APPENDIX

B

WATER MANAGEMENT PLAN

Village of New Maryland

Water Management Plan

For Submission to NBDELG

April 8, 2016

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Water Management Plan

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1 Introduction

1.1 About This Document

It is nearly always true that water is most often *not* afforded its true value.

Although it may be debatable that the Village of New Maryland's most valuable resource is water, it can be confidently stated that water is an invaluable resource upon which all Village residents are dependent. Without a good water supply the Village wouldn't be what it is or what it may aspire to become.

Similarly to nearly all other New Brunswick municipalities, the Village is tasked with providing a '*clean and safe'* drinking water supply to its citizens and businesses. The Village considers proper water resource and water utility management as an essential element to being a responsible municipality.

This document is about the Village's drinking water resources, its drinking water utility and the plan devised to manage them. The water utility to which this document applies involves only the Village's communal drinking water supply and distribution systems. This document does *not* involve, nor does it apply to, any of the Village's private residential or commercial water supply wells or wellfields.

Until recently, a formal written plan for water resource management in the Village has not existed. The Province of New Brunswick Department of Environment and Local Government (NBDELG) has requested that New Brunswick municipalities develop water management plans for review by the Department. In response to NBDELG's request, this document intends to provide the framework for managing the Village's drinking water resources moving forward into the future. This framework is to be known as the **Water Management Plan**.

The Water Management Plan (WMP) is considered to be a 'living document'. As the Village gains greater understanding of how to best manage its water resources, the original presumptions and data that shaped this document will invariably change over time. As such, future versions of this document are anticipated to incorporate adjustments, modifications and additions, reflecting the Village's most current knowledge and preferences for managing its drinking water resources and water infrastructure.

1.2 Contents

The WMP presented in this document incorporates the following general elements:

- Management plan goals and objectives,
- Existing water service areas and current water supply sources,
- Water utility infrastructure components,
- Water quality, production and consumption,
- Water source protection,
- Operation and maintenance,
- Anticipated future servicing requirements, and
- Water source exploration.

Each of the above elements are described and discussed in subsequent sections of this document.

1.3 Glossary

A glossary of engineering units and terms appearing in this document is provided in Table 1.

Table 1 - Glossary of Engineering Units and Terms

Abbreviation	Unit or Term
AWWA	American Water Works Association
GIS	geographic information system
hr.	hours
hr./d	hours per day
Igpm	Imperial gallons per minute
Lpcd	litres per capita per day
L/s	litres per second
m	meters
mm	millimeters
m^3	cubic meters
m^3/d	cubic meters per day
m^3/yr.	cubic meters per year
mg/L	milligrams per litre
µg/L	micrograms per litre
NBDELG	New Brunswick Department of Environment and Local Government
O&M	operation and maintenance
O&P	operation and performance
PF	peaking factor
ppu	people per unit
PSAB	Public Sector Accounting Board
SCADA	Supervisory Control and Data Acquisition
WMP	Water Management Plan

2 Foundation Components

2.1 Goals and Objectives

It is paramount that a communal drinking water supply be at a quality that is safe and healthy. This means that water quality must meet Health Canada's Guidelines for Canadian Drinking Water Quality. These guidelines were established by a federal/provincial/territorial drinking water committee and are applicable to all Canadian municipalities.

It is fair to assume that the Village's current customer base will expect that its drinking water supply will always be available in the quantities that satisfies their consumption demands. As ratepayers, they will also demand that both water quality and quantity be achievable at reasonable costs.

The ***Primary Goal*** of the Village's WMP is to operate its drinking water utility to meet its customers' water needs indefinitely.

The ***Primary Objective*** of the Village's WMP is to preserve the ability of its water resources to maintain acceptable water quality and quantity for current and future populations.

To accomplish the Primary Goal and Primary Objective, the Village's WMP incorporates the following additional goals and objectives:

1. Provide clean, safe drinking water.

2. Ensure sustainable use of drinking water.

3. Ensure efficient supply of drinking water.

4. Manage and protect the watersheds that provide the Village's water as natural assets.

5. Identify existing vulnerabilities of the water utility system and identify solutions to rectify these vulnerabilities.

6. Explore for and secure additional water sources within the Village municipal boundaries.

2.2 Sustainability Principles

Recognizing that the essential components of the Village are its *society*, its *economy and* its *natural environment*, it is also important to recognize that each component is intricately dependent upon and impacted by water resource development. Each of these three components must remain strong if the Village is to fulfil the water quality/quantity needs of its customer base. To achieve a strong economy, society and natural environment, the Village intends to adopt the following sustainability principles as cornerstone elements of its WMP:

- **Resource Management** - The Village maintains its responsibility for protecting its most precious and valuable resource – water, through appropriate management approaches and conservation techniques.
- **Climate Change** - The Village recognizes that its water utility is vulnerable to climate impacts, and that future global climatic changes will most likely contribute to hydrological variations of significance in Atlantic Canada.
- **Waste Reduction** - Waste is not efficient, thus the Village believes that its ratepayers (customers) want to know that its water utility is being operated efficiently.
- **Risk Management** - Sustainable water utility operating practices create lower risk exposure over time.
- **Operating Cost Reduction** - Cost savings are attainable through waste reduction strategies, and electrical and hydraulic energy efficiencies.
- **Managing Water Demands** - Encouraging water consumption efficiency (reduction) can reduce O&M costs to Village customers.
- **Growth** - Make available an adequate water supply to enable sustainable future growth opportunities within the Village's boundaries.
- **Asset Management** - Knowing its water system assets and their current condition enables the Village to plan for timely and cost-effective infrastructure replacement.
- **Public Relations** - Maintaining effective and on-going communication with its customer base contributes to developing favourable relationships and respect among Village officials, staff and ratepayers.

2.3 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Foundation Components' portion of the VONM Water Management Plan:

1. Adopt the following resolution as a public commitment to adhering to the proposed Water Management Plan, as defined herein by this document:

   The Village of New Maryland Mayor and Council are dedicated to providing its citizens with quality water and customer service in a manner that protects the natural environment, supports a strong economy and promotes a robust community, and which is based on the goals, objectives and sustainability principles identified in the Village's Municipal Plan By-law.

2. Annual review of the Water Management Plan to confirm that the original goals and objectives remain valid and relevant to the Village's sustainability principles identified in the Village's Municipal Plan By-law.

3 Service Areas, Water Resources

3.1 Service Areas

Water supply services in the Village consist of individual private wells and two (2) separate communal water systems. A total of approximately 2 500 people are serviced by individual private wells in the following Village subdivisions:

- Springwater Place Phase 1,
- Castle Acres,
- Cedar Acres Court,
- Sunrise Estates Phase 1 and 2,
- Highland Acres,
- Centennial Heights.
- Highway 101 – portion south of Crown Avenue, and
- Baker Brook Court (that portion on private wells).

Approximately 1 900 people are serviced by two (2) separate communal water supply systems, namely the Applewood Acres and the Springwater Place systems. These communal water supply systems service the following Village subdivisions:

- Applewood Acres,
- Springwater Place Phase 2,
- Pine Ridge Estates,
- Forbes Subdivision,
- Baker Brook Court (that portion on the communal water supply system),
- Centennial Gardens Subdivision, and
- Highway 101 – portion north of Crown Avenue.

Private residential wells and wells servicing commercial establishments are not considered in this Water Management Plan. Only the two (2) communal water supply systems for which the Village is responsible, namely Applewood Acres and Springwater Place, are incorporated in this Plan. In addition, Peterson Park (mini-home park), which is located within the Village boundaries, is serviced by its own private communal water supply well system. The Village is not responsible for this water supply system and it is not considered in this Plan.

An aerial map showing the various Village subdivisions and route locations for the communal water supply and distribution piping systems is provided in Appendix A.

3.2 Groundwater Sources

All Village water communal and private water supplies are sourced from groundwater aquifers. The groundwater aquifers are located in sedimentary bedrock underlying the Village. The general lack of surface water streams located within the Village boundaries suggests that much of the groundwater originates from precipitation infiltrating downward from the ground surface over the groundwater catchment area. Topography and surface water drainage patterns play a significant role in groundwater recharge within the Village boundaries.

A 2011 report prepared by Gemtec Limited indicated that groundwater aquifers in the New Maryland area rely predominantly on groundwater movement through fractured bedrock. This has resulted in well yields that are quite variable, with wells of highest yield being predominantly positioned west of Highway 101. The Village's communal water supply currently depends on four (4) production wells. These wells are:

- Wells A10, A11 and A20 – located in Applewood Acres wellfield (west of Hwy. 101), and
- Well S4 – located in Springwater Place wellfield (east of Hwy. 101).

The locations of these production wells are provided in Appendix A.

Also identified in Appendix A are additional observation, decommissioned and potential well target sites that have been developed over time within the Village boundaries. These wells amount to at least 46 additional sites, consisting of 11 known observation wells, 5 assumed observation wells, 12 decommissioned wells, and 18 well 'target' sites. Note: 'Target' well sites are locations considered to have potential.

3.3 Surface Water Sources

The Village's primary surface water courses are Baker Brook (at its northern boundary) and the Rusagonis Stream (at its southern boundary). The drainage basin for Baker Brook incorporates Applewood Acres, Springwater Place Phase 2, Forbes Subdivision, Pine Ridge Estates and Highland Acres. The Rusagonis Stream drainage basin incorporates Centennial Heights, Sunrise Estates Phase 1 and 2, and Peterson Park.

Both of these water courses contain relatively low flows and serve as receiving streams to treated wastewater (Baker Brook), and/or untreated sanitary sewer overflow discharges (Baker Brook, Rusagonis Stream). Thus, neither stream represents a suitable drinking water source.

There does not exist within the Village boundaries, or within the immediate surrounding area, an impounded water body of significant volume that would represent a suitable surface water source for drinking water. Therefore, the Village has no surface water supply options from which a future water source supply could be developed.

3.4 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Service Areas, Water Resources' portion of the VONM Water Management Plan:

1. Existing surface water sources located within the Village (i.e., Baker Brook, Rusagonis Stream) are not considered as suitable drinking water sources.

2. Exploration for future water supply within the Village boundaries is limited to groundwater sources, due to the lack of suitability available surface water sources.

4 Water System Infrastructure

4.1 Background

The Village's communal water system consists primarily of the following infrastructure components:

- Four (4) water production wells,
- Two (2) water storage reservoirs,
- Water supply and distribution piping totalling over 19 km in length,
- 240 isolation valves (many with chambers) located on the water distribution piping system,
- 82 hydrants, and
- One (1) pressure regulating control valve and chamber.

4.2 System Configuration

The Village's communal water system is configured as two (2) individual water supply and distribution systems. These systems are referenced herein as the Applewood Acres system and the Springwater Place system. A simplified schematic of the Village's communal water supply and distribution systems is provided in Appendix G.

The Applewood Acres system incorporates three (3) production wells identified as Wells A10, A11 and A20. These wells connect directly to a water distribution system serving Applewood Acres, Forbes Subdivision, Pine Ridge Estates, and that portion of Highway 101 north of Crown Avenue. Currently, 514 dwelling units connected to the Applewood Acres system, which represents an estimated serviced population of 1 491 people (assuming 2.9 ppu).

Raw water from each Applewood Acres production well undergoes chlorine disinfection prior to entering the water distribution piping network. An elevated water storage reservoir is located within Pine Ridge Estates and is connected directly to the distribution piping network.

The Springwater Place system incorporates one (1) production well identified as Well S4. This well discharges directly to an in-ground water reservoir prior to any flow entering the water distribution system. Prior to entering the reservoir, raw water from Well S4 is initially routed through a manganese removal ion exchange filter system, and is then chlorinated.

Chlorinated water is pumped directly from the in-ground reservoir to the water distribution system network serving the Springwater Place Phase 2 and Baker Brook Court subdivisions. Currently, there are 150 dwelling units connected to the Springwater Place system, which represent an estimated serviced population of 435 people (assuming 2.9 ppu).

The Applewood Acres and Springwater Place systems are interconnected by piping and a pressure regulating valve (PRV) and chamber. The PRV and chamber are positioned at the intersection of Highway 101 and Springwater Lane (i.e., at the entrance to the Springwater Place Phase 1 Subdivision). In the event of a decrease in Springwater Place distribution system water pressure (and flow), such as caused by failure of the distribution system supply pumps, the interconnecting PRV will automatically open upon detection of a pre-set minimum pressure loss, thus allowing for uni-directional water flow from the Applewood Acres system into the Springwater Place system. Under these conditions, Springwater Place water distribution system pressure (and flow) is provided by the Applewood Acres system elevated water storage reservoir.

4.3 Production Wells

Details of the existing four (4) production wells serving the Village's communal water system are summarized in Table 2.

Table 2 - Summary of Existing Water Production Well Details

Communal Water Distribution System	Well No.	In-service Date	Depth	Diam.	Safe-Yield Capacity[1]	Actual Well Capacity[2]
			m	*mm*	*Igpm (L/s)*	*Igpm (L/s)*
Applewood Acres	**A10**		120	200	80 (6.1)	75 (5.7)
	A11		112.7	200	20 (1.5)	13 (1.0)
	A20	2007	128	200	75 (5.7)	50 (3.8)
Springwater Place	**S4**				20 (1.5)	13 (1.0)

Notes:

1. *A calculated value, based on hydrogeological assessment and field measurements, and approved by NB Dept. of Environment. Capacity is based on well production being sustained at the stated yield assuming continuous 24/7/365 operation.*
2. *Actual well yields are based on flow discharge measurements conducted for each well.*

4.4 Distribution Network Piping

The total communal distribution network piping consists of a variety of pipe sizes and materials equaling a total linear length of over 19 000 m (19 Km). A general inventory summary of the total distribution piping network is summarized in Table 3. A general inventory of distribution system pipe isolation valves is provided in Table 4.

Table 3 - Inventory of Communal Water Distribution System Piping

Pipe Material	Size *(mm)*	Length *(m)*	Total Pipe Length (by material) *(m)*
Copper	32	15	56
	38	41	
PVC	50	476	15 444
	75	1 061	
	100	186	
	150	5 468	
	200	7 850	
	300	403	
Ductile Iron	75	537	3 750
	100	117	
	150	2 848	
	200	206	
	400	42	
		Total Pipe Length	**19 250**

Table 4 - Inventory of Communal Water Distribution System Valves and Hydrants

Valve Type	No. of Units
Gate Valve and Box	104
Gate Valve and Chamber	136
Pressure Regulating (PRV)	1
Hydrants	82
Total	**323**

4.5 Water Reservoirs

The Village's communal water supply and distribution systems incorporate two (2) water storage reservoirs - an elevated reservoir and an in-ground reservoir.

The Applewood Acres system utilizes an *elevated* water storage reservoir. This reservoir is located on Sprucewood Drive adjacent to the New Maryland Elementary School in Pine Ridge Estates. The elevated reservoir has an overall height of approximately 32 m (105 ft.), which provides for consistent pressure zones throughout the Applewood Acres water distribution system. The elevated water reservoir storage capacity is 2 250 m^3 (495 000 Igal).

The elevated reservoir is hydraulically connected as a 'node' on the water distribution piping system. It is operated to maintain a consistent liquid level within the reservoir tank (and thus maintains consistent pressure zones) by automatically calling for production well ON/OFF operation. At any time through the day it can be in the 'fill' mode or in the 'discharge' mode. Additional internal chlorination occurs at the elevated water reservoir to maintain sufficient chlorine residual while the water resides in storage.

The Springwater Place system incorporates an *in-ground* concrete water storage reservoir located at the end of Woodlawn Lane in Springwater Place Phase 2. The in-ground reservoir is positioned entirely below grade. This reservoir is 2.6 meters in depth and has a storage capacity of 200 m^3 (44 000 Igal).

This reservoir receives flow directly from Production Well S4. Well S4 is operated automatically to maintain pre-set minimum and maximum reservoir liquid levels. A separate set of pumps, located internal to the reservoir, discharge directly into the Springwater Place water distribution system to maintain a pre-set system operating pressure range. The in-ground reservoir capacity was originally sized for typical domestic demands only. No provisions were made for fire flow water storage capacity.

4.6 Water Reservoir – Ultimate Support Population

The elevated water reservoir currently supports a connected population of approx. 1 491 people (514 dwelling units x 2.9 ppu). The in-ground reservoir currently supports a connected population of approx. 435 people (150 dwelling units x 2.9 ppu).

Water storage facilities should have sufficient capacity to meet the required domestic demands and also fire flow demands, where fire protection is provided. Typically, water reservoir storage is required for fire flow, peak balancing and emergency usages.

Fire flow storage for the Village's existing reservoirs has been established as follows:

- ***Elevated Reservoir*** – Fire flow capacity is based on providing a water flow of 2 000 Igpm for a 120 minute (i.e., 2-hr.) duration to attend to the largest potential structure fire in the Village. This equates to a total volume of 240 000 Igal, or 1 090 m^3.
- ***In-ground Reservoir*** – No fire-fighting provisions were provided in the original design, as the reservoir discharge pumps are not capable of fire flow discharge rates.

Water reservoir peak balancing storage, emergency storage, and useable storage (for reservoirs without a fire flow component) are typically sized in Atlantic Canada in accordance with *Atlantic Canada Guidelines for the Supply, Treatment, Storage, distribution and Operation of Drinking Water Supply Systems - September 2014*. Sizing formulae for these storage requirements are as follows:

- ***Peak Balancing Storage*** – This is also referred to as operational storage and is directly related to the amount of water needed to satisfy peak demand conditions. Peak balancing storage is intended to make-up the difference between the consumers' peak demands and the system's available supply. The volume of peak balancing storage is typically estimated at 25% of the total maximum day demand.
- ***Emergency Storage*** – This is the volume of water recommended to meet the demand during maintenance shutdowns, production well shutdowns, watermain failures (breaks), electrical power outages, or natural disasters. The amount of emergency storage is typically based on an assessment of risk and a desired degree of system dependability. Typically, this amount is calculated as 25% of (Peak Balancing + Fire Flow).
- ***Useable Storage Capacity*** – This is applicable when no fire protection storage capacity is provide, as is the case for the Village's in-ground reservoir. Useable Storage Capacity is typically based on 25% the design year maximum day, plus 40% of the design year average day.

Water storage capacity requirements and ultimate support population for the Village's elevated reservoir is summarizes as follows:

> *A storage capacity of 1 160 m^3 is available in the elevated reservoir for peak balancing and emergency storage requirements. This figure is based on the total storage volume of 2 250 m^3 <u>minus</u> the fire flow storage requirement of 1 090 m^3. Based on the current estimated per capita water demand of 207 Lpcd (includes water leakage loss allowance), and an assumed Max. Day peaking factor of 2.0, the storage capacity of 1 160 m^3 has been calculated to support a theoretical ultimate connected population of approximately 6 800 people.*

*A population of 6 800 generates a peak balancing storage requirement of **710 m³** and an emergency storage requirement of **450 m³**. Note: The ability of the elevated water reservoir to support a theoretical future population of 6 800 people will be dependent upon the ability of the Applewood Acres production wells to maintain water supply to the reservoir and distribution system. This issue is further discussed in Section 11 – Future Development.*

Water storage capacity requirements and ultimate support population for the Village's in-ground reservoir is summarizes as follows:

The Useable Storage Capacity available in the in-ground reservoir is 200 m³. Note: There is no fire flow storage provided for this reservoir. Therefore, based on the current estimated per capita water demand of 207 Lpcd (includes water leakage loss allowance), and a Max. Day peaking factor of 3.0 (for a population less than 500), the existing storage capacity of 200 m³ has been calculated to support a theoretical ultimate connected population of approximately 840 people. Note: The ability of the in-ground reservoir to support a theoretical future population of 840 people will be dependent upon the ability of the Springwater Place production wells (currently only Well S4) to maintain water supply to the reservoir and distribution system.

Details of the Village's elevated and in-ground water reservoirs are provided in Table 5.

Table 5 - Water Storage Reservoir Details

Reservoir (location)	Type	Year	Water Storage Capacities (m³)				Service Population (people)	
			Fire Flow	Peak Balancing	Emergency	Total	Current	Ultimate
Elevated *(Pine Ridge Estates)*	Concrete pedestal + steel tankage	2010	1 090	630(1)	430(1)	2 250	1 491	6 090
In-ground *(Springwater Place)*	In-ground concrete tank	1986	*NA(3)*	*NA(3)*	*NA(3)*	200	435	840

Notes:

1. *Calculated capacities are based on a service population of 6 090 people, demand of 207 Lpcd, Max. Day PF of 2.0 and the following formulae:*
    - *Peak Balancing Storage = 25% of the total maximum day demand.*
    - *Emergency Storage = 25% of (Peak Balancing Storage + Fire Flow Storage).*
2. *Calculated capacities are based on a service population of 390 people, demand of 207 Lpcd, Max. Day PF of 3.0 and the following formula:*
    - *No fire protection storage.*
    - *Usable Storage Capacity (for Peak Balancing, Emergency use) = 25% the design year maximum day, plus 40% of the design year average day.*
3. *NA - Not Applicable.*

4.7 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Water System Infrastructure' portion of the VONM Water Management Plan:

1. Maintain and update annually an inventory of the Village water system infrastructure, as generally outlined in this section.
2. Develop a long-range asset management plan that will replace aging water infrastructure in accordance with Public Sector Accounting Board (PSAB) standards and recognized best asset management practices.
3. Undertake annual calculations comparing current and ultimate service population capabilities of each Village water storage reservoir.

5 Water Quality

5.1 Background

The Village undertakes annual organic and inorganic water quality testing of production wells A10, A11, A20 and S4, in accordance with its water system's Certificates to Operate. Organic and inorganic test results are presented in Appendix B for each production well.

According to *the Guidelines for Canadian Drinking Water Quality*, if a value exceeds the Maximum Acceptable Concentration (MAC) for a particular organic or inorganic parameter, there is concern that it will cause adverse health effects to those who use it. If a value exceeds the Aesthetic Objective (AO) for a particular parameter, there is concern that taste, smell or colour of the water may be compromised.

Bacteriological testing is also undertaken on a regular basis throughout the Village's water distribution system. No known bacteriological incidents has occurred within the Village's communal water supply and distribution systems at least since 2007 (i.e., the date since which other water quality data is presented herein). Bacteriological test results have not been included in this document, but are available from the Village.

5.2 Inorganic Parameters

Inorganic water quality parameters for which the Village's water quality analysis is undertaken are provided in

Table 6. Also included are the respective MAC and AO values for these parameters.

Water quality results for inorganic parameters for each of the Village's water production wells (A10, A11, A20 and S4) are presented in graphical format for the period from 2007 to 2015 in Appendix B. Nearly all inorganic parameters tested below their respective MAC and AO values, and many tested are well below these values.

However, manganese concentrations for Well A11 have been consistently at or above the AO value of 0.05 mg/L since 2007. Figure 1 shows tested manganese concentrations for each of the Village's production wells for the period from 2007 to 2015. Well A11 manganese concentrations from 2012, 2014 and 2015 exceed the AO value by 5 to 7.5 times.

Likewise, manganese concentrations for Well A20 have consistently exceeded the AO value since 2012, and by over 7 times the AO value in 2015. Manganese concentrations for Well A10 had exceeded the AO value in 2007 and 2008, but have since tested well below this value. Manganese concentrations for Well S4 is consistently well below the AO value.

Table 6 - Inorganic Parameters for Water Quality Testing

Inorganic Parameter	MAC[1] (mg/L)	AO[2] (mg/L)	Inorganic Parameter	MAC (mg/L)	AO (mg/L)
Alkalinity	NA[4]	NA[4]	Manganese	NA[4]	≤ 0.05
Arsenic	10	NA[4]	pH	NA[4]	6.5 - 8.5
Barium	1.0	NA[4]	Potassium	NA[4]	NA[4]
Boron	5.0	NA[4]	Sodium	NA[4]	≤ 200
Calcium	NR[3]	NA[4]	Sulfate	NA[4]	≤ 500
Chloride	NA[4]	≤ 250	Total Hardness	NA[4]	NA[4]
Iron	NA[4]	≤ 0.3	Turbidity	1	NA[4]
Magnesium	NR[3]	-	Zinc	NA[4]	≤ 5.0

Notes:

1. *MAC - Maximum Acceptable Concentration.*
2. *AO - Aesthetic Objective.*
3. *NR – none required.*
4. *NA – not applicable.*

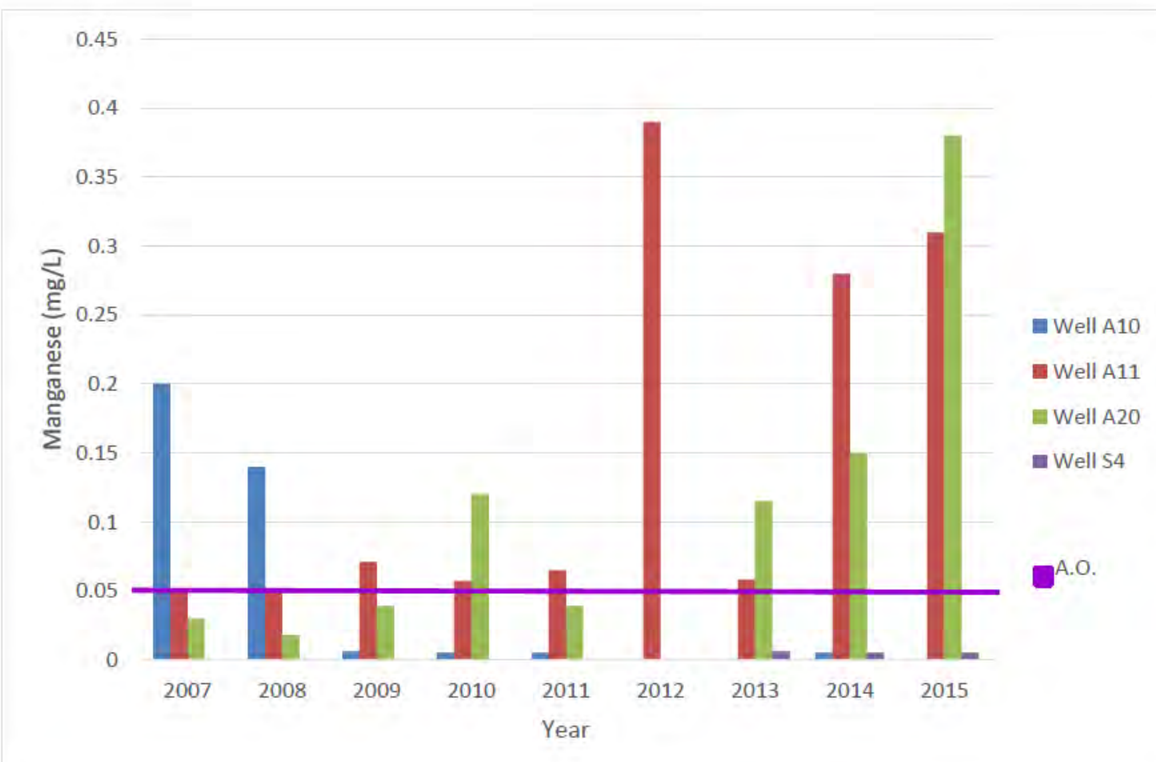


Figure 1 - Manganese Levels in Village Production Wells

While these manganese levels do not represent human health related concerns, they do represent long-term problems, including: staining of plumbing fixtures (i.e., toilets, clothes washers, dishwashers); laundry staining; precipitation of manganese dioxide solids (coating) within water distribution piping systems; imparting of a brownish colour; imparting of a metallic taste.

Iron concentrations are also often a concern in New Brunswick groundwater wells. However, since 2007 iron concentrations in all of the Village's production wells have remained below the AO value of 0.3 mg/L (see Appendix B).

5.3 Organic Parameters

Organic water quality results from 2013 to 2015 for Wells A10, A11, A20 and S4 are presented in Appendix B. These results are further summarized in Table 7, and including the MAC and AO values for each parameter.

A review of 2013 to 2015 organic parameters results reveals the following:

- Nearly all organic water quality parameters have been found to be non-detectable (ND) in each production well over the 3-year sampling period.
- In 2013, total trihalomethanes and chloroform were detected in 1 of 2 samples in Well A11, but at below the limit of quantification (<L.O.Q.). Both parameters were non-detectable in the remaining sample.
- In 2013, total trihalomethanes were detected in Well A20 in 1 of 4 samples, but at a concentration less than the MAC. Trihalomethanes were non-detectable in the remaining samples.
- In 2013, chloroform and bromodichloromethane were detected in 1 of 4 samples in Well A20. However, there are no stated MAC or AO for either chloroform or bromodichloromethane. Both were non-detectable in the remaining samples.
- In 2015, total trihalomethanes and chloroform were detected in 1 of 3 samples in Well A20, but at below the limit of quantification (<L.O.Q.). Both were non-detectable in the remaining samples.

Table 7 - Inorganic Parameter Water Quality Test Results

Organic Parameter	Units	MAC[1]	AO[2]	Years - 2013 to 2015 *(except where noted)*			
				Well A10	Well A11	Well A20	Well S4
Benzene	μg/L	5.0	NA[3]	ND[4]	ND	ND	ND
Carbon tetrachloride	μg/L	5.0	NA	ND	ND	ND	ND
1,2-Dichlorobenzene	μg/L	200	NA	ND	ND	ND	ND
1,4-Dichlorobenzene	μg/L	5.0	NA	ND	ND	ND	ND
1,2-Dichloroethane	μg/L	5.0	NA	ND	ND	ND	ND
Dichloromethane	μg/L	50	NA	ND	ND	ND	ND
Ethylbenzene	μg/L	NA	2.4	ND	ND	ND	ND
Tetrachloroethylene	μg/L	30	NA	ND	ND	ND	ND
O-Xylene *(2015 only)*	μg/L	NA	NA	ND	ND	ND	ND
M&P-Xylenes *(2015 only)*	μg/L	NA	NA	ND	ND	ND	ND
Total Xylenes	μg/L	NA	300	ND	ND	ND	ND
Toluene	μg/L	NA	24	ND	ND	ND	ND
Trichloroethylene	μg/L	5.0	NA	ND	ND	ND	ND
Vinyl Chloride	μg/L	2.0	NA	ND	ND	ND	ND
Total Trihalomethanes	μg/L	100	NA	ND	<L.O.Q.[5]	55[6]	ND
Chloroform	μg/L	NA	NA	ND	<L.O.Q.[5]	53[7]	ND
Bromodichloromethane	μg/L	NA	NA	ND	ND	1.4[8]	ND
Dibromochloromethane	μg/L	NA	NA	ND	ND	ND	ND
Bromoform	μg/L	NA	NA	ND	ND	ND	ND
Benzo(a)pyrene	μg/L	0.010	NA	ND	ND	ND	ND
Pentachlorophenol	μg/L	60	NA	ND	ND	ND	ND

Notes:

1. *MAC - Maximum Acceptable Concentration*
2. *AO - Aesthetic Objective*
3. *NA – Not Applicable (typical)*
4. *ND – Non-Detectable (typical)*
5. *<L.O.Q. – less than Limit of Quantification in 1 of 2 samples in 2013, ND in all other samples*
6. *55 μg/L in 1 of 4 samples in 2013; less than Limit of Quantification in 1 of 3 samples in 2015; ND in all other samples*
7. *53 μg/L in 1 of 4 samples in 2013; less than Limit of Quantification in 1 of 3 samples in 2015; ND in all other samples.*
8. *1.4 μg/L in 1 of 4 samples in 2013; ND in all other samples.*

5.4 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Water Quality' portion of the VONM Water Management Plan:

1. Undertake an annual assessment of organic and inorganic water quality parameters for each Village production well. Report the results in a format similar to that presented herein.

2. Continue to monitor all production well manganese concentrations. Review manganese removal treatment options, especially for Wells A11 and A20.

3. If excessive raw water manganese concentrations prove to be of operation and maintenance concern, undertake to devise a manganese removal treatment strategy.

4. Create and maintain a summarized version of the analytical results for the Village's bacteriological data base.

6 Water Production

6.1 Production Data

The Village's communal drinking water supply is currently sourced from four (4) groundwater production wells. The Applewood Acres system is supplied from Wells A10, A11 and A20. The Springwater Place system is supplied from Well S4. Production well details are provided in Table 2 of Section 4 – Water System Infrastructure.

Production from each water supply well is continuously monitored using flow meters located within each well control building. Flow meter data is transmitted (by radio wave technology) from individual well control buildings to a central SCADA system located at the Village's water storage tower. Daily water productions totals for each well are automatically logged by the SCADA system. Monthly production well results for 2012 to 2015 are provided in Appendix C, and are summarized below in Table 8.

In the Applewood Acres system, the three production wells are programmed to operate in pairs. Wells A11 and A20 are paired to operate simultaneously, and are alternated with the pairing of Wells A11 and A10. Thus, Well A11 is operated each time the elevated reservoir calls for water. In the Springwater Place system, only Well S4 is available for operation and is operated each time the in-ground reservoir calls for water.

Table 8 - Well Production Data (2012 – 2015)

Production Wells	***Units***	**Years**				**Avg. 2012 - 2015**
		2012	**2013**	**2014**	**2015**	
Applewood Acres System Only: Wells A10 + A11 + A20						
Total Prod.	*m3*	116 358	106 219	110 723	109 781	**110 800**
Avg. Annual Daily Prod.	*m3/d*	317.9	291.0	303.4	300.8	**303**
Springwater Place System Only: Well S4						
Total Prod	*m3*	35 020	33 290	30 690	32 060	**32 800**
Avg. Annual Daily Prod.	*m3/d*	95.7	91.2	84.1	87.8	**90**
Applewood Acres + Springwater Place Systems: Wells A10 + A11 + A20 + S4						
Total Prod. (rounded)	*m3*	151 400	139 500	141 400	141 800	**143 600**
Avg. Annual Daily Prod. (rounded)	*m3/d*	414	382	387	388	**393**

For the 4-year period from 2012 to 2015, inclusive, total annual well production ranged from 139 500 to 151 400 m^3. Average well production was 143 600 m^3/yr., or 393 m^3/d.

Wells A10 and A20 supply the largest production volumes of the four wells, each having an average annual production of approximately 50 000 m^3. Combined, Wells A10 and A20 currently provide approximately 70 percent of the Village's total communal water supply. They represent the Village's most valuable drinking water system asset.

6.2 Well Contribution and Utilization

Each production well has a rated safe-yield capacity, as approved by the NB Dept. of Environment. Safe-yield capacities are provided in Table 9 for each Village production well. Safe-yield capacities are determined based on hydrogeological assessment and field measurements associated with each individual well. These maximum capacities represent the maximum sustainable well yield (pumping) capacity, and are based on the assumption of continuous 24/7/365 operation.

Table 9 - Well Utilization

Well No.	Rated Safe-Yield Capacity[1]				Actual Well Yield[2]			Avg. Annual Production 2012 – 2015[3]	% Contrib.[4]	Effective Utilization[5]
	Igpm	*L/s*	*m³/d*	*m³/yr.*	*Igpm*	*L/s*	*m³/d*	*m³/yr.*	*% of Total*	*% (hr./d)*
A10	80	6.1	523	190 900	75	5.7	491	50 047	35	26 (6.2)
A11	20	1.5	131	47 700	13	1.0	85	12 941	9	27 (6.5)
A20	75	5.7	490	179 000	50	3.8	327	48 127	33	27 (6.5)
S4	20	1.5	131	47 700	13	1.0	85	33 027	23	69 (16.6)
							Totals	144 142	100	

Notes:

1. *A calculated value, based on hydrogeological assessment, field measurements, and NB Dept. of Environment approval. Capacity is based on well production being sustained at the stated yield, assuming continuous 24/7/365 operation.*
2. *Actual well yields are based on flow discharge measurements conducted for each well.*
3. *Based on well production data measurements obtained from VONM.*
4. *Contribution is based on % of Avg. Annual Production total. Ex. for Well A20: (48 127 ÷ 144 142) x 100% = 33%.*
5. *Based on % of annual production to rated safe-yield capacity. Ex. for Well A10: (50 047 ÷ 190 900) x 100% = 26%.*

The contribution of each production well is identified in Table 9 as a percentage of the 2012 to 2015 Average Annual Production aggregate. Well contributions range from 35% (Well A10) to 9% (Well A11). Wells A10 and A20 provide a combined annual contribution of 68%.

The *effective utilization* of each production well is also presented in Table 9. This parameter represents the average annual water volume withdrawn from the well as a percentage of the well's total safe-yield capacity. For example – Well A10 has an average annual production of 50 047 m^3 for the period 2012 to 2015. The rated safe-yield capacity of Well A10 is 190 900 m^3/yr. Therefore, the effective utilization of Well A10 during this period is 26%, as follows: (50 047 ÷ 190 900) x 100% = 26.2, say 26%.

Assuming the well is operated at or near its safe-yield pumping capacity, the effective utilization closely represents the average run-time of the well. Thus, an average run-time of 26% represents 6.2 hr. /d, as follows: 24 hrs/d x 26 ÷ 100 = 6.2 hr. /d. Average well pump run-times are presented in Table 9. *Note: Actual well pump run-time measurements have not been considered in this evaluation.*

Theoretically, each well is capable of sustaining 100% utilization of its rated safe-yield capacity. However, this is not practically achievable, nor is it desirable from an operations and maintenance standpoint. NB Dept. of Environment has previously imposed maximum daily operating limits of 18 hours on some municipal water production wells, which would limit the effective utilization to (18 ÷ 24) x 100% = 75%.

Based on 2012 to 2015 average annual production results, Wells A10, A11 and A20 are operated at approximately 27% effective utilization. In comparison, Well S4 is operated at a much higher effective utilization of 69% (but below preferred maximum limit of 75%).

6.3 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Water Production' portion of the VONM Water Management Plan:

1. Maintain daily production volumes, flow rates and pump run-time records for all production wells.

2. Undertake an annual calibration of all flow meters to ensure the most accurate well production measurements. Confirm actual well yield flow rates.

3. Periodically (every 3 to 5 years) undertake a hydrogeological evaluation to assess the rated safe-yield sustainability of individual production wells and associated aquifers. Utilize water production volumes and flow rates, and well level drawdown/recovery data obtained from production and observation wells.

4. Obtain groundwater level data annually from Environment Canada's Victoria Hall well monitoring station. Undertake a comparative historical review of data groundwater levels at the Victoria Hall location.

5. Prepare an annual report summarizing water production data and calculations based on a current 3-year period. Compare actual well pump rates to the re-confirmed rated safe-yield capacity to determine if well pump capacities remain sufficient and sustainable. Determine what well capacity improvements, if any, are needed.

7 Water Consumption

7.1 Background

Water consumption within the Village's Applewood Acres and Springwater Place communal water supply systems occurs nearly exclusively through residential use. Currently, all of the Village's commercial water consumption is limited to non-communal (private) use wells. The New Maryland Elementary School represents the only institutional water use, which occurs on the Applewood water supply. No industrial water consumption occurs within the Village.

Water consumption within the Applewood and Springwater supply systems is monitored using water meters installed in each dwelling unit. Water meters installations were started in the Village 2007. Water meters have been installed in all dwelling units connected to a communal water supply. Currently, there are 514 water meters installed in the Applewood Acres system and 150 water meters installed in the Springwater Place system. The Village collects water meter consumption data for billing purposes on a quarterly basis.

Environment Canada's website provides statistical water use data summarized by a 2011 Municipal Water Use Report on various Canadian municipalities. The following average daily per capita residential water consumptions are reported on this website for those Canadian municipalities participating in the voluntary survey:

- National average = 327 Lpcd (2006),
- National average = 274 Lpcd (2007),
- New Brunswick = 394 Lpcd (2009),
- Nova Scotia = 292 Lpcd (2009),
- Prince Edward Island = 189 Lpcd (2009), and
- Municipalities w. serviced populations of 1 000 – 2 000 people = 371 Lpcd (2009).

7.2 Consumption Data

Calculations of the Village's residential water consumption, as obtained from water meter data for 2012 to 2015, inclusive, are presented in Appendix D.

Average daily residential water consumption ranges from 183 to 198 Lpcd, with an average of 187 Lpcd over this 4-year period. These consumption rates are substantially less than the national average (274 Lpcd) and the New Brunswick average (394 Lpcd), as identified in the 2011 Municipal Water Use Report. The Village consumption rates are in-line with residential water use reported for PEI (189 Lpcd) and are also less than all other reported provincial averages (199 to 395 Lpcd range). Additional Village of New Maryland residential water consumption statistics are summarized in Table 10 below.

Table 10 – VONM Residential Water Consumption Statistics (2012 – 2015)

Residential Water Consumption for Applewood, and Springwater Systems	Units	Years				Avg. 2012 - 2015
		2012	2013	2014	2015	
Serviced Dwelling Units - Both Systems	*no.*	651	657	661	664	658
Estimated Connected Population (@ 2.9 ppu)	*people*	1 888	1 905	1 917	1 926	1 909
Annual Consumption - Both Systems	*m3*	136 800	127 600	127 900	129 000	130 300
Avg. Daily Consumption - Both Systems	*m3/d*	374	350	350	353	357
Avg. Daily Consumption per Dwelling Unit	*L/unit*	575	533	530	532	543
Avg. Daily per Capita Consumption	*Lpcd*	198	184	183	183	187

Environment Canada's website states that Canadians have consistently ranked among the world's highest water consumers. Per capita water use is well above that in European and many other industrialized nations. Factors affecting water use include the following:

- *Climatic Conditions* – lawn-watering and gardening are usually greater in warm, dry regions versus humid areas.
- *Economic Conditions* – water use is typical a function of economic status and standard of living. Higher priced residential dwelling units typically have higher water consumption versus medium and low-priced units.
- *Community/Region Composition* – the type, magnitude and relative mixture of residential, commercial and industrial development have a pronounced effect on community water usage.
- *Water Pressure* – Water usage rates typically increase with increases in point-of-use water pressures.
- *Water Costs* – Populations have a tendency to conserve water when the cost of water is high or is increased.
- *Metering* – Introduction of water meters and water charges based on proportion use (i.e., use more pay more) tend to reduce overall water consumption rates.

7.3 Water Sustainability

As stated in Section 2.1, a goal of the Village's Water Management Plan is to ensure sustainable water use. By reducing average consumer consumption, water production needs can be reduced, or more growth can be sustained for the same production volumes. High water consumption can contribute to a variety of environmental and economic issues, including:

- Water shortages,
- Groundwater aquifer drawdown,
- Increased temperature and pollutants in water bodies that receive the resulting wastewater flows,
- Need (and associated costs) for water and wastewater capacity expansion, and
- Increased energy consumption and costs associated with water/wastewater pumping.

Village residential per capita water consumption is considered reasonable when compared to other Canadian municipalities. It is believed the introduction of water meters in 2007 and maintaining sustainable water/sewage user rates has had a positive impact on lowering water consumption within the Village.

Given the continued potential for high water use activities during summer periods, such as lawn-watering, gardening, car washing, and swimming pool use, the Water Management Plan fully endorses the Village's Green Plan for water conservation, as outlined on the Village website (www.vonm.ca/greenplan).

7.4 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Water Consumption' portion of the VONM Water Management Plan:

1. Undertake an annual assessment of the Village's water demand using quarterly water meter data.

2. Present annual water consumption data on the Village website, and/or as bill stuffers accompanying residential water/sewage invoice mail-outs.

3. Encourage the following water conservation measures:

    a) Installation of low water use/flow plumbing fixtures (i.e., toilets) and appliances (laundry washers, dish washers).

    b) Avoidance of lawn watering during high evaporation time-of-day periods.

    c) Public water conservation awareness and effective public water conservation education, using printed materials such as American Water Works Association (AWWA) Value of Water.

    d) Low water use and low-flow plumbing fixtures in new home construction.

8 Water Supply Losses

8.1 Background

Water supply losses are defined herein as the difference between measured water entering the distribution system (from production wells) and measured water consumed by connected users. Water *production* data for the Village's communal water supply system are presented in Appendix C and Section 6.1. Water *consumption* data and calculations are presented in Appendix D and Section 7.2.

Potential water loss sources include:

- Inaccurate and/or erroneous flow metering results,
- Water distribution system leakage, and
- Unmetered water used for water distribution piping flushing; sanitary sewer flushing, water piping system repairs, firefighting, firefighting training (if applicable), community use facilities (i.e., flooding of outdoor ice rinks).

8.2 Water Loss Calculations

Water production data is obtained using flow meter measurements at each production well. Water consumption data is obtained from water meter readings of each connected water user customer. The net water loss is determined as the difference between the total measured water supplied to the distribution system and the total measured water consumed by connected users.

Water loss calculations for both the Applewood Acres and Springwater Place systems are presented for 2012 to 2015 in Appendix C. The percent water loss is calculated as the difference between quarterly water production and quarterly water consumption figures as follows:

$$\%\ \text{Water Loss} = (\text{Quarterly Prod.} - \text{Quarterly Consump.}) \div \text{Quarterly Prod.} \times 100\%$$

Percentage water loss calculation results are summarized in Table 11.

Table 11 - Summary of Water Production Losses

Water Distribution System	Percentage Water Production Loss (%)				Avg. Annual Water Loss 2012 – 2015	
	2012	2013	2014	2015	*Loss (%)*	*Vol. (m^3/yr.)*
Applewood Acres	9.3	7.3	10.6	8.9	9.0	10 000
Springwater Place	10.6	12.3	5.7	9.7	9.6	3 100
					Total	13 100

8.3 Typical Water Losses

Applewood Acres system production losses range from 7.3 to 10.6% for the period from 2012 to 2015, inclusive. The average annual water loss from the Applewood Acres system over this period is 9.0%, or approximately 10 000 m^3/yr.

Springwater Place system production losses range from 5.7 to 12.3% for the period from 2012 to 2015, inclusive. The average annual water loss from the Springwater Place system over this period is 9.6%, or approximately 3 100 m^3/yr.

The average annual volumetric water loss for both the Applewood and Springwater systems combined is estimated at 13 100 m^3 (see Table 11), or the equivalent of approximately 33 days (1 month) of water demand based on a total average daily well production of 393 m^3/d for 2012-15 (see Table 8 of Section 6 – Water Production).

Water losses occurring in municipal water supply systems can vary significantly depending upon the aforementioned sources of water loss. In accordance with statistics presented by the Canadian Geographic website, Canadian municipalities average approximately 14% water loss in pipeline leakage. Some municipalities experience as high as 30% pipeline leakage water loss. Environment Canada's website states municipalities, on average, lose 13.3% of their water supply volume prior to it reaching consumers.

It appears that the Village is able to maintain water losses in the Applewood and Springwater systems to less than the 10 to 12% range, which is slightly less than the current national average of 13 to 14%.

8.4 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Water Supply Losses' portion of the VONM Water Management Plan:

1. Review and assess the merits of developing and implementing an annual water audit process, utilizing similar concepts and procedures as outlined in the American Water Works Association (AWWA) Manual of Water Supply Practices M36 – Water Audits and Leak Detection.

2. Document and estimate, where possible, all non-revenue water uses occurring within the Village's water supply and distribution piping network.

3. Document all leak repairs to the Village's water supply and distribution piping system as part of normal O&M routine and practice.

9 Water Resource Protection

9.1 Background

As part of the NB Dept. of Environment's approval to operate a municipal well, an approved Wellfield Protection Plan must be developed and implemented. The Wellfield Protection Plan identifies well's protection area, which consists of three (3) designated protection 'zones' (Zones A, B and C) encompassing the well's recharge area.

Wellfield protection zones are determined based on detailed hydrogeological assessments, calculations and modelling. Each zone is related to different contaminants that can potentially threaten a wellfield. Each zone reflects the fact that different contaminants persist in the environment for different time-frames, migrate at different rates and pose different health risks.

Zone A is positioned closest to the wellhead; Zone B surrounds Zone A; Zone C surrounds both Zones A and B. Zone A has the most restrictions, as it is closest to the wellhead. Septic tanks, sewer lines, petroleum products, chlorinated solvents and pesticides must be controlled or, in some cases, are banned from Zone A. The risk of contamination decreases in Zone B, but some risks are still present. In Zone C, wellfield protection guidelines apply only to chlorinated solvents and petroleum products.

Hydrological catchment/drainage areas are defined by the land area topography from which all surface water run-off (drainage) flows into a common point. Catchment areas in the immediate vicinity of the Village involve the primary surface water sources of Baker Brook, and the Rusagonis Stream.

9.2 Wellfield Designations

Wellfield protection zones have been delineated for the Applewood Acres water system production wells - Wells A10, A11 and A20. The wellfield protection zones for these wells are delineated and identified in the mapping provided in Appendix F. This wellfield protection area has been officially designated by the Minister of Environment and Local Government under NB Regulation 2000-47 – Wellfield Protected Designated Order – *Clean Water Act*.

Wellfield protection zones have been established for the Springwater Place water system production well - Well S4. These zones are identified in Appendix F.

In 2011 the Village undertook a preliminary hydrogeological study to delineate the wellfield protection area surrounding the potential municipal water supply Well 3A. The preliminary wellfield protection zones for Well 3A are also identified in the Appendix F mapping. *Note: Due to its current status as an observation well, the Village has not proceeded with completing an official Wellfield Protected Designated Order for Well 3A.*

9.3 Water Resource Protection

It is a goal of the Village's WMP to manage and protect, where possible, the watersheds and wellfields that supply the Village's water production wells.

In wellfield protection study reports prepared by Gemtec Limited in 2001 and 2011 for the Village, it was speculated that groundwater in the New Maryland area originates from precipitation that infiltrates downward from the ground surface over the groundwater catchment area, and that groundwater aquifers in this area rely predominantly on groundwater movement through fractured bedrock.

Appendix F shows that Trans-Canada Highway Route No. 2 located immediately north of the Village boundary cuts across the Applewood Acres water supply wellfield and catchment area. The alignment of Route No. 2 passes through each of the three wellfield protection zones within 120 meters of Well A20.

It would appear that Route No. 2 alignment was established without consideration to the Village's water supply wellfield, which was established well before the new highway. There is concern for the long-term use of de-icing chemicals on the highway surface (during winter months) and the associated water quality impact potential on the catchment and wellfield protection areas. The Applewood Acres wellfield is also potentially vulnerable to any chemical spills that might occur due to highway vehicular activity.

Industrial park lands in the Hanwell LSD are positioned immediately adjacent to the New Maryland – Hanwell boundary. In 2014, these lands were re-zoned by the developer and approved by the province for commercial/light industrial use. These lands are positioned within 600 meters of the Applewood Acres wellfield protection area, and are up-gradient and border on the Well 3A preliminary wellfield protection area. Surface run-off from the industrial park properties potentially contribute to the surface water catchment area (and potentially to the groundwater recharge) of both wellfields.

9.4 Incorporation of Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Water Resource Protection' portion of the VONM Water Management Plan:

1. Develop a municipal source water protection plan for the wellfield protection areas in Applewood Acres, and Springwater Place (and potentially for Well 3A). Such a plan would involve applying appropriate management practices to the surface water catchment areas. Components of the plan could include an advisory committee, catchment boundary delineation (wellfield delineation has already been completed), risk assessment, and water quality monitoring and evaluation.

2. Install signage along the Trans-Canada Highway Route No. 2 that brings awareness to vehicular traffic that a designated section of the highway passes through a drinking water wellfield protection zone.

10 Operation, Maintenance and Asset Management

10.1 Introduction

Water system operation and maintenance (O&M) is considered to be an integral component of the Village's Water Management Plan. The Plan's goals and objectives of providing and ensuring a clean, safe and efficient water drinking water supply system are heavily dependent upon an effective O&M approach.

The Village's water system staff are trained and hold municipal water distribution system operation certification in accordance with the requirements of the NB Dept. of Environment. Water system staff undertake regular and preventative maintenance activities to provide for well-operated water supply and distribution systems.

10.2 O&P Standards and Manual

The Village does not have a comprehensive manual documenting the overall operational and performance (O&P) standards required for the Village's water supply and distribution systems. The performance standards are intended to specify and provide guidance (to staff and management) with respect to expected level-of-service, operational performance, maintenance and operational activity levels for the water system core elements.

The O&P manual would document (for the Village O&M staff, management and community at large) a description of the utility's core activities, and the level of operational services, maintenance and expenditures necessary to attain and maintain O&P standards.

A review of current O&M vulnerabilities will identify existing and/or potential shortcomings in the Village's ability to provide the essential service of continued water supply during emergency situations. This review would be coordinated with the Village's Emergency Measures Organization (EMO) committee. For example, an evaluation of the need for back-up power at key production wells and the elevated water storage reservoir could be part of this review assessment.

10.3 Asset Management

In response to the national Public Sector Accounting Board (PSAB) requirements the Village has developed a robust inventory of its water infrastructure assets. The Village has also prepared an extensive geographic information system (GIS) database of its water supply and distribution system infrastructure components.

The Village's current level of asset management provides O&M staff and management with an inventory of water system assets, and an integrated planning framework for electronic display and analysis of these assets. GIS mapping of the Village incorporates high resolution digital aerial imagery. Documentation of water system assets and their current condition enables the Village to plan for timely and cost-effective infrastructure replacement.

10.4 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Operation, Maintenance and Asset Management' portion of the VONM Water Management Plan:

1. Attain and maintain the appropriate levels of operator certification for the water system O&M staff.
2. Prepare a comprehensive manual documenting the operational and performance standards required for the Village's communal water supply and distribution systems.
3. Provide the necessary resources to enable O&M staff to carry out their duties efficiently, effectively and in a timely manner.
4. Update annually the digital mapping for water supply and distribution system infrastructure.
5. Advance the foundational asset management work already developed by the Village. Continue to focus on establishing the core asset management fundamentals (i.e. inventory, condition, levels of service) that will support improved decision making for asset renewal and replacement.
6. Develop an initial Asset Management Plan that documents current practices, processes and tools used to support water asset management. Establish short-term (5-year) and long term (30-years) investment plans, and an asset management improvement plan.
7. Evaluate current O&M vulnerabilities and the Village's ability to maintain drinking water supply during emergency situations.
8. Evaluate potential impacts of climate change on future design, operation and maintenance considerations of the Village's drinking water supply and distribution systems.

11 Future Development

11.1 Introduction

It is a goal of the Mayor and Council to continue to facilitate continued growth within the Village of New Maryland community. The Village is cognisant that the future strength of its economy, society and natural environment are dependent upon how its water resources and water utility are managed.

To facilitate growth, the Village must provide for a sustainable water supply under stressed operation conditions. As such, this section evaluates the ability of the Applewood Acres production wells and elevated storage reservoir to meet residential water demands under future growth and 'worst case' operating conditions.

Calculations were performed that simulated 'stressed' operating conditions. Results from these calculations were used to assess the system's response in maintaining a minimum performance standard. The results were used to predict the future anticipated growth (in terms of number of dwelling units) that can be reasonably sustained by the current Applewood Acres water system.

11.2 System Stress Simulations

The following simulations were used in performing calculations to gauge the system's response to a variety of 'stressed' operating conditions.

- Water Demand – based on water production and consumption data for 2012 to 2015, and an assumed 7-day demand curve (see below) that includes a maximum day condition. Current average day demand is approximately 205 Lpcd, based on an average per capita usage of 187 Lpcd + average system losses of 9.0% or 18 Lpcd.

- Maximum day demand = average day demand x 2.0 (peaking factor).

- 7-day Maximum Demand Curve - intended to represent a potential 'worst case' demand condition which is likely to occur during the summer season. Each of the 7 days utilizes the average day demand x peaking factor. Peaking factors (PF) are:

  Day 1 – PF = 1.0 (average day demand)
  Day 2 – PF = 1.125
  Day 3 – PF = 1.25
  Day 4 – PF = 2.0 (maximum day demand)
  Day 5 – PF = 1.25
  Day 6 – PF = 1.125
  Day 7 – PF = 1.0 (average day demand)

- Base Population – based on the current 514 connected dwelling units and a density of 2.9 ppu (calculated using 2011 VONM census data), equating to 1 491 people.

- Future Growth –population increases were simulated using an incremental number of housing additions at a density of 2.9 ppu (i.e., current avg. dwelling density).

- Water Supply – based on the following production well yields (see also Table 9):

    - Well A10 = 491 m^3/d
    - Well A11 = 85 m^3/d
    - Well A20 = 327 m^3/d
    - Well S4 = 85 m^3/d.

11.3 Scenarios and Results

Various system stress 'scenarios' were developed and evaluated as a means of simulating future growth under reasonably stressed operating conditions. System stress was simulated by simultaneously applying a 7-day maximum water demand curve (see Section 11.2 – System Stress Simulations), an increasing number of dwelling units (representing future growth), and removing the availability of the largest product well (i.e., either Well A10 or A20) to simulate it being 'out-of-service'.

All 'scenarios' commenced with a full reservoir. Calculations for each scenario were performed to identify the number of days required to restore the water reservoir to its 'full' operating level, after system stress was applied. The number of days calculated are referenced herein as 'Days to Recover'.

Iterative calculations were performed to determine the maximum population that can be adequately supported by the available water supply. The system is consider to have failed if either of the following situations occur during these iterative calculations:

- Lowering of the elevated reservoir level to less than the fire flow capacity of 1 090 m^3. *Note: Fire flow storage volume cannot be used to assist with reservoir recovery, as the full fire flow capacity must be available for fire-fighting at all times.*

- Calculated 'Days to Recover' time greater than 7 days. 'Days to Recover' are measured after the system stress commences. They represent the time commencing from the initial day during which the reservoir is unable to be restored to its maximum full level, and ending on the day when the reservoir is capable of reaching its maximum full level.

Details of the each scenario, including system stress assumptions and calculated results, are presented in Appendix E. System stress results are summarized in Table 12 and are further discussed below.

Table 12 - Summary of System Stress Scenarios

System Stress Scenario	System Stresses			Days to Recover[2]	Max. No. of Dwelling Units[3] (Equivalent pop.)
	7-day Max. Demand	Production Well Availability	Demand fr. Springwater[1]		
1	Yes	A10, A11, A20 avail.	No demand	7	1 214 (3 520)
2	Yes	A10, A11, A20 avail.	Full demand	7	1 064 (3 090)
3	Yes	A20 *not* avail.	No demand	6	764 (2 215)
4	Yes	A20 *not* avail.	Full demand	6	614 (1 780)
5	Yes	A10 *not* avail.	No demand	8	564 (1 640)
6	Yes	A10 *not* avail.	Full demand	Fail	514 (1 490)

Notes:

1. *No demand - assumes Well S4 is available and Springwater Place is self-sustaining.*
   Full demand - assumes Well S4 is out-of-service and the Applewood Acres system is supplying all demands from Springwater Place based on a current connected dwelling units = 150.
2. *No. of days required to restore the water reservoir to 'full' operating level, after system stress commences.*
3. *Maximum number of dwelling units supported by the stated system stresses to reach a 'Days to Recover' of 7 days. Stated maximum no. of dwelling units includes 514 existing connected dwelling units (1 490 people) + future growth connections to Applewood Acres system.*

System Stress Scenario 1: Represents typical day-to-day operation with all production wells available, but stressed by a maximum 7-day demand condition. Approximately 1 214 dwelling units (514 exist. + 700 future) would stress the system to a 7-day recovery period.

System Stress Scenario 2: Represents same conditions as Scenario 1, but with the added system stress of full demand from Springwater Place. Approximately 1 064 dwelling units (514 exist. + 550 future) would stress the system to a 7-day recovery period.

System Stress Scenario 3: Represents situation where Well A20 is not available for production during a maximum 7-day demand condition, and Springwater Place is self-sufficient. Approximately 764 dwelling units (514 exist. + 250 future) would stress the system to a 6-day recover period.

System Stress Scenario 4: Represents same situation as Scenario 3, but with the added system stress of full demand from Springwater Place. Approximately 614 dwelling units (514 exist. + 100 future) would stress the system to a 6-day recover period.

System Stress Scenario 5: Represents same situation as Scenario 3, but with Well A10 (instead of Well A20) not available for production during a maximum 7-day demand condition. Springwater Place is self-sufficient. Approximately 564 dwelling units (514 exist. + 50 future) would stress the system to an 8-day recover period.

System Stress Scenario 6: Represents same situation as Scenario 4, but with Well A10 (instead of Well A20) not available for production. Includes stresses of a maximum 7-day demand and full demand from Springwater Place. Under these conditions the system is unable to recover (i.e., system failure occurs) at the existing 514 dwelling units. Therefore, system cannot support existing development load.

Of the scenarios evaluated and presented in Table 12, the reasonable 'worst-case' condition is considered to be represented by Scenario 5. The operating conditions of Scenario 5 are based on the 7-day maximum demand, Well A10 (largest production well) being out-of-service, and no demand from Springwater Place (i.e., Springwater Place is self-sufficient). Based on these conditions, approx. 564 dwelling units (i.e., 514 existing + 50 new) will stress the Applewood Acres system to the point where a 7-day period is required to restore the elevated water reservoir to a full level. At no time during this period is the fire flow capacity impacted. The 564 dwelling units represents a service population of approx. 1 640 people.

Therefore, the assumed maximum future growth currently sustainable by the Applewood Acres water system is calculated at 50 new dwelling units (approx. 145 additional people), based on the assumed system stresses represented by Scenario 5. Additional future growth greater than 50 units can be sustained if greater risk tolerances are accepted.

11.4 System Redundancy

Minimizing risk associated with 'worst-case' system operating conditions is an important component of the Village's Water Management Plan. Risk reduction can be attained through preventative equipment maintenance (see Section 10 – Operation, Maintenance and Asset Management), and by providing system redundancy of key infrastructure components.

Based on the system stress scenarios presented herein, the addition of new production well capacity would enhance system operating flexibility and enable greater future growth opportunities with reduced operating risk. The addition of a well (or wells) with a sustainable yield equal to, or greater than, the Village's largest production well (i.e., Well A10) would add immediate back-up redundancy should well failure occur.

For example, assuming the addition of a fourth (new) large capacity well available to the Applewood Acres system, then Scenario 2 would represent the availability of three (3) production wells and would account for one (1) large capacity production well being out-of-service. Under Scenario 2, the 7-day maximum demand and full demand from Springwater Place (i.e., Well S4 out-of-service) are applied as system stresses. The future growth potential was calculated at greater than a total of 764 serviced dwelling units (> 2 200 people), which represents an increase of 250 dwelling units over the existing 514 units.

Additional well production capacity will also allow for the removal of any existing well from service for scheduled maintenance, without concern for meeting average and maximum day demand situations.

11.5 Future Water Source Exploration

The future growth potential of the Village's Applewood Acres communal water system is dependent upon locating and developing addition water sources. The addition of redundant water source capacity will allow for continued growth and enable the Applewood Acres system to withstand potential 'worst-case' operating conditions.

A primary component of the Village's Water Management Plan involves continued exploration for new groundwater sources within the Village boundaries. A new production well positioned within an aquifer separate from the existing Applewood and Springwater wellfields represents the most favourable level of redundancy. A third wellfield would provide additional risk reduction in the event of contamination or water quality deterioration of any one aquifer.

Potential well exploration sites identified by previous hydrogeological studies are provided in Appendix A in tabular form and on Village aerial mapping. One potential area of known groundwater resources is represented on the aerial mapping provided in Appendix A as observation wells TW05-1, TW05-2, TW05-3 and TW05-4. These wells, positioned remote from the Applewood and Springwater wellfields in the Village's southeast quadrant, represent known production quality and quantities. Initial well exploration undertaken in 2005 on behalf of a private developer suggested potential yield capacities in the 20 to 100 Igpm (1.5 to 7.6 L/s) range.

Another potential area for well exploration is the area surrounding the New Maryland Centre, located at the Village's extreme southern boundary and immediately west of Highway 101 (i.e., southwest quadrant). Well drilling records of two existing observation wells indicate potential water quantities in the 100 to 150 Igpm (7.6 to 11.3 L/s) range.

11.6 Plan Elements

It is the Village's intention to incorporate the following elements as part of the 'Future Developments' portion of the VONM Water Management Plan:

1. Prepare options for increasing revenue sources for further well exploration and aquifer development.

2. Prepare an annual review of the system stress simulation calculations based on the general methodology identified in this section.

3. Undertake exploration efforts within the Village and outside of existing wellfields to secure an additional production well(s) located in a new wellfield. Prepare options for further evaluation of existing observation wells located in the Village's southeast and southwest quadrants as potential production wells. The options may include additional new well exploration in these areas.

12 Plan Elements – Summary

This section provides a summary listing of the 'Plan Elements' as presented in each section of this Water Management Plan.

Section 2 - Foundation Components

1. Adopt the following resolution as a public commitment to adhering to the proposed Water Management Plan, as defined herein by this document:

   The Village of New Maryland Mayor and Council are dedicated to providing its citizens with quality water and customer service in a manner that protects the natural environment, supports a strong economy and promotes a robust community, and which is based on the goals, objectives and sustainability principles identified in the Village's Municipal Plan By-law.

2. Annual review of the Water Management Plan to confirm that the original goals and objectives remain valid and relevant to the Village's sustainability principles identified in the Village's Municipal Plan By-law.

Section 3 - Service Areas, Water Resources

3. Existing surface water sources located within the Village (i.e., Baker Brook, Rusagonis Stream) are not considered as suitable drinking water sources.

4. Exploration for future water supply within the Village boundaries is limited to groundwater sources, due to the lack of suitability available surface water sources.

Section 4 - Water System Infrastructure

5. Maintain and update annually an inventory of the Village water system infrastructure, as generally outlined in this section.

6. Develop a long-range asset management plan that will replace aging water infrastructure in accordance with Public Sector Accounting Board (PSAB) standards and recognized best asset management practices.

7. Undertake annual calculations comparing current and ultimate service population capabilities of each Village water storage reservoir.

Section 5 - Water Quality

8. Undertake an annual assessment of organic and inorganic water quality parameters for each Village production well. Report the results in a format similar to that presented herein.

9. Continue to monitor all production well manganese concentrations. Review manganese removal treatment options, especially for Wells A11 and A20.

10. If excessive raw water manganese concentrations prove to be of operation and maintenance concern, undertake to devise a manganese removal treatment strategy.

11. Create and maintain a summarized version of the analytical results for the Village's bacteriological data base.

Section 6 - Water Production

12. Maintain daily production volumes, flow rates and pump run-time records for all production wells.

13. Undertake an annual calibration of all flow meters to ensure the most accurate well production measurements. Confirm actual well yield flow rates.

14. Periodically (every 3 to 5 years) undertake a hydrogeological evaluation to assess the rated safe-yield sustainability of individual production wells and associated aquifers. Utilize water production volumes and flow rates, and well level drawdown/recovery data obtained from production and observation wells.

15. Obtain groundwater level data annually from Environment Canada's Victoria Hall well monitoring station. Undertake a comparative historical review of data groundwater levels at the Victoria Hall location.

16. Prepare an annual report summarizing water production data and calculations based on a current 3-year period. Compare actual well pump rates to the re-confirmed rated safe-yield capacity to determine if well pump capacities remain sufficient and sustainable. Determine what well capacity improvements, if any, are needed.

Section 7 - Water Consumption

17. Undertake an annual assessment of the Village's water demand using quarterly water meter data.

18. Present annual water consumption data on the Village website, and/or as bill stuffers accompanying residential water/sewage invoice mail-outs.

19. Encourage the following water conservation measures:

    a) Installation of low water use/flow plumbing fixtures (i.e., toilets) and appliances (laundry washers, dish washers).

    b) Avoidance of lawn watering during high evaporation time-of-day periods.

    c) Public water conservation awareness and effective public water conservation education, using printed materials such as American Water Works Association (AWWA) Value of Water.

    d) Low water use and low-flow plumbing fixtures in new home construction.

Section 8 - Water Supply Losses

20. Review and assess the merits of developing and implementing an annual water audit process, utilizing similar concepts and procedures as outlined in the American Water Works Association (AWWA) Manual of Water Supply Practices M36 – Water Audits and Leak Detection.

21. Document and estimate, where possible, all non-revenue water uses occurring within the Village's water supply and distribution piping network.

22. Document all leak repairs to the Village's water supply and distribution piping system as part of normal O&M routine and practice.

Section 9 - Water Resource Protection

23. Develop a municipal source water protection plan for the wellfield protection areas in Applewood Acres, and Springwater Place (and potentially for Well 3A). Such a plan would involve applying appropriate management practices to the surface water catchment areas. Components of the plan could include an advisory committee, catchment boundary delineation (wellfield delineation has already been completed), risk assessment, and water quality monitoring and evaluation.

24. Install signage along the Trans-Canada Highway Route No. 2 that brings awareness to vehicular traffic that a designated section of the highway passes through a drinking water wellfield protection zone.

Section 10 – Operation, Maintenance and Asset Management

25. Attain and maintain the appropriate levels of operator certification for the water system O&M staff.

26. Prepare a comprehensive manual documenting the operational and performance standards required for the Village's communal water supply and distribution systems.

27. Provide the necessary resources to enable O&M staff to carry out their duties efficiently, effectively and in a timely manner.

28. Update annually the digital mapping for water supply and distribution system infrastructure.

29. Advance the foundational asset management work already developed by the Village. Continue to focus on establishing the core asset management fundamentals (i.e. inventory, condition, levels of service) that will support improved decision making for asset renewal and replacement.

30. Develop an initial Asset Management Plan that documents current practices, processes and tools used to support water asset management. Establish short-term (5-year) and long term (30-years) investment plans, and an asset management improvement plan.

31. Evaluate current O&M vulnerabilities and the Village's ability to maintain drinking water supply during emergency situations.

32. Evaluate potential impacts of climate change on future design, operation and maintenance considerations of the Village's drinking water supply and distribution systems.

Section 11 - Future Development

33. Prepare options for increasing revenue sources for further well exploration and aquifer development.

34. Prepare an annual review of the system stress simulation calculations based on the general methodology identified in this section.

35. Undertake exploration efforts within the Village and outside of existing wellfields to secure an additional production well(s) located in a new wellfield. Prepare options for further evaluation of existing observation wells located in the Village's southeast and southwest quadrants as potential production wells. The options may include additional new well exploration in these areas.

Appendix A

- **Table A1 - VONM Existing and Former Water Supply Well Locations**

- **Table A2 - VONM Potential Water Supply Well Locations**

- **VONM Well and Water Supply/Distribution Piping System Locations – Map**

APPENDIX A
Table A1 - Summary of VONM Existing and Former Water Supply Well Locations

Item No.	Well ID	Location	PID	Provincial Well ID	Depth m	Safe-Yield Capacity Igpm	Safe-Yield Capacity Litres/sec.	Well Status[1]	Decomission Date
1	**A20**	Applewood Acres - 222 Gravenstein	75371682		128.0	75	5.7	Prod.	*NA* [2]
2	**A11**	Applewood Acres - 296 Gravenstein	75259754		112.7	20	1.5	Prod.	*NA*
3	**A10**	Applewood Acres - 254 Gravenstein	75331033			80	6.1	Prod.	*NA*
4	**S2**	309 Woodlawn Lane - rear corner	75403956					Prod. (stand-by)	
5	**S4**		75318725			20	1.5	Prod.	*NA*
6	**A3**	Hwy. 101/MacIntosh Intersection	75259762					Obser.	
7	**1A-West**	Chen Property	75064667	54223	152.4	20	1.5	Obser.	
8	**1B-West**	Chen Property	75064667	54224	121.9	8	0.6	Obser.	
9	**ENV. CAN**	466 NM Hwy. - green hut	75061689					Obser.	
10	**NMC-10**	North of New Maryland Center	75290791	38783	105.2	90	6.8	Obser.	
11	**NMC-10A**	NM Centre parking lot	75290791	24223	121.9	150	11.4	Obser.	
12	**P2**	44 Doherty Street	75260083			16	1.2	Obser.	
13	**TW #3**	Intercan Property	75062042					Obser.	
14	**TW #4**	Intercan Property	75062042					Obser.	
15	**TW05-1**	Arsam Property	75062174		91.4	65	4.9	Obser.	
16	**TW05-2**	Arsam Property	75062174		97.5	100	7.6	Obser.	
17	**TW05-3**	Arsam Property	75062174		91.4	20	1.5	Obser.	
18	**TW05-4**	Arsam Property	75062174		103.6	60	4.5	Obser.	
19	**3**	SW of Pine Ridge Estates	75265793		67.1	90	6.8	Obser.	
20	**3A**	SW of Pine Ridge Estates	75486670		91.4	150	11.4	Obser.	
21	**11**	West of Pine Ridge Estates	75071076		113.4	20	1.5	Obser.	
22	**11A**	West of Pine Ridge Estates	75486670					Obser.	
23	**A1**	Gravenstein	75259796		82.7			Decom.	2007
24	**A2**	7 Gravenstein	75259770		100+			Decom.	2007
25	**A4**	Gravenstein/Well A20 Intersection	75330175		100+	5	0.4	Decom.	2007
26	**A5**	100 Gravenstein	75066001		36.3			Decom.	2007
27	**A6**	3 Melrose	75317537		119.0	18	1.4	Decom.	
28	**A7**	Berkley/Melrose Trail	75368498		144.0	2.5	0.2	Decom.	
29	**A8**	Betw. 27 Baldwin and 10 Melba	75331041		115.0	3	0.2	Decom.	
30	**A9**		75061986		-			Decom.	
31	**F1**	214 NM Hwy. - rear lot	75489575		260.0			Decom.	2012
32	**F2**	28 Crown Avenue	75259937					Decom.	?
33	**P1**	42 Doherty Street	75076976		78.9			Decom.	2014
34	**S1**		75150508		29.5			Decom.	2007
35	**S3**		75407163					Decom.	

Notes:

1. *Prod. - production well; Obser. - observation well; Decom. - decommissioned well*

   Production Well
   Observation Well
   Decommissioned Well

2. *NA - Not Applicable*

APPENDIX A

Table A2 - Summary of VONM Potential Water Supply Well Locations

Item No.	Well ID	Location	PID	Well Status
1	**1A-West**	West of Hwy. 101	75064667	Potentent Site[1]
2	**1B-West**	West of Hwy. 101	75064667	Potentent Site
3	**2-West**	West of Hwy. 101	75062604	Potentent Site
4	**4-West**	West of Hwy. 101	01501931	Potentent Site
5	**5-West**	West of Hwy. 101	75064865	Potentent Site
6	**6-West**	West of Hwy. 101	01501931	Potentent Site
7	**7-West**	West of Hwy. 101	75061382	Potentent Site
8	**8-West**	West of Hwy. 101	75065318	Potentent Site
9	**9-West**	West of Hwy. 101	75242396	Potentent Site
10	**1-East**	East of Hwy. 101	75062042	Potentent Site
11	**2-East**	East of Hwy. 101	75242990	Potentent Site
12	**3-East**	East of Hwy. 101	75061820	Potentent Site
13	**4-East**	East of Hwy. 101	75061820	Potentent Site
14	**5-East**	East of Hwy. 101	75260323	Potentent Site
15	**TW #1**	Intercan Property	75062042	Potentent Site
16	**TW #2**	Intercan Property	75062042	Potentent Site

Notes:

1. *Target on map only, not yet drilled.*

Revision	Amendment	Approved	Revision Date

OPUS
Fredericton Office
+1 506 451 0055
80 Bishop Drive
Fredericton NB E3C 1B2
Canada

Designed	Approved	Approved Date
S.PYKE		2016-03-02

Drawn	Scale
PRC	1:8000

Project
VILLAGE OF NEW MARYLAND
WATER MANAGEMENT PLAN

Sheet
LOCATION OF VONM WELLS AND WATER SUPPLY / DISTRIBUTION PIPING SYSTEMS

Project No.	Sheet. No.	Revision
C-84507.60	001	0

Original Sheet Size A1 [841x594] Plot Date 2016-04-06 at 3:28:34 PM Path G:\JOBFILES\800\845_NewMaryland\C-84507.60 - Water Management Plan (2015)\04_Project Working Files\C-84507.60-001.dwg C-84507.60-001

Appendix B

- **Table B1 - Inorganic Test Results for Wells A10, A11, A20 and S4**
- **Raw Water Quality Graphs – Inorganic Parameters**
- **Table B2 - Organic Test Results for Wells A10, A11, A20 and S4**

Village of New Maryland
Water Management Plan - 2016

APPENDIX B

Table B1 - Inorganic Testing Results for Wells A10, A11, A20 and S4

Well A10 Inorganic Results

Parameter	Units	M.A.C.	A.O.	L.O.Q.	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alkalinity	mg/L				128	129	116	112	129			123	
Arsenic	µg/L	10			1.5	1.5	1.9	1.5	1.5			1.5	
Barium	mg/L	1.0			0.145	0.155	0.145	0.187	0.135			0.165	
Boron	mg/L	5.0			0.027	0.021	0.01	0.011	0.018			0.01	
Calcium	mg/L	None required			53.8	57.6	87.3	97.8	67.2			87.9	
Chloride	mg/L		≤ 250		26	32.8	85.8	93.7	41.3			67.3	
Iron	mg/L		≤ 0.3		0.048	0.038	0.123	0.022	0.01			0.01	
Magnesium	mg/L	None required			3.29	3.56	6.94	6.08	4.2			6.06	
Manganese	mg/L		≤ 0.05		0.2	0.14	0.006	0.005	0.005			0.005	
pH			6.5 - 8.5		8.04	7.73	7.84	7.99	8.14			7.67	
Potassium	mg/L				0.6	0.6	1.2	1.1	0.9			1.1	
Sodium	mg/L		≤ 200		19	19.4	10.8	12.1	16.4			14.7	
Sulfate	mg/L		≤ 500		19.1	19.8	6.6	44.3	26.4			41.5	
Total Hardness	mg/L				148	158	247	243	185			244	
Turbidity	NTU	1			0.2	0.2	1.7	0.2	0.2			0.2	
Zinc	mg/L		≤ 5.0		0.005	0.005	0.061	0.018	0.005			0.005	

Well A11 Inorganic Results

Parameter	Units	M.A.C.	A.O.	L.O.Q.	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alkalinity	mg/L				140	140	137	124	123	118	124	121	128
Arsenic	µg/L	10			2.5	2.6	2.3	2.4	2.4	3.3	2.3	2.1	2.9
Barium	mg/L	1.0			0.123	0.123	0.113	0.122	0.116	0.21	0.108	0.21	0.164
Boron	mg/L	5.0			0.036	0.033	0.034	0.032	0.031	0.01	0.035	0.016	0.034
Calcium	mg/L	None required			21.4	21.4	20.8	22	22.5	48.4	23.8	46.5	42
Chloride	mg/L		≤ 250		9.01	7.51	11.1	16.1	14.6	21	12.2	18.9	18.9
Iron	mg/L		≤ 0.3		0.01	0.01	0.01	0.01	0.01	0.175	0.01	0.021	0.026
Magnesium	mg/L	None required			0.64	0.63	0.65	0.69	0.76	4.3	0.89	3.28	3.1
Manganese	mg/L		≤ 0.05		0.051	0.051	0.071	0.057	0.065	0.39	0.058	0.28	0.31
pH			6.5 - 8.5		8.46	8.19	8.42	8.45	8.46	8.07	8.29	8.07	8.1
Potassium	mg/L				0.4	0.2	0.3	0.3	0.3	0.6	0.3	0.5	0.6
Sodium	mg/L		≤ 200		48.9	47.9	49	48.8	45.3	11.2	44.8	16.1	19.5
Sulfate	mg/L		≤ 500		9.31	10.4	10.8	11.8	11.7	13.8	10.5	14.1	11.1
Total Hardness	mg/L				56.1	55.9	54.6	57.9	59.4	139	63	130	118
Turbidity	NTU	1			0.2	0.2	0.3	0.2	0.2	1	0.2	0.21	0.3
Zinc	mg/L		≤ 5.0		0.008	0.008	0.005	0.005	0.005	0.014	0.005	0.005	0.005

Well A20

Parameter	Units	M.A.C.	A.O.	L.O.Q.	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alkalinity	mg/L				104	108	115	122	101		118.5	121	126.5
Arsenic	µg/L	10			1.5	1.5	1.5	1.5	1.5		1.5	1.5	1.5
Barium	mg/L	1.0			0.093	0.128	0.105	0.14	0.105		0.1435	0.142	0.252
Boron	mg/L	5.0			0.027	0.023	0.024	0.028	0.024		0.0275	0.0305	0.0315
Calcium	mg/L	None required			37.8	54.4	27.9	33.8	27.9		36.65	33.25	32.75
Chloride	mg/L		≤ 250		17.9	32.4	15.7	17	15.7		18.95	14.65	13.9
Iron	mg/L		≤ 0.3		0.067	0.031	0.097	0.093	0.097		0.025	0.034	0.06
Magnesium	mg/L	None required			1.6	2.38	1.11	1.41	1.11		1.53	1.445	1.385
Manganese	mg/L		≤ 0.05		0.03	0.018	0.039	0.12	0.039		0.115	0.15	0.38
pH			6.5 - 8.5		7.97	7.74	8.28	8.22	8.28		8.08	8.08	8.085
Potassium	mg/L				0.4	0.4	0.4	0.4	0.4		0.4	0.4	0.4
Sodium	mg/L		≤ 200		20	13.5	28.7	33.2	28.7		31.1	33.7	32.3
Sulfate	mg/L		≤ 500		16.2	18.6	13.3	12.2	13.3		12.6	10.05	9.39
Total Hardness	mg/L				101	146	74.3	90.2	74.3		97.85	89.05	87.5
Turbidity	NTU	1			0.77	0.21	0.31	0.26	0.31		0.29	0.325	0.8
Zinc	mg/L		≤ 5.0		0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005

Well S4

Parameter	Units	M.A.C.	A.O.	L.O.Q.	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alkalinity	mg/L										166	164	159
Arsenic	µg/L	10									1.5	1.5	1.5
Barium	mg/L	1.0									0.088	0.0905	0.086
Boron	mg/L	5.0									0.038	0.0335	0.046
Calcium	mg/L	None required									18.3	18.85	16.9
Chloride	mg/L		≤ 250								23.4	19.75	23
Iron	mg/L		≤ 0.3								0.01	0.01	0.01
Magnesium	mg/L	None required									0.67	0.705	0.61
Manganese	mg/L		≤ 0.05								0.006	0.005	0.005
pH			6.5 - 8.5								8.35	8.15	8.14
Potassium	mg/L										0.4	0.4	0.3
Sodium	mg/L		≤ 200								74.4	76.45	71.3
Sulfate	mg/L		≤ 500								13.4	11.55	10.6
Total Hardness	mg/L										48.4	49.95	44.7
Turbidity	NTU	1									0.2	0.2	0.2
Zinc	mg/L		≤ 5.0								0.005	0.005	0.005

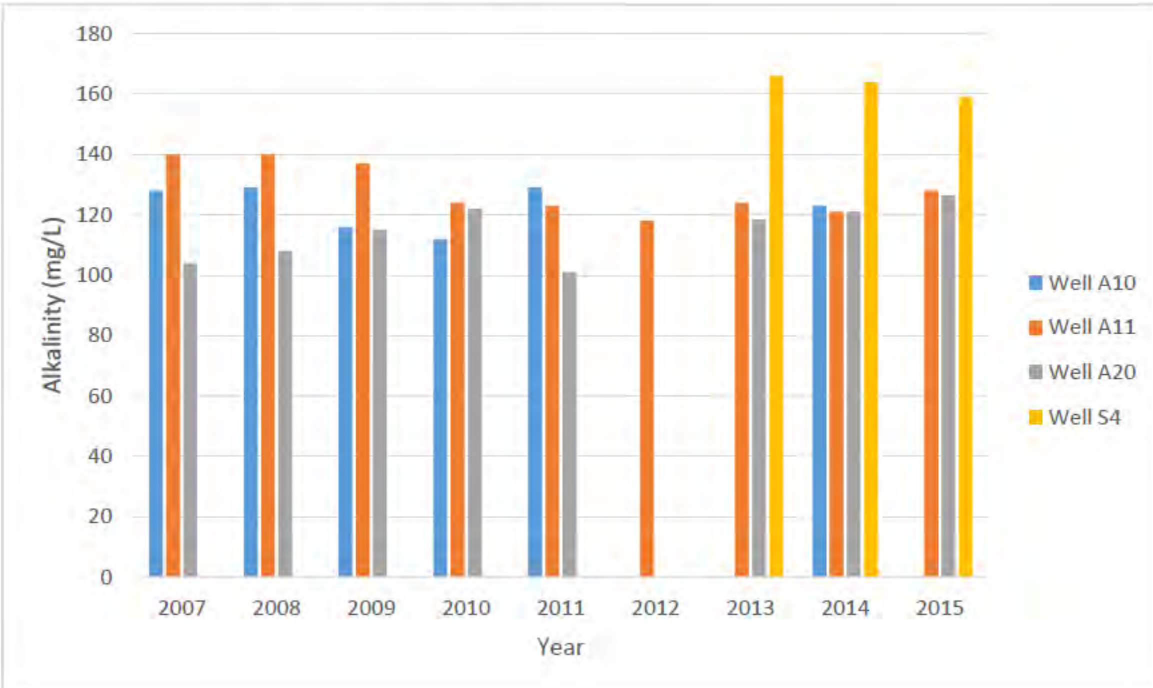
Units:
mg/L — milligrams per litre
µg/L — micrograms per litre
NTU — Nephelometric Turbidity Units

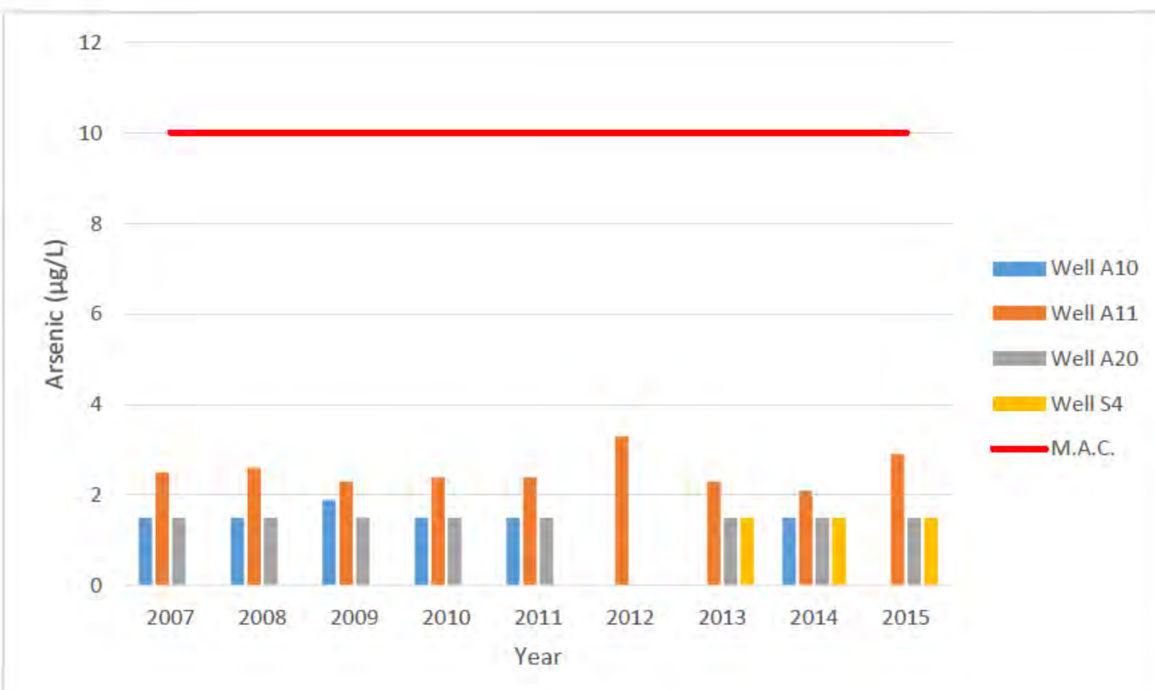
Notes:
1. Values in **RED** indicate that the parameter has exceeded either the M.A.C. or A.O.
2. Some values have been adjusted to the Limit of Quantification for graphing purposes.

APPENDIX B

Raw Water Quality Graphs - Inorganic Parameters

Wells A10, A11, A20 and S4 (2007-2015)

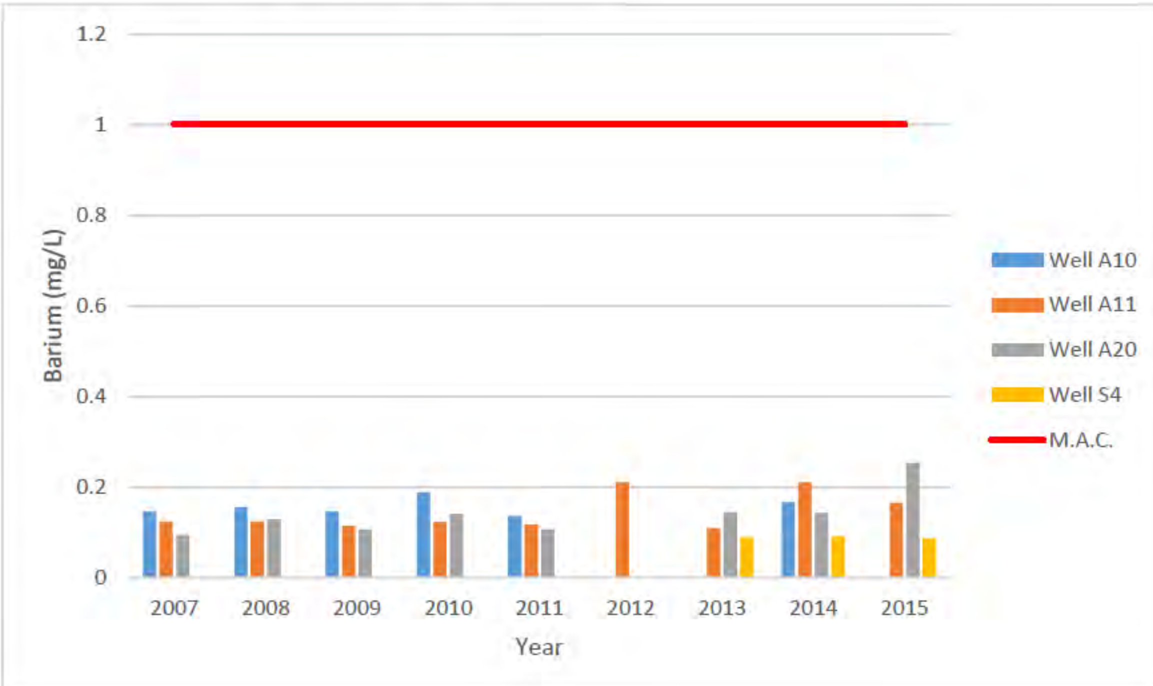


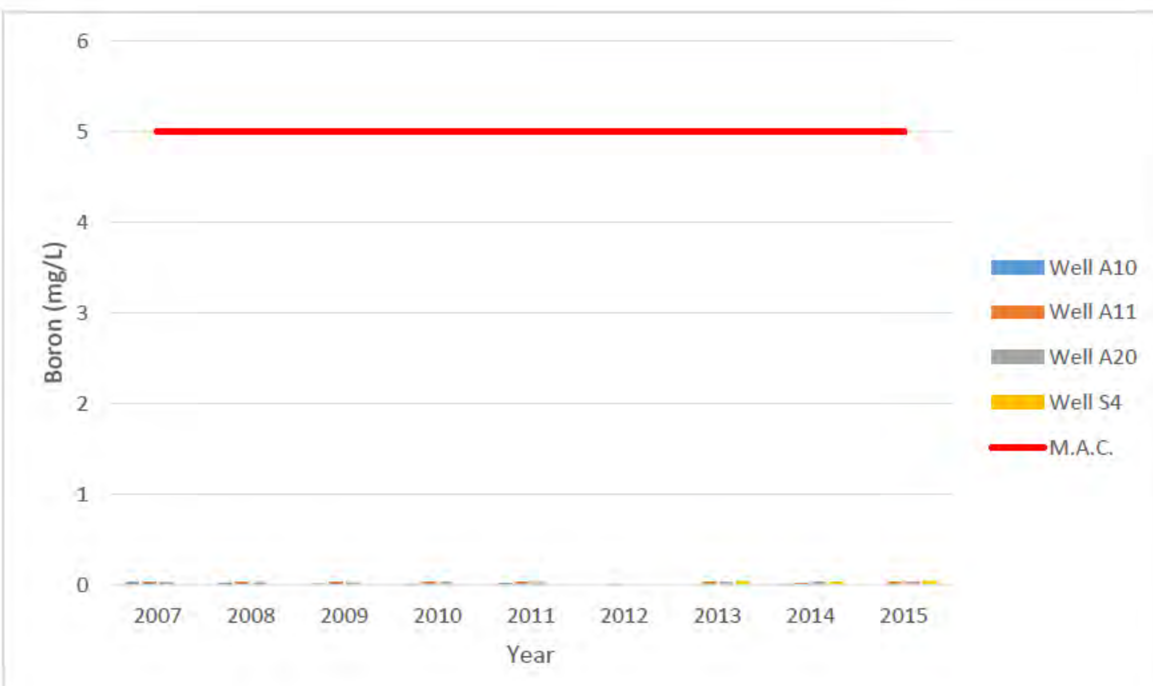


APPENDIX B

Raw Water Quality Graphs - Inorganic Parameters

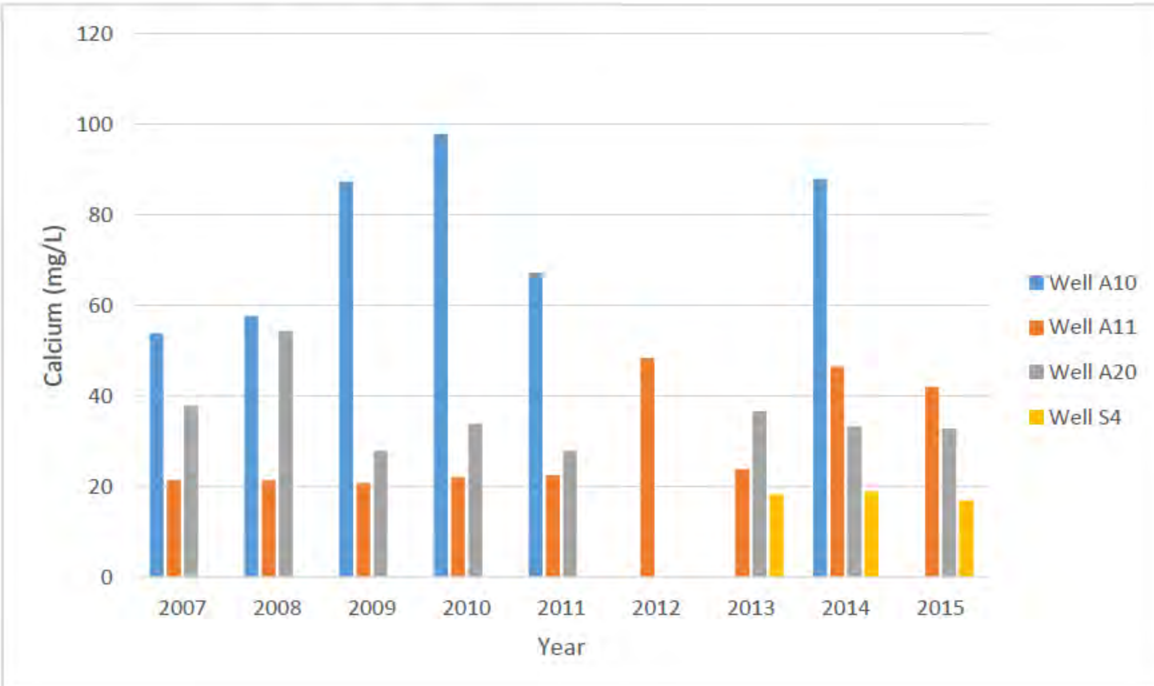
Wells A10, A11, A20 and S4 (2007-2015)

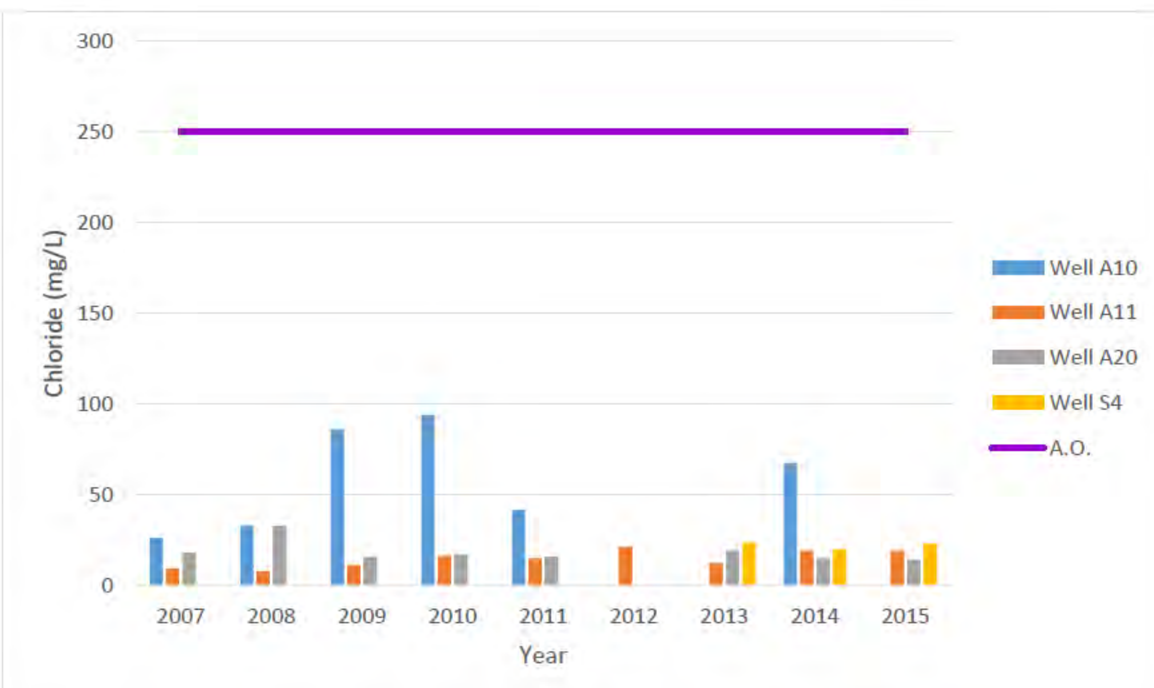




APPENDIX B

Raw Water Quality Graphs - Inorganic Parameters
Wells A10, A11, A20 and S4 (2007-2015)

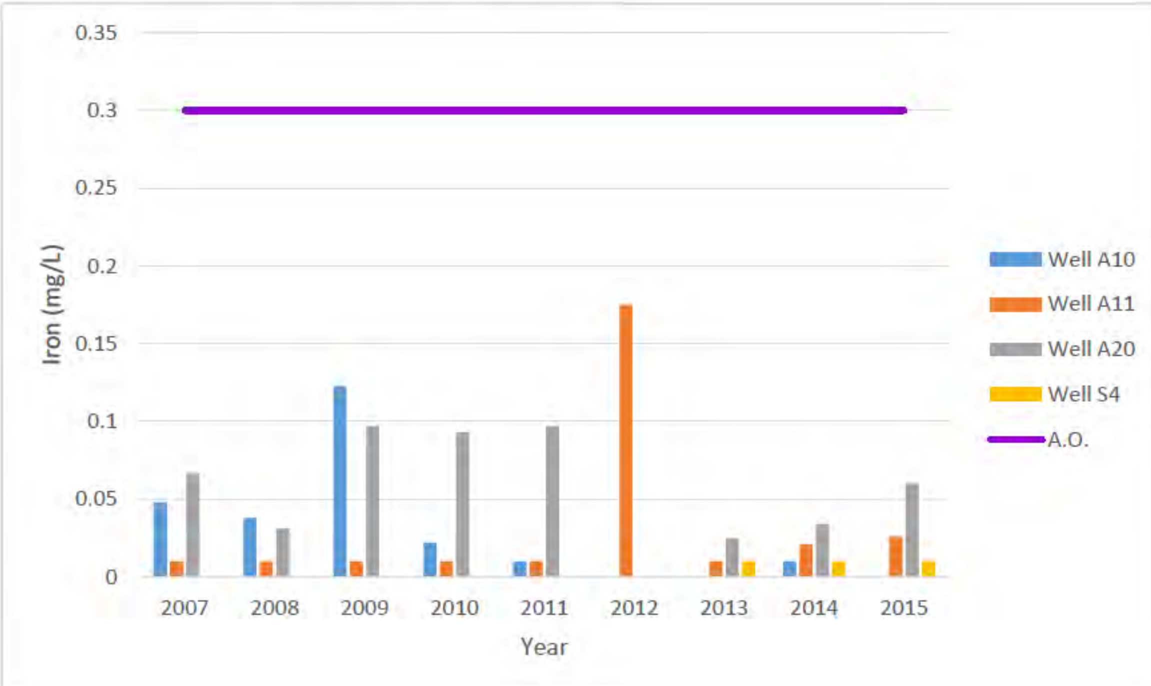


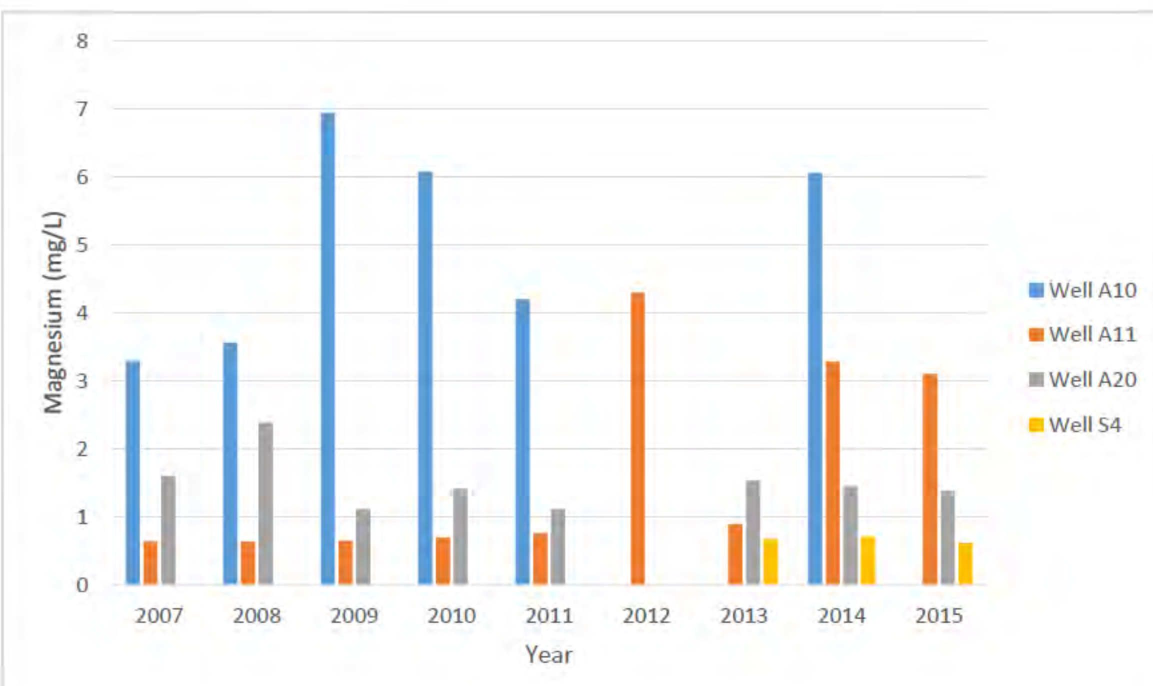


APPENDIX B

Raw Water Quality Graphs - Inorganic Parameters

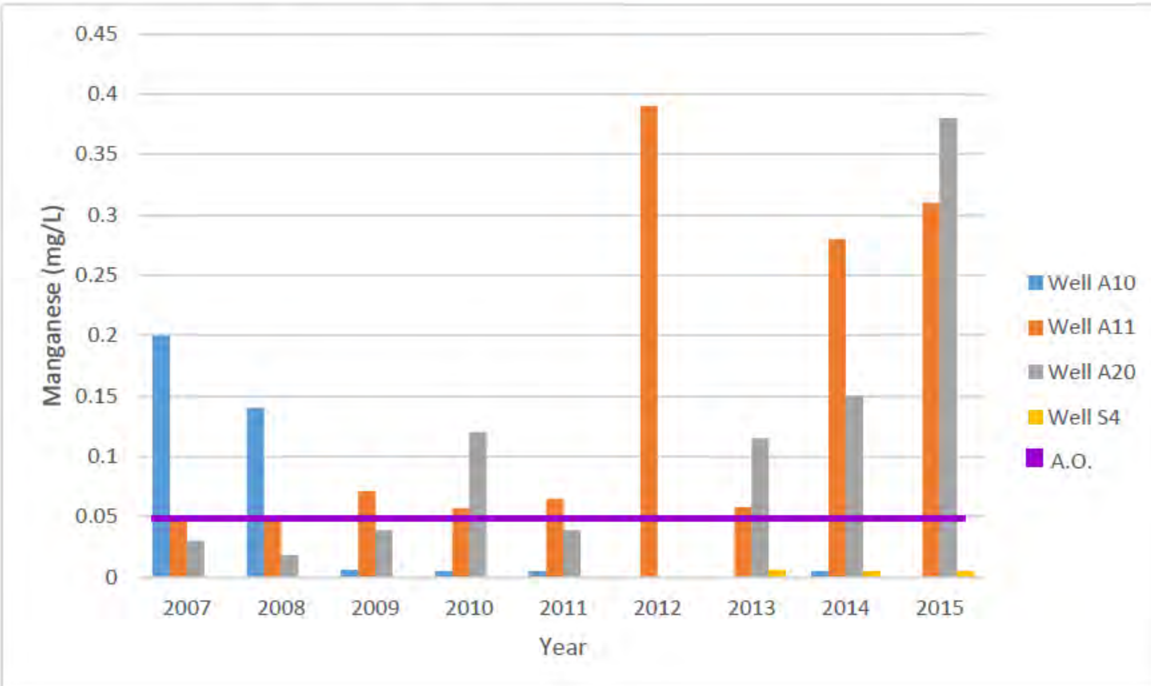
Wells A10, A11, A20 and S4 (2007-2015)

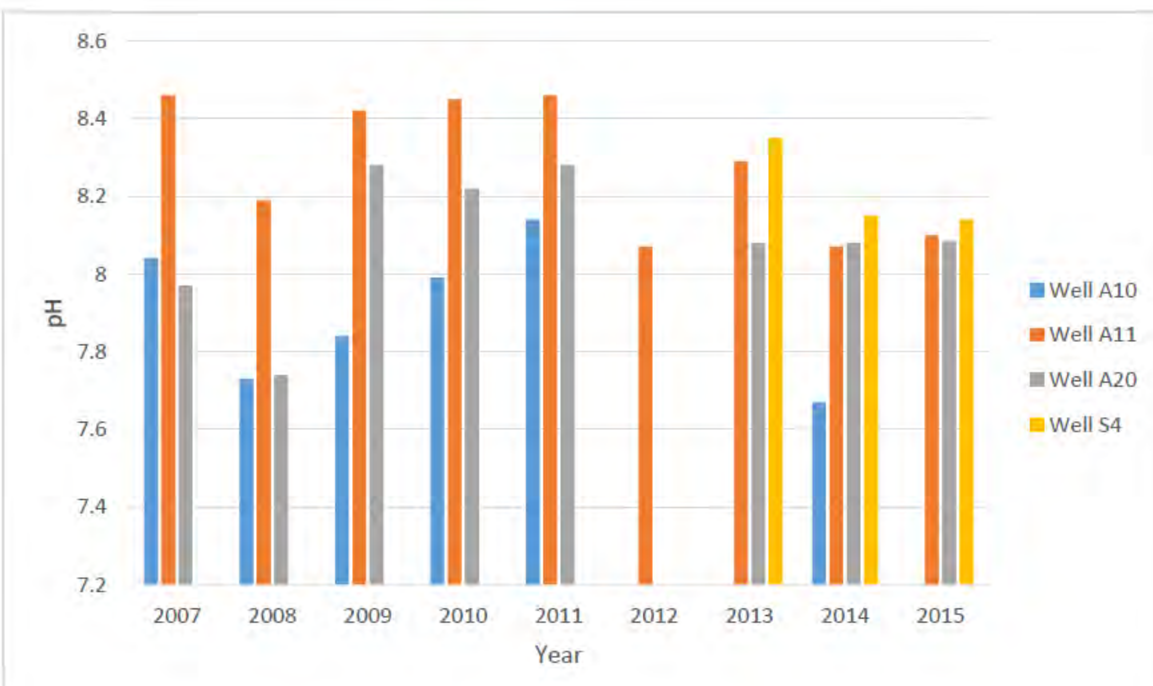




APPENDIX B

Raw Water Quality Graphs - Inorganic Parameters
Wells A10, A11, A20 and S4 (2007-2015)

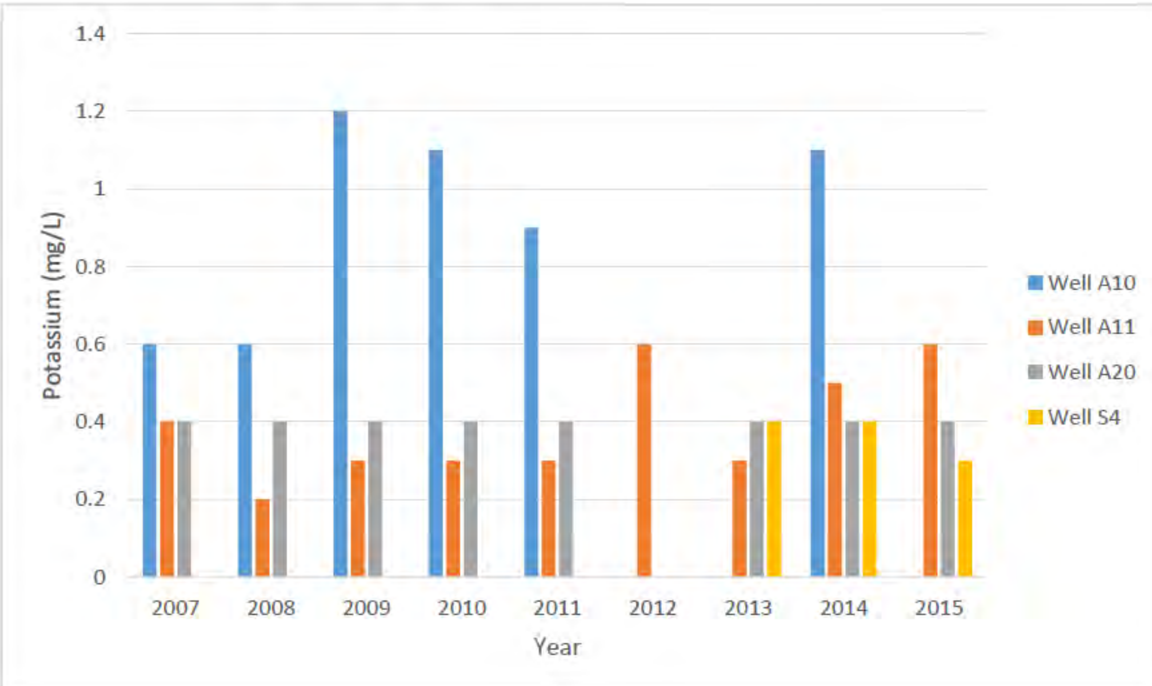


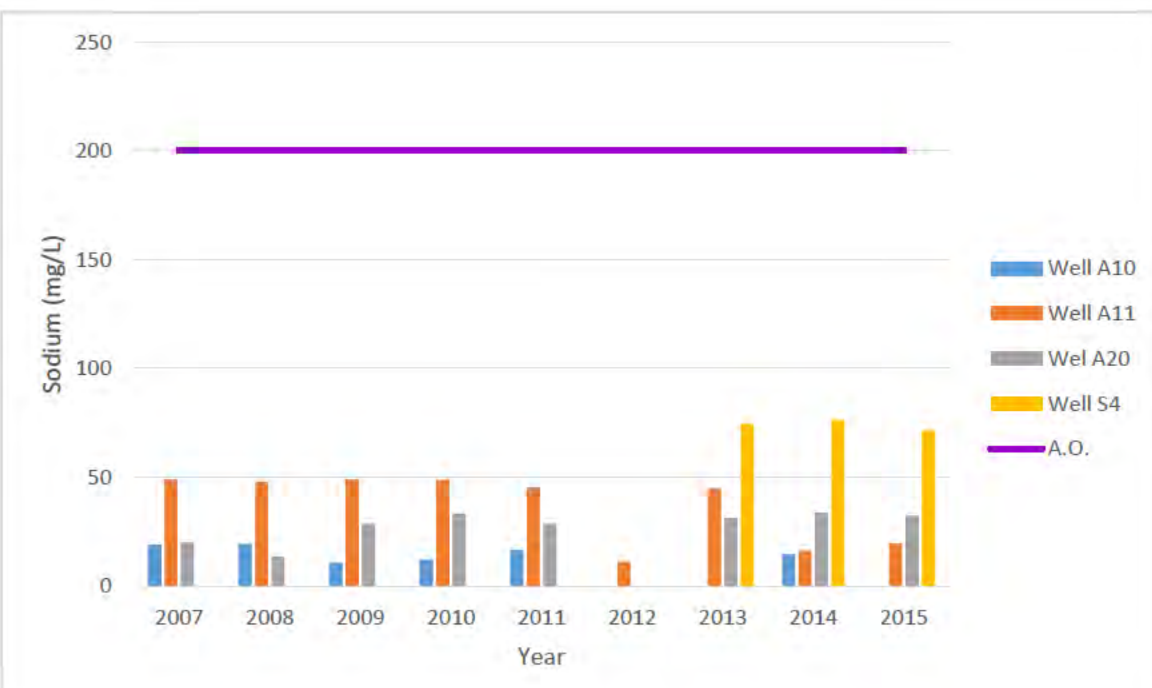


APPENDIX B

Raw Water Quality Graphs - Inorganic Parameters

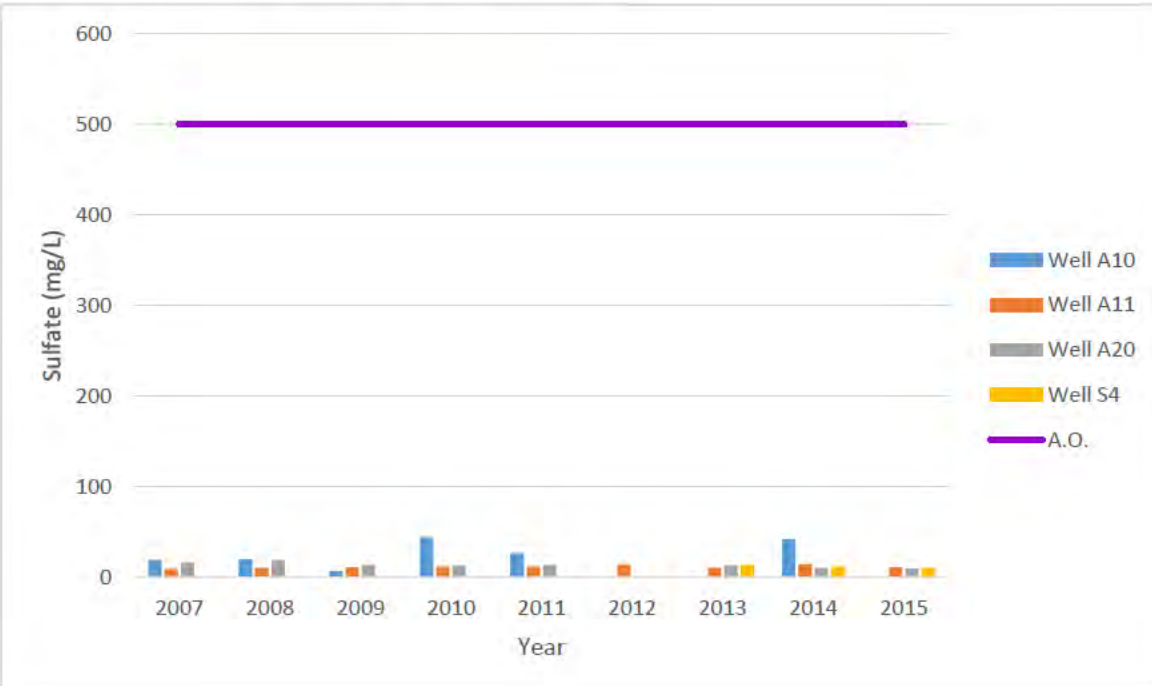
Wells A10, A11, A20 and S4 (2007-2015)

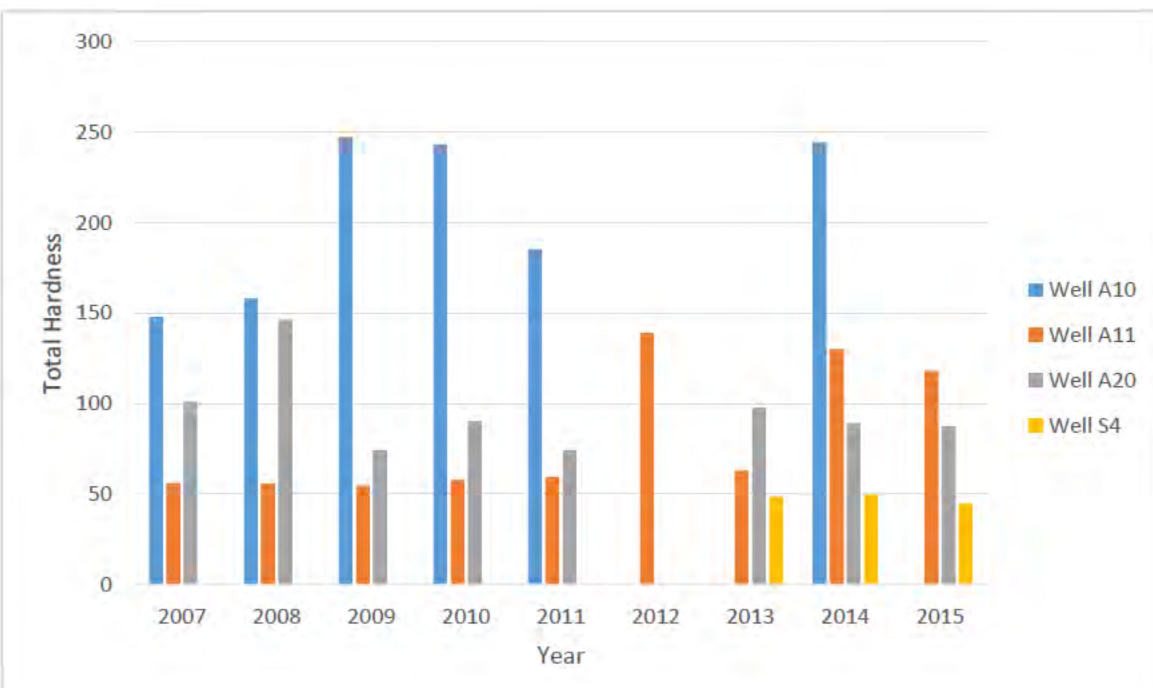




APPENDIX B

Raw Water Quality Graphs - Inorganic Parameters
Wells A10, A11, A20 and S4 (2007-2015)

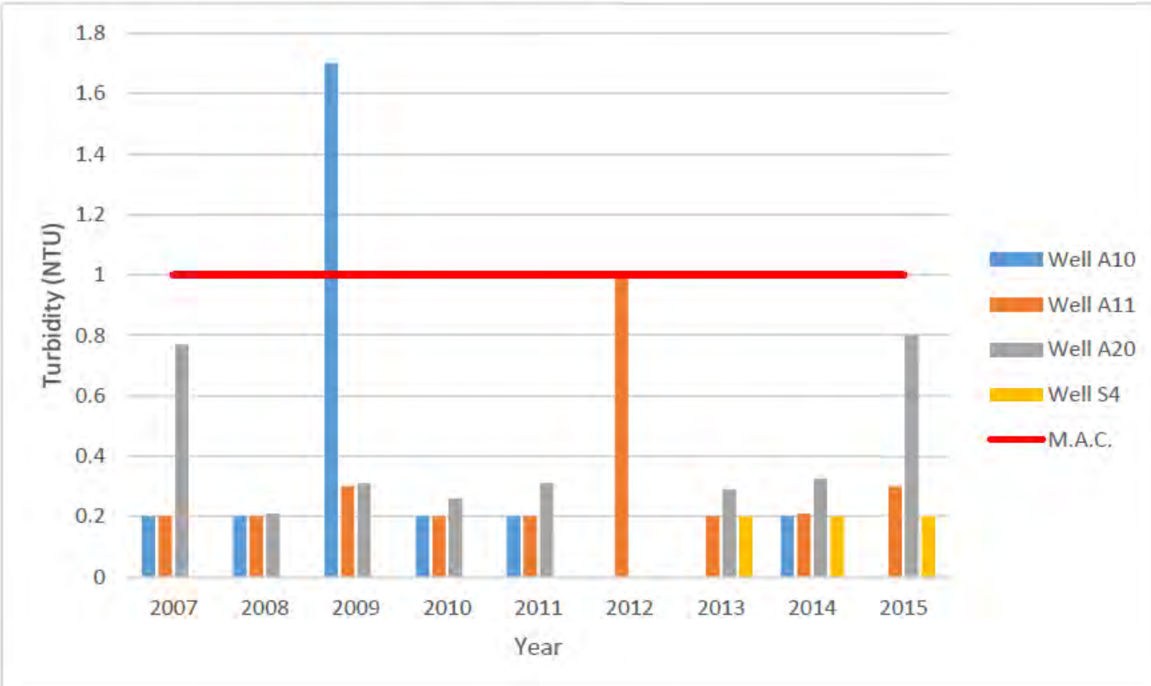


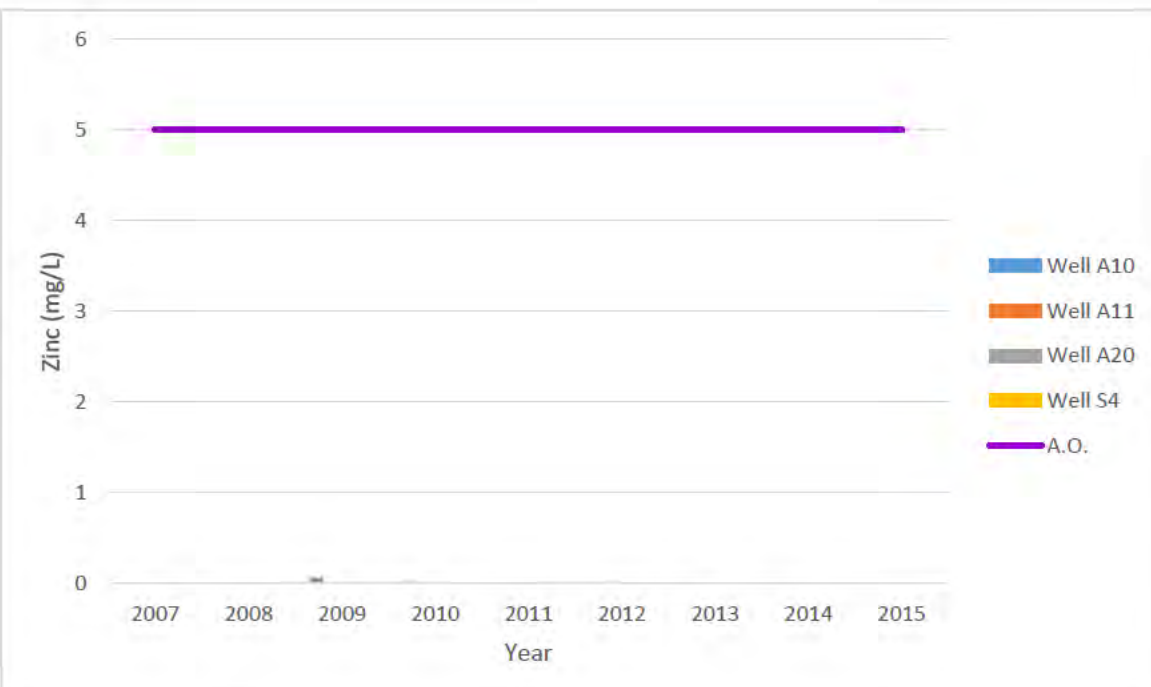


APPENDIX B

Raw Water Quality Graphs - Inorganic Parameters

Wells A10, A11, A20 and S4 (2007-2015)





APPENDIX B

Table B2 - Organic Testing Results for Wells A10, A11, A20 and S4

Well A10 Organic Results

Parameter	Units	H.A.L.	A.O.	2013		2014		2015	
Benzene	µg/L	5		ND	ND	ND	ND	ND	ND
Carbon tetrachloride	µg/L	5		ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	200		ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	5		ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	µg/L	5		ND	ND	ND	ND	ND	ND
Dichloromethane	µg/L	50		ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L		2.4	ND	ND	ND	ND	ND	ND
Tetrachloroethylene	µg/L	30		ND	ND	ND	ND	ND	ND
O-Xylene	µg/L							ND	ND
M&P-Xylenes	µg/L							ND	ND
Total Xylenes	µg/L		300	ND	ND	ND	ND	ND	ND
Toluene	µg/L		24	ND	ND	ND	ND	ND	ND
Trichloroethylene	µg/L	5		ND	ND	ND	ND	ND	ND
Vinyl Chloride	µg/L	2		ND	ND	ND	ND	ND	ND
Total Trihalomethanes	µg/L	100		ND	ND	ND	ND	ND	ND
Chloroform	µg/L			ND	ND	ND	ND	ND	ND
Bromodichloromethane	µg/L			ND	ND	ND	ND	ND	ND
Dibromochloromethane	µg/L			ND	ND	ND	ND	ND	ND
Bromoform	µg/L			ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	µg/L	0.01		ND	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	60		ND	ND	ND	ND	ND	ND

Well A11 Organic Results

Parameter	Units	H.A.L.	A.O.	2013		2014		2015	
Benzene	µg/L	5.0		ND	ND	ND	ND	ND	ND
Carbon tetrachloride	µg/L	5.0		ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	200		ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	5.0		ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	µg/L	5.0		ND	ND	ND	ND	ND	ND
Dichloromethane	µg/L	50		ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L		2.4	ND	ND	ND	ND	ND	ND
Tetrachloroethylene	µg/L	30		ND	ND	ND	ND	ND	ND
O-Xylene	µg/L							ND	ND
M&P-Xylenes	µg/L							ND	ND
Total Xylenes	µg/L		300	ND	ND	ND	ND	ND	ND
Toluene	µg/L		24	ND	ND	ND	ND	ND	ND
Trichloroethylene	µg/L	5.0		ND	ND	ND	ND	ND	ND
Vinyl Chloride	µg/L	2.0		ND	ND	ND	ND	ND	ND
Total Trihalomethanes	µg/L	100		ND	< L.O.Q.	ND	ND	ND	ND
Chloroform	µg/L			ND	< L.O.Q.	ND	ND	ND	ND
Bromodichloromethane	µg/L			ND	ND	ND	ND	ND	ND
Dibromochloromethane	µg/L			ND	ND	ND	ND	ND	ND
Bromoform	µg/L			ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	µg/L	0.010		ND	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	60		ND	ND	ND	ND	ND	ND

Well A20 Organic Results

Parameter	Units	H.A.L.	A.O.	2013				2014				2015		
Benzene	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	200		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloromethane	µg/L	50		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L		2.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethylene	µg/L	30		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
O-Xylene	µg/L											ND	ND	ND
M&P-Xylenes	µg/L											ND	ND	ND
Total Xylenes	µg/L		300	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L		24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethylene	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	µg/L	2.0		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Trihalomethanes	µg/L	100		55	ND	ND	ND	ND	ND	ND	ND	ND	< L.O.Q.	ND
Chloroform	µg/L			53	ND	ND	ND	ND	ND	ND	ND	ND	< L.O.Q.	ND
Bromodichloromethane	µg/L			1.4	ND	ND	ND	ND	ND	ND	ND	ND	N.D.	ND
Dibromochloromethane	µg/L			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	µg/L			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	µg/L	0.010		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	60		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

APPENDIX B

Table B2 - Organic Testing Results for Wells A10, A11, A20 and S4

Well S4 Organic Results

Parameter	Units	H.A.L.	A.O.	2013		2014			2015	
Benzene	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	200		ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND
Dichloromethane	µg/L	50		ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L		2.4	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethylene	µg/L	30		ND	ND	ND	ND	ND	ND	ND
O-Xylene	µg/L								ND	ND
M&P-Xylenes	µg/L								ND	ND
Total Xylenes	µg/L		300	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L		24	ND	ND	ND	ND	ND	ND	ND
Trichloroethylene	µg/L	5.0		ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	µg/L	2.0		ND	ND	ND	ND	ND	ND	ND
Total Trihalomethanes	µg/L	100		ND	ND	ND	ND	ND	ND	ND
Chloroform	µg/L			ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	µg/L			ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	µg/L			ND	ND	ND	ND	ND	ND	ND
Bromoform	µg/L			ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	µg/L	0.010		ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	60		ND	ND	ND	ND	ND	ND	ND

Units:
µg/L micrograms per litre

Notes:
1. ND signifies that the parameter was not detected.
2. L.O.Q. refers to the Limit of Quantification

Appendix C

Water Production Data and Calculations

APPENDIX C
Water Production Data and Calculations

2012 — Applewood Acres System

Month	Monthly Well Production A-10	Monthly Well Production A-11	Monthly Well Production A-20	Total System Quarterly Production	Total Est. Quarterly Water Consumption	Production Losses
	m^3	m^3	m^3	m^3	m^3	%
Jan.	4 051	0	5 685			
Feb.	3 417	0	4 476	26 398	24 550	7.0
Mar.	3 878	0	4 891			
Apr.	5 373	590	3 714			
May	6 548	1 893	3 587	31 834	27 365	14.0
Jun.	3 041	1 766	5 322			
Jul.	3 467	1 907	4 775			
Aug.	2 912	1 663	4 619	28 848	26 749	7.3
Sep.	3 638	1 653	4 214			
Oct.	4 040	1 723	4 967			
Nov.	4 528	1 403	3 380	29 278	26 837	8.3
Dec.	4 456	1 266	3 515			
Totals	49 349	13 864	53 145			
Total Estimate Annual Production (m^3/yr.)				116 358	105 500	**9.3**
Avg. Daily Production (m^3/d)				**317.9**		

2012 — Springwater Place System

Month	Monthly Well Prod. Well S-4	Total System Quarterly Production	Total Est. Quarterly Water Consumption	Production Losses
	m^3	m^3	m^3	%
Jan.	3 660			
Feb.	3 530	10 650	7 252	31.9
Mar.	3 460			
Apr.	3 650			
May	2 580	8 930	8 139	8.9
Jun.	2 700			
Jul.	2 630			
Aug.	2 560	8 420	7 939	5.7
Sep.	3 230			
Oct.	2 140			
Nov.	2 120	7 020	7 965	-13.5
Dec.	2 760			
Totals	35 020			
		35 020	31 296	**10.6**
		95.7		

2013 — Applewood Acres System

Month	Monthly Well Production A-10	Monthly Well Production A-11	Monthly Well Production A-20	Total System Quarterly Production	Total Est. Quarterly Water Consumption	Production Losses
	m^3	m^3	m^3	m^3	m^3	%
Jan.	3 834	1 444	3 553			
Feb.	3 723	1 414	3 074	25 008	23 070	7.8
Mar.	3 443	1 096	3 427			
Apr.	4 930	879	2 704			
May	3 739	1 043	4 614	27 244	25 661	5.8
Jun.	4 019	1 350	3 966			
Jul.	3 219	1 466	5 058			
Aug.	3 897	1 157	3 761	27 498	24 936	9.3
Sep.	4 201	1 110	3 629			
Oct.	3 852	1 096	4 305			
Nov.	3 328	700	4 229	26 469	24 746	6.5
Dec.	4 299	845	3 815			
Totals	46 484	13 600	46 135			
Total Estimate Annual Production (m^3/yr.)				106 219	98 413	**7.3**
Avg. Daily Production (m^3/d)				**291.0**		

2013 — Springwater Place System

Month	Monthly Well Prod. Well S-4	Total System Quarterly Production	Total Est. Quarterly Water Consumption	Production Losses
	m^3	m^3	m^3	%
Jan.	2 580			
Feb.	2 100	7 370	6 820	7.5
Mar.	2 690			
Apr.	3 020			
May	3 890	10 050	7 622	24.2
Jun.	3 140			
Jul.	2 930			
Aug.	2 660	8 170	7 422	9.2
Sep.	2 580			
Oct.	2 470			
Nov.	2 490	7 700	7 321	4.9
Dec.	2 740			
Totals	33 290			
		33 290	29 185	**12.3**
		91.2		

APPENDIX C
Water Production Data and Calculations

2014	Applewood Acres System					
	Monthly Well Production			Total System Quarterly Production	Total Est. Quarterly Water Consumption	**Production Losses**
Month	A-10	A-11	A-20			
	m^3	m^3	m^3	m^3	m^3	%
Jan.	3 412	1 050	4 967			
Feb.	3 792	1 005	3 299	26 164	23 566	9.9
Mar.	4 267	917	3 455			
Apr.	3 551	759	4 350			
May	3 129	979	5 580	29 461	25 492	13.5
Jun.	6 790	1 058	3 265			
Jul.	7 453	925	1 067			
Aug.	6 190	940	2 373	28 986	25 697	11.3
Sep.	4 991	1 094	3 953			
Oct.	3 140	1 068	4 913			
Nov.	4 249	743	3 342	26 112	24 212	7.3
Dec.	3 242	821	4 594			
Totals	54 206	11 359	45 158			
	Total Estimate Annual Production (m^3/yr.)			110 723	98 966	**10.6**
	Avg. Daily Production (m^3/d)			**303.4**		

2014	Springwater Place System			
	Monthly Well Prod.	Total System Quarterly Production	Total Est. Quarterly Water Consumption	**Production Losses**
Month	Well S-4			
	m^3	m^3	m^3	%
Jan.	2 670			
Feb.	2 160	7 110	6 912	2.8
Mar.	2 280			
Apr.	2 750			
May	2 940	8 450	7 462	11.7
Jun.	2 760			
Jul.	2 450			
Aug.	2 680	6 990	7 522	-7.6
Sep.	1 860			
Oct.	2 900			
Nov.	2 510	8 140	7 046	13.4
Dec.	2 730			
Totals	30 690			
		30 690	28 943	**5.7**
		84.1		

2015	Applewood Acres System					
	Monthly Well Production			Total System Quarterly Production	Total Est. Quarterly Water Consumption	**Production Losses**
Month	A-10	A-11	A-20			
	m^3	m^3	m^3	m^3	m^3	%
Jan.	3 151	815	4 941			
Feb.	3 999	736	3 636	25 617	23 975	6.4
Mar.	3 871	673	3 795			
Apr.	4 375	666	3 752			
May	3 633	853	5 339	29 433	25 908	12.0
Jun.	5 567	866	4 382			
Jul.	4 900	1 052	4 513			
Aug.	3 321	975	5 013	29 001	25 472	12.2
Sep.	3 376	881	4 970			
Oct.	3 599	776	4 373			
Nov.	3 803	669	3 672	25 730	24 673	4.1
Dec.	4 204	722	3 912			
Totals	47 799	9 684	52 298			
	Total Estimate Annual Production (m^3/yr.)			109 781	100 028	**8.9**
	Avg. Daily Production (m^3/d)			**300.8**		

2015	Springwater Place System			
	Monthly Well Prod.	Total System Quarterly Production	Total Est. Quarterly Water Consumption	**Production Losses**
Month	Well S-4			
	m^3	m^3	m^3	%
Jan.	2 710			
Feb.	2 500	7 520	6 977	7.2
Mar.	2 310			
Apr.	2 860			
May	2 880	8 550	7 525	12.0
Jun.	2 810			
Jul.	2 380			
Aug.	2 650	7 890	7 434	5.8
Sep.	2 860			
Oct.	2 680			
Nov.	2 900	8 100	7 022	13.3
Dec.	2 520			
Totals	32 060			
		32 060	28 958	**9.7**
		87.8		

Appendix D

Water Consumption Data and Calculations

2012

					Applewood Acres System						Springwater Place System					
Yearly Quarter	Days	Meters Read	Total Water Consumption Measured	Avg. Water Meter Reading	Connected Dwelling Units	Population per Unit (assumed)	Estimated Population	Total Est. Quarterly Water Consumption	Avg. Daily Consumption per Unit	Avg. Daily per Capita Consumption	Connected Dwelling Units	Population per Unit (assumed)	Estimated Population	Total Est. Quarterly Water Consumption	Avg. Daily Consumption per Unit	Avg. Daily per Capita Consumption
	no.	*no.*	m^3	m^3/meter	*no.*	*ppu*	*persons*	m^3	*L/unit*	*Lpcd*	*no.*	*ppu*	*persons*	m^3	*L/unit*	*Lpcd*
1st	91	649	31802	49.0	501	2.9	1453	24550	538	186	148	2.9	429	7252	538	186
2nd	91	650	35504	54.6	501	2.9	1453	27365	600	207	149	2.9	432	8139	600	207
3rd	92	651	34688	53.3	502	2.9	1456	26749	579	200	149	2.9	432	7939	579	200
4th	92	651	34802	53.5	502	2.9	1456	26837	581	200	149	2.9	432	7965	581	200
				Total Estimated Annual Consumption *(m^3)*				**105500**						**31296**		
				Avg. Daily Consumption *(m^3/d)*				**288**						**86**		
				Avg. Daily Consumption per Dwelling Unit *(L/unit)*					**575**						**575**	
				Avg. Per Capita Annual Consumption *(Lpcd)*						**198**						**198**

2013

					Applewood Acres System						Springwater Place System					
Yearly Quarter	Days	Meters Read	Total Water Consumption Measured	Avg. Water Meter Reading	Connected Dwelling Units	Population per Unit (assumed)	Estimated Population	Total Est. Quarterly Water Consumption	Avg. Daily Consumption per Unit	Avg. Daily per Capita Consumption	Connected Dwelling Units	Population per Unit (assumed)	Estimated Population	Total Est. Quarterly Water Consumption	Avg. Daily Consumption per Unit	Avg. Daily per Capita Consumption
	no.	*no.*	m^3	m^3/meter	*no.*	*ppu*	*persons*	m^3	*L/unit*	*Lpcd*	*no.*	*ppu*	*persons*	m^3	*L/unit*	*Lpcd*
1st	90	653	29890	45.8	504	2.9	1462	23070	509	175	149	2.9	432	6820	509	175
2nd	91	655	33283	50.8	505	2.9	1465	25661	558	193	150	2.9	435	7622	558	193
3rd	92	654	32358	49.5	504	2.9	1462	24936	538	185	150	2.9	435	7422	538	185
4th	92	657	32067	48.8	507	2.9	1470	24746	531	183	150	2.9	435	7321	531	183
				Total Estimated Annual Consumption *(m^3)*				**98413**						**29185**		
				Avg. Daily Consumption *(m^3/d)*				**270**						**80**		
				Avg. Daily Consumption per Dwelling Unit *(L/unit)*					**534**						**534**	
				Avg. Per Capita Annual Consumption *(Lpcd)*						**184**						**184**

APPENDIX D
Water Consumption Data and Calculations

2014

					Applewood Acres System						Springwater Place System					
Yearly Quarter	Days	Meters Read	Total Water Consumption Measured	Avg. Water Meter Reading	Connected Dwelling Units	Population per Unit (assumed)	Estimated Population	Total Est. Quarterly Water Consumption	Avg. Daily Consumption per Unit	Avg. Daily per Capita Consumption	Connected Dwelling Units	Population per Unit (assumed)	Estimated Population	Total Est. Quarterly Water Consumption	Avg. Daily Consumption per Unit	Avg. Daily per Capita Consumption
	no.	*no.*	*m^3*	*m^3/meter*	*no.*	*ppu*	*persons*	*m^3*	*L/unit*	*Lpcd*	*no.*	*ppu*	*persons*	*m^3*	*L/unit*	*Lpcd*
1st	90	657	30478	46.4	508	2.9	1473	23566	515	178	149	2.9	432	6912	515	178
2nd	91	658	32954	50.1	509	2.9	1476	25492	550	190	149	2.9	432	7462	550	190
3rd	92	658	33219	50.5	509	2.9	1476	25697	549	189	149	2.9	432	7522	549	189
4th	92	661	31258	47.3	512	2.9	1485	24212	514	177	149	2.9	432	7046	514	177
							Total Estimated Annual Consumption *(m^3)*	**98966**						**28943**		
							Avg. Daily Consumption *(m^3/d)*	**271**						**79**		
							Avg. Daily Consumption per Dwelling Unit *(L/unit)*		**532**						**532**	
							Avg. Per Capita Annual Consumption *(Lpcd)*			**183**						**183**

2015

					Applewood Acres System						Springwater Place System					
Yearly Quarter	Days	Meters Read	Total Water Consumption Measured	Avg. Water Meter Reading	Connected Dwelling Units	Population per Unit (assumed)	Estimated Population	Total Est. Quarterly Water Consumption	Avg. Daily Consumption per Unit	Avg. Daily per Capita Consumption	Connected Dwelling Units	Population per Unit (assumed)	Estimated Population	Total Est. Quarterly Water Consumption	Avg. Daily Consumption per Unit	Avg. Daily per Capita Consumption
	no.	*no.*	*m^3*	*m^3/meter*	*no.*	*ppu*	*persons*	*m^3*	*L/unit*	*Lpcd*	*no.*	*ppu*	*persons*	*m^3*	*L/unit*	*Lpcd*
1st	90	661	30952	46.8	512	2.9	1485	23975	520	179	149	2.9	432	6977	520	179
2nd	91	662	33433	50.5	513	2.9	1488	25908	555	191	149	2.9	432	7525	555	191
3rd	92	664	32906	49.6	514	2.9	1491	25472	539	186	150	2.9	435	7434	539	186
4th	92	668	31695	47.4	520	2.9	1508	24673	516	178	148	2.9	429	7022	516	178
							Total Estimated Annual Consumption *(m^3)*	**100028**						**28958**		
							Avg. Daily Consumption *(m^3/d)*	**274**						**79**		
							Avg. Daily Consumption per Dwelling Unit *(L/unit)*		**538**						**538**	
							Avg. Per Capita Annual Consumption *(Lpcd)*			**186**						**186**

Appendix E

System Stress Scenarios

APPENDIX E
System Stress Scenarios

Scenario 1 - All Wells On + No Demand from Springwater System (Springwater Well is Online) Using 7 Day Peak Demand Event

	No. Dwelling Units on System				Well Production (m^3/day)					Results			
Sub-Scenario	Applewood System	Springwater System	Add'n Dwelling Units	Total	A10	A11	A20	S4	Total	Average Daily Demand	Minimum Remaining Storage (of 1160 m^3)	Days to Recover (from a Peak Day Event)	Comments
A	514	0	100	614	491	85	327	N/A	903	368	1160	0	
B	514	0	150	664	491	85	327	N/A	903	398	1160	0	
C	514	0	200	714	491	85	327	N/A	903	428	1160	0	
D	514	0	250	764	491	85	327	N/A	903	458	1146	2	
E	514	0	700	1214	491	85	327	N/A	903	728	592	7	

Scenario 2 - All Wells On + Full Demand from Springwater System (Springwater Well is Offline) Using 7 Day Peak Demand Event

	No. Dwelling Units on System				Well Production (m^3/day)					Results			
Sub-Scenario	Applewood System	Springwater System	Add'n Dwelling Units	Total	A10	A11	A20	S4	Total	Average Daily Demand	Minimum Remaining Storage (of 1160 m^3)	Days to Recover (from a Peak Day Event)	Comments
A	514	150	100	764	491	85	327	N/A	903	458	1146	2	
B	514	150	150	814	491	85	327	N/A	903	488	1086	2	
C	514	150	200	864	491	85	327	N/A	903	518	1026	2	
D	514	150	250	914	491	85	327	N/A	903	548	966	2	
E	514	150	550	1214	491	85	327	N/A	903	728	592	7	

Scenario 3 - Wells A10, A11 + No Demand from Springwater System (Springwater Well is Online) Using 7 Day Peak Demand Event

	No. Dwelling Units on System				Well Production (m^3/day)					Results			
Sub-Scenario	Applewood System	Springwater System	Add'n Dwelling Units	Total	A10	A11	A20	S4	Total	Average Daily Demand	Minimum Remaining Storage (of 1160 m^3)	Days to Recover (from a Peak Day Event)	Comments
A	514	0	100	614	491	85	0	N/A	575	368	999	3	
B	514	0	150	664	491	85	0	N/A	575	398	939	4	
C	514	0	200	714	491	85	0	N/A	575	428	879	4	
D	514	0	250	764	491	85	0	N/A	575	458	819	6	
E	514	0	300	814	491	85	0	N/A	575	488	689	10	

APPENDIX E
System Stress Scenarios

Scenario 4 - Wells A10, A11 + Full Demand from Springwater System (Springwater Well is Offline) Using 7 Day Peak Demand Event

	No. Dwelling Units on System				Well Production (m^3/day)					Results			
Sub-Scenario	Applewood System	Springwater System	Add'n Dwelling Units	Total	A10	A11	A20	S4	Total	Average Daily Demand	Minimum Remaining Storage (of 1160 m^3)	Days to Recover (from a Peak Day Event)	Comments
A	514	150	100	764	491	85	0	N/A	575	458	819	6	
B	514	150	150	814	491	85	0	N/A	575	488	689	10	
C	514	150	200	864	491	85	0	N/A	575	518	539	16	
D	514	150	250	914	491	85	0	N/A	575	548	337	36	Avg. daily demand and supply are nearly equivalent.

Scenario 5 - Wells A11, A20 + No Demand from Springwater System (Springwater Well is Online) Using 7 Day Peak Demand Event

	No. Dwelling Units on System				Well Production (m^3/day)					Results			
Sub-Scenario	Applewood System	Springwater System	Add'n Dwelling Units	Total	A10	A11	A20	S4	Total	Average Daily Demand	Minimum Remaining Storage (of 1160 m^3)	Days to Recover (from a Peak Day Event)	Comments
A	514	0	50	564	0	85	327	N/A	412	338	874	8	
B	514	0	75	589	0	85	327	N/A	412	353	807	10	
C	514	0	100	614	0	85	327	N/A	412	368	735	15	
D	514	0	125	639	0	85	327	N/A	412	383	*Not Applicable*	*FAIL*	Avg. daily demand and supply are nearly equivalent.

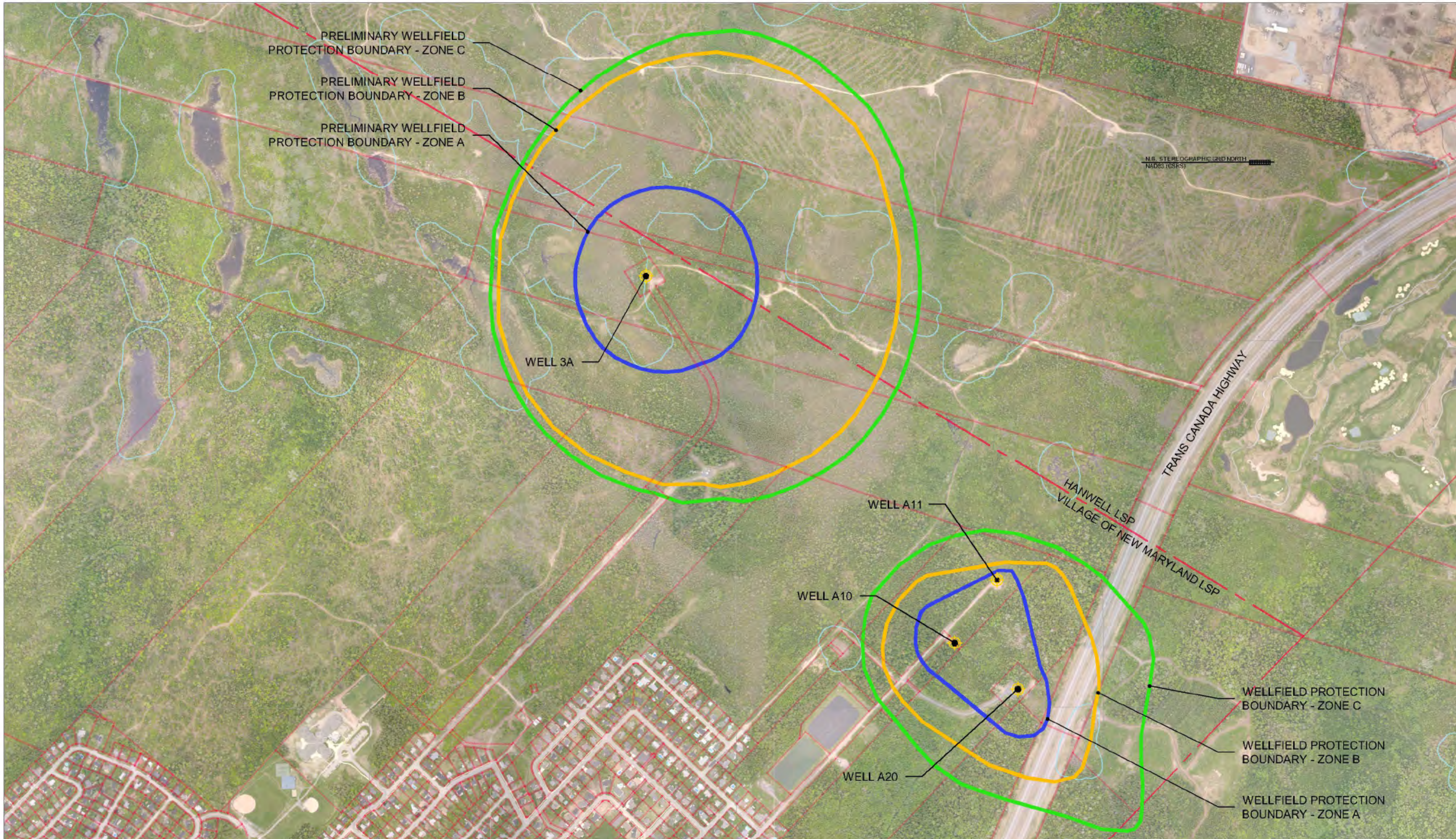
Scenario 6 - Wells A11, A20 + Full Demand from Springwater System (Springwater Well is Offline) Using 7 Day Peak Demand Event

	No. Dwelling Units on System				Well Production (m^3/day)					Results			
Sub-Scenario	Applewood System	Springwater System	Add'n Dwelling Units	Total	A10	A11	A20	S4	Total	Average Daily Demand	Minimum Remaining Storage (of 1160 m^3)	Days to Recover (from a Peak Day Event)	Comments
A	514	150	50	714	0	85	327	N/A	412	428	*Not Applicable*	*FAIL*	Avg. daily demand exceeds supply.
B	514	150	75	739	0	85	327	N/A	412	443	*Not Applicable*	*FAIL*	Avg. daily demand exceeds supply.
C	514	150	100	764	0	85	327	N/A	412	458	*Not Applicable*	*FAIL*	Avg. daily demand exceeds supply.
D	514	150	125	789	0	85	327	N/A	412	473	*Not Applicable*	*FAIL*	Avg. daily demand exceeds supply.

Appendix F

- **Wellfield Protection Zones for A10, A11, A20 and 3A - Preliminary**

- **Wellfield Protection Zones for S4**



1:10000 @ ANSI B 0 100 200 300 400 m

Revision	Amendment	Approved	Revision Date

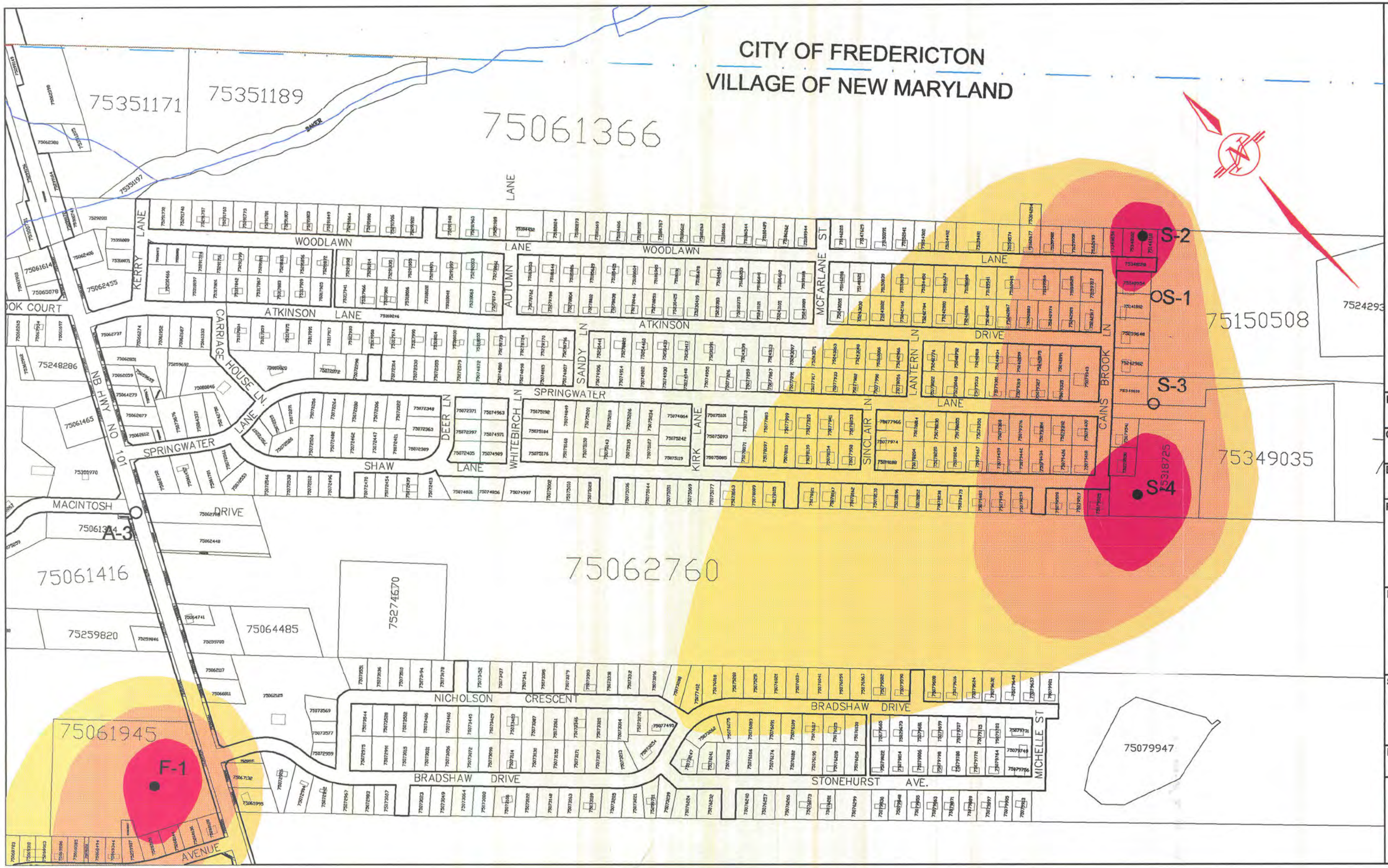
OPUS
Fredericton Office
+1 506 451 0055
80 Bishop Drive
Fredericton NB E3C 1B2
Canada

Designed	Approved	Approved Date
SAC	SRP	21-02-2014
Drawn	**Scales**	
SAC	1:10 000	

Project
Wellfield Protection Zones For Wells A10, A11, A20 and 3A

Sheet
VILLAGE OF NEW MARYLAND
WATER MANAGEMENT PLAN

Project No.	Sheet No.	Revision
C-84507.60	1	0



LEGEND:

PROTECTION AREA A

PROTECTION AREA B

PROTECTION AREA C

S-4 ACTIVE WELL LOCATION

S-3 NON-ACTIVE WELL LOCATION

Drawn By CGH	Checked By JAB
Calculations By	Checked By

Date
OCTOBER 2000

Project
WELLFIELD PROTECTION STUDY
VILLAGE OF NEW MARYLAND

Drawing
PROPOSED PROTECTION AREAS
(SPRINGWATER WELLFIELDS)

Scale
1:5000

0 100 200 300m

File No.	Drawing	Revision No.
39200116	FIGURE 11	0

GEMTEC LIMITED
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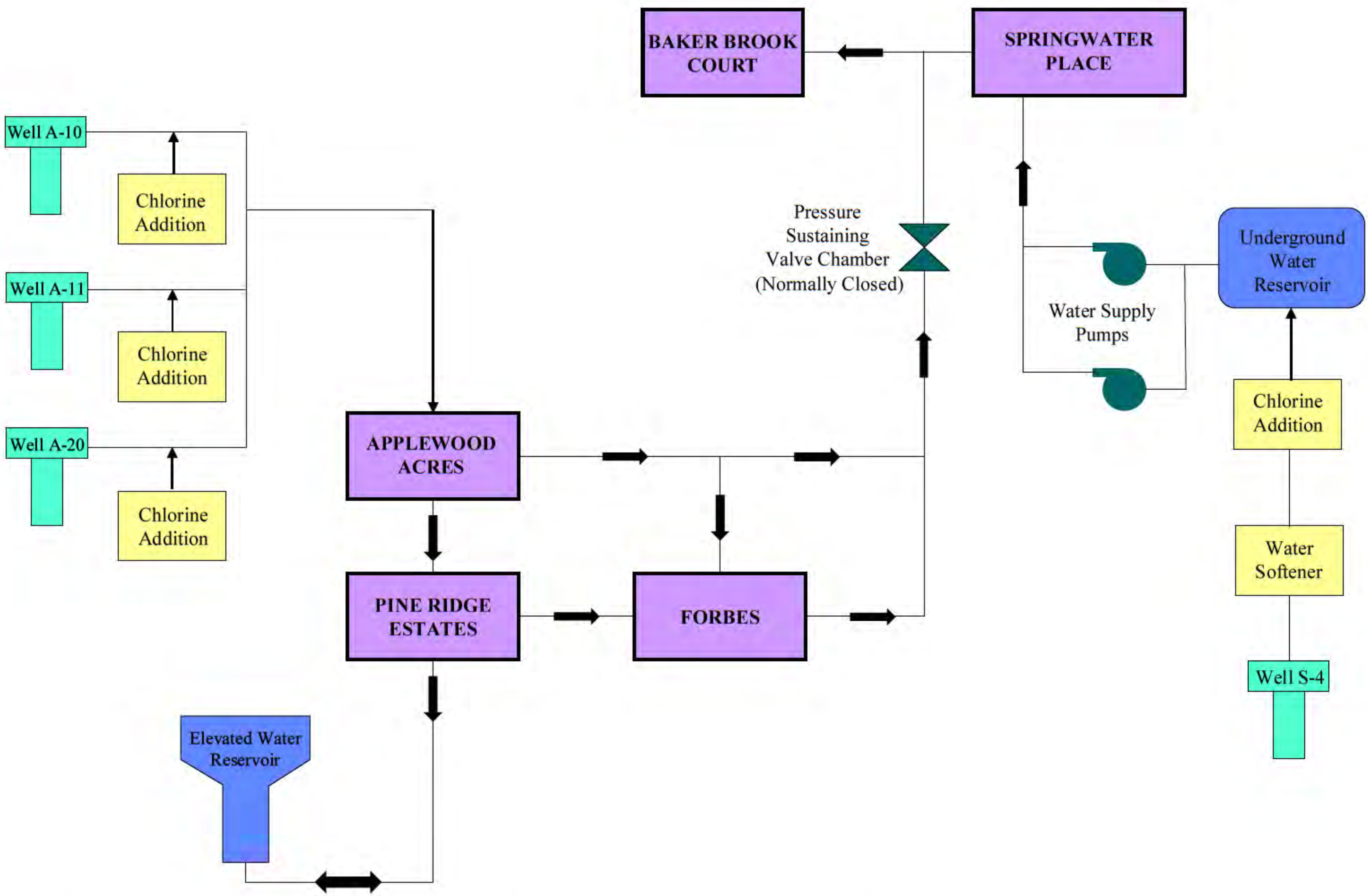
Appendix G

Simplified Schematic of Village of New Maryland's Communal Water Supply and Distribution System



Appendix G – Simplified Schematic of Village of New Maryland Communal Water Supply System and Distribution System

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