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August 17, 2016
File: 2016-8114.000

Barry Palumbo
Box 123
Golden, BC V0A 1H0

**Re: HYDROGEOLOGICAL ASSESSMENT OF PROPOSED SUBDIVISION OF SECTION 35,
TOWNSHIP 25, EXCEPT PLAN 66313 & 7**

Dear Mr. Palumbo:

Associated Environmental Consultants Inc. (Associated) is pleased to provide this hydrogeological assessment of two wells and one surface water source for a three lot subdivision on the above-mentioned property in the Columbia Shuswap Regional District (CSRD).

1 BACKGROUND AND OBJECTIVES

We understand that you are planning to subdivide your property into three lots with each lot serviced by its own water supply well or surface water source as follows:

- Lot A will be serviced by Well Plate Identifier [WPID] 40252.
- Lot B will be serviced by WPID 40253.
- The Remainder Lot will be serviced by West Twin Creek.

To complete the subdivision application, the CSRD requires a water quality and quantity report be prepared by a professional engineer or geoscientist who is registered with the Association of Professional Engineers and Geoscientists of B.C. (APEGBC). The report is intended to satisfy the applicable sections of CSRD Subdivision Servicing Bylaw No. 641 (the Bylaw) regarding assessment and demonstration of potable water (CSRD 2014). The Bylaw requirements for subdivisions that require this professional-directed approach (i.e. assessments by a Qualified Professional) and will use groundwater are listed in Table 1. We understand an authorization for a surface water license from West Twin Creek has recently been received and accepted as proof of quantity by CSRD. Therefore, only a quality assessment is required for the creek. The requirement for *Proof of Water Quality* is the same for surface water sources as it is for groundwater sources (Table 1).

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Table 1: Proof of water quantity and quality requirements for groundwater sources under CSRD Bylaw 641

Bylaw Requirements	
<i>Source Yield</i>	A Qualified Professional has submitted written confirmation that the sustainable Well yield is at least 2,275 L/day.
<i>Well Recovery</i>	A Qualified Professional has submitted written confirmation that well recovery is adequate to support the intended use of the well (minimum 2,275 L/day).
<i>Drawdown Interference</i>	A Qualified Professional has submitted written confirmation that the operation of the proposed well at the desired rate (minimum 2,275 L/day) will not: <ul style="list-style-type: none">• reduce the amount of available water for any well within 250 m of the tested well; or• result in changes to the water balance of the aquifer, considering cumulative impacts that could result in long-term environmental changes and/or reduced yield on a regional scale.
<i>Proof of Water Quality</i>	A Qualified Professional has reviewed the water quality results, prepared a water system design, including treatment and disinfection system components if required, and provided written confirmation that the water will be potable water as defined in this bylaw when the recommended system is properly installed and operated.

Source: Requirements for Independent On-site Water System (CSRD 2014)

2 METHODS

2.1 SOURCE YIELD AND WELL RECOVERY

To meet the *Source Yield* and *Well Recovery* Bylaw requirements (Table 1), Associated coordinated and performed aquifer pumping tests on WPID 40252 and WPID 40253 on June 27 and June 28, 2016. Each well was pumped at a rate of 8 L/minute for 5 hours, producing 2,400 L each. The pump was supplied and set by you and operated by Associated's field hydrogeologist. Groundwater was discharged downgradient, approximately 30 m downhill of the wellheads for both tests. Groundwater levels were monitored with electronic well sounders during pumping and after pump shut-off (recovery) at set intervals laid out by Associated prior to the tests.

The data from the pumping tests followed the Guidelines for Evaluating Longterm Well Capacity for a Certification of Public Convenience and Necessity (CPCN) (MOE 2007). This method extrapolates drawdown in pumping wells and observation wells during pumping to 100 days and calculates a sustainable

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pumping rate based on this extrapolation. The sustainable pumping rate is then reduced by a safety factor, often 30%, to account for changes in water levels over seasons, and over longer periods in cases where water level fluctuations are unknown.

2.2 DRAWDOWN INTERFERENCE

To meet the *Drawdown Interference* Bylaw requirement (Table 1), Associated completed a search of the BC Water Resources Atlas (MOE 2016) and interviewed you to assess the number of wells within 250 m your property. There are four wells within 250 m: the two on your proposed lots (i.e., WPID 40252 and WPID 40253) and two neighbouring wells. The two neighbouring wells are located at 11U 0512221 5669008 (OBS 2) and UTM 11U 0512119 5668985 (OBS 3). To assess interference effects when WPID 40252 is pumping, Associated measured and recorded groundwater levels in the nearest well (WPID 40253) prior to the start of the test and towards the end of the test. To assess interference effects when WPID 40253 is pumping, Associated measured and recorded groundwater levels in WPID 40252, OBS 2, and OBS 3 prior to the pumping test and just before pump shut-off.

2.3 WATER QUALITY

To meet the *Proof of Water Quality* Bylaw requirement (Table 1), Associated reviewed existing water quality data and coordinated further sample collection. You collected water quality samples from WPID 40252 and WPID 40253 in December 2015 and submitted those samples to WSH Labs in Calgary. A signed affidavit with details on how those samples were collected is included in Appendix A. Associated compared the list of parameters tested with those required by the CSRD. All required parameters were tested except turbidity and true colour. To address this data gap, Associated instructed you to collect a second set of samples from each well and submit them to ALS Laboratories in Calgary for analysis of the missing parameters. For WPID 40252, total coliforms were also re-tested because they were detected in the December 2015 sample. To ensure the pumping test equipment was decontaminated before sampling, you chlorinated the wells to a chlorine concentration of 50 ppm 24 hours prior to the pumping test (as per Associated's instructions). Prior to collecting groundwater samples, the chlorine concentration was determined to be 0 ppm using LaMotte™ InstaTest 6 Chlorine Strips.

Additionally, to meet the *Proof of Water Quality* for the surface water source, Associated collected a sample on June 28 from West Twin Creek at UTM coordinates 11U 5669001.75 m N, 512390.27 m E. The initial sample bottle collected from West Twin Creek was not preserved in the field, which causes sample integrity issues. A second set of samples for the creek were collected and preserved in the field. Standard sampling procedures were used by Associated (MOE 2013) and the samples were submitted to an accredited laboratory (ALS Laboratories in Calgary, AB) for analysis.

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Based on the Bylaw requirements and Associated's recommendations, water samples WPID 40252, WPID 40253, and West Twin Creek were ultimately analyzed for the following parameters:

- total coliforms
- *E. coli*
- alkalinity
- arsenic
- calcium
- chloride
- colour
- conductivity
- fluoride
- hardness (total)
- iron
- magnesium
- manganese
- nitrate-N
- nitrite-N
- pH
- potassium
- silicon
- sodium
- sulfate
- total dissolved solids
- turbidity
- uranium

The results were compared with the Guidelines for Canadian Drinking Water Quality (GCDWQ) (Health Canada 2014). Guideline levels specified in the GCDWQ are designated as either "maximum acceptable concentrations" (MAC) or "aesthetic objectives" (AO). The MAC guidelines are health-based, and are determined based on the known health effects associated with the substance. The AO guidelines apply to those variables that affect taste or laundry (e.g., by staining) but do not pose a health hazard.

3 RESULTS

3.1 SOURCE YIELD AND WELL RECOVERY

During the pumping tests, a total of 2,400 L of water was removed each from WPID 40252 and WPID 40253. WPID 40252 recovered to greater than 92%¹ of the original static water level within 1,280 minutes of pump shut-off and WPID 40253 recovered to 97% of the original static water level within 409 minutes of pump shut-off. The pumping test specifications and results are summarized in Table 3-1. The data from the pumping test, including raw data and figures showing drawdown extrapolated to 100 days, are attached in Appendix B. The sustainable pumping rates, calculated using the CPCN method as mentioned in the methods section above, exceed the Bylaw-required amount of 2,275 L/day for both wells. **Therefore, both WPID 40252 and WPID 40253 meet the Bylaw requirement regarding source yield and well recovery.**

Table 3-1 Summary and results of constant rate pumping test of WPID 40252 and 40253

	WPID 40252	WPID 40253
PUMPING SPECIFICATIONS		
Pumping rate (L/s)	0.13	0.13
Test duration (hours)	5	5

¹ The groundwater level in WPID 40252 was recorded immediately after the pump was removed from the well which likely caused the groundwater level to drop. Therefore, recovery in WPID 40252 is anticipated to be greater than 92% at 1280 minutes.

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	WPID 40252	WPID 40253
Depth of pump intake (mbtoc)	73.76	73.76
Static water level (mbtoc)	15.58	15.83
Depth to top of screen (mbtoc)	68.88	68.88
Depth of well (mbgl)	72.84	72.84
RECOVERY		
Length of recovery (min)	1280	409
% recovered	92	97
CPCN INPUTS		
Pumping rate (L/s)	0.13	0.13
Available drawdown (m) ¹	52.30	52.05
Drawdown at 100 days (m) ²	20.98	10.65
CPCN OUTPUTS		
100-day specific capacity (L/s/m)	0.006	0.012
Sustainable pumping rate (L/d) ³	2,400	2,400
Sustainable well yield meets Bylaw rate of 2,275L/d	YES	YES

Notes:

m btoc = metres below top of casing

¹ The available drawdown is the difference between the static water level and 1 metre above the top of the perforated section of the bedrock liner.

² The 100-day drawdown is the sum of the 100-day drawdown in the pumping well and the 100-day drawdown in the observation well(s), and in this way includes well interference.

³ The CPCN theoretical capacity for WPID 40252 was 20,100 L/day and 38,400 L/day for WPID 40253. However, a well cannot be rated higher than it was tested. Therefore, the maximum yield at which WPID 40252 and WPID 40253 could be rated is 8 L/min for 5 hours (or 2,400 L/day). If higher pumping rates are required from the well, additional pumping tests would be required.

3.2 DRAWDOWN INTERFERENCE

3.2.1 WPID 40252 Pumping Test

During the pumping test at WPID 40252, the groundwater level in the pumping well dropped from an initial static level of 15.58 m below top of casing (btoc) to a maximum of 24.45 m btoc. This equates to a total drawdown of 8.87 m or 17% of available drawdown. This drawdown extrapolated to 100 days is 20.8 m.

The observation well WPID 40253 had a total drawdown of 0.01 m prior to pump shut-off. This drawdown, extrapolated to 100 days, is 0.18 m. To assess well interference, this observation well drawdown was combined with the 100-day drawdown in WPID 40252 when calculating the sustainable yield.

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3.2.2 WPID 40253 Pumping Test

During the pumping test at WPID 40253, the groundwater level in the pumping well dropped from an initial static of 15.83 m btoc to a maximum of 22.89 m btoc. This equates to a total drawdown of 7.06 m or 13% of available drawdown. This drawdown extrapolated to 100 days is 10.4 m. The rate of drawdown decreased towards the end of the test. This is inferred to be a positive boundary, which is presumed to be due to a hydraulic connection between the aquifer and the nearby West Twin Creek. West Twin Creek is approximately 130 m east of WPID 40253.

The observation wells monitored during the test were WPID 40252, OBS 2, and OBS 3. Groundwater levels in WPID 40252 increased during the test (from 16.26 m btoc at the start to 15.99 m btoc before pump shut-off), indicating it was still recovering from the previous day's test. Groundwater levels in OBS 2 well increased throughout the test from an initial water level of 24.37 m btoc to 21.48 m btoc prior to pump shut off; an increase of 2.89 m. Groundwater levels in OBS 3 dropped by 0.15 m during the test from an initial level of 13.62 m btoc prior to the test to 13.79 m btoc prior to pump shut off. This drawdown extrapolated to 100 days is approximately 0.25 m, which has been accounted for when calculating the sustainable yield, to assess well interference.

3.3 WATER QUALITY

Laboratory reports showing all water quality data are included in Appendix C.

3.3.1 Groundwater (WPID 40252 and WPID 40253)

Total dissolved solids (TDS) concentrations in both WPID 40252 and WPID 40253 exceeded the GCDWQ AO of 500 mg/L, with measured concentrations of 523 and 564 mg/L, respectively. At high levels, TDS can affect water hardness and unpalatability (Health Canada 1991). At levels above 500 mg/L, TDS can cause scaling in pipes, water heaters, and appliances (Health Canada 1991). The water hardness (as CaCO₃) was 257 and 140 mg/L for WPID 40252 and 40253, respectively. These levels are considered hard (for WPID 40253) and very hard (for WPID 40252) (Health Canada 1995). Turbidity, which was measured in the field towards the end of the pumping tests, was 8.05 NTU in WPID 40252 and 18.6 NTU in WPID 40253. Although turbidity does not have a MAC or AO guideline, Health Canada suggests that turbidity in groundwater should generally be below 1 NTU to ensure levels do not interfere with disinfection or water supply distribution (Health Canada 2013).

Total aluminum in WPID 40253 was 0.261 mg/L, which exceeds Health Canada's operational guidance value of 0.100 mg/L; however, this guidance value is neither an AO or an MAC. The guideline technical document for aluminum states that there is no "*consistent, convincing evidence that aluminum in drinking water causes adverse health effects in humans, and aluminum does not affect the acceptance of drinking*

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water by consumers or interfere with practices for supplying good water. Therefore, a health-based guideline or aesthetic objective has not been established for aluminum in drinking water” (Health Canada 1998). The guidance value of 0.100 mg/L applies to treatment plants using aluminum based coagulants. For conventional treatment plants, the recommended value is less than 0.200 mg/L (Health Canada 1998).

No GCDWQ MAC exceedances were found in the results from either well. As described in Section 2.3, total coliforms were detected at 1 CFU/100 mL in the December 2015 sample from WPID 40252. Total coliforms were retested on July 13, after the well was chlorinated and pumped until all chlorine was removed from the system (see methods in Section 2.3 for further details). No coliforms were detected, suggesting that the presence of coliforms in the December sample was likely a result of contamination from the sampling methods (for example, insufficient purging before collecting the sample).

3.3.2 Surface Water (West Twin Creek)

None of the tested parameters from West Twin Creek exceeded the GCDWQ AO. The water hardness (as CaCO₃) was 257 mg/L, which is considered very hard.

The only exceedance of the GCDWQ MAC was total coliforms in West Twin Creek, which exceeded the guideline value of 0 MPN/100mL with a concentration of 580 MPN/100mL. The results confirmed that total coliforms are present in West Twin Creek. This is a common finding for most surface waters, which are generally not considered safe for human consumption without treatment. See Section 4 for recommended treatment options.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1.1 Groundwater (WPID 40252 and WPID 402053)

Based on the above results, WPID 40252 and WPID 40253 are each capable of producing the Bylaw required rate of 2,275 L/day with consideration of drawdown in neighbouring wells. The water from the wells can be considered potable because no health-based (MAC) guideline exceedances were found in the water samples. However, we recommend testing the water from both WPID 40252 and WPID 40253 for total coliforms and *E. coli* two or three times per year, as per Health Canada’s standard recommendations for wells (Health Canada 2008). Additionally, you may want to treat for TDS to reduce scaling and increase palatability.

4.1.2 Surface Water (West Twin Creek)

Because an authorization for a surface water license from West Twin Creek has recently been received and accepted as proof of quantity by the CSRD, only a quality assessment was required for West Twin Creek.

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The results of the quality assessment indicated total coliforms are present. **Therefore, we recommend that water drawn from West Twin Creek be treated for microbiological parameters prior to consumption.** Best practice for any surface water is a multi-barrier approach to water treatment. This includes filtration to remove solids (particulate matter and some microorganisms) and disinfection to kill and/or inactivate disease-causing parasites, bacteria, and viruses.

Treatment objectives for potable water should include filtration and disinfection to achieve a minimum 3-log (99.9%) removal and inactivation of *Giardia* and *Cryptosporidium* and 4-log (99.99%) inactivation of viruses (MOH 2012).

Filtration with conventional filters should achieve a turbidity of 0.3 NTU in 95% of samples with conventional filters (0.1 NTU with membrane filtration). This can be achieved using a 5-micron cartridge filter to remove larger particles, followed by a 1-micron absolute cartridge filter to remove smaller particles. This two-step process should extend the life of the filters by reducing clogging of fine filters with large particles. Turbidity in a stream varies over time, and replacement of the cartridges are expected to be more frequent after heavy precipitation events when solids in the stream may be stirred up. The filters also have a finite capacity (maximum filtration volume), which will impact the service life of the filter depending on water use.

After removal of particulate matter with filtration, the water needs to be disinfected to inactivate any potential pathogenic microorganisms in the water. UV disinfection is very effective against parasites in the water and is recommended for *Giardia* and *Cryptosporidium* inactivation. At sufficient doses, UV can also be used to inactivate viruses; however, it does not produce a residual to maintain the water quality in the plumbing system. However, chlorination is very effective for bacteria and virus inactivation, but does require sufficient contact time for inactivation. The two disinfection processes in combination are recommended to inactivate parasites, bacteria, and viruses. We recommend maintaining a small (>0.1 mg/L) chlorine concentration in any water storage and using a distribution/plumbing system to reduce bacterial regrowth in the system.

The treatment processes described above are those recommended for potable (drinking) water. The treatment can be applied to all of the water entering a household (Point of Entry), or can be modified to provide treatment only to drinking water faucets (Point of Use), or a combination of the two. The most comprehensive approach is to treat all of the water entering the dwelling to potable standards using filtration, UV disinfection, and chlorine. This requires larger and more expensive equipment to treat a larger volume of water for all uses (e.g., faucets, showers, toilets, etc.). Alternatively, to reduce costs, treatment could include filtration and chlorination before water enters the dwelling, followed by a point of use UV disinfection system applied directly at the source that will be used for drinking water (e.g., under kitchen sinks).

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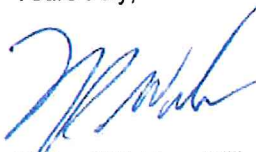
When selecting a treatment system, only consider those that are NSF (National Sanitation Foundation) certified (NSF International 2016). Note that all components in contact with water must be NSF 61 certified, and all products added to the water must be NSF 60 certified. Point of Use (POU) devices fall under NSF Residential Drinking Water Treatment Standards. At minimum, the filters should meet NSF 53: Drinking Water Treatment Units – Health Effects and UV should meet NSF 55: Ultraviolet Microbiological Water Treatment Systems (Class A). Because of the natural variability of surface water quality, we recommend that the water be periodically tested especially for microbiological parameters to confirm that water is safe to drink.

5 CLOSURE

The services provided by Associated in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

We trust this completes our assessment to your satisfaction. Please contact the undersigned if you have any questions.

Yours truly,



Michael Weldon, GIT
Hydrogeologist



Marta Green, P. Geo.
Senior Hydrogeologist



Attachments

- Appendix A: Signed Affidavit
- Appendix B: Pumping Test Data
- Appendix C: Laboratory Reports

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References:

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APPENDIX A – SIGNED AFFIDAVIT

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CANADA) **IN THE MATTER OF PID 016-556-003,**
PROVINCE OF) **Legal Subdivision 2 Section 35 Township 25**
BRITISH) **Range 21 W5M Kootenay District Except Plans**
COLUMBIA) **NEP66313, NEP74775, EPP27115, and EPP45014**
) **(the "Lands")**

TO WIT:


I, Barry John Palumbo, businessman, of Box 123, Golden, British Columbia DO HEREBY SOLEMNLY DECLARE THAT:


- 1. I am the owner of the Lands and therefore have personal knowledge of the facts discussed herein.**
- 2. Well #40252/110330, Well #40253/110332 and West Twin Creek 1 are water sources located on the Lands**
- 3. On December 13, 2015 at 2:00 p.m., I collected a water sample ("Sample #1") from Well #40252/110330 by dipping Well #40252/110330 and then collecting Sample #1 in a bottle from the lanyard line. While collecting Sample #1 I wore nitrile gloves and filled the bottle without touching the inside or the lip of the bottle.**
- 4. On December 13, 2015 at 2:30 p.m., I collected a water sample ("Sample #2") from Well #40253/110332 by dipping Well #40253/110332 and then collecting Sample #2 in a bottle from the lanyard line. While collecting Sample #2 I wore nitrile gloves and filled the bottle without touching the inside or the lip of the bottles.**
- 5. On July 13, 2016 at 4:00 p.m., I collected a water sample ("Sample #3") from Well #40252/110330 by pumping Well #40252/110330 for 30 minutes and then collecting Sample #3 in a bottle from the discharge line. While collecting Sample #3 I wore nitrile gloves provided by ALS Laboratories and filled the bottle without touching the inside or the lip of the bottle.**
- 6. On July 13, 2016 at 5:45 p.m., I collected a water sample ("Sample #4") from West Twin Creek 1 at the northern boundary of the property line by dipping a bottle provided by ALS Laboratories into West Twin Creek 1 and filling it. Once the said bottle was almost full I added HNO₃, a preservative provided by ALS Laboratories, to the bottle. While collecting Sample #4 I wore nitrile gloves provided by ALS Laboratories and filled the bottle without touching the inside or the lip of the bottle**
- 7. All of the equipment that I used when collecting the samples was sterilized before use.**
- 8. I did not apply any water treatment to any of the water sources before collecting any of the samples.**
- 9. I submitted Sample #1 and Sample #2 to WSH Labs in Calgary, Alberta.**

10. I submitted Sample #3 and Sample #4 to ALS Laboratories in Calgary, Alberta.

AND I make this solemn declaration, conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath:

DECLARED before me, at the Town of)
Golden, in the Province of British)
Columbia this 11th day of August, 2016)


_____)
A Commissioner for taking Affidavits for)
British Columbia)


_____)
Barry John Palumbo

HESTER SOLES
ARTICLED STUDENT
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APPENDIX B – PUMPING TEST DATA

Table 1
Pumping Test Data

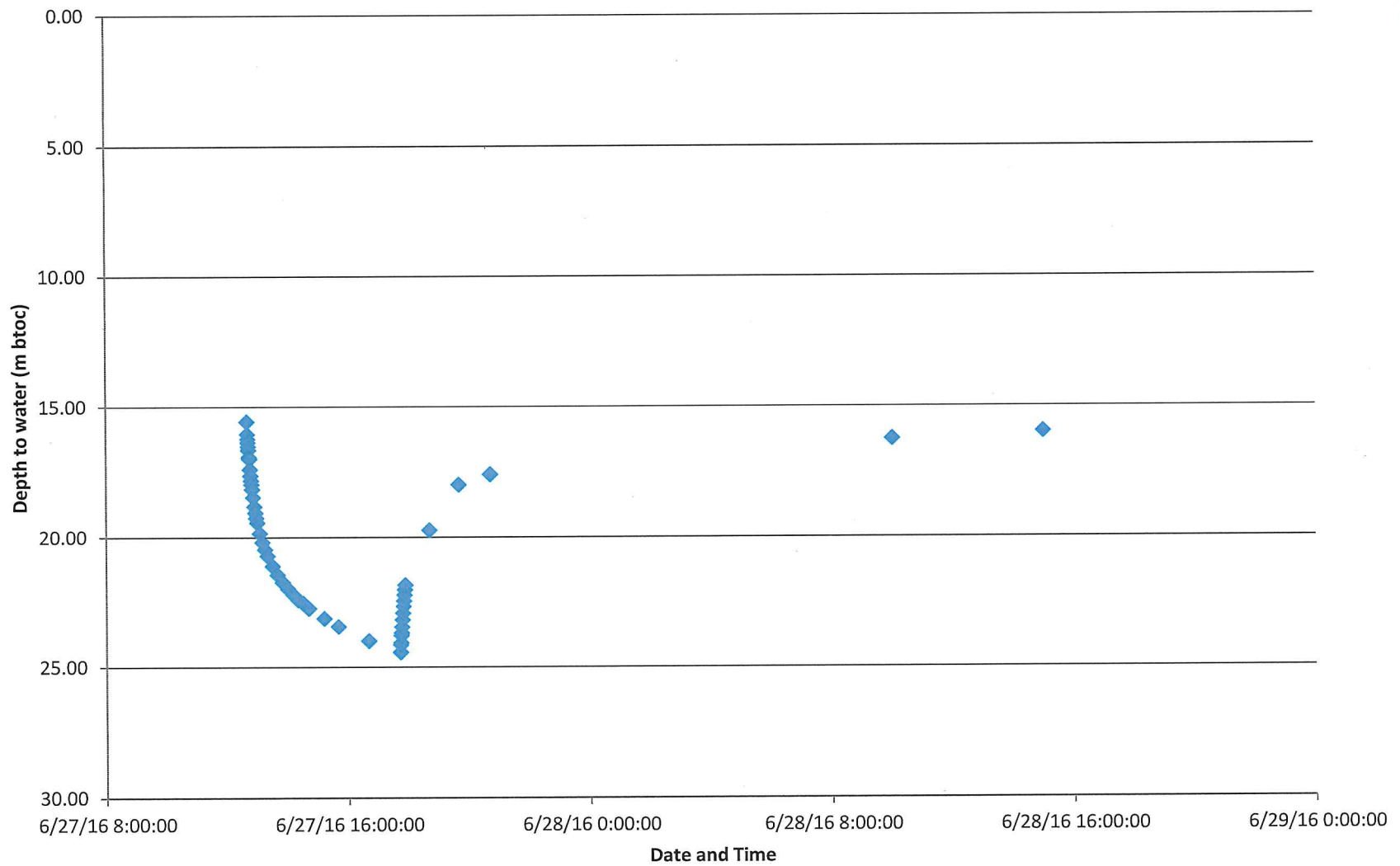


Well ID:	WPID 40252	Static Water Level (mbtoc)	15.58	
Start Date/Time	6/27/16 12:40 PM	Pre-Test Water Level (mbtoc)	15.58	
Client	Barry Palumbo	Total Well Depth (m)	72.84	
Project	2016-8114.000.000	Pump Intake Depth (mbtoc)	64.92	
Test	Constant Rate Test	Pump Used	Submersible 0.5 HP	
Contractor	Barry Palumbo	Pumping Rate (L/s)	0.13	
Clock Time	Time Elapsed (min)	Depth to Water (m)	Drawdown (m)	Comments
6/27/16 12:40:00	0.00	15.58	0.00	
6/27/16 12:41:00	1.00	16.06	0.48	
6/27/16 12:41:30	1.50	16.24	0.66	
6/27/16 12:42:00	2.00	16.37	0.79	
6/27/16 12:42:30	2.50	16.53	0.95	
6/27/16 12:43:00	3.00	16.66	1.08	
6/27/16 12:44:00	4.00	16.93	1.35	Flow rate = 0.13 L/s
6/27/16 12:45:00	5.00	17.00	1.42	
6/27/16 12:46:00	6.00	17.40	1.82	
6/27/16 12:47:00	7.00	17.64	2.06	
6/27/16 12:48:00	8.00	17.83	2.25	
6/27/16 12:49:00	9.00	17.98	2.40	
6/27/16 12:50:00	10.00	18.16	2.58	
6/27/16 12:52:00	12.00	18.47	2.89	
6/27/16 12:54:21	14.35	18.83	3.25	
6/27/16 12:56:17	16.28	19.07	3.49	
6/27/16 12:58:00	18.00	19.27	3.69	
6/27/16 13:00:00	20.00	19.45	3.87	
6/27/16 13:05:00	25.00	19.85	4.27	
6/27/16 13:10:15	30.25	20.20	4.62	
6/27/16 13:15:00	35.00	20.48	4.90	
6/27/16 13:20:00	40.00	20.72	5.14	
6/27/16 13:30:00	50.00	21.11	5.53	
6/27/16 13:40:00	60.00	21.45	5.87	
6/27/16 13:50:00	70.00	21.74	6.16	
6/27/16 14:00:00	80.00	21.98	6.40	
6/27/16 14:11:00	91.00	22.22	6.64	
6/27/16 14:20:00	100.00	22.41	6.83	
6/27/16 14:30:00	110.00	22.54	6.96	
6/27/16 14:41:00	121.00	22.74	7.16	
6/27/16 15:12:00	152.00	23.13	7.55	
6/27/16 15:40:00	180.00	23.45	7.87	
6/27/16 16:40:00	240.00	24.01	8.43	
6/27/16 17:43:00	303.00	24.45	8.87	Shut off pump. Start recovery.
6/27/16 17:43:30	303.50	24.16	8.58	
6/27/16 17:44:03	304.05	24.08	8.50	
6/27/16 17:44:30	304.50	23.79	8.21	
6/27/16 17:45:08	305.14	23.70	8.12	
6/27/16 17:46:00	306.00	23.47	7.89	

Table 1
Pumping Test Data



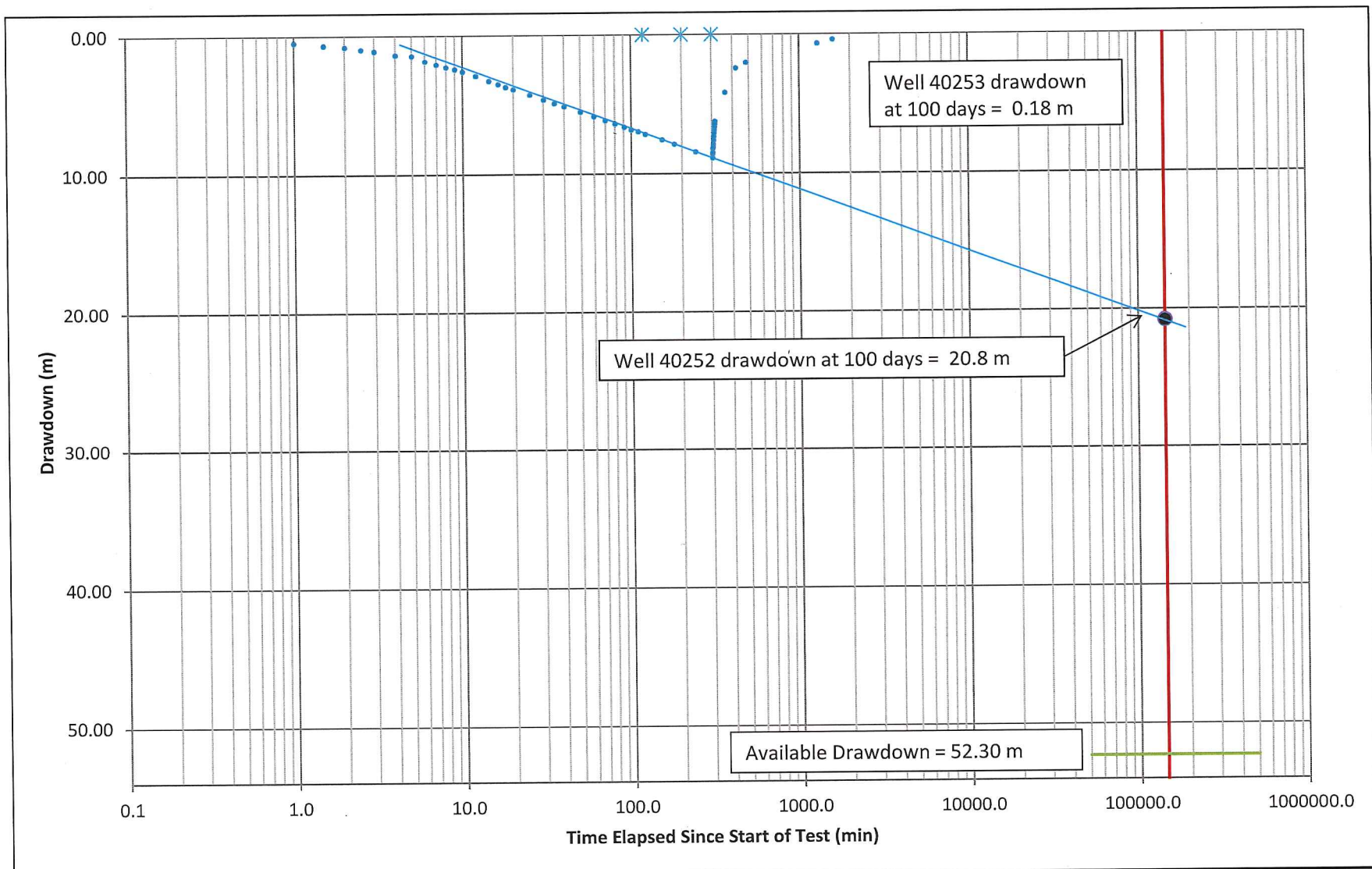
Clock Time	Time Elapsed (min)	Depth to Water (m)	Drawdown (m)	Comments
6/27/16 17:47:00	307.00	23.19	7.61	
6/27/16 17:48:00	308.00	22.92	7.34	
6/27/16 17:49:00	309.00	22.66	7.08	
6/27/16 17:50:00	310.00	22.45	6.87	
6/27/16 17:51:00	311.00	22.23	6.65	
6/27/16 17:52:00	312.00	22.03	6.45	
6/27/16 17:53:00	313.00	21.84	6.26	
6/27/16 18:41:28	361.46	19.74	4.16	
6/27/16 19:40:00	420.00	18.00	2.42	
6/27/16 20:42:00	482.00	17.60	2.02	Recovered to 77% of static water level.
6/28/16 10:00:00	1280.0	16.26	0.68	Recovered to 92% of static water level.
6/28/16 15:00:00	1580.0	15.99	0.41	Recovered to 95% of static water level.



PROJECT: 2016-8114.000.000
 DATE: 20-Jul-16
 DRAWN BY: MAW

PREPARED FOR
 Barry Palumbo

FIGURE 1
 Pump test data
 WPID 40252



PROJECT: 2016-8114.000.000
 DATE: 20-Jul-16
 DRAWN BY: MAW

PREPARED FOR
 Barry Palumbo

FIGURE 2
 Drawdown extrapolated to 100
 days
 WPID 40252

Table 1
Pumping Test Data

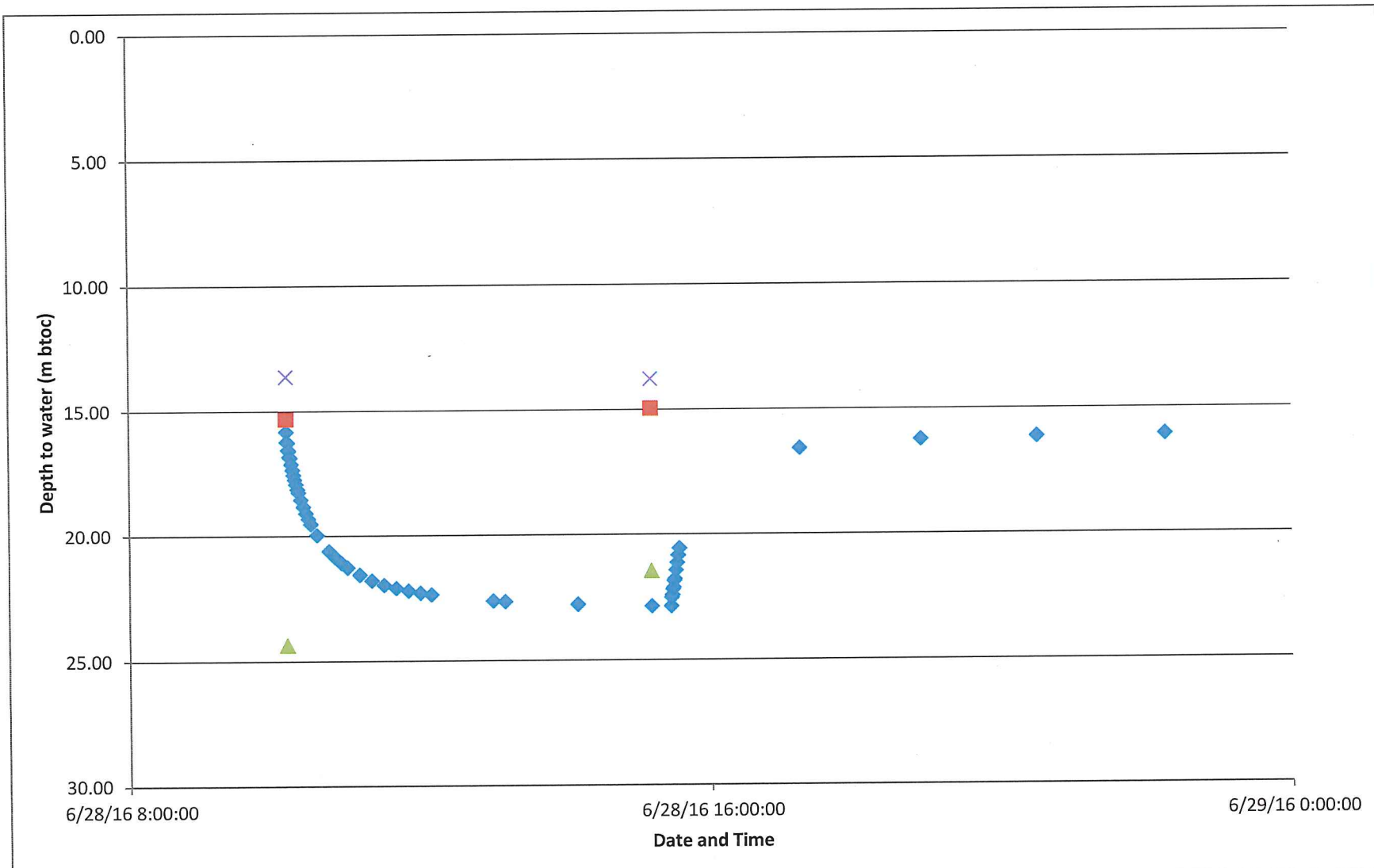


Well ID:	WPID 40253	Static Water Level (mbtoc)	15.83	
Start Date/Time	6/28/16 10:10 AM	Pre-Test Water Level (mbtoc)	15.83	
Client	Barry Palumbo	Total Well Depth (m)	72.84	
Project	2016-8114.000.000	Pump Intake Depth (mbtoc)	Approximately 60 m	
Test	Constant Rate Test	Pump Used	Submersible 0.5 HP	
Contractor	Barry Palumbo	Pumping Rate (L/s)	0.13	
Clock Time	Time Elapsed (min)	Depth to Water (m)	Drawdown (m)	Comments
6/28/16 10:10:00	0.00	15.83	0.00	
6/28/16 10:10:30	0.50	16.23	0.40	
6/28/16 10:11:00	1.00	16.27	0.44	
6/28/16 10:11:30	1.50	16.56	0.73	
6/28/16 10:12:00	2.00	16.60	0.77	
6/28/16 10:12:30	2.50	16.83	1.00	
6/28/16 10:13:00	3.00	16.88	1.05	
6/28/16 10:14:00	4.00	17.13	1.30	
6/28/16 10:15:00	5.00	17.36	1.53	
6/28/16 10:16:00	6.00	17.56	1.73	
6/28/16 10:17:00	7.00	17.75	1.92	
6/28/16 10:18:00	8.00	17.93	2.10	
6/28/16 10:19:04	9.07	18.13	2.30	
6/28/16 10:20:00	10.00	18.26	2.43	
6/28/16 10:22:00	12.00	18.56	2.73	
6/28/16 10:24:00	14.00	18.84	3.01	
6/28/16 10:26:00	16.00	19.10	3.27	
6/28/16 10:28:00	18.00	19.32	3.49	
6/28/16 10:30:00	20.00	19.53	3.70	
6/28/16 10:35:00	25.00	19.98	4.15	
6/28/16 10:45:00	35.00	20.63	4.80	
6/28/16 10:50:00	40.00	20.88	5.05	
6/28/16 10:55:00	45.00	21.10	5.27	
6/28/16 11:00:00	50.00	21.29	5.46	
6/28/16 11:10:00	60.00	21.58	5.75	
6/28/16 11:20:00	70.00	21.81	5.98	
6/28/16 11:30:07	80.12	22.00	6.17	
6/28/16 11:40:00	90.00	22.12	6.29	
6/28/16 11:50:11	100.18	22.23	6.40	
6/28/16 12:00:00	110.00	22.32	6.49	
6/28/16 12:09:06	119.10	22.38	6.55	
6/28/16 13:00:00	170.00	22.64	6.81	
6/28/16 13:10:00	180.00	22.67	6.84	
6/28/16 14:10:00	240.00	22.80	6.97	
6/28/16 15:11:00	301.00	22.89	7.06	
6/28/16 15:27:00	317.00	22.89	7.06	Pump shut off. Start recovery
6/28/16 15:27:30	317.5	22.54	6.71	
6/28/16 15:28:06	318.1	22.44	6.61	
6/28/16 15:28:30	318.5	22.21	6.38	

Table 1
Pumping Test Data



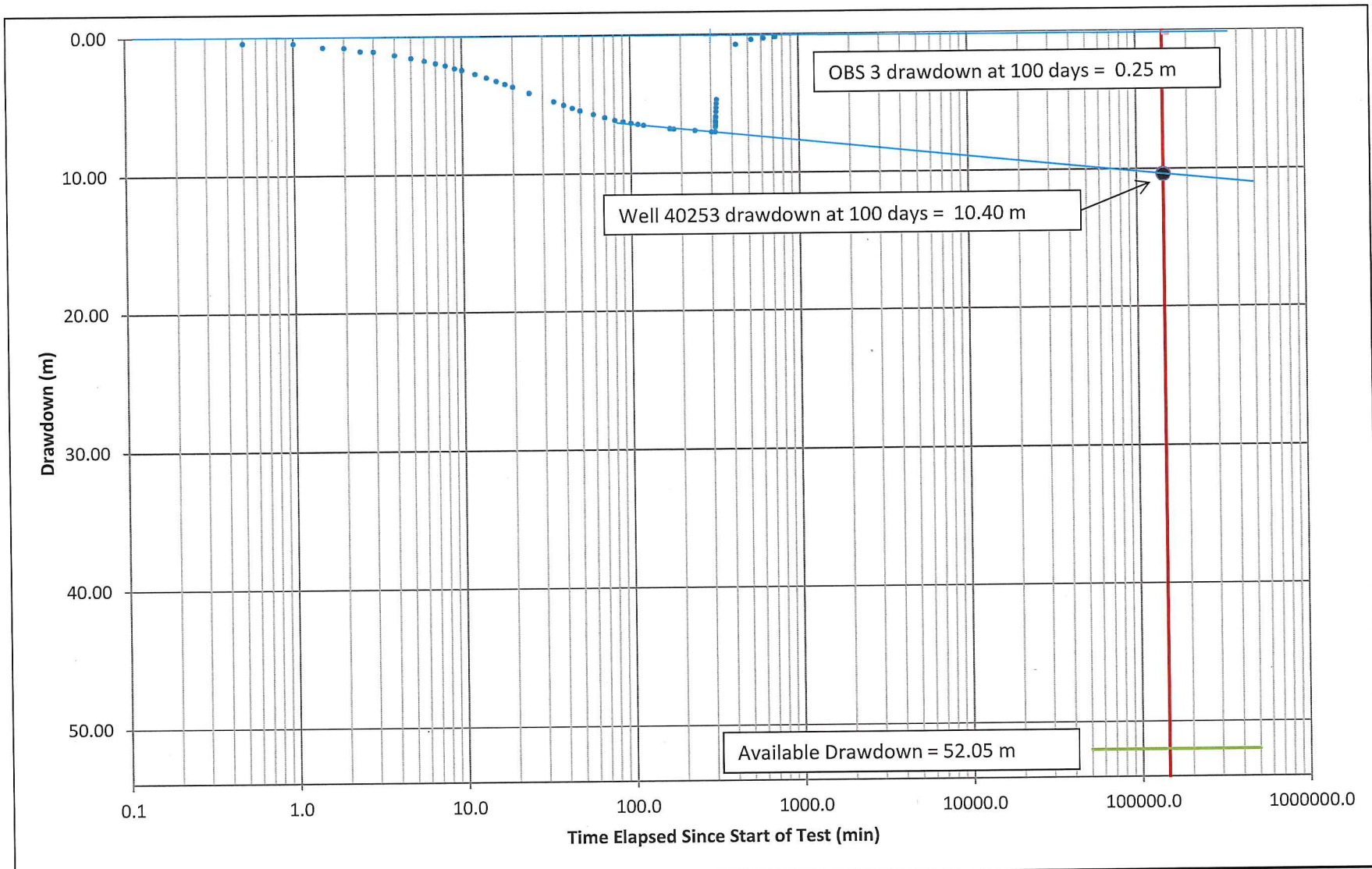
Clock Time	Time Elapsed (min)	Depth to Water (m)	Drawdown (m)	Comments
6/28/16 15:29:00	319.0	22.14	6.31	
6/28/16 15:29:30	319.5	21.87	6.04	
6/28/16 15:30:03	320.1	21.80	5.97	
6/28/16 15:31:04	321.1	21.46	5.63	
6/28/16 15:32:00	322.0	21.16	5.33	
6/28/16 15:33:00	323.0	20.86	5.03	
6/28/16 15:34:00	324.0	20.58	4.75	
6/28/16 17:14:00	424.0	16.58	0.75	
6/28/16 18:54:00	524.0	16.24	0.41	
6/28/16 20:30:00	620.0	16.14	0.31	
6/28/16 22:16:00	726.0	16.07	0.24	Recovered to 97% of original static.



PROJECT: 2016-8114.000.000
 DATE: 20-Jul-16
 DRAWN BY: MAW

PREPARED FOR
 Barry Palumbo

FIGURE 1
 Pump test data
 WPID 40253



PROJECT: 2016-8114.000.000

DATE: 20-Jul-16

DRAWN BY: MAW

PREPARED FOR

Barry Palumbo

FIGURE 2

Drawdown extrapolated to 100 days
WPID 40253

August 17, 2016
Barry Palumbo

APPENDIX C – LABORATORY REPORTS



Associated Environmental Consultants Inc.
ATTN: NICOLE PENNER
200 2800 29 TH STREET
VERNON BC V1T 9P9

Date Received: 14-JUL-16
Report Date: 21-JUL-16 12:38 (MT)
Version: FINAL

Client Phone: 250-545-3672

Certificate of Analysis

Lab Work Order #: L1798223
Project P.O. #: NOT SUBMITTED
Job Reference: 2016-8114.000
C of C Numbers:
Legal Site Desc:

Nelson Kwan, B.Sc.
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 2559 29 Street NE, Calgary, AB T1Y 7B5 Canada | Phone: +1 403 291 9897 | Fax: +1 403 291 0298
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1798223-1 WEST TWIN CREEK 1 Sampled By: BP on 13-JUL-16 @ 17:45 Matrix: WATER Hardness Hardness (as CaCO3)	257		0.50	mg/L		20-JUL-16	
Total Metals in Water by CRC ICPMS							
Arsenic (As)-Total	0.00012		0.00010	mg/L		19-JUL-16	R3506945
Calcium (Ca)-Total	56.7		0.050	mg/L		19-JUL-16	R3506945
Iron (Fe)-Total	0.121		0.010	mg/L		19-JUL-16	R3506945
Magnesium (Mg)-Total	28.0		0.0050	mg/L		19-JUL-16	R3506945
Manganese (Mn)-Total	0.00679		0.00010	mg/L		19-JUL-16	R3506945
Potassium (K)-Total	0.726		0.050	mg/L		19-JUL-16	R3506945
Sodium (Na)-Total	1.74		0.050	mg/L		19-JUL-16	R3506945
Uranium (U)-Total	0.000880		0.000010	mg/L		19-JUL-16	R3506945
L1798223-2 WPID 40252 Sampled By: BP on 13-JUL-16 @ 16:00 Matrix: WATER Miscellaneous Parameters Colour, True	<5.0		5.0	CU		14-JUL-16	R3503759
Turbidity	26.3		0.10	NTU		14-JUL-16	R3503865
UV Absorbance (254 nm)	0.051		0.005	Abs/cm		15-JUL-16	R3504059
Transmittance, UV (254 nm)	88.9		1.0	%T/cm		15-JUL-16	
Total Coliforms and E. Coli by MPN MPN - E. Coli	<1		1	MPN/100mL		14-JUL-16	R3504111
MPN - Total Coliforms	<1		1	MPN/100mL		14-JUL-16	R3504111

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
COLOUR-TRUE-CL	Water	Colour (True) by Spectrometer	APHA 2120 Color
True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
HARDNESS-CALC-CL	Water	Hardness	APHA 2340 B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
MET-T-CCMS-CL	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
TC-EC-MPN-CL	Water	Total Coliforms and E. Coli by MPN	APHA METHOD 9223
This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.			
TURBIDITY-CL	Water	Turbidity	APHA 2130 B-Nephelometer
This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.			
UV-ABS-ED	Water	UV Absorbance (Spectrometry)	APHA 5910 B
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um filter and its UV Absorbance is measured in a quartz cell at 254 nm and reported as UV Absorbance per cm. The analysis is carried out without pH adjustment.			
UV-TRANS-CALC-ED	Water	UV Transmittance (Calculated)	APHA 5910 B-Spectrophotometer
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um filter and its UV Absorbance is measured in a quartz cell at 254 nm. UV Transmittance is calculated from the UV Absorbance result and reported as UV Transmittance per cm. The analysis is carried out without pH adjustment.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
ED	ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample
 mg/kg wwt - milligrams per kilogram based on wet weight of sample
 mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
 mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Quality Control Report

Workorder: L1798223

Report Date: 21-JUL-16

Page 1 of 3

Client: Associated Environmental Consultants Inc.

200 2800 29 TH STREET

VERNON BC V1T 9P9

Contact: NICOLE PENNER

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
COLOUR-TRUE-CL	Water							
Batch	R3503759							
WG2348011-2	LCS							
Colour, True			98.0		%		85-115	14-JUL-16
WG2348011-1	MB							
Colour, True			<5.0		CU		5	14-JUL-16
MET-T-CCMS-CL	Water							
Batch	R3504343							
WG2348699-2	LCS	TMRM						
Arsenic (As)-Total			98.7		%		80-120	15-JUL-16
Calcium (Ca)-Total			100.6		%		80-120	15-JUL-16
Iron (Fe)-Total			97.1		%		80-120	15-JUL-16
Magnesium (Mg)-Total			97.4		%		80-120	15-JUL-16
Manganese (Mn)-Total			99.0		%		80-120	15-JUL-16
Potassium (K)-Total			100.3		%		80-120	15-JUL-16
Sodium (Na)-Total			102.2		%		80-120	15-JUL-16
Uranium (U)-Total			90.4		%		80-120	15-JUL-16
WG2348699-1	MB							
Arsenic (As)-Total			<0.00010		mg/L		0.0001	15-JUL-16
Calcium (Ca)-Total			<0.050		mg/L		0.05	15-JUL-16
Iron (Fe)-Total			<0.010		mg/L		0.01	15-JUL-16
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	15-JUL-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	15-JUL-16
Potassium (K)-Total			<0.050		mg/L		0.05	15-JUL-16
Sodium (Na)-Total			<0.050		mg/L		0.05	15-JUL-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	15-JUL-16
Batch	R3508436							
WG2348699-6	LCS	TMRM						
Arsenic (As)-Total			99.3		%		80-120	20-JUL-16
Calcium (Ca)-Total			96.2		%		80-120	20-JUL-16
Iron (Fe)-Total			93.9		%		80-120	20-JUL-16
Magnesium (Mg)-Total			96.3		%		80-120	20-JUL-16
Manganese (Mn)-Total			96.8		%		80-120	20-JUL-16
Potassium (K)-Total			98.0		%		80-120	20-JUL-16
Sodium (Na)-Total			95.6		%		80-120	20-JUL-16
Uranium (U)-Total			91.9		%		80-120	20-JUL-16
WG2348699-5	MB							
Arsenic (As)-Total			<0.00010		mg/L		0.0001	20-JUL-16



Quality Control Report

Workorder: L1798223

Report Date: 21-JUL-16

Page 2 of 3

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-CL Water								
Batch R3508436								
WG2348699-5 MB								
Calcium (Ca)-Total			<0.050		mg/L		0.05	20-JUL-16
Iron (Fe)-Total			<0.010		mg/L		0.01	20-JUL-16
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	20-JUL-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	20-JUL-16
Potassium (K)-Total			<0.050		mg/L		0.05	20-JUL-16
Sodium (Na)-Total			<0.050		mg/L		0.05	20-JUL-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	20-JUL-16
TC-EC-MPN-CL Water								
Batch R3504111								
WG2348464-5 DUP								
MPN - E. Coli		L1798223-2	<1	RPD-NA	MPN/100mL	N/A	65	14-JUL-16
MPN - Total Coliforms			<1	RPD-NA	MPN/100mL	N/A	65	14-JUL-16
WG2348464-4 MB								
MPN - E. Coli			<1		MPN/100mL		1	14-JUL-16
MPN - Total Coliforms			<1		MPN/100mL		1	14-JUL-16
TURBIDITY-CL Water								
Batch R3503865								
WG2348156-2 LCS								
Turbidity			96.0		%		85-115	14-JUL-16
WG2348156-1 MB								
Turbidity			<0.10		NTU		0.1	14-JUL-16
UV-ABS-ED Water								
Batch R3504059								
WG2348342-2 DUP								
UV Absorbance (254 nm)		L1798223-2	0.048		Abs/cm	6.1	10	15-JUL-16
WG2348342-1 MB								
UV Absorbance (254 nm)			<0.005		Abs/cm		0.005	15-JUL-16

Quality Control Report

Workorder: L1798223

Report Date: 21-JUL-16

Page 3 of 3

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



BR 168187

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Affix ALS label



L1798223-COFC

if 1

www.alsglobal.com

Report To Company: Associated Environmental Consultants Inc. Contact: Nicole Penner Address: 200 2800 29th Street Vernon, B.C. V1T 9P9 Phone: 250-545-3672 250-938-5537 (cell)		Report Format / Distribution Select Report Format: <input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input type="checkbox"/> EDD (DIGITAL) Quality Control (QC) Report with Report <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Criteria on Report - provide details below if box checked Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX Email 1 or Fax pennem@ae.ca Email 2 greenm@ae.ca			(table for all tests)	
Invoice To Same as Report To <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Copy of Invoice with Report <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Company: Associated Environmental Consultants Inc. Contact: Nicole Penner		Invoice Distribution Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX Email 1 or Fax pennem@ae.ca Email 2 anzej@ae.ca			Analysis Request Specify Date Required for E2, E or P:	
Project Information ALS Quote #: 2016-8114.000 Job #: 2016-8114.000 PO / AFE: LSD:		Oil and Gas Required Fields (client use) Approver ID: Cost Center: GL Account: Routing Code: Activity Code: Location:			Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below	
ALS Lab Work Order # (lab use only)		ALS Contact: Nelson Kwan Sampler:			Number of Containers	
ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total metals (*see note) Total hardness Total coliforms and E. coli (*see note) Colour and turbidity UV transmissivity	Number of Containers
	West Twin Creek 1	13/7/16	5:45 Pm	Water	R	
	WPID 40252	13/7/16	4:00 Pm	Water		R R R
Drinking Water (DW) Samples¹ (client use)		Special Instructions / Specify Criteria to add on report (client Use)			SAMPLE CONDITION AS RECEIVED (lab use only)	
Are samples taken from a Regulated DW System? <input type="checkbox"/> Yes <input type="checkbox"/> No		*For total metals only include the following: arsenic, calcium, iron, magnesium, manganese, potassium, sodium, and uranium.			Frozen: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No SIF Observations: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Ice packs: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Custody seal intact: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Cooling initiated: <input checked="" type="checkbox"/>	
Are samples for human drinking water use? <input type="checkbox"/> Yes <input type="checkbox"/> No		**Detection limit on total coliforms and E.coli must meet 1 count/100 mL.			INITIAL COOLER TEMPERATURES *C: FINAL COOLER TEMPERATURES *C:	
SHIPMENT RELEASE (client use)		INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)	
Released by: <i>[Signature]</i>	Date: 13/7/16	Time: 6:00 Pm	Received by: <i>[Signature]</i>	Date: 13/7/16	Time: 9:00 Pm	Received by: <i>[Signature]</i>



Ship out July 7th
Bottle 0



L1798223-COFC

Bottle Order #: BR168187
Lab: CALGARY
Account #: 11329
Order Created By: Nelson Kwan, B.Sc.
Expected Date: 08/07/2016 12:00 PM
Order Priority: Emergency
Ship/Pickup Via: GREYHOUND
Waybill Number:
Prepared Date:
Prepared By:

Company: Associated Environmental Consultants Inc.
Client Contact: Barry Palumbo (250-344-8288) ***HFPU***
Address: Nicole Penner (AE) c/o Greyhound Express Greyhound Depot 1050 TransCanada Highway Golden, BC, V0A 1H1
Phone Number: 403-262-4500
Fax Number: 403-269-7640
Client Job Number: 2016-8114

Checked By: 7-July-2016 [Signature] Initials

Comments:
Prelabel all bottles

Qty	Item (Analysis)	Container	Colour	Preservative	Instructions #
<input checked="" type="checkbox"/> 2	Bacteriological (TC-EC)	250 mL Sterilized Plastic	+Coli/coc	Sodium Thiosulfate	3,5,9,27
<input checked="" type="checkbox"/> 1	Cooler	Cooler with Ice Packs			
<input checked="" type="checkbox"/> 3	Nitrile Gloves	1 pair			
<input checked="" type="checkbox"/> 2	Routine (colour, turbidity, UV)	500 mL Polyethylene		No Preservative	3,8
<input type="checkbox"/> 2	Total Metals (As, U, major ions)	250 mL HDPE Bottle	Blue	3 mL 1:3 Nitric Acid	13, 3
<input checked="" type="checkbox"/> 2	pre-printed COC				

Please note the "Instructions #" above for the sample containers and items shipped to you. Find the corresponding number below and follow the instructions/guidelines.

Instructions #	Guideline
3	Keep cool (40C).
5	CAUTION: preservative already in container.
8	No preservative.
9	Sodium Thiosulphate (Na2O3S2): irritant- in case of contact with skin, rinse affected area several times with cold water.
13	Nitric acid (HNO3): highly toxic/corrosive- in case of contact with skin, rinse affected area with excess cold water.
27	Submit samples to the laboratory IMMEDIATELY after sampling.



Associated Environmental Consultants Inc.
ATTN: Nicole Penner
200, 2800 29 TH STREET
VERNON BC .

Date Received: 29-JUN-16
Report Date: 08-JUL-16 14:07 (MT)
Version: FINAL

Client Phone: 250-545-3672

Certificate of Analysis

Lab Work Order #: L1790907
Project P.O. #: NOT SUBMITTED
Job Reference: 2016-8114.000
C of C Numbers: 14-478931
Legal Site Desc:

Nelson Kwan, B.Sc.
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 2559 29 Street NE, Calgary, AB T1Y 7B5 Canada | Phone: +1 403 291 9897 | Fax: +1 403 291 0298
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1790907-1 WPID 402053 Sampled By: NP on 28-JUN-16 @ 15:30 Matrix: WATER							
Miscellaneous Parameters							
Colour, True	<5.0		5.0	CU		29-JUN-16	R3492547
Turbidity	24.9		0.10	NTU		29-JUN-16	R3492723
L1790907-2 WEST TWIN CREEK 7 Sampled By: NP on 28-JUN-16 @ 15:30 Matrix: WATER							
Hardness							
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					05-JUL-16	R3496255
Calcium (Ca)-Dissolved	59.8		0.10	mg/L		05-JUL-16	R3496265
Magnesium (Mg)-Dissolved	26.8		0.10	mg/L		05-JUL-16	R3496265
Hardness							
Hardness (as CaCO3)	260		0.50	mg/L		07-JUL-16	
Miscellaneous Parameters							
Chloride (Cl)	1.47		0.50	mg/L		29-JUN-16	R3493728
Colour, True	<5.0		5.0	CU		29-JUN-16	R3492547
Fluoride (F)	0.040		0.020	mg/L		29-JUN-16	R3493728
Sulfate (SO4)	15.6		0.30	mg/L		29-JUN-16	R3493728
Total Dissolved Solids	235	DLHC	20	mg/L		04-JUL-16	R3496522
Turbidity	2.68		0.10	NTU		29-JUN-16	R3492723
UV Absorbance (254 nm)	0.057		0.005	Abs/cm		30-JUN-16	R3492874
Transmittance, UV (254 nm)	87.7		1.0	%T/cm		30-JUN-16	
pH, Conductivity and Total Alkalinity							
pH	8.48		0.10	pH		29-JUN-16	R3492749
Conductivity (EC)	445		2.0	uS/cm		29-JUN-16	R3492749
Bicarbonate (HCO3)	257		5.0	mg/L		29-JUN-16	R3492749
Carbonate (CO3)	9.5		5.0	mg/L		29-JUN-16	R3492749
Hydroxide (OH)	<5.0		5.0	mg/L		29-JUN-16	R3492749
Alkalinity, Total (as CaCO3)	226		5.0	mg/L		29-JUN-16	R3492749
Total Coliforms and E. Coli by MPN							
MPN - E. Coli	<1		1	MPN/100mL		29-JUN-16	R3493373
MPN - Total Coliforms	580		1	MPN/100mL		29-JUN-16	R3493373
Total Metals in Water by CRC ICPMS							
Arsenic (As)-Total	0.00013		0.00010	mg/L		06-JUL-16	R3497064
Calcium (Ca)-Total	54.9		0.050	mg/L		06-JUL-16	R3497064
Iron (Fe)-Total	0.099		0.010	mg/L		06-JUL-16	R3497064
Magnesium (Mg)-Total	26.4		0.0050	mg/L		06-JUL-16	R3497064
Manganese (Mn)-Total	0.00547		0.00010	mg/L		06-JUL-16	R3497064
Potassium (K)-Total	0.659		0.050	mg/L		06-JUL-16	R3497064
Sodium (Na)-Total	1.37		0.050	mg/L		06-JUL-16	R3497064
Uranium (U)-Total	0.000986		0.000010	mg/L		06-JUL-16	R3497064
NO2, NO3 and Sum of NO2/NO3							
Nitrate in Water by IC							
Nitrate (as N)	0.131		0.020	mg/L		29-JUN-16	R3493728
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.131		0.050	mg/L		07-JUL-16	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		29-JUN-16	R3493728
Total Si (reported as Silica) by ICPOES							
Total Silicon (reported as Silica)							
Silicon (as SiO2)-Total	7.22		0.11	mg/L		07-JUL-16	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SPL	TOTAL METALS - Sample was Preserved at the laboratory
SFPL	HARDNESS - Sample was Filtered and Preserved at the laboratory

Sample Parameter Qualifier Key:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
COLOUR-TRUE-CL	Water	Colour (True) by Spectrometer	APHA 2120 Color
True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
F-IC-N-CL	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HARDNESS-CALC-CL	Water	Hardness	APHA 2340 B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
MET-DIS-ICP-CL	Water	Dissolved Metals by ICPOES	APHA 3030B/EPA 6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
MET-T-CCMS-CL	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
MET-TOT-ICP-CL	Water	Total Metals in Water by ICPOES	APHA 3030E/EPA 6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion using a hotblock (APHA Method 3030E). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B)			
N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-CL	Water	Nitrite in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-IC-N-CL	Water	Nitrate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320
All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed) pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode. Alkalinity measurement is based on the sample's capacity to neutralize acid Conductivity measurement is based on the sample's capacity to convey an electric current			
SiO2-T-CALC-CL	Water	Total Silicon (reported as Silica)	ICP/CALCULATION-ICP/CALCULATION
SO4-IC-N-CL	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
SOLIDS-TDS-CL	Water	Total Dissolved Solids	APHA 2540 C
A well-mixed sample is filtered through a glass fibre filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2 C. The increase in vial weight represents the total dissolved solids (TDS).			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
TC-EC-MPN-CL	Water	Total Coliforms and E. Coli by MPN	APHA METHOD 9223
This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.			
TURBIDITY-CL	Water	Turbidity	APHA 2130 B-Nephelometer
This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.			
UV-ABS-ED	Water	UV Absorbance (Spectrometry)	APHA 5910 B
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um filter and its UV Absorbance is measured in a quartz cell at 254 nm and reported as UV Absorbance per cm. The analysis is carried out without pH adjustment.			
UV-TRANS-CALC-ED	Water	UV Transmittance (Calculated)	APHA 5910 B-Spectrophotometer
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um filter and its UV Absorbance is measured in a quartz cell at 254 nm. UV Transmittance is calculated from the UV Absorbance result and reported as UV Transmittance per cm. The analysis is carried out without pH adjustment.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
ED	ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

14-478931

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample
 mg/kg wwt - milligrams per kilogram based on wet weight of sample
 mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
 mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Quality Control Report

Workorder: L1790907

Report Date: 08-JUL-16

Page 1 of 5

Client: Associated Environmental Consultants Inc.
200, 2800 29 TH STREET
VERNON BC .

Contact: Nicole Penner

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-IC-N-CL	Water							
Batch	R3493728							
WG2339412-6	LCS							
Chloride (Cl)			96.3		%		90-110	29-JUN-16
WG2339412-5	MB							
Chloride (Cl)			<0.50		mg/L		0.5	29-JUN-16
COLOUR-TRUE-CL	Water							
Batch	R3492547							
WG2338204-2	LCS							
Colour, True			98.4		%		85-115	29-JUN-16
WG2338204-1	MB							
Colour, True			<5.0		CU		5	29-JUN-16
F-IC-N-CL	Water							
Batch	R3493728							
WG2339412-6	LCS							
Fluoride (F)			95.1		%		90-110	29-JUN-16
WG2339412-5	MB							
Fluoride (F)			<0.020		mg/L		0.02	29-JUN-16
MET-DIS-ICP-CL	Water							
Batch	R3496265							
WG2340981-2	LCS	TMRM						
Calcium (Ca)-Dissolved			103.4		%		80-120	05-JUL-16
Magnesium (Mg)-Dissolved			98.7		%		80-120	05-JUL-16
WG2340981-7	LCS	TMRM						
Calcium (Ca)-Dissolved			107.3		%		80-120	05-JUL-16
Magnesium (Mg)-Dissolved			103.0		%		80-120	05-JUL-16
WG2340981-1	MB							
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	05-JUL-16
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	05-JUL-16
WG2340981-6	MB							
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	05-JUL-16
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	05-JUL-16
MET-T-CCMS-CL	Water							
Batch	R3496343							
WG2340922-2	LCS	TMRM						
Arsenic (As)-Total			94.7		%		80-120	05-JUL-16
Calcium (Ca)-Total			99.1		%		80-120	05-JUL-16
Iron (Fe)-Total			94.0		%		80-120	05-JUL-16
Magnesium (Mg)-Total			99.4		%		80-120	05-JUL-16



Quality Control Report

Workorder: L1790907

Report Date: 08-JUL-16

Page 2 of 5

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-CL	Water							
Batch	R3496343							
WG2340922-2	LCS	TMRM						
Manganese (Mn)-Total			97.1		%		80-120	05-JUL-16
Potassium (K)-Total			94.7		%		80-120	05-JUL-16
Sodium (Na)-Total			97.1		%		80-120	05-JUL-16
Uranium (U)-Total			94.1		%		80-120	05-JUL-16
WG2340922-1	MB							
Arsenic (As)-Total			<0.00010		mg/L		0.0001	05-JUL-16
Calcium (Ca)-Total			<0.050		mg/L		0.05	05-JUL-16
Iron (Fe)-Total			<0.010		mg/L		0.01	05-JUL-16
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	05-JUL-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	05-JUL-16
Potassium (K)-Total			<0.050		mg/L		0.05	05-JUL-16
Sodium (Na)-Total			<0.050		mg/L		0.05	05-JUL-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	05-JUL-16
Batch	R3497064							
WG2340922-5	LCS	TMRM						
Arsenic (As)-Total			108.6		%		80-120	06-JUL-16
Calcium (Ca)-Total			98.0		%		80-120	06-JUL-16
Iron (Fe)-Total			93.4		%		80-120	06-JUL-16
Magnesium (Mg)-Total			110.5		%		80-120	06-JUL-16
Manganese (Mn)-Total			111.2		%		80-120	06-JUL-16
Potassium (K)-Total			110.5		%		80-120	06-JUL-16
Sodium (Na)-Total			110.9		%		80-120	06-JUL-16
Uranium (U)-Total			90.5		%		80-120	06-JUL-16
WG2340922-4	MB							
Arsenic (As)-Total			<0.00010		mg/L		0.0001	06-JUL-16
Calcium (Ca)-Total			<0.050		mg/L		0.05	06-JUL-16
Iron (Fe)-Total			<0.010		mg/L		0.01	06-JUL-16
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	06-JUL-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	06-JUL-16
Potassium (K)-Total			<0.050		mg/L		0.05	06-JUL-16
Sodium (Na)-Total			<0.050		mg/L		0.05	06-JUL-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	06-JUL-16
NO2-IC-N-CL	Water							



Quality Control Report

Workorder: L1790907

Report Date: 08-JUL-16

Page 3 of 5

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-N-CL	Water							
Batch	R3493728							
WG2339412-6	LCS							
Nitrite (as N)			97.8		%		90-110	29-JUN-16
WG2339412-5	MB							
Nitrite (as N)			<0.010		mg/L		0.01	29-JUN-16
NO3-IC-N-CL	Water							
Batch	R3493728							
WG2339412-6	LCS							
Nitrate (as N)			96.2		%		90-110	29-JUN-16
WG2339412-5	MB							
Nitrate (as N)			<0.020		mg/L		0.02	29-JUN-16
PH/EC/ALK-CL	Water							
Batch	R3492749							
WG2338522-8	LCS							
pH			7.01		pH		6.9-7.1	29-JUN-16
Conductivity (EC)			108.8		%		90-110	29-JUN-16
Alkalinity, Total (as CaCO3)			96.7		%		85-115	29-JUN-16
WG2338522-7	MB							
Conductivity (EC)			<2.0		uS/cm		2	29-JUN-16
Bicarbonate (HCO3)			<5.0		mg/L		5	29-JUN-16
Carbonate (CO3)			<5.0		mg/L		5	29-JUN-16
Hydroxide (OH)			<5.0		mg/L		5	29-JUN-16
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	29-JUN-16
SO4-IC-N-CL	Water							
Batch	R3493728							
WG2339412-6	LCS							
Sulfate (SO4)			96.3		%		90-110	29-JUN-16
WG2339412-5	MB							
Sulfate (SO4)			<0.30		mg/L		0.3	29-JUN-16
SOLIDS-TDS-CL	Water							
Batch	R3496522							
WG2339993-3	DUP	L1790907-2						
Total Dissolved Solids		235	235		mg/L	0.0	20	04-JUL-16
WG2339993-2	LCS							
Total Dissolved Solids			99.4		%		85-115	04-JUL-16
WG2339993-1	MB							
Total Dissolved Solids			<10		mg/L		10	04-JUL-16
TC-EC-MPN-CL	Water							

Quality Control Report

Workorder: L1790907

Report Date: 08-JUL-16

Page 5 of 5

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



Report To		Report Format / Distribution			Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)																																								
Company: <u>Ass Environmental Consultants</u>		Select Report Format: <input checked="" type="checkbox"/> PDF <input type="checkbox"/> EXCEL <input type="checkbox"/> EDD (DIGITAL)			R <input checked="" type="checkbox"/> Regular (Standard TAT if received by 3pm)																																								
Contact: <u>Nicole Jenner</u>		Quality Control (QC) Report with Report <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			P <input type="checkbox"/> Priority (2-4 business days if received by 3pm)																																								
Address: <u>200, 2800 24th Street Vernon, BC</u>		<input type="checkbox"/> Criteria on Report - provide details below if box checked			E <input type="checkbox"/> Emergency (1-2 business days if received by 3pm)																																								
Phone: <u>250-845-3672 250-938-5537</u>		Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX			E2 <input type="checkbox"/> Same day or weekend emergency if received by 10am - contact ALS for surcharge.																																								
Invoice To: Same as Report To <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Invoice Distribution			Specify Date Required for E2, E or P:																																								
Copy of Invoice with Report <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX			Analysis Request																																								
Company:		Email 1 or Fax: <u>Jenner N @ AE.CA</u>			<table border="1"> <tr> <td colspan="7">Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below</td> <td rowspan="10">Number of Containers</td> </tr> <tr> <td>Alkalinity + PH</td> <td>Nitrate-N</td> <td>Nitrite-N</td> <td>Conductivity</td> <td>Sulphate</td> <td>TDS</td> <td>Total Metabolite</td> <td>Trace Metals</td> <td>Chloride, Fluoride</td> <td>Silicon</td> <td>Total Coliforms</td> <td>Colour + Turbidity</td> <td>UV-trans</td> </tr> <tr> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> </tr> </table>							Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below							Number of Containers	Alkalinity + PH	Nitrate-N	Nitrite-N	Conductivity	Sulphate	TDS	Total Metabolite	Trace Metals	Chloride, Fluoride	Silicon	Total Coliforms	Colour + Turbidity	UV-trans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below												Number of Containers																																	
Alkalinity + PH	Nitrate-N	Nitrite-N	Conductivity	Sulphate									TDS	Total Metabolite	Trace Metals	Chloride, Fluoride	Silicon	Total Coliforms		Colour + Turbidity	UV-trans																								
✓	✓	✓	✓	✓									✓	✓	✓	✓	✓	✓		✓	✓																								
Contact:	Email 2: <u>g.ozey @ AE.CA</u>																																												
Project Information		Oil and Gas Required Fields (client use)																																											
ALS Quote #:	Approver ID:	Cost Center:																																											
Job #: <u>2016-8114-000</u>	GL Account:	Routing Code:																																											
PO / AFE:	Activity Code:																																												
LSD:	Location:																																												
ALS Lab Work Order # (lab use only)	ALS Contact:	Sampler:																																											
ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type																																									
	<u>WPID 40253 West Twin Creek 9</u>	<u>28 June</u>	<u>3:30</u>	<u>Water</u>																																									
Drinking Water (DW) Samples (client use)		Special Instructions / Specify Criteria to add on report (client use)			SAMPLE CONDITION AS RECEIVED (lab use only)																																								
Are samples taken from a Regulated DW System? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		<u>Surface label = West Twin Creek 9 metals = arsenic, calcium, iron, magnesium manganese, potassium, sodium, uranium coliforms 1 count / 100 mL</u>			Frozen <input type="checkbox"/> SIF Observations Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>																																								
Are samples for human drinking water use? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No					Ice packs Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Custody seal intact Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>																																								
SHIPMENT RELEASE (client use)		INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)																																								
Released by: <u>[Signature]</u>	Date: <u>29 June</u>	Time: <u>11:27</u>	Received by: <u>[Signature]</u>	Date: <u>06/29</u>	Time: <u>11:30 am</u>																																								

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

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NA-F40356-005 Rev 04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.



Associated Environmental Consultants Inc.
ATTN: Marta Green
#200-2800 29TH STREET
VERNON BC .

Date Received: 28-JUN-16
Report Date: 05-JUL-16 16:41 (MT)
Version: FINAL

Client Phone: 250-503-7330

Certificate of Analysis

Lab Work Order #: L1790164
Project P.O. #: NOT SUBMITTED
Job Reference: 2016-8114
C of C Numbers: 14-479279
Legal Site Desc:

Nelson Kwan, B.Sc.
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 2559 29 Street NE, Calgary, AB T1Y 7B5 Canada | Phone: +1 403 291 9897 | Fax: +1 403 291 0298
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
EHT	UV Transmittance, Colour True, Turbidity - Exceeded Recommended Holding Time Prior To Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
COLOUR-TRUE-CL	Water	Colour (True) by Spectrometer	APHA 2120 Color
True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
TURBIDITY-CL	Water	Turbidity	APHA 2130 B-Nephelometer
This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.			
UV-ABS-ED	Water	UV Absorbance (Spectrometry)	APHA 5910 B
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um filter and its UV Absorbance is measured in a quartz cell at 254 nm and reported as UV Absorbance per cm. The analysis is carried out without pH adjustment.			
UV-TRANS-CALC-ED	Water	UV Transmittance (Calculated)	APHA 5910 B-Spectrophotometer
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um filter and its UV Absorbance is measured in a quartz cell at 254 nm. UV Transmittance is calculated from the UV Absorbance result and reported as UV Transmittance per cm. The analysis is carried out without pH adjustment.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
ED	ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

14-479279

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample
 mg/kg wwt - milligrams per kilogram based on wet weight of sample
 mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
 mg/L - unit of concentration based on volume, parts per million.
 < - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1790164

Report Date: 05-JUL-16

Page 2 of 3

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Workorder: L1790164

Report Date: 05-JUL-16

Page 3 of 3

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
UV Transmittance (Calculated)	1	27-JUN-16 17:40	05-JUL-16 13:04	48	187	hours	EHT

Legend & Qualifier Definitions:

- EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
- EHTR: Exceeded ALS recommended hold time prior to sample receipt.
- EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
- EHT: Exceeded ALS recommended hold time prior to analysis.
- Rec. HT: ALS recommended hold time (see units).

Notes*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1790164 were received on 28-JUN-16 12:50.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Affix



L1790164-COFC

Report To Company: <u>Associated Environmental</u> Contact: <u>MARIA GREEN</u> Address: <u>#200-2800 29th Street, Vernon BC</u> Phone: <u>250-503-7330</u>		Report Format / Distribution Select Report Format: <input type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input checked="" type="checkbox"/> EDD (DIGITAL) Quality Control (QC) Report with Report <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Criteria on Report - provide details below if box checked Select Distribution: <input type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX Email 1 or Fax: <u>GreenM@AE.CA</u> Email 2:		<small>(TAT) is not available for all tests</small> R <input checked="" type="checkbox"/> Regular (Standard TAT if received by 3pm) P <input type="checkbox"/> Priority (2-4 business days if received by 3pm) E <input type="checkbox"/> Emergency (1-2 business days if received by 3pm) E2 <input type="checkbox"/> Same day or weekend emergency if received by 10am - contact ALS for surcharge. Specify Date Required for E2,E or P:				
Invoice To: Same as Report To <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Copy of Invoice with Report <input type="checkbox"/> Yes <input type="checkbox"/> No		Invoice Distribution Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX Email 1 or Fax: Email 2:		Analysis Request Indicate Filtered (F), Preserved (P) or Filled and Preserved (F/P) below				
Project Information ALS Quote #: <u>2015-8114</u> Job #: <u>2015-8114</u> PO / AFE: LSD:		Oil and Gas Required Fields (client use) Approver ID: GL Account: Activity Code: Location: ALS Contact: Sampler:		Total Coliforms Colour + turbidity UV Transmissivity				
ALS Lab Work Order # (lab use only)	ALS Sample # (lab use only)		Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mm-yy)	Time (hh:mm)	Sample Type	Number of Containers	
	WPID 40352		ONE 27	5:40pm	WATER	X X X		
Drinking Water (DW) Samples¹ (client use) Are samples taken from a Regulated DW System? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Are samples for human drinking water use? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Special Instructions / Specify Criteria to add on report (client use) *Detection limit on total coliforms + E.coli not meet 1 count/100mL		SAMPLE CONDITION AS RECEIVED (lab use only) Frozen <input type="checkbox"/> SIF Observations Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Ice packs Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Custody seal intact Yes <input type="checkbox"/> No <input type="checkbox"/> Cooling Initiated <input checked="" type="checkbox"/> INITIAL COOLER TEMPERATURES °C: <u>12</u> FINAL COOLER TEMPERATURES °C:				
SHIPMENT RELEASE (client use) Released by: <u>[Signature]</u> Date: <u>ONE 27</u> Time: <u>8:23</u>		INITIAL SHIPMENT RECEPTION (lab use only) Received by: <u>[Signature]</u> Date: <u>ONE 28</u> Time: <u>12:00</u>		FINAL SHIPMENT RECEPTION (lab use only) Received by: <u>[Signature]</u> Date: Time:				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

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ALS-FAA052a v04 Form 04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.
 1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.



3851B - 21 Street NE • Calgary, Alberta, Canada • T2E 6T5

Phone: (403) 250-9164 • Fax: (403) 291-4597 • www.wshlabs.com

Barry Palumbo

Phone: 250-344-8288 Lab Number: 78744
 Email: barrypalumbo@gmail.com
 Email: shellybott@yahoo.ca PO Number:

Sample Info: Akremzede
 LS2 - Sec 35 - TWP 25 - RGE 21 - W5
 P1 66313 & 7477
 Well # 40252/110330

Sampled By: BP
Date Sampled: 12/13/2015
Date Received: 12/15/2015
Date Reported: 12/17/2015

Analyte	Units	Result	Canadian Drinking Water Guideline Maximum
Calcium	mg/L	56.9	No Guideline
Iron	mg/L	0.09	0.3
Magnesium	mg/L	27.9	No Guideline
Manganese	mg/L	<0.01	0.05
Potassium	mg/L	3.7	No Guideline
Sodium	mg/L	114	200
Bicarbonates	mg/L	452	No Guideline
Bromides	mg/L	2.6	No Guideline
Carbonates	mg/L	0	No Guideline
Chlorides	mg/L	30.1	250
Fluorides	mg/L	0.32	1.5
Nitrates as N	mg/L	0.1	10
Nitrites as N	mg/L	<0.02	1
NO ₃ + NO ₂ as N	mg/L	0.1	No Guideline
Sulfates	mg/L	67	500

Parameter	Units	Result	Canadian Drinking Water Guideline Maximum
Electrical Conductivity	µS/cm	864	No Guideline
pH	pH	7.88	6.5 - 8.5
Hardness (as CaCO ₃)	mg/L	257	No Guideline
Total Alkalinity (as CaCO ₃)	mg/L	371	No Guideline
P-Alkalinity (as CaCO ₃)	mg/L	0	No Guideline
Hydroxide (as CaCO ₃)	mg/L	0	No Guideline
Total Dissolved Solids (calculated)	mg/L	523	500

Microbiology	Units	Result	Canadian Drinking Water Guideline Maximum
Total Coliform	CFU/100 mL	1	Zero / Absent
Escherichia Coliform	CFU/100 mL	0	Zero / Absent

Sum of Cations	10.18	TDS / EC Ratio	0.61
Sum of Anions	9.69	Sodium Adsorption Ratio	3.09
Ion Balance	1.05	Saturation Index	0.73