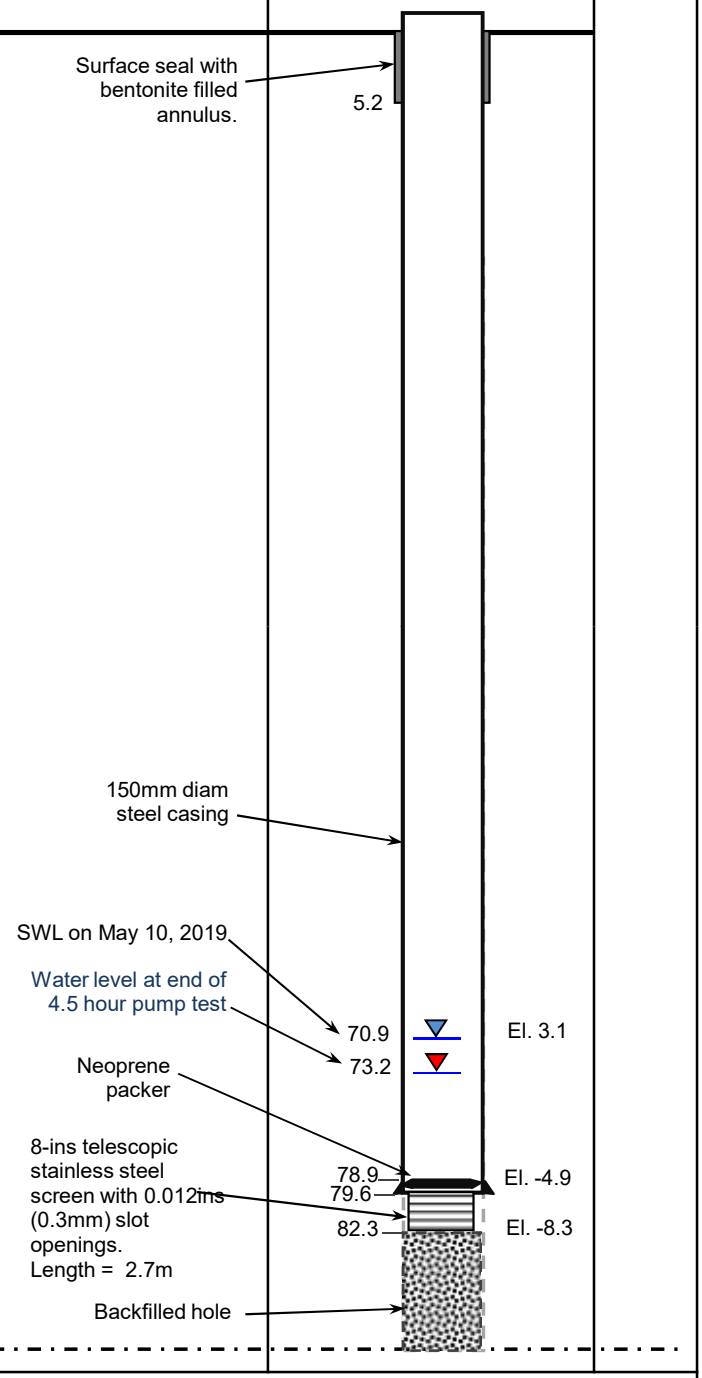
Borehole No: **Senior's Village Well**
Date Drilled: April 2019
Method: Air rotary
Datum above ground (m): 0.57
Elevation top of flange (m-asl): 74.6

Constructed By: Red Williams Well Drilling Ltd.
Hole Diameter: 150 mm
Ground elevation: 74.00 m-asl
Depth to water at construction : 70.1 m-below top of casing
Depth to water below ground: 69.5 m-bg

Depth (m)	Elevation (m)	Description of lithology encountered
0.0	74.0	Ground Surface
		Brown silty SAND and GAVEL with cobbles and boulders
20.0	54.0	Grey silty SAND (till like)
		Coarse GRAVEL
30.0	44.0	Brown-grey fine to medium SAND
40.0	34.0	
50.0	24.0	Brown fine to medium SAND
60.0	14.0	
70.0	4.0	Light grey fine to medium SAND
80.0	-6.0	Brown fine to medium SAND
		Brown to light grey fine to medium SAND
90.0	-16.0	Bottom hole at 90.8m El =-16.8m-asl

Well Construction Materials

Well Diagram



CORTES ISLAND SENIORS SOCIETY
HOUSING COMMITTEE

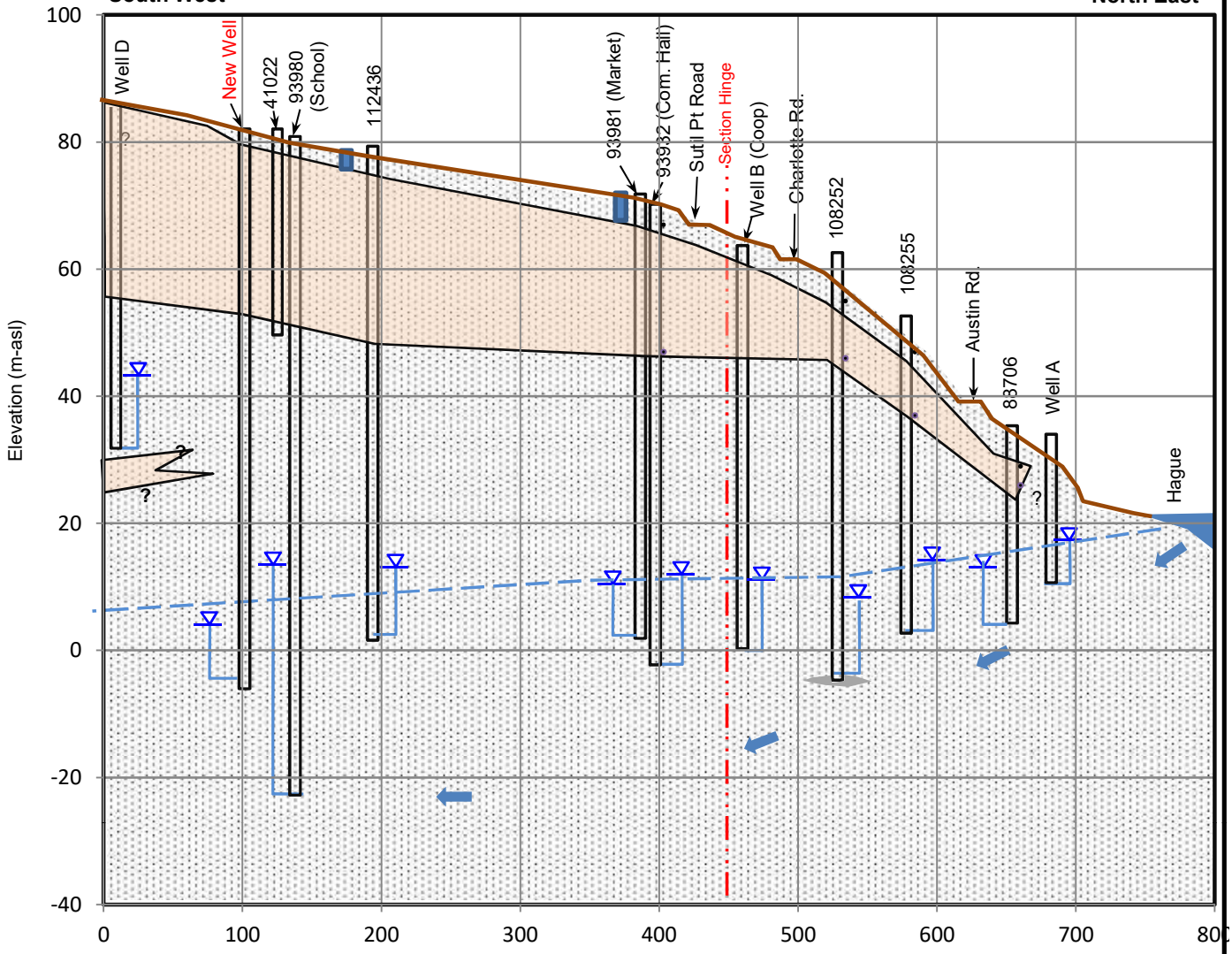
ELANCO ENTERPRISES LTD.
Victoria, B.C. (250 744-1357)

HYDROGEOLOGICAL ASSESSMENT FOR NEW WELL, 951 BEASLEY ROAD, CORTES ISLAND. B.C.

Senior's Village Well

BY: rad
DATE: Jun. 2019
APPROVED:
FIG: **Fig. 3**

JOB NUMBER: 241



Legend

- Clay layer
- Dug well (See Note 3)
- Fine sand, with some gravel and occasional silt lenses.
- Interpreted hydraulically restrictive layer (See Note 2)
- Drilled 150mm diameter steel cased water well. The number is the Provincially assigned Well Tag number.
- Elevation of static water level at time of well construction.
- Well screen location.
- Interpreted groundwater flow direction

Vertical exaggeration = 10x

NOTES

1) See location of section on Fig. 1 and log of New Well on Fig. 3..
3) The restrictive layer is a zone with higher apparent silt content in the sand and is generally grey in colour. It is not well defined in many areas.
3) Dug wells are typically 5 to 7m deep and are rarely used for a potable water supply in the area..

Horizontal Scale (1:5,000)

0 80 160m

CORTES ISLAND SENIORS SOCIETY HOUSING COMMITTEE

ELANCO ENTERPRISES LTD.
Victoria, B.C. (250 744-1357)

HYDROGEOLOGICAL ASSESSMENT FOR NEW WELL, 951 BEASLEY ROAD, CORTES ISLAND. B.C.

Hydrogeological Section A - A'

Drawn:

Date: Jun. 2019

Approved:

Fig. **4**