Agricultural Land Use and Management in the West Souris River Watershed

Submitted by

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and

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A. Executive Summary

The West Souris River IWMP study area is located in the southwestern corner the Manitoba, west of the Souris River (the study area is approximately 432,250 ha in size). An integrated watershed management plan is being developed for this watershed by the West Souris River Conservation District (WSRCD) in collaboration with Manitoba Water Stewardship and numerous other stakeholders.

Understanding changes in agricultural land use is essential for the development of an integrated watershed management plan. The overall objective of this report is to examine risks to key watershed resources by analyzing the physical characteristics of the landscape with consideration for how specific agricultural activities may be influencing them. This analysis also assists in identifying where soil and water management efforts could be directed to help address priority issues or identified risks within the watershed.

An assessment of the subwatersheds of the study area provides a snapshot in time of the agricultural activities within the West Souris River Watershed. Census of Agriculture data, temporal in nature, illustrates influences from external factors like weather, government programs and polices, market drivers, and technology to land use and land management decisions and the community response to those interactions. Such events, with an examination of a watershed's physical resource characteristics and risks, assist to develop an understanding of potential impacts on the basin's water quality, and identify opportunities for future sustainable land use strategies. This is particularly important to the West Souris River Integrated Watershed Management Plan where, through public consultation, public consultations identified six key areas of concern: Water Supply, Water Quality, Flooding, Natural Areas (Ecosystem Services & Recreation), Groundwater Recharge and Groundwater Protection, and Aquatic Ecosystems Health. For the purpose of this document, the focus is aimed at determining where soil and water management could be directed to help address those groups. The overall objective of this document is to examine risks to key watershed resources by analyzing the physical characteristics of the landscape with consideration for how specific agricultural activities may be affecting them either positively or negatively. This analysis serves as the basis for recommendations to address the identified risks.

Ag-Profiling examines variables from 2006 Census of Agriculture database depicted over three subwatershed regions, including farm area, type of farm, cropping practices, tillage practices, fertilizer and pesticide use, financial activity, and livestock numbers. The same variables from the 2001 Census of Agriculture data were used to five-year changes in agricultural activities in the study area. Land cover data from 1993, 2000, and 2006, were used to examine temporal changes in land cover. Using soils data and modeling, environmental indicators were developed for Agricultural Capability, Wind and Water Erosion Risks, and Soil Drainage characteristics. These were examined in combination with the annual cropland identified in the 2006 land cover. A review of recent federal and provincial policies and programs was also conducted to assess their impact on agricultural land use and management.

Results reveal that the West Souris River IWMP study area has a diverse agricultural landscape. Slight differences are evident from the northern part of the watershed compared to the southern areas with respect to soils type, land use, cropping practices, crop types, and types and number of livestock and poultry. From 2001 to 2006, there were fewer but larger farms located in the study area, with the greatest decrease of farms in the Pipestone Subwatershed over the 5 year period. Although both crop and livestock production is important throughout the watershed, crop production tends to dominate in the south, while beef production becomes more dominant in the northern part, due to more environmentally sensitive soils in the area. The southern portion of the watershed tends to rely more on commercial fertilizers and pesticides than the northern regions, with a larger proportion of cropland being treated to crop inputs. Compared to five years ago, there has been an overall decrease in annual cropland and an increase in pastures and seeded forages which corresponds to moderate increases in cattle numbers across the watershed. This change is especially seen in the Pipestone subwatershed. Tillage practices changed over the past five years with an increase in conservation or zero tillage and a decrease in summerfallowed and conventionally-tilled areas.

Analysis of Land Cover over a 13-year period corresponds well with the Census data, particularly the conversion of annual cropland to forages and grasslands, which occurred at the same time as external drivers such as the elimination of the Western Grain Transportation subsidy. Analysis of soils under annual cropland showed trends toward improved management, with a decreasing amount of annual cropland on class 4 or lower, on lands with a severe or high risk of wind or water erosion risk. Areas were identified and mapped within the watershed where the combination of annual cropping and landscape risk factors such as wind erosion, agricultural capability, and drainage indicate special management of these lands may be warranted. An examination of land cover data changes was undertaken to identify changes in land cover with respect to grasslands, wetlands, and annual cropland, and how they relate to the issues of flooding and natural areas. The identification of annual cropland within a 50 m buffer to waterways that had a high or severe water erosion risk indicates a small area that could contribute to water quality issues because of the likelihood of transport of sediment and nutrients to nearby waterways. Due to data limitations, all geographic analyses using land cover and soils data require further verification and ground-truthing to ensure accuracy.

The interest and willingness of producers with in the watershed in addressing environmental issues was demonstrated by their participation in the Environmental Farm Plan (EFP) Program (2003-2008) and Canada-Manitoba Farm Stewardship Program (CMFSP) and the, two key environment based programs under the Agricultural Policy Framework (APF) Environmental Farm Plan (EFP) Program (2003-2008). The implementation of 285 beneficial management practice (BMP) projects between 2003 and 2008 indicates that producers are interested in taking environmental action. Over 75% were non-point source crop related BMP projects and 10% were Point Source Protection BMPs (Livestock Manure Related (2) and-other (26)).

Recommendations from the analysis to address surface water quality issues include the support for marginal land management options such as the adoption of BMPs for sustainable land management, water erosion mitigation practices such as grassed waterways, buffer establishment, and land conversion to forages, as well as promoting BMPs that will reduce nutrient transport to waterbodies. With respect to water supply, a water supply assessment and surface water management assessment study of the entire watershed could be conducted to understand where gains could be made for flood protection and drought mitigation. In addition, an examination of potential wetland restoration project sites could be carried out to explore options for maintaining particular lands that provide environmental benefits by reducing impacts of drainage and flooding. Promotion or incentives for permanent cover are also recommended for those lands that are class 4 and lower, or are considered prone to wind or water erosion. Other BMPs, such as the use of cover crops and residue management techniques as well as shelterbelt establishment, should be promoted where wind erosion is an issue. Potential indicators were also identified for each recommendation presented to allow the Integrated Watershed Planning Process to evaluate progress related to addressing the issue in the future.

B. Acknowledgements:

The following individuals contributed to the compilation, interpretation, and derivation of information contained in this submission.

AAFC-AESB: Holweger, U., Michiels, P., Powers, J., Becenko, S., Kopytko, M.

MAFRI: Mitchell, L, Gauer, E

C. Preface

In 2008, the West Souris Conservation District was designated as the Watershed Planning Authority to initiate an Integrated Watershed Management Plan for the West Souris River Watershed study area. In support of updating this plan, a Project Management Team (PMT) was formed to guide the watershed planning process. A formal request was made on behalf of the PMT and Manitoba Water Stewardship to Agriculture and Agri-Food Canada - Agri-Environment Services Branch (AAFC-AESB) and Manitoba Agriculture Food and Rural Initiatives (MAFRI) to provide technical support as it relates to their respective mandates (See Appendix A) in support of developing the plan.

This report focuses on information related to agricultural activities and land resources in the watershed. It is important to note that in addition to agriculture, there are other industries, sectors, and users of the watershed's resources that also have an impact on the watershed. As there are scale and accuracy limitations associated with the available data (including soils, land cover, and Census of Agriculture data), it should be noted that the information contained within this report does not replace the need for site-specific analysis; rather, it serves as a guide for general planning purposes in the West Souris River IWMP study area. More information on the data used in this document can be found within the Appendices.

D. Introduction

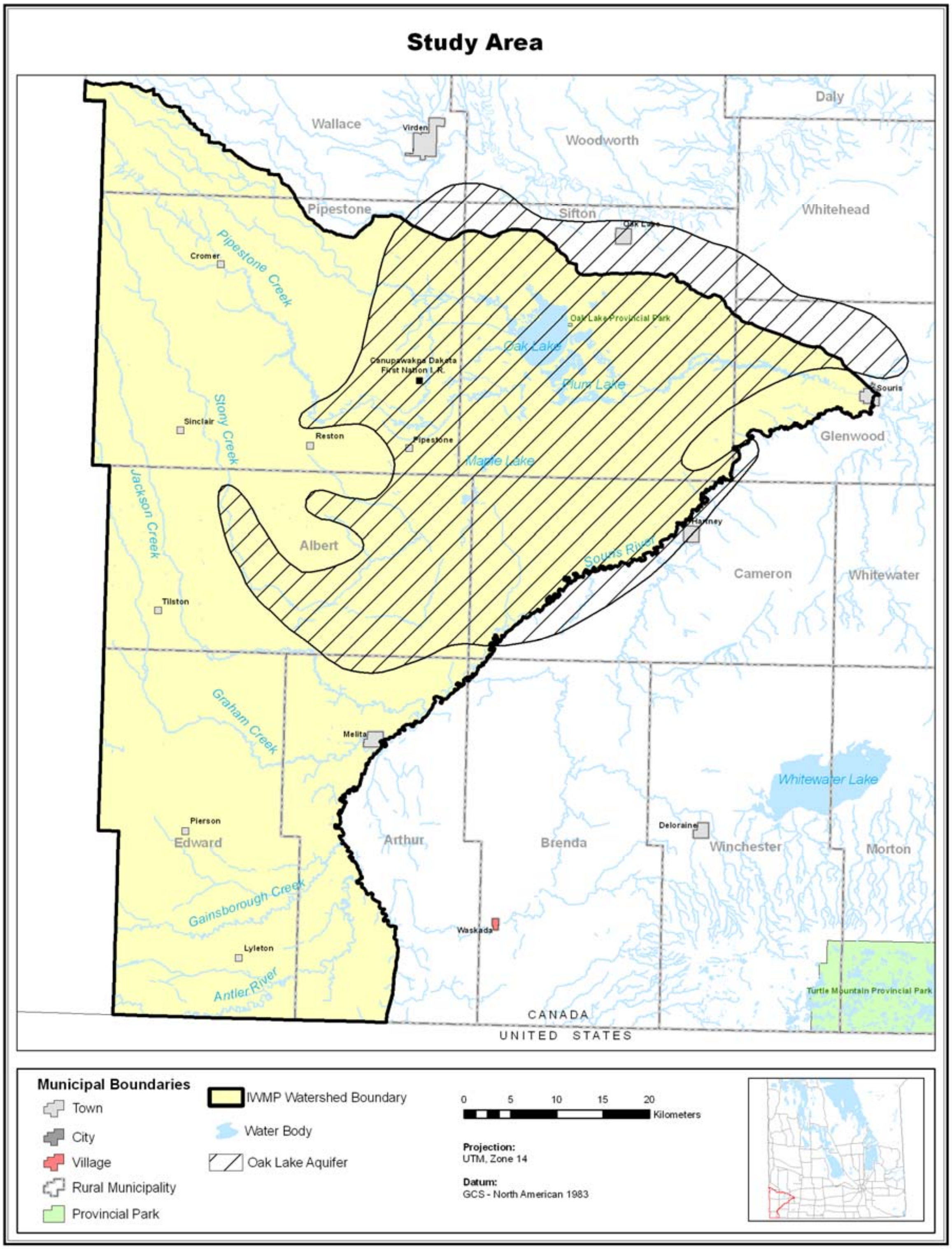
The West Souris River IWMP study area is a part of the Souris River watershed which drains parts of southeast Saskatchewan, northwest North Dakota and southwest Manitoba. It terminates where it enters the Assiniboine River in southwest Manitoba. The Souris River itself is approximately 720 kilometres long and has a drainage area of approximately 45,500 km^2. The West Souris River IWMP study area is approximately 432,250 ha in size and consists of the area that is west of the Souris River, north of the Canada-US border, east of the Manitoba-Saskatchewan border and includes the Pipestone Creek watershed to the north (***Figure 1***). Some of the communities located within the IWMP study area include Melita, Pierson, Lyleton, Reston, Pipestone, Sinclair, Cromer, part of the Town of Souris, as well, the community of the Canupawakpa Dakota First Nations. The Oak Lake Aquifer, an unconfined aquifer composed mainly of medium to fine grained sand with some gravel areas is also part of the study area.

Objective

Understanding the current state and trends in agricultural land use and practices along with landscape characteristics is essential for developing an integrated watershed management plan. Agricultural land use and associated land cover can influence watershed processes and impact issues like water quality and hydrological flow within the watershed. Understanding these factors contributes to developing sustainable land use strategies that will lead to a healthier and more ecologically functioning landscape. To better understand agricultural changes and impacts within the watershed, AESB and MAFRI partnered to analyze agricultural aspects, focusing on the major issues identified in the 2008 public consultations pertaining to the IWMP. **Specifically, this document examines the following in order to help guide watershed management:**

1. **"Near-Current" Agricultural Land Use and Management using the latest available Census of Agriculture data and satellite imagery**
2. **Five-year change in agricultural land use and management using 2001 and 2006 Census of Agriculture data and a time series of satellite imagery**
3. **Land cover data in combination with landscape risk factors pertaining to the soil and water resource**
4. **The impact of recent federal and provincial initiatives, policies and regulations impacting agricultural land management and land use planning activities in the watershed**

Figure 1: West Souris River Watershed Study Area



E. Agricultural Land Use and Management

i. Current Agricultural Land Use of the West Souris IWMP Study Area

a) Agricultural Profile

Agricultural profiling refers to the characterization of agricultural production in an area or a region. The ability to use Census of Agriculture information collected from producers can provide a snapshot in time of the various agricultural activities within the watershed. The information can be portrayed either on a municipal or geographical boundary (like a watershed) and can provide value to understanding the role and trends of the industry to the area.

Census of Agriculture data at a subwatershed scale has been obtained from Statistics Canada for the 2006 Census year. Further details on the method used to interpolate Statistics Canada's Census of Agriculture from a geographic boundary to a subwatershed boundary are provided in ***Appendix B***. For reporting purposes, numbers have been rounded to the nearest 5 for farm numbers, 10 for livestock and smaller area data, and 100 for poultry, financial data and for larger areas.

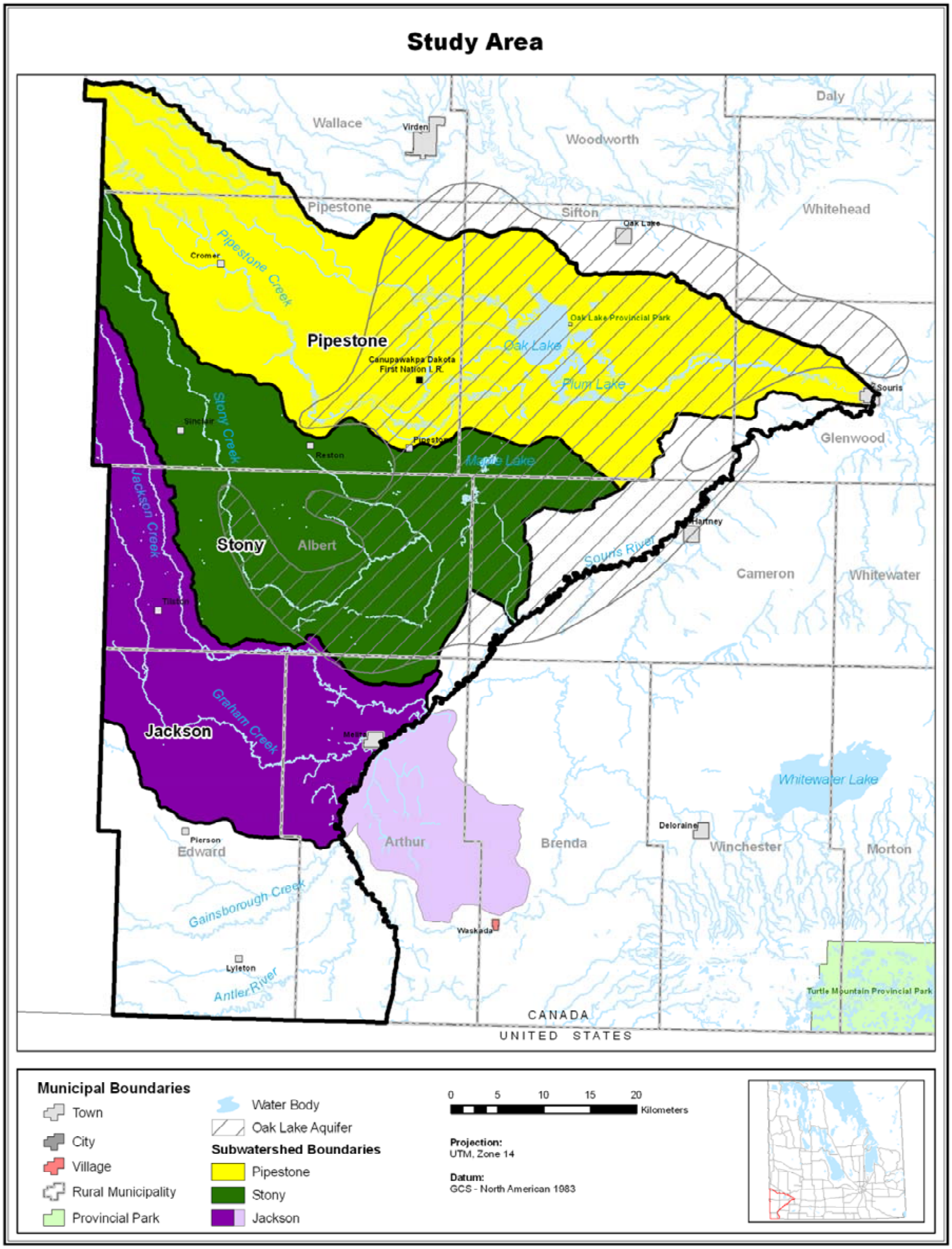
Due to the different boundaries between the IWMP study area and the Manitoba subwatershed layer which has the Census data rolled up to a subwatershed boundary, only 79% of the watershed can be accurately represented in the following agricultural profile. For the purpose of this report, three areas will be described with respect to agricultural activities (***Figure 2***). The Pipestone Subwatershed is the area drained by the Pipestone creek, Oak Lake and Plum Creek. The Stony Subwatershed refers to the area which drains into Stony Creek and Maple Lake Drain. The Jackson Subwatershed can be described as the area draining into the Jackson and Graham Creeks as well as some areas draining into the Souris River, some of which are located outside of the IWMP study area (see ***Figure 2***). Since the Census data is summarized for the entire area of the subwatershed, the following profile for Jackson includes this area. Table 1 lists these subwatersheds with their respective sizes.

Table 1: Subwatershed Areas

Subwatershed name	Area (hectares)	Percent of West Souris IWMP study area
Jackson	104,727 (77,789 ha within IWMP study area)	18%*
Stony	110,510	26%
Pipestone	152,662	35%

* Only 75% is of the Jackson subwatershed is located within IWMP boundary, though the Census data summary is for the entire subwatershed.

Figure 2: Subwatershed Groupings for the Agriculture Profile (2006 Census of Agriculture)



Summary of Land Use and Land Management

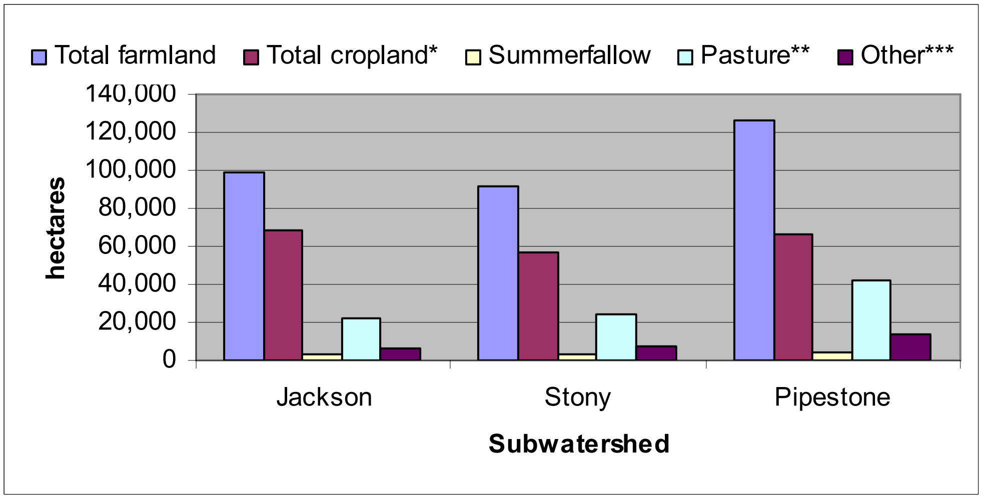
Jackson Creek Subwatershed:
According to the 2006 Census of Agriculture data, over 70% of the farmland in the Jackson Subwatershed was dedicated to annual crop production and over 20% to pasture, alfalfa, hay and fodder crops. Cereals made up over 55% of the cultivated land while over 25% was seeded to oilseeds. There was a small area of pulse crops reported, and almost 15% of the cultivated land was in forages. Land management practices included over 75% of the cultivated land was prepared using conservation or zero tillage, while the remaining area was prepared using conventional tillage practices. One farm operation reported the use of irrigation on field crops and fruits. Beef production was the main livestock in the area, with almost 110 farm operations reporting beef cows, with an average of almost 80 cows per farm. Total cattle and calves in the area added up to over 18,700 animals. Dairy cows were reported by a few farms. Approximately 10 farms reported poultry with an average flock size of over 470 birds per farm for a total of 4,600 birds in the subwatershed. Approximately 5 farms reported pigs, with an average of almost 2,400 pigs per farm for a total of almost 11,800 pigs.

Stony Creek Subwatershed:
In 2006, over 65% of the farmland in the Stony Subwatershed was dedicated to annual crop production, 25% to pasture, alfalfa, and hay and fodder crops. Cereals made up almost 55% of the cultivated area, oilseeds over 20%, and forages another 20%. Land management practices included almost 15% of the cultivated land under conventional tillage practices, over 20% using conservation tillage practices, and over 25% prepared with zero tillage. One farm operation reported the use of irrigation on field crops and fruits. Over 5 farms had poultry with an average flock size of 75 birds per farm for a total of almost 500 birds reported. Less than 5 operations reported pigs. Beef production is the main livestock in the subwatershed, with over 40 farm operations reporting beef cows, an average of over 75 cows per farm. Total cattle and calves reported in the area added up to almost 6,300 animals. Dairy cows were reported by a few farms.

Pipestone Creek Subwatershed:
In the Pipestone Subwatershed, about 55% of the farmland was dedicated to annual crop production, and over 20% to pasture, alfalfa, and hay and fodder crops. Cereals made up about half of the cultivated land while over 20% was seeded to oilseeds. Forages covered over 25% of the cultivated land. Land management practices included almost 30% of the cultivated land prepared using conventional tillage practices, almost 25% using conservation tillage practices and 50% prepared with zero tillage. Two farm operations reported the use of irrigation on field crops, vegetables and fruits .Over 15 farms reported poultry with an average flock size of about 500 birds per farm, for a total of almost 8,900 birds in the subwatershed. Less than 10 operations reported pigs with an average of 2,000 pigs per farm, for a total of 16,000 pigs in the subwatershed. Almost 175 farm operations reported beef cows, with an average of over 85 cows per farm. Total cattle and calves reported in the area added up to over 35,300 animals with dairy cows being reported by only a few farms.

In comparing the three sub-watersheds, although Pipestone had more reported total farmland, all three had a similar proportion of each agricultural land use type in a subwatershed, as reported by farmers (***Figure 3***). In Pipestone, cropland made up just over half of the total farmland reported, while in the Jackson subwatershed, almost 70% of the farmland was reported as cropland. With respect to pasture (both native and tame), about a third of Pipestone's farmland was made up of pasture while in Jackson, it was just over 20%. Summerfallow occurred throughout the area, though at a small percentage (~ 3%).

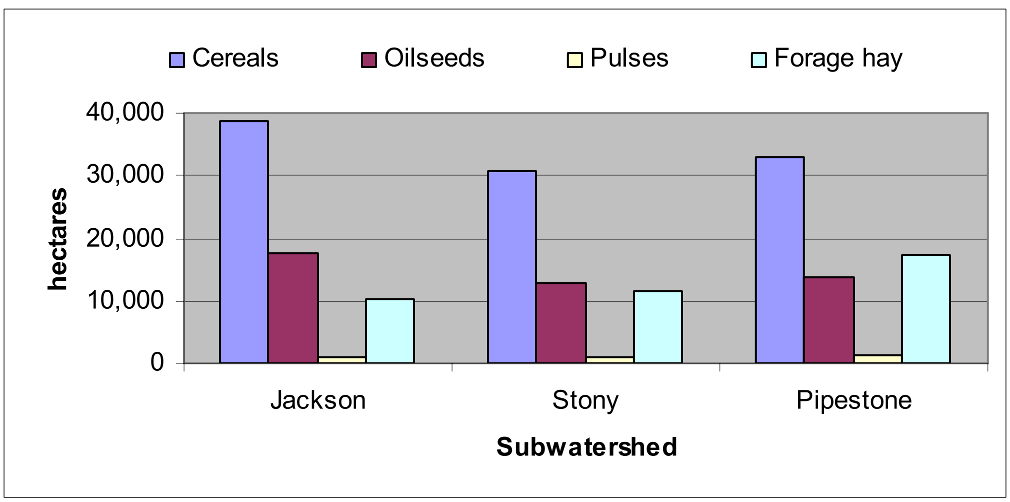
Figure 3: Distribution of Agricultural Land Use (2006 Census of Agriculture)



* Total cropland includes all field crops, vegetables, fruit and nuts and sod
** Pasture includes tame pasture and natural areas used for pasture
*** Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.

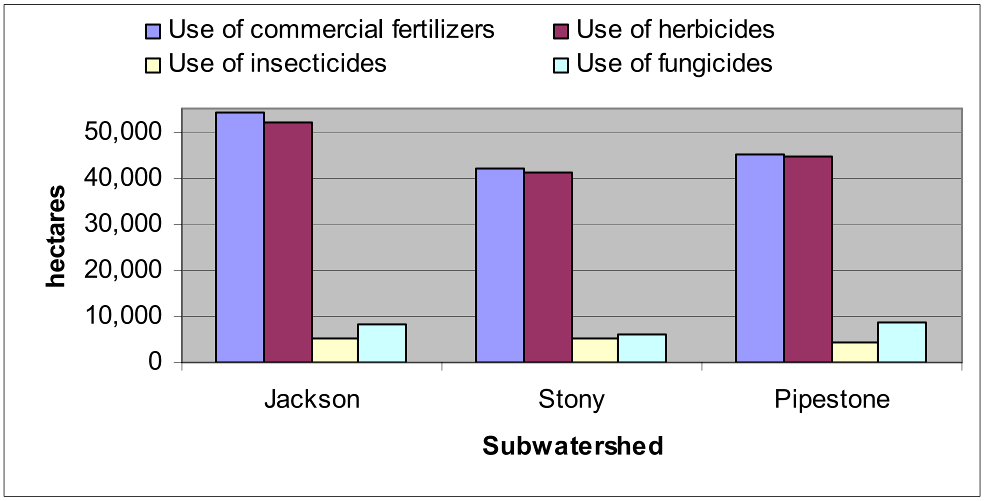
With respect to crops grown in 2006, cereals were grown on about half of the cropland, while oilseeds made up a quarter of the cropland in Jackson, to 20% in Pipestone (***Figure 4***). Seeded forages ranged from 15% of the cropland in Jackson to 25% in Pipestone. All three subwatersheds reported similar areas seeded to pulse crops (over 1,000 ha), the majority consisting of dry field peas.

Figure 4: Distribution of the main crop types grown in the West Souris Watershed (2006 Census of Agriculture)



As for crop inputs, cropland in Pipestone received, on average, less inputs than in the other two subwatersheds. Farmers in Jackson and Stony applied fertilizer and herbicides to approximately 75% of the cropland. In Pipestone, these numbers are less with just over 65% of the cropland receiving inputs (***Figure 5***). Use of insecticides and fungicides is similar in all three subwatersheds.

Figure 5: Area treated to crop inputs in the 2005 crop year (2006 Census of Agriculture)



With respect to seedbed preparation, tillage practices tended to be dominantly conservation with over 85% of the cropland is managed using either conservation or zero tillage practices in the Jackson and Stony subwatersheds. In these areas, zero tillage occurred on two thirds of the seeded acres (***Figure 6***). In Pipestone, half of the cropland was prepared using zero tillage and almost a quarter of the fields using conservation tillage. The higher occurrence of conventional tillage in Pipestone could be due to the larger area of seeded forage in the crop rotation.

Figure 6: Tillage practices in the West Souris Watershed (2006 Census of Agriculture)

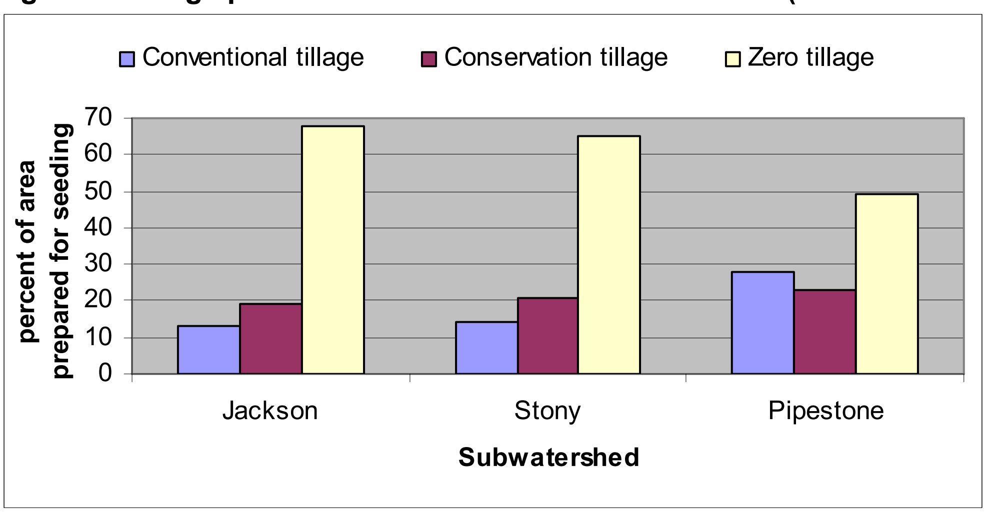
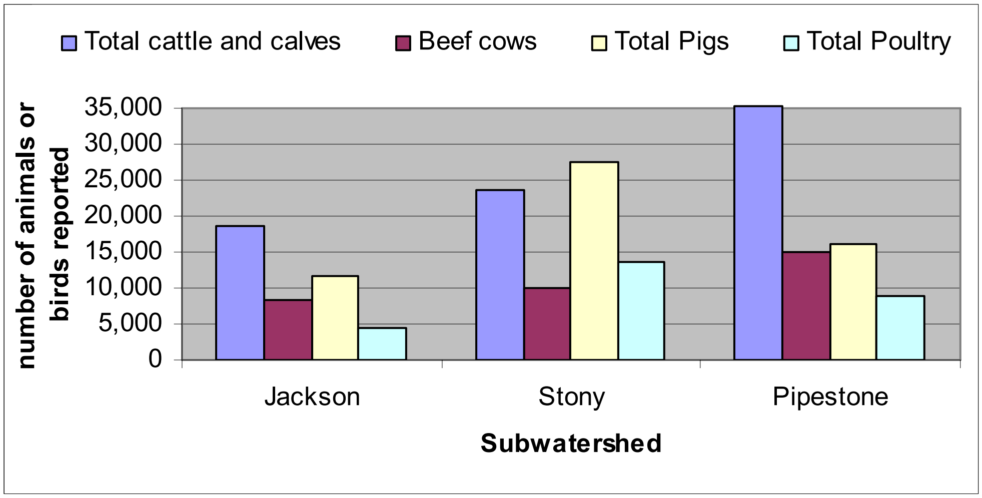


Figure 7 summarizes the livestock numbers in the West Souris Watershed. The livestock industry is important in all three subwatersheds, with beef production being the main livestock present. In all three subwatersheds, beef cows make up about half of the total cattle and calves number, indicating that cow/calf operations dominate. Pigs and poultry are present, though in small numbers.

Figure 7: Total livestock numbers in the West Souris Watershed (2006 Census of Agriculture)



Total Animal Units (AU) produced in the watershed (based on annual nitrogen production) has been estimated using Manitoba's AU coefficients and by making several assumptions (refer to ***Appendix C***). As represented in ***Table 2***, cattle and calves, consisting mainly of beef cattle, contributed the majority of animal units produced in each of the subwatersheds (almost 90% in Pipestone and Jackson, over 80% in Stony). Since beef production consists of mainly cow/calf operations, manure nitrogen (and phosphorous) will be deposited on pastureland naturally by the animals during the grazing season, and possibly accumulated in more concentrated areas during the winter season. Pigs are an important livestock industry in Stony, and they contribute to around 15% of the total Animal Units produced in that subwatershed.

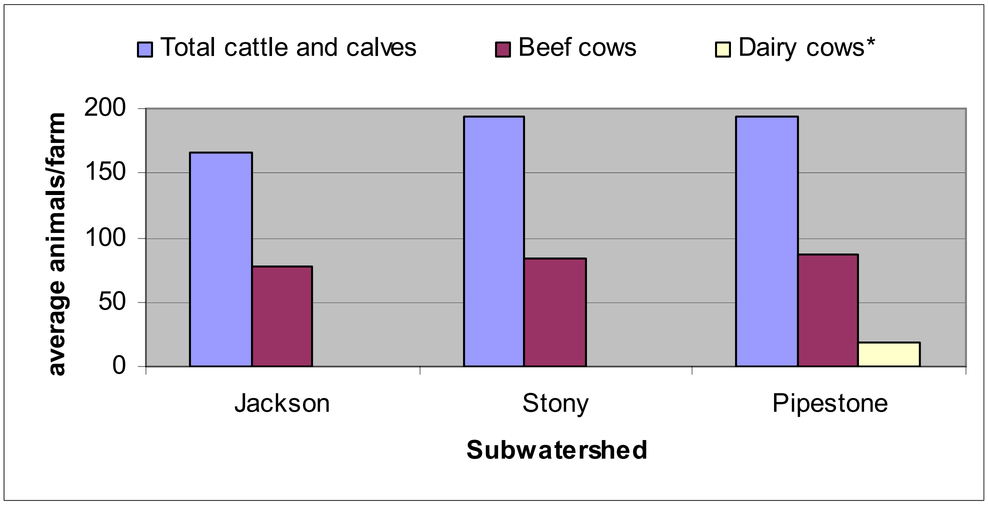
Table 2: Estimated annual animal units produced in the three subwatersheds of West Souris * (according to the number of livestock reported on Census day, 2006)

Livestock Type	Animal Units (AU)			Total Animal Units
	Jackson	Stony	Pipestone	
Total Cattle and Calves	11,924	14,603	22,269	48,796
Total Pigs	1,177	2,669	1,496	5,341
Total Poultry	13	43	27	83
Total Horses and Ponies	314	238	943	1,495
Other livestock - sheep, goats, bison, elk)	73	79	138	290
TOTAL AU*	13,500	17,632	24,872	56,004

* some livestock numbers have been suppressed to ensure confidentiality of the Census data and are not included in the calculations of total animal units.

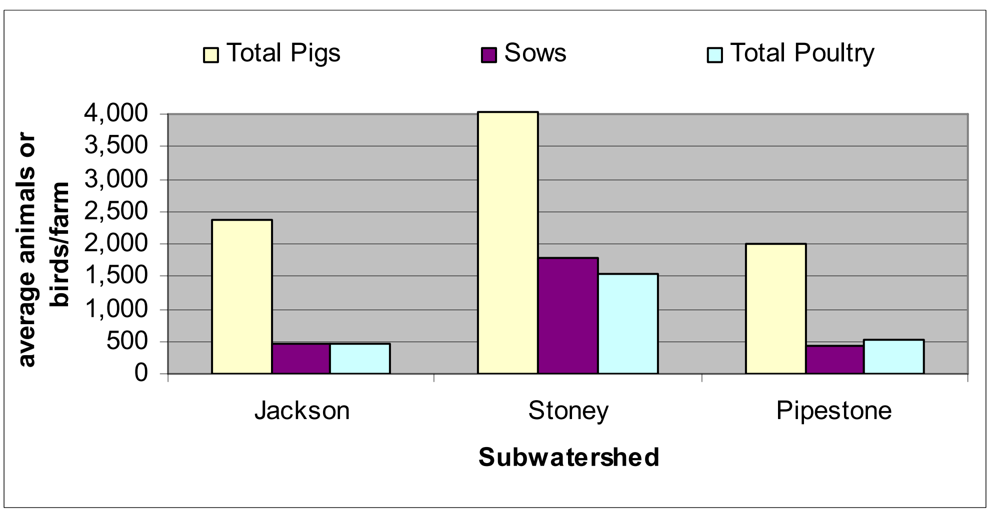
Intensity of the livestock industry can be determined by the average size of flocks and herds. In all three subwatersheds, the average number of total cattle and calves, as well as beef cows per farm, is similar (***Figure 8***). The average number of pigs per farm is highest in Stony, with an average of over 4,000 total pigs per farm, and an average of almost 1,800 sows per farm reporting pigs (***Figure 9***). Stony also reported the largest average poultry birds per farm at over 1,500 birds per farm.

Figure 8: Average number of cattle per farm in the West Souris Watershed (2006 Census of Agriculture)



* Suppression of dairy cow numbers occurs in Stony and Jackson

Figure 9: Average number of pigs or poultry per farm in the West Souris Watershed (2006 Census of Agriculture)



Summary of Farm Financial Characteristics

Jackson Creek Subwatershed:
In 2006, the Jackson subwatershed reported approximately 110 farms with a total farm area equivalent to almost 95% of the subwatershed area. Generally, the average farm size was almost 520 ha/farm (almost 1,280 acres) with an average capital investment of $1,700 per hectare of farmland (or over $876,400 per farm). Livestock-related expenses per hectare of farmland were over $40/ha of farmland, while crop-related expenses were almost $110/ha of cropped land. Per farm, profit was estimated to be over $24,600 and the sales to expense ratio was reported to be 1.17 (farm operations received an average of $1.17 gross revenue for every $1 of agricultural expense).
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Stony Creek Subwatershed:
In the Stony subwatershed, approximately 185 farm operations managed an area of farmland equivalent to almost 85% of the subwatershed area. Generally, the average farm size was around 490 ha/farm (1,200 acres) and farms had an average capital investment of over $1,700 per hectare or over $845,600 per farm. Average livestock-related expenses per hectare of farmland were almost $105/ ha farmland, while crop-related expenses were $106/ha of cropped land. Profit was estimated to be almost $24,200 per farm and the sales to expense ratio was reported to be 1.14.

Pipestone Creek Subwatershed:
In 2006, the Pipestone subwatershed had almost 280 farms operating a total farm area equivalent to almost 85% of the Subwatershed. Generally, the average farm size (including rented and leased fields) was about 455 ha/farm (1,124 acres) with an average capital investment of almost $1,800 per hectare of farmland $816,500 per farm). Livestock-related expenses per hectare of farmland were over $80/ha of farmland, while crop-related expenses were just over $110/ha if cropped land. Profit was estimated to be over $17,400 per farm, and the sales to expense ratio was reported to be 1.13.

In comparing the three subwatersheds, farm operations were large (around 500 ha (1,235 acres) per farm), with the average farm in Pipestone being slightly smaller than the average farm in the other two areas (***Figure 10***). Pipestone, covering a larger area, contained almost 100 more farm operations compared to the other two subwatersheds. A look at the farm financial activity shows that farms in Stony tend to have slightly higher sales and expense activity, likely due to the greater presence of pigs and poultry operations. Estimated profit per farm was similar for operations in Stony and Jackson, which is slightly higher that that of operations in Pipestone (***Figure 11***).

Figure 10: Total number of farms and average farm size in the West Souris Watershed (2006 Census of Agriculture)

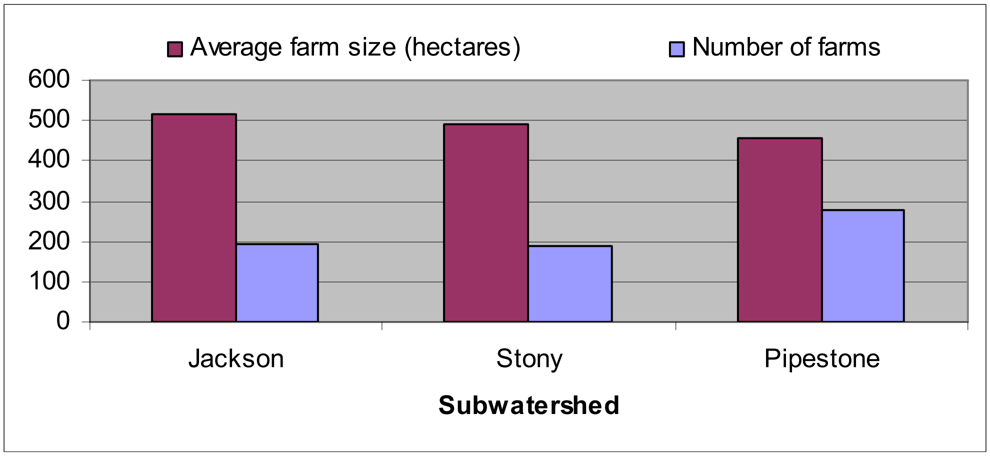
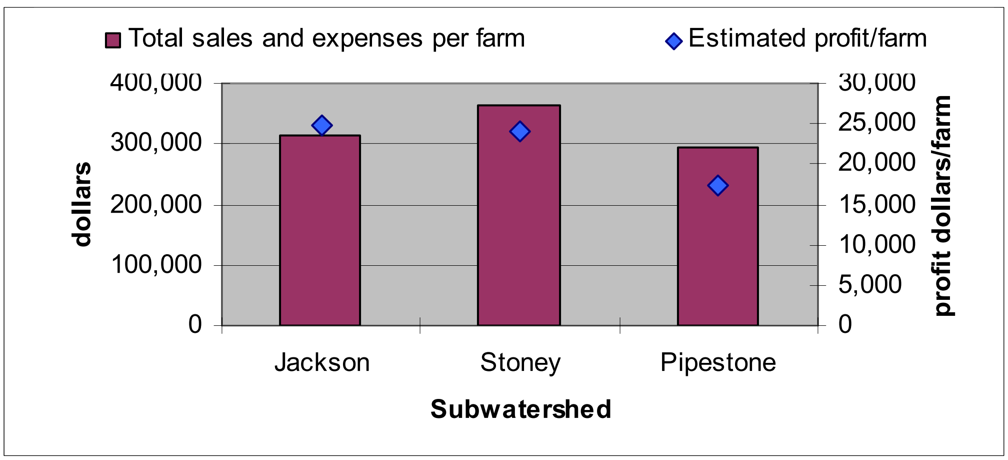
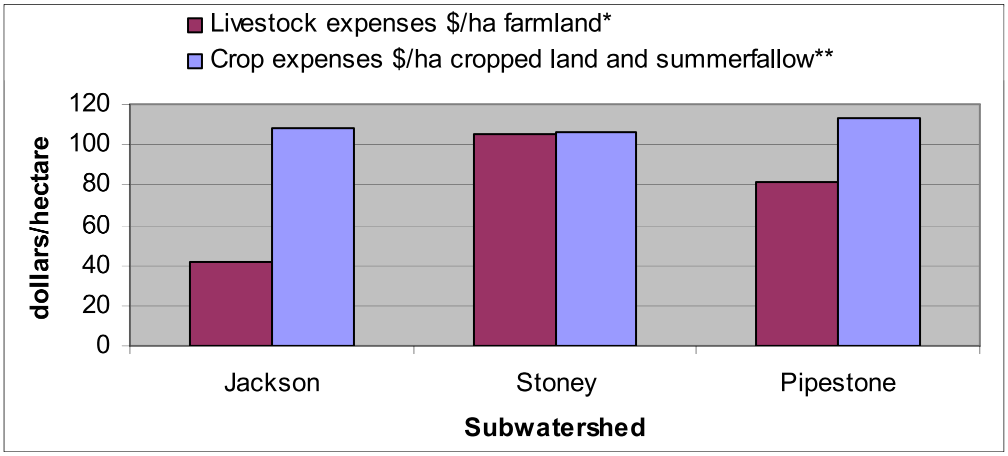


Figure 11: Summary of farm financial activity for the 2005 calendar year (2006 Census of Agriculture)



Livestock and Crop-related expenses reported for the 2005 crop year have been determined on a per hectare basis. ***Figure 12*** shows that on average, farm operations in Jackson had the lowest livestock-related expenses per hectare of farmland. In fact, it is half as much as that reported for Pipestone. Stony reported the highest livestock expenses, likely due to the higher number of pigs and poultry. With respect to crop-related expenses, producers in the all three areas reported similar expenses per hectare of cropped land and summerfallow. A closer look at the crop input costs shows that farms in Pipestone spent the most on fertilizer and pesticides per hectare compared to the other two (***Table 3***).

Figure 12: Average livestock and crop-related expenses per hectare for the 2005 calendar year (2006 Census of Agriculture)



* Livestock-related expenses include total feed, supplements, and hay purchases, livestock and poultry purchases, veterinary services, drugs, semen, breeding feeds, etc
** Crop-related expenses include purchases of fertilizer, lime, herbicides, insecticides, fungicides, and seed and plant (excluding materials purchased for resale)

Table 3: Average dollars per hectare spent on fertilizer and pesticides in the 2005 calendar year (2006 Census of Agriculture)

Subwatershed name	Dollars spent on fertilizer per hectare applied	Dollars spent on pesticides per hectare applied
Jackson	$68	$38
Stony	$73	$41
Pipestone	$85	$47

2006 Agriculture Profile Summary

- The ag profile for the Jackson subwatershed is for the entire area, even though only 75% of it is located within the West Souris IWMP
- Pipestone is the largest subwatershed of the three profiles, and is more dominantly in beef production. This is demonstrated by the livestock numbers and by the land use. Cropland makes up 50% of the farmland, seeded forages make up 25% of cropland, and pastures make up a third of the farmland.
- Although the average herd size is similar in all three subwatersheds, Pipestone has the highest total number of cattle and calves. With respect to confined livestock, Stony reported the highest number of total pigs and total poultry, as well as, the largest average herd or flock size.
- Crop production is important in all three subwatersheds. It is the most dominant land use in Stony and Jackson. In these areas, fertilizer and herbicides are used on approximately 75% of the cropped land. In Pipestone, these inputs are used on a smaller percentage of the cropped land.
- In Stony and Jackson, conservation and zero tillage practices are reported on over 85% of the fields prepared for seeding, with zero tillage practices dominating.   In Pipestone, these numbers are slightly lower due to higher reporting of conventional tillage practices, perhaps due to the larger area of seeded forages occurring, increased use of tillage for weed control, or to facilitate stone removal.

ii. Agricultural Land Use Trends

Agricultural land use is dynamic and there are many factors influencing changes over time. The factors vary from economic drivers like commodity prices, land values, input costs, and government programs to social influences like changing demographics and increasing environmental awareness. Changes in land use can have an environmental and economic impact on the health of a watershed. By assessing anticipated changes, land use trends can be useful for guiding the development of future programs and actions to encourage sustainable resource management in the watershed.

a) Changes in Agricultural Production (2001 to 2006 Census Data)

Census of Agriculture data from 2001 has also been acquired to the same subwatershed boundaries as the 2006 data, which can illustrate changes in production. This can be analyzed to better understand the contributions of the agricultural industry in the West Souris IWMP study area and its three subwatersheds. For absolute numbers from 2001 and 2006 Census of Agriculture, refer to ***Appendix J*** and ***K***.

There are many factors that influence decisions made on individual farms. In order to understand if changes are the result of adaptation in farming systems and/or practices, or due to weather, market and other conditions, it is important to also be aware of events and conditions. As a result, many of the noted changes will need to be further examined by land use and industry specialists and individuals with significant local watershed knowledge.

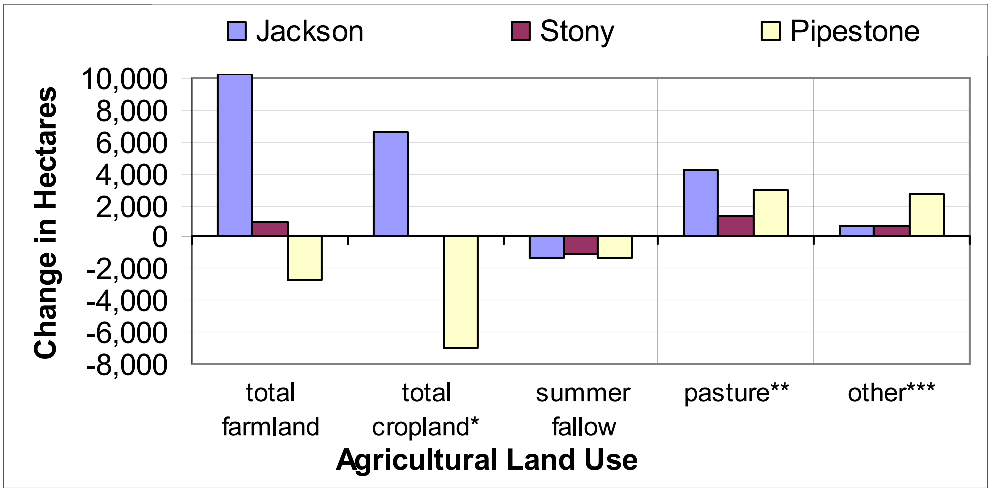
Five-Year Change in Land Use

According to the analysis of the Census of Agriculture from 2001 to 2006, there was a general reduction in number of farms reporting. Subsequently, a corresponding increase in average farm size in all three subwatersheds occurred (***Table 4***). Jackson experienced a large increase in total farm land, while in Pipestone, there was a slight decrease in farmland. In Pipestone there was a general shift in land use from cropland and summerfallow to pasture and other land uses (***Figure 13***). In Jackson, there was a large increase in cropland and pastureland. In Stony, there was an overall increase in pastured areas. In all three subwatersheds, there was a general decrease in the use of summerfallow.

Table 4: Change in number of farms reporting, and average farm size from 2001 to 2006.

Subwatershed	Number of Farms			Average Farm size (ha/farm)		
	2001 Census	2006 Census	5-Year Change	2001 Census	2006 Census	5-Year Change
Jackson	207	192	-15	431	518	+87
Stony	214	186	-28	423	491	+68
Pipestone	328	278	-50	395	456	+61

Figure 13: Change in agricultural land use types from 2001 to 2006 according to Census of Agriculture data.



* Total cropland includes all field crops, vegetables, fruit and nuts and sod
** Pasture includes tame pasture and natural areas used for pasture
*** Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.

Changes to Annual Cropping Practices
Analysis of 2001-2006 Ag. Census data (see ***Figure 14***) shows a decrease in cereal production with an increase in acreage of oilseeds, pulses and forages.

Within the Jackson Creek Subwatershed, from 2001 to 2006:

- Increases in cropland were due mainly to increases in areas seeded to oilseeds (~5,000 ha) and forages (~2,000 ha)
- Pulse acreage decreased by almost 600 ha

Within Stony Creek Subwatershed, from 2001 to 2006:

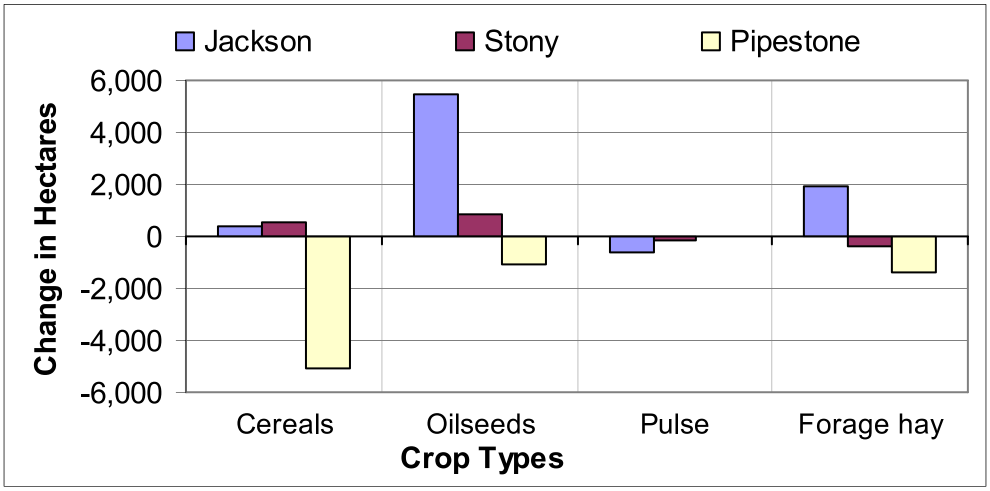
- There was little overall change in distribution of crop type.

Within the Pipestone Creek Subwatershed, from 2001 to 2006, due to the overall decrease in cropland:

- There was a large decrease in areas seeded to cereals (~5,000 ha)
- There was also slight decreases in areas seeded to oilseeds and forages (over 1,000 each)

These changes are likely in direct response to market signals, as producers attempt to maximize profits.

Figure 14: Change in crop types from 2001 to 2006 according to Census of Agriculture data.



Changes in tillage practices that occurred in the five year interval included an overall decrease in use of both conventional tillage (incorporating most crop residue in the soil), as well as conservation tillage (retaining most of the crop residue on the soil surface). The use of zero-till seeding practices increased in all three subwatersheds (***Table 5***).

Table 5: Comparison of distribution of tillage practices between 2001 and 2006

Subwatershed	Percent of area prepared for seeding using:					
	Tillage incorporating most crop residue into the soil		Tillage retaining most crop residue on the surface		No-till or zero-till seeding	
	2001	2006	2001	2006	2001	2006
Jackson	23%	13%	37%	19%	40%	68%
Stony	23%	14%	36%	21%	41%	65%
Pipestone	31%	28%	36%	23%	33%	49%

Change in Annual Cropping Inputs
Notable changes in crop inputs are summarized below for the three subwatersheds (***Figure 15*** and ***Tables 6*** and ***7***).

Within the Jackson Creek Subwatershed, from 2001 to 2006:

- There was a slight increase in fields with fertilizer application and a slight decrease in areas with herbicide treatment
- Farmers reported an increase in fertilizer costs of over $20 per hectare. Pesticide costs per hectare increased slightly

Within Stony Creek Subwatershed, from 2001 to 2006:

- There was a slight increase in fields with fertilizer application and little change in areas with herbicide treatment
- Farmers reported an increase in fertilizer costs of almost $25 per hectare. Pesticide costs per hectare increased slightly.

Within the Pipestone Creek Subwatershed, from 2001 to 2006:

- Although there was a decrease in areas applied with fertilizer (due to the decrease in area of cropland), the proportion of cropland with fertilizer and herbicide applications remained constant.
- Farmers reported an increase in fertilizer costs of over $30 per hectare. Pesticide costs per hectare increased slightly

Figure 15: Change in areas treated to crop inputs from 2000 to 2005 according to Census of Agriculture data.

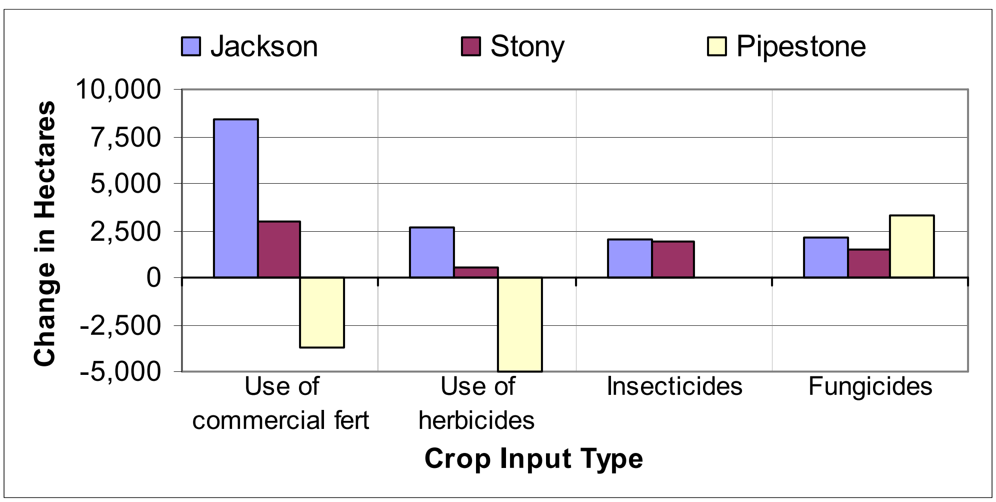


Table 6: Percent of cropland with fertilizer or herbicide applications in 2000 and 2005 (as reported in the 2001 and 2006 Census of Agriculture)

Subwatershed	Percent of cropland with Fertilizer Application		Percent of cropland with Herbicide Application	
	2000	2005	2000	2005
Jackson	74%	79%	79%	76%
Stony	69%	74%	72%	73%
Pipestone	66%	67%	67%	67%

* Cropland includes all field crops (including alfalfa and other seeded forages), vegetables, fruit and nuts and sod

Table 7: Comparison of average cost of fertilizer or pesticide inputs in 2000 and 2005 (as reported in the 2001 and 2006 Census of Agriculture)

Subwatershed	Average cost of fertilizer input ($/ha)		Average cost of pesticide input ($/ha)	
	2000	2005	2000	2005
Jackson	$47	$68	$35	$39
Stony	$51	$73	$37	$41
Pipestone	$53	$85	$41	$47

Relative Change in the Livestock and Poultry Sector

With respect to livestock, there was a slight overall decrease in total cattle reported from 2001 to 2006, as well as, the number of farms reporting cattle (see ***Figures 16*** and ***17*** and ***Table 8).***

Cattle Industry

From 2001 to 2006 in the Jackson Creek Subwatershed, there was:

- An increase in total cattle, beef cows making up half of the increase
- A decrease in number of farms reporting cattle
- A slight increase in average herd size

From 2001 to 2006 in the Stony Creek Subwatershed, there was:

- An increase in total cattle as well as a decrease in number of farms reporting
- A slight increase in average herd size

From 2001 to 2006 in the Pipestone Creek Subwatershed, there was:

- An increase in total cattle, the majority of which is from an increase in beef cows
- A decrease in farms reporting cattle
- An increase average herd size of almost 40 animals per farm, and almost 25 beef cows per farm

Hog Industry

With respect to the hog production, there appears to be an overall intensification of the industry.

From 2001 to 2006 in the Jackson Creek Subwatershed, there was:

- A decrease in total pigs (almost 5,000 animals), but only a very small decrease in sows (less than 50 sows)
- A decrease in number of farms reporting cattle

- A slight increase in average herd size

From 2001 to 2006 in the Stony Creek Subwatershed, there was:

- A large decrease in total pigs reported, but a small increase in sows reported
- A decrease in number of farms reporting. Although there was a decrease in number of animals, average pigs per farm increased

From 2001 to 2006 in the Pipestone Creek Subwatershed, there was:

- Only a small decrease in total pigs reported
- A decrease in number of farms reporting, resulting in a large increase in total pigs per farm

<u>Poultry Industry</u>
From 2001 to 2006 in the Jackson Creek Subwatershed, there was:

- A small decrease in total poultry (over 200 birds) with a small increase in the number of farms reporting poultry
- An overall decrease in the average number of poultry per farm reporting

From 2001 to 2006 in the Stony Creek Subwatershed, there was:

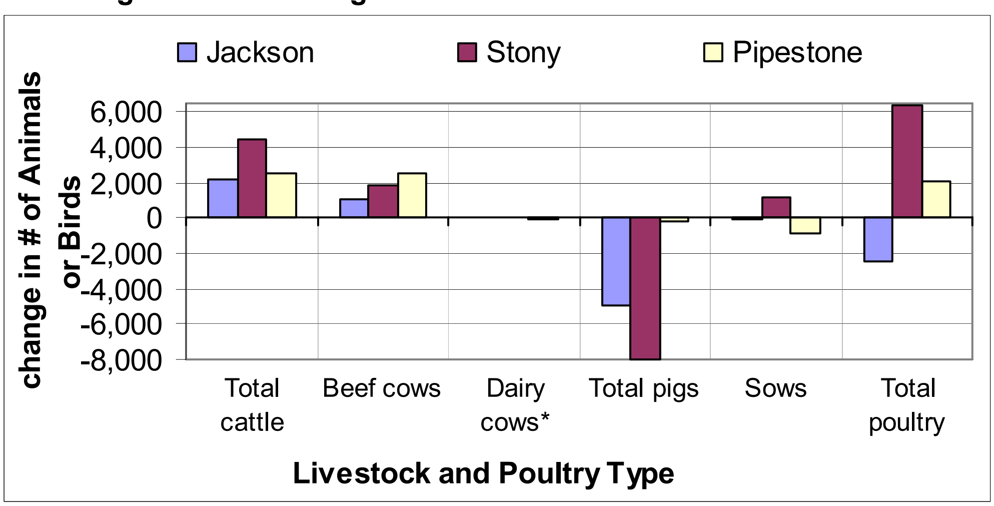
- A large increase in total poultry reported, along with a small decrease in the number of farms reporting poultry
- An overall increase of over 800 birds to the average flock size per farm

From 2001 to 2006 in the Pipestone Creek Subwatershed, there was:

- A small decrease in total poultry reported with little change in the number of farms reporting poultry
- A slight increase in average birds per farm reporting

Again, changes from one commodity to another are largely market driven. The general trend toward fewer but larger farms would be directly related to economy of scale.

Figure 16: Percent change in number of livestock and poultry from 2001 to 2006, according to Census of Agriculture data.

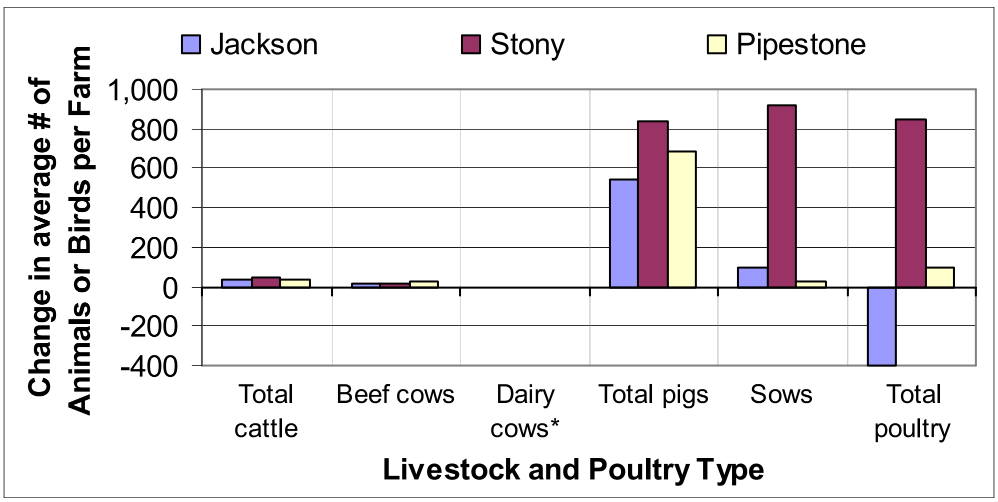


* Suppression of dairy cow numbers for both 2001 and 2006 occurs in Jackson and Stony

Table 8: Five-year change in number of farms reporting livestock and poultry from 2001 to 2006, according to Census of Agriculture data

Subwatershed/Census year		Number of Farms reporting:					
		Total cattle	**Beef cows**	**Dairy cows**	**Total Pigs**	**Sows**	**Total Poultry**
Jackson	2006	113	108	2	5	4	10
	2001	129	124	4	9	5	8
	5-year change	***-15***	***-15***	***-2***	***-4***	***-1***	***+2***
Stony	2006	121	119	3	7	3	9
	2001	131	128	3	11	4	11
	5-year change	***-9***	***-9***	***0***	***-4***	***-1***	***-2***
Pipestone	2006	182	173	5	8	5	17
	2001	209	200	7	12	7	17
	5-year change	***-27***	***-27***	***-2***	***-4***	***-3***	***0***

Figure 17: Change in average number of livestock or poultry per farm from 2001 to 2006, according to Census of Agriculture data.



* Suppression of dairy cow numbers for both 2001 and 2006 occurs in Jackson and Stony

Summary of Changes in Agricultural from 2001 to 2006:

Over the five year period, there was/were:

- Fewer but larger farms (increase in average farm size was greatest in Jackson)
- A decrease in summerfallowed areas and increase in pasture
- A general shift to zero tillage practices
- An increasing in average crop input costs per hectare, especially for fertilizer
- A general increase in intensity of confined livestock operations: fewer but larger pig herds in all three subwatersheds, larger poultry flocks in Stony.
- Beef production experienced a slight increase in herd size in all three subwatersheds

b) 2006 Land Cover Summary

Land cover data used in this analysis was derived from 30 metre resolution LANDSAT Thematic Mapper satellite imagery taken on August 22, 2006. The land cover data provides information on the spatial extent of general types of land cover within a given area at that point in time. Further details on the land cover data, and the constraints associated with this data are provided in ***Appendix D***.

Summary of 2006 Land Cover

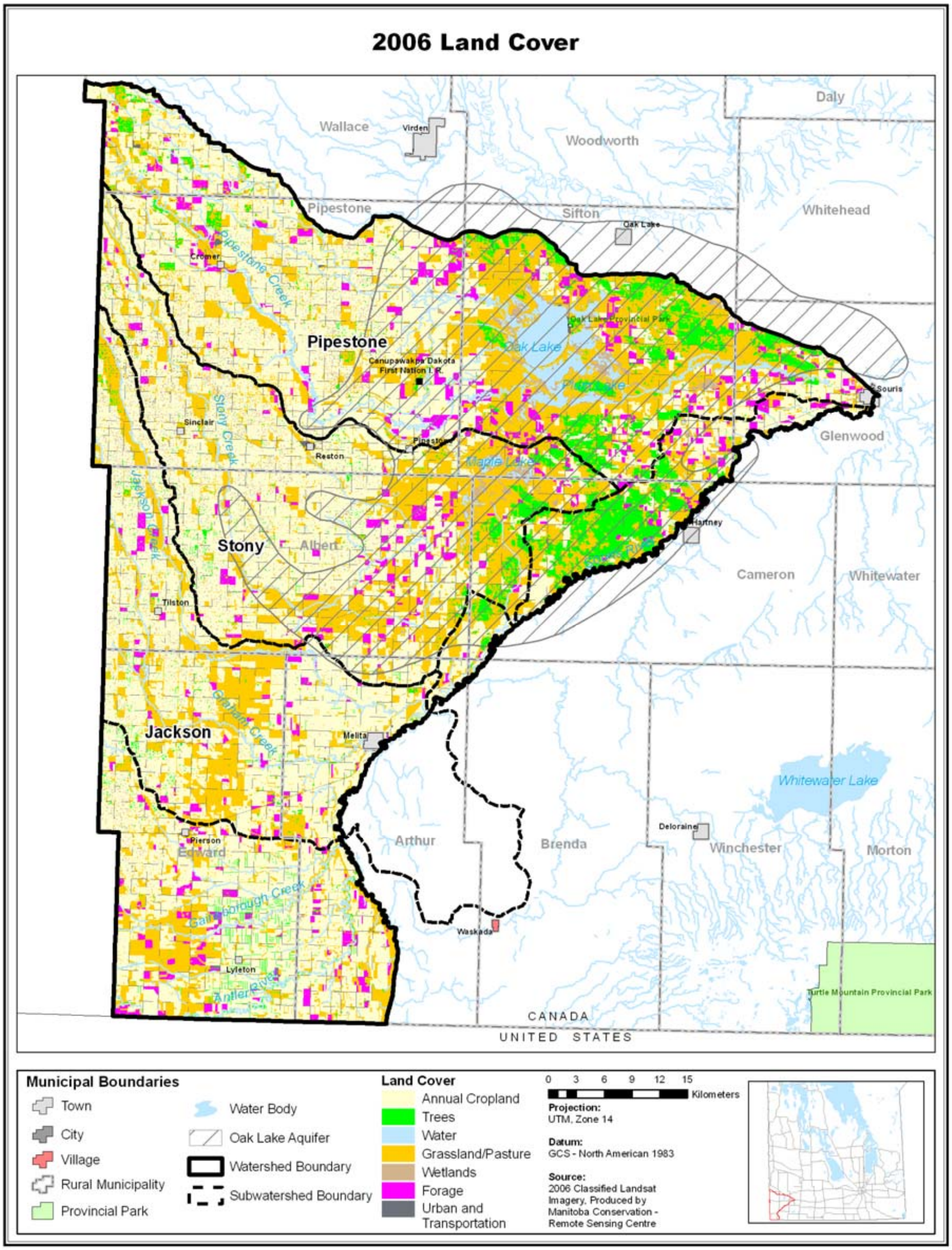
Agriculture is the primary land use in the West Souris River watershed. In 2006, over half (224,257 ha) of the land was classified as annual cropland (***Table 9, Figures 18*** and ***19***). Grassland/pasture areas cover another 30% (or 128,841 ha) of the watershed and are located throughout the area, but are more prevalent in the eastern part of the Pipestone and Stony subwatersheds. Forage land, usually consisting of alfalfa stands, makes up 5% of the watershed and is found throughout, though a bit more prevalent in Pipestone and Stony subwatersheds. Treed areas occupy just over 5% of the watershed and are mainly found in the northeastern part of the watershed. In the Lyleton area, there is also an extensive system of field shelterbelts which was planted in the 1950's. Wetlands occupy a small portion of the watershed (approximately 3%) with the majority found in Pipestone and Stony subwatershed. Approximately 2% of the watershed can be classified as water, consisting mainly of Oak and Plum Lakes.

Table 9: 2006 Land Cover by Subwatershed (hectares)[1]

Subwatershed	Annual Cropland	Trees	Water	Grassland	Wetlands[2]	Forage	Urban / Transportation
Jackson[3]	47,393	1,259	248	22,398	1,840	2,432	2,230
Stony	60,559	3,891	970	33,466	3,963	4,453	3,209
Pipestone	67,612	11,486	7,467	48,231	4,498	9,084	4,134
Remaining area[4]	48,693	10,153	682	24,746	1,003	5,182	2,351
West Souris River IWMP	**224,257**	**26,789**	**9,367**	**128,841**	**11,304**	**21,151**	**11,924**

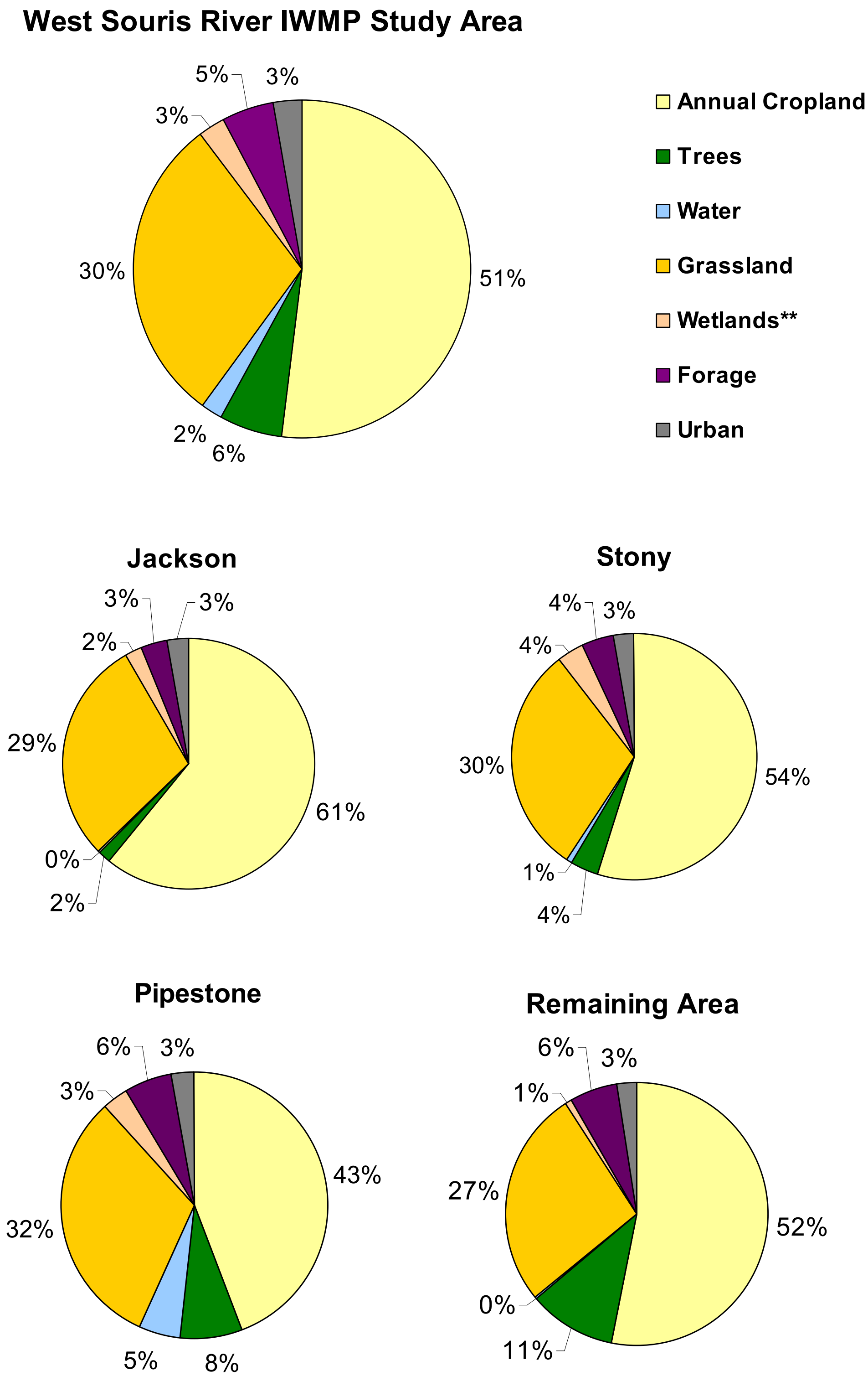
1. Area totals are approximate due to the nature of the image analysis procedure
2. Due to seasonal changes in wetland size, date of imagery will affect area
3. Area calculations are for the portion of the Jackson Creek subwatershed which is located within the IWMP study area
4. Remaining area includes area within the IWMP study area that are outside the Jackson, Stony and Pipestone Creek subwatersheds

Figure 18: 2006 Land Cover in the West Souris River Watershed*



*Land cover was derived from satellite imagery captured August 22, 2006.

Figure 19: Distribution of Land Cover within the Duck River Watershed in 2006



** Due to seasonal changes in wetland size, date of imagery will affect area

Land Cover – 1993, 2000, 2006

Land cover maps used in this analysis were developed using raster-based data sets derived from 30 metre resolution LANDSAT Thematic Mapper satellite imagery. These data sets are point in time and allow users to see the spatial extent of general types of land cover within a given area over time. Further details on the information used for the land cover analysis and the constraints associated with this data are provided in ***Appendix D***. The 1993 land cover was derived from satellite imagery captured on May 14, 1993, and the 2000 land cover is from imagery taken on September 14, 2000.

Change in Land Cover

An analysis of land cover data from 1993, 2000 and 2006 satellite imagery supports the trends seen in the census data, with modest declines in cropland since the 1990s, and increases in grassland and forage classes over the same period (refer to ***Figure 20***).

Although there are some inherent limitations in utilizing land cover analysis methods to determine changes in land use, some changes can be noted:

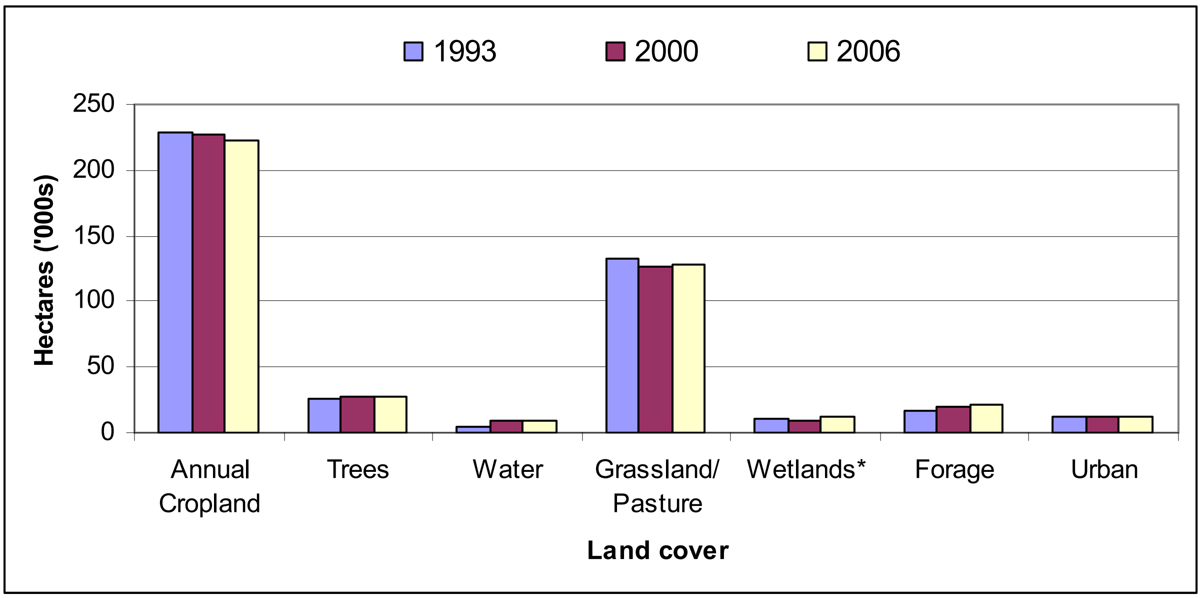
- Annual cropland remains the predominant land cover type in the watershed with an overall decrease of over 6,000 ha (or 3%) between 1993 and 2006 (refer to ***Table 10***).
- In correlation with the decrease in annual cropland, there is an increase in forages and grassland from 1993 to 2006. This can be attributed, in part, to the Permanent Cover Program (PCP) introduced in the early 1990s to encourage the conversion of marginal lands for agriculture from annual crop production to perennial cover. Federal and Provincial assistance programs like Farming for Tomorrow and Green Plan provided further support in the way of soil conservation groups and seed drill rentals The repeal of the Western Grain Transportation Act (WGTA) also influenced the conversion of annual cropland to forage production on marginal lands. Impacts of the PCP and the removal of the WGTA coupled with favourable exchange rates (higher Canadian dollar versus United States dollar) led to accelerated land conversion of both viable lower class and prime agricultural land to forages. In addition, during this time period, there was an increase in the number of cattle reported in the census data (see ***Figure 21***), resulting in a higher demand for pasture and hayland.
- Recharge water for the Oak Lake Aquifer infiltrates mainly from snowmelt and spring rainfall and to a lesser degree from streamflow in Pipestone and Stony Creek. Summer precipitation is used mostly by the vegetations and only during heavy rainfalls does water infiltrate past the root zone and reach the aquifer (Oak Lake Aquifer Management Plan, 2000)
- Increases noted in water, wetlands, and grasslands would also be attributed to the flooding observed in 1999 and 2005 years to the portions of the watershed. These flooding events, the result of two significant spring rainfall periods, would have created ponding areas of water and unseedable arable acres having the appearance of grasslands in the following year. While these acres may be noted as higher than normal in 2001, the 1999 landcover data still supports changes that were already occurring; movement away from annual cropland and closer to forages and grasslands.

Table 10: Change in Land Cover from 1993 to 2000 to 2006[1]

Land Cover	1993 Area (ha)	2000 Area (ha)	2006 Area (ha)	Change in Hectares from 1993 to 2000	Change in Hectares from 2000 to 2006
Annual Cropland	229,341	227,314	222,916	-2,027	-4,398
Trees	26,667	27,216	27,359	+549	+143
Water	4,070	9,821	9,445	+5,751	-376
Grassland	133,128	127,233	128,769	-5,895	+1,536
Wetlands	11,130	9,028	12,090	-2,102	+3,062
Forage	16,104	19,952	21,151	+3,848	+1,199
Urban	11,670	11,688	11,913	+18	+225
Totals	**432,110**	**432,252**	**433,643**	+142	+1,391

1. Area totals are approximate due to the nature of the image analysis procedure

Figure 20: Comparison of change in land cover from 1993 to 2006



iii. Other Agricultural Land Use Trends/Impacts

Agricultural land use is constantly changing due to factors such as climate, markets, crop rotation or changes in agricultural production systems (livestock versus crop production). The previous section summarized the overall change in land cover from 1993 to 2006. A more detailed examination of the land cover classes from 1993 and correlating them to data collected from the 2006 imagery can not only tell us how much one classification has changed over a time period, it can also identify where changes in land use are occurring, thereby giving some indication of influences of land management or land use change. It should be noted that data classification limitations and the timing of the satellite images can introduce discrepancies into these values and further ground-truthing would be required to verify these findings.

Changes in Annual Cropland Area

Analyzing changes in annual cropland can indicate issues such as surface and groundwater quality and flooding. Changes in land use can result in changes in land management practices, which in turn can impact these issues in environmentally sensitive areas. Areas of annual cropland will be constantly changing due, in part, to crop rotations, especially where seeded forages are part of the rotation, as well as shifts to and from livestock production.

In the West Souris River IWMP, there was an overall decrease in annual cropland in 2006, from 1993 (***Table 10***). ***Figure 23*** summarizes parcels which experienced changes to and from annual cropland from 1993 to 2006. Some of these changes will be due to seeded forages included in the crop rotation, as well as shifts to livestock production, as shown by the increase in livestock number in the Census data (***Figure 16, page 28***). There is no real pattern to the change, though some larger parcels, which are adjacent to areas with other land cover classes, have experienced changes from annual cropland. This can be an indication of a change of land use to that more suitable to the agricultural capability of the soil.

Further analysis indicates that annual cropland experienced most of its changes with forages and grassland. While the conversion of grassland in 1993 to cropland in 2006 was over 10,500 ha, there was an almost equal reciprocal conversion of cropland in 1993 to grassland in 2006, resulting in a small net decrease in annual cropland with respect to grassland (see ***Figure 21 and 22***). With seeded forages, there was more cropland being converted to forage than the reverse, resulting in a net decrease in cropland of almost 5,000 ha, with respect to forages.

The net change in annual cropland was also analyzed for the area over the Oak Lake Aquifer. From 1993 to 2006, there was a very small net decrease in annual cropland. The conversion of the 1993 annual cropland to forages and wetlands in 2006 was offset by an almost equal conversion of 1993 grassland to annual cropland in 2006. In the West Souris River IWMP, slightly less than half of the annual cropland converted to wetlands occurred over the Oak Lake Aquifer. This could be due to a higher than average annual precipitation in 2005 (***Appendix O***).

Figure 21: Total change in area of annual cropland, in relation to other land cover types, in the entire West Souris River IWMP study area (from 1993 to 2006)

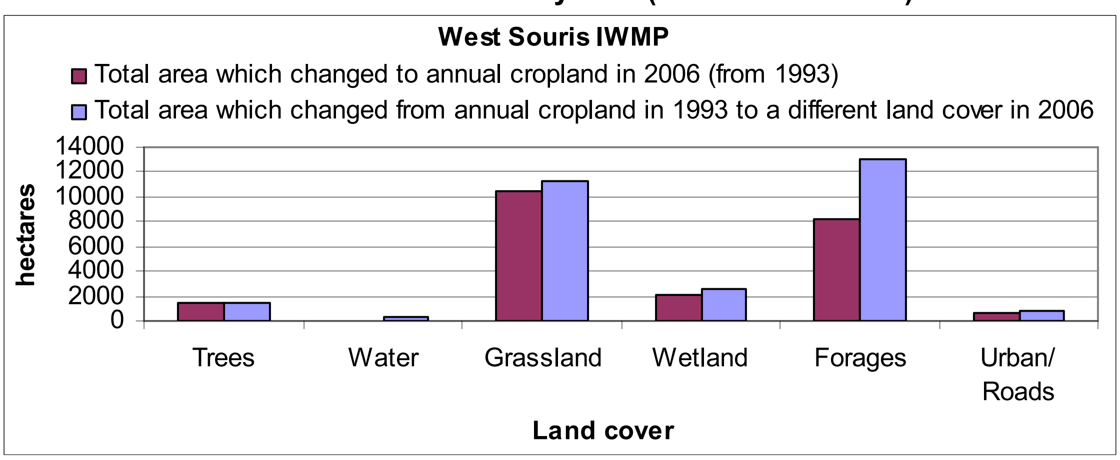


Figure 22: Net change in area of annual cropland, in relation to other land cover types, in the entire IWMP study area, as well as the Oak Lake Aquifer (from 1993 to 2006)

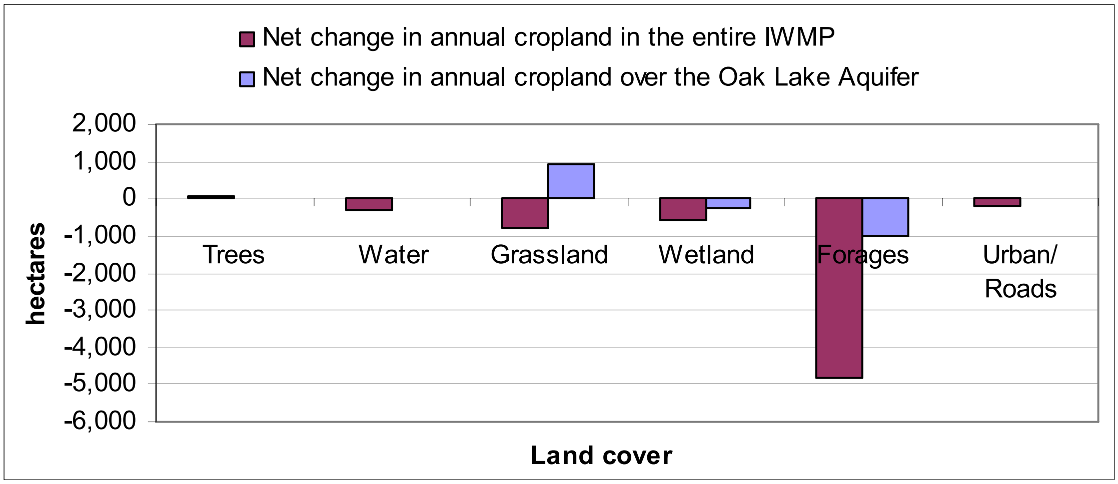
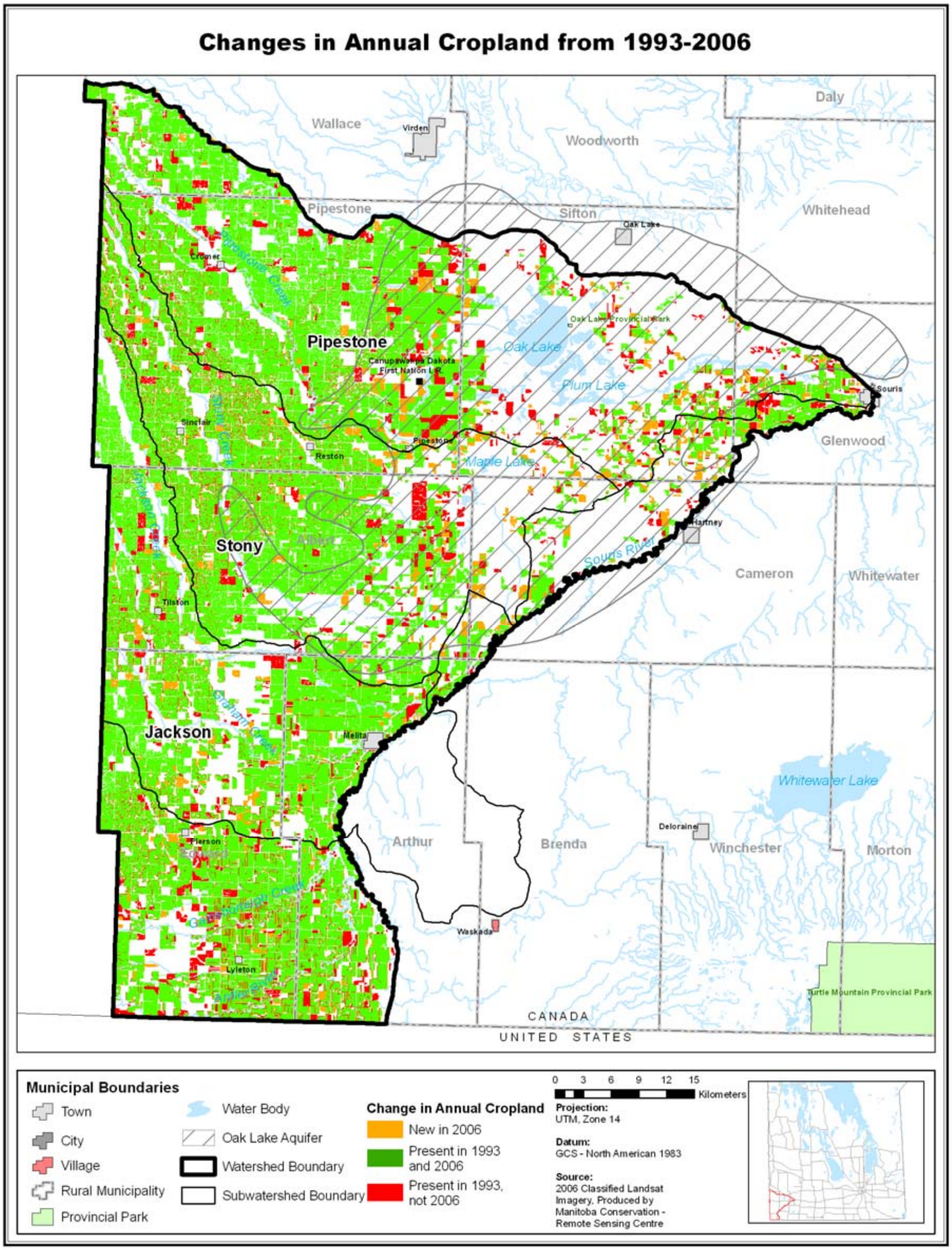


Figure 23: Analysis of Annual Cropland between the 1993 and 2006 satellite imageries*



* Land cover is derived from satellite imagery taken May 12, 1993 and August 22, 2006

Changes in Grassland Area

Changes in grassland land cover from 1993 to 2006 are indicative of issues such as flooding or groundwater and surface water quality as potential ongoing issues within the watershed.

In the West Souris River IWMP, there was an overall decrease of almost 5,000 ha of grassland in 2006, from 1993 (***Table 10***). Figure 26 summarizes parcels which experienced changes to and from grassland from 1993 to 2006. Some of these changes may be due to seeded forages included in the crop rotation, shifts to livestock production, as shown by the increase in livestock number in the Census data (***Figure 16, page 28***) or annual precipitation. Over the thirteen year period, the larger parcels which experienced conversions to or from grassland tends to be found overt he Oak Lake Aquifer, while changes on small areas can be found throughout the IWMP area (see ***Figure 27***)

Further analysis indicates that grassland experienced most of its changes with annual cropland, forages, wetlands and water. While the conversion of annual cropland in 1993 to grassland in 2006 was over 11,000 ha, there was an almost equal reciprocal conversion of grassland in 1993 to cropland in 2006, resulting in a small net increase in grassland with respect to annual cropland (see ***Figure 24*** and ***Figure 25***). The greatest loss of grassland is a result of conversion to wetland or water (***Figure 25***), a possible result of increase in precipitation in 2005, or in increased drainage of upland areas.

The net change in grassland was also analyzed for the area over the Oak Lake Aquifer. Most of the net conversion from grassland in the IWMP occurred in area over the Oak Lake Aquifer, due to conversion of 1993 grassland to annual crops, wetlands and water in 2006. The conversion to wetland and water could be due to a higher than average annual precipitation in 2005 and possibly a result of field drainage (refer to ***Appendix O***).

While conversion to grasslands may be the result of market trends and present economic opportunities and benefits, there may be a risk to the environment. For example, the increased conversion of grasslands to annual cropland on soils prone to erosion could impact water quality as well as increased flooding downstream. In turn, it could also lead to increased concentrations of contaminants in water if appropriate management practices are not utilized.

Figure 24: Total change in area of grassland, in relation to other land cover types, in the entire West Souris River IWMP study area (from 1993 to 2006)

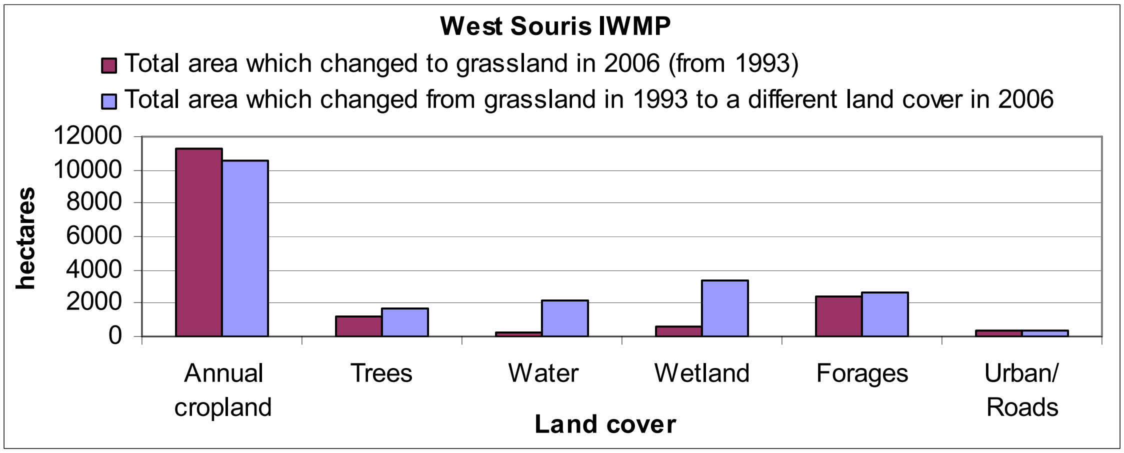


Figure 25: Net change in area of grassland, in relation to other land cover types, in the entire IWMP study area, as well as the Oak Lake Aquifer (from 1993 to 2006)

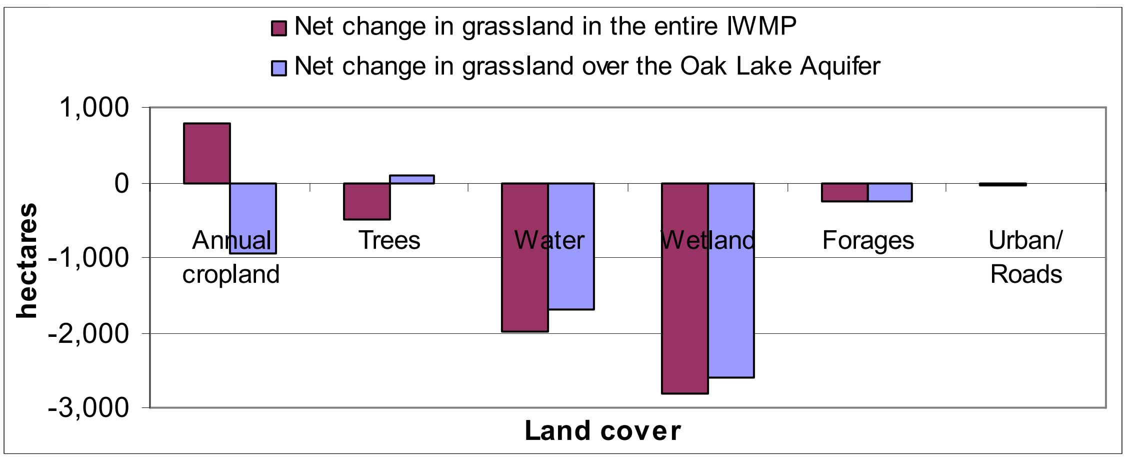
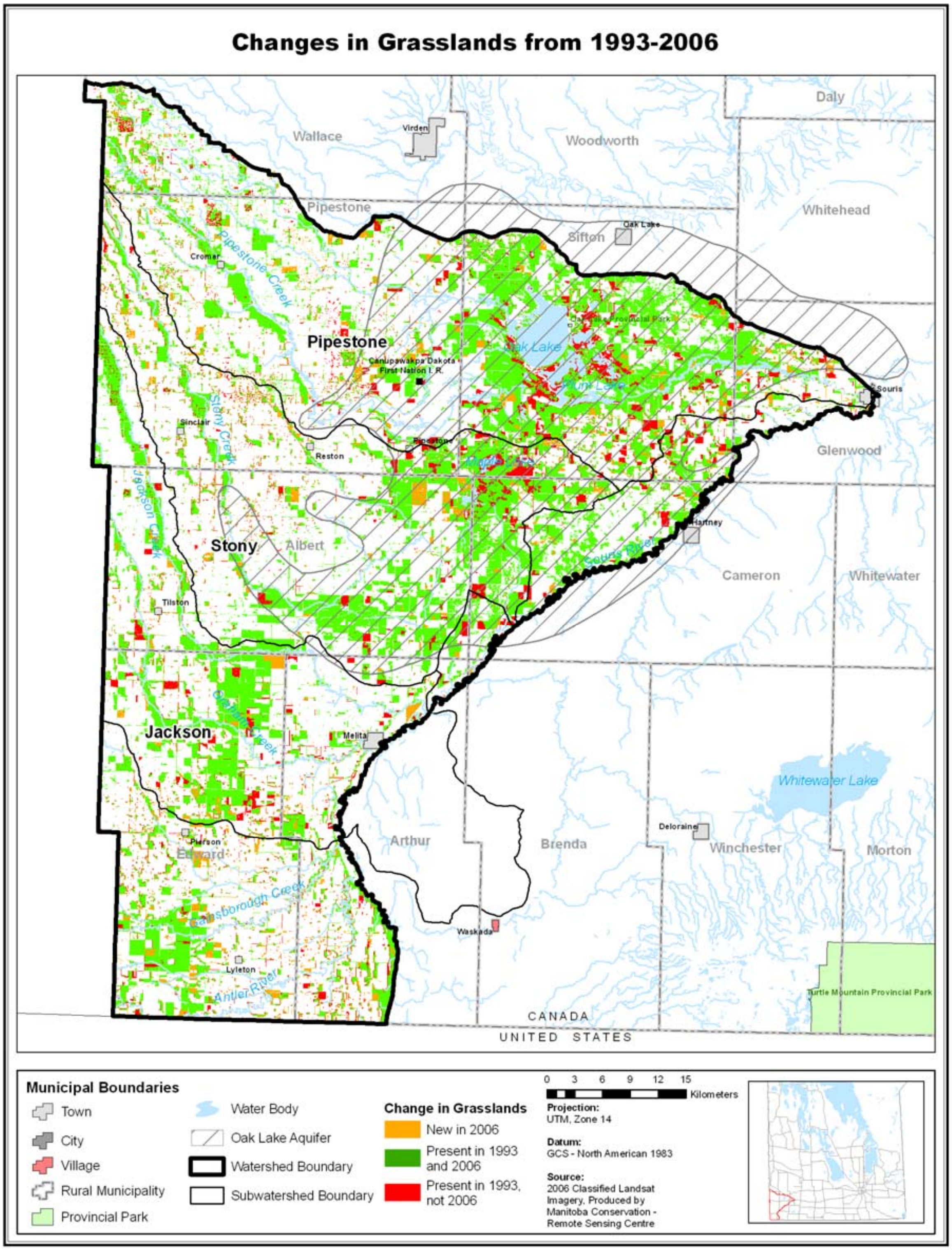


Figure 26: Analysis of Grasslands between the 1993 and 2006 Satellite imageries*



* Land cover is derived from satellite imagery taken May 12, 1993 and August 22, 2006

Conversions to Wetlands

Assessing the wetland classification change can provide some information about impacts of flooding, water supply and quality, as well as natural areas.

In the West Souris River IWMP, there was an overall increase of almost 900 ha of wetland in 2006, from 1993 (***Table 10***). Figure 29 summarizes parcels which experienced changes to and from wetland from 1993 to 2006. Some of these changes may be due to increase drainage and increased precipitation (***Figure 16, page 28***). Over the thirteen year period, larger parcels which experienced conversions to or from wetlands were found adjacent to the Oak, Plum and Maple Lakes. Changes on small areas can be found throughout the IWMP area (***Figure 29***).

Further analysis indicates that wetland experienced most of its changes with annual cropland, grasslands and water. The conversion of over 2,600 ha of annual cropland in 1993 to wetlands in 2006 was partly offset by the conversion of cropland in 1993 to wetland in 2006, resulting in a net increase in wetland with respect to annual cropland (see ***Figure 27*** and ***28***). The greatest loss of wetland is a result of conversion to water, whereas the greatest gain of wetland came from the conversion of 1993 grassland (***Figure 28***), a possible result of an increase in precipitation in 2005, or in increased drainage of upland areas.

The net change in wetlands was also analyzed for the area over the Oak Lake Aquifer. The majority of the net conversion of wetlands in the IWMP occurred in area over the Oak Lake Aquifer, where grasslands become wetland and wetlands became water. This could be due to a higher than average annual precipitation in 2005 (refer to ***Appendix O***) and possibly a result of field drainage.

Figure 27: Total change in area of wetland, in relation to other land cover types, in the entire West Souris River IWMP study area (from 1993 to 2006)

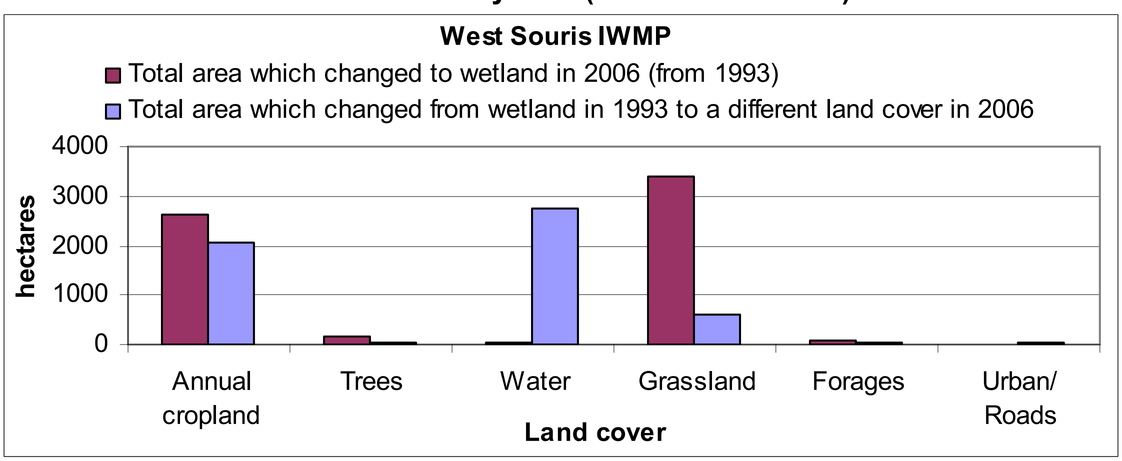


Figure 28: Net change in area of wetland, in relation to other land cover types, in the entire IWMP study area, as well as the Oak Lake Aquifer (from 1993 to 2006)

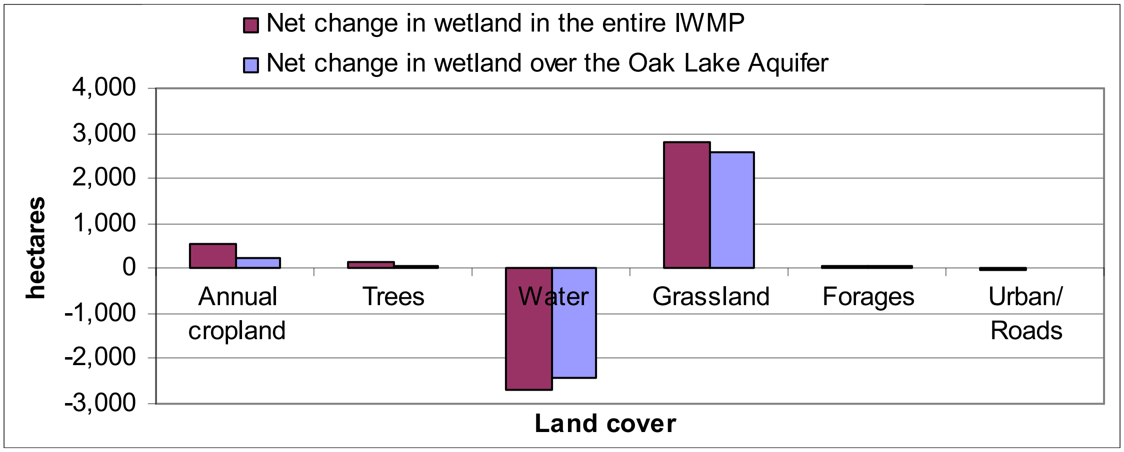
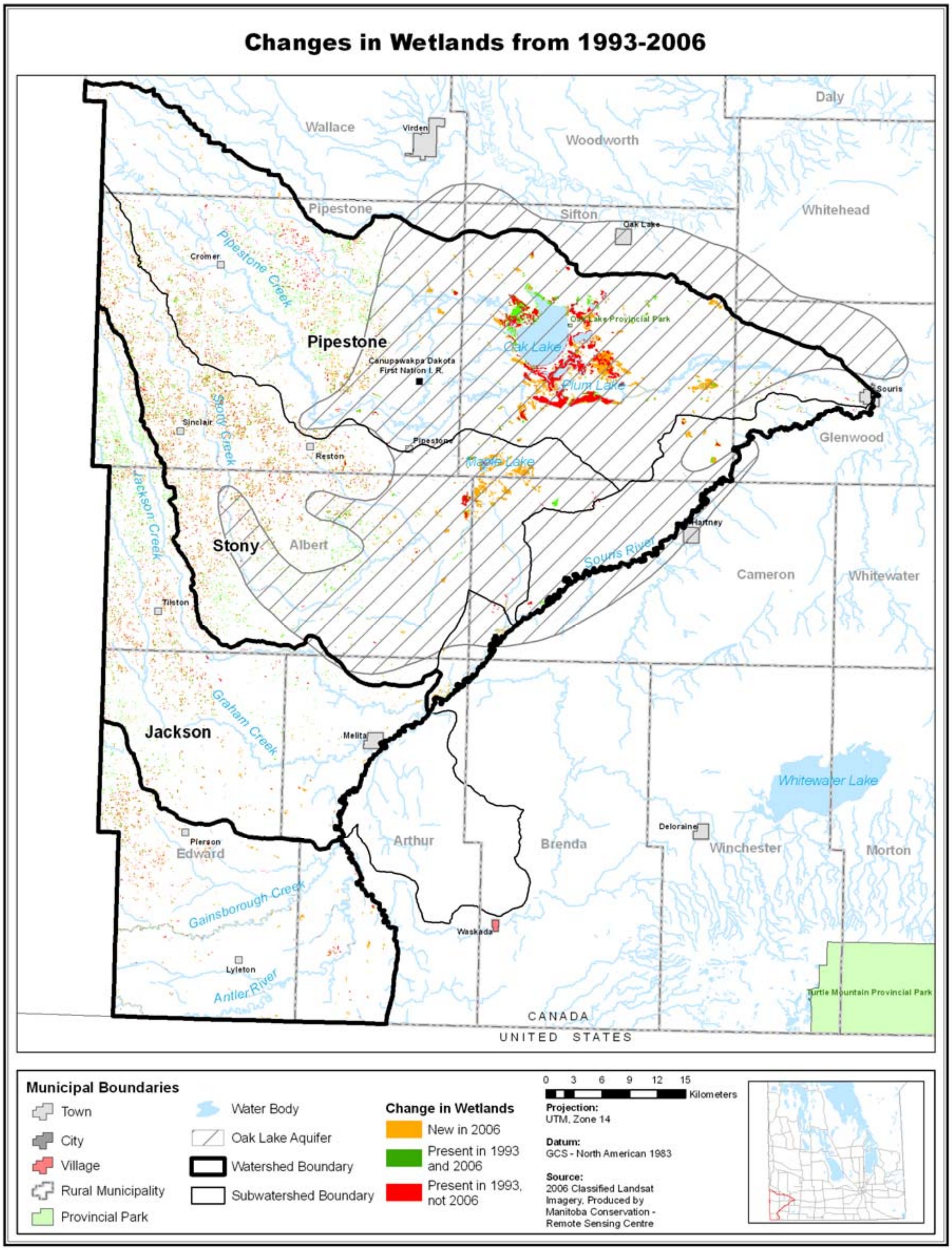


Figure 29: Analysis of Wetlands between the 1993 and 2006 Satellite imageries*



* Land cover is derived from satellite imagery taken May 12, 1993 and August 22, 2006

F. Agricultural Land Use and Management Considerations

This section involves the analysis of a combination of factors, land use and the characteristics of the local landscape, in order to determine where consideration should be given to how the land is used or managed, including the potential for adoption of Beneficial Management Practices (BMPs). Land cover data represents an indicator of how the land is being used, while relevant landscape characteristics and risk factors are contained within the soils dataset. Further information about land cover data can be found in ***Appendix D***, while more information about the soils data can be found in ***Appendix E***.

i. Agricultural Capability Analysis

The Canada Land Inventory System (CLI) was used to classify land based on agricultural capability. The CLI is a comprehensive survey of land capability and land use aimed at providing a basis for making land-use planning decisions. Under the CLI, lands are classified according to physical capability for agricultural use (PFRA, 2005).

Agriculture capability can best be described as the ability of the land to support the appropriate type of crops and agriculture management techniques. Not all land can be managed in the same manner with soil types, topography, stoniness, soil moisture deficiency and low fertility and other potential limitations influencing land use and practices. Classes ranging from 1 to 7 have been established, with 1 being the highest rated land class with no limitations to annual crop production and 7 being the lowest rated land for agriculture (not suitable for agriculture). Further information about CLI and specific characteristics and limitations associated with individual land classes is provided in ***Appendix F***.

Analytical Methods
Analysis of the land classes with respect to land cover helps to understand the extent of agricultural activity over marginal lands. An examination of annual cropland from the 2006 land cover will provide estimation to the extent of how much annual cropping is occurring on those marginal lands. Such analysis can also provide an indication of where producers are demonstrating good land management practices by utilizing these marginal lands for purposes other than annual crop production. As well, comparisons examining land cover analysis from the 1993 data sets provide opportunity to examine how much change has occurred in agricultural activity with respect to time.

Within the West Souris River Watershed study area, the majority of the land is classified as Class 1, 2, and 3, covering approximately 70% of the study area (***Table 11***).

2006 Cropland Class 4 -7
Almost 30% (123,500 ha.) of the study area is considered Class 4 to Class 7 for crop production (see ***Table 12***). Examination of 2006 land cover data indicates that approximately over 15% (or 37,000 ha) of annual cropland is located on land rated as Class 4 or lower (***Table 11*** and ***Figure 30***). The amount of marginal land being annually cropped has shown a slight decrease since 1993.

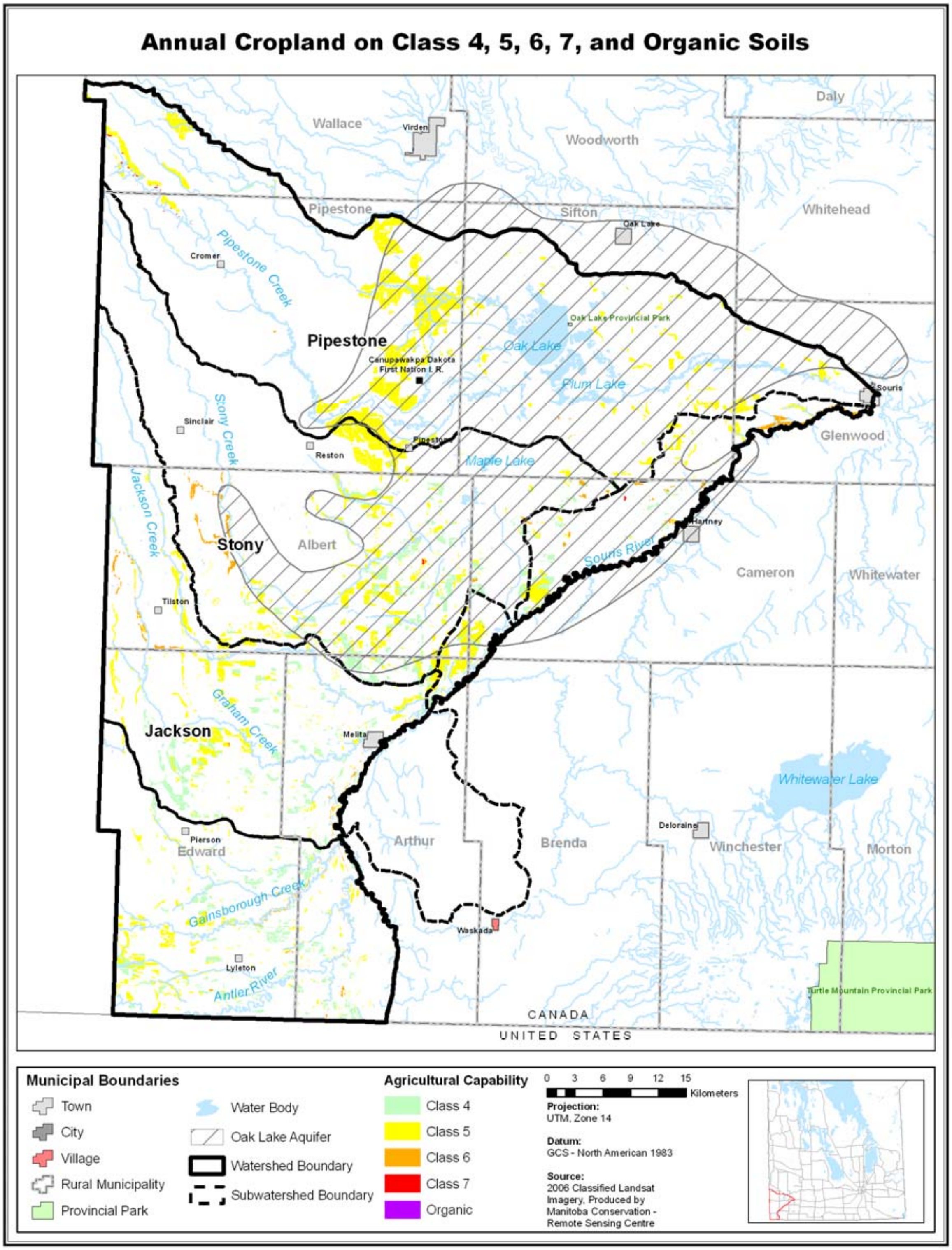
From the 1993 land cover analysis, it was noted that annual cropland had decreased by over 6,500 ha due to land conversions forages as noted in the earlier in this document. The most significant changes occurred in the Class 2 and 3 soils, where over 3,000 ha changed from annual cropland to another land cover category (***Table 11***).

Table 11: Agricultural Capability in the West Souris River Watershed Study Area

Class[1]	Total Area in IWMP (ha)	2006 Annual Cropland (ha) [2]	Distribution of Annual Cropland (%)	1993 Annual Cropland (ha)[3]	1993 to 2006 Change in Annual Cropland Area (ha)[4]
Class 1	86	55	0%	54	1
Class 2	163,598	115,357	51%	119,714	-4,357
Class 3	137,058	71,488	32%	72,666	-1,178
Class 4	26,383	10,001	4%	10,449	-448
Class 5	79,914	25,241	11%	25,689	-448
Class 6	15,559	1,770	1%	1,821	-51
Class 7	1,595	64	0%	91	-27
Organic	0	0	0%	0	0
Unclassified	83	11	0%	10	1
Water	7,974	108	0%	135	-27
TOTAL	**432,250**	**224,095**	**100%**	**230,629**	**-6,534**

1. Agricultural Capability is based on the CLI Rating of the dominant soil series for each soil polygon
2. Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on Aug. 22, 2006)
3. Annual Cropland taken from the 1993 Land Cover (from Landsat Imagery captured on May 14, 1993)
4. Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1993 in each Class

Figure 30: Areas annually cropped in 2006 on soils with an agricultural capability of Class 4, 5, 6 or 7 in the West Souris River Watershed IWMP study area[1]



1. Agricultural capability is based on the CLI Rating of the dominant soil serried for each soil polygon

iii. Wind Erosion Risk Analysis

Wind erosion risk information in Manitoba has been developed from the provincial soil survey data and the Soil Landscapes of Canada (SLC Ver 1.0 - see ***Appendix H***). The Wind Erosion Risk model used for the Agriculture Canada Wind Erosion Risk Maps (1989) incorporates soil moisture, surface roughness and aggregate size, and drag velocity by wind. Erosion risk classes were assigned based on the weighted average soil loss for each map polygon. The five classes of soil erosion risk (ranging from negligible to severe) are based on a bare, unprotected soil condition and do not consider land use and crop management factors. Cropping and residue management practices can significantly reduce erosion risk depending on crop rotation, soil type, and landscape features. Basing soil erosion risk on a bare soil scenario helps to identify areas dominated by sensitive, erosive soils which may otherwise be masked if a land use or surface vegetation cover factor was considered (Eilers et. al. 1989).

Approximately 46% of the West Souris River Watershed study area is considered to have a high to severe wind erosion risk (***Table 12***), primarily in the eastern portion of the watershed (***Figure 31***). Affected areas generally correspond to the portions of the study area with light textured soils. Approximately 40% of the watershed is considered to have a low risk of wind erosion.

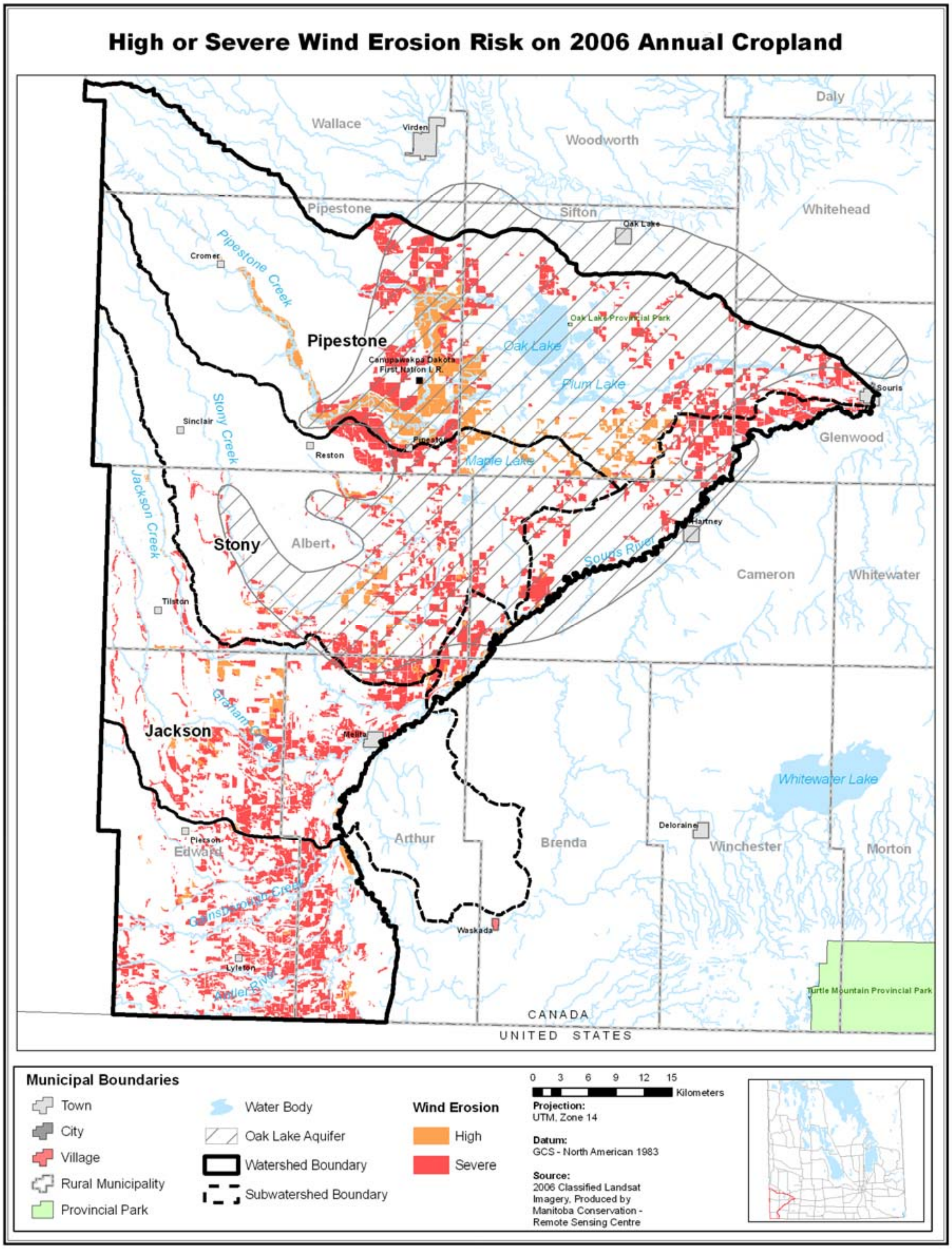
Based on the 2006 land cover data, approximately 33% of the annual cropland was located on soils with a high to severe risk for wind erosion (***Table 12***). When compared to 1993 land cover, there is a decreasing trend of annual cropland located on soils with a high or severe risk of wind erosion. This decrease was noted in all wind erosion categories, indicating that the changes were probably more attributed to the decrease in annual cropland acres from 1993 to 2006 than due to wind erosion risk factors. In addition to this, information from Census survey indicates that 70 to 85% of seeded fields were prepared using minimum or zero tillage in 2006, which is an increase in area from 2001.

Table 12: Wind Erosion Risk on Annual Cropland in the West Souris River Watershed Study Area from 2006 Land Cover [1]

Class[2]	Total Area in IWMP (ha)	2006 Annual Cropland (ha) [2]	Distribution of Annual Cropland (%)	1993 Annual Cropland (ha)[3]	1993 to 2006 Change in Annual Cropland Area (ha)[4]
Negligible	0	0	0%	0	0
Low	179,245	121,458	54%	124,965	-3,507
Moderate	42,034	27,949	12%	29,596	-1,647
High	39,787	15,756	7%	15,940	-184
Severe	158,783	58,133	26%	59,281	-1,148
Organic Soil	0	0	0%	0	0
Water	10,517	127	0%	161	-34
Unclassified	1,884	672	0%	689	-17
TOTAL	**432,250**	**224,095**	**100%**	**230,632**	

1. Wind Erosion Risk is based on the weighted wind erosion rating for each soil polygon and assumes bare soil.
2. Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on Aug. 22, 2006)
3. Annual Cropland taken from the 1993 Land Cover (from Landsat Imagery captured on May 14, 1993)
4. Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1993 in each Risk Class

Figure 31: Wind Erosion Risk on 2006 Annual Cropland in the West Souris River Watershed[1]



1. Wind Erosion Risk is based on bare soil and does not take into account vegetative cover or management practices.

iv. Water Erosion Risk Analysis

The overland flow of water can, under certain circumstances, carry particles of soil with it. Rain splash erosion, sheet erosion, rill erosion and gully erosion are all caused by water. Where this occurs, there is the potential to carry large quantities of sediment and contaminants to nearby waterways and waterbodies throughout the watershed. This section examines where in the watershed that there may be a greater potential for this to happen.

The analytical component of this section focuses on annual cropland from land cover data (see ***Appendix D***) in conjunction with water erosion risk (see ***Appendix G***) and the proximity of these areas to water courses.

Water Erosion Risk

The risk of water erosion was estimated using the Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith (1965). The USLE predicted soil loss (tonnes/hectare/year) was calculated for each soil component in the soil map polygon. Water erosion risk factors used in the calculation include mean annual rainfall, slope length, slope gradient, vegetation cover, management practices, and soil erodibility (Eilers et. al. 2002). Erosion risk classes were assigned based on the weighted average soil loss for each map polygon. The five classes of soil erosion risk (ranging from negligible to severe) are based on bare and unprotected soil conditions. Cropping and residue management practices can significantly reduce this risk depending on crop rotation, soil type, and landscape features. Basing the soil erosion risk on a bare soil scenario helps to identify areas dominated by sensitive, erosive soils which may otherwise be masked if a land use or surface vegetation cover factor was considered (Eilers et. al. 2002).

Over 11,100 hectares (almost 3% of the study area) within the study area are subject to a high or severe risk of water erosion. Analysis of land cover shows that over 5,300 hectares were annual cropland in 2006, which is a slight decrease from 2001 (***Table 13, Figure 32***).

Table 13: Water Erosion Risk on Annual Cropland in the West Souris River Watershed Study Area from 2006 Land Cover

Class[1]	Total Area in IWMP (ha)	2006 Annual Cropland (ha)[2]	Distribution of Annual Cropland (%)	1993 Annual Cropland (ha)[3]	1993 to 2006 Change in Annual Cropland Area (ha)[4]
Negligible	217,710	83,722	37%	86,503	-2,781
Low	116,136	78,605	35%	80,426	-1,821
Moderate	79,196	56,298	25%	57,931	-1,633
High	5,050	2,405	1%	2,603	-198
Severe	6,101	2,946	1%	3,010	-64
Organic Soil	0	0	0%	0	0
Water	7,974	108	0%	134	-26
Unclassified	83	11	0%	10	1
TOTAL	**432,250**	**224,095**	**100%**	**230,617**	

1. Water Erosion Risk is based on the weighted average USLE predicted soil loss within each soil polygon, assuming bare unprotected soil.
2. Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on Aug. 22, 2006)
3. Annual Cropland taken from the 1993 Land Cover (from Landsat Imagery captured on May 14, 1993)
4. Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1993 in each Risk Class

Buffer Identification: Analytical Methods

In order to focus on areas that may have significant potential to contribute sediments and nutrients to water courses, this section examines three factors. They are (a) land cover, specifically whether the land was in annual crop, which significantly increases the likelihood of bare soil conditions and high nutrient application rates, (b) water erosion risk, which takes into account important factors such as topography (slope and slope length), rainfall, and soil erodibility, and (c) proximity to water courses, where when these factors are considered, there would likely be an increase to the probability of sediment and nutrients reaching surface waters.

A 50 metre buffer was chosen for this particular analysis (note that subsequent analysis could be undertaken using a buffer of a different size) and applied to all provincially designated drains in the watershed. All polygons classified as annual crop in 2006 and located on land with a high or severe risk of water erosion within 50 m of a designated drain were selected (***Figure 40***).

The analysis does not take into account land adjacent to lakes and wetlands, but does include streams and rivers of all sizes and intermittent or permanent. Forage land was not selected but could be considered in future analyses, as it is part of annual crop rotations in some areas. This analysis did not consider other factors that can contribute to bare soil and nutrient transport such as tillage practices or livestock grazing and wintering in riparian areas and along streambanks.

Results

Analysis revealed that, in 2006, approximately 130 ha of annual cropland was located on land with a high to severe risk of water erosion and located within 50 m of a waterway, with the majority found in the Pipestone Creek Subwatershed region (approximately 2% of total buffers in subwatershed) (***Table 14***). It should also be noted that the area of cropland located within 50 m of a designated drain totaled over 14,500 ha and the importance of tillage practices, crop rotation, and nutrient management on these lands is also significant as there is a likelihood that runoff from these fields could enter nearby streams and rivers.

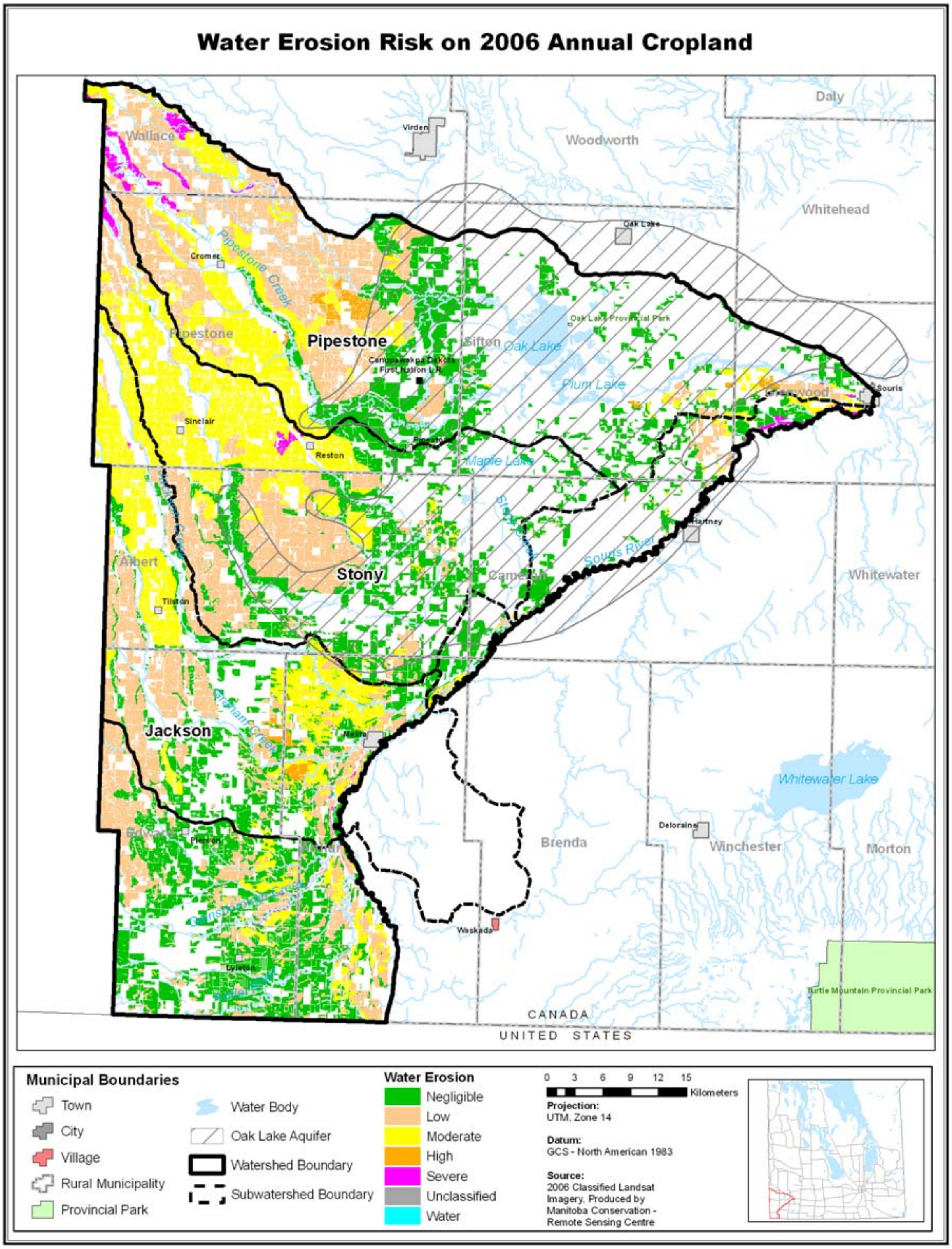
Although this analysis identifies areas in the watershed that may be worthy of consideration for future action or mitigation, it is important to note that this approach can only give a general indication of risk; limitations in the datasets used dictate that ground-truthing of these sites is required. Data limitations include the scale of the soils data in some areas of the watershed (see ***Appendix E***), spatial accuracy of watercourses in the map, and the limitations associated with land cover to identify land use. Land cover data is never completely accurate and land use is dynamic and changes may have occurred since the 2006 data was collected. It is important to further investigate whether specific area actually at high risk to water erosion to verify if site characteristics correlate with the results derived from the soils data (greatly dependant on amount of overland flow, soil type, topography, and vegetation cover). Although there are data limitations, this methodology can potentially be considered as an approach to identifying sites where BMPs that reduce water erosion could have a significant positive influence in the watershed.

Table 14: Annual cropland in 2006 located within 50 metres of a provincially designated drain that has a high to severe risk of water erosion by subwatershed

Watershed	Buffer (within 50m of a watercourse) area (ha)	Area of buffer in annual cropland in 2006 with high or severe risk of water erosion (ha)	Percent of buffer in annual cropland in 2006 with high or severe risk of water erosion (ha)
Jackson	2,644	16	1%
Stony	2,159	1	0%
Pipestone	5,534	93	2%
Remaining area*	4,333	22	1%
West Souris River	**14,670**	**132**	**1%**

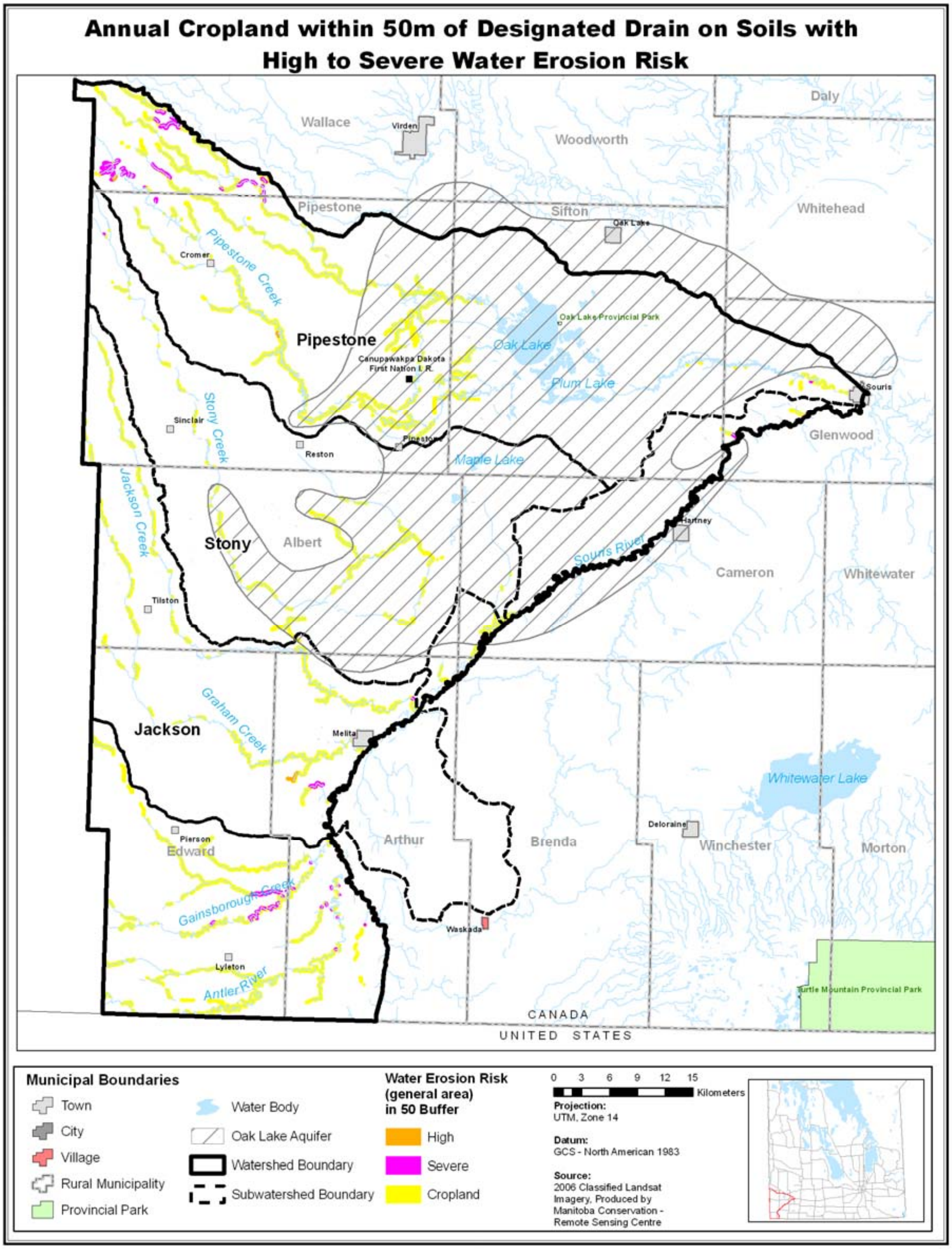
* Remaining area includes area within the IWMP study area that are outside the Jackson, Stony and Pipestone Creek subwatersheds

Figure 32: High and Severe Risk of Water Erosion on 2006 Annual Cropland in the West Souris River Watershed[1]



1. Water Erosion Risk is based on bare soil and does not take into account vegetative cover or management practices

Figure 33: 2006 Annual Cropland located within 50 m of a Designated Drain with a high to sever risk of Water Erosion Risk in the West Souris River Watershed[1]



1. Water Erosion Risk is based on bare soil and does not take into account vegetative cover or management practices

v. Soil Drainage Analysis

Soil drainage reflects the actual moisture content in excess of field capacity and the length of the saturation period within the plant root zone. Excess water content in the soil limits the free movement of oxygen and decreases the efficacy of nutrient uptake. Delays in spring tillage and planting are more likely to occur in depressional or imperfectly to poorly drained areas of individual fields. Surface drainage improvements and tile drainage are management practices that can potentially be used to manage excess moisture conditions in soils but should only be used if deemed appropriate for a site specific situation and only where regulations requirements can be met. Agriculture and Agri-Food Canada (AAFC) has classified soils for their drainage capacity using a five class system (see ***Appendix I***).

Approximately 40% (173,230 ha) of the study area can be considered poor to imperfectly drained. These types of lands make up 30% (66,440 ha) of the 2006 annual cropland (***Table 15***). Most of the imperfectly drained soils are associated with the eastern portion of the watershed (refer to ***Figure 34***). Patches of poorly drained soils is scattered throughout but found mainly in the Oak, Plum and Maple Lake areas. In areas with porous underlying soils, such as the Oak Lake Aquifer, rapid drainage can pose a risk to leeching of nutrients and contaminants into the groundwater. Over 12,000 ha of annual cropland was located on these soils, of which a large portion were over the Oak Lake Aquifer.

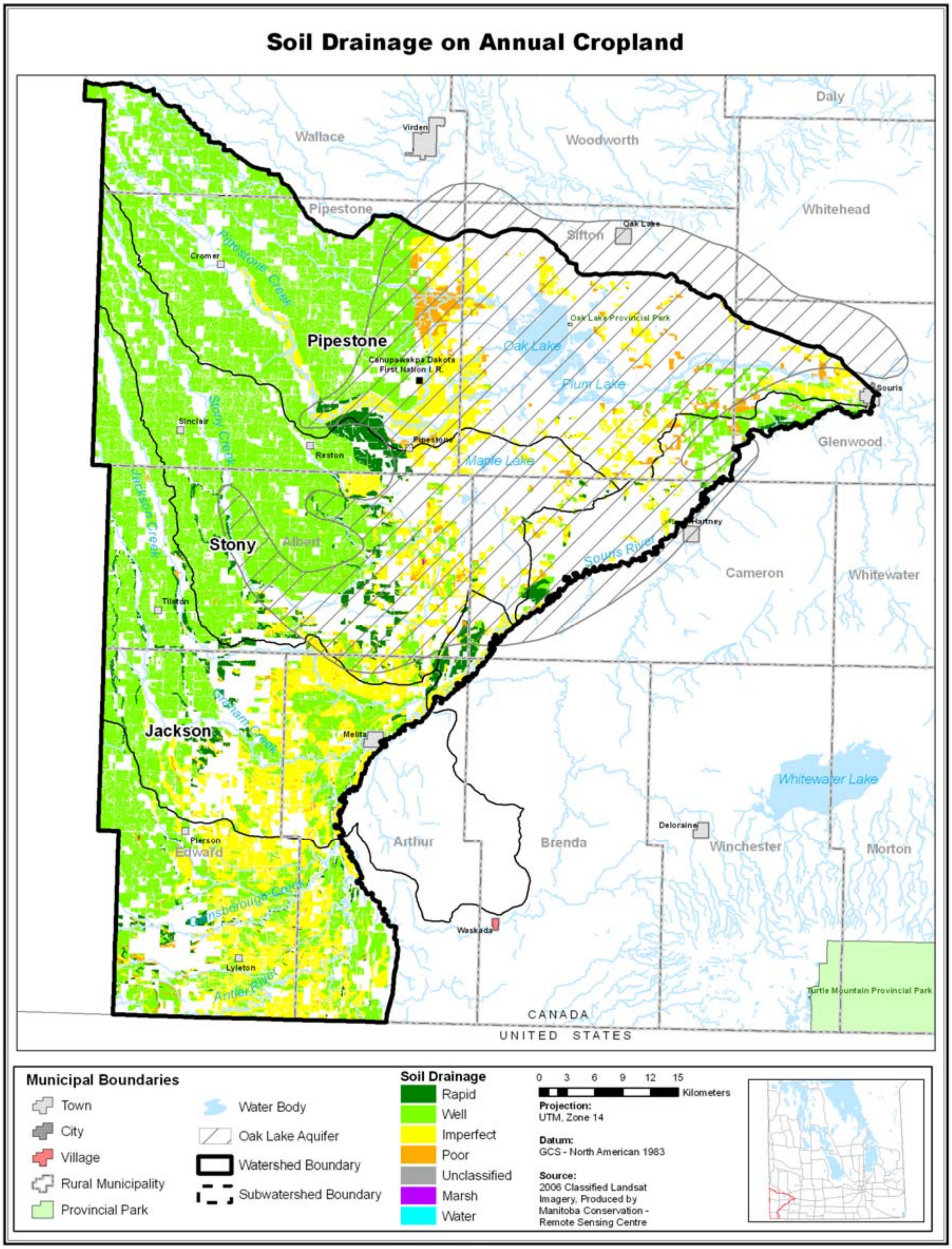
Improved drainage indicates areas where networks of surface drains can accelerate surface runoff that reduce the duration of surface ponding and provide greater flexibility to crop management. While these drains effectively move water off fields and decrease the amount of standing water in agricultural fields, other adverse effects need to be considered. The drains facilitate water moving off fields more quickly than under natural run off conditions resulting in river channels being filled to high water levels during heavy precipitation events. High water levels could lead to a flood or near-flood stage, thereby increasing the risk for water erosion or property damage. Also, man-made drainage systems tend not to have riparian buffers associated with them, unlike natural and undisturbed watercourses. With decreased or non-existing riparian buffers, there is an increased risk of nutrient and sediment loading into watercourses. Riparian areas and perennial vegetation on adjacent lands are able to trap and store sediment and nutrients from field runoff during the growing season, reducing the risk of contaminating surface water.

Table 15: Soil Drainage Classes in the West Souris River Watershed

Drainage Class[1]	Area (ha)	2006 Annual Cropland area (ha)	Distribution of 2006 Annual Cropland[2]
Rapid	38,031	12,662	6%
Well	212,862	144,862	65%
Imperfect	124,694	57,994	26%
Poor	48,536	8,445	4%
Unclassified	83	11	0%
Marsh	70	12	0%
Water	7,974	108	0%
TOTAL	**432,250**	**224,094**	**100%**

1. Soil Drainage is based on the dominant soil series for each soil polygon
2. Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery)

Figure 34 - Soil Drainage with Respect to 2006 Annual Cropping in the West Souris River Watershed Study Area[1]



1. Soil drainage class is based on the dominant soil series for each soil polygon

G. Recent Federal and Provincial Policies and Programs Affecting Agricultural Land Use and Management

i. Agriculture and Land Use Planning Policies

Integrated watershed planning is a community based focused planning process around issues which affect water quality. This planning needs to support the existing community framework for economic development and land use planning. In most cases, this means, integration of the IWMP into the existing Development Plan. The Development Plan is the local legal framework build around the Provincial Land Use Policies.

All of the municipalities included in the West Souris River Watershed have Development Plans which govern land use decisions including the protection and use of agricultural lands. Development of rural lands for non-agricultural use can impact watershed health, and may result in enhanced drainage above agricultural requirements. Because of this, the ability of the landscape to provide ecological goods and services such as the retention and filtering of water is impacted when agricultural land is subdivided or taken out of agricultural production.

Within a Development Plan, protecting agricultural land from non agricultural use may also mean protecting wetlands and tree cover, especially if the farmland is maintained for grazing purposes. For these reasons, having agricultural lands protected in a Development Plan will have benefits for the issues identified within the West Souris River IWMP.

In the West Souris River Watershed, there are four planning districts, each with their own development plan. These are;

- Southwest Planning District (R.M.'s of Albert, Edward, Arthur, and Brenda)
- Dennis County Planning District (R.M.'s of Pipestone, Sifton, and Cameron)
- Trans Canada West Planning District (R.M.'s of Wallace and Archie; Town of Virden; Village of Elkhorn)
- Souris-Glenwood Planning District (R.M. of Glenwood; Town of Souris)

The following sections describe the framework for land use planning from a legal perspective, set out by the Provincial Government.

Provincial Land Use Policies (PLUPs): These policies guide local and provincial authorities in preparing Development Plans and in making land use decisions. The PLUPS cover nine broad policy areas, of which Agriculture is one component. The other areas, besides agriculture, are General Development, Renewable Resources, Water and Shoreline, Recreational Resources, Natural Features and Heritage Resources, Flooding and Erosion, Provincial Highways, and Mineral Resources. The various government departments "own" their policies and are involved in setting them.

Development Plans: The Development Plan is the agreement between the local and provincial governments on matters concerning land use. Once in place, all proposed development and land use changes must be evaluated under the policies of the development plan. This is where the policies governing the protection of prime agricultural land and agricultural operations are set out.

The Provincial Land Use Policies are applied at the local level through the Development Plans, initiated by a municipality or planning district (group of municipalities). The purpose is to set out land use objectives and patterns or characteristics of development for an area. Through the Development Plan, lands are designated for certain uses such as agriculture, agriculture restricted, residential, industrial or commercial.

Zoning By-Laws – Regulating the Use of the Land: Following the approval of a development plan, a municipality must enact a zoning by-law that is consistent with their development plan. A municipal zoning by-law contains the rules and regulations that control development as it occurs. A zoning by-law further divides a municipality into various zones such as rural residential, highway-commercial and general agricultural. For example, an area that is designated as Agricultural in a development plan may be further zoned as Agricultural General and Agricultural Restricted, with both zones having separate criteria for agricultural development. The zoning by-law sets out requirements and criteria under which development may occur, including property site size, dimensions, separation distances and other siting criteria. It also specifies permitted and conditional uses within each zone.

Zoning by-laws can influence the consumption of agricultural land by the types of development it will permit within the agricultural areas. Generally, only resource-related and agriculturally related developments should be permitted in agricultural areas.

As a **Permitted Use,** a development has the basic right to be established but a development permit must be issued. **Conditional Uses** are certain types of development (e.g. livestock operations), which due to their inherent characteristics may have potential adverse impacts on nearby properties and resources and therefore have to undergo a special process of review and approval, including a public hearing.

PLUPS Agriculture Policy: The Provincial Land Use Policies outline Agriculture's interests to protect land that is used for agriculture by minimizing the subdivision and wasteful use of this land and protecting farms from encroachment and disturbance by other uses which may be incompatible with normal farming operations. These interests are addressed in the PLUPs Policy #1- General Development, Policy #2 – Agriculture and Subdivision Policies sections of the Provincial Land Use Polices Regulation.

Policy #2 – The objectives of the Agriculture Policy are to maintain a viable base of agricultural lands for present and future food production and agricultural diversification, and to protect economically viable agricultural operations from encroachment by other land uses which could adversely affect their sustainability.

Soils and Provincial Land Use Planning: It is important to recognize that for planning purposes, the determination of the classification of the agricultural capability of an area is based on the capability class of 60% or greater of the quarter section or river lot. If 60% or greater of a river lot or quarter section is Class 3 or better for agricultural capability, then the entire river lot or quarter section is considered to be prime agricultural land from a planning perspective. For example, MAFRI staff often review subdivision applications in designated agricultural areas for 5-10 acre lots for residential purposes. The 5 acre site itself may have an agricultural capability rating of CLI Class 4 or poorer but the remaining quarter section may be considered prime agricultural land by definition in the Provincial Land Use Policies. Because the majority of the quarter section is prime agricultural land and the surrounding area is actively farmed, MAFRI would not recommend approval of the subdivision.

One non-farm dwelling in an agricultural area can have a shadow effect that covers a much larger area than the 5 acre lot that it is located on. The potential for land use conflicts increases as the number and the density of non-farm dwellings increase.

For planning purposes, MAFRI supports only the use of detailed soil survey information (at a scale of 1:50,000 or better) in making site specific decisions pertaining to land use. Reconnaissance scale information published by Manitoba Soil Survey and Canada Land Inventory Maps as published by the Government of Canada may be used in the development plan as reference maps, but should never be used as the basis for a site specific land use decision. In any case, Prime Agricultural Land and Viable Lower Class land are areas of concern for agriculture.

Prime Agricultural Lands: Land composed of mineral soil determined by Manitoba Agriculture to be of dryland Agricultural Capability Class 1, 2 or 3 and includes a land unit of one quarter section or more or a river lot, 60% or more of which is comprised of land of dryland Agricultural Capability Class 1, 2, or 3.

Viable Lower Class Land – Land that is not prime agricultural land but that is used for agriculture or has the potential to be used for agriculture. It is defined in the Provincial Land Use Policies Regulation 184/94 as "land other than prime agricultural land on which agricultural activities that contribute to the local economic base are the dominant land use". Lower class agricultural lands (i.e. Class 4 and 5) are well suited for expanding forage production and pastureland to support the Province's beef industry.

Some municipalities, particularly those municipalities with smaller areas of prime agricultural land, have included policies to protect land that is Class 4. Careful planning for the use of this lower rated land in an agricultural area provides for maximum agricultural diversification opportunities. It should be noted that protection of Viable Lower class soil often protects areas of biodiversity on the landscape.

Some of the Planning Districts across the province have started to integrate the Nutrient Management Regulations into their development plans. Whether or not these regulations are included, they still apply to all lands across Manitoba, and are administered by Manitoba Water Stewardship (Appendix K).

Livestock: MAFRI recommends that new livestock operations should not be permitted on soils determined by detailed soil survey (scale of 1:50,000 or better) to have an agricultural capability of Class 6, 7 or on unimproved organic soils as described under the Canada Land Inventory.

It is important to note that MAFRI recommends that livestock operations for this purpose be defined as "a permanent or semi-permanent facility or non-grazing area, including all associated manure collection facilities, where at least 10 animal units of livestock are kept or raised"**.** Therefore, this does not include enclosed grazing areas and use of Class 6 and 7 soils within areas used for pasture should still be permitted. This reflects new regulations for manure application and residual nitrate nitrogen levels permissible based on the agricultural capability class and subclass of the soil under the Livestock Manure Management and Mortalities Regulation under The Environment Act administered by Manitoba Conservation (Appendix L).

Municipalities are encouraged to use the agricultural capability maps as a support tool when making planning decision related to livestock development.

Livestock Operations Policy (LOP): In 2000, the Manitoba Government announced its Livestock Stewardship Initiative with the aim to ensuring the sustainable development of Manitoba's livestock industry. Following consultations with public, municipalities, environmental groups and industry, the government announced changes to *The Planning Act* and other legislation with respect to livestock operations. This included the following:

- Mandatory adoption of a development plan by Jan. 1, 2008 with a livestock operation policy
- All livestock operations of a size of 300 animal units (AUs) or greater are a conditional use and require a Technical Review (3 km notification)
- Specifies the types of conditions that may be imposed on the approval of a livestock operation
- Development agreements can involve timing of construction, control of traffic, and construction or maintenance of roads or landscaping required to service the livestock operation
- Municipalities or planning districts must designate areas in the development plan where expansion or development of livestock operations: may be allowed; may be allowed up to a specified maximum size; and/or, will not be allowed
- A Development Plan should state the general separation distances for livestock operations with reference to the minimums

These guidelines provide better "up-front" planning for livestock – done in the development plan process, more certainty in terms of how LO's will be handled in the municipality – and reduced conflict at the conditional use stage. Municipalities continue to have a final say in where LO's are permitted in their municipality.

Note: NO conditions may be set regarding the storage, handling, application or transportation of manure, other than requiring a cover.

Additional Considerations from an Agricultural Perspective

The Nature of the Surrounding Area: If the surrounding area is predominantly agricultural and is generally maintained in large parcels, the conversion of farmland to non-farm uses can influence the commercial viability of farms in the following ways:

- Loss of farmland and presence of non-farm development may reduce a farmer's ability to respond and adapt to changing economic and market conditions and ultimately manage their business.
- Increased rural residential development in agricultural areas generally tends to increase land assessment values and property taxes.
- Increased non-farm uses in agricultural areas increases land use conflicts (crop spraying, dust, odours).

Proximity of Livestock Operations: The creation of a rural residential lot may impose a minimum separation distance, which may restrict the expansion of existing livestock operations and the establishment of any new operations.

Municipal zoning by-laws set out separation distances between livestock operations and residential development. MAFRI recommends that municipalities use the minimum separation distances from livestock operations to non-farm land uses (ex. single residence and designated residential and recreational areas). These separation distances are based on odour considerations and are therefore greater for operations using an earthen manure storage facility.

The separation distance also increases as the size of the livestock operation increases. It is important to note that the recommended separation distances for siting livestock operations are much greater from designated residential areas than from a single residence. The distances are about 4 times as great.

Manure Application in the Surrounding Area: Proposed changes to the *Pesticide and Fertilizer Control Act* will bring into regulation recommended setbacks for manure spreading. These distances were determined based on odour considerations and vary with the method of application. Distances are significantly greater for designated residential areas than they are from a single residence.

Development Plans are a key tool for land management at the local level, and are crucial for meeting environmental goals within the economic and social framework of the area. Protection of agricultural lands is one means of meeting environmental goals on the landscape, while keeping the stewards of the land; the farmers; on the land, so they can care for the soil and water resources of our communities.

ii. Recent Federal-Provincial Programs

Environmental Farm Planning and Canada-Manitoba Farm Stewardship Program - On-Farm Beneficial Management Practices Adoption

In 2003, the Agricultural Policy Framework (APF) was launched as a new national approach to support agricultural activities associated with Business Risk Management, food safety and quality, science and innovation, environment, and skill development. In support of priorities related to soil, air, water and biodiversity, various environmental initiatives were introduced across Canada including Environmental Farm Planning and the National Farm Stewardship Program. Environmental Farm Planning (EFP) is an awareness and planning tool used to enhance producers' understanding of potential on-farm environmental risks and to develop action plans for how these risks can be addressed. Many producers in Manitoba, including those in this watershed, have participated in the EFP process to gain an improved understanding of the potential environmental risks associated with agriculture, as well as, those on their own farms. The EFP process also allowed producers to develop an action plan that outlines how potential risks on their farms can be addressed through the adoption of beneficial management practices (BMPs). Financial and technical support was offered to producers wishing to adopt BMPs through the Canada Manitoba Farm Stewardship Program (CMFSP) between 2003 and 2009. This program offered 30 different BMPs to producers that had completed an EFP. (For a list and description of the BMPs see ***Appendix N***).

Participation in the Environmental Farm Plan Program is reported by municipalities in and around the study area (***Appendix O***). The information portrays the number of participants in the Environmental Farm Planning process based on where EFP workshops were held. Therefore it should be noted that participants may reside in the surrounding area and not necessarily in location where the workshop was offered. Environmental Farm Planning Workshops were well attended, with a high degree of producers completing the EFP process and receiving a Statement of Completion. The participation rate is consistent with the Manitoba average, indicating that producers in the West Souris watershed have a high environmental stewardship ethic and wish to be proactive in addressing environmental risks on their own farms.

In the West Souris Watershed study area; there were a total of 285 BMP projects that were adopted by producers (***Table 16***). All of these BMPs contribute to reducing risks to water quality. Of the 285 adopted, 88 of the BMPs were related to Soil Erosion Risk – Soils at Risk Protection. Almost 40% were non-point source crop related and 89 BMPS were adopted for Non Point Source – livestock related. It should also be noted that a majority of the Soil Erosion and Non Point Source crop related BMPs were implemented in the Oak Lake Aquifer region of the watershed.

The top three BMPs adopted by producers in the study area through the CMFSP were Improved Cropping Systems, Product and Waste Management, and Winter Site Management which is consistent with trends observed in other regions of Manitoba.

The adoption of BMPs by producers is not limited to those funded through the CMFSP. Other agencies like Conservation Districts, Ducks Unlimited Canada, and Manitoba Habitat Heritage Corporation also support the adoption of various BMPs. In addition, as indicated in the public consultation process for the IWMP, there have been many producers who have adopted BMPs on their own initiative, so it is difficult to determine precise adoption levels. However, the CMFSP program data does suggest that producers in the watershed are progressive in terms of BMP adoption and that future conservation programs that may stem from IWMP implementation are likely to have considerable levels of participation in this region.

Table 16: BMP Adoption through the Canada-Manitoba Farm Stewardship Program 2003-2008[8]

BMP Categories	West Souris IWMP	Oak Lake Aquifer
Point Source - Livestock Manure Related[1]	<5	<5
Point Source - Other (Petroleum, Nutrients from Feed, Pesticides, etc.)[2]	26	15
Non Point Source - Livestock Related[3]	89	45
Non Point Source - Crop Related[4]	115	56
Non Point Source - Crop Related (Pesticides)[5]	18	11
Soil Erosion - Soils at Risk[6]	24	21
Biodiversity[7]	>10	<5
Total	**285**	**151**

1. These include BMPs 1, 2, 4, 5, 6
2. These include BMPs 8, 9, 17
3. These include BMPs 3, 7, 10, 26, 30
4. These include BMPs 14, 18, 24, 29
5. These include BMPs 16, 20, 25
6. These include BMPs 11, 12, 13, 15, 19, 27
7. These include BMPs 21, 22, 23, 28
8. Refer to Appendix M for BMP descriptions

H. Agricultural Land Use and Management Recommendations*

This section provides a list of recommended actions, target areas and potential indicators. Recommended actions are provided for each of the priority issues relating to agricultural activities and land resources as identified during the public consultation portion of the IWMP process. Recommended actions are based on the analysis carried out and reported on in the previous sections of this report. Target areas identified for each recommended action area based on the analysis and serve as a general guide for the IWMP, but should not replace the need for site-specific analysis. A list of potential indicators is included in this table to provide some suggestions for comparison for future monitoring and evaluation of the IWMP.

Watershed Issue	Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
Water Supply	• **Irrigation** – In the 2006 Census of Ag survey, four farm operations reported the use of irrigations for crops, fruit and vegetables • **Livestock numbers -** There was an increase in livestock numbers for beef from 2001 to 2006, a decrease in pigs in the same timeframe and an increase in poultry numbers for Stony subwatershed. At the same time, the number of farms reporting has decreased, with a result of fewer, larger livestock operations. • **Increase in water and wetlands –** Satellite imagery analysis for land cover between 1993 and 2006 show a net conversion of grasslands to wetlands and wetlands to water; the majority of this occurs in the area over the Oak Lake Aquifer. This may be a result of increased surface water in the watershed due to higher average annual precipitation in 2005, or increased drainage upstream, or a combination of both.	**1. Surface Water Management Assessment -** Examine potential for the development of a long term surface water management plan similar to what was completed at Turtle Mountain Conservation District for entire watershed. **2. Rural Water Assessment** - Examine rural water infrastructure needs to address potential water shortages (e.g. pipelines, wells)	1. Entire watershed 2. Entire watershed	Drought Monitoring Program - proportion of farms reporting sustainable water supplies for on-farm water needs

Water Quality	• **Annual cropping of marginal lands** - Class 4 land and lower is considered to be at significant risk to soil erosion and nutrient transfer to surface waters when cropped annually. Approximately 30% (123,500 ha) of the 2006 annual cropland within the study area was located on Class 4 and lower soils
	• **Water erosion risk** – 11,151 hectares (3%) within the entire watershed are indicated to be of high or severe risk of erosion; 5,351 ha of these were in annual cropland in 2006. The area of annual crops on soils with a high or severe risk for water erosion has experienced a slight decrease since 1993
	• **Water erosion risk on annual cropland near watercourses** - Soils and land cover data suggest there is some annual cropland within 50 m of a designated drain that is located on soils with a high to severe risk for water erosion. Though the total is quite small, these areas are found on the upper reaches of Pipestone Creek and its tributaries, Gainsborough Creek, some areas along the Antler River and Graham Creek.
	• **Wind erosion risk** - Approximately 46% of the West Souris River IWMP study area is considered to have a high or severe wind erosion risk; almost a third of the 2006 annual cropland was located on these soils.
	• **Tillage practices** – Zero tillage and conservation tillage dominate, alleviating the risks of wind and water erosion to approximately 85% of the annual cropland in Jackson and Stony Subwatershed, and 70% of the annual cropland in Pipestone. Conventional tillage is more prevalent in the Pipestone Creek Watershed, compared to the remaining area. (2006 Census of Agriculture).
	• **Summerfallow** was reported in the 2006 Census, but on a small scale and total area has declined since 2001
	• **Land use -** Cropland is the dominant land use in the watershed, but has experienced a net decrease in acres due to conversion to seeded forages. This increased perennial cover will help mitigate erosion risk.
	• There was also a net decrease in grassland, a result of conversation to wetlands and water. This may be a result of increased water in the watershed due to higher average annual rainfall is 2005, or increased drainage upstream, or a combination of both.
	• **Crop inputs** - In 2005, approximately 75% of cropland had fertilizer and pesticides applications, a slight increase from 2000. Pipestone watershed had slightly less at 67%.
	• **Livestock Production** – beef production is the dominant livestock in Pipestone subwatershed, and pigs in Stony. Uptake of BMPs addressing livestock-related non point source contamination issues by producers was seen, indicating a willingness to address on-farm environmental issues
	• **Income Levels** – Average level of income reported suggests external factors have played a role and could impact pasture acres and ability to invest in farm management improvements.
	• **BMP adoption for soils at risk** – A number of producers have adopted BMPs (erosion control, soil management, perennial cover, etc) through various government programs, indicating their willingness to address environmental issues on their farm
	• **BMP adoption of non point source** – The majority of BMPs adopted by producers through the NFSP program address issues of non point source contamination of water through crop-related management practices (precision farming applications, variable fertilizer applications, equipment modification for low disturbance placement of seed and fertilizer, nutrient management planning, etc)
		1. Non Point Source BMP Implementation:
		• **Water Erosion** - Promote BMPs which mitigate water erosion (e.g. riparian buffer design, Zero Tillage, grassed waterways, perennial cover and establishment assistance programs) for the lower class of lands in severe or highly erosive areas, and Rotational Grazing Plans
		• **ii) Wind Erosion** - Promote BMPs which mitigate wind erosion -(e.g perennial crops, cover crops and residue management techniques, as well as shelterbelt establishment where wind erosion is an issue)
		• **Marginal Land Management** - Promote the adoption of sustainable beneficial management practices where annual cropland is located on soils with agricultural capabilities of Class 4 and, poorer
		• **Nutrient Management** - Promote BMPS that provide opportunities for moving nutrient loading onto field and away from surface waters (that include winter site management, nutrient management planning, variable rate applications, and perennial forage /legumes in crop rotation, precision agriculture,
		
		2. Point Source BMP Implementation:
		• **Water Erosion Mitigation** - Promote and provide technical support for BMPs in prioritized water erosion risk areas (e.g. erosion control structures, controlled livestock crossings, offer design and establishment assistance programs)
		• **Riparian BMPS -** In environmentally sensitive areas that are used for pasture, grazing management BMPs should be promoted to support an increase of BMPs being implemented
		• **Nutrient Management** - Promote BMPs within source watersheds related to reducing nutrient transport to waterbodies (e.g., soil testing, manure testing, livestock relocations, riparian area management and buffer strips)
		
		3. Riparian Assessment – Develop an assessment of the riparian vegetation and condition of the riparian shoreline areas
			1. Areas in the watershed which have:
			• Annual cropland on Class 4 and poorer soils
			• High to severe risk of wind or water erosion
			
			2. Areas in the watershed which have:
			• Riparian areas with:
			  • Annual cropland within 50 m of water body or water course
			  • Pastures
			• Annual cropland located:
			  • On soils with high to severe risk of wind or water erosion
			  • On soils of class 4 or poorer capability
			
			3. Riparian areas throughout the watershed
				Proportion of the watershed that:
				• Has annual cropland located on soils with a high or severe risk to water erosion
				• Has annual cropland located on soils with a high or severe risk to wind erosion
				
				Proportion of the watershed where water erosion mitigation BMPs (e.g. cover crops, buffer strips, etc.) have been implemented
				
				Proportion of the riparian areas (for example, areas within 50 m of a waterbody or water course) that is:
				• Annually cropped
				• Annually cropped on soils with a high to severe risk of erosion
				
				Level of adoption of Point Source and Non-Point Source BMPs within those critical areas or targeted areas.
				
				Proportion of cropland that is prepared for seeding using conservation or zero tillage practices
				
				Baseline water quality:
				• Results of source water quality tests
				• Number of nutrient management plans occurring in sensitive areas or areas of high water erosion risk
				• Number of Riparian Assessments done

* Specific approaches and opportunities related to recommended actions, including potential target areas and indicators, need to be explored further by the Project Management Team. Potential collaboration with partners and stakeholders should be considered. Specific recommendations from the IWMP process must be forwarded to local councils for consideration within the Development Plan. These recommendations should take agricultural land management into consideration, for preservation of existing farm land and operations.

Watershed Issue	Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
Flooding	• **Soil Drainage** - Approximately 40% of the IWMP study area can be considered poor to imperfectly drained soils. These soil types make up 30% (66,440 ha) of annual crop production in the overall watershed and are mostly found on the eastern half of the study area. • **Increase in water and wetlands –** Satellite imagery analysis for land cover between 1993 and 2006 show a net conversion of grasslands to wetlands and wetlands to water, This may be a result of increased water in the watershed due to higher average annual rainfall is 2005, increased drainage upstream, or a combination of both. The majority of this occurs in the area over the Oak Lake Aquifer. • **Conversion of annual cropland to wetlands –** There was a net conversion of 1993 cropland to 2006 wetlands, possibly due to higher average annual rainfall is 2005. Wetlands can help to reduce the risk and severity of flooding by storing excess water from spring runoff and heavy rains and slowing the flow or runoff. • **Timing of land cover imagery** -Timing of Imagery and classification definitions may provide a higher or lower number of wetlands present than what may be on the landscape and should be verified with local examination for proper site identification as the presence of wetlands fluctuates on the landscape. • **Cropping practices** - Zero tillage practices maintain a stubble cover on fields, which traps snow and can reduce run-off rate, allowing for increased infiltration and decrease runoff. Approximately 50 to 65% of annual cropland was zero tilled in 2006. • **Tree cover –** Trees are important in mitigation of downstream flooding. They trap snow and slow down the melting rate of snow, reducing the rate of melt waters flowing downstream during spring run-off. Approximately 6% of the watershed is treed. • **BMP uptake** of winter site management, livestock confinement area relocation away from riparian and areas subject to flooding. • **Average farm size** – From 2001 to 2006, there was a general decrease in number of farms, but an increase in the average farm size? – may lead to less time for sustainable practices around wetlands	**1. Surface Water Management Assessment -** Examine potential development of a long term water management similar to what was completed at Turtle Mountain Conservation District for entire watershed. **2. Point Source BMP Implementation - Water Management Landscape Approach** - Promote and provide technical support for water management BMPs prioritized in a particular region (e.g. riparian buffer design and, riffle structures/ headwater storage options, and erosion control). **3. Non Point Source BMP Implementation - Water Management Landscape Approach** - Promote and provide technical support for BMPs in prioritized water management on a landscape level (e.g. perennial forage establishment assistance programs, Sustainable woodlot management options, sustainable rotational grazing plans, offsite watering systems, exclusion and riparian grazing). **4. Wetland Restoration Program -** Support the potential development of a Wetland Restoration Program for the watershed. **5. Coordinate BMP initiatives** to alleviate regional flooding issues on landscape approach.	1. Entire watershed 2. Riparian areas with annual cropland within 50 m of water body or water course 3. Entire watershed, on annual cropland, forages and pasture land 4. Entire watershed, and more specifically, in the western half in the upstream areas. 5. Entire watershed	Proportion of watersheds in land cover analysis that: • have changes in wetland sizes and numbers, • is annual cropland on imperfectly drained soils • is wetland, tree, grassland/pasture and forage land cover classes • has BMPs implemented related to flood control and wetland restoration • stream Flow Monitoring of the watershed Annual number of flood events that cause damage.
Natural Areas	• **Conversion of annual croplands –** analysis of land cover data from 1993 to 2006 reveals a general net decrease in annual cropland, with most being converted to forage, but also to grassland and wetland. On the other hand, over the Oak Lake Aquifer there were almost 1000 hectares converted from grassland to cropland • **Increase in water and wetlands –** satellite imagery analysis for land cover between 1993 and 2006 so a net conversion of grasslands to wetlands and wetlands to water, This may be a result of increased water in the watershed due to higher average annual rainfall is 2005, or increased drainage upstream, or a combination of both. The majority of this occurs in the area over the Oak Lake Aquifer. • **Riparian areas –** analysis of land cover within 50 m of all provincial designated drains shows cropland makes up 1% of this buffer area, majority found in Pipestone subwatershed	**1. Vegetated buffers** - Promote the use of vegetated buffers in and around riparian areas. 2. Wetlands – Promote the restoration of drained wetlands	1. Riparian areas of water courses and water bodies 2. Entire watershed	Change in area of tree, grassland and wetlands and open water Proportion of riparian areas made up of trees and shrubs

Groundwater Supply and Quality	• **The Oak Lake Aquifer –** makes up **almost 40%** of the West Souris River IWMP study area and is a major source of water for rural residents, communities and agriculture.
	• **Soil Drainage** – over small part of the aquifer, annual cropland was located on soils with rapid internal drainage in 2006, increasing the risk for nutrient leeching.
	• **Annual cropping of marginal lands** - Class 4 land and lower is considered to be at significant risk to soil erosion and nutrient transfer to surface waters when cropped annually. Approximately 30% (123,500 ha) of the 2006 annual cropland within the study area was located on Class 4 and lower soils
	• **Conversion of annual croplands** – analysis of land cover data from 1993 to 2006 reveals that over the Oak Lake Aquifer, there were almost 1,000 hectares converted from grassland to cropland. There was an almost equal number of net hectares converted from annual cropland to forages
	• **Tillage practices** – Zero tillage and conservation tillage dominate, serving to alleviate the risks of wind and water erosion on annual cropland on up to 85% of the annual cropland in Jackson and Stony Subwatershed, and 70% of the annual cropland in Pipestone. Conventional tillage is more prevalent in the Pipestone Creek Watershed, compared to the remaining area. (2006 Census of Agriculture).
	• **Crop inputs** - In 2005, approximately 75% of cropland has fertilizer and pesticides applications, Pipestone slightly less. This is a slight increase from 2000.
	• **BMP adoption for non point source** – the majority of BMPs adopted by producers over the Oak Lake Aquifer address issues of non point source contamination of water through crop-related management practices (precision farming applications, variable fertilizer applications, equipment modification for low disturbance placement of seed and fertilizer, nutrient management planning, etc)
	• **BMP adoption for soil erosion** - the majority of BMP's adopted to address issues of soil erosion occurred over the Oak Lake Aquifer – mainly perennial cover on sensitive land
	• **Increase in water and wetlands –** satellite imagery analysis for land cover between 1993 and 2006 so a net conversion of grasslands to wetlands and wetlands to water, This may be a result of increased water in the watershed due to higher average annual rainfall is 2005, or increased drainage upstream, or a combination of both. The majority of this occurs in the area over the Oak Lake Aquifer.
	• **Livestock numbers** - in both Pipestone and Stony subwatersheds, there was an increase in livestock numbers for beef from 2001 to 2006. At the same time, the number of farms reporting has decreased, with a result of fewer, larger livestock operations.
		1. See Recommended Actions for Water Quality (page #) – apply recommendations for areas over the Oak Lake Aquifer and other groundwater sources, as well as the recharge areas for these waterbodies
		
		2. Private Water Source Assessments - Continued promotion of private source assessments and action plans like those included in the EFP program
		
		3. Point Source BMP Implementation - Continue to promote upgrades to wells that prevent the contamination of groundwater.
		
		4. Water Source Protection – Identify recharge areas for the Oak Lake Aquifer and other groundwater sources and promote adoption of BMPs that encourage recharge and protect water quality (e.g. perennial cover, grazing management, vegetative buffers, wetlands, etc)
			1a. Areas over the Oak Lake Aquifer and other groundwater sources which have:
			• Annual cropland on Class 4 and poorer soils
			• High to severe risk of wind or water erosion
			1b. Areas over the Oak Lake Aquifer and other groundwater sources which have:
			• Riparian areas with:
			  • Annual cropland within 50 m of water body or water course
			  • Pastures
			• Annual cropland located:
			  • On soils with high to severe risk of wind or water erosion
			  • On soils of class 4 or poorer capability
			1c. Riparian areas
			1d. Entire watershed
			
			2. Entire watershed
			
			3. Entire watershed
			
			4. Oak Lake Aquifer and other groundwater sources
				See Potential Indicators for Water Quality (page #) – apply indicators for areas over the Oak Lake Aquifer and other ground water sources.
				
				Number of assessments/plans developed as a percentage of total farms
				
				Baseline water quality:
				• Results of source water quality tests
				• Number of nutrient management plans developed and implemented for operations located over the Oak Lake Aquifer or other groundwater sources
				
				Proportion of recharge area under perennial cover

* Specific approaches and opportunities related to recommended actions, including potential target areas and indicators, need to be explored further by the Project Management Team. Potential collaboration with partners and stakeholders should be considered. Specific recommendations from the IWMP process must be forwarded to local councils for consideration within the Development Plan. These recommendations should take agricultural land management into consideration, for preservation of existing farm land and operations.

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J. Appendices

Appendix A: Mandates of Federal and Provincial Agriculture Departments

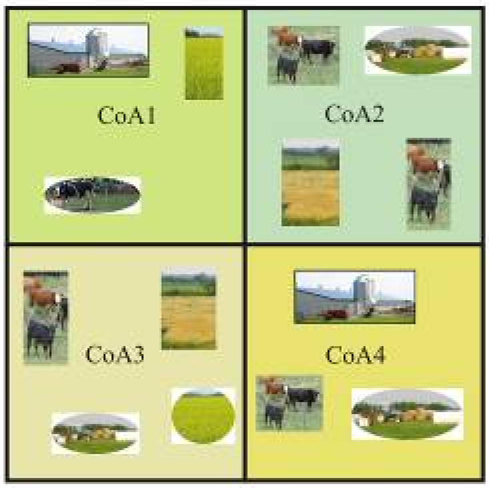
i) **Agriculture and Agri-Food Canada – Agri-Environment Services Branch (AESB)** mission is to provide integrated expertise and innovative environmental solutions to the agriculture and agri-food sector. AESB's focus is on providing knowledge and information; leading adaptation and practice change; and developing and coordinating policy and programs.

ii) **Manitoba Agriculture, Food and Rural Initiatives (MAFRI)**
MAFRI's mission is to assist with the compilation of a technical resource package and deliver expertise with the technical information to aid in issue identification, and to assist the proponent in completing the final Integrated Watershed Management Plan.

Appendix B: Diagram for Interpolating Census of Agriculture Data (Area Weighting Method)

Basic concept of interpolating Census of Agriculture (CoA) using the area weighting method*

Census of Agriculture (CoA) from Statistics Canada's geographic boundaries



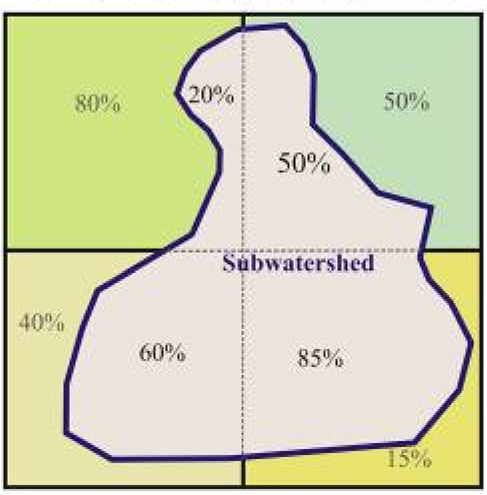
CoA is the sum of all survey forms of farms with farm headquarters located in the specific boundary

For Example - Total cattle and calves

CoA1 = 540 total cattle
CoA2 = 300 total cattle
CoA3 = 125 total cattle
CoA4 = 1200 total cattle

CoA from Statistics Canada's geographic boundary

CoA interpolated to subwatershed boundary



Interpolated CoA for Subwatershed =
(CoA1: 540 cattle x 20%) +
(CoA2: 300 cattle x 50%) +
(CoA3: 125 cattle x 60%) +
(CoA4: 1200 cattle x 85%) = 1353.6 total cattle and calves**

** due to the methodology of interpolating data, final census numbers are estimates.

*This is a simplified explanation of the methodology used to interpolated Census of Agricultural data from Statistic Canada's geographic boundaries into other specified boundaries such as watersheds. There are other factors not explained here that are taken into account during the process.

Appendix C: Animal Unit Calculations

Summary of Animal Unit coefficients used in Manitoba as compared to those used for calculations in this report[1]. Assumptions are given in the following Table:

Livestock	Animal Units produced by one animal (MAFRI)	Animal Unit coefficient used in report
Dairy		
Milking Cows (including associated livestock)	2.000	2.000
Beef		
Beef Cows, incl. associated livestock	1.250	1.250
Backgrounder	0.500	\
Summer pasture	0.625	} 0.631
Feedlot	0.769	/
Hogs		
Sows, farrow-to-finish	1.250	--
Sows, farrow-to-weanling	0.313	0.313
Sows, farrow-to-nursery	0.250	--
Weanlings	0.033	--
Grower/finishers	0.143	0.143
Boars (artificial insemination operations)	0.200	0.200
Chickens		
Broilers	0.0050	0.0050
Roasters	0.0100	--
Layers	0.0083	0.0083
Pullets	0.0033	0.0033
Turkeys		
Broilers	0.010	\
Heavy Toms	0.020	} 0.014
Heavy Hens	0.010	/
Horses (PMU)		
Mares, including associated livestock	1.333	1.00
Sheep		
Ewes, including associated livestock	0.200	0.200
Feeder Lambs	0.063	--
Goats	0.143	0.143
Bison		
Cow	1.00	\
Bull	1.00	} 0.8875
Calf	0.25	/
Elk		
Cow	0.53	\
Bull	0.77	} 0.520
Calf	0.05	/

1. An Animal Unit is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period (as defined in the Farm Practices Guidelines for Poultry Producers in Manitoba)

Summary of assumptions made in calculating Animal Units[1] from 2001 Agricultural Census Data

Livestock	Manitoba Animal Unit Category	Census Category	Assumptions Used for Animal Unit Calculations with census data
Dairy	Milking cows (including associated livestock)	Dairy cows	Assumed categories are equal.
Beef	Beef cows	Beef cows	Assumed number of beef cows reported in 2001 Census equal cow/calf pairs
	Backgrounder Summer pasture Feedlot cattle	Heifers and steers for slaughter or feeding 1 yr and older (combined categories)	Assumed steers and heifers reported in these census categories are split into the three categories (communication with MAFRI). Animal unit coefficient determined using this ratio.
Pigs	Sows, farrow–to-weanling	Sows	Assumed there are no farrow-to-finish operations and no weanling operations in Manitoba – only farrow-to-weanling and grower/finisher operations.
	Grower/finishers	Grower and finisher pigs	
	Boars (artificial insemination operations)	Boars	Assumed all boars reported in the 2001Census are from artificial inseminations.
Chickens	Broilers	Broilers and roasters	Assumed all birds reported in the census category are broilers (communication with MAFRI).
	Layers	Laying hens (19 weeks and older)	Assumed categories are equal.
	Pullets	Pullets (under 19 weeks)	Assumed categories are equal.
	Broiler breeding hens	Laying hens in hatcheries	Assumed all laying hens in hatchery supply flocks reported in Manitoba are broiler breeder hens.
Turkeys	Broiler, Heavy Toms, Heavy Hens	Turkeys	Assumed “turkeys” represents 20% boilers, 40% heavy toms, 40% heavy hens (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Sheep	Ewes, including associated livestock	Ewes	Assumed ewe/lamb pairs (communication with MAFRI).
	Feeder lambs	Lambs	Assumed no feeder lambs in province since numbers are very small and cannot be determined from census data (communication with MAFRI).
Horses	Horses	Total horses and ponies	Assumed each animal produces 1 Animal Unit – PMU farms not identified in Census (communication with MAFRI).
Bison	Bison	Bison	Assumed adults represent 85% and calves represent 15% of bison population in Manitoba (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Elk	Elk	Elk	Number of calves and sex of animals not identified in Census – assumed 45% cows, 35% bulls and 20% calves (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Goats	Goats	Goats	Number of kids and sex of animals not identified in Census – assumed 7 goats make up one Animal Unit, irregardless of age and sex.

1. One Animal Unit is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period (as defined in the Farm Practices Guidelines for Poultry Producers in Manitoba)

Appendix D: Land Cover Time Frame, Classifications, and Constraints

For the IWMP study area, imagery was available for the years of 1993, 2000, and most recently, 2006. Imagery was classified by the Manitoba Conservation - Manitoba Remote Sensing Centre into 16 unique land cover classes. To simplify the analysis, the 16 classes were aggregated into 7 basic land cover classes: annual cropland, forages, grasslands/pasture, trees, wetlands, water, and urban/transportation.

The 1993 land cover used satellite imagery that was captured on May 14, 1993. Imagery for the 2000 land cover data was taken September 14, 2000. The 2006 land cover data utilized satellite imagery that was captured on August 22, 2006.

Data Constraints

It should be noted that the use of land cover data has limitations from a couple of perspectives. Weather patterns in years leading up to the imagery will impact the cover analysis and may be short term as opposed to a long term trend. Further, past image classifications were undertaken for specific purposes with standardization occurring between 2000-2001 and 2005-2006 as detailed below:

- Classification effort - the 1993 image classification concentrated specifically on annual cropland to aid in delivery of the Western Grains Transportation Payment Program. Greater attention was paid to all classification categories on the 2000 image classification.
- The classification of forages and forages/grasslands - As the land cover classifications could be difficult to interpret given the age of the forage stand and the reflectance of the satellite imagery for classification.
- With respect to the increased level of forages, some of the forage conversion trends may be explained through the adoption of Permanent Cover Program offered by Agriculture Canada in the early 1990s. A program summary for the West Souris River Watershed study area could provide more insight toward understanding the forage trends and if they were indeed related to the Permanent Cover Program, however, the data could not be made available in time for this report. There is some indication from local contacts that the program uptake by producers was low for this watershed, however, without an actual program summary, it cannot be quantified. This information will be available for future reports or for this watershed at a later date.

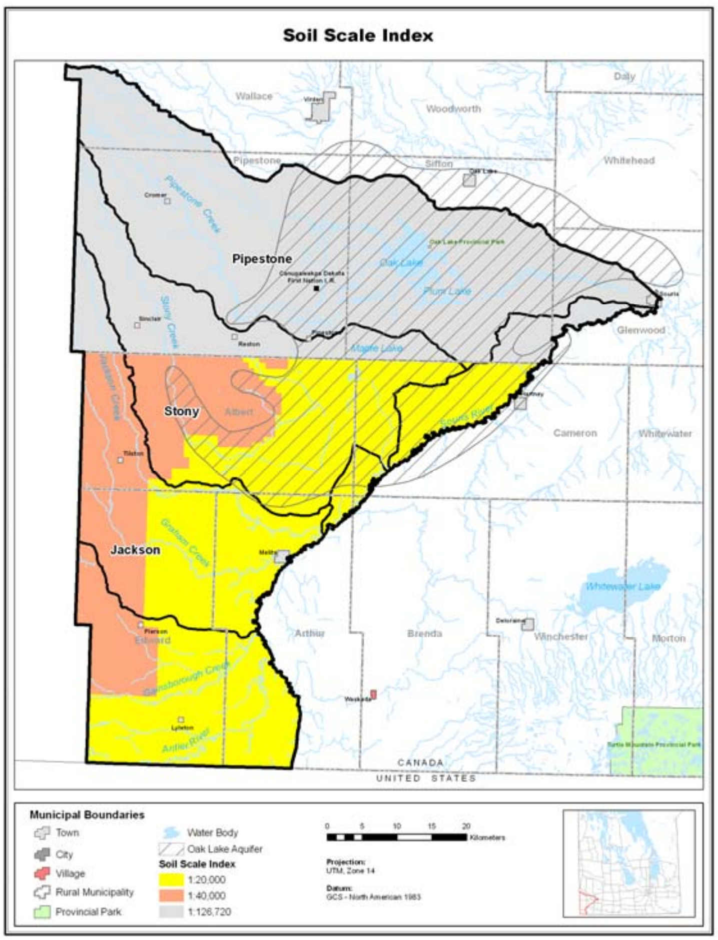
Classification Scheme: Land Cover Mapping of Manitoba	
1. Annual crop land:	Land that is normally cultivated on an annual basis.
2. Forage:	Perennial forages, generally alfalfa or clover with blends of tame grasses.
3. Grassland:	Areas of native or tame grasses, may contain scattered stands of trees
4. Trees:	Lands that are primarily in tree cover
5. Wetlands:	Areas that are wet, often with sedges, cattails, and rushes
6. Water	Open water – lakes, rivers, streams, ponds, and lagoons
7. Urban and Transportation:	Towns, roads, railways, quarries

Appendix E: Soil Information and Background

Soils data within the watershed can be used to provide information on various soil characteristics as well as interpretative ratings such as agriculture capability, water and wind erosion risk. Used in conjunction with the land cover data from 1993-2006, observations about temporal land use trends can be made and used to explain any changes in land management practices.

Soils data within Manitoba have been mapped at different scales of accuracy. In the West Souris River study area, soils in the Rural Municipalities of Pipestone and Sifton were surveyed at a scale of 1:126,720 (reconnaissance level) while the remaining area of the watershed were surveyed at more detailed scales of 1:40,000 (orange area) and 1: 20,000 (yellow area)(see figure below).

Reconnaissance soils data is more suitable for broader landscape based analysis and regional planning purposes. This information is not suitable for the development of municipal development plans/zoning by-laws, agronomic assessment for irrigation and other site specific land use activities. Analysis of this nature requires more detailed soils information for assessments and management considerations. Soil information provided in this report is based on the characteristics of the dominant soil series within the various soils polygons



Appendix F: Canada Land Inventory System Land Classes

Agricultural Capability for Manitoba

Agriculture capability is a 7 class rating of mineral soils based on the severity of limitations for dryland farming. This system does not rate the productivity of the soil, but rather its capability to sustain agricultural crops based on limitations due to soil properties and landscape features and climate. This system is usually applied on a soil polygon basis and the individual soil series are assessed and maps portray the condition represented by the dominant soil in the polygon. Class 1 soils have no limitations, whereas Class 7 soils have such severe limitations that they are not suitable for agricultural purposes. In general, it takes about 2 acres (0.8 hectares) of Class 4 land to equal production from 1 acre (0.4 hectares) of prime (Class 1) land. (From *Land: The Threatened Resource*).

Class 1: Soils in this class have no important limitations for crop use. The soils have level to nearly level topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops (field crops).

Class 2: Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of field crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3: Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. Under good management, these soils are fair to moderate in productivity for a fairly wide range of field crops.

Class 4: Soils in this class have significant limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few field crops, the yield for a range of crops may be low or the risk of crop failure is high. These soils are low to moderate in productivity for a narrow range of field crops but may have higher productivity for a specially adapted crop or perennial forage.

Class 5: Soils in this class have severe limitations that restrict their capability to producing perennial forage crops and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants.

Class 6: Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery or because the soils are not responsive to improvement practices.

Class 7: Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

Agriculture capability subclasses identify the soil properties or landscape conditions that may limit use. A capital letter immediately following the class number identifies the limitation (eg. 2W, 3N, etc.).

Subclasses:
C - adverse climate (outside the boundaries of agro-Manitoba)
D - undesirable soil structure and/or low permeability
E - erosion damage
I - inundation (flooding) by streams and lakes
M - moisture (droughtiness) or low water holding capacity
N - salinity
P - stoniness
R - consolidated bedrock
T - topography (slopes)
W - excess water other than flooding (inadequate soil drainage or high water table)
X - two or more minor limitations

Appendix G: Water Erosion Risk

Water erosion information is available as part of the provincial soil survey data that has been compiled from reconnaissance (1:126,720 scale) and detailed (1:40,000 & 1:20,000 scale) soil survey reports. The Universal Soil Loss Equation (USLE) that was developed by Wischmeier and Smith (1965) was used to provide information on water erosion as part of the provincial soils data. The USLE provides a quantitative estimate on the amount of soil that is displaced due to water erosion (either tonne/ha or ton/ac) on an annual basis due to soil, climatic, landscape and management factors that influence the rate of erosion. The USLE can be written as:

$$\mathbf{A = RKLSCP}$$

Where:

A = Predicted water erosion rate
R = Erosivity of rainfall and snowmelt factor
K = Soil erodibility factor
L = Slope length factor
S = Slope steepness factor
C = Crop cover and management factor (set at 1.0 - assuming bare, unprotected soil)
P = Conservation practice factor (set at 1.0 - assuming no conservation practices)

Due to limitations that are inherent in the model, the lack of the inclusion of conservation management practices and crop cover factors, the numbers that are generated from the USLE should not be used as a value for actual soil loss due to water erosion. However, the USLE is useful in comparing water erosion risk between soils based on their soil/landscape properties and climatic conditions. To accomplish this, the computed USLE values have been compiled into the following 5 group risk classes:

N = Negligible	< 2.7 ton/ac/yr (< 6 tonne/ha)
L = Low	2.7 – 4.9 ton/ac/yr (6 – 11 tonne/ha)
M = Moderate	4.9 – 9.8 ton/ac/yr (11 – 22 tonne/ha)
H = High	9.8 – 14.7 ton/ac/yr (22 – 33 tonne/ha)
S = Severe	> 14.7 ton/ac/yr (> 33 tonne/ha)

By using the risk class groupings, soils can be compared on the basis of their soil physical properties, landscape and climate for resource analysis and targeting of soil conservation programming.

Appendix H: Wind Erosion Risk

Wind erosion information in Manitoba has been developed from the provincial soil survey data and the Soil Landscapes of Canada (SLC Ver 1.0). A geographic information system (GIS) was used to combine both spatial datasets, creating a derived product upon which wind erosion was calculated.

The wind erosion model that is used for the Agriculture Canada Wind Erosion Risk Maps (1989) was applied to the derived dataset. The model was developed from the works of Chepil (1945, 1956) and Chepil and Woodruff (1963) and derives an index value *E* for wind erosion risk (Coote, Eilers & Langman, 1989). The model is stated as:

$$\mathbf{E = kC(V_*^{\,2} - \gamma W^{\,2})^{1.5}}$$

Where:

E = maximum instantaneous soil movement by wind (dimensionless)
k = surface roughness and aggregation factor (dimensionless)
C = factor representing soil; resistance to movement by wind (dimensionless)
V_* = drag velocity of wind at soil surface ($cm \cdot s^{-1}$)
γ = soil moisture shear resistance (dimensionless), a value of 5000 was used
W = available moisture of the surface soil ($m^3 water \cdot m^{-3} soil$)

For the analysis, the V_* and W values were used from the Soil Landscapes of Canada series. These values are listed for each polygon in the Wind Erosion Risk publication. A listing of *k* and *C* values are also listed in the report and are based on soil surface texture. The values were entered into the database based on soil surface texture types taken from the provincial soil survey data.

Following entering of values for *K*, *C*, *W* and calculating values for V_*, the dimensionless wind erosion index values (*E)* were calculated for each polygon. These values were rated as per the rating system in the Wind Erosion Risk publication.

Class	**E Value**
Negligible	< 100
Low	101 - 250
Moderate	251 - 400
High	401 - 700
Severe	> 700

The ratings are for bare soil and do not consider land use and crop management factors. *E* values were calculated only for those soils within the seamless soil layer that had a mineral soil surface texture rating. Polygons that were rated as being organic soils, bare rock and water in either the seamless soil data or the SLC data did not have *E* values calculated.

For those polygons that have secondary and/or tertiary soils listed within the map unit, a weighted calculation was done based on the percent of occurrence. If organic soils existed in any combination (primary, secondary, tertiary) with mineral soils, weightings were based on mineral soils only.

Appendix I: Soil Drainage Classes

Soil Drainage Class	Description
Very Poor	Water is removed from the soil so slowly that the water table remains at or on the soil surface for the greater part of the time the soil is not frozen. Excess water is present in the soil throughout most of the year
Poor	Water is removed so slowly in relation to supply that the soil remains wet for a large part of the time the soil is not frozen. Excess water is available within the soil for a large part of the time.
Imperfect	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly down the profile if precipitation is the major source
Well	Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying materials or laterally as subsurface flow
Rapid	Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep slopes during heavy rainfall.
Source: *System of Soil Classification of Canada – Canada-Manitoba Soil Survey Reports*	

Drainage classification is based on the dominant soil series within each individual soil polygon

Appendix J: 2006 Census of Agriculture data

Table 1: Agricultural Land Use types reported in the 2006 Census of Agriculture (hectares)

Subwatershed	Total Farmland	Total Cropland**	Summerfallow	Pasture***	Other*
Jackson	99,466	68,732	2,938	21,726	6,070
Stony	91,337	56,577	3,309	23,788	7,662
Pipestone	126,829	66,834	4,394	41,640	13,960

*Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.
** Total cropland includes all field crops, vegetables, fruit and nuts and sod
*** Pasture includes tame pasture and natural areas used for pasture.

Table 2: Distribution of crop types as reported in the 2006 Census of Agriculture (hectares)

Subwatershed	Total Cropland*	Cereals	Oilseeds	Pulse	Forage for hay	Forage for seed	Other**
Jackson	68,732	38,741	17,723	1,010	10,254	182	822
Stony	56,577	30,878	12,713	1,001	11,468	x	518
Pipestone	66,834	33,096	13,735	1,272	17,407	255	1,068

x – data has been suppressed by Statistics Canada to preserve confidentiality of the data
* Total Cropland includes all field crops, vegetables, fruits and nuts, and sod
** Other category includes other special field crops, fruits and nuts, sod, vegetables, and all suppressed hectares in the listed categories

Table 3: Total area treated with crop inputs for the 2005 cropping year, as reported in the 2006 Census of Agriculture (hectares)

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Jackson	54,266	51,985	5,125	8,230
Stony	42,074	41,352	5,161	5,962
Pipestone	45,046	44,658	4,514	8,834

Table 4: Total dollars spent on crop inputs for the 2005 cropping year, as reported in the 2006 Census of Agriculture

Subwatershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides & fungicides	Total seed
Jackson	$7,759,718	$3,704,717	$2,531,186	$1,523,814
Stony	$6,347,154	$3,090,207	$2,131,407	$1,125,541
Pipestone	$8,039,404	$3,819,079	$2,710,237	$1,510,088

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land

Subwatershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Jackson	13%	19%	68%
Stony	14%	21%	65%
Pipestone	28%	23%	49%

Table 6: Total number of livestock and poultry on Census Day in 2006, as reported in the 2006 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Jackson	18,745	8,448	x	11,770	1,679	4,570
Stony	23,480	10,022	x	27,487	4,644	13,740
Pipestone	35,319	15,097	96	16,031	2,137	8,878

x – data has been suppressed by Statistics Canada to preserve confidentiality

Table 7: Total number farms reporting livestock and poultry on Census Day in 2006, as reported in the 2006 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Jackson	113	108	2	5	4	10
Stony	121	119	3	7	3	9
Pipestone	182	173	5	8	5	17

Table 8: Average number of livestock animals or poultry birds per farm on Census Day in 2006, as reported in the 2006 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Jackson	165	78	x	2,359	447	472
Stony	194	84	x	4,042	1,786	1,539
Pipestone	194	87	19	2,006	436	511

x – data has been suppressed by Statistics Canada to preserve confidentiality

Table 9: Summary of Farm financial characteristics

Subwatershed	Number of Farms	Average farm size (ha)	Average Capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)*	Average crop-related expenses ($/ha farmland)*	Estimated profit ($/farm)*
Jackson	192	517	876,377	42	108	24,816
Stony	186	490	845,618	105	106	24,010
Pipestone	278	456	816,502	81	113	17,328

* Calculations are based on the expenses for the 2005 calendar year, as reported in the 2006 Census of Agriculture

Appendix K: 2001 Census of Agriculture data

Table 1: Agricultural Land Use types reported in the 2001 Census of Agriculture (hectares)

Subwatershed	Total Farmland	Total Cropland**	Summerfallow	Pasture***	Other*
Jackson	89,217	62,084	4,257	17,473	5,402
Stony	90,449	56,571	4,407	22,490	6,983
Pipestone	129,511	73,838	5,734	38,742	11,198

*Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.
** Total cropland includes all field crops, vegetables, fruit and nuts and sod
*** Pasture includes tame pasture and natural areas used for pasture.

Table 2: Distribution of crop types as reported in the 2001 Census of Agriculture (hectares)

Subwatershed	Total Cropland*	Cereals	Oilseeds	Pulse	Forage for hay	Forage for seed	Other**
Jackson	62,084	38,362	12,251	1,596	8,366	x	1,509
Stony	56,571	30,335	11,847	1,149	11,884	x	1,355
Pipestone	73,838	38,177	14,839	1,262	18,822	x	737

x – data has been suppressed by Statistics Canada to preserve confidentiality of the data
* Total Cropland includes all field crops, vegetables, fruits and nuts, and sod
** Other category includes other special field crops, fruits and nuts, sod, vegetables, and all suppressed hectares in the listed categories

Table 3: Total area treated with crop inputs for the 2000 cropping year, as reported in the 2001 Census of Agriculture (hectares)

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Jackson	45,819	49,309	3,070	6,067
Stony	39,141	40,827	3,201	4,454
Pipestone	48,752	49,615	4,533	5,513

Table 4: Total dollars spent on crop inputs for the 2000 cropping year, as reported in the 2001 Census of Agriculture

Subwatershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides & fungicides	Total seed
Jackson	$5,067,349	$2,145,506	$2,026,972	$894,870
Stony	$4,611,648	$1,977,124	$1,778,572	$855,952
Pipestone	$6,309,748	$2,589,136	$2,421,797	$1,298,815

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land

Subwatershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Duck	13%	19%	68%
Pine	14%	21%	65%
Mossey	28%	23%	49%

Table 6: Total number of livestock and poultry on Census Day in 2006, as reported in the 2001 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Jackson	16,572	7,367	x	16,723	1,726	7,037
Stony	18,983	8,201	x	35,514	3,458	7,366
Pipestone	32,766	12,562	175	16,250	3,038	6,839

x – data has been suppressed by Statistics Canada to preserve confidentiality

Table 7: Total number farms reporting livestock and poultry on Census Day in 2001, as reported in the 2001 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Jackson	129	124	4	9	5	8
Stony	131	128	3	11	4	11
Pipestone	209	200	7	12	7	17

Table 8: Average number of livestock animals or poultry birds per farm on Census Day in 2001, as reported in the 2001 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Jackson	129	60	x	1,818	345	869
Stony	145	64	x	3,199	865	695
Pipestone	157	63	24	1,321	410	410

x – data has been suppressed by Statistics Canada to preserve confidentiality

Table 9: Summary of Farm financial characteristics for the 2000 fiscal year, as reported in the 2001 Census of Agriculture

Subwatershed	Number of Farms	Average farm size (ha)	Average Capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)*	Average crop-related expenses ($/ha farmland)*	Estimated profit ($/farm)*
Jackson	207	432	664,697	55	76	11,664
Stony	214	423	602,386	101	76	19,458
Pipestone	328	395	631,883	79	79	10,270

* Calculations are based on the expenses for the 2000 calendar year, as reported in the 2001 Census of Agriculture

Appendix L: Nutrient Management Regulations

The Nutrient Management Regulation is the first regulation to be passed under *The Water Protection Act*. The purpose is to protect water quality by encouraging nutrient management planning, regulating the application of nitrogen and phosphorus and restricting development within environmentally sensitive areas, especially along natural water systems.

The regulation sets out Nutrient Management Zones based on Canada Land Inventory (CLI) agriculture capability ratings. The various Nutrient Management Zones contain maximum nitrate-nitrogen limits and maximum allowable phosphorus application rates. These can be found on the provincial website at
http://www.gov.mb.ca/waterstewardship/wqmz/limitsandthresholds.pdf

Under the regulation, some agricultural operations may be required to file a Nutrient Management Plan (NMP) with Manitoba Water Stewardship.

Effective January 1, 2009, a Nutrient Management Plan must be registered if:

- Nutrients are mechanically applied within Nutrient Management Zone N4 for those agricultural operations in existence prior to November 8, 2006. Nutrient Management Zone N4 consists of CLI class 6 and 7 lands and unimproved organic soils.

Effective January 1, 2011, a Nutrient Management Plan must be registered if:

- Nutrients will be applied to any field that exceeds the residual soil nitrate-nitrogen limits listed in Table 1 for Nutrient Management Zones N1, N2 and N3.
- Nutrients will be applied to any field resulting in soil test phosphorus measuring 60 ppm or more within Nutrient Management Zones N1, N2 and N3 and the phosphorus application rates listed in Table 2 cannot be met.

Table 1. Soil Nitrate-Nitrogen Limits

Nutrient Management Zone	Agriculture Capability Soil Class	Residual Soil Nitrate-Nitrogen Limits within 60 cm (24") of soil
N1	Class 1, 2 and 3 except any 3M subclass	157 kg/ha (140 lb/ac)
N2	Any 3M subclass, class 4 and 5M subclass if it is being irrigated	101 kg/ha (90 lb/ac)
N3	Class 5 except 5M under irrigation	33.6 kg/ha (30 lb/ac)
N4	Class 6, 7 and unimproved organic	No Nitrogen Applications
Nutrient Buffer Zone	Not Applicable	No Nitrogen Applications

Table 2. Soil Test Phosphorus Thresholds and Maximum P Application Rates

Nutrient Management Zone	Soil Test Phosphorus (P) Thresholds within 15 cm (6”) of soil (ppm)	Allowable Application Rate of P expressed as P_2O_5 (kg/ha (lb/ac)
N1,N2 and N3	< 60	No restriction
	Between 60 and < 120	Two times crop removal rate
	Between 120 and < 180	One time crop removal rate
	180 or more	No application without approval by the director
N4	No Phosphorus Applications	
Nutrient Buffer Zone	No Phosphorus Applications	

Parcels of land included in a Manure Management Plan registered with Manitoba Conservation do not need to be included in a Nutrient Management Plan submitted to Manitoba Water Stewardship.

Nutrient Buffer Zones apply to all water bodies and groundwater features located across Manitoba. As of January 1, 2009, nutrients containing nitrogen or phosphorus cannot be applied to areas within Nutrient Buffer Zones. The width of the Nutrient Buffer Zone varies depending on the nature of the body of water (Table 3)

Table 3: Nutrient Buffer Zones under the Nutrient Management Regulation

Width* of Nutrient Buffer Zones

Water Body	Setback if Nutrient Buffer Zone IS covered with permanent vegetation	Setback if Nutrient Buffer Zone IS NOT covered with permanent vegetation
• a roadside ditch or an Order 1 or 2 drain†	No direct application to ditches and Order 1 and 2 drains	
• a groundwater feature	15 m (49 feet)	20 m (66 feet)
• a wetland, bog, marsh or swamp other than a major wetland, bog, marsh or swamp‡	Distance between the water's edge and the high water mark	
• a lake or reservoir designated as vulnerable**	30 m (98 feet)	35 m (115 feet)
• a lake or reservoir (not including a constructed stormwater retention pond) not designated as vulnerable** • a river, creek or stream designated as vulnerable**	15 m (49 feet)	20 m (66 feet)
• a river, creek or stream not designated as vulnerable** • an Order 3 or higher drain† • a major wetland, bog, marsh or swamp‡ • a constructed stormwater retention pond	3 m (10 feet)	8 m (26 feet)

* ***The Nutrient Buffer Zone is measured out from the water body's high water mark or the top of the outermost bank on that side of the water body, whichever is further from the water.***

† Designated on a Manitoba Water Stewardship plan that shows the designation of drains.

‡ As defined in 1(2) in the Nutrient Management Regulation under the *Water Protection Act.* "For the purposes of this regulation, a wetland, bog, marsh or swamp is major if
(a) it has an area greater than 2 ha (4.94 acres)
(b) it is connected to one or more downstream water bodies or groundwater features; and
(c) it contains standing water or saturated soils for periods of time sufficient to support the development of hydrophytic vegetation."

** Designated as vulnerable if listed in the Schedule in the Nutrient Management Regulation under the *Water Protection Act.*

Appendix M: Livestock Manure and Mortalities Management Regulation

An Important regulation for agriculture is the Livestock Manure and Mortalities Management Regulation, administered by Manitoba Conservation under the Provincial Environment Act. Details can be found at the provincial government website:

http://www.gov.mb.ca/conservation/envprograms/livestock/index.html

The main points of the legislation are:

- Annual manure management plans are required for operations of 300 animal units or more and cover the storage, handling, disposal and application. These need to be submitted to the department before Feb 10 (for spring application) or July 10 (fall application).
- Manure application is regulated on the basis of residual nitrogen in soil; application rates cannot result in more than 140lbs/acre for Class 1, 2 and 3 (see exception); 90lbs/acre for Class 3M, 3MW and 4; and no more than 30lbs/acre for Class 5 soils
- Annual water analysis required by livestock operations (greater than 300 animal units)
- Winter spreading is prohibited between November 10 and April 10 of following year (with exceptions for operations under 300 Animal Units, pre-1998 operations and applications within defined setback distances)
- Permits are required for the construction of a manure storage facility as well as for a confined livestock facility.

Recent Revisions to LMMR

1. **Phosphorus:** As a result of increasing concerns of rising phosphorus levels in Manitoba, the provincial government has amended the LMMMR regulation. The amendment includes phosphorus as criteria in manure application, as of November 2008.

Some of its key points:

Introduction of soil phosphorus (P) threshold for regulating livestock manure management application:

- If soil test P threshold is 60ppm or less, no restriction on P application (use N-based application)
- If soil P threshold is between 60-119ppm, apply P4 up to 2 times crop removal rate
- If soil P threshold is between 120-179ppm, apply P4 at 1 times crop removal rate
- If soil P threshold is at or above 180ppm, no manure application is allowed without written consent by the Department

2**. Introduction of Special Management Areas (SMA's)** – designating lakes and other watercourses as well as the Red River Valley and other floodplains as areas where special manure management practices are required (no winter application in floodplains; use of buffer strips for water ways).

SMA's require special consideration when implementing management strategies to mitigate the risk of phosphorus loss. They have certain properties of location, soil, climate and landscape (topography) that cause them to be likely sources of phosphorus loss to surface water. The attributes of SMA's provide only limited opportunity for natural attenuation of phosphorus movement before it is transported to surface water. In light of this elevated risk, adoption of beneficial management practices (BMPs) to influence the processes involved in phosphorus transfer to surface water is more critical than in the rest of the landscape. BMPs that inhibit phosphorus mobilization and delivery, in particular, will be important in SMAs.

SMA's in Manitoba have been identified as those areas that are:

- subject to regular inundation, or
- immediately adjacent to surface water (lakes, rivers, creeks, large unbermed drains, or other watercouses and roadside ditches)

Regularly inundated lands (Red River Valley and Floodplains)
Lands that are subject to regular inundation, whether by overflow from a water body or precipitation and impeded drainage, require special management because of the prolonged contact between water and the soil surface (and particularly exposed manure). Under these conditions, manure could be directly transferred to surface water, especially if the manure has been deposited on frozen ground or on top of the snow. There is also a potential for transfer of dissolved phosphorus, and to a lesser degree particulate phosphorus, to overlying floodwaters.

Proximity to surface water is not the criterion for designating regularly inundated lands as SMAs – rather, it is the high risk of connectivity between these lands and surface water via surface drainage, whether natural or artificial. Therefore, practices that reduce the exposure of applied manure at the soil surface prior to inundation should reduce the risk of phosphorus transfer to floodwaters and, ultimately, to downstream drains and surface water bodies. One such practice is the elimination of winter applications of manure. Large livestock operations are already prohibited from spreading manure during the winter. Another practice that should reduce the risk of phosphorus transfer to floodwaters is subsurface placement of manure by injection or incorporation following broadcast application. Injection or incorporation of manure is most critical in the fall on regularly inundated lands so that there is minimal or no exposure at the soil surface prior to spring snowmelt. The adoption of this practice is limited by the cropping system (*i.e.,* limited feasibility for perennial forage or reduced-till systems). Special consideration should be given to low or zero disturbance systems that receive manure where full injection or incorporation is not feasible. In these situations, the risk posed by surface application of manure may be partially offset by reduced risk of erosion and runoff, compared to cultivated annual cropland.

Lands immediately adjacent to surface water or watercourses
Lands immediately adjacent to surface water or watercourses are at an elevated risk of contributing phosphorus simply due to their physical proximity. Maintaining narrow strips of perennial vegetation on the edges of tilled fields reduces the direct deposition of manure phosphorus into surface water and watercourses. Direct deposition could also occur via the actual entry of tillage equipment or the movement of soil due to tillage as the equipment passes very near to the waterway. Wider buffer strips along more significant waterbodies help to filter sediment from runoff before it enters the waterbody.

Harvesting of the perennial vegetation in the buffer strip serves as a means to remove accumulated phosphorus in plant tissue and potentially provides a source of livestock feed.

No manure phosphorus should be applied to the permanently vegetated buffer strips.

3. POINT SOURCES

Agricultural point sources or “end of pipe” sources include confined livestock areas, manure storage structures or field storage sites, grazing livestock access to watercourses for drinking water, and seasonal feeding areas. The *Livestock Manure and Mortalities Management Regulation* already requires a 100 metre setback from watercourses for any manure storage structures or field storage sites, as well as confined livestock areas. In addition, livestock in confined areas are prohibited from having direct access to surface watercourses.

While direct access to watercourses by grazing livestock is not specifically prohibited by the *Livestock Manure and Mortalities Management Regulation*, direct discharge of manure in surface water is prohibited. The *Protection of Water Sources Regulation* is used to protect surface water sources of community drinking water.

APPLICATION FORMS & REPORTS RELATING TO THE LMMMR

Here are some practical links regarding application forms and other information on manure management (also found on Manitoba Conservation's website):

- Application for Registration of a Manure Storage Facility Without a Permit (française)
- Application for Permit to Construct, Modify or Expand a Manure Storage Facility *(134 Kb pdf file)*
- Construction Requirements for Confined Livestock Areas and Collection Basins
- Application for Permit to Construct, Modify or Expand a Confined Livestock Area
- Obtaining a permit to construct, modify or expand a manure storage facility
- Nutrient Status Report *(18 Kb PDF file)*
- Manure Management Plan Form *(230 Kb DOC file)*
- Manure Management Plan Form *(32 Kb PDF file)*
- MMP Detailed Instructions and Schedules *(104 Kb PDF file)*
- Spreading Confirmation Sheet *(32 Kb PDF file)*
- Manure Management Plan Filer Software

Appendix N: Beneficial Management Practices offered under the Canada Manitoba Farm Stewardship Program 2003-2008

NFSP System Development
BMP Category Code/Practice Code Assignment

NOTE 1: The units of measurement are: distance = kilometers (km), area = acres, volume = cubic meters (m3)

NOTE 2: Funding is expressed as thousands of $ = K (eg. $4K = $4,000)

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
01	Improved Manure Storage and Handling	0101	increased storage to meet winter spreading restrictions (including satellite storage)	volume (m^3)	30%	$30K
		0102	improved features to prevent risks of water contamination (leaks, spills)	N/A		
		0103	slurry storage covers to reduce odours and GHG emissions	N/A		
		0104	containment systems for solid manure (includes covers)	N/A		
		0105	assessment and monitoring of existing manure storage infrastructure	N/A		
		0106	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)	N/A		
02	Manure Treatment	0201	dewatering systems, nutrient recovery systems	N/A	30%	$30K
		0202	composting of manure			
		0203	anaerobic biodigestors			
		0204	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
03	Manure Land Application	0301	specialized/modification to equipment for improved manure application	N/A	30%	$10K
04	In Barn Improvements	0401	more efficient livestock watering devices and cleanout systems to reduce water use and decrease manure volumes	N/A	30%	$20K
		0402	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
05	Farmyard Runoff Control	0501	upstream diversion around farmyards ;downstream protection (eg. catch basins, retention ponds, constructed wetlands)	N/A	50%	$20K
		0502	construction of impermeable base and roof for minimizing runoff from livestock pen areas and confinement areas (feed bunks, water infrastructure, walls and electrical costs are not eligible)			
		0503	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
06	Relocation of Livestock Confinement and Horticultural Facilities	0601	relocation of livestock facilities such as corrals, paddocks and wintering sites away from riparian areas	N/A	50%	$30K
		0602	relocation of horticultural facilities such as greenhouses and container nurseries from riparian areas			
		0603	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
07	Wintering Site Management	0701	shelterbelt establishment	# kms	50%	$15K
		0702	portable shelters and windbreaks	# kms		
		0703	alternative watering systems (ie: solar, wind or grid power)	N/A		
		0704	field access improvements: alleyway/access lane upgrades	# kms		
		0705	fence modifications	# kms		
08	Product and Waste Management	0801	improved on-farm storage and handling of agricultural products (eg. fertilizer, silage, petroleum products, and pesticides)	N/A	30%	$15K
		0802	improved on-farm storage, handling, and disposal of agricultural waste (eg. livestock mortalities, fruit and vegetable cull piles, wood waste)			
		0803	composting of agricultural waste (eg. Livestock mortalities fruit, vegetable, wood, straw residue)			
		0804	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
		0901	sealing & capping old water wells	N/A	50%	$6K

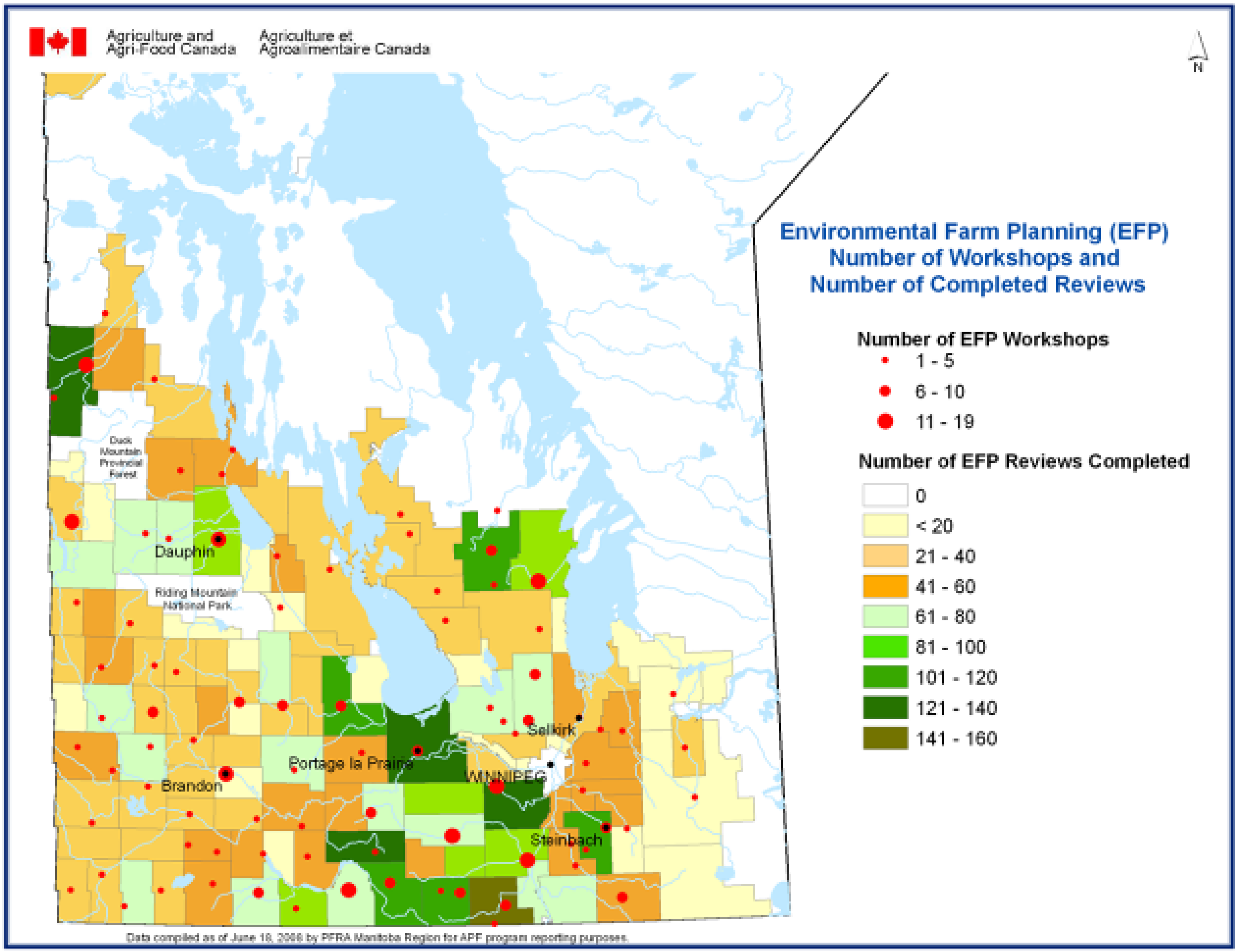
BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
09	Water Well Management	0902	protecting existing water wells from surface contamination			
		1001	alternative watering systems (ie: solar, wind or grid power)to manage livestock:	N/A		
		1002	buffer establishment and planting of forages (planting and establishment costs for trees and shrubs for the year of planting and one year after the planting year, or the termination of the NFSP funding, whichever comes first)	# acres		
10	Riparian Area Management (GREENCOVER)	1003	fencing to manage grazing and improve riparian condition/function	# kms	50%	$20K
10	Riparian Area Management (GREENCOVER)	1004	native rangeland restoration or establishment: native species of forages, shrubs, and trees	# acres		
		1005	grazing management in surrounding uplands: alternative watering systems (ie: solar, wind or grid power) and cross fencing	# kms offence		
		1006	improved stream crossings	N/A		
11	Erosion Control Structures(Riparian) (GREENCOVER)	1101	constructed works in riparian areas: contour terraces, gully stabilization, bank stabilization, erosion control matting, silt fencing, drop inlet and enhanced infiltration systems, in-channel control, retention ponds and erosion control dams	N/A	50%	$20K
		1102	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
12	Erosion Control Structures(Non Riparian)	1201	constructed works in non riparian areas: contour terraces, gully stabilization, bank stabilization, erosion control matting, silt fencing, drop inlet systems and enhanced infiltration systems, in-channel control, retention ponds and erosion control dams, mechanical wind screens	N/A	50%	$20K
		1202	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
13	Land Management for Soils at Risk	1301	forage or annual barrier establishment for soils at risk (eg. stripcropping, grassed waterways, perennial forages on severely erodible or saline soils)	# acres	50%	$5K
		1302	straw mulching	# acres		

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
		1303	grazing management in critical erosion areas not associated with riparian zones: alternative watering systems (ie: solar, wind or grid power), crossfencing	# kms offence		
14	Improved Cropping Systems	1401	equipment modification on pre-seeding implements for restricted zone tillage for row crops, seeding and post seeding implements for low disturbance placement of seed and fertilizer	N/A	30%	$15K
		1402	chaff collectors and chaff spreaders installed on combines			
		1403	precision farming applications: GPS information collection, GPS guidance (ie: autosteer, lightbars, software) , manual and variable rate controllers for variable fertilizer application			
15	Cover Crops	1501	establishment of non-economic cover crop	# acres	30%	$5K
		1502	equipment modification for inter row seeding of cover crops (eg. relay crops)	N/A		
16	Improved Pest Management	1601	equipment modification for improved application	N/A	30%	$5K
		1602	information collection and monitoring			
		1603	biological control agents			
		1604	cultural control practices			
		1605	mobile water tanks			
17	Nutrient Recovery from Waste Water	1701	recycling of waste water streams from milkhouses, fruit and vegetable washing facilities, and greenhouses in order to recover nutrients	N/A	30%	$20K
		1702	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
18	Irrigation Management	1801	irrigation equipment modification/improvement to increase water or nutrient use efficiency	N/A	30%	$10K
		1802	equipment to prevent backflow of altered irrigation water into water sources			
		1803	improved infiltration galleries and irrigation intake systems			

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
19	Shelterbelt Establishment (GREENCOVER)	1901	establishment of shelterbelts for farmyard, live stock facilities, dugout snowtrap, wildlife habitat enhancement, field (planting and establishment costs for trees and shrubs for the year of planting and one year after the planting year, or the termination of the NFSP funding, whichever comes first)	# kms	50%	$10K
		1902	tree materials required for shelterbelt establishment	N/A		
20	Invasive Alien Plant Species Control	2001	integrated approaches (cultural, mechanical, and biological) for control of invasive plant species (eg. leafy spurge, purple loosestrife, scentless chamomile)	N/A	50%	$5K
21	Enhancing Wildlife Habitat and Biodiversity	2101	buffer strips: native vegetation	# acres	50%	$10K
		2102	alternative watering systems (ie: solar, wind or grid power)	N/A		
		2103	improved grazing systems: crossfencing	# kms		
		2104	wildlife shelterbelt establishment	# kms		
21	Enhancing Wildlife Habitat and Biodiversity	2105	improved stream crossings	N/A		
		2106	hayland management to enhance wildlife survival	N/A		
		2107	wetland restoration	acres		
22	Species at Risk	2201	alternative watering systems (ie: solar, wind or grid power)	N/A	50%	$10K
		2202	improved grazing systems: crossfencing	# kms		
		2203	plant species establishment	# acres		
		2204	infrastructure development and relocation	N/A		
23	Preventing Wildlife Damage	2301	forage buffer strips	# acres	30%	$10K
		2302	fencing or netting to protect stored feed, concentrated livestock, high value crops, drip irrigation systems, and other ag. activities	# km offence		
		2303	scaring and repellant systems and devices	N/A		

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
24	Nutrient Management Planning	2401	consultative services to develop nutrient management plans, planning and decision support tools	# acres	50%	$4K
25	Integrated Pest Management Planning	2501	consultative services to develop integrated pest management plans, planning and decision support tools	# acres	50%	$2K
26	Grazing Management Planning (GREENCOVER)	2601	consultative services to develop range and grazing management plans, planning and decision support tools	# acres	50%	$2K
27	Soil Erosion and Salinity Control Planning	2701	consultative services to develop soil erosion and salinity control plans, planning and decision support tools	# acres	50%	$2K
28	Biodiversity Enhancement Planning	2801	consultative services to plan habitat enhancement, wetland restoration, stewardship for species at risk and/or wildlife damage prevention within agricultural land base; planning and decision support tools	# acres	50%	$2K
29	Irrigation Management Planning	2901	consultative services for planning improved water use efficiency and reduced environmental risk of existing irrigation systems, planning and decision support tools	# acres	50%	$2K
30	Riparian Health Assessment (GREENCOVER)	3001	consultative services for assessing riparian health, planning and decision support tools	# acres	50%	$2K

Appendix O: Environmental Farm Plan Workshops and EFP Statement of Completions in Manitoba



Appendix P: Annual Precipitation for weather stations located in the West Souris River IWMP for selected years.*

Weather Station	Total Annual Precipitation (mm)						
	1992	**1993**	**1999**	**2000**	**2005**	**2006**	**30-year average (1971 - 2000)**
Virden	415.3	437.4E	M	612.8	---	---	474.3
Pierson	239.6	371.8	582.2	534	491.6	330.6	467.2
Melita	308.5	413.1	469.4E	549.2	544.9*	378	

Weather Station	Total Annual Rainfall (mm)						
	1992	**1993**	**1999**	**2000**	**2005**	**2006**	**30-year average (1971 - 2000)**
Virden	246	387.9	M	440.6			353.5
Pierson	239.6	371.8	478.2	395.8	408.4	245.6	352.7
Melita	203.8	319.8	385.8E	445.4	469.6	282.4	

*Annual precipitation and rainfall data was obtained from the Environment Canada website at:
http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html