Okanagan Groundwater Monitoring Project Summary 2013

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British Columbia – The Best Place on Earth | Ministry of Environment

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Local Government Partners:

Regional District of Okanagan Similkameen	Town of Oliver	Township of Spallumcheen
Regional District of Central Okanagan	District of West Kelowna	Southeast Kelowna Irrigation District

EXECUTIVE SUMMARY

Groundwater is a resource vulnerable to over-exploitation. While depletion of surface water is seen easily with the public eye, groundwater depletion is invisible. Water managers need tools to understand the health of aquifers and to make evidence-based decisions. One such tool for monitoring groundwater is the *BC Observation Well Network* operated by the BC Ministry of Environment. This network supports management, protection and sustainability of our groundwater resource and associated ecosystems in British Columbia.

A major review of the *BC Observation Well Network* was completed in 2009 to identify gaps in the monitoring network. Another Okanagan specific survey of groundwater resources was conducted as part of the *Okanagan Water Supply and Demand Study: Phase Two*. These two reports were summarized by BC Ministry of Environment staff and it was recommended:

> That expansion of the network be targeted to those [identified] priority aquifers in the next 3 years where it is anticipated that observation well data will be needed to support water management decision making and local water services planning.

This became the foundation on which the Okanagan Groundwater Monitoring Project was established. The project is a collaborative effort involving local, federal and provincial governments.

The Okanagan Groundwater Monitoring Project is managed by the Okanagan Basin Water Board (OBWB), a local government entity created by the three regional districts of the Okanagan. The OBWB acts as a funding partner and additional local funding is provided by individual municipalities and regional districts for wells within their jurisdictions.

The Province of BC, through the Ministry of Environment and the Ministry of Forests, Lands and Natural Resources Operations, contributes major in-kind support by providing hydrogeological expertise, providing access to Crown lands for well-siting, equipping observation wells and maintaining the on-going remote monitoring programs.

The Government of Canada participates as a major funding partner, through Agriculture and Agri-Food Canada (AAFC), and with in-kind support through core-logging by Environment Canada.

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1.0 Introduction

The Okanagan Groundwater Monitoring Project is an initiative to increase the monitoring of priority aquifers in the Okanagan region. The project is led by the Okanagan Basin Water Board (OBWB) and involves collaboration between local, provincial and federal levels of government.

2.0 Purpose

The purpose of the Project is to obtain data pertaining to and to monitor, over time, various Okanagan aquifers, to provide a case study for aquifer measurement and monitoring, and to assist in the development of protocols and best practices for other ground water observation wells for optimizing the value of data through a local or regional community engagement process.

3.0 Partnership Details

The partnership between the parties was formalized in a memorandum of understanding in 2010. The document defined the roles and responsibilities of the participants and the terms and conditions under which the project would be conducted.

Okanagan Basin Water Board

Background: The Okanagan Basin Water Board (OBWB) is a local government organization initiated in 1968 (legislated in 1970) as a water governance body tasked with identifying and resolving critical water issues at the scale of the Okanagan watershed. The overall objective of the organization is to undertake strategic projects and programs at the Basin scale that meet the collective needs of Okanagan citizens for long-term sustainable water supplies while supporting the capacity of member jurisdictions to meet their own water management goals.

Role: The OBWB's involvement in this project was as a facilitator and funding partner. OBWB staff coordinated with member local governments and other parties to solicit project funding. The OBWB entered into contracts with well drillers and other local contractors involved in the construction of wells. Additionally, the OBWB contributed funds for the construction of each well.

Province of British Columbia

Background: In British Columbia, the ownership of water is vested in the Crown as stated in the *Water Act*. With increasing population, industrial, and agricultural growth and the potential impacts of climate change, the Province takes responsibility for planning and protecting our water resources to ensure it is

sustainable for future generations. The *BC Observation Well Network* is operated by BC's Ministry of Environment and enables the monitoring of water level and groundwater chemistry of priority aquifers and basins, by collecting, interpreting and reporting high quality, relevant data and information in a timely fashion. The operational component of water stewardship was relocated to the Ministry of Forests, Lands and Natural Resource Operations.

Role: The Province of BC was involved by providing in-kind support through hydrogeological expertise, providing access to Crown lands for well-siting, equipping observation wells and maintaining the on-going remote monitoring programs. Additionally, BC became the owner of the wells after completion, and responsible for its future operation, maintenance, repair, and replacement, and eventual closing.

Government of Canada

Background: The health of our water is one of Canadians' chief environmental concerns. Agriculture is a major water user in Canada, dependent on the availability of sufficient water of appropriate quality for all aspects of livestock and crop production. Water is also needed for agri-food industries and rural households. Agriculture and Agri-Food Canada (AAFC) is committed to doing its part, working with Provinces/Territories and stakeholders, to address agricultural water-related issues, to improve the sector's competitiveness and to protect the environment.

Role: Canada was involved as a funding partner and in providing technical assistance. AAFC agreed to contribute a maximum of half the eligible costs of each well, to a maximum of $15,000. The AAFC contributed a maximum of $35,000 each year. Technical personnel were also made available by Environment Canada for on-site advice and assistance, up to 15 working days per year.

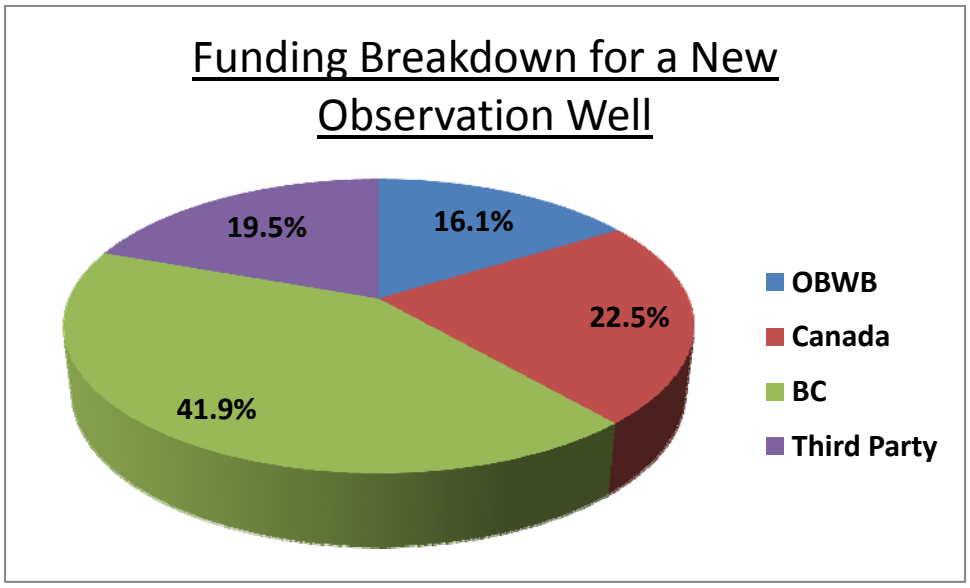


Figure 1. Funding breakdown for a new observation well in the Okanagan Groundwater Monitoring Project

4.0 BC Observation Well Network

This project was conducted to expand coverage BC Observation Well Network in the Okanagan Valley. The Observation Well Network was established in 1961 and was comprised of a number of unused dug and drilled wells in the Lower Fraser Valley and the Okanagan Valley. The primary purpose of the Observation Well Network is to collect, analyze and interpret groundwater hydrographs and groundwater quality data from various developed aquifers in BC. This supports management, protection and sustainability of our groundwater resource and associated ecosystems. Many of the wells are monitored in cooperation with irrigation districts, municipalities and communities utilizing groundwater supplies.

The stated objectives of the BC Observation Well Network are as follows:

1. Understand local and regional hydrogeological processes and characteristics including:
    - Monitoring groundwater/surface water relationships, recharge and discharge mechanisms/rates/timing in lowland and upland areas and impact of drought and flooding on groundwater,
    - Fundamental aquifer or basin characteristics (e.g. water table and potentiometric levels, gradients and trends, transmissivity, hydraulic conductivity and storativity values, water chemistry, etc.),
    - Monitoring impact of short and long term effects of climate and climate change on groundwater levels.
2. Support effective use of the resource and minimize groundwater conflicts between users by:
    - Helping to assess the impact of groundwater withdrawals in specific areas to determine if further ground water development is possible without adversely affecting sustainability of the resource,
    - Helping to resolve water use conflicts, such as interference between wells and ground water withdrawal near fully allocated lakes and streams,
    - Assessing the long-term and short-term effects of human-induced activities such as pumping and construction of drainage works on ground water levels, both locally and regionally.

5.0 Identifying Priority Aquifers in the Okanagan

In 2009, the current BC Observation Well Network was reviewed in a report led by Hy-Geo Consulting. The purpose of the network review was to develop a method to recommend where

observation wells need to be located in the province to help protect, manage and sustain groundwater resources.

Following the completion of *Provincial Observation Well Network Review*[1] Report, groundwater staff for each MoE region reviewed the report and identified additional areas or aquifers where regional concerns or issues were known but had not been specifically addressed in the report. Each priority aquifer was cross-referenced to existing observation wells to confirm they were geographically and stratigraphically located within each of the priority aquifers.

Since the report had not specifically looked at the Okanagan region, the priority aquifers in the Okanagan-Kettle region was paired down to only include the Okanagan aquifers. As well, MoE groundwater staff reviewed the 2009 report titled *Phase 2 Okanagan Water Supply and Demand Project: Groundwater Objectives 2 and 3 Basin Study*[2] prepared by Golder Associates for the Okanagan Basin Water Board.

The entire Summary of the Process to Prioritize BC Aquifers, including tables with aquifer specific recommendations for observation wells is included in Appendix A.

[1] Hy- Geo Consulting (2009). Provincial Observation Well Network Review – British Columbia. Report prepared for Water Stewardship Division, BC Ministry of Environment.
[2] Golder Associates, Summit Environmental Consultants, and Sustainable Subsurface Solutions (2009). Phase 2 Okanagan Water Supply and Demand Project. Groundwater Objectives 2 and 3 Basin Study. Report prepared for Okanagan Basin Water Board.

6.0 Completed Observation Wells

Over the duration of the Project, 12 new observation wells were installed in the Okanagan Basin.

Well Number	Location	Aquifer Materials	Screen Depth (ft)
401	Bullmoose Rd, Osoyoos	Bedrock	600
402	Anarchist Summit, Osoyoos	Bedrock	120
403	Twin Lakes Rd, Twin Lakes	Bedrock/Sand interface	260
404	Eastview Rd, Twin Lakes	Siltstone/Shale	112
405	101 St & 338 Ave, Oliver	Cemented sand/gravel/clay	86.5
407	Tuc-el-nuit Rd, Oliver	Coarse sand	70
409	Schubert Rd, Spallumcheen	Sand/silt	76
410	Goudie Rd, Joe Rich	Bedrock	440
411	Gill Rd, West Kelowna	Bedrock	396
412	Upper Trout Creek, West of Summerland	Bedrock	196
413	Bemrose Rd, SE Kelowna	Compressed sand/gravel	324
442	Black Rd & Whelan Rd, Ellison/Kelowna	Fine sand/silt	176

APPENDIX A: Summary of the Process to Prioritize BC Aquifers

In 2009, the current *Provincial Observation Well Network* was reviewed in a report by Hy-Geo Consulting, Hodge Hydrogeology Consulting and Azar and Associates. The purpose of the network review was to develop a method to recommend where observation wells need to be located in the province to help protect, manage and sustain ground water resources (Hy-Geo, 2009).

In order to determine priority areas for monitoring, suites of criteria were developed by compiling comments from workshops (attended by MoE staff, local and federal government, health authorities and ground water consulting staff), individual comments from Ministry staff and through a review of other jurisdictions in Canada (Hy-Geo, 2009). For further detailed descriptions of criteria selection, please refer directly to the report. Three suites of Criteria were established and grouped on their relative importance from highest to lowest:

Level I Criteria (Aquifer-based hydrogeology and water use)

1. Aquifer area, geology and hydrology (Aquifer Classification and Ranking)
2. Quantity and quality concerns including threats to sustainability and water quality, human health issues, existing and new developments, e.g. coal bed methane, geo-exchange wells.
3. Existing water use, well density, population and water systems dependent on ground water.
4. Ground water management area planning and future regulation.

Level II Criteria (Geographical, BCGS area-based)

1. Number of aquifers and wells.
2. Location of other monitoring sites, e.g. climate stations, hydrometric and snow survey sites.
3. Surface water interaction and community watersheds.
4. Sensitive ecological areas e.g. Parks and Protected areas.

Level III Criteria (Operational)

1. Regional balance and biogeoclimatic representation.
2. Economic sustainability, cost of establishing and maintaining wells including; access, construction, equipment and long-term site security versus available resources (funding and staffing).
3. Representative recharge areas without significant well interference.
4. Duration of monitoring e.g. minimum 10 years.

Figure 1: Criteria developed for the review and prioritization of BC aquifers (Source: Hy- Geo Consulting (2009). Provincial Observation Well Network Review – British Columbia. Report prepared for Water Stewardship Division, BC Ministry of Environment. 164 pp)

The review project involved the application of the first two suites of weighted criteria to the 923 classified BC aquifers and to the 574 BCGS areas (1:20,000 scale map) having 10 or more water wells. The top-rated aquifers and BCGS areas in each MoE region were compared for commonality and resulted in the identification of a small number of key areas in each region containing high priority aquifers. The main steps involved in the prioritization of aquifers within each region are provided below in the following schematic.

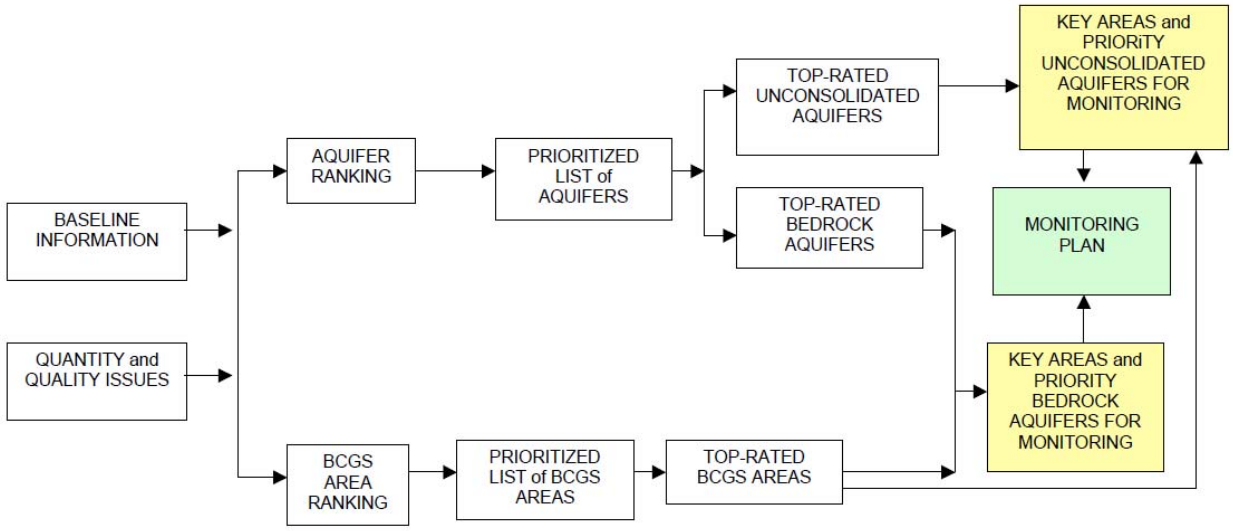


Figure 2: Schematic showing main steps and general process of prioritizing areas for observation wells in each MoE region (Source: Hy-Geo, 2009)

Various types of baseline information from various sources were obtained and compiled including:

(a) Major watershed boundaries,
(b) Classified aquifers,
(c) Well locations and well density,
(d) Community watersheds,
(e) Active climate stations,
(f) Active snow courses and snow pillows,
(g) Active hydrometric stations,
(h) Locations of groundwater supply systems and sources,
(i) Reported ground water quality and quantity concerns,
(j) Current or planned ground water research/planning projects,
(k) Areas of Mountain Pine Beetle infestation,
(l) Estimates of current ground water usage,

(m) Location and number of reported irrigation wells and well yields,
(n) Estimates of population served by ground water,
(o) Number of parks and protected areas, and
(p) Potential areas for future ground water licensing.

For a detailed discussion of each of the above baseline items, refer to Hy-Geo (2009), Appendix H.

The actual ranking process involved completing an Excel template for each individual aquifer and BCGS in each MoE region. As points were assigned, the spreadsheet generated scores and the completed score out of 100 was assigned to each aquifer. An example of the spreadsheet is provided below:

Aquifer Number:		Type:	Location:				
Item	**Description**	**Measure**	**Point Scale**	**Points Assigned**	**Weighting Factor**	**Maximum Weighting**	**Score**
A.	Aquifer Area	> 50 km²	**3**		1	10%	0.0
		10 – 50 km²	**2**		0.5		0.0
		< 10 km²	**1**		0.25		0.0
B.	Aquifer Classification and Ranking	Degree of Development I	3		1	10%	0.0
		II	2		0.5		0.0
		III	1		0.25		0.0
C.	Aquifer Classification and Ranking	Vulnerability A	3		1	5%	0.0
		B	2		0.5		0.0
		C	1		0.25		0.0
D.	Aquifer Classification and Ranking	Ranking Value (based on 7 sub-factors)	5 to 21		1.0 – 0.24	5%	0.0
E.	Estimated Current Ground Water Use	High > 64 L/s	3		1	10%	0.0
		Medium 32 - 64 L/s	2		0.5		0.0
		Low < 32 L/s	1		0.25		0.0
F.	Number of Ground Water Supply Systems	> 5	3		1	15%	0.0
		2 – 5	2		0.66		0.0
		1	1		0.33		0.0
		none reported	0		0		0.0
G.	Number of Reported Irrigation and large production wells, e.g. > 32L/s	> 10	3		1	5%	0.0
		2 – 10	2		0.5		0.0
		< 2	1		0.25		0.0
		none reported	0		0		0.0
H.	Well Density	> 5 km²	3		1	10%	0.0
		1 – 5 km²	2		0.5		0.0
		< 1 km²	1		0.25		0.0
I.	Water Quantity &Quality Issues/Concerns Reported	> 3 (regional)	3		1	10%	0.0
		2 to 3 (local)	2		0.5		0.0
		1 (isolated)	1		0.25		0.0
		none reported	0		0		0.0
J.	Estimated Population Served by Groundwater	> 1000	3		1	10%	0.0
		500 - 1000	2		0.5		0.0
		< 500	1		0.25		0.0
K.	Water management planning and future regulation	Being planned	3		1	10%	0.0
		Possible	2		0.5		0.0
		Unlikely	1		0.25		0.0
						Total	0.0

Figure 3: Template for ranking unconsolidated aquifers.

After applying the ranking process described above, a summary listing of all the descending ranking scores for the unconsolidated and bedrock aquifers was completed for each MoE region. The top-rated prioritized aquifers and the top-rated BCGS aquifers were compiled and a summary table was completed. Approximately, the top 25% of the unconsolidated and bedrock aquifers have been highlighted in the green background in Figures 4 and 5.

Item	Unconsolidated Aquifer Number	Aquifer Name	Aquifer Class	Location Description	Ranking Score for Monitoring
1	158		IA	Grand Forks	89.0
2	464		IC	Valley bottom S, E, NE of Kelowna	87.5
3	463		IC	S, E, NE of Kelowna; S & E side of valley	82.5
4	259		IIA	US Border to Princeton	80.8
5	193	Osoyoos West	IIA	Osoyoos West	76.3
6	254		IIA	Osoyoos Lake to southwest of Tug Lake	76.3
7	255		IA	North of Tug Lake to Vaseux Lake	73.6
8	111		IIC	Lower Shuswap River Valley	69.3
9	194	Osoyoos East	IIA	Osoyoos East	68.6
10	524		IIA	Cranbrook, Surficial	66.4
11	344		IB	Ellison Lake to Wood Lake	65.6
12	456		IIB	Golden, confluence of 2 rivers	62.9
13	521		IA	Jaffray	58.7
14	540		IA	Wasa Lake	58.7
15	316		IIIA	Lumby	57.1
16	102		IIC	Hullcar	56.8
17	353		IA	SE of Armstrong	55.8
18	103		IIA	Parkinson Lake	55.4
19	264		IIB	Okanagan Falls and east of Okanagan Falls	55.1
20	477		IIA	Kettle R., eastward from Rock Ck.	53.9
21	317		IIIC	Lumby	53.8
22	802		IIA	Revelstoke – South	53.7
23	257		IIA	Meyers Flat	53.3
24	345		IIA	Oyama	53.3
25	346		IA	Kalamalka Lake to Vernon	53.1
26	525		IIC	Cranbrook - West	52.6
27	478		IIA	Midway	51.4
28	347		IC	Vernon to Okanangan Lake	51.2
29	603		IIA	Invermere 3km N and S	51.2
30	354		IIA	O'Keefe Valley and Grandview Flats	49.8
31	487		IIIA	Goat River Floodplain near Creston	49.7
32	352		IIC	Coldstream Valley. E of Lavington to W of	49.3
33	860		IA	Mouth of Peachland Creek, SW of Peachland	48.7
34	482		IIIA	Kettle river Valley near Beaverdell	48.5
35	508		IIB	Selkirk Colledge, Southeast of Castlegar	48.5
36	505		IIB	Castlegar Townsite North	48.0
37	349		IIC	Northeast of Vernon along BX Creek	47.7
38	816		IIA	Canal Flats	47.7
39	497		IIB	Erie 1, Salmo	47.0
40	485		IIB	Southwest of the Village of Montrose	46.7
41	484		IIC	Waneta Junction/southeast of Trail	45.9
42	507		IIA	Airport Creek	44.9
43	516		IIA	Willow Point	44.9
44	492		IIA	Yahk	44.7
45	299	Fauder	IIIC	Fauder (Meadow Valley)	44.0

Figure 4: Descending ranking scores for unconsolidated aquifers in the Okanagan-Kettle sub-region.

Item	Bedrock Aquifer Number	Aquifer Name	Aquifer Class	Location Description	Ranking Score for Monitoring
1	260		IIB	Marron Valley northwest of Okanagan Falls	46.8
2	523		IB	Cranbrook S., B. R.	46.0
3	537		IIB	Kimberley, B.R.	45.7
4	351		IIC	NE of Vernon and to the north of BX Creek	45.5
5	488		IIC	Lister, South of Creston	44.4
6	298	Naramata	IIB	Naramata	41.5
7	110		IIIB	Grandview Bench	36.1
8	535		IIIB	Cranbrook N., B. R.	35.7
9	350		IIC	NE of Vernon and to the south of BX Creek	35.5
10	473		IIC	Mission, Daves & Cardinal Ck area	35.2
11	808		IIB	East of Osoyoos, Anarchist Mountain	34.3
12	263		IIA	North of Okanagan Falls/ shore of Skaha Lk	33.8
13	269		IIB	Ellis Creek	33.8
14	304	Westbank	IIB	West side of Okanagan Lk, west of Kelowna	33.8
15	300	Faulder	IIC	Faulder (Eneas Creek)	33.5
16	495		IIB	Fruitvale Creek	33.0
17	534		IIIC	Fernie S. B. R.	31.7
18	107		IIB	Gardom Lake to Enderby	31.3
19	494		IIB	Ross Spur, South	30.7
20	536		IIB	Wycliffe	30.7
21	486		IIB	Columbia Gardens northwards to Kelly Ck.	29.2
22	104		IIB	1 kilometre northwest of Hullcar	28.8
23	863		IIB	N Trepanier Creek Valley N of Peachland	28.5
24	861		IIB	Lower Peachland Creek watershed	28.2
25	499		IIB	Alice Siding, north of Creston	28.0
26	511		IIIB	Fortynine Creek	28.0
27	529		IIIB	Wardner B.R.	28.0
28	518		IIIC	Mt. Nelson	27.9
29	106		IIIC	Southwest of Leduc Creek	27.5
30	493		IIB	Ross Spur, North	27.0
31	475		IIIC	Bedrock slope north of Rock Creek	26.7
32	268		IIB	Penticton East and east shore of Skaha Lk.	26.5
33	305	Westbank	IIB	West side of Okanagon Lk, west of Kelowna	26.3
34	472		IIIB	Southeast of Ellison Lake	26.1
35	512		IIIB	Falls Creek near West Arm, Kootenay Lake	25.5
36	805		IIB	West of Mabel Lake – East of Enderby	25.5
37	812		IIB	North of Grand Forks	25.5
38	879		IIIB	Lillian Lake, NW of Wilmer Creek	25.5
39	500		IIIB	Blueberry, between China Ck. and Kinnaird	25.2

Figure 5: Descending ranking scores for bedrock aquifers in the Okanagan-Kettle subregion.

One of the recommendations from the *Provincial Observation Well Network Review* Report included the expansion of observation wells where it is anticipated that monitoring well data will be needed to support local water services planning and water management decision making. Expansion of the network needs to be integrated with other planned water activities for example; water management planning, ambient water quality monitoring, priorities for well record processing, future groundwater licensing plans and research initiatives. As well, networks should be designed to monitor potential effects of emerging issues such as coal bed methane development, pine beetle infestation/deforestation, and geo-exchange wells.

Following the completion of *Provincial Observation Well Network Review* Report, groundwater staff for each MoE region reviewed the report and identified additional areas or aquifers where regional concerns or issues were known but had not been specifically addressed in the report. Each priority aquifer was cross-referenced to existing observation wells to confirm they were geographically and stratigraphically located within each of the priority aquifers. Since the report had not specifically looked at the Okanagan region, the priority aquifers in the Okanagan-Kettle region was paired down to only include the Okanagan aquifers. As well, MoE groundwater staff reviewed the 2009 report titled "Phase 2 Okanagan Water Supply and Demand Project: Groundwater Objectives 2 and 3 Basin Study" prepared by Golder Associates for the Okanagan Basin Water Board. The following observation well recommendations were proposed as part of the Golder (2009) report and aquifer numbers are specific to their report:

(a) Observation wells located at various points along Trout Creek (specifically the upper reaches near Thirsk reservoir),
(b) Within the Summerland unconsolidated aquifers (AQ 234, 235, 237),
(c) On the east and west side of Okanagan River at Penticton (AQ 229),
(d) At the southern end of Vaseux lake (AQ 218),
(e) Near the head of Okanagan Lake (AQ 272, 273),
(f) Near Vernon (AQ 267, 268), and
(g) At least one alluvial aquifer on the north-west side of Okanagan Lake (AQ 241 or 268)

Regional MoE Groundwater Staff complied a summary spreadsheet outlining the recommendations for new observation wells from Hy-Geo (2009) and Golder (2009) with additional comments for each recommended aquifer.

Okanagan sub region - Unconsolidated Aquifers

Aquifer Number (MoE classification)	Aquifer Location	Ranking Score	New Well(s) Recommended by Hy-Geo (2009)	New Wells Recommended by MOE Penticton GW staff	Okanagan MOE groundwater team comments
Priority Aquifers recommended for establishment of new Observation Wells recommended by Hy-Geo (2009)					
464	Valley Bottom S, E, NE Kelowna	**87.5**	1	**1**	Obs. Well Needed
463	Kelowna, S, E, NE; S and E of valley	**82.5**	1	**1**	Obs. Well Needed
193	Osoyoos West	**76.3**	0	0	No Action required at this time; aquifer contains OW 101, 105, 107 and 96
254	Osoyoos Lake to Southwest of Tug Lake	**76.3**	1	**1**	Obs. Well Needed
255	North of Tug Lake to vaseux lake	**73.6**	1	**1**	Obs. Well Needed
111	Lower Shuswap River valley	**69.3**	0	0	No Action required at this time; aquifer contains OW 122, 117 and 119
194	Osoyoos E	**68.6**	0	**1**	Obs. Well Needed - High ranked aquifer, no Obs. Well Present - Look for opportunities to partner with local gov'ts
344	Ellison lake to Wood Lake	**65.6**	0	0	No Action required at this time; aquifer contains OW 356
316	Lumby	**57.1**	0	0	No Action required at this time; aquifer contains OW 294
102	Hullcar	**56.8**	0	0	No Action required at this time; aquifer contains OW 384
353	Armstrong SE	**55.8**	0	0	No Action required at this time; aquifer contains OW 180
103	Parkinson lake	**55.4**	0	**1**	Obs. Well Needed - Shallow aquifer in Hullcar area
264	Okanagan Falls, E	**55.1**	1	**1**	Obs. Well Needed
317	Lumby	**53.8**	1	**1**	Obs. Well Needed
257	Willowbrook/Meyers Flats	**53.3**	0	0	No Action required at this time; aquifer contains OW 282
345	Oyama	**53.3**	0	0	No Action required at this time; aquifer contains OW 172, 173, 174
346	Kalamalka Lake to Vernon	**53.1**	0	0	Regional MOE GW staff does not see this aquifer as a priority - small aquifer , no current concerns
347	Vernon to Okanagan lake	**51.2**	1	0	Artesian conditions - not suitable for Obs Well
261	Twin Lakes - Marron Valley (NW OK Falls)	**50.1**	1	**1**	Obs. Well Needed
354	Okeefe Valley and Grandview Flats	**49.8**	1	0	Coordinate Well Installation with MoE staff from Thompson Caribou region
352	Coldstream Valley/ Lavington	**49.3**	1	0	Artesian conditions - not suitable for Obs Well
860	SW Peachland	**48.7**	1	0	Regional GW staff does not see this as a priority - small aquifer , no current concerns
349	Vernon NE	**47.7**	0	0	No Action required at this time;
299	Faulder	**44.0**	0	**1**	Obs. Well Needed - Aquifer contains OW 366, 367 ; look for other well opportunities to establish well in Faulder area - continuous water level decline
			TOTAL	**10**	

Priority Aquifers recommended for establishment of new Observation Wells recommended by Golder (2009) - Phase 2 Okanagan Water Supply and Demand Project (note - aquifer numbering same as used in the study)					
Aquifer Number (OB supply-demand study)	**Aquifer Location**	**Ranking Score**	**New Well(s) Recommended by Golder Associates and Summit as a part of 2009 Phase 2 Okanagan Water Supply and Demand Project**	**New Wells Recommended by MOE Penticton GW staff**	**Okanagan MOE groundwater team comments**
234, 235 and 237	Within Summerland	N/A	3	0	Aquifer 235 already has 2 Obs Wells. Additional Obs Well is planned in Faulder Area. Aquifers 234 and 237 are not significant for the purpose of the long-term monitoring
229	Penticton - both sides of the Okanagan River	N/A	2	**1-3**	Establishment of 1-3 wells would be interesting for a special project but not for the purpose of the long-term monitoring. The 1-3 wells would be used for a purpose of estimating groundwater component of the inflow into Okanagan Lake. One side of the Okanagan River is suitable because of the First Nation Reservation Land
218	Upstream and downstream of the Vaseux Creek	N/A	2	0	Interesting for special projects but not for the long term monitoring objectives
272, 273	Near the head of Okanagan Lake	N/A	2	0	MoE Classification Aquifer 354 - Coordinate Well Installation with MoE staff from Thompson Caribou region
267, 268	Near Vernon	N/A	2	0	No current issues (located on Indian Reserve)
241	North West side of Okanagan Lake	N/A	1	0	not sure about the purpose of the proposed observation Well
			TOTAL	**1-3**	

Okanagan sub region - Bedrock Aquifers

Aquifer Number (MoE classification)	Aquifer Location	Ranking Score	Number of New Well(s) Recommended by Hy-Geo Consulting review report, 2009	New Wells Recommended by MOE Penticton GW staff	Okanagan MOE groundwater team comments
Priority Aquifers recommended for establishment of new Observation Wells Recommended by Hy-Geo (2009)					
260	Twin Lakes - Marron Valley (NW Ok Falls)	**46.8**	1	**1**	New Obs. Well Needed
351	North BX Creek, NE Vernon	**45.5**	0	0	No Action required at this time; aquifer contains OW 311
298	Naramata	**41.5**	1	**1**	New Obs. Well Needed
110	Grandview Bench	**36.1**	1	0	coordinate with MoE groundwater staff from Thompson Caribou region
350	South BX Creek, NE Vernon	**35.5**	0	0	No action required at this time
473	Mission Creek, Joe Riche	**35.2**	1	**1**	New Obs. Well Needed
808	E Osoyoos, Anarchist Mtn	**34.3**	2	**1**	New Obs. Well Needed
263	NE Ok Falls	**33.9**	1	0	Regional GW staff does not see this as a priority - no major gw users , no current concerns
269	Carmi Area - Ellis Creek	**33.8**	0	**1**	New Obs. Well Needed
304	Westbank	**33.8**	1	**1**	New Obs. Well Needed
300	Faulder	**33.5**	1	**1**	New Obs. Well Needed
104	Hullcar	**28.8**	0	0	Regional GW staff does not see this as a priority - no major gw users , no current concerns
863	Trepanier Creek/ Peachland	**28.5**	1	0	Regional GW staff does not see this as a priority - no major gw users , no current concerns
861	Lower Peachland	**28.2**	1	0	Regional GW staff does not see this as a priority - no major gw users , no current concerns
			TOTAL	**7**	
Priority Aquifers recommended for establishment of new Observation Wells recommended by Golder (2009) - Phase 2 Okanagan Water Supply and Demand Project					
N/A	Upper reaches of Trout Creek near Thirsk Reservoir	**N/A**		**1**	MoE proposes the well would be installed next to the existing MoE snow survey station 2F01. the well will be useful for monitoring groundwater recharge and correlating with the snow pack data
			TOTAL	**1**	

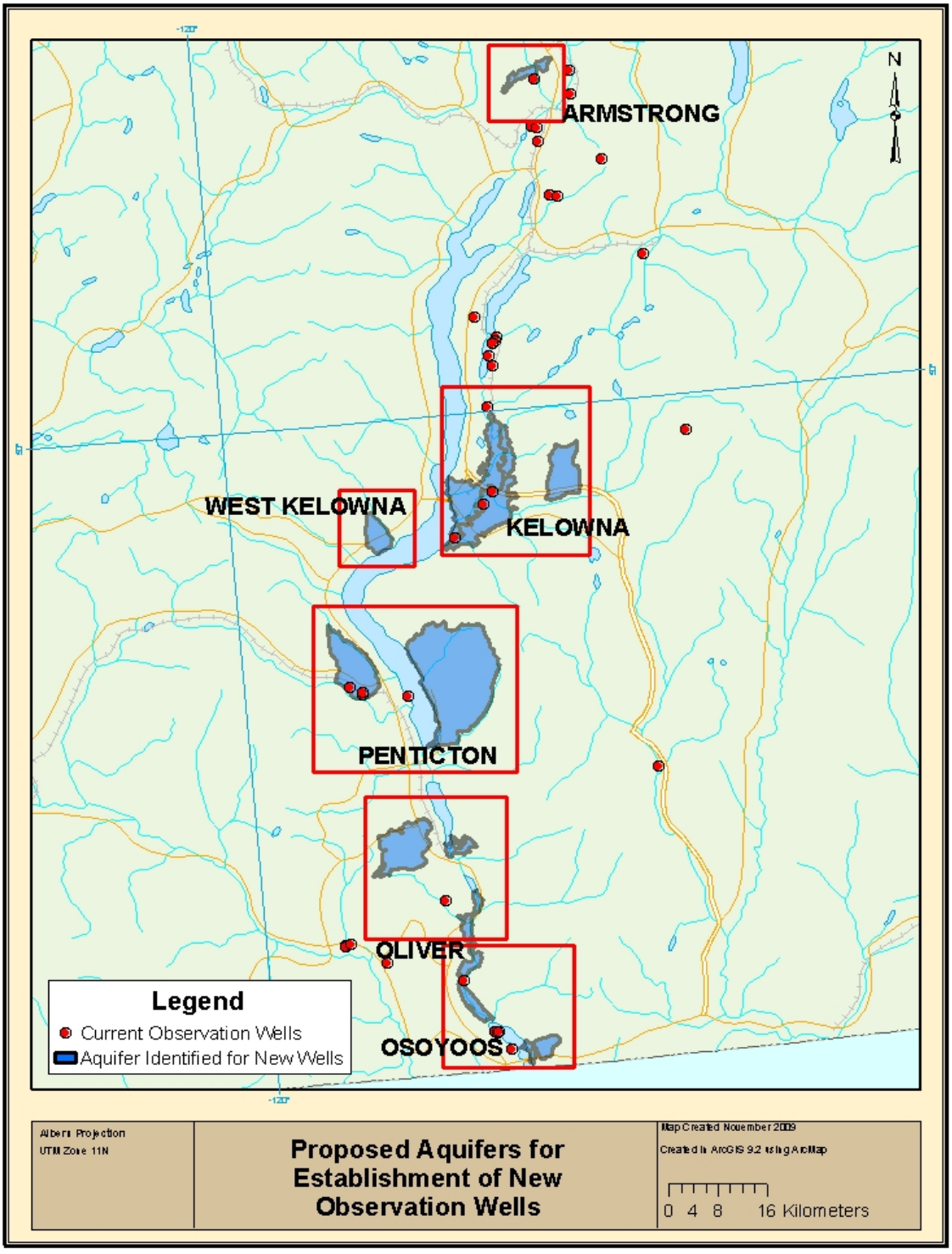


Figure 6: Overview of Proposed Aquifer Location Maps.

In summary, a total of 10 unconsolidated aquifers (potentially 13 based on Golder (2009) recommendation) and 8 bedrock aquifers were identified for the establishment of new observation wells. It is recommended that expansion of the network be targeted to these priority aquifers in the next 3years where it is anticipated that observation well data will be needed to support water management decision making and local water services planning.

References:

Hy- Geo Consulting (2009). Provincial Observation Well Network Review – British Columbia. Report prepared for Water Stewardship Division, BC Ministry of Environment. 164 pages.

Golder Associates, Summit Environmental Consultants, and Sustainable Subsurface Solutions (2009). Phase 2 Okanagan Water Supply and Demand Project. Groundwater Objectives 2 and 3 Basin Study. Report prepared for Okanagan Basin Water Board. 114 pages.

APPENDIX B: Memorandum of Understanding between Involved Parties

This Agreement made in triplicate effective the _____ day of _____, 2010.

BETWEEN:

HER MAJESTY THE QUEEN in Right of CANADA

as represented by the Minister of Agriculture and Agri-Food Canada

("hereinafter called "Canada")

- and -

OKANAGAN BASIN WATER BOARD

a local government established through supplementarty Letters Patent in the Province of British Columbia with offices in

Kelowna, British Columbia

("hereinafter called "the Water Board")

- and -

HER MAJESTY THE QUEEN in Right of the PROVINCE

OF BRITISH COLUMBIA

as represented by the Minister of Environment

("hereinafter called "B.C.")

WHEREAS:

A. The parties wish to have groundwater observation wells with measuring devices installed throughout various parts of the Okanagan Basin of the Province of British Columbia for the purpose of obtaining data about and monitoring, over time, certain groundwater aquifers situated in the Province;

B. Canada is willing, on a pilot project for this fiscal year, to contribute up to 50% of the eligible costs associated with the costs of installing and equipping these wells, up to a maximum of $15,000.00 per well and to a maximum total contribution by Canada of $35,000.00 this fiscal year;

C. B.C. is willing to make in-kind contribution to the Project, including by providing ongoing maintenance for some Project Wells or by facilitating the gaining of access rights to provincial Crown land for the siting of particular Project Wells and

D. The Water Board is also willing to contribute some of its funds to these well projects, where located within the Okanagan Water Basin, and to enter into the contracts with water-well drilling contractors for the installation of such wells;

NOW THEREFORE THIS AGREEMENT WITNESSES that in consideration of the mutual covenants set out herein, the parties agree with each other as follows:

1. Definitions

In this Agreement:

a) "Eligible Costs" means the reasonable costs directly incurred for well-site ground preparation (including, but not limited to, geodetic surveying, locating underground utilities) and the drilling of a ground water observation well, to the depth(s) and to the specifications as provided by Canada and B.C., which costs may include the rental of or charging rate for drilling equipment, actual labour costs, the costs of materials and supplies used, and the costs of monitoring and measuring and communication equipment installed;

b) "Term" means the fiscal year of April 1, 2010 to and ending on March 31, 2011, unless otherwise extended by mutual agreement of the parties, confirmed in writing;

c) "Monitor" shall have the meaning contemplated in clause 7 of this Agreement;

d) "Project" means the drilling of ground water observation wells during the Term of this Agreement, into the various Okanagan aquifers, and various sites selected or approved by B.C. and Canada, to the depth(s) and to the specifications as provided by Canada and B.C. for the purpose of obtaining data about and monitoring, over time, various Okanagan aquifers situated in the Province of British Columbia;

e) "Project Well" means any well drilled and installed during the term for the purpose of the Project and in accordance with the provisions of this Agreement: and

f) "Driller's Report" means a British Columbia Ministry of Environment Well Construction Report.

2. Purpose

a) The purpose of this Agreement is to set out the rights, responsibilities, contributions and obligations of the parties regarding the drilling and installing of Project Wells.

b) The purpose of the Project is to obtain data pertaining to and to monitor, over time, various Okanagan aquifers, to provide a case study for aquifer measurement and monitoring, and to assist in the development of protocols and best practices for other ground water observation wells for optimizing the value of data through a local or regional community engagement process.

3. Responsibilities of Water Board

a) The Water Board shall contract with one or more reputable and qualified ground water well drilling contractors through a competitive process to drill and install Project Wells at sites to be approved by B.C. and Canada. The Water Board shall pay the Project Well contractor(s) for the contracted goods and services, and may apply to Canada and/or B.C. for contribution of funds as re-imbursement of Eligible Costs for any completed Project Well. The drilling and installation of a Project Well, and the delivery of the Driller's Report to Canada for any Project Well must be completed by March 31, 2011.

b) Compliance with Water Act and Regulations

The Water Board and its drilling contractors shall drill and install all Project Wells in accordance with the Ground Water Protection Regulations of The Water Act (B.C.). B.C. may have one or more of its Ministry of Environment officials present at any Project Well site to observe and monitor the drilling and well installation work and activities. Canada may also have one or more staff from Environment Canada and/or Agriculture and Agri-Food Canada present at any Project Well site to observe and monitor the drilling and well installation work and related activities.

c) Subject to paragraph b) above, and unless otherwise specified in writing by Canada for any particular Project Well, the Project Wells shall be drilled to the specifications set out in the attached Schedule "A" to this Agreement.

4. Applying for Reimbursement of Eligible Costs

To apply for reimbursement of Eligible Costs for a completed Project Well, the Water Board shall submit the Driller's Report, to Canada's and to B.C.'s satisfaction, on the completion of a Project Well, as well as copies of all invoices and billing records in respect of the Eligible Costs for that Project Well, and shall set out the total amount of contribution funding sought from Canada and from B.C.

5. Responsibilities of Canada

a) Reimbursement of Eligible Costs

Upon receipt of the Water Board's application for partial reimbursement of Eligible Costs, with all supporting materials, Canada shall review same, and when satisfied as to the amount of Eligible Costs qualified for that Project Well, shall make payment as reimbursement for same, up to a maximum of 50% of the Eligible Costs incurred, but not to exceed a maximum total payment of $15,000.00 per Project Well, and provided that, during the fiscal year expiring March 31, 2011, Canada's maximum total contribution under this Agreement shall not exceed $35,000.00. Canada may report to B.C. on the amount of contribution paid or proposed to be paid to the Water Board for any and all Project Wells.

In the event that Canada contributes measuring devices, monitoring equipment, or other related necessary equipment or supplies to a Project Well, the value or purchase price of such devices and equipment shall be counted as part of Canada's contributed reimbursement of Eligible Costs for that Well.

b) Technical Assistance

During the period that a Project Well is drilled and installed, Canada may provide to the Water Board and its drilling contractor, Her technical personnel for on-site technical advice and assistance, free of charge or cost, to a maximum of the equivalent of 15 person-days per fiscal year.

6. Responsibilities of B.C.

a) Provision of Well-Site Lands

B.C. will assist the parties in gaining access rights to provincial Crown land for the siting, installation, inspection, maintenance, repair, servicing and replacement of particular Project Wells on provincial Crown land by pursuing applications for the disposition of provincial Crown land for such purposes in particular cases, provided always that the

proposed provincial Crown lands are suitable for such purposes and are not required for other purposes in the public interest. The parties acknowledge that the issuance of tenures for provincial Crown land is a matter of statutory discretion and that this provision is not intended to fetter nor influence the exercise of that discretion.

b) B.C. shall be given credit for the value of B.C.'s in-kind contribution in respect of the Project Wells, as well for any payment, at the sole discretion of its Minister, to reimburse the Water Board's Eligible Expenses in respect of any of the Project Wells. B.C. shall be responsible for the design of the Project Wells. B.C. shall also be responsible for monitoring the drilling contractors during the drilling and installation activities.

c) Unless otherwise agreed by the parties, B.C. shall become the owner of each Project Well, and be responsible for its future operation, maintenance, repair, and replacement, and eventual closing, all without any future fee, charge, cost, or other liability to Canada or to the Water Board.

7. Reporting Duties of Well Monitor

a) B.C. shall be designated as the Monitor for each particular Project Well.
b) The Monitor shall collect near-real-time data, including water levels (the "raw data") from that Project Well's measuring and monitoring equipment, and shall promptly make that raw data available, by data report in electronic format, to the other parties.
c) Unless otherwise agreed by the parties, none of the raw data collected at any of the Project Wells shall be considered confidential and may be made accessible to the public.
d) Subject to section 8, none of the parties shall have or shall claim intellectual property rights in, to, or over any of this raw data.

8. Intellectual Property

e) All intellectual property rights, including copyright, in any publication (including any report, graph, website, training manual or other thing) produced from or created using the raw data obtained from any of the Project Wells shall vest in the party that produced or created the publication.
f) Each party grants the other parties a non-exclusive, irrevocable, world-wide, free and royalty-free licence in perpetuity to use or sublicense the use of any publication produced from or created using the raw data obtained from the Project Wells for non-commercial purposes.

9. Environmental Assessment

The Water Board and B.C. acknowledge that in order to be entitled to receive any contribution funding from Canada, an environment assessment for each Project Well must, unless otherwise excluded by federal law, be conducted in accordance with the Canadian Environmental Assessment Act, as soon as practicable, and that Canada must be satisfied that the project to be carried out is unlikely to cause any significant adverse environmental effects, or alternatively, if

the implementation of any mitigation measures, as may be specified by Canada, are implemented, that the project is then unlikely to cause any significant adverse environmental effects. Where Canada does specify in writing any mitigation measures in respect of a particular Project Well, or group of wells, the Water Board shall implement same, at its expense. Canada agrees that the reasonable cost of a project environmental assessment, and the reasonable costs of implementing the specified mitigation measures shall also qualify as Eligible Costs for the purpose of this Agreement. The parties expressly acknowledge that Canada's contribution towards any particular Project Well shall be conditional upon compliance with this provision. Canada shall have the right, at all reasonable times, upon prior notice, to enter upon any Project Well site lands to inspect same for the purpose of examining the status of the implementation of any specified mitigation measures.

10. Pilot Project/Extension of Agreement

The parties agree that this Project shall serve as a pilot project for a future, prospective enlarged project for more Project Wells for up to two additional years. After the completion of this Project, and prior to the expiration of the Term, the Parties shall assess the performance of and the results derived from this Project, and determine whether and to what extent it may be extended. The Parties may extend this Project by entering into a written Project Extension and Amending Agreement.

11. Contact Persons/Address for Notice

The respective Contact Persons and the respective address for notices for this Project are as follows:

For Canada: Agriculture and Agri-Food Canada
3015 Ord Road
Kamloops, B.C. V2B 8A9
Attention: Doug Edwards
Regional Water Resources Engineer
Pacific Region
Fax: (250) 554-5204

For B.C.: Ministry of Environment
102 Industrial Place
Penticton, B.C. V2A 7C8
Attention: Oleg Ivanov
Groundwater Hydrologist
Fax: (250) 490-2231

For the Water Board:

Okanagan Basin Water Board
1450 KLO Road
Kelowna, B.C. V1W 3Z4
Attention: Anna Warwick Sears
Executive Director
Fax: (250) 762-7011

12. Miscellaneous

The interpretation and application of this Agreeement shall be governed by the laws of British Columbia and the applicable laws of Canada.

13. This Agreement may be amended at any time by the parties, by mutual consent expressed in writing.

APPENDIX C: Groundwater Monitoring Well Project: Backgrounder

Environment Canada has designated the Okanagan as a priority water-limited region where many water bodies are supported by flows from groundwater. Recent scientific groundwater studies[3] show that there is a need to increase the observation wells throughout the Okanagan, both to develop better local information in priority areas, and to gain a better understanding of ongoing changes to groundwater supplies in the valley as a whole. Monitoring wells help water managers understand the basic health of the aquifers, and how they are affected by human use and changes in rain and snowfall. The management of local groundwater plays an integral role in the environmental and socio-economic sustainability of the region.

As identified by Ministry staff,

> It is recommended that expansion of the network be targeted to those [identified] priority aquifers in the next 3 years where it is anticipated that observation well data will be needed to support water management decision making and local water services planning.

The groundwater monitoring project consists of 4 agencies working in partnership: BC Government (Ministry of Environment and Ministry of Forests, Lands and Natural Resources Operations), Agriculture and Agri-Food Canada, Environment Canada and the Okanagan Basin Water Board. In addition to the project management team, local governments have been instrumental in providing resources (financial and in-kind) to support this groundwater monitoring initiative.

2010-11 members of the Okanagan Groundwater Monitoring Project team include:

- Oleg Ivanov, Acting Section Head, Public Safety and Protection, Ministry of Environment
- Doug Edward, Regional Water Resources Engineer, Agriculture and Agri-Food Canada
- Gwyn Graham, Senior Hydrogeologist, Environment Canada
- Nelson Jatel , Water Stewardship Director, Okanagan Basin Water Board (Project Manager)

Participating local government partners will have access to enhanced groundwater monitoring that may be useful for land-use development decisions that occur over local groundwater aquifers. This project is designed to bring together all levels of government to develop and

[3] HyGeo Consulting Review (2009); Golder Associates (2009) – Phase 2 Okanagan Water Supply and Demand Project.

enhance the available information about local Okanagan aquifers – with significant cost sharing support.

The primary goal of the Okanagan Groundwater Monitoring Project is to develop fifteen (15) new observation wells in the Okanagan basin over three years (2010-13); with six wells having been drilled in 2010 and an anticipated five (5) monitoring wells implemented this year.

A draft project budget is given below (Figure 1) that shows estimated costs to partner Local Governments and the contributions of the Project steering committee team. The costs associated with different monitoring will vary depending on location and well depth, and will be finalized upon determination of interested Local Government partners.

In 2009, the current *Provincial Observation Well Network* was reviewed in a report by Hy-Geo Consulting, Hodge Hydrogeology Consulting and Azar and Associates. The purpose of the network review was to develop a method to recommend where observation wells need to be located in the province in order to help protect, manage and sustain ground water resources (Hy-Geo, 2009).

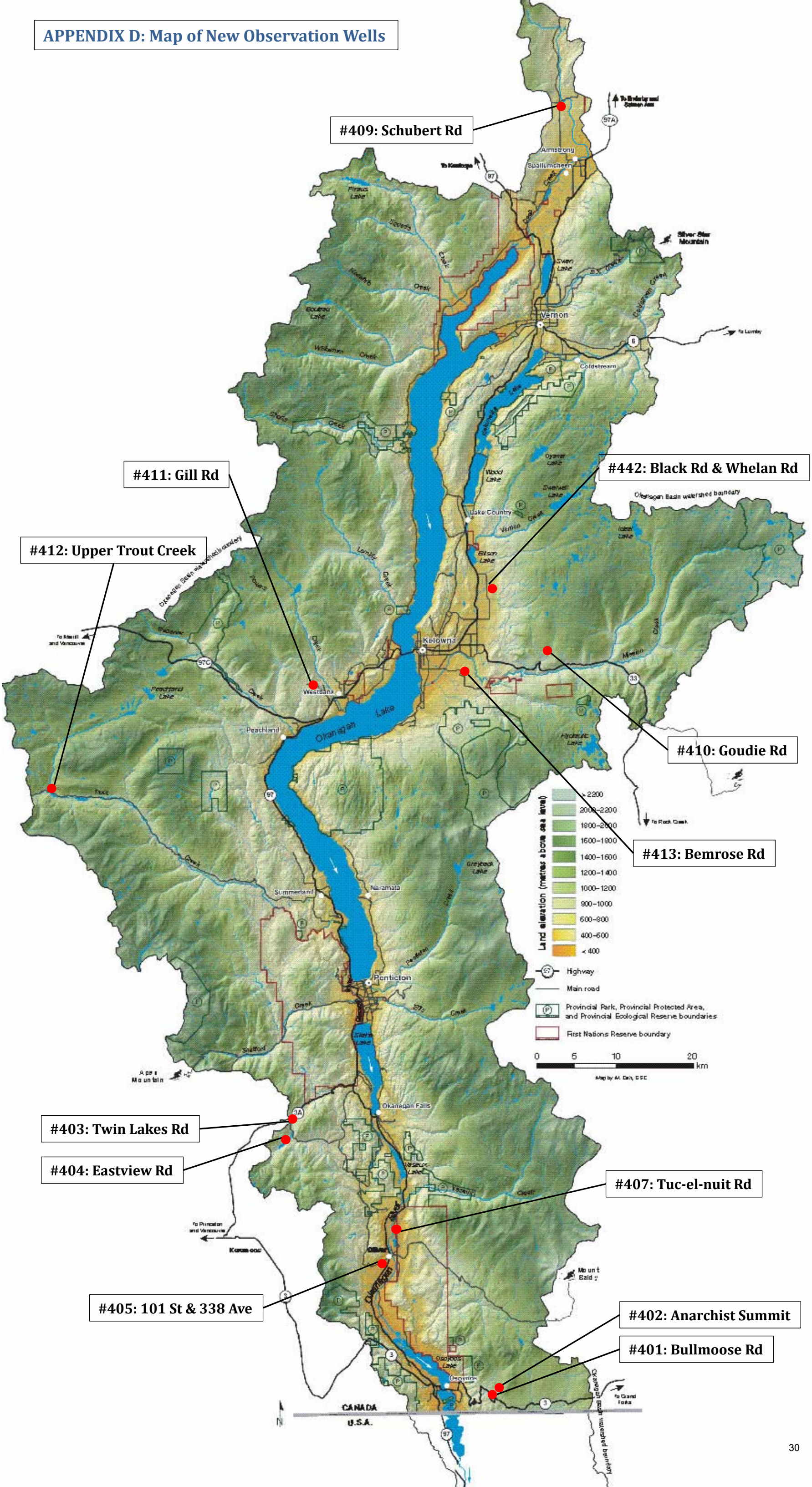
One of the recommendations from the *Provincial Observation Well Network Review* Report included the expansion of observation wells where it is anticipated that monitoring well data will be needed to support local water services planning and water management decision making. Expansion of the network needs to be integrated with other planned water activities for example; water management planning, ambient water quality monitoring, priorities for well record processing, future groundwater licensing plans and research initiatives. As well, networks should be designed to monitor potential effects of emerging issues such as coal bed methane development, pine beetle infestation/deforestation, and geo-exchange wells.

In recognition of the implementation of six groundwater monitoring wells developed last year a ribbon cutting ceremony is scheduled for 10am on Wednesday July 13th in Oliver (Tuk-Ul-Nuit Rd).

Figure 1. Proposed draft budget to develop one monitoring well

	2010 **$ (1,000's)**
Project Revenue (Proposed)	
Ministry of Environment	
Equipment (5 monitoring stations)	8.0
On-going data collection / web reporting	5.0
Well sighting and consultation	5.0
Agriculture and Agri-Food Canada	7.5
Okanagan Basin Water Board	6.0
Local Government contribution	**6.5**
Total Monitoring Well Revenue	38.0
Expenses	
Well monitoring stations	8.0
On-going data collection / web reporting	5.0
Well sighting and consultation	5.0
Well drilling (estimate – depends on well depth)	20.0
Total Expenses	38.0
Project surplus (loss)	-

APPENDIX D: Map of New Observation Wells



APPENDIX E: Logs from New Observation Wells

Well Number	Location
401	Bullmoose Rd, Osoyoos
402	Anarchist Summit, Osoyoos
403	Twin Lakes Rd, Twin Lakes
404	Eastview Rd, Twin Lakes
405	101 St & 338 Ave, Oliver
407	Tuc-el-nuit Rd, Oliver
409	Schubert Rd, Spallumcheen
410	Goudie Rd, Joe Rich
411	Gill Rd, West Kelowna
412	Upper Trout Creek, West of Summerland
413	Bemrose Rd, SE Kelowna
442	Black Rd & Whelan Rd, Ellison/Kelowna

BRITISH COLUMBIA
The Best Place on Earth

Ministry of Environment

☑ **Well Construction Report**
☐ **Well Closure Report**
☐ **Well Alteration Report**

Stamp company name/address/ phone/fax/e-mail here, if desired.

Ministry Well ID Plate Number: 30285
Ministry Well Tag Number: _____
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. **See reverse for notes & definitions of abbreviations.**

Owner name: REGAL RIDGE

Mailing address: _____ Town _____ Prov. _____ Postal Code _____

Well Location: Address: Street no. BULL MOOSE Street name LOAS OBSERVATION Town WELL. No. 401

(or) Legal description: Lot _____ Plan _____ D.L. _____ Block _____ Sec. _____ Twp. _____ Rg. _____ Land District _____

(or) PID: _____ (and) Description of well location (attach sketch, if nec.): 1.9 KM FROM BULLMOOSE RD. ENTRANCE ON RIGHT

NAD 83: Zone: _____ (see note 2) (and) UTM Easting: _____ m UTM Northing: _____ m (or) Latitude (see note 3): _____ Longitude: _____

Method of drilling: ☑ air rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify): _____

Orientation of well: ☑ vertical ☐ horizontal Ground elevation: _____ ft (asl) Method (see note 4): _____

Class of well (see note 5): WATER SUPPLY Sub-class of well: _____

Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☐ commercial or industrial ☐ other (specify): _____

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
0	2'			MEDIUM GRAVEL & FINE SAND		WATER BEARING FRACTURES
2	5'			HARD PAN		46' - 1/2 GPM
5	7			BOULDER		90' - 1/2 "
7	8			BROKEN BEDROCK		98' - 5 "
8	17			SOLID BEDROCK		338' - 1 1/3 "
17	600			OPEN BEDROCK HOLE		360' - 1/2 "
						513' - 2 1/2 "
						536' - 8 "
						TOTAL - 18 GPM

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
0	17	6 5/8	STEEL	.250	N

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size

Surface seal: Type: BENTONITE Depth: 17 ft
Method of installation: ☑ Poured ☐ Pumped Thickness: 2 in
Backfill: Type: _____ Depth: _____ ft
Liner: ☐ PVC ☐ Other (specify): _____
Diameter: _____ in Thickness: _____ in
From: ____ ft (bgl) To: ____ ft (bgl) Perforated: From: ____ ft (bgl) To: ____ ft (bgl)

Intake: ☐ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☐ Telescope ☐ Pipe size
Screen material: ☐ Stainless steel ☐ Plastic ☐ Other (specify): _____
Screen opening: ☐ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☐ Bail ☐ Plug ☐ Plate ☐ Other (specify): _____
Filter pack: From: ____ ft To: ____ ft Thickness: _____ in
Type and size of material: _____

Developed by:

☑ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
☐ Other (specify): _____ Total duration: 3 hrs
Notes: _____

Well yield estimated by:

☐ Pumping ☒ Air lifting ☐ Bailing ☐ Other (specify): _____
Rate: 12 USgpm Duration: 3 hrs
SWL before test: _____ ft (btoc) Pumping water level: _____ ft (btoc)

Obvious water quality characteristics:

☐ Fresh ☐ Salty ☒ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: _____ Water sample collected: ☐

Well driller (print clearly):

Name (first, last) (see note 19): ROB CRUMPTON
Registration no. (see note 20): WD0506230 1
Consultant (if applicable; name and company): _____

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the *Water Act* and the Ground Water Protection Regulation.

Signature of Driller Responsible _____

Final well completion data:

Total depth drilled: 600 ft Finished well depth: 600 ft (bgl)
Final stick up: 3" in Depth to bedrock: 7 ft (bgl)
SWL: _____ ft (btoc) Estimated well yield: 18 USgpm
Artesian flow: _____ USgpm, or Artesian pressure: _____ ft
Type of well cap: BOLTED Well disinfected: ☐ Yes ☐ No
Where well ID plate is attached: TOP OF CASING

Well closure information:

Reason for closure: _____
Method of closure: ☐ Poured ☐ Pumped
Sealant material: _____ Backfill material: _____
Details of closure (see note 17): _____

Date of work (YYYY/MM/DD):

Started: 2010/09/20 Completed: 10/09/29
Comments: _____

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

white: Customer copy
canary: Driller copy
pink: Ministry copy

BRITISH COLUMBIA

Ministry of Water, Land and Air Protection
Water, Air & Climate Change Branch

WATER WELL RECORD

Date 06 03 (YR MO DY)

BCGS MAP ____ WELL No. ____ ELEV ____ Location Accuracy ____

UTM Z ____ E ____ N ____ UTM Date 20__ Well Type ____ Well ID Plate # ____

Owners Name & Address REGAL RIDGE

Legal Description & Address ANARCHIST

Descriptive Location ~~TEST WELL #3~~ OBSERVATION WELL 402 - OSOYOOS (ANARCHIST MT.)

1. TYPE OF WORK: 1 ☑ New Well 2 ☐ Reconditioned 3 ☐ Deepened 4 ☐ Abandoned

2. WORK METHOD: 1 ☐ Cable tool 2 ☐ Bored 3 ☐ Jetted 4 ☑ Rotary a ☐ mud b ☑ air c ☐ reverse ☐ Other ____

3. WATER WELL USE: 1 ☑ Domestic 2 ☐ Municipal 3 ☐ Irrigation 4 ☐ Comm. & Ind. ☐ Other ____

4. DRILLING ADDITIVES ____

5. MEASUREMENTS from 1 ☐ ground level 2 ☐ top of casing
casing height above ground level ____ ft.

FROM ft	TO ft	6. WELL LOG DESCRIPTION	SWL ft
0	1'	TOP SOIL	
1'	19'	CASED BEDROCK	
19'	120'	OPEN BEDROCK HOLE	
		WATER BEARING FRACTURE	
		108' - 30 GPM	

7. CONSULTANT ____
Address ____

8. WELL LOCATION SKETCH

9. CASING: Materials 1 ☑ Steel 2 ☐ Galvanized 3 ☐ Wood 4 ☐ Plastic 5 ☐ Concrete ☐ Other ____

							units
Hole Diameter	6 5/8						ins
Diameter							ins
from	0						ft
to	19'						ft
Thickness	.250						ins
Weight							lb/ft

Pitless unit ____ ft 1 ☐ above 2 ☐ below ground level
1 ☐ Welded 2 ☐ Cemented 3 ☐ Threaded | 1 ☐ New 2 ☐ Used
Perforations: ____

Shoe(s): —
Open hole, from 19' to 120' ft Diameter 6. ins
Grout: CEMENT & BENTONITE

10. SCREEN: 1 ☐ Nominal (Telescope) 2 ☐ Pipe Size
Type 1 ☐ Continuous Slot 2 ☐ Perforated 3 ☐ Louvre ☐ Other ____
Material 1 ☐ Stainless Steel 2 ☐ Plastic ☐ Other ____
Set from ____ to ____ ft below ground level

RISER, SCREEN & BLANKS							units
Length							ft
Diam. I D							ins
Slot Size							ins
from							ft
to							ft

Fittings, top ____ bottom ____
Gravel Pack ____

11. DEVELOPED BY: 1 ☐ Surging 2 ☐ Jetting 3 ☐ Air 4 ☐ Bailing 5 ☐ Pumping ☐ Other ____

12. TEST 1 ☐ Pump 2 ☐ Bail 3 ☐ Air Date ____ (YR MO DY)
Rate ____ USgpm Temp ____ °C SWL before test ____ ft
Water Level ____ ft after test of ____ hrs

☐ DRAWDOWN in ft				☐ RECOVERY in ft			
mins	WL	mins	WL	mins	WL	mins	WL

13.

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING ft	RECOMMENDED PUMPING RATE USgpm

14. WATER TYPE: 1 ☐ fresh 2 ☐ salty 3 ☐ clear 4 ☐ cloudy
colour ____ smell ____ ; gas 1 ☐ yes 2 ☐ no

15. WATER ANALYSIS: 1 Hardness ____ mg/L 2 Iron ____ mg/L 3 Chloride ____ mg/L 4 pH ____ Field Date ____ Lab Date ____ (YR MO DY)

EMS SITE No. ____

16. FINAL WELL COMPLETION DATA
Well Depth 120 ft Well Yield 30 ~~US~~ gpm
Static Water Level ____ ft Artesian Flow ____ US gpm Pressure Head ____ ft
Back filled ____
Well Head Completion ____

17. DRILLER PLEASE PRINT SURNAME CRAMPTON FIRST NAME ROB
Signature ____

18. CONTRACTOR,
Address

Member, B C G W A ☐ yes ☐ no ; ____

33

BRITISH COLUMBIA
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Ministry of Environment

☑ Well Construction Report
☐ Well Closure Report
☐ Well Alteration Report

JR Drilling Central
1-866-711-8118
WD 0[illegible]
Stamp company name/address/phone/fax/email here, if desired.

Ministry Well ID Plate Number: 34383
Ministry Well Tag Number:
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. See reverse for notes & definitions of abbreviations.

Owner name: OBWB.
Mailing address: ______ Town ______ Prov. ______ Postal Code ______
Well Location (see note 2): Address: Street no. ______ Street name ______ Town ______
(or) Legal description: Lot A Plan KAP 46761 D.L. 2285 Block ______ Sec. ______ Twp. ______ Rg. ______ Land District SDYD
(or) PID: ______ (and) Description of well location (attach sketch, if nec.): Adjacent to 161 Twin Lakes Rd.

NAD 83: Zone: ______ (and) UTM Easting: ______ m (or) Latitude (see note 4): 49° 19, 48
(see note 3) UTM Northing: ______ m Longitude: 119° 43, 23

Method of drilling: ☑ air rotary ☑ dual rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ other (specify): ______
Orientation of well: ☑ vertical ☐ horizontal Ground elevation: ______ ft (asl) Method (see note 5): ______
Class of well (see note 6): Monitoring Sub-class of well: Permanent
Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☑ commercial or industrial ☐ other (specify): ______

Lithologic description (see notes 8-13) or closure description (see notes 14 and 15)

From ft (bgl)	To ft (bgl)	Surficial Material: Clay	Silt	Till	Sand with clay/silt	Sand, fine-med	Sand, med-coarse	Sand with gravel	Bedrock Material: Siltstone/shale	Sandstone	Conglomerate	Limestone	Basalt	Volcanic	Cyrstalline	Other Surficial/ Bedrock	Colour: Red	Orange	Brown	Tan	Light Grey	Blue	Green	Dark Grey	Hardness: Very Hard	Hard	Dense/Stiff	Loose	Water Content: Dry	Moist	Wet	High Production	Lost circulation	Not Available	Observations (e.g. other geological materials (e.g. boulders), est. water bearing flow (USgpm), or closure details)
0	37						✓												✓									✓	✓						
37	40					✓															✓							✓	✓						
40	50					✓													✓									✓	✓						
50	90		✓																✓									✓	✓						
90	115					✓													✓									✓		✓					
115	145		✓																		✓							✓	✓						
145	195	✓	✓																✓		✓							✓		✓					
195	207					✓													✓									✓		✓					
207	215		✓																✓									✓		✓					
215	230	✓	✓																		✓							✓		✓					

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole (see note 17)	Wall Thickness in	Drive Shoe
0	20	8	Casing pulled		
0	252	6	Steel	.219	B.B

Surface seal: Type: Bentonite chip's Depth: 20 ft
Method of installation: ☑ Poured ☐ Pumped Thickness: ______ in
Backfill: Type: ______ Depth: ______ ft
Liner: ☐ PVC ☐ Other (specify): ______
Diameter: ______ in Thickness: ______ in
From: ___ ft (bgl) To: ___ ft (bgl) Perforated: From: ___ ft (bgl) To: ___ ft (bgl)

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
250	252	5	K-pak, riser	
252	256	5	Screen	12

Intake: ☑ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☑ Telescope ☐ Pipe size
Screen material: ☑ Stainless steel ☐ Plastic ☐ Other (specify): ______
Screen opening: ☑ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☑ Bail ☐ Plug ☐ Plate ☐ Other (specify): ______
Filter pack: From: ______ ft To: ______ ft Thickness: ______ in
Type and size of material: ______

Developed by:
☑ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
Other (specify): ______ Total duration: 2 hrs
Notes: ______

Well yield estimated by:
☐ Pumping ☑ Air lifting ☐ Bailing ☐ Other (specify): ______
Rate: 7 USgpm Duration: 2 hrs
SWL before test: 125 ft (btoc) Pumping water level: ______ ft (btoc)

Obvious water quality characteristics:
☑ Fresh ☐ Salty ☑ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: ______ Water sample collected: ☐

Well driller (print clearly):
Name (first, last) (see note 19): Jerry Opper
Registration no. (see note 20): WD 08052101
Consultant (if applicable; name and company): OLEG IVANOV B.C. MINISTRY OF NATURAL RESOURCE

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible: Jerry Opper

Final well completion data:
Total depth drilled: 264 ft Finished well depth: 256 ft (bgl)
Final stick up: 18 in Depth to bedrock: 256 ft (bgl)
SWL: 125 ft (btoc) Estimated well yield: 7 USgpm
Artesian flow: ______ USgpm, or Artesian pressure: ______ ft
Type of well cap: Lock Well disinfected: ☐ Yes ☐ No
Where well ID plate is attached: Casing

Well closure information:
Reason for closure: ______
Method of closure: ☐ Poured ☐ Pumped
Sealant material: ______ Backfill material: ______
Details of closure (see note 16): ______

Date of work (YYYY/MM/DD):
Started: 11/1/14 Completed: 11/1/17
Comments: ______

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

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☑ **Well Construction Report**
☐ **Well Closure Report**
☐ **Well Alteration Report**

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Ministry of Environment

JR Drilling Central
Stamp company name/address/phone/fax/email here, if desired.
1-866-711-8118
WD 06030601

Ministry Well ID Plate Number: 34383
Ministry Well Tag Number: ____
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. See reverse for notes & definitions of abbreviations.

Owner name: OBWB
Mailing address: ____ Town ____ Prov. ____ Postal Code ____
Well Location (see note 2): Address: Street no. ____ Street name ____ Town ____
(or) **Legal description:** Lot A Plan KAP46761 D.L. 2285 Block ____ Sec. ____ Twp. ____ Rg. ____ Land District SDYD.
(or) **PID:** ____ (and) **Description of well location (attach sketch, if nec.):**
ADJACENT TO 161 TWIN LAKES ROAD.

NAD 83: Zone: ____ (and) **UTM Easting:** ____ m (or) **Latitude (see note 4):** 49° 19, 48
(see note 3) **UTM Northing:** ____ m **Longitude:** 119° 43, 23

Method of drilling: ☑ air rotary ☑ dual rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ other (specify): ____
Orientation of well: ☑ vertical ☐ horizontal Ground elevation: ____ ft (asl) Method (see note 5): ____
Class of well (see note 6): Monitoring **Sub-class of well:** Permanent
Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☑ commercial or industrial ☐ other (specify): ____

Lithologic description (see notes 8-13) or closure description (see notes 14 and 15)

		Surficial Material							Bedrock Material								Colour								Hardness				Water Content						Observations (e.g. other geological materials (e.g. boulders), est. water bearing flow (USgpm), or closure details)
From ft (bgl)	To ft (bgl)	Clay	Silt	Till	Sand with clay/silt	Sand, fine-med	Sand, med-coarse	Sand with gravel	Siltstone/shale	Sandstone	Conglomerate	Limestone	Basalt	Volcanic	Cyrstalline	Other Surficial/Bedrock	Red	Orange	Brown	Tan	Light Grey	Blue	Green	Dark Grey	Very Hard	Hard	Dense/Stiff	Loose	Dry	Moist	Wet	High Production	Lost circulation	Not Available	
230	235							✓											✓									✓			✓				
~~3~~235	245				✓														✓									✓		✓					
245	255		✓					✓											✓									✓			✓				
255	256							✓											✓									✓			✓				
256	260															✓								✓	✓					✓					
~~260~~																																			

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole (see note 17)	Wall Thickness in	Drive Shoe
0	20	8	Casing pulled		
0	~~256~~ 252	6	Steel	.219	B.B

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
250	252	5	K-pak, riser	
252	256	5	Screen	12

Surface seal: Type: Bentonite chip's Depth: 20 ft
Method of installation: ☑ Poured ☐ Pumped Thickness: ____ in
Backfill: Type: ____ Depth: ____ ft
Liner: ☐ PVC ☐ Other (specify): ____
Diameter: ____ in Thickness: ____ in
From: ____ ft (bgl) To: ____ ft (bgl) Perforated: From: ____ ft (bgl) To: ____ ft (bgl)

Intake: ☑ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☑ Telescope ☐ Pipe size
Screen material: ☑ Stainless steel ☐ Plastic ☐ Other (specify): ____
Screen opening: ☑ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☑ Bail ☐ Plug ☐ Plate ☐ Other (specify): ____
Filter pack: From: ____ ft To: ____ ft Thickness: ____ in
Type and size of material: ____

Developed by:
☑ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
Other (specify): ____ Total duration: 2 hrs
Notes: ____

Well yield estimated by:
☐ Pumping ☑ Air lifting ☐ Bailing ☐ Other (specify): ____
Rate: 7 USgpm Duration: 2 hrs
SWL before test: 125 ft (btoc) Pumping water level: ____ ft (btoc)

Obvious water quality characteristics:
☑ Fresh ☐ Salty ☑ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: ____ Water sample collected: ☐

Well driller (print clearly):
Name (first, last) (see note 19): Jerry Opper
Registration no. (see note 20): WD 08052101
Consultant (if applicable; name and company):
OLEG IVANOV B.C. MINISTRY

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible [signature]

Final well completion data:
Total depth drilled: 264 ft Finished well depth: 256 ft (bgl)
Final stick up: 18 in Depth to bedrock: 256 ft (bgl)
SWL: 125 ft (btoc) Estimated well yield: 7 USgpm
Artesian flow: ____ USgpm, or Artesian pressure: ____ ft
Type of well cap: Lock Well disinfected: ☐ Yes ☐ No
Where well ID plate is attached: Casing

Well closure information:
Reason for closure: ____
Method of closure: ☐ Poured ☐ Pumped
Sealant material: ____ Backfill material: ____
Details of closure (see note 16): ____

Date of work (YYYY/MM/DD):
Started: 2011/1/14 **Completed:** 11/1/17
Comments: ____

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

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☑ Well Construction Report
☐ Well Closure Report
☐ Well Alteration Report

JR Drilling Central
Stamp company name/address/phone/email here, if desired.
1866-711-8118
WD 06030601

Ministry Well ID Plate Number: 34382
Ministry Well Tag Number: _____
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. See reverse for notes & definitions of abbreviations.

Owner name: QBuB

Mailing address: _____ Town _____ Prov. _____ Postal Code _____

Well Location (see note 2): Address: Street no. _____ Street name _____ Town _____

(or) **Legal description:** Lot A Plan 45902 D.L. 280 Block _____ Sec. _____ Twp. _____ Rg. _____ Land District SD 4D

(or) **PID:** _____ (and) **Description of well location (attach sketch, if nec.):** 2km. South of Intersection with Highway 3A.

NAD 83: Zone: _____ (see note 3) (and) **UTM Easting:** _____ m **UTM Northing:** _____ m (or) **Latitude (see note 4):** 49° 18, 58 **Longitude:** 119° 43, 45

Method of drilling: ☑ air rotary ☑ dual rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ other (specify): _____

Orientation of well: ☑ vertical ☐ horizontal Ground elevation: _____ ft (asl) Method (see note 5): _____

Class of well (see note 6): Monitoring **Sub-class of well:** permanent

Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☑ commercial or industrial ☐ other (specify): _____

Lithologic description (see notes 8-13) or closure description (see notes 14 and 15)

From ft (bgl)	To ft (bgl)	Surficial Material: Clay	Silt	Till	Sand with clay/silt	Sand, fine-med	Sand, med-coarse	Sand with gravel	Bedrock Material: Siltstone/shale	Sandstone	Conglomerate	Limestone	Basalt	Volcanic	Cyrstalline	Other Surficial/ Bedrock	Colour: Red	Orange	Brown	Tan	Light Grey	Blue	Green	Dark Grey	Hardness: Very Hard	Hard	Dense/Stiff	Loose	Water Content: Dry	Moist	Wet	High Production	Lost circulation	Not Available	Observations (e.g. other geological materials (e.g. boulders), est. water bearing flow (USgpm), or closure details)
0	20							✓											✓									✓	✓							
20	82					✓													✓									✓	✓							
82	89							✓											✓									✓		✓						
89	109				✓														✓									✓	✓							
109	112								✓										✓							✓						✓				

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole (see note 17)	Wall Thickness in	Drive Shoe
0	15	8	Casing pulled		
0	107	6	Steel	.219	B.B

Surface seal: Type: Bentonite chips Depth: 15 ft
Method of installation: ☑ Poured ☐ Pumped Thickness: _____ in
Backfill: Type: _____ Depth: _____ ft
Liner: ☐ PVC ☐ Other (specify): _____
Diameter: _____ in Thickness: _____ in
From: ___ ft (bgl) To: ___ ft (bgl) Perforated: From: ___ ft (bgl) To: ___ ft (bgl)

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
105	107	5	K-pak, riser	
107	113	5	Screen	10

Intake: ☑ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☑ Telescope ☐ Pipe size
Screen material: ☑ Stainless steel ☐ Plastic ☐ Other (specify): _____
Screen opening: ☑ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☑ Bail ☐ Plug ☐ Plate ☐ Other (specify): _____
Filter pack: From: _____ ft To: _____ ft Thickness: _____ in
Type and size of material: _____

Developed by:

☑ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
Other (specify): _____ Total duration: 1 hrs
Notes: _____

Well yield estimated by:

☐ Pumping ☑ Air lifting ☐ Bailing ☐ Other (specify): _____
Rate: 15 USgpm Duration: 1 hrs
SWL before test: 85 ft (btoc) Pumping water level: _____ ft (btoc)

Obvious water quality characteristics:

☑ Fresh ☐ Salty ☑ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: _____ Water sample collected: ☐

Well driller (print clearly):

Name (first, last) (see note 19): Jerry Opper
Registration no. (see note 20): WD 08052101
Consultant (if applicable; name and company): OLEG IVANOV. B.C. MINISTRY OF NATURAL RESOURCE.

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible _____

Final well completion data:

Total depth drilled: 118 ft Finished well depth: 113 ft (bgl)
Final stick up: 48 in Depth to bedrock: 111 ft (bgl)
SWL: 85 ft (btoc) Estimated well yield: 15 USgpm
Artesian flow: _____ USgpm, or Artesian pressure: _____ ft
Type of well cap: lock Well disinfected: ☐ Yes ☐ No
Where well ID plate is attached: casing

Well closure information:

Reason for closure: _____
Method of closure: ☐ Poured ☐ Pumped
Sealant material: _____ Backfill material: _____
Details of closure (see note 16): _____

Date of work (YYYY/MM/DD):

Started: 11/1/17 Completed: 11/1/18
Comments: _____

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

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☒ Well Construction Report
☐ Well Closure Report
☐ Well Alteration Report

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Stamp company name/address/ phone/fax/e-mail here if desired

Ministry Well ID Plate Number: 17881
Ministry Well Tag Number:
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. **See reverse for notes & definitions of abbreviations.**

Owner name: Groundwater Section, BC Ministry of Environmental
Mailing address: Town Prov. Postal Code
Well Location: Address: Street no. Street name 338th AVE Town Oliver
(or) Legal description: Lot Plan D.L. Block Sec. Twp. Rg. Land District
(or) PID: (and) Description of well location (attach sketch, if nec.): Located in road R/W at the Intersection of No 2 rd (338th AVE) and NO 2A rd (101st)
NAD 83: Zone: (see note 2) (and) UTM Northing: 5449442 m UTM Easting: 313115 m (or) Latitude (see note 3): Longitude:
Method of drilling: ☐ air rotary ☒ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify):
Orientation of well: ☒ vertical ☐ horizontal Ground elevation: ft (asl) Method (see note 4):
Class of well (see note 5): Monitoring Sub-class of well: Permanent
Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☐ commercial or industrial ☒ other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
0	3	VH	Br	Coarse Sand + Gravel	D	Well 1
3	12	M	Br	medium Sand + Gravel	D	
12	20	M	Br	medium Sand + Gravel	D	
20	30	M	Br	Coarse Sand	D	
30	35	M	Br	Gravel	D	
35	40	M	Br	Gravel + Coarse Sand	D	
40	50	M	Br	Gravel round + Coarse Sand	D	
50	55	M	Br	Gravel + Coarse Sand	D	
55	70	M	Br	Coarse Sand + Gravel	W.B.	50 Gpm
70	85	M	Br	Coarse Gravel + Coarse Sand	W.B	100 Gpm
85	86.5	VH	Br	Cemented Sand+Gravel Brown CLAY		

Casing details Observation well #4/05

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
+1	80	6 5/8	Steel	.250	Yes
3ft	riser with Box installed				

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
~~81.8~~				
78.8	84.85	5"	Kpacker+Bottom	0.020

Surface seal: Type: Drilled + Pulled 8" Pipe Depth: 5 ft
Method of installation: ☒ Poured ☐ Pumped Thickness: 2 in
Backfill: Type: Bentonite. Depth: ft
Liner: ☐ PVC ☐ Other (specify):
Diameter: in Thickness: in
From: ft (bgl) To: ft (bgl) Perforated: From: ft (bgl) To: ft (bgl)

Intake: ☒ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☒ Telescope ☐ Pipe size
Screen material: ☒ Stainless steel ☐ Plastic ☐ Other (specify):
Screen opening: ☒ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☐ Bail ☒ Plug ☐ Plate ☐ Other (specify):
Filter pack: From: ft To: ft Thickness: in
Type and size of material:

Developed by:

☐ Air lifting ☐ Surging ☐ Jetting ☒ Pumping ☒ Bailing
☐ Other (specify): Total duration: 1 hrs
Notes: 100 Gpm pumping

Well yield estimated by:

☒ Pumping ☐ Air lifting ☐ Bailing ☐ Other (specify):
Rate: 100 USgpm Duration: 45 min hrs
SWL before test: 59.8 ft (btoc) Pumping water level: 60 ft (btoc)

Obvious water quality characteristics:

☐ Fresh ☐ Salty ☒ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: Water sample collected: ☐

Well driller (print clearly):

Name (first, last) (see note 19): Steven Robbins
Registration no. (see note 20): WD0605601
Consultant (if applicable; name and company): SKYE M.E.

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements of the *Water Act* and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: 86.5 ft Finished well depth: 84.9 ft (bgl)
Final stick up: 12 in Depth to bedrock: N/A ft (bgl)
SWL: 59.8 ft (btoc) Estimated well yield: 100 USgpm
Artesian flow: — USgpm, or Artesian pressure: — ft
Type of well cap: Minstry Box Well disinfected: ☒ Yes ☐ No
Where well ID plate is attached: Clamped to Side

Well closure information:

Reason for closure:
Method of closure: ☐ Poured ☐ Pumped
Sealant material: Backfill material:
Details of closure (see note 17):

Date of work (YYYY/MM/DD):

Started: Jan. 17/2011 Completed: Jan. 18/2011
Comments:

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PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time

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☒ Well Construction Report
☐ Well Closure Report
☐ Well Alteration Report

Stamp contact name/address/phone/fax/e-mail here, if desired.

102 Industrial Place

Ministry Well ID Plate Number: 17852
Ministry Well Tag Number: _____
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. **See reverse for notes & definitions of abbreviations.**

Owner name: Groundwater Section, BC Ministry of Environment
Mailing address: _____ Town _____ Prov. _____ Postal Code _____
Well Location: Address: Street no. _____ Street name 37889 Town Tucel-nuit Rd
(or) Legal description: Lot _____ Plan _____ D.L. _____ Block _____ Sec. _____ Twp. _____ Rg. _____ Land District _____
(or) PID: _____ (and) Description of well location (attach sketch, if nec.): Located in road s/w adjacent to 37889 Tucel-nuit Rd (PID 015-613-836.
NAD 83: Zone: _____ (see note 2) (and) UTM Northing: 5454575 m (or) Latitude (see note 3): _____
UTM Easting: 314952 m Longitude: _____
Method of drilling: ☐ air rotary ☒ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify): _____
Orientation of well: ☒ vertical ☐ horizontal Ground elevation: _____ ft (asl) Method (see note 4): _____
Class of well (see note 5) Monitoring Sub-class of well: Permanent
Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☐ commercial or industrial ☒ other (specify): _____

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
0	10	L	Br	Coarse Sand + Gravel	D	
10	15	L	Br	Fine Sand	D	
15	20	L	Br	Coarse Sand	D	
20	25	L	Br	Clean Medium Sand	D	
25	30	L	Br	Coarse Sand + Small Gravel	D	
30	35	L	Br	Coarse Sand + Small Gravel	D	
35	40	L	Br	Medium Gravel + Fine Sand	D	
40	50	L	Br	Brown Medium Sand	☒ W.D	10 Gpm
50	70	L	Br	Coarse Sand	☒ W.D	40 Gpm.
				Observation well	407	

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
+1	63.5	6 5/8	Steel	.250	Yes
+3ft riser with Box installed From M.O.E.					

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
62.3	68	5"	Kepacker + Bottom	0.010

Surface seal: Type: Drilled + Pulled 8" Depth: 5 ft
Method of installation: ☒ Poured ☐ Pumped Thickness: 2 in
Backfill: Type: Bentonite Depth: 5 ft
Liner: ☐ PVC ☐ Other (specify): _____
Diameter: _____ in Thickness: _____ in
From: ____ ft (bgl) To: ____ ft (bgl) Perforated: From: ____ ft (bgl) To: ____ ft (bgl)

Intake: ☒ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☒ Telescope ☐ Pipe size
Screen material: ☒ Stainless steel ☐ Plastic ☐ Other (specify): _____
Screen opening: ☒ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☐ Bail ☒ Plug ☐ Plate ☐ Other (specify): _____
Filter pack: From: ____ ft To: ____ ft Thickness: _____ in
Type and size of material: _____

Developed by:

☐ Air lifting ☐ Surging ☐ Jetting ☒ Pumping ☒ Bailing
☐ Other (specify): _____ Total duration: 1 hrs
Notes: Pumping 40 Gpm.

Well yield estimated by:

☒ Pumping ☐ Air lifting ☐ Bailing ☐ Other (specify): _____
Rate: 40 USgpm Duration: 45 m.n hrs
SWL before test: 38.4 ft (btoc) Pumping water level: 60 ft (btoc)

Obvious water quality characteristics:

☐ Fresh ☐ Salty ☒ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: _____ Water sample collected: ☐

Well driller (print clearly):

Name (first, last) (see note 19): Steven Robbins
Registration no. (see note 20): WD6605/601
Consultant (if applicable; name and company): SKYE MOE

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the *Water Act* and the Ground Water Protection Regulation.

Signature of Driller Responsible _____

Final well completion data:

Total depth drilled: 70 ft Finished well depth: 68 ft (bgl)
Final stick up: 12 in Depth to bedrock: N/A ft (bgl)
SWL: 38.4 ft (btoc) Estimated well yield: 40 USgpm
Artesian flow: _____ USgpm, or Artesian pressure: _____ ft
Type of well cap: M.E. Box Well disinfected: ☒ Yes ☐ No
Where well ID plate is attached: Clamped to Side

Well closure information:

Reason for closure: _____
Method of closure: ☐ Poured ☐ Pumped
Sealant material: _____ Backfill material: _____
Details of closure (see note 17): _____

Date of work (YYYY/MM/DD):

Started: Jan. 20/2011 Completed: Jan. 21/2011
Comments: _____

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

white: Customer copy
canary: Driller copy
pink: Ministry copy

Hullcar Unconfined Aquifer – Observation Well Drilling Summary

Wednesday November 2nd, 2011-11-03

Personnel On Site: Martin Suchy (Hydrogeologist – Environment Canada)
Colton Cantner (Coop Student – Environment Canada
Kelly Pelletier (Owner – JR Drilling)
Jerry (Lead Driller – JR Drilling)
Dean (Assistant – JR Drilling)
Wayne Anshelm (Land Owner)

Location

South side road right-of-way near 5081 Schubert Rd. Township of Spallumcheen
Coordinates: Zone 11U,
Easting: 342160
Northing: 5597750

Driller Info

JR Drilling
Drill Rig: DR-12 (Dual Rotary - air)

Time Line

07:55 Arrived on site
08:10 Discuss safety and exact borehole location
08:30 Drilling begins
09:10 Current borehole depth 36-ft
09:30 Water table reached at ~40-ft
10:00 Drilling stopped at 76-ft
10:05 Water pumped into casing to stop sand from heaving up through bottom
10:10 Well Screen and K-packer installed (pushed down using drill rod)
10:25 Surging air well development begins
11:10 Non surging well development begins
11:40 Well development stopped (water clear)
11:50 Casing cut to length
12:05 aluminum box/casing welded on to well casing
12:15 BC Well ID tag attached (#34589)
12:25 Static water level 39 ft (12.955 mbgs), 14.265 m below box level
12:30 Driller demobilizes from site

Lithology (Unified Classification System)

0 to 25 ft	Desert Brown, Dry, Fine to Medium Sand, Some Silt
25 to 30 ft	Brown, Dry, Medium Sand, Some Coarse Sand
30 to 34 ft	Brown, Dry, Fine Sand, Trace Medium Sand
34 to 38 ft	Light Brown, Dry, Silty Fine Sand
38 to 41 ft	Light Brown, Moist, Silty Fine Sand
41 to 50 ft	Brown, Wet, Fine Sand, Some Medium Sand
50 to 60 ft	Grey, Wet, Fine Sand, Well Sorted.
60 to 70 ft	Grey, Wet, Medium Sand, Some Fine Sand
70 to 71 ft	Grey, Wet, Silt with Clay Lens
71 to 76 ft	Grey, Wet, Medium to Coarse Sand, Some Silt. Well Sorted.

Installation / Completion

- 8-inch borehole drilled from 0 to 20-ft bgs
- 6-inch borehole drilled from 20 to 76-ft bgs
- K-packer from 70 to 72 ft bgs
- SS Screen installed from 72 to 76-ft bgs
- Surface seal (bentonite) from 0 to 20-ft (annular space between 8-inch borehole and 6-inch casing)
- Well development, surging screen length with air – on/off, moving drill rod throughout screen. Approx 20 gal/min. 45 minutes duration.
- Non surging well development, drill rod at top of screen. Measured 15 gal/min. 30 minutes duration
- Welded on supplied casing stick-up with aluminum box
- Bottom of box height (casing height 1.31 m) ft

Materials and Supplies

- 6 - bags 3/8-inch Holeplug (Wyoming Sodium Bentonite)
- 1 - SS 6-inch diameter screen (4-ft long) with 20-slot
- 1 - 6-inch diameter carbon steel K-packer (2-ft long) with rubber seal.
- 4 - lengths of 6-inch steel casing

General Notes

- As previously arranged by Sky Thomson, the land owner (Wayne Anshelm) had previously removed the fence wire to allow for site access from his property.
- Martin Suchy met the Wayne Anshelm the previous afternoon (Tuesday November 1st) to discuss drilling plan for the following day.
- Wayne Anshelm was on-site before, during and after drilling, and gave permission to temporarily remove two fence posts for better access to drilling location.
- Drilling proceeded very quickly and with no complications both above and below the water table.
- Drill cuttings were obtained from siphon every 5-10-ft (collected by drilling assistant), to catalogue the lithology.

- Samples were retained in plastic bags (currently located at EC warehouse).
- Site was cleaned up to pre-drilling conditions, except that drill cuttings were spread out around the well-head (but not on private property).
- Fence posts were re-installed into previous holes.
- Land owner to re-install fence wires.

Joe Rich Bedrock Aquifer – Observation Well Drilling Summary

February 1st to 3rd, 2012

Personnel at start-up: Martin Suchy (Hydrogeologist – Environment Canada)
Kelly Pelletier (Owner – JR Drilling)
Jerry (Lead Driller – JR Drilling)
Dean (Assistant – JR Drilling)

Location

Southwest corner of Joe Rich Fire Hall property, located at 6550 Gouldie Rd, Joe Rich.
Coordinates: Zone 11U,
Easting: 338036 m
Northing: 5527829 m
Elevation: 1070 masl (approx)

Driller Info

JR Drilling
Drill Rig: DR-12 (Dual Rotary - air)

Time Line (from on-site observation)

Day 1: Wednesday Feb 1st

10:30 Meet drillers on site
10:35 Discuss safety and exact borehole location
11:30 Begin drilling 12" surface seal
12:40 Resume drilling 6" borehole at 20 ft
13:45 Hit fractures bedrock at ~70ft
14:30 Casing stopped at 91 ft
14:30 Switched from tri-cone to hammer drill bit at 91 ft
15:45 Stopped drilling for the day at 200 ft
16:00 Drillers leave site

Day 2: Thursday Feb 2nd

07:00 Arrive on site
07:30 Re-start drilling at 200 ft
10:00 Drilling at 350 ft, entered fracture zone
10:20 Drilling at 370 ft, exit fracture zone
10:30 Drilling temporarily stopped at 380 ft to allow water to accumulate in borehole
11:30 Purge accumulated water, estimate well yield is 0.5 gal/min
(seek permission to continue drilling to approx ~450 ft)
11:50 Re-start drilling at 380 ft
13:00 Terminate drilling at 440 ft
14:00 Drillers leave site

Day 3: Friday Feb 3rd

08:00 Arrive on site (after fill support truck with water to purge well)
08:20 Air purge well development begins
09:20 Well development finished
09:30 Preparation for media event
12:30 PVC Borehole-liner installation begins
(approx. 13:00) Casing stick-up with aluminum box (equipment housing) welded installed
(approx. 15:00) Drillers demobilize from site

Borehole Lithology Log(Unified Classification System)

0 to 9 ft	Brown – Light Brown, Dry, Fine to Coarse Sand, some Gravel
9 to 12 ft	Light Yellowish Brown, Dry, Fine to Coarse Sand, some Gravel
12 to 20 ft	Brown – Light Brown, Dry, Fine to Coarse Sand, trace Gravel
20 to 22 ft	Gradation from Brown to Grey, Dry, Fine to Coarse Sand, some Silt w/ Clay
22 to 44 ft	Grey Till, Dry, Silty Sand w/ Clay, some Cobbles, trace Gravel
34 to 38 ft	Grey Till, slight Moisture, Silty Sand w/ Clay, some Cobbles, trace Gravel
38 to 45 ft	Grey Till, Dry, Bolder chips (gneissic)
45 to 47 ft	Grey Till, some Moisture, Clay (medium stiffness) w/ trace Gravel and Silt
47 to 52 ft	Grey, Damp, Fine Sand, w/ trace Silt
52 to 60 ft	Grey, Damp Clay (medium stiffness), some Silt, trace Gravel and Sand
60 to 70 ft	Grey, Dry, Clay (medium stiffness), some Boulders, trace Sand.
70 to 73 ft	Bedrock, (suspect Schist or Gneiss from cutting chips), Greenish Grey, suspected to be highly fractured (weathered surface)
73 to 80 ft	Bedrock (same as above), Greenish Grey, some fractures
80 to 92 ft	Bedrock (same as above), minor fractured (decreasing fracture trend w/ depth)
92 to 350 ft	Bedrock (same as above), minimal fractures
350 to 370 ft	Bedrock (same as above), significant Fracture Zone, water-bearing.
370 to 440 ft	Bedrock (same as above), minimal fractures

Installation / Completion

- 12-inch borehole drilled from 0 to 20-ft bgs
- Surface seal (bentonite) from 0 to 20-ft (annular space between 12-inch borehole and 6-inch casing)
- 6-inch casing installed from ground to 91ft bgs (keyed into bedrock 20 ft)
- Well development, air purging below fracture zone for approximately 1 hr (water added during well development)
- Well lined with perforated 4-inch standard schedule PVC pipe from 440 ft bgs to ground surface
- Welded on supplied casing stick-up with aluminum box (stickup not measured)
- BC Well ID tag attached (#34596)
- Static water level not measured as water level needed to recover overnight before taking measurement

Materials and Supplies (from on-site observation)

- 18 bags (50 lbs) 3/8-inch Holeplug (Wyoming Sodium Bentonite)
- 5 pieces (20 ft each) of 6” steel casing (91 ft used, 9 ft cut off)
- 1 piece 6” casing drive shoe
- 22 pieces (20 ft each) of 4” PVC 160 psi perforated liner

General Notes

- Skye Thompson (BCFLNRO) arranged for a utilities locate to be conducted week prior to drilling (no underground utilities identified and safe from overhead power lines).
- Drill cuttings were obtained from the outlet pipe (collected by drilling assistant), to catalogue the lithology. Every 5-10-ft for the unconsolidated material, and every approx 20 ft for bedrock.
- Selected samples were retained in plastic bags (currently located at EC warehouse).
- Site clean-up: All garbage removed but drill cuttings remain spread-out where they were discharged from the outlet pipe (partially snow-covered).

BRITISH COLUMBIA
Ministry of Environment

[X] **Well Construction Report**
[ ] **Well Closure Report**
[ ] **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number: 34309
Ministry Well Tag Number: 106351
Existing Well Tag Number:
[ ] Confirmation/alternative specs. attached
[ ] Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviations.**

Owner Name: Okanagan Basin Water Board
Mailing address: 1450 KLO Rd Town Kelowna Prov BC Postal Code V1W 3Z4
Well location: Street 3470 Gill Rd Town West Kelowna
(or) Legal description: Lot ____ Plan ____ D.L. ____ Block ____ Sec. ____ Twp. ____ Rg. ____ Land District ____
(or) PID: 12078549 (and) Description of well location (attach sketch, if nec.): Adjacent to above parcel

NAD 83:Zone: ____ (see note 2) (and) UTM Northing: ____ m UTM Easting: ____ m (or) Latitude (see note 3): 49º 50' 12.00" Longitude: 119º 41' 11.00"

Method of drilling: [X] air rotary [ ] cable tool [ ] mud rotary [ ] auger [ ] driving [ ] jetting [ ] excavating [ ] other (specify): ____
Orientation of well: [X] vertical [ ] horizontal Ground elevation: ____ ft (asl) Method (see note 4): ____
Class of well (see note 5): Monitoring Sub-class of well: Permanent
Water supply wells, indicate intended water use: [ ] private domestic [ ] water supply system [ ] irrigation [X] commercial or industrial [ ] other (specify): ____

Lithologic description (see notes 7- 14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
0	10	Loose	brown		sand with gravel		dry
10	14	Dense	brown		clay		moist
14	20	Loose	brown		till		dry
20	26	Loose	grey		till		dry
26	200	Very hard	brown		other surficial bedrock		dry
200	240	Very hard	grey		other surficial bedrock		dry and very layered
240	396	Very hard	grey		other surficial bedrock		moist

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe
0	20	8	Steel Pulled Out		No
0	40	6	Steel	219	Yes
40	396	6	Open hole		No

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size

Surface seal: Type: Bentonite clay Depth: 20 ft
Method of installation: [X] Poured [ ] Pumped Thickness: 1 in
Backfill: Type: ____ Depth: ____ ft
Liner: [X] PVC [ ] Other (specify): ____
Diameter: 4 in Thickness: ____ in
From: 0 ft bgl To: 400 ft bgl Perforated: From: 0 ft bgl To: ** ft bgl

Intake: [ ] Screen [ ] Open bottom [ ] Uncased hole
Screen type: [ ] Telescope [ ] Pipe size
Screen material: [ ] Stainless steel [ ] Plastic [ ] Other (specify):
Screen opening: [ ] Continuous slot [ ] Slotted [ ] Perforated Pipe
Screen bottom: [ ] Bail [ ] Plug [ ] Plate [ ] Other (specify): ____
Filter pack From: ____ ft To: ____ ft Thickness: ____ in
Type and size of material: ____

Developed by:

[X] Air lifting [ ] Surging [ ] Jetting [ ] Pumping [ ] Bailing
[ ] Other (specify): ____ Total duration: 1 hrs
Notes: ____

Well yield estimated by:

[ ] Pumping [X] Air lifting [ ] Bailing [ ] Other (specify): ____
Rate: 1 USgpm Duration: 1 hrs
SWL before test: ____ ft (btoc) Pumping water level: ____ ft (btoc)

Obvious water quality characteristics:

[X] Fresh [ ] Salty [ ] Clear [ ] Cloudy [ ] Sediment [X] Gas
Colour/odour: ____ Water sample collected: [ ]

Well driller (print clearly):

Name (first, last) (see note 19): Jerry Opper
Registration no. (see note 20): WD 08052101
Consultant (if applicable name and company): Ministry of Environment

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirenments in the *Water Act* and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: 396 ft Finished well depth: 396 ft bgl
Final stick up: 48 in Depth to bedrock: 26 ft bgl
SWL: ____ ft (btoc) Estimated well yield: 1.00 USgpm
Artesian flow: ____ USgpm, or artesian pressure: ____ ft
Type of well cap: locking box Well disinfected: [ ] yes [X] no
Where well ID plate is attached: casing

Well closure information:

Reason for closure: ____
Method of closure: ____
Sealant material: ____ Backfill material: ____
Details of closure: ____

Date of work (YYYY/MM/DD):

Started: 2012/03/05 Completed: 2012/03/05
Comment: ____

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

Trout Creek – Observation Well Drilling Summary

July 30th – 31st, 2012

Personnel at start-up: Martin Suchy (Hydrogeologist – Environment Canada)
Kelly Pelletier (Owner – JR Drilling) – Monday morning only
Jerry (Lead Driller – JR Drilling)
Dean (Assistant – JR Drilling)
Jesse (Assistant – JR Drilling) – Monday morning only

Location

First left Spur Rd. (approx. 2 km) from Trout Creek Forest Service Rd, which is located approximately at the 40 km mark (from Summerland) of the Princeton-Summarland Rd.

Coordinates: Zone 10U,
Easting: 0704890 m
Northing: 5513004 m
Elevation: 1250 masl (approx)

Driller Info

JR Drilling
Drill Rig: DR-12 (Dual Rotary - air)

Time Line (from on-site observation)

Day 1: Monday July 30th

9:30 Meet Kelly on site, he was fixing spur road with mini excavator
10:30 Drillers arrive on site
10:45 Discuss safety and borehole location and bollard placement
11:15 Drilling of two bollards to 5ft
11:55 Begin drilling 12" diameter surface seal to 20 ft
12:50 Resume drilling 6" borehole at 20 ft using hammer drill bit
13:25 Hit water bearing fractures at ~43ft
13:20 Casing stopped at 36 ft
15:40 Stopped drilling at 196 ft
15:45 Estimated well yield is 5 gal/min
16:00 Drillers leave site

Day 2: Tuesday July 31st

07:00 Arrive on site
07:00 Purge accumulated water, estimate well yield is 5 gal/min
07:05 Air purge well development begins
08:00 Completion of well development, estimate well yield is 6 gal/min
08:30 PVC Borehole-liner installation begins
09:30 Welding / installation of bollards and well stick-up with aluminum equipment box
10:00 Drillers demobilize from site

Borehole Lithology Log (Unified Classification System)

0 to 165 ft	Olive grey – brown, Dry, Fine to Coarse Sand, and Gravel / Cobbles/ Boulders?
16 to 27 ft	Mafic plutonic rock, medium grained, diorite or gabbro, suspected highly fractured / weathered bedrock or unconsolidated boulders
27 to 43 ft	Mafic plutonic bedrock, medium grained, diorite or gabbro, less fractured than previous
43 to 56 ft	Mafic plutonic bedrock, medium grained, diorite or gabbro, water-bearing fractures starting at 43 ft,
56 to 180 ft	Mafic plutonic bedrock, medium grained, diorite or gabbro, no discernable fracturing,
180 to 190 ft	Intermediate plutonic bedrock, medium grained, orange white and dark colour, higher orthoclase content; granite or monzonite, or no discernable fracturing
190 to 196 ft	Mafic plutonic bedrock, medium grained, diorite or gabbro, no discernable fracturing,

Installation / Completion

- 12-inch borehole drilled from 0 to 20-ft bgs
- Surface seal (bentonite) from 0 to 20-ft (annular space between 12-inch borehole and 6-inch casing)
- 6-inch casing installed from ground to 36 ft bgs (keyed into bedrock between 10 and 20 ft)
- Well development, air purging from bottom of well for approximately 1 hr. No water was added as well yield was sufficient (~5-6 gpm)
- Well lined with perforated 4-inch standard schedule PVC pipe from 196 ft bgs to top of casing
- Welded on supplied casing stick-up with aluminum box
- BC Well ID tag attached (#34503)
- Stick-up height = 1.34m
- Static water level at time of completion = 13.304 m below top of casing @ 9:55 July 31, 2012.

Materials and Supplies (from on-site observation)

- 6 bags (50 lbs) 3/8-inch Holeplug (Wyoming Sodium Bentonite)
- 3 pieces (20 ft each) of 6” steel casing (1 piece used for two 10 ft bollards)
- 1 piece 6” casing drive shoe
- 11 pieces (20 ft each) of 4” PVC 160 psi perforated liner

General Notes

- No underground utilities locate was conducted for this site, as it was located on a remote forest service road.
- Drill cuttings were obtained from the outlet pipe (collected by drilling assistant), to catalogue the lithology. Every 5-10-ft for the unconsolidated material, and every approx 20 ft for bedrock.
- Selected samples were retained in plastic bags (currently located at EC warehouse).
- Site clean-up: All garbage and various cuttings removed but drill cuttings remain spread-out where they were discharged from the outlet pipe.
- There is no BCMOE Groundwater Observation Network sticker / identifier on the aluminum box.

Samples

#1	22 ft
#2	38 ft
#3	65 ft
#4	85 ft
#5	105 ft
#6	125 ft
#7	145 ft
#8	165 ft
#9	185 ft
#10	195 ft

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Ministry of Environment

☑ **Well Construction Report**
☐ **Well Closure Report**
☐ **Well Alteration Report**

JR Drilling Central
1-866-711-8118
WD-06030601
Stamp company name/address/phone/fax/e-mail here (suggested)

Ministry Well ID Plate Number: 38363
Ministry Well Tag Number:
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. **See reverse for notes & definitions of abbreviations.**

Owner name: M.O.E / OBWD
Mailing address: 102 Industrial Pl Town: Penticton Prov. B.C Postal Code:
Well Location: Address: Street no. 3505 rd/RW Street name Bemrose Pl Town Kelowna
(or) Legal description: Lot 1 Plan 30818 D.L. Block Sec. 10 Twp 26 Rg. Land District ODYD
(or) PID: 003-844-064 (and) Description of well location (attach sketch, if nec.): Obs well 413

NAD 83: Zone: (see note 2) (and) UTM Easting: m UTM Northing: m (or) Latitude (see note 3): 49° 51.24 Longitude: 119° 23.55
Method of drilling: ☑ air rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify):
Orientation of well: ☑ vertical ☐ horizontal Ground elevation: ft (asl) Method (see note 4):
Class of well (see note 5): Monitoring Sub-class of well: Permanent
Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☑ commercial or industrial ☐ other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
0	30	Medium	Brown	Sand + gravel		
30	40	Soft	Brown	Sand medium		
40	70	Medium	Brown	Sand + gravel		
70	80	Medium	Brown	Sand + gravel with moisture		
80	95	Medium	Brown	Sand + gravel dry		
95	100	Hard	gray	Till		
100	130	Medium	Brown	Sand + gravel with moisture		
130	265	Medium	Brown	Sand + gravel, dry		
265	281	Hard	gray	Compressed sand + gravel, dry		
281	295	Hard	Brown	Compressed sand + gravel, moist		
295	324	Hard	Brown	Compressed sand + gravel, wet		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
0	20	8	Casing pulled		
0	315	6	Steel	.219	BB

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
311	313	5	K-pak, riser	
313	317	5	Screen	20

Surface seal: Type: Bentonite chip's Depth: 20 ft
Method of installation: ☑ Poured ☐ Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: ☐ PVC ☐ Other (specify):
Diameter: in Thickness: in
From: ft (bgl) To: ft (bgl) Perforated: From: ft (bgl) To: ft (bgl)

Intake: ☑ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☑ Telescope ☐ Pipe size
Screen material: ☑ Stainless steel ☐ Plastic ☐ Other (specify):
Screen opening: ☑ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☑ Bail ☐ Plug ☐ Plate ☐ Other (specify):
Filter pack: From: ft To: ft Thickness: in
Type and size of material:

Developed by:

☑ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
☐ Other (specify): Total duration: 5 hrs
Notes:

Well yield estimated by:

☐ Pumping ☑ Air lifting ☐ Bailing ☐ Other (specify):
Rate: 3 USgpm Duration: 5 hrs
SWL before test: 282 ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

☑ Fresh ☐ Salty ☑ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: Water sample collected: ☐

Well driller (print clearly):
Name (first, last) (see note 19): Jerry Opper
Registration no. (see note 20): WD-08052101
Consultant (if applicable; name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the *Water Act* and the Ground Water Protection Regulation.

Signature of Driller Responsible [signature]

Final well completion data:

Total depth drilled: 342 ft Finished well depth: 317 ft (bgl)
Final stick up: 48 in Depth to bedrock: ft (bgl)
SWL: 282 ft (btoc) Estimated well yield: 3 USgpm
Artesian flow: USgpm, or Artesian pressure: ft
Type of well cap: lock Box Well disinfected: ☐ Yes ☐ No
Where well ID plate is attached: Casing

Well closure information:

Reason for closure:
Method of closure: ☐ Poured ☐ Pumped
Sealant material: Backfill material:
Details of closure (see note 17):

Date of work (YYYY/MM/DD):
Started: 13/3/18 Completed: 13/3/20
Comments: Hole #1

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

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Sheet 1 of 2

BRITISH COLUMBIA
The Best Place on Earth

Ministry of Environment

☑ **Well Construction Report**
☐ **Well Closure Report**
☐ **Well Alteration Report**

JR Drilling Central 1-866-711-8118 WD 06080601
Stamp company name/address/phone/fax/email here, if desired.

Ministry Well ID Plate Number: 38363
Ministry Well Tag Number:
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. **See reverse for notes & definitions of abbreviations.**

Owner name: M.O.E / OBWA
Mailing address: 102 Industrial Pl Town Penticton Prov B.C Postal Code
Well Location: Address: Street no. 3505 rd RW Street name Bemrose Pl Town Kelowna
(or) Legal description: Lot 1 Plan 32818 D.L. Block Sec. 10 Twp 26 Rg. Land District ODYD
(or) PID: 003-844-064 (and) Description of well location (attach sketch, if nec.): Obs Well 413

NAD 83: Zone: (see note 2) (and) UTM Easting: m UTM Northing: m (or) Latitude (see note 3): 49° 51, 24 Longitude: 119° 23, 55
Method of drilling: ☑ air rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify):
Orientation of well: ☑ vertical ☐ horizontal Ground elevation: ft (asl) Method (see note 4):
Class of well (see note 5): Monitorin Sub-class of well: Permanent
Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☑ commercial or industrial ☐ other (specify):

Lithologic description (see notes 7-14) **or closure description** (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
324	342	Soft	gray	Clay & rock		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
0	20	8	Casing pulled		
0	315	6	Steel	219	B.B

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
311	313	5	K-pak, riser	
313	317	5	screen	20

Surface seal: Type: Bentonite chip's Depth: 20 ft
Method of installation: ☑ Poured ☐ Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: ☐ PVC ☐ Other (specify):
Diameter: in Thickness: in
From: ft (bgl) To: ft (bgl) Perforated: From: ft (bgl) To: ft (bgl)

Intake: ☑ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☑ Telescope ☐ Pipe size
Screen material: ☑ Stainless steel ☐ Plastic ☐ Other (specify):
Screen opening: ☑ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☑ Bail ☐ Plug ☐ Plate ☐ Other (specify):
Filter pack: From: ft To: ft Thickness: in
Type and size of material:

Developed by:
☑ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
☐ Other (specify): Total duration: 5 hrs
Notes:

Well yield estimated by:
☐ Pumping ☑ Air lifting ☐ Bailing ☐ Other (specify):
Rate: 3 USgpm Duration: 5 hrs
SWL before test: 282 ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:
☑ Fresh ☐ Salty ☑ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: Water sample collected: ☐

Well driller (print clearly):
Name (first, last) (see note 19): Jerry Opper
Registration no. (see note 20): WD-08052101
Consultant (if applicable; name and company):
DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the *Water Act* and the Ground Water Protection Regulation.
Signature of Driller Responsible [signature]

Final well completion data:
Total depth drilled: ~~330~~ 342 ft Finished well depth: 317 ft (bgl)
Final stick up: 48" in Depth to bedrock: ft (bgl)
SWL: 282 ft (btoc) Estimated well yield: 3 USgpm
Artesian flow: USgpm, or Artesian pressure: ft
Type of well cap: lock Box Well disinfected: ☐ Yes ☐ No
Where well ID plate is attached: casing

Well closure information:
Reason for closure:
Method of closure: ☐ Poured ☐ Pumped
Sealant material: Backfill material:
Details of closure (see note 17):

Date of work (YYYY/MM/DD):
Started: 13/3/18 Completed: 13/3/20
Comments: Hole #1

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

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☑ **Well Construction Report**
☐ **Well Closure Report**
☐ **Well Alteration Report**

JR Drilling Central 1-866-711-8118 WD-06030601
Stamp company name/address phone

Ministry Well ID Plate Number: 38358
Ministry Well Tag Number:
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. **See reverse for notes & definitions of abbreviations.**

Owner name: M.O.E \ OB W B
Mailing address: 102 Industrial Pl Town Penticton Prov. BC Postal Code
Well Location: Address: Street no B/W ~~3505~~ Street name ~~Benso~~ Black RD Town Kelowna
(or) Legal description: Lot 12 Plan 4660 (21785) D.L. 121 Block Sec. Twp. Rg. Land District ODYD
(or) PID: 001-561-707 (and) Description of well location (attach sketch, if nec.): Obs Well 442

NAD 83: Zone: (see note 2) (and) UTM Easting: m UTM Northing: m (or) Latitude (see note 3): 49° 57.03 Longitude: 119° 21.57

Method of drilling: ☑ air rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify):
Orientation of well: ☑ vertical ☐ horizontal Ground elevation: ft (asl) Method (see note 4):
Class of well (see note 5): Monitoring Sub-class of well: Permanent
Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☑ commercial or industrial ☐ other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
0	10	Soft	Brown	Clay		First sign of
10	20	Soft	Brown	Fine to medium sand		moisture @ 30'
20	43	Medium	Brown	Sand & gravel		
43	73	Medium	Brown	~~Sand~~ & gravel & fine to medium sand with silt, dry		
73	85	Medium	gray	Silt & clay with some gravel		
85	140	Medium	gray	Till		
140	172	Soft	Brown	Fine to medium sand & silt	wet	
172	176	Soft	gray	Fine sand & silt	wet	

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
0	20	8	Casing pulled		
0	167	6	Steel	.219	B.B

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
165	167	5	K-pak, rizer	
167	171	5	Screen	20

Surface seal: Type: Bentonite chip's Depth: 20 ft
Method of installation: ☑ Poured ☐ Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: ☐ PVC ☐ Other (specify):
Diameter: in Thickness: in
From: ft (bgl) To: ft (bgl) Perforated: From: ft (bgl) To: ft (bgl)

Intake: ☑ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☑ Telescope ☐ Pipe size
Screen material: ☑ Stainless steel ☐ Plastic ☐ Other (specify):
Screen opening: ☑ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☑ Bail ☐ Plug ☐ Plate ☐ Other (specify):
Filter pack: From: ft To: ft Thickness: in
Type and size of material:

Developed by:

☑ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
☐ Other (specify): Total duration: 4 hrs
Notes:

Well yield estimated by:

☐ Pumping ☑ Air lifting ☐ Bailing ☐ Other (specify):
Rate: 80 + USgpm Duration: 4 hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

☑ Fresh ☐ Salty ☑ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: Water sample collected: ☐

Well driller (print clearly):

Name (first, last) (see note 19): Jerry Opper
Registration no. (see note 20): WD-08052101
Consultant (if applicable; name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the *Water Act* and the Ground Water Protection Regulation.
Signature of Driller Responsible [signature]

Final well completion data:

Total depth drilled: 180 ft Finished well depth: 171 ft (bgl)
Final stick up: 48 in Depth to bedrock: ft (bgl)
SWL: 75 ft (btoc) Estimated well yield: 80 + USgpm
Artesian flow: USgpm, or Artesian pressure: ft
Type of well cap: Lock box Well disinfected: ☐ Yes ☐ No
Where well ID plate is attached: casing

Well closure information:

Reason for closure:
Method of closure: ☐ Poured ☐ Pumped
Sealant material: Backfill material:
Details of closure (see note 17):

Date of work (YYYY/MM/DD):

Started: 13/3/26 Completed: 13/3/27
Comments:

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

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