PART ONE - BACKGROUND

1.0 INTRODUCTION

Overview of the Basin

The Okanagan Basin is located in south-central British Columbia. The Basin consists of a main north-south trending valley occupied by five major lakes, the Okanagan River, and several major population centres; and is surrounded on both sides by higher elevation plateaus. It is an arid region, with average annual precipitation of about 300 – 400 mm along the main valley bottom, and 800 – 1,000 mm at the highest elevations of the surrounding plateaus. In addition, there is high variation in the amount of precipitation received each year – some years are very dry and some are much wetter than average. Much of the incoming precipitation is lost to evapotranspiration (direct evaporation from lakes, and transpiration from plants and trees). The Basin had a population of 294,000 in 2006, according to the Canada Census, and is reported to have the highest ratio of population to water supply of any basin in Canada. The population continues to grow.

Much of the water used in the Basin by humans is provided by the melting of the winter snowpack that forms each year on the high elevation plateaus surrounding the main valley. Some of this annual spring snowmelt infiltrates into the ground to become groundwater, and some flows down tributary creeks into the main valley lakes. The flow in these tributary streams drops to low levels in summer (after the upper level snow has finished melting), and stays low until the following spring. Because the climate is arid, agricultural crops, golf courses, lawns, and other outdoor vegetation depend on irrigation to supplement natural precipitation. Humans require water for other uses as well (e.g. domestic and industrial). Accordingly, diversion structures have been constructed to extract water from creeks to supply water to distribution systems throughout the valley. However, irrigation continues well beyond the time when the high elevation winter snowpack has finished melting; and humans require water year-round for other purposes. Therefore, the development of communities and agriculture in the Basin has depended on capturing and storing a portion of the annual snowmelt in upper elevation reservoirs, and staging the release of that stored water to meet demands that are spread out over the year. The high elevation dams and reservoirs are owned and operated by a multitude of water suppliers, and are operated to serve the needs of the individual owners and operators. The main valley lakes are each controlled by dams which are operated by the B.C. Ministry of Environment (MOE) to serve multiple purposes - including flood prevention, aquatic ecosystem sustainability, intake submergence, navigation, and recreation. Water levels on these main lakes reflect the rate of water input to them by creeks and groundwater, and also reflect the rate of outflow and evaporation.

In addition to tributary creeks, other key water sources include the main valley lakes and groundwater.

The most recent Basin-wide analysis of water supply and demand took place in 1974 (the 1974 Okanagan Basin Study Report - Consultative Board, 1974). Since then there have been many local studies of water supply and forecasts of demand made by various water suppliers, but a Basin-wide assessment has not been repeated. Meanwhile, there is increasing concern about the sustainability of the water supply. Water shortages have recently occurred in some parts of the Basin (e.g. in 2003 in Trout Creek), which has led to conflicts between water users (e.g. between communities, fisheries interests, and irrigators). Previous studies in parts of the Basin have suggested that in future, continuing climate change will likely reduce water supply, but increase water use. Other studies have indicated that summers could become longer, hotter and drier, which would increase the demand for water to be supplied for irrigation, even as the climate makes those water supplies smaller and less reliable. If realized, lower and more variable streamflows will threaten aquatic ecosystems and species, and the ability to satisfy the needs of human water users. The MOE, which is responsible for the licensing of surface water in the Province of British Columbia (groundwater use is not licensed), has temporarily suspended the issuing of new surface water licences in the Basin, unless those licences are supported by upper elevation storage.

Uncertainty about the water remaining for allocation, combined with continuing population growth, the need to protect aquatic ecosystems and maintain a reliable water supply for a sustainable agricultural economy, and the potential for climate variability and climate change highlight the challenges to water management in the Okanagan Basin, and reinforce the need to update the 1974 Basin-wide water supply and demand estimates.

Overview of the Project

Against this backdrop, in 2004 the MOE initiated the Okanagan Water Supply and Demand Project. The Project is a multi-phase work program focussed on improving the state of knowledge of the water resources of the Okanagan Basin. In particular, MOE identified the need for a credible scientific study to establish current water availability, water use, and future potential influences on supply and demand. The "Basin" is defined as the watershed of the Okanagan River upstream of Zozel Dam near the outlet of Osoyoos Lake. Zozel Dam is located in Washington State, and controls the outflow from Osoyoos Lake. The lake is operated to maintain lake levels within certain ranges according to protocols established by the Osoyoos Lake Board of Control under the authority of the International Joint Commission, but is not operated to provide specified flows into the United States. The Basin covers 8,024 km^2, all but 73 km^2 of which is located in Canada.

Phase 1 of the Project was completed in 2005, and Phase 2 is now complete. Phase 2 was led by the Okanagan Basin Water Board in partnership with the MOE, and completed in collaboration with a large number of federal and provincial agencies and the Okanagan Nation Alliance.

The Phase 1 study (Summit 2005) identified and evaluated the information available for a comprehensive Basin-wide analysis of water supply and demand in the Basin, and identified data gaps. It also proposed a strategy for completing Phase 2. The Phase 1 report is available on the Okanagan Basin Water Board website: http://www.obwb.ca/104/.

The goals of Phase 2 of the Project were to:

- determine the **current** supply of and demand for water throughout the Okanagan Basin;
- develop or select a model (or models) that computes water demand, estimates natural hydrology and groundwater conditions, and routes water from tributaries into main valley lakes and downstream into Osoyoos Lake - that can be used to examine water management alternatives; and
- identify potential **future** changes in both supply and demand and run the model (or models) for several realistic future scenarios.

A Steering Committee with representation from the major funders and other agencies guided the Project. A technical Working Group of about 20 technical experts from various agencies was responsible for Project implementation. A Project Manager and Technical Advisor provided project management services to help the Working Group manage the Phase 2 work program.

A Communication Plan was developed and implemented during Phase 2 of the Project to ensure that First Nations, elected officials, local water managers, and the public were informed about the technical aspects of the study, the results, and the science used to support the recommendations.

Phase 2 was not designed to examine other aspects of water resource than supply and demand, except for a desktop examination of instream flow needs for aquatic species inhabiting tributary streams and lakes in the Basin. In addition, although the results are intended to support a variety of water management decisions, the Phase 2 work and this report are primarily technical in nature.

The Phase 2 work has made optimal use of the existing information base. However, the information used has strengths and weaknesses. Each component of Phase 2 encountered data limitations that restrict the reliability of the conclusions that can be drawn from that information. The findings, conclusions, and recommendations expressed in this report are appropriate for the level of information available. However, the reliability of those findings, conclusions and recommendations would be improved if more and better data were available - the report makes specific recommendations for obtaining such additional data.

Future phases of the Project will extend the Phase 2 work. The Phase 2 Working Group has recommended that Phase 3 focus on:

- Turning results into policy;
- Use and maintenance of the databases and models developed during Phase 2; and
- Updating and improving the Phase 2 data and models.

Specific recommendations for achieving these objectives are provided later in this report.

Organization of this Summary Report

This report summarizes the work completed during Phase 2 of the Project. It is organized into five parts. Part One (Background) provides information necessary to understand the work completed within Phase 2 of the Project. Part Two (Data and Databases) describes the datasets and databases developed during Phase 2, and summarizes the major technical studies. The major technical studies are reproduced in their entirety in electronic form in the Appendices which follow the main report text. Part Three (Models) summarizes the three main models developed during Phase 2: the Okanagan Water Demand Model, the Okanagan Basin Hydrology Model, and the Okanagan Basin Water Accounting Model. These models were developed and calibrated based on the technical studies summarized in Part Two. Part Four (Scenarios) describes the rationale for scenario selection, the 15 chosen scenarios, and scenario outputs. Part Five (Conclusions and Recommendations) lists the major findings of Phase 2 and recommends the next steps for subsequent phases of the Water Supply and Demand Project.

A glossary of technical terms used in the report is provided in Section 21.0, and a list of the acronyms used is provided in Section 22.0.

2.0 PHASE 2 OVERVIEW

This section of the Summary Report provides an overview of Phase 2.

Deliverables

Technical Reports

The core of Phase 2 is the data and information collected by component water supply and demand studies. The following technical reports were produced:

- A User Needs Assessment Report (Appendix A);
- A series of reports on specific aspects of water supply and demand in the Okanagan (these studies are reproduced in electronic form in the Appendices to this Summary Report); and
- A Summary Report (this report) that summarizes the Phase 2 work.

The User Needs Assessment (UNA) was one of the first tasks of Phase 2. It was completed early in the program to capture the input of key water users and reflect their wishes in the design of the work program. The report (ESSA 2007), reproduced in Appendix A, clarified and prioritized user needs, and identified 13 functional requirements for Phase 2. The UNA process also highlighted the challenges of managing the enormous amount of data to be generated; of finding a way to make different models "talk to each other"; and of ensuring ready access to and sharing of this data and knowledge with water authorities and the public, so that it can be easily incorporated into water decision-making.

Technical reports on several independent studies were published during Phase 2. These studies were undertaken to fill information gaps identified during Phase 1, and to provide information required to calibrate the models developed during Phase 2. The following studies were completed and are provided in the Appendices to this Summary Report:

- A groundwater assessment and development of a conceptual groundwater model for the Basin (Section 7.0 and Appendices D and E);
- A surface water study (Section 9.0 and Appendix G);
- An assessment of current water use within the Basin (Section 6.0 and Appendix C);
- A study of evaporation models useful for estimating evaporation from Okanagan Lakes (Section 8.0 and Appendix F); and
- An assessment of instream flow needs for aquatic and other organisms in the Okanagan Basin (Section 10.0 and Appendix H).

New Demand, Supply, and Water Balance Models

Three models were developed during Phase 2:

- The Okanagan Water Demand Model (Section 14.0 and Appendix I);
- The Okanagan Basin Hydrology Model (Section 15.0 and Appendix J); and
- The Okanagan Basin Water Accounting Model (Section 16.0 and Appendix J).

Datasets and Databases

Three databases and a series of climate datasets were developed to support the Phase 2 work:

- The OkWater database (Section 11.0 and Appendix K);
- The Water Demand GIS database (Section 14.0);
- The Okanagan Water Information Reference Library database (Section 12.0 and Appendix L); and
- Gridded climate datasets (Section 5.0 and Appendix N).

The OkWater database is the repository and management tool for technical Project data. It is the bridge between the Project models, and hosts data required by a web-based reporting tool, which is being developed to display results of the Phase 2 work to interested parties over the Internet. Its first function was to host the time series outputs and other data produced by the Project's technical studies, and provide that information to the Okanagan Basin Hydrology Model, which was calibrated using that information. The OkWater database also hosts the output from the Okanagan Water Demand Model, which is used to estimate water use throughout the Basin. That data is delivered from the OkWater database to the Okanagan Basin Water Accounting Model, which calculates the effects of water management on natural flows and lake levels. The Accounting Model results are delivered back to the OkWater database, where they can be viewed by users over the Internet through the web-based reporting tool.

The Water Demand GIS database was developed by the Ministry of Agriculture and Lands (MAL) and Agriculture and Agri-Food Canada (AAFC), and houses all the information needed by the Okanagan Water Demand Model. It contains detailed cadastral maps, as well as maps of soil, irrigation systems, and crop types throughout the developed areas of the Okanagan Basin (areas where irrigation is used). The Demand database also has detailed topographical information (elevation, slope, and aspect) and climate data (daily maximum and minimum temperature and daily precipitation). With this data, the model is able to compute daily irrigation requirements for field-sized parcels of land throughout the developed area of the Basin.

The Okanagan Water Information Reference Library database includes summary information on all the source documents used in Phases 1 and 2 of the Project. A user can search the database for relevant documents using several different information classifications (e.g. subject matter or geographic location). Once identified, summary information on the source document is displayed, and a user can obtain the original document through a hyperlink.

Communication with Stakeholders

The Phase 2 work is scientifically specialized, but the results are intended for use by planners, developers, decision-makers, and others. The Project team has undertaken to provide results in a form that can be understood by a broad audience. Communication has taken the form of:

- A series of presentations to local governments, First Nations, and stakeholders explaining the Project and its results;
- Media releases;
- Presentations at conferences; and
- Development of a web-based reporting tool to provide model output and other information on the current state of water supply and demand at multiple locations within the Okanagan, and on the likely future influences of population growth, climate change, land use change, and other factors.

Project Management and Work Program

The Phase 2 Project Management team included several committees and individuals, each with well-defined roles and responsibilities (Figure 2.1). The individuals who served on the Project team are listed in Appendix M. The Phase 2 work program and schedule is outlined in Table 2.1.

Funding for Phase 2 was obtained from a number of sources:

- Province of British Columbia;
- Okanagan Basin Water Board; and
- Government of Canada (Gas Tax rebate program, Natural Resources Canada, the Canada-B.C. Water Supply Expansion Program).

In-kind contributions of time and expenses were made by all the agencies and organizations listed in Appendix M.

Table 2.1 Phase 2 work program and schedule

Activity	Dates
Establish Steering Committee and Working Group, and complete initial strategic discussions	June - July 2006
Hire a Project Manager and develop detailed work plan and cost estimate	January - April 2007
Conduct a User Needs Assessment	February - April 2007
Conduct technical studies of groundwater, water use, hydrology, lake evaporation, and instream flow needs – needed to calibrate the demand model and the supply model.	May 2007 – October 2009
Update and maintain the Information Database created in Phase 1.	May 2007 – March 2010
Develop a data warehouse (the OkWater database) to house data provided by the technical studies, and results generated by the Project models.	March - August 2007
Extend the MAL/AAFC Agricultural Demand Model by adding non-crop irrigation and indoor water use to create the Okanagan Water Demand Model.	May 2007 – August 2009
Choose an appropriate supply model – the MikeSHE-based Okanagan Basin Water Accounting Model (and its main sub-model, the Okanagan Basin Hydrology Model).	April 2008
Calibrate the chosen models.	April 2008 – November 2009
Choose and run scenarios to illustrate the effects of different future conditions on water supply and demand.	June 2008 – February 2010
Communicate to public and stakeholders.	February 2007 – March 2010
Study Reporting: create stand-alone reports for each major study component; a Summary Report document, and a web-based reporting tool.	December 2007 – June 2010

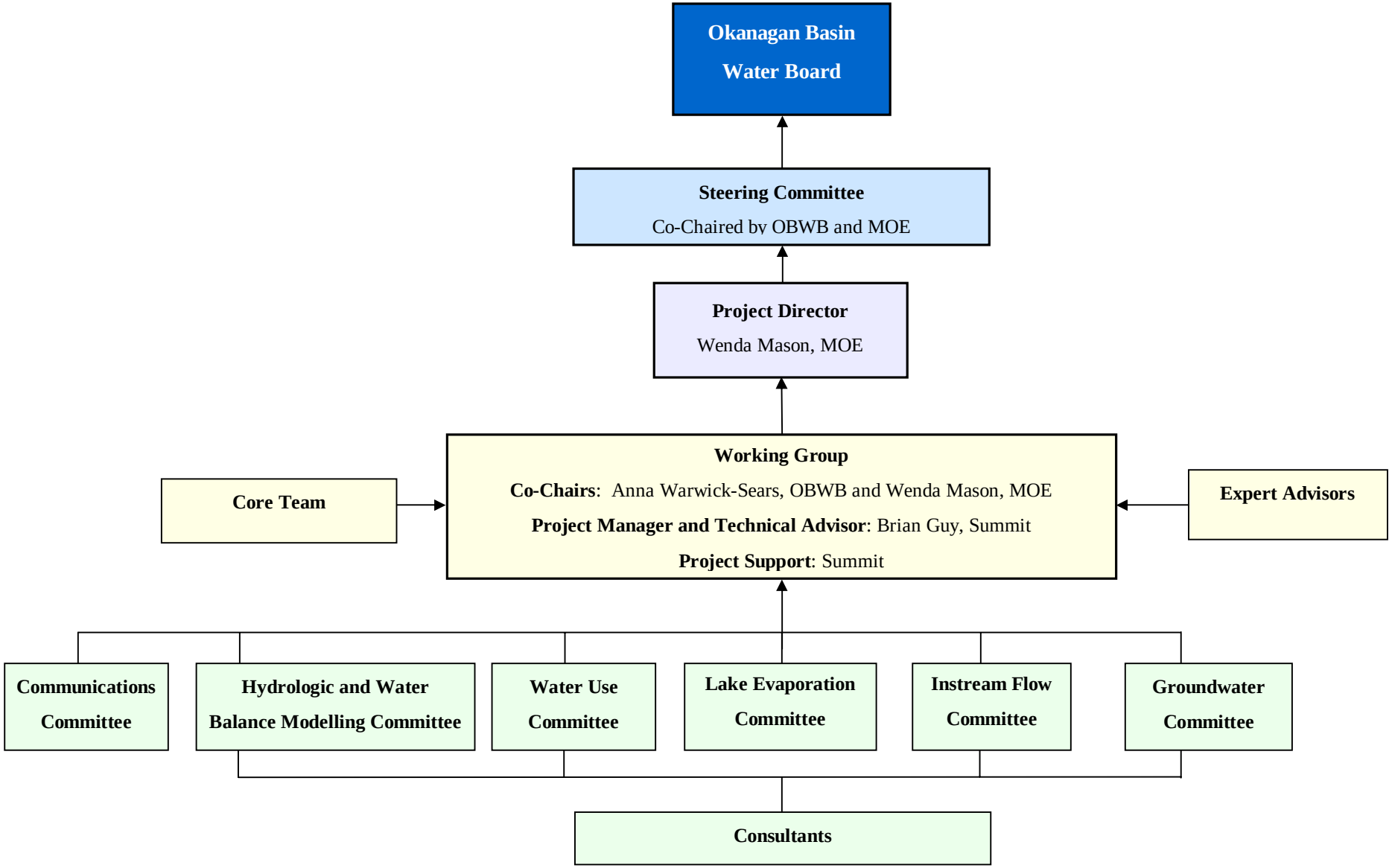

Figure 2.1 Phase 2 organization chart.

PART TWO – DATA AND DATABASES

3.0 PART TWO OVERVIEW

Part Two of the Summary Report summarizes the various datasets, databases, and technical studies completed during Phase 2 of the Okanagan Water Supply and Demand Project. Figure 3.1 is a schematic diagram that illustrates the various studies and the links between them.

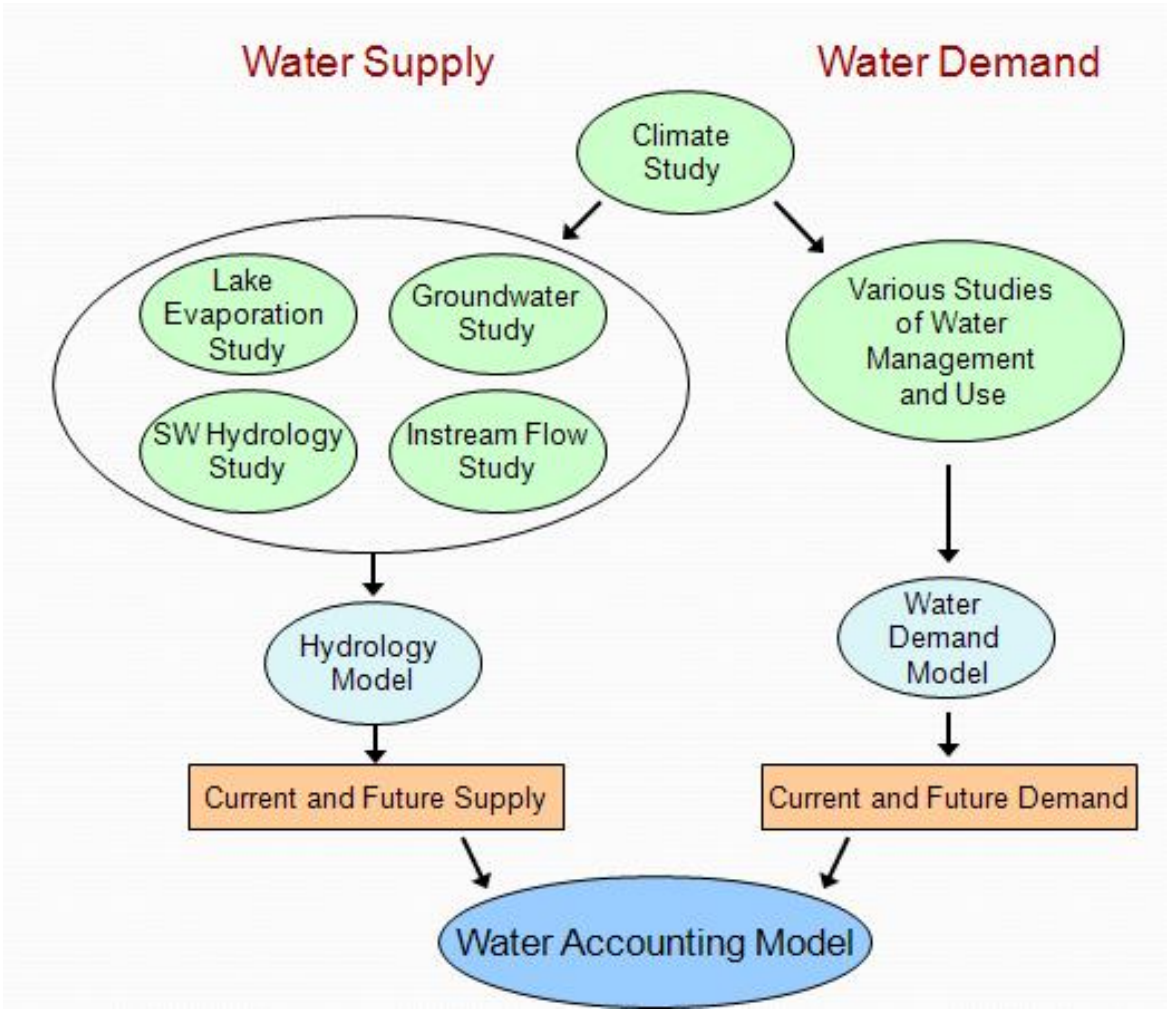

Figure 3.1 Interactions between the various Phase 2 technical studies and models.