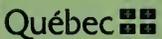
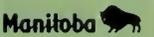


# Watershed Evaluation of Beneficial Management Practices (WEBs)



## South Tobacco Creek/ Steppler Manitoba



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# The Watershed Evaluation of Beneficial Management Practices (WEBs)

is a national project led by Agriculture and Agri-Food Canada (AAFC), with Ducks Unlimited Canada a key funding partner. Designed to measure the performance of selected agricultural beneficial management practices (BMPs) at a watershed scale, the project studies the impact of BMPs on water quality in seven micro-watersheds across Canada. Each site includes an on-farm economic assessment and a hydrologic modelling component, with integrated modelling occurring at two of the sites. WEBs was initiated in 2004 and will run to March 31, 2008.

The WEBs project has stimulated the formation of a network of living laboratories across Canada, bringing together hydrologists, economists, modellers and agri-environmental experts from government, academia and non-government organizations. The result is high quality applied research and exceptional opportunities for future collaboration in areas of common interest.

**Beneficial management practices** are science-based farming activities designed to help minimize potential environmental impacts such as sediment and nutrient runoff into water bodies. Prior to WEBs, the effectiveness of individual BMPs was evaluated largely on test plots or at a small field scale, with results extrapolated through modelling to the watershed scale. WEBs was created to address limitations to these evaluation methods by applying a suite of BMPs and studying their economic impact and effect on water quality at the micro-watershed level (i.e. approximately 300 hectares). The suites of BMPs have been specifically tailored to the unique conditions of each watershed.

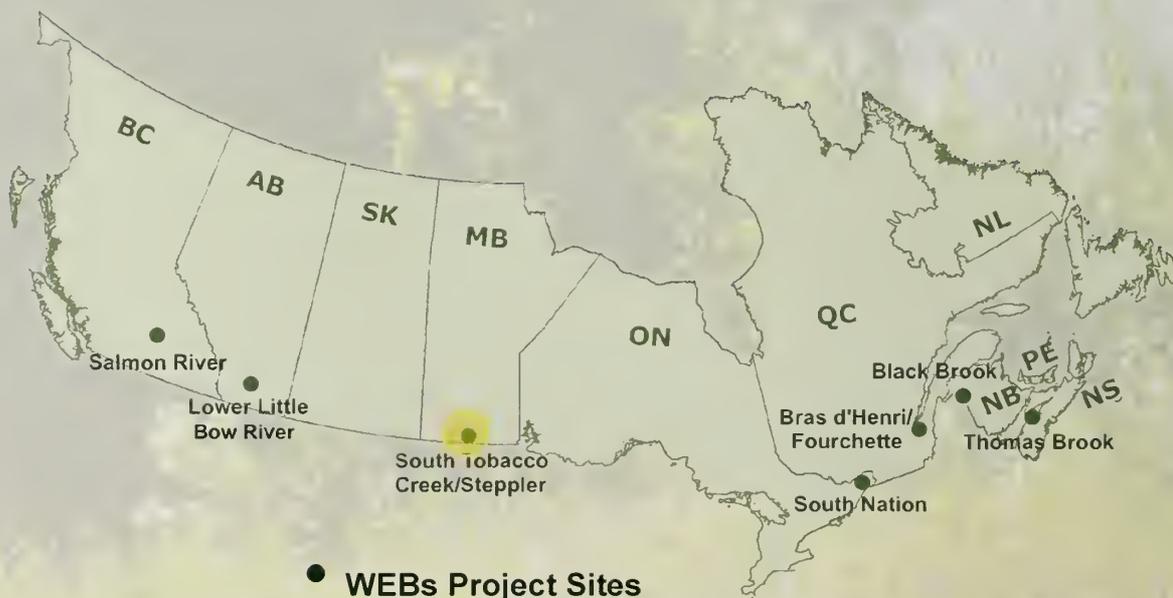
The long-term history of conditions and trends is generally well understood at each of the seven WEBs watersheds, due to past activities and data collection by local watershed associations and multi-agency teams. It is anticipated that these sites will continue as long-term benchmarks for watershed health.

**Environmental evaluations** are being conducted through a range of validation techniques to determine the impact of individual and suites of BMPs on water quality at each watershed. Methods employed include historic benchmarking, paired watersheds, upstream and downstream monitoring, and edge-of-field testing. All studies have been designed with in-field assessments, intended to yield scientifically valid and publishable results at the end of the project.

**On-farm economic assessments** are being conducted at all WEBs watersheds, using approaches that are best suited to the unique circumstances of each site. Through the development of economic models and impact assessment tools, economists will be able to determine the costs and benefits of BMP implementation scenarios. The socio-economic factors that might affect producers' decisions to adopt BMPs are also being examined.

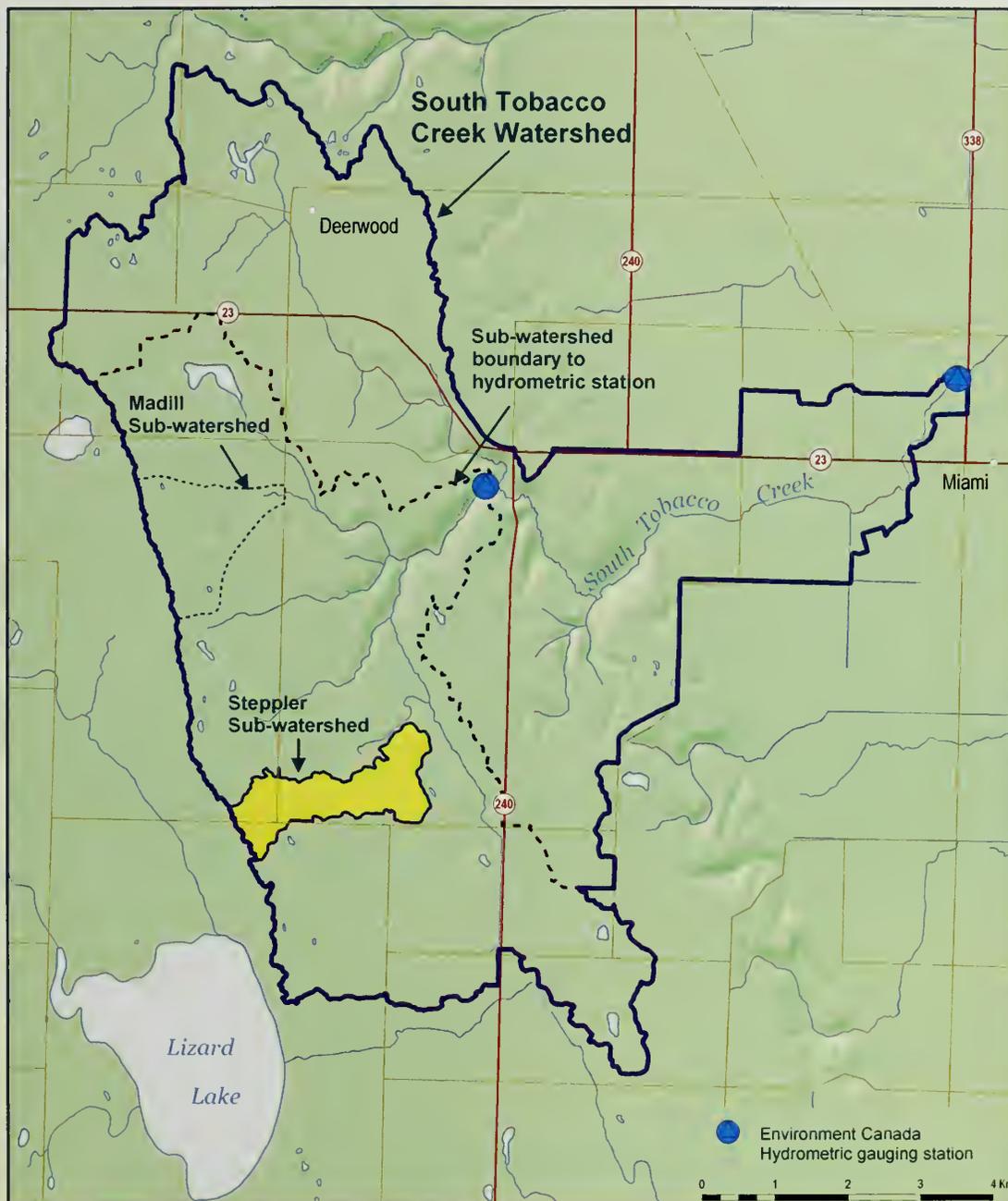
**Hydrologic modelling** is being conducted at each WEBs site in order to characterize watershed processes under baseline conditions and to examine the water quality benefits of BMP implementation. In most cases, models based on the Soil and Water Assessment Tool (SWAT) are being used to evaluate the impact of different BMP scenarios. These models are being modified to suit Canadian climatic conditions and to accommodate specific BMPs. The South Tobacco Creek, Bras d'Henri and Black Brook watershed sites are particularly well advanced in the process.

**Integrated modelling** is underway at the South Tobacco Creek and Bras d'Henri sites. This component incorporates hydrologic, environmental, economic and producer behavioural aspects into a multi-faceted decision tool at the micro-watershed and larger watershed scale. Models are being validated using actual watershed data, as opposed to data extrapolated from other studies.



## Steppler Watershed

The 206-hectare Steppler Watershed is contained within a single farm operation and is located near Miami, Manitoba, approximately 150 kilometres southwest of Winnipeg. It is a sub-watershed of the South Tobacco Creek Watershed, a site that has been the focus of scientific studies and research projects for more than 20 years, and has had a runoff/water sampling infrastructure since the early 1990s.



The South Tobacco Creek Watershed is situated on the edge of the Manitoba Escarpment such that the elevation drops nearly 60 metres in less than three kilometres. Soils are primarily clay-loams formed on moderately to strongly calcareous glacial till which overlays shale bedrock. Land use within the watershed is agricultural, with the majority of the land under annual cropping. Average annual precipitation is about 550 millimetres, of which approximately one-quarter falls as snow.

The Steppler Watershed drains into the South Tobacco Creek and then into the Morris River, and eventually into the Red River, which then flows north into Lake Winnipeg. Due to water quality concerns, the Government of Manitoba has committed to reducing the amount of nitrogen and phosphorus entering Lake Winnipeg to pre-1970 levels. Much of this reduction must come from non-point sources upstream in the watershed. Effective BMP validation may have a significant impact on where and how efforts to reduce this loading should be focused.

# Beneficial Management Practices

Five BMPs are being assessed within the Stepler Watershed and surrounding sub-watersheds.

## Riparian area enhancement and management

The runoff and nutrient loading from two riparian areas is being compared. Each study area is being managed differently; one has a rotational grazing plan, the other has no cattle access and the forage is harvested.

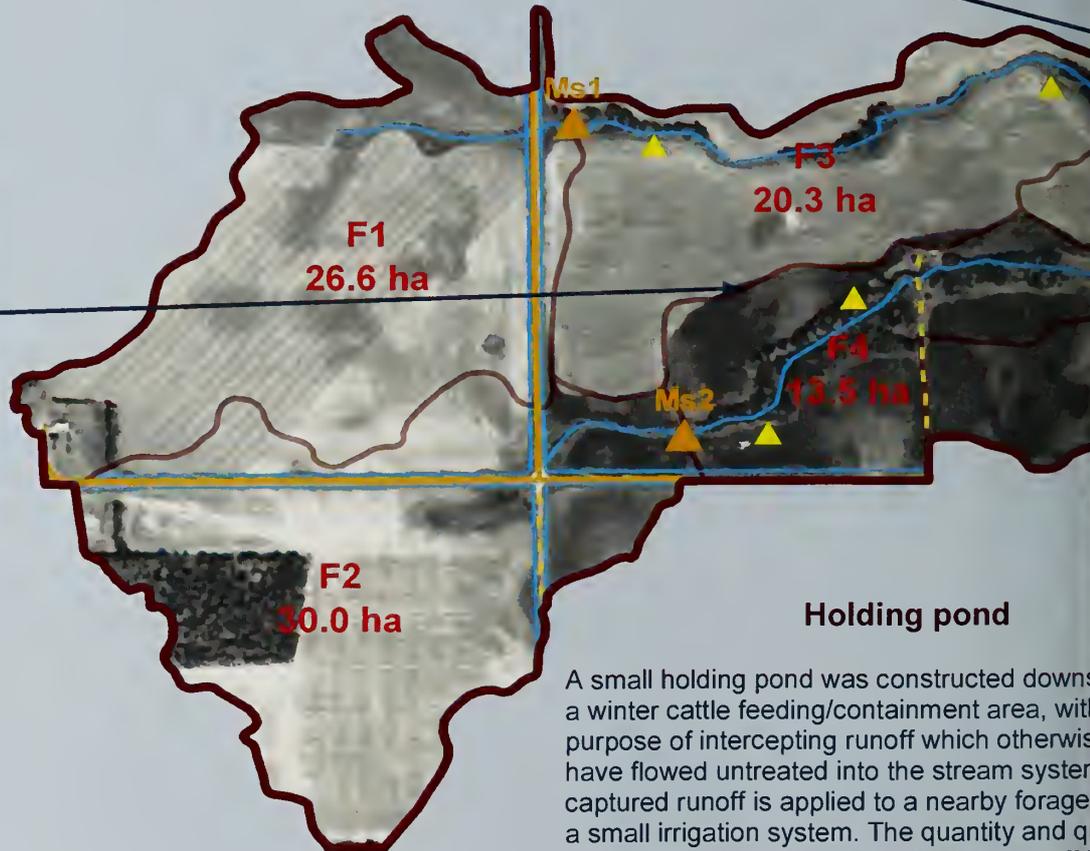
Field F5 was used to pasture cattle and as a corridor to move cattle from outer fields to the farmyard for watering. As a result, the field was often over-grazed. In order to improve the riparian, stream and pasture areas, cattle have been given limited access through rotational grazing and off-site watering. As part of the rotational grazing plan, cattle are given access to the area twice a year and are removed from the field after mid-August.



## Converting annual cropland to forage



The impact on water quantity and quality of converting cropped land (the field on the left) to forage (the field on the right) is being assessed using a twin watershed approach for two sets of sub-watersheds. Fields F3 and F9 have been left in annual cultivation and fields F4 and F7 have been converted to forage.



A small holding pond was constructed downslope of a winter cattle feeding/containment area, with the purpose of intercepting runoff which otherwise would have flowed untreated into the stream system. The runoff captured in the holding pond is applied to a nearby forage field through a small irrigation system. The quantity and quality (nutrient, sediment and *E. coli*) of the runoff is being monitored in order to assess the effectiveness of the holding pond.

# ces at the Stepler Watershed

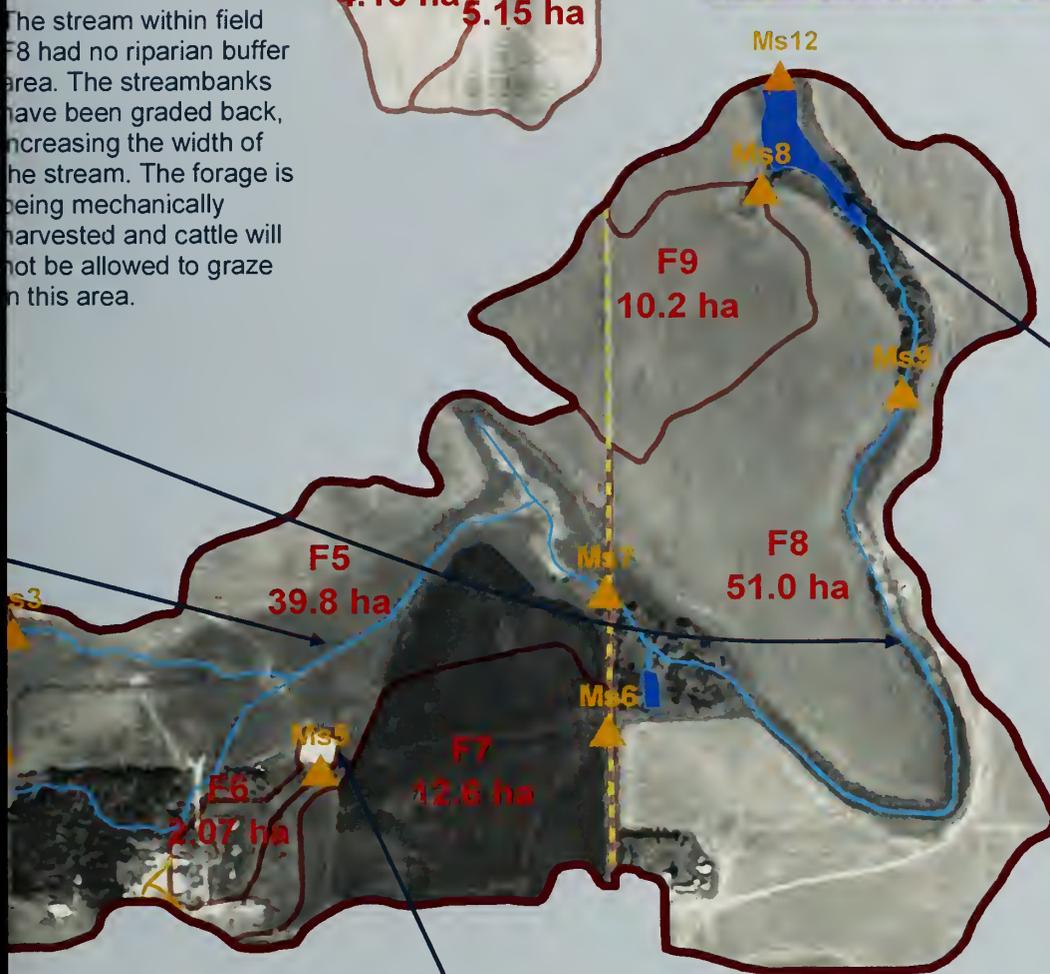
sheds.

## Zero-tillage versus conventional tillage



Two sub-watersheds (fields F10 and F11) sited outside the main study area are being used to compare the runoff and nutrient loading from a zero-tillage field (on the right) and a conventionally-tilled field (on the left).

The stream within field F8 had no riparian buffer area. The streambanks have been graded back, increasing the width of the stream. The forage is being mechanically harvested and cattle will not be allowed to graze in this area.



## Small reservoirs



Two reservoirs are being monitored for their effectiveness in reducing downstream nutrient and sediment loading and flood peaks. This photo shows the Stepler reservoir. The other reservoir is in the Madill sub-watershed (see map on page 2).

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	Stepler sub-watershed boundary
	Field boundaries
	Runoff monitoring/sampling station
	Edge-of-field manual water sampling site (and approximate location of soil, residue and snow core transects)

## Monitoring Techniques

**Water quality and quantity** within the South Tobacco Creek Watershed are monitored at 23 sites, 18 of which are part of the WEBs project (see the BMP map on the previous pages for 16 of the sites; two more are located at the Madill reservoir).

**Flow** is monitored through the use of V-notched weirs or circular flumes at 10 of the Stepler monitoring sites. Flumes are composed of a one-metre horizontal pipe containing a 300-millimetre vertical pipe.

Data loggers, in conjunction with water-level monitoring equipment, monitor flow and activate auto-samplers at each of these sites. Water sampling is runoff-event based. The data loggers, auto-samplers and solar power supply are stored in small sheds adjacent to the flumes.

**Water levels** in the two reservoirs (Stepler and Madill) are monitored using electronic water-level recorders. The levels are used to calculate the inflow and outflow rates, using reservoir parameters and reservoir-routing software in conjunction with the physical parameters for each reservoir.

**Water quality samples** are collected from the auto-samplers on a daily basis by a field technician and sent to a laboratory for sediment and nutrient analysis. Other samples are taken manually for bacterial analysis both upstream and downstream from the cattle containment area.

**Soil moisture data** is collected throughout the growing season in fields F10 and F11. Continuous soil moisture monitoring is provided using moisture probes in conjunction with data loggers.

**Climate data**, including rainfall depth (measured on a continuous basis), are collected at two locations (Ms10 and Ms4). Producers within the South Tobacco Creek Watershed also record daily rainfall accumulations at their farm sites. Air temperature and wind speed and direction data are also collected at monitoring site Ms10.



Picture above:  
Circular flume at  
monitoring station  
Ms6



Picture left:  
V-notch weir at  
monitoring station  
Ms11

**Residue, soil and snow core sampling** occurs on defined transects in fields F3, F4, F10 and F11, just upstream of the manual water sampling sites as shown on the map on the preceding pages.

**Soil samples** are collected each fall to determine any changes in soil nutrients.

**Snow core samples** are collected every spring and assessed for water and nutrient content. The water content is used in conjunction with a snow survey to estimate runoff potential in fields F10 and F11.

*Pictures from left to right: Snow core collection at F10, auto-sampler and data logger in equipment shed at Ms1, meteorological station at Ms11, manual water sampling from below the Madill Dam*



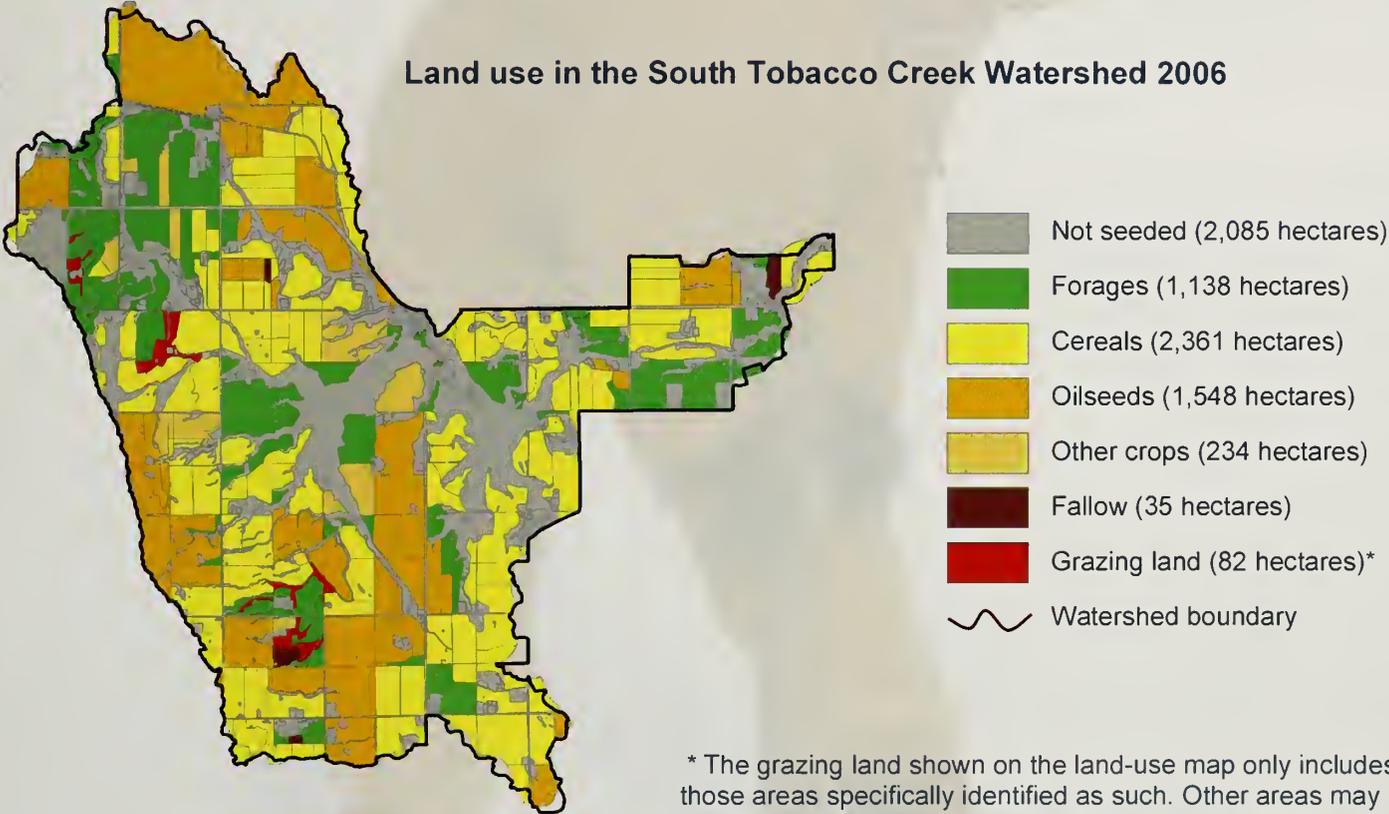
**Residue (trash or surface material)** is collected just before snowfall and after the producer has completed tillage. The collected material is assessed for nutrients using an aqueous extraction technique.

A comprehensive **collection of agronomic data** exists for the South Tobacco Creek Watershed as producers have been providing researchers with this information since 1992. Land-use data (see map below) will be combined with economic data to provide a benefit-cost analysis for the implementation of BMPs.

All information collected from the samples and data is being used to determine the impact of the BMPs on water quality, and to contribute to a record of the watershed's land-use history.



*Residue collection at the conventional tillage site*



\* The grazing land shown on the land-use map only includes those areas specifically identified as such. Other areas may also be used as pasture, such as riparian areas within the land marked as not seeded.

A **hydrological model** based on the Soil and Water Assessment Tool (SWAT) is also being developed and has been calibrated successfully at the project site. In addition, the South Tobacco Creek Watershed is one of two WEBs project sites where data from the economic and hydrologic models are being fed into an **integrated model** in order to enable predictions of economic and environmental tradeoffs of BMPs, both at the farm and micro-watershed scale.

WEBs studies will lead to a greater understanding of the ecology of the South Tobacco Creek/Steppler Watershed, thus bringing us a step closer to achieving improved water quality and a clearer picture of the value of BMPs for agriculture and the environment.

Methods and findings from this study may one day be applicable to larger watersheds and contribute to a better quality of life for more Canadians.



## Project Partners

WEBS is a multidisciplinary project led by Agriculture and Agri-Food Canada, with Ducks Unlimited Canada a key funding partner. Various other provincial and federal government departments, universities, and conservation groups are also providing valuable cash and in-kind contributions. The support of local producers and watershed associations has greatly contributed to the project's success. The project's overall national budget totals more than \$16 million.

Other participating partners in the South Tobacco Creek/Steppler WEBS project include: the Deerwood Soil and Water Management Association (an established farmer-run conservation group); Environment Canada; Fisheries and Oceans Canada; Manitoba Water Stewardship; Manitoba Agriculture, Food and Rural Initiatives; the University of Manitoba; and the University of Guelph.

The local landowners, Dale and Caroline Steppler, are supporting the project by incorporating the BMPs and working with the technical experts to assess the BMPs.

## Further Information

For more information on the South Tobacco Creek/Steppler Watershed project, please contact:

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