DISTRICT OF SUMMERLAND

WATER AVAILABILITY REPORT

District of Summerland
March, 2014

Agua Consulting Inc.
"Engineered Water Solutions"
3660 Anderson Road, Kelowna, BC, V1X 7V8
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ABBREVIATIONS

AES	Atmospheric Environment Service
ADD	Average Daily Demand
AF	Acre-foot
ALR	Agricultural Land Commission
AWWA	American Water works Association
DoS	District of Summerland
DSM	Demand Side Management
FF	Fire flow
HGL	Hydraulic Grade Line (slope of water in m/m)
HWL	High Water Level
Igpm	Imperial Gallons per minute (flow rate)
IRR	Irrigation license (in megaliters
kPa	kilopascals (pressure)
L	Litre
L/ca/d	Litres per capita per day (usage rate)
L/s	Litres per second (flow rate)
m^3/s	cubic metre per second, (flow rate)
MAR	Mean Annual Runoff
MF	multi-family
ML	mega-litre (one million litres = 1,000 m^3)
ML / day	Mega-litres per day
MDD	Maximum daily demand
MIgpd	Million Imperial gallons per day
MOE	Ministry of Environment
MVID	Meadow Valley Irrigation District
OBWB	Okanagan Basin Water Board
OWSC	Okanagan Water Stewardship Council
OCP	Official Community Plan
O & M	Operations and Maintenance
PD	Point of Diversion (licensing)
PET	Potential evapo-transpiration
PHD	Peak hour demand
PRV	Pressure reducing valve
PS	Pump Station
psi	pounds per square inch (pressure)
PZ	Pressure Zone (identified by normal HGL in metres)
RDOS	Regional District of Okanagan Similkameen
SFE	Single Family Equivalent (equivalent to a SF lot)
TWL	Top Water Level (metres)
UFW	Unaccounted For Water
USgpm	US gallons per minute(flow rate)
WSC	Water Survey of Canada
WUP	Water Use Plan

Agua Consulting Inc.
"Engineered Water Solutions"

March 24, 2014

District of Summer1and
9215 Cedar Avenue
Box 159
Summer1and, BC
VOH 1ZO

Attention: Don Darling, Director of Works and Utilities

RE: WATER AVAILABLITY REPORT

Dear Don:

Please find enclosed the Water Availability Report for the District of Summer1and. This report summarizes the following:

- Available water from the Aeneas Creek and Trout Creek watersheds including return period drought volumes;
- Historic, existing, and Mure forecasted demands for the Summer1and service area, including characterization of the water demands;
- Available water for Mure development based on existing source capacity to a 1:25 year drought scenario;
- Considerations for re-allocation of current District of Summer1and water licenses.

We trust that you will find the content and structure of this report useful for tracking and understanding water use over time, and for the allocation of future water use within the District. We thank you for the opportunity to be of service.

Yours truly,

Bob Hrasko, P.Eng.
Agua Consulting Inc.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
R. J. HRASKO
Feb 4. 2015

RJH/rh

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DISTRICT OF SUMMERLAND

WATER AVAILABILITY REPORT

Prepared for:

District of Summerland
9215 Cedar Avenue,
Box 159
Summerland, BC
V0H 1Z0

Prepared by:

Agua Consulting Inc.
"Engineered Water Solutions"
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March 2014

Project No. 023-017

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1. INTRODUCTION

1.1 GENERAL

This report summarizes the annual volume of source water that should be available to the District of Summerland to meet the needs of their residents. This report sets out a guideline for water use and allocation. The report was requested in 2013 by Don Darling, Director of Works and Utilities.

This report contains data that supersedes hydrological information presented by Agua Consulting Ltd. in the 2008 Water Master Plan and the 2011 Watershed Master Plan. The hydrology information for Aeneas Creek has significant revisions to what was presented in earlier Agua reports.

This report can be used as a centralized document for tracking water availability and water use over time for the District.

1.2 REPORT OBJECTIVES

There have been many recent changes in the operation of the District of Summerland water system. Changes include the raising of Thirsk Dam to secure more source water from Trout Creek, the construction of a Water Treatment Plant below Summerland Reservoir to improve water quality, the installation of meters on all agricultural and domestic connections to better monitor water usage, and separation of the domestic and irrigation water sources through the Prairie Valley area of Summerland. The result is that the residents of Summerland have a more reliable water supply with higher quality domestic water.

There are also changes expected in the distribution of water throughout Summerland with the plans for separation of much of the remaining agricultural area within Summerland over time. As distribution system separation progresses, demands on the Water Treatment Plant should be reduced with irrigation water being provided by gravity from both the Summerland Balancing Reservoir and Garnett Reservoir.

The intent for this document is to provide a central reference report for use by staff in regards to water allocation. The report specifically provides:

1. An estimate of the volume of water that is reliably available annually from the Trout Creek and Aeneas Creek watersheds;
2. The reliable volume of water that could be obtained from Trout Creek and Aeneas Creek accounting for diversions, groundwater inflow, instream flow needs and drought scenarios;
3. Provide guidance for how to deal with allocation during drought years, in compliance with the District of Summerland drought management plan;
4. Reconciliation of water licenses so that the District of Summerland has sufficient licensing for their existing and future water demands;
5. Provide suggested measures for tracking of source water and diverted water so that a long term record can be developed so that more informed decision-making is possible;

1.3 DEFINITIONS

Definitions are provided to clearly explain water use terms used in this report.

Water Use Terms

Average Daily Demand (ADD) ADD is the flow rate that is calculated by the total amount of water used in a year divided by 365 days. ADD is used to determine licensing allocation and compare total water requirements of different customer groups;

Maximum Daily Demand (MDD) MDD is the daily flow rate during the highest day demand in a year. The MDD is used to size reservoir storage, pump station pumping rates, and transmission main pipe sizes that is used in conjunction with reservoirs and pump stations. Fire flow is analyzed during a MDD conditions;

Peak Hour Demand (PHD) The PHD flow is the highest hour of water usage recorded or estimated for a water system during a year. Typically the PHD occurs at some time during the maximum day demand. The PHD does not include fire flows that may temporarily increase the overall water system demand. PHD is used to size local water distribution system pipes and service lines;

Fire Flow (FF) Fire flows must be provided through the municipal water system and can impact water main sizing. Fire flow is analyzed under MDD conditions. The distribution system must have sufficient capacity to convey the flow while still providing positive pressure throughout the distribution system.

UFW Unaccounted For Water is water that is not metered, measured or accounted for within other water use categories. It can include the leakage component but for the purpose of this report, it does not as leakage is accounted for independently. UFW is the remaining water after all other metered water use is factored into the water demand;

Leakage For the this report, leakage is all water that escapes from the distribution system both on public right-of-way from District mains and services and from services on private property beyond the location of the curb stop. The total leakage is an estimated number based on a percentage of the minimum consistent system read leaving the water sources. The leakage flow rate is applied to the entire year and forms part of the water system demand characterization. The majority of the system leakage is estimated to occur on public property as large leaks on private property are found by the home owners that have high water usage that is flagged by the water utility staff. Leakage is a portion of the water use within the ADD, MDD and PHD flow rate numbers;

Water Licensing Terms

IRR Irrigation licensing that is for outdoor used and generally is permitted annually from April 1 to September 30. Water was allocated in acre-feet (AF) permitted annually but is now accounted for in megalitres (ML) per year on the revised provincial license database. In Summerland, the IRR portion of licensing would be assigned to the *Arable Lands* acreage of the District land use database;

WWLA Waterworks Local Authority licensing, is for domestic purposes including residential uses indoors and outdoors, industrial, commercial and institutional uses. The licensing is permitted annually from January 1 to December 31. Water is allocated in Imperial gallons per day or per year, but is reported in m^3 permitted annually on the revised provincial license database;

CONSERV Conservation licensing is issued by the Province on selected streams for the support of in-stream flow needs, primarily fish habitat. The licenses are issued to conservation organizations or those that have storage with a requirement to provide instream flows. A minimum flow rate is typically defined in the license;

Storage The Province requires a license for storing water. The storage license permits the licensee to collect excess water at high flow times of year in a creek and release the water at a later time for beneficial use;

POD Point of Diversion is a water licensing term identifying the physical location of where the water source can be accessed. The PODs for Summerland are at the intake gates on Trout Creek and at Garnett Dam at the south end of Garnett Reservoir. A water license may have a primary POD and an alternative POD for the same water;

Land Use Terms

SF Single Family (SF) development refers to residential development that typically includes a home with some land for lawn and/or garden. The Single family water use includes indoor and outdoor components. In the Okanagan, SF water use has a significant outdoor summer demand. The future trend for Single family housing is to smaller lot sizes and less outdoor watering. Demands are typically estimated based on 3.0 persons per SF unit;

MF MF refers to multi-family development. MF water use includes both an indoor and an outdoor component. The MF water use typically has a relatively small outdoor component and a monthly demand that has less variation that those with irrigation. MF water use includes a higher fire demand requirement, usually in the range of 150 L/s for a 2 hour duration. MF demand is typically estimated based on a population density of 2.0 persons per MF unit;

ICI Industrial-Commercial-Institutional is a customer category defined by water utilities to match a range of water use for businesses. The water demand for these customers includes all indoor and outdoor water uses. The amount of water is determined by metered flow readings or estimates if the connections are not metered;

Arable Land in Summerland, arable land is land of a defined area that is permitted to use water for outdoor irrigation. The toll rate for arable land is based on an acreage that has the rights to use water for irrigation;

Volumetric Terms

ML Megaliters is a volumetric measurement used for large volume water measurement such as overall district water demand. One mega-litre equals 1,000 cubic meters;

AF Acre-feet is a volumetric measurement used for irrigation licensing and large volume water measurements. One acre foot equals 1,233 cubic metres;

Igpm Imperial gallons per minute is the flow rate historically used by District staff when measuring overall system flow. The majority of the water users are moving towards measuring Water Treatment Plant flow in ML/day or system flow rate in Litres / second;

Miscellaneous Terms

Development Cost Charge The development cost charge for water is a charge per development unit to cover off the reduction of supply capacity due to additional development and the resulting increased water demand;

Water Use Characterization For the purposes of this report, water use characterization is the segregation of the overall water demand, either annually or during the maximum daily demand day, into different customer categories;

Naturalized Flow: This term refers to a natural stream flow volume that is not influenced by diversions or storage or other impacts by man.

1.4 ABBREVIATIONS / CONVERSIONS

Abbreviations are included on the inside front cover of this report. Acronyms for various terms are also included on the front inside cover list. Conversions for various flow, volume and pressure units are included on the inside back cover of this report.

1.5 RELATED REPORTS & REFERENCES

The following references were used in the preparation, review, and writing of this document.

- Agua Consulting Inc., AF Consulting Ltd., District of Summerland, Computer Water Model, EPANET format, 2013;
- Agua Consulting Inc., District of Summerland, Water Master Plan, 2008;
- Agua Consulting Inc., District of Summerland – Watershed Master Plan, 2011;
- District of Summerland, Billing Register Summary, March, 2013;
- District of Summerland, Drought Management Plan, October, 2007;
- District of Summerland, Water System Maps, Current to year end, December, 2007;
- Google Earth Pro, 4.3.7191.6508 (beta), License Key - JCPMH4P70UV61GJ
- Letvak, D.B.; Ministry of Environment, Water Supply Analysis for Trout Creek and the District of Summerland, August, 1989;
- Ministry of Environment, Water License Database, MOE website, 2013;
- Reksten, D.E., Trout Creek Water Supply for District of Summerland, BC Ministry of Environment;
- Summit Environmental Consultants Ltd., - Surface Water Hydrology and Hydrologic Modelling Study – Part 1 – State of the Basin Report (2009);
- USEPA, Drinking Water Glossary (website http://www.epa.gov/safewater/Pubs/gloss2.html);
- Water Management Consultants Inc., Trout Creek Water Supply System, Water Use Plan, Technical Background Document on Hydrology, Water Usage and Reservoir Operations, update, 2008;
- Water Management Consultants Inc., Trout Creek Water Use Plan, Operating Agreement, March, 2005.

2. SOURCE WATER CAPACITY

2.1 INTRODUCTION

This section provides a summary of the water available from the Aeneas Creek and Trout Creek sources on a monthly and annual basis. The estimates provided within are based on historic flow records with a focus on the most recent flows and best available hydrological studies. Factors that impact the volume of annual available water include:

- Operations of Summerland upper watershed reservoirs as per the District of Summerland Master plan;
- Flow requirements and reservoir management to avoid downstream flooding in the developed urban areas along Aeneas Creek;
- Downstream flow requirements in the creeks to support fish habitat and instream flow needs;
- The issue of climate change.

The integrated effect of these factors is accounted for within this report.

2.2 AENEAS CREEK SUPPLY CAPACITY

Aeneas Creek is the second largest water source currently available to Summerland. It is a gravity supply source that is treated only with chlorine, making it a very cost effective source of irrigation and domestic water. The headwaters of the watershed originate at Aeneas Provincial Park. At its outlet to Okanagan Lake, Aeneas Creek draws water from a 91.4 km^2 watershed. Water available to Summerland is limited to the watershed above Garnett Reservoir which collects the upper 56.7 km^2 of the watershed. The major hydrological features of Aeneas Creek include:

1. Aeneas Reservoir Dam;
2. Significant diversion at Finlay Creek and rediversion at Lapsley Creek out of the watershed to Darke Lake-Reservoir;
3. Significant return of groundwater from the Darke Creek watershed to Garnett Reservoir within north Meadow Valley;
4. Garnett Reservoir Dam;

The general boundaries of Aeneas Creek are illustrated on Figure 2.1 on the next page. From the figure, the location of Garnett Reservoir is approximately in the middle of the total watershed.

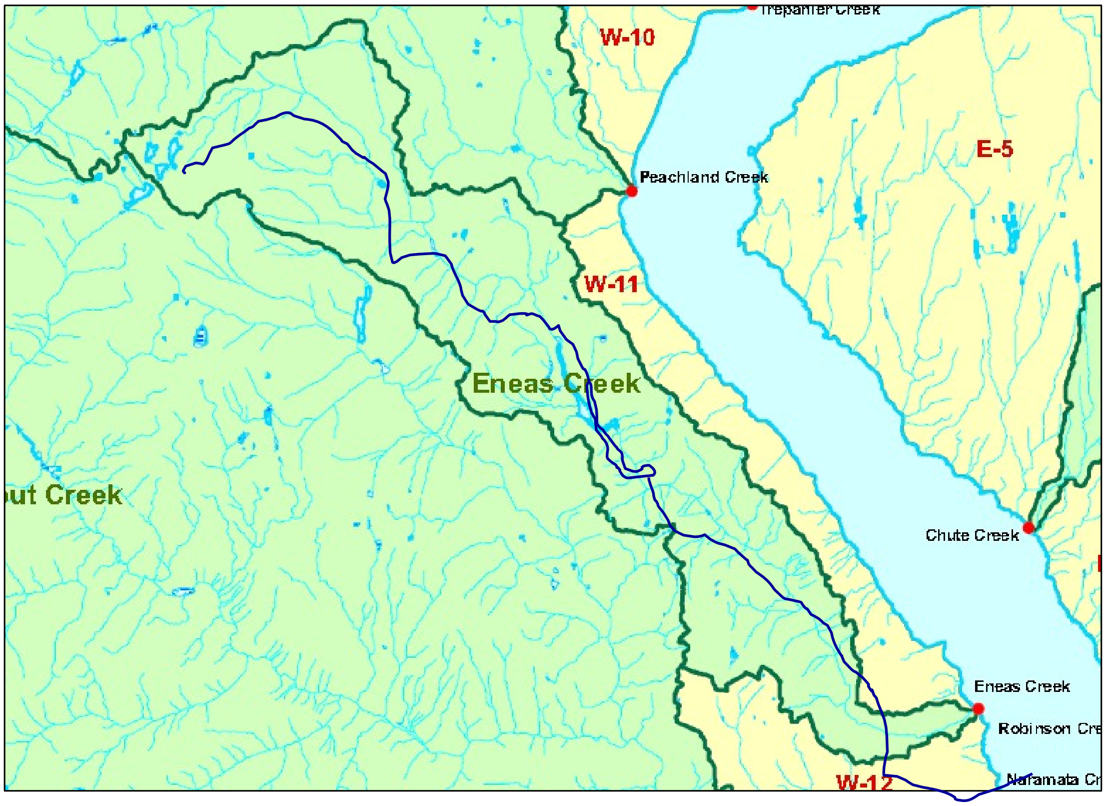
Aeneas Reservoir-Lakes Dam

The data provided within the 2008 Water Master Plan and subsequent 2011 Watershed Master Plan has not changed. There are no changes with regards to the Aeneas Reservoir dams since the 2011 Watershed Master Plan. Aeneas Reservoirs are very small and difficult to access. There are two options available to Summerland with respect to operations of these dams:

1. One is to breach (decommission) the outlet pipe and dams;
2. The second is to provide the necessary works to properly maintain them.

The maintenance costs would be quite high, because the total reservoir storage volume is so small, and access is very difficult, our recommendation is to breach the dam, but retain the licenses for their use and dam reinstatement at some time in the future.

Figure 2.1 - Aeneas Creek Watershed (image source - Okanagan Water Supply & Demand Study)



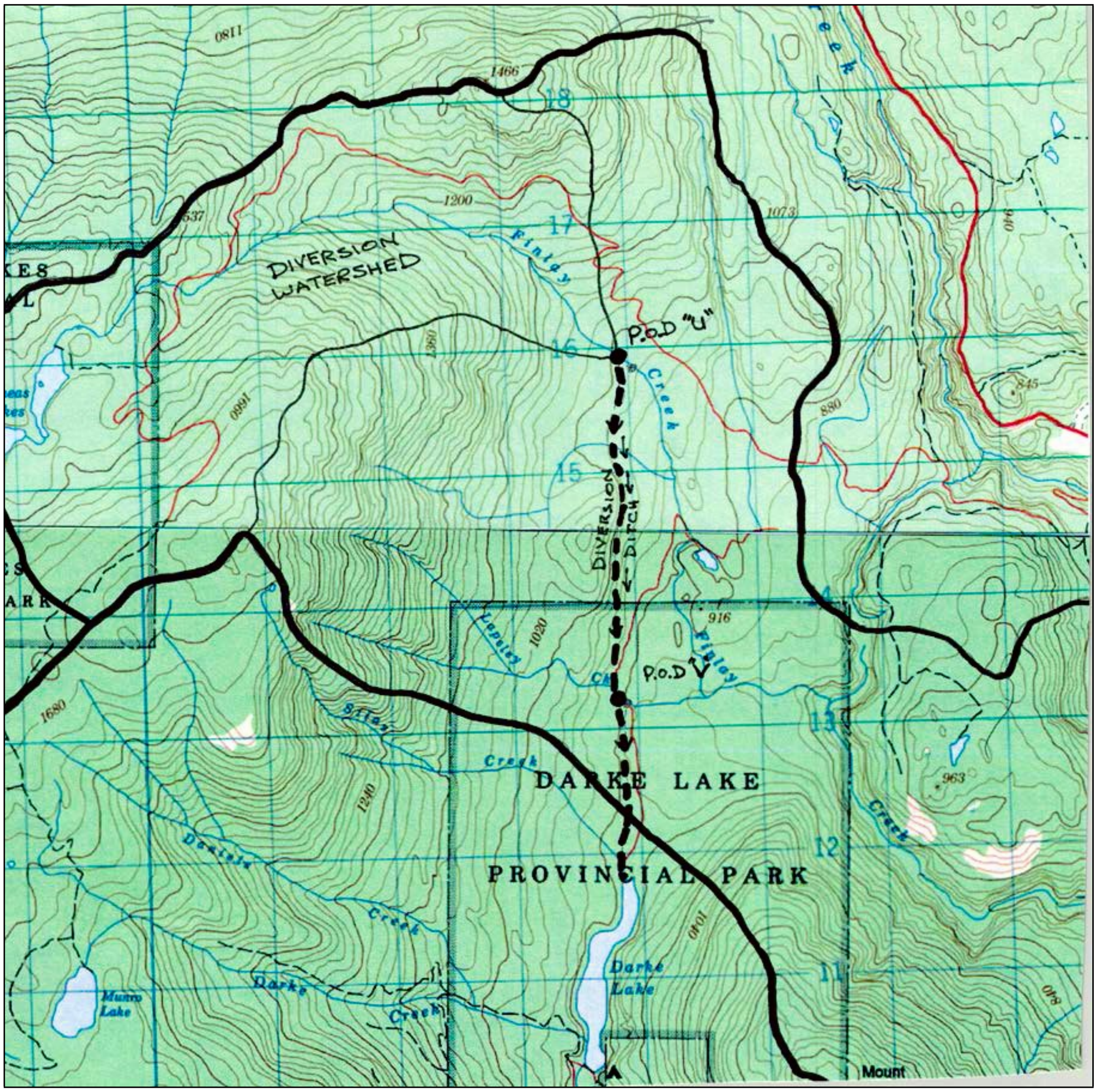
Findlay Creek / Lapsley Creek Diversion

The Finlay-Lapsley diversion is a licensed diversion of source water from the upper Aeneas Creek watershed to Darke Lake-Reservoir. The diversion is held by the Meadow Valley Irrigation District (MVID) and is authorized under Water License CL 029856 to divert up to 615 ML (498.5 AF) of water annually. The diversion originates at high elevation on Finlay Creek where water is diverted by ditch to Lapsley Creek and then rediverted by ditch to Munro Creek above Darke Lake-Reservoir.

The Operator of the Meadow Valley Irrigation District was contacted for detailed information on the diversion operation. The diversion is operated annually from April 1 to September 30 and is left open (in diversion mode) most of that time. Finlay Creek is very low or dry through the later part of each year. The years 2011 and 2012 were exceptions when Darke Reservoir was full, the weather was wetter than usual, and the diversion was closed for most of the diversion period.

According to the MVID Operator, the diversion flow is typically 1/3 to MVID with 2/3 of the remaining flow flowing to Garnett Reservoir. The diversion consists of two 300 to 350mm diameter sized pipes through a berm structure and then to a 3.5 kilometer ditch. Agua Consulting estimates maximum diversion flow to be in the range of 100 L/s. The majority of water is diverted in April, May and June annually. For the purposes of assessing available water, in an average year, the volume of diverted water is estimated to be 600 ML.

Figure 2.2 – Lapsley Diversion to Darke Lake



Groundwater Recharge to Garnett Reservoir

Meadow Valley is located immediately to the west of Garnett Reservoir and is approximately 200 metres higher than the normal Garnett Reservoir water levels. The 2011 Summerland Watershed Master Plan identified the groundwater influence issue, but did not quantify the diverted annual volumes. The comment by R. Allard in Appendix B of that report is that the recharge amount is substantial.

As a general observation, it would be expected that the recharge water would be a function of available water in the Meadow Valley watershed. In years of drought, there may be less recharge of soil higher up and less contribution to the ground, however Darke Reservoir would be full most years leading to a stable water source for recharging the aquifer.

For the purpose of developing a water balance model for Garnett Reservoir, the groundwater diversion was estimated to be 360 ML annually.

Aeneas Creek Capacity

The best available technical report on creek flows for the region is the *Surface Water Hydrology Report (2009)* on the Okanagan Basin, prepared by Summit Consulting for the Okanagan Basin Water Board. The report provides naturalized flow, i.e. flow that is not influenced by diversions or withdrawals by man. From that report, a historic naturalized flow was developed based on 11 years of data from 1996 to 2006. The flows are estimated at the mouth of the creek.

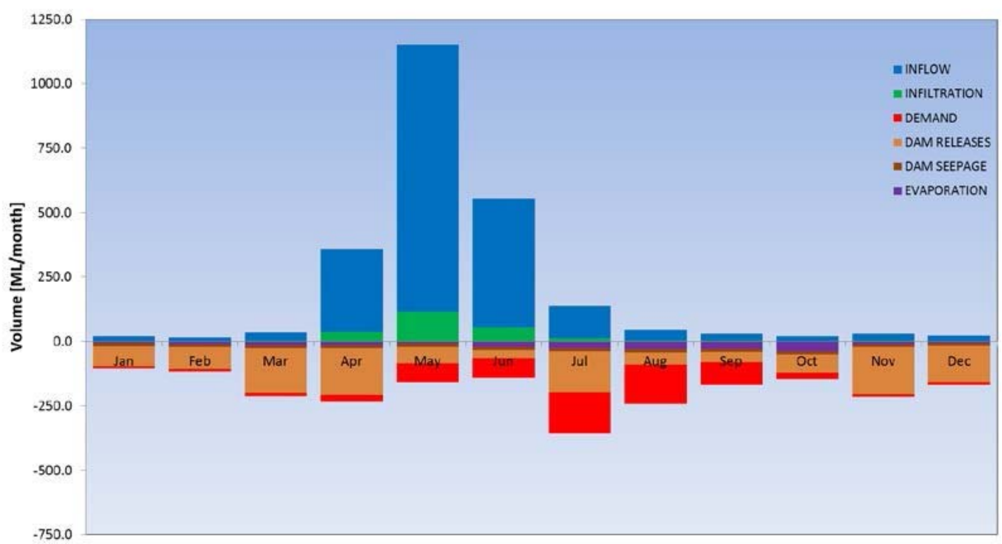
Table 2.1 - Aeneas Creek (Naturalized flow)

Aeneas Creek	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
max cms	**0.03**	**0.03**	**0.07**	**0.42**	**1.28**	**0.52**	**0.17**	**0.07**	**0.05**	**0.03**	**0.03**	**0.03**	
mean cms	0.01	0.01	0.01	0.14	0.44	0.21	0.05	0.02	0.01	0.01	0.01	0.01	
min cms	**0.00**	**0.01**	**0.01**	**0.04**	**0.12**	**0.04**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
max ML/month	**70**	**75**	**185**	**1097**	**3352**	**1368**	**435**	**181**	**137**	**81**	**90**	**80**	**7151**
ML/month	**21**	**16**	**34**	**356**	**1153**	**554**	**138**	**47**	**29**	**21**	**29**	**23**	**2420**
min ML/month	**12**	**17**	**23**	**110**	**312**	**105**	**14**	**12**	**12**	**12**	**12**	**12**	**656**

With the knowledge of the 600 ML diversions to Darke Lake-Reservoir and the 360 ML recharge via groundwater back to Garnett, the estimated flow available is reduced by approximately 240 ML/year or in the range of 2180 ML/year.

Agua Consulting developed a water balance model for Aeneas Creek in 2012 accounting for inflow, outflow, seepage, evaporation and releases into the water distribution system. This balance model is presented in Figure 2.3 and is summarized in Table 2.2.

Figure 2.3 - Water Balance Model – Garnett Dam Releases



For 2012 and 2013, the District has maintained excellent records of the outflow and releases downstream to Aeneas Creek. This recording of data should be continued to determine future available water.

Table 2.2 - Water Balance Model – Garnett Dam Releases

COMPONENT	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTALS
INFLOW	18.7	14.1	30.4	320.8	1037.4	498.8	124.1	42.2	25.8	18.7	25.8	21.1	2178
DEMAND	-8.5	-8.5	-10.1	-25.4	-74.6	-78.4	-160.1	-152.2	-85.6	-27.3	-7.6	-8.6	-647
EVAPORATION	-6.2	-10.2	-14.9	-14.0	-9.1	-21.8	-27.1	-29.7	-28.0	-38.3	-9.2	-5.7	-214
INFILTRATION	2.1	1.6	3.4	35.6	115.3	55.4	13.8	4.7	2.9	2.1	2.9	2.3	242
DAM SEEPADE	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-150
DAM RELEASES	-77.7	-83.8	-173.9	-181.5	-62.7	-29.3	-157.4	-47.3	-41.2	-68.7	-183.7	-139.5	-1247
BUDDET BALANCE	-84	-99	-178	[illegible]	994	412	-219	[illegible]	-139	-126	-184	-143	162

The information developed through the water balance model was adjusted to provide order of magnitude estimates of water availability during return period droughts. The releases from Garnett Reservoir downstream are a substantial volume as Summerland must maintain Garnett Reservoir well below full pool as the channel downstream of the reservoir has limited capacity to convey flow from the dam.

To determine drought frequency and drought runoff from the Aeneas Creek, multiplication factors derived from the regional drought frequency curves for the west side of Okanagan Lake by the Ministry of Environment were used.

Table 2.3 - Aeneas Creek Runoff (Drought Year Multiplication Factors)

Condition	MF	ML/yr
Average Year	1.00	2178
1:25 yr Drought	0.50	1089
1:50 yr Drought	0.34	740
1:100 yr Drought	0.26	566

As listed in Table 2.3, based on average available water from the reservoir of 2,178 ML, in a 1:25 year drought, the runoff volume would be 1,089 ML or only 44% of the total average inflow of 2,420 ML.

2.3 TROUT CREEK SUPPLY CAPACITY

Trout Creek is the second largest watershed in the Okanagan behind only Mission Creek. Based on licensing, it is the largest source of water available to Summerland. The headwaters originate at the Headwaters Reservoirs some 70 kilometres up the creek. Trout Creek, at its mouth, draws water from a 768 km^2 watershed with Summerland accessing water from the upper 713 km^2 of the watershed.

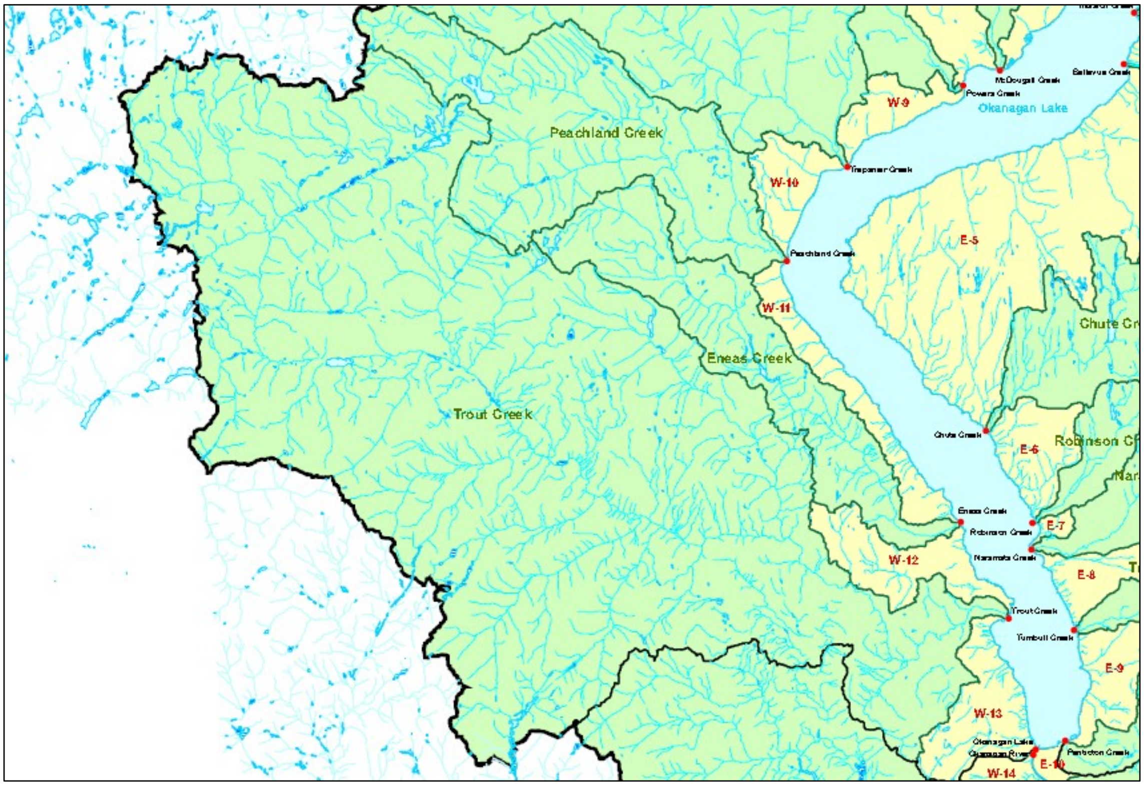
Trout Creek is a gravity supplied source that has an Actiflo water filtration treatment plant located immediately below Summerland Balancing Reservoir at the top of Dale Meadows valley. There are two means of distribution for this source water, one through the irrigation water system, where the water is treated only with chlorine, making supply very cost effective. The second means of distribution is through the water treatment plant to the domestic water distribution system.

The major hydrological features of Trout Creek include:

1. Thirsk Reservoir and Dam which collects all water from the upper 195 km^2 of the watershed;
2. Eight (8) upper watershed reservoirs include the 4 Headwaters Reservoirs, Crescent Reservoir, Whitehead Reservoir, Tsuh Reservoir and Isintok Reservoir, and;
3. Diversion gates and Summerland Balancing Reservoir at 595m elevation.

The general boundaries of Trout Creek are illustrated on Figure 2.4. The location of Thirsk Reservoir is in the western area of the watershed before the creek heads north.

Figure 2.4 - Trout Creek Watershed (image source - Okanagan Water Supply & Demand Study)



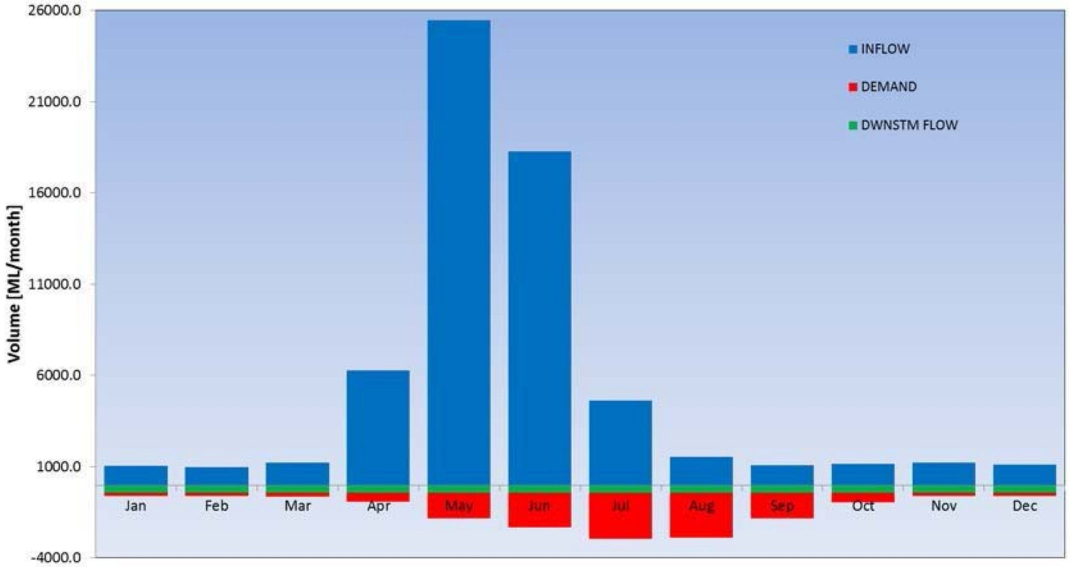
Trout Creek Capacity

The best available technical data on creek flows for the Okanagan region is the *Surface Water Hydrology Report (2009)* on the Okanagan Basin, prepared by Summit Consulting for the Okanagan Basin Water Board. The report provides naturalized flow, i.e. flow that is not influenced by diversions or withdrawals by man. The historic naturalized flow that was developed is based on 11 years of data from 1996 to 2006. The report provides a monthly distribution of naturalized flows and this number was reduced based on Summerland accessing 92% of the total watershed (98% of the watershed flow). Table 2.4 provides the monthly average naturalized flow in Trout Creek at the mouth.

Table 2.4 - Trout Creek (Naturalized flow)

Trout Creek	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
mean cms	0.420	0.390	0.482	2.460	9.980	7.170	1.810	0.611	0.428	0.456	0.490	0.441	
ML/mo @ Mouth	1093	1015	1254	6401	25968	18656	4710	1590	1114	1187	1275	1147	65409
ML/mo @ Intake	**1071**	**994**	**1229**	**6273**	**25449**	**18283**	**4615**	**1558**	**1091**	**1163**	**1249**	**1125**	**64101**

Figure 2.5 - Water Balance Trout Creek Withdrawals (Ave. Year)



For the purposes of determing larger water allocations, a simple water balance model was developed to illustrate on a monthly basis, available water, the amount of water demand by Summerland, and water to support downstream fish habitat.

A fish flow of 11.5 AF/day (14.1 ML/day or 430 ML/month) is the desired daily flow rate for conservation and riparian zone base flows. The amount works out to a flow rate of 166 L/s, or 8.0% of the total naturalized runoff from the watershed.

It is noted that during a drought scenario, this release would be scaled back to manageable levels as identified in the Summerland Water Use Plan.

The volume of water available under various water availability conditions is listed in Table 2.5. The drought scenarios were created based on reduced water availability in accordance with the west side regional drought frequency multiplication factors.

Table 2.5 - Water Balance – Trout Creek

Average Year

COMPONENT	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTALS
INFLOW	1071.0	994.5	1229.1	6272.9	25448.6	18283.2	4615.4	1558.0	1091.4	1162.8	1249.5	1124.5	64101
DEMAND	-170.9	-159.4	-180.7	-464.8	-1381.6	-1881.8	-2525.2	-2450.8	-1403.3	-529.4	-179.3	-170.3	-11498
DWNSTM FLOW	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-5172
BUDDET BALANCE	469.1	404.1	617.4	5377.1	23636.0	15970.4	1659.2	-1323.8	-742.9	202.4	639.2	523.3	47431

Storage Required -1460.3 ML

1:25 Drought Year

COMPONENT	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTALS
INFLOW	535.5	497.2	614.5	3136.5	12724.3	9141.6	2307.7	779.0	545.7	581.4	624.7	562.3	32050
DEMAND	-170.9	-159.4	-180.7	-464.8	-1381.6	-1881.8	-2525.2	-2450.8	-1403.3	-529.4	-179.3	-170.3	-11498
DWNSTM FLOW	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-5172
BUDDET BALANCE	-66.4	-93.2	2.9	2240.6	10911.7	6828.8	-648.5	-2102.8	-1288.6	-379.0	14.4	-39.0	15381

Storage Required -4600.3 ML

1:50 Drought Year

COMPONENT	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTALS
INFLOW	364.1	338.1	417.9	2132.8	8652.5	6216.3	1569.2	529.7	371.1	395.3	424.8	382.3	21794
DEMAND	-170.9	-159.4	-180.7	-464.8	-1381.6	-1881.8	-2525.2	-2450.8	-1403.3	-529.4	-179.3	-170.3	-11498
DWNSTM FLOW	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-5172
BUDDET BALANCE	-237.8	-252.3	-193.8	1237.0	6839.9	3903.4	-1386.9	-2352.1	-1463.3	-565.1	-185.5	-218.9	5125

Storage Required -6855.7

1:100 Drought Year

COMPONENT	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTALS
INFLOW	278.5	258.6	319.6	1631.0	6616.6	4753.6	1200.0	405.1	283.8	302.3	324.9	292.4	16666
DEMAND	-170.9	-159.4	-180.7	-464.8	-1381.6	-1881.8	-2525.2	-2450.8	-1403.3	-529.4	-179.3	-170.3	-11498
DWNSTM FLOW	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-431.0	-5172
BUDDET BALANCE	-323.5	-331.8	-292.1	735.1	4804.0	2440.8	-1756.2	-2476.8	-1550.6	-658.1	-285.5	-308.9	-3

Storage Required -7983.4

Table 2.6 - Trout Creek Summary Table

Condition	MF	ML/yr	Required Storage /Yr
Average Year	1.00	64101	1460
1:25 yr Drought	0.50	32050	4600
1:50 yr Drought	0.34	21794	6856
1:100 yr Drought	0.26	16666	7983

2.4 SOURCE TRACKING RECOMMENDATIONS

Tracking forms for source capacity are included in Appendix B. Either the current format that District staff uses or revised updated forms should be included and summarized in Appendix B.

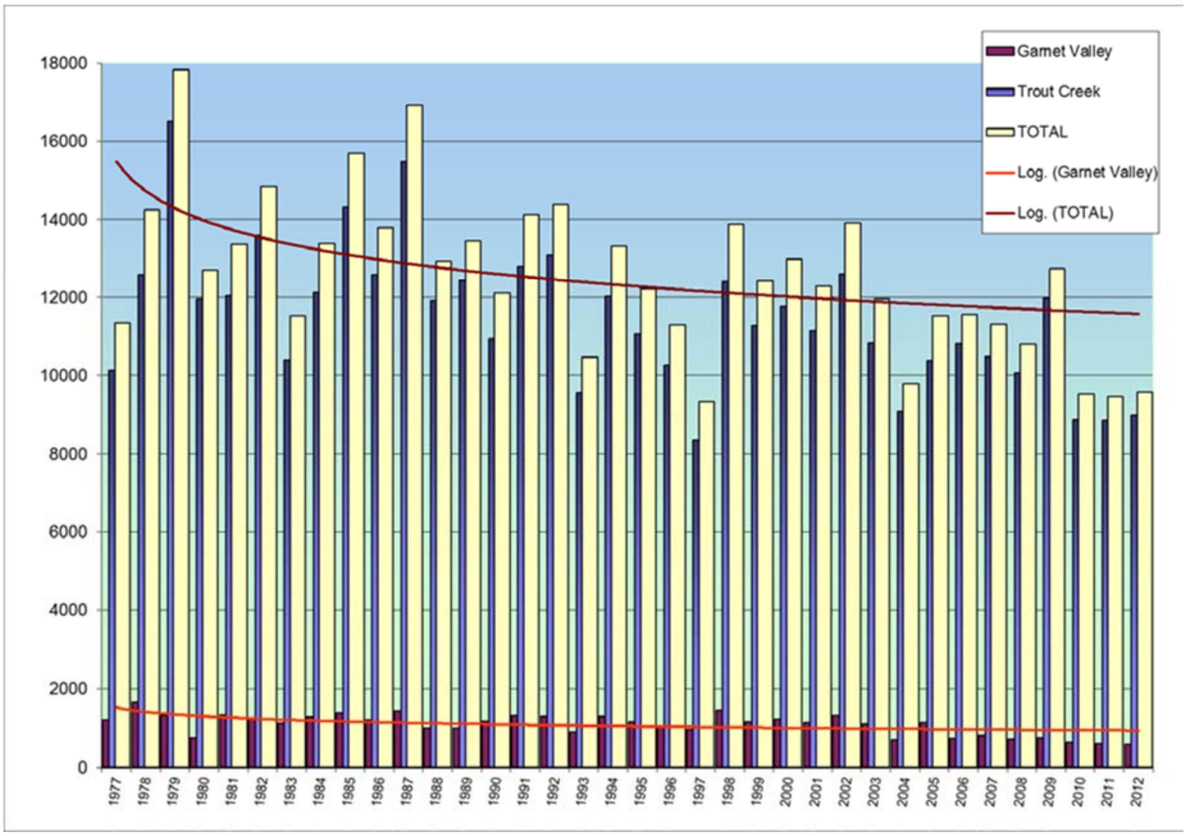
3. WATER AVAILABILITY ASSESSMENT

3.1 INTRODUCTION

There are two conditions to review when assessing water availability, one is the annual water supply capacity, and the second is the annual water demand.

The Water Availability Assessment includes a summary of historic and existing District of Summerland water demands. The factors that may impact future demands are provided. The Summerland water systems are assessed independently including the Garnett, Summerland domestic, and Summerland irrigation systems. The total Summerland demands are included. The total water demand for Summerland from 1979 to 2012 is summarized in Figure 3.1 in ML per year.

Figure 3.1 - District of Summerland – Water Demands - 1979 to present (ML/year)



The information provided in Figure 3.1 corresponds to Table 3.1 on the following page. The numbers include the Summerland irrigation system, the Summerland domestic system and the Garnett Valley water system. In the year 2008, the irrigation system in Dale Meadows was separated from the Summerland main domestic system and that water demand was recorded separated.

The numbers show a reduction in total water usage. Trend lines in red (TOTAL) and orange (GARNETT) systems are presented. The reductions are apparent both in the Summerland and Garnett water systems with noted drops in consumption since 2009.

Table 3.1 - District of Summerland – Water Demands (1979 – to present) - ML/year

Year	Jan.	Feb.	Mar.	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL TROUT	TOTAL GARNETT	TOTAL
1977	143	120	135	160	188	1868	2278	2148	2599	234	131	132	10137	1205	11342
1978	125	110	123	154	1670	3058	3500	2374	469	513	346	141	12581	1664	14245
1979	211	234	176	429	2509	3159	3533	3110	2407	456	162	127	16513	1314	17827
1980	130	143	148	411	1207	2164	3111	2751	1232	395	133	130	11956	750	12706
1981	128	125	153	527	1501	1592	2610	3382	1537	225	132	124	12038	1327	13366
1982	134	126	135	2815	2132	3071	1151	2270	1146	350	134	133	13598	1241	14840
1983	135	124	145	235	1661	2162	1857	2977	430	403	139	145	10410	1114	11524
1984	141	132	141	179	1257	2063	3585	2173	1528	546	166	214	12125	1268	13394
1985	161	151	170	456	1990	2866	4304	2832	777	221	184	203	14316	1373	15689
1986	160	148	165	215	1592	2805	2092	3642	1182	259	159	170	12589	1205	13794
1987	165	148	181	991	2010	2862	3196	2891	2253	427	187	180	15493	1427	16920
1988	195	176	185	274	1346	1939	2706	2518	1718	496	191	179	11923	1005	12927
1989	176	181	210	419	1641	2560	2594	2097	1366	843	185	180	12452	1005	13456
1990	182	169	205	548	939	880	2699	2786	1524	657	172	179	10939	1164	12103
1991	184	165	182	460	1192	2005	2845	2354	1974	1038	200	201	12800	1318	14118
1992	189	172	250	584	2350	2407	1653	2720	1694	651	211	205	13086	1296	14382
1993	212	210	215	262	1561	1381	890	2042	1550	849	191	210	9573	896	10468
1994	212	194	245	594	1439	1910	2904	2291	1198	633	209	191	12021	1296	13317
1995	201	175	206	361	1774	1520	2390	1732	1873	441	198	198	11068	1155	12223
1996	199	199	190	306	521	1715	2841	2571	780	535	200	202	10258	1023	11281
1997	217	195	214	300	1209	971	1829	2048	704	280	201	198	8367	964	9331
1998	170	164	197	399	1481	1409	2806	3075	1853	481	191	195	12421	1455	13876
1999	198	179	212	507	1054	1793	2369	2364	1430	788	193	186	11273	1159	12433
2000	198	186	205	611	1272	1826	2444	2716	1111	743	254	191	11758	1232	12990
2001	197	183	215	473	1587	1398	2198	2224	1720	611	180	168	11156	1132	12288
2002	166	152	185	500	1241	2148	2919	2583	1655	701	176	178	12602	1309	13911
2003	174	160	177	313	1194	2015	3022	1804	1302	356	158	159	10832	1105	11937
2004	172	155	201	515	1204	1383	2247	1699	592	625	159	153	9104	696	9800
2005	156	151	169	495	1302	947	2239	2647	1362	527	215	182	10393	1132	11525
2006	195	186	191	268	1113	1369	2574	2476	1394	680	190	184	10820	727	11547
2007	174	157	206	486	1509	1630	2110	2176	1303	391	176	178	10496	809	11305
2008	184	143	181	391	1100	1332	2585	1737	1467	649	150	156	10075	723	10798
2009	151	141	152	350	1739	2149	3094	2093	1268	558	149	149	11993	756	12749
2010	152	140	169	342	672	1049	2325	2279	930	524	161	144	8888	637	9525
2011	144	126	141	217	579	1386	1709	2349	1635	314	139	126	8864	592	9456
2012	122	117	130	190	1003	955	1697	2299	1554	657	130	140	8994	576	9570
2013															
2014															
2015															
Average	171	159	181	465	1382	1882	2525	2451	1403	529	179	170	11498	1085	12582
Extreme Low	122	110	123	154	188	880	890	1699	430	221	130	124	8367	576	
Extreme High	217	234	250	2815	2509	3159	4304	3642	2599	1038	346	214	16513	1664	
Red shading denotes sum of supplemental line, WTP inflow and Irrigation System															
Monthly Ave.	171	159	181	465	1382	1882	2525	2451	1403	529	179	170	11498		
% of annual	1.5	1.4	1.6	4.0	12.0	16.4	22.0	21.3	12.2	4.6	1.6	1.5	100		

Although the long term average is 12,580 ML per year, the trended average as per Figure 3.1 is less at 11,500 ML/year. Recent years have shown that the recent three years of demand are even lower averaging only 9,600 ML/year.

Trout Creek water demands are summarized monthly with Garnett totals added prior to the TOTAL column. The Trout Creek monthly numbers are in ML/month including three measurements, the domestic demands, the irrigation system demands and flow that bypasses the plant (supplemental flows) at times when the WTP has insufficient capacity to meet the maximum daily domestic demand although this hasn't happened since the Dale Meadows area was separated from the WTP flow.

Table 3.2 - Garnett Valley Water Demands (2008 – to present) - ML/year

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTALS
2008	7.85	7.48	8.41	26.37	100.64	88.19	192.80	119.96	113.82	39.70	9.04	9.89	724.15
2009	10.17	9.20	10.64	35.91	43.60	155.87	200.93	156.38	85.01	26.82	9.50	11.87	755.90
2010	12.98	14.32	17.91	29.40	71.24	60.18	189.57	160.60	40.78	24.61	7.88	8.74	638.21
2011	7.37	7.31	8.91	21.15	55.55	64.91	114.20	179.46	110.28	17.30	5.90	6.04	598.38
2012	6.24	6.05	7.15	15.54	90.91	38.86	112.14	191.04	121.94	42.45	5.93	6.56	644.81
2013	6.30	6.52	7.55	23.85	85.81	62.44	150.89	105.72	42.00	12.70			
2014													
2015													
Average	8.48	8.48	10.09	25.37	74.63	78.41	160.09	152.19	85.64	27.26	7.65	8.62	646.92

Garnett valley water demands have been tracked monthly as provided in Table 3.2.

3.2 WATER USE CHARACTERIZATION

Over the past 36 years, the District of Summerland used an average of 12,590 ML of water per year. As shown in Figure 3.1, the overall water use is declining as shown by the red trend line. The current normalized water demand for 2012 is estimated to be lower at 11,600 ML/year.

The recent decline in water use is due to a combination of reasons with similar reduced water demands throughout the Okanagan Valley. Water use efficiency is increasing, there is densification of the urban population, changes in land use, and higher prices for water, all of which lead to lower water consumption. Table 3.1 shows the last three years in Summerland being some of the lowest years of consumption on record.

The normalized demand is the number used to estimate the current state of water demands for the community. It considers trending and smoothing out of climatic factors, land use changes, and changes in the management and pricing of water.

There are two trend lines presented on Figure 3.1, one for Total Consumption and one for Garnett Valley consumption. The normalized flow for the total consumption is approximately 11,600 ML/year with 10,800 ML/year from the Summerland system and Garnett Valley being at 800 ML/year.

Meter readings for 2011 and 2012 were reviewed to develop an estimate of the water demand profile for Summerland. Meter readings were available for the arable land connections and for the domestic meter reads for single family housing. A summary of the estimated annual water demand for various customer groups is provided in Table 3.3.

Table 3.3 – Estimated Water Consumption per Customer Group

Description	Amount	unit	Applic. (ML/yr)	2011 Demand (ML)
Grade A Land	1290	ha.	3.990	5147
Single Family Lots	3787	lots	0.471	1784
MF / Townhouses	626	lots	0.388	243
ICI	261	units	0.970	253
Leakage (38 L/s or 12.7%)				1198
UFW (8.90%)				842
AVERAGE ANNUAL WATER DEMAND				**9467**

Leakage is based on the background lowest level of flow recorded for outflow from the Water Treatment Plant. The flow rate is 35 L/s for the Summerland system and 3 L/s for the Garnett system. It includes both private and public system leakage. A portion of the system leakage is included in the metered flows for domestic customers.

The Unaccounted-For-Water (UFW) is the un-metered water that is not covered in the metered readings, leakage and estimates for various customer uses.

The year 2011 meter readings are provided, but are below the normalized annual total water use. The normalized Total Water Demand is estimated higher at 11,600 ML. The current consumption pattern in Table 3.4 was developed for the entire District of Summerland.

Table 3.4 – Estimated Water Consumption per Customer Group per month

WATER USAGE PER MONTH (ML)																
LAND USE				Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Grade A Land	1290	ha.		0	0	0	149	598	1003	1323	1256	632	186	0	0	5146
Single Family Lots	3787	Lots		87	80	86	77	86	138	193	226	268	243	213	88	1784
MF / Townhouses	626	Units		12	11	12	11	12	19	26	31	37	33	29	12	243
ICI	261	Units		12	11	12	11	12	20	27	32	38	35	30	13	253
Leakage	1198	ML/yr		102	92	102	98	102	98	102	102	98	102	98	102	1198
UFW	842	ML/yr		72	65	72	69	72	69	72	72	69	72	69	72	842
TOTAL DEMAND PER MONTH				284	258	283	415	881	1347	1743	1718	1142	670	439	286	9466

3.3 WATER CRITERIA MODIFICATIONS

Water utilities in the Okanagan have reduced their water demand criteria for new development. Historic levels of 3,000 L/person/day or 2,400 L/person per day for MDD have been reduced to 1,800 L/ person /day or 2,100 L/person/day. It is recommended that Summerland revise their water demand numbers for new development as follows:

- ADD 500 L / person / day
- MDD 2,100 L / person / day
- PHD 3,600 L / person / day (120 L/person0/hour

- Agriculture Water Demand 800mm depth per year (maximum annual usage)
- Agriculture Water Demand 5.0 USgpm / acre (maximum watering rate)

3.4 WATER AVAILABILITY SUMMARY

The availability of water for the future was considered based on recent source water trending and trended Summerland water demands. The availability from both Aeneas Creek (Garnett Dam) and from Trout Creek are assessed.

Table 3.5 - Aeneas Creek - Water Availability Summary

Available Water	Ave. Annual Source Water (ML/yr)	Ave. Demand (ML/yr)	Spare Capacity (ML/yr)	Sufficient for SFE units	Sufficient for Irrigated acres
Average Year	2178	647	1531	3828	473
1:25 yr Drought	1089	647	442	1105	137
1:50 yr Drought	740	647	93	0	0
1:100 yr Drought	566	647	-81	0	0

Table 3.6 - Trout Creek - Water Availability Summary

Available Water	Ave. Annual Source Water (ML/yr)	Ave. Demand (ML/yr)	Spare Capacity (ML/yr)	Sufficient for SFE units	Sufficient for Irrigated acres
Average Year	64101	9000	55101	137753	17028
1:25 yr Drought	32050	9000	23050	57625	7123
1:50 yr Drought	21794	9000	12794	31985	3954
1:100 yr Drought	16666	9000	7666	19165	2369

The tables show that there is sufficient water under normal conditions and up to a 1:25 year drought to provide adequate water to Summerland for the foreseeable future. The situation has been improved greatly with the additional storage that was developed when Thirsk Dam was raised in 2007.

3.5 SUMMERLAND – GARNETT WATER SYSTEM INTERCONNECTION

There are several factors that will affect the availability of water from the Aeneas Creek water supply system. One is the determination of the safe high water level that can be maintained at Garnett Reservoir. Because of the limited dam spillway capacity, and the limited channel capacity through Summerland, careful operation of water releases and reservoir levels must be maintained so that there is buffering provided by the reservoir storage so that downstream flows are managed at safe levels at all times.

With the possibility of there being less water capacity for storage in Garnett Reservoir, there are options for supplying more water to Garnett Valley in times of drought. The simplest option is to provide a single pump from the main Summerland water system to feed into the Garnett water distribution system in times of drought. This can be done by either

1. Oversizing the separated water distribution system and pumping complete with a cross connection control device to supply from the domestic system to the irrigation system in times of drought; or
2. By installing a dedicated pump from the Summerland main system (PZ 586) to pump up to PZ 629 (Garnett Reservoir);

An indication of pumping capacity for various pump sizes is included in Table 3.7. As the shortfall in Garnett Valley would be in the range of only several hundred ML of water, a pump in the 25 to 50 hp size range should be considered.

During a drought, it would be known for a period of time that the water levels in Garnett will be low and there would be time to transfer water from the Summerland system to Garnett to reduce demands on the reservoir. Our recommendation would be to utilize a 25 hp pump and consider oversizing the domestic water system by one or two pipe sizes to convey this emergency flow in times of drought.

Table 3.7 - Summerland to Garnett Valley Pumping

Horsepower	TDH (m)	Effic.	Flow (L/s)	ML/day	ML annually
25	45.0	80%	33.8	2.92	1066
50	45.0	80%	67.6	5.84	2131
75	45.0	80%	101.4	8.72	3195
100	45.0	80%	135.2	11.68	4264

For the volume of water projected for use in the near future, a 25 hp pump should be adequate for the foreseeable needs of the area.

4. WATER LICENSE RECONCILIATION

4.1 INTRODUCTION

This section provides our review of existing water licenses held by the District of Summerland. The District holds 25 licenses for Storage, Waterworks Local Authority (WWLA) and Irrigation (IRR). The 25 licenses held by Summerland issued by the Province of BC consist of the following allocations:

STO (Storage) Licenses	11 licenses	18,883 ML/yr.
WWLA (Waterworks) Licenses	5 licenses	7,491 ML/yr.
IRR (Irrigation) Licenses	9 licenses	20,926 ML/yr.

The storage licenses (STO) are held in conjunction with the consumptive licenses (IRR and WWLA) and are for the impoundment of water at times when there is excess flow in the creek. The storage licenses are reviewed in comparison with the actual storage volume constructed. A summary of District water licenses is presented on Table 4.1 on the following page.

The Province of BC issues water licenses based on need and beneficial use The licenses are reviewed in terms of being of appropriate volume for the size and capacity of the water source to meet the demand.

Table 4.1 - Summary of District of Summerland Water Licenses

Lic. No	Stream Name	Purpose	Quantity	Units	Storage	WWLA	Irrig.	Status	Priority
C014568	Trout Creek (Thirsk Reservoir)	Storage	2630	AF	3243			Current	19400626
C014569	Trout Creek	Waterworks Local Auth	91250000	GY		414		Current	19400626
C016412	Trout Creek	Irrigation Local Auth	3170	AF			3909	Current	18881218
C016413	Trout Creek	Irrigation Local Auth	6000	AF			7398	Current	19030711
C016414	Isintok Creek	Storage (1665 ML)	5500	AF				Current	19260326
"	Tsuh Creek	Storage (370 ML)	5500	AF				Current	19260326
"	Crescent Creek	Storage (617 ML)	5500	AF				Current	19260326
"	ZZ Creek (7819) (Whitehead)	Storage (432 ML)	5500	AF				Current	19260326
"	ZZ Creek (7824) (Headwaters)	Storage (3699 ML)	5500	AF				Current	19260326
"	ZZ Creek (7788)	Storage	5500	AF				Current	19260326
"	Trout Creek	Storage	5500	AF	6782			Current	19260326
C016415	Eneas Creek	Irrigation Local Auth	3000	AF			3699	Current	18890801
"	Eneas Creek	Irrigation Local Auth	3000	AF				Current	18890801
"	Latimer Creek	Irrigation Local Auth	3000	AF				Current	18890801
"	Eneas Creek	Irrigation Local Auth	3000	AF				Current	18890801
"	Eneas Creek	Irrigation Local Auth	3000	AF				Current	18890801
C016416	Eneas Creek (Garnet)	Storage	2000	AF	2466			Current	19130429
"	Finlay Creek (Garnet)	Storage	2000	AF				Current	19130429
C029847	Trout Creek (Headwaters 1)	Storage	750	AF	925			Current	19610518
C030786	ZZ Creek (7788) (Whitehead)	Storage	222	AF	274			Current	19650628
C030787	ZZ Creek (7819)	Storage	250	AF	308			Current	19650628
"	ZZ Creek (7824)	Storage	250	AF				Current	19650628
"	Trout Creek	Storage	250	AF				Current	19650628
C032615	Okanagan Lake	Waterworks Local Auth	584000000	GY		2651		Current	19670606
C034398	Crescent Creek	Storage	255	AF	314			Current	19670606
C034399	Crescent Creek (Headwaters)	Storage	1000	AF	1233			Current	19670606
C034400	ZZ Creek (7788) (Whitehead)	Storage	348	AF	429			Current	19670717
C056161	Eneas Creek	Irrigation Local Auth	25	AF			31	Current	19480318
C056869	Eneas Creek	Storage	360	AF	444			Current	19800624
C060898	Trout Creek	Irrigation Local Auth	1500	AF			1850	Current	19730803
"	Trout Creek	Waterworks Local Auth	213000130	GY		967		Current	19730803
C066455	Trout Creek	Irrigation Local Auth	2500	AF			3083	Current	19880602
C066491	Trout Creek	Irrigation Local Auth	75	AF			92	Current	19410526
C106027	Thirsk Lake	Storage	2000	AF	2466			Current	19930122
C106243	Prairie Creek	Land Improve	0	TF				Current	19930217
C106464	Eneas Creek	Land Improve	0	TF				Current	19940421
C118910	Okanagan Lake	Waterworks Local Auth	760000000	GY		3450		Current	20031022
F066492	Trout Creek	Irrigation Local Auth	697	AF			859	Current	18881218
"	Trout Creek	Waterworks Local Auth	1825000	GY		8		Current	18881218
F066493	Trout Creek	Irrigation Local Auth	5	AF			6	Current	18901220
Okanagan Lake Licenses						6,102			
Trout Creek Licenses					15,974	1,390	17,197		
Garnet Valley Licenses					2,910	0	3,730		
TOTAL WATER LICENSING IN ML / YEAR					18,883	7,491	20,926		
Total number of Licences and/or Applications found is 25									

4.2 STORAGE LICENSES

A list of storage licenses and reservoir volumes is included in Table 4.2. The licenses were reviewed in earlier reports and the actual volume stated in the licenses is in order for all reservoirs with the exception of Thirsk Reservoir where the licensed volume for storage is low. Summerland Balancing Reservoir provides a balancing function rather than water storage from water collected at another time of year and the licensing to cover this is held at the upper watershed reservoirs.

Table 4.2 - Storage License Reconciliation

Reservoir	Actual Storage (ML)	Licensed Storage (ML)	Net difference (ML)
Thirsk-	6,490	5,709	- 781
Headwaters (all 4)	4,472	5,857	+ 1,385
Isintok	1,384	1,665	+ 281
Whitehead	1,216	1,442	+ 226
Crescent	765	931	+ 166
Tsuh	308	370	+ 62
Summerland Balancing Res.	260	0	- 260
TOTALS	**17,255**	**18,884**	**+ 1,629**

At Thirsk Reservoir there is a licensing shortfall of 781 ML of storage. Transfer of licensing is possible if the water sources are in the same watershed. There is substantial excess capacity at the Headwaters Lakes-Reservoirs and the surplus licensing can be transferred to Thirsk and Summerland Reservoirs to reconcile these licenses. The Ministry would require an application through Front Counter BC to start the process for this re-allocation request.

4.3 WATERWORKS LOCAL AUTHORITY (WWLA) LICENSES

WWLA licenses are for all domestic water use including outdoor irrigation for those customers. The portions of UFW and leakage must also be factored into the WWLA licensing as that is a function of the water delivery and distribution.

When including the portion of UFW and Leakage, the annual average demand that has to be covered by the WWLA licenses is 3,603 ML. Based on metered readings and adjustments as presented in Section 3, Summerland currently provides 1,780 ML annually to the SF connections and smaller amounts for MF connections and ICI use. The amount of water used per domestic connection is small, however the cost and value of domestic water is high due to the requirements for treatment, fire protection and system renewal.

Summerland holds 7,491 ML of WWLA licensing. The volume is sufficient to meet the existing demands, however 6,101 ML of the licensed volume is from Okanagan Lake. There exists only 1,390 ML of WWLA from Trout Creek and none on Aeneas Creek. The shortfall in WWLA licensing from Trout Creek amounts to 2,213 ML.

The shortfall in WWLA licensing from Aeneas Creek is small and there are plans for dual distribution to this area, so no additional allocation of WWLA should be pursued from that source. There are three options for reconciling the WWLA licensing:

1. Reallocate the surplus IRR licensing to become WWLA licensing;
2. Apply for additional new WWLA licensing on Trout Creek;
3. Add an alternate Point of Diversion (POD) along Trout Creek for the new conditional licensing awarded to Summerland on Okanagan Lake (CL 118910 in the amount of 3,450 ML).

Any of the three options provided above are reasonable approaches to reconciling the Summerland WWLA water licenses. The Ministry water licensing staff should be contacted to determine which preference they have for reconciling the WWLA licenses.

With a shortfall of 2,213 ML of WWLA licensing as listed on Table 4.2, Summerland should look to secure another 3,000 ML of WWLA license.

4.4 IRRIGATION LICENSES

When including the portion of UFW and Leakage, the annual average demand that has to be covered by the IRR licenses is 8,023 ML. Based on metered readings and adjustments as presented in Section 3, Summerland currently irrigates 1,290 ha (3,187 acres) of arable land with an average annual volume of 4,900 ML. The average depth of water applied in an average year is 0.36 m. In a dry year, more water would be used and therefore a budget number of 6,000 ML should be considered.

The recognized allocated maximum volume that could be used by a property in Summerland is 0.800m after which time, water use would be considered excessive. If all existing irrigated land were to use their full allotment, the volume of water required per year would be 10,320 ML.

Summerland holds 20,926 ML of licensing for IRR. The volume is sufficient to provide double the irrigated area to a depth of 0.800 m. This is sufficient for intensive irrigation to a total area of 2,615 hectares (6,470 acres).

Summerland holds sufficient IRR licenses. The probability for the irrigated area to double is very low. If this was ever to occur, there would be complications as the distribution system infrastructure would also have to substantially increase to provide for this flow of water.

The large IRR licensing allows Summerland some flexibility to reconcile the WWLA licenses which are insufficient. If this option were selected by the Province and Summerland, it is recommended that the District retain at least 15,000 ML of IRR for future development of agriculture in the region and consider reallocation of Trout Creek License C016412 (3,909 ML) as it is of sufficient volume to make the adjustment through the transfer of one single license. This would still allow Summerland to retain more than 15,000 ML of licensing for IRR purposes.

5. SUMMARY

Section 5 provides a summary of the conclusions and recommendations made in the Water Availability Report.

5.1 CONCLUSIONS

The following is a summary of the conclusions of this report:

C-1 Based on the technical information summarized in this report, Summerland has sufficient water for the foreseeable future and the ability to adjust water usage by enacting their drought bylaw in times of a water shortage;

C-2 It is recognized that there is the potential for conflict between user groups when assessing and allocating water to customers. The District of Summerland is entrusted with the responsibility of administering water supply to the community, including securing sufficient water supply for the various customer groups. It is up to the District and Summerland Municipal Council to make decisions in regards to water allocation and adjustment of water supply licensing for the greater good of the community. This includes the development of policy, procedures, and the rationing of water appropriately in times of drought;

C-3 The concept of water rights assigned to property only exists if that property holds an individual water license with the Province. The issuance of "water rights" to arable land by Summerland is a service mechanism and moral obligation of providing fair allotment and reliable supply to the water customers. The licensed rights to water exist in a contract between the Province and the District of Summerland and not with individual customers;

C-4 Recognition of the history of the community, the community ties to agriculture, and the community value to provide lowest-possible-cost water for agriculture should be maintained. At the same, time the provision of water should be done so that the overall economic impacts are manageable by the community;

C-5 Based on the hydrological review summarized in Section 2 of this report, the Garnet water system has an average reliable supply of 2,180 ML/year. The supply of Garnett Reservoir water to the Garnet Valley customers has recently averaged only 650 ML/year;

C-6 The influential factors in the Aeneas Creek watershed include a significant diversion of water to Darke Reservoir, owned by Meadow Valley Irrigation District, and the continuous return of groundwater from that Darke Creek valley back to Garnett Reservoir. Information on the diversion and recharge is provided in Section 2 of this report;

C-7 Based on the hydrology summary in Section 2 of this report, the Summerland water system has an average reliable supply of 64,101 ML/year. The supply of all Trout Creek water to the customers historically has averaged 10,800 ML/year. In recent years, this has dropped to 8,810 ML/year;

C-8 Based on recent meter records, the community water demand is now around 9,600 ML/year, with approximately 5,100 ML/year or 53%, used for irrigation of arable lands;

C-9 A simple drought frequency analysis was conducted to determine the water availability in the event of various return period frequency droughts. For Trout Creek under all scenarios up to a 1:100 year drought, there was sufficient water to meet the customer demands. For Garnett Reservoir (Aeneas Creek), there was sufficient water for up to a 1:50 year drought. For drought events greater than a 1:50 year frequency, either alternate supply or drought restrictions would have to apply;

C-10 Of the Summerland water sources, Aeneas Creek is the source at highest risk of not being able to meet the annual water demand. The development of supplemental flow from the Summerland main water system is viable and should be considered to ensure there is reliable water supply to the Garnett Valley area;

C-11 Water trending over the last 30 years shows that Summerland water demands are declining. This is occurring across the Okanagan in other communities and there are a variety of reasons for the decrease as described in Section 3 of this report;

C-12 Summerland holds sufficient STO (storage) licensing for their upper watershed as set out in Section 4 of this report. The Thirsk Reservoir licensing needs to be adjusted to reflect the actual storage in Thirsk Reservoir in the amount of 6,490 ML. With the existing storage license of 5,709 ML, there is currently a shortfall of 781 ML of storage for that facility;

C-13 Summerland holds sufficient IRR licensing for the foreseeable future as set out in Section 4 of this report;

C-14 Excluding the new Okanagan Lake waterworks license, which is not yet accessible, Summerland has insufficient WWLA licensing with a shortfall of 2,213 ML annually;

C-15 There are three options for reconciling the WWLA licensing:

1. Reallocate the surplus IRR licensing to become WWLA licensing;
2. Apply for additional new WWLA licensing on Trout Creek;
3. Add an alternate Point of Diversion (POD) on Trout Creek for the new conditional licensing awarded to Summerland on Okanagan Lake (CL 118910 in the amount of 3,450 ML).

5.2 RECOMMENDATIONS

In consideration of the conclusions, the following recommendations are presented:

R-1 It is recommended that district staff continue to track monthly water use from all Summerland water sources as set out in Appendix B or equivalent procedure;

R-2 Due to cost, the small volume of storage, and the remoteness of the Aeneas Reservoir dam, it is recommended that Summerland breach the water storage dam, but they should retain the water storage license for reinstatement of the dam at some time in the future. The dam poses a low to moderate risk if not properly maintained. Discussions should be held with the local Dam Safety Officer in this regard;

R-3 Reduced water demand criteria should be set for the District of Summerland Subdivision Bylaw. Average Daily Demand (ADD) could be reduced to 600 L/person/day, Maximum Daily Demand (MDD) should be reduced to 2,100 L/person/day and Peak Hour Demand (PHD) should be set at 3,200 L/person/day;

R-4 It is recommended that Summerland utilize their water source capacity to a maximum of a 1:25 year return period drought as this limit allows for all foreseeable growth without substantially overbuilding the water system infrastructure. This is a cost-effective and practical horizon for determining water source limits for the community. Shortfalls for droughts greater than 1:25 year frequency can be dealt with through reductions in accordance with the community drought response plan;

R-5 While carrying out the system separation in Garnet Valley, a contingency design should be simultaneously carried out to allow higher pumping capacity of water from the Summerland domestic system (PZ 586) up to Garnett Reservoir (PZ 629). A pump in the 25 hp size range would have sufficient flow capacity in the range of 30 L/s as set out in Table 3.7 of this report. This pump size would be adequate to make up a water supply shortfall if there were an event greater than a 1:25 year drought. There is the means to adjust the Garnett separation design to provide emergency water to the Garnett system irrigation distribution mains;

R-6 Summerland must consider operating Garnett Reservoir at reduced water elevations so that the probability of spillway breaching or downstream channel inundation does not occur. The revised Garnett Dam Inundation study and technical memoranda provide recommendations for the operating levels for Garnett Reservoir;

R-7 It is recommended that Summerland annually monitor the diversion activities in upper Aeneas Creek watershed by Meadow Valley Irrigation District so that the long term hydrology operations are recorded for future hydrological reviews. The process set out in Appendix B or similar procedure could be used;

R-8 It is recommended that the District approach the Provincial government to reconcile the water storage license at Thirsk Dam, increase it from 5,709 ML of storage to 6,490 ML to storage;

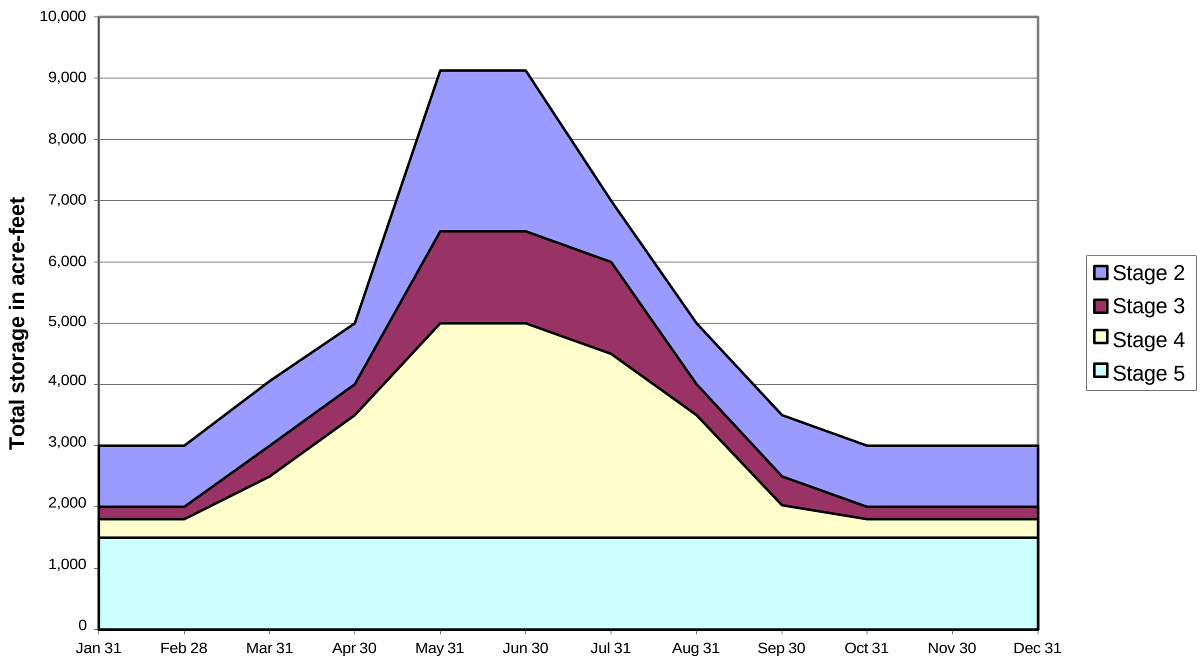
R-9 It is recommended that the District approach the Provincial government to reconcile the WWLA water licenses for the community. A shortfall of 2,213 ML/year exists and it is recommended that Summerland secure an additional 3,000 ML/year of WWLA to meet the domestic water demands in the foreseeable future by way of one of the three options set out in conclusion C-15.

APPENDIX A - TROUT CREEK WATER USE PLAN

(insert)

TROUT CREEK WATER USE PLAN

OPERATING AGREEMENT



The Trigger Graph tracks total storage in the Trout Creek Reservoirs and indicates Stage Levels at which water usage reductions will be required.

TROUT CREEK WATER USE PLAN
RESERVOIR OPERATING AGREEMENT

The Trout Creek Water Use Plan Consultative Committee met in 2004 and in early 2005 to develop an Operating Agreement for the Trout Creek Reservoirs. The members included representatives from the District of Summerland, Ministry of Water, Land and Air Protection, Ministry of Agriculture, Food and Fisheries, Fisheries and Oceans Canada, Agricultural Water Users and the Penticton Indian Band

The steps that were taken in developing the proposed Operating Agreement for operation of the Trout Creek water supply system were as follows:

- Each stakeholder on the Trout Creek Water Use Plan Consultative Committee presented their specific objectives in terms of their water requirements.

- It was demonstrated by modelling the Trout Creek water supply over a 67-year period, that it was not feasible to meet the objectives of all stakeholders in full.

- Operations for the “design drought” condition were incorporated in the modelling analysis to ensure that three consecutive years of drought could be managed.

- Compromises were made until a feasible operating regime was developed. This was the basis of the Operating Agreement.

The Trout Creek watershed, which supplies most of Summerland’s water, has highly variable flows. They vary during the year and between the years. Drought years with very low flows pose special challenges for users. The water system developed by Summerland is fully allocated to current users. Domestic users, irrigators and fish have all taken a reduction in use to reach agreement on this Water Use Plan.

Summerland holds Water Licences to utilize approximately 15,000 acre feet of water per year from Trout Creek for irrigation and domestic purposes. The maximum use occurred in 1979 with consumption of 13,367 acre feet.

Summerland also holds Water Licences to store approximately 12,500 acre feet of water in 9 reservoirs within the Trout Creek watershed. Actual storage is calculated at 9,373 acre feet in all of the reservoirs combined. During the storage use season from July 1 to October 31 the maximum use was 7,695 acre-feet in 1979.

The Trout Creek aquatic ecosystem also requires water for sustainability, so is another important user of water. Specific flows are required in the creek to sustain fish populations, benthic invertebrates, and maintain a functional stream channel (sediment flushing, gravel recruitment, and development/maintenance of fish habitat features). As is the case with other water users, insufficient water can negatively impact the aquatic ecosystem and can risk sustainability when conditions are extreme.

Most years Summerland has lots of water for all users. It is the dry years that are critical for water use planning. The variability of the flows allows for different seasonal approaches to water use and an understanding of the different seasonal priorities is essential to the success of our efforts in sharing. A trigger graph model has been developed to set usage levels and to help predict periods of shortfall. When storage levels go below specified targets of storage volume over time, usage reductions must occur to ensure equitable sharing of the resource between users.

The required Summerland intake bypass flows in Trout Creek (fish flow) are based on the lesser of a multiplier of Camp Creek flows and fisheries conservation flows. Camp Creek is a tributary watershed of Trout Creek and the Camp Creek flow times a multiplier provides an index (but not an absolute value) of natural flow variations in Trout Creek. Seepage losses from the stream bed in Trout Creek are an additional source of uncertainty regarding natural flows in Trout Creek, particularly in drought years. It is important to note that at a given Camp Creek multiplier the fish flow releases in Trout Creek will reduce as Camp Creek flows decline through the summer.

Agricultural irrigation consumes an estimated 80% of the water used by Summerland. Increased crop water demand during drought years creates additional pressure on the water resource. The Trout Creek hydrology model illustrates that it is simply not possible for the reservoir system to supply irrigation water demands equivalent to 2002 usage and fish flows equivalent to natural flows in Trout Creek during drought years.

For those who lack faith in computer models, the real life indicators of potential problems are storage levels, snowpack conditions and date of entry into use of storage water. The participants to this agreement are hopeful that the increased understanding gained from this process will help us manage this water system for the benefit of all.

Irrigators will conserve early season water to assist in ensuring that the full storage can meet peak crop water demand later in the season. The District will provide a water conservation officer that will work with irrigators to ensure responsible water use by all.

This Agreement recognizes the potential for a 10% increase in irrigation requirement due to global warming and a 9% potential increased draw if all Irrigation Roll commitments are met. Participants to this Agreement recommend increasing water storage in Trout Creek by raising Thirsk Dam to meet those challenges.

Normal Operation

The District of Summerland as the licensee will continue to be responsible for operations of the Trout Creek water supply system under the Water Use Plan Operating Agreement

The basis of the Operating Agreement is to use a Trigger Graph as shown on Page 1 to make water use allocations. The total storage in the system is 9,132 acre-feet (excluding Tsuh Reservoir) and the Trigger Graph indicates what the safe consumption would be for lower storage levels as the irrigation season progresses. The table on Page 5 for **Operating Agreement-A**, indicates the target water usage reductions for the community and the fish flow releases based on a multiplier of Camp Creek flows.

Stage 1 usage reduction targets (based on 90% of 2002 water usage) will be in effect throughout the summer until reservoir storage levels drop below full pool at which time Stage 2 will be introduced. The plan for usage reductions and fish flow releases is based on modelling of the watershed and supply system over the 67-year period. The modelling indicates that with **Operating Agreement-A**, the system would have avoided dropping into Stage 4 and Stage 5 at any time in the 67-year period.

The Trigger Graph is set so that if the reservoirs are not full in the month of June, Stage 2 will automatically be implemented. This will conserve early season storage water by implementing reductions in usage by both fisheries and the community.

The fish flow releases in **Operating Agreement-A** are less than that required to sustain the aquatic resource. If these multipliers are increased to levels that provide adequate flows for fish habitat, there is a risk of the water supply system dropping into Stage 4. The modelling indicates that this would occur twice in the 67-year period with higher fish flows. The committee concluded that this level of risk was not acceptable for the existing water supply system. However, with the planned expansion of Thirsk Reservoir this risk will be removed, as there will be sufficient storage to avoid the two occurrences of Stage 4 in the 67-year period. Therefore the Committee concluded that after the Thirsk Dam is raised, **Operating Agreement–B** would be used. The Trigger Graph remains the same but the fish flow multipliers are increased in **Operating Agreement-B** as shown in the table on Page 5.

The agricultural water users are accepting water usage reductions to make the current system work for all stakeholders and furthermore, water has not been allocated under the Agreement for land on the Irrigation Roll that is not currently irrigated. Therefore, any additional water realized from raising Thirsk Dam should first be allocated to the agricultural users

Emergency operation

The original design drought condition for the Trout Creek reservoir system was based on three consecutive years of drought with flows at 36% of mean flows. It is understood that this corresponds to the three consecutive drought years that occurred in the Okanagan Basin in 1929, 1930 and 1931. The Operating Agreement was established so that the design condition can be accommodated for both A and B scenarios.

Catastrophic events could occur such as major fires in the watershed, an infestation of mountain pine beetle or dam failures, which would compromise the capability of the system to operate normally. Planning of the system to operate for three consecutive drought years would partially address emergency events. However, more stringent measures could be required if the event resulted in a more serious situation.

Monitoring and Review

The Water Use Plan (WUP) should be reviewed within 5 years to address changing circumstances such as:

- Metering
- Appointment of a water conservation officer
- Climate change
- Thirsk expansion

Any of the parties to this Agreement can initiate the review. Consistent with the current Water Use Plan, the District would lead any review process. In addition, continuation of the flow monitoring program is recommended to improve the understanding of the hydrology of Trout Creek and tributaries.

Water Usage Reductions for **Operating Agreement A**

	Reduction Stage					
	1	2	3	4	5	
June	10	8	6	4	0	Fish flow x Camp
	90	85	80	70	0	Community target factor %
July	9	8	7	4	0	Fish flow x Camp
	90	85	80	70	0	Community target factor %
Aug	10	9	8	4	0	Fish flow x Camp
	90	85	80	70	0	Community target factor %
Sept	10	10	10	4	0	Fish flow x Camp
	90	85	80	70	0	Community target factor %
Oct	10	10	10	4	0	Fish flow x Camp
	50	50	50	50	0	Community target factor %

The District target water usage reductions are expressed as a percentage of the monthly 2002 water use.

Water Usage Reductions for **Operating Agreement B**

	Reduction Stage					
	1	2	3	4	5	
June	10	8	6	4	0	Fish flow x Camp
	90	85	80	70	0	Community target factor %
July	10	10	9	4	0	Fish flow x Camp
	90	85	80	70	0	Community target factor %
Aug	10	10	10	4	0	Fish flow x Camp
	90	85	80	70	0	Community target factor %
Sept	10	10	10	4	0	Fish flow x Camp
	90	85	80	70	0	Community target factor %
Oct	10	10	10	4	0	Fish flow x Camp
	50	50	50	50	0	Community target factor %

APPENDIX B - WATER USE - TRACKING FORMS

Table B.1 - Garnett Valley Water Demands (2008 – to present) - ML/year

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTALS
2008	7.85	7.48	8.41	26.37	100.64	88.19	192.80	119.96	113.82	39.70	9.04	9.89	724.15
2009	10.17	9.20	10.64	35.91	43.60	155.87	200.93	156.38	85.01	26.82	9.50	11.87	755.90
2010	12.98	14.32	17.91	29.40	71.24	60.18	189.57	160.60	40.78	24.61	7.88	8.74	638.21
2011	7.37	7.31	8.91	21.15	55.55	64.91	114.20	179.46	110.28	17.30	5.90	6.04	598.38
2012	6.24	6.05	7.15	15.54	90.91	38.86	112.14	191.04	121.94	42.45	5.93	6.56	644.81
2013	6.30	6.52	7.55	23.85	85.81	62.44	150.89	105.72	42.00	12.70			
2014													
2015													
Average	8.48	8.48	10.09	25.37	74.63	78.41	160.09	152.19	85.64	27.26	7.65	8.62	646.92

Garnett valley water demands have been tracked monthly as provided in Table 3.2.

Table B.2 - District of Summerland – Water Demands (1979 – to present) - ML/year

Year	Jan.	Feb.	Mar.	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL TROUT	TOTAL GARNETT	TOTAL
1977	143	120	135	160	188	1868	2278	2148	2599	234	131	132	10137	1205	11342
1978	125	110	123	154	1670	3058	3500	2374	469	513	346	141	12581	1664	14245
1979	211	234	176	429	2509	3159	3533	3110	2407	456	162	127	16513	1314	17827
1980	130	143	148	411	1207	2164	3111	2751	1232	395	133	130	11956	750	12706
1981	128	125	153	527	1501	1592	2610	3382	1537	225	132	124	12038	1327	13366
1982	134	126	135	2815	2132	3071	1151	2270	1146	350	134	133	13598	1241	14840
1983	135	124	145	235	1661	2162	1857	2977	430	403	139	145	10410	1114	11524
1984	141	132	141	179	1257	2063	3585	2173	1528	546	166	214	12125	1268	13394
1985	161	151	170	456	1990	2866	4304	2832	777	221	184	203	14316	1373	15689
1986	160	148	165	215	1592	2805	2092	3642	1182	259	159	170	12589	1205	13794
1987	165	148	181	991	2010	2862	3196	2891	2253	427	187	180	15493	1427	16920
1988	195	176	185	274	1346	1939	2706	2518	1718	496	191	179	11923	1005	12927
1989	176	181	210	419	1641	2560	2594	2097	1366	843	185	180	12452	1005	13456
1990	182	169	205	548	939	880	2699	2786	1524	657	172	179	10939	1164	12103
1991	184	165	182	460	1192	2005	2845	2354	1974	1038	200	201	12800	1318	14118
1992	189	172	250	584	2350	2407	1653	2720	1694	651	211	205	13086	1296	14382
1993	212	210	215	262	1561	1381	890	2042	1550	849	191	210	9573	896	10468
1994	212	194	245	594	1439	1910	2904	2291	1198	633	209	191	12021	1296	13317
1995	201	175	206	361	1774	1520	2390	1732	1873	441	198	198	11068	1155	12223
1996	199	199	190	306	521	1715	2841	2571	780	535	200	202	10258	1023	11281
1997	217	195	214	300	1209	971	1829	2048	704	280	201	198	8367	964	9331
1998	170	164	197	399	1481	1409	2806	3075	1853	481	191	195	12421	1455	13876
1999	198	179	212	507	1054	1793	2369	2364	1430	788	193	186	11273	1159	12433
2000	198	186	205	611	1272	1826	2444	2716	1111	743	254	191	11758	1232	12990
2001	197	183	215	473	1587	1398	2198	2224	1720	611	180	168	11156	1132	12288
2002	166	152	185	500	1241	2148	2919	2583	1655	701	176	178	12602	1309	13911
2003	174	160	177	313	1194	2015	3022	1804	1302	356	158	159	10832	1105	11937
2004	172	155	201	515	1204	1383	2247	1699	592	625	159	153	9104	696	9800
2005	156	151	169	495	1302	947	2239	2647	1362	527	215	182	10393	1132	11525
2006	195	186	191	268	1113	1369	2574	2476	1394	680	190	184	10820	727	11547
2007	174	157	206	486	1509	1630	2110	2176	1303	391	176	178	10496	809	11305
2008	184	143	181	391	1100	1332	2585	1737	1467	649	150	156	10075	723	10798
2009	151	141	152	350	1739	2149	3094	2093	1268	558	149	149	11993	756	12749
2010	152	140	169	342	672	1049	2325	2279	930	524	161	144	8888	637	9525
2011	144	126	141	217	579	1386	1709	2349	1635	314	139	126	8864	592	9456
2012	122	117	130	190	1003	955	1697	2299	1554	657	130	140	8994	576	9570
2013															
2014															
2015															
Average	171	159	181	465	1382	1882	2525	2451	1403	529	179	170	11498	1085	12582
Extreme Low	122	110	123	154	188	880	890	1699	430	221	130	124	8367	576	
Extreme High	217	234	250	2815	2509	3159	4304	3642	2599	1038	346	214	16513	1664	
Red shading denotes sum of supplemental line, WTP inflow and Irrigation System															
Monthly Ave.	171	159	181	465	1382	1882	2525	2451	1403	529	179	170	11498		
% of annual	1.5	1.4	1.6	4.0	12.0	16.4	22.0	21.3	12.2	4.6	1.6	1.5	100		

Example of a tracking system used to determine annual watershed production above a reservoir. It accounts for precipitation, snowmelt, releases, evaporation, etc. this data is used to forecast reservoir production over a longer period of time. Two years of data collection are shown.

Reservoir High Water Level and Volume							31.4	5537			
Reservoir Level at end of Previous Year							23	2952			
Reservoir Level at Start of Year							31.4	5537			2585
Enter Volume of Water Recorded over spillway during year (input thalimedes su								6794			
Storage Release Summary											
Date	No. of Days	Gauge Reading Before	Gauge Reading After	Release Rate (acre-feet/day) Before	Release Rate (acre-feet/day) After	Ave Release Rate over Period (acre-feet/day)	Reservoir Level (ft)	Remaining Reservoir Storage Vol. (acre-feet)	Change in Storage (acre-feet)	Natural Supply (+)Supply or (-) Loss (acre-feet)	Basin Outflow Rel. Rate x No. Days (acre-feet)
18-Jun-08	0	0	0.95	0	69		31.4	5537	0	0	0
05-Jul-08	17	0.15	0.6	4	34	36.685	31.4	5537	0	623.645	623.645
14-Jul-08	9	0.6	0.87	34	60	34	31	5537	0	306	306
23-Jul-08	9	0.87	0.87	60	60	60	28.5	4394	-1143	-603	540
30-Jul-08	7	0.87	0.63	60	37	60	28.5	4394	0	420	420
25-Aug-08	26	0.63	0	37	0	37			-4394	-3432	962
05-Sep-08	11	0	0.52	0	26	0	25.5	3600	3600	3600	0
09-Sep-08	4	0.52	0.24	26	8	26	24.5	3300	-300	-196	104
19-Sep-08	10	0.24	0.31	8	12	8	24.5	3300	0	80	80
25-Sep-08	6	0.31	0.46	12	23	12	23	2952	-348	-276	72
30-Sep-08	5	0.46	0.6	23	34	23	24.5	3300	348	463	115
03-Oct-08	3	0.6	0.35	34	15	34.1	23.5	3100	-200	-97.7	102.3
06-Oct-08	3	0.35	0	15	0	15	23	2952	-148	-103	45
								Net Reservoir Change for Season	-3188.5506		
Days Relea	110									968.2154149	
Natural Inflow (+) or Loss (-) to Reservoir during release period											9693.8
Watershed Runoff Produced for Period of Record (ML)											
		Calculated Cell		Data Entry cell							

Reservoir High Water Level and Volume							31.4	5537			
Reservoir Level at end of Previous Year							25	3499			
Reservoir Level at Start of Year							31.4	5537			2038
Enter Volume of Water Recorded over spillway during year (input thalimedes su								2031			
Storage Release Summary											
Date	No. of Days	Gauge Reading Before	Gauge Reading After	Release Rate (acre-feet/day) Before	Release Rate (acre-feet/day) After	Ave Release Rate over Period (acre-feet/day)	Reservoir Level (ft)	Remaining Reservoir Storage Vol. (acre-feet)	Change in Storage (acre-feet)	Natural Supply (+)Supply or (-) Loss (acre-feet)	Basin Outflow Rel. Rate x No. Days (acre-feet)
14-Jun-07	0								0	0	0
22-Jun-07	8	0.45	0.55	23	30	11.5	31.4	5537	5537	5629	92
05-Jul-07	13	0.55	0.55	30	30	29.6	31.4	5537	0	384.8	384.8
09-Jul-07	4	0.55	0.65	30	41	29.6			-5537	-5418.6	118.4
13-Jul-07	4	0.87	0.88	59	60	49.85	31	5393	5393	5592.4	199.4
16-Aug-07	34	0.88	0.67	60	42	60	25.5	3600	-1793	247	2040
19-Aug-07	3	0.67	0.31	42	12	42			-3600	-3474	126
20-Aug-07	1	0.31	0	12	0	12	25	3499	3499	3511	12
Days Relea	67							Net Reservoir Change for Season	4315.953		
Natural Inflow (+) or Loss (-) to Reservoir during release period										7982.601175	
Watershed Runoff Produced for Period of Record (ML)											9203.6
		Calculated Cell		Data Entry cell							

CONVERSIONS

AREAS

1 acre =	0.404687 hectares
1 acre =	43,560 ft^2
1 acre =	0.00404686 km^2
1 acre =	4,046.87 m^2
1 acre =	0.0015625 miles^2
1 acre =	4840 yds^2
1 hectare =	2.47105 acres
1 hectare =	10,000 m^2
1 hectare =	0.01 km^2
1 km^2 =	247.1054 acres
1 mile^2 =	640 acres

FLOW

1 ft^3/s =	28.31687 L/s
1 ft^3/s =	374.04 USgpm
1 ft^3/s =	6.234 Igpm
1 ft^3/s =	7.48052 US gallons (liquid)
1 Igpm =	0.075765 L/s
1 L/s =	0.001 m^3/s
1 L/s =	0.0353 cubic feet / second
1 L/s =	13.1986 Igpm
1 L/s =	15.8503 USgpm
1 USgpm =	0.06309 L/s
1 AF/day =	1.23348184 ML/day
1 AF/day =	1233.48184 m^3/day
1 AF/day =	14.276405 L/s
1 AF/day =	188.43008 Igpm
1 AF/day =	226.285 USgpm

DISTANCE / LENGTH

1 foot =	0.3048 metres
1 foot =	0.3333 metres
1 kilometre =	0.621371 miles
1 metre =	3.28084 feet
1 mile =	1,609.344 metres
1 mile =	1.609344 kilometres
1 mile =	5,280 feet

VOLUME

1 AF =	1.23348184 ML
1 AF =	325,849 Imperial Gallons
1 AF =	43,560 ft^3
1 AF =	271,329 US gallons
1 ft^3 =	28.31687 liters
1 ft^3 =	6.229 Imperial Gallons
1 ft^3 =	7.48052 US Gallons
1 Imperial gallon =	4.546 litres
1 Imperial gallon =	1.2009 US gallons
1 Imperial gallon =	0.1605 ft^3
1 Litre =	0.0353 ft^3
1 Litre =	0.21997 Imperial gallons
1 Litre =	0.26417 US gallons
1 Litre =	1,000 litres
1 ML =	0.810713 AF
1 ML =	0.810713 AF
1 ML =	1,000 m^3
1 ML =	1,000,000 litres
1 ML =	219,970 Imperial gallons
1 ML =	264,170 US gallons
1 US gallon =	0.13368 ft^3
1 US gallon =	0.83267 Imperial Gallons
1 US gallon =	3.78541 Litres

PRESSURE

1 psi =	2.3067 ft (of head)
1 psi =	0.703082 metres (of head)
1 psi =	0.06805 bars or atmospheres
1 psi =	6.89476 kPa (kilopascals)

WORK UNITS

1 watt =	1.341022 hp
1 horsepower =	745.7 Watts

WEIGHT

1 lb =	453.59 grams
1 lb =	0.45359 kilograms
1 Ton =	2,000 lbs.
1 Tonne =	2,204.62 lbs.
1 kilogram =	2.204 lbs.