SECTION 2
SELECTION OF WATERSHEDS AND ADDITIONAL FIELD SITES

2.1 Selection Approach

Two main watersheds were selected for this study, as well as two individual field sites in additional watersheds. Several factors were considered when selecting watersheds in Alberta for this study. 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 study. 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 beneficial management practices (BMPs) in the watersheds. The final factor used to select watersheds was the level of cooperation from local producers. This study requires the installation of monitoring equipment and the implementation of BMPs on farms within the watersheds. The design and the implementation of BMPs will be carried out in partnership with local producers, and without producer cooperation, working in a given watershed would not be possible. Our goal was to establish five to seven BMP sites within each the two main watersheds.

2.2 Indianfarm Creek Watershed

Indianfarm Creek (IFC) Watershed is approximately 100 km west of Lethbridge (Figure 2.1). The approximate centre of the watershed is at 49.43° N, 113.87° W. The watershed is within Township 6 - Range 20,

Township 6 - Range 29, Township 5 - Range 30, and Township 5 - Range 29 - west of the fourth Meridian. The Town of Pincher Creek borders along part of the northwest boundary of the watershed and is the only urban centre near the watershed. Total area of the IFC watershed is 14,624 ha (146.24 km^2), or approximately 56 sections of land.

The IFC Watershed lies in the Foothills Fescue Subregion, which is part of the Grassland Natural Region of the Alberta natural region classification. Natural regions consist of mountain rough fescue on moister areas, and western wheatgrass on drier areas. Wet areas often have shrubs. The watershed is in a relatively high precipitation zone of Alberta and the surface topography is well drained. The 30-yr average (1971 to 2000) annual precipitation for nearby Pincher Creek is 515 mm (Environment Canada 2008). The highest precipitation falls in May (76.2 mm) and June (71.2 mm) followed by July (56.0 mm), September (51.4 mm), and August (51.2 mm) (Environment Canada 2008). The annual runoff for IFC Watershed is estimated to be approximately 78 mm (Bell 1994). The 30-yr average annual daily temperature for Pincher Creek is 5.0 °C. The monthly averages range from -6.7 °C in January to 16.5 °C in July (Environment Canada 2008).

The IFC Watershed is in the Black Soil Zone (Figure 2.1), with Orthic, Calcareous, and Rego Chernozemic soils, as well as some Gleysolic soils present (Alberta Soil Information Centre 2001). Common soil series include Cardston, Beazer, Ockey, Cowley, and Oldman in the north part of the watershed, and Dunvargan and Fish Creek in the southern part of the watershed. The soils are

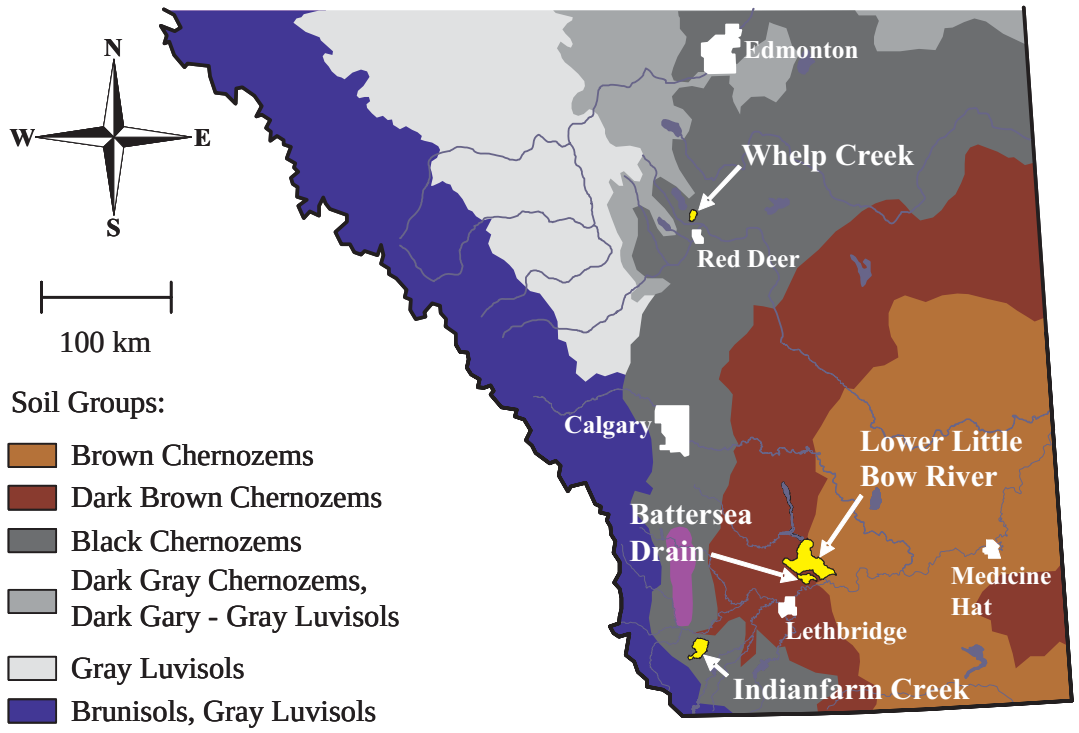

Figure 2.1. Location of the Indianfarm Creek, Whelp Creek, Battersea Drain, and Lower Little Bow River watersheds relative to the soil groups in Alberta. Based on a map adapted from Alberta Agriculture, Food and Rural Development (2005).

generally fine textured, including clay, silty clay, clay loam, and loam. While the soils are productive, the area is limited by the length of growing season especially in the southern end of the watershed (Canada Land Inventory 1968). The soils are susceptible to wind and water erosion.

Topography is undulating with low to high relief and hummocky with low relief. Slopes in the southern portion of the watershed are short, complex and range from 2 to 9%. In the northern portion of the basin, the slopes are much longer and simpler, ranging from 2 to 5% with some areas of 5 to 9%. The dividing area between the south and north portions of the watershed is very steep with slopes ranging from 12 to 20%. The northern part of the watershed is of lower elevation compared to the southern part, with about a 500-m difference between the lowest and high elevation points (Figure 2.2a).

Indianfarm Creek itself (Figure 2.3c,d) flows in the south and east portions of the watershed with the major drainage flowing from south to north. Three smaller tributaries drain the north-central and northwest portions of the watershed, and these tributaries flow into the north end of Indianfarm Creek. Indianfarm Creek flows into Pincher Creek, which in turns flows into the Oldman River. Indianfarm Creek is ephemeral, primarily driven by snowmelt and rainfall. Flows from the outlet of IFC to Pincher Creek generally occur from March to July. A Prairie Farm Rehabilitation Administration dam, the Therriault Dam, was constructed in the 1970s on Indianfarm Creek in Section 27 - Township 5 - Range 29 - west of the fourth Meridian. The reservoir is filled during snowmelt and rainfall runoff events. When water is required by downstream users during the summer months, it is released from the dam. Depending on the weather, this may occur several times per year.

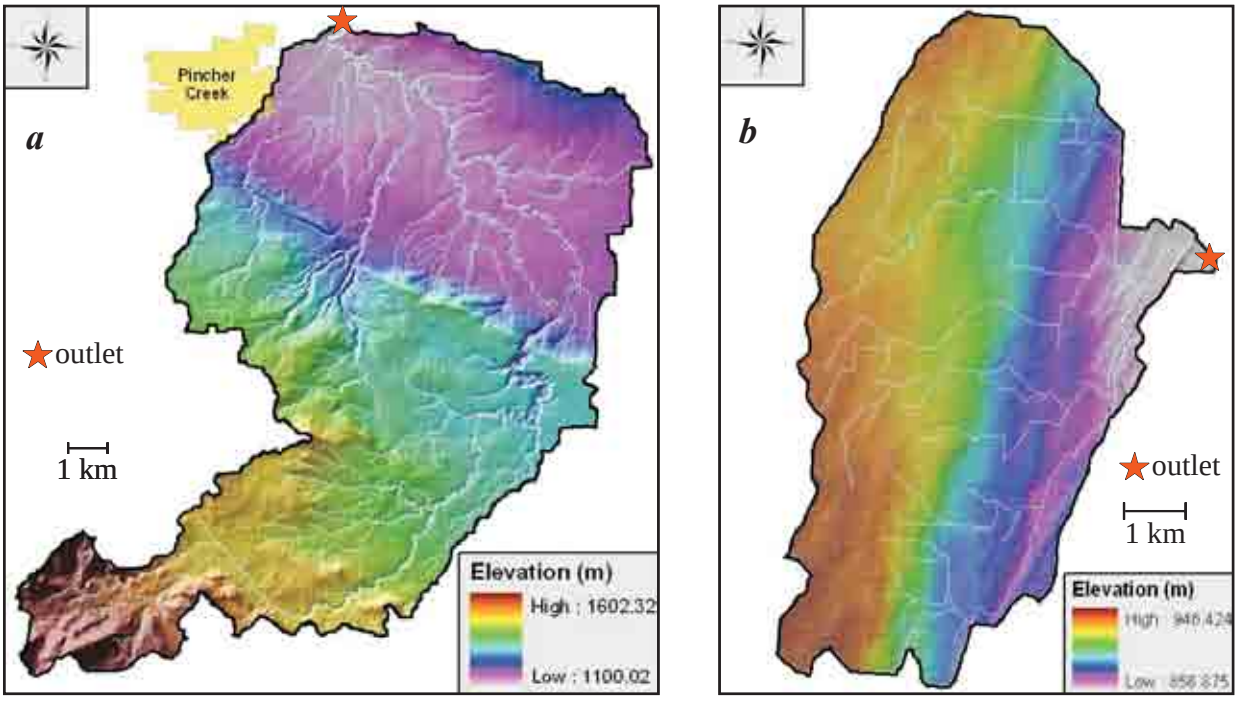

Figure 2.2. Topography of the (a) Indianfarm Creek Watershed and (b) Whelp Creek Sub-watershed.

Figure 2.3. Indianfarm Creek Watershed as viewed (a) to the north along the northwest side of the watershed, with the Town of Pincher Creek in the background, and (b) from the north side of the watershed looking across the watershed towards the west-southwest. Portions of Indianfarm Creek itself are shown in the bottom two images.

Agriculture is the primary land use in the watershed and was established in the area in the 1880s. Several producers have been established in the IFC watershed for many years with second and third generation families still on their original properties. Annual cereal crop and livestock production dominate. Annual crop production is dominated by barley. Forages are also produced, and native range and improved pasture are maintained for cow-calf production. Livestock production is the other major agricultural component. There are several beef cattle confined feeding operations in IFC ranging in size from approximately 14,000 head to less than 50 head. There are also several cow-calf operations and a 50-head dairy operation.

2.3 Whelp Creek Sub-watershed

The Whelp Creek Sub-watershed (WHC) is north of Red Deer (Figure 2.1) and approximately 6 km west from the Town of Lacombe. The majority of this sub-watershed is located within Township 40 - Range 27; however, a small southern portion is in Township 29 - Range 27 west of the fourth Meridian. The approximate centre of the watershed is at 52.43^{o} N, 113.88^{o} W. The total drainage area delineating the sub-watershed is approximately 4,500 ha (45 km^{2}), or 17 sections of land.

The Whelp Creek Sub-watershed lies in the Central Parkland Subregion, which is part of the Parkland Region of the Alberta natural region classification. Natural areas consist of aspen and balsam poplar forests, along with numerous lakes and permanent wetlands in low areas. The 30-yr average (1971 to 2000) annual precipitation for Lacombe is 446 mm (Environment Canada 2008). The highest precipitation falls in June (75.7 mm) and July (89.4 mm) followed by August (70.8 mm) and May (55.6 mm) (Environment Canada 2008). The annual runoff for WHC is estimated to be approximately 38 mm (Bell 1994). The 30-yr average annual daily temperature at Lacombe is 2.6 °C. The monthly averages range from -12.3 °C in January to 15.4 °C in July (Environment Canada 2008).

Whelp Creek flows from the northwest corner of the sub-watershed in a south direction then turns and flows east until meeting up with the southern tributaries and flows under Highway 2, which is the outlet of the sub-watershed. Whelp Creek continues to flow north for about 30 km and eventually empties into the Battle River near Ponoka, Alberta. Whelp Creek and its tributaries, within the sub-watershed, are small intermittent streams, typically only flowing in the late winter, early spring, and the summer months following snowmelt or extreme rain runoff. Unlike IFC, the stream beds are usually undefined with shallow channelization (Figure 2.4a). These characteristics combined with the variability of the weather enables producers, during some years, to cultivate through the creek and tributaries (Figure 2.4b).

Whelp Creek Sub-watershed is in the Black Soil Zone (Figure 2.1b). This area includes the Orthic and Eluviated Chernozem subgroups (Alberta Soil Information Centre 2001). Also found in WHC are Solodized Solonetzic and Gleysolic Black soils along with their subgroups: Black Solodized Solonetz and Orthic Humic Gleysol. Throughout the sub-watershed, common soil series include Penhold, Cygnet, and Lonepine (Alberta Soil Information Centre 2001). Soils are of a medium texture, composed of loam and silty loam, which were deposited by wind and water, and loam, clay loam, and silty clay loam, which was deposited over medium (Cygnet) or fine (Lonepine) textured till (Alberta Soil Information Centre 2001). Issues surrounding the soil types within WHC include poorly drained soils (Alberta Soil Information Centre 2001) and water erosion (Lacombe County 2007).

In a broad sense, the Central Parkland has a gently rolling landscape and serficial deposits range from intermediate textured hummocky and ground moraines to fine textured glaciolacustrine

deposits and coarse outwash (Alberta Parks 2006). Specifically for WHC, the topography is undulating with high relief landforms (Figure 2.4c). When broken down into 20 smaller sub-watersheds, the slope of the land varies from 0.5 to 2.25%. The sub-watershed slopes downward from west to east, with about a 90-m difference between the lowest and highest elevation points (Figure 2.2b).

Development and cultivation in the area have modified the land cover and native vegetation. Today, like IFC, the primary land use in WHC is agriculture with annual cereal crops and livestock dominating the agricultural activities in the watershed. A large portion of the land is cultivated, and the majority is used for barley; however, canola, potato, wheat, and corn are also grown. In addition to cultivated crops, hay crops and pasture cover 1430 ha of land within WHC. Livestock land use includes three hog operations, ten dairy operations, and seven feedlot operations. The largest feedlot in the sub-watershed has approximately 1800 head at full capacity. In addition to agriculture, the oil and gas sector is active and becoming more prevalent in the WHC sub-watershed.

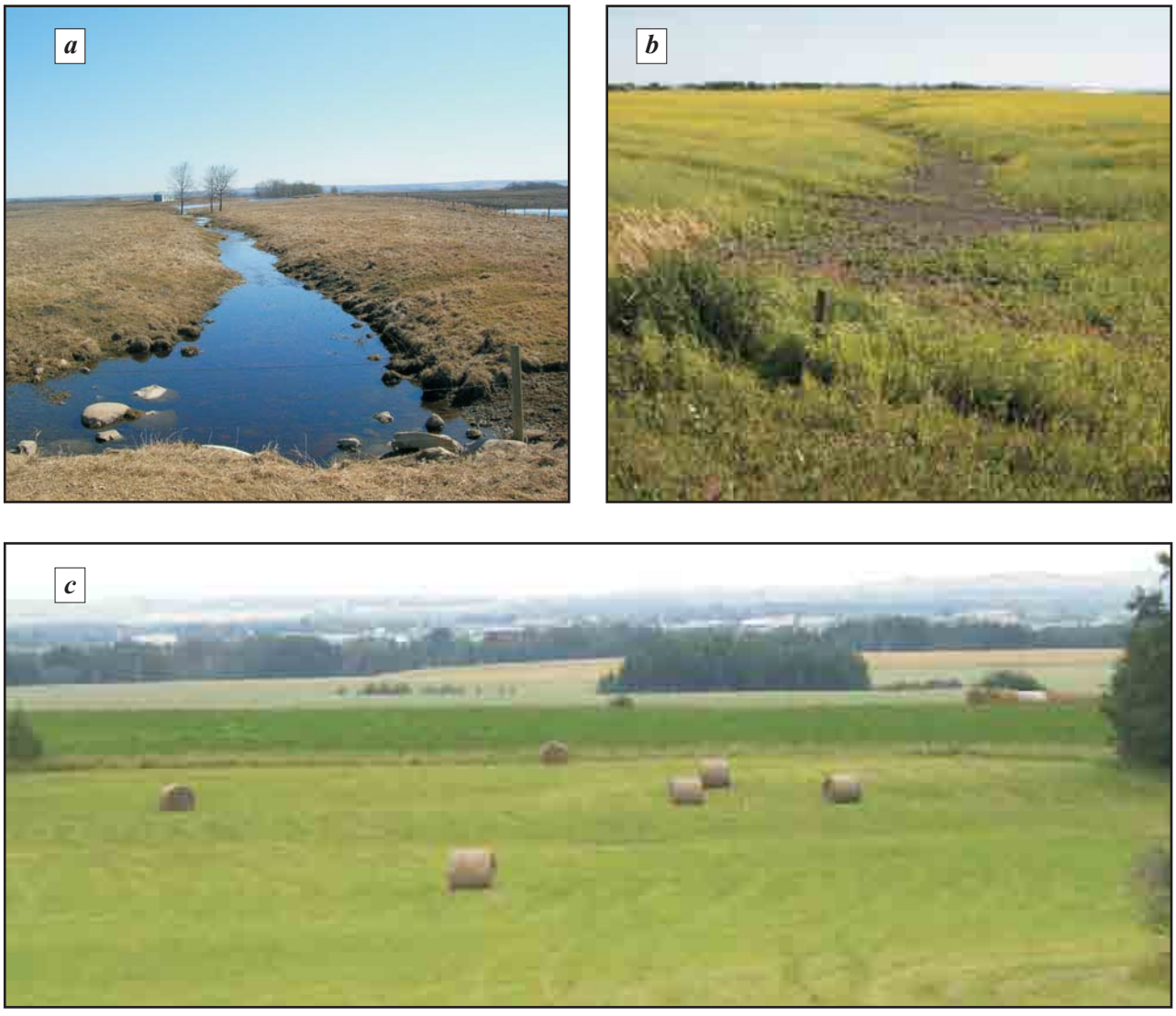

Figure 2.4. Views of the Whelp Creek Sub-watershed including (a) portion of Whelp Creek itself, (b) a farmed-through tributary, and (c) the general landscape.

2.4 Field Sites in the Battersea Drain and Lower Little Bow River Watersheds

Preliminary soil analysis carried out for IFC indicated that nutrient levels were not excessive in the watershed. To include sites that had high soil nutrients, particularly phosphorus (P), two field sites outside of the IFC and WHC Watersheds were selected: one in the Battersea Drain Watershed and the other in the Lower Little Bow River Watershed (Figures 2.1 and 2.5). Previous research work at these two field sites showed high P in the soil as a result of cattle manure application. These two field sites, with high soil-test phosphorus (STP) levels, were chosen to evaluate manure management.

The two watersheds are adjacent to each other and are northeast of Lethbridge (Figure 2.1). The approximate centre of the Battersea Drain Watershed is at 49.89° N, 112.70° W, and the approximate centre of the Lower Little Bow River Watershed is at 50.03° N, 112.70° W. These two watersheds are mainly in the Mixedgrass Subregion, which is part of the Grassland Natural Region of the Alberta natural region classification. A portion of the Lower Little Bow River Watershed extends into Dry Mixedgrass Subregion. Native vegetation includes needle and thread grass, porcupine grass, northern wheatgrass, western wheatgrass, buckbrush, and shrubs. The nearest long-term weather station, which is at Lethbridge, has a 30-yr (1971 to 2000) average annual precipitation of 365 mm (Environment Canada 2008). Highest monthly precipitation occurs in June (53 mm) followed by May (48.3 mm), August (47.4 mm), and July (37.2 mm). The 30-yr average annual daily temperature at Lethbridge is 5.8 °C. The monthly averages range from -7.8 °C in January to 18.2 °C in July.

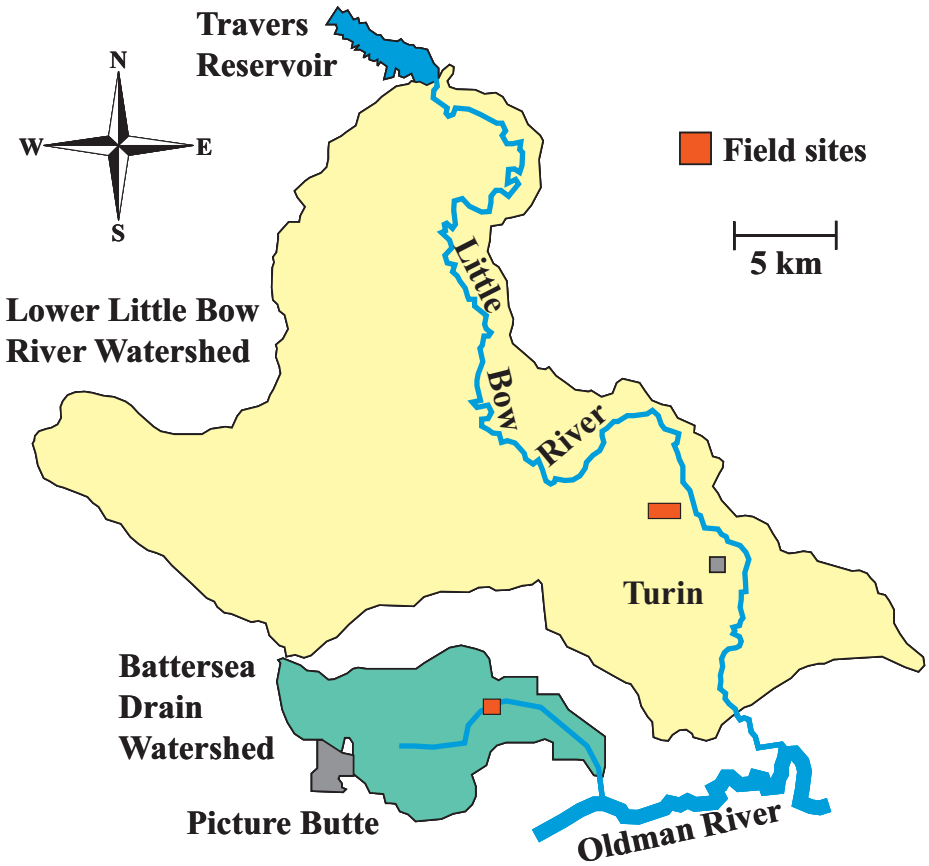

Figure 2.5. The two field sites within the Battersea Drain Watershed and the Lower Little Bow River Watershed.

The Battersea Drain Field (BDF) site is about 26 km north-northeast of Lethbridge and is 65 ha in size. The site has been under long-term cultivation with annual crops and has a centre pivot irrigation system. The Battersea Drain bisects the field from the southwest to the northeast, and culverts are used to direct surface runoff into the drain (Figure 2.6a). The soil is an Orthic Dark Brown Chernozem, and the area has Lethbridge and Kessler soil series as well as some salinity (Alberta Soil Information Centre 2001). The soil texture ranges from loam to silty loam. The field has been heavily manured, and STP ranged from 646 to 1,476 kg ha^{-1} (about 323 to 738 mg kg^{-1}) in the top 15 cm in 2002 (Riemersma et al. 2004).

The Lower Little Bow Field (LLB) site is about 38 km north-northeast of Lethbridge. The site is a small drainage area (88 ha) within two adjacent quarter sections (130 ha), each with a centre pivot irrigation system (Figure 2.6b). The soil is an Orthic Dark Brown Chernozem (Figure 2.1), with a loam to a clay loam texture. The area includes the Lethbridge, Readymade, and Whitney soil series (Alberta Soil Information Centre 2001). The site is under long-term annual crop production. Cattle manure is applied on a regular basis. This site was used for a previous research study, during which STP was measured. Little et al. (2006) reported STP concentrations of 269 mg kg^{-1} (about 538 kg ha^{-1}) in 2002, 236 mg kg^{-1} (about 472 kg ha^{-1}) in 2003, and 242 mg kg^{-1} (about 484 kg ha^{-1}) in 2004.

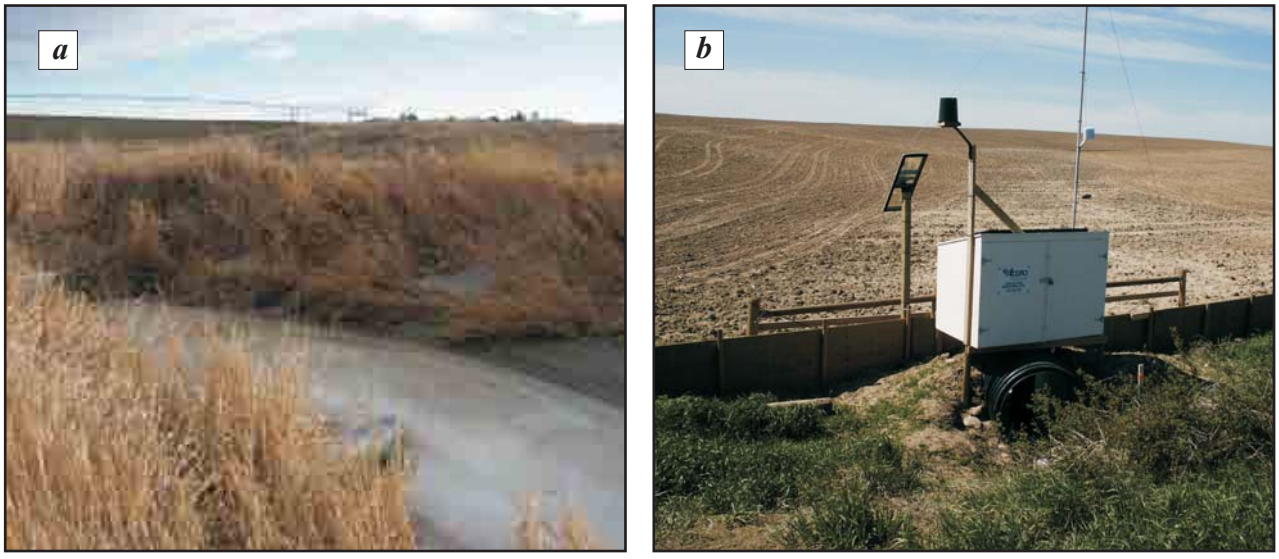

Figure 2.6. The (a) Battersea Drain Field and (b) Lower Little Bow River Field sites.