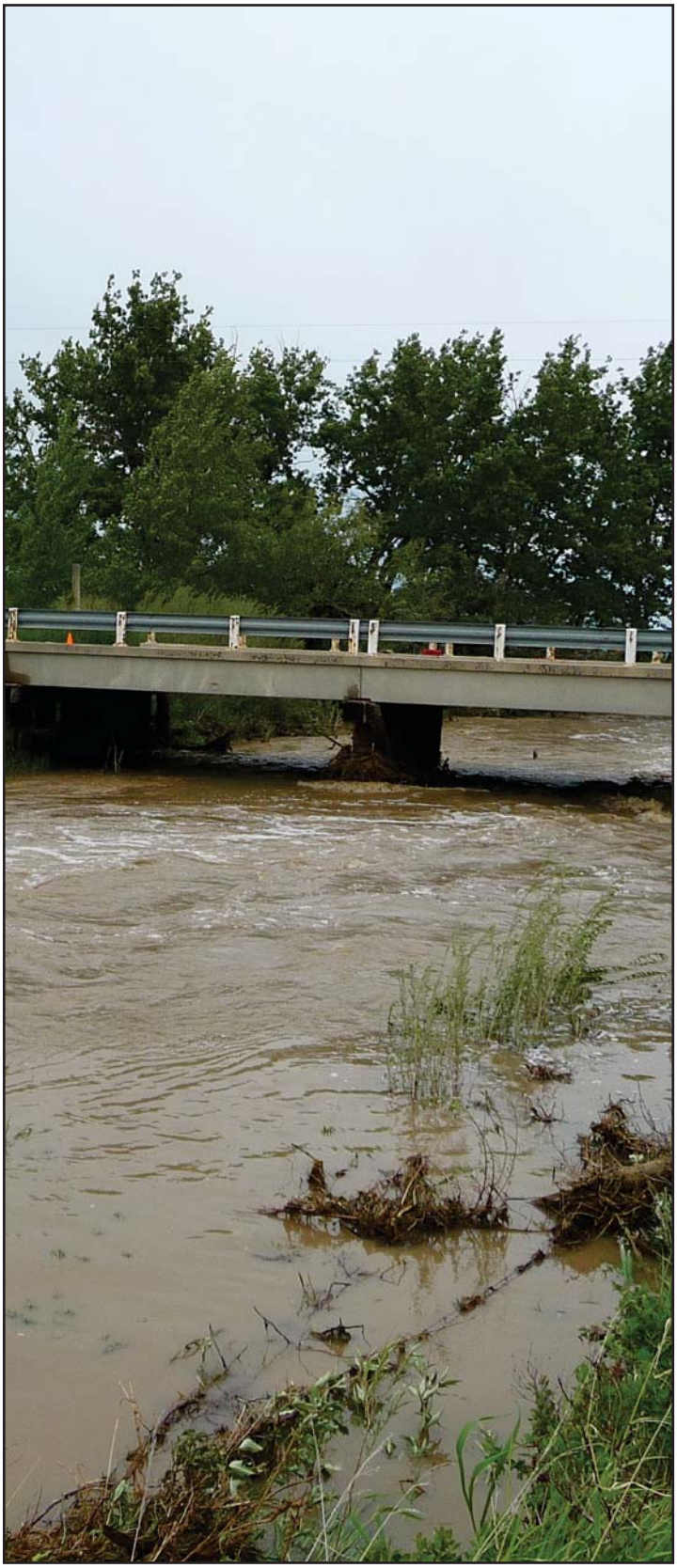
SECTION 1
INTRODUCTION

1.1 Background

Alberta crop and livestock producers face challenges of increasing input costs, market competition, and continued pressure to improve environmental stewardship. Producers are seeking proven management practices that will allow them to maintain efficient and viable operations while protecting the environment.

In recent years, the impact of agriculture on the environment has been focused on livestock production, and in particular the intensive livestock industry and manure management. As the impacts of agriculture on the environment are being determined, numerous beneficial management practices (BMPs) have been developed and promoted to minimize the impacts on the environment and increase the sustainability of the agricultural industry. While several BMPs have been developed for managing manure from the livestock industry, and nutrient management in general, it is unlikely that one BMP will effectively utilize manure nutrients for crop growth and at the same time reduce all negative environmental impacts. It is more realistic that a combination of management practices will result in improved nutrient retention for crop growth and reduced environmental impacts (Bishop et al. 2005). Sustainable agriculture combines optimum agricultural productivity and profitability without damaging the environment, especially soil and water resources. Beneficial management practices are practical control measures (including technological, economic, and institutional considerations) that have been demonstrated to effectively minimize environmental impact (Ice 2003).

The effectiveness of BMPs under Alberta conditions is not well known. This is, in part, because many BMPs were developed in other parts of North America or at a research plot scale. Individual BMPs have rarely been evaluated under Alberta conditions (Wuite and Chanasyk 2003) and recent studies have recommended further research, especially with



respect to phosphorus management (Paterson et al. 2006). In addition, producers are requesting site-specific, risk-based analytical tools to assist them in deciding which management practices would yield the greatest impact for their financial investment. Science-based proof is needed to show that these practices reduce risks to producers, gain environmental advantages, and provide options for producers to meet regulatory requirements in Alberta. Producers and policy makers require information on the least-cost alternatives for decreasing environmental impacts, and this requires an economic analysis of costs and benefits to the producer and the environment. In addition, without information on the impact of management practices on nutrient utilization, prediction tools cannot provide the degree of accuracy producers need to make management decisions.

Although BMPs were promoted and supported through past programs such as the Alberta Environmental Farm Plan, Alberta Environmentally Sustainable Agriculture Program, and the Canada-Alberta Farm Stewardship Program, and currently promoted through the Alberta Stewardship Network (ASN 2011) and Growing Forward (ARD 2011a), there is limited research to show the cumulative effects of BMPs on the environment and specifically the health of watersheds.

At the farm scale, and particularly at the watershed scale, research becomes more difficult because fewer factors can be controlled, replication is less feasible, and large-scale studies are expensive. In spite of the challenges involved with this type of research, several individual studies and large research projects have studied the effectiveness of BMPs at field and watershed scales, and in some cases carried out economic analysis. Examples of two major research projects include the Watershed Evaluation of Beneficial Management Practices (WEBs) Project in Canada (AAFC 2010) and the Conservation Effects Assessment Project (CEAP) in the United States (USDA 2011). Although there was one research watershed under the original WEBs Project in Alberta (Miller 2008), additional sites were needed because of the diverse agro-climatic regions in the province.

1.2 Project Objectives

This project will examine nutrient management, with a focus on livestock production systems. The project will evaluate several BMP categories including manure management by land application (nutrient management), wintering site management, and riparian management. The specific project objectives are:

- Evaluate the effectiveness of individual nutrient BMPs in reducing agricultural impacts on the environment at the farm scale.
- Assess the impacts of selected BMPs on the water quality in specific reaches of the stream in the watershed.
- Predict the cumulative impacts of selected BMPs on the overall quality of the watershed stream using models.
- Evaluate nutrient management BMPs for effective use of manure in crop production.
- Assess economic costs and benefits associated with individual BMPs implemented in this study.
- Investigate the ability to determine the source of nutrient loss to the environment, i.e., manure or fertilizer.

1.3 Experimental Approach

There are several experimental and statistical approaches used to evaluate BMPs at field and watershed scales. Overviews of these approaches are in the literature, such as Spooner et al. (1985), Hirsch et al. (1991), and Walker (1994).

In our study, we adopted the before-and-after approach. The main focus will be on water quality, but other indicators, such as rangeland and riparian health will be assessed, where applicable. The strength of the study will be to examine the effectiveness of individual BMPs within watersheds. In addition, watershed-wide assessments of water quality, land use, and economics, as well as the information obtained from individual BMP sites, will be used in a modelling exercise to predict BMP influence on agricultural watersheds in Alberta.

The selected BMP sites will be monitored for 2 to 3 yr under existing management practices. This will provide the current status of various indicator parameters (e.g., water quality, riparian health) under current management practices. This is referred to as the pre-BMP phase. Then the BMPs will be implemented and the sites monitored for another 2 to 3 yr. This will be the post-BMP phase. Regarding water quality parameters, the monitoring method at BMP sites was either upstream and downstream monitoring, or edge-of-field monitoring, or a combination of these two monitoring methods for some BMP sites.

1.4 Selection of Sites

Two main watersheds were selected for this study, as well as two individual field sites in two other watersheds. The watersheds are the Indianfarm Creek (IFC) Watershed near Pincher Creek and the Whelp Creek (WHC) Sub-watershed near Lacombe. The other two watersheds, with a single field selected in each, are the Battersea Drain and the Lower Little Bow River watersheds, both northeast of Lethbridge (Figure 1.1).

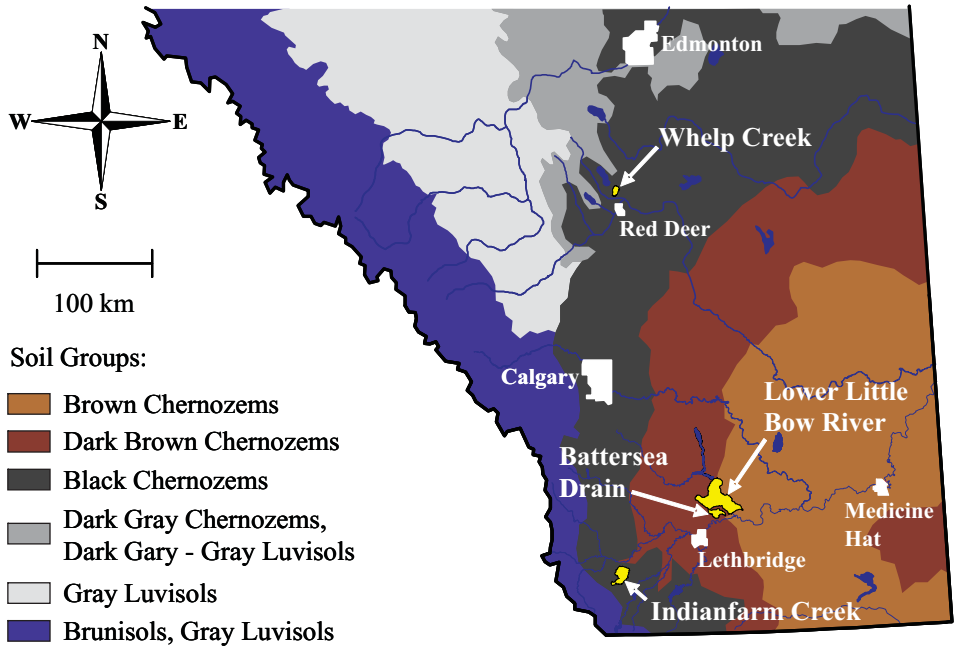


Figure 1.1. Location of the Indianfarm Creek, Whelp Creek, Battersea Drain, and Lower Little Bow River watersheds relative to the soil groups in Alberta. Based on a map adapted from Alberta Agriculture, Food and Rural Development (2005a).

Several factors were considered when selecting watersheds in Alberta for this project. These included physical factors, agricultural factors, and level of cooperation by local producers. The primary physical factor considered was the level of hydrological activity. We required watersheds that would likely generate runoff within the 6-yr period of the project. Travel distance to the watersheds and access within the watersheds were also considered. In terms of agriculture factors, watersheds had to be agriculturally intensive and diverse, with little or no non-agricultural influences on the landscape. The level of diversity required a range of livestock operations, forage production, rangeland, and annual crop production. The initial assessment of agriculture intensity and diversity also provided an indication of possible opportunities to implement and test BMPs in the watersheds. The final factor used to select watersheds was the level of cooperation from local producers.

Based on the methodology described by Anderson et al. (1999) and Johnson and Kirtz (1998) and used for the Alberta Environmentally Sustainable Agriculture Water Quality Monitoring Project (Lorenz et al. 2008), the IFC Watershed was rated as moderate agriculture intensity and the WHC Sub-watershed was rated as high agriculture intensity. Agriculture intensities were determined based on agriculture census data of pesticide expenses, fertilizer expenses, and manure production. A description of the selected watersheds is in the 2007 Progress Report (Olson and Kalischuk 2008) and updates in the 2008 and 2009 Progress Reports (Olson and Kalischuk 2009, 2010). Further information and updates are provided in the current report in Section 2 for the IFC Watershed, in Section 3 for the WHC Sub-watershed, in Section 4 for the Battersea Drain Field (BDF) site, and in Section 5 for the Lower Little Bow River Field (LLB) site.

Within the IFC and WHC watersheds, several sites were selected to assess individual BMPs. There are seven original sites in the IFC Watershed: Impoundment site, Wintering site, Pasture site, North Manure Field site, South Manure Field site, Dairy Manure Field site, and Reference site. In 2010, four additional BMP sites were established: Fencing site, Dugout site, Off-stream Watering site, and Feedlot site. Six BMP sites and two Reference sites were established in the WHC Sub-watershed. The six BMP sites include the North Field, West Field, South Field, East Field, North Pasture, and South Pasture. Further information about the BMP sites is presented in Olson and Kalischuk (2008, 2009, 2010) and in the following sections.

1.5 Current Report and Timeline Status

This report is the fourth progress report of the 6-yr Nutrient BMP Evaluation Project. The first progress report provided (1) background information; (2) a description of the establishment and first year of monitoring of the IFC Watershed, BDF site, and LLB site; and (3) a description of the establishment of the WHC Sub-watershed (Olson and Kalischuk 2008). The second progress report provided information on (1) the second year of pre-BMP monitoring in the IFC Watershed and at the BDF and LLB sites, (2) the first year of monitoring of the WHC Sub-watershed, and (3) a description and initial work on the modelling component (Olson and Kalischuk 2009). A description of two synoptic water quality surveys carried out in the IFC Watershed and an introduction to potential groundwater influence in the WHC Sub-watershed were also presented in the second progress report. The third progress report summarized the results of synoptic survey carried out in the WHC Sub-watershed, as well as a description of the initial groundwater field work in the sub-watershed (Olson and Kalischuk 2010). Preliminary comparisons between the pre- and post-BMP phases at some of the IFC BMP sites and at the BDF and LLB sites were also highlighted in the third report.

In this report, a description is provided of 4 yr of monitoring in the IFC Watershed and the BDF and LLB sites and 3 yr of monitoring in the WHC Sub-watershed. The intent was to initiate the BMPs after the second year of pre-BMP monitoring at all the sites (Olson and Kalischuk 2008).

After 2 yr of pre-BMP phase monitoring, BMPs were implemented at the BDF, LLB, Impoundment, and Wintering sites. However, for various reasons, it was determined that for the other BMP sites in the IFC Watershed there was not enough data to establish an adequate pre-BMP database for comparison to the post-BMP phase. Beneficial management practices were initiated at the Pasture, North Manure Field, and Dairy Manure Field, and Reference sites (Figure 1.2). Beneficial management practices were not implemented at the South Manure Field in 2010. This report also describes the establishment of four new BMP sites in the IFC Watershed.

Two years of pre-BMP monitoring have been carried out in the WHC Sub-watershed (2008 and 2009) and BMPs were implemented at the four nutrient management sites and the two pasture sites in 2010 (Figure 1.2). Also presented are the initial results from the groundwater investigation in the sub-watershed.

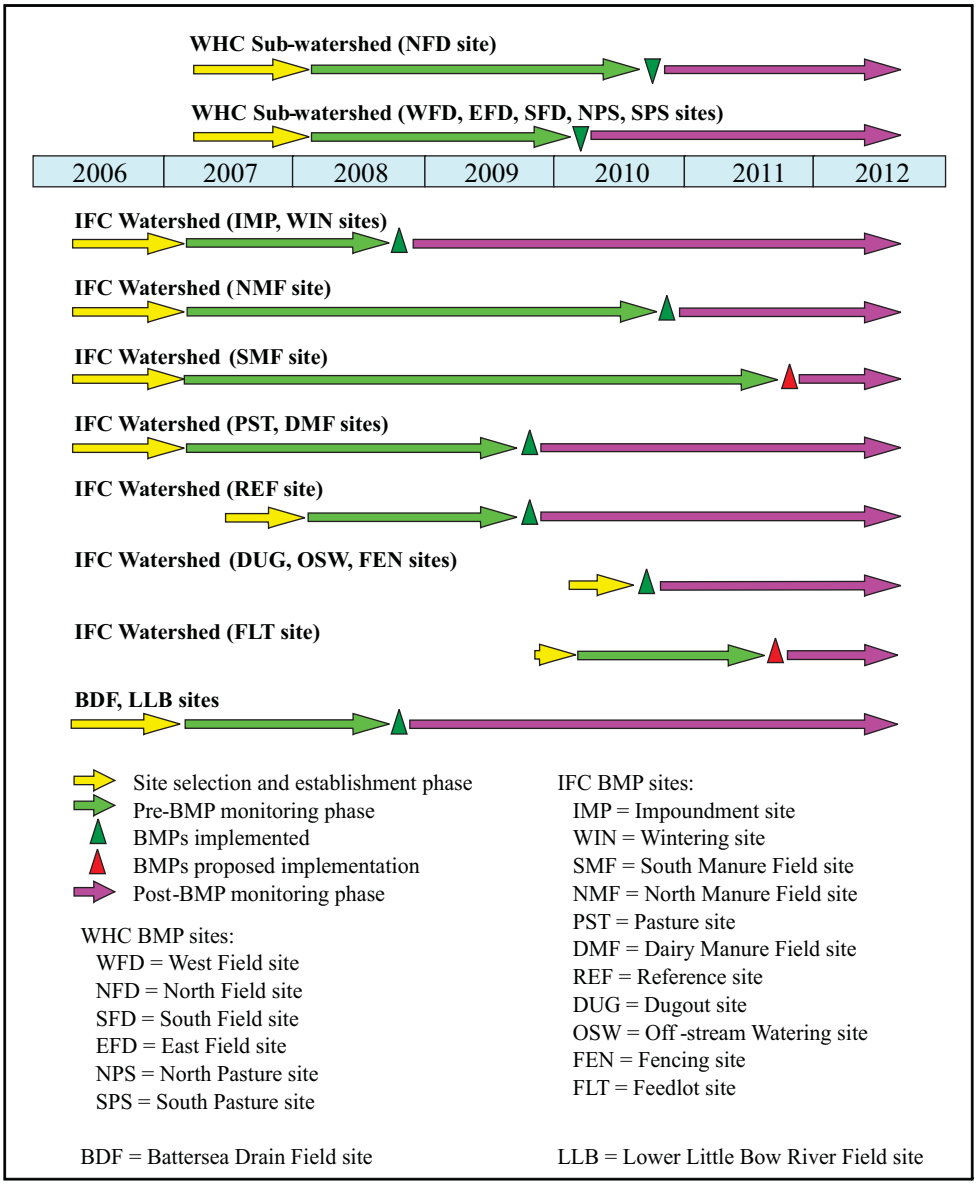


Figure 1.2. Revised project timeline and major phases for the Indianfarm Creek (IFC) Watershed, Battersea Drain Field (BDF) site, Lower Little Bow River Field (LLB) site, and the Whelp Creek (WHC) Sub-watershed.