

# Measuring Nutrient Losses via Runoff from an Established Golf Course

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## Objectives:

1. Compare nutrient loading via surface water runoff from a new golf course versus the site's previous native prairie condition.
2. Investigate the new golf course's impact on surface water quality during construction and during golf course operations.

**Start Date:** 1998

**Project Duration:** 6 years

**Total Funding:** \$148,155

Kansas State University in cooperation with Jim Colbert, PGA TOUR, GCSAA, and various alumni built a 27-hole championship golf course, Colbert Hills Golf Course, near Manhattan, Kansas. The construction and operation of the golf could possibly impact the surface water quality of nearby streams. Sediment washed away from the construction site would eventually flow into rivers and lakes and cause ecological damages. Excessive concentration of nutrient in rivers, lakes, and reservoirs can accelerate the growth of algae and other aquatic plants causing problems such as clogged pipelines, fishkill, and restricted recreation.

Four monitoring stations were established on Little Kitten Creek (the major stream) and its tributaries to collect water samples, measure runoff discharges, and collect precipitation data. Water samples were tested for total nitrogen, total phosphorus, and sediment concentrations. Surface water runoff amounts were studied so that mass transport of nutrients and sediment can be analyzed.

Over 200 samples were collected over the past year from inlet and outlet sites. For analysis, the data set was divided into three subsets, namely pre-construction (native conditions), during construction, and during operation. At the main stream leaving the golf course, 28, 138, and 233 surface water samples were collected for the three periods.

Data analysis showed that golf course construction has the greatest impacts on surface water quality with average concentrations of 3.94 mg/L, 0.93 mg/L, and 2,955 mg/L for total N (TN), total P (TP), and sediment (TSS) respectively, compared with 1.18 mg/L, 0.39 mg/L, and 477 mg/L for the pre-construction

Analyte	Nutrients and Soluble Solids in Stream Flow (ppm)		
	Native Pre-construction (4/98 - 7/98) 28 samples	During Construction (8/98 - 4/00) 138 samples	Early Operation (5/00 - 7/04) 233 samples
<b>Total N</b>			
Mean	1.18	3.94	1.91
Minimum	0.30	0.00	0.05
Maximum	4.80	13.40	21.53
<b>Total P</b>			
Mean	0.39	0.93	0.51
Minimum	0.00	0.00	0.01
Maximum	1.70	8.36	2.83
<b>TSS</b>			
Mean	477	2955	604
Minimum	116	54	2.5
Maximum	2496	38,412	15,903

*Nutrients concentrations (N and P) and sediment (TSS) in major outflow at three different phases: native pre-construction conditions, during construction, and during early golf course operation.*

tion period.

During operation, sediment content was brought down significantly to an average of 750 mg/L, slightly higher than that of the native prairie condition. The average concentrations of TN and TP were 2.09 mg/L and 0.64 mg/L, much lower than those in the construction period, but still about twice as much as those in the native prairie condition.

Sources of nutrients in streams under native prairie condition and during construction are thought to be from the input of rainfall and sediment eroded from fertile topsoils. During golf course operation, fertilizer application is another source of nutrients in streams in addition to those mentioned above. Particulate nitrogen and phosphorus absorbed by sediment particles and brought down to streams in runoff events are the major source of nutrient in streams in these periods.

Further analysis shows that there are direct connections between fertilizer

application and concentration of TN and TP in streams. There are cases that clearly indicate the amount and timing of fertilizer application are to be blamed. This is the case when a good amount of fertilizer is applied over a large area and significant rainfall comes shortly after the application.

Less sediment in streams during operation is a contribution of golf courses to the environment. Higher concentration of TN and TP than that under native prairie condition is expectable. However, the rate of nutrient transport during construction was 3 to 4 times that under native conditions, which was consistent with the estimation of sediment yields.

## Summary Points

- Water samples were collected from inflow and outflow of watershed.
- Samples were tested for nitrogen, phosphorus, and suspended solids.
- Established turf greatly improved runoff water quality.