



Saskatchewan
Agriculture, Food
and Rural
Revitalization

2003 Surface Water Quality Monitoring Report For Intensive Livestock Operations



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2003 EXECUTIVE SUMMARY

This report summarizes data collected by Agricultural Operations as part of its Intensive Livestock Operation (ILO) water quality monitoring program. In general, there is no evidence or apparent trend indicating that surface water is being compromised by the monitored ILOs.

Overall, the results from year to year are similar. There are occasional spikes of elevated water quality along the flow path of the surface water systems, but generally, the downstream water quality appears to be the same as, or in some cases, better than the upstream sampling points. In some years, spring runoff for some of the sampling locations is very low or non-existent and samples were not collected.

For areas with livestock wintering on the river system itself, there has been little sampling conducted to determine if there are any major water quality impacts. For these operations, it is difficult to determine what degree of impact exists. To date, the main emphasis on surface water quality monitoring has been with respect to manured areas. We have looked at a couple of operations that have made improvements to their management practices, and hence, water quality under the guidance of Agricultural Operations staff. Results will be used to direct program activities and priorities.

Agricultural Operations thanks the ILOs for their cooperation. The data collected from these operations is being compiled and used to enhance understanding of environmental effects each type of operation may have on the environment.

INTRODUCTION

The purpose of this monitoring report is to summarize information on the environmental impact that ILOs may have under different types of conditions throughout the Province of Saskatchewan. The information will aid in determining the trends and impacts on existing surface water and groundwater. This information has been assembled by Agricultural Operations, which is a part of the Inspection and Regulatory Management Branch within Saskatchewan Agriculture, Food and Rural Revitalization (SAFRR). Some of the important monitoring locations deal with drainage of agricultural land, wetlands management, riparian management, groundwater sensitivity, sensitive soil conditions and operational management with the ILOs.

Data in this report is from voluntary monitoring programs, SAFRR's own monitoring program and monitoring programs required as a special condition of approval. Monitoring programs required as a special condition of approval usually consist of inspecting existing wells, conducting field measurements, acquiring water samples for chemical and bacteriological analyses, and developing a report for each monitoring program. In some cases, a surface water monitoring program is required. Agricultural Operations has taken on the task of performing the monitoring required for some sites to aid in understanding the impact of livestock on the environment.

SAFRR is monitoring spring runoff water in eight regions of Saskatchewan in cooperation with Saskatchewan Environment (SE).

SURFACE WATER QUALITY

There are many users and functions that take place near or on the surface water that can influence the surface water quality. Water quality varies in every area of the province, mainly because of the different soil types and varying vegetation cover.

SAFRR has focused on the major nutrients and bacterial quality of the surface water in this report. These parameters are major constituents in the composition of manure. It is important to note that a majority of manure spread or injected on the land is used as a nutrient resource for crop requirements and is not a waste product. These nutrients, without losses to the air through volatilization, remain tied up in the top 300 mm of the soil. Manure is not spread in excess because the result of excess manure or fertilizer is crop damage and poor crop yields. The major nutrients provided by manure are nitrogen, phosphorous, potassium and sulphur.

Sources of nitrogen and phosphorous can be found in commercial fertilizer, manure, detergents, and naturally in soil. Elevated levels of phosphorous can increase the potential of accumulated algae and weed growth in an aquatic system. This excessive growth can deteriorate the water quality in surface waters, leading to eutrophication of water bodies. Eutrophication is the aging of a pond, lake or slow moving stream cause by increased organic material that eventually uses the oxygen in the water. Over time, this water body would fill in and become dry land. This process is accelerated by the excessive vegetative growth that results from excess nutrients in the water body.

The following pages in this report give a brief outline and description of the watercourse being monitored and charts noting the bacteria and nutrient levels of most of the watercourses.

I. SAFRR and SE Joint Monitoring

In 1998, SAFRR partnered with the Environmental Protection Branch of SE to conduct a three-year monitoring program. This three-year monitoring program has since become an annual monitoring project as more of this important information needs to be collected to better understand any effects the ILO industry may have on the environment. The monitoring program was designed to establish a baseline of the surface water quality near several large intensive hog operations in Saskatchewan. Four areas selected had ILOs that spread manure near watercourses on a regional scale. Data was collected during the spring run-off events for the years of 1998 to 2003.

Unfortunately, the runoff for the past couple of years has been limited and there were only three samples collected from all areas in total for 2002 and only one in 2003. More runoff



events are required to evaluate the water quality trends that may be occurring. The areas selected for the baseline study are described by the watercourses; i) Dellwood Brook/Burr

C&D ditch, ii) Lanigan Creek, iii) Duck Creek/Meadowbank Creek and iv) the Leather River/Sweetwater Creek area.

The water samples are analyzed by the Provincial Water Laboratory and compared to Provincial Surface Water Quality Objectives. The results are also compared to Municipal Drinking Water Quality Objectives to use as an indication of the quality of water for drinking purposes. Since the monitored surface water has not been through a treatment process, it is not expected to meet Drinking Water Quality Guidelines and is only compared to the guidelines as a tool to compare the quality of the water.

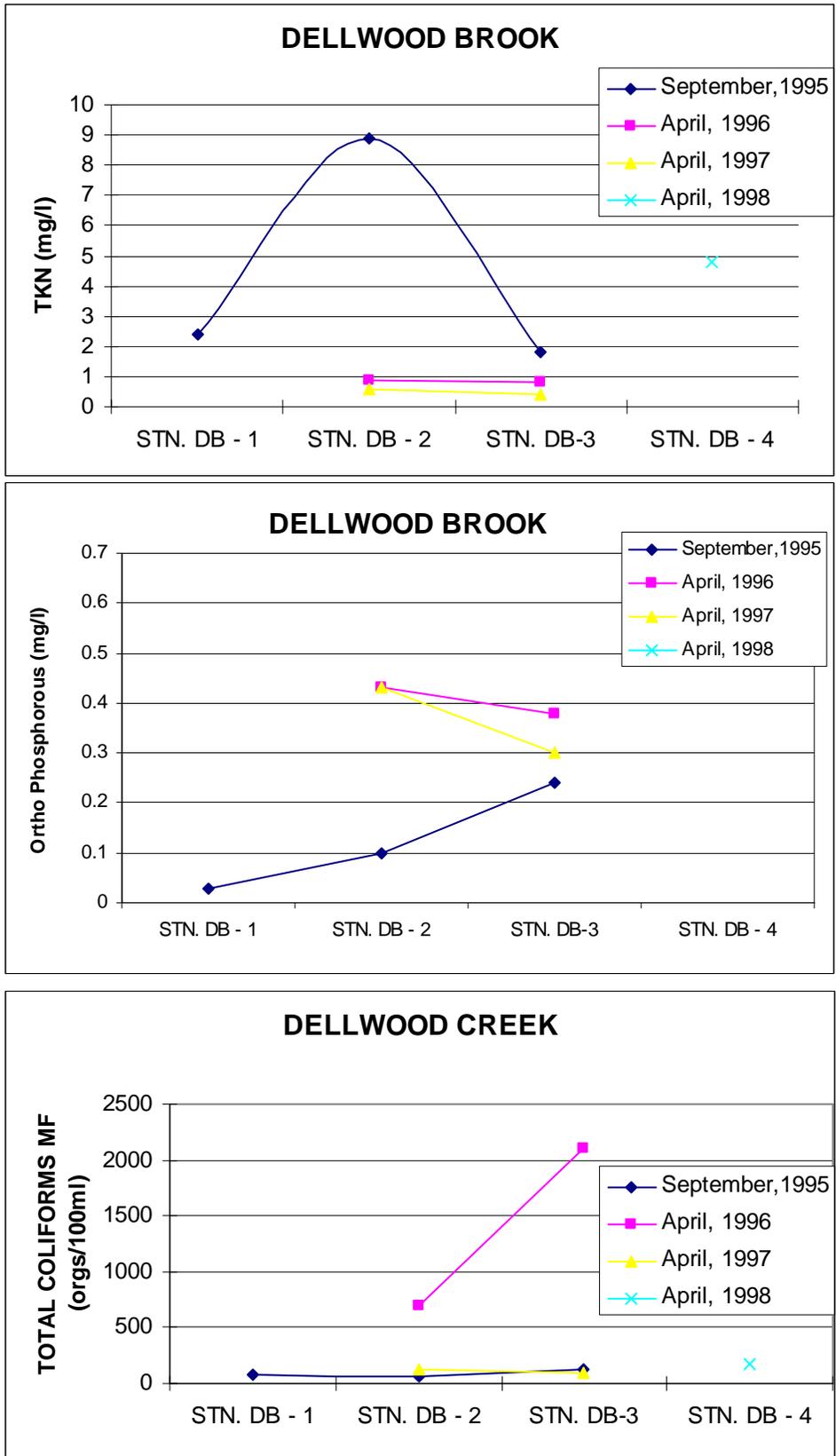
i. Dellwood Brook and Burr C & D Ditch RM 340 and 310

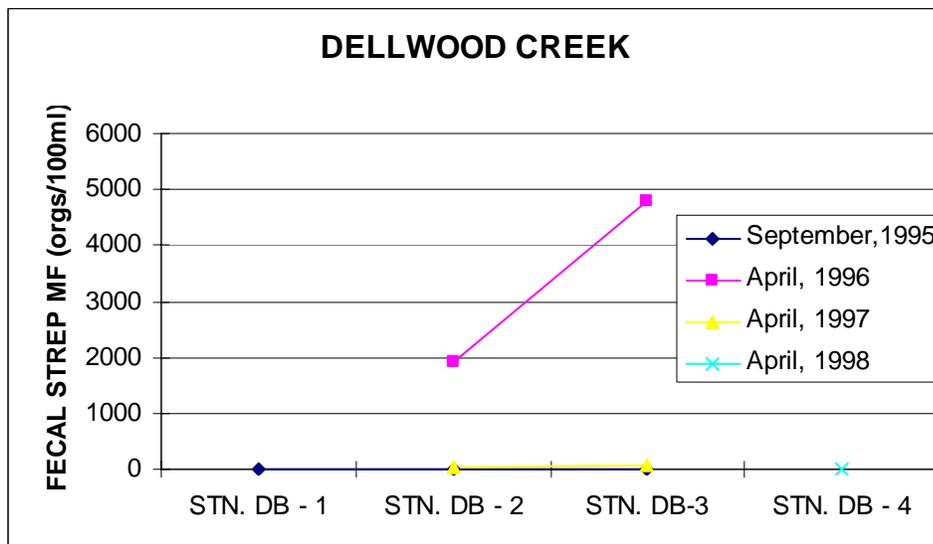
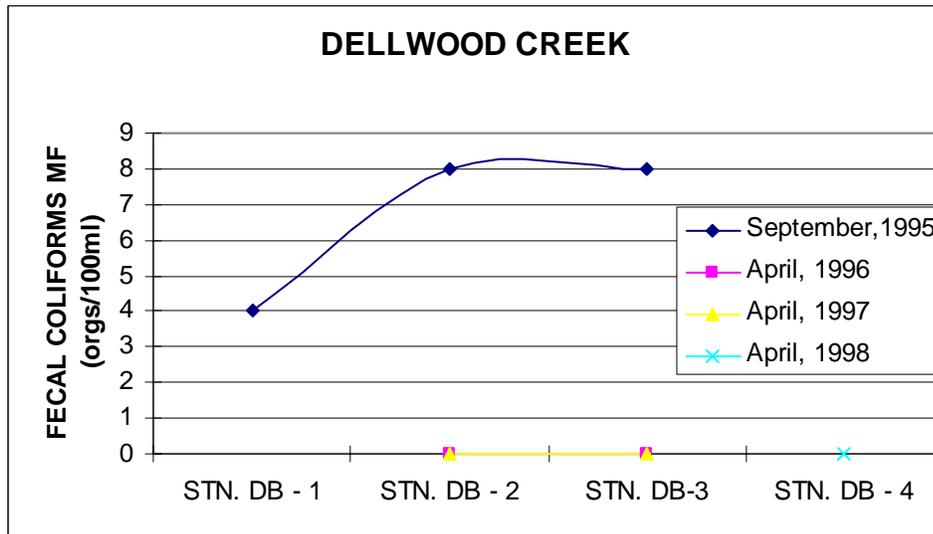
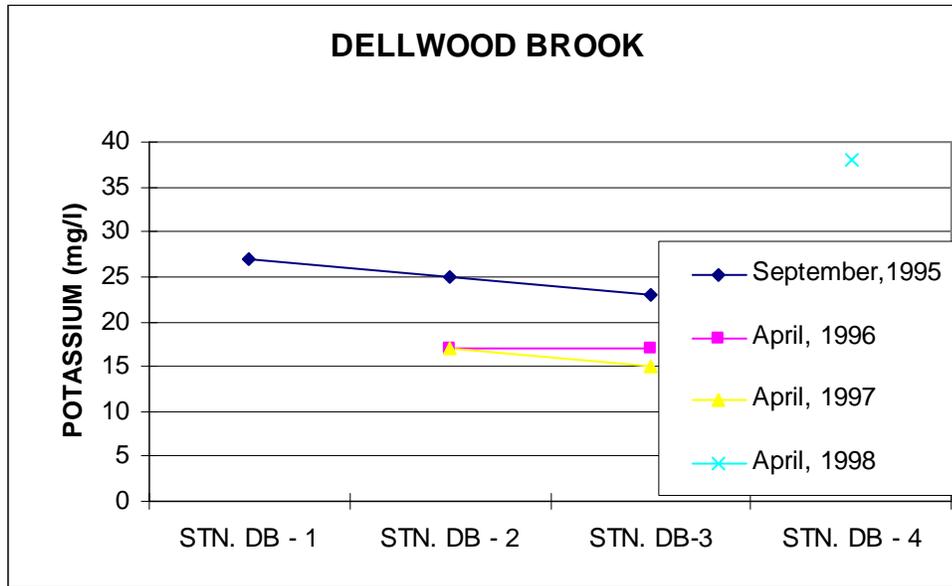
The Dellwood Brook area was selected to complement the previous data that had been collected jointly by SE and SAFRR. Data has been collected in years of flow at this location since 1995.

The results vary considerably over the period of sampling, likely because of the difference in spring water runoff volumes over the years of study. SE reports that all water collected to date in the Dellwood Brook area has met the surface water quality objectives for the primary water uses.

The water quality at Dellwood and the Burr ditch varies considerably from one another even though they are in close proximity to each other in the province. This would also be true at other locations throughout the province. The water quality at streams or creeks close to each other may also vary greatly. There are many factors that may affect the water quality of a given watercourse at any given time.

The following charts show the water quality of the Dellwood Brook watercourse for each year of sampling from upstream to downstream locations:





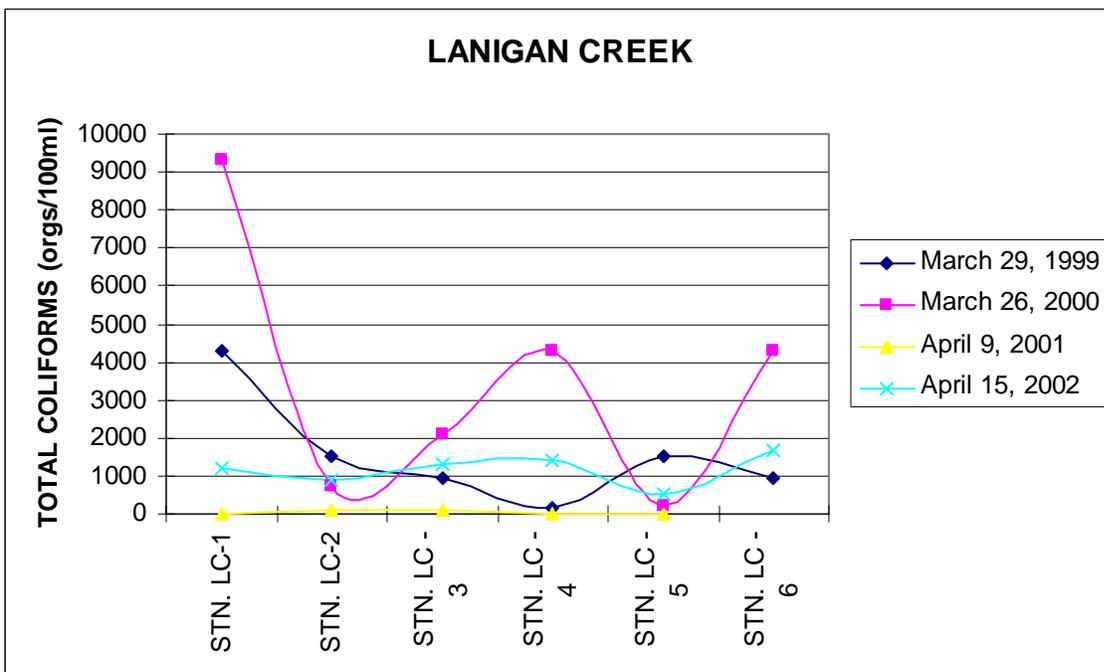
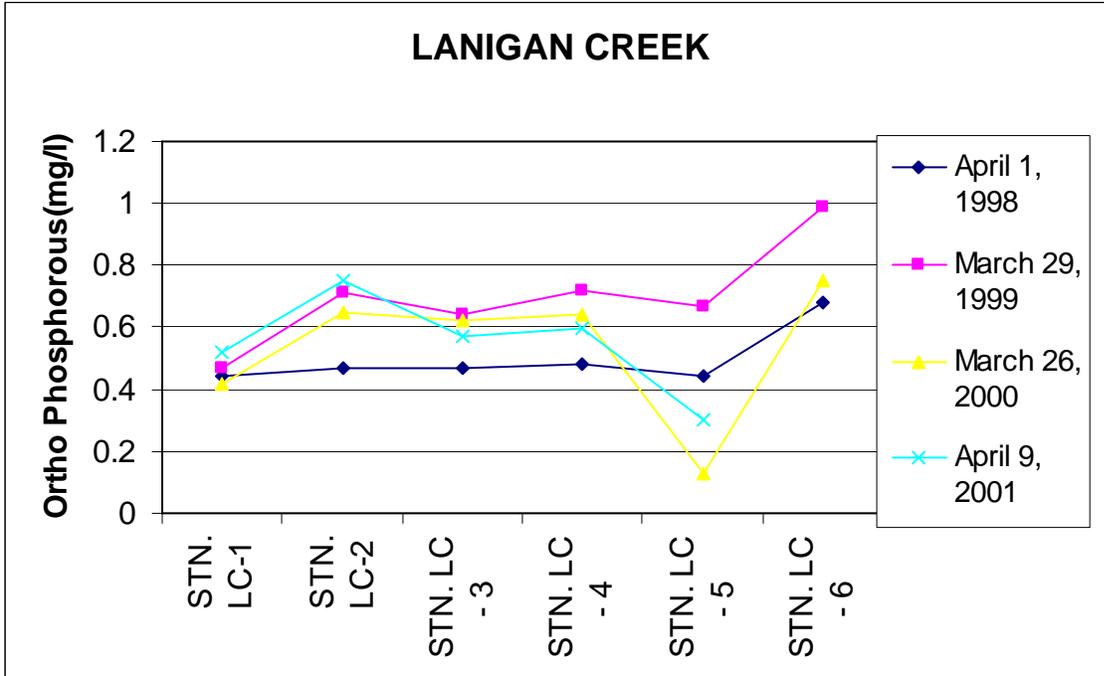
ii. Lanigan Creek – RM 310 & RM 339

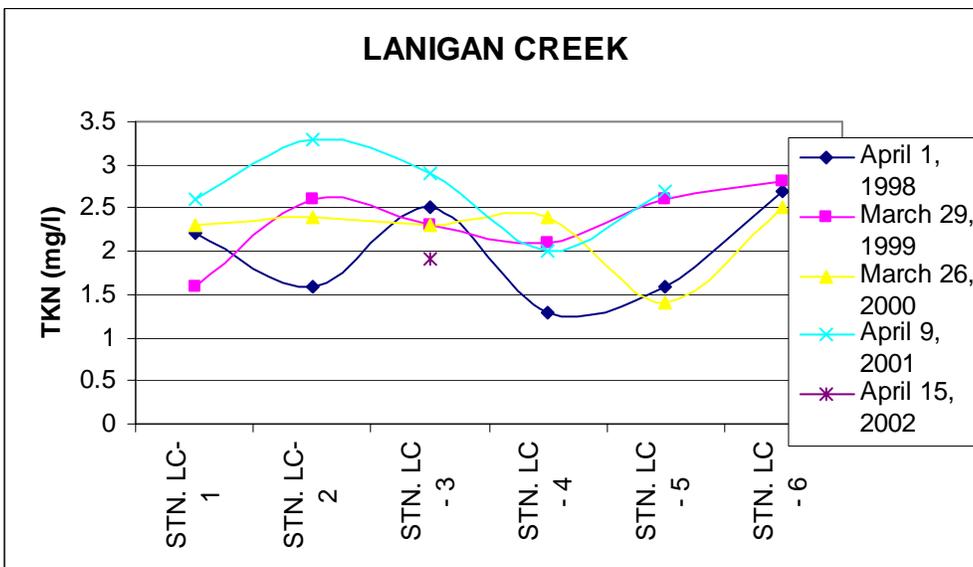
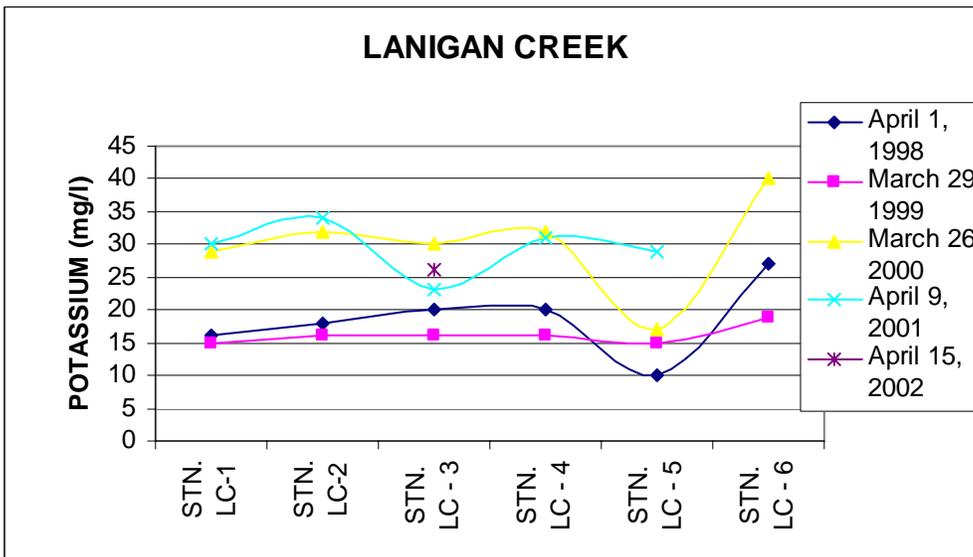
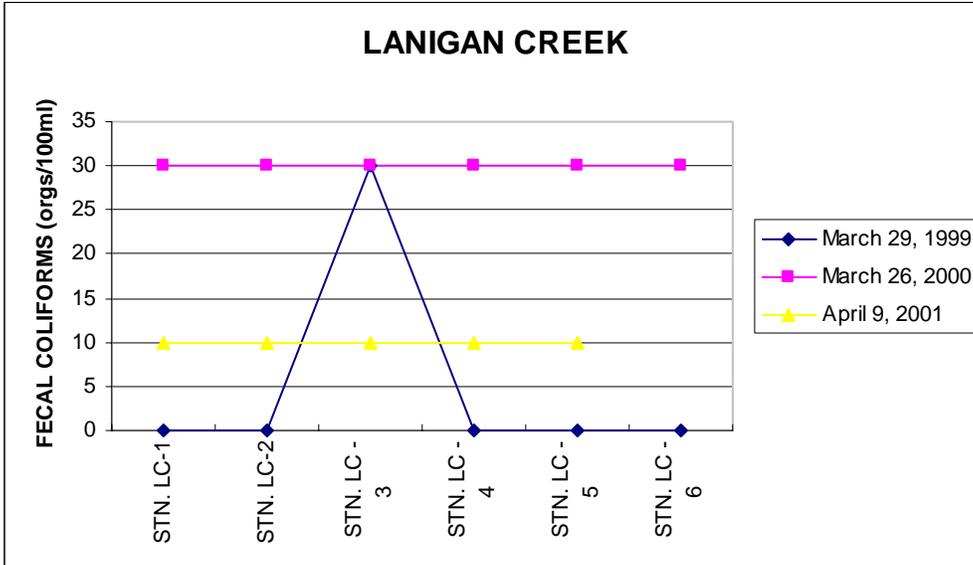
The Lanigan Creek was selected for monitoring because it has a continuous flow during most years and there is also a significant amount of manure spread in the drainage basin. There are six sampling locations along the Lanigan Creek that were sampled for the first time in 1998. After the first year, SE reported that the water quality objectives were met overall. However, SE noted higher than acceptable levels of Fecal Streptococci (Fecal Strep). Fecal Strep can be found at greater distances from the source than other types of coliforms because it is more resistant to the natural purification processes.

SE indicated that, for the year 1999 sampling, the laboratory would perform Most Probable Number (MPN) bacterial tests. This was done because the water was quite turbid in 1998, and that may have affected the results of the Fecal Streptococci. Fecal Coliforms originate from inside a warm-blooded animal's intestinal tract and some common forms of Fecal Coliforms are known as Escherichia Coli or E-Coli. In surface water, coliforms are a reliable indicator for the safety of human consumption. Total coliform includes a variety of natural bacteria, most of which are harmless. These bacteria are mainly from the organic breakdown of natural vegetation. The presence of total coliform does not mean there are disease-causing organisms in the water, but can be used as an indicator to suggest that the water supply may include harmful bacteria.

In 1999, the results of the six sampling locations versus 1998 show that the water quality in 1999 is much better than 1998, which could be attributed to higher flow and more dilution. In 2000, the results indicate that, with very little runoff, there was little to no effect on the water quality from the manure spreading area. The fecal coliform levels were indicated as < 30, which could indicate no organisms were found in this sample, but because of dilution factors, the test conducted is only accurate to less than 30 organisms. For the 2001 runoff event, five of the six locations were sampled. There was less flow than the previous year and very little runoff. This low runoff event appears to have allowed for the concentration of some of the parameters, but they were still well below the surface water quality guidelines. Very little flow in 2002 resulted in only one location being sampled and, therefore, the data is of limited use. The information collected to date indicates the water quality has remained fairly consistent over the past four sampling events.

The following charts show the water quality of the Lanigan Creek watercourse for each year of sampling from upstream to downstream locations:





iii. Duck Creek/Meadowbank Creek – RM 336 and RM 366

SAFRR made a commitment to the general public to conduct background water characteristics because of public concern in the Kelvington Super Swine project. The manure spreading locations and barns are near the Duck Creek and the Meadowbank Creek. These two watercourses flow intermittently and there are good monitoring locations along each waterway. There are six sampling locations along the Duck Creek and Meadowbank Creek waterways. They have been sampled during the spring run-off since 1997.

In 1998, many of the results were 200% of the reported values from 1997, likely because of lower flows in 1998 versus above average flows in 1997. In 1999, most locations except for Station 5, on the Duck Creek, were at lower levels than initial 1997 data. Station 5 continued to rise to slightly higher levels than previous location's tested parameters. In 1999, at the time of sampling at Station 5, there was a high volume of water entering the Duck Creek from an adjacent field. This run-off directly entered the sampling location and may have affected the results because there has not been adequate mixing of the two water sources. Overall, the water quality is very good and has low levels of bacteria.

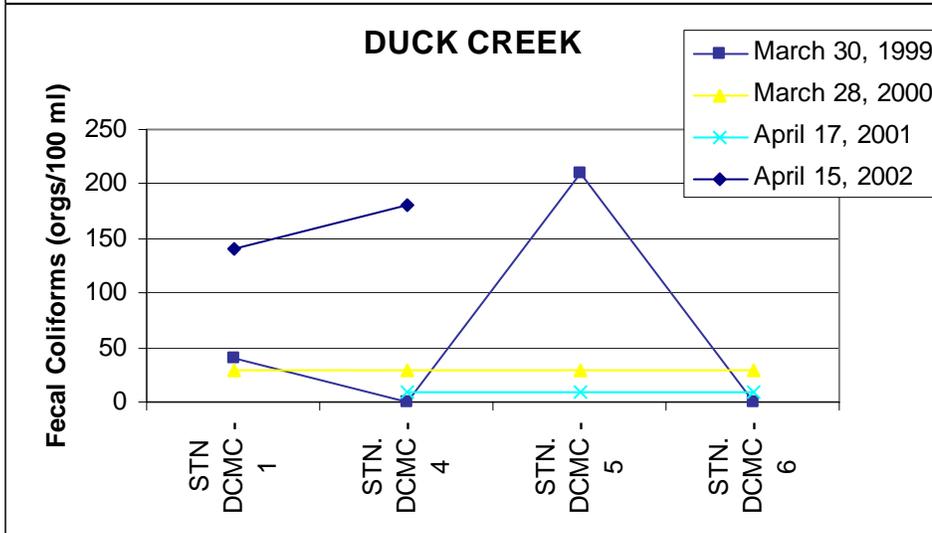
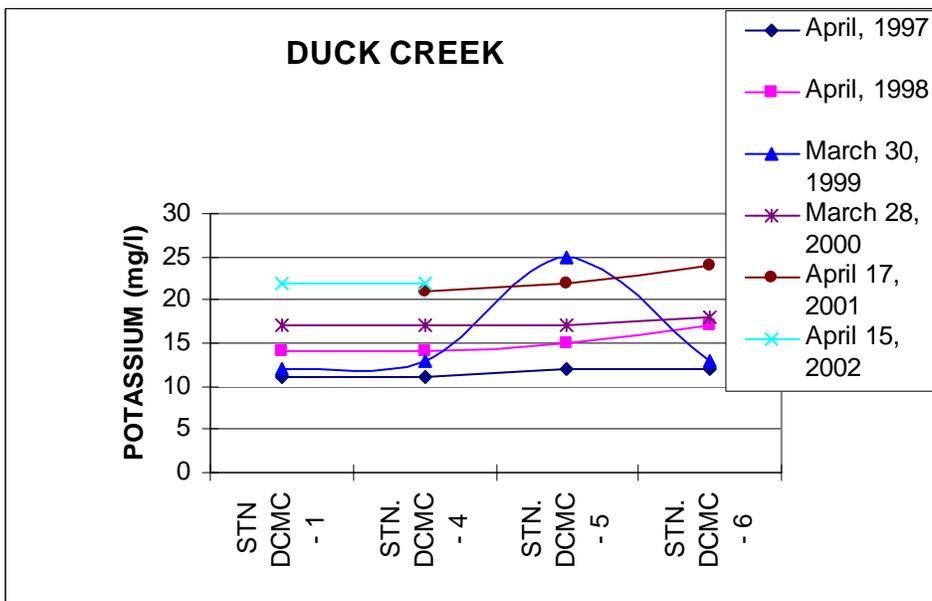
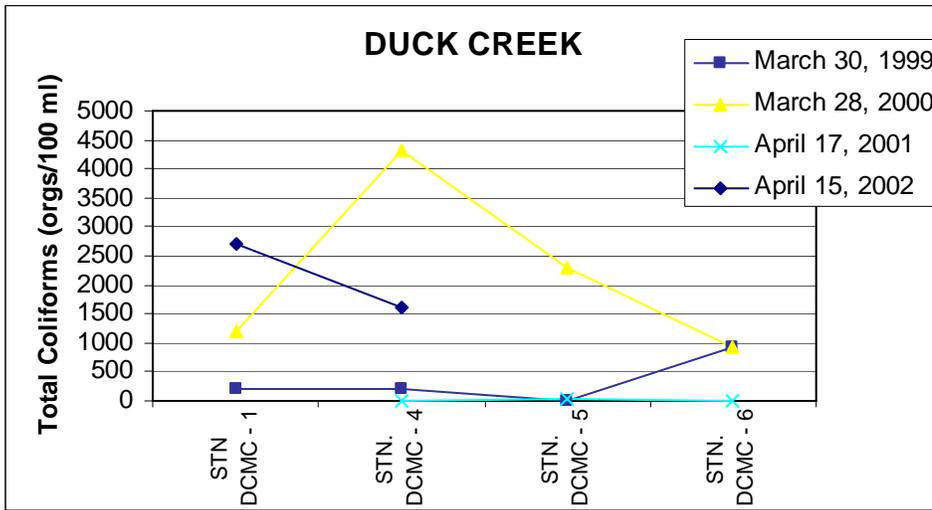
Two new locations were also tested for water quality in 1999. Location 2A was created close to location DCMC - 2. This was done because DCMC - 2 was still frozen and had little or no flow and the new location was flowing very well. Location 1A was also sampled because of its flow capacity and its overland flow pattern during high flow times like the spring runoff. This location is in the watershed and is located just south of DCMC - 1.

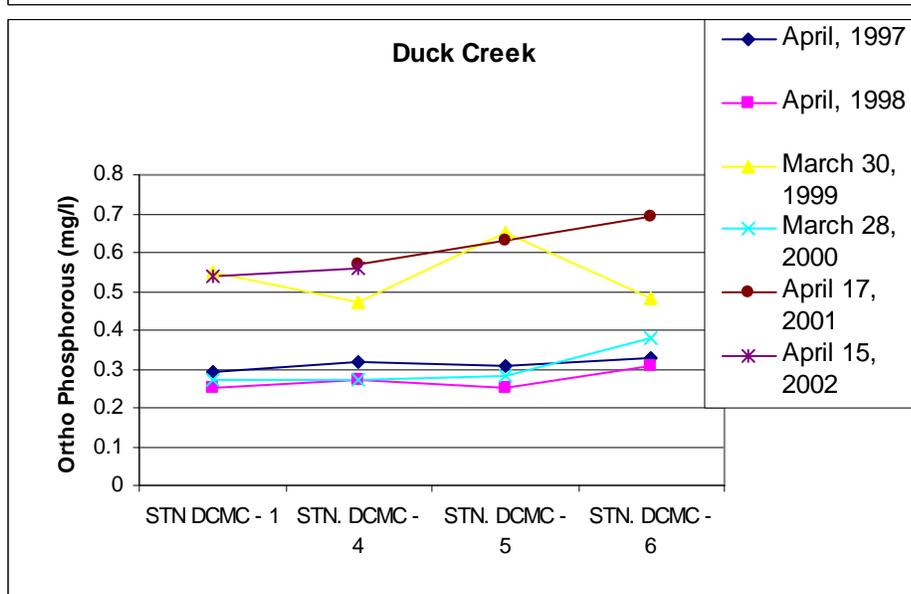
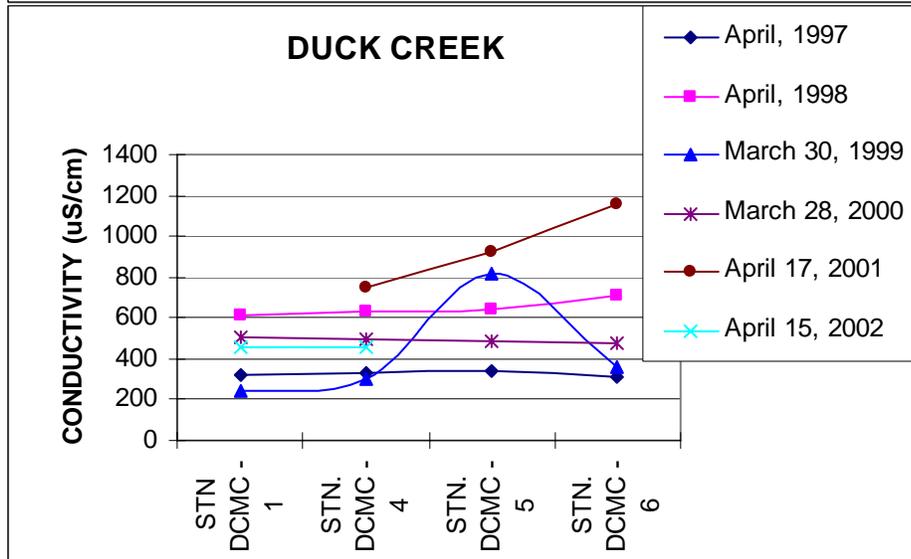
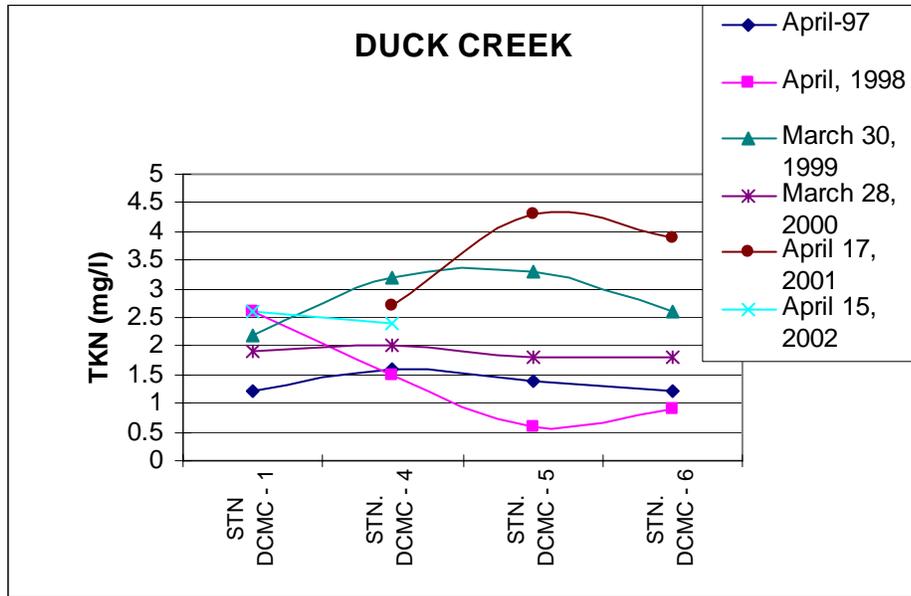
In the 2000 sampling event, there was a lower discharge throughout the entire drainage system, which resulted in little runoff. Most parameters were similar to previous years. The nitrates and fecal coliforms were less than previous years, and the fecal strep colonies continually lowered from upstream to downstream locations. In general, the trend of the water quality in Duck Creek slightly improved or had slightly lower parameter values from upstream to downstream.

For the 2001 runoff event, there was only flow along the Duck Creek. This flow was very low when compared to previous years. When the data is compared to previous years, it shows that the nutrient levels are slightly higher than previous years. These nutrient levels were higher all the way through the sampling area and have not changed significantly enough to warrant concern. These results show that, with limited runoff, the nutrients are slightly more concentrated and already exist naturally within the watercourse.

For the 2002 runoff event, because of low flows, there were only two samples taken along Duck Creek. These were Station 1 and Station 4. These two locations have a water quality that is consistent with the data from previous years.

The following charts show the water quality of the Duck Creek watercourse for each year of sampling from upstream to downstream locations:





iv. Leather River/Sweetwater Creek – RM 427 and RM 428

There are two major ILOs in the immediate basins of the Leather River and Sweetwater Creek. Fields near both the Leather River and Sweetwater Creek are available for manure application. The impact on Leather River is harder to determine because manure spreading has already taken place over many years. As for the Sweetwater Creek, SAFRR will have background data along with data after manure has been spread in the Sweetwater Creek Drainage basin. The intensive livestock operation did not spread manure prior to the 1998 sampling. This area was first sampled in 1998. All locations except Station 6 were sampled in 1998. The results of the 1998 data show that the water quality in that area meets the surface water quality guidelines.

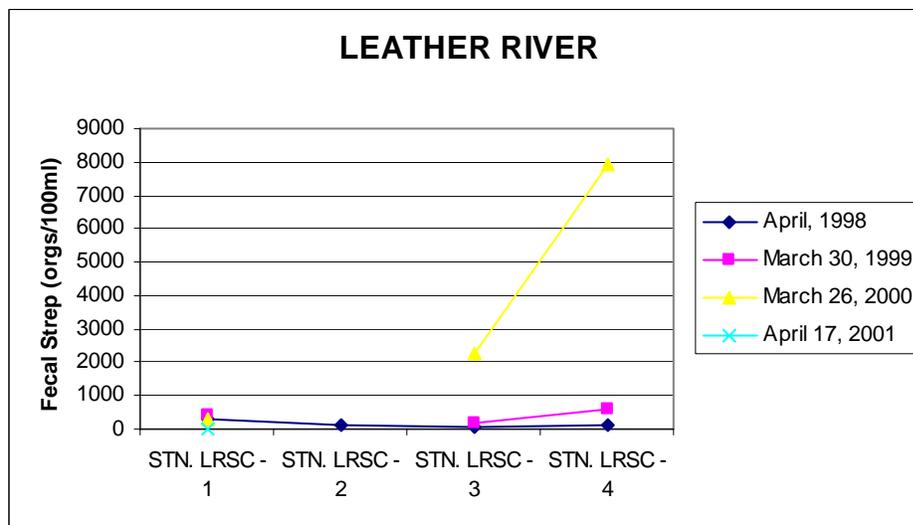
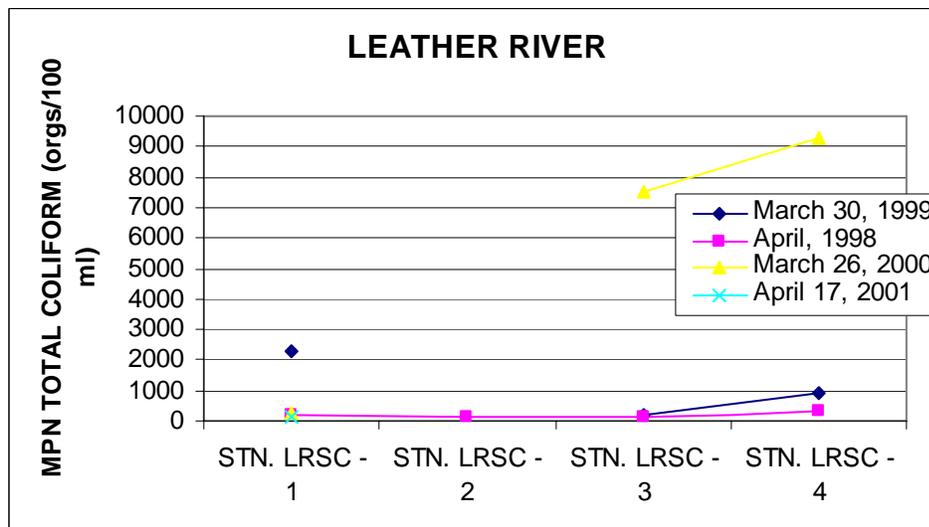
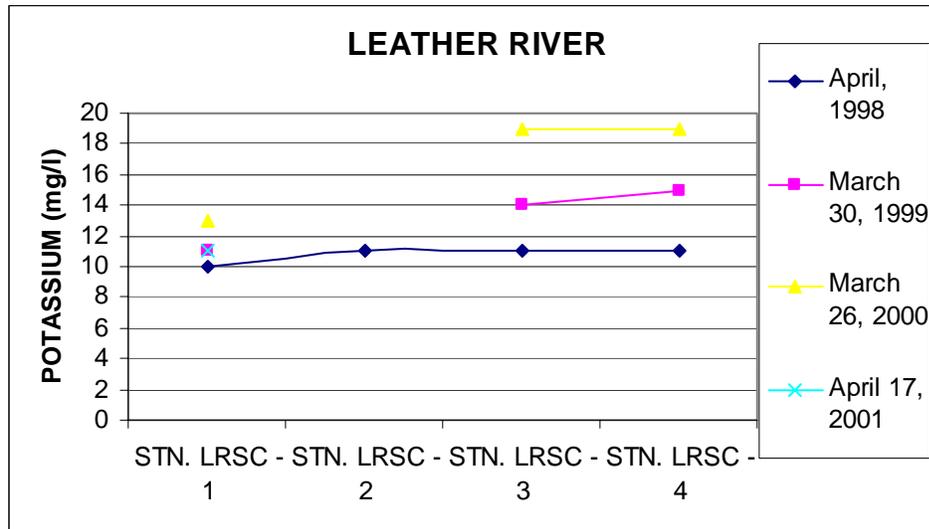
After sampling in 1999, which had a lower than normal snowmelt over the region, the data shows approximately the same values as in the previous year. Site 1 is the only location that had slightly higher values for most parameters. Station 1 had a low discharge that may indicate less mixing and more concentration. Station 1 is upstream of the manured areas. Station 1 is located upstream approximately four miles south of the ILO site and the Leather River flows in a northerly direction. Station 2 was not tested in 1999 because there was no access to this location at the time of sampling.

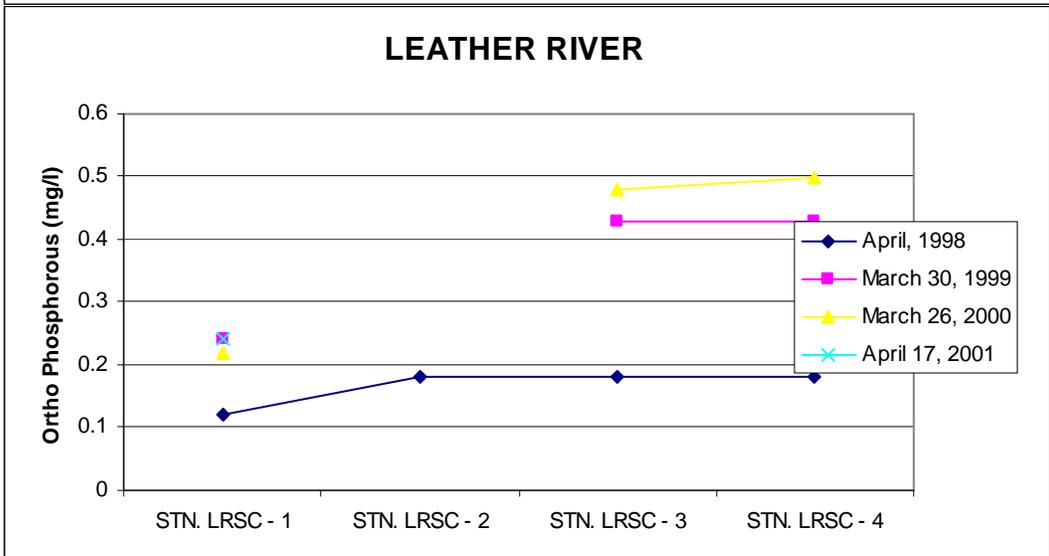
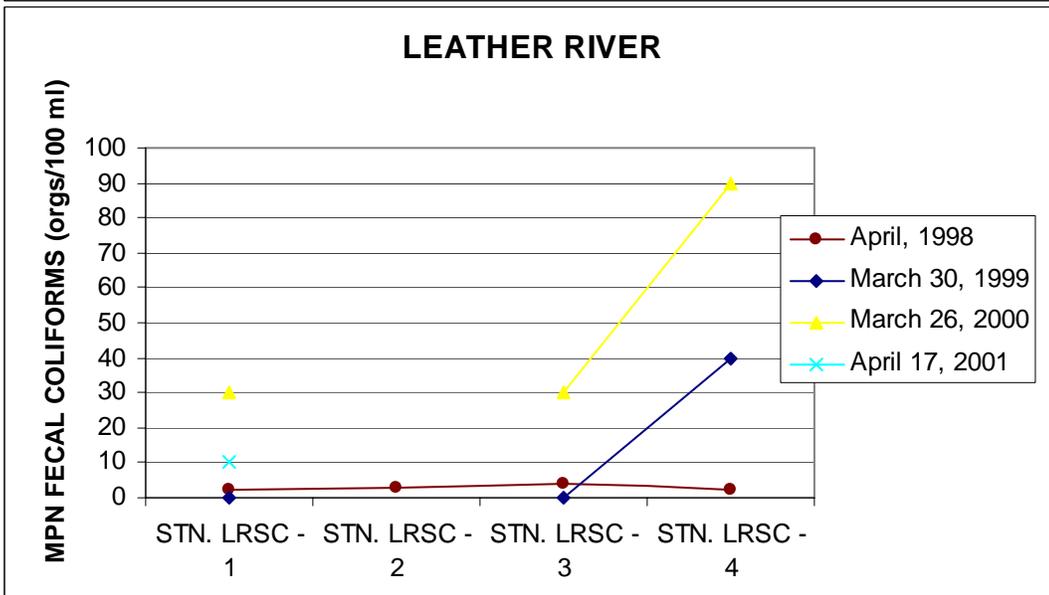
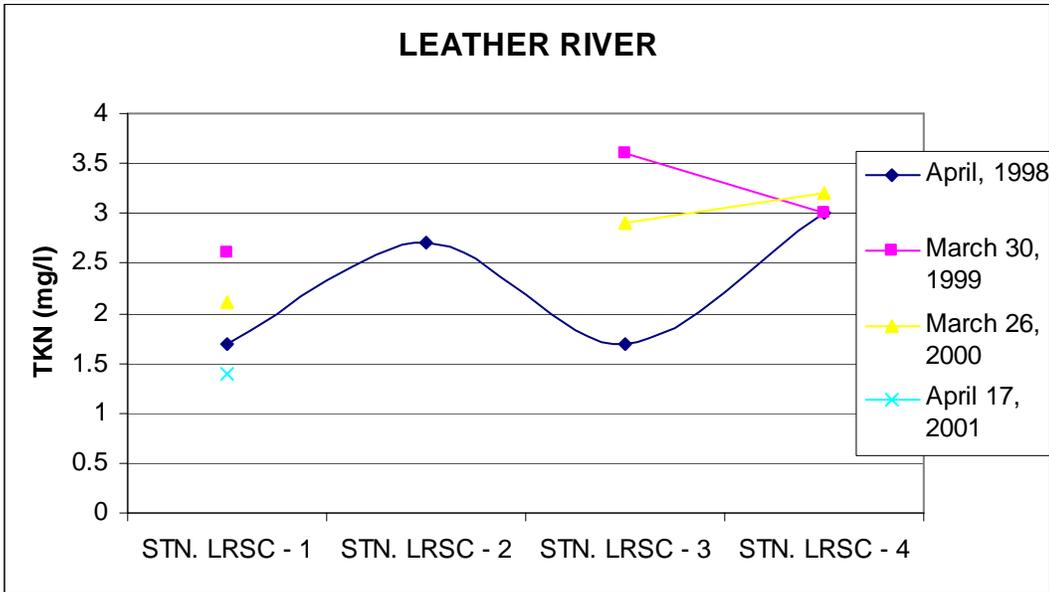
In the year 2000 sampling event, discharge gradually increased from Station 1 to Station 4 along the Leather River. All discharge levels were lower than the 1999 levels. This region had average to lower than normal snow levels, and the data shows that the water quality on the Leather River has not changed over the past three years with the exception of the bacteria levels. In 2000, Total and Fecal Coliforms were both elevated at station 4, which is well past the manure spreading areas. The Fecal Strep colony numbers had risen to quite high levels at Stations 3 and 4 as well. It is difficult to determine why these values had risen to higher levels without more occurrences of the yearly runoff sampling events. More sampling over a longer period is required to better determine if the manured areas are affecting the bacteria levels of this watercourse, or if there are other factors that may have influenced the water quality at this particular sampling location.

For the 2001 sampling event, there was very little runoff in this area. The only runoff sample that could be taken was at Station LRSC #1 which is the most upstream location on the Leather River. The parameters at this location were consistent with previous sampling events at this location. Unfortunately, there were no runoff samples acquired in this area for spring 2002 because of little to no runoff.

Overall, the surface water quality in this area is very good and meets the surface water quality guidelines. The following data shows the results of the water analyses performed from upstream to downstream locations over the period of study.

The following charts show the water quality of the Leather River for each year of sampling from upstream to downstream locations:





SAFRR/ SE SPRING RUNOFF SUMMARY

After these first years of data, there have been no major trends identified at any of the locations sampled, nor is there evidence that there is any detrimental effect on water quality caused by manure fertilized fields near watercourses. The monitoring to date indicates, that when manure is handled appropriately and according to manure management plans set out in the ILO Approval process, it can be used in an environmentally safe manner. Research has shown benefits to crops and soil quality when manure is handled appropriately.

II. Whitesand River

SAFRR also performed surface water quality sampling at two locations along the Whitesand River, which is located between Yorkton and Canora, during the 1999 spring run-off event. The two locations sampled were both cattle operations: one was wintering cattle on and beside the Whitesand River, and the other operation was wintering cattle in a coulee that is a tributary to the Whitesand River.

i. Cattle Facility Wintered in Coulee

The cattle at this facility winter alongside and in a coulee that is a tributary of the Whitesand River. During the spring run-off of 1999, water samples were collected before entering the cattle facility via the coulee and after the water exited the cattle facility, just before entering the Whitesand River. The results of the two water samples were comparable. The most evident difference between the two samples was the colour and suspended solids. The water was quite clear upon entering the site but had become a very



dark straw colour when exiting. There were a higher number of suspended solids because the livestock stirred up the sediments within the coulee. Other than the above two factors, the overall water quality parameters increased only a marginal amount. Even though the river was not sampled at this location, it is expected that dilution and mixing would mitigate any impacts. Unfortunately, an error during analyses of the two water samples was not able to reveal the bacterial aspects of the water entering and exiting the facility. More years of sampling are required to determine what the impact is on water quality that may result from this type of operation.

Another spring runoff sample was taken in year 2000. This sample included both fecal and coliform bacteria within the parameters tested. The results of the 2000 sample indicate that the

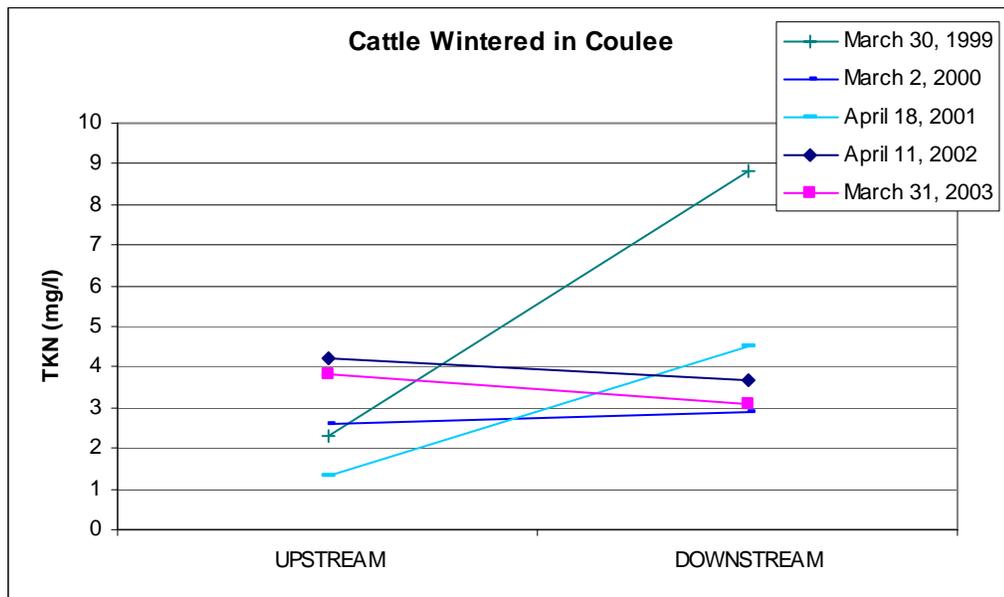
only parameters that changed were the bacteria levels. Levels of both fecal and total coliforms rose significantly from the upstream to the downstream sampling points. The downstream sampling point is located immediately after the water passed through and over manure. An increase in bacteria was expected.

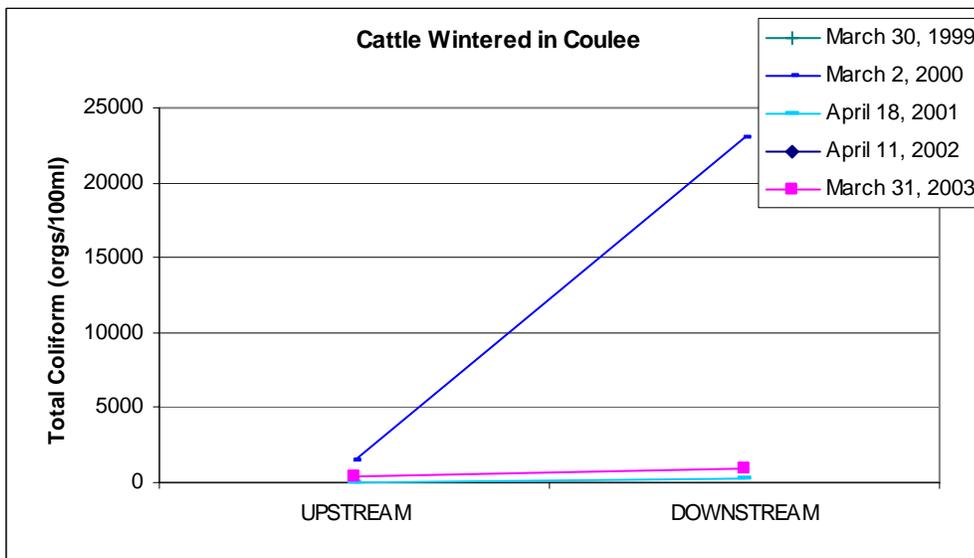
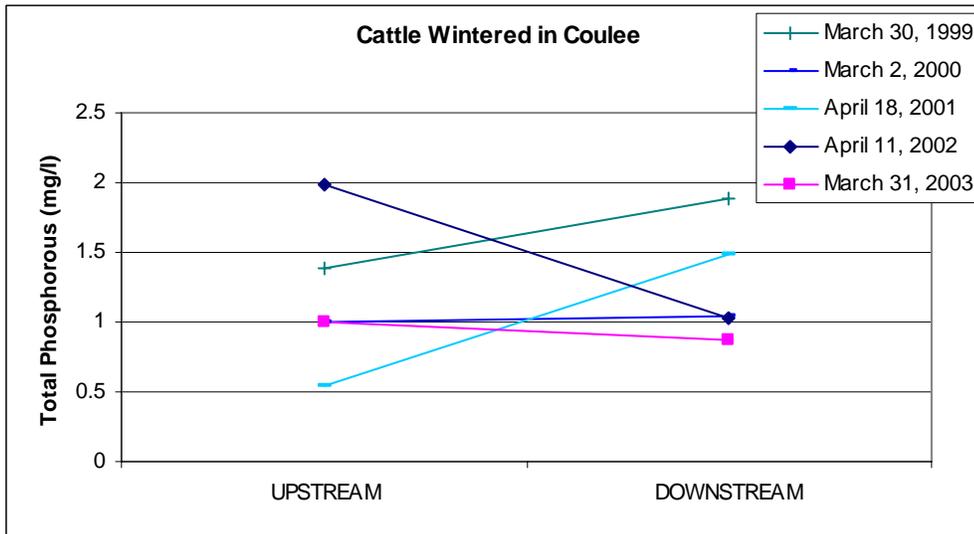
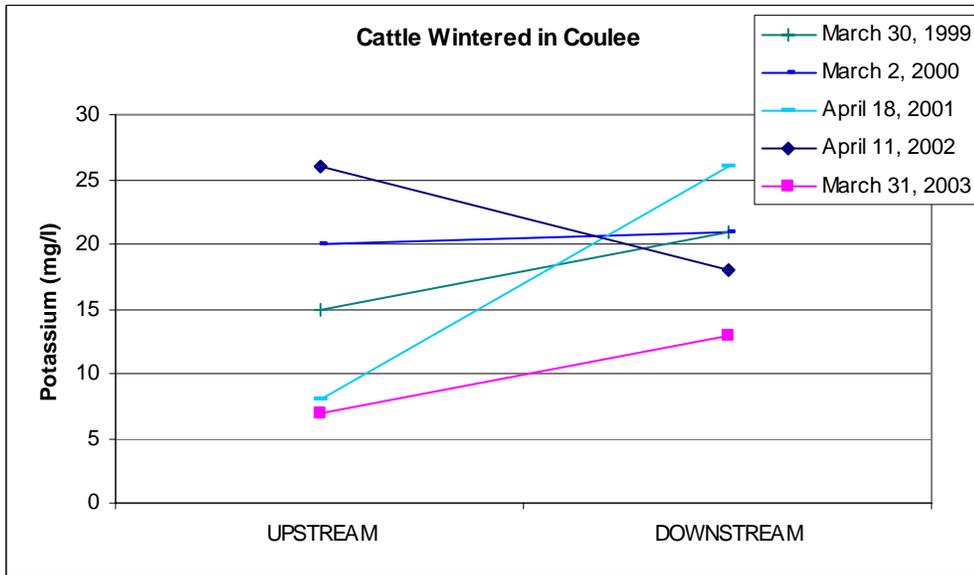
A condition of approval for this operation was to fence the coulee off from the cattle over the winter. The coulee was fenced off from the cattle and the overgrown vegetation was removed downstream from the wintering facility prior to the 2001 runoff. In the 2001 spring runoff-sampling event, most of the parameters rose slightly from the upstream sampling point to the downstream sampling point. The bacteria levels in 2001 were very low compared to the high levels observed the previous years. The fecal coliforms are well below the levels of 200 orgs/100 ml for contact recreation.

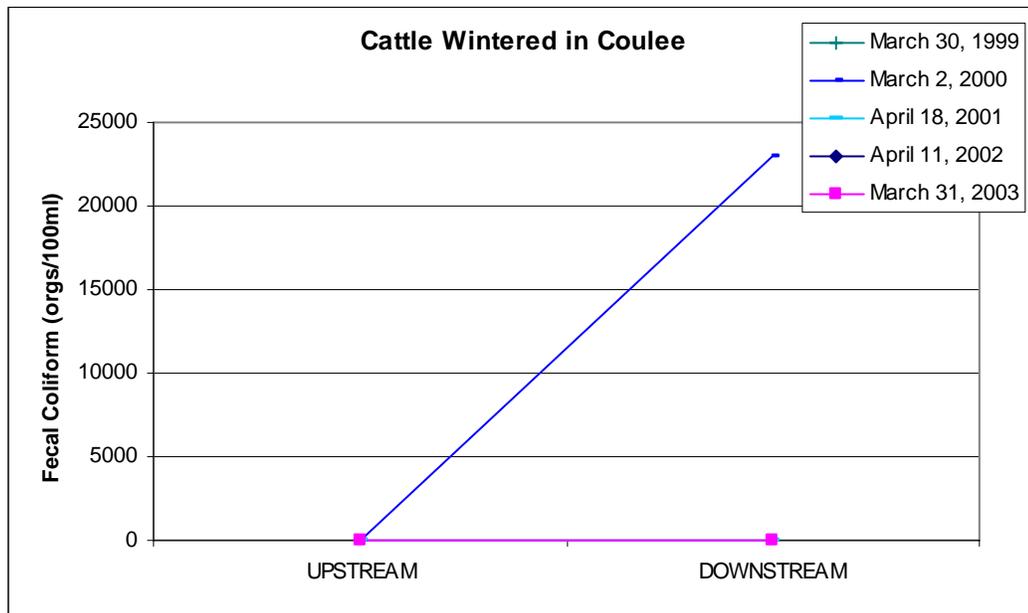
In 2002, another sample was collected upstream and downstream of the coulee to determine the water quality after the livestock have been fenced away from the coulee over the winter and spring. There was another lab error and the bacteria were not tested. Most other parameters tested showed a slight increase in concentration when comparing the downstream sample to the upstream sample.

In 2003, a sample was taken within just a few hours of the spring runoff starting to flow down and through the coulee. Again, samples were taken upstream and downstream of the cattle wintering facility. Water quality results were comparable from upstream to downstream samples. Nutrients rose slightly and the bacteria levels were down considerably. The process of moving the cattle out of the coulee to restrict the access to this area has shown to reduce the impact and improve quality of water entering the Whitesand River as the spring runoff goes through this facility.

The following charts reflect reduced nutrients and especially reduced bacteria levels by keeping the livestock out of the coulee where the runoff travels before entering the Whitesand River.







ii. Cattle Facility Wintered on Whitesand River

This operation is located on No. 9 highway between Yorkton and Canora, and was often associated with public concern about the farming practice of wintering cattle alongside and on a river system. The wintering facility at this operation was along the Whitesand River in a low-lying area where the cattle were fed and also watered directly from the river.

In the spring of 1999, water samples from upstream and immediately downstream of the wintering location were taken to aid in determining its impact on the water quality of the Whitesand River. The tests indicated that the water quality upstream and downstream of the operation was relatively unchanged. The Whitesand River was flowing at a fairly high rate of discharge and there may have been enough dilution and mixing of the water to not have a measurable impact on the water quality.



The wintering location has now been relocated away from the Whitesand River and the cattle are no longer wintered along the river, which negates the need for further sampling.

III. Surface Runoff Near Hog Manure Sites

i. Solid Hog Manure in Southwest Saskatchewan

This operation consists of an intensive hog operation located in an area with rolling topography. No other approved intensive livestock operations exist in the immediate area. However, there are a number of smaller cattle operations near this particular operation that may also have an impact on the water quality. Manure is handled and stored in a solid stockpile. The stockpile area is contained with dikes that prevent runoff leaving the containment area. The site is located approximately 450 m from a natural, well-vegetated watercourse that contains numerous springs.

The site geology consists of thin clay till layer underlain by a sand/gravel formation approximately 1 m in thickness. The sand and gravel is underlain by clay till to a minimum depth of 4.5 m excavation. The well logs in the area show a minimum depth of 50 m of clay till.

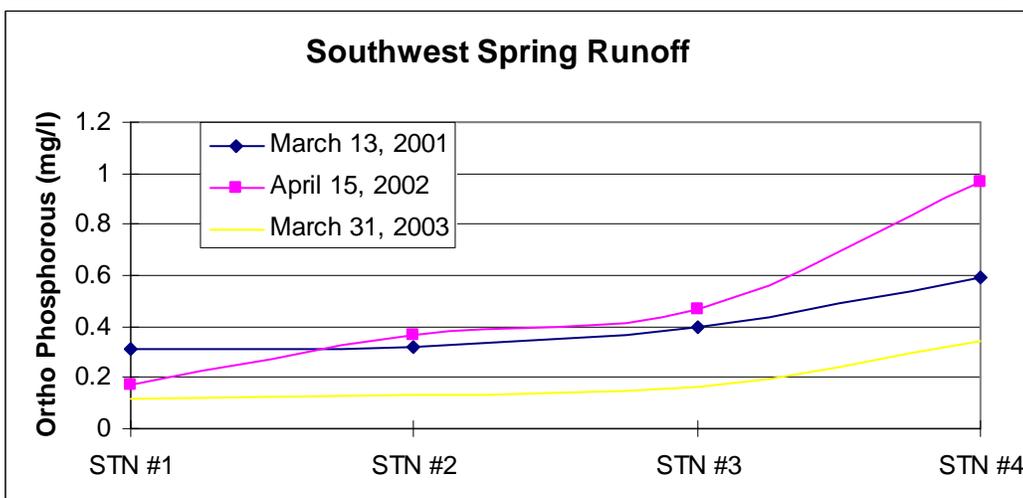
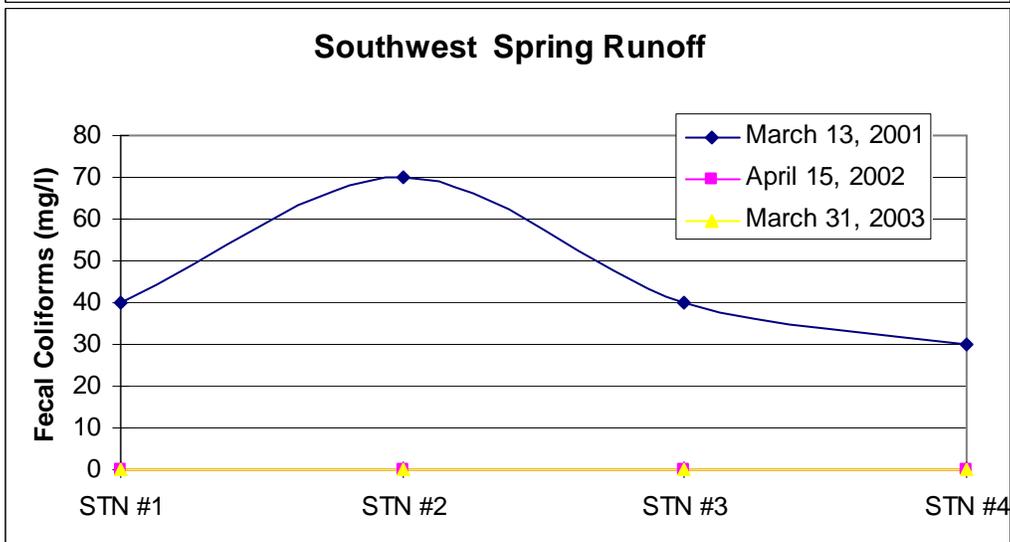
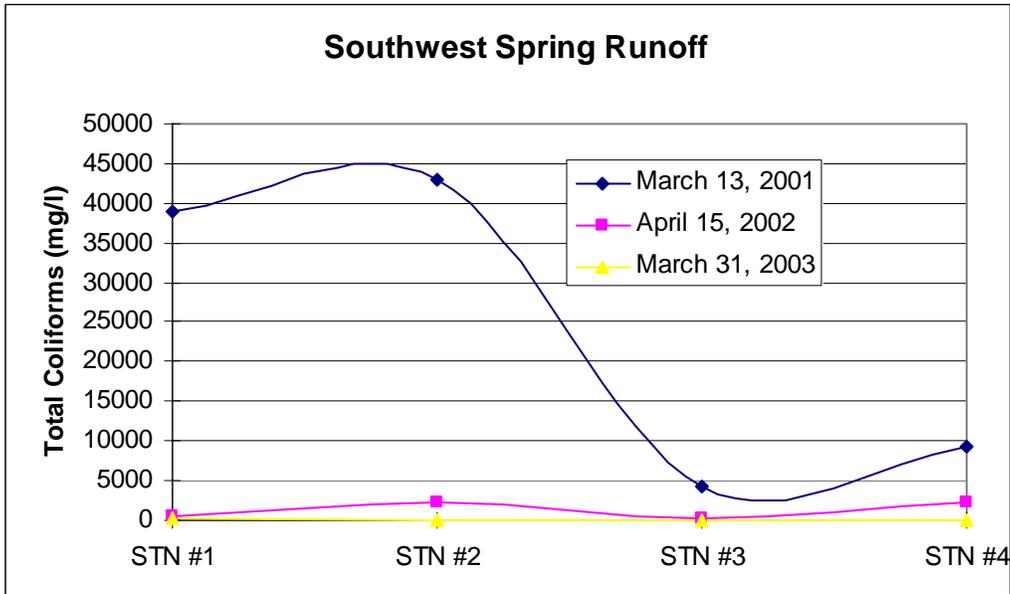
Area residents expressed concern about the potential contamination of the watercourse and natural springs. This watercourse is a main source of livestock water supply for ranchers in the area. Saskatchewan Water Corporation (now Saskatchewan Watershed Authority) also expressed concern for potential contamination of the watercourse through the sand/gravel layer on site. A collection system was required to ensure contaminants from the manure stockpile area are not transported from the site.

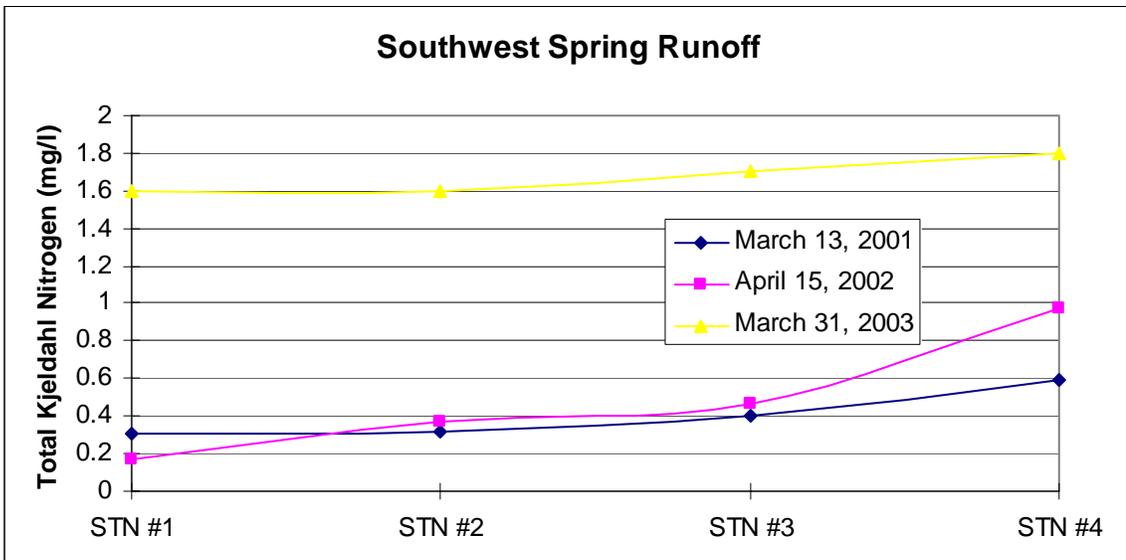
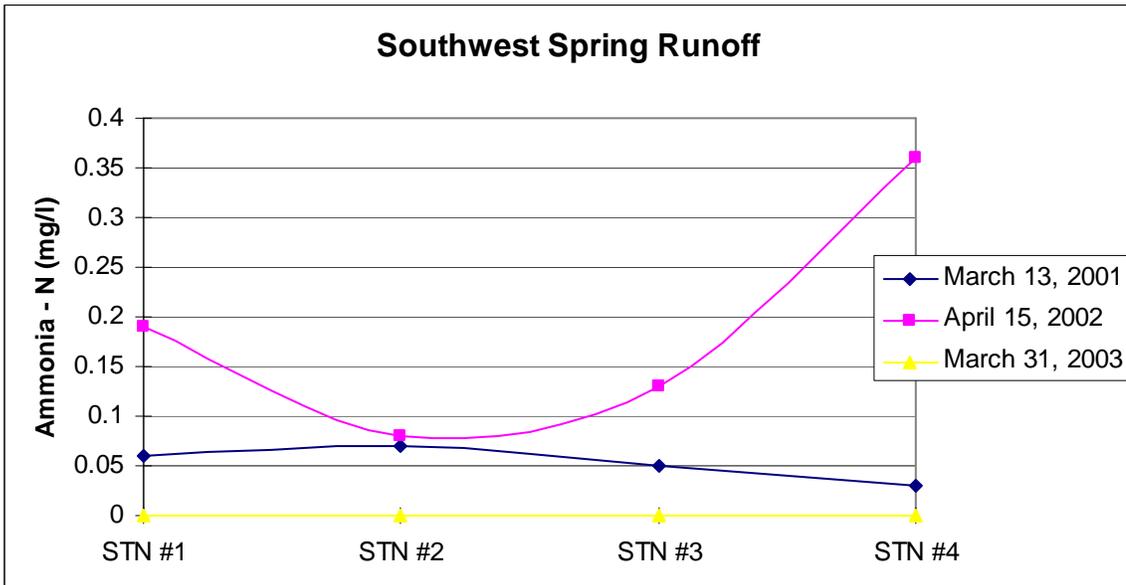
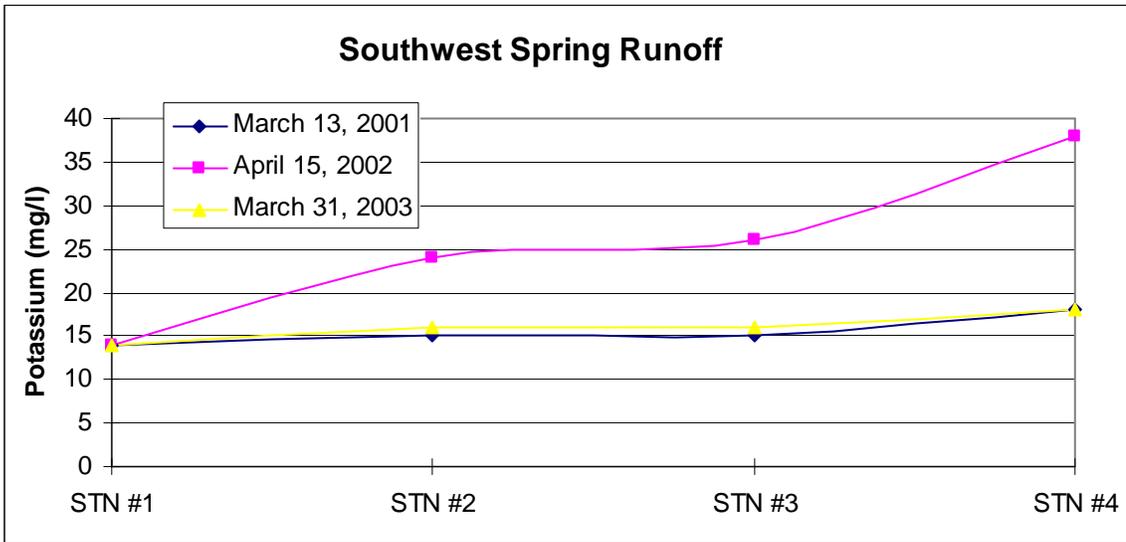
Saskatchewan Agriculture, Food and Rural Revitalization sampled the spring runoff of the watercourse for the first time in 2001. Water quality is compared from upstream to downstream locations of the ILO.

According to the results, there was a slight decrease in fecal and total coliform after the water flowed in the vicinity, approximately 300 m south of the ILO area. The 2001 sampling event data from this area is considered to be baseline water quality. In 2002, runoff was very low and samples were obtained from all four locations. The water quality for 2002 is slightly poorer quality than the 2001 data. This is expected for low flows and little runoff. The bacteria levels were much lower than 2001 levels and the overall water quality improves as it enters the area adjacent to the hog operation and continues to improve downstream of the operation.

A new sampling location was added for the 2003 spring runoff located at a culvert receiving runoff from a manured field. Flows in 2003 were generally larger than 2002 and the water quality had changed very little from upstream to downstream locations. There were no fecal coliforms present in the water samples in 2003, and the total coliform is significantly lower when compared to 2001. The monitoring location receiving water from the manured field also showed no elevated nutrients or bacteria levels, with most of the parameters being lower than upstream locations. Further samples and testing may be required in the future and compared to the previous samples.

The following charts show the water quality of the sampling sites for each year of sampling from upstream to downstream locations:



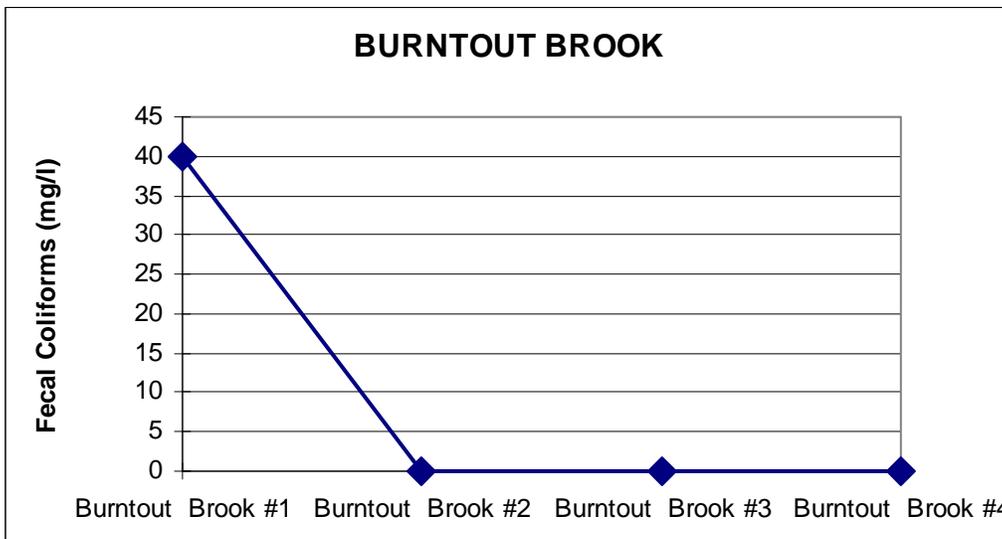
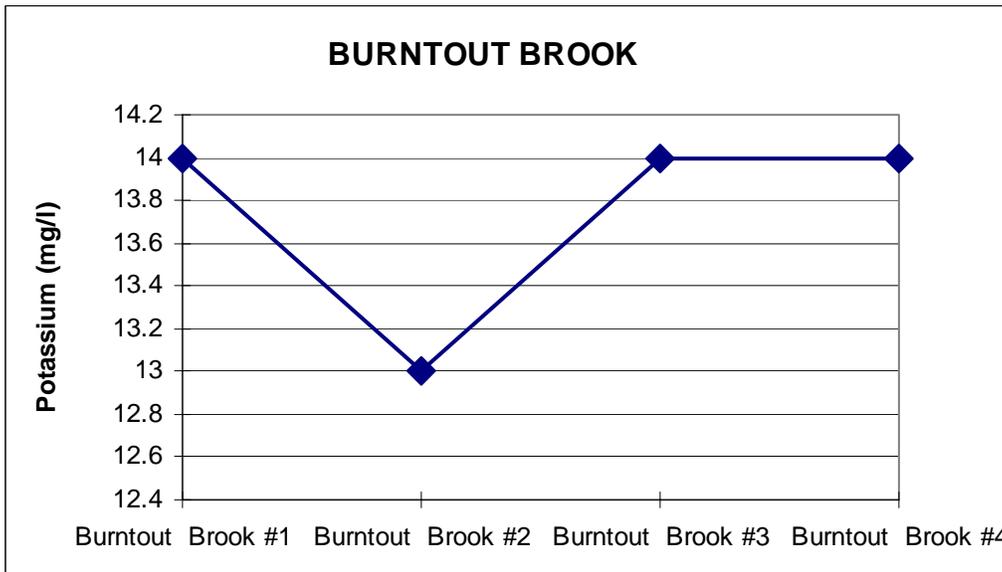


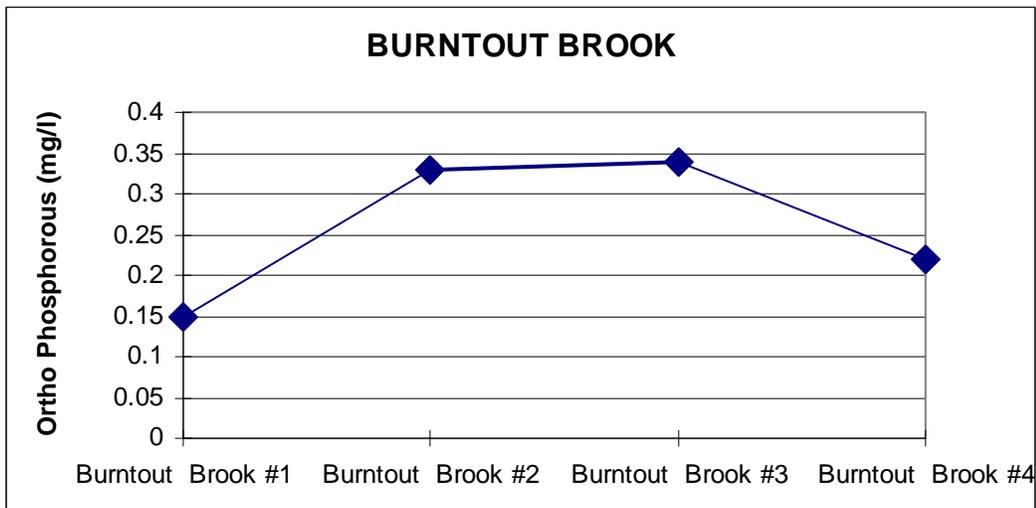
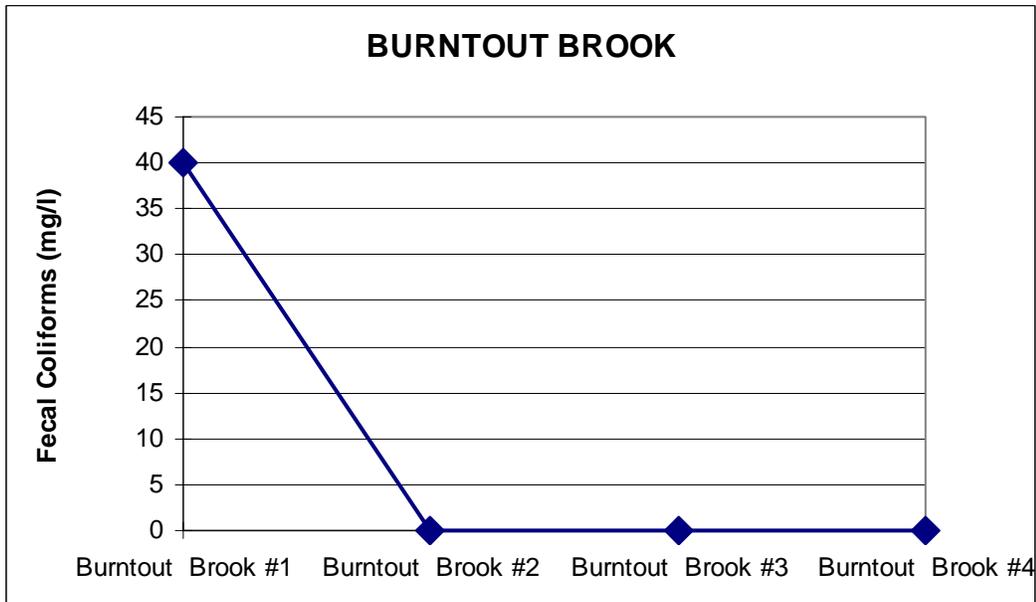
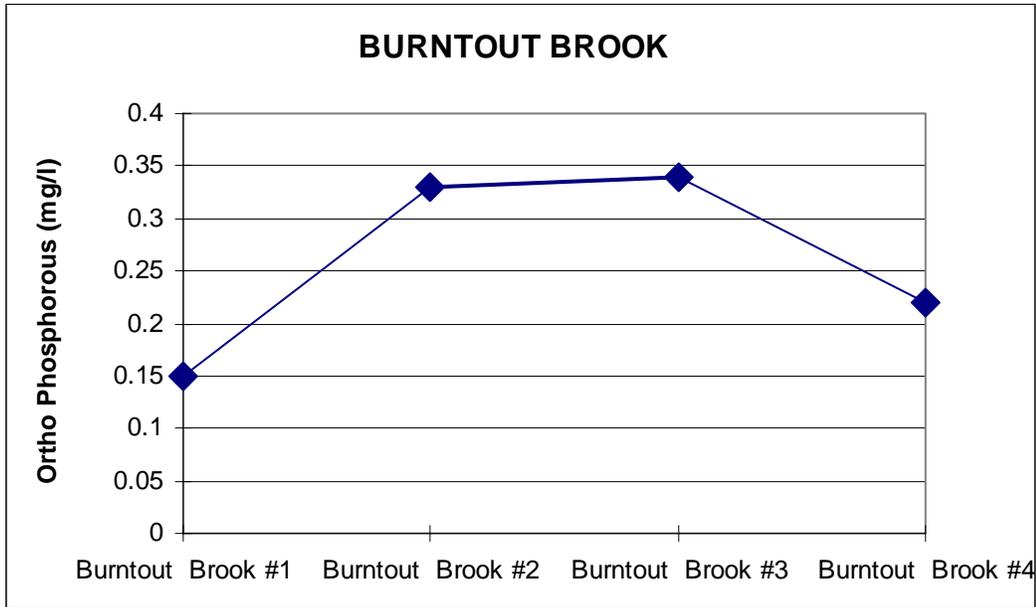
ii. Liquid Hog Manure Injection in Northeast Saskatchewan

This area is in the vicinity of a 1,200 farrow to finish hog operation located near a large reservoir that is the main water supply for a town located downstream. Concern for water quality from the runoff adjacent to manured areas into Burntout Brook prompted SAFRR to acquire baseline water quality data for future reference. Baseline samples of the Burntout Brook were taken on April 21, 2003 prior to manure injection on adjacent land areas that followed approximately a week later. There were four baseline samples taken and they were located at the following locations:

- #1 - 2.4 kilometres upstream of the reservoir,
- #2 – Directly from the Reservoir,
- #3 – Immediately downstream of the Reservoir, and
- #4 – 4 kilometres downstream of the Reservoir.

The following are the results of the baseline samples from the Spring runoff of 2003.





IV. Surface Runoff from Poultry Manure Stockpiles

Two poultry operations under the same management and located approximately 400 m apart are located near a watercourse and within the local town limits. The operations wanted to utilize vegetative filters to minimize impacts from the temporary storage of manure in stockpiles. Although containment of runoff may be an option, there were other concerns associated with the containment pond, such as increased odour, flies and other insects.

Because of limited design information for vegetative filters and uncertainty about the actual effectiveness in preventing nutrients from entering the water course, a monitoring program was required.

Literature shows buffer strips to be effective, but it is difficult to quantify how effective.

Monitoring of runoff water quality is required and, if necessary, containment or other mitigation will be required.



The monitoring plans specified monitoring equipment or control structure requirements, sample locations, sampling collection protocol, conditions when sampling will occur (type of event), water parameters that will be monitored, and frequency of reporting of data, analysis and recommendations.

Three weirs were installed at the ILO site, and

sampling of spring runoff and high rain events can occur at each weir. The sampling and testing of the water is to be performed by the operators of the farm and the results submitted to SAFRR for review.



Agricultural Operations staff collected one set of samples of spring runoff water in 1999. The results showed that the water running off the property was distinctly different than the water running in the creek. The runoff water was much higher in Fecal and Total Coliforms, TDS, COD, BOD and Total Hardness to name a few of the parameters, and the runoff water quality does not meet the criteria for surface water quality guidelines. However, after a short distance, a downstream sample was taken after some mixing had occurred and the upstream/downstream water quality were comparable.

The ILO proponent had stated plans to seed the ILO site to a permanent vegetative cover. This has not yet been implemented. This vegetative cover would help reduce the higher nutrient content leaving this site. Further testing of runoff, other options of containment, or better management of the stockpiles is required to determine the levels of nutrients and bacteria that is running off the poultry sites in order to further assess impact to the water course.

The operation's data collection, analysis and reporting has been inconsistent and insufficient to properly evaluate the potential impacts from the runoff at this site.

In 2001, the operators conducted their own sampling during spring runoff. There are still high levels of nutrients and bacteria flowing over the weirs and exiting the property. Once the water flows through the buffer zone and into the creek, the downstream sample shows only a slight elevation of nutrients and coliform bacteria when compared to the upstream values. The bacteria levels are well below surface water quality guidelines for contact recreation. The nutrient levels are significantly less at the downstream side as compared to the weir locations.

SAFRR received a report from the proponent in the winter of 2003. The report indicates that there are significant amounts of bacteria and nutrients leaving the poultry operation property during high rainfall events when there is manure stored on the temporary manure storage pads. When the manure is not being stored and there are rainfall events to produce runoff, it does not appear to result in excess nutrient and bacteria runoff.

More information is required to evaluate this site. Additional mitigation may be required and is being considered.

CONCLUSION AND RECOMMENDATIONS

The data collected to date will provide an important reference for future sampling. More information is required to evaluate the trends and determine if impacts are occurring. The data collected to this point generally does not show evidence of contamination or deterioration to existing surface water.

The initial three-year monitoring program with SE has been extended. A larger time commitment to this monitoring is required to ensure that sufficient data is collected to evaluate long term trends and if impacts are occurring. To date, no trends in surface water quality have been observed in watercourses adjacent to manure spreading areas. The water quality data collected to date has not shown a measurable deterioration (change) in water quality downstream of manure spreading areas compared to upstream.

More water quality information and data is required to ensure current development and practices are not negatively impacting Saskatchewan surface water.