January 2010

Naramata Water Conservation Plan

Engineering Services

Abbreviations

ALR	Agricultural Land Reserve
BC	British Columbia
FTE	Full Time Equivalent
ICI	Industrial, Commercial and Institutional
MFD	Multi Family Dwelling
OBWB	Okanagan Basin Water Board
OKIM	Okanagan Irrigation Management
OSWS	Okanagan Sustainable Water Strategy
OWSC	Okanagan Water Stewardship Council
PARC	Pacific Agri-Food Research Centre
PEOPLE	Population Extrapolation for Organizational Planning with Less Error
RDOS	Regional District of Okanagan-Similkameen
RGS	South Okanagan Regional Growth Strategy
SEKID	South East Kelowna Irrigation District
SFD	Single Family Dwelling

Units

$	Canadian dollars
d	days
g CO_2	grams of carbon dioxide equivalents
ha	hectares
kVA	kilo Volt Amperes, peak electrical load
kWh	kilowatt hours, electricity or energy consumption
L	litres
min	minutes
ML	mega litres, one million litres, one thousand cubic metres
t	tonnes
t CO_2	tonnes of carbon dioxide equivalents
US$	United States dollars
y	years

Glossary

Allotment	Volume of water consumption permitted over an extended period of time, such as an irrigation season, or in times of drought, a month or a week. An irrigation allotment may be expressed as volume:area or as a depth, such as ML/ha or mm.
Area 'E'	Electoral Area 'E' of RDOS, which includes the Village of Naramata.
Evapotranspiration	The process of water entering the atmosphere either directly from the soil surface, or from the soil through the plant roots, and out through the leaves.
External	Pertains to costs and benefits outside the utility. The impacts may be felt by the customer, other basin water users, the ecosystems that supply natural gas and electricity, or the world.
Fertigation	The application of fertilizer through the irrigation system.
Fixed Rate	Water charges are fixed per connection, per hectare, or per connection size.
Flow	Flow rate permitted for outdoor use by residential connections, Grade A Domestic, and Grade A Agriculture water
Increasing Block	Consumption charges increase when more water is consumed.
Internal	Pertains to costs and benefits within the utility.
Irrigation Scheduling	The process of determining the timing and duration of the application of water to crops in order to promote plant growth.
Naramata	In this document, usually means the people and parcels connected to the Naramata water system.
Portfolio	A group of water conservation measures that are implemented together, based on their similarity, mutual dependence, synergy, and independence and distinctiveness from other portfolios.
Soil Moisture Deficit	The difference between evapotranspiration and effective precipitation; used to estimate irrigation requirements.
Uniform Rate	Consumption charges remain the same regardless of usage levels.
Xeriscaping	Environmental design of residential and park land using various methods for minimizing the need for water use

Conversions

1 hectare = 0.405 acres
1 ML/ha = 100 mm = 3.937 inches
1 inch = 25.4 millimetres
1 US gallon = 3.785 litres

1 Imperial gallon = 4.546 litres
1 acre-foot = 1.2335 ML
1 ML = 1,000 m^3 = 1,000,000 litres

Prepared by

Joe Fitzpatrick, P.Ag.
Water Conservation Coordinator
Engineering Services Department
Regional District of Okanagan – Similkameen
January 29, 2010

Acknowledgements

The following RDOS staff members participated in the production of this plan:

- Liisa Bloomfield, Engineering Technician
- Donna Butler, Development Services Manager
- Alf Hartviksen, Engineer
- Erica Kroeker
- Rob Palmer, Environmental Technician
- Andrew Reeder, Engineering Services Manager

This plan was funded with a $25,000 Water Conservation and Quality Improvement grant from the Okanagan Basin Water Board and a $15,000 from a Regionally Significant Project Fund Funding Agreement with the Union of BC Municipalities.

We thank Naramata farmers Richard Brungardt, Sakinder Singh, Tim Watts, Rob van Westen, Kiranpreet Gill, Judy Kingston and Roy Kato for providing their input on available irrigation scheduling methods.

We appreciate information provided to us by the City of Penticton, Gary Dicken (R.W.O.P.), the District of Peachland, the District of Summerland, Fred Surridge Ltd., Neptune Technology Group, the Okanagan Basin Water Board, TerasenBC, the Town of Oliver, and the City of Kelowna WaterSmart program.

Table of Contents

List of Tables

Executive Summary

This plan is required in order to access senior government funding for capital expenditures, such as the proposed system separation project.

This plan addresses the goals of several levels of government – Regional Growth Strategy (RGS), Okanagan Sustainable Water Strategy (OSWS), BC Water Smart, and BC Climate Action plan.

With commitment to this water conservation plan, by 2020 Naramata can decrease water use by 25%, in keeping with the provincial Water Smart strategy.

This plan calls for:

- Meters on all customer connections
- Meters on non-account irrigation connections (parks and cemetery)
- Increasing block consumption charges
- Robust education programs for both irrigation and domestic customers
- Employment of Okanagan Irrigation Management (OKIM) software
- A weather station for irrigation scheduling
- Regular land use inventories
- Rebates for both irrigation and domestic customers
- Water accounting

It would be difficult for the Naramata water utility to recover the cost of water conservation measures within its own operations. Naramata lacks the commonly seen opportunity to use water conservation as an approach to delay system expansion. In addition, there is no community sewage system to additionally motivate the community to implement indoor water conservation measures.

The main drivers for water conservation come from outside the utility, but a portion of the cost can be recovered from within. Thirty two percent of the costs of water conservation measures are recoverable within the utility due to reductions in variable costs. Quantified external benefits, in the form of reduced customer energy bills and GHG emissions offsets, total 60% of water conservation costs. Additional benefits not quantified in dollars include:

- improvements in the management of onsite wastewater systems;
- ability to respond effectively to a basin-wide drought;

- decreased pressure on the ecosystems that provide water and the energy related to the production, delivery and consumption of water;
- the increased availability of water to other users in the basin; and
- fostering the development of water efficient technology.

The proposed program requires approximately $1.1 million in capital expenditures, mainly for meter installation. The annual operating cost would be approximately $37,000. The additional staff workload would be 0.27 FTE/y mainly for water conservation coordination, but also for additional duties with respect to meter reading, utility billing, information services, building inspection and management. Student assistance at 0.15 FTE/y would be required for domestic education programs.

Based on 2009 experience, enforcement of the flow rate bylaw for irrigation connections reduced peak day consumption in the Naramata water system by about 4.7 ML/d. Other measures may further reduce peak day consumption by up to 4.5 ML/d, making it easier to supply water at stable pressures.

Measures that reduce irrigation consumption would have the greatest impact on annual and peak day consumption. Most of the measures that reduce indoor consumption would have the greatest impact on customer energy savings and reducing GHG emissions. However, simply enacting new bylaws and enforcing both new and existing ones could be very cost effective in reducing both annual and peak day consumption.

1. Introduction

1.1 Why Does Naramata Need a Water Conservation Plan?

Water is vital for the sustainability of the Naramata community. There are many direct uses, such as domestic, irrigated agriculture, commercial operations, and recreational areas. Water availability is tied to the many attractive features Naramata offers the tourism industry. These include orchards, wineries, and Naramata Centre. In addition, sustained creek flow is necessary for maintaining healthy fish populations.

A Water Conservation Plan will reduce water consumption by the residents thus reducing the demands on limited resources and ecosystems.

"With more and more people, balancing the water needs of the environment, drinking water, crop irrigation and other outdoor watering, tourism and recreation, industry and cultural values is increasingly difficult. Climate change is expected to increase the frequency of drought and flood events in the Okanagan due to warmer, wetter winters, and longer, hotter, drier summers" (1)

Both at the regional (1) and provincial (2) level, there is pressure to develop and implement water conservation plans.

"[Water conservation plans] are now a mandatory requirement for local governments applying to the Province for capital grant funds for drinking water and wastewater infrastructure. In the future, all communities accessing provincial infrastructure funds will be required to actively conserve water". (3)

In the proposed Regional Growth Strategy (RGS), South Okanagan municipalities and electoral areas are investigating the following policies that directly or indirectly involve water conservation: (4)

- Support environmental stewardship strategies
- Reduce contribution to and increase adaptation to climate change
- Promote water sustainability through conservation and related best practices
- Support the protection of access to adequate water for the agriculture sector in any future inter-regional Water Plan

Naramata has a single water supply system that supplies both domestic and irrigation water requirements. The water system has significant variable costs, as it requires electricity for pumping, UV treatment and chlorination. Therefore, reducing water consumption will lower the cost for the water utility operations.

Parts of the distribution system are strained to capacity during the irrigation season. Water conservation measures that reduce the peak flows would help to ensure reliable supply pressures and volumes.

The Onsite Wastewater Consumer Information Centre recommends the use of water conservation measures to assist the operation maintenance of onsite wastewater systems (typically septic systems). (5)

1.2 Purpose and Scope

The purpose of the Water Conservation Plan for Naramata is to provide a strategy for conserving both water and the associated electricity and greenhouse gas emissions related to its production, delivery and use. This will save money for the users, ensure continued eligibility when applying for infrastructure grants, and assist in the implementation of policies and strategies for the different levels of government. (1) (2) (4)

In this plan, water conservation measures are assessed in terms of both internal and external benefits with respect to the water utility.

Internal Benefits to the Water Utility

- Reductions in peak day consumption
- Reductions in annual water use
- Reductions in variable costs from pumping and treatment
- Improvements in the understanding of water used in the community
- Accurate costing, ability to generate fair water rates and design effective water conservation programs

External Benefits to the Water Utility

- Reductions in energy consumption for water supply and water heating
- Reductions in greenhouse gas (GHG) emissions from water related energy consumption
- Perception of fairness with the introduction of volume based rate structures
- Ease of management of onsite wastewater systems due to decreased wastewater flows
- Encourage businesses that provide water efficiency products and services

1.3 Reference Material

A list of abbreviations and symbols for units of measurement can be found inside the front cover.

For simplicity, only metric units are used in the text and tables of the plan. A glossary and a table of metric conversions can be found inside the back cover.

Literature cited is listed on page 37.

Greenhouse gas emissions are expressed in carbon dioxide equivalents. Compared on the basis of weight, methane and nitrous oxide have a greater global warming potential, as shown in Table 1.

Table 1. Global warming potential of greenhouse gases

Gas	CO_2 equivalents
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310

1.4 Accuracy and Significant Figures

Values used in the Water Conservation Plan were obtained from numerous and diverse sources that vary in their reliability. Some estimates are quite accurate while others will be accurate to only one or two significant figures. For instance, we know that the average annual water use for 2003 to 2008 is 1995 ML. However we do not know precisely which sector is using the water, so plausible assumptions were made in order to divide that consumption among different types of customers.

2. Community Water System Profile

2.1 Community Portrait

2.1.1 Residents

Electoral Area 'E' – Naramata, has the following demographic characteristics: (6)

- The 2006 population estimate is 2010, including those not served by the water system.
- Similar to the rest of BC, the age demographics show large peaks in the mid forties and teens, and a smaller peak showing percentage of people in their twenties.
- 96% of residents live in single family dwellings.
- All survey respondents have knowledge of English, but 2% speak languages other than English at home, and 13% have a mother tongue other than English.
- A higher portion have university education relative to the entire RDOS
- Median earnings of women who live in Area 'E' are 74% of their male counterparts, compared to 63% in BC as a whole.
- 23% of residents have moved to Area 'E' from elsewhere within the last five years.

2.1.2 Commerce

Agriculture and tourism form the basis for commerce in Naramata, and they operate synergistically. Perennial horticulture, farm gate sales and wineries contribute to an attractive setting and activities for visitors. Motels, resorts, cabins, bed and breakfasts and campgrounds provide accommodations. Naramata Centre (7) is an important destination for visitors and a key component of the village's economy.

2.1.3 Agriculture

The irrigation connections are used typically for irrigation, but they may also be used for other agricultural purposes. In some cases, the connections are used for frost protection, evaporative cooling or fertigation. It is estimated that in Naramata, 61% of total water use and 70% of peak day use are attributable to agriculture.

In 2006 and 2007, Ministry of Agriculture and Lands (MAL) conducted windshield surveys of agricultural land use (8). Naramata's main crops are apples, grapes, pears, and forage or pasture. Sixty percent of the crop area is irrigated with impact sprinklers. The remainder is irrigated with water saving systems, including micro sprinklers, drip and micro jet.

2.2 Water System Portrait

2.2.1 Sources and Licences

Available water sources for Naramata include Okanagan Lake, Robinson Creek and Naramata Creek. The creek sources present risks to drinking water quality, including *Giardia*, *Cryptosporidium*, turbidity and colour (9). In 2007, the source of water for Naramata became solely Okanagan Lake with the installation of UV treatment and pumping upgrades. With this single source, the utility is able to meet water quality standards.

Naramata holds water licences on Naramata Creek and Robinson Creek (see Table 2). Although the licences on Robinson Creek and Naramata Creek are not currently in use, the provincial government has allowed Naramata to retain rights to this water until May 31, 2044 (10). Once the water distribution system has been twinned, with separate domestic and irrigation mains, the anticipated plan is to utilize the creek sources for the irrigation water demands. The irrigation water would be supplied mainly by gravity from the creeks and unlike the potable water supply, would not require treatment.

Some water is diverted from Robinson Creek to Naramata Creek in order to sustain fish flow. Naramata Creek is an important habitat for Kokanee salmon.

Table 2. RDOS water licences held in the Okanagan Basin (11)

	Storage *ML*	Water Works *ML/y*	Irrigation *ML/y*
Upland Licences	2405	185	8366
Okanagan Lake Licences	0	2064	247
TOTAL WATER LICENCING	**2405**	**2249**	**8613**

There are three reservoir lakes in the Robinson Creek system (see Table 3).

Table 3. Water storage in Robinson Creek watershed (12)

Site	Elevation *m*	Volume *ML*
Big Meadow Dam	1612	530
Elinor Lake	1308	284
Naramata Lake	1301	666
Total		**1480**

2.2.2 Water Treatment

Water is pumped from the raw water pump station located at Okanagan Lake to the water treatment plant on McKay Road. The water is treated with ultraviolet (UV) light for disinfection, and the water is pumped to North Naramata and South Naramata, and supplied by gravity to Naramata village. Prior to water entering the distribution system, sodium hypochlorite is added to prevent any regrowth of organisms and protect against cross contamination as water passes throughout the system to the end user.

2.2.3 Distribution System

The distribution system has four balancing reservoirs. The Juniper Road reservoir is used at its maximum potential during peak days and is supplemented from two higher elevation reservoirs. The fourth reservoir is located at the water treatment plant.

The distribution system has approximately 49 km of piping with an average age of 40 years. Approximately 56% of the total piping system is about 50 years old. The prevalent pipe materials are Asbestos Cement and Poly Vinyl Chloride, constituting 61% and 31% of the total length respectively. (13)

2.2.4 Connections and Service Profile

The values contained in Table 4 and Table 5 were used for estimating costs and benefits of water conservation measures. The information comes primarily from the utility billing system. Table 4. Naramata water connections shows the number of actual connections while Table 5 provides more detail. For instance some connections supply more than one building, as in the case of a strata parcel, or other parcel with more than one house. Some of the Domestic connections have an additional charge for their commercial enterprises.

Dwellings associated with seasonal habitation are listed separately. When the water demand estimates were made it was assumed that these facilities use more water in the warmer months.

Small residential yards and some publicly owned irrigation connections are not accounted for in the billing system. An estimate of their areas was included in Table 5 because like Grade A Domestic and Grade A Irrigation accounts, they have an impact on seasonal demand.

The Grade A Domestic and smaller residential yards shown in Table 5. Naramata service summary seldom have separate connections. Like Grade A Irrigation they impact peak day and seasonal consumption, but once system separation and metering is in place, these uses will be recorded within the Domestic consumption.

Table 4. Naramata water connections

Type of Connection	Number
Domestic	800
Grade A Irrigation	182
Non-account irrigation	3

Table 5. Naramata service summary

Domestic Use	Number
Permanent dwellings	830
Industrial, Commercial and Institutional (ICI) customers	22
Visitors' Dwellings – motel units, bunkhouses, cabins, etc.	87
Irrigation Use	**Hectares**
Grade A Irrigation, as billed	352.5
Grade A Domestic, as billed	80.0
Small residential yards with no extra fee, estimated	46.0
Non-account irrigation (parks and cemetery), estimated	2.0
Total hectares	**480.5**

2.3 Water Use

The values in Table 6 were used for estimating costs and benefits of water conservation measures. However, without universal meters, there can be no assurance of accuracy. The main assumptions were:

1. That winter use reflects system losses, indoor use of permanent dwellings and ICI;
2. That additional seasonal use reflects a summer increase in occupancy of visitors' dwellings and irrigation; and,

3. In the absence of reliable data, that the depth of irrigation is assumed equal whether agricultural, residential or public property.

Table 6. Annual water use partitioned by category

Use Category	ML/y	%	Includes
Domestic indoors	288	14.4%	Permanent dwellings, accommodation and ICI
Domestic outdoors	437	21.9%	Yards and landscaping
Grade A Irrigation	1223	61.3%	Agriculture
Non-account irrigation	7	0.3%	Parks, cemetery
System losses	40	2.0%	
Total Annual Use	**1995**		**Average of 2003-2008**

Peak day consumption (Table 7) was partitioned into the same use categories. The assumptions were the same as for annual water use. In this case all the categories that involve outdoor irrigation comprise a higher percentage of the total because they are weather dependent.

Table 7. Peak day consumption partitioned by category

Use Category	ML/d	%	Weather Dependent
Domestic indoors	0.79	4.5%	no
Domestic outdoors	4.41	24.9%	yes
Irrigation customers	12.34	69.6%	yes
Non-account water	0.07	0.4%	yes
System losses	0.11	0.6%	no
Peak Day Total, 2009	**17.72**		

2.4 Water-related Energy Consumption

Supplying water requires energy, mainly in the form of electricity. Further treatment of water at the point of end use, such as heating, refrigeration or ice making, also consumes energy.

2.4.1 Electricity Demand of Water Treatment and Distribution

In July 2009, upon request from RDOS staff, FortisBC conducted an energy audit of Naramata's three main water facilities: the raw water pump station, the water treatment plant, and the Juniper Road balancing reservoir. Consumption at these locations was analysed in detail. Other facilities that use much less power, such as the office and the other balancing reservoirs, were not considered.

Ninety-four percent of the power consumption, measured in kilowatt-hours (kWh), and 63% of the cost at the three main facilities is proportional to flow. The remaining consumption is associated with heating and lighting. A significant part of the electricity cost is related to peak load, measured in kilovolt-amperes (kVA), for pumphouse and water treatment plant operation.

When taking into account only the electricity consumption that is proportional to flow, it takes about 1135 kWh of electricity to treat and pump 1 ML of water.

2.4.2 Energy consumption at point of end use

Most water-related energy consumption occurs indoors at the point of end use. Water heating is by far the largest component. Most agriculture related uses and residential irrigation add negligible amounts of energy.

Hot water requirements for various residential uses are shown in Table 8. The values in this table can be used to estimate water savings and reductions in GHG emissions due to indoor water conservation measures.

Table 8. Estimated hot water requirements and energy intensity of residential use

	Percent of Indoor Water Use (14) (15)	Percent Hot Water (16)	Energy Intensity of Water Used (17) *kWh/ML*
Bath	1%	78.2%	42,065
Clothes Washer	21%	27.8%	14,954
Dishwasher	1%	100.0%	53,791
Faucet	16%	72.7%	39,106
Leaks	10%	26.8%	14,416
Shower	15%	73.1%	39,322
Toilet	28%	0.0%	-
Other	8%	No data	-
Energy intensity of indoor residential water			**17,696**

It was estimated in Table 6 that the domestic indoor use is 288 ML in Naramata annually. By multiplying the energy intensity of indoor residential water (Table 8) by domestic indoor use, it is estimated that Naramata consumes 5,096,448 kWh/y for water heating.

2.5 Water-related GHG Emissions

In BC, there is variation in both the production and consumption of power from year to year. With these variations, power is typically exported and imported between BC and the United States. BC exports mainly clean hydroelectric power, but the imported power may come from any source such as coal or nuclear generation. In a typical year, GHG emissions from BC power consumption average 122 g CO_2/kWh.

Naramata heats water mainly with natural gas or electricity, but some homes have recently begun to use solar energy.

In this plan, we include a cost estimate for GHG emissions at $25/t. This price is approximately medial with respect to other values recently used in BC. FortisBC and BC Hydro in their strategic planning have priced GHG emissions at $30/t (18). Pacific Carbon Trust expressed a goal for a cost of less than $25/t (19).

Table 9. Energy intensity and GHG emissions of Naramata water

Source of Energy	Used for	Amount of Water *ML/y*	Energy Intensity *kWh/ML*	Emissions *g CO_2/kWh*	Emissions *t CO_2/y*	GHG Emissions *Cost* *$/y @$25/t*
Electricity	Supplying all water	1,995	1,135	122	276	$6,900
Mixed	Heating indoor water	288	17,696	362	1,845	$46,125

2.6 Agricultural Demand and Climate Change

Upon request from RDOS, Pacific Agri-Food Research Centre (PARC) research scientists estimated crop water requirements for Naramata's historical conditions, and forecast the rate of increase due to climate change (20).

The estimates in the following tables consider only water requirements in a hot year with a high soil moisture deficit. In such a year, crops will need more water than usual, putting water supply, water conservation measures and drought response to the test.

The calculated irrigation requirement for 2003 is shown in Table 10. The 797 mm estimate for a high-use crop is very close to one calculated earlier for Summerland. Agua Consulting Inc. recently recommended an allotment of 800 mm (21) for Summerland, a level that provides enough water for a high-use crop in a year with a high soil moisture deficit.

Table 10. Irrigation demand estimates for hot year

Usage Level	Description	2003 Water Demand *mm*	Relative Amount
High	High-use crop with average practices	797	116%
Average	Existing crop mix with average practices	689	100%
Low	Existing crop mix with good practices	482	70%

As climate change continues, the calculated water requirements will increase. Nine scenarios for a high demand year in approximately 2060 are shown in Table 11. The values shown are calculated from the annual rate of increase, added to the 2003 demands from Table 10.

Table 11. Irrigation demand and climate change

Usage Level	Scenario	Demand Increase *mm/y*	High Demand Year c.2060 *mm*
High	High	2.24	925
	Mid	1.27	869
	Low	0.27	812
Average	High	2.24	817
	Mid	1.36	767
	Low	0.28	705
Low	High	1.53	669
	Mid	0.93	535
	Low	0.19	493

3. Water Conservation Goals

Regional and provincial plans have previously identified goals for water conservation and for increasing adaption to and decreasing contribution to climate change. They include the RGS, Okanagan Sustainable Water Strategy (OSWS), and BC Water Smart: British Columbia's Water Plan. Goals and strategies from these documents are listed in Appendix A. Some of the identified goals include:

- Work towards the achievement of the planning goals listed in Appendix A;
- Work towards the BC Water Smart goal of improving water use efficiency by 33% by 2020;
- Educate customers about the value of water;
- Improve ability to respond to a basin scale drought;
- Reduce peak demand to ensure consistent water supply and pressures;
- Encourage the reduction of hot water consumption to help reduce GHG emissions; and,
- Monitor changes in land use to help predict water supply requirements.

In aid of the water use efficiency goal:

- Reduce per capita indoor water use;
- Improve irrigation efficiency, taking into account planted area and soil moisture deficit;
- Encourage water efficient landscaping;
- Improve water accounting in order to better manage losses, design water rates and design water conservation programs;
- Reward customer improvements in water efficiency through rebates, water rates and other measures; and
- Enforce bylaws.

4. Building a Water Conservation Program

4.1 Review of Water Conservation Measures

Design of the proposed water conservation program for Naramata began with a comprehensive review of water conservation measures. Detailed discussion of these measures can be found in Appendixes G and H.

4.2 Screening Water Conservation Measures

4.2.1 Included

Meters are a building block for many measures in water conservation. With meters in place, purveyors can:

- Implement volume based rate structures
- Equitably implement drought management plans
- Identify flow anomalies, thus locate and repair leaks or malfunctioning equipment
- Evaluate changes in water use with respect to weather
- Design and monitor the effectiveness of water conservation programs

Volume based rate structures automatically accompany the metering of account connections. They provide financial incentive to save water, and a tool for fairly distributing fees among water users. We anticipate that with metering, a new rate structure, and a very basic education program a 16% water saving would be realized.

Many education measures are included in the plan and are expected to also have a significant impact on water use. We put the combined effect of these measures at an additional 5% reduction.

Rebate programs for agricultural equipment are worth exploring. Mathematically they would save water, though in the literature review we did not find successful models that could be used, and could not establish what the barriers to success might be. This option could be particularly strong in the event of a delay in metering and system separation. Possibilities include a rebate for the purchase of irrigation scheduling aids like irrigation timers or soil moisture sensors, or retrofitting inefficient irrigation systems.

The plan includes rebate measures for indoor fixtures, including toilet replacement, dual flush conversions and front loading washers. We estimate that after ten years of operation these rebate measures would result in a 3.5% reduction of indoor water use. Front loading washers provide additional benefits by reducing GHG emissions due to water heating, and reducing electricity consumption for drying, thus reducing customer utility bills.

OKIM is included as a measure that enhances irrigation management for both farmers and purveyors. It provides a systematic method for farmers to evaluate their own water use relative to the needs of their crop, irrigation system, soil type and the weather. This measure functions as an informative water bill. It enables purveyors to evaluate water requirements and identify parcels that over-irrigated. Metering of all irrigation connections and up to date high quality land use inventory data are prerequisites for this measure.

4.2.2 Excluded

We excluded system leak detection and repair from the analysis because observations of winter flows suggest that losses are very low. Leaks are repaired as they are detected. After metering and establishing water accounting, the utility will have sufficient data to determine whether a leak detection program would be beneficial.

Gray water re-use is most cost effective when it reduces both the consumption of potable water and the production of sewage. As Naramata does not have a sewage system against which costs can be offset, gray water re-use would be less rewarding than in municipalities that have one. In addition, the piping of non-potable water increases the risk of cross connections. Gray water systems for new construction may be addressed in Part 10 of the Building Code in the future, thus allowing conservation-minded builders to use them. Currently there is no provision in the Code for gray water systems, but they are permitted if designed and certified by a professional engineer.

Rainfall capture is used in some communities in the form of rain barrel promotions. We excluded rain barrels from the plan, as there is a high capital investment relative to the amount of water saved. In this climate, the rain barrel would fill only a few times during an irrigation season. It does not conserve hot water, nor does it reduce demands on a sewage system. However, there is potential for economically incorporating rainfall capture into the construction of new strata complexes. The same system could combine rainwater and clean gray water for use in landscape irrigation and / or toilet flushing.

We excluded community-wide toilet retrofits due to the absence of cost recovery from savings in sewage treatment. This would, however, be a very strong option if at some point in the future the community planned to build a sewage treatment facility.

4.2.3 Building Blocks for the Water Conservation Program

Measures that showed promise for use in Naramata were divided into seven Groups based on their similarity, synergy or dependence upon each other for success, and target users. With meters in place, the other five groups of measures can also be implemented. When all seven Groups are combined into a program, Naramata will be able to achieve the BC WaterSmart goal of 33% improvement in water efficiency by 2020.

These Groups are:

1. *Irrigation meters* with a volume based rate structure
2. *Domestic meters* with a volume based rate structure
3. *Irrigation education*
4. *Domestic (residential) education*
5. *Irrigation rebates*
6. *Domestic rebates*
7. *Management*, to be conducted by the purveyor in the areas of leak detection and repair, improved bylaws and enforcement, and using water use data to improve price structures and water conservation programs.

An eighth Group was prepared as a stand-alone *No Meters* option, which takes into account all the selected measures that could be implemented without meters. It was estimated that with this Group, an eight or nine percent reduction could be achieved.

5. Water Conservation Groups of Measures

5.1 Irrigation Meters

Measures include:

- Install meters with radio read on all Grade A Irrigation and non-account irrigation
- Establish a volume based rate structure and allotment
- Read meters six times per year and import readings into the utility billing system
- Maintain the meters
- Publicize the introduction of the meters
- Conduct regular land use inventories
- Subscribe to OKIM, an informational tool for farmers and purveyors

Other measures required:

- None

Group is required for:

- Management Group
- Is beneficial for Irrigation Education Group

Internal Benefits:

- Reduce peak day demand by 2.0 ML/d
- Reduce Irrigation sector water consumption by 16%, or 196 ML/y
- Reduce variable costs by $16,104/y

External Benefits:

- Save 208,595 kWh/y of supply side electricity consumption
- Reduce GHG emissions by 25 t CO_2/y and save $636/y from GHG emissions offsets

Barriers, Disadvantages:

- Capital cost
- Customer acceptance of rate structures
- Savings in variable costs decrease after system separation

5.2 Domestic Meters

Measures include:

- Install meters with radio read on all Domestic connections
- Establish a volume based rate structure
- Read meters twelve times per year and import readings into the utility billing system
- Maintain the meters
- Publicize the introduction of the meters
- Generate an informative water bill

Other measures required:

- None

Group is required for:

- Management Group

Internal Benefits:

- Reduce peak day demand by 0.8 ML/d
- Reduce Domestic sector water consumption by 16%, or 116 ML/y
- Reduce variable costs by $9,547/y

External Benefits:

- Save 123,656 kWh/y of supply side electricity consumption
- Save 815,421 kWh/y from reduced water heating
- Reduce GHG emissions by 310 t CO_2/y and save $7,757/y from GHG emissions offsets
- Customers save $42,402/y on their other utility bills
- Improve management of onsite wastewater systems

Barriers, Disadvantages:

- Capital cost
- High internal net cost per ML saved

5.3 Irrigation Education

Measures include:

- Consistent education program, accomplished by cooperating with other purveyors, and with MAL and the fruit industry field service to provide a steady supply of winter workshops and irrigation season field days
- Weather station for irrigation scheduling

Other measures required:

- Better with Irrigation Meters Group

Group is required for:

- None

Internal Benefits:

- Reduce peak day demand by 0.6 ML/d
- Reduce Irrigation sector water consumption by 5%, or 62 ML/y
- Reduce variable costs by $5,061/y
- May increase acceptance of metering

External Benefits:

- Save 65,559 kWh/y from supply side electricity consumption
- Reduce GHG emissions by 8 t CO_2/y and save $200/y in GHG emissions offsets

Barriers, Disadvantages:

- Requires specialized staff

5.4 Domestic Education

Measures include:

- Water ambassador
- Water conservation kits for homes
- Promotional materials
- Xeriscape education
- School programs

Other measures required:

- None

Group is required for:

- Management Group

Internal Benefits:

- Reduce peak day demand by 0.3 ML/d
- Reduce Domestic sector water consumption by 5%, or 36 ML/y
- Reduce variable costs by $2,983/y

External Benefits:

- Save 38,643 kWh/y from supply side electricity consumption
- Save 254,819 kWh/y from reduced water heating
- Customers save $13,251 on their other utility bills
- Reduce GHG emissions by 97 t CO_2/y and save $2,424/y in GHG emissions offsets
- Improve management of onsite wastewater systems

Barriers, Disadvantages:

- Program delivery on the customer's property could introduce liability and worker safety issues
- Potential for inconsistent delivery from one year to the next

5.5 Irrigation Rebates

Measures include:

- Rebates for purchase of irrigation scheduling aids such as irrigation timers, electrical controllers, soil moisture sensors or weather station equipment

Other measures required:

- None

Group is required for:

- None

Internal Benefits:

- Reduce peak day demand by 0.2 ML/d
- Reduce Irrigation sector water consumption by 2%, or 24 ML/y
- Reduce variable costs by $2,013/y

External Benefits:

- Save 26,074 kWh/y from supply side electricity consumption
- Reduce GHG emissions by 3 t CO_2/y and save $80/y in GHG emissions offsets
- Generates business for water efficiency oriented manufacturers, vendors and services

Barriers, Disadvantages:

- This measure is untested
- External Cost: customer expenditures and time

5.6 Domestic Rebates

Measures include:
- Toilet exchange rebate
- Front loading washer rebate
- Dual flush conversion rebate
- Turf removal rebate

Other measures required:
- None

Group is required for:
- None

Internal Benefits:
- Reduce peak day demand by 0.2 ML/d
- Reduce Domestic sector water consumption by 3.5%, or 25 ML/y
- Reduce variable costs by $2,088/y

External Benefits:
- Save 27,050 kWh/y from supply side electricity consumption
- Save 127,409 kWh/y from reduced water heating bills
- Reduce GHG emissions by 49 t CO_2/y and save $1,236/y in GHG emissions offsets
- Customers save $6,625 on other utility bills
- Additional savings on the demand side, in power consumption, GHG emissions and costs due to increases washer and drier efficiency
- Generate business for water efficiency oriented manufacturers, vendors and services
- Improve management of onsite wastewater systems

Barriers, Disadvantages:
- It is difficult to calculate the cost effectiveness of this Group because it is confounded with education, customer decisions about equipment replacement and renovations, the customer's labour and expenditures, and other conservation initiatives like the Eco Energy Grant program.
- Poor internal recovery of costs
- External Cost: customer expenditures and time

5.7 Management Measures

Measures include:

- Accounting for water use and identifying losses
- Using water cost estimates by sector for use in pricing
- Tracking and analysis of land use
- Enacting a landscape water efficiency bylaw
- Enforcing existing and new bylaws

Other measures required:

- Irrigation Meters Group
- Domestic Meters Group
- Irrigation Education Group

Group is required for:

- None

Internal Benefits:

- Reduce peak day demand by 4.8 ML/d by enforcing flow rate, plus an additional 0.3 ML/d with new measures
- Reduce community water consumption by 2%, or 40 ML/y
- Reduce variable costs by $3,284/y
- Understand how water is used in the community
- Accurate costing, ability to generate fair water rates and design effective water conservation programs

External Benefits:

- Save 45,533 kWh/y from reduced supply side electricity consumption.
- Save 101,928 kWh/y from reduced water heating
- Reduce GHG emissions by 42 t CO_2/y and save $1,052/y in GHG emissions offsets.
- Customers save $5,300/y on other utility bills
- Perception of fairness. Customers do not like to witness neighbours' wasteful practices.
- Encourages businesses that provide water efficiency products and services

Barriers, Disadvantages:

- None.

5.8 No Meters Option

Measures include:

- All measures drawn from the Education, Rebates and Management groups that do not rely on meters for their implementation

Other measures required:

- None

Group is required for:

- None

Internal Benefits:

- Reduce peak day demand by 1.5 ML/d
- Reduce community water consumption by 8.5%, or 169 ML/y
- Reduce variable costs by $13,890/y

External Benefits:

- Save 179,916 kWh/y from reduced supply side electricity consumption
- Save 435,740 kWh/y from reduced water heating
- Reduce GHG emissions by 180 t CO_2/y and save $4,492/y in GHG emissions offsets
- Customers save $22,659 on other utility bills
- Additional savings in power, GHG emissions and costs with increases washer and drier efficiency
- Improve management of onsite wastewater systems

Barriers, Disadvantages:

- Without meters, some measures will have reduced impact
- Customer will bear part of the cost of water efficient appliances

5.9 Business Case for Water Conservation

The Business Case for water conservation is illustrated in detail in Tables 12 thru 15. A 25% reduction in water use can be achieved by 2020 with the employment in concert of Groups 1 through 7. This would require approximately $1.1 million in capital expenditures, mainly for installing meters, and $37,000 in annual operating costs. The additional load to RDOS staffing would be 0.27 full time equivalents for experienced staff, plus 0.15 full time equivalents for a student assistant. Thirty two percent of the cost can be recovered internally due to reductions in variable costs. An additional 60% was identified as recovered in the form of GHG emissions offsets and savings on customers' other utility bills. So after the BC carbon tax reaches its maximum, a total of 92% of costs would be recovered by the utility and its customers.

A second possibility is to implement a *No Meters* option. Forty seven percent of the costs can be recovered within the utility. After the BC carbon tax reaches its maximum, 130% of the costs of water conservation would be recovered. Water saving of 8 to 9%, or about 169 ML per year could be expected. This option could be introduced immediately, whether or not there will be a follow-up with meters and additional water conservation measures. This option would require an initial investment of $26,000 in capital costs plus $26,000 per year in annual operating costs. After the first year, the annual work load would be approximately 0.17 full time equivalents for experienced staff plus 0.15 full time equivalents for a student assistant.

Many of the benefits of water conservation are external to the utility and its customers. It would be reasonable to seek grants designed to foster conservation of water or energy, the reduction of GHG emissions, and environmental stewardship.

Table 12. Internal benefits and costs of water conservation measures

	Group of Measures	Total Capital Costs	Years of Life	Life Debt Servicing Cost	Annual Debt Servicing Cost	Annual Operating Cost	Inflated Life Operating Cost	Life Debt and Operating Costs	Water Saved ML/y	Variable Cost of Water Saved /y	Net Cost/ML saved	Internal Cost Recovery %
1	Irrigation meters	330,996	20	530,134	26,507	7,423	176,817	706,951	196	16,104	91	47%
2	Domestic meters	746,040	20	1,249,544	62,477	2,415	57,524	1,307,068	116	9,547	477	15%
3	Irrigation education	6,095	10	7,911	791	9,074	98,449	106,369	62	5,061	78	51%
4	Domestic education	13,800	10	17,911	1,791	6,268	68,003	85,914	36	2,983	140	37%
5	Irrigation rebates	6,325	10	8,359	836	1,380	14,973	23,332	24	2,013	8	91%
6	Domestic rebates	-	1	-	-	5,578	5,578	5,348	25	2,088	138	37%
7	Management	-	1	-	-	5,233	5,233	5,233	40	3,284	49	63%
	Total 1-7	**1,102,965**		**1,813,859**	**92,402**	**37,369**			**499**	**41,081**	**178**	**32%**
8	No meters	26,220	10	34,031	3,403	25,979	281,870	315,901	169	13,890	92	47%
	Column Label ------------>	C	D	E	F	G	H	I	J	K	L	M
	Source or Calculation -->	ss	ss	entered	E/D	ss	ss	E+H	ss	J*AC	(F+G-K)/J	K/(F+G)

Group of Measures	Self explanatory
Total Capital Costs	Self explanatory
Years of Life	Self explanatory
Life Debt Servicing Cost	"Total Payment" from the MSA amortization schedule
Annual Debt Servicing Cost	Life debt servicing cost for the Group, divided by years of life
Annual Operating Cost	Annual operating cost in today's dollars
Inflated Life Operating Cost	The sum of lifetime operating costs in years of life, including inflation
Life Debt and Operating Costs	Life debt servicing cost plus inflated life operating cost, i.e. All internal costs
Water Saved ML/y	Self explanatory
Variable Cost of Water Saved /y	Water saved times variable cost of water (a portion electricity, operating + labour)
Net Cost/ML saved	In today's dollars
Internal Cost Recovery %	Variable cost of water / Debt servicing and operating costs

Table 13. Internal benefits and costs per connection

	Group of Measures	Number of Conns	Total Cost / Conn	Annual Cost / Conn	Variable Costs Saved / Conn	Net Increase Cost / Conn
1	Irrigation meters	185	3,821.36	191.07	87.05	104.02
2	Domestic meters	800	1,633.83	81.69	11.93	69.76
3	Irrigation education	185	574.92	57.49	27.36	30.13
4	Domestic education	800	107.39	10.74	3.73	7.01
5	Irrigation rebates	185	126.12	12.61	10.88	1.73
6	Domestic rebates	800	6.97	6.97	2.61	4.36
7	Management	985	5.31	5.31	3.33	1.98
8	No meters	985	320.71	32.07	14.10	17.97
	Column Label	O	P	Q	R	S
	Source or Calculation	entered	I/O	P/D	K/O	Q-R

Number of Conns	The number of connections over which costs are distributed
Total Cost / Conn	Life debt and operating costs divided by number of connections
Annual Cost / Conn	Total cost / connection divided by years of life
Variable Costs Saved / Conn	Variable cost of water saved divided by number of connections
Net Increase in Variable Cost / Conn	(Annual cost - variable cost of water saved) / connections

Table 14. Non-financial benefits of water conservation measures

	Group of Measures	Water Saved *ML/y*	Impact on Peak Day *ML/d*	Supply Side Energy Saved *kWh/y*	Demand Side Energy Saved *kWh/y*	Supply side GHG saved *t CO2/y*	Demand side GHG saved *t CO2/y*
1	Irrigation meters	195.7	-2.0	208,595	-	25.45	0.00
2	Domestic meters	116.0	-0.8	123,656	815,421	15.09	295.18
3	Irrigation education	61.5	-0.6	65,559	-	8.00	0.00
4	Domestic education	36.3	-0.3	38,643	254,819	4.71	92.24
5	Irrigation rebates	24.5	-0.2	26,074	-	3.18	0.00
6	Domestic rebates	25.4	-0.2	27,050	127,409	3.30	46.12
7	Management	39.9	-0.3	42,533	101,928	5.19	36.90
	Total 1-7	**499.2**	**-4.5**	**532,110**	**1,299,577**	**64.92**	**470.45**
8	No meters	168.8	-1.5	179,916	435,740	21.95	157.74
	Column Label	U	V	W	X	Y	Z
	Source or Calculation	ss	ss	ss	ss	ss	ss

Water Saved ML/Y	Self explanatory
Impact on Peak Day ML/d	Self explanatory
Supply Side Elec Saved kWh/Y	Electricity for pumping and treating saved
Demand Side NG saved kWh/Y	Energy, mostly natural gas for water heating, saved at point of end use
Supply side GHG saved t CO2/Y	Reduction in GHG emissions on the supply side
Demand side GHG saved t CO2/Y	Reduction in GHG emissions on the demand side

Table 15. External and internal financial benefits and costs of water conservation measures

	Group of Measures	Group Cost / ML saved	Variable Cost of ML saved	Offsets for supply side GHG saved /ML	Offsets for demand side GHG saved /ML	Customer savings in NG and electricity	Net Benefit / Cost Ratio
1	Irrigation meters	180.64	82.30	3.25	0.00	0.00	-53%
2	Domestic meters	563.39	82.30	3.25	63.62	365.53	-9%
3	Irrigation education	172.94	82.30	3.25	0.00	0.00	-51%
4	Domestic education	237.01	82.30	3.25	63.62	365.53	117%
5	Irrigation rebates	95.39	82.30	3.25	0.00	0.00	-10%
6	Domestic rebates	219.80	82.30	3.25	45.44	261.10	78%
7	Management	131.14	82.30	3.25	23.12	132.84	84%
	1 - 7	**259.98**	**82.30**	**3.25**			**-8%**
8	No meters	187.17	82.30	3.25	23.36	134.25	30%
	Column Label	AB	AC	AD	AE	AF	AG
	Source or Calculation	I/U/D	vcw	ss	ss	ss	calculated

Group Cost / ML saved	All internal costs divided by ML saved
Variable Cost of ML saved	Cost of portion of electricity consumption, operations and labour that is proportional to water produced
Offsets for supply side GHG saved /ML	GHG offsets at $25/t CO2
Offsets for demand side GHG saved /ML	GHG offsets at $25/t CO2
Customer savings in NG and elec	The reduction in customers other utility bills due to using low flow showerheads, faucet screens, shower timers, front loading washers
Net Benefit / Cost Ratio	(all benefits - all costs) / all costs x 100%

6. References

1. **Okanagan Water Stewardship Council.** *Okanagan sustainable water strategy.* s.l. : Okanagan Basin Water Board, 2008. Action Plan.

2. **BC Ministry of Environment.** *Living WaterSmart - British Columbia's Water Plan.* 2008. Action Plan. http://www.livingwatersmart.ca/book.html.

3. **Wong, J., et al.** *Water Conservation Planning Guide for British Columbia's Communities.* Victoria : POLIS Project on Ecological Governance with the BC Ministry of Community Development, 2009. p. 80, Guidebook. Accessed August 19, 2009 at http://www.obwb.ca/fileadmin/docs/water_conservation_planning_guide_v1.0.pdf.

4. **Regional District of Okanagan and Similkameen.** South Okanagan Regional Growth Strategy. *RGS Bylaw 2421, 2007 Schedule A, South Okanagan Regional Growth Strategy.* Penticton : Regional District of Okanagan and Similkameen, October 16, 2007. p. 57.

5. **Applied Science Technologists & Technicians of BC.** OWRP Consumer Information Centre Maintenance Requirements. *OWRP ASTTBC.* [Online] [Cited: December 1, 2009.] http://owrp.asttbc.org/c/maintenance.php.

6. **Statistics Canada.** Community Profiles from the 2006 Census, Statistics Canada. *Statistics Canada Canada's national statistical agency.* [Online] July 24, 2009. [Cited: August 20, 2009.] http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E.

7. **Naramata Centre.** Welcome to the Naramata Centre. [Online] http://www.naramatacentre.net.

8. **Lee, Samson and Roesler, Corrine.** *Okanagan Land Use Inventory Documentation.* [PDF] s.l. : MAL, September 2008.

9. **Associated Engineering.** *Naramata Water Supply Improvements Pre-design Report.* 2005. p. 166.

10. **BC Ministry of Environment.** Water Reserves/Proposed Reserves registered in the Water Rights Information System, as at June 5, 2009. *http--www.env.gov.bc.ca-wsd-water_rights-reserves_restrictions-cabinet-reserves.pdf.* [Online] June 5, 2009. [Cited: August 20, 2009.] http://www.env.gov.bc.ca/wsd/water_rights/reserves_restrictions/cabinet/reserves.pdf.

11. —. Water Licences Report. [Online] August 2009. [Cited: August 27, 2009.] http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input.

Naramata Water Conservation Plan
12. **Naramata Irrigation District.** Sketch Map of Naramata Water System.

13. **Associated Engineering.** *Naramata Water System Asset Management Plan, Final Report.* 2008.

14. **Clean Calgary Association Resources.** Indoor Water Use. *Clean Calgary Association Environmental Education, Products & Services.* [Online] [Cited: August 27, 2009.] http://cleancalgary.org/images/uploads/File/IndoorWaterUse.pdf.

15. **Aquacraft Inc. and AWWA.** Residential Water Use Summary. *aquacraft.com.* [Online] 1999. [Cited: August 31, 2009.] http://www.aquacraft.com/Publications/resident.html.

16. **DeOreo, William B. and Mayer, Peter W.** The end use of hot water in single family homes from flow trace analysis. *Aquacraft.com.* [Online] [Cited: August 31, 2009.] http://www.aquacraft.com/Download_Reports/DISAGGREGATED-HOT_WATER_USE.pdf.

17. **Wolff, Gary, Cohen, Ronnie and Nelson, Barry.** nrdc Energy Down the Drain - The Hidden Costs of California's Water Supply. *nrdc Natural Resources Defense Council - The Earth's Best Defense.* [Online] August 2008. [Cited: August 27, 2009.] http://www.nrdc.org/water/conservation/edrain/contents.asp.

18. **FortisBC.** *2009 Resource Plan.* Kelowna : FortisBC, 2009. p. 160, Resource Plan.

19. **Pacific Carbon Trust.** Pacific Carbon Trust Service Plan 2009/10 to 2011/12. *Pacific Carbon Trust.* [Online] September 2009. [Cited: October 5, 2009.] http://www.pacificcarbontrust.ca/Portals/0/PCT%20SP%20-%20update%20Sept%2009-aug25.pdf.

20. **Neilsen, Denise and Losso, Estvan.** *Naramata irrigation demand and climate change.* [Electronic mail and excell worksheets] October 2009.

21. **Agua Consulting Inc.** 2008 Draft Water Master Plan and Financial Review. *The District of Summerland Municipal Web Site.* [Online] August 29, 2008. [Cited: September 10, 2009.] http://www.summerland.ca/Local%20Projects/Summerland_Draft/401_Main_Report.pdf.

Appendix A:
List of Water Conservation Goals

This appendix lists water conservation goals and strategies that have been expressed in recent planning documents.

Goals arising from the Regional Growth Strategy (1)

Policy EN3 – Reduce contribution to and increase adaptation to climate change

The south Okanagan municipalities and electoral areas agree to:

1. Consider a policy for green buildings for local government buildings.
2. Work with business and agriculture to apply innovative best practices that include renewable energy technologies and energy efficiency.
3. Consider rebate programs for high-efficiency fixtures, appliances and water efficiency.
4. Investigate the opportunity to use tax and other incentives in the region.
5. Consider the region's vulnerability to climate change in planning responses to proposed and existing activities for their resilience to climate change impacts and minimization of greenhouse gas emissions.
6. Support public awareness and education on climate change to foster best environmental management practices and stewardship.

Policy EN5 – Promote water sustainability through conservation and related best practices

The south Okanagan municipalities and electoral areas and Ministry of Environment agree to:

1. Apply and promote four guiding principles to manage the water resource capacity and efficiency in the Okanagan basin;
    a. preserve ecosystems functions to maintain water quantity and quality,
    b. encourage best water management practices in agriculture,
    c. reduce residential water use to support population growth in urban areas,
    d. use best practices to manage water use for industrial, commercial and institutional purposes.
2. Support the development of an inter-regional Water Plan, including consideration of long term plans for upper level water storage / source water protection and work collaboratively with the Okanagan Basin Water Board to further expand on the

Okanagan Water Supply and Demand study with other agencies and levels of government.

3. Collaborate with the Water Sustainability Committee of the BC Water and Waste Association, the Water Stewardship Council of the Okanagan Basin Water Board, local governments and others on the management of the inter-regional water resource.
4. Support the development of a water-centric outreach and education program as the next phase of the Convening for Action program.
5. Promote, support and participate in local and basin-wide solutions for effective water management practices, recognizing that water currently allocated to the agriculture sector will remain allocated to the agriculture sector, with;
    a. the non-agricultural sector to support population growth in settlement centres, and
    b. the agricultural sector to adapt to climate variability and/or expand irrigated farm land.
6. Promote the implementation of universal metering for water service connections, in alignment with policy recommendations proposed by the Okanagan Basin Water Board.
7. Create partnerships to provide infrastructure and services regionally where applicable.

Guiding Principles for the Okanagan Sustainable Water Strategy (2)

1. **Recognize the value of water.** Water is a common good that is essential to the survival of people and ecosystems. The consumptive and non consumptive values of water will be recognized and respected in all water management decisions.
2. **Control pollution at its source.** Water quality in lakes, streams, and aquifers will be protected for the benefit of healthy ecosystems and to help ensure clean, safe, and reliable drinking water is available to all residents of the Okanagan Basin.
3. **Protect and enhance ecological stability and biodiversity.** Natural processes in healthy watershed ecosystems are the most effective and cost-efficient means to maintain instream water quality and quantity. Water management will commit to protecting and restoring ecosystems and will ensure that local and cumulative impacts on sensitive habitats are considered in land and water management decisions. A watershed based approach will be taken to identify the natural features that are essential to protecting water quality and quantity (e.g. wetlands, waterways, adjacent uplands, and riparian areas).
4. **Integrate land use planning and water resource management.** Integrated water resource management means recognizing the interrelationship between land use and water quantity and quality. Land use decisions will work to minimize the impact of

urbanization and reduce the human footprint on the environment, which will in turn reduce impacts on water resources.

5. **Allocate water within the Okanagan water budget in a clear, transparent, and equitable way.** Identifying how and when water will be allocated is critically important to prepare for the possibility of increasing drought conditions in the Okanagan. Sufficient water must be available for the environment, agriculture, basic human needs, and economic development now and in the future. Existing historical inequities of water supply in the Basin need to be addressed and policies should be developed to prevent the emergence of new inequities as a result of increasing competition over water.
6. **Promote a Basin-wide culture of water conservation and efficiency.** Reducing water waste and promoting water use efficiency is central to sustainable water management. Water saved through improved water use efficiencies by a water use sector should be held for that sector.
7. **Ensure water supplies are flexible and resilient.** Even with improved Basin-wide water conservation and efficiency, water storage capacity will need to be increased in some sub-basins to meet the joint challenges of population growth and climate change.
8. **Think and act like a region.** Local decisions must consider watershed and aquifer interconnections with the larger Basin. Work towards a governance system that integrates existing institutions from the sub-basin level to the Basin as a whole, and provincial and federal governments. Specific types of decisions are appropriate at each level of this nested system of governance institutions and a reasonable balance of authority must be achieved.
9. **Collect and disseminate scientific information on Okanagan water.** The best available technology and science will be used to inform water management decision-making. Information will be managed in an integrated manner that is readily available to stakeholders Basin-wide.
10. **Provide sufficient resources for local water management initiatives.** Sufficient financial resources will be allocated to support better use of supplies of water that we have already developed, to employ new technology and infrastructure, to improve and refine management practices, and to draw on better information.
11. **Encourage active public consultation, education, and participation in water management decisions.** Transparent decision-making processes and opportunities for information sharing and open communication are essential to a collective understanding and acceptance that we are part of the environment and our activities have implications on clean available water. A culture of accountability needs to inform everything from high level planning to individual perceptions and patterns of consumption.
12. **Practice adaptive water and land management.** Continuous learning, innovation, and improvement are essential to effective and efficient implementation of the Sustainable

Water Strategy. An on-going monitoring and reporting program will be developed for the Strategy. In addition, a comprehensive review of the Strategy needs to be conducted every five to seven years.

Living Water Smart - British Columbia's Water Plan (3)

Doing Business Differently

1. By 2012, all land and water managers will know what makes a stream healthy, and therefore be able to help land and water users factor in new approaches to securing stream health and the full range of stream benefits.
2. By 2012, water laws will improve the protection of ecological values, provide for more community involvement, and provide incentives to be water efficient.
3. Legislation will recognize water flow requirements for ecosystems and species.
4. Government will require all users to cut back their water use in times of drought or where stream health is threatened.
5. Government will limit all new licences to 40-year terms in areas where there is high demand and pressure on water.
6. The Ground Water Protection Regulation will protect the quality and quantity of our groundwater.
7. By 2012, government will regulate groundwater use in priority areas and large groundwater withdrawals.
8. Government will support communities to do watershed management planning in priority areas.
9. By 2020, water use in British Columbia will be 33 percent more efficient.
10. By 2012, government will require all large water users to measure and report their water use.
11. Government will require more efficient water use in the agriculture sector.
12. Government will secure access to water for agricultural lands.
13. Government will work with the private sector and support communities to conserve and restore stream function.
14. Government and partners will restore ecological health to 30 km of stream between Vaseux Lake and Osoyoos Lake.
15. Government will fund the Mount Washington mine remediation project with $4.5 million, restoring the health of the Tsolum River.
16. To enhance some watersheds, government will examine the potential of decommissioning dams.

Preparing Communities for Change

17. By 2012 new approaches to water management will address the impacts from a changing water cycle, increased drought risk and other impacts on water caused by climate change.
18. Government will work with other provinces to share ideas and resources to improve water conservation and collectively help communities adapt to climate change.
19. Community development strategies will be developed to recognize the importance of riparian zones in adapting to climate change.
20. Adapting to climate change and reducing our impact on the environment will be a condition for receiving provincial infrastructure funding.
21. Where new development on flood plains is unavoidable, it will be flood-proofed to high provincial standards.
22. The government will provide $100M for flood protection over 10 years to help communities manage flood losses.
23. Wetland and waterway function will be protected and rehabilitated.
24. Government will provide incentives for restoration of streams or wetlands.
25. Green developments waiting for provincial environmental approvals will be fast-tracked and given priority.
26. Government will develop new protocols for capital planning that will look at the lifecycle costs and benefits of buildings, goods and services.
27. Government will improve the quality and protection of drinking water sources.
28. The government will cooperate with Canada to ensure the quality of drinking water in all Aboriginal communities will meet the same provincial standards applied across British Columbia by 2015.

Choosing to be Water Smart

29. Fifty percent of new municipal water needs will be acquired through conservation by 2020.
30. Government will look at new ways to help promising water conservation technology succeed.
31. Government will fund household evaluations of water, energy and transportation use.
32. The Green Building Code will require water conservation plumbing fixtures such as low flush toilets.
33. By 2010, government will mandate purple pipes in new construction for water collection and re-use.
34. In partnership with industry, government will develop a water efficiency labelling system for water consuming products.
35. By 2012, all students in B.C. will have completed at least one stream-health assessment.

36. Government will award a youth water-science prize or scholarship for excellence in water stewardship.
37. Government will provide summer jobs for youth between the ages of 16 to 22, to undertake twenty stream restoration projects across the province.
38. Government and First Nations' treaty water negotiations and other related agreements support providing a clean and safe domestic, agricultural and industrial water supply for First Nation communities.
39. Government will continue to work toward preserving First Nations' social and cultural practices associated with water.
40. Tools to incorporate traditional ecological knowledge into information and decision making will be developed by 2015.
41. By 2010, a strategy to set the direction for water science in B.C. will be implemented.
42. Government is expanding British Columbia's hydrometric and other climate-related networks.
43. Government will publish a report on the state of our water by 2012 and every five years after that.
44. Government will celebrate examples of successful water stewardship by awarding annual water awards to individuals or groups.
45. The government of British Columbia will work with our Olympic partners to use sports and the Olympic Games spotlight to engage British Columbians and support smarter water choices.

Appendix B:
RDOS and Electoral Area 'E' Census Data

Summary

The age distribution of Electoral Area 'E' residents has an accentuated peak at ages 45 to 54, slightly older than British Columbia's peak. There is another peak at ages 5 to 19. Few residents are in the 20 to 34 year age categories. In contrast to RDOS as a whole, which has high numbers of people aged 55 and older, the percentage of Area 'E' residents aged 65 and over is only slightly higher than the British Columbia average. Most of the older people in RDOS live in other areas. See Figure 1. (1)

Ninety-six percent of Area 'E' residents live in a single detached dwelling (Figure 2). Eighty-six percent own their home. The percentage of people renting is about half the British Columbia average. Sixty-four percent of residents live in homes more than twenty years old.

In Area 'E' 2.7% of residents identify with at least one aboriginal group and 2.7% of residents are not Canadian citizens. Nearly all residents are either non-immigrant (78%) or immigrated to Canada more than fifteen years ago (20%). All Area 'E' residents can speak English and 14.4% have a language other than English as a mother tongue.

Median income of Area 'E' families is close to the British Columbia average. Median income after tax for women is 78% of that for men, compared to a ratio of 67% British Columbia-wide. The percentage of people living in low-income households is noticeably lower than the British Columbia average.

Among 15 to 24 year olds, high school graduation rates are similar in Area 'E', RDOS and BC. Those who have completed college or university level programs are absent from Area 'E'. See Figure 5.

In Area 'E', 70% of residents aged 25 to 34 have attained high school graduation or less. See Figure 6.

In Area 'E', among residents aged 35 to 64, 60% have completed some form of post-secondary education, a level similar to that for British Columbia, and slightly higher than within RDOS. Area 'E' has a lower percentage of people with a background in trades, and more with university degrees. See Figure 7.

Among those who completed posts-secondary education, the distribution among the fields of specialty is similar between Area 'E', RDOS and British Columbia.

Relative to RDOS and British Columbia as a whole, a higher percentage of Area 'E' residents who live in the same home or the same census subdivision as they did one year ago. See Figure 8.

Sixty-eight percent of Area 'E' residents live at the same address as they did five years ago, and an additional 9% lived in Area 'E' at a different address. Compared to RDOS, a higher percentage of residents immigrated from elsewhere in British Columbia and Canada. See Figure 9.

References

1. **Statistics Canada.** Community Profiles from the 2006 Census. *Statistics Canada Canada's national statistical agency.* [Online] July 24, 2009. [Cited: August 20, 2009.] http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E.

Figure 1. Age distribution of RDOS and Area 'E' residents

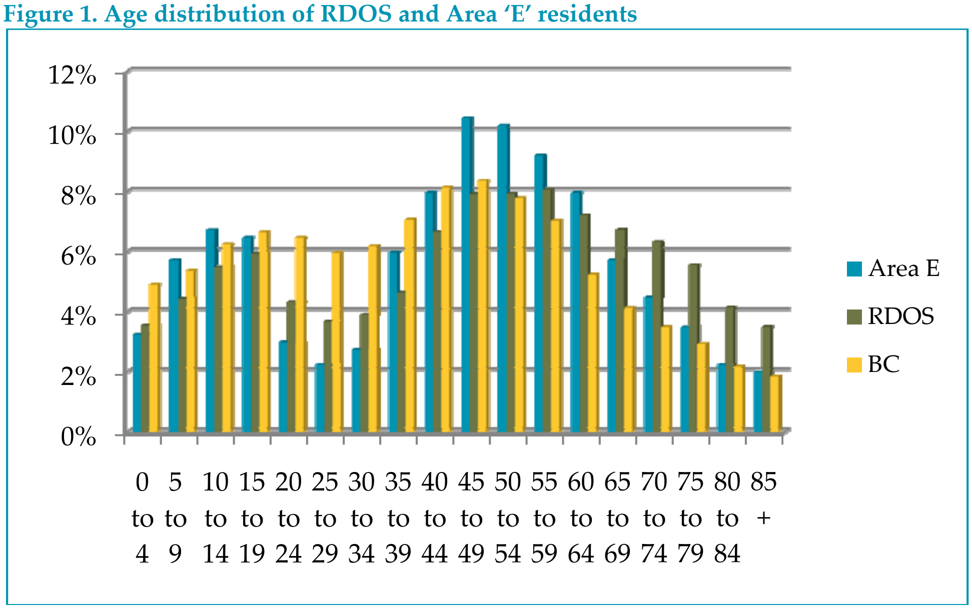


Figure 2. Types of dwellings occupied by RDOS and Area 'E' residents

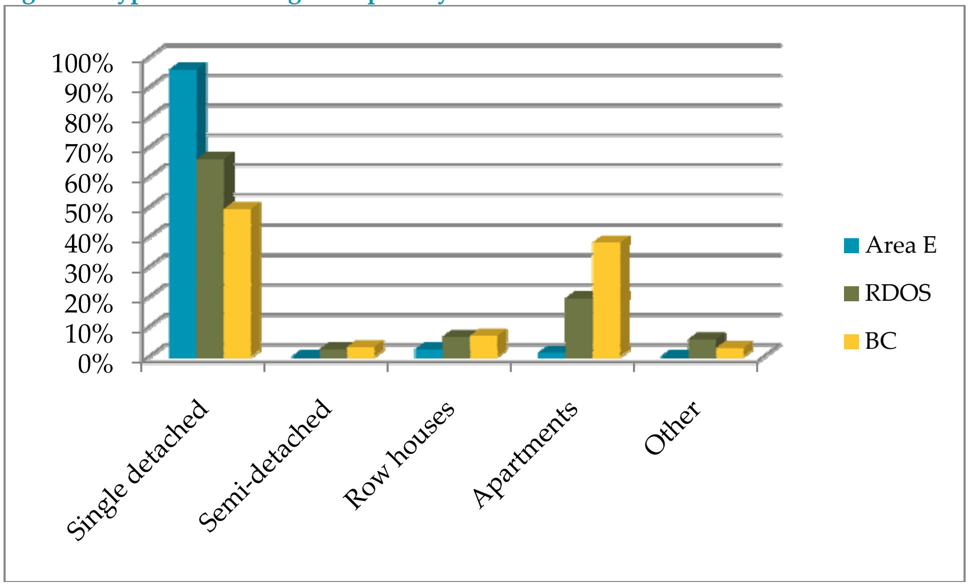


Figure 3. Occupations of RDOS and Area 'E' residents aged 15 and older

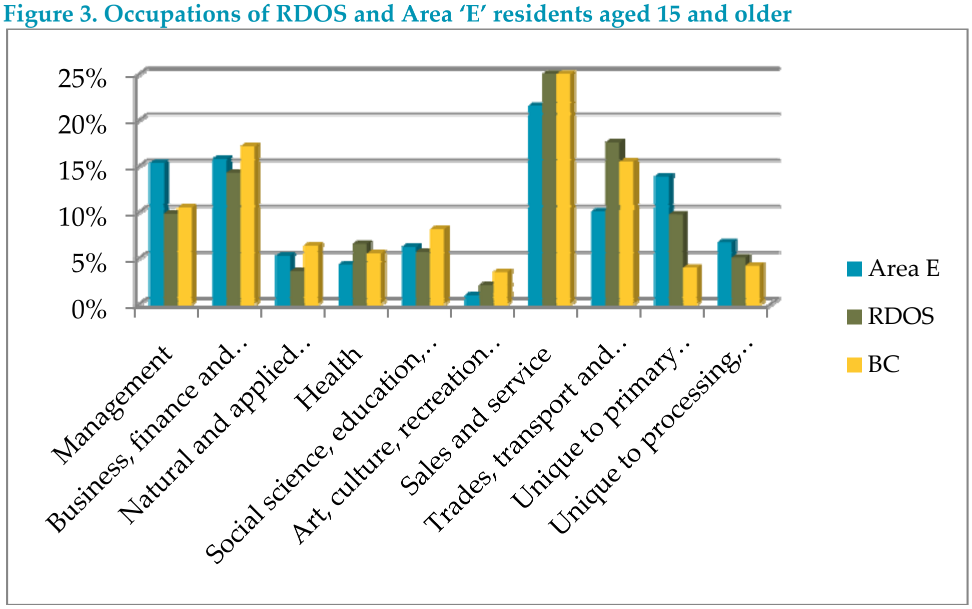


Figure 4. Industries employing RDOS and Area 'E' residents aged 15 and older

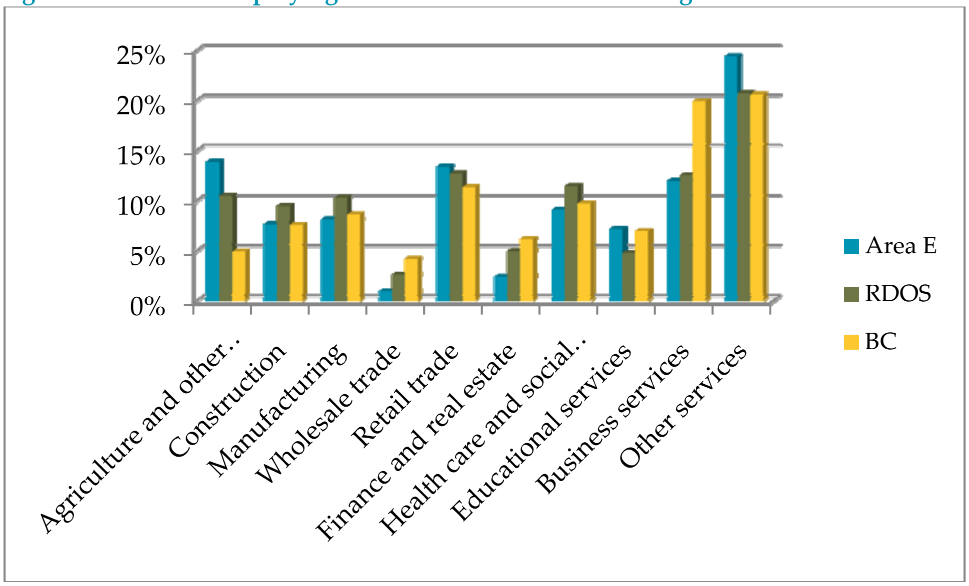


Figure 5. Education attained by RDOS and Area 'E' residents aged 15 to 24

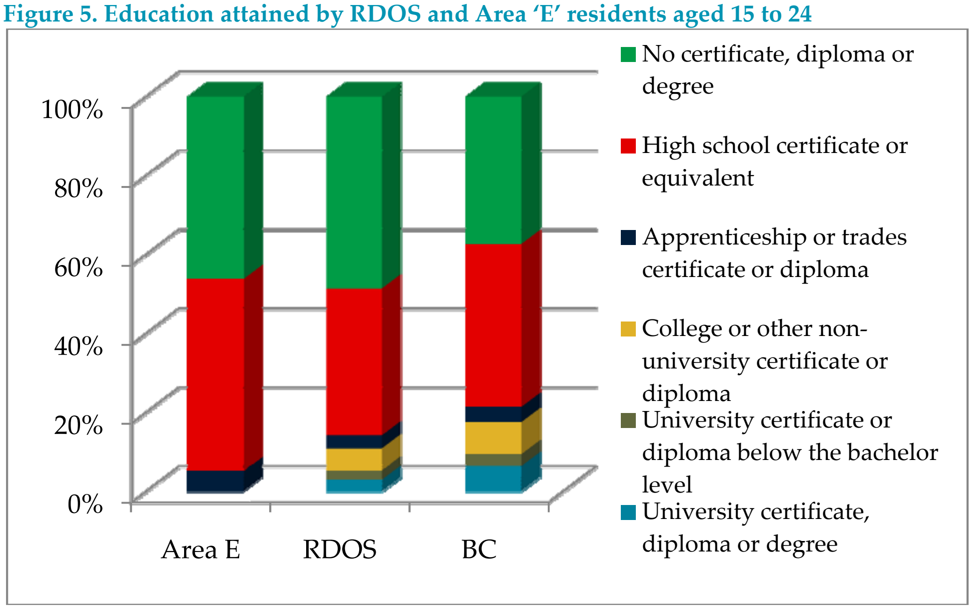


Figure 6. Education attained by RDOS and Area 'E' residents aged 25 to 34

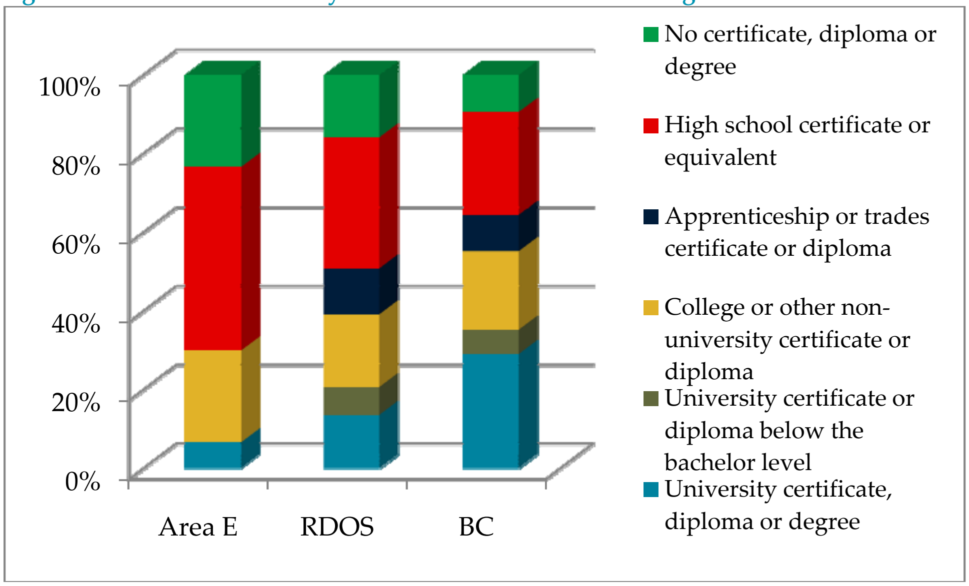


Figure 7. Education attained by RDOS and Area 'E' residents aged 35 to 64

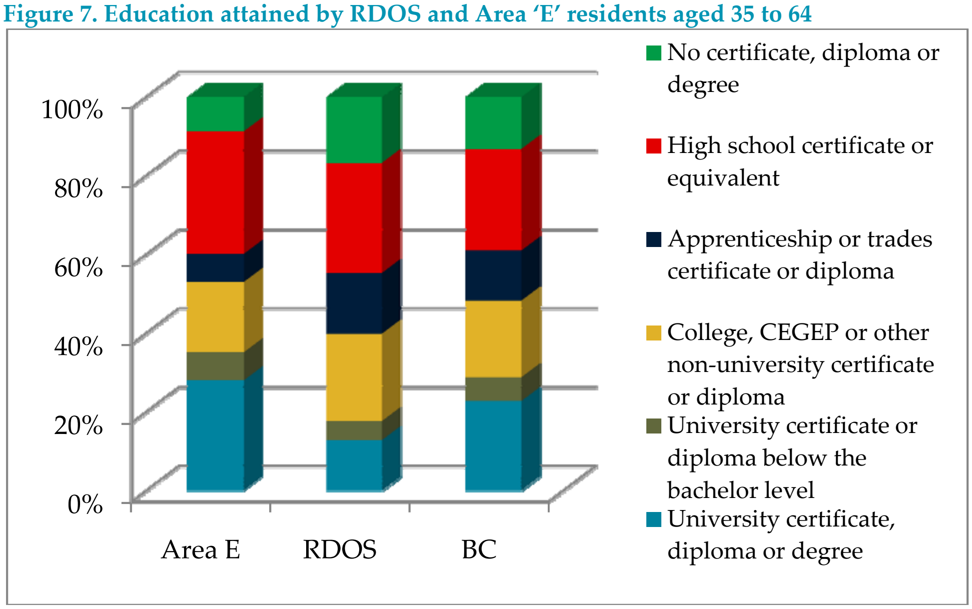


Figure 8. One year mobility of RDOS and Area 'E' residents

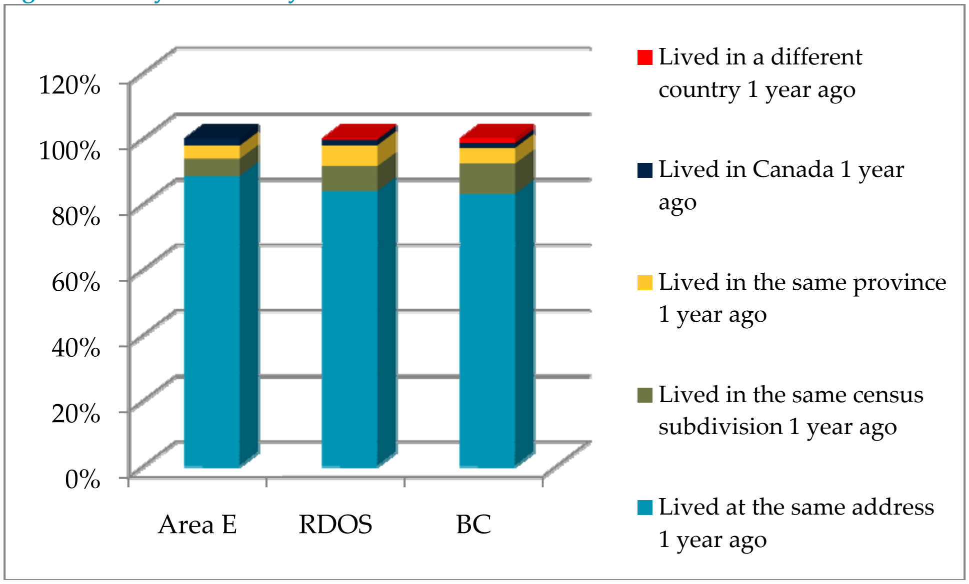
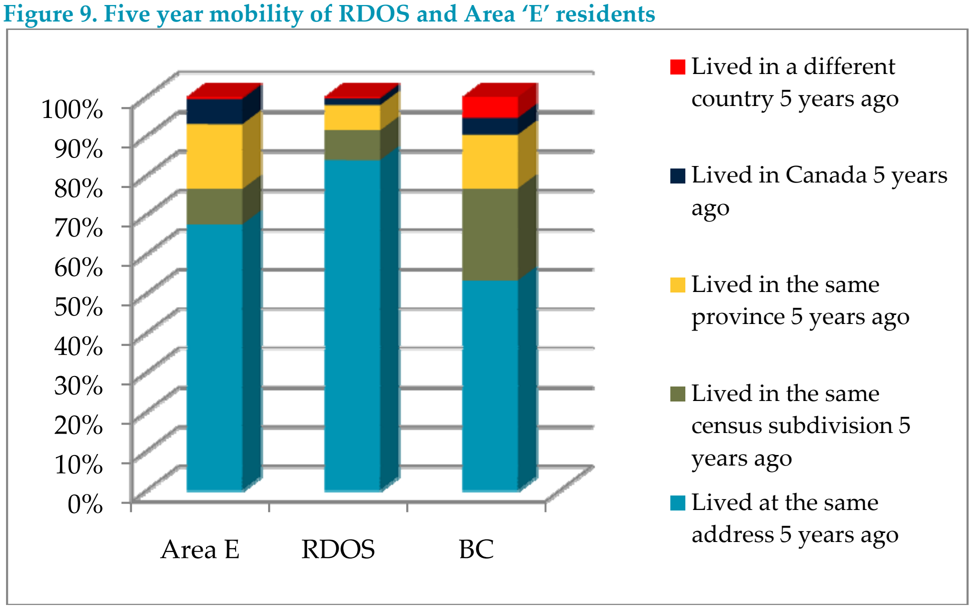


Figure 9. Five year mobility of RDOS and Area 'E' residents



Appendix C:
Detailed Water System Profile

Table 1. RDOS water licences held in the Okanagan Basin (1)

	Storage *ML*	Water Works *ML/y*	Irrigation *ML/y*
Upland Licences	2405	185	8366
Okanagan Lake Licences	0	2064	247
TOTAL WATER LICENCING	**2405**	**2249**	**8613**

Table 2. Water storage in Robinson Creek watershed (2)

Site	Elevation *m*	Volume *ML*
Big Meadow Dam	1612	530
Elinor Lake	1308	284
Naramata Lake	1301	666
Total		**1480**

Table 3. Naramata water connections

Type of Connection	Number	
Domestic	800	Number of accounts. It is assumed that with metering, Grade A Domestic connections will be extinguished.
Grade A Irrigation	182	Actual connections.
Non-account irrigation	3	Two parks and cemetery.

Table 4. Naramata service summary

Domestic Use	Number
Permanent dwellings	830
ICI customers	22
Visitors' Dwellings, # units	87
Irrigation Use	**Hectares**
Grade A Irrigation, ha	352.5
Grade A Domestic, ha	80.0
Yards in the first 0.1 ha, estimated	46.0
Non-account irrigation, ha	2.0
Total hectares	**480.5**

The values in Table 5 were used for estimating costs and benefits of water conservation portfolios. However without universal meters, there can be no assurance of accuracy. The main assumptions were:

1. That winter use reflects system losses, indoor use of permanent dwellings and ICI;
2. That additional seasonal use reflects a summer increase in occupancy of visitors' dwellings and irrigation; and
3. In the absence of reliable data, that the depth of irrigation is assumed equal whether agricultural, residential or public property.

Table 5. Annual water use partitioned by category

Use Category	ML/y	%	Includes
Domestic indoors	288	14.4%	Permanent dwellings, accommodation and ICI
Domestic outdoors	437	21.9%	Yards and landscaping
Grade A Irrigation	1223	61.3%	Agriculture
Non-account irrigation	7	0.3%	Parks, cemetery
System losses	40	2.0%	
Total Annual	**1995**		**Average of 2003-2008**

Peak day consumption was also partitioned into the same use categories. The assumptions were the same as for annual water use. In this case all the categories that involve outdoor irrigation comprise a higher percentage of the total because they are weather dependent.

Table 6. Peak day consumption partitioned by category

Use Category	ML/d	%	Weather Dependent
Domestic indoors	0.79	4.5%	no
Domestic outdoors	4.41	24.9%	yes
Irrigation customers	12.34	69.6%	yes
Non-account water	0.07	0.4%	yes
System losses	0.11	0.6%	no
Peak Day Total, 2009	**17.72**		

References

1. **BC Ministry of Environment.** Water Licences Report. [Online] August 2009. [Cited: August 27, 2009.] http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input.

2. **Naramata Irrigation District.** Sketch Map of Naramata Water System.

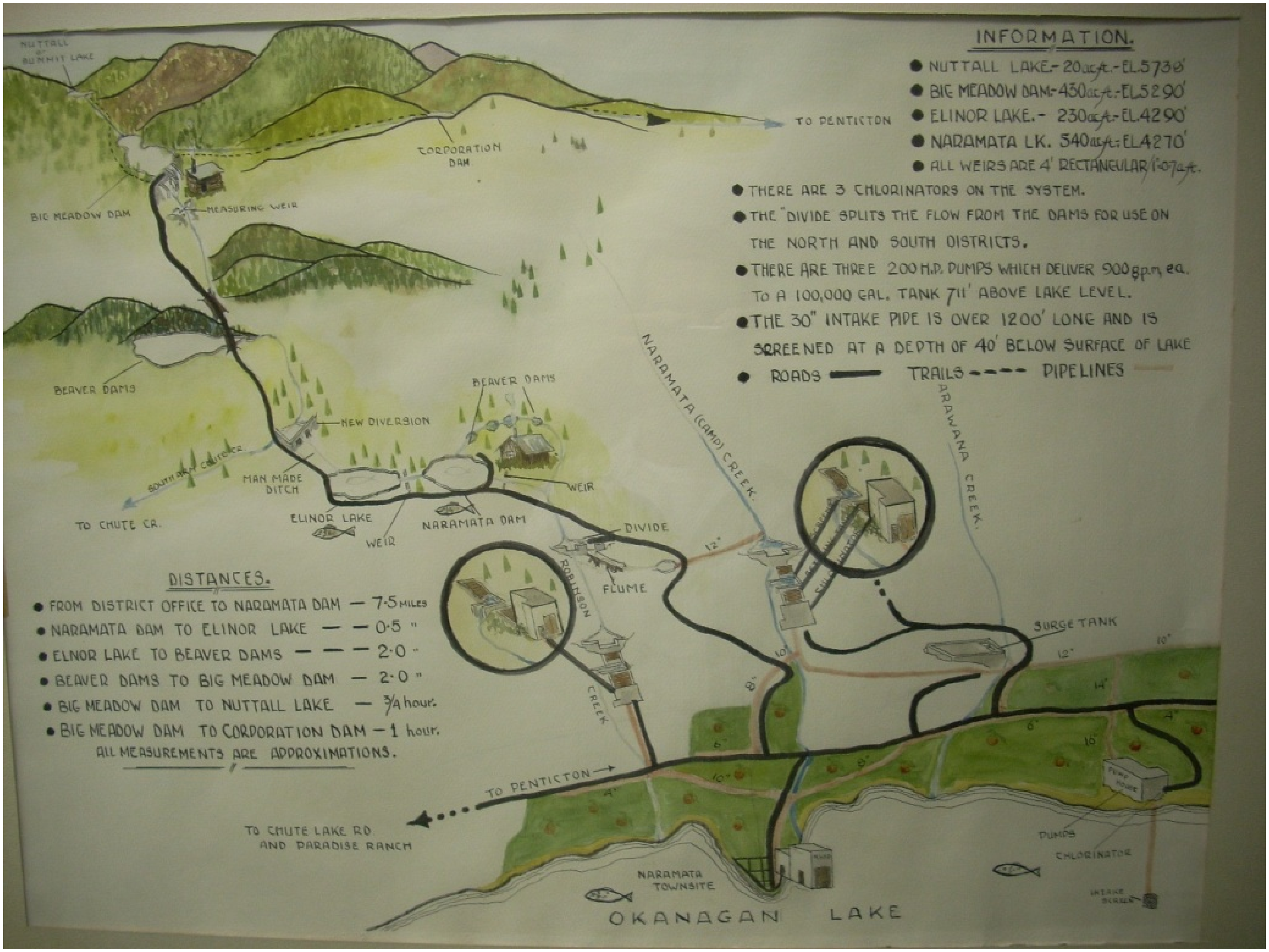
Table 7. RDOS Water Licences in the Okanagan Basin (1)

Licence	Stream Name	Purpose	Quantity	Unit	Storage *ML*	Water Works *ML/y*	Irrig. *ML/y*	Priority	Issued
C017735	Robinson Creek	Irrigation	3000	AF			3701	19050728	0
C017736	Chute Creek	Storage	1950	AF	2405			19210411	0
C017736	Robinson Creek	Storage	1950	AF				19210411	0
C017736	Robinson Creek	Storage	1950	AF				19210411	0
C017737	Arawana Creek	Irrigation	670	AF			826	19031013	0
C017737	Arawana Creek	Irrigation	670	AF				19031013	0
C017737	Arawana Creek	Irrigation	670	AF				19031013	0
C017738	Naramata Creek	Irrigation	3000	AF			3701	19050728	0
C017739	Chute Creek	Irrigation	3000	AF				19061019	0
C017739	Chute Creek	Irrigation	3000	AF				19061019	0
C019634	Naramata Creek	Waterworks	365000	GY		2		19500425	0
C023506	Naramata Creek	Waterworks	36500000	GY		166		19560814	0
C023506	Robinson Creek	Waterworks	36500000	GY				19560814	0
C023506	Robinson Creek	Waterworks	36500000	GY				19560814	0
C024078	Chute Creek	Waterworks	36500000	GY				19570212	0
C026484	Robinson Creek	Irrigation	15	AF			19	19600428	0
C026484	Tennant Spring	Irrigation	15	AF				19600428	0
C032543	Naramata Creek	Waterworks	3650000	GY		17		19140917	0
C034312	Okanagan Lake	Irrigation	1000	AF		1234		19680925	0
C049292	Ritchie Creek	Irrigation	25	AF			25	19761108	0
C066533	Naramata Creek	Irrigation	50	AF			50	19880624	0
C113317	Okanagan Lake	Waterworks	182500000	GY		830		19610505	19980601
C113324	Okanagan Lake	Irrigation	200	AF			247	19890322	19980601
F013941	Naramata Creek	Irrigation	20	AF			25	19430202	0
F013941	Naramata Creek	Irrigation	20	AF				19430202	0
F013941	Naramata Creek	Irrigation	20	AF				19430202	0
F013941	Naramata Creek	Irrigation	20	AF				19430202	0
F052018	Arawana Creek	Irrigation	15	AF			19	19780315	0
Upland Licences (ML or ML / y)					2405	185	8366		
Okanagan Lake Licences (ML / y)					0	2064	247		
TOTAL WATER LICENCING (ML or ML / y)					**2405**	**2249**	**8613**		

Table 8: Utility billing system classification and counts, 2009

Code	Description	Fee	Per	Comments	Units	Permanent Dwellings	Rented Temporary Seasonal	Industrial Commercial Institutional	Oversize	Grade A hectares
W100	Grade A Domestic	$ 593	hectare		80.08					80.08
W101	Grade A Irrigation	$ 593	hectare		352.49					352.49
W102	Residential User Fee	$ 624	house		835	835				
W103	Grade B	$ 365	parcel	does not have a house	19					
W104	Grade C	$ -	hectare	no charge	2.67					
W105	Grade D	$ -	hectare	no charge	204.38					
W106	Suites, Summer, Picker Cabin	$ 148	unit	additional fee	7		7			
W107	Multi-Family Dwelling	$ 624	unit	additional fee after first	17	17				
W108	1" connection	$ 197	connection	additional fee	6				6	
W109	1 1/4" connection	$ 422	connection	additional fee	2				2	
W110	Tent and Trailer Court	$ 690	facility	additional fee	1			1		
W111	Packinghouse	$ 964	facility	additional fee	1			1		
W112	2" connection	$ 1,024	connection	additional fee	4				4	
W113	Motel / Auto Court	$ 131	unit	additional fee	2		2			
W114	School	$ 4,005	facility	additional fee	1			1		
W115	Bunkhouse	$ 304	facility	additional fee	1		1			
W116	Motel / Auto Court	$ 131	unit	additional fee	10		10			
W117	Retail, Business, Winery	$ 178	facility	additional fee	18			18		
W118	Cottages, Cabins			additional fee	15		15			
W119	Guesthouse, Summer Cabin			additional fee	9		9			
W120	1 1/2" connection	$ 596	connection	additional fee	8				8	
W121	Resort		unit	additional fee	30		30			
W122	Naramata Centre	$ 9,106	facility	additional fee	1			1		
W123	Capital Charge	$ 131	parcel		966					
W124	Rebate Well Water Users				32					
W125	Bed & Breakfast	$ 262	facility		13		13			
						852	**87**	**22**	**20**	

Figure 1. Sketch map of the Naramata water system (2)



Appendix D:
Energy Consumption and GHG Emissions

Energy Consumption

Water Treatment and Distribution

Table 1. Electricty consumption within Naramata water treatment plant, 2009

	Power Consumption *kWh*	% of Use	Proportional
UV treatment	103,500	9%	yes
Chlorination	151,548	13%	yes
Pumping from WTP	811,275	71%	yes
Total Proportional to flow	*1,066,323*	*93%*	
Geothermal temperature control	50,000	4%	no
Lighting	30,000	3%	no
Total	1,146,323	100%	

Table 2. Electricity consumption and costs at three key Naramata water facilities, 2008

	Annual			Proportional to volume pumped			
Facility	*kWh*	*kVA*	*Cost*	*kWh*	*Cost*	*% of kWh*	*% of Elec Cost*
Water treatment plant	1,115,000	605	57,149	1,036,950	51,848	93%	91%
Juniper Road	137,231	93	11,683	130,369	8,474	95%	73%
Raw water	817,664	516	85,154	776,781	37,285	95%	44%
Total	**2,069,895**		**153,986**	**1,944,100**	**97,607**	**94%**	**63%**

During an audit of Naramata's main water facilities in 2009, it was estimated that 94% of electricity consumption is proportional to water use. Analysis of these estimates and the 2008 water bills revealed that 63% of electricity cost is proportional to water use. A significant portion of the electrical bill is paid to cover the maximum load (peak kVA). (1)

Point of End Use

Most water-related energy consumption occurs in the home. Most agriculture related uses, and outdoor residential use add negligible amounts of energy. Almost all energy consumption at point of end use attributable to water heating.

Table 3. Estimated hot water requirements and energy intensity of residential end use

	Indoor Water Use (2) (3) %	Hot Water (4) %	Energy Intensity of Hot Water Used (5) *kWh/ML*
Bath	1%	78.2%	42,065
Clothes Washer	21%	27.8%	14,954
Dishwasher	1%	100.0%	53,791
Faucet	16%	72.7%	39,106
Leaks	10%	26.8%	14,416
Shower	15%	73.1%	39,322
Toilet	28%	0.0%	-
Other	8%	No data	-
Energy intensity of indoor residential water			**17,696**

We estimated that Naramata residents use approximately 288 ML inside their homes, and from the table, we calculate that 5,096,448 kWh of energy is used to heat their residential water per year. This is more than twice the energy consumed in delivering the water to their homes.

Table 4. Energy intensity of Naramata water

Supply or End Use	Energy Intensity *kWh / ML*	Comments
Water supplied to connection (proportional to flow)	1,135	Pumping, UV treatment, Chlorination
Water supplied to connection (non-proportional)	149	Heating, Lighting
Residential indoor end use	17,696	Considering hot water only
Residential outdoor end use	0	
Agricultural end use	0	
Commercial end use	> 0	Not estimated

GHG Emissions

Sources of water heat were estimated as follows:

1. Approximately 1% of homes in Naramata have solar water heating.
2. By observing building footprints and natural gas supply lines on the RDOS GIS system it appears likely that about 2/3 of homes are supplied with natural gas.
3. It is assumed that the remaining homes use electricity to heat their water.

Table 5. Energy for water heating in Naramata

Heat Source	Proportion %	Emissions *t CO_2/kWh*	Price *$/kWh*
Natural Gas	66%	487	0.031
Electricity	33%	122	0.050
Solar	1%	183	0.026
Mixed		**364**	**0.052**

Table 6. Energy intensity and GHG emissions of Naramata water

Source of Energy	Used for	Amount of Water *ML/y*	Energy Intensity *kWh/ML*	GHG Emissions *g CO_2/kWh*	GHG Emissions *t CO_2/y*	GHG Offsets *$/y @$25/t*
Electricity	Supplying all water	1,995	1,135	122	276	6,900
Mixed	Heating indoor water	288	17,696	362	1,855	46,378

BC Hydro and FortisBC recently used $30/t in their strategic plans, on assuming that the final level of July 1, 2012 BC carbon tax would be applied equally to all carbon emission sources (6). However, Pacific Carbon Trust aims to be able to sell offsets for below $25/t (7). In this document we assume a middle value: $25/t.

References

1. **Feser, Perry.** Naramata water utility 2008 electricity consumption. [Excel worksheet]. Penticton : s.n., July 28, 2009.

2. **Clean Calgary Association Resources.** Indoor Water Use. *Clean Calgary Association Environmental Education, Products & Services.* [Online] [Cited: August 27, 2009.] http://cleancalgary.org/images/uploads/File/IndoorWaterUse.pdf.

3. **Aquacraft Inc. and AWWA.** Residential Water Use Summary. *aquacraft.com.* [Online] 1999. [Cited: August 31, 2009.] http://www.aquacraft.com/Publications/resident.html.

4. **DeOreo, William B. and Mayer, Peter W.** The end use of hot water in single family homes from flow trace analysis. *Aquacraft.com.* [Online] [Cited: August 31, 2009.] http://www.aquacraft.com/Download_Reports/DISAGGREGATED-HOT_WATER_USE.pdf.

5. **Wolff, Gary, Cohen, Ronnie and Nelson, Barry.** nrdc Energy Down the Drain - The Hidden Costs of California's Water Supply. *nrdc Natural Resources Defense Council - The Earth's Best Defense.* [Online] August 2008. [Cited: August 27, 2009.] http://www.nrdc.org/water/conservation/edrain/contents.asp.

6. **FortisBC.** *2009 Resource Plan.* Kelowna : FortisBC, 2009.

7. **Pacific Carbon Trust.** Pacific Carbon Trust Service Plan 2009/10 to 2011/12. *Pacific Carbon Trust.* [Online] September 2009. [Cited: October 5, 2009.] http://www.pacificcarbontrust.ca/Portals/0/PCT%20SP%20-%20update%20Sept%2009-aug25.pdf.

Appendix E: Naramata demand projections, population growth and climate change

Population Growth

Indoor water use is considered to be proportional to population. The growth rate may be as low as 0.4% based on the P.E.O.P.L.E. forecast for RDOS in the period 2009 to 2036 (1), but according to the official community plan Naramata has the capacity to grow at 1.5% per year until 2026 (2).

Density of New Development

In the water demand forecast, it is assumed that the ratios of commercial, institutional, single family dwelling and multi family dwelling accounts to each other will remain the same.

Depending on where it occurs, continued emphasis on low density development will have the impact of:

- removing Grade A Domestic from service due to subdivision of residential lots,
- removing Grade A Irrigation area from service by building on agricultural land, or
- adding to water demand by building on hillsides east of Naramata Road.

Residential expansion to hills east of Naramata Road would increase electricity consumption and pumping cost per ML of potable water. Development in the village would decrease these amounts.

Emphasis on higher density development would cause higher demand for indoor water, while removing less Grade A area. Average electricity consumption and cost per ML of potable water consumed would decrease. Significant high density development, such as on the Okanagan Tree Fruit property, could create pressure to construct a sewage treatment facility, which in turn could push the village in the direction of higher density development.

Changing Demographics

Age can have an impact on water demand projections (3). For Naramata, this is a minor factor because the projected shift in age distribution over the next 25 to 30 years is small.

The pattern of multi-modal age distribution will continue, with age peaks in RDOS forecast at approximately age 75, 48 and 16. In Naramata, the age 75 peak will likely be absent as the facilities to accommodate them and provide services are located elsewhere in RDOS. However, it is anticipated that Naramata will see a gradual shift toward a population of increasing age, fewer children and fewer people in each household (4).

Industrial, Commercial and Institutional Trends

In general, institutional, commercial and institutional water use is assumed to match growth. Water use at Naramata Elementary School will decline with declining enrolment. The fate of the Okanagan Tree Fruits property is not yet known.

Trends in Agriculture

In recent years there have been considerable decreases in agricultural water use. This can be attributed to replanting. There is a crop shift to grapes, which use less water per hectare. At the time of replanting the new irrigation system is usually more efficient by design, and new systems effectively remove old leaks and wastage, whether known or not.

There may be an increase in demand if some of the currently unused land comes into production. For instance if crop area increases from 64% to 100% of Grade A Irrigation area, there would be a 56% increase in crop area.

Upon request from RDOS, Pacific Agri-Food Research Centre (PARC) research scientists estimated crop water requirements for Naramata's historical conditions, and forecast the rate of increase due to climate change (5).

The estimates in the following tables consider only water requirements in a hot year with a high soil moisture deficit. In such a year, crops will need more water than usual, putting water supply, water conservation measures and drought response to the test.

The calculated irrigation requirement is shown for 2003 in Table 1. The 797 mm estimate for a high-use crop is very close to one calculated earlier for Summerland. Agua Consulting Inc. recently recommended an allotment of 800 mm (6) for Summerland, a level that provides enough water for a high-use crop in a year with a high soil moisture deficit.

Table 1. Irrigation demand estimates for hot year

Usage Level	Description	2003 Water Demand *mm*	Relative Amount
High	High-use crop with average practices	797	116%
Average	Existing crop mix with average practices	689	100%
Low	Existing crop mix with good practices	482	70%

As climate change continues, the calculated water requirements will increase. Nine scenarios for a high demand year in approximately 2060 are shown in Table 2. The values shown are calculated from the annual rate of increase, added to the 2003 demands from Table 1.

Table 2. Irrigation demand and climate change

Usage Level	Scenario	Demand Increase *mm/y*	High Demand Year c.2060 *mm*
High	High	2.24	925
	Mid	1.27	869
	Low	0.27	812
Average	High	2.24	817
	Mid	1.36	767
	Low	0.28	705
Low	High	1.53	669
	Mid	0.93	535
	Low	0.19	493

References

1. **BCSTATS.** Population Extrapolation for Organizational Planning with Less Error - Okanagan Similkameen. [Online] July 2009. [Cited: September 1, 2009.] http://www.bcstats.gov.bc.ca/data/pop/pop/popproj.asp.

2. **Regional District of Okanagan and Similkameen.** *Area 'E' Naramata Area Official Community Plan OCP Bylaw No 2458, 2008.* Penticton : Regional District of Okanagan and Similkameen, 2009. Official Community Plan.

3. **Edwards, Jennifer Wong and Susanne Porter-Bopp with Oliver M Brandes and Liam.** *Water Conservation Planning Guide for British Columbia's Communities.* Victoria : POLIS Project on Ecological Governance with the BC Ministry of Community Development, 2009. Guidebook. Accessed August 19, 2009 at http://www.obwb.ca/fileadmin/docs/water_conservation_planning_guide_v1.0.pdf.

4. **Regional District of Okanagan and Similkameen.** South Okanagan Regional Growth Strategy. *RGS Bylaw 2421, 2007 Schedule A, South Okanagan Regional Growth Strategy.* Penticton : Regional District of Okanagan and Similkameen, October 16, 2007.

5. **Neilsen, Denise and Losso, Estvan.** *Naramata irrigation demand and climate change.* [Electronic mail and excell worksheets] October 2009.

Appendix F:
Agricultural Land Use Inventory

Land use inventory conducted by MAL in 2006-2007.

Table 1. Cover areas of Naramata parcels with irrigation connections (ha)

Naramata Parcels with Irrigation Connections Cover Areas (ha)	***Not Stated***	***Sprinkler except micro***	***Micro - sprinkler***	***Drip and N.S. Trickle***	***Overtree and drip***	***Spray emitter***	***No irrigation***	***Cover Total***
Apples	-	48.21	2.45	24.22	-	11.80	-	86.68
Cherries	-	13.13	4.01	1.09	-	2.92	-	21.14
Pears	-	11.18	-	-	-	1.00	-	12.18
Other tree fruits, or N.S.	-	16.61	0.09	0.23	-	-	-	16.93
Grapes	-	44.02	-	20.58	1.97	-	-	66.57
Raspberries	-	0.32	-	-	-	-	-	0.32
Forage and pasture	-	9.46	-	0.57	-	-	-	10.03
Vegetables	0.35	-	-	-	-	-	-	0.35
Christmas trees	-	-	-	0.36	-	-	-	0.36
Other field crops, or N.S.	-	0.14	-	-	-	-	-	0.14
Abandoned or neglected farm	-	0.04	-	-	-	-	-	0.04
Changing agricultural use	-	6.59	-	-	-	2.05	0.98	9.61
Outdoor recreation	0.08	2.53	-	-	-	-	-	2.61
Buildings, yards, parking	43.03	1.25	-	-	-	-	-	44.27
Vegetated areas	90.72	-	-	-	-	-	-	90.72
Connected parcels not surveyed	30.03	-	-	-	-	-	-	30.03
Parcel area with connections	**164.21**	**153.49**	**6.55**	**47.04**	**1.97**	**17.77**	**0.98**	**392.00**
Irrigated area total								225.99

Table Error! No text of specified style in document.**2. Cover areas of Naramata parcels with irrigation connections (% of area)**

Naramata Parcels with Irrigation Connections Cover Areas (% of parcel)	***Not Stated***	***Sprinklers except micro***	***Micro sprinklers***	***Drip and N.S. Trickle***	***Overtree and drip***	***Spray emitter (e.g. microjet)***	***No irrigation***	***Cover Total***
Apples	0.0%	12.3%	0.6%	6.2%	0.0%	3.0%	0.0%	**22.1%**
Cherries	0.0%	3.3%	1.0%	0.3%	0.0%	0.7%	0.0%	**5.4%**
Pears	0.0%	2.9%	0.0%	0.0%	0.0%	0.3%	0.0%	**3.1%**
Other tree fruits, or N.S.	0.0%	4.2%	0.0%	0.1%	0.0%	0.0%	0.0%	**4.3%**
Grapes	0.0%	11.2%	0.0%	5.3%	0.5%	0.0%	0.0%	**17.0%**
Raspberries	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.1%**
Forage and pasture	0.0%	2.4%	0.0%	0.1%	0.0%	0.0%	0.0%	**2.6%**
Vegetables	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.1%**
Christmas trees	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	**0.1%**
Other field crops, or N.S.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
Abandoned or neglected farm	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
Changing agricultural use	0.0%	1.7%	0.0%	0.0%	0.0%	0.5%	0.2%	**2.5%**
Outdoor recreation	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.7%**
Buildings, yards, parking	11.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	**11.3%**
Vegetated areas	23.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**23.1%**
Connected parcels not surveyed	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**7.7%**
Parcel area with connections	**41.9%**	**39.2%**	**1.7%**	**12.0%**	**0.5%**	**4.5%**	**0.2%**	**100.0%**
Irrigated area total								57.7%

Appendix G
Review of Water Conservation Measures

This appendix is a comprehensive literature review of water conservation measures employed elsewhere and potentially available to be used in Naramata.

Water Meters

This measure affects both total use and peak demand.

Metering Source Water

Source water meters are necessary for ensuring appropriate levels of chlorination, and for reporting annual water use to the provincial government. It is also essential for water accounting purposes, which can be undertaken when connections are fully metered.

Metering Service Connections

Metering of service connections provides a tool for:

- Detecting leaks or other anomalous water consumption patterns during meter reading
- Calculating volumes applied as an adjunct to irrigation scheduling
- Volumetric pricing
- Allotting water during drought
- Designing water conservation programs and monitoring their effects

Water Free for Public Use

Water provided free of charge to the public should be metered and read at regular intervals. This allows accurate accounting for water. Lack of metering undermines loss control, costing and pricing, and other conservation measures.

Costing, Pricing and Allotments

This measure impacts both total use and peak demand.

Residential Pricing

Indoor residential demand is generally price-inelastic while outdoor demand is generally price-elastic.

Residential rates should be charged monthly as a connection charge plus a three or four tiered inclined block consumption charge. The connection charge should reflect the cost of managing the connection and the billing system. The first block should reflect lifeline water requirements for cooking, health and sanitation. A low priced first block makes some water available to everyone at a very reasonable price. The third block should reflect the marginal cost of water, and take into account the pressure that high water use places on ecosystems. Kelowna has neighbourhoods with very high users, and has a high priced high fourth tier, employed as a measure to discourage waste.

With the introduction of such a rate structure, the Grade A Domestic water category would be eliminated, as customers would be paying for water that flows through their connection. This would impact homeowners with large yards.

Industrial, Commercial and Institutional (ICI)

Institutional customer demand is generally price inelastic. (1)

ICI should be charged a fixed fee according to the diameter of the service connection. Consumption should be charged at a flat rate. An inclined block structure would discriminate against large customers. A decreasing block structure would deemphasize the importance of conservation.

Agriculture

Agriculture requires a secure supply of water, of suitable quality, provided at reasonable cost.

Okanagan Basin water utilities often have a single water system that meets demand for both irrigation and indoor requirements. Thus all of the water must be treated to meet stringent drinking water quality guidelines. In such communities where a large component of water consumption is used by agriculture there is a cost burden for that must be borne either by agriculture customers, who do not need the highest quality, or by potable water customers who do not use the water.

Fixed charge and allotment with high use penalties

This fee structure is composed of a high fixed fee per area accompanied by an allotment plus an increasing block fee for excess consumption. There is no consumption charge for water use that is within the allotment. OWSC recommends this option:

The increasing block rate is also an effective tool for agriculture, but must be used differently. Farmers require a certain amount of water to grow a marketable crop. Reducing water use below this point is not possible. The water allocated to the farm should be based on a higher water use crop with a sprinkler system. This will allow for changes in crop type and irrigation type to be accommodated. Farmers require a set price for the water required to grow the crop. However, where water use is in excess of the amount allocated, an increasing block rate can be used in an effort to reduce excessive use. (2)

OWSC recommends that an Agricultural Water Reserve be established, to link water budget requirements to land in the ALR and land zoned for agriculture (2). The allotment is determined in consultation with Agriculture and Agri-Food Canada and the MAL. It is enough water to meet the needs of a crop with high water requirements in a year with a large soil moisture deficit.

This rate structure was adopted by SEKID in 2000 and has been very successful. Rigorous analysis of water use from 1977 to 2004 showed that the pricing structure introduced in 2000 reduced water use significantly (3). After taking into account seasonal weather variation, water use declined by 40%. The authors were unable to discern any effect attributable to metering and education in the years preceding the new rate structure. However meter installation and education are viewed as necessary components of the program.

Shifts to drought tolerant crops and more efficient irrigation systems are possible confounding factors in the SEKID analysis, but they were not accounted for. Since 2003, Summerland and Naramata have also seen drops in water use without a change in rate structure. However it would be reasonable to expect further reductions in the neighbourhood of 15 to 25% as a result of the introduction of meters and volume based rates.

Allotment and increasing block

Israel's national water company, Mekorot (4), employs an increasing block price structure within an allotment of irrigation water. In 1996, their average water cost was US$310/ML, with 41% attributable to capital costs, 26% to fixed costs and 33% to variable costs. The blocks are divided at 50%, 80% and 100% of the allocation, and in 1996 were priced at US$150/ML, US$180/ML and US$210/ML respectively. Tertiary effluent charges are roughly equal to 95 to 100% of the first fresh water block. Secondary effluent charges are 80% of the first fresh water block. The government subsidizes about 18% of the cost and sets the irrigation fee structure. Shevah estimated that introducing this rate structure saved between 10% and 15%. (5)

Mekorot's variable costs were approximately US$102/ML, an order of magnitude that is similar to present day variable costs for providing treated drinking water for irrigation in Summerland and Naramata. There is however, an important difference between Israel and the Okanagan Valley in that the Okanagan communities have the option of substantially reducing variable costs by investing in system separation. Note that all the consumption charges were higher than the variable costs, ranging between US$120 and US$210 and comprise approximately half of a typical water bill.

Table 1. Partitioning Mekorot water costs

	Percent	**Cost** *US$/ML*
Capital Costs	41%	127
Fixed Costs	26%	81
Variable Costs	33%	102
Agriculture Subsidy	*-18%*	*- 56*
Total Water Costs	**100%**	**310**

Table 2. Mekorot irrigation block rates in 1996

Water Source	Portion of Allotment	Price *US$/ML*
Fresh Water	0-50%	$150
	51-80%	$180
	80-100%	$210
Tertiary Effluent	Low Season	$140
	High Season	$150
Secondary Effluent	Average Price	$120

Drought

With universal meters, a community can manage drought fairly by setting reduced allotments or tweaking the price structure. Some examples include:

1. Reduce the irrigation allotment. SEKID's water system was designed to provide 2.5 feet of irrigation. In 1998, facing a drought, the utility set an allotment of 2.25 feet, a 10% reduction. Ultimately, this became SEKID's normal allotment. (6)
2. Ration according to a percentage of historical use. Summerland greenhouse operators agreed to this principle, given that their needs are different from each other and from those of field crops, sports fields and parks.
3. Reduce the size of the price blocks, and / or increase the prices of all but the first block.
4. Restrict residential use to lifeline volumes. In the case of a severe drought, water can be restricted to lifeline volumes, either per connection or per person.

Water Accounting and Loss Control

This measure targets water losses on the supply side. It provides a basis to develop a strategy to control losses over time. Water utilities should repair known leaks and have a protocol for detection.

Agricultural Land Cover Tracking

MAL conducted land cover inventories in 2006 and 2007. These data are used to assist with basin wide programs such as agricultural water demand modelling for predicting the effects of climate change and estimating suitable volume allotments. RDOS has the results of this survey and can use it to help estimate agricultural water requirements at the purveyor level. A purveyor can track changes in the mix of crops and irrigation systems by conducting the same type of survey every five years.

Water Accounting

With universal meters installed, comprehensive water accounting can be used to help design water conservation programs.

Leak Detection and Repair

Canadian municipal purveyors have system losses that average 13%. Systematic leak detection and repair could reduce these losses to 5%.

Information and Education

Information and education programs can impact both total and peak day water consumption.

Understandable and Informative Water Bill

Customers should be able to read and understand their water bill. The bill should identify volume of usage, rates and charges, and other relevant information.

Comparisons to previous bills can provide information to customers about their water use and help them to make informed choices. This type of information would be particularly useful during the first few years after meters have been installed.

Passive Information Sources

Purveyors can supply basic information about water conservation at all times, and help to channel information about individual programs to water customers. The required investment is small compared to larger education initiatives.

Water purveyors in the Okanagan Valley have access to a twice yearly newsletter that can be sent with the bill to water customers or distributed via unaddressed mail.

A water conservation web page supports water conservation initiatives and provides links to additional information.

Water Ambassador

In 1997, Durham, Ontario tested different methods of community based social marketing. The most successful one employed summer students, who were able to achieve a 26% reduction in residential watering. The program cost $88 per household. (7)

In Penticton, water ambassadors have been used each summer since 2004. The lowest MDD since then occurred in 2009, even though the lowest soil moisture deficit was in 2004. The water ambassador program ran concurrently with others that would also impact MDD, so it was difficult to confirm the contribution made by the water ambassadors to the overall water use reductions. (8)

Schools

Virescens Environmental Impact Management Inc (9) prepared a 'Sustainability Suitcase' series of interactive exhibits that can be used in a classroom setting for the Greater Vancouver Regional District. The kit is suitable for grades 5 thru 12.

Xeriscape Education

The community of West Bench is seeking funding to develop methods for xeriscaping large residential lots and for teaching them to homeowners. The size of the lots poses a particular challenge because many are not farmed, but to landscape entirely with nursery raised stock would be too expensive. The land cover that is selected has implications for water consumption, erosion control, terrain stability and scenic value. Although this is an important objective for West Bench, these types of parcels exist in neighbouring municipalities also.

Okanagan Irrigation Management (OKIM)

OKIM is web based software that provides meaningful water use information to purveyors with agricultural meters, and their customers. It combines data from

The OKIM website is designed for agricultural property landowners within the Greater Vernon Services and the District of Summerland to obtain information on metered water use, calculated theoretical water demand, and land use data for their properties (10). Water purveyors that have water meters installed can subscribe to this service. Glenmore Ellison Improvement District joined the program in 2009.

Irrigation Education

A series of calculators can be found at www.irrigationbc.com to help with irrigation scheduling in response to weather. They include one for landscape, one for agriculture, and one for calculating evapotranspiration. There is also a soil calculator for calculating accurate soil water holding capacity when soil test results are available.

MAL has engineers and agrologists available to teach irrigation scheduling courses. In spring 2009 Summerland hosted the first such course that included instruction on the use of the agriculture irrigation calculator. Ideally a course should be offered regularly in the off season. Classes can be kept full if neighbouring purveyors, packinghouses and MAL cooperate in putting them on.

One criticism of the Summerland course was that it contained plenty of scheduling theory, but that farmers also need to learn the importance of and see some system components, such as flow control valves, pressure reducing valves, backflow preventers, filters and so on.

Bylaws

Enforcement of Existing Bylaws

Enforcement of existing bylaws can be very effective for saving water. Naramata recently had a favourable experience with respect to bylaw enforcement. In February 2009, Public Works sent a notice to remind all irrigators of a bylaw that flow control devices were required. Early in the irrigation season, each connection was inspected for confirmation. As a result there was a 21% reduction in peak day (2009 vs average peak day of 2003-2008).

Summerland is considering a volume allotment of approximately 800 mm (11). In 2008, it was found that 9% of metered agricultural water use was in excess of this amount. Site inspections of the users who were at least 50% over the proposed allotment revealed serious problems with the condition of the irrigation systems, and in some cases, scheduling problems with sprinkler systems. Without a new allotment and rate structure in place, the municipality enforced its existing bylaw prohibiting the waste of water, sending warning letters to the twenty highest users. Theoretically there would be at least a 9% water saving as a result of this measure.

Building Code

Part 10 of the building code provides standards for energy and water efficient fixtures in construction (12). Flow rates for faucets, showerheads, water closets and urinals are included. Gray water reuse systems may be included in the code a later date.

Landscape and Irrigation Standards

In Kelowna, landscape irrigation drives peak demand and is biggest consumptive use of domestic water. The city plans to introduce a landscape standards bylaw that promotes water saving practices in landscaping, including use of certified irrigation designers, and minimum topsoil depth. The bylaw will address outdoor water use challenges that were identified early in their Get Water Smart program. They included:

Naramata Water Conservation Plan

1. Low soil water storage capacity
2. Poor lawn care practices
3. Landscaping not suited to climate
4. Poorly installed and maintained irrigation systems

With a 2008 Water Conservation and Quality Improvement grant, Kelowna began work to set landscape and irrigation standards. They should address water efficiency by ensuring that all new landscapes use less water than traditional landscapes, and that all newly installed irrigation systems meet minimum requirements for water efficiency. (13)

The procedure would look something like this:

1. A developer obtains a development permit to build a subdivision
2. The developer would be responsible to provide a landscape and irrigation plan that follows the pre-determined guidelines for public spaces such as parks and boulevards.
3. A contractor building homes in the subdivision would be responsible to provide landscape and irrigation plans for individual homes.
4. In each of these cases, they must submit plans when applying for a building permit.
5. A certified landscaper and a certified irrigation designer would sign off the plans before the municipality issues a building permit.
6. The properties would be subject to inspection to ensure developers actually followed the standards and guidelines.

Rebates and Retrofits

Retrofits can be conducted successfully as part of a community wide program of 100% replacement, or as part of a program of water conservation education and publicity.

Community Toilet Retrofits

When faced with expansion or upgrading of sewage treatment facilities, a community can mandate toilet replacements, allowing them to reduce and defer capital costs. Toilet replacement costs much less than expansion of tertiary treatment facilities.

Toilet flushing accounts for roughly 28% of indoor water use (14) (15). The simple act of replacing 19 L toilets with 6 L toilets can result in indoor water savings of about 20%. There is potential for the savings to be greater because replacing the equipment can also eliminate leaks due to worn flappers.

Metering and Retrofits

Indoor retrofits can be performed by qualified people at the time installation of water meters or water saving toilets. This minimizes the inconvenience to customers of having municipal employees or installation contractors in their house more than once within the space of a few years.

Indoor Conservation Retrofit Kits

As part of a water ambassador program, water conservation kits can be offered to homeowners, at a cost of about $15 per kit. Many of the items in the kits impact hot water consumption, in which case there is potential to reduce energy bills for homeowners and reduce greenhouse gas emissions. Kit components may include:

- Shower timer
- Faucet flow restrictors
- Low flow showerheads
- Dye tablets for detecting toilet tank leaks

Toilet Exchange Rebate

As previously noted, replacing existing toilets has the potential to reduce indoor water use by 20%. A toilet exchange rebate program can be used to promote water conservation while offering a material benefit to the customer. It can result in significant reductions in sewage treatment costs, or in the case of Naramata, reductions in demands placed on septic tanks and seepage fields.

Front Loading Washer Rebate

Washing clothes accounts for 21% of indoor water use (14) (15). Front loading washers cost $380 more than toploading washers with comparable options but they have the following advantages:

- They use 40% less electricity
- They use 35% less water
- Drying time would likely be reduced by at least 25% (16)
- They do not have an agitator, so clothes would last longer (16)
- Customer energy bills would likely decrease by $11 per person per year. At Penticton water rates, the customer would save $5 per person per year from reduced water consumption.

Switching to a front loading washer would reduce indoor water use by about 7%. This amount is smaller than what can be accomplished by toilet replacement, but when they are compared as two rebate programs competing for funding, the following should be considered:

- There is usually only one washing machine per household, but many homes have more than one toilet.
- Front loading washers offer environmental benefits other than water savings, because they are associated with reductions in power consumption and GHG emissions.

Turf Some Turf

In 2007, a small group of merchants and the District of Summerland introduced a turf removal program. The merchants offered discounts for water saving landscaping supplies and services, such as landscape design, Xeriscaping plants, drip irrigation equipment and hardscaping (e.g. concrete) products. The municipality contributed recreation passes, discounts for municipal compost, and priority access to municipal compost. The program was administered by a xeriscape nursery. The main cost to the municipality was joint participation in the advertising campaign. For the merchants, it served as a positive way to promote their products. Eighteen homeowners took advantage of the program, which accounts for at least 800 square metres of removed turf, with less than $300 spent by the municipality.

The Southern Nevada Water Authority offers rebates of US$1.50/ft^2 on the first 5,000 square feet (17), or about $17/m^2 in Canadian dollars, to convert from turf to desert landscaping.

1 Bibliography

1. **American Water Works Association.** *Principles of Water Rates, Fees and Charges .* AWWA Manual M1, 5th Edition. Denver : American Water Works Assocation, 2000.

2. **Okanagan Water Stewardship Council.** *Okanagan Sustainable Water Strategy.* s.l. : Okanagan Basin Water Board, 2008. Action Plan.

3. **Pike, Toby, et al.** Does Pricing Water Reduce Agricultural Demand? An Example from British Columbia. *SEKID.* [Online] March 2007. [Cited: September 9, 2009.] http://www.sekid.ca/pdf/reports/SEKID%20PRI%20Brief.pdf.

4. **Mekorot.** *Mekorot, Israel's National Water Company.* [Online] http://www.mekorot.co.il/Eng/Pages/default.aspx.

5. **Shevah, Yehuda.** Irrigation and Agriculture Experience and Options in Israel. *The World Commission on Dams.* [Online] 2000. [Cited: September 10, 2009.] http://www.dams.org/docs/kbase/contrib/opt159.pdf.

6. **Nyvall, Janine and Van der Gulik, Ted.** *South East Kelowna Irrigation District Demand Management Project.* Resource Management Branch, BC Ministry of Agriculture, Food and Fisheries. Abbotsford : s.n., 2000.

7. **Pleasance, Glen.** Water Efficiency Durham. *Fostering Sustainable Behaviour - Community Based Social Marketing.* [Online] [Cited: September 14, 2009.] http://www.cbsm.com/cases/water+efficiency+durham_165.

8. **Stewart, Carolyn.** Email re water ambassadors and peak day. Penticton : s.n., September 15, 2009.

9. **Virescens Environmental Impact Management Inc.** *Passion for Action.* [Online] [Cited: September 14, 2009.] http://www.passion4action.com.

10. OKIM - Okanagan Irrigation Management. *OKIM.* [Online] 2008. [Cited: September 14, 2009.] http://www.okim.ca.

11. **Agua Consulting Inc.** 2008 Draft Water Master Plan and Financial Review. *The District of Summerland Municipal Web Site.* [Online] August 29, 2008. [Cited: September 10, 2009.] http://www.summerland.ca/Local%20Projects/Summerland_Draft/401_Main_Report.pdf.

12. **BC Ministry of Forests and Range and Minister Responsible for Housing.** Part 10 - Energy and Water Efficiency. *British Columbia Building Code 2006.* Revised 2008.

13. **Degen, Don.** City of Kelowna Landscape and Irrigation Standards for Water Efficiency. *Okanagan Basin Water Board.* [Online] 2008. [Cited: January 15, 2010.] http://www.obwb.ca/fileadmin/docs/090106_kelowna_landscape.pdf.

14. **Aquacraft Inc. and AWWA.** Residential Water Use Summary. *aquacraft.com.* [Online] 1999. [Cited: August 31, 2009.] http://www.aquacraft.com/Publications/resident.html.

15. **Clean Calgary Association Resources.** Indoor Water Use. *Clean Calgary Association Environmental Education, Products & Services.* [Online] [Cited: August 27, 2009.] http://cleancalgary.org/images/uploads/File/IndoorWaterUse.pdf.

16. **Sears Canada - Penticton.** Telephone interview with appliance department. Penticton : s.n., December 3, 2009.

17. **Southern Nevada Water Authority.** Water Smart Landscapes Rebate. *SNWA Official Web Site.* [Online] 2008. [Cited: January 15, 2010.] http://www.snwa.com/html/cons_wsl.html.

Appendix H
Irrigation Conservation Measures

Information about irrigation conservation measures was collated from three sources: personal experience, literature reviews and in local trials. The following summarizes the irrigation conservation information that was used to help prepare the Naramata Water Conservation Plan.

Farmers who were known to be trying various methods of irrigation scheduling were interviewed for feedback on how these methods were working for them. Barriers were identified, and some solutions are offered here.

Work on the Naramata project began in June, and three water meters were installed in July. The season was progressing, so there were limits to the usefulness of the data that were collected. Seven Naramata irrigators were asked to adopt one irrigation scheduling method, and give it a try for the remainder of the season. There were supplied with educational materials and equipment. Three farms had water meters installed. Farmers were interviewed as the season progressed or at the end in order to identify the usefulness of the techniques and barriers to their use.

Irrigation District Bylaws

Flow rate

Irrigation districts in this region typically have a bylaw that governs flow rates that irrigation customers may draw, and require the installation of flow control valves. Flow control allowed economical water system construction while ensuring that all customers have access to the water that they need.

Recently it has been found that enforcing existing flow rate bylaws remains a useful tool for managing peak demand. In February 2009, RDOS Public Works sent a notice to remind all Naramata irrigators of a bylaw that flow control devices were required. Early in the irrigation season, each connection was inspected for confirmation. As a result, there was a 21% reduction in peak day (2009 vs. average peak day of 2003-2008).

Waste of water

Water bylaws typically prohibit the waste of water. Since most irrigation occurs outdoors, there can be opportunities to observe instances of water waste, and water purveyors are empowered to take action. However, without water meters most water waste can go undetected. Often enforcement is done in response to a complaint, and is more likely to occur in the more visible areas while being ignored on parcels located on back roads. Installation of irrigation water meters allows this type of bylaw to be applied more equitably.

Farm Practices Protection (Right to Farm) Act

Irrigation covered by BC Farm Practices Protection Act. Farmers' rights and responsibilities are discussed in a MAL interpretation bulletin.

Irrigation equipment may operate 24 hours a day during the crop-growing season. The amount of water applied should not exceed the climatic moisture deficit or an amount that can be stored by the soil within the crop rooting depth. Irrigation systems should be designed and operated in accordance with the BC Sprinkler Irrigation Manual or the BC Trickle Irrigation Manual. Irrigation water should be applied only to the target area. Part circle sprinklers, shields or other devices should be used to ensure irrigation spray does not strike public roads, power lines or other non-target areas. (1)

The preceding paragraph defines limits to irrigating. It should not exceed the climatic moisture deficit or the amount that can be stored in the soil within the root zone. With the benefit of water meters, purveyors could use this paragraph to help them define water waste.

Farms may use their irrigation connections to supply water for irrigation, frost protection, crop cooling and chemigation, if the total water use does not exceed their volume allotment.

Certified Irrigation Professionals

Efficient irrigation starts with a well-designed irrigation system.

The Irrigation Industry Association of British Columbia certifies irrigation system designers (CIDs). Employing their services provides assurance that irrigation systems are designed to conform to irrigation district bylaws and will operate efficiently. Irrigation districts should maintain a list of CIDs in their area, and make them available to their water customers.

Barriers

- None

System Maintenance

After installation, there is potential for an irrigation system to lose efficiency if it is not well maintained. Emitters and sprinkler nozzles should be checked for plugging. Filters should be kept clean. Nozzles should be checked for wear and periodically replaced.

Barriers

- There may be little incentive to keep old plantings in top condition shape. This can be a particular problem in the case of leasing out.
- Without water meters most parcels with leaks or inefficient irrigation will be missed.

Overcoming Barriers

- Install irrigation water meters, and follow up with OKIM and the automatic leak detection afforded by some water meter configurations.

Irrigation Water Meters

Agriculture requires a secure supply of water, of suitable quality, provided at reasonable cost.

Okanagan Basin water utilities often have a single water system that meets demand for both irrigation and indoor requirements. Thus, all of the water must be treated to meet stringent drinking water quality guidelines. In such communities where a large component of water consumption is used by agriculture there is a cost burden for that must be borne either by agriculture customers, who do not need the quality, or by potable water customers who do not use the water.

S.E.K.I.D.'s rate structure

This fee structure is composed of a high fixed fee per area accompanied by an allotment plus an increasing block fee for excess consumption. There is no consumption charge for water used within the allotment. OWSC recommends this option:

The increasing block rate is also an effective tool for agriculture, but must be used differently. Farmers require a certain amount of water to grow a marketable crop. Reducing water use below this point is not possible. The water allocated to the farm should be based on a higher water use crop with a sprinkler system. This will allow for changes in crop type and irrigation type to be accommodated. Farmers require a set price for the water required to grow the crop. However, where water use is in excess of the amount allocated, an increasing block rate can be used in an effort to reduce excessive use. (2)

OWSC recommends that an Agricultural Water Reserve be established, to link water budget requirements to land in the ALR and land zoned for agriculture (2). The allotment is determined in consultation with Agriculture and Agri-Food Canada and the MAL. It is enough water to meet the needs of a crop with high water requirements in a year with a large soil moisture deficit.

This rate structure was adopted by SEKID in 2000 and has been very successful. Rigorous analysis of water use from 1977 to 2004 showed that the pricing structure introduced in 2000 reduced water use significantly (3). After taking into account seasonal weather variation water use declined by 40%. The authors were unable to discern any effect attributable to metering and education in the years preceding the new rate structure. However meter installation and education are viewed as necessary components of the program.

Shifts to drought tolerant crops and more efficient irrigation systems are possible confounding factors in the SEKID analysis, but they were not accounted for. Since 2003, Summerland and Naramata have also seen drops in water use without a change in rate structure. However it would be reasonable to expect further reductions in the neighbourhood of 15 to 25% as a result of the introduction of meters and volume based rates.

Mekorot's rate structure

Israel's national water company, Mekorot (4) employs an increasing block price structure within an allotment of irrigation water. In 1996, their average water cost was US$310/ML, with 41% attributable to capital costs, 26% to fixed costs and 33% to variable costs. The blocks are divided at 50%, 80% and 100% of the allocation, and in 1996 were priced at US$150/ML, US$180/ML and US$210/ML respectively. Tertiary effluent charges are roughly equal to 95 to 100% of the first fresh water block. Secondary effluent charges are 80% of the first fresh water block. The government subsidizes about 18% of the cost and sets the irrigation fee structure. Shevah estimated that introducing this rate structure saved between 10% and 15%. (5)

Mekorot's variable costs were approximately US$102/ML, an order of magnitude that is similar to present day variable costs for providing treated drinking water for irrigation in Summerland and Naramata. There is however, an important difference between Israel and the Okanagan Valley in that the Okanagan communities have the option of substantially reducing variable costs by investing in system separation. Note that all the consumption charges were higher than the variable costs, ranging between US$120 and US$210 and comprise approximately half of a typical water bill.

Table 1. Partitioning Mekorot water costs

	Percent	**Cost** *US$/ML*
Capital Costs	41%	127
Fixed Costs	26%	81
Variable Costs	33%	102
Agriculture Subsidy	*-18%*	*- 56*
Total Water Costs	**100%**	**310**

Table 2. Mekorot irrigation block rates in 1996

Water Source	**Portion of Allotment**	**Price** *US$/ML*
Fresh Water	0-50%	$150
	51-80%	$180
	80-100%	$210
Tertiary Effluent	Low Season	$140
	High Season	$150
Secondary Effluent	Average Price	$120

Irrigation Scheduling Workshop

In March 2009, the District of Summerland hosted a one day irrigation scheduling workshop that presented information for scheduling according to weather or according to soil moisture content. It included the introduction of a new agricultural irrigation calculator located at www.irrigationbc.com.

Barriers

- One interviewee found it too technical, was lost in the mathematics, and wanted basic hands-on information.
- Many interviewees had not actually tried to use any of the methods taught.
- Some who tried to use the calculator were lost when they got to it at home.

Overcoming Barriers

- Maintain the technical workshop, offering it at regular intervals in the Okanagan Valley but offer a second type of workshop or field day that focuses more on the equipment and less on the mathematics.

- Attending the workshop does not necessarily translate to action. Follow up, possibly several times, e.g. with field days to demonstrate how to collect site data.
- Train horticultural field service personnel, so that they can in turn assist their clients.

Agricultural Irrigation Calculator

MAL launched this web-based irrigation-scheduling calculator early in 2009. The irrigator supplies data about the crop, irrigation system and soil type to a database, chooses a weather station, and is then able to conveniently schedule irrigation.

Barriers

- Many Naramata farmers are resistant to irrigating according to weather because soil variation requires close site monitoring anyway.
- Some farmers have the ability to work with computers and this program, but believe that their time is better spent in their plantings, and observing and making decisions there.
- There is limited documentation at the website.
- While the calculator seems accurate for sprinkler irrigation, it overestimates the requirements for drip-irrigated perennials.

Overcoming Barriers

- Continue to promote and teach the use of the calculator.
- The instructor should work with farmers and horticulturists in the field to help increase comfort with the software.
- A solution is needed for the 'over-irrigation' of drip irrigated perennials. Perhaps in future versions of the calculator, canopy size and field coverage can be taken into account. In the meantime, farmers or their horticultural consultants must estimate canopy and or field coverage factors on their own, and schedule according.

Weather Station

It would cost about $5,000 to set up a weather station suitable for the Farmwest network, and hundreds of dollars to operate. The nearest weather stations now on the network are located in Summerland and Penticton.

Barriers

- Cost relative to projected use.

- Thus far, few Naramata fruit growers are receptive to the idea of irrigating according to weather station data.

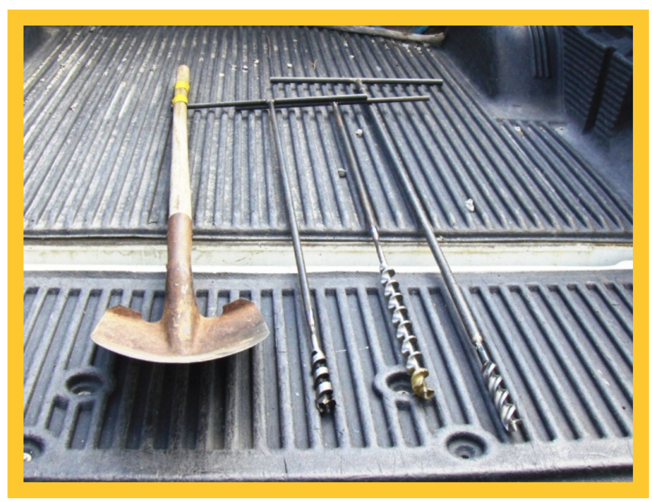
Overcoming Barriers

- Share costs with other potential partners. The horticultural field service may want to use a weather station as an aid to pest management, e.g. predicting apple scab infection periods or apple codling moth hatches.
- The presence of a Farmwest weather station in Naramata would increase the likelihood that Naramata farmers will adopt weather based irrigation scheduling.

Checking the Soil

Visual inspection of the soil profile can be used to assess the need to irrigate (6). It can be done with a spade or an auger. The method is easy to teach, and can be used by anyone regardless of whether or not they are also using more technical methods.

An Eijkelkamp soil auger can be purchased for about $100. It is lightweight and the 'combination' type is effective in a variety of soil textures, allowing operators to auger the full rooting depth relatively quickly. Other bits are available that are more effective in specific soils, including clay, sand, coarse sand and stony soils.



Or farmers can make their own augers from wood auger bits. They can be acquired for about $25, and have T handles welded onto them for about $15. Summerland and Naramata farmers tested three models of commercially available wood auger bits. In addition, two Summerland farmers have made their own soil augers from old wood auger bits. A 7/8" wood auger is a perfect size for installing Irrometers and WaterMark sensors.

Barriers

- The open wood auger bits were more effective at getting deep than were the closed ones.
- Battery powered drills with wood auger bits worked very quickly, but only went as deep as the length allowed.

- The combination type Eijkelkamp auger worked more quickly than the T-handled wood auger bits.
- After one season, most who had acquired a wood auger bit had not used it by the end of the irrigation season.

Overcoming Barriers

- Field service and orchardists suggested that it would be a good idea for the field service or the irrigation district to lend out augers for soil moisture monitoring, installing soil moisture sensors, or sampling soils for laboratory analysis.
- An extension welded onto a wood auger bit could be used with a battery-powered drill to get deeper into the soil.

Soil Moisture Sensors

In the 2009 Naramata project, soil moisture sensors were found to be very useful for testing the accuracy of the agricultural irrigation calculator.

Irrometers

Irrometers offer a relatively inexpensive (approximately $90) and relatively reliable method of measuring soil moisture tension. Soil moisture tension and soil moisture content are related, and there is a different response curve for each soil texture. The instrument is essentially a tube of distilled water with a tension gauge and a porous ceramic tip in contact with the soil.

WaterMarks

WaterMark sensors measure electrical resistance. As the soil dries out it becomes more difficult for electricity to pass through the fabric of the sensor and the resistance increases. The WaterMark meter uses the electrical reading and the estimated soil temperature to predict soil moisture tension. The sensors are inexpensive at $35 each but the meter costs about $350. The WaterMarks become more economical than irrometers when there are more than six sensors in use.

Barriers

- Sensors need good contact with the soil or the readings will be inaccurate.
- Irrometers are not suitable for fine textured soils, because the range is too small.
- Irrometers can freeze. They must be removed each fall and reinstalled the next year.
- WaterMark meters require regular calibration because measurements are affected by temperature.
- Unlike augers and other tools that allow inspection of the soil, the soil moisture sensors must remain in place. They would be either less useful or more expensive to use when dealing with variations in soil texture, crops, irrigation systems or with several parcels.

Overcoming Barriers

- An outdoor workshop would be a useful method for demonstrating installation, taking readings, and maintaining soil moisture sensors.

Irrigation Timers

- Timers are often installed with new systems. Most drip and overhead cooling systems have them.
- Irrigation timers allow you to make more precise irrigation sets, and use your time more efficiently.

Barriers

- Retrofitting electrical control valves can be expensive if the tees to individual zones are spread out in the field. This is the usual situation for older plantings.

- It may be difficult to justify making this improvement to an older planting especially if it is on a leased parcel

Overcoming Barriers

- Offer a rebate for purchase of a battery powered irrigation timer and electrical control valve on the main.

Barriers: a comprehensive list

Barrier	Recommended Response
Motivation	• Volume based rate structure • OKIM • Bylaw enforcement • Retrofit rebates • Follow-ups to education
Knowledge	• Workshops, field days, literature, web links
Comfort with technology	• Offer low tech alternatives • Workshops, field days, literature, web links • Train field horticulturists
Variable soils	• Promote the use of CIDs and zoning irrigation according to soil types • Promote a variety of scheduling methods
Undetected losses	• Install irrigation water meters with the capability to detect potential leaks
Requires capital investment on a planting with short lifespan remaining	• Install irrigation water meters with the capability to detect potential leaks • Retrofit rebates

Proposed Program

- Irrigation water meters
- Monthly readings, with leak and backflow indicators
- Investigate the potential for Okanagan Irrigation Management software
- Investigate the potential for partnerships in establishing and maintaining a Farmwest-compatible weather station
- Volume based rate structure that rewards water conserving measures

- Education program that includes:
  - Winter workshops and irrigation season field days, conducted in cooperation with neighbouring irrigation purveyors, tree fruit field service and wineries
  - Field days to train horticultural consultants
  - Web page with links to irrigation calculators, farmwest.com, MAL PDFs, and other sources of irrigation information
- Consider offering rebates for purchase of water saving equipment such as irrigation timers, or soil moisture sensors

Bibliography

1. **BC Ministry of Agriculture Food and Fisheries.** Farm Practices - Irrigation. *Agriculture and Lands - Province of British Columbia.* [Online] January 2004. [Cited: January 22, 2010.] http://www.agf.gov.bc.ca/resmgmt/fppa/refguide/activity/870218-40_Irrigation.pdf.

2. **Okanagan Water Stewardship Council.** *Okanagan Sustainable Water Strategy.* s.l. : Okanagan Basin Water Board, 2008. Action Plan.

3. **Pike, Toby, et al.** Does Pricing Water Reduce Agricultural Demand? An Example from British Columbia. *SEKID.* [Online] March 2007. [Cited: September 9, 2009.] http://www.sekid.ca/pdf/reports/SEKID%20PRI%20Brief.pdf.

4. **Mekorot.** *Mekorot, Israel's National Water Company.* [Online] http://www.mekorot.co.il/Eng/Pages/default.aspx.

5. **Shevah, Yehuda.** Irrigation and Agriculture Experience and Options in Israel. *The World Commission on Dams.* [Online] 2000. [Cited: September 10, 2009.] http://www.dams.org/docs/kbase/contrib/opt159.pdf.

6. **van der Gulik, Ted.** Irrigation Scheduling Techniques. *Agriculture and Lands - Province of British Columbia.* [Online] May 2006. [Cited: December 18, 2009.] http://www.agf.gov.bc.ca/resmgmt/publist/500Series/577100-1.pdf.

6. **Agua Consulting Inc.** 2008 Draft Water Master Plan and Financial Review. *The District of Summerland Municipal Web Site.* [Online] August 29, 2008. [Cited: September 10, 2009.] http://www.summerland.ca/Local%20Projects/Summerland_Draft/401_Main_Report.pdf.