

Part A. General Description of the Centre

A1: Summary of Research Plan

The adequacy of healthy fresh water is a concern in Alberta, as it is worldwide. Fresh water resources face progressively greater challenges as a result of increasing human demands and impacts. A deeper understanding of the underlying physical and biological processes, as well as human uses and impacts, is essential for effective management of this critical resource. The Alberta Ingenuity - Advanced Water Research Centre (AWRC) will deliver this fundamental knowledge.

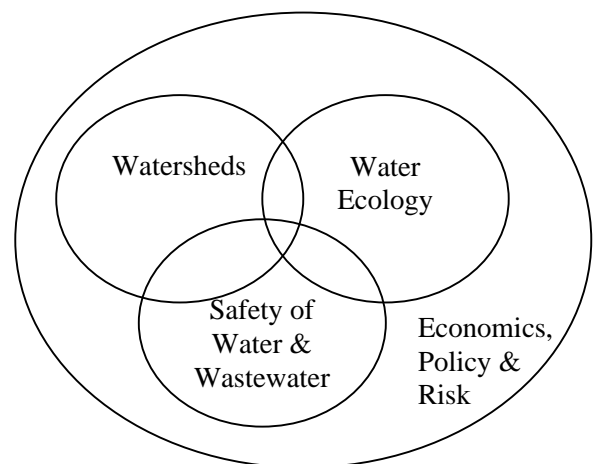
The AWRC is a new and progressive partnership among Alberta's three research universities. Well-established research scientists and engineers will form the Centre's foundation and it will recruit talented water researchers, promote research opportunities for junior colleagues and help to train the next generation of water researchers. The proposed research projects are designed to fill knowledge gaps pertinent to Alberta. The AWRC will be of international caliber, producing high impact journal papers and developing applications specific to Alberta and relevant worldwide.

The AWRC is committed to research excellence and anticipates that its initial success will catalyze its expansion. The Centre will rely on initial funding provided by Alberta Ingenuity and from the three participating universities, which have made substantial commitments including the involvement of ten research chairs. These funds represent an equivalent of roughly \$1.5M annually, to start the program. It is anticipated that within a decade the Centre will grow into a research consortium with \$5 million per year in funding, from public and private sources, conducting collaborations with academic, government and private sector partners.

The interdisciplinary research program, capitalizing on unique opportunities, will focus on a cluster of urgent and fundamental research challenges. The AWRC will investigate the interrelated characteristics of water quantity and water quality relevant to three overlapping theme areas: Watersheds, Water Ecology, and Safety of Water and Wastewater. A fourth, overarching theme will further consider the human dimensions of Economics, Policy and Risk.

In all four themes, comparative analyses will consider river systems in the different ecoregions that uniquely occur in Alberta: the wetter mountains, foothills and boreal forests, the transitional foothills and parkland, and the semi-arid prairies. The provincial geography enables two complementary comparisons: (1) west-to-east transitions along the longitudinal sequence from the mountains to the prairies, and (2) north-to-south transitions along a latitudinal sequence from the boreal forest to the prairies. Some watersheds and rivers are relatively pristine, while others have been altered significantly through damming and diversion, and through other human interventions. The natural diversity of rivers combined with the broad range of human alterations provides a unique opportunity for comparative, experimental, and modeling studies that will extend our understanding of the processes underlying quantity and quality of natural waters.

Figure 1. AWRC Research Themes



The Watersheds theme investigates Alberta's water supplies with consideration for current and future water balances and spatial distributions. Investigations of watershed hydrology will consider potential responses due to changing human uses and climate change. Impacts of land-use practices such as forestry, agriculture and municipal development will be investigated with catchment studies across the different ecoregions. Groundwater resources and interrelationships with surface waters will also be investigated. Watershed studies will investigate water flow and associated flows of nutrients, pollutants, sediments, and organisms.

The Water Ecology theme will investigate the linkages between water quantity and quality, and ecosystem function. Models will be developed for predicting processes that determine the resilience of aquatic and riparian ecosystems and, for example, their susceptibility to species invasions. We will also develop analytical tools that will enable water management to sustain Alberta's natural ecosystems and support the human activities that are reliant on healthy water resources.

The Safety of Water and Wastewater theme will build on our understanding of both watershed inputs and ecological processes that determine water quality which is critical for the health of humans and other organisms. The theme will investigate the processes that impact health such as the occurrence of disease-causing enteric microbes, contribute tools for the detection of pathogens and provide effective water treatment approaches appropriate for different ecoregions facing different challenges. Wastewater treatment is essential for downstream human health as well as for the maintenance of functional water ecology.

The Economics, Policy and Risk theme recognizes that human activities influence our aquatic ecosystems, and in turn, these ecosystems sustain our activities. This theme will develop quantitative tools to assist in the management and allocation of water resources and in refining land-use policies. Knowledge gained will assist in the development of policies that promote environmental sustainability and economic prosperity. Assessing risks will be a key consideration. The knowledge gained will be used to identify future risks on both regional and broader scales and help inform public debate.

The AWRC projects will embrace emerging research technologies. Geomatics tools such as geographical information systems will facilitate analyses of spatial patterns and layering of digital information from the overlapping theme areas. Analytical models capturing essential processes will underpin these spatial analyses. Naturally occurring stable isotopes will be used for tracing transfers of water and solutes. Molecular biology methods will contribute to studies of organisms in the scientific theme areas.

The AWRC will undertake some studies that inventory current conditions but its primary focus will be on the understanding of underlying processes. This understanding will enable quantitative modeling to reveal current patterns and predict future conditions. Specific projects include a strategic mix of short-term low-risk investigations, which will rapidly produce scientific publications and refinement of applications, and higher-risk and longer-term investigations to provide novel insight into fundamental processes and future applications. Thus, the Alberta Ingenuity AWRC will provide an investment into Alberta's future economic prosperity and environmental sustainability and will offer a case study for water resource research and management worldwide.

The program of studies proposed is deliberately ambitious. These studies do not address all relevant aspects of water research but instead the proposal provides an initial, broad program of interdisciplinary study that is considered to be economically and environmentally urgent, scientifically profound and feasible. Not all projects will commence immediately and it anticipated that the AWRC will grow substantially in funding to allow for these different studies and for the future expansion in scope and scale.