2003 SAMPLING PLAN FOR HILLSDALE LAKE TRIBUTARIES

Introduction

In any given year, the Hillsdale Water Quality Project has a limited sum of funds allocated for the sampling within the Hillsdale Lake Watershed. This limits the number of samples to the extent that the budget can afford. Because sampling cannot occur continuously, it is necessary to compile a series of sampling events that results in the best representation of water quality.

The sampling year begins January 1 and ends on December 31. It allows for a wet and dry season. The wet season begins April 15 and ends August 15. Due to the application of pesticides during summer months, atrazine is tested only during this season. The remainder of the year is considered the dry season. Atrazine is not tested for during the dry period. This plan does not include random grab samples that may be taken when the project is alerted of potential spills or intentional dumping of waste.

Sample Types

Two sample types are accounted for in the 2003 Sampling Plan. They include grab samples, which are taken during low flow periods and composite samples, taken during storm or snowmelt runoff events.

Sampling Locations

Both the Montgomery Study and the Hillsdale Water Quality Project have conducted sampling within four subwatersheds of the Hillsdale Lake Watershed. The Montgomery Study is officially known as Johnson County, Kansas and the Johnson County Unified Wastewater Districts Report on Hillsdale Lake Nutrient Loading Study, January 1991. James M. Montgomery, Consulting Engineers, Inc., prepared the report. These four subwatersheds account for more than 65 percent of the lake's drainage area. Grab sample locations include: Big Bull Creek at Interstate 35, Little Bull Creek at 207th Street, Rock Creek at Indianapolis Road and Wade Branch at Crescent Hill Road. Composite sample locations include: Big Bull Creek at Interstate 35 and Little Bull Creek at 207th Street (see sampling location map, page 8).

Sample Parameters

The parameters to be tested include total kjeldahl nitrogen, total phosphorus, soluble phosphorus, nitrate nitrogen, total suspended solids and atrazine.

Stratification of Grab Samples Among Sampling Sites

Grab sample events are determined by a stratified statistical process based on estimates of variability of sampling data collected from 1993 through December 2002. At the project's beginning, it was determined that the sampling network would be designed for 80 percent assurance of the mean within plus or minus 25 percent. With these data quality objectives (DQO) specified the adequacy of the total number of samples can be determined. The total number, mean and standard deviation of samples for all calculations are based on total phosphorus. This is accomplished utilizing Equation #1:

Equation #1

$$N = \frac{t^2 \ S^2}{(D \ X)^2}$$

Where:
- N = the calculated number of samples
- t = the student's t value of the probability at 80% assurance and 60 degrees of freedom (1.296).
- D = the chosen confidence interval about the mean of the strata of interest (0.25)
- S = the standard deviation of the strata of interest
- X = the mean of the strata of interest

Using Equation #1, it was determined that the Data Quality Objectives could be reached for the four sampling sites with 42 nutrient samples. Using the same equation, it was determined that the DQO for atrazine could be reached with 68 samples.

Stratification of Grab Samples Among Sampling Sites – Nutrients and Sediment

The potential number of nutrient grab samples is distributed both among sites and between seasons at each site. A stratified sampling procedure enhances the ability to draw meaningful conclusions from the data collection effort. The first stratum between sites is made utilizing Equation #2:

Equation #2

$$P_I = N \ x \ \frac{(N_I S_I)}{\Sigma(N_I S_I)}$$

Where: P_I = the number of samples to be taken from that site
N = the total number of samples to be taken
S_I = an estimate of the standard deviation of the Ith strata
N_I = the number of samples on which S_I is based.

Equation #2 applies to the estimates of the standard deviation and number of total phosphorus grab samples from 1993 though 2002 at each station. The results of this initial level of stratification are presented in Table 1.

Table 1
2003 - Stratification of Nutrient Grab Samples Among Sampling Sites

	Big Bull	Little Bull	Rock Creek	Wade Branch
S_I	0.611454	0.216936	0.213911	0.196243
N_I	242	112	119	146
$N_I S_I$	148	24	25	29
Samples	**27**	**4**	**5**	**5**

Seasonal Stratification of Grab Samples – Nutrients and Sediment

At each of these sampling sites a second level of stratification is imposed based on the season the samples are collected. The data is partitioned into a wet season that runs from mid-April to mid-August and a dry season that consists of the remainder of the year. At each site an estimate of the standard deviation is developed for both seasons. Stratification based on the two seasons is made utilizing Equations #3 and #4:

Equation #3 (wet season)

$$P_I = N \times \frac{N_I S_I [wet]}{N_I S_I [wet] + N_I S_I [dry]}$$

Equation #4 (dry season)

$$P_I = N \times \frac{N_I S_I [dry]}{N_I S_I [wet] + N_I S_I [dry]}$$

Table 2
2003 - Final Nutrient Grab Sample Sizes

		Wet Season		
	Big Bull Creek	Little Bull Creek	Rock Creek	Wade Branch
S_I	0.417418	0.198422	0.132273	0.138190
N_I	108	59	61	81
$N_I S_I$	45	12	8	11
Samples	**11**	**2**	**2**	**2**
		Dry Season		
S_I	0.751657	0.239061	0.273503	0.249265
N_I	92	53	58	65
$N_I S_I$	69	13	15.86317	16.2022
Samples	16	2	3	3
Total	**26**	**4**	**5**	**5**

Because grab samples taken during the dry season produce consistent results, the grab samples taken during the dry season at Big Bull are reduced to five as opposed to 16 (see Table 2, above, and Table 3, below). The 2002 loading report also has an impact on the final sample size. Because the Little Bull Creek Subwatershed was declared the project's priority subwatershed an additional four samples is subtracted from Big Bull and added to Little Bull. Since the wet season produces more lake inflow than the dry season samples are skewed towards the wet season. Sample quantities in Rock Creek as well as Wade Branch are then changed so that more samples occur during the wet season than the dry season. The final maximum number of nutrient samples for the 2003 sampling season is 30. Overall, the sampling plan shows an increase of one sample allocated for the 2003 sampling season when compared to the planned 2002 sampling season (see Tables 3 and 4, below). Actual sample numbers can vary due to weather conditions as shown in Table 4, below.

Table 3
2003 - Final Nutrient Sample Sizes

	Big Bull	Little Bull	Rock Creek	Wade Branch	Season Total
Wet Season	9	5	3	3	20
Dry Season	3	3	2	2	10
Total	**12**	**8**	**5**	**5**	**30**

Table 4
2002 - Final Nutrient Sample Sizes (actual number taken in parentheses)

	Big Bull	Little Bull	Rock Creek	Wade Branch	Season Total
Wet Season	10 (2)	2 (1)	2 (1)	2 (1)	16 (5)
Dry Season	5 (5)	2 (1)	3 (0)	3 (0)	13 (6)
Total	**15**	**4 (2)**	**5 (1)**	**5 (1)**	**29 (11)**

Stratification of Grab Samples Among Sampling Sites – Atrazine

Sample size determination for atrazine presents different considerations than sample size determination for nutrients. Unlike the naturally occurring nutrients, atrazine is a man-made and applied chemical. Therefore, it has certain characteristics that affect the design of a network to monitor it. Some important specifications that need to be considered are -- it is selective in action and thus not used on all crops; it is applied during a limited time period in the spring; it is soluble in water; and it has somewhat of a restricted half-life.

These considerations suggest that the need for a dual layer of stratification (site and season) is unnecessary for atrazine and that samples will be collected only during the wet season. Therefore when the sample numbers are determined for each site, they are distributed only during the wet season. However, high atrazine concentrations have been discovered in the Little Bull arm of Hillsdale Lake prior to the beginning of the wet season. Therefore, atrazine may be sampled for before the beginning of the wet season (April 15) upon concerns of the Field Representative in order to establish a correlation between stream samples and lake samples.

Table 5
2003 - Final Atrazine Sample Sizes

Big Bull	Little Bull	Rock Creek	Wade Creek	Total
18	3	12	35	68

Table 6
2002 - Final Atrazine Sample Sizes (actual number taken in parentheses)

Big Bull	Little Bull	Rock Creek	Wade Branch	Atrazine Totals
19 (9)	3 (1)	13 (4)	36 (9)	71 (23)

During the spring of 2001, Wade Creek experienced extreme concentrations of atrazine. One sample taken on May 5, 2001, produced a level of 40.1 ug/L. Another taken on May 15, 2001, resulted in a content of 45.2 ug/L. These

samples resulted in a drastic increase in the number of atrazine samples for the 2002 season at Wade Creek (see Table 6, above). In 2002, atrazine concentrations were much lower at this site. The total atrazine samples fell from 71 in 2002 to 68 in 2003.

Monitoring Frequency

A monitoring frequency guideline for the dry season at each site is determined by dividing the number of days in during the dry season by the number of samples allocated to that site during the dry season. The resulting number is rounded up to the next whole number. The dry season consists of 243 days.

This process provides a guideline for the sampling schedule during the dry season. During the 2003 dry season, samples will be collected at Big Bull and Little Bull every 81 days and the Rock and Wade sites will be sampled every 122 days. This guideline is flexible since sampling dates must coincide with laboratory workdays.

During the wet season the sampling frequency guideline is not used. Because the stream flow is consistently higher during the first two months of the wet season, the sampling frequency must be higher during this period. The frequency of atrazine and nutrients will vary in comparison due to the different number of samples required for the parameters. A monitoring calendar is included as attachment A-1.

Grab samples are to be excluded from Big Bull and Little Bull sites if stream flow is greater than 150 percent of average low flow levels (low flow levels: Big Bull – 2 cfs, Little Bull – 2 cfs) (*Occurrence of Phosphorus, Other Nutrients, and Triazine Herbicides in Water From the Hillsdale Lake Basin, Northeast Kansas, May 1994 Through May 1995*, Putnam, USGS / WRIR 1997,pages 5 – 6). Exclusion of samples from the Rock Creek or Wade Creek sites will be left to the discretion of project staff. Grab samples are to be excluded from the plan if no flow is visible at the sampling site. Sampling will also not occur when ice obscures a retrieval point within 20 meters of the normal sampling retrieval site. If a sampling date is missed, it shall be omitted from sampling plan.

This sampling frequency does not consider runoff events. Since this is primarily a nonpoint source project, monitoring during runoff events is critical. In 2002, a total of 40 runoff samples were assigned to Big Bull and Little Bull sites, 20 per site. A total of five runoff samples were taken from the Big Bull site and ten runoff samples were taken from the Little Bull site. It is suggested that the project maintain the current allotment of runoff samples.

The runoff samples need to be added to the nutrient and atrazine totals because runoff samples are tested for all parameters. The number of nutrient samples will vary from 30 and 70, and the number of atrazine samples will be between 68 and 108 depending on the number of runoff events throughout the year. Duplicates are samples taken at the same site and at the same time as a scheduled sample. Duplicates are a requirement for the project Quality Assurance / Quality Control Plan. One Duplicate is taken from each site once per year. Table 7, below, shows a cost estimate range based on the Johnson County Environmental Department's price per sample of $81.75 (an increase of $3.75 from the 2002 season – see Table 8, below) for nutrient analysis and $32.00 for atrazine analysis (an increase of $2.00 from the 2002 season).

Table 7
2003 - Estimate of Total Monitoring Cost

	Number of Samples		**Sampling Cost**		**Total Cost**
	Nutrients	Atrazine	Nutrients	Atrazine	
Grab Samples	30	68	$2,452.50	$2,176.00	**$4,628.50**
Composite Samples	40	40	$3,270.00	$1,280.00	**$4,550.00**
Duplicates	4	4	$327.00	$130.00	**$457.00**
Total	74	112		Min. total	**$5,085.50**
				Max. total	**$9,635.50**

Table 8
2002 - Final Total Monitoring Cost

	Number of Samples		**Sampling Cost**		**Total Cost**
	Nutrients	Atrazine	Nutrients	Atrazine	
Grab Samples	29	71	$2,262.00	$2,130.00	**$4,392.00**
Composite Samples	40	40	$3,120.00	$1,200.00	**$4,320.00**
Duplicates	4	4	$312.00	$120.00	**$432.00**
Total	73	115		Min. total	**$4,824.00**
				Max. Total	**$9,144.00**

Compared to the 2002 sampling plan (see Table 8, above), the 2003 sampling plan (see Table 7, above) would increase the minimum total cost by $261.50 and the maximum total cost by $491.50. This is due to both the increased number of

atrazine grab samples scheduled for Wade Creek and the increased cost of nutrient and atrazine samples. The monitoring costs presented do not reflect staff time or any other related expenses. These are likely costs for sample analysis for the 2003 sampling season.

2003 Hillsdale Lake Watershed Sample Locations