DISTRICT OF SUMMERLAND

2012 WATERSHED MASTER PLAN - FINAL

September, 2012

Agua Consulting Inc.
"Engineered Water Solutions"

ABBREVIATIONS

AES	Atmospheric Environment Service
ADD	Average Daily Demand
AF	Acre-foot
ALR	Agricultural Land Commission
AO	Aesthetic Objective
ARDA	Agriculture Rehab. & Development Amendment Act
AWWA	American Waterworks Association
AWWARF	AWWA Research Foundation
CCI	Construction Cost Indices
CCP	Critical Control Points
Cl_2	Chlorine or sodium hypochlorite
CMHO	Chief Medical Health Officer
CPI	Consumer Price Index
CT	concentration x time (disinfection measurement)
DAF	Dissolved Air Flotation
DoS	District of Summerland
DBP	Disinfection By-product
DSM	Demand Side Management
DWO	Drinking Water Officer
DWPA	Drinking Water Protection Act
DWPR	Drinking Water Protection Regulation
ECA	Equivalent Clear Cut Area
FF	Fire flow
FUS	Fire Underwriters Survey
GCDWQ	Guideline for Canadian Drinking Water Quality
GIS	Geographical Information System
HGL	Hydraulic Grade Line (slope of water in m/m)
Igpm	Imperial Gallons per minute (flow rate)
IHA	Interior Health Authority
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)
mg/L	milligrams/litre (parts per million)
MAC	Maximum Acceptable Concentration
MAR	Mean Annual Runoff
MCC	Motor Control Centre
MF	multi-family
ML	mega-litre (one million litres = 1,000 m^3)
ML / day	Mega-litres per day
MDD	Maximum daily demand
MHO	Medical Health Officer
MIgpd	Million Imperial gallons per day
MOE	Ministry of Environment
MPB	Mountain Pine Beetle
MVID	Meadow Valley Irrigation District
NTU	Nephelometric Turbidity Unit
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
PHO	Provincial Health Officer
PIB	Penticton Indian Band
PRV	Pressure Reducing Valve
PS	Pump Station
Psi	pounds per square inch (pressure)
PLC	Programmable Logic Controller
PST	Provincial Sales Tax
PZ	Pressure Zone (identified by normal HGL in metres)
RDOS	Regional District of Okanagan Similkameen
RPBA	Reduced Pressure Backflow Assembly
SCADA	Supervisory Control and Data Acquisition
SFE	Single Family Equivalent (equivalent to a SF lot)
SDWR	Safe Drinking Water Regulation
SWTR	Surface Water Treatment Rule
TCID	Trout Creek Irrigation District
TCU	True Color Units
TDH	Total Dynamic Head
THM	Tri-halomethane
TOC	Total Organic Carbon
TWL	Top Water Level (metres)
UFW	Unaccounted For Water
µg/L	micrograms / litre (parts per billion)
uS /cm	micro siemens
USgpm	US gallons per minute(flow rate)
UV	Ultra-violet
UVT	Ultra-violet Transmissivity
VFD	Variable Frequency Drive (motor speed control)
WSC	Water Survey of Canada
WUP	Water Use Plan

Cover photo: Crescent Reservoir – Trout Creek watershed, July 29, 2009

Agua Consulting Inc.
"Engineered Water Solutions"

September 12, 2012

District of Summerland
PO Box 159
Summerland, BC
V0H 1Z0

Attention: Mr. Don Darling, AScT, GSC
Director, Engineering and Public Works

Dear Don:

Re: 2012 Watershed Master Plan and Source Assessment

We are pleased to submit our final report of the 2012 Watershed Master Plan for the District of Summerland. The report provides a comprehensive summary of watershed issues facing the District of Summerland in the management of their watersheds. Key components of the report include:

- A listing of stakeholders and government agencies with jurisdictional responsibility and control within the multi-use Eneas Creek and Trout Creek watersheds;
- A water source assessment including Modules 1, 2, 7 and 8 in compliance with the Interior Health Authority's Conditions on Permit requirements for the District of Summerland;
- A recommended water quality monitoring program for the watersheds;
- A review of water quantity measurements and recommendations for monitoring sites in the watersheds;
- Review of the District of Summerland infrastructure in the watershed, including dams, diversion ditches, and release and intake gates;
- Mapping of key risk management areas for the District and a plan for dealing with potential risks in the watershed;
- A summary of conclusions and recommendations based on our investigation.

We thank you for the opportunity to develop this plan for the District of Summerland. We are available to assist the District is the implementation of improvements in the watershed.

Yours truly,

Agua Consulting Inc.

R.J. Hrasko, P.Eng.
Principal

Agua Consulting Inc. "Engineered Water Solutions"
- 3660 Anderson Road, Kelowna, BC, V1X 7V8
- Phone: 250.212.3266

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APPENDICES

EXECUTIVE SUMMARY

1.0 INTRODUCTION

The Summerland 2008 Water Master Plan and Financial Review provides a comprehensive review of the community water supply system including an extensive list of short, interim and long term projects for the District of Summerland. This report is consistent with the 2008 Water Master Plan and confirms the recommendations made and direction taken from that plan.

This report focuses on the watersheds upon which the District relies for their water supply. The primary objectives of this report are to:

- Review activities within the community watersheds and make recommendations as to how to improve management to protect those resources;
- To conduct and summarize a source water assessment of the Comprehensive Drinking Water Source to Tap Assessment Guideline in conformance with the Interior Health Authority Conditions on Permit for Summerland.

  This involves completing:

  Module 1, (Section 3) Water Source Characterization;
  Module 2, (Section 4) Contaminant Source Inventory:
  Module 7 (Section 5) Risk Characterization; and
  Module 8 (Section 7) Summary;

- Carry out a review of District of Summerland watershed infrastructure including all dams, reservoirs and intakes;
- Summarize the findings in a comprehensive report.

WATERSHED ISSUES

The watersheds are multiple use areas with multiple jurisdictional responsibilities by various Provincial Ministries and local government. Watershed issues addressed in this report include a review of Forestry activity and the impacts of Mountain Pine Beetle (MPB), wildfire risks, recreational activities, leased lot impacts, agriculture and range activities, human wastewater, forestry, climate change, nutrient loadings and algal blooms, groundwater contamination, and infrastructure security.

2.0 STAKEHOLDERS AND WATERSHED GOVERNANCE

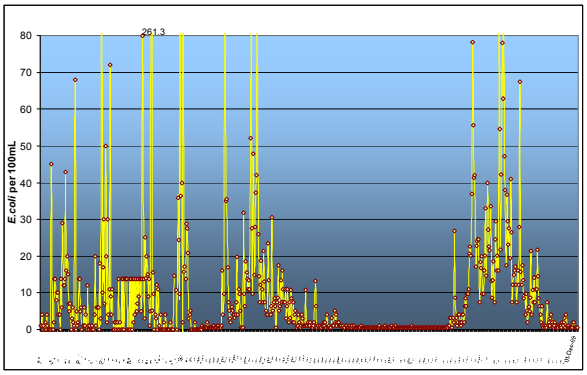
Section 2 of this report sets out a listing of regulatory acts and regulations, a list of stakeholders that have some role in the watersheds and the Regulator's requirements for the District of Summerland water utility in the watershed. A brief discussion on the current Water Act Modernization process and Operating Principles for governance within watersheds is presented in Section 2.

3.0 WATER SOURCE CHARACTERIZATION (MODULE 1)

Section 3 presents the natural physical and biological characteristics of the water sources that are relied upon by the District of Summerland.

A brief presentation of the District of Summerland water supply system is included in Section 3. Summerland has three present sources of water with 90% of the supply originating from Trout Creek, 10% from Eneas Creek via Garnet Reservoir and emergency supply from two groundwater wells.

The majority of this section focuses on the larger watershed areas. The characteristics of the creeks, ground cover and raw water quality are listed in Section 3. Groundwater is characterized in a comprehensive report and included in Appendix B. The aquifers below the watershed and below the municipal boundaries are listed and illustrated in Appendix B. The groundwater flow explanations provide insight into why Garnet Reservoir appears to have such a high percentage of groundwater inflow. Supplemental hydrological and water quality data on the water sources is provided in Appendix C.



Water quality graphs for Total Coliforms, *E.Coli*, and trihalomethane levels for both Trout and Garnet Reservoir raw water are presented. Generally the levels of fecal matter are moderate, but there are seasonal spikes in bacteria in the raw water. The reasons for the seasonal spikes are the natural levels of wildlife and the range and agricultural activities in the watersheds.

A review of the vulnerability of the water intakes was also carried out. Garnet Reservoir provides significant buffering protection simply due to the size of the reservoir, the intake depth and distance of intake from shore. The reservoir stores more than a year of water supply for Garnet Valley. Trout Creek is the largest intake for the District. The Trout Creek Reservoir above town is of limited size and therefore has limited buffering capacity to settle out material or provide any level of protection to Summerland.

4.0 CONTAMINANT SOURCE INVENTORY (MODULE 2)

As part of monitoring and managing the hazards that exist within the watersheds, a detailed contaminant source assessment was carried out. Noted hazards include:

- **Microbiological hazards**: such as bacteria, viruses and protozoa that can come from fecal matter deposited in the streams;
- **Man-made Hazards**: Caused through recreational, industrial or forestry activity;
- **Natural Hazards**: Such as forest fires, drought, climate change, flooding and soil erosion; and
- **Chemical hazards**: due to accident such as a fuel spill or similar catastrophe.

Several days of field reconnaissance were carried out in the late fall of 2008 and summer of 2009. Hazards to drinking water and stream and ecosystem stability were documented, photographed and recorded. The information was tabulated in detail and some 300 photographs and sites were listed in the inventory exercise. Photographs for many of the sites are listed in Table D.1 in Appendix D of this report. The risks are numbered by site location, Mapping is provided in Section 4 to illustrate the hazard locations.


000_081106-1 Squatters cabin on Tr. Ck @ .9km.JPG


001_081106-1 Squatters cabin on Tr. Ck @ .9km.JPG


005_081106-5 Camper @ 4600 location.JPG


006_081106-6 Septic tanks not installed.JPG


010_081106-10 Junction point in Summ- Princeton...


011_081106-11 Road sign on route to Whitehead res...

Separate pages are dedicated to specific issues such as protozoa (specifically *Cryptosporidium* and its characteristics), timber harvesting and range activities in the watersheds, fire management and the benefits of a fire management plan, backcountry recreational pressures and issues in the Okanagan, the transportation and utility corridors, the issue of leased lots and gravel extraction.

Recommendations in relation to these activities are provided in Section 4 as well as in the Summary. With the multiple uses within the watershed and the lack of coordination between different activities, Summerland, as the primary stakeholder, has inherited the role of essentially being the caretaker of the Eneas Creek and Trout Creek watersheds.

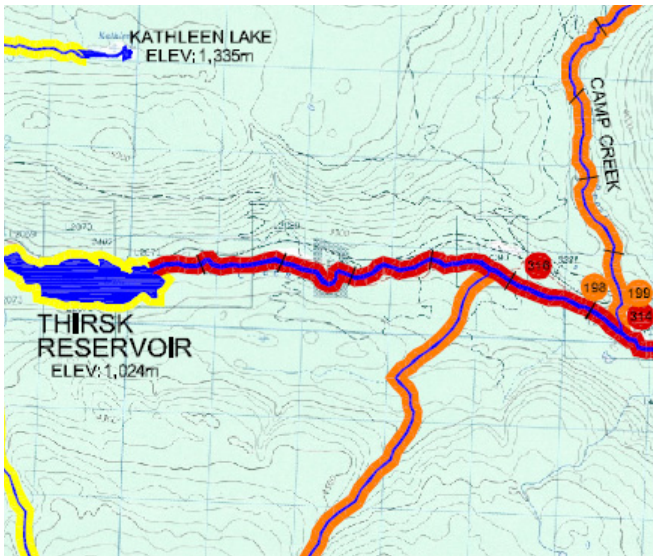
To effectively be able to manage the watersheds in the future will require partnerships with other stakeholders, a great deal of teamwork, and effort. The present operating principles in community watersheds are under review as part of the Water Act Modernization (WAM) process.

5.0 CHARACTERIZATION OF RISK (MODULE 7)

Section 5 provides information on the sensitivities of the physical aspects of the watershed. Contamination was found in the watersheds. The transferring of the found contamination from its found location to where it would be of risk to the District of Summerland is estimated in Section 5. Figure 5.1 shows the watershed sensitivity above the District of Summerland intakes. The watershed sensitivity is colour coded into red, orange or yellow corridors along the water conveyance channels.

Red Corridors: The red corridors along the creeks identify the areas of highest sensitivity in the watershed. In these areas, the water flows with significant flow volume past the District of Summerland water intake(s). The areas of highest sensitivity are the main stem of Trout Creek from Thirsk Reservoir to the intake and through the agricultural land in the Darke Creek Valley.

Orange Corridors: The orange corridors are considered to be of medium sensitivity and risk as these areas are either buffered through dilution from Trout Creek, which is larger, or are a further distance away from the intake. The sub-tributaries to Trout Creek have less activity within them, are sometimes completely dry in the summer, and provide minimal inflow to Trout Creek which is fed in the summer primarily from releases at Thirsk Reservoir.



Yellow Corridors: The yellow corridor areas of lower sensitivity and risk are those areas that are buffered with a larger storage reservoir such as Thirsk Reservoir or Garnet Reservoir located below. The large reservoirs provide substantial settling times and reduce risks of the named hazards.

For assessing the cumulative risk and priorities, the equation from Section 5.2 is utilized.

RISK = LIKELIHOOD OF OCCURRENCE X CONSEQUENCE OF OCCURRENCE

The "*Likelihood of Occurrence*" is the product of the presence of the contaminant from Section 4 and the watershed sensitivity (Figure 5.1) as there are the issues of flow rate and buffering that is created by the larger reservoirs.

LIKELIHOOD OF OCCURRENCE = WATERSHED SENSITIVITY X PRESENCE OF CONTAMINANT

The consequences of a risk are generally the potential for waterborne disease illness to occur, poisoning from a chemical spill or algae toxin, or the long term cumulative effect from exposure to THMs that can form from the disinfection process.

The high and very high hazards that were identified in the Contaminant Source Inventory were plotted in conjunction with the highly sensitive areas illustrated in Figure 5.1. The location of the highest risk contaminant sites to the District of Summerland are illustrated in Figure 5.2. A larger version of Figure 5.2 is included in Appendix A as Figure A.2. There are 24 sites tabulated in Table 5.1 that identify the areas of highest risk.

6.0 FACILITIES ASSESSMENT

An assessment was carried out on the District of Summerland watershed related infrastructure. The review included an audit of the water licenses, a review of the water storage and diversion facilities in conjunction with a dam inspection, hydrometric monitoring sites for water quantity, and a review of water quality monitoring parameters. The items within this section are not a requirement of the Source to Tap assessments, but is important information when reviewing the watershed.

Water Licensing

The amount of Water licensing held by Summerland is adequate for the foreseeable future. The allocation of the licensing, however, should be adjusted in two areas:

1. Water storage allocation does not match up with the reservoir storage volumes. Thirsk Reservoir is undersized with more storage actually existing in Thirsk than what is licensed. Headwaters Reservoir No. 1 has more license allocation than available actual storage. Adjustments should be made, but the total volume of licensing held should remain the same.
2. Water allocation for domestic use by the water utility is below what Summerland currently uses. If Summerland is successful with their application for licensing on Okanagan Lake, this will be partially corrected. We believe that Summerland should hold 4,500 ML of licensing for the purposes of Waterworks Local Authority (WWLA)

Dam Assessments

Dam safety reviews were carried out in November of 2008 and in July of 2009. Maintenance works and capital projects related to the dams, gates and spillways were summarized and are listed in Section 6 of this report. With the exception of Thirsk Dam, which is a concrete arch dam that was recently constructed, the District watershed dams are all earth embankment dams of moderate or low height.

The low head pressure against the dam results in lower risk of failure and/or seepage. The dam embankments are in good condition. Maintenance works and capital works are listed in Section 6. Upgrades and maintenance should be carried out annually so that the dam structures are maintained in the best possible shape.

Hydrometric Monitoring

Over the last 30 years, the Province and Federal governments have reduced their funding towards Hydrometric Monitoring. Only one real-time hydrometric monitoring station remains on Camp Creek. The releases at Thirsk Dam are remotely read, however the overall condition and monitoring of natural flows in the watersheds is minimal. Monitoring of creek main stem flows are recommended at the outlet of Headwaters No. 1, Thirsk Dam and at the Trout Creek intake. Flows at Thirsk, Garnet and Headwaters No. 1 spillways are also recommended as is the reinstatement of a real-time monitoring site at Bull Creek.

Water Quality Monitoring

Only minor water quality monitoring adjustments are recommended. The adjustments are to selectively monitor for *Cryptosporidium* and *Giardia* at the Garnet Reservoir outlet at the times of highest Total Coliform and *E.Coli* readings during the summer. Although there is poor correlation between bacteria and protozoa, the highest potential for collecting the protozoa would be when there is fecal matter present. Sampling four times per year for Halo-acetic acids is also recommended. Algae monitoring is recommended in the summer at three reservoirs, Garnet, Thirsk and Headwaters No. 1.

7 CONCLUSIONS

Major conclusions generated during the development of this plan include the following points. The critical points from the Groundwater Study summarized in Appendix B are also listed in this section.

Governance Conclusions

C-1 The Province is going through the Water Act Modernization (WAM) process at the current time. The outcome should have significant changes in how water is managed. Stream health, water allocation, groundwater regulation and licensing and water governance are all being considered within the update;

C-2 Presently there are many Provincial Acts and Regulations that govern water use in the Province. The District of Summerland relies on two large watersheds for which they have no authority regarding land use or multiple use activities. Because of this, working with the Province for Crown Lands, and Regional District of Okanagan Similkameen for private lands use is critical;

C-3 The drinking water regulator for Summerland is the Interior Health Authority and they have made the preparation of components of this report a Condition on Permit;

C-4 Summerland holds 25 licenses for storage, waterworks local authority, and irrigation on Eneas Creek, Trout Creek, and Okanagan Lake. The total annual allotments are 20,926 ML for Irrigation, 7,491 ML for WWLA, and 18,883 ML for storage. These volumes of licensing should be sufficient for the foreseeable future but require modifications for storage locations and for water used for WWLA purposes;

Groundwater Conclusions

C-5 Regardless of surface water or groundwater sourced potable water, the most significant water quality threat to the current water supply is the disturbance of the delicate hydraulic balance that exists in the shallow aquifer in the area between the Summerland Landfill and the Trout Creek Reservoir. If the balance is changed, leachate from the Landfill could potentially be introduced into the Trout Creek Reservoir;

C-6 Potential exists for point or non-point contamination of surface water within Trout Creek, at locations up-gradient of the diversion point where water is directed to the Trout Creek Reservoir. The shallow aquifer in the area and Trout Creek are hydraulically connected and fertilizers, pesticides, animal waste, accidental spills, etc., may compromise the water quality of both surface and shallow groundwater;

C-7 The three (3) Summerland water wells located near the Trout Creek Reservoir are in a deep aquifer which is at the lowest [down-gradient] section of the Trout Creek/Meadow Valley Aquifer, and thus vulnerable to unregulated up-gradient groundwater extraction. On-going monitoring of groundwater levels at Faulder by RDOS indicates water levels are fluctuating in the deeper aquifer for an unknown reason. The risk exists that continued unchecked development of water resources in the Trout Creek catchment area could ultimately reduce the sustainable yields in the existing Summerland wells;

C-8 The most significant threat to future groundwater development within Summerland itself is incorrectly grouted geothermal boreholes, which can provide for a preferential pathway for surface contaminants to migrate into the deep aquifer beneath Summerland;

C-9 Additional details on groundwater aquifers in the region are provided in Appendix B;

Watershed Conclusions

C-10 The existing watershed areas supplying Summerland are presented on Figure 3.1 and Figure A.1 in Appendix A. The watershed primary creeks and creek tributaries are illustrated on the drawings;

C-11 Characteristics of the watersheds are presented in Section 3 including creek slope, watershed soils, land and forest cover;

C-12 Five years of water quality data for Trout Creek and Garnet Reservoir are presented for Total Coliforms, *E.Coli* and THM levels in Section 3 of this report to support the review of watershed characteristics of the Trout Creek watershed;

C-13 Supplemental water quality and water quantity data is included in this report as Appendix C. The data provided is adjusted excerpts from the 2008 Water Master Plan;

C-14 Water supply hazards to the District of Summerland include bacteriological hazards, man-made hazards, chemical/accidental spills and natural hazards. These hazards are reviewed as part of a Contaminant Source Inventory exercise conducted on the watersheds. The Contaminant Source Inventory is summarized in Section 4 and Appendix D;

C-15 A summary of the contamination inventory of the Trout Creek and Eneas Creek watersheds is listed in Table D.1 in Appendix D of this report. The hazards are identified, numbered, photographed, and a hazard rating for each of the sites is identified. The sites correspond to locations on the larger scale watershed maps that are provided in Appendix D;

C-16 A listing of range activities and range licensees is included in this report. Range lessees areas are shown on Figure 4.2;

C-17 With respect to human wastes, the activities in the watershed fall under the jurisdiction of land use bylaws of the Regional District of Okanagan Similkameen, or if on Provincial Crown lands, then under the authority of the applicable Provincial Ministry. Human wastes such as failed septic fields fall under the jurisdiction of the Interior Health Authority, however, monitoring is required to prove that there is a failure;

C-18 There are three larger Forest Lessees operating within the Summerland watersheds: Tolko Industries Inc., BC Timber Sales, and Gorman Brothers Forest Products. Their areas of activity are presented in Figure 4.3. There are also several Wood Lots that exist within the watershed that are active under a different operating structure than the forest lessees;

C-19 Fire risks are high in the watershed and will only increase with the dead pine stands created by the recent Mountain Pine Beetle infestation;

C-20 Backcountry recreational activities currently exist in the watersheds including hunting, fishing, recreational vehicle trail riding, hiking (Trans-Canada trail), and mud bogging. Controls and education are needed on the detrimental activities where soil and ground cover damage is occurring. Education to the residents of Summerland and regional areas is needed to raise the profile of damaging activities;

C-21 Transportation corridors are the link for the public to the watersheds. Road jurisdiction is maintained by the Ministry of Transportation (Summerland-Princeton Road), Ministry of Forest Service (FSRs), and by the forest lessees (logging roads). In addition there is a trail corridor (Trans-Canada Trail) and a BC Hydro Right-of-Way bisecting the Trout Creek watershed as

shown on Figure 4.6. Non-status forestry roads also exist in the watershed and the Ministry of Forests and Natural Resource Operations is reviewing how to decommission these roads;

C-22 A Risk Sensitivity Map was developed as Figure 5.1. The map is important in that it provides the areas of high, moderate and low risk for contamination through the water network to the District of Summerland intakes. The watershed riparian areas of highest risk are located between the Trout Creek intake and Thirsk Dam and Darke Creek beyond the agricultural activities;

C-23 Summerland has several barriers in place to reduce the risk of contamination in the drinking water. These barriers include the Water Treatment Plant, the setting and buffering time provided by the large storage reservoirs and the best management practises by stakeholders in the watershed, whose practices and regulations are working (Forestry);

C-24 Risk priority for Summerland was developed based on the contaminants found and the contaminant location in relation to the risk sensitivity map. The results are presented in Figure 5.2 and A.2 (larger scale);

C-25 Table 5.1 provides a summary of 24 sites of where the highest risks located. The majority of risks present are due to range activities along the section of Trout Creek between Thirsk Reservoir and Summerland's Trout Creek intake;

C-26 The greatest number of present risks facing Summerland is related to range activities with no buffers or setbacks from the lower reaches of Trout Creek. Coordination will be required with the Ministry of Forest and Range staff to review and work collectively to fence and reduce grazing and range activities along the lower reaches of Trout Creek;

C-27 Water quality monitoring is fairly thorough. The District is not yet collecting *Cryptosporidium* data, algae data or data on Halo acetic acids, which are a disinfection by-product.

8.0 RECOMMENDATIONS

Major recommendations of the Watershed Master Plan are as follows. Similar to the conclusions section, they are grouped into general categories for common reference.

Governance Recommendations

R-1 Although Summerland does not have jurisdiction on the majority of issues within their watershed, it is important to develop and maintain a healthy dialogue with the Provincial staff and MLAs on the issues and challenges that the District and the Province are collectively facing. Open and direct communication with the Provincial representatives is critical for identifying and resolving issues in the watersheds;

R-2 It is recommended that for private land issues, where the Regional District of Okanagan Similkameen has jurisdiction on land use, that the District of Summerland approach the RDOS to collaborate on bylaw and/or OCP language that would be protective in nature for the watershed;

R-3 With the Water Act Modernization (WAM) process underway, the District of Summerland should consider a submission to the province. Agreement with the outline in Section 2.6, Watershed Operating Principles should be considered for input to the WAM process. Licensing and/or permitting of groundwater withdrawals is worthwhile and should be supported;

R-4 Storage license adjustments are required for both Thirsk Reservoir and on Headwaters Reservoir-Lakes to make the stored volumes equivalent to the in-place constructed volumes;

R-5 Storage license adjustments are required to allocate sufficient water for Waterworks Local Authority purposes (domestic licensing). Should Summerland be successful in obtaining water licensing on Okanagan Lake, they would then have sufficient licensing for withdrawal for domestic purposes.

Groundwater Related Recommendations

R-6 Lining of the Trout Creek Balancing Reservoir is not recommended as the leakage and groundwater mounding from the Balancing Reservoir into the shallow aquifer in the area reduces the potential for landfill leachate migration into the water supply;

R-7 Continue to monitor water quality in the observation wells between the Landfill and Balancing Reservoir. Consider implementing automated water level monitoring and low level alarms into current SCADA system;

R-8 Investigate the potential of re-capturing lost water down-gradient of the Balancing reservoir for re-use in the irrigation system;

R-9 Mandatory provision of information [borehole logs] on all subsurface investigations completed within the catchments contributing runoff to Summerland should be implemented. Geo-exchange boreholes should be inspected to ensure that grouting is completed accordingly.

R-10 No closed-loop or open-loop geo-exchange systems should be constructed in the area of the Balancing Reservoir, Landfill and Rodeo Grounds. RDOS and the District of Summerland should develop guidelines for geo-exchange that require closed loop geo-exchange systems to be inspected to assure they are grouted for the full length of the borehole;

R-11 The entire Trout Creek channel section between the Rodeo Grounds (Summerland intake) and Thirsk Reservoir should be designated as a surface water and groundwater protection area and travel speeds on the roadways should be reduced in the areas nearer to the creek;

R-12 An overall Watershed Management Plan, which incorporates surface water and groundwater withdrawals in the upper part of the Trout Creek Catchment, is critical. Such a plan will require coordination with the Provincial Government under the Groundwater Protection Regulation (part of the BC Water Act), as groundwater withdrawals are currently not regulated in BC. However, the Province can designate and area for groundwater management, if conditions warrant. The Trout Creek Catchment is an excellent location for the Province to consider as a Pilot.

Source Protection Recommendations

R-13 Timber harvesting licensees have not historically managed forest cut-blocks in terms of fire risk reduction. Developing of defendable forest guards through managed cut-blocks should be discussed with the forest licensees to see if there is the potential to reduce the risk of a large devastating fire in either of Summerland's watersheds. A plan that requires management of forest stands, fuel reduction management in interface areas, and protects Summerland's infrastructure and water sources is a large undertaking and must be done in conjunction with the Ministry of Forests and possibly other stakeholders. The end objectives for this type of work protects both the interests of the community and the forest licensees;

R-14 District of Summerland should only lobby the Province to stop the sale of lease lots if the leased lot owners are applying pressure to purchase them. Rather than conflict, more responsibility and

controls should apply for the occupancy of leases around the Reservoir-Lakes. An application to the Crown should be considered for a 200m covenant around the Reservoir-Lakes foreshore to protect these water reservoirs in perpetuity;

R-15 Summerland should pursue a working partnership with the Reservoir-Lot lessees. The basis for such a partnership should be to protect source water quality and maintain the health of the natural eco-system. This is in both groups interests. The incentive would be that Summerland would support the lessee's objective to have lease costs reduced to previous levels, and the lessees would not pursue ownership of the lots but rather maintain them to the highest possible standards. In partnership with Summerland the lessees would share the caretaker's responsibility of watersheds with the District of Summerland;

R-16 Although present, gravel extraction is not a critical issue in the watersheds as the District control the largest pit in the area immediately west of the Water Treatment Plant. It is recommended that Summerland utilize the Red-Yellow-Green designations for gravel pit extraction, should any other pits be proposed for development in the watersheds;

R-17 Algae and full parameters sampling is recommended at three district reservoirs during the mid and late summer. The sites are Thirsk Reservoir, Headwaters No. 1 Reservoir, and Garnet Reservoir;

R-18 Sampling for halo-acetic acids are recommended in the water distribution system after disinfection for both the Garnet and Summerland water distribution systems. Monitoring is recommended 4 times per year;

R-19 *Cryptosporidium* monitoring is recommended on water from the Garnet Reservoir outlet when *E.Coli* counts are highest. The potential for its presence is highest if fecal matter is found in the raw water;

R-20 The highest probable risks to Summerland's drinking water are listed in Table 5.1. Twenty four (24) risk locations are provided in the table. All of the issues require attention. Many of the issues will be dependent on coordinated efforts with Provincial Ministries and other existing watershed stakeholders;

R-21 For the cattle and range issues, work proactively with the Ministry of Forest, Range and Natural Resource Operations staff. Their staff is available to work through risk reduction methods for cattle activities including range practices, liaison with the range lessees, and installation of cattle guards and fencing at appropriate locations;

R-22 The data and locations provided within this report should serve as a guideline with the Ministry of Forest, Range and Natural Resource Operations for the cattle lessees to identify and start to work to improve riparian setbacks and cattle activities in relation to the creeks;

R-23 Sampling should be conducted for *E.Coli* in Trout Creek and on Darke Creek, above and below the community of Faulder. This is to determine if there is any septic tank seepage to the creeks from the 100 or so homes in that community;

Development of additional storage is not required for the foreseeable future, however should the frequency of drought cycles increase, Summerland should revisit the timing of the development of additional water storage sites in the upper watershed.

1. INTRODUCTION

1.1 GENERAL

The 2008 Water Master Plan provides a comprehensive working outline for the District of Summerland with respect to water supply issues, projects, financing requirements, toll rate adjustments, and setting of Development Cost Charge rates.

The intent of this document is to provide some foresight to the District of Summerland to manage their water resources effectively now and for the foreseeable future. This is a stand-alone document that compliments the 2008 Water Master Plan that was prepared for Summerland by Agua Consulting Inc. in 2008.

Spillway at Thirsk Dam flowing

The District of Summerland is fortunate to have access to several sources of water including Eneas Creek, groundwater, Okanagan Lake, and Trout Creek, which is the second largest watershed feeding Okanagan Lake.

The primary objectives of this report are to:

- Review activities within the community watersheds and make recommendations for improving management for the protection of those resources;
- Conduct a source water assessment in conformance with the 2009 Conditions on Permit that were issued by the Interior Health Authority. This involves completing Modules 1, 2, 7 and 8 of the Comprehensive Drinking Water Source to Tap Assessment Guideline;
- Characterize the risks to drinking water and make recommendations for corrective measures;
- Provide recommendations for a watershed monitoring plan;
- Carry out a review of District of Summerland watershed infrastructure including all dams and reservoirs, suitable for annual submission to the Dam Safety Branch. Include costs for maintenance and upgrades;
- Provide input for improved management of the watershed considering all activities, all stakeholders, and all government agencies with jurisdiction on activities within the watershed;
- Summarize the findings in a comprehensive and functional report.

1.2 WATERSHED ISSUES TO BE ADDRESSED IN THIS REPORT

The primary issues facing Summerland's water sources were identified over the course of our investigation. As work progressed, additional issues came to light and were added to the scope of this report. The primary source issues include:

- **Source Protection Program:** Maintaining an effective measure of source protection and controlling pollution at its source. Water, like air, has the unique ability to be able to transport and diffuse contamination over a much larger area than where the pollution source may have originated. Developing conscious plans to contain pollution at its source is a primary watershed control issue;
- **Mountain Pine Beetle (MPB):** MPB is now entrenched in the District of Summerland watershed. There is a high percentage of pine in the watershed. What can be done by the water utility is included in this document;

- **Wildfire:** Wildfire potential is increasing due to the lack of natural fires and the ability of man to control and put out many of the fires that might otherwise burn uncontrollably. With the MPB infecting the pine stands in the Trout and Eneas Creek watersheds, the fuel load and potential for a major forest fire in the watersheds are increasing;
- **Recreational Activities**: Recreational activities will be increasing in the watershed. Camping, trail riding, (quads and motorcycles), hiking, hunting and fishing activities by the public increase with the density of persons in the Okanagan Valley. As the population increases, so too will the number of people accessing the watershed. It is noted that damage from mudboggers is still occurring within the Trout and Eneas Creek watersheds;
- **Sale of Leased Lots:** The leased lot owners have received substantial increases in their assessments and annual tax that they must pay for their leases. As a result, they have lobbied the Province to purchase the leases outright. This has led to conflict and opposition from all of the water utilities and many levels of local government in the Okanagan Valley;
- **Agriculture:** Agricultural activities, particularly the cattle that are in the range lands, are a known source of microbiological contamination to drinking water. In addition, there are the risks of pesticides and herbicides that can be applied to crops that may be present in the watershed;
- **Human Wastewater:** Septic tanks and human effluent contamination of the watershed is of concern. With human wastewater, there is the potential for contamination of personal care products and endocrine disrupters from pharmaceuticals which could be present at the parts per billion levels. Conventional water filtration plants offer little protection from these minute contaminants. These contaminants must be controlled at their source;

- **Forestry:** Forestry is a primary resource industry within the BC interior. Practices to respect the protecting riparian areas have substantially improved in recent years;

- **Climate Change:** Climate change has been verified through scientific measurements. The issue that is not understood is the impact that these changes will have on the water sources in our region. The current predictions are that the total annual precipitation may remain the same, however the amount of snowpack will be reduced and the arid seasons in the Okanagan may be lengthened. The impact of Global Warming on the watersheds is discussed in this report;
- **Algae Blooms:** With global warming, the potential exists for algae and nutrient level to increase in the upper watershed reservoirs;

- **Groundwater Contamination:** Natural levels of uranium are known to occur from within the lower aquifer in the Faulder area of the Trout Creek watershed. The levels of uranium are of concern with respect to community water supply;
- **Infrastructure Security:** Protection of the District water sources and water infrastructure from vandalism and damage is a concern. With the remoteness of the sites, reliance on the public to be part of the solution to patrol and report abuses will be a key strategy of future watershed management;
- **Mining/Gravel Extraction:** Recently, mining extraction applications have taken place and have been approved within the riparian setbacks without considering that the areas were in a community watershed.

These challenges must be dealt with by approaching them with knowledge and understanding of the mechanisms that are currently in place which are affecting the water-use habits of the ratepayers. These mechanisms and a future forecast for water supply for the valley are presented in Section 5 of this report. The mechanisms include such items as densification of housing forms; reduced agriculture in the region, metering and the price and value of water, long term sustainability, and full cost accounting.

1.3 WATER SUPPLY – GUIDING PRINCIPLES

Two sets of guiding principles were considered in the course of this report. One is the set of 12 Guiding Principles from the 2008 Water Master Plan. These are set out and are used in context with respect to overall water management. These principles, which are the foundation for the Okanagan Water Stewardship *Sustainable Water Strategy*, are summarized below.

Principle 1: Recognize the Inherent Value of Water

Principle 2: Control Pollution at its Source

Principle 3: Protect and Enhance Ecological Stability

Principle 4: Integrate Land Use Planning and Water Resource Management

Principle 5: Clearly Allocate Water within the Okanagan Water Budget

Principle 6: Promote a Basin-Wide Culture of Water Conservation and Efficiency

Principle 7: Ensure Water Supplies are Flexible and Resilient

Principle 8: Think and Act Like a Region

Principle 9: Collect and Disseminate Scientific Information

Principle 10: Provide Sufficient Resources for Local Water Management Initiatives

Principle 11: Encourage Active Community Engagement, Education and Participation in Water Management Decisions

Principle 12: Practice Adaptive Management

Source to Tap Assessment Principles

The second set of principles adopted were the Guiding Principles for Drinking Water Source to Tap Assessments that was included as Appendix 1A of Module 1, Introduction of the Ministry of Health Comprehensive Drinking Water Source to Tap Assessment Guideline. These principles are summarized below.

- Drinking water protection is a public health issue, hence drinking water assessments should focus on threats to public health;
- Drinking water assessments should be a tool to assist in the protection of drinking water;
- Drinking water assessments should be conducted in an integrated manner, with consideration for both source and system components;
- Drinking water assessments should embody the multi-barrier approach;
- Drinking water assessments should be an opportunity for education and communication among stakeholders;
- Drinking water assessments should be focused on preventing problems;
- Drinking water assessments should be science-based;
- Drinking water source assessments should be flexible and tailored to the size and type of water system and the level of risk to its users;
- Drinking water assessments should result in the development and implementation of specific actions and/or recommendations;
- Drinking water assessments should foster and promote the highest water quality possible through stewardship and involvement of the broader community.

It is noted that the Source to Tap Assessment Principles do not in any way conflict with the Guiding Principles of the Okanagan Water Stewardship Council for the Okanagan Valley.

1.4 UNITS / CONVERSIONS / TERMINOLOGY

Units used within this report are primarily metric. Volumes provided are in mega litres (ML) as the major valley-wide studies underway and trend provincially is towards utilizing mega litres as the primary volume unit. Areas are in hectares or square kilometres for the largest areas, and flow rates are provided in ML/day or L/s.

A Conversion Table is provided on the back inside cover of this report to convert metric units to Imperial and vice versa.

1.5 ABBREVIATIONS / DEFINITIONS

The abbreviations used in this report are listed on the inside of the front cover for easy reference. A Glossary of Terms is included in this report in Appendix F. The Glossary of Terms originates from the Province's *Comprehensive Drinking Water Source to Tap Assessment Guideline*.

1.6 ACKNOWLEDGEMENTS

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Project Team

- Robert Hrasko, P.Eng. — Agua Consulting Inc. (Hydrology, Regulatory and Project Management
- Antonio Faccini, P.Eng. — AF Consulting Ltd. (Spatial, Mapping, Risk Documentation)
- Remi Allard, MSc., P.Eng. — Hydro geologist (Hydrogeology, Groundwater risks)
- Bruce Wilson — Agua Consulting Inc. (Field Investigations, Risk ID)

Regulator Input

- Rob Dinwoodie — Ministry of Natural Resource Operations
- Duncan Watson — Ministry of Natural Resource Operations – Range Agrologist
- Rob Birtles — Interior Health Authority – Drinking Water Specialist
- Solvej Patschke — Ministry of Environment

2. STAKEHOLDERS AND WATERSHED GOVERNANCE

2.1 INTRODUCTION

This section provides a summary of the provincial agencies with statutory authority for activities within the watersheds, the Regulations and Acts that they follow and the activities that they oversee within the watersheds above Summerland.

2.2 STAKEHOLDERS

A listing of the involved stakeholders with some role in the watersheds is provided in Table 2.1. The list includes government regulatory agencies, private utility companies, First Nations, other water utilities, forestry and range licensees, cabin owners and local recreational groups that are active in the watersheds. Table 2.1 provides for each stakeholder their area of responsibility, their impact, and comments on what might be improved.

There are some nine Provincial ministries with impacts on the raw water supply, two Federal agencies, a regional district, a large utility company, and several stewardship groups that are active in the watershed. The District of Summerland is the stakeholder with the highest attention and focus to source water protection and has the highest risk potential as they are dependent on the water resources for the community water supply. The District could be considered the caretaker of the water resources in the Trout and Eneas Creek watersheds.

A key concept that is stressed within this document is to place the onus of responsibility on the users within the watershed. Any new activity within the watershed should be given the responsibility to prove that they have no negative net effect on the natural resources of the watershed. It should not be the responsibility of the water utility to collect water quality data to prove that the new activity is harming the natural water resources of the watersheds.

There are many activities permitted within the community watersheds that can be harmful to maintaining a high quality drinking water source. A focus on education and adjusting processes at the start of an activity rather than at later stages is recommended.

"Make Everyone within the Watershed a Stakeholder"

A precautionary principle must be adopted for watershed management throughout the Province. The principle is simply that the burden of proof falls on those proposing an activity that could potentially harm the environment of the public. If the new activity is required to provide the burden of proof, they are forced to invest in monitoring and maintaining the natural resource and become more respectful of the environment.

Table 2.1 - Summerland Watershed Stakeholders and Related Legislation

Agency	Legislation	Area of Responsibility	Comments on Location and Impact
Federal			
DFO - Department of Fisheries	Federal Fisheries Act	Sets requirements for fish flows in lower Trout Creek	Only involved in Lower Trout Creek, works in conjunction with MOE, competing interest is volume with DoS
INAC - Indian and Northern Affairs		Regulator for Penticton Indian Band infrastructure	Regulator overseeing PIB
ONA - Okanagan Nation Alliance	Federal , Indian Act	Oversees collective first nations concerns within the Okanagan region	Coordinating agency for Okanagan Indian Bands. Independent from bands, and acts in areas where local band may not have expertise
PIB - Penticton Indian Band	Federal, Indian Act	Has land use controls and activity within Trout Creek watershed. Oversees band locatee activities	Trout Creek watershed immediately above intake, has range activity along creek. May have interest in accessing HQ drinking water from DoS
Provincial			
MOE - Ministry of Environment	BC Provincial Water Act	Water Licensing	Issues licenses for water withdrawals
MOE - Ministry of Environment	BC Provincial Water Act, Provincial Fisheries Act	Fisheries in Watershed Creeks and Lakes	Has downstream requirements for DoS to meet in lower Trout Creek
MOE - Ministry of Environment	BC Provincial Water Act, Drinking Water Protection Act	Raw Water Quality	Concerns related to releases and flows in creeks. Common goal of maintaining highest possible raw water quality
MOE - Ministry of Environment	Water Utilities Act	Issuing of new Utility licenses	Any new small utility application (none)
MOE - BC Parks		Provincial park use	Darke Creek and Eneas Lake Prov.Parks
MoAL - Ministry of Agriculture and Lands	Farm Practises Protection Act (Right to Farm act), Range Act	Range Licensee for Cattle, advisor to Agriculture activities in watershed	Range and agricultural activities in watershed
ALC - Agricultural Land Commission	Agricultural Land Commission Act	Authority on agricultural land zoning in BC, overrides municipal authority	ALR lands are limited in this watershed. ALC controls land use which overrides Provincial authority
MOT - Ministry of Transportation	Ministry of Transportation and Highways Act, Rail Safety Act, Transportation Act	Authority on primary roads in Regional District areas	Trout Creek watershed roads
MoHLS- Ministry of Healthy Living and Sport	Public Health Act Drinking Water Protection Act	Authority on provincial health regulation with respect to water - delegates authority down to the Health Authorities	Delegates authority to Interior Health Authority
MOTCA - Ministry of Tourism, Culture and the Arts	Delegated authority through Forest and Range Practices Act	Authority for off-road vehicles and Recreational Sites, Forestry campgrounds, Trans-Canada Trail	Reviews applications for recreational activities, trail riding may have soil disturbance effects
MOF - Ministry of Forests and Range	Forest Act, Forest and Range Practices Act, Ministry of Forests Act, Ministry of Forest and Range Act, Wildfire Act	Awards timber licenses to Forestry Companies, reviews and considers forest health	Forestry activity falls under Forestry section, cattle and range licensees fall under range section, Forestry roads, Forest fires
MCRD - Ministry of Community and Rural Development	Local Government Act , Ministry of Municipal Affairs Act	Oversees local governments and their activities	Approvals for borrowing, bylaws, etc for DoS
MEMPR - Ministry of Energy Mines and Petroleum Resources	Mining Act, Ministry of Energy, Mines and Petroleum Resources Act, Petroleum and Natural Gas Act	Approval Authority for Gravel Pits and Mining Activity	Oversees gravel pits and mining claims

Table 2.1 - Watershed Stakeholders and Related Legislation (continued)

Agency	Legislation	Area of Responsibility	Comments on Location and Impact
Regional Authorities			
IHA - Interior Health Authority	DWPA - Drinking Water Protection Act Drinking Water Protection Regulation	Delegated authority on Drinking Water Protection	Drinking water to Faulder and to DoS
IHA - Interior Health Authority	Sewerage System Regulation	Authority for Septic Tank and tile field installations	Septic systems throughout Faulder
RDOS - Regional District of Okanagan Similkameen	Local Government Act	Responsible for land use decisions on Private lands in lower part of watershed.	Faulder land use, private lands land use
District of Summerland	Local Government Act	Operates water storage facilities in the watershed, licenses have requirement for release of flow to lower Trout Creek	Controls great deal of flow in mainstem of Trout Creek
Meadow Valley Irrigation District	Local Government Act	Draws water off from Darke Creek and has storage at Darke Lake.	
BC Hydro	Utilities Commission Act, BCUC	Electrical Transmission towers in watershed	
Stakeholders			
Cabin Owners	MoFR leases	Cabin leases at Headwaters, OCOA is organized format for them	Septic and poor land use practices if riparian area is not respected
Local Fish and Game Clubs	Wildlife Act		
Trail Riders		Not Organized in this watershed	
Bobtail Ranch (RAN074038)	Farm Practises Protection Act (Right to Farm act), Range Act	Range Leasee	Area south of Trout Creek
T- 6 Ranch (RAN075502)	Farm Practises Protection Act (Right to Farm act), Range Act	Range Leasee	Both sides of Trout Creek
Glen Johnson (RAN075654)	Farm Practises Protection Act (Right to Farm act), Range Act	Range Leasee	Trout Creek Ranch
Dave Casorso (RAN075493)	Farm Practises Protection Act (Right to Farm act), Range Act	Range Leasee	Headwaters Area
Tolko Industries	FRPA	Forest Leasee from Provincial Government	
Gormans Forest Products Ltd.	FRPA	Forest Leasee from Provincial Government	
BC Timbers Sales	FRPA	Forest Leasee from Provincial Government	
Snowmobile Club		Not Organized in this watershed	
Kettle Valley Railway	Rail Safety Act	Rail tours along Kettle Valley Railway	

2.3 ACTS AND REGULATIONS

As illustrated in Figure 2.1, there are many pieces of Provincial and Federal legislation that have an impact on water quantity and water quality. Several of the Acts are designed to protect the natural resources. These include the Water Protection Act, the Drinking Water Protection Act the Environmental Assessment Act. Alternately, many of the Acts and Regulations are designed for end purposes that may not be conducive to the protection of the water resource. With the conflicting objectives, the conflicts must be resolved prior to the activity proceeding, however, this isn't always the case.

Figure 2.1 - Provincial and Federal Water Related Legislation

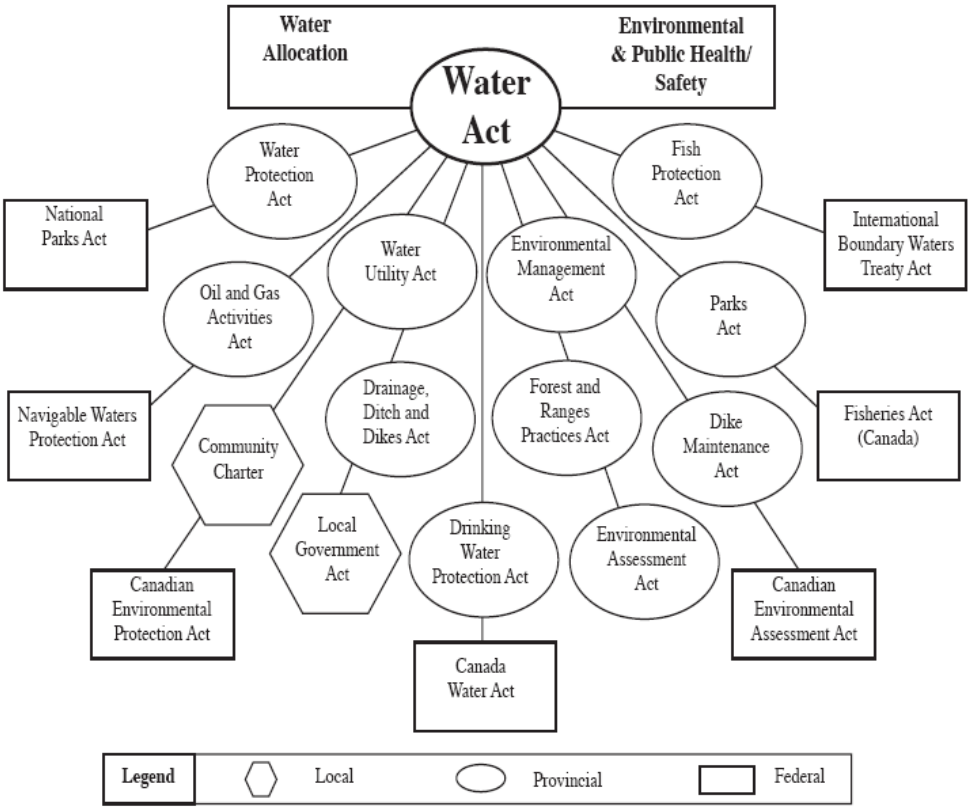


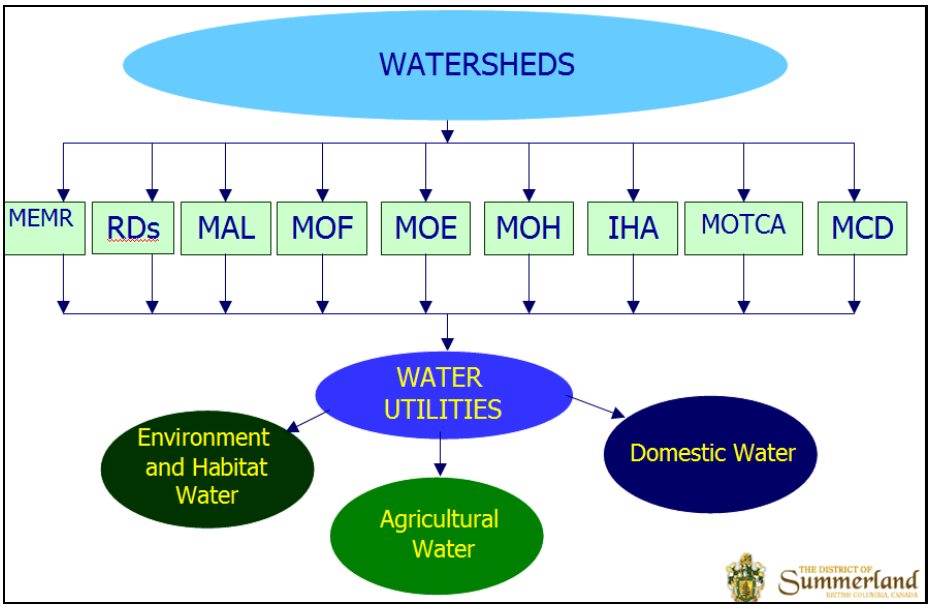
Figure Source: Polis Project Discussion Paper 09-02, May, 2009

There are additional Provincial Acts to those identified in Figure 2.1 that have an impact on water resources, including the Forest and Range Practises Act.

2.4 WATERSHED GOVERNANCE

The governance of provincial crown lands and community watersheds is complicated. The responsibilities and legislation of various Provincial Acts and Regulations often results in land use decisions that conflict with what might be best management of the water resources. The result is that the front-line agency, which in many cases is the local water utility, must interpret and work with numerous agencies for varying issues that arise within the watersheds.

Figure 2.2 - Regulatory Agency Involvement in Watersheds



2.5 WATER ACT MODERNIZATION (WAM)

The Province has begun the process for modernizing the Water Act. The WAM process is focused on four primary areas:

1. Providing for improved stream and ecosystem health;
2. Reviewing and modifying Water Governance;
3. Reviewing and revising the Water Allocation Process;
4. Adjusting and either licensing or permitting Groundwater extractions.

Governance has been discussed at the Provincial level with several reports to the Province in recent years. In the Okanagan, the Okanagan Basin Water Board has taken a stronger leadership role in the coordination of valley-wide water issues. In the last 30 years, the focus for the OBWB has been to improve wastewater treatment capability of the community wastewater treatment plants. This has resulted in reduced nutrients levels reaching the valley lakes. Recently, the role by OBWB is based on a consultative, partnership approach focused on protecting the source water. Drinking water challenges with respect to treatment is considered to be a local utility issue that varies across the basin, depending on the community.

2.6 WATERSHED OPERATING PRINCIPLES

Watershed operating principles should be formalized between the primary local watershed stakeholder and the Province of BC. These principles already exist and are practices in some of the more forward thinking regions, but these principles needs the focus, attention, and leadership by the Provincial staff. Each primary stakeholder has the responsibility to look after their watershed with the collective support of the other stakeholders, the Province in a leadership and regulatory role, and the utilities and water supply associations in a supportive role. The actual operating principles to adopt within watersheds include:

- Local attention, local responsibility and vigilance in protection;
- Centralized rules, leadership and expertise in specialized roles such as water allocation;
- Assignment of one operator per watershed to operate dams, reservoir releases and flows in the sub-basin creeks;
- Education to the public that it is "*not a right to be able access the watershed areas, it is a privilege to be respected*";
- Utilize local stewardship, local action, local care, with regional support and coordination, and strong and centralized Provincial legislation and regulation;
- Respect of other water suppliers and water supply agencies, respect differences;
- Build in resiliency into the water supplies. Develop more than one source water per utility;
- A precautionary principle must be adopted for watershed management throughout the Province. The principle is simply that the burden of proof falls on those proposing an activity that could potentially harm the environment of the public. As the new activity strives to provide the burden of proof, they invest in maintaining the natural resource and become respectful of the environment.
- The requirement for collecting baseline water quality information should be collected by the local watershed stakeholders, but the responsibility lies with the new activity to prove no impact rather than remediating a problem later.

2.7 INTERIOR HEALTH AUTHORITY REQUIREMENTS

Currently, for the delivery of safe water, the District of Summerland is obligated to meet the criteria as stated in the Drinking Water Protection Regulation, BC Reg. 200/2003. This regulation sets out the standards for water supply by public and private utilities in their supply of water to the residents of BC. Requirements of the Drinking Water Protection Regulation include the following items:

- Operating Permits for all utilities with specific requirements for each;
- Qualification standards for personnel operating water systems;
- Emergency Response and Contingency Plans for utilities;
- Water Quality Monitoring requirements;
- Water Source and System Assessments, and;
- Drinking Water Protection Plans.

The Drinking Water Officer authority is delegated by the Province to the local health authorities and this responsibility lies with an appointed Medical Health Officer. The Interior Health Authority has stated in their Conditions on Permit for the District of Summerland that they expect that the following conditions water quality targets be achieved by all larger water utilities in the Southern Interior.

- 4 log (99.99%) removal and/or inactivation of Viruses;
- 3 log (99.9%) removal and/or inactivation of *Giardia Lamblia and Cryptosporidium;*
- 2 types of treatment processes including at least one form of disinfection;
- < 1.0 NTU Turbidity units year round;
- 0 *Fecal Coliforms* in the distribution system.

In addition to the 4,3,2,1,0 Protocol Criteria, a Water System Assessment Plan is required by the IHA. The purpose of an assessment is to identify, inventory and assess:

(a) The drinking water source for the water supply system, including land use and other activities and conditions that may affect that source;
(b) The water supply system, including treatment and operation;
(c) Monitoring requirements for the drinking water source and water supply system; and
(d) Threats to drinking water that is provided by the system.

The IHA has stated that they require that Modules 1, 2, 7 and 8 of the Province's Source to Tap Assessment be carried out for the District of Summerland sources.

Modules 1 and 2 These sections include the assessment and delineation of the water sources, mapping, area, volumes of runoff and quality of that raw water runoff to be documented with all of the available information. Impacts on the quality and quantity are to be understood and defined in these sections.

Module 7 Within Module 7, a list of potential drinking water risks that may impact on the District water sources are to be defined.

Module 8 Recommendations with respect to source protection, future source development and water treatment upgrades are to be developed within the works required in Module 8.

MULTI-BARRIER APPROACH

A primary objective for the development of a safe water supply is to implement a multi-barrier approach. A multi-barrier approach is defined by Health Canada as follows:

The key to ensuring clean, safe and reliable drinking water is to understand the drinking water supply from the source all the way to the consumer's tap. This knowledge includes understanding the general characteristics of the water and the land surrounding the water source, as well as mapping all the real and potential threats to the water quality. These threats can be natural, such as seasonal droughts or flooding, or created by human activity, such as agriculture, industrial practices, or recreational activities in the watershed. Threats can also arise in the treatment plant or distribution system thanks to operational breakdowns or aging infrastructure.

The multi-barrier approach takes all of these threats into account and makes sure there are "barriers" in place to either eliminate them or minimize their impact. It includes selecting the best available source (e.g., lake, river, and aquifer) and protecting it from contamination, using effective water treatment, and preventing water quality deterioration in the distribution system. The approach recognizes that while each individual barrier may be not be able to completely remove or prevent contamination, and therefore protect public health, together the barriers work to provide greater assurance that the water will be safe to drink over the long term.

Part of the multi-barrier approach is to carry out Source to Tap Assessments as set out by the Ministry of Health in their *"Comprehensive Source to Tap Assessment"* modules.

Within Section 4 (Module 2), the potential and field noted risks are to be identified. Within Section 3 of this report, a multi-barrier approach is listed as the recommended approach for risk management for drinking water supplies. The multi-barrier approach has six forms of barriers. They include:

1. Source Protection:
2. Appropriate Water Treatment
3. Water System Maintenance
4. Water Quality Monitoring
5. Operator Training
6. Emergency Response Planning

These six barriers are enabled by three supporting mechanisms:

1. Sound water supply management
2. Affordability
3. Effective Governance

3. WATER SOURCE CHARACTERIZATION (MODULE 1)

3.1 INTRODUCTION

The information provided within this section is developed to address Module 1 – Delineate and Characterize Drinking Water Source, within the Provincial Comprehensive Source to Tap Assessment Guidelines. This section generally defines the natural hazards present in the Summerland watersheds.

Recently, a Hydrological Risk Assessment was carried out for Trout Creek for the Ministry of Environment by Grainger and Associates. The hydrological risk assessment focused on overall water quality objectives and impacts due to changes in stream flow. Water quality changes due to flow regime variation were presented and it was noted that additional investigation would be required to address all of the concerns in the Provincial Source to Tap Assessment Guidelines and the requirements of the Drinking Water Regulator.

This report focuses on specific drinking water risks and the watershed influences that specifically influence drinking water quality and safety. The works in this section include:

1. Delineate the contributing watershed;
2. Define the assessment area;
3. Characterize the watershed and/or water body; and
4. Evaluate the integrity and location of the water intake.

The District of Summerland relies on three separate sources of water, but only two of the sources, Trout Creek and Eneas Creek are consistently used. Groundwater is used intermittently as a drinking water source only when the levels of water in storage are lower than seasonal averages. For the works carried out in this section, a description is provided for both Trout Creek and for Eneas Creek.

3.2 DISTRICT OF SUMMERLAND – EXISTING WATER SOURCES

The District of Summerland access water from three sources:

1. Trout Creek - approximately 90% of the total annual supply;
2. Eneas Creek - approximately 10 % of the total annual water supply;
3. Groundwater – Two wells at the Rodeo Grounds (addressed in Appendix B)

Trout Creek Source

The Trout Creek raw water supply currently meets the water quality criteria standards set by the IHA for the majority of the year. The new water treatment plant (WTP) achieves the goals for water demand up to 75 ML/day. There can be times during the summer months when water demand is above 75 ML/day and unfiltered water is forced to bypass the WTP. This results in inadequate disinfection/inactivation of *Cryptosporidium,* elevated trihalomethanes levels in the disinfected water, and elevated turbidity for these brief periods of time. Works are underway to separate off large areas of irrigated lands from the domestic

water distribution system so that water demands on the Water Treatment Plant do not exceed plant capacity.

The future plan is to have all water quality upgrades by the District of Summerland meet the IHA requirements for domestic water. Water quantity and water quality data for Trout Creek is included in Appendix C of this report.

Eneas Creek Source (Garnet Reservoir)

Water supplied from Eneas Creek is of generally good quality, but does not meet the IHA requirements for two types of treatment or protection from *Cryptosporidium*.

From the Garnet Reservoir source, due to the long retention times of water in Garnet Reservoir, and the high influence of groundwater in supplying source water to the reservoir, the levels of *Giardia* and *Cryptosporidium* occurrence are expected to be very low. Water supplied through the Eneas Creek system is in the range of 15 ML/day during maximum day summer demands.

Table 3.1 provides a summary of compliance with the 4,3,2,1,0 Protocol Criteria set out by the IHA.

Table 3.1 Summerland Treated Water Quality - 4,3,2,1,0 Compliance Summary

IHA Protocol	Description	Trout Creek	Garnet Reservoir	Rodeo Ground Well	Okanagan Lake (Proposed)
4	4 log (99.99% inactivation/removal of viruses)	Achieved by chlorination	Achieved by chlorination	Not applicable	requires chlorination
3	3 log (99.9%) inactivation/removal of Protozoa	Is in compliance for flows up to 75 ML/day through WTP	**Not achieved, background risk is low but requires additional treatment**	Not applicable	requires Cl_2 and UV disinfection to achieve protection
2	2 types of treatment	In compliance for flows under 75 ML/day	**Presently only chlorination is implemented**	Not applicable	UV and Cl_2 are technically sufficient
1	< 1.0 NTU Turbidity	Same as above	usually less than 1.0 NTU, rarely above 5.0 NTU	Achieved	would be achieved
0	0 Total and E.Coli bacteria	Achieved	Achieved	Achieved	would be achieved
	Area of concern		**Out of Compliance**		

4 log Virus Inactivation Four log virus inactivation and three log bacteria inactivation is achieved at both surface water sources.

3 log Protozoa Inactivation With the new WTP, three log *Giardia* and two log *Cryptosporidium* inactivation / removal will be achieved as per USEPA rating criteria for WTP removal credits. This is applicable only for the Trout Creek water source when flows are less than WTP capacity. *Giardia* inactivation is achieved for the Garnet Reservoir source as the chlorine contact time is sufficient to the first user on the system. *Cryptosporidium* inactivation is not achieved for the Garnet water supply.

2 Types of Treatment Chlorine provided at both surface water sources. The Summerland WTP is a Actiflow process that adds a sand ballast to assist in the removal of particulate matter. The USEPA gives conventional filtration treatment processes 2.0 log credit for the removal of *cryptosporidium*. Chlorination follows the Actiflo process. Additional treatment is required at Garnet in order to meet the IHA protocol.

< 1.0 NTU Turbidity Units For both surface water sources, less than 1.0 NTU is not reliably achieved. Normal turbidity levels are in the 1.5 to 3.0 NTU range. For Trout Creek, the turbidity levels will be below 1.0 NTU with the exception of short duration runoff events that are normally bypassed. The spring freshet is also reliably reduced to below 1.0 NTU. A natural level of turbidity in Trout Creek during the winter months is less than 0.40 NTU.

0 Total Coliforms and *E.Coli* Bacteria Chlorine provided at both surface water sources and contact times are sufficient to disinfect all viruses, bacteria and *E.Coli*.

This source water assessment does not change or improve any of the above conditions, but does provide insight into the risks that will be challenging the disinfection and treatment processes in place by the District of Summerland water system.

3.3 DELINEATION OF WATERSHEDS AND ASSESSMENT AREA

Figure 3.1 sets out the watershed catchment boundaries for both Trout Creek and Eneas Creek. The intake locations are identified, as are the channel reaches for the creeks, the reservoir storage locations, the creek sub-basins, and general areas of the watersheds. For the purposes of this assessment, the entire watershed was reviewed and the investigative works were conducted throughout the entire watershed. Like air, water has an enormous ability to convey contaminants throughout the environment. For the long term sustainability of the watershed, a comprehensive review of the entire hydrological area was conducted.

Figure 3.1 also has kilometre markings (blue ticks) for the creeks as reference locations. These can be tied to GPS coordinates in the future if deemed to be necessary. A larger scale version of Figure 3.1 is provided in Appendix A as Figure A-1.

3.4 WATERSHED ELEVATION CONSIDERATIONS

Generally, for the BC Southern Interior, raw water quality improves with elevation. It is desirable that the water from the higher elevations be utilized for drinking water for the following reasons:

- High elevation lands generally have greater precipitation and more runoff water is produced per surface area (Hydrology Report, Okanagan Water Supply and Demand Study);
- At higher elevations there is generally less waste and man-made contaminants (roads, pipe discharges into lakes, septic tanks, etc.);
- Water is available by gravity for re-use downstream;
- Natural wildlife risks are lower and more manageable than man-made risks;
- Temperatures are lower at higher elevations so risks such as algae blooms would occur at a lesser rate than within warmer water bodies at lower elevations (Larratt Aquatic – monitoring of utility reservoirs in upper Mission Creek) ;
- Supply is more reliable as elevation increases and there is less evaporation and evapotranspiration (Hydrology Report, Okanagan Water Supply and Demand Study);

Quality improves as elevation increases with less organic content in the water, particularly at elevations over 1,600 metres.

3.5 TROUT CREEK WATERSHED CHARACTERIZATION

3.5.1 INTRODUCTION

Trout Creek is the primary water source for the District of Summerland. It is the second largest community watershed in the Okanagan with a catchment area of 759 km^2 at the mouth and 713 km^2 above the District of Summerland water intake. The watershed, located on the Thompson Plateau on the west side of Okanagan Lake, has elevations ranging from 623m at the Summerland Intake to 1925m at the summit of Mt. Kathleen. The topographic relief through the water generating range of elevations is gently rolling hills with the surface gradients being moderate through most of the watershed. The Trout Creek watershed includes all lands above Thirsk Reservoir and the local creeks contributing below Thirsk which include Camp Creek, Tsuh Creek, O'Hagen Creek, Lost Chain Creek, Kirton Creek, Fenton Creek, Bearspaw Creek, Bull Creek, Isintok Creek and Denike Creek.

There are many natural occurring hazards within the watershed that include:

- Wildfire;
- Pests such as the Mountain Pine Beetle (MPB) or Spruce Beetle;
- Areas of channel erosion (source of soil and nutrient loading to water source and subsequent algae blooms in downstream reservoirs). Inadequate rip rap or bank stabilization in streams (source of soil erosion, resulting in channel erosion and increased nutrient loading to downstream reservoirs);
- Algae blooms in the reservoir-lakes or natural lakes;
- Heavy rainfall or snowfall and landslides;
- Elevated turbidity due to natural events;
- Elevated TSS levels due to natural rainstorm and runoff events;
- Fecal matter from wildlife.

For the majority of these hazards, Summerland is subject to the natural occurrences. Characterization of the watershed follows.

3.5.2 TROUT CREEK WATER QUANTITY

The majority of runoff from the watershed comes from above the 50 percentile 1,400 metre elevation (Hydrology Report, Okanagan Water Supply and Demand Study). The average precipitation for the watershed is in the range of 550mm of which 60% occurs as snowfall in the winter months. The total average precipitation on the Trout Creek watershed is in the range of 415,000 ML per year. Of this amount only 83,370 ML is estimated to run-off and be available to support District of Summerland water demands and fish habitat in lower Trout Creek. This is only 20% of the total precipitation. The normalized water demand (averaged out for season and precipitation) for Summerland is 11,156 ML per year from Trout Creek. The average annual peak flow in Trout Creek is 23 m^3/s. The maximum flood recorded was 71.6 m^3/s occurring in 1972.

Data on water quantity availability and watershed reservoir characteristics is included in Appendix C. Other specific items related to watershed hydrology and quantity in Trout Creek is also provided in Appendix C.

These items include:

- Water availability;
- Watershed hydrological information from all storage reservoir catchment areas;
- Drought considerations for the watershed;
- Water that is considered to be unavailable for use by the district, either due to losses to ground or atmosphere.

Precipitation – Runoff Relationship

One concern with the conclusions of the earlier studies regarding the impacts of Mountain Pine Beetle (MPB) on the hydrology is that potential for the underestimation of the impacts of the MPB. If the forest cover is substantially impacted, the ability of the watershed to absorb or evapotranspire the moisture is reduced. If this mechanism is impacted by as much as 5% (20,000 ML), there would be a notable difference in the total annual flow in Trout Creek (20% increase). If the mechanism is a 10% change (40,000 ML), then the runoff change is Trout Creek would be 50%. There is an exponential relationship between the amount of precipitation and how the water is redistributed into the environment through evapotranspiration and runoff.

The ability for the watershed to absorb and then redistribute the water is a key mechanism that requires further study. The ability for water management experts to model these relationships is improving.

3.5.3 TROUT CREEK CHANNEL STABILITY

The April 2009 Grainger report provided a review of the channel stability in Trout Creek. The channel reaches are identified in Figure A-1 in Appendix A of this report. The stream lengths, stream gradients, catchment area of the stream, volume production of the stream, and channel sensitivity are listed in Table 3.2. The steeper the section of channel and the higher the potential for runoff, the greater the stream reach sensitivity. With increased grade and runoff come increased erosion, increased turbidity and nutrient contribution to the stream, and water quality degradation.

Table 3.2 – Trout Creek Watershed Creek Stability Characteristics

Sub Basin	Reach	Stream Length (km)	Gradient (m/m)	Sediment	Catchment Area (km2)	Runoff (m3/km2)	Channel Sensitivity
Lower Trout Creek (Intake to above Lost Chain)	2 - 7	17.1	0.02	Transport	185.3	Low	Moderate
Lower Trout Creek (above Lost Chain to Thirsk)	8 - 12	10.2	0.01	Dep/Source		Low	High
Darke Creek	1 - 7	14	0.01	Depositional	76.6	Low	Low
Isintok Creek	1 - 6	12.6	0.07	Source	45.4	Moderate	Low
Bull Creek	1 - 2	12	0.07	Source	47.7	Moderate	Low
Bears Paw Creek	1 - 3	10.3	0.08	Source	22.3	Moderate	Low
Lost Chain Creek	1 - 4	8.7	0.08	Source	40.7	Moderate	Low
Tsuh Creek	1 - 3	6.9	0.09	Source	17.8	Moderate	Low
Camp / Chapman Creek	1 - 2	9.9	0 .07	Source	36.7	Moderate	High
Upper Trout (above Thirsk)	13 - 17	19.5	0.01	Trans/Dep	142.8	High-Mod.	Moderate
North Trout (NW corner of watershed)	1 - 3	14	0.03	Source	50.9	High	Low
Headwaters (above HW Lake)	18-21	6.8	0.06	Source	49.9	High	Low

The channel gradients of the sub-basin creeks are much higher than the primary creek channels. The Grainger Report identified problematic areas in Camp Creek and in Lower Trout Creek immediately below Thirsk Reservoir.

Camp Creek has existing problems with aggradation and reduced channel capacity with compromised riparian areas. Lower Trout Creek has channels with erodible banks and areas where the floodplain can erode. The riparian area along these channel sections has been compromised.

3.5.4 TROUT CREEK FOREST COVER AND DEVELOPMENT

The bio-climatic zones for the region include the designations of Bunchgrass, Ponderosa Pine, Interior Douglas Fir, Montane Spruce and Engleman Spruce Sub-alpine Fir. The Montane Spruce, Engleman Spruce Sub-alpine Fir, and Interior Douglas Fir are the most predominate zones. Soils are generally coarse grained and moderately well-draining. The forest cover and soil types have a notable impact on the water quality that is produced by the watershed. The levels of organic material and Total Organic Carbon are lower than similar elevations elsewhere in the Okanagan. The colour level of the source water is generally lower than in similar elevation watersheds within the Okanagan Basin.

The well-draining soils and the surface cover are the predominate factors that affect the water quality parameters. It is possible that there is a higher percentage of water that infiltrates to the ground and then recharges the creeks at lower elevations in the watershed. A higher groundwater component could explain the lower colour and organic levels in the raw water. Consistent with the colour and TOC levels is that the UV transmissivity numbers for the watershed are higher than other watersheds in the region. This means that there is less organic material absorbing the UV light.

3.5.6 TROUT CREEK RAW WATER QUALITY

There are several raw water quality parameters that provide an indication of the source water quality. The parameters include the following:

Algae Counts: Algae is naturally present within the watersheds and high elevation reservoirs. The types of algae and levels of algae vary, depending on activities in the watershed, nutrients, soils, sunlight, and the environment. The most dangerous one is cyanobacteria (blue-green algae) which are known to form neurotoxins when reacting with chlorine in the disinfection process. Algae levels historically have not been monitored or measured in the upper elevation reservoirs in Trout Creek. Desired counts for algae are to remain as low as possible in the raw water. The AWWA recommends the following alert system be utilized for lakes that have a history of cyanobacteria blooms:

- **Alert Level 1** - Cyanobacteria biomass > 500 but < 2000 cells / mL
  Taste and Odour problems may occur, Move from Weekly to twice per week algae monitoring
  (cyanotoxin poisoning risk is low)
- **Alert Level 2** - Cyanobacteria > 2000 cells / mL but < 15,000 cells / mL
  Perform jar tests with powdered activated carbon and with an oxidant (chlorine, etc.)
  Develop treatment and monitoring contingency plan
  (cyanotoxin poisoning risk is low)

- **Alert Level 3** - Cyanobacteria > 15,000 cells / mL (6,500 cells / mL M. aeriginosa)
  Toxin presence is likely – implement contingency plan
  Monitor and analyze for algal toxins through the water treatment process until cell numbers drop below 2000 cells / mL
  (cyanotoxin poisoning risk is moderate)
- **Very High Risk** - Cyanobacteria biomass > 100,000 cells / mL of a toxin producing species
  Toxin presence at levels that impact human health probable
  (cyanotoxin poisoning risk is high)

As Health Canada and the Provincial Regulator have no rigid standard for this water quality parameter, it is recommended that the alert system recommended by AWWA be implemented.

Colour: True colour which is the colour after the water is filtered through a 0.45 micron filter, is an aesthetic parameter. Although it does not have an immediate impact on health, it is an indicator of the possibility of there being high organic levels within the raw water. Levels below 15 True Colour Units (TCU) are desired in the treated water at all times. The level of colour for raw water from Trout Creek has averaged 14.1 TCU for the last 8 years. Chlorination can bleach the colour, but the result can be the formation of chlorinated disinfection by-products such as trihalomethanes (THMs) or Halo-acetic Acids (HAAs). High colour water can also have taste and odour issues associated with them.

Total Coliforms: Total coliform measurements provide an indication of the level of bacteria in the source water prior to disinfection. The higher the number, the greater the need for enhanced treatment and reliable and adequate disinfection processes. A number less than 100 CFU/100 mL is desired at all times in the raw water prior to disinfection. The historic levels in the Trout Creek source water are illustrated in Figure 3.2.

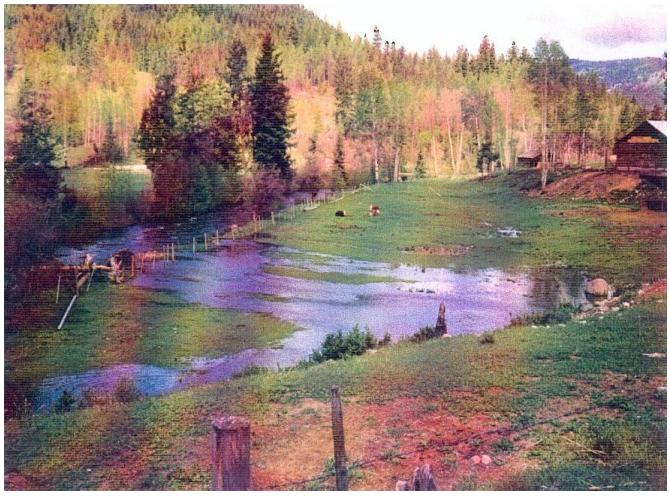
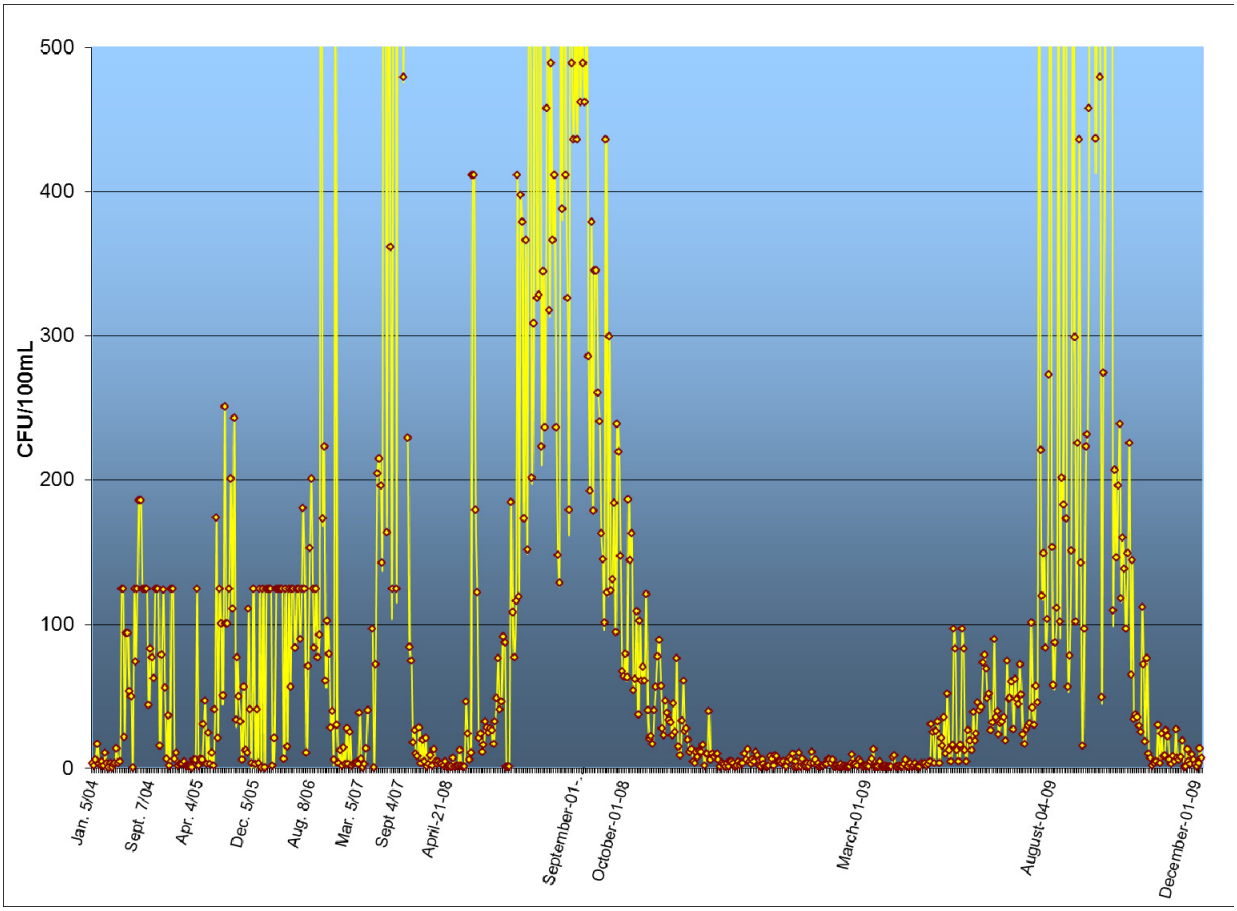
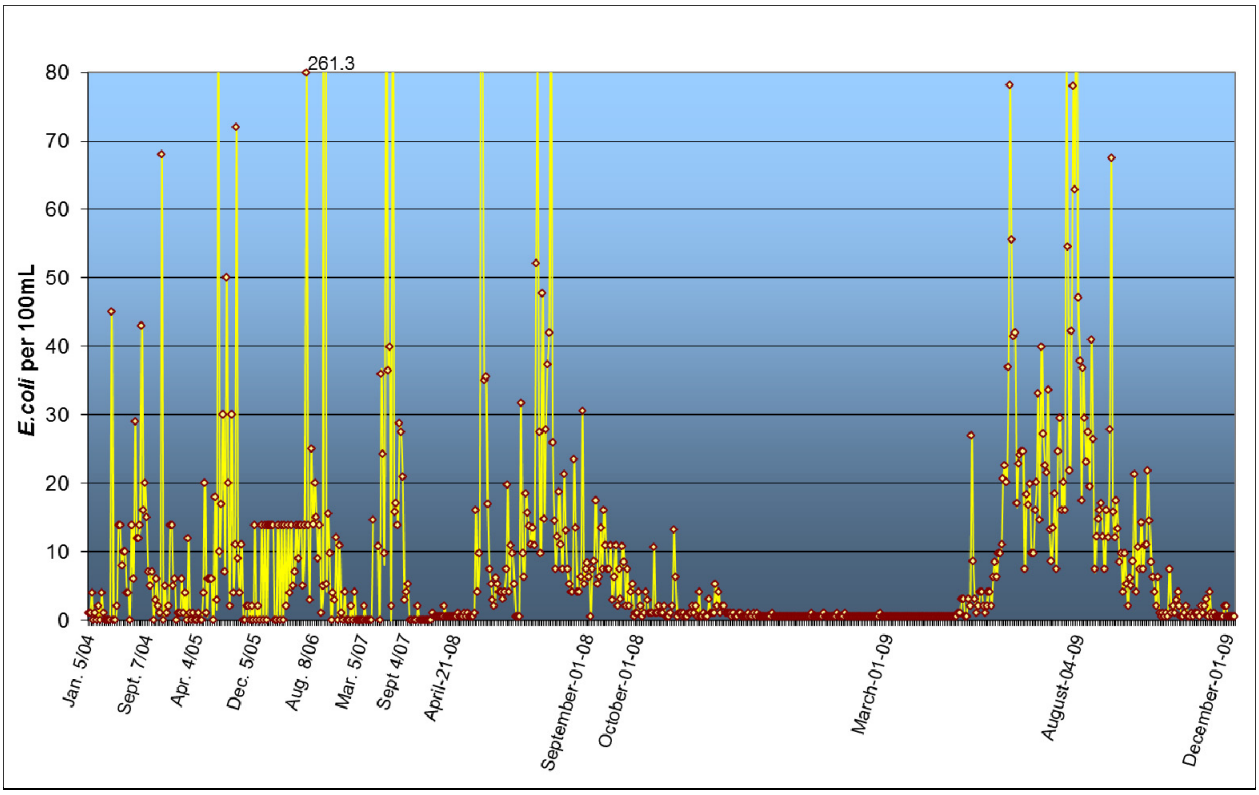


Figure 3.2 - Total Coliforms in Raw Water prior to Disinfection – Trout Creek (2004 – 2009)



Escherichia Coli: *E.Coli* provides an indication of the type of bacteria present in the source water that originate from a warm-blooded animal. Again, the higher the number, the greater the need for enhanced treatment and reliable and adequate disinfection processes. An *E.Coli* number less than 20 CFU/100 mL is desired at all times in the raw water prior to disinfection. The historic levels in the Trout Creek source water are illustrated below in Figure 3.3. The most harmful strain of *E.Coli* known is one named *E.Coli O157:H7* which is particularly harmful and known to cause deaths and have high impacts on young children (less than five years) and the elderly. The recently released research has confirmed the link of *E.Coli* to *Cryptosporidium* is poor. The research also states that if *E.Coli* is present, the presence of *Cryptosporidium* is possible but not guaranteed. It is safe to assume that *E.Coli* will always be present if *Cryptosporidium* is present.

Figure 3.3 - *E.Coli* in Raw Water prior to Disinfection – Trout Creek (2004-2009)



Temperature: The impacts of water temperature are usually underestimated by utilities. High temperature environments enable faster growth of bacteria, viruses and protozoa. Chlorine levels within the disinfected water distribution system will decay more quickly and regrowth potential can occur much more quickly. An objective is for temperature levels in Trout Creek to be kept lower through riparian management (tree cover) and through consistent and constant rates for water releases from Thirsk Reservoir. Temperature also affects the coagulation chemistry in the WTP. Opposite to chlorination, higher water temperatures allow for better performance of the water treatment coagulant chemicals.

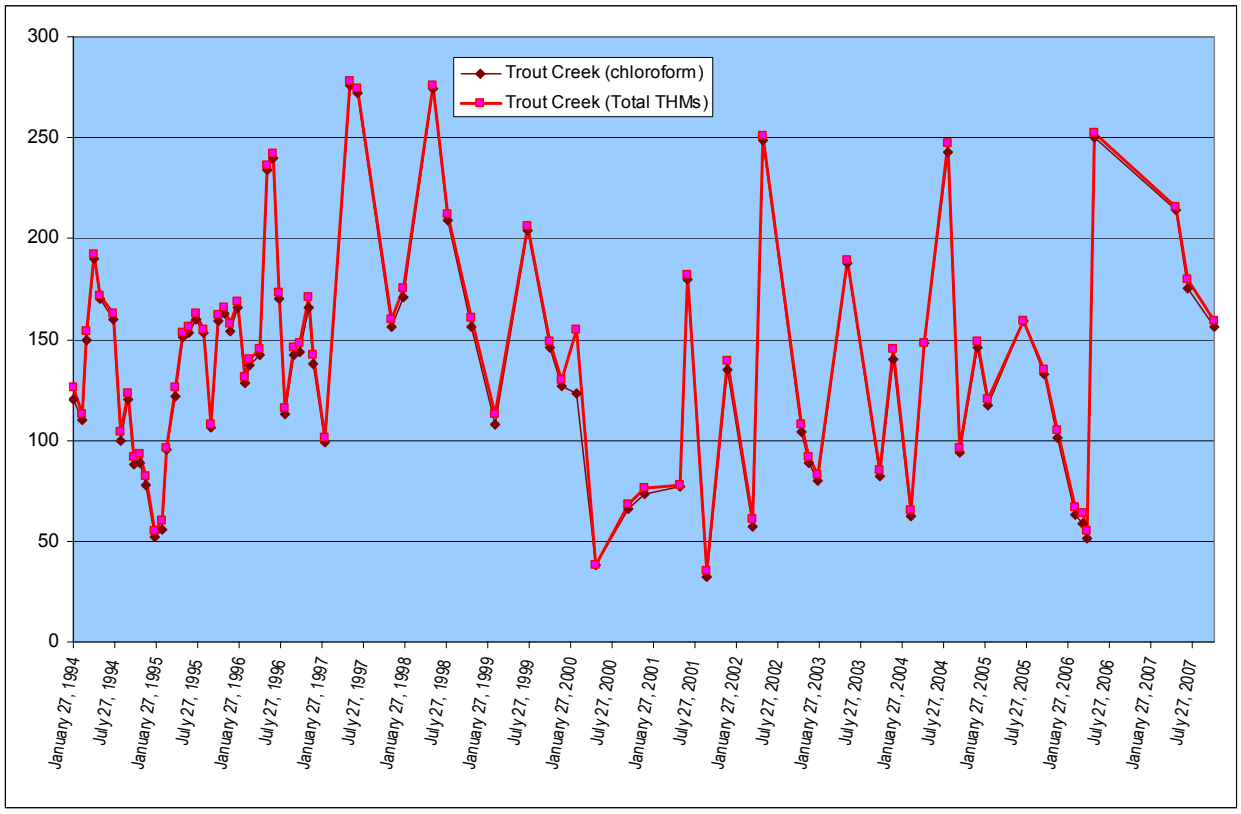
Total Organic Carbon (TOC): TOC is an indicator of the potential for THM formation in the disinfected water. It also is an indicator of the potential for there being nutrients present in the raw water sufficient to cause problems in drinking water reservoirs. TOC levels below 4.0 mg/L are desired at all times. As set out in Table E.6 in Appendix E, the TOC levels for Summerland over the last 8 years have averaged 2.75 mg/L. This level is lower than most watersheds in the Okanagan Valley. It is likely due to the capacity of the watershed soils to absorb moisture and filter the water through the natural gravels within the watershed prior to the water being returned to Trout Creek.

Turbidity: Turbidity is a measurement of the clarity of the water. The lower the turbidity level, the less that the disinfection process will be compromised, and the cleaner and clearer the raw water will be. The objective is that the raw water be below 1.0 Nephelometric Turbidity Units (NTU) 95% of the time and that the raw water levels never exceed 5.0 NTU. For Summerland, the turbidity levels in Trout Creek are variable, but are buffered by the retention time in Trout Creek balancing reservoir located immediately

above the water treatment plant. For the 8 years prior to the Water Treatment Plant being operational, turbidity levels prior to disinfection averaged just below 2.0 NTU for the Trout Creek water system.

Trihalomethane (THM) Precursors: THMs are not a raw water parameter, but rather a by-product of the chlorination process. Chloroform is the most prevalent trihalomethane and typically forms the majority of THM content. THMs are a known carcinogen and 100 ug/L (micrograms) is the current Maximum Acceptable Concentration for drinking water. The objective is to have the THM number as low as possible. As shown in Figure 3.4, numbers historically have been above 100 ug/L for the Trout Creek source. The Summerland WTP currently reduces the level of THMs to well below 100 ug/L.

Figure 3.4 - Total THMs & Chloroform – Trout Creek (1994-2007)



UV Transmissivity (UVT): UVT is a measurement of the ability of UV light to transmit through the water. Dissolved and particulate matter can absorb the UV light and can compromise that disinfection process. UVT for the Trout Creek water was found to be above 80% most of the time. This would lead us to believe that the UV disinfection process could have been an excellent barrier for the raw water in Trout Creek, however, the level of THMs would not have been reduced.

3.6 ENEAS CREEK WATERSHED CHARACTERIZATION

3.6.1 INTRODUCTION

Eneas Creek, which is the secondary water source for the District of Summerland, is delineated on Figure 3.1. The creek has a catchment area of approximately 91 km^2 at the outlet of Garnet Reservoir. The watershed, located on the Thompson Plateau between the Trout Creek watershed and the residual drainage lands along the west shores of the Okanagan Lake, has elevations ranging from 627 m at Garnet Reservoir to 1763 m at the summit of the unnamed mountain immediately east of Eneas Lakes Provincial Park. The topographic relief through the water producing range of elevations is moderately sloping hillside with the surface gradients being moderate throughout most of the watershed.

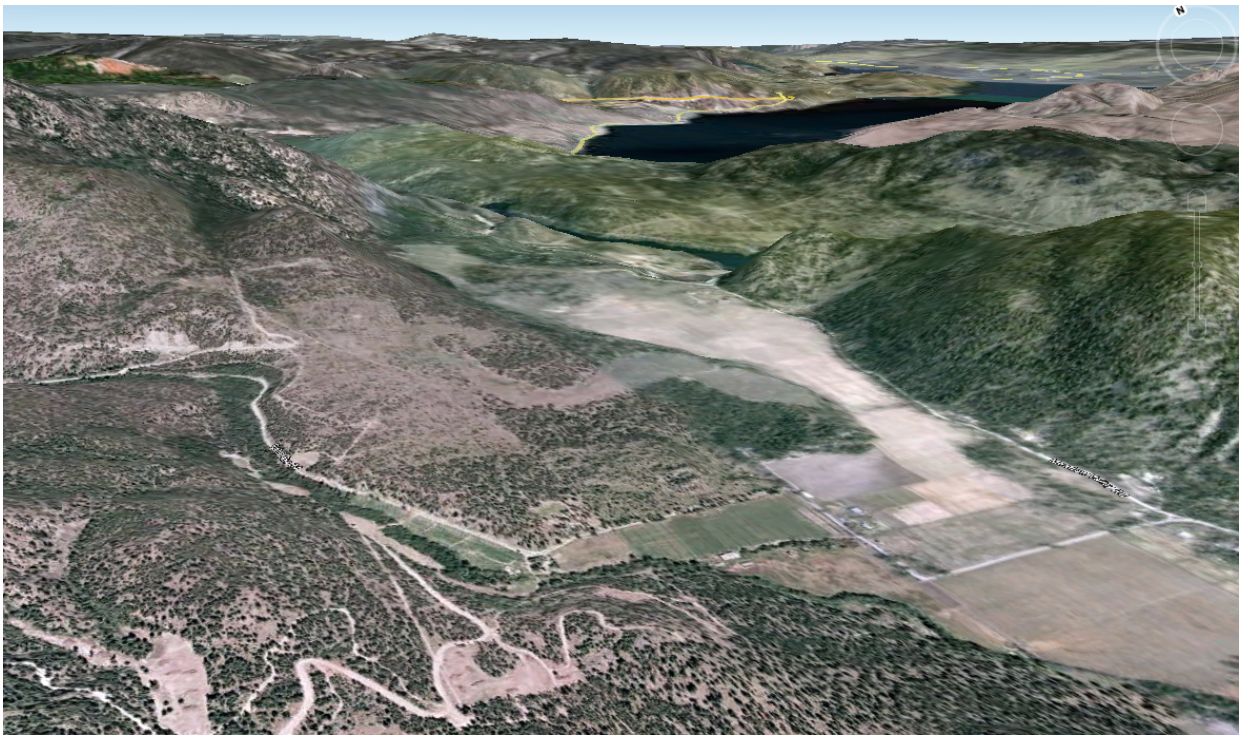
Water originates within this watershed at the high elevation headwaters within Eneas Lake Provincial Park. The Eneas lakes, which are at an elevation of 1,560m, are licensed storage reservoirs of the District of Summerland. They are not operated due to their remote location and the very small volume of storage that they provide. All water that overflows from them is captured at Garnet Reservoir.

3.6.2 ENEAS CREEK WATER QUANTITY

Hydrological data for both the Eneas Reservoir-Lakes and Garnet Reservoir are provided in Appendix C. The average annual runoff to Garnet Reservoir varies, depending on which report is referenced. It ranges between 2.440 and 5,690 ML/year. The majority of runoff from the watershed comes from surface runoff from areas above the 1,400 metre elevation. The average precipitation for the watershed is lower than Trout Creek and in the range of 400mm per year. The total average precipitation for the watershed above Garnet Reservoir is in the range of 36,000 ML per year. Of this amount only 2,440 to 5,690 ML (or 7-15%) is estimated to flow through Garnet Reservoir. The normalized water demand (averaged out for season and precipitation) for Summerland withdrawals from Garnet Reservoir is 1,132 ML per year. Data on water availability and watershed reservoir characteristics is included in Appendix C.

A critical factor on the Garnet Reservoir water supply is the influence of Darke Creek groundwater flows. Figure 3.5 shows a Google Earth aerial image of the Darke Creek valley in the foreground. The irrigated agricultural areas in the foreground are supplied with water from the Meadow Valley Irrigation District. Groundwater flows in the Darke Creek valley back-up in the valley and flow both southwards along Darke Creek and to the northeast towards Garnet Reservoir (next valley to the east) which is at an elevation that is 100m lower.

Figure 3.5 - Landforms influencing flow to Garnet Reservoir



3.6.3 ENEAS CREEK FOREST COVER AND FORESTRY DEVELOPMENT

The bioclimatic zones for this region are primarily Interior Douglas Fir for the lower elevations below 1400 m. For the higher elevations around Eneas Lakes, the zone changes to Montane-Spruce, and Englemann. Soils are generally coarse-grained and moderately well-draining.

The influence of the soil and forest cover in the watershed are key factors, however for this watershed, it appears that the soils have a greater influence in the resulting water quality. The levels of alkalinity, conductivity and metals are much higher in this watershed than for any of the surrounding watersheds in the Central and South Okanagan.

3.6.4 ENEAS CREEK CHANNEL STABILITY

The impact of activities on the stream flows within the channels is buffered by the 2,360 ML of water in Garnett Reservoir located at the 627 metre elevation on Eneas Creek. The volume of water in Garnett Reservoir is sufficient to provide approximately 5 months of storage which can buffer the high runoff or sediment deposition that is caused by extreme storm runoff events.

A cursory review of the channel grades, areas where steep slopes may be located close to the creeks, where silt bluffs may occur was conducted. Aerial photographs and land shapes from Google Earth were the primary tools used in the assessment.

Table 3.3 – Eneas Creek Watershed Creek Stability Characteristics

Sub Basin	Reach	Chainage	Stream Length (km)	Stream Gradient (m/m)	Sediment	Runoff (m3/km2)	Channel Sensitivity
Eneas Creek - Mainstem (Garnet to upper watershed)	1	0+000-4+700	4.7	0.01 - 0.02	Transport	Low	Low
Lapsley Creek - Lower reach (chainage starts at intersection with Eneas mainstem	2	1+600-5+000	3.4	0.02 - 0.03	Transport	Low	Low
- Mid section	3	5+000-6+500	1.5	0.1	Source	Low	Moderate
- Upper Section	4	6+500-9+500	3	0.03	Transport	Moderate	Low
Findlay Creek - Lower reach (starts at chainage 5+570 with Lapsley Creek)	5	5+570-6+000	0.43	0.09	Source	Moderate	Moderate
- Lower section	6	6+000-8+000	2	0.04 - 0.09	Source	Moderate	Moderate
- Lower mid section	7	8+000-10+000	2	0.08 - 0.09	Source	Moderate	Moderate
- Upper mid section	8	10+000-12+000	2	0.01 - 0.06	Transport	Moderate	Low
- Upper Section	9	12+000-15+200	3.2	0.07 - 0.15	Source	Moderate	Moderate

3.6.5 ENEAS CREEK WATER QUALITY

Eneas Creek water quality is generally good for much of the year. The parameters discussed for Trout Creek are provided for the Garnet Reservoir source. Water quality data for the Garnet Reservoir source are included in Appendix C of this report.

Algae Counts: The District of Summerland has had algae issues with Garnet Reservoir due to its temperature and low elevation. The issue has improved through aeration and through the reduction of the anaerobic layer that formed below the old dam located approximately 100m north and underwater from the existing dam.

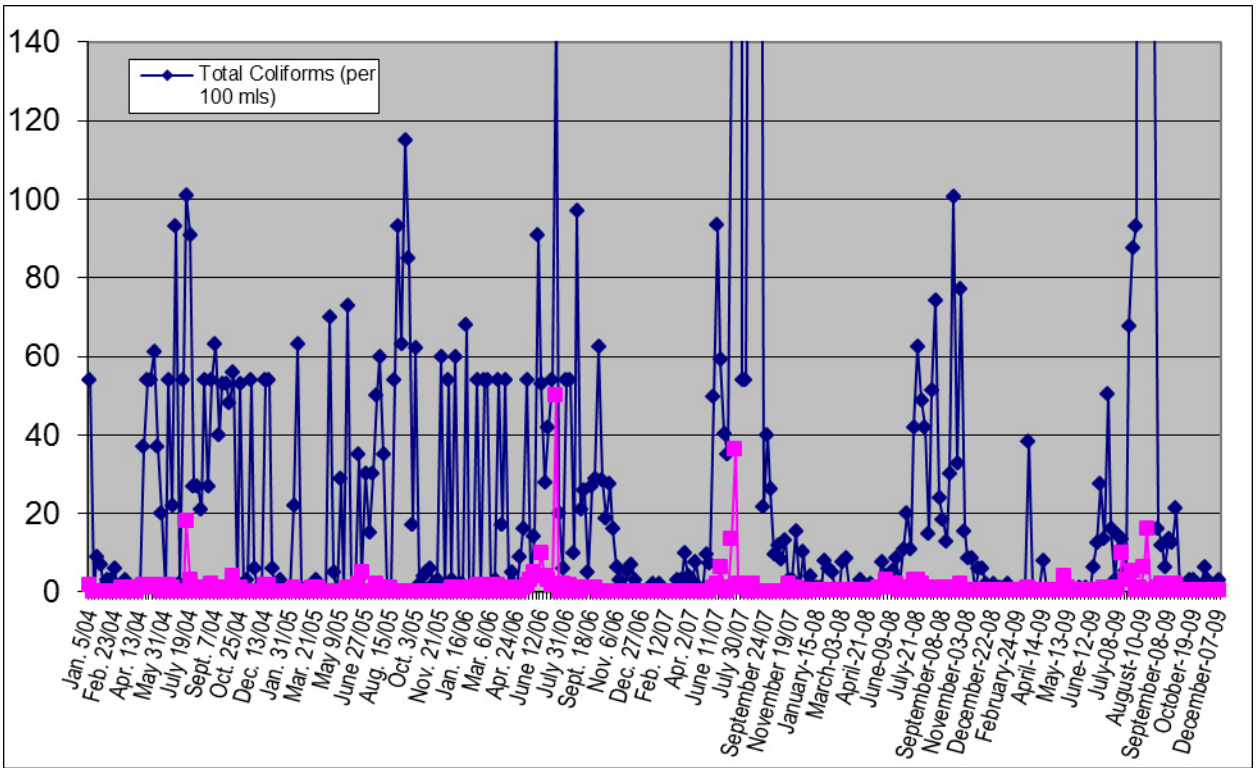
Historically, algae counts for Garnet Reservoir were at very high levels after the reservoir was raised in the late 1970s. This was due to the fact that a large anaerobic zone developed in the bay of water near the intake. The breached abandoned dam is visible in the aerial photograph to the right.

Colour: Colour levels in Garnet Reservoir are very low. Levels in the raw water are below 10 TCU all of the time and are slightly lower after 2001 than for the samples taken prior to 2001. It is likely that the groundwater influence of flow into the reservoir is part of the reason for the reduced colour levels.

Temperature: Temperatures in Garnet Reservoir can reach high levels annually in the months of August and September. The withdrawal temperatures at depth can reach 18 degrees Celsius. The maximum recommended temperature for raw water is 15 degrees Celsius.

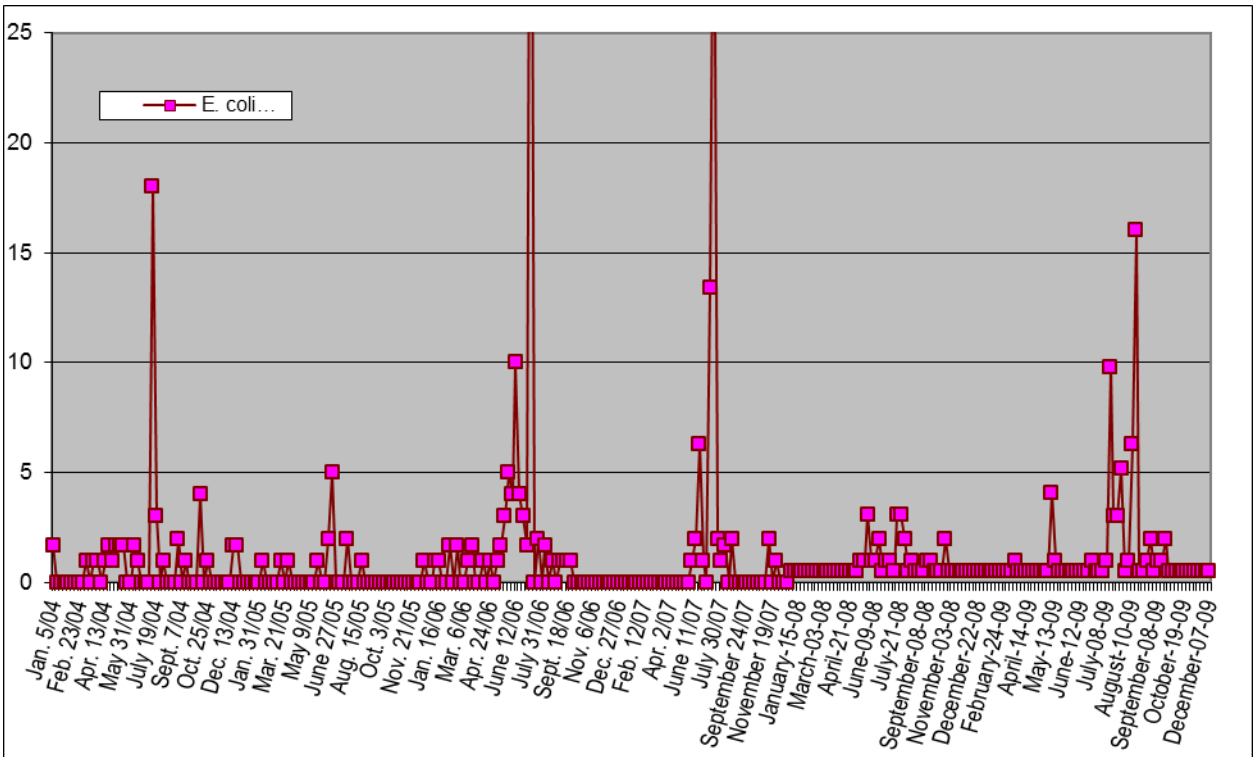
Total Coliforms: Total coliform levels for Garnet Reservoir are moderately low with the level rarely rising above 100 CFU/100 mL sample. An illustration of the graph of the historic Total Coliform levels is provided below in Figure 3.6.

Figure 3.6 - Total Coliforms – Garnet Reservoir raw water (1994-2009)



***Escherichia Coli*:** *E.Coli* is present in Garnet Reservoir, but at relatively low numbers. Only three readings have been taken between January 2004 and December 2007 where the *E.Coli* levels were above 20 CFU/100 mL sample. Typically the raw water *E.Coli* levels are at 2 or lower. The buffering/settling capacity of the reservoir is a major contributing factor to the safety of the water supply. An illustration of the graph of the historic E.Coli levels for the outlet of Garnett Reservoir is provided below in Figure 3.7.

Figure 3.7 - *E.Coli* in Raw water at Garnet Reservoir Outlet (1994-2009)

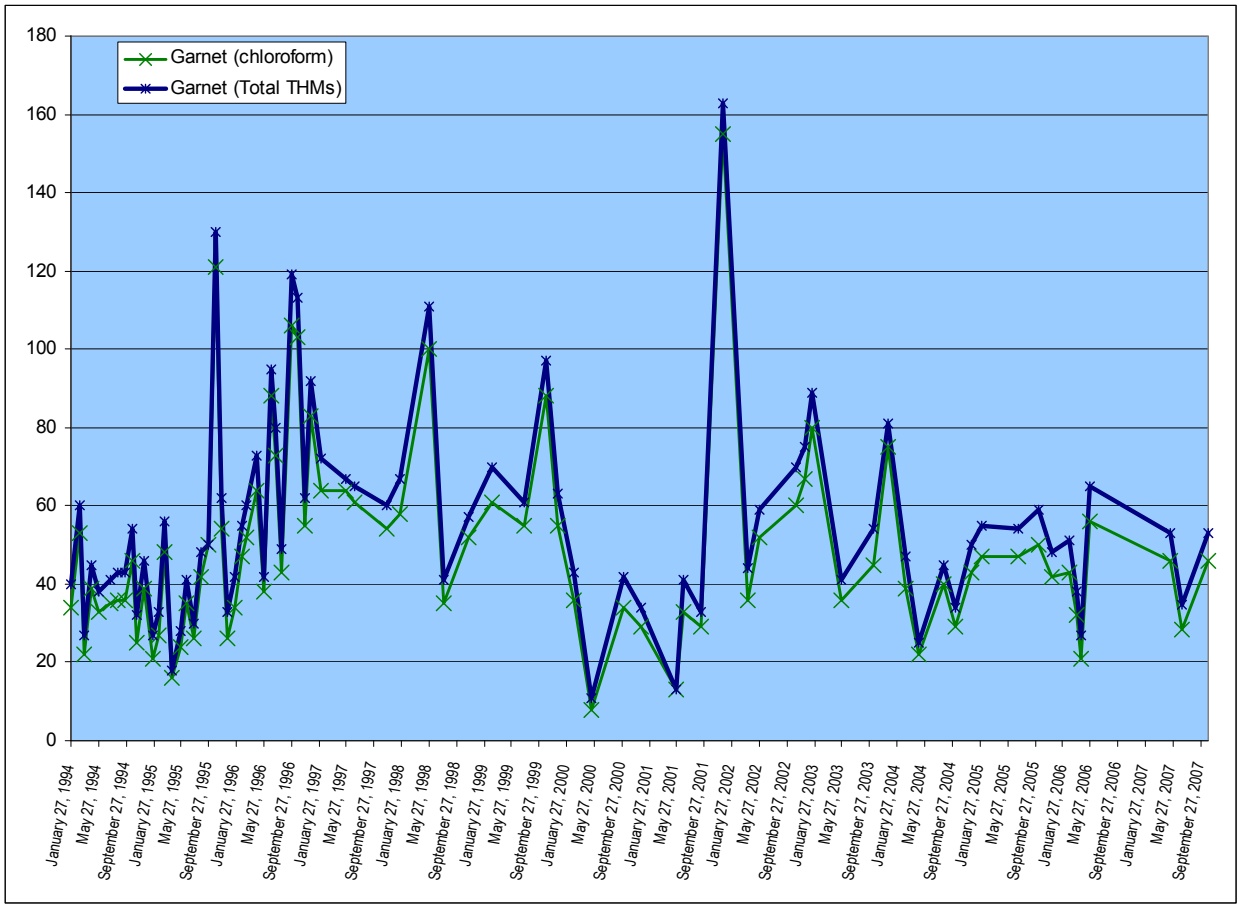


Total Organic Carbon (TOC): TOC levels in Garnet Reservoir are higher than the levels in Trout Creek. This is surprising in that lower levels would be expected. The nutrients must be higher from either the lower elevation watershed or the influence of nutrients in the natural soils.

Turbidity: Turbidity levels in Garnet averaged 1.8 NTU since 2001. The level is above the maximum desired level of 1.0 NTU for raw water for a drinking water source.

Trihalomethanes (THMs): THMs are not a raw water parameter, but rather a by-product of the chlorination process. Chloroform is the most prevalent trihalomethane and typically forms the majority of THM readings. THMs are a known carcinogen and 100 ug/L (micrograms) is the current Maximum Acceptable Concentration for drinking water. As shown in Figure 3.8, numbers historically have been below 100 ug/L for the Eneas Creek source with only a few occasions where the limit has been exceeded.

Figure 3.8 - Total THMs & Chloroform – Garnet Reservoir (1994-2007)



UV Transmissivity (UVT): UVT for Eneas Creek at the outlet of Garnett Reservoir is in the range of 89 % for the raw water. UVT is a measurement of the ability of UV light to transmit through the water. Dissolved and particulate matter can absorb the UV light and can compromise that disinfection process. UVT for the Eneas Creek water was found to be significantly above 80% most of the time.

The high transmissivity indicates that there may be a significant groundwater source influence to Garnett Reservoir from higher lands to the east.

3.7 TROUT CREEK WATER INTAKE VULNERABILITY

The existing water intake for the Trout Creek in Summerland consists of several infrastructure components as illustrated in Figure 3.9. These components include:

- Gas chlorination at the end of the water treatment and filtration process for the purposes of providing primary and secondary disinfection;
- The 75 ML/day capacity Summerland Water Filtration Plant for particle removal;
- Trout Creek Balancing Reservoir (150 ML storage capacity). Only the top 1.0 m is considered to be effective balancing storage as this is the buffering storage required to balance creek flow variation during maximum daily water demands;
- 1.2 km Conveyance Channel from Trout Creek to Trout Creek Balancing Reservoir;
- The ability to selectively allow lower quality water to run to Lower Trout Creek prior to diversion.

The District of Summerland Water Treatment Plant is not discussed in this section but is one of the critical barriers available to Summerland.

Trout Creek Balancing Reservoir

The Trout Creek Balancing Reservoir is an open-surface reservoir used to balance the daily water demand variations that can occur in the daily flow rates. The balancing storage allows Summerland to release optimal amounts of water to meet their user and the downstream fish habitat needs. The reservoir runs off of the top metre of elevation which is roughly 69 ML or 2/3 of a day of storage. However in the event of an emergency, the water level can be run over a wider range resulting in 1 ½ days of storage. Having a full reservoir provides for greater settling times which allows some protection by allowing the heaviest sand and silt particles to fall out prior to being drawn to the Water Treatment Plant.

Stokes Law, which was developed in 1851, is a mathematical formula for determining how quickly spherical objects can settle in a viscous fluid. If particles are falling by their own weight due to gravity, then a terminal velocity is reached once the drag forces (from friction), and the gravity force are exactly balanced. Stokes Law provides a good starting point for understanding the settling rates for particles. Table 3.4 provides a summary of settling rates vs. particle size.

Table 3.4 Particle Size Settling Rates (Stokes Law – Calculation)

Material	Size (microns)	Time to Fall 1.0 metres
Gravel	10,000	0.30 seconds
Coarse Sand	1,000	3 seconds
Fine Sand	100	38 seconds
Silt	10	33 minutes
Bacteria	1	55 hours
Colloidal Matter	0.1 to 0.01	230 days to 6 years
Colour	0.001	63 years

With only 24 to 36 hours of settling time during maximum daily demands, the size range for removal is expected for particles 1 micron size and larger. The existing water intake on Trout Creek has some physical barriers to reduce human and wildlife contact upstream, however the intake is not secure. The means of operating the intake gates is manually and this results in delays in control that can allow lower quality to be drawn in to the Trout Creek balancing Reservoir.

An uncovered concrete flume conveys water from Trout Creek to Trout Creek Reservoir. The flume has fencing along much of it and is partially secure. Contamination could be conveyed through this exposed channel, similar to the natural creek flow. The length of the concrete flume is approximately 1,400 metres.

Trout Creek Intake

The Trout Creek intake is only partially secure. The location is fenced, there is limited access, and is not in a highly visible area. Immediately upstream there is cattle grazing activity on Penticton Indian Band lands and therefore limited or no ability to have jurisdictional protection of the activities that take place immediately above the intake.

The District of Summerland Landfill exists immediately upstream of the reservoir as does a gravel pit, the rodeo grounds, and the Kettle Valley Railway train depot.

The landfill is a cause of concern and Summerland has carried out extensive hydro-geotechnical studies on the reservoir. Earlier reports by Golder Associates have stated that the Trout Creek balancing reservoir charges the local aquifer resulting in a mounding of groundwater in the vicinity of the reservoir. This creates a protecting hydraulic grade line that forces upstream groundwater leachate to be diverted around the Summerland Trout Creek balancing reservoir.

3.8 ENEAS CREEK WATER INTAKE VULNERABILITY

Garnet Reservoir is located approximately 10 kilometres north of the Summerland Town Centre. The intake is located at the low end of the reservoir at the centre of the Garnet Reservoir Dam. The reservoir holds 2,360 ML of water. With a watershed that produces sufficient water that the reservoir reliably fills.

Summerland does not utilize the full capacity of the reservoir on an annual basis and there is carry-over of water volume from year to year. The residence time for water in the reservoir can range from only a month during the freshet period to over 10 months in times of drought or low inflow to the reservoir.

The ability of the reservoir to settle out heavier particles is notable and it is estimated that the removal of particulate matter would be into the range of particle sizes of 1 to 10 microns.

The vulnerability of the intake is low as the reservoir provides a buffer to contamination. In addition, there is fencing around the reservoir to keep animals and human activity at a distance to the reservoir.

In time, the District of Summerland is planning to utilize Eneas Creek only for irrigation and maximize the amount of drinking water supplied through the Water Treatment Plant.

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4. CONTAMINANT SOURCE INVENTORY (MODULE 2)

4.1 INTRODUCTION

The information provided within this section is designed to address Module 2 – Conduct Contaminant Source Inventory, within the Provincial Comprehensive Source to Tap Assessment Guidelines. An inventory of information on the possible and existing documented contamination sources in the watersheds is presented within this section. The section builds on the natural hazards identified in Section 3 and focuses primarily on man-made activities.

4.2 POSSIBLE WATER SUPPLY RISKS

The District of Summerland has invested a significant amount of money in the new Water Treatment Plant (WTP). The plant will be a critical tool in providing high quality, safe drinking water to the residents of Summerland. The WTP does not allow Summerland to become less vigilant in protecting their raw water sources as there are events and resulting contaminants from which the WTP will not provide protection, including forest fires and toxic algae blooms.

Presently, the District of Summerland provides water to customers by gravity, with the majority of water being drawn from Trout Creek.

Algae Bloom in Okanagan Lake, 2003

There are numerous hazards that may be present in the watershed. The field investigations were carried out with knowledge and concern that these hazards may be present. They include:

Possible Microbiological Hazards

Microbiological hazards that may be present in the watershed include:

- Feedlots and concentrated agricultural activities that relate to livestock (source of fecal matter);
- Sewerage / sewerage discharges / septic tanks / pit toilets (source of fecal matter);
- Recreational activities including swimming in reservoirs, hiking, camping, recreational vehicle use, etc. (source of soil deposition and erosion and source of fecal matter);

Possible Human Activity Hazards

- Unrestricted human access to source water (potential contamination);
- Roadway instability (increased soils and silt loading to creeks);
- Gravel extraction and mining operations and all of the increased activities that go with processing of minerals/gravels and increased transportation through the watershed;
- Forestry and instability on slopes and less tree cover;
- Slides and bank stabilization.

A leading authority on microbiological risks in drinking water is the American Water Works Association Research Foundation (AWWARF). The AWWARF provides funding for research to understand drinking water risks, contamination and emerging contaminants. Their manual, *M-48 - Waterborne Pathogens*, sets out a summary of all known waterborne disease causing contaminants. The contaminants are listed in the primary groups of bacteria, viruses and protozoa. A listing of these contaminants is summarized in a two-page table at the end of Appendix C.

Protection from these contaminants is by a disinfection process which is the critical step in achieving the desired health outcomes. A summary of the characteristics of each of the known waterborne pathogens is included the Supplemental Data section in Appendix C. The summary includes the type of pathogen, a description of the disease it can cause, reservoir or agent for the pathogen (where it resides), modes of transmission, methods in which it is detected, how long it survives in the natural environment, documentation of known outbreaks, methods of treatment and the reference location in Manual M-48.

Possible Chemical Hazards

Chemical hazards that may be present in the watershed include:

- Fuel spills along the road and/or rail lines;
- Herbicide use;
- Pesticide use;
- Discharges of personal care products such as medicines, caffeine, medicinal by-products, etc. through the sewerage septic tanks and groundwater transfer;
- Nutrient loading due to fertilizer application on fields (increased nitrogen and/or phosphorous levels;

Potential Water Supply Hazards

A significant issue facing Summerland is the lack of alternative supply capacity in the event of a catastrophic event such a major algae bloom in Thirsk Reservoir or a natural event such as a major forest fire that could render the watershed water supply unusable.

There are several projects in the 2008 Water Master Plan Report that address means of increasing the water supply capacity from other sources. Projects for expansion of the conveyance capacity from Garnet Reservoir and expansion of capacity from Okanagan Lake are two such projects that were reviewed as part of this work.

4.3 FIELD INVESTIGATION

Field investigations considered in our summary of watershed risks were collected at three dates. In addition, the water quality from Trout Creek was reviewed over time to determine if there have been any changes over a longer time frame.

Field investigations were carried out on the following dates by the qualified individuals listed below:

- May, 2002, Watershed Risk Assessment, conducted by Earth Tech Canada Inc. for the District of Summerland. The results from the Earth Tech investigation are included in Appendix A with the drawings. The key information is the table and the 11x17" Figure A-2 in Appendix A of this report.
- November 4, 6, 13 & 14, 2008, Dam Safety Review and Detailed Watershed Risk Assessments, conducted by Mr. Bruce Wilson, Agua Consulting Inc., and Scott Lee, District of Summerland, Lead Water Operator. Photographs and a summary of the investigation is documented and included in this section of the report;
- July 29, 2009, Dam Safety Review and Watershed Risk Assessment, Bob Hrasko, Agua Consulting Inc. and Shawn Hughes, Senior Operator, District of Summerland. Photographs of the site visits are included in this section of the report.

Table D-1 forms nine (9) pages in Appendix D of this report. Table D-1 provides a summary of the field investigations with an inventory of buildings, facilities, activity, risks, and locations for sites located within the watershed that the District of Summerland relies upon. All of the photographs are referenced to corresponding photographs by site identification numbers (*Site ID*). The activities are also co-referenced to a location within the watershed.

The activities are assigned a hazard rating with respect to their impact on drinking water as either "*Moderate*", "*High*", or "*Very High*". The activity is rated at its specific location within the watershed. The items rated as "*High*" and "*Very High*" require higher consideration with respect to their location and their subsequent risk to drinking water.

Figures D-1 through D-6 in Appendix D show the locations of the hazards within the watershed. All items are referenced by a common consecutive identification number.

4.4 RANGE ACTIVITIES

There are a number of ranchers with grazing licenses for livestock within the Trout Creek and Eneas Creek watersheds. The Tenure Holder (Licensee), Range License No., period of use and cow/calf pair units are listed in Table 4.2. The areas occupied are illustrated in Figure 4.2. The numbers were current for the 2009-10 years. Each year, Summerland should contact the provincial Ministry of Forest, Range and Natural Resource Operations to get up-to-date information on the range leases.

Table 4.2 - Summary of Range Lessees (Years 2009-10 Example)

Tenure Holder	RAN #	Period of Use	# of Cattle	# of AUM's
Bobtail Ranch	RAN076797	May 1 – May 21	130 c/c + 6 bulls	68
		June 7 – June 21	130 c/c + 6 bulls	68
		June 21 – July 7	280 c/c + 13 bulls	147
		May 21 – Jun3 21	130 c/c + 6 bulls	68
		May 21 – June 21	½ of 150 c/c + 7 bulls	78
		Nov 1 – Nov 30	1/3 of 287 Cows	96
		Aug 1 – Oct 15	400 c/c	
Glenn Johnson	RAN075654	July 15 – Oct 15	20 c/c	60
		May 15 – June 30	20 c/c	30
		May 15 – Oct 15	80 c/c	400
		May 15 – July 14 July 1 – Oct 15	20 c/c 45 c/c	40 158
		June 1 – June 30 July 1 - Sept 15	75 c/c 30 c/c	75 75
		May 15 – May 31 Sept 16 – Oct 15	75 c/c 30 c/c	37 30
		July 1 – Oct 15	20 c/c	60
Dave Casorso	RAN075493	June 15 – Oct 21	250 c/c	1050
T-6 Ranch	RAN075502	July 1 – Oct 15	25 c/c	87
		May 25 – June 30	25 c/c	30
		May 25–June 10 / Sept 15-Oct15	75 c/c	112
		June 11 – Sept 15	75 c/c	240
Don Barron	RAN077114	May 1 – May 31 (odd years)	60 c/c + 3 bulls	60
		June 1 – July 15 Oct 16 – Oct 31	60 c/c + 3 bulls	120
Vern Sopow	RAN077115	May 1 – May 31	35 c/c	35
		June 1 – July 15 Oct 16 – Oct 31	35 c/c	60

AUM stands for the number of Animal Unit-Months.
One cow-calf pair grazing for one month equals 1 AUM.
One bull equals 1.5 AUM. One yearling equals 0.70 AUM.

Best management practice for range activity in BC are being developed and improved upon. The impact of range activities is now recognized by the Province as a conflicting issue within community watersheds. The Province has recognized the conflicting objectives that range licensees have with drinking water suppliers and has assigned manpower and funds to help improve the situation. Historically the watersheds were primarily a source of irrigation water for the agriculture industry. The issues of the costs for water treatment are now influencing the decisions made in the watersheds with respect to fencing and range activities.

The key objectives for BMP for range activities, as developed by the Forest and Range staff, are as follows:

1. Maintain healthy upland grass cover and riparian plant community to stabilize the soils;
2. Grazing to prescribed stubble heights will assist in reduced fecal transport through the watershed;
3. Limit cattle grazing time so that the cattle do not compromise the grass and vegetation cover in riparian areas;
4. During cooler times, graze cattle out in the open areas and save the riparian and vegetation cover areas for hotter times of the year;
5. Allow damaged soils areas to recover;
6. Prevent livestock from entering streams and lakes, and provide buffers through the installation of fencing and watering facilities at strategic locations;
7. Create riparian pastures that allow controlled timing and access to riparian features;
8. Create ground hardened areas for "nose-holes" to prevent direct access to streams or standing water in reservoir-lakes;
9. Provide off-stream water using gravity feed systems;
10. Allow trough water to overflow back to the water source without carrying ground or fecal contamination;
11. Design watering areas so that concentrated watering areas do not have runoff back to water courses;
12. Place salt-blocks in areas well away from riparian areas;
13. Spread grazing livestock over a range and do not allow them to congregate near riparian areas;
14. Treat sick animals and remove sick animals from herd and watershed;
15. Do not release young calves to watersheds until at least 4 months of age as they are known to be more common carrier of *Cryptosporidium* oocysts;
16. When found, remove dead animal carcasses from creeks and wetland areas to drier and higher ground outside of a water course;
17. When high *E.Coli* counts are found, change operational activity to reduce counts as soon as possible. Pick up feces if they are accumulated near or within a stream;

The objective for District staff should be to work with and contribute to watershed resource initiatives in partnership with the Ministry of Forest and Range staff.

4.5 *CRYPTOSPORIDIUM* AND *GIARDIA LAMBLIA*

This page is provided as a summary of information on *Cryptosporidium*. The reason for this specific information is for the benefit of all persons involved in protecting the public water supply. *Cryptosporidium* is recognized as an extremely high drinking water risk due to its ability to survive the chlorination process.

Cryptosporidium can be found in a wide range of invertebrates including humans. There are approximately 14 species of Cryptosporidium with C.Parvum and C.Hominus being the two most commonly implicated in gastrointestinal illness outbreaks. Cryptosporidium oocysts attach to the intestine wall where the animal acts as a host for the protozoa to infect and reproduce. Typically, healthier younger hosts can produce more oocysts which explain why young calves are known to be one of the highest risk hosts. The reproduction cycle for *Cryptosporidium* oocysts in the host is very short and can be as little as 12 to 14 hours. Huge numbers of oocysts can reproduce in the host in a number of days and additional areas within the host may become infected. This intense and high infection cycle explains why immunosuppressed individuals may have oocysts in their stomach, biliary and pancreatic ducts and respiratory tracts. It takes 4 days for oocysts to start leaving the host. The length of time for which oocysts are shed in the feces can last between 6-18 days (4-10 days of diarrhea) for immunocompetent individuals. It may be longer for immunosuppressed individuals.

Cryptosporidium is prevalent in the environment with approximately 0.40% of the population passing oocysts in Industrialized nations. For hospital patients with diarrhea, the average is that 2-3% are passing oocysts. An estimated 30-35% of the US population has anti-bodies to *Cryptosporidium*. In third world countries, up to 60-70% have antibodies to this protozoa. There are minimal ways to treat for removal of the oocysts, however, the only completely effective means of eliminating the parasite is a healthy and intact immune system.

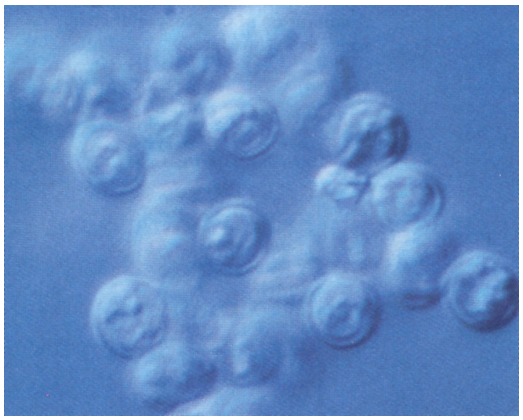


Photo Image of Cryptosporidium Oocysts - 4 – 7 microns in size

There are two types of *Cryptosporidium*: *Cryptosporidium hominis*; and *Cryptosporidium parvum*. The first type is exclusively a parasite of humans and the second is prevalent in a wide range of animals including humans. Recent studies have estimated that the average infectious dose of *Cryptosporidium* in humans is around 132 oocysts although one study volunteer was infected by only 30 oocysts.

There are great difficulties in monitoring the amount of *Cryptosporidium* in the environment as there are issues with sampling techniques, detection methods and the small volume of sample versus the large volume of water passing a sampling point. There are also issues regarding the viability of the oocysts to be able to infect the host.

Cryptosporidium can be ineffective or non-viable due to age, freezing (below -10C) or from UV irradiation.

Prevention and control of *Cryptosporidium* oocysts is through the process of eliminating the ingestion of them. Commercial disinfectants have been used to attempt to kill sporozoites within the oocysts. Even

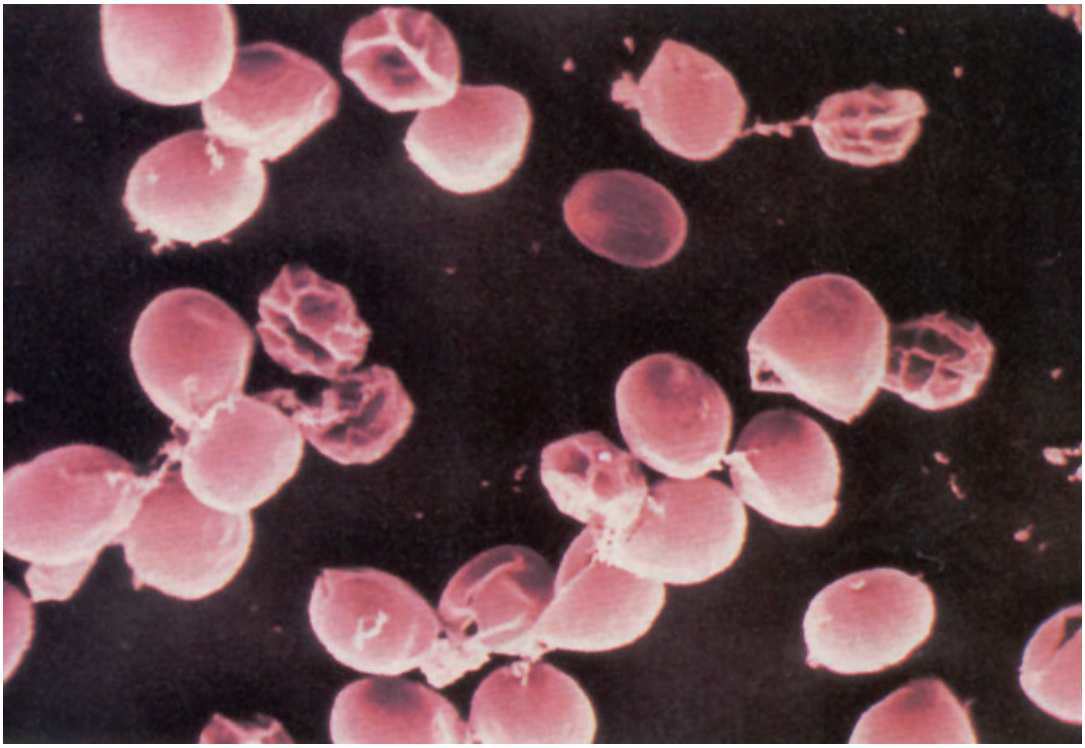
UV irradiation is not 100 % effective in eliminating all of the ineffective oocysts. Typically, only 100% of the oocysts are killed when extreme and unpractical measures are used.

These include exposure to:

- ☐ 1 Joule/square cm pulsed light (irradiation)
- ☐ 100% bromomethane gas for 24 hours
- ☐ 28,000 mg/L of chlorine for 24 hours
- ☐ 10% formoline saline solution for 18 hours
- ☐ 5% ammonia for 18 hours
- ☐ 100% ethylene dioxide gas for 24 hrs.

Many of these forms of disinfection reduce the numbers of infective oocysts, but rarely result in 100% efficacy.

The most effective means in which to render oocysts infective is desiccation (drying in air). Drying of feces in the environment is perhaps the most effective method in reducing the concentration and re-infection of the protozoa. By managing the means for reintroducing Cryptosporidium into new hosts, overall reduction in the presence of *Cryptosporidium* in the environment can be achieved.



Source: Kansas State University – Parasitology Laboratory – Basic Biology of Cryptosporidium, Steve Upton, Ph.D., Feb. 17, 2008;
Link: http://www.k-state.edu/parasitology/basicbio

4.6 TIMBER HARVESTING ACTIVITY – MOUNTAIN PINE BEETLE

Forest harvest licensees issued within the watersheds are listed within Table 4.3. The majority of harvesting activity in the past year and forecast for the next two years is related to salvaging pine hit by the Mountain Pine Beetle. The areas of activity cover the majority of the watershed with the exception of the Provincial Park designated areas.

There are three major timber harvesting licensees in the Trout and Eneas Creek watersheds, BC Timber Sales (BCTS), Gorman Brothers Lumber Ltd. and Tolko Industries Ltd. The majority of licensed area is held in the following areas as described below:

- Gorman Brothers is the largest timber area licensee including the main stem areas along Trout Creek and lower Eneas Creek;
- Tolko Industries holds licensing only in the north area of the Eneas Creek watershed. They also hold licensing in upper Trout Creek north of Mount Kathleen and along the north side of North Trout Creek;
- BCTS holds licensing in the area to the west of Trout Creek north of Osprey Lake and to the area immediately west of Tsuh Lake. The areas for the licensees are illustrated in Figure 4.9.

Table 4.3 - Harvesting Licensees

Tenure Holder	Operating Area within Watershed
BC Timber Sales	44.7 km^2
Gorman Brothers	609.1 km^2
Tolko Industries	133.4 km^2
TOTAL	787.2 km^2

The key points for forest management that were raised at the Forrex – Forum for Research and Extension in Natural Resources in May, 2009 were as follows:

- Snowmelt rates in salvage harvested stands are greater than those in stands where the dead pine is retained, and this effect can persist for approximately 30 years;
- Model simulations indicate that peak flow magnitudes increase with the area of salvage harvesting;
- A regional study found little short term influence from the Mountain Pine Beetle (MPB) infestation on chemical water quality across BC, and that water quality concerns arising from the MPB infestation are primarily related to forest management responses (e.g. road building and salvage harvesting)

4.7 FIRE MANAGEMENT

Although fire management is not the responsibility of the District of Summerland, monitoring and awareness of this risk should be of concern. Forest fires were a major issue in the Okanagan in 2003 and again in 2009. The fires on the west side of Okanagan Lake caused evacuations of large areas of the District of West Kelowna and smaller communities along the west side of Okanagan Lake.

The majority of fire management is preventative in nature. The issues of fuel loading and forest class condition are important factors in assessing what risk may be present in the watershed. We know of only one Fire Management Plan within a community watershed in the Okanagan and that was carried out by Black Mountain Irrigation District in the Mission Creek watershed (see Figure below).

The intent with a fire management plan is to identify what would be defendable cut-blocks. In the event of a major forest fire, the links between cut blocks could be quickly harvested so that the areas where there was a major fire could be contained.

The deliverables for a Fire Protection Plan for a water utility are as follows:

- Integration of local information into the provincial planning process and delivery of the District mapping of critical resources to the Provincial Emergency Program groups;
- Grid mapping of the watershed in the Provincial grid aligning notification of the grid with the Provincial fire protection agencies so that quick and accurate measures can be taken to prevent very dangerous impacts such as a fire at a major chlorinator.

Figure 4.4 - Example of Fire Identification Grid Mapping

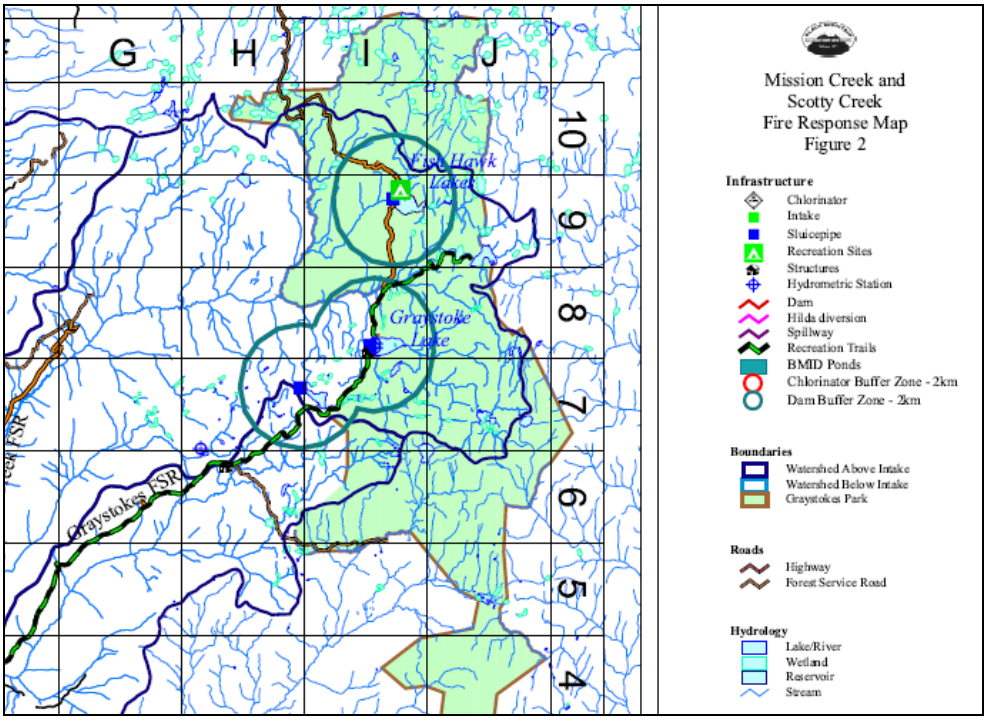


Image Source: Black Mountain Irrigation District – Dobson Engineering Map

The stumbling block for developing community and watershed Fire Protection Plans is the lack of funding and the lack of revenue afforded to timber harvesters. On Crown land areas, the stumpage fee is high enough to make the harvesting of difficult areas economically non-viable. If the stumpage were removed in these Crown land areas, it would assist in the development of defendable cut-blocks. This is being considered by the Province.

The outcome of a forest fire in a watershed can be substantial, particularly if it is the primary source of water for the community. The area encompassed by the 2003 Okanagan Mountain Fire was over 250 km^2 which is approximately 1/3 of the entire Trout Creek watershed.

The impact on Drinking Water has been studied for basins in the Old Man River Basin in Alberta and it was found that for post fire runoff, there would be expected to be increased nutrient levels, increased heavy metals, and increases in chlorophyll which could lead to increased algae activities. The end result is that the community would be challenged with the requirement to have treatment capacity for the removal of solids and increased Dissolved Organic Carbon (DOC) levels.

Summerland may not be at as high a risk as other communities, however, the silt and sediment bed load in Trout Creek would be expected to rise and the Water Treatment Plant would be stressed by the increased treatment challenges.

Photo: Terrace Mountain Fire, July, 2009

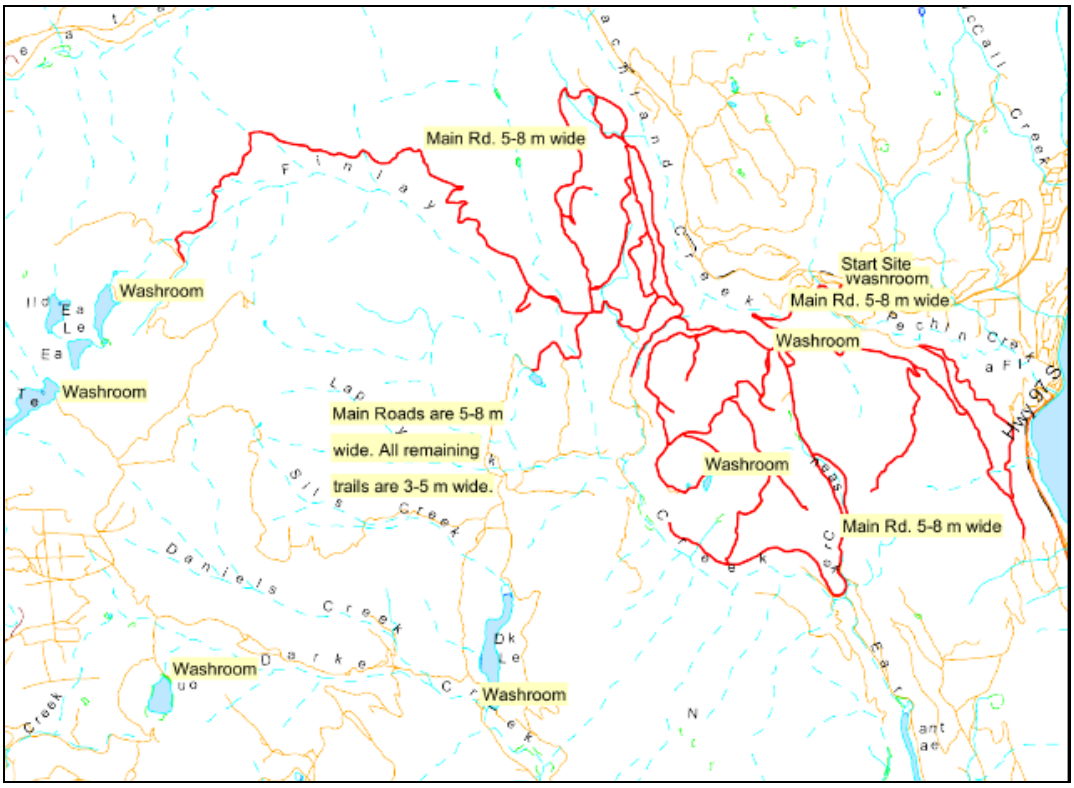
4.8 BACKCOUNTRY RECREATION ACTIVITIES

Backcountry activities in the watersheds include motorized recreational vehicle trail riding (quads and motorcycles), snowmobiling, hiking, camping, fishing, hunting, and 4-wheel drive access to remote locations. Some of these activities are sanctioned by the Province and are acceptable use, however, there are always persons that do not respect the natural environment.

The Ministry of Tourism, Culture and the Arts has developed a Trail Strategy for the Province. The first draft was issued in November of 2008 and feedback was provided from stakeholders in watersheds across the province. The lack of environmental protection was noted in the feedback received on the first document. Environmental protection is expected to be improved in the second version of the Provincial Trail Strategy.

With increased population in the Okanagan comes increased activity in the watersheds. Recreational activities are increasing and there is a great deal of pressure to increase the backcountry experience. Figure 4.5 shows an application that is currently in front of the Province to allow a tour company trail riding permit in the Peachland and Summerland watersheds.

Figure 4.5 - Current Application for Trail Tenure in Peachland/Summerland Watersheds



Agua Consulting Inc.
"Engineered Water Solutions"

A positive example of backcountry recreational activity in the Province between a water utility and a recreational club is the relationship between the Kelowna Snowmobile Club and the Black Mountain Irrigation District in the Mission Creek watershed.

The KSC is the organized group that holds tenure for snowmobile trail riding in the Graystokes area in the Mission Creek watershed. The KSC was formed over 40 years ago and is a respected and well-run organization. During the winter months, they groom the trails, educate their members and invest heavily in protecting their natural resource so that they do not lose their tenure within the watershed. They work in partnership with the other local stakeholders such as the Black Mountain Irrigation District and the Ministry of Environment to ensure that the natural resources aren't compromised. The members pay an annual fee and get a reduction in the fee if they volunteer time and hours to assisting the club in their maintenance and operational tasks.

Observations

Based on our review of various issues that have arisen in the past 10 years, we have the following observations related to tourism and recreational activities in community watersheds:

- Vigilance is needed to review applications and activities in the watershed;
- Presence in the watershed is important as a visible activity by the District in the watershed is important to understanding and protecting the resource. Many partners are needed for a watershed the size of Trout Creek. Working in partnership with other larger watershed stakeholders and build mutual trust and respect with the other stakeholder organizations;
- The onus and responsibility for a new group to prove they are a watershed stakeholder lies with that group to invest in and protect the watershed;
- Open communication is always necessary and sometimes compromise is required by both parties.

4.9 TRANSPORTATION AND UTILITY CORRIDORS

The transportation and utility corridors within the watersheds are listed in this section and are illustrated in Figure 4.6. The primary corridors are as follows:

- Princeton to Summerland Road – Ministry of Highways: This road bisects the Trout Creek watershed following the Trout Creek valley. It is utilized primarily for forestry, recreational use and by the District to access their water reservoirs. It is not a dangerous goods route. The contamination due to problems or transportation emergencies is somewhat limited but still present. To mitigate the impacts from transportation type emergencies would be part of an Emergency Response Procedure;
- Trans-Canada Trail – Kettle Valley Railway : The train grade still exists and runs parallel to Trout Creek. The risks from hikers and bicyclers is low, but the proximity to the creek is close;
- Trout Creek Forest Service Road (FSR): This road runs from the west end of the watershed northwards to Headwaters Lakes;
- Glen Lake FSR: This road, located in the middle of the Trout Creek watershed, is a shorter route through the back country between Peachland and Summerland;
- Whitehead FSR: This road connects the Trout Creek FSR to the Coquihalla Connection (Highway 97C);
- Isintok – McNulty FSR: Access road to Isintok Reservoir;
- Bathfield Road: is a MOT road located on the south side of Trout Creek connecting from Summerland town to Isintok FSR;
- BC Hydro Right-of-Way: This right-of-way runs north-south across the middle of the Trout Creek watershed and is also illustrated on Figure 4.6.

The hazards associated with transportation routes are tied to the damages caused by the road construction and the increased activities by opening up an area with road access.

In addition to transportation being considered in isolation, the conditions exist in most watersheds to have a negative synergistic effect when range cattle and motorized recreation co-exist in a watershed. The fecal contamination can be spread throughout the watershed at a far quicker rate and to a more extensive area if there is motorized vehicles running through the fecal matter. This condition should be minimized.

4.10 LEASED LOTS ON DRINKING WATER RESERVOIRS

The issue of leased lots has received substantial media attention in the last three years. The lease lots have quietly existed in the watersheds for decades. Summerland has 41 lots located at Headwaters Reservoir-Lakes. There is one (1) commercial lot on Headwaters No. 1, seven (7) recreational lots at Headwaters No. 3 and 33 lots at Headwaters No. 4. A listing of the lease owners and the location of their lots is provided in Appendix C.

The leased-lot issue was elevated when the Province raising the lease rate on the lots by approximately 10 fold. Four hundred dollar ($400) per year leases became $4,000 per year. The Cabin owners with these leases then lobbied the Province to buy out the leases and own the lots in a fee-simple arrangement. The cabin owners organized and formed the Okanagan Cabin Owners Association (OCOA). The water utilities became very vocal in their opposition to the sale of the leases to private ownership. Their arguments were supported by all levels of local government valley-wide. The pressures by the cabin owners to purchase the lots was counter petitioned with pressures to the government to get rid of the lots altogether or allow the utilities dependant on the reservoir-lakes to have first right of refusal on the leases. The Province carefully reconsidered their position on the sale of the lots. The arguments on both sides were left at a stalemate and a moratorium on the sale of lots was set by the Province.

The hazards from the activities around the reservoir-lakes are moderate to high, with few "Very High" contaminants. In addition, the Headwaters Reservoir-lakes have substantial settling volumes, significant dilution capacity. They are a long distance from the Trout Creek intake with Thirsk Reservoir located in-between.

Recommendation

In further action on this issue, we would recommend the following steps:

- ☐ Formally advise the lessees that Summerland will not support the sale of leased lots in their watershed and that if OCOA continues to lobby for the sale, Summerland will lobby strongly for their removal altogether with the support of the public;
- ☐ Work with the Province to inform the lessees that there is an expectation to proper operations, cleanliness and management of all wastes on the leased lot sites. Activities must be in harmony with nature and of low impact to the environment;
- ☐ Advise the lessees that Summerland is looking to form a partnership with them in protecting the watershed and maintaining the raw water quality within the lakes;
- ☐ Provide the lessees with information on how to spot algae-blooms so that they can provide Summerland with an early warning as to when and where a bloom might be occurring;
- ☐ Lobby for electric motors only on all reservoir-lakes within the watershed;
- ☐ Lobby co-operatively to the province with the OCOA for lower lease rates in the watershed.

A co-operative approach should lead to much more productive outcomes with mutual benefits.

4.11 GRAVEL EXTRACTION

Gravel extraction is noted and present above Summerland. The majority of the current gravel extraction is directly controlled by the District. Above Summerland, for mineral or gravel extraction within the watershed, the activities fall under the jurisdiction of the Ministry of Energy Mines and Petroleum Resources.

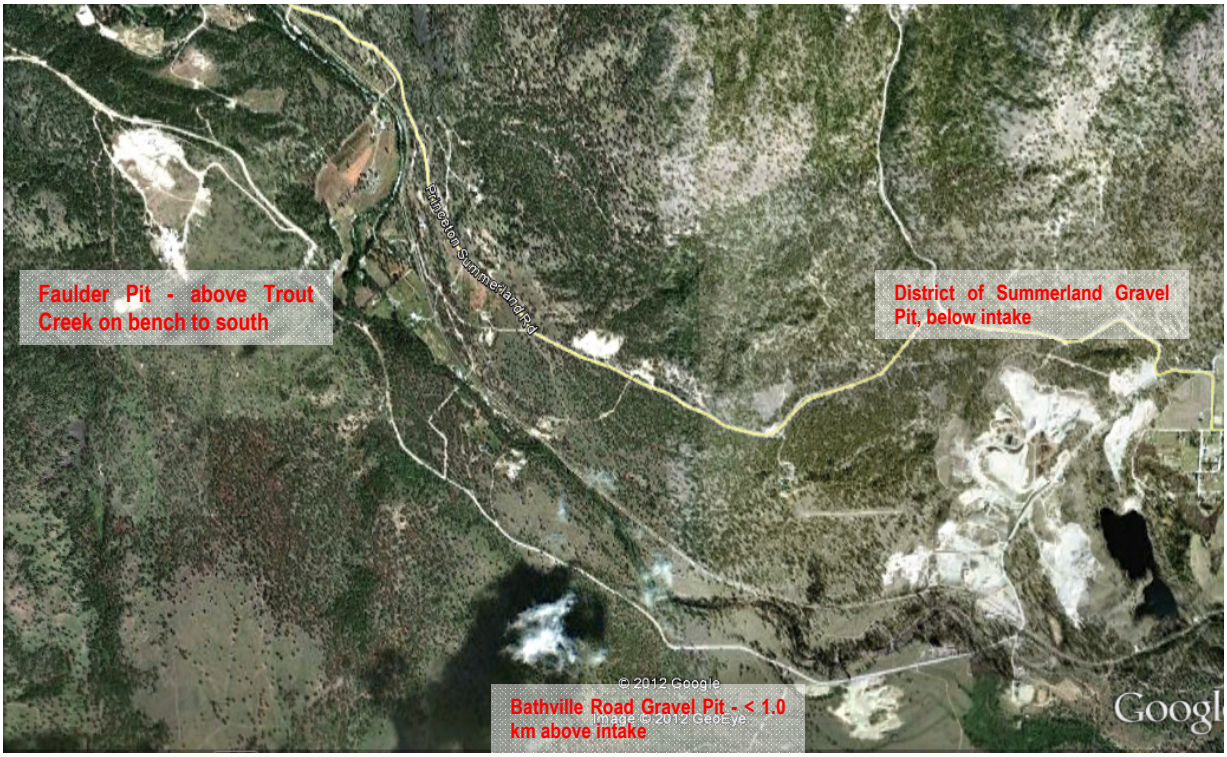
Of concern with any mining application is the setbacks and clearance to the stream and the impact on stream health. In the last three years, there has been a shortage of aggregate in the Okanagan and there were local lobby groups that set out guidelines and lobbied the Province for changes to their approach in permitting gravel and mineral extraction. The Provincial Permit Process overrides the local government authority, even within existing municipal boundaries.

The Guidelines set out on the next page reflect the following assessment levels:

- **Green** – OK to develop pit,
- **Yellow** – can be developed with proper controls, and
- **Red** zone – cannot be developed at site due to sensitivities and setbacks, for pit development within urban areas in the Central Okanagan.

Figure 4.7 shows an aerial image of where the existing gravel pits exist within the watershed.

Figure 4.7 - Gravel Pit Locations near Trout Creek



For the Yellow and Green Zones, the permit decision process needs to be jointly approved by Ministry of Mines and the local municipal authority.

Mine Inspectors and regional inspectors should monitor and publicly report mining and/or reclamation progress on a minimum of an annual basis or as triggered by complaints.

Proposed Urban Mining Zones for the Central Okanagan

Red Zone – Environmental or residential protection zone – **no mining** if:

- the proposed pit or processing area is within 500 m of the nearest residence OR
- sections of the proposed pit/processing area or haul route have been identified as Environmentally Sensitive Area ESA 1[10] or parkland or ecological reserve[2,5,7] OR
- the proposed pit area is in a groundwater recharge zone/groundwater protection zone[10, 20] OR
- a significant, documented health risk is posed by: dust, compromised water supply, contaminants, trucking hazards or noise disturbance[23] OR
- the proposed pit footprint is in the ALR and would reduce agricultural potential OR
- the viewscape is permanently damaged by pit or stockpiles or can be viewed from an urban center or Okanagan mainstem lake (Okanagan, Kalamalka, Wood, Duck) OR
- haul route is unsuitable (type C low volume roads or less)[4]

Yellow Zone – **Mining possible** with significant restrictions if

- exploration of the mining site is subject to the same standards, including reclamation, as an active pit.
- the proposed pit/ is within 1000 m of the nearest residence
- the proposed pit/processing area or haul route has been identified as ESA2[10]
- the proposed pit area is within 30m[8,10,13,20] of surface or groundwater features
- storm water from the disturbed area and haul route can be managed by infrastructure[18,23]
- health risk posed by: dust, storm water drainage, contaminants, trucking hazards or noise disturbance can be managed through restrictions and infrastructure [20,23]
- impact to the viewscape from the pit or stockpiles is minimal or the impact can be remediated according to a staged, sustainable plan
- the haul route will bear limited hauling (type B medium volume roads) [4] and be <10% grade and conform to Health Safety and Reclamation Code section 6-8 specifications [19]
- no screening, crushing, or cement plant is possible without industrial zoning
- Extension of the mining permit by more than 3-4 months or expansion of the disturbed area by more than 35%[21] (cumulative during the life of the pit permit) would trigger a re-application with public input. This includes existing aggregate extraction permits[17,18]

Green Zone – **Responsible mining is acceptable** if

- exploration of the mining site is subject to the same standards, including reclamation, as an active pit.
- the proposed pit/processing area is more than 1000 m of the nearest residence and in an area zoned for industrial use AND
- the proposed pit area/haul route has been identified as ESA3[10]or less and storm water can be effectively managed AND
- the proposed pit/processing area is not within 30m[8,10,13,23] of surface or groundwater features AND
- health risk is unlikely via dust, compromised water supply, trucking hazards, contaminants or noise disturbance [21,22] AND
- the haul route is type B, C, or an unpaved, designated industrial route[4] AND
- plans for staged, sustainable reclamation are annually inspected and successfully completed
- Extension of the mining permit by more than 3-4 months or expansion of the disturbed area by more than 35% [21](cumulative during the life of the pit permit) would trigger a re-application with public input.

V 1.9

Source: H. Larratt – G. Lawrence – Proposal for Urban Mining Guidelines for the Central Okanagan, August 20, 2007;

5. RISK CHARACTERIZATION (MODULE 7)

5.1 INTRODUCTION

The information provided within this section is developed to provide a logical format from which the risks within the overall watershed can be prioritized. The information should be suitable to address Module 7 – Characterize Risks from Source to Tap, within the Provincial Comprehensive Source to Tap Assessment Guidelines.

The risks identified in Section 4 are presented with a more definitive review of their risk to drinking water. The process recommended within the Source to Tap Guidelines is to:

1. Evaluate the robustness of the drinking water protection barriers;
2. Assess risk for hazards/vulnerabilities identified in Modules 1 and 2;
3. Evaluate the water supply system as an integrated whole.

5.2 RISK EVALUATION

Standard risk characterization ranges from qualitative to semi-quantitative to fully quantitative. Qualitative risk approaches are based on best available data and assessment of indicators without the aid of quantitative and factual data. If substantial Total Coliforms and *E.Coli* count data is available and trended over time, a more quantitative the risk assessment may be considered. The assessment carried out for this study is a semi-qualitative risk assessment. For Summerland, there is insufficient data to carry out a fully quantitative risk assessment.

In accordance with the Ministry of Health *Comprehensive Drinking Water Source to Tap Assessment*, risks in the watershed were assessed based on the following principle:

RISK = LIKELIHOOD OF OCCURRENCE X CONSEQUENCE OF OCCURRENCE

The risks listed in Table 4.1 assessed the presence of the risk, and assigned a rating based on the immediate location and contamination at the immediate location. Conveyance of the risk by moving stream or other means to the District of Summerland water supply is assessed within this section. Consideration in this assessment is given to the location of the contaminant in the watershed, the travel time, concentration of contaminant, the volume of contaminant and its prevalence to survive in the watershed.

For the purposes of characterizing the risks facing Summerland's drinking water supply, we assessed the risks in the watershed based on consideration of the following critical factors:

1. The potential for the risk to cause illness as documented in Section 4;
2. The potential for the contaminant to reach the stream or reservoir-lake;
3. The volume of the contaminant and the location of the contaminant within the watershed.

Consideration of the preceding factors resulted in the assessed risk to the Summerland drinking water supply. Within the water courses, there is the ability of the larger reservoirs to mitigate and buffer the impacts of some of the risk events. Turbidity and fecal contamination contributed to Trout Creek above Thirsk Reservoir, depending on time of year, can have settling times ranging between several hours to several months.

The risk of the contaminant is also affected by the treatment processes that are in place prior to the water entering the water distribution system. Summerland has a Water Treatment Plant in place that substantially reduces the risks, however, there is a bypass valve that opens when water demands are greater than the capacity of the Water Treatment Plant. Separation of the water distribution system will reduce the possibility of this valve opening.

5.3 EXISTING BARRIERS

The District of Summerland has three water sources upon which they draw for drinking water. The primary source is Trout Creek. Emergency supply is provided by two groundwater wells located at the fairgrounds. Trout Creek supplies 90% of the annual volume of water. Garnet Reservoir is the other source that supplies only 10% of the total annual volume.

TROUT CREEK WATER TREATMENT PLANT

The Trout Creek Water Treatment plant is not specifically included in the hazard and risk evaluation, but is provided to add perspective to the barriers that Summerland has in place below the watershed.

Treatment in the form of an advanced *Actiflo* Water Filtration Plant is in place for the Trout Creek source. This WTP has the capacity to treat 75 ML/day. The maximum daily demand (MDD) has reached 102 ML/d. Therefore the potential exists for water of lower quality to be introduced into the water system during high demand periods in the summer months. In 2009, the Prairie Valley area was separated so that untreated irrigation water could be supplied to this area by bypassing the WTP. This reduced the MDD by 13 ML/day which reduced the potential MDD on the WTP from 102 ML/day to 89 ML/day. This results in less potential days when water would be required to bypass the WTP, thus reducing the risk to Summerland domestic customers. After filtration, the water is disinfected with gas chlorine prior to entering the 6,000 m^3 clear well at the WTP.

Typically, the regulators give 3 log inactivation credit for protozoa removal/inactivation for a filtration plant with half log credit for the disinfection process that follows. All water that is treated through this WTP process would have 3 log protozoa inactivation credit.

TROUT CREEK RESERVOIR

Trout Creek Reservoir is located immediately upstream from the Water Treatment Plant. The reservoir holds 69 ML of live storage and approximately 270 ML of total storage. Hydraulic details of the reservoir are listed in Appendix C of this report. The reservoir provides buffering storage for creek flows and affords Summerland some variation in water demand while allowing the releases to lower Trout Creek to remain relatively stable.

Turn-over time (ignoring short circuiting) created by the reservoir is 60 hours during typical summer demands. During the off-season from irrigation, the settling time is increased substantially to approximately 40-50 days.

THIRSK RESERVOIR

Thirsk Reservoir is located approximately 37 km upstream from the Water Treatment Plant. The reservoir was recently raised and holds 6,490 ML of storage. The reservoir buffers the sediment and contamination from the 236 km^2 of watershed above the reservoir. The area provides a buffer for both high turbid flows and for silt and sediment erosion to the lower creek channel. The highest risk areas in the watershed are located below Thirsk Reservoir as the reservoir does not provide buffering to the lower areas. Hydrological details for Thirsk Reservoir and catchment area are presented in Appendix C.

AUTOMATED CONTROL GATES ON TROUT CREEK (FUTURE)

Automated control at the Trout Creek intake is planned as Project No. 21 in the 2008 Master Water Plan. The project cost was estimated at $185,000 and will allow Summerland to control inflows to Trout Creek Reservoir, based on water quantity and water quality parameters. Power supply must be extended to the intake gates to provide electricity to open and close the intake gates, to power the flow monitoring devices, to monitor releases to lower Trout Creek, and to run water quality instrumentation equipment. Sampling parameters to be measured at the creek intake include turbidity, pH, temperature, conductivity and Dissolved Organic Carbon (DOC). The intake gates would automatically shut off in the event of compromised water quality in Trout Creek. This project is in the works as part of the 2008 Summerland Water Master Plan.

GARNET RESERVOIR

Garnet Reservoir is located at elevation 629 metres which is the starting hydraulic grade line for the pressurized Garnet Valley water supply system. The reservoir is 2,360 ML in size and supplies the annual water demand requirements to the Garnet Valley. Hydraulic details are provided in Appendix C. The reservoir provides 10 months of settling time under summer demands and much longer times under winter demands.

5.4 RISK ASSESSMENT PROCESS

This section integrates the identified hazards with the sensitivities of the physical aspects of the watershed. Included is a summary of the highest risks and a recommended approach for addressing those risks.

Figure 5.1 shows the watershed sensitivity and water corridors in the Eneas and Trout Creek watersheds. The corridors are highlighted with yellow, orange and red shading.

Yellow Corridors: The yellow corridor areas of lower sensitivity and risk are those areas that are buffered with a larger on-line storage reservoir such as Thirsk Reservoir or Garnet Reservoir.

Orange Corridors : The orange corridors are considered to be of medium sensitivity and risk as these areas are either buffered by dilution from Trout Creek, which is larger, or they are creek corridors that are a further distance away from the intake. The sub-tributaries to Trout Creek have less activity on them, are sometimes completely dry in the summer, and provide minimal inflow to Trout Creek which is fed in the summer primarily from releases at Thirsk Reservoir.

Red Corridors: The red corridors along the creeks identify the areas of highest sensitivity in the watershed. In these areas, the water flows with significant volume directly by the District of Summerland water intake(s). The areas of highest sensitivity are the main stem of Trout Creek from Thirsk Reservoir to the intake and through the agricultural land in the Darke Creek Valley.

For assessing the cumulative risk and priorities, the equation from Section 5.2 is utilized.

RISK = LIKELIHOOD OF OCCURRENCE X CONSEQUENCE OF OCCURRENCE

The "*Likelihood of Occurrence*" is the product of the presence of the contaminant (hazard from report Section 4) and of the watershed sensitivity (Figure 5.1).

LIKELIHOOD OF OCCURRENCE = WATERSHED SENSITIVITY X PRESENCE OF CONTAMINANT

The consequences of a risk are generally the potential for waterborne disease illness to occur, poisoning from a chemical spill or algae toxin, or the long term cumulative effect from exposure to THMs that can form from the disinfection process.

The high and very high hazards listed in Table D.1 are plotted in conjunction with the highly sensitive areas illustrated in Figure 5.1. The highest risk contaminants to the District of Summerland is tabulated in Table 5.1 and illustrated in Figure 5.2. A large scale version of Figure 5.2 is included in Appendix A as Figure A.2.

Please note that Table 5.1 is sorted by site location for ease of reference. The table does not list the data in priority order as all are considered to be of highest priority risk.

Table 5.1 - Risk Reduction Priorities

Site ID	Contaminant	Distance to Water	Contaminant of Concern	Comments
192	Trout area all along the Hwy. 40 corridor is sporadically fenced giving little protection from contaminated laden runoff that drains in to the Trout Creek water course Photo is taken from Hwy. 40 at road marker sign 24K	< 15 metres	surface runoff that increases turbity and soil erosion and bed load in Creek	Cattle can access Trout Creek. High risk of bacteriological contamination
193	Photo shows open cattle access to Trout Creek and water source fro cattle access.	< 15 metres	Cattle, fecal contamination, pathogens	Cattle can access Trout Creek. High risk of bacteriological contamination
194	Horse paddocks along side creek giving horses and other livestock direct access to Trout Creek.	< 15 metres	Horses, fecal contamination and pathogens	Livestock can access Trout Creek. High risk of bacteriological contamination
195	Standing water in paddock area, direct drainage to Trout Creek, no apparent berm protecting from effluent flows.	< 15 metres	Horses, fecal contamination and pathogens	High risk of bacteriological contamination
196	Trout Creek Ranch cattle pens all draining towards the creek	< 15 metres	Cattle, fecal contamination, pathogens	High risk of bacteriological contamination
197	Trout Creek Ranch cattle pens all draining towards the creek	< 15 metres	Cattle, fecal contamination, pathogens	High risk of bacteriological contamination
267	Intake Flume	< 15 metres	not secure, human contamination	Security risk as flume is open and accesible to public
270	* District has limited communication with Band, squatter problems and influence on intake. Summer camping location for natives, debris control even a huge issue.	< 15 metres	debris, human waste, pathogens, livestock and fecal matter	Human activity in the proximity of water body very close to water distribution system intake
275	* Vulnerable creek (500m) upstream of intake on native land and and also a party spot for all. NOT FENCED, SHOULD BE.	< 15 metres	debris, human waste, pathogens, livestock and fecal matter	Human activity in the proximity of water body very close to water distribution system intake
281	Horse coral and paddock above well No. 28501. Trailer (caretaker resident – Darrold)	15 - 100 metres	fecal matter, pathogens	Geotech report addresses this
282	Trout creek flume --- Summerland main reservoir. Trans Canada trail – fast traffic & horse manure evident.	< 15 metres	fecal matter, pathogens	Risk of bacteria and materials to be washed towards flume or Trout Creek Reservoir
289	Example of domestic dwellings on Summerland Princeton - Hwy 40 Trout Creek running next settlements.	< 15 metres	human waste, pathogens from septic tank	Human activity near water body
290	Horse paddocks	< 15 metres	fecal matter, pathogens	Potential runoff towards creek with risk of bacteriological contamination
291	Open cattle gathering area, unfenced bowl around creek.	< 15 metres	fecal matter, pathogens	Risk of bacteriological contamination
292	12.1Km (McNulty Rd) – 3 empty fuel tanks and cattle.	15 - 100 metres	chemical/fuel spill plus fecal matter, pathogens	Cattle is the highest risk
314	No fencing next creek, Huge exposure – cattle.	< 15 metres	Cattle, pathogens	Risk for bacteriological contamination
315	21.7Km – Broken bridge into creek, cattle, unfenced, possible erosion Issue at bridge site.	< 15 metres	Cattle, pathogens	Risk for bacteriological contamination
316	24.2Km Camp Creek – cattle on both sides of low land on regular basis.	< 15 metres	cattle pathogens	Risk for bacteriological contamination
326	Faulder Community - Septic tanks	15 - 100 metres	Human waste, pathogens	Risk for bacteriological contamination
327	Meadow Valley Agriculture - livestock	15 - 100 metres	cattle pathogens	Risk for bacteriological contamination
328	Algae Blooms, Thirsk and Garnet Reservoirs	< 1 metre	algae toxins	Risk of algae toxins, blue-green variety linked to alzheimers
329	Wildfire	< 15 metres	nutrient release to source water storage reservoirs and creeks	Loss of community water supply potential

Note that the majority of risks identified fall into one of following four categories:

1. Range activities and management of cattle, horses and livestock along the lower creeks;
2. Human wastes and practices such as Sites 270, 282, 292, and 326;
3. Nutrient based risks such as 192 and 328;
4. Security of intake facilities.

With the water treatment plant, Summerland has good barriers in place, however, the formation of algae blooms in the Thirsk and Garnet Reservoirs is possible and the WTP provides minimal protection from algae toxins which can be in a dissolved form. The WTP provides no protection for the source water originating from Garnet Reservoir.

Risk Reduction Recommendations

To develop means and methods with which to reduce the risks, the range work must be done in conjunction with other stakeholders in the watershed. The following is recommended:

- On the cattle and range issues, work proactively with the Ministry of Forest and Range staff. Their staff is available to work through risk reduction methods for cattle activities including range practices, liaison with the range lessees, and installation of cattle guards and fencing at appropriate locations;
- With respect to human wastes, the activities in the watershed fall under the jurisdiction of land use bylaws of the Regional District of Okanagan Similkameen, or if on Provincial Crown lands, then under the authority of the applicable Provincial Ministry. Human wastes such as failed septic fields fall under the jurisdiction of the Interior Health Authority, however monitoring is required to prove that there is a failure;
- Nutrient-based wastes can be caused by human activity, however the majority is influenced by natural factors. Monitoring is required for contaminant recognition, risk management and risk reduction;
- The improvement of water intake facility with regards to monitoring and controls is identified in the 2008 Master Plan as a medium priority project.

The majority of costs associated with the risk reduction are related to fencing costs and staff time to create partnerships with external agencies. Costs for fencing and range management should be an annual allowance for contribution towards works that would be carried out in conjunction with other stakeholders. Cost estimates for the works are listed in Section 6. Only nominal costs are recommended for remediation of the works as funding for remedial works should come from a number of funding sources.

5.5 POTENTIAL IMPACTS OF CLIMATE CHANGE

Although there is an extensive body of international reports related to the cause of global warming, there is no dispute that in the last century, the earth is getting warmer. The heating of the earth is expected to change weather patterns and cause more extreme weather events both in the form of droughts and flooding.

The expected impact as they related to the watersheds, water supply, and drinking water are as follows:

- The best available model that was assembled as part of the Okanagan Water Supply and Demand Study predicts that the long term trend with global warming will be the same amount of annual precipitation for the Okanagan Basin, however, there will be less snowpack, more rainfall, and an earlier spring runoff of what snow there is;
- With warmer air, the air has the capacity to hold more water vapour resulting in a greater volume of rainfall and potentially more extreme weather events. Resulting higher runoff flows would create higher silt and sediment deposition, particularly in the steeper channel sections;
- Snow packs may lessen so the storage of the spring water supply will lessen. This means that water utilities will have to rely on storage earlier in the year as the growing season may extended to a longer period;
- Additional storage may be needed to collect the rainfall in the shoulder seasons;
- Additional silt and sediment for extreme wet events poses the risk of challenging treatment facilities and increasing turbidity in the water.

There should be time to react to the changes. Adaptation is key to addressing the perceived challenges for the foreseeable future. If drought conditions occur with increased frequency, then the development of additional storage in the upper watershed will become a higher priority.

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6 WATERSHED FACILITIES ASSESSMENT

6.1 INTRODUCTION

This section provides an assessment of existing licenses, existing watershed facilities and recommended steps for facility improvement. An inspection of the District of Summerland dams was carried out and is summarized in this section. A review of hydrometric information and hydrometric monitoring is provided as are recommendations for water quality monitoring in the watershed.

Although not specifically part of a water source assessment, the information provided forms part of the overall Summerland Watershed Master Plan.

6.2 WATER LICENSING AND STORAGE

This section is an extension of the water licensing review works carried out in the 2008 Water Master Plan for the District of Summerland. A summary of water licenses held by Summerland is provided in Appendix C. The District currently holds licensing for Irrigation (IRR), domestic water supply (Waterworks Local Authority (WWLA)), and storage (STO) to support the IRR and WWLA licenses. A summary of the licenses held is presented in Table 6.1.

Table 6.1 - Summary of Existing District of Summerland Water Licenses (ML)

License Type	Trout Creek Watershed	Eneas Creek Watershed	Total	Estimated Usage	% of License Used
IRR Irrigation	17,197	3,730	20,926	8,600	41%
WWLA Waterworks Local Authority	1,390	0	1,390	3,800	100%
Storage	15,974	2,910	18,883		0
Total Consumptive Licenses	18587	3730	22316	12400	55%

All licenses are presented in ML (megalitres or 1000 cubic metres)

Table 6.2 - Summary of All Water Licenses in Watershed (ML)

License Type	Summerland	All Others	Total	% held by DoS
IRR Irrigation	20,926	2351	23,277	89.9 %
WWLA Waterworks Local Authority	1,390	88	1,478	94.0 %
Storage	18,883	1425	20,308	93.0 %

All licenses are presented in ML (megalitres or 1000 cubic metres)

As shown in the tables above, the District of Summerland holds the majority of water licenses in the Trout Creek watershed. The next largest licensee is the Meadow Valley Irrigation District which utilizes

water from Darke Creek and Darke Lake to irrigate pasture and hay land in the Darke Creek Valley approximately 3 miles north of Faulder.

A rationalization of licenses is necessary for the District of Summerland for two specific reasons:

1 One is to have sufficient licensing in the correct categories. The total overall licensed capacity for Summerland is sufficient for the foreseeable future: however, there is insufficient licensed capacity for the WWLA component for both the Trout Creek and Eneas Creek water sources. The total annual licensed capacity is listed in Table 6.1 along with current dry year usage. We believe that Summerland should allocate approximately 4500 ML annually for WWLA from Trout Creek and another 500 ML annually to be withdrawn from Garnet Reservoir (Eneas Creek);

2 The second component is the rationalization of licensed versus actual storage volumes. Table 6.3. The information presented in the Table is a summary of the licensed versus actual storage volumes. Recommended adjustments are listed in the table.

Table 6.3 provides a summary of water storage licenses held and actual usable storage volumes within each of the District of Summerland holding reservoirs.

Table 6.3 - Water Storage License Required Rationalization

Reservoir	Licensed Storage Volumes and Licence No.					TOTAL LICENSE HELD	ACTUAL STORAGE	Licensed Surplus + Shortfall (-)	Comments
Thirsk Reservoir	2466	3243				5709	6490	**-781**	Additional Licensing required to match actual
Lic. No.	C106027	C014568							
Eneas Reservoir-Lake	444	C056869				444	148	296	758 ML of dead storage exists
Whitehead Reservoir	429	308	274	432		1443	1216	227	Hold surplus for raising
	C034400	C030787	C030786	C016414					
Headwaters, HW 1	1233	314	617	3699	925	6788	4472	2316	Transfer license to Thirsk storage shortfall, hold rem. for raising
	C034399	C034398	C016414	C016414	C019847				
Garnett Reservoir	2466	C016416				2466	2360	106	Close - no adjustment required
Isintok Reservoir	1665	C016414				1665	1384	281	Hold in case of raising Isintok
Tsuh Reservoir	370	C016414				370	308	62	Close - no adjustment required
CURRENT TOTALS						**18885**	**16378**	**2507**	

The recommendation is to adjust only one or two licenses on Headwaters (HW No. 1) and allocate that storage to Thirsk Reservoir. The storage at Eneas, Isintok, Whitehead, and Tsuh are adequate and allow a small surplus if Summerland wishes to raise any of these reservoir-lake levels.

6.3 WATERSHED INFRASTRUCTURE ASSESSMENT

This section provides a review of District of Summerland assets in the watershed. These assets include the dams, spillways, gates, access roads and facilities needed to operate and maintain control of the water resources in the watershed.

With the exception of Thirsk Dam, which was recently reconstructed and completed in 2007, the majority of the Districts dams were rebuilt in the late 1960s and early 1970s. Fortunately, the majority of water retaining structures are earth-embankment dams and are relatively small structures. As a result, the hydrostatic head creating stress on the dams is relatively low.

As part of the annual dam safety review, Agua staff conducted two trips to the District of Summerland facilities at the same time that the Watershed Assessments were being carried out.

- ☐ November 4, 6, 13 & 14, 2008 by Mr. Bruce Wilson (Agua) and Scott Lee, Senior Operator for the District of Summerland reviewed the dams, overall watershed areas and risks;
- ☐ July 29, 2009, by Bob Hrasko (Agua) and Shawn Hughes, Senior Operator for the District of Summerland reviewed the dam structures and specific watershed risks;

Dam safety inspection forms were filled out for each dam structure with the exception of Thirsk Dam which requires more in-depth review due to its *Very High Consequence* rating. Items requiring maintenance are listed in Table 6.4 along with an estimate of capital costs to carry out the works and annual operating costs required to maintain the dams. Gates, dam slopes, concrete structures and other infrastructure components were all reviewed under this task.

Operating costs are considered to be an annual expense. Capital costs listed are a one-time capital expenditure that is not required every year.

A priority rating for upgrades is provided in Table 6.4.

Table 6.4 - Watershed Infrastructure Cost Summary

Location and Description	O & M Cost	Capital Cost	Extension	Priority
Isintok Dam and Reservoir Improvements				
Minor brushing on upstream toe of dam	$ 1,500.00	$ -	$ 1,500.00	H
Erosion at Upstream toe of Rip rap	$ -	$ 20,000.00	$ 20,000.00	M
Security Fencing at Dam entrance	$ -	$ 10,000.00	$ 10,000.00	M
Clear Downstream Vegetation (minor)	$ 1,500.00	$ -	$ 1,500.00	M
Flow measurement at outlet weir	$ -	$ 5,000.00	$ 5,000.00	M
Gate tension - diver investigation	$ 2,000.00	$ -	$ 2,000.00	H
- allowance for remediation	$ -	$ 15,000.00	$ 15,000.00	L
Remove Debris on Upstream Dam Face (1 man-day)	$ 750.00	$ -	$ 750.00	M
Sum for Isintok Reservoir Works	$ 5,750.00	$ 50,000.00	$ 55,750.00	
Thirsk Dam and Reservoir Improvements				
Graffitti to remove	$ 750.00	$ -	$ 750.00	M
Divert Outlet water away from DI pipe (place rocks)	$ -	$ 5,000.00	$ 5,000.00	H
Cavitation Potential and Groaning noise (Allowance)	$ -	$ 15,000.00	$ 15,000.00	H
Removal of logs and debris at Spillway	$ -	$ 25,000.00	$ 25,000.00	L
	$ -	$ -	$ -	
Sum for Thirsk Reservoir Works	$ 750.00	$ 45,000.00	$ 45,750.00	
Garnet Dam and Reservoir Improvements				
Toe Rip Rap Lining	$ -	$ 12,500.00	$ 12,500.00	M
Dam Crest Stability Survey (set marker posts)	$ -	$ 5,000.00	$ 5,000.00	M
Energy Dissipator - cracks to patch	$ 3,000.00	$ -	$ 3,000.00	M
Spillway - Rip Rap realignment at road	$ -	$ 5,000.00	$ 5,000.00	L
	$ -	$ -	$ -	
Sum for Garnet Reservoir Works	$ 3,000.00	$ 22,500.00	$ 25,500.00	
Whitehead Dam and Reservoir Improvements				
Form and repair concrete wing wall on Spillway	$ -	$ 5,000.00	$ 5,000.00	M
Minor brushing on Downstream toe of dam	$ 1,500.00	$ -	$ 1,500.00	M
Measuring weir on release structure	$ -	$ 5,000.00	$ 5,000.00	M
Excavate upstm side of spillway channel	$ 5,000.00	$ -	$ 5,000.00	M
	$ -	$ -	$ -	
Sum for Whitehead Reservoir Works	$ 6,500.00	$ 10,000.00	$ 16,500.00	

Table 6.4 - Watershed Infrastructure Cost Summary (Continued)

Location and Description	O & M Cost	Capital Cost	Extension	Priority
Crescent Dam and Reservoir Improvements				
Grout on Spillway	$ 750.00	$ -	$ 750.00	M
Erosion repair along reservoir full pool level	$ -	$ 12,500.00	$ 12,500.00	L
Water Level markers at release gate	$ 500.00	$ -	$ 500.00	M
Brushing - moderate brushing required	$ 3,500.00	$ -	$ 3,500.00	M
Measuring weir on release structure	$ -	$ 5,000.00	$ 5,000.00	M
Sum for Crescent Reservoir Works	$ 4,750.00	$ 17,500.00	$ 22,250.00	
Headwaters No. 1 Dam and Reservoir Upgrades				
Measuring weir on release structure	$ -	$ 3,500.00	$ 3,500.00	M
Erosion at Corner of Spillway to repair	$ 1,500.00	$ -	$ 1,500.00	H
Brushing on Dwnstream Slope of Dam Face	$ 2,500.00	$ -	$ 2,500.00	M
Seepage on Dwnstrm side near spillway, mainten.	$ 2,500.00	$ -	$ 2,500.00	M
	$ -	$ -	$ -	
Sum for Headwaters No. 1 Reservoir Works	$ 6,500.00	$ 3,500.00	$ 10,000.00	
Headwaters No. 2 Dam and Reservoir Upgrades				
Wave erosion to repair	$ -	$ 7,500.00	$ 7,500.00	M
Minor shrubs to pull on dam face	$ 500.00	$ -	$ 500.00	M
Water elevation markers req'd on gate wheel stem	$ 500.00	$ -	$ 500.00	M
Rocks in spillway	$ 500.00	$ -	$ 500.00	L
Moderate brushing, right side of dwnstm face of dam	$ 2,000.00	$ -	$ 2,000.00	M
Major Brushing, left side of outlet	$ 3,000.00	$ -	$ 3,000.00	H
Sum for Headwaters No. 2 Reservoir Works	$ 6,500.00	$ 7,500.00	$ 14,000.00	
Headwaters No. 3 Dam and Reservoir Upgrades				
Road through spillway channel, large culvert or bridge deck reqd	$ -	$ 7,500.00	$ 7,500.00	H
Rocks in outlet stilling basin	$ 500.00	$ -	$ 500.00	L
Left dwnstm embankment at toe, brushing req'd	$ 2,500.00	$ -	$ 2,500.00	M
Bike path on dam face to be removed, reseeding req'd	$ 1,500.00	$ -	$ 1,500.00	H
signage required	$ 500.00	$ -	$ 500.00	M
Sum for Headwaters No. 3 Reservoir Works	$ 5,000.00	$ 7,500.00	$ 12,500.00	

Table 6.4 - Watershed Infrastructure Cost Summary (Continued)

Location and Description	O & M Cost	Capital Cost	Extension	Priority
Headwaters No. 4 Dam and Reservoir Upgrades				
Timber and deadfall at outlet location to be removed	$ 1,500.00	$ -	$ 1,500.00	H
Significant seepage below outlet structure	$ -	$ 10,000.00	$ 10,000.00	H
Gravel around gate stem, to be removed	$ 1,000.00	$ -	$ 1,000.00	M
minor erosion upstrem, small trees and shrubs to pull off of the dam face	$ 1,500.00	$ -	$ 1,500.00	H
Sum for Headwaters No. 4 Reservoir Works	$ 4,000.00	$ 10,000.00	$ 14,000.00	
Miscellaneous Protection Programs				
Cattle Fencing (Allowance - Partnership with Range)	$ -	$ -	$ -	
- allowance per year	$ 5,000.00	$ -	$ 5,000.00	H
Community Wildfire Protection Plan		$ 75,000.00	$ 75,000.00	M
Contingency Fund	$ -	$ 100,000.00	$ 100,000.00	L
Sum for Miscellaneous Protection Programs	$ 5,000.00	$ 175,000.00	$ 180,000.00	
SUMMARY OF WATERSHED WORKS				
Isintok Dam and Reservoir Improvements	$ 5,750.00	$ 50,000.00	$ 55,750.00	
Thirsk Dam and Reservoir Improvements	$ 750.00	$ 45,000.00	$ 45,750.00	
Garnet Dam and Reservoir Improvements	$ 3,000.00	$ 22,500.00	$ 25,500.00	
Whitehead Dam and Reservoir Improvements	$ 6,500.00	$ 10,000.00	$ 16,500.00	
Crescent Dam and Reservoir Improvements	$ 4,750.00	$ 17,500.00	$ 22,250.00	
Headwaters No. 1 Dam and Reservoir Upgrades	$ 6,500.00	$ 3,500.00	$ 10,000.00	
Headwaters No. 2 Dam and Reservoir Upgrades	$ 6,500.00	$ 7,500.00	$ 14,000.00	
Headwaters No. 3 Dam and Reservoir Upgrades	$ 5,000.00	$ 7,500.00	$ 12,500.00	
Headwaters No. 4 Dam and Reservoir Upgrades	$ 4,000.00	$ 10,000.00	$ 14,000.00	
Miscellaneous Protection Programs	$ 5,000.00	$ 175,000.00	$ 180,000.00	
Sum of Watershed Works	$ 47,750.00	$ 348,500.00	$ 396,250.00	

6.4 HYDROMETRIC MONITORING RECOMMENDATIONS

Hydrometric monitoring of both Trout and Eneas Creek is required to determine both the natural and managed hydrological flow in both of these sources. With better base data, better forecasting and operational decisions can be made for maintaining a reliable water supply for Summerland. With improved data, better decisions can also be made in determining the best value for future capital expenditures.

Hydrometric mapping has been extensively reviewed in recent years with a strong lobby effort made to the Province to maintain and upgrade the hydrometric network. The network, which at one time had 150 Water Survey of Canada flow monitoring stations within the Okanagan, has now less than 30 stations in the valley. There are now many privately operated stations that are not recognized by Water Survey of Canada. These stations, which are operated usually by private utilities, provide reliable and key data in understanding the hydrology in the region. There is presently incomplete data for the basin, particularly at the mid-level elevations.

The 2008 Water Master Plan recommended an additional station to be re-established on Bull Creek at the site of the previous WSC Station, No. 08NM133. The other key piece of information was the collection of data where water was flowing over the reservoir spillways in the spring. This data is important in that it provides the missing information as to how much runoff water is produced on an annual basis from each of the reservoir sub-catchment areas. Spillway monitors were recommended for five reservoirs. One modification to the recommendation in the 2008 Water Master Plan is to relocate the proposed thalimedes device from Crescent Reservoir to Garnet Reservoir.

Presently, there is only one on-line WSC station operating in the watershed at Camp Creek. The link to the station on the web is provided below. The station is critical to Summerland and DFO as the operating rules for the Water Use Plan for Trout Creek are dependent on naturalized flow measured at Camp Creek.

Link to WSC on-line station at Camp Creek http://scitech.pyr.ec.gc.ca/waterweb/formnav.asp?lang=0

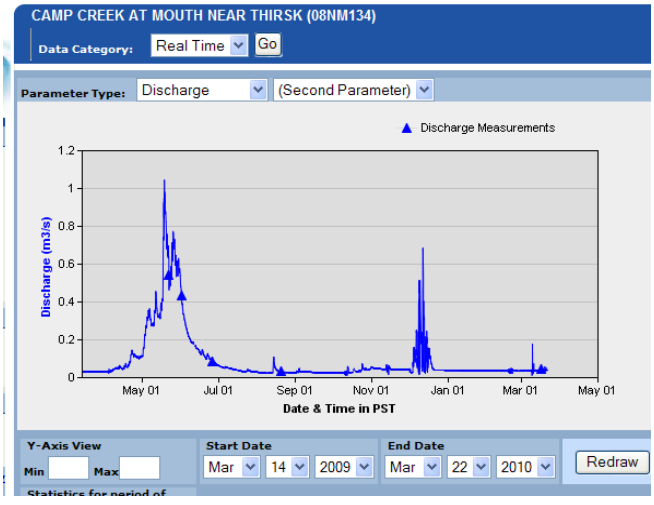


Figure 6.1 - Hydrometric Station Locations – Trout and Eneas Creek Watersheds

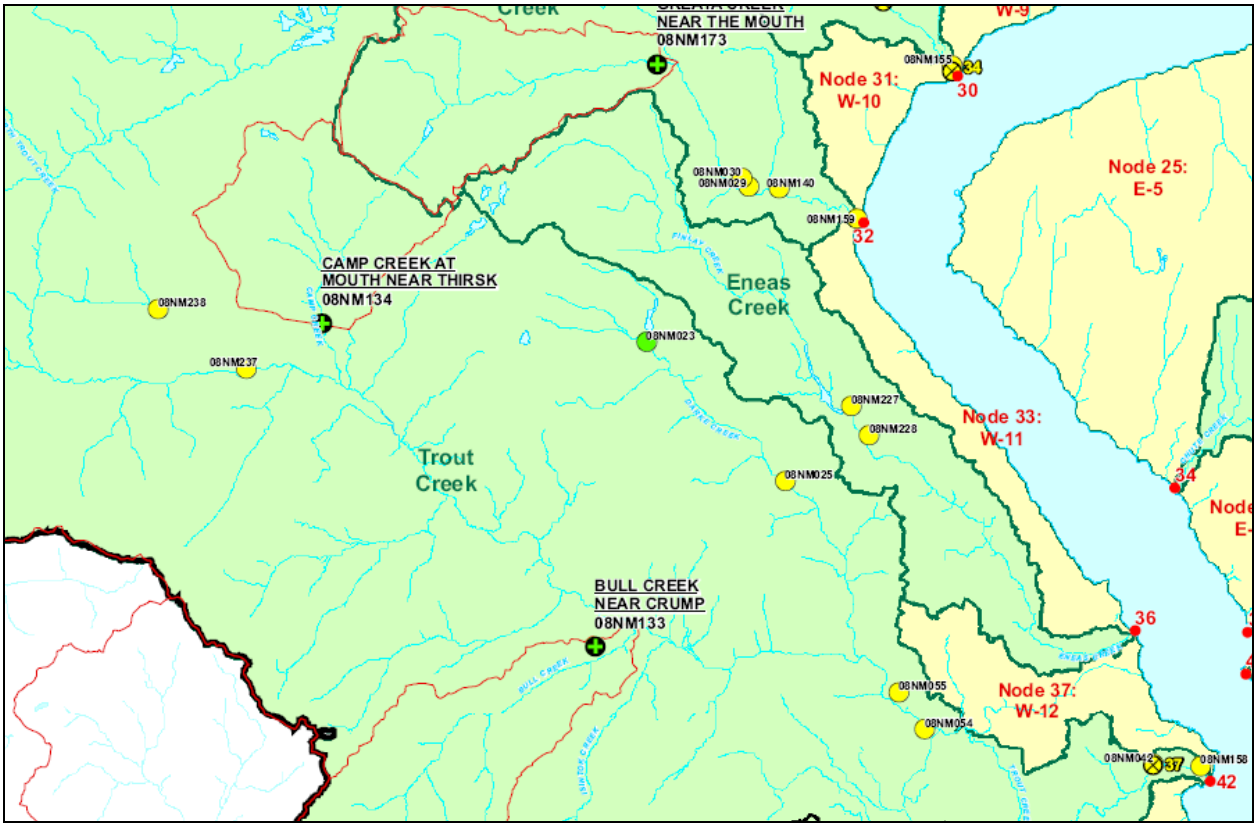


Table 6.5 - Summary of Active and Discontinued Stations

Location Description	Stn No.	Operation by	Natural or Regulated	Active or Discontinued	Years of Record
Trout Creek Near Thirsk Reservoir Outlet	08NM238	WSC	Reg.	Discontinued	1979-87
Trout Creek Mainstem below Thirsk	08NM237	WSC	Reg.	Discontinued	1936-78
Darke Creek at Meadow Valley	08NM025	WSC	Reg.	Discontinued	1921-22
Trout Creek Mainstem at Summerland Diversion	08NM055	WSC	Reg.	Discontinued	1922-31
Trout Creek Mainstem near Faulder	08NM054	WSC	Reg.	Discontinued	1921-54
Camp Creek at Mouth near Thirsk	08NM134	WSC	Nat.	Active	1965-2007
Bull Creek near Crump	08NM133	WSC	Nat.	Discontinued	1965-86
Darke Creek, NW fork	08NM023	WSC	Nat.	Discontinued	1921-22
Trout Creek at Mouth	08NM158	WSC	Reg.	Discontinued	1969-82
Trout Creek at Canyon, old WSC stn	08NM042	MOE	Reg.	Active	1920-28, 2004-07
Eneas Creek at Outlet to Garnet Reservoir	08NM227	WSC	Reg.	Discontinued	1973-81
Eneas Creek downstream of Garnet Reservoir	08NM228	WSC	Reg.	Discontinued	1974-75

Table 6.6 below provides a form for tracking and maintaining an inventory of the hydrology at specific reservoir storage sites. Reservoir size, level from previous year, and amount flowing over the spillway are manually entered in the green cells. As adjustments are made through the year with releases from dams, the amount of water that is released is recorded and compared to reservoir elevations. The difference in flow between releases and reservoir storage indicates if there is water still being supplied to the reservoir from above or if there are losses through the summer due to evaporation. This type of tracking will provide insight into how much water is produced by each sub-basin. The spillway recorded data can be tied to snow pillow data so that forecasting for the upcoming year is more accurate and the upper watersheds are better understood.

Table 6.6 - Example Operational Form for Reservoir Monitoring

Reservoir High Water Level and Volume							31.4	5537			
Reservoir Level at end of Previous Year							27.5	4240			
Reservoir Level at Start of Year							31.4	5537			1297
Enter Volume of Water Recorded over spillway during year (input thalimedes summary)											3215
Storage Release Summary											
Date	No. of Days	Gauge Reading Before	Gauge Reading After	Release Rate (ML/day) Before	Release Rate (ML/day) After	Ave Release Rate over Period (ML/day)	Reservoir Level (ft)	Remaining Reservoir Storage Vol. (ML)	Change in Storage (ML)	Natural Supply (+)Supply or (-) Loss (ML)	Basin Outflow Rel. Rate x No. Days (ML)
16-Jul-09	0	0.45	0.45	23	23		31.4	5537	0	0	0
20-Jul-09	4	0.45	0.8	23	54	23	31	5445	-92	0	92
10-Aug-09	20	0.33	0.33	49	49	51.5	28	4394	-1051	-21	1030
12-Aug-09	2	0.77	0.33	49	22.5	49	27.5	4240	-154	-56	98
09-Sep-09	28	0.33	0	22	0	22.25	27.5	4240	0	623	623
Shut off releases, September 9, 2009											
Days Release	54							Net Reservoir Change for Season	-1297		
Natural Inflow (+) or Loss (-) to Reservoir during release period										546	
Watershed Runoff Produced for Period of Record (ML)											6355

Calculated Cell | Data Entry cell

Recommendations for hydrometric monitoring are as follows:

- Monitor flows at three locations on the Trout Creek Main stem including release at Headwaters No. 1 dam, at release of Thirsk Reservoir and at the spillway at the Trout Creek diversion structure;
- Monitor flows at one location at Garnet Reservoir, which is the spillway for the reservoir;
- Monitor naturalized flows at two locations, the existing Camp Creek station and at a reinstated station on Bull Creek;
- Monitor sub-basin flows by recording spillway releases at District reservoirs including Thirsk Reservoir, Isintok Reservoir and Whitehead Reservoir.

The preceding information tracked and summarized will provide Summerland with the monitoring data that is needed to understand the reservoir and hydrological contribution from various elevations in the watersheds.

6.5 WATER QUALITY MONITORING RECOMMENDATIONS

A baseline of water quality data is required to monitor if there are changes to the source water. If the Province grants approval for a specific activity within the watershed, the District should have a baseline of water quality data prior to the land use changes, for comparison. This then puts the onus on the new activity to not have a detrimental effect on the raw water quality.

With the water treatment plant now functional, a great deal of staff time and operating costs is necessary to optimize and maintain this facility. There is a danger that too high a trust will be placed on this single barrier. Continued water quality monitoring in the watershed forms an early warning system for risks and contamination that will challenge the treatment barriers and disinfection system.

Table 6.7 provides a summary sheet of water quality parameter that should be tested from the distribution system, back through the WTP, to the intakes and into the upper watershed reservoirs. The only notable changes are:

1. Testing for disinfection by-products, which should include the testing for halo acetic acids (HAAs) after disinfection for both the Garnet and Trout Creek sources, and;

2. Testing for *Cryptosporidium* and *Giardia*, only at the Garnet Reservoir outlet. With the filtration plant in place, Garnet Reservoir does not have UV disinfection or filtration. Testing should be carried out at the times of highest E.Coli readings during the year to see if *Cryptosporidium* oocysts or *Giardia* cysts are present. Several rounds of testing should be carried out to determine if the buffering provided by Garnet Reservoir is sufficient to have a dampening effect and some protection for these protozoa. If the system is to be twinned in the near future, the monies may be better spent on the capital cost of separating the Garnet Valley water distribution system;

3. Algae testing is recommended at Garnet Reservoir and at Thirsk Reservoir in the late summer. Temperatures through the water column in both reservoirs should be collected to determine the level at which the reservoirs stratify. This may provide some insight to whether an anaerobic zone forms within Thirsk. Algae blooms are known to occasionally form in Garnet Reservoir.

Table 6.7 - Water Quality Monitoring Program

LOCATION / SITE	Frequency: ON-LINE	DAILY	2 x PER WEEK	WEEKLY	2 X PER MONTH	MONTHLY	QUARTERLY	2 X PER YEAR	ANNUALLY	Comments
WATER DISTRIBUTION SYSTEM										For water entering or within WD system
Chlorine Residual										at various locations. On-line may be where
Turbidity										water leaves WTP clearwell.
Chlorine Residual										
Temperature										
Total Coliforms										Sampled at various locations within WD system
E.coli										
DPBs THMs and HAAs										4x per yr, reduce to 2x once baseline is established
WATER TREATMENT PLANT										
pH										
Turbidity										
Particle Counts										
Conductivity										
Temperature										
Total Coliforms										Sample at leaving WTP clearwell
E.coli										Sample at leaving WTP clearwell
Colour										
TOC										
UVT										
Alkalinity and Hardness										
WATER INTAKES ON SOURCES										
Total Coliforms										
E.coli										
pH (future)										Creek intake instrumentation dependant on
Turbidity (future)										power to intake site.
Conductivity (future)										
Temperature (future)										
Dissolved Organic Carbon (future)										
Full Parameters										
WATERSHED										
Total Coliforms										Sample raw water at key locations
E.coli										Sample raw water at key locations
Algae at Thirsk and Garnett										Monthly - Summer months only
Cryptosporidium and *Giardia*										Garnet Reservoir outlet only, at time of highest *E.coli*
Full Parameters in Res-Lakes at surface and at Depth										two times during summer months
Reservoirs include Thirsk, Isintok, Whitehead, Crescent, HW outlet, Garnet										Carry out sufficient to determine baseline

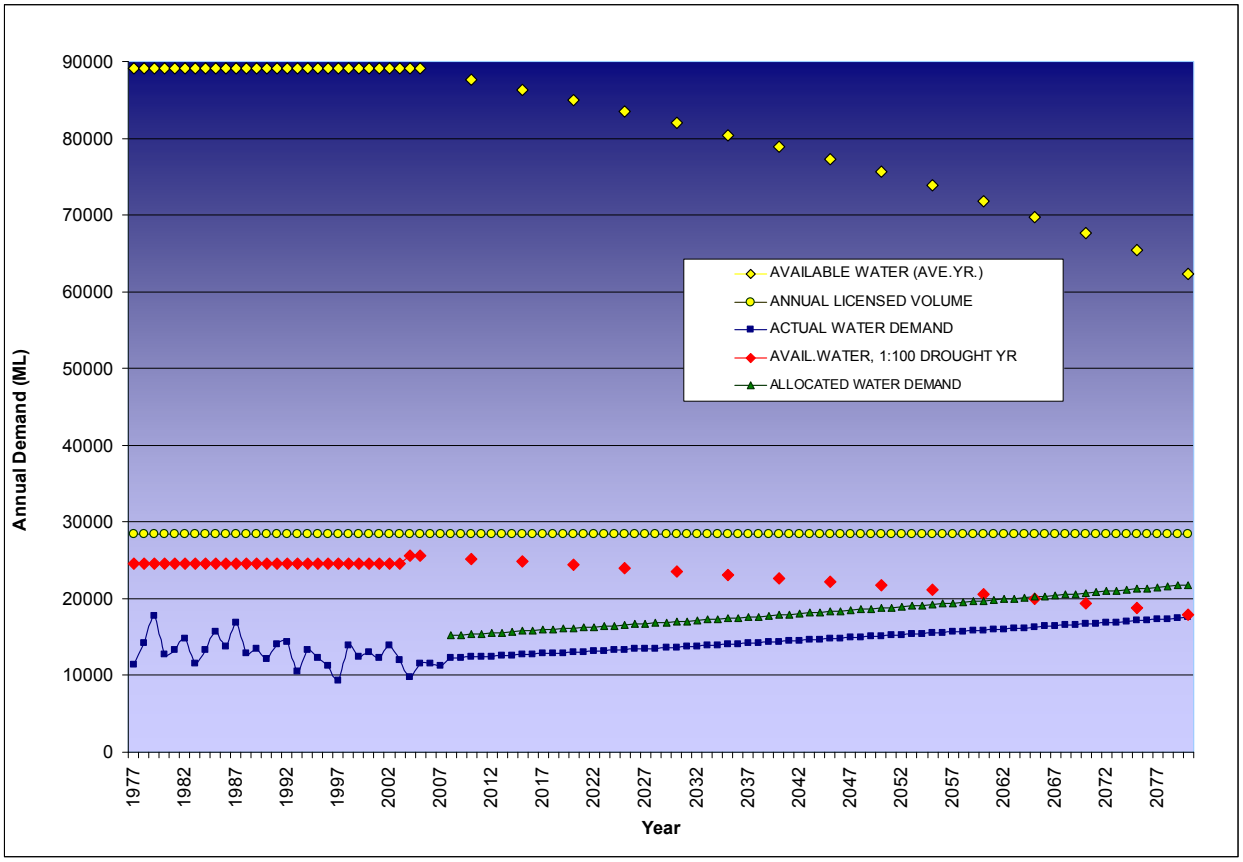
on-line

grab samples

6.6 FUTURE SOURCE DEVELOPMENT

Within the 2008 Water Master Plan, a summary of future water projections was presented. A graph was developed forecasting future water consumption, climate change and licensing. This graph was brought forward and is included in this report for information as Figure 6.2. The data was projected over a 75 year timeframe so that some of the climate change predictions for the greater Okanagan Valley can be considered.

Figure 6.2 - Projected Source Capacity vs. Annual Water Demand



Trend lines within Figure 6.2 are described below.

- Yellow Triangles: Source water available in an average year from all available sources;
- Red Triangles: Extreme 1:100 year drought source water available from the watersheds and groundwater plus reduction of 15 % source water by 2050 and 30% source water by 2080. The increase in 2004 accounts for the installation of groundwater wells;
- Yellow Top Line: Annual consumptive licenses - Irrigation and WWLA licenses = 28,417 ML/yr.;
- Dark Blue: Actual water demand, all uses increasing at 0.50% every year;
- Yellow triangles: Existing water use plus water allocated. Projected annually at 15,230 ML/yr. annually and projected upwards at 0.50%;

For the long term supply projects, a cost per ML/year was provided on a cost-benefit review. A summary of all of the water supply projects is listed in Table 6.8 in order of cost-benefit for volume of water secured.

Table 6.8 - Cost / ML to Secure Source Water

No.	SOURCE CAPACITY PROJECTS	ML Secured	Project Cost	Cost / ML
32	TROUT CREEK RESERVOIR - LEAKAGE CONTROL	730	$ 232,033	$ 318
4	REMOTE READ AGRICULTURE METERS	432	$ 291,077	$ 674
24	TROUT CREEK INTAKE MONITORING & CONTROLS	330	$ 255,639	$ 775
22	ADDITIONAL GROUNDWATER CAPACITY	413	$ 347,875	$ 842
9	OKANAGAN LAKE PUMP STATION (PHASE 1)	5141	$ 5,253,229	$ 1,022
39	SITE 13 RESERVOIR (3,700 ML)	3700	$ 4,199,800	$ 1,135
47	LOWER TOWN LAKE INTAKE - SOURCE UPGRADE	402	$ 569,250	$ 1,416
27	SITE 2 RESERVOIR, 7600 ML + PITIN CREEK DIVERSION	7600	$ 12,037,229	$ 1,584
3	DOMESTIC METERING PROGRAM	405	$ 674,800	$ 1,666
40	SITE 9 RESERVOIR, KATHLEEN CREEK (1600 ML)	1600	$ 2,828,793	$ 1,768
41	SITE 1 RESERVOIR, UPPER TROUT CREEK (2220 ML)	2220	$ 4,797,386	$ 2,161
50	OKANAGAN LAKE PUMP STN - PEACH ORCHARD DR.	12000	$ 31,092,000	$ 2,591

The projects above are listed in order of cost-benefit for securing water. The No. column in Table 6.8 listed the priority order of each project within the 2008 Water Master Plan. External factors changed the order of recommended project implementation.

As highlighted in Figure 6.2, additional source and storage water is not expected to be needed within the 20 year horizon. It should be noted that an alternative domestic supply from Okanagan Lake should be pursued in the event of a wildfire or major landslide on Trout Creek.

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7 SUMMARY

7.1 INTRODUCTION

This section provides a summary of the major conclusions and recommendations of the 2010 Watershed Master Plan. The watershed plan is consistent with the approach taken in the 2008 Water Master Plan for Summerland and is intended to be a parallel planning document to the 2008 Water Master Plan.

7.2 CONCLUSIONS

Major conclusions generated during the development of this plan include the following points. The critical points from the Groundwater Study summarized in Appendix B are also listed in this section.

Governance Conclusions

C-1 The Province is going through the Water Act Modernization (WAM) process at the current time. The outcome should have significant changes in how water is managed. Stream health, water allocation, groundwater regulation and licensing and water governance are all being considered within the update;

C-2 Presently there are many Provincial Acts and Regulations that govern water use in the Province. The District of Summerland relies on two large watersheds for which they have no authority regarding land use or multiple use activities. Because of this, working with the Province for Crown Lands, and Regional District of Okanagan Similkameen for private lands use is critical;

C-3 The drinking water regulator for Summerland is the Interior Health Authority and they have made the preparation of components of this report a Condition on Permit;

C-4 Summerland holds 25 licenses for storage, waterworks local authority, and irrigation on Eneas Creek, Trout Creek, and Okanagan Lake. The total annual allotments are 20,926 ML for Irrigation, 7,491 ML for WWLA, and 18,883 ML for storage. These volumes of licensing should be sufficient for the foreseeable future but require modifications for storage locations and for water used for WWLA purposes;

Groundwater Conclusions

C-5 Regardless of surface water or groundwater sourced potable water, the most significant water quality threat to the current water supply is the disturbance of the delicate hydraulic balance that exists in the shallow aquifer in the area between the Summerland Landfill and the Trout Creek Reservoir. If the balance is changed, leachate from the Landfill could potentially be introduced into the Trout Creek Reservoir;

C-6 Potential exists for point or non-point contamination of surface water within Trout Creek, at locations up-gradient of the diversion point where water is directed to the Trout Creek Reservoir. The shallow aquifer in the area and Trout Creek are hydraulically connected and fertilizers, pesticides, animal waste, accidental spills, etc., may compromise the water quality of both surface and shallow groundwater;

C-7 The three (3) Summerland water wells located near the Trout Creek Reservoir are in a deep aquifer which is at the lowest [down-gradient] section of the Trout Creek/Meadow Valley Aquifer, and thus vulnerable to unregulated up-gradient groundwater extraction. On-going monitoring of groundwater levels at Faulder by RDOS indicates water levels are fluctuating in the deeper aquifer for an unknown reason. The risk exists that continued unchecked development of water resources in the Trout Creek catchment area could ultimately reduce the sustainable yields in the existing Summerland wells;

C-8 The most significant threat to future groundwater development within Summerland itself is incorrectly grouted geothermal boreholes, which can provide for a preferential pathway for surface contaminants to migrate into the deep aquifer beneath Summerland;

C-9 Additional details on groundwater aquifers in the region are provided in Appendix B;

Watershed Conclusions

C-10 The existing watershed areas supplying Summerland are presented on Figure 3.1 and Figure A.1 in Appendix A. The watershed primary creeks and creek tributaries are illustrated on the drawings;

C-11 Characteristics of the watersheds are presented in Section 3 including creek slope, watershed soils, land and forest cover;

C-12 Five years of water quality data for Trout Creek and Garnet Reservoir are presented for Total Coliforms, *E.Coli* and THM levels in Section 3 of this report to support the review of watershed characteristics of the Trout Creek watershed;

C-13 Supplemental water quality and water quantity data is included in this report as Appendix C. The data provided is adjusted excerpts from the 2008 Water Master Plan;

C-14 Water supply hazards to the District of Summerland include bacteriological hazards, man-made hazards, chemical/accidental spills and natural hazards. These hazards are reviewed as part of a Contaminant Source Inventory exercise conducted on the watersheds. The Contaminant Source Inventory is summarized in Section 4 and Appendix D;

C-15 A summary of the contamination inventory of the Trout Creek and Eneas Creek watersheds is listed in Table D.1 in Appendix D of this report. The hazards are identified, numbered, photographed, and a hazard rating for each of the sites is identified. The sites correspond to locations on the larger scale watershed maps that are provided in Appendix D;

C-16 A listing of range activities and range licensees is included in this report. Range lessees areas are shown on Figure 4.2;

C-17 With respect to human wastes, the activities in the watershed fall under the jurisdiction of land use bylaws of the Regional District of Okanagan Similkameen, or if on Provincial Crown lands, then under the authority of the applicable Provincial Ministry. Human wastes such as failed septic fields fall under the jurisdiction of the Interior Health Authority, however, monitoring is required to prove that there is a failure;

C-18 There are three larger Forest Lessees operating within the Summerland watersheds: Tolko Industries Inc., BC Timber Sales, and Gorman Brothers Forest Products. Their areas of activity are presented in Figure 4.3. There are also several Wood Lots that exist within the watershed that are active under a different operating structure than the forest lessees;

C-19 Fire risks are high in the watershed and will only increase with the dead pine stands created by the recent Mountain Pine Beetle infestation;

C-20 Backcountry recreational activities currently exist in the watersheds including hunting, fishing, recreational vehicle trail riding, hiking (Trans-Canada trail), and mud bogging. Controls and education are needed on the detrimental activities where soil and ground cover damage is occurring. Education to the residents of Summerland and regional areas is needed to raise the profile of damaging activities;

C-21 Transportation corridors are the link for the public to the watersheds. Road jurisdiction is maintained by the Ministry of Transportation (Summerland-Princeton Road), Ministry of Forest Service (FSRs), and by the forest lessees (logging roads). In addition there is a trail corridor (Trans-Canada Trail) and a BC Hydro Right-of-Way bisecting the Trout Creek watershed as shown on Figure 4.6. Non-status forestry roads also exist in the watershed and the Ministry of Forests and Natural Resource Operations is reviewing how to decommission these roads;

C-22 A Risk Sensitivity Map was developed as Figure 5.1. The map is important in that it provides the areas of high, moderate and low risk for contamination through the water network to the District of Summerland intakes. The watershed riparian areas of highest risk are located between the Trout Creek intake and Thirsk Dam and Darke Creek beyond the agricultural activities;

C-23 Summerland has several barriers in place to reduce the risk of contamination in the drinking water. These barriers include the Water Treatment Plant, the setting and buffering time provided by the large storage reservoirs and the best management practises by stakeholders in the watershed, whose practices and regulations are working (Forestry);

C-24 Risk priority for Summerland was developed based on the contaminants found and the contaminant location in relation to the risk sensitivity map. The results are presented in Figure 5.2 and A.2 (larger scale);

C-25 Table 5.1 provides a summary of 24 sites of where the highest risks located. The majority of risks present are due to range activities along the section of Trout Creek between Thirsk Reservoir and Summerland's Trout Creek intake;

C-26 The greatest number of present risks facing Summerland is related to range activities with no buffers or setbacks from the lower reaches of Trout Creek. Coordination will be required with the Ministry of Forest and Range staff to review and work collectively to fence and reduce grazing and range activities along the lower reaches of Trout Creek;

C-27 Water quality monitoring is fairly thorough. The District is not yet collecting *Cryptosporidium* data, algae data or data on Halo acetic acids, which are a disinfection by-product.

7.3 RECOMMENDATIONS

Major recommendations of the Watershed Master Plan are as follows. Similar to the conclusions section, they are grouped into general categories for common reference.

Governance Recommendations

R-1 Although Summerland does not have jurisdiction on the majority of issues within their watershed, it is important to develop and maintain a healthy dialogue with the Provincial staff and MLAs on the issues and challenges that the District and the Province are collectively facing. Open and direct communication with the Provincial representatives is critical for identifying and resolving issues in the watersheds;

R-2 It is recommended that for private land issues, where the Regional District of Okanagan Similkameen has jurisdiction on land use, that the District of Summerland approach the RDOS to collaborate on bylaw and/or OCP language that would be protective in nature for the watershed;

R-3 With the Water Act Modernization (WAM) process underway, the District of Summerland should consider a submission to the province. Agreement with the outline in Section 2.6, Watershed Operating Principles should be considered for input to the WAM process. Licensing and/or permitting of groundwater withdrawals is worthwhile and should be supported;

R-4 Storage license adjustments are required for both Thirsk Reservoir and on Headwaters Reservoir-Lakes to make the stored volumes equivalent to the in-place constructed volumes;

R-5 Storage license adjustments are required to allocate sufficient water for Waterworks Local Authority purposes (domestic licensing). Should Summerland be successful in obtaining water licensing on Okanagan Lake, they would then have sufficient licensing for withdrawal for domestic purposes.

Groundwater Related Recommendations

R-6 Lining of the Trout Creek Balancing Reservoir is not recommended as the leakage and groundwater mounding from the Balancing Reservoir into the shallow aquifer in the area reduces the potential for landfill leachate migration into the water supply;

R-7 Continue to monitor water quality in the observation wells between the Landfill and Balancing Reservoir. Consider implementing automated water level monitoring and low level alarms into current SCADA system;

R-8 Investigate the potential of re-capturing lost water down-gradient of the Balancing reservoir for re-use in the irrigation system;

R-9 Mandatory provision of information [borehole logs] on all subsurface investigations completed within the catchments contributing runoff to Summerland should be implemented. Geo-exchange boreholes should be inspected to ensure that grouting is completed accordingly.

R-10 No closed-loop or open-loop geo-exchange systems should be constructed in the area of the Balancing Reservoir, Landfill and Rodeo Grounds. RDOS and the District of Summerland should develop guidelines for geo-exchange that require closed loop geo-exchange systems to be inspected to assure they are grouted for the full length of the borehole;

R-11 The entire Trout Creek channel section between the Rodeo Grounds (Summerland intake) and Thirsk Reservoir should be designated as a surface water and groundwater protection area and travel speeds on the roadways should be reduced in the areas nearer to the creek;

R-12 An overall Watershed Management Plan, which incorporates surface water and groundwater withdrawals in the upper part of the Trout Creek Catchment, is critical. Such a plan will require coordination with the Provincial Government under the Groundwater Protection Regulation (part of the BC Water Act), as groundwater withdrawals are currently not regulated in BC. However, the Province can designate and area for groundwater management, if conditions warrant. The Trout Creek Catchment is an excellent location for the Province to consider as a Pilot.

Source Protection Recommendations

R-13 Timber harvesting licensees have not historically managed forest cut-blocks in terms of fire risk reduction. Developing of defendable forest guards through managed cut-blocks should be discussed with the forest licensees to see if there is the potential to reduce the risk of a large devastating fire in either of Summerland's watersheds. A plan that requires management of forest stands, fuel reduction management in interface areas, and protects Summerland's infrastructure and water sources is a large undertaking and must be done in conjunction with the Ministry of Forests and possibly other stakeholders. The end objectives for this type of work protects both the interests of the community and the forest licensees;

R-14 District of Summerland should only lobby the Province to stop the sale of lease lots if the leased lot owners are applying pressure to purchase them. Rather than conflict, more responsibility and controls should apply for the occupancy of leases around the Reservoir-Lakes. An application to the Crown should be considered for a 200m covenant around the Reservoir-Lakes foreshore to protect these water reservoirs in perpetuity;

R-15 Summerland should pursue a working partnership with the Reservoir-Lot lessees. The basis for such a partnership should be to protect source water quality and maintain the health of the natural eco-system. This is in both groups interests. The incentive would be that Summerland would support the lessee's objective to have lease costs reduced to previous levels, and the lessees would not pursue ownership of the lots but rather maintain them to the highest possible standards. In partnership with Summerland the lessees would share the caretaker's responsibility of watersheds with the District of Summerland;

R-16 Although present, gravel extraction is not a critical issue in the watersheds as the District control the largest pit in the area immediately west of the Water Treatment Plant. It is recommended that Summerland utilize the Red-Yellow-Green designations for gravel pit extraction, should any other pits be proposed for development in the watersheds;

R-17 Algae and full parameters sampling is recommended at three district reservoirs during the mid and late summer. The sites are Thirsk Reservoir, Headwaters No. 1 Reservoir, and Garnet Reservoir;

R-18 Sampling for halo-acetic acids are recommended in the water distribution system after disinfection for both the Garnet and Summerland water distribution systems. Monitoring is recommended 4 times per year;

R-19 *Cryptosporidium* monitoring is recommended on water from the Garnet Reservoir outlet when *E.coli* counts are highest. The potential for its presence is highest if fecal matter is found in the raw water;

R-20 The highest probable risks to Summerland's drinking water are listed in Table 5.1. Twenty four (24) risk locations are provided in the table. All of the issues require attention. Many of the issues will be dependant on coordinated efforts with Provincial Ministries and other existing watershed stakeholders;

R-21 For the cattle and range issues, work proactively with the Ministry of Forest, Range and Natural Resource Operations staff. Their staff is available to work through risk reduction methods for cattle activities including range practices, liaison with the range lessees, and installation of cattle guards and fencing at appropriate locations;

R-22 The data and locations provided within this report should serve as a guideline with the Ministry of Forest, Range and Natural Resource Operations for the cattle lessees to identify and start to work to improve riparian setbacks and cattle activities in relation to the creeks;

R-23 Sampling should be conducted for *E.coli* in Trout Creek and on Darke Creek, above and below the community of Faulder. This is to determine if there is any septic tank seepage to the creeks from the 100 or so homes in that community;

R-24 Development of additional storage is not required for the foreseeable future, however should the frequency of drought cycles increase, Summerland should revisit the timing of the development of additional water storage sites in the upper watershed.