Agricultural Land Use and Management in the Fisher River Watershed

Submitted by

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and

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A. Executive Summary

The Fisher River Watershed, located in the Interlake Region of Manitoba, is approximately 315,160 hectares (ha) in size. The River flows northeast passing through the communities of Fisher River and the First Nations of Peguis and Fisher River before draining into Lake Winnipeg. An Integrated Watershed Management Plan (IWMP) is being developed for this watershed by the East Interlake Conservation District in collaboration with Manitoba Water Stewardship and numerous other stakeholders.

Understanding changes in agricultural land use is essential for the development of the integrated watershed management plan. The overall objective of this report is to examine potential 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 at a watershed scale provides a snapshot in time of the various agricultural activities in the Fisher River Watershed. Census of Agriculture data, temporal in nature, illustrates influences from external factors like weather, government programs and policies, market drivers, and technology on land use and land management decisions and the community response to those interactions. Consideration of such influences, with an examination of a watershed's physical resource characteristics and risks, assists in developing an understanding of potential impacts of agriculture on the basin's water, soil, and wildlife resources and identifies opportunities for future sustainable land use strategies. This information also assists in improving the understanding of the following four key issues that were identified through public consultations for the Fisher River IWMP: (i) protection and health of the natural areas including fish and wildlife, wetlands, (ii) forests and the protection of medicines and traditional territories; (iii) surface water quality; (iv) agriculture and ground water quality.

Ag-profiling examines variables from 2006 Census of Agriculture database depicted over the watershed, including farm area, type of farm, cropping practices, tillage practices, fertilizer and pesticide use, financial activity, and livestock numbers. These same variables from the 2006 Census of Agriculture data were used to examine 15-year changes in agricultural activities in the study area. Land cover data, derived from 1994, 2002, and 2006 satellite imagery, was analyzed to document temporal changes in land cover. Using soils data and modeling, environmental indicators were developed for agricultural capability, wind and water erosion risks, soil drainage, and surface texture 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 conducted to assess their impact on agricultural land use and management.

The Fisher River IWMP study area has a limited agricultural landscape, with most of the watershed covered by wetlands and forested areas. The majority of the agricultural lands surround the towns of Fisher Branch and Hodgson. From 1991 to 2006, there were fewer but larger farms located in the study area, with a trend towards smaller, sustainable agriculture production systems. Crop production in the watershed has an increasing reliance on commercial fertilizers and pesticides, with a larger proportion of cropland being treated with crop inputs. In the same fifteen year period, there was an overall increase in forages and decrease in grasslands. Forested areas saw a dramatic increase in area at the expense of both wetlands and grasslands. Total farmland saw a modest rise in area from 1991 to 2006 but cereals in particular have been slightly declining since 1996. The majority of farms in the study area employ traditional conventional tillage rather than conservation or zero tillage practices. However, since 2001 conventional tillage is on the decline being replaced by conservation and zero tillage.

Analytical results of land cover over a 12-year period correspond well with the Census of Agriculture data analysis, particularly the conversion of annual cropland and grasslands to forage. Annually cropped land at risk to factors such as wind erosion, agricultural capability, drainage, and slope may warrant special management of these lands. An examination of land cover data 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 area conservation. Due to data limitations, all spatial analyses and interpretations using land cover and soils data require further verification for accuracy assessment.

The interest and willingness of producers within the watershed to address environmental issues is demonstrated by their participation in environmental programs through the Agricultural Policy Framework (APF) and more recently under Growing Forward (participation in the Environmental Farm Plan (EFP) Program and the Canada-Manitoba Farm Stewardship Program (CMFSP) were analyzed in this report). The results indicate good uptake; 53 beneficial management practice (BMP) projects were completed with financial and technical assistance through the CMFSP in the Fisher River IWMP area. Over 74% of these projects were non-point source BMP projects and 17% were non-point source livestock related BMPs. The total number of projects completed in the watershed under Growing Forward 1(GF I), were not available, but IWMP participation included considerable uptake in soil management, water quality, manure and grazing management BMPs.

IWMP study questions were provided by the project management team to watershed stakeholders relating to land cover changes and their relationship to water quality. Results showed that the issues raised in the questions regarding agricultural land management changes were not as evident as first expected. Where analysis completed in the report did have some similarities to what was observed in the public consultations should be explored more closely through ground truthing.

With respect to riparian areas, predictive modeling has been incorporated on the main waterway in the watershed. Recommendations include further assessment of riparian status to other creeks in the watershed and additional educational initiatives that support land management within healthy riparian areas. Potential indicators were also identified for each recommendation to evaluate progress on issues in the future.

Key recommendations are provided as suggested strategies to the IWMP questions by the project management team. They include communication strategies to watershed stakeholders of the current plan activities, updates to any monitoring occurring as part of IWMP plan, and a need for continued support for environmental farm planning. While positive trends were noted with respect to the watershed's agricultural influence on lake health, riparian and wildlife habitat, there may still be a need to target specific BMPs that are site specific to address local issues. These include riparian and surface water protection BMPs, as well as, nutrient management planning. There is also an opportunity to explore new BMP technologies to further address environmental risks identified in the watershed. Local leadership will be essential in developing partnerships between watershed stakeholders, coordinating multi-levels of government involvement, and serving as a bridge between landscape needs and provincial/federal regulations.

B. Acknowledgements

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

AAFC-STB: Holweger, U., Powers, J., Mischuk, N., Kopytko, M., Michiels, P., Gottfried, K., Fedenuik, S.

MAFRI: Gauer, E., Riekman, M., Schindler, D.

C. Preface

In March 2009, the East Interlake Conservation District (EICD) was designated as the Watershed Planning Authority to develop a comprehensive Integrated Watershed Management Plan (IWMP) for the Fisher River study area. 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 Conservation and Water Stewardship to Agriculture and Agri-Food Canada (AAFC) – Science and Technology Branch and Manitoba Agriculture Food and Rural Initiatives (MAFRI) to be involved in the IWMP process. As agriculture is a shared responsibility between the federal and provincial governments, AAFC and MAFRI are partnering to provide professional and technical guidance to the IWMP process on agricultural issues and agri–environmental priorities.

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 available 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 Fisher River study area. More information on the data used in this document can be found within the Appendices section of the report.

D. Introduction

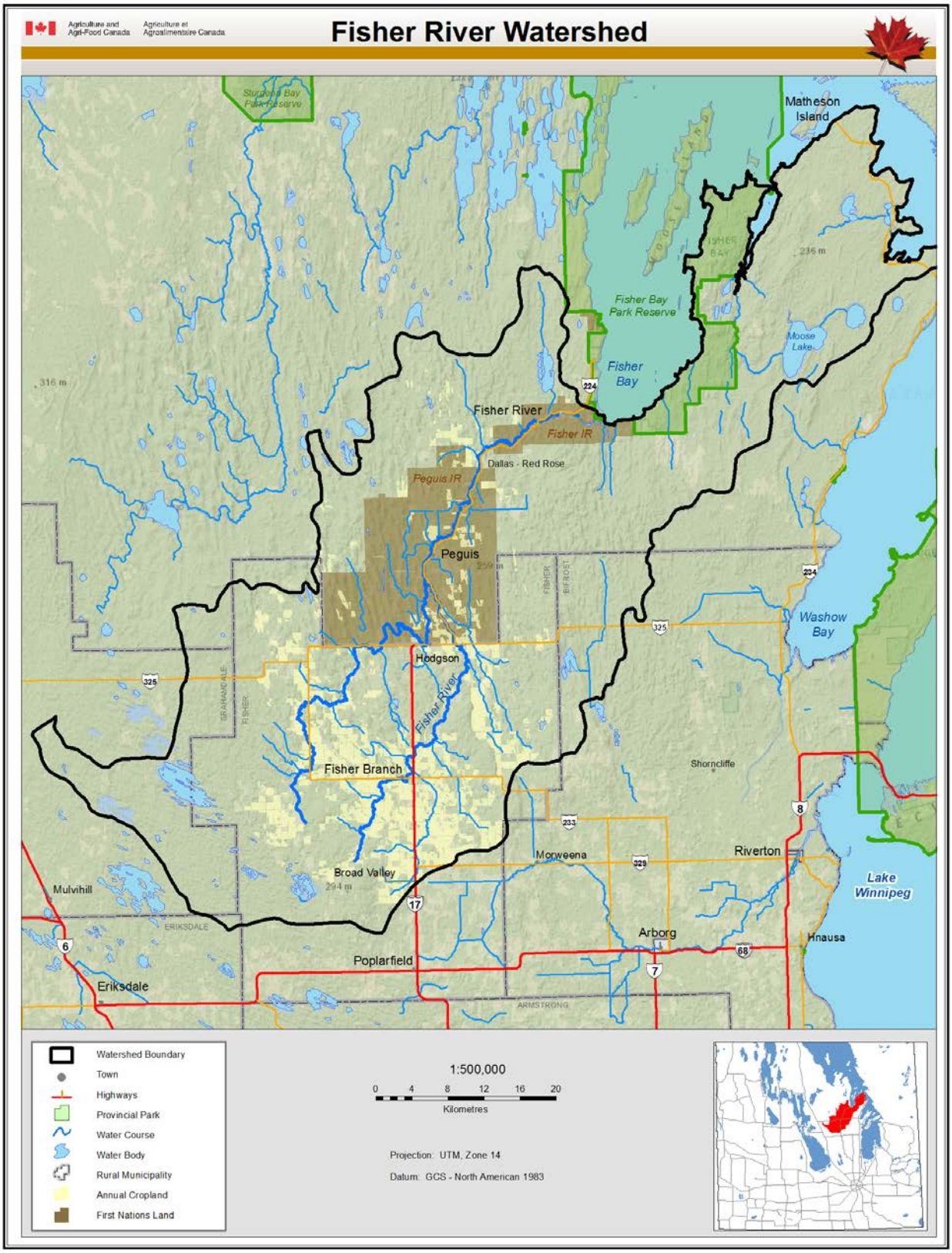
The Fisher River Integrated Watershed Management Plan (IWMP) study area is defined by Manitoba Conservation and Water Stewardship as encompassing watershed “05SD”, and is situated west of Lake Winnipeg. The study area is 315,160 hectares in size and is the most northern agricultural extent within the Interlake Region. The Fisher River watershed is located on the western shore of Lake Winnipeg and drains into the Fisher Bay (***Figure 1***). Some of the communities located within the area include Fisher Branch, Hodgson, Dallas – Red Rose and Broad Valley. It includes land located in the Rural Municipalities of Fisher, Bifrost, and Grahamdale, and those managed by Manitoba Aboriginal and Northern Affairs. The Fisher Bay Park Reserve, and the Fisher River and Peguis First Nations are also located within the IWMP study area.

Objective

Understanding the current state and trends in agricultural land use and management 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. Knowledge of these factors will inform the development of sustainable land use strategies that will lead to a healthier and more ecologically functioning landscape. AAFC and MAFRI have partnered to undertake an assessment of the changes to agricultural activities and their potential impacts within the watershed, focusing on the major issues identified in the 2012 public consultations in support of the IWMP. Specifically, the document will examine the following:

- **"Near-Current" Agricultural Land Use and Management using the latest available Census of Agriculture data and satellite imagery;**
- **Fifteen-year change in agricultural land use and management using 1991, 1996, 2001, and 2006 Census of Agriculture data and a time series of satellite imagery;**
- **Land cover data in combination with landscape risk factors pertaining to soil and water resources and;**
- **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: Fisher River Watershed Study Area



E. Agricultural Land Use and Management

i. Current Agricultural Land Use of the Fisher River IWMP Study Area

a) Agricultural Profile

Agricultural profiling refers to the characterization of agricultural production in a specified area or region. The ability to use Census of Agriculture information collected from producers can provide a snapshot in time of the agricultural footprint on the landscape. The information can be portrayed either on a municipal or geographic boundary (like a watershed) and can provide value to understanding the influence and trends of the industry to the area.

Census of Agriculture data at a subwatershed scale has been obtained from Statistics Canada for the 1991, 1996, 2001, and 2006 Census years. Agricultural activities were analyzed for Fisher River watershed (***Figure 1***). The majority of the agricultural lands are situated in the southern half of the watershed surrounding the communities of Fisher Branch and Hodgson. ***Table 1*** lists the area of the watershed, along with the area of the annual cropland based on the 2006 Landsat dataset. The Peguis First Nation and Fisher River Cree Nation are located in the central portion of the watershed and make up a significant portion (over 37,500 hectares or 12%) of the Fisher River Watershed.

Table 1: The Fisher River Watershed

Watershed	Watershed Area (hectares)	Annual Cropland Area (hectares)
Fisher River Watershed	315,160	30,353

Land Use and Land Management

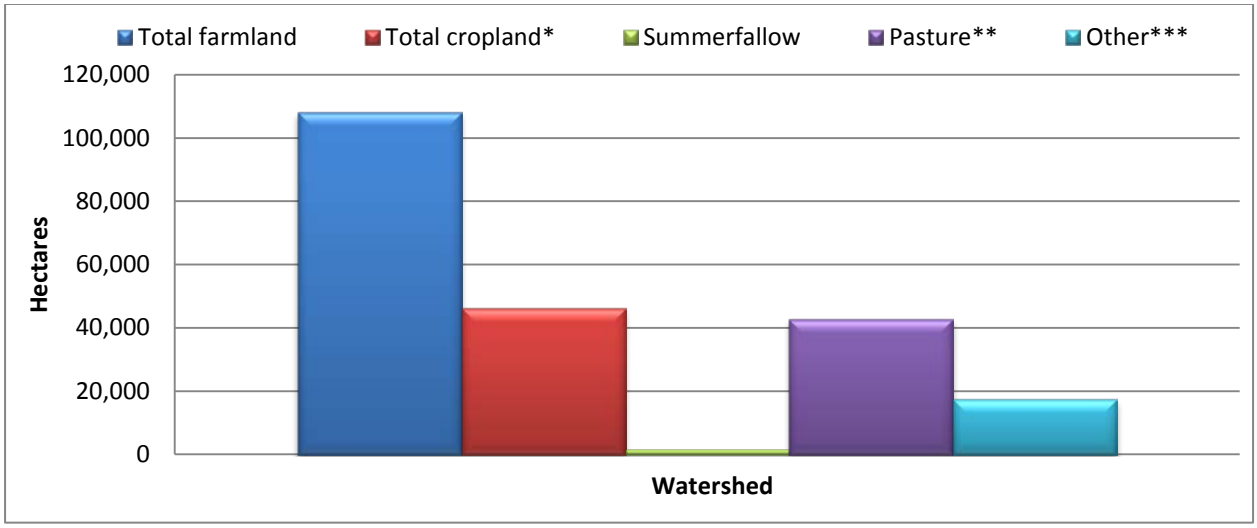
Fisher River Watershed:

According to the 2006 Census of Agriculture, the Fisher River Watershed contained 182 farms, a number that declined over the previous 15 years. Agricultural land in the Fisher River Watershed covered only 34% of the watershed and over 42% of the farmland was dedicated to annual crop production while approximately 40% was being used for pasture, alfalfa, and hay and fodder crops. Cereals made up almost a third of the cultivated land while less than 20% was seeded to oilseeds (mainly canola but also some flax). Forty-eight (48%) percent of the total farmland was in forages. Only 16% of cultivated land was managed using zero tillage practices. Conservation tillage practices were applied on over 37% of cultivated land while the majority at 47% of cultivated land was tilled conventionally.

Livestock production was the most important industry to the area. Hog production was most common (based on the number of animals) in the watershed, with approximately 8 farm operations reporting nearly 48,800 animals; an average of over 6,000 hogs per farm. Total number of cattle and calves in the area was almost 25,200 animals. Beef production was the second largest operation type with 108 cattle farms averaging just over 230 head per farm. Fourteen farms reported poultry for a total of over 15,000 birds, averaging 1,100 poultry per farm.

When comparing the distribution of farmland, total cropland saw the largest increase in area change over the 15 years, increasing by over 10,000 hectares. There was a modest increase of close to 4,000 hectares for "other crops" and pastures saw a reduction in area with a reduction of over 4,500 hectares of total farmland. While summerfallow was present in the watershed, it comprised only a small area (less than 1%) of the watershed (***Figure 2***).

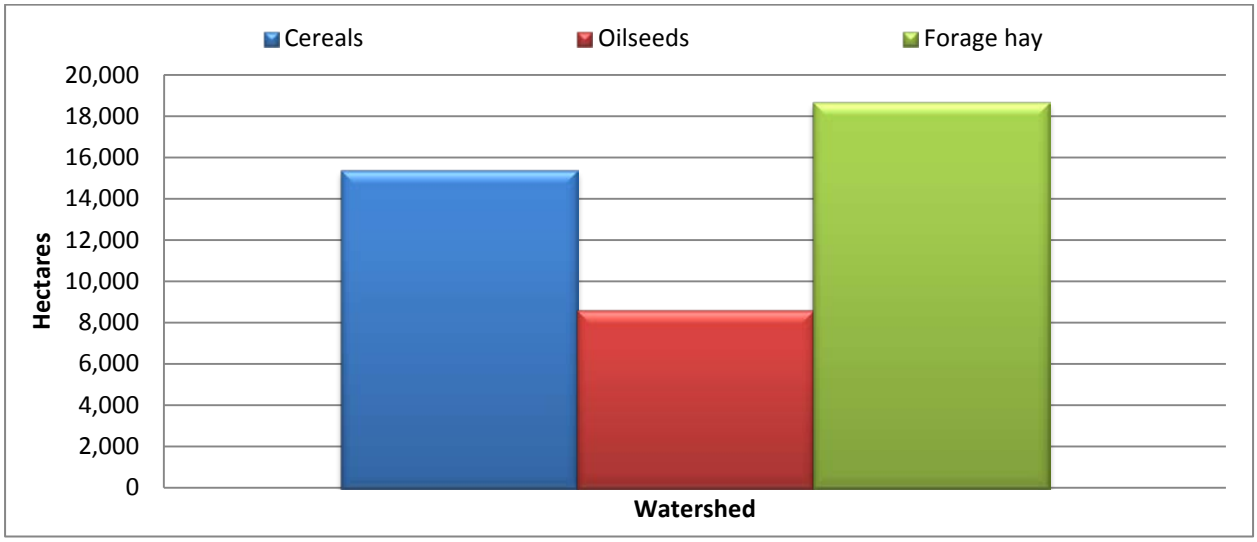
Figure 2: Distribution of agricultural land use in the Fisher River Watershed (2006 Census of Agriculture)



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

With respect to the distribution and types of crops grown in 2006, out of the three leading crop types, forages have changed the most since 1991. Production of forages increased from close to 12,000 hectares in 1991 to over 22,100 hectares in 2006. Oilseeds (mainly canola) have more than doubled from 2001 coming in at 8,600 hectares. While wheat was the dominant cereal crop, wheat and other cereals changed very little in total hectares over the 15 year period (***Figure 3 & 18***).

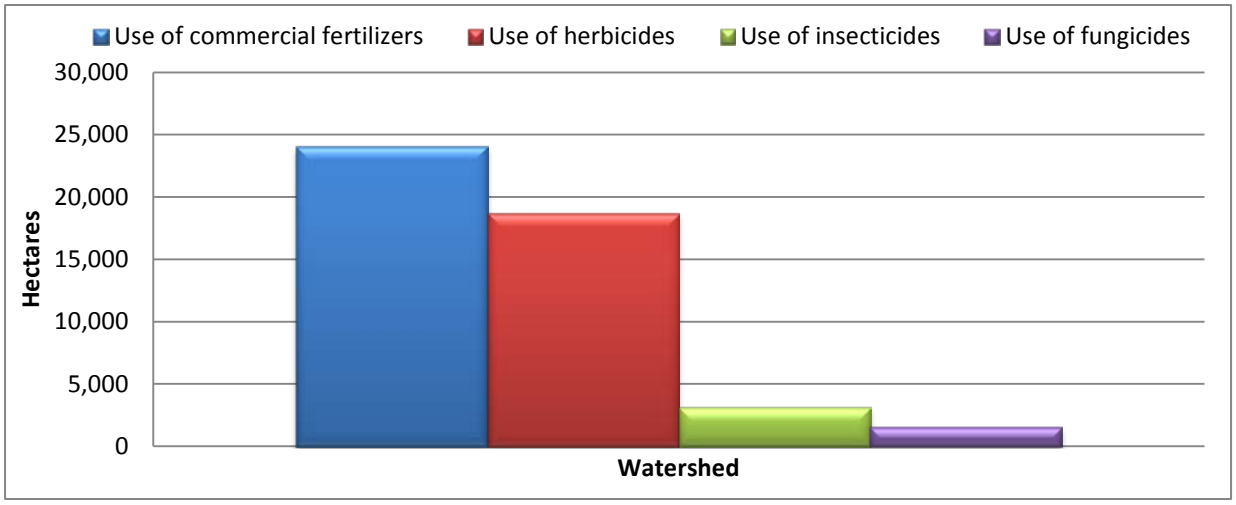
Figure 3: Distribution of the main crop types grown in the Fisher River Watershed (2006 Census of Agriculture)*



*Data has been suppressed by Statistics Canada to preserve landowner confidentiality

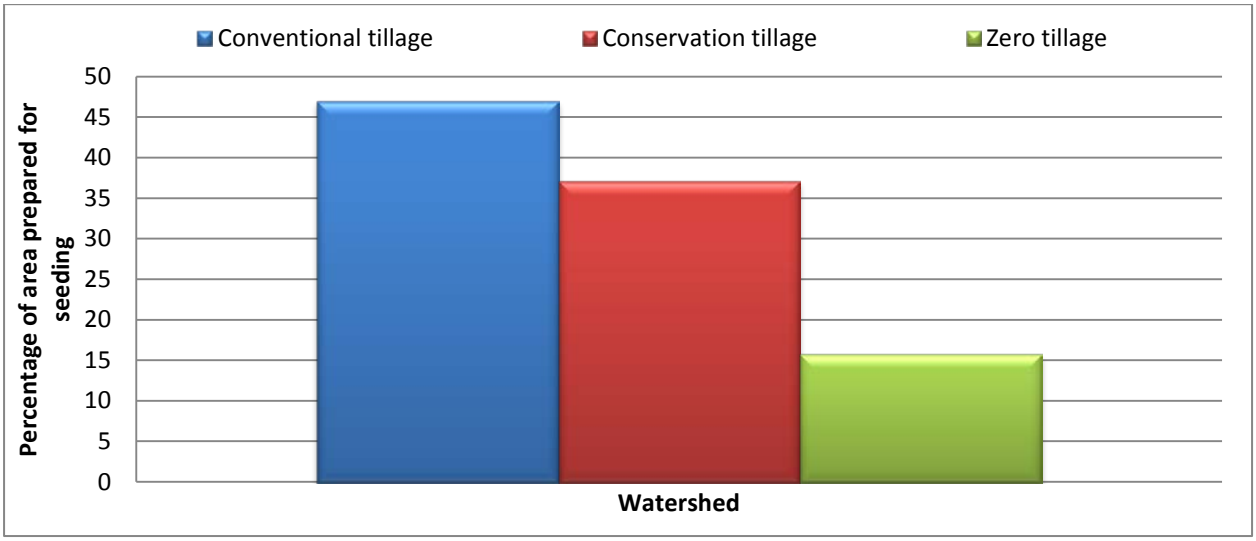
Over the ten years from 1996 to 2006, both fertilizer and herbicide, the key crop inputs (***Figure 4***), saw a slight decline in the number of hectares applied on and pesticides stayed relatively constant over the same time period.

Figure 4: Area of land treated to crop inputs in the 2005 crop year in the Fisher River Watershed (2006 Census of Agriculture)



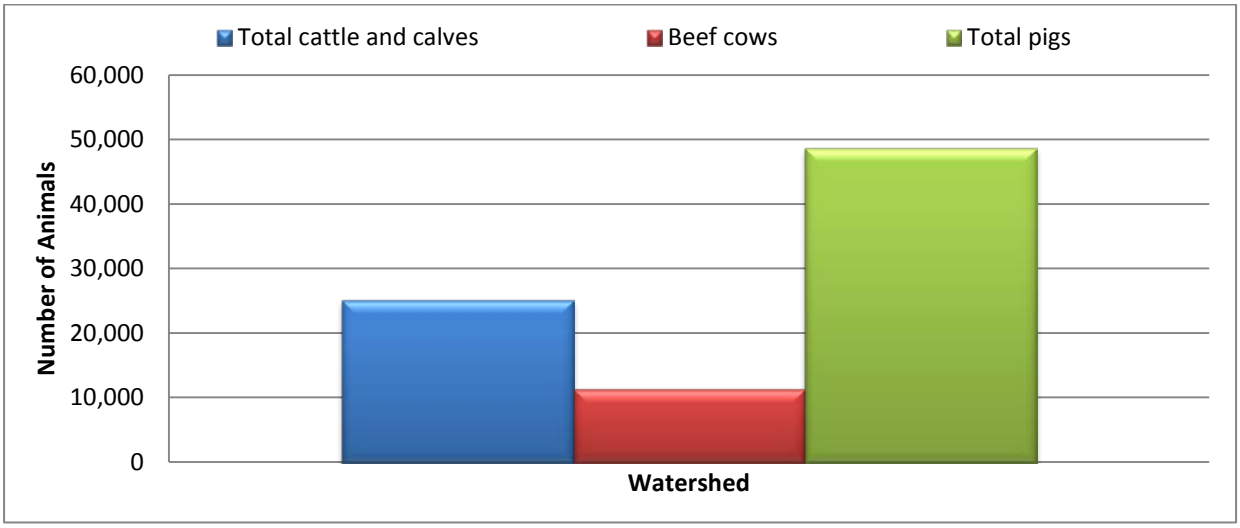
With respect to seedbed preparation, zero tillage was the least used tillage practice in the Fisher River Watershed. Together, conservation and zero-tillage was used on 53% of the crop land while conventional tillage continued to be a common practice in the watershed, with over 47% of the total area prepared for seeding using conventional tillage (***Figure 5***).

Figure 5: Tillage practices in the Fisher River Watershed (2006 Census of Agriculture)



Livestock production was and still is important in the watershed, and livestock numbers are summarized in ***Figure 6***. The total number of pigs increased dramatically since 1991 with the total number of pigs having gone from 10,000 animals in 1991 to almost 50,000 in 2006. Cattle Production The cattle and calves livestock saw a slight increase in animal numbers since 1991 and the poultry numbers declined almost by half, from 27,500 total birds in 1991 to 15,000 in 2006.

Figure 6: Total livestock numbers in the Fisher River 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 B***). As represented in ***Table 2***, cattle and calves, consisting primarily of beef cattle, contributed the majority of animal units in the watersheds and accounted for approximately 73% of the total AU in the watershed. Since beef production consists mainly of cow/calf operations, manure nitrogen (and phosphorous) will be deposited on pastureland naturally by the animals during the grazing season. Depending on the type of winter management used (with the application of extensive over-wintering) natural deposition of manure onto pastureland may continue over the winter season. Hog farms had the next highest AU percentage at 23% within the watershed. Horse/pony and other livestock accounted for 1.5% each of the total animal units to the watershed.

Table 2: Estimated annual animal units produced in the Fisher River Watershed (according to the number of livestock reported on Census day, 2006)*

Livestock Type	Total Animal Numbers	Total Animal Units (AU)	Percentage of Total AU
Total Cattle and Calves	25,181	15,731	73%
Total Pigs	48,743	5,013	23.5%
Total Poultry	15,005	291	1.5%
Total Horses and Ponies	287	287	1.5%
Other livestock – sheep, goats, bison, elk	n/a	112	0.5%
TOTAL	89,216	21,435	100%

* Some livestock numbers have been suppressed by Statistics Canada to preserve landowner confidentiality and are not included in the calculations of total animal units

Figures 7 and ***8*** illustrate the average size of livestock herds and bird flocks within the watershed. This number can be used to compare livestock production within the watershed and identify areas of possible environmental impact associated with intensive livestock production. Identifying these areas within the watershed helps with targeting of livestock related beneficial management practices. The average beef cow herd was just under half of the total average of the cattle and calve herds, averaging 109 for the beef herds and 233 for the average cattle and calve herd (***Figure 7***). Hog herd size was quite large for the watershed, averaging over 6,085 hogs per farm (***Figure 8***). The average poultry flock size was less than 1,110. These values must be observed with caution however, because barns that were empty on census day had no inventory to report, and may have led to an under-reporting of livestock numbers in the watershed.

Figure 7: Average number of cattle per farm in the Fisher River Watershed (2006 Census of Agriculture)

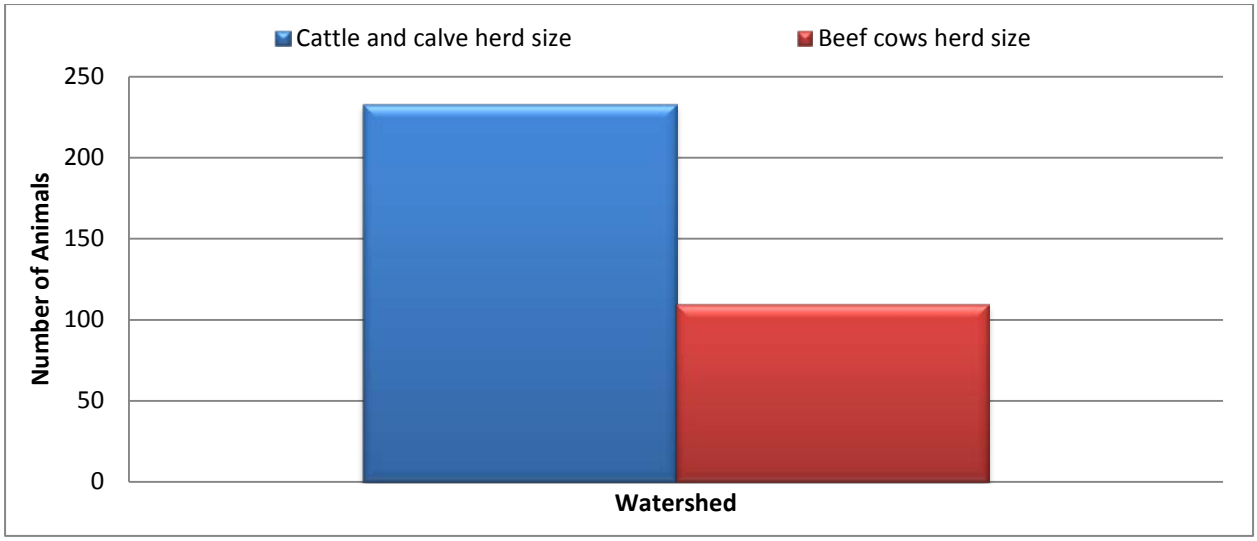
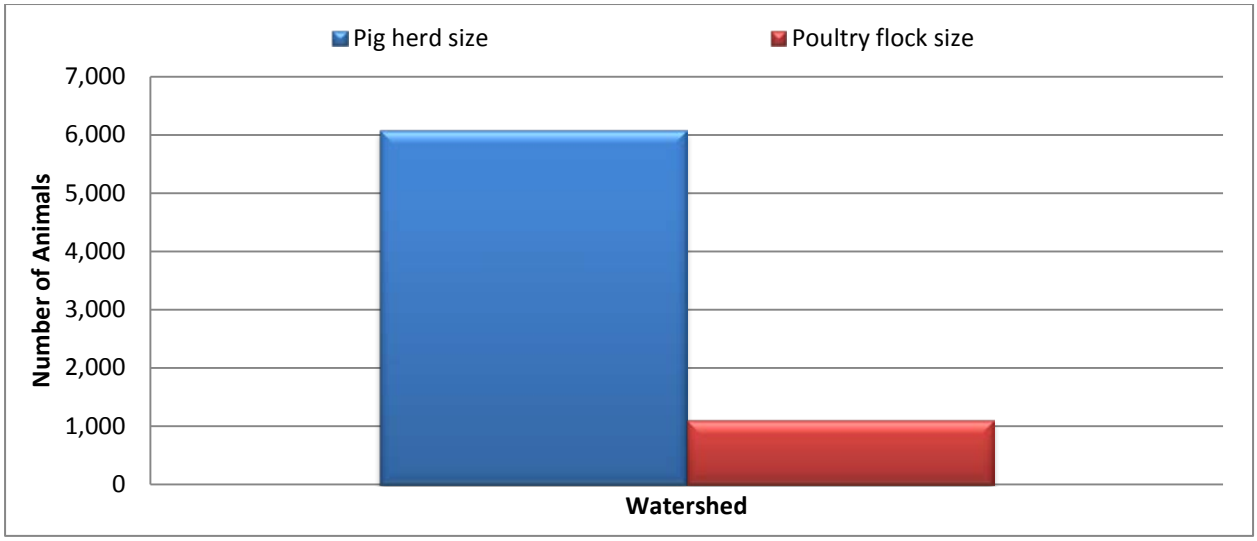


Figure 8: Average number of pigs and poultry per farm in the Fisher River Watershed (2006 Census of Agriculture)



Farm Financial Summary

In 2006, the Fisher River Watershed reported approximately 182 farms (***Figure 9***) with just over 10% of the watershed area being used for farming. The average farm size was approximately 595 ha/farm (1,470 acres/farm) with an average capital investment of $1,485 per hectare of farmland (or almost $881,900/farm). Livestock-related expenses were nearly $98/ha of farmland and crop-related expenses were over $94/ha (***Figure 10***) of cropped land and summerfallow. Per farm, net cash income was estimated to be almost $42,000 (***Figure 11***) and the sales to expense ratio was reported to be 1.2 (farm operations received $1.20 gross revenue for every $1 of agricultural expense).

Figure 9: Total number of farms and average farm size in the Fisher River Watershed (2006 Census of Agriculture)

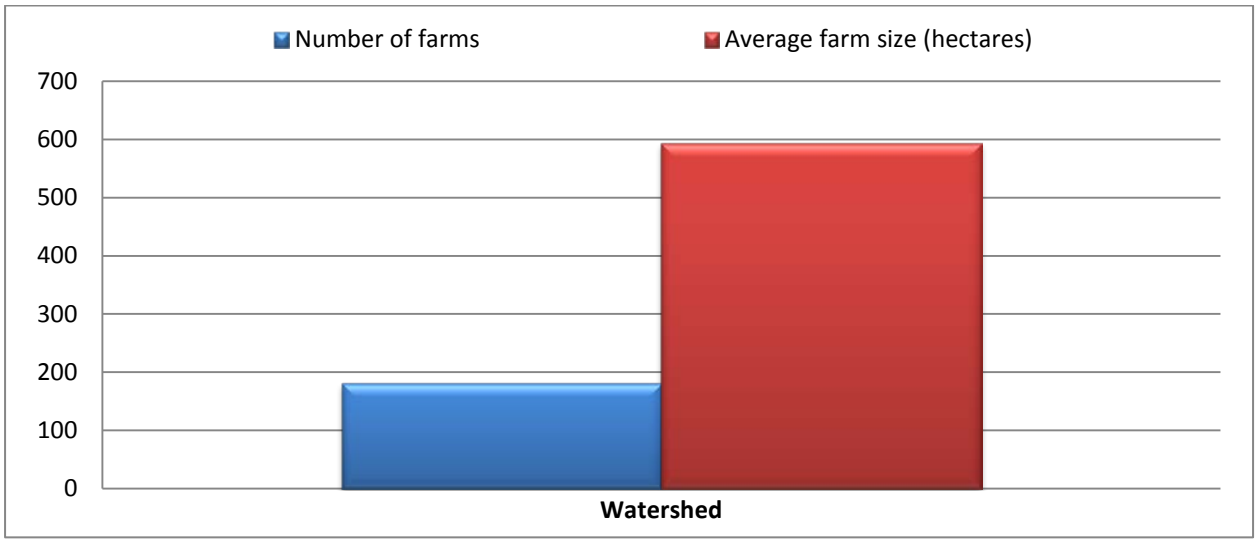
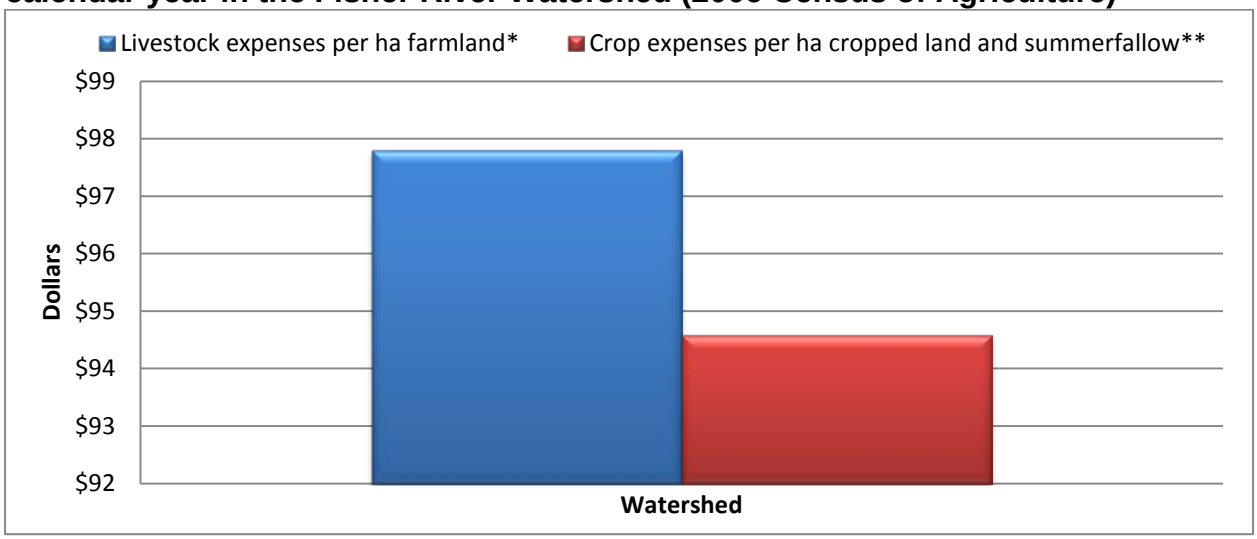


Figure 10: Average livestock and crop-related expenses per hectare for the 2005 calendar year in the Fisher River Watershed (2006 Census of Agriculture)



* 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)

Figure 11: Summary of farm average financial activity for the 2005 calendar year in the Fisher River Watershed (2006 Census of Agriculture)

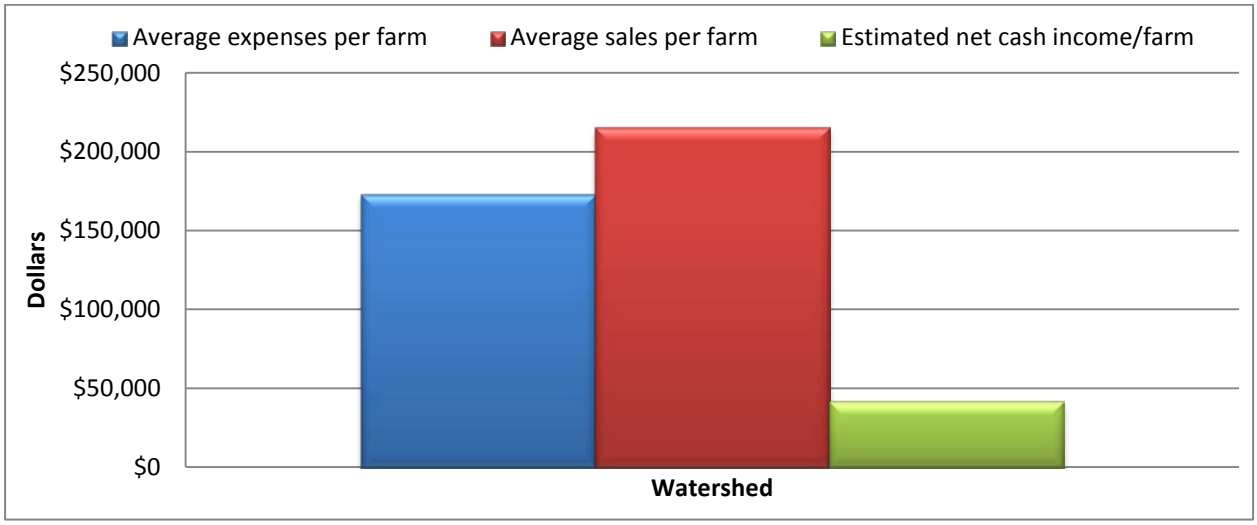
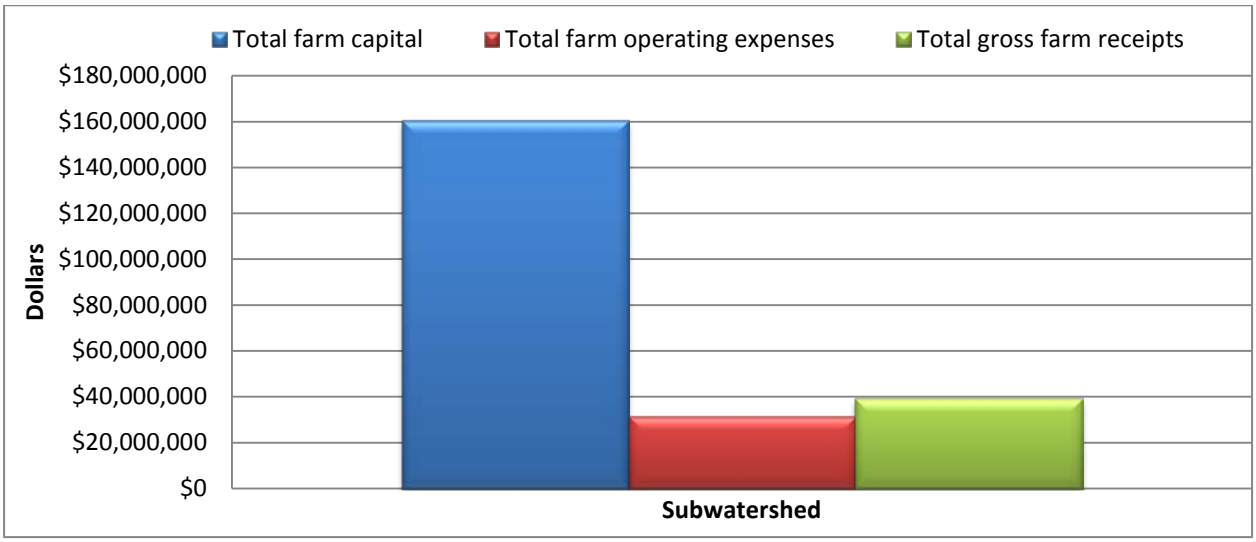


Figure 12: Summary of financial activity for the 2005 calendar year in the Fisher River Watershed (2006 Census of Agriculture)



Livestock and crop-related expenses reported for the 2005 crop year have been determined on a per hectare basis. ***Figure 10*** shows that, on average, farm operations in the watershed had similar livestock and crop related expenses per hectare of farmland. Also, a closer look at the crop input costs indicates that farms, on average, spent more per hectare on fertilizer ($103 per ha) than on pesticides ($59 per ha) (***Table 3***).

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

Watershed	Dollars spent on fertilizer per hectare applied	Dollars spent on pesticides per hectare applied
Fisher River	$103	$59

2006 Agriculture Profile Summary

- Approximately 33% of the land in the watershed was owned and managed by farm operations.
- Total farmland (108,200 hectares) was split in between total cropland at 46,300 hectares and pasture land at 42,700 hectares. The other 17,500 hectares include farmyard, woodlots and wetlands that are on privately owned lands.
- Alternative tillage methods were not as common in the watershed and applied on over 53% of all cultivated land. While conventional tillage remained the most common in tillage practice in the watershed at 47%, both conservation and no-tillage practices increased since 2001.
- Hog production is the main livestock industry in the watershed averaging over 6,000 hogs per farm. Cattle farms are the next largest livestock operation with over 230 cattle per farm (half of those being beef cattle at approximately 110 beef cows).

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 08, 2005 and September 09, 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 C***.

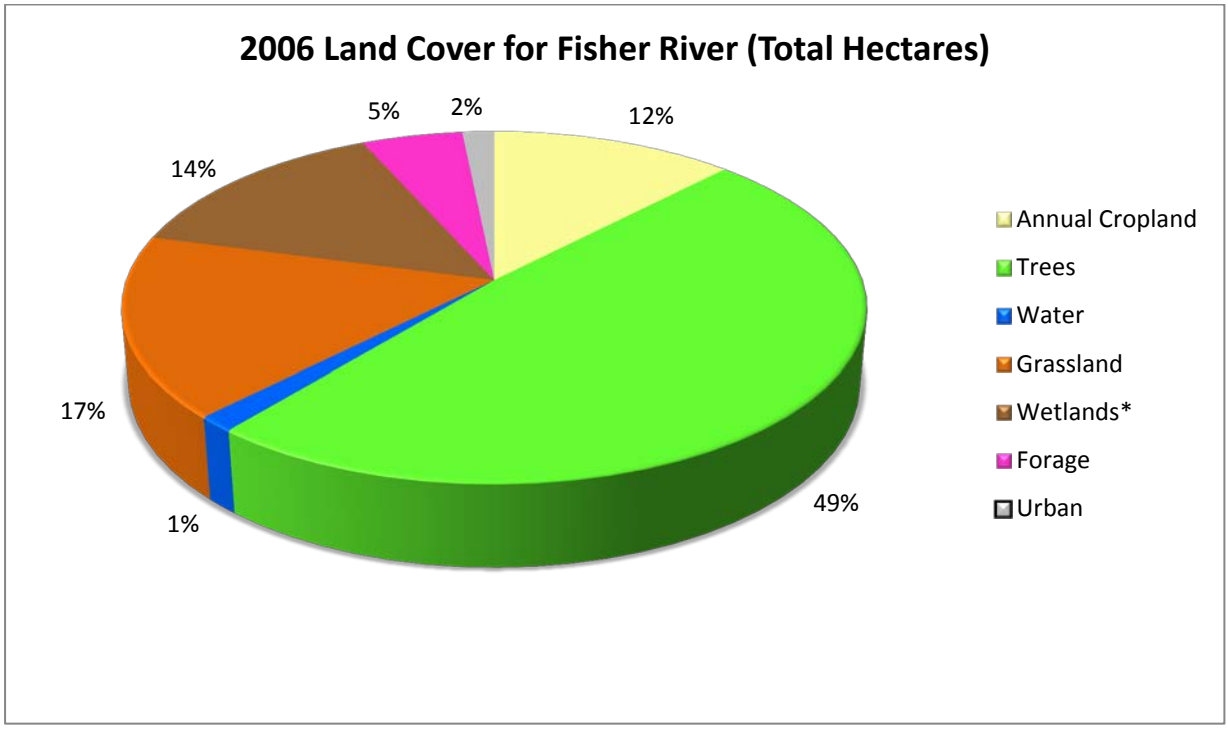
- Forested area (Trees) was the predominant land cover type in the watershed, the majority of which is located within the northern half of the watershed, and accounted for nearly 50% of the total land cover in the watershed.
- Grasslands were the second most common land cover type and made up 17% (41,424 ha) of the watershed. Large tracts of grasslands occur within the First Nations boundaries of Peguis and Fisher River.
- Wetlands were the third biggest land cover type, comprising14% (35,081 ha) of the total land cover. The majority of the wetlands occur in the northern portion of the watershed near Lake Winnipeg.
- In 2006, approximately 12% of the land cover (30,353 ha) was classified as Annual Cropland. This is the northern extent of agricultural lands within the Interlake Region, thus the topography and soils are not well suited to annual cropland.
- Forage lands, usually indicative of alfalfa stands, made up 5% of the watershed.
- Approximately 3% of the watershed was classified as water and urban areas (***Table 4, Figures 13 and 14***).

Table 4: 2006 Land Cover (hectares)*

Land Cover Class	Total Hectares
Annual Cropland	30,353
Trees	120,775
Water	3,539
Grassland	41,424
Wetlands**	35,081
Forage	12,575
Urban	3,961
Total	**247,709**

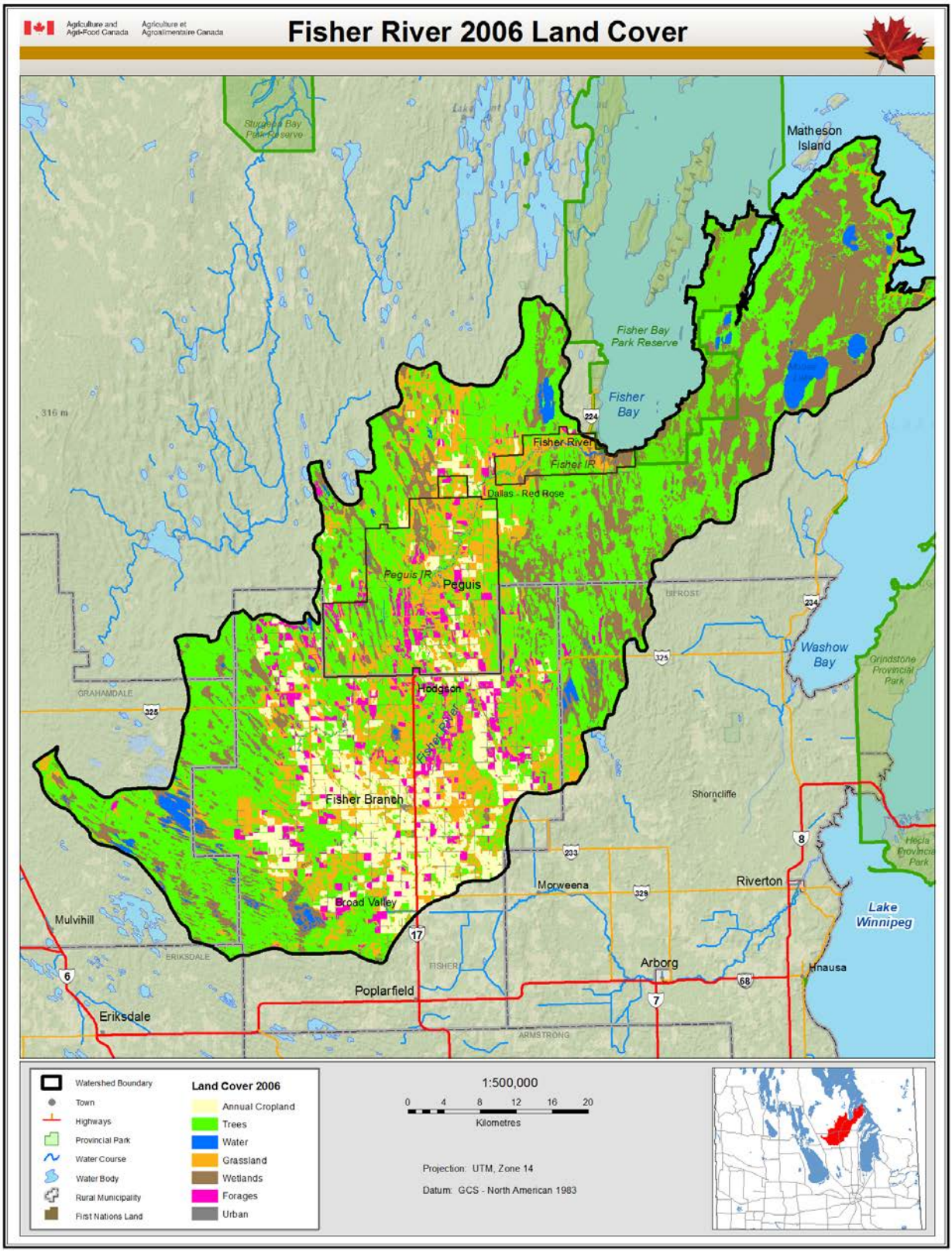
* Area totals are approximate due to the nature of the image analysis procedure
** Due to seasonal changes in wetland size, date of imagery will affect area.
***Total hectares are smaller than earlier reported due to imagery not covering full watershed.

Figure 13: Distribution of Land Cover within the Fisher River Watershed in 2006



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

Figure 14: 2006 Land Cover in the Fisher River Watershed*



*Land cover is composite was derived from satellite imagery captured August 5, 2005 and September 9, 2006.

ii. Agricultural Land Use Trends

Agricultural land use is diverse and there are many factors influencing changes over time. Influences include 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. Understanding land use trends can guide the development of future initiatives and actions to encourage sustainable resource management in the watershed.

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 or other conditions, it is important to also be aware of events and conditions. As a result, many of the land use changes noted in this report will need to be further examined by land use and industry specialists and individuals with significant local watershed knowledge to provide a more detailed understanding of trends and drivers.

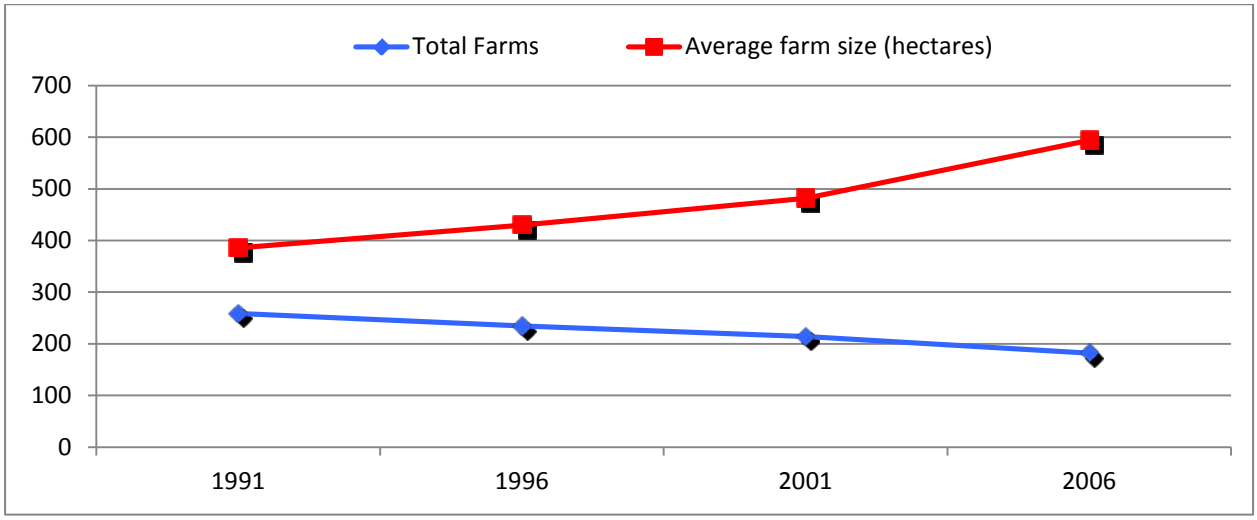
a) Changes in Agricultural Production (1991 to 2006 Census Data)

Census of Agriculture data from 1991, 1996, 2001 and 2006 has been acquired from Statistics Canada. The use of multiple data sets can illustrate changes in agricultural production practices and financial characteristics. This can be analyzed to better understand the agricultural effects on landscape resources in the Fisher River Watershed. For more detailed data from the 1991, 1996, 2001 and 2006 Census of Agriculture, refer to ***Appendix I, J, K,*** and ***L***.

Number of Farms and Farmed Area

The number of farms in the Fisher River Watershed decreased from 259 in 1991 to 182 farms in 2006, a decline of approximately 30% over the 15 year period (***Figure 15***). Although a decrease occurred during this time frame, the average farm size significantly increased from 386 ha in 1991 to 594 ha in 2006.

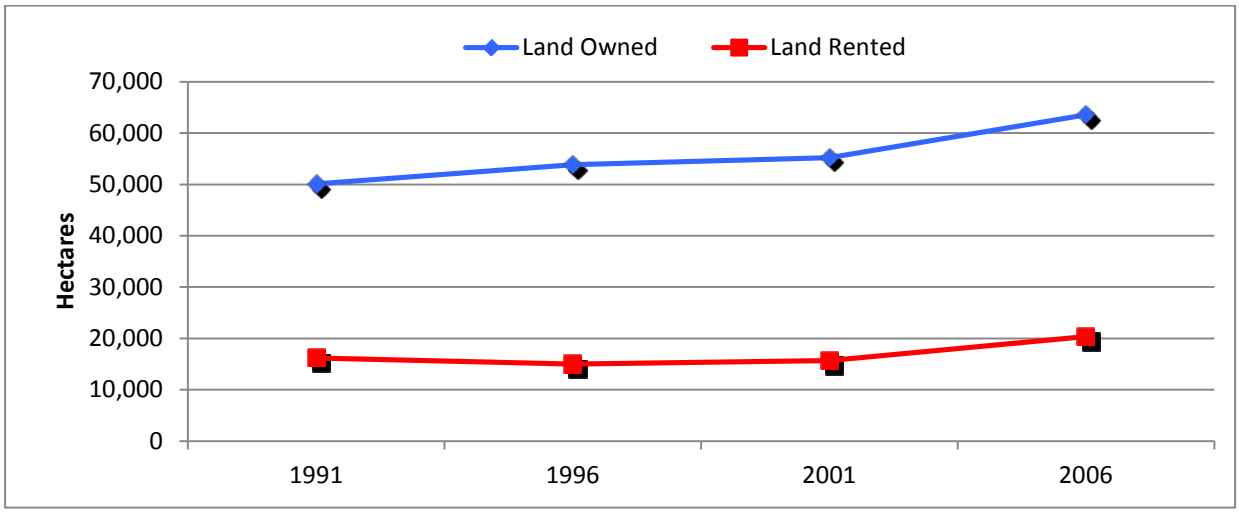
Figure 15: Total number of farms and average farm size in hectares in the Fisher River Watershed from 1991 to 2006



Land Tenure

Owned and rented land area saw very little change from 1991 to 2006 (***Figure 16***). A steady increase occurred in the area of land owned from 2001 to 2006. Local knowledge of farming practices would be required to explain this cause. Rented land saw a decrease in area after 1991, which then increased from 2001 to 2006. It should be noted that a significant amount of rented Crown land is being used by the ranching industry, and this may be influencing some of the changes.

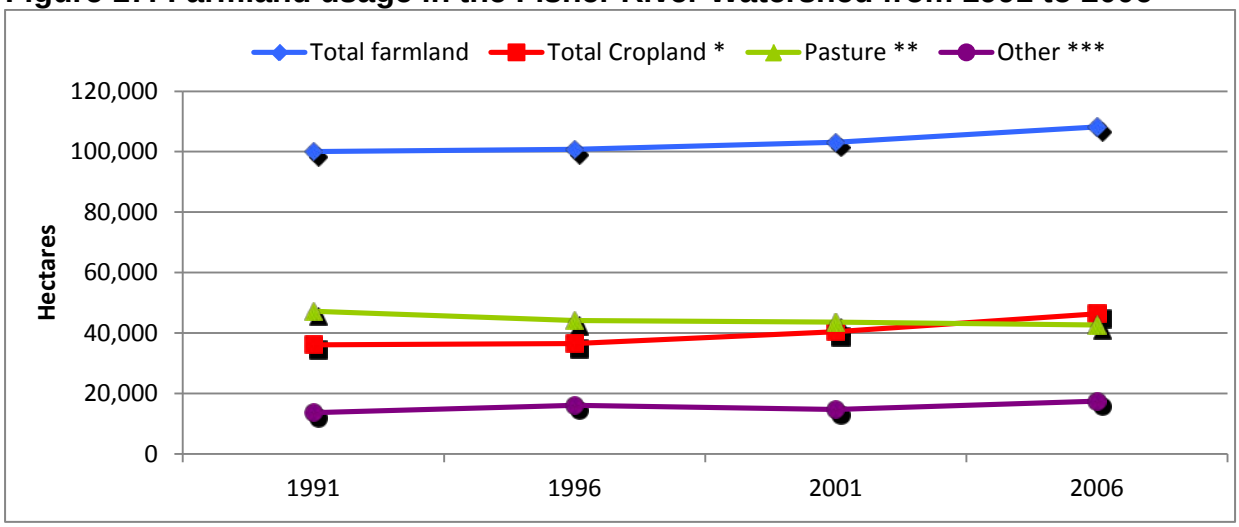
Figure 16: Owned versus rented lands in the Fisher River Watershed from 1991 to 2006



Farmland Usage

Total farmland usage, cropland and pasture were all constant between 1991 and 2006 (***Figure 17***). The largest increase was noted for total cropland, which had a slight increase in hectares from 1991 to 2006, 33,115 ha to 46,364 ha respectively.

Figure 17: Farmland usage in the Fisher River Watershed from 1991 to 2006

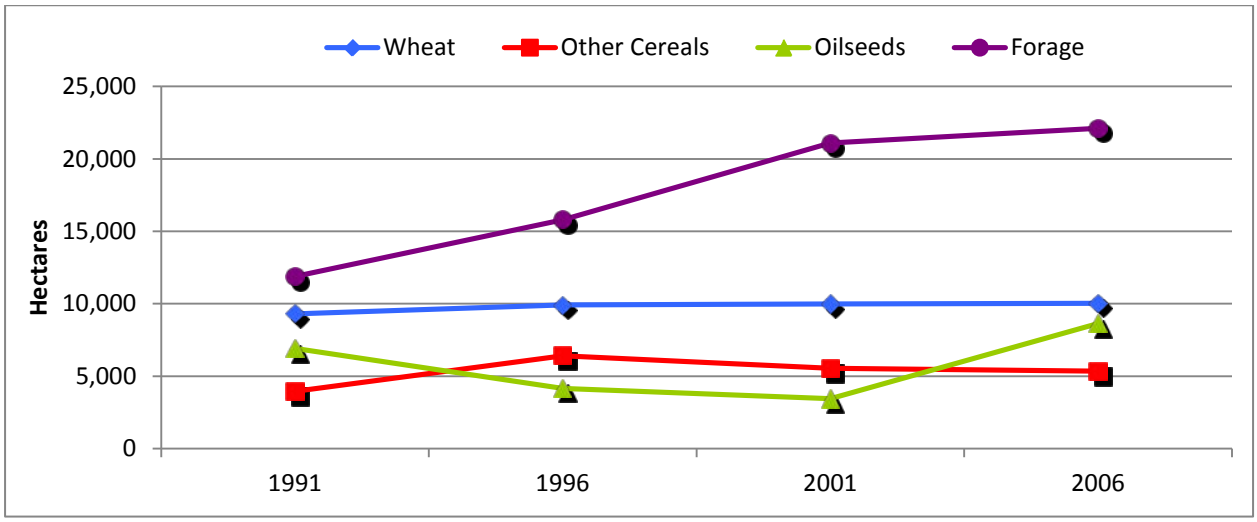


* Total cropland includes all field crops, vegetables, fruit and nuts, and sod
** Pasture includes tame pasture and natural areas used for pasture
*** Other land refers to all other land uses including farmyard, woodlot, wetland, Christmas tree, etc.

Cropping Practices

The area of land seeded to different types of crops showed modest changes from 1991 to 2006, except in the category of forages, which was more variable (***Figure 18***). Constant trends for spring wheat were noted for the watershed (a change of 100 ha over the period from 1996 to 2006). Changes noted to other cereals (an overall increase of 1,387 ha from 1991-2006) was met with reciprocal change of oilseeds. Oilseed area decreased from 1991 by approximately 6,910 ha to 4,165 ha in 1996; then increase to 8,633 ha in by 2006. Conceivably due to a move toward canola production that showed a reported production increase.

Figure 18: Major crop types in the Fisher River Watershed from 1991 to 2006*

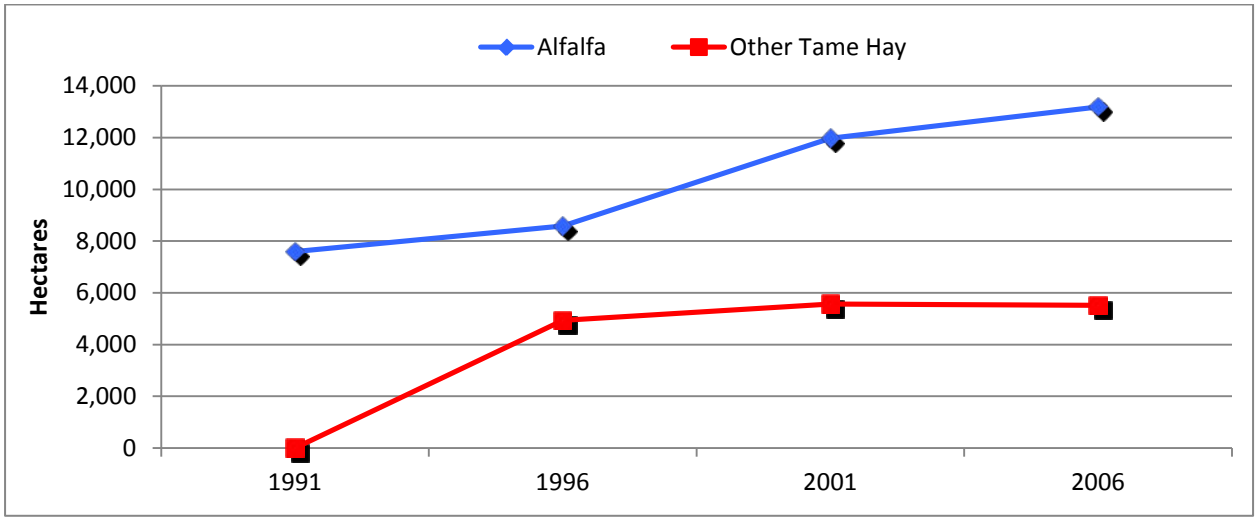


* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Alfalfa and Hay Production

Forage production made up 40% of the total agricultural area cropland in the watershed in 2006. This percentage increased over the 15 year period with alfalfa, seeing the highest increase while other tame forages increased in 1996 and then stabilized in the ten year period from 1996 to 2006 (***Figure 19***).

Figure 19: Alfalfa and tame hay trends in the Fisher River Watershed from 1991 to 2006*

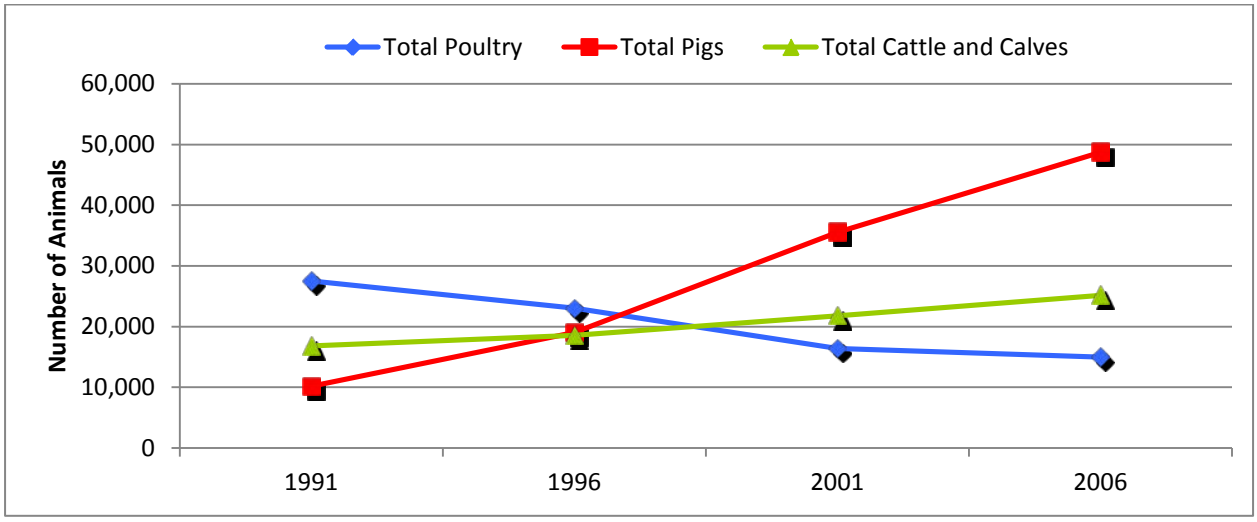


* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Livestock Production

The amount of livestock and poultry produced in the watershed varied during the 1991 to 2006 period (***Figure 20***). Both pig and cattle (less so than hogs) numbers increased every year since 1991. The number of pigs reported by hog operations increased significantly by 38,566 animals (from 10,177 to 48,743 animals) during the time period. Cattle numbers also saw a slight rise from 1991, with an increase of over 33% over fifteen years. Poultry production in the watershed saw a decline over the same 15-year period. The number of birds the highest observed value peaked in 1991 with almost 27,544 birds and declined to 15,005 birds by 2006.

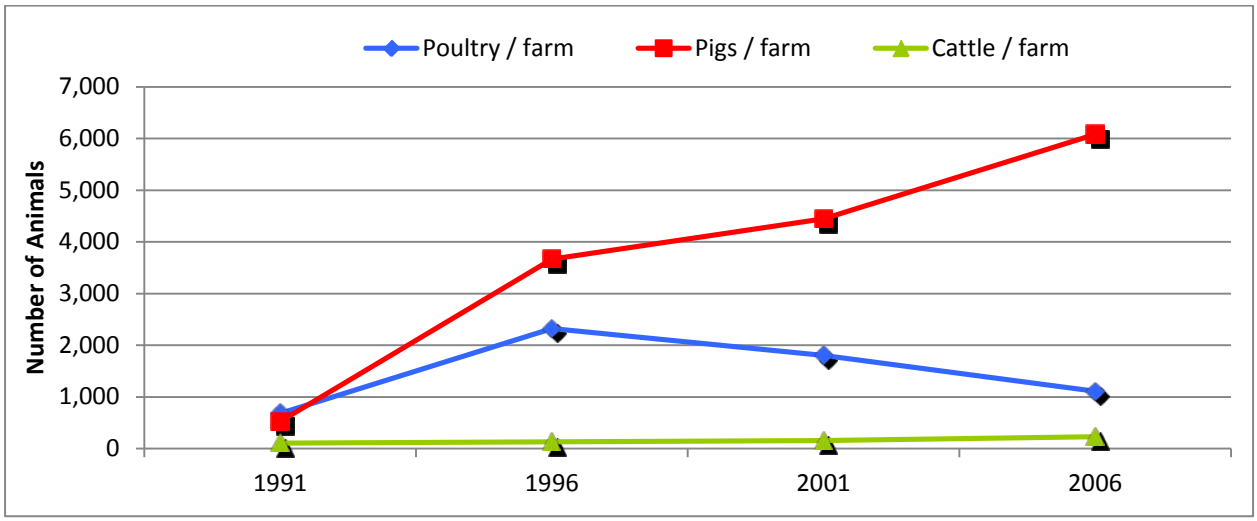
Figure 20: Major livestock productions trends in the Fisher River Watershed from 1991 to 2006*



* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

The cattle herd and pig herd size showed increase between 1991 and 2006 (***Figure 21***). This increase may be attributable to the decreasing number of farms (and increasing average farm size) within the watershed and the viability of these sectors between 1996 and 2006. Hog herd size saw the largest relative increase of all livestock types, with an increase of over 1000%. The Poultry farms saw a 240% increase rise in numbers from 1991 to 1996 and then fell dramatically in 2006.

Figure 21: Average number of livestock per farm reporting in the Fisher River Watershed from 1991 to 2006

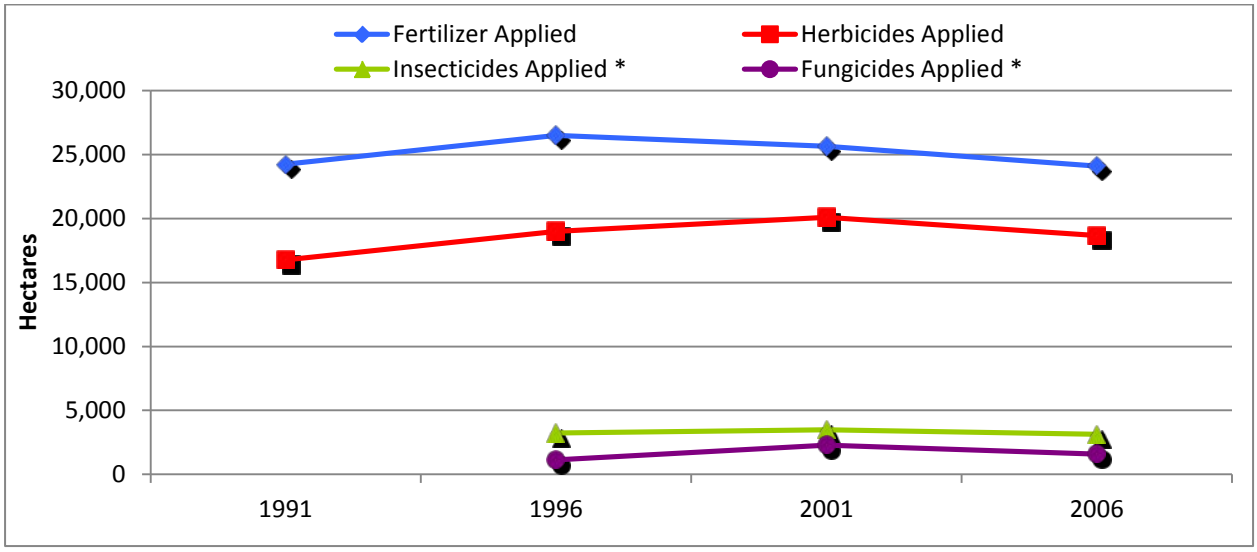


Land Management:

Fertilizer and Pesticide Usage

Over the 15 year period, the area of crops with fertilizer and herbicide inputs saw an increase in 1996 from 1991 levels and then a decreased in application after 1996 (***Figure 22***). In 2006, fertilizer was applied on approximately 22% of the cultivated land and 17% of cultivated land was treated with herbicides. The use of fungicides and insecticide remained fairly consistent from 1996 to 2006, with a slight overall decrease in the area that had insecticide applied and a slight increase for the area with fungicides application.

Figure 22: Fertilizer, herbicide, insecticide, and fungicide use in the Fisher River Watershed from 1991 to 2006

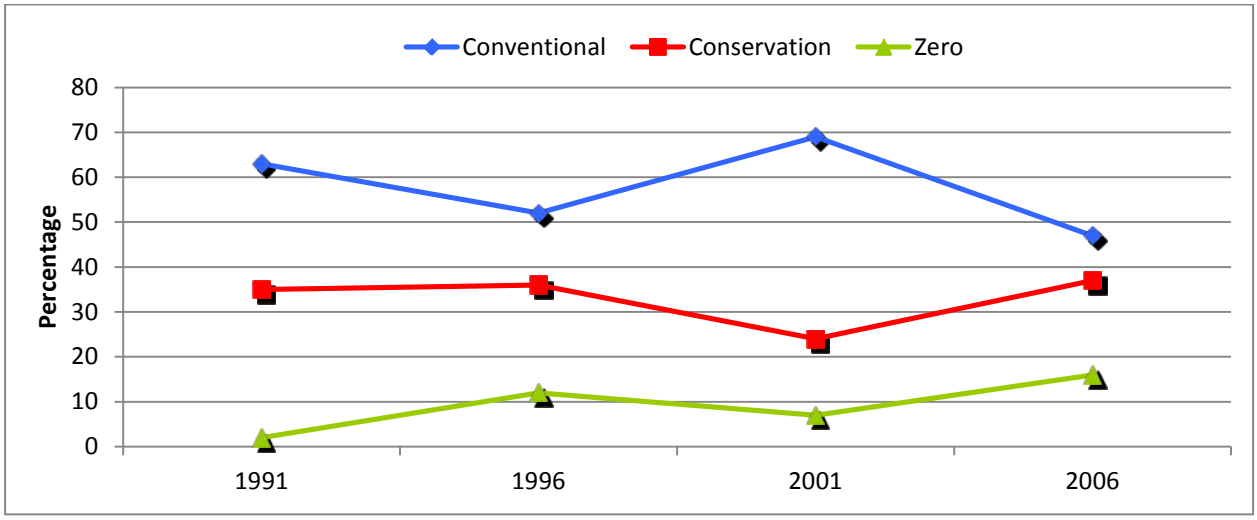


* Data for insecticides and fungicides was not available for the 1991 Census year

Tillage Practices

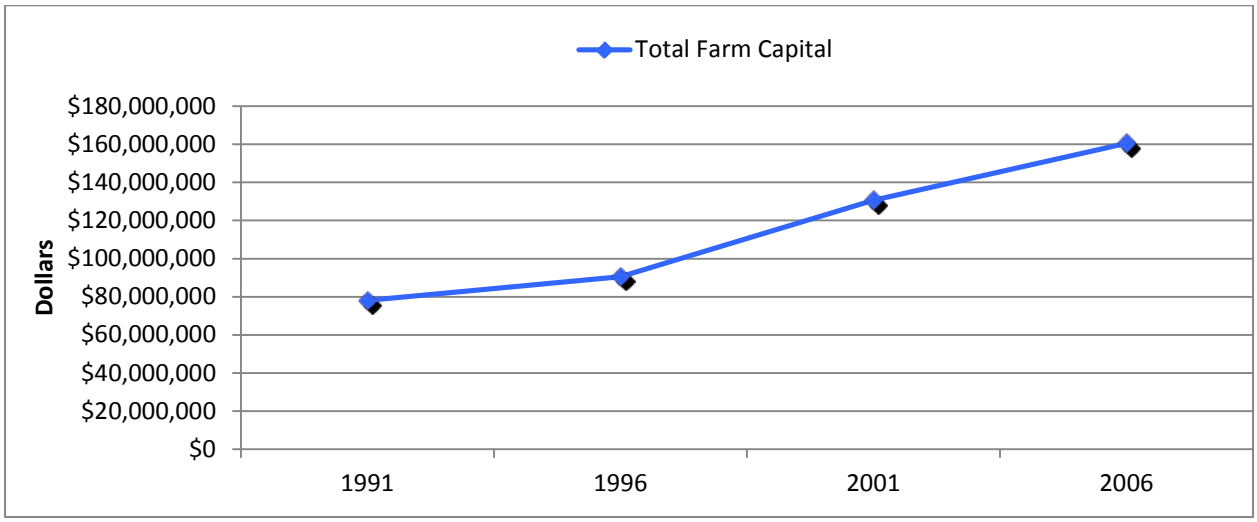
Land management of crop residue has shifted from conservation tillage to greater adoption of conservation and zero tillage practices (***Figure 23***). The area of land managed under conservation tillage saw a modest decrease from 1996 to 2001 and then increased in 2006 to similar levels of 1996. The area of land managed with zero tillage saw a similar trend as conservation practices, but saw the largest increase by 2006.

Figure 23: Tillage practices in the Fisher River Watershed from 1991 to 2006



Financial Characteristics
A near linear increase in total farm capital occurred in the watershed over the fifteen year period. Farm capital more than doubled from $78 million in 1991 to over $160 million in 2006 (***Figure 24***).

Figure 24: Total farm capital trends in the Fisher River Watershed from 1991 to 2006*



*Inflation has not been accounted for in total farm capital

b) Changes in Land Cover – 1994, 2002, 2006

Land cover maps used in this analysis were developed from 30 metre resolution LANDSAT Thematic Mapper satellite imagery. These datasets are *a 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 C***. The 1993-94 land cover was derived from satellite imagery captured on October 26, 1994; the 2000-02 land cover is from imagery taken on August 2, 2002; and the 2005-06 land cover was captured on August 8, 2005 and September 9, 2006. Landcover coverage of the Fisher River Watershed for the 3 time periods is limited to approximately 80% of the watershed (bottom portion).

Summary of Land Cover Change
An analysis of land cover data from 1994, 2002 and 2006 satellite imagery supports the trends observed in the census data, with a small decline in annual cropland, a significant decrease in grassland and a large increase in forages since the 1990s (***Table 5***, ***Figure 25***).

Although there are some inherent limitations in analyzing land cover data to determine changes in land use, some general changes can be noted:

- The largest change in land cover was observed in grassland, where there was a decrease of approximately 25,000 ha (from 66,400,000 to 41,400 ha). These changes have been linked mainly to increases in forages and treed areas.
- Forages showed a 10,000 ha increase from 1994 to 2006. This is largely attributed to changes from Grassland and Annual Cropland.

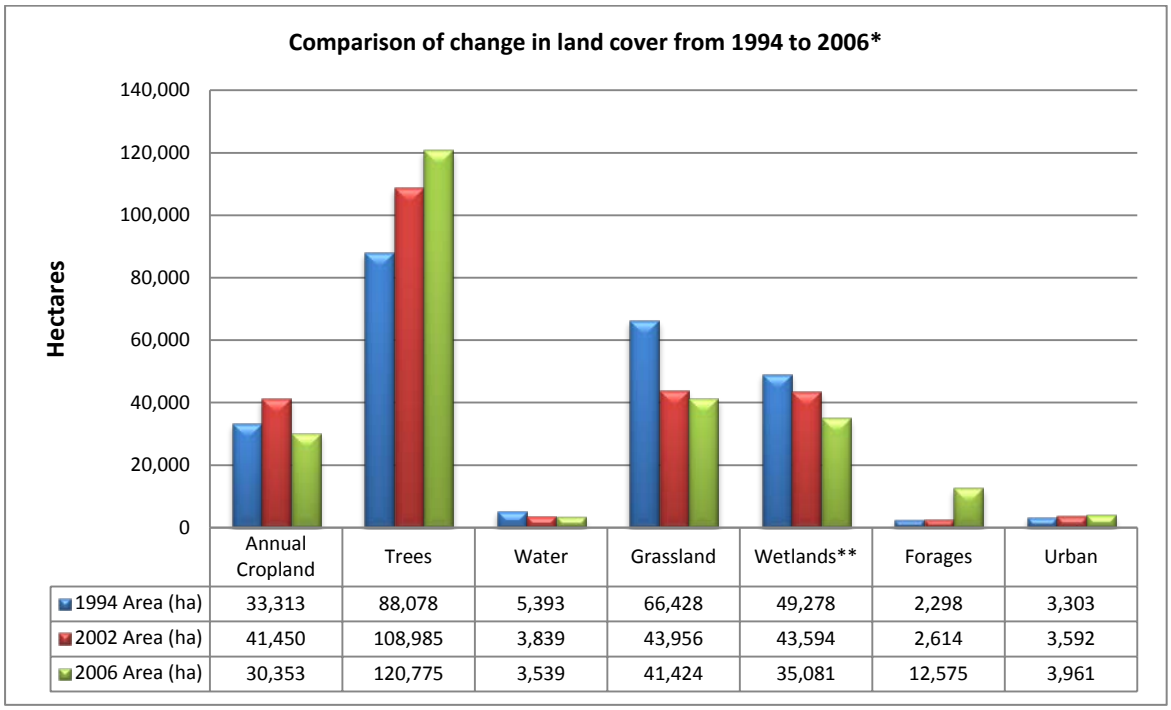
- Annual Cropland saw an increase in 2002 and then an 11,000 hectares decrease in 2006 which is consistent to the findings of the Ag Census information.
- There was a significant decrease in the area with wetlands, down 14,200 hectares. It should be noted that the accuracy of the land cover features other than agricultural features (i.e. annual cropland, grassland, forage) was not as accurate for the trees, water and wetlands due to data classification issues with earlier data sets concentrating primarily on agricultural lands.
- Total annual precipitation levels in 1994 indicate that parts of the IWMP area had received precipitation amounts lower than the 30 year average by 100 millimeters. Conversely in 2006, parts of the watershed received participation that exceeded the 30 year average by 100 millimeter. This information is particularly important when considering the extent of wetland areas, which may be misrepresented during years when recorded rainfall deviates from the average (see ***Appendix Q***).

Table 5: Change in land cover from 1994 to 2006*

Land Cover	1994 Area (ha)	2002 Area (ha)	2005 Area (ha)	Change from 1994 to 2001 (ha)	Change from 2001 to 2005 (ha)	Change from 1994 to 2005 (ha)
Annual Cropland	33,313	41,450	30,353	8,137	-11,097	-2,959
Trees	88,078	108,985	120,775	20,907	11,790	32,697
Water	5,393	3,839	3,539	-1,554	-300	-1,854
Grassland	66,428	43,956	41,424	-22,472	-2,532	-25,003
Wetlands	49,278	43,594	35,081	-5,684	-8,513	-14,196
Forages	2,298	2,614	12,575	316	9,961	10,277
Urban	3,303	3,592	3,961	288	370	658
Total	248,091	248,030	247,709			

*Area totals are approximate due to the nature of the image analysis procedure
**Total hectares are smaller than earlier reported due to imagery not covering full watershed.

Figure 25: Comparison of change in land cover from 1994 to 2006



	Annual Cropland	Trees	Water	Grassland	Wetlands**	Forages	Urban
1994 Area (ha)	33,313	88,078	5,393	66,428	49,278	2,298	3,303
2002 Area (ha)	41,450	108,985	3,839	43,956	43,594	2,614	3,592
2006 Area (ha)	30,353	120,775	3,539	41,424	35,081	12,575	3,961

* Area totals are approximate due to the nature of the image analysis procedure
** Due to seasonal changes in wetland size, date of imagery will affect area

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 1994 to 2006. A more detailed examination of the land cover classes from 1994 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 acquisition dates of the satellite images can introduce discrepancies into these values. As noted in the earlier section, precipitation levels may also influence land cover classifications. Further field investigations would be required to verify these findings.

Changes in Annual Cropland Area

Changes in land use can reflect changes in land management practices and provide insight to possible impacts in environmentally sensitive areas. Annual cropland changes can be attributed to a number of factors including crop rotations, market and economic drivers, and environmental factors. ***Figure 27*** identifies parcels of land which experienced changes to and from annual cropland from 1994 to 2006.

In the Fisher River Watershed:

- A total decrease of almost 3,000 ha (10%) of annual cropland was observed in the watershed from 1994 to 2006 (***Table 5***).
- Small changes to annual cropland cover occurred throughout the entire watershed, with no concentrated areas of annual cropland loss or gain (***Figure 27***).
- Annual cropland was most often converted to forested areas (24,000 ha) and grasslands (19,000 ha), which is consistent with trends observed in the Census of Agriculture data (***Figure 26***).
- 8,900 ha of cropland were converted to forage during the 13-year period. While the reciprocal conversion saw forages loosing 2,400 ha to annual cropland during that time.
- Other changes to and from annual cropland cover were associated with wetlands and water areas; however the amounts were negligible in comparison to the size of the watershed.

Figure 26: Total change in area of annual cropland, in relation to other land cover types, in the Fisher River Watershed (from 1994 to 2006)

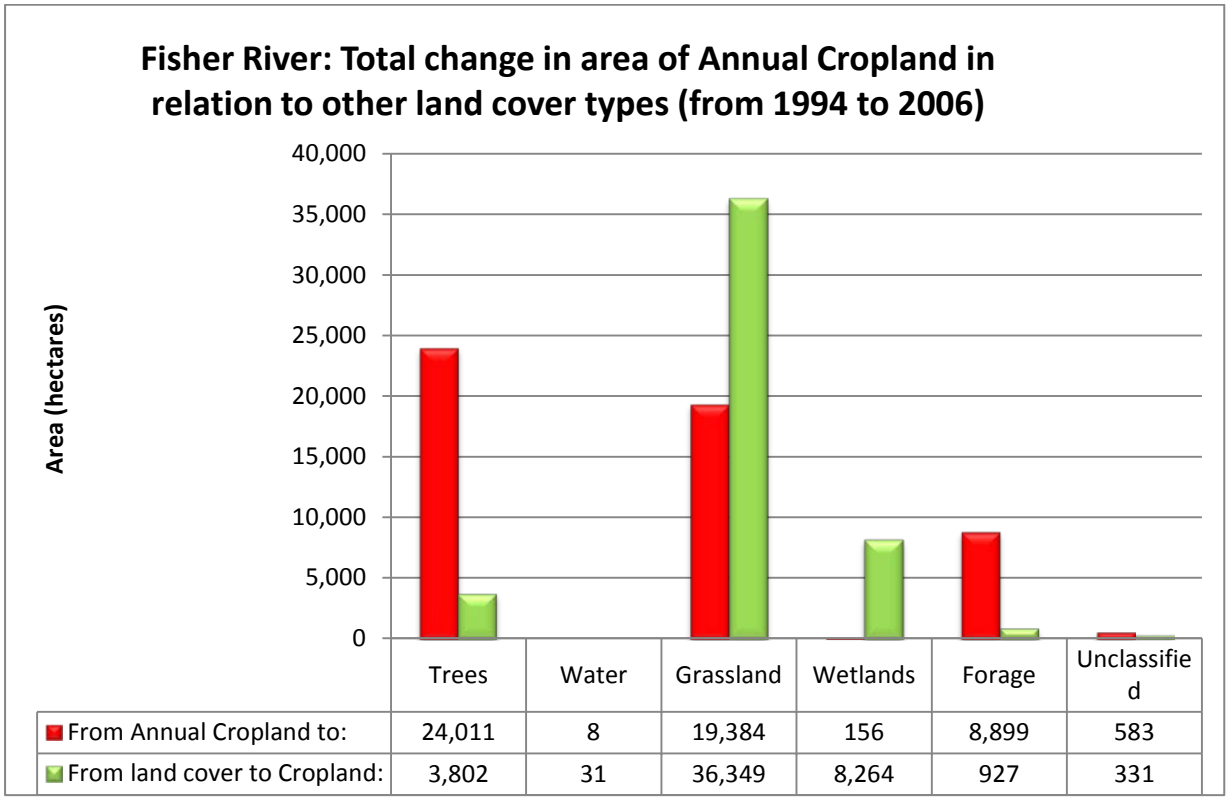
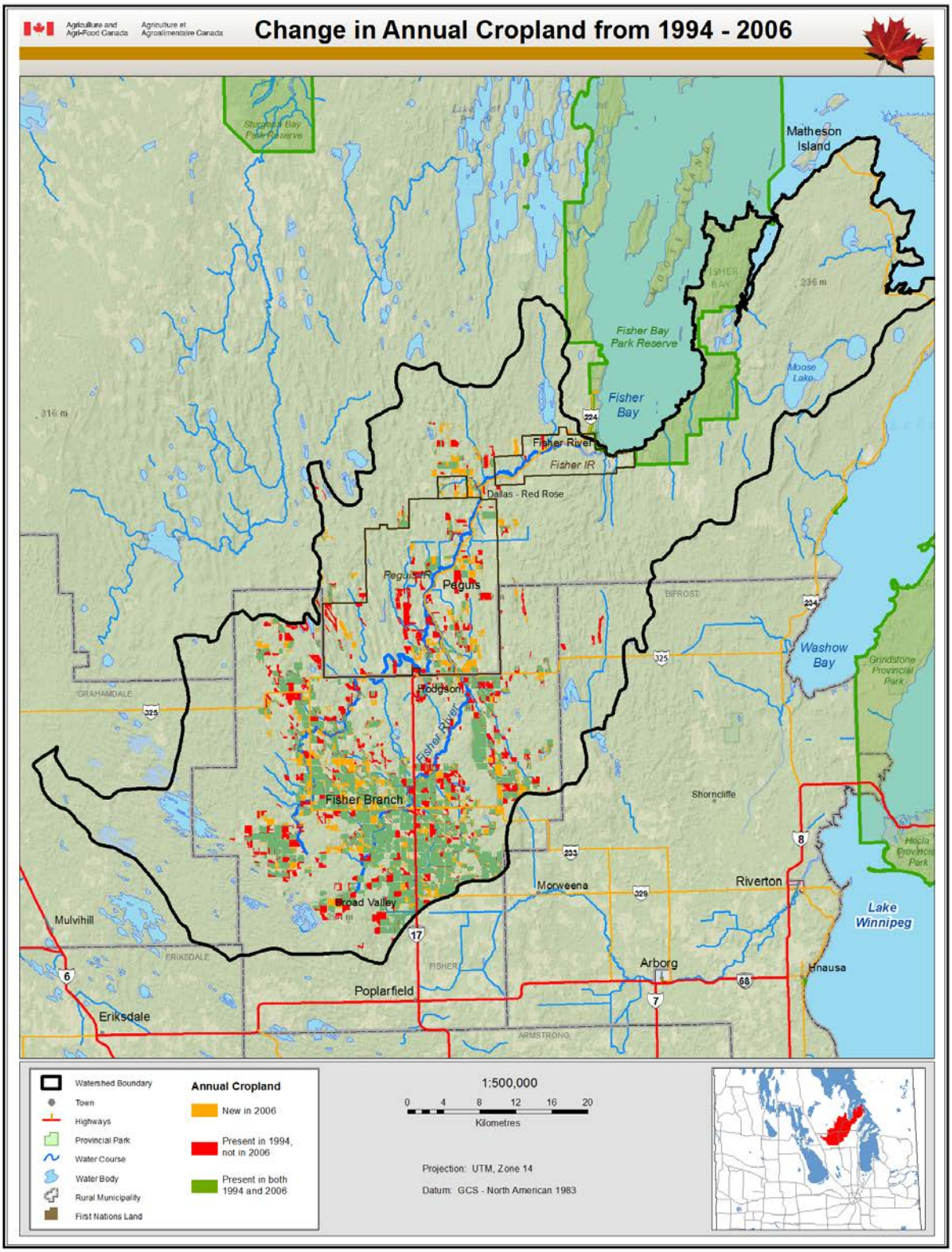


Figure 27: Analysis of Annual Cropland changes between the 1994 and 2006 Land Cover data*



* Land cover is derived from satellite imagery taken (October 26, 1994) and (August 8, 2005 & September 9, 2006)

Changes in Grassland Area

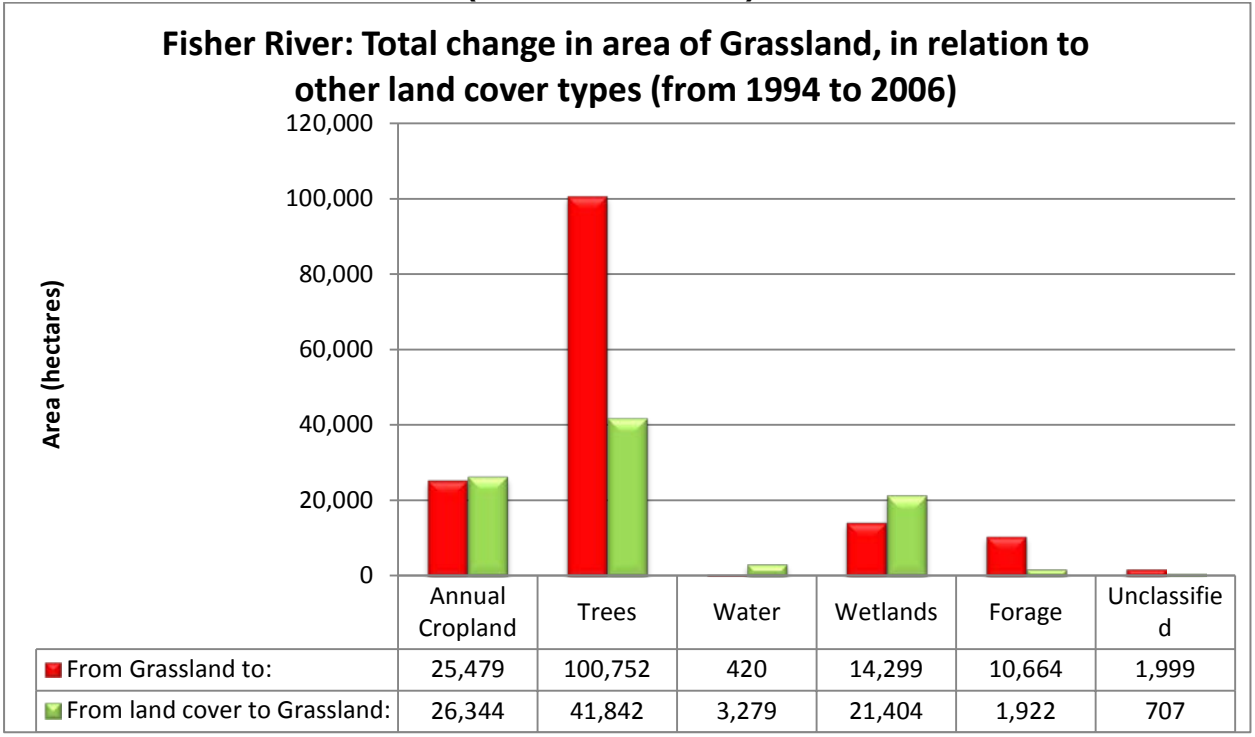
Grasslands can be beneficial for reducing soil erosion, enhancing flood mitigation and providing natural cover for wildlife. Analyzing changes in grassland cover can provide some insight into potential risks associated with water quality. ***Figure 29*** summarizes parcels which experienced changes to and from grassland from 1994 to 2006.

While conversion to and from grasslands may sometimes be the result of market trends and present economic opportunities and benefits, there may be an associated 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 increase flooding downstream due to the potential of increased runoff levels. In turn, increased runoff levels could increase the concentrations of contaminants in water if appropriate management practices are not utilized.

In the Fisher River Watershed:

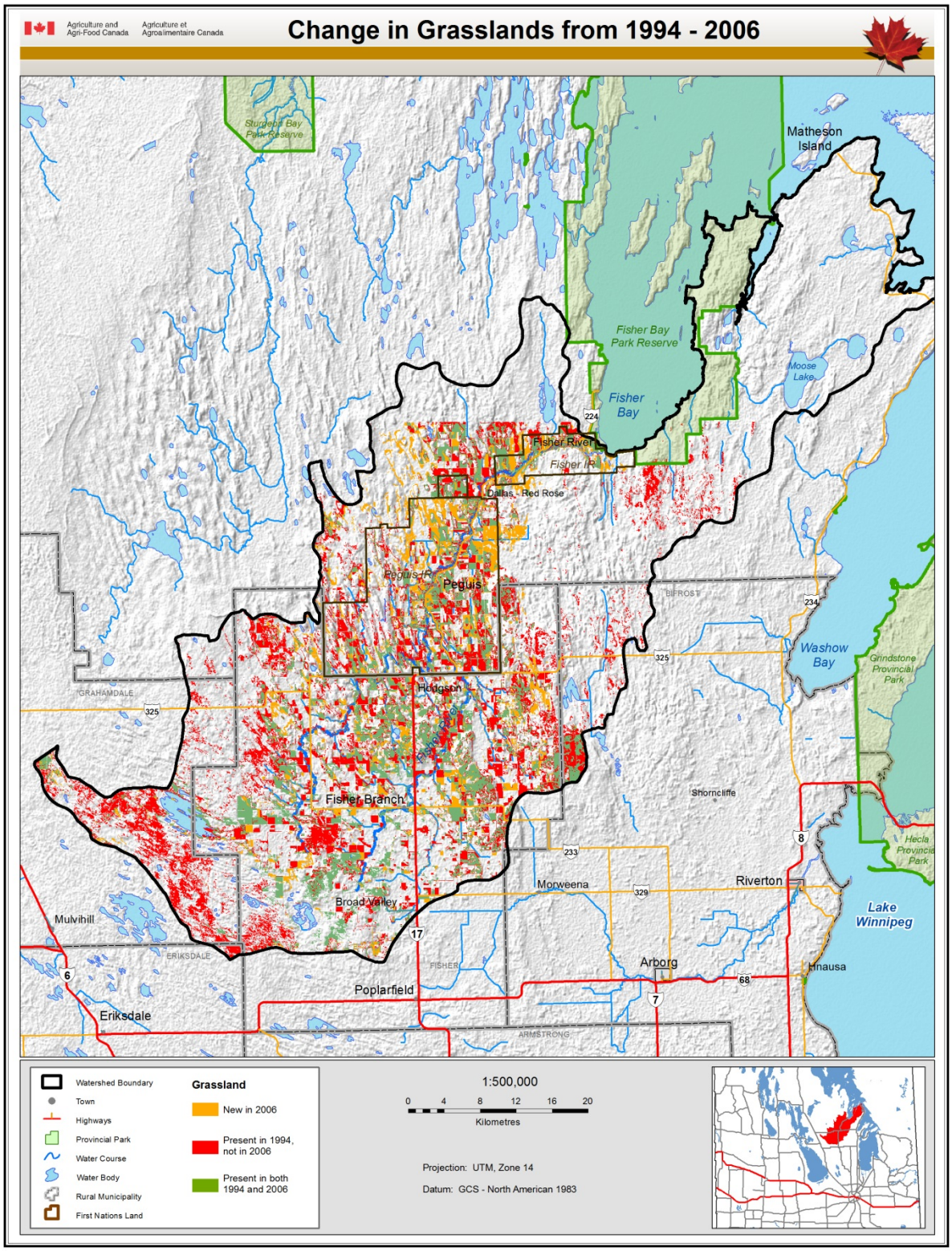
- There was an overall decrease of 25,000 ha of grassland in 2006 (***Table 5***), a decrease of almost 60% from 1994.
- Conversion of grassland to forested areas was the primary factor responsible for the major decline in grassland cover (***Figure 28***). Over 100,000 ha of grassland were converted to forested areas alone.
- Conversion of grassland to cropland, forages and wetlands were the next major cover types contributing to the major decline in grassland cover (***Figure 28***). Over 25,000 ha of grassland was converted to cropland over the 13-year period; followed by 14,300 ha of grassland converted to wetlands and almost 10,600 ha converted to forage.
- All other land cover categories (water and urban) experienced a net increase in their respective areas as a result of changes to and from grasslands. Of these, water bodies areas had the largest total area converted to grasslands.

Figure 28: Total change in area of grassland, in relation to other land cover types, in the Fisher River Watershed (from 1994 to 2006)



	Annual Cropland	Trees	Water	Wetlands	Forage	Unclassified
From Grassland to:	25,479	100,752	420	14,299	10,664	1,999
From land cover to Grassland:	26,344	41,842	3,279	21,404	1,922	707

Figure 29: Analysis of Grassland changes between the 1994 and 2006 Land Cover data*



* Land cover is derived from satellite imagery taken (October 26, 1994) and (August 8, 2005 & September 9, 2006)

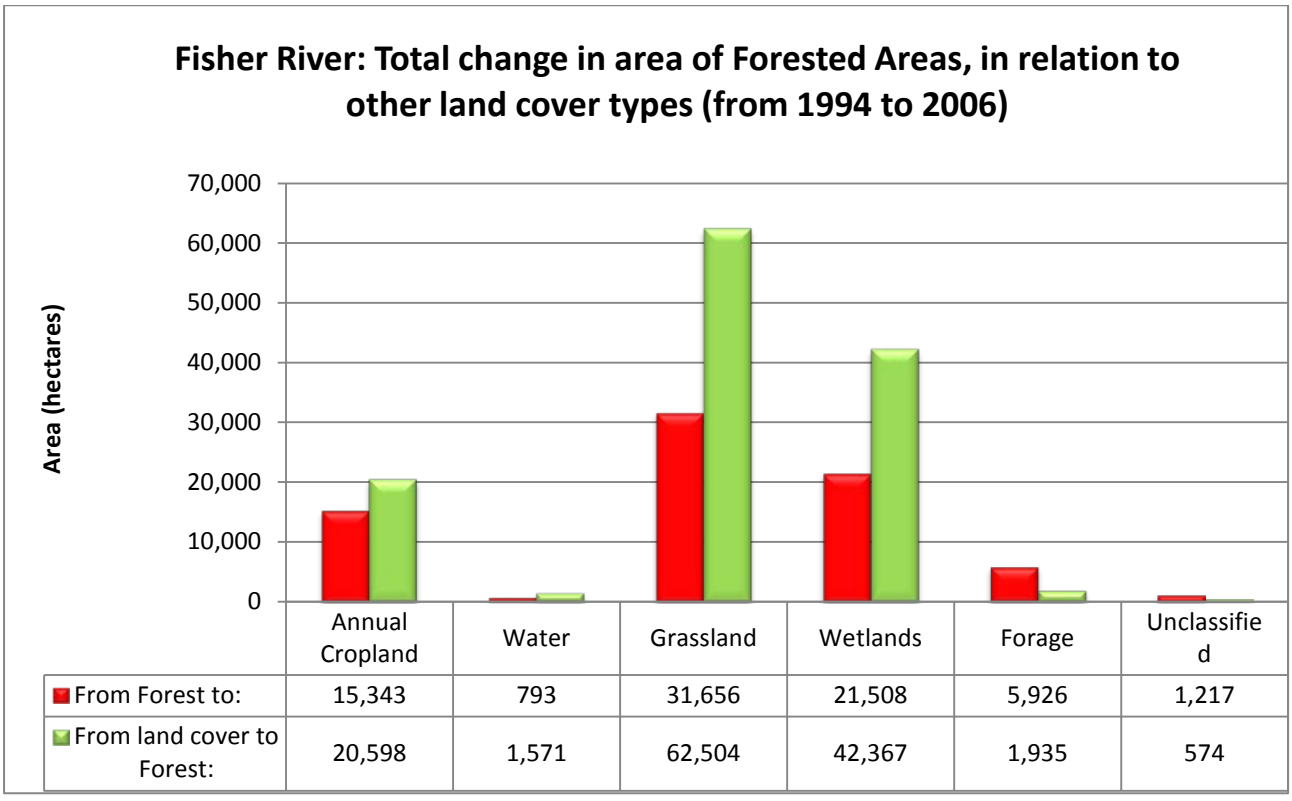
Changes in Forested Areas

Assessing the forested areas classification change can provide some information about impacts on flooding, water supply and quality, as well as natural areas. ***Figure 31*** summarizes parcels which experienced changes to and from forested areas from 1994 to 2006.

In the Fisher River Watershed:
Forested areas encompass the largest portion of the watershed (49%). The area of forest in the watershed increased significantly over the 13-year period, increasing by 32,700 ha. (over a 27% increase compared to the 1994 land cover) (see ***Table 5***).

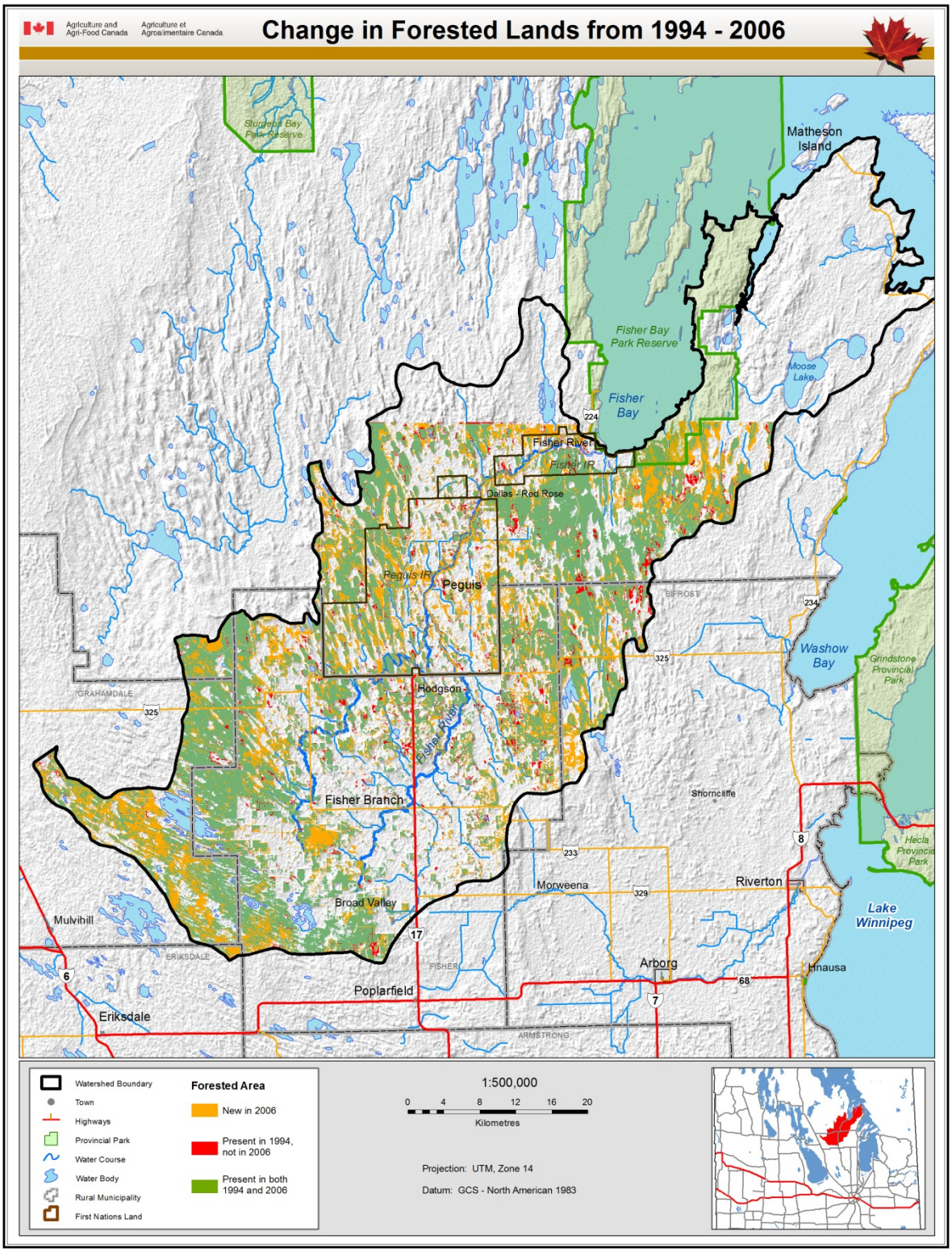
- The largest change to forested cover was related to grassland and wetland cover changes with62,500 ha converted from grasslands to forested areas and 42,000 ha of wetlands lost to forest. This resulted in a net gain of 20,000 ha in forest (***Figure 30***) from wetlands.
- Other large changes occurred with the annual cropland category; reciprocal changes to and from annual cropland displayed almost a 5,000 ha net gain to forests.
- The other land classes (water, forage and unclassified) had negligible effects on the forested areas.

Figure 30: Total change in Forested Areas, in relation to other land cover types, in the Fisher River Watershed (from 1994 to 2006)



	Annual Cropland	Water	Grassland	Wetlands	Forage	Unclassified
From Forest to:	15,343	793	31,656	21,508	5,926	1,217
From land cover to Forest:	20,598	1,571	62,504	42,367	1,935	574

Figure 31: Analysis of Forested Area change between the 1994 and 2006 Land Cover data*



* Land cover is derived from satellite imagery taken (October 26, 1994) and (August 8, 2005 & September 9, 2006)

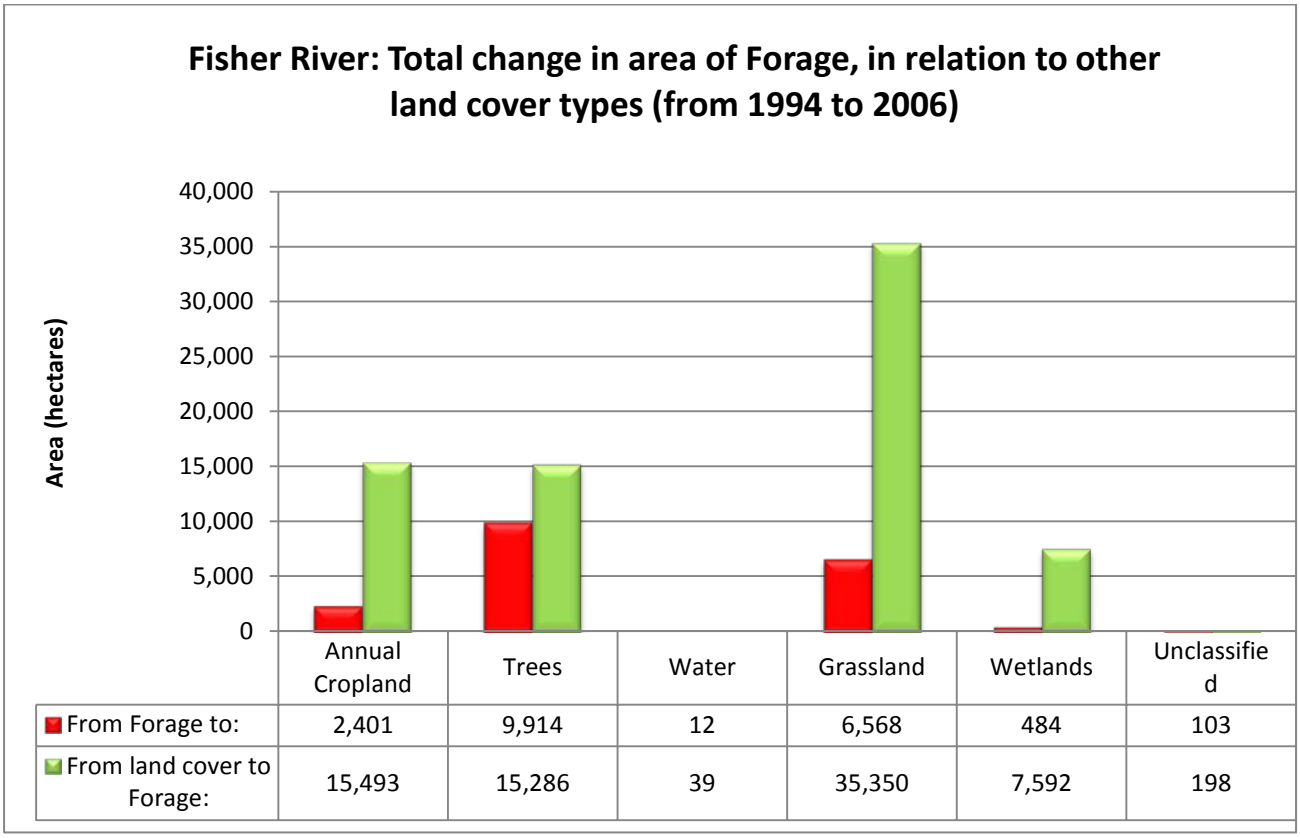
Changes in Forage Area

Assessing forage area changes can provide information regarding the conservation of natural habitat and the adoption of erosion control beneficial management practices. ***Figure 33*** summarizes parcels which experienced changes to and from forages from 1994 to 2006.

In the Fisher River Watershed:

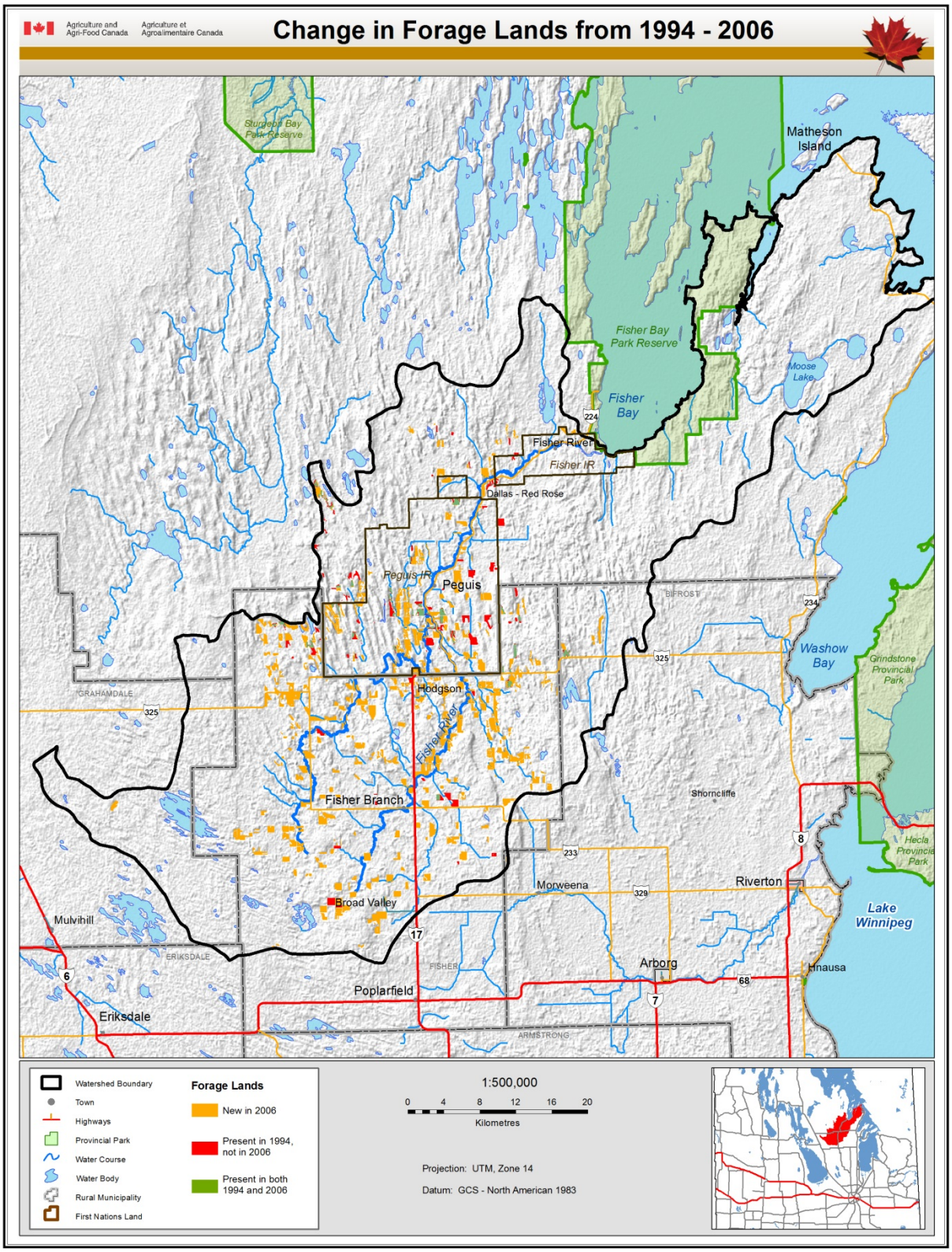
- Forage cover increased dramatically in the watershed by nearly 82% or 10,300 ha between 1994 and 2006 (***Table 5***).
- Analysis indicates that conversion from grasslands, annual cropland and forested areas was primarily responsible for the increased forage cover in the watershed, which is consistent with land use trends observed using Census of Agriculture data.
- 35,400 ha of grasslands were converted to forages during the 13-year period. Less than 6,500 ha experienced the reciprocal conversion to grassland during that time ***(Figure 32)***.
- A large amount of annual cropland was also converted to forages between 1994 and 2006 (15,300 ha), with only 2,400 ha converted from forages back to annual cropland.
- 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.
- Some was also converted to forages between 1994 and 2006 (7,600 ha), with only 484 ha converted from forages back to wetlands.

Figure 32: Total change in area of forages, in relation to other land cover types, in the Fisher River Watershed (from 1994 to 2006)



	Annual Cropland	Trees	Water	Grassland	Wetlands	Unclassified
From Forage to:	2,401	9,914	12	6,568	484	103
From land cover to Forage:	15,493	15,286	39	35,350	7,592	198

Figure 33: Analysis of Forage changes between the 1994 and 2006 Land Cover data*



* Land cover is derived from satellite imagery taken (October 26, 1994) and (August 8, 2005 & September 9, 2006)

F. Agricultural Land Use and Management Considerations

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

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 their physical capability for agricultural use (PFRA 2005).

Agricultural capability can best be described as the ability of the land to support the appropriate type of crops and agriculture management techniques. Soil properties and landscape conditions such as topography, stoniness, and other potential limitations all influence how the land is being used and what agricultural management practices should be in place to reduce environmental risks. 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 (not suitable for agriculture). Further information about CLI and specific characteristics and limitations associated with individual land classes is provided in ***Appendix E***.

Analytical Methods
With respect to land cover, analysis of the land classes helps to understand the extent of agricultural activity on marginal lands. Such an 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.

In the Fisher River Watershed:

- Only a small proportion of annual cropland in the watershed is considered highly productive Class 1, 2 and 3 lands (15% or approximately 46,600 ha).
- 24% (76,600 ha) of the soils in the watershed are Class 4 and lower.
- Approximately 8% of the watershed (24,300 ha) has organic soils.

Agricultural Capability of Annual Cropland:

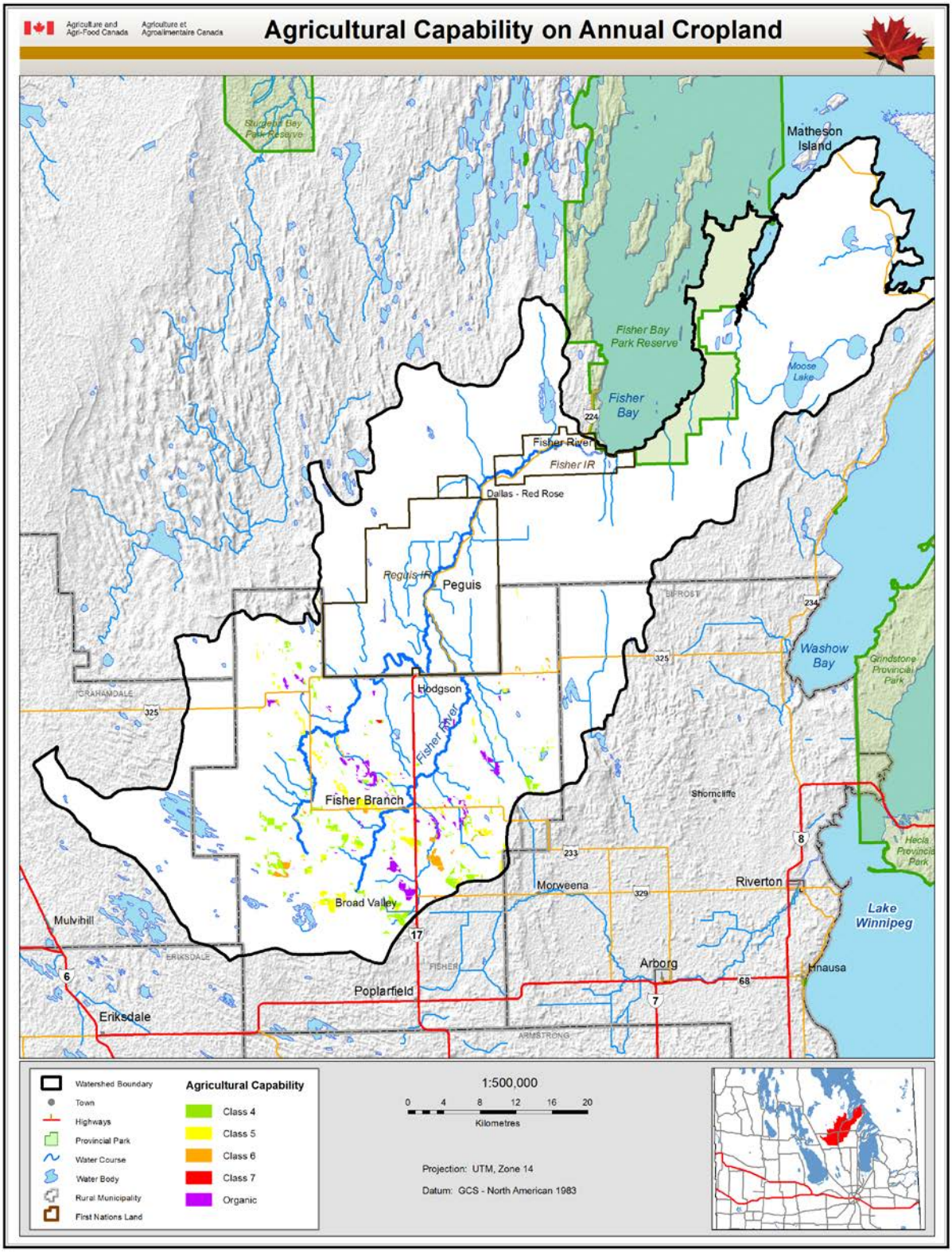
- Within the Fisher River Watershed study area, the majority of the annual cropland is located on productive agricultural land, classified as Class 2 and 3 (16% and 50%, or 4,915 and 15,300 ha respectively).
- There is only a small portion of the annual cropland that is on Class 4 or lower classified soils, 14%. The majority of the annual cropland on Class 4 and lower classified soils are scattered throughout the watershed (see ***Figure 34***).
- In 2006, there was a small area of land (1,218 ha) with organic soils used as annual cropland (***Table 6***).
- The total amount of annual cropland in the watershed has decreased slightly since 1994. These decreases are reflected on most soil classes with the majority of the decrease noted on Class 3 land (approximately 1,000 ha.).

Table 6: Agricultural Capability on Annual Cropland in the Fisher River Watershed Study Area

Ag Capability Class*	Total Area in IWMP (ha)	% Area of Ag Capability	1994 Annual Cropland (ha)***	2006 Annual Cropland (ha)**	Distribution of Cropland in 2006	1994 to 2006 Change in Cropland Area (ha)****
Class 1	218	0%	67	74	0%	7
Class 2	16,370	5%	5,731	4,903	16%	-829
Class 3	30,064	10%	16,349	15,317	50%	-1,032
Class 4	48,356	15%	2,712	2,264	7%	-449
Class 5	14,455	5%	1,562	1,629	5%	67
Class 6	9,783	3%	766	583	2%	-183
Class 7	4,022	1%	35	26	0%	-9
Organic Soil	24,272	8%	1,270	1,218	4%	-51
water	2,967	1%	2	1	8%	-1
Unclassified	8	0%	0	0	0%	0
No Data	164,643	52%	4,820	4,340	14%	-480
Total	**315,158**	**100%**	**33,313**	**30,353**	**100%**	**-2,959**

* Agricultural Capability is based on the CLI Rating of the dominant soil series for each soil polygon
** Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on August 5, 2005 and Sept 9, 2006)
***Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on Oct. 26, 1994)
**** Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1994 in each Class

Figure 34: Areas annually cropped in 2006 on soils with an Agricultural Capability of Class 4, 5, 6 or 7 in the Fisher River Watershed *



*Agriculture capability is based on the CLI Rating of the dominant soil series for each soil polygon.

ii. 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 G***). 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).

In the Fisher River Watershed:

- Only 2% of land is considered to have soils with a moderate, high, or severe wind erosion risk (***Table 7***).
- A larger portion of the watershed (34%) is considered to have a negligible to low risk of wind erosion.

Wind erosion risk on Annual Cropland :

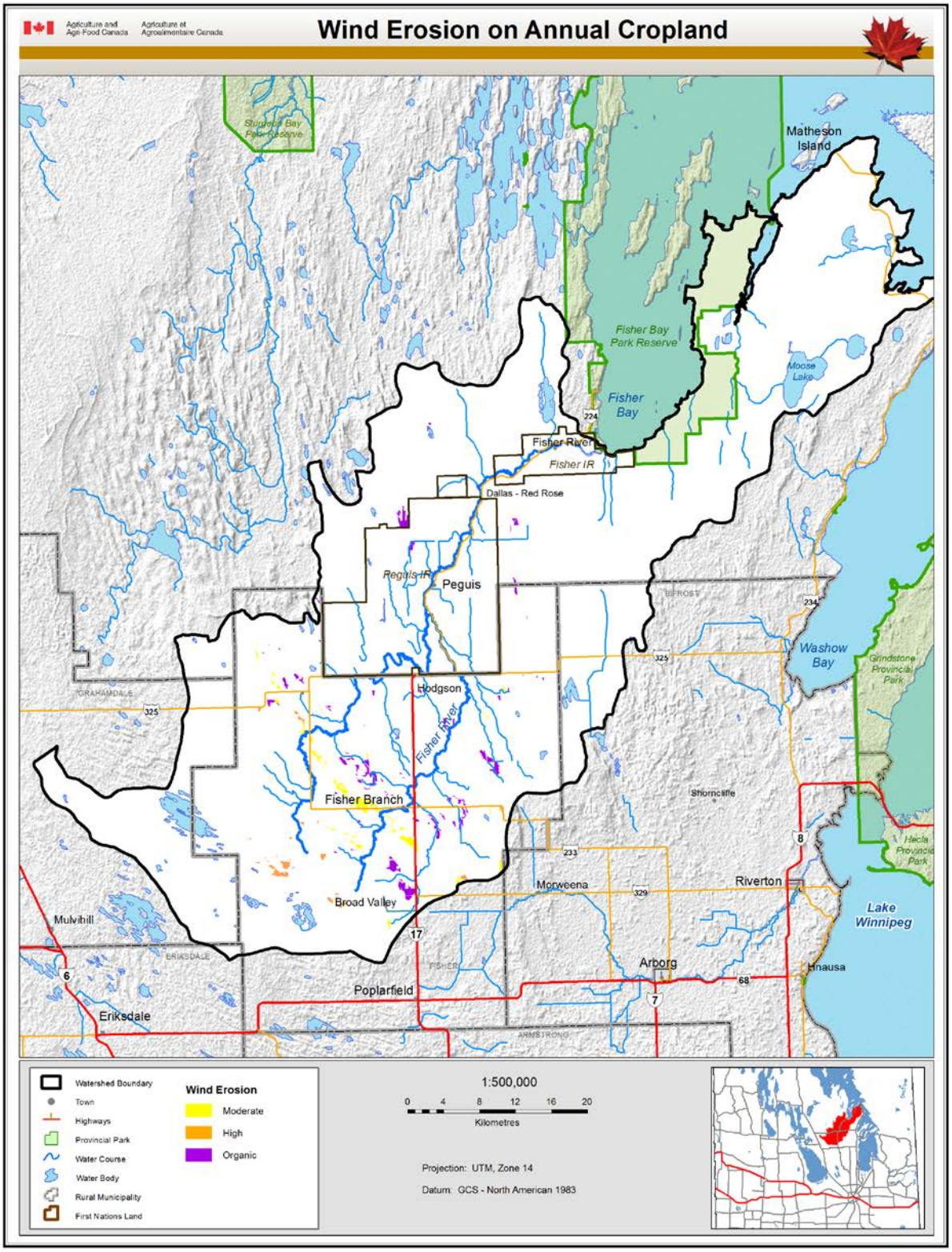
- Based on the 2006 land cover data, approximately 4% of the annual cropland was located on soils with moderate, high, to severe risk for wind erosion (***Table 7***).
- These areas are found throughout the watershed (***Figure 35***). In general, they are associated with sandy, coarse-textured soils.

Table 7: Wind Erosion Risk on Annual Cropland in the Fisher River Watershed study area from 2006 Land Cover *

Wind Erosion Class	Total Area in IWMP (ha)	% Area of Ag Capability	1994 Annual Cropland (ha)***	2006 Annual Cropland (ha)**	Distribution of Cropland in 2006	1994 to 2006 Change in Cropland Area (ha)****
Negligible	67,414	21%	10,936	10,085	33%	-852
Low	40,051	13%	14,679	13,343	44%	-1,336
Moderate	3,869	1%	772	895	3%	123
High	2,100	1%	618	403	1%	-215
Severe	0	0%	0	0	0%	0
Organic Soil*****	118,988	38%	1,603	1,517	5%	-86
Water	4,670	1%	2	1	8%	-1
Unclassified	74,355	24%	4,668	4,083	13%	-586
Rock	3,710	1%	35	26	0%	-9
Total	**315,158**	**100%**	**33,313**	**30,353**	**100%**	**-2,959**

* Wind Erosion Risk is based on the weighted wind erosion rating for each soil polygon and assumes bare soil.
** Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on August 5, 2005 and Sept 9, 2006)
*** Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on Oct. 26, 1994)
**** Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1994 in each Risk Class
***** The northern half of the watershed was not surveyed and is classified either as Organic or Unclassified, due to the high values in each class.

Figure 35: Risk of Wind Erosion Risk on 2006 Annual Cropland in the Fisher River Watershed*



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

iii. 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 water bodies throughout the watershed. This section examines where in the watershed that there may be a greater potential for this to happen. The analysis focuses on annual cropland using land cover data (see ***Appendix C***) in conjunction with water erosion risk (see ***Appendix F***) 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, erodible soils which may otherwise be masked if a land use or surface vegetation cover factor was considered (Eilers *et al.* 2002).

In the Fisher River Watershed:

- Fifty two percent of the watershed is not classified within the soil survey boundary (class N/A in ***Table 8***). An examination of the portion of the watershed that has soils information, approximately 129,000 ha (41%) has a negligible risk to water erosion..

Water erosion risk on Annual Cropland:

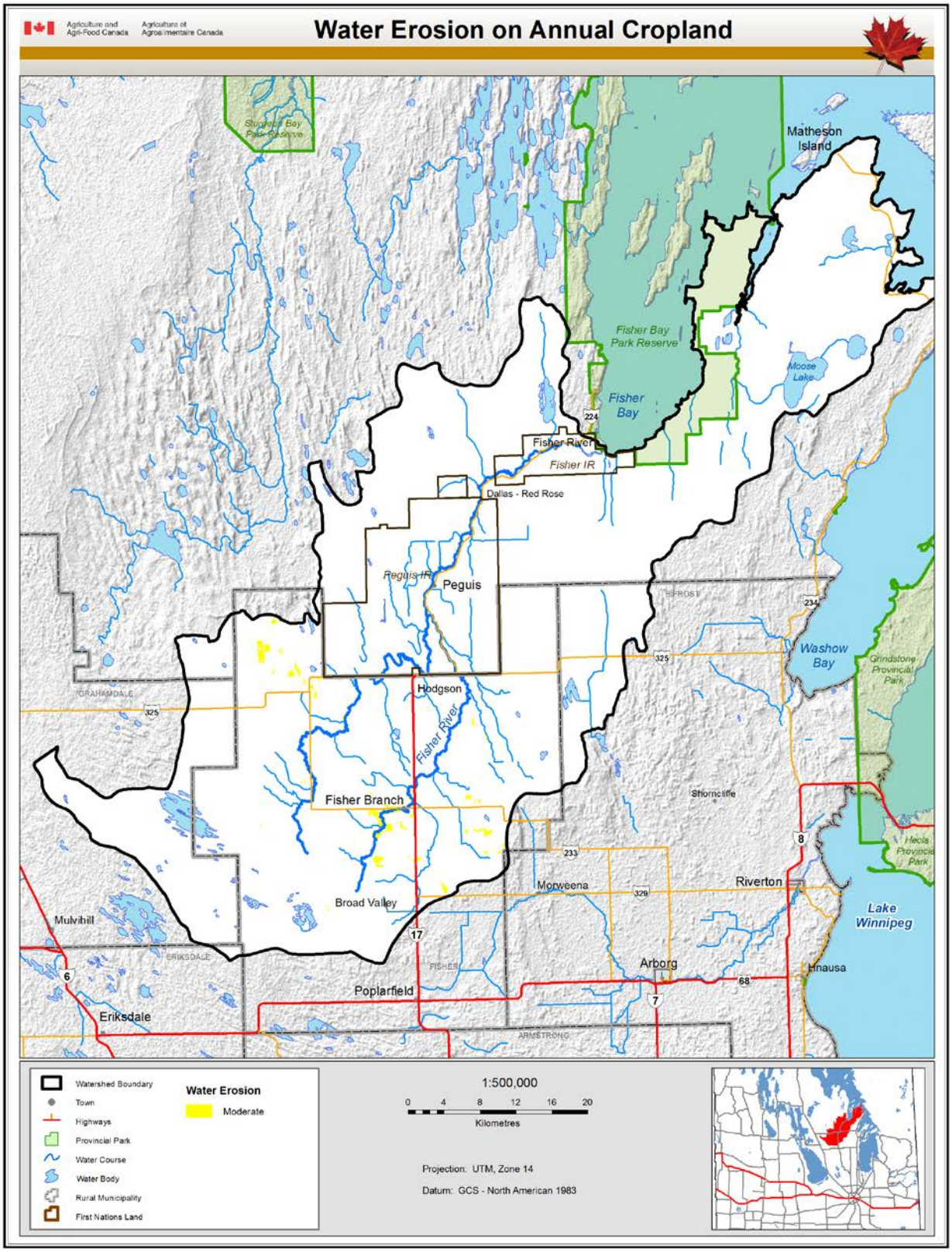
- Analysis of 2006 land cover shows that approximately 4,000 ha (13%), of the annual cropland was located on soils with a low water erosion risk.
- Most of the soils with moderate risk (1,300 ha or 4%) to water erosion are located in the annual cropland area surrounding the community of Fisher Branch (***Figure 36***).

Table 8: Water Erosion Risk on Annual Cropland in the Fisher River Watershed from 2006 Land Cover *

Water Erosion Class	Total Area in IWMP (ha)	% Area of Ag Capability	1994 Annual Cropland (ha)***	2006 Annual Cropland (ha)**	Distribution of Cropland in 2006	1994 to 2006 Change in Cropland Area (ha)****
Negligible	128,938	41%	0	0	0%	0
Low	12,807	4%	4,478	4,074	13%	-403
Moderate	5,795	2%	1,274	1,326	4%	52
Water	2,967	1%	2	1	0%	-1
Unclassified	8	0%	22,739	20,612	68%	-2,128
N/A	164,643	52%	4,820	4,340	14%	-480
Total	**315,158**	**100%**	**33,313**	**30,353**	**100%**	**-2,959**

* Water Erosion Risk is based on the weighted average USLE predicted soil loss within each soil polygon, assuming bare unprotected soil.
** Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on August 5, 2005 and Sept 9, 2006)
*** Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on Oct. 26, 1994)
**** Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1994 in each Risk Class

Figure 36: Risk of Water Erosion (Moderate to Severe) on 2006 Annual Cropland in the Fisher River Watershed*



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

iv. 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 efficiency 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 regulation requirements can be met. Agriculture and Agri-Food Canada (AAFC) has classified soils for their drainage capacity using a five class system (see ***Appendix H***).

Improved drainage indicates areas where networks of surface drains can accelerate surface runoff to 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 and property damage. Unlike natural and undisturbed watercourses, man-made drainage systems tend not to have healthy riparian buffers associated with them. Insufficiently sized (or a complete absence of) riparian buffers may result in an increased risk of nutrient and sediment loading in 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.

In the Fisher River Watershed:

- Analysis of the soil drainage shows that the majority within the area with available soils data (approximately 83,400 ha or 26%) of the study area is rapid to imperfectly drained (***Table 9***).
- A slightly smaller area of land in the watershed is poor to very poorly drained (60,400 ha or 20%).

Soil drainage on Annual Cropland:

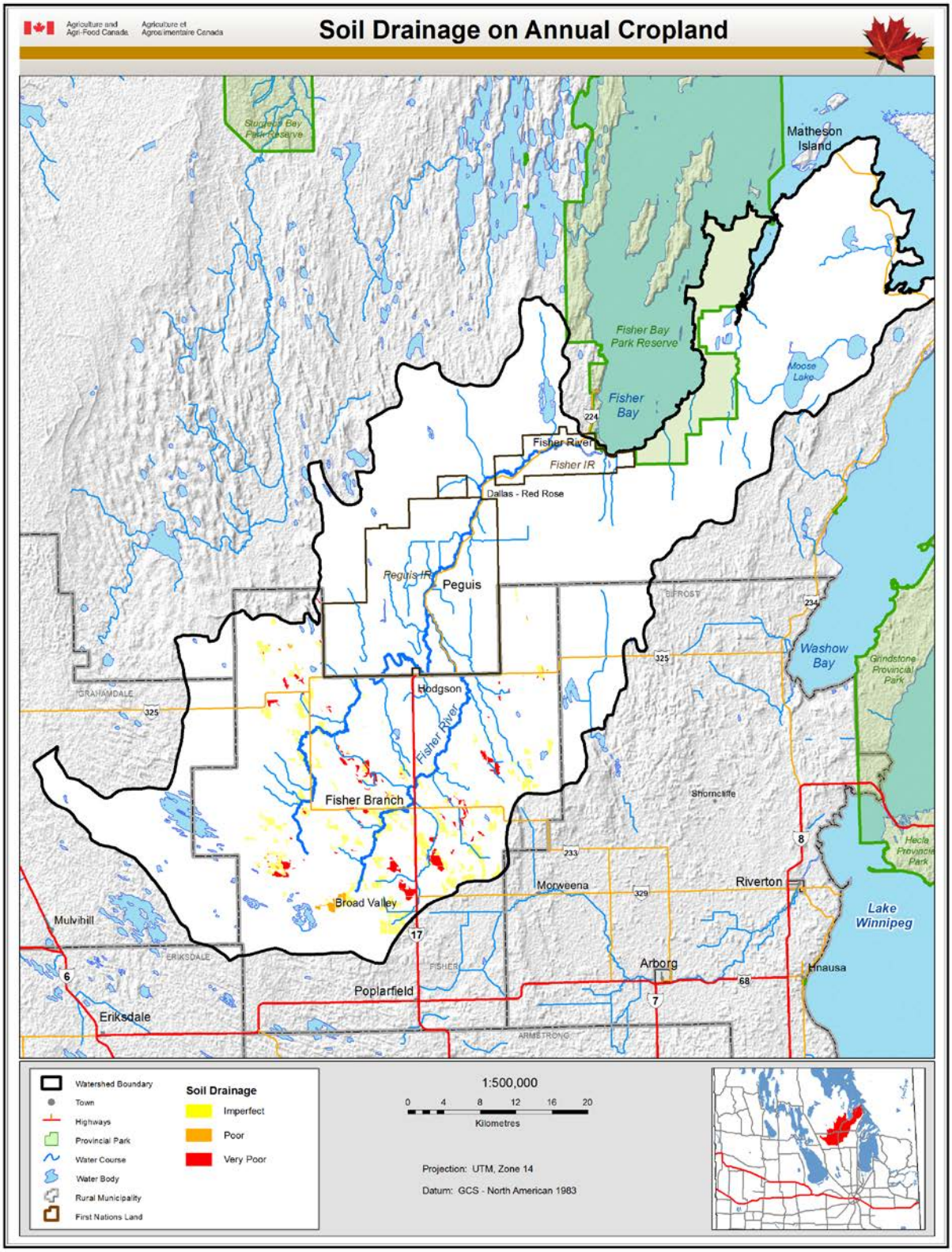
- Only 33% of the annual cropland in 2006 was located on well and imperfectly drained soils, (***Figure 37***).
- Fifty-three percent (53%) of the annual cropland is poor to very poor drained soils is and will likely have more of a local impact on the watershed.

Table 9: Soil Drainage Classes in the Fisher River Watershed*

Soil Drainage Class	Total Area in IWMP (ha)	% Area of Ag Capability	1994 Annual Cropland (ha)***	2006 Annual Cropland (ha)**	Distribution of Cropland in 2006	1994 to 2006 Change in Cropland Area (ha)****
Rapid	3,362	1%	672	791	3%	119
Well	35,104	11%	3,536	2,586	9%	-950
Imperfect	44,926	14%	7,053	6,522	21%	-531
Poor	1,881	1%	250	222	1%	-28
Poor (improved)	27,420	9%	15,201	14,281	47%	-920
Very Poor	31,108	10%	1,745	1,583	5%	-161
Rock	3,721	1%	35	26	0%	-9
Water	2,967	1%	2	1	0%	-1
N/A	164,643	52%	4,820	4,340	14%	-480
Total	**315,132**	**100%**	**33,313**	**30,353**	**100%**	**-2,959**

* Drainage Class is based on the CLI Rating of the dominant soil series for each soil polygon
** Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on August 5, 2005 and Sept 9, 2006)
*** Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on Oct. 26, 1994)
**** Figures are derived from the total area of Annual cropland in 2006 minus total Annual cropland in 1994 in each class

Figure 37: Soil Drainage with Respect to 2006 Annual Cropping in the Fisher River Watershed*



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

v. Soil Texture Analysis

Soil surface texture strongly influences the soil's ability to retain moisture, its general level of fertility, and the ease or difficulty of cultivation. For example, water moves easily through coarse-textured (sandy) soils, with little moisture being retained resulting in these soils drying out more quickly than fine-textured (clayey) soils. Sandy soils are often characterized as having a loose or single-grained structure which is very susceptible to wind erosion whereas clay soils have a high proportion of very small pore spaces that are capable of retaining moisture. Clay soils are usually fertile because they have a greater capacity to retain nutrients than sandy soils. However, they transmit water very slowly and are therefore susceptible to saturation from excess moisture conditions (PFRA, 2005).

Soil texture in the Fisher River Watershed can have a bearing on groundwater management and potential risk of contamination. Proper land management is important as soil textures can contribute to greater subsurface movement to the groundwater source, particularly where there is thin soil overburden to the aquifer. Furthermore, surface water movement into the bedrock material can increase contamination risks due to the chemical makeup of the surface water and by the physical properties of freezing and thawing.

In the Fisher River Watershed:

- Fine loamy textured soils make up the largest single portion of the watershed at 72,000 ha or 23% (***Table 10***).
- Approximately 31,300 ha (10%) of the watershed has clayey textured soils, which are mainly located in the annual cropland portion around Fisher Branch (***Figure 38***).
- Also, approximately 31,800 ha (10%) soil in the watershed is considered to be organic.

Soil texture of Annual Cropland:

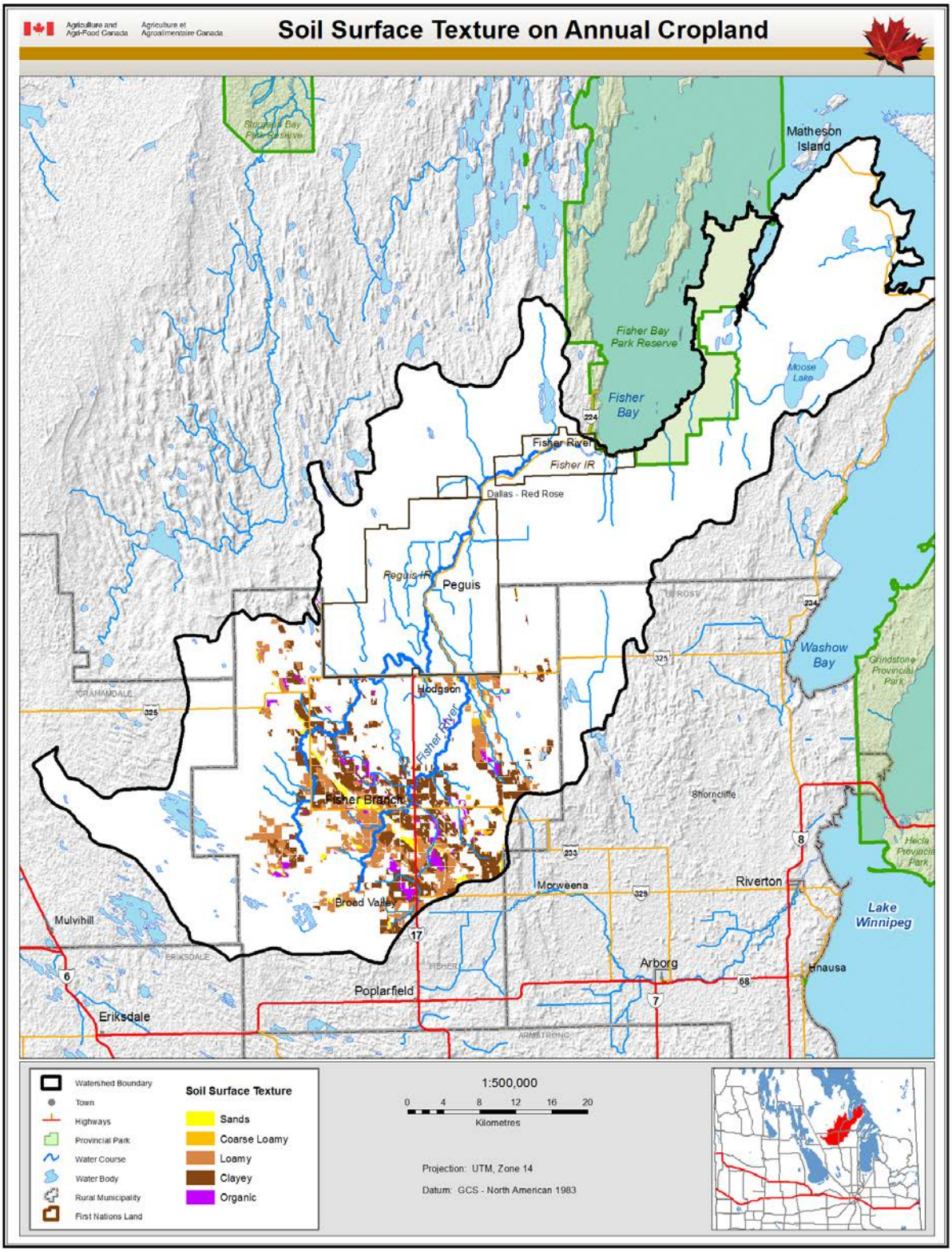
- Approximately 12,300 ha (41%) of the 2006 annual cropland was located on clay textured soils and followed by fine loamy textures at 10,100 ha or 33%.
- The biggest decrease on annual cropland occurred on the clayey soils, decreasing 1,300 ha from 1994 to 2006.
- Less than 7% of annual cropland in 2006 was located on organic soils.

Table 10: Soil Texture in the Fisher River Watershed *

Surface Texture Class	Total Area in IWMP (ha)	% Area of Ag Capability	1994 Annual Cropland (ha)***	2006 Annual Cropland (ha)**	Distribution of Cropland in 2006	1994 to 2006 Change in Cropland Area (ha)****
Clayey	31,343	10%	13,695	12,348	41%	-1,347
Fine Loamy	72,038	23%	10,995	10,110	33%	-885
Coarse Loamy	2,537	1%	654	629	2%	-25
Sand	5,783	2%	1,130	1,127	4%	-3
Organic Soil	31,835	10%	1,983	1,772	6%	-210
Rock	3,721	1%	35	26	0%	-9
Water	2,967	1%	2	1	8%	-1
N/A	164,643	52%	4,820	4,340	14%	-480
Total	**314,867**	**100%**	**33,313**	**30,353**	**100%**	**-2,959**

* Soils Surface Texture is based on the textural rating of the dominant soil series for each soil polygon
** Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on August 5, 2005 and Sept 9, 2006)
*** Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on Oct. 26, 1994)
**** Figures are derived from the total area of Annual cropland in 2006 minus total Annual cropland in 1994 in each class

Figure 38: Areas Annually Cropped in 2006 on Surface Texture in the Fisher River Watershed *



* Soils Surface Texture is based on the textural rating of the dominant soil series for each soil polygon

G: Riparian Management

Riparian Health Predictive Model Background

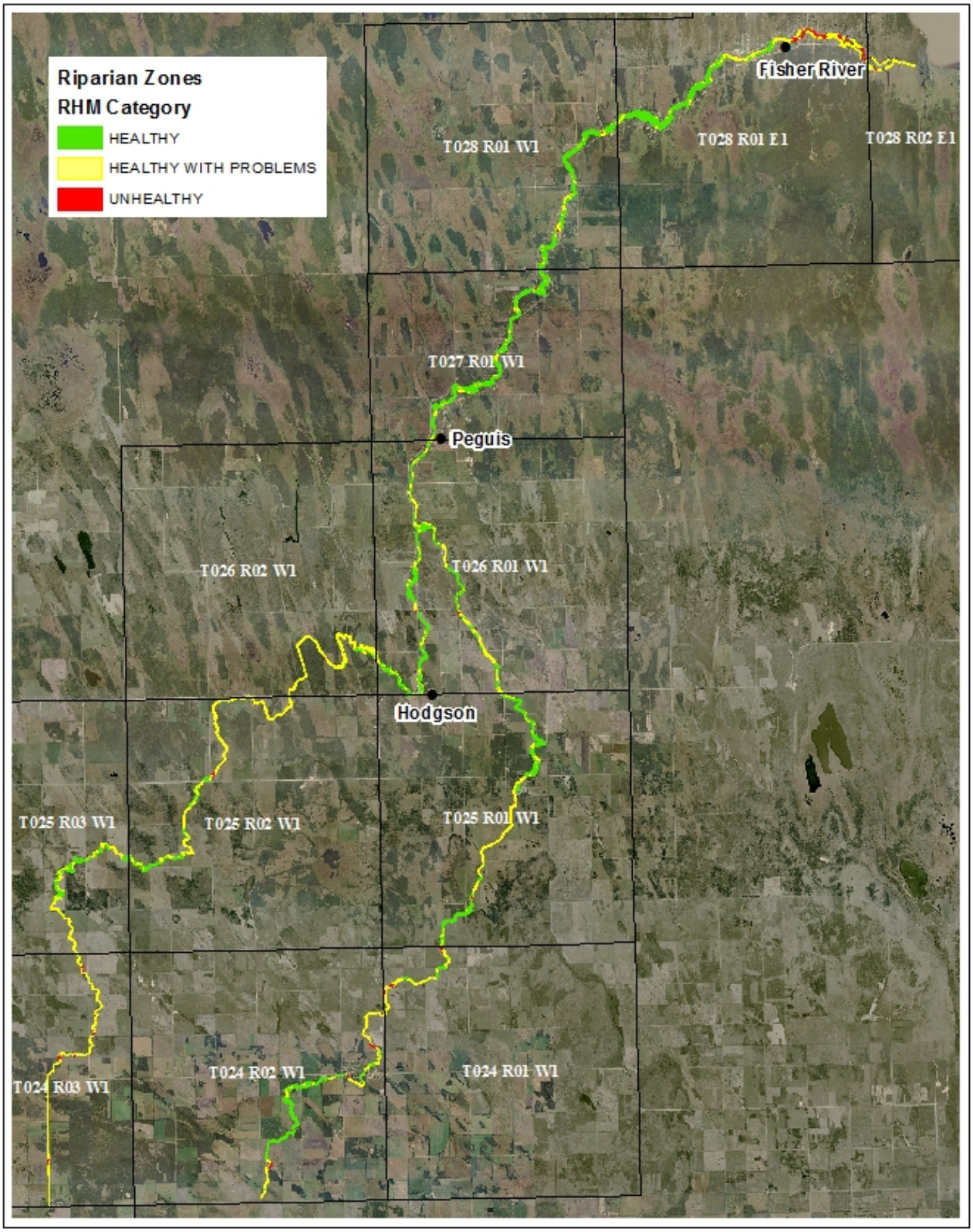
From 2010-2012, AAFC conducted a study to develop a remote sensing approach to assess riparian health on watercourses in agricultural landscapes. The project utilized high resolution aerial imagery and digital elevation model (DEM) data to define the riparian area and classify land cover. Color aerial imagery was readily available for most of the agricultural region of the province. DEMs were available for some areas from Light Detection and Ranging (LiDAR) data or were produced using photogrammetry from existing aerial imagery. The Cows and Fish riparian health assessment methodology was used to collect field data within the study areas. The field data and Cows and Fish assessment protocol was used to develop and validate a land cover based riparian health model (***Figure 39***) and derive riparian health category rating along the entire riparian extent of the study's 3 pilot watercourses. There are three categories of health for the riparian health assessment (1) Healthy; the site performs all key ecological functions, (2) Healthy with problems; some ecological functions are impaired because of degradation and (3) Unhealthy; most riparian functions are lost or impaired.

The riparian health model showed the presence of treed, shrub and shadow to have high positive impact on riparian health scores in Manitoba. The grass/pasture/forage (GPF) vegetation category generally had middle positive weight for all three watercourses. Urban and road features such as compacted paths, pavement, buildings, construction and rip rap had negative weights, meaning these vegetation cover classes had a weakening effect on predicted riparian health scores. A high percentage of barren ground and agriculture also had a negative correlation with high riparian health assessment scores.

Figure 39: Riparian Health Predictive Model Formula

RIPARIAN HEALTH MODEL FORMULA:
[(Agland % *-0.89) + (Barren % *-2.70) + (GPF %*0.64) + (Road %*-0.11) + (Treed %*0.99) + (Shrub %*1.09) + (Shadow %*0.94) + (Urban%*-5.75)]

Figure 40: Riparian Modeling in the Fisher River Watershed



Results

The riparian health predictive model was extrapolated on Fisher River Watershed and the results were divided by township. Riparian zones varied in length but in general averaged 150 m in length and 2200 m^2. In the chart below, the number of riparian polygons categorized as healthy (H), healthy with problems (HP) and unhealthy (U) were identified by township. Furthermore, the percentage riparian health polygons listed by category were identified by township.

Table 11: Fisher River Riparian Health Model Results.

Location	H #	HP #	U #	H %	HP %	U %
T24-R2-W	138	81	10	**60%**	35%	4%
T24-R1-W	37	76	5	31%	**64%**	4%
T25-R1-W	246	134	5	**64%**	35%	1%
T24-R3-W	4	149	15	2%	**89%**	**9%**
T25-R3-W	63	99	0	39%	**61%**	0%
T25-R2-W	82	191	2	30%	**69%**	1%
T26-R2-W	21	169	2	11%	**88%**	1%
T26-R1-W	321	172	5	**64%**	35%	1%
T27-R1-W	244	59	1	**80%**	19%	0%
T28-R1-W	156	43	2	**78%**	21%	1%
T28-R1-E	208	102	19	**63%**	31%	6%
T28-R2-E	0	15	2	0%	**88%**	**12%**

Overall, healthier riparian zones were more likely to be near the communities of Hodgson and Peguis, as well as north of Peguis **(*Table 11, Figure 39*)**. T26-R1-W, T27-R1-W and T28-R1-W had the highest number and percentage of healthy riparian zones. Generally, the riparian areas in these townships contained higher amounts of trees and shrub which contribute to higher riparian health scores through increased vegetative cover and deep-binding rootmass protection. These townships were also less likely to have bare ground which is another riparian health parameter. T24-R3-W, T25-R1-W and T26-R2-W had significant channelization, which generally coincides with low scores from the riparian parameters of streambank alteration and human physical alteration. It was difficult to distinguish a floodplain near the community of Fisher River but generally had poor riparian health scores.

Overall, the riparian health prediction model categorized 53% of the riparian area as “healthy”, 45% as “healthy with problems” and 2% as “unhealthy” for Fisher River

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

i. Crown Land Management in the Fisher River Watershed

The management of crown land in the watershed is protected through special interest from the Province of Manitoba and have designations based on their available resources, through Provincial Coding for Crown Lands (***Table 12*** and ***Figure 41***).

In the Fisher River Watershed:

- Approximately 59% (185,529 ha) of the watershed is Crown Land.
- Only 57,500 ha of Crown land are available for agricultural use through the Agricultural Crown Land Leasing and Permitting Program (See ***Appendix L***).
- The vast majority (68%) of Crown Land is made up mostly of forested areas and wetlands in the northeast portion of the watershed, north of the RM of Bifrost ***(Table 13)*** and is classified as having no agricultural use.

Table 12: Crown Lands by MAFRI Crown Land Use Coding

Generalized Operation Land Use Code	Total Area (ha)	Percentage
Agriculture - No Time Restriction	38,592	21%
Agriculture - Yearly Use Only	18,963	10%
Community Pasture	1,544	1%
No Agriculture Use (Wildlife, Recreational)	126,316	68%
Uncoded (No Agriculture Use)	114	0%
Total	**185,529**	**100%**

Crown Land statistics are currently captured on a municipal boundary basis. As such, the statistics shown below are based on the total amount of Crown Land within the municipalities.

Table 13: Crown Lands by Rural Municipality in the Fisher River Watershed

Rural Municipality	Total Area (ha)	Percentage
FISHER	34,522	19%
GRAHAMDALE	23,259	13%
BIFROST	13,974	8%
ERIKSDALE	377	0%
N/A	113,397	61%
Total	**185,529**	**100%**

Crown Land is subject to specific land use and management based on government acts, regulations and policies. MAFRI is involved in the planning and regulatory management to approximately 648,500 Crown land leased hectares in Manitoba. More information regarding Crown Land Policy, Management, and regulation can be found in ***Appendix L***. This provincially owned land base, which is primarily utilized for forage production and rangeland, provides the annual feed requirements for approximately 10% of the provincial beef herd according to local authorities.

ii. Management Considerations on Crown Lands

a) Land Capability Classification

Table* 14** illustrates the available soils information of agricultural land use capability of Crown Land in the Fisher River Watershed. The vast majority of Crown Lands is Class 4-5 located in the forested area northeast of Fisher Branch (21%). There is a small portion located on the southwest watershed boundary (Figure* 42)**.

Table 14: Agricultural Capability of Crown Lands in the Fisher River Watershed Study Area*

Agriculture Capability	Total Area (ha)	Percentage
Class 1-3	4,471	2%
Class 4-5	39,515	21%
Class 6-7	8,522	5%
Organic	16,830	9%
Water	2,785	2%
Unclassified	7	0%
N/A	112,767	61%
Total	**184,897**	**100%**

* Table does not include other categories and reflects a smaller area of Crown lands in the watershed.

Figure 41: Crown Land Characterization Coding in the Fisher River Watershed Area

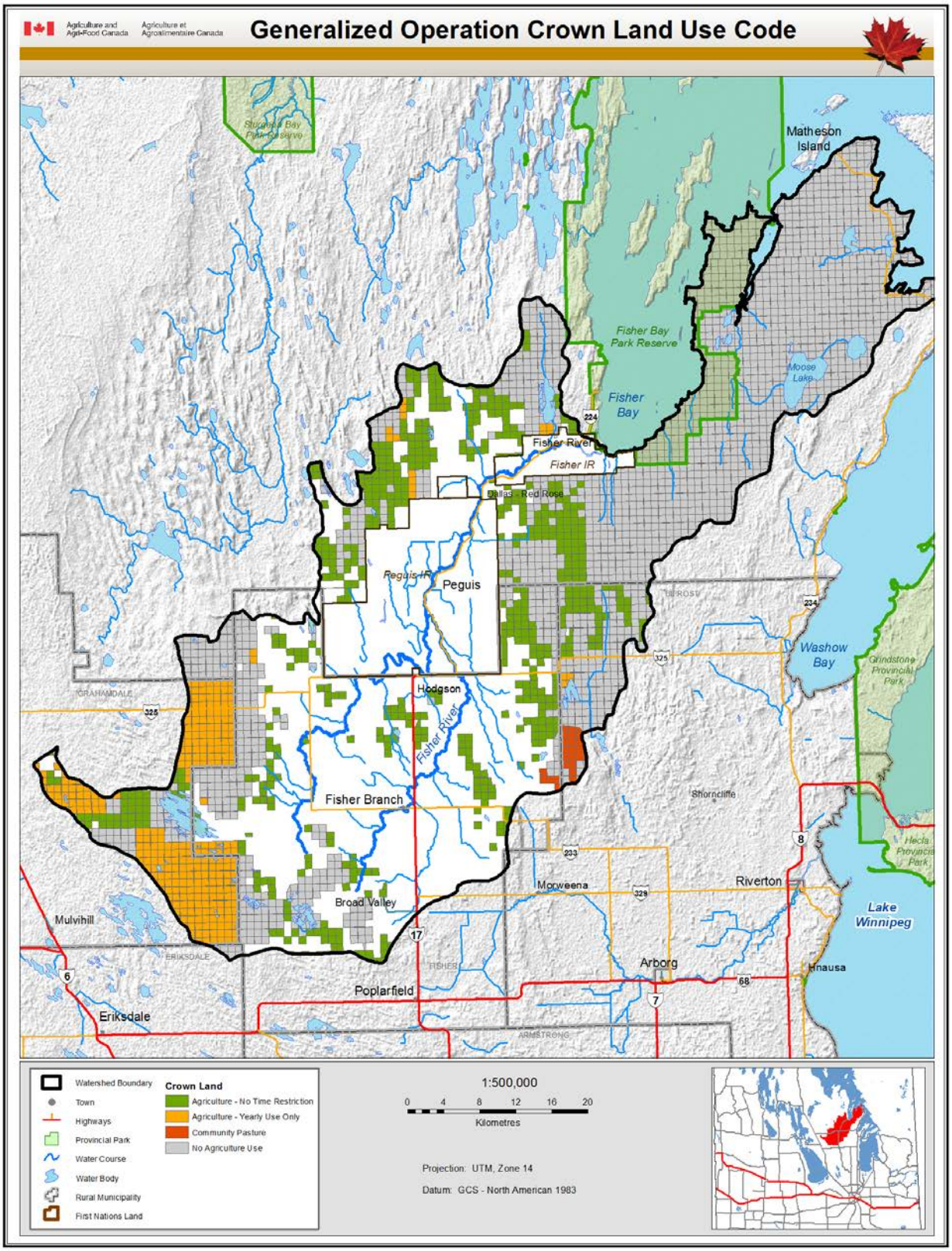
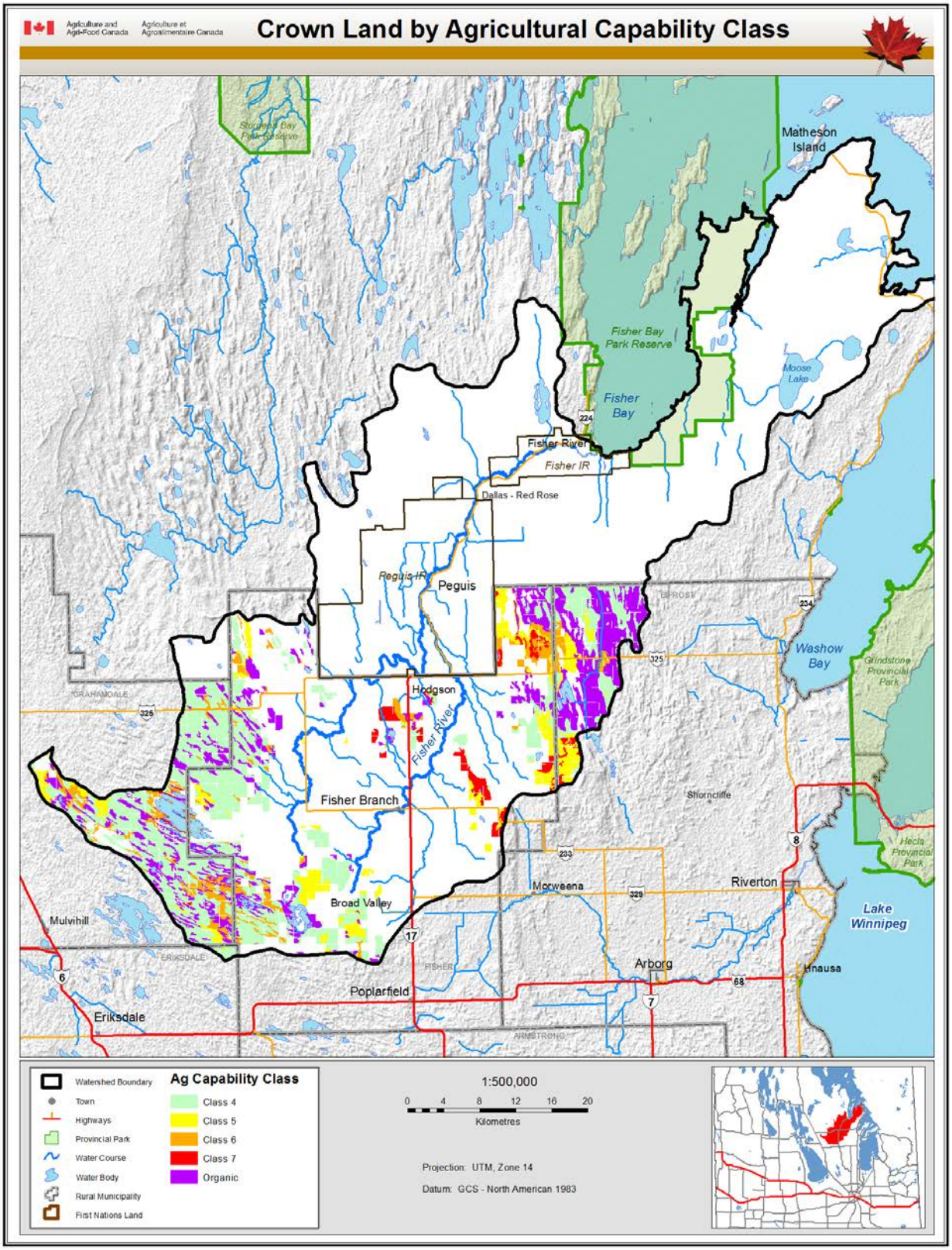


Figure 42: Agricultural Capability of Crown Lands in Fisher River Watershed



b) Woody Species Encroachment on Crown Lands

Wooded species encroachment is influenced by management (e.g. grazing), weather (rainfall), drainage, and by financial pressures in the industry. In general terms, the primary woody species encroaching on grassland tend to be poplar and willow. Encroachment can be identified through temporal analysis of landcover within the Generalized Operation Land Use Coding in the watershed.

There was an overall decrease of almost 25,000 ha of grassland between 1994 and 2006 in the watershed. On Crown Land within the watershed, 14,600 ha of grassland were lost to tree encroachment (***Table 15***).

The largest observed change took place on Crown Lands that were designated *No Agricultural Use* (Wildlife and Recreational), at 42%. *Agriculture* (Yearly leases and no time restrictions) also had a large area, (28% and 26% respectively) affected by tree encroachment. Other Crown Land coded areas, *Community Pastures* and *Uncoded* (No Agriculture Use) had observed values that were quite low. This trend was also observed using land cover data in the change to forested areas analysis (***Figure 31***).

Noted increases of wooded species may be the result of a number of factors. The conversion of annual crop land to tame forage production may have led to a decrease on the reliance of native hay and grazing production. The lower hay and grazing pressures on native marginal lands could have resulted in significant poplar and willow encroachment. This encroachment of woody species can also be accelerated through above normal precipitation causing additional pressures on drainage s resulting in wetter than normal soil conditions.

Table 15: Change in Grassland to Trees on Crown Lands (1994-2006)

Generalized Operation Land Use Code	Total Area (ha)	Area that changed from grassland in 1994 to trees in 2006 (ha)	Percentage Change
Agriculture - No Time Restriction	38,592	4,071	28%
Agriculture - Yearly Use Only	18,963	3,792	26%
Community Pasture	1,544	634	4%
No Agriculture Use (Wildlife, Recreational)	126,316	6,086	42%
Uncoded (No Agriculture Use)	114	17	0%
Total	**185,529**	**14,600**	**100%**

Agricultural Policies in Development Plans

Privately owned agriculturally designated land is protected by polices in development plans. In the watershed, these are as follows: The RM of Fisher is included in the Fisher-Armstrong Planning District, Bifrost in the Eastern-Interlake PD, Eriksdale in the Western Interlake PD, while the RM of Grahamdale has its own development plan policies. All of the municipalities recognize agriculture as being the leading industry, and have included policies to maintain the landbase for that use. A good example of such policies can be found in the Eastern Interlake Development Plan for the Rural Policy Area ***(see Appendix L)***.

iii. 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 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 the 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 has been 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 M***.

Participation in the Environmental Farm Plan Program is captured on a municipal basis in the study area in ***Appendix M***. The information portrays the number of participants in the Environmental Farm Planning process based on where EFP workshops were held. It should be noted that participants may reside in the surrounding area and not necessarily in the location of the workshop. Environmental Farm Planning Workshops were well attended, with a high degree of producers completing the process to receive a Statement of Completion for eligibility of BMP funding through the CMFSP. Participation numbers within the study area were at the Manitoba average, indicating that producers in the Fisher River Watershed are proactive and that addressing environmental issues are high on their priorities.

In the Fisher River Watershed study area, a total of 53 BMP projects were completed (***Table 16***). Of these, 18 projects were categorized as Non-Point Source – Crop Related BMPs.

The top three BMP categories adopted by producers in the study area through the CMFSP were Improved Cropping Systems, Winter Site Management, and Product and Waste Management. More specifically, the top three BMP practices adopted were precision farming practices, portable wind breaks, improved on-farm storage (fuel), and alternative watering systems. With respect to wildlife habitat, Enhancing Wildlife Habitat and Biodiversity BMP had some adoption in the IWMP area.

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 actual adoption levels. However, considering the number of farms in the watershed, 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 [9]

BMP Categories	Fisher River IWMP
Point Source - Livestock Manure Related [1]	1
Point Source - Other (Petroleum, Nutrients from Feed, Pesticides, etc.) [2]	8
Non Point Source - Livestock Related [3]	18
Non Point Source - Crop Related [4]	18
Non Point Source - Crop Related (Irrigation) [5]	0
Non Point Source - Crop Related (Pesticides) [6]	3
Soil Erosion - Soils at Risk [7]	1
Biodiversity [8]	4
Total	53

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, 24
5. These include BMPs 18, 29
6. These include BMPs 16, 20, 25
7. These include BMPs 11, 12, 13, 15, 19, 27
8. These include BMPs 21, 22, 23, 28
9. Refer to Appendix N for BMP description

Growing Forward: Environmental Farm Action and Manitoba Sustainable Agriculture Practices Programs

Beginning in 2009**,** Manitoba Food and Rural Initiatives (MAFRI) offered programs under the Growing Forward Agricultural Policy Framework, a provincial and federal initiative over five years (2008 – 2013), such as the continuation of environmental farm planning and BMP support (see ***Appendix Q*****)**.

Financial and technical support was available through Growing Forward's suite called Environmental Action, directed to improve the environmental performance and sustainability of agricultural operations. Funding for eligible BMPs focused on agriculture's capacity to reduce risk to water and air quality, improve soil productivity and enhance wildlife habitat. BMP support was available to producers upon completion of an environmental farm plan.

Once producers completed the EFP program, they received a Statement of Completion which enabled them to apply for financial assistance for specific beneficial management practices through the Environmental Farm Action Program (EFAP). In addition, the Manitoba Sustainable Agriculture Practices Program (MSAPP) was a provincial climate change program and had an objective to assist in implementing practices that reduce greenhouse gas emissions from agriculture. ***Table 17*** outlines the BMPs that were available through each respective program.

Table 17: BMPs available through the Environmental Farm Action Program (EFAP) and/or Manitoba Sustainable Agriculture Practices Program (MSAPP)

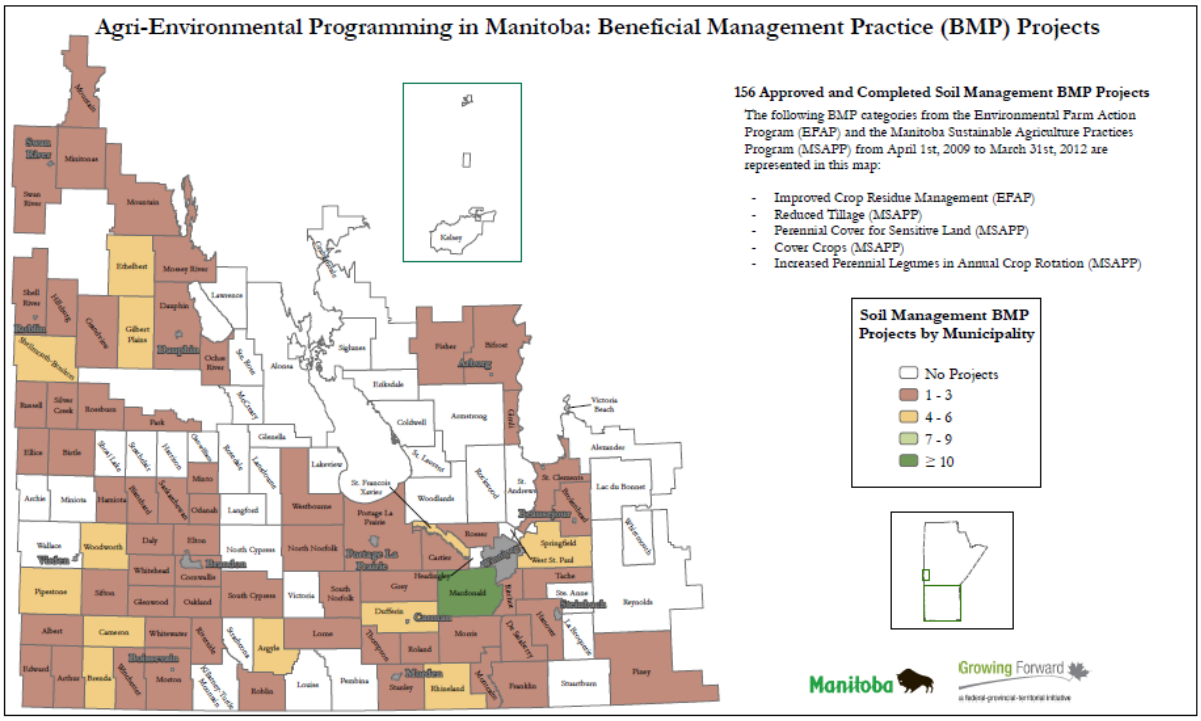
BMP Categories	BMP Suite
Increased Manure Storage Capacity	EFAP
Improved Manure Storage and Handling	EFAP
Solid-Liquid Separation of Manure	EFAP
Composting of Manure	EFAP
Farmyard Runoff Control	EFAP
Relocation of Livestock Confinement Facilities	EFAP
Wintering Site Management	EFAP
Riparian Area Management	EFAP
Improved Crop Residue Management	EFAP
Precision Agriculture Applications	EFAP
Nutrient Management Planning	EFAP
Reduced Greenhouse Gas (GHG) Emissions from Manure Storage	MSAPP
Manure Land Application	MSAPP
Reduced Tillage	MSAPP
Spring Fertilizer Application	MSAPP
Perennial Cover for Sensitive Land	MSAPP
Cover Crops	MSAPP
Improved Pasture and Forage Quality	MSAPP
Increased Perennial Legumes in Annual Crop Rotation	MSAPP
Grazing and Pasture Management Planning	MSAPP

Program participation was summarized by MAFRI on a municipal basis and by environmental category as well. With respect to the Fisher River IWMP, it was noted that producers in the area mainly adopted BMPs that address soil management and water quality, as well as, Manure Management BMPs to a lesser extend (***see Figure 43***). Further information about the current Growing Forward Program in support of Environmental Farm Planning and BMPs can be found on the MAFRI website at: http://www.gov.mb.ca/agriculture//soilwater/farmplan/index.html

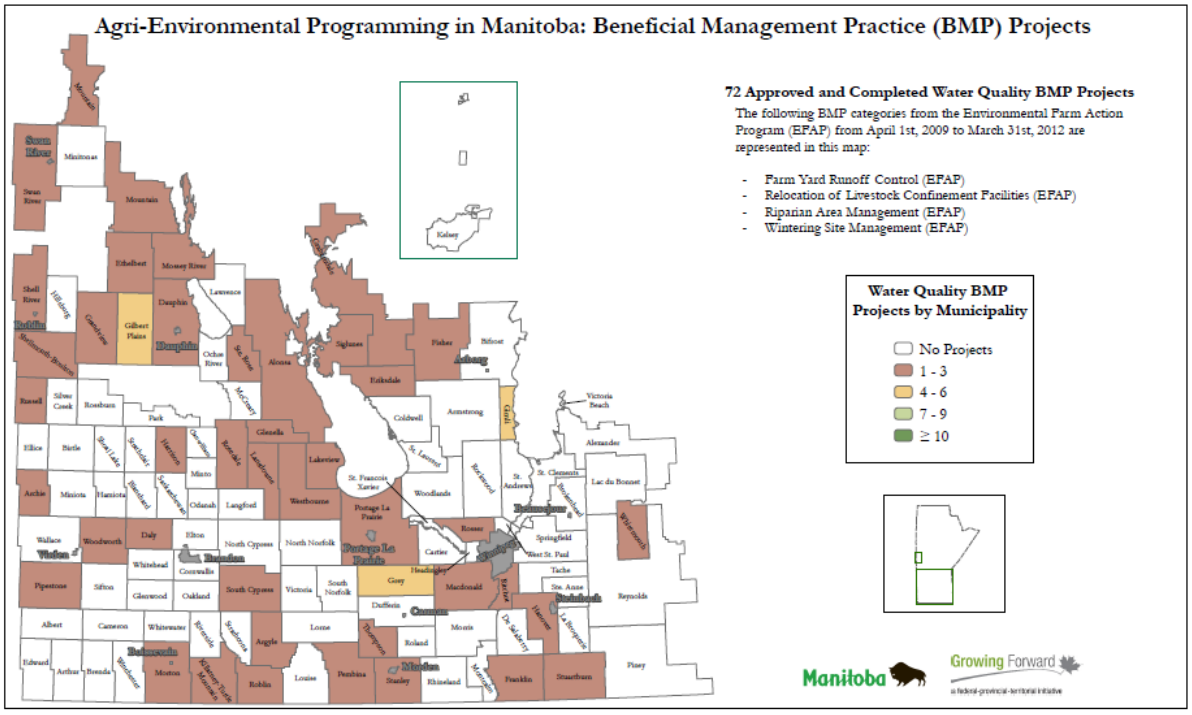
Adoption for the Growing Forward Program is unknown as results are still being compiled and analyzed. However, considering the support for the CMFSP program and the level of BMP adoption, data does suggests that future agri-environmental programs that support. IWMP implementation are likely to have considerable levels of participation in this region.

Figure 43: BMP Adoption Under Growing Forward I

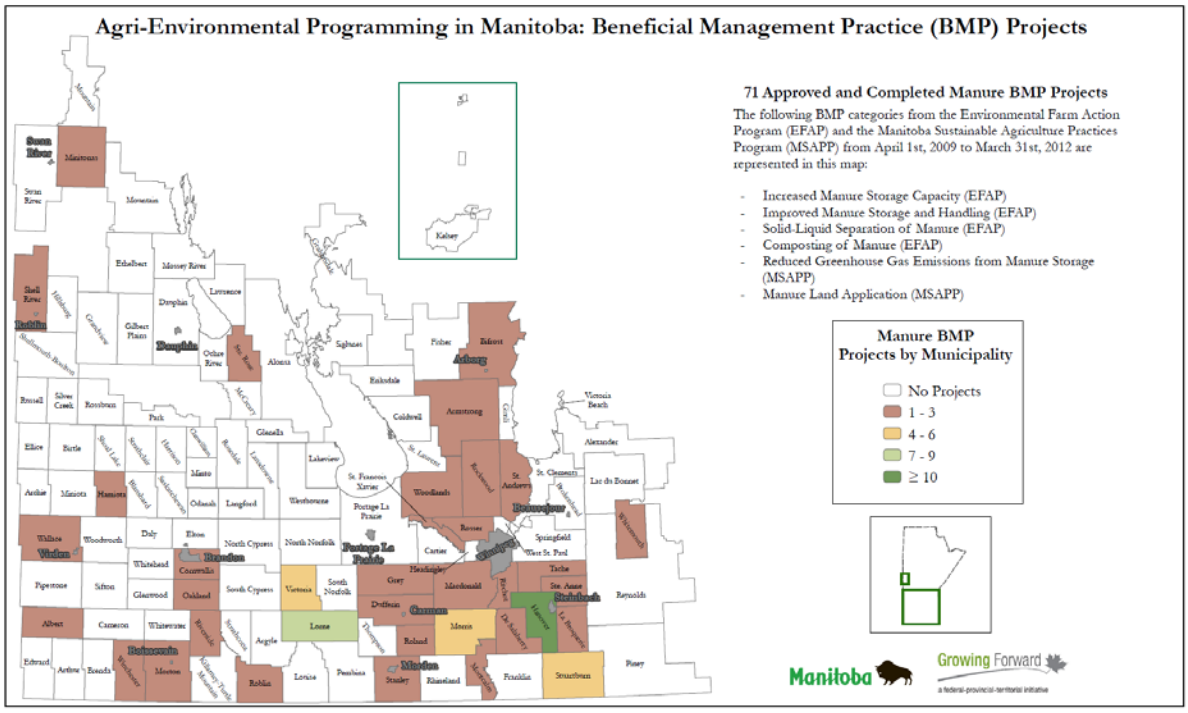
i) Completed Soil Management BMP Projects



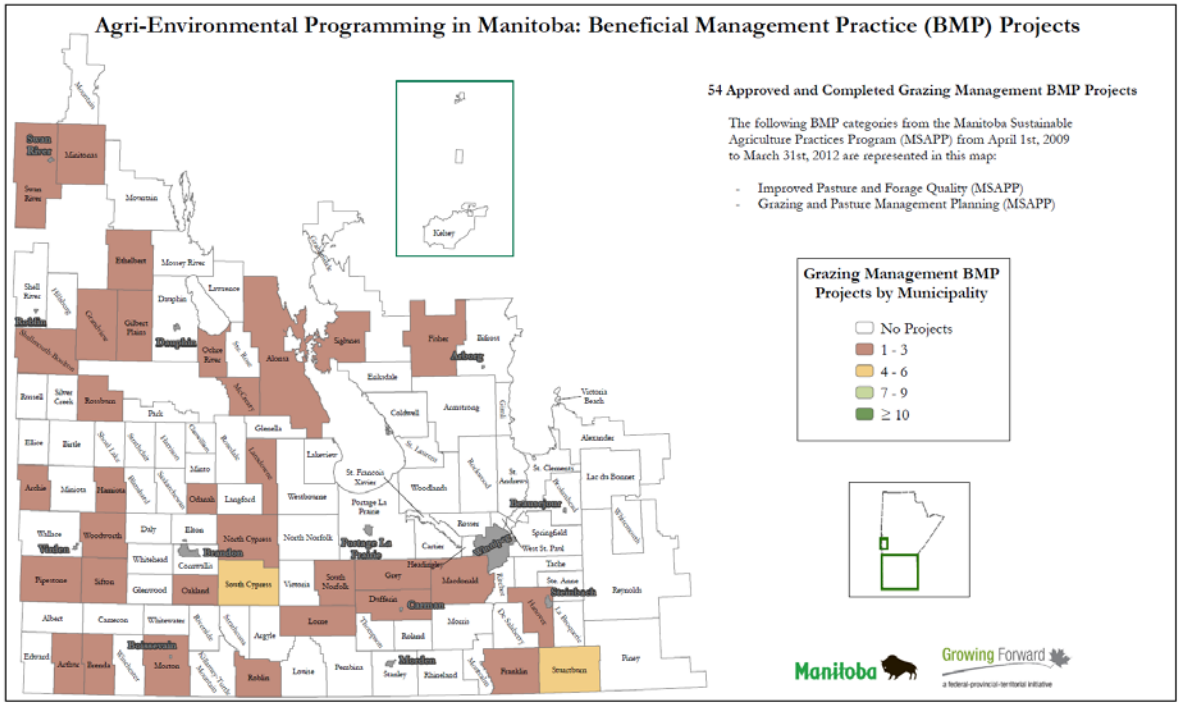
ii) Completed Water Quality Management BMP Projects



iii) Completed Manure Management BMP Projects



iv) Completed Grazing Management BMP Projects



I. Agricultural Land Use and Management Recommendations*

Watershed Issue	Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
How has land clearing and wetland drainage changed the landscape in the Fisher River Watershed? To what extent has the natural cover changed in the past 30 years?	**Influences on Natural Habitat Change** –The following trends have been noted in the watershed: • **Parks and Protected Areas-** With respect to understanding changes to agricultural lands, it should be noted that a portion of the Fisher River Watershed Study Area is comprised of First Nation Lands (Fisher River IR and Peguis IR- (over 37,500 hectares, or 12%), and a portion of the Fisher River Park Reserve (< 5%). Agricultural activity is present in both First Nation areas. • **2006 Land Cover -** Forested area (Trees) was the predominant land cover type in the watershed in the throughout the watershed and accounted for almost 49% of the total land cover in the watershed. • Grasslands were the third most predominant land cover type in the watershed comprising 17% (41,400 ha) of the total land cover. The vast majority of the grasslands cover was found in the southern portion of the watershed. In 2006, approximately 15% of the land cover (38,600 ha) was classified as unclassified, wetlands or water (***Table 4, Figures 13 and 14, Pages 22-24***). • **Farmland Usage-Census Trends (1991-2006)** - Total farmland usage, cropland and pasture were all very stable across the 15 years between 1991 and 2006 ***(Figure 17, Page 26).*** • **Forages-Census Trends (1991-2006)** - Forage production made up just over 40% of the total cropland in the watershed in 2006. This proportion has increased over 15 years, as both alfalfa (slight drop in 1996 and up again in 2001) and other tame forages rose during this time (***Figure 19, Page 28***). • **Annual Cropland- Census Trends (1991-2006) -**Decreases noted with wheat and other cereals were noted from 1996 -2006. Oilseed area from 1991 to 2006 increased slightly, despite drops noted in 1996 and 2001, seemingly at the expense of other cereals ***(Figure 18, Page 27).*** • **Land Cover – 1994, 2002, and 2006** - ***(Table 5, Page 32).*** (a) **Natural Areas –** The total area of natural areas, including grassland/pasture and forested land, increased between 1994 and 2006 (7,700 ha. from 1994 to 2006). (b) **Forested Areas/Trees** - Forested areas in the watershed increased significantly over the 13-year period, approximately 32,700 ha or 27% compared to the 1994 land cover. These changes have been linked mainly to decreases in grasslands, wetlands, and annual cropland. (c) **Grasslands**- Grasslands had the biggest decrease noted, approximately 25,000 ha (from 49,278 to 35,081 ha). (d) **Wetlands -** Besides grasslands, wetlands were the next feature that had the next biggest decrease (14,200 ha). (e) **Forages –Forages** saw a small increase from 1994 to 2006 with a gain of 10,300 ha. • **Changes to Annual Cropland** – Conversion of annual cropland to trees and grasslands was consistent with trends observed using Census of Agriculture data. Conversion from cropland to other land cover was focused distributed through the south and central portions of the watershed. 8,900 ha of cropland were converted to forage during the 13-year period. The reciprocal conversion saw forages converting 2,400 ha to annual cropland during that time (***Figure 25 & 26*, Pages 33-34**). • **Changes to Grassland Area -** There was an overall decrease of 25,000 ha of grassland in 2006 (***Table 5***), a decrease of almost 60% from 1994 land cover. Conversion of grassland to forested areas was the primary factor responsible for the major decline in grassland cover. Over 100,000 ha of grassland was converted to forested areas alone. Conversion of grassland to cropland, forages and wetlands were the next major cover types responsible for the major decline in grassland cover. Over 25,000 ha of grassland was converted to cropland over the 13-year period; followed by 14,300 ha of grassland converted to wetlands and almost 10,600 ha converted to forages (***Figure 28 & 29*, Pages 37-38**). • **Change in Forested Area -** The largest change to forested cover was in respect to the grasslands and wetlands cover. Increases to forested areas, resulted in 62,500 ha converted from grasslands to forested areas. Other large changes occurred with the annual cropland category; reciprocal changes to and from annual cropland displayed almost a 5,000 ha net gain to forests (***Figure 30 & 31*, Pages 39-40**). • **Change in Forage Area-** Analysis indicates that conversion from grasslands annual cropland and forested areas were primarily responsible for the increased forage cover in the watershed. This is consistent with land use trends observed using Census of Agriculture data. A large amount of annual cropland was also converted to forages between 1994 and 2006 (15,300 ha), with only 2,400 ha converted from forages back to annual cropland ***(Figure 32 -33, Pages 42 – 43).*** • **Agricultural Capability –32**% (101,000 ha) of the soils in the watershed are Class 4 and lower. The total amount of annual cropland in the watershed has decreased since 1994. These decreases are reflected on all soil classes (except Class 1 & 5 saw a small ha increase) ***(Table 6, Page 45)***. • **Crown Lands** - There are approximately 59% (185,500 ha) of Crown Land in the watershed. Only (32%) 57,500 ha of Crown land are available for agricultural use through the Agricultural Crown Land leasing and permitting program (See ***Appendix M***). The largest change from grassland to forested areas took place on Crown lands that were No Agricultural Use (Wildlife, Recreational - 42%). Agriculture leases (No time Restriction and Yearly use Permits) had 28% and 26% respectively (***Table 12-15, Figure 44, Page 61-65)***. • **BMP Adoption -** Of the 53 completed, less than 10 of the projects were categorized as Biodiversity BMPs *under the Farm Stewardship Program* ***(Table 16, Page 67).*** Under Growing Forward Program, it was noted that there was BMP uptake noted in the Fisher River IWMP study area that support wildlife habitat ***(Page 70, Figure*** • **Precipitation Levels on Wetlands -** Total annual rainfall and precipitation amounts exceeded the 30 year average in 2006 (*see* ***Appendix P, Page 108).*** ***Data Gaps Identified:*** *(a) There is approximately 52% of the watershed (164,600 ha) that no data exists for soils information.* *(b) Most of the lands identified as class 4 or lower are located in areas with reconnaissance soil data (scale of 1:100,000).* *(c) Satellite imagery that is used for the land cover analysis is developed using a 30 meter pixel, which makes the identification of smaller wetlands difficult. Land classifications are focused on agricultural cover categories and less time and effort were devoted to non-agricultural categories that may result in misclassification errors.* *(d) Timing of land cover Imagery - Imagery acquisition date and classification definitions may affect the number (i.e. a decrease or increase) of wetlands identified and should be verified with site specific analysis (ground truthing). Native grasslands are not distinguished from tame grass under the grassland category.* *(e) Species at Risk data is not available for analysis.*	**Identify Suite of BMPs for Evaluation and Implementation for Wildlife Habitat** - Promote and provide technical assistance for BMPs that maintains a healthy level of natural habitat (e.g. riparian buffers, wetland options, and wildlife habitat) in key priority areas of the watershed. **Education -** Encourage educational initiatives that demonstrate the BMPs which maintain and enhance natural cover. Encourage sustainable land management practices on soils with lower agricultural capability that maintain wildlife capability	Areas in the watershed that are: • class 4 or lower and are adjacent to Fisher River and Fisher Bay Park Reserve Entire Study Area	Proportion of watershed area: • with annual cropland on Class 4 and lower lands, • that is wetland or treed, • that is grassland/pasture or forage land cover Number of BMPs implemented that have a wildlife benefit. Number of educational initiatives carried out # of hectares impacted bu BMPs implemented through financial assistance programs and/or initiatives

* 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*
Can you provide suggestions as to how we can protect and manage critical riparian areas? Where should riparian management programs be targeted?	• **Riparian Health Predictive Model-** Riparian Health Predictive Model capable of estimating riparian condition using remote sensing . The riparian health predictive model was applied on the Fisher River and the results were divided by township (***Table 11, Figures 39 & 40, Page 58-60***). • Overall, the riparian health prediction model categorized 53% of the riparian area as "healthy", 45% as "healthy with problems" and 2% as "unhealthy" for Fisher River. o T26-R1-W, T27-R1-W and T28-R1-W had the highest number and percentage of healthy riparian zones. o T24-R3-W, T25-R1-W and T26-R2-W had significant channelization, which generally coincides with low scores from the riparian parameters of streambank alteration and human physical alteration. It was difficult to distinguish a floodplain near the community of Fisher River but generally had poor riparian health scores. • **BMP Adoption -** Of the 53 completed, 18 (34%) included riparian practices under the Farm Stewardship Program ***(Table 16, Page 66)***. Under Growing Forward Programming, there was BMP uptake in the Fisher River Watershed of Water Quality BMPs***) (Figure43, Pages 67- 69)***. • **Workshops and Completed Environmental Farm Plans**– Two municipalities within the Fisher River IWMP area (Rural Municipalities of Bifrost and Fisher) were one of the highest numbers of completed Environmental Plans and Reviews in the Province of Manitoba (Approximately 6- 20 workshops conducted and between 100-120 of Environmental Farm Plans completed.) **Data Gaps Identified:** *(a) Riparian Assessment only completed on main arm of Fisher River* *(b) There has been no previous riparian health reports completed for this area*	**Riparian Health Predictive Model** - Need to do further assessment or apply the predictive model in other parts of the watershed to understand riparian health. **Identify Suite of BMPs for Evaluation and Implementation for Wildlife Habitat** - Promote and provide technical assistance for BMPs that maintains a healthy level of natural habitat (e.g. riparian buffers, wetland options, and wildlife habitat) in key priority areas of the watershed. (a) Alternative Watering Systems (b) Fence to manage Grazing and Improve Riparian Condition/Function (c) Native Rangeland Restoration or Establishment (d) Improved Stream Crossing (e) Buffer Design for Annual Cropland **Education -** Encourage educational initiatives that demonstrate the BMPS which show the value of health riparian areas. (e.g EFPs, Managing the Water's Edge, Buffer Tool Design for Annual Cropland) **Modelling BMPs/landUse Ghangeand the Effect on Water Quality (**Encourage the CD to work on establishing requirements toward developing effective watershed modeling which will enable the CD to see impacts of BMPs on water quality).	Beyond the main stem of the Fisher River Specific Riparian Areas identified along the Fisher River Throughout the watershed Entire watershed	Amount of improved by implementing riparian management initiatives Number of Projects developed Number of ha that have been secured through BMP adoption Number of educational initiatives carried out by stakeholders and the # of attendees

* 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*
Are there certain landuse activities that should be restricted from occurring in specific regions of the watershed or on certain types of land or soil?	• **Crown Lands -** There are approximately 59% (185,500 ha) of Crown Land in the watershed. Only (32%) 57,500 ha of Crown land are available for agricultural use through the Agricultural Crown Land leasing and permitting program (See Appendix M). The largest change from grassland to forested areas took place on Crown lands that were No Agricultural Use (Wildlife, Recreational - 42%). Agriculture leases (No time Restriction and Yearly use Permits) had 28% and 26% respectively (Table 12-15, Figure 44, Page 60-64).			

Watershed Issue	Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
Are there specific beneficial management practices that could be implemented to reduce nutrient loading in the Fisher River Watershed and where should these activities be targeted?	**Analysis of Landcover (forested areas, forage, and annual cropland) as well as census analysis of forage, annual cropland and farmland usage have been completed for the land clearing section and are applicable for here** • **Zero Tillage -Census Trends (1991-2006)** -The area of land managed with conservation made 53% of land management. The area of land managed with conservation tillage saw a modest decrease from 1996 to 2001 and then increased in 2006 to the similar levels of 1996. The area of land managed with zero tillage saw a similar trend as conservation practices, but saw the largest increase by 2006 **(Figure 23, Page 30)**. • **2006 Land Cover -** Forested area (Trees) was the predominant land cover type in the watershed and accounted for almost 49% of the total land cover in the watershed. (***Table 4, Figures 13 and 14, Pages 22-24***). • Grasslands was the third most predominant land cover type in the watershed comprising 17% (41,400 ha) of the total land cover. The vast majority of the grasslands cover was found in the southern portion of the watershed. In 2006, approximately 15% of the land cover (38,600 ha) was classified as Unclassified, Wetlands or Wate**r. (*Table 4, Figures 13 and 14, Pages 22-24***). • **Riparian Health Predictive Model-** Riparian Health Predictive Model capable of estimating riparian condition using remote sensing . The riparian health predictive model was extrapolated on Fisher River and the results were divided by township (***Table 11, Figures 39& 40, Page 58-60***). • Overall, the riparian health prediction model categorized 53% of the riparian area as "healthy", 45% as "healthy with problems" and 2% as "unhealthy" for Fisher River. o T26-R1-W, T27-R1-W and T28-R1-W had the highest number and percentage of healthy riparian zones. o T24-R3-W, T25-R1-W and T26-R2-W had significant channelization, which generally coincides with low scores from the riparian parameters of streambank alteration and human physical alteration. It was difficult to distinguish a floodplain near the community of Fisher River but generally had poor riparian health scores • **BMP Adoption -** Of the 53 completed, 18 (34%) included riparian practices under the Farm Stewardship Program ***(Table 16, Page 67)***. Under Growing Forward Programming, there was good adoption of Water Quality BMPs within the Fisher River Watershed***(Figure43, Pages 67- 69)***. • **Workshops and Completed Environmental Farm Plans**– Two municipalities within the Fisher River IWMP area (Rural Municipalities of Bifrost and Fisher) were one of the highest numbers of completed Environmental Plans and Reviews in the Province of Manitoba (Approximately 6- 20 workshops conducted and 100-120 of Environmental Farm Plans completed. ***(Appendix N, Page 106***) • **Precipitation Levels on wetlands -** Total Annual Rainfall and Precipitation amounts exceeded the 30 year average in 2006 (***see Appendix P, Page 109***). **Data Gaps Identified:** *Census Trends are derived on a volunteer basis.*	Examine Suite of BMPs for Evaluation and Implementation to reduce nutrient loading **Watershed Evaluation of BMPs (WEBS) process - to study applied research results carried out in other watershed to determine potential effectiveness in Fisher River** . **Red Assiniboine DSS Model Modelling BMPs/Land Use Change and the Effect on Water Quality (-** Encourage the Conservation Districts to work on establishing requirements toward developing effective watershed modeling which will enable cd to see impacts of BMPS on water quality (like Red Assiniboine and the decision support model). Study to look at existing drainage system and develop drainage and retention options through hydrological model, economic analysis, and also examining current infrastructure, as well as new possibilities.	**Fisher River Main River Branch** **Entire Watershed**	Number of Projects developed Number of ha that have been improved or affected secured through BMP adoption Model simulations depicting results

* 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*
What adaptation tools or activities can residents of the watershed adopt to prepare for climate change and variability?	• **Crown Lands** - There are approximately 59% (185,500 ha) of Crown Land in the watershed. Only (32%) 57,500 ha of Crown land are available for agricultural use through the Agricultural Crown Land leasing and permitting program (See ***Appendix M***). The largest change from grassland to forested areas took place on Crown lands that were No Agricultural Use (Wildlife, Recreational - 42%). Agriculture leases (No time Restriction and Yearly use Permits) had 28% and 26% respectively (***Table 12-15, Figure 41, Page 61-65***). • **Land Cover – 1994, 2002, and 2006 - *(Table 5, Page 32)* –** Landcover analysis of annual cropland, forage, and grasslands in 1994 (noted as one of the drier years compared to the 30 year normal precipitation levels against similar landcover of 2005- 2006 (noted as one of the wetter years compared to the 30 year normal) reveal which soils under cropping practices could have risks. Further Mapping analysis is required to identify broad areas, which would also require in ground truthing for accuracy and to refine accuracy of imagery. **Areas prone to flooding during wet cycles–** • There are approximately 36,450 ha. That were identified as annual cropland, forage, and grassland in 1994 than wetlands in 2006, suggesting these areas are prone to flooding. • **Water Erosion Risk -** Most of the soils with moderate risk (1,300 ha or 4%) of water erosion are located in the annual cropland area surrounding Fisher Branch of the watershed **(*Table 8, Figure 36 Pages 50-51*).** • **Soil Texture -** Approximately 12,300 ha (41%) of the 2006 annual cropland was located on clayey textured soils and followed by fine loamy textures at 10,100 ha or 33%. The biggest decrease on annual cropland occurred on the clayey soils, decreasing 1,300 ha from 1994 to 2006 **(Table 10, *Figure38, Pages 56- 57*).** • **Soil Drainage -** A slightly smaller area of land in the watershed is poor to very poorly drained (60,400 ha or 20%). The percentage of annual cropland on poor to very poor drained soils is 53% and will likely have more of a local impact on the watershed (***Figure 37, Table 9, Pages53-54***). **Areas prone to drought during dry cycles–** • There are approximately 79,630 ha that were identified converted from annual cropland, forage, and grassland in 1994 to wetlands in 2006, suggesting these areas are prone to flooding. • **Soil Texture -** There are approximately 37,600 ha. (12%) Those are considered organic or sandy textured soils in the watershed. This equated to approximately 3,100 ha. (or 10% of the 2006 annual cropland) ***(Table 10, Figure38, Pages 56-57)***. • **Wind Erosion Risk** - Most of the soils with moderate risk (1,300 ha or 4%) of water erosion are located in the annual cropland area surrounding Fisher Branch of the watershed **(*Table 7*, *Figure 36, Pages 47-48*).** • **Agricultural Capability -**24% (76,600 ha) of the soils in the watershed are Class 4 and lower. About 8% of the watershed (24,300 ha) has organic soils. Based on the 2006 land cover data, approximately 4% of the annual cropland was located on soils with moderate, high, to severe risk for wind erosion. These areas are situated throughout the watershed, in general, they are associated with sandy, coarse-textured soils. ***(Table 7, Figure 34, Pages 45-46)***. **Proactive Indicators** • **Workshops and Completed Environmental Farm Plans–** Two municipalities within the Fisher River IWMP area (Rural Municipalities of Bifrost and Fisher) were one of the highest number of completed Environmental Plans and Reviews in the Province of Manitoba (Approximately 6- 20 workshops conducted and between a 100-120 of Environmental Farm Plans completed ***(Appendix N, Page 105)*** • **Alfalfa and Hay Production -** Forage production made up 40% of the total cropland in the watershed in 2006. This proportion has increased over 15 years, notable Alfalfa, seeing the highest increase and other tamed forages increased in 1996 and then stabilized from the ten year period from 1996 to 2006 ***(Figure 19, Page 28)*** • **Tillage Practices** - Although the conventional practice is the most common, it has declined dramatically since 2001 at the expense of both conservation and zero tillage practices ***(Figure 23, Page 30*** . **Data Gaps Identified:** *(a) There is approximately 52% of the watershed (164,600 ha) that no data exists for soils information* *(b) Most of the lands identified as class 4 or lower are located in areas with reconnaissance soil data (scale of 1:100,000)* *(c) Census Trends are derived on a volunteer basis.* *(d) Land cover Analysis is developed using a 30 meter pixel, which makes the identification of smaller wetlands difficult. Land Classifications were focused on Agricultural Lands Primarily.* *(e) Timing of Land cover Imagery -Timing of Imagery and classification definitions may affect the number (i.e. a decrease or increase) of wetlands identified and should be verified with site specific analysis (ground truthing). Native Grasslands are not distinguished from tame grass under the Grassland category.* (f) *Fifty two percent of the watershed is not classified within the soil survey boundary*	**Encourage Monitoring of Climate Change Indicators** • Pests and Diseases- • Water Use and Demands- • Record Water Needs and Systems used • Precipitation **Communication and Planning Tools** • **AAFC Agriculture Impact Reporting Participation-** Have cd coordinate representation from across the watershed that can proactively report on watershed conditions that may lead to agricultural impacts felt by climate variability (water storage, precipitation forage supply, soil moisture) • **Modelling BMPs/Land Use Change and the Effect on Water Quality** Encourage cd to work on requirements toward developing effective watershed modeling which will enable cd to see impacts of BMPS on water quality (like Red Assiniboine and the decision support model). • **Climate Projection Scenarios** and Modeling of Impacts (physical, economic, socio) **Drought Preparation** • Exploring different crop, forage , and pasture seed varieties that are more drought tolerant, and responsive to climate variability • Plan water storage to meet livestock for longer duration • Assess municipal water infrastructure and plan to help meet water shortages • Track/Report number of Drainage Applications **Flood Preparation** • Exploring different crop, forage , and pasture seed varieties that are more flood tolerant, and responsive to climate variability • Assess municipal water infrastructure and plan to help address flood prone areas • Track/report number of drainage applications Examine Suite of BMPs for Evaluation and Implementation to meet climate variability. Explore new opportunities for BMP development	Agricultural Regions of the watershed	Early indicators of drought , hay shortages, soil moisture , and water supply Number of Participants that are participating Completion of A comprehensive Drought Plan complete with and implementation plan Completion of a comprehensive Flood Management Plan that details an implementation strategy Number of Projects developed Number of ha that have been completed secured through BMP adoption (delivered by CD

* 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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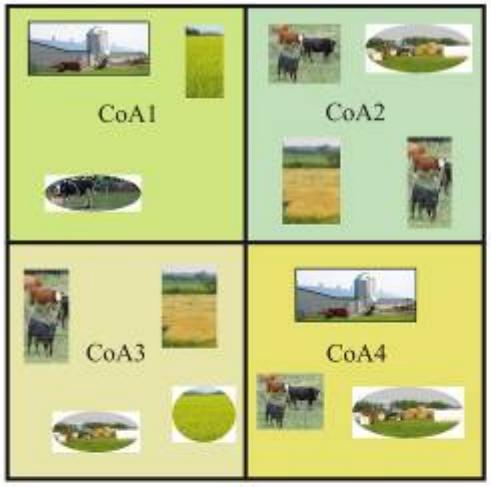
K. Appendices

Appendix A: 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



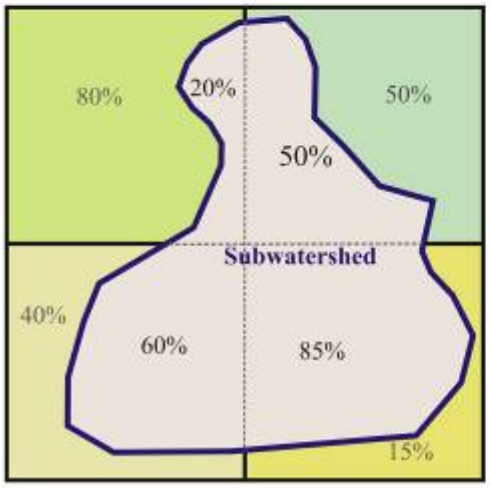
CoA is the sum of all survey forms of farms with farm headquarters located in the specific boundary

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 B: Animal Unit Calculations

Summary of Animal Unit coefficients used in Manitoba as compared to those used for calculations in this report[1]

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	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 Units1 from 2006 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 2006 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 2006 Census 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 categories are equal.
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 C: Land Cover Time Frame, Classifications, and Constraints

For the IWMP study area, imagery was available for the years of 1994, 2002, 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 1994 land cover used satellite imagery that was captured on October 26, 1994. Imagery for the 2002 land cover data was taken August 2, 2002. The 2006 land cover data utilized satellite imagery that was captured on August 5, 2005 and September 9, 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 1994 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 Central Assiniboine and Lower 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.

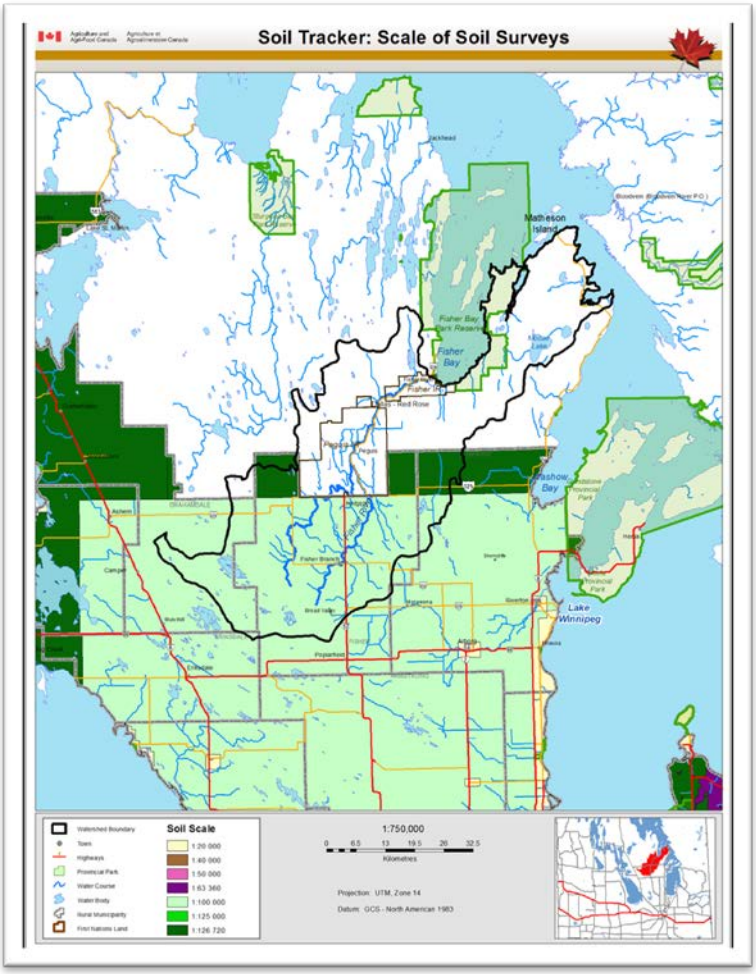
Classification Scheme: Land Cover Mapping of Manitoba	
1. Annual crop land:	Land that is normally cultivated on an annual basis.
2. Forage:	Perennial forages, generally alfalfa or clover with blends of tame grasses.
3. Grassland:	Areas of native or tame grasses, may contain scattered stands of trees
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 D: 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 1994-2006, 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 Fisher River study area, soils were surveyed at a reconnaissance scale of 1:125,000 and 1:126,720 (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 E: 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 F: 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:

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 G: 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:

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

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 H: 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 I: 2006 Census of Agriculture data

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

Watershed	Total Farmland	Total Cropland**	Summerfallow	Pasture***	Other*
Fisher River	**108,246**	**46,364**	**1,675**	**42,697**	**17,510**

*Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.
** Total cropland includes all field crops, forages, 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)*

Watershed	Total Cropland	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other
Fisher River	46,364	15,376	8,633	0	2	18,704	3,414	0

* Some data has been suppressed by Statistics Canada to preserve confidentiality of the data
** Total Cropland includes all field crops, forages, 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)

Watershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Fisher River	24,101	18,683	3,119	1,589

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

Watershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides, & fungicides	Total seed
Fisher River	$4,543,793	$2,476,820	$1,368,707	$698,266

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land, as reported in the 2006 Census of Agriculture

Watershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Fisher River	47	37	16

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

Watershed	Total cattle	Beef cows	Dairy cows	Total pigs	Sows	Total poultry
Fisher River	25,181	11,363	0	48,743	6,245	15,005

* Some 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

Watershed	Total cattle	Beef Cows	Dairy cows	Total pigs	Sows	Total poultry
Fisher River	108	104	0	8	7	14

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*

Watershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Fisher River	233	109	0	6,085	936	1,108

* Some data has been suppressed by Statistics Canada to preserve confidentiality

Table 9: Summary of farm financial characteristics in 2005, as reported in the 2006 Census of Agriculture

Watershed	Number of farms	Average farm size (ha)	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Fisher River	182	594	$881,856	$98	$95	$41,961

Appendix J: 2001 Census of Agriculture data

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

Watershed	Total Farmland	Total Cropland	Summerfallow	Pasture	Other
Fisher River	103,170	40,485	4,368	43,649	14,668

* Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.
** Total cropland includes all field crops, forages, 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)

Watershed	Total Cropland	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other
Fisher River	40,485	15,125	3,447	0	0	17,542	3,545	170

* Total cropland includes all field crops, forages, 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)

Watershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Fisher River	25,654	20,105	3,486	2,282

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

Watershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides, & fungicides	Total seed
Fisher River	$3,691,462	$1,991,635	$1,241,302	$458,524

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land, as reported in the 2001 Census of Agriculture

Watershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Fisher River	69	24	7

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

Watershed	Total cattle	Beef cows	Dairy cows	Total pigs	Sows	Total poultry
Fisher River	21,800	9,465	0	35,557	5,625	16,414

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

Watershed	Total cattle	Beef Cows	Dairy cows	Total pigs	Sows	Total poultry
Fisher River	138	132	1	8	7	9

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*

Watershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Fisher River	158	72	0	4,445	852	1,804

Table 9: Summary of farm financial characteristics in 2000, as reported in the 2001 Census of Agriculture

Watershed	Number of farms	Average farm size (ha)	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Fisher River	132	426	$568,126	$58	$103	$16,636

Appendix K: 1996 Census of Agriculture data

Table 1: Agricultural Land Use types reported in the 1996 Census of Agriculture (hectares)

Watershed	Total Farmland	Total Cropland	Summerfallow	Pasture	Other
Fisher River	100,784	36,503	4,066	44,108	16,107

* Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.
** Total cropland includes all field crops, forages, 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 1996 Census of Agriculture (hectares)*

Watershed	Total Cropland	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed
Fisher River	36,503	16,307	4,165	0	0	13,513	2,283

* Total cropland includes all field crops, forages, 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 1995 cropping year, as reported in the 1996 Census of Agriculture (hectares)

Watershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Fisher River	26,513	19,008	3,223	1,128

Table 4: Total dollars spent on crop inputs for the 1995 cropping year, as reported in the 1996 Census of Agriculture

Watershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides, & fungicides	Total seed
Fisher River	$3,455,881	$2,090,912	$978,204	$386,765

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land, as reported in the 1996 Census of Agriculture

Watershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Fisher River	52	36	12

Table 6: Total number of livestock and poultry on Census Day in 1996, as reported in the 1996 Census of Agriculture

Watershed	Total cattle	Beef cows	Dairy cows	Total pigs	Sows	Total poultry
Fisher River	18,547	8,039	119	19,043	1,581	23,030

Table 7: Total number farms reporting livestock and poultry on Census Day in 1996, as reported in the 1996 Census of Agriculture

Watershed	Total cattle	Beef Cows	Dairy cows	Total pigs	Sows	Total poultry
Fisher River	142	131	5	5	3	10

Table 8: Average number of livestock animals or poultry birds per farm on Census Day in 1996, as reported in the 1996 Census of Agriculture

Watershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Fisher River	131	61	23	3,669	475	2,324

Table 9: Summary of farm financial characteristics in 1995, as reported in the 1996 Census of Agriculture

Watershed	Number of farms	Average farm size (ha)	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)*	Average crop-related expenses ($/ha cropland and summerfallow)*	Estimated profit ($/farm)
Fisher River	234	430	$386,172	$33	$85	-$65,385

Appendix L: 1991 Census of Agriculture data

Table 1: Agricultural Land Use types reported in the 1991 Census of Agriculture (hectares)

Watershed	Total Farmland	Total Cropland	Summerfallow	Pasture	Other
Fisher River	100,006	36,115	2,964	47,242	13,685

* Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.
** Total cropland includes all field crops, forages, 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 1991 Census of Agriculture (hectares)*

Watershed	Total Cropland	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other
Fisher River	36,115	13,197	6,910	186	0	7,601	4,282	0

* Total cropland includes all field crops, forages, 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 1990 cropping year, as reported in the 1991 Census of Agriculture (hectares)

Watershed	Use of commercial Fertilizers	Use of Herbicides
Fisher River	24,244	16,774

Table 4: Total dollars spent on crop inputs for the 1990 cropping year, as reported in the 1991 Census of Agriculture

Watershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides, & fungicides	Total seed
Fisher River	$2,094,001	$1,203,254	$613,882	$276,865

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land, as reported in the 1991 Census of Agriculture

Watershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Fisher River	63	35	2

Table 6: Total number of livestock and poultry on Census Day in 1991, as reported in the 1991 Census of Agriculture

Watershed	Total cattle	Beef cows	Dairy cows	Total pigs	Sows	Total poultry
Fisher River	16,834	7,399	114	10,177	916	27,544

Table 7: Total number farms reporting livestock and poultry on Census Day in 1991, as reported in the 1991 Census of Agriculture

Watershed	Total cattle	Beef Cows	Dairy cows	Total pigs	Sows	Total poultry
Fisher River	152	143	15	19	11	40

Table 8: Average number of livestock animals or poultry birds per farm on Census Day in 1991, as reported in the 1991 Census of Agriculture

Watershed	Total cattle	Beef Cows	Dairy cows	Total Pigs	Sows	Total Poultry
Fisher River	110	52	8	526	87	685

Table 9: Summary of farm financial characteristics for the 1990, as reported in the 1991 Census of Agriculture

Watershed	Number of farms	Average farm size (ha)	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Fisher River	259	386	$301,413	$25	$54	-$46,441

Appendix M: Private and Crown Land Planning in the Fisher River Watershed

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

PRIVATE LAND PLANNING

Within the Planning Act is the Provincial Planning Regulation #81,2011, otherwise known as the Provincial Land Use Policies (PLUPs). These policies outline agriculture's interests of private land that is used for agriculture by maintaining this land as viable agricultural land, minimizing subdivision, and protecting farms from encroachment or other uses which may be incompatible with normal farming operations. Crown Lands fall under the Crown Lands Act, but Agricultural Crown Lands are ultimately integrated with private agricultural lands through land use planning via the Land Use Branch of Manitoba Agriculture, Foods and Rural Initiatives.

Provincial Land Use Policies

The PLUPs were rewritten and came into effect in June 2011 to include 9 General Policy areas. Policy Area #1 of the Provincial Land Use Policies Regulation deals with General Development while Policy Area #3 deals with Agriculture. The objectives of Policy Area #3 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.

These policies guide local and provincial authorities in preparing Development Plans and in making land use decisions. Aside from agriculture, other policy areas include General Development, Settlement Areas, Renewable Resources, Heritage and Recreation, Water, Infrastructure, Transportation, Minerals and the Capital Region. The various government departments "own" their policies and are involved in establishing them.

Development Plans

The Development Plan is an agreement between 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.

Integrated Planning
Integrated watershed planning is a community based focused planning process around issues which effective water management. 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.

Planning Districts within the Watershed
The Fisher River Watershed includes several municipalities, one provincial park reserve (Fisher Bay) and two First Nations (Peguis and Fisher River).The main RMs are Fisher, Bifrost, parts of Grahamdale and touches Eriksdale. Main Planning Districts include Fisher Branch, Hodgson Dallas-Red Rose and Broad Valley.

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 by development. 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 four issues (water quality; surface water management; natural and traditional areas, wildlife and fish) identified in the public consultation process.

Article I. Agricultural Area Land Policies - applicable in areas designated as A on Land Use Classification Maps

1. Lands designated as Agricultural Area (A) shall allow the full range of agricultural activities, subject to limitations posed by provincial legislation and regulations, Section 3.3.2 of this Development Plan, and the R.M. of Bifrost and R.M. of Gimli Zoning By-Laws.

2. Prime lands and viable lower class agricultural lands in the A area should not be developed for non-agricultural uses.

3. Prime lands and viable lower class agricultural lands shall be protected from fragmentation into smaller parcels, with a general policy guideline of 80 acres minimum to be encouraged. A more specific guidance on the minimum parcel size may be stipulated in the Zoning By-Law and generally will reflect the agricultural characteristics and capabilities of the area.

CROWN LAND MANAGEMENT and PLANNING

Overview

In ***1930***, responsibility for ***Crown Lands*** was transferred to the Province of ***Manitoba.*** Virtually all of Northern ***Manitoba***, beyond the Department of Aboriginal and Northern Affairs boundary, is what they called “unorganized territory" and is also ***Crown land*****.** Today, Manitoba’s Crown Lands are used for varying purposes, including agriculture, mining, and cottages. Other areas are set aside for research, environmental protection, public recreation, and resource management. Approximately 95% of the province's forests are on provincial Crown land.

Operations

The planning and classification of Crown land in Agro-Manitoba is the ultimate responsibility of the Crown Lands Assistant Deputy Minister’s Committee (CLADMC), formerly known as the Crown Land Classification Committee (CLCC). The CLCC was created in 1975 by the Premier of Manitoba for the specific purpose of Crown land use planning and resolution of land and resource use conflicts between departments of government. It is an interdepartmental committee with representation from Manitoba Agriculture, Food and Rural Initiatives (MAFRI), Conservation & Water Stewardship, Aboriginal and Northern Affairs, Science Technology Energy & Mines (STEM) and Local Government (IAF). This committee reports to cabinet.

The CLCC determined that to achieve its objectives, there is a need for on-the-ground planning and resource management expertise. This is achieved by creating local Block Planning Committees (BPC’s), comprised of regional specialists from those departments on CLADMC. Eight BPCs were created in 1976. The BPC’s meet every two months or as needed to discuss issues related to Crown lands in their respective regions. Minutes are then forwarded to CLADMC for final approval.

Multi-Use Concept

The Provincial Crown Land Planning Process is strongly guided by the concept of multiple resource use whereby Crown Lands may be used by both competing and complementary users. Complementary use of Crown land requires special consideration be given to management in order to ensure that one resource use does not compromise the other. One such example in the watershed is timber harvesting/livestock grazing, where a project initiated by MAFRI (Garland Project) is showing that proper management (of livestock grazing and forestry practices) can result in long term benefits to both resource users. The science and research from this project will be very beneficial in resolving a longstanding land use issue, and ultimately make more land available for complementary use. The information from this project will also assist private landowners

in terms of managing their resources (e.g.; in instances where the land management objective is to enhance both forestry potential and livestock grazing).

Management and Administration

Management and administration of Crown land is shared by Manitoba Conservation & Water Stewardship, Manitoba Agriculture, Food and Rural Initiatives (MAFRI), Aboriginal and Northern Affairs and Manitoba Infrastructure and Transportation (MIT). The Crown Lands and Property Agency of MIT is responsible for the administration of Crown land, issues leases and permits upon the direction of MAFRI with regard to Crown lands classified for agricultural uses and issues leases and permits for all other Crown lands as directed by Manitoba Conservation & Water Stewardship. Manitoba Aboriginal and Northern Affairs maintain authority equivalent to that of local government for Crown land dispositions in the Northern Affairs area.

Manitoba Agricultural Crown Lands

Agricultural Crown Lands in Manitoba are managed and regulated by the Agriculture Crown Lands section of the Land Use Branch of Manitoba Agriculture, Food and Rural Initiatives. MAFRI issues agricultural leases and permits on those lands which are designated as primarily agricultural as well as multi-use lands which may be used for agricultural purposes on a secondary or interim use-basis, subject to specific conditions and covenants required by other resource users. The section also advertises available agricultural Crown lands for lease and ensures equitable allocation.

Appendix M: 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

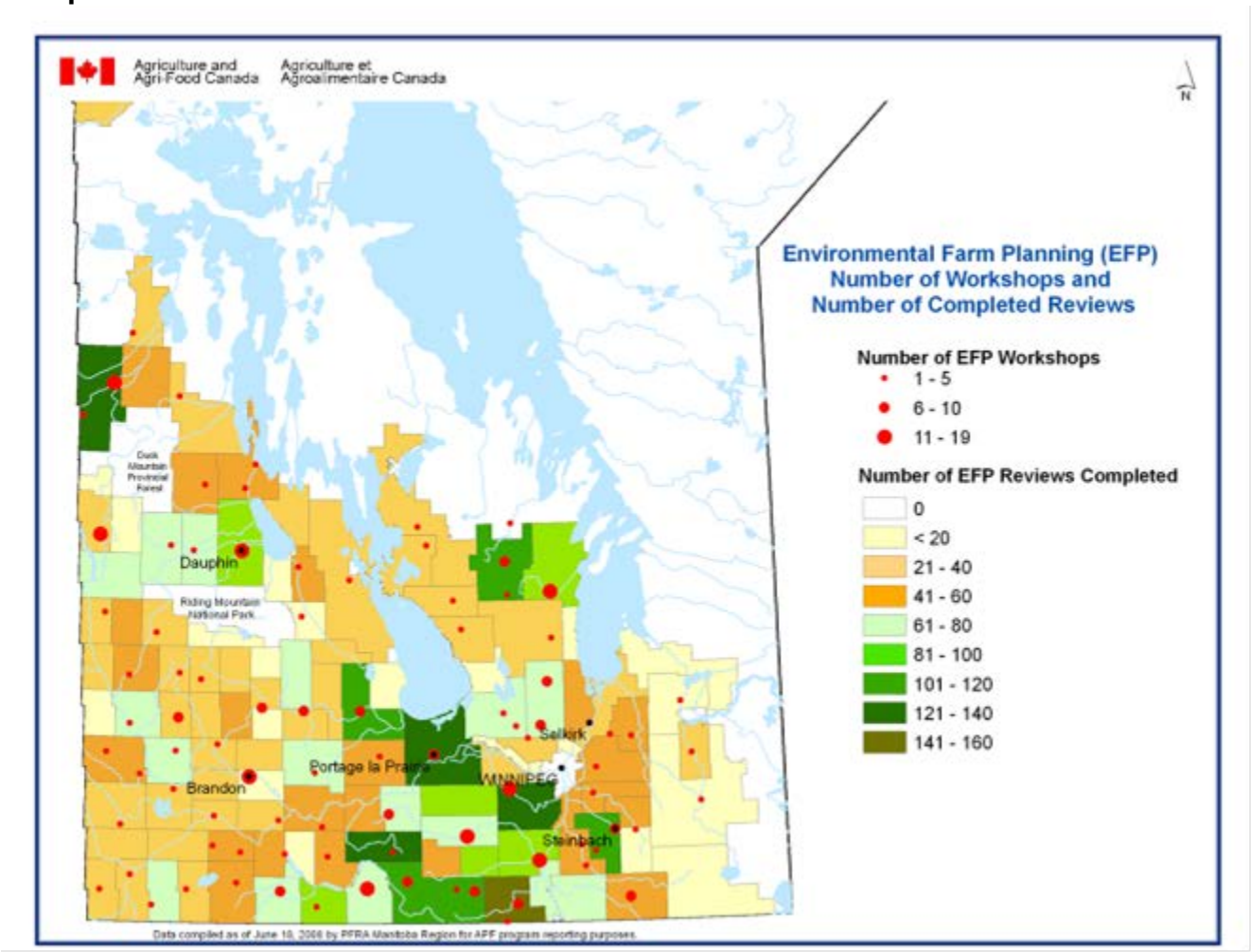
BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
09	Water Well Management					
		0902	protecting existing water wells from surface contamination			
10 10	Riparian Area Management (GREENCOVER) Riparian Area Management (GREENCOVER)	1001	alternative watering systems (ie: solar, wind or grid power)to manage livestock:	N/A	50%	$20K
		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		
		1003	fencing to manage grazing and improve riparian condition/function	# kms		
		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 N: Environmental Farm Plan Workshops and EFP Statement of Completions in Manitoba under APF



Appendix O: Growing Forward Program

Growing Forward is the foundation for coordinated federal-provincial-territorial government action to help the agriculture and agri-food sectors become more profitable, competitive and innovative. Governments are investing $1.3 billion over five years (2008 – 2013) toward *Growing Forward* programs. The funding represents $330 million more than the Agricultural Policy Framework (APF) and will be cost-shared between the Government of Canada, as well as provincial and territorial governments on a 60:40 basis.

The **Environment Suite** supports two funding avenues: Environmental Action and Environmental Information.

I. Environmental Action improves the environmental performance and sustainability of agricultural operations.

To do this, the program will provide funding for eligible Beneficial Management Practices that enhance agriculture's capacity to reduce risk to water and air quality, improve soil productivity and enhance wildlife habitat.

Programs included in Environmental Action are:

Environmental Farm Plan

The Environmental Farm Plan (EFP) Program has created opportunities for farmers to take part in a confidential self-assessment of the environmental risks and assets existing on their operations. Once producers complete the EFP program, they receive a Statement of Completion which enables them to apply for financial assistance for specific beneficial management practices through EFAP and MSAPP.

Environmental Farm Action The Environmental Farm Action Program (EFAP) is part of the federal-provincial Growing Forward suite of agricultural programs designed to support agricultural producers in reducing environmental risks specifically through beneficial management practices (BMPs). This program provides technical and financial assistance to producers to accelerate the adoption of BMPs in Manitoba to improve the environmental performance and sustainability of agricultural operations.

The EFAP provides cost-shared funding to producers to implement eligible beneficial management practices (BMPs) identified in their action plans, under such categories as:

- Increased Manure Storage Capacity;
- Improved Manure Storage and Handling;
- Solid-Liquid Separation of Manure;
- Composting of Manure;
- Farmyard Runoff Control;
- Relocation of Livestock Confinement Facilities;
- Wintering Site Management;
- Riparian Area Management;
- Improved Crop Residue Management;
- Precision Agriculture Applications; and
- Nutrient Management Planning

Additional BMP categories are available to Manitoba producers through the Manitoba Sustainable Agriculture Practices Program (MSAPP). MSAPP is the provincial climate change program for agro-Manitoba. Its main objective is to provide incentives to producers to implement practices that reduce greenhouse gas emissions from agriculture.

- Reduced Greenhouse Gas (GHG) Emissions from Manure Storage
- Manure Land Application
- Reduced Tillage
- Spring Fertilizer Application
- Perennial Cover for Sensitive Land
- Cover Crops
- Improved Pasture and Forage Quality
- Increased Perennial Legumes in Annual Crop Rotation
- Grazing and Pasture Management Planning

II. Environmental Information supports the provision of environmental information to help decision-making and improve the sustainability of agriculture.

Programs include:
Agri-Extension Environment

Activities include:
Soil Survey Program: Provide operational support (equipment, staff, etc) to create an inventory of soil properties such as pH, salinity or erosion and to map the distribution of these soil types in Manitoba to direct agricultural management practices. Farmers, government, conservation groups and commodity groups will be able to use the information to guide environmental farm planning, land-use planning, watershed management and nutrient management planning purposes.

Ecological Goods and Services Pilot Projects: The program will support research, modeling and evaluation of Environmental Goods and Services (EG&S) policy options to determine the most effective EG&S policy instrument for agro Manitoba. Different models for this program will be developed and tested on the Manitoba agro-landscape using agricultural landowners in selected pilot study areas.

Environmental Sustainability: Provides funding and technical assistance to a max of $50,000 per proponent to local producer groups and commodity organizations with an interest in agricultural sustainability to carry out applied investigation projects. The Agricultural Sustainability Initiative will support projects aimed to improve sustainable agriculture farming practices, transfer or sharing of technology and information, workshops and fact sheets. Capital items are not covered under this initiative.

Agro-Meteorology Information System: Monitors meteorology patterns throughout agro-Manitoba and develops decision-support systems through the use of real-time data dissemination that enhances risk mitigation and input efficiency tools for producers. The information uses include, but are not limited to: pest forecasting, stubble-burning authorizations and risk mitigation of weather-related threats to crop and livestock production.

Appendix P: Annual Precipitation for weather stations located in the Fisher River IWMP study area for selected years.*

Degree of Moisture Surplus
Light Blue indicates yearly amount exceeded the 30 year average by 50 millimeters
Dark Blue indicates yearly amount exceeded the 30 year average by 100 millimeters

Degree of Moisture Deficit
Yellow indicates yearly amount was lower than the 30 year average by 50 millimeters
Orange indicates yearly amount was lower than the 30 year average by 100 millimeters

Weather Station	Total Annual Rainfall (mm)						
	1993	1994	2001	2002	2005	2006	30-year average (1971 - 2000)
Fisher Branch	413.4	327.2	405.4	336	M	M	404.7
Arborg	477.8	349.4	431.6	309.6	489.6	371.8	402.5

Weather Station	Total Annual Precipitation (mm)						
	1993	1994	2001	2002	2005	2006	30-year average (1971 - 2000)
Fisher Branch	522.1	393	555.4	481	M	M	511.9
Arborg	538.5	396.4	516.6	412.1	629.6	504.3	506.1

*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
[1] Data was gathered from a community located outside the IWMP study area.
M refers to missing data.