AGRICULTURAL WASTE MANAGEMENT PROGRAM

PROGRESS REPORT

January, 1990

Ministry of the Environment
Upper Thames River Conservation Authority

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1. Introduction

The objectives and tasks of the MOE/UTRCA Agricultural Waste Management Program are as follows:

i) continue to monitor background and runoff event conditions of the Kintore Creek east and west sub-basins.
ii) provide an interim report on the effects of soil conservation practices on sub watershed water quality.
iii) provide laboratory support costs for water sample analysis
iv) initiate a study in cooperation with the Oxford County Health Unit to determine the extent and impact of unacceptable private septic systems within a rural geographical area of the Pittock Reservoir watershed.
v) research, develop and install an alternate, low cost milkhouse wash water treatment method in the Pittock Reservoir, Sub-Basin #2 study area.
vi) undertake a literature review of the effects of livestock access to streams on herd health and/or production.

As of December 1989, most of the above objectives and tasks have been completed. The reports and associated data is enclosed in this Progress Report. The literature review will be completed during the winter months and will be included in the March 31, Final Report.

Also note that for this report, the septic investigations data is presented in summary form. The data will be reviewed in more detail and presented again in the Final Report.

Figure 1: Cattle were completely restricted from 6000' of stream on Keith Wiffin's farm in 1989

2. 1989 Work Program

2.1 Kintore Creek Monitoring

Routine sampling of the Kintore Creek east and west sub-basin began March 13th and finished December 4th. A total of 38 background sample runs were carried out. The total number of water samples collected at the 7 sampling stations was 266. These samples were transported to the MOE laboratory and analyzed for Total Phosphorus, Suspended Solids, the four Nitrogens, pH, Conductivity and Soluble Reactive Phosphorus. The SRP samples were field filtered before being sent to the laboratory. Results of the 1989 sampling programs are presented in Tables 1 to 7.

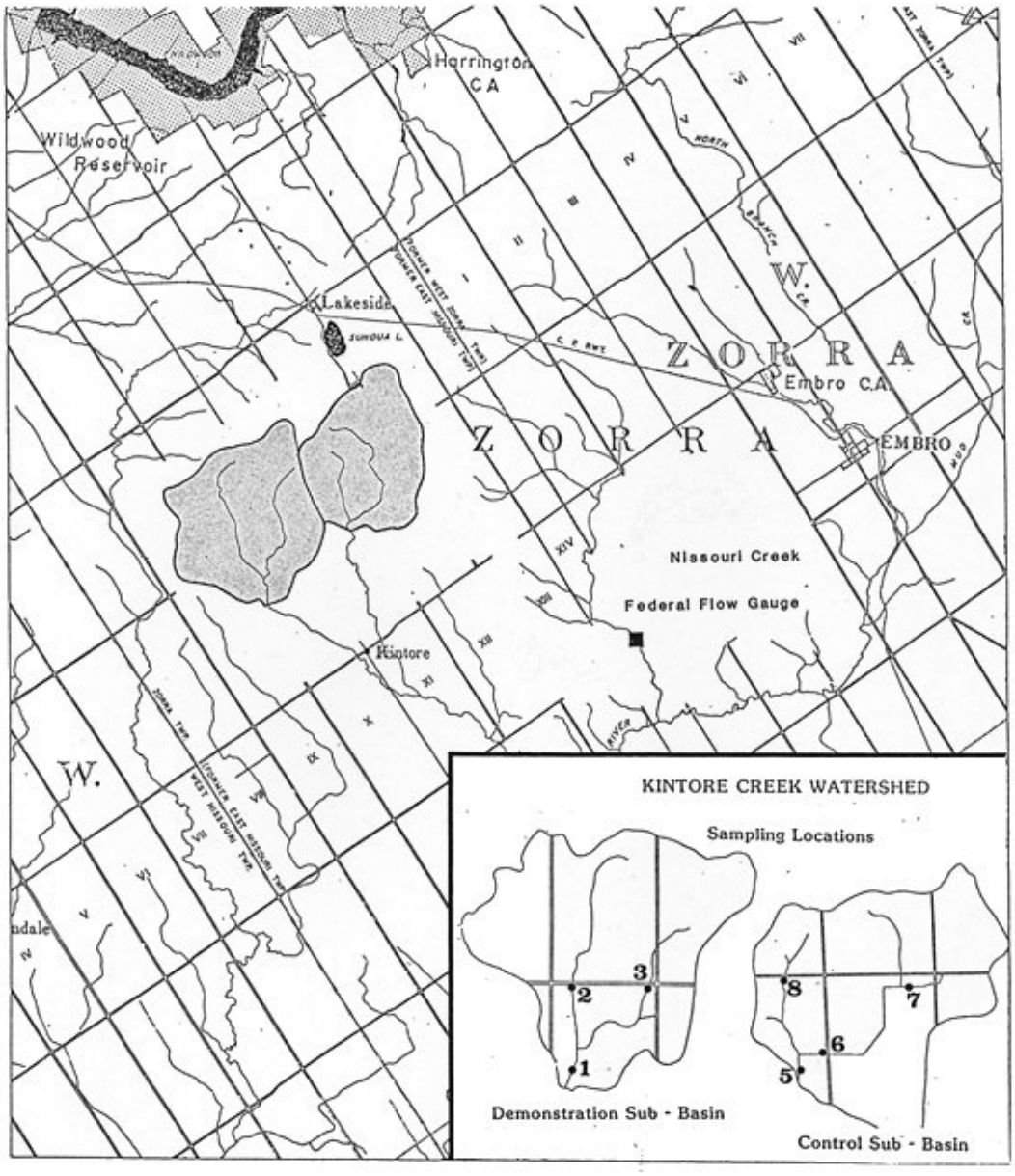

Figure 2: Location of Water Sampling Stations

In addition to the 266 background samples collected, 7 runoff events were monitored by the ISCO automatic samples located at the two sub-watershed outlets. The samplers were triggered by depth level actuators to collect water throughout the storm hydrograph. These samples were analyzed for Total Phosphorus and Suspended Solids. The data is summarized in Table 8 and 9.

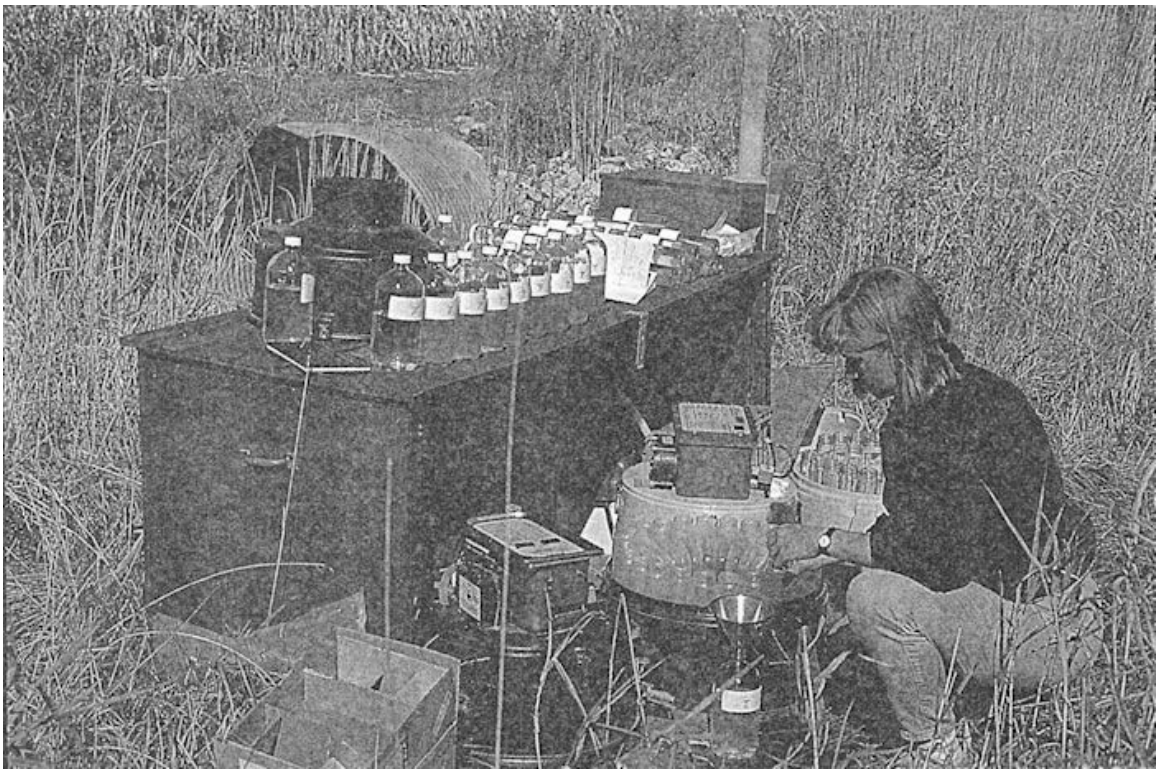

Figure 3: Storm events samples are collected from ISCO automatic samplers located at the outlets of both the demonstration and control sub-basins.

On May 5, 1988, a major fish kill in the Vannatter Drain was reported to MOE. The cause of the fish kill appeared to be manure related. Follow-up investigations by both MOE and UTRCA staff indicated the likely source was a hog operation located on Lot 20, Concession 9, Zorra Township, (figure 4).

When the landowner was approached, he admitted to recently pumping manure contaminated liquid from a ponding area onto his fields. He was apparently unaware the liquid had run overland and outletted into a catchbasin located on his property.

During the following months, Authority staff approached the landowner in an attempt to resolve the situation. It was learned that the manure ponding area was not originally intended to contain manure. As his herd size increased, it became necessary to utilize the pond as an over flow from his undersized existing in-barn manure storage pit.

Plans for a properly sized manure storage lagoon were presented to the landowner. Although he was receptive to the plans, he did not implement them.

In the spring of 1989 continued evidence of contamination appeared in the Vannatter water samples. Staff suspected the same source, however, there was no evidence of overland runoff originating from his property. Further investigation revealed the landowner had broken a field tile close to the edge of the manure ponding area. When the level of the pond rose to a certain height, the contaminated liquid outletted through this tile.

The landowner was confronted again. He agreed to an interim measure until he could install a proper storage system. A 6" non-perforated field tile was installed around the perimeter of the pond. The tile intercepted any existing field tiles entering or exiting from the ponding area. The tile was installed 50' from the edge of the pond, the work was done with a ditching machine. The ditching machine as opposed to a plow machine, ensured no file tiles accidently not connected to the interceptor tile.

Initial water quality data collected from the landowner's catchbasin indicates a drop in contamination. The catchbasin will continue to be monitored to determine if further remedial work is required.

2.2. Interim Sub-Watershed Water Quality Report

A report entitled "A Water Quality Assessment of the Demonstration and Control Subwatersheds of the Kintore Creek Study Area 1985 - 1988," has been prepared and appended to this Report.

The Report contains an analysis of the water quality data collected from Kintore Creek from 1985 to 1988. Among the recommendations is a call for continued funding of the Project for at least two average precipitation years in order to properly assess the effect of conservation practices on water quality compared to conventional practices.

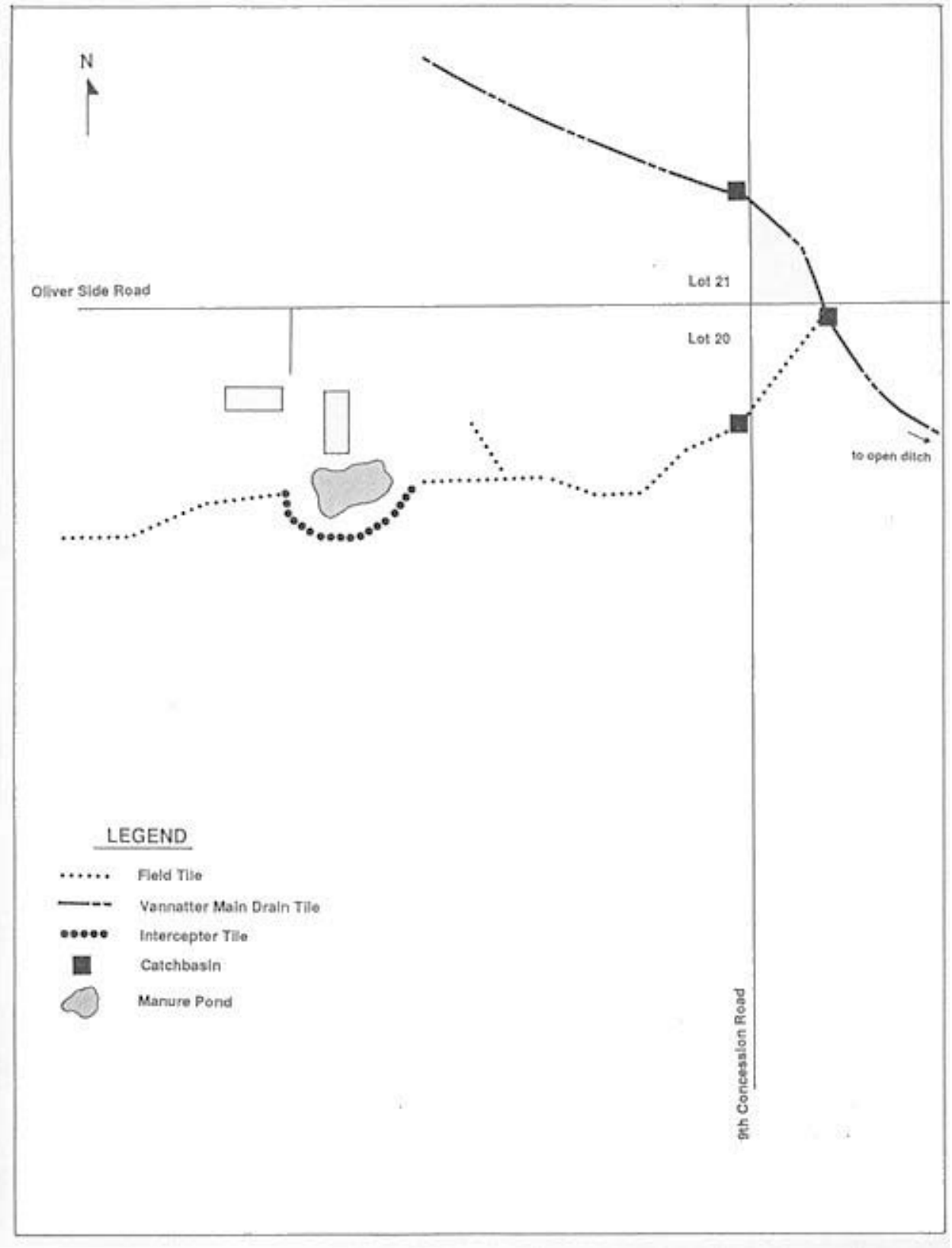

Figure 4: Site of Interceptor Tile Installation.

2.3 Laboratory Support

The Regional laboratory was provided with a person to assist with sample analysis. The lab assistant was responsible for analyzing water samples for Total Phosphorus according to supervisory staff, a total of 14,000 samples were analyzed.

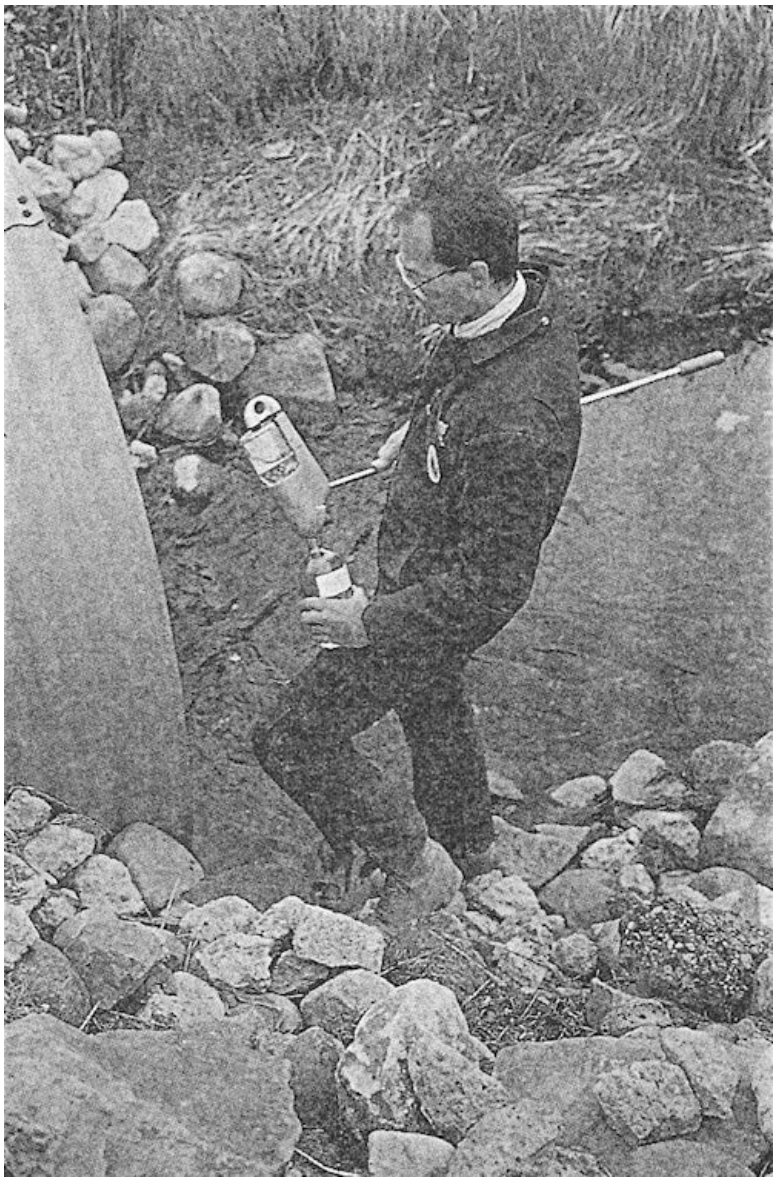

Figure 5: Grab sample collected with hand-held depth integrated sampler from Kintore Creek.

2.4 Septic Investigations

Figure 6: Weeping bed installation near Innerkip

A large portion of the 1989 Agriculture Waste Management Program was devoted to the septic system investigations in the Pittock watershed. The aim of the exercise was to determine the extent and impact of unacceptable private septic systems on the water quality of Pittock Reservoir. It was agreed that the UTRCA supply one summer student to the Oxford County Board of Health. The person would be supervised by the Health Unit and be responsible for the following tasks;

i) screen past septic system records to establish the extent to which septic systems have been installed in rural areas of the County.

ii) identify areas of the County which appear to lack proper septic system installation.

iii) conduct field investigations in a small study area identified from file records.

iv) carry out other investigations assigned by the supervisor.

It was originally estimated that six weeks would be sufficient time to complete the screening of Health Unit records. The remaining eight weeks would be used to conduct field survey investigations.

Unfortunately, the Health records were very complex. All but the screening task. The final two weeks were used to conduct a hurried field survey of 33 homes in the Pittock watershed. The original task has called for a larger more representative area of the watershed to be surveyed.

Fortunately, Environmental Youth Corps funding had been obtained to assist with the septic investigations. EYC funding of the program during the summer months, enabled the hiring of the same staff person in the fall to complete the original set of tasks.

An area in East Zorra-Tavistock Township was selected to conduct an expanded, detailed, survey of house hold septic systems (figure 7). The number of questionnaires completed rose from the original 33 to 162.

The survey queried home owners about the age of their system, general working conditions, grey water hook-ups, proximity to field tiles and whether or not they knew if the system was inspected at the time of installation. The Health Unit records were then checked to see how many of the surveyed households were on file. The survey preliminary results are summarized in Table 10.

Of the 162 questionnaires completed, the Health Unit found only 43 listed on their files. It is worth noting that in 70 cases, home owners indicated that their system had been inspected at time of installation. In some of these cases the owner probably assumed the system had been inspected. In other cases the records have been misfiled.

Tables 11, 12, and 13 provides a summary of some of the survey data collected. The information will be reviewed in more detail for the Final Report.

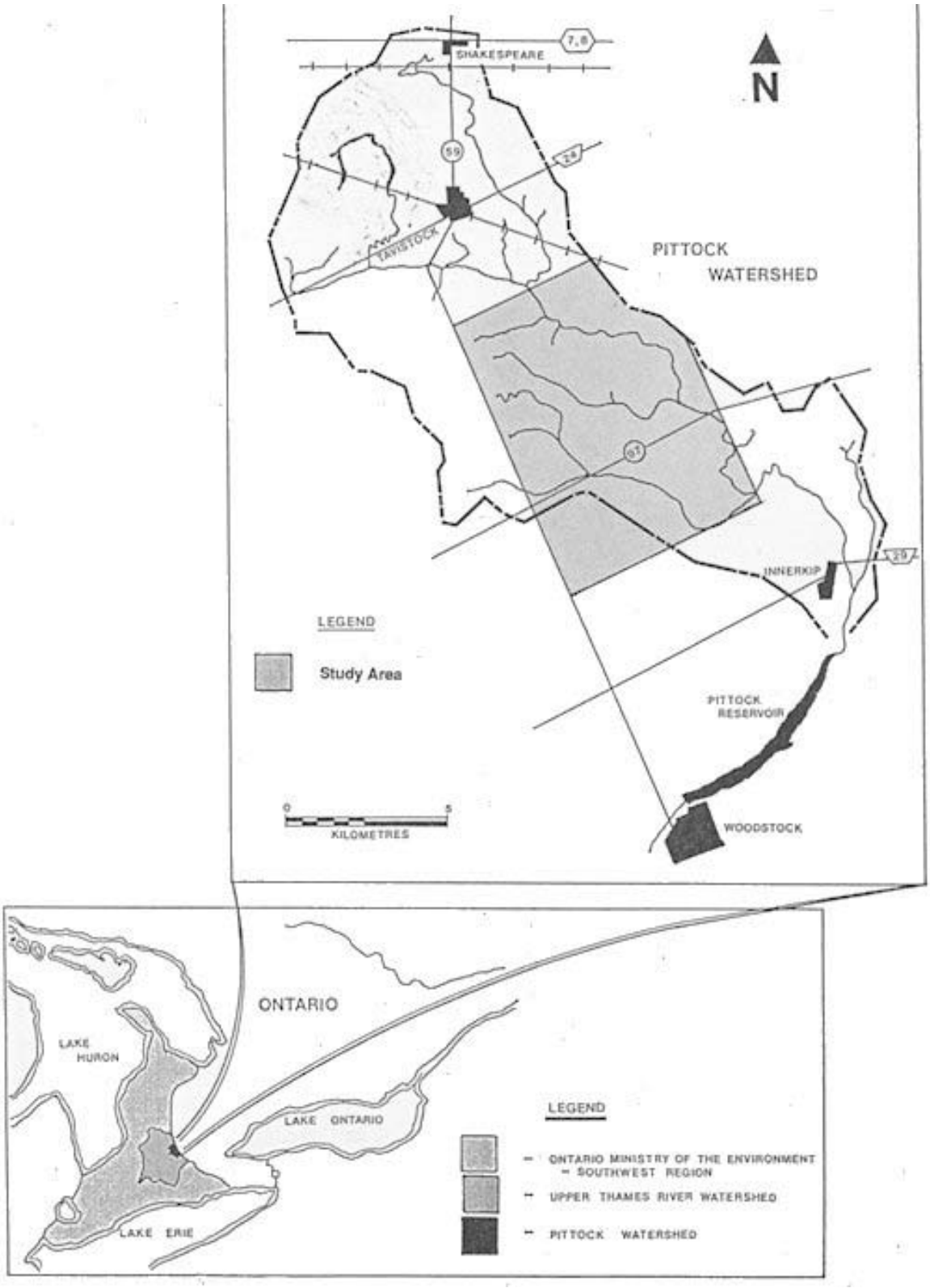

Figure 7: Septic investigations study area, located between Lots 16 to 30 and Conc. 12 to 16.

TABLE 10: Septic Survey Summary

Area	Number	Untreated Grey Waste	H.U. Record	Inspected	Field Tiles	Average Age	Age 40+
00257	22	6	7	11	4	13.6	1
00256	25	6	8	11	9	12.5	2
00255	15	6	3	6	2	15.6	1
00250	19	5	6	8	3	13.3	2
00249	12	3	4	6	2	18.2	2
00248	14	3	3	6	3	16.3	2
CON12	16	4	4	7	2	16.0	1
HICKSON	39	11	8	15	N/A	20.3	6
TOTALS	162	44	43	70	25	15.7	17
PERCENT		27%	26%	43%	15%		10%

AREA LOCATIONS

AREA	LOTS	CONCESSION
00257	26-30	15/16
00256	21-25	15/16
00255	16-20	15/16
00250	16-20	13/14
00249	21-25	13/14
00248	26-30	13/14
CON12	16-30	12
HICKSON	VILLAGE OF HICKSON	

TABLE 11: Septic System Ages

AREA	0-5	6-10	11-15	16-20	21-30	31-40	40+	Unknown	Totals
0257	4	3	3	3	6	0	0	4	23
00256	6	3	7	0	3	1	1	4	26
00255	2	3	4	2	3	0	1	0	15
00250	2	3	4	1	1	2	0	2	15
00249	4	1	1	1	2	1	1	2	13
00248	1	4	2	1	3	1	1	2	15
CON12	2	3	1	7	0	0	1	2	16
HICKSON	1	4	9	2	11	2	4	6	39
TOTALS	22	24	32	17	29	7	9	22	162
PERCENT	14	15	20	10	18	4	5	14	100

TABLE 12: Grey Waste Outlet Location

AREA	Drain	Tile	Catchbasin	Other	Unspecified	Total
00257	2	0	0	1	0	3
00256	1	2	2	1	1	7
00255	1	1	0	2	2	6
00250	2	0	0	0	1	3
00249	2	0	1	0	0	3
00248	0	1	0	1	1	3
CON12	2	0	0	0	2	4
HICKSON	7	0	0	0	0	7
TOTALS	17	4	3	5	7	36
PERCENT	47	11	9	14	19	100

FIELD 13: Distance Between Weeping Bed And A Known Field Tile

AREA	Under 50'	Over 50'	Unspecified	Totals
00257	1	0	3	4
00256	1	1	7	9
00255	0	1	1	2
00250	1	1	1	3
00249	0	1	1	2
00248	0	1	2	3
CON12	0	1	1	2
TOTALS	3	6	16	25
PERCENT	12	24	64	100

2.5 Milkhouse Waste Treatment System

Currently only two viable methods to handle milkhouse waste water are promoted to a dairy farmer. The first method involves pumping the waste water to a holding tank or liquid manure storage containment, then spreading it on the land at the appropriate time of year. The second method is to treat the waste water in a treatment trench system. With proper maintenance, the system has proven itself reliable if installed in medium or course soil types. However, the jury is still out on the long-term reliability of the treatment trench system installed in heavy soils. Current research in the Pittock sub-basin #2 study area and at the University of Guelph will help answer this question.

Dairy farmers located on these heavier soil types need inexpensive alternatives to the treatment trench system. For this reason, Authority staff have researched and designed an above ground filtering method of treatment. The system is based on a switchback waterway design. Waste water is pumped from the milkhouse to the top of the waterway. The waste water soaks into the ground as it flows by gravity down the waterway. The length of the waterway is based on the amount of wash water in the milking operation.

Because this system relies on gravity flow to transport the waste water down the filter strip, the installation site must have some natural gradient. An appropriate location was found in Zorra Township on the John McKay farm. At the time, McKay outletted this waste water through a field tile, which emptied on a flat area close to a stream. McKay was receptive to the switch-back waterway method of treatment, and agreed to having a set of plans drawn up.

During the second visit to his farm, Authority staff raised the question of up-grading his current manure storage system. With his existing uncontained solid manure system, runoff from the area would flow towards the stream.

After considering various options presented to him by Authority staff, McKay made a decision to up-grade his entire method of storing and handling manure. He opted for a walled solid manure storage area, with a runoff containment tank.

Once he had made the commitment to the system, it made sense to simply enlarge the capacity of the runoff tank to contain his milkhouse waste water. It was therefore decided not to proceed with the installation of the switch-back waterway system of milkhouse waste treatment on his farm.

Several other dairy operators have expressed an interest in the system. Steps will be taken in the spring of 1990 to have the system installed and monitored on one of these alternate locations.

A copy of the McKay plans have been enclosed in this Report.

2.6 Literature Review

As statistics from the recent U.T.R.C.A. CURB Model indicate, cattle with direct access to the stream can have a significant impact on downstream water quality. The effect on herd health and/or production from cattle watering from these contaminated streams is not fully understood.

An important component of this year's work plan, is to conduct a literature review to determine if any studies have been undertaken in this area. The literature review will be conducted in the upcoming months and included in the Final Report.

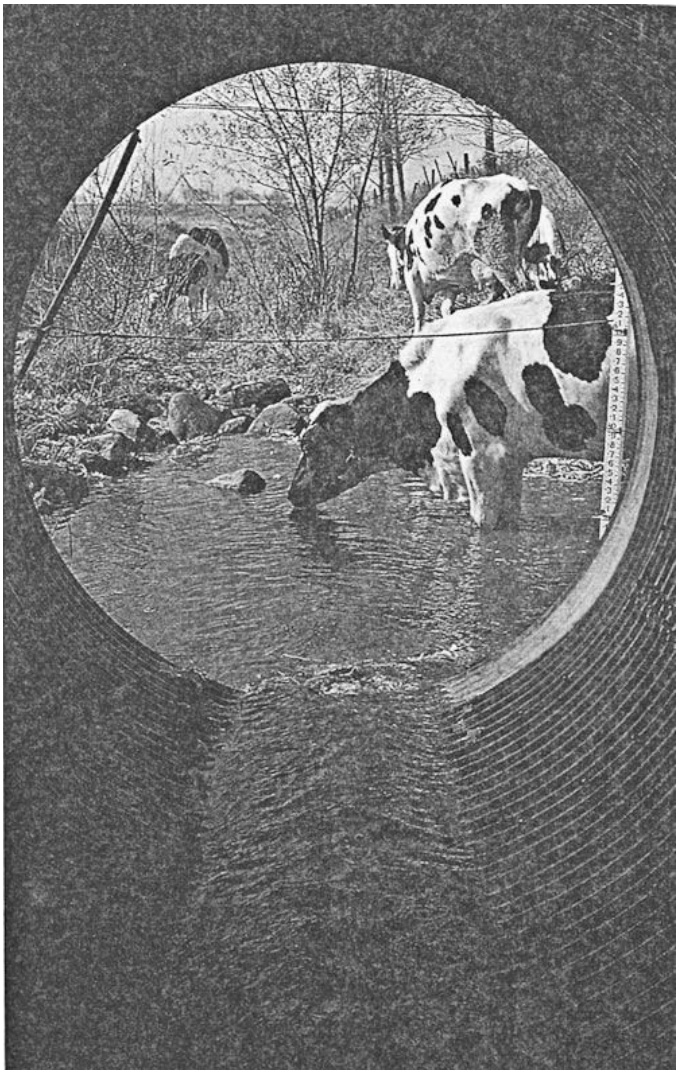

Figure 8: Cattle watering directly from the stream may risk significant herd health problems.

Table 1: KINTORE CREEK WATER QUALITY DATA 1989 Sample Station 1

Date	Time	Staff G meters	F Ammonia	TKN	Nitrite	Nitrate	Total P	SRP	Susp. Sol	pH	Cond.
MAR1389		0.514	1.9	2.81	0.04	5.7	0.29	0.179	22.9		
MAR3089	1500	0.617	0.665	1.55	0.04	8.5	0.12	0.074	5		
APR0389	1200	0.782	0.605	1.92	0.03	7.2	0.24	0.053	103		
APR1389	1200	.607	0.376	0.95	0.02	9.4	0.063	0.029	5		
APR2789	1030	0.51	0.963	1.89	0.1	5.9	0.108	0.056	5.8		
MAY0989	1040	0.495	0.471	1.03	0.05	5.4	0.072	0.033	5.9		
MAY1589	1400	.495	0.204	0.88	0.08	4.8	0.059	0.007	6		
MAY2389	930	0.48	2.7	ND	0.13	5.5	0.21	0.158	5.5		
MAY2989	1000	0.482	0.27	0.72	0.13	5.6	0.21	0.114	6		
JUN0289	935	.732	1.1	2.98	.15	8.4	.48	.124	153		
JUN0589	1130	.508	0.276	0.81	0.08	7	0.071	0.029	8.8		
JUN1289	945	.475	0.372	0.98	0.12	6.2	0.065	0.056	6.8		
JUN1989	1010	0.47	0.001	0.59	0.13	6.1	0.046	ND	8.4		
JUN2689	1130	0.47	1.18	1.88	0.14	6.1	0.151	0.084	11		
JUL0489	1010	0.461	0.107	0.43	0.09	5.3	0.06	0.036	5	8.02	618
JUL1089	1130	0.458	0.956	1.92	0.13	4.9	0.13	0.065	5	8.3	605
JUL1789	1100	0.46	0.014	0.41	0.04	5.2	0.025	0.015	5	8.22	592
JUL2689	945	0.472	0.024	0.42	0.04	4.3	0.028	0.022	5	8.14	600
JUL3189	945	0.471	0.009	0.45	0.04	4.6	0.056	0.024	5	8.2	594
AUG0889	945	0.466	0.005	0.4	0.04	4.3	0.025	0.022	5	8.23	590
AUG1589	1350	0.463	0.003	0.44	0.02	3.7	0.025	0.001	5	8.32	560
AUG2189	1200	0.492	0.014	0.51	0.03	5.4	0.034	ND	10.1	8.29	602
AUG2889	930	.475	0.413	0.97	0.06	4.3	0.077	0.039	5	8.09	602
SEPT0689	1100	.475	0.013	0.49	0.05	4.2	0.057	0.015	5	8.11	593
SEPT1289	1030	0.471	0.005	0.41	0.03	4.3	0.039	0.017	5	8.19	600
SEPT1889	1010	0.481	0.009	0.51	0.03	4.3	0.055	ND	22.2	8.2	596
SEPT2589	1115	0.482	0.001	0.39	0.01	4.2	0.027	0.009	5	8.17	592
OCT0289	1135	0.487	0.003	0.55	0.01	3.9	0.054	0.005	12.6	8.07	603
OCT1189	1200	0.53	0.002	0.9	0.53	4.7	0.185	ND	14.7	8.05	89
OCT2389	1110	0.498	2.31	ND	0.09	4.2	0.215	0.156	8	8.14	675
OCT3089	1420	0.478	2.53	ND	0.23	4.2	0.205	0.184	5	8.23	636
NOV0789	1537	0.65	0.003	3	0.22	0.3	0.59	ND	294	7.94	588
NOV1489	1040	0.49	0.011	0.72	0.03	2.3	0.031	0.003	5	8.25	582
NOV1689	1345	0.738	0.191	1.95	0.05	13.8	0.39	0.057	106	7.77	701
NOV2089	1000	0.567	0.148	0.86	0.05	7.9	0.091	0.025	32.4	7.97	701
NOV2789	1115	0.499	0.064	0.5	0.01	6.1	0.028	0.001	5	8.11	683
NOV2889	950	0.642	0.215	3.4	0.07	10.9	2.1	ND	422	7.76	654
DEC0489	1400	0.495	0.002	0.4	0.12	7	0.04	0.006	19.7	8.09	671
JAN1790	10.4	1.02	ND	ND	ND	ND	0.5	ND	ND	ND	513
FEB0190	1030	0.535	0.975	1.68	0.03	10.2	0.134	0.082	5	7.87	659
FEB0990	1130	0.979	0.203	2	0.02	8.9	0.35	0.055	146	7.68	439
FEB2290	1550	1.175	0.243	2.5	0.01	3.5	0.685	0.06	312	7.56	279

ND = no data

Table 2: KINTORE CREEK WATER QUALITY DATA 1989 Sample Station 2

Date	Time	Staff G meters	F Ammonia	TKN	Nitrite	Nitrate	Total P	SRP	Susp. Sol	pH	Cond.
MAR1389		0.65	0.208	0.89	0.03	3.4	0.14	0.024	38.1		
MAR3089	1445	0.77	0.029	0.71	0.02	7.1	0.04	0.013	5		
APR0389		0.98	0.16	1.83	0.01	6.7	0.153	0.001	54.7		
APR1389		0.77	0.011	0.48	0.01	7.4	0.024	0.002	10.1		
APR2789	1400	0.64	0.025	0.51	0.02	3.5	0.013	0.012	3.2		
MAY0989	1110	0.63	0.011	0.4	0.03	3.5	0.011	0.004	5		
MAY1589	1255	0.62	0.026	0.34	0.02	2.9	0.012	0.002	5		
MAY2389	1040	0.6	0.026	0.47	0.02	3.3	0.016	0.001	7.1		
MAY2989	1110	0.6	0.004	0.46	0.03	3	0.018	ND	5		
JUN0289	1025	.890	.032	1.66	.15	7.1	.238	.036	104		
JUN0589	1300	0.63	0.012	0.52	0.03	4.3	0.018	0.001	5		
JUN1289	1050	0.59									
JUN1989	1045	0.59	0.065	0.58	0.03	3	0.033	0.008	7.5		
JUN2689	1040	0.58	0.406	0.97	0.02	3.5	0.061	0.032	5		
JUL0489	1315	0.55	0.021	0.41	0.02	2.9	0.032	0.01	7.3	8.13	551
JUL1089	1440	0.53	0.053	0.49	0.02	2.9	0.042	0.013	5	8.36	539
JUL1789	1215	0.53	0.014	0.39	0.02	2.7	0.03	0.011	5	8.27	538
JUL2689	1042	0.55	0.014	0.39	0.02	2.3	0.033	0.029	5	8.18	547
JUL3189	1015	0.55	0.01	0.43	0.02	2.3	0.03	0.001	5	8.29	541
AUG0889	1055	0.54	0.006	0.35	0.03	2.3	0.019	0.002	5	8.33	533
AUG1589	1315	0.55	0.003	0.36	0.02	2.1	0.021	0.013	5	8.34	529
AUG2189	1120	0.57	0.019	0.4	0.01	2	0.027	ND	5	8.28	546
AUG2889	1000	0.55	0.003	0.37	0.02	2.1	0.024	ND	5	8.19	540
SEPT0689	1140		0.01	0.36	0.04	2	0.028	0.014	5	8.17	543
SEPT1289	1120	0.56	0.004	0.4	0.02	1.9	0.032	0.02	5.8	8.3	548
SEPT1889	1035	0.57	0.004	0.38	0.02	2.1	0.024	0.009	5	8.28	544
SEPT2589	1255	0.57	0.001	0.35	0.01	1.9	0.021	0.014	5	8.27	542
OCT0289	1055	0.58	0.003	0.41	0.01	1.8	0.035	ND	8.6	8.15	559
OCT1189	1340	0.66	0.022	0.75	0.05	3.3	0.049	ND	15.7	8.6	605
OCT2389	1140	0.62	0.036	0.42	0.02	2.6	0.02	0.006	5	8.21	590
OCT3089	1435	0.59	0.005	0.34	0.02	2.3	0.016	0.015	5	8.29	556
NOV0789	1525	0.94	0.056	3.3	0.23	3.9	0.875	ND	352	7.6	580
NOV1489	1120	0.64	0.017	0.44	0.01	2.8	0.033	0.01	12	8.23	563
NOV1689	1400	0.95	0.058	2.3	0.05	12.3	0.66	0.04	200	7.78	602
NOV2089	1045		0.021	0.73	0.04	6.5	0.056	0.048	14	7.96	611
NOV2789	1132	0.64	0.018	0.43	0.01	4.7	0.016	0.001	5	8.18	603
NOV2889	930	0.86	0.158	6.3	0.1	9.4	3.02	ND	915	7.76	530
DEC0489	1420	0.63	0.1	0.39	0.03	5.6	0.027	0.007	5	8.13	539
JAN1790	1455	bent	ND	ND	ND	ND	0.66	ND	ND	ND	513
FEB0190	1245	bent	0.101	0.57	0.02	7.5	0.027	0.02	5	7.93	550
FEB0990	1053	1.35	0.167	2.4	0.02	8.5	0.44	0.078	186	7.62	417
FEB2290	1515	1.7	0.108	2.8	0.01	3.4	0.59	0.104	287	7.57	256

ND = no data

Table 3: KINTORE CREEK WATER QUALITY DATA, 1989 Sample Station 3

Date	Time	Staff G meters	F Ammonia	TKN	Nitrite	Nitrate	Total P	SRP	Susp. Sol	pH	Cond.
MAR1389		0.48	0.274	1.13	0.02	5	0.3	0.175	35.4		
MAR3089	1430	0.58	0.005	0.74	0.02	3.9	0.05	0.013	5		
APR0389		0.67	0.072	1.3	0.02	3.6	0.25	0.015	62.8		
APR1389		0.57	0.023	0.73	0.01	4	0.042	0.001	15.7		
APR2789			0.001	0.47	0.02	4.4	0.019	0.007	5.1		
MAY0989	1115	0.495	0.008	0.44	0.02	4.9	0.02	0.002	21.2		
MAY1589	1320	0.49	0.007	0.49	0.01	4.2	0.026	0.002	14.1		
MAY2389	1050	0.42	0.012	0.52	0.01	4.8	0.026	0.001	21.5		
MAY2989	1435	0.47	0.005	0.43	0.02	4.7	0.019	0.004	5		
JUN0289	1020	0.635	0.016	0.82	0.09	2.1	0.077	0.026	18.2		
JUN0589	1335	0.5	0.088	0.66	0.03	4.2	0.036	0.01	8.1		
JUN1289	1100	0.48	0.05	0.45	0.25	4.9	0.028	0.01	19.3		
JUN1989	1109	0.49	0.007	0.37	0.03	4.8	0.019	0.002	12.3		
JUN2689	1050	0.49	0.017	1.88	0.14	6.1	0.034	0.002	5		
JUL0489	1340	0.51	0.023	0.37	0.02	5.2	0.018	0.014	10.2	8.16	583
JUL1089	1500	0.2	0.027	0.4	0.02	5	0.03	0.021	9.4	8.14	568
JUL1789		0.5	0.015	0.33	0.02	5.7	0.014	0.001	9.8	8.06	558
JUL2689	1052	0.5	0.022	0.35	0.22	4.6	0.02	0.024	5	8.24	590
JUL3189	1030	0.49	0.029	0.32	0.01	5	0.015	0.001	3.3	8.29	588
AUG0889	1105	0.48	0.007	0.35	0.02	5.1	0.012	0.001	5.9	8.33	584
AUG1589	1320	0.48	0.011	0.35	0.01	5.3	0.019	0.001	5	8.19	578
AUG2189	1130	0.49	0.04	0.42	0.02	5.1	0.021	ND	6.9	8.28	602
AUG2889	1005	0.48	0.004	0.32	0.02	5	0.012	0.008	5	8.2	595
SEPT0689	1150	0.48	0.006	0.34	0.03	5.1	0.017	0.011	5	8.2	594
SEPT1289	1130	0.49	0.003	0.37	0.02	4.9	0.023	0.001	5	8.29	591
SEPT1889	1040	0.51	0.009	0.33	0.02	5.3	0.019	0.003	7.4	8.29	596
SEPT2589	1310	0.51	0.001	0.36	0.01	5.1	0.024	ND	7.7	8.26	597
OCT0289	1045	0.52	0.015	0.43	0.01	5	0.037	0.01	9.6	8.17	601
OCT1189	1355	0.57	0.021	0.53	0.02	4.4	0.042	ND	7.2	8.17	65
OCT2389	1145	0.55	0.003	0.39	0.01	4.8	0.023	0.004	12.2	8.22	654
OCT3089	1442	0.54	0.023	0.43	0.02	5.2	0.029	0.009	5	8.26	609
NOV0789	1522	0.86	0.009	3.2	0.02	3	0.54	ND	233	7.9	761
NOV1489	1130	0.63	0.024	0.78	0.01	4.5	0.077	0.013	35.7	8.22	706
NOV1689	1405	0.8	0.03	0.91	0.04	4.5	0.107	0.052	18.7	7.99	690
NOV2089	1050	0.68	0.045	0.65	0.04	4.1	0.053	0.013	14.5	8.06	729
NOV2789	1150	0.61	0.001	0.39	0.01	5.1	0.025	0.001	14.2	8.18	649
NOV2889	1010	0.63	0.053	0.78	0.01	4.4	0.083	ND	19	8.05	722
DEC0489	1425	0.59	0.025	0.53	0.01	5.5	0.061	0.002	39.1	8.18	617
JAN1790	1450	snow	ND	ND	ND	ND	0.36	ND	ND	ND	574
FEB0190	1255	0.59	0.034	0.95	0.02	4.7	0.078	0.02	40	8.06	612
FEB0990	1044	0.94	0.098	1.74	0.01	3.7	0.31	0.111	114	7.81	493
FEB2290	1455	ice	0.092	2.6	0.01	1	0.565	0.113	214	7.63	327

ND = no data

Table 4: KINTORE CREEK WATER QUALITY DATA, 1989 Sample Station 5

Date	Time	Staff G meters	F Ammonia	TKN	Nitrite	Nitrate	Total P	SRP	Susp. Sol	pH	Cond.
MAR1389	1045	0.24	0.178	0.77	0.02	1.9	0.11	0.014	22.9		
MAR3089	1300	0.334	0.027	0.72	0.02	4.4	0.05	0.018	11.1		
APR0389	1100	0.522	0.065	1.19	0.01	3.1	0.18	0.007	92.9		
APR1389	1100	0.288	0.039	0.62	0.01	3.9	0.043	0.007	16.2		
APR2789			0.001	0.47	0.02	1.9	0.025	0.006	8.1		
MAY0989	1230	0.205	0.003	0.41	0.02	1.8	0.029	0.006	6		
MAY1589	930	0.2	0.021	0.56	0.01	1.7	0.018	0.009	8.6		
MAY2389	1130	0.22	0.019	0.45	0.01	1.9	0.028	0.009	4.5		
MAY2989	1330	0.18	0.132	0.74	0.02	2	0.071	0.061	5		
JUN0289	955	.432	.041	1.28	.11	5	.129	.042	41.8		
JUN0589	1500	0.202	0.025	0.77	0.04	3	0.049	ND	16.9		
JUN1289	1215	0.169	0.048	0.56	0.06	3.1	0.041	0.028	4.5		
JUN1989	1310	0.18	0.085	0.69	0.04	2.6	0.07	0.036	11.7		
JUN2689	950	0.16	0.082	0.5	0.04	3.1	0.072	0.055	5		
JUL0489	1450	0.15	0.079	0.41	0.07	2.7	0.075	0.043	7.3	8.07	568
JUL1089	1540	0.149	0.051	0.58	0.06	2.3	0.096	0.045	22.2	8.26	543
JUL1789	1415	0.15	0.022	0.48	0.03	1.8	0.065	0.034	16.9	8.34	532
JUL2689	1125	0.14	0.026	0.34	0.03	1.6	0.073	0.145	5	8.21	554
JUL3189	1055	0.16	0.01	0.39	0.02	1.6	0.085	0.04	5	8.22	554
AUG0889	1420	0.16	0.004	0.24	0.03	1.4	0.043	0.015	5	8.32	532
AUG1589	1110	0.16	0.007	0.33	0.03	1.2	0.047	0.011	5	8.08	552
AUG2189	1015	0.175	0.031	0.35	0.03	1.5	0.057	ND	5	8.11	569
AUG2889	1050	0.15	0.005	0.26	0.04	1.4	0.051	0.021	5	8.1	553
SEPT0689	1250	0.17	0.003	0.26	0.04	1.2	0.062	0.041	5	8.11	551
SEPT1289	1245	0.161	0.004	0.35	0.03	1.3	0.063	0.027	5	8.22	549
SEPT1889	1245	0.17	0.004	0.27	0.03	1.6	0.042	0.023	5	8.23	559
SEPT2589	1420	0.167	0.001	0.27	0.02	1.5	0.039	ND	5	8.21	549
OCT0289	940	0.17	0.005	0.34	0.02	1.5	0.062	ND	5.2	7.98	568
OCT1189	1525	0.212	0.01	0.65	0.06	2.2	0.088	ND	25.8	8.0	636
OCT2389	1240	0.202	0.1	0.39	0.01	1.6	0.022	0.007	5		
OCT3089	1520	0.179	0.018	0.41	0.03	1.6	0.046	0.044	5	8.13	594
NOV0789	1503	0.342	0.005	2	0.12	3.2	0.4	ND	170	7.74	592
NOV1489	1220	0.21	0.023	0.48	0.01	1.7	0.038	0.025	5	8.1	585
NOV1689	1445	0.462	0.03	1.04	0.05	5.5	0.072	0.031	10	7.8	563
NOV2089	1125	0.279	0.023	0.8	0.04	3.7	0.058	0.018	7.5	7.88	587
NOV2789	945	0.23	0.012	0.51	0.01	2.3	0.024	0.001	5	8	583
NOV2889	1110	0.35	0.032	0.83	0.02	5.3	0.073	ND	20.9	7.83	562
DEC0489	1445	0.211	0.006	0.5	0.04	3.2	0.036	0.03	5	8.05	583
JAN1790	1315	0.525	ND	ND	ND	ND	0.32	ND	ND	ND	494
FEB0190	1400	0.25	0.008	0.45	0.01	1.8	0.026	0.004	5	7.79	481
FEB0990	950	0.642	0.037	1.54	0.02	7	0.31	0.039	126	7.91	386
FEB2290	1420	0.825	0.182	2.3	0.01	3.5	0.48	0.056	236	7.56	267

ND = no data

Table 5: KINTORE CREEK WATER QUALITY DATA, 1989 Sample Station 6

Date	Time	Staff G meters	F Ammonia	TKN	Nitrite	Nitrate	Total P	SRP	Susp. Sol	pH	Cond.
MAR1389		0.53	0.192	0.88	0.01	2.1	0.1	0.013	32.6		
MAR3089		0.843	0.002	0.65	0.02	4.3			5		
APR0389		1.05	0.035	1.31	0.01	3.7	0.2	0.005	75.9		
APR1389		0.8	0.011	0.61	0.01	0.1	0.027	0.001	11.2		
APR2789			0.001	0.5	0.02	2	0.013	0.008	3.3		
MAY0989	1150	0.6	0.011	0.39	0.02	1.9	0.013	0.002	5		
MAY1589	1100	0.53	0.001	0.51	0.01	1.7	0.029	0.003	8.5		
MAY2389	1120	0.55	0.019	0.45	0.01	2.2	0.019	0.001	4.4		
MAY2989	1400	0.52	0.025	0.71	0.02	2.2	0.037	0.01	10		
JUN0289	1005	0.975	0.033	1.23	0.1	4.8	0.109	0.02	44.5		
JUN0589	1420	0.58	0.001	0.78	0.03	3	0.036	0.003	12		
JUN1289	1133	0.47	0.043	0.59	0.05	3.1	0.019	0.01	5.8		
JUN1989	1320	0.455	0.001	0.52	0.03	2.5	0.023	0.005	4.8		
JUN2689	1000	0.43	0.032	0.44	0.03	3.4	0.032	0.012	5		
JUL0489	1410	0.35	0.03	0.36	0.03	3.5	0.034	0.017	5.2	8.09	565
JUL1089	1530	0.32	0.01	0.37	0.03	3	0.036	0.015	5	8.23	550
JUL1789	1500	0.3	0.014	0.33	0.02	2.8	0.31	0.023	5	8.29	549
JUL2689	1110	0.3	0.011	0.29	0.02	2.4	0.022	0.005	5	8.17	564
JUL3189	1135	0.33	0.014	0.28	0.02	2.4	0.038	0.006	5	8.26	557
AUG0889	1325	0.33	0.005	0.23	0.02	2.1	0.015	0.001	5	8.27	552
AUG1589	1135	0.33	0.001	0.26	0.02	1.8	0.023	0.001	5	8.09	566
AUG2189	1040	0.375	0.014	0.28	0.01	2.2	0.031	ND	5	8.16	582
AUG2889	1040	0.36	0.002	0.23	0.02	2.2	0.026	0.004	5	8.14	564
SEPT0689	1225	0.39	0.006	0.34	0.03	5.1	0.017	0.011	5	8.2	594
SEPT1289	1230	0.37	0.004	0.3	0.02	2.1	0.031	0.005	5	8.23	567
SEPT1889	1110	0.38	0.002	0.27	0.02	2.1	0.026	0.006	5	8.22	570
SEPT2589	1405	0.41	0.001	0.23	0.01	2	0.017	ND	5	8.19	560
OCT0289	1015	0.43	0.026	0.37	0.01	2	0.05	0.022	5	8.12	577
OCT1189	1430	0.56	0.018	0.46	0.01	2.7	0.035	ND	5	8.14	634
OCT2389	1210	0.38	0.004	0.4	0.01	2.1	0.001	8.17	5	8.17	611
OCT3089	1500	0.34	0.001	0.24	0.02	2.2	0.01	0.001	5	8.23	594
NOV0789	1518	0.77	0.056	3.3	0.23	3.9	0.875	ND	352	7.6	539
NOV1489	1210	0.4	0.018	0.38	0.01	1.8	0.019	0.008	5	8.12	580
NOV1689	1430	0.93	0.018	1.04	0.06	4.2	0.079	0.033	16.4	7.75	532
NOV2089	1110	0.63	0.001	0.72	0.04	2.9	0.037	0.008	5	7.89	550
NOV2789	1430	0.47	0.001	0.51	0.01	2.3	0.014	0.001	5	8.05	561
NOV2889	1050	0.77	0.02	0.83	0.02	4.9	0.063	ND	23.4	7.83	553
DEC0489	1440	0.43	0.009	0.35	0.01	3.3	0.015	0.004	5	7.96	564
JAN1790	1350	1	ND	ND	ND	ND	0.365	ND	ND	ND	480
FEB0190	1335	0.47	0.222	0.93	0.02	5.3	0.045	ND	5	7.88	522
FEB0990	1003	1.07	0.001	1.78	0.01	7.4	0.37	0.02	199	7.62	388
FEB2290	1405	1.37	0.239	2.4	0.01	3.5	0.54	0.07	321	7.6	275

ND = no data

Table 6: KINTORE CREEK WATER QUALITY DATA, 1989 Sample Station 7

Date	Time	Staff G meters	F Ammonia	TKN	Nitrite	Nitrate	Total P	SRP	Susp. Sol	pH	Cond.
MAR1389		0.08	0.203	0.73	0.01	1.4	0.07	0.011	8.8		
MAR3089	1350	0.14	0.017	0.45	0.01	1.5	0.04	0.022	5		
APR0389		0.34	0.031	0.67	0.01	1	0.076	0.001	23.9		
APR1389		0.14	0.02	0.37	0.01	3.4	0.022	0.001	5		
MAY0989	1135	0.05	0.007	0.21	0.02	0.6	0.011	0.003	5		
MAY1589	1130	0.02	0.025	0.29	0.01	0.4	0.016	0.004	4.4		
MAY2389	1110	0.03	0.017	0.4	0.01	0.3	0.04	0.001	22.9		
MAY2989	1420	0.001	0.008	0.47	0.01	0.3	0.056	0.014	7.5		
JUN0289	1010	0.245	0.018	0.67	0.09	0.7	0.071	0.007	15.3		
JUN0589	1405	0.04	0.011	0.33	0.02	0.6	0.027	0.003	5		
JUN1289	1115	0.001	0.034	0.27	0.04	0.5	0.026	0.012	8.8		
JUN1989	1405	0.001	0.004	0.23	0.02	0.3	0.022	0.009	5		
JUN2689	1014	0	0.008	0.22	0.01	0.3	0.034	0.008	5		
JUL0489	1405	-0.03	0.014	0.2	0.01	0	0.037	0.024	11.3	8.06	556
JUL1089	1520	-0.075	0.009	0.16	0.21	0.3	0.026	0.009	5	8.22	552
JUL1789	1350	-0.075	0.012	0.12	0.02	0.2	0.033	0.024	5	8.17	559
JUL2689	1100	-0.075	0.001	0.13	0.01	0.1	0.025	0.014	5	8.1	562
JUL3189	1145	0	0.008	0.29	0.02	0.1	0.066	0.001	29.6	8.17	561
AUG0889	1300	-0.03	0.007	0.17	0.02	0.2	0.024	ND	5	8.16	562
AUG1589	1240	-0.03	0.023	0.16	0.01	0.2	0.021	0.001	5	8.13	566
AUG2189	1050	0.025	0.012	0.33	0.01	0.1	0.53	ND	23.6	8.03	588
AUG2889	1025	0	0.005	0.12	0.02	0.3	0.016	0.001	5	8.06	565
SEPT0689	1210	0	0.002	0.2	0.03	0.3	0.034	0.012	11.6	8.05	571
SEPT1289	1220	0	0.03	0.21	0.01	0.2	0.031	0.022	6.4	8.16	570
SEPT1889	1100	0.001	0.004	0.16	0.02	0.4	0.018	ND	5	8.11	573
SEPT2589	1345	0.001	0.001	0.15	0.01	0.2	0.016	0.006	3.4	8.02	569
OCT0289	1030	0.001	0.001	0.21	0.01	0.1	0.038	0.008	9.2	7.97	576
OCT1189	1315	0.05	0.017	0.33	0.01	0.4	0.021	ND	5	7.95	636
OCT2389	1200	0	0.004	0.22	0.01	0.2	0.018	0.002	11.8	8.02	620
OCT3089	1455	0.04	0.001	0.21	0.01	0.2	0.016	0.002	5	7.95	602
NOV0789	1520	0.27	0.005	1	0.01	0.4	0.15	ND	58.1	7.7	580
NOV1489	1200	0.09	0.01	0.27	0.01	0.2	0.022	0.01	4.9	7.99	599
NOV1689	1415	0.24	0.017	0.59	0.23	2.1	0.057	0.04	6.7	7.75	540
NOV2089	1100	0.16	0.001	0.47	0.04	1.9	0.031	0.056	5	7.8	557
NOV2789	1205	0.08	0.001	0.33	0.01	1.4	0.016	0.001	2.6	7.95	576
NOV2889	1030	0.18	0.009	0.39	0.01	1.7	0.04	ND	7.7	7.79	547
DEC0489	1435	0.06	0.021	0.22	0.01	1.7	0.014	0.002	5	7.93	566
JAN1790	1400	0.52	ND	ND	ND	ND	0.19	ND	ND	ND	385
FEB0190	1320	0.18	0.001	0.6	0.01	4.8	0.016	0.012	5	7.89	502
FEB0990	1020	0.61	0.002	0.94	0.01	2.6	0.152	0.073	60.4	7.67	343
FEB2290	1355	0.8	0.029	0.86	0.01	0.5	0.145	0.018	59.9	7.53	262

ND = no data

Table 7: KINTORE CREEK WATER QUALITY DATA, 1989 Sample Station 8

Date	Time	Staff G meters	F Ammonia	TKN	Nitrite	Nitrate	Total P	SRP	Susp. Sol	pH	Cond.
MAR1389		0.35	0.023	2.18	0.01	3.8	0.21	0.004	110		
MAR3089	1400	0.57	0.017	1.21	0.01	8.5	0.09	0.011	34.5		
APR0389		0.73	0.035	2.29	0.01	6.5	0.22	0.001	98.8		
APR1389		0.56	0.038	1.46	0.01	6	0.105	0.001	66.8		
APR2789			0.001	0.41	0.02	3.3	0.014	0.006	6.9		
MAY0989	1130	0.398	0.005	0.34	0.02	3.3	0.016	0.002	10.3		
MAY1589	1150	0.38	0.015	0.34	0.01	2.9	0.012	0.001	13.7		
MAY2389	1100	0.38	0.012	0.27	0.01	3.3	0.01	0.001	4.2		
MAY2989	1430	0.35	0.005	0.25	0.01	3.3	0.018	ND	5		
JUN0289	1015	0.47	0.023	0.89	0.18	6.8	0.059	0.014	26		
JUN0589	1400	0.25	0.006	0.4	0.02	4.5	0.015	0.003	5		
JUN1289	1105	0.24	0.028	0.33	0.04	3.3	0.011	0.006	5		
JUN1989	1400	0.18	0.001	0.31	0.02	3.1	0.028	ND	5		
JUN2689	1025	0.25	0.003	0.32	0.01	3.1	0.013	0.003	5		
JUL0489	1400	0.18	0.023	0.24	0.01	2.8	0.014	0.012	5	8.02	574
JUL1089	1510	0.15	0.012	0.28	0.01	2.9	0.015	0.004	5	8.2	575
JUL1789	1341	0.14	0.017	0.25	0.02	3.1	0.012	ND	5	8.16	579
JUL2689	1055	0.14	0.001	0.29	0.01	2.1	0.014	0.006	5	8.07	581
JUL3189	1200	0.11	0.01	0.29	0.01	2.6	0.03	0.001	5	8.16	581
AUG0889	1315	0.1	0.006	0.31	0.02	2.4	0.011	0.001	5	8.14	581
AUG1589	1255	0.11	0.001	0.34	0.01	2.4	0.015	0.001	5	8.13	588
AUG2189	1100	0.14	0.014	0.29	0.01	2	0.056	ND	5	8.04	585
AUG2889	1015	0.125	0.004	0.27	0.02	2.4	0.012	0.001	5	8.04	586
SEPT0689	1200	0.13	0.001	0.3	0.03	0.2	0.013	0.01	5	8.06	587
SEPT1289	1205	0.14	0.01	0.35	0.02	2.2	0.014	0.001	5	8.12	586
SEPT1889	1050	0.15	0.002	0.3	0.01	2	0.012	0.007	5	8.12	583
SEPT2589	1330	0.16	0.001	0.25	0.01	2.1	0.01	0.009	5	8.04	577
OCT0289	1040	0.19	0.003	0.38	0.01	1.7	0.022	0.006	6.9	8	588
OCT1189	1405	0.33	0.015	0.48	0.01	3.8	0.014	ND	5	8	585
OCT2389	1150	0.29	0.004	0.35	0.01	2.5	0.01	0.002	5	8.06	581
OCT3089	1445	0.23	0.002	0.36	0.02	2.3	0.016	0.002	5	8.03	578
NOV0789	1321	0.72	0.011	1.7	0.01	1.4	0.12	ND	55.1	7.88	507
NOV1489	1140	0.27	0.009	0.4	0.01	2	0.022	0.005	8	8.05	553
NOV1689	1410	0.0089	0.007	0.71	0.04	14	0.028	0.018	7.7	7.93	584
NOV2089	1055	0.35	0.001	0.48	0.04	5.4	0.021	0.023	6.9	7.95	571
NOV2789	1200	0.29	0.007	0.41	0.01	3.4	0.023	0.09	11	7.99	571
NOV2889	1012	0.47	0.011	0.61	0.01	8.8	0.043	ND	19.3	7.94	566
DEC0489	1430	0.31	0.011	0.34	0.01	4	0.021	0.006	11.6	8.02	566
JAN1790	1414	0.84	ND	ND	ND	ND	0.3	ND	ND	ND	412
FEB0190	1305	0.36	0.001	1.61	0.01	6	0.108	0.019	70.3	7.99	538
FEB0990	1023	0.87	0.017	2.6	0.01	7.2	0.3	0.003	195	7.75	360
FEB2290	1450	1.15	0.013	2.2	0.01	2.2	0.45	ND	260	7.61	214

ND = no data

Table 8: Kintore Station 1 Rain Event Data

Date	Time	Total P	Susp. Sol.
APR0389	1300	1.17	612
	1700	0.28	101
	2100	0.178	50.5
APR0489	100	0.157	38.7
	500	0.19	59.6
	800	0.39	169
APR1389	1600	0.9	408
	2000	0.32	181
APR1589	0	0.18	94.4
	400	0.18	91.7
	800	0.74	441
MAY2989	500	0.81	469
	600 Peak	1.44	570
	700	0.74	165
	800	0.59	60.7
	900	0.46	35.5
	1000	0.46	26.8
MAY3089	2140 Peak	0.58	156
MAY3189	40	3.45	1320
	140	1.69	551
	240	0.93	268
	340	0.72	172
	440	0.58	106
JUN0289	1530	0.215	15.9
	1630	0.21	18.4
	1730	0.205	21.2
	1830	0.115	5
	1930	0.131	14.6
	2030	0.145	17.3
	2130	0.15	17.8
	2230	0.154	17.5
	2330	0.15	17.5
JUN0389	30	0.154	19.1
JUN2289	400	1	408
	500	0.615	269
	600	4.6	1949
	700	1.45	564
	800	2.52	910
	900	0.835	308
	1000	0.38	116
	1100	0.264	75.3
	1200	0.192	47.2
AUG1589	1930	0.172	59.1
	2030	1.12	695
	2130	0.655	370
	2230	0.348	168
	2330	0.218	84.6
	30	0.164	60.4
0CT1089		0.175	13.7
		0.28	151
		0.215	82.7
		0.21	39.1
		0.42	174
		0.675	286
		0.57	131
		0.395	85
		1.1	603
		0.31	87.9
		0.235	50.5
		0.19	22

KINTORE STORM EVENT DATA 1989 Sample Station 1 (cont'd)

Date	Time	Total P	Susp. Sol
NOV0789	1430	0.16	63.4
	1530	0.58	312
	1630 Peak	0.75	295
	1730	2.28	308
	1930	0.52	124
	2130	0.47	95.5
NOV2889	100	2.08	968
	200	0.87	408
	300	3.12	1174
	400	3.7	1379
	500	3.23	1191
	600	2.8	996
	800	1.6	634
	1000	1.34	433
	1200	1.06	332
	1400	0.81	240
	1600	0.63	182
	1800	0.53	167

Table 9: Kintore Rain Storm Event Station 5 Data, 1989

Date	Time	Total P	Susp. Sol
APR0389	1430	0.17	74.6
	1830	0.177	47.1
	2230	0.074	37.9
APR0489	230	0.057	27.3
	630	0.151	66.9
	1030	0.95	36.8
APR1389	1600	0.62	167
	2000	0.44	202
APR1589	400	0.38	194
	800	0.18	88.8
MAY3089	2030	1.27	552
MAY3189	2130 Peak	8.78	6278
	2230 Peak	4.42	2373
	2330 Peak	1.9	774
	30	0.84	387
	530	0.145	53.9
JUN0289	730	0.34	172
	830	0.266	100
	930	0.131	49.2
	1030	0.09	30.8
	1130	0.075	20.7
	1230	0.072	21.9
	1330	0.074	19.5
	1430	0.057	14.7
	1530	0.053	15.4
	1630	0.167	108
	1730	0.053	19.2
	1830	0.055	17.5
	1930	0.056	17.2
	2030	0.056	13.4
	2130	0.074	18.9
	2230	0.055	21.5
	2330	0.051	17.6
JUN0389	30	0.055	20.1
JUN2289	230	0.525	269
	330	2.55	1261
	430	1.2	621
	530	0.8	334
	630	0.346	155
	730	0.218	87.4
	830	0.14	44
	930	0.14	41.5
	1030	0.118	37.2
AUG1589	2115	2.18	1192
	2215	0.795	383
	2315	0.365	148
	15	0.194	59.9
	115	0.148	51
	315	0.14	60.3
N0V0789	1500	0.48	153
	1600 Peak	0.51	112
	1700	0.42	86.4
	1900	0.185	32.1
	2300	0.093	31
	400	0.11	57.7
N0V2889	ND	ND	ND

ND = no data