

# 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 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. Beneficial management practices are practical control measures (including technological, economic, and institutional considerations) that have been demonstrated to effectively minimize environmental impact (Ice 2003). 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.

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 that these practices reduce risks to producers, gain economic and 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 are promoted and supported through programs such as the Alberta Stewardship Network (ASN), Alberta Environmental Farm Plans (AEFP), Alberta Environmentally Sustainable Agriculture Program (AESAP), and the Canada-Alberta Farm Stewardship Program (CAFSP), there is limited research to show their cumulative effects 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 more 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 2007) and the Conservation Effects Assessment Project (CEAP) in the United States (USDA 2008). Even though there is one research watershed under the WEBs Project in Alberta (Miller 2008), additional sites are 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 focus of the project will evaluate three BMP categories: 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

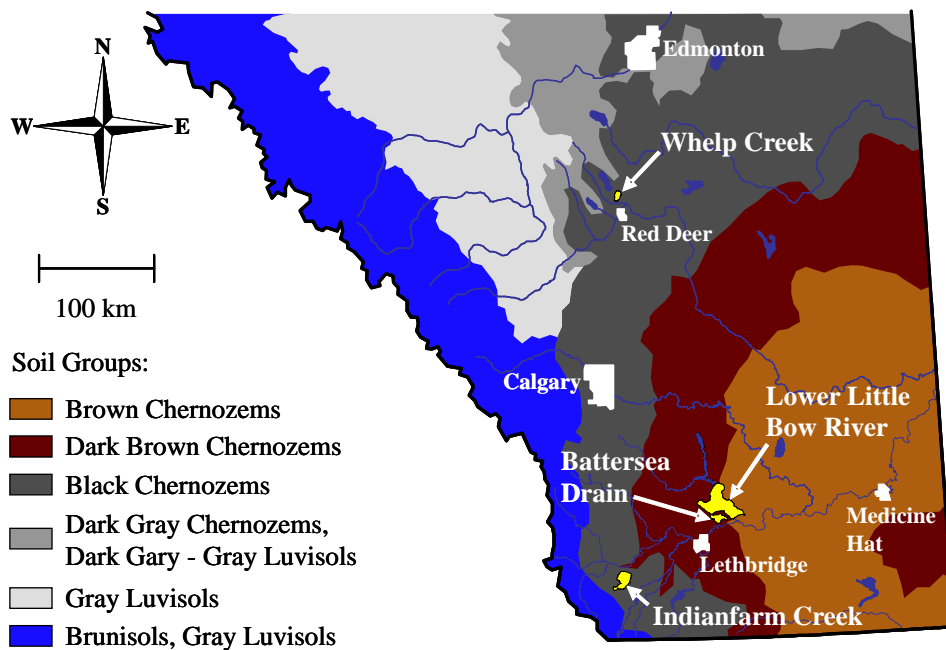
There are several experimental and statistical approaches used to evaluate BMPs at field and watershed scales. Overviews of these approaches are in the literature, such as Spooner et al. (1985), Hirsch et al. (1991), and Walker (1994).

In our study, we have 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 as well, 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 modeling exercise to predict BMP influence on agricultural watersheds in Alberta.

The selected BMP sites will be monitored for 2 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 applied 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 will either be upstream and downstream monitoring, or edge-of-field monitoring, or a combination of the two monitoring methods for some BMP sites.

### 1.4 Site Selection

Two main watersheds were selected for this study, as well as two individual field sites in additional 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 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 (2005).*

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 5-yr period of the project. Travel distance to the watersheds and access within the watershed 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.

A description of the selected watersheds is in the 2007 Progress Report (Olson and Kalischuk 2008). Further information and updates are provided in the current report in Section 2 for the Indianfarm Creek Watershed, in Section 3 for the Whelp Creek Sub-watershed, in Section 4 for the Battersea Drain Field Site, and in Section 5 for the Lower Bow River Field site.

Within the IFC and WHC watersheds, several sites were selected to assess individual BMPs. Seven sites were selected in IFC: Impoundment Site, Wintering Site, Corral Site, Pasture Site, North Manured Field, South Manured Field, and Dairy Manured Field. Though, initially selected as individual BMP assessment sites, the Corral and Pasture Sites are within the same land management unit and will be combined into one BMP assessment. In addition, a Reference Site was established and monitored in 2008 in the IFC Watershed. Five BMP sites and two Reference Sites were established in the WHC Sub-watershed. The five BMP sites include the North Field, West Field, South Field, East Field, and Whelp Pasture. Further information on the BMP sites is presented in Olson and Kalischuk (2008) and in the following sections.

## **1.5 Current Report and Timeline Status**

This report is the second progress report of the 5-yr Nutrient BMP Evaluation Project. The first progress report provided background information; a description of the establishment and first year of monitoring of the IFC Watershed, BDF Site, and LLB Site; and a description of the establishment of the WHC Sub-watershed (Olson and Kalischuk 2008).

In this report, a description of 2 yr of pre-BMP monitoring for the IFC Watershed and the Battersea Drain Field (BDF) and Lower Little Bow Field (LLB) sites and 1 yr of pre-BMP monitoring for the WHC Sub-watershed is provided. The 2007 and 2008 data for IFC, BDF, and LLB sites are presented and BMP options discussed. The intent was to initiate the BMPs after the second year of pre-BMP monitoring at the IFC, BDF, and LLB sites as shown in the original project timeline (Figure 1.2). The BMPs were implemented at the BDF, LLB, Impoundment, and Wintering sites. However, for various reasons, it was determined that for some of the BMP sites there was not enough data to establish an adequate pre-BMP database for comparison to the post-BMP phase. It was decided to extend the pre-BMP monitoring phase into 2009 for the Corral, Pasture, North Manured Field, South Manured Field, and Dairy Manured Field sites in the IFC Watershed (Figure 1.3). Also, a Reference Site was established and monitored in the IFC Watershed in 2008.

One year of pre-BMP monitoring was carried out at the BMP sites in the WHC Sub-watershed in 2008. The second year of pre-BMP monitoring will be carried out in 2009.

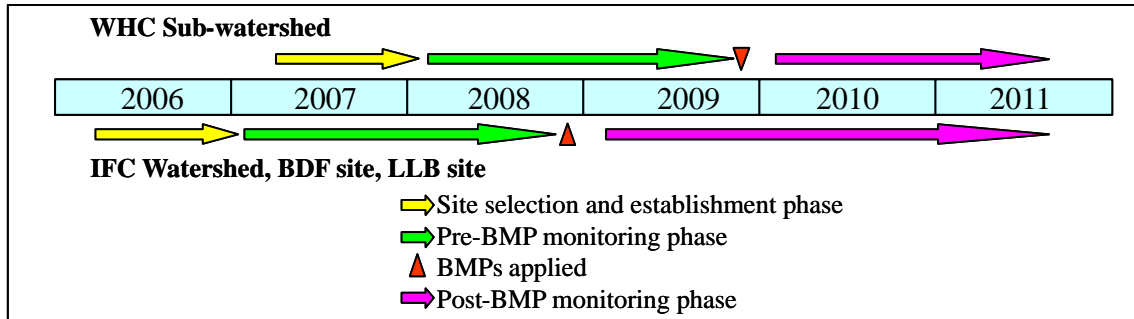


Figure 1.2. Original project timeline and major phases for the Indianfarm Creek (IFC) Watershed, Battersea Drain Field (BDF) site, Lower Little Bow Field (LLB) site, and the Whelp Creek (WHC) Sub-watershed (Olson and Kalischik 2008).

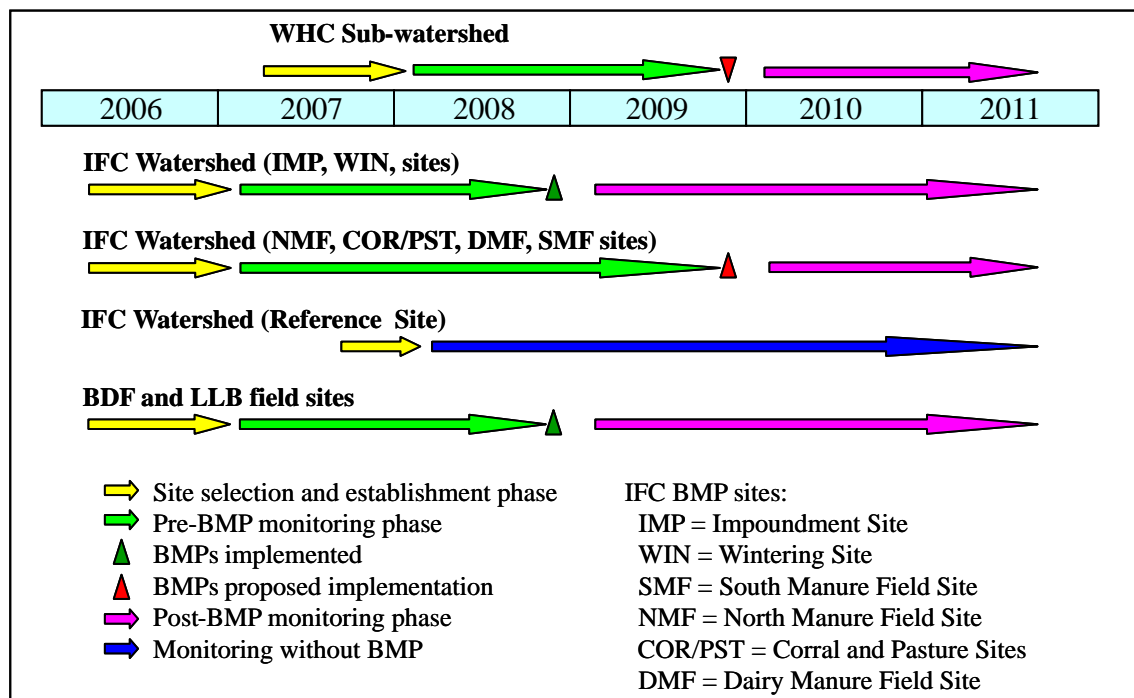


Figure 1.3. Revised project timeline and major phases for the Indianfarm Creek (IFC) Watershed, Battersea Drain Field (BDF) site, Lower Little Bow Field (LLB) site, and the Whelp Creek (WHC) Sub-watershed.

