Regional Growth Strategy

Water Resources, Lakes and Streams

Discussion Paper

Regional District of Central Okanagan

“Your Home...Your Future”

June 2012
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Anna Warwick Sears, Executive Director, Okanagan Basin Water Board
Bernard Bauer, Chair of Okanagan Water Stewardship Council, Professor UBCO
Judi Ekkert, Interior Health Authority, Water Quality Specialist
Rob Birtles, Interior Health Authority, Water Quality Specialist
Fred Schaad, City of Kelowna, Infrastructure Planning
Dan Brown, Westbank First Nation, Manager of Planning/Development
Ted Van Gurlik, Ministry of Agriculture
Bob Hrasko, Black Mountain Irrigation District
Doug Allin, District of Peachland
Darren Schlamp, Glenmore-Ellison Irrigation District
Valeria Cameron, Water Stewardship Manager, Ministry of Forests Lands and Natural Resource Operations (by phone)

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1.0 Executive Summary

Water is an essential and integral resource for our life, our economy, and for the natural environment. Water in the Central Okanagan is a central feature, providing a unique and beautiful landscape for the enjoyment of all and the basic sustenance needed for a vibrant community and economy. It is therefore important to protect and enhance the quality of life in the Okanagan by developing regional growth policies for the sustainable long-term management of this precious resource.

Water resources are a complex, multi-jurisdictional theme in the Central Okanagan. This discussion paper identifies water resource issues and concerns pertinent to the Central Okanagan in the context of an updated Regional Growth Strategy (RGS). The paper updates a previous Discussion Paper, issued in 2000, and compares current perspectives with those of neighbouring regions. Since 2000, an incredible amount of water resources research and regional collaboration has helped better characterize the delicate balance between water supply and water demand in the Okanagan Basin. Although much work has been done, the issues for the most part, remain the same. The major water resource issues generally relate to: water quantity, water quality, and flood hazard.

The results of this Discussion Paper include RGS policy considerations and performance indicators to evaluate the success of water resource management decisions. Broadly, suggested policies for water resource protection may include:

- Promote ongoing collaboration to form a “common voice”
- Ensure water for agriculture
- Ensure clean, safe water for drinking
- Increase resiliency to drought
- Encourage effective public communication, education and outreach
- Reduce potential for water quality impacts at domestic water intake sites
- Reduce potential water quantity and water quality impacts on aquatic resources from changes in land use
- Promote integrated stormwater management
- Enforce and monitor compliance with existing regulations
- Encourage groundwater protection and well siting requirements
- Participate and support water stewardship activities

The overall objective of the RGS is to develop policies for sustainable development. The subsequent implementation of meaningful and measureable water resource protective measures will ensure the long-term protection of the features and qualities that make the Okanagan a unique and beautiful place to live, work and play.
2.0 Context

The Regional District of the Central Okanagan (RDCO) is undertaking a review of its Regional Growth Strategy (RGS) to update the previous RGS adopted in 2000. A RGS is defined by the Local Government Act (1996) as a plan that promotes a human settlement pattern that is “socially, economically and environmentally healthy and that makes an efficient use of public facilities, land and other resources”. This Discussion Paper focuses on the issues and concerns related to Water Resources, Lakes and Streams within the Central Okanagan region. During the completion of the Discussion Paper, a stakeholder focus group session was held to gather local professional knowledge regarding needs and priorities. The following document provides a summary of the results of the focus group session and other background research, comparisons, consultations and analysis. The purpose is to provide a document that will be used to stimulate discussion at later stages of the RGS review.

2.1 State of the Resource

For the purposes of this Discussion Paper, “Water Resources, Lakes and Streams” refers to water as a regionally important resource for life sustenance, economic value, and environmental significance. The Okanagan is one of the most water-stressed regions in Canada and yet the population and economy are most dependant on water. The Discussion Paper presents broad water-related issues and concerns from a long-term regional perspective, whilst highlighting the importance of recognizing the interconnectedness of water with everything else. A message consistent with current thinking is that of:

One Region – One Water

Population in the Central Okanagan has grown from 152,000 in 2000 to 179,839 in 2011. The rate of growth over this period is 18%, which is considerably higher than the average provincial rate of growth (7%). Water resource issues and concerns that have arisen since 2000 are addressed here to ensure effective development planning and management.

Local governments and agencies within the region, including the City of Kelowna, District Municipalities of Lake Country, Peachland and West Kelowna, the Central Okanagan East and West Electoral Areas, Westbank First Nation and the Okanagan Indian Band have a stake in the development of the updated RGS.

2.1.1 Review of Surface Water Resources

RDCO (3142 km²) represents 39% of the total area of the whole Okanagan Basin, which extends almost 200 km from north of Vernon into the US, south of Osoyoos (Figure 2.1). Within, or partly within, RDCO there are eight watersheds, of which six are designated community watersheds, providing water for domestic consumption. Sub-basins and residual areas are delineated and shown the Surface Water Quantity map in the Appendix. These watershed areas, contribute almost half (46%) of the total annual flow into the Okanagan Basin.

Average annual basin runoff contributed by each of the eight sub-basins that are within RDCO ranges from 28% from Mission Creek, the largest watershed within the Okanagan Basin, to less than 1% from McDougall Creek. Annual runoff from the individual sub-basins in RDCO is shown in Table 2.1, below.
Table 2.1: Annual Runoff Contributions from RDCO Sub-Basins

<table>
<thead>
<tr>
<th>Sub-Basin</th>
<th>Area (km$^2$)</th>
<th>Total Annual Runoff (ML) (period 1996-2006)</th>
<th>% of Total Basin runoff (period 1996-2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambly Creek</td>
<td>243.3</td>
<td>45,023</td>
<td>5%</td>
</tr>
<tr>
<td>Mill Creek</td>
<td>222.8</td>
<td>26,484</td>
<td>3%</td>
</tr>
<tr>
<td>Mission Creek</td>
<td>844.7</td>
<td>246,583</td>
<td>28%</td>
</tr>
<tr>
<td>Bellevue Creek</td>
<td>92.9</td>
<td>10,600</td>
<td>1%</td>
</tr>
<tr>
<td>McDougall Creek</td>
<td>53</td>
<td>2,792</td>
<td>0.3%</td>
</tr>
<tr>
<td>Powers Creek</td>
<td>144.6</td>
<td>25,765</td>
<td>3%</td>
</tr>
<tr>
<td>Trepanier Creek</td>
<td>257.9</td>
<td>38,575</td>
<td>4%</td>
</tr>
<tr>
<td>Peachland Creek</td>
<td>144.9</td>
<td>13,948</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: Summit Environmental Consultants (2009)

While the presence of a large lake may be incongruous with the concept of a limited water supply, the Okanagan is in fact, a water-deficient area. The region is relatively dry due to low precipitation and high rates of evaporation. This, combined with high variability from year to year and from season to season, places constraints on the water supply.

Water supply in the Central Okanagan is highly variable and subject to extremes on an annual basis. Annual variability in water supply is illustrated in Figure 2.2, which shows annual net inflow volume to Okanagan Lake for 1921-2004. Extreme low flow periods have occurred in 1929-1931 and more recently in 2003, when the region experienced unprecedented wildfires. Extreme high flows have occurred periodically and most recently in 1997, when the region experienced extensive flooding. There is some correlation of long-term climate variability with global climate interactions, such as El Nino-Southern Oscillation or the Pacific Decadal Oscillation. Climate variability needs to be recognized and anticipated as part of any long term water management plan.

Another characteristic of water availability in the Central Okanagan is high seasonal variability, which is illustrated in a plot of mean monthly flows on Mission Creek (Figure 2.3). Peak flows occur in the spring during freshet due to snow melt. Low flows typically occur in the summer, between June and September. Many of the smaller tributaries to Okanagan Lake lose surface flow to the ground before reaching Okanagan Lake during the summer months (e.g., Bellevue Creek).
Figure 2.2: Annual variability in water supply to Okanagan Lake (source: Okanagan Basin Water Board)

Figure 2.3: Seasonal variability reflected in mean monthly flow recorded for Mission Creek (1949-2010) (Source: Water Survey of Canada)
Water quantity is potentially affected by natural processes such as climate change, drought, forest fire and mountain pine beetle. Land use activities that potentially affect water quantity and runoff rate include forest development, urbanization (loss of forest cover and increase in impervious surfaces), and consumptive losses due to irrigation or other forms of water use.

While these above-listed processes and activities affect the quantity (and quality) of water for downstream purposes, they predominantly occur on the high elevation, Crown Land watershed areas, upon which RDCO has limited control. Lands administered by RDCO and municipal governments (i.e. private lands) that are available for future land development are located downstream of the surface water intake sites.

The quantity of water available to water suppliers on Source Watersheds within the RDCO is dependant on the supply of water from the high elevation catchment areas. Snow accumulation at higher elevations and melt in the spring fills upland reservoirs, where water is stored for later use during periods of higher demand. Watersheds with limited upland storage capability are at a higher risk of supply problems because natural stream flows are low during the period of greatest demand. This highlights the importance of upland storage to water supply in the Okanagan.

A water balance diagram (Figure 2.4) illustrates how incoming precipitation in the Okanagan is allocated. Approximately 75-80% of incoming precipitation is lost to evapotranspiration from plants and evaporation from lake surfaces. Another 13-15% goes to surface flows, and groundwater recharge accounts for 7-10% of the incoming precipitation.
Figure 2.4 Okanagan Water Balance Diagram (Source: Okanagan Basin Water Board)
2.1.2 Review of Groundwater Resources

Surface water and groundwater are “interconnected” and this relationship is illustrated in the Groundwater Resources Map (Appendix A). Extraction of water at one location within the hydrologic-hydrogeologic cycle may affect water at other locations. The degree of interaction between surface water and groundwater is dependent on many factors including geology, recharge to the subsurface, direction of groundwater flow, the slope of the water table (groundwater flow gradient), seasonal variability in climate (precipitation, evaporation), location and volume of groundwater pumped, relative position within a surface water catchment and other factors. The influence of pumping from wells on groundwater levels, and in some cases surface water flow, can be additive and compounded by many water extraction points in close proximity, or the cumulative effects of uncontrolled development within a watershed with a finite water balance. Groundwater extraction can also impact the availability of water for aquatic ecosystems (surface water ecosystems).

Both unconsolidated and bedrock aquifer types exist within RDCO. Unconsolidated aquifers consist of various mixtures of sand, gravel, cobbles, silt, and/or clay sediments. Unconsolidated aquifers exist at lower elevations in the Okanagan Valley, along creek/stream gullies; however smaller footprint area unconsolidated aquifers exist along smaller streams and gullies in upland, bedrock-dominated areas.

Bedrock aquifers are zones within solid rock where fractures in the rock are filled with water. Bedrock aquifers dominate the highland areas of the Okanagan Basin, but may also be present beneath unconsolidated deposits in lower elevation areas. Groundwater in bedrock aquifers resides in the cracks within the rock (fractures) and water migrates through the aquifer where the fractures are connected. However, groundwater may be significantly limited if the fracture zones are isolated (i.e., not connected to other fractures). The variability in the intensity and orientation of fracturing within the various types of bedrock in the RDCO strongly influences the success of wells drilled in the upland areas and in some places, wells do not encounter water or yields are less than 0.03 L/s (0.5 gallons/minute).

Achievable long-term groundwater pumping rates in both bedrock and unconsolidated aquifer types, is dependent on the ability of the aquifer to supply water to the well or open bore in rock at a rate equal to the pumping rate. The hydraulic connection between fractures governs the response of the bedrock aquifer to pumping. Groundwater supply to a well within an isolated fracture zone may be limited to the volume of water stored within the fractures intersected by the well. In this case, groundwater pumped is said to be obtained from “aquifer storage”.

Seasonal effects due to the variability in precipitation can also influence potential pumping rates for a well within a given aquifer. Seasonal influences on water levels in wells within unconsolidated and bedrock aquifers have been documented by the BC Ministry of Environment’s Observation Well Network. Groundwater levels in unconfined unconsolidated aquifers are significantly affected by seasonal variation in precipitation (i.e., because they are typically the “direct recipients” of surface infiltration). Water levels in bedrock aquifers have also been shown to vary significantly due to the seasonal variability of precipitation.

It is the seasonal and long term variability in available surface water and groundwater, coupled with the growing need for water in the Okanagan in response to population and agriculture, that have prompted several studies on groundwater in the Okanagan Basin. Several recent studies are relevant to a discussion on groundwater, the most notable including the collective works referred to as the Groundwater Assessment of the Okanagan Basin (GAOB) Project (2005), followed by work undertaken by Nielsen-Welch & Allen (2007), Smerdon & Allen (2009) and the Geological Survey of Canada (GSC, 2010).
Notwithstanding these important studies, the most practical estimate of groundwater resources in the Central Okanagan was completed as part of the Groundwater Objectives 2 and 3 Component of the Water Supply and Demand Study (Golder, et al 2009). This study was completed for the Okanagan Basin Water Board (OBWB). Included in this assessment were water balances for 20 unconsolidated aquifers in the RDCO area, including 7 in the West Kelowna Area, 1 at Bear Creek, 1 at Fintry, 2 in the Glenmore Valley, 3 in Kelowna, 2 in Upper Mission Creek, 2 in Winfield and 1 in Oyama. Water balances were also completed for 48 upland bedrock aquifers, which provide lateral recharge to these unconsolidated aquifers and for 15 bedrock aquifers that report directly to lakes. All of these aquifers were delineated on the premise that groundwater flow in the area is topographically driven and therefore the contiguous extent of the alluvial and bedrock aquifers combined are consistent with the well-established limits for existing surface water catchments that exist within the RDCO.

A listing of the aquifers within RDCO and the surrounding areas is presented in Table 2.2. Comments regarding the approximate extent of groundwater development and yield potential for each aquifer are also provided in the table. The locations and extents of these aquifers are shown on the Groundwater Resources Map in the Appendix.

Most of the unconsolidated aquifers exist in areas that are serviced by public water supply, with the exception being the upper limits of the Mission Creek Aquifer. This aquifer is designated as Aquifer No. 250 in the Table 2.2, based on the numbering convention used in the OBWB Report. There are also several areas along the periphery of the unconsolidated aquifers where transition occurs from unconsolidated to bedrock, where domestic and small scale agricultural water wells exist. With the exception of the growth areas that are in downtown area of Kelowna and in close proximity to Lake Okanagan, many of the development areas lie near the boundaries between unconsolidated and bedrock aquifers and thus in areas of relatively low groundwater development potential. Furthermore, the majority of rural development area within RDCO is underlain by bedrock aquifers, which also have relatively low groundwater development potential and therefore will not support high density development without importing community based water supply.

Alley et al (1999) caution against groundwater development based on the concept of “safe yield", which assumes groundwater withdrawal is sustainable so long as the annual volume withdrawn does not exceed annual or natural recharge to the source aquifer. This assumption is referred to as the "Water-Budget Myth" because it is an oversimplification of the information needed to understand the effects that human activities can impart on the larger hydrologic-hydrogeologic cycle, specifically aquifer inflows, outflows, and changes in storage, that must be accounted for in any management decision. The need for monitoring and management of groundwater is supported in a recent paper on sustainable management of groundwater by the Council of Canadian Academies (2009). The BC Auditor General’s audit of the management of groundwater resources in BC (2010) also supports the need for increased monitoring and management.

### 2.1.3 Water Demand – Water as a “Critical” Resource

Future growth and development in the Central Okanagan is dependant on the availability of good quality water. Water is a critical resource as it is required for:

- Agricultural irrigation;
- Domestic/residential consumption and irrigation;
- Commercial/industrial/institutional use;
- Recreation and tourism; and,
Aquatic resources, such as critical fisheries and wildlife habitats (e.g., floating nesting locations for Western Grebes); and,

Tourism and business.

The majority of water (both surface and groundwater) that is extracted for use in the Central Okanagan is supplied by seven (7) large water utilities (listed below in Table 2.3). Five (5) of the largest water utilities in the region provide water to residents within the City of Kelowna and have formed a collaborative group called the Kelowna Joint Water Committee (KJWC). There has been some recent integration of small water utilities, including Westbank Irrigation District, Lakeview Irrigation District, and two small utilities of RDCO into the amalgamated District of West Kelowna. There are additional 33 small private licensed water suppliers in the RDCO, including RDCO itself.

Currently, of all the water used in the Okanagan Basin, about 68% of the total is from surface water sources. Within the RDCO there are 1848 licences for offstream surface water use (i.e. irrigation, stock watering, domestic, industrial, commercial, institutional, waterworks) and of these, almost half (861 licenses) are for Okanagan Lake. This excludes licenses for water storage, conservation flow for instream needs, and power generation. Points of Diversion (PODs), which indicate the specific location of a water diversion on a stream, lake or spring, are shown on the enclosed Surface Water Quantity Map (Appendix). Table 2.4 summarizes the number of licenses for offstream surface water within each sub-basin of the RDCO.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>City of Kelowna</td>
<td>Okanagan Lake</td>
<td>17,906</td>
</tr>
<tr>
<td>Black Mountain Irrigation District (BMID)</td>
<td>Mission Creek</td>
<td>12,402</td>
</tr>
<tr>
<td>South East Kelowna Irrigation District (SEKID)</td>
<td>Hydraulic Creek</td>
<td>11,878</td>
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<tr>
<td>Glenmore-Ellison Irrigation District (GEID)</td>
<td>Mill Creek</td>
<td>9,700</td>
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<tr>
<td>District of West Kelowna (DWK)</td>
<td>Powers Creek</td>
<td>4,050</td>
</tr>
<tr>
<td></td>
<td>Lambly Creek</td>
<td>2,967</td>
</tr>
<tr>
<td>Rutland Waterworks</td>
<td>Groundwater</td>
<td>2,920(^2)</td>
</tr>
<tr>
<td>Municipality of Peachland</td>
<td>Peachland Creek</td>
<td>2,311</td>
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<tr>
<td></td>
<td>Trepanier Creek</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>64,134</td>
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</tbody>
</table>

Sources:
\(^1\) – from Okanagan Water Supply and Demand Study
\(^2\) – from KJWC Integrated Water Supply Plan (estimated for period 1976-2010)
<table>
<thead>
<tr>
<th>Sub-basin (Surface Node ID)</th>
<th>Irrigation</th>
<th>Domestic</th>
<th>Stock-watering</th>
<th>ICI(^2)</th>
<th>Waterworks</th>
<th>Total</th>
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<tr>
<td>13</td>
<td>22</td>
<td>18</td>
<td>4</td>
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<td>18 (Lambly)</td>
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<td>2</td>
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<td>24 (Bellevue)</td>
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<td>2</td>
<td></td>
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<td>18</td>
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<td>26 (McDougall)</td>
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<td>1</td>
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<tr>
<td>30 (Trepanier)</td>
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<td>68</td>
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<td>9</td>
<td>22</td>
<td>1</td>
<td></td>
<td></td>
<td>32</td>
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<tr>
<td>32 (Peachland)</td>
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<td>7</td>
<td>2</td>
<td></td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>47 (Okanagan Lake)</td>
<td>217</td>
<td>511</td>
<td>1</td>
<td>22</td>
<td>110</td>
<td>861</td>
</tr>
</tbody>
</table>

Notes:  
1 – Off-stream use does not include “storage”, “conservation” for instream flows, or “power generation”  
2 – ICI = Industrial, Commercial, Institutional  
Source: Okanagan Water Supply and Demand Project (www.obwb.ca/wsd)

Water allocation rights are granted according to the priority date of the water license. The “first in time first in right” doctrine means in times of water scarcity the senior licences with earlier priority dates may extract water over the later licences regardless of what the water is to be used for. Ongoing consultation regarding BC Water Act modernization will examine alternate approaches. For example, some jurisdictions may temporarily reduce water rights according to the priority of use (rather than date), which would allow for the reduction of non essential uses (like landscape irrigation) in preference to more essential uses (like domestic or municipal water supplies) and provide for ecological needs. The major water utilities source raw water from Okanagan Lake, eight (8) watersheds, and from the ground. Total historical water use, estimated for the period 1976 to 2010 for the utilities serving the City of Kelowna, shows increases but at a manageable rate despite considerable population growth over
the period. This is reportedly attributed to a decreased agricultural water demand and development densification (KJWC 2011).

Water demand is subject to a high degree of seasonal variation and there is a fundamental difference in the timing between surface water availability and the demand. Monthly demand on Mission Creek for example, as a percentage of the monthly water supply, is 10% or less during winter months, increasing steadily during spring and summer until September when demand is nearly 200% of the available supply (Polar Geoscience, 2012). The imbalance between late summer supply and demand is addressed by storing water during spring runoff and regulating releases depending on downstream needs.

The ability to deliver a consistent year-round supply of water is dependant upon the ability to store water during times of high runoff. Within RDCO at least 25 upland reservoirs provide storage and have an estimated total storage capacity of 113,654 ML.

**End uses of water:** The use of water in the Okanagan Basin (1996-2006), described by end use, indicates that most (86%) water used in the Okanagan is for outdoor purposes (i.e. agriculture, residential outdoor use, golf courses and parks), while only 14% is used for indoor purposes (i.e. residential, institutional, commercial, and industrial) (Summit Environmental Consultants Ltd., 2010). The breakdown is as follows:

- over half (55%) of the water used in the Okanagan Basin is for agricultural irrigation;
- 24% is for residential outdoor use;
- 7% is for residential indoor use;
- 7% is for outdoor irrigation of golf courses and parks area; and
- 7% is for institutional, commercial and industrial purposes.

### 2.1.4 Future Water Supply and Use Scenarios

Results from a recent study titled “Projected Water Supply and Use in the Okanagan (2011-2040)” projects water supply and demand for the Okanagan Basin based on the Phase 3 modelling of the Okanagan Water Supply and Demand Study (Polar Geoscience Ltd., 2012 draft). Projections are modelled using the Okanagan Basin Water Accounting Model and its supporting models, the Okanagan Basin Hydrology Model, which models supply, and the Okanagan Water Demand Model. The study used two new climate models to simulate the impacts of climate change, population growth, and land use change on water supply and demand in the Okanagan. Key points are summarized here.

**Water Supply Scenarios**

Climate change models predict a water-stressed future for the Okanagan. Climate influences the supply of water and predicted climate changes that impact water supply include:

- **increased air temperatures** - air temperatures are expected to increase, which means that more winter precipitation will fall as rain rather than as snow. With higher air temperatures, the high elevation snowpack would melt sooner – by roughly one week over the 2011-2040 period.
- **less water stored as snow** - although average annual precipitation will not change too dramatically, winter precipitation will occur more often as rain and on average there will be less...
water stored as snow. The snow pack is an important component of water supply, so there may be less water available for summer use if early spring runoff spills over storage reservoirs that are already full.

- **lower summer stream flows** – climate change is not expected to significantly affect average annual stream flows. However, the models predict that stream flow during the summer months (June and September) could decrease by roughly 1/3 over the 2011-2040 period, having potential to impact important fisheries or wildlife resources.

- **increased flood risk** – climate change models predict a higher frequency of more intense storms, which would increase the risk of flash flooding on streams.

The overall effect of climate change is an increase in annual runoff but with redistributed timing of flows. It is expected that runoff in the winter would increase due to increased rain and snow melt and that runoff would decrease in the summer due to an earlier spring peak in flow. Year to year runoff variability is expected to increase, particularly in the winter. Additionally, prolonged periods of drought are anticipated to have a dramatic impact on surface water supply. In a five-year drought scenario, such as the historic Okanagan drought of the early 1930s, it is predicted that the average annual net inflows to Okanagan Lake would be roughly half of what they are presently. In this situation, under current operating procedures, Okanagan Lake levels would drop below its normal operating ranges, and the ability to keep water flowing in Okanagan River would be affected.

The effects of this reduced inflow on infrastructure could be dramatic and costly. Potential effects include but are not limited to moorages and boat launches being exposed or not functional (key to recreational activities and tourism), reduced depths for large intakes increasing treatment costs (because of increased risks of contamination), reduced depths or irrigation intakes being exposed, impacts to fisheries (e.g., shore spawning kokanee or low stream flows reducing fish spawning in creeks), impacts to wildlife (e.g., nesting grebes), etc. A full accounting of impacts is beyond the scope of this report, but a prolonged drought that reduces the level of Okanagan Lake could have significant economic consequences that must be considered.

Groundwater supply is generally not as vulnerable as surface water to short-term drought cycles. Thus, groundwater, sourced from the more productive unconsolidated aquifers, may be a suitable supplement to deficient surface water supply during periods of drought.

**Future Water Use Scenarios**

The Projected Water Supply and Use in the Okanagan (2011-2040) study examined the effect of different population growth and land use scenarios and found notable differences in water use.

To model population growth, the model simulated a medium-density population pattern (with single- and multi-family dwellings) with areas likely to be developed in the future based on the OCPs. The model was able to simulate both development in new areas, and redevelopment in existing neighbourhoods under higher densities to 2035. Water use was estimated by parcel size and shape, assuming an associated daily indoor use and a percentage representing landscape irrigation. An urban sprawl growth scenario was simulated where, instead of infill, new lands continued to be developed using similar lot sizes and similar landscape irrigation use. New development areas avoided the Agricultural Land Reserve (ALR) lands but extended development into higher elevations. An expansion of agricultural land use was also simulated where “all irrigable lands” in the ALR and on First Nations lands that are not currently irrigated were included. This is a reasonable scenario as there will be a growing pressure to increase production and efficiency to maintain food security in the province.
Highlights of the study results for each scenario are as follows:

- **with climate change alone** (no growth), Okanagan residents would use on average 5 to 10% more water during most months, 40% more water in April, and 20% more water in late fall. In addition, with climate change, the growing season would be extended, meaning demand increases of 5-10% from irrigation during this time. With climate change, water demand is projected to exceed supply during the late summer period by up to 280% (Polar Geoscience Ltd., 2012). In the future, the management of upland reservoirs will become even more important in meeting water demands. With predicted hydrologic effects of climate change (less snow, earlier melt) it is expected that suppliers may have to modify current reservoir operations and/or identify potential opportunities for expansion.

- **with modest population growth (1% annual growth)** comprised of infill and densification of developed areas within existing city boundaries, and with expected improvements to agricultural water, surface water use should not dramatically change in the future.

- **a population boom (2.5% annual growth) with urban sprawl** saw the biggest differences in water use. The urban sprawl scenario assumed that residential lots would continue to have large landscaped yards with high outdoor water use. Because development was projected onto areas that would not normally have been irrigated, overall surface water requirements in the summer increase by 20-30%, primarily for landscape irrigation.

- **agricultural expansion** alone is projected to increase overall water use by 5-10%.

- A five-year drought, similar to that of 1929-1931 is predicted to have increased demands of 40% to 50% over present use, depending on the agricultural land base and population at the time of occurrence.

The results of the study highlight the fact that the type of land use development has a considerable effect on the amount of water being used. Urban sprawl scenarios use considerably more water than infill development scenarios. The results underscore the importance for land use planning to accommodate population growth in the Central Okanagan and that increased demand in the future will put pressure on existing infrastructure to maintain supply.

### 2.1.5 Water Quality Management for Drinking Water and Aquatic Life

With population growth and a desire for improved community health and well-being there is an increased demand for high quality domestic water. Water must meet the Government of Canada Drinking Water Quality Guidelines and the BC Interior Health Authority requirements.

Health threats associated with waterborne pathogens were brought to the forefront after the Okanagan cryptosporidium outbreak in 1996, and the Walkerton, Ontario *E. Coli* bacteria event in 2000. These events raised the profile and need for stronger safeguards for drinking water quality. Municipal governments are currently challenged with finding economical ways to provide safe water.

Water intakes on creeks are typically situated upstream of developed areas, so threats to water quality at these intakes occur within the watershed area upstream of the intake. Natural processes and land use activities in source watershed areas that may potentially impact water quality are evaluated by Source Water Assessments. Source Water Assessments have been completed for 5 of the 8 watersheds in the RDCO (Lambly Creek, Mill Creek, Powers Creek, Peachland Creek and Trepanier Creek).

Common hazards identified in the Source Water Assessments that have a high to very high risk to drinking water quality include sediment delivery, changes in peak flows or runoff, biological hazards (bacteria, protozoa, viruses or algae), and chemical hazards (natural organic matter and accidental
release of pollutants). Natural processes occurring in the source watersheds that are hazards with a high risk to water quality include:

- Effects of Mountain Pine Beetle or other insect attacks such as the Tussock moth;
- Sediment from natural landslides or channel erosion
- Wildfire
- Wildlife and waterfowl

Although natural threats themselves are largely unmanageable, the end results are not. Anticipating effects to water quality make it easier to adapt and manage. Human land use activities in the source watersheds are, on the other hand, potentially manageable where mechanisms exist. Activities that are potential hazards with a high risk to water quality include:

- Forest development activities
- Range Use
- Roads on Potentially unstable or unstable terrain
- Road crossings on streams
- Mining and quarries
- Unauthorized recreation, including camping, ATV and dirt bike use
- Wildfire Fighting (sedimentation due to fire fighting activity and use of retardant)
- Densification and intensive Land Development; and,
- Storm water discharge (commonly referred to as sedimentation in SWP assessments).

Land use activities on private land that may potentially affect water quality on Okanagan Lake include:

- stormwater runoff from urbanized areas (paved surfaces);
- agricultural activities (livestock, chemicals – fertilizers, pesticides/herbicides);
- industrial or chemical spills;
- septic or waste water treatment discharge;
- treatment system failures; and,
- recreation on the lake.

Potential water quality effects associated with the above-listed activities may be addressed by Liquid Waste Management Plans (LWMP), Master Drainage Plans and Water System Master Plans. These documents provide analysis and strategic direction for stormwater management, including recommendations for bylaw policies and effectiveness monitoring. Stormwater management planning studies, completed for Electoral Area East (2009), the City of Kelowna, and the District of West Kelowna, provide an inter-disciplinary team approach with a goal to retain natural streamflow conditions. Objectives of stormwater management are to reduce the potential for flooding, reduce pollution from runoff, and to protect and enhance aquatic environments.

LWMPs provide long-term options to resolve potential septic system failures that are expected to occur with projected growth and as tile fields age. Another potential water quality issue addressed in LWMPs relates to the cumulative effect of hillside development as septic effluent may break out lower down on the slope and pollute streams and lakes.

Ultimately, water quality is degraded by most intensive land use activities to some extent. Managing water quality is best achieved by setting short and long term goals and ensuring that all current changes in land use are assessed to minimize risks to water quality. Continued assessment of risks to urban and undeveloped watersheds will ensure that source water quality is maintained for future generations.
Drinking Water Quality

In Kelowna, the KJWC completed the Integrated Water Supply Plan (2011) to evaluate and prioritize the quality of domestic water sources to determine whether a source would be:

- Primary domestic water source - a preferred source providing a high quality drinking water;
- Secondary domestic water source - a source that provides good raw water quality but not as high as the primary source;
- Irrigation or emergency water source – a source that provides raw water suitable for irrigation but does not meet the quality requirements for drinking water and would be challenging to treat for potable use.

The outcome of the KJWC report recommended that, for long-term water supply there should be 3 large intakes on Okanagan Lake, 1 intake on Mission Creek, and groundwater supply from 7 wells. The report indicated that there would be sufficient capacity to meet annual and maximum daily demand for the service area into the long –term. These sources were deemed best able to buffer from water quality impacts and ensure the most reliable long term source for human consumption.

Okanagan Lake is the ultimate receiving body of water. The lake services not only RDCO residents but all residents drawing water from the Okanagan Lake. Further, Okanagan Lake is the source water for downstream residents and all Okanagan Regional Growth Strategy documents deem the lake an important feature and drinking water source. This means that any impacts to Okanagan Lake water quality not only affect local residents but those downstream. Coupled with this, threats to water quality in Okanagan Lake also originate from the upland watersheds simply because they are upstream of the lake. This highlights the importance of Source Assessments in upland areas and those completed on Okanagan Lake including RDCO at Killiney & Westshore Estates (Larratt Aquatic 2012), City of Kelowna, District of West Kelowna, and the Glenmore-Ellison Irrigation District.

The Source Protection assessments were used to define Intake Protection Zones (IPZ), based on a two hour travel time of water currents to the intake under moderate winds. Key recommendations included: applying best management practices for shoreline protection, conducting a cost-benefit analysis for extending the intakes to >20 m with 3 m clearance from the substrate, and applying to ILMB for a license of occupation for the intake protection zones.

2.1.6 Water as a Resource for Aquatic Life

Okanagan Lake and tributary streams in the Central Okanagan provide valuable spawning and rearing habitat for salmonid species (e.g., trout and kokanee) and other aquatic life. Further, water also provides or creates critical habitats for numerous rare and endangered wildlife species (e.g., those associated with floodplains or riparian areas). Associated floodplains and riparian areas act as critical buffers to help protect water quality (as buffers) and in providing habitat or nutrients for fish and wildlife.

Historic water extraction, land development and flood control structures such as dams have negatively impacted fish and wildlife habitat. Further, land uses that increase density along shoreline or streamside areas have also been shown to directly impact habitat function and buffering capacity. There is a growing need to protect important shoreline and streamside areas to ensure adequate water quality buffers are achieved. Part of this challenge is the need to have secure instream flows for the needs of water-dependant species. However, the challenge with attaining water for these purposes, particularly during periods of high demand, is sometimes in direct conflict with other needs. Thus, a balance of instream flow needs is required.
“Instream Flow” is defined as the amount of water needed in a stream to adequately provide for downstream uses such as drinking water, aquatic habitat, recreation, riparian vegetation, and water quality. The successful management of instream flows will balance the protection of water resources with existing uses such as the recreational and traditional food fisheries and important wildlife habitats occurring in riparian, wetland, and floodplain buffers.

Preliminary instream flow needs were assessed for Okanagan Basin nodes/sub-basins as part of the Okanagan Water Supply and Demand Project as a way to target priority areas for site-specific field studies. The study found that minimum risk flow thresholds were most frequently challenged in summer months of high demand. These minimum flows were met more frequently on regulated streams than on unregulated streams, presumably due to increased storage of spring runoff and subsequent release in late summer. Regulated streams, however, had more difficulty meeting minimum risk thresholds during mid-winter months.

In context with projected future climate change and a growing demand for water, storage in combination with ecological water releases that target fish needs are a recommended management approach to better meet ecological requirements. Setting aside water for ecological requirements is referred to as an “ecological water reserve” and will benefit fish, wildlife and buffers intended to protect water quality.

Policies to limit development along water corridors would reduce potential for localized effects of domestic surface water licensing and groundwater extraction from shallow wells adjacent to creeks and tributaries that are fish-bearing. This approach is promoted in a draft watershed master plan for the District of Summerland being prepared by Aqua Consulting (Agua, 2010). Further, this approach is supported by all OCPs and other planning documents. What is currently considered important is ensuring decisions made regarding land uses are in line with recommended water quality protection needs (which includes protection of associate riparian and floodplain buffers).

2.1.7 Floodplain Hazard

Properties adjacent to streams and lakes in the Central Okanagan are subject to floodplain hazards. These hazards may include: spring freshet flooding associated with snow melt and rain, intense summer convective rainstorms, and landslide-generated outburst floods or debris flows associated with structural failures or temporary damming.

Climate change effects on stream flow predict an earlier freshet, and potential for larger winter and early floods due to earlier snow melt and higher proportion of precipitation falling as rain. Climate change models also anticipate more frequent and intense storm events.

The City of Kelowna has completed Flood Hazard Mapping of Mill Creek (Bylaw). Flood elevation and inundation mapping is an effective tool for local government, providing a reliable means of evaluating hazard exposure to properties. The lower reaches of Mission Creek, below Gallagher’s Canyon are dyked for flood protection through the City of Kelowna. It should be noted here that proposed restoration works to restore the floodplain of Mission Creek (i.e., increase capacity and improve habitat function) are ongoing. This initiative is costly; highlighting that initial protection of floodplain areas is more cost effective than restoring floodplains in the future. Achieving the same level of restoration on either Mill Creek or Smith Creek would be extremely costly and may not be feasible, highlighting the need to ensure adequate protection at time of land use change or development.
The flood construction elevation for Okanagan Lake is based on regulated lake level management combined with a 0.6 m wind and wave freeboard. Other than these two areas, floodplain mapping has not been completed for any other stream or watercourse in the Central Okanagan. It should be noted that floodplain mapping is only a snapshot and does not model climate change effects, nor does it include debris flow processes or floods generated by landslide or dam break. For these types of hazards, floodplain mapping would need to extend to a larger area that includes the entire fan.

In the absence of floodplain mapping, guidelines for flood hazard management along a stream should be incorporated into local government policy. Development on streams is typically recommended to have a 15 m horizontal setback and a recommended flood construction elevation 1.5 m above the high water mark. In cases of redevelopment, flood hazard and habitat function (for water quality buffers and wildlife/fisheries values) should be assessed and habitat function restored to some extent. As noted above, this policy does not consider debris flow risks, which should also be assessed to avoid significant consequences such as those observed in the south Okanagan.

2.2 REVIEW OF 2000 REGIONAL GROWTH STRATEGY


Emerging issues identified in the Discussion Paper were centered upon four major themes as follows:

- Water Quantity, identified as top priority.
  - Water for consumptive uses (irrigation and domestic supply)
  - Concept of water being a limited, or “finite” resource in the Central Okanagan
  - Over-allocation of water in streams
- Impacts to Aquatic Habitat and Fish
  - Low flows
  - Sedimentation
  - Loss of riparian vegetation along streams and lakeshores
  - Balance of public and private ownership along lakeshores
- Water Quality
  - Drinking water quality
  - Water quality for aquatic resources
  - Invasive aquatic plants (i.e. milfoil)
- Floodplains
  - Potential flooding impacts along streams and lakes
  - Fish and wildlife habitat value and floodplain function

The Discussion Paper concluded that, rather than become one more player in an already complex water governance structure, the RDCO would participate in an Okanagan Basin Partnership and that the RDCO would work collaboratively with the Okanagan Basin Water Board on issues of regional (basin-level) importance. The Discussion Paper concluded that member communities would work independently, making incremental decisions for the effective coordination of water delivery, water use planning, and stewardship of individual watercourses.

Policy directions recommended in the 2000 Discussion Paper included:
- **Stream and Watercourse Policies**
  - Use the BC Ministry of Environment guidelines as a baseline;
  - Watershed Advisory Committee participation;
  - Develop Best Management Practices for septic fields and wastewater management;
  - Seek partnerships related to stewardship and restoration

- **Land Use and Water Delivery Policy**
  - Require water meters in all new homes
  - Participate in regional forums such as the Kelowna Joint Water Committee and the BC Water and Wastewater Association of BC;
  - Work with the BC Water Management Branch to coordinate land development forecasts with water license allocations and water conservation targets.

Subsequent outcomes of the 2000 Discussion Paper, led to some consideration of water resource issues in the development of the Regional Growth Strategy. In the 20/20 Vision Statement, the following water-related direction is provided:

- The Central Okanagan Is a region that protects and respects its natural attributes. The region’s green spaces and water resources are managed to ensure their long-term health and sustainability.
- The Central Okanagan Is part of a larger region and ecosystem. Our development and growth management decisions respect our neighbouring Okanagan communities. Valley-wide cooperation is supported to sustain the health of our water, air and lands.

### 2.2.1 Events since 2000

In the twelve years since the RGS was adopted, there have been considerable social, economic and environmental changes. While the population within RDCO has grown, there is increasing awareness and effort for higher density growth as opposed to urban sprawl into rural areas. There is also an increasing awareness of water conservation and water efficiency, green and sustainable growth as it becomes apparent that the environment is stressed by development pressures and that global climate models threaten the future availability of water resources.

From a water resources perspective, since 2000, major research initiatives of the Okanagan Basin Water Board have provided a wealth of high quality water resource data that is directly pertinent to the RDCO RGS. The multi-jurisdictional organization, which includes representation from many local government in the Okanagan, has been able to achieve substantial data collection in many areas. Further, the OBWB has initiated the Water Stewardship Council, a strong technical and professional working group. One of the biggest achievements is the Okanagan Water Supply and Demand Project issued in 2010. The study provides a strong baseline understanding of water resources in the Okanagan Basin and Phase 3 modelling of the study is in progress.

Other significant water resources events and initiatives occurring since 2000 include:

- The 2003 region-wide drought resulted in water shortages, extreme low flows and, ultimately the 2003 Okanagan Mountain Fire.
- 2001 – BC Drinking Water Protection Act and BC Water Act Modernization process is underway.
- BC Stream Protection Act and the Riparian Areas Regulation
- Inventory work and studies including,
- Sensitive Habitat Inventory and Mapping of nearly all streams in RDCO, except Mission Creek;
- Wetland Inventory and Mapping in City of Kelowna;
- Okanagan Sustainable Water Strategy
- Source Water Assessments of nearly all domestic watersheds and major lake intakes, except Mission Creek
- Groundwater Protection Planning
- Revisions to Public Health Act & Sewerage System Regulation
- Surface Water Treatment Objectives (March 2012)

Many of the above studies and initiatives would not have been possible without the support of the OBWB, local and Regional governments, and community organizations. It is through these partnerships that ongoing achievements can be reached.

2.3 REGIONAL CONTEXT OF RGS

RDCO is a region within a region. Communities in the Okanagan Valley from Vernon in the north, to Osoyoos in the south, are connected by water. Water withdrawals upstream in the Basin may potentially influence the availability to downstream users. Similarly, downstream users would bear the brunt of land use decisions and/or practices that would impact water quality. The interconnectedness of Okanagan communities with respect to water resources needs to appreciate that decisions and policies made in one region may potentially affect others.

Regional Growth Strategies were recently adopted in the two neighbouring regional districts, the Regional District of North Okanagan (2011) and the Regional District of Okanagan Similkameen (2011). The strategies, its goals and policies for the protection of water resources were reviewed to provide a basis of comparison.

2.3.1 Regional District of North Okanagan

The RDNO RGS addresses “Water Stewardship”, as a means to protect water resources in the region. Through consultation, residents, elected officials and working groups indicated that their greatest concern about regional growth is the availability and quality of water. The RGS underscored the importance of water as an important natural asset, the supply of which is inherently limited.

Some areas within the North Okanagan region that rely on the supply of water from the Duteau Creek watershed, have already experienced water shortages, and shortages are expected to occur more widely and frequently. Additionally, some areas that rely on groundwater, have already experienced a source compromised by contamination.

The primary goals for water stewardship described in the RDNO RGS are for the:

- Protection of Groundwater
- Protection and Conservation of Water Resources
- Consider the True Cost of Water

The RGS is directed to take a balanced approach that acknowledges water as a resource required to meet multiple needs including health and well-being, agriculture, economic activity, and environment. For each goal, specific objectives and actions are described that generally recommend the development...
of clear and consistent policies for the protection of water resources. Highlights of the recommended actions include:

- Evaluating proposed development on basis of local hydrological conditions, long-term water supply, and potential impact on supply to existing users;
- Adopting Best Management Practices;
- Lot size policies;
- Coordinate Water Management Plans and Drought Management Plans;
- Enact water conservation measures for new and existing development and support use of innovative technologies;
- Develop the North Okanogan Water Conservation Strategy;
- Consider the economic, social, ecological and hydrological consequences of inter- and intra-basin water transfers;
- Collaborate with other agencies to address regional and local watershed and source protection and management issues;
- Develop and implement a full-cost accounting framework for water and sewer infrastructure that reflects the true cost of delivering a long-term sustainable resource and use this as a tool for land use planning and decision making; and,
- Discourage the approval of new water and wastewater utilities under private ownership.

The RGS describes an implementation and monitoring program. However, clearly defined thresholds or capacity limits are not identified.

### 2.3.2 Regional District of Okanagan Similkameen

The South Okanagan RGS addresses water resource issues and includes policies for water resource protection. Water in the south Okanagan is recognized as one of the key environmental concerns and is a priority consideration for environmental resource management.

Water resources are addressed in the following RGS goals:

- Promote Sustainable Economic Diversification – which highlights the need to protect the allocation of water for the agricultural industry, and recognizes that water management is a key economic and business feature of the south Okanagan
- Ensure the Health of Ecosystems – recommends developing policy and regulation to protect the natural environment, and to promote conservation and sustainability of watersheds, wetlands, riparian areas and green space. The RGS includes policy to promote water sustainability through conservation and recommends the following four guiding principles to manage water resource capacity:
  - Preserve ecosystem functions to maintain water quality and quantity
  - Encourage best water management practices in agriculture
  - Reduce residential water use to support population growth
  - Use best practices to manage water use for industrial, commercial and institutional purposes.
- Maximize the Efficient Use of Infrastructure – this goal is intended to recognize the scarcity of resources and acknowledges that the availability of infrastructure is a major consideration in identifying future growth areas. The RGS includes policy to recognize the critical link between water, resource management, human settlement and effective growth management. It also includes goals to reduce waste production and to promote use of innovation and BMPs to
increase efficiencies and reduce environmental impacts of infrastructure by integrating stormwater management with watercourse protection strategies.

The RGS includes a monitoring and evaluation program with reporting on an annual and 5 year basis and with specific targets and thresholds to measure progress. Pertinent to water management, “water consumption (litres per capita)” is the monitoring indicator. The data is obtained from the Okanagan Water Supply and Demand Model. This model is not necessarily run every year and whether or not the modelled parameter can be relied upon as a comparable indicator should be confirmed. Water quality was deemed to be difficult to monitor due to the large number of systems and the lack of data.

2.4  **Existing Policies for Water Resource Management**

Water resource management responsibilities at the Regional District level of government are primarily planning related. The Regional District provides development planning and guidance to member municipalities for private land development. Regional authority also extends to: drainage planning, acquisition of park land, operating water systems (where RDCO is the purveyor), and issuing Development Permits and Building Permits.

Key policies for water resource management from member municipalities (Official Community Plans), First Nations, provincial and federal government were reviewed. Policies for water resource management help to integrate water into land management and community planning processes and outcomes.

2.4.1  **Member Municipalities**

Member municipalities will need to update the context statements into their respective Official Community Plans (OCPs) upon acceptable of the updated RGS. All member municipalities (and the Province) acknowledges the environmental sensitivity of lakes, streams and wetlands and have identified these areas as Development Permit Areas. The OCP enables the local government to place restrictions on the use of land within these areas.

The following municipalities have incorporated policies for water resource protection in recently adopted OCPs. Some municipalities place water servicing policies and stormwater management in sections dealing with “Infrastructure and Services” and policies regarding the protection of water resources in sections dealing with “Environment”. OCPs completed by member municipalities include the following:

- North Westside OCP (1999)
- District of Peachland Bylaw No. 1600 (2010)
- City of Kelowna OCP to 2030 (2011)
- District of West Kelowna OCP (2011)
- Rural Westside OCP Bylaw No. 1274 (2011)
- Ellison OCP Bylaw No. 1124 (2011)
- Brent Road – Trepanier OCP Bylaw No. 1303 (2012)
- South Slopes OCP Bylaw No. 1304 (2012)
2.4.2 First Nations

First Nations are self-governing and are not subject to the same legislation and policies as the other member municipalities. The Westbank First Nation (WFN) has adopted a Land Use Law (2007) and zoning regulations that address land development and neighbourhood planning. Specific guidelines for protection of water resources include minimum setbacks from watercourses and land use planning. Stormwater runoff and potential surface water impacts associated with hillslope development is addressed. Water and sewer infrastructure considerations for new development are addressed at a Neighbourhood Plan level.

The Okanagan Nation Alliance (ONA) has the jurisdiction to conserve, manage, co-manage, and where appropriate develop natural lands and waters on First Nation Reserves and Traditional Territories. ONA has a natural resource and land use team that have documented a development vision.

2.4.3 Provincial and Federal Government

Existing provincial and federal government legislation, and policies, associated with the protection of water resources are complex and inter-related. Integral to all is the BC Water Act, which is currently undergoing a Modernization Process. Relations between the BC Water Act and other provincial and federal legislation that addresses water resources is summarized in the Figure 2.5 and Table 2.5 below.

![Figure 2.5: Legislation Associated with water in British Columbia](livingwatersmart.ca)
Table 2.5: Provincial and Federal Government Legislation and Policies Associated with Water Resource Attribute:

<table>
<thead>
<tr>
<th>Resource Attribute</th>
<th>Provincial (BC) Government</th>
<th>Federal Government</th>
</tr>
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<tbody>
<tr>
<td>Drinking Water Quality</td>
<td>• Health Act (administered by Interior Health Authority)</td>
<td>• Water Act</td>
</tr>
<tr>
<td></td>
<td>• Forests and Range Practices Act</td>
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<td>• Waste Management Act</td>
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<td>• Water Act</td>
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<tr>
<td>Surface Water Protection</td>
<td>• Water Act (undergoing updates)</td>
<td>• Water Act</td>
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<td></td>
<td>• Fish Protection Act</td>
<td>• Fisheries Act (potential future changes)</td>
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<td>• Riparian Areas Regulation</td>
<td>• Environmental Protection Act</td>
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<td>Surface Water Quantity</td>
<td>• Water Act (domestic and irrigation)</td>
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<td>Groundwater Quantity</td>
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<td>Groundwater Quality</td>
<td>• Groundwater Protection Act</td>
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<tr>
<td>Floodplain Hazard</td>
<td>• Forests and Range Practices Act (associated with forest development on Crown Land)</td>
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<td>• Local Government Act (floodplain development)</td>
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The overall trend and direction of provincial and federal government is to reduce the size and role of government. There is an increased use of Practice Guidelines and Best Management Practices as a means of directing responsible practices. Some examples include:

- Develop with Care Guidelines
- Stormwater and Rainwater Management Planning Guidelines
- Water Sustainability Action Plan
- Living Water Smart Plan

There is some future uncertainty associated with upcoming future potential changes to provincial and federal legislation. For instance, Bill C 38 could result in substantial changes the Fisheries Act and Canadian Environmental Assessment Act that are not fully understood yet. This change in legislation increases the role for local governments to develop local policies and regulations to address local water resource needs and requirements to meet regional growth objectives. Although this type of downloading is difficult to manage, without appropriate planning and commitment at the local level, water quality and associated habitats will inevitably be impacted. Ensuring appropriate partnerships and the ongoing efforts of agencies such as Okanagan Basin Water Board (OBWB) will continue to ensure an adequate and safe supply of water that is available for all uses, including ecological purposes.

2.4.4 Existing Regional Water Resource Management Initiatives

Existing regional water resource management initiatives include:

- **Okanagan WaterWise** an initiative of the OBWB and RDCO is a partner – goal is to develop and implement best practices for water conservation and protection
- **Living Water Smart** – provincial initiative with goals and objectives for effective water management
- **Water Evaluation and Planning (WEAP) Model**, includes the Okanagan Hydrologic Connectivity Model. This model analyses the sensitivity of water demand and supply from the perspective of any given water utility, taking into consideration upstream and downstream storage, need for environmental base flows, and other users. The outcomes will allow for closer examination of water allocation and will be able to model effects of drought, climate change and population growth.
- **Okanagan Irrigation Management (OKIM)**, which includes online access to irrigation scheduling tools and consumption information (www.okim.ca). So far, within RDCO, the system has only been developed for the Glenmore-Ellison Improvement District.
- **The BC Water Sustainability Act**, will include a number of components that may be relevant to the RGS. These include: groundwater regulation, management of water during drought, Provincial Water Objectives that link land use to water quality and quantity, instream flow requirements for aquatic ecosystems, agricultural water reserves and alternate governance structures. It is anticipated that the legislation will not get introduced until 2014, so there may be opportunity for the RGS to anticipate and integrate relevant policies.
- **Tool kits** – the Green Bylaw Toolkit and the Groundwater Protection tool kit – provide example policies for surface water and groundwater protection.
- **Okanagan Large Lakes Protocol** provides policies for the protection of kokanee spawning habitats and western ridged mussels in Okanagan and other large interior lakes. The Okanagan Lake Action team (consisting of staff from all local governments) is working on developing regional partnerships to better manage Okanagan Lake foreshores.

### 2.5 Key Indicators Related to Water Resources

An enormous amount of data has been collected pertaining to water resources since the previous RGS. These data may be effectively used as key indicators to measure change, loss, or improvement. Some of the key indicators and the data available that can be used to monitor change and provide a measure of water resource protection are described below:

- **Water quantity**
  - (net) flow, especially during summer months,
  - reservoir storage volume,
  - precipitation and snowpack depth (drought stage triggers),
  - ability to meet instream flow needs

- **Water quality key indicators for drinking water**
  - boil water advisories,
  - water quality advisories
  - nutrients, Total Organic Carbon, turbidity, total suspended solids
  - Biochemical Oxygen Demand, pathogens

- **Water quality indicators for aquatic resources**
  - temperature,
  - turbidity and total suspended solids
  - impervious surface area (%) and percent of shoreline (FIM) / streamside impacted (SHIM), total wetland area (WIM), etc.
- % of properties with on-site septic system

- Water use
  - Domestic use (litres/person/day) – aim to be closer to the BC and Canadian average

Another key indicator that could be used is Foreshore Inventory and Mapping (lakes), Sensitive Habitat Inventory and Mapping (FIM), Wetland Inventory and Mapping (WIM), Sensitive Ecosystem Inventory (SEI)/Terrestrial Ecosystem and Mapping (TEM), Source Water Assessments (e.g., risk zones). This GIS data allows tracking of changes over time through comparison of habitat alteration. On Okanagan Lake, the FIM was utilized to determine the annual rate of change in Okanagan Lake as -0.5 to 2% per year. Indicators such as this, that allow quantification of change in a measurable manner are the most effective measures of change because they allow clear targets to be set and measured.
3.0 Issues

3.1 Issues Identified in Current Research and Literature

Water resource issues and concerns that have arisen since 2000 are identified.

Urban sprawl, characterized by uncontrolled expansion into un-serviced rural areas, places great stress on water resources in the Okanagan. Expansion into un-serviced rural areas in the form of rural subdivisions require drinking water and use more water to irrigate landscapes that wouldn’t otherwise have been irrigated. Further, servicing costs of rural areas is substantially more costly. Rural subdivisions are also more likely to rely on septic fields for wastewater treatment. Land development, including the loss of forest cover and increase in paved or impervious surfaces, alters the rates and volumes of runoff. These effects are compounded when urban sprawl extends upwards on steep hill slopes. Recent research has indicated that an alteration of natural areas to urban development and increased impervious space that covers less than 5% of a watershed is large enough to permanently alter important ecological processes (Booth and Jackson 1997). Although not specifically calculated and a bit presumptuous, it is plausible that more than 5% of the Central Okanagan is moderately impervious given the size of urban centers in Kelowna, West Kelowna, Peachland, and Lake Country.

Water Quantity Issues

With population growth and climate change, it will become increasingly difficult to meet the competing water resource needs during periods of high demand.

Streams in the Okanagan are over-allocated. The actual amount of surface water extracted is much less than the licensed quantity. If, during periods of high demand, all licenses extracted their licensed volume, then many streams would dry up and would be unable to provide the water necessary for downstream water users or aquatic resources.

The available water supply would not be able to withstand a multi-year drought. A five-year drought would reduce the availability of water by 40-50% and Okanagan Lake would fall below the Operating Level.

There is an increased need for upland water storage in reservoirs to deliver a consistent year-round supply of water. Storage would offset the imbalance between late summer supply and demand by regulating releases depending on downstream needs.

Low flow periods in the late summer – early fall will be unable to meet instream flow needs and will negatively impact instream aquatic resources.

There will be an increased demand for groundwater as the surface water supply becomes stressed. There is an associated concern for the safe development and extraction of water from aquifers in the Central Okanagan. There is also a potential impact on surface water when groundwater wells are located in close proximity to creeks. Shallow wells in close proximity creeks are increasingly used to augment surface water licences. Such withdrawals are essentially unlicensed use of surface water.
Interbasin water transfers that occur when water from one catchment is used to irrigate another will alter the natural water balance of a catchment. This may artificially increase runoff and lead to downslope erosion, instability, and/or septic seepage.

Water Quality Issues

The potential for water quality issues increases with development in the Source Watersheds and with urban land development on private lands.

Cumulative downstream water quality effects associated with septic field development on hill slopes are a concern with growth and, with age, there will be increasing rates of septic field failure.

Urban stormwater runoff may potentially impact water quality for downstream aquatic resources. Increased runoff rates from impervious surfaces may cause erosion, sedimentation of streams and transport contaminants.

Inadequate riparian buffers for water quality around wetlands, streams, and lakes will continue to degrade water quality. Further, failure to ensure adequate buffer restoration during redevelopment will prolong restoration of historical impacts.

Flood Hazard Issues

Climate change, loss of forest cover (pine beetle, forestry, wildfire), and impervious surfaces will increase rates of runoff and may potentially increase flood hazard to properties situated within floodplains.

Engineers Canada has developed new protocols for evaluating the size and failure risk of dams, pipes, bridges and drainage systems. These protocols may be used to assess infrastructure.

3.2 Stakeholder perspective

A focus group of water resource stakeholders were invited to participate in an on-line survey and met to assist in the preparation of the Water Resources Discussion Paper. Discussion touched on the identified priority water resource themes and issues identified in the previous 2000 Water Resource Discussion Paper. Highlights of the survey and key discussion points are summarized as follows:

General:

- Provincial government direction is to reduce the size of government, and therefore unnecessary red tape, with a goal to maintain the same quality of service. There remains a need for monitoring and enforcement. Overall message that we don’t need more regulation, just need to enforce the ones we already have.
- It is acknowledged that the issues are well known but policy is not moving forward to address them. The RGS is an opportunity for local government to take the lead. It is important to note that all local government policies speak to the importance of water resources, meaning that local residents care about this issue.
- Water resource issues associated with Regional Growth are not associated with actual population, rather the issues are associated with the type of land use (i.e. high density vs. low
density; urban vs. rural; lot size) and where the development is to occur (i.e. hill slope vs. valley bottom). Land use decisions will be important. Some possible mechanisms:
  o Direct compact growth in Community Plans
  o Reduce outdoor water use through guidelines for residential landscaping
  o New communities to get water through conservation (Living Water Smart)

- Current growth area shown will occur over next 10 to 20 years. This RGS will help influence this development. RDCO is interested in next 30 to 50 years as a long term vision for growth.
- Regional Growth Strategy should reflect societal values. Must articulate how it will look and then how to get there.

Regional Watershed Approach:

- Recommend looking at Okanagan Basin watershed.
- desire to “speak as one voice”. Look at commonalities and the bigger picture. We are living in a multi-use watershed with varying governance and competing interests.
- Regional watershed approach – It is important to recognize a potential conflict between local accountability for water vs. provincial control over Crown Land. This can be addressed by continuing to consider the watershed as a whole (i.e. Okanagan Basin) and to continue to collaborate on issues of regional importance.

Multiple Jurisdiction Collaboration:

- There is still a strong need for inter-jurisdictional collaboration as municipal government has little control over what is happening in the upper watersheds.
  o KJWC has drafted a document called Integrated Planning for Water Quality pertaining to long-term water management.
  o Water Use Plan completed for Mission Creek
  o Stewardship collaboration on Mission Creek, City of Kelowna has established a Habitat Trust Fund.
- OBWB and the Water Stewardship Council are unique organizations able to bring together multiple jurisdictions to address water resource issues of regional importance. It is a challenge to maintain good communication and ensure representation of water suppliers.

Water Quantity and Allocation:

- Allocation of water supply still an issue. Additional storage is needed to manage for lower flows associated with climate change, including conservations flows. This need should be acknowledged in long-term planning.
- Need to acknowledge the fact that the Provincial Government (Water Smart 2009) committed to dedicating water to agriculture and that an Agricultural Water Reserve would guarantee water for agricultural land use. A significant amount of water is allocated, and used, for agricultural purposes in Okanagan Basin. Suggestion was made to distinguish between water for irrigation on land with farm status (i.e. lower rates) and water for irrigation on non-agricultural land. It will be a challenge to reserve land and reserve water and to allocate fair water rates.
The “beneficial use” clause on water license has a 3-yr time limit which is why an agricultural water reserve is important because it protects resources for the longer term.

A possible water conservation tool could be to waive farm status in times of drought. Also to promote the development of Environmental Farm Plans that assess irrigation use.

**Water Quality:**

- **Use of Best Management Practices (BMPs)** is thought to be a means of directing good stewardship for the protection of water resources but avoids over-prescriptive approaches. There are many Provincial BMP documents out there that are relevant (Motorized recreation, cattle management, septic use, mining). There are also existing provincial guideline documents out there that should be adopted. Such as the one pertaining to groundwater development in rural area. A reduced role of government will mean that there is a stronger reliance on professionals and professional opinion. A risk of this approach is that professional reliance may lead to poor practices and mechanisms to safeguard residents is required through appropriate compliance and enforcement monitoring.
- Source Protection Mechanisms – buffers, or setbacks along water courses, are important.
- Data (water quality/quantity inventory) is important.
- Need to choose from a choice of targets, critical thresholds and/or measureable indicators. It will be a political decision as to whether RDCO should show a growth boundary. Monitoring keeps the dialogue open and up to date.

**Floodplain Hazard:**

- **Floodplain hazard is still an issue** and the Regional District (and member municipalities) would like a better way to assess risk. Mill Creek floodplain mapping (a snapshot) has been effective and helped address riparian encroachment issues. Recommend floodplain mapping for Mission Creek and digital elevation maps to identify areas with higher flood risk.

**Emerging Issues:**

- **Emerging issue pertains to infrastructure, efficiencies, life-cycle, and long-term maintenance.** Size of utility is proportional to efficiency. Ministry of Health White Paper recommends reducing the number of improvement districts. Independently owned and operated (incl. strata) sewage plants and water mains are not permitted due to history of failures and long-term maintenance concerns. Short-term costs may be addressed by DCC but more difficult to address long-term concerns. Rural services cost more (25-50% more) than urban services and the cost is not reflected. There should be more accurate pricing on development but cost cannot be thought of in isolation of other issues such as transportation.
4.0 Analysis

4.1 GAP COMMENTARY
Based on the literature review and focus group session, issues that have not yet been fully addressed, or where more information (inventory data) or analysis is required include:

- **Consolidate water quality information** for domestic surface water and groundwater sources and aquatic resources. This information is scattered amongst water utilities, Interior Health Authority and MFLNRO, or is simply not reported depending on what objectives are being considered. Subdivision service bylaws require that water quantity and quality be reported but the data is not in public domain.
- There is little information on the potential **use of treated wastewater for irrigation purposes** within RDCO.
- **Cumulative effects of septic development** resulting from urban sprawl into rural areas are not well understood. However, the potential for septic effluent breakout below hillside development increases with growth.
- **Debris Flow Hazard zone mapping** – In light of the 2010 Testalinden Creek debris flow in Oliver, BC, the RDCO should work together with Ministry of Forests Lands and Natural Resource Operations (MFLNRO) dam safety officers and local engineering staff to identify drainages subject to debris flow, and be prepared to manage development in those areas to reduce risk. This could include requiring geotechnical assessments in high hazard areas and RDCO could access BC Flood Protection Program funds to mitigate risks.
- **Drought Management Plans** have been prepared for individual water utilities. However, in anticipation for drought, a region-wide Drought Preparedness Plan would provide resiliency to drought and act to help coordinate drought management at a basin scale.
- **Consistent policy for the protection of aquatic habitats is not forthcoming.** A consistent approach that ensures adequate protection of aquatic habitats for human consumption, fish, wildlife, and associated habitats is not generally apparent. Although some policies are in place, they often rely upon other agencies or have jurisdictional issues (e.g., OCP versus Riparian Areas Regulation, Fisheries Act versus Land Use, Source Water Protection and Land Use, etc.). A local approach to shoreline and streamside management would streamline activities and promote better protection of local water courses since most decisions that can have the greatest effect (i.e., land use) are made at the local level.

4.2 OPPORTUNITIES FOR RDCO POLICY DEVELOPMENT
Land use planning decisions that minimize the impact of urbanization associated with population growth will reduce the human footprint on the environment, which will in turn reduce impacts on water resources. The integration of land use planning and water resource management begins with the recognition that land use has an impact on water quantity and water quality and subsequent impacts to fish and wildlife that rely upon these water resources. Land use planning decisions that recognize the interconnectedness of land use and water resources are beneficial to the natural environment and to the residents and species that make use of it.

Based on a review of existing policies, background technical information, and stakeholder consultation, opportunities for policy development for the protection and sustainable management of water resources in the Central Okanagan are discussed.
Member municipalities of RDCO have included consideration for water resources and policies for protection in their OCPs. RDCO, through the development of the Regional Growth Strategy, has an opportunity to integrate individual policies to ensure consistency. \textbf{Integration of water resource protection policies recognizes that water is a shared resource}, and that watersheds and sub-basins cross jurisdictional boundaries.

Existing policies advocate for water conservation and protection measures as a means to address climate change. \textit{Water conservation alone, however, will not sufficiently address potential supply shortages during extended periods of drought}, or with long-term effects of climate change. To ensure that water supply is resilient to these effects, storage capacity will need to be increased in some sub-basins to meet the challenges of population growth.

Another opportunity for effective water resource management policy is to \textbf{promote the watershed-approach}. The RGS should recognize that land use activities have regional connections with watersheds and aquifers. Development within a specific area will be affected by natural processes and activities upstream/upslope and needs to consider potential consequences to downstream/downslope resources.

An appreciation for connectivity is lacking in some existing policies and an opportunity for policy development is to \textit{utilize the water balance approach on a sub-basin scale by considering rural lot development based on water budgets}. This approach may be used gain a larger perspective on growth and to guide development such that natural water balance is maintained.

For example, the water balance approach would limit the density of rural subdivision lots relying on groundwater based on the availability of groundwater on a catchment by catchment basis. The initial estimates of groundwater developed by Golder et al (2010), could be used as a starting point to rationalize lot density and these numbers could be refined to accommodate increased density, as more information becomes available and if the information supports further development. Applications for development would also need to consider the relative location of proposed versus existing development, the potential impacts on existing groundwater users in light of the groundwater budget established for the catchment and the sensitivity of existing groundwater users as well as the proposed supply to future development within the same catchment.

In anticipation to potential changes in the BC \textit{Water Act}, the RGS may also want to consider policy that \textbf{acknowledges potential allocation issues} associated with the priority of water rights. RDCO, together with the large public water utilities, should make use of the results of the Okanagan Hydrologic Connectivity Model (Summit Environmental Consultants Ltd., 2012) to understand where allocation issues exist. The information could help identify and classify essential or non-essential water use, and understand where water is required to for ecological needs.

With a goal to \textbf{promote water efficient land development and to fairly allocate infrastructure costs}, some jurisdictions have implemented cost sharing and tax incentives. Use of a “Stormwater Rate” has been implemented by the City of Kitchener, Ontario as a way to recover stormwater management costs. The user-fee program is based on the measured area of impervious ground cover (e.g., rooftops, driveways, and parking lots) on a property, which is a common indicator of the relative contribution of stormwater runoff and pollutant loading to the municipal stormwater management system. Funding through a stormwater rate has the primary advantages of a fair and equitable allocation of charges to property owners, it is a sustainable and dedicated funding source, provides incentive opportunities to reduce stormwater runoff and pollutant discharge, and it provides a mechanism to charge tax exempt properties for municipal services.
4.3 EMERGING AND POTENTIAL FUTURE ISSUES / CHALLENGES

The following emerging and potential future issues and challenges associated with water resources are identified:

1. Floodplain management and flood response. Floodplain mapping in the Central Okanagan is lacking and with predicted climate change, storms are expected to be more frequent and more intense. Currently, residential properties are unable to acquire flood insurance. Thus, the costs to protect homes falls to the district. It was suggested RDCO might consider “local service area” status under the Local Government Act, which is the framework to provide authority for municipal governments to levy a parcel tax to recover all or part of flood protection costs.

2. Agricultural water system separation. Separation of agricultural water from domestic water will become more important as the cost of treating poor quality water increases. This is considered a priority for areas serviced by South East Kelowna Irrigation District (SEKID) and some areas of Glenmore-Ellison Improvement District (GEID). High colour, high organic content and high turbidity make it more difficult for effective UV treatment. If filtration becomes a necessary form of treatment for potable use, then separation of agricultural water is warranted, with the construction of small filtration plants for drinking water.

3. Acquire Crown Leases on land surrounding upland reservoirs. Recreation and development in and around upland reservoir lakes is a hazard to downstream drinking water quality. With a growing importance for stored water, storage opportunities will be maximized by water utilities. Attaining control over land surrounding reservoirs would reduce potential limitations to reservoir increases.

4. Open and Closed Loop Geothermal Systems. The geothermal industry has experienced huge growth in the last decade and the construction of open loop wells and closed loop geothermal boreholes is not monitored to ensure compliance with the BC Groundwater Protection Regulation (BCMoE, 2005). The most significant issue is improper grouting of closed loop boreholes, which can allow for the migration of contaminants into aquifers from surface. Implementation of third party monitoring to ensure proper grouting of geothermal boreholes, to be funded by the contractor, will help to reduce this potential threat to water quality.

5. Increased recreation and utilization of upper watershed areas. Given the project population growth of the Okanagan, coupled with increased population growth in BC and the world, it is anticipated that there will be significantly greater pressures on upper watershed areas. Pressures will result from increased recreation, water infrastructure development (e.g., raising or new reservoirs), and overall changes in land use that will impact water quality and quantity. The future challenges in our upper water sheds will be much more apparent in the future when compared to the past 30 to 50 years (aka next generation versus the past or current generations).

6. Balancing future growth needs with the need to protect important water resources will become increasingly more difficult with time. Although this is not a new concept, identified in the previous RGS, it is apparent that the current pressures on local water resources are now greater than ever before. Further, it is apparent that current land uses and activities have already had substantial impacts. Finally, all water availability models tend to point to increased stresses in the future. This means that all decisions made are important because they have the potential to impact current and future water resources to some extent. Water resources should be considered in every land use decision made for these reasons.
4.3.1 Importance of Water Use Efficiencies - Demand Management

While average annual flows are not predicted to change significantly over the long term, the summer low flow period is expected to be longer. Withdrawals for human use, during the summer months, will be significant relative to the water availability and will be similarly extended. The Okanagan Water Supply and Demand Project reports that agricultural water users, while being the largest water user group, are more efficient water users than other outdoor water users (such as golf course, parks and residential landscaping) (Summit Environmental Consultants Ltd., 2010). Agricultural water use has found efficiencies through crop choices that use less water and through improved irrigation practices such as use of drip systems and irrigation scheduling.

The water demand model predicts that accelerated implementation of water efficiency measures will decrease water use by 6-7%. With even moderate reductions in water use, these efficiencies will likely make a significant difference in the available streamflow in the tributaries. This, in turn, will reduce the requirement for water releases from the upland reservoirs. As indicated previously, however, water conservation measures alone will not be sufficient during extended periods of drought.

**Metering and leakage reduction** are critical for long term water management. Universal metering provides a consistent means of monitoring water use and in metered areas water use has dropped. Leakage accounts for a significant loss of supply (9% of total demand) and reductions in leakage would result in more efficient water use and cost savings for utilities.

4.4 Connection to other RGS issues

Water Resources are very much connected with other RGS issues being examined in other Discussion Papers. Issues and concerns related to Water Resources affect other subject areas, as water is an essential and critical resource for life, for the economy and for the environment. Consideration and collaboration amongst other issue areas will increase the ability to balance often competing demands on the same resource. Connections between Water Resources and other RGS issues are described below.

**Environmental Protection** – This Discussion Paper identifies issues and concerns associated with protecting the natural environment. Fish and wildlife rely on the availability of clean water in streams, lakes, and wetlands. Development pressures that impact water quantity and/or water quality may potentially impact aquatic habitat so recommended policies focus on the protection of water resources. Thus, there is considerable overlap between the Environmental Protection Discussion Paper and the Water Resources Discussion Paper.

**Economic Development** – Agriculture is completely dependant upon the availability of water, particularly during periods coinciding with low supply. During water shortages and drought, impacts on agriculture will have consequences on the local economy. Other economic sectors, such as recreation and tourism (incl. golf courses and resorts) are also reliant on a consistent supply of clean water. Additionally, urban sprawl will have economic consequences since it costs more to extend infrastructure (including water and sewer) to outlying rural areas. As previously discussed, periods of long term drought could have significant and substantial economic consequences and therefore, care must be taken to ensure water resources are adequately maintained to maintain a vibrant local economy. *Although water resources and environmental protection are typically at odds with economic considerations, we suggest and argue that it is our vibrant ecological and water resources that are..."
responsible for development of our vibrant economies. The Okanagan life style would not be the same if the lakes, streams, and visual aesthetics of the region were altered to the point where people no longer wished to reside, recreate, or vacation here. Alteration of thought such as this will help ensure that adequate resources are dedicated to protection of water resources and the environment.

**Parks and Open Spaces** — Developed parkland and cultivated open spaces rely on water for outdoor irrigation and landscape watering. Public outreach and education will provide gaining acceptance of water conservation measures, water-efficient landscape choices, and irrigation scheduling and forms.
5.0 Suggestions for Community Discussion

5.1 Policy Directions to Update the RGS

The RGS consultation process forms part of the RGS update. For discussion, the following policies for effective responsible water resource management are suggested. Through consultation, RDCO will construct a “vision” for future growth. Appreciating the current state of the resource and what changes have taken place over the past decade, existing policies for water resource protection and management may be updated. Some general policy direction for the RGS update is provided.

**Promote ongoing collaboration amongst stakeholders to form a “common voice”**

Watersheds in the RDCO are situated within the Okanagan Basin Watershed. The watershed supports multiple land use activities within various jurisdictions with varying governance and competing interests. Ongoing collaboration amongst stakeholders provides an opportunity to identify common goals and facilitate communication and cooperation. Consistent messages and the use of a “common voice” will be more effective than multiple voices from individual stakeholders. Potential conflicts between local accountability for water and the provincial control over Crown Land, can be addressed by approaching issues with a regional watershed, or Basin, approach by promoting ongoing collaboration on issues of regional importance.

**Water Quantity / Water Supply / Water Service:**

**Ensure a supply of water for agriculture**

Being mindful that an agricultural water reserve will guarantee future water for agricultural purposes, RDCO can anticipate appropriate allocation.

**Ensure sustainability of water in rural development areas serviced by private systems**

Subdivision approvals should be based on a water budget, which recognizes sensitivity to drought, climate change and future subdivision approval within the same catchment. Unchecked development potentially could render an area as over–subscribed and provision of community based water supply to isolated areas could be cost prohibitive.

**Protect and expand reservoir storage.**

Identify areas where reservoirs will help meet future water demands.

**Water Demand / Water Use / Conservation:**

**Increase Resilience to Drought by minimizing consumption and by preparing drought preparedness plans.**

Water conservation best management practices may include: water metering, public education and outreach, and an equitable water rate structure. Infrastructure improvements might include leak reduction and system design efficiencies. Outdoor residential water use may be reduced through the development of bylaws that include landscaping and irrigation standards, top-soil standards, water use restrictions and hardscape design guidelines. Residential indoor water use may be reduced through efficiencies in plumbing and reduction of impervious surfaces and outdoor landscape irrigation demand may be reduced through efficiencies in irrigation systems.
Encourage effective public communication, education and outreach
Public education programs that promote an understanding of environmental conditions would reduce water demand through behavioural change. Consistent messages for the conservation and protection of water resource are important to facilitate change. Outreach and education programs might also include pollution prevention practices, such as tips for septic tank maintenance.

Water Quality:

Ensure a supply of clean, safe water for drinking
Drinking water quality from small, private water sources is not well characterized and is potentially at a greater risk of contamination. Policies for growth should identify unserviced areas and prioritize for future expansion of the supply system. Policies should discourage the development of small, private water utilities and encourage new development to connect to a community water system (except for non-consummptive agricultural use).

Reduce potential for water quality impacts at domestic water intake sites
The RGS should recognize the need to protect domestic water at intake sites on streams, lakes and in the ground. Community water intakes on Okanagan Lake are protected by Intake Protection Zones. Community groundwater wells if not already done, should have wellhead capture zones delineated and development in these zones should be limited or restricted.

Promote integrated stormwater/rainwater management
Rainwater capture and infiltration is considered good practice as it helps to replenish groundwater reserves and contributes to nearby streams. Infiltration also reduces runoff rates, which reduces erosion potential.

Currently, at the time of subdivision, RDCO requires stormwater to be attenuated on the subject parcel and, for large subdivisions, the post-development storm water flows from the property cannot exceed the pre-development flows. For large hill slope developments, monitoring wells may be used to monitor cumulative downslope effects on groundwater.

Protection of Water Resources (refer also to the Environmental Protection Discussion Paper):

Support enforcement and compliance with existing policies and regulations
This may be accomplished through monitoring efforts.

Require site-specific Instream Flow Needs (IFN) assessments
Instream flow needs should be determined for fish streams that are subject to surface water withdrawals or when groundwater wells are proposed within close proximity to streams.

Encourage groundwater protection and well siting requirements.
With increasing reliance on groundwater, Aquifer Source Protection Bylaws would assist in protecting the resource.
a. Observation wells are recommended in primary or secondary growth centres that rely on groundwater. Groundwater level data, monitored in conjunction with precipitation, would be useful for the RDCO and for the Province to identify trends in aquifer levels.

b. Well siting requirements, to be included as part of Phase 2 of the BC Groundwater Protection Regulation, will minimize impacts on surface water. The RGS should provide some direction and guidance for responsible well siting, given the state of knowledge regarding groundwater resources in the Okanagan Basin.

c. Well head capture zones should be delineated and development within the zones should be restricted.

Encourage stream, lake, and wetland protection requirements that will ensure long term water quality it protected.

With increasing development pressure, continued efforts to protect and manage stream, lake, or wetland buffers (setbacks) will help maintain water quality. Data clearly shows that intial protection is more cost efficient than future restoration efforts. Management of these buffer areas need should consider all aspects of the water resource, including fish, wildlife, water quality, and general aesthetics.

Participate in and support water stewardship activities

Federal, provincial, regional, local and private stewardship efforts to protect and enhance watersheds and water resources will benefit all in the region and should be encouraged.

5.2 Monitoring and Performance Indicators

Monitoring and performance indicators provide a rapid summary assessment of the current status or trends in condition. Indicators reflect causes, processes or results of impacts on different aspects of the resource. Performance trends indicate the response to land use activity and/or mechanisms for management.

Effective monitoring and choice of performance indicators should prescribe to the S.M.A.R.T. criteria. That is, indicators should be:

- Specific, with reference to a specific goal;
- Measurable, such that progress may be evaluated;
- Attainable, or realistic;
- Relevant; and,
- Time-bound, or framed within a certain time period.

RGS performance evaluation should maintain a long term perspective. Annual variability is to be expected and may potentially be misinterpreted.

Performance indicators will, initially describe baseline conditions and subsequent monitoring will measure progress or departure from the baseline condition. Monitoring and summary reporting is recommended on an annual basis and more comprehensive analysis is recommended on a five-year basis.

The following monitoring parameters are selected to describe the State of Water Resources in the Central Okanagan. Criteria for evaluating performance are provided for each parameter.
Monitoring Parameter: Water Use (litres/person/day)
Performance Evaluation: Decreasing. Less water used per capita would indicate more efficient use of water. With an aim to be closer to the BC and Canadian average, this performance indicator would measure progress towards that goal.

Recent development of the “Streamlined Water Use Reporting Tool” will be used by major public utilities capable of more sophisticated measurement of bulk water use. This method of reconciling previously patchy and inconsistent data is not able to capture use by small utilities of private use by unmetered domestic, industrial and agricultural users, but will account for the majority of water use in RDCO.

Monitoring Parameter: Surface Water Quality (various parameters – such as turbidity, BOD, nutrients, pathogens)
Performance Evaluation: Meets BC Water Quality Standards for Aquatic Life. Surface water quality monitoring is recommended for higher density areas with existing on-site sewage disposal programs to determine the effect on nearby creeks and streams as well as the effect on groundwater quality in local aquifers.

Monitoring Parameter: Proportion of population serviced by a secondary wastewater treatment system (%)
Performance Evaluation: Increasing. An increasing trend of integration into a municipal wastewater treatment system would reflect a potential decrease in the amount of pollution discharged to the environment in sewage effluent.

Monitoring Parameter: Percentage of impervious area on developed lots (%)
Performance Evaluation: Decreasing. Impervious areas (such as driveways, dwellings, and parking lots) directly affect the rates of runoff and erosion. This has an indirect impact on downstream aquatic resources. Impervious areas may be visually determined using remote sensing imagery. The analysis of digital imagery would be completed every 5-10 years depending on how regular the imagery for RDCO is updated. The costs of the imagery are assumed to be borne by other RDCO programs.

Monitoring Parameter: Proportion of dwellings serviced by a public water utility (%).
Performance Evaluation: Decreasing. A decreasing trend in the number of dwellings serviced by a water utility would reflect a growing reliance on groundwater.

Monitoring Parameter: Groundwater Levels Relative to Precipitation
Performance Evaluation: Stable. Groundwater levels monitored at priority locations of projected growth, would characterize aggregate, or cumulative groundwater impacts when compared with trends in precipitation and groundwater use. The rationale is, that groundwater levels respond to pumping, the disposal of storm runoff and wastewater to ground and due to both seasonal and long-term trends in precipitation. BC MoE already has some provincial observation wells in the RDCO, where water levels are monitored against cumulative departure from mean precipitation (CPD). The objective is to monitor climate and development indicators in relation to water level changes and to differentiate between the effects of development on the groundwater resource, as opposed to climate impacts.
The goal is to increase the number of monitoring wells by providing incentives to existing well owners within the RDCO to participate in a water level monitoring program. It is also proposed to require new developments to install shallow observation wells at the down slope limits of development areas to monitor the changes in water levels, during build out and for a prescribed period after full build out. The latter is to identify cumulative impacts from storm disposal to ground, sewage disposal via domestic disposal fields and water return to the subsurface from domestic irrigation.

The resources to implement the aggregate groundwater impacts monitoring would be minimal. The BCMoE data is available on the internet. Some staff support will be required to manage the program including accessing data from the BCMoE and private well owners that are enrolled in the monitoring program, as well as collection of precipitation data from the Kelowna Airport. The cost of shallow wells at down slope locations and the collection and analysis of data would be the responsibility of development applicants throughout the duration of subdivision build out and for say 5 years afterwards. If a review of data at the end of the proposed subdivision monitoring period indicates that a subdivision is not impacting groundwater levels, then the wells could be abandoned or taken over by the RDCO and monitored less frequently. All water level and climate data would be analyzed every 3-5 years, or more frequently during drought.

**Monitoring Parameter: Percentage of impacted stream, lake, or wetland area (%)**

**Performance Evaluation:** Decreasing. The current GIS methods used to monitor stream (SHIM), lake (FIM), and wetland areas (WIM) are useful tools to monitor change. The re-sampling frequency of these assessments is approximately 5 to 8 years, as this timeline is sufficient to monitor and measure change.

### 5.3 Adaptive Management

An adaptive management approach includes a mechanism for feedback and improvement. Upon implementation, baseline conditions, as represented by various performance indicators, are established. Effectiveness monitoring is used to assess progress and the results point the direction to adapt and improve policies.

### 5.4 Opportunities for Regional and Inter-Agency Collaboration

The OBWB provides the greatest opportunity for regional and inter-agency collaboration of water resources. The OBWB is a water governance body that addresses water resource issues on a Basin scale. OBWB Board of Directors includes representatives from the three Okanagan regional districts, the Okanagan Nation Alliance, the Water Supply Association of BC and the Okanagan Water Stewardship Council.

The RDCO is also represented on the Okanagan Water Stewardship Council (WSC), a multi-jurisdictional technical working group that advises the Okanagan Basin Water Board. The Vision of the Water Stewardship Council is:

“that the Basin will have clean and healthy water in sufficient abundance to support the Okanagan’s natural ecosystems, agricultural lands and high quality...”
of life for perpetuity. Accurate, up-to-date water information and scientific knowledge will support community and regional planning. Water will be managed in a spirit of cooperation, and a valley-wide ethic of conservation will create a lasting legacy of sustainable water resources for future generations.”

Water utilities servicing residents of the City of Kelowna collaborate within the Kelowna Joint Water Committee (KJWC). In West Kelowna, the Water Utility Master Plan has resulted in the integration of five different service areas that source water from two different sources (Lambly Creek and Powers Creek). The District of Peachland is the only other large public water utility in RDCO. However, there are still numerous small public and private water utilities that would benefit from greater collaboration.

There are also collaborative opportunities amongst other jurisdictions in BC through professional and technical practice organizations such as the BC Water Supply Association and BC Water and Waste Association.
6.0 Next Steps

6.1 SUMMARY OF PAPER

The Water Resources, Lakes and Streams Discussion Paper examines water resource issues and concerns pertinent to the Central Okanagan in the context of an updated RGS.

6.1.1 State of Water Resources in the Central Okanagan

Water is critical and finite resource, responsible for maintaining a high quality of life in the Okanagan. Water is essential for good health, economic opportunity, and for the natural environment and for these reasons is considered one of the most important aspects affecting sustainable, regional growth.

While the presence of a large lake may be incongruous with the concept of a limited water supply, the Okanagan is, in fact a water-deficient area. The region is relatively dry due to low precipitation and high rates of evaporation. The seasonal and long-term variability in precipitation affects available surface water and groundwater. This, combined with the growing need for water for population growth and agriculture, has prompted a considerable amount research in the Okanagan on water availability.

Within, or partly within, RDCO there are eight watersheds, of which six are designated community watersheds, providing water for domestic consumption. These watersheds, contribute almost half (46%) of the total annual flow into the Okanagan Basin. Domestic water supply for RDCO residents is also obtained from a combination of municipal sources in Okanagan Lake and groundwater wells. Most (86%) water used in the Okanagan is for outdoor purposes (i.e. agriculture, residential outdoor use, golf courses and parks). Agricultural irrigation alone represents 55% of the water used in the Okanagan.

Recent climate change modeling predicts that annual runoff will increase overall, but with increased seasonal variability (increased winter runoff due to increased rain and snow melt and decreased summer runoff due to an earlier spring freshet). Year to year runoff variability is also expected to increase, particularly in the winter. Prolonged periods of drought will have a dramatic impact on surface water supply, such that in a five-year drought scenario, it is predicted that the average annual net inflows to Okanagan Lake would be roughly half of what they are presently. The economic consequences of a drought are considered to be substantial due to the significant potential impacts on existing infrastructure and subsequent impacts on things such as tourism. Groundwater supply is generally not as vulnerable as surface water to short-term drought cycles and may be a suitable supplement to deficient surface water supply. Other options to manage drought include development of increased upland storage to address drought and ecological flow needs. With the projected changes in climate and population growth, the future management of upland reservoirs will become even more important in meeting water demands.

The Projected Water Supply and Use in the Okanagan (2010-2040) study concluded that, with modest population growth (1% annual growth) and with expected improvements to agricultural water, surface water use should not dramatically change in the future (Polar Geoscience, 2012). However, a population boom with urban sprawl would increase overall surface water requirements by 20-30% throughout the year. A worst case scenario of population boom and agricultural expansion is projected to increase overall water use by 30-40% during the spring and summer and 50-70% during the winter. It is noted that groundwater, sourced from wells in rural and semi-rural areas where bedrock dominates, is expected to augment only a small portion of the additional demand requirements, should urban sprawl occur in these areas.

In the twelve years since the previous RGS, there have been considerable social, economic and environmental changes. While the population within RDCO has grown, there is increasing awareness
and effort for higher density growth as opposed to urban sprawl into rural areas. There is also an increasing awareness of water conservation and water efficiency, green and sustainable growth as it becomes apparent that the environment is stressed by development pressures and that global climate models threaten the future availability of water resources.

From a water resources perspective, since 2000, major research initiatives of the Okanagan Basin Water Board have provided a wealth of high quality water resource data that is directly pertinent to the RDCO RGS. The multi-jurisdictional organization, which includes representation from the RDCO on the Water Stewardship Council, together with strong technical and professional input, produced the Okanagan Water Supply and Demand Project (Summit Environmental Consultants Ltd.) in 2010. The study provides a strong baseline understanding of water resources in the Okanagan Basin. Further, environmental inventories such as the Foreshore Inventory and Mapping projects have compiled data that catalogue the condition of important shoreline areas that act as water quality buffers.

### 6.1.2 Water Resources Issues

Urban sprawl or uncontrolled expansion into un-serviced rural areas, places great stress on water resources in the Okanagan. Rural areas require water for domestic and outdoor irrigation purposes, and have to manage wastewater and stormwater. Land development, including the loss of forest cover and increase in paved surfaces, alters the rates and volumes of runoff. These effects are compounded when urban sprawl extends upwards onto steep hill slopes. Current research suggests that changes to impervious surfaces of less than 5% in a watershed are sufficient to alter ecological processes and continued urban sprawl will only result in an increase in imperviousness in our local watersheds.

The major water resource issues identified in this paper include:

*With population growth and climate change, it will become increasingly difficult to meet the competing water resource needs during periods of high demand.*

- Streams in the Okanagan are over-allocated.
- Water supply would not be able to withstand a multi-year drought
- There is an increased need for upland water storage in reservoirs to deliver a consistent year-round supply of water
- Low flow periods in the late summer – early fall will be unable to meet instream flow needs and will negatively impact instream aquatic resources
- There will be an increased demand for groundwater as the surface water supply becomes stressed
- Inter-basin water transfers that occur when water from one catchment is used to irrigate another will alter the natural water balance of a catchment.

*The potential for water quality issues increases with development in the Source Watersheds and with urban land development on private lands.*

- potential for cumulative downstream water quality effects associated with septic field development on hill slopes
- Urban stormwater runoff may potentially impact water quality for downstream aquatic resources.
- Inadequate riparian buffers to protect water quality on lakes, streams, and wetlands.
Climate change, loss of forest cover (pine beetle, forestry, wildfire), and impervious surfaces will increase rates of runoff and may potentially increase flood hazard to properties situated within floodplains.

6.1.3 Opportunities for Policy Development

Based on a review of existing policies, background technical information, and stakeholder consultation, opportunities for policy development for the protection and sustainable management of water resources in the Central Okanagan are presented. Opportunities for policy development include:

- Integrate individual water resource protection policies of member municipalities of RDCO to ensure consistency and to acknowledge that watersheds and sub-basins cross jurisdictional boundaries.
- Increase storage capacity in some sub-basins to meet the challenges of population growth, as water conservation alone will not sufficiently address potential water supply shortages during extended periods of drought, or with long-term effects of climate change.
- Recognize that land use activities have regional connections with watersheds and aquifers, so the RGS should promote the watershed-approach.
- Utilize the water balance approach on a sub-basin scale as a means to limit the density of rural subdivision lots that rely on groundwater.
- Acknowledge potential allocation issues associated with the priority of water rights and uses.
- Promote water efficient land development and to allocate infrastructure costs equitably.

Emerging and potential future issues and challenges associated with water resources include: floodplain management responsibilities, agricultural water separation, greater control on land use activities in source watersheds including acquisition of Crown Leases on land surrounding upland reservoirs. There are also future issues and challenges associated with the growing use of open and closed loop geothermal systems.

6.1.4 Policy Directions for Future Discussion

The following water resource management policies are identified and briefly described for future discussion:

- Promote ongoing collaboration amongst stakeholders to form a “common voice”;
- Ensure a supply of water for agriculture
- Increase Resilience to Drought by minimizing consumption
- Encourage effective public communication, education and outreach
- Ensure a supply of clean, safe water
- Reduce potential for water quality impacts at domestic water intake sites
- Promote integrated stormwater management
- Support enforcement and compliance with existing policies and regulations
- Require site-specific Instream Flow Needs (IFN) assessments
- Encourage groundwater protection and well siting requirements.
- Participate in and support water stewardship activities.
Monitoring and performance indicators are selected to provide a summary assessment of the current status or trends in condition. Periodic monitoring (annual and five-year intervals) is used to assess progress and the results point the direction to adapt and improve policies.

The following monitoring parameters are selected to describe the State of Water Resources in the Central Okanagan:

- Water Use (litres/person/day)
- Surface Water Quality (various parameters – such as turbidity, BOD, nutrients, pathogens)
- Proportion of population serviced by a secondary wastewater treatment system (%)
- Percentage of impervious area on developed lots (%)
- Proportion of dwellings serviced by a public water utility (%).
- Groundwater Levels Relative to Precipitation

The overall objective of the RGS is to develop policies for sustainable development. The development of effective policies for water resource protection, and subsequent implementation of protective measures, will ensure the long-term protection of the features and qualities that make the Okanagan a unique and beautiful place to live, work and play.

6.2 “CALL TO ACTION”

In a “Call to Action”, the following actions and activities are identified to resolve data gaps or to move forward on water resource protection policy:

**Water Quantity**

1. Investigate options to reuse treated wastewater for landscape irrigation
2. Promote water conservation and water efficient land development.
3. Complete a Water Conservation Plan and a Drought Preparedness Plan
4. Utilize the water balance approach based on water budgets for rural lot subdivision.
5. Consolidate information on groundwater well location and use in a GIS format.
6. Become aware of the results of the Okanagan Hydrologic Connectivity Model (Summit Environmental Consultants Ltd., 2012) to identify potential surface water allocation issues.
7. Assert interest for additional control in Source Watersheds by considering Crown Leases along reservoirs. Continue to participate in Watershed Advisory Committees and the Water Stewardship Council and maintain interest through the interagency referral process.
8. Create increased public awareness of water resource protection issues and promote water conservation and protection through education and outreach programs.

**Water Quality**

1. Consolidate water quality information for domestic water supply and for aquatic resources and determine where additional information is required to better characterize the resource.
2. Assess potential for cumulative downslope impacts where septic development is proposed on hillslope areas.
3. Monitor the location and construction details (open vs. closed loop) of existing and new geothermal systems.
4. Establish or limit development activity near Intake Protection Zones and Well Head Protection Zones.
5. Continue ongoing GIS mapping exercises such as Foreshore Inventory and Mapping (FIM) for lakes, Sensitive Habitat Inventory and Mapping (SHIM) for streams, and Wetland Inventory and Mapping (WIM) for wetlands. These mapping initiatives are intended to be completed on a 5 to 8 year cycle as part of an adaptive management strategy.

**Flood Hazard**

1. Extend floodplain mapping along Mission Creek to cover the floodplain reaches within the RDCO and use digital elevation models to identify floodprone lands for other areas within the RDCO.
2. Refer to the provincial dam safety review and identify drainages subject to debris flow hazard. Complete risk mapping for high hazard basins.
7.0 References

AGUA Consulting. 2010. Draft Watershed Master Plan, District of Summerland, Summerland BC.


BC Ministry of Healthy Living and Sport. 2010. The Source to Tap Assessment Guideline.


RDCO. 2006. Ellison Official Community Plan, Bylaw No. 1124. Kelowna, BC.


RDCO. 2012b. South Slopes Official Community Plan, Bylaw No. 1304. Kelowna, BC.


RDOS. 2010. Regional Growth Strategy. Penticton, BC.


Westbank First Nation. 2007. Land Use Law. Westbank. BC.
Appendix A – Maps
Table 2.2: Listing of Unconsolidated and Bedrock Aquifers in the RDCO Area (5 pages)

<table>
<thead>
<tr>
<th>No.</th>
<th>Aquifer Name from OBWB Study</th>
<th>RDCO Locale and Watershed</th>
<th>Aquifer Type</th>
<th>Footprint Area (Ha)</th>
<th>Level of Use, Development Potential, Connectivity</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>259 259</td>
<td>Fintry Unconsolidated</td>
<td>95</td>
<td>major aquifer, hosts several high capacity wells, RDCO Fintry System</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>259 A</td>
<td>Shorts Creek Upland Bedrock</td>
<td>18900</td>
<td>largely undeveloped, some private domestic wells in Valley of Sun Area</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>OK 19</td>
<td>Westside, direct to Lake Bedrock</td>
<td>2013</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>OK 21</td>
<td>Westside, direct to Lake Bedrock</td>
<td>1114</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>OK 16</td>
<td>Westside, direct to Lake Bedrock</td>
<td>1857</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>OK 14</td>
<td>Westside, direct to Lake Bedrock</td>
<td>1442</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>OK 13</td>
<td>Westside, direct to Lake Bedrock</td>
<td>1844</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
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<tr>
<td>8</td>
<td>255  255</td>
<td>Bear Creek Fan Unconsolidated</td>
<td>60</td>
<td>undeveloped, unproven, likely major aquifer</td>
<td></td>
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<tr>
<td>9</td>
<td>255 A</td>
<td>Bear Creek Upland Bedrock</td>
<td>24265</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
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<tr>
<td>10</td>
<td>OK 11</td>
<td>Westside, direct to Lake Bedrock</td>
<td>685</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>246</td>
<td>West Kelowna along Hwy 97 Near Lake Unconsolidated</td>
<td>473</td>
<td>largely undeveloped, unproven</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>246 A</td>
<td>NE Boucherie Bedrock</td>
<td>175</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>246 B</td>
<td>Rose Valley Bedrock</td>
<td>1497</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>243</td>
<td>West Kelowna along Hwy 97, WFN + Stevens Rd &amp; Bartley Rd Area Unconsolidated</td>
<td>589</td>
<td>aquifer that is largely undeveloped, medium to high yield wells probable</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>243 A</td>
<td>McDougal Creek Upland Bedrock</td>
<td>4983</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
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<tr>
<td>16</td>
<td>243 B</td>
<td>NW and North Boucherie Bedrock</td>
<td>251</td>
<td>largely undeveloped, low yield potential</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>242</td>
<td>Shannon Lake, extending south to Twin eagles Golf to Lake Unconsolidated</td>
<td>786</td>
<td>moderately developed, moderate to low yields</td>
<td></td>
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<tr>
<td>No.</td>
<td>Aquifer Name from OBWB Study</td>
<td>RDCO Locale and Watershed</td>
<td>Aquifer Type</td>
<td>Footprint Area (Ha)</td>
<td>Level of Use, Development Potential, Connectivity</td>
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<tr>
<td>18</td>
<td>242 A</td>
<td>Upland Area North of Shannon Lake</td>
<td>Bedrock</td>
<td>879</td>
<td>largely undeveloped, low yield potential</td>
</tr>
<tr>
<td>19</td>
<td>242 B</td>
<td>Hill SE of Shannon Lake (Shannon way)</td>
<td>Bedrock</td>
<td>42</td>
<td>largely undeveloped, low yield potential</td>
</tr>
<tr>
<td>20</td>
<td>241</td>
<td>Lower Powers Creek To Gellatly Fan</td>
<td>Unconsolidated</td>
<td>1384</td>
<td>limited development, good yield potential in some areas</td>
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<tr>
<td>21</td>
<td>241 A</td>
<td>Upland to west of Powers Creek</td>
<td>Bedrock</td>
<td>712</td>
<td>moderately developed, low to medium potential</td>
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<tr>
<td>22</td>
<td>241 B</td>
<td>Powers Creek Upland</td>
<td>Bedrock</td>
<td>12558</td>
<td>largely undeveloped, low yield potential</td>
</tr>
<tr>
<td>23</td>
<td>OK 9</td>
<td>West of Powers, direct to Lake</td>
<td>Bedrock</td>
<td>714</td>
<td>largely undeveloped, low yield potential</td>
</tr>
<tr>
<td>24</td>
<td>240</td>
<td>Trepanier</td>
<td>Unconsolidated</td>
<td>973</td>
<td>largely undeveloped, most wells in west end of aquifer, moderate yield potential</td>
</tr>
<tr>
<td>25</td>
<td>240 A</td>
<td>Trepanier Upland</td>
<td>Bedrock</td>
<td>19425</td>
<td>largely undeveloped, low yield potential</td>
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<td>26</td>
<td>240 B</td>
<td>Upland to NW</td>
<td>Bedrock</td>
<td>3561</td>
<td>largely undeveloped, low yield potential</td>
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<tr>
<td>27</td>
<td>240 C</td>
<td>Upland to North</td>
<td>Bedrock</td>
<td>1940</td>
<td>largely undeveloped, low yield potential</td>
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<tr>
<td>28</td>
<td>244</td>
<td>Old Boucherie / Pritchard Road</td>
<td>Unconsolidated</td>
<td>220</td>
<td>low to moderate development, low to medium yield potential</td>
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<td>29</td>
<td>244 A</td>
<td>SW Boucherie</td>
<td>Bedrock</td>
<td>208</td>
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<tr>
<td>30</td>
<td>OK 10</td>
<td>Boucherie, direct to Lake</td>
<td>Bedrock</td>
<td>233</td>
<td>undeveloped, very low yield potential</td>
</tr>
<tr>
<td>31</td>
<td>245</td>
<td>SE Boucherie, adjacent to Lake</td>
<td>Unconsolidated</td>
<td>86</td>
<td>sparse development, low yield potential</td>
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<tr>
<td>32</td>
<td>245 A</td>
<td>SE Boucherie, upland</td>
<td>Bedrock</td>
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<td>33</td>
<td>OK 7</td>
<td>Okanagan Park, direct to Lake</td>
<td>Bedrock</td>
<td>4711</td>
<td>undeveloped, low yield potential</td>
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<td>No.</td>
<td>Aquifer Name from OBWB Study</td>
<td>RDCO Locale and Watershed</td>
<td>Aquifer Type</td>
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<td>Level of Use, Development Potential, Connectivity</td>
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<tr>
<td>34</td>
<td>OK 8</td>
<td>Okanagan Park, direct to Lake</td>
<td>Bedrock</td>
<td>3528</td>
<td>sparse development, low yield potential, only near lake</td>
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<tr>
<td>35</td>
<td>247</td>
<td>South Mission, Bellevue Creek</td>
<td>Unconsolidated</td>
<td>1386</td>
<td>major aquifer, moderate to heavy development, moderate to high yield wells possible</td>
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<tr>
<td>36</td>
<td>247 A</td>
<td>Upper Bellevue SW</td>
<td>Bedrock</td>
<td>1165</td>
<td>sparse development, low yield potential, only near transition to Aquifer 247</td>
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<tr>
<td>37</td>
<td>247 B</td>
<td>Upper Bellevue SE</td>
<td>Bedrock</td>
<td>8360</td>
<td>undeveloped, low yield potential</td>
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<tr>
<td>38</td>
<td>248</td>
<td>Greater Kelowna Aquifer</td>
<td>Unconsolidated</td>
<td>7262</td>
<td>major aquifer with shallow unconfined and deeper confined systems, highly developed, moderate to high yields possible</td>
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<td>39</td>
<td>248 A</td>
<td>Priest Creek Upland</td>
<td>Bedrock</td>
<td>2720</td>
<td>sparse development, low yield potential</td>
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<td>40</td>
<td>248 B</td>
<td>KLO Creek Upland</td>
<td>Bedrock</td>
<td>6266</td>
<td>sparse development, low yield potential</td>
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<tr>
<td>41</td>
<td>248 C</td>
<td>Black Mountain Upland West</td>
<td>Bedrock</td>
<td>900</td>
<td>sparse development, low yield potential</td>
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<td>42</td>
<td>248 D</td>
<td>SW Dillworth Mountain</td>
<td>Bedrock</td>
<td>110</td>
<td>undeveloped, low yield potential</td>
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<td>43</td>
<td>249</td>
<td>East Gallaghers Canyon</td>
<td>Unconsolidated</td>
<td>303</td>
<td>undeveloped, low to medium potential</td>
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<td>249 A</td>
<td>Hydraulic Creek Upland</td>
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<td>249 B</td>
<td>East of Hydraulic Creek</td>
<td>Bedrock</td>
<td>340</td>
<td>undeveloped, low yield potential</td>
</tr>
<tr>
<td>46</td>
<td>249 C</td>
<td>Black Mountain Upland South</td>
<td>Bedrock</td>
<td>407</td>
<td>sparse development, low yield potential</td>
</tr>
<tr>
<td>47</td>
<td>250</td>
<td>Mission Creek and Tributaries</td>
<td>Unconsolidated</td>
<td>2302</td>
<td>mostly shallow, low to moderate yield wells, near Mission Creek or upland tributaries</td>
</tr>
<tr>
<td>48</td>
<td>250 A</td>
<td>Daves Creek Upland</td>
<td>Bedrock</td>
<td>3689</td>
<td>low to moderate development in lower extreme of catchment, low yields possible</td>
</tr>
<tr>
<td>49</td>
<td>250 B</td>
<td>Mission Creek North Joe Rich Upland</td>
<td>Bedrock</td>
<td>2080</td>
<td>low to moderate development in lower extreme of catchment, low yields possible</td>
</tr>
<tr>
<td>No.</td>
<td>Aquifer Name from OBWB Study</td>
<td>RDCO Locale and Watershed</td>
<td>Aquifer Type</td>
<td>Footprint Area (Ha)</td>
<td>Level of Use, Development Potential, Connectivity</td>
</tr>
<tr>
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</tr>
<tr>
<td>50</td>
<td>250 C</td>
<td>Mission Creek South Joe Rich Upland</td>
<td>Bedrock</td>
<td>3833</td>
<td>undeveloped, unproven, likely low yield potential</td>
</tr>
<tr>
<td>51</td>
<td>250 D</td>
<td>Belgo Creek</td>
<td>Bedrock</td>
<td>17520</td>
<td>largely undeveloped, low yield potential</td>
</tr>
<tr>
<td>52</td>
<td>250 E</td>
<td>Joe Rich Creek</td>
<td>Bedrock</td>
<td>4893</td>
<td>largely undeveloped, low yield potential</td>
</tr>
<tr>
<td>53</td>
<td>250 F</td>
<td>Upper Mission Creek</td>
<td>Bedrock</td>
<td>19388</td>
<td>largely undeveloped, low yield potential</td>
</tr>
<tr>
<td>54</td>
<td>250 G</td>
<td>Pearson Creek</td>
<td>Bedrock</td>
<td>6790</td>
<td>largely undeveloped, low yield potential</td>
</tr>
<tr>
<td>55</td>
<td>253</td>
<td>North Kelowna Aquifer</td>
<td>Unconsolidated</td>
<td>4644</td>
<td>major aquifer with shallow unconfined and deeper confined systems, moderate to high development, especially along eastern benchlands, generally low yields along periphery of aquifer, except with proximity to creeks and at University</td>
</tr>
<tr>
<td>56</td>
<td>253 A</td>
<td>West Dillworth Mountain</td>
<td>Bedrock</td>
<td>136</td>
<td>undeveloped, low yield potential</td>
</tr>
<tr>
<td>57</td>
<td>253 B</td>
<td>NW Sexsmith Rd / College Heights</td>
<td>Bedrock</td>
<td>1652</td>
<td>undeveloped, low yield potential</td>
</tr>
<tr>
<td>58</td>
<td>253 C</td>
<td>Towers Ranch</td>
<td>Bedrock</td>
<td>1865</td>
<td>undeveloped, low to medium potential</td>
</tr>
<tr>
<td>59</td>
<td>253 D</td>
<td>Scotty / Whelan / RockFace Creeks</td>
<td>Bedrock</td>
<td>5034</td>
<td>moderate development at west end of aquifer, low yield potential</td>
</tr>
<tr>
<td>60</td>
<td>253 E</td>
<td>Kelowna Creek</td>
<td>Bedrock</td>
<td>8346</td>
<td>largely undeveloped, low yield potential</td>
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<tr>
<td>61</td>
<td>253 F</td>
<td>Quail Ridge / University</td>
<td>Bedrock</td>
<td>116</td>
<td>undeveloped, low yield potential</td>
</tr>
<tr>
<td>62</td>
<td>251</td>
<td>Old Glenmore /Clifton</td>
<td>Unconsolidated</td>
<td>91</td>
<td>undeveloped, low yield potential</td>
</tr>
<tr>
<td>63</td>
<td>251 A</td>
<td>Highpointe Upland Area</td>
<td>Bedrock</td>
<td>17</td>
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</tr>
<tr>
<td>64</td>
<td>251 B</td>
<td>Magic Estates</td>
<td>Bedrock</td>
<td>225</td>
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<td>65</td>
<td>252</td>
<td>North Glenmore Valley</td>
<td>Unconsolidated</td>
<td>1214</td>
<td>undeveloped, low yield potential</td>
</tr>
<tr>
<td>66</td>
<td>252 A</td>
<td>Dillworth Selkirk</td>
<td>Bedrock</td>
<td>150</td>
<td>undeveloped, low yield potential</td>
</tr>
<tr>
<td>67</td>
<td>252 B</td>
<td>Glenmore Highlands</td>
<td>Bedrock</td>
<td>1652</td>
<td>undeveloped, low yield potential</td>
</tr>
<tr>
<td>No.</td>
<td>Aquifer Name from OBWB Study</td>
<td>RDCO Locale and Watershed</td>
<td>Aquifer Type</td>
<td>Footprint Area (Ha)</td>
<td>Level of Use, Development Potential, Connectivity</td>
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<tr>
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<tr>
<td>68</td>
<td>254 Winfield</td>
<td>Unconsolidated</td>
<td>1512</td>
<td>major aquifer with shallow unconfined and deeper confined systems, moderate to high development, especially along eastern benchlands, generally low yields along periphery of aquifer, except with proximity to creeks</td>
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<tr>
<td>69</td>
<td>254 A East Elison Lake</td>
<td>Bedrock</td>
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</tr>
<tr>
<td>70</td>
<td>254 B NW Elison Lake</td>
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<td>71</td>
<td>EL 1 Elison Lake</td>
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<td>65</td>
<td>undeveloped, low yield potential</td>
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<tr>
<td>72</td>
<td>254 C West Winfield / Bond Rd</td>
<td>Bedrock</td>
<td>410</td>
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<tr>
<td>73</td>
<td>254 D East Winfield / Woodsdale Rd</td>
<td>Bedrock</td>
<td>463</td>
<td>sparse development, low development potential</td>
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<tr>
<td>74</td>
<td>256 Vernon Creek Upper Fan</td>
<td>Unconsolidated</td>
<td>293</td>
<td>moderate aquifer, undeveloped, with probable medium yields possible</td>
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<tr>
<td>75</td>
<td>256 A Upland Middle Vernon Creek</td>
<td>Bedrock</td>
<td>8845</td>
<td>undeveloped, low yield potential</td>
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</tr>
<tr>
<td>76</td>
<td>256 B Middle Vernon Creek North</td>
<td>Bedrock</td>
<td>2920</td>
<td>undeveloped, low yield potential</td>
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</tr>
<tr>
<td>77</td>
<td>257 Oyama</td>
<td>Unconsolidated</td>
<td>410</td>
<td>moderate development, low to medium yields</td>
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</tr>
<tr>
<td>78</td>
<td>257 A West Oyama</td>
<td>Bedrock</td>
<td>597</td>
<td>sparse development, low development potential</td>
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</tr>
<tr>
<td>79</td>
<td>257 B Oyama Creek</td>
<td>Bedrock</td>
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<td>undeveloped, low yield potential</td>
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<tr>
<td>80</td>
<td>OK 12 McKinley / East Lake Okanagan</td>
<td>Bedrock</td>
<td>1420</td>
<td>sparse development, low development potential</td>
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<tr>
<td>81</td>
<td>OK 15 Okanagan Centre</td>
<td>Bedrock</td>
<td>945</td>
<td>low to moderate development, low development potential</td>
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<tr>
<td>82</td>
<td>OK 17 Pixie Beach</td>
<td>Bedrock</td>
<td>884</td>
<td>sparse development, low development potential</td>
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<tr>
<td>83</td>
<td>OK 18 Carrs Landing</td>
<td>Bedrock</td>
<td>1883</td>
<td>moderate development, low to medium yields</td>
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</tbody>
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