TECHNICAL MEMO

To:	Craig Suchy, WSP Project Manager
From:	Paul Morton and Alyssa Barker
Copy:	Annika Nilsson
Date:	August 10, 2021
WSP Ref.:	*211-04399-00_1_303*
Subject:	**Schott's Lake RV and Guest Ranch: Groundwater Supply Well Testing – Campground Well**

This technical memo provides a summary of the on-site well and aquifer testing conducted on the Schott's Lake RV and Guest Ranch (the Client) Campground Well during July 13-15, 2021. For this work, a licensed water well contractor was selected by the Client (Wild Rose Water Wells Ltd.), with part-time on-site coordination by WSP field staff.

The objectives of the well testing were to test the existing Campground Well to evaluate its maximum and sustainable (long-term) pumping rates, as well as evaluate the groundwater resource potentially available from the on-site bedrock aquifer.

The July 2021 well testing coordinated by WSP was conducted to provide resort expansion planning support. In the absence of an available observation well, data was not collected for analyses or interpretation to support future Water Licence application(s) that may be required, and as such well licensing was beyond the scope of the authorized work.

DESKTOP HYDROGEOLOGICAL ASSESSMENT

A Desktop Hydrogeological Assessment report[1] is on file for the Schott's Lake Resort.

CAMPGROUND WELL

Black Dog Drilling Ltd. completed drilling, well construction, and the Provincial two-hour well testing of the Campground Well on May 11, 2021. The driller's log developed at the time describes an overburden and bedrock sequence that is consistent with the regional geology reported in the Desktop Hydrogeological Assessment[1]. The documented stratigraphy is summarized in Table 1, with a Provincial Water Well Drilling Report provided as Attachment A.

[1] WSP (2021). *Desktop Hydrogeological Assessment, Schott's Lake RV and Guest Ranch Resort Development. Draft Report.*

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Table 1 Local Geology Logged at Campground Well (GIC Well ID: 2086364)

Lithology Log Description	Logged Depth from Ground Level (m)
Brown Clay	Ground to 4.88
Gray Clay	4.88 to 12.80
Clay & Rocks	12.80 to 14.94
Brown Sandstone	14.94 to 20.12
Brown Shale	20.12 to 25.60
Gray Shale	25.60 to 33.53
Brownish Gray Sandstone	33.53 to 40.84
Gray Shale	40.84 to 48.77

Note: based on Provincial Water Well Drilling Report (Black Dog Drilling Ltd., Attachment A).

The overburden-bedrock contact was encountered at approximately 15 m depth, involving gray till overlying brown sandstone. The driller's log indicates the presence of a water-bearing sandstone aquifer (7.93 m thick), from 33.53 to 40.84 m depth below ground level. This aquifer is 'sandwiched' between gray shale, and the static (unpumped) well water level was recorded by the driller in May 2021 to be 27.95 m depth. The static level was measured by WSP on July 13, 2021 to be 27.54 m depth.

CAMPGROUND WELL TESTING

PREPARATION

On July 13, 2021, Wild Rose Water Wells Ltd. and WSP mobilized to the Campground Well. The non-pumping (static) groundwater level was measured in the Campground Well to be used for the well and aquifer testing (Photo 1, Attachment B).

A temporary submersible pump was installed into the Campground Well to 34.8 m depth and connected to a well-head manifold (Photo 2, Attachment B), which was fitted with an inline flow regulator and flowmeter, supplied by Wild Rose Water Wells Ltd. A temporary discharge line was connected to convey produced water to a nearby surface water ditch, leading to a road culvert (Photo 3, Attachment B).

The submersible pump was activated at 4:37 PM on July 13, 2021 and regulated for a series of step tests to determine the Campground Well's specific capacity (flow rate per drawdown depth) as a measure of well performance and to identify a constant pumping rate to test the aquifer for a minimum of 24 hours.

An on-site residential water well (Photo 4, Attachment B) was selected as an observation well (designated 'Residence Well'); this well is approximately 300 m southwest of the Campground Well and was the only available observation well. Given the large well-to-well distance, the Residence Well was considered to act as a trial observation well for the Campground Well testing.

STEP TESTING

The Campground Well's response to pumping suggested minimal-to-low well storage effects on the measured drawdown levels, appearing to only influence the first 10 to 15 minutes of pumped water levels, for a given rate.

Six steps were completed, at rates shown in Table 2, for a total of 300 step test minutes, with the sixth step being longer at 87 litres per minute (Lpm) as a trial constant rate test, which continued overnight and ended after 1,020 minutes of total pumping time. The drawdown–time data, plus a derived graph, is provided as Attachment C.

Table 2 Step Test Pumping Rates

Step	Pumping Rate (Lpm)
1	41
2	53
3	65
4	77
5	82
6	87

Note: Step 6 was conducted as a trial constant rate test.

The step tests were followed by a 210-minute unpumped well recovery period, in which the well water level returned to 27.54 m depth.

CONSTANT RATE TESTING

Based on the five step tests and sixth step conducted as a trial constant rate test, the submersible pump was re-activated at 1:30 PM on July 14, 2021, at a rate of 92 Lpm and maintained for 1,140 minutes, followed by a 130-minute well recovery period, in which the unpumped well water level returned to 27.73 m depth.

CHLORINATION

On completion of the constant rate test recovery, Wild Rose Water Wells Ltd. prepared a chlorination solution which was circulated into the Campground Well, followed by rig-down and demobilization from the site, at the end of July 15, 2021.

On July 16, 2021, the original pumping equipment was returned to the Campground Well by Schott's Lake Resort operations staff, who also flushed the well to remove residual chlorination.

WSP attended the chlorination event and collected pre- and post-chlorination water grab samples. These samples were field screened by WSP for free chlorine using colour-change testing strips. The testing strips indicated free chlorine concentrations of 200 ppm (Photo 5, Attachment B) and approximately 10 ppm (Photo 6, Attachment B), i.e., residual chlorine was present after the overnight contact time.

PRODUCED WATER SAMPLING AND ANALYSES

Two water samples were collected by WSP from the well-head during the pumping periods and transferred to laboratory-supplied containers, prior to packing in coolers for transportation to AGAT Laboratories in Red Deer, AB. The samples were analyzed for routine potability parameters, dissolved metals, nitrogen-cycle nutrients, and bacteriological analyses.

A tabulated summary of these laboratory results is provided as Attachment D, together with a comparison to the *Guidelines for Canadian Drinking Water Quality*[2].

CAMPGROUND WELL TESTING RESULTS

AQUIFER PERFORMANCE

Campground Well water levels measured during the constant rate testing are shown in Attachment C. The 24-hour performance data indicates an initial well storage period (zero to 15 minutes), followed by a short period of recharge (15 to 130 minutes) and thereafter a constant drawdown response with time. No negative boundary (barrier) effects were noted in the drawdown data for the 24-hour constant rate period.

The 24-hour constant rate pumping drawdown test data was analyzed using four methods, including:

- Theis method (confined aquifer)
- Hantush method (confined aquifer with overlying leakage)
- Hantush with storage method (confined aquifer with overlying leakage and storage)
- Double porosity method (primary and secondary fracture porosities).

Graphical curve-fitting solutions for each of these methods were applied to the drawdown data, using AquiferTest to derive aquifer transmissivity (T). In the absence of an observation well within the pumping influence, Storativity values were not determined. The graphical curve-fitting results are provided in Attachment C.

Ranges and geometric means for the graphed-analytical values of aquifer transmissivity and hydraulic conductivity (using 7.31 m aquifer thickness), derived from each of the four analysis methods, are summarized as follows:

- Transmissivity, T - 33 to 123 m^2/d (mean 62 m^2/d);
- Hydraulic conductivity, K - 9.5×10^{-5} to 1.9×10^{-4} m/s (mean 9.8×10^{-5} m/s); and
- Storativity, S - not determinable (no observation data).

The two recovery tests were not analyzed due to limited data.

Only minor water level changes were measured in the Residence Well, acting as a trial observation well, during July 13-15, 2021. These minor changes did not have an obvious correlation to the Campground Well pumping, i.e., no obvious well-to-well influence detected.

[2] Health Canada (2020). *Guidelines for Canadian Drinking Water Quality.*

SAFE WELL YIELD AND SUSTAINABLE USE

A theoretical long-term yield was calculated using the average transmissivity (T) and a value for available head (H_A), defined in the case of confined aquifers as 'the distance between the non-pumping water level in the well prior to the pumping test and the top of the aquifer or at the top of the completion interval, whichever is less'[3]. Long-term is defined in the guideline as being a 20-year period over which well yield sustainability is to be assessed, i.e., identifying a pumping rate that minimizes undesirable over-pumping effects, typically observed as a declining non-pumping well level and ultimately well degradation.

The sustainable yield (Q_{20}) was calculated using the Modified Moell Method[3], using the following equation:

$$Q20 = \frac{0.7\ x\ Q\ x\ Ha}{S100 + (S20yr - S100)}$$

where:

Q = tested pumping rate (m^3/day)
S_{100} = actual drawdown during pumping test after 100 minutes (m)
S_{20yr} = theoretical drawdown after 20 years of pumping (m)
S_{100} = theoretical drawdown after 100 minutes of pumping (m)
0.7 = factor of safety term (70%)

The sustainable yield of 115 m^3/day (80 Lpm) establishes a pumping rate applicable to aquifer extraction by a single well, i.e., the maximum sustainable single-well yield without other wells in proximity. The Q_{20} evaluation assumes an infinite groundwater resource.

Another measure of sustainable groundwater use is the Suitability Index, based on simple water balance, defined as:

$$SI = \frac{A\ x\ R}{D}$$

where:

SI = Sustainability Index
A = on-site catchment area
R = annual groundwater recharge rate
D = annual groundwater demand

Calculated SI values greater than one (unity) indicate the catchment recharge area will theoretically receive more groundwater recharge than will be removed by water well diversion (pumping), i.e., a sustainable usage of the available groundwater resource.

As a site-specific evaluation of the groundwater resource that is available, when the following values are used with a SI value of one, i.e., sustainability threshold or sustainability balance.

[3] Government of Alberta (2011). *Alberta Environment Guide to Groundwater Authorization.*

A = 200,000 m^2 (conceptual built-out expansion footprint)
R = 425 mm/year (Red Deer River watershed precipitation) * 0.1 (10% becomes groundwater recharge)
SI = one (sustainability threshold)

This gives a D value of 8,500 m^3 (rounded), i.e., the theoretical total available groundwater resource for a fully built-out Resort expansion. This value of D equates to an annualized groundwater resource of 23 m^3/day (16 Lpm). This is a theoretical rate that is balanced by precipitation that becomes groundwater recharge, applicable to the groundwater resource for a conceptual fully built-out expansion with a 200,000 m^2 footprint.

In conclusion, the Campground Well is capable of a moderate yield (flow rate), up to 115 m^3/day (80 Lpm), this being the limit of sustainable single-well performance. This is greater than the on-site bedrock aquifer appears to be capable of meeting over the long-term, however. The on-site groundwater resource appears to be on the order of an annualized, continuous rate of 23 m^3/day (16 Lpm), based on precipitation recharge alone.

WELL WATER QUALITY

As summarized in Attachment D, the analytical results indicate the tested groundwater samples to be a calcium-sulphate type, moderately mineralized, hard water. None of the analyzed parameters had concentrations greater than the Maximum Acceptable Concentrations, described in the *Guidelines for Canadian Drinking Water Quality*[2].

Two water parameters (total dissolved solids and manganese) had concentrations greater than the guideline Aesthetic Objectives, i.e., based on colour, odour, taste and staining household fixtures (baths, sinks and toilets).

Overall, the tested samples indicate a moderate water quality.

Yours truly,
WSP

Written by:

PROFESSIONAL GEOLOGIST ALBERTA
PAUL R. MORTON
11 August 2021

Paul Morton, P.Geol.
Hydrogeologist and Engineering Geologist
Technical Lead, Hydrogeology

Reviewed by:

PROFESSIONAL GEOSCIENTIST ALBERTA
ALYSSA BARKER
ID# 73090 August 11 2021

Alyssa Barker, P.Geo., PMP
Project Manager | Hydrogeologist, Earth & Environment

Attachments

Attachment A Water Well Drilling Report
Attachment B Well Testing Photographs (July 13-16, 2021)
Attachment C Well Testing Data and Graphs
Attachment D Water Quality Results Summary

PERMIT TO PRACTICE
WSP CANADA INC.
RM SIGNATURE:
RM APEGA ID #: 73090
DATE: August 11 2021
PERMIT NUMBER: P007641
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Attachment A

WATER WELL DRILLING REPORT

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 2086364
GoA Well Tag No. A3160
Drilling Company Well ID
Date Report Received 2021/06/08

GOWN ID

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
VERKERK, MIKE & KIM	SITE 8, COMP 3, RR 2	SUNDRE	ALBERTA	CANADA	T0M 1X0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	1	33	7	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.803790 Longitude -114.867380
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation 1201.52 m
How Elevation Obtained
Hand held autonomous GPS 20-30m

Drilling Information

Method of Drilling
Rotary - Air

Type of Work
New Well

Proposed Well Use
Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.88		Brown Clay
12.80		Gray Clay
14.94		Clay & Rocks
20.12		Brown Sandstone
25.60		Brown Shale
33.53		Gray Shale
40.84		Brownish Gray Sandstone
48.77		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 90.92 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2021/05/11	127.29	27.95

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
48.77 m	48.77 m	2021/05/11	2021/05/11

Borehole

Diameter (cm)	From (m)	To (m)
22.23	0.00	29.57
12.70	29.57	48.77

Surface Casing (if applicable)
Plastic
Size OD : 15.24 cm
Wall Thickness : 0.993 cm
Bottom at : 29.57 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.587 cm
Top at : 24.38 m
Bottom at : 48.77 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)
36.58	42.67	1.270	30.48	

Perforated by Drill

Annular Seal Bentonite Chips
Placed from 0.00 m to 29.57 m
Amount 250.00 Pounds

Other Seals

Type	At (m)
Drive Shoe	29.57

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
RILEY PEARSON

Certification No
83061A

Company Name
BLACK DOG DRILLING & ENV SERV. LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2021/05/11

Water Well Drilling Report

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View in Imperial | Export to Excel

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GoA Well Tag No. A3160
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Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.803790 Longitude -114.867380
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation 1201.52 m
How Elevation Obtained
Hand held autonomous GPS 20-30m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 76.20 cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 90.92 L/min
Recommended Pump Intake Depth (From TOC) 38.10 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion Yes
Geophysical Log Taken
Submitted to ESRD

Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Top of Casing
Measurement in Metric

Test Date	Start Time	Static Water Level
2021/05/11	1:00 PM	27.95 m

Method of Water Removal

Type Air
Removal Rate 127.29 L/min
Depth Withdrawn From 48.77 m

If water removal period was < 2 hours, explain why

Depth to water level

Pumping (m)	Elapsed Time Minutes:Sec	Recovery (m)
	0:00	48.77
	1:00	40.42
	2:00	33.95
	3:00	30.51
	4:00	28.50
	5:00	27.98
	6:00	27.95
	7:00	27.95
	8:00	27.95
	20:00	27.95
	60:00	27.95
	120:00	27.95

Water Diverted for Drilling

Water Source	Amount Taken		Diversion Date & Time
SHOP	9092.18	L	2021/05/11 7:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
RILEY PEARSON

Certification No
83061A

Company Name
BLACK DOG DRILLING & ENV SERV. LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2021/05/11

Attachment B

WELL TESTING PHOTOGRAPHS (JULY 13-16, 2021)

July 13, 2021

Photograph 1 – Installing temporary Well Testing Pump in Campground Well

July 13, 2021

Photograph 2 – Well-head with Inline Flow Meter and Discharge Line to Ditch

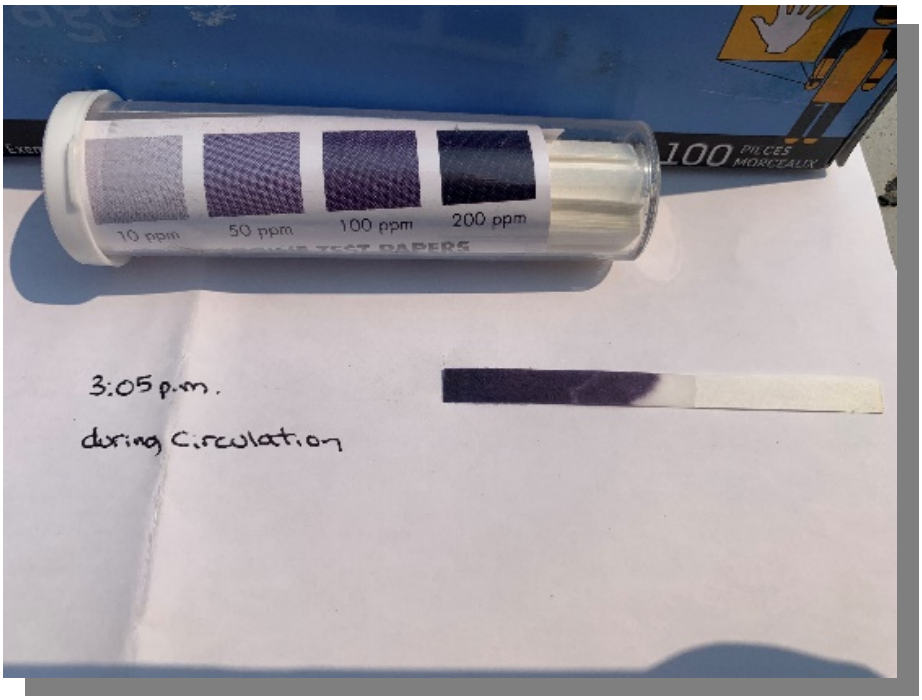
July 13, 2021

Photograph 3 – Temporary Discharge Line to Ditch and Road Culvert

July 13, 2021

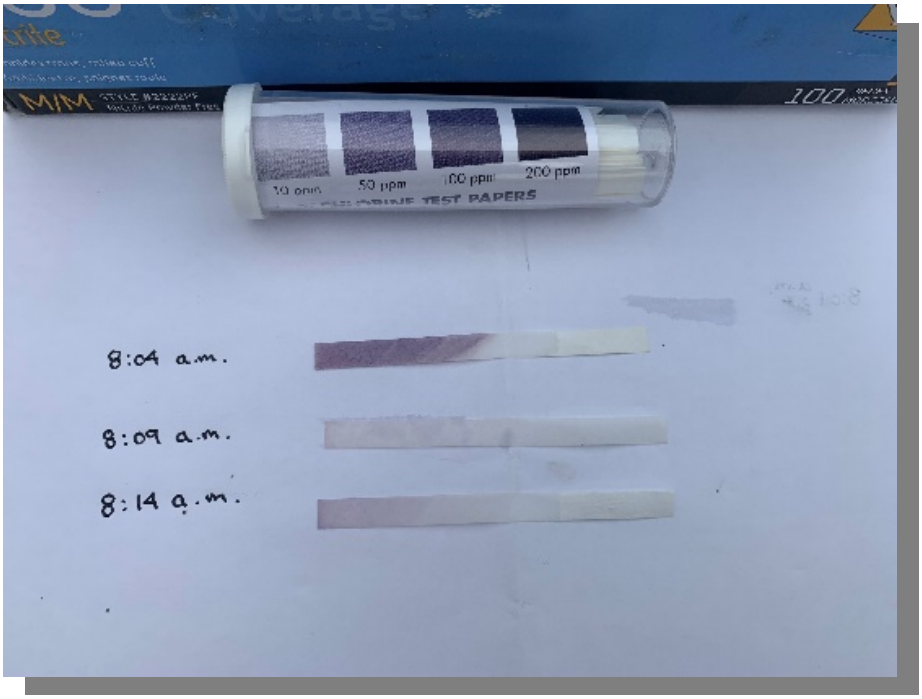
Photograph 4 – Trial Observation Well (No Influence from Campground Well).

July 15, 2021



Photograph 5 – Initial Chlorination Concentration During Pump-in Circulation.

July 16, 2021



Photograph 6 – Next-day Chlorination Concentration During Pump-out Flushing.

Attachment C

WELL TESTING DATA AND GRAPHS

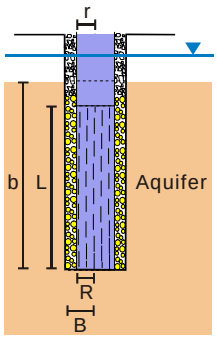
Wells

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

Location:



	Name	X [m]	Y [m]	Elevation (ams)		Penetration	L [m]	B [m]
1	Campground Well	51.80379	-114.86738	1201.52		Partially	4.26	0.0635

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

Location:	Pumping Test: Step Test	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Date: 7/13/2021		Discharge: average rate 0.08378 [m³/min
Observation Well: Campground Well	Static Water Level [m]: 27.29	Radial Distance to PW [m]: -

	Time [min]	Water Level [m]	Drawdown [m]
1	0	27.29	0.00
2	0.5	28.31	1.02
3	1	28.31	1.02
4	1.5	28.50	1.21
5	2	28.24	0.95
6	2.5	28.43	1.14
7	3	28.53	1.24
8	3.5	28.56	1.27
9	4	28.56	1.27
10	4.5	28.56	1.27
11	5	28.57	1.28
12	5.5	28.57	1.28
13	6	28.57	1.28
14	6.5	28.58	1.29
15	7	28.58	1.29
16	7.5	28.58	1.29
17	8	28.58	1.29
18	8.5	28.59	1.30
19	9	28.59	1.30
20	9.5	28.59	1.30
21	10	28.60	1.31
22	11	28.68	1.39
23	12	28.69	1.40
24	13	28.67	1.38
25	18	28.67	1.38
26	24	28.69	1.40
27	28	28.69	1.40
28	29	28.69	1.40
29	30	29.28	1.99
30	31	29.36	2.07
31	32	29.39	2.10
32	33	29.41	2.12
33	34	29.41	2.12
34	36	29.42	2.13
35	37	29.42	2.13
36	38	29.43	2.14
37	39	29.43	2.14
38	40	29.43	2.14
39	41	29.43	2.14
40	42	29.43	2.14
41	43	29.44	2.15
42	45	29.43	2.14
43	46	29.43	2.14
44	47	29.43	2.14
45	50	29.43	2.14
46	51	29.43	2.14
47	52	29.43	2.14
48	53	29.43	2.14

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

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	Time [min]	Water Level [m]	Drawdown [m]
49	54	29.435	2.145
50	55	29.435	2.145
51	57	29.38	2.09
52	57.5	30.42	3.13
53	58	30.47	3.18
54	58.5	30.49	3.20
55	59	30.50	3.21
56	59.5	30.51	3.22
57	60	30.52	3.23
58	61	30.53	3.24
59	62	30.54	3.25
60	63	30.55	3.26
61	64	30.55	3.26
62	65	30.56	3.27
63	66	30.56	3.27
64	67	30.57	3.28
65	68	30.57	3.28
66	69	30.575	3.285
67	70	30.575	3.285
68	71	31.12	3.83
69	71.5	31.30	4.01
70	72	31.46	4.17
71	72.5	31.56	4.27
72	73	31.66	4.37
73	74	31.74	4.45
74	74.5	31.78	4.49
75	75	31.80	4.51
76	76	31.825	4.535
77	77	31.84	4.55
78	80	31.88	4.59
79	81	31.88	4.59
80	82	31.89	4.60
81	83	31.89	4.60
82	84	31.895	4.605
83	85	31.90	4.61
84	86	31.90	4.61
85	87	31.905	4.615
86	88	31.905	4.615
87	89	31.905	4.615
88	90	31.905	4.615
89	91	31.91	4.62
90	92	31.91	4.62
91	95	31.92	4.63
92	96	31.92	4.63
93	97	31.95	4.66
94	98	31.95	4.66
95	106	31.94	4.65
96	116	31.955	4.665
97	120	31.955	4.665
98	125	32.56	5.27
99	126	32.56	5.27
100	127	32.56	5.27
101	128	32.565	5.275

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

	Time [min]	Water Level [m]	Drawdown [m]
102	129	32.57	5.28
103	130	32.575	5.285
104	131	32.58	5.29
105	132	32.58	5.29
106	133	32.58	5.29
107	134	32.585	5.295
108	135	32.59	5.30
109	136	32.59	5.30
110	137	32.59	5.30
111	138	32.59	5.30
112	139	32.59	5.30
113	140	32.59	5.30
114	141	32.59	5.30
115	142	32.59	5.30
116	143	32.595	5.305
117	144	32.60	5.31
118	145	32.60	5.31
119	146	32.60	5.31
120	147	32.605	5.315
121	148	32.605	5.315
122	149	32.605	5.315
123	150	32.605	5.315
124	151	32.605	5.315
125	156	32.62	5.33
126	157	32.63	5.34
127	158	32.63	5.34
128	159	32.63	5.34
129	160	32.63	5.34
130	161	32.74	5.45
131	162	32.97	5.68
132	163	33.09	5.80
133	164	33.14	5.85
134	165	33.16	5.87
135	166	33.18	5.89
136	167	33.19	5.90
137	168	33.20	5.91
138	169	33.21	5.92
139	170	33.215	5.925
140	171	33.22	5.93
141	172	33.225	5.935
142	173	33.22	5.93
143	174	33.22	5.93
144	175	33.22	5.93
145	176	33.22	5.93
146	177	33.22	5.93
147	178	33.225	5.935
148	179	33.225	5.935
149	180	33.225	5.935
150	181	33.23	5.94
151	182	33.23	5.94
152	183	33.23	5.94
153	184	33.23	5.94
154	185	33.23	5.94

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

	Time [min]	Water Level [m]	Drawdown [m]
155	186	33.235	5.945
156	187	33.24	5.95
157	188	33.245	5.955
158	189	33.25	5.96
159	190	33.255	5.965
160	191	33.26	5.97
161	192	33.27	5.98
162	193	33.27	5.98
163	194	33.27	5.98
164	195	33.27	5.98
165	196	33.27	5.98
166	197	33.275	5.985
167	198	33.28	5.99
168	199	33.28	5.99
169	200	33.28	5.99
170	201	33.28	5.99
171	202	33.28	5.99
172	203	33.285	5.995
173	204	33.29	6.00
174	205	33.295	6.005
175	206	33.295	6.005
176	207	33.295	6.005
177	208	33.295	6.005
178	209	33.295	6.005
179	210	33.295	6.005
180	211	33.295	6.005
181	212	33.295	6.005
182	213	33.295	6.005
183	214	33.295	6.005
184	215	33.30	6.01
185	216	33.30	6.01
186	217	33.30	6.01
187	218	33.31	6.02
188	219	33.31	6.02
189	220	33.31	6.02
190	221	33.31	6.02
191	222	33.31	6.02
192	223	33.31	6.02
193	224	33.31	6.02
194	225	33.32	6.03
195	226	33.32	6.03
196	228	33.325	6.035
197	229	33.325	6.035
198	230	33.35	6.06
199	231	33.36	6.07
200	233	33.36	6.07
201	235	33.365	6.075
202	237	33.37	6.08
203	238	33.37	6.08
204	239	33.37	6.08
205	240	33.375	6.085
206	241	33.38	6.09
207	242	33.38	6.09

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

	Time [min]	Water Level [m]	Drawdown [m]
208	243	33.38	6.09
209	244	33.375	6.085
210	245	33.37	6.08
211	246	33.38	6.09
212	247	33.38	6.09
213	248	33.38	6.09
214	249	33.38	6.09
215	250	33.38	6.09
216	252	33.38	6.09
217	253	33.38	6.09
218	254	33.385	6.095
219	255	33.385	6.095
220	256	33.39	6.10
221	257	33.39	6.10
222	258	33.39	6.10
223	259	33.39	6.10
224	260	33.40	6.11
225	262	33.40	6.11
226	265	33.40	6.11
227	285	33.425	6.135
228	300	33.44	6.15
229	315	33.445	6.155
230	330	33.39	6.10
231	345	33.41	6.12
232	360	33.42	6.13
233	375	33.44	6.15
234	390	33.44	6.15
235	405	33.46	6.17
236	420	33.46	6.17
237	435	33.45	6.16
238	450	33.44	6.15
239	465	33.45	6.16
240	480	33.44	6.15
241	495	33.47	6.18
242	510	33.47	6.18
243	540	33.49	6.20
244	570	33.49	6.20
245	600	33.53	6.24
246	660	33.54	6.25
247	720	33.56	6.27
248	780	33.575	6.285
249	810	33.575	6.285
250	840	33.58	6.29
251	900	33.61	6.32
252	960	33.61	6.32
253	990	33.62	6.33
254	1020	33.63	6.34
255	1021	29.95	2.66
256	1022	28.39	1.10
257	1023	27.85	0.56
258	1024	27.73	0.44
259	1025	27.72	0.43
260	1026	27.705	0.415

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

	Time [min]	Water Level [m]	Drawdown [m]
261	1027	27.68	0.39
262	1028	27.69	0.40
263	1029	27.67	0.38
264	1030	27.665	0.375
265	1032	27.665	0.375
266	1033	27.66	0.37
267	1034	27.66	0.37
268	1035	27.66	0.37
269	1036	27.66	0.37
270	1037	27.66	0.37
271	1038	27.655	0.365
272	1039	27.655	0.365
273	1040	27.655	0.365
274	1041	27.655	0.365
275	1042	27.655	0.365
276	1043	27.655	0.365
277	1045	27.65	0.36
278	1046	27.645	0.355
279	1047	27.645	0.355
280	1048	27.645	0.355
281	1049	27.645	0.355
282	1050	27.645	0.355
283	1055	27.64	0.35
284	1060	27.63	0.34
285	1065	27.63	0.34
286	1070	27.625	0.335
287	1075	27.62	0.33
288	1080	27.615	0.325
289	1085	27.61	0.32
290	1090	27.61	0.32
291	1095	27.605	0.315
292	1100	27.60	0.31
293	1105	27.60	0.31
294	1110	27.60	0.31
295	1115	27.59	0.30
296	1120	27.59	0.30
297	1125	27.585	0.295
298	1130	27.585	0.295
299	1135	27.575	0.285
300	1140	27.575	0.285
301	1150	27.57	0.28
302	1170	27.56	0.27
303	1230	27.54	0.25

StepTest - Discharge Data

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

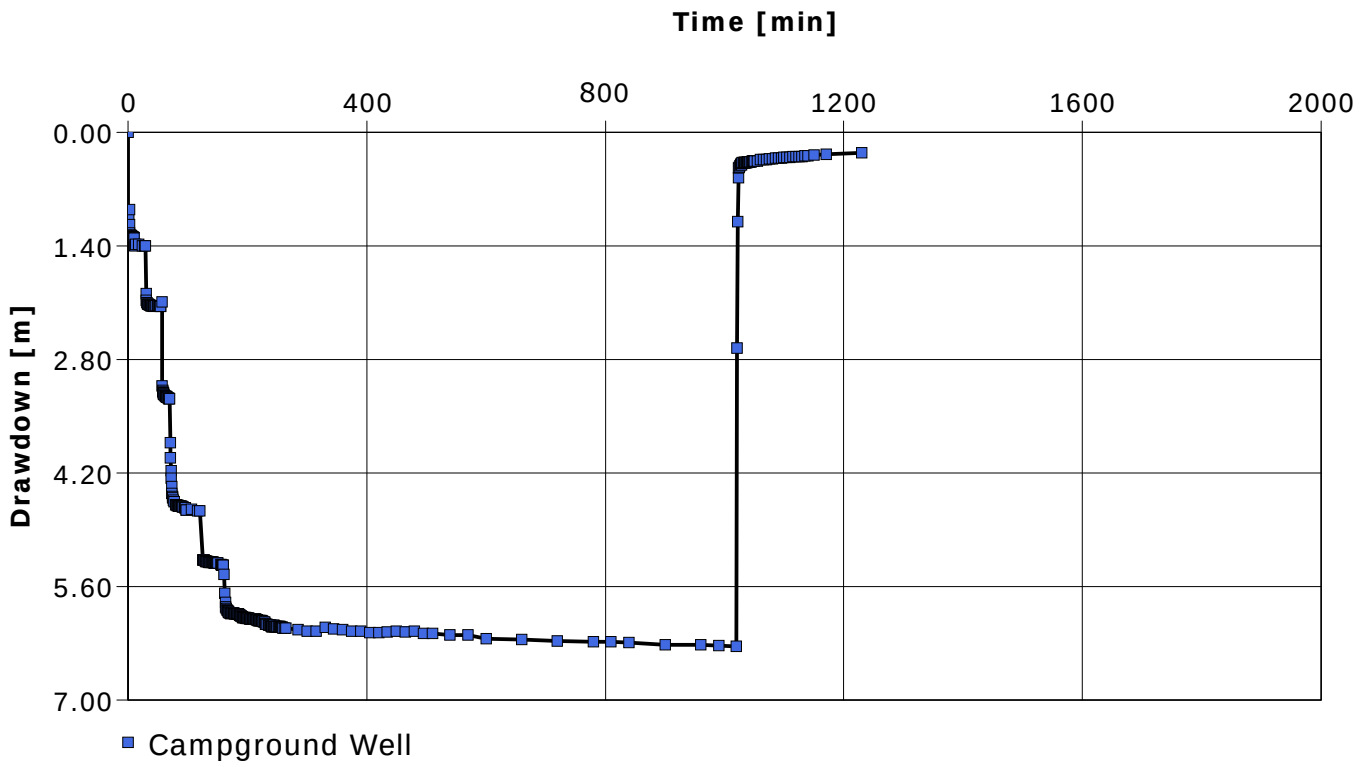
Client: Schott's Lake Resort

Location:	Pumping Test: Step Test	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Date: 7/13/2021		Discharge: average rate 0.08378 [m³/min
Observation Well: Campground Well		Radial Distance to PW [m]: -

	Time [min]	Discharge [m³/min]
1	30	0.041
2	57	0.053
3	70	0.065
4	120	0.077
5	160	0.082
6	1020	0.087
7	1230	0.00

	Pumping Test Analysis Report
	Project: Schott's Lake Resort - GW Supply
	Number: 211-04399-00
	Client: Schott's Lake Resort

Location:	Pumping Test: Step Test	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd.		Test Date: 7/13/2021
Analysis Performed by: Annika Nilsson	Time - Drawdown Curve	Analysis Date: 7/30/2021
Aquifer Thickness: 7.31 m	Discharge: variable, average rate 0.08378 [m³/min]	



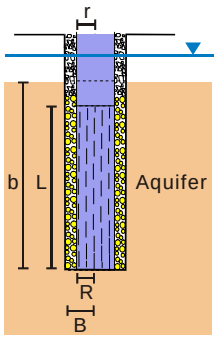
Wells

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

Location:



	Name	X [m]	Y [m]	Elevation (masl)		Penetration	L [m]	B [m]
1	Campground Well	51.803790	-114.867380	1201.52		Partially	4.26	0.0635

Pumping Test - Water Level Data

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

Location:	Pumping Test: Constant Rate	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd. Date: 7/14/2021		Discharge: Average rate 0.092 [m³/min]
Observation Well: Campground Well	Static Water Level [m]: 27.54	Radial Distance to PW [m]: -

	Time [min]	Water Level [m]	Drawdown [m]
1	0	27.54	0.00
2	1	31.43	3.89
3	2	32.56	5.02
4	3	33.36	5.82
5	4	33.70	6.16
6	5	33.90	6.36
7	6	33.96	6.42
8	7	33.98	6.44
9	8	34.01	6.47
10	9	34.015	6.475
11	10	34.02	6.48
12	15	34.06	6.52
13	20	34.08	6.54
14	25	34.10	6.56
15	30	34.105	6.565
16	35	34.12	6.58
17	40	34.12	6.58
18	50	34.11	6.57
19	60	34.12	6.58
20	70	34.13	6.59
21	80	34.14	6.60
22	90	34.17	6.63
23	100	34.18	6.64
24	120	34.19	6.65
25	150	34.21	6.67
26	165	34.23	6.69
27	180	34.25	6.71
28	210	34.28	6.74
29	240	34.29	6.75
30	270	34.31	6.77
31	300	34.31	6.77
32	330	34.32	6.78
33	360	34.335	6.795
34	390	34.34	6.80
35	420	34.35	6.81
36	450	34.36	6.82
37	480	34.38	6.84
38	510	34.34	6.80
39	540	34.36	6.82
40	570	34.38	6.84
41	600	34.39	6.85
42	630	34.40	6.86
43	660	34.40	6.86
44	690	34.42	6.88
45	720	34.425	6.885
46	750	34.45	6.91
47	780	34.45	6.91
48	810	34.45	6.91

Pumping Test - Water Level Data

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

	Time [min]	Water Level [m]	Drawdown [m]
49	840	34.455	6.915
50	870	34.425	6.885
51	900	34.47	6.93
52	930	34.48	6.94
53	960	34.49	6.95
54	990	34.475	6.935
55	1020	34.475	6.935
56	1050	34.495	6.955
57	1080	34.50	6.96
58	1110	34.51	6.97
59	1140	34.54	7.00
60	1141	34.535	6.995
61	1142	28.78	1.24
62	1143	27.95	0.41
63	1144	27.89	0.35
64	1145	27.88	0.34
65	1146	27.875	0.335
66	1147	27.87	0.33
67	1148	27.86	0.32
68	1149	27.86	0.32
69	1150	27.855	0.315
70	1155	27.84	0.30
71	1160	27.835	0.295
72	1170	27.875	0.335
73	1175	27.82	0.28
74	1200	27.80	0.26
75	1210	27.79	0.25
76	1220	27.78	0.24
77	1230	27.77	0.23
78	1240	27.76	0.22
79	1260	27.75	0.21
80	1270	27.73	0.19

Pumping Test - Discharge Data

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

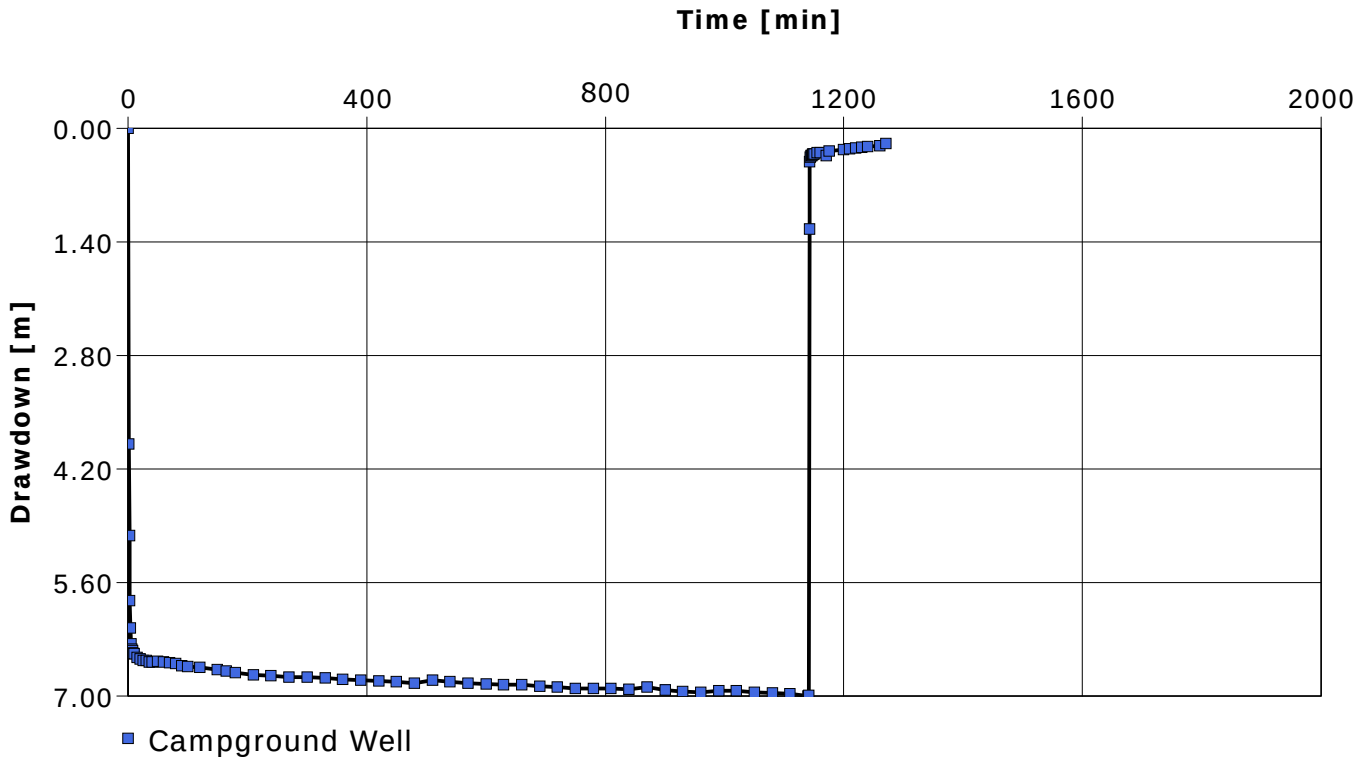
Client: Schott's Lake Resort

Location:	Pumping Test: Constant Rate	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd. Date: 7/14/2021		Discharge: Avarage reat 0.092 [m³/min]
Observation Well: Campground Well		Radial Distance to PW [m]: -

	Time [min]	Discharge [m³/min]
1	0 to 1139	0.0918
2	1140 to 1270	0.00

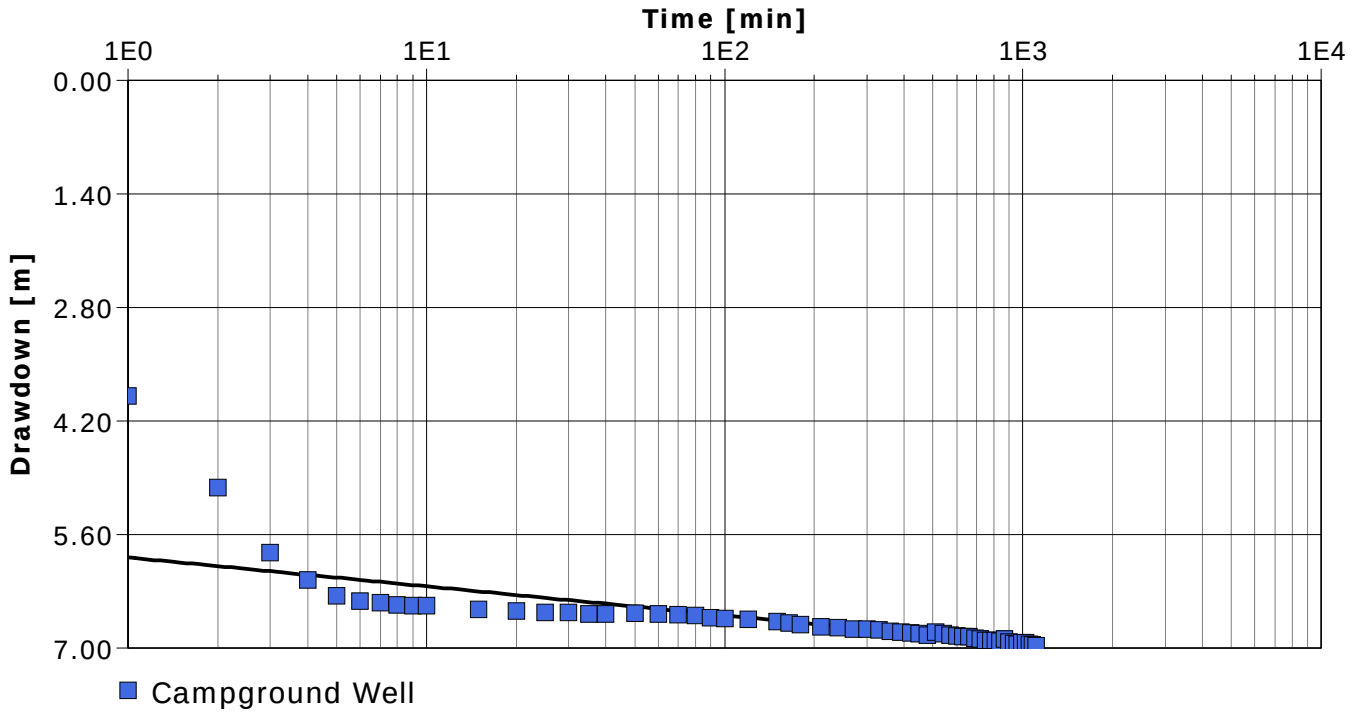
	Pumping Test Analysis Report
	Project: Schott's Lake Resort - GW Supply
	Number: 211-04399-00
	Client: Schott's Lake Resort

Location:	Pumping Test: Constant Rate	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd.		Test Date: 7/14/2021
Analysis Performed by: Annika Nilsson	Time - Drawdown Curve	Analysis Date: 7/30/2021
Aquifer Thickness: 7.31 m	Discharge: variable, average rate 0.092 [m³/min]	



	Pumping Test Analysis Report
	Project: Schott's Lake Resort - GW Supply
	Number: 211-04399-00
	Client: Schott's Lake Resort

Location:	Pumping Test: Constant Rate	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd.		Test Date: 7/14/2021
Analysis Performed by: Annika Nilsson	Theis	Analysis Date: 7/21/2021
Aquifer Thickness: 7.31 m	Discharge: variable, average rate 0.092 [m³/min]	

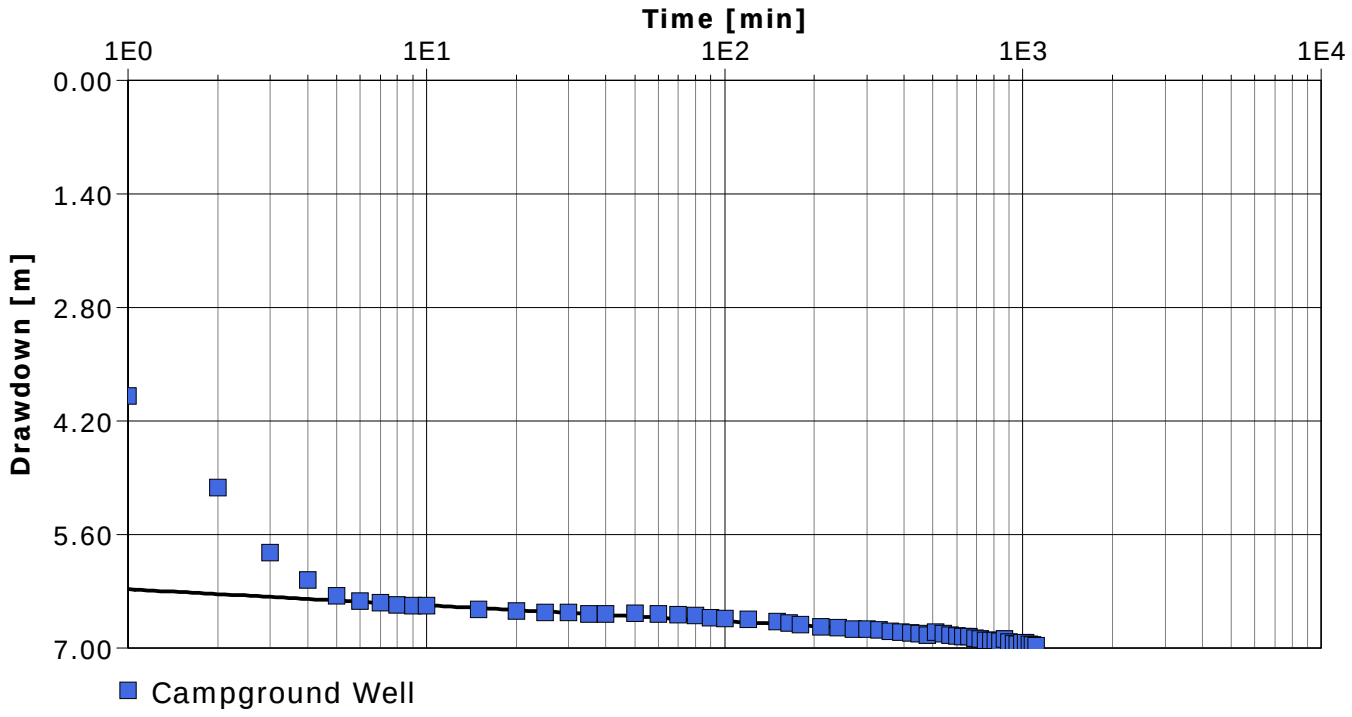


Calculation using Theis

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Campground Well	6.10×10^{1}	8.34×10^{0}	1.10×10^{-15}	0.05	

	Pumping Test Analysis Report
	Project: Schott's Lake Resort - GW Supply
	Number: 211-04399-00
	Client: Schott's Lake Resort

Location:	Pumping Test: Constant Rate	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd.		Test Date: 7/14/2021
Analysis Performed by: Annika Nilsson	Hantush	Analysis Date: 7/21/2021
Aquifer Thickness: 7.31 m	Discharge: variable, average rate 0.092[m³/min]	

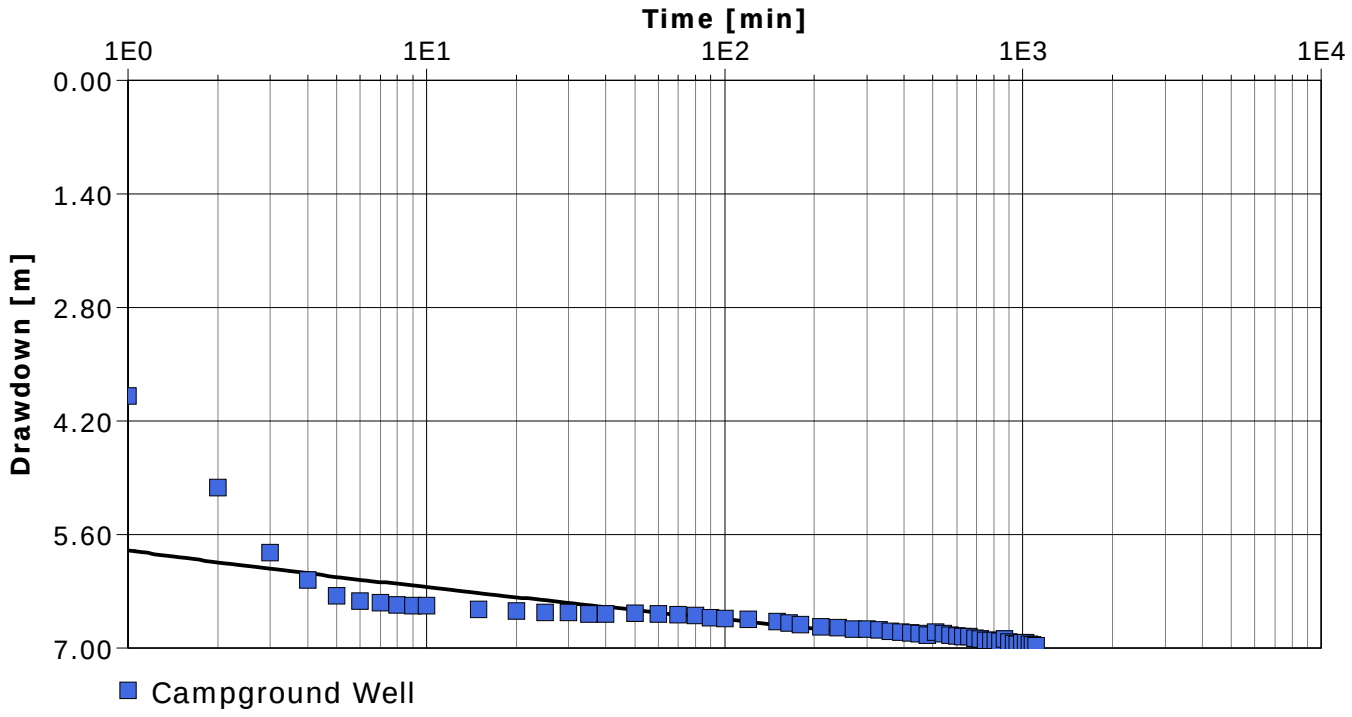


Calculation using Hantush

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Ratio K(v)/K(h)	Hydr. resistance [min]	Leakage factor [m]	Radial Distance to PW [m]
Campground Well	1.23×10^{2}	1.68×10^{1}	1.00×10^{-30}	2.13×10^{9}	1.57×10^{100}	3.66×10^{49}	0.05

	Pumping Test Analysis Report
	Project: Schott's Lake Resort - GW Supply
	Number: 211-04399-00
	Client: Schott's Lake Resort

Location:	Pumping Test: Constant Rate	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd.		Test Date: 7/14/2021
Analysis Performed by: Annika Nilsson	Handtush with Storage	Analysis Date: 7/27/2021
Aquifer Thickness: 7.31 m	Discharge: variable, average rate 0.092 [m³/min]	

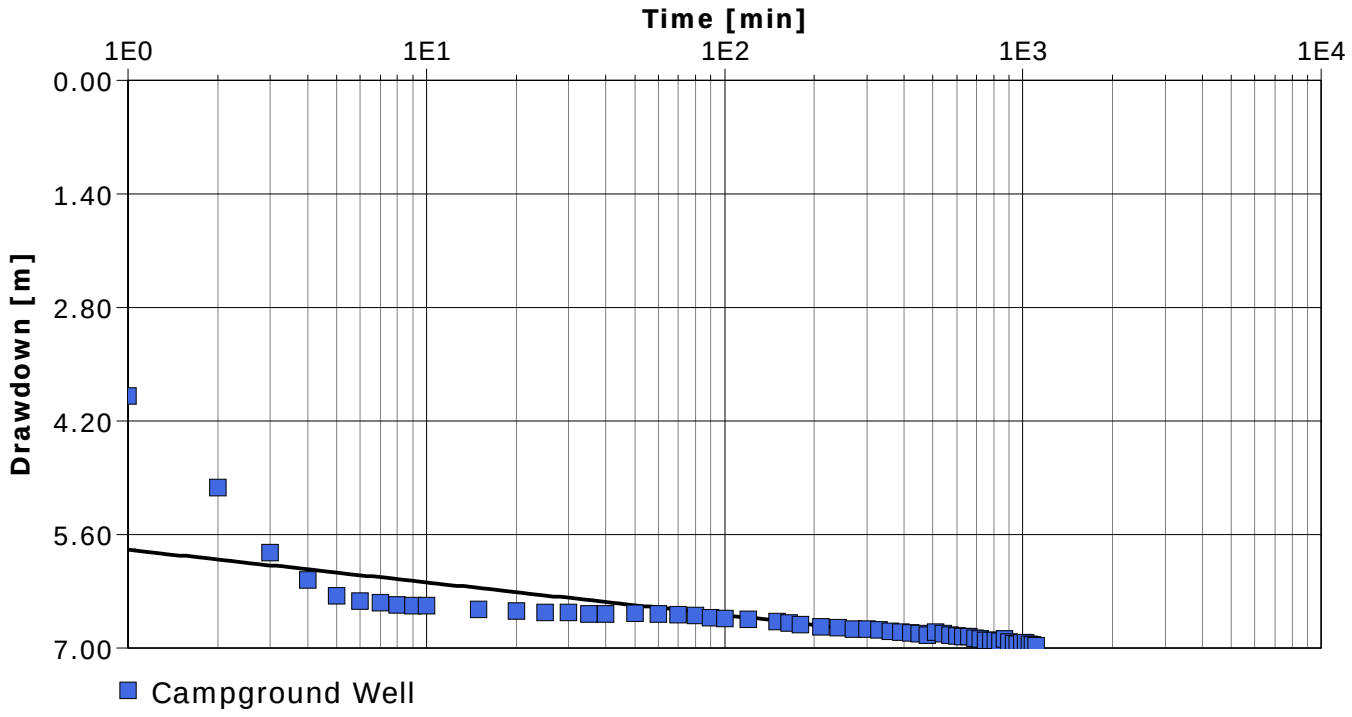


Calculation using Hantush with Storage

Observation Well	Transmissivit [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Ratio K(v)/K(h)	Hydr. resistance [min]	Storage coefficient of the aquitard	Leakage factor [m]	Radial Distance to PW [m]
Campground Well	3.29×10^{1}	4.50×10^{0}	1.00×10^{-7}	2.94×10^{-1}	2.13×10^{8}	3.67×10^{-6}	2.21×10^{3}	0.05

	Pumping Test Analysis Report
	Project: Schott's Lake Resort - GW Supply
	Number: 211-04399-00
	Client: Schott's Lake Resort

Location:	Pumping Test: Constant Rate	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd.		Test Date: 7/14/2021
Analysis Performed by: Annika Nilsson	Double Porosity	Analysis Date: 7/28/2021
Aquifer Thickness: 7.31 m	Discharge: variable, average rate 0.092[m³/min]	



Calculation using Double Porosity

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Sigma	Lambda	Radial Distance to PW [m]
Campground Well	6.03×10^{1}	8.24×10^{0}	1.65×10^{-16}	8.70×10^{2}	2.98×10^{-1}	0.05

Pumping Test Analysis Report

Project: Schott's Lake Resort - GW Supply

Number: 211-04399-00

Client: Schott's Lake Resort

Location:	Pumping Test: Constant Rate	Pumping Well: Campground Well
Test Conducted by: Wild Rose Water Wells Ltd.		Test Date: 7/14/2021
Aquifer Thickness: 7.31 m	Discharge: variable, average rate 0.092[m³/min]	

	Analysis Name	Analysis Performed b	Analysis Date	Method name	Well	T [m²/d]	K [m/d]	
1	Theis	Annika Nilsson	7/21/2021	Theis	Campground Well	6.10×10^{1}	8.34×10^{0}	
2	Hantush	Annika Nilsson	7/21/2021	Hantush	Campground Well	1.23×10^{2}	1.68×10^{1}	
3	Handtush with Storag	Annika Nilsson	7/27/2021	Hantush with Storage	Campground Well	3.29×10^{1}	4.50×10^{0}	
4	Double Porosity	Annika Nilsson	7/28/2021	Double Porosity	Campground Well	6.03×10^{1}	8.24×10^{0}	

Attachment D

WATER QUALITY RESULTS SUMMARY

Water Quality Summary
211-04399-00 Schott's Lake RV and Guest Ranch - Campground Well

				Sample Date	13-Jul-21		15-Jul-21	
				Sample Time	9:00 PM		8:30AM	
				Monitoring Well	Well Sample 1		Well Sample 2	
Parameters	**Units**	**Guidelines**			**Result**	**RDL**	**Result**	**RDL**
		GCDWQ - MAC[1]	**GCDWQ - AO[2]**					
Inorganic								
Electrical Conductivity (EC)	µS/cm	NS	NS		1040	5	1030	5
Sodium Adsorption Ratio (SAR)		NS	NS		6.68		7.27	
pH		NS	**7-10.5**		8	N/A	8.11	N/A
Total Dissolved Solids (TDS)	mg/L	NS	**500**		601	0.6	623	0.6
Ion Balance	%	NS	NS		97	1	105	1
Total Alkalinity	mg $CaCO_3$/L	NS	NS		418	5	434	5
Hardness	mg $CaCO_3$/L	NS	NS		137	1	143	1
Hydroxide	mg/L	NS	NS		<5	5	<5	5
Bicarbonate (HCO_3)	mg/L	NS	NS		510	5	530	5
Carbonate (CO_3)	mg/L	NS	NS		<5	5	<5	5
Chloride (Cl)	mg/L	NS	**250**		<1.0	1.0	<1.0	1.0
Fluoride (F)	mg/L	**1.5**	NS		0.31	0.01	0.28	0.01
Sulphate (SO_4)	mg/L	NS	**500**		122	1.0	112	1.0
Nitrate-N + Nitrite-N (NO_3-N+NO_2-N)	mg/L	NS	NS		<0.02	0.02	<0.02	0.02
Nitrate-N (NO_3-N)	mg/L	**10**	NS		<0.02	0.02	<0.02	0.02
Nitrite-N (NO_2-N)	mg/L	**1**	NS		<0.01	0.01	<0.01	0.01
Calcium (Ca)	mg/L	NS	NS		35	0.3	36.9	0.3
Magnesium (Mg)	mg/L	NS	NS		11.9	0.2	12.4	0.2
Potassium (K)	mg/L	NS	NS		1	0.6	1.2	0.6
Sodium (Na)	mg/L	NS	**200**		180	0.6	200	0.6
Iron (Fe)	mg/L	NS	**0.2**		<0.1	0.1	<0.1	0.1
Manganese (Mn)	mg/L	**0.12**	**0.03**		0.093	0.005	0.109	0.005
Total Kjeldahl Nitrogen (TKN)	mg/L	NS	NS		0.4	0.1	<0.1	0.1
Ammonia (NH_3-N)	mg/L	NS	NS		<0.05	0.05	0.04	0.02
Total Coliforms	MPN/100 ml	**0**	NS		-	-	<1	1
Escherichia coli (MPN)	MPN/100 mL	**0**	NS		-	-	<1	1.0
Metals								
Dissolved Aluminum (Al)	mg/L	**0.14**	NS		0.042	0.004	0.008	0.004
Dissolved Antimony (Sb)	mg/L	**0.006**	NS		<0.001	0.001	<0.001	0.001
Dissolved Arsenic (As)	mg/L	**0.01**	NS		0.002	0.001	<0.001	0.001
Dissolved Barium (Ba)	mg/L	**2**	NS		<0.05	0.05	<0.05	0.05
Dissolved Beryllium (Be)	mg/L	NS	NS		<0.001	0.001	<0.0005	0.0005
Dissolved Boron (B)	mg/L	**5**	NS		0.20	0.01	0.14	0.01
Dissolved Cadmium (Cd)	mg/L	**0.007**	NS		0.000018	0.000016	<0.000016	0.000016
Dissolved Chromium (Cr)	mg/L	**0.05**	NS		<0.001	0.001	<0.0005	0.0005
Dissolved Cobalt (Co)	mg/L	NS	NS		<0.001	0.001	<0.0009	0.0009
Dissolved Copper (Cu)	mg/L	2	**1**		0.008	0.001	0.003	0.0008
Dissolved Lead (Pb)	mg/L	**0.005**	NS		0.0008	0.0001	0.0003	0.0001
Dissolved Molybdenum (Mo)	mg/L	NS	NS		0.009	0.001	0.006	0.001
Dissolved Nickel (Ni)	mg/L	NS	NS		<0.003	0.003	<0.003	0.003
Dissolved Selenium (Se)	mg/L	**0.05**	NS		0.0023	0.0005	<0.0005	0.0005
Dissolved Silver (Ag)	mg/L	NS	NS		<0.00005	0.00005	<0.00005	0.00005
Dissolved Thallium (Tl)	mg/L	NS	NS		<0.0005	0.0005	<0.0005	0.0005
Dissolved Titanium (Ti)	mg/L	NS	NS		<0.003	0.003	0.001	0.001
Dissolved Uranium (U)	mg/L	**0.02**	NS		0.002	0.001	0.001	0.001
Dissolved Zinc (Zn)	mg/L	NS	**5**		0.02	0.01	<0.01	0.01

Note: "-" - Not Available
"<" - Below laboratory detection limits; detection limits are less than the applied guideline
NS - No Standard
RDL - Reportable Detection Limit
GCDWQ - Guidelines for Canadian Drinking Water Quality Summary Table - Table 2. Chemical and Physical Parameters (Health Canada, 2020)
[1] GCDWQ guideline is health based and listed as maximum acceptable concentrations
[2] GCDWQ guideline based on aesthetic considerations and listed as aesthetic objectives
Shading indicates values above the guideline based on aesthetic considerations and listed as aesthetic objectives