

August 9, 2019

## WELLHEAD PROTECTION PLAN FOR SENIORS VILLAGE WELL

951 BEASLEY ROAD, CORTES ISLAND

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Table II Assessment of Potential Risk of Well Contamination  
Figure 1 Location Map - Showing Extent of Well Capture Zone.  
Figure 2 Hydrogeological Section A - A'  
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### Conclusion:

The well will be adequately protected against contamination from potential surface sources

### Recommendation:

Ensure that construction of the operating wellhead meets BC Groundwater Protection regulations in terms of flood proofing and surface water drainage.

Prepared by:



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**Table I  
Capture Zone Analysis and Travel Time**

**Capture Zone**

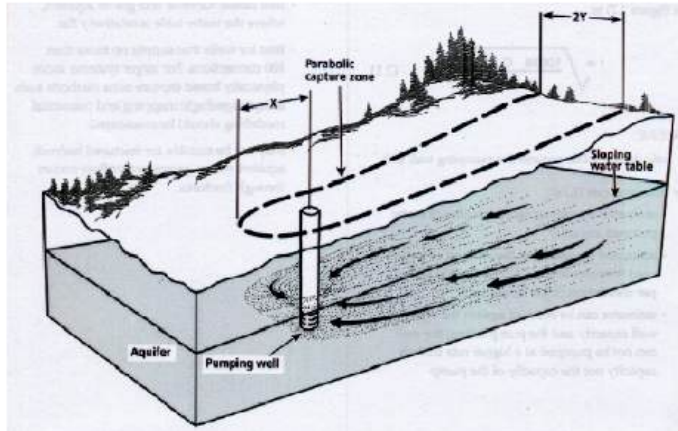
Formula	Symbol	Parameter	Note No	Value	Unit
		Village housing units		10	
		Estimated water usage		1.25	m <sup>3</sup> /d
$Y = Q/2T/i$	Q	Pumping rate	1	12.50	m <sup>3</sup> /d
				0.00014	m <sup>3</sup> /s
				0.145	L/s
				2.3	gpm
				3,313	gpd
T	Transmissivity	2	6.6E-04	m <sup>2</sup> /s	
			57.0	m <sup>2</sup> /d	
i	Gradient	3	0.017		
$X = Y/pi$	Y	half width	4	6.5	m
	2Y	Width		13.0	m
	x	down distance	4	2.1	m

**Travel Time in Aq**

$T/m$	m	Thickness of aquifer at well		3	m	
	K	Hydraulic conductivity		2.2E-04	m/s	
$V = Ki/n$	n	Aquifer porosity		0.35		
	V	Travel velocity		0.92	m/day	
			Distance for 100 days		92	m
			Distance for 200 days		184	m
			Distance to Hague Lake		510	m
		Travel time from the Lake		1.5	years	

Notes:

- 1) Assumes a constant pumping rate based on the conservative water consumption value indicated above.
- 2) Transmissivity calculated from 4 hour pump test drawdown data
- 3) Average gradient between local area wells.
- 4) See dimension illustration below



## Level 2 Hydrogeological Assessment

Topic	Elements	Comments
a) Location, topography and drainage	Site plan	Fig. 1 attached
	Hydrogeological profile	Fig. 2 attached
	Topographic contours	Reviewed and presented in another report
	Well locations	Yes
	Drainage flow directions	Reviewed and presented in another report
	Conditions around well head	Well drained
	Potential sources of contamination	On-site wastewater systems and fuel tanks
b) Climatic conditions	Nearest climate station	Whaletown, Cortes Island
	Monthly precipitation normals	Range from 50.5mm in Jul. to 211.9mm in Nov.
	Annual precipitation	1378.8mm
	Mean annual temperature	10.2 °C
c) Soils and geology	Local soil information	Typically less than 1m thickness of medium to coarse sands overlying a >10m thick restrictive layer of massive dense loamy sand and silt.
	Surficial geology	Vashon till overlying Quadra glacial outwash medium to fine sand.
	Bedrock geology	Jurassic to Tertiary granodiorite, located well below the bottom of the well.
d) Well and well head conditions	Detailed well log	See attached Fig. 3
	Depth to water intake	The depth to the top of the well screen is 79.6m below ground, which easily exceeds the GARP trigger guideline depth of 15m
	Well yield and efficiency	Assessed and presented in another report
	Distances from surface water bodies	Distance to Hague Lake = 510m
	Depth to water bearing zones	Presented on Figs. 2 and 3
	Pump installation details	To be determined by others
	Well head completion details	To be determined by others, however top of casing is to be flood proof and surface drainage directed away from the wellhead, as per the BC Groundwater Protection regulation.
e) Hydrogeological conditions and aquifer characteristics	Origin and nature of aquifer and confining zones	Unconfined Quadra medium to fine sand aquifer with overlying unsaturated sand (>10m thick) and a restrictive silty sand layer (>6m thick).
	Non pumping water levels	Indicated on Fig. 2
	Pump test data	Assessed and key results presented in another report
	Aquifer recharge	Principal source of aquifer recharge is infiltration from Hague Lake
f) Surface water hydrology and watershed conditions	Ditch drainage system	Assessed and presented in another report
	River and lake stages	Hague Lake has a controlled outlet that minimizes water level changes.
	Flood plain conditions	Not relevant
g) Aquifer water levels, flow directions and gradients	Water level trends	Estimated water levels are relatively steady with a potential 1 to 2m annual fluctuation.
	Hydraulic gradient	Hydraulic gradient is about 0.017 with slope to the southwest towards the ocean
	Unsaturated zone	Very thick unsaturated zone with downward flow

Level 2 Hydrogeological Assessment

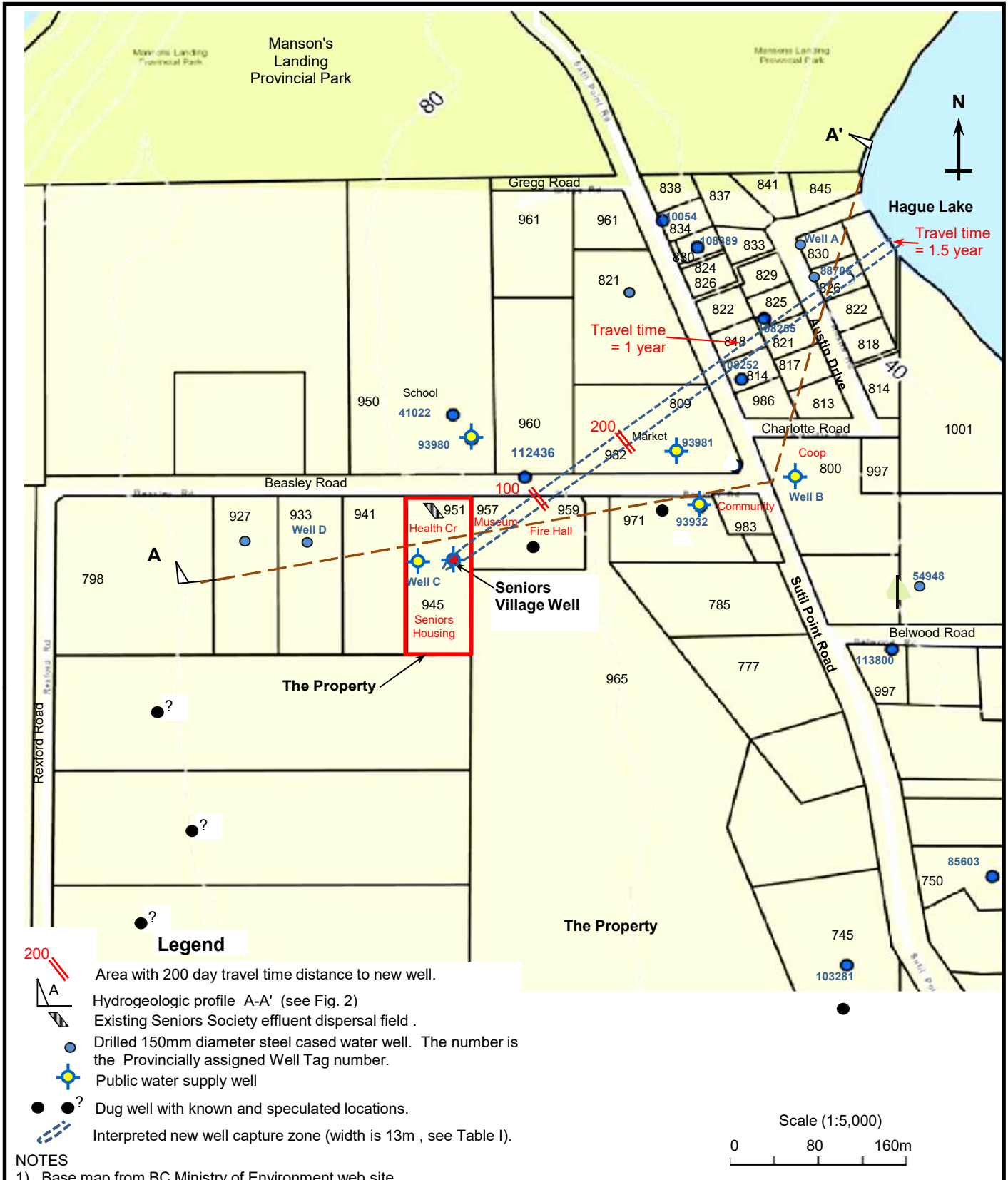
Topic	Elements	Comments
h) Pumping conditions in well	Anticipated pumping rate	Well to supply ten small cottages. Anticipated average daily pumping rate is 0.145 L/s (see Table I)
	Drawdown effects	Drawdown in operating well = 0.5m and in nearest well = < 1cm.
i) Groundwater and surface water quality	Surface source vs. groundwater quality	Groundwater quality is very different from lake source water quality
	Surface water source vs. groundwater temperatures	Groundwater temperatures are relatively constant throughout the year while lake water quality varies considerably.
	Surface source microbiological quality	2014 e-coli sampling counts from two stations along the Hague Lake shoreline ranged from 2 to 9.9 MPM/100ml. The 2017 sampling from the same two stations had results with MPN/100mL values of 1 or no detect.
	Well water quality	Well water has a low TDS and very low hardness. Iron and manganese concentrations are both below AO limits. One analysis of coliform bacteria indicated none present. Heterotrophic Plate Count was 9 CFU/1ml, which is a relatively low value suggesting low bacterial activity in the aquifer. The turbidity was 1.1 NTU, which is slightly over the 1 NTU guideline
j) Conditions for virus transport and survival	Aquifer sediments	The local aquifer is in a medium to fine sand unit, which has a high filtration capacity.
	Capping layer	The aquifer unit is capped by a low permeability >6m thick sediment layer which will provide a significant barrier to migration of microorganisms from the near surface.
	Unsaturated zone above the aquifer	The unsaturated sand above the aquifer will provide a very effective medium for filtering out microorganisms in seepage from the land surface near the well.
	Travel time from recharge area and the only potential microbiological source.	The estimated lateral travel time from Hague Lake to the well is 1.5 years, which is much greater than the 200 day guideline for travel from a potential microbiological source.
	Narrow capture zone	The estimated width of the capture zone is 13m (see Table II) which potentially passes under two sewage effluent dispersal fields, the nearest of which is located well beyond the GARP 200 day travel time limit..

Level 2 Hydrogeological Assessment

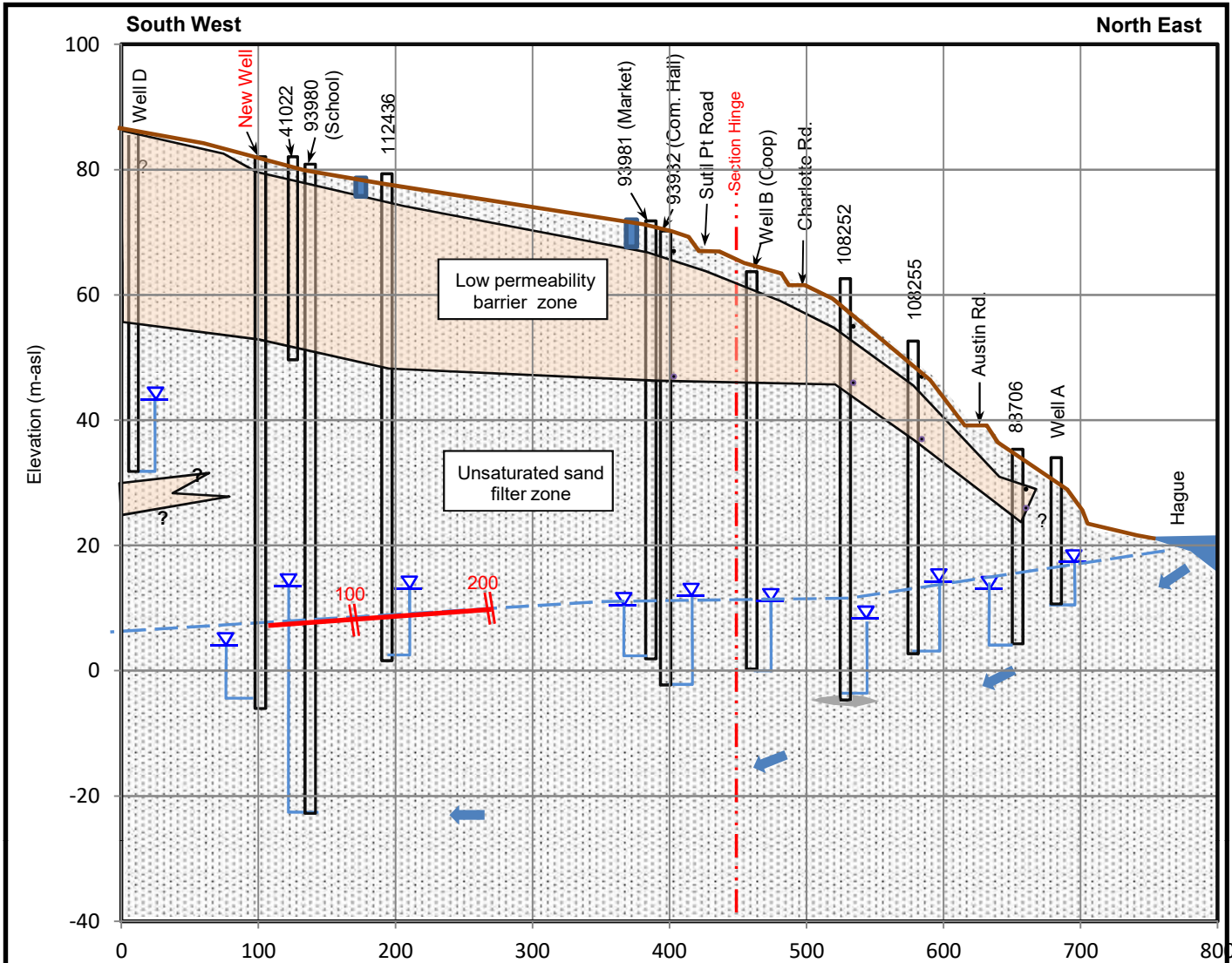
Topic	Elements	Comments
k) Land use and potential sources of contamination	Improperly surface seals in local area wells	There is a potential for some local area wells having no installed surface seal. However the nearest well in the capture zone is located well beyond the 200 day travel limit. (see Fig. 1)  Even if a surface seal was not installed, the sediments in the sand unit will fill the annulus outside the well casing, thereby lessening the potential for microbiological migration along the annulus.
	Leaking underground storage tanks	Local people confirmed that there was no known leaking underground gasoline and heating oil tanks in the area. However, if present, the hydrocarbon contaminants would not pass through the upper silt layer and the thick unsaturated sand unit.
l) Conclusions	Well depth and setting	The depth to the top of the well screen is easily sufficient to remove contaminants that may flow from the surface.
	Extent of operating well capture zone	The estimated width of the capture zone is 13m and does not pass under any potential surface sources of contamination with a travel time to the well that is less than 200 days.
	Wellhead completion and other protection measures.	Provided that the top of casing is flood proofed and surface water drainage is directed away from the wellhead, as per the BC Groundwater Protection regulation, no further protection measures are required.
m) Recommendations	1)	The top of the well casing should be flood proofed and surface water drainage directed away from the wellhead, as per the BC Groundwater Protection regulation.
	2)	Regular monitoring of water quality be conducted as per Ministry of Health requirements and if a water quality issue becomes apparent, a revised protection plan developed.

Note:

GARP = Groundwater at risk of containing pathogens. BC Ministry of Health guidance document (2017)



<p><b>CORTES ISLAND SENIORS SOCIETY HOUSING COMMITTEE</b></p>		<p><b>ELANCO ENTERPRISES LTD.</b> Victoria, B.C. (250 744-1357)</p>	
<p><b>HYDROGEOLOGICAL ASSESSMENT FOR NEW WELL, 951 BEASLEY ROAD, CORTES ISLAND. B.C.</b></p>		<p><b>Location Map - Showing Extent</b></p>	
		<p>Drawn: </p>	<p>Date Aug. 2019</p>
		<p>Approved:</p>	<p>Fig. <b>1</b></p>



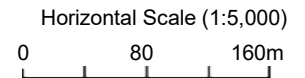
**Legend**

- 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
- 100 day flow distance to New Well

**Vertical exaggaration = 10x**

**NOTES**

- 1) See location of section on Fig. 1
- 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..



**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.**

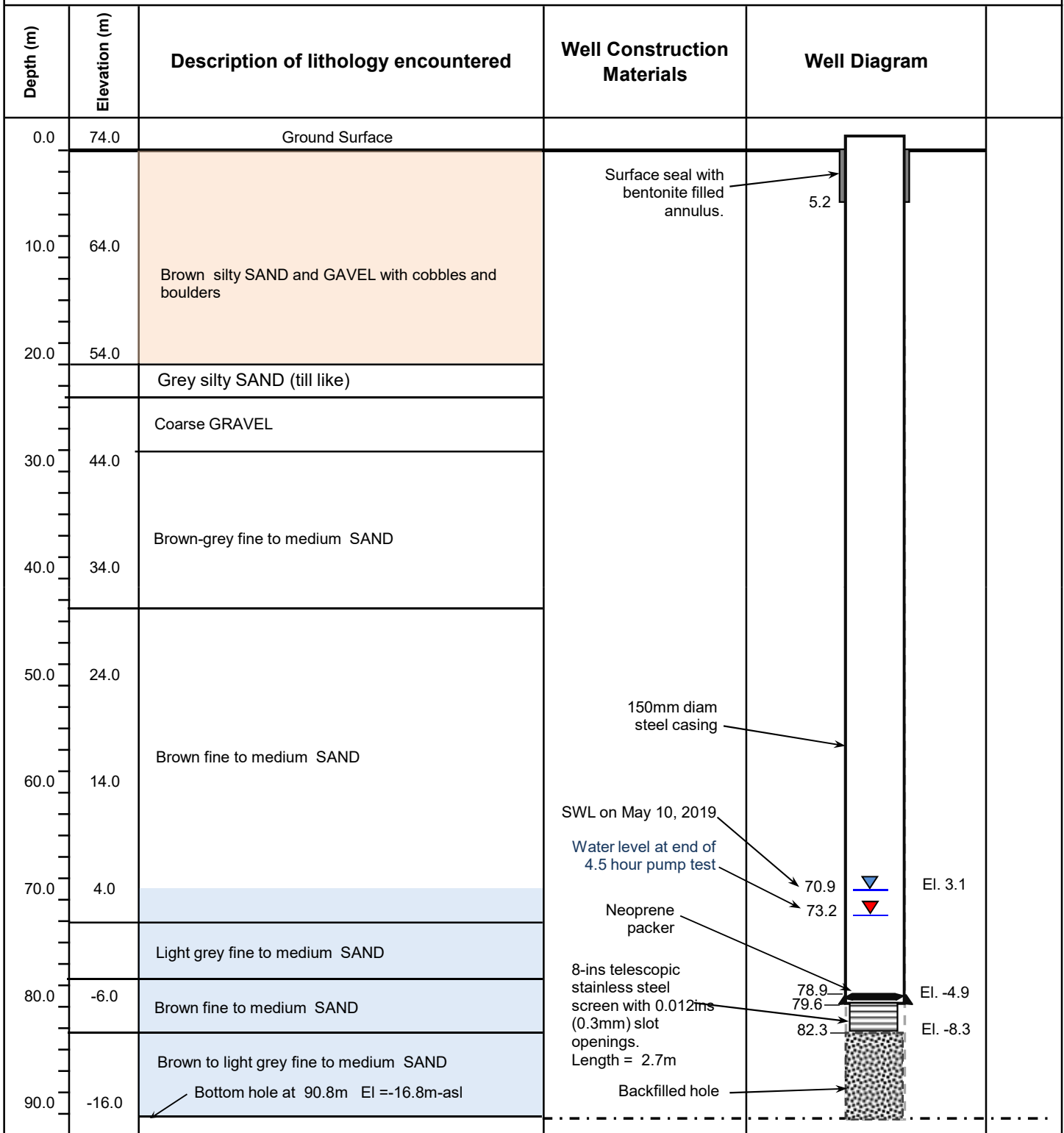
**Profile of New Senors Well and  
Hydrogeological Section A - A'**

Drawn: Date  
Aug. 2019

Approved: \_\_\_\_\_ Fig. **2**

JOB NUMBER : 244

<b>Borehole No: Seniors Village Well</b> 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
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