FINAL REPORT

TREPANIER LANDSCAPE UNIT WATER MANAGEMENT PLAN

EXECUTIVE SUMMARY

Prepared for:

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Introduction and objectives:
The Trepanier Landscape Unit (TLU) water management plan was initiated by the B.C. Ministry of Sustainable Resource Management (MSRM) and the Regional District of Central Okanagan (RDCO). The Trepanier area was chosen because it is known to be relatively dry with a range of water users and growing pressures on the water resource. The objectives of the project were to conduct technical analyses and provide both practical tools and strategic direction to provincial and local planning agencies to incorporate sound water management decisions into land-use planning within the TLU. In particular, RDCO will be able to incorporate technical recommendations into Official Community Plans and servicing policies that will in turn guide land use decisions. The ability of MSRM to implement the objectives and strategies of the Okanagan-Shuswap Land and Resource Management Plan (LRMP) in the TLU will be increased, and MSRM will be able to identify water-related economic constraints and opportunities in the TLU.

Overview:
The study included analysis of current water conditions in the TLU, and of conditions expected in 2020 and 2050. The analyses of current conditions required significantly more effort than was originally envisioned, because of the state of the available information. This report makes several recommendations to address data shortcomings for planning purposes. Analyses of conditions in 2020 and 2050 were based on trends in population as well as the predicted effects of climate change. The analyses conclude that expansion of water supply from streams, unless supported by storage, is not environmentally sustainable, nor does it permit population and economic growth to occur as planned. Failure to reduce rates of water use or seek alternative water sources will either constrain economic growth or impair environmental resource values, or both. The report makes several detailed recommendations for improved water management in the TLU, including creation of a leadership group that will champion the cause of improved water management and encourage adoption and implementation of the recommendations.

The study was led by a Steering Committee comprised of MSRM, RDCO, Land and Water B.C. (LWBC) and the Ministry of Water, Land, and Air Protection (MWLAP). Technical advice was provided by a "Technical Advisory Working Group" (referred to in the report as the TAWG). The main report (Volumes 1 and 2) provides details of the technical studies and of several recommendations for improved water management. This Executive Summary highlights the key points. Technical terms are defined in a Glossary at the end of the main report (Volume 1).

Population and land use:
The TLU covers 990 km^2 (Figure 1), including five major watersheds on the west side of Okanagan Lake (Lambly, McDougall, Powers, Trepanier, and Peachland Creeks). Land use includes forestry, mining, agriculture (range, vineyards, orchards, pasture, and crops), recreation, and urban (commercial, industrial, and residential). The bulk of the land base is managed by the provincial crown. Private lands include one small municipality (Peachland), a First Nation community (Westbank I.R. #9 and I.R. #10), and the largest rural unincorporated area in B.C. Commercial and industrial operations include a nursery, two wineries, retail malls, an industrial

park, several aggregate operations, and many small businesses. There are 982 ha of intensive agriculture in the TLU, much of which is irrigated. The population has doubled in the past 20 years to 36,366, and is expected to increase by 65% in the next 20 years.

Climate, surface water hydrology, and groundwater hydrology:
The area is relatively dry, with annual precipitation (total of rain and snow) averaging about 600 mm. Flows in the creeks rise in the spring as the winter snowpack melts, then decrease over summer to reach low levels in late summer, and flows stay low through the fall and winter. Streamflows are highly variable from year to year – the driest year in an average five-year period has only two-thirds of the runoff of an average year.

Flows in all five principal streams in the TLU have been altered by human intervention – largely by the construction and operation of reservoirs to regulate flow for water supply purposes. In this report, we have utilized estimates of "naturalized" flows at 14 locations (Figure 2) in the TLU (a "naturalized" flow is an estimate of a natural flow, i.e. of a flow that would exist if storage reservoirs didn't capture any water and water intakes did not operate). On an annual basis, current average annual flows (referred to in the report as "net" flows) at the mouths of the major creeks are 13% smaller than the "naturalized" flows, due to water removals for offstream use, as shown in Table 1. Offstream use means that the water is removed from a stream for human use. Although current flows are only 13% smaller than naturalized flows, water licences for offstream use that are already issued account for (on average) 28% of the naturalized flow in the TLU, as shown in Table 2. The amount of offstream use that is supported by storage varies widely, as shown in Table 2.

There is very little information on groundwater conditions or use in the TLU. Six large aquifers have been identified, all located in the vicinity of Westbank. There are likely additional, smaller aquifers in the upland area of the TLU that have not yet been identified. Detailed assessments of aquifer size and extent, aquifer yield and aquifer use are not possible due to a lack of basic hydrogeological information. Maximum groundwater extraction rates in the TLU are currently estimated at 400 L/s (i.e. 0.4 m^3/s, or 12.6 million m^3 per year), which is approximately equal to the estimated average annual recharge rate from precipitation. There is likely additional room to develop groundwater resources.

Water supply systems, water use, and water pricing:
Water service delivery is managed by four major utilities (Westbank and Lakeview Irrigation Districts, Peachland, and Westbank First Nation), and 16 small utilities (Figure 3). Water licences have been issued for the withdrawal of 53.674 million m^3 per year from 184 streams and waterbodies in the TLU (including Okanagan Lake). Actual annual offstream water use is estimated to be 24.554 million m^3 (i.e. about 46% of the licensed amount). Storage licences have been issued for 36.098 million m^3, of which 28.950 million m^3 is actually utilized. Two-thirds of the water used in the TLU is obtained from surface streams, of which 90% is obtained from the five major streams. Approximately 30% of the total water used is pumped from Okanagan Lake, and the remaining 4% is obtained from groundwater wells.

The residential water use rate in the TLU is 789 litres per person per day (year-round average), which is very high - more than double the Canadian average, and almost double the B.C.

average. In Kelowna and Vernon, water use rates are 550 to 600 L per person per day – above the B.C. average but 30% less than in the TLU. Prior to implementation of demand management measures, use rates in Kelowna and Vernon were similar to those in the TLU. Approximately 41% of the total water used in the TLU is used for residential purposes, 20% is used for commercial/industrial purposes, and 34% is used for agriculture (including golf courses). The final 5% is accounted for by distribution system losses.

A variety of water pricing systems is in use in the TLU, but the flat rate system is by far the most common. Very few residential, commercial or agricultural users are connected to water meters. Without meters, volume-based billing cannot be applied, and economic tools to encourage conservation are unavailable. TLU residents pay only about \$0.25 per m^3 for water, which is less than half the B.C. average (which is about \$0.63 per m^3) and much less than the Canadian average (which is about \$0.93 per m^3). Similarly, commercial, industrial, and agricultural water users in the TLU pay relatively low prices for water.

Water quality and fisheries resources:
Water quality in the streams in the TLU is influenced by a number of natural and human-caused processes. Land use effects on water quality include urban development, agriculture, forestry, mining, recreation, and tourism. A number of measures have been implemented by RDCO to reduce impacts from existing urban areas and to avoid water quality effects from development. Range activity on Crown Land can result in damage to riparian areas and stream banks, and introduction of pathogens to the water supply. Few issues have been identified with forest practices, and water quality protection is an integral part of forest development planning in the TLU. Water quality concerns over recreation include existing development and the potential for increased development on upland reservoirs, and erosion from ATV traffic.

Water quality data are available through the provincial Environmental Management System (EMS) database for sites within the Lambly Creek (6 locations), Peachland Creek (6 locations), Trepanier Creek (6 locations including McDonald Creek), Powers Creek (3 locations), and McDougall Creek (2 locations) watersheds. Other data not in the EMS is available from water purveyors and others. Provisional Water Quality Objectives were set for Trepanier and Peachland Creeks in 1992. MWLAP is currently revising and/or developing new Water Quality Objectives for Lambly, Peachland, Trepanier, and Powers Creeks based on monitoring conducted between 1996 and 2000, with the reports expected in spring 2004.

In general, water in TLU streams can be characterized as having neutral to alkaline pH with moderate concentrations of dissolved solids. All of the major streams that serve as sources of domestic and irrigation water occasionally have turbidity, coliform bacteria, and true colour concentrations that do not meet the B.C. water quality guidelines for raw water, and thus require treatment. The causes of the above-guideline concentrations of these variables include both natural factors and land use effects. Boil water advisories have occasionally been implemented to address risks from bacteria. Noranda continues to treat the discharge from the Brenda Mine site under permit from MWLAP and monitors for molybdenum, copper, and other parameters. By far the majority of sampling results are within guidelines/objectives, however, exceedances for molybdenum and copper have occurred on occasion in Trepanier and Peachland Creeks.

Preliminary analyses of the EMS datasets indicate changes in the concentrations of some water quality variables as the streams flow through urbanized areas.

Streams in the TLU support a variety of fish species, including rainbow trout and kokanee salmon. Fish populations have faced pressures in recent decades due to flow withdrawals from tributaries and habitat impacts, particularly in the lower reaches of TLU creeks below the intakes of the major municipal water purveyors. Instream water uses (e.g. water required for fish) are in general not protected by water licences. Instead, efforts have been made to negotiate "conservation" flows in the major streams of the TLU. The conservation flows that have been proposed are based on a percentage of the mean annual discharge, with the percentage changing each month. In many stream reaches these flows will produce optimal flows for fish as opposed to minimum flows. In a year with average runoff, the proposed conservation flows are close to the naturalized flows during the low-flow months. In drier than average years, conservation flows exceed naturalized flows, suggesting that conservation flows may be set too high. However, even in an average runoff year, water withdrawals for offstream use leave insufficient water behind in some months to satisfy conservation flows. Additional effort to set realistic conservation flows is recommended.

Water management issues and barriers:
The TAWG identified several water-related issues in the TLU, including unregulated groundwater use, over-licensed streams, reductions in flow affecting fish, urban development near streams, increasing competition for water, and water quality impacts associated with land use.

There are several provincial and federal Acts and regulations that govern water in B.C. In addition, the Okanagan-Shuswap LRMP and four Official Community Plans (OCPs) in the TLU provide a long list of goals, objectives, and policies for managing water. The TAWG members reported that their rates of implementation of LRMP and OCP policies were relatively low. These agencies identified several challenges to water management in the TLU, including ineffective management tools, lack of data, limited education on water value and use, organizational barriers, and differing institutional priorities and conflicting objectives. These barriers will have to be overcome for water management to improve in the TLU. The recommendations of this report should help achieve that goal.

Technical analysis of future pressures on water:
RDCO predicts that the population of the TLU will increase from 36,336 at present to 59,937 by 2020. If that growth rate continues, the TLU population will be 97,201 by 2050. Along with the associated economic growth, water demand will be 41% higher by 2020 and 91% higher by 2050 due to population growth alone, as shown in Table 3.

In addition, the climate is changing, which will further increase the demand for water because the growing season will be longer, drier, and warmer. In total, water demand in the TLU will increase by 55% by 2020 and by 128% by 2050 under the combined influences of population growth and climate change, as shown in Table 4.

These changes are summarized on Figure 4. The effects of increased water demands on the five major streams in the TLU (assuming that all of the increased demand is satisfied from surface streams) are shown on Figure 5.

In addition to its effect on water demand, climate change will have a second effect on the TLU's streams – it will substantially reduce water supply. Predictions of three global circulation models and the UBC watershed model (Figures 12.1 through 12.5 of the main report) show that natural streamflows will be about 15% smaller in 2020 and 35% smaller in 2050 than they are now, even if water use does not increase in future. These changes are summarized in Table 5.

Detailed analyses were done on the effects of population growth (increased water use) and climate change (increased water use and reduced streamflow) on the five major streams of the TLU. The output consists of 56 graphs (Figures 14.1 through 14.56 of the main report - one for each of 14 locations on five creeks), for each of the following four future scenarios:

Scenario 1: Effects of Population Growth only
- Scenario 1.1: Effects of Population Growth to 2020
- Scenario 1.2: Effects of Population Growth to 2050

Scenario 2: Effects of Population Growth and Climate Change
- Scenario 2.1: Effects of Population Growth and Climate Change to 2020
- Scenario 2.2: Effects of Population Growth and Climate Change to 2050

The analysis relied on several key assumptions, including that all future water demand is satisfied from surface streams (not groundwater or Okanagan Lake), and that no intervention is made to prevent future water conflicts. We also examined the effect of conservation measures, specifically the effects of 10%, 20%, and 30% reductions in demand due to implementation of conservation measures. Detailed spreadsheets and analysis of the output are provided in Appendices I through M and O of the main report (Volume 2).

The technical analyses are summarized in Figures 6 through 10. These figures show the combined effects of future changes in both demand and supply, and demonstrate clearly that present-day water resource issues and conflicts will be substantially intensified throughout the TLU in future.

Summary of current conditions and future pressures:
The following points summarize present conditions in the TLU, and future water-related pressures:

1. Water agencies and stakeholders have identified many water-related issues in the TLU, which are currently being managed under a wide variety of regulations, goals, objectives, and policies. Analyses of water licences, land use, flows, water quality, and fisheries information confirm that water resources are presently under pressure in the TLU and that there are several barriers to more effective water resource management in the TLU.
2. There are data gaps that should be filled to fully understand water resources and water use in the TLU. Streamflow data is only collected on an ongoing basis on two of the five major streams in the TLU, water licence information is maintained in a complex format that is

difficult to use and the data are difficult to interpret, there is virtually no information on rates of groundwater supply or demand or on groundwater quality, and fish conservation flows in some streams may be set unrealistically high because of a lack of actual data on natural historic flows.

3. Flows in the five major streams of the TLU have already been reduced from historic levels due to offstream withdrawals, by an average of 13%. Streamflows are highly variable from year to year. A 5-year drought year has only 67% of the streamflow of an average year in the Okanagan.
4. Water quality generally meets water quality guidelines (or water quality objectives where they have been set) although exceedances for turbidity, colour, and coliform bacteria (raw water) are not uncommon. However, water quality conditions are such that all major utilities chlorinate their water. There are existing and future threats to water quality, including recreational use of upland lakes, motorized recreational vehicle impacts on streams, and livestock access to surface water bodies. Though poorly studied in the TLU, experience from other locations suggests that residential, agricultural, and commercial development could affect water quality in stream reaches downstream of the major water supply intakes. These activities could contribute to pollution loads of groundwater and low-elevation stream reaches.
5. Downstream of the major water intakes, streamflows in summer and fall are often lower than recommended "fisheries conservation flows".
6. Total annual water use in the TLU is about 24.55 million cubic metres (66% from surface sources, 30% from Okanagan Lake, and 4% from groundwater). Water use is distributed as follows: residential - 41% (36,366 population); agriculture (including golf courses) - 34%; commercial/industrial - 20%, and leakage - 5%. Actual water withdrawn from surface sources is about half of the total amount currently licensed for withdrawal. In three of the five principal streams (Lambly, McDougall, Trepanier), neither licensed offstream use nor actual offstream use is fully supported by storage, but in Peachland and Powers Creeks, both licensed and actual offstream use are fully supported by storage.
7. Rates of water use in the TLU are very high (residential use averages 789 L/person per day on a year-round basis – about double the B.C. average) and prices are relatively low (residential rates average about 25 cents per cubic metre – less than half the B.C. average). Agricultural and commercial/industrial rates are even cheaper. Effective water conservation measures could reduce water use by 30% to 50%.
8. Population in the TLU is forecast to grow from 36,336 in 2001 to 59,937 in 2020 and 97,201 in 2050. Water use in the TLU is expected to grow by 41% by 2020 and 91% by 2050, if it is assumed that the climate does not change over that time period. However, if the effects of climate change currently predicted by computer models are accounted for, total water use in the TLU will increase by 55% by 2020 and 128% by 2050, relative to 2003.
9. In addition to affecting water demand, climate change will also reduce streamflows throughout the TLU. Based on three representative climate models and the UBC Watershed Model, streamflow would become an average of 15% smaller by 2020, and 35 % smaller by 2050 even if water withdrawals from the streams did not change.

Conclusions:

Specific predictions of the effects of population growth and climate change on streamflows in the five principal streams of the TLU for the years 2020 and 2050 have been made. These predictions make many assumptions, including that future demand is satisfied entirely from tributary sources, and that no changes in management to prevent conflicts takes place. On this basis, the following conclusions are drawn:

1. If potential climate changes are ignored, streamflows in 2020 will be smaller than today due simply to population and economic growth, but the predicted flow reductions will be relatively small. Nevertheless, the flow allocation, fish habitat, and water quality issues that are experienced now will intensify. Conservation flows will not be met in Powers Creek. Streamflows in 2050 will decrease further, resulting in more substantial flow reductions and associated water quality and fisheries impacts, which will be concentrated in Lambly, McDougall, and Powers Creeks.
2. If climate change is accounted for, significant streamflow reductions (averaging 25%) are expected in all five major creeks by 2020 due to increased use and reduced supply. This will result in zero flow at some locations for parts of the year in an average year. An average year will be like a 5-year drought year today, and a 5-year drought year will be like a 20-year drought year today. Current licences will not be sufficient to satisfy demand on Powers Creek.
3. These impacts will be even more severe by 2050, when annual flows will be reduced by an average of 56%, resulting in conservation flows not being met at many locations, and zero flow in all creeks for parts of the year. An average year will be like a 20-year drought year today, and a 5-year drought year in 2050 will be like a 50-year drought year today. Current licences will not be sufficient to satisfy demand on Powers and Lambly Creeks.
4. Streamflow impacts will be much larger downstream of the intakes of the major water purveyors than further upstream.
5. If future demands are satisfied from sources other than tributary streams, the predicted impacts on the tributaries will be smaller than indicated here. For example, if groundwater were developed to its currently estimated capacity, increased use of tributaries and Okanagan Lake could be avoided until about 2020.
6. If the climate does not change, demand management alone to 2020 would allow future demand to be satisfied from tributaries alone, and permit population and economic growth to occur without streamflow reductions relative to 2003, and the associated water quality and fisheries impacts.
7. However, by 2050 (even without climate change), both demand management and alternate supplies will be needed to prevent streamflow reductions and associated environmental impacts.
8. If the climate does change as predicted, augmentation of the water supply will be needed (along with demand management) to prevent streamflow reductions and associated environmental impacts by 2020.

Recommendations for improved water management:
On the basis of the key findings and conclusions of the study, several recommendations are made for improved water management. The recommendations are consistent with the goals and policies for water management contained within the Okanagan-Shuswap LRMP and the four OCPs in the TLU. They are listed in approximate priority order.

1. Demand management
Demand-side management approaches for the TLU should be adopted and implemented before 2010. Measures should include at least the following approaches, as described in Section 15.0 of the main report:

- A minimum water use reduction target should be set;
- Public education programs (to promote water conservation and to encourage changes such as xeriscaping and improvements in irrigation application techniques and irrigation scheduling);
- Universal metering;
- Financial incentives (use of a volume-based rate system and potentially other incentives);
- Ensuring full cost-recovery pricing; and
- Regulations (including requiring water conserving fixtures, restrictions on water use in peak periods).

It is expected that 30% reductions in water demand, which would reduce residential per capita water use to the same levels as experienced in Kelowna and Vernon, are attainable in the TLU with these basic approaches. It is recommended that as soon as metering is in place, additional measures (that depend on meters) be implemented:

- Utilities should implement a leak detection program;
- Utilities should conduct water audits to determine locations and amounts of water use and leakage;
- Improvements in irrigation application techniques should continue to be made; and
- A program of irrigation scheduling should be implemented.

Finally, the following measures that do not depend on meters should be implemented:

- Promotion of land use changes. Local governments should encourage developments with lower per capita water use such as multi-family residential vs. large single-family lots, and low impact development designs including xeriscaping and onsite retention and infiltration of stormwater runoff. The low density of development in the TLU, combined with substantial future development potential, provides opportunities for significantly affecting water use and quality through urban design;
- Promotion of crops that require less irrigation, considering the economic implications within and beyond the TLU;
- Implementation of recycling and reuse of wastewater by businesses and jurisdictions; and
- The potential for achieving water supply and distribution efficiencies through combining water systems should be investigated.

Although realizing the benefits of these actions may take years, they can generate substantial reductions in water use. Regardless of the return period, however, such actions should be implemented as soon as possible, and before 2010. Some of the planning changes (such as changes in urban form) generate other secondary benefits, such as reduced vehicle use and road

area, and more efficient servicing patterns (for water, power, sewer, drainage, and transportation). Low impact development techniques often accompany new urban forms, reducing runoff peaks and improving the quality of stormwater runoff.

Adoption of all of these conservation measures could result in total water savings near 50%. It is recommended that all of these demand-side approaches be applied throughout the TLU, and adjusted to reflect local conditions and the potential benefit of implementing the identified opportunities.

2. Supply Side Management

In order to prevent exacerbation of present-day water management issues and conflicts, development of additional water supplies will likely be necessary by 2020 if climate change is accounted for, and by 2050 if only projected population changes are considered. Since it is likely that the climate is changing, it is recommended that all utilities that rely on surface water sources develop additional water supplies before 2020.

Supply-side management strategies recommended for the TLU include (in approximate chronological order):

- Operational improvements, including achieving operational efficiencies, leakage reduction in the primary conveyance systems, and reductions in system pressure;
- Additions to or development of new upstream storage on the plateau;
- Pumping from Okanagan Lake; and
- Increased use of groundwater.

Although a great deal of upland storage has already been developed and licensed, there is likely some remaining opportunity to increase storage in upland areas. An assessment of the potential for increases in storage is beyond the scope of this report. Each water utility should evaluate the extent to which additional storage can be developed in the areas under their management. In the short term, increased storage is likely to be the most cost-effective approach to increasing supply. In the longer term, however, tributary storage will become more difficult and costly to develop, and there is a limit to the availability of water from this source.

It is recommended that the province carefully consider any proposed sale of Crown land around upland lakes or storage reservoirs, because private shoreline ownership could constrain the development of increased storage.

Because of limits to the availability of new upland storage, it is recommended that investigation and development of Okanagan Lake and groundwater become higher priorities than they have been in the past. However, current knowledge of groundwater is limited, so large-scale groundwater development should not occur before the resource has been properly evaluated (see Recommendation 8). It is noteworthy that while the use of Okanagan Lake and groundwater to service future demands represents a medium to long-term solution, there is a limit to the use of these alternative supplies. Groundwater-surface water interactions could cause reductions in baseflows in surface streams if groundwater is overused. Also, water use from Okanagan Lake will eventually become significant enough to affect lake levels, which has negative implications for lake water quality and downstream flows. Already it is estimated that consumptive water use

(i.e. water that is permanently lost) from the TLU represents 2 to 4 cm annually lost from the lake, and with continued economic growth, this figure will rise.

Increased use of tributary flow without upstream storage development, and inter-basin diversions into the TLU are two supply-side options that are not consistent with the goals and policies for water management contained in the Okanagan-Shuswap LRMP, and are not recommended for the TLU. Even though Table 2 indicates that Powers and Peachland Creeks may have sufficient storage to support current offstream use, the detailed scenario output summarized above indicates that increased withdrawals without supporting storage are not recommended on these creeks.

Prior to embarking on supply augmentation programs, it is recommended that each of the three major water utilities in the TLU that obtain water from surface sources conduct detailed analyses, specific to their particular water supply system, of future supply-side and demand-side management options, including analyses of costs and benefits, and determine which of the demand or supply options described in this report are most appropriate for implementation.

It is recommended that RDCO assist the smaller water utilities with similar utility-specific analyses to determine the optimal adaptation approach in each case. Many of these smaller utilities obtain water directly from Okanagan Lake, so detailed analyses of alternative sources of supply is not likely necessary. However, analyses of demand reduction strategies will be relevant to these utilities. Utilities using Okanagan Lake water may need to be convinced of the merits of demand reduction.

In summary, both augmentation of water supply and reduction in water demand will be needed in order to ensure economic development and maintenance of environmental quality in the Trepanier Landscape Unit in the future. Demand management should be the first priority. If it is assumed that the climate is not changing, both approaches will be needed by 2050. If it is assumed that the climate is changing, both approaches will be needed by 2020. We recommend that demand management be implemented by 2010, and that additional water supplies be developed as a second priority by 2020.

3. Surface Water Allocation

If current licences for offstream use were fully utilized, water withdrawals from surface sources would exceed those in Scenario 2.2 (year 2050, assuming climate change takes place) by 10.2 million m^3 per year, or 18%. Therefore, it is recommended that, despite the fact that there is room available within the scope of existing licences for additional withdrawals from the five major tributaries, no increases to offstream withdrawals should be made without an equivalent increase in upstream storage to support the withdrawal. This recommendation is consistent with current practice.

Future water licence applications for surface streams in the TLU should be accompanied by proof that all reasonable alternatives have been pursued for obtaining water from already licensed sources, and that demand management measures are incapable of meeting the water requirements of the applicant.

4. Protection of Water Quality

It is recommended that appropriate effort be directed at protecting water quality on both Crown Land and private land by the appropriate agencies. On Crown Land, this may take the form of source assessments under the *Drinking Water Protection Act*, potentially followed by Drinking Water Protection Plans. On private land, this could take the form of measures to control development in order to minimize development impacts on hydrologic response and water quality. This recommendation is particularly salient, since the province is considering the sale of Crown land along the shorelines of upland lakes and reservoirs, which may result in increased development pressures.

5. Protection of Streamside Corridors

It is recommended that the appropriate agencies ensure that sufficient protection is provided to streamside areas within the TLU to maintain the functioning of riparian and floodplain processes at adequate levels, and minimize the negative impacts to the aquatic ecosystem that will be associated with reduced future streamflows.

Recommendations to improve water information:

Each of the above water management recommendations should be implemented without waiting for additional data or information. However, this study revealed several issues with respect to data and information in the TLU. The following recommendations are made to improve the quality and quantity of the data available in the TLU for making water management decisions. They are organized approximately in order of priority. They are all important, and it is recommended that they all be implemented before 2010.

6. Water Licence Information System

A thorough examination of the Water Licence Information System is recommended in order to identify improvements for access and querying. A map and database (GIS) approach should be pursued, in which a user could easily identify existing water licences upstream of a particular location on a stream network. In order to facilitate analysis, metric units should be adopted. At a minimum, metric units should be provided along with traditionally used (non-metric) units.

The Provincial government should become more proactive in cancelling licences that are no longer in use, so that water managers will be able to more easily identify currently active instream and offstream licences.

7. Measurement of Water Use

It is recommended that all water utilities in the TLU measure their rate of water withdrawal from primary sources (surface streams, Okanagan Lake, and groundwater).

It is recommended that customers of each of the water utilities in the TLU be metered, whether the water source is tributaries, groundwater, or Okanagan Lake. Meters are most urgent where customers are supplied from tributary sources.

It is recommended that water utilities conduct an audit or survey of water withdrawal rates, and indoor and outdoor use among their residential and commercial customers after a one or two year period. Such information can guide conservation programs, water pricing decisions, and public

education messages. This information can also be used to update the estimates of water use and other analyses presented in this report.

8. Groundwater

Improvements in groundwater management depend on obtaining improved groundwater inventory and use information, which should be done prior to significant new groundwater development. It is recommended that the Provincial government enact legislation to regulate groundwater use in British Columbia – including establishing standards for well construction, and requiring reporting of relevant information, including yields.

It is recommended that (even in the absence of provincial legislation) RDCO, Peachland, and the Westbank First Nation implement a program of voluntary provision of groundwater information. Owners of selected properties in the TLU would be asked to allow monitoring of well yields, water table depth, water use, and water quality. The costs of such a program could be covered by the provincial government, and the results would be used to better understand and assess groundwater resources and use in the TLU.

Aquifer mapping, based on surficial geology mapping, anecdotal evidence and limited field mapping, should be considered for the upland areas of the TLU. Detailed hydrogeological data and information should be generated for the six identified aquifers so detailed assessments of aquifer yield and sustainability can be completed. Information for this task would be obtained from the voluntary monitoring program and from other sources. Detailed aquifer vulnerability mapping that considers land use, zoning and levels and types of development should be considered for the six identified aquifers. Finally, the need for wellhead protection plans and groundwater protection areas should be assessed, based on the results of the updated vulnerability mapping and the monitoring program.

9. Streamflow Inventory

In order to reduce reliance on regional flow estimation, it is recommended that hydrometric stations be re-established in all five major watersheds of the TLU, at least near the mouths of each stream, and also preferably above major intake locations and below major storage reservoirs. Flows in all significant municipal and irrigation diversions should be monitored - at least those of the Westbank and Lakeview Irrigation Districts and the District Municipality of Peachland. All data collection in the TLU should be managed by a single agency, which would disseminate the information to all stakeholders.

10. Water Quality

The following recommendations are made to further the existing understanding of water quality and to provide the information needed to manage water sources in the future:

- RDCO, water utilities, and other water agencies and stakeholders should review the forthcoming water quality assessment reports from MWLAP, including the basis for any new Water Quality Objectives that are set;
- MWLAP should update the EMS database to include the recent MWLAP data and any other available data (e.g. data collected by water purveyors, Noranda, or Riverside);
- Water quality monitoring should continue in all the water supply watersheds, and the list of monitoring parameters should be expanded beyond the minimum requirements in the

Drinking Water Protection Act. The list and sampling schedule should be customized for each stream depending on uses (e.g. drinking water or aquatic life), but should include at least turbidity and/or total suspended solids, total dissolved solids, pH, water temperature, and true colour (or another measure of organic carbon). Sampling for metals, nutrients, parasites (e.g. *Cryptospridium parvum*), trihalomethanes, or other parameters will be of value at some sites.

- The monitoring should take place at the water intakes (in addition to whatever sampling within the system that the water utilities conduct). If additional sampling sites are considered beneficial they would ideally be located at the sites of any new hydrometric stations because flow data assists in data interpretation.
- Future water quality monitoring programs should be designed carefully to ensure that the goals of the program are well understood and can be achieved. A specialist in statistical study design should be consulted early in the design process.
- Opportunities for cost sharing of the monitoring should be explored among the water utilities, forest licensees, RDCO, Interior Health Authority, and other stakeholders, and all stakeholders should be involved in development of the study design.

11. Fish Conservation Flows

The following recommendations are made to advance the process of setting conservation flows in TLU tributaries:

- Consider adopting conservation flows that vary depending on the naturalized flows (i.e., flows without water storage, release, or diversion) in any given year, i.e. are not intended to preserve "optimal" conditions at all times. In particular, during low-flow periods, conservation flows should be no greater than the total naturalized flows available. Sufficient information should be collected on habitat-flow relationships to enable explicit evaluation of the implications of managing flow on this basis.

However, if an approach based on preserving "optimal" conditions for fish is selected:

- Complete field assessments of fish habitat-flow relationships in order to calibrate the conservation flow recommendations. The assessments should concentrate on the nature of the relationship at flows near the range of reasonable conservation flows, as determining the shape of the curve in this flow range is critical.
- Determine whether conservation flows in those sections of channel not containing kokanee can reasonably be reduced during the fall/winter months from the proposed universal conservation flows, keeping in mind that rainbow trout require sufficient flows for over-wintering.
- Careful consideration should be given to determining which life history stage is most limiting to each fish population, then structuring conservation flows accordingly. Additionally, it should be confirmed that flow is the primary controlling factor for each population, as opposed to temperature or another factor that may be beyond the influence of water managers.
- Incorporate water temperature moderation into future conservation flows, if there is evidence that this is a key fish production bottleneck in the streams of interest.
- Finally, it is recommended that once conservation flow discussions have been concluded, instream licences should be issued for these amounts, to ensure that instream uses are legally protected. Even though these licences will rank low in terms of priority, they will provide

more protection than if there was no licence in place. In addition, such licences could facilitate use of the Fish Protection Act to ensure conservation flows are maintained.

12. Water Information Accessibility

It is recommended that an Okanagan water information clearinghouse be developed, and that local and provincial agencies with water-related mandates in the TLU support such an initiative.

Next steps:

The analyses conducted in support of the Trepanier Landscape Unit water management plan indicate very specifically where and by how much streamflows in the TLU will be affected in future. Recommendations have been made to mitigate these impacts, beginning with substantial reductions in water demand beginning before 2010, and including development of alternative water sources beginning before 2020. Failure to change rates of water use or seek alternative water sources will either constrain economic growth or impair environmental resource values, or both.

The recommended next steps are as follows:

- creation of a leadership group that will champion the cause of improved water management and encourage adoption and implementation of the recommendations presented in this report;
- holding stakeholder and public consultations to agree on goals, strategies, and action items, using the recommendations of this report as a starting point;
- creation of a water management implementation plan; and
- implementation of improved water management actions using a variety of existing mechanisms.

These points are outlined in more detail below.

1. Establish a leadership group

It is recommended that a Water Management Advancement Team be established as a strategic alliance of key stakeholders to administer the water management plan and champion improved water management in the TLU. The group could be lead by RDCO or another of the members of the Steering Committee created for the present study, or another body, and would consist of a cross-section of agencies with a mandate to manage water in the TLU. The Water Management Advancement Team could be formally established under an existing mechanism (such as RDCO or the Okanagan Basin Water Board). It would work to improve water management in the TLU, foster the development of partnerships as needed to implement recommendations, seek funding to complete technical studies, oversee technical studies, conduct monitoring and data management, ensure access to data, and coordinate educational programs.

2. Hold stakeholder and public consultations and develop an implementation plan

It is recommended that the recommendations contained herein be used as a basis for development of a water management implementation plan for the TLU. The implementation plan would include broader stakeholder consultation than has been possible in the course of this study, and seek agreement on key goals for water management in the TLU among key stakeholders. The water management implementation plan should contain, at a minimum:

- water management goals and policies;
- priorities among action items;
- targets for water conservation and quality;
- assigned responsibilities for implementing plan elements;
- schedules to ensure timely attainment of targets and implementation of identified actions; and
- budgets for action items, including statements of cost-effectiveness and identification of sources of funding.

3. Implement improved water management

Once a water management implementation plan has been adopted for the TLU, it is recommended that recommendations be adopted as appropriate into Official Community Plans and servicing bylaws, Water Use Plans, Drinking Water Protection Plans, and specific management objectives for community watersheds under the Forest and Range Practices Act.

Firm commitments need to be gained for the water management implementation plan and its elements in associated plans and bylaws. Once committed, the responsible agencies need to be accountable for implementation. The Water Management Advancement Team can aid in plan implementation and finding solutions that are acceptable to water managers, purveyors, and users.

Table 1 Comparison of naturalized flow and net flow for the five major creeks of the TLU

	Naturalized flow	Net flow
o Lambly Creek:	1.77 m^3/s	1.58 m^3/s
o McDougall Creek:	0.119 m^3/s	0.084 m^3/s
o Powers Creek:	0.920 m^3/s	0.849 m^3/s
o Trepanier Creek:	1.09 m^3/s	1.03 m^3/s
o Peachland Creek:	0.570 m^3/s	0.515 m^3/s

Table 2 Comparison of actual and licensed offstream water use (expressed as a percent of the naturalized flow) and of storage

	Licensed Offstream Use	Actual Offstream Use	Percentage of Licensed Offstream Use Supported by Storage
o Lambly Creek:	23%	11%	37%
o McDougall Creek:	30%	30%	43%
o Powers Creek:	29%	18%	191%
o Trepanier Creek:	13%	5%	19%
o Peachland Creek:	43%	10%	115%

Table 3 Present and future TLU water use (in millions of m^3/year) assuming that climate change does not occur.

Land use	**2003**	**2020**	**2050**
Residential	10.2	16.8	27.3
Commercial / Industrial	4.9	7.8	9.1
Agricultural[1]	8.3	8.3	8.3
Distribution system losses	1.2	1.6	2.2
TOTAL	**24.6**	**34.5**	**46.9**

Note: 1. includes water used by golf courses.

Table 4 Present and future TLU water use (in millions of m^3/year) accounting for climate change.

Land use	**2003**	**2020**	**2050**
Residential	10.2	18.3	32.0
Commercial / Industrial	4.9	8.5	10.6
Agricultural[1]	8.3	9.6	10.8
Distribution system losses	1.2	1.8	2.7
TOTAL	**24.6**	**38.2**	**56.1**

Note: 1. includes water used by golf courses.

Table 5 Predicted reductions in annual flow caused by climate change

	2020	2050
o Lambly Creek:	11%	30%
o McDougall Creek:	11%	36%
o Powers Creek:	17%	34%
o Trepanier Creek:	20%	39%
o Peachland Creek:	18%	34%
Average	**15%**	**35%**

Note: This table represents the changes that are likely to occur if the climate changed but future water usage remained the same as it is today. Percentage reductions are based on 2003 levels.

Figure 1 Boundaries of the Trepanier Landscape Unit.

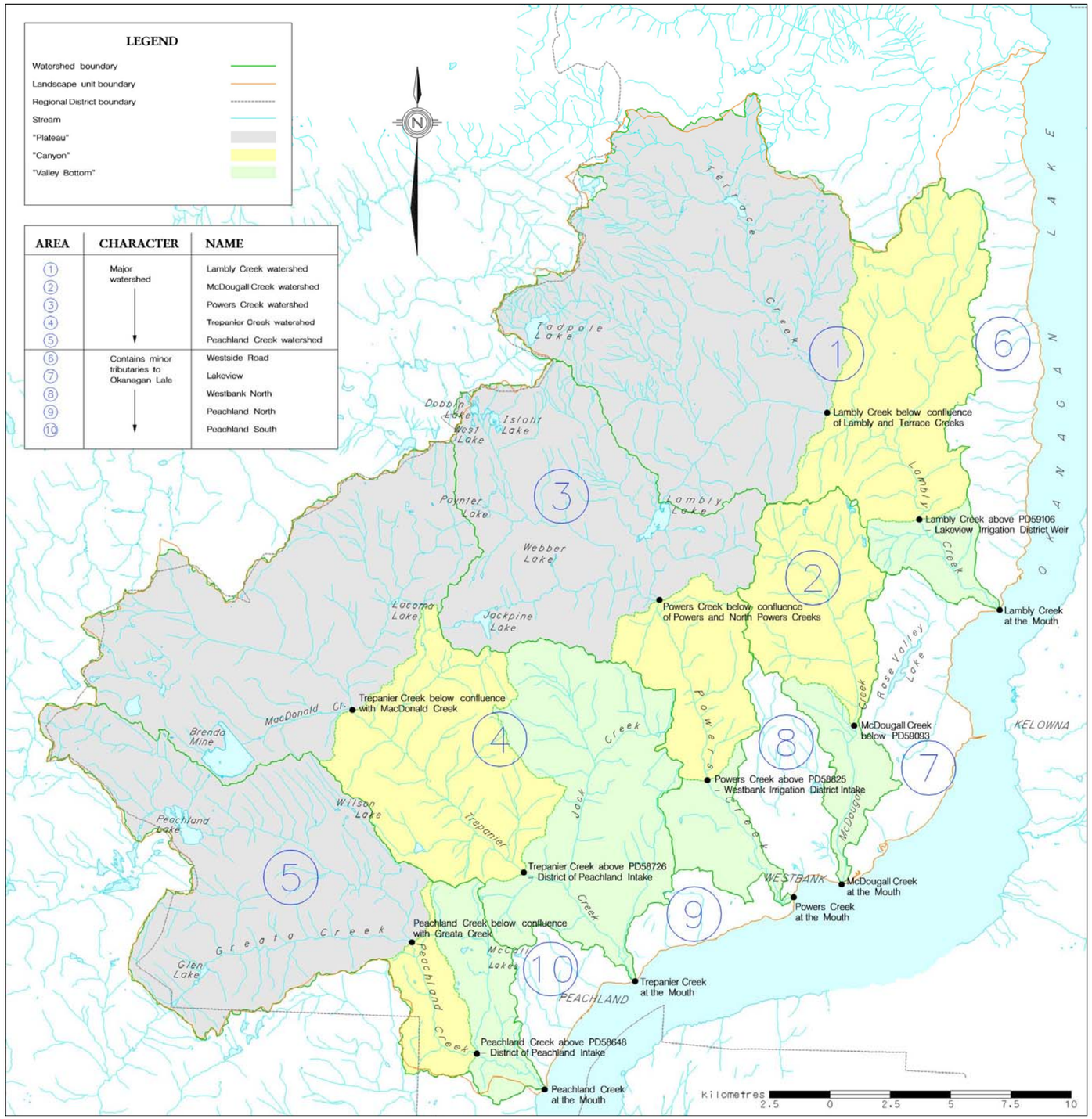

Figure 2 Map of the TLU indicating the 14 points-of-interest at which flows have been estimated.

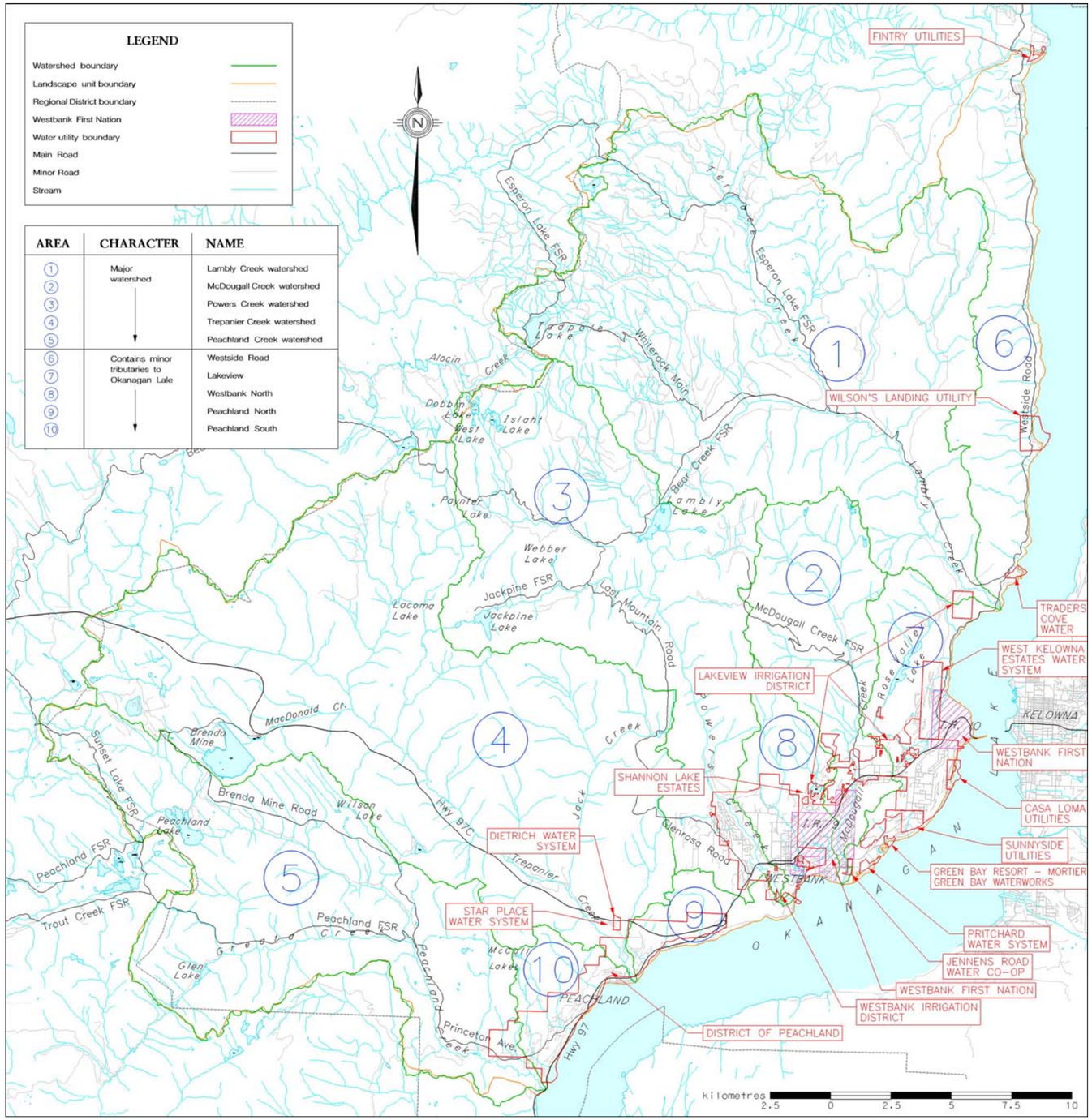

Figure 3 Distribution areas of the water utilities present in the TLU.

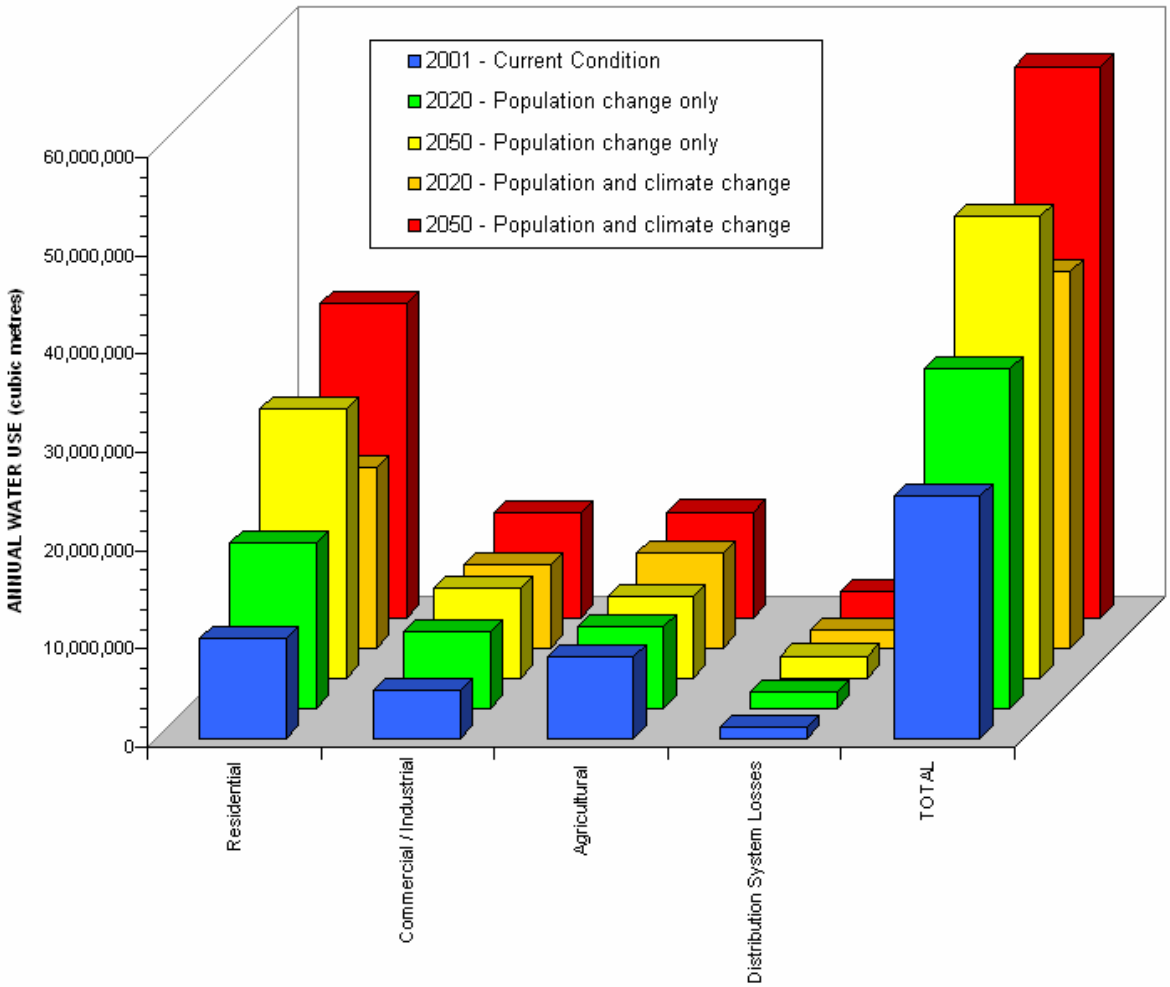

Figure 4 Estimated annual water use in the Trepanier Landscape Unit by land use.

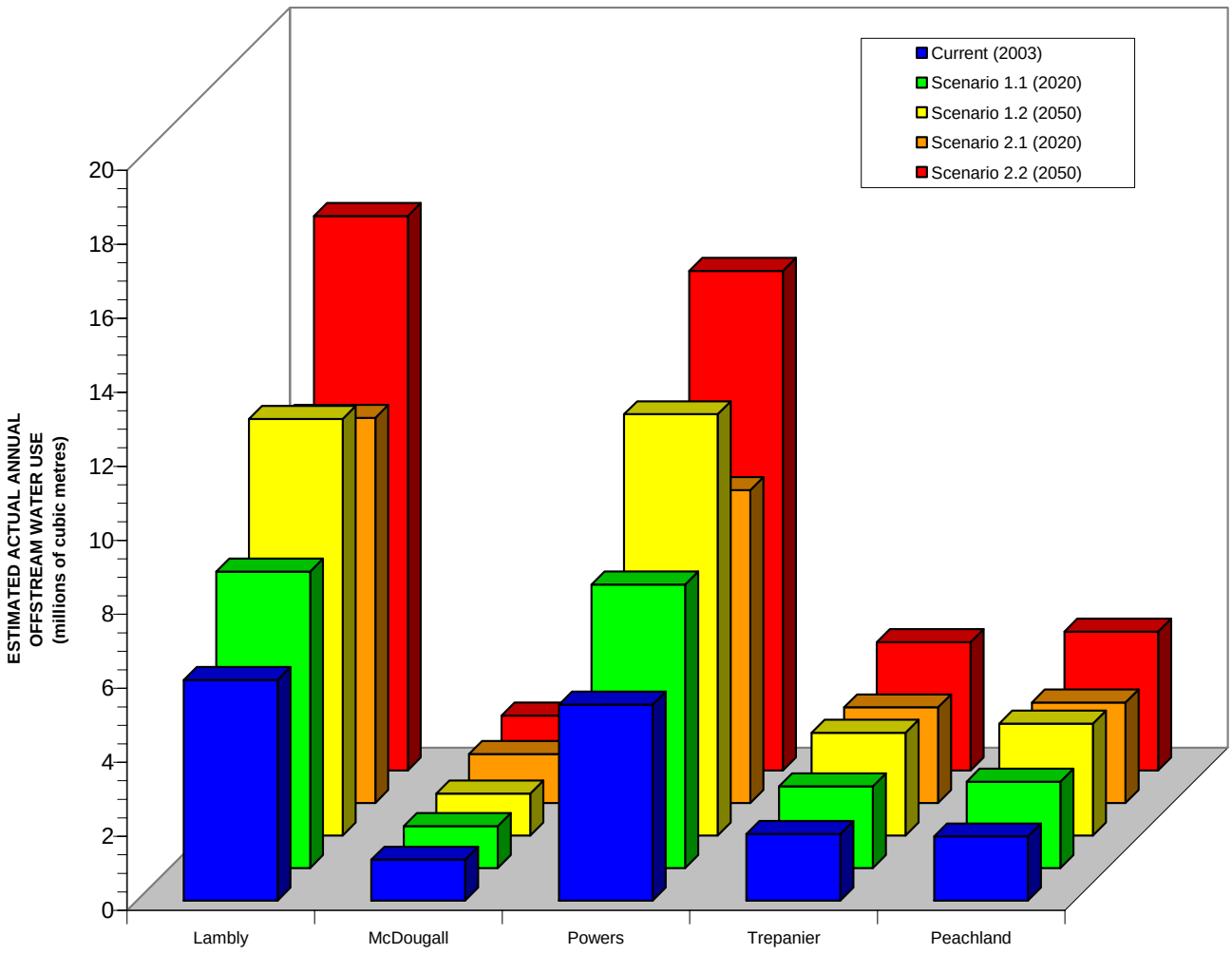

Figure 5 Estimated actual annual offstream water use at the mouths of the five principal streams in the TLU.

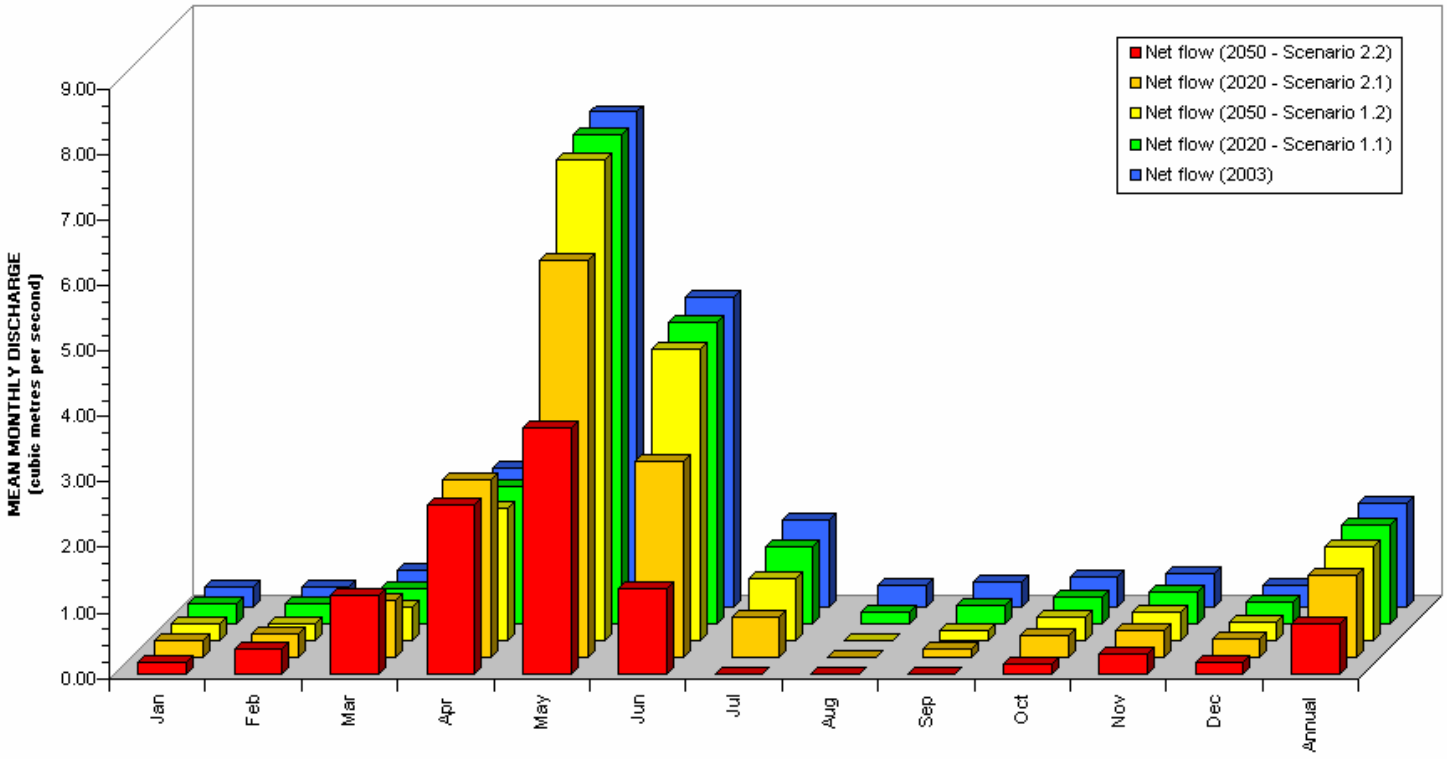

Figure 6 Net flows: Lambly Creek at the mouth.

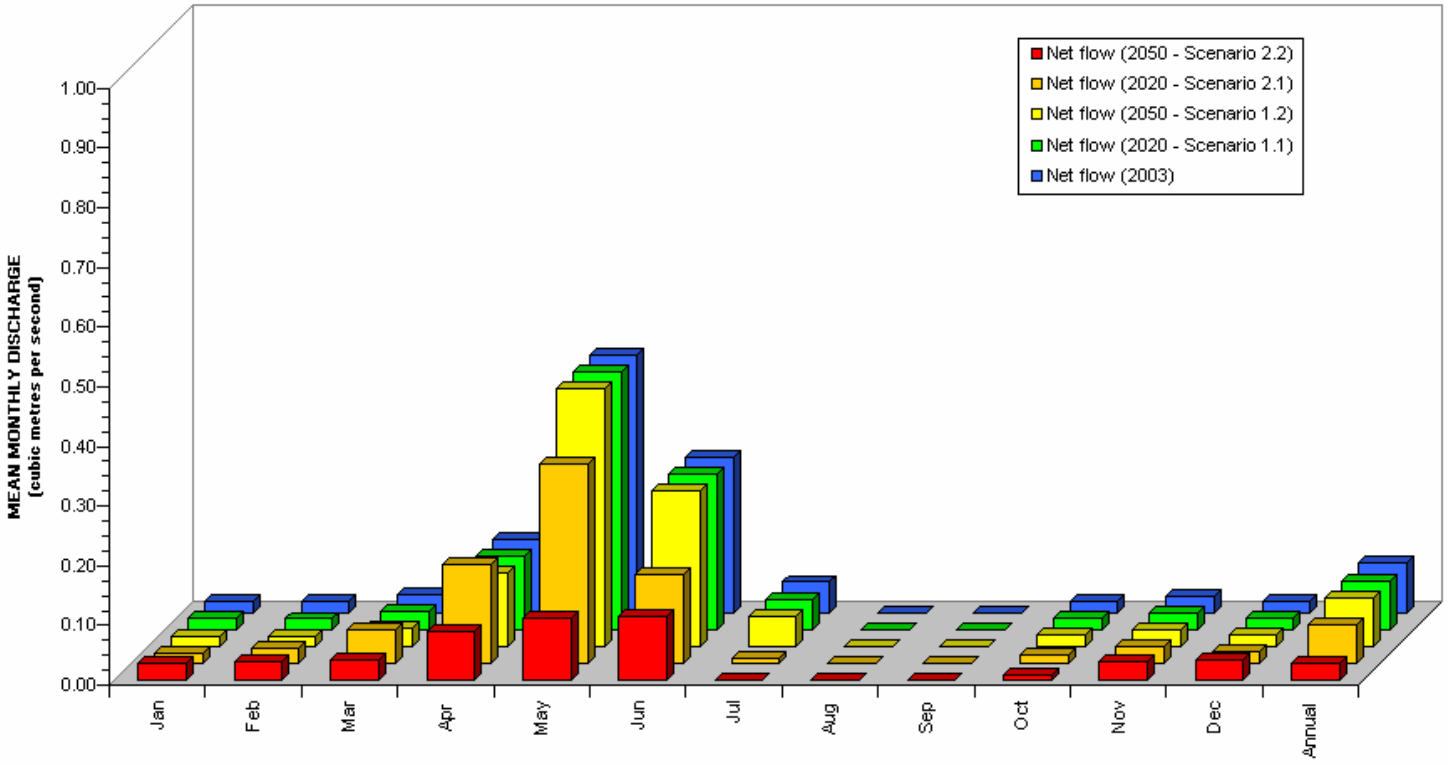

Figure 7 Net flows: McDougall Creek at the mouth.

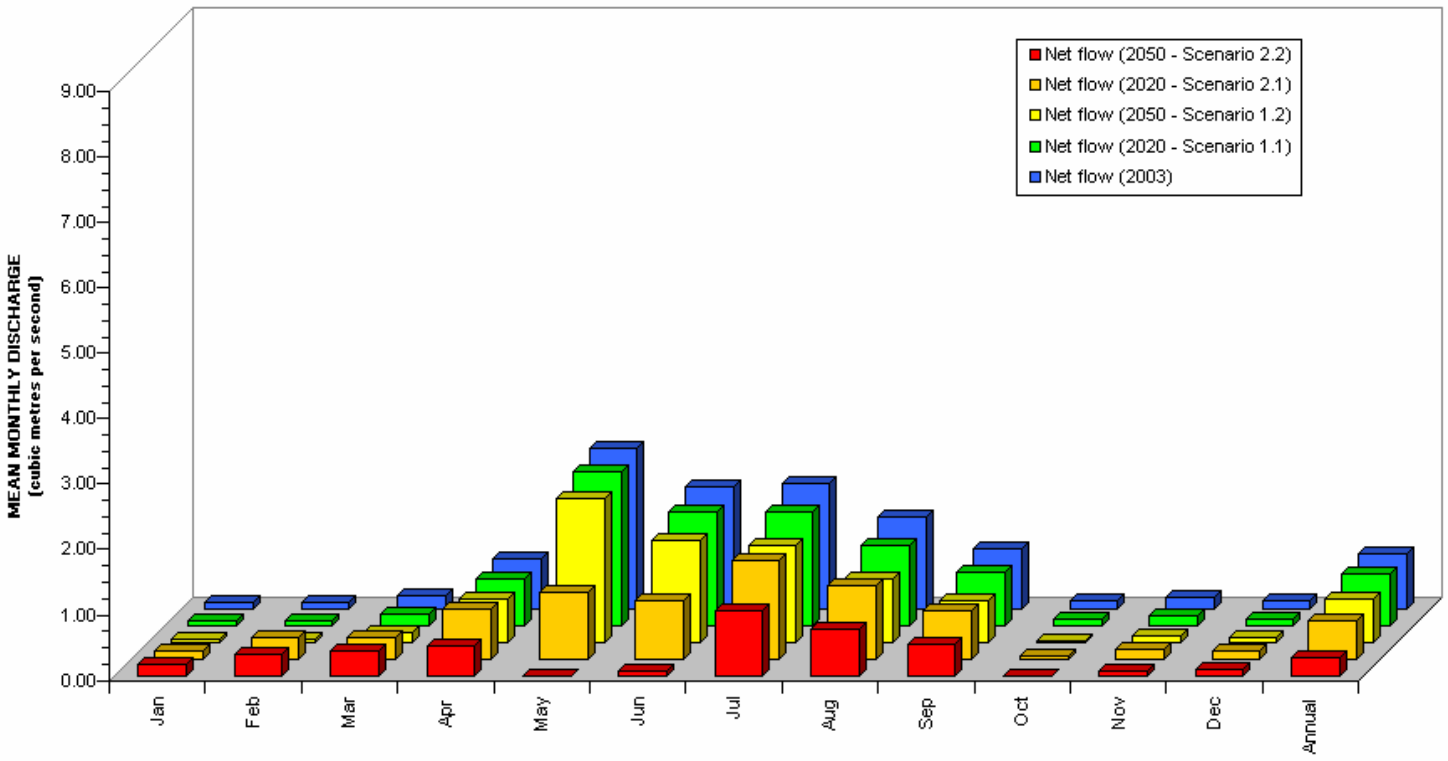

Figure 8 Net flows: Powers Creek at the mouth.

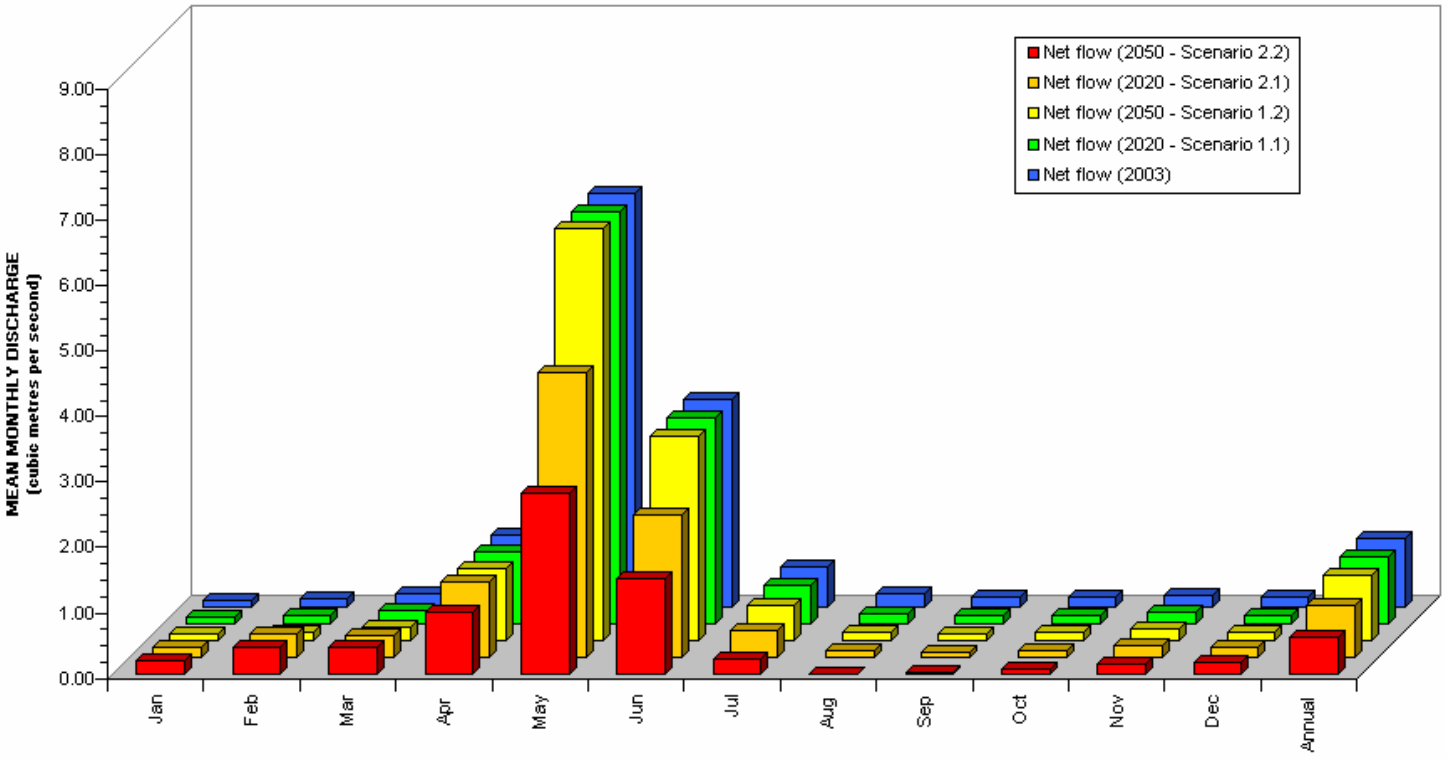

Figure 9 Net flows: Trepanier Creek at the mouth.

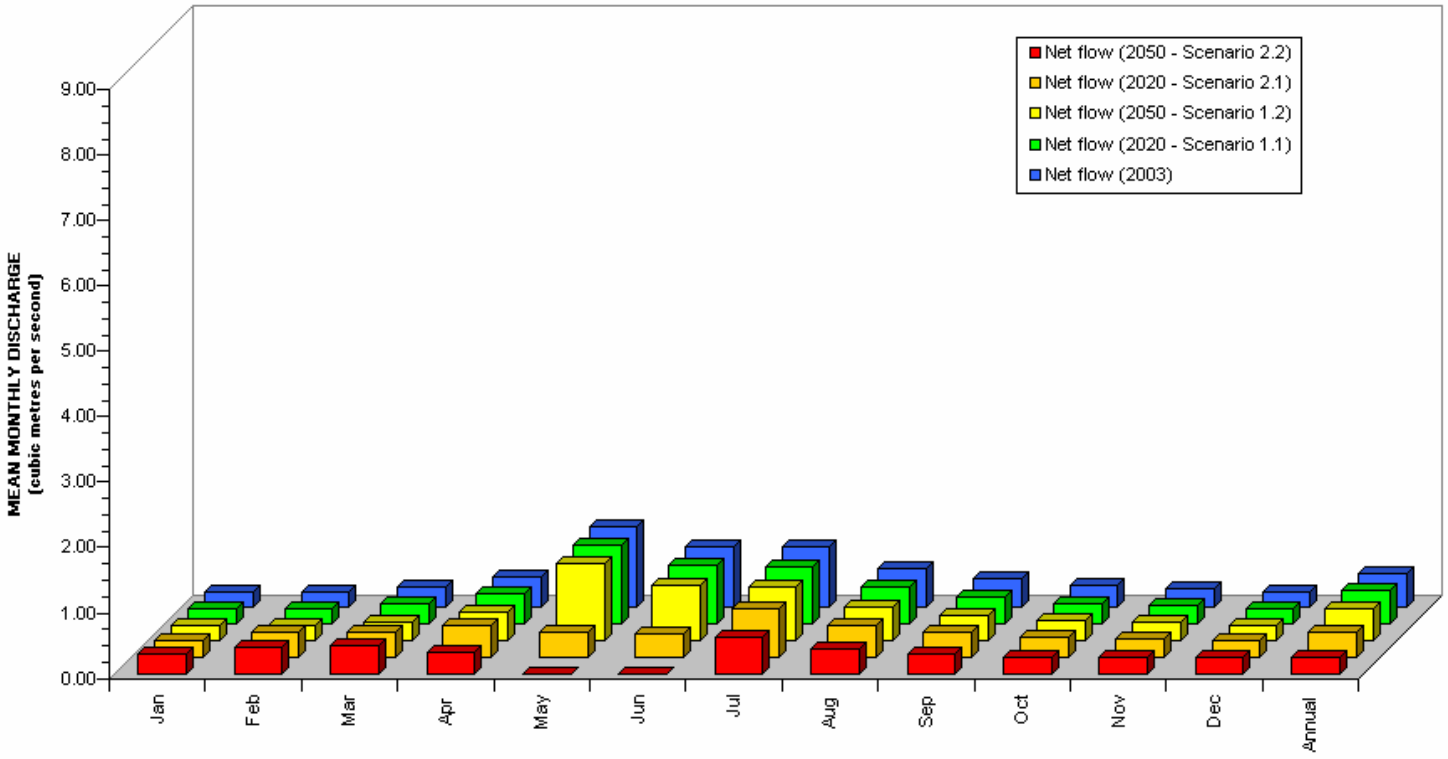

Figure 10 Net flows: Peachland Creek at the mouth.