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Technical Memorandum

DATE: May 1, 2013

TO: Andrew Sinclair, 0915294 BC Ltd.
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CC: Wayne Wong, M.A.Sc., P.Eng., PMP

FROM: Mark Burger, M.A.Sc., P.Eng.

RE: **BULLOCK LAKE COTTAGES**
Development Water Demands and Sustainable Well Yield
Our File 2963.007-300

1. Introduction and Background

This technical memorandum has been prepared to summarize drinking water demands for the initial phase of Bullock Lake Cottages at 315 Robinson Road, Salt Spring Island (the Property). This report also contains details of the sustainable well yield for the existing production wells that service the distribution system for the Property.

The initial phase of development at the Property (Phase 1) includes 50 existing cottages and a multi-purpose amenity building.

The water system servicing the Property has already been constructed and includes:

- 2 production wells;
- manganese removal treatment;
- UV disinfection;
- chlorination; and
- a 332 m^3 treated water storage reservoir.

There is a distribution system already constructed to deliver water to all Phase 1 cottages and the future amenity building.

This report demonstrates that there is sufficient capacity through the combined use of both production wells to provide water to meet Phase 1 development requirements. Additional analysis will be completed for future phases of development based on actual water use, occupancy patterns, and sanitary capacity observed as the cottages at the Property become occupied.

2. Projected Water Demands

2.1 Population

It is anticipated that the cottages will be used as non-permanent secondary residences by the cottage owners. Nevertheless, a peak population has been estimated for the project for water system design purposes. The projected population per cottage is estimated at 2.5, which is higher than the average household population (2.1 per household) on Salt Spring Island as of the 2011 Census. The cottage units are relatively small in floor space (140 m^2 (1,500 ft^3) or less) and will have 2 bedrooms. Therefore a per-cottage average population of 2.5 was selected. For the months of July and August, a higher per-cottage population of 3 was selected to reflect anticipated higher usage of the cottages during the summer. A summary of the projected population for Phase 1 is shown in Table 1.

Table 1. Phase 1 Projected Population

Development Phase	Residential Unit Type	Number of Units	Persons Per Unit	Projected Peak Seasonal Population
Phase 1	Cottages	50	2.5-3	125-150

In addition to the proposed cottages, a multi-purpose amenity building with meeting/banquet facilities will also be constructed during Phase 1. The projected maximum capacity for meetings and banquets is 150 people. There will be no other residential or commercial/institutional water use in Phase 1.

2.2 Water Demand Calculation Overview

The framework used to calculate the water demands at the Property is modified from the method proposed in the *British Columbia Design Guidelines for Rural Residential Community Water Systems.* In that method, the projected water demand is the sum of:

- Indoor water use (in this case, from the cottages and the amenity building);
- Water loss allowance (leakage); and
- Irrigation demand.

Allowances for all these uses have been made in the water demand projection and are further explained in Section 2.3.

Maximum Day Demands for Phase 1 of Bullock Lake Cottages have been detailed in Table 4 appended to this technical memorandum. For water storage calculations (discussed later in the report), it was assumed that 6 days of maximum day demand would occur every year to reflect potential occupancy patterns during the summer long weekends. However, most days of the year, the Bullock Lake Cottages development is expected to have lower water demands due to lower occupancy. The cottages will be used as secondary residences only, and/or may be included in an optional rental pool. Occupancy projections for each month of the year were estimated based on occupancy rates at other comparable properties in coastal British Columbia.

These occupancy projections and their effect on the overall water demand projections are summarized in Table 5 appended to this technical memorandum.

The following sections discuss how the water demands were estimated using a combination of accepted standard values and evidence-based modified values relevant to the Property.

2.3 Indoor Water Use

2.3.1 Overview

The *British Columbia Design Guidelines for Rural Residential Community Water Systems* suggest using 230 L/capita/day to estimate residential demands in small water systems. This figure reflects an “average” water system that may include older homes that contain older, less efficient water fixtures.

Since the water system servicing the Bullock Lake Cottages consists entirely of newer cottages, the residential per capita demands suggested by the BC Rural Design Guidelines are overly conservative given that the cottages will not be used as primary residences. Additionally, the modern water conserving fixtures found in the existing cottages should result in lower water demands compared to an older residential home. The following sections provide a revised water demand scenario based on implementation of a water conservation approach at the Property.

2.3.2 Water Demands in Other Areas

Water use and water demands for other jurisdictions are presented as follows. Of significant interest is the report “Analysis of Water Use in New Single Family Homes – 2011” by Aquacraft Inc. Water Engineering and Management. Aquacraft is the leading North American consultant on water use and efficiency, which provides a very rigorous analysis for the USEPA of water demands in older (pre-1995) homes, "standard" newer (post-2001) homes that use fixtures that met code when constructed, and new homes with high-efficiency fixtures and appliances.

The per capita water consumption benchmarks for standard newer homes (post- 2001) and high efficiency homes are quoted as 176 L/capita/day and 139 L/capita/day, respectively. Fixtures that contribute the most towards improving water use efficiency are low flow shower heads and high efficiency clothes washers.

(Ref.: http://www.aquacraft.com/sites/default/files/pub/DeOreo-%282011%29-Analysis-of-Water-Use-in-New-Single-Family-Homes.pdf).

Cedar Lane, Salt Spring Island

The Cedar Lane Water System on Salt Spring Island services a residential community and used approximately 120 m^3/year per connection in 2010 (Cedar Lane Water Service Report, November 28, 2011). Assuming that Cedar Lane’s population per household is the same as the Salt Spring Island average of 2.1 people per household (2011 Census), the average daily water consumption per resident is 157 L/capita/day.

2.3.3 Water Conservation

High efficiency fixtures are currently installed throughout the cottages including WaterSense™ fixtures for faucets, toilets, and showers. The owners have indicated that high efficiency clothes washing machines will be installed prior to occupancy. There will be no dishwashers in any of the cottages.

The water conservation measures implemented at the Property will help achieve lower household water demands compared with an “average” neighbourhood. The indoor water demands for the Property are projected to be more in line with the demands observed in neighbourhoods such as Cedar Lane and closer to benchmark values for newer and high efficiency homes.

The operators of the system have stated they will consider installing water meters, which will encourage home owners to conserve water and detect leaks more quickly. The operators also intend to use reclaimed water for toilet flushing in the amenity building and other newly constructed uses at the Property (e.g. common area irrigation), which will also reduce overall water demands.

2.3.4 Indoor Water Use Summary

Based on the evidence provided in nearby communities and from the water use from commonly available water saving products available on the market, the indoor per capita demands at the cottages are projected to be below the level suggested in the BC Rural Design Guidelines. The indoor per capita water demand projection has been broken down by type of use and shown in Table 2.

Table 2. Residential Indoor Water Demand Breakdown

Usage Component	Total Demand With Water Conservation Fixtures (L/capita/day)
Toilets[1]	30.3
Clothes Washer[2]	25.7
Showers[1]	25
Faucets[1]	41.3
Other Indoor Use	6.4
Baths	4.5
Dish Washing	3.8
Cottage Leaks[3]	18
Total Indoor Use	**155**

Notes:

1. Use of WaterSense fixtures is assumed. US EPA http://www.epa.gov/watersense/about_us/index.html.
2. CEE Tier 3 washing machine.
3. Assumes regular maintenance of house leaks. Source: Ben Dziegielewski and Jack C. Kiefer, Water Conservation Metrics Guidance Report, January 2010.

Therefore a per capita indoor water demand of 155 L/capita/day has been calculated based on the expected characteristics of the cottages at the Property.

As stated previously, the owners will consider the use of reclaimed water for toilet flushing in the amenity building, which will reduce water demands. A demand of 30 L/guest for banquet meal preparation was used to project water demands from the amenity building.

2.4 Leakage

2.4.1 Observed Leakage Rates

During the well pump testing period between October 2012 and March 2013, it was possible to measure leakage in the water distribution system based on the pump cycles that occurred during the periods between pump tests Some reservoir drawdowns occurred that caused the pumps to automatically turn on at certain times.

Based on these observations, current leakage in the system is estimated at approximately 0.6-0.8 m^3/day.

2.4.2 Standard Leakage Rate Calculations

It is widely recognized that leakage increases in a distribution system as it ages. For these reasons, standard leakage estimates project leakage rates that are typical of older distribution systems. This is reflected in the BC Rural Design guidelines. They recommend the use of a formula that calculates "unavoidable system losses" and then multiplies that number by a factor of 5 (called an Infrastructure Leakage Allowance or ILI number) to account for the other water losses experienced in older and poorly maintained systems.

If this formula were used to estimate leakage rates at the Property, it would estimate leakage rates that are higher than what would realistically be expected for this distribution system. Since the system servicing the Property is relatively small and much newer than an average water distribution system in British Columbia, the use of the leakage formula is considered to be excessive in this case. This is substantiated by the leakage rates actually observed in the system.

However, the leakage formula indicates what could happen if leakage is left unchecked and unmonitored in any distribution system. A program of flow monitoring and regular maintenance of the water system at the Property is recommended to help minimize leakage water demands.

2.4.3 Leakage Projections for the Property

For this report, a leakage rate of 0.8 m^3/day has been used to project the leakage component of total water demands at the Property.

It is recognized that leakage rates may increase as the distribution system ages and that this may impact the water system in the long term. However, monitoring and regular maintenance of the system should help the system operators to identify and fix potential leakage problems in their infancy before they create large demands on the system.

2.5 Irrigation Allowance

Allowances for irrigation have been made in the water demand calculation. Although it is often suggested that a "no irrigation" policy can be implemented as part of a water conservation program, the reality is that some irrigation will take place no matter what cottage owners are told. In this water demand calculation, an allowance has been made for cottage owners to irrigate an area of 5 m^2 on each cottage deck throughout the summer growing season. Strata restrictions will be put in place preventing cottage owners from planting in common areas. Additionally, the existing vegetation in the common areas consists of native and hardy materials that do not require additional irrigation.

The irrigation rate was calculated based on the watering required to replace the average evapotranspiration in Metro Vancouver during the growing season. Since the cottages will either be occupied part-time or put into a rental pool, it is not expected that each unit will irrigate 5 m^2 of area. Therefore the irrigation allowance in this demand calculation is a conservative projection of the irrigation that will actually take place at the Property. To reflect seasonal occupancy changes, the full irrigation demand was multiplied by the occupancy factor for the months during which irrigation is expected to occur (May-October).

2.6 Water Demand Calculation Summary

The evidence and discussion presented in the previous sections has been brought together to project overall water demands for Phase 1 of development at the Property and is shown in Table 3.

Table 3. Daily Water Demand Projection Summary

Type of Use	Projected Demand Range (m^3/day)	Average Daily Demand (m^3/day)
Residential Indoor Usage	5 - 23	9
Water Loss Allowance (Leakage)	0.8	0.8
Amenity Building Use	0.4 - 4.5	0.5
Irrigation Contingency Allowance	0 - 1.0	0.3
TOTAL	**6 - 30**	**10.5**

Some of the demand components are presented as a range. This reflects the monthly changes in projected occupancy shown in Table 5 at the end of this report. Regulations will be implemented to prevent the cottages from being used as primary residences, while some cottage owners will choose to become part of a managed rental pool.

The amenity building demand was also projected as a range. Although the amenity building will have a banquet capacity of 150, it is likely that the building will host smaller events most of the time or be used by individual residents. To project amenity building use throughout the year, the maximum day amenity use was multiplied by 2/7 (28%) to reflect that on average, it is expected the building will mainly be used on weekend days. The demand was multiplied again by the residential occupancy rates to reflect the lower demand for amenity building use that is expected to correlate to the fluctuations in residential demand.

3. Well Testing Summary

3.1 Well Testing Procedures, October 2012 to March 2013

Well testing took place from October 2012 to March 2013 under the direction of KWL and Waterline Resources Inc. The testing involved pumping of Wells No.1 or No. 2 at various rates to determine the effect on the aquifer and on neighbouring properties. A level sensor was placed in a neighbour's well to determine the maximum sustainable well yield that would not disrupt flows to neighbouring wells.

A detailed description of the tests can be found in a separate report by Waterline. The results determined that the sustainable yield from the production wells at the Property is 16.1 m^3/day. Pumping rates exceeding 16.1 m^3/day are possible for short periods but some aquifer drawdown would be experienced. A sustained period of higher pumping rates may begin to impact neighbouring wells. Monitoring of groundwater levels and of water demands is recommended as part of a water demand management plan. Additional information is found in Section 6.

3.2 GWUDI Analysis / Hydraulic Connection to Lake

Levels in Bullock Lake were monitored during the pump testing. Drawdowns in Wells No. 1 or No. 2 during testing were not accompanied by corresponding changes in the lake level. Further details are included in Waterline's report, but the general conclusion from the testing is that the production wells for the Property are not under direct influence of surface water from Bullock Lake.

3.3 Well Yield vs. Calculated Demands

On an annual basis, the estimated sustainable yield of the aquifer is sufficient to provide the Property with water, as the average daily demand of 10.5 m^3/d is less than the sustainable yield of 16.1 m^3/d. However, during July and August, the daily demand is expected to exceed the maximum sustainable yield. Additional above-ground water storage is recommended to accommodate seasonal peak demands while maintaining daily pumping from the aquifer below the sustainable yield.

4. Water Storage

A preliminary calculation of the seasonal water supply deficit at the Property determined that 310 m^3 of storage would be required to make up the water supply deficit anticipated during July and August. This number may be revised pending more detailed calculations.

The existing storage reservoir at the Property has a capacity of 332 m^3. Most of this capacity is required for fire flow to the 4-plex townhomes (the largest non-sprinklered buildings at the Property). Based on fire flows previously calculated by Timberlake-Jones Engineering (2007), the volume remaining for balancing storage in the reservoir is about 20 m^3. This number could be revised upwards pending a reassessment of the fire rating of the buildings at the Property or the installation of sprinkler systems in some of the buildings. Nevertheless, based on the existing preliminary calculations, the installation of 290 m^3 of additional above-ground balancing storage is recommended to be constructed at the Property to meet anticipated water supply deficits.

5. Water Quality and Treatment

Wells No. 1 and No. 2 have obtained source water approval from the Vancouver Island Health Authority to be used for the water system at the Property. An operating permit application has also been submitted to VIHA and is under evaluation at the time of publication.

Water treatment equipment is already installed and consists of the following:

- Manganese removal treatment;
- Ultraviolet (UV) disinfection; and
- Sodium hypochlorite disinfection.

Water quality data was provided to KWL which showed that the source water parameters of concern are microbiological parameters (which are a default concern in all water systems), and manganese. Based on the information provided to KWL regarding water quality and treatment, the treatment equipment installed is appropriate for treating the water source at the Property.

6. Proposed Management Plan

6.1 Water Supply & Storage - Discussion

As stated in Section 4, the construction of additional above-ground reservoir capacity is recommended to meet seasonal water demands for the Property without impacting the water supply wells of neighbouring properties.

However, it is also noted in Section 3 that it is possible to access water in the aquifer at rates exceeding the sustainable well yield in temporary situations such as emergencies.

The sustainable yield stated in this report is a conservative estimate of a well yield that will produce no impacts to neighbouring properties, and not an absolute indicator of how much water is available under all circumstances.

Construction of additional above-ground storage is recommended as a strategy to meet seasonal demands without pumping from the wells in excess of the sustainable yield of 16.1 m^3. Based on the projected water demands and information available at this time, the construction of one additional water storage reservoir with approximately the same capacity as the existing one (332 m^3) is recommended.

6.2 Water Supply Management Plan

Assumptions have been made in this report and the attached Waterline Report (Appendix A) based on information obtained through the 2012-2013 Well Monitoring Program, previous reports by others, and local and regional water consumption information. Should the assumptions change over time, it is recommended that a water supply management plan be implemented to cover these uncertainties. It is also recognized that there will be time to refine water demand and storage requirement projections as the Property becomes occupied over time.

The implementation of a water supply management plan should include (but not be limited to) the following items:

1. Monitor flows throughout the Property's system as it becomes occupied to determine actual water demands and potential leakage.
2. Monitor and record well levels.
3. Construct an additional reservoir for balancing storage of approximately 332 m^3 (same volume as existing reservoir, but also subject to change pending more detailed calculations). Monitor reservoir levels.
4. Continue to monitor reservoir levels and daily flows to develop a demand curve based on actual water use data. This data should be compared with occupancy data (e.g. unit purchase dates, move-in dates, numbers of units in rental pool) to determine per capita rates for the Property. Flow monitoring will also help manage leakage in the distribution system.
5. If water levels in the reservoir fall to emergency storage levels, the system operator should follow an operation plan that should include the following:
   a. water use conservation measures;

b. leak repairs; and/or

c. construction of additional water storage infrastructure.

The items presented above are the recommended preliminary framework for a water supply management plan, and may be refined pending further discussions.

7. Closure

7.1 Conclusions & Recommendations

Based on the scope and findings of this report, the following conclusions and recommendations are presented:

1. Daily water demands for the Property are projected to range between 6 m^3/day and a peak of 30 m^3/day, with a projected average daily demand of 10.5 m3/day.
2. The sustainable yield of the production wells is 16.1 m^3/day.
3. Well testing results suggest that the production wells for the Property are not hydraulically connected to Bullock Lake.
4. Based on the existing data and water demand projections, the aquifer should have sufficient capacity on an annual basis to meet the water demands of the Property without impacting neighbouring wells. Water demands in July and August, however, are expected to exceed the sustainable well yield, but this can be managed through the implementation of a water supply management plan.
5. The installation of one additional water storage reservoir is recommended to allow the Property to store water in low demand periods for use during high demand periods.
6. The implementation of a water supply management plan will allow the operators of the system to monitor actual demands and respond as necessary in a phased approach.

7.2 Report Submission

If you have any questions regarding this technical memorandum, please contact the undersigned.

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Revision History

Revision #	Date	Status	Revision	Author
0	April 16, 2013	Draft	N/A	MB
1	April 29, 2013	Draft Final	Revised for final.	MB
2	May 1, 2013	Final	Finalized, signed, & submitted.	MB

Scenario Details: Maximum Day Demand (Full Occupancy, Full Amenity Building Use)

Summary of Available Water Capacity					**Reference**
Well 1 or Well 2	0.19	L/s	16,100	L/d	
Total	0.19	L/s	16,100	L/d	

Water Demand Calculation

$$MDD = Indoor\ Usage + Water\ Loss\ Allowance + Irrigation + Amenity\ Building\ Water\ Use$$

Note: Adapted From Design Guidelines for Rural Residential Community Water Systems (2012).

					Reference
Indoor Usage					
Number of Cottages	50				
Population per Cottage	3	people			Assumed maximum day occupancy based on similar resort properties in BC.
Population Serviced by System	150				
Occupancy	100%				
Per Capita Water Demand	155	L/p/d	465	L/d/unit	Design Guidelines for Rural Residential Community Water Systems (2012)
Indoor Usage Subtotal	23.3	m^3/d	23,250	L/d	
Water Loss Allowance (Leakage)					
Water Loss Subtotal	0.8	m^3/d	800	L/d	Based on leakage observed in distribution system.
Amenity Building Water Use					
Number of banquet guests	150				Assume 20 ft^2 per person for a 3,000 ft^2 banquet room.
Water used per meal served	30	L			Tchobanoglous and Schroeder (1987)
Toilet water used per guest	0	L			Assumption - recycled water used
% Occupancy	100%				
Amenity Building Water Use Subtotal	4.5	m^3/d	4,500	L/d	
Irrigation Contingency Allowance					
Number of Cottages	50				
Area Per Cottage to be Irrigated	5	m^2			Allowance for planters on deck.
Total Area to be Irrigated	250	m^2	0.025	ha	
Peak Daily Evapotranspiration Rate	4	mm/d			Metro Vancouver pan evaporation rate for July is 124 mm.
Irrigation Rate (using potable water)	40	m^3/ha /d			
Gardening Participation Rate (Occupancy)	100%				
Irrigation Contingency Allowance Subtotal	1.0	m^3/d	1000	L/d	
Maximum Day Projected Demand	**29.6**	**m^3/d**	0.34	L/s	

Bullock Lake Cottages
Water Demand Calculation
Table 5. Projected Monthly Water Demand Patterns

0915294 BC Ltd.
April 2013

Month	Occupancy	Occupant Load (occupants per cottage)	Daily Indoor Water Use (m^3/d)	Leakage (m^3/d)	Amenity Building Use (m^3/d)	Irrigation Allowance (m^3/d)	Total Projected Demand (m^3/d)
January	25%	2.5	4.8	0.8	0.32	0	**6.0**
February	30%	2.5	5.8	0.8	0.38	0	**7.0**
March	30%	2.5	5.8	0.8	0.38	0	**7.0**
April	35%	2.5	6.8	0.8	0.44	0	**8.0**
May	45%	2.5	8.7	0.8	0.57	0.45	**10.5**
June	50%	2.5	9.7	0.8	0.63	0.5	**11.6**
July	75%	3.0	17.4	0.8	0.95	0.75	**19.9**
August	75%	3.0	17.4	0.8	0.95	0.75	**19.9**
September	50%	2.5	9.7	0.8	0.63	0.5	**11.6**
October	40%	2.5	7.8	0.8	0.50	0.4	**9.5**
November	30%	2.5	5.8	0.8	0.38	0	**7.0**
December	30%	2.5	5.8	0.8	0.38	0	**7.0**
Average Over Year	**43%**	**2.6**	**8.8**	**0.8**	**0.54**	**0.28**	**10.5**