MANURE MANAGEMENT AWARENESS PROGRAM

SUMMARY REPORT 1986

Prepared by: Tracey E. Ryan

Ausable Bayfield Conservation Authority

March 1987

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF MAPS

LIST OF APPENDICES

SUMMARY

This study was a continuation of the on-going manure management program initiated by the Ausable Bayfield Conservation Authority in conjunction with the Ontario Ministry of the Environment in 1982. The Manure Management Awareness Program had two broad goals: to facilitate a better understanding of the sources and causes of manure pollution from farms; and to promote and encourage the use of remedial measures by farmers to improve water quality. Three program components were used to meet these goals.

The 1986-87 farm contact program continued to conduct on-farm site visits with farmers. During the program 84 farmers were contacted and 46 farm visits were completed. The site visits facilitate a better understanding of the causes and sources of manure pollution as well as improving the farmer's perception of on-site problems. The site visit program helps to identify issues of concern to farmers such as optimum manure application rates based on soil characteristics. The program has also identified a need for increased farmer education on proper manure management to reduce water quality impacts.

The information extension component focused on promoting remedial measures to the farm community through personal contact and special events. Information seminars proved to be very useful in disseminating information to selected audiences.

The water sampling component measured the water quality impairment in 10 selected agricultural drains. The drains have been sampled by the Ontario Ministry of the Environment and the Conservation Authority for 3 years. The samples were analyzed for bacterial and chemical parameters. The sampling program established that the drains had less than acceptable water quality. Further work is required to reduce the impact that livestock inputs have on surface water quality.

ACKNOWLEDGEMENTS

This program was made possible through funding provided by the Ontario Ministry of the Environment, Southwestern Region, London, Ontario.

The author would like to thank staff members of the Ausable Bayfield Conservation Authority and the Ontario Ministry of the Environment for their technical support, guidance and editorial reviews.

1. INTRODUCTION

Until the late 1970's and the completion of the PLUARG Reports agriculture had not been considered as a major source of water quality contamination in the Great Lakes Basin. The findings of PLUARG (1978) and other related research determined that agricultural land use has a significant effect on the water quality of the Great Lakes Basin. The ecological balance that was thought to previously exist between agriculture and the environment has been upset by an emphasis on intensified production, increased mechanization and a number of other changing farm practices.

Water pollution from farming is the result of a number of factors including the addition of bacteria and nutrients from fertilizer and livestock manure, the addition of pesticides and chemicals and the addition of sediment from soil erosion. In rural Ontario, livestock operations are responsible for about 20% of the total agricultural input to streams of the Great Lakes Basin (PLUARG, 1978). Water pollution from livestock manure causes stream enrichment and degradation via phosphorous and nitrogen as well as the delivery of pathogenic organisms to water causes.

Studies conducted by the Ontario Ministry of the Environment (1984; 1985) along the Lake Huron shoreline have concluded that bacteria contaminating recreational beach waters originated in the agricultural areas upstream of the beaches. Pollution of water by livestock manure occurs primarily as a result of runoff originating from barnyards, feedlots, manure storages and field spread manure. Manure contamination can also result from livestock access to watercourses in pastures and exercise yards.

In order to improve the water quality of the Great Lakes and watersheds of the Ausable Bayfield Conservation Authority, the problem of manure pollution has been addressed. This report outlines the steps taken by the Ausable Bayfield Conservation Authority during the 1986-87 Manure Management Awareness Program to reduce the impact of manure pollution on water quality.

2. BACKGROUND

The 1986-87 Manure Management Awareness Program of the Ausable Bayfield Conservation Authority is a continuation of the Manure Management Program that was launched in 1982. The original program was initiated in response to concerns expressed by a number of watershed municipalities regarding the apparent impact of poor manure management practices of watershed farmers on water quality. The program has received continued support and funding by the Ontario Ministry of the Environment (O.M.E.).

Through an air photo identification and ground truthing process 20% (827) of all farm operations in the Ausable Bayfield Conservation Authority watersheds were identified as having a potential to impact water quality through manure management. Of these farms, 177 (21%) were designated as having a high potential to pollute (Ryan, 1982; Balint 1985 and 1983).

The need to improve manure handling practices in the Ausable Bayfield Conservation Authority's jurisdiction was intensified by the Lake Huron Beach Study (O.M.E., 1984). The report was in response to the 1983 beach closures in Grand Bend and a number of other beach resorts along the Lake Huron shoreline. The public beaches were closed due to elevated concentrations of fecal coliform bacteria in the onshore waters. The study investigations determined that agricultural sources were a significant contributor of fecal bacteria to the onshore waters. The report concluded that "improvements to the Lake Huron beach quality will depend largely on improved manure management on the watersheds of the Ausable, Maitland and other watercourses" (O.M.E., 1984).

Further to the initiatives of the Manure Management Awareness Program, the Ministry of the Environment and the Ausable Bayfield Conservation Authority have launched a sub-basin program under the Provincial Rural Beaches Strategy Program. Unlike the Manure Management Awareness Program which is administered on a watershed wide basis, the Beaches Strategy program focuses on the in-depth study of a single sub-basin. The two programs are complementary and share many of the same goals and objectives.

3. GOALS AND OBJECTIVES

The purpose of the 1986-87 Manure Management Awareness Program is a direct continuation of the initiatives set out in the 1985-86 program (Ryan, 1986). The program is to identify livestock farm practices that cause water quality impairment and determine their impact on the watercourse as well as to promote corrective measures to remedy these problems.

The program had two broad goals. The first was to facilitate a better understanding of the sources and causes of manure pollution on individual farms. The second was to promote and encourage the use of remedial measures by the farm community to improve water quality. These goals were addressed by three inter-related program components.

1. In 1985 a farmer interview program was established to meet both goals. This program component was continued using the methodology developed in 1985. Information was gathered on the nature and severity of manure pollution problems on individual farms by interviewing farm operators on site. This method also provided a means of promoting site specific remedial measures. Emphasis was given to encouraging the use of the Ontario Soil Conservation and Environmental Protection Assistance Program (O.S.C.E.P.A.P) which is administered by the Ontario Ministry of Agriculture and Food (O.M.A.F.) The interview method also provided the opportunity to detail factors affecting compliance and non-compliance in implementing remedial works.

2. The information extension component focused on the "Awareness" aspect of the Manure Management Awareness Program. Awareness of the sources and causes of pollution as well as awareness of remedial measures was encouraged. A portion of this component was structured and involved news releases and public education seminars. Generally this component was carried out on a less structured scale such as the farmer contact, technical information extension and liaising with staff from the Ministry of the Environment, the Ministry of Agriculture and Food, and farmers in trying to bring about solutions to manure pollution.

3. The water sampling component measured water quality impairment and assisted in the identification of problem areas. During the 1985 study 10 agricultural drains which had been previously sampled by the Ministry of the Environment in the 1984 and 1985 Lake Huron program were routinely sampled for chemical and bacterial parameters. The sampling of these 10 drains was continued during the 1986 program. The sampling program provides some continuity of information and long term data for comparison of water quality changes. The data is also useful in other programs such as the Ministry of the Environment - Ausable Bayfield Conservation Authority Rural Beaches Strategy Program.

   Samples were also collected in response to requests of landowners and concerned citizens in the watershed. The samples were collected to determine whether pollution was occurring and to measure the effects of some practices.

4. FARM CONTACT PROGRAM

4.1 Methodology

The 1986-87 farm contact program continued the visiting of farms identified during previous air photo analysis and ground truthing studies. This methodology is described by Ryan (1982) and by Balint (1983 and 1985). The 292 farms selected for the contact program are generally located close to a watercourse or have characteristics of a livestock intensive operation. In 1985, 83 of the farms previously selected were contacted.

The 1986-87 methodology is the same procedure of contact that was used in the 1985-86 study. The farms on the contact list which had not been previously contacted were sent a letter asking for their continued co-operation and informing them of the upcoming site-visit (Appendix A). Appointments for the site visit were arranged by telephone. For each farm visited, a farm file was created consisting of a completed questionnaire, site plan and photographs. A copy of the questionnaire is located in Appendix B. Following each site visit the farm operator was sent a letter of appreciation for his/her co-operation in the study. The letter also reviewed the remedial measures that had been discussed and included fact sheets and resource material where required.

4.2 Observations and Results

4.2.1. Analysis of the Contact Procedure

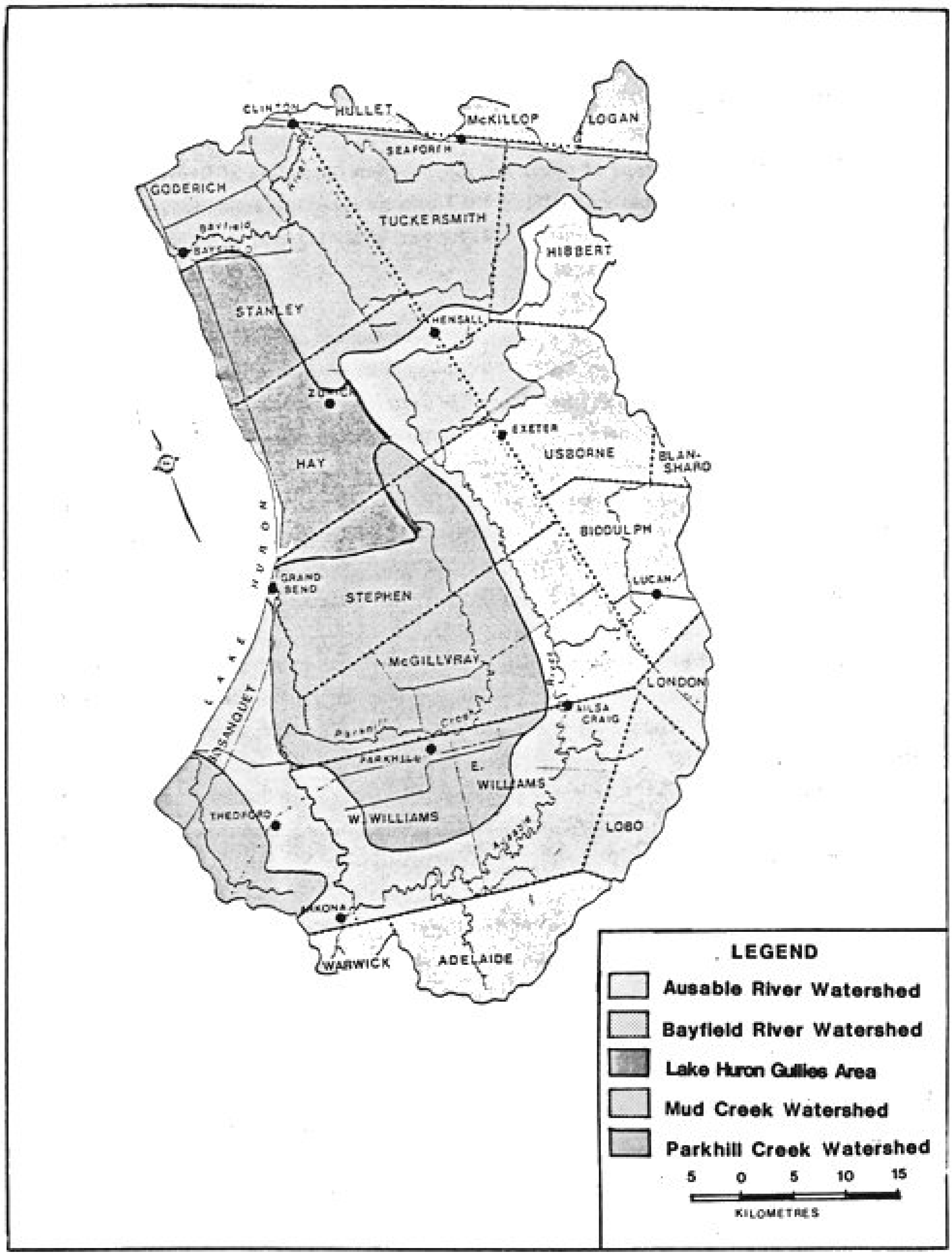
During the study period 84 farmers were contacted. Of the 84 contacted, 13 farmers did not wish to participate in the program and 16 farmers no longer kept livestock. Seven farm visits were farmer-requested consultation calls and therefore were not included in the farm contact data. These were specific requests from farmers for information on remedial measures for their operations. Of the 84 contacts, 48 farms were visited and had a farm file created although 2 of these operators were phasing out livestock and therefore their data was not included in analysis.

Although the 1985-86 study found pre-arranging farm appointments by telephone to be time consuming, this aspect of the methodology was continued in 1986-87 for a number of reasons. It is felt that the telephone contact prepares the farmer for the meeting, improving the reception that the interviewer receives upon arrival. It also avoids a number of problems related to making unannounced visits such as time spent on farms without livestock, farmers unavailable for an interview and non-complying farm operators.

The contact procedure was done on a random basis and does not attempt to reflect the actual distribution of livestock operations in the Ausable Bayfield Conservation Authority's watersheds. During the 1986-87 program the distribution of farms surveyed in the watersheds are as follows: 1 in the Lake Huron Gullies drainage area; 4 in the Mud Creek watershed; 8 in the Ausable River watershed; 16 in the Parkhill Creek watershed; and 19 in the Bayfield River watershed. (Map 1). There was also a wide variety of operation sizes and livestock types. The distribution of farms according to livestock type is as follows: 16 were swine farms; 13 were beef farms; 8 were dairy farms; and I was a poultry farm. Eight of the farms surveyed were a combination of livestock types such as beef and swine.

4.2.2 Analysis of Questionnaire Data

The following is a discussion of the data gathered from the farm interviews specifically from the portion of the questionnaire that was administered by the interviewer as opposed to the portion that was based on observation and site descriptions. A complete tabulation of the results used in this section is located in Appendix C. Data for this section is based on the survey of 46 farms. In some instances where the opinion of the farm operator is solicited the results are out of 45 since one operator owned 2 of the farms surveyed.



Map 1: Sub-basins of the Ausable-Bayfield Conservation Authority

Type of Manure Storage

The most prevalent type of manure storage system regardless of livestock type is a solid manure storage. Nineteen (41%) of the farms surveyed had solid manure storages as their sole manure handling system. A further 28% (11) had a solid storage in conjunction with a liquid manure system.

Solid manure storages are generally a source of manure contaminated runoff since these storages seldom have provisions for containing or catching the liquid portion of the manure. Only 4 (13%) of the solid storages had retaining walls erected to confine the liquids and 2 (6%) had runoff ponds to catch and store manure contaminated runoff. The majority of the solid storages (69%) were simply concrete pads. Some of these storages did have eavestroughing diverting roof water away from the manure storage or partial walls to divert or catch runoff. In most cases though these provisions did not adequately deal with runoff. Six (19%) of the storages consisted simply of manure piled on the ground or a gravel base with no regard for surface runoff or percolation.

Generally, most of the beef operations surveyed relied on solid manure as storage either in pile form or feedlot pack. The dairy farms were also predominantly solid manure system users. Only 2 of the swine operators relied solely on solid manure storage, although most of the swine producers had a solid storage in conjunction with a liquid storage. It appears that solid storages will remain predominant due to the preference for the use of straw for certain aspects of livestock production such as young animal bedding.

Semi-solid manure storages are the least prevalent manure storage system. Only 3 (7%) farm operations had a semi-solid manure storage as their only manure handling system. One farm had a semi-solid storage in conjunction with a liquid storage. All four of the operators had designed their own systems and were pleased with the results. Semi-solid systems were found on swine, beef and dairy farms.

Eleven (24%) of the respondents had liquid manure storage systems as their only storage system. Another 28% (13) used liquid manure storages in addition to a solid manure storage. Some farms had more than one type of storage facility. Covered pits were the most common type of liquid manure storages and were found on 16 (67%) of the farms with liquid manure storages. This included pits located under slatted floor barns. Earthen lagoons were used by 6 (25%) of the farm operators with liquid manure. Uncovered pits were the least common storage and were found on only 17% (4) of the farms surveyed which had liquid manure systems.

Dairy and swine farms appear to be the most common users of liquid manure systems. Of the 16 swine farms surveyed 13 (81%) had a liquid manure system in operation. Six (75%) of the 8 dairy farms surveyed had installed a liquid manure system. Only 2 (15%) of the 13 beef farms surveyed had a liquid manure system. Three (38%) of the 8 mixed farms had liquid manure systems.

Storage Capacity

Studies have shown that the critical factor affecting the pollution potential of a livestock farm is not the size of the operation or the type of storage system, but the management of the storage and disposal system (Switzer-Howse, 1982). Management practices include things such as storage maintenance and storage capacity. If the manure storage is well maintained and has adequate storage capacity for the liquid and solid portion of the manure, the operator has a great deal of flexibility as to when to spread the manure and optimize its fertilizer value. Inadequately sized storages increase the pollution potential of an operation by constraining the management options. Farmers with less than 200 days storage are often at the mercy of the weather and can find themselves with overloaded storages. As a result, to avoid overflow and runoff, they must spread manure when field conditions are less than ideal such as during wet periods or when the ground is frozen.

The storage facilities of farms surveyed ranged from daily spreading to having over a year of storage capacity. Although very few of the solid storages adequately dealt with the liquid portion of the manure, the majority of the storages had greater than 6 months of storage for the solid portion. Ten (53%) of the 19 farms which had only solid storages had greater than 6 months of storage. Seven (64%) of the 11 farms with only liquid manure systems had greater than 6 months of storage. On farms which had more than one system of manure storage, over half of the manure storage facilities had more than 6 months of storage capacity.

Milkhouse Waste Water Disposal

Recent studies have found that the improper disposal of milkhouse washwater is a significant source of water contamination (U.T.R.C.A., 1985). It is unsatisfactory to drain waste water from milkhouses through a field drainage system or onto the surface of the ground. The wastes should be properly treated by either adding them to a liquid manure tank or treating them in a sediment tank with a stone filled trench (Agriculture Canada, 1983).

Six (55%) of the 11 dairy farmers surveyed provided satisfactory treatment of milkhouse waste water. This was surprising, since a Maitland Valley Conservation Authority study found that only 4.9% of the surveyed dairy farmers properly treated their milkhouse wastes (Evans and Fuller, 1987). Of the 6 dairy farms who reported that they adequately treat their waste water, 3 add it to their liquid storage and 3 have a sediment tank with a stone-filled treatment trench. The 5 other dairy operators tile the wash water to a field drainage system or dispose of it onto the ground.

Factors Affecting Compliance

Fifteen (33%) of the respondents indicated that they had made some type of improvement to their manure storage system within the last 5 years. The farm operators often gave more than one reason for making the improvements. The most frequent reason, given 73% of the time, was that the changes had been made to reduce the amount of work required to operate the system and to make manure handling much easier. Herd expansion and runoff containment were each noted by 6 operators as being part of the reason for making the improvements. Only 2 of the 15 operators mentioned containment of runoff for its fertilizer value as being a reason for making improvements.

Of the 15 farmers who had made recent improvements to their manure handling facilities, 12 (80%) were satisfied with their present systems. Three (20%) of the operators wished to make further improvements to their manure handling systems. Only 7 (47%) of the 15 farmers received financial assistance from the Ontario Ministry of Agriculture and Food. Of the 7 who received the grant, 5 indicated that they would have made the improvements even without the financial assistance. The 2 other farmers indicated that without the O.S.C.E.P.A.P. grant the improvements would not have been made.

All of the respondents were asked if they would be interested in making improvements to their manure storage facilities. Ten wished to make improvements, 32 said no and 3 were uncertain. The respondents gave a number of reasons for not having made the necessary improvements to their manure storages. Fifty-one percent (23) of the farmers surveyed said that the present cost of improvements and the economics of farming were prohibiting them from making any changes. Twenty-two (49%) farmers indicated that their present manure handling facilities were adequate and that improvements were not required. A number of secondary reasons such as retirement and size of operation were also given.

The 10 respondents who would like to make improvements to their systems would like to receive both financial and technical assistance when they make the changes. The question on the subsidizing of manure storage improvements evoked a range of responses from the farm operators. Of the 45 operators who responded to this question, 12 (27%) were uncertain as to the amount of funding that should be provided by the government. This uncertainty was the result of a lack of knowledge about the O.S.C.E.P.A.P. grant and/or a lack of knowledge on the costs of remedial improvements. Eleven (25%) of the respondents felt that the present level of funding (⅓ of total costs up to $5,000) was adequate. A large percentage (20%) felt that the farmer should be responsible for all the cost and that a grant for manure storage improvements was unnecessary. Six (13%) of the respondents suggested that the grant should cover 50% of the costs and 2 (4%) felt that it should be greater than 50%. Eleven percent (5) of the respondents did not specify a grant rate but said that it should be greater than one-third in order to act as a better incentive.

The following is a summary of some of the comments that were given by farm operators concerning funding. A number of farmers remarked that if product prices were better, grants would not be necessary. Although a number of farmers stated that they were basically against subsidies, they also noted that due to the present economic situation, "I have my hand out whenever there is one (grant) to get". Concern was also expressed that those who need the improvements most are often unable to take advantage of the grant due to economies of scale. A larger farm can generally afford the improvements while a smaller operator cannot, despite the grants. Many of the farmers in favour of the grant felt that the $5,000 limit did not provide enough incentive.

Subsurface Drainage

It is believed that artificial drainage systems increase the delivery of manure contaminated water to watercourses (Upper Thames River Conservation Authority, 1984). In order to have a better understanding of the role of subsurface drainage, farm operators were asked questions concerning their knowledge of their tile drainage system. Forty-three farm operators responded to this set of questions. Only 4 (9%) of the farms surveyed were not tile drained. Four (9%) of the farms surveyed had only random tile drainage. Twenty (47%) of the farms were systematically tile drained and 15 (35%) had both random and systematic tile drainage on the farm. In general, systematic tile drainage accounts for 72% of all acres reported.

Livestock Access to Watercourses

Seventeen (38%) of the farms surveyed rely on a watercourse as a source of water for their livestock. Of these farms, only 2 (12%) have some form of limited access to the watercourse. Of the 17 farmers surveyed whose livestock rely on water from a stream, 5 feel that it is beneficial to limit livestock access to watercourses. Herd health and water quality were cited as equally important reasons for limiting access. Most farmers though felt that the pollution potential of livestock access to watercourses was minimal. Bottom lands and fields traversed by a watercourse have traditionally been used for pasture. Many of the farmers commented that livestock access kept the weeds down and the drains clear.

Problems With Manure Storages and Water Quality

The majority of the respondents indicated that they had never had any problems with their manure storage and handling systems. Twelve (26%) farmers indicated that they had experienced some problems with their facilities such as leaks, runoff and complaints. Four (9%) farmers admitted that they had experienced problems with excessive runoff from their storages. Two of the farmers had put in remedial measures to improve the situation. Three (7%) respondents indicated that they had experienced some runoff problems due to manure spreading. The problems had resulted from inexperience with the equipment and have since been overcome. Five (10%) of the farmers surveyed had been subject to Ministry of the Environment investigation due to complaints concerning their liquid manure storage and disposal systems. None of the investigations resulted in charges being laid.

In order to discover the agricultural community's awareness of water quality, the respondents were asked if they had ever had a problem with water quality on their farm that originated from another farm. Twelve (26%) of the farmers surveyed indicated that they had been aware of a water quality problem on their farm. These problems ranged from chemical disposal and milkhouse wastes to excessive algae blooms. Two farmers indicated that they had experienced problems with herd health due to degraded water quality. Only 2 of the farmers surveyed had ever reported the pollution incidents to the Ministry of the Environment. Two other operators had spoken with the farmers responsible for the problem in order to solve it. A number of farmers mentioned that they didn't want to report the problem for fear of becoming "bad neighbours".

5. INFORMATION EXTENSION

One of the Water Quality Strategies outlined in the Ausable Bayfield Conservation Authority's Watershed Plan is to develop an educational program, in co-operation with the Ministry of the Environment, member municipalities and other concerned agencies, aimed at reducing the potential for water quality impairment from manure handling and storage facilities.

The entire Manure Management Awareness Program actually fulfills this objective although there were separate information education activities.

5.1. Seminars

In response to a growing concern over the increasing incidence of agricultural pollution in municipal drains, the Ausable Bayfield Conservation Authority together with the Ministry of the Environment, hosted a seminar entitled Pollution Abatement in Municipal Drains, February 18, 1937. The workshop was directed toward municipal clerks, drainage inspectors and elected representatives of the watershed municipalities. The purpose of the workshop was to help municipal officials to better deal with problems of municipal drain pollution. The seminar featured speakers from the abatement and enforcement sections of the Ministry of the Environment, the water management branch of the Ministry of Agriculture and Food, and the Ausable Bayfield Conservation Authority. The speakers discussed the role of their agencies in dealing with municipal drain pollution. A great deal of the discussion centered on the enforcement of relevant legislation. For a copy of the agenda, see Appendix D.

Over 60 municipal officials attended the workshop. From the discussions that were generated it was apparent that municipalities are concerned about water pollution. It was also evident that the municipalities feel that enforcement of water quality legislation should be strictly carried out by the province. They also indicated that further discussion is required in order to clarify the inter-agency protocol that is involved in municipal drain pollution.

Public information sessions are an effective means of communicating a variety of ideas to a large number of people. Information sessions also provide a forum for the exchange of information between professionals and the public. In the past, the Ausable Bayfield Conservation Authority has hosted a Manure Management Information Day to disseminate program concerns and promote remedial measures to the public. The 198687 Manure Management Awareness Program expanded the approach to a Rural Water Quality Information Day which encompassed a variety of water quality issues. Although the seminar had an expanded focus much of the discussion dealt specifically with manure pollution.

The purpose of the seminar was to provide members of the rural community with an opportunity to exchange information on rural water quality. The agenda was developed so as to provide a broad range of discussion on rural water quality issues. Topics included public health, livestock health, agricultural pollution and the law, and remedial measures studies. For a copy of the agenda, see Appendix D.

Over 150 people attended the one day seminar on February 20, 1987. Representatives from the Ontario Ministry of the Environment, Ministry of Natural Resources, the Huron County Health Unit and a Goderich Veterinarian participated in the seminar. The Rural Water Quality Information Day provided the Rural Beaches Strategy Program with the opportunity to fulfill a portion of its public information obligation. This portion of the agenda elicited a great deal of discussion concerning the types of remedial measures that had been implemented.

Although most of the information extension work is in an unstructured format, a formal education section is composed for use at Camp Sylvan, the Ausable Bayfield Conservation Authority's Conservation School. "Water Quality Study" is provided as a course option for the participating grade six to eight students. During the spring and fall camp sessions, 8 classes were taught about water quality.

5.2. Information Requests

Answering requests for information is a major portion of the information extension component. The number of requests that are received are a good indication of the increased public interest in the program and its objectives. During the year, 50 requests for information and/or assistance were received. Seven farmers requested assistance in designing manure storages and remedial measures. For each of these farms a site evaluation was completed with the farmer. Relevant plans and information were provided to the farmer.

Approximately 30 requests were received for general manure management information. Many of the requests were for information on the O.S.C.E.P.A.P. grant and manure storage designs. The requests came from students and farmers. The remaining information requests concerned water quality information pertaining to drinking water and swimming objectives. Many of the requests were for information on water sampling and treatment methods.

5.3. Investigative Actions

The Ausable Bayfield Conservation Authority co-operates with the Ontario Ministry of the Environment in the investigation of fish kills, manure spills and other water quality degradation situations. During the 1986-87 program, only 1 fish kill was reported to the Conservation Authority. It was verified and referred to the Ministry of the Environment for action. On 2 occasions the Conservation Authority assisted the Ministry of the Environment in the investigation and monitoring of two municipal drains that were blocked by biological slime growths. On 3 occasions, the Conservation Authority received complaints from residents about degraded water quality in streams. The situations were monitored and the upstream farms were surveyed and encouraged to improve their manure handling practices.

6. WATER QUALITY SAMPLING

A water quality program co-ordinated and funded by the Ontario Ministry of the Environment was initiated by the Ausable Bayfield Conservation Authority in 1985 to monitor the water quality of 10 agricultural drains which could have a potential negative effect on Lake Huron beaches in the Village of Grand Bend. The sampling program was established to continue the one initiated by the Lake Huron Beach Study in 1984 (O.M.E.). During the 1986-87 program, water quality sampling was continued in order to provide long-term continuous data for the on-going water quality studies.

6.1. Methodology

The sampling stations established for the 1985-86 program remained unchanged from the previous program. The location of the 10 drains and sampling stations are identified on Map 2. The samples were collected on a weekly basis from March 13 to December 17, 1986. The sites were sampled in both wet and dry weather conditions. In total, 3,350 individual tests were taken on 35 sample days over a period of 280 days. All samples were analyzed for both chemical and microbiological parameters (Table 1). The samples were analyzed at the Ontario Ministry of the Environment Laboratory at the Regional Office in London, Ontario, with the exception of microbiological samples taken from June 9 to August 25 inclusive. These samples were analyzed at the Ontario Ministry of the Environment mobile laboratory in Grand Bend. All samples were analyzed by standard Ministry procedures.

Samples were also taken upon request, by farmers seeking information about the effects of their farm practices on water quality.

Table 1: Water Quality Parameters

Bacterial Parameters

Fecal Coli forms
Fecal Streptococci
Escherichia coli (June 9 - August 25)

Total coliforms (March 13 - June 4, September 17 - December 17)
Pseudomonas aeruginosa

Chemical Parameters

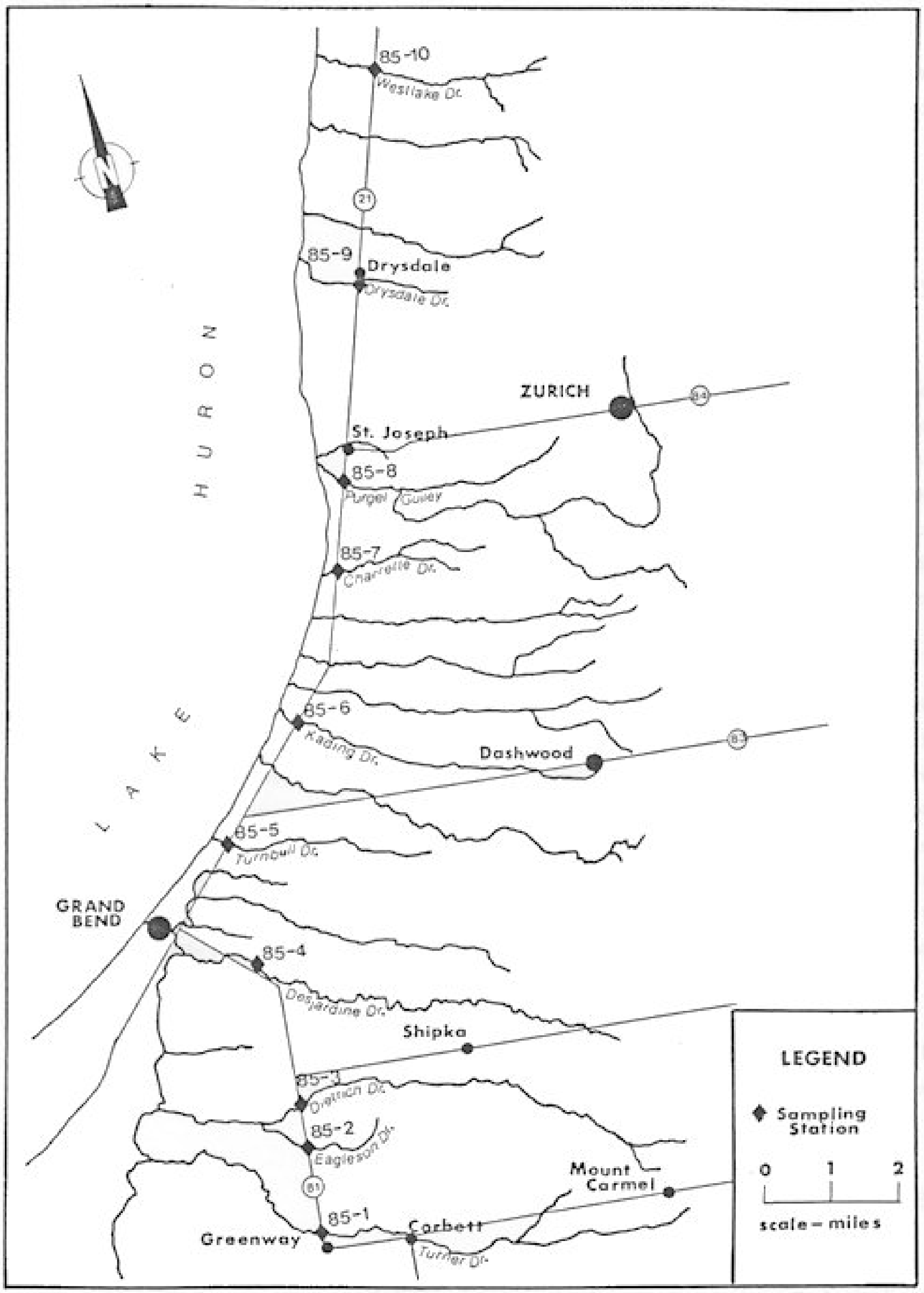
Biological Oxygen Demand (BOD5) Total Phosphorus
Filtered Reactive Phosphorus
Ammonia Nitrogen
Total kjeldahl Nitrogen
Nitrate
Nitrite
Turbidity
Chlorides
Conductivity
pH

The data depicted in this report will allow the reader to envisage the relative order of the concentrations of contaminants found at the sampling sites. The results of the analysis of all parameters are included in Appendix E.

6.2. Microbiological Parameter Analysis

Microbial safety of water is determined by using concentrations of normal intestinal bacterium as indicators of the presence of pathogenic bacteria. Since disease causing bacteria and viruses are difficult to detect it is assumed that if it can be shown that water has been contaminated by feces through the detection of fecal bacteria, then pathogenic organisms may be present.

During the 1986 sampling period the water samples were analyzed for 5 bacterial parameters. Throughout the duration of the sampling program the samples were analyzed for concentration of fecal coliforms, fecal streptococci and *Pseudomonas aeruginosa*. Water samples were analyzed for total coli forms from March 13 to June 4 and from September 17 to December 17. During the period from June 9 to August 25, the samples were analyzed for concentrations of *Escherichia coli* at the mobile laboratory facility at Grand Bend.



Map 2: Location of the Sampling Stations

Total Coliforms

Total coliforms are normal inhabitants of soils as well as the intestinal tract of warm-blooded animals including man. Total coliforms are always present in surface water although the levels are elevated by pollution events (O.M.E., 1982). The Ontario Ministry of the Environment water quality guideline and objective for general agricultural uses such as irrigation and livestock watering and for the protection of aquatic life and recreation is 1,000 coliforms per 100 ml. During the periods that total coliforms were analyzed for only 27.3% of the total 227 samples were of acceptable quality.

The samples exhibited a great deal of variability between high and low concentrations in individual drains. Figure I illustrates the results of the data analysis for total coliforms for the 10 drains. The figure indicates the geometric mean concentration of each drain as well as the upper and lower limits of the data. Concentrations of over 100,000 coliforms per 100 ml were recorded in the Dietrich, Desjardine, Turnbull and Kading drains. Subsequently, these 4 drains had the highest geometric mean concentrations of total coliforms. The lowest mean concentration of total coliforms was 1,265 per 100 ml recorded in the Charrette drain. None of the 10 drains sampled met the Ministry of the Environment guideline for total coliforms.

Figure 2 illustrates the geometric means and upper and lower limits for total coliforms for the periods from September to December in 1985 and 1986. The geometric mean concentration of total coliforms for both years shows very little variation.

Fecal Coliforms

Fecal coliforms are generally found in the intestinal tract of warm-blooded animals including man. Elevated concentrations of fecal coliforms are a significant indication of fecal contamination. The Ontario Ministry of the Environment guideline for the protection of

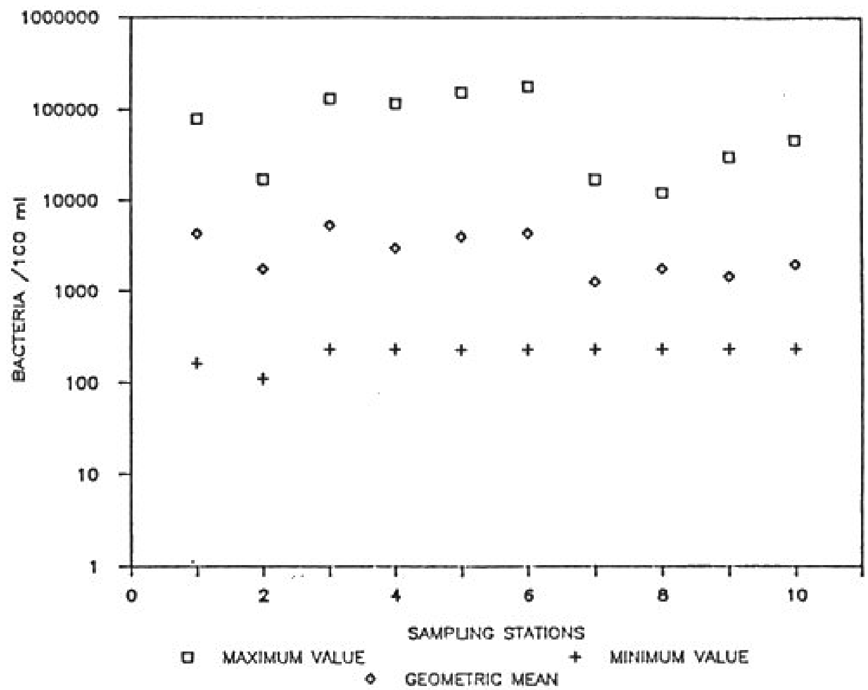


Figure 1: Levels of total coliforms March to December 1986

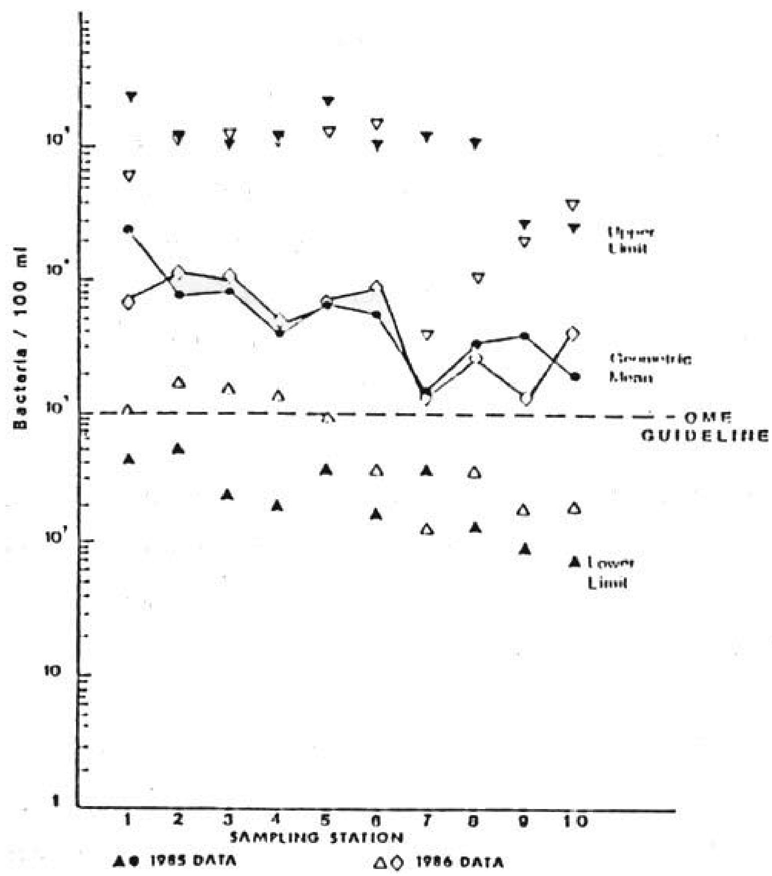


Figure 2: Comparison of total coliform levels for the period of September to December in 1985 and 1986

aquatic life and for the general uses of agriculture and recreation is 100 fecal coliforms per 100 ml. During the study period only 23.9% of the 347 collected samples met this guideline. The Charrette drain had 40% of its 32 samples meeting the guideline. The Dietrich drain met the guideline only 8.6% of the time.

As has been shown there is a great deal of variability between the high and low concentrations of bacteria for any one particular drain. Figure 3 illustrates the geometric mean concentrations of fecal conforms as well as the upper and lower limits of the data for all 10 drains. The lowest recorded concentration of fecal conforms was 4 bacteria per 100 ml which was found in a number of drains. The highest concentration of bacteria was 127,000 fecal coliforms per 100 ml recorded in the Turnbull and Drysdale drains during a period of stagnation in the summer. The Dietrich drain had the highest mean concentration of fecal conforms with 1,332 bacteria per 100 ml. The Charrette drain had the best quality with a geometric mean concentration of 162 fecal coliforms per 100 ml. It should be noted that none of the drains had a geometric mean concentration that met the Ministry of the Environment guideline for fecal coli forms.

Seasonal variation appears to have a great deal of effect on the concentration of fecal coliforms in the drains. Figure 4 illustrates the seasonal variation of fecal coli form concentrations in the 10 drains. The March to May period exhibited the lowest concentration of fecal coliforms for the three seasons, spring, summer and fall, despite the influence of spring rains and snow melt. During this period the Eagleson, Charrette, Purge! Gulley and Drysdale drains all had geometric mean concentrations of less than 100 fecal coliforms per 100 ml. The summer period from June to August elevated the levels of fecal coliforms above the other seasons in all but the Turner drain. Some of the drains such as the Turnbull and the Charrette exhibited mean summer concentrations that were at least an order of magnitude larger than the geometric means for the spring period. In most cases, the geometric mean concentration of fecal coliforms for the fall period was lower than the geometric mean concentration for the entire sampling period. During the fall period the Charrette and Purgel Gulley drains have mean concentrations of fecal coliforms below 100 bacteria per 100 ml.

Figure 5 illustrates a comparison of geometric means and upper and lower data limits for the September to December period in 1985 and 1986. In general the geometric mean concentration of fecal coliforms shows very little variation between the two periods.

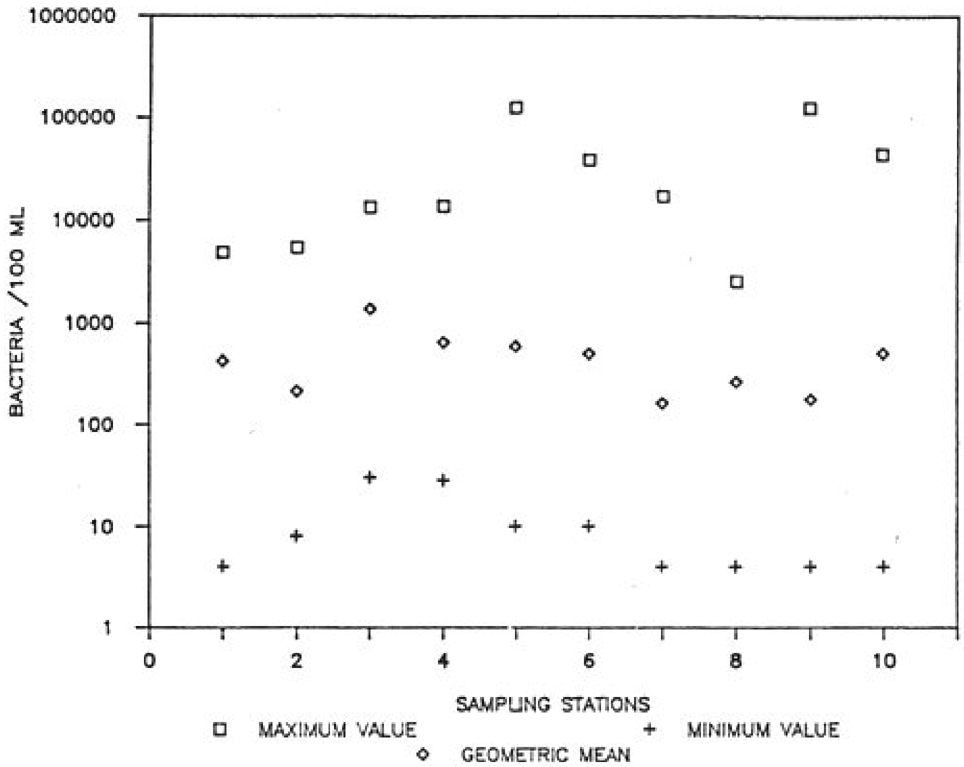


Figure 3: Levels of fecal coliforms March to December 1986.

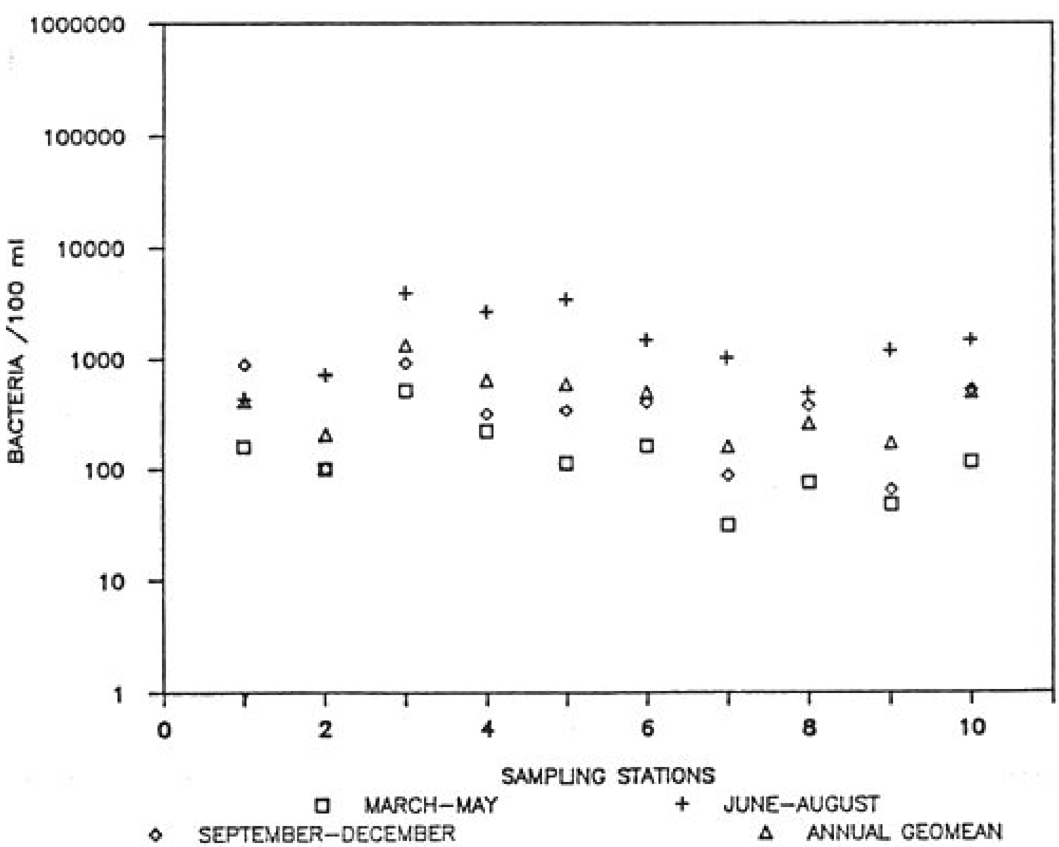


Figure 4: Seasonal variation of fecal coliforms March to December 1986.

It appears that there has been no significant change in the bacterial water quality of these 10 drains over this period.

Fecal Streptococci

Similar to fecal coliforms, fecal streptococci are indicators of fecal waste pollution, since they also originate in the intestinal tract of warm-blooded animals. Fecal streptococci are generally more persistent in the environment than fecal coliforms and are therefore often found at points distant from the pollution source. There is no Ministry of the Environment guideline for counts of fecal streptococci in the water.

Figure 6 illustrates the geometric mean concentrations of fecal coliforms in the drains as well as the maximum value and minimum value of the data. The lowest recorded count of fecal streptococci was 4 bacteria per 100 ml. This count was recorded in the Turner, Turnbull, Charrette, Purgel Gulley and Westlake drains. The highest concentration of fecal streptococci of 260,000 bacteria per 100 ml was recorded in the Turnbull drain. This illustrates the amount of variability of bacterial counts that can be recorded in any one drain. The geometric mean counts range from 253 fecal streptococci per 100 ml in the Charrette drain to 943 per 100 ml in the Dietrich drain.

As was shown in the graph of the seasonal variation in fecal coli form concentrations, Figure 7 exhibits similar characteristics for seasonal variation of fecal streptococci concentrations. The March to May period had the lowest mean count of fecal streptococci in the 10 drains. In all the drains the September to December period had mean concentrations of fecal streptococci similar to or below the annual mean concentration. The summer period, June to August, had consistently higher concentrations of fecal streptococci than any other season. In most cases the difference between the spring and summer mean concentrations is at least an order of magnitude. Low flows and high temperatures in the summer appear to exert a greater influence on the concentration of fecal streptococci in these 10 drains than high rainfall and runoff events in the spring and fall.

A comparison of data from the 1985 and 1986 September to December periods as shown on Figure 8, exhibits very little variation between the geometric mean concentration of fecal streptococci. The mean concentrations of fecal streptococci are very similar for the

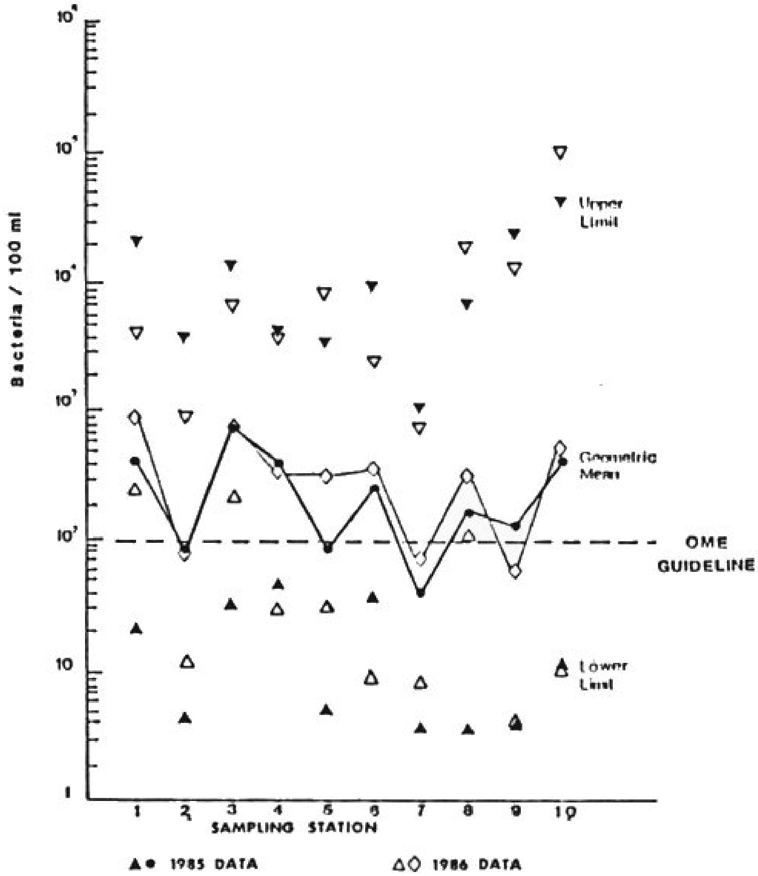


Figure 5: Comparison of fecal coliform levels for the period of September to December in 1985 and 1986.

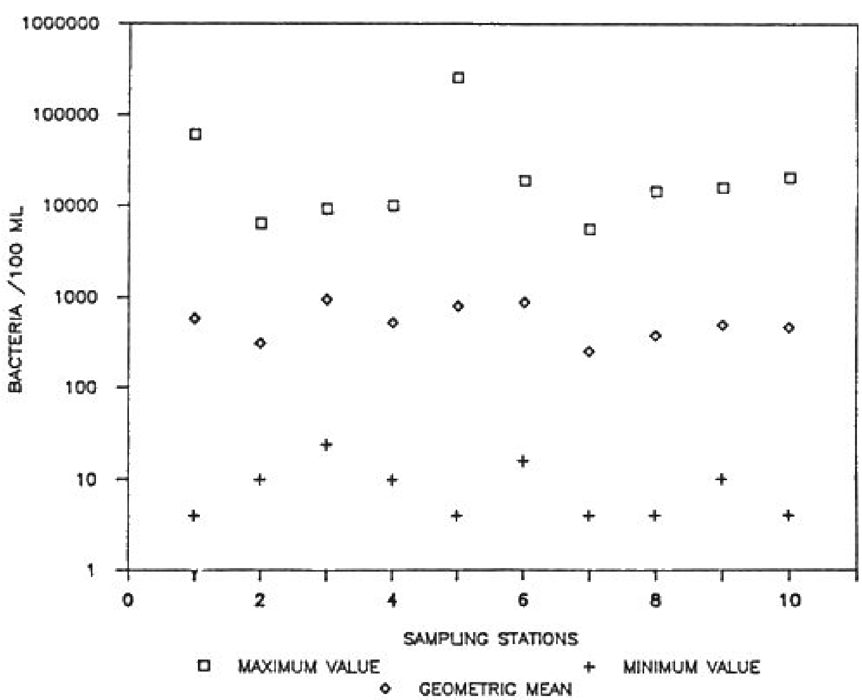


Figure 6: Levels of fecal streptococci March to December 1986.

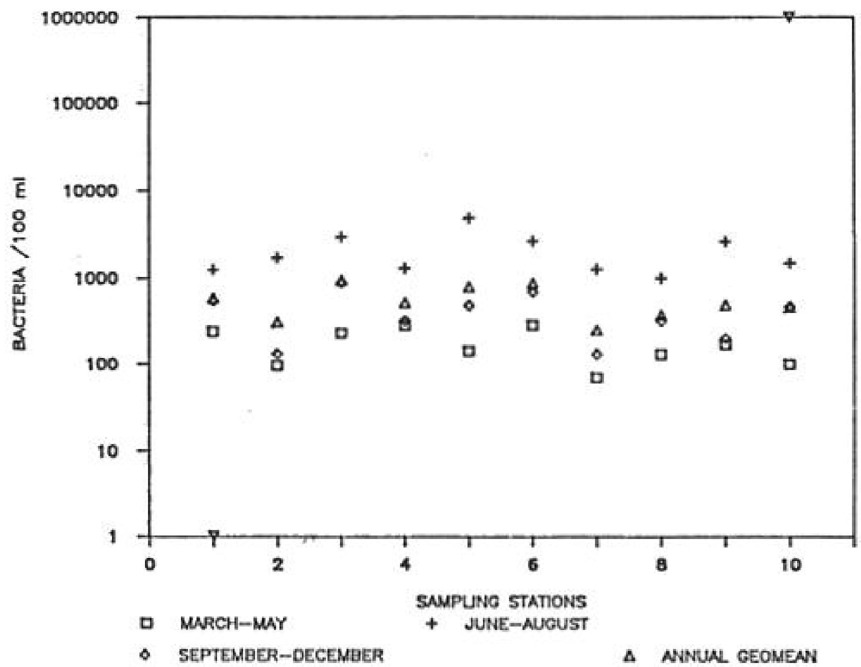


Figure 7: Seasonal variation of fecal streptococci March to December 1986.

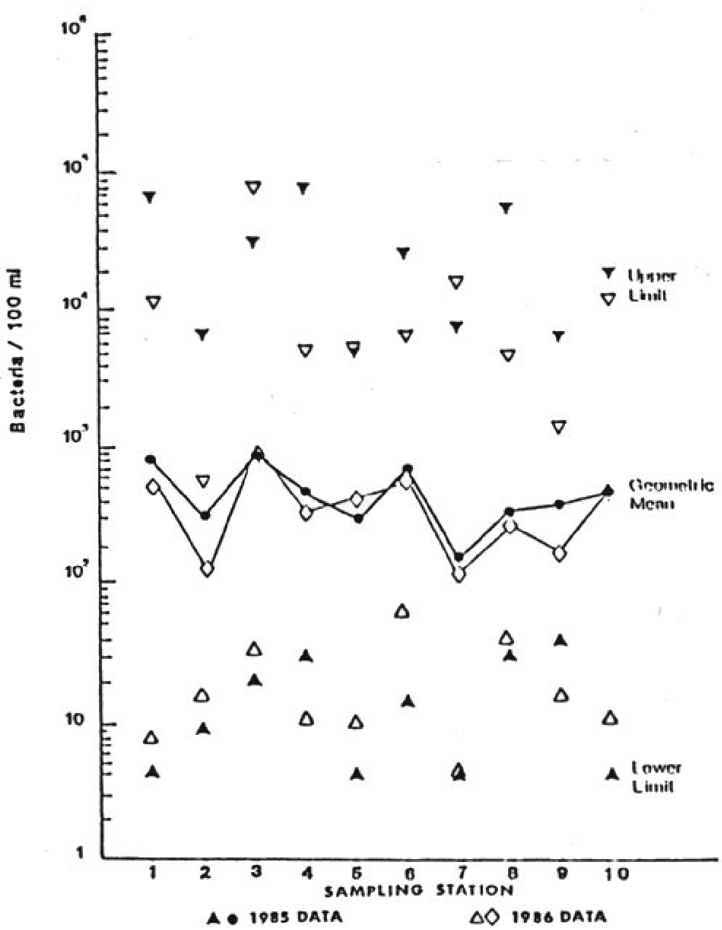


Figure 8: Comparison of fecal streptococci levels for the period of September to December in 1985 and 1986.

two periods indicating that there has been no significant change in the bacterial water quality of these 10 drains over this period.

Pseudomonas aeruginosa

Pseudomonas aeruginosa is a pathogenic bacteria that is associated with human wastes. *P. aeruginosa* is pathogenic to humans, animals and plants. When found in waters used for body contact recreation, *P. aeruginosa* is the major etiological agent in skin infections and otitis externa (ear aches) (O.M.E., 1982). Concentration of the bacterium below 20 bacteria per 100 ml are somewhat common and may indicate a natural background level of *P. aeruginosa*. Concentrations of over 20 bacteria per 100 ml are considered significant and can be regarded as an indication of contamination by human wastes.

Of the 349 samples analyzed from March 13 to December 17, 1986, only 10% of the samples had readings above 20 bacteria per 100 ml. The Eagleson and Charrette drains both had consistent readings of less than 4 *P. aeruginosa* per 100 ml during the sampling period. The Turnbull drain had readings of over 20 *P. aeruginosa* per 100 ml 23% of the time.

Figure 9 illustrates the maximum and minimum data values and the geometric mean concentration of *P. aeruginosa* for each of the 10 drains. The highest reading was 520 *P. aeruginosa* per 100 ml which was recorded in the Turnbull drain. This drain also had the highest percentage of readings above 20 bacteria per 100 ml and subsequently exhibited the highest geometric mean concentration of 10 *P. aeruginosa* per 100 ml. The prevalence of *P. aeruginosa* in the Turnbull drain indicates that human wastes are responsible for some of the bacterial pollution in the drain.

A comparison of the occurrence of rainfall events and elevated levels of *P. aeruginosa* exhibits a relationship between water quality and rainfall events. Data for the Exeter weather station is illustrated in Figure 10. Figure 11 illustrates the bacterial concentrations throughout the sampling program of the Turnbull drain. A comparison of the rainfall data (Figure 10) and the bacterial composite (Figure 11) shows that some peaks of *P. aeruginosa* are concurrent with or follow a rain event. For example, elevated levels of *P. aeruginosa* occur on days 124, 131 and 138, which also appear to be on or after days which had received rainfall. However, this relationship requires further investigation since the greatest rainfall event occurred on day 180, but *P. aeruginosa* concentrations were declining during

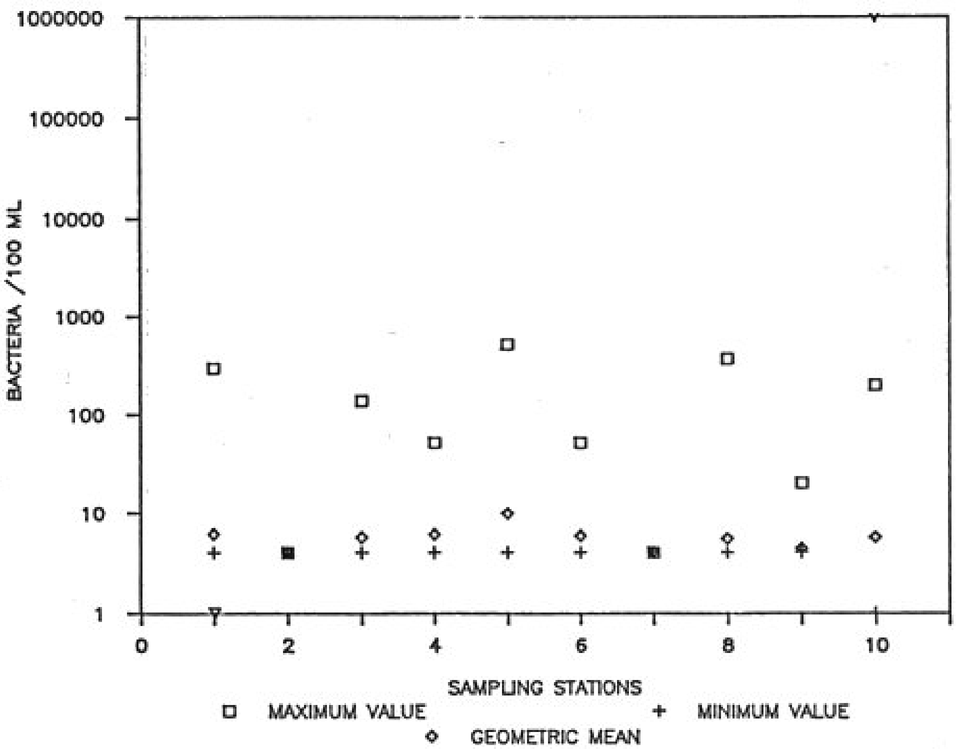


Figure 9: Levels of *Pseudomonas aeruginosa* March to December 1986.

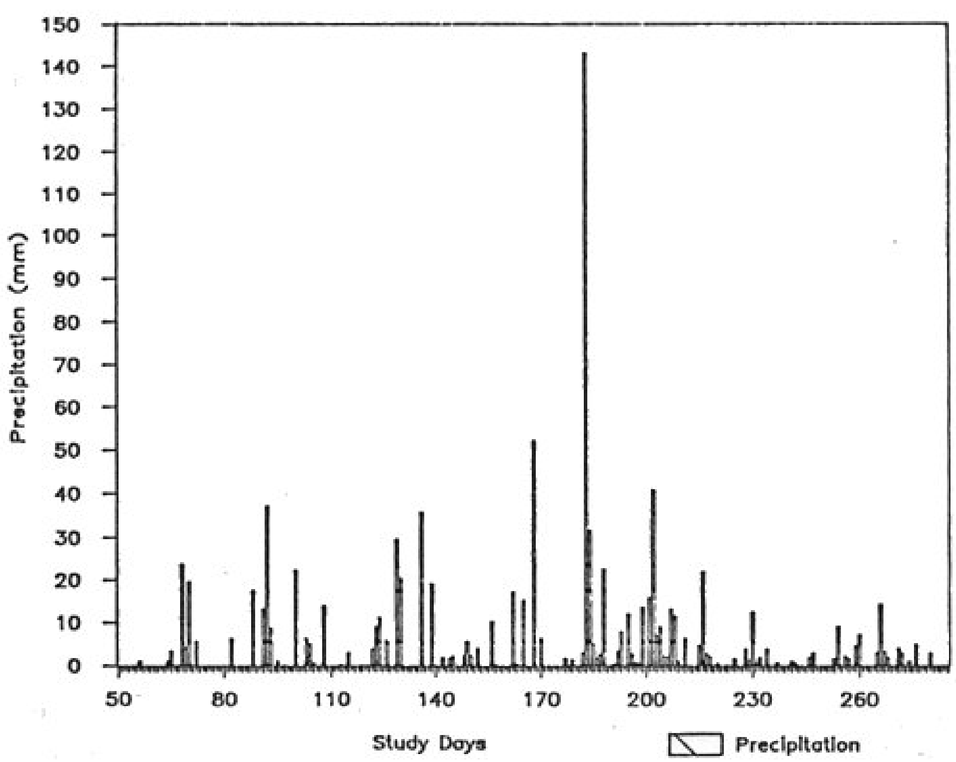


Figure 10: Exeter rainfall data May 1 to December 17, 1986.

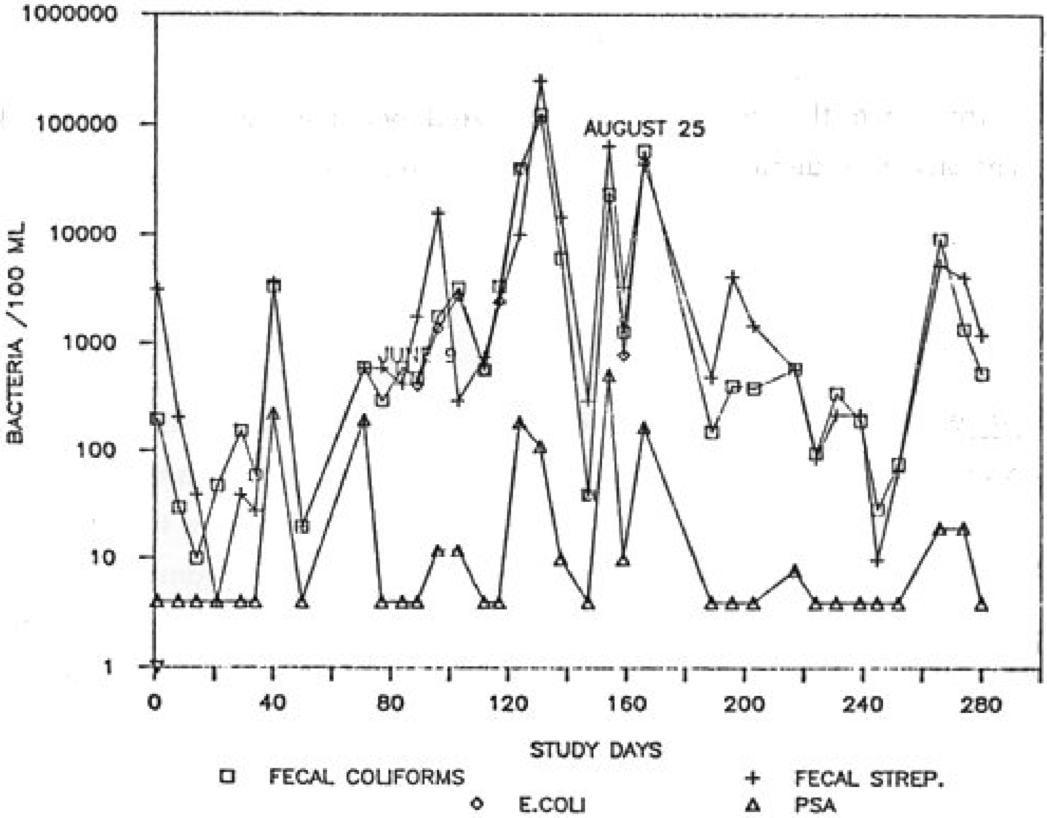


Figure 11: Turnbull drain bacterial composite March to December 1986.

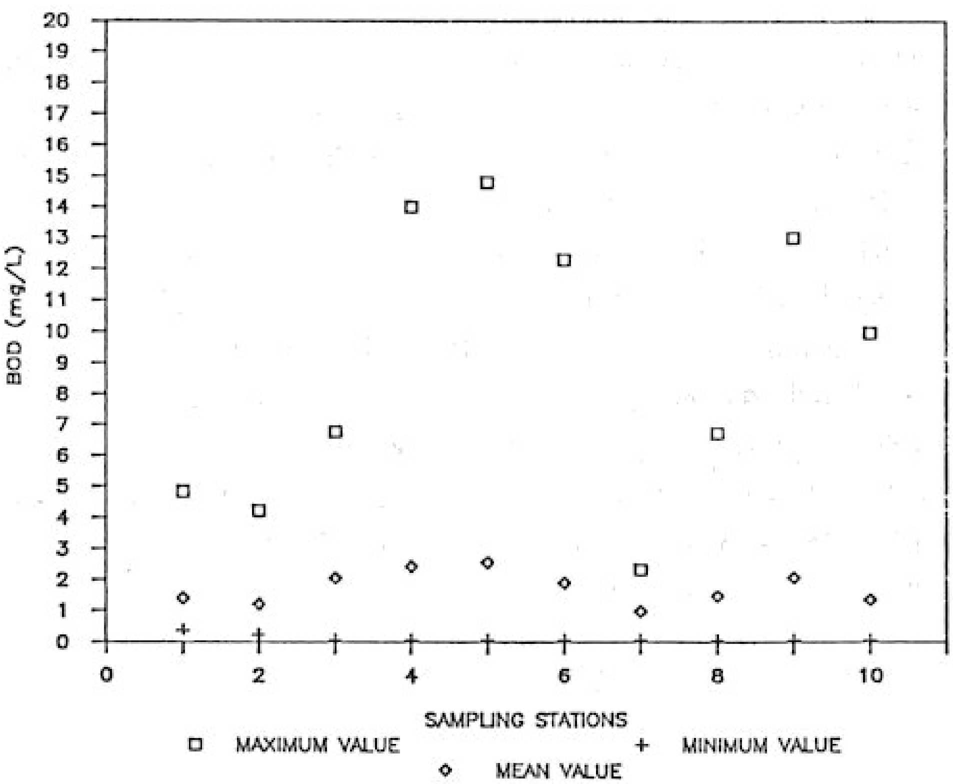


Figure 12: Levels of Biological Oxygen Demand March to December 1986.

and after this event.

Escherichia Coli

Escherichia coli is a fecal coliform bacterium used as an indicator of fecal pollution and the existence of pathogenic organisms. This parameter was sampled for a limited period of time, June 9 to August 25. It is felt therefore that the reporting of the geometric mean would be an unrealistic indication of the parameter. It was found that the concentration of E. coli varied very little from the concentrations of fecal coliforms. This is illustrated in the bacterial composite graphs (Figure 11 and Appendix F).

6.3. Chemical and Physical Parameter Analysis

Biological Oxygen Demand (BOD_5)

Biological oxygen demand is a measure of the unstable organic matter present in the water which through aerobic decomposition, utilizes the oxygen resources of a watercourse to oxidize to a stable inorganic form. BOD_5 is the laboratory measure of the amount of oxygen consumed in a sample incubated at 20°C for 5 days (O.M.E., 1982). It is not a pollutant itself, but the level of BOD is an important measure of the potential effects of pollutants on the concentration of dissolved oxygen in the water.

Figure 12 illustrates the recorded upper and lower limits of the data, as well as the arithmetic mean measurement of BOD_5 in the drains. Less than 2% of the 321 samples analyzed had BOD_5 concentrations over 10 mg/L. The Turnbull drain was the worst drain and had BOD_5 levels exceeding 10 mg/L in 9.6% of the samples. The Turnbull drain had a recorded high of 14.8 mg/L. The Charrette drain had the least amount of variance in BOD_5 levels with the maximum value recorded being 2.34 mg/L. Subsequently this drain had the lowest mean concentration of 1 mg/L.

Chlorides

Chloride is a major inorganic anion that occurs in practically all natural waters. Chlorides can be of a natural mineral origin or of anthropogenic sources such as domestic sewage, industrial wastes and road salts. Chlorides are not harmful in moderate amounts but high quantities may make water unfit for livestock watering. High chloride levels are not normally found in Canadian inland waters. They are concentrated by high evaporation rates. Most domestic industrial and agricultural uses require chloride concentrations of less than 250 mg/L (McNeely, *et al*, 1979).

Figure 13 illustrates the maximum, minimum and mean concentration of chloride in the drains. There was very little variation in mean chloride concentrations with the exception of the Drysdale drain. All of the other drains have mean concentrations between 20 and 30 mg/L while the Drysdale had a mean concentration of 73 mg/L. The elevated level in the Drysdale drain may be explained by its stagnation during a portion the summer. At this time, the evaporation of pure water may have concentrated the chlorides in the drain. Levels of chloride as high as 470 mg/L were recorded in this drain during the summer.

Conductivity

Conductivity testing provides a measure of the electrolytic properties of the water. Water is rendered conductive by the presence of dissolved ions such as calcium, sulphates and chlorides. Data is reported in micromhos per cubic centimetre. Conductivity is a good indicator of water quality changes since it is sensitive to variations in dissolved solids concentrations. There is often a direct relationship between conductivity and dissolved solids in many waters (O.M.E., 1982).

Figure 14 illustrates the minimum, maximum and mean levels of conductivity in the 10 drains. Generally the data exhibited very little variation. The minimum recorded levels were between 299 and 359 μmho/cm^3. Except for the Drysdale drain, the maximum recorded levels of conductivity were between 770 and 1,110 μmho/cm^3. The elevated reading for the Drysdale drain was recorded during a period of stagnation. Due to this the Drysdale drain had a mean conductivity level of 889 μmho/cm^3. The average mean conductivity in the other drains was 616 μmho/cm^3.

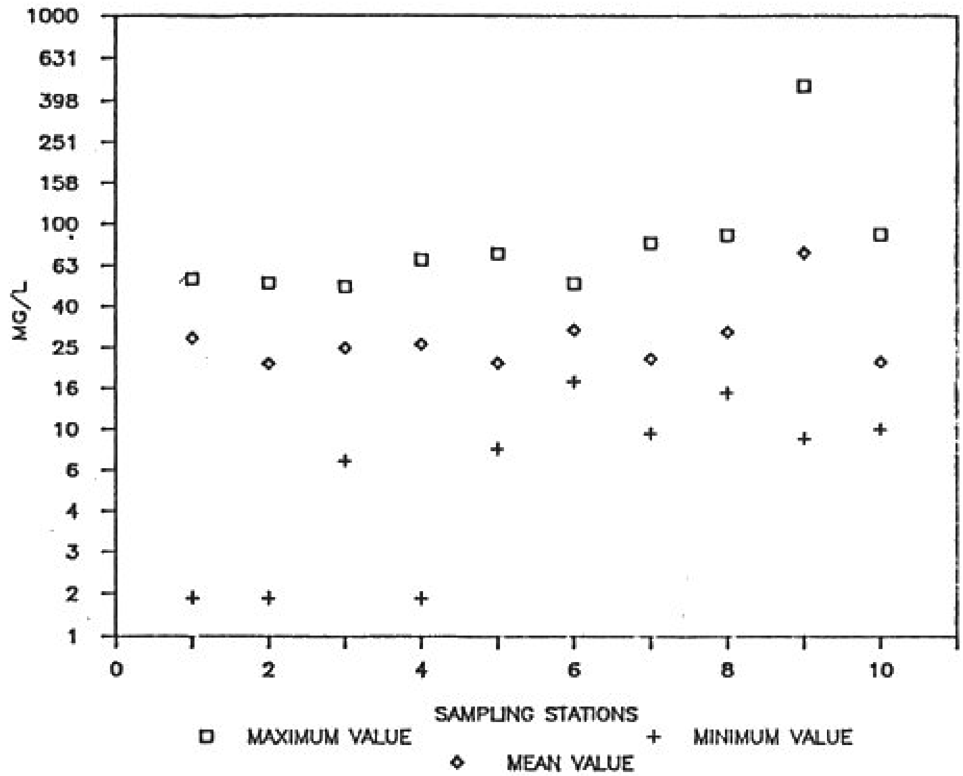


Figure 13: Levels of chloride March to December 1986.

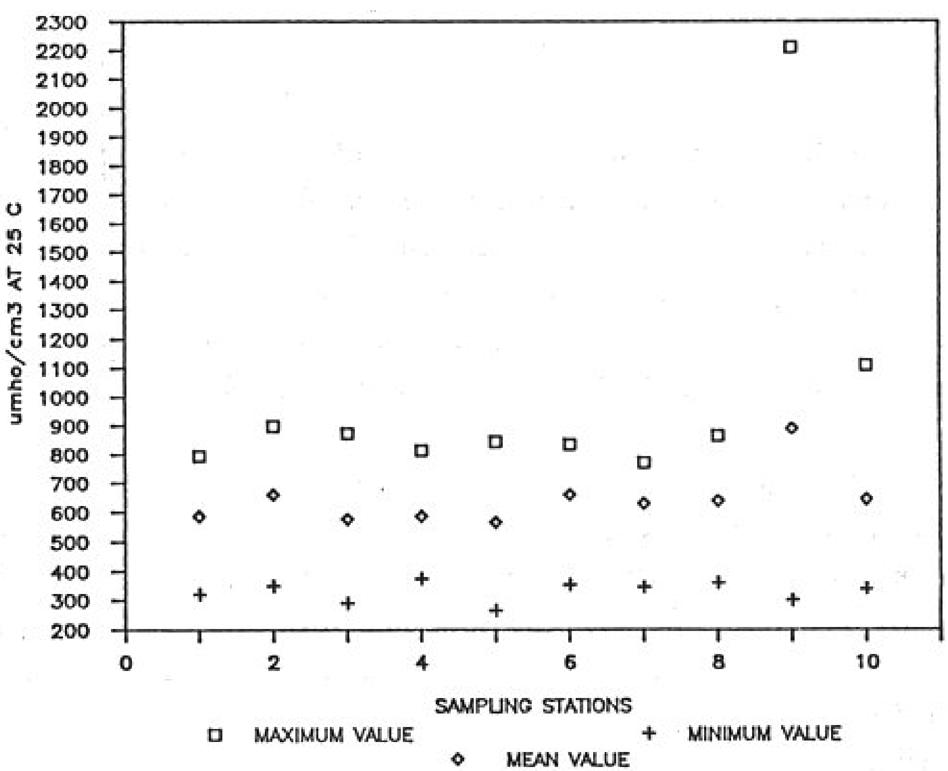


Figure 14: Conductivity level March to December 1986.

Nitrogen

Nitrogen compounds are present in most animal and plant matter and therefore is released by decaying organic matter. Nitrogen is an essential plant nutrient contributing to the fertility of water. Four measures of nitrogen were tested for during the study; free ammonia, total kjeldahl, nitrate and nitrite.

(i) Free Ammonia

The anaerobic decomposition of nitrogenous organic material yields the soluble product, filtered ammonia (ammonia NH_3 and ammonium NH_4^+). Free ammonia is also the product of the microbial reduction of nitrates and nitrites under anaerobic conditions. Sewage, livestock wastes and commercial fertilizers are common sources of ammonia. Watercourses which are considered unpolluted generally have free ammonia levels of less than 0.1 mg/L. Levels greater than this may be indicative of anthropogenic inputs (O.M.E., 1982). The Environmental Studies Board (1973) suggests that for the protection of freshwater aquatic life a level of 0.02 mg/L of NH_3 should not be exceeded.

Figure 15 illustrates the maximum, minimum and mean level of nitrogen as free ammonia in the drains. In all the drains, the minimum recorded level was 0.005 mg/L. The maximum recorded level of free ammonia showed a great deal of variation ranging from 0.155 mg/L in the Eagleson drain to 9.7 mg/L in the Desjardine drain. The elevated levels of free ammonia on individual sample days indicates that some of the drains may have experienced pollution events. The mean level of free ammonia was below 0.1 mg/L in all but the Desjardine and Turnbull drains. This elevated mean level of free ammonia in these drains is one indication of their poor water quality.

(ii) Nitrate

Nitrate results from the complete oxidation of nitrogen compounds. It is the end product of the stabilization of organic nitrogen through aerobic biochemical processes. Waters which have undergone some degree of self-purification generally contain nitrates. A major source of nitrates are human and animal wastes. Watercourses that receive drainage from fertilized agricultural areas also contain nitrates. Nitrogen as a nitrate is readily available to aquatic plants and algae for growth (O.M.E., 1982).

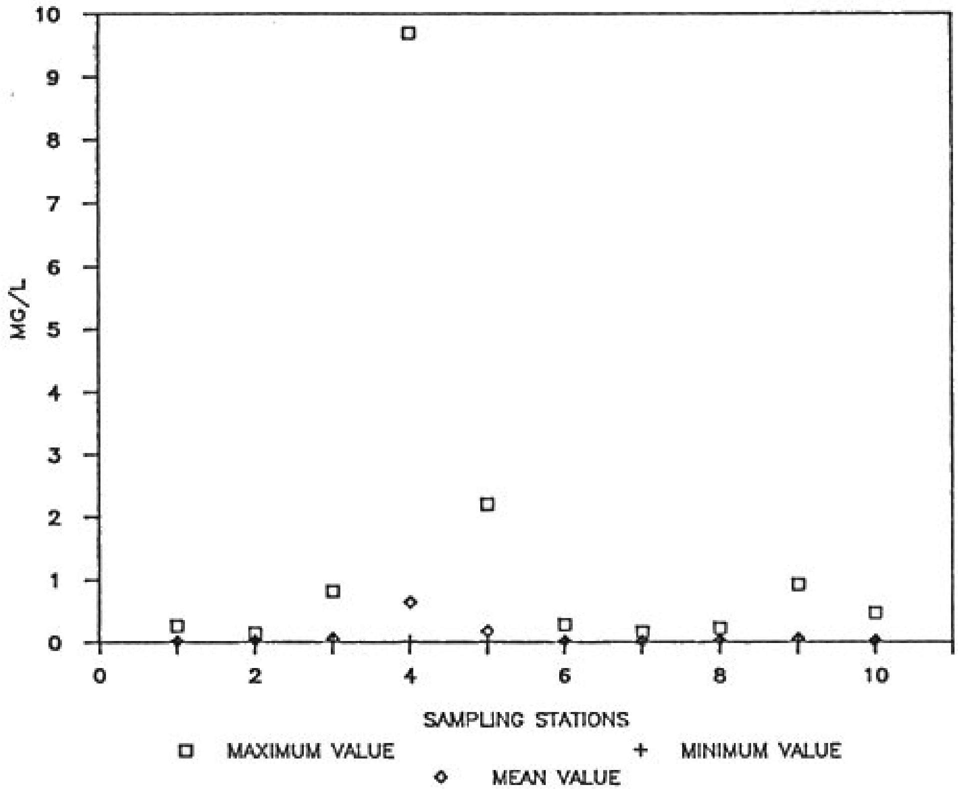


Figure 15: Levels of nitrogen as free ammonia March to December 1986.

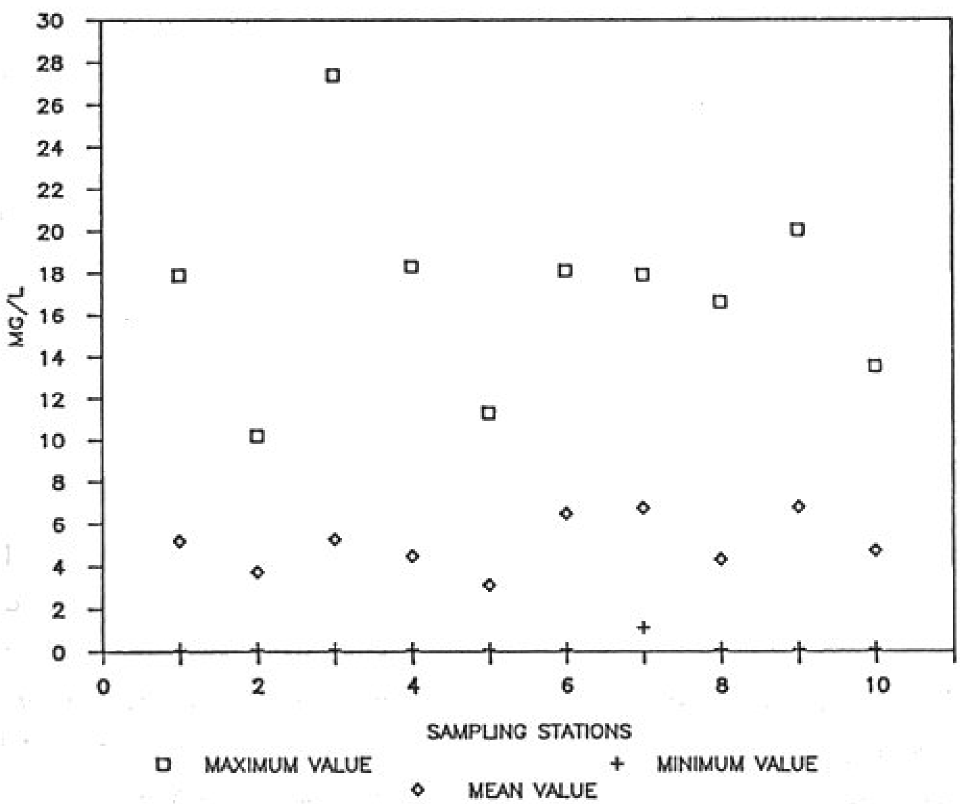


Figure 16: Levels of nitrogen as a nitrate March to December 1986.

Surface waters can contain a wide range of nitrate concentrations. Although surface waters rarely contain as much as 5 mg/L, they may contain more than 100 mg/L or less than 1 mg/L of nitrate (McNeely, 1979).

Figure 16 illustrates the maximum, minimum and mean concentration of nitrate in each of the 10 drains. The results of the analysis illustrate the wide range of variability in nitrate concentrations. The maximum concentration recorded was 27.4 mg/L in the Dietrich drain. The lowest concentration of 0.1 mg/L was recorded numerous times in all but the Charrette drain. The highest mean concentration of nitrate was 6.75 mg/L in the Drysdale drain. The lowest mean level was 3.1 mg/L of nitrate in the Turnbull drain.

(iii) Nitrite

Nitrite is unstable in the presence of oxygen as it occurs as an intermediate product of the oxidation of ammonia and the denitrification of nitrate to a nitrogen gas. "Nitrite is easily and rapidly converted to nitrate and thus its presence in concentrations greater than a few micrograms per litre is generally a good indication of active biological processes" in the water (O.M.E., 1982).

In the 10 sampled drains the mean level of nitrite ranged from 0.03 to 0.06 mg/L as illustrated in Figure 17. The maximum value of 0.89 mg/L was recorded on the Drysdale drain.

Total Kjeldahl

Total kjeldahl nitrogen measures the total nitrogenous matter, excluding nitrate and nitrite. Rivers that are not influenced by excessive organic inputs have total kjeldahl levels ranging from 0.1 to 0.5 mg/L (McNeely, 1979).

Figure 18 illustrates the minimum, maximum and mean concentrations of total kjeldahl in the 10 drains. The graph illustrates the amount of variability in concentration levels. The minimum recorded concentration was 0.4 mg/L in the Drysdale and Westlake drains. The maximum recorded level of total kjeldahl was 11.3 mg/L in the Desjardine drain. The lowest mean concentration was 0.72 mg/L in the Charrette drain. The maximum mean concentration was 1.2 mg/L in the Desjardine drain. All the drains must be influenced by

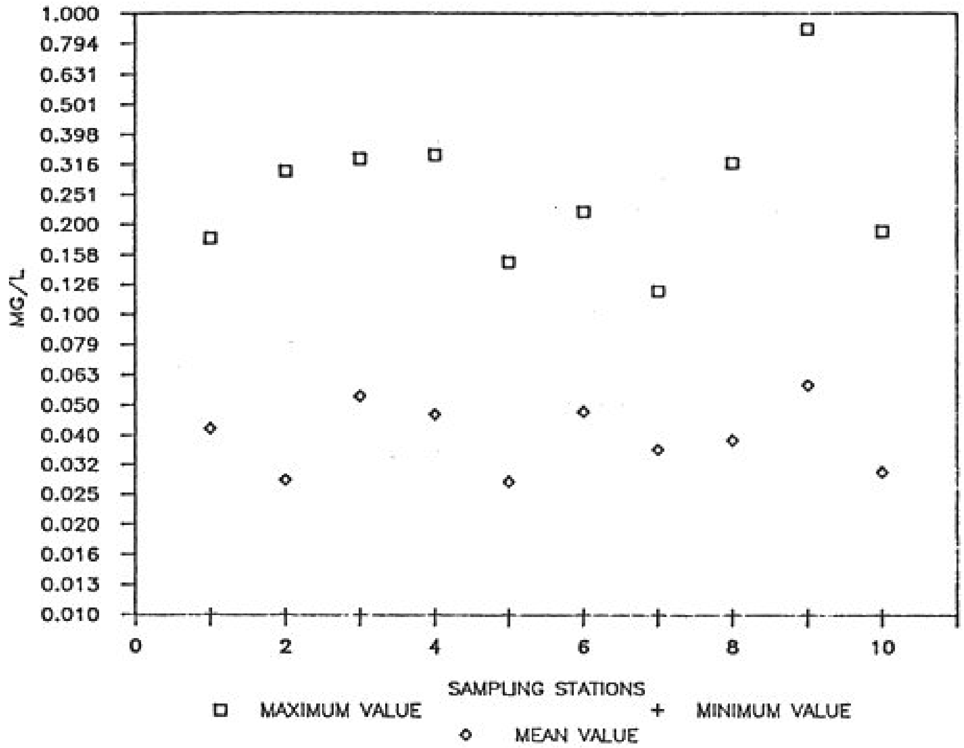


Figure 17: Levels of nitrogen as a nitrite March to December 1986.

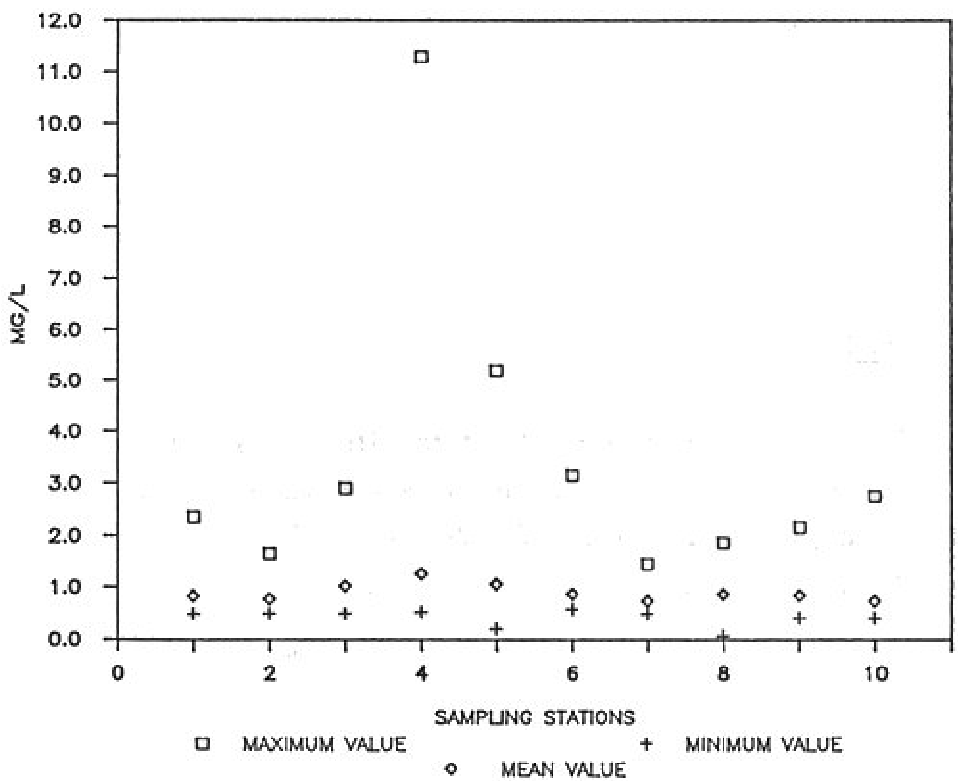


Figure 18: Levels of nitrogen as total Kjeldahl March to December 1986.

excessive organic inputs since they all have mean total kjeldahl concentrations in excess of 0.5 mg/L.

Phosphorus

Phosphorus is normally found in nature in the form of inorganic phosphates and organically bound phosphorus. Like nitrogen it passes through cycles of decomposition and photosynthesis and is an essential nutrient for plant and animal life. Sewage, livestock wastes, some industrial wastes and urban and agricultural drainage are sources of phosphorus.

(i) Total Phosphorus

Total phosphorus is a measure of the orthophosphate, condensed phosphates and organically bound phosphorus in both the particulate and dissolved form. Although there is no firm guideline for phosphorus, it is generally considered that to prevent biological nuisances total phosphorus should not exceed 0.03 mg/L in a watercourse (0.M(O.M.E.,2).

The maximum, minimum and mean concentration of total phosphorus in the 10 drains is illustrated in Figure 19. The highest recorded level of total phosphorus was 2.8 mg/L in the Turnbull drain. Subsequently, this drain had the highest mean concentration of 0.22 mg/L. The Eagleson and Charrette drains had the lowest mean concentrations of 0.05 and 0.04 mg/L respectively. The mean concentration of all the drains exceeded the recommended guideline of 0.03 mg/L. The data for the Charrette drain met the suggested guideline of 0.03 mg/L over 65% of the time.

ii) Dissolved Reactive Phosphorus

Dissolved reactive phosphorus is a combination of simple orthophosphate and readily hydrolyzed phosphate primarily in the dissolved form. This form of phosphorus is considered to be readily available for aquatic plant growth (O.M.E., 1982).

Figure 20 illustrates the maximum, minimum and mean concentration of dissolved reactive phosphorus for the 10 drains. The Eagleson and Charrette drains exhibited the lowest maximum concentrations as well as the lowest mean concentrations of 0.01 mg/L and

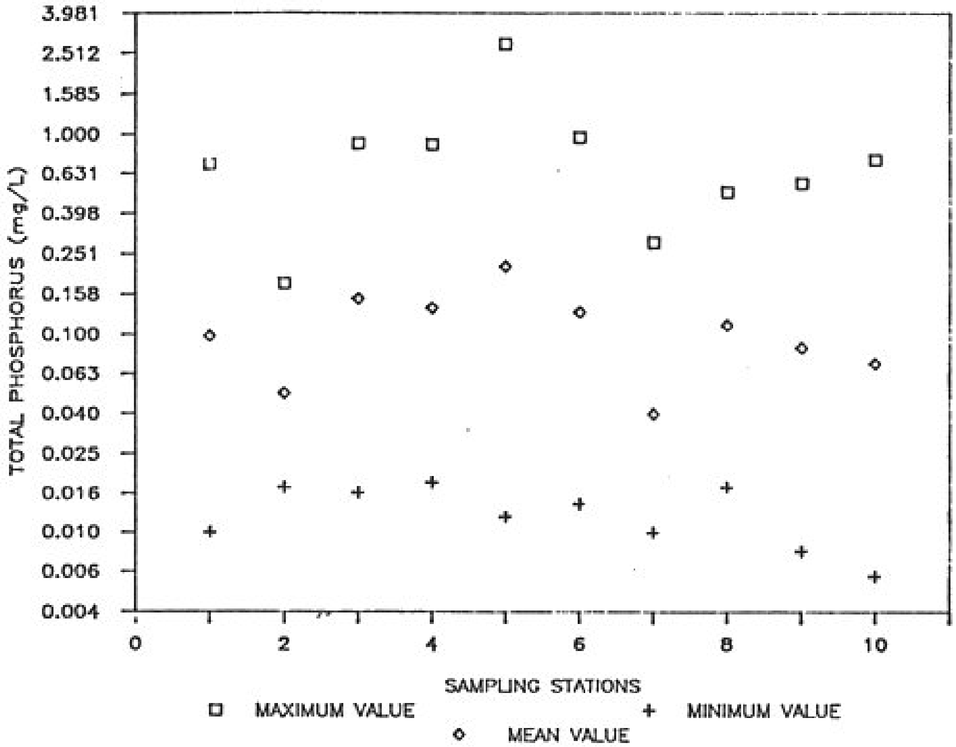


Figure 19: Levels of total phosphorus March to December 1986.

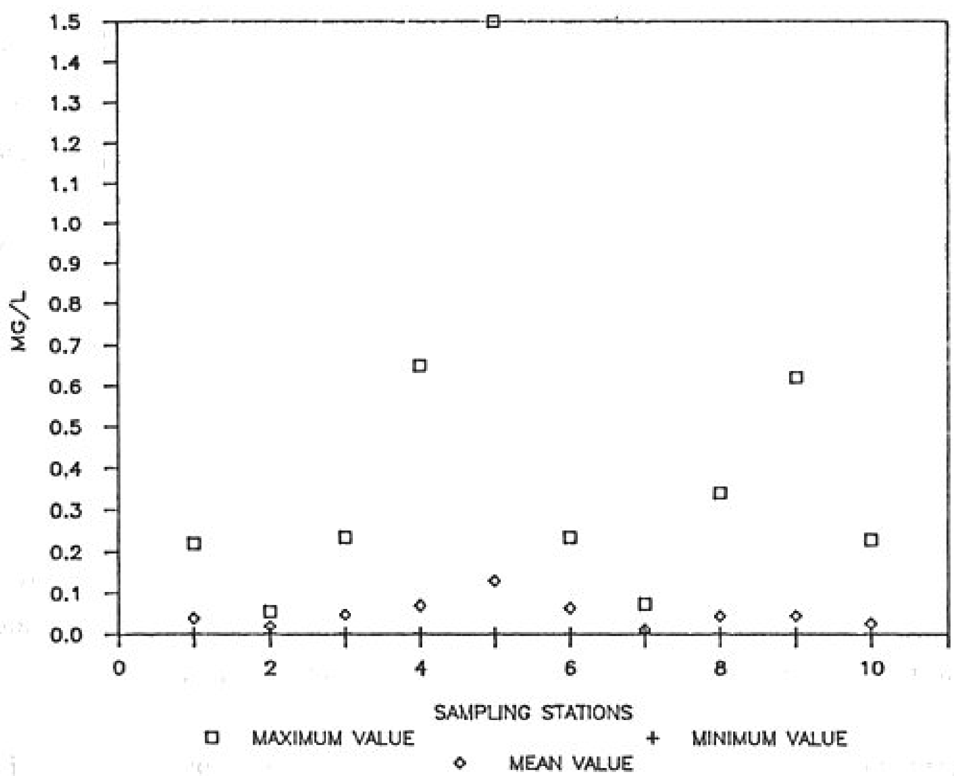


Figure 20: Levels of dissolved reactive phosphorus March to December 1986.

0.018 mg/L respectively. This is contrasted to the Turnbull drain which had a mean concentration of 0.13 mg/L and a maximum recorded concentration of 1.5 mg/L.

Turbidity

Turbidity is a measure of suspended and colloidal particles in the water such as clay, silt, micro-organisms, organic matter and plankton. These substances reduce light penetration and diminish the clarity. Turbidity can result from natural erosion, livestock and wildlife activity, runoff and algae blooms or man-made stream disruptions and inputs. Turbidity fluctuates a great deal as shown in Figure 21. The Charrette and Eagleson drains had the lowest mean turbidity of 11.9 and 12.4 formazin units respectively. The Dietrich drain had the highest mean level of turbidity of 65 formazin units.

There may be a relationship between turbidity and bacterium levels. Bacteria can be washed into watercourses with soil particles from surface runoff. Bacteria can also be resuspended in the water column with sediments during periods of turbulence. The relationship is illustrated in the Desjardine drain as shown in Figure 22. It appears in that the elevated levels of fecal coliforms occur during periods of increased turbidity. This relationship though is not always simple. Figure 23 illustrates the relationship between turbidity and fecal coliforms in the Eagleson drain. In this drain, the peaks of turbidity and fecal coliform are not as closely related as those in the Desjardine drain. Further research is required to determine what variables in the stream regime influence the relationship between turbidity and fecal coliforms. Graphs of this relationship for the other 8 drains are located in Appendix G.

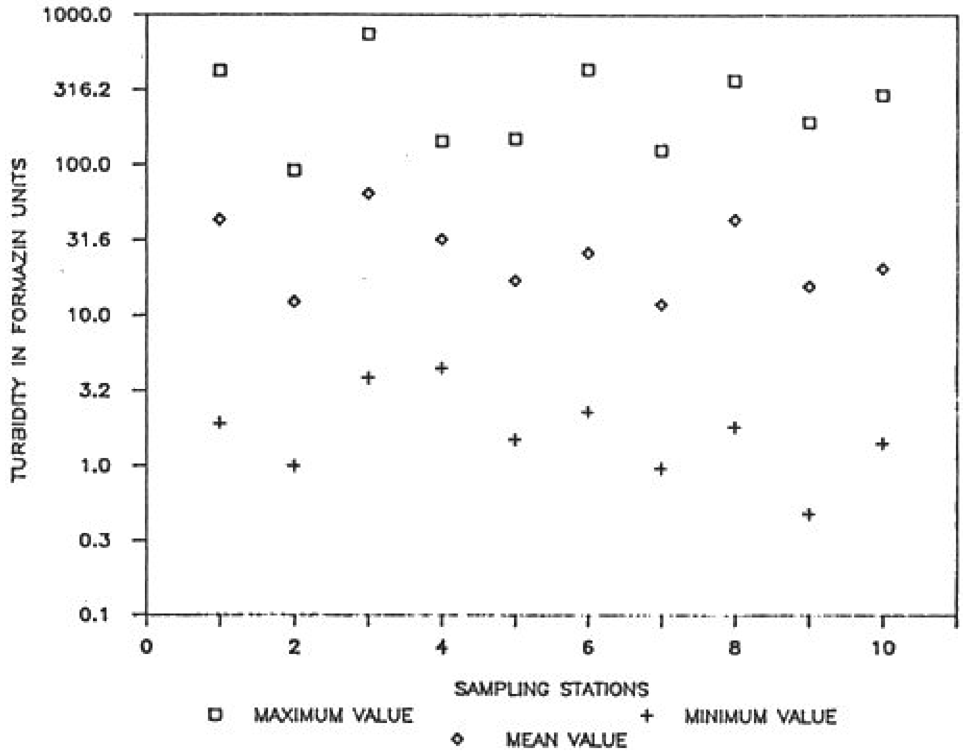


Figure 21: Turbidity levels March to December 1986.

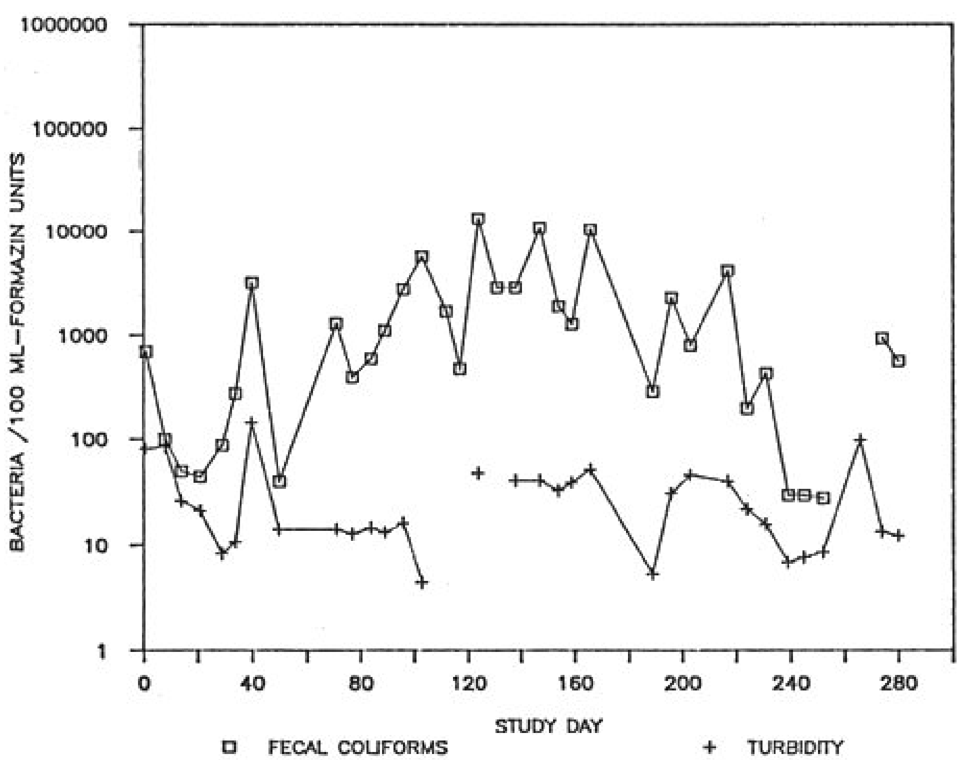


Figure 22: The relationship between turbidity and fecal coliform levels in the Desjardine drain March to December 1986.

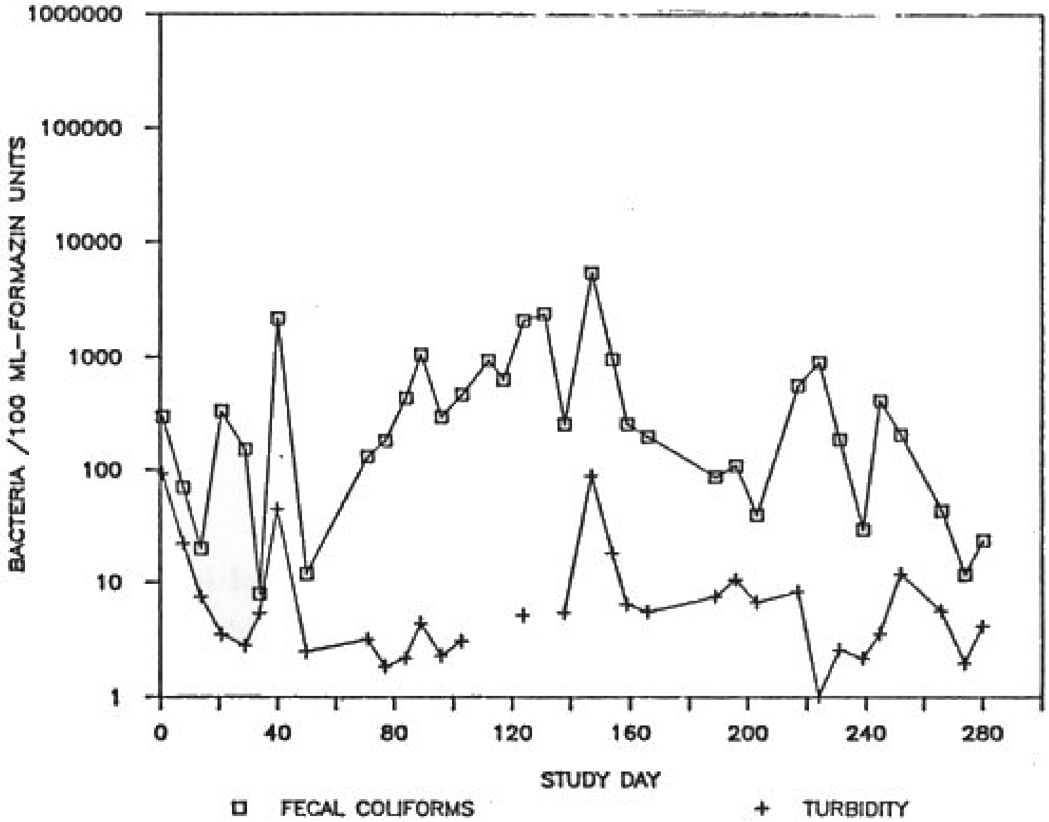


Figure 23: The relationship between turbidity and fecal coliform levels in the Eagleson drain March to December 1986.

7. CONCLUSIONS

The intent of the program was to identify farms and farm practices that are causing water quality impairment and to promote measures to rectify identified problems. This has been accomplished through the delivery of the three separate program components: Farmer Contact Program; Information Extension; and Water Quality Sampling.

7.1. Farmer Contact Program

The farmer contact program provided a great deal of insight into the individual farm operations and the types of problems that must be addressed in order to improve water quality. The individual contact provided site specific information which aids in developing effective remedial measures. The overall methodology of contact was an adequate means of addressing problem farms. More technical assistance should be available from the Conservation Authority once a site evaluation has been completed.

From the interviews it was determined that solid manure storages are the most prevalent type of storage. They are also a very common source of manure contaminated runoff. More education is required in order to encourage farmers to regard solid manure runoff as a serious source of water pollution. More research should be given to developing alternative management and handling options for solid manure. It was also apparent that all farmers must be encouraged to provide at least 200 days of storage for the manure produced on their farms. Larger storages would reduce the occurrence of accidental spills as well as the need to spread during less than optimal field conditions. There is generally a reluctance among farmers to admit storage problems since only 26% of the respondents acknowledged that they had a problem with their manure storage facilities. There is also a need for more information on spreading rates especially for irrigated manure on various soil conditions.

Although the survey indicated that milkhouse wash water disposal is not a major problem for area dairy farmers there are still a number of them who do not adequately treat this waste. More education is required to inform farmers of the pollution potential of inadequately treated milkhouse washwater. The new O.S.C.E.P.A.P. grant should also be promoted among area dairy farmers to promote the installation of treatment and holding tanks.

The cost was the main reason that farmers did not make improvements to their manure storages. Since the O.S.C.E.P.A.P. grant has been restructured (January, 1987), more farmers may take the initiative to improve their facilities. Farmers that have been contacted should be informed of the grant increase in order to see if the offer of more money improves the uptake of the grant. The prevalence of systematic tiling systems in the watersheds of the Ausable Bayfield Conservation Authority indicates that subsurface drainage may be a major source of water contamination. This issue warrants more study to determine the sources of contamination and the factors affecting transport and delivery. More research should be done on acceptable manure spreading rates and field conditions with specific regard to contamination transport in tile systems.

Livestock access to watercourses is a concern of both the Conservation Authority and the Ministry of the Environment. It does not appear to be a concern to farmers. There needs to be more public education stressing the potential health hazards for livestock. The use of O.S.C.E.P.A.P. should also be encouraged as it provides funding for alternate watering sources, low level crossings and fencing. Efforts by all concerned agencies to limit livestock access should be concentrated in areas where fish habitat is of concern.

The survey indicated that there are attitude problems which need to be addressed. There appears to be a prejudice against farms with liquid manure as indicated by the number of complaints against liquid operators. intense odours seem to have predisposed people to assume that these operators are the cause of all water pollution. The public needs to be shown that any livestock farm can cause manure pollution regardless of the type of storage. Contamination of watercourses is a question of management and it only takes one poorly managed farm to contaminate a watercourse.

Many farmers are reluctant to report water quality problems to the Ministry of the Environment. They generally don't want to be 'bad neighbours' by reporting a pollution problem. More education stressing the effects of water pollution and that irresponsible actions of some landowners are giving the agricultural community a bad name, may change this attitude.

7.2. Information Extension

Information extension focused on promoting remedial measures to the farm community. This component generated a great deal of interest in the community for the program. The Rural Water Quality Information Day was an effective means of disseminating information and generating interest in the issues. The event should be continued next year. The Pollution Abatement in Municipal Drains seminar was successful. Workshops of this nature should be investigated in order to inform municipal officials of the program objectives and means of dealing with the problems.

Within the program there exists a better opportunity to expand the education section. The success of the Camp Sylvan water quality section emphasizes the need to continue this type of program. It may be possible to develop some study units on rural water quality which could be integrated into the classroom curriculum.

7.3. Water Quality Sampling

The water quality sampling program confirmed that the 10 sampled drains had less than acceptable water quality based on Ontario Ministry of the Environment water quality guidelines. Using this as an indication of the general water quality in the watersheds, greater efforts are required to reduce water quality impairment.

The water quality data can be used to identify the worst and best drains. The drains with the best overall water quality were the Charrette and Eagleson drains. The Drysdale drain also exhibited above average water quality expect during the period of stagnation during the summer. The Dietrich and Turnbull drains generally exhibited the worst water quality throughout the sampling period. These drains should be inventoried to determine what land uses are impacting on their water quality. From an initial survey it appears that the Charrette and Eagleson drains do not have any livestock operations in the immediate area as opposed to the Turnbull and Dietrich which both have major livestock operations on their banks. Elevated levels of *P. aeruginosa* in the Turnbull drain indicates that rural septic systems require investigation.

The data analysis indicated a number of relationships that require further investigation. From the initial analysis, it appears as though high summer temperatures and low flows elevate bacteria levels above those levels caused by precipitation and runoff in the spring and fall. This is crucial since good bacterial water quality is most important during the summer recreation season. The absolute loading of bacteria should be investigated since more bacteria may be delivered during high flow events although in a more dilute concentration.

More investigation should also be given to the relationship between bacteria levels and turbidity. Soil types and stream regimes may influence a stream's response to runoff events and periods of high turbidity. This type of investigation will help to determine what factors affect water quality and what methods should be used to reduce the impact of agriculture on water quality.

8. RECOMMENDATIONS

Recommendation #1:

The Ausable Bayfield Conservation Authority should continue the farmer contact program as a component of its overall manure management awareness program. Emphasis should be given to promoting the use of the O.S.C.E.P.A.P. grant to implement remedial measures, including milkhouse waste disposal.

Recommendation #2:

The Ausable Bayfield Conservation Authority in co-operation with the Ontario Ministry of the Environment and the Ontario Ministry of Agriculture and Food should further investigate cost-effective remedial measures which are acceptable to the farm community and will reduce water quality impairment to acceptable levels as per O.M.E. guidelines. The Ausable Bayfield Conservation Authority should provide technical assistance in design and planning of remedial measures when other agencies are unable to provide this support.

Recommendation #3:

The Ausable Bayfield Conservation Authority in co-operation with the Ontario Ministry of the Environment and the Ontario Ministry of Agriculture and Food should further investigate the delivery and transport of contaminants through the tile drainage system as related to manure application rates and soil conditions in order to develop spreading guidelines.

Recommendation #4:

The Ausable Bayfield Conservation Authority together with the Ontario Ministry of the Environment should continue the water quality monitoring of the 10 watershed drains. Monitoring should be conducted to determine which drains have the greatest impact on the recreation waters of the Grand Bend beach area. It should also be conducted to document water quality changes and to help determine the factors involved in either improved or degraded conditions.

Recommendation #5:

The Ausable Bayfield Conservation Authority together with the Ontario Ministry of the Environment and other concerned agencies should develop a program to study and identify illegal septic systems and/or malfunctioning septic systems to determine their impact on water quality.

Recommendation #6:

The Ausable Bayfield Conservation Authority should continue to co-operate and assist the Ontario Ministry of the Environment in reporting and investigating problems of gross negligence resulting in water quality impairment.

9. REFERENCES

Agriculture Canada. 1983. Planning Your Milkhouse. Communications Branch, Ottawa Canada. Publication 1620E.

Balint, D. S. 1983. Potential Farm Pollution From Manure Storage and Handling Systems in Watersheds of the Ausable Bayfield Conservation Authority. Ausable Bayfield Conservation Authority, Exeter, Ontario.

Balint, D. S. 1985. Water Quality of Subsurface and Surface Drainage in the Parkhill Creek Watershed. Ausable Bayfield Conservation Authority, Exeter, Ontario.

Environmental Studies Board. 1973. Water Quality 1972. Committee of Water Quality Criteria. Environmental Protection Agency, Washington, D.C. EPA-R3-73-033.

Evans, P. and B. Fuller. 1987. Maitland Manure Management Study - 1986. Maitland Valley Conservation Authority, Wroexeter, Ontario.

International Reference Group on Great Lakes Pollution From Land Use Activities (PLUARG). 1978. Environmental Management Strategy for Great Lakes System: Final Report to the International Joint Commission. Internation Joint Commission, Windsor, Ontario.

McNeely, R. N., V. P. Neimanis and L. Dwyer. 1979. Water Quality Sourcebook - A Guide to Water Quality Parameters. Inland Waters Directorate, Environment Canada, Ottawa, Canada.

Ontario Ministry of the Environment. 1982. Water Quality Data Ontario Lakes and Streams - 1981. Toronto, Ontario.

Ontario Ministry of the Environment. 1984. Lake Huron Beaches: Factors Affecting Microbiological Water Quality in 1984 - Summary Report. Southwestern Region, London, Ontario.

Ontario Ministry of the Environment. 1985. Lake Huron Beach Study. Southwestern Region, London, Ontario.

Ryan, T. E. 1982. Assessment of Potential Water Quality Problems From Agricultural Manure Handling and Storage Systems. Ausable Bayfield Conservation Authority, Exeter, Ontario.

Ryan, T. E. 1986. Manure Management Awareness Program - Summary Report 1985. Ausable Bayfield Conservation Authority, Exeter, Ontario.

Switzer-Howse, K. D. 1982. Agricultural Management Practices for improved Water Quality in the Canadian Great Lakes Basin. Land Resource Research Institute, Agriculture Canada, Ottawa, Ontario.

Upper Thames River Conservation Authority and Ontario Ministry of the Environment. 1984. Pittock Watershed - Livestock Manure Management and Water Quality Study. London, Ontario.

Upper Thames River Conservation Authority and Ontario Ministry of the Environment. 1985. Pittock Watershed - Manure Management and Water Quality Sub-Basin Study - 1985. London, Ontario.

APPENDIX A

Letter of Introduction

Chairman: Gordon Johnson
Vice-Chairman: Donald Lithgow
Secretary-Treasurer: Sandra Arnold
General Manager: Tom Prout, P.Ag.

P.O. BOX 2410
EXETER, ONTARIO
NOM 160
Telephone: (519) 235-2610

AUSABLE-BAYFIELD CONSERVATION AUTHORITY

June 10, 1986
File: W.4.5.1.

Dear Sir:

During 1986 the Ausable Bayfield Conservation Authority will be continuing its manure management program to improve water quality within its watersheds.

Similar to last years program, we will be continuing our site visits to livestock farmers. Since you did not participate in a site visit last year, one of our staff members, Tracey Ryan, will be contacting you to arrange a site visit. The visit will include an inspection of your manure storage area and a short questionnaire.

The results will be used to help the Conservation Authority determine the type of remedial measures that are needed and the areas where funding needs to be improved. The purpose of the site visit is not to lay blame on individuals but to assess the problem of manure pollution at the farm level.

Following the site visit, a copy of the suggested improvements will be sent to you. Tracey will be available to provide technical assistance and to help landowners obtain financial assistance for improvements from relevant agencies.

We appreciate your cooperation and look forward to meeting you and hearing your views. If you have any questions or wish to set up an appointment, please feel free to contact Tracey at the office.

Yours truly,
AUSABLE BAYFIELD CONSERVATION AUTHORITY

Gordon Johnson
Chairman

MEMBER OF THE
ASSOCIATION OF CONSERVATION
AUTHORITIES OF ONTARIO

APPENDIX B

Questionnaire / Checklist

SITE VISIT CHECKLIST

FARM I.D. DATE
NAME PHONE
COUNTY TOWNSHIP
LOT CONCESSION
MAILING ADDRESS ____
____

---

1. LIVESTOCK (ON THIS FARM)

LIVESTOCK	NUMBER	DETAILS
Dairy	_____	Young Cattle
		Mature Cows
Beef	_____	Cow-Calf or Feeder
Swine	_____	Farrowing Feeder or
		Farrow to finish
Poultry	_____	Broiler, Laying Hen, Breeder
Horses	_____	
Sheep	_____	
Other	_____	

2. MANURE STORAGE

TYPE OF MANURE SYSTEM

Dry Solid ____ Livestock Access ________________________________
Semi-Solid ____
Liquid ____
Description ____
____
____
____

Do you have any of the following?

Retaining Walls ______ Concrete _____
Earthen _____
Wooden _____

Concrete pad _____
Cover _____

Diversion System (Describe) ____

____

____

Other features (Describe) ____

____

____

Storage Capacity ____________________ Size ________________________

Is runoff from the yard and/or manure storage areas collected for manure application? ______________________________

Describe ____

____

Is milkhouse washwater added to the storage? ______________________________

3. POTENTIAL POLLUTION SOURCE SITE DESCRIPTION

Distance from source to open watercourse ____________________________________

DESCRIPTION OF SURROUNDING TERRAIN

Slope from Source to Watercourse ____

Nature of Flow Path ____

Buffer, Vegetation ____

Other ____

____

____

IF THE SOURCE IS A FEEDLOT / BARNYARD

Number of Livestock ______________________

Size of Lot ______________________

What portion is roofed? ______________________

What portion is paved? ______________________

Are there retaining walls? ______________________

Runoff control ____

____

When does it contain livestock? ________________________

How often is it cleaned? ________________________

Management practices, Comments ____

____

____

____

DRAINAGE CHARACTERISTICS

Is the area drained? ______________________

Location surface/subsurface ____

____

____

Do drains run under or near the area surface/subsurface

Are there surface catchments in the barnyard that connect with field tiles? _____

Are there ways that manure coued gain access to a watercourse? ______________

____

____

* See Site Plan

4. STORAGE IMPROVEMENTS

Have you changed or improved you manure handling and storage system within the last 5 years? ____________________

If YES go to SECTION A

If NO go to SECTION

SECTION A

What improvements or changes have been made? (When?) ________________________

____

____

____

____

Why did you make these changes?

Herd expansion ________

Increased amount of manure ________

Containment of runoff ________

Diversion of runoff or precipitation ________

Containment of nutrient's for use on land ________

Other (Explain) ____

____

____

Are you satisfied with your present system? Explain

____

____

Technical Information

Did you receive technical assistance in planning designing and construction of your manure system? ___________________________

From whom? ____

Was the assistance adequate? ______________

Explain ____

____

____

Financial Information

Estimate Construction Costs

Structural ____________ Labour ____________________

Did you receive financial assistance? ____________________

If yes, what percentage of your costs were subsidized? _____________________

Would you have made the improvements without financial assistance or subsidization?

____

Comments ____

____

____

Construction

Did you experience problems during the construction phase? ______________________

Explain ____

____

____

Comments

Do you feel any other improvements are required? ______________________________

Explain ____

____

____

____

SECTION B

Would you be interested in improving on changing your manure storage system? _______
Explain ____

____

____

____

No - Reasons:

1) Economics
2) Near retirement
3) Operation too small
4) Not required
5) Present system is adequate
6) Other ____

____

____

If yes:

Would you be interested in receiving technical and/or financial assistance? _______

What percentage of yours costs do you feel should be subsidized? ________________

What changes do you feel could be made to improve your present system? ___________

____

____

____

5. TILING

Acreage of land that is tiled ________________

Acreage of tiled land where manure is spread ________________

What type of tiling system? systematic ________________

random ________________

How many catch basins are there? private ________________

municipal ________________

Do you know where your septic tank is? _____________

Is it - public health approved? _____________

original (existing)? _____________

don't know _____________

6. LIVESTOCK WATERING

Does your farming operation and/or Livestock rely on a nearby stream for livestock watering? ______________________

If yes,

Is there limited / unlimited access? ________________

Size of pasture ________________

Number of Livestock ________________

Length of stream (Describe if necessary) ____

____

If you have limited access, describe i.e. ramps, pumps, bridge _______________

____

____

____

What time of year do livestock have access? _________________________________

Is there erosion along streambank? ______________________

Length of watercourse directly affected ______________________

Do you feel it would be beneficial or possible to limit access? _______________

____

____

Would you be interested in limiting access? _________________

Would you like information? _________________

7. GENERAL COMMENTS

Have you ever had any problems with you storage/yard?

Leaks ____

Runoff ____

Complaints ____

Other ____

____

____

Have you ever had any problems with water quality or manure pollution from another source? _________________

Explain ____

____

____

____

Comments ____

____

____

____

8. REMEDIAL MEASURES

PROBLEM | SUGGESTED MEASURE

REMEDIAL MEASURE	UNIT COST	UNITS	TOTAL COST

APPENDIX C

Summary of Questionnaire Results

Summary of Questionnaire Results

Total number of Respondents: 46

Type of Livestock:

Dairy	8	Dairy and Beef	1
Beef	13	Dairy and Poultry	1
Swine	16	Dairy and Swine	1
Poultry	1	Beef and Swine	4
		Sheep and Swine	1

Type of Manure System:

Dry Solid	19
Semi Solid	3
Liquid	11
Combination (solid and liquid)	13

Features of Dry Solid Storage

Stored on Ground	6
Concrete Pad	22
Cement Pad and Walls	4
Runoff Pond	2
Cattle Access to Storage	11

Features of Liquid Storage (Some farms reported more than one)

Earthen lagoon	6
Pit with cover	16
Open pit	4

Storage Capacity

	Solid	Semi-Solid	Liquid	Combination
Greater than 6 months	10	2	7	7
Less than 6 months	8	1	4	6
Daily spreads	1			

Milkhouse Waste Water Treatment

Added to manure storage	3
Sediment tank and trench	3
Tile or ground disposal	5

Changes to the System Within the Last 5 Years

Yes	15
No	30

Reasons for Making Changes

Herd expansion	6
Increased amount of manure	4
Containment of runoff	6
Diversion of runoff or precipitation	1
Containment of nutrients for use on land	2
Ease of handling	11

Are you satisfied with your present system?

Yes	12
No	3

Did you receive technical assistance in design and planning of manure system?

Yes	5
No	10

From whom?

OMAF	5
Other	0

Was the assistance adequate?

Yes	5

Did you receive financial assistance?

Yes	7
No	8

Would you have made the improvements without financial assistance?

Yes	13
No	2

Would you be interested in changing your manure storage?

Yes	10
No	3
Uncertain	3

If no, why not?

Economics	23
Near retirement	7
Operation too small	3
Not required	13
Present system adequate	22

If yes, would you be interested in receiving technical or financial assistance?

Technical	10
Financial	10

What percentage of your costs do you feel should be subsidized?

0%	9	Uncertain	12
33%	11	Greater than 33%	5
50%	6	Greater than 50%	2

Type of Tiling System

No tile drainage	4
Random drainage	4
Systematic	20
Both	17

Number of Reported Acres

Random drainage	1967
Systematic drainage	4997

Do you know where your septic tank is?

Yes	43
Have no septic tank	2

Is it:

Public health approved	24
Original	13
Do not know	6

Does your farm rely on a stream for livestock watering?

Yes	17
No	28

Is there limited access?

Yes	2
No	15

Would you be interested in limiting access?

Yes	3
No	12

Have you ever had any problems with your storage/yard?

Leaks	4
Runoff	3
Complaints	5

Have you ever had any problems with water quality or manure pollution from another farm?

Yes	12
No	33

APPENDIX D

Seminar Agendas

WATER QUALITY INFORMATION DAY
South Huron Recreation Centre
February 20, 1987 at 10:00 a.m. to 4:00 p.m.

9:30	Registration
10:00	Opening Remarks Chairman Gordon Johnson
10:05	An Introduction to Rural Water Pollution Gary Palmateer, Ministry of the Environment
10:35	What Happens Downstream of a Manure Spill Stu Thornley, Ministry of the Environment
11:00	Rural Water Pollution and the Law Ron Quipp, Ministry of the Environment
11:30	Ontario Soil Conservation and Environmental Protection Assistance Program Ron Fleming, Ministry of Agriculture and Food
11:15	Discussion
12:00	Lunch
1:00	Introduction to the Rural Beaches Strategy Tom Prout, Ausable Bay field Conservation Authority
1:10	The Ausable Bayfield Conservation Authority Beaches Strategy: 1986 Summary Doug Hocking, Ausable Bay field Conservation Authority
1:40	Extent and Causes of Water Quality Problems in Subsurface Drainage in the Parkhill Watershed Luc Brunet, Ministry of Agriculture and Food
2:10	Manure Runoff and Runoff Storages Ron Fleming, Ministry of Agriculture and Food
2:30	Coffee
2:45	Effect of Agriculture on Fisheries Mike Malhiot, Ministry of Natural Resources
3:05	Water Quality and Public Health Huron County Health Unit, Representative
3:25	Water Quality and Livestock Health Dr. W.A. Schilthuis, Goderich Veterinary Clinic
3:45	Discussion
4:00	Closing Remarks

MUNICIPAL DRAINAGE POLLUTION ABATEMENT SEMINAR

January 23, 1987

South Huron Recreation Centre, Exeter

Chairman Gordon Johnson, A.B.C.A. Chairman

1:00 p.m. Introduction
Gary Palmateer, SW Regional Microbiologist (MOE)
- brief description of sources and types of pollution common to municipal drains

1:30 p.m. Phil Bye, Environment Officer, Owen Sound District (MOE)
- investigation and enforcement procedure
- use of the legislation as a tool
- what is enforceable and who should enforce it
- when and why call in MOE
- the difficulty of getting convictions

2:15 p.m. Ray Bowen, Supervisor, SW Region, Investigations and Enforcement Branch (MOE)
- outline purpose and function of the branch with specific regard to the applicable legislation
- outline the branch's role in municipal drains

2:45 p.m. Coffee

3:00 p.m. John Johnston, Manager, Drainage and Water Management Section (OMAF)
- discussion of the Drainage Act
- role of the Drainage Act in dealing with municipal drain pollution
- how should the Act be enforced and by who

3:45 p.m. Paul Elston, Planning Resources Co-ordinator (ABCA)
- C.A.'s involvement in Municipal Drains

4:00 p.m. Panel Discussion Period

APPENDIX E

Water Quality Data

Stream - Turner Dr. Station No - 85-1 Mileage - Location

RATE DAY	MTH	TIME	TEMP	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1345	0	Fast, Turbid, High	4.44	80000	2500	62000	36	430	0.275	2.35	0.11	3.9	0.71	0.22	7.25	20.5	321	
20	3	940	0	Good Flow, Turbid	2.01	2400	400	4600	8	96	0.07	1.1	0.03	6.3	0.194	0.08	7.99	17.5	490	
26	3	1355	10	Fast, Turbid	1.59	19000	150	60	4	37	0.04	0.62	0.01	5.1	0.09	0.049	8.24	20	570	
2	4	1352	16	Good Flow, Clear, Low	0.92	410	20	<4	<4	18	0.015	0.77	0.01	<0.1	0.045	0.021	8.46	34.5	605	
10	4	1522	4	Fast, Clear	1.80	200	8	8	<4	14.4	0.01	0.55	0.01	4.9	0.023	0.011	8.48	29	575	
15	4	1015	8	Fast, Clouast Flow	2.00	4800	304	260	20	23	0.01	0.76	0.02	4.3	0.055	0.022	8.33	40	645	
21	4	1504	6	Fast, Turbid, High	3.40	13200	3100	4200	4	1.94	0.08	1.9	0.05	10.0	0.335	0.113	7.91	23.5	570	
1	5	1440	18	Fast, Clear	1.4	1000	<4	20	<4	13	0.015	0.59	0.05	5.9	0.024	0.001	8.15	25.5	459	
22	5	1140	14	Fast, Clear	0.9	4600	600	600	<4	36	0.01	0.84	0.11	14.7	0.043	0.012	8.18	32	775	
28	5	1240	24	Good Flow, Clear, Low	1.29	2500	204	84	<4	3.2	0.005	0.52	0.06	1.4	0.01	0.002	8.45	26.5	555	
4	6	1310	26	Slow, Clear, Algae	0.49	160	150	172	<4	3.8	0.01	0.58	0.01	3.0	0.01	0.001	9.18	29.5	426	
9	6	1200	22	Slow, Clear, Algae Slime	1.39		80	9800	<4	3.1	0.01	0.74	0.07	1.0	0.019	0.003	9.66	27	344	72
16	6	1000	20	Good Flow, Clear, Algae	0.36		470	1700	<4	14.7	0.005	0.62	0.09	17.9	0.021	0.005	8.27	31.5	795	400
23	6	1055	24	Good Flow, Clear, Algae	0.8		840	1600	8	18.6	0.01	0.68	0.14	7.4	0.015	0.002	8.24	30.5	605	840
2	7	1115	28	Slow, Clear, Low, Algae			240	3000	<4											240
7	7	1335	23	Slow, Clear, A Lot Of Algae			296	930	<4											208
14	7	1200	24	Good Flow, Clear, Algae	0.44		730	4400	<4	16.7	0.01	0.73	0.18	3.9	0.024	0.003	8.55	33	545	730
21	7	1425	31	Good Flow, Clear, Dead Algae			320	1300	<4											320
28	7	935	22	Fast, Clear, High, No Algae	0.84		2900	3700	4	17.8	0.01	0.9	0.05	10.1	0.086	0.038	8.35	28	730	2200
6	8	945	26	Good Flow, Clear, Some Algae	0.94		340	100	8	12.3	0.02	0.51	0.01	<0.1	0.025	0.002	8.43	31	435	300
13	8	945	18	Good Flow, Clear, Low, Algae	1.38		620	590	8	12.2	0.02	0.70	<0.01	<0.1	0.026	0.003	8.48	49.5	474	540
18	8	1005	23	Good Flow, Clear, Some Algae	1.6		680	660	4	19.3	0.025	0.76	<0.01	<0.1	0.034	0.009	8.64	54.5	500	550
25	8	940	16	Good Flow, Clear	1.04		640	1100	16	15.5	0.01	0.76	0.02	0.1	0.021	0.006	8.35	52	610	350
17	9	923	11	Fast, Murky, High	0.76	10600	370	600	32	16.8	0.05	0.76	0.02	5.9	0.124	0.102	8.0	21	615	
24	9	952	15	Fast, Turbid, High	0.58	19000	2500	2700	4	21	0.03	0.81	0.02	5.6	0.122	0.087	8.03	22	670	
1	10	925	16	Fast, Turbid, High	1.8	16000	3500	5600	4	26	0.005	1.17	0.02	4.6	0.205	0.135	7.83	17	595	
15	10	1410	11	Fast, Turbid, High	0.65	67000	4900	11200	8	43	0.025	0.84	0.02	4.5	0.176	0.103	8.05	17.5	595	
22	10	1105	10	Good Flow, Clear	0.53	1000	140	100	<4	6.5	0.005	0.55	0.01	4.9	0.017	0.005	8.11	23.5	655	
29	10	933	10	Good Flow, Clear, Algae	0.62	3200	430	410	4	18.3	<0.005	0.58	0.01	4.3	0.033	0.013	8.23	22	610	
6	11	945	6	Good Flow, Clear	2.32	2200	1080	50	<4	8.1	0.02	0.55	0.02	4.2	0.016	0.002	8.22	24.5	660	
12	11	1005	2	Good Flow, Clear. Low	0.93	2600	320	100	<4	7.8	0.015	0.51	0.02	4.3	0.023	0.005	8.32	26	660	
19	11	730	1	Good Flow, Clear, Low, Some Ice	0.67	2800	330	8	<4	8.7	0.015	0.59	0.04	4.6	0.022	0.008	8.16	1.5	685	
3	12	1004	4	Fast, Turbid, High	4.84	34000	1900	1500	296	390	0.01	1.7	0.03	5	0.49	0.127	7.88	26.5	600	
11	12	930	0	Fast, Clear	1	4300	360	7100	<4	17	0.015	0.57	0.01	5.4	0.056	0.036	8.1	26.5	740	
17	12	930	1	Good Flow, Clear	0.92	6000	3300	370	<4	20	0.03	0.48	0.01	4.7	0.038	0.002	8.15	27.5	695	
				MAXIMUM	4.84	80000	4100	62000	296	430	0.275	2.35	0.18	17.9	0.71	0.22	9.66	54.5	795	2200
				MINIMUM	0.36	160	4	4	4	1.94	0.005	0.48	0.01	0.1	0.01	0.001	7.75	1.5	321	72
				MEAN	1.40	4282.00	418.39	583.84	6.15	43.44	0.03	0.82	0.04	5.18	0.10	0.04	8.27	27.84	587.78	404.79
				COUNT	32	23	35	35	35	32	32	32	32	32	32	32	32	32	32	12

STREAM- EAGLESON DR.   MILEAGE-   LOCATION-   STATION NO. -

RATE DAY	RATE MTH	TIME	TEMP	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1355	0	Med. Flow, Turbid, High	2.08	10000	300	3100	<4	93	0.085	1.2	0.03	4.6	0.18	0.053	7.54	12	349	
20	3	950	0	Good Flow, Turbid	1.68	500	70	130	<4	22	0.015	0.74	0.01	5	0.071	0.031	7.15	12	462	
26	3	1400	9	Slow, Clear	1.96	2200	20	10	<4	7.5	0.02	0.62	0.01	5.2	0.027	0.013	8.07	15.5	580	
2	4	1356	13	Clear, Slow, Low	0.66	1410	336	24	<4	3.5	0.155	0.68	0.04	4.2	0.031	0.013	8.36	17.5	565	
10	4	1515	4	Slow, Clear	1.65	920	152	44	<4	2.8	0.035	0.58	<0.01	3.5	0.018	0.009	8.29	17.5	575	
15	4	1020	7	Good Flow, Clear	0.86	690	8	72	<4	5.4	0.01	0.65	<0.01	2.3	0.021	0.005	7.94	20.5	580	
21	4	1456	6	Fast, Turbid, High	1.44	>17000	2200	240	<4	45	0.015	1	0.02	7.3	0.1	0.033	7.8	16.5	520	
1	5	1415	12	Slow, Clear	2.65	110	12	12	<4	2.5	0.025	0.82	0.02	4.3	0.042	0.002	8.3	18.5	491	
22	5	1135	14	Good Flow, Clear	0.74	2600	132	600	<4	3.2	0.03	0.63	0.04	7.6	0.029	0.015	7.82	20	755	
28	5	1235	17	Slow, Clear	0.79	4400	184	124	<4	1.84	0.025	0.64	0.02	4.6	0.025	0.069	7.99	19	685	
4	6	1305	18	Slow, Clear, Algae	0.82	2000	440	216	<4	2.2	0.065	0.72	0.02	3.4	0.035	0.016	8.11	22	735	
9	6	1205	17	Slow, Clear	1.61		1060	1400	<4	4.4	0.08	0.78	0.05	1.8	0.049	0.078	7.94	24.5	745	1010
16	6	1005	18	Good Flow, Clear	0.22		300	2200	<4	2.3	0.02	0.63	0.03	10.2	0.028	0.015	8.03	22	815	290
23	6	1100	20	Slow, Clear, Algae	0.9		410	2100	<4	3.1	0.035	0.74	0.03	3	0.038	0.016	8.06	20	770	470
2	7	1120	20	Slow,<Turbid			940	3800	<4											490
7	7	1345	20	Slow, Turbid, Some Algae			640	2200	<4											580
11	7	1205	24	Slow, Clear	0.86		2100	6500	<4	5.2	0.035	0.92	0.04	2.9	0.062	0.029	8.16	20.5	760	1900
21	7	1430	23	Stagnant, Turbid, Algae			2400	3300	<4											2300
28	7	940	19	Good Flow, Higher, No Algae	0.64		260	3100	<4	5.5	0.005	0.79	0.02	6.5	0.049	0.028	7.7	18	710	
6	8	1000	24	No Flow, Turbid, Some Algae	4.21		5400	2500	<4	89	0.02	1.64	0.3	<0.1	0.166	0.008	7.73	42.5	900	4000
13	8	950	19	Good Flow, Clear, Low, Algae	1.6		960	730	<4	18.3	0.085	0.98	0.06	0.1	0.066	0.015	7.9	47	895	860
18	8	1010	19	No Flow, Clear, Some Algae	2.3		260	840	<4	6.5	0.035	0.92	0.01	<0.1	0.002	0.011	7.72	52	855	250
25	8	950	15	Some Flow, Clear	0.8		200	670	<4	5.6	0.015	0.67	0.01	0.4	0.057	0.034	7.88	37.5	760	200
17	9	930	12	Good Flow, Clear, High	0.45	3100	88	280	<4	7.6	0.005	0.69	<0.01	3.8	0.041	0.029	7.72	14.5	560	
24	9	957	15	Fast, Murky, High	0.28	12000	110	400	<4	10.7	0.015	0.81	<0.01	3.5	0.046	0.021	7.7	16	625	
1	10	930	16	Fast, Clear (Brown),High	2.64	7900	40	540	<4	6.8	0.01	1.17	0.01	2.5	0.081	0.037	7.41	11.5	525	
15	10	1415	11	Good Flow, Clear, High	0.22		570	600	<4	8.4	0.013	0.69	<0.01	3.4	0.052	0.024	7.78	11.5	575	
22	10	1110	10	Good Flow, Clear	0.39	1400	910	152	<4	1.01	0.025	0.6	<0.01	3.7	0.033	0.017	7.83	18	680	
29	10	939	10	Good Flow, Clear, Algae	0.5	3100	190	300	<4	2.6	0.005	0.63	<0.01	3.9	0.024	0.007	7.8	16.5	665	
6	11	950	1	Good Flow, Clear	1.94	410	30	36	<4	2.2	0.015	0.54	<0.01	3.4	0.022	0.009	7.71	20.5	705	
12	11	1010	2	Good Flow, Clear, Low	0.54	1700	420	30	<4	3.6	0.02	0.5	<0.01	3.1	0.021	0.01	7.96	20	645	
19	11	935	1	Slow, Clear, Low, Some Ice	0.57	1000	210	64	<4	12.1	0.035	0.64	<0.01	2.4	0.038	0.015	7.86	1.5	720	
3	12	1010	4	Good Flow, Clear	0.65	5400	44	420	<4	5.7	0.01	0.61	<0.01	3.9	0.034	0.016	7.86	22.5	560	
11	12	935	1	Good Flow, Clear	0.56	310	12	32	<4	2	0.01	0.54	<0.01	4.9	0.017	0.009	7.84	20	665	
17	12	938	1	Good Flow, Clear	1.08	270	24	16	<4	4.2	0.01	0.48	<0.01	3.4	0.02	0.006	7.91	19	665	
				MAXIMUM	4.21	11000	5,400	6,500	4	93	0.155	1.640	0.300	10.200	0.180	0.055	8.360	52.000	900.000	4,000
				MINIMUM	0.22	110	8	10	4	1	0.005	0.480	0.010	0.100	0.017	0.002	7.470	1.500	349.000	200
				MEAN	1.20	1739.00	210	310	4	12	0.031	0.750	0.028	3.719	0.050	0.019	7.893	20.891	659.594	726
				COUNT	32	22	35	35	35	32	32	32	32	32	32	32	32	32	32	11

STREAM - DIETRICH DR MILEAGE- LOCATION- STATION NO.-

RATE DAY	MTH	TIME	T°C	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1400	0	Slow (Ice Jam), Turbid, High	6.78	62000	13200	9300	20	750	0.825	2.9	0.13	2.8	0.9	0.235	7.47	16	291	
20	3	955	0	Good Flow, Turbid	2.02	2900	<100	2800	4	95	0.045	1.02	0.05	4.5	0.196	0.09	7.94	13.5	423	
26	3	1405	8	Good Flow, Turbid	0.92	300	30	40	<4	54	0.035	0.56	0.01	4.3	0.089	0.049	8.19	15.5	505	
2	4	1402	15	Good Flow, Turbid, Low	1.55	230	56	24	<4	24	0.01	0.57	0.02	5.4	0.033	0.023	8.5	24	520	
10	4	1510	5	Slow, Turbid	2.08	860	200	56	<4	13.2	0.005	0.65	<0.01	3	0.027	0.009	8.51	22.5	540	
15	4	1078	0	Good Flow, Turbid	2.05	>1500	456	140	<4	30	0.015	0.69	0.01	2.3	0.055	0.016	8.24	25	565	
21	4	1451	6	Fast, Turbid, High	3.5	11800	3300	310	4	324	0.095	2.1	0.07	8.6	0.485	0.093	7.09	24	545	
1	5	1430	18	Good Flow, Turbid	2.06	2700	890	30	<4	14.8	0.02	0.8	0.01	3.8	0.053	0.009	8.29	22.5	457	
22	5	1176	13	Fast, Turbid	1.36	11000	1360	640	<4	22	0.15	0.88	0.33	19.3	0.089	0.046	8.18	35	805	
28	5	1230	21	Slow, Clear, Low	1.42	4600	>1500	360	<4	8	0.015	0.78	0.1	10.9	0.028	0.004	8.38	30.5	600	
4	6	1300	20	Slow, Clear, Algae	0.59	1900	790	210	<4	10.1	0.01	0.67	0.04	4.2	0.016	0.002	8.63	30.5	530	
9	6	1210	20	Slow, Clear, Algae	1.07		440	2400	<4	3.9	0.005	0.73	0.02	2	0.018	0.002	8.6	27	525	430
16	6	1010	21	Good Flow, Turbid	0.6		6000	1100	<4	11.6	0.005	0.77	0.16	27.4	0.078	0.049	8.51	33	875	6000
23	6	1105	22	Good Flow, Turbid, Algae	1.3		8600	2800	<4	22	0.01	0.96	0.18	13.1	0.059	0.008	8.31	36.5	710	8500
2	7	1125	23	Slow,<Turbid, Lot Of Algae			3100	2600	<4											3000
7	7	1350	22	Slow,<Turbid, Some Algae			4300	4700	<4											4200
14	7	1210	25	Slow, Turbid, Algae	2.31		10000	7100	8	44	0.015	1.15	0.03	1.8	0.109	0.019	8.4	38	615	7700
21	7	1438	26	Slow, Turbid, High			2800	3900	<4											2700
28	7	947	22	Good Flow, Turbid, High, No Algae	1.47		4400	4000	4	73	<0.005	1.26	0.07	11.3	8.164	0.073	8.24	26.5	660	4400
6	8	1005	25	Slow, Turbid, No Algae	1.73		7000	7600	40	53	0.04	1.05	0.08	1	0.097	0.017	7.93	32.5	520	7000
13	8	1000	19	Slow, Turbid	1.38		8900	4100	12	54	0.035	0.89	0.01	<0.1	0.082	0.042	8.06	50	545	6700
18	8	1020	23	Slow, Turbid, No Algae	3.1		3900	6000	140	82	0.055	1.35	0.02	<0.1	0.15	0.027	7.88	39.5	485	3900
23	8	955	15	Some Flow, Clear	6.56		7700	2700	8	40	0.005	1.6	<0.01	<0.1	0.265	0.015	8.16	37.5	520	6300
17	9	940	12	Fast, Turbid, High	1.26	25000	450	600	<4	37	0.025	0.8	0.03	3.9	0.118	0.09	7.94	18	540	
24	9	1004	16	Fast, Turbid High	0.99	22000	1900	2100	8	46	0.025	0.96	0.05	3.6	0.148	0.095	8.06	19	600	
1	10	935	16	Fast, Turbid, High	1.93	43000	1100	4900	<4	74	0.02	1.1	0.03	2.5	0.234	0.147	7.71	13.5	485	
15	10	1420	11	Fast, Turbid, High	0.88	134000	2700	8500	16	60	0.015	0.91	0.01	3.2	0.167	0.088	7.99	15	540	
22	10	1115	10	Good Flow, Turbid	0.64		950	200	<4	26	<0.005	0.6	0.02	3.7	0.046	0.026	8.33	19.5	655	
29	10	945	11	Good Flow, Turbid	1.4	6500	1240	930	<4	27	0.01	0.75	0.02	3.5	0.074	0.029	8.14	18.5	620	
6	11	955	5	Good Flow, Murky	3.11	1600	220	30	4	10.5	0.015	0.62	0.02	3.2	0.025	0.003	8.26	20	640	
12	11	1015	2	Good Flow, Turbid, Low	3.02	6700	1010	330	<4	6.1	0.32	1.2	0.03	3.5	0.11	0.041	8.36	21.5	590	
19	11	945	1	Slow, Clear, Low, Ice Cover	2.06	2600	590	600	<4	15.4	0.04	0.85	0.04	3.5	0.063	0.01	8.15	7	660	
3	12	1015	3	Fast, Turbid, High	5.12	46000	7900	6200	<4	4.75	0.345	1.7	0.03	4.5	0.59	0.122	7.98	22.5	585	
11	12	945	1	Good Flow, Murky	0.59	3200	220	1500	<4	16.3	0.025	0.66	0.01	3.9	0.11	0.037	8.07	26	665	
17	12	945	1	Good Flow, Turbid	1.09	2200	490	410	<4	28	0.005	0.48	0.01	3	0.15	0.025	8.12	21.5	655	
				MAXIMUM	6.78	134000	13200	9300	140	750	0.825	2.9	0.33	27.4	0.9	0.235	8.63	50	875	8,500
				MINIMUM	0.059	230	30	24	4	3.9	0.005	0.48	0.01	0.1	0.016	0.002	7.47	7	291	430
				MEAN	2.06	5314.00	1331.55	941.31	5.64	64.99	0.07	1.01	0.05	5.25	0.15	0.05	8.17	25.05	577.22	4,188
				COUNT	32	22	35	33	35	32	32	32	32	32	32	32	32	32	32	12

STREAM - DESJARDINE DR. MILEAGE- STATION NO- LOCATION -

RATE DAY	MTH	TIME	T°C	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1410	0	Fast, Turbid, High	2.24	4600	700	10100	24	82	0.2	1.12	0.03	3.3	0.244	0.13	7.67	13.5	374	
20	3	1005	0	Frozen, Turbid	2.04	5800	100	1900	<4	85	0.09	1.02	0.05	4.7	0.2	0.101	7.97	12	405	
26	3	1411	9	Slow Flow, Turbid	1.36	800	50	30	<4	26	0.14	0.63	0.02	3.8	0.098	0.061	8.24	14	471	
2	4	1410	14	Slow, Turbid	1.28	200	44	32	<4	21	0.035	0.66	0.01	3.4	0.041	0.015	8.44	19.5	525	
10	4	1500	3	Slow, Turbid	1.82	510	88	48	<4	8.4	0.01	0.57	<0.01	3.3	0.024	0.007	8.47	21	540	
15	4	1035	8	Good Flow, Turbid	1.96	430	276	464	20	10.8	0.005	0.63	0.01	2.5	0.041	0.009	8.19	22.5	545	
21	4	1443	6	Fast, Turbid, High	3.88	13000	3200	1200	52	146	0.13	1.8	0.09	9	0.31	0.135	7.99	20	492	
1	5	1422	17	Slow, Turbid	1.34	3500	40	60	<4	14.3	0.01	0.64	0.02	4	0.024	0.005	8.22	23	444	
22	5	1120	13	Slow, Turbid	1.15	3600	1310	560	4	14.3	0.075	0.84	0.17	17.2	0.063	0.03	8.23	29	785	
28	5	1220	21	Slow, Turbid, Low	1.76	3200	400	204	<4	13	0.015	0.85	0.06	6	0.041	0.005	8.35	26	580	
4	6	1250	22	Slow, Turbid, Low	1.14	610	>600	60	<4	14.8	0.03	0.76	0.03	1.7	0.03	0.008	8.49	32	595	
9	6	1220	20	Slow, Turbid, Algae	1.47		1120	1700	<4	13.3	0.025	0.78	0.01	0.5	0.031	0.006	8.5	33	570	1020
16	6	1110	22	Good Flow, Turbid	3.05		2800	850	<4	16.4	0.015	0.8	0.08	18.3	0.053	0.027	8.56	30	815	2300
23	6	1110	23	Slow,<Turbid	1		5800	>1500	<4	4.5	0.025	0.73	0.08	11.5	0.027	0.003	8.25	32	670	5100
2	7	1140	23	Slow, Turbid, Some Algae			1700	3900	<4											1100
1	7	1355	23	Slow, Turbid			480	450	<4											480
14	7	1225	23	Slow, Turbid	5.99		13700	5300	<4	48	0.28	1.92	0.03	<0.1	0.232	0.046	8.12	48	530	11900
21	7	1445	25	Slow, Turbid, No Algae			2900	1800	<4											1800
28	7	1000	23	Good Flow, Turbid, High, No algae	1.3		2900	2200	<4	<1	0.025	1.42	0.06	8.4	0.128	0.049	8.27	27.5	675	
6	8	1012	28	Slow, Turbid, No Algae	5.25		11100	2000	<4	41	0.11	1.75	0.34	0.5	0.215	0.087	7.73	44.5	585	9200
13	8	1005	19	Slow, Turbid	6.22		1900	550	4	33	9.7		0.04	<0.1	0.22	0.105	7.78	55	620	1400
18	8	1025	23	Slow, Turbid, No Algae	14		1300	660	<4	19	8.8	11.3	0.15	0.1	0.89	0.65	7.78	68	735	1300
25	8	1005	15	Good Flow, Turbid	5.46		10700	8300	20	52	0.455	1.13	0.01	<0.1	0.166	0.02	7.87	56	635	8300
17	9	950	12	Fast, Turbid, High	0.5	4500	290	324	<4	5.4	0.01	0.14	0.02	4.6	0.127	0.102	8.05	17.5	545	
24	9	1012	16	Fast, Turbid, High	0.6	5300	2300	2300	8	31	0.015	0.86	0.02	4.5	0.149	0.108	8.15	18.5	595	
1	10	945	16	Fast, Turbid. High	1.62	13000	800	1500	<4	46	0.015	1.28	0.03	2.4	0.244	0.159	7.95	13	498	
15	10	1435	10	Fast, Turbid. High	0.6	118000	4200	5700	12	40	0.025	0.89	0.01	3.7	0.225	0.131	8.13	15	535	
22	10	1125	10	Good Flow, Turbid	0.29	5100	200	40	<4	22	<0.005	0.56	<0.01	4	0.033	0.018	8.34	20.5	650	
29	10	954	11	Good Flow, Turbid	0.84	4400	432	432	20	16	<0.005	0.72	0.01	3.7	0.068	0.033	8.2	17.5	620	
6	11	1000	5	Good Flow, Murky	2.13	3300	30	<10	<4	7	0.005	0.53	<0.01	3.3	0.019	0.002	8.29	21	645	
12	11	1025	1	Good Flow, Turbid, Low	0.56	1100	30	20	<4	7.8	0.005	0.51	<0.01	3.2	0.02	0.005	8.29	23	635	
19	11	1000	0	Slow, Clear, Low, Slush	0.85	1300	28	20	<4	8.7	0.01	0.55	<0.01	3.1	0.018	0.004	8.16	1.5	655	
3	12	1020	2	Good Flow, Turbid, High	4.27	12000		1440	40	99	0.415	1.25	0.03	3.1	0.245	0.123	7.96	20	520	
11	12	955	0	Good Flow, Turbid, Some Ice	1.08	3300	940	170	12	13.6	0.06	0.66	0.02	4	0.065	0.044	8.04	23	675	
17	12	1005	0	Frozen, Clear	1.4	2100	570	2800	<4	12.4	0.05	0.58	0.02	3.5	0.061	0.029	8.04	20.5	640	
				MAXIMUM	14	118000	13700	10100	52	146	9.7	11.3	0.34	18.3	0.89	0.65	8.56	68	815	11900
				MINIMUM	0.059	230	28	10	4	4.5	0.005	0.51	0.01	0.1	0.018	0.002	7.67	1.5	374	480
				MEAN	2.45	3003.00	635.05	522.21	6.03	32.27	0.65	1.24	0.05	4.44	0.14	0.07	8.15	26.11	587.63	2,447
				COUNT	32	23	34	35	35	32	32	31	32	32	32	32	32	32	32	11

STREAM - TURNBULL DR. MILEAGE- LOCATION- STATION NO.-

RATE DAY MTH		TIME	T°C	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1415	0	Fast, Turbid, High	1.9	20000	200	3200	<4	152	0.08	1.08	0.07	1.8	0.282	0.11	7.55	8.5	264	
20	3	1015	0	Good Flow, Less Turbid	1.5	700	30	210	<4	23	0.03	0.6	0.02	2	0.066	0.029	7.88	8	413	
26	3	1423	7	Mod. Flow, Turbid	1.19	380	<10	40	<4	25	0.065	0.56	<0.01	2.3	0.075	0.05	8.01	12.5	466	
2	4	1421	16	Slow, Clear, Low	0.73	780	48	<4	<4	69	0.005	0.56	0.01	3	0.027	0.01	8.5	14	505	
10	4	1454	3	Slow. Clear	1.36	450	156	40	<4	12.8	0.01	0.45	<0.01	1.6	0.021	0.009	8.5	14.5	520	
15	4	1045	7	Good Flow, Cloudy	1.18	>1500	60	28	<4	10.7	0.015	0.19	<0.01	1	0.012	0.01	8.21	10.5	505	
21	4	1434	6	Fast, Turbid High	2.56	13000	3100	3700	228	38	0.005	1.02	0.02	3.2	0.122	0.038	7.96	11	472	
1	5	1412	19	Good Flow, Clear	1.36	690	20	20	<4	2.9	0.01	0.5	<0.01	1.6	0.02	0.002	8.46	12.5	388	
22	5	1105	13	Good Flow, Clear	1.61	>20000	>600	>600	196	5.4	0.19	0.94	0.08	9.6	0.119	0.086	7.96	20	730	
28	5	1150	19	Slow Clear, Algae Bloom	1.83	4700	300	>600	<4	3	0.02	0.67	0.02	4.7	0.024	0.01	8.46	16	570	
4	6	1240	18	Slow, Clear, Low, Algae	1.51	>1500	>600	430	<4	3	0.005	0.7	0.04	2.5	0.022	0.001	8.6	17.5	565	
9	6	1230	22	Slow, Clear, Algae			490	1800	<4											420
16	6	1115	21	Slow, Clear, Lot Of Algae	0.94		1800	>16300	12	2.1	0.125	0.62	0.05	11.3	0.126	0.102	8.4	23.5	755	1400
23	6	1120	23	Slow, Clear, Algae	1.3		3300	300	12	2.1	0.06	0.81	0.11	6.2	0.165	0.118	8.18	48.5	755	2800
2	7	1150	23	No Flow, Clear, Lot Of Algae			580	760	<4											580
7	7	1400	23	Slow, Clear, Covered In Algae			3400	2400	<4											2500
14	7	1235	24	Slow, Clear, Lot Of Algae	1.45		41000	10300	188	9.2	0.06	1.25	0.07	1	0.58	0.49	8.71	24	462	41000
21	7	1455	29	Slow, Turbid, High, Algae			127000	260000	112											115000
28	7	1010	23	Good Flow, Clear, High. No Algae	1.97		6200	15000	<10	11.7	0.215	1.18	<0.01	<0.1	0.375	0.29	8.09	41	640	
6	8	1025	22	Slow. Murky, Some Algae	2.94		40	300	4	9.5	0.175	1.63	0.15	<0.1	0.46	0.37	7.7	72.5	845	40
13	8	1020	18	Stagnant, Turbid (Green), Algae	14.8		24000	67000	520	19.8	2.2	5.2	0.03	<0.1	2.8	1.5	7.58	62.5	770	22000
18	8	1035	21	Slow, Murky, Some Algae	2.18		1300	3400	<10	10.6	0.04	1.15	0.01	<0.1	0.093	0.04	8.11	50.5	570	800
25	8	1015	15	Slow, Clear, Algae	3.08		60000	45000	170	6.9	0.175	0.93	0.01	<0.1	0.187	0.128	7.92	18	494	48000
17	9	1000	12	Fast. High. Turbid	0.52	7300	156	504	<4	5.4	0.005	0.69	<0.01	9.7	0.052	0.041	7.95	12.5	515	
24	9	1022	16	Fast, High, Clear	0.38	18000	420	4300	<4	6.5	0.045	0.8	0.01	1.1	0.087	0.066	7.93	15	585	
1	10	958	16	Fast, High, Clear	1.3	15000	400	1500	<4	10.4	<0.005	1	0.01	2.5	0.098	0.06	7.67	9	440	
15	10	1445	12	Fast. High, Clear	0.33	157000	600	600	8	3.8	0.06	0.82	<0.01	3.1	0.073	0.046	8.06	11.5	545	
22	10	1140	10	Good Flow, Clear	0.4	4700	100	90	<4	1.52	0.015	0.6	<0.01	3.6	0.015	0.009	8.28	13.5	595	
29	10	1010	11	Good Flow, Clear, Algae	0.55	3200	360	228	<4	5.5	0.02	0.69	<0.01	3	0.046	0.026	8.08	12.5	575	
6	11	1015	6	Good Flow, Clear	1.73	890	200	230	<4	3.4	0.015	0.62	<0.01	2.9	0.025	0.005	8.24	11.5	610	
12	11	1040	2	Good Flow Murky, Low. Scum	0.55	3300	30	10	<4	12.1	0.005	0.55	<0.01	3	0.018	0.009	8.36	13.5	615	
19	11	1010	0	Slow. Clear, Low, Ice Cover	0.88	1900	80	68	<4	10.4	<0.005	0.69	<0.01	2.9	0.029	0.005	8.2	29.5	645	
3	12	1035	3	Fast, Turbid, High	12.1	26000	9500	5500	20	19	0.895	3	0.01	3.7	0.366	0.173	7.57	15	515	
11	12	1010	1	Good Flow, Clear, Smelly	10.48	6200	1400	4200	20	2.5	1.12	2.15	0.01	3.1	0.24	0.18	7.91	I5	640	
17	12	1015	1	Good Flow, Turbid	5.23	4700	550	1240	<4	34	0.11	1.02	0.01	2.2	0.096	0.007	8.03	13	575	
				MAXIMUM	14.8	157000	127000	260000	520	152	2.2	5.2	0.15	11.3	2.8	1.5	8.71	72.5	845	115,000
				MINIMUM	0.059	230	10	4	4	1.52	0.005	0.19	0.01	0.1	0.012	0.001	7.55	8	264	40
				MEAN	2.58	4038.00	580.66	804.36	9.88	17.16	0.19	1.05	0.03	3.10	0.22	0.13	8.10	21.19	566.58	3,216
				COUNT	31	23	35	35	35	31	31	31	31	31	31	31	31	31	31	11

STREAM - KADING DR. MILEAGE- LOCATION- STATION NO.-

RATE DAY	MTH	TIME	T°C	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
11	3	1427	0	Fast. Turbid, High	6.26	46000	7800	>19100	12	440	0.285	3.15	0.1	3.9	0.965	0.235	7.44	19.5	353	
20	3	1025	0	Good Flow, Turbid	2.09	7000	<100	3900	<4	35	0.00	0.87	0.09	6.9	0.169	0.102	8.0	24.5	585	
26	3	1430	8	Mod. Flow,<Clear	1.43	2300	100	130	<4	30	0.06	0.8	0.02	7.5	0.15	0.089	8.15	26	660	
2	4	1428	13	Good Flow, Clear	0.71	180	36	16	<4	6.8	<0.005	0.67	0.02	3.6	0.094	0.012	8.4	35	685	
10	4	1400	3	Good Flow. Clear	2.13	170	20	20	<4	7	0.005	0.61	0.01	6.8	0.034	0.023	8.61	36.5	645	
15	4	1050	7	Fast, Clear	1.84	3400	128	96	<4	6.60	0.005	0.78	0.05	5.9	0.039	0.014	8.31	37.5	665	
21	4	1425	6	Fast, Turbid, High	3.11	10700	810	4000	8	42	0.045	1.22	0.05	8.0	0.186	0.078	7.96	25.5	660	
1	5	1404	18	Good, Flow Clear	1.12	1200	10	20	<4	2.7	0.005	0.61	0.07	6.9	0.024	0.005	8.33	34	494	
22	5	1100	13	Good Flow, Clear	1.18	3800	344	256	<4	4.6	0.02	0.71	0.22	12.9	0.117	0.098	8.11	27.5	805	
28	5	1136	17	Good Flow, Clear	0.62	420	>600	>600	<4	2.3	0.015	0.64	0.09	11.	0.086	0.083	8.41	30	735	
4	6	1030	16	Slow, Clear, Low, Algae	0.61	3300	260	430	<4	11.7	0.005	0.65	0.05	5.3	0.014	0.001	8.5	34	560	
9	6	1175	18	Good Flow. Clear, Slime	1.22		310	1600	<4	11.4	0.02	0.77	0.02	2.6	0.017	0.001	8.53	36.5	340	190
16	6	1125	20	Good Flow, Clear, Algae	0.31		690	2100	4	1.6	0.01	0.64	0.09	14.8	0.07	0.051	8.65	29.5	825	420
23	6	1145	21	Good Flow, Clear	0.6		5100	6800	<1	11.1	0.02	0.78	0.07	18.1	0.121	0.092	8.42	32.5	835	5100
2	7	1045	20	Slow, Clear, Algae			370	4500	<4											330
7	7	1410	23	Slow, Clear, Some Algae			890	2500	<4											680
14	7	1125	22	Good Flow, Clear	1.02		1600	5400	<4	13.4	0.025	0.75	0.01	0.5	0.06	0.024	8.74	39	540	1300
21	7	1355	24	Good Flow,<Turbid			3100	3400	4											3100
28	7	1035	22	Good Flow, Clear, High No Alg	12.3		1700	2000	<4	12.3	<0.005	0.76	0.03	7.1	0.091	0.059	8.45	35.5	765	
6	8	1055	23	Good Flow, Clear, Some Algae	1.15		1200	2400	20	6.5	0.035	0.69	0.02	<0.1	0.035	0.023	8.23	48	630	1200
13	8	1040	18	Good Flow, Clear	1.12		2500	1210	<4	8.2	0.03	0.7	<0.01	0.1	0.013	0.029	8.34	52	670	2100
18	8	1115	24	Slow, Clear, Some Algae	1.61		1400	2200	<4	14.5	0.055	0.82	<0.01	<0.1	0.105	0.056	8.17	46	565	1400
25	8	1050	15	Good Flow. Clear	2.98		39000	12300	32	14	0.055	1.19	0.01	0.2	0.181	0.091	8.11	37	525	39000
17	9	1010	13	Fast. Turbid, High	0.63	16600	600	600	12	14.9	0.015	0.76	0.03	8.2	0.134	0.113	8.02	24.5	675	
24	9	1030	16	Fast, Clear, High	1.31	12000	540	1300	8	15.2	0.12	0.93	0.06	8.8	0.164	0.103	8.06	27.5	725	
1	10	1005	16	Fast, Clear (Brown), High	1.23	27000	2300	1300	20	38	0.01	1.08	0.02	6.1	0.2	0.134	7.83	17	605	
15	10	1500	11	Fast, Murky, High	0.32	183000	2600	3500	<4	15.6	0.025	0.76	0.02	1.4	0.142	0.091	8.09	22	690	
22	10	1150	11	Good Flow, Murky	0.56	7200	510	290	<4	6.2	<0.005	0.6	0.03	7.9	0.079	0.066	8.34	25	675	
29	10	1020	11	Good Flow, Clear, Algae	0.71	4300	220	240	<4	5.5	<0.005	0.62	0.04	7.2	0.086	0.061	8.22	22.5	715	
6	11	1020	7	Good Flow, Clear	2.22	1300	30	60	<4	3.6	0.01	0.6	0.04	6.7	0.059	0.028	8.36	25	710	
12	11	1050	2	Good Flow. Murky, Low	0.74	1900	10	90	52	5.8	<0.005	0.57	0.05	6.7	0.014	0.057	8.49	28.5	695	
19	11	1020	0	Slow, Clear, Low, Ice Cover	1.27	350	84	164	<4	16.9	<0.005	0.86	0.04	6.4	0.106	0.044	8.33	21	105	
3	12	1045	4	Fast, Turbid, High	5.63	75000	1500	1500	28	76	0.02	1.72	0.05	5.6	0.29	0.064	7.76	29.5	635	
11	12	1020	1	Fast, Clear	1.15	6800	610	2400	<4	5.9	0.005	0.63	0.01	7	0.075	0.048	8.1	28.5	780	
17	12	1025	2	Good Flow, Clear	2.1	30000	3000	2800	4	2.5	<0.005	0.61	0.1	5.6	0.086	0.05	8.15	32	760	
				MAXIMUM	12.3	183000	39000	19100	52	440	0.285	3.15	0.22	18.1	0.965	0.235	8.74	52	835	39,000
				MINIMUM	0.059	230	10	16	4	2.3	0.005	0.57	0.01	0.1	0.014	0.001	7.44	17	353	190
				MEAN	1.92	4390.00	496.84	885.97	5.86	26.24	0.03	0.86	0.05	6.46	0.13	0.06	8.24	30.91	659.15	1,429
				COUNT	32	23	35	35	35	32	32	32	32	32	32	32	32	32	32	11

STREAM - CHARRETTE DR. MILEAGE- LOCATION- STAT10N NO,-

RATE DAY	MTH	TIME	T°C	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1435	0	Fast, Turbid, High	2.34	17000	80	5600	<4	127	0.17	1.44	0.07	4.1	0.286	0.074	7.64	9.5	344	
20	3	1030	0	Fast, Turbid	1.67	1900	<10	220	<4	41	0.03	0.82	0.04	5.6	0.117	0.041	7.98	10	417	
26	3	1436	9	Mod. Flow, Clear	1.44	380	24	<10	<4	8	0.025	0.55	0.03	6.3	0.025	0.008	8.08	15	595	
2	4	1435	13	Good Flow, Clear	0.6	300	8	<4	<4	4.2	0.015	0.68	0.02	4.4	0.011	0.003	8.21	15.5	560	
10	4	1410	3	Good Flow, Clear	1.55	290	<4	12	<4	6	0.025	0.55	0.01	4	0.016	0.006	8.26	15.5	570	
15	4	1100	8	Good Flow, Murky	0.88	1370	20	84	<4	10.1	0.03	0.56	0.01	3.1	0.034	0.007	8.04	13.5	560	
21	4	1416	6	Fast,<Turbid	1.16	1000	112	192	<4	14.1	0.03	0.77	0.02	6.4	0.04	0.007	8.0	15.5	595	
1	5	1356	9	Good Flow, Clear	1.16	380	60	10	<4	1.59	0.01	0.63	0.03	6.9	0.017	0.001	8.01	18.5	525	
22	5	1050	14	Fast, Clear	1.43	560	104	240	<4	3.7	0.045	0.75	0.06	7.3	0.022	0.002	7.94	18	645	
28	5	1127	17	Good Flow, Clear	1.61	5400	100	108	<4	1.59	0.015	0.79	0.07	14	0.023	0.001	8.17	22.5	665	
4	6	1015	15	Slow, Clear	0.64	5300	568	>600	<4	2.2	0.01	0.61	0.05	10.4	0.01	<0.001	7.98	22.5	670	
9	6	1115	18	Good Flow, Clear	1.37		1200	2200	<4	1.44	0.005	0.7	0.04	12	0.01	0.001	8.11	23	655	1100
16	6	1135	19	Good Flow, Clear	0.27		620	5300	<4	0.97	<0.005	0.68	0.06	17.9	0.01	0.001	8.14	24.5	770	550
23	6	1150	21	Good Flow, Clear	0.4		340	1500	<4	5	<0.005	0.69	0.06	16	0.025	0.005	7.92	21	680	310
2	7	1035	18	Slow, Clear, Lot Of Algae			490	2000	<4											450
7	7	1420	21	Slow, Clear, Some Algae			580	3600	<4											580
14	7	1115	20	No Flow, Clear, Algae	1.12		960	2800	<4	12.6	0.02	0.84	0.1	4	0.018	<0.001	7.97	27.5	560	920
21	7	1345	23	Good Flow, Clear, Algae			710	2100	<4											716
28	7	1040	22	Fast, Turbid, High, No Algae	0.96		560	2000	<4	41	0.01	0.88	0.03	8.9	0.09	0.035	7.67	17	500	
6	8	1100	23	Good Flow, Clear	1.03		3700	1400	<4	9.8	0.06	0.81	0.09	6.6	0.026	0.003	7.55	27	645	3700
13	8	1050	17	Good Flow	0.68		240	340	<4	2.8	0.035	0.7	0.04	6.5	0.021	0.001	7.82	37	675	240
18	8	1175	21	Slow, Clear, Some Algae	1.21		17000	290	<4	8.2	0.045	0.91	0.12	5.4	0.028	0.002	7.6	39.5	665	12000
25	8	1059	15	Good Flow, Clear	1.46		4500	170	<4	8.7	0.06	1.17	0.03	1.1	0.041	0.004	7.87	81.5	765	4100
17	9	1020	13	Fast, Clear, High	0.38	3200	96	352	<4	5.6	0.01	0.72	0.02	4.7	0.032	0.021	7.83	18.5	615	
24	9	1042	17	Fast, Clear, High	0.16	2500	390	1400	<4	5.1	0.015	0.15	0.02	6.6	0.032	0.016	7.97	20.5	645	
1	10	1015	16	v. Fast, Clear (Brown), High	0.96	3900	190	1900	<4	10.4	<0.001	0.94	0.03	5.3	0.07	0.038	7.7	15	575	
15	10	1510	10	Fast, Clear, High	0.1	1940	180	600	<4	2.8	0.01	0.65	<0.01	5.9	0.028	0.008	8.01	19	675	
22	10	1155	12	Good Flow. Clear	0.42	4000	500	48	<4	2.1	<0.005	0.62	<0.01	5.2	0.016	0.002	8.11	20	730	
29	10	1025	11	Good Flow, Clear, Some Algae	0.64	1100	40	80	<4	3	<0.005	0.58	<0.01	6.2	0.014	0.001	7.97	19	685	
6	11	1025	7	Good Flow, clear	2.06	720	30	10	<4	2.1	0.005	0.56	<0.01	4.4	0.012	0.001	8.03	19	690	
12	11	1055	4	Good Flow, Clear, Low	0.57	500	<10	40	<4	5.5	<0.005	0.51	<0.01	4.1	0.013	0.003	8.18	22	665	
19	11	1025	1	Slow, Clear, Low	0.43	140	8	<4	<4	5.8	0.01	0.56	<0.01	3.8	0.011	0.004	8.07	23.5	685	
3	12	1050	3	Fast, Clear, High	0.98	3700	890	570	<4	11.8	0.02	0.63	<0.01	5.9	0.039	0.007	7.96	19.5	650	
11	12	1025	0	Fast, Clear	1.1	300	30	280	<4	4	0.01	0.55	<0.01	6.4	0.018	0.005	7.94	22.5	755	
17	12	1035	2	Good Flow, Clear	0.92	1700	140	40	<4	5.8	0.015	0.48	0.017	5.5	0.013	0.033	7.98	20	685	
				MAXIMUM	2.34	17000	17000	5600	4	127	0.17	1.44	0.12	17.9	0.286	0.074	8.27	81.3	770	12,000
				MINIMUM	0.059	230	4	4	4	0.97	0.001	0.48	0.01	1.1	0.01	0.001	7.55	9.5	344	240
				MEAN	1.00	1265.00	161.86	252.49	4.00	11.87	0.02	0.12	0.04	6.72	0.04	0.01	7.96	22.27	628.63	1,032
				COUNT	32	23	35	35	35	32	32	32	32	32	32	32	32	32	32	11

STREAM - PURGEL GULLEY MILEAGE- LOCATION- STATION NO,-

RATE DAY	MTH	TIME	T°C	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1440	0	Fast, Turbid, High	3.22	12000	1700	14600	68	370	0.21	1.65	0.07	3.1	0.51	0.108	7.62	17	359	
20	3	1043	0	Fast, Turbid	1.63	300	<10	290	4	75	0.08	0.79	0.04	3.8	0.135	0.065	8.11	16	472	
26	3	1450	7	Fast, Turbid	1.38	1600	120	150	<4	81	0.145	0.6	0.01	2.7	0.144	0.087	8.18	15	457	
2	4	1442	11	Fast, Clear	0.74	130	28	72	4	15.5	0.075	0.75	0.03	2.7	0.07	41	8.48	25.5	565	
10	4	1416	3	Good Flow, Clear	1.97	90	<4	<4	<4	6.9	<0.005	0.61	0.01	2.43	0.025	0.01	8.62	26.5	560	
15	4	1108	8	Fast, Clear	1.99	70	36	16	<4	11.1	0.005	0.73	0.01	2	0.033	0.009	8.32	25.5	565	
21	4	1410	6	Fast, Turbid	3.19	3900	250	670	20	1.83	0.23	141	0.05	5.8	0.245	66	8.1	21.5	545	
1	5	1350	11	Fast, Clear	0.61	330	48	16	<4	5.6	<0.005	0.62	0.02	2.7	0.017	0	8.27	21.5	505	
22	5	1040	12	Fast, Turbid	1.46	3200	264	344	<4	21	0.05	0.81	0.32	16.6	0.08	0.044	8.22	32	805	
28	5	1121	17	Good Flow, Clear	1.12	3200	240	128	<4	10.2	0.01	0.76	0.05	6.9	0.049	21	8.38	28.5	685	
4	6	1045	16	Low, Turbid	1.27	1700	420	144	<4	18.2	0.01	0.79	0.03	2.9	0.048	0.013	8.35	39.5	665	
9	6	1110	18	Good Flow, Turbid	6.72		1400	2400	<4	51	0.005	1.76	0.07	4.6	0.185	0.039	8.42	51	735	800
16	6	1140	18	Strong Flow, Turbid	0.52		400	1400	<4	27	0.005	0.64	0.06	14.1	0.059	0.03	8.48	30	820	400
23	6	1155	20	Fast, Turbid, High	2.4		2000	13600	<4	161	0.025	1.85	0.06	14.7	0.29	0.066	8.28	26.5	725	1800
2	7	1030	20	Good Flow,< Turbid			180	3100	<4											150
7	7	1430	24	Good Flow,< Turbid			430	640	<4											250
14	7	1105	22	Good Flow, Murky	0.71		2500	5000	<4	30	0.02	0.56	0.01	0.5	0.034	0.01	8.58	23.5	525	1700
21	7	1340	25	Good Flow,< Turbid			660	1200	<4											590
28	7	1050	22	Fast, Turbid, High, No Algae	1.5		1800	4400	<4	38	0.005	1.12	0.03	6.2	0.118	0.063	8.37	22.5	710	
6	8	1110	24	Good Flow, Clear	0.84		120	580	<4	21	0.02	0.66	<0.01	0.7	0.027	2	8.43	27.5	600	20
13	8	1055	19	Good Flow, Clear	0.77		120	16	<4	23	0.02	0.57	<0.01	0.3	0.03	0.004	8.52	29.5	595	100
T8	8	1130	25	Good Flow, Clear, Low	0.98		170	360	<4	22	0.01	0.57	<0.01	0.2	0.028	0.004	8.49	34.5	560	130
25	8	1105	17	Good Flow, Clear	1.2		290	690	4	27	0.06	0.93	<0.01	0.1	0.05	7	8.36	87	845	250
17	9	1025	11	Fast, Turbid, Hi6h	0.36	2900	152	264	<4	37	0.01	0.76	0.03	9.3	0.074	0.044	8.12	21	640	
24	9	1050	16	Fast, Turbid, High	1.2	10000	2200	2900	368	48	0.13	0.93	0.07	4.1	0.134	0.013	8.14	19	650	
1	10	1020	16	Very Fast Turbid, High	1.32	12000	700	5400	<4	86	0.035	1.2	0.03	3	0.19	97	8.05	15	585	
15	10	1515	11	Fast, Turbid, High	0.19	6800		600	<4	29	0.01	0.79	0.03	3.6	0.088	42	8.19	17	630	
22	10	1210	10	Good Flow, Clear	0.32	4200	200	90	<4	18	<0.005	0.61	<0.01	3.3	0.019	0.01	8.35	18	695	
29	10	1040	11	Good Flow,< Turbid	0.65	3400	600	240	4	22	<0.005	0.61	0.01	3.5	0.035	0.016	8.23	18.5	650	
6	11	1035	6	Good Flow, Clear	2.22	1700	110	80	<4	11.4	0.025	1.05	0.08	2.5	0.4	34	8.3	89	665	
12	11	1105	3	Good Flow, Clear,(Dark)Low	1.99	3000	180	80	<4	12.4	<0.005	0.91	0.01	2.6	0.106	0.045	8.47	38.5	735	
19	11	1035	1	Good Flow, Clear, Low, Some Ice	0.65	310	200	40	<4	14.2	<0.005	0.65	0.01	2.6	0.023	7	8.34	26	630	
3	12	1100	3	Fast, Turbid, High	2.52	11000	1700	3200	32	49	0.035	0.95	0.02	2.7	0.25	72	8.16	40.5	640	
11	12	1035	0	Fast, Murky, Some Ice	0.75	2400	270	310	<4	18.1	0.025	0.06	0.01	3.5	0.049	0.031	8.16	26	715	
17	12	1045	1	Good Flow, Clear	1.18	950	330	80	<4	29	<0.005	0.46	0.01	3	0.025	0.011	8.21	34	700	
				MINIMUM	672	12000	2500	14600	368	370	0.23	1.85	32	16.6	0.51	34	8.62	89	865	1800
				MINIMUM	0.059	230	4	4	4	1.83	0.005	0.06	0.01	0.1	0.017	2	7.62	15	359	20
				MEAN	1.49	1759.00	256.48	377.58	5.48	43.45	0.04	0.85	4	4.27	0.11	0.04	8.29	30.09	638.53	294
				COUNT	32	23	34	45	35	32	32	32	32	32	32	32	32	32	32	11

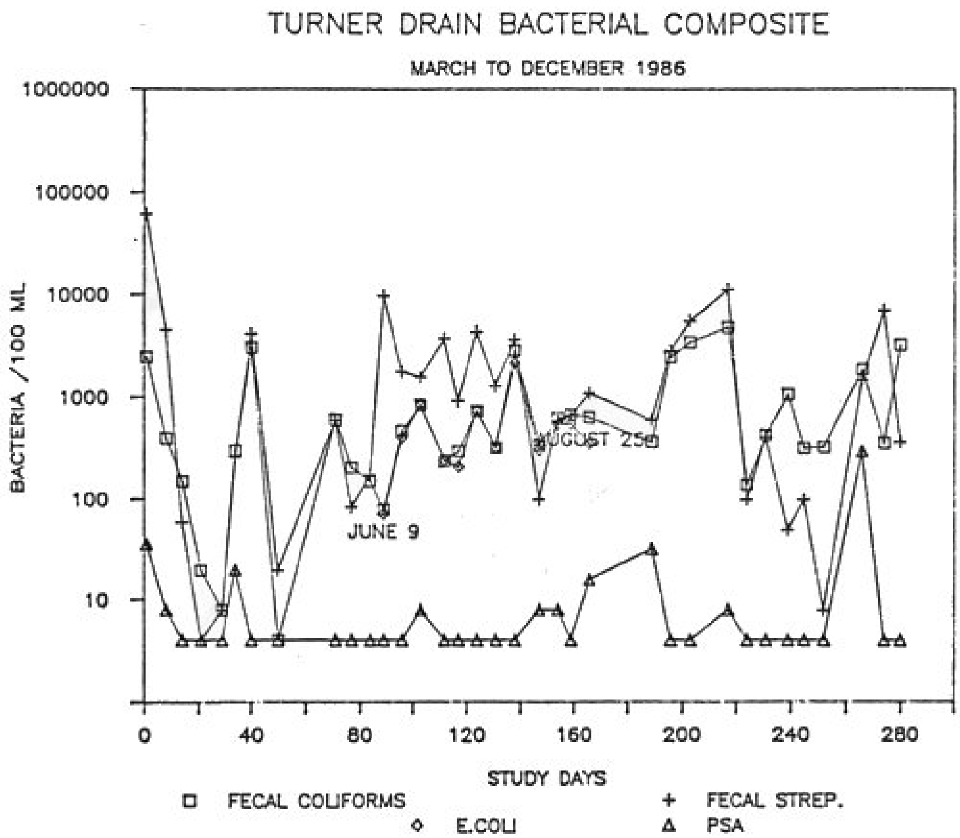
STREAM - DRYSDALE DR. MILEAGE- LOCAT10N STA11ON NO.-

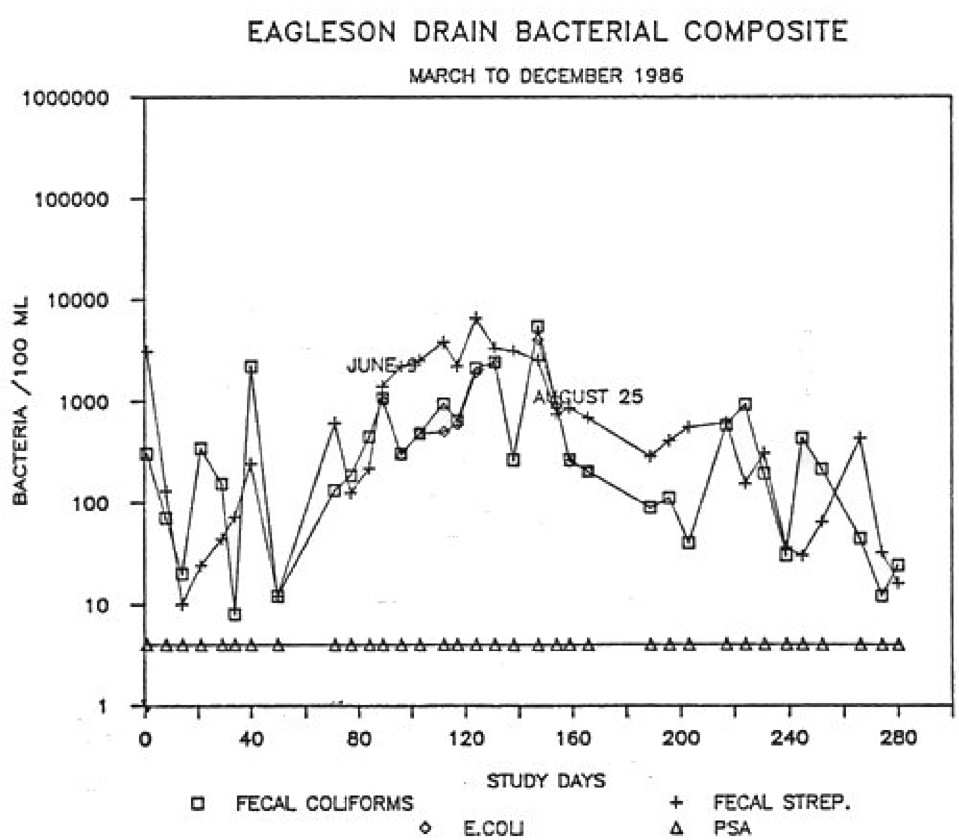
RATE DAY	MTH	TIME	T°C	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1445	0	Fast, Turbid, High	3.04	30000	180	6300	<4	195	0.175	2.15	0.07	4.1	0.565	0.18	7.52	9	299	
20	3	1052	0	Fast, Turbid	1.95	300	<10	290	<4	33	0.05	0.81	0.06	6.7	0.159	0.62	7.93	15	553	
26	3	1453	7	Fast, Turbid	2.14	29000	120	140	<4	31	0.215	0.82	0.04	8.3	0.013	0.046	8.02	32.5	700	
2	4	1450	15	Slow, Clear	0.65	96	4	40	<4	4.5	0.015	0.66	0.04	8.6	0.038	0.015	8.33	24	670	
10	4	1420	3	Slow, Clear	1.6	290	16	68	<4	4.3	0.005	0.59	0.01	6.5	0.02	0.009	8.59	21.5	580	
15	4	11T5	7	Fast, Clear	1.6	520	84	272	<4	10.3	0.02	0.81	0.01	5	0.045	0.012	8.33	18	585	
21	4	1358	6	Fast,< Turbid	1.47	3100	192	288	<4	21	0.03	0.87	0.02	7.1	0.083	0.016	8.16	19	625	
1	5	1342	20	Slow, Clear	1.09	310	30	10	<4	2.7	0.01	0.63	0.04	5.2	0.024	0.002	8.34	23	520	
22	5	1030	11	Good Flow, Clear	0.76	2400	112	332	<4	9	0.03	0.63	0.11	19.5	0.039	0.017	7.98	29.5	870	
28	5	1110	14	Slow, Clear	1.11	4400	80	104	<4	2.6	0.01	0.6	0.02	13.6	0.017	0.003	8.27	29	740	
4	6	1055	19	Slow, Clear, Low, Algae	0.96	1600	444	232	8	2.9	0.005	0.45	0.08	9.1	0.015	0.003	8.16	470	2200	
9	6	1100	19	Slow, Clear, Algae	1.37		540	4800	<4	5.4	0.01	0.74	0.06	3	0.026	0.003	8.32	118	1050	430
16	6	1148	20	Slow, Clear, Algae	0.27		3200	520	<4	2.3	0.025	0.64	0.06	13.4	0.021	0.011	8.38	28	880	3200
23	6	1200	23	Good Flow, Clear, Algae	0.5		500	6000	<4	7.5	0.035	0.71	0.08	20	0.049	0.025	8.15	30.5	935	500
2	7	1020	19	Slow. Clear, Algae Filled			28	5800	<4											20
7	7	1159	25	Mod Flow, Clear, Algae Covered	7.26		28	12400	<4	1.54	0.93	1.07	0.89	11.6	0.195	0.129	7.44	70	945	12
14	7	1055	25	Mod Flow, Murky,Algae Covered	6.6		440	12000	<4	38	0.13	1.66	0.15	0.8	0.194	0.021	7.44	85.5	843	440
21	7	1330	25	Slow, Clear, Lot of Algae			150	4000	<4											130
28	7	1055	22	Good Flow, Clear, High, No Alg	0.63		1900	16000	4	3.2	0.015	0.4	0.03	4.8	0.036	0.006	8.17	36.5	850	
6	8	1115		Stagnant, Algae Filled, Slimy	13		127000	3400	<4	10.5	0.04	1.8	<0.01	<0.1	0.174	0.001	7.77	195	1390	30000
13	8	1105	21	Stagnant, Turbid, Lot Of Algae	4.82		12000	360	<4	26	0.075	1.48	<0.01	<0.1	0.208	0.023	7.47	220	1380	10000
18	8	1135	25	Stagnant, Turbid, Low, Algae	6.96		40000	800	4	25	<0.005	1.55	<0.01	<0.1	0.315	0.096	7.61	460	2210	13000
25	8	1115	17	Stagnant, Murky,Lot Of Algae	4.16		3200	1500	20	23	0.105	1.3	<0.01	<0.1	0.13	0.018	7.48	215	1540	1600
17	9	1035	11	Fast, Clear. High	0.33	2500	40	600	<4	1.48	0.005	0.61	<0.01	10.4	0.035	0.029	7.98	24.5	750	
24	9	1100	16	Fast, Clear, High	0.13	3600	140	1100	<4	4.1	0.015	0.72	<0.01	6.8	0.048	0.034	7.96	20.5	690	
1	10	1030	16	Fast, Clear, High	0.47	15000	60	1600	<4	7.1	<0.005	0.86	0.01	5	0.097	0.07	7.73	14.5	605	
15	10	1525	12	Good Flow, Clear, High	0.1	1460	108	580	<4	1.88	0.015	0.58	<0.01	5.6	0.029	0.017	8.17	18.5	705	
22	10	1215	11	Good Flow, Clear	0.2	1900	430	56	<4	0.48	0.005	0.54	0.01	6.2	0.008	0.003	8.29	24.5	730	
29	10	1045	11	Good Flow, Clear	0.36	2900	96	260	<4	2.6	<0.005	0.58	0.0T	6.5	0.034	0.014	8.01	20	665	
6	11	1045	7	Good Flow, Clear	2.32	330	40	32	<4	0.62	0.015	0.53	0.01	6	0.014	0.007	8.21	23	100	
12	11	1115	4	Slow, Clear, Low	0.35	240	100	16	<4	7.2	0.025	0.5	<0.01	5.9	0.031	0.013	8.36	32	750	
19	11	1045	1	Slow, Clear, Low, Some Ice	0.38	580	84	124	<4	5.2	<0.005	0.44	<0.01	4.8	0.021	0.005	8.17	25	1280	
3	12	1110	4	Fast, Murky, High	1.17	21000	300	1500	12	21	0.015	0.71	<0.01	5.7	0.098	0.039	7.96	20.5	575	
11	12	1045	0	Good Flow. Clear. Muskrat	0.74	300	<10	140	<4	0.92	0.005	0.46	<0.01	6.9	0.015	0.01	8.16	24.3	773	
17	12	1055	2	Good Flow	0.73	200	<4	36	<4	6.5	0.005	0.41	<0.01	5.3	0.022	0.011	8.13	23.5	700	
				MAXIMUM	13	30000	127000	16000	20	195	0.93	2.15	0.85	20	0.565	0.62	8.59	470	2210	30,000
				MINIMUM	0.059	230	4	10	4	0.48	0.005	0.4	0.01	0.1	0.008	0.001	7.44	9	299	12
				MEAN	2.10	1431.00	174.07	496.46	4.41	15.69	0.06	0.83	0.06	6.75	0.09	0.05	8.03	73.33	888.31	773
				COUNT	33	23	35	35	35	33	33	33	33	33	33	33	33	33	33	11

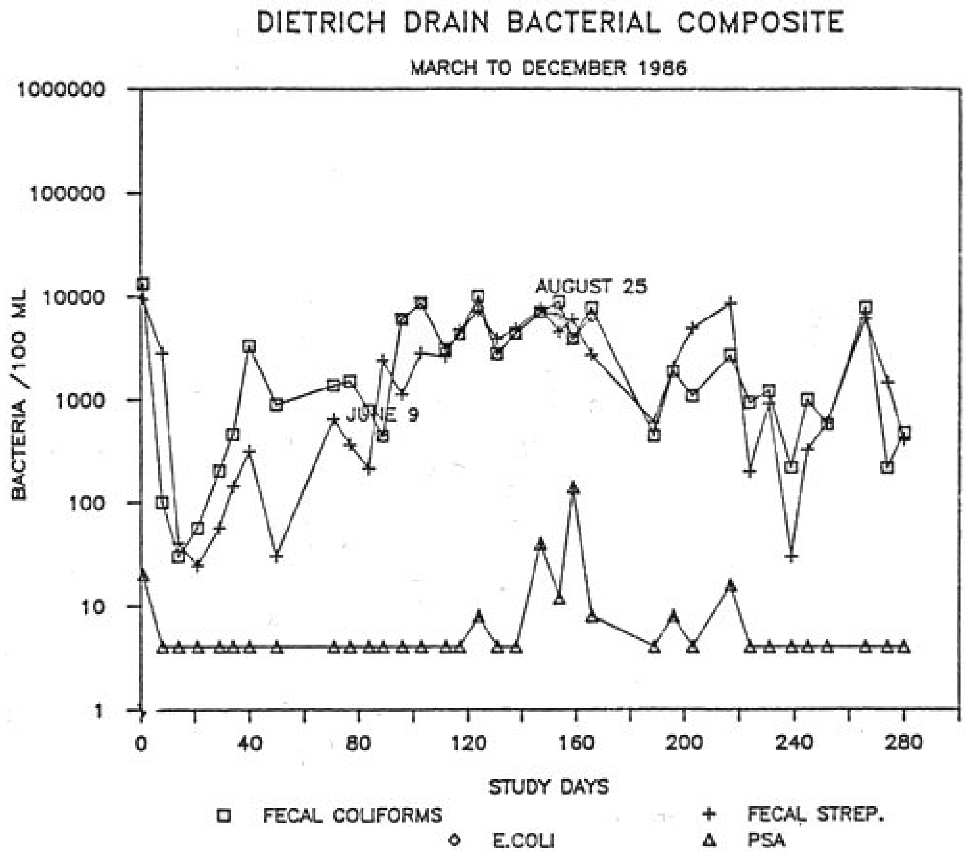
				STREAM - WESTLAKE DR.				MILEAGE-			LOCATION-	STATION NO.-								
RATE DAY	MTH	TIME	T°C	NATURE	BOD	Total Coliform	Fecal Coliform	FECAL STREP.	PSA.	TURB.	NH3	TOTAL KJELD	NO2	NO3	TOTAL P.	REACT P	pH	Cl-	COND-UCT	E. COLI
13	3	1455	0	Fast, Turbid, High	4.64	32000	>45000	>21000	1	295	0.475	2.75	0.07	4.2	0.745	0.23	7.27	12	338	
20	3	1100	0	Good Flow,< Turbid	1.86	300	100	300	<10	28	0.05	0.75	0.03	7	0.118	0.062	8.0	11.5	555	
26	3	1506	0	Mod. Turbid	1.62	200	<100	<100	<4	24	0.045	0.57	<0.01	4.3	0.067	0.03	8.11	10	515	
2	4	1458	13	Slow, Clear	0.99	76	12	<4	<4	14.8	<0.005	0.6	0.01	4.7	0.037	0.007	8.33	12.5	565	
10	4	1434	3	Slow, Clear	1.46	112	<4	8	<4	3.5	<0.005	0.46	<0.01	4.4	0.006	0.002	8.38	12.5	565	
15	4	1125	7	Good Flow, Clear	0.81	100	16	44	<4	6.1	0.015	0.61	0.01	3.1	0.010	0.003	8.25	12	560	
21	4	1352	6	Fast, Turbid	1.57	2100	396	360	12	17	0.02	0.92	0.02	5.9	0.07	0.018	8.13	13	590	
1	5	1335	11	Slow, Clear	1	2100	10	<10	<4	4	0.005	0.53	0.02	3.1	0.015	0.001	8.09	12	500	
22	5	1023	12	Good Flow, Clear	1	3100	552	388	4	7.2	0.045	0.72	0.11	13.5	0.035	0.016	8.18	21	805	
28	5	1105	17	Slow, Turbid	0.74	5100	>600	76	<4	4.3	0.025	0.6	0.07	6.1	0.019	0.008	8.24	16	680	
4	6	1105	15	Slow, Clear, Low	0.37	3700	>1500	152	<4	7.5	0.015	0.46	0.04	4.1	0.01	0.004	8.17	14.5	700	
9	6	1050	15	Slow, Clear	0.61		7300	1010	<4	6.2	0.02	0.5	0.05	2.5	0.021	0.005	8.29	14	665	4900
16	6	1200	20	Slow, Clear	0.35		170	3100	4	11.6	0.015	0.45	0.03	1.9	0.021	0.007	8.26	16	695	80
23	6	1215	21	Good Flow, Clear	0.6		4000	1000	<4	17	0.01	0.64	0.04	4.5	0.032	0.009	8.21	16	680	4000
2	7	1015	19	Slow, Clear			2100	2600	<4											2100
7	7	1152	25	Slow, Clear	9.96		1600	2600	<4	8.4	<0.005	1.82	0.19	10	0.102	0.001	8.02	84	1110	1000
14	7	1045	21	Slow, Turbid	0.8		4900	3100	<4	35	0.01	0.51	<0.01	<0.1	0.048	0.007	8.23	15.5	505	4300
21	7	1323	20	Slow, Turbid			360	730	<4											340
28	7	1105	22	Good Flow, Clear,No Algae	1.1		750	1400	4	5.2	<0.005	0.86	<0.01	<0.1	0.044	0.008	8.29	11	515	
6	8	1125		Slow, Turbid, Muskrat, Algae	1.01		1400	2700	<4	13.9	0.025	0.53	<0.01	<0.1	0.034	0.002	8.07	90	775	1100
13	8	1115	11	Slow, Clear. No Algae	1.14		2000	1000	<4	8.1	0.015	0.53	<0.01	<0.1	0.031	0.001	8.27	56.5	680	2004
18	8	1150	23	Slow, Clear, No Algae	1.2		690	2200	<4	14.6	0.01	0.58	<0.01	<0.1	0.038	0.006	8.0	71	615	690
25	8	1125	16	Good Flow, Murky, Algae	1.49		2200	3000	8	22	0.005	0.61	<0.01	<0.1	0.047	0.005	8.17	12	515	2000
17	9	1045	11	Good Flow, Clear, High	0.33	6900	256	352	<4	3.2	0.015	0.67	0.03	3.6	0.05	0.041	8.1	18	750	
24	9	1110	16	Fast, Turbid, High	0.17	27000	1030	4900	44	11.1	0.025	0.8	0.03	1.6	0.12	0.073	8.08	15.5	100	
1	10	1015	16	Fast, Turbid, High	0.88	47000	1800	13600	68	19	<0.005	0.95	0.02	6.1	0.16	0.122	7.98	12	635	
15	10	1535	10	Good Flow, Clear, High	0.1	6500	1110	610	20	3.2	0.015	0.64	0.01	7.5	0.043	0.026	8.22	15	705	
22	10	1220	11	Good Flow, Clear	0.35	1600	296	104	<4	2.5	<0.005	0.59	0.01	6.6	0.009	0.002	8.25	14	685	
29	10	1050	11	Good Flow, Clear	0.57	3100	460	348	<4	3.0	<0.005	0.47	0.02	6.8	0.019	0.005	8.16	15.5	700	
6	11	1050	6	Good Flow, Clear	2.13	2100	610	260	<4	1.43	0.04	0.54	0.02	5.6	0.021	0.009	8.2	13.5	690	
12	11	1120	2	Slow, Clear, Low	0.44	210	<10	10	<4	3	<0.005	0.45	0.02	4.8	0.016	0.003	8.27	13.5	670	
19	11	1050	1	Slow, Clear, Low, Ice Cover	0.46	1900	252	20	<4	2.3	<0.005	0.52	0.02	5.2	0.015	0.002	8.17	14.5	675	
3	12	1115	2	Fast, Turbid, High	3.88	28000	11800	4900	200	62	0.11	1.35	0.02	5	0.29	0.113	8.02	14	520	
11	12	1055	0	Fast, Clear, Some Ice	0.94	1600	420	4300	4	3.8	0.02	0.52	<0.01	6.1	0.033	0.018	8.05	16	720	
17	12	1105	2	Good Flow, Clear	065	1600	700	210	<4	4.7	0.01	0.4	0.01	5	0.014	0.007	8.13	13.5	655	
				MAXIMUM	9.96	47000	45000	21000	200	295	0.475	2.75	8.19	13.5	0.745	0.23	8.38	90	1110	4,900
				MINIMUM	0.059	230	4	4	1	1.13	0.005	0.4	0.01	0.1	0.006	0.001	7.27	10	338	80
				MEAN	1.37	1986.40	497.48	463.42	5.65	20.59	0.03	0.72	0.03	4.68	0.07	0.03	8.14	21.45	644.03	1,276
				COUNT	33	23	35	35	35	33	33	33	33	33	33	33	33	33	33	11

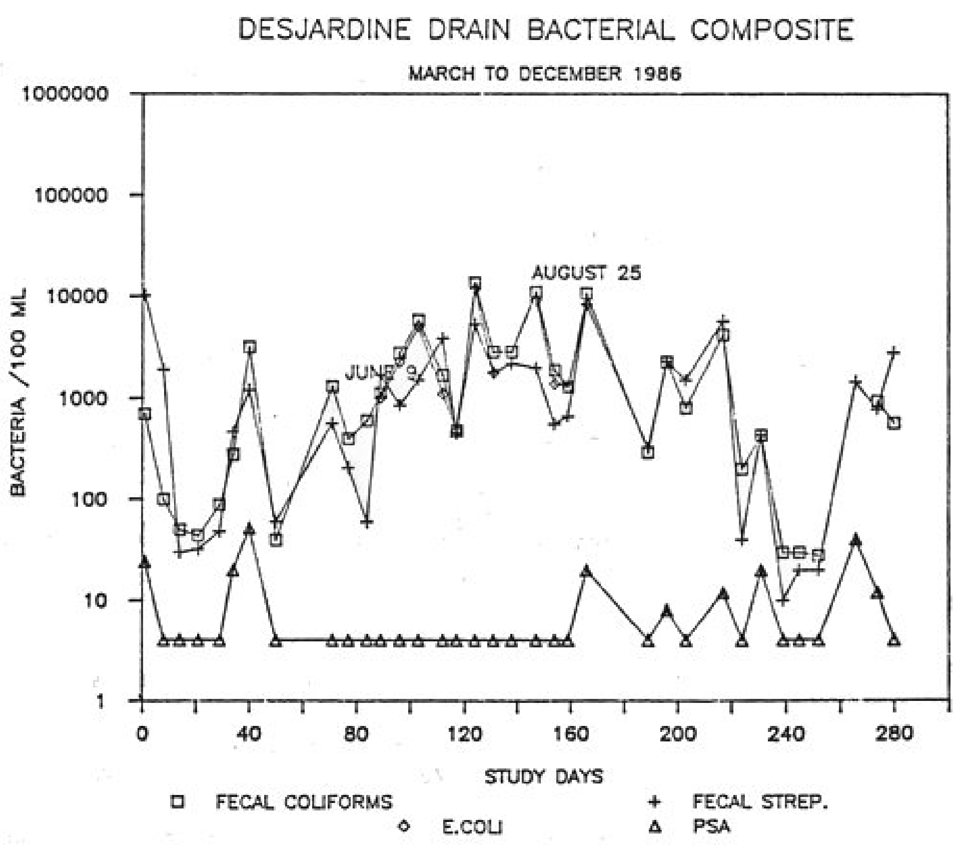
APPENDIX F

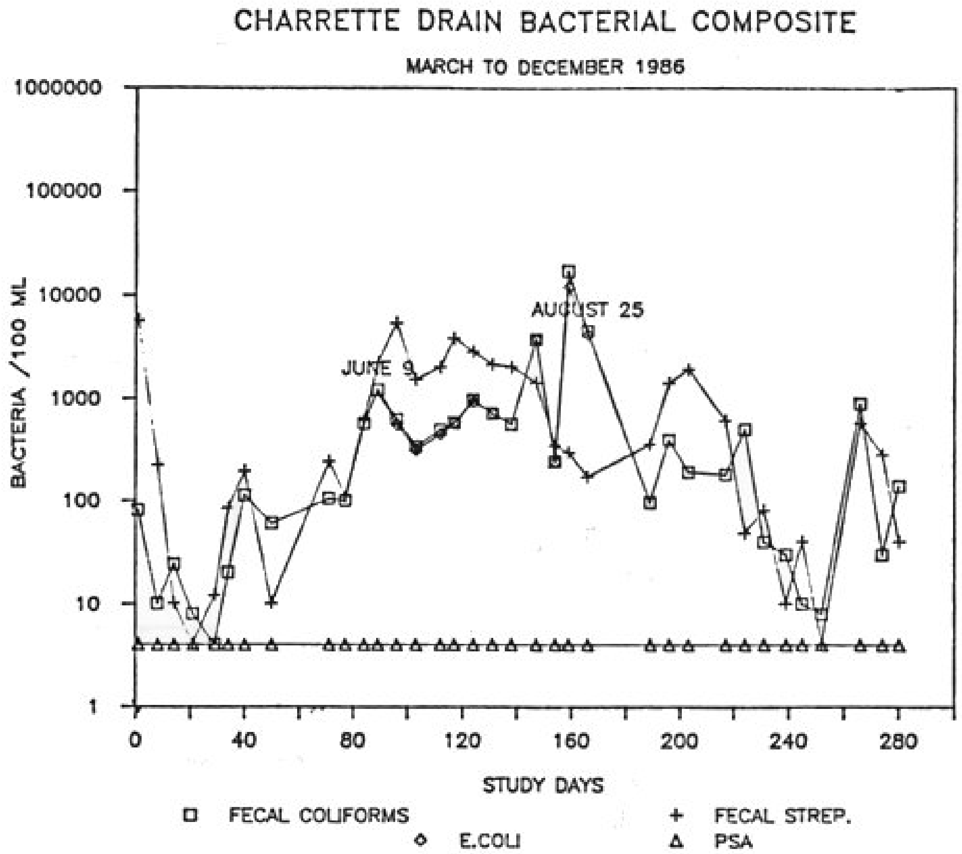
Bacterial Composite Graphs

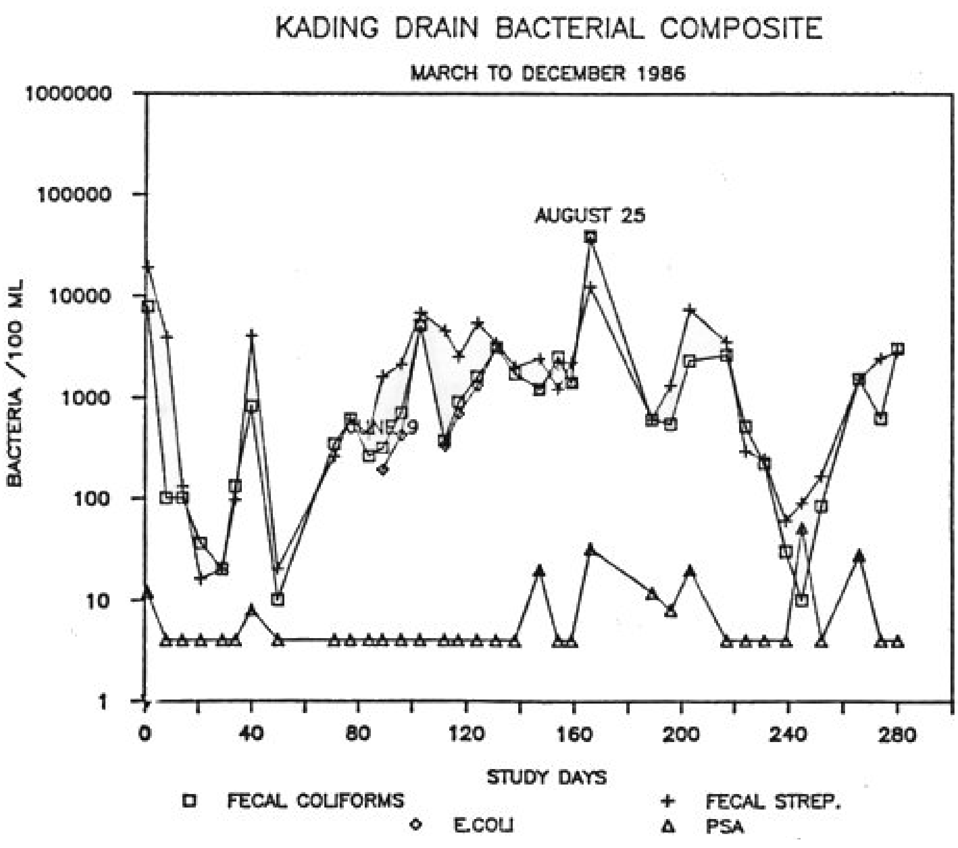

TURNER DRAIN BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
BACTERIA /100 ML
1000000
100000
10000
1000
100
10
JUNE 9
AUGUST 25
0
40
80
120
160
200
240
280
STUDY DAYS
FECAL COLIFORMS
FECAL STREP.
E.COLI
PSA

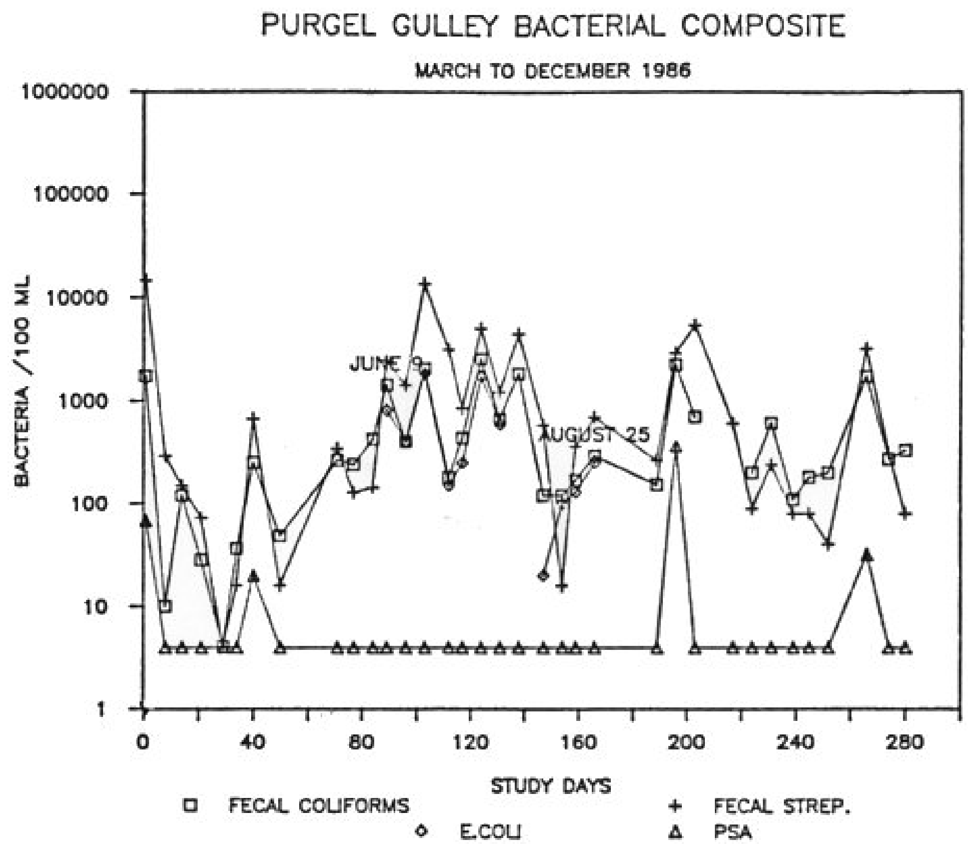

EAGLESON DRAIN BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
BACTERIA /100 ML
1000000
100000
10000
1000
100
10
1
JUNE 9
AUGUST 25
0
40
80
120
160
200
240
280
STUDY DAYS
FECAL COLIFORMS
FECAL STREP.
E.COLI
PSA

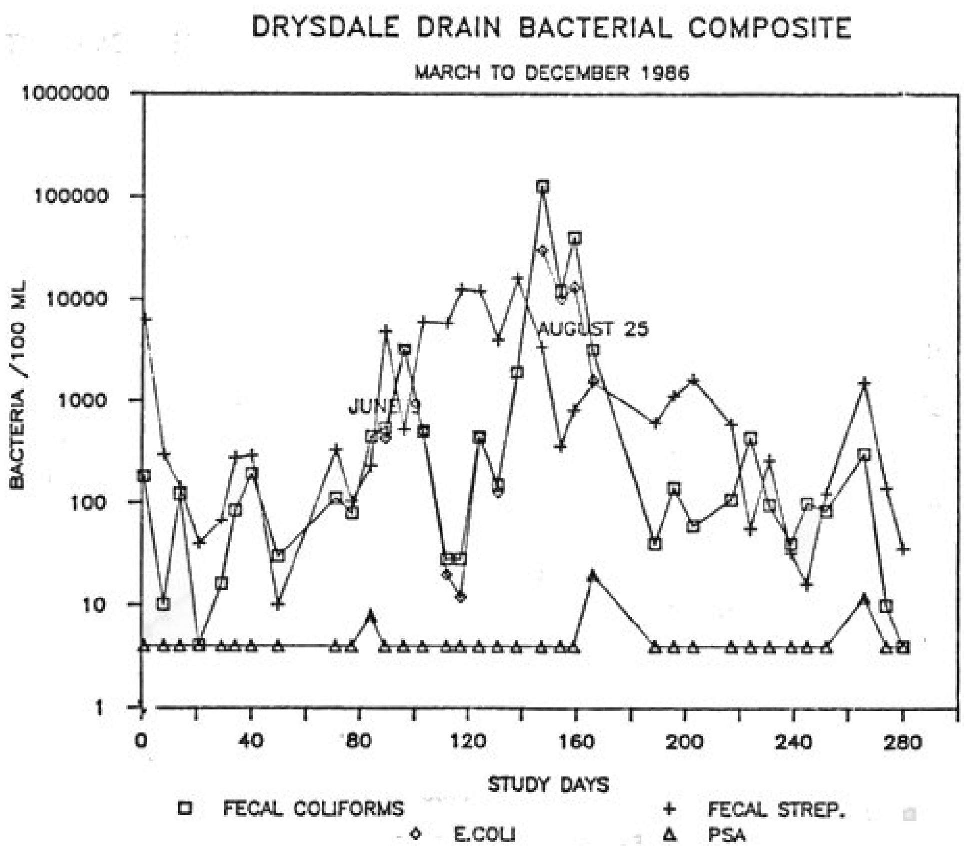

DIETRICH DRAIN BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
AUGUST 25
JUNE 9
BACTERIA /100 ML
STUDY DAYS
FECAL COLIFORMS
FECAL STREP.
E.COLI
PSA

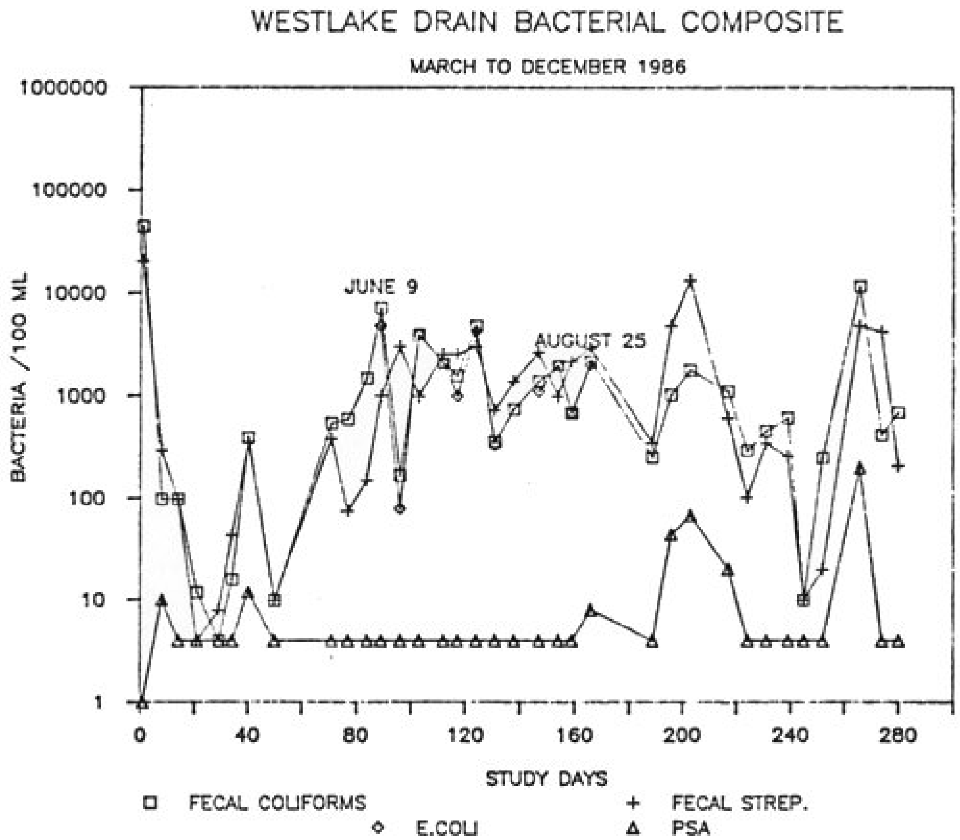

DESJARDINE DRAIN BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
AUGUST 25
JUNE 9
BACTERIA /100 ML
STUDY DAYS
FECAL COLIFORMS
FECAL STREP.
E.COLI
PSA


CHARRETTE DRAIN BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
BACTERIA /100 ML
1000000
100000
10000
1000
100
10
1
JUNE 9
AUGUST 25
0
40
80
120
160
200
240
280
STUDY DAYS
FECAL COLIFORMS
E.COLI
FECAL STREP.
PSA


KADING DRAIN BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
BACTERIA /100 ML
1000000
100000
10000
1000
100
10
1
AUGUST 25
JUNE 9
0
40
80
120
160
200
240
280
STUDY DAYS
FECAL COLIFORMS
E.COLI
FECAL STREP.
PSA


PURGEL GULLEY BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
BACTERIA /100 ML
1000000
100000
10000
1000
100
10
1
JUNE 9
AUGUST 25
0
40
80
120
160
200
240
280
STUDY DAYS
FECAL COLIFORMS
E.COLI
FECAL STREP.
PSA

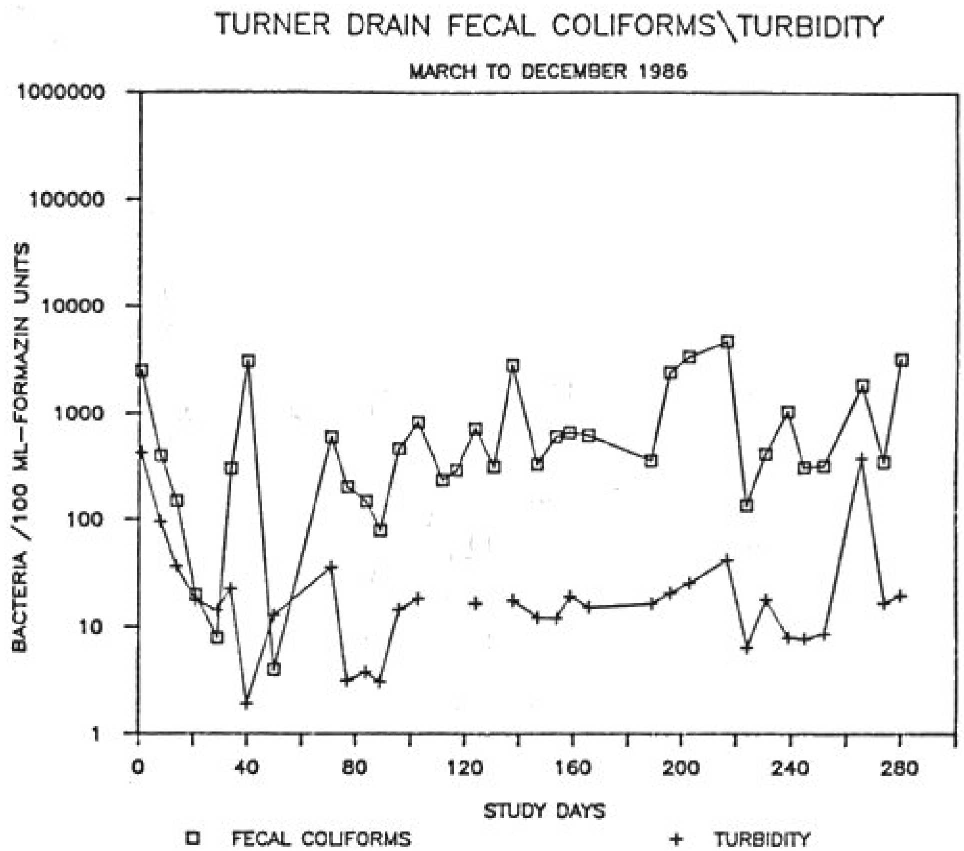

DRYSDALE DRAIN BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
BACTERIA /100 ML
1000000
100000
10000
1000
100
10
1
AUGUST 25
JUNE 9
0
40
80
120
160
200
240
280
STUDY DAYS
FECAL COLIFORMS
E.COLI
FECAL STREP.
PSA

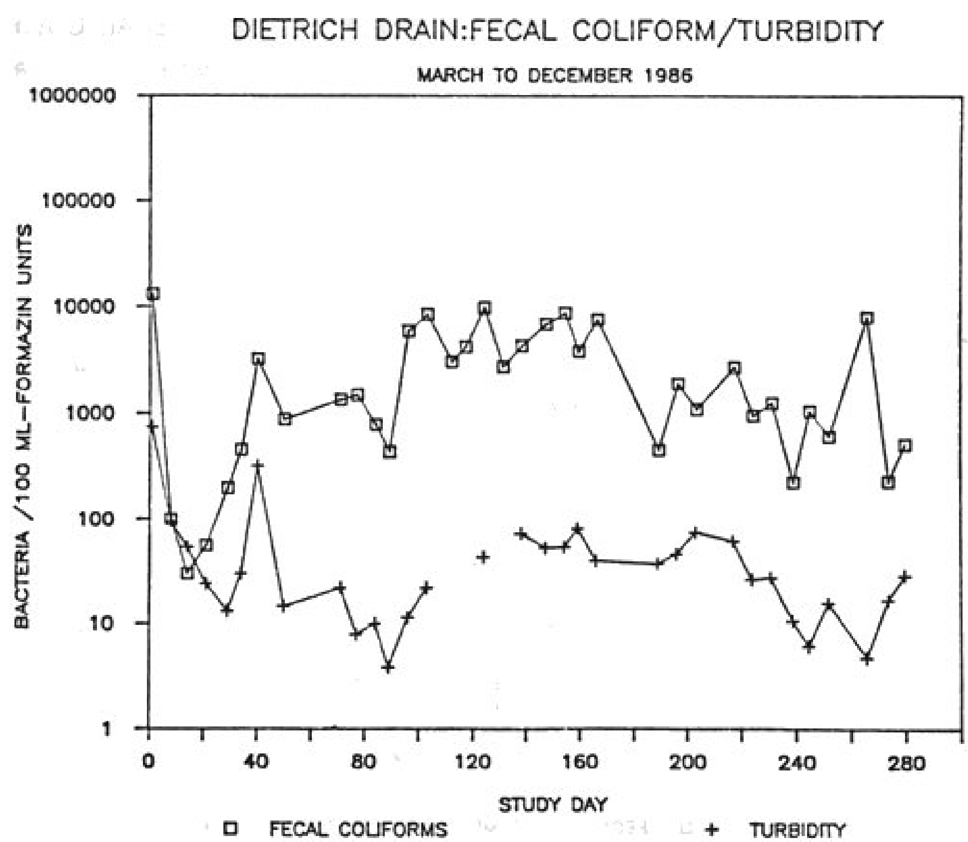


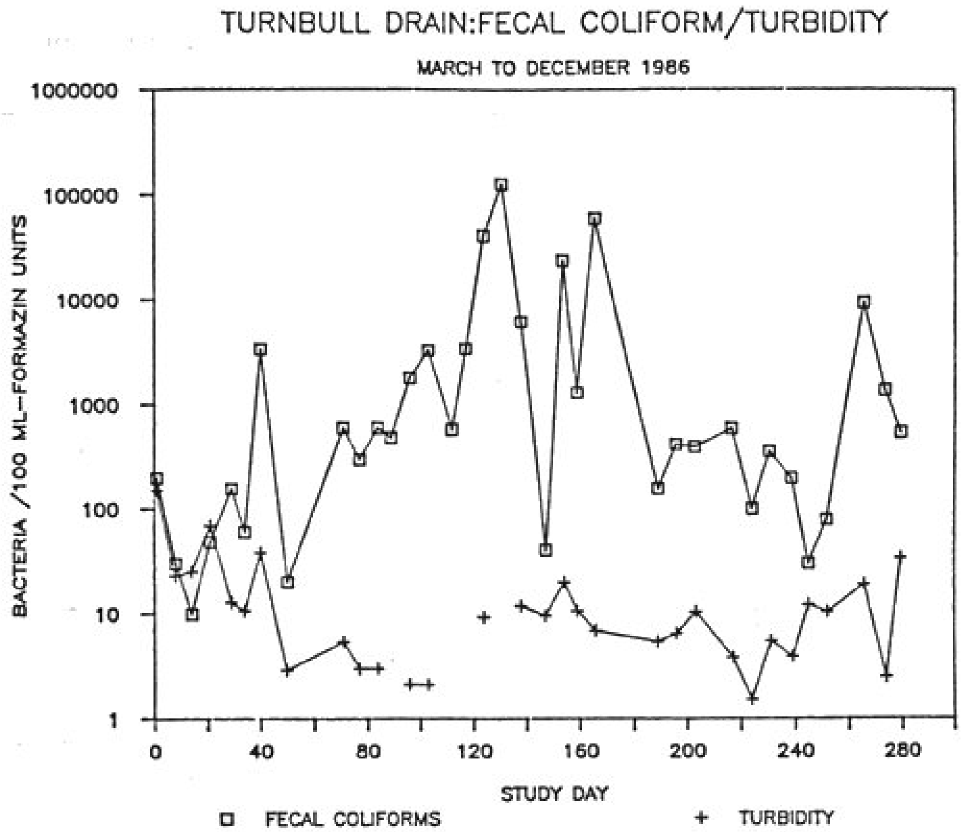
WESTLAKE DRAIN BACTERIAL COMPOSITE
MARCH TO DECEMBER 1986
BACTERIA /100 ML
1000000
100000
10000
1000
100
10
1
JUNE 9
AUGUST 25
0
40
80
120
160
200
240
280
STUDY DAYS
FECAL COLIFORMS
FECAL STREP.
E.COLI
PSA

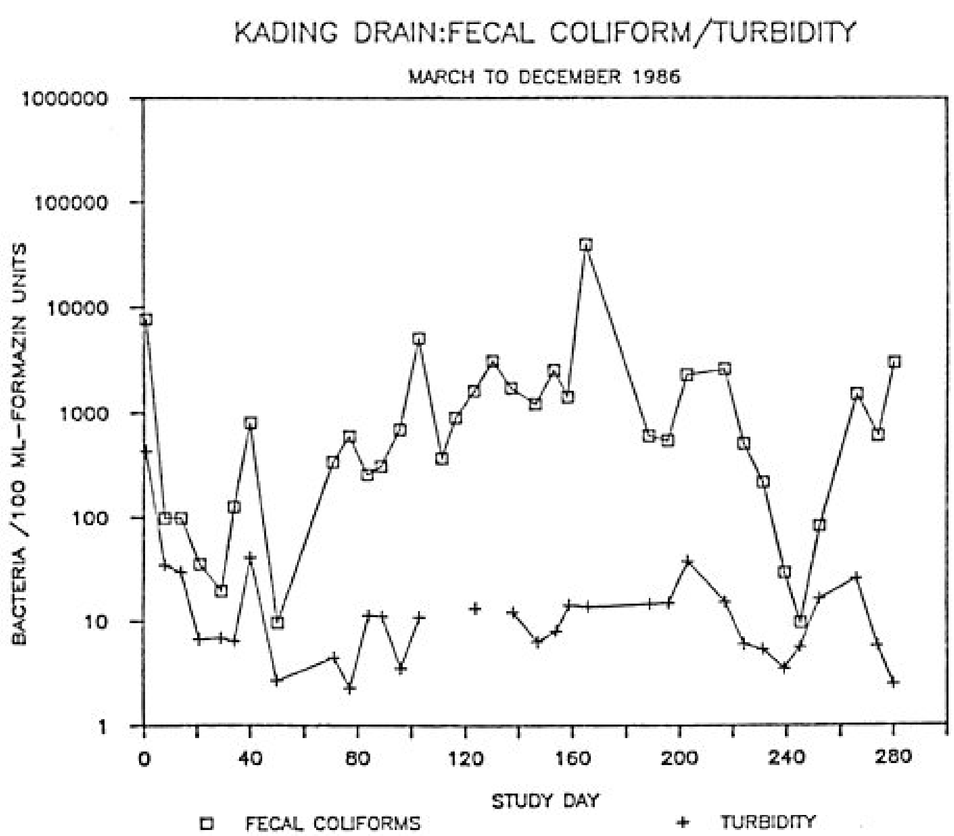
APPENDIX G

Graphs of the relationship between turbidity and fecal coliform levels


TURNER DRAIN FECAL COLIFORMS\TURBIDITY
MARCH TO DECEMBER 1986
BACTERIA /100 ML–FORMAZIN UNITS
1000000
100000
10000
1000
100
10
1
0
40
80
120
160
200
240
280
STUDY DAYS
FECAL COLIFORMS
TURBIDITY

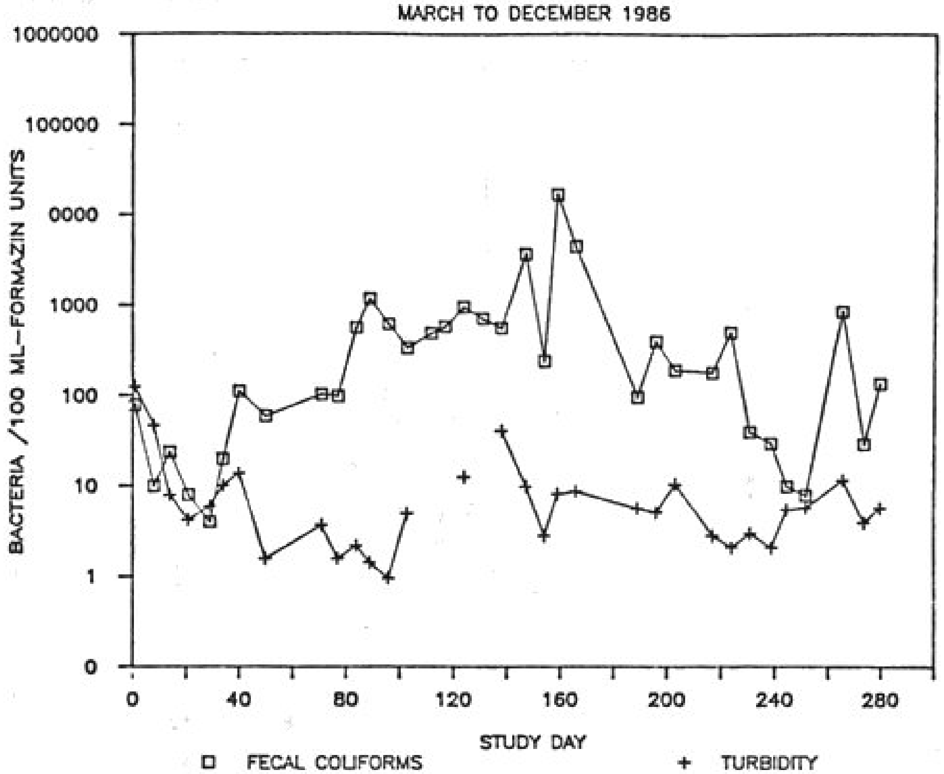

DIETRICH DRAIN:FECAL COLIFORM/TURBIDITY
MARCH TO DECEMBER 1986
BACTERIA /100 ML–FORMAZIN UNITS
1000000
100000
10000
1000
100
10
1
0
40
80
120
160
200
240
280
STUDY DAY
FECAL COLIFORMS
TURBIDITY


TURNBULL DRAIN:FECAL COLIFORM/TURBIDITY
MARCH TO DECEMBER 1986
BACTERIA /100 ML–FORMAZIN UNITS
1000000
100000
10000
1000
100
10
1
0
40
80
120
160
200
240
280
STUDY DAY
FECAL COLIFORMS
TURBIDITY


KADING DRAIN:FECAL COLIFORM/TURBIDITY
MARCH TO DECEMBER 1986
BACTERIA /100 ML–FORMAZIN UNITS
1000000
100000
10000
1000
100
10
1
0
40
80
120
160
200
240
280
STUDY DAY
FECAL COLIFORMS
TURBIDITY

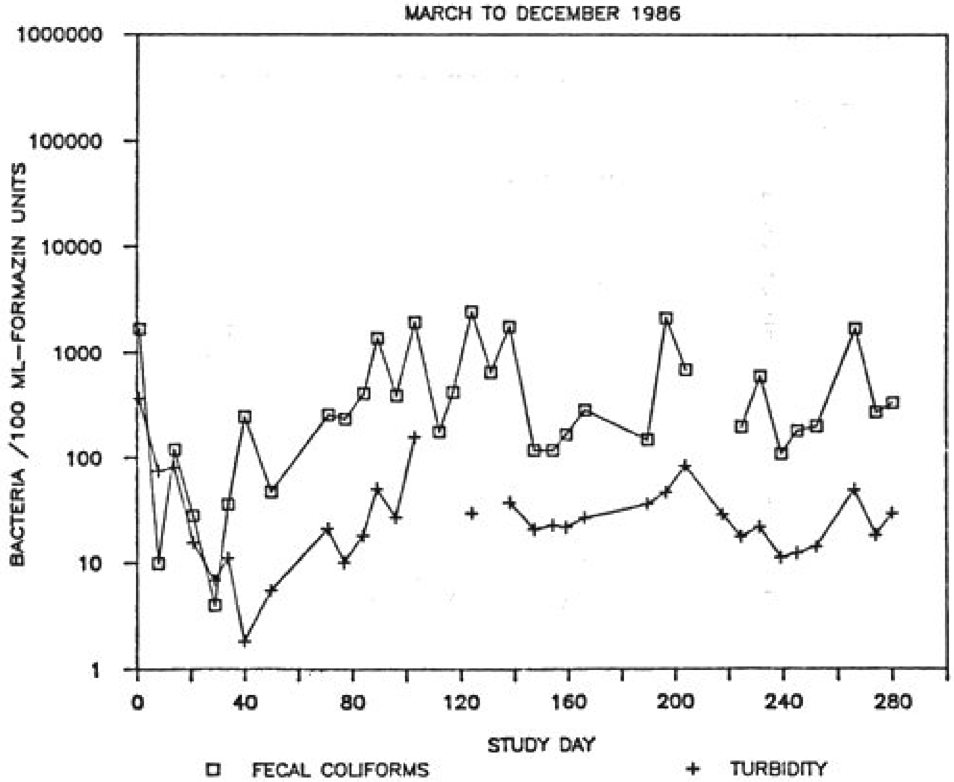
CHARRETTE:FECAL COLIFORM/TURBIDITY

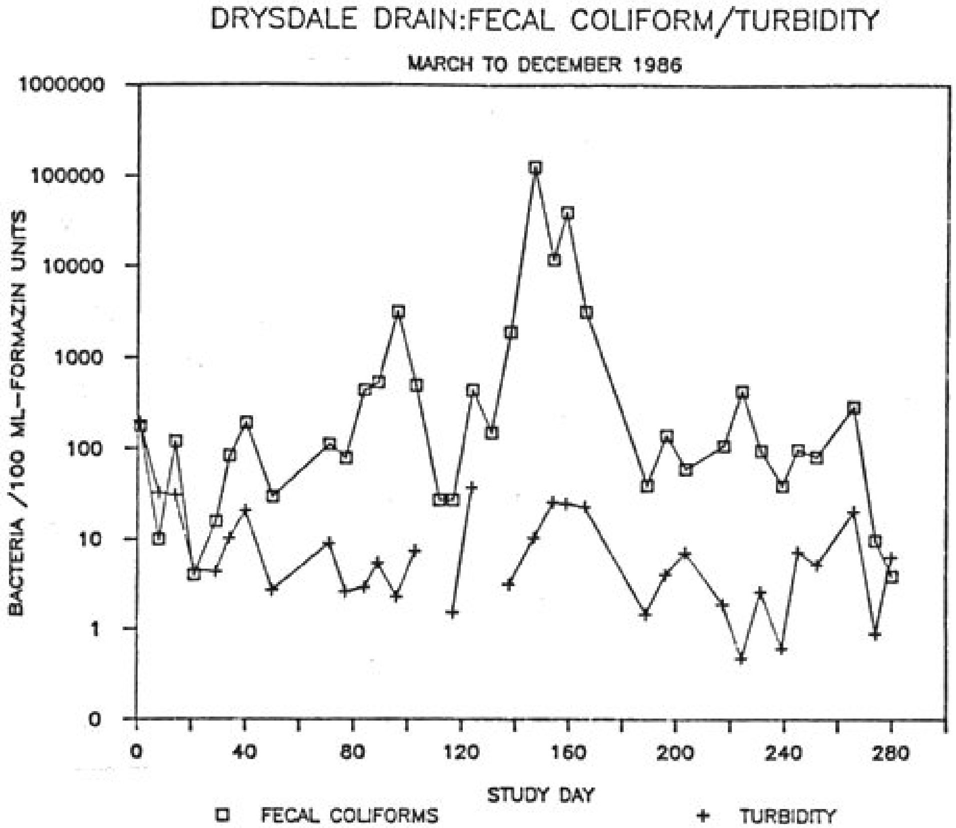
MARCH TO DECEMBER 1986

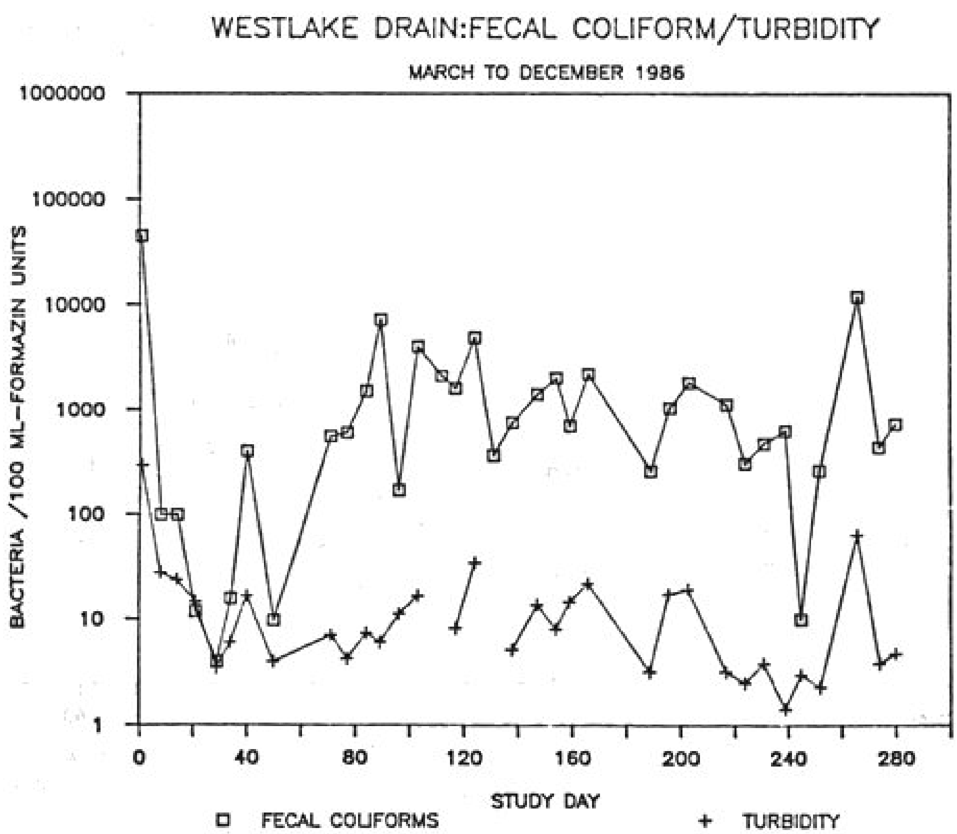


PURGEL GULLEY:FECAL COLIFORM/TURBIDITY

MARCH TO DECEMBER 1986




DRYSDALE DRAIN:FECAL COLIFORM/TURBIDITY
MARCH TO DECEMBER 1986
BACTERIA /100 ML–FORMAZIN UNITS
1000000
100000
10000
1000
100
10
1
0
0
40
80
120
160
200
240
280
STUDY DAY
FECAL COLIFORMS
TURBIDITY


WESTLAKE DRAIN:FECAL COLIFORM/TURBIDITY
MARCH TO DECEMBER 1986
BACTERIA /100 ML–FORMAZIN UNITS
1000000
100000
10000
1000
100
10
1
0
40
80
120
160
200
240
280
STUDY DAY
FECAL COLIFORMS
TURBIDITY