9.0 SURFACE WATER RESOURCES

Introduction

The Surface Water Hydrology and Hydrologic Modelling Study consisted of three main parts. The overall objectives of Part One were to summarize existing information on surface water flows and develop a solid understanding of the natural surface water supply in the Okanagan Basin. The baseline data developed in Part One were used in Part Two (Appendix J) to calibrate and check the performance of the Okanagan Basin Hydrologic Model (OBHM) (Section 15.0). Once calibrated, the OBHM was used to run future water supply scenarios in Part Three in order to support the Okanagan Basin Water Accounting Model (Section 16.0).

This section summarizes the results of Part One – the "State of the Basin", which refers to the state of the current understanding of surface flows, climate and other biophysical factors that influence surface water flow, and the development of estimates of natural flow (i.e. streamflow in the absence of storage and diversions). Data were compiled and summarized for 81 points-of-interest or "nodes" in the Basin (Attachment 1) and naturalized flows were developed for 73 nodes for an 11-year period (1996-2006) that was adopted for modelling. This period is referred to as the "standard period" or the "calibration period" in this report. Flows were not naturalized for the mainstem lakes and the nodes on the Okanagan River because flows through the lakes and river have been regulated by dams and other control structures for many decades.

Methodology

Most Okanagan streams and lakes have been developed for surface water storage and withdrawals, thus the majority of streamflow records are considered *regulated* (i.e. affected by the storage and diversion of water). Determining natural streamflows using data from regulated watercourses is accomplished by a process of *streamflow naturalization* which removes the effects of human management from the data. Streamflow naturalization therefore requires information on water use and management, which was provided to the study team through the water management and use investigations (Section 6.0 and Appendix C). Streamflow estimates derived in this way are referred to as naturalized streamflows.

Although a reasonable number of streamflow measurement stations have existed or currently exist in the Basin, several streams have never had direct measurements of flow. For these locations, several estimation approaches for naturalized streamflow were used, depending on the available data.

Natural Streamflow Results and Patterns

The pattern of natural runoff in the Basin varies not only by elevation but also geographically in response to precipitation type and amount, evapotranspiration, and other factors such as soil type, vegetation, and the distribution of wetlands and ponds in catchment areas. For the 1996-2006 standard period, total natural streamflow from all tributaries and residual areas in the Okanagan Basin averaged 884,000 ML per year. If spread evenly over the entire Basin, this volume would cover the landscape to a depth of 117 mm. Approximately 83% of this total flowed into Okanagan Lake, while 17% of the total flowed into Okanagan River and the mainstem lakes downstream of Okanagan Lake. Upstream of Penticton, the runoff averages 130 mm, while downstream of Penticton, it averages 78 mm. Furthermore, runoff on the east side of the Basin tends to be higher than on the west side. This is because the prevailing winds are generally from the west – these winds are forced to ascend the east side of the valley, causing more precipitation on that side due to orographic effects. Total annual flow from the west side of the Okanagan Valley averaged approximately 371,000 ML over the 1996-2006 period (equivalent to 99 mm of runoff), while flow from the east side averaged 513,000 ML (or 134 mm of runoff).

Average annual discharge and runoff were calculated for the 1996-2006 standard period at each node, with averages presented in Table 5.3 and Figure 5.4 of Appendix G. Mission Creek is the largest tributary, delivering 28% of the total flow in the Basin. Trout and Vernon Creeks are the second and third largest contributors, each delivering about 7% of the total. Although the residual areas[6] cover 17% of the Basin, they contribute only about 5% of the annual flow because of high actual evapotranspiration rates at lower elevations.

Over the period 1996-2006, total flow varied considerably from a peak in 1997 to a low in 2001. In seven of the 11 years, runoff was above normal, while in four of the 11 years it was below normal. Because it captures extremes, and includes a mix of “wet” and “dry” years, the 11-year standard period is appropriate for calibrating the Okanagan Basin Hydrology Model (OBHM).

On an annual basis, streamflow during the low flow months of August to February accounts for only 14% of the Basin total, while flows in March to July account for 86%. The August to February total streamflow averages about 18,200 ML per month, which is being contributed by groundwater as there is virtually no surface runoff during this period. This volume is a small fraction of the 334,147 ML in the peak month of May.

[6] Residual areas are land areas in the watershed that do not have a major stream network.

Accuracy of Natural Flow Data

The natural and naturalized flow data was given a rating to indicate the estimated error and quality of the data (Table 6.5, Appendix G). Of the 73 nodes addressed in this study (including node "00" - inflows to Kalamalka Lake), 12 have uncertainty ratings of "2" (indicating uncertainties between 10% and 25%). A total of 18 nodes have uncertainty ratings of "3" (uncertainty between 25% and 50%) and the remaining 43 nodes have uncertainty ratings of "4" (uncertainty between 50% and 100%). However, 40 of the 43 nodes with ratings of "4" are residual areas, which have no major streams, and in total produce only about 5% of the runoff in the Basin. Therefore, high uncertainty in these minor flows has very little impact on the overall strong confidence in the results outlined in the study.

Recommendations:

The following recommendations are made for future studies to refine the estimates of natural flows in the Basin:

- Obtain improved water use and management information from the Basin water suppliers to improve naturalized flow estimates. The priority sub-basins are Kelowna (Mill) Creek, Powers Creek, Penticton Creek, Ellis Creek, Shuttleworth Creek, and Inkaneep Creek.
- Implement the recommendations of Dobson and Letvak (2008) to improve the existing Okanagan Basin hydrometric network and obtain better flow records for important streams.
- A key information gap identified in this study is data on streamflow-groundwater interactions where streams flow across alluvial fans and other unconsolidated deposits. Although there are ongoing modelling studies on this process, a field-based investigation should be undertaken that targets a select number of locations on critical streams.
- To provide further insight to streamflow–groundwater interactions, the groundwater regime should be assessed in areas of interest by establishing test wells and obtaining field measurements of groundwater levels. This program will increase our understanding of the spatial and temporal variability of streamflow gains and losses across alluvial fans in the Basin, which will further improve the Okanagan Basin Hydrology Model.
- Further investigation and monitoring is recommended to improve the flow estimates of small streams during low flow (or no flow) periods (late summer through winter). This would include obtaining flow information from local residents, conducting field surveys and discharge measurements, and incorporating this data into the surface water – groundwater interaction investigations.
- Consider the potential impacts of land use changes on runoff and infiltration over time.