

# Well Assessment and Asset Evaluation: City of Merritt, B.C.

*Prepared for:*

**The City of Merritt**  
**2185 Voght Street**  
**PO Box 189**  
**Merritt, B.C. V1K 1B8**



*Prepared by:*

**Western Water Associates Ltd.**  
**#106-5145 26<sup>th</sup> Street**  
**Vernon, B.C. V1T 8G4**

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December 31, 2012

City of Merritt  
Public Works Department  
2185 Voght St  
Merritt, B.C. V1K 1B8

Attn.: Shawn Boven, AScT, Public Works Manager

**Re: Well Asset Evaluation, City of Merritt Groundwater Supplies**

Western Water Associates Ltd. (WWAL) is pleased to provide this report assessing the status and relative asset value of the City's groundwater supply production wells. At the end of the report we provide recommendations for your consideration in planning for maintenance and improvement of the City's groundwater supplies.

We trust that the professional opinions and advice presented in this document are sufficient for your current requirements. Should you have any questions, or if we can be of further assistance in this matter, please contact the undersigned.

**WESTERN WATER ASSOCIATES LTD.**



**Ryan Rhodes, P.Geo., P. Geol**  
**Hydrogeologist**



**Douglas Geller, M.Sc., P.Geo.**  
**Senior Hydrogeologist**

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## **1. INTRODUCTION AND GENERAL APPROACH**

At the request of the City of Merritt, Western Water Associates Ltd. (WWAL) has completed an assessment of all of the City of Merritt operational groundwater wells. This assessment which was based primarily on a review of existing information, focused on assessing the current efficiency (specific capacity) of each well compared various times in the past when the well had been subjected to controlled testing. In doing this, we have compiled and reviewed all available information for the City's wells, and present a summary of pertinent information for each well. The approach used was in general keeping with WWAL's June 2011 proposal to the City of Merritt.

In addition to assessing specific capacity, we have also reviewed well construction data, groundwater quality data and operational data, and use this data to objectively rank each of the City's well assets. This ranking, completed using Multiple Criteria Analysis (MCA), can be used to prioritize wells for maintenance and replacement, and along with the City's Master Water Plan, is a guide for management and long-term planning for water infrastructure.

In addition to reviewing reports prepared by various consultants for the City of Merritt, we also reviewed several reports prepared for ongoing water management studies in the Nicola Basin, including those prepared for the Water Use Management plan (WUMP) and studies by the Ministry of Environment on surface water and groundwater interaction.

At the end of this report, we present several recommendations outlining short-term and longer-term activities Merritt can consider to maintain well assets, prepare for asset replacement, and proactively address forthcoming requirements of Interior Health (IH) and other agencies.

## **2. PREVIOUS STUDIES AND HYDROGEOLOGIC SETTING**

The Merritt area and Nicola Valley has been fairly extensively studied over the last few decades, with efforts increasing in recent years to understand the valley's water supply. Reports have been commissioned by the City of Merritt, local First Nations, the Nicola Community Roundtable, and the Province of B.C. WWAL reviewed over 20 reports prepared for the City, Improvement Districts and private landowners in the area. References for these reports, organized by subject (e.g. a particular well) are provided in the references section near the end of this report.

The Merritt Aquifer is mapped and classified by the B.C. Ministry of Environment as Aquifer 074IIA, and characterized as having a high demand, high productivity and high vulnerability to contamination (MOE 2012). The aquifer is assigned a ranking of 16 using the B.C. Aquifer Classification system (Kreye et al. 1994). Higher values indicate a higher risk, and the Merritt aquifer is considered the fourth most vulnerable of the 153 aquifers in B.C. characterized by the MOE.

Recent drilling for the deep aquifer exploration program and the Kengard production well confirmed the presence of deeper aquifers underlying portions of Aquifer 074. The surficial Merritt Aquifer 074 is considered to be unconfined, and over much of its aerial extent, relatively shallow (<15 m). Well logs indicate that there is a deeper trough in this aquifer created through erosion by a paleo-river and subsequent infilling. Merritt's most productive wells (Voght Park GE and VFD, Collettville and Fairley Park) are completed in this trough, which is up to 50 m (165 ft) deep. This trough is relatively narrow in the vicinity of Voght Park, and its lateral extent to the



east and west is not well-constrained. A review of pumping test data for wells completed in the trough indicates that the aquifer responds as a leaky-confined system. Logs for wells in the trough do not indicate thick, low permeability layers were encountered during drilling, but thin clay layers or “silty” layers are reported on these logs and could produce this leaky-confined response.

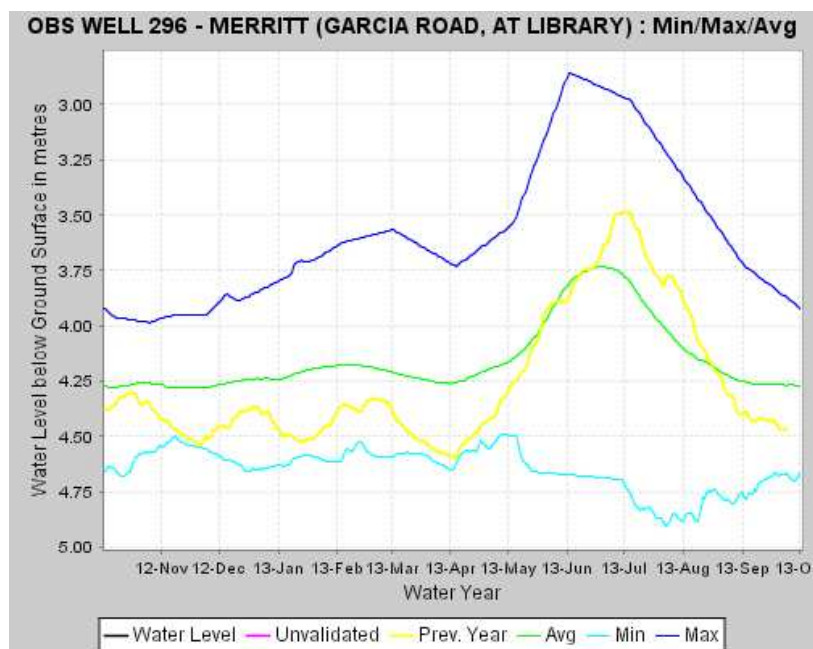
Drilling in support of the Kengard Well project indicated multiple deeper, confined aquifer systems. The Kengard Well is completed in the middle zone of three deeper aquifers, while the nearby River Ranch irrigation well is completed in the deepest aquifer. **Figure 2.1** shows the locations of the City production wells.

**Figure 2.1 General location of Merritt municipal production wells**

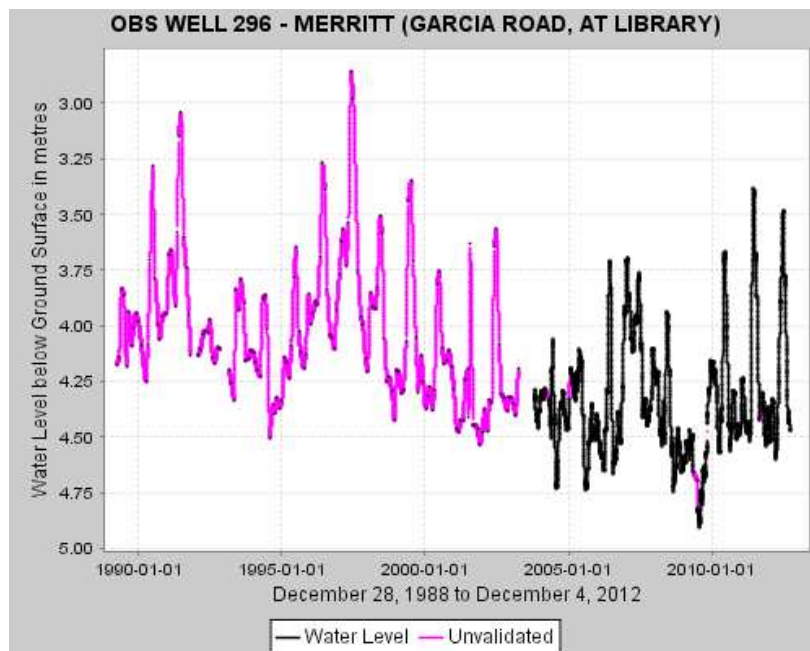


The Ministry of Environment maintains one monitoring well in Aquifer 074, which has been collecting data since 1989. **Figure 2.2** illustrates summary water level responses in the well and the long term hydrograph is provided in **Figure 2.3**. On average there is a 0.5 m rise in groundwater levels that corresponds with higher river levels in May through August. The long-term trend in water levels would suggest an overall declining trend in minimum water levels between 1988 and 2005, after which water levels appear to stabilize.

**Figure 2.2 Summary hydrograph for Observation Well 296**



**Figure 2.3 Long-term hydrograph for Observation Well 296**



A significant amount of work has gone into characterizing and attempting to quantify surface water and groundwater interaction between the Nicola and Coldwater Rivers and the Merritt aquifer system (BCGW 2007, Water Management Consultants 2008 and BC MoE 2009). When boiled down, the data suggest that all of the Merritt aquifer systems receive the majority of their recharge from surface water sources. Comparison of temperature and water level data in groundwater wells and the rivers make a strong case for a direct hydraulic connection between surface water and groundwater for all Merritt wells except Kengard, where the connection is likely less direct.

### 3. MERRITT WATER SYSTEM OPERATION

Details on the City of Merritt water system are presented in annual reports prepared each year by the Public Works Department. Merritt is completely reliant on groundwater and has five wells currently in use. A sixth well (the May Street well) was a part of the municipal water system until 2007 after which it has not been used. Selected construction and operational details for these wells are presented in **Table 3.1**.

**Table 3.1 City of Merritt Well Construction Summary**

Well Name	Date Drilled	Diameter (in)	Total Depth (m)	Screen Interval (m)	Operational Yield	WPN
Voght Park GE	Jul-71	16	29.9	20.7-29.9	83 L/s (1300 US gpm)	12729
Voght Park VFD	Sep-76	16	34.1	24.6 - 34.1	106 L/s (1680 US gpm)	12728
Colletville	Jul-78	10	45.1	37.6 - 45.1	56 L/s (890 US gpm)	12727
Fairley Park	Jan-66	12	25.3	19.2 - 25.3	76 L/s (1200 US gpm)	12730
Kengard	Oct - 07	20	139	120-139	50 L/s (800 US gpm)	97218

Notes: Operational yields presented from 2011 Annual Water System Report. The Kengard well has a higher rated capacity (100+ L/s). WPN = Well Plate Number.

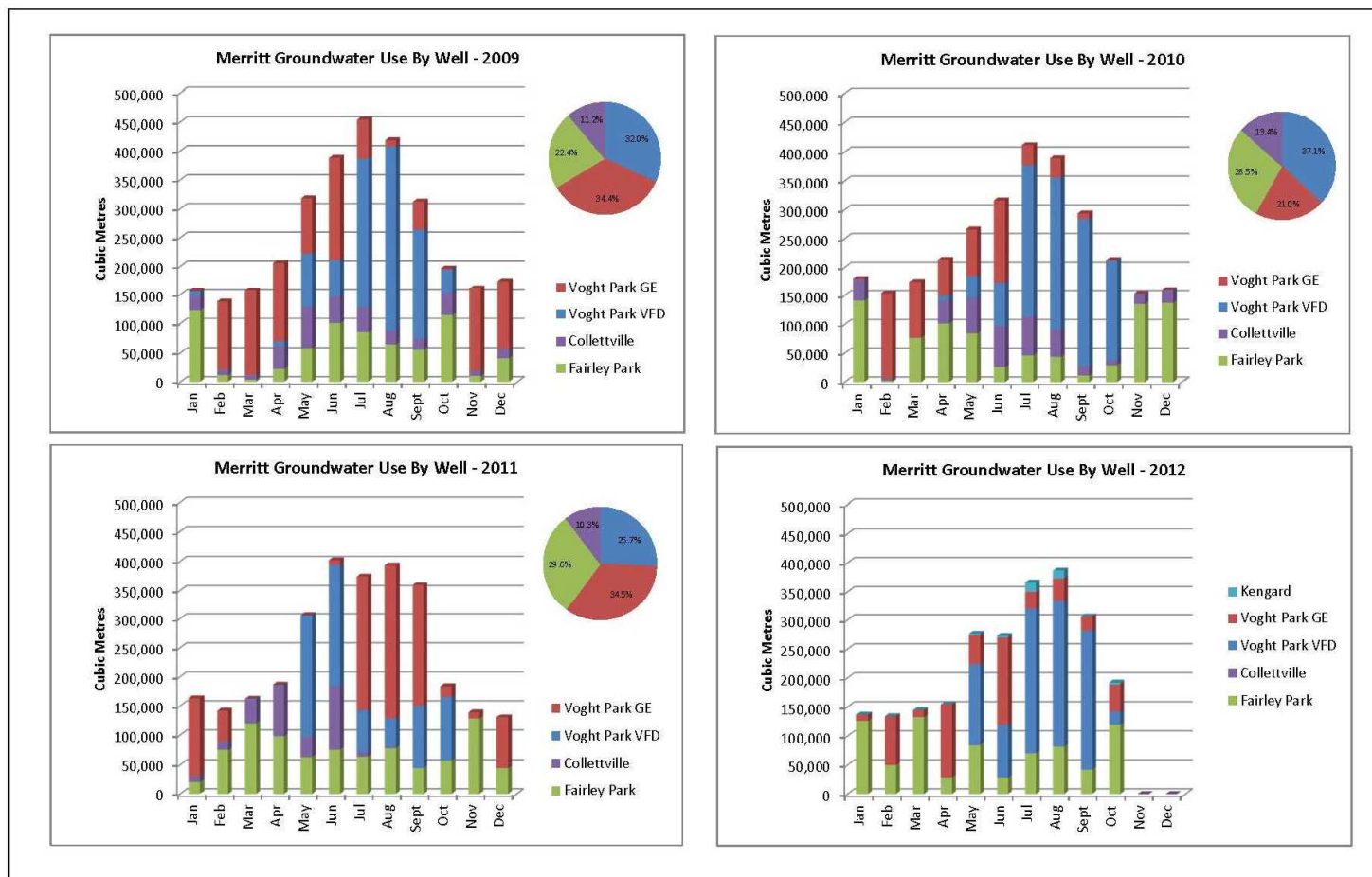
The capacity of these wells vary, and the use of the wells is also adjusted depending on seasonal demand. **Figure 3.1** illustrates water use in Merritt by well for the period of 2009 to 2012. Some key observations from this review include:

- The two Voght Park wells combined provide approximately 2/3 of the City's annual water. Between May and September, one of these wells appears to serve as the primary duty well, and provides the bulk of Merritt's water.
- The Fairley Park well is consistently used throughout the year and provides a large percentage of the City's water during the low demand season.
- At 10-inches in diameter, the Colletville well is undersized relative to the other wells and the productivity of the local aquifer.

The total combined capacity of City's production wells based on the 2011 Annual Report is 371 L/s (5,900 US gpm). The peak daily water consumption in 2011, which occurred on July 5, was equivalent to 222 L/s. This would indicate that there is sufficient source capacity available to the water system to meet demands providing there are no distribution system constraints.

The operation of the water system is such that water is distributed to connections as the City's reservoirs are being filled. Water treatment in Merritt consists of injecting a 12% sodium hypochlorite solution into the distribution system near each wellhead. The addition of chlorine in this manner provides some level of disinfection and maintains a chlorine residual in the lines to prevent the regrowth of bacteria, but does not meet the criteria of primary disinfection with contact time system-wide.

**Figure 3.1 Merritt Water Production By Well**



#### 4. ASSESSMENT OF INDIVIDUAL WELLS

The following sections provide a discussion on the status of each of the municipal supply wells. This assessment draws on the historical reports reviewed, and is augmented by recent data collected during our site visit and up to date operational information provided by Public Works Department staff.

##### 4.1 Voght Park VFD

The Voght Park VFD well (also referred to as Voght Park #2) was drilled in 1976 and at that time subjected to a series of pumping tests (Livingston and Associates 1976). Some redevelopment works were completed on the



well in 1990 (PHC 1990) and pumping tests were also completed at that time. No other rehabilitation works have reportedly been completed on the well.

In December 2012, Ryan Rhodes of WWAL with the aid of Public Works staff completed a brief drawdown test on the well using the existing turbine pump. Operational data from the SCADA system were also reviewed. There is some confusion over the units being reported on the LCD screen in the pumphouse (which appears to report feet of water above the sensor) and those being reports on the SCADA (which reads %). A review of the water level data, pump installation forms on record from Mearl's Machine Works Ltd. (Mearl's) and a static level measurement made on December 7 indicates that data on the LCD screen in the pumphouse fairly accurately reads feet of water above the sensor, which is located at 82.4 ft below the underside of the motor head (see Mearl's installation record of April 2010). A comparison of the LCD data and SCADA data for the period of the brief test on December 7 indicated both numbers were the same (even though the units reported are different). Therefore, for at least this well, data being collected appear to be in feet of water above the sensor.

**Table 4.1 Summary of specific capacity data for the Voght Park VFD well.**

Date	Duration	Discharge		Drawdown		Specific Capacity	
		L/s	US gpm	m	ft	L/s/m	US gpm/ft
Sep-76	0-265	123.8	1962	6.93	22.73	17.68	86.30
Jan-90	0-20	104.2	1651	12.71	41.69	8.20	39.60
	20-40	107.7	1707	13.41	44.00	8.03	38.80
	40-100	115.4	1829	14.02	45.97	8.23	39.79
Mar-90	0-25	49.0	775	2.27	7.44	21.61	104.17
	0-25	90.0	1440	5.06	16.60	17.79	86.75
	25-45	118.3	1875	7.47	24.51	15.83	76.50
	15-60	128.1	2030	8.47	27.77	15.13	73.10
08/23/2012	typical operation	106.00	1683	10.29	38.90	10.30	43.26
12/07/12	0-15	89.0	1412	9.65	36.48	9.22	38.71

Notes:

- 1) September 1976 is post-construction test.
- 2) January 1990 is pre-rehabilitation assessment testing.
- 3) March 1990 is post-rehabilitation testing

Review of the available specific capacity data indicates that the well has experienced a substantial decline in specific capacity since it was constructed, but that specific capacity is still fairly high, in the typical range for economical large diameter supply wells. The best comparison from Table 4.1 is the 90 L/sec data from March 1990 and the December 2012 data; on the basis of these limited data, it appears current specific capacity is a little less than one-half of the 1990 value, which was derived following some well redevelopment and rehabilitation. It appears that the 1990 rehabilitation works were successful at restoring most of the well's original specific capacity, so there is a good potential that the specific capacity of the well could be increased with future redevelopment.

## 4.2 Voght Park GE

The Voght Park GE (Gas-Electric) well was the first well completed in Voght Park, drilled in 1971 (also referred to as Voght Park #1). After drilling, the well was subjected to a round of test pumping, and was tested again in 1976 when the Voght Park VFD well was drilled. The only redevelopment that has been completed on the well occurred in the spring of 1990, but high-rate testing was not completed before or after these works. Pacific Hydrology (1990) reported that when the 1990 rehabilitation work was completed on Voght Park VFD, the work was also performed on the GE well even though it had not exhibited signs of deteriorating well performance.

A brief drawdown test was completed on December 7 while WWAL staff were completing site visits. The intent was to allow the SCADA system to collect water level data which would be collected and processed. Unlike the Voght Park VFD well, the GE well transducer does not appear to be calibrated to provide depth of water data. Mearl's was contacted to enquire as to the programming of probes in Merritt but no concrete answers were provided. A review of the SCADA data and an attempt to reconcile the data with manual water level measurements and the reported depth to the probe on the Mearl's form was unsuccessful, so no meaningful current specific capacity data can be presented. Based on the operating rate and the pump setting depth reported on the Mearl's form, we can assume that the specific capacity of the well must currently be greater than 37 US gpm/ft at 108 L/s.

**Table 4.2 Summary of specific capacity data for the Voght Park GE well.**

Date	Duration	Discharge		Drawdown		Specific Capacity	
		L/s	US gpm	m	ft	L/s/m	US gpm/ft
Jul-71	0-24	31.6	500	2.77	9.08	11.40	55.08
	35-68	64.1	1016	5.87	19.26	10.92	52.76
	38-154	94.7	1500	9.94	32.61	9.52	46.01
	154-1443	104.0	1648	11.88	38.95	8.76	42.32
Sep-76	unknown	55.1	874	4.72	17.86	11.68	48.93
Mar-90	Not tested at high rates after rehabilitation in Spring 1990						

## 4.3 Collettsville

The Collettsville well was completed in 1978 for the former Collettsville Improvement District, under the supervision of Ed Livingston Associates (later Pacific Hydrology Consultants). The well is 10 inches in diameter with 8 inch diameter screens. Of note, the completion report for this well indicates that good material was still being encountered and actually getting better at 148 ft depth when drilling stopped.

The Collettsville well was tested after completion in 1978 (PHC 1978). In 1996, the well was redeveloped under the supervision of AGRA Earth and Environmental (AGRA 1996a and 1996b). The well was subsequently redeveloped in July 2012 (Piteau 2012). As of December 2012, the well had not been put back on line following the summer redevelopment.

Even with a significant decline in specific capacity since construction, the Collettsville well has the highest specific capacity of the existing Merritt Wells. Production from this well is limited only by its diameter. A larger diameter, higher capacity well could very likely be completed at this location.

**Table 4.3 Summary of specific capacity data for the Collettsville well.**

Date	Duration	Discharge		Drawdown		Specific Capacity	
		L/s	US gpm	m	Ft	L/s/m	US gpm/ft
Aug-78	10-250	56.8	901	1.32	4.33	43.0	208.1
Sep-96	0-1440	53.6	850	2.28	7.48	23.5	113.7
Oct-96	well rehabilitated in October 1996, but no post-rehab testing was completed						
27-Jul-12	40-100	25.2	400	5.70	18.70	4.4	21.4
10-Aug-12	0-25	25.2	400	1.50	4.92	16.8	81.2
17-Aug-12	0-25	52.0	824	1.90	6.23	27.4	132.3

#### 4.4 Fairley Park

Relative to the other wells, less information is available for the Fairley Park Well. The construction report for the well, reportedly drilled in 1966, was not available for review. The B.C. Wells database was queried using the plate number attached to the Fairley Park well and the log produced indicates a construction date of 1978, so there may be some confusion in this regard as well.

We reviewed a BCGW Technical Memorandum (2007) concerning a monitoring well drilled at the Fairley Park site. A July 2007 water sample from this monitoring well detected Tetrachloroethene, which is a chlorinated solvent chemical. Although this occurred several years ago, some points of clarification are provided here as incorrect information was provided in the tech memo. We note that BCGW stated on Page 2 of the memo that Tetrachloroethene is not the same compound as Tetrachloroethylene, but according to our chemical reference (Montgomery and Welkom 1989), the two compounds are the same, with another informal name being Perchloroethylene (PERC). PERC was formerly used in septic tank cleaning as well as other industrial uses such as degreasing. Once it dissolves into groundwater, PERC can be persistent even at the low concentration (0.3 ug/L or 0.3 parts-per-billion, ppb) indicated in the monitoring well. BCGW also stated (incorrectly) on Page 2 of the memo that there was no drinking water Guideline concentration for the chemical. The Guideline for Canadian Drinking Water Quality Maximum Acceptable Concentration (MAC) for PERC is 30 ppb, and was established by Health Canada in 1995. Therefore, the detection in the monitoring well was 1/100<sup>th</sup> of the Guideline concentration. To our knowledge, PERC has not been detected in samples from the production well.

The BCGW memo also recommended a well rehabilitation program for the Fairley Park well, but in our review we found no record of this having been completed.

At the time of our field visit on December 7, 2012, the Fairley Park well was not operational because the soft start was being replaced. SCADA data from September 2012 were reviewed and compared to the most recent Mearl's pump installation form in an attempt to determine static and pumping water levels. As with the Voght Park VFD well, the SCADA data for the Fairley Park well appears to fairly accurately present depth of water above the sensor in feet. If this is true, the specific capacity of the well in September 2012, when operating at 875 US gpm was approximately 67 US gpm/ft.

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#### 4.5 Kengard Well

This well is located near the northeastern part of Merritt and is the newest well in the system. The installation and testing of the Kengard well is documented in a series of reports prepared by BC Groundwater Consulting (BCGW). Operational data indicates that the well was operated for the first time and used only sparingly in the summer of 2012. We understand, from a review of the BCGW reports as well as discussions with the water operator that the well produces water of a lower aesthetic quality than the other wells, with the specific issues being elevated manganese resulting in discolored water and hardness. The well is 139 m (460 ft) deep, constructed with 500 mm (20 in) diameter casing and 300 mm (12 in) diameter screens, with the screens placed within the lowermost part of the second deepest aquifer identified during the program by BCGW. The one-day specific capacity of the well when tested in 2008 at 110 L/sec (1,750 US gpm) was in the range of 3.6 L/s/m (17.5 US gpm/ft). However, this low (relative to the shallow wells) specific capacity is offset by the large amount of available drawdown in the deep well.

The Kengard well has a 150 L/sec (2,400 US gpm) capacity rating, which is based partly on the 2008 pumping test results and the theoretical screen transmitting capacity, which is approximately 150 L/sec. However, the well is currently equipped to operate at a rate of 50 L/sec (800 US gpm) on an interim basis while further monitoring of drawdown effects and water quality is performed. Operational pumping and water quality data were not reviewed for the current study. Of particular importance in this regard would be whether or not manganese and hardness levels stabilize, increase, or decrease with continued pumping at 50 L/sec.

#### 5. WATER QUALITY

For this assessment, WWAL completed a brief review of available water quality data for the City of Merritt wells. The review focused on samples collected directly from pumphouses so that raw groundwater quality could be assessed and factors associated with processes in the distribution system (e.g. regrowth of bacteria) could be excluded.

The review included a search of Merritt's WaterTrax™ records for historical bacteriological testing results, as well as the results of comprehensive potability analyses periodically conducted in accordance with IH requirements.

The WaterTrax™ records for the City of Merritt begin in September 2006 and are ongoing. **Table 5.1** below summarizes the results of the bacteriological data, and indicates excellent microbiological water quality from all of the wells. Only one sample from the Kengard well was available in WaterTrax™ and was negative for both total coliforms and *E.Coli*. It is our understanding based on discussions with Merritt water system operators that in the rare event that a bacteriological result was positive, resampling following detection has never confirmed positive bacteriological counts.

**Table 5.1 Summary of Recent Bacteriological Testing**

Well Source	Period	# of Samples	Results
Voght Park GE	Sept 2006 - Dec 2012	181	2 positive Total coliform; no E.Coli
Voght Park VFD	Sept 2006 -Oct 2012	172	No positive Total coliform or E.Coli
Fairley Park	Sept 2006 - Dec 2012	187	1 positive Total coliform; no E.coli
Collettville	Sept 2006 - June 2011	111	No positive Total coliform or E.Coli

Note: each coliform detection counted 1 total coliform/100 mL

From the above Table 5.1 summary, it appears that the Merritt wells comply with the requirements of the B.C. Drinking Water Protection Regulation, Schedule A of which states that for systems sampling more than once per month, 90% of samples have no detectable coliform and no single sample has greater than 10 total coliform per 100 mL. Approximately 99.5% of the samples have been coliform-free, with no detections approaching 10 coliforms/100mL. The GWUDI status of the wells will be discussed in Section 6.

In terms of chemical water quality, water quality from the Merritt wells is also very good. Water quality from the older wells (Voght Park, Fairley and Collettville) is excellent, and consistently meets all health-based Guidelines for Canadian Drinking Water Quality. Exceedences of aesthetic objective guidelines are rare, but are reported for total manganese in some wells.

Raw water from the Kengard well is poorer, being overall more mineralized, which in our experience is typical of deeper (confined aquifer) groundwater wells in the B.C. Interior. Two parameters are found at concentrations exceeding their aesthetic objectives (manganese and total dissolved solids), and water hardness is extremely hard, approximately twice that of the older, shallower wells.

## 6. MULTIPLE CRITERIA ANALYSIS

Multiple Criteria Analysis (MCA) was used to, objectively as possible, rank the asset value, or relative present worth, of each of the wells. MCA is a useful tool for identifying and prioritizing higher value assets for preventative maintenance and servicing, and recognizing assets with lower relative worth which could be forgone or selected for replacement. Application of this technique to the assessment of the City's wells is in general consistent with the Asset Management Policy as adopted by Council (No. 0261/10) in 2010. However, the MCA analysis does not include detailed economic accounting, nor a detailed valuation of natural resources.

The well attributes considered in the analysis fall into three categories: water quality, water quantity and life-cycle management. We identified five factors to apply in this analysis, the first five of which are water quality focused, with the second five being reliability or water quantity focused. The factors assessed include:

1. Preliminary GWUDI status
2. Land use within 300 m of the well
3. Proximity to a major transportation corridor
4. Health-based water quality
5. Aesthetic based water quality
6. Well Yield



- 
7. Proportion of well yield versus total system yield
  8. Age of infrastructure (well)
  9. Frequency of maintenance or rehabilitation
  10. Required upgrades i.e. to meet regulations or current industry standards

An ordinal ranking was assigned to each attribute characteristic, such that a total scoring for all attributes at each well location was determined. The total scores for all wells were then compared and a ranking order, based on highest value asset (with the highest score) to lowest value asset (with the lowest score) was determined.

The results of the MCA assessment for the wells in the City are presented in **Table 6.1**. A summary of the attributes along with the rationale behind the ordinal ranking for each is presented below:

Preliminary GWUDI Rating (Quality) – This attribute accounts for the relative vulnerability of a well as determined by GWUDI analysis. We used the GWUDI/GARP screening tool criteria provided in the Provincial Guidance document to assign values for this parameter. The higher the likelihood of a GWUDI source, the lower the score for this category. We should point out that while the BCGW reports pertaining to the Kengard Well indicate that the well should be considered GWUDI until proven otherwise, the well is likely not GWUDI owing to its depth and completion in a confined aquifer system. It appears that microparticulate analysis (MPA) or modified MPA using a CALA-accredited laboratory has to date not been done on any of the Merritt wells.

Dominant Land Use within 300 m (Quality) – Although capture zones for most of the City of Merritt Wells were developed for groundwater protection planning purposes, WWAL used a simple 300 m radius around each well for assessing land use in the area. Wells with higher-risk activities nearby (industrial/commercial), due to the use of chemicals and generation of waste products, are given a lower ranking. Agriculture and light commercial use was assigned a moderate value, while wells surrounded by residential, park land or undeveloped lands were assigned higher values.

Proximity to Major Transportation Corridor (Quality) – Similar to varying levels of exposure to impact based on land use, the proximity of a well to a transportation corridor increases the risk of impact due to the potential for accidental release of chemicals during transportation. The closer to the major transportation corridors through Merritt, the lower the value assigned. Major Transportation corridors considered were Highway 5, Highway 8 and Voght Street.

Water Quality Health-Based (Quality) – This attribute is related to the level of treatment required to make raw groundwater meet the health-based Guidelines for Canadian Drinking Water Quality and water treatment objectives required by Interior Health. In terms of raw water quality, available data indicate that all parameters with health-based Maximum Allowable Concentrations (MACs) are met for the existing City wells.

While the Interior Health Authority has a policy in place outlining treatment expectations for surface water sources, it does not have a similar policy for groundwater. A policy for groundwater is currently in development and should be released in early 2013. It can be expected that GWUDI sources will require the same level of treatment as surface water sources (4-3-2-1-0 policy). One of the largest uncertainties associated with the

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Merritt System and implications for treatment is uncertainty over whether the wells are considered GWUDI or not. Further discussion of GWUDI is provided in later sections of the report.

Water Quality Aesthetic (Quality) – This attribute is related to the level of treatment required (if any) to address aesthetic concerns with the raw groundwater. Common aesthetic issues with raw groundwater include iron, manganese and hardness. Treatment is not required where parameters exceed their aesthetic objective guidelines, but raw groundwater which does not exceed these parameters is typically preferred by consumers.

Well Yield (Quantity) – A relative value for well yield was assigned to each well, with 50 L/s assigned one point and an additional point assigned for each additional 5 L/s possible. At present, the Kengard well is only pumped at 50 L/s, but is capable of much higher yields. For the MCA analysis, the yield of the well was assumed to be 75 L/s, the threshold beyond which the environmental assessment process is triggered.

Percentage Contribution to Overall Water Use (Quantity) – Percentage contribution to overall water use was calculated by determining the average percentage supplied by each well between 2009 and 2011 (Figure 3.1), and higher values were assigned to the larger contributors.

Age (Life-Cycle / Cost) – Like any other infrastructure, water wells have a finite operational lifespan which can range anywhere from 20 to 40 years. The lifespan is limited by casing and screen deterioration that occurs over time. Well casing and welded joints tend to corrode, primarily due to oxidation which results from cyclic exposure to moisture and oxygen in the so-called splash zone, which is the zone between the pumping and non-pumping water level within the casing. Screen deterioration and degradation of the aquifer within the immediate area of the screen assembly occur due to encrustation of mineral precipitates. In addition, the need for and frequency of well rehabilitation increases with well age and increases the cost of operating that well. The older the well, the lower the value assigned, unless there are specific data indicating a particular well is deteriorating at a lesser rate than other wells. There is a large gap in the age of City's wells, with four of the five wells assessed being more than 30 years old, and only the Kengard well being relatively new.

Frequency of Rehabilitation (Life-Cycle / Cost) – This attribute is somewhat subjective, and values ranging from one to 5 were assigned to each of the wells. Our experience with well rehabilitation has shown that it is seldom possible to completely restore efficiency, and it becomes more difficult to restore efficiency when the length of time between maintenance is longer. The idea behind this criterion is that wells that have been rehabilitated more often are more valuable because the likelihood of the success and effectiveness of redevelopment efforts is greater. The Kengard well was assigned a value of five because it has only been in use for a short time.

Upgrades Required (Life Cycle / Cost) – This attribute is related to any obvious upgrades the wells may require to ensure the safe delivery of drinking water or that may be requested by Interior Health for source protection reasons. To our knowledge, the requirements of the BC Groundwater Protection Regulation (BC GPR) are not retro-active and existing wells are not required to comply, but many of those requirements (surface seals, well caps etc.) are good practices and the BC GPR was used as a guide.

**Table 6.1**  
**Multiple Criteria Analysis of Well Attributes**

11-038-01

No.	Attribute Name	Weighting	Well Location and Value Assigned					Management Issue	Ranking Criteria
			Voght Park GE	Voght Park VFD	Coletville (existing)	Coletville (new)	Fairly Park		
1	Preliminary GWUDI Rating	1	5	5	6	6	7	10	Quality 1 = Definitive GWUDI, 5 = Potentially GWUDI, 10 = Not GWUDI
2	Dominant Land Use Within 300 m	1	7	7	7	7	5	5	Quality 1 = Industrial / Commercial / 5 = Agricultural / Light Commercial, 7 = Residential / Park 10 = Undeveloped
3	Proximity to Major Transportation Corridor	1	10	10	10	10	7	8	Quality 1 = within 50 m, 4= from 50 to 200 m, 7 = from 200 to 400 m, 10 = greater than 400 m
4	Water Quality Health-Based (treatment)	1	10	10	10	10	10	10	Quality 1 = requires treatment for a MAC, 5 = Potentially requires treatment for MAC 10 = Does not require treatment for a MAC
5	Water Quality Aesthetic (treatment)	1	10	10	10	10	10	5	Quality 1 = Unpalatable, 5 = Treatment for Aesthetic Parameters warranted , 10 = No Treatment Required
6	Well Yield	1	8	10	2	7	5	5	Quantity 1 = < 50 L/s, 5 = 75 L/s, 10 = 100+ L/s
7	% Contribution to Overall Water Use (Avg 2009-2011)	1	10	8	4	6	8	2	Quantity relative ranking from 1 = low relative contribution; 10 = Highest single contributor
8	Age (years)	1	1	3	3	10	1	10	Life Cycle / Cost 1 = greater than 40 years, 3 = from 30 to 40 years, 6 = from 20 to 30 years, 9 = less than 20 years
9	Frequency of Rehabilitation	1	2	2	4	4	1	5	Life Cycle / Cost relative ranking 1 to 5
10	Upgrades Required (BCGPR Considerations)	1	9	9	5	10	9	10	Life Cycle / Cost 1 = Major Upgrades required, 5 = Minor Upgrades Required, 10 = No Upgrades
	<b>Total</b>		<b>72</b>	<b>74</b>	<b>61</b>	<b>80</b>	<b>63</b>	<b>70</b>	<b>larger number denotes relatively higher asset worth</b>

## 7. DISCUSSION

Table 6.1 provides the summary results of the Multiple Criteria Analysis. The results of the MCA indicate relative asset values ranging from a low of 61 for the Colletville well to 74 for Voght Park VFD.

**Voght Park:** These wells are high value, with good water quality, but are the oldest wells. Well replacement could be needed within the next 5 to 10 years.

**Fairley Park and Colletville:** These wells are lower value, but still important contributors to the supply. Colletville was successfully redeveloped in 2012. A new larger diameter Colletville well (12 inch or 16 inch) would easily jump from the lowest value well to the highest value well in the MCA. Table 6.1 illustrates this point – see the “Colletville new” ratings. The Colletville well site appears to have sufficient space for an additional (replacement) well.

**Kengard:** The newer deep well ranked as medium value, though it is likely its capital cost was very high. Operational costs were not considered in the analysis, but it is likely that it is also expensive to operate and further capital investment may be needed in order to more fully utilize this source.

The following are some summary points regarding the future use of the Merritt groundwater supplies:

- The 2009 BC MoE study on surface water and groundwater interaction concluded that pumping the City of Merritt shallow wells has a depleting effect (0.07 m<sup>3</sup>/sec) on river flow. We consider these findings to be preliminary and indicative that more information on the location and timing of impacts from pumping on river flow is needed. Should mitigation of surface water effects be required in future, strategic operation of the deep Kengard well could be a strategy to help meet this objective.
- The Kengard well is less susceptible to surface impacts than the shallow wells. However, the natural groundwater quality from the shallow wells is superior to that of the Kengard well.
- A definitive GWUDI status would clarify future disinfection and treatment requirements for all wells. This would take some time to complete and would involve field sampling through at least 3 seasons of pumping and surface water runoff.
- There are at least four options with regard to addressing the aesthetic water quality issues with the Kengard well: 1) treatment 2) limit use to emergencies only 3) no treatment and blend with shallow well sources 4) convert well to an Aquifer Storage and Recovery well and inject higher quality shallow groundwater during periods of low demand to be stored in the deep aquifer for later use when needed.
- The cost and benefits of utilizing the deep aquifer should be compared to the costs and relative risks (e.g. continue dependence on shallow groundwater) of expanding capacity in the shallow aquifer, for example, installation a larger diameter Colletville well.

In regards to proactive well maintenance, a rotating well rehabilitation schedule should be established. Assuming that each year one well is subjected to well and pump maintenance, a systematic program that involves well step testing, camera surveys as needed, and redevelopment as needed would help improve the long term reliability of the groundwater system and reduce the chances of unplanned outages.

## 8. FINDINGS AND RECOMMENDATIONS

In summary, it is our opinion that the City of Merritt owns and operates an effective groundwater supply system, and has taken some proactive steps to ensure an adequate supply of groundwater is available into the future. The City continues to rely primarily on a series of relatively shallow wells completed in sands and gravels that exhibit varying degrees of hydraulic connection to the Coldwater and/or Nicola Rivers. A deep aquifer has also been developed that is more isolated from the surface and less directly connected to surface water. The shallow wells, while more susceptible to effects from surface contaminants, produce better quality water than the deep Kengard well.

Except for the Kengard well, all of the City of Merritt wells are in the range of 35 to 45 years old. Recent well maintenance and redevelopment projects have demonstrated that the well performance tends to decline as pumping continues year to year; and that redevelopment can restore some but not all of the lost specific capacity.

The City relies mostly on the Voght Park wells in terms of the overall volume of supply and these wells are among the oldest in the system. The recently redeveloped Collettville well is undersized relative to the other wells in the system and a larger well could be developed at this site if needed in the future (and could become the City's largest producer based on what is known about the local aquifer properties).

- R1** There is some uncertainty over the calibration and/or outputs of some of the water level transducers installed in some production wells. The Voght Park VFD well and Fairley Park well transducers appear to fairly accurately report depth of water above the sensor, while the same cannot be said for the other wells. In order for meaningful data to be collected, all of the sensors should be inspected and re-calibrated to read uniformly (i.e. all feet of water above sensor). The units currently being read should be determined before recalibration so that existing data can be interpreted.
- R2** Consider prioritizing the Voght Park wells as these are the highest value assets, and consider planning for replacement wells in the next 5-10 years. Replacement wells could be located in close proximity to the existing wells or potentially at the Collettville site (see next recommendation)
- R3** If additional source capacity is ever required, the Collettville site is the recommended location for a new high capacity well.
- R4** Commission a comprehensive GWUDI study to definitively classify all well sources as either GWUDI or not GWUDI (i.e. secure groundwater). This study would focus on the shallow wells as it is highly likely the Kengard well would be classified as not-at-risk using Stage 1 provincial guidelines. It can be anticipated that a similar study will be requested at some point in the near future by IH, following the release of the forthcoming groundwater source treatment objectives. Further details on the approach to the GWUDI study can be provided upon request.
- R5** Work with the province to promote additional study of surface water and groundwater interactions to provide more certainty as to the effect on river flows from pumping the City's shallow wells.
- R6** Evaluate Kengard well options including 1) treatment 2) no treatment and blending 3) emergency use only (no treatment) 4) ASR using one or more of the shallow wells as the recharge source water. Further details on the approach to any or all of the options can be provided upon request.



- R7** Plan and budget for yearly well pump and well screen maintenance projects (1 well per year on a rotating basis). Recent annual water system reports indicate a similar maintenance plan has been enacted with one pump being pulled and serviced in each of recent years. Once the pump is out, the additional costs for well rehabilitation are not substantial and this work should be completed. Based on what we know about past efforts to rehabilitate and redevelop wells, the suggested order would be Fairley Park, Voght Park VFD, Voght Park GE, Kengard, and Colletville.

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