Drought Management Plan

Town of Oliver

September 2017

Project No. 306-1701

TRUE CONSULTING

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Report Submission

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Table of Contents

List of Tables

List of Figures

List of Acronyms

ADD	Average Day Demand
BGS	Below Ground Surface
GSC	Geological Survey of Canada
MFLNRO	Ministry of Forests, Lands, and Natural Resource Operations
MDD	Maximum Day Demand
MOE	Ministry of Environment
OBWB	Okanagan Basin Water Board
OIB	Osoyoos Indian Band
OLRS	Okanagan Lake Regulation System
OW	Observation Well
RDOS	Regional District of Okanagan-Similkameen
RFC	River Forecast Centre
SOLID	South Okanagan Lands and Irrigation District
SOLP	South Okanagan Lands Project
TRUE	TRUE Consulting Ltd.
WSA	Water Sustainability Act

Units of Measure

cfs	cubic feet per second
ft	feet
km	kilometre
L/d	Litres per day
L/s	Litres per second
lpcd	Litres per capita per day
m^3/sec	cubic metres per second
m	metre
mbgs	metres below ground surface
ML	megalitre
USgpm	US gallons per minute

Executive Summary

With climate change consistently becoming a greater concern in the Southern Okanagan Region, drought forecasting and planning is emerging as a requirement for water purveyors such as the Town of Oliver. In August 2015, the Province of British Columbia declared a Level 4 drought in the Okanagan Basin. A complicating factor relating to this drought declaration was that water purveyors in the South Okanagan manage each licensed system independently and drought management planning is not widely considered. Following the 2015 drought, the Okanagan Basin Water Board recognized that a Valley-wide forecasting and response plan was likely the most effective method of drought mitigation in the future. This document has therefore been prepared at the behest of the Okanagan Basin Water Board as a means to address drought management planning deficiencies relating to water sources utilized by the Town of Oliver.

The Town of Oliver withdraws domestic and irrigation water from groundwater and surface water sources. For perspective, the Town's annual irrigation demand is approximately five to six times greater than its domestic demand. Ensuring long-term sustainability of these water sources is of utmost importance to the Town of Oliver. The following subsections summarize the proposed methods for forecasting and responding to drought conditions.

Drought Forecasting for Surface Water

Drought forecasting for the Town's surface water surfaces has been proposed to be based on Okanagan Lake levels measured at Kelowna. Monitoring data for this station can be found by visiting: http://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08NM083. The following Okanagan Lake water levels have been proposed as indicators for each stage of drought.

Month	Normal	Stage 1	Stage 2	Stage 3	Stage 4
June	>342.44	342.44 - 342.39	342.39 - 342.24	342.24 - 341.83	<341.83
July	>342.24	342.24 - 342.22	342.22 - 342.12	342.12 - 341.75	<341.75
August	>342.04	342.04 - 342.01	342.01 - 341.96	341.96 - 341.62	<341.62
September	>341.89	341.89 - 341.88	341.88 - 341.81	341.81 - 341.46	<341.46
October	>341.84	341.84 - 341.82	341.82 - 341.71	341.71 - 341.39	<341.39
November	>341.84	341.84 - 341.74	341.74 - 341.67	341.67 - 341.34	<341.34

Drought Forecasting for Groundwater

Drought forecasting for the Town's groundwater surfaces has been proposed to be based on Provincial groundwater observation well data. Monitoring data for these wells can be found by visiting: http://www.env.gov.bc.ca/wsd/data_searches/obswell/map/. The following observation well water levels measured below ground surface have been proposed as indicators for each stage of drought.

- Normal: Groundwater supply is at or above normal levels.

- Stage 1: OW 405 ≥ 18.7 bgs, OW 407 ≥ 11.7 bgs, OW 332 ≥ 18.0 bgs
- Stage 2: OW 405 ≥ 18.7 bgs, OW 407 ≥ 11.7 bgs, OW 332 ≥ 18.0 bgs
- Stage 3: OW 405 ≥ 20.5 bgs, OW 407 ≥ 12.35 bgs, OW 332 ≥ 19.1 bgs
- Stage 4: OW 405 ≥ 20.5 bgs, OW 407 ≥ 12.35 bgs, OW 332 ≥ 19.1 bgs

Corresponding Water Restrictions

Domestic system restrictions associated with each drought level have been proposed as follows:

- Stage 1: Outdoor watering (not associated with agricultural irrigation) is allowed 3 days per week.
- Stage 2: Outdoor watering (not associated with agricultural irrigation) is allowed 2 days per week.
- Stage 3: Outdoor watering (not associated with agricultural irrigation) is allowed 1 day per week.
- Stage 4: Moratorium on outdoor water use (not associated with agricultural irrigation).

During severe water restrictions, Town personnel will also shift domestic production to other parts of the system to even out the demand across systems in order to maintain adequate water levels.

For the irrigation system, the Town will not mandate or enforce reduced irrigation water supply to agricultural customers unless absolutely necessary. In the event of a severe water shortage, Town personnel will institute a rolling shut down of irrigation system pumphouses where water is sequentially shut off and then turned back on for each irrigation system within the Town's boundaries.

1.0 Introduction and Objectives

Drought is defined as a water shortage resulting from a prolonged period of abnormally low precipitation. The other common contributing factors to drought in British Columbia include insufficient snowpack and hot and dry weather. These factors can result in reduced flow conditions in streams and insufficient recharge rates for lakes and aquifers, thereby potentially depleting sources of water commonly utilized for domestic and irrigation purposes.

The Town of Oliver (the Town) utilizes both groundwater and surface water sources to satisfy domestic and irrigation demand. The Town's domestic water system is entirely supplied by the Town's groundwater sources while the irrigation system is supplied by a combination of groundwater sources and a surface water source which originates from the Okanagan River. For perspective, the Town's annual irrigation demand is approximately five to six times greater than its domestic demand.

Surface water for irrigation provides service to agricultural land (i.e. orchards, wineries, etc.). This water provides livelihood for these users. Limiting the water supply to these users could result in crop loss and loss of actual trees or vines. Therefore, the Town's position is that they will not mandate or enforce reduced irrigation to their agricultural customers unless absolutely necessary.

Oliver's groundwater sources comprise a series of relatively shallow wells completed in valley-bottom aquifers. These aquifers are thought to be recharged in the north by Vaseux Lake, Vaseux Creek and Okanagan River and discharge to wetlands and the Okanagan River north of Osoyoos Lake. Generally speaking, groundwater availability is less susceptible to the effects of drought, although severe droughts spanning more than a year have the potential to impact groundwater supplies.

Drought can affect the availability of groundwater supplies in two primary ways: 1) increased demand can lead to higher than normal pumping rates and greater drawdown in aquifer water levels and 2) reduced river levels (and flow) and lower than normal runoff and precipitation combine to lower the water table, which in turn could affect pumping rates in wells. However, because the Okanagan River system is regulated to the extent that there is always at least 5 m^3/sec of flow (and historically flows rarely fall below 8 m^3/sec), the drought risk associated with groundwater availability is believed to be low.

Ensuring that source water for the domestic and irrigation water systems is maintained is of utmost importance to the Town. This Drought Management Plan has been prepared to assist Town staff with recognizing drought conditions by way of easily monitored target thresholds and connecting these targets to usage reductions for the Town's water system. These objectives are recommended as a method to reduce the effects of drought conditions, thereby ensuring that the Town has access to water during periods of extended drought.

1.1 Background

In August 2015, the Province of British Columbia declared a Level 4 drought in the Okanagan Basin. This Level 4 classification resulted from extremely dry weather conditions which put stream, lake and aquifer levels at risk. Provincial drought levels are declared on a regional basis by the Province of British Columbia. These drought levels are based on stream flows to ensure that adequate water is available to support fish viability. A complication resulting from the Province's Level 4 declaration was that water purveyors in the Okanagan region manage each licensed system independently. Therefore, at the time of the Level 4 drought declaration there was widespread uncertainty about which level of response would satisfy the requested water usage reductions that the Province was mandating. Another complicating factor was that water purveyors in the Okanagan Valley who rely on source water obtained via mainstem lake intakes or groundwater sources typically do not have drought triggers and corresponding reactionary guidelines in place to manage water demand during extended periods of drought.

The Okanagan Basin Water Board (OBWB) was instituted in 1970 as a collaboration of the three Okanagan regional districts to provide leadership on water issues spanning the Okanagan Valley. A key mandate of the OBWB is to work with Valley water users to protect water resources in the Okanagan Valley. Based on the 2015 Level 4 drought declaration and the resulting varied responses by Okanagan Valley water users, the OBWB commissioned a technical team of experts in the field of drought management with the goal of proposing consistent Valley-wide drought triggers based on mainstem lake levels. The subsequent goal of the OBWB is for each water purveyor in the Okanagan Valley to adopt these drought triggers by way of a council endorsed Drought Management Plan, thereby ensuring that water users in the Okanagan Valley act in sync during drought conditions.

1.2 Drought Plan and Purpose

Drought response plans provide water purveyors with guidelines to plan for and reduce the impact of drought conditions. The risk of drought impacts communities by:

- Reducing source water availability for domestic, irrigation and fire fighting purposes;
- Impacting water quality; and
- Increasing risk to aquatic species.

The purpose of this report is to provide the Town with a response plan meant to minimize the effects of drought conditions. Being prepared for drought conditions will help to protect source water availability. The response plan should also be comparable to other Okanagan Valley water users to ensure drought responses are consistent on a Valley-wide basis and effects of extended drought are minimized.

1.3 Components of the Drought Response Plan

This report includes the following sections:

- The Town's water supply and demand profile – drought response restrictions are typically based on reductions in water usage. Therefore, reviewing past water demand and future projections are an important component of a drought response plan.
- Factors influencing the likelihood of drought for the Town's water sources – identifying specific factors that have the greatest likelihood of affecting the Town's water sources are an important aspect of this report. Identifying these factors will provide Town staff with an understanding of the reasons why specific targets have been recommended to trigger the drought response plan.
- Drought forecast approach methods – As with the factors influencing the likelihood of drought, this section provides the Town with background for recommended drought targets. This section identifies quantifiable methods that are available to Town staff to aid in forecasting the stages of a drought. Ideally, this section will coordinate forecasting methods with other water purveyors in the Okanagan Valley.
- Stages of Drought – this section defines each stage of a drought and identifies the forecast methods which are proposed to be utilized by Town staff when declaring a drought stage.
- Drought Plan Implementation – This section identifies Town resources that will be utilized during a drought event.

The final objective of this report is to ensure that the Town has a series of guidelines that will assist Town staff in responding to each stage of a drought. Of vital importance to the Town will be to ensure that source water is maintained for both the domestic and irrigation systems. Therefore, the drought response guidelines have been proposed to maintain these services in the event of an extended drought.

2.0 Water Supply and Demand Profile

2.1 Background

In 1918, the Provincial Government, led by “Honest John Oliver” the Premier of the time, purchased over 22,000 acres of land in the South Okanagan to develop an Irrigation Canal system to convert 8,000 acres of desert land on each side of the Okanagan River into viable agricultural land. This land would then be for sale, at a reasonable cost, designated to the soldiers returning from World War I. This land arrangement was known as the “The Soldiers’ Land Act.” This project then became the South Okanagan Lands Project (SOLP).

Construction of the irrigation system, including the intake dam at the base of McIntyre Bluff, began in 1919 and was not completed until 1927. The resulting canal, known as “The Ditch”, had an overall length of approximately 40 km measuring 5.6m across the top, and 1.5m deep, delivering 230 cubic feet of water per second or approximately 10 inches of water on every acre, every month during the irrigation period. Relevant historical phots of “The Ditch” are shown in the following Figure 2-1.

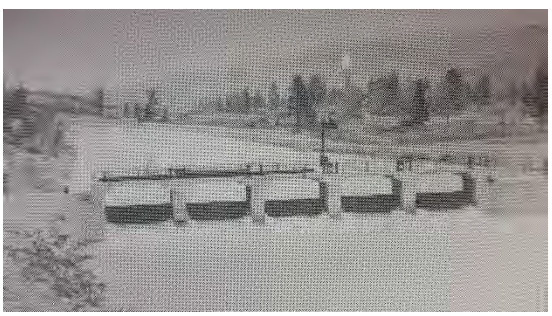

FIGURE 2-1 THE DAM NORTH OF OLIVER BELOW MCINTYRE BLUFF IN THE 1950'S (LEFT) AND CONSTRUCTION OF THE DITCH (RIGHT) (SOURCE: CANCELA. 1986).

Overall, the canal was composed of a diversion dam, 32 km of concrete-lined ditches, 27 flumes, 7 spillways and a woodstave siphon. The flumes were mainly constructed of half round galvanized steel on timber trestles or timber boxes lined with zinc. The SOLP designed the canal to transport irrigation water from one side of the Valley to the other. To accomplish this, a 7-foot diameter siphon made out of wood stave pipe had to be built underground, which ran approximately 590m long directly beneath the center of the Town, connecting the North and South parts of the canal.

Over the next forty years the canal was maintained and run by the provincial government employees (SOLP), until the spring of 1964, as the province decided it was removing itself from the irrigation business. Premiere W.A.C. Bennet passed the canal to the Oliver and Osoyoos Fruit Growers’ Association which volunteered itself to become the cornerstone of the South Okanagan Lands and Irrigation District (SOLID). During these years, SOLID installed the first of several groundwater wells to supplement the canal system (e.g. the Fairview and Tuc-El-Nuit wells). The district operated and maintained the canal system until 1989 when it was divided into two municipal governments: The Town of Oliver and the Town of Osoyoos. At that time, the Town was given the responsibility to maintain and operate the canal, which continues to be a major contributor to 100 billion liters of water that Oliver and Osoyoos delivers annually to the parched desert area of the Valley.

Today, the Town provides domestic water to approximately 2,393 residential (including rural users), and 174 commercial and industrial connections. Irrigation water is also provided to 601 connections which is irrigating approximately 5,200 acres of agricultural land with 1,025 acres of that pumping their own water from the Town's Irrigation Canal. Approximately, 455 acres of non-agricultural land is also irrigated from this system.

2.2 Water System Description

The Town owns and operates water systems servicing lands adjacent to the Okanagan River over a length of about 20 km from the Highway 97 Bridge at the north to the north end of Osoyoos Lake at the south. An overall plan of the water systems owned and operated by the Town is presented in *Appendix A*. Areas within the Town's municipal boundaries are serviced by the Town's domestic water system which also provides domestic water service to rural areas via a twinned domestic / irrigation water system. This domestic system is described in Section 2.2.1. Rural areas in Regional District of Okanagan-Similkameen Electoral Area C, both north and south of the Town, are provided water for irrigation purposes by the irrigation system. This system is described in Section 2.2.2.

Municipal wastewater is also treated and stored for reuse by irrigation in the Fairview Area. In 2004, the Town completed extensions of its reclaimed water supply system thereby making reclaimed water available for irrigation purposes to areas adjacent to or near the Fairview Road and Co-Op Avenue corridors within the municipal boundaries. The reclaimed water supply system is described in Section 2.2.3.

The Town's overall water system is broken down into seven (7) individual systems which over time have been inter-connected to provide a more sustainable water supply system as a whole. An overview of the overall water system is illustrated in the following Figure 2-2. Each system is defined or known due to the area, and the wells that support it:

- System 1 – also referred to as Rural North – Buchanan Road Pumphouse
- System 2 and 2B – Black Sage Area – Black Sage and Miller Rd Pumphouses (system 2 is combined domestic and irrigation)
- Municipal System – includes area once referred to as System 3 – Rockcliffe and Tucelnuit Pumphouses
- System 4-7 – also referred to as Rural South – Fairview and Miller Rd 13 Pumphouses

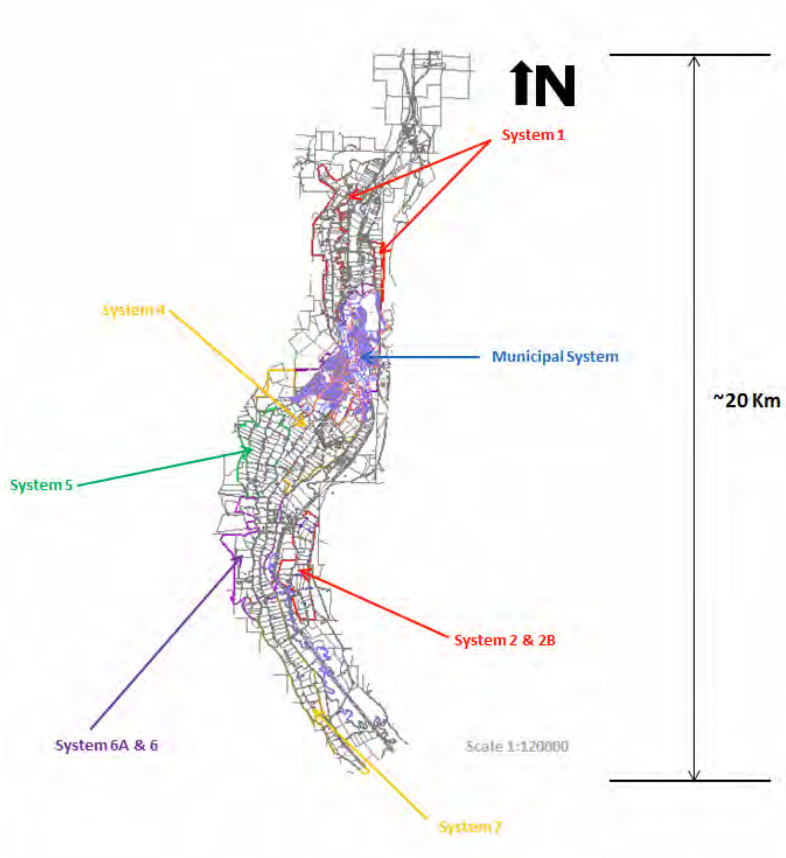

FIGURE 2-2: TOWN OF OLIVER'S 7 WATER SYSTEM OVERVIEW

2.2.1 Domestic Water System

The domestic water system provides service to all residential, commercial and industrial lands within the Town's municipal boundaries and also conveys domestic water to rural areas via a watermain twinning system that was recently constructed adjacent to the existing irrigation system. The various systems that are supplied via the domestic water system are discussed in the subsequent sections. A total of eight (8) drilled wells represent the water source for the domestic water system. The domestic system water supply well locations are illustrated in *Appendix A*. *Appendix A* also includes a map depicting the well locations, the mapped aquifers and Province of key water monitoring locations. The domestic water system is a single pressure zone controlled by the Town's three (3) municipal storage reservoirs having a combined storage capacity of 4,455m³ and a full water elevation of 380.7m. The municipal water system provides domestic service and fire protection consistent with accepted municipal water system design standards.

2.2.1.1 System 1 Domestic

System 1, also known as "Rural North," supplies domestic water to approximately 161 accounts. System 1 has an irrigation main, and a domestic main that runs approximately 4.5km from the edge of town to the end of Sportsman Bowl Road. The Buchanan pump station supplies both Irrigation surface water and domestic ground water to System 1. System 1 is connected to the Municipal System at Highway 97 near the Town Boundary and at Vineyard Road and Tuc-el-Nuit Drive. Storage for System 1 Domestic is provided by the Municipal Reservoir.

2.2.1.2 System 2 & 2B Domestic

System 2, also known as “Black Sage” area, supplies domestic and irrigation water to approximately 52 accounts. System 2 is unique having separated into two areas, System 2, and 2B. System 2B, along with every other system, is twinned. Whereas System 2 is the only system that does not have separate water sources for both irrigation and domestic water. System 2 and 2B have two domestic pump stations within its boundary; Black Sage pump station, and Miller well pump station.

2.2.1.3 Municipal System Domestic

The Municipal System, including what was System 3, supplies domestic groundwater to approximately 2,400 accounts. Municipal System utilizes two pump stations, and one booster station to supply its users within the Town boundary; Rockcliffe pump station, Tucelnuit pump station, and the Airport Booster station.

2.2.1.4 System 4, 5, 6 and 7 Domestic

Systems 4, 5, 6 and 7, also known as “Rural South,” supplies domestic ground water to approximately 483 accounts. The Systems utilize the Miller Well pump station, 6A Domestic Booster station, and the Airport Booster station. The Miller Well pump station also acts as a supplemental source of domestic groundwater to System 2 during peak demands. Storage for Systems 4-7 Domestic is the Road 13 Reservoir. The Airport Booster Station is capable of pumping both directions which allows Town staff to move water between each system as required.

2.2.2 <u>Irrigation Systems</u>

The Town has a semi-arid climate with hot, dry summers. The average annual rainfall is only 284mm, which would not sustain the crops that are now grown in the Valley. The Town operates seven major irrigation systems which largely derive their water supply from the Town’s Irrigation Canal.

With the exception of irrigation water supplied from the Buchanan Irrigation Well and the Fairview Irrigation Well and the combined irrigation/domestic water supplied to System 2 in the Black Sage area, the water source for the Town’s irrigation systems serving the rural areas is the Irrigation Canal. The canal is supplied by diversion from the Okanagan River at the McIntyre Dam (refer to *Appendix A)*. Irrigation water for systems 1, 4, 5, 6 and 7 is supplied by pumphouses drawing water from the Irrigation Canal. In total, the Town’s irrigation systems provide water to about 5,200 acres of agricultural land.

The canal is a 21-km long Town-owned asset that has enormous importance for the economy of Oliver and the surrounding communities. Oliver is known as the Wine Capital of Canada and as the centre of the wine industry in the Okanagan with the largest concentration of both vineyards and commercial wineries in British Columbia. New wineries and additional lands are being put into production in what is expected to be a growth industry. Tree fruit, vegetable and cattle production form an important base for secondary industries in the area. The horticulture industry is reliant on the canal. This is a key industry in the Okanagan, both for crop production and as a draw for increased tourism. The economic effects of a failure of the system would be severe.

It is understood that the water licenses associated with the Irrigation Canal are subject to the following conditions:

- A total withdrawal of 56,000 acre-feet for irrigation only between April 1st and September 30th and 1,600 acre-feet for irrigation only between October 1st and October 31st. Some discretion is exercised at either end of the season.
- Fisheries is a major constraint on water delivery. As per Table 2-1, MOE tries to maintain a minimum of 9.9 m³/sec (350 cfs) during the spawning season (i.e. September to November) and half of that during the incubation period. This table also summarizes the preferred flows in the Okanagan River throughout the operational season of the Irrigation Canal.

TABLE 2-1: PREFERRED FLOWS AT OLIVER TO SATISFY SOCKEYE SALMON LIFE-HISTORY STAGE REQUIREMENTS

Sockeye life history stage	Dates	Preferred range (m³/sec)
Adult migration	August 1st - Sept. 15th	8.5 - 12.7
Spawning	Sept. 16th - Oct 31st	9.9 - 15.6
Incubation	Nov. 1st - Feb 15th	5.0 - 28.3 Incubation flows ≥ 50% spawning
Fry migration	Feb 16th - April 30th	5.0 - 28.3

(Source: Fisheries and Oceans Canada. 2009)

- The Oliver canal requires a minimum water level of 327.355m at the diversion to take in and control the flow required to realize the canal's full hydraulic capacity of 2.97-3.11 m³/sec (105-110 cfs). For the purposes of this report, 3.11 m³/sec (110 cfs) is considered to be the maximum hydraulic capacity of the Town's Irrigation Canal. This maximum hydraulic capacity of the Irrigation Canal is approximately 3.2% of the Okanagan River's design hydraulic capacity of the 96.3 m³/sec (Ministry of Environment, Lands and Parks Water Management Division. April 1992), between McIntyre Dam and Osoyoos Lake.

The average volume pumped from the Irrigation Canal by the Town in the period of 2013 to 2015 was 11.7 ML or about 9,500 acre-feet. If we assume that 35% of water diverted from the Okanagan River is pumped, which is a comparable conclusion from the 1993 CH2M Hill Engineering report on canal capacity, then it can be assumed that the average diversion by the

Town is approximately 33.3 ML or about 27,030 acre-feet, which is 47% of its total license. In summary, the average approximate flow rates associated with the Irrigation Canal in the period of 2013 to 2015 are provided in the following Table 2-2. This table also compares average flows in the Irrigation Canal to preferred flow rates in the Okanagan River as per the MOE.

TABLE 2-2: IRRIGATION CANAL AVERAGE FLOW RATES (2013-2015)

Flow associated with Irrigation Canal time period (number of days)	Quantity Acre-feet	Flow rate over period m^3/sec (cfs)	Preferred range in Okanagan River m^3/sec (cfs)
Total Available April 1st to September 30th (183 days)	56,000	4.4 (155)	8.5 (300) - 12.7 (450)
Total Available October 1st to October 31st (31 days)	1,600	0.74 (26)	9.9 (350) - 15.6 (550)
Average Withdrawn – April 1st to September 30th (183 days)	8,965	0.7 (25)	8.5 (300) - 12.7 (450)
Average Withdrawn October 1st to October 31st (31 days)	501	0.23 (8.1)	9.9 (350) - 15.6 (550)
Average Diverted April 1st to September 30th (183 days)	25,600	2.0 (71)	8.5 (300) - 12.7 (450)
Average Diverted October 1st to October 31st (31 days)	1,430	0.66 (23)	9.9 (350) - 15.6 (550)

From the above table, it can be concluded that:

- The maximum hydraulic capacity of the Irrigation Canal is less than the total licensed flow available. Therefore, a total maximum flow rate of 3.11 m^3/sec (110 cfs) has been utilized for the Irrigation Canal. Comparing the three-year average flow rate diverted from the Okanagan River to this total maximum flow rate results in the Town utilizing about 58% of the canal's rated capacity on an annual basis.
- This intake is the last major diversion between Skaha Lake and Osoyoos Lake. Therefore, if minimum Okanagan River flow requirements are not affected by the Town's surface water usage it can be concluded that irrigation demand has little affect on the Okanagan River.
- In order for the maximum hydraulic capacity to be achieved in the Irrigation Canal during operation (i.e. April to October), a preferred minimum flow rate of 11.61 m^3/sec (410 cfs) would have to be available in the Okanagan River immediately upstream of the McIntyre Dam structure. This preferred minimum flow rate would provide adequate flow in the Okanagan River near Oliver as per Fisheries and Oceans Canada recommendations (see Table 2-1). During extended drought conditions the minimum transborder flow is specified as 2.83 m^3/sec (100 cfs) (source: Ministry of Environment, Lands and Parks Water Management Division. March 1994). Therefore, a minimum flow rate of 5.94 m^3/sec (210 cfs) would have to be available in the Okanagan River immediately upstream of the

McIntyre Dam structure to satisfy the hydraulic capacity of the Irrigation Canal during an extended drought.

2.2.3 Reclaimed Water System

Wastewater from the Town is treated by a two-cell aerated lagoon system located in the Fairview area west of the core area of the Town. Treated effluent is then stored for irrigation (re-use) purposes. Separate reclaimed water mains originate from the treated effluent storage lagoon and supply the Fairview Mountain Golf Course and public lands, i.e. cemetery, airport, and school area within the Town's municipal boundaries.

The reclaimed water supply main on Fairview Road represents the opportunity to supply irrigation water to areas currently using the Town's municipal water system (i.e. South Okanagan Secondary School site) and supply irrigation water to currently irrigated areas which would 'normally' utilize domestic water (i.e. future lease areas on the airport site). The reclaimed water supply system which extends through the core area of the Town represents a water conservation opportunity which is unique to the Town.

The reclaimed water system supplies irrigation water to currently irrigated areas which would 'normally' utilize domestic water. This system provides a reliable water supply for irrigation purposes at these locations, thereby reducing demand on the Town's groundwater and surface water sources. As such, the reclaimed water system will not be discussed further in this report.

2.3 Current and Future Water Demand

As discussed in Section 2.2, the water system is twinned in Oliver, meaning that groundwater, generally used for domestic purposes, has its own pipe network while surface water, used for irrigation purposes, also has its own pipe network. The only exception for the irrigation system is System 2, which utilizes groundwater for both irrigation and domestic purposes. For the purposes of this report, the source water originating from groundwater sources in the System 2 area is considered to be used for irrigation purposes only. In reality, some portion of this source water is used for domestic purposes and therefore the domestic usage specified in the following sections is moderately higher while the irrigation usage is lower.

2.3.1 Existing Demand

Water usage for the period of 2011 to 2016 was reviewed to determine existing demand for both the domestic and irrigation water systems. As shown in the following Figure 2-3 and Figure 2-4, the Town consumed approximately 16,700 ML of water in 2015. The total water consumed in Oliver was high in 2015 with overall water consumption approximately 18% higher than the previous year. This high demand is influenced by a moderate increase in population, but is likely more greatly influenced by annual weather patterns. As stated in Section 1.1, the South Okanagan was at Level 4 drought from July 2015 until the end of September 2015. The hot and dry weather associated with drought conditions is considered to be the contributing factor for the increased demand in 2015.

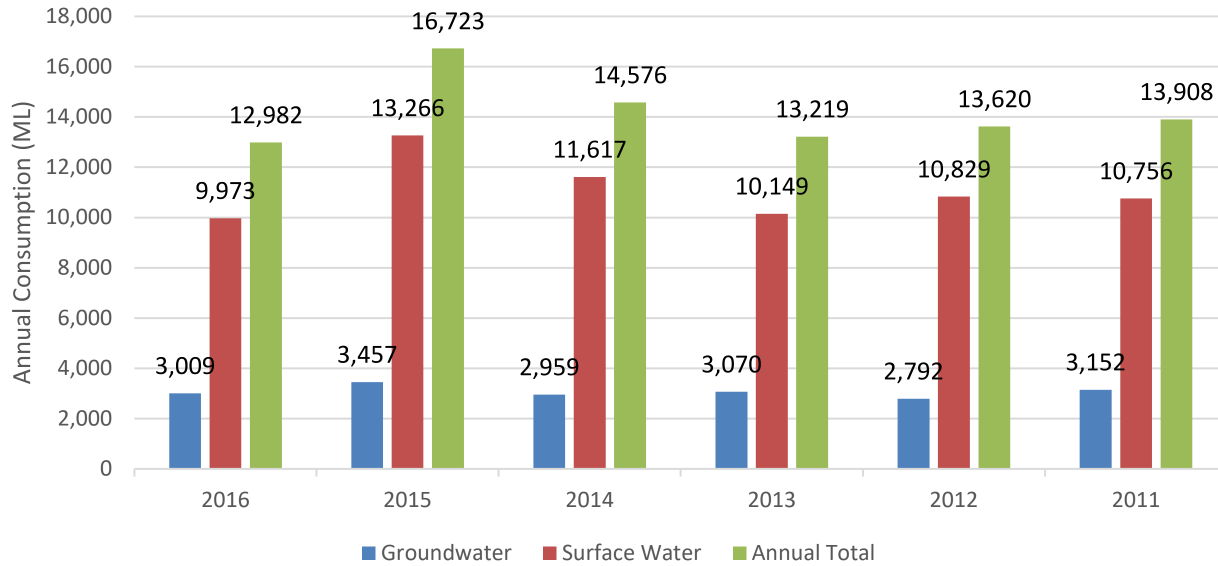

FIGURE 2-3: GROUNDWATER AND SURFACE WATER DEMAND (2011-2016)

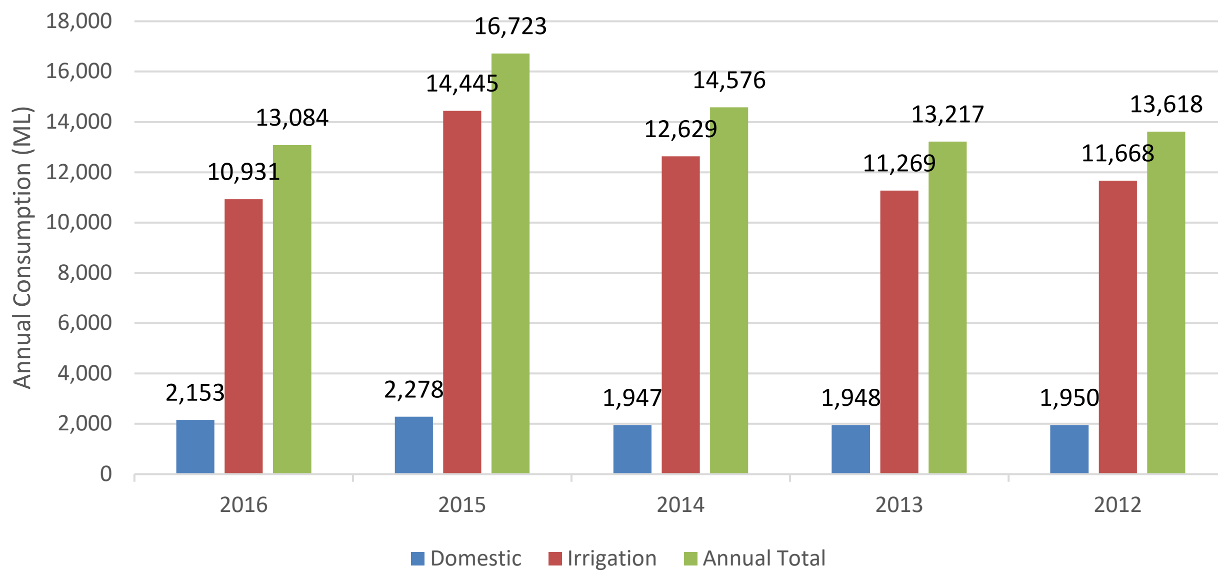

FIGURE 2-4: DOMESTIC AND IRRIGATION WATER DEMAND (2012-2016)

2.3.2 Future Demand

Future projections for water demand are generally assessed to determine system capacity and the requirement for capital improvements in relation to the maximum day demand (MDD). For the purposes of this report, future demand projections have been assessed to determine whether future demand will require additional source capacity and whether future demand may negatively impact the existing source capacity during periods of extended drought.

Future demand projections are generally based on historical population growth and projected growth rates for the region. The Town's Draft Official Community Plan (Bylaw 1370) states that the period prior to 2011 showed modest but steady population growth of between 1% and 2% while projections for future growth in the area were obtained from BC Stats which projected a low growth rate of 0.25% in the period of 2015 to 2030. This projected growth rate is considered to be conservative for water demand projections since underestimating demand growth may lead to overestimating the adequacy of source water capacity. Therefore, a growth rate of between 1% and 2% has been utilized for the domestic water system while a more conservative growth rate of between 0.5% and 1% has been utilized for the irrigation system recognizing the higher level of demand associated with this system. Water demand projections are presented following in Figure 2-5.

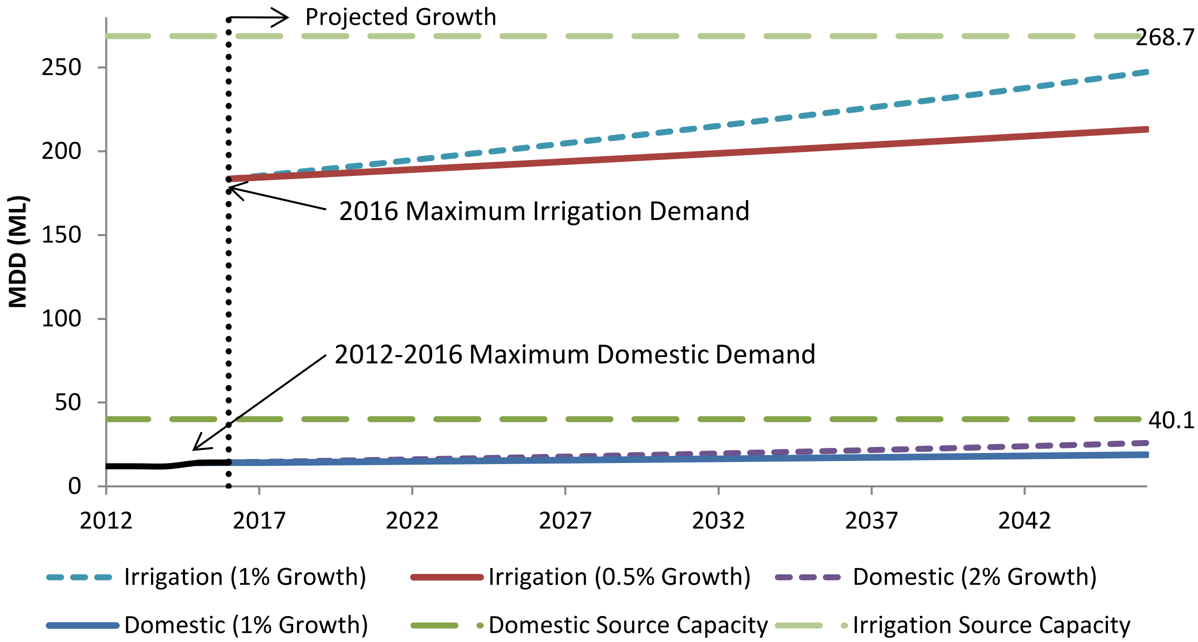

FIGURE 2-5: MAXIMUM DAY WATER DEMAND PROJECTIONS (2016-2046)

Related to the above figure:

- The maximum rate of irrigation flow for 2016 occurred on July 1 and was measured at 75 cfs (2.12 m^3/sec) which equates to approximately 184 ML per day.
- Domestic demand projections have been based off high annual demand levels from 2015. Projecting demand levels based on higher than average demand provides conservative future demand projections. For the purposes of this report, conservative demand projections are considered appropriate as these projections likely provide an accurate

representation of future demand during a Level 4 drought similar to the one that occurred in 2015.

- Domestic source capacity is far greater than projected domestic demand. The source capacity of approximately 14,600 ML annually and 40.1 ML daily is based on the rated capacity of each existing domestic well servicing the Town's domestic water system. These domestic wells are as follows: Tucelnuit Well No. 2 & No. 3, Buchanan Domestic Well, Rockcliffe Well, Black Sage Well No. 1, No. 2, & No. 3, and Miller Domestic Well. Refer to *Appendix A* for the location of each of these water sources.
- The hydraulic capacity of the Irrigation Canal equates to approximately 57,500 ML annually which is less than the licensed maximum withdrawal amount of approximately 71,600 ML annually. The maximum daily demand associated with the Irrigation Canal's hydraulic capacity is therefore approximately 269 ML when considering the irrigation season of April 1st to October 31st.
- Both domestic and irrigation demand are well below the existing source capacity for each water system. Therefore, additional source capacity associated with these systems should not be required for the foreseeable future.

3.0 Oliver Specific Factors Influencing the Potential for Drought

The Town is fortunate to have multiple sources of water supply and the ability to move water between systems in response to supply and demand changes. Surface and groundwater sources providing service for the Town's water systems are affected by flows in the Okanagan River. Surface water entering the Irrigation Channel is directly affected by the river while groundwater recharge rates and groundwater levels are also potentially affected, but to a lesser extent because flow maintenance in the River serves to maintain minimum groundwater levels in the shallow aquifers close to the river. Additionally, surface flow responds more quickly to changing climate conditions than groundwater, and the time lag between a change in climate and a change in groundwater conditions is longer. However, a multi-year drought poses a greater threat to groundwater supplies.

The Province utilizes the Okanagan Lake Regulation System (OLRS) to control lake levels and releases from the Okanagan River from Okanagan Lake to the inlet of Osoyoos Lake. This system therefore directly influences source water availability for the Town's water systems. The OLRS consists of dams located at Okanagan Lake near Penticton, Skaha Lake near Okanagan Falls, and Vaseux Lake north of Oliver (source: OBWB. 2016). Other infrastructure associated with the OLRS includes the channelized sections of Okanagan River between Okanagan Lake and Osoyoos Lake, including the associated dikes and drop structures. The OLRS regulates lake levels that are affected by a gross drainage area of approximately 8,275 square kilometres.

The OLRS is operated to attain seasonal targets for mainstem lake elevations and river flows as per the 1976 Okanagan Basin Implementation Agreement. These targets consider flood and drought conditions while also accounting for water requirements for fish viability. To aid with drought forecasting, the OLRS utilizes inflow forecasts from the River Forecast Centre (RFC) which considers precipitation levels, snowpack levels, and hot and dry weather. Additionally, climate change is expected to intensify these issues.

The following sections are intended to provide the Town with specific factors which may directly influence surface and groundwater levels for the Town's water system sources. Since contributing factors such as precipitation levels, snowpack levels, and hot and dry weather are considered during operation of the OLRS, it is considered unnecessary for the Town to consider these factors in further detail.

3.1 Groundwater Factors

In 2016, the Province of B.C. completed a groundwater budget study for the aquifer systems in the Oliver Area (Western Water Associates 2016). This study developed a conceptual model of groundwater flow through the valley bottom, and identified monthly water budgets for normal, wet and dry year climate scenarios. Pumping from the Town of Oliver's wells was included in the water budget study, which found that adequate groundwater supplies are likely available year-round in each of the area aquifers, mapped by the Province B.C. as Aquifers 255, 254 and 256. As noted above, there is a map provided in *Appendix A* that is excerpted from the 2016 water budget study that shows the extent of the mapped aquifers, Oliver's wells, the Okanagan River gauge at Oliver at the observation wells discussed below.

The Ministry also maintains actively monitored water level observation wells in each of the aquifers. At the present time, the Ministry collects the water level data and provides the data for download in spreadsheet format, but does not publish statistics on long-term water levels.

Some, but not all, of the observation wells report water levels in "real time." Those that are real-time can be used during a drought to assess whether or not abnormally low aquifer water levels are occurring. It is suggested that aquifer water levels be used as a supplemental drought indicator by the local drought response team. Fortunately, there are three wells that may be used as indicators of potential abnormally low groundwater levels, and these monitor conditions in all three of the main aquifers. The following graphs depict the historical groundwater levels in three Provincial observation wells currently used in the Oliver area. From north to south these are: Observation Well (OW) 405, OW 407 and OW 332 completed in Aquifers 255, 256 and 254 respectively. The data from these wells are available online using the B.C. Provincial Observation Well Network interactive mapping tool which can be found by visiting: http://www.env.gov.bc.ca/wsd/data_searches/obswell/map/

Note that OWs 407 and 405 report real-time data while currently OW 332 does not. During a drought situation when updated information is needed, water level data for OW 332 may be obtained by emailing Groundwater@gov.bc.ca and requesting the latest available data.

The drought-related factor thought to have the greatest potential to stress the Town's groundwater supplies is simply increased demand for water during periods of drought. This might occur locally within one or more of the Town's Systems or broadly over the whole area. Pumping the wells for longer durations at the maximum pump capacity can increase the well and local aquifer drawdown below normal levels, and eventually could curtail the available supply. Low Okanagan River flow and associated lower river levels would also influence the local groundwater table but is less likely to stress groundwater supplies. To our knowledge, none of the Town's wells experienced supply issues during the 2015 drought. Therefore, we recommend that a groundwater level of more than 0.5 m below the lowest recorded water level in any of the three Provincial observation wells be used as an indicator of potentially drought-stressed groundwater supplies. This information is summarized in Table 3-1 below and should be used in combination with primary drought indicators. Graphs showing the OW water levels are provided in Figure 3-1, Figure 3-2, and Figure 3-3. The data include both "validated" and "unvalidated" water levels, but are likely suitable for purposes of illustration for this report. Note that "unvalidated" measurements are indicative of levels recorded by remote sensors and have not be "validated" by ministry personnel. It is not uncommon for individual monitors to give false, "unvalidated" readings due to temporary local conditions, and on occasion the readings can be grossly inaccurate.

The recommended indicators below should be considered provisional. A more robust approach would be to conduct detailed statistical analysis of long-term water level data and establish valley-wide definitions of "normal", "above normal" and "below normal" groundwater level conditions. This statistical approach would enable water suppliers and water managers to use selected observation wells as drought index wells. A U.S. Geological Survey publication by Taylor, C. and W. Alley (2001) provides a detailed discussion of the importance of long-term groundwater level data and how the data can be used in monitoring and forecasting drought.

TABLE 3-1: GROUNDWATER LEVEL DROUGHT STRESS INDICATORS

Observation Well Number and Aquifer Number	Historic low water level (m bgs)	Average/typical seasonal low water level (m bgs)	Suggested Stage 1&2 indicator water level (m bgs)	Suggested Stage3&4 indicator water level (m bgs)	Associated Town Wells
OW 405 (256)	20.0	18.7	18.7	20.5	Rockcliffe, Fairview
OW 407 (255)	11.85	11.7	11.7	12.35	Buchanan, Tuc-El-Nuit
OW 332 (254)	18.6	18.0	18.0	19.1	Miller Rd, Black Sage

Note: The difference between Stages is the duration of the observed water level at or below the threshold. Refer to Section 5.0 below.

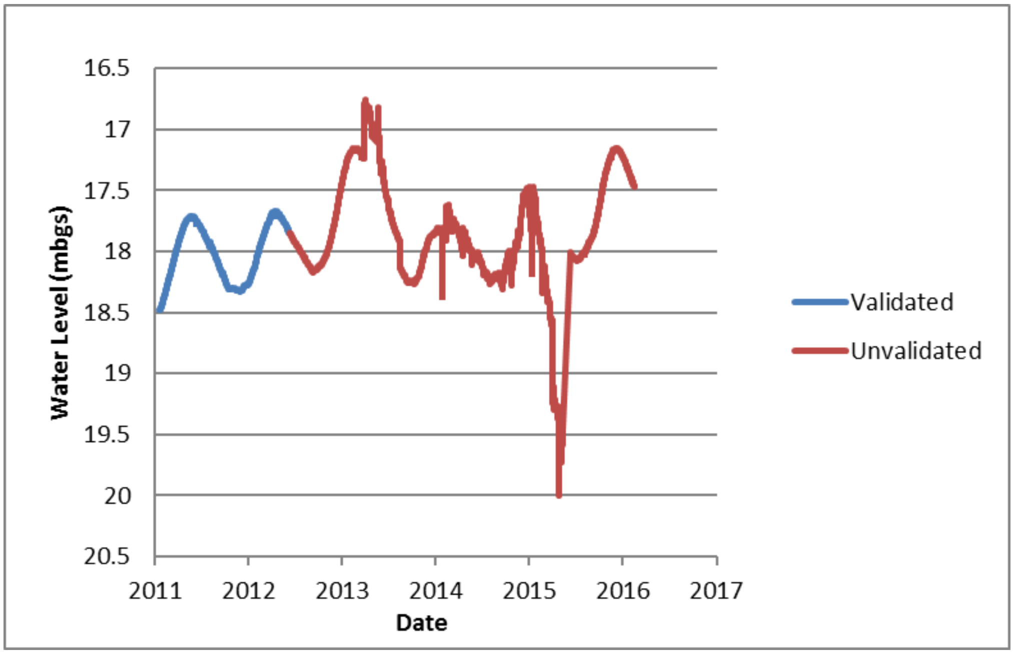

FIGURE 3-1: OBSERVATION WELL 405 HYDROGRAPH (INDICATOR FOR ROCKCLIFFE WELL)

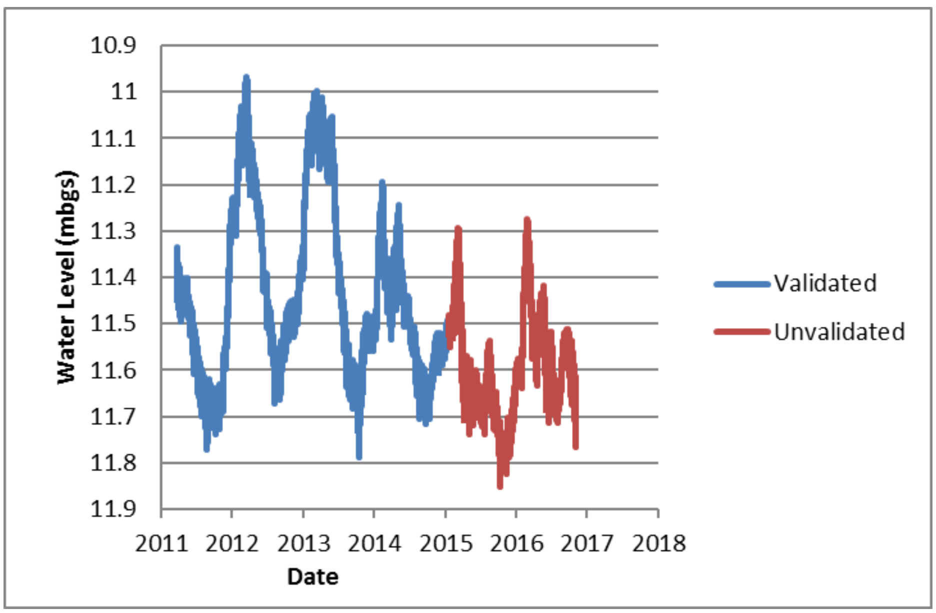

FIGURE 3-2: OBSERVATION WELL 407 HYDROGRAPH (INDICATOR FOR BUCHANAN WELLS)

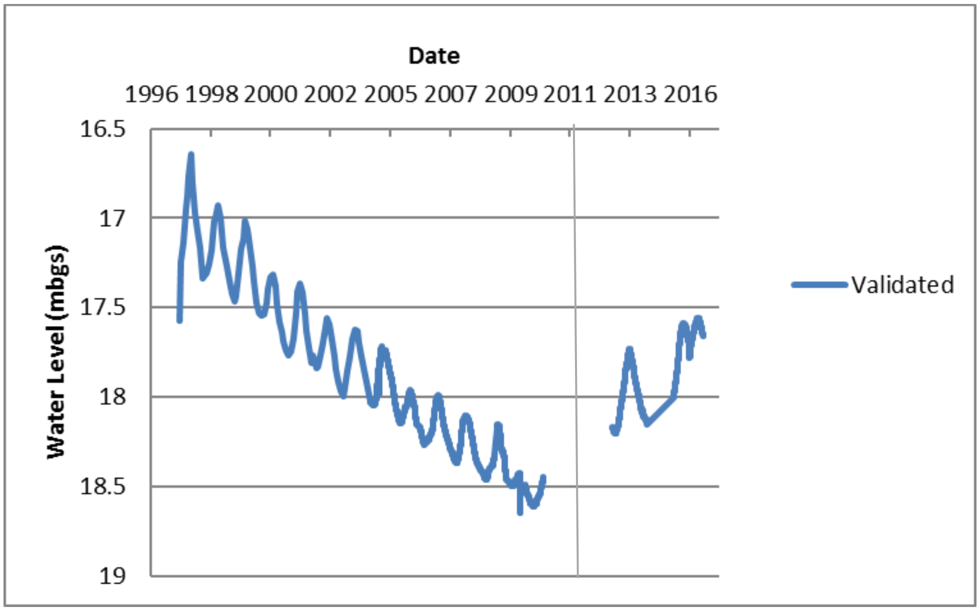

FIGURE 3-3: OBSERVATION WELL 332 HYDROGRAPH (INDICATOR FOR TUC-EL-NUIT AND SYSTEM 2 WELLS)

3.2 Preferred and required flows in Okanagan River at Oliver

The main objectives of the OLRS is flood control and drought management while also considering aquatic and riparian ecosystem needs by way of targeting the preferred flows as summarized in Table 2-1. Additionally, operation of the OLRS accounts for maintaining minimum transborder operating flows that were set for the following drought conditions (source: Ministry of Environment, Lands and Parks Water Management Division. March 1994):

- Second-year drought
  - (Aug 1st – Oct 31st) 5.66 m³/s (200 cfs)
  - (Nov 1st – Mar 31st) 2.83 m³/s (100 cfs)
- Third-year drought 2.83 m³/s (100 cfs)

The above flow rates are considered the minimum flow rates that must be maintained in the Okanagan River. The above third-year drought minimum Okanagan River flows correspond to measured flows near Oliver (Monitoring Station 08NM085) as summarized in the following Table 3-2 (source: Ministry of Environment, Lands and Parks Water Management Division. March 1994).

TABLE 3-2: MINIMUM FLOW RATES IN OKANAGAN RIVER NEAR OLIVER (08NM085)

Dates	Minimum flow rate m^3/sec (cfs)
January 1st to end of February	2.83 m^3/s (100 cfs)
March 1st to March 31st	3.51 m^3/s (124 cfs)
April 1st to June 30th	2.83 m^3/s (100 cfs)
July 1st to July 31st	3.91 m^3/s (138 cfs)
August 1st to August 31st	3.74 m^3/s (132 cfs)
September 1st to September 30th	2.86 m^3/s (101 cfs)
October 1st to December 30th	2.83 m^3/s (100 cfs)

Flow rates at this station have been reviewed for the period of June 2015 to December 2016. From these data, the following Figure 3-4 is presented as an illustration of typical river flow rates compared to the preferred range of flows in the Okanagan River (see Table 2-1) and the maximum operating capacity of the Town's Irrigation Canal (3.11 m^3/sec). Data from this table has been reduced to the period of April 1, 2016 to October 31, 2016 to reflect the licensed operational period of the Town's Irrigation Canal.

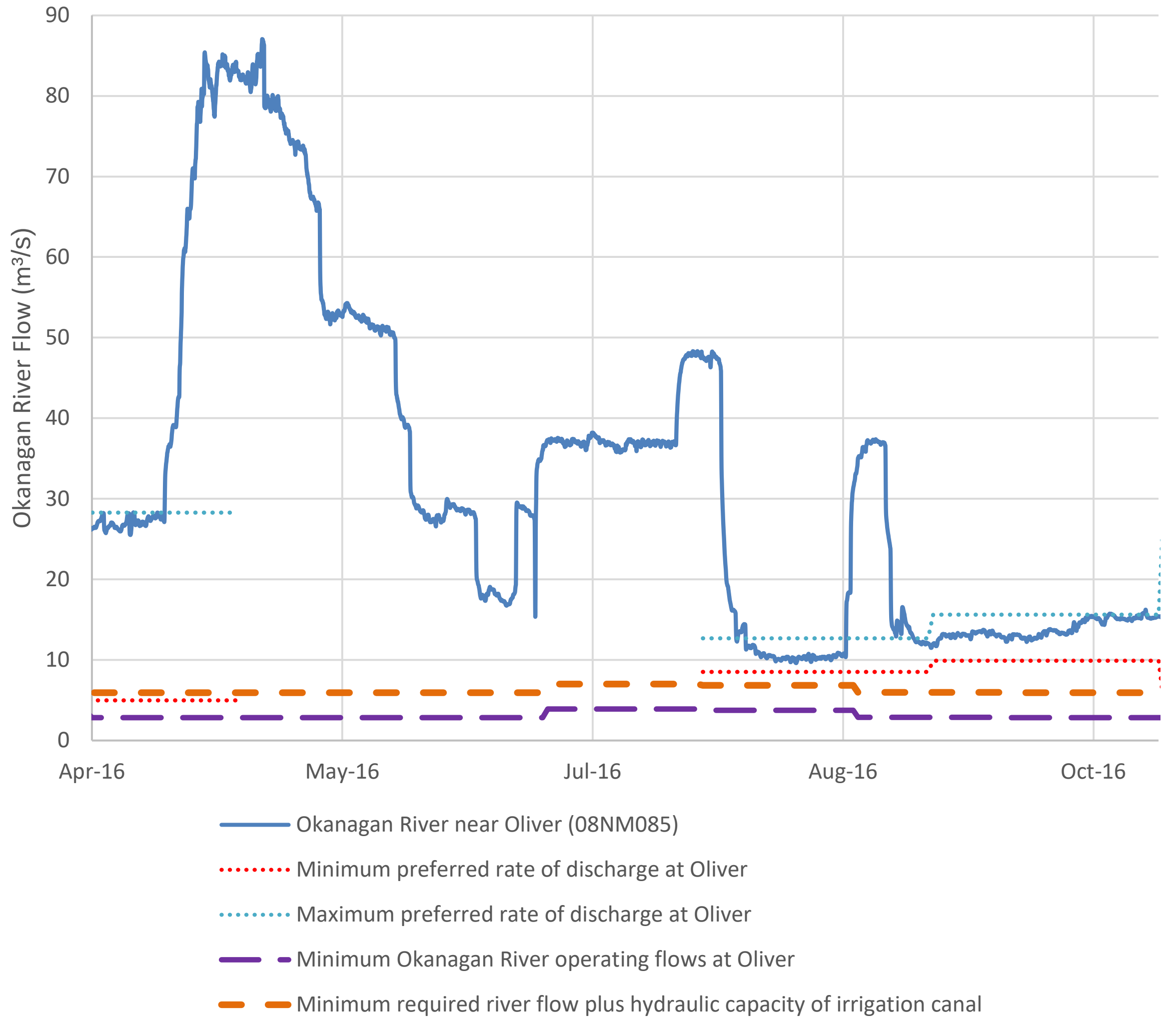

FIGURE 3-4: OKANAGAN RIVER FLOWS AT OLIVER (08NM085) - APRIL 1, 2016 TO OCTOBER 31, 2016

From the above figure:

- During the period of April 1, 2016 to October 31, 2016 the recorded Okanagan River flows near Oliver were found to be well above the minimum required operating flows.
- Adding the maximum operating capacity of the Town's Irrigation Canal (3.11 m³/sec) to the minimum required operating flows yields minimum required flows well below those recorded in the Okanagan River during this period. Therefore, if the Town utilized the maximum capacity of the Irrigation Canal for the full irrigation season, the minimum required flow in the Okanagan River would not have been compromised during this period. This result is encouraging for the continued success of the Town's Irrigation Canal as it indicates that maximizing the use of Irrigation Canal should not have a detrimental effect on flows in the Okanagan River.

Since 2016 was not considered to be a drought year, a similar analysis was conducted for the period of June 2, 2015 to October 31, 2015. This period represents available data for the 2015 Level 4 drought declared by the Province and is therefore indicative of flows that should be expected in the Okanagan River during periods of severe drought. The following Figure 3-5 is presented to illustrate Okanagan River flows in the period of June 2, 2015 to October 31, 2015.

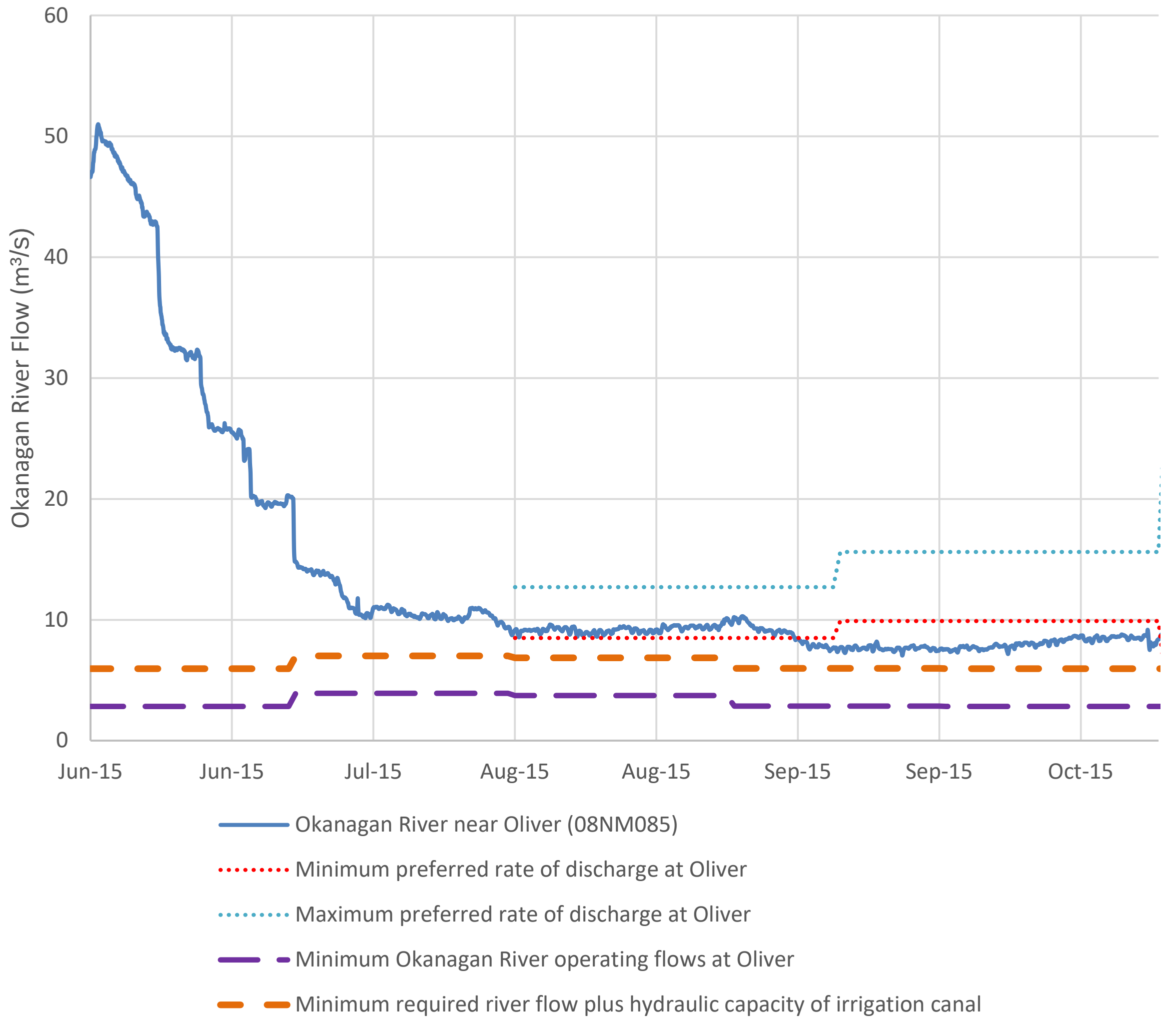

FIGURE 3-5: OKANAGAN RIVER FLOWS AT OLIVER (08NM085) - JUNE 2, 2015 TO OCTOBER 31, 2015

From the above figure:

- As with Figure 3-4, the recorded flow rate in the Okanagan River during the 2015 Level 4 drought was never lower than the minimum required operating flows. This analysis indicates that the OLRS will ensure that minimum flows are maintained in the Okanagan River during periods of severe drought.

- Okanagan River flows dropped below the preferred range (see Table 2-1) in this period. This effect is likely indicative of the severe drought conditions observed in the Okanagan Valley during this period.

4.0 Drought Forecast Approach

4.1 Groundwater Sources

As indicated in Section 3.1 above, the groundwater levels measured in the three Provincial observation wells can be used as secondary drought risk indicators. Although termed "secondary" the indicators could in theory be reached even if there is no Provincially declared drought.

Should the low water level indicator be reached at any of the three locations, the supplemental triggers, particularly those for Levels 3 and 4 drought risk, would alert the drought response team to increase monitoring of individual supply well output at the nearby associated wells (as shown in Table 3-1), and to monitor production well water levels to the extent possible and prepare to implement possible adaptive management strategies, such as shifting production from one area to another where low water level stress has not been reached.

4.2 Surface Water Sources

4.2.1 Okanagan Lake Levels

A purpose of this drought management plan is to forecast drought levels consistently with other water purveyors in the Okanagan Valley. OBWB's technical team has recommended that Okanagan Lake levels be utilized for this purpose. The justification for utilizing these targets is that the monitoring records for Okanagan Lake are readily available and that "the water required to satisfy the instream and withdrawal demands downstream of Okanagan Lake is primarily provided through releases from the lake." Monitoring the elevations of this lake provides an indication of the water volume available for release through OLRS works. Additionally, historical records of lake levels for the period since 1943 are readily available for Okanagan Lake. Therefore, an examination of these records by OBWB technical staff yielded target elevations which are considered indicative of drought conditions.

Table 4-1 provides a summary of the target, median, lower quartile and minimum end of month elevations of Okanagan Lake at Kelowna for the critical period of June through November. This summary is consistent with the OBWB's October 2016 draft report entitled "Drought Trigger Guidelines for Okanagan Mainstem Lakes and River" which is also provided in Appendix B of this report. Utilization of these values as drought triggers will be discussed in Section 5.0. Real-time hydrometric data for the monitoring station at Kelowna can be found by visiting: http://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08NM083.

TABLE 4-1: OKANAGAN LAKE ELEVATIONS (IN METRES GSC) AT MONTH END

Month	Target Elevation	Median	Lower Quartile	Minimum
June	342.44	342.39	342.24	341.83
July	342.24	342.22	342.12	341.75
August	342.04	342.01	341.96	341.62
September	341.89	341.88	341.81	341.46
October	341.84	341.82	341.71	341.39
November	341.84	341.74	341.67	341.34

(source: Monitoring Station 08NM083, Okanagan Lake at Kelowna, Period of Record - 1943-2015, Geodetic datum 340.236m and OBWB. 2016)

4.2.2 River Forecast Centre Bulletins

River flow forecasts are prepared by the Ministry of Forests, Lands, and Natural Resource Operations and are available through the RFC. The River Forecast Centre monitors, analyzes and models the streamflow conditions around the province by using a variety of scientific knowledge, methodologies, techniques and models with data input of snow surveys, weather and streamflow from BC Ministry of Environment, Environment Canada and other sources (source: MFLNRO. 2016).

While the use of Okanagan Lake levels to forecast drought stages (see Section 4.2.1) is recommended to be consistent with other water purveyors in the Okanagan Valley, the Town should also routinely monitor Okanagan River flows. If at any time Okanagan River flows are forecasted to be less than the levels summarized in the following Table 4-2, the Town should proceed with declaring a Level 4 drought for irrigation users.

TABLE 4-2: MINIMUM OKANAGAN RIVER FLOWS AT MCINTYRE DAM TO MAINTAIN MAXIMUM HYDRAULIC CAPACITY OF IRRIGATION CANAL

Dates	Minimum flow rate m^3/sec (cfs)
April 1st to June 30th	5.94 m^3/s (210 cfs)
July 1st to July 31st	7.02 m^3/s (248 cfs)
August 1st to August 31st	6.85 m^3/s (242 cfs)
September 1st to September 30th	5.97 m^3/s (211 cfs)
October 1st to December 30th	5.94 m^3/s (210 cfs)

Related to the above table:

- As shown in Section 3.2, the OLRS manages flows in the Okanagan River and has shown to consistently maintain flow rates greater than those shown in the above table.
- In the event that flow rates in the Okanagan River approach the minimum threshold it is likely that the Province will independently mandate water usage restrictions. This effect,

in combination with the highly controlled nature of flows in the Okanagan River, indicates that drought forecasting utilizing Okanagan River flows may not be an effective drought management method.

- As previously stated, if Okanagan River flows drop below the minimum flow rates at McIntyre Dam the Town should immediately declare a Level 4 drought. Note that, as shown in Figure 3-5, minimum flow rates were not observed during the 2015 Level 4 drought. Therefore, these thresholds may be indicative of an extended period of drought and it can be concluded that if this event does occur it will likely coincide with the Province mandating Level 4 drought restrictions (see Section 4.2.3).

4.2.3 Provincial Drought Declarations

As per the Government of British Columbia:

> *"water users, whether licensed or not, are required to use water as efficiently as practicable. When voluntary conservation measures are not sufficient to meet all water rights, or to protect critical environmental flows or the survival of a fish population, the Water Sustainability Act (WSA) provides authority for statutory officials, under specified conditions, to regulate water diversion, use (and storage) by users of both stream water and groundwater. When this regulatory action is required, it can now involve groundwater users even if they do not have an authorization."*

Consistent with the above statement, the Province has prepared a Drought Response Plan which outlines specific responses during drought events with the goal of protecting water rights and protecting critical environmental flows. The following Table 4-3 summarizes each level of the Province's drought classification system along with associated drought response targets.

It is important to note that the Province's drought triggers vary greatly from the drought triggers presented in this report. Also of note is that the Province's drought declarations will take precedent over drought stages presented in this report. Therefore, if the Province declares a regional drought which is at a higher level than the Town's, the Province's drought declaration will take precedent.

TABLE 4-3: PROVINCIAL DROUGHT LEVEL CLASSIFICATION

Level	Conditions	Significance	Objective	Target
1 (Green)	Normal Conditions	There is sufficient water to meet human and ecosystem needs	Preparedness	Ongoing reductions in community water use
2 (Yellow)	Dry Conditions	First indications of a potential water supply problem	Voluntary conservation	Minimum 10% reduction
3 (Orange)	Very Dry Conditions	Potentially serious ecosystem or socio-economic impacts are possible	Voluntary conservation and restrictions	Minimum additional 20% reduction to a minimum of total of 30%
4 (Red)	Extremely Dry Conditions	Water supply insufficient to meet socio-economic and ecosystem needs	Voluntary conservation, restrictions and regulatory action as necessary	Maximum reduction
Loss of Supply		Potential loss of a community's potable or fire fighting supply	Emergency response	

(source: Province of British Columbia. 2016)

5.0 Drought Stages

The following sections describe the specific conditions under which the Drought Management Plan will be implemented. This section is summarized in Table 5-1.

TABLE 5-1: DROUGHT RESPONSE STATUS MATRIX

Water Supply Status	**Normal**	Stage 1 - Dry	Stage 2 - Very Dry	Stage 3 - Extremely Dry	Stage 4 - Emergency
Groundwater Supply Trigger Factors	Groundwater supply is at or above normal levels.	The groundwater level in any of the three Provincial observation wells reaches the average / typical seasonal low water level for one week or more (OW 405 ≥ 18.7 bgs, OW 407 ≥ 11.7 bgs, OW 332 ≥ 18.0 bgs).	The groundwater level in any of the three Provincial observation wells reaches the average or typical seasonal low water level and remains at or below this level for four weeks or more (OW 405 ≥ 18.7 bgs, OW 407 ≥ 11.7 bgs, OW 332 ≥ 18.0 bgs).	The groundwater level in any of the three Provincial observation wells falls 0.5m below the historical low water level and remaining at or below this level for two weeks or more (OW 405 ≥ 20.5 bgs, OW 407 ≥ 12.35 bgs, OW 332 ≥ 19.1 bgs).	The groundwater level in any of the three Provincial observation wells falls 0.5m below the historical low water level and remaining at or below this level for four weeks or more (OW 405 ≥ 20.5 bgs, OW 407 ≥ 12.35 bgs, OW 332 ≥ 19.1 bgs).
Surface Water Supply Trigger Factors	Surface water supply is at or above normal levels.	The Okanagan Lake levels at Kelowna are less than the month end target elevations and equal to or greater than the historic median month end elevations (utilize the measured value plus the geodetic datim of 340.236m).	The Okanagan Lake levels at Kelowna are less than the historic median month end elevations and greater than or equal to the lower quartile month end elevations (utilize the measured value plus the geodetic datim of 340.236m).	The Okanagan Lake levels at Kelowna are less than the lower quartile month end elevations and equal to or greater than or equal to the historic minimum month end elevations (utilize the measured value plus the geodetic datim of 340.236m).	The Okanagan Lake levels at Kelowna are lower than the historic minimum month end elevations (utilize the measured value plus the geodetic datim of 340.236m).
Domestic Water Demand Goal	Encourage water conservation through measures presented in the Town's Water Conservation Plan.	Minimum 10% domestic usage reduction.	Minimum additional 20% domestic usage reduction to a minimum total of 30%.	Reduce domestic usage to maintain critical water supply (50% reduction).	Maintain minimum domestic water supply to maintain basic community health and safety (90% reduction).
Irrigation Water System Goal		Target 10% irrigation usage reduction	Target additional 20% irrigation usage reduction to a minimum total of 30%.	Reduce irrigation usage to maintain minimum crop yields (50% reduction).	Reduce irrigation canal flows to maintain minimum Okanagan River flows.
Corresponding Domestic System Drought Restrictions	Water conservation measures promoted by the Town.	Stage 1 Domestic Restrictions, characterized by reduced lawn and garden sprinkling to 3 days per week.	Stage 2 Domestic Restrictions, characterized by reduced lawn and garden sprinkling and other outdoor water use to 2 days per week.	Stage 3 Domestic Restrictions, characterized by severe restrictions in outdoor water use to one day per week.	Stage 4 Domestic Restrictions, characterized by a prohibition of outdoor water use.
Corresponding Irrigation System Drought Restrictions		Stage 1 Irrigation Restrictions, characterized by voluntary water conservation.	Stage 2 Irrigation Restrictions, characterized by voluntary water conservation.	Stage 3 Irrigation Restrictions, characterized by restrictions and regulatory action as mandated by Province of British Columbia.	Stage 4 Irrigation Restrictions, characterized by restrictions and regulatory action as mandated by Province of British Columbia.
Communication and Enforcement	Normal levels of communication with water users.	Heightened awareness by Town's drought response team.	High level of education and communication directed towards high domestic system water users.	High level of education and communication directed towards all water users. Town's drought response team directed to begin enforcement of domestic and/or irrigation system outdoor water use restrictions.	High level of education and communication maintained. All Town staff currently available will be used for enforcement of domestic and/or irrigation system outdoor water use restrictions.

The data relating to OW 405, OW 407 and OW 332 is available online using the B.C. Provincial Observation Well Network interactive mapping tool which can be found by visiting: http://www.env.gov.bc.ca/wsd/data_searches/obswell/map/

Real-time hydrometric data for the monitoring station at Kelowna (WM08NM083) can be found by visiting: http://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08NM083.

5.1 Normal (No Drought, Average, or Wet Years)

The Normal status is defined as water sources being at or above target levels. In this stage, water conservation measures as presented in the Town's Water Conservation Plan would be encouraged for both domestic and irrigation water system users. From a drought perspective, water conservation measures should always be encouraged during Normal status to reduce the likelihood of moving to Stage 1 drought status.

5.2 Stage 1 – Dry (Mild Drought)

The Stage 1 status is representative of mild drought conditions. If this stage is encountered early in the year it may be indicative of future water shortages. Management practices for this stage of a drought include public awareness and encouraging voluntary water usage reductions with the goal of reducing consumption by 10% overall by way of restricting domestic system outdoor water usage to a maximum of three (3) days per week. The Town's drought response team would also be made aware that a Stage 1 status has been declared and that further actions may be necessary if the Town moves to a Stage 2 status.

Triggers associated with each water source (i.e. groundwater and surface water) are as follows for a Stage 1 status.

Status Triggers Associated with Groundwater Sources

A supplemental trigger for Stage 1 would be the groundwater level in any of the three Provincial observation wells reaches the average / typical seasonal low water level (proposed in Table 3-1) for one week or more.

Status Triggers Associated with Surface Water Sources

As per recommendations presented by the OBWB, the target for moving to a Stage 1 drought status is as follows: The forecast or actual month end elevations of Okanagan Lake at Kelowna for the months June through November are less than the month end target elevations and equal to or greater than the historic median month end elevations (see Table 4-1).

5.3 Stage 2 – Very Dry (Moderate Drought)

The Stage 2 status is representative of very dry conditions. Management practices for this stage of a drought include reduced outdoor water use with the goal of reducing water consumption by 30% overall by way of restricting domestic system outdoor water usage to a maximum of two (2) days per week. The Town's drought response team would be in contact with high water users to promote voluntary usage reductions.

Triggers associated with each water source (i.e. groundwater and surface water) are as follows for a Stage 2 status.

Status Triggers Associated with Groundwater Sources

A supplemental trigger for Stage 2 would be the groundwater level in any of the three Provincial observation wells reaches the average or typical seasonal low water level (Table 3-1) for the period of record, and remains at or below this level for four weeks or more.

Status Triggers Associated with Surface Water Sources

As per recommendations presented by the OBWB, the target for moving to a Stage 2 drought status is as follows: The forecast or actual month end elevations of Okanagan Lake at Kelowna for the months June through November are less than the historic median month end elevations and greater than or equal to the lower quartile month end elevations (see Table 4-1).

5.4 Stage 3 – Extremely Dry (Severe Drought)

The Stage 3 status is representative of extremely dry conditions. Management practices for this stage of a drought include severe restrictions related to outdoor water use for the domestic water system by way of restricting domestic system outdoor water usage to a maximum of one (1) day per week. The Town would also not mandate any usage restrictions for irrigation users unless mandated by the Province. The Town's drought response team would begin enforcement of outdoor water restrictions for the domestic system and for the irrigation system if directed by the Province. Moderate fines would be imposed in the event of non-compliance.

Triggers associated with each water source (i.e. groundwater and surface water) are as follows for a Stage 3 status.

Status Triggers Associated with Groundwater Sources

A supplemental trigger for Stage 3 would be the groundwater level in any of the three Provincial observation wells falling 0.5 m below the historical low water level (Table 3-1) and remaining at or below this level for two weeks or more.

Status Triggers Associated with Surface Water Sources

As per recommendations presented by the OBWB, the target for moving to a Stage 3 drought status is as follows: The forecast or actual month end elevations of Okanagan Lake at Kelowna for the months June through November are less than the lower quartile month end elevations and equal to or greater than or equal to the historic minimum month end elevations (see Table 4-1).

5.5 Stage 4 – Emergency

The Stage 4 status is representative of emergency conditions and the potential for compromised fire protection and a loss of source water supply. Management practices for this stage of a drought include a prohibition of outdoor water use for the domestic water system. The Town would also not mandate any usage restrictions for irrigation users unless mandated by the Province or if Okanagan River flows are found to be inadequate. At this stage of a drought all available Town staff would be utilized for enforcement of outdoor water restrictions for the domestic system and for the irrigation system if directed by the Province. Moderate fines or disconnection from the water system would be imposed in the event of non-compliance.

Triggers associated with each water source (i.e. groundwater and surface water) are as follows for a Stage 4 status.

Status Triggers Associated with Groundwater Sources

A supplemental trigger for Stage 4 would be the groundwater level in any of the three Provincial observation wells falling 0.5 m below the historical low water level (Table 3-1) and remaining at or below this level for four weeks or more.

Status Triggers Associated with Surface Water Sources

As per recommendations presented by the OBWB, the target for moving to a Stage 4 drought status is as follows: The forecast or actual month end elevations of Okanagan Lake at Kelowna for the months June through November are lower than the historic minimum month end elevations.

6.0 Drought Plan Implementation (Drought Response Plan)

From Table 5-1, the Town's domestic system water restrictions aim for a range of approximately 10% reduction during a Stage 1 drought to 90% usage reduction during a Stage 4 drought. To achieve this level of domestic system water usage reductions, the following outdoor watering restrictions are proposed:

- Stage 1: Outdoor watering (not associated with agricultural irrigation) is allowed 3 days per week.
- Stage 2: Outdoor watering (not associated with agricultural irrigation) is allowed 2 days per week.
- Stage 3: Outdoor watering (not associated with agricultural irrigation) is allowed 1 day per week.
- Stage 4: Moratorium on outdoor water use (not associated with agricultural irrigation).

The following sections are presented to aid the Town with achieving the above drought management plan objectives. These sections include:

- Outlining the Town's personnel resources available during drought conditions.
- Forms of communication that the Town will utilize during drought conditions.
- Methods that Town staff will utilize to determine drought stages.
- Conducting annual water supply assessments and annual water supply plans each spring.
- Operational measures that the Town will utilize in the event of severe drought conditions.

It should be noted that this Response Plan applies to all water supplied by the Town, but does not apply to the use of rainwater, gray water, recycled, reclaimed water or other sources of water outside the domestic and irrigation systems. The use of alternative sources of water such as those listed above should be encouraged by the Town since these alternative sources may assist with limiting the effects of drought conditions.

6.1 Drought Response Team

The Town's drought response team is listed in the following Table 6-1. As per Table 5-1, the drought response team will be responsible for varying degrees of enforcement between drought Stages 1 and 4. The Director of Operations is responsible for implementation of each stage of the drought response matrix.

TABLE 6-1: DROUGHT RESPONSE TEAM

Personnel	Task
Director of Operations	Implementation of drought response plan.
Engineer Technologist	Monitoring of Okanagan Lake and Observation Well Levels.
Public Works Clerk	Work with Engineer Technologist and implementation of notifications as necessary.
Utility Operators	Provide high users with notifications and provide enforcement services.

6.2 Communications

The following Table 6-2 outlines the Town's drought management communications strategy.

TABLE 6-2: DROUGHT MANAGEMENT COMMUNICATIONS STRATEGY

Drought Level	Domestic System	Irrigation System
Normal	▪ Website notifications promoting water conservation	
Stage 1	▪ Website notifications limiting outdoor watering to 3 days per week. ▪ Signage on Main Street.	▪ Website notifications promoting water conservation
Stage 2	▪ Website notifications limiting outdoor watering to 2 days per week. ▪ Signage on Main Street. ▪ Letters sent to high water users.	▪ Website notifications promoting water conservation
Stage 3	▪ Website notifications limiting outdoor watering to 1 day per week. ▪ Signage on Main Street. ▪ Drought response team begins enforcement through individual user visits.	▪ Website notifications promoting water conservation ▪ Drought response team begins enforcement through individual user visits if mandated by the Province.
Stage 4	▪ Website notifications informing users of outdoor water use moratorium. ▪ Signage on Main Street. ▪ All available staff utilized for enforcement.	▪ Website notifications providing a schedule of rolling pumphouse shutdowns through each irrigation system, as necessary. ▪ All available staff utilized for enforcement if mandated by the Province.

6.3 Monitoring and Supply Planning

Okanagan Lake Levels

Okanagan Lake water levels measured at Kelowna (Monitoring Station 08NM083) should be monitored on an ongoing basis during periods of potential drought and increased to daily monitoring during drought conditions. It will be the Director of Operations responsibility to implement each stage of the drought response matrix if lake levels are found to be lower than the elevations specified in Table 4-1. Real-time hydrometric data for the monitoring station at Kelowna (WM08NM083) can be found by visiting:

http://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08NM083.

Okanagan River Flows

As per Figure 3-5, during the 2015 Level 4 Drought the Okanagan River was found to never be lower than the minimum required operating flows necessary for maintaining aquatic and riparian ecosystem needs while also continuing to provide source water for the Town's Irrigation Canal. Therefore, for the purposes of this report, it is concluded that the OLRS will maintain minimum flow requirements in the Okanagan River and the Town should not establish drought targets based on Okanagan River flows. Further to this point, if minimum flow requirements are not achieved in the Okanagan River, it can be assumed that the Province will have mandated Level 4 Drought Conditions.

Groundwater levels

To the greatest extent possible, monitor Town well water levels during Stages 1 to 4. Increase the frequency of monitoring from weekly in Stages 1 to 3 to daily during Stage 4 and report any abnormally low water levels or reduced production from any well to the drought response team. Check water levels in the associated Provincial observation wells on the same frequency. The data relating to OW 405, OW 407 and OW 332 is available online using the B.C. Provincial Observation Well Network interactive mapping tool which can be found by visiting:

http://www.env.gov.bc.ca/wsd/data_searches/obswell/map/

Each year, ideally in the early spring, the Town's drought response team should complete a supply assessment based upon monitored conditions such as snow pack and forecasted river runoff. This assessment can then be used to inform an Annual Supply Plan that is based on presumed scenarios, such as normal year to maximum Stage 1 drought; Stage 1 to 2 drought; and Stage 3 to 4 drought conditions. This plan can be implemented in concert with demand management and other adaptive management measures.

6.4 Operational Measures During Severe Drought

Surface Water Sources

If severe surface water shortages are impacting the supply from the Irrigation Canal, commence rolling shut down of irrigation system pumphouses. The rolling shut down would sequentially provide irrigation water to each irrigation system within the Town's boundaries and would ensure that system users do not have access to irrigation water for as short a period as possible.

Groundwater Sources

If severe low groundwater levels are impacting or have the potential to impact the supply from one or more of the Town's wells, shift production to other parts of the system to even out the demand across systems in order to maintain adequate water levels. Avoid depending on only one or two well sources, especially during Stages 3 and 4.

7.0 Drought Plan Updates

The drought triggers presented in Section 5.0 have been recommended by the OBWB's technical team of experts in the field of drought management. These drought triggers were recommended as quantifiable indicators of Valley-wide drought conditions which can easily be utilized by each water purveyor in the Okanagan Valley. To these triggers, we have added the suggested secondary indicator / trigger of groundwater levels in Provincial observation wells. Using the observation wells as potential drought index wells is recommended not just for Oliver, but for the entire Okanagan valley. The recommended approach is to develop statistics that would define "normal" as water levels between the 25th and 75th percentile of monthly mean water levels, "below normal" as 24th percentile and below, and "above normal" as 76th percentile and above. Ideally, this information would be accessible using the same or similar existing interactive mapping application. Observation wells could also be colour-coded on the map based on the drought index condition (i.e. below normal, normal or above normal).

A further recommendation by the OBWB is that each water purveyor test the recommended drought triggers to help determine their effectiveness. It is of utmost importance that drought response plans are consistent with observed drought conditions in each community. If not, individual water users may begin to ignore these declarations and will not recognize the importance of water conservation during periods of drought.

Therefore, the Town should review the drought response plan triggers on an ongoing basis. These triggers should be discussed with OBWB to determine the effectiveness of the recommended triggers and whether new triggers should be recommended. If the recommended triggers prove to not be an effective drought management method, the Town should recommend triggers that more closely resemble conditions of water supply sources for the Town's irrigation and domestic water systems.

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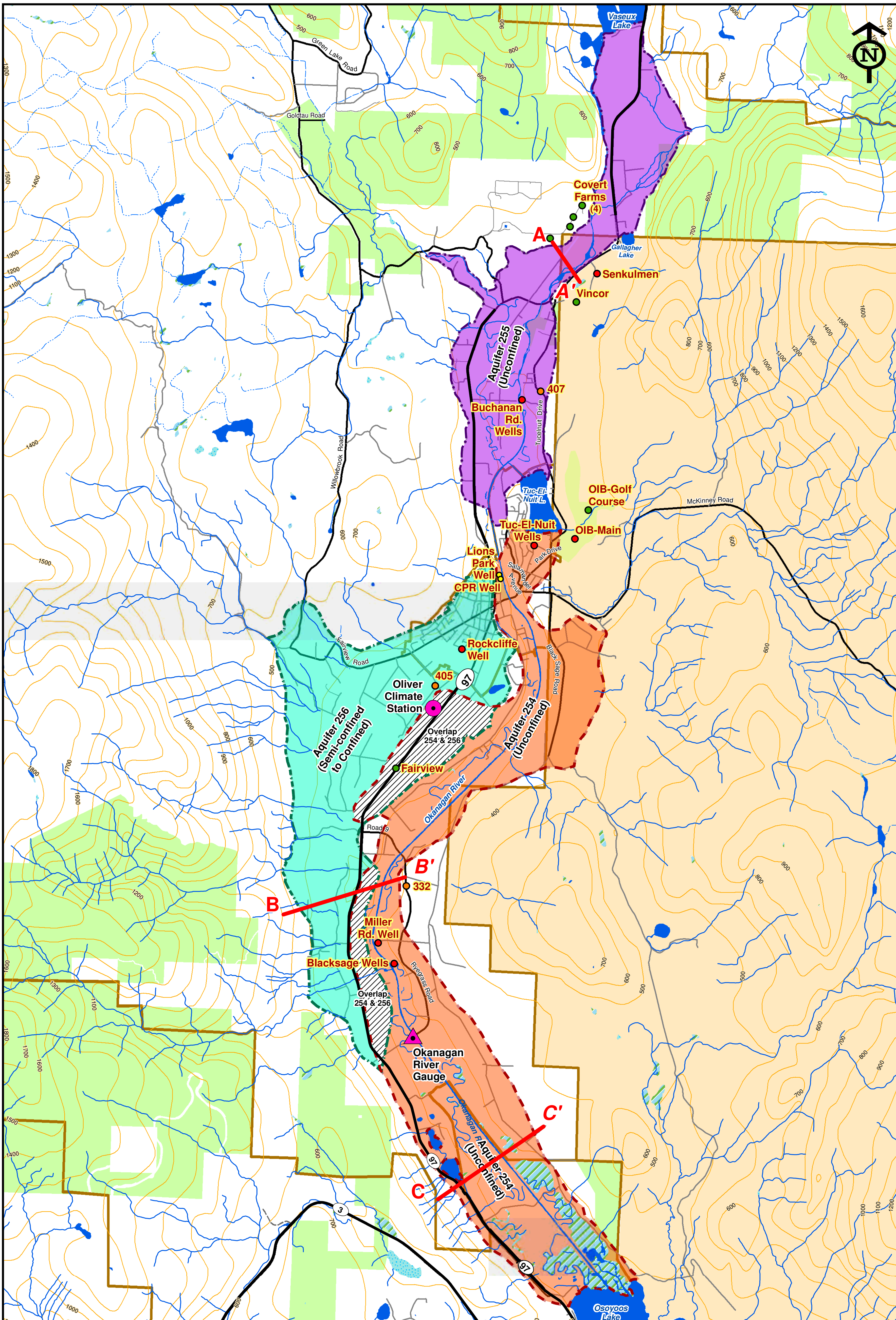
APPENDIX A

Town of Oliver Water System Map and Oliver Area Aquifer Map

Appendix A - Town of Oliver Water System Map

APPROX # OF CUSTOMER ACCOUNTS		
SYSTEM	DOMESTIC	IRRIGATION
IN TOWN	1,924	45
1	137	95
2	46	46
4	182	158
5	84	79
6	108	102
7	74	73
OIB	12	3



LEGEND

Aquifer 254	Railway
Aquifer 255	Elevation (100m)
Aquifer 256	Rivers / Streams
Overlap 309.4 Ha	Intermittent
First Nations	Indefinite
BC Parks	Water Body
Golf Courses	Indefinite Lk.
Municipal Parks	Wetlands

Figure 2: Mapped Aquifers and Selected Wells Monthly Groundwater Budget for Oliver Area Aquifers

Domestic   Irrigation   Deactivated   Observation

Okanagan River Gauge (Stn. 08NM085)   Oliver Climate Station

1 0.5 0 1 2 3 4

Kilometres

Data Sources and Disclaimers

Date: May 18 2016
Map Created By: Geo Earth Mapping
Map Reviewed By: D.G.
Project #: 16-004-01
File: 16-004.01-Fig2.mxd
Coordinate System: NAD 83 UTM Zone 11N

western water ASSOCIATES LTD
Consultants in Hydrogeology and Environmental Science

Source data provided by DataBC and Geogratis. The data used in these maps does not originate from legally recorded surveys. It is part of a GIS database system which may contain errors and/ or omissions and is subject to change, therefore accuracy cannot be guaranteed.

APPENDIX B

OBWB - Drought Trigger Guidelines for Okanagan Mainstem Lakes and River

DROUGHT TRIGGER GUIDELINES FOR OKANAGAN MAINSTEM LAKES AND RIVER

Draft 1.0
October 2016

PREFACE

<u>Background:</u> In 2015, the Province of B.C. declared a Level 4 drought for the Okanagan Basin. There was widespread uncertainty among water purveyors about how to react to the province's request for water use reductions. Regional drought declarations by the Province are based on stream flows over a wide area – a general hydrological condition. In the Okanagan, purveyors manage their systems independently. Purveyors with reservoirs and storage licenses have plans that trigger water restriction stages based on set indicators. Purveyors with mainstem lake intakes or groundwater sources do not have set drought triggers, or storage licenses.

Rapid and smooth drought response depends on all purveyors having plans in place that include rational and easy to quantify drought triggers, water restriction stages that apply to different user types, and internal and public communication plans. A lack of drought triggers, or a regional drought declaration that doesn't speak to local conditions, can make the decision to enact water restrictions more difficult for elected boards and councils. This can slow the response to a water shortage and lead to confusion among the public.

Many Okanagan purveyors with mainstem intakes are working on their drought response plans, and have requested assistance with triggers for moving between water restriction stages.

<u>Proposed Drought Trigger Guidelines:</u> The OBWB commissioned a technical team to come up with proposed guidelines for drought triggers on the mainstem system.[1] The proposed guidelines are based on lake levels, and consider Okanagan Lake dam operations. The guidelines fill an immediate gap. The triggers can be readily incorporated into drought plans so that mainstem purveyors will have a consistent, rational process for drought response – similar to the water use plans and reservoir management plans in place for purveyors with reservoir storage. Ideally, using these guidelines, water managers with mainstem intakes would move through water restriction stages in a coordinated way.

<u>The guidelines are not a proposal for top-down regulation.</u> Provincial water managers are supportive of local drought planning processes, with locally-derived triggers. The goal is for each water purveyor to have a robust plan adopted by board or council; and that these plans would be coordinated throughout the basin. The OBWB has been developing a valley-wide drought response strategy to support and link the efforts of local purveyors and provincial water managers and improve communication to the public.

<u>Broader Application:</u> As we've worked on these guidelines, a number of people have suggested that lake level triggers should apply to all water purveyors in the basin. Our waters are connected. Water retained in reservoirs does not reach the mainstem lakes, affecting water levels. We know that pumping from some groundwater sources can directly influence surface flows. We have studies showing that withdrawals from streams and groundwater can have a sizable net impact on lake levels in drought years with low precipitation and high evaporation.

[1] The technical team was led by Brian Symonds, former Director of Water Stewardship with the Ministry of Forests, Lands, and Natural Resource Operations, and included Kari Alex and Dawn Machin from the Okanagan Nation Alliance Fisheries Department, Dr. Brian Guy and Drew Lejbak of Associated Environmental Consultants, and Bob Hrasko of Agua Consulting.

The proposed mainstem drought trigger guidelines could be incorporated into a valley-wide drought plan by applying them to withdrawals on stream, reservoir and groundwater sources, in addition to other existing triggers for these sources. Even regionally, there are benefits for neighbouring communities with more than one purveyor and a variety of different sources, to have combined drought triggers for water restriction stages, and the mainstem triggers could be part of that plan.

To scale the mainstem triggers to the entire valley, meaning that groundwater and reservoir users would also have restrictions triggered by mainstem lake levels, several things would have to be considered:

- Many reservoir and stream systems are more sensitive to water shortages than the main-stem lakes, and may be triggered, according to their drought plans, more frequently than they would if they used mainstem triggers.
- Reservoir sources have storage licenses and conservation requirements to maintain fish flows.
- Most groundwater sources are in the process of being licensed, over the next three years, and more work is needed to quantify groundwater/surface water connections.

Our project scope – to develop the guidelines proposed here, focuses on the immediate need of mainstem purveyors seeking drought triggers for their individual plans – and did not allow us to address the complexities of a more comprehensive planning process.

Establishing common triggers for mainstem intakes does not preclude arrangements between neighbouring purveyors, who may agree to move through water restriction stages based on a combination of triggers on different sources. Having examples like these would help grow trust among communities to move towards a valley-wide drought plan.

<u>**Adaptation:**</u> Climate change is altering the hydrology of the Okanagan Basin, shifting to less snow storage, which will affect reservoir storage and lake management over time. The lake level triggers proposed here are based on historical conditions. If mainstem purveyors adopt common triggers, and agree to a common approach for drought response, the exact lake levels that form the triggers can be adjusted, if necessary, in future years.

Sincerely,

Anna L. Warwick Sears

Anna Warwick Sears, PhD
Executive Director, Okanagan Basin Water Board

Contents

1 INTRODUCTION

The Okanagan Basin Water Board (OBWB) is working to facilitate more consistent and coordinated drought planning and response in the Okanagan. As part of this, they are helping local water suppliers prepare drought plans that include a defensible decision making framework for responding to drought, such as the implementation of watering restrictions. This project specifically addresses water suppliers on mainstem lakes and the unique challenges they face when preparing their decision making frameworks.

Unlike water suppliers with upland storage reservoirs, suppliers on mainstem lakes do not control the level of their reservoirs – the Province does. The water suppliers also share these mainstem lake reservoirs with many other water users – both consumptive and non-consumptive. Given these factors, it is important that water suppliers with intakes on the mainstem lakes have consistent drought stage triggers in their drought plans that relate to the provincial management of the lakes.

2 OBJECTIVES

The objectives of the Project are to:

- involve the appropriate technical experts, water suppliers, and other stakeholders to ensure a well-rounded and accurate discussion of factors to consider when setting triggers for local drought stages on the mainstem lakes and Okanagan River; and
- through that discussion, recommend drought stage triggers for the mainstem lakes and Okanagan River that will result in a consistent and coordinated response to drought conditions by local water suppliers.

3 HYDROLOGY OF THE MAINSTEM LAKES

The hydrology of the Okanagan Watershed is dominated by the accumulation of water in the mountain snowpacks over the winter, and the subsequent melting and runoff of the snow in the spring and early summer. The high volume of runoff during freshet provides most of the annual inflow into the mainstem lakes. Heavy rainfall events throughout the year can also make important, although significantly smaller, contributions to the amount of water available in the Okanagan, particularly on tributary streams and to a lesser extent the mainstem lakes.

The mainstem lakes in the Okanagan provide a large volume of natural and regulated storage. This storage captures and retains most of the freshet runoff volume, which then modifies the shape of the annual natural runoff hydrograph on the Okanagan mainstem compared with the annual inflow hydrographs observed on the tributary streams. During years of high inflow the available storage in the lakes is used to attenuate the timing and magnitude of the peak downstream flows, thereby reducing the flood risks in these areas. More importantly from a water supply perspective, during years with a normal or low freshet runoff the water retained in storage is available to supplement, maintain and augment natural lake levels and river flows during the drier parts of the summer and fall when tributary contributions are typically at or near their minimum levels for the year.

4 REGULATION OF THE MAINSTEM LAKES

Regulation of the Okanagan mainstem lakes and the Okanagan River began in the early 1900s and now includes dams or control structures on each of the lakes. Management objectives for each of the lakes and the sections of river that connect the lakes have evolved over time in response to changing considerations and demands, and with improved understanding of the natural factors, the physical limitations of the regulatory works and the impacts of different regulatory actions on different objectives.

In 1969, the federal and provincial governments signed an agreement to undertake a study to develop a comprehensive framework plan for the development and management of the water resources of the Okanagan. After considering concerns and input from a broad and diverse range of stakeholders, the various levels of government and the public a framework plan was released as part of the “Canada-British Columbia Okanagan Basin Agreement Report” (1974). The plan included a series of recommendations for specific operational target levels for each the mainstem lakes and flows in Okanagan River. The target levels and flows in the framework plan were developed to balance diverse and sometimes competing goals of economic development (e.g., flood control, water supply, lake shore development, tourism), environmental quality (e.g., instream flows for fish, lake level fluctuations for shore spawning kokanee), and social betterment. It was expected that the operational recommendations would, to the extent practicable, be met in all years except in consecutive drought years. The targets were subsequently reaffirmed in the Okanagan Basin Implementation Board's “Report on the Okanagan Basin Implementation Agreement” (1982).

Provincial decision makers continue to use the framework plan targets to provide higher level guidance regarding the management and operation of the regulatory works for each of the mainstem lakes.

Sections 4.1 to 4.3 provide more detail on the regulation of the Okanagan mainstem lakes and river.

4.1 Okanagan Lake Regulation System

The Okanagan Lake Regulation System (OLRS) regulates the lake levels and releases in Okanagan River from Okanagan Lake to the inlet of Osoyoos Lake. The main OLRS regulatory works consists of the dams on Okanagan (Penticton), Skaha (Okanagan Falls) and Vaseux lakes. The OLRS works also include the channelized sections of Okanagan River between Okanagan Lake and Osoyoos Lake, including the associated dikes and drop structures.

The OLRS is operated by the Province to meet a range of economic, environmental and social objectives for each of the mainstem lakes and the different reaches of Okanagan River. These management objectives include flood control, water supply, aquatic and riparian ecosystem needs, and recreational interests.

Okanagan Lake Dam is the main control point in the OLRS due to its upstream position in the system and because the surface area and storage capacity of Okanagan Lake are so much larger than the area and capacity of any of the downstream lakes (see Table 4.1). The dam and the storage capacity it provides enable large volumes of water to be captured and stored in Okanagan Lake during the annual freshet and other periods of high inflow. The stored water is then available to meet the various instream and offstream downstream objectives during the drier periods of the year. These objectives include augmenting downstream flows to meet environmental objectives, supporting direct withdrawals from the lake and downstream locations to meet community, agricultural, and other demands, and supporting various recreational and social objectives. In most years the elevation of Okanagan Lake varies from a low of 341.5 to 341.6 m GSC in the late winter to a high of 342.4 to 342.5 m GSC in late June.

Table 4.1 compares the gross drainage and surface areas of the mainstem lakes, and the relative impact a 1 m^3/s change in the release from each of the lakes will have on the level of that lake during a 24 hour period.

Table 4-1 Drainage and Surface Areas of the Okanagan Mainstem Lakes

LAKE	GROSS DRAINAGE AREA (in square kilometres)	SURFACE AREA (in square kilometres)	DAILY CHANGE IN LAKE LEVEL RESULTING FROM A 1 M^3/S CHANGE IN DISCHARGE (in cm/day)
Kalamalka/Wood	569	35.20	0.245
Okanagan	5980	340.75	0.025
Skaha	6720	20.23	0.427
Vaseux	7150	2.43	3.556
Osoyoos	8275	23.18	0.372

More specific information on the management and operation of the OLRS is provided in Section 5.2.

4.2 Kalamalka/Wood Lake Regulation

Kalamalka and Wood lakes are connected by a short, low gradient section of channel in Oyama. This short channel allows the level of the two lakes to rise and fall in unison. Therefore, the two lakes (herein after referred to simply as Kalamalka Lake) are considered as a single body of water for management purposes.

A small control structure located at the north end of Kalamalka Lake is used to regulate the level of the lake and the releases from Kalamalka Lake into Vernon Creek. Although the control structure is not considered part of the OLRS the structure is also operated by the Province to meet multiple economic, environmental and social objectives.

The normal target operating range for the lake is between a minimum elevation of 391.2 to 391.3 m GSC in the winter months and a controlled maximum target elevation of 391.7 m during freshet. The minimum winter lake level typically occurs during the weeks before the start of spring freshet when the control gates are allowed to freeboard and the inflows and outflows are in balance. The normal range for releases into Vernon Creek is 0.085 to 5.7 m^3/s. During years of high freshet runoff the maximum elevation of Kalamalka Lake and rate of release may exceed the target maximums.

Decisions regarding the management and operation of the control structure are based on freshet inflow volume forecasts for Kalamalka Lake, realtime lake levels and streamflows, and seasonal target levels. Given the relatively small drainage and surface areas of Kalamalka Lake compared with the much larger Okanagan Lake (see Table 4.1) management and operational decisions regarding Kalamalka Lake are typically made independent of any significant consideration of any potential impacts, either positive or negative, on the elevation of Okanagan Lake. This includes operational decisions during a drought year.

4.3 Osoyoos Lake

Osoyoos Lake is a transboundary lake with approximately 2/3 of its surface area in Canada and 1/3 in the USA. The level of Osoyoos Lake is regulated by Zosel Dam near Oroville, Washington. Zosel Dam is operated and maintained by the Washington State Department of Ecology and therefore is not considered part of the OLRS. Nevertheless, Osoyoos Lake is an important source of water for both Canadian and American interests around the lake.

The water in Osoyoos Lake also plays a critical role in supporting healthy ecosystems in the South Okanagan and in particular key stages in the life cycle of Okanagan sockeye salmon. Over the last several years, considerable effort has been made by First Nations, senior levels of government and a number of partners in both British Columbia and Washington State to better understand and improve water management in the region to support the recovery of salmon stocks in Okanagan River and Osoyoos Lake.

Zosel Dam controls lake levels on both sides of the international border. Therefore the management and operational decisions are made by the dam operators in accordance with the relevant Orders of the International Joint Commission (IJC), with an appropriate level of oversight provided by the Commission's appointed International Osoyoos Lake Board of Control. The Orders allow the operators to regulate the elevation of Osoyoos Lake between the elevations 909.0 ft and 913.0 ft. USGS. The Orders recognizes that during periods of high inflow from Okanagan River or naturally restricted outflows due to high water levels downstream in Similkameen River the controlled maximum lake elevation of 913 ft. may be exceeded.

5 ANNUAL INFLOW FORECASTS AND MAINSTEM MANAGEMENT FORECASTS

5.1 Annual Inflow Volume Forecasts

As noted previously, the volume of freshet inflow to the mainstem lakes and the management of this water are critical in determining the amount of water that will be available throughout the remainder of the year. Water managers rely on forecasts made prior to and during freshet to prepare for and effectively manage the anticipated inflow and resultant available storage.

When assessing the seasonal or annual water supplies during years of potential scarcity, water managers place the highest importance on the freshet inflow volume and lake elevations during critical periods. A secondary consideration is the distribution and timing of the freshet runoff in the current year compared to normal. Relatively low importance is given to short term weather events and daily or weekly fluctuations in tributary inflows due to the dominant moderating influence of these short term events by the large storage capacity in the mainstem lakes, particularly Okanagan Lake.

Each year, beginning in January, forecasts are made of the expected freshet inflow volumes to Kalamalka and Okanagan lakes. These forecasts are updated regularly over the next few months to reflect the changing snowpack conditions, observed lake levels and streamflows, and other factors. Provincial water managers use these forecasts and other information to inform their ongoing operational decisions regarding the release of water stored in each of the mainstem lakes to best meet the various operational objectives during freshet and the remainder of the year.

5.2 Operational Objectives and Considerations

5.2.1 General

As noted in Section 4.0, the Okanagan mainstem lakes are regulated in accordance with the recommendations of the Okanagan Basin Agreement. Since the recommendations were first released, additional information and experience gained by the operators and others has provided a better understanding of limitations and opportunities to improve the water management of the mainstem lakes. This has led to further refinements to the operational guidelines for the various mainstem regulatory works, while still respecting the recommendations contained in the Agreement.

The recommendations and the subsequent improved operational knowledge and experience have been incorporated into the Okanagan Fish/Water Management Tool (see Section 5.3), which is currently used by water managers and others to inform in season management decisions regarding the OLRS.

5.2.2 Specific Objectives during a Drought Year

In drought years the mainstem lakes are regulated to capture and store as much of the freshet volume as possible for use later in the year. Throughout the summer and fall, levels and flows are closely monitored and releases generally kept at or near minimum levels to optimize the water available to meet the different environmental and human objectives. This includes managing the releases to the extent practicable to meet the desired operational targets elevations for each of the lakes prior to the onset of winter, particularly Okanagan Lake. Meeting the pre-winter target elevations is important to reduce the potential for any adverse impacts of the current drought year to carry over into the next year.

5.3 Okanagan Fish/Water Management Tool

The Okanagan Fish/Water Management Tool (FWMT) was developed by a partnership of fishery and water managers from the Okanagan Nation Alliance, Fisheries and Oceans Canada, and the Province of BC, with support from consultants and others. The purpose of the FWMT was to identify opportunities to improve the management of the OLRS for fish without compromising other water management goals and objectives.

The FWMT is a computer based model that uses and shares knowledge and expertise provided by different subject matter experts in combination with the best available historic and real time data to examine the implications of various potential scenarios for releasing water from Okanagan Lake on the different OLRS objectives. The FWMT runs in weekly time steps and assesses the impacts of the proposed releases on objectives at indicator locations from Okanagan Lake to Osoyoos Lake for several weeks or months into the future.

Different experts are able to run the FWMT independently to game with, evaluate and share the results of their proposed release scenarios with others. Throughout the year the shared outputs are used to facilitate conversations between the different subject matter experts which in turn inform future release decisions by the OLRS water manager.

6 DESCRIPTION OF PROVINCIAL DROUGHT LEVELS

6.1 British Columbia Drought Response Plan (updated July 2016)

The British Columbia Drought Response Plan was developed by the Province, with input from local authorities and others, to provide guidance on how to prepare for and respond to hydrologic droughts in BC "to assist in ensuring that the water needs of people and aquatic ecosystems are met in times of drought." Section 4 of the Plan provides a description of the four provincial drought response levels, and indicators and recommended corresponding actions for each level.

The following is an excerpt from the Plan that describes the four drought response levels:

> "At **Level 1** (Green), conditions are normal and there is sufficient water to support ecosystem and water uses. Emphasis is on preparedness and taking action in advance of droughts in order to increase readiness of water users and communities when they inevitably occur.
>
> At **Level 2** (Yellow), conditions are dry and first indications of potential water supply shortages are recognized. Emphasis is on stewardship, voluntary conservation through education, communications and planning and possibly curtailing unauthorized use.
>
> At **Level 3** (Orange), conditions are becoming very dry. Potentially serious ecosystem or socio-economic impacts are possible or imminent and impacts may already be occurring. Emphasis continues to be on voluntary conservation and restricting or curtailing unauthorized use, while water suppliers may impose increasing watering restrictions. If serious impacts are occurring in an area, the provincial government will likely consider regulatory action.
>
> At **Level 4** (Red), conditions are extremely dry and there is insufficient supply to meet

community or ecosystem needs, progressively more severe and widespread socio-economic impacts are expected. Voluntary measures and increasing use of watering restrictions will continue but may be augmented by regulatory action by the provincial government."

The Plan also includes the following table, which summarizes the different provincial drought levels and their corresponding objectives and suggested water use targets.

Table 6.1: Provincial Drought Levels Summary Table

Level	Conditions	Significance	Objective	Target
1 (Green)	Normal Conditions	There is sufficient water to meet human and ecosystem needs	Preparedness	Ongoing reductions in community water use
2 (Yellow)	Dry Conditions	First indications of a potential water supply problem	Voluntary conservation	Minimum 10% reduction
3 (Orange)	Very Dry Conditions	Potentially serious ecosystem or socioeconomic impacts are possible	Voluntary conservation and restrictions	Minimum additional 20% reduction to a minimum total of 30%
4 (Red)	Extremely Dry Conditions	Water supply insufficient to meet socio-economic and ecosystem needs	Voluntary conservation, restrictions and regulatory action as necessary.	Maximum reduction
Loss of Supply		Potential loss of a community's potable or fire fighting supply	Emergency response	Ensure health and safety

(**Source:** "The British Columbia Drought Response Plan" (updated July 2016))

The provincial drought levels outlined in Table 6.1 are determined by the Province based on observed stream flow at representative locations. The targets suggested in the table are only provided as examples for consideration by others. These provincial levels and targets may be different from the local drought stages that are established and used by local water suppliers to trigger local watering restrictions. Local or regional targets and the appropriate response actions for each are typically established based on a more specific examination of local conditions and considerations.

7 RECOMMENDATIONS

As noted in Section 5.1 the water supply outlook for the Okanagan mainstem lakes in any given year, but especially in drought years, is a function of the volume of water available from or forecast to be available from storage at the critical times of the year. When evaluating how to best manage the available stored water consideration must be given to not only addressing short term objectives but also how to optimize the water supply outlook over the longer term (i.e., month to month). This is in contrast to the approach taken in areas where the streamflows are not supported by natural or man-made storage to the same degree as on the mainstem and the focus is more exclusively on addressing short term objectives.

Given the importance of water stored in the mainstem lakes to the Okanagan water supply outlook, it is recommended that the triggers for determining drought levels for the mainstem lakes be based on the elevation of key lakes during the critical periods of the year.

Before developing drought stage triggers based on lake elevations it is first necessary to understand the current operational targets and historic lakes levels for each of the lakes.

7.1 Recommended Drought Stage Criteria - Okanagan Lake Regulation System

The most important factor to consider when determining the appropriate drought stage and corresponding recommended response actions for the mainstem lakes from Okanagan Lake downstream is the current and forecast the elevation and therefore the volume of water available in Okanagan Lake. This is particularly important during the summer and fall when natural inflows are low and the demand and competition for the limited available water are typically the greatest.

From July through September, it is not uncommon for the flow in the Okanagan River between Skaha Lake and Osoyoos Lake to be significantly less than the rate at which water is being released from Okanagan Lake Dam in Penticton. The difference in flows can be attributed to downstream withdrawals, natural losses due higher evaporation and groundwater losses, and reduced inflows from tributary streams and groundwater. During these times of scarcity, the water required to satisfy the instream and withdrawal demands downstream of Okanagan Lake is primarily provided through releases from the lake.

Table 7.1 provides a summary of the target, median, lower quartile and minimum end of month elevations of Okanagan Lake at Kelowna for the critical period of June through November.

Table 7.1: Okanagan Lake Elevations (in metres GSC) at Month End

Month	Target Elevation	Median	Lower Quartile	Minimum
June	342.44	342.39	342.24	341.83
July	342.24	342.22	342.12	341.75
August	342.04	342.01	341.96	341.62
September	341.89	341.88	341.81	341.46
October	341.84	341.82	341.71	341.39
November	341.84	341.74	341.67	341.34

(**Source:** WSC Stn 08NM083, Okanagan Lake at Kelowna, Period of Record - 1943-2015, Geodetic datum 340.236 m)

Note:

1. The 2003 end of month elevations for the four months August through November were the lowest recorded during the 73 year period of record at WSC Stn 08NM083. It is worth noting that in 2004 the lake elevation returned to target elevation range by the end of June.

In view of the foregoing it is recommended that the following preliminary triggers be used to determine the local drought stages for the OLRS, including Okanagan, Skaha and Vaseux lakes and the Okanagan River between Okanagan Lake and Osoyoos Lake:

> **Non-drought** – Water suppliers would remain at their Normal stage (or no stage if they do not have a Normal stage in their bylaw) unless one of the triggers listed below was met.
>
> **Stage 1** (green)– The forecast or actual month end elevations of Okanagan Lake at Kelowna for the months June through November are less than the month end target elevations and equal to or greater than the historic median month end elevations (see Table 7.1).
>
> **Stage 2** (yellow) **–** The forecast or actual month end elevations of Okanagan Lake at Kelowna for the months June through November are less than the historic median month end elevations and greater than or equal to the lower quartile month end elevations (see Table 7.1).
>
> **Stage 3** (orange) – The forecast or actual month end elevations of Okanagan Lake at Kelowna for the months June through November are less than the lower quartile month end elevations and equal to or greater than or equal to the historic minimum month end elevations (see Table 7.1).
>
> **Stage 4** (red) – The forecast or actual month end elevations of Okanagan Lake at Kelowna for the months June through November are lower than the historic minimum month end elevations.

When determining the drought stage for the OLRS it is recommended that the Okanagan FWMT be used to forecast the future month end elevations of Okanagan Lake.

Table 7.2 shows what stages we would have been at in 2003, 2009, 2010, 2015, and the first part of 2016 using the above recommended triggers.

Table 7.2: Hypothetical local drought stages in 2001, 2003, 2004, 2009 to 2013, 2010, 2015, and 2016 if recommended OLRS drought triggers had been used (Non-drought = white, Stage 1= green, Stage 2 = yellow, Stage 3 = orange and Stage 4 = red).

	YEAR / MONTH END ELEVATION (m)									
MONTH	**2001**	**2003[1.]**	**2004**	**2009**	**2010**	**2011**	**2012**	**2013**	**2015**	**2016**
June	342.21	342.05	342.23	342.03	342.43	342.56	342.61	342.57	342.25	342.49
July	342.12	341.85	342.10	341.92	342.28	342.22	342.33	342.21	342.01	342.29
August	341.98	341.62	341.99	341.80	342.04	341.99	342.03	342.02	341.88	342.08
September	341.82	341.46	341.87	341.65	341.94	341.83	341.86	341.91	341.74	341.93
October	341.71	341.39	341.80	341.55	341.84	341.76	341.78	341.76	341.69	
November	341.71	341.34	341.89	341.50	341.77	341.69	341.81	341.83	341.66	

Note:
1. The 2003 end of month elevations for the four months August through November were the lowest recorded during the 73 year period of record at WSC Stn 08NM083. It is worth noting that in 2004 the lake elevation was 23 cm below the target elevation for the end of June and then returned to target range in early September.

7.2 Recommended Preliminary Drought Stage Triggers – Kalamalka/Wood Lake

The factors to consider when determining the appropriate drought stage for Kalamalka Lake are similar to those described above for Okanagan Lake and the OLRS, albeit on a smaller scale. Therefore, it is recommended that a similar approach, based on target and historical lake elevations, be used to establish drought stage triggers for Kalamalka Lake. Table 7.3 summarizes the key historical information regarding Kalamalka Lake levels.

Table 7.3: Kalamalka Lake Elevations (in metres GSC) at Month End

Month	Target Elevation	Median [1.]	Lower Quartile[1.]	Minimum [2.]
June	391.7 [3.]	391.68	391.60	391.33
July	391.6	391.60	391.52	391.23
August	391.5	391.50	391.40	391.16
September	391.4	391.43	391.34	391.09
October	391.35	391.39	391.30	391.05
November	391.3	391.38	391.28	391.04

(**Source:** WSC Stn 08NM143 - Kalamalka Lake at Vernon, Period of Record – 1967-2015 [1.], Geodetic datum 386.122 m)

Notes:

1. A review of the WSC records indicates a significant change in the way water levels were recorded and reported from 1972 onward compared with levels reported between 1967 and 1971. As a result, the median and lower quartile statistics obtained from the WSC site, which are included in the table above, are likely slightly lower than the actual median and lower quartile values (i.e., less than 1 cm difference from the actual values).
2. The minimum values are different than those reported on the WSC site. The WSC site includes the data from 1967 to 1971, which is inconsistent with the data reported after 1972. The minimums noted in Table 7.2 are based on a manual review of the individual years from 1972 to 2015 to extract the month end minimum levels from 1972 to present. The minimums in the table are comprised of levels from 2003 (September to November) and 2004 (June to August).
3. Month End Target Elevations (Source: Ministry of Forests, Lands and Natural Resource Operations) are to the nearest 0.1 metres.

Based on the historical data in Table 7.3, the following preliminary triggers for drought stages for Kalamalka Lake and Vernon Creek downstream are recommended:

Non-drought – Water suppliers would remain at their Normal stage (or no stage if they do not have a Normal stage in their bylaw) year round unless one of the triggers listed below was met.

Stage 1 (green) – The forecast or actual month end elevations of Kalamalka Lake at Vernon for the months June through August are less than the month end target elevations and equal to or greater than the historic median month end elevations (see Table 7.3).
(Note: Stage 1 does not apply during the months September through November when the historic median month end elevations exceed the month end target elevations. During these months whenever the forecast or actual month end elevation exceeds the month end target elevation in Table 7.3 Kalamalka Lake shall be considered to be at a Non-drought stage (see above description of Non-drought stage).

Stage 2 (yellow) – The forecast or actual month end elevations of Kalamalka Lake at Vernon for the months June through August are less than the historic median month end elevations and greater than or equal to the lower quartile month end elevations, AND when the forecast or actual month end elevations for the months September through November are less than the month end target elevations and greater than or equal to the lower quartile month end elevations (see Table 7.3).

Stage 3 (orange) – The forecast or actual month end elevations of Kalamalka Lake at Vernon for the months June through November are less than the lower quartile month end elevations and equal to or greater than or equal to the historic minimum month end elevations (see Table 7.3).

Stage 4 (red) – The forecast or actual month end elevations of Kalamalka Lake at Vernon for the months June through November are lower than the historic minimum month end elevations (see Table 7.3).

Table 7.4 shows what stages we would have been at in 2003, 2009, 2010, 2015, and the first part of 2016 using the above recommended triggers.

Table 7.4: Hypothetical local drought stages in 2001, 2003, 2004, 2009 to 20113, 2015, and 2016 if recommended Kalamalka Lake drought triggers had been used (Non-drought = white, Stage 1= green, Stage 2 = yellow, Stage 3 = orange and Stage 4 = red).

	YEAR / MONTH END ELEVATION (m GSC)									
MONTH	2001	2003	2004	2009	2010	2011	2012	2013	2015	2016
June	391.68	391.49	391.33	391.59	391.59	391.70	391.98	391.83	391.57	391.66
July	391.64	391.34	391.23	391.51	391.53	391.64	391.81	391.63	391.43	391.65
August	391.56	391.18	391.16	391.41	391.41	391.54	391.52	391.53	391.30	
September	391.48	391.09	391.12	391.32	391.36	391.43	391.43	391.47	391.22	
October	391.45	391.05	391.10	391.32	391.29	391.41	391.38	391.38	391.21	
November	391.43	391.04	391.13	391.30	391.25	391.38	391.37	391.37	391.22	

7.3 Recommended Preliminary Drought Stage Triggers – Osoyoos Lake

As discussed in Section 4.3, Zosel Dam in Orville, Washington, is used to regulate the levels of Osoyoos Lake on both sides of the international boundary. The IJC has issued Orders that detail operational drought criteria and dam management rules for the dam operators.

Although the operation of Zosel Dam is outside the scope of this review, there would be a benefit to adopting drought stage triggers for the management of water withdrawals from Osoyoos Lake in BC. However, it is recognized that any drought stage triggers adopted through this process would be considered subordinate to the drought conditions and regulatory requirements contained in the IJC's Orders.

An approach to establishing triggers for the lake should be similar to the approach used elsewhere on the Okanagan mainstem. During times of scarcity the water available to users on Osoyoos Lake largely depends on the inflow from the Okanagan River, which in turn depends on the volume of water available upstream in the OLRS. Therefore, it is recommended that the triggers for determining the different drought stages for Osoyoos Lake be the same triggers recommended in Section 7.1 for determining drought levels for the OLRS.

8 CLOSING COMMENTS

The information and recommendations provide in this document are intended to help stimulate a conversation with stakeholders that will eventually lead to the adoption of drought stage triggers for the Okanagan mainstem lakes. In view of the foregoing the approach and triggers recommended herein should be considered preliminary recommendations to help facilitate engagement. Further discussions with a range of stakeholders through a collaborative process will be required before these or any other drought stage triggers can be adopted.

Finally, although the recommendations provided herein are intended to be applied during the first year of a drought they could also be applied to the second year of a drought. In the event a consecutive drought year is forecast it would be desirable to revisit the triggers and response actions to confirm their appropriateness for a multi-year drought.

APPENDIX A: SUPPLEMENTARY REFERENCE INFORMATION

Table A-1: Impact of Changes to the Release from the Kalamalka Lake on the Levels of Kalamalka-Wood Lake and Okanagan Lake

Change in Release (m3/s)	Resulting Change in Lake Level (cm)							
	Kalamalka – Wood Lake [1.] Duration of Change (Days)				Okanagan Lake [2.] Duration of Change (Days)			
	30	**60**	**90**	**120**	**30**	**60**	**90**	**120**
0.1	0.7	1.5	2.2	2.9	0.1	0.1	0.2	0.3
0.2	1.5	2.9	4.4	5.9	0.1	0.3	0.4	0.6
0.3	2.2	4.4	6.6	8.8	0.2	0.4	0.7	0.9
0.4	2.3	5.9	8.8	11.8	0.3	0.6	0.9	1.2
0.5	3.7	7.4	11.0	14.7	0.4	0.7	1.1	1.5
0.6	4.4	8.8	13.3	17.7	0.5	0.9	1.3	1.8
0.7	5.2	10.3	15.5	20.6	0.5	1.0	1.6	2.1
0.8	5.9	11.8	17.7	23.6	0.6	1.2	1.8	2.4
0.9	6.6	13.3	19.9	26.5	0.7	1.3	2.0	2.7
1.0	7.4	14.7	22.1	29.5	0.7	1.5	2.2	3.0

Notes:

1. Surface area of Kalamalka- Wood Lake: 35.2 km^2
2. Surface area of Okanagan Lake: 348 km^2

Table A-2: Impacts of Changes to the Releases from the Okanagan Lake on the Levels of Okanagan Lake

Change in Release (m3/s)	Change in Lake Level (cm)							
	Duration of Change (days)							
	5	**10**	**15**	**20**	**30**	**60**	**90**	**120**
5	0.6	1.2	1.9	2.5	3.7	7.4	11.2	14.9
10	1.2	2.5	3.7	5.0	7.4	14.9	22.3	29.8
15	1.9	3.7	5.6	7.4	11.1	22.3	33.5	44.7
20	2.5	5.0	7.4	9.9	14.9	29.8	44.6	60.0
25 [2.]	3.1	6.2	9.3	12.4	18.6	37.2	55.9	74.5
30	3.7	7.4	11.1	14.8	22.3	44.7	67.0	89.4
35	4.3	8.7	13.0	17.4	26.1	52.1	78.2	104.3
40	5.0	9.9	14.8	19.9	29.7	59.6	89.4	119.2
45	5.6	11.2	16.7	22.3	33.5	67.0	100.6	134.1
50	6.2	12.4	18.6	24.8	37.2	74.5	111.7	149.0

Notes:

1. Surface area of Okanagan Lake: 348 km^2
2. Suggested magnitude of change to releases for late summer pulse flow for fish in Osoyoos Lake. Duration of change between 10 and 20 days.

Table A-3: Licensed and Actual Use Volumes for the Okanagan Mainstem Lakes and Basin [1.]
Average Water Use During the Period 1996 – 2006

Point-of-Interest	Surface Area of Lake (sq. km)	Annual Offstream Licenced Volume [5.] (ML)	July 10 to September 30			August 1 to September 30		
			Actual Water Use [6.] (ML)	Water Conserved Under Level 3 Drought Declaration [7.]		Actual Water Use [6.] (ML)	Water Conserved Under Level 3 Drought Declaration [7.]	
				Volume (ML)	Depth on Lake (cm)		Volume (ML)	Depth on Lake (cm)
Kalamalka-Wood Lake	35.2	17,077	5,994	1,798	5.11	4,133	1,240	11.74
Okanagan Lake	348.0	118,353	15,313	4,594	1.32	10,490	3,147	0.90
Okanagan Lake Watershed [2.]	348.0	275,125	92,078	27,623	7.94	62,879	18,864	5.42
Okanagan Basin Downstream of Okanagan Lake [3.]	348.0	48,244	25,424	7,627	2.19	17,282	5,185	1.49
Okanagan Basin Total [4.]	348.0	323,369	117,502	35,350	10.16	80161	24,049	6.91

Table A-4: Licensed and Actual Use Volumes for the Okanagan Mainstem Lakes and Basin [1.]
Water Use During Drought Year (2003)

Point-of-Interest	Surface Area of Lake (sq. km)	Annual Offstream Licenced Volume [5.] (ML)	July 10 to September 30			August 1 to September 30		
			Actual Water Use [6.] (ML)	Water Conserved Under Level 3 Drought Declaration [7.]		Actual Water Use [6.] (ML)	Water Conserved Under Level 3 Drought Declaration [7.]	
				Volume (ML)	Depth on Lake (cm)		Volume (ML)	Depth on Lake (cm)
Kalamalka-Wood Lake	35.2	17,077	5,994	2,049	5.82	4,656	1,397	4.00
Okanagan Lake	348.0	118,353	16,865	5,060	1.45	11,446	3,434	0.99
Okanagan Lake Watershed [2.]	348.0	275,125	105,159	31,548	9.07	71,090	21,327	6.13
Okanagan Basin Downstream of Okanagan Lake [3.]	348.0	48,244	28,375	8,513	2.45 [8.]	19,307	5,792	1.66 [8.]
Okanagan Basin Total [4.]	348.0	323,369	133,834	40,061	11.51	90,397	27,119	7.79

Explanatory Notes for Tables A-3 and A-4

1. Data used in the tables (i.e., licensed volumes, lake surface areas, water use volumes, etc.) was obtained from Summit Environmental Consultants Inc. 2015. Memorandum – Okanagan Basin Drought Calculations.
2. This includes Okanagan Lake plus all contributing areas to Okanagan Lake and both surface and groundwater water use.
3. This includes all of the mainsteam lakes and contributing areas below Okanagan Lake and surface and groundwater water use.
4. Sum of Okanagan Lake Watershed and Okanagan Basin Downstream of Okanagan Lake.
5. Water licence information obtained from the most recent files (dated May 2015) available from the provincial government of B.C. (www.data.gov.bc.ca). Annual licensed volume represents current licences for offstream purposes only.
6. Actual water use information from weekly data from the OWDM for Weeks 28 – 39 (July 9th – September 30th [representative of the date of declaration to the end of the irrigation season]) and Weeks 31 – 39 (July 30th – September 30th (representative of August 1st to end of irrigation season) for water use areas supplied by the mainstem lakes and other contributing watersheds.
7. The volume of water conserved under a Level 3 Drought Declaration was assumed equivalent to a 30% reduction in actual water use for each lake and the entire Okanagan Basin.
8. Area of Okanagan Lake used to determine the "Depth on Lake" as water conserved downstream would reduce the volume of water required to be released from Okanagan Lake to maintain flows in Okanagan River.

APPENDIX C

Water Conservation Plan

TOWN OF OLIVER

WATER CONSERVATION PLAN

Draft Report: December 2006
Final Report: January 2007
Ref. No. 306-1111

TRUE
CONSULTING GROUP

January 26, 2007

Our File: 306-1111

Town of Oliver
Box 638
Oliver, B.C. V0H 1T0

Attention: Mr. Tom Szalay, P. Eng.

Dear Sir:

RE: ***Water Conservation Plan – Town of Oliver***

Submitted herewith is our final report dated January 2007 representing a Water Conservation Plan for the Town of Oliver's Municipal Water System. The report reflects input and comment received from Town staff and council at the presentation on January 15, 2007.

Principal elements of the Water Conservation Plan include:

- establishing a water conservation plan coordinator position. The coordinator is assumed to represent a half time position.

- proceeding with a universal metering program for the municipal system service area. Assuming the Town of Oliver's applications under the Canada-BC Rural Infrastructure Assistance Program is approved, the metering program is assumed to be implemented in 2008.

- major user audits focussing initially on public and institutional lands where there are opportunities to provide alternative sources of irrigation water.

The conservation plan implementation schedule should not be considered as fixed recognizing assumptions related to assistance from senior governments.

In the short term, next five year period, the preceding described elements of the water conservation plan represent the potential to reduce the average annual water consumption of the municipal water system by at least 25% and the reduce municipal system maximum day demand by at least 20%.

We appreciate the opportunity to assist the Town with the preparation of a Water Conservation Plan.

Yours truly,

T.R. Underwood, P. Eng.

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Enclosure
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TOWN OF OLIVER
WATER CONSERVATION PLAN

TABLE OF CONTENTS

Page

The Town of Oliver has adopted a plan to construct, on a phased basis, twin domestic water distributions in the rural areas north and south of the Town to address drinking water quality deficiencies. Water is currently supplied to approximately 700 domestic connections in the rural area by direct pumping from the Town's irrigation canal with the only treatment being chlorination. These systems are significantly deficient in relation to the Interior Health 43210 treatment guidelines requiring, at a minimum, filtration and disinfection.

The Province of British Columbia approved, in December 2005, a capital cost grant to assist the Town of Oliver with the construction of the initial phase of the Rural Area Water System Twinning project. A condition of the approved grant is that the Town of Oliver prepare and adopt a water conservation plan.

Beginning in the later part of 2004, Town council members and Town administrative staff have participated in a number of planning activities where sustainability and the finite capacity of the available water resource have represented major issues. Some examples in this regard include:

- Regional Growth Strategy being undertaken by the Regional District of Okanagan Similkameen.
- Smart Growth on the Ground initiatives to accommodate population growth within the Town and adjacent rural areas.
- participation in initiatives of the Water Sustainability Committee of the BC Water and Waste Association.
- participation in the Bench Marking Initiative pilot programme and Water Conservation Calculator Guide of the Ministry of Community Services.

The Town of Oliver recognizes the importance and benefits of water conservation and, based on the study as described herein, intends to proceed with the adoption and implementation of a water conservation program.

2.1 General

The Town of Oliver owns and operates water systems servicing lands adjacent to the Okanagan River over a length of about 17 km from the Highway 97 Bridge at the north to the north end of Osoyoos Lake at the south. An overall plan of the water systems owned and operated by the Town of Oliver is presented in *Figure 1*. Areas within the Town's municipal boundaries are serviced by the Town's municipal water system which is described in Section 2.2. Rural areas in Regional District of Okanagan Similkameen Electoral Area C, both north and south of the Town, are provided water service by combined irrigation-domestic systems. These systems are described in Section 2.4.

Municipal wastewater is treated and stored for reuse by irrigation in the Fairview Area. In 2004, the Town completed extensions of its reclaimed water supply system thereby making reclaimed water available for irrigation purposes to areas adjacent to or near the 350^{th} and 348^{th} corridors within the municipal boundaries. The reclaimed water supply system is described in Section 2.3.

2.2 Municipal Water System

The municipal water system provides service to all urban density residential, commercial and industrial lands within the Town's municipal boundaries. A total of four drilled wells represent the water source for the municipal water system. The municipal system water supply well locations are illustrated in *Figure 1*. The municipal water system is a single pressure zone controlled by the Town's municipal water reservoir having a capacity of 1360 m^3 and a full water elevation of 381 m. The municipal water system provides domestic service and fire protection consistent with accepted municipal water system design standards.

Treatment of water from the municipal system supply wells is currently limited to chlorination at the Lions Park and CPR wells for distribution system residual. Building provisions were made for chlorination at the Rockcliffe well however chlorination equipment has not been installed.

Outside of the irrigation season, typically mid October to early April annually, the Town has the ability to supply its rural area water systems from the municipal water system through system interconnections. These interconnections are not metered which represent a complication in accurate calculations of existing water use in the municipal system service area. Relying on its municipal water system wells as the primary source of supply outside of the irrigation system does however simplify overall operation of the systems.

Future population growth in the Oliver area is anticipated to be accommodated within the Town's municipal boundaries and within the service area of the municipal water system. Water conservation programs focusing on the municipal water system service area therefore represent the potential of the Town being able to defer capital improvements planned to provide increased capacity, i.e. new wells.

2.3 Irrigation Systems

With the exception of System 2 in the Black Sage area, the water source for the Town's irrigation-domestic systems serving the rural areas is the Irrigation Canal. The canal was constructed in the early 1920's and is supplied by diversion from the Okanagan River at the McIntyre Dam (refer to *Figure 2*). Irrigation systems 1, 4, 6 and 7 are supplied by pumphouses drawing water from the irrigation canal. In total, the Town's irrigation systems provide water to about 700 domestic connections and approximately 1600 ha of agricultural land.

In 2001, the Interior Health Authority (IHA) requested, through the IHA issued water system operating permit, that the Town prepare a plan to address drinking water quality deficiencies in the rural areas. In response, the Town adopted a plan to construct separate groundwater supplied domestic water systems within the service areas of Irrigation systems 1, 4, 6 and 7. The existing systems using the canal as a water source would remain in service only as irrigation water supply systems.

The rural area water twinning program has been sized from a water source perspective to supply domestic water quantities only. Concurrent with the construction of the twin domestic systems, water meters will be installed on new domestic services. The water meters are essential to discourage use for irrigation purposes from the twin domestic system and thereby ensure that consumptive use will be principally represented by in house water use consistent with the design philosophy of the system.

The Town has secured assistance under the BC Community Water Improvement Program for the construction of the domestic twin water systems in the service areas of irrigation systems 6 and 7. These twin systems in the service areas of systems 6 and 7 are anticipated to be operational in the fall of 2007. Consistent with the overall twinning plan, the Town intends to make application in 2007 under the Canada BC Infrastructure program for capital grants for the second phase of implementation comprising systems 4 and 5.

2.4 Reclaimed Water System

The Town's wastewater treatment system and reclaimed water supply system are illustrated in *Figure 2*. Wastewater from the Town is treated by a two cell aerated lagoon system located in the Fairview area west of the core area of the Town. Treated effluent is stored for irrigation (re-use) purposes. As illustrated in *Figure 2* separate reclaimed water mains supply the Fairview Mountain Golf Course and public lands, i.e. cemetery, airport, and school area linear park within the Town's municipal boundaries.

The reclaimed water supply main on 350th Avenue represents the opportunity to supply irrigation water to areas currently using the Town's municipal water system (i.e. South Okanagan Secondary School site) and supply irrigation water to currently irrigated areas which would 'normally' utilize domestic water (i.e. future lease areas on the airport site). The reclaimed water supply system which extends through the core area of the Town represents a water conservation opportunity which is unique to the Town of Oliver.

3.1 General

Fundamental to estimating the benefits (reduced water consumption and costs) of a water consumption plan is defining the current situation from the perspective of both water consumption and costs. The Province has initiated a Benchmarking program on a pilot basis which provides a format for defining current water consumption and costs. The water conservation calculator, which links to the benchmarking spreadsheets, provides a means to assess in measurable form water conservation amounts and operating and capital cost benefits. As the benchmarking program expands, the program will enable comparisons to other municipalities on a common data format basis. A historical difficulty in cost comparisons with other municipalities is varying formats for cost calculation and data presentation.

For the Town of Oliver, benchmarking forms for the municipal and rural area (irrigation systems) have been completed for the period 2000 to 2005 utilizing operating budget and consumption data provided by the Town. The benchmarking forms are included herein in Appendix 1. Of particular relevance to the water conservation program are sections relating to consumption and costs. Some sections of the benchmarking spreadsheets not specifically relevant to the water conservation program, remain to be completed. Examples in this regard are inventory statistics on the water distribution system and the frequency of water main breaks.

3.2 Municipal System Water Consumption

3.2.1 Annual Average Water Consumption

Water consumption data for the Town's municipal water system has been reviewed and assessed for the period 2000 to 2006 to determine current annual average day and maximum day water usage on a per capita basis. The Town's municipal water system supplies areas within the municipal boundaries during the irrigation season, April to September annually, and some rural areas during the winter months. As the volume of water supplied by the municipal system to rural areas in the period October to March annually is not metered, water volumes supplied to rural areas have been estimated by:

- estimating the average winter period water demand on a per capita basis by dividing the total consumption (all systems) by the serviced population (4400 municipal and 2000 rural for a total of 6400). Winter period (November to March) water demands in areas serviced by the Town's water systems average 690 L/capita/day (182 USgal/capita/day) for the period 2000 to 2006.
- estimating the winter period total consumption of the rural areas based on actual winter period per capita demands, and an assumed rural area serviced population of 2000. The volume supplied to the rural areas by the municipal system is then calculated as the difference between the calculated total winter period demand and the volume supplied by water supply sources within the rural areas.

The 'adjustments' to the municipal system total water consumption data for estimated volumes supplied to the rural area systems based on the above calculation methodology is presented in Table 3.1. From Table 3.1,

- the percentage of the estimated winter period rural and water demands supplied by the municipal system varies significantly from 37% in 2000 to about 10% in 2004 and 2005.
- in 2004, the estimated volume supplied by the municipal system to the rural areas of 18 ML (4.8 MUSgallons) represents a net volume. Operating records suggest that Buchannen Road well in System #1 was used as a source of supply to the municipal system in February and March 2004.

Table 3.1: Winter Period (Nov. to March) Water Quantities supplied from the Municipal System to Rural Areas

	Est. Winter Period Rural Area Water Consumption		*Volume Supplied by Rural Area Water Sources*		*Calculated Volume Supplied by Municipal System to Rural Areas*	
Year	ML	(MUSgal)	ML	(MUSgal)	ML	(MUSgal)
2000	217	(57.4)	136	(36.1)	81	(21.3)
2001	219	(57.9)	155	(41.1)	64	(16.8)
2002	209	(55.3)	153	(40.5)	56	(14.8)
2003	209	(55.3)	135	(35.7)	74	(19.6)
2004	195	(51.5)	177	(46.9)	18	(4.6)
2005	192	(50.7)	169	(44.7)	23	(5.8)

A further complication in calculating water consumption within the municipal system service area is flow meter inaccuracy for water supplied by the Municipal Lions Park and CPR water wells. Calibration tests of the Lions Park/CPR flow meter by Town staff in July 2005 indicate that the flow meter was in error by:

- CPR Well Pump on only - low by 8%
- Lions Park Pump on only - low by 13%
- Lions Park and CPR Pumps on - low by 36%

Assuming this flow meter error is applicable to all Lions Park and CPR water consumption data for the period 2000 to 2005, adjustments for flow meter error were calculated for each year by analyzing from operating records, total hours that the CPR and Lions Park well pumps operated individually and together. Table 3.2 summarizes total annual water consumption data for the Town's municipal system for the period 2000 to 2006.

Table 3.2: Total Annual Municipal Water Consumption

METRIC - ML	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Total Volume Pumped (per Town Annual Reports)	2627	2543	2742	2713	2150	2104
(less) Volume supplied to Rural Areas Net	81	64	56	74	18	23
(plus) Flow Meter Adjustment	36	40	65	69	173	205
Total Annual Consumption	2,582	2,519	2,751	2,708	2,305	2,286
Serviced Population (BC Stats)	4405	4409	4441	4426	4378	4379
Annual Average Per Capita (Litres/capita/day)	1605	1565	1697	1676	1442	1430
IMPERIAL - M USgals						
Total Volume Pumped (per Town Annual Reports)	695.2	672.8	725.4	717.8	568.9	556.8
(less) Volume supplied to Rural Areas Net	21.3	16.8	14.8	19.6	4.6	5.8
(plus) Flow Meter Adjustment	9.5	10.6	17.2	18.3	45.8	54.4
	683.2	666.6	727.8	716.5	610.1	605.4
Serviced Population (BC Stats)	4405	4409	4441	4426	4378	4379
Average Annual Per Capita (USgal/capita/day)	425	414	449	444	382	379

Table 3.2 indicates that the average annual water consumption in the Town's municipal water system was in the range of 1560 to 1700 L per capita in the period 2000 to 2003, and in 2004 and 2005 has decreased averaging 1440 L per capita. Summer period weather conditions were not as dry and hot as 2002 and 2003 which is likely a contributing factor to reduced annual average water consumption.

Accurate and complete water assumption data is essential for water supply system improvements and assessments of benefits achieved by water consumption programs. Calculation of municipal system water consumption from historical data is complicated by unmetered supplies to the rural areas and flow meter errors at the Lions Park and CPR wells. The Town should include in its capital budgets provisions to replace the Lions Park/CPR flow meter and provisions for meters at all supply interconnection points between the Municipal and Rural Area Systems.

3.2.2 Maximum Day Water Demands

The maximum day water demand is the most important demand criteria for the purposes of assessing the adequacy of source of supply capacity and determining when additional source capacity (in the Town's case an additional well) has to be constructed. Accepted design practice is that the combined capacity of supply sources has to exceed, with a safety factor to address unforeseen events or periods of unprecedented high water demands, the maximum day demand of the water system service area.

Peak water usage periods for the Town's municipal water system have been assessed for each year in the period 2000 to 2005 inclusive. In each from detailed system operating records provided by the Town, the 5 day period of peak water consumption has been determined as the average of this five day period. Some averaging is necessary recognizing that the flow meters in each of the Town's three water supply wells are not read at the same time each day by Town staff. Maximum daily water demand data for the Town's municipal system is presented in Table 3.3. The data reflects corrections for flow meter inaccuracies at the Lions Park/CPR water wells as described in Section 3.2.

Table 3.3: Municipal Water System Maximum Day Water Demands

			Maximum Day Demand		*Maximum Day Per Capita*	
Year	*Population*	*Dates*	*ML/day*	*MUSgal/day*	*L/day*	*USgpd*
1998	3900	July 27	16.2	4.28	3860	1020
2000	4405	July 18-22	18.9	5.00	4300	1137
2001	4409	July 6-10	17.4	4.62	3970	1048
2002	4441	July 15-19	19.8	5.24	4470	1180
2003	4426	July 26-30	19.3	5.09	4350	1150
2004	4378	Jul30-Aug3	16.58	4.36	3770	996
2005	4379	Aug 5-9	15.9	4.21	3640	962

** BC Stats except 1998 which was estimated

From Table 3.3, municipal system maximum day demands in the period 2000 to 2006 range between 3640 L/capita and 4470 L/capita. The maximum day demand in any year is dependent on climatic factors and therefore significant variability in the maximum day demand from year to year is anticipated.

3.2.3 Comparison to Other Southern Interior Municipalities

As described in Section 3.1, comparison of derived annual average and maximum day water consumption values for Oliver is not straightforward and may be inaccurate. Factors which complicate and result in comparison inaccuracies include:

- lawn and garden irrigation is the largest component of residential water use in the Southern Interior area. Lawn and garden irrigation amounts are climate and average lot size dependent therefore strict comparison between municipalities is difficult. Single family lot sizes in the Tuc El Nuit and Rockcliffe areas of the Town are significantly larger than typical urban density averages because these areas were serviced by individual onsite septic tank systems when developed. In the 1990's boundary expansions were undertaken to include these areas in Town and sanitary sewer service provided.
- where universal metering is provided, non residential uses, i.e. industrial, commercial, and institutional uses can be separated and residential usage rates

accurately calculated. Water consumption on a per capita basis calculated for Oliver includes all non residential land uses.

- per capita water consumption is calculated on the basis of the census population. Where there is significant tourist related industry and/or seasonal population, water consumption associated with these land uses will be reflected in the per capita water demands of the permanent census population.

Comparative data for annual average and maximum day water demands are presented in Table 3.4. Average annual water consumption on a per capita basis for Oliver and Osoyoos is comparable at about 1400 L/capita and significantly greater than all other municipalities listed in Table 3.4. Maximum day water consumption within the service area of the municipal water system is 4300 L/capita per day which is the highest of all comparison municipalities. The comparisons presented in Table 3.4 would appear to suggest that there are significant opportunities in Oliver to reduce water usage through a water conservation program.

Table 3.4: Average Annual and Maximum Day Water Demands Comparisons

Municipality	*Average Water Consumption (L/capita)*	*Maximum Day Water Demand (L/capita)*
Oliver (non metered)	1400	4300
Osoyoos (non metered)	1380	3900
Penticton (metered) (see Note 1)	670	2500
Summerland (non metered) (see Note 2)	800	3000
RDOS Development Servicing Bylaw No. 2000, 2002		8000 L/connection
Vernon (3) (metered)	600	1300
Princeton (non metered)	1800 (4)	3200
Lillooet (non metered)	1650 (4)	3650
Kamloops (non metered)	800	1700

Notes: (1) Annual Averages for period 2003 to 2005, Maximum Day from Design Standards

(2) Summerland Values are Design Criteria used in Water Master Plan (2002)

(3) Vernon Data to 1999

(4) High annual average water consumption likely reflective of system leakage from old distribution mains

3.3 Municipal System Water Costs

As described in Section 3.1, the Ministry of Community Services benchmarking forms have been utilized to calculate unit operating costs for the Town's municipal system. The methodology utilized to generate operating cost data for the Town's municipal system for input into the benchmarking forms is summarized as follows:

- water system operating budgets obtained from Town staff were separated into municipal system and irrigation system operating costs.
- total municipal system operating costs, excluding debt retirement, were divided into withdrawal, treatment and distribution categories.
- administration costs were allocated to each category on a proportional basis.

On the basis of the above total municipal system operating costs by benchmark categories including administration but excluding debt retirement for the period 2000 to 2006 are summarized in Table 3.5.

Table 3.5: Summary of Municipal Water System Operating Costs*

Year	*Drinking Water Source*	*Drinking Water Treatment*	*Distribution System*	*Total Operating Cost (Fixed Cost % Approx)*
2000	$157,876	$6,547	$80,069	$244,491 (41%)
2001	$179,997	$8,859	$88,334	$227,190 (41%)
2002	$231,168	$8,523	$72,223	$311,914 (31%)
2003	$228,576	$23,790	$89,786	$342,152 (35%)
2004	$169,435	$35,493	$98,144	$303,071 (37%)
2005	$167,018	$34,980	$110,242	$312,240 (39%)

* Includes administration, does not include debt retirement

Unit costs for each category are calculated by the benchmarking forms by dividing the annual costs for each operating cost category by the total water consumption for each year. Unit costs for the Town's municipal water system from the benchmarking program are presented in Table 3.6. It is important to note that the water system operating costs comprise both volume or quantity related items, i.e. electrical energy, water treatment chemicals, pump maintenance, etc. and fixed costs, i.e. staff salaries, insurance, administration, etc. Water conservation will result in savings to the Town of volume related operating costs only. Table 3.5 provides percentages of the total that represent fixed operating costs, i.e. about 31 to 41% of the Town's total water system operating costs are fixed costs.

Table 3.6: Municipal Water System Benchmark Unit Costs*

Year	*Drinking Water Source*	*Drinking Water Treatment*	*Distribution System*	*Total*
2000	$0.061	$0.003	$0.031	$0.095
2001	$0.071	$0.004	$0.035	$0.110
2002	$0.084	$0.003	$0.026	$0.113
2003	$0.084	$0.009	$0.033	$0.126
2004	$0.073	$0.015	$0.043	$0.131
2005	$0.073	$0.015	$0.050	$0.136

* all cost reported in $ per cubic meter of water volume pumped at source, i.e. measured at each supply well.

** total does not include debt retirement nor does it include municipal system revenue subsidy to the Town's Rural Area water Systems.

The following should be noted from Table 3.6:

- Drinking water source costs comprised all costs to deliver water to the distribution system, i.e. pump station maintenance, pump station electrical energy, etc. represent about 53% of the total cost.

- treatment provided in the water system comprises chlorination for distribution system residual only in the period 2000 to 2002. Treatment unit costs increased in 2004 and 2005 to $0.015 per cubic meter reflecting the Town's hardness sequestering program.

- in 2004 and 2005 on an overall basis, the cost to supply one cubic meter of water from the municipal water system averaged $0.134 per cubic meter of which 62% or $0.083 per cubic meter represents variable or quantity dependent costs.

Cost information presented in Table 3.6 forms the basis for assessing water conservation strategies on a cost benefit basis.

3.4 Reclaimed Water Utilization

Referring to *Figure 2*, reclaimed water services for irrigation purposes were constructed in 2004 to:

- the cemetery – replaces irrigation service from the municipal water system.
- linear park adjacent to High School – new park which would have been irrigation from municipal water system
- public works yard – replaces irrigation service from the municipal water system
- airport – new irrigation service

Reclaimed water use on the above in 2005 and 2006 are summarized in Table 3.7.

Table 3.7: Reclaimed Water Use for Irrigation

	2005	*2006*
Areas replacing Irrigation from Municipal Water System		
Cemetery	14,015 m^3	12,455 m^3
Public Works Yard	7,720 m^3	12,535 m^3
Total Replacement	21,735 m^3	24,990 m^3
New Area		
High School Linear Park	4,555 m^3	9,255 m^3
Airport	221,400 m^3	238,400 m^3

In 2006, reclaimed water usage on the Cemetery and Public Works Yards represented a total volume of 24,990m^3. This total represents municipal domestic water conserved. The total volume of 24,990m^3 represents about 1% of the total municipal water consumption in 2005 therefore it can be concluded that reclaimed water use for irrigation on both the cemetery and public works yards have resulted in a 1% reduction of the Town's consumption from the municipal water system.

Irrigation of the linear park near the High School represents a total volume used of 9255m^3 in 2006. If water from the Town's municipal system had been used for irrigation of this park, overall municipal water consumption would have increased by about 0.5%.

The reclaimed water supply system represents an important and significant opportunity for conservation of available source capacity of the municipal water system. Replacement services at the public works yard and cemetery have achieved an estimated 1% reduction in total municipal water system use and utilization on the High School linear park avoided a 0.5% increase in total annual consumption.

3.5 Wastewater Treatment and Disposal Costs

Several water conservation strategies, i.e. low flush toilet replacement incentives and water efficient appliance rebates, represent the potential of reducing both domestic water consumed and wastewater quantities generated. To enable a cost benefit analysis of these strategies, cost savings associated with reduced wastewater generation have to be considered.

Utilizing the Ministry of Community Services benchmarking program, unit costs for wastewater collection and treatment have been calculated. Sanitary sewer operating budget data, excluding debt retirement, provided by the Town has for benchmarking purposes been separated into collection and treatment/disposal categories. Unit costs are then derived by dividing these component costs by total sewage volumes generated as presented in the Town's annual sewer reports to result in unit costs. Benchmark spreadsheets are presented herein in *Appendix 1*.

Unit costs of the Town of Oliver for sewer collection, treatment and disposal derived from the Benchmarking program are summarized in Table 3.8. Unit costs average about \$0.45 per cubic meter for the period 2001 to 2005. A cost of \$0.495 per cubic meter is derived for 2003, approximately \$0.05 higher than the 5 year average reflecting higher than normal costs associated with repairs and maintenance of the Town's High Lift Pumps. In 2005, the unit cost reduces to \$0.407 per cubic meter, approximately 10% reduction, primarily as a result of reduced costs (\$33,000) for electrical energy for the high lift pumps realized by restrictive time of use, energy cost incentives offered by Fortis.

Table 3.8: Sanitary Sewer Collection, Treatment and Disposal Costs

Year	*Cost per Cubic Meter*
2000	\$0.386
2001	\$0.450
2002	\$0.434
2003	\$0.495
2004	\$0.441
2005	\$0.407

3.6 Existing Water Conservation Measures

The Town of Oliver does not currently have a formal water conservation program, however many of the Town's administration and operational practices represent water conservation related measures. These include:

- public information brochures describing water conservation tips and measures which are included with utility invoices mailed to all of the Town's water customers.
- implementing the Waste Management Plan which makes reclaimed water available as an irrigation source to several public land parcels where the municipal water system currently represents the irrigation water source.
- Bylaw No. 1509 passed in 2003 which requires all new water services to be metered.

4.1 Municipal System Capital Plan

The Town's water system capital plan for the municipal water system is summarized in Table 4.1 represent projects which will increase the supply capacity of the system or represents the potential of changing the water demands on the system.

Table 4.1: Municipal Water System Capital Plan

Schedule	*Project*	*Budgeted Cost (Year Estimate Prepared)*
2007 and 2008	Expand Municipal System Reservoir	\$650,000 (Jan. 2000)
2008	93rd Street Water Supply Main (Wine Village Area)	\$123,000 (Feb. 2006)
2009	Phase 2 Rural Area Twinning (Systems 4 and 5)	\$4,200,000 (Jan. 2007)
	Universal Water Metering – Municipal System	\$1,620,000 (Jan. 2007)
2010	Water Supply Well No. 5	\$350,000 (July 1999)
2011	Phase 3 Rural Area Twinning – System No. 1	\$1,856,000 (Feb. 2005)

The Town has recently initiated its budget process for 2007 and is intending to review its water capital budget. The municipal system universal metering program, at an estimated capital cost of \$1,620,000, is proposed to be combined with the Systems 4 and 5 twinning project. Accordingly metering would be completed prior to the construction of additional source capacity, proposed water supply well No. 5. It is logical that metering of the municipal water system service area be scheduled prior to the construction of additional source capacity recognizing that water demands will decrease with metering and thereby enable the Town to possibly defer the construction of additional source capacity. Phase 2 of Rural Area Twinning and Universal Metering of the municipal system are dependent on approval of the Town's grant application under the Canada-BC Rural Infrastructure Program to be submitted in January 2007.

4.2 Population and Water Demand Projections

Town staff is currently undertaking an Oliver and Area growth study of which a component is long range population projects. The growth study reviews population growth projections from several independent sources and concludes that the following growth rates are applicable to the Oliver community area (Town and Regional District of Okanagan Similkameen Area C).

- 2006 to 2010 – 3.5% growth rate
- 2011 to 2015 – 2.0% growth rate
- 2015 to 2020 – 1.2% growth rate
- 2020 to 2041 – 1.0% growth rate

The above presented growth rates would be applied to the community area population estimate of 8623 in 2005.

The Growth Study identifies a goal of the Oliver Smart Growth and the RDOS Regional Growth Strategy to direct the majority of new growth into existing communities. This goal also minimizes conflicts with and growth pressures on rural ALR lands. The Growth Study therefore concludes with the assumption that 90% of community (Town and Electoral Area C) population growth will occur or be directed within Town Municipal Boundaries.

From the Growth Study, population projections for the Town of Oliver for the period to year 2026 are presented in Table 4.2. The System 4 rural area twinning project anticipated to be completed in 2009 will add an additional 150 population to the Town's municipal water system. From Table 4.2, the serviced population of the Town's municipal water system is projected to increase by about 86% to 8298 by year 2026.

For the Town of Oliver to increase in population from 4441 to 8298 over the next 20 years, and not significantly encroach onto lands within the ALR, the population density within municipal boundaries will increase. It is anticipated that a component of the population increase will result from redevelopment of existing single family residential areas to higher densities and by medium to high density development on vacant developable lands. This densification process will result in the Town's current per capita maximum day and average day water demands decreasing, recognizing current demands largely reflect lawn and garden irrigation of relatively large single family lots.

The trend of decreasing maximum day water demands when population growth is largely represented by non single family residential land use is demonstrated by historical data for the Town of Osoyoos. While climate remains a significant factor in maximum day water demands, data for the Town of Osoyoos for the period 1990 to 2005 indicates a decrease from 4400 L per capita prior to 2000 and to an average of 3900 L/capita since 2000. This decrease in per capita maximum day water demands of approximately 12% is largely attributable to densification of the serviced population.

Long range projection of municipal water demands on the basis of current average day (1400 L/capita) and maximum day (4300 L/capita) demand criteria is not realistic. For demand projections, it is assumed that densification will result in a 20% reduction of current average and maximum day per capita water demands. Water demand projections presented in Table 4.2 are based on the assumed 20% reduction as a result of densification.

Table 4.2: Municipal Water System Service Population and Water Demand Projections

Year	*Town Population*	*Water System Service Population*	*Annual Water Consumption (ML)*	*Maximum Day Demand (ML/day)*
2005	4441	4441	2269	19.1
2006	4713	4713	2384	20.1
2007	4994	4994	2501	21.0
2008	5285	5285	2620	22.0
2009	5587	5587	2741	23.1
2010	5898	6048	2936	24.7
2011	6083	6233	2994	25.2
2012	6271	6421	3051	25.7
2013	6463	6613	3109	26.2
2014	6658	6808	3166	26.6
2015	6858	7008	3223	27.1
2016	6980	7130	3243	27.3
2017	7103	7253	3262	27.4
2018	7228	7378	3280	27.6
2019	7355	7505	3298	27.8
2020	7485	7635	3316	27.9
2021	7591	7741	3323	28.0
2022	7700	7850	3329	28.0
2023	7810	7960	3335	28.1
2024	7922	8072	3341	28.1
2025	8035	8185	3346	28.2
2026	8148	8298	3350	28.2

Total annual municipal system consumption projections for the period to year 2026 (20 year horizon) from Table 4.2 are illustrated in *Figure 4.1.* Total annual water consumption is projected from a 2005 consumption of 2269 ML per year. Over a 20 year project period to year 2026, total annual water consumption within the service area of the municipal water system is anticipated to increase by about 50% from 2269 ML to 3350 ML per year.

Total annual water consumption within the service area of the municipal water system is not an important design criteria for new water supply infrastructure. The total annual water consumption is however a measure of the utilization by the Town of the available groundwater resource in the Oliver area. Agencies of senior governments are currently undertaking assessment studies of both the available water resources in both the Okanagan Valley and the south Okanagan area. It is however recognized that the available water resource is not unlimited and in this regard the RDOS growth management study has advanced the following policies.

I1: The RDOS, including its rural areas and member municipalities, will apply the concept *water for life and livelihoods* to promote a water balanced approach to social, economic and environment sustainability over the short and long term.

I2: The RDOS, including its rural areas and member municipalities, will promote two guiding principles to stretch the water resource capacity of the Okanagan basin:

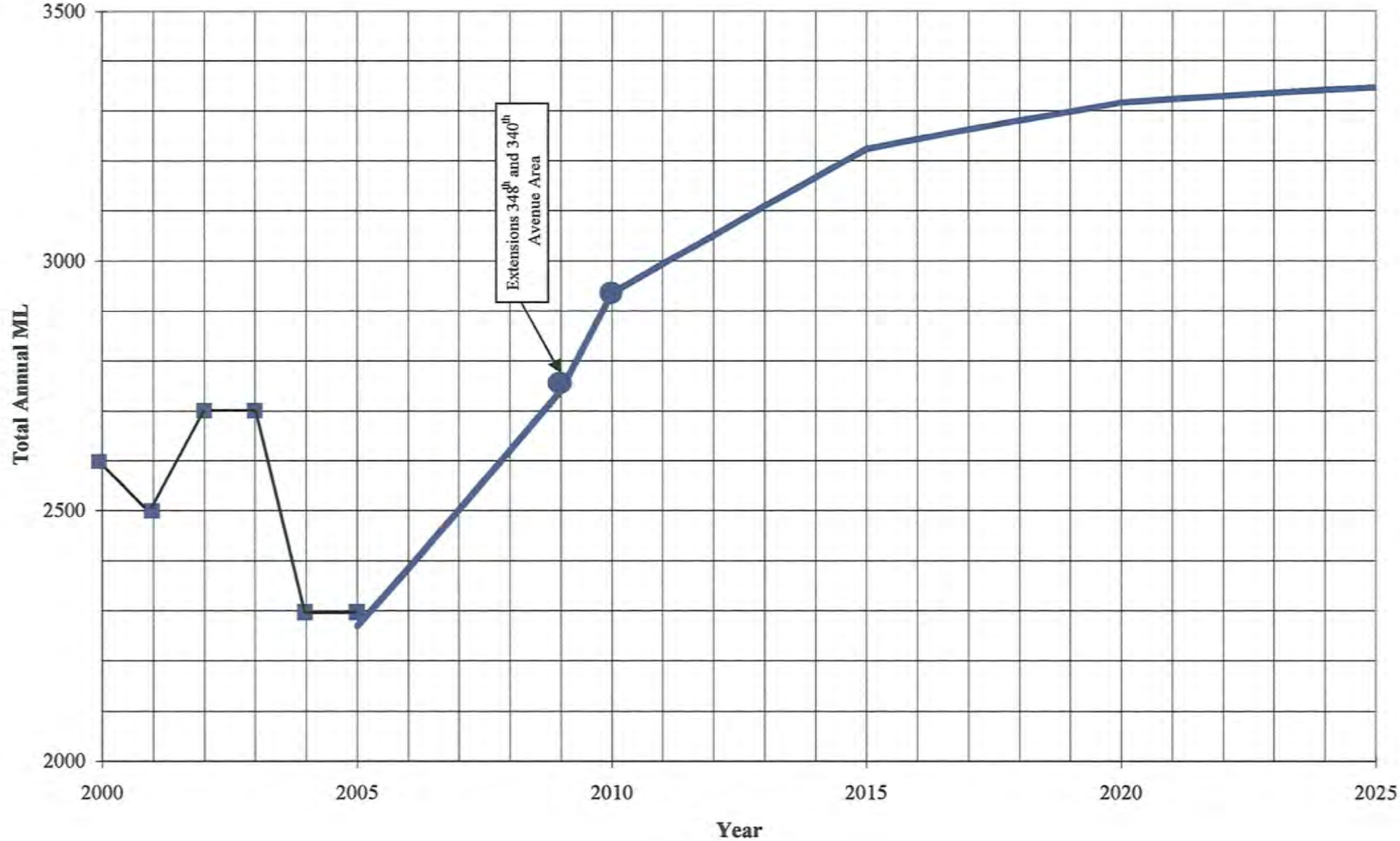
- Increase agricultural water use efficiency to offset climate variability and/or expand irrigation farmland;
- Reduce residential water use to support population growth in urban areas.

I3: The RDOS, including its rural areas and member municipalities, will follow and pursue best practices for achieving integrated water management on-the-ground.

The underlying principle of the above RDOS policies related to water supply infrastructure is water conservation recognizing the limited capacity of the available water supply resource.

The projection of annual total water consumption from the municipal water system as presented in *Figure 4.1* assumes that future development, all land use categories including residential, commercial and industrial, will be comparable to what currently exist in the water system service area. The projection does not therefore include any provisions for a new abnormally high water use development. Typically a high water use development is presented by a new industry, for example a winery, or a food processing

Figure 4.1 - Municipal System Total Annual Water Consumption Projections



plant. Of equal impact to a high water use industry would be additional parks where the municipal water system is the irrigation water source or summer water related recreational facilities, similar to the water park constructed in 2006.

Assuming twinning of Systems 4 and 5 is completed in 2009, the total annual water consumption within the municipal system service area will increase by about 70 ML annually as a result of extensions into the 338th and 340th Avenue area. This 70 ML of annual water consumption increase does not represent an additional demand on the area's water resource but a 'transfer' of demand which up to 2009 had been supplied by System 4.

The important design criteria from an infrastructure planning perspective, i.e. additional wells and upgraded supply mains, is the maximum day water demand. On the basis of a maximum day demand projections presented in Table 4.2, *Figure 4.2* illustrates a 20 year projection. Similar to the annual total consumption, the municipal system maximum day demand is projected to increase by about 50% over a 20 year period to about 28.2 ML/day.

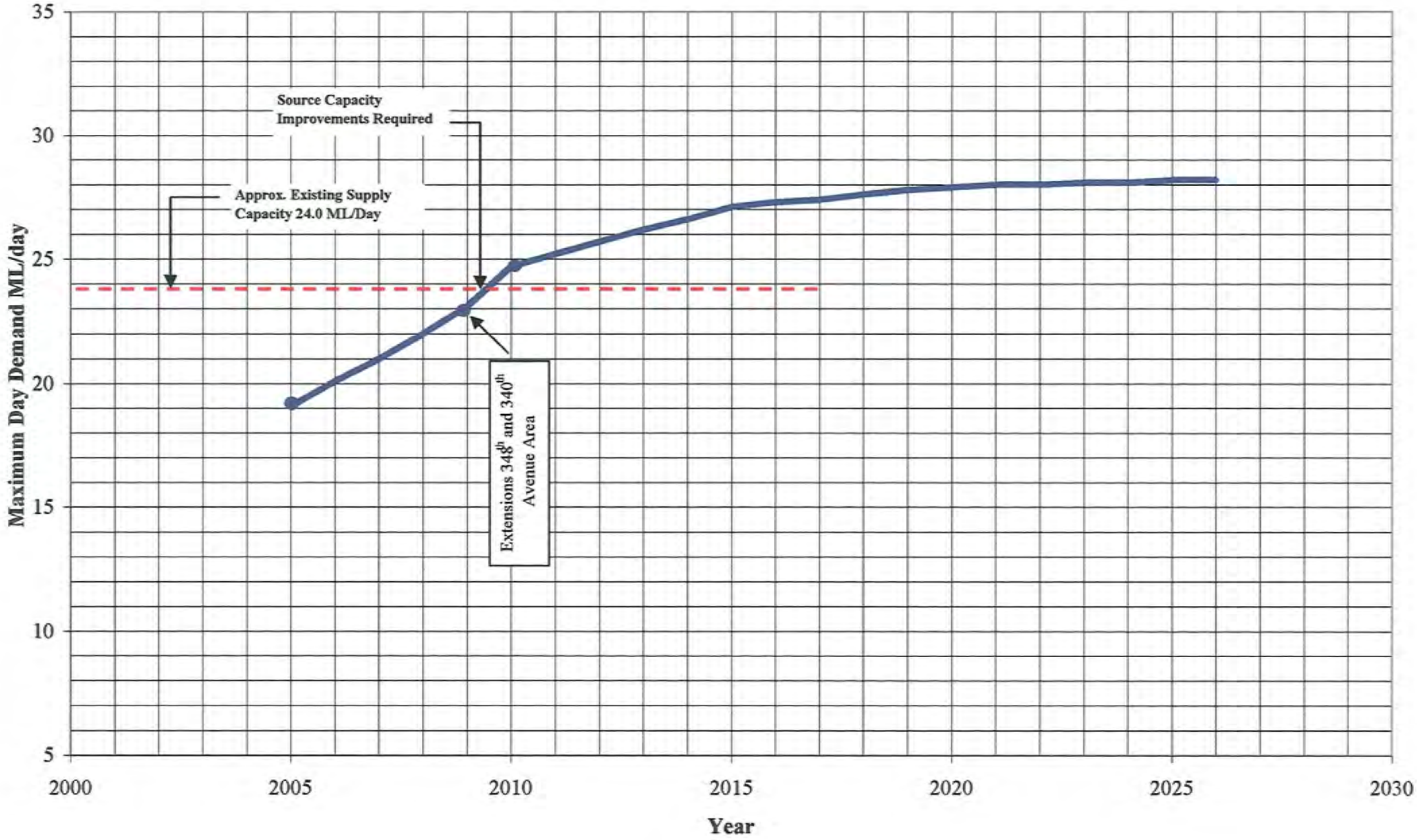
The present supply capacity of the Town's municipal system is estimated as follows.

Lions and CPR Wells (1900 USgpm) -	9.4 ML/day
Tuc El Nuit Well (1100 USgpm) -	6.0 ML/day
Rockcliffe Domestic (1600 USgpm) -	8.6 ML/day
Total Supply Capacity-	24.0 ML/day

In the above calculation, CPR, Lions and Tuc El Nuit wells capacities are estimated on 24 hour per day pump operation and the Rockcliffe well, 16 hour per day operation. A reduced operating period for the Rockcliffe well during a maximum day water demand event represents a factor of safety for unanticipated high water consumption, i.e. fire fighting event, short duration electrical service interruption, etc.

As illustrated in *Figure 4.2*, the present supply capacity of 24.0 ML/day appears to be adequate to about year 2008. At this point maximum day water demands will approach 24.0 ML/day indicating that additional source capacity, i.e. new well will be required. As with the discussion of average annual water demands, no allowances have been made for new abnormally high water consumption development in the maximum day water demand projections as presented in Table 4.2. High water consumption development

Figure 4.2 - Municipal System Maximum Day Water Demand Projections



could include new parks and/or public facilities like the water park. The water park likely represents a water demand of the order of 9 L/sec (140 USgpm or 0.70 ML/day) over a 10 hour period. This demand could equate to up to 4% of the available total water supply pumping capacity over a 10 hour period under maximum day demand conditions.

From *Figure 4.2*, if water conservation strategies can be implemented to reduce the maximum day demand by about 15% over the next 5 year period, the currently available supply capacity of 24 ML/day may be adequate through the 20 year projection period.

5.1 General Objectives

Sections following describe water conservation measures that have been assessed and implemented by other local governments, in Canada and the United States. Where information is available, experience of local governments in British Columbia is described.

Several water conservation measures described in this section including:

- education and information
- universal water metering
- low flush toilets
- landscaping incentives
- rain barrels
- major user audits

represent the potential of reducing water use. Of particular importance to the Town of Oliver are water conservation measures which represent the potential of significant reductions in the Town's maximum day water demand. Additional source capacity represent capital expenditures which can potentially be deferred or 'down sized' if water conservation measures can be implemented to reduce the municipal system maximum day demand.

It is important to also note that all new source capacity will have to fully comply with IHA 43210 treatment objectives. Full compliance may require two separate disinfections and therefore unit supply capacity capital costs will be substantially higher than well sources constructed by the Town in the 1990's, i.e. the Rockcliffe domestic and Tuc El Nuit water supply wells.

While not strictly water conservation measures, alternative water sources, i.e. reclaimed water irrigation system, represent an opportunity for the Town to reduce demands on the municipal water system. Any capacity realized in this fashion would then become reserve municipal system capacity and be available to service population growth with the Town.

5.2 Education and Information

5.2.1 Description and Experience

Public information and education is an essential element of a water conservation plan. An ongoing well conceived public education program has the objective of providing information on costs, the importance and benefits of conservation measures, and descriptive information on specific conservation strategies. Public information programs may include announcements, workshops, school curriculums, websites, bill stuffers, and seminars. Public information initiatives appear to be most effective when combined with the implementation of other water conservation strategies, the most common being universal metering.

The City of Kamloops in the early 1990's implemented a water smart program focusing only on public education and implementable water conservation strategies including low flow shower heads, low volume toilets, appropriate lawn and garden irrigation practices, watering restrictions, xeriscaping, irrigation application rate measuring 'cups', etc. The Kamloops Water Smart program has continued on annual basis and now includes significant enforcement of irrigation restriction regulations. The City of Kamloops estimates that annual average per capita water consumption has been reduced by about 20% by its Water Smart Initiatives. The City of Kamloops has not implemented universal water metering but is proceeding with pilot studies with the objective of at least implementing a voluntary metering program through use rate incentives.

The Cities of Kelowna and Vernon undertook major public information and education programs concurrently with the implementation of universal water metering. In both cases annual average water consumption reductions of more than 20% were achieved. The City of Kelowna's Water Smart program continues to aggressively pursue water conservation objectives and more recently includes compost applications to lawns to retain moisture and reduce irrigation requirements, experimentation with drought tolerant grasses and free water use audits focusing on the highest volume users.

As a stand alone water conservation strategy, consumption reductions to be achieved by a public education and information program are difficult to accurately estimate. Water conservation information has been provided by the Town of Oliver to residents through newsletters. The media, other local governments and senior governments have consistently brought water conservation themes to the attention of the public in the southern Okanagan area. The Smart Growth on the Ground report for Greater Oliver suggests that public information and education by itself represents the potential of a 10% reduction in overall annual water consumption. Recognizing the water conservation information that is currently provided to the public, the Smart Growth estimate of a 10% water reduction may be optimistic.

5.2.2 Oliver Proposal

Consistent with the suggestions of the Water Conservation calculator prepared by the Ministry of Community Services, it is suggested the Town of Oliver implement a public information program concurrently with the universal metering program. The public information and education program is assumed to represent approximately half time of a staff member whose primary focus during the summer months would be the Town's water conservation program and public information and education. As has been the experience of other local governments, the focus of the Town's water conservation staff member will change as the program is implemented. The change in focus might be as follows.

Year 1 - 2007 - Hire Water Conservation Coordinator.

Year 2 - 2008 - Water conservation information and education program implementation.
- Participation in contractual arrangements for water meter program, following public liaison during 'construction'.
- Information on the universal metering program; description, schedule, what it means, what it will cost.
- Public information updates on the metering program status, explanation of billing procedures, etc.

Year 3 - 2009 - Participation in billing system.
- Ongoing liaison with public and response to inquiries, information updates.
- Water conservation program initiatives, i.e. low flush toilet rebates, rainwater capture barrels, xeriscape demonstration gardens, etc.

Year 4 - 2010 - Ongoing implementation of water conservation initiatives, and public information.

- Public information on actual conservation achieved, overall and per capita water conservation data.
- Identification of apparent major users.

Year 5 - 2011 - Continued water conservation information and 'success' to date based on actual data.

- Water use audits both in response to requests from public and Town initiated focusing on major users.

The above is not intended to be all inclusive however the objective is to illustrate that the implementation of universal metering is considered an important initial element of the public information and education program and that the programs focus will evolve and change with time.

5.2.3 Cost Benefit Analysis

The water conservation information and education program would represent an additional cost to the Town's Water Utility of the order of $50,000 annually. This estimate includes a staff member on a half time basis and allowances for printed material, demonstration equipment, etc. The costs associated with the water conservation program coordinator would be recovered by increases in the Town's metered water rate. The necessary increase in the Town's water metered rate to fund the water conservation program coordinator position is estimated as follows.

Total Annual Municipal Water Consumption – 2300 ML (from Table 4.2)

- ➢ Assume 20% Water Conservation Achieved – Annual Consumption Reduces to 1840 ML
- ➢ Assume 80% of Total Water Consumption is Invoiced on Metered Basis – 1472 ML
- ➢ Coordinator Cost Recovery - $50,000/1472 ML = 0.034¢/m^3

The above calculation does not include any offsets of reduced costs realized by water conservation against the water conservation public information and education program costs.

5.3 Universal Water Metering

5.3.1 Background And Status

The Town of Oliver initiated consideration of a universal metering program in 1998 as a component of its water capital plan. Preliminary capital cost estimates were prepared and the anticipated benefits of metering described in a general fashion. In this period, the principal anticipated benefit of a universal metering program was achieving equity in the water billings.

In 2001, the Interior Health Authority (IHA) requested that the Town prepare a plan to provide domestic water quality fully complying with the IHA 43210 watering treatment guidelines in the rural service areas of the Town's irrigation systems. A compliance plan comprising the installation of a groundwater supplied separate domestic system (twin system) within the service areas of Irrigation Systems 1, 4, 6 and 7 was adopted by the Town in 2002. A fundamental design assumption of the proposed twin domestic systems plan was that domestic use would be limited to in house consumption use and lawn and garden irrigation use would be minimal. To ensure reasonable compliance with the source sizing assumptions of the rural area twinning plan, a universal metering program for service areas of both the rural area and municipal water systems was adopted by the Town. Metering will be implemented in the rural areas concurrent with the construction of twin domestic systems. Universal metering within the service area of the municipal system is proposed to be implemented in 2008 as described in Section 4.1.

5.3.2 Potential Water Savings

The experience in British Columbia is that a universal water metering program to replace a flat rate water usage and rate structure will result in significant water use reduction both on an annual average and maximum day demand basis. A water metering program must however be combined with an appropriate volume based rate structure to take full advantage of the opportunities available through a metering program. Some examples:

- per capita water usage in the City of Vernon during the period 1993 to 1998 (after metering) was 19 percent lower than the period 1985 to 1991 (before metering).
- since the introduction of universal metering and volume based rates between 1996 and 1998, residential average day water usage in the City of Kelowna

has reduced by more than 20 percent compared to consumption prior to metering.

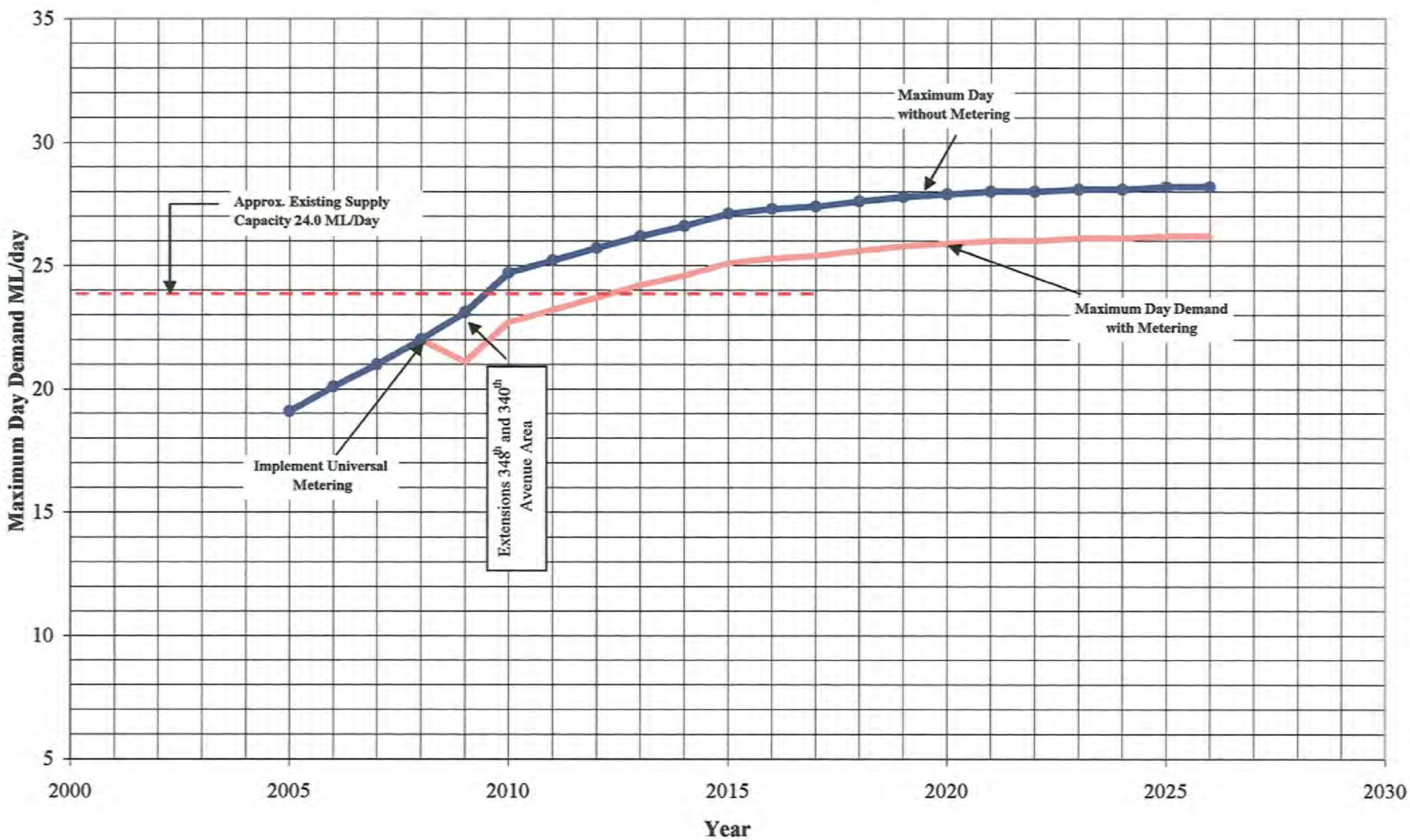
- the maximum day demand in the City of Vernon has decreased from about 2000 Lpcd in 1975 to about 1200 Lpcd in 1999. This decrease likely reflects the combined effects of densification of new development and water metering.
- a "Summary Report on Residential Watermetering" prepared by Kerr Wood Leidal Gore and Storie Inc. in 1996 for the Greater Vancouver Regional District estimates that universal metering complimented by a user pay pricing system, reinforced by public education, can be expected to result in a 20% reduction in total annual residential water use. Even greater peak day demand reductions would be expected to occur.

On the basis of the above, it is assumed that universal metering will achieve a 20% reduction in the Town's average day demand and a 10% reduction of the Town's 2005 maximum day water demand of 19.1 ML/day. The 10% reduction is applied only to the 2005 maximum day water demands recognizing that the majority of customers in 2005 are charged on a flat rate basis. For population growth beyond year 2005, all new customers will, in accordance with Town bylaws, be metered therefore no water use reductions are assumed to be achieved for population growth. The 10% reduction in maximum day demands and 20% reduction in average day demands anticipated to be achieved by universal metering equates to 2.0 ML/day and are likely conservative.

Figure 5.1 illustrates that with a 10% reduction of the 2005 maximum day water demand with universal metering:

- existing source capacity of 24.0 ML/day would be adequate through to year 2013. As discussed previously, universal metering is assumed to be implemented on or before 2009.
- in the long range, the municipal system maximum day demand remains constant at about 26 ML/day. Should actual reductions approach 20% instead of 10%, the existing supply capacity of 24.0 ML/day may be adequate for an extended period of time.

Figure 5.1 - Municipal System Maximum Day Water Demand Projections with Universal Metering



Coupled with the universal metering program, the Town of Oliver should implement a water rate structure which provides further encouragement to conserve water. Table 5.1 provides a summary of metered rate structure for other central interior municipalities' with a comparison to the Town of Oliver. All comparisons provided in Table 5.1 are for a 20mm dia. residential water service.

Table 5.1: Residential Metered Water Rates for Southern Interior Municipalities

Municipality	*Basic Charge (per year)*	*Consumptive Charge (per cu.m.)*	*Increasing Block*
City of Salmon Arm (2004)	$90.00	$0.38 for up to 180m³/mon	Yes (1)
Vernon (2005)	$207.00	$0.70	No
Kelowna (2006)	$72.00	$0.25 for up to 30m³/mon	Yes (2)
Peachland (2004)	$144.00	$0.51	No (3)
Summerland (2006)	$288.00 (4)	$0.40	No
Penticton (2006)	$128.40	$0.32	No
Kamloops (2006)	$244.00	$0.51	No
Sicamous (2006)	$144.00	$0.332`	No
Lake Country (2006)	$325.00 (5)	$0.29	No
OLIVER (2005)	$121.25	$0.112	No

(1) Salmon Arm consumptive change increases an average of 10% for each additional $180m^3$/mon consumption.

(2) Kelowna consumptive rates, $0.25/$m^3$ up to $30m^3$/mon, $0.33/$m^3$ for next $50m^3$/mon, $0.36/$m^3$ for next $45m^3$/mon and $0.50/$m^3$ for consumption in excess of $125m^3$/mon.

(3) Peachland metered rate for 20mm dia. multi-family or commercial service.

(4) Summerland metered rate for 20mm dia. commercial service. All Summerland residential on flat rate basis. Base rate includes first $20m^3$ of consumption.

(5) Lake Country base rate includes first $220m^3$ of consumption every six months.

From Table 5.1:

- the Oliver base rate of $121.25 is comparable to other local governments when base rates that include a consumption allowance (Summerland and Lake Country) are excluded.

- the Oliver metered charge of $0.112 per cubic meter, while reflecting the cost of supply, is low in comparison to other local governments. The Town should implement incremental increases to the consumptive charge with the objective of being comparable to other local governments. From the comparison in Table 5.1, the consumptive charge should be at least $0.30 per cubic meter. Revenues from the difference between the consumptive charge and costs may represent an appropriate source of funds for the Town's water conservation program.

5.3.3 Cost Benefit Analysis

Universal water metering is anticipated to result in a 20% reduction of the Town's annual municipal system water consumption. In the first several years following implementation, reductions may be significantly higher than 20%; however there is a 'rebound' effect as water customers adjust to the metered cost of water. The direct benefit of a 20% reduction in overall consumption is reduced system operating costs, principally electrical energy, pump maintenance, etc. The reduced costs (cost savings) cannot be estimated on the basis of the $0.136 cost per cubic meter derived from the benchmarking spreadsheets as discussed in Section 3.3 recognizing that fixed system costs are included. Variable or quantity dependent municipal water system operating costs in 2005 are estimated to be about $188,000. On this basis, quantity dependent costs are:

- Total 2005 Quantity Dependent Operating Costs - $188,000
- Total Volume Supplied 2005 – 2286 ML
- Cost per m^3 - $188,000/2286 = $0.082/$m^3$

On the basis of a unit supply cost of $0.082 per cubic meter, anticipated operating cost savings to be realized by universal metering are:

Total Annual Consumption – 2300 ML
Estimated Water Conserved 20% – 460 ML
Annual Cost Savings – 460 ML x $0.082/$m^3$ = $37,720

The Town of Oliver is making an application for grants from senior governments to assist with the implementation of the municipal system metering program. With and without grants the annual costs of the universal metering program are derived as follows.

	No Grants	Canada-BC Infrastructure
Estimated Cost (2007)	$1,620,000	$1,620,000
Grant	$0	$1,080,000
Net Cost to Town	$1,620,000	$540,000
Annual Cost ± (6% for 20 years)	$129,000	$43,000

Direct savings to be realized by universal metering would cover about 80% of the amortization costs if the Town were successful in obtaining a 2/3 project grant under the Canada-BC Infrastructure program.

5.4 Low-Flush Toilets

5.4.1 Description

On average, toilets account for 30% of residential indoor water consumption. By mandating or promoting low-flush or dual-flush toilets, local governments can significantly reduce residential water use. Ultra-low consumption toilets have a flush cycle of 6L in contrast to 13L "water saver" toilets and older 20+ L models. Dual-flush toilets have short-flush (three litres) and long-flush (six litres) options.

5.4.2 Experience

The BC *Water Conservation Plumbing Regulation* was amended in September 2005 to include local governments that wished to require the installation of low-flush (6 litre) toilets within their jurisdictions. The Building Policy Branch (of BC Housing) is currently surveying participating local governments regarding the Regulation's effectiveness. Local governments that are not presently included in the Regulation will also have an opportunity to participate in the survey.

In areas that are not mandated to require low-flush toilets, the Regulation requires that newly installed toilets have a flush cycle of no greater than 13.25 litres. New installations are defined as toilets installed in buildings under construction, as well as new toilets that are replacing old toilets. The regulation does not require the replacement of existing functioning toilets.

The Regulation requirement for low consumption toilets currently applies to the following local governments:

- All electoral areas of the Cowichan Valley Regional District;
- All electoral areas of the Regional District of Nanaimo;
- electoral areas C and D of the North Okanagan Regional District;
- Municipality of Bowen Island;
- City of Enderby;
- City of Kamloops;
- City of Vernon;
- District of Campbell River;
- District of Coldstream;
- District of North Cowichan;
- Greater Vancouver Water District (excluding those areas not subject to regulations established pursuant to the *Local Government Act*);
- Town of Gibsons;
- Township of Spallumcheen;
- Village of Cumberland;
- Village of Lumby;
- Village of Sayward;
- Village of Telkwa;
- Capital Regional District, including areas, such as the Gulf Islands, that are not supplied by CRD water.

The following table describes some of the low-flush toilet incentive programs implemented by municipalities and regional districts across BC:

Municipality/Regional District	Incentive Program	# of Program Participants
Penticton	$50 rebate (utility credit) for installation of a new 6L or dual flush toilet	• had ceiling of 200; this was reached between March and Nov., 2006 • demand for rebates outstripped available funds • 3.3 million L of water saved due to 200 replaced toilets
Coquitlam	• $100 rebate for each toilet replaced with ultra low flow model (max. 2 toilets per residence) after July 29, 2004 • applies only to flat-rate water utility customers (not metered customers)	455 since late 2004
Sunshine Coast Regional District	• Bathroom Fixture Replacement Program allows residents to swap up to 2 13+L toilets for new dual flush toilet at no charge (also includes low flow shower head and low flow faucet aerator), **or:** • $200 rebate option for replacement of 13+L toilets with 6L models (free toilet drop-off at landfill)	

Municipality/Regional District	Incentive Program	# of Program Participants
Richmond	• Offers a water saving toilet device (reduces water use by up to 35%) and a low flow shower head to anyone who volunteers for a water meter • both items are free, with free installation	55% (477 households) of those who volunteered for water metering (based on survey responses)
District of North Cowichan	• requires low flush toilets and urinals in local Building Bylaw • $75 rebate for replacement of 13+L toilet with approved low flow model (max. 2 rebates per residence)	
Capital Regional District	$75 rebate per bathroom installing water efficient toilets and showerheads (max. 2 rebates per residence; old toilets must be recycled	12 652 (roughly 11 000 since 2001)

5.4.3 Oliver Assessment

Several municipalities in British Columbia have successful low flush toilet rebate programs with rebates ranging between $50 and $100 for each 6 L (usually two unit maximum) being installed on a retrofit basis of 13 L plus toilets. The response rates of these programs on an overall community basis are difficult to determine based on the data provided.

Until such time as the Town of Oliver completes the planned universal metering program and establishes a metered water rate comparable to other local governments in the area, there would appear to be no benefit to a homeowner in Oliver to consider toilet replacement with low flush units. Under the Town's current flat rate water and flat rate sewer rate structure there is no reason for a resident to consider toilet replacement as a financial benefit. A toilet retrofit incentive program therefore does not warrant assessment by the Town until such time as the universal metering program has been implemented.

5.4.4 Cost Benefit Assessment

A cost benefit assessment of an ultra low flush toilet (6 L or less) incentive program has been undertaken from both the perspective of the Town and a property owner. Literature suggests that conversion from 13 L flush toilets to 6 L or less toilets represents water savings of about 40 L per capita per day. Assuming a household population of 2.2, the average water savings per household would be about 100 L per day or 36.5 m^3 per year.

A 36.5m^3/year water savings in the average household in Oliver would represent the following cost savings to the Town of Oliver.

➢ reduced water supply cost – 36.5m^3 @ \$0.082 =	\$ 3.00
➢ reduced sewer system operating cost – 36.5m^3 @ \$0.40 =	\$14.60
Total Annual Savings	\$17.60

The above calculated savings to the Town of \$17.60 per year are for sewer and water system operating costs and do not include any provisions for deferred or reduced capital expenditures. If the Town were to offer a \$50 per toilet retrofit incentive, and the typical home had two toilets, the Town's payback period would be about 3 years.

From the perspective of the typical homeowner in the Town of Oliver, interest in taking advantage of a toilet retrofit incentive program will be directly proportional to potential water utility bill cost savings. The cost benefit analysis from a homeowner's perspective is:

	Cost for Ultra Low Flush Toilet – assume \$150 x 2 units =	\$300.00
(less)	Town Rebate – assume – 2 ea. @ \$50 =	\$100.00
	Net Cost to Homeowner	\$200.00
	Annual Water Bill Savings @ \$0.30/m^3 x 36.5 =	\$ 11.00
	Payback Period	≈ 18 years

From the above, significant participation by the public in a low flush toilet rebate program would not be achieved unless:

- metered water rates were substantially more than $0.30 per cubic meter

and/or

- Town offered rebates of up to $100 per unit.

and/or

- Town implemented a system of metered sewer rate charges to replace current flat rate structure.

5.5 Water Conserving Appliances

5.5.1 Description

The majority of Canadian appliance rebate programs appear to be designed primarily to promote the use of energy-efficient appliances. Most of these programs offer rebates to those who purchase appliances with the ENERGY STAR designation. ENERGY STAR qualified clothes washers use 35 to 50 percent less water and 20 to 50 percent less energy per load than other washers. ENERGY STAR dishwashers use "smart" sensors that adjust the wash cycle and the amount of water to match the load. Water conservation therefore appears to be a positive byproduct of energy conservation programs.

5.5.2 Experience

The following table provides examples of appliance rebate programs:

Jurisdiction	Program
Capital Regional District, BC	• $125 rebate to homeowners who purchase a high-efficiency clothes washer • replaced clothes washers must be recycled
Alberta	• $100 rebate for Edmonton and Calgary residents who replace their old clothes washer with an ENERGY STAR washer • $50 rebate to residents in other parts of the province who replace their old clothes washer with an ENERGY STAR washer
Saskatchewan	PST (7%) exemption for ENERGY STAR clothes washers and dishwashers purchased or leased for minimum of one year
Manitoba Hydro	$100 credit to customer account for purchase of ENERGY STAR front loading clothes washer
Thunder Bay Hydro	Up to $85 credit to customer account for purchase of ENERGY STAR clothes washers and dishwashers
Yellowknife	• $75 rebate to Northland Utilities customers who replace their old clothes washer with an ENERGY STAR washer (800 rebates avail., first come, first serve) • old washers must be recycled

Jurisdiction	Program
Hawkesbury Hydro, ON	15% rebate for purchase of ENERGY STAR clothes washers and dishwashers (max. $500 per appliance)
Newmarket Hydro, ON	$100 credit to customer account for purchase of ENERGY STAR clothes washer
City of Toronto	• $60 rebate for purchase of high-efficiency clothes washer • rebate recipients also entered in draw to win amount paid for washer (max. $2500)
Soquel Creek Water District, California	$100 rebate to customer for purchase and installation of ENERGY STAR clothes washer
Monterey Peninsula Water Management District, California	$100 rebate for purchase and installation of ultra-low consumption clothes washers and dishwashers

5.5.3 Oliver Assessment

Incentive and rebate programs for water conserving appliances appear to be more commonly offered by electrical utility companies. The Town of Oliver may consider participating or partnering in an energy-efficient applicant rebate program which may be developed by Fortis or departments of the Provincial or Federal government. As with toilet replacement incentives described in Section 5.4, the public will be in a better position to assess the benefits of high efficiency water conserving appliances once the Town has completed the universal metering program and implemented metered rates consistent with other local governments in the Okanagan Valley.

5.6 Landscaping

5.6.1 Description

Xeriscaping is a landscaping technique that significantly reduces water consumption. It involves the selection of plants with minimal water requirements, the use of soil amendments such as compost and mulch, and efficient irrigation and maintenance practices.

5.6.2 Experience

Examples of Canadian communities and organizations that have developed programs to encourage water-efficient landscaping include the following:

British Columbia Buildings Corporation

- In 1997, adopted technical standards requiring improved irrigation and landscaping efficiency for all BCBC owned and operated buildings
- Standards include giving preference to native plant species and practices such as xeriscaping

City of Kelowna

- *Water Smart* program has included a soil amendment program since 2001. In 2005, the lawns of 275 homes received a top-dressing, a compost product that helps soil retain moisture so lawns require less water. The soil amendment program is incentive-based, meaning the homeowner pays for the cost of the product and the *Water Smart* program pays for delivery and spreading.
- Ogogrow is organic matter made up of composted biosolids from Kelowna's wastewater treatment facility. Each participant's lawn received core aeration and a top dressing of Ogogrow, to help customers achieve a green lawn without the use of high-nitrogen fertilizers and excessive water consumption. Participants reduced their average water use in July 2001 by 35 per cent compared to July 2000.
- Offers on a limited basis, a $100 rebate towards the purchase and installation of an irrigation timer with "water saving" features. All available rebates for 2006 were claimed.

- The *Water Smart* program conducted a drought-tolerant grass experiment in 2006. Ten to twelve volunteer participants were sought; interest was such that the program expanded to accommodate 40.

- Offers a professional assessment of participants' irrigation systems and the improvements they could make to increase system efficiencies. Participants were offered financial incentives toward upgrades, with the option of paying for further upgrades themselves. These participants reduced their average July 2001 water consumption by 15 per cent.

Capital Regional District, BC

- $25 rebate for rain sensors or automatic rain shutoff devices
- $50 rebate for irrigation controllers with 365-day calendar

Several communities in the United States offer rebates to homeowners with Xeriscaped yards. The following table provides examples of American water conservation initiatives aimed at reducing irrigation requirements.

Governing Body	Program
Southern Nevada Water Authority	• Water Smart Landscapes Program brings in $1.58 worth of freed-up local water for every dollar spent on rebates (37% positive return) • in modeled scenarios, $1 / sq. ft. is sufficient incentive for homeowners to convert landscapes
City of Peoria, Arizona	• Xeriscape rebate of up to $550 (utility credit) for City water customers who convert a minimum of 500 sq. ft. of high water use landscaping • rebate amounts depend on square footage converted and water use level of new plant material
City of Gallup, New Mexico	• water bill credit of 25 cents / sq. ft. of irrigated turf grass removed and replaced with Xeriscape • spray irrigation not permitted in rebate area
Albuquerque Bernalillo County Water Utility Authority, New Mexico	• water bill credit of 60 cents / sq. ft. of Xeriscape, min. 500 sq. ft. • spray irrigation not permitted in rebate area
City of Scottsdale, Arizona	• turf removal rebate of 25 cents / sq. ft., max. $1500 • 50 cents sq.ft. rebate for turf removal as well as installation of low-water-use plant material, max. $1500 • rebate of up to $250 for installation of landscape irrigation controller
Fargo, North Dakota	• $1200 rebate to those willing to have landscapes converted for Xeriscape study

Denver, Colorado	• $300 new start rebate and $600 retrofit rebate for participants in Xeriscape study (2002)

The new start sign-up rates for both the Fargo and Denver studies were lower than expected, although the larger amount offered in the Fargo study contributed to increased interest. The main obstacles to recruiting participants for the Denver study were:

- cost of installing a landscape
- completing landscape by set date

It is also noteworthy that the Colorado Springs Utilities Board eliminated Xeriscape rebates in 2005, citing the following reasons:

- savings cannot be quantified
- does not pass total resources cost test
- 40% denial rate
- very labour intensive for staff
- difficult for customers to comply with rebate rules and requirements
- landscape contractors indicated that costs associated with complying with rebate requirements exceed rebate amount
- research showed other utility companies cut Xeriscape funding and planned on spending funding on educational water saving programs

5.6.3 Oliver Assessment

Landscaping related incentive programs to encourage water conservation may be considered by the Town of Oliver at some point in the future. As with other incentive type water conservation strategies, full implementation of the municipal system universal metering program should precede any landscaping related incentive program to enable the public to assess costs and benefits.

As part of the education and information program described in Section 5.2, the Town may consider the construction of xeriscape demonstration gardens. Xeriscaping will be an important component of the water conservation education and information activities of the water conservation program coordinator.

From a regulation perspective, the Town should consider implementing a bylaw requiring topsoil removed or stripped for construction of a subdivision or development to be replaced following building or house construction. A bylaw regulating removal of topsoil is relatively straightforward for multi-family type developments where the developer is also constructing the actual dwelling units. The bylaw would be difficult to apply to a single family subdivision where the developer and house building are typically separate parties.

5.7 Rain Barrels

5.7.1 Description

This measure involves the installation of rainwater collection barrels for non potable water outside water use, the most common use being landscape irrigation. Rain barrels are available from several manufacturers and are intended to be permanently installed on drop pipes from household roof rainfall collection gutter systems. Typically the rain barrels are supplied with a cover and outlet tap near the bottom of the barrel to enable easy withdrawal of collected rainwater by the homeowner. In addition to saving water for landscape irrigation, rain barrels reduce stormwater quantities that may be collected by storm drainage infrastructure and discharged to receiving watercourses.

5.7.2 Experience

The two main forms of incentive that local authorities provide to encourage the purchase of rain barrels are rebates and subsidized rates. The latter are more common in Canada, and the former in the United States and Australia. The average retail price for a standard 200L rain barrel is $120 – $150.

Governing Body	Incentive Program
City of Vancouver	Provides rain barrels to residents for $75 (50% subsidy)
City of Calgary	Barrels available for $60 each at annual sale
Township of Langley	Provides rain barrels to residents for $35
Region of Peel, ON	Provides rain barrels to residents for $50
Town of Perth, ON	Provides rain barrels to residents for $74
Monterey Peninsula Water Management District, California	Provides rebates of $25 for every 100 gallons of rainwater storage capacity in a cistern system (max. 3000 gallons)
Soquel Creek Water District, California	Provides customers with a credit of $25 for every 100 gallons of storage capacity (min. 200 gallon tank, max. 3000 gallons for rebate)
City of Albuquerque, New Mexico	Provides $25 water bill credit to those who purchase rain barrels
Wambo Shire Council, Australia	Provides a rebate of up to $750 for the installation of rain barrels (min. combined capacity 20 000L) to those who have already installed low-flush toilet and low-flow shower head
Mackay Water, Australia	Provides a rebate of up to $500 for the installation of rain barrels (min. 5000L)

The City of Armstrong, on a trial period basis in the summer of 2006, offered $50 rebates on rain barrels purchased by City residents from local retailers. Less than 10 residents took advantage of the program. Armstrong, like Oliver, has a non metered flat rate water billing structure and accordingly there was no ongoing financial benefit to residents to consider the purchase and installation of rain barrels.

5.7.3 Oliver Assessment

Rainwater harvesting is referenced in a Foundation Research Bulletin prepared by Smart Growth on the Ground as representing the opportunity to reduce water use for lawn and garden irrigation and possibly for toilet flushing. Lawn and garden irrigation is however considered to be the principal use for water collected by rain barrels.

Climate records from Environment Canada for Oliver for the period 1971 to 2000 indicated an average, for the period April to October, an average of 62 days with rainfall greater than 0.2mm and an average of 11 days with rainfall greater than 5mm. A typical rain barrel having a capacity of 175 L would require a rainfall event of about 1.5mm to fill assuming the catchment area is one half of the roof area of a typical 120m² single family home. The potential water savings associated with a rain barrel is estimated as:

- assume 30 rainfall events greater than 1.5mm in an average year April to October
- water savings 30 x 175L = 5250L/household
- average water savings per capita = 2390L/capita/year or 6.5L/capita/day

From Section 3.2, the average annual water consumption is currently 1400L/capita per day. With 100% acceptance, rain barrels represent the potential of reducing average annual water consumption by about 0.5%.

Rainwater harvesting through rain barrels appear to represent the potential for modest water consumption savings. A rain barrel rebate program may be considered at some future date by the Town as a component of an overall education and information program. Water metering and a metered rate billing structure will provide a method to describe the potential costs and benefits of rainwater harvesting and create public interest in the concept.

5.8 Major User Audits

5.8.1 Description

Reclaimed water usage data at the Cemetery and the Public Works Yard in 2005 and 2006 as presented in Table 3.7 suggest that irrigation of public lands, i.e. parks, school playing fields, etc. represent major water consumers from the municipal water system. As a component of its water conservation plan, the Town should assess all of the major public and institutional irrigation uses from the municipal water system and assess opportunities to utilize alternative sources.

Water use audits would also be suggested for major industrial and commercial water users. Following implementation of the universal metering of the municipal system, the major water users would be identified and contacted by the Town's water conservation program coordinator with an offer of assistance to undertake a water audit. An example would be the Okanagan Similkameen Coop whose annual water consumption is of the order of 80,000m^3 which is about 4% of the total annual water consumption of the Town. Experience at Vincor suggests that there are numerous water conservation technologies available to industry that can achieve substantial reductions in water use.

5.8.2 Potential Water Savings

For illustrative purposes, following are listed several major irrigation water users from the municipal water system with suggestions as to alternative water source options and estimates of potential water savings as measured by reduced consumption from the Town's municipal water system.

Location	*Water Conservation Strategy*	*Potential Water Savings*
Oliver Secondary School Site Irrigation	Supply from Reclaimed Water System	± 60,000m^3 (2)
Splash Park	Implement Recycle	± 5,000m^3 (1)
Tuc-El-Nuit Elementary School	Supply from unused Former System No. 3 Well	± 40,000m^3 (2)
Lions Park Area	Drill/Construct Separate Water Supply Well	±20,000m^3 (3)
	Total	125,000m^3

(1) Splash Park annual use estimated from comparable data for other water parks. Actual water consumption data is limited as Park opened mid August 2006.

(2) School playing field annual water use estimated on the basis of approximate irrigated area and on annual water use of 1.2m.

(3) Lions Park annual water use estimated on the basis of approximate irrigated area and on annual water use of 1.0m.

Conservatively, the above major irrigation water uses represent the potential of 125,000m^3 of annual savings from the municipal system. The savings represent about 6% of the total annual water usage from the municipal water system. Reductions achieved in relation to maximum day demands will be significantly higher, i.e. at least 10%.

6.1 Summary

The Town of Oliver, as illustrated in *Figure 1*, operates a total of eight water systems; one (municipal system) servicing areas within the Town's municipal boundaries and seven servicing rural areas north and south of the Town. The rural area water systems are combined irrigation domestic systems supplying approximately 700 domestic connections and 1600 ha of agricultural land. The Town is currently undertaking the first of a planned three phase program to construct separate twin domestic water systems in the rural areas to address drinking water quality deficiencies associated with water supplied from the Town's irrigation canal. As a result of the rural and twinning project, all domestic connections in the rural areas will ultimately be metered.

This water conservation plan focuses on the Town's municipal water system which currently services a population of about 4500 within the Town's municipal boundaries.

Water consumption data for the municipal water system has been assessed in detail for the period 2000 to 2005 to define present average annual and maximum day demands. Establishing current demands is fundamentally important to future assessments of the results of water conservation initiatives. Determining current water demands within the municipal system service area is complicated by:

- unmetered supply to the rural area systems outside of the irrigation season, typically mid October to mid April annually.
- flow meter inaccuracies of the meter at the Lions Park and CPR wells.

Replacing the meter at the Lions Park CPR wells and installing meters and all supply interconnections between the municipal system and the irrigation systems is recommended a first priority of this water conservation plan.

On the basis of water consumption records for the municipal system for the period 2000 to 2005, correcting for flow meter inaccuracies and estimating water quantities supplied to the rural area systems; the current water use within the service area of the municipal water system is:

- average day demand – 1400 Litres/capita
- maximum day demand – 4300 Litres/capita

The Oliver municipal system average day water demand of 1400 L/capita/day is:

- comparable to the Town of Osoyoos which, like Oliver, is non metered.
- approximately double the average day demands of Penticton and Vernon which are both metered.

The Oliver municipal system maximum day demand of 4300 L/capita is:

- about 10% higher than the Town of Osoyoos (also unmetered).
- about 50% higher than maximum day demand criteria for the City of Penticton (2500 L/capita) and the District of Summerland (3000 L/capita).

Town of Oliver staff are currently undertaking a growth study of which a component is population projections consistent with the Oliver Area Smart Growth report. Municipal water system service population and water demand projections are summarized as follows:

Year	*Service Population*	*Annual Water Consumption (ML)*	*Maximum Day Demand (ML/day)*
2005	4441	2269	19.1
2011	6233	2994	25.2
2016	7130	3243	27.3
2021	7741	3323	28.0
2026	8298	3350	28.2

Population growth is anticipated to be at a higher density than currently exists within the community. Water demands are therefore anticipated to decrease at a rate averaging 1% per year to year 2026 as a result of densification of the Town's service population.

The municipal water system has an estimated supply capacity of 24.0 ML/day. In the absence of water conservation measures, additional source capacity will be required on or before year 2010.

A range of water conservation measures implemented by other local governments in British Columbia, other Canadian Provinces and the United States have been reviewed and assessed for applicability to the Town of Oliver municipal system. These assessments are summarized as follows:

(1) Public Information and Education

- establish ½ time water conservation coordinator position to prepare and carry out public information program, coordinate universal metering program, assess future water conservation initiatives.
- approximate cost - $50,000/year
- cost recovery through metered water rate charge of $0.034 per cubic meter.
- water conservation achieved – uncertain.

(2) Municipal System Universal Water Metering Program and Metered Rate Structure

- advance implementation of municipal system water metering program to 2008.
- implement increases to the Town's metered rate (currently $0.112 per cubic meter) to be consistent with other Okanagan area municipalities (currently in the $0.30 to $0.40 per cubic meter range).
- approximate capital cost - $1,620,000 (2007 construction costs).
- operating cost savings – est. $37,700 per year.
- water conservation achieved - 20% reduction average day demand
- 10% reduction 2005 maximum day demand

(3) Low Flush Toilet Replacement Incentives

- provide incentives of $50 to $100 for low flush toilet replacement by homeowners consistent with programs offered by other local governments.
- no financial incentive for homeowner to consider retrofit until universal metering program is complete and metered rate structure is in place.
- Town 'payback' (reduced sewer and water operating costs) for a $50.00 rebate (incentive) is about 3 years.
- Homeowner 'payback' (reduced metered water charges at $0.30 per cubic meter) is about 9 years for every $100 of expenditure on low flush toilets.

- water conservation achieved – 36.5m^3/year per household. Overall, uncertain as is dependent on participation rate.
- Town should assess participation in Water Conservation Plumbing Regulation to require low flush (6 Litres) toilets in all new construction.

(4) Water Conserving Appliances

- provide incentives for residents to purchase appliances with ENERGY STAR designation. In other jurisdictions, incentive is offered by the electrical energy utility provider.
- no financial incentive for homeowner to consider until universal metering program is complete and metered rate structure is in place.
- water conservation achieved – uncertain, depends on participation.

(5) Landscaping Incentives

- wide variety of programs have been implemented ranging from irrigation controller rebates, xeriscape landscaping incentives and turf removal incentives.
- no financial incentive for Oliver homeowner to consider until universal metering program is complete and metered rate structure is in place.
- water use reductions possible are significant. Program options warrant consideration in future.
- Town should assess bylaw requiring topsoil placement on landscaping areas of new development.

(6) Rain Barrels – Rainwater Harvesting

- provide rain barrel rebate (installation incentive) of up to $50 comparable to other BC municipalities.
- no financial incentive for Oliver residents to consider until universal metering is complete and metered rate structure in place.
- water use reductions anticipated are modest, approximately 0.5% of the current average annual water demand with 100% participation.
- rain barrels warrant consideration in the future.

(7) Major User Audits

- assess alternative irrigation water sources for institutional and public lands including parks and school playing fields.
- as water metering program is implemented, identify major industrial and commercial water users and provide assistance for water use audits.
- estimated capital costs – subject to individual opportunity assessment. Town may provide some incentives commensurate with water system operating cost savings realized.
- water conservation achieved - 5% of average day demand
  - 10% of 2005 maximum day demand

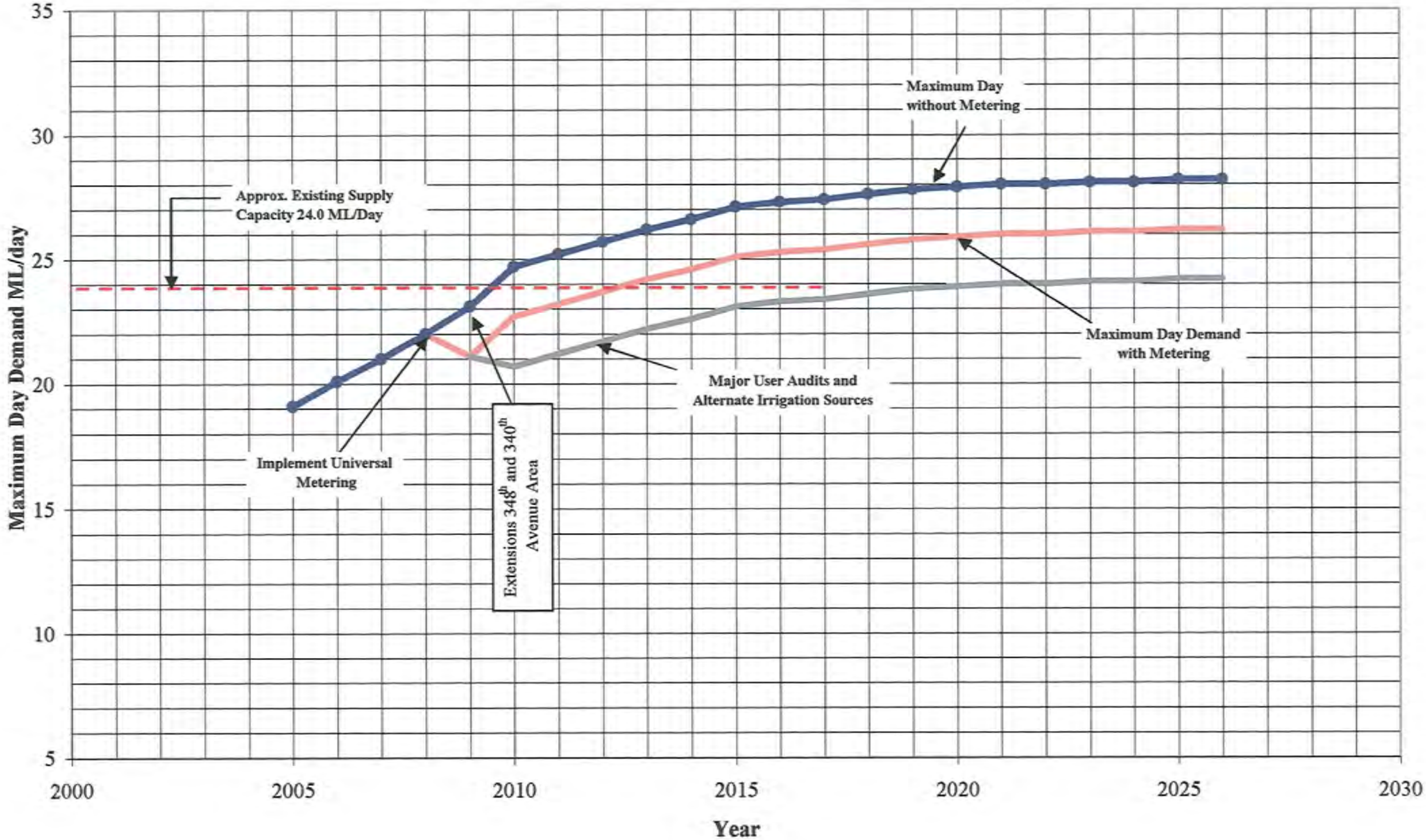
Of the above described water conservation initiatives, measures which warrant implementation in the short term include:

	Annual Water Savings	*Maximum Day Water Savings*
➤ water conservation coordinator for public information and education	uncertain	uncertain
➤ universal water metering and metered rate structure	20%	10% of 2005 max. day demand
➤ major user audits focusing on alternative irrigation water sources	5%	10% of 2005 max. day demand
Overall Conservation	25%	20%

To accurately assess the results of water conservation initiatives, the flow meter at the CPR-Lions Park wells should be replaced and meters installed at all operational interconnections with the irrigation systems.

Conservatively, the recommended short term water conservation initiatives will result in a 20% reduction of the 2005 maximum day water demands. As illustrated in *Figure 6.1*, the result is that existing water source capacity of 24.0 ML/day may remain adequate for at least a ten year period through to year 2016.

Figure 6.1 - Municipal System Maximum Day Water Demand Projections with Universal Metering and Major User Audits/Alternative Irrigation Sources



Other water conservation initiatives that warrant consideration by the Town in the longer term once the universal metering program has been completed and a metered rate structure implemented are:

- landscaping initiatives including demonstration gardens, xeriscaping incentives, efficient irrigation controllers, etc.
- low flush toilet retrofit incentive program.
- rain barrel incentives for rainwater harvesting for lawn and garden irrigation.

Landscaping initiatives encouraging xeriscaping represent the potential of achieving significant reductions of both the maximum day and average day water demands. Low flush toilets and rain barrel initiatives represent the potential of reducing average day water demands.

6.2 Proposed Water Conservation Program

Consistent with the summary and recommendations as presented in Section 6.1, a suggested implementation program is presented in Table 6.1. The implantation schedule is flexible and is presented to illustrate how the various water conservation measures discussed and assessed herein might be implemented over a period of years.

All suggested increases in the Town's metered rate schedule have the objective of achieving rates comparable to other Okanagan Valley municipalities. Additional increases to the metered (consumptive rate) and meter base charges will likely be necessary to finance the planned rural area domestic twinning program.

Table 6.1: Town of Oliver
Proposed Water Conservation Program

Year One – 2007:

- Replace water meter at Lions/CPR Wells
- Install water meters on interconnects to irrigation systems (all operational interconnections).
- Budget and Hire ½ time Water Conservation Program Coordinator.
- Raise metered water rate minimum of $\$0.05/m^3$ to $\pm\$0.17/m^3$.

Year Two – 2008:

- Implement Public Water Conservation and Education Program.
- Prepare tender documents for and contract for Implementation of Municipal System Universal Metering Program.
- Implement Public Information on Universal Metering.
- Raise metered water rate minimum of $\$0.05/m^3$ to $\pm\$0.22/m^3$.
- Assessment of alternative irrigation water sources for public and institutional lands.

Year Three – 2009:

- Continue Public Water Conservation/Education Program in relation to universal metering and new rate structures.
- Complete universal metering installation.
- End flat rate billing system.
- Raise metered water rate minimum of $\$0.05/m^3$ to $\pm\$0.27/m^3$.
- Assess Xeriscape initiatives.
- Implement construction of alternative irrigation water sources for public and institutional lands.

Year Four – 2010:

- Water billings now on metered schedule.
- Continue Public Education Program.
- Assess in detail toilet retrofit, rain barrel initiatives.
- Raise metered water rate minimum of $\$0.05/m^3$ to $\pm\$0.32/m^3$.
- Water audits major water users.
- Continued construction of alternative irrigation sources.
- Implement Xeriscape and landscaping initiative.

Year Five – 2011:

- Continue Public Information Program.
- Continue with water audits.
- Ongoing toilet replacement, landscaping and other water conservation initiatives.

S:\My Documents\306\306-1111\Oliver Water Conservation Plan.doc

APPENDIX 1

Ministry of Community Services
Benchmark Initiative Summary

BRITISH COLUMBIA

Ministry of Community Services

Infrastructure Benchmark Initiative

Updated July 20, 2006
KZ

PLEASE **READ** THE POST PROJECT COMPLETION FORM GUIDE **BEFORE** COMPLETING THIS FORM.
Applicants should be aware that information collected is subject to provincial freedom of information legislation.

Applicant Name and Contact Name	Town of Oliver - Municipal	Date	20-Jul-06
Population served by infrastructure being measured	4,379	Projected population growth (%)	1%

D.1 Drinking Water Source

	2000	2001	2002	2003	2004	2005	2006	2007
D.1.1 SYSTEM EFFICIENCY								
Annual operating costs for the maintenance and withdrawal of drinking water per cubic meter ($/m^3).	$157,876	$179,997	$231,168	$228,576	$169,435	$167,018	$0	$0
Annual amount of water withdrawn from source.	2,586,786	2,523,671	2,754,889	2,712,378	2,309,105	2,291,025	-	-
Cost per cubic meter ($/m3)	$0.061	$0.071	$0.084	$0.084	$0.073	$0.073	$0.000	$0.000
Objective - Efficient municipal source water maintenance and withdrawal services.								
D.1.2 SYSTEM QUALITY								
Total number of occurrences that raw water sample testing resulted in 1 NTU* or greater (* nephelometric turbidity units).	0	0	0	0	0	0	0	0
Objective - Source protection.								

D.2 Drinking Water Treatment

	2000	2001	2002	2003	2004	2005	2006	2007
D.2.1 SYSTEM EFFICIENCY								
Annual operating & maintenance cost for the treatment of drinking water.	$6,547	$8,859	$8,523	$23,790	$35,493	$34,980	$0	$0
Annual amount of water treated (cubic meters) **NOTE**.	2586786	2523671	2754889	2712378	2,309,105	2291025	0	0
Cost per cubic meter	$0.003	$0.004	$0.003	$0.009	$0.015	$0.015	$0.000	$0.000
Objective - Efficient municipal water treatment services. **NOTE a volume must be entered in order for the formula to work.**								
D.2.2 DISTRIBUTION EFFICIENCY								
Annual operating and maintenance costs for the distribution of drinking water.	$80,069	$88,334	$72,223	$89,786	$98,144	$110,242	$0	$0
Total length of distribution network (km).	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cost per kilometre of water distribution.	$0	$0	$0	$0	$0	$0	$0	$0
Objective - Efficient municipal water distribution services.								

D.2.3 TOTAL DRINKING WATER SYSTEM COSTS								
Total Drinking Water System costs	$244,491	$277,190	$311,914	$342,152	$303,071	$312,240	$0	$0
Annual operating costs for the withdrawal, treatment and distribution of drinking water per cubic meter treated - **NOTE, in order to derive a total cost/cubic meter a volume must be entered in row 22.**	$0.095	$0.110	$0.113	$0.126	$0.131	$0.136	$0.000	$0.000
Objective - Efficient integrated municipal water system.								
D.2.4 DISTRIBUTION NEWTWORK CONDITION								
Total Number of water main breaks per year.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total number of water main breaks per kilometre of water main per year.	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		
Objective - Improve system reliability and effectiveness.								
D.2.5. SYSTEM QUALITY								
Total number of days of boil water advisories per year.	0	0	0	0	0	0	0	0
Objective - Drinking water is safe and meets local needs.								
D.2.6. PERMIT COMPLIANCE								
Total number of days out of compliance with operating permit per year.	0	0	0	0	0	0	0	0
Objective - Meeting operational compliance.								

D.3 Wastewater Systems

	2000	2001	2002	2003	2004	2005	2006	2007
D.3.1 COLLECTION EFFICIENCY								
Annual operating and maintenance costs for the collection of wastewater.	$72,437	$74,592	$85,917	$74,429	$87,852	$101,331	$0	$0
Total length of collection network (km).	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cost per kilometre of wastewater collection.	$0	$0	$0	$0	$0	$0	$0	$0
Objective – Efficient municipal wastewater collection services.								
D.3.2 TREATMENT EFFICIENCY								
Operating costs for the treatment and responsible discharge of (treated) wastewater.	$270,967	$304,838	$314,887	$371,682	$338,089	$319,228	$0	$0
Annual amount of treated wastewater discharged (cubic meters)	702688	678052	726354	751139	766046	783947	0	0
Cost per cubic meter	$0.386	$0.450	$0.434	$0.495	$0.441	$0.407	$0.000	$0.000
Objective - Efficient municipal wastewater treatment and disposal services.								
D.3.3 INTEGRATED SYSTEM EFFICIENCY								
Total wastewater system operating costs	$343,404	$379,430	$400,804	$446,111	$425,941	$420,559	$0	$0
Total wastewater system operating costs per cubic meter.	$0.49	$0.56	$0.55	$0.59	$0.56	$0.54	$0.00	$0.00
Objective - Efficient integrated municipal wastewater system.								

Updated July 20, 2008

D.3.4 MAIN BACKUPS								
Number of wastewater main backups per 1 kilometre of wastewater main per year.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	KZ 0.0
Objective - Prevention of environmental and human health								
D.3.5 BYPASSES TREATMENT								
Total annual amount of wastewater estimated to have by-passed treatment (cubic meters).	0	0	0	0	0	0	0	0
Percentage of wastewater estimated to have by-passed treatment.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Objective - Prevention of environmental and human health hazards and increased system effectiveness.								

D.4 Stormwater Systems

	2000	2001	2002	2003	2004	2005	2006	2007
D.4.1 COLLECTION EFFICIENCY								
Operating costs for the collection of stormwater .	$0	$0	$0	$0	$0	$0	$0	$0
Total length of collection network (km).	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cost per kilometre of stormwater main.	$0	$0	$0	$0	$0	$0	$0	$0
Objective - Efficient municipal stormwater system.								
D.4.2 TREATMENT AND DISPOSAL EFFICIENCY								
Operating costs for the treatment and disposal of stormwater.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total annual amount of stormwater discharged (cubic meters).	0	0	0	0	0	0	0	0
Cost per cubic meter	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000
Objective - Efficient municipal stormwater treatment and disposal services.								
D.4.3 INTERGRATED SYSTEM EFFICIENTCY								
Total operating costs for the collection, treatment and disposal of stormwater.	$0	$0	$0	$0	$0	$0	$0	$0
Total operating cost for stormwater systems per cubic meter.	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000
Objective - Efficient integrated municipal stormwater system.								

D.5 Energy Efficiency

	2000	2001	2002	2003	2004	2005	2006	2007
D.5.1 BUILDING EFFICIENCY								
Gigajoules* per square meter**.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Objective - Efficient municipal facilities and infrastructure.								
* Gigajoule (GJ) is equal to 277.8 kWh of electricity; 1 billion BTUs, 26.9 m³ of natural gas or 25.9 litres of heating oil. **May be calculated from Natural Resources Canada's website http://oee.nrcan.gc.ca/commercial/technical-info/tools/gigajoule.cfm?attr=20								
D.5.2 APPLIANCE EFFICIENCY								
Percentage of "Energy Star"* products in use.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Objective - Efficient municipal operations. * Energy Star or equivalent products.								
D.5.3 FLEET VEHICLE EFFICIENCY								
Annual vehicle carbon dioxide emissions in tonnes (entire fleet)*.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Objective - Efficient fleet vehicles. *use the following website to calculate emissions http://www.terrapass.com/carboncalc.html								