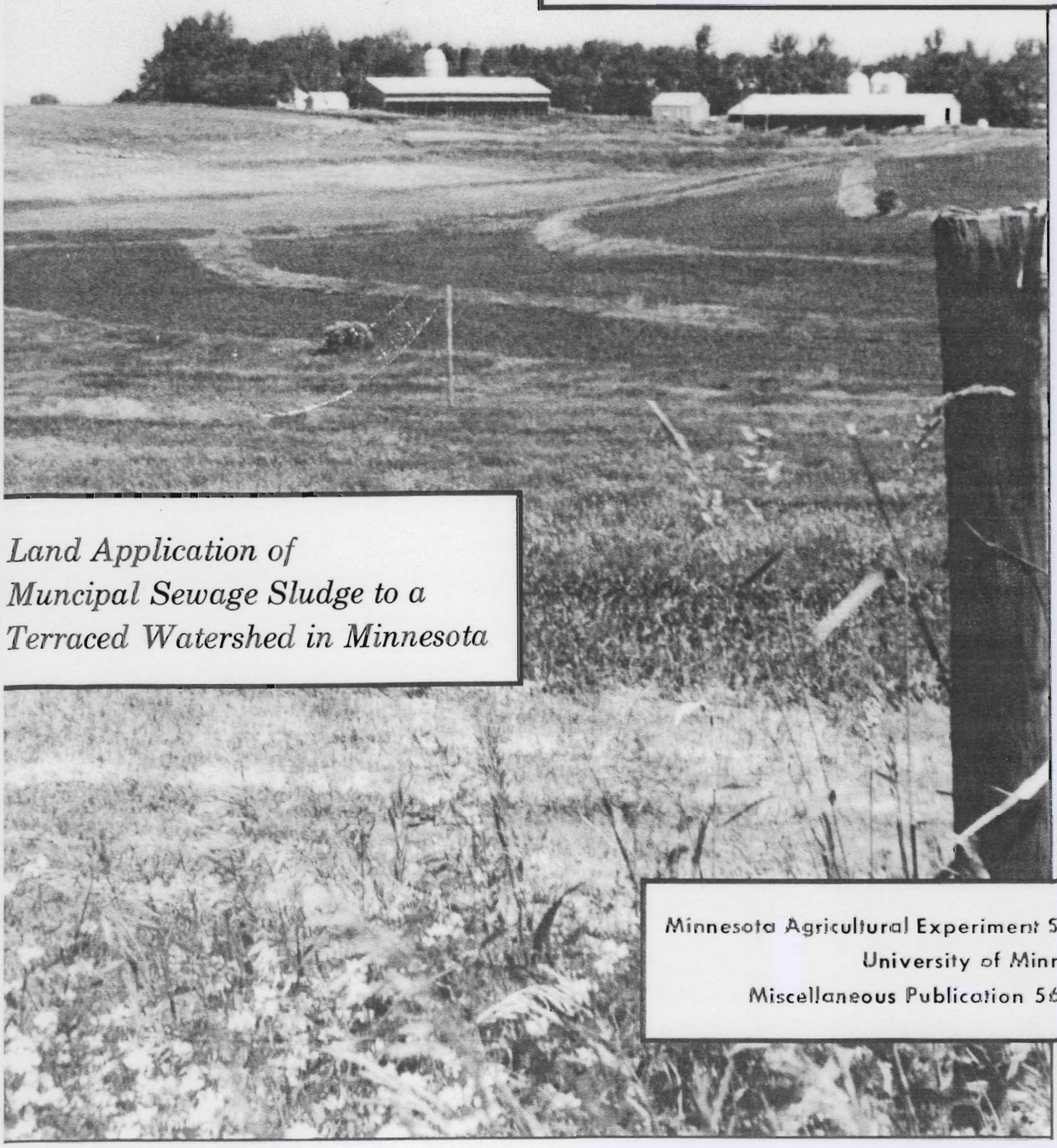
Sewage Sludge Management



Land Application of Muncipal Sewage Sludge to a Terraced Watershed in Minnesota

Minnesota Agricultural Experiment Station
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Introduction

Management of municipal sewage sludge is a cloudy issue. In its simplest terms, the situation is that the municipality wants to dispose of this by-product of wastewater treatment and the farmer wishes to obtain a — usually free — fertilizer. The issue clouds when the social, economic, and technical aspects of sludge are not understood by the players.

As you read further sludge will be defined. Soil is then evaluated as a sludge-receiving material. A long-term case study of applying sludge to agricultural crops in a field-scale research site in Minnesota is reviewed. In short, the cloudy issues should soon clear for a better overall understanding of municipal sludge and its application to land.

Problem Definition

The simple definition of a willing provider and a willing accepter of the sludge is too narrow. In reality there are many more players influencing the outcome of the game. Chief among these are legislators, regulatory agencies, and environmental and other citizens groups all of which operate at federal, state, county, and local levels.

Environmental concerns

Inclusion of these people and organizations in the sludge disposal process should not be viewed as "interfering with progress" but as a positive input to the process. No one individual or organization knows all there is to know about the on- and off-site effects of sludge utilization on land. Some of the public reluctance to accept land spreading sludge may be fear of harming ourselves by changing our environment.

Major problems to public acceptance

Let's face it—sludge doesn't have a good public image. It is generally regarded as a liability rather than an asset; something to dispose of rather than seek. Much of this reaction to human wastes by the public is psychological, however, in the case of municipal sewage sludge there are components of the sludge which may have undesirable traits.

Info Box

Awareness of the '70s (PL92-500)

Environmental issues — United States society as a whole became aware of environmental degradation in the early 1970's. Popular books like Rachel Carson's *Silent Spring* and Barry Commoner's *Spaceship Earth* marked the beginning of an environmental movement — in part reactionary — resulting in rapid legislation at state and federal levels to protect the environment. As an example, a significant piece of federal legislation, called the Clean Water Act (PL92-500), was a 1972 amendment to the Federal Water Pollution Control Act of 1956 to abate water pollution in the nation's waters.

Systems approach

At face value stopping water pollution seems a well defined problem ideal for solving by our task-oriented society. Unfortunately the solution to water pollution abatement is not bounded by the banks of the stream. This problem creeps up the bank to the uplands where the bulk of society lives. Suddenly we were no longer looking at one phase of the problem — the symptom — but were forced to look at the whole hydrologic system and the things we do on the uplands that might cause water pollution (including sludge application to land).

Environmental modeling

As important as the popular environmental movement was the realization by scientists that the environmental systems being studied were too complex and interrelated to be understood by one discipline alone. The interdisciplinary nature of environmental studies led to the development of large computer-assisted "models" of the impact of land-use upon the environment. Although few of the multitude of models were thoroughly tested and functional, a positive result of the modeling was that many basic natural processes were identified as being important but not well understood.

While you might guess that only a scientist could call not knowing something a positive result, it is true that the most difficult step in problem solving is to clearly define the problem. Focusing on a critical problem, for example describing the fate of a pesticide in a soil, contributes to our overall understanding of the things we do which affect our environment.

A large problem for anyone trying to generalize about the good/bad qualities of sludge is the variation of components in sludge from city to city. The human waste component of sludge is rather invariant geographically; people tend to eat the same kinds of food. Sludge components from other sources, however, like industrial waste, suburban lawn care, urban atmospheric

fallout, and road-wash vary with city size and/or industrialization.

Unpopular components of untreated sludge can be grouped into two broad catagories. These groups are the disease-causing organisms, pathogens, and the toxic chemicals which may be present in some sludges.

Pathogens — There are a host of pathogenic "agents" that as part of their life cycle are transmitted by human wastes. Numerous methods exist to deactivate these agents and thereby reduce or eliminate public health risks.

Toxic chemicals — Toxic, or poisonous, chemicals in sludge can be further subdivided into organic and inorganic groups. Most of the potentially harmful organic chemicals are synthetic, man-made compounds or their decomposition products. Inorganic chemicals include common compounds like nitrate (NO_3-N), which are not harmful except in high concentrations, and some trace metals, like lead (Pb), that are toxic at a lower concentration.

The popularity of sludge landspreading is also affected by the concerns of odors, increased truck traffic on local roads, and impacts on nearby property values.

Benefits from land application

On the positive side, there are also benefits to be gained from land application of sludge. First, many believe that any other disposal method is a waste of precious resources — organic matter and plant nutrients. Sludge in several forms has been used as a soil conditioner, a fertilizer for field crops, forests, ornamentals, and sod. It has been used to enhance reclamation of mined land and other disturbed sites.

Need for sludge research

Neither the sludge provider nor the farmer, or the silent partner, Society, wants to knowingly cause harm to ourselves or each other by applying municipal sewage sludge to land. But who knows what potential hazards lie in this practice? A real need for answers must be developed in the municipal sewage sludge area.

Undesirable aspects of sludge utilization can be divided into short and long term effects. Short term effects deal with problems that show up soon after the sludge is applied and often can be attributed to contact with the sludge itself. Long term effects are, in a general sense, consequences of using the

land upon which derivitives of the sludge remain. Complete understanding of potential problems necessitates research which evaluates both the short and long term effects of sludge application.

Research in Minnesota

Land application of human wastes is a national and international research topic. Because of the variability of sludges and environmental conditions around the world, case-specific studies offer the best way to evaluate landspreading of sludge. Researchers in Minnesota began studies on land application of sludge in the early 1970's amid the uprising environmental awareness. In addition to adding to our general knowledge of sludge utilization, Minnesota research represents the cool, humid portion of the United States with its geologically young soils and landscapes.

Research on land application of municipal sewage sludge in Minnesota was initiated by the United States Department of Agriculture — Agricultural Research Service (USDA-ARS) Soil and Water Management Unit, North Central Region, with cooperation and support from the Twin Cities area Metropolitan Sewer Board (now the Metropolitan Waste Control Commission), the University of Minnesota and the Minnesota Agricutural Experiment Station, and the USDA Soil Conservation Service.

Several experiments with municipal sewage sludge have been undertaken in Minnesota (some are currently still underway). These studies were established to answer questions about the effects of different types of sludges and rates of application on crop yield/quality. Of the experiments mentioned below, this report presents the Rosemount Watershed study in detail.

The Rosemount Watershed study is the longest on-going *liquid sewage sludge* research project in the state and possibly the country. As its name implies, it is based on the realistic idea that sludge is applied on large, field-sized areas within watersheds. In essence, it is a study of nutrient and trace metal uptake by crops from sludge-treated land in comparison to fertilized control areas. Important information has been gathered on runoff/erosion and groundwater quality. Overall, it is a demonstration of a land application system finely tuned to safely utilize sludge while taking full advantage of the agricultural benefits of the material.

The Elk River / Becker experiments were a series of important studies using three different *liquid sludge* types (aerobically digested, anaerobically digested, and primary-settled, waste-activated) and a *dried* sludge (anaerobically digested). The primary reason for the scientific design, small plots on a sandy soil under irrigation, was to evaluate each sludge as a source

Info Box

The waste treatment process

The wastewater treatment process is part of the cycle of water use in communities. Raw sewage flows through pipe networks to a central processing plant for treatment. The treatment process can be broken into three general categories. Primary treatment consists of shredding/ homogenizing the raw sewage and then allowing the solids (often including sand and gravel if storm sewers are not separated from residential sewers) to settle out of suspension. Secondary treatment is variable but generally consists of allowing microbes (bacteria) to decompose suspended and dissolved organic compounds in the presence of air (oxygen). The wastewater contains an organic component which ranges in its ability to be decomposed by the bacteria. The more resistant organic compounds and the short-lived bacterial bodies eventually settle to the bottom of the secondary treatment facility. The semi-fluid material scraped from the bottom is termed sludge (a word derived from mud or ooze for any heavy, slimy sediment). The sludge and the treated water travel different routes. The sludge must be disposed of somehow. The effluent may be released to a stream or enter a tertiary treatment phase. Tertiary treatment consists of removing inorganic (not organic) dissolved elements such as phosphorus and nitrogen by largely physico-chemical methods.

of nutrients for crops. Various rates of sludge were applied to plots for four years while growing a corn crop. Four more years of corn were grown on the plots with no sludge application. Important information on the rate of sludge decomposition and nitrogen release in soil were obtained for the sludge types by these experiments. Another set of plots with dried sludge focused on trace metal uptake by vegetable crops.

Additional experiments were conducted on the Rosemount Experiment Station to determine the effects of *processed sludges* on crop yield/quality. The Limecake (filter-cake) experiment evaluated the effect of a dewatered, high lime municipal sewage sludge on soil, soil water and crops. The Plate and Frame experiment looked at the same effects of another type of dewatered sludge.

Finally, current interest in *composted sludge* has generated experiments in this area. Municipal sewage sludge is added to other materials, often wood chips or solid waste, and composted for a short time. The product is a stabilized mixture which is more easily handled. The effect of composted

Info Box

Sludge disposal methods

The sludge that is removed from primary and secondary treatment processes is either disposed of immediately, stored, or further processed. Of the many ways sludge is processed, in general the first step is to de-water or concentrate the sludge. Large and expensive equipment has been employed to spin (centrifuge) out the water, press out the water through screens and filters, or evaporate the water by heat and/or vacuum methods. Removing excess water is important if the sludge is to be transported far from the source, to be bagged and sold as a soil amendment, or to be incinerated. Only large municipalities can afford de-watering equipment and incineration. Smaller systems must handle the liquid sewage sludge. The sludge may be stored in lagoons or directly applied to land by spreading it over the surface or injecting it into the soil.

sludge on soils/crops is quite different than other sludge types. Numerous microbiological studies have added to our knowledge in this area.

Role of Soil Science

Soil science is one of the natural sciences, a relatively recent discipline, with roots in both agronomy/crop science and geology. Soil scientists view the weathered zone of the earth's crust that is affected by biological activities (rarely more than a one meter below the surface) as a collection of unique, dynamic entities. These entities, kinds of soil, vary locally and worldwide in physical and chemical properties.

Soil scientists study the intrinsic properties of soils and how soils react to use and management. There are five commonly recognized sub-disciplines within soil science. *Soil physicists* study the mechanisms of air, heat, and water flow through soils in relation to soil physical characteristics like the type, size, and composition of soil individual particles and aggregates. *Soil chemists* study the unique reactions inherent in a complex inorganic/organic environment. *Soil fertility* experts examine the response of plant growth/yields to mineral nutrition and soil management. *Soil genesis and classification* scientists study the mechanisms of soil formation and group soils by important soil properties so that research performed on one soil may be extrapolated to similar soils. *Soil microbiologists* study the important groups of microorganisms which are an essential component of the soil biosphere. Other specialists in soil science include *soil mineralogists, forest soils scientists, soil/range scientists, microclimatologists* and others.

Soils are so diverse and complex internally that often a working group of soil scientists from several sub-disciplines form to answer specific questions. Several questions relevant to land application of municipal sewage sludge are listed below:

- What happens to sludge-applied metals, nutrients, and other sludge constituents?
- What happens to the quality of the soil and water flowing through the soil in sludge application areas?
- What is the fertilizer value of sludge; what kinds of crop yields might be expected?
- Do crops take-up metals which then enter the food chain?
- What are background levels of elements in natural soils?

These and many more questions are ideally suited for study by those trained in the discipline of soil science.

Purpose of this Report

The purpose of this report is to address agronomic and environmental issues concerning the application of municipal sewage sludge to agricultural land. Data has been compiled, summarized, and evaluated for one of the Minnesota land application experiments in regard to these issues.

Rosemount Watershed Study

The Rosemount Watershed study was initiated in 1973 on land owned by the University of Minnesota as part of the Agricultural Experiment Station near Rosemount, Minnesota. The summary of data from this long term study is the primary purpose of this publication on land application of municipal sewage sludge.

There were numerous, scattered studies on land disposal of sewage sludge prior to 1973 in the USA. The justification for further study on the subject was three-fold. First, there was evidence that sludge composition influenced experimental results, and it was known that sludge composition was quite variable among the studies. Second, climatic conditions in Minnesota were different from those where other studies were located, e.g. microbial activity ceases a third of the year due to cold temperatures. Third, soils, waters, and crops would be studied on a larger scale and for a longer time than most other experiments. Therefore a study was begun to demonstrate methods of applying liquid sewage sludge to agricultural lands in Minnesota using sludge from local sources.

Goals and Objectives

The primary goal of the study was to increase our knowledge about effects of *liquid sewage sludge* on surface and groundwater quality, crop yield and quality, and soils over the long term. Here, long-term means about 20 years, of which about 14 years of research has been completed. Twenty years is an arbitrary number for a long-term study but is a window wide enough for the sludge, crops, and soils to experience natural variations in climate. It is hoped the time is long enough to show subtle, but important, trends, if they are present. An uninterrupted study also allows us to evaluate changes in management practices. In a study with a historical management record, increasingly more valuable and valid information is received as the experiment proceeds.

Specific objectives of the study were to:

- Collect, mix, and apply liquid sewage sludge from local sources to land

for the production of corn and grass crops.

- Construct a water diversion terrace system that served a dual purpose. First, the terraces protected the site from excessive soil erosion and runoff. Second, the terrace channel outlets allowed measurement of water runoff, sediment loss, and chemical movement in surface waters following snowmelt or rainfall events.

- Grow two types of crops. Corn (*Zea mays* L.) was selected because it is a common crop for animal feed grain and silage in the region. It is the most probable crop to be grown on sludge-amended soil due to its profitability. The other crop used in this study, because of its known ability to utilize large amounts of nitrogen and provide a high-protein forage crop, was reed canarygrass (*Phalaris arundinacea* L.). Yields of these crops grown on commercial-fertilized control areas was compared to those of sludge-amended areas.

- Analyze plant tissue of both crops for elements considered essential for plant growth or considered undesirable in the food chain. Plant tissue analysis would show any nutrient imbalance or deficiency resulting from the treatments. Elemental composition could be directly compared between plants from sludge and fertilized control treatments. Total amounts of elements removed from the site by cropping could be compared to total elements applied by the sludge or fertilizer.

- Monitor shallow and deep groundwater quality. Also monitor water extracted from unsaturated, but moist, soil for compounds that might be moving through the soil profile with percolating water. The monitoring would consist of periodically sampling and analyzing the water at various locations and depths in the watershed.

Taken together, these operational objectives give us a complete picture of how annual applications of liquid sewage sludge affect the crop-soil-water ecosystem.

Site Selection and Construction

A research site was selected on a portion of the University of Minnesota's Rosemount Experiment Station in southeastern Minnesota (Legal description: NE 1/4 SE 1/4 Section 10, Range 19 West, Township 114 North; Empire Township, Dakota County, Minnesota, USA). Enough land was available to encompass an entire small watershed basin (about 40 acres; 16 ha) and build the necessary support facilities outside of the basin. There were several advantages in locating the research site on land owned by the University

of Minnesota Agricultural Experiment Station. Planting and harvest assistance has been provided by the Rosemount Experiment Station. The site offered more security for equipment and crops. Also, the preservation of a long term experiment was ensured.

Climate / geology / soil

The climate is typical of mid-continental, humid regions with four distinct seasons (44°42' Latitude; 93°05' Longitude). Precipitation averages 30 inches (760 mm) per year. About 70 percent falls as rain during the growing season of most crops. Average annual air temperature is 44°F (7°C). The record high temperature, recorded by the US Weather Service 7 miles (11 km) to the south at Farmington Minnesota, was 99°F (37°C) and the record low was -36°F (-38°C). **Table 1** summarizes the climate for the period 1951 to 1974. Growing season length is about 137 days. Extreme meteorologic conditions sometimes occur during the growing season and affect crop yields. These extremes include thunderstorms (an average of 36 per year) with associated high winds, hail, and short duration, high intensity rainfall (record rainfall in a 24-hr period was 5.1 inches). Prevailing winds are northwesterly. Average relative humidity is about 60 percent. Clear skies occur about 65 percent of summer days.

Conversions:

Fahrenheit to Celsius
°C = 5/9 (°F - 32)

Celsius to Fahrenheit
°F = 9/5 (°C) + 32

Inches to Centimeters
cm ≐ 2.54 (inches)

Table 1. Climatic data 1951—1974 Farmington, Minnesota.[1]

Month	Average daily temperature (°F)	Average growing degree days[2]	Average precipitation (cm)	Average snowfall (cm)
January	11.5	0	1.9	19.8
February	17.3	0	2.5	21.8
March	28.7	12	4.4	27.2
April	45.6	48	5.6	5.6
May	58.1	269	9.0	0.2
June	67.7	531	11.9	0
July	71.6	670	10.9	0
August	69.6	608	10.1	0
September	60.1	307	7.1	0
October	50.3	140	5.6	0.8
November	33.2	0	3.4	9.9
December	18.9	0	2.6	21.1
Year	44.4	2585	75.1	106.4

[1] Source: Hundley (1983).

[2] Growing degree day is a unit of heat available for plant growth.

The site is located in an area of complex glacial moraine deposits. The gradient of slopes in the watershed range from 1 to 10 percent. Soils on the site formed in a wind-deposited, silty loess which overlays dense glacial till. Elevation is about 1000 feet (305 m) above mean sea level. Local relief (vertical distance between top and bottom of hills) is about 40 feet (12 m).

Diversion terraces with tile outlets

Slopes on the Rosemount Watershed are about 600 feet (180 m) long and up to 10 percent gradient making them susceptible to runoff and erosion. In addition to the detrimental removal of surface soil by water erosion, surface-applied sludge would likely be washed off the upper slopes. Therefore, parallel graded terraces were constructed prior to sludge application at this site.

INFO BOX

Parallel terraces are parallel to each other, not necessarily to the slope contour, to eliminate inconvenient point rows. They consist of an embankment with a graded channel on the up-slope side designed to safely carry runoff to an outlet. Terrace ridge side-slopes and channel depth increase with increasing land slope making it difficult to farm over terraces built on slopes greater than about 6 percent. Rosemount Watershed terraces were designed to safely handle a 2.5-inch (6.4-cm) runoff event without overtopping.

Outlets for graded terraces are usually grassed waterways or tile lines. Grassed waterways are a vegetated channel designed to take terrace water safely down the hill. Tile lines have open surface inlets at a low spot in the terrace channel and move the water underground to a lower position on the landscape. The Rosemount Watershed terraces were constructed with surface inlets (**Fig. 1**).

Backslope Terrace Cross-section

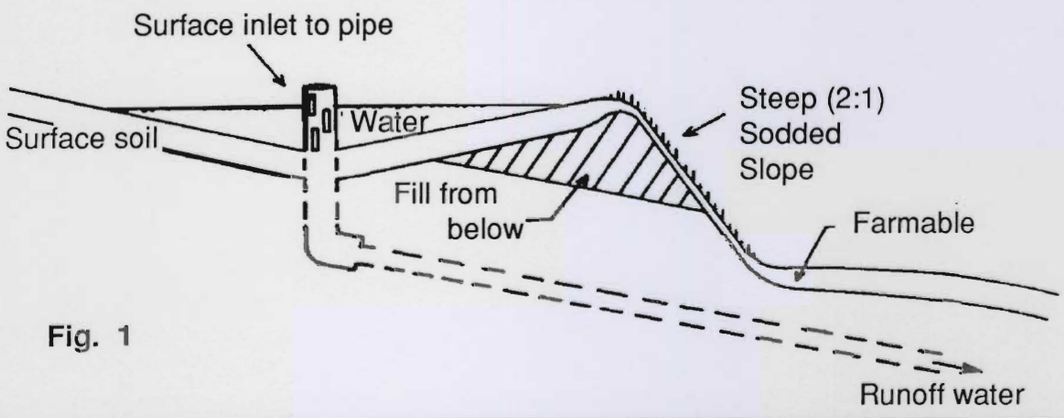


Fig. 1

Runoff Sampling Solid PVC pipe was the conduit used for the terrace outlet "tile" lines in the Rosemount Watershed study. Lines from individual terraces terminated in gauging/sampling instrument boxes. Total surface water runoff, following snowmelt and rain storms, could be measured from each terrace. Samples of the runoff could also be taken for laboratory analysis.

Site plan map

The site map shows the location of terraces and support facilities at the Rosemount Watershed study area (**Fig. 2**). Also shown are permanent sample stations and wells.

Water reservoir

At the very lowest position of the watershed a storage reservoir was constructed to receive all watershed runoff. The reservoir was constructed to hold the equivalent of a 100-yr frequency storm (4.4 inches of runoff). The 10-yr frequency water storage pool was lined with plastic to limit seepage. Accumulated runoff would be periodically pumped from this pool to irrigate grass on the northwest terraces of the watershed. Water has never overtopped the reservoir dam.

Support facilities

On-site facilities needed to operate the sludge application study were constructed next to the terrace system, outside of the watershed basin. These facilities included storage lagoons, electric lines, roads, and a water well. Two liquid sewage sludge storage lagoons were built on a hilltop adjacent to the south edge of the watershed. Each was of earth construction with mechanically compacted bottom and sides. Storage capacity of each lagoon was 1.5 million gallons (5678 m^3) or enough to allow winter delivery of sludge for prompt spring application and efficient fall application. Lagoon II, the east-most lagoon, was lined with plastic although it was felt that the unlined lagoon, Lagoon I, would be effectively sealed by sludge against leakage.

Methods and Materials

It is an understatement to say that a lot has gone on at the Rosemount Watershed over the last 15 years. A great deal of effort has been put into the management of the crops alone. More effort was placed on research sampling and sample analysis.

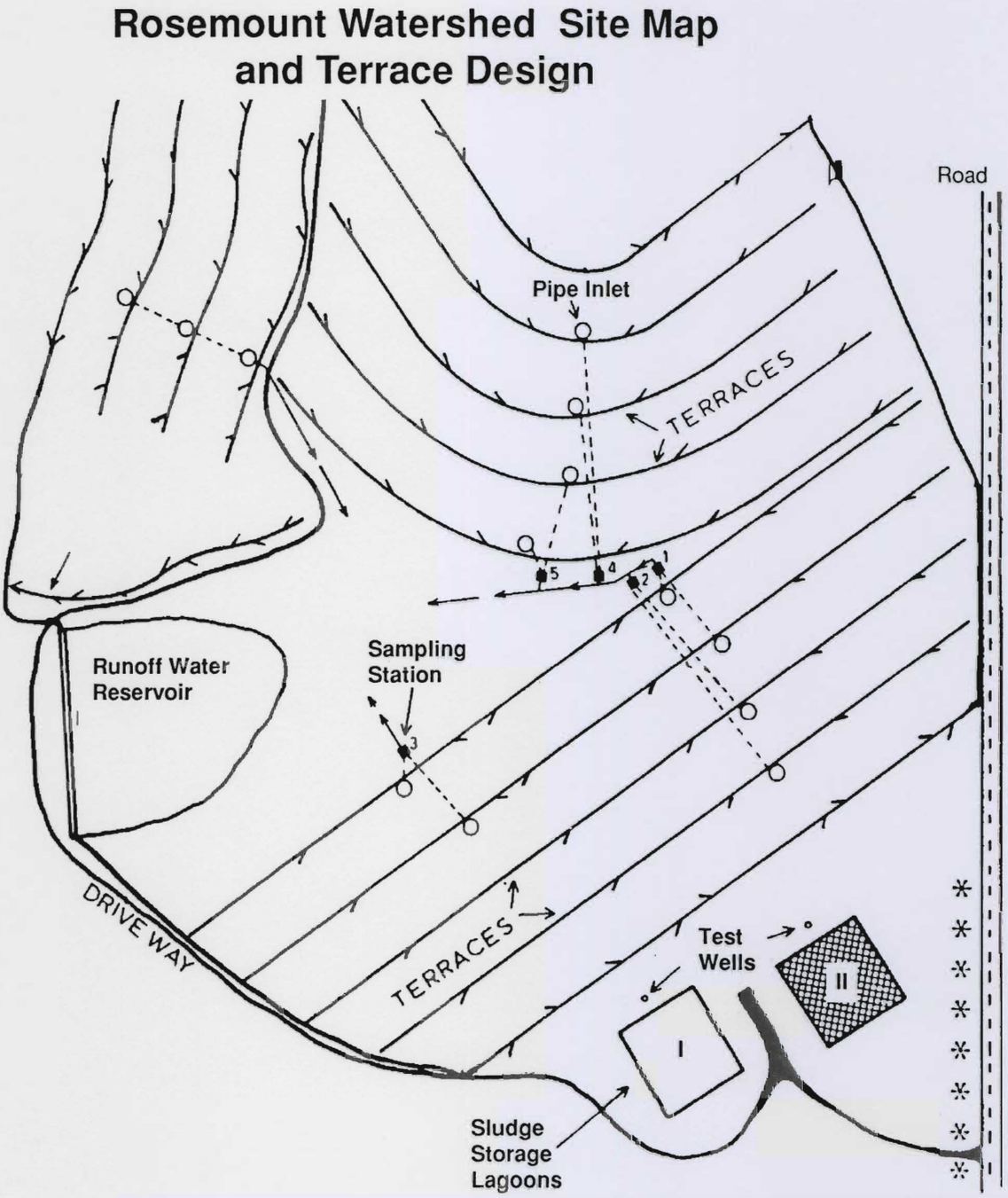

Rosemount Watershed Site Map
and Terrace Design
Road
Pipe Inlet
TERRACES
Runoff Water
Reservoir
Sampling
Station
DRIVE WAY
TERRACES
Test
Wells
II
I
Sludge
Storage
Lagoons

Fig. 2

Unlike rigidly controlled experiments, those conducted in a growth chamber or greenhouse, some of the methods and materials in this field experiment have changed over time. Reasons for these changes vary and will be discussed in the following sections.

Sludge sources and delivery

Liquid sewage sludge was delivered by tank truck to the Rosemount Watershed site from eight different wastewater treatment plants. Some of these plants have been closed and consolidated since the start of the experiment. Over 80% of all sludge brought to the site has been from three municipalities: Hastings, Apple Valley, and Cottage Grove. **Table 2** contains a breakdown of sludge delivered to the watershed. It should be noted that an initial gross estimate of sludge to be applied was 6 inches over 35 acres or about 6 million gallons (22,700 m^3) per year. Sludge deliveries approached this amount only one year during the project.

Amount

Volume of sludge delivered was variable over the study period. Apple Valley only delivered sludge during the first 5 years of the study but still contributed 30% of the total volume trucked to the site. Hastings and Cottage Grove delivered sludge every year sludge was required for the project. No sludge was requested or delivered in 1983 and 1986. In 1983, the project leaders decided not to apply sludge prior to the 1984 crop year. In 1986, a one-year moratorium on sludge-spreading was self-imposed by the Metropolitan Waste Control Commission for public review of the project. A total of 29.9 million gallons (113,195 m^3) of liquid sewage sludge was delivered to the site from 1973 to 1987.

Table 2. Liquid sewage sludge delivered to the Rosemount Watershed.

Wastewater[1] Treatment Plant	Year												Total	Percent
	1975[2]	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986		
	m^3													
Hastings	4090	7370	8980	5770	3430	2490	4300	1410		3318	702		41860	36.98
Lakeville	280	70	370	740									1460	1.29
Farmington	2790	1550	490	740	1070								6640	5.87
Apple Valley	4190	3480	12560	7200	7050								34480	30.46
Cottage Grove	1100	2100	1320	1060	1090	1840	4330	1930			230		15000	13.25
St. Paul Park	90												90	0.08
Blue Lake	2010												2010	1.78
Empire										5375	6280		11655	10.30
Total	14550	14570	23720	15510	12640	4330	8630	3340	0	8693	7212	0	113195	100.0

[1] Hastings, Lakeville, and Farmington used an anaerobic treatment process while Apple Valley sludge was from an aerobic process and Cottage Grove sludge was from both processes.

[2] Includes volume of sludge delivered starting November 1973. [Note that 264.17 US gallons = one cubic meter.]

Composition of sludge delivered

Samples of the *liquid sewage sludge* were collected from every truck load delivered. A composite sample was made by mixing individual samples from each plant for a month. Monthly laboratory values for these composite samples were averaged and reported as the sludge composition for each year.

Liquid sewage sludge was tested for 23 characteristics and components. A liquid subsample was analyzed for total solids, volatile solids, total nitrogen, ammonium nitrogen, electrical conductivity, and pH (reaction). A freeze-dried subsample was analyzed for 9 major components of sludge (percentage of organic matter, total carbon, total phosphorus, potassium, calcium, magnesium, sodium, aluminum, iron) and 8 trace elements (chromium, copper, zinc, lead, manganese, boron, nickel, cadmium).

Composition of sludge was variable among the wastewater plants and, for some components, with time from any one plant. **Table 3** presents arithmetic means of sludge properties from the three major contributing plants to the project and the overall arithmetic mean for all contributors. The values shown

Table 3. Composition of liquid sewage sludge delivered to the Rosemount Watershed.[1]

Component[2]	Wastewater Treatment Plant						All Plants	
	Apple Valley		Cottage Grove		Hastings			
— % of liquid sample —								
Total solids	1.93	(0.09)	2.59	(0.43)	2.90	(0.65)	2.98	(1.09)
Volatile solids	1.29	(0.07)	1.50	(0.34)	1.70	(0.37)	1.76	(0.52)
Total Nitrogen (mg L^{-1})	1336	(64)	1480	(312)	1790	(285)	1786	(562)
NH_4-N (mg L^{-1})	351	(23)	660	(182)	743	(230)	751	(417)
EC (dS m^{-1})	3.55	(0.08)	5.63	(0.88)	5.80	(1.18)	5.56	(1.95)
pH (pH units)	7.28	(0.04)	7.91	(0.06)	7.81	(0.32)	7.76	(0.32)
— weight % of dry total solids —								
OM	70.78	(0.25)	58.14	(6.05)	59.92	(1.97)	60.93	(5.40)
C	39.30	(1.51)	30.04	(2.87)	30.92	(1.28)	32.25	(3.59)
P	2.14	(0.08)	2.59	(1.06)	2.97	(0.69)	2.65	(1.18)
K	0.44	(0.05)	0.28	(0.12)	0.32	(0.06)	0.51	(0.51)
Ca	2.68	(0.04)	3.66	(1.42)	3.79	(0.17)	3.98	(1.97)
Na	1.48	(0.13)	1.76	(0.94)	1.41	(0.30)	1.25	(0.68)
Mg	0.52	(0.05)	0.53	(0.20)	0.56	(0.07)	0.57	(0.22)
Al	0.55	(0.10)	0.86	(0.37)	1.50	(0.38)	0.86	(0.53)
Fe	0.61	(0.11)	0.49	(0.22)	0.56	(0.10)	0.57	(0.26)
— mg kg^{-1} of dry total solids —								
Cr	27	(3)	586	(1546)	8409	(4458)	2582	(4312)
Cu	644	(44)	392	(103)	1519	(740)	767	(620)
Zn	783	(45)	1047	(69)	866	(365)	947	(288)
Pb	120	(4)	134	(57)	252	(70)	853	(2019)
Mn	183	(31)	189	(73)	143	(33)	236	(237)
B	37	(11)	28	(14)	31	(15)	28	(13)
Ni	11	(2)	30	(14)	16	(6)	22	(13)
Cd	9	(1)	8	(1)	6	(2)	8	(4)

[1] Arithmetic mean over years delivered; refer to Table 2 and text; standard deviation in ( ).

[2] NH_4-N, ammonium nitrogen; EC, electrical conductivity; pH, reaction; OM, organic matter; C, total carbon; P, phosphorus; K, potassium; Ca, calcium; Na, sodium; Mg, magnesium; Al, aluminum; Fe, iron; Cr, chromium; Cu, copper; Zn, zinc; Pb, lead; Mn, manganese; B, boron; Ni, nickel; Cd, cadmium.

here illustrate the differences and similarities among the plants (the mean value) and the annual variation which occurs in sludge from a plant (the standard deviation). (This does not accurately reflect the actual composition of mixed sludge in the lagoons because it is not weighted by the volume delivered from the plant.) More detailed information on sludge delivered to the Rosemount Watershed is presented in **Appendix A**.

Total solids in *liquid sewage sludge* deliveries to the site were about 3% on the average. Apple Valley sludge had only about 2% total solids, but proportionately greater organic matter in the solids. The nature of organics in the sludges were not characterized, but aerobically digested sludge generally has organics that are less stable than anaerobically digested sludge. The sludges were very similar among wastewater plants and over time with respect to major inorganic components (P through Fe). Trace metals, however, are much more variable among plants and over time. Notable are levels of Cr, Cu, and Zn among the three major contributors. Overall, Pb means are biased by a high Pb sludge from Lakeville early in the experiment (Refer to **Appendix A**). The majority of material delivered to the site can be characterized as a *low Cd sludge*, with levels less than 10 mg kg^{-1}.

Comparison to other liquid sludges

To give perspective to the trace metal values, typical levels found in sludge are presented in **Table 4**. Trace metal levels delivered to Rosemount were fairly typical of most municipal sewage sludges with the exception of Cr. Polychlorinated biphenyls (PCBs) were tested for two years in the sludge delivered from Hastings and Cottage Grove. Levels were 1.4 and 1.6 mg

Table 4. Representative values of components in sewage sludge.

Component	Median Sommers[1]	Typical US EPA[2]
Fe	17000	28000
Cr	500	230
Cu	800	410
Zn	1700	678
Pb	500	248
Mn	260	—
Ni	80	45
Cd	10	8.2
PCB	—	0.99

[1] Source Sommers (1977).
[2] Source US EPA (1985).

kg^{-1} from Hastings for 1980 and 1981, respectively. PCB levels were 1.7 and 1.3 mg kg^{-1} in Cottage Grove sludge in 1980 and 1981, respectively.

Currently, there is no standard classification system for sludge materials. The metropolitan area sludges were generally "good" for agricultural application. "Good" meaning that the sludges were neutral to slightly alkaline, low to medium in salt and Na content, contained balanced plant nutrients, and had low amounts of most trace metals, especially Cd.

Investigation of site geology and soils

A soils and geology investigation was conducted at the site in 1986 by Dr. Harlan R. Finney, a soil geomorphologist. The purpose was to document the earthen materials present in the watershed and interpret the influence of these on subsurface water movement.

Geologic sequence

Five borings were made to 28–35 feet deep (8.5-10.5 m) and four more 6–10 feet deep (1.8-3.0 m) in the watershed area. The youngest sediment is the 5–20 feet (1.5-6.1 m) thick wind-deposited silt (loess) which covers glacial till. Measurements of the till indicate a very high density (low porosity, slow hydraulic conductivity) material. The only exception to the silt-over-till sequence is in the main watershed drainageway where a placer of sand and gravel about 8 feet thick is located about 10 feet (3 m) below the silts, but above the till.

Water movement

Water that enters the soil percolates downward through the silts (gravitational water) but can not readily enter the dense till. Instead a portion of it flows laterally underground "downhill" along the silt-till contact to the lowest portions of the watershed where it enters the sand placer. Water remains perched on the dense till and is not able to move directly from the surface to the deep groundwater aquifer (St. Peter sandstone), which underlies the till, at a depth of 120–140 feet (36-43 m), at this site.

Soil series

Soils on the site have formed in the silty surface mantle. A number of different soils were identified in the watershed. These soils form a complex pattern in response to landscape position. Major soils on the convex hilltops and upper side slopes are Tallula series (coarse-silty, mixed, mesic Typic Hapludolls). These soils have a naturally dark surface horizon. Subsurface horizons are only slightly different from the buff-colored silty parent material. Subsoil horizons are redder in color and structural aggregates are better expressed. On the side-slopes, the dominant soils are Port Byron series (fine-silty, mixed, mesic Typic Hapludolls). Port Byron soils have received enough run-on water to form a thick soil with a subsurface horizon that has greater

clay content than the parent material. The major soils in the lower drainageways are Colo series (fine-silty, mixed, mesic Cumulic Haplaquolls). The dark surface horizon of Colo soils is up to 4-feet thick. They are poorly drained with a perched water table at a depth of 2 feet in most years.

Soils in the Rosemount Watershed study area are representative of medium-textured soils important to non-irrigated agriculture in southern Minnesota. Unlike other studies, where sludge was applied to irrigated sandy soils, this study more nearly approximates dryland farming systems which need medium to fine textured soils for sustained agricultural production.

Plant materials

Field corn (*Zea mays* L.) and reed canarygrass (*Phalaris arundinacea* L.) were the two crops grown on the watershed. About one-half of the watershed was devoted to corn and one-half to grass. The two crop system was implemented so that sludge could be applied during the growing season. A short-season corn hybrid was selected so that corn could be removed early to allow fall sludge application. Corn hybrids and seeding rates changed over the course of the experiment. The varieties used in the Rosemount Watershed study were those in common use by area farmers.

Equipment

Large scale sludge application experiments like the Rosemount study require both farm implements and scientific equipment. Most of the specialized field equipment was acquired in the early 1970's and has not been upgraded to take advantage of new technology, especially in sludge application techniques.

Lagoon agitation and pumping equipment

The general procedure for handling the sludge was tied to the on-site lagoon storage system. Sludge was delivered to the west lagoon. Sludge solids settled to the lagoon bottom and needed to be re-suspended immediately prior to application to the land. A tractor-driven pump was used to agitate the sludge by recycling.

In normal operation, liquid sludge was pumped from the west lagoon to an underground irrigation pipe extending across the watershed (**Fig. 5**). Sludge could be transferred underground to an outlet valve near any cropped terrace. Above-ground irrigation pipe and a flexible hose was connected to the valve.

Field application equipment

The flexible hose was connected to either a traveling-gun (**Fig. 3**) irrigation unit (grass areas) or a soil injection toolbar (**Fig. 4**) pulled by a track-type tractor (corn areas). These applicators were not in service during the project's first year (1974) so sludge was applied by tank wagon spreader. A dis-

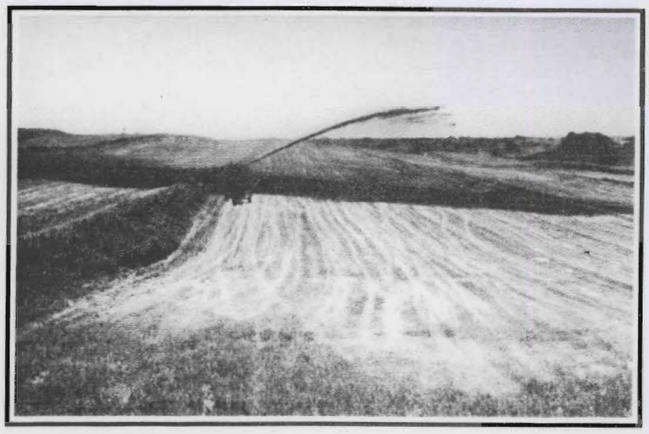


Fig. 3 Traveling gun irrigation unit applying liquid sewage sludge to grass.

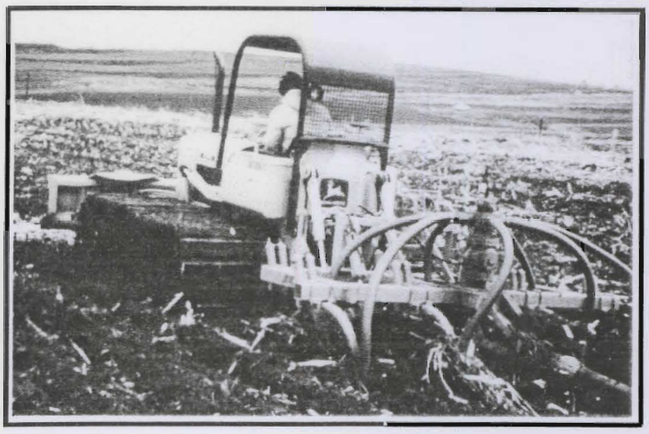


Fig. 4 Injection toolbar applying liquid sewage sludge to corn treatment areas.

advantage of surface application (tank wagon and overhead irrigation) versus injection is that soil infiltration rates limit application rates. Too rapid an application rate (greater than about 1.1 cm ha^{-1} h^{-1}) caused surface flow of sludge toward the terrace channel. Injection rates greater than about 1.5 cm ha^{-1} h^{-1} caused surface flow with the light-weight injection equipment used. Injection depth was 3 to 6 inches (8- to 15-cm). Tile inlets were sealed during sludge application to prevent direct contamination of surface waters. Also, to prevent off-site travel of aerosols, application with the traveling-gun irrigator was limited to times when wind speed was less than 5 mph (8 km h^{-1}).

Sampling and harvest equipment

For applications by traveling overhead sprinkler, sludge samples were collected in plastic pans at three sites on each of three sampling lines (**Fig. 5**) and composited for each grass treatment area. For subsurface injection applications, samples were taken from a manifold valve during injection over each of three sampling lines (**Fig. 5**) and composited for each corn treatment area.

Water from runoff events on each area was collected in the permanent sampling stations by automatic samplers modified to begin collection when water flow started and at 1-h intervals during runoff. Flow rates were measured by water stage recorder with slotted tube and stilling well.

Soil water was sampled with porous ceramic samplers (See Info Box) installed at 60-cm and 150-cm depths at 24 sites. Duplicate samplers were installed at each depth. Sampling sites were located in the terrace channel and at the mid-terrace. Samples from 12 shallow groundwater monitoring wells within the watershed were collected monthly initially and less frequently in later years. Background samples from various water sources, both within and around the watershed, were taken bimonthly for the 1973 season before any sludge was applied on the project site.

Specialized laboratory equipment

Once in the laboratory, samples were prepared for analysis and then analyzed on various specialized pieces of equipment, depending on the component of interest. Some of the equipment included high temperature furnaces, emission and atomic absorption (AA) spectrometers, automatic chemical analyzers, and inductively coupled plasma (ICP) spectrometers.

Meteorological equipment and methods

Temperature, precipitation, and pan evaporation information were recorded on-site, at the nearby experiments, or at the Experiment Station headquarters. During the growing season, rainfall and pan evaporation were measured on-site by recording rain gauge and standard US-Weather Service pan, respectively. Minimum and maximum daily temperatures were recorded.

Sampling methods

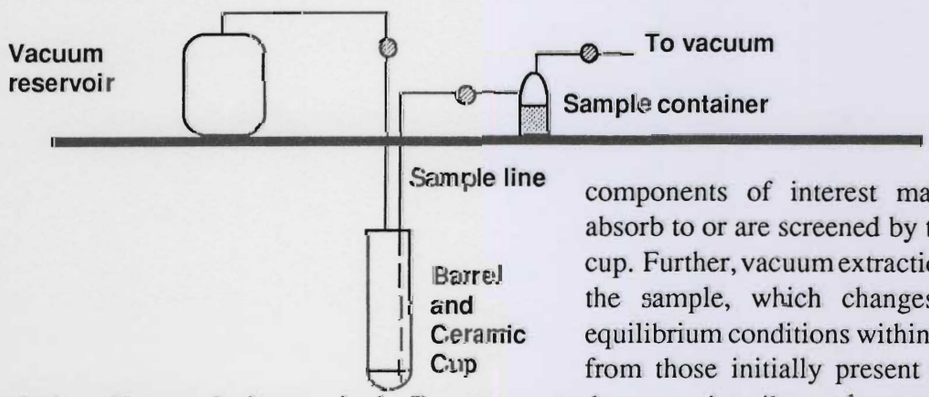
Corn leaf samples (center one-third of leaf below and opposite the primary ear) were taken at 75% silking stage along three permanent sampling lines of each corn area. Corn was harvested at late dent stage. Ears were picked, then, the rest of the plant (stover) was chopped. Composite samples were taken from 15-m of row (10 rows, 1.5-m long) on the permanent sampling lines. Reed canarygrass samples were harvested three times a year — early June, mid-July, and early September. Plots of 0.9-m by 6.1-m were sampled at three sites (in the terrace channel, at the mid-terrace interval, and near the upper terrace interval) along 3 sampling lines of each grass area.

Info Box

Porous ceramic samplers, also known as *vacuum lysimeters*, are devices to extract water from moist soil. They are constructed of an unglazed, cup-like ceramic tip connected to an inert plastic barrel and sealed at the opposite end to form a chamber. A vacuum line from the sampler may be connected to a vacuum pump or vacuum reservoir. Sample tubing extends to the tip of the sample cup. The sampler tip is installed in an augered hole at the desired depth in the soil being sure the tip is in contact with an envelope of silica flour which provides contact with undisturbed soil. The hole around the sampler barrel is backfilled and tamped with the material excavated from the hole. The sampler barrel may extend to the surface or the whole sampler may be buried. Specially constructed samplers must be used to sample depths below about 10 feet (3 m).

In a typical configuration one or several *vacuum lysimeters* are connected to a vacuum reservoir evacuated to about a negative 0.6 bar (-60 kPa) pressure. The negative pressure within the sampler draws water being held by unsaturated, moist soil in small pores (mesopores) through the ceramic and into the sampler tip cavity. Because the rate at which water moves through soil at higher tensions (drier soil) can be quite slow, usually samples are collected at 24 h or more after a vacuum is applied. Samples are often brought to the surface by releasing the vacuum in the sampler barrel. A sample container is placed in-line before a vacuum pump and the sample is drawn up. An alternative, and better, way is to apply a slight positive pressure to the sample thus forcing it up the sample line to a transport container.

The *vacuum lysimeter* is a widely-used apparatus to extract **in-situ** ("in place") soil water samples for environmental monitoring. It does have limitations, the most severe being the narrow range of water able to be extracted (relatively moist soil) and the undefined volume of soil being sampled. Other questions involve the integrity of the water sample. Some components of interest may strongly absorb to or are screened by the ceramic cup. Further, vacuum extraction degasses the sample, which changes chemical equilibrium conditions within the sample from those initially present in the soil solution. Vacuum lysimeters in the Rosemount study were primarily used to sample nitrate-nitrogen, which is relatively unaffected by ceramic extractors. Fritted glass and porous Teflon extractor cups are available that offer advantages, but ceramic cups are commonly used due to their lower cost and durability.



Analysis techniques

Water and sludge samples were refrigerated immediately after collection. Analyses of organic components were performed within one week or the samples were acidified. Soil samples were air-dried at 35°C. Plant samples were oven-dried at 65°C.

For sludge, total and volatile solids were determined at 105°C and 550°C, respectively. Total nitrogen and ammonium-nitrogen (NH_4-N) were determined on liquid samples by the micro-Kjeldahl procedure involving digestion, distillation, and titration. Electrical conductivity was measured by a resistance method. Potentiometric methods were used for pH measurement. Organic matter was estimated by heating a subsample at 650°C for 2 h. Total carbon was measured with a Leco carbon furnace. Total P, K, Ca, Mg, and trace metals were determined by dry-ashing at 450°C for 24 h. The ash was extracted with 2.0 *M* HCL (hydrochloric acid) and the extract analyzed by emission or AA spectroscopy. Unlike other early sludge studies, background correction was always applied to AA analyses for greater accuracy (Pb, Mn, Cu, Cr, Cd, Ni). This correction is especially important for low levels of Cd.

For water samples, total N and total P (after digestion), NH_4-N (ammonium), NO_3-N (nitrate), and PO_4-P (orthophosphate) were determined colorimetrically by Technicon AutoAnalyzer. Analyses for Na, Ca, Mg, and K were performed by ICP or AA. Conductivity, pH, and fecal coliform counts were determined by standard procedures.

Soil tests

Composite soil samples were sent to the University of Minnesota soil testing laboratory for evaluation of available plant nutrients.

Experimental design

An experimental design is a plan of action drafted before any field work is done. A researcher tries to foresee and avoid pitfalls and conflicts in the field. In addition to planning the preliminary materials and the logistics of operation, experimental designs include ways to test the results statistically.

Experimental design at the Rosemount site was inextricably tied to the terrace system. **Fig. 5** is a diagram of treatment areas at the site. Terrace intervals were treated as separate areas. These areas were to be used as replicated blocks of the treatments.

Unfortunately, topography and soils are highly variable within terraces. Conventional statistical inference methods, using the replicated block design

Rosemount Watershed treatment areas

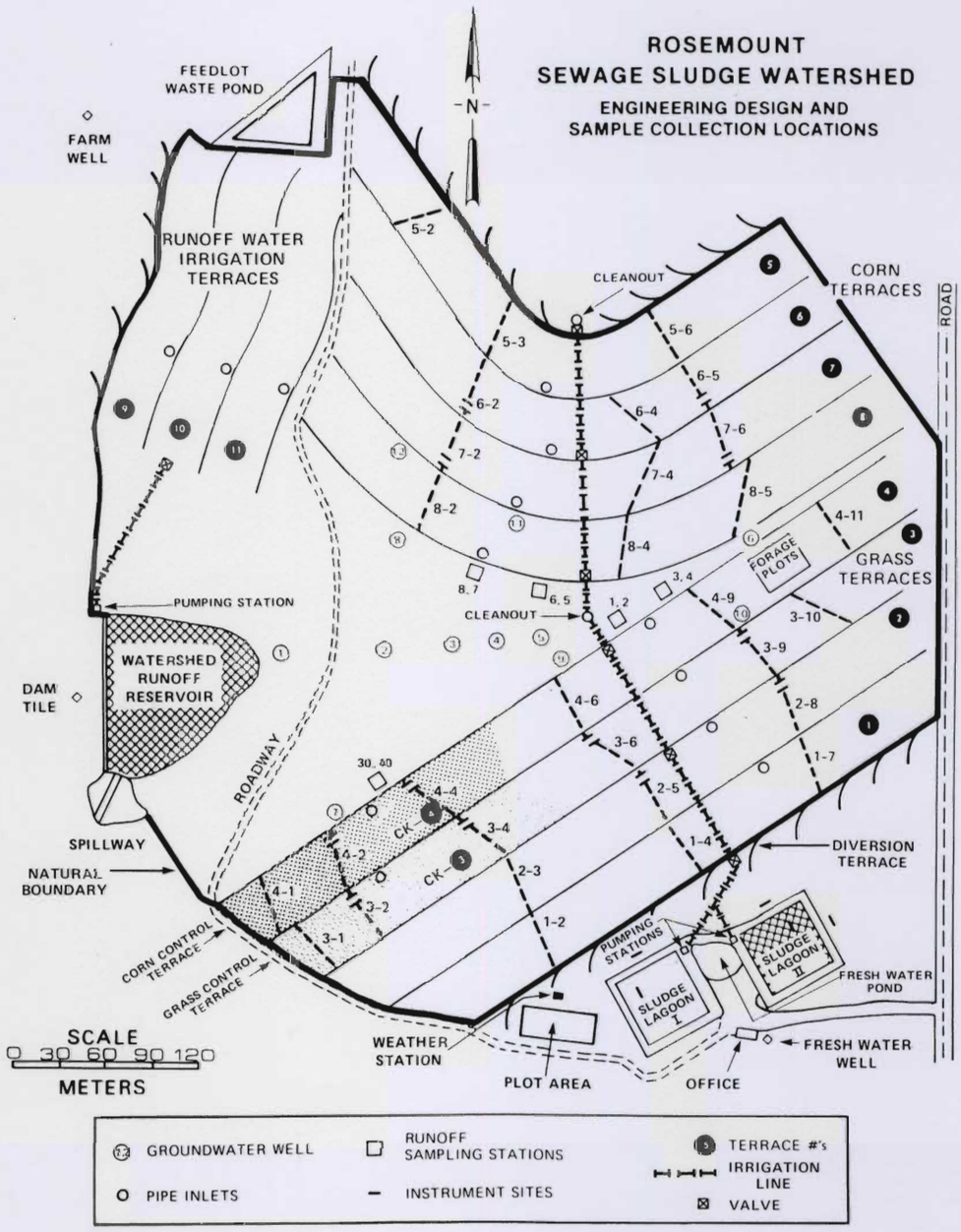


Fig. 5

on this scale, are inadequate to account for the variation. Summary statistics and a graphical approach to trends were adopted for presentation of results in this report.

Info Box

This is not to say that the sampling or analysis methods were not good enough to characterize treatments; they were certainly adequate. It is the statistical methods which have short-comings when applied field research is undertaken. Recent developments in geostatistics, which take locational variation into account, will help future field studies in this respect.

Some might argue for an attempt to analyze the data *a posteriori* (after-the-fact). By blocking on terraces and letting individual sample lines be replicates one could analyze the data and mechanically generate the desired statistics. However, as soil and crop scientists, we know that the soils are different on upper terraces from lower terraces (in response to landscape position and soil forming factors), and that the soils are different on the different sample lines within a terrace (they were placed on concave, linear, and convex slopes, on purpose, to characterize the entire terrace), and that the aspect (direction and degree of slope) is quite different between north- and south-facing slopes (affects net solar radiation important to crop growth and soil warming). Assumptions of randomness are violated. And, after much blocking, you realize what was already stated; this field-sized natural site is too complex for conventional statistical analysis (i.e. ANOVA) as degrees-of-freedom quickly vanish.

Treatment areas and control areas

Sludge was applied to 8 of the 10 large terraced areas (**Fig. 5**). Portions of two terraces were kept sludge-free but fertilized to soil test recommendations. A smaller terraced area, on the northwest portion of the study area, was kept in grass for run-off reservoir water disposal. Two crops were grown, a forage (reed canarygrass) and silage corn. Grass was seeded to terraces 1, 2, 3, and 4, the north facing slope, in 1975. Corn occupied terraces 5, 6, 7 and 8, the south and west facing terraces, starting in 1974. The east end of terrace 4 was reserved for special forage plots. The west ends of terraces 3 and 4 were reserved for the fertilized control for grass (CK-3) and corn (CK-4), respectively.

Changes in experimental design and cropping treatments over time

Some changes have occurred to the treatments on terraces over time. From an agronomic viewpoint, it is relatively easy to grow an annual crop like corn compared to a perennial grass crop. Reed canarygrass plants are quite vigorous during the first few years of the stand. But in time, the stand thins due to disease, winter-kill, weed competition, and general age, until, the stand must be reseeded.

Grass was grown on terraces 1, 2, 3, and 4 for eight years (1975-1982). The grass terraces were phased out over the next few years, being wholly replaced by corn in 1986. Terraces 5, 6, 7, 8, and the corn control section of terrace 4 remain unchanged since the start of the experiment. Therefore, the experiment which began with two cropping treatments changed solely to continuous corn by 1986.

Sampling changes over time

Sampling was frequent for the first five years of the project. Shallow groundwater wells, soil-water extractors (vacuum lysimeters), and deep groundwater wells were sampled monthly at first, then bimonthly, and finally semi-annually. The same is true for surface watershed and runoff reservoir water. Sampling of crops has remained at the same intensity through the years, although more emphasis has been placed on data from the "middle terraces" (terraces 2, 3 and CK-3, grass; and 6, 7 and CK-4, corn) in later years.

Analysis method changes

Laboratory methods have not changed significantly in the last decade. The exception was a change in research equipment in 1978, when samples were analyzed by an inductively coupled plasma spectrometer as opposed to the previous spark emission spectrometer.

Special forage plots

Located on the east end of terrace 4 were small plots of grass and alfalfa varieties. Four replicate plots of each of five forage crops were planted in 1975. Forage species studied were 'Fox' smooth bromegrass, 'Rise' reed canarygrass (the same as the rest of the grass terraces), 'Kentucky 31' tall fescue, 'Agate' alfalfa, and 'Saranac' alfalfa. The purpose of the special forage plots were to evaluate the performance of the crops under sludge treatments. Performance was measured by maintenance of stand population, quantity of forage produced, and feed quality (*in vitro* digestible dry matter, IVDDM; crude protein, CP; and cell wall constituents, CWC). This experiment terminated in 1980.

Field management techniques

Field management activities were not unlike those practiced by good farmers in the area. Detailed records of tillage, fertilization, weed control, planting, cultivation, and harvest were kept for both corn and grass crops.

Excluding 1974 and spring 1975, when sludge was surface-applied, the routine application of sludge to corn terraces was fall injection into the soil. This method required 2-3 passes, each delivering about 1.5 cm ha^{-1} of sludge, depending upon the amount to be applied for the next year's crop. Sludge was generally applied in October, after removal of the previous corn crop by chopping. In some years, the sludge treatments were fertilized with inorganic potassium (K) to supplement the low-K sludge. The control areas

received nitrogen annually and phosphorus and potassium fertilizers as required.

Managing corn treatments

In early May, the corn treatment areas were field-cultivated. Corn was planted in 75-cm (30 inch) row spacing in early- to mid-May, depending upon weather conditions. An insecticide was applied with the planter (Furadan, Dyfonate, Counter, Amaze, or Thimet). Herbicide was also applied each year (pre-emergence Lasso plus atrazine and/or a post-emergence application of atrazine plus oil). In some years the corn was cultivated by shovel sweep or rotary hoe row cultivator. Corn leaves were sampled in late July at 75% silking stage. Grain and stover sampling was done in September on the permanent sampling lines. The remainder of the corn crop was chopped and ensiled. All corn treatment areas were fall chisel plowed.

Managing grass treatments

Grass treatment areas were seeded in June 1975. They were irrigated in July 1975 from the runoff reservoir and mowed in August 1975 to control broadleaf weeds. In most years sludge was applied by traveling overhead sprinkler in April, June, July, and September. Grass plots were harvested in June, July, and September from the permanent sampling lines on each terrace. The remainder of the grass crop was harvested by either cutting, chopping, and ensiling (usually first cutting) or cut, raked into windrows to dry, then baled and removed. Sludge application immediately followed these harvests so that sludge would not contaminate the surface of growing plants.

Significant changes in management

Liming — Soil reaction (pH) did not decrease significantly, in the sludge treatment areas, during the experiment. It is thought that the soils at this site were naturally well-buffered (to resist pH change) and that sludge contained enough bases (alkalinity) to offset acidity produced by nitrification of sludge organic-N compounds. Corn control area CK-4, however, did not benefit from these bases and, in 1986, was limed with 4 Mg ha^{-1} (2 T A^{-1}) of crushed agricultural limestone to correct a declining soil pH.

Fertilization — Soil test results and crop removal data showed that sludge treatments were not receiving adequate amounts of K for optimum crop growth. Therefore, commercial fertilizer K was occasionally applied to all treatment areas in the form of KCl (0-0-60). Commercial fertilizer nitrogen (34-0-0) and phosphorus (0-46-0) were also applied to the control areas. **Table 5** summarizes the fertilization schedule used at the Rosemount Watershed. Generally, the fertilizer was broadcast, then incorporated on corn areas. Split broadcast applications, following harvests of the crop, were used on the grass treatments.

Crop treatment changes — Major cropping changes occurred at the study area following decline of the forage crops. The special forage plots

Table 5. Commercial fertilizer applied to corn and grass treatment areas.[1]

Year	Treatment[2]	Grass			Corn		
		N	P	K	N	P	K
		kg ha^{-1}					
1974	Control	-	-	-	230	20	66
	Sludge	-	-	-	0	0	66
1975	Control	-	-	-	230	20	66
	Sludge	-	-	-	0	0	66
1976	Control	221	58	59	249	65	88
	Sludge	0	0	59	0	0	88
1977	Control	232	20	69	175	16	43
	Sludge	0	0	69	0	0	43
1978	Control	415	17	170	200	17	80
	Sludge	0	0	100	0	0	80
1979	Control	368	17	0	340	17	100
	Sludge	0	0	0	0	0	100
1980	Control	300	23	110	240	23	110
	Sludge	0	0	110	0	0	110
1981	Control	330	50	230	235	50	150
	Sludge	0	0	230	0	0	150
1982	Control	340	0	340	280	0	135
	Sludge	0	0	340	0	0	135
1983	Control	197	0	0	224	0	0
	Sludge	0	0	0	0	0	0
1984[3]	Control	-	-	-	220	0	0
	Sludge	-	-	-	0	0	0
1985[4]	Control	-	-	-	340	0	140
	Sludge	-	-	-	0	0	140
1986[5]	Control	-	-	-	315	0	0
	Sludge	-	-	-	0	0	0

[1] N, nitrogen, 34-0-0; P, phosphorus, 0-46-0; K, potassium, 0-0-60.

[2] Control areas: grass, CK-3; corn, CK-4. Sludge areas: grass, terraces 1, 2, 3, 4; corn, terraces 5, 6, 7, 8.

[3] Control areas: grass, none; corn, CK-3 and CK-4. Sludge areas: grass, terraces 1, 2; corn, terraces 3, 4, 5, 6, 7, 8.

[4] Control areas: grass, none; corn, CK-4. Sludge areas: grass, terraces 1,2; corn, terraces 3, 4, 5, 6, 7, 8.

[5] Control areas: corn, CK-4. Sludge: corn, terraces 1, 2, 3, 4, 5, 6, 7, 8.

at the east end of terrace 4 were terminated in 1980 and reseeded to 'Rise' reed canarygrass in that year. The stands of reed canarygrass, on terraces 1 and 4, declined due to weed competition so that they were treated with glyphosate, then, reseeded to 'Blaze' alfalfa in 1982. Only terraces 2 and

3, and CK-3 were sampled for grass in 1983. In 1984, terraces 3 and 4 were converted from grass to corn sludge treatment areas, and CK-3 was converted from a grass control area to a corn control area. Grass samples were only collected from terrace 2 in 1984. In 1985, CK-3 was changed from a corn control area to a corn sludge treatment area; no samples were taken from this area after the change. Also in 1985 the alfalfa and grass stands on terraces 1 and 2, respectively, had deteriorated so that they were plowed and reseeded to 'Flaire' reed canarygrass. Weed competition caused this seeding to fail and terraces 1 and 2 were instead converted to corn sludge treatment areas in 1986. Therefore by 1986, corn was grown on all treatment areas.

Crop variety changes — For the most part, the grass portion of the study resulted from a single 1975 seeding of 'Rise' reed canarygrass. Thus it has a uniform varietal history, although vigor of the stand changed over the time period. On the other hand, a number of changes occurred in corn hybrid used over the course of the study. **Table 6** summarizes these changes in variety and plant population at harvest. It is difficult to ascertain the effect of corn variety on yield and element uptake. Corn varieties can be quite different in their ability to take up nutrients and other elements. Hinesley et al. (1978) examined twenty corn inbred lines grown on sludge-amended soil. Differences of up to 40 times were found in grain Cd content among the inbreds.

Table 6. Corn varieties used in the Rosemount Watershed study.

Year	Brand	Population[1]
1974	Pioneer 3780 (105 day)	67300
1975	Northrup King PX476 (100 day)	62900
1976	Northrup King PX448 (95 day)	52800
1977	Northrup King PX448 (95 day)	65000
1978	Northrup King PX448 (95 day)	65900
1979	Northrup King PX448 (95 day)	66000
1980	Northrup King PX448 (95 day)	63000
1981	Pioneer 3780 (105 day)	59300
1982	Pioneer 3780 (105 day)	54360
1983	Pioneer 3780 (105 day)	59770
1984	Funks 4256 (95 day)	56800
1985	Stauffer 4402 (105 day)	58300
1986	Stauffer 4402 (105 day)	52800

[1] Population estimate at harvest in plants ha^{-1}.

Results and Discussion

Clearly, the aggressive Rosemount Watershed study has produced a great deal of "raw" data. Some of this information was summarized, on an annual basis, in an updated report entitled *Utilization of Sewage Wastes on Land* (Larson *et al.* 1974 through 1987). The available information is presented here with a long-term perspective in mind.

Analysis of sludge applied

Composition of the *liquid sewage sludge* actually applied to the sludge treatment areas was quite different from the sludge delivered from any one source. Composition of the applied sludge also differed between corn and grass treatment areas.

Obviously, mixing of the sludges from different wastewater treatment plants occurred in the lagoons. But, sedimentation of sludge solids and incomplete re-suspension of these solids also affected composition of the applied sludge. The sludge resided in the lagoons for up to 6 months. During this time some of the volatile components may have escaped to the atmosphere. A portion of the organic fraction might have decomposed. But the most significant change was stratification of sludge materials in the lagoon.

Core samples were taken in February 1986 of the ice, supernatant liquid, liquid sludge, and sedimented sludge in the lagoons (King et al., 1986). The cores were subdivided by the stratified layers (**Table 7**).

Table 7. Characteristics of strata in the Rosemount lagoons (February 1986).[1]

Stratum[2]	Thickness (m)	Solids (%)	NH_4-N	NO_3-N	Organic Nitrogen	Total Phosphorus	Total Chromium
Ice	0.49	0	288	9	3	600	1
Water	0.62	0	1,360	16	224	1200	2
Suspended solids	0.28	6	18,500	488	29,800	23,900	1,900
Dense solids	0.52	24	6,200	248	18,400	20,200	4,400
Soil liner	0.10	76	1,430	22	748	1,800	20

[1] Ice and water are reported on a mass per volume basis, mg L^{-1}; suspended solids, dense solids, and soil liner are reported on a gravimetric basis (oven-dry), mg kg^{-1}; averages of 18 core samples on 18 m grid (nine cores per lagoon).

[2] Strata are listed from lagoon surface to 0.10 m below sludge-soil liner interface.

Components of the sludge are concentrated in different layers of the lagoon. For instance, removal of liquid sewage sludge following incomplete mixing would tend to leave Cr (and probably other trace metals) in the lagoon. Lagoon stratification also explains the differences seen between composition of sludge applied to grass versus sludge applied to corn, even though it came from the same lagoon (**Table 8**).

Table 8. Composition of sludge applied to crops (1974 - 1986).[1]

Component[2]	Corn (1974-1986)	Grass (1974-1984)
Total solids (% of liquid sample)	2.90	2.04
Volatile solids (% of liquid sample)	1.43	1.05
EC (dS m^{-1})	4.27	4.55
pH	7.77	7.84
— % of oven-dry total solids —		
Total N	5.33	5.76
NH_4-N	2.16	2.43
OM	49.30	49.80
C	25.70	25.10
P	2.64	2.49
K	0.36	0.48
Ca	4.44	4.37
Na	1.37	1.99
Mg	0.72	0.79
Al	1.69	1.69
Fe	0.94	0.85
— mg kg^{-1} oven-dry total solids —		
Cr	5650	7640
Cu	747	1030
Zn	913	804
Pb	348	283
Mn	290	254
B	34	33
Ni	21	21
Cd	7	6

[1] Averages weighted by amount of dry sludge solids (Mg ha^{-1}) applied each year.

[2] NH_4-N, ammonium nitrogen; EC, electrical conductivity; pH, reaction; OM, organic matter; C, total carbon; P, phosphorus; K, potassium; Ca, calcium; Na, sodium; Mg, magnesium; Al, aluminum; Fe, iron; Cr, chromium; Cu, copper; Zn, zinc; Pb, lead; Mn, manganese; B, boron; Ni, nickel; Cd, cadmium.

Often, during summer applications to grass, sludge was taken from the "clear supernatant" of the lagoon, in other words, the lagoon was not mixed. This practice tended to separate sludge components. Soluble and suspended sludge components (ammonium-N, nitrate-N, potassium, and sodium) went with the water. Total solids content was lower in sludge applied to grass than to corn, but the total nitrogen fraction was higher. From this fact, one might deduce that the solids applied to grass, during the growing season, was withdrawn from the "suspended solids" stratum of the lagoon, where solids have a higher N content (refer to **Table 7**). In addition to differences in solids and N content, the average composition of sludge applied to grass had higher K and Na content (along with a slightly higher EC).

The fall sludge application to grass and corn treatment areas followed a more thorough mixing of sludge in the lagoons. Sludge composition, therefore, did not vary as much between grass and corn treatment areas in fall.

Appendix B presents more detailed information on composition of sludge applied to crops at the Rosemount Watershed.

Climatological observations

Temperature, precipitation, and pan evaporation data are summarized in **Table 9**.

Crop growth and yields can be affected by adverse weather conditions. Especially critical are the conditions early in the growing season. A wet spring in 1975 and a cool spring in 1979 may have depressed crop yields in those years. Precipitation was extremely limiting during the 1976 growing season. Most other years had near ideal growing conditions.

Pan evaporation measurements provided an estimate of potential evapotranspiration. Potential evapotranspiration (PET) is defined as the amount of water evaporated from a short green crop which fully shades the ground and is always supplied with water. Actual evapotranspiration is usually 60 to 80 percent of pan evaporation, but varies with crop, soil water availability, and advection (regional movement of air masses). The greatest difference between PET and precipitation occurred in 1976.

Agronomic yields

Crop yield perhaps is the most important information leading to a decision by a producer regarding the use of sludge as a substitute for commercial fertilizer. Corn and forage crop yields are presented for *liquid sewage sludge* and commercial fertilizer treatments at the Rosemount Watershed study area.

Table 9. Meteorological conditions at the Rosemount Watershed (1974 -1986).

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1975	MIN[1]	-16.2	-15.0	-10.5	-0.7	9.5	13.6	17.0	15.2	8.3	4.2	-2.4	-11.0	
	MAX[2]	-5.6	-5.2	-1.8	6.7	21.1	23.9	29.0	26.4	19.5	16.3	17.1	-3.9	
	PRECIP[3]	5.5	1.0	2.8	15.9	11.1	13.6	3.0	11.0	3.2	0.8	10.1	2.4	80.4
	PAN[4]					17.7	18.9	25.2	16.0	11.9	12.3			88.3
1976	MIN		-8.8	-5.6	2.8	7.2	14.4	16.1	13.9					
	MAX		0.6	2.8	15.5	19.4	27.2	30.5	27.8					
	PRECIP	0.8	1.1	5.5	2.8	1.2	6.3	4.5	3.8	2.7	1.4	0.6	0.9	31.6
	PAN					17.6	26.7	27.2	23.3	17.3	6.1			118.2
1977	MIN			-1.0		11.0	12.0	16.0	12.0	11.0	2.0	-4.0	-9.0	
	MAX			6.0		22.0	23.0	26.0	23.0	20.0	11.0	-1.0	-6.0	
	PRECIP	1.2	2.8	9.0	7.3	6.7	9.6	8.1	9.6	11.9	6.3	2.8	1.9	77.2
	PAN					19.9	19.3	21.5	16.6	10.3	6.0			93.6
1978	MIN	-17.0	-18.0	-7.0	1.0	9.0	14.0	16.0	16.0	13.0	5.0	-3.0	-13.0	
	MAX	-10.0	-6.0	0	10.0	21.0	24.0	26.0	27.0	25.0	15.0	3.0	-4.0	
	PRECIP	0.1	1.9	0.9	8.1	10.4	16.1	11.7	14.6	12.9	0.3	3.3	0.9	81.2
	PAN				9.0	21.7	17.0	13.2	24.4	13.7				99.0
1979	MIN				6.0	7.0	13.0	16.0	15.0	11.0	4.0			
	MAX				14.0	16.0	24.0	26.0	24.0	21.0	11.0			
	PRECIP	1.1	2.1	6.8	2.3	6.1	12.0	9.0	12.1	9.0	7.7	2.1	1.0	71.3
	PAN					15.3	16.0	20.4	14.8	14.4				80.9
1980[5]	MIN					10.0	14.0	16.0	16.0	10.0				
	MAX					25.0	25.0	29.0	26.0	20.0				
	PRECIP	4.0	2.3	2.6	4.1	3.2	8.8	3.1	14.2	10.1	2.8	0.9	0.8	53.7
	PAN					—	—	—	—	—				—
1981	MIN					9.0	13.0	15.0	14.0	6.0				
	MAX					19.0	25.0	28.0	24.0	19.0				
	PRECIP	0.3	6.9	1.8	10.5	6.0	8.6	8.2	16.0	2.4	6.0	3.5	2.3	72.4
	PAN					11.6	16.6	16.9	13.7	11.2				70.0
1982	MIN					11	10	16	14	11				
	MAX					22	23	29	27	20				
	PRECIP	6.5	1.1	5.6	6.6	9.8	3.5	3.8	8.0	6.0	11.6	8.8	8.8	80.1
	PAN					14.8	18.8	20.1	10.8	7.9				72.4
1983	MIN					9	16	21	30	14				
	MAX					19	26	31	32	23				
	PRECIP	1.4	3.1	8.7	9.9	13.6	9.9	8.8	4.0	9.8				
	PAN						18.3	22.7	16.2	11.9				
1984	MIN					9	16	16	18	9				
	MAX					19	26	27	28	20				
	PRECIP	1.3	4.6	4.7	11.2	4.8	11.6	12.6	11.2	5.6	15.4	2.1	5.8	90.9
	PAN					19.6	21.3	19.5	14.3	8.2				82.9
1985	MIN					11	12	16	14	11				
	MAX					23	23	28	23	20				
	PRECIP	1.6	1.1	11.4	3.7	6.9	5.3	4.2	11.4	10.3	10.3	5.5	3.7	75.4
	PAN					23.5	17.9	22	14.4	9.2				87.0
1986	MIN					9	14	17	13	11				
	MAX					21	26	28	25	20				
	PRECIP	2.2	2.0	7.4	15.5	10.1	14.9	10.3	8.2	18.8	5.9	1.6	0.7	97.5
	PAN					17.4	23.0	16.8	14.4	5.0				76.6

[1,2] Mean minimum daily temperature (°C); Mean maximum daily temperature (°C).
[3,4] Total precipitation (cm); Total pan evaporation during growing season (cm).
[5] 1980 to 1986: May through June data collected at tillage research area one mile from Watershed; other data collected at Rosemount Experiment Station headquarters.

Corn

The term fodder denotes total dry matter for corn.

There are two ways to evaluate corn yields; measure grain and/or fodder mass per unit area. Each of these is reported on an oven-dry (65°C) basis.

Corn grain and fodder yields are shown in **Fig. 6.** The overall appearance of both kinds of yield is the same, each having peaks and valleys in the same years. Control and sludge treatment yields also follow the same trends. This relation leads one to conclude that environmental conditions, rather

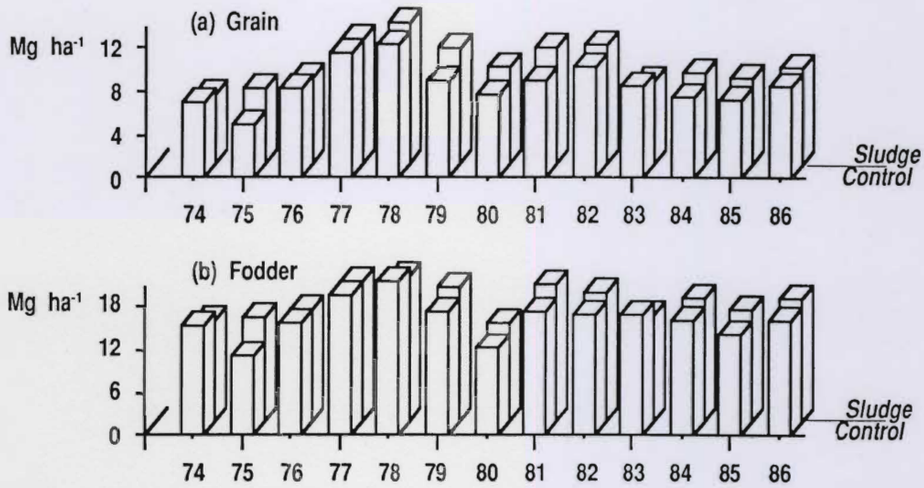


Fig. 6 Corn grain (a) and fodder (b) yields on sludge and control treatment areas at the Rosemount Watershed (1974 - 1986).

than treatments, contribute to most of the variation seen in yields over the years.

Average corn grain yield was 8.9 Mg ha^{-1} (163 bu A^{-1} at 15.5% moisture) for sludge treatments (**Table 10**), whereas corn grain yield averaged 8.2 Mg ha^{-1} (151 bu A^{-1}) on the fertilized control area. The sludge treatment out-yielded the control by 0.7 Mg ha^{-1} (12 bu A^{-1}) averaged over 13 years of corn production at the Rosemount Watershed study area.

Average corn fodder yield on sludge treatment areas was 16.5 Mg ha^{-1} (7.3 oven-dry T A^{-1} of silage). This yield compares to 15.8 Mg ha^{-1} (7.0 T A^{-1}) from the control treatment.

Variation in corn grain yield, over these years, was identical for sludge and control treatments (standard deviation 1.9 Mg ha^{-1}). Variation in fodder yield, over the same years, was slightly greater (2.6 Mg ha^{-1}) for the control area than for the sludge treatment area (2.1 Mg ha^{-1}).

Reed canarygrass

Annual reed canarygrass yields are shown in **Fig. 7**. Average annual yield from sludge treatment areas was 11.0 Mg ha^{-1} versus 9.6 Mg ha^{-1} from the fertilized control area. Yields ranged from 9.7 to 13.0 Mg ha^{-1} on sludge treatment areas and 7.8 to 12.1 Mg ha^{-1} on the control area. **Table 11** data show grass yields generally decreased from first to third cutting. The influence of water added with the sludge on yield , or lack of it on the control, is unknown.

Overall, corn and grass yields are representative of those found in this part of the state. Sludge treatment average yields were slightly greater than

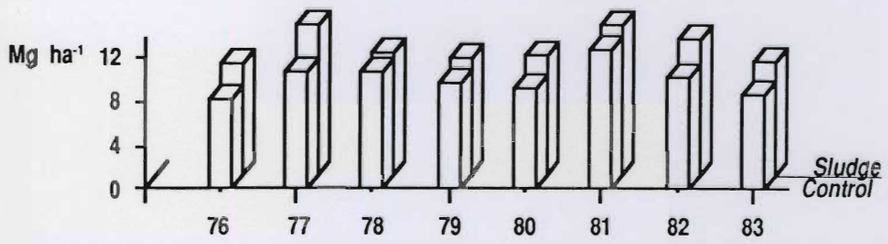


Fig. 7 Reed canarygrass yields on sludge and control treatment areas at the Rosemount Watershed (1976 - 1983).

average yields from fertilized control treatments for corn and grass crops.

Other than the occasional wet (1975) or cold (1979) spring, only a few severe conditions for crop growth were noted. Drought stressed crops in 1976. In 1978, a heavy infestation of army worms caused severe damage to reed canarygrass in localized spots. In 1980, a severe wind and hail storm on July 16 may have reduced yields for that year.

Special forage plots

The mini-experiment tucked into the east end of terrace 4 was a comparison of forages. All of these small plots were treated with sludge just like the rest of the terrace. This four-year experiment found that the best forage, of the five forages tested, was the one chosen for the Rosemount Watershed grass crop, reed canarygrass.

Table 10. Corn grain and fodder yields at Rosemount (1974-1986).[1]

Year	Grain				Fodder	
	Mg ha^{-1}		Bu A^{-1}		Mg ha^{-1}	
	Control	Sludge	Control[2]	Sludge[2]	Control	Sludge
1974	6.7	6.2	123	114	15.1	14.0
1975	4.7	6.6	86	121	10.9	14.1
1976	7.8	7.7	143	141	15.2	15.4
1977	11.0	11.1	202	204	19.0	19.0
1978	11.7	12.4	215	228	20.8	19.9
1979	8.7	10.3	160	189	16.9	18.2
1980	7.4	8.5	136	156	12.1	13.4
1981	8.7	10.2	160	187	17.0	18.7
1982	9.9	10.6	182	195	16.4	17.5
1983	8.1	7.5	149	138	16.4	14.8
1984	7.2	8.2	132	151	15.6	16.8
1985	6.8	7.7	125	141	13.9	15.4
1986	8.2	8.5	151	156	15.7	17.0
Average	8.2	8.9	151	163	15.8	16.5
Std. deviation	1.9	1.9	34	34	2.6	2.1

[1] Oven dry (65°C) basis; grain is shelled corn; fodder is whole plant.
[2] Bushels per acre of shelled corn at 15.5 % water; calculated value.

Conversions:

Mg ha^{-1} grain to Bu A^{-1} grain (56 lb bu^{-1} corrected to 15.5% water);
Bu A^{-1} grain = Mg ha^{-1} grain X 18.365.

Mg ha^{-1} fodder to T A^{-1} fodder ;
T A^{-1} fodder = Mg ha^{-1} fodder X 0.446.

Table 11. Reed canarygrass yields at Rosemount (1976-1984).

Year	Yield							
	1st Cutting		2nd Cutting		3rd Cutting		Total	
	Control	Sludge	Control	Sludge	Control	Sludge	Control	Sludge
	Mg ha^{-1}							
1976	3.9	4.6	2.5	3.4	1.4	1.7	7.8	9.7
1977	5.7	6.1	2.8	3.9	1.8	3.0	10.3	13.0
1978	4.9	5.5	3.4	2.8	2.0	2.5	10.3	10.8
1979	3.5	4.9	3.7	3.3	2.1	2.0	9.3	10.2
1980	4.7	5.9	1.6	1.5	2.5	3.0	8.8	10.4
1981	6.5	5.7	3.1	4.3	2.5	3.0	12.1	13.0
1982	4.9	5.5	2.7	3.7	2.2	2.7	9.8	11.9
1983	5.1	5.5	3.1	4.4	—	—	8.2	9.9
1984	—	4.5	—	5.5	—	—	—	10.0
Average	4.9	5.4	2.8	3.6	2.1	2.6	9.6	11.0
Std. Deviation	0.9	0.6	0.6	1.1	0.6	0.7	1.4	1.3

Criteria used to evaluate the crops were yield, stand vigor, and feed quality. 'Saranac' alfalfa was badly affected by *Phytophthera* root rot; 'Agate' was also slightly damaged. Sludge application severely affected the smooth bromegrass stands for unknown reasons. Only the tall fescue and the reed canarygrass maintained vigorous stands.

Forage quality was measured by *in vitro* digestible dry matter (IVDDM), crude protein (CP), and cell wall constituents (CWC). Ruminant intake is reduced when CWC reaches 55% dry weight or more. The higher the IVDDM and CP content, the better the forage quality.

Table 12 shows that 'Rise' reed canarygrass maintained a good stand and high yield throughout the study. Total IVDDM and CP was maximum in reed canarygrass (multiplying the dry weight % by the dry matter yield). Alfalfa had slightly better feed quality but did not maintain a vigorous stand in this study. Reed canarygrass is clearly the superior forage species for long-term utilization of nutrients applied in sludge.

Table 12. Yield and quality of special forage plots (1976 - 1980).

	Yield				IVDDM[1]		CP[2]		CWC[3]		Stand	
	1976	1977	1978	1979	1978	1979	1978	1979	1978	1979	1979	1980
	Mg ha^{-1}				% Dry Mass						%	
Fox[4]	10.2	11.2	9.0	6.3	71	68	18	18	59	59	78	19
Rise	11.9	12.8	13.4	13.1	69	65	19	20	60	57	100	98
Kentucky 31	11.0	11.6	9.7	5.9	71	69	19	18	54	54	65	38
Agate	12.1	10.7	9.5	5.7	76	68	23	22	37	41	61	20
Saranac	13.1	10.2	7.0	1.4	73	72	22	22	38	36	25	5

[1,2,3] IVDDM, *in vitro* digestible dry matter; CP, crude protein; CWC, cell wall constituents.

[4] 'Fox' smooth bromegrass; 'Rise' reed canarygrass; 'Kentucky 31' tall fescue; 'Agate' and 'Saranac' alfalfa.

Fertilizer value of sludge

Yield

There are several ways to evaluate the effectiveness of sludge as a commercial fertilizer substitute. One way is to look at crop yield, as in the previous section, to see how crops respond to sludge-fertilization. As we have already found, corn and reed canarygrass yields were not adversely affected by sludge fertilization. In fact, yields were slightly higher than commercial-fertilized control areas. The Rosemount Watershed study was more concerned with finding the maximum disposal rates of sludge on agricultural land, while protecting the environment and producing a crop, than finding optimum sludge application rates for crop production. Therefore, the economic value of sludge, or finding the maximum net return to a producer who substitutes sludge for commercial fertilizer, is not addressed in this research.

Nutrients

A second, common, way to evaluate the nutrient-supplying power of sludge is to look at an assay of elements found in the sludge and simply assume the elements are available to plants. Even though we know many of the elements found in sludge are in organic form, and must be mineralized (changed into inorganic form by decomposition or release from the organic component) before they become available for plant use, this approach assumes that, eventually, all nutrients will become available. For example, a unit of nitrogen in sludge is thought to be equivalent to a unit of nitrogen in commercial fertilizer in this approach.

Soil tests

A third way to evaluate the fertilizer-value of sludge is to look at soil test levels of nutrients on sludge treatment areas versus fertilized-control areas. A soil test is a laboratory procedure devised to extract a portion of the nutrient pool from the soil for the purpose of evaluating the amount of nutrient available to produce a specified yield of a specified crop. If the test procedure adequately differentiates soils of differing fertility levels, then the laboratory results are correlated to crop yields. A soil test, in most cases, is nothing more than an index that can be used when determining the amount of fertilizer that is needed to satisfy crop needs.

Soil test values for treatment areas at Rosemount are presented in **Table 13**. In general, the fertility levels, as indicated by P and K soil test results, are in the high to very high range for control and sludge treatment areas. Sludge supplied a large amount of P to the soil, increasing the soil test value. The adequate amount of K in the soil, as shown by the soil test, reflects the good K fertilization program maintained on all treatment areas. Soil pH decreased when commercial fertilizer was applied. The corn control area required agricultural limestone to restore optimum pH levels for plant growth. This decrease is due to the acidifying nature of the nitrification process. Sludge contains components to neutralize this acidity, therefore, soil pH did not decrease on sludge treatment areas.

Table 13. Soil fertility of treatment areas at the Rosemount Watershed (1973 - 1986).[1]

Year	Crop	pH		Soil Test[2] Phosphorus		Potassium		Lime Req[3].	
		Con	Slu	Con	Slu[4]	Con	Slu	Con	Slu
				kg ha^{-1}				Mg ha^{-1}	
1973	Corn	6.2	6.9	—	—	—	—	—	—
	Grass	6.7	6.4	—	—	—	—	—	—
1978	Corn	6.7	7.2	—	—	—	—	—	—
	Grass	7.1	6.6	—	—	—	—	—	—
1981	Corn	6.2	7.3	73	224	232	298	0	0
	Grass	6.1	6.4	62	224	263	258	0	0
1983	Corn	5.7	6.8	69	224	273	321	0	0
	Grass	6.0	6.6	86	224	302	240	0	0
1984	Corn	5.6	6.6	69	224	296	315	9.0	0
	Grass	—	6.7	—	224	—	197	—	0
1985	Corn	5.9	6.9	47	224	284	312	7.8	0
	Grass	—	6.4	—	224	—	292	—	0
1986	Corn	6.1	6.7	46	224	278	302	0	0
	Grass	—	—	—	—	—	—	—	—

[1] **Composite samples from the 0- to 15-cm (0-6 inch) depth; University of Minnesota.**

[2] **Control (Con) and sludge (Slu) treatment areas.**

[3] **Lime requirement (SMP buffer); amount of lime to adjust soil to pH 6.5.**

[4] **Soil samples were in excess of this soil test value (over-ranged 224).**

Applied nutrients versus nutrients removed

Another way to look at the power of sludge to supply nutrients is by comparing plant tissue concentrations between control and sludge treatments. By using crop tissue concentrations and yields, we can also compare total amounts of nutrients removed by a crop to total amounts applied in sludge and fertilizer treatments. In this region, the three macronutrients of interest are nitrogen (N), phosphorus (P), and potassium (K).

Fig. 8 shows that there is little difference between tissue concentrations of N, P, and K in crops grown on sludge versus control areas, when averaged over the life of the experiment. Because large amounts of N and P were applied in the sludge compared to the commercial fertilizer treatment, one could say that crops on both treatment areas were in the optimum range for maximum crop yield. In comparison, sufficient levels of N, P, and K in the North Central region (NCR 13 committee recommendations) are reportedly 27.6-, 2.5-, and 17.1 g kg^{-1} respectively for corn ear leaf at tasseling, and, 30.0-, 3.9-, and 27.5 g kg^{-1} respectively for tall grasses.

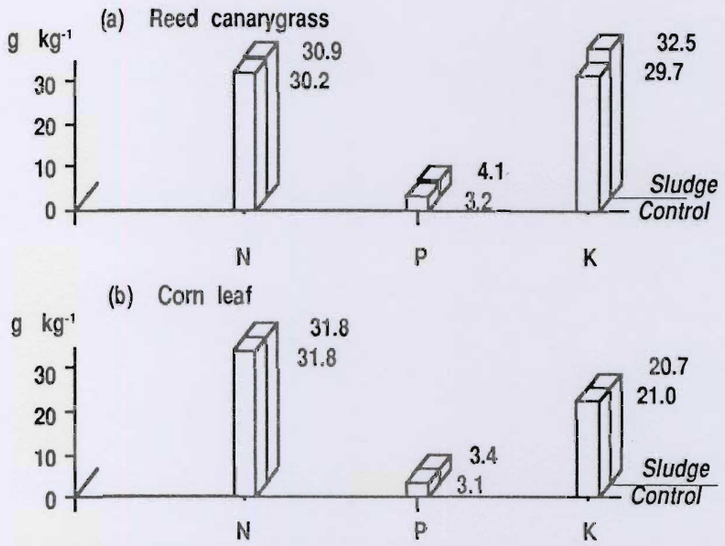


Fig. 8 Average tissue concentration in reed canarygrass (a) and corn leaf at silking (b) at the Rosemount Watershed study (1974-1986).

Corn

A clear view of the total macronutrients removed by corn versus the amounts applied in sludge or commercial fertilizer is found in **Fig. 9, 10, and 11** for N, P, and K. For N and P, much more nutrient was added with sludge than with commercial fertilizer. The amounts removed, however, are nearly equal for sludge and control treatments. Because the municipal sewage sludge was K-deficient, control treatment areas would have received a larger amount of K, illustrated in **Fig. 11**, than sludge treatment areas. In reality, the sludge treatments received the same amount of K-fertilizer as the control area, plus the amount contained in the sludge (**Table 14 and Fig. 12b**).

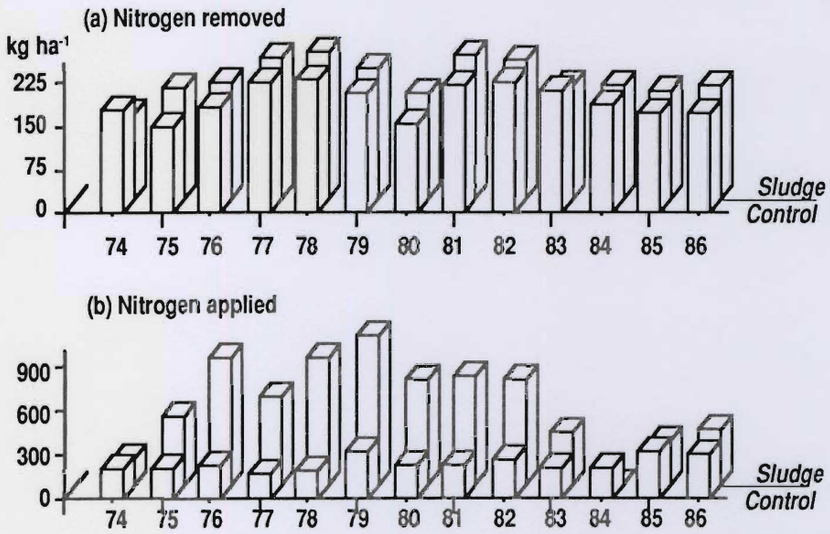


Fig. 9 Nitrogen removed by corn fodder (a) versus nitrogen applied (b).

Table 14. Total amounts of N, P, and K applied to corn at the Rosemount Watershed study area.

Year	Control Treatments[1]			Sludge Treatments[2]			
	N	P	K	N	P	K	K-fertilizer
	kg ha^{-1}						
1974	230	20	66	211	64	6	66
1975	230	20	66	499	165	71	66
1976	249	65	88	898	614	72	88
1977	175	16	43	617	332	41	43
1978	200	17	80	897	201	65	80
1979	340	17	100	1040	579	62	100
1980	240	23	110	742	382	30	110
1981	235	50	150	767	414	35	150
1982	280	0	135	746	316	26	135
1983	224	0	0	367	202	15	0
1984	220	0	0	0	0	0	0
1985	340	0	140	324	154	22	140
1986	315	0	0	400	203	40	0
Total	3278	228	978	7507	3626	485	978

[1] **Commercial fertilizer.**

[2] **Fertilizer potassium was added to supplement sludge-K.**

Corn fodder removed a total of 2387-, 373-, and 1817 kg ha^{-1} of N, P, K, respectively, from the control treatment area, over the 1974 to 1986 period (**Fig. 12**). This amount was 73-, 163-, and 186 percent of the fertilizer applied to the control treatment area. Corn removed a total of 2634-, 488-, and 1938 kg ha^{-1} of N, P, and K, respectively, from the sludge treatment areas over the 1974 to 1986 period. This amount was 35, 13, and 132 percent of total N, P, and K applied to sludge treatment areas. Crop uptake efficiency less than 100 percent means that excess nutrients remain in the soil system. Uptake efficiency values greater than 100 percent means that the crop is removing native soil reserves.

Grass

Reed canarygrass exhibited the same behavior as corn, when considering N, P, and K removal, in that nearly equal amounts were removed by the crop in control and sludge treatment areas (**Fig. 13, 14, and 15**). Sludge-treated grass seemed to remove more P, however. Again, the amounts of N and P applied in sludge to grass over-shadowed the amounts applied in the commercial fertilizer treatments (**Table 15**).

Grass removed a total of 2318-, 257-, and 2432 kg ha^{-1} of N, P, and K, respectively, from the control treatment area over the 1976 to 1983 cropping

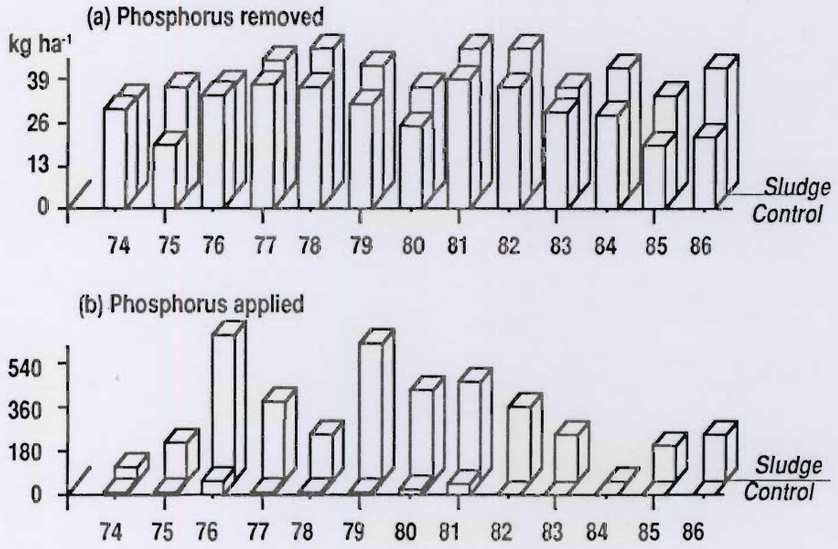


Fig. 10 Phosphorus removed by corn (a) versus phosphorus applied (b) to sludge and control treatments at the Rosemount Watershed study (1974-1986).

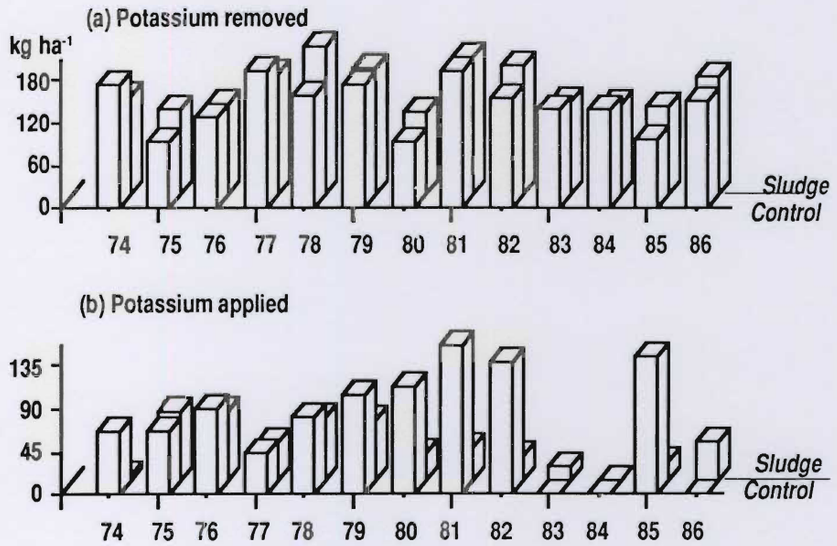


Fig. 11 Potassium removed by corn (a) versus potassium applied (b) to sludge and control treatments at the Rosemount Watershed study (1974-1986). Sludge treatment areas also received supplemental fertilizer-K, not shown, in amounts equivalent to the amount shown for control treatment areas.

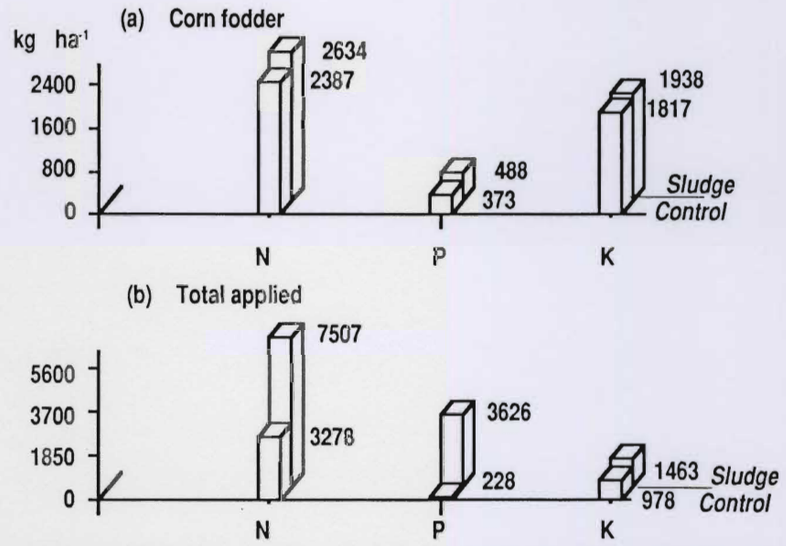


Fig. 12 Macronutrients removed in corn fodder (a) versus applied in sludge and fertilizer (b) at the Rosemount Watershed (1974-1986).

period (**Fig. 16**). This amount was 96-, 140-, and 250 percent of the total applied in commercial fertilizer to the control area. Grass removed a total of 2705, 360, and 2855 kg ha^{-1} of N, P, and K, respectively, from the sludge treatment area over the 1976 to 1983 cropping period. This amount was 30, 9, and 180 percent of the N, P, and K, respectively, applied to the sludge treatment areas.

Table 15. Total amounts of N, P, and K applied to grass at the Rosemount Watershed study area.

Year	Control Treatment[1]			Sludge Treatment[2]			
	N	P	K	N	P	K	K-fertilizer
	kg ha^{-1}						
1976[3]	221	58	59	1256	528	161	59
1977	232	20	69	1270	583	93	69
1978	415	17	170	908	382	79	100
1979	368	17	0	1380	555	73	0
1980	300	23	110	1360	648	125	110
1981	330	50	230	1914	840	95	230
1982	340	0	340	729	309	42	340
1983	197	0	0	260	129	8	0
Total	2403	185	978	9077	3974	676	908

[1] Commercial fertilizer

[2] Fertilizer potassium was used to supplement sludge treatments.

[3] Total application of sludge applied N, P, and K for 1974, 1975, and 1976.

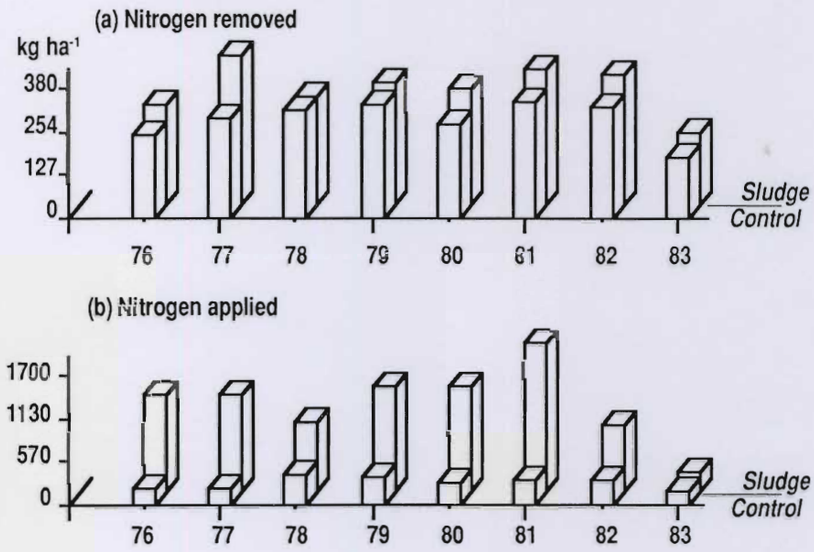


Fig. 13 Nitrogen removed by grass (a) versus nitrogen applied (b) to grass sludge and control treatments at the Rosemount Watershed study (1976-1983).

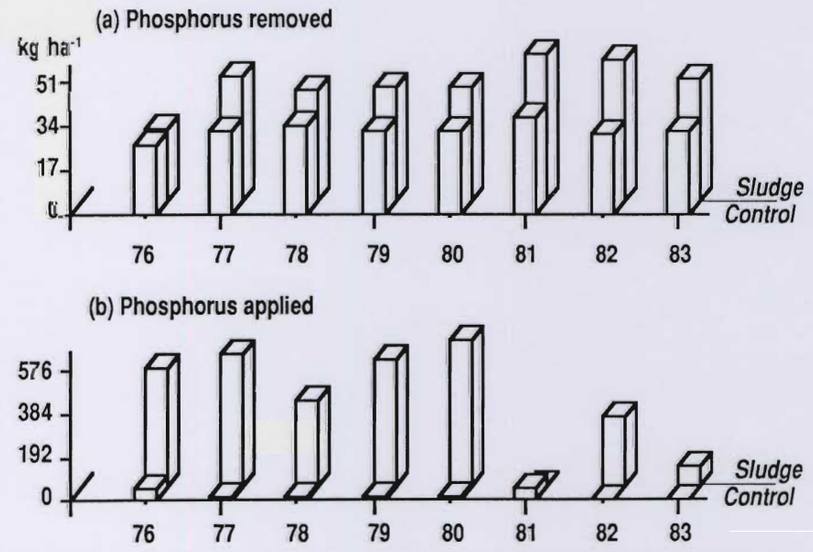


Fig. 14 Phosphorus removed by grass (a) versus phosphorus applied (b) to grass sludge and control treatments at the Rosemount Watershed study (1976-1983).

On an average annual basis, reed canarygrass out-performed corn in the ability to remove N, P, and K. Grass removal of N, P, and K was 338, 45, and 357 kg ha^{-1} yr^{-1}, respectively, on sludge treatment areas. Average annual removal of N, P, and K by corn from the sludge treatment areas was 206, 38, and 163 kg ha^{-1} yr^{-1}, respectively.

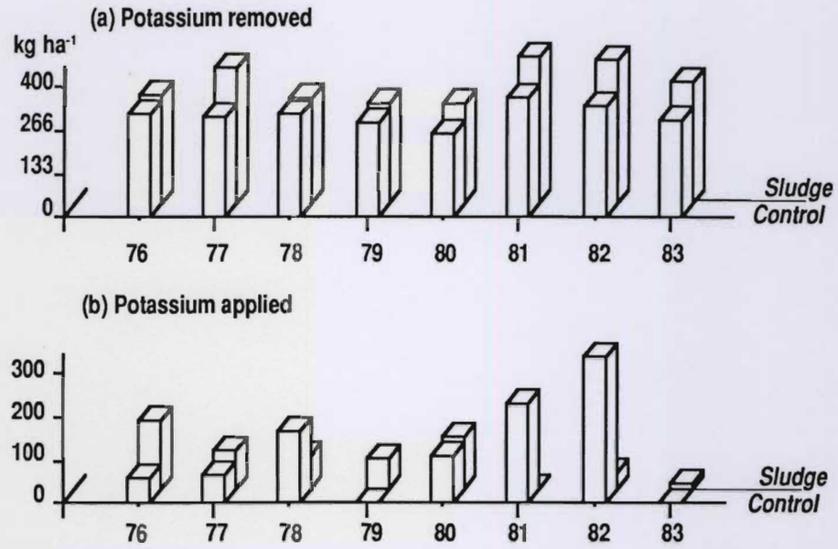


Fig. 15 Potassium removed by grass (a) versus potassium applied (b) to grass sludge and control treatments at the Rosemount Watershed study (1976-1983). Sludge treatment areas also received supplemental fertilizer-K, not shown, in amounts equivalent to the amount shown for control treatment areas.

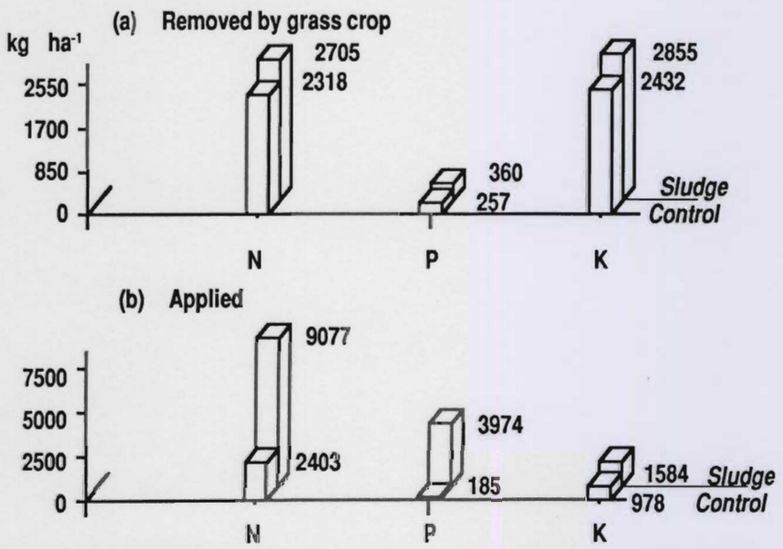


Fig. 16 Macronutrients removed in reed canarygrass (a) versus applied in sludge and fertilizer (b) at the Rosemount Watershed (1976-1983).

Summary

In summary, liquid sewage sludge was an effective substitute for commercial fertilizer on corn and forage crops. *Yields* equalled those of areas of traditional fertilizer management. Commercial potassium fertilizer was used to supplement the K-deficient sludge, however. *Soil tests* indicated that phosphorus was not limiting on sludge or control management areas. Soil pH decreased under control corn treatments, requiring additional inputs of agricultural limestone, whereas sludge maintained optimum soil pH throughout the experiment. *Elemental analysis* of plant tissue showed that corn took up N, P, and K equally well from sludge and control managed areas. Elemental analysis of grass plant tissue showed less-than-optimum amounts of P were available in the grass control area. The discrepancy between soil tests and tissue analysis could be due to the nature of application methods.

Neither sludge nor commercial fertilizer was incorporated into the soil on grass treatment areas. Commercial fertilizer was broadcast on the surface and required natural rainfall to dissolve and move the fertilizer into the soil. Inorganic phosphorus is not very mobile in the soil. It is likely that most fertilizer P was trapped in the first 5 cm of soil where it often is too dry for plants to obtain it. Much of the sludge-applied P was in organic form which could move with the irrigation water deeper into the soil. An application rate of 2.5 cm of liquid sewage sludge would saturate the top 15 cm of the soil. Phosphorus in the sludge then mineralized in a soil zone more favorable for plant uptake. Soil test sampling mixed the top 15 cm of soil and could not discriminate P levels within this zone. Sludge appeared to be more effective in delivering P to a forage crop.

An important point to note is that large amounts of N and P applied by sludge did not adversely affect yields by creating imbalances of nutrients within the plant. Sludge also supplied many of the other required plant nutrients. Because the amount of N and P removed by sludge and control treatments were nearly equal for the corn crop, it appeared that lower sludge application rates could be used, thus increasing the efficiency of nutrient-use by the crop.

Trace metals

Eight trace metals were monitored in sludge and plant-tissue samples from inception of the Rosemount Watershed study. Four of these are considered essential for plant growth (micronutrients Zn, Cu, B, and Mn) and four are considered impurities in the food chain (Cr, Pb, Ni, Cd). The micronutrients, while essential, generally have a narrow range of sufficiency and can be toxic to plants when they are above critical concentrations in the plant. All eight metals occur naturally in soils of this area.

Background levels of trace metals

A survey of Minnesota soils found amounts of Zn, Cu, Cr, Pb, Ni, and Cd present to different degrees in surface and subsurface soil materials (Pierce *et al.*, 1982). Three kinds of chemical extracting solutions were used to determine total, available, and organic-bound metals in the soils. **Table 16** lists the average metal concentrations for 16 soil series in Minnesota and 2 major soil series in southeastern Minnesota.

Total- minus Available-metal is thought to be metal that is tightly bound within the crystal structure of resistant soil minerals and not active in plant uptake processes. The metal fraction between Available and Organic-bound values is metal in easily-weathered soil minerals which can become available for active plant uptake. The Organic extractant measures metal bound to soil organic matter and inorganic metal ions sorbed to mineral surfaces. This last fraction is considered the most labile, or immediately available, for plant uptake. In southeastern Minnesota , for example, about one-half of Total-Cd in *surface* soil was in the Organic-bound fraction (**Table 16**). No Cd was found in the Available fraction in this layer. Variation in Total- and Available-Cd levels in Minnesota was explained by the $CaCO_3$ content of soils (Pierce *et al.*, 1982). Cd can substitute for Ca in the calcite ($CaCO_3$) crystal structure. Higher Cd levels were found in soils with free $CaCO_3$. About one-half of the Cd was in the Available form in southeastern Minnesota parent material, probably due to the calcite present in the loess parent material. Overall, native levels of metals, especially Cr, Pb, Ni, and Cd, are quite low in Minnesota soils.

Metals were also measured in soil samples before and after 5 years of sludge application at the Rosemount Watershed study area. The chemical extraction agent used was DTPA ($C_{14}H_{23}O_{10}N_3$, Diethylenetriaminepentacetic acid), a chelating agent. DTPA is used in several soil test procedures to evaluate plant-available micronutient metals. **Table 17** presents data that show DTPA-extractable Zn, Cu, and Pb increased as a result of sludge additions. DPTA-extractable Cr, Ni, and Cd did not increase over the 5 years of application.

Table 16. Trace metal concentrations in Minnesota soils (Pierce *et al.*, 1982)[1].

Source	Soil layer	Zn	Cu	Cr	Pb	Ni	Cd
				mg kg^{-1}			
SE Minn	Surface	59/10/5.5	19/3.6/3.3	14/3.4/1.5	<25/7.8/ 3.6	18/5.6/4.6	0.32/0.15/0.15
	Subsurface	59/ 9/0.6	23/4.2/1.8	23/9.0/1.3	<25/5.5/<0.8	22/5.0/0.6	0.15/0.06/0.08
All	Surface	60/16.3/4.9	23/5.6/3.9	39/4.1/1.4	<25/6.8/<1.4	18/6.7/1.6	0.39/0.26/0.16
	PM[2]	52/17.7/0.4	27/9.8/2.5	48/4.8/<0.7	<25/3.8/<0.7	24/10.4/0.3	0.30/0.13/0.08

[1] Values are for Total/Available/Organic-bound extractants; (HCl-HNO_3-HF) / (1*M* HNO_3) / (0.1*M* $K_2P_4O_7$ $3H_2O$).
[2] Parent materials.

Table 17. DTPA-extractable metals from Rosemount Watershed soils.[1]

Metal	Extractable-DTPA				Added in Sludge[2]	
	Corn		Grass		Corn	Grass
	1973	1977	1973	1977		
	mg kg^{-1}				kg ha^{-1}	
Zn	1.4	6.7	1.9	3.5	27.00	19.85
Mn	37.0	25.0	92.0	43.0	9.54	8.82
Cr	<0.1	0.1	<0.1	0.1	89.65	53.47
Cu	1.1	6.4	1.1	3.3	17.98	16.14
Pb	0.7	2.2	1.4	2.7	8.48	5.79
Ni	1.4	1.2	2.1	2.3	0.44	0.51
Cd	<0.1	<0.1	0.4	<0.1	0.21	0.17

[1] 0-15 cm soil depth.
[2] Total metals added in sludge 1973-1976 to sludge treatment areas.

The DTPA soil test results in **Table 17** also show this extractant's lack of sensitivity for Mn and Cr. Both of these metals were applied in large amounts in the sludge. Zn is the only micronutrient known to be deficient on some southeastern mineral soils. These soil test results prove that Zn was not deficient before sludge was added at the Rosemount Watershed study area. DTPA-extractable Zn concentrations over 1 mg kg^{-1} is considered adequate for crop needs. More metal analysis work must be done on the Watershed soils to determine Total, Available, and Organic-bound fractions for a complete picture of the metal status of the sludge-amended soils at Rosemount.

Trace element additions and crop uptake

The amount of trace elements that enter the food chain is always a concern when the subject of sludge-amended land is discussed. We have already found that sludge has good potential as a fertilizer-substitute. We also know that native soils contain small amounts of metals that are considered to be impurities in the food chain (Cr, Pb, Ni, Cd). The remaining questions, then, deal with the amount of metals-applied versus the uptake (and removal) of these elements by the crop.

Corn and grass tissue concentrations — The eight elements of interest were taken up, by corn and grass, to different degrees (**Fig. 17**). Corn leaf tissue, at silking, had adequate amounts of the micronutrients Cu, Zn, Mn and B for plant growth. These micronutrients were well below toxic levels. Very low amounts of Cr, Ni, Pb, and Cd were detected in the corn leaf tissue. In fact, little difference was detected between leaf tissue from control- and sludge-treatment areas for these metals. Grass tissue also

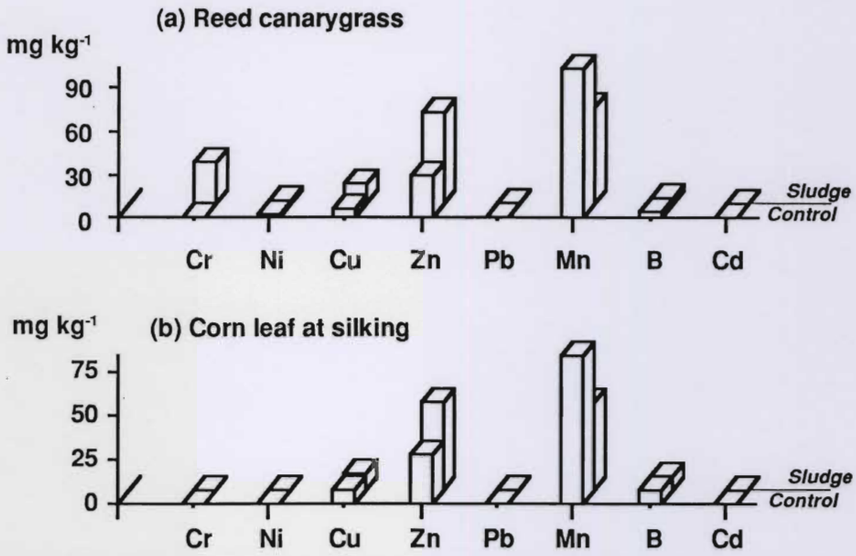


Fig. 17 Average tissue concentrations of trace elements in corn leaf and reed canarygrass at the Rosemount Watershed study area.

had adequate micronutrient concentrations for crop growth and no toxic levels. Again, little difference was seen between control- and sludge-treatment uptake of metals by grass, except for Cr. The amount of Cr, Ni, Pb, and Cd in grass tissue was about the same as in corn leaf tissue, except for Cr from the sludge-treatment area. In general, Cr is not taken up by plants in significant amounts. The high Cr value reported here may be from adsorption of Cr to the surface of grass plants due to direct contact with the sludge during application.

In some research studies, a Zn deficiency has been induced by high levels of P added to a low Zn soil. It is important to note that, although large amounts of P were added by the sludge, no Zn-deficiency was detected by plant tissue analysis. This result could have been expected because the sludge also supplied adequate amounts of Zn to the crop (**Appendix B**). **Fig. 17** also shows a possible Zn-Mn interaction. Zn seemed to depress Mn concentrations in corn and grass tissue compared to control areas. Depression of Mn in plant tissue might also be related to large amounts of available-Fe released by sludge. In any case, Mn concentrations were still within sufficient levels for plant growth. Liquid sewage sludge should be analyzed for micronutrient content so that potential nutrient imbalances can be corrected with proper fertilization. The municipal sewage sludge delivered to the Rosemount Watershed was well-balanced. It is also worth repeating that Cr, Ni, Pb, and Cd tissue concentrations were very low and essentially the same between sludge- and control-treatment areas. See **Appendix E** for more detailed information about crop tissue analysis at Rosemount.

Total trace elements applied versus removed by crops — Corn tissue was also sampled for tissue analysis at harvest. Grain, cob, and stover tissue were analyzed separately. With knowledge of dry-matter yields of each component, a weighted-average metal concentration for the whole plant and the total amount removed by the crop was calculated (**Appendices C, D, E, and F**). **Tables 18 and 19** list the total amount of elements applied in the sludge over the course of the study to corn and grass crops.

Table 18. Elements applied in sludge to corn treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	kg ha^{-1}										
1974	211	64	6	1.1	0.4	0.8	0.10	0.9	0.40	0.03	0.02
1975	499	165	71	4.4	3.5	2.4	0.30	12.9	2.30	0.13	0.04
1976	898	614	72	21.4	5.7	14.7	0.60	76.1	5.80	0.29	0.15
1977	617	332	41	10.8	2.7	9.0	0.62	60.5	2.25	0.16	0.06
1978	897	201	65	9.7	3.4	8.6	0.50	44.5	5.10	0.23	0.07
1979	1040	579	62	16.7	5.0	14.0	0.40	53.6	5.00	0.44	0.11
1980	742	382	30	14.4	3.4	19.2	0.37	198.0	4.10	0.49	0.09
1981	767	414	35	14.4	3.4	4.2	0.38	197.7	4.11	0.48	0.09
1982	746	316	26	13.6	3.8	14.5	0.02	110.0	3.12	0.56	0.09
1983	367	202	15	8.6	3.4	7.8	0.04	116.9	2.72	0.20	0.05
1984	0	0	0	0.0	0.0	0.0	0.00	0.0	0.00	0.00	0.00
1985	324	154	22	6.0	2.8	5.1	0.19	19.9	1.46	0.14	0.05
1986	400	203	40	7.1	3.8	5.8	0.19	14.9	1.11	0.23	0.04
Sum	7510	3630	485	128.1	41.4	106.0	3.71	905.8	37.47	3.38	0.85

Table 19. Elements applied in sludge to reed canarygrass treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	kg ha^{-1}										
1976	1256	528	161	17.8	7.4	15.0	0.70	45.0	5.30	0.45	0.16
1977	1270	583	93	17.4	5.1	17.7	1.20	83.1	6.20	0.63	0.14
1978	908	382	79	10.0	3.4	11.6	0.71	70.8	5.80	0.27	0.09
1979	1380	555	73	33.0	6.5	35.6	0.99	182.0	11.40	0.46	0.16
1980	1360	648	125	11.1	4.1	31.5	1.03	324.0	6.10	0.41	0.13
1981	1914	840	95	28.4	8.0	40.5	0.27	348.2	7.92	1.05	0.20
1982	729	309	42	10.3	2.9	15.0	0.28	197.8	2.75	0.50	0.06
1983	260	129	8	4.8	1.0	5.8	0.14	204.7	1.12	0.13	0.03
Sum	9080	3970	676	133	38.4	173	5.32	1460	46.6	3.90	0.97

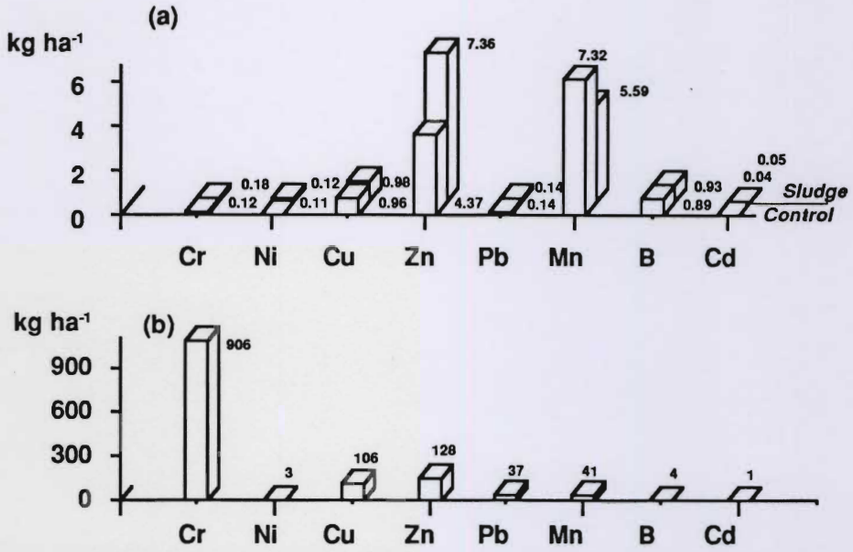


Fig. 18 Total trace elements removed by (a) corn fodder, versus, (b) amounts applied in sludge (1974-1986).

The above-ground portion of Rosemount Watershed crops were harvested and removed from the site. Total amounts of trace elements removed from the site, versus applied in sludge, for corn fodder and reed canarygrass crops are shown in **Fig. 18** and **Fig. 19**. Corn fodder is commonly ensiled for cattle feed in this region. More detailed information on metals removed by crops from the Rosemount Watershed study area is summarized in **Appendix F**.

Only small differences in uptake values exist between control- and sludge-treatments for corn (**Fig. 18**). The slightly greater values in sludge-treatment fodder are largely due to higher yields in those treatment areas. Of primary interest is the comparison between the amount-applied versus that which was removed by the crop. The applied:removed ratio ranged from 4:1 for B to 5,000:1 for Cr in the sludge treatments. These ratios are much greater when sludge uptake values are corrected for control uptake.

Small amounts of applied trace elements were removed by the corn crop over the 13-year cropping period. For example, less than 49 g ha^{-1} of Cd was removed during this period from sludge-amended soil. Control-treatment corn removed nearly as much, 45 g ha^{-1}, of Cd as did corn receiving regular additions of sludge. In general, the corn plant found all of the trace elements studied in the native soil environment (or from impurities in commercial fertilizers) but still did not take up excessive amounts of elements when they were added in sludge. Annual variation in trace element uptake (**Appendix F**) can be due to crop yield, environmental conditions, and corn variety.

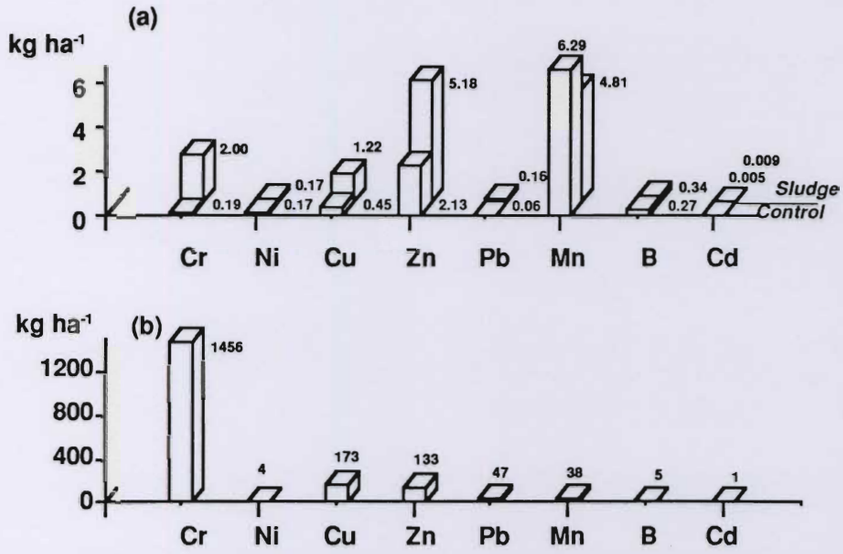


Fig. 19 Total trace elements removed by (a) reed canarygrass, versus, (b) amounts applied in sludge (1976-1983).

The distribution of elements within the harvested corn plant should also be considered if only ear corn or shelled-corn is to be removed, leaving the residue in the field. **Table 20** presents this kind of information for sludge-amended corn from the Rosemount Watershed. Most of the N, P, and Cd was removed in the corn grain. Significant proportions of Ni, Cd, Cr, and Cu were found in the cob tissue. Most of the K, Mn, Cr, B, Pb, Cu, and Ni, however, were removed with the corn stover. Total Zn removed was evenly divided between the corn ear and corn stover tissue.

Total amounts of elements removed by the grass crop were also small compared to the amounts applied in sludge (**Fig. 19**). Sludge-treated grass removed more Cr and Cu than the control counterpart. This removal was a function of higher yield and tissue concentrations of these metals in sludge-treatment areas. The applied:removed ratios ranged from 10:1 for Mn to 700:1 for Cr.

Grass removed more Cr, Ni, and Pb but less Cd than did corn, in a shorter period of time. Total Cr, Ni, Pb, and Cr removed, however, were low, and not much different than amounts removed by these crops grown on fertilized control areas.

Table 20. Amount and distribution of elements removed by corn on sludge-amended soil from the Rosemount Watershed (1974-1986).

	Grain	Cob	Stover	Grain	Cob	Stover
	kg ha^{-1}			Percent of Total		
N	1680	46	905	64.0	1.7	34.3
P	361	5	122	74.0	1.0	25.0
K	449	85	1400	23.2	4.4	72.4
Zn	3100	501	3760	42.1	6.8	51.1
Mn	655	89	4850	11.7	1.6	86.7
Cu	256	70	660	26.0	7.1	66.9
B	257	33	639	27.6	3.6	68.8
Cr	20	15	145	11.1	8.3	80.6
Pb	41	4	94	29.5	2.9	67.6
Ni	27	18	72	23.1	15.4	61.5
Cd	28	6	15	57.2	12.2	30.6

Summary

In summary, significant amounts of Cr, Zn, and Cu were added to sludge treatment areas. Corn fodder and grass crops removed only a small fraction of the amount applied. Grass, however, removed a greater proportion of these three elements than did corn. Lesser amounts of Pb, B, Ni, and Cd were applied to the treatment areas with sludge. These elements were taken up in only trace amounts by corn and grass crops with no distinction between sludge- and control-treatment areas. Therefore, the trace elements applied with the sludge (Zn, Mn, Cu, Cr, B, Pb, Ni, Cd) were not a significant source of contamination to the food chain in this study.

Water quality studies

Another important environmental issue, surface and subsurface water quality, was studied at the Rosemount Watershed. Water quality information was collected in conjunction with sludge-spreading and cropping activities at the site.

Four kinds of water were defined based on the physical characteristics of the watershed. Surface (*runoff*) waters and solids were collected at the terrace outlets and the runoff reservoir. *Soil water*, defined as water held by the soil against the pull of gravity, was sampled in the zone between the soil surface and the perched water table at this site. *Shallow groundwater* was sampled by wells which extended into the groundwater perched above the dense till. *Deep groundwater* was sampled from an existing well adjacent to the site.

Table 21. Quantity and quality of snowmelt runoff and sediment yield from the Rose-

Crop Treatment Year	Precip-itation cm	Run-off cm	Peak Rate cm hr^{-1}	Sedi-ment Mg ha^{-1}	Total N	Total P
GRASS						
Control						
1975	13.2	2.1	0.18	0.28	1.8	0.0
1976	4.6	2.0	0.16	0.02	1.4	0.1
1977	8.5	3.8	0.16	0.00	1.9	0.3
1978	13.7	2.2	0.09		2.3	0.2
1979	14.6	6.2	0.60	0.00	3.6	0.9
1980		2.8			3.0	0.3
1981		2.4			2.1	0.2
1982		1.7			1.3	0.3
Total		23.2			17.1	2.2
Sludge						
1975	13.2	4.8	0.46	1.02	20.2	0.0
1976	4.6	2.3	0.21	trace	1.8	0.3
1977	8.5	5.4	0.32	0.00	6.8	1.4
1978	13.7	2.9	0.15		6.1	1.2
1979	14.6	4.8	0.12	0.00	5.6	1.2
1980		5.0			14.5	1.7
1981		1.8			11.0	0.7
1982		3.8			2.8	1.2
Total		30.8			68.8	7.9
Winter applied sludge on Terrace #3						
1978	13.7	3.0	0.06		12.5	3.1
1979	14.6	12.3	0.24	0.00	40.6	8.6
CORN						
Control						
1975	13.2	0.1	0.02			
1976	4.6	1.2	0.24	0.04	0.4	0.0
1977	8.5	1.8	0.10	0.01	1.4	0.0
1978	13.7	2.1	0.04		1.4	0.1
1979	14.6	2.8	0.39	trace	1.8	0.1
Total	54.6	8.0		0.05	5.0	0.2
Sludge						
1975	13.2	4.4	0.36	0.02	11.6	0.1
1976	4.6	1.4	0.33	0.20	0.8	0.0
1977	8.5	5.8	0.33	0.09	9.5	0.5
1978	13.7	3.6	0.02		2.8	0.4
1979	14.6	3.5	0.36	trace	12.5	0.4
Total	54.6	18.7		0.31	37.2	1.4

[1] Means of four replications on sludge treatment areas and one replication on control

Runoff and erosion

Two important components of surface water quality are dissolved and suspended materials. Problems can occur in aquatic communities when runoff waters contain excess nutrients, trace elements, organics, or are turbid with eroded soil. The Rosemount Watershed study area was designed with terraces and a runoff reservoir to reduce erosion and minimize the chance of surface waters leaving the site.

Runoff was characterized as snowmelt (often a mixture of water from melting snowpack and spring rainfall) or rainfall runoff (no snowpack present). Runoff was measured and sampled from terraces representing sludge and

mount Watershed (1975—1982).[1]

K	Ca	Mg	Na	Zn	Cu	Ni	Cr	Pb	Cd	Mn
	kg ha^{-1}					g ha^{-1}				
0.1										
1.4				4	7		1			
4.4				14	7	6				
2.7	1.0	0.4	0.1	7	2		5			21
6.2	4.2	1.4	0.6	16	6		2	3	2	32
2.4	1.4	0.6	0.2	3	2	1				14
3.6	2.6	1.1	0.3	2	1		3			23
1.0	1.0	0.3	0.2	3	2		2			5
21.7	10.7	3.8	1.5	48	26	7	13	3	2	96
0.9										
2.4				4	8		1			
9.0				14	31	9		11	2	
6.0	5.2	1.7	1.9	7	9		3			12
4.9	11.6	3.2	5.2	37	20	3	4	2	1	8
5.3	10.5	3.1	6.0	14	20	5	5			24
4.1	13.0	4.4	8.4	7	13	2	4			9
2.6	3.9	1.4	1.1	14	17	2	9			5
35.2	44.2	13.	22	7 9	11	21	27	13	3	58
5.0				16	28	4	8	4	1	
18.8				213	118	21	75	20		
0.4										
0.3										
0.7				4	2	1	1	3	0	
0.9				8	2	0	0	2	0	
2.3				12	4	1	1	5	0	
0.2										
0.4										
5.0										
1.3				10	6	3	1	4	1	
2.2				9	4	0	3	0	0	
9.1				19	10	3	4	4	1	

treatment areas.

control treatments for corn and grass crops.

Snowmelt runoff — Snowmelt runoff contributed about one-half of total annual runoff during the 1975 to 1979 period. Thus it is a significant portion of surface water movement from the watershed. Characteristics of snowmelt runoff are summarized in **Table 21.**

• Runoff and erosion - Snowmelt runoff amounts were roughly equivalent during the 1975-1979 period for all but the corn-control treatment area

which had less runoff. Sediment data show that essentially no erosion occurs from an established grass sod during snowmelt runoff. The small amount of sediment measured in 1975 occurred before the grass crop was fully established. Erosion during snowmelt runoff was slightly greater on corn treatments.

• Nutrient loss - Loss of total P, and K in snowmelt runoff was greater in grass than in corn treatments for control and sludge application areas (1976-1979). A mat of sludge on the soil surface and an abundance of above-ground plant material in the grass-sludge treatment may have contributed to these losses. Loss of total N was slightly greater in snowmelt runoff from the corn-sludge treatment than grass-sludge treatment (1976-1979). Nitrogen loss from both of these sludge treatments were significantly greater than the control areas during the same period.

• Trace element loss - Amounts of trace elements removed by snowmelt runoff were related to treatments. In general, the treatments were ranked, from greatest to least metal loss, grass-sludge > grass-control > corn-sludge > corn-control. Only very small amounts of trace elements were lost from corn treatments through runoff.

The relative amount of trace elements in runoff was related to tissue concentrations of the crops. Runoff from grass treatment areas had higher Cu levels than corn. Also, Zn and Mn levels in runoff from control- and sludge-grass was in the same unique proportions as found in plant tissue concentrations (**See Fig. 17**). This evidence suggests that the source of most trace elements in snowmelt runoff is plant tissue, perhaps through leaching or cell rupture by freezing processes.

• Winter sludge spreading on grass - A short-term experiment was conducted on Terrace #3, a grass-sludge treatment, to determine the effects of spreading sludge during winter on snowmelt runoff and water quality (**Table 21**). Surface application of sludge during winter increased all nutrient and metal water quality parameters in runoff. Values for snowmelt runoff in 1979 alone exceed totals for the seven year period (1976-1982) for almost all parameters measured. Winter application of sludge on sloping land can have a deleterious impact on water quality.

Rainfall runoff — The other, less predicable, component of total runoff at the Rosemount Watershed occurred during rainfall events.

• Runoff and erosion -Runoff amounts from sludge treatment areas were greater than amounts from control areas (**Table 22**). Overall, about 6 to 8 percent of rainfall received was lost as runoff. Discounting 1975, when the

Table 22. Rainfall runoff parameters recorded at the Rosemount Watershed.[1]

Crop Treatment Year	Period	Precip-itation cm	Run-off cm	Peak Rate cm hr^{-1}	Sedi-ment Mg ha^{-1}	Total N	Total P kg ha^{-1}	K
GRASS								
Control								
1975	4/27-4/30	9.3	3.5	0.55	1.86	0.4	0.0	0.3
	5/2-6/23	24.7	1.2	0.09	0.24	0.2	0.0	0.1
	7/1-9/30	17.2	2.2	0.31	0.24	0.2	0.0	0.5
	10/1-12/15	12.5	1.3	0.12	0.02	0.2	0.0	1.3
1976	3/29-3/30	2.2	0.1	0.01	0.01	0.0	0.0	0.0
1977	6/26-10/14	64.2	0.2	0.03	0.00	0.1	0.0	0.2
	11/20-12/18	4.2	0.5	0.06	0.00	0.3	0.0	0.6
1978	5/27-9/18	65.7	5.3	0.35	0.00	2.7	0.6	4.7
1979	4/25-9/13	50.0	0.5	0.17	0.00	1.6	0.2	0.9
Sludge								
1975	4/27-4/30	9.3	5.7	0.47	2.24	5.8	0.0	0.9
	5/2-6/23	24.7	5.1	0.21	0.76	8.8	0.0	0.6
	7/1-9/30	17.2	1.4	0.12	0.26	1.5	0.0	0.4
	10/1-12/15	12.5	0.6	0.05	0.00	0.1	0.1	0.9
1976	3/29-3/30	2.2	0.3	0.09	trace	0.2	0.0	0.3
1977	6/26-10/14	64.2	0.3	0.10	trace	2.4	0.2	0.5
	11/20-12/18	4.2	0.2	0.06	0.00	0.4	0.1	0.3
1978	5/27-9/18	65.7	7.3	0.36	0.00	16.1	5.0	7.4
1979	4/25-9/13	50.0	0.8	0.44	0.00	1.9	0.3	2.3
CORN								
Control								
1975	4/27-4/30	9.3	1.7	0.42		0.1	0.0	0.0
	6/11-9/30	17.2	0.3	0.17	0.06	0.2	0.0	0.1
	10/1-12/15	12.5	0.1	0.00	0.00			
1976	3/29-3/30	2.2	0.1	0.02	trace	0.2	0.0	0.1
1977	6/26-10/14	64.2	0.6	0.13	0.22	0.2	0.0	0.4
	11/20-12/18	4.2	0.0					
1978	5/27-9/18	65.7	9.1	0.58	1.20	1.7	0.3	3.0
1979	4/25-9/13	50.0	5.1	0.70	0.44	2.7	0.3	1.8
Sludge								
1975	4/27-4/30	9.3	5.2	0.38		9.4	0.1	2.6
	6/11-9/30	17.2	1.9	0.09	0.11	2.2	0.0	0.5
	10/1-12/15	12.5	0.0	0.00				
1976	3/29-3/30	2.2	0.0	0.01	trace	0.2	0.0	0.0
1977	6/26-10/14	64.2	1.8	0.43	0.58	1.5	0.2	1.2
	11/20-12/18	4.2	0.0					
1978	5/27-9/18	65.7	8.4	0.37	0.88	2.1	0.6	2.8
1979	4/25-9/13	50.0	3.2	0.51	0.28	3.0	0.3	1.8

[1] **Mean of four replicates for sludge and one for control treatment areas.**

grass crop was not yet established, erosion was negligible on grass treatments. Sediment loss was 1.8- to 1.9-Mg ha^{-1} on corn treatments for the 5 year period (1975-1979). No differences in sediment yield were observed between control and sludge corn treatments.

• Nutrient loss - The greatest nutrient (N, P, and K) loss occurred on sludge treatment areas. Grass-sludge areas lost more nutrients in rainfall runoff than did corn-sludge areas. Even though more sediment was removed

from corn treatments, incorporation of sludge into the soil on these areas prevented excessive losses of nutrients to runoff.

Season totals — Total runoff for the five year period (1975-1979) was about 12, 12, 9, and 7-percent of total precipitation from grass-sludge, corn-sludge, grass-control, and corn-control treatments, respectively (**Table 23**). P and K loss from grass treatments were several times the amount lost from corn treatments. N loss was significantly greater on sludge treatments than on control treatment areas. Overall, the corn-sludge treatment lost the most N over the period, whereas the grass-sludge treatment lost the greatest amounts of P and K.

Soil water

Water was extracted *in situ* from 60-cm and 150-cm depths in the soil. Analysis data are presented in **Table 24**.

Most striking was the rise in NO_3-N concentration during the first five years of the study. For corn, control and sludge treatments experienced a general increase of nitrate in the soil water. For grass, the nitrate levels increased under the sludge treatment but not under the control treatment. The dramatic jump of nitrate concentration in 1977 was due to a drought year in 1976 when mineralization rates were high and little leaching occurred. Nitrate levels in sludge treatment areas were nearly double those on control areas by 1979.

Concentrations of trace elements in the soil water were variable and, in general, not different between sludge and control treatments. However, Cu and Ni levels were slightly greater in corn-sludge treatments than corn-control areas. Under grass, elevated levels of P were found in the sludge treatment areas, whereas elevated levels of Zn were found in the control area. Overall, Cr, Pb, and Cd concentrations were very low, near detection limits of the analysis.

Shallow groundwater

Water was sampled from shallow wells which reached the perched water table in the Watershed basin. Nitrate levels in the 12 wells over the 1974 to 1986 period are presented in **Table 25**. A general increase in nitrate concentration occurred in the shallow water aquifer over time. Nitrate levels peaked in 1981 to 1984 and have been decreasing steadily since nitrogen application rates have been reduced in recent years. Average nitrate concentrations over this period were 18, 27, 48, and 40 mg L^{-1} for wells in the central drainage, fertilized control, corn-sludge, and grass-sludge areas, respectively. Therefore, as expected, higher levels of nitrate did move from the soil to the perched water table under sludge treatments.

Table 23. Season total runoff from the Rosemount Watershed (1975-1979).

Crop Treatment Year	Precip-itation cm	Run-off cm	Sedi-ment Mg ha^{-1}	Total N	Total P kg ha^{-1}	K
Grass						
Control						
1975	76.9	10.3	2.64	2.8	0.0	2.3
1976	31.6	2.1	0.03	1.4	0.1	1.4
1977	77.2	4.5	0.00	2.3	0.3	5.3
1978	81.2	7.5		5.0	0.8	9.4
1979	71.3	6.7	0.00	5.2	1.0	7.1
Total	338.2	31.1	2.67	16.8	2.2	25.4
Sludge						
1975	76.9	17.6	4.28	3.6	0.1	3.7
1976	31.6	2.6	trace	2.0	0.4	2.8
1977	77.2	5.9	trace	9.7	1.7	9.9
1978	81.2	10.3		23.8	6.7	13.2
1979	71.3	5.6	0.00	7.5	1.6	7.2
Total	338.2	42.0	4.28	46.6	10.5	36.7
Corn						
Control						
1975	76.9	2.4	0.13	1.2	0.1	0.4
1976	31.6	1.3	0.04	0.5	0.0	0.4
1977	77.2	2.4	0.23	1.5	0.1	0.7
1978	81.2	11.2		3.1	0.3	3.7
1979	71.3	7.9	0.44	4.6	0.4	2.8
Total	338.2	25.2	0.84	11.0	0.9	7.9
Sludge						
1975	76.9	12.5	0.29	24.3	0.2	3.5
1976	31.6	1.4	0.20	1.0	0.0	0.4
1977	77.2	7.6	0.67	10.9	0.7	6.2
1978	81.2	12.0		4.9	1.0	4.1
1979	71.3	6.7	0.28	15.5	0.6	4.0
Total	338.2	40.2	1.44	56.6	2.5	18.2

Deep well

The deep well located at a site adjacent to the Rosemount Watershed area and the watershed runoff reservoir were also sampled to complete the picture of ground and surface water quality. Activities at the Watershed have not affected water quality of the potable groundwater supply in this area. Nitrate nitrogen was very low in the deep well over the 1973 to 1986 period, much below the 10 mg L^{-1} NO_3-N standard for potable water (**Table 26**). Other water quality parameters are within normal ranges for groundwater in this area. Fecal coliform counts, an index to pathogens, were negligible. The thick, dense glacial till at this site prevented deep leaching of materials located in the near surface layers.

Surface reservoir

Surface runoff water stored in the watershed reservoir also had remarkably high quality. Concentrations of N and P were low in this water over the 1973 to 1986 period. Inorganic water quality was not unlike that of the deep well but fecal coliform counts were higher, as might be expected in surface waters.

Table 24. Soil water quality as determined by ceramic samplers in mid-terrace position

Treatment	NO_3-N	PO_4-P	Zn	Cu	Cr	Pb	Ni	Cd
Corn								
Control								
			60-cm depth					
1974	24	20						
1975	11	10	160	60	<10	<10	10	<1
1976	26	10	230	105	7	<15	<10	<1
1977	257	10	43	14	12	12	21	4
1978	92	40	54	4	<7	<12	6	<1
1979	64	20	92	4	<9	<5	11	<1
Sludge								
			60-cm depth					
1974	32	80						
1975	72	10	170	100	20	10	10	<1
1976	95	60	284	122	9	<15	<10	<1
1977	207	10	37	12	43	12	19	<4
1978	162	10	61	9	12	<12	12	<1
1979	200	20	43	7	<9	<5	13	<1
Grass								
Control								
			60-cm depth					
1975	44	70						
1976	22	20	296	148	5	<15	<10	<1
1977	17	20	208	62	12	11	24	<3
1978	19	0	110	18	<7	<13	6	<2
1979	30	0	219	14	<9	<5	<10	<1
Sludge								
			60-cm depth					
1975	54	20						
1976	21	20	341	46	6	<15	<10	<1
1977	115	40	124	74	11	<11	20	<3
1978	102	80	95	39	<7	<13	13	<2
1979	112	150	94	14	<9	<5	<10	<1

[1] **N amd P; Means of 8 replicated samples on each corn and grass control area and 16 ceramic samplers at 2- to 4-week intervals between May and October.**

[2] **Zn, Cu, Cr, Pb, Ni, and Cd; Means of composite samples from 8 replicated samples porous ceramic samplers in spring of year.**

[3] **No sample due to dry soil conditions.**

Summary

Protection of water quality is an important consideration when land applying fertilizers and sludge as soil amendments. Erosion can be a problem on sloping land used for row crops. Sediment and nutrients attached to the soil particles can cause environmental problems in surface waters. Controlling erosion, as done in the Rosemount Watershed study, prevented excessive sediment loads in runoff waters. Incorporation of fertilizers and injection of sludge into the soil was also important in reducing loss of nutrients in runoff. Crop type also had an effect on nutrient movement. Runoff waters from reed

at two depths for soils in the Rosemount Watershed study.[1,2]

NO_3-N	PO_4-P	Zn	Cu	Cr	Pb	Ni	Cd
			150-cm depth				
14	20						
18	40	60	40	10	<10	10	<1
31	40	101	27	5	<15	<10	<1
81	0	69	14	<7	11	20	4
228	30	68	4	<10	<12	9	<1
104	10	76	4	<5	<5	13	<4
			150-cm depth				
28	60						
48	20	10	70	20	<10	10	<1
78	10	131	42	10	<15	<10	<1
207	10	37	12	43	12	19	<4
348	20	74	11	<10	<12	31	<1
233	20	45	5	12	<5	51	<4
			150-cm depth				
35	10						
21	10	62	22	6	<15	<10	<1
—[3]	—	—	—	—	—	—	—
9	0	262	31	<6	<15	5	<2
45	0	122	8	<7<8	2	<1	
			150-cm depth				
18	10						
20	0	100	17	7	<15	<10	<1
39	10	—	—	—	—	—	—
70	10	80	23	<6	<15	8	<2
77	50	59	118	<8	8	<1	

replicated samples on each corn and grass sludge-treatment area taken by porous

from the control area and 16 replicated samples from the sludge-treated areas taken by

canarygrass treatment areas had higher P and K levels than those from corn areas that had much less residue on the surface over winter. Trace element levels were very low in runoff from the watershed, except when sludge was surface-applied in winter. Overall, surface water quality was very good at the study site.

High levels of nitrates impaired quality of shallow, but not the deep, groundwater at the Rosemount Watershed. Other water quality parameters, including trace elements levels in groundwater, were not affected by activities

Table 25. Groundwater quality as determined by nitrate nitrogen con- the Rosemount Watershed study area.[1]

Year	Well Number[2]							
	1	2	3	4	5	6	7	8
	mg L^{-1}							
1974	3.5	0.3	2.1	2.7	1.1	1.9	1.4	8.5
1975	5.7	1.3	5.5	9.4	8.2	12.9	9.8	18.6
1976	3.2	2.7	5.3	6.5	18.9	13.5	0.8	22.2
1978	2.1	2.3	0.4	1.7	4.8	1.7	7.6	66.3
1979	0.7	0.3	10.3	33.5	35.9	24.5	20.9	72.3
1980	—	10.2	—	2.4	4.8	2.2	—	4.9
1981	15.3	24.0	5.2	10.0	46.4	21.0	—	79.0
1982	14.4	14.9	6.8	4.2	47.2	15.7	20.4	85.1
1983	16.0	27.1	11.2	34.4	56.4	34.2	52.4	107.9
1984	54.4	33.4	34.0	55.6	69.2	7.3	59.4	85.2
1985	14.2	34.2	40.9	41.6	37.0	0.1	41.6	62.4
1986	16.8	25.8	28.4	31.5	17.9	22.4	51.1	75.1
Average	13.3	14.7	13.6	19.5	29.0	13.1	26.5	57.3
Std. Deviation	14.3	12.9	13.3	17.9	21.8	10.4	21.4	33.0

[1] **Samples are from a saturated zone 0.5- to 1.5-m from the surface which is**

[2] **Wells were grouped into the following areas: Central drainage channel, wells 6, 9, 10.**

at the site. The nitrate problem occurred due to rates of nitrogen-supplying fertilizer and sludge to the site which were in excess of that needed by crops. Nitrate levels in the shallow groundwater were decreasing in recent years in response to decreased application rates. At this site, the nitrates did not enter the deep groundwater because of a dense glacial till overlaying the deep aquifer. It is likely that the nitrates of the shallow groundwater are converted to gaseous nitrogen forms (denitrified) when the groundwater flows to the surface at a lower position in the landscape. Periodic monitoring of the small stream below the watershed showed no decrease in water quality over the study period.

centration in water samples from shallow wells in the perched water table in

9	10	11	12	Sampling Schedule
1.0	—	—	—	2-4 week interval (May to October)
17.8	65.3	34.3	—	3-week interval (June to November)
14.7	43.5	45.2	20.6	Monthly (April to November)
22.9	141.2	37.5	76.2	Monthly (April to November)
48.8	70.0	65.0	47.8	Monthly (April to November)
9.4	—	4.0	8.4	Monthly (April to November)
37.5	104.8	—	29.2	Annual (October)
57.0	114.0	65.4	50.2	Biannual (April and November)
54.8	59.7	100.0	55.5	Biannual (April and November)
50.8	32.1	111.0	56.0	Biannual (April and November)
28.0	52.4	71.6	0.1	Biannual (April and November)
35.2	70.6	39.1	0.1	Monthly (April to November)
31.5	75.4	57.3	34.4	
18.0	32.4	30.5	25.2	

above dense glacial till.
wells 1-5; Fertilizer control, well 7; Corn area wells 8, 11, 12; Grass area

Summary and Conclusions of Rosemount Watershed Study

The long term study of the Rosemount Watershed is the best example in Minnesota of a detailed environmental and agronomic analysis of sludge application to land. The value of sludge as a fertilizer substitute was established for corn and grass crops. Yields were on the average slightly better than those on fertilized control areas within the same watershed. Information was gathered as to the amount of nutrients the crops removed. Grass was more efficient than corn in removing N, P, and K supplied in the sludge. Choice of crop may be important if land application of sludge is primarily a disposal method. It was also found that reed canarygrass thrived on sludge amendments whereas some other forages performed poorly.

This study also answered questions concerning sludge application and the integrity of the environment. From a food-chain viewpoint, it was shown that negligible amounts of trace elements are removed by crops grown on sludge-

Table 26. Water quality parameters of the deep well and watershed runoff reservoir at the Rosemount Watershed study area.

	Source	Year												
		1973[1]	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
		mg L^{-1}												
Total N	Reservoir	2.7	3.0	1.6	1.6	0.8	2.0							
	Well	1.6	0.8	0.9	1.1	0.5	2.1							
NO_3-N	Reservoir	2.1	2.8	0.0	0.1	0.5	1.2	0.4	1.5	1.0	15.4	4.2	0.1	2.3
	Well	0.8	0.6	0.8	0.8	0.5	2.0	0.7	0.2	0.2	1.0	0.1	0.1	0.1
NH_4-N	Reservoir	0.1	0.2	0.3	0.6	0.3	0.1							
	Well	0.1	0.0	0.0	0.0	0.0	0.0							
Total P	Reservoir	0.06	0.04	0.09	0.20	0.50	0.60							
	Well	0.02	0.04	0.05	0.07	0.20	0.20							
PO_4-P	Reservoir	0.06	0.01	0.02	0.11	0.29	0.09							
	Well	0.01	0.01	0.01	0.01	0.02	0.03							
Ca	Reservoir	21	27	29	26	38	77							
	Well	70	75	79	84	81	101							
Mg	Reservoir	10	14	15	11	13	33							
	Well	24	25	25	24	27	31							
Na	Reservoir	2	4	6	9	11	11							
	Well	4	4	5	5	5	5							
K	Reservoir	2	2	5	10	8	5							
	Well	1	1	1	1	1	4							
EC X 10^{-4} S m^{-1}	Reservoir	180	282	310	317	350	350	660	540	370	580	610	550	660
	Well	560	557	560	577	570	570	540	550	550	620	1160	520	530
pH	Reservoir	7.8	8.3	8.3	8.1	8.1	8.1	7.7	7.9	7.4	8.2	8.4	8.3	8.1
	Well	8.3	8.1	8.0	8.0	8.0	8.3	7.9	7.9	7.6	8.2	8.0	8.3	8.2
Fecal coliform	Reservoir	150	41	29	1	30	40							
	Well	0	0	0	0	0	1							

[1] **Sampled prior to sludge application at this site.**

amended soils. For corn, trace metal levels in plant tissue were not different from the low levels found in corn grown with commercial fertilizer. Only Cu and Cr levels in grass tissue from sludge treatments were slightly elevated over that of grass supplied with commercial fertilizer. No health problems could be foreseen to animals or humans for the low levels observed.

From a water quality viewpoint, the Rosemount Watershed study showed that sludge application can be conducted in an environmentally safe fashion. Surface water quality was protected by adequate soil erosion measures taken at the site. Terraces were installed on the sloping ground. Soil conservation practices are very important for row crops and initial establishment of

permanent grass cover. More nutrients moved in surface runoff from grass terraces than from corn areas for two reasons. First, the fertilizer and sludge was not incorporated into the soil on the grass areas so surface runoff had greater contact with these materials. Second, grass tissue exposed to the elements over the winter lost nutrients to snowmelt runoff. Snowmelt was found to be an important source of runoff in this region. Winter spreading of sludge significantly increased the nutrient and trace metal content of snowmelt runoff at the study area. Surface application of sludge on sloping land during winter should be discouraged.

It was shown that fertilizer and sludge application rates, rates which supplied nitrogen in excess of crop uptake, affected the nitrate concentration of groundwater. At this study site, high nitrate concentration in the near-surface, perched groundwater did not affect the quality of the deep aquifer. In other areas excess nitrates may directly affect groundwater quality. This issue emphasizes the need for proper management of all nutrient sources in agriculture to protect groundwater resources.

In conclusion, the Rosemount Watershed study is one of very few studies to address the agronomic and environmental issues concerning sludge application to land. Overall, the recommendation is that sludge is a very good soil amendment to supply the nutrient needs of crops. The quality of the field crops grown on sludge amended soil is good. Also, our water resources can be protected if proper soil conservation and nutrient management methods are used. There are more benefits than costs in using the sludge resource.

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University of Minnesota

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APPENDIX A

Composition of Sludge Delivered from Local Sources — Rosemount Watershed

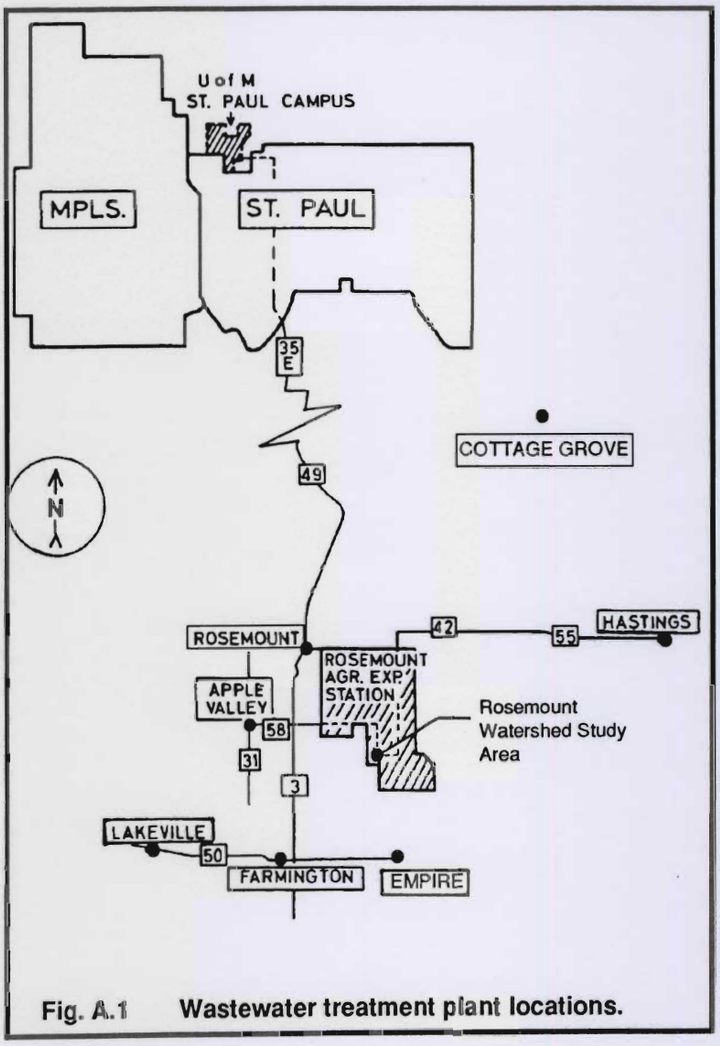

Fig. A.1 Wastewater treatment plant locations.

Liquid municipal sewage sludge was delivered from eight different wastewater treatment plants, at various times, in the local area. Some of the treatment plants have been taken out of service since the beginning of the experiment. Information presented in this appendix summarizes the available data on composition of the delivered sludge.

Presented are means of analyses of 400-mL samples taken from each truckload, composited monthly for the indicated years. Where a range of years is identified, the values reported are averaged over that range, therefore, the summary statistics provided in some of the following tables do not represent the true variability in sludge composition.

Volume of sludge delivered is given for the last year of the range. The exception is 1975, which includes all sludge delivered from November 1973 through 1975. No sludge was delivered in 1986.

Table A.1 Composition of Apple Valley sludge delivered to Rosemount Watershed.

Source	Year	Total solids %	Volatile solids %	Total N mgL^{-1}	NH_4-N mgL^{-1}	EC dSm^{-1}	pH	OM %	C %	P %	K %	Ca %	Na %	Mg %
Apple Valley	1974-75	2.06	1.42	1450	392	3.68	7.2	70.4	36.6	2.11	0.36	2.73	1.26	0.43
Apple Valley	1974-76	1.86	1.28	1310	342	3.52	7.3	71.1	40.2	2.20	0.46	2.63	1.47	0.52
Apple Valley	1974-77	1.83	1.23	1300	343	3.54	7.3	70.8	39.9	2.19	0.47	2.69	1.58	0.54
Apple Valley	1974-78	1.96	1.26	1310	340	3.50	7.3	70.8	39.9	2.19	0.47	2.69	1.58	0.54
Apple Valley	1974-79	1.96	1.26	1310	340	3.50	7.3	70.8	39.9	2.02	0.45	2.65	1.53	0.56
Average		1.93	1.29	1336	351	3.55	7.3	70.8	39.3	2.14	0.44	2.68	1.48	0.52
Standard deviation		0.09	0.07	64	23	0.08	0.0	0.2	1.5	0.08	0.05	0.04	0.13	0.05

Source	Year	Al %	Fe %	Cr $mg\ kg^{-1}$	Cu $mg\ kg^{-1}$	Zn $mg\ kg^{-1}$	Pb $mg\ kg^{-1}$	Mn $mg\ kg^{-1}$	B $mg\ kg^{-1}$	Ni $mg\ kg^{-1}$	Cd $mg\ kg^{-1}$	Volume m^3
Apple Valley	1974-75	0.57	0.54	24	620	775	120	140	35	12	8	4190
Apple Valley	1974-76	0.48	0.58	24	674	816	121	186	36	9	10	3480
Apple Valley	1974-77	0.48	0.57	27	675	808	123	182	38	10	10	12560
Apple Valley	1974-78	0.48	0.57	27	675	808	123	182	38	10	10	7200
Apple Valley	1974-79	0.72	0.81	32	578	708	113	227	36	13	8	7050
Average		0.55	0.61	27	644	783	120	183	37	11	9	
Standard deviation		0.10	0.11	3	44	45	4	31	1	2	1	

Table A.2 Composition of Blue Lake sludge delivered to Rosemount Watershed.

Source	Year	Total solids %	Volatile solids %	Total N mgL^{-1}	NH_4-N mgL^{-1}	EC dSm^{-1}	pH	OM %	C %	P %	K %	Ca %	Na %	Mg %
Blue Lake	1975	3.22	2.08	1540	465	4.10	6.8	65.4	33.7	—	—	—	—	—

Source	Year	Al %	Fe %	Cr $mg\ kg^{-1}$	Cu $mg\ kg^{-1}$	Zn $mg\ kg^{-1}$	Pb $mg\ kg^{-1}$	Mn $mg\ kg^{-1}$	B $mg\ kg^{-1}$	Ni $mg\ kg^{-1}$	Cd $mg\ kg^{-1}$	Volume m^3
Blue Lake	1975	—	—	150	685	960	—	—	—	30	4	2010

Table A.3 Composition of Cottage Grove sludge delivered to Rosemount Watershed.

Source	Year	Total solids	Volatile solids	Total N	NH_4-N	EC	pH	OM	C	P	K	Ca	Na	Mg
		%		mgL^{-1}	mgL^{-1}	dSm^{-1}					%			
Cottage Grove	1974-75	2.64	1.32	1220	566	5.07	7.9	51.8	26.3	—	—	—	—	—
Cottage Grove	1974-76	2.43	1.26	1220	508	4.67	7.9	51.8	26.3	3.72	0.29	3.80	2.59	0.58
Cottage Grove	1974-77	2.51	1.41	1300	501	4.90	7.9	53.9	28.9	3.21	0.27	3.76	2.77	0.57
Cottage Grove	1974-78	2.62	1.47	1340	508	4.95	7.9	53.9	28.9	3.21	0.27	3.76	2.77	0.57
Cottage Grove	1974-79	2.62	1.47	1340	508	4.95	7.9	54.8	28.9	2.81	0.23	3.97	2.27	0.57
Cottage Grove	1980	3.09	1.87	2180	950	6.10	8.0	62.1	32.8	2.56	0.27	4.69	0.96	0.62
Cottage Grove	1981	1.89	1.14	1700	870	6.75	7.9	63.3	32.7	2.57	0.40	4.46	1.75	0.67
Cottage Grove	1982	3.32	2.23	1380	693	6.58	7.8	64.5	34.2	2.90	0.43	4.45	1.63	0.59
Cottage Grove	1985	2.15	1.36	1640	840	6.67	8.0	67.2	31.4	2.31	0.34	4.08	1.14	0.63
Average		2.59	1.50	1480	660	5.63	7.9	58.1	30.0	2.59	0.28	3.66	1.76	0.53
Standard deviation		0.43	0.34	312	182	0.88	0.1	6.0	2.9	1.06	0.12	1.42	0.94	0.20

Source	Year	Al	Fe	Cr	Cu	Zn	Pb	Mn	B	Ni	Cd	Volume
		— % —						$mg\ kg^{-1}$				m^3
Cottage Grove	1974-75	—	—	32	340	1140	—	—	—	16	10	1100
Cottage Grove	1974-76	0.90	0.57	30	315	1100	166	242	33	17	9	2100
Cottage Grove	1974-77	0.77	0.56	40	304	1020	168	211	36	23	8	1320
Cottage Grove	1974-78	0.77	0.56	40	304	1020	168	211	36	23	8	1060
Cottage Grove	1974-79	0.81	0.60	53	325	984	187	200	33	27	8	1090
Cottage Grove	1980	1.25	0.74	29	443	1094	142	240	48	27	9	1840
Cottage Grove	1981	1.26	0.53	4700	610	915	153	205	16	43	7	4330
Cottage Grove	1982	1.05	0.58	334	469	1080	106	178	22	61	7	1930
Cottage Grove	1985	0.93	0.28	16	422	1070	116	210	25	30	7	230
Average		0.86	0.49	586	392	1047	134	189	28	30	8	
Standard deviation		0.37	0.22	1546	103	69	57	73	14	14	1	

Table A.4 Composition of Empire sludge delivered to Rosemount Watershed.

Source	Year	Total solids	Volatile solids	Total N	NH_4-N	EC	pH	OM	C	P	K	Ca	Na	Mg
		%		mgL^{-1}	mgL^{-1}	dSm^{-1}					%			
Empire	1984	1.70	1.15	2110	1440	9.27	7.9	62.2	32.4	3.09	0.76	4.92	0.98	0.79
Empire	1985	2.06	1.21	2090	1270	8.98	8.2	62.2	27.4	3.43	0.82	5.27	1.02	0.87
Average		1.88	1.18	2100	1355	9.13	8.0	62.2	29.9	3.26	0.79	5.10	1.00	0.83
Standard deviation		0.25	0.04	14	120	0.21	0.2	0.0	3.5	0.24	0.04	0.25	0.03	0.06

Source	Year	Al	Fe	Cr	Cu	Zn	Pb	Mn	B	Ni	Cd	Volume
		— % —						$mg\ kg^{-1}$				m^3
Empire	1984	0.82	0.65	102	613	1420	136	1360	29	38	9	5375
Empire	1985	0.73	0.76	76	825	1055	108	901	28	48	6	6280
Average		0.78	0.71	89	719	1238	122	1131	29	43	8	
Standard deviation		0.06	0.08	18	159	258	20	325	1	7	2	

Table A.5 Composition of Farmington sludge delivered to Rosemount Watershed.

Source	Year	Total solids	Volatile solids	Total N	NH_4-N	EC	pH	OM	C	P	K	Ca	Na	Mg
		%		mgL^{-1}	mgL^{-1}	dSm^{-1}					%			
Farmington	1974-75	3.40	2.00	2930	1510	9.42	8.0	61.0	31.6	4.68	2.05	7.89	0.97	0.85
Farmington	1974-76	3.42	2.03	2870	1550	8.01	7.9	61.0	31.6	4.32	1.65	7.93	0.87	0.92
Farmington	1974-77	3.42	2.03	2870	1550	8.01	7.9	61.0	31.6	4.32	1.65	7.93	0.87	0.92
Farmington	1974-78	3.39	2.00	2890	1550	7.97	7.9	61.0	31.6	4.32	1.65	7.93	0.87	0.92
Farmington	1974-79	3.39	2.00	2890	1550	7.97	7.9	61.0	31.6	4.17	1.52	7.92	0.87	0.92
Average		3.40	2.01	2850	1522	8.28	7.9	61.0	31.6	4.36	1.70	7.92	0.89	0.91
Standard deviation		0.02	0.02	60	26	0.64	0.0	0.0	0.0	0.04	0.04	0.00	0.00	0.00

Source	Year	Al	Fe	Cr	Cu	Zn	Pb	Mn	B	Ni	Cd	Volume
		%						$mg\ kg^{-1}$				m^3
Farmington	1974-75	0.32	0.37	50	310	980	120	280	25	14	9	2790
Farmington	1974-76	0.31	0.42	40	295	937	151	310	22	12	8	1550
Farmington	1974-77	0.31	0.42	40	295	937	151	310	22	12	8	490
Farmington	1974-78	0.31	0.42	40	295	937	151	310	22	12	8	740
Farmington	1974-79	0.33	0.51	49	314	928	161	301	22	13	8	1070
Average		0.32	0.43	44	302	944	417	302	23	13	8	
Standard deviation		0.01	0.05	5	9	21	16	13	1	1	0	

Table A.6 Composition of Hastings sludge delivered to Rosemount Watershed.

Source	Year	Total solids	Volatile solids	Total N	NH_4-N	EC	pH	OM	C	P	K	Ca	Na	Mg
		%		mgL^{-1}	mgL^{-1}	dSm^{-1}					%			
Hastings	1974-75	3.29	1.95	1820	710	5.04	8.0	60.3	31.6	3.56	0.32	3.46	0.85	0.42
Hastings	1974-76	3.02	1.79	1800	761	5.22	7.9	60.2	31.4	3.92	0.46	3.83	1.85	0.57
Hastings	1974-77	2.80	1.68	1690	740	5.24	7.9	59.6	31.3	3.48	0.32	3.78	1.13	0.52
Hastings	1974-78	2.87	1.68	1690	747	5.59	7.9	59.6	31.3	3.48	0.32	3.78	1.13	0.52
Hastings	1974-79	2.87	1.68	1690	747	5.59	7.9	59.4	31.3	3.31	0.32	3.87	1.46	0.58
Hastings	1980	3.21	1.74	2080	1030	6.94	7.9	54.8	28.6	2.67	0.30	3.96	1.78	0.64
Hastings	1981	2.89	1.72	1970	820	6.70	7.9	61.4	31.2	2.41	0.29	4.02	1.49	0.55
Hastings	1982	1.23	0.78	1830	755	5.89	7.9	61.1	32.1	2.87	0.25	3.76	1.47	0.51
Hastings	1984	3.77	2.26	2190	960	8.02	7.9	61.4	31.9	1.86	0.35	5.56	1.42	0.66
Hastings	1985	3.04	1.76	1140	160	3.78	6.9	61.4	28.5	2.10	0.29	3.90	1.56	0.64
Average		2.90	1.70	1790	743	5.80	7.8	59.9	30.9	2.97	0.32	3.79	1.41	0.56
Standard deviation		0.65	0.37	285	230	1.18	0.3	2.0	1.3	0.69	0.06	0.17	0.30	0.07

Source	Year	Al	Fe	Cr	Cu	Zn	Pb	Mn	B	Ni	Cd	Volume
		%						$mg\ kg^{-1}$				m^3
Hastings	1974-75	1.72	0.68	7610	1470	1290	340	150	37	14	9	4090
Hastings	1974-76	1.33	0.49	7490	1800	1220	260	198	56	14	5	7370
Hastings	1974-77	1.61	0.62	6960	1320	1170	327	172	43	14	8	8980
Hastings	1974-78	1.61	0.62	6960	1320	1170	327	172	43	14	8	5770
Hastings	1974-79	2.17	0.63	9120	1360	951	304	155	39	14	7	3430
Hastings	1980	1.86	0.60	14340	1200	288	222	120	19	29	4	2490
Hastings	1981	1.39	0.54	13740	1630	640	225	130	10	20	5	4300
Hastings	1982	1.36	0.61	13740	3430	355	204	83	16	8	4	1410
Hastings	1984	1.05	0.34	1760	732	487	159	114	22	13	5	3318
Hastings	1985	0.90	0.48	2374	924	991	153	138	24	16	5	702
Average		1.50	0.56	8409	1519	866	252	143	31	16	6	
Standard deviation		0.38	0.10	4458	740	365	70	33	15	6	2	

Table A.7 Composition of Lakeville sludge delivered to Rosemount Watershed.

Source	Year	Total solids %	Volatile solids %	Total N mgL^{-1}	NH_4-N mgL^{-1}	EC dSm^{-1}	pH	OM %	C %	P %	K %	Ca %	Na %	Mg %
Lakeville	1974-75	5.14	3.20	1600	325	2.94	7.8	58.1	34.4	1.63	0.21	3.32	0.67	0.52
Lakeville	1974-76	3.89	6.62	1250	277	2.78	7.8	58.1	34.4	1.50	0.15	3.25	0.58	0.50
Lakeville	1974-77	3.89	6.62	1250	277	2.78	7.8	58.1	34.4	1.50	0.15	3.25	0.58	0.50
Lakeville	1974-78	3.89	6.62	1250	277	2.78	7.8	58.1	34.4	1.50	0.15	3.25	0.58	0.50
Average		4.20	2.77	1338	289	2.82	7.8	58.1	34.4	1.53	0.17	3.27	0.60	0.51
Standard deviation		0.63	0.29	175	24	0.08	0.0	0.0	0.0	1.07	0.03	0.04	0.05	0.01

Source	Year	Al %	Fe %	Cr $mg\ kg^{-1}$	Cu $mg\ kg^{-1}$	Zn $mg\ kg^{-1}$	Pb $mg\ kg^{-1}$	Mn $mg\ kg^{-1}$	B $mg\ kg^{-1}$	Ni $mg\ kg^{-1}$	Cd $mg\ kg^{-1}$	Volume m^3
Lakeville	1974-75	0.89	1.11	910	400	1110	7050	240	37	25	17	280
Lakeville	1974-76	0.79	1.06	1520	808	1260	6400	230	34	39	16	70
Lakeville	1974-77	0.79	1.06	1520	808	1260	6400	230	34	39	16	370
Lakeville	1974-78	0.79	1.06	1520	808	1260	6400	230	34	39	16	740
Average		0.82	1.07	1368	706	1223	6563	233	35	36	16	
Standard deviation		0.05	0.03	305	204	75	325	5	2	7	1	

Table A.8 Composition of St. Paul Park sludge delivered to Rosemount Watershed.

Source	Year	Total solids %	Volatile solids %	Total N mgL^{-1}	NH_4-N mgL^{-1}	EC dSm^{-1}	pH	OM %	C %	P %	K %	Ca %	Na %	Mg %
St. Paul Park	1975	7.48	2.54	2860	723	4.19	7.7	50.8	28.0	—	—	—	—	—

Source	Year	Al %	Fe %	Cr $mg\ kg^{-1}$	Cu $mg\ kg^{-1}$	Zn $mg\ kg^{-1}$	Pb $mg\ kg^{-1}$	Mn $mg\ kg^{-1}$	B $mg\ kg^{-1}$	Ni $mg\ kg^{-1}$	Cd $mg\ kg^{-1}$	Volume m^3
St. Paul Park	1975	—	—	—	—	—	—	—	—	—	—	90

Table A.9 Average composition of sludge delivered to Rosemount Watershed (1974 to 1986).[1]

Source	Year	Total solids %	Volatile solids %	Total N mgL^{-1}	NH_4-N mgL^{-1}	EC dSm^{-1}	pH	OM %	C %	P %	K %	Ca %	Na %	Mg %
Average	1974-1986	2.98	1.76	1790	751	5.56	7.8	60.9	32.2	2.65	0.51	3.98	1.25	0.57
Standard deviation		1.09	0.52	562	417	1.95	0.3	5.4	3.6	1.18	0.51	1.97	0.68	0.22

Source	Year	Al %	Fe %	Cr $mg\ kg^{-1}$	Cu $mg\ kg^{-1}$	Zn $mg\ kg^{-1}$	Pb $mg\ kg^{-1}$	Mn $mg\ kg^{-1}$	B $mg\ kg^{-1}$	Ni $mg\ kg^{-1}$	Cd $mg\ kg^{-1}$	Volume m^3
Average	1974-1986	0.86	0.57	2580	767	947	853	236	28	22	8	3059
Standard deviation		0.53	0.26	4310	620	288	2020	237	13	13	4	
Number Observations:		37										

[1] These are arithmetic means for all sludge deliveries over time and are not weighted for amount of sludge delivered, therefore are not representative of an actual sludge mixture. Some information on variability of sludge composition has been lost due to averaging of data during the 1974-1979 period.

APPENDIX B

Composition of Sludge Applied to Crops — Rosemount Watershed

Liquid sewage sludge was applied to corn and grass treatment areas from storage lagoons at the Rosemount Watershed study site. Samples of sludge were taken at three sampling positions on each treatment area during application and composited. Composition values were averaged over all applications and treatment areas for a crop. In general, sludge was applied to corn the fall before the year reported in the following tables. Values for the grass treatments include sludge applied the fall before and sludge applied during the growing season of the year reported in the tables.

Total solids, volatile solids, electrical conductivity (EC), and reaction (pH) are based on the bulk liquid sample. Remaining sludge constituents are referenced to the mass of total solids after freeze-drying the sample. Mean values were calculated over all years sludge was applied to a crop. Three means are reported; the arithmetic mean, a mean weighted by the mass of dry sludge solids applied, and a mean weighted by the number of applications. Of these, the mean weighted by dry mass best represents average composition of sludge applied to a crop treatment area.

Table B.1 Composition of sludge applied to corn by year.

Year	Total Solids	Volatile Solids	Total N	NH_4-N	EC	pH	Organic Matter	Carbon
	%	%	%	%	dSm^{-1}		%	%
1974	0.69	0.34	13.80	9.60	4.70	7.90	55.1	30.2
1975	1.16	0.38	5.93	3.53	3.52	8.00	32.3	18.4
1976	2.83	1.41	5.20	2.11	3.92	7.90	50.8	25.4
1977	2.82	1.57	6.17	2.62	5.19	8.00	56.1	27.3
1978	1.31	0.59	6.95	2.81	3.44	7.90	47.5	24.5
1979	3.42	1.78	4.82	1.62	4.87	7.80	51.1	28.2
1980	4.56	2.13	4.42	1.30	4.08	7.70	47.2	24.7
1981	3.95	2.11	5.11	1.61	4.89	7.60	55.3	28.4
1982	2.50	1.20	5.42	2.09	4.08	7.50	49.4	25.6
1983	2.53	1.20	3.82	2.09	4.08	7.50	49.4	25.6
1985	2.22	0.97	4.56	1.90	4.08	7.80	45.5	23.9

Year	P	K	Ca	Na	Mg	Al	Fe	Cr
				%				$mg\ kg^{-1}$
1974	4.02	0.42	4.56	3.14	0.85	0.50	0.52	502
1975	1.92	0.81	3.79	1.64	0.87	1.04	0.81	1490
1976	3.43	0.42	4.54	1.17	0.63	1.09	0.76	4360
1977	3.11	0.47	4.42	2.07	0.75	2.41	0.65	5650
1978	2.45	0.55	4.03	2.13	0.83	1.83	0.89	3360
1979	2.67	0.29	5.11	1.31	0.69	2.31	1.10	7130
1980	2.29	0.20	4.48	0.71	0.66	1.47	1.32	3140
1981	2.76	0.23	4.27	1.10	0.62	1.87	0.90	13180
1982	2.65	0.34	4.41	1.29	0.70	1.65	0.96	6400
1983	2.09	0.15	4.41	1.29	0.70	1.65	0.96	6400
1985	2.17	0.31	4.16	1.22	0.96	1.41	0.74	2800

Year	Cu	Zn	Pb	Mn	B	Ni	Cd	Dry Solids	Applic-ations
				$mg\ kg^{-1}$				$Mg\ ha^{-1}$	
1974	372	542	219	216	74	15	5	1.8	2
1975	294	535	315	388	34	15	5	8.8	6
1976	842	1200	325	316	34	16	8	17.8	2
1977	842	1010	221	255	58	15	6	10.7	1
1978	650	725	377	275	47	18	6	13.2	3
1979	987	894	587	259	35	17	6	21.6	2
1980	836	993	294	298	23	26	7	17.3	1
1981	280	958	274	229	25	32	6	15.0	1
1982	909	876	338	293	30	22	7	13.6	1
1983	909	876	338	293	30	22	7	9.6	1
1985	719	841	205	397	27	20	7	7.1	1

Table B.2 Composition of sludge applied to grass by year.

Year	Total Solids	Volatile Solids	Total N	NH_4-N	EC	pH	Organic Matter	Carbon
	%	%	%	%	dSm^{-1}		%	%
1974	1.45	0.56	7.27	4.40	5.72	8.20	41.0	20.4
1975	1.20	0.37	4.13	2.20	2.49	7.90	35.8	18.2
1976	1.83	0.90	6.40	3.14	4.45	8.00	50.3	25.2
1977	2.00	1.01	5.69	2.34	4.44	7.90	40.1	19.2
1978	1.30	0.62	6.07	3.11	4.48	7.80	48.1	24.9
1979	2.12	1.08	5.23	1.96	4.06	7.80	53.4	27.6
1980	1.74	0.86	5.75	2.26	4.62	7.80	52.6	25.7
1981	2.87	1.60	5.63	2.07	5.07	7.80	54.5	27.7
1982	2.00	1.02	5.71	2.31	4.41	7.80	50.3	25.4
1983	2.00	1.02	5.71	2.31	4.41	7.80	50.3	25.4
1984	1.94	1.00	5.93	2.58	4.35	7.80	50.8	25.7

Year	P	K	Ca	Na	Mg	Al	Fe	Cr
				%				$mg\ kg^{-1}$
1974	2.23	1.33	4.05	1.93	0.79	1.07	0.87	796
1975	2.25	0.70	4.32	1.68	1.07	0.80	0.84	2130
1976	2.79	0.54	3.70	1.72	0.66	1.26	0.91	3073
1977	2.21	0.56	4.98	2.24	1.10	1.74	0.90	3570
1978	2.53	0.53	4.83	2.20	0.94	1.69	0.83	4690
1979	2.62	0.36	4.11	1.70	0.67	2.17	0.92	7270
1980	2.56	0.51	4.42	3.15	0.79	1.72	0.70	12600
1981	2.47	0.28	4.24	1.38	0.65	1.62	0.85	10240
1982	2.50	0.43	4.32	1.83	0.76	1.64	0.86	9520
1983	2.50	0.43	4.32	1.83	0.76	1.64	0.86	9520
1984	2.46	0.43	4.29	1.76	0.75	1.60	0.84	9090

Year	Cu	Zn	Pb	Mn	B	Ni	Cd	Dry Solids	Applic-ations
				$mg\ kg^{-1}$				$Mg\ ha^{-1}$	
1974	432	734	302	339	46	14	9	7.4	4
1975	484	742	241	400	38	19	7	2.4	2
1976	919	945	222	362	24	29	6	10.6	3
1977	577	605	177	323	53	15	5	22.5	9
1978	768	663	380	230	49	18	5	15.1	10
1979	1400	1300	456	233	37	16	6	26.9	8
1980	1240	436	240	164	42	17	5	24.8	8
1981	1190	834	233	236	8	31	6	34.0	7
1982	1066	826	273	253	28	25	6	12.6	5
1983	1066	826	273	253	28	25	6	3.8	1
1984	1040	816	268	270	28	25	6	11.7	3

Table B.3 Average composition of sludge applied to corn (1974—1986).

Total Solids %	Volatile Solids %	Total N %	NH_4-N %	EC dSm^{-1}	pH	OM %	Carbon %	
2.54	1.24	6.02	2.84	4.26	7.8	49.1	25.6	(not weighted)
2.90	1.43	5.33	2.16	4.27	7.8	49.3	25.7	(weighted by solids)
2.06	0.97	6.36	3.23	4.04	7.9	45.4	24.1	(weighted by 21 applications)

P	K	Ca	Na %	Mg	Al	Fe	Cr $mg\ kg^{-1}$	
2.69	0.38	4.38	1.55	0.75	1.57	0.87	4950	(not weighted)
2.64	0.36	4.44	1.37	0.72	1.69	0.94	5650	(weighted by solids)
2.58	0.50	4.26	1.67	0.78	1.43	0.85	3840	(weighted by 21 applications)

Pb	Mn	B $mg\ kg^{-1}$	Ni	Cd	
318	293	38	20	6	(not weighted)
348	290	34	20	6	(weighted by solids)
331	310	39	18	6	(weighted by 21 applications)

Table B.4 Average composition of sludge applied to grass (1974—1984).

Total Solids %	Volatile Solids %	Total N %	NH_4-N %	EC dSm^{-1}	pH	OM %	Carbon %	
1.86	0.91	5.78	2.61	4.41	7.9	47.9	24.1	(not weighted)
2.04	1.05	5.76	2.43	4.55	7.8	49.8	25.1	(weighted by solids)
1.89	0.95	5.80	2.56	4.51	7.9	48.5	24.4	(weighted by 60 applications)

P	K	Ca	Na %	Mg	Al	Fe	Cr $mg\ kg^{-1}$	
2.46	0.56	4.33	1.95	0.81	1.54	0.85	6590	(not weighted)
2.49	0.48	4.37	1.99	0.79	1.69	0.85	7640	(weighted by solids)
2.47	0.52	4.43	2.05	0.83	1.66	0.85	6840	(weighted by 60 applications)

Pb	Mn	B $mg\ kg^{-1}$	Ni	Cd	
279	278	35	21	6	(not weighted)
283	254	33	21	6	(weighted by solids)
290	260	37	20	6	(weighted by 60 applications)

Table B.5 Total elements applied in sludge to corn treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	kg ha^{-1}										
1974	211	64	6	1.1	0.4	0.8	0.10	0.9	0.40	0.03	0.02
1975	499	165	71	4.4	3.5	2.4	0.30	12.9	2.30	0.13	0.04
1976	898	614	72	21.4	5.7	14.7	0.60	76.1	5.80	0.29	0.15
1977	617	332	41	10.8	2.7	9.0	0.62	60.5	2.25	0.16	0.06
1978	897	201	65	9.7	3.4	8.6	0.50	44.5	5.10	0.23	0.07
1979	1040	579	62	16.7	5.0	14.0	0.40	53.6	5.00	0.44	0.11
1980	742	382	30	14.4	3.4	19.2	0.37	198.0	4.10	0.49	0.09
1981	767	414	35	14.4	3.4	4.2	0.38	197.7	4.11	0.48	0.09
1982	746	316	26	13.6	3.8	14.5	0.02	110.0	3.12	0.56	0.09
1983	367	202	15	8.6	3.4	7.8	0.04	116.9	2.72	0.20	0.05
1984	0	0	0	0.0	0.0	0.0	0.00	0.0	0.00	0.00	0.00
1985	324	154	22	6.0	2.8	5.1	0.19	19.9	1.46	0.14	0.05
1986	400	203	40	7.1	3.8	5.8	0.19	14.9	1.11	0.23	0.04
Sum	7507	3626	485	128.1	41.4	106.0	3.71	905.8	37.47	3.38	0.85

Table B.6 Total elements applied in sludge to grass treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	kg ha^{-1}										
1976	1256	528	161	17.8	7.4	15.0	0.70	45.0	5.30	0.45	0.16
1977	1270	583	93	17.4	5.1	17.7	1.20	83.1	6.20	0.63	0.14
1978	908	382	79	10.0	3.4	11.6	0.71	70.8	5.80	0.27	0.09
1979	1380	555	73	33.0	6.5	35.6	0.99	182.0	11.40	0.46	0.16
1980	1360	648	125	11.1	4.1	31.5	1.03	324.0	6.10	0.41	0.13
1981	1914	840	95	28.4	8.0	40.5	0.27	348.2	7.92	1.05	0.20
1982	729	309	42	10.3	2.9	15.0	0.28	197.8	2.75	0.50	0.06
1983	260	129	8	4.8	1.0	5.8	0.14	204.7	1.12	0.13	0.03
Sum	9077	3974	676	132.7	38.4	172.6	5.32	1455.6	46.59	3.90	0.97

APPENDIX C

Elemental Composition of Corn Tissue at Harvest — Rosemount Watershed

At harvest, corn yields were measured, then composite tissue samples were taken comprising grain, cob, and stover. Subsamples were sent to at least three laboratories for various analyses. Most of the metal concentrations were obtained by spark emission (1974 and 1975) or inductively coupled plasma (1976 to present) spectrometry. Chromium, lead, and cadmium were analyzed by atomic absorption with background correction (1977 to present). Total nitrogen was obtained with a micro-Kjeldahl procedure.

Elemental concentration in fodder, a value based on the whole above-ground portion of the harvested plant, is calculated by taking the mean concentration of grain, cob, and stover weighted by the yield mass of each component. All tissue concentrations are reported in micrograms per gram of oven-dry (65°C) plant tissue, except N which is reported as a percentage. The ID field contains an identifier describing the terrace and permanent sample line for the sample. Summary statistics are provided and are grouped by treatment (Sludge or Control).

ROSEMOUNT WATERSHED CORN DATA 1974

TISSUE	ID	P	K	CA	MG	NA	AL	ZN	B	PB	CR	FE	MN	CU	NI	CD	%N
- SLUDGE -		(ug/g)===>>>															
GRAIN	TERRACE 6	3784.00	5920.00	NA	1450.00	NA	NA	22.00	3.25	0.30	0.35	27.20	NA	1.38	0.20	0.02	1.55
STOVER		1146.00	14950.00	4187.00	3257.00	NA	62.09	13.18	6.10	1.72	0.72	99.10	66.37	5.11	0.33	0.10	0.96
COB		344.00	6960.00	NA	200.00	NA	NA	10.88	4.66	0.30	1.40	NA	17.57	3.38	0.99	0.05	0.32
FODDER		2176.25	10641.61	NA	2288.66	NA	NA	16.65	4.82	1.03	0.62	NA	NA	3.44	0.32	0.06	1.16
GRAIN	TERRACE 7	3762.00	5920.00	NA	1381.00	NA	NA	22.10	3.25	0.30	0.35	25.90	NA	1.38	0.20	0.02	1.55
STOVER		1224.00	13760.00	3796.00	3340.00	NA	54.15	13.41	6.43	1.10	0.71	88.60	57.62	5.11	0.35	0.13	0.88
COB		430.00	8040.00	NA	226.00	NA	NA	11.44	4.01	0.30	1.32	NA	NA	3.41	0.79	0.03	0.28
FODDER		2197.42	10167.57	NA	2321.66	NA	NA	16.80	4.97	0.72	0.61	NA	NA	3.47	0.32	0.08	1.11
- SLUDGE MEANS -																	
GRAIN		3773.00	5920.00	NA	1415.50	NA	NA	22.05	3.25	0.30	0.35	26.55	NA	1.38	0.20	0.02	1.55
STOVER		1185.00	14355.00	3991.50	3298.50	NA	58.12	13.30	6.27	1.41	0.72	93.85	62.00	5.11	0.34	0.12	0.92
COB		387.00	7500.00	NA	213.00	NA	NA	11.16	4.34	0.30	1.36	NA	NA	3.40	0.89	0.04	0.30
FODDER		2186.84	10404.59	NA	2305.16	NA	NA	16.72	4.89	0.87	0.61	NA	NA	3.46	0.32	0.07	1.13
- CONTROL -																	
GRAIN	TERRACE 4	3372.00	5270.00	NA	1228.00	NA	NA	18.80	3.04	0.32	0.23	19.60	13.59	1.38	0.21	0.02	1.59
STOVER		1341.00	16160.00	3444.00	2933.00	NA	111.15	16.12	7.39	1.18	1.13	152.20	51.19	4.32	0.63	0.11	0.96
COB		413.00	7010.00	NA	165.00	NA	NA	13.13	3.47	0.30	1.41	NA	12.39	3.41	0.91	0.09	0.31
FODDER		2085.80	11172.14	NA	2058.07	NA	NA	16.98	5.38	0.78	0.79	NA	33.46	3.08	0.48	0.07	1.17

Emission Spectrometer data

NA Data not available or Calculation not applicable

ROSEMOUNT WATERSHED CORN DATA 1975

TISSUE	ID	P	K	CA	MG	NA	AL	ZN	B	PB	CR	FE	MN	CU	NI	CD	%N
- SLUDGE -		(ug/g)===>>>															
GRAIN	TERRACE 6	3902.00	5520.00	0.00	1729.00	0.00	0.00	21.79	2.12	0.00	0.13	0.00	0.00	2.05	0.32	<0.04	1.78
STOVER		1491.00	9730.00	4458.00	3931.00	0.00	57.08	20.48	4.73	1.25	0.77	111.10	51.74	4.50	0.56	0.07	1.15
COB		389.00	4290.00	0.00	224.00	0.00	0.00	8.10	0.00	0.00	0.36	0.00	0.00	2.09	0.32	0.00	0.33
FODDER		2426.29	7548.45	2244.93	2725.80	0.00	28.74	20.11	3.28	0.63	0.47	55.95	26.05	3.29	0.44	0.04	1.35
GRAIN	TERRACE 7	3757.00	5400.00	0.00	1665.00	0.00	0.00	21.65	0.00	0.00	0.16	24.93	0.00	1.99	0.25	0.00	1.81
STOVER		1479.00	13040.00	5504.00	4945.00	0.00	99.49	20.74	5.13	1.15	0.74	159.90	52.14	5.83	0.39	0.09	1.26
COB		357.00	4530.00	0.00	280.00	0.00	0.00	8.65	0.00	0.00	0.41	0.00	0.00	2.19	0.43	0.00	0.30
FODDER		2365.42	9144.12	2744.47	3196.35	0.00	49.61	20.22	2.56	0.57	0.47	90.36	26.00	3.92	0.33	0.04	1.42
- SLUDGE MEANS -																	
GRAIN		3829.50	5460.00	0.00	1697.00	0.00	0.00	21.72	1.06	0.00	0.15	12.47	0.00	2.02	0.29	0.00	1.80
STOVER		1485.00	11385.00	4981.00	4438.00	0.00	78.29	20.61	4.93	1.20	0.76	135.50	51.94	5.17	0.48	0.08	1.21
COB		373.00	4410.00	0.00	252.00	0.00	0.00	8.38	0.00	0.00	0.39	0.00	0.00	2.14	0.38	0.00	0.32
FODDER		2395.86	8346.29	2494.70	2961.08	0.00	39.18	20.16	2.92	0.60	0.47	73.15	26.03	3.60	0.39	0.04	1.39
- CONTROL -																	
GRAIN	TERRACE 4	2641.00	4690.00	0.00	1141.00	0.00	0.00	15.33	2.42	0.00	0.19	0.00	0.00	1.25	0.32	<0.04	1.72
STOVER		1292.00	11130.00	4380.00	4242.00	0.00	63.07	20.24	4.87	1.56	0.65	126.80	56.40	5.08	0.49	0.08	1.20
COB		393.00	5050.00	0.00	264.00	0.00	0.00	10.05	0.00	0.00	0.65	0.00	0.00	3.09	0.47	0.00	0.33
FODDER		1754.49	8210.99	2377.93	2764.42	0.00	34.24	17.63	3.58	0.85	0.47	68.84	30.62	3.46	0.42	0.04	1.34

Emission Spectrometer data

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1976 TISSUE	ID	P (ug/g)	K ====>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	PB	NI	CR	CD	% N
-- SLUDGE --																	
GRAIN	6	3506.00	3899.00	32.78	1747.00	1.45	28.52	5.21	8.78	37.20	4.19	3.25	0.94	0.44	0.23	0.05	1.770
STOVER	6	1229.00	11656.00	6150.00	5167.00	89.31	115.30	17.53	44.51	31.80	5.95	8.58	2.28	1.15	1.31	0.21	1.080
COB	6	327.20	4058.00	141.80	451.80	3.51	10.72	0.00	6.00	18.85	2.81	2.16	0.00	0.99	1.07	0.00	0.310
FODDER		2004.54	8336.05	3530.83	3616.52	51.72	76.91	11.91	28.99	32.95	5.11	6.22	1.64	0.88	0.90	0.14	1.283
G	7	3423.00	4406.00	34.24	28603.00	0.96	31.09	6.83	10.50	39.11	3.85	3.21	0.89	0.33	0.16	0.04	1.780
S	7	1184.00	12541.00	6805.00	5327.00	125.90	157.50	18.48	46.35	30.95	6.43	10.99	3.92	1.74	1.94	0.35	1.010
C	7	299.80	4018.00	1.34	455.60	1.34	12.70	0.00	4.92	21.30	2.63	2.06	0.00	1.10	1.35	0.00	0.300
FODDER		2121.59	8225.68	3235.82	15408.50	60.11	89.49	11.81	27.03	33.87	4.98	6.80	2.26	1.06	1.09	0.18	1.301
— CONTROL —																	
G	4	3182.00	3759.00	36.96	1691.00	3.75	31.29	6.45	9.65	32.12	3.85	3.04	0.87	0.65	0.29	0.05	1.680
S	4	764.80	12326.00	5541.00	4201.00	81.55	109.40	14.06	50.19	21.56	6.06	9.94	3.43	1.04	1.34	0.25	0.843
C	4	290.60	4313.00	150.30	417.60	7.99	14.47	0.00	6.32	11.35	2.45	2.74	0.00	1.35	1.50	0.00	0.310
FODDER		1766.97	7922.81	2690.78	2784.85	41.49	67.33	9.54	28.83	25.22	4.79	6.33	2.02	0.90	0.90	0.14	1.158

- - - - ROSEMOUNT WATERSHED CORN DATA 1976 MEANS - - - - - TISSUE	TREATMENT	P (ug/g)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	PB	NI	CR	CD	% N
GRAIN	SLUDGE	3464.50	4152.50	33.51	15175.00	1.20	29.81	6.02	9.64	38.16	4.02	3.23	0.91	0.38	0.19	0.04	1.775
STOVER	SLUDGE	1206.50	12098.50	6477.50	5247.00	107.61	136.40	18.01	45.43	31.38	6.19	9.79	3.10	1.45	1.62	0.28	1.045
COB	SLUDGE	313.50	4038.00	71.57	453.70	2.42	11.71	0.00	5.46	20.08	2.72	2.11	0.00	1.04	1.21	0.00	0.305
FODDER	SLUDGE	2063.07	8280.87	3383.32	9512.51	55.92	83.20	11.86	28.01	33.41	5.04	6.51	1.95	0.97	1.00	0.16	1.292
GRAIN	CONTROL	3182.00	3759.00	36.96	1691.00	3.75	31.29	6.45	9.65	32.12	3.85	3.04	0.87	0.65	0.29	0.05	1.680
STOVER	CONTROL	764.80	12326.00	5541.00	4201.00	81.55	109.40	14.06	50.19	21.56	6.06	9.94	3.43	1.04	1.34	0.25	0.843
COB	CONTROL	290.60	4313.00	150.30	417.60	7.99	14.47	0.00	6.32	11.35	2.45	2.74	0.00	1.35	1.50	0.00	0.310
FODDER	CONTROL	1766.97	7922.81	2690.78	2784.85	41.49	67.33	9.54	28.83	25.22	4.79	6.33	2.02	0.90	0.90	0.14	1.158

Elements P through CD analysed by Inductively Coupled Plasma Spectroscopy, except where noted, to present.

ROSEMOUNT WATERSHED CORN DATA 1977 TISSUE	P (ug/g) ===>>>	K	CA	MG	NA	AL	ZN	B	FE	MN	CU	NI	CD	CR	PB	%N
- SLUDGE -																
GRAIN	3413.00	3851.00	33.31	1642.00	2.26	1.26	28.06	1.31	20.32	6.42	0.12	0.23	0.13	0.26	0.70	1.61
STOVER	1089.00	16343.00	6883.00	3798.00	18.69	134.90	30.41	7.38	164.90	48.81	6.38	1.23	0.20	1.27	1.74	1.05
COB	272.30	4697.00	100.30	301.00	2.53	1.54	18.49	1.36	12.32	4.23	2.51	1.29	0.10 *	0.35	0.60 *	0.29
FODDER	2161.85	9297.94	2988.37	2463.56	9.36	58.83	28.31	3.93	81.94	24.50	3.00	0.75	0.16	0.70	1.14	1.26
- CONTROL -																
GRAIN	3077.00	3757.00	30.74	1556.00	1.67	2.05	24.51	1.70	23.61	5.78	0.82	0.20	0.13	0.25 *	0.62	1.55
STOVER	642.30	16143.00	4334.00	3238.00	15.62	97.60	13.40	6.72	122.40	54.60	4.38	1.07	0.14	1.43	1.16	0.80
COB	270.10	3588.00	98.69	289.40	4.25	2.00	13.26	1.47	13.64	4.68	2.40	1.12	0.15	1.34	0.60	0.31
FODDER	1808.75	9043.48	1877.63	2173.58	7.85	42.93	18.85	3.83	65.08	26.58	2.47	0.65	0.14	0.84	0.85	1.13

* Detection limit for respective element, tissue, year.

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1978 TISSUE	ID	P (ug/g)	K ==========>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
— SLUDGE —																	
GRAIN	6 2	3716.90	4199.10	30.56	1626.50	1.89	22.04	2.12	7.47	25.72	0.39	1.60	0.76	0.25	0.74	0.23	1.65
	6 2	3703.20	4135.60	31.86	1621.80	2.43	21.53	2.74	7.91	25.39	0.35	1.58	0.15				1.71
STOVER	6 2	1210.70	15419.00	4211.80	2804.90	72.93	134.41	92.04	30.73	17.39	6.83	7.23	0.15	0.27	1.33	0.50	0.65
	6 2	1158.90	15223.00	4105.30	2714.80	71.04	130.86	88.90	29.66	15.62	6.42	6.88	0.15				0.72
COB	6 2	215.63	3067.90	101.15	233.43	12.19	11.68	4.55	4.59	6.37	3.07	1.35	0.28	0.25	0.74	0.95	0.29
	6 2	206.96	3024.10	100.75	231.95	15.43	11.80	4.84	4.43	6.18	3.25	1.34	0.81				0.29
FODDER		2444.66	8281.71	1596.83	1929.45	29.58	62.77	35.90	15.91	20.42	2.98	3.63	0.35	0.26	0.96	0.40	1.18
G	6 4	3121.80	3810.80	36.23	1487.60	2.56	20.90	2.86	6.51	25.68	0.42	1.71	0.15	0.25	0.74	0.23	1.55
	6 4	3207.50	3811.80	36.15	1528.80	1.89	20.45	2.69	6.29	26.63	0.43	1.71	0.15				1.55
S	6 4	900.97	12025.00	5186.10	3568.90	54.07	96.75	91.69	33.42	15.42	6.52	6.37	0.15	0.25	1.26	1.73	0.74
	6 4	890.04	12368.00	5176.90	3585.20	54.94	97.58	88.56	33.39	16.39	6.49	6.48	0.29				0.75
C	6 4	213.56	5294.20	97.29	228.35	15.77	11.92	4.30	4.70	6.62	3.48	1.64	1.11	0.25	0.74	0.91	0.28
	6 4	215.63	5331.80	94.44	221.25	2.38	11.36	4.16	4.42	6.75	2.61	1.49	0.58				0.28
FODDER		2250.87	6218.67	1424.53	1931.61	16.98	40.29	26.39	13.46	21.39	2.33	2.96	0.24	0.25	0.88	0.70	1.20
G	6 5	3394.40	3970.70	33.72	1446.30	2.02	18.90	2.81	6.35	22.93	0.31	2.06	0.15	0.25	0.74	0.23	1.63
	6 5	3484.90	3995.80	33.88	1480.10	2.00	19.37	2.79	6.61	23.23	0.32	2.04	0.15				1.61
S	6 5	1467.40	15801.00	5060.70	2076.00	65.30	110.18	88.89	34.18	17.30	6.79	8.68	0.45	0.25	1.56	1.36	0.96
	6 5	1473.20	15976.00	5148.50	2086.60	66.32	112.42	90.98	34.18	16.48	6.89	8.65	0.34				0.96
C	6 5	260.51	3339.60	90.71	216.20	3.93	12.36	4.38	4.33	6.95	2.52	1.30	0.60	0.25	0.74	1.50	0.29
	6 5	250.09	3288.80	91.45	212.16	1.90	13.48	5.32	4.50	7.91	2.49	1.32	1.10				0.29
FODDER		2388.48	8498.74	1988.68	1585.52	26.62	54.00	36.49	16.94	19.26	3.03	4.52	0.31	0.25	1.06	0.78	1.24
TERRACE MEAN...		2361.34	7666.37	1670.01	1815.53	24.39	52.35	32.93	15.44	20.36	2.78	3.71	0.30	0.25	0.97	0.63	1.21
G	7 2	3418.40	3841.30	36.75	1554.60	1.78	20.10	2.50	6.53	25.28	0.40	1.87	0.15	0.25	0.74	0.23	1.60
	7 2	3268.70	3770.70	36.34	1485.60	2.50	19.13	2.36	6.26	25.01	0.36	1.76	0.15				1.67
S	7 2	912.55	14537.00	4703.70	2775.30	66.32	107.88	62.07	30.30	19.15	5.82	6.47	0.37	0.27	1.33	1.00	0.76
	7 2	925.10	14633.00	4594.00	2724.90	64.56	103.75	61.91	29.25	18.50	5.63	6.48	0.15				0.76
C	7 2	198.70	3837.30	87.95	309.45	1.74	8.50	3.24	3.84	7.45	2.45	1.21	0.15	0.25	0.74	0.64	0.28
	7 2	189.62	3955.40	88.96	302.72	0.91	8.57	3.04	3.64	6.07	2.37	1.23	0.53				0.28
FODDER		2311.85	6964.73	1389.51	1754.89	20.55	43.66	19.91	12.95	21.41	2.15	3.12	0.20	0.26	0.91	0.50	1.24
G	7 4	3350.30	3824.00	34.68	1460.50	2.43	19.83	2.09	5.63	24.89	0.23	1.66	0.44	0.25	0.74	0.23	1.70
	7 4	3313.80	3746.30	34.57	1462.40	2.62	19.75	2.09	5.26	24.83	0.26	1.58	0.18				1.64
S	7 4	1257.30	15609.00	4655.20	3513.10	91.77	144.53	72.86	30.69	26.65	5.74	6.18	0.84	0.29	1.48	3.72	0.92
	7 4	1240.80	15546.00	4572.20	3474.40	88.53	141.29	70.10	30.08	24.51	5.69	6.03	0.15				0.90
C	7 4	232.03	3839.20	104.09	208.69	1.09	14.78	4.54	4.77	16.30	2.30	1.48	1.34	0.25	0.74	1.59	0.26
	7 4	226.46	3824.90	103.70	210.94	1.77	14.92	4.00	5.11	16.44	2.30	1.36	0.65				0.26
FODDER		2311.20	7969.97	1664.27	2068.01	33.49	62.99	26.89	14.24	24.34	2.37	3.19	0.44	0.26	1.00	1.59	1.27
G	7 6	3638.10	3847.10	32.08	1502.60	2.67	18.65	2.67	7.10	22.98	0.20	1.63	0.15	0.25	0.74	0.23	1.79
	7 6	3662.20	3921.60	31.73	1506.00	2.77	18.19	2.42	7.08	22.99	0.25	1.51	0.15				1.82
S	7 6	1567.30	20131.00	4091.10	1706.10	67.49	119.53	87.41	45.76	22.22	4.98	7.19	0.15	0.29	1.48	1.64	1.04
	7 6	1560.20	20031.00	4086.30	1706.40	65.82	118.66	85.15	45.86	21.60	5.05	7.17	0.15				1.03
C	7 6	371.33	4122.00	114.85	214.47	1.82	20.65	4.72	6.63	21.11	1.94	1.30	1.14	0.25	0.74	2.31	0.33
	7 6	352.04	4140.50	118.53	215.98	1.30	20.54	4.72	6.32	21.05	1.85	1.39	1.23				0.33
FODDER		2351.81	12310.30	2143.86	1524.87	35.84	70.84	46.17	27.15	22.30	2.82	4.47	0.22	0.27	1.12	1.10	1.31
TERRACE MEAN...		2324.95	9081.67	1732.55	1782.59	29.96	59.16	30.99	18.12	22.69	2.45	3.59	0.29	0.26	1.01	1.06	1.27
SLUDGE FODDER AVE...		2343.15	8374.02	1701.28	1799.06	27.18	55.76	31.96	16.78	21.52	2.61	3.65	0.29	0.26	0.99	0.84	1.24
STD...		61.85	1928.44	278.25	195.63	6.70	10.93	8.56	4.84	1.58	0.34	0.63	0.08	0.01	0.08	0.40	0.04
MIN...		2250.87	6218.67	1389.51	1524.87	16.98	40.29	19.91	12.95	19.26	2.15	2.96	0.20	0.25	0.88	0.40	1.18
MAX...		2444.66	12310.30	2143.86	2068.01	35.84	70.84	46.17	27.15	24.34	3.03	4.52	0.44	0.27	1.12	1.59	1.31
N...		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
— CONTROL —																	
G	4 1	2654.00	3470.00	33.74	1285.50	2.29	20.13	3.49	5.41	17.32	1.36	1.75	0.41	0.25	0.74	0.23	1.54
	4 1	2805.30	3575.40	36.42	1370.40	2.05	21.44	2.98	5.77	18.50	1.39	1.87	0.15				1.51
S	4 1	512.46	13030.00	4304.50	3261.50	74.81	114.86	121.15	48.55	8.33	5.33	6.69	0.37	0.25	1.18	0.68	0.65
	4 1	507.85	12806.00	4224.20	3245.40	69.04	112.17	96.57	47.16	7.59	5.24	6.51	0.78				0.61
C	4 1	180.54	4263.80	102.21	200.10	3.88	11.59	4.31	4.47	2.75	2.16	1.52	1.71	0.25	0.74	0.91	0.25
	4 1	176.72	4455.80	92.83	194.13	4.88	11.35	4.57	4.16	3.25	2.25	1.43	0.34				0.25
FODDER		1616.08	7315.04	1713.11	1984.69	29.96	56.59	45.11	22.18	12.60	3.00	3.67	0.47	0.13	0.46	0.24	1.05
G	4 2	2974.20	3435.10	31.07	1435.00	1.19	19.55	2.21	6.71	19.29	0.35	1.62	0.86	0.25	0.74	0.23	1.65
	4 2	2968.40	3522.60	31.18	1443.60	1.67	19.65	2.67	6.48	19.99	0.36	1.67	0.15				1.59
S	4 2	865.20	12197.00	3754.30	2797.70	59.25	99.28	112.76	41.74	10.93	5.48	7.05	0.15	0.25	1.11	0.32	0.65
	4 2	863.48	11714.00	3730.90	2791.80	59.39	99.54	114.02	41.03	9.96	5.08	6.92	0.15				0.67
C	4 2	201.39	2586.00	103.06	441.20	5.15	12.26	5.05	4.74	8.80	1.96	1.29	0.45	0.25	0.74	1.04	0.28
	4 2	184.36	2601.20	106.36	440.58	5.97	13.05	4.26	4.56	9.86	1.99	1.28	1.92				0.28
FODDER		1746.50	7438.33	1801.78	2003.67	29.29	56.99	55.37	22.98	14.44	2.83	4.16	0.39	0.13	0.46	0.17	1.06

			P (ug/g)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
G		4 4	2643.10	3437.30	34.74	1238.70	2.04	20.12	3.01	5.22	18.80	0.84	2.01	0.66	0.25	0.74	0.23	1.54
		4 4	2695.20	3473.70	34.88	1271.70	1.56	20.46	2.55	5.29	19.70	1.07	2.07	0.36				1.49
S		4 4	844.96	12667.00	2909.80	2750.10	38.97	70.68	94.42	32.23	9.44	4.29	6.48	0.15	0.27	0.74	0.23	0.66
		4 4	879.73	13146.00	2980.70	2771.00	38.91	70.87	96.92	32.14	10.33	4.32	6.66	0.63				0.68
C		4 4	231.72	4009.60	107.68	487.21	7.20	16.10	6.25	5.85	7.21	2.36	1.67	0.50	0.25	0.74	1.59	0.34
		4 4	226.15	4153.00	107.94	487.36	10.60	15.62	5.71	6.05	7.59	2.46	1.59	1.37				0.34
FODDER			1650.27	7805.92	1364.87	1878.15	19.27	42.90	45.30	17.56	14.03	2.60	4.07	0.49	0.13	0.37	0.17	1.04
	TERRACE MEAN...		1670.95	7519.76	1626.59	1955.50	26.17	52.16	48.59	20.91	13.69	2.81	3.97	0.45	0.13	0.43	0.19	1.05
CONTROL	FODDER	AVE...	1670.95	7519.76	1626.59	1955.50	26.17	52.16	48.59	20.91	13.69	2.81	3.97	0.45	0.13	0.43	0.19	1.05
		STD...	55.22	208.51	188.57	55.24	4.89	6.55	4.79	2.39	0.79	0.16	0.21	0.04	0.00	0.04	0.03	0.01
		MIN...	1616.08	7315.04	1364.87	1878.15	19.27	42.90	45.11	17.56	12.60	2.60	3.67	0.39	0.13	0.37	0.17	1.04
		MAX...	1746.50	7805.92	1801.78	2003.67	29.96	56.99	55.37	22.98	14.44	3.00	4.16	0.49	0.13	0.46	0.24	1.06
		N...	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

- - - - ROSEMOUNT WATERSHED CORN DATA 1978 MEANS - - - - -

TISSUE	TREATMENT	YEAR	P (ug/g)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
GRAIN	SLUDGE	1978	3440.02	3906.23	34.05	1513.57	2.30	19.90	2.51	6.58	24.63	0.33	1.73	0.23	0.13	0.37	0.12	1.66
STOVER	SLUDGE	1978	1213.71	15608.25	4632.65	2728.05	69.09	118.15	81.71	33.96	19.27	6.07	6.98	0.28	0.14	0.70	0.83	0.85
COB	SLUDGE	1978	244.38	3922.14	99.49	233.80	5.02	13.38	4.32	4.77	10.77	2.55	1.37	0.79	0.13	0.37	0.66	0.29
FODDER	SLUDGE	1978	2343.15	8374.02	1701.28	1799.06	27.18	55.76	31.96	16.78	21.52	2.61	3.65	0.29	0.26	0.99	0.84	1.24
GRAIN	CONTROL	1978	2790.03	3485.68	33.67	1340.82	1.80	20.22	2.82	5.81	18.93	0.90	1.83	0.43	0.13	0.37	0.12	1.55
STOVER	CONTROL	1978	745.61	12593.33	3650.73	2936.25	56.73	94.57	105.97	40.48	9.43	4.96	6.72	0.37	0.13	0.51	0.21	0.65
COB	CONTROL	1978	200.15	3678.23	103.35	375.10	6.28	13.33	5.03	4.97	6.58	2.20	1.46	1.05	0.13	0.37	0.59	0.29
FODDER	CONTROL	1978	1670.95	7519.76	1626.59	1955.50	26.17	52.16	48.59	20.91	13.69	2.81	3.97	0.45	0.13	0.43	0.19	1.05

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1979

TISSUE		ID	P (ug/g)	K ==>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
- SLUDGE -																		
GRAIN		6 2	3406.00	3656.30	33.20	1391.30	0.79	21.48	6.32	5.38	24.68	1.18	1.48	0.15	0.038	0.320	0.300	1.49
		6 2	3460.10	3896.60	33.79	1396.30	0.48	21.40	4.50	5.41	24.87	0.90	1.48	0.15				
STOVER		6 2	938.75	15337.00	6162.70	3733.80	124.96	174.44	34.73	46.90	32.27	8.14	5.11	1.54	0.137	1.940	2.400	0.96
		6 2	945.55	15200.00	6199.70	3743.90	125.26	177.97	34.94	47.29	32.83	8.13	5.12	1.46				
COB		6 2	287.94	4636.90	93.49	189.70	2.12	20.77	2.56	4.71	16.60	2.96	1.77	2.79	0.038	0.320	2.800	0.34
		6 2	294.37	4607.70	92.66	188.34	2.07	22.36	3.16	4.81	16.69	2.99	1.79	3.13				
FODDER			2122.94	8720.65	2646.74	2291.69	53.57	87.12	17.69	23.04	27.42	4.21	3.05	0.95	0.080	1.007	1.393	1.17
G		6 4	3419.60	4220.30	38.87	1490.90	0.99	22.15	3.57	6.52	29.08	0.80	1.56	0.15	0.038	0.320	0.300	1.60
		6 4	3367.00	4272.50	40.15	1466.10	0.84	21.87	2.93	6.53	28.88	0.81	1.52	0.17				
S		6 4	939.84	15603.00	4171.60	2423.10	82.99	125.07	37.50	30.85	28.23	6.44	5.18	1.19	0.150	1.390	1.600	1.04
		6 4	956.46	15758.00	4231.70	2460.10	85.49	128.37	37.19	31.21	28.48	6.56	5.23	1.16				
C		6 4	248.38	4357.60	80.10	195.91	1.88	16.13	2.52	4.20	14.47	2.98	1.40	1.97	0.038	0.320	1.900	0.33
		6 4	243.02	4384.80	77.30	190.87	1.53	15.62	1.41	4.15	14.38	2.95	1.38	2.08				
FODDER			2163.42	8758.89	1681.58	1748.62	33.79	62.72	16.57	15.97	27.50	3.23	2.97	0.72	0.082	0.741	0.948	1.27
G		6 5	3625.10	4521.90	34.83	1356.80	0.75	20.10	1.71	5.62	23.70	0.67	1.48	0.15	0.038	0.320	0.300	1.59
		6 5	3612.30	4677.00	35.02	1341.90	0.79	19.90	2.40	5.60	23.82	0.87	1.49	0.15				
S		6 5	1151.00	17934.00	3857.10	1546.60	108.72	157.36	36.53	31.67	25.06	6.22	4.64	1.87	0.176	1.740	2.900	0.89
		6 5	1203.60	18136.00	3978.50	1645.10	113.89	166.08	38.74	33.31	26.83	6.82	4.93	2.30				
C		6 5	370.32	6321.50	103.58	136.62	1.68	20.13	2.42	4.07	14.78	2.53	1.64	2.39	0.038	0.320	2.400	0.36
		6 5	366.63	6436.10	104.62	139.45	1.72	19.35	1.04	3.99	14.67	2.47	1.60	2.53				
FODDER			2266.41	10804.97	1794.16	1367.71	50.77	84.00	18.10	17.63	24.05	3.50	2.99	1.20	0.100	0.961	1.636	1.18
TERRACE MEAN...			2184.26	9428.17	2040.83	1802.67	46.04	77.94	17.45	18.88	26.32	3.65	3.00	0.96	0.087	0.903	1.325	1.21
G		7 2	3378.70	4223.00	41.05	1384.90	0.85	21.68	2.35	6.07	27.33	0.77	1.44	0.15	0.038	0.320	0.300	1.60
		7 2	3566.20	4366.60	42.59	1467.10	1.02	22.64	2.72	6.35	28.37	0.69	1.49	0.15				
S		7 2	1098.30	14262.00	4829.60	3190.60	61.93	100.93	44.18	38.17	44.56	7.37	5.23	2.03	0.116	1.590	1.500	0.97
		7 2	1114.60	14165.00	4755.90	3219.70	61.33	100.50	44.89	37.94	45.60	7.39	5.18	2.30				
C		7 2	262.64	4870.50	98.48	154.55	1.02	21.31	1.18	4.88	17.75	2.83	1.48	3.08	0.038	0.320	2.900	0.32
		7 2	262.53	4755.60	98.97	154.09	1.06	21.96	1.73	4.87	16.87	2.83	1.47	3.07				
FODDER			2188.66	8653.94	2114.67	2100.04	27.37	56.32	20.73	19.97	34.52	3.79	3.09	1.26	0.072	0.873	1.028	1.22
G		7 4	3844.30	4773.10	41.18	1501.40	0.87	23.60	2.67	6.35	27.42	0.42	1.53	0.15	0.038	0.320	0.300	1.57
		7 4	3794.00	4533.30	38.80	1474.30	1.08	23.29	2.40	6.08	27.16	0.39	1.53	0.15				
S		7 4	1035.50	15745.00	4711.60	3152.70	89.73	142.08	42.63	35.50	50.55	6.99	4.91	2.38	0.195	1.640	2.500	0.91
		7 4	1038.00	15718.00	4713.10	3134.60	90.36	142.84	42.46	35.13	49.95	6.99	4.91	2.52				
C		7 4	389.10	5355.00	103.87	159.79	1.09	21.23	4.26	6.03	19.98	2.55	1.43	2.25	0.038	0.320	2.600	0.33
		7 4	387.65	5122.30	103.99	158.86	1.01	21.30	4.60	5.96	19.87	2.54	1.41	2.42				
FODDER			2324.07	9582.38	2104.58	2113.72	40.24	75.74	20.32	19.03	36.83	3.48	3.01	1.33	0.107	0.902	1.450	1.18
G		7 6	3656.30	4554.30	29.89	1347.60	0.52	21.21	2.03	6.17	25.98	0.28	1.21	0.15	0.038	0.320	0.300	1.59
		7 6	3786.20	4816.20	30.72	1390.80	0.77	21.89	1.50	6.33	26.81	0.41	1.26	0.19				
S		7 6	1790.80	20955.00	4285.40	1932.60	101.57	150.90	86.13	43.10	55.82	7.45	4.98	1.99	0.247	1.900	4.400	1.09
		7 6	1777.60	21261.00	4285.30	1895.60	101.17	149.66	84.23	42.44	55.94	7.27	4.94	2.01				
C		7 6	489.55	5074.00	100.36	149.31	0.81	26.15	5.17	6.58	19.74	2.77	1.49	2.86	0.038	0.320	3.300	0.34
		7 6	491.19	5066.20	103.40	149.63	1.09	26.80	6.03	6.62	19.75	2.78	1.46	2.92				
FODDER			2569.79	12446.95	2039.23	1535.43	48.10	82.53	41.33	23.47	39.79	3.83	3.01	1.23	0.136	1.064	2.453	1.26
TERRACE MEAN...			2360.84	10227.75	2086.16	1916.40	38.57	71.53	27.46	20.82	37.05	3.70	3.04	1.28	0.105	0.946	1.644	1.22
SLUDGE	FODDER	AVE...	2272.55	9827.96	2063.49	1859.54	42.31	74.74	22.46	19.85	31.68	3.67	3.02	1.12	0.096	0.925	1.484	1.22
		STD...	148.54	1391.72	306.45	333.78	9.42	11.43	8.56	2.71	5.69	0.31	0.04	0.21	0.022	0.104	0.494	0.04
		MIN...	2122.94	8653.94	1681.58	1367.71	27.37	56.32	16.57	15.97	24.05	3.23	2.97	0.72	0.072	0.741	0.948	1.17
		MAX...	2569.79	12446.95	2646.74	2291.69	53.57	87.12	41.33	23.47	39.79	4.21	3.09	1.33	0.136	1.064	2.453	1.27
		N...	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.000	6.000	6.000	6.00
— CONTROL —																		
G		4 1	3201.60	4166.80	43.67	1371.60	1.59	25.10	5.51	6.77	21.29	3.68	2.05	0.15	0.038	0.320	0.300	1.56
		4 1	3115.80	4258.90	44.14	1347.80	1.23	23.07	3.78	6.55	20.75	1.29	1.71	0.15				1.47
S		4 1	930.13	15072.00	4655.70	3390.30	61.25	99.18	46.39	65.20	13.50	6.38	4.01	0.54	0.123	1.740	0.700	1.10
		4 1	940.40	15106.00	4690.10	3418.60	58.57	98.05	46.45	65.24	13.52	6.47	4.07	0.81				1.07
C		4 1	252.51	5933.20	68.74	120.77	2.04	22.00	2.29	5.59	8.52	2.91	2.00	2.79	0.038	0.320	2.500	0.34
		4 1	256.79	5834.90	68.41	123.13	2.02	21.90	2.79	5.59	8.59	3.00	1.91	2.82				0.31
FODDER			1885.29	9524.30	2254.25	2244.66	29.37	59.49	24.42	34.52	16.52	4.40	2.92	0.59	0.079	0.997	0.652	1.22
G		4 2	3086.60	4221.00	41.41	1370.00	0.96	22.85	5.12	6.53	21.50	2.76	1.68	0.15	0.038	0.320	0.300	1.51
		4 2	3035.80	4232.80	41.88	1343.00	0.84	22.92	5.70	6.41	21.10	2.72	1.63	0.15				1.47
S		4 2	866.94	14435.00	4434.60	3204.60	58.04	95.45	45.76	72.86	12.90	5.72	3.94	0.70	0.084	1.740	0.700	1.06
		4 2	895.36	14961.00	4566.00	3334.20	59.40	98.81	47.93	75.06	13.63	5.78	4.08	0.72				1.04
C		4 2	313.29	6379.90	86.46	204.71	1.95	18.47	3.85	5.57	10.85	2.91	1.86	2.29	0.038	0.320	2.100	0.34
		4 2	321.87	6385.10	87.01	209.19	1.60	18.77	2.61	5.58	10.87	2.85	1.83	2.25				0.35
FODDER			1751.27	9771.05	2343.18	2264.64	30.77	60.87	26.62	41.20	16.45	4.30	2.88	0.58	0.062	1.052	0.628	1.19

Rosemount Terraces : Corn Tissue Elemental Analyses *Continued from previous page*

			P (ug/g)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
G		4 4	3220.80	4181.80	33.67	1339.60	0.80	22.68	5.03	5.62	21.63	2.12	1.59	0.15	0.038	0.320	0.300	1.50
		4 4	3215.90	4039.30	33.20	1339.40	0.65	22.76	5.03	5.56	21.71	2.19	1.57	0.15				1.49
S		4 4	919.28	17872.00	3513.10	3114.40	47.99	83.13	12.47	40.12	14.52	4.54	4.39	0.93	0.077	1.230	0.900	0.96
		4 4	946.54	18216.00	3642.50	3160.70	49.79	85.41	12.47	41.16	14.84	4.66	4.52	1.10				0.94
C		4 4	282.25	5396.90	79.60	179.43	1.87	22.08	2.70	5.15	12.05	2.71	1.73	2.80	0.038	0.320	2.600	0.30
		4 4	286.27	5394.30	79.60	185.33	1.65	22.59	1.96	5.17	11.78	2.77	1.71	2.90				0.31
FODDER			1896.12	10871.75	1731.36	2108.42	23.83	52.11	8.38	22.31	17.56	3.37	2.97	0.77	0.057	0.755	0.767	1.14
	TERRACE MEAN...		1844.23	10055.70	2109.59	2205.91	27.99	57.49	19.81	32.68	16.85	4.02	2.92	0.65	0.066	0.935	0.682	1.18
CONTROL	FODDER AVE...		1844.23	10055.70	2109.59	2205.91	27.99	57.49	19.81	32.68	16.85	4.02	2.92	0.65	0.066	0.935	0.682	1.18
	STD...		65.88	585.76	269.91	69.41	2.99	3.84	8.13	7.82	0.51	0.46	0.03	0.09	0.009	0.129	0.061	0.03
	MIN...		1751.27	9524.30	1731.36	2108.42	23.83	52.11	8.38	22.31	16.45	3.37	2.88	0.58	0.057	0.755	0.628	1.14
	MAX...		1896.12	10871.75	2343.18	2264.64	30.77	60.87	26.62	41.20	17.56	4.40	2.97	0.77	0.079	1.052	0.767	1.22
	N...		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.000	3.000	3.000	3.00

- - - - ROSEMOUNT WATERSHED CORN DATA 1979 MEANS - - - - -

TISSUE	TREATMENT	YEAR	P (ug/g)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
GRAIN	SLUDGE	1979	3576.32	4375.93	36.67	1417.45	0.81	21.77	2.93	6.03	26.51	0.68	1.46	0.16	0.038	0.320	0.300	1.57
STOVER	SLUDGE	1979	1165.83	16672.83	4681.85	2673.20	95.62	143.02	47.01	37.79	39.68	7.15	5.03	1.90	0.170	1.700	2.550	0.98
COB	SLUDGE	1979	341.11	5082.35	96.74	163.93	1.42	21.09	3.01	5.07	17.13	2.77	1.53	2.62	0.038	0.320	2.650	0.34
FODDER	SLUDGE	1979	2272.55	9827.96	2063.49	1859.54	42.31	74.74	22.46	19.85	31.68	3.67	3.02	1.12	0.096	0.925	1.484	1.22
GRAIN	CONTROL	1979	3146.08	4183.43	39.66	1351.90	1.01	23.23	5.03	6.24	21.33	2.46	1.71	0.15	0.038	0.320	0.300	1.50
STOVER	CONTROL	1979	916.44	15943.67	4250.33	3270.47	55.84	93.34	35.25	59.94	13.82	5.59	4.17	0.80	0.095	1.570	0.767	1.03
COB	CONTROL	1979	285.50	5887.38	78.30	170.43	1.86	20.97	2.70	5.44	10.44	2.86	1.84	2.64	0.038	0.320	2.400	0.33
FODDER	CONTROL	1979	1844.23	10055.70	2109.59	2205.91	27.99	57.49	19.81	32.68	16.85	4.02	2.92	0.65	0.066	0.935	0.682	1.18

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1980

TISSUE	ID	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
		(ug/g)	=====>>>>>														
- SLUDGE -																	
GRAIN	6	3831.10	4240.10	37.53	1819.80	1.25	26.52	4.50	8.12	35.75	1.51	2.05	0.25	0.04	0.30	0.30	1.80
	6	3863.30	4242.40	38.61	1835.50	1.27	26.69	4.84	8.27	36.01	1.46	2.00	0.31				
STOVER	6	1098.90	15050.00	6637.10	3910.00	158.27	216.74	43.13	40.65	40.80	6.43	6.29	1.09	0.20	1.10	2.40	0.89
	6	1101.20	15102.00	6723.80	3964.30	158.26	213.40	43.32	40.84	43.03	6.77	6.33	1.05				
COB	6	304.89	5465.90	123.30	296.41	2.14	19.27	7.64	5.60	21.36	2.56	2.02	2.54	0.04	0.30	3.00	0.28
	6	302.16	5465.00	122.43	294.50	2.10	19.06	6.52	5.46	20.86	2.59	1.85	2.55				
FODDER		2493.88	8453.96	2562.01	2491.69	60.82	97.35	19.49	20.29	36.86	3.52	3.64	0.78	0.10	0.60	1.33	1.32
G	7	3695.60	4040.90	36.07	1730.60	1.32	26.06	4.39	8.01	34.01	1.36	1.99	0.39	0.04	0.30	0.30	1.71
	7	3442.50	3777.90	33.89	1599.10	1.06	24.75	4.14	7.55	32.05	1.36	1.87	0.30				
S	7	1111.00	15571.00	5919.30	4070.10	149.14	192.81	34.75	51.40	45.52	5.13	6.08	1.27	0.18	0.60	2.80	0.92
	7	1133.30	15926.00	5680.10	3851.60	141.54	182.66	32.53	50.08	44.28	4.42	6.00	1.00				
C	7	284.93	3552.40	104.68	399.31	1.81	14.69	5.26	6.54	30.74	2.42	1.59	1.79	0.04	0.30	2.20	0.26
	7	288.81	3533.70	104.14	390.28	1.67	15.85	5.51	6.73	32.36	2.37	1.55	2.05				
FODDER		2371.20	8350.24	2217.99	2426.09	55.68	85.87	15.45	23.91	37.39	2.74	3.45	0.77	0.09	0.41	1.40	1.29
— CONTROL —																	
G	4	3094.70	3665.50	40.41	1566.40	1.01	24.51	4.50	7.90	26.49	1.36	1.87	0.49	0.04	0.30	0.30	1.60
	4	3010.60	3575.90	37.22	1520.50	1.10	24.20	3.97	7.96	25.94	1.31	1.84	0.34				
S	4	1074.00	13757.00	5225.10	4089.60	125.97	158.98	29.79	83.81	18.47	4.51	5.68	0.83	0.09	0.50	1.30	0.95
	4	1040.50	13692.00	5075.00	4048.30	124.09	161.58	28.61	80.28	18.30	4.76	5.60	0.87				
C	4	218.52	3922.20	101.42	313.03	2.57	24.73	5.96	6.99	15.64	2.39	1.83	3.26	0.04	0.30	3.80	0.24
	4	217.37	4005.10	101.77	317.43	2.64	23.33	5.74	6.99	15.87	2.42	1.87	3.25				
FODDER		2024.49	7629.40	2057.24	2433.15	50.02	77.86	14.21	37.04	22.24	2.73	3.35	0.83	0.06	0.38	0.99	1.23

- - - - ROSEMOUNT WATERSHED CORN DATA 1980 MEANS - - - - -

TISSUE	TREATMENT	YEAR	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
			(ug/g)	=====>>>>>														
GRAIN	SLUDGE	1980	3708.13	4075.33	36.53	1746.25	1.23	26.01	4.47	7.99	34.46	1.42	1.98	0.31	0.04	0.30	0.30	1.76
STOVER	SLUDGE	1980	1111.10	15412.25	6240.08	3949.00	151.80	201.40	38.43	45.74	43.41	5.69	6.18	1.10	0.19	0.85	2.60	0.91
COB	SLUDGE	1980	295.20	4504.25	113.64	345.13	1.93	17.22	6.23	6.08	26.33	2.49	1.75	2.23	0.04	0.30	2.60	0.27
FODDER	SLUDGE	1980	2432.54	8402.10	2390.00	2458.89	58.25	91.61	17.47	22.10	37.13	3.13	3.55	0.78	0.10	0.51	1.37	1.31
GRAIN	CONTROL	1980	3052.65	3620.70	38.82	1543.45	1.06	24.36	4.24	7.93	26.22	1.34	1.86	0.42	0.04	0.30	0.30	1.60
STOVER	CONTROL	1980	1057.25	13724.50	5150.05	4068.95	125.03	160.28	29.20	82.05	18.39	4.64	5.64	0.85	0.09	0.50	1.30	0.95
COB	CONTROL	1980	217.95	3963.65	101.60	315.23	2.61	24.03	5.85	6.99	15.76	2.41	1.85	3.26	0.04	0.30	3.80	0.24
FODDER	CONTROL	1980	2024.49	7629.40	2057.24	2433.15	50.02	77.86	14.21	37.04	22.24	2.73	3.35	0.83	0.06	0.38	0.99	1.23

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1981 TISSUE	ID	P (ug/g)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
- SLUDGE -																	
GRAIN	6 2	3783.10	5011.40	58.80	1576.40	2.78	21.76	5.38	6.82	36.06	1.69	3.15	0.43	0.66	0.10	0.14	1.60
STOVER	6 2	1060.70	15988.00	4662.00	3011.30	28.56	57.53	8.56	108.77	13.16	5.78	8.98	0.40	0.14	0.52	0.68	1.06
	6 2	1099.20	16015.00	4841.00	3057.10	30.18	61.28	8.05	111.68	13.79	6.40	9.36	0.33				
COB	6 2	396.45	6248.20	67.82	181.70	0.32	11.63	3.54	7.77	63.73	1.82	1.35	1.79	0.03	0.30	2.23	0.25
	6 2	401.88	6293.70	67.62	177.63	0.29	11.75	2.51	7.76	62.09	1.82	1.36	1.80				
FODDER		2279.01	10160.87	2216.73	2138.64	14.81	38.29	6.54	54.43	27.75	3.72	5.78	0.51	0.37	0.31	0.55	1.26
G	6 4	3403.00	4682.90	58.10	1544.10	2.42	22.16	5.34	7.12	30.11	2.23	3.07	0.27	0.64	0.12	0.11	1.65
S	6 4	1373.80	15148.00	8279.80	3306.30	52.72	85.29	20.41	66.46	63.28	10.80	8.75	0.36	0.28	0.95	1.03	1.15
	6 4	1360.80	15194.00	8216.90	3281.30	52.91	85.13	20.05	65.66	60.75	10.47	8.64	0.38				
C	6 4	314.64	6052.80	75.22	211.52	0.28	9.74	2.08	6.28	30.44	1.71	1.26	1.30	0.03	0.30	1.73	0.26
	6 4	322.92	5949.90	76.98	216.88	0.28	10.20	3.05	6.21	31.19	1.71	1.32	1.36				
FODDER		2236.88	9574.75	3800.71	2241.49	25.28	50.03	11.93	33.98	44.74	6.03	5.50	0.40	0.43	0.51	0.65	1.32
G	6 5	3739.50	5281.60	62.71	1567.50	8.56	21.32	5.70	7.47	30.14	2.73	3.29	0.19	0.68	0.10	0.13	1.58
S	6 5	1055.30	12730.00	3737.60	2849.30	23.51	46.26	33.91	84.45	14.56	4.25	7.16	0.32	0.11	0.48	0.56	1.24
	6 5	1075.30	12909.00	3786.10	2923.70	23.58	45.86	34.64	84.88	14.61	4.01	7.00	0.34				
C	6 5	298.85	5846.60	110.13	173.64	0.92	9.15	2.69	10.25	30.93	2.29	1.62	1.14	0.04	0.30	1.61	0.25
	6 5	289.36	5521.80	108.96	172.88	0.47	10.14	1.91	10.10	30.33	2.07	1.49	1.17				
FODDER		2207.98	8858.98	1806.30	2077.11	14.98	32.03	18.87	43.99	22.86	3.34	4.93	0.33	0.36	0.29	0.45	1.31
TERRACE MEAN...		2241.29	9531.53	2607.91	2152.41	18.36	40.11	12.45	44.13	31.78	4.37	5.41	0.41	0.39	0.37	0.55	1.30
G	7 2	3410.20	4709.10	55.26	1503.00	2.42	21.21	5.89	7.04	31.58	2.98	3.12	0.15	0.77	0.11	0.13	1.55
S	7 2	1569.40	16224.00	5942.80	3515.60	37.96	78.09	8.38	74.28	18.61	4.78	8.18	0.46	0.15	0.66	0.68	0.98
	7 2	1600.90	16194.00	5998.10	3576.40	39.48	80.04	8.83	75.92	19.06	5.10	8.22	0.52				
C	7 2	384.49	6961.10	71.84	128.91	0.28	8.18	1.23	6.78	48.33	1.85	1.24	0.95	0.03	0.30	1.57	0.25
	7 2	368.66	6728.30	68.87	128.13	0.55	9.62	3.86	6.66	47.80	1.96	1.27	1.16				
FODDER		2378.36	9801.02	2584.43	2261.97	17.77	44.91	6.77	36.10	27.50	3.73	5.14	0.37	0.44	0.36	0.48	1.20
G	7 4	3741.20	4918.60	54.86	1562.80	2.26	21.93	6.05	7.14	39.69	1.61	3.08	0.15	0.81	0.10	0.13	1.51
S	7 4	2310.30	20058.00	5146.00	1793.80	55.57	87.38	32.58	58.57	90.58	5.09	6.44	0.64	0.26	0.70	1.38	1.33
	7 4	2361.80	20332.00	5256.80	1809.40	59.53	92.07	31.67	59.77	94.57	5.19	6.47	0.73				
C	7 4	455.31	5453.70	78.68	237.30	1.06	12.37	4.15	10.39	93.84	2.15	1.44	1.84	0.05	0.30	2.15	0.26
	7 4	502.47	5632.60	86.39	249.76	1.24	12.91	4.59	11.41	102.31	2.35	1.52	1.85				
FODDER		2871.86	11584.84	2286.07	1560.77	26.12	50.55	17.21	29.98	67.26	3.19	4.41	0.52	0.51	0.38	0.83	1.33
G	7 5	3827.50	4984.80	63.33	1533.20	2.93	22.70	5.92	7.43	36.63	1.56	3.12	0.19	0.85	0.10	0.12	1.56
S	7 5	2190.90	18266.00	5569.50	2804.20	62.83	93.48	35.19	53.25	97.48	6.91	8.04	0.57	0.26	0.62	1.07	1.14
	7 5	2217.90	18268.00	5652.90	2798.70	66.25	98.23	34.10	53.64	99.97	6.89	7.95	0.47				
C	7 5	501.77	6818.80	90.35	186.10	1.67	10.64	5.32	9.65	79.42	2.35	1.67	1.45	0.05	0.30	2.04	0.36
	7 5	498.23	6858.30	95.03	187.84	1.58	11.52	4.49	9.90	79.97	2.37	1.66	1.60				
FODDER		2865.77	10904.97	2478.90	1981.44	29.63	53.63	18.34	27.63	66.95	3.94	5.13	0.44	0.53	0.34	0.68	1.29
TERRACE MEAN...		2705.33	10763.61	2449.80	1934.73	24.50	49.70	14.11	31.23	53.90	3.62	4.89	0.44	0.50	0.36	0.67	1.27
SLUDGE FODDER AVE...		2473.31	10147.57	2528.85	2043.57	21.43	44.91	13.28	37.68	42.84	3.99	5.15	0.43	0.44	0.37	0.61	1.28
STD...		284.59	889.59	619.36	235.93	5.81	7.57	5.19	9.10	18.45	0.94	0.43	0.07	0.06	0.07	0.13	0.05
MIN...		2207.98	8858.98	1806.30	1560.77	14.81	32.03	6.54	27.63	22.86	3.19	4.41	0.33	0.36	0.29	0.45	1.20
MAX...		2871.86	11584.84	3800.71	2261.97	29.63	53.63	18.87	54.43	67.26	6.03	5.78	0.52	0.53	0.51	0.83	1.33
N...		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
— CONTROL —																	
G	4 1	3101.80	5589.90	67.48	1439.60	2.18	18.46	6.50	8.46	20.61	3.04	3.10	0.38	0.83	0.45	0.14	1.66
S	4 1	2282.00	16472.00	7760.20	3184.50	57.04	101.10	42.88	79.55	123.80	8.32	8.10	0.42	0.36	0.88	1.30	1.08
	4 1	2348.60	16794.00	7974.60	3327.70	57.69	103.02	39.68	80.48	125.78	9.12	8.34	0.49				
C	4 1	257.15	5729.20	68.96	148.15	0.28	12.61	3.24	7.07	13.24	1.80	1.98	1.83	0.03	0.30	2.12	0.25
	4 1	255.47	5717.50	67.46	153.83	0.43	12.58	3.34	6.95	12.99	1.82	1.61	1.79				
FODDER		2491.25	11109.76	3959.08	2247.10	29.57	59.72	23.61	44.05	72.01	5.78	5.55	0.53	0.27	0.33	0.44	1.26
G	4 2	3021.90	5273.30	71.03	1422.50	3.26	19.22	8.01	8.91	22.38	2.82	2.91	0.30	0.73	0.11	0.11	1.50
S	4 2	1785.10	19145.00	6416.70	2237.20	57.12	91.82	32.72	52.50	36.35	7.23	8.42	0.47	0.20	0.70	1.18	0.99
	4 2	1838.60	19217.00	6545.00	2299.30	58.20	93.68	32.22	53.26	37.41	7.50	8.52	0.43				
C	4 2	285.74	5276.10	77.19	203.00	0.47	11.23	3.39	7.85	7.42	2.00	1.70	1.45	0.03	0.30	2.08	0.30
		288.13	5327.80	75.28	196.38	0.40	11.57	5.24	7.83	7.66	2.06	2.02	1.46				
FODDER		2219.83	12015.40	3177.72	1735.94	29.40	54.24	19.57	30.13	28.24	4.96	5.52	0.46	0.21	0.21	0.39	1.16
G	4 4	3502.60	5357.50	66.88	1545.60	2.38	20.63	6.21	7.45	23.30	2.73	3.09	0.18	0.79	0.20	0.12	1.60
S	4 4	1587.20	15887.00	6567.90	2987.30	50.96	91.45	25.45	58.66	60.89	8.01	8.01	0.68	0.25	0.66	1.38	1.26
	4 4	1584.50	15795.00	6547.80	2956.90	53.66	95.78	25.67	58.02	60.68	7.99	7.91	0.65				
C	4 4	311.47	6065.20	89.85	180.10	0.75	12.67	3.88	10.07	14.16	2.10	1.56	1.75	0.03	0.30	1.81	0.25
	4 4	308.05	5907.40	86.19	172.94	0.70	11.89	4.27	9.75	13.74	2.05	1.53	1.68				
FODDER		2349.58	10346.31	3126.94	2110.58	25.78	54.37	15.16	31.62	40.23	5.16	5.26	0.53	0.24	0.21	0.42	1.33

Rosemount Terraces : Corn Tissue Elemental Analyses *Continued from previous page*

			P (ug/g)	K ==>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
	TERRACE MEAN...		2353.55	11157.16	3421.25	2031.21	28.25	56.11	19.45	35.27	46.83	5.30	5.45	0.51	0.24	0.25	0.42	1.25
CONTROL	FODDER	AVE...	2353.55	11157.16	3421.25	2031.21	28.25	56.11	19.45	35.27	46.83	5.30	5.45	0.51	0.24	0.25	0.42	1.25
		STD...	110.84	682.23	380.87	216.10	1.75	2.56	3.45	6.24	18.47	0.35	0.13	0.03	0.02	0.06	0.02	0.07
		MIN...	2219.83	10346.31	3126.94	1735.94	25.78	54.24	15.16	30.13	28.24	4.96	5.26	0.46	0.21	0.21	0.39	1.16
		MAX...	2491.25	12015.40	3959.08	2247.10	29.57	59.72	23.61	44.05	72.01	5.78	5.55	0.53	0.27	0.33	0.44	1.33
		N...	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

- - - - ROSEMOUNT WATERSHED CORN DATA 1981 MEANS - - - - -

TISSUE	TREATMENT	YEAR	P (ug/g)	K ==>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
GRAIN	SLUDGE	1981	3650.75	4931.40	58.84	1547.83	3.56	21.85	5.71	7.17	34.04	2.13	3.14	0.23	0.37	0.05	0.06	1.58
STOVER	SLUDGE	1981	1606.36	16443.83	5590.79	2893.93	44.42	75.89	23.03	74.78	50.04	6.31	7.93	0.46	0.10	0.33	0.45	1.15
COB	SLUDGE	1981	394.59	6197.15	83.16	187.69	0.75	10.65	3.29	8.60	58.37	2.04	1.43	1.45	0.02	0.15	0.94	0.27
FODDER	SLUDGE	1981	2473.31	10147.57	2528.85	2043.57	21.43	44.91	13.28	37.68	42.84	3.99	5.15	0.43	0.44	0.37	0.61	1.28
GRAIN	CONTROL	1981	3208.77	5406.90	68.46	1469.23	2.61	19.44	6.91	8.27	22.10	2.86	3.03	0.29	0.39	0.13	0.06	1.59
STOVER	CONTROL	1981	1904.33	17218.33	6968.70	2832.15	55.78	96.14	33.10	63.75	74.15	8.03	8.22	0.52	0.14	0.37	0.64	1.11
COB	CONTROL	1981	284.34	5670.53	77.49	175.73	0.51	12.09	3.89	8.25	11.54	1.97	1.73	1.66	0.02	0.15	1.00	0.27
FODDER	CONTROL	1981	2353.55	11157.16	3421.25	2031.21	28.25	56.11	19.45	35.27	46.83	5.30	5.45	0.51	0.24	0.25	0.42	1.25

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1982

TISSUE	ID	P (ug/g)	K =====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
- SLUDGE -																	
GRAIN	6 2	3419.60	4309.30	51.49	1676.90	2.47	21.38	23.71	8.05	34.70	1.73	2.51	0.50	0.02	0.21	0.04	1.56
STOVER	6 2	1589.30	19241.00	7351.10	4838.80	120.24	159.30	34.60	60.92	78.09	7.67	8.03	0.91	0.12	0.91	2.02	1.20
COB	6 2	176.00	6567.40	59.04	245.23	2.51	12.06	24.92	7.90	41.58	1.95	1.86	1.49	0.02	0.10	1.97	0.21
FODDER		2448.12	10335.54	2911.49	2803.14	48.61	74.67	28.07	28.75	52.24	4.07	4.62	0.74	0.05	0.48	0.97	1.31
G	6 4	3624.70	4526.60	55.15	1716.50	1.76	22.48	21.59	8.10	42.65	1.78	2.75	0.41	0.02	0.10	0.04	1.56
S	6 4	1365.40	15800.00	9823.70	6201.00	143.18	190.99	35.58	103.84	56.49	10.81	8.38	1.13	0.11	0.61	2.42	1.34
C	6 4	150.66	5663.90	50.30	232.44	0.64	12.94	21.95	7.10	25.17	1.78	1.45	1.76	0.02	0.21	2.17	0.23
FODDER		2499.05	8822.83	3697.15	3267.64	54.40	84.53	26.84	43.72	46.39	5.15	4.74	0.79	0.05	0.30	1.10	1.37
G	6 5	3283.00	4134.10	53.85	1581.60	1.71	21.37	22.50	7.93	30.15	1.43	2.42	0.26	0.03	0.27	0.06	1.54
S	6 5	1337.20	18154.00	7325.60	3619.20	165.03	204.33	45.20	60.92	53.11	7.41	7.31	1.31	0.12	0.57	2.86	1.27
C	6 5	155.98	5346.10	53.97	215.51	1.34	14.87	23.62	8.23	38.62	1.84	1.76	2.10	0.02	0.10	2.04	0.26
FODDER		2200.77	10175.10	3135.37	2332.49	70.89	98.37	32.21	30.41	40.58	4.00	4.44	0.86	0.07	0.38	1.41	1.32
TERRACE MEAN...		2382.64	9777.82	3248.00	2801.09	57.96	85.86	29.04	34.29	46.40	4.41	4.60	0.79	0.06	0.39	1.16	1.33
G	7 2	3747.10	4747.20	63.97	1852.50	2.02	27.79	23.43	9.59	36.26	2.13	2.73	0.36	0.02	0.09	0.10	1.67
S	7 2	1635.30	17647.00	9647.40	5825.80	206.41	273.02	37.78	84.14	61.14	10.82	9.00	1.33	0.15	1.22	3.50	1.34
C	7 2	197.68	5620.00	64.35	304.39	1.33	8.33	23.35	8.58	34.54	1.72	1.73	0.98	0.02	0.10	1.16	0.27
FODDER		2592.57	10168.23	4040.52	3379.80	86.77	128.02	29.38	40.44	46.45	5.70	5.25	0.81	0.07	0.56	1.59	1.42
G	7 4	3625.60	4544.60	56.42	1652.50	1.55	24.87	21.68	8.46	33.90	1.37	2.73	0.20	0.02	0.10	0.04	1.57
S	7 4	1472.20	16708.00	8919.00	5163.20	164.32	197.31	48.52	88.86	114.28	8.88	8.06	1.11	0.16	0.59	2.80	1.12
C	7 4	185.23	4644.30	63.51	354.22	1.13	7.01	23.25	7.40	71.49	1.70	1.41	0.88	0.03	0.10	0.98	0.29
FODDER		2484.10	9487.23	3652.65	2975.77	67.56	93.44	32.69	41.00	69.44	4.44	4.79	0.62	0.08	0.30	1.23	1.29
G	7 5	3651.40	4706.70	47.98	1576.90	1.76	21.52	22.23	8.11	38.67	1.13	2.61	0.37	0.02	0.10	NA	1.58
S	7 5	1890.00	21874.00	6262.70	2894.90	134.65	174.39	34.20	110.16	119.50	4.88	6.93	1.14	0.19	0.34	2.75	1.07
C	7 5	218.32	4945.80	40.77	199.03	3.61	10.57	27.28	6.37	60.53	1.81	1.52	2.16	0.02	0.10	2.18	0.23
FODDER		2674.10	11630.35	2547.06	1999.12	55.36	82.15	27.44	49.02	72.89	2.69	4.26	0.82	0.09	0.20	NA	1.27
TERRACE MEAN...		2583.59	10428.61	3413.41	2784.90	69.90	101.20	29.84	43.49	62.93	4.28	4.77	0.75	0.08	0.35	NA	1.33
SLUDGE FODDER AVE...		2483.11	10103.22	3330.71	2792.99	63.93	93.53	29.44	38.89	54.66	4.34	4.68	0.77	0.07	0.37	1.26	1.33
STD...		147.00	857.74	511.50	490.82	12.80	17.22	2.27	7.16	12.19	0.95	0.31	0.08	0.01	0.12	0.22	0.05
MIN...		2200.77	8822.83	2547.06	1999.12	48.61	74.67	26.84	28.75	40.58	2.69	4.26	0.62	0.05	0.20	0.97	1.27
MAX...		2674.10	11630.35	4040.52	3379.80	86.77	128.02	32.69	49.02	72.89	5.70	5.25	0.86	0.09	0.56	1.59	1.42
N...		6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	6
— CONTROL —																	
G	4 1	2995.10	4830.40	66.76	1677.60	2.66	21.87	22.32	9.71	26.11	2.39	2.88	0.42	0.03	0.24	0.04	1.60
S	4 1	1131.00	13377.00	6765.40	6054.40	88.79	128.51	36.26	121.28	18.27	8.33	7.06	1.10	0.09	0.80	1.22	1.28
C	4 1	200.26	5843.10	109.13	437.45	2.59	15.31	24.13	12.92	12.76	2.26	1.84	1.89	0.03	0.10	2.41	0.20
FODDER		1966.94	8484.71	2863.46	3391.08	38.56	65.74	28.29	56.52	21.64	4.85	4.53	0.84	0.05	0.46	0.74	1.34
G	4 2	3364.00	4792.80	55.06	1657.60	2.91	22.18	24.03	8.84	28.81	2.64	2.97	0.50	0.03	0.31	0.04	1.51
S	4 2	1176.50	14967.00	8284.30	5950.90	96.30	143.61	34.69	141.98	29.22	7.53	7.43	1.16	0.07	0.25	1.68	1.21
C	4 2	133.44	6162.60	58.00	187.80	2.36	13.04	24.27	9.25	16.11	1.49	1.64	1.63	0.02	0.10	2.13	0.19
FODDER		2194.18	9071.75	3422.00	3288.98	41.07	71.08	28.41	63.34	27.90	4.54	4.68	0.87	0.04	0.27	0.89	1.27
G	4 4	3162.00	4540.00	50.73	1646.30	1.86	20.33	22.96	8.70	26.41	1.89	2.58	0.35	0.02	0.12	0.04	1.55
S	4 4	1612.20	18083.00	9193.90	6578.70	120.45	174.48	37.34	133.85	28.31	7.95	8.73	0.97	0.12	0.61	1.86	1.30
C	4 4	213.18	5468.10	76.43	242.22	2.01	13.46	23.29	11.02	19.03	1.88	1.86	1.71	0.02	0.10	2.15	0.29
FODDER		2284.56	10008.23	3689.25	3483.60	49.04	81.03	28.71	58.68	26.51	4.30	4.96	0.72	0.06	0.31	0.95	1.34
TERRACE MEAN...		2148.56	9188.23	3324.90	3387.89	42.89	72.62	28.47	59.51	25.35	4.57	4.72	0.81	0.05	0.35	0.86	1.32
CONTROL FODDER AVE...		2148.56	9188.23	3324.90	3387.89	42.89	72.62	28.47	59.51	25.35	4.57	4.72	0.81	0.05	0.35	0.86	1.32
STD...		133.62	627.41	344.05	79.49	4.46	6.33	0.17	2.85	2.68	0.23	0.18	0.06	0.01	0.08	0.09	0.03
MIN...		1966.94	8484.71	2863.46	3288.98	38.56	65.74	28.29	56.52	21.64	4.30	4.53	0.72	0.04	0.27	0.74	1.27
MAX...		2284.56	10008.23	3689.25	3483.60	49.04	81.03	28.71	63.34	27.90	4.85	4.96	0.87	0.06	0.46	0.95	1.34
N...		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

- - - - ROSEMOUNT WATERSHED CORN DATA 1982 MEANS - - - - -

TISSUE	TREATMENT	P (ug/g)	K =====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
GRAIN	SLUDGE	3558.57	4494.75	54.81	1676.15	1.88	23.24	22.52	8.37	36.06	1.60	2.63	0.35	0.02	0.14	NA	1.58
STOVER	SLUDGE	1548.23	18237.33	8221.58	4757.15	155.64	199.89	39.31	84.61	80.44	8.41	7.95	1.16	0.14	0.71	2.72	1.22
COB	SLUDGE	180.65	5464.58	55.32	258.47	1.76	10.96	24.06	7.60	45.32	1.80	1.62	1.56	0.02	0.12	1.69	0.25
FODDER	SLUDGE	2483.11	10103.22	3330.71	2792.99	63.93	93.53	29.44	38.89	54.66	4.34	4.68	0.77	0.07	0.37	1.22	1.33
GRAIN	CONTROL	3173.70	4721.07	57.52	1660.50	2.48	21.46	23.10	9.08	27.11	2.31	2.81	0.42	0.02	0.22	0.04	1.55
STOVER	CONTROL	1306.57	15475.67	8081.20	6194.67	101.85	148.87	36.10	132.37	25.27	7.94	7.74	1.08	0.09	0.55	1.59	1.26
COB	CONTROL	182.29	5824.60	81.19	289.16	2.32	13.94	23.90	11.06	15.97	1.88	1.78	1.74	0.02	0.10	2.23	0.23
FODDER	CONTROL	2148.56	9188.23	3324.90	3387.89	42.89	72.62	28.47	59.51	25.35	4.57	4.72	0.81	0.05	0.35	0.86	1.32

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1983

TISSUE	ID	P (ug/g)	K =====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
- SLUDGE -																	
GRAIN	6 2	3478.60	4150.10	38.74	1599.90	5.53	25.59	3.14	7.32	33.99	2.57	3.03	0.21	0.50	0.53	0.09	1.71
STOVER	6 2	1019.70	13973.00	5247.00	2982.10	309.07	326.75	58.60	47.53	45.83	6.25	7.86	1.10	0.14	1.35	5.70	0.83
COB	6 2	247.40	4481.90	102.71	527.20	17.94	20.05	3.04	7.20	62.60	8.78	2.46	0.55	0.50	0.53	0.68	0.24
FODDER		2194.57	8275.59	2217.20	2091.04	133.19	150.82	26.27	24.09	41.21	4.60	5.00	0.61	0.35	0.87	2.48	1.23
G	6 4	2910.40	3997.60	37.90	1457.30	4.50	23.69	11.48	6.26	26.54	2.06	3.08	0.16	0.50	0.53	0.08	1.63
S	6 4	784.70	12951.00	7178.40	3622.80	190.99	234.61	16.38	63.77	36.28	7.58	8.34	0.76	0.11	0.90	4.18	0.94
C	6 4	238.35	5339.10	77.50	349.19	17.85	22.23	4.19	6.68	29.90	8.62	2.46	0.37	0.50	0.53	0.57	0.27
FODDER		1864.47	7606.14	2832.96	2214.91	78.49	106.04	12.81	28.78	30.62	4.75	5.09	0.41	0.35	0.67	1.73	1.25
G	6 5	3415.10	4250.20	41.00	1529.00	6.11	25.65	9.16	7.05	28.02	2.27	3.48	0.23	0.50	0.55	0.08	1.68
S	6 5	1062.70	17869.00	5820.20	2300.90	178.67	205.26	26.82	46.00	32.62	6.51	7.17	0.69	0.12	0.49	3.59	1.04
C	6 5	211.76	5238.40	56.27	273.99	14.46	18.42	3.16	5.51	27.09	8.56	2.37	0.45	0.50	0.53	NA	0.24
FODDER		2149.62	10210.19	2538.71	1764.79	81.30	102.68	16.32	23.76	29.93	4.59	4.99	0.45	0.34	0.53	NA	1.29
TERRACE MEAN..		2069.55	8697.31	2529.62	2023.58	97.66	119.85	18.47	25.54	33.92	4.65	5.02	0.49	0.34	0.69	NA	1.26
G	7 2	3021.00	3886.40	44.20	1444.10	4.55	25.06	6.56	7.38	26.81	2.34	2.95	0.34	0.50	0.53	0.08	1.62
S	7 2	1241.40	14437.00	6456.70	3390.90	298.38	329.71	17.37	62.16	53.62	8.23	8.17	1.76	0.14	1.14	5.85	1.08
C	7 2	192.44	4524.90	84.03	359.89	15.91	21.92	3.13	6.94	31.86	8.96	2.27	0.29	0.50	0.60	0.48	0.24
FODDER		2106.20	8050.28	2547.75	2118.56	120.01	143.61	10.51	28.71	37.66	5.15	4.93	0.89	0.36	0.77	2.36	1.30
G	7 4	3217.80	3972.20	41.70	1484.70	4.10	24.93	8.39	7.23	32.86	2.24	3.16	0.19	0.50	0.68	0.10	1.70
S	7 4	1431.40	12364.00	7168.40	4143.50	188.51	212.58	25.08	45.52	98.38	6.57	7.37	0.87	0.13	0.92	4.07	1.12
C	7 4	211.96	5110.30	105.83	367.94	14.86	33.23	24.40	7.27	59.46	7.30	2.37	0.37	0.50	0.53	0.44	0.23
FODDER		2259.63	7370.98	2851.47	2436.10	77.58	99.47	16.32	22.30	60.90	4.37	4.75	0.47	0.35	0.76	1.69	1.35
G	7 6	3379.50	4038.10	37.57	1394.50	4.53	25.97	9.81	7.31	36.41	1.79	3.13	0.36	0.50	0.53	0.08	1.63
S	7 6	1833.90	19745.00	5057.00	2083.70	223.05	253.87	38.67	60.81	84.72	5.64	7.74	1.16	0.18	0.65	NA	1.04
C	7 6	260.47	4872.10	88.48	313.73	20.22	35.92	15.41	10.50	77.61	11.96	2.33	0.72	0.50	0.53	0.68	0.28
FODDER		2467.31	10740.69	2161.57	1595.65	98.12	123.04	22.46	30.17	60.24	4.26	5.01	0.73	0.36	0.58	NA	1.27
TERRACE MEAN...		2277.71	8720.65	2520.27	2050.10	98.57	122.04	16.43	27.06	52.93	4.60	4.90	0.70	0.36	0.70	NA	1.31
SLUDGE FODDER AVE...		2173.63	8708.98	2524.94	2036.84	98.11	120.94	17.45	26.30	43.43	4.62	4.96	0.59	0.35	0.70	2.06	1.28
STD...		180.18	1291.62	267.38	279.70	21.60	20.11	5.41	3.01	12.73	0.29	0.10	0.17	0.01	0.12	0.36	0.04
MIN...		1864.47	7370.98	2161.57	1595.65	77.58	99.47	10.51	22.30	29.93	4.26	4.75	0.41	0.34	0.53	1.69	1.23
MAX...		2467.31	10740.69	2851.47	2436.10	133.19	150.82	26.27	30.17	60.90	5.15	5.09	0.89	0.36	0.87	2.48	1.35
N...		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	4.00	6.00
- CONTROL -																	
G	4 1	2664.70	3817.00	36.82	1317.60	6.79	22.54	3.69	7.29	19.61	3.33	2.65	0.18	0.50	0.63	0.08	1.51
S	4 1	904.31	13801.00	5488.70	3736.10	152.73	176.37	18.93	114.31	14.00	7.44	7.53	0.92	0.11	0.84	1.17	1.07
C	4 1	190.12	4879.10	62.85	274.47	23.73	79.58	5.99	8.57	10.57	13.51	3.61	0.45	0.50	0.53	0.48	0.24
FODDER		1697.04	8231.93	2401.82	2279.49	71.44	93.93	10.49	53.78	16.43	5.95	4.84	0.52	0.33	0.71	0.59	1.21
G	4 2	2761.00	3950.50	40.93	1380.40	4.57	26.39	2.95	7.80	21.83	6.56	2.86	0.15	0.50	0.53	0.11	1.50
S	4 2	821.95	13805.00	5505.40	3899.30	110.61	137.68	21.41	105.43	14.43	7.19	6.42	0.78	0.06	0.46	5.04	1.00
C	4 2	206.59	5808.20	66.80	279.78	19.72	25.07	3.66	8.55	13.15	9.62	2.69	0.66	0.50	0.53	0.91	0.26
FODDER		1745.40	8202.53	2316.65	2338.46	49.93	72.59	10.69	48.48	18.04	7.07	4.33	0.45	0.32	0.50	2.22	1.19
G	4 4	2893.80	3862.40	40.96	1370.20	4.24	21.48	10.03	7.22	20.39	2.43	2.93	0.15	0.50	0.53	0.11	1.66
S	4 4	957.25	14919.00	5718.70	4000.50	123.51	172.59	48.99	77.80	18.21	5.85	7.26	0.60	0.09	1.70	2.53	1.05
C	4 4	173.39	5427.00	55.54	263.93	20.11	25.72	3.13	7.02	16.30	10.67	2.47	0.61	0.50	0.53	0.75	0.23
FODDER		1871.31	8510.17	2360.45	2349.90	54.29	83.54	25.35	36.02	19.15	4.53	4.66	0.37	0.33	1.00	1.15	1.29
TERRACE MEAN...		1771.25	8314.88	2359.64	2322.62	58.55	83.35	15.51	46.09	17.87	5.85	4.61	0.45	0.33	0.74	1.32	1.23
CONTROL FODDER AVE...		1771.25	8314.88	2359.64	2322.62	58.55	83.35	15.51	46.09	17.87	5.85	4.61	0.45	0.33	0.74	1.32	1.23
STD...		73.46	138.61	34.78	30.85	9.29	8.71	6.96	7.44	1.12	1.04	0.21	0.06	0.01	0.21	0.68	0.04
MIN...		1697.04	8202.53	2316.65	2279.49	49.93	72.59	10.49	36.02	16.43	4.53	4.33	0.37	0.32	0.50	0.59	1.19
MAX...		1871.31	8510.17	2401.82	2349.90	71.44	93.93	25.35	53.78	19.15	7.07	4.84	0.52	0.33	1.00	2.22	1.29
N...		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

- - - - ROSEMOUNT WATERSHED CORN DATA 1983 MEANS - - - - -

TISSUE	TREATMENT	P (ug/g)	K =====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	% N
GRAIN	SLUDGE	3237.07	4049.10	40.19	1484.92	4.89	25.15	8.09	7.09	30.77	2.21	3.14	0.25	0.50	0.56	0.09	1.66
STOVER	SLUDGE	1228.97	15223.17	6154.62	3087.32	231.45	260.46	30.49	54.30	58.58	6.80	7.78	1.06	0.14	0.91	4.68	1.01
COB	SLUDGE	227.06	4927.78	85.80	365.32	16.87	25.30	8.89	7.35	48.09	9.03	2.38	0.46	0.50	0.54	0.57	0.25
FODDER	SLUDGE	2173.63	8708.98	2524.94	2036.84	98.11	120.94	17.45	26.30	43.43	4.62	4.96	0.59	0.35	0.70	2.06	1.28
GRAIN	CONTROL	2773.17	3876.63	39.57	1356.07	5.20	23.47	5.56	7.44	20.61	4.11	2.81	0.16	0.50	0.56	0.10	1.56
STOVER	CONTROL	894.50	14175.00	5570.93	3878.63	128.95	162.21	29.78	99.18	15.55	6.83	7.07	0.77	0.08	1.00	2.91	1.04
COB	CONTROL	190.03	5371.43	61.73	272.73	21.19	43.46	4.26	8.05	13.34	11.27	2.92	0.57	0.50	0.53	0.72	0.24
FODDER	CONTROL	1771.25	8314.88	2359.64	2322.62	58.55	83.35	15.51	46.09	17.87	5.85	4.61	0.45	0.33	0.74	1.32	1.23

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1984

TISSUE	ID	P (ug/g)	K ===>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	CR	PB	%N
- SLUDGE -																	
G	3 6	3896.30	4599.60	32.91	1595.30	4.14	23.05	5.19	5.79	26.36	4.74	3.96	0.15	0.57	0.14	0.12	1.676
S	3 6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C	3 6	495.07	2888.60	55.90	222.53	18.17	15.61	0.60	3.43	31.30	8.51	1.95	0.28	1.86	0.31	0.10	0.233
FODDER		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G	3 9	3583.80	4522.30	39.01	1489.60	3.76	23.11	4.18	5.23	25.00	3.76	4.12	0.15	0.53	0.13	0.10	1.572
S	3 9	2119.70	13839.00	4278.90	3059.30	55.27	81.45	84.52	32.79	49.74	8.35	9.12	0.29	0.22	0.72	0.95	1.030
C	3 9	561.58	3193.00	61.04	218.48	15.10	14.71	1.47	3.48	29.15	7.67	1.99	0.35	1.46	0.30	0.10	0.202
FODDER		2620.83	8790.09	2037.94	2113.92	29.05	49.83	41.77	18.05	37.03	6.28	6.28	0.23	0.47	0.42	0.50	1.193
G	3 10	3474.50	4441.60	39.58	1459.90	3.29	20.06	3.54	5.07	19.25	9.55	3.44	0.15	0.52	0.12	0.14	1.608
S	3 10	1824.50	10503.00	3726.50	3571.50	110.86	102.59	84.64	27.80	27.93	12.10	8.40	0.45	0.25	0.72	0.56	0.893
C	3 10	363.47	2674.90	57.76	236.14	21.90	18.61	1.23	3.50	13.34	8.77	1.98	0.38	1.98	0.33	0.10	0.249
FODDER		2440.69	7110.36	1756.39	2337.56	54.93	58.33	41.07	15.51	22.78	10.67	5.62	0.31	0.52	0.42	0.33	1.159
	TERRACE MEAN...	2530.76	7950.22	1897.16	2225.74	41.99	54.08	41.42	16.78	29.91	8.47	5.95	0.27	0.49	0.42	0.42	1.176
G	4 6	3287.40	4025.90	30.20	1328.50	2.80	19.77	3.32	4.52	22.60	5.36	3.34	0.19	0.45	0.13	0.11	1.592
S	4 6	2167.70	16262.00	3701.30	2124.30	48.37	67.11	41.10	22.67	41.19	8.69	9.64	0.15	0.19	0.62	0.36	0.904
C	4 6	473.73	2428.70	64.91	208.55	69.68	22.16	1.91	3.96	33.18	11.50	1.93	0.38	2.13	0.34	0.10	0.260
FODDER		2527.30	9988.17	1856.26	1642.63	30.28	43.46	21.98	13.50	32.60	7.46	6.37	0.18	0.44	0.39	0.23	1.154
G	4 11	3569.60	4236.30	34.96	1536.20	3.46	22.93	4.28	5.88	26.85	6.23	3.87	0.23	0.53	0.10	0.14	1.678
S	4 11	1780.50	12193.00	4801.30	3458.40	52.36	76.69	10.08	37.56	77.04	9.97	11.71	0.25	0.21	0.67	0.44	0.986
C	4 11	339.50	1919.30	69.72	233.02	15.98	16.21	1.47	3.71	33.15	7.36	1.89	0.15	2.45	0.27	0.10	0.268
FODDER		2512.96	7556.14	2141.30	2276.74	26.08	46.10	6.61	19.68	49.52	7.97	7.17	0.23	0.55	0.37	0.27	1.256
	TERRACE MEAN...	2520.13	8772.15	1998.78	1959.69	28.18	44.78	14.30	16.59	41.06	7.72	6.77	0.21	0.50	0.38	0.25	1.205
G	5 2	3206.00	3912.20	40.16	1354.90	3.75	20.21	3.94	6.11	33.06	10.72	2.65	0.77	0.46	0.15	0.34	1.446
S	5	1688.20	9940.90	4957.00	3154.60	59.22	84.90	45.76	32.45	34.58	8.79	7.43	0.24	0.25	0.80	NA	0.736
C	5 2	225.52	3243.30	46.42	185.39	20.31	16.50	2.75	4.36	28.26	8.67	1.78	0.35	2.54	0.48	0.10	0.200
FODDER		2370.57	6259.06	1997.05	1980.16	27.11	45.66	20.49	16.45	33.29	9.79	4.48	0.53	0.54	0.43	NA	1.067
G	5 3	2813.40	3284.70	29.97	1270.20	3.27	19.11	2.81	5.26	24.65	4.57	2.56	0.21	0.50	0.08	0.22	1.418
S	5 3	1313.90	10786.00	5416.60	4025.70	119.24	144.18	6.78	36.06	37.68	9.15	8.80	0.71	0.32	1.92	0.57	0.641
C	5 3	209.31	2398.20	62.46	319.79	20.96	21.14	5.02	4.51	29.09	10.07	2.06	0.39	2.46	0.39	0.10	0.214
FODDER		2016.44	6209.41	2181.26	2296.86	50.88	69.16	4.56	17.49	30.19	6.82	5.01	0.42	0.58	0.84	0.35	1.016
G	5 6	3260.00	3717.90	29.18	1374.10	2.62	18.17	2.77	5.94	23.01	3.93	2.75	0.15	0.54	0.09	0.21	1.548
S	5 6	1291.60	12844.00	4012.70	2915.50	69.26	82.72	10.36	22.98	20.62	6.59	8.23	0.15	0.15	0.86	0.34	0.651
C	5 6	260.64	2407.60	52.30	287.09	29.68	15.19	1.63	4.35	30.12	7.38	1.56	0.59	1.55	0.44	0.10	0.210
FODDER		2309.55	6861.01	1450.55	1833.09	28.61	40.92	5.38	11.88	22.75	5.16	4.60	0.19	0.48	0.39	0.25	1.117
	TERRACE MEAN...	2232.19	6443.16	1876.29	2036.70	35.53	51.91	10.14	15.27	28.74	7.26	4.70	0.38	0.53	0.56	NA	1.067
G	6 2	2900.30	3474.60	32.73	1195.10	3.38	18.34	4.32	4.98	22.37	5.39	2.94	0.20	0.61	0.09	0.10	1.460
S	6 2	872.18	13021.00	4520.00	3697.60	75.81	89.52	40.15	23.49	16.69	6.94	7.29	0.15	0.17	0.91	0.27	0.652
C	6 2	194.35	2530.60	53.68	246.01	20.40	16.27	0.47	3.72	26.50	7.78	1.74	0.38	3.07	0.40	0.13	0.219
FODDER		1821.24	7312.89	1879.06	2137.63	34.70	47.41	18.70	12.47	20.41	6.24	4.62	0.20	0.65	0.46	0.27	1.015
G	6 4	3137.00	3677.60	34.95	1398.60	3.55	21.58	4.66	6.96	26.47	5.31	2.68	0.15	0.59	0.11	0.22	1.464
S	6 4	1055.50	10809.00	4967.00	3844.60	84.95	100.24	9.50	31.28	33.15	8.19	8.72	0.15	0.15	1.17	0.28	0.668
C	6 4	190.56	2876.60	40.68	229.58	15.49	13.66	0.47	3.59	20.34	5.87	1.49	0.55	1.45	0.37	0.33	0.199
FODDER		2048.21	6532.70	2054.48	2306.04	37.83	53.15	6.30	16.65	28.71	6.53	5.06	0.18	0.48	0.56	0.25	1.037
G	6 5	3085.20	3613.90	29.80	1194.10	3.08	16.62	4.04	4.99	20.94	6.33	2.82	0.15	0.56	0.09	0.10	1.542
S	6 5	1510.40	14892.00	3605.90	2234.80	61.23	76.17	41.32	23.60	18.06	7.91	8.78	0.22	0.15	0.74	0.20	0.756
C	6 5	229.69	2739.30	42.22	144.33	18.79	16.04	0.68	3.56	19.65	6.86	1.58	0.40	1.17	0.49	0.10	0.207
FODDER		2271.39	7793.68	1377.54	1504.88	26.19	39.00	17.82	11.89	19.76	6.97	4.97	0.20	0.45	0.37	0.14	1.143
	TERRACE MEAN...	2046.95	7213.09	1770.36	1982.85	32.91	46.52	14.27	13.67	22.96	6.58	4.88	0.19	0.53	0.46	0.19	1.065
G	7 2	3142.90	3542.20	32.99	1342.80	3.46	20.61	5.17	6.49	24.42	5.92	2.54	0.15	0.59	0.08	0.10	1.584
S	7 2	1000.80	13499.00	4865.30	3196.60	69.86	88.72	12.17	32.78	23.26	7.74	7.88	0.15	0.15	0.95	0.46	0.846
C	7 2	214.48	2469.10	45.47	272.30	12.36	11.28	2.27	4.47	27.10	5.26	1.62	0.20	1.17	0.33	0.10	0.218
FODDER		2073.71	7327.28	1913.02	1977.28	30.00	46.34	7.66	16.55	24.19	6.57	4.54	0.15	0.47	0.44	0.24	1.187
G	7 4	3220.30	3560.10	31.58	1350.10	2.99	19.17	4.52	5.99	26.09	1.21	2.76	0.15	0.66	0.09	0.19	1.493
S	7 4	1285.50	8593.10	5483.20	4085.40	75.00	83.24	42.72	26.34	38.10	6.25	7.71	0.26	0.28	0.99	0.37	0.800
C	7 4	230.05	2496.70	58.09	243.91	16.65	16.28	1.79	4.19	38.80	7.07	1.81	0.62	1.03	0.61	0.10	0.212
FODDER		2176.40	5657.27	2385.58	2452.91	35.01	46.61	20.81	14.64	32.16	3.79	4.83	0.23	0.52	0.51	0.26	1.104
G	7 6	3286.10	3794.70	33.43	1370.80	2.65	19.99	4.40	6.05	28.03	2.04	3.24	0.15	0.58	0.14	0.25	1.530
S	7 6	1809.90	14348.00	3992.60	2360.60	58.01	74.75	21.75	32.21	31.13	6.13	8.29	0.15	0.32	0.69	0.26	0.956
C	7 6	353.22	3340.70	64.97	220.33	16.10	21.18	1.91	4.96	45.37	7.38	1.76	0.35	0.63	0.50	0.18	0.232
FODDER		2468.96	7977.58	1618.31	1677.32	25.82	41.97	11.14	16.42	30.61	4.09	5.14	0.17	0.48	0.39	0.25	1.200
	TERRACE MEAN...	2239.69	6987.38	1972.30	2035.84	30.28	44.97	13.20	15.87	28.99	4.82	4.84	0.18	0.49	0.45	0.25	1.164

Rosemount Terraces : Corn Tissue Elemental Analyses

Continued from previous page

ROSEMOUNT WATERSHED CORN DATA 1984 TISSUE	ID	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	CR	PB	%N
		UG/G ===>>>															
G	8 2	3251.10	3971.70	32.79	1318.70	2.49	17.52	2.11	6.00	26.22	2.31	3.04	0.15	0.60	0.15	0.10	1.550
S	8 2	1495.40	17408.00	4301.50	2745.40	60.07	82.88	15.72	28.08	35.19	7.69	8.42	0.16	0.22	0.74	0.30	0.898
C	8 2	273.36	2704.80	55.33	209.09	20.10	25.46	1.83	4.97	31.15	10.40	1.72	0.28	0.75	0.47	0.13	0.208
FODDER		2286.40	9564.90	1841.37	1840.06	28.17	45.78	7.85	15.27	30.38	5.19	5.22	0.16	0.45	0.42	0.19	1.174
G	8 4	3099.20	3908.00	35.17	1281.60	70.19	184.09	1.71	11.52	27.47	62.87	3.29	0.73	0.58	0.23	0.10	1.440
S	8 4	1155.70	10561.00	5529.60	3033.40	65.48	82.33	45.14	31.04	40.56	7.66	8.56	0.15	0.29	0.79	0.22	0.952
C	8 4	241.28	2944.90	58.82	195.65	15.17	15.46	2.27	4.21	30.55	6.41	1.71	0.27	0.87	0.48	0.10	0.175
FODDER		2047.40	6708.51	2408.96	1957.04	64.06	127.60	20.50	19.40	33.35	34.83	5.45	0.45	0.48	0.49	0.15	1.135
G	8 5	3192.70	3827.30	35.48	1380.20	58.65	133.66	2.08	9.03	26.47	48.09	3.19	1.01	0.57	0.23	0.10	1.488
S	8 5	1345.00	11000.00	4844.00	3474.60	56.73	78.38	93.06	23.97	25.97	5.83	7.50	0.15	0.17	0.67	0.21	0.863
C	8 5	199.69	2825.70	56.53	200.76	14.90	12.54	2.21	4.54	29.05	5.14	1.71	0.32	0.65	0.46	0.10	0.194
FODDER		2129.48	7114.85	2285.51	2281.13	54.84	99.75	44.63	15.72	26.41	25.47	5.11	0.56	0.39	0.45	0.15	1.110
TERRACE MEAN...		2154.43	7796.08	2178.61	2026.07	49.02	91.04	24.33	16.80	30.05	21.83	5.26	0.39	0.44	0.45	0.16	1.140
SLUDGE FODDER AVE...		2257.60	7422.74	1949.04	2038.45	36.47	56.32	18.58	15.72	29.63	9.62	5.28	0.27	0.50	0.46	0.25	1.129
STD...		217.66	1153.20	293.21	273.62	12.08	23.32	12.99	2.33	7.13	8.12	0.73	0.13	0.06	0.11	0.09	0.067
MIN...		1821.24	5657.27	1377.54	1504.88	25.82	39.00	4.56	11.88	19.76	3.79	4.48	0.15	0.39	0.37	0.14	1.015
MAX...		2620.83	9988.17	2408.96	2452.91	64.06	127.60	44.63	19.68	49.52	34.83	7.17	0.56	0.65	0.84	0.50	1.256
N...		16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	15.00	16.000
- CONTROL -																	
G	3 1	2907.20	4105.70	37.74	1291.60	12.87	34.62	3.58	5.92	19.89	10.53	3.51	0.39	0.38	0.14	0.23	1.612
S	3 1	730.14	17005.00	3364.90	2772.10	52.84	69.02	100.81	98.24	17.41	10.35	8.47	0.24	0.18	0.50	0.60	0.853
C	3 1	307.68	3177.20	55.30	179.79	51.11	28.96	1.35	4.31	13.27	14.25	2.31	0.35	2.81	0.36	0.10	0.215
FODDER		1700.50	9621.88	1486.26	1824.15	34.08	49.01	45.64	45.90	18.15	10.82	5.55	0.32	0.54	0.32	0.38	1.142
G	3 2	3253.90	4506.70	38.18	1467.40	5.96	28.44	3.21	6.36	23.47	7.14	4.00	0.61	0.37	0.17	0.26	1.669
S	3 2	943.05	19150.00	3875.90	2866.10	62.33	83.17	85.78	94.82	21.97	13.32	10.39	0.15	0.18	0.56	0.73	1.052
C	3 2	290.35	3592.80	60.98	199.39	17.74	19.85	1.75	4.22	15.46	8.58	2.22	0.33	2.59	0.31	0.10	0.240
FODDER		1949.64	11044.61	1774.64	1988.35	32.47	52.42	40.40	46.15	22.09	10.06	6.73	0.38	0.48	0.36	0.46	1.265
G	3 4	3338.10	4307.10	33.56	1464.60	4.69	26.09	3.92	5.95	22.78	5.18	4.02	0.47	0.43	0.14	0.11	1.548
S	3 4	1117.30	15951.00	3539.30	2611.40	46.36	67.66	98.24	56.25	17.57	9.21	8.25	0.15	0.15	0.44	0.42	0.946
C	3 4	339.65	3403.30	53.72	164.95	22.24	18.98	1.27	4.90	14.86	9.72	2.24	0.21	2.90	0.34	0.13	0.232
FODDER		2035.43	9689.37	1679.50	1889.27	25.76	44.97	47.93	29.45	19.65	7.47	5.85	0.30	0.51	0.30	0.26	1.151
TERRACE MEAN...		1895.19	10118.62	1646.80	1900.59	30.77	48.80	44.65	40.50	19.96	9.45	6.04	0.33	0.51	0.33	0.36	1.186
G	4 1	2564.40	3644.60	36.04	1381.50	4.48	26.36	4.41	6.39	20.24	6.25	2.86	0.50	0.52	0.14	0.19	1.558
S	4 1	711.68	11683.00	4433.40	3851.10	64.87	90.63	58.95	101.62	14.09	10.68	6.41	0.39	0.17	0.46	0.68	0.972
C	4 1	240.67	3014.10	78.98	249.10	17.30	27.25	1.27	5.79	12.82	12.07	2.08	0.39	1.98	0.29	0.10	0.195
FODDER		1464.61	7461.51	2158.63	2470.49	34.72	57.41	30.41	52.22	16.62	8.90	4.50	0.44	0.48	0.31	0.42	1.154
G	4 2	2900.20	3984.60	33.88	1437.50	3.60	22.81	6.09	6.95	18.81	3.98	3.06	0.59	0.47	0.15	0.10	1.602
S	4 2	793.00	14467.00	3572.00	2938.10	50.18	73.44	86.82	83.13	16.69	10.71	6.46	0.15	0.42	0.45	0.57	0.892
C	4 2	254.65	2891.70	83.85	218.06	20.52	16.84	1.08	6.72	13.48	9.78	2.24	0.49	1.90	0.31	0.10	0.200
FODDER		1804.19	8056.57	1448.85	1917.49	23.80	42.41	37.78	37.29	17.45	7.22	4.34	0.40	0.59	0.29	0.29	1.183
G	4 4	2684.90	3835.30	35.37	1308.80	3.90	21.72	6.28	4.26	17.54	4.84	3.06	0.15	0.45	0.13	0.20	1.428
S	4 4	813.39	10736.00	4506.20	4085.40	63.48	85.10	51.36	43.81	20.49	10.69	6.60	0.15	0.15	0.50	0.59	0.956
C	4 4	255.19	3877.00	66.67	191.52	17.49	16.58	0.60	3.92	12.11	9.34	2.16	0.22	2.15	0.33	0.10	0.210
FODDER		1621.83	6933.74	2043.18	2451.05	31.87	49.67	25.97	21.96	18.36	7.88	4.56	0.16	0.47	0.31	0.37	1.104
TERRACE MEAN...		1630.21	7483.94	1883.55	2279.67	30.13	49.83	31.39	37.16	17.48	8.00	4.47	0.33	0.51	0.30	0.36	1.147
CONTROL FODDER AVE...		1762.70	8801.28	1765.18	2090.13	30.45	49.31	38.02	38.83	18.72	8.73	5.25	0.33	0.51	0.31	0.36	1.167
STD...		193.06	1433.64	263.75	266.52	4.16	4.86	7.80	10.47	1.77	1.34	0.87	0.09	0.04	0.02	0.07	0.050
MIN...		1464.61	6933.74	1448.85	1824.15	23.80	42.41	25.97	21.96	16.62	7.22	4.34	0.16	0.47	0.29	0.26	1.104
MAX...		2035.43	11044.61	2158.63	2470.49	34.72	57.41	47.93	52.22	22.09	10.82	6.73	0.44	0.59	0.36	0.46	1.265
N...		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.000
- - - - 1984 MEANS - - - -																	
GRAIN SLUDGE		3259.16	3888.86	33.82	1367.10	10.44	36.35	3.71	6.22	25.25	11.08	3.13	0.28	0.56	0.13	0.16	1.535
STOVER SLUDGE		1482.28	12531.19	4562.71	3186.39	70.11	87.24	37.80	29.07	34.43	8.00	8.53	0.24	0.22	0.87	0.39	0.827
COB SLUDGE		297.38	2710.71	55.66	227.82	21.28	16.96	1.76	4.11	29.18	7.77	1.78	0.37	1.60	0.41	0.12	0.218
FODDER SLUDGE		2257.60	7422.74	1949.04	2038.45	36.47	56.32	18.58	15.72	29.63	9.62	5.28	0.27	0.50	0.46	NA	1.129
GRAIN CONTROL		2941.45	4064.00	35.80	1391.90	5.92	26.67	4.58	5.97	20.46	6.32	3.42	0.45	0.44	0.15	0.18	1.570
STOVER CONTROL		851.43	14832.00	3881.95	3187.37	56.68	78.17	80.33	79.65	18.04	10.83	7.76	0.21	0.21	0.49	0.60	0.945
COB CONTROL		281.37	3326.02	66.58	200.47	24.40	21.41	1.22	4.98	13.67	10.62	2.21	0.33	2.39	0.32	0.11	0.215
FODDER CONTROL		1762.70	8801.28	1765.18	2090.13	30.45	49.31	38.02	38.83	18.72	8.73	5.25	0.33	0.51	0.31	0.36	1.167

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1985

TISSUE	ID	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	CR	PB	%N
		UG/G ===>>>															
- SLUDGE -																	
GRAIN	3 6	2911.80	3757.90	53.56	1397.20	29.47	52.47	0.47	7.93	34.37	13.59	2.35	0.16	0.30	0.15	0.35	1.703
STOVER	3 6	1655.10	14116.00	6627.10	3775.10	206.37	210.68	19.87	44.24	94.85	8.74	5.40	0.42	0.26	5.18	0.38	0.854
COB	3 6	231.21	4979.60	68.34	281.86	10.99	16.00	5.68	6.64	78.88	6.41	1.97	0.46	1.43	0.54	0.35	0.228
FODDER		2172.12	7941.78	2639.07	2229.78	97.32	111.32	8.57	22.09	62.22	11.08	3.51	0.29	0.39	2.16	0.36	1.234
G	3 9	3331.60	3875.10	47.29	1581.90	7.61	27.68	0.47	8.27	46.17	3.26	2.63	0.28	0.39	0.15	0.35	1.762
S	3 9	1904.40	15522.00	5819.40	3408.70	142.23	154.89	16.25	45.73	127.65	9.65	5.00	0.17	0.29	2.41	0.46	0.970
C	3 9	360.14	5151.30	68.18	301.67	10.61	12.47	5.78	7.48	103.00	6.23	2.14	0.46	1.34	0.41	0.35	0.291
FODDER		2466.14	8944.40	2507.63	2251.24	65.20	80.57	7.64	24.16	85.70	6.22	3.60	0.25	0.43	1.13	0.40	1.300
G	3 10	3223.70	3913.90	50.91	1481.70	7.21	28.05	0.47	6.88	34.86	3.03	2.68	0.15	0.33	0.16	0.35	1.655
S	3 10	1114.90	10107.00	6522.20	4418.80	167.13	183.37	196.35	32.20	53.97	10.62	5.21	0.24	0.18	3.99	0.36	0.920
C	3 10	171.54	5900.80	61.34	153.68	16.07	47.51	5.31	5.38	42.85	9.26	2.33	0.56	1.54	0.74	0.35	0.237
FODDER		2111.66	6553.28	2623.36	2529.58	71.55	91.52	78.74	16.81	43.17	6.61	3.65	0.22	0.38	1.73	0.35	1.236
	TERRACE MEAN...	2249.98	7813.15	2590.02	2336.86	78.03	94.47	31.65	21.02	63.70	7.97	3.59	0.25	0.40	1.68	0.37	1.256
G	4 6	3379.00	4074.80	47.16	1534.00	7.05	27.57	2.62	8.47	41.10	2.57	2.39	0.36	0.28	0.08	0.35	1.620
S	4 6	1203.20	16950.00	6129.70	3409.00	140.57	151.94	11.89	66.16	101.27	8.43	4.71	0.16	0.26	1.71	0.50	0.840
C	4 6	192.07	5778.80	68.90	258.47	14.13	40.80	6.80	7.80	73.07	7.61	2.28	0.73	1.51	0.81	0.35	0.215
FODDER		2279.25	8979.38	2291.00	2105.86	56.92	74.64	6.43	29.67	66.26	5.20	3.23	0.32	0.39	0.75	0.41	1.201
G	4 9	3189.50	3864.80	49.10	1440.50	6.87	24.18	6.03	6.90	35.24	2.41	2.84	0.54	0.22	0.08	0.35	1.581
S	4 9	1451.80	12676.00	5875.40	3971.20	130.22	144.61	9.66	27.51	62.47	7.88	5.07	0.24	0.27	1.91	0.35	0.880
C	4 9	158.80	6138.50	69.25	172.11	15.79	20.50	5.07	5.34	51.51	8.17	2.35	0.84	1.53	0.83	0.35	0.208
FODDER		2245.44	7512.43	2331.99	2320.96	55.94	71.01	7.37	14.31	47.32	5.05	3.67	0.45	0.35	0.86	0.35	1.187
G	4 11	3001.90	3672.60	53.51	1365.10	6.46	23.25	4.42	6.68	27.76	2.43	2.75	0.28	0.19	0.08	0.35	1.545
S	4 11	1168.30	11358.00	5732.00	4589.50	162.84	183.71	12.80	63.74	31.68	9.75	5.64	0.15	0.26	2.11	0.48	0.798
C	4 11	160.36	5304.60	53.44	164.20	14.89	27.02	4.84	5.54	26.35	8.79	2.02	0.68	1.47	0.80	0.35	0.243
FODDER		2002.15	6925.60	2347.07	2557.92	70.39	88.40	7.84	29.62	29.21	5.97	3.85	0.26	0.34	0.97	0.40	1.125
	TERRACE MEAN...	2175.61	7805.80	2323.35	2328.25	61.08	78.02	7.21	24.53	47.60	5.41	3.59	0.34	0.36	0.86	0.39	1.171
G	5 2	2692.40	3373.90	48.68	1345.30	6.05	22.89	5.55	6.86	24.09	2.61	2.27	0.23	0.26	0.08	0.35	1.506
S	5 2	713.05	8312.30	7121.00	4331.00	334.50	475.39	16.31	75.99	22.13	16.68	5.35	0.40	0.35	5.31	1.12	0.750
C	5 2	181.26	5046.30	73.33	288.98	51.70	13.57	5.16	6.02	16.34	5.98	1.87	0.47	1.31	0.49	0.48	0.294
FODDER		1714.60	5410.94	2758.20	2395.68	135.79	195.30	9.63	33.25	22.66	8.29	3.41	0.32	0.39	2.12	0.66	1.110
G	5 3	2929.90	3513.80	47.70	1470.90	5.93	24.49	5.17	7.43	30.69	2.61	2.45	0.27	0.28	0.08	0.35	1.550
S	5 3	684.59	13523.00	6917.10	4926.60	299.45	357.34	22.45	53.12	38.86	17.30	5.87	0.27	0.27	3.28	0.45	0.751
C	5 3	188.61	4685.90	76.24	398.05	9.69	14.84	4.81	7.09	35.50	6.57	1.80	0.40	1.17	0.48	0.35	0.268
FODDER		1870.87	7257.56	2548.45	2632.76	113.01	144.69	11.42	24.02	34.09	8.30	3.64	0.28	0.36	1.28	0.39	1.146
G	5 6	3023.20	3709.50	39.73	1492.10	7.70	25.18	4.34	7.59	32.60	2.60	2.40	0.27	0.32	0.08	0.35	1.506
S	5 6	1104.30	16215.00	5927.90	3682.40	336.35	242.93	44.61	42.14	34.34	14.02	5.09	0.16	0.30	3.25	0.88	0.932
C	5 6	158.54	5346.90	70.27	277.94	8.92	11.85	4.08	6.74	37.14	5.23	1.83	0.34	1.21	0.38	0.35	0.226
FODDER		2044.63	8515.04	2234.07	2195.26	130.13	104.99	19.30	20.37	33.67	7.09	3.35	0.24	0.39	1.29	0.55	1.174
	TERRACE MEAN...	1876.70	7061.18	2513.57	2407.90	126.31	148.32	13.45	25.88	30.14	7.90	3.47	0.28	0.38	1.56	0.53	1.144
G	6 2	3016.60	3488.00	43.73	1474.90	7.11	22.06	4.40	8.05	32.15	2.29	2.29	0.34	0.30	0.13	0.35	1.668
S	6 2	1566.10	9230.20	4911.30	4212.50	188.94	241.01	16.97	32.93	51.65	17.66	4.97	0.26	0.40	2.33	0.75	0.940
C	6 2	220.98	3907.10	92.83	513.42	8.27	9.14	4.62	7.59	42.57	4.97	1.70	0.22	1.25	0.31	0.35	0.253
FODDER		2129.62	6118.26	2248.03	2632.79	89.40	119.96	10.10	19.26	41.83	9.46	3.45	0.29	0.42	1.14	0.53	1.222
G	6 4	3107.10	3757.20	55.03	1556.60	6.88	23.70	5.95	8.20	29.18	2.57	2.64	0.32	0.29	0.12	0.35	1.561
S	6 4	1494.70	11089.00	7307.10	4778.60	223.04	276.47	17.57	55.15	39.20	17.78	5.40	0.32	0.30	3.96	0.91	1.084
C	6 4	165.64	4915.90	61.95	277.48	9.33	14.59	4.73	6.24	24.53	5.99	1.74	0.29	1.38	0.48	0.35	0.241
FODDER		2230.86	6662.47	2828.08	2675.37	89.73	119.53	10.28	25.98	32.60	8.69	3.62	0.32	0.39	1.62	0.56	1.262
G	6 5	2960.40	3436.80	38.00	1351.00	6.12	21.74	5.63	6.35	25.36	2.04	2.60	0.42	0.26	0.08	0.42	1.578
S	6 5	774.23	13588.00	6057.20	3248.00	187.01	216.23	17.83	37.83	22.41	10.35	4.44	0.19	0.22	2.74	0.78	0.684
C	6 5	146.36	4994.20	50.70	181.20	7.73	13.66	4.68	5.01	18.96	4.67	1.76	0.40	1.41	0.43	0.35	0.220
FODDER		1904.75	7268.55	2225.38	1931.24	71.97	91.63	9.97	17.66	23.69	5.30	3.19	0.33	0.35	1.08	0.54	1.127
	TERRACE MEAN...	2088.41	6683.09	2433.83	2413.13	83.70	110.37	10.12	20.96	32.71	7.82	3.42	0.32	0.39	1.28	0.55	1.204
G	7 2	2984.10	3698.30	44.65	1432.00	6.06	21.64	4.42	6.72	29.91	1.98	2.50	0.33	0.30	0.23	0.35	1.572
S	7 2	1359.20	15170.00	6370.60	4739.40	272.34	293.51	22.61	42.23	51.14	14.11	5.17	0.38	0.22	5.47	0.82	0.849
C	7 2	155.35	5287.80	63.43	242.94	10.81	13.87	4.60	6.55	36.82	5.69	1.79	0.33	1.31	0.53	0.35	0.213
FODDER		2120.77	8183.45	2442.82	2580.83	107.35	123.95	11.33	20.16	38.56	6.90	3.45	0.35	0.36	2.24	0.53	1.179
G	7 4	3212.60	3719.00	47.23	1518.50	8.71	24.23	5.64	7.87	36.04	1.89	2.46	0.41	0.27	0.10	0.35	1.620
S	7 4	1191.30	11386.00	6978.80	4463.00	219.46	230.34	12.59	63.69	75.38	10.02	5.56	0.34	0.25	3.28	0.59	0.812
C	7 4	173.80	4820.60	67.50	308.70	9.23	11.34	6.90	6.85	53.40	4.94	1.70	0.33	1.25	0.46	0.35	0.232
FODDER		2135.38	6918.05	2856.41	2608.16	94.11	106.61	8.56	30.39	53.45	5.44	3.65	0.37	0.35	1.42	0.45	1.175
G	7 6	3230.90	3737.70	37.93	1524.60	7.75	26.18	5.23	7.04	33.03	1.92	2.32	0.34	0.26	0.20	0.35	1.622
S	7 6	1085.60	13494.00	7337.90	4301.10	247.25	262.33	13.07	61.47	53.78	16.40	5.90	0.35	0.23	3.79	0.81	0.972
C	7 6	151.17	4979.40	49.88	229.86	7.53	10.45	5.95	5.12	35.52	4.52	1.62	0.21	1.34	0.43	0.35	0.215
FODDER		2144.78	7472.43	2745.81	2431.90	96.53	112.26	8.20	27.04	40.96	7.53	3.58	0.33	0.35	1.55	0.52	1.248
	TERRACE MEAN...	2133.64	7524.64	2681.68	2540.30	99.33	114.27	9.36	25.86	44.32	6.63	3.56	0.35	0.35	1.74	0.50	1.201

ROSEMOUNT WATERSHED CORN DATA 1985 TISSUE		ID	P UG/G ===>>>	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	CR	PB	%N
G		8 2	2957.00	3715.30	44.63	1417.70	6.95	22.45	4.78	6.09	28.37	1.20	2.45	0.23	0.31	0.11	0.35	1.528
S		8 2	828.71	17561.00	5651.90	2403.40	260.71	291.74	16.17	44.59	38.45	13.14	4.74	0.41	0.22	4.74	0.61	0.826
C		8 2	158.31	6477.10	57.70	202.95	12.14	16.82	6.21	5.89	29.47	6.55	1.78	0.50	1.45	0.55	0.35	0.203
FODDER			1889.78	9382.83	2248.61	1704.64	107.07	127.78	9.37	21.20	32.42	6.33	3.29	0.32	0.37	1.97	0.45	1.143
G		8 4	2940.00	3652.00	49.84	1402.20	7.22	24.25	6.31	6.85	29.27	2.66	2.49	0.33	0.31	0.17	0.35	1.476
S		8 4	1195.90	12342.00	6860.80	4426.50	361.53	387.26	14.33	52.24	55.85	15.83	5.39	0.49	0.31	7.49	1.24	0.993
C		8 4	148.69	5910.30	55.56	176.32	11.96	17.87	5.03	5.27	28.33	6.54	1.67	0.39	1.35	0.59	0.35	0.192
FODDER			2012.73	7269.55	2733.33	2488.04	147.20	166.70	9.36	24.59	39.66	8.18	3.56	0.40	0.40	3.09	0.70	1.175
G		8 5	3216.70	3776.10	41.30	1559.30	6.38	24.85	6.18	7.66	33.50	1.88	2.38	0.52	0.44	0.24	0.35	1.550
S		8 5	1056.10	13284.00	5667.30	3066.20	326.66	363.92	11.73	52.19	56.80	18.55	4.51	0.39	0.40	7.80	1.48	0.718
C		8 5	138.80	4432.60	66.33	274.61	10.55	14.28	3.65	5.41	32.67	5.24	1.65	0.37	1.21	0.57	0.38	0.209
FODDER			2149.42	7164.66	2009.49	1955.40	118.70	142.24	7.86	22.99	41.56	8.05	3.05	0.46	0.50	2.91	0.75	1.123
	TERRACE MEAN...		2017.31	7939.02	2330.48	2049.36	124.33	145.57	8.86	22.93	37.88	7.52	3.30	0.39	0.42	2.66	0.63	1.147
G		3 1	2186.40	3750.10	84.33	1238.20	17.36	39.19	0.47	9.37	24.40	10.26	2.72	0.31	0.14	0.20	0.35	1.496
S		3 1	902.30	13603.00	6001.20	3776.70	167.69	180.49	14.32	106.39	19.31	15.79	5.47	0.41	0.28	1.00	0.74	0.962
C		3 1	186.41	5436.70	77.29	239.15	16.35	24.25	6.78	7.36	18.54	8.15	1.99	0.48	1.70	0.46	0.35	0.231
FODDER			1420.02	8188.42	2641.96	2230.34	82.25	98.71	7.12	51.11	21.58	12.43	3.83	0.37	0.37	0.57	0.52	1.132
G		3 2	2828.70	3700.30	48.84	1429.80	11.22	34.73	0.47	8.99	29.31	7.90	2.91	0.15	0.23	0.27	0.35	1.626
S		3 2	712.66	19811.00	4496.10	2988.00	129.62	190.66	19.93	100.20	23.24	14.21	5.07	0.15	0.28	0.77	0.56	0.863
C		3 2	144.73	4395.20	46.13	218.27	11.75	16.26	4.88	6.78	23.48	6.21	1.70	0.53	1.60	0.40	0.35	0.223
FODDER			1784.08	10010.99	1774.68	1933.75	57.22	93.71	8.39	44.21	26.47	10.21	3.65	0.18	0.36	0.47	0.43	1.213
G		3 4	2710.30	3601.70	59.05	1347.40	31.19	53.73	2.02	8.25	27.93	14.50	2.63	0.22	0.46	0.21	0.35	1.504
S		3 4	722.60	16653.00	5337.80	3330.90	119.81	148.58	11.63	86.84	26.54	11.56	5.06	0.15	0.27	0.87	0.51	0.881
C		3 4	170.33	5097.90	49.90	197.09	12.73	16.47	5.07	6.12	20.87	7.02	1.82	0.67	1.58	0.72	0.35	0.267
FODDER			1704.49	8697.64	2059.13	1984.99	62.95	85.98	5.97	37.83	26.70	12.64	3.47	0.24	0.50	0.51	0.41	1.145
	TERRACE MEAN...		1636.20	8965.68	2158.59	2049.69	67.47	92.80	7.16	44.38	24.92	11.76	3.65	0.26	0.41	0.52	0.45	1.163
SLUDGE	FODDER	AVE...	2025.41	7684.65	2433.07	2303.64	91.46	111.98	12.55	26.51	40.18	7.86	3.51	0.31	0.39	1.47	0.49	1.184
		STD...	231.16	1109.02	285.50	277.82	26.53	30.19	15.04	8.88	15.58	2.21	0.20	0.07	0.04	0.72	0.11	0.051
		MIN...	1420.02	5410.94	1774.68	1704.64	55.94	71.01	5.97	14.31	21.58	5.05	3.05	0.18	0.34	0.47	0.35	1.110
		MAX...	2466.14	10010.99	2856.41	2675.37	147.20	195.30	78.74	51.11	85.70	12.64	3.85	0.46	0.50	3.09	0.75	1.300
		N...	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.000
- CONTROL -																		
G		4 1	1726.40	3300.50	64.77	1068.00	10.08	22.49	0.47	8.77	20.67	4.64	2.89	0.15	0.29	0.25	0.35	1.651
S		4 1	541.80	9268.60	6941.80	5158.00	183.46	175.96	8.10	143.61	13.82	11.97	5.47	0.28	0.16	0.21	0.82	0.872
C		4 1	203.19	5415.50	88.84	310.01	13.00	103.93	4.32	7.12	11.39	6.17	2.42	0.40	1.00	0.42	0.35	0.261
FODDER			1073.01	5961.22	2856.75	2640.80	80.73	93.98	4.00	63.27	16.84	7.79	3.88	0.23	0.32	0.25	0.54	1.177
G		4 2	2099.70	3513.80	54.72	1129.80	8.85	23.21	0.47	8.12	21.25	4.31	2.39	0.20	0.25	0.08	0.35	1.552
S		4 2	744.02	12520.00	5522.30	3639.80	220.24	229.05	8.10	155.86	17.56	11.79	4.88	0.23	0.13	0.23	0.54	0.994
C		4 2	166.50	4815.50	58.72	219.97	17.44	25.85	4.88	6.13	11.59	9.84	1.84	0.49	1.87	0.51	0.38	0.209
FODDER			1342.05	7413.48	2344.95	2091.63	98.22	109.68	4.10	69.80	18.76	7.99	3.38	0.24	0.36	0.19	0.43	1.186
G		4 4	2633.20	3617.30	43.50	1370.00	6.47	23.83	0.47	8.35	23.57	3.16	2.49	0.15	0.27	0.17	0.53	1.653
S		4 4	1011.90	12540.00	6039.80	4441.50	186.96	212.17	8.82	62.97	16.79	13.83	5.45	0.30	0.14	0.70	0.58	0.967
C		4 4	166.86	4395.10	48.61	271.43	11.97	13.46	5.38	5.25	14.31	6.10	1.75	0.46	1.36	0.43	0.35	0.250
FODDER			1741.39	7367.45	2516.87	2537.29	81.40	100.56	4.36	30.60	19.94	7.83	3.64	0.24	0.32	0.41	0.53	1.243
	TERRACE MEAN...		1385.48	6914.05	2572.86	2423.24	86.79	101.41	4.15	54.56	18.51	7.87	3.64	0.24	0.33	0.28	0.50	1.202
CONTROL	FODDER	AVE...	1385.48	6914.05	2572.86	2423.24	86.79	101.41	4.15	54.56	18.51	7.87	3.64	0.24	0.33	0.28	0.50	1.202
		STD...	274.59	674.02	212.66	238.26	8.09	6.43	0.15	17.15	1.28	0.09	0.21	0.00	0.02	0.10	0.05	0.029
		MIN...	1073.01	5961.22	2344.95	2091.63	80.73	93.98	4.00	30.60	16.84	7.79	3.38	0.23	0.32	0.19	0.43	1.177
		MAX...	1741.39	7413.48	2856.75	2640.80	98.22	109.68	4.36	69.80	19.94	7.99	3.88	0.24	0.36	0.41	0.54	1.243
		N...	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.000
- - - MEANS - - -																		
GRAIN	SLUDGE		3001.61	3704.23	49.15	1445.76	9.87	28.31	3.86	7.50	31.68	4.11	2.53	0.31	0.29	0.14	0.35	1.582
STOVER	SLUDGE		1137.57	13618.60	6173.80	3916.50	220.18	247.02	25.66	56.50	51.47	13.26	5.19	0.29	0.28	3.49	0.70	0.870
COB	SLUDGE		176.34	5189.88	64.21	255.19	13.39	18.26	5.27	6.30	39.51	6.42	1.88	0.46	1.40	0.54	0.36	0.234
FODDER	SLUDGE		2025.41	7684.65	2433.07	2303.64	91.46	111.98	12.55	26.51	40.18	7.86	3.51	0.31	0.39	1.47	0.49	1.184
GRAIN	CONTROL		2153.10	3477.20	54.33	1189.27	8.47	23.18	0.47	8.41	21.83	4.04	2.59	0.17	0.27	0.17	0.41	1.619
STOVER	CONTROL		765.91	11442.87	6167.97	4413.10	196.89	205.73	8.34	120.81	16.06	12.53	5.27	0.27	0.14	0.38	0.65	0.944
COB	CONTROL		178.85	4875.37	65.39	267.14	14.14	47.75	4.86	6.17	12.43	7.37	2.00	0.45	1.41	0.45	0.36	0.240
FODDER	CONTROL		1385.48	6914.05	2572.86	2423.24	86.79	101.41	4.15	54.56	18.51	7.87	3.64	0.24	0.33	0.28	0.50	1.202

Rosemount Terraces : Corn Tissue Elemental Analyses

ROSEMOUNT WATERSHED CORN DATA 1986

TISSUE	ID	P (ug/g)	K =====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CR	CD	% N
- SLUDGE -																
G	1 2	3504.70	4306.50	53.11	1448.00	10.50	22.84	2.00	5.79	26.87	2.30	4.08	0.15	0.07	0.51	1.46
S	1 2	1508.20	15980.00	5179.00	1881.70	99.68	153.43	12.13	47.45	35.54	7.95	5.59	0.45	1.84	0.12	0.68
C	1 2	263.80	8751.30	59.09	181.63	33.83	26.64	3.35	5.39	22.35	8.91	4.94	0.23	0.54	1.21	0.30
FODDER		2326.39	10235.62	2527.78	1573.50	55.09	86.13	6.98	25.87	30.76	5.46	4.87	0.30	0.96	0.37	1.01
G	1 4	3131.40	3905.60	51.33	1393.60	9.42	24.12	2.62	7.90	33.44	2.46	3.53	0.15	0.10	0.57	1.49
S	1 4	2843.80	16218.00	4265.00	2705.20	103.22	133.42	20.40	53.55	53.98	4.89	5.08	0.15	1.87	0.19	0.72
C	1 4	222.59	4765.70	55.49	247.79	21.52	18.37	1.77	6.63	38.51	7.20	4.49	0.15	0.42	1.16	0.24
FODDER		2745.85	9724.86	2017.78	1906.58	54.23	74.62	10.84	29.09	43.46	4.00	4.34	0.15	0.95	0.44	1.02
G	1 7	3288.90	4032.60	47.55	1372.50	9.89	22.43	4.85	5.49	29.98	2.29	3.94	0.22	0.11	0.53	1.39
S	1 7	1798.10	15242.00	4457.60	2259.90	114.12	140.72	18.62	44.49	35.01	7.51	5.23	0.23	1.99	0.12	0.74
C	1 7	189.57	7112.30	47.93	154.90	19.98	23.37	2.64	5.25	29.84	8.02	4.06	0.15	0.46	1.19	0.25
FODDER		2309.84	9568.87	2116.33	1678.89	59.69	78.00	11.11	23.76	32.33	5.26	4.56	0.22	1.02	0.40	0.98
TERRACE MEAN...		2460.70	9843.11	2220.63	1719.65	56.34	79.58	9.64	26.24	35.51	4.91	4.59	0.22	0.98	0.40	1.00
G	2 3	3519.30	4224.60	55.41	1475.70	6.97	24.38	3.92	6.77	35.34	1.85	3.50	0.15	0.13	0.51	1.62
S	2 3	1634.80	19293.00	4919.10	1865.60	95.35	154.88	19.48	52.22	40.98	6.78	5.21	0.15	2.00	0.10	0.91
C	2 3	212.20	4891.60	73.11	266.87	19.85	21.36	3.94	9.26	50.09	8.53	3.12	0.27	0.44	1.19	0.24
FODDER		2319.28	11737.07	2464.28	1571.02	51.76	88.73	11.62	29.47	39.32	4.83	4.32	0.16	1.08	0.36	1.16
G	2 5	3206.80	3874.60	46.66	1405.10	8.04	21.89	3.19	6.70	39.93	1.88	3.57	0.15	0.14	0.57	1.56
S	2 5	1670.20	18306.00	6327.10	2169.00	128.55	151.73	12.94	77.80	101.77	11.22	6.25	0.35	2.02	0.27	1.11
C	2 5	226.76	6645.10	43.71	206.10	15.75	19.30	19.89	5.91	65.33	6.74	3.80	0.21	0.40	0.92	0.28
FODDER		2308.35	10529.52	2857.37	1662.21	62.52	79.82	8.73	38.47	69.40	6.40	4.79	0.24	1.00	0.46	1.27
G	2 8	3139.80	3824.70	47.62	1281.30	6.29	22.70	3.29	6.01	31.06	2.00	3.40	0.15	0.14	0.53	1.31
S	2 8	1435.20	17836.00	4427.50	1764.70	82.71	110.38	14.83	61.80	52.13	6.61	4.72	0.15	1.22	0.15	0.82
C	2 8	210.58	5418.80	33.76	96.70	13.94	18.64	3.47	4.11	30.95	6.26	5.56	0.20	0.36	0.82	0.26
FODDER		2155.19	10452.05	2085.91	1429.13	42.37	63.26	8.67	31.86	40.86	4.42	4.16	0.15	0.66	0.37	1.01
TERRACE MEAN...		2260.94	10906.21	2469.18	1554.12	52.22	77.27	9.68	33.27	49.86	5.22	4.42	0.19	0.91	0.40	1.15
G	3 1	2813.10	3489.90	46.05	1393.40	7.27	20.83	4.38	8.87	28.70	2.00	2.97	0.29	0.13	0.49	1.54
S	3 1	745.10	20676.00	5311.10	2944.20	150.50	175.72	14.83	84.90	31.62	11.51	7.26	0.23	1.15	0.26	1.00
C	3 1	130.93	5706.00	43.04	208.60	11.72	14.91	2.13	7.58	24.88	6.26	4.10	0.15	0.35	0.90	0.23
FODDER		1728.83	10838.68	2240.93	1941.87	67.35	84.92	8.55	40.46	29.60	6.32	4.85	0.25	0.57	0.43	1.21
G	3 2	2716.50	3800.60	45.68	1424.60	7.51	28.76	3.71	6.99	28.55	2.58	2.94	0.15	0.14	0.63	1.36
S	3 2	821.33	24228.00	4921.40	2083.00	106.16	175.07	14.53	105.10	37.76	10.01	6.00	0.18	1.22	0.27	0.98
C	3 2	113.23	7096.80	36.39	159.78	13.64	14.36	2.40	5.21	16.79	4.81	3.55	0.15	0.38	0.82	0.23
FODDER		1721.16	12472.96	2049.55	1590.28	48.58	87.72	8.05	47.18	31.36	5.82	4.25	0.16	0.60	0.50	1.11
G	3 4	2827.40	3584.60	42.72	1218.60	5.95	22.38	3.86	5.60	23.11	2.02	3.26	0.15	0.17	0.65	1.38
S	3 4	1025.70	19778.00	5088.50	2639.10	123.68	145.47	10.18	60.54	22.51	9.87	5.53	0.15	0.99	0.16	1.01
C	3 4	186.62	4699.10	47.16	254.72	22.20	17.80	1.73	5.55	14.70	7.05	3.07	0.33	0.50	1.01	0.28
FODDER		1874.00	10459.36	2159.18	1742.14	56.54	73.66	6.35	28.64	22.23	5.69	4.20	0.16	0.54	0.47	1.14
TERRACE MEAN...		1774.66	11257.00	2149.89	1758.10	57.49	82.10	7.65	38.76	27.73	5.94	4.43	0.19	0.57	0.47	1.15
G	3 6	3820.00	4265.90	51.21	1721.90	5.10	25.67	2.41	6.77	44.23	1.65	2.93	0.15	0.18	0.61	1.38
S	3 6	1660.20	14547.00	5113.90	3288.00	54.23	74.74	6.61	35.24	126.71	6.26	4.52	0.15	1.16	0.18	0.81
C	3 6	132.84	5487.50	42.61	150.88	19.59	20.91	1.61	5.88	71.11	8.24	3.50	0.35	0.59	1.02	0.19
FODDER		2662.50	8433.56	2053.32	2212.32	25.73	44.69	4.01	17.96	79.07	4.02	3.61	0.17	0.60	0.47	1.06
G	3 9	3344.70	4183.40	49.97	1472.70	5.42	21.45	2.10	5.32	37.93	1.73	3.21	0.15	0.20	0.56	1.44
S	3 9	1377.30	18987.00	5220.70	3411.10	83.80	100.52	12.08	38.31	77.41	8.88	5.59	0.15	1.97	0.22	0.87
C	3 9	175.03	8266.00	50.76	145.75	17.92	21.18	3.58	5.63	55.70	8.76	3.85	0.43	0.60	0.95	0.22
FODDER		2230.79	11113.39	2365.88	2243.42	41.44	56.84	6.68	20.12	56.92	5.45	4.32	0.17	1.02	0.44	1.10
G	3 10	2955.80	3579.70	49.08	1348.80	4.59	19.22	3.24	5.20	27.37	1.57	2.81	0.15	0.11	0.50	1.43
S	3 10	986.14	15420.00	5267.10	3327.00	83.84	102.66	8.81	25.35	37.46	8.94	4.78	0.15	2.12	0.25	0.73
C	3 10	133.48	5779.90	58.29	226.98	18.78	22.43	2.76	5.26	38.89	8.14	4.77	0.35	0.63	0.92	0.26
FODDER		1954.25	8516.71	2154.33	2064.33	37.60	53.11	5.45	13.33	32.29	5.02	3.75	0.16	0.96	0.43	1.06
TERRACE MEAN...		2282.51	9354.55	2191.18	2173.36	34.92	51.55	5.38	17.14	56.09	4.83	3.89	0.17	0.86	0.45	1.07
G	4 6	3352.70	4065.30	49.76	1410.30	5.60	24.59	2.52	5.60	36.09	1.57	3.12	0.15	0.14	0.54	1.34
S	4 6	1387.50	14609.00	6505.70	3678.80	78.65	114.12	9.93	44.67	84.60	8.11	4.98	0.15	1.04	0.20	0.83
C	4 6	270.58	8147.70	73.35	194.44	20.62	18.76	2.28	6.00	53.45	7.79	4.23	0.15	0.46	0.92	0.31
FODDER		2308.41	8787.65	2766.21	2278.27	37.38	61.83	5.62	22.06	57.72	4.76	3.98	0.15	0.54	0.42	1.05
G	49	3462.60	3830.20	43.24	1609.30	5.49	23.60	3.60	6.63	32.91	1.34	2.78	0.15	0.14	0.60	1.54
S	4 9	1433.60	14867.00	4422.80	3362.40	61.67	84.94	6.97	21.21	31.52	6.30	4.80	0.15	1.27	0.14	0.72
C	4 9	188.06	4867.70	63.12	301.77	21.68	26.86	3.50	6.92	50.27	9.68	2.68	0.42	0.57	1.16	0.26
FODDER		2193.82	8956.71	2036.05	2267.80	32.74	51.83	5.12	13.29	34.12	4.48	3.69	0.18	0.70	0.45	1.03
G	4 11	3174.20	3735.30	41.88	1468.30	4.75	21.41	4.43	6.09	30.04	1.48	2.85	0.15	0.13	0.63	1.42
S	4 11	1448.50	14227.00	5067.70	2965.60	86.73	111.99	14.17	43.00	47.07	9.12	4.66	0.15	1.82	0.26	0.77
C	4 11	178.32	4358.40	46.47	236.19	19.70	27.26	3.90	5.32	31.48	8.44	2.87	0.24	0.48	1.35	0.24
FODDER		2192.34	8262.32	2186.35	2006.05	40.95	60.53	8.54	21.77	37.42	5.31	3.62	0.16	0.88	0.53	1.05
TERRACE MEAN...		2231.53	8668.89	2329.54	2184.04	37.02	58.06	6.43	19.04	43.08	4.85	3.76	0.16	0.71	0.47	1.04

Rosemount Terraces : Corn Tissue Elemental Analyses *Continued from previous page*

ROSEMOUNT WATERSHED CORN DATA 1986 TISSUE	ID	P (ug/g)	K ==========>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CR	CD	% N
G	5 2	2964.70	3718.70	43.76	1338.40	4.25	20.14	2.31	5.15	22.73	1.66	3.14	0.15	0.14	0.54	1.49
S	5 2	650.75	12071.00	5151.20	3347.90	103.89	323.45	26.33	51.27	50.25	13.88	5.51	0.79	2.08	0.41	0.70
C	5 2	155.12	6436.20	46.43	142.14	18.90	22.25	4.57	4.61	13.54	6.16	3.09	0.22	0.58	1.07	0.27
FODDER		1849.83	7149.01	2008.68	2015.72	43.75	136.98	11.73	22.85	32.58	6.72	4.05	0.40	0.92	0.53	1.09
G	5 3	3341.80	3913.70	52.20	1464.70	7.14	31.27	7.43	8.58	29.74	2.67	3.40	0.54	0.24	0.69	1.33
S	5 3	1968.90	11808.00	4339.40	3750.50	85.09	139.34	24.95	36.27	43.18	10.25	5.91	0.15	1.47	0.24	0.75
C	5 3	188.07	4243.20	41.62	231.84	19.06	16.76	4.13	4.79	33.05	6.44	2.09	0.15	0.48	1.08	0.25
FODDER		2606.33	6610.45	1500.43	2131.24	34.51	66.55	13.07	17.61	34.57	5.56	4.14	0.37	0.68	0.57	1.04
G	5 6	2955.50	3628.90	41.25	1226.20	6.40	29.18	4.74	6.63	26.36	2.76	3.46	0.59	0.22	0.72	1.30
S	5 6	1522.80	19262.00	4541.10	3551.20	83.87	115.69	12.23	38.26	51.47	11.72	5.72	0.15	1.37	0.29	0.83
C	5 6	207.08	4616.40	36.84	214.17	29.70	28.70	2.91	4.91	43.48	7.19	1.94	0.27	0.45	1.19	0.26
FODDER		2244.30	9352.98	1668.61	1996.13	36.06	60.44	7.32	17.95	36.64	6.31	4.17	0.41	0.65	0.60	1.06
		2233.49	7704.15	1725.91	2047.70	38.11	87.99	10.71	19.47	34.60	6.20	4.12	0.39	0.75	0.57	1.06
	TERRACE MEAN...															
G	6 2	3466.60	3817.10	43.15	1649.10	5.76	25.71	3.97	6.56	33.41	1.28	2.88	0.15	0.16	0.70	1.54
S	6 2	1422.50	13302.00	6586.90	4398.70	55.39	96.17	8.86	43.57	73.68	10.60	6.39	0.15	0.80	0.24	0.94
C	6 2	161.29	5075.90	38.89	237.20	16.50	17.50	2.05	5.84	45.89	6.42	2.31	0.15	0.46	1.13	0.26
FODDER		2570.31	6597.81	1876.16	2281.26	20.72	44.65	5.15	16.86	45.91	4.39	3.81	0.15	0.37	0.61	1.25
G	6 4	3017.30	3579.40	46.57	1489.20	8.62	21.15	2.93	5.33	25.40	1.98	2.79	0.15	0.18	0.68	1.51
S	6 4	1304.00	12115.00	7948.50	3390.90	74.78	121.33	9.37	59.34	33.48	12.53	5.84	0.18	1.22	0.24	1.13
C	6 4	156.53	5490.40	44.34	248.40	25.75	17.77	4.10	5.29	21.63	6.36	2.98	0.24	0.50	1.16	0.27
FODDER		2370.06	5566.20	1708.22	1764.71	24.25	41.88	4.40	16.68	26.72	4.64	3.45	0.17	0.43	0.64	1.31
G	6 5	3178.20	3786.40	38.36	1410.30	5.84	20.31	3.40	5.22	26.34	1.90	2.67	0.15	0.18	0.58	1.42
S	6 5	933.39	17920.00	4292.70	2290.10	79.62	122.29	9.67	34.77	31.85	11.11	4.79	0.28	1.30	0.33	0.75
C	6 5	158.94	5330.00	37.36	159.56	11.99	14.72	5.79	4.23	21.45	5.51	4.19	0.15	0.39	0.98	0.25
FODDER		2147.89	8728.76	1484.88	1598.85	31.47	54.49	5.74	15.18	27.78	5.35	3.53	0.19	0.58	0.53	1.09
	TERRACE MEAN...	2362.75	6964.26	1689.75	1881.61	25.48	47.01	5.10	16.24	33.47	4.79	3.59	0.17	0.46	0.59	1.21
G	7 2	3198.50	3825.90	51.12	1557.80	8.76	24.26	4.07	6.22	26.34	2.39	2.50	0.15	0.19	0.66	1.44
S	7 2	848.51	16865.00	6067.30	3160.70	77.73	92.96	8.91	41.76	36.94	23.43	5.79	0.24	1.12	0.32	0.82
C	7 2	143.01	5844.20	43.89	212.94	20.39	17.14	4.76	5.26	17.60	6.54	4.18	0.32	0.40	0.95	0.22
FODDER		2133.61	8397.21	2076.27	1977.11	33.03	46.76	5.76	18.10	29.13	9.85	3.76	0.20	0.52	0.57	1.12
G	7 4	3574.40	4073.60	54.33	1581.70	5.65	28.49	4.17	6.39	37.24	2.22	2.79	0.15	0.18	0.77	1.47
S	7 4	1678.50	14023.00	6004.70	4235.70	60.40	92.43	11.21	58.82	129.45	11.22	5.01	0.15	1.03	0.45	0.87
C	7 4	156.26	5787.20	48.75	215.85	19.86	17.12	5.00	5.57	54.08	6.87	4.55	0.22	0.39	0.88	0.23
FODDER		2497.07	8364.83	2534.23	2573.30	29.67	54.19	7.17	28.18	77.09	6.36	3.86	0.16	0.55	0.65	1.12
G	7 6	3632.00	3964.60	49.95	1700.60	6.21	26.43	3.92	8.10	44.26	1.53	2.52	0.15	0.44	0.77	1.58
S	7 6	2099.30	21141.00	5809.80	2081.10	88.00	127.16	9.01	61.20	124.34	12.75	5.08	0.15	1.52	0.42	0.98
C	7 6	170.88	5778.30	58.72	245.11	19.07	20.63	5.20	9.21	85.88	8.54	3.03	0.34	0.58	1.02	0.22
FODDER		2770.89	10434.83	2168.09	1715.30	37.38	62.96	5.90	27.72	77.28	6.26	3.50	0.17	0.85	0.66	1.24
	TERRACE MEAN...	2467.19	9065.62	2259.53	2088.57	33.36	54.63	6.28	24.66	61.17	7.49	3.71	0.17	0.64	0.63	1.16
G	8 2	3336.00	3740.20	48.23	1563.90	6.95	22.42	5.52	6.26	26.94	2.03	2.58	0.15	0.22	0.72	1.47
S	8 2	1366.70	20826.00	4705.70	2730.80	121.68	155.68	26.89	39.18	33.92	12.10	5.04	0.42	2.87	0.32	0.85
C	8 2	141.43	4981.70	46.53	243.54	19.59	15.60	4.02	5.41	18.36	6.36	3.11	0.15	0.49	0.95	0.26
FODDER		2244.94	11184.82	2051.61	1965.05	57.27	79.22	14.60	20.36	29.29	6.69	3.68	0.27	1.38	0.57	1.11
G	8 4	3275.10	3814.60	44.75	1435.50	4.45	20.88	2.33	6.08	35.31	1.84	2.49	0.34	0.14	0.67	1.42
S	8 4	2018.80	14263.00	5030.50	3603.20	68.91	100.57	13.05	45.47	73.37	8.36	4.39	0.15	1.49	0.35	0.93
C	8 4	192.68	6079.00	37.48	180.26	20.58	17.61	2.47	5.04	52.68	7.10	3.71	0.29	0.50	0.92	0.23
FODDER		2479.90	8772.11	2333.29	2341.79	35.19	57.24	7.26	24.09	54.01	5.21	3.45	0.25	0.79	0.54	1.11
G	8 5	3285.60	3915.30	41.82	1444.10	4.93	21.40	3.03	5.43	35.72	1.48	2.66	0.15	0.16	0.62	1.43
S	8 5	1731.40	16896.00	6526.60	2818.90	100.26	151.58	58.16	41.11	92.28	9.93	4.49	0.15	2.06	0.32	0.97
C	8 5	145.95	6598.00	43.11	137.57	17.66	17.18	2.39	5.20	47.50	6.40	3.74	0.38	0.70	0.88	0.26
FODDER		2389.79	9527.24	2739.02	1912.11	45.59	75.21	25.91	20.25	60.18	5.39	3.51	0.17	0.99	0.52	1.15
	TERRACE MEAN...	2371.54	9828.05	2374.64	2072.98	46.02	70.56	15.92	21.57	47.83	5.76	3.54	0.23	1.05	0.54	1.12
SLUDGE FODDER	AVE...	2271.70	9287.98	2156.69	1942.24	42.33	67.64	8.53	24.04	43.26	5.55	4.01	0.21	0.77	0.50	1.11
	STD...	275.76	1611.12	342.19	283.63	12.11	19.44	4.34	8.17	16.69	1.14	0.43	0.08	0.24	0.09	0.08
	MIN...	1721.16	5566.20	1484.88	1429.13	20.72	41.88	4.01	13.29	22.23	4.00	3.45	0.15	0.37	0.36	0.98
	MAX...	2770.89	12472.96	2857.37	2573.30	67.35	136.98	25.91	47.18	79.07	9.85	4.87	0.41	1.38	0.66	1.31
	N...	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00

Rosemount Terraces : Corn Tissue Elemental Analyses *Continued from previous page*

ROSEMOUNT WATERSHED CORN DATA 1986 TISSUE	ID	P (ug/g)	K =====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CR	CD	% N
- CONTROL -																
G	4 1	2308.90	3564.10	47.60	1312.20	7.75	20.35	3.76	6.57	23.68	2.16	2.59	0.15	0.11	0.52	1.41
S	4 1	543.66	17103.00	4446.00	3688.80	108.16	136.74	16.67	82.24	16.50	10.70	5.13	0.15	1.09	0.38	0.94
C	4 1	131.91	6796.10	47.05	206.75	18.76	15.43	3.58	5.78	13.19	5.69	2.85	0.15	0.48	0.84	0.27
FODDER		1398.42	9366.86	1840.65	2184.16	49.65	67.37	9.01	37.35	19.83	5.95	3.65	0.15	0.54	0.49	1.12
G	4 2	2077.00	3301.00	45.96	1077.60	7.46	20.78	4.28	5.43	19.75	2.07	2.50	0.15	0.12	0.59	1.23
S	4 2	740.83	20782.00	3475.90	2506.60	92.46	129.28	10.70	84.36	20.39	10.68	5.61	0.15	0.83	0.42	0.94
C	4 2	132.13	6522.60	30.68	203.66	16.58	17.44	2.95	4.44	11.42	5.93	3.00	0.19	0.38	0.99	0.25
FODDER		1391.22	10505.50	1408.06	1576.09	41.97	63.64	6.73	36.72	19.34	5.80	3.78	0.15	0.42	0.55	1.04
G	4 4	2045.50	3287.40	40.40	1072.50	6.16	29.85	3.50	5.04	21.44	2.72	2.82	0.16	0.11	0.55	1.26
S	4 4	486.92	16065.00	4116.70	3728.80	84.73	124.69	10.54	50.61	19.52	12.30	5.10	0.28	1.02	0.26	0.80
C	4 4	131.63	5442.50	26.57	203.05	16.67	15.51	2.24	3.09	12.69	5.73	2.99	0.15	0.32	0.96	0.25
FODDER		1300.14	8234.80	1558.44	1987.78	36.35	63.96	6.02	21.86	19.97	6.55	3.68	0.20	0.47	0.48	1.00
TERRACE MEAN...		1363.26	9369.05	1602.39	1916.01	42.66	64.99	7.25	31.98	19.72	6.10	3.70	0.17	0.48	0.51	1.05
CONTROL FODDER	AVE...	1363.26	9369.05	1602.39	1916.01	42.66	64.99	7.25	31.98	19.72	6.10	3.70	0.17	0.48	0.51	1.05
	STD...	44.73	927.01	179.32	253.38	5.45	1.69	1.28	7.16	0.27	0.32	0.05	0.02	0.05	0.03	0.05
	MIN...	1300.14	8234.80	1408.06	1576.09	36.35	63.64	6.02	21.86	19.34	5.80	3.65	0.15	0.42	0.48	1.00
	MAX...	1398.42	10505.50	1840.65	2184.16	49.65	67.37	9.01	37.35	19.97	6.55	3.78	0.20	0.54	0.55	1.12
	N...	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

- - - - ROSEMOUNT WATERSHED CORN DATA 1986 MEANS - - - - -

TISSUE	TREATMENT	P (ug/g)	K =====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CR	CD	%N
GRAIN	SLUDGE	3240.13	3869.70	47.29	1455.76	6.58	23.63	3.63	6.36	31.68	1.94	3.07	0.20	0.17	0.61	1.45
STOVER	SLUDGE	1456.34	16692.81	5314.76	2952.04	90.83	132.16	15.38	49.88	58.90	10.07	5.34	0.22	1.56	0.25	0.86
COB	SLUDGE	178.22	5861.27	48.08	203.77	19.62	19.82	3.94	5.75	38.87	7.21	3.61	0.25	0.49	1.03	0.25
FODDER	SLUDGE	2271.70	9287.98	2156.69	1942.24	42.33	67.64	8.53	24.04	43.26	5.55	4.01	0.21	0.77	0.50	1.11
GRAIN	CONTROL	2143.80	3384.17	44.65	1154.10	7.12	23.66	3.85	5.68	21.62	2.32	2.64	0.15	0.11	0.55	1.30
STOVER	CONTROL	590.47	17983.33	4012.87	3308.07	95.12	130.24	12.64	72.40	18.80	11.23	5.28	0.19	0.98	0.35	0.89
COB	CONTROL	131.89	6253.73	34.77	204.49	17.34	16.13	2.92	4.44	12.43	5.78	2.95	0.16	0.39	0.93	0.26
FODDER	CONTROL	1363.26	9369.05	1602.39	1916.01	42.66	64.99	7.25	31.98	19.72	6.10	3.70	0.17	0.48	0.51	1.05

APPENDIX D

Elements Removed by Corn at Harvest — Rosemount Watershed

The values in the following tables are calculated from elemental tissue concentrations (see Appendix C) and yield information for grain, cob, and stover components of corn harvested at the Rosemount Watershed study. Elements removed by the respective plant parts and for the whole plant (fodder) are reported in kilograms per hectare. These data are very useful when comparing total amounts of elements applied, in sludge or fertilizer, to elements removed by the corn crop. Summary statistics are provided and are grouped by treatment (Sludge or Control).

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1974 TISSUE	ID	ELEMENTS REMOVED (kg/ha) P	K	CA	MG	NA	AL	ZN	B	PB	CR	FE	MN	CU	NI	CD	N
- SLUDGE -		=====>>>>>															
GRAIN	TERRACE 6	23.2533	36.3793	NA	8.9105	NA	NA	0.1352	0.0200	0.0018	0.0022	0.1671	NA	0.0085	0.0012	0.0001	95.24
STOVER		8.7797	114.5351	32.0775	24.9526	NA	0.4757	0.1010	0.0467	0.0132	0.0055	0.7592	0.5085	0.0391	0.0025	0.0008	73.54
COB		0.3730	7.5477	NA	0.2169	NA	NA	0.0118	0.0051	0.0003	0.0015	NA	0.0191	0.0037	0.0011	0.0001	3.47
FODDER		32.4060	158.4620	NA	34.0799	NA	NA	0.2480	0.0718	0.0153	0.0092	NA	NA	0.0513	0.0048	0.0009	172.26
GRAIN	TERRACE 7	24.2465	38.1550	NA	8.9007	NA	NA	0.1424	0.0209	0.0019	0.0023	0.1669	NA	0.0089	0.0013	0.0001	99.89
STOVER		10.1519	114.1262	31.4842	27.7021	NA	0.4491	0.1112	0.0533	0.0091	0.0059	0.7349	0.4779	0.0424	0.0029	0.0011	72.98
COB		0.4891	9.1445	NA	0.2570	NA	NA	0.0130	0.0046	0.0003	0.0015	NA	NA	0.0039	0.0009	0.0000	3.18
FODDER		34.8874	161.4256	NA	36.8599	NA	NA	0.2667	0.0798	0.0114	0.0096	NA	NA	0.0552	0.0051	0.0012	176.07
- SLUDGE MEANS -																	
GRAIN		23.7499	37.2671	NA	8.9056	NA	NA	0.1388	0.0205	0.0019	0.0022	0.1670	NA	0.0087	0.0013	0.0001	97.57
STOVER		9.4658	114.3306	31.7808	26.3273	NA	0.4624	0.1061	0.0500	0.0112	0.0057	0.7470	0.4932	0.0408	0.0027	0.0009	73.26
COB		0.4311	8.3461	NA	0.2370	NA	NA	0.0124	0.0048	0.0003	0.0015	NA	NA	0.0038	0.0010	0.0000	3.32
FODDER		33.6467	159.9438	NA	35.4699	NA	NA	0.2573	0.0753	0.0134	0.0094	NA	NA	0.0532	0.0050	0.0011	174.16
- CONTROL -																	
GRAIN	TERRACE 4	19.5930	30.6213	NA	7.1353	NA	NA	0.1092	0.0177	0.0019	0.0013	0.1139	0.0790	0.0080	0.0012	0.0001	92.38
STOVER		10.3675	124.9362	26.6263	22.6756	NA	0.8593	0.1246	0.0571	0.0091	0.0087	1.1767	0.3958	0.0334	0.0049	0.0009	74.21
COB		0.4235	7.1879	NA	0.1692	NA	NA	0.0135	0.0036	0.0003	0.0014	NA	0.0127	0.0035	0.0009	0.0001	3.17
FODDER		30.3840	162.7455	NA	29.9801	NA	NA	0.2473	0.0784	0.0113	0.0115	NA	0.4874	0.0449	0.0070	0.0011	169.78

ROSEMOUNT WATERSHED CORN DATA 1975 TISSUE	ID	ELEMENTS REMOVED (kg/ha) P	K	CA	MG	NA	AL	ZN	B	PB	CR	FE	MN	CU	NI	CD	N
- SLUDGE -		=====>>>>>															
GRAIN	TERRACE 6	22.1696	31.3624	0.0000	9.8235	0.0000	0.0000	0.1238	0.0120	0.0000	0.0007	0.0000	0.0000	0.0116	0.0018	0.0000	101.13
STOVER		10.1097	65.9740	30.2274	26.6540	0.0000	0.3870	0.1389	0.0321	0.0085	0.0052	0.7533	0.3508	0.0305	0.0038	0.0005	77.97
COB		0.3900	4.3013	0.0000	0.2246	0.0000	0.0000	0.0081	0.0000	0.0000	0.0004	0.0000	0.0000	0.0021	0.0003	0.0000	3.30
FODDER		32.6693	101.6378	30.2274	36.7021	0.0000	0.3870	0.2708	0.0441	0.0085	0.0063	0.7533	0.3508	0.0443	0.0059	0.0005	182.41
GRAIN	TERRACE 7	23.9070	34.3619	0.0000	10.5949	0.0000	0.0000	0.1378	0.0000	0.0000	0.0010	0.1586	0.0000	0.0127	0.0016	0.0000	116.17
STOVER		11.0117	97.0880	40.9795	36.8175	0.0000	0.7407	0.1544	0.0382	0.0086	0.0055	1.1905	0.3882	0.0434	0.0029	0.0007	93.81
COB		0.4009	5.0869	0.0000	0.3144	0.0000	0.0000	0.0097	0.0000	0.0000	0.0005	0.0000	0.0000	0.0025	0.0005	0.0000	3.36
FODDER		35.3196	136.5368	40.9795	47.7268	0.0000	0.7407	0.3019	0.0382	0.0086	0.0070	1.3492	0.3882	0.0585	0.0050	0.0007	212.35
- SLUDGE MEANS -																	
GRAIN		23.0383	32.8622	0.0000	10.2092	0.0000	0.0000	0.1308	0.0120	0.0000	0.0009	0.0793	0.0000	0.0122	0.0017	0.0000	108.15
STOVER		10.5607	81.5310	35.6034	31.7358	0.0000	0.5639	0.1466	0.0351	0.0085	0.0054	0.9719	0.3695	0.0370	0.0034	0.0006	85.89
COB		0.3955	4.6941	0.0000	0.2695	0.0000	0.0000	0.0089	0.0000	0.0000	0.0004	0.0000	0.0000	0.0023	0.0004	0.0000	3.33
FODDER		33.9945	119.0873	35.6034	42.2145	0.0000	0.5639	0.2863	0.0412	0.0085	0.0067	1.0512	0.3695	0.0514	0.0055	0.0006	197.38
- CONTROL -																	
GRAIN	TERRACE 4	11.6859	20.7523	0.0000	5.0487	0.0000	0.0000	0.0678	0.0107	0.0000	0.0008	0.0000	0.0000	0.0055	0.0014	0.0000	76.10
STOVER		7.9883	68.8159	27.0812	26.2279	0.0000	0.3900	0.1251	0.0301	0.0096	0.0040	0.7840	0.3487	0.0314	0.0030	0.0005	74.19
COB		0.3069	3.9433	0.0000	0.2061	0.0000	0.0000	0.0078	0.0000	0.0000	0.0005	0.0000	0.0000	0.0024	0.0004	0.0000	2.57
FODDER		19.9811	93.5115	27.0812	31.4828	0.0000	0.3900	0.2008	0.0408	0.0096	0.0054	0.7840	0.3487	0.0394	0.0048	0.0005	152.87

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1976 TISSUE	ID	ELEMENTS REMOVED P (kg/ha)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	PB	NI	CR	CD	N
— SLUDGE —																	
GRAIN	6	17.6929	19.6761	0.1654	8.8162	0.0073	0.1439	0.0263	0.0443	0.1877	0.0211	0.0164	0.0047	0.0022	0.0012	0.0002	89.32
STOVER	6	9.6773	91.7805	48.4257	40.6855	0.7032	0.9079	0.1380	0.3505	0.2504	0.0469	0.0676	0.0179	0.0091	0.0103	0.0017	85.04
COB	6	0.2868	3.5573	0.1243	0.3961	0.0031	0.0094	0.0000	0.0053	0.0165	0.0025	0.0019	0.0000	0.0009	0.0009	0.0000	2.71
FODDER		27.6570	115.0140	48.7154	49.8977	0.7136	1.0612	0.1643	0.4000	0.4546	0.0705	0.0859	0.0227	0.0122	0.0124	0.0019	177.08
G	7	23.3741	30.0866	0.2338	195.3170	0.0065	0.2123	0.0466	0.0717	0.2671	0.0263	0.0219	0.0061	0.0023	0.0011	0.0003	121.54
S	7	8.5149	90.1908	48.9394	38.3101	0.9054	1.1327	0.1329	0.3333	0.2226	0.0462	0.0790	0.0282	0.0125	0.0140	0.0025	72.63
C	7	0.3528	4.7283	0.0016	0.5361	0.0016	0.0149	0.0000	0.0058	0.0251	0.0031	0.0024	0.0000	0.0013	0.0016	0.0000	3.53
FODDER		32.2419	125.0057	49.1748	234.1632	0.9135	1.3599	0.1795	0.4108	0.5147	0.0757	0.1034	0.0343	0.0161	0.0166	0.0028	197.71
- SLUDGE MEANS -																	
GRAIN		20.5335	24.8814	0.1996	102.0666	0.0069	0.1781	0.0365	0.0580	0.2274	0.0237	0.0192	0.0054	0.0022	0.0011	0.0002	105.435
STOVER		9.0961	90.9857	48.6825	39.4978	0.8043	1.0203	0.1355	0.3419	0.2365	0.0466	0.0733	0.0231	0.0108	0.0121	0.0021	78.83
COB		0.3198	4.1428	0.0629	0.4661	0.0023	0.0122	0.0000	0.0055	0.0208	0.0028	0.0022	0.0000	0.0011	0.0013	0.0000	3.12
FODDER		29.9494	120.0099	48.9451	142.0305	0.8136	1.2106	0.1719	0.4054	0.4847	0.0731	0.0946	0.0285	0.0141	0.0145	0.0024	187.39
— CONTROL —																	
G	4	22.0240	26.0177	0.2558	11.7042	0.0259	0.2166	0.0447	0.0668	0.2223	0.0267	0.0210	0.0060	0.0045	0.0020	0.0003	116.28
S	4	5.8883	94.8994	42.6608	32.3440	0.6279	0.8423	0.1082	0.3864	0.1660	0.0466	0.0765	0.0264	0.0080	0.0103	0.0020	64.90
C	4	0.4091	6.0710	0.2116	0.5878	0.0112	0.0204	0.0000	0.0089	0.0160	0.0034	0.0039	0.0000	0.0019	0.0021	0.0000	4.36
FODDER		28.3214	126.9881	43.1282	44.6360	0.6650	1.0792	0.1529	0.4621	0.4043	0.0767	0.1014	0.0324	0.0144	0.0144	0.0023	185.54

ROSEMOUNT CORN DATA 1977 TISSUE	ELEMENTS REMOVED P (kg/ha)	K ====>>>>>	CA	MG	NA	AL	ZN	B	FE	MN	CU	NI	CD	CR	PB	N
- SLUDGE -																
GRAIN	30.3536	34.2490	0.2962	14.6032	0.0201	0.0112	0.2496	0.0117	0.1807	0.0571	0.0010	0.0020	0.0012	0.0023	0.0062	143.18
STOVER	8.5177	127.8285	53.8361	29.7065	0.1462	1.0551	0.2379	0.0577	1.2898	0.3818	0.0499	0.0096	0.0016	0.0099	0.0136	82.12
COB	0.3942	6.8002	0.1452	0.4358	0.0037	0.0022	0.0268	0.0020	0.0178	0.0061	0.0036	0.0019	0.0001	0.0005	0.0009	4.19
FODDER	39.2656	168.8777	54.2776	44.7454	0.1699	1.0686	0.5142	0.0713	1.4883	0.4450	0.0546	0.0135	0.0029	0.0128	0.0207	229.51
- CONTROL -																
GRAIN	28.6286	34.9553	0.2860	14.4771	0.0155	0.0191	0.2280	0.0158	0.2197	0.0538	0.0076	0.0019	0.0012	0.0023	0.0058	144.21
STOVER	5.2036	130.7837	35.1122	26.2329	0.1265	0.7907	0.1086	0.0545	0.9916	0.4423	0.0355	0.0087	0.0011	0.0116	0.0094	64.81
COB	0.4125	5.4796	0.1507	0.4420	0.0065	0.0031	0.0203	0.0023	0.0208	0.0071	0.0037	0.0017	0.0002	0.0020	0.0009	4.73
FODDER	34.2447	171.2187	35.5489	41.1520	0.1486	0.8128	0.3569	0.0725	1.2321	0.5033	0.0468	0.0123	0.0026	0.0160	0.0161	213.75

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1978		ELEMENTS REMOVED															
TISSUE	ID	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha)	=====>>>>>														
— SLUDGE —																	
GRAIN	6 2	38.6252	43.3862	0.3249	16.9090	0.0225	0.2268	0.0253	0.0801	0.2661	0.0039	0.0166	0.0047	0.0026	0.0077	0.0024	174.90
STOVER	6 2	8.7405	113.0254	30.6783	20.3598	0.5310	0.9785	0.6674	0.2228	0.1218	0.0489	0.0520	0.0011	0.0010	0.0049	0.0018	50.53
COB	6 2	0.3671	5.2915	0.1754	0.4042	0.0240	0.0204	0.0082	0.0078	0.0109	0.0055	0.0023	0.0009	0.0002	0.0006	0.0008	5.03
FODDER		47.7327	161.7031	31.1786	37.6731	0.5775	1.2257	0.7009	0.3106	0.3987	0.0582	0.0709	0.0068	0.0038	0.0133	0.0051	230.47
G	6 4	31.5477	37.9941	0.3608	15.0349	0.0222	0.2061	0.0277	0.0638	0.2607	0.0042	0.0170	0.0015	0.0025	0.0074	0.0023	154.51
S	6 4	3.8171	51.9877	22.0862	15.2472	0.2323	0.4142	0.3842	0.1424	0.0678	0.0277	0.0274	0.0009	0.0005	0.0027	0.0037	31.75
C	6 4	0.3511	8.6938	0.1569	0.3678	0.0148	0.0190	0.0069	0.0075	0.0109	0.0050	0.0026	0.0014	0.0002	0.0006	0.0007	4.58
FODDER		35.7160	98.6756	22.6038	30.6500	0.2694	0.6393	0.4187	0.2137	0.3395	0.0369	0.0470	0.0038	0.0032	0.0107	0.0067	190.85
G	6 5	37.7041	43.6629	0.3705	16.0390	0.0220	0.2098	0.0307	0.0710	0.2530	0.0035	0.0225	0.0016	0.0027	0.0081	0.0025	177.57
S	6 5	11.8436	127.9851	41.1186	16.7653	0.5301	0.8965	0.7244	0.2753	0.1361	0.0551	0.0698	0.0032	0.0010	0.0063	0.0055	77.33
C	6 5	0.4939	6.4110	0.1762	0.4143	0.0056	0.0250	0.0094	0.0085	0.0144	0.0048	0.0025	0.0016	0.0002	0.0007	0.0015	5.60
FODDER		50.0416	178.0590	41.6653	33.2187	0.5578	1.1313	0.7645	0.3549	0.4034	0.0634	0.0948	0.0065	0.0040	0.0151	0.0094	260.51
TERRACE MEAN...		44.4968	146.1459	31.8159	33.8472	0.4682	0.9988	0.6280	0.2931	0.3805	0.0529	0.0709	0.0057	0.0037	0.0130	0.0071	227.28
G	7 2	33.9300	38.6229	0.3709	15.4258	0.0217	0.1991	0.0247	0.0649	0.2552	0.0039	0.0184	0.0015	0.0025	0.0075	0.0023	165.918
S	7 2	4.5017	71.4583	22.7768	13.4739	0.3206	0.5184	0.3037	0.1459	0.0922	0.0280	0.0317	0.0013	0.0007	0.0033	0.0024	37.23
C	7 2	0.3341	6.7056	0.1522	0.5268	0.0023	0.0147	0.0054	0.0064	0.0116	0.0041	0.0021	0.0006	0.0002	0.0006	0.0006	4.81
FODDER		38.7659	116.7868	23.2998	29.4265	0.3446	0.7322	0.3338	0.2172	0.3590	0.0361	0.0522	0.0034	0.0034	0.0114	0.0053	207.97
G	7 4	36.4942	41.4568	0.3792	16.0065	0.0277	0.2167	0.0229	0.0596	0.2723	0.0027	0.0177	0.0034	0.0027	0.0081	0.0025	182.90
S	7 4	8.7467	109.0846	32.3084	24.4657	0.6313	1.0008	0.5006	0.2128	0.1791	0.0400	0.0428	0.0035	0.0010	0.0052	0.0130	63.72
C	7 4	0.4121	6.8892	0.1868	0.3772	0.0026	0.0267	0.0077	0.0089	0.0294	0.0041	0.0026	0.0018	0.0002	0.0007	0.0014	4.67
FODDER		45.6531	157.4305	32.8744	40.8494	0.6615	1.2442	0.5311	0.2813	0.4808	0.0468	0.0630	0.0087	0.0040	0.0140	0.0170	251.30
G	7 6	38.8586	41.3519	0.3397	16.0144	0.0290	0.1961	0.0271	0.0755	0.2447	0.0024	0.0167	0.0016	0.0027	0.0079	0.0024	192.15
S	7 6	20.8092	267.2225	54.4093	22.7055	0.8870	1.5848	1.1481	0.6096	0.2916	0.0667	0.0955	0.0020	0.0019	0.0098	0.0109	137.72
C	7 6	0.6061	6.9228	0.1955	0.3607	0.0026	0.0345	0.0079	0.0109	0.0353	0.0032	0.0023	0.0020	0.0002	0.0006	0.0019	5.52
FODDER		60.2739	315.4971	54.9445	39.0805	0.9186	1.8154	1.1832	0.6959	0.5716	0.0723	0.1145	0.0056	0.0048	0.0183	0.0153	335.41
TERRACE MEAN...		48.2309	196.5715	37.0396	36.4522	0.6416	1.2639	0.6827	0.3981	0.4705	0.0517	0.0766	0.0059	0.0041	0.0146	0.0125	264.89
SLUDGE FODDER AVE...		46.3639	171.3587	34.4277	35.1497	0.5549	1.1313	0.6554	0.3456	0.4255	0.0523	0.0738	0.0058	0.0039	0.0138	0.0098	246.09
STD...		7.9635	69.9630	11.1798	4.3019	0.2121	0.3854	0.2791	0.1644	0.0790	0.0135	0.0238	0.0018	0.0005	0.0025	0.0047	46.47
MIN...		35.7160	98.6756	22.6038	29.4265	0.2694	0.6393	0.3338	0.2137	0.3395	0.0361	0.0470	0.0034	0.0032	0.0107	0.0051	190.85
MAX...		60.2739	315.4971	54.9445	40.8494	0.9186	1.8154	1.1832	0.6959	0.5716	0.0723	0.1145	0.0087	0.0048	0.0183	0.0170	335.41
N...		6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.00
— CONTROL —																	
G	4 1	24.3543	31.4300	0.3130	11.8481	0.0194	0.1854	0.0289	0.0499	0.1598	0.0123	0.0161	0.0025	0.0022	0.0066	0.0021	136.06
S	4 1	3.5144	88.9916	29.3769	22.4129	0.4955	0.7820	0.7499	0.3297	0.0548	0.0364	0.0455	0.0040	0.0009	0.0041	0.0023	43.40
C	4 1	0.2879	7.0266	0.1572	0.3177	0.0071	0.0185	0.0072	0.0070	0.0048	0.0036	0.0024	0.0017	0.0002	0.0006	0.0007	4.02
FODDER		28.1566	127.4482	29.8471	34.5787	0.5219	0.9859	0.7860	0.3865	0.2195	0.0522	0.0640	0.0081	0.0033	0.0113	0.0051	183.49
G	4 2	29.9265	35.0385	0.3135	14.4964	0.0144	0.1974	0.0246	0.0664	0.1978	0.0036	0.0166	0.0051	0.0025	0.0075	0.0023	163.16
S	4 2	9.3173	128.8760	40.3439	30.1264	0.6394	1.0716	1.2223	0.4461	0.1126	0.0569	0.0753	0.0016	0.0013	0.0060	0.0017	71.14
C	4 2	0.3509	4.7187	0.1905	0.8021	0.0101	0.0230	0.0085	0.0085	0.0170	0.0036	0.0023	0.0022	0.0002	0.0007	0.0009	5.09
FODDER		39.5947	168.6332	40.8479	45.4250	0.6640	1.2920	1.2553	0.5210	0.3274	0.0641	0.0942	0.0089	0.0041	0.0141	0.0050	239.40
G	4 4	27.1617	35.1638	0.3542	12.7731	0.0183	0.2064	0.0283	0.0535	0.1959	0.0097	0.0208	0.0052	0.0025	0.0075	0.0023	154.16
S	4 4	8.5979	128.6825	29.3652	27.5237	0.3882	0.7057	0.9539	0.3209	0.0986	0.0429	0.0655	0.0039	0.0013	0.0037	0.0011	66.80
C	4 4	0.4047	7.2145	0.1906	0.8614	0.0157	0.0280	0.0106	0.0105	0.0131	0.0043	0.0029	0.0017	0.0002	0.0007	0.0014	6.01
FODDER		36.1643	171.0607	29.9100	41.1582	0.4223	0.9401	0.9927	0.3849	0.3075	0.0569	0.0891	0.0107	0.0041	0.0119	0.0049	226.98
TERRACE MEAN...		34.6385	155.7140	33.5350	40.3873	0.5361	1.0727	1.0113	0.4308	0.2848	0.0577	0.0824	0.0092	0.0038	0.0124	0.0050	216.62
CONTROL FODDER AVE...		34.6385	155.7140	33.5350	40.3873	0.5361	1.0727	1.0113	0.4308	0.2848	0.0577	0.0824	0.0092	0.0038	0.0124	0.0050	216.62
STD...		4.7926	20.0115	5.1711	4.4614	0.0992	0.1562	0.1921	0.0638	0.0469	0.0049	0.0132	0.0011	0.0004	0.0012	0.0001	23.97
MIN...		28.1566	127.4482	29.8471	34.5787	0.4223	0.9401	0.7860	0.3849	0.2195	0.0522	0.0640	0.0081	0.0033	0.0113	0.0049	183.49
MAX...		39.5947	171.0607	40.8479	45.4250	0.6640	1.2920	1.2553	0.5210	0.3274	0.0641	0.0942	0.0107	0.0041	0.0141	0.0051	239.40
N...		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.00

- 1978 MEANS --		ELEMENTS REMOVED															
TISSUE	TREATMENT	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha)	=====>>>>>														
GRAIN	SLUDGE	36.1933	41.0791	0.3577	15.9050	0.0242	0.2091	0.0264	0.0692	0.2587	0.0034	0.0182	0.0024	0.0026	0.0078	0.0024	174.66
STOVER	SLUDGE	9.7431	123.4606	33.8962	18.8362	0.5221	0.8989	0.6214	0.2681	0.1481	0.0444	0.0532	0.0020	0.0010	0.0054	0.0062	66.38
COB	SLUDGE	0.4274	6.8190	0.1738	0.4085	0.0087	0.0234	0.0076	0.0083	0.0188	0.0045	0.0024	0.0014	0.0002	0.0006	0.0012	5.04
FODDER	SLUDGE	46.3639	171.3587	34.4277	35.1497	0.5549	1.1313	0.6554	0.3456	0.4255	0.0523	0.0738	0.0058	0.0039	0.0138	0.0098	246.09
GRAIN	CONTROL	27.1475	33.8774	0.3269	13.0392	0.0174	0.1964	0.0272	0.0566	0.1845	0.0085	0.0178	0.0043	0.0024	0.0072	0.0022	151.13
STOVER	CONTROL	7.1432	115.5167	33.0287	26.6877	0.5077	0.8531	0.9754	0.3656	0.0887	0.0454	0.0621	0.0032	0.0012	0.0046	0.0017	60.44
COB	CONTROL	0.3478	6.3199	0.1794	0.6604	0.0110	0.0232	0.0087	0.0086	0.0116	0.0038	0.0025	0.0018	0.0002	0.0006	0.0010	5.04
FODDER	CONTROL	34.6385	155.7140	33.5350	40.3873	0.5361	1.0727	1.0113	0.4308	0.2848	0.0577	0.0824	0.0092	0.0038	0.0124	0.0050	216.62

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1979

TISSUE		ID	P (kg/ha)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
- SLUDGE -																		
GRAIN		6 2	32.2445	35.4699	0.3146	13.0911	0.0060	0.2014	0.0508	0.0507	0.2327	0.0098	0.0139	0.0014	0.0004	0.0030	0.0028	139.94
STOVER		6 2	7.5834	122.8974	49.7530	30.0943	1.0070	1.4183	0.2804	0.3791	0.2620	0.0655	0.0412	0.0121	0.0006	0.0078	0.0097	77.27
COB		6 2	0.4452	7.0675	0.1423	0.2890	0.0032	0.0330	0.0044	0.0073	0.0255	0.0045	0.0027	0.0045	0.0000	0.0002	0.0021	5.19
FODDER			40.2731	165.4347	50.2099	43.4744	1.0162	1.6526	0.3356	0.4370	0.5201	0.0798	0.0578	0.0180	0.0009	0.0111	0.0146	222.41
G		6 4	28.9529	36.2319	0.3371	12.6151	0.0078	0.1878	0.0277	0.0557	0.2473	0.0069	0.0131	0.0014	0.0003	0.0027	0.0026	136.51
S		6 4	6.1090	101.0312	27.0717	15.7315	0.5428	0.8165	0.2406	0.1999	0.1827	0.0419	0.0335	0.0076	0.0005	0.0045	0.0052	67.00
C		6 4	0.3413	6.0716	0.1093	0.2686	0.0024	0.0221	0.0027	0.0058	0.0200	0.0041	0.0019	0.0028	0.0000	0.0002	0.0013	4.58
FODDER			35.4032	143.3347	27.5181	28.6152	0.5529	1.0263	0.2711	0.2614	0.4500	0.0529	0.0486	0.0117	0.0008	0.0074	0.0090	208.11
G		6 5	32.1803	40.9019	0.3106	11.9995	0.0068	0.1779	0.0183	0.0499	0.2113	0.0068	0.0132	0.0013	0.0003	0.0028	0.0027	141.39
S		6 5	10.0293	153.6384	33.3754	13.5949	0.9482	1.3777	0.3206	0.2768	0.2210	0.0555	0.0408	0.0178	0.0007	0.0074	0.0124	75.81
C		6 5	0.5334	9.2343	0.1507	0.1998	0.0025	0.0286	0.0025	0.0058	0.0213	0.0036	0.0023	0.0036	0.0000	0.0002	0.0017	5.21
FODDER			42.7430	203.7746	33.8366	25.7942	0.9575	1.5841	0.3414	0.3325	0.4536	0.0660	0.0563	0.0227	0.0011	0.0105	0.0168	222.42
	TERRACE MEAN...		39.4731	170.8480	37.1882	32.6279	0.8422	1.4210	0.3160	0.3436	0.4746	0.0662	0.0542	0.0175	0.0010	0.0097	0.0135	217.65
G		7 2	30.7517	38.0344	0.3704	12.6285	0.0083	0.1962	0.0224	0.0550	0.2466	0.0065	0.0130	0.0013	0.0003	0.0028	0.0027	141.69
S		7 2	8.7849	112.8512	38.0531	25.4480	0.4893	0.7996	0.3536	0.3021	0.3579	0.0586	0.0413	0.0172	0.0005	0.0063	0.0060	77.01
C		7 2	0.3786	6.9388	0.1423	0.2225	0.0015	0.0312	0.0021	0.0070	0.0250	0.0041	0.0021	0.0044	0.0000	0.0002	0.0021	4.61
FODDER			39.9152	157.8243	38.5658	38.2990	0.4991	1.0271	0.3781	0.3642	0.6295	0.0691	0.0564	0.0230	0.0008	0.0094	0.0107	223.32
G		7 4	31.5002	38.3794	0.3298	12.2717	0.0080	0.1934	0.0209	0.0513	0.2251	0.0033	0.0126	0.0012	0.0003	0.0026	0.0025	129.49
S		7 4	7.8379	118.9317	35.6258	23.7663	0.6807	1.0770	0.3216	0.2670	0.3799	0.0528	0.0371	0.0185	0.0007	0.0062	0.0095	68.79
C		7 4	0.5215	7.0339	0.1395	0.2139	0.0014	0.0286	0.0059	0.0080	0.0268	0.0034	0.0019	0.0031	0.0000	0.0002	0.0017	4.43
FODDER			39.8596	164.3450	36.0952	36.2520	0.6902	1.2989	0.3485	0.3263	0.6317	0.0596	0.0516	0.0229	0.0011	0.0091	0.0137	202.72
G		7 6	31.3115	39.4228	0.2550	11.5208	0.0054	0.1813	0.0149	0.0526	0.2221	0.0029	0.0104	0.0014	0.0003	0.0027	0.0025	133.78
S		7 6	15.5354	183.7912	37.3133	16.6664	0.8826	1.3085	0.7417	0.3724	0.4866	0.0641	0.0432	0.0174	0.0011	0.0083	0.0192	94.90
C		7 6	0.6717	6.9448	0.1396	0.2047	0.0013	0.0363	0.0077	0.0090	0.0270	0.0038	0.0020	0.0040	0.0000	0.0002	0.0023	4.65
FODDER			47.5186	230.1588	37.7079	28.3919	0.8894	1.5261	0.7642	0.4340	0.7357	0.0708	0.0556	0.0228	0.0014	0.0112	0.0239	233.35
	TERRACE MEAN...		42.4311	184.1094	37.4563	34.3143	0.6929	1.2840	0.4969	0.3748	0.6656	0.0665	0.0546	0.0229	0.0011	0.0099	0.0161	219.79
SLUDGE	FODDER AVE...		40.9521	177.4787	37.3222	33.4711	0.7676	1.3525	0.4065	0.3592	0.5701	0.0664	0.0544	0.0202	0.0010	0.0098	0.0148	218.72
	STD...		3.6480	29.8226	6.8015	6.3169	0.1987	0.2546	0.1632	0.0620	0.1043	0.0085	0.0032	0.0042	0.0002	0.0013	0.0048	10.25
	MIN...		35.4032	143.3347	27.5181	25.7942	0.4991	1.0263	0.2711	0.2614	0.4500	0.0529	0.0486	0.0117	0.0008	0.0074	0.0090	202.72
	MAX...		47.5186	230.1588	50.2099	43.4744	1.0162	1.6526	0.7642	0.4370	0.7357	0.0798	0.0578	0.0230	0.0014	0.0112	0.0239	233.35
	N...		6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.00
- CONTROL -																		
G		4 1	23.6809	31.5840	0.3292	10.1937	0.0106	0.1806	0.0348	0.0499	0.1576	0.0186	0.0141	0.0011	0.0003	0.0024	0.0022	113.58
S		4 1	7.4393	120.0215	37.1694	27.0798	0.4765	0.7844	0.3692	0.5188	0.1075	0.0511	0.0321	0.0054	0.0005	0.0069	0.0028	86.30
C		4 1	0.3108	7.1812	0.0837	0.1488	0.0025	0.0268	0.0031	0.0068	0.0104	0.0036	0.0024	0.0034	0.0000	0.0002	0.0015	3.96
FODDER			31.4311	158.7867	37.5822	37.4224	0.4896	0.9918	0.4072	0.5755	0.2755	0.0733	0.0486	0.0099	0.0008	0.0095	0.0066	203.85
G		4 2	21.6878	29.9464	0.2950	9.6104	0.0064	0.1621	0.0383	0.0458	0.1509	0.0194	0.0117	0.0011	0.0003	0.0023	0.0021	105.56
S		4 2	7.7237	128.8346	39.4471	28.6578	0.5147	0.8514	0.4106	0.6483	0.1163	0.0504	0.0351	0.0062	0.0004	0.0076	0.0031	92.03
C		4 2	0.3663	7.3611	0.1000	0.2387	0.0020	0.0215	0.0037	0.0064	0.0125	0.0033	0.0021	0.0026	0.0000	0.0002	0.0012	3.97
FODDER			29.7777	166.1421	39.8422	38.5069	0.5231	1.0350	0.4527	0.7006	0.2797	0.0731	0.0490	0.0099	0.0007	0.0101	0.0064	201.57
G		4 4	24.6996	31.5469	0.2566	10.2802	0.0056	0.1744	0.0386	0.0429	0.1663	0.0165	0.0121	0.0012	0.0003	0.0025	0.0023	114.73
S		4 4	7.7141	149.2032	29.5843	25.9439	0.4043	0.6968	0.1031	0.3360	0.1214	0.0380	0.0368	0.0084	0.0003	0.0051	0.0037	78.55
C		4 4	0.3850	7.3075	0.1078	0.2470	0.0024	0.0302	0.0032	0.0070	0.0161	0.0037	0.0023	0.0039	0.0000	0.0002	0.0018	4.13
FODDER			32.7987	188.0576	29.9487	36.4711	0.4122	0.9014	0.1449	0.3859	0.3038	0.0583	0.0513	0.0134	0.0006	0.0078	0.0078	197.42
	TERRACE MEAN...		31.3358	170.9955	35.7911	37.4668	0.4750	0.9761	0.3349	0.5540	0.2863	0.0683	0.0496	0.0111	0.0007	0.0091	0.0069	200.94
CONTROL	FODDER AVE...		31.3358	170.9955	35.7911	37.4668	0.4750	0.9761	0.3349	0.5540	0.2863	0.0683	0.0496	0.0111	0.0007	0.0091	0.0069	200.94
	STD...		1.2351	12.4328	4.2329	0.8317	0.0464	0.0556	0.1356	0.1293	0.0125	0.0070	0.0012	0.0016	0.0001	0.0010	0.0006	2.66
	MIN...		29.7777	158.7867	29.9487	36.4711	0.4122	0.9014	0.1449	0.3859	0.2755	0.0583	0.0486	0.0099	0.0006	0.0078	0.0064	197.42
	MAX...		32.7987	188.0576	39.8422	38.5069	0.5231	1.0350	0.4527	0.7006	0.3038	0.0733	0.0513	0.0134	0.0008	0.0101	0.0078	203.85
	N...		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.00

- 1979 MEANS -

TISSUE	TREATMENT	ELEMENTS REMOVED P (kg/ha)	K ====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
GRAIN	SLUDGE	31.1569	38.0734	0.3196	12.3545	0.0071	0.1897	0.0258	0.0525	0.2308	0.0060	0.0127	0.0014	0.0003	0.0028	0.0026	137.13
STOVER	SLUDGE	9.3133	132.1902	36.8654	20.8836	0.7585	1.1329	0.3764	0.2996	0.3150	0.0564	0.0395	0.0151	0.0007	0.0067	0.0103	76.80
COB	SLUDGE	0.4819	7.2151	0.1373	0.2331	0.0020	0.0299	0.0042	0.0072	0.0243	0.0039	0.0022	0.0037	0.0000	0.0002	0.0019	4.78
FODDER	SLUDGE	40.9521	177.4787	37.3222	33.4711	0.7676	1.3525	0.4065	0.3592	0.5701	0.0664	0.0544	0.0202	0.0010	0.0098	0.0148	218.72
GRAIN	CONTROL	23.3561	31.0258	0.2936	10.0281	0.0075	0.1724	0.0373	0.0462	0.1583	0.0182	0.0126	0.0011	0.0003	0.0024	0.0022	111.29
STOVER	CONTROL	7.6257	132.6864	35.4003	27.2272	0.4652	0.7775	0.2943	0.5010	0.1150	0.0465	0.0347	0.0067	0.0004	0.0065	0.0032	85.63
COB	CONTROL	0.3540	7.2833	0.0972	0.2115	0.0023	0.0262	0.0033	0.0067	0.0130	0.0035	0.0023	0.0033	0.0000	0.0002	0.0015	4.02
FODDER	CONTROL	31.3358	170.9955	35.7911	37.4668	0.4750	0.9761	0.3349	0.5540	0.2863	0.0683	0.0496	0.0111	0.0007	0.0091	0.0069	200.94

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1980		ELEMENTS REMOVED															
TISSUE	ID	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha)	=====>>>>>														
- SLUDGE -																	
GRAIN	6	26.8002	29.5452	0.2652	12.7317	0.0088	0.1853	0.0325	0.0571	0.2499	0.0103	0.0141	0.0020	0.0003	0.0021	0.0021	125.39
STOVER	6	5.4474	74.6554	33.0811	19.4965	0.7837	1.0650	0.2140	0.2018	0.2076	0.0327	0.0312	0.0053	0.0005	0.0027	0.0059	22.03
COB	6	0.3499	6.3012	0.1417	0.3406	0.0024	0.0221	0.0082	0.0064	0.0243	0.0030	0.0022	0.0029	0.0000	0.0002	0.0017	1.61
FODDER		32.5975	110.5018	33.4880	32.5688	0.7949	1.2724	0.2547	0.2652	0.4818	0.0460	0.0476	0.0102	0.0008	0.0050	0.0098	149.04
G	7	26.6898	29.2350	0.2616	12.4500	0.0089	0.1900	0.0319	0.0582	0.2470	0.0102	0.0144	0.0026	0.0003	0.0022	0.0022	127.876
S	7	5.8808	82.5324	30.3942	20.7574	0.7617	0.9839	0.1763	0.2659	0.2353	0.0250	0.0317	0.0059	0.0005	0.0016	0.0073	24.10
C	7	0.3319	4.0998	0.1208	0.4568	0.0020	0.0177	0.0062	0.0077	0.0365	0.0028	0.0018	0.0022	0.0000	0.0002	0.0013	1.50
FODDER		32.9026	115.8672	30.7766	33.6642	0.7726	1.1915	0.2144	0.3318	0.5188	0.0380	0.0479	0.0107	0.0008	0.0040	0.0109	153.48
- CONTROL -																	
G	4	18.9959	22.5307	0.2415	9.6045	0.0066	0.1516	0.0264	0.0493	0.1631	0.0083	0.0115	0.0026	0.0002	0.0019	0.0019	99.56
S	4	4.9764	64.6007	24.2411	19.1524	0.5885	0.7544	0.1374	0.3862	0.0865	0.0218	0.0265	0.0040	0.0002	0.0012	0.0031	22.35
C	4	0.2226	4.0486	0.1038	0.3220	0.0027	0.0245	0.0060	0.0071	0.0161	0.0025	0.0019	0.0033	0.0000	0.0002	0.0019	1.22
FODDER		24.1949	91.1800	24.5864	29.0789	0.5977	0.9305	0.1698	0.4427	0.2658	0.0326	0.0400	0.0099	0.0005	0.0032	0.0069	123.14
- 1980 MEANS --		ELEMENTS REMOVED															
TISSUE	TREATMENT	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha)	=====>>>>>														
GRAIN	SLUDGE	26.7450	29.3901	0.2634	12.5908	0.0088	0.1877	0.0322	0.0576	0.2485	0.0103	0.0143	0.0023	0.0003	0.0022	0.0022	126.63
STOVER	SLUDGE	5.6641	78.5939	31.7377	20.1270	0.7727	1.0244	0.1952	0.2338	0.2214	0.0289	0.0315	0.0056	0.0005	0.0021	0.0066	23.07
COB	SLUDGE	0.3409	5.2005	0.1312	0.3987	0.0022	0.0199	0.0072	0.0070	0.0304	0.0029	0.0020	0.0026	0.0000	0.0002	0.0015	1.55
FODDER	SLUDGE	32.7501	113.1845	32.1323	33.1165	0.7838	1.2320	0.2346	0.2985	0.5003	0.0420	0.0477	0.0105	0.0008	0.0045	0.0103	151.26
GRAIN	CONTROL	18.9959	22.5307	0.2415	9.6045	0.0066	0.1516	0.0264	0.0493	0.1631	0.0083	0.0115	0.0026	0.0002	0.0019	0.0019	99.56
STOVER	CONTROL	4.9764	64.6007	24.2411	19.1524	0.5885	0.7544	0.1374	0.3862	0.0865	0.0218	0.0265	0.0040	0.0002	0.0012	0.0031	22.35
COB	CONTROL	0.2226	4.0486	0.1038	0.3220	0.0027	0.0245	0.0060	0.0071	0.0161	0.0025	0.0019	0.0033	0.0000	0.0002	0.0019	1.22
FODDER	CONTROL	24.1949	91.1800	24.5864	29.0789	0.5977	0.9305	0.1698	0.4427	0.2658	0.0326	0.0400	0.0099	0.0005	0.0032	0.0069	123.14

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1981		ELEMENTS REMOVED															
TISSUE	ID	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha)	=====>>>>>														
- SLUDGE -																	
GRAIN	6 2	30.3097	40.1507	0.4711	12.6299	0.0223	0.1743	0.0431	0.0546	0.2889	0.0135	0.0252	0.0034	0.0053	0.0008	0.0011	128.19
STOVER	6 2	8.5901	127.2784	37.7942	24.1345	0.2336	0.4725	0.0661	0.8767	0.1072	0.0484	0.0729	0.0029	0.0006	0.0021	0.0027	85.90
COB	6 2	0.5336	8.3834	0.0905	0.2402	0.0004	0.0156	0.0040	0.0104	0.0841	0.0024	0.0018	0.0024	0.0000	0.0002	0.0015	3.34
FODDER		39.4334	175.8125	38.3558	37.0046	0.2563	0.6625	0.1132	0.9418	0.4802	0.0644	0.1000	0.0087	0.0059	0.0031	0.0053	217.43
G	6 4	29.2016	40.1847	0.4986	13.2502	0.0208	0.1902	0.0458	0.0611	0.2584	0.0191	0.0263	0.0023	0.0055	0.0010	0.0009	141.58
S	6 4	11.4859	127.4431	69.2898	27.6694	0.4437	0.7158	0.1699	0.5549	0.5210	0.0893	0.0730	0.0031	0.0012	0.0040	0.0043	96.60
C	6 4	0.4490	8.4532	0.1072	0.3017	0.0004	0.0140	0.0036	0.0088	0.0434	0.0024	0.0018	0.0019	0.0000	0.0002	0.0012	3.66
FODDER		41.1366	176.0809	69.8955	41.2212	0.4648	0.9200	0.2194	0.6248	0.8227	0.1109	0.1012	0.0073	0.0067	0.0052	0.0065	241.85
G	6 5	33.8968	47.8752	0.5684	14.2087	0.0776	0.1933	0.0517	0.0677	0.2732	0.0247	0.0298	0.0017	0.0062	0.0009	0.0012	143.21
S	6 5	10.0883	121.3996	35.6244	27.3349	0.2230	0.4362	0.3246	0.8018	0.1381	0.0391	0.0670	0.0031	0.0005	0.0023	0.0027	117.42
C	6 5	0.4705	9.0926	0.1752	0.2772	0.0011	0.0154	0.0037	0.0163	0.0490	0.0035	0.0025	0.0018	0.0000	0.0002	0.0013	3.99
FODDER		44.4556	178.3674	36.3681	41.8207	0.3017	0.6449	0.3799	0.8958	0.4603	0.0673	0.0994	0.0067	0.0067	0.0034	0.0051	264.64
TERRACE MEAN...		41.6752	176.7536	48.2065	40.0155	0.3409	0.7425	0.2375	0.8175	0.5877	0.0809	0.1002	0.0076	0.0064	0.0039	0.0056	241.31
G	7 2	31.8207	43.9408	0.5156	14.0246	0.0226	0.1979	0.0550	0.0657	0.2947	0.0278	0.0291	0.0014	0.0072	0.0010	0.0012	144.631
S	7 2	12.9106	132.0175	48.6276	28.8811	0.3154	0.6440	0.0701	0.6117	0.1534	0.0402	0.0668	0.0040	0.0006	0.0027	0.0028	79.81
C	7 2	0.5959	10.8314	0.1113	0.2034	0.0007	0.0141	0.0040	0.0106	0.0761	0.0030	0.0020	0.0017	0.0000	0.0002	0.0012	3.95
FODDER		45.3272	186.7898	49.2545	43.1091	0.3386	0.8560	0.1291	0.6880	0.5241	0.0711	0.0979	0.0071	0.0078	0.0040	0.0052	228.40
G	7 4	34.7217	45.6491	0.5092	14.5042	0.0210	0.2035	0.0561	0.0663	0.3684	0.0149	0.0286	0.0014	0.0075	0.0009	0.0012	140.14
S	7 4	19.2829	166.6998	42.9350	14.8713	0.4750	0.7406	0.2652	0.4884	0.7642	0.0424	0.0533	0.0057	0.0011	0.0029	0.0057	109.78
C	7 4	0.7295	8.4445	0.1257	0.3710	0.0018	0.0193	0.0067	0.0166	0.1494	0.0034	0.0023	0.0028	0.0000	0.0002	0.0016	3.96
FODDER		54.7342	220.7933	43.5699	29.7465	0.4978	0.9634	0.3280	0.5713	1.2819	0.0608	0.0841	0.0099	0.0086	0.0040	0.0085	253.88
G	7 5	37.3390	48.6289	0.6178	14.9570	0.0286	0.2214	0.0578	0.0725	0.3573	0.0152	0.0304	0.0019	0.0083	0.0010	0.0012	152.18
S	7 5	19.1629	158.7951	48.7782	24.3530	0.5610	0.8333	0.3012	0.4646	0.8582	0.0600	0.0695	0.0045	0.0011	0.0027	0.0047	99.10
C	7 5	0.7678	10.5011	0.1423	0.2871	0.0025	0.0170	0.0075	0.0150	0.1224	0.0036	0.0026	0.0023	0.0000	0.0002	0.0016	5.52
FODDER		57.2696	217.9252	49.5383	39.5972	0.5921	1.0717	0.3665	0.5521	1.3379	0.0788	0.1025	0.0087	0.0095	0.0039	0.0074	256.81
TERRACE MEAN...		52.4437	208.5028	47.4542	37.4843	0.4762	0.9637	0.2745	0.6038	1.0480	0.0702	0.0948	0.0085	0.0086	0.0040	0.0071	246.36
SLUDGE FODDER AVE...		47.0594	192.6282	47.8304	38.7499	0.4085	0.8531	0.2560	0.7106	0.8179	0.0756	0.0975	0.0081	0.0075	0.0039	0.0063	243.84
STD...		6.6604	19.2668	11.0387	4.4603	0.1186	0.1550	0.1085	0.1508	0.3683	0.0168	0.0062	0.0011	0.0012	0.0007	0.0013	16.53
MIN...		39.4334	175.8125	36.3681	29.7465	0.2563	0.6449	0.1132	0.5521	0.4603	0.0608	0.0841	0.0067	0.0059	0.0031	0.0051	217.43
MAX...		57.2696	220.7933	69.8955	43.1091	0.5921	1.0717	0.3799	0.9418	1.3379	0.1109	0.1025	0.0099	0.0095	0.0052	0.0085	264.64
N...		6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.00
— CONTROL —																	
G	4 1	21.9338	39.5279	0.4772	10.1798	0.0154	0.1305	0.0460	0.0598	0.1457	0.0215	0.0219	0.0027	0.0059	0.0032	0.0010	117.38
S	4 1	19.2464	138.2649	65.3992	27.0669	0.4769	0.8484	0.3431	0.6651	1.0373	0.0725	0.0683	0.0038	0.0015	0.0037	0.0054	89.77
C	4 1	0.3274	7.3107	0.0871	0.1929	0.0005	0.0161	0.0042	0.0090	0.0168	0.0023	0.0023	0.0023	0.0000	0.0002	0.0014	3.19
FODDER		41.5075	185.1035	65.9635	37.4397	0.4927	0.9950	0.3933	0.7339	1.1998	0.0963	0.0925	0.0088	0.0074	0.0070	0.0077	210.35
G	4 2	19.3849	33.8272	0.4556	9.1251	0.0209	0.1233	0.0514	0.0572	0.1436	0.0181	0.0187	0.0019	0.0047	0.0007	0.0007	96.22
S	4 2	12.9028	136.5943	46.1523	16.1530	0.4106	0.6605	0.2312	0.3766	0.2626	0.0524	0.0603	0.0032	0.0007	0.0025	0.0042	70.50
C	4 2	0.3325	6.1437	0.0883	0.2314	0.0005	0.0132	0.0050	0.0091	0.0087	0.0024	0.0022	0.0017	0.0000	0.0002	0.0012	3.47
FODDER		32.6202	176.5653	46.6963	25.5094	0.4320	0.7970	0.2876	0.4428	0.4149	0.0729	0.0811	0.0068	0.0054	0.0034	0.0061	170.19
G	4 4	28.4483	43.5138	0.5432	12.5534	0.0193	0.1676	0.0504	0.0605	0.1892	0.0222	0.0251	0.0015	0.0064	0.0016	0.0010	129.95
S	4 4	13.4699	134.5502	55.7010	25.2444	0.4443	0.7951	0.2171	0.4955	0.5163	0.0680	0.0676	0.0056	0.0011	0.0028	0.0059	107.02
C	4 4	0.4370	8.4459	0.1242	0.2490	0.0010	0.0173	0.0057	0.0140	0.0197	0.0029	0.0022	0.0024	0.0000	0.0002	0.0013	3.52
FODDER		42.3552	186.5099	56.3684	38.0469	0.4647	0.9800	0.2733	0.5700	0.7252	0.0931	0.0949	0.0095	0.0075	0.0046	0.0081	240.50
TERRACE MEAN...		38.8276	182.7262	56.3427	33.6653	0.4631	0.9240	0.3181	0.5823	0.7800	0.0874	0.0895	0.0084	0.0068	0.0050	0.0073	207.01
CONTROL FODDER AVE...		38.8276	182.7262	56.3427	33.6653	0.4631	0.9240	0.3181	0.5823	0.7800	0.0874	0.0895	0.0084	0.0068	0.0050	0.0073	207.01
STD...		4.4029	4.3941	7.8658	5.7724	0.0248	0.0900	0.0535	0.1192	0.3228	0.0104	0.0060	0.0011	0.0010	0.0015	0.0009	28.79
MIN...		32.6202	176.5653	46.6963	25.5094	0.4320	0.7970	0.2733	0.4428	0.4149	0.0729	0.0811	0.0068	0.0054	0.0034	0.0061	170.19
MAX...		42.3552	186.5099	65.9635	38.0469	0.4927	0.9950	0.3933	0.7339	1.1998	0.0963	0.0949	0.0095	0.0075	0.0070	0.0081	240.50
N...		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.00

- 1981 MEANS -		ELEMENTS REMOVED															
TISSUE	TREATMENT	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha)	=====>>>>>														
GRAIN	SLUDGE	32.8816	44.4049	0.5301	13.9291	0.0321	0.1968	0.0516	0.0646	0.3068	0.0192	0.0283	0.0020	0.0067	0.0009	0.0011	141.65
STOVER	SLUDGE	13.5868	138.9389	47.1748	24.5407	0.3753	0.6404	0.1995	0.6330	0.4237	0.0533	0.0671	0.0039	0.0008	0.0028	0.0038	98.10
COB	SLUDGE	0.5911	9.2844	0.1254	0.2801	0.0011	0.0159	0.0049	0.0130	0.0874	0.0031	0.0022	0.0022	0.0000	0.0002	0.0014	4.07
FODDER	SLUDGE	47.0594	192.6282	47.8304	38.7499	0.4085	0.8531	0.2560	0.7106	0.8179	0.0756	0.0975	0.0081	0.0075	0.0039	0.0063	243.84
GRAIN	CONTROL	23.2557	38.9563	0.4920	10.6194	0.0186	0.1405	0.0493	0.0592	0.1595	0.0206	0.0219	0.0020	0.0057	0.0018	0.0009	114.51
STOVER	CONTROL	15.2063	136.4698	55.7509	22.8214	0.4439	0.7680	0.2638	0.5124	0.6054	0.0643	0.0654	0.0042	0.0011	0.0030	0.0052	89.10
COB	CONTROL	0.3656	7.3001	0.0999	0.2244	0.0007	0.0155	0.0050	0.0107	0.0151	0.0025	0.0022	0.0021	0.0000	0.0002	0.0013	3.39
FODDER	CONTROL	38.8276	182.7262	56.3427	33.6653	0.4631	0.9240	0.3181	0.5823	0.7800	0.0874	0.0895	0.0084	0.0068	0.0050	0.0073	207.01

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1982		ELEMENTS REMOVED														
TISSUE	ID	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha)	=====>>>>>														
- SLUDGE -																	
GRAIN	6 2	28.2575	35.6094	0.4255	13.8569	0.0204	0.1767	0.1959	0.0665	0.2867	0.0143	0.0207	0.0041	0.0001	0.0017	0.0003	128.90
STOVER	6 2	9.7100	117.5548	44.9123	29.5631	0.7346	0.9733	0.2114	0.3722	0.4771	0.0469	0.0491	0.0056	0.0007	0.0056	0.0123	73.31
COB	6 2	0.2154	8.0375	0.0723	0.3001	0.0031	0.0148	0.0305	0.0097	0.0509	0.0024	0.0023	0.0018	0.0000	0.0001	0.0024	2.57
FODDER		38.1829	161.2018	45.4100	43.7201	0.7581	1.1647	0.4378	0.4484	0.8147	0.0635	0.0721	0.0115	0.0009	0.0074	0.0151	204.79
G	6 4	33.6528	42.0262	0.5120	15.9365	0.0163	0.2087	0.2004	0.0752	0.3960	0.0165	0.0255	0.0038	0.0002	0.0009	0.0004	144.83
S	6 4	8.6634	100.2502	62.3309	39.3450	0.9085	1.2118	0.2258	0.6589	0.3584	0.0686	0.0532	0.0072	0.0007	0.0039	0.0154	85.02
C	6 4	0.2090	7.8576	0.0698	0.3225	0.0009	0.0180	0.0305	0.0098	0.0349	0.0025	0.0020	0.0024	0.0000	0.0003	0.0030	3.19
FODDER		42.5252	150.1340	62.9127	55.6040	0.9257	1.4385	0.4567	0.7439	0.7893	0.0876	0.0807	0.0134	0.0009	0.0051	0.0187	233.04
G	6 5	31.4292	39.5770	0.5155	15.1411	0.0164	0.2046	0.2154	0.0759	0.2886	0.0137	0.0232	0.0025	0.0002	0.0026	0.0005	147.42
S	6 5	10.9850	149.1344	60.1795	29.7316	1.3557	1.6786	0.3713	0.5005	0.4363	0.0609	0.0601	0.0108	0.0010	0.0047	0.0235	104.33
C	6 5	0.2492	8.5399	0.0862	0.3443	0.0021	0.0238	0.0377	0.0131	0.0617	0.0029	0.0028	0.0034	0.0000	0.0002	0.0033	4.15
FODDER		42.6634	197.2514	60.7813	45.2170	1.3742	1.9069	0.6244	0.5895	0.7866	0.0775	0.0860	0.0166	0.0013	0.0074	0.0273	255.91
TERRACE MEAN...		41.1238	169.5291	56.3680	48.1804	1.0193	1.5034	0.5063	0.5939	0.7969	0.0762	0.0796	0.0138	0.0010	0.0066	0.0204	231.25
G	7 2	30.3039	38.3920	0.5173	14.9817	0.0163	0.2247	0.1895	0.0776	0.2932	0.0172	0.0221	0.0029	0.0002	0.0007	0.0008	135.05
S	7 2	10.8309	116.8790	63.8964	38.5853	1.3671	1.8083	0.2502	0.5573	0.4049	0.0717	0.0596	0.0088	0.0010	0.0081	0.0232	88.75
C	7 2	0.2474	7.0328	0.0805	0.3809	0.0017	0.0104	0.0292	0.0107	0.0432	0.0022	0.0022	0.0012	0.0000	0.0001	0.0015	3.37
FODDER		41.3822	162.3038	64.4942	53.9479	1.3851	2.0434	0.4689	0.6456	0.7414	0.0910	0.0839	0.0129	0.0012	0.0089	0.0254	227.18
G	7 4	34.9764	43.8421	0.5443	15.9418	0.0150	0.2399	0.2091	0.0816	0.3270	0.0132	0.0263	0.0019	0.0001	0.0010	0.0004	151.45
S	7 4	11.1575	126.6269	67.5955	39.1310	1.2454	1.4954	0.3677	0.6735	0.8661	0.0673	0.0611	0.0084	0.0012	0.0045	0.0212	84.88
C	7 4	0.2694	6.7541	0.0924	0.5151	0.0016	0.0102	0.0338	0.0108	0.1040	0.0025	0.0021	0.0013	0.0000	0.0001	0.0014	4.21
FODDER		46.4033	177.2231	68.2322	55.5879	1.2619	1.7455	0.6107	0.7658	1.2971	0.0830	0.0895	0.0116	0.0014	0.0056	0.0230	240.55
G	7 5	37.7774	48.6955	0.4964	16.3146	0.0182	0.2226	0.2300	0.0839	0.4001	0.0117	0.0270	0.0038	0.0002	0.0010	NA	163.46
S	7 5	15.1400	175.2235	50.1679	23.1898	1.0786	1.3970	0.2740	0.8824	0.9573	0.0391	0.0555	0.0091	0.0015	0.0027	0.0220	85.71
C	7 5	0.3405	7.7137	0.0636	0.3104	0.0056	0.0165	0.0425	0.0099	0.0944	0.0028	0.0024	0.0034	0.0000	0.0002	0.0034	3.58
FODDER		53.2579	231.6327	50.7279	39.8149	1.1025	1.6361	0.5465	0.9763	1.4517	0.0536	0.0849	0.0163	0.0017	0.0039	NA	252.76
TERRACE MEAN...		47.0145	190.3866	61.1514	49.7835	1.2498	1.8083	0.5420	0.7959	1.1634	0.0759	0.0861	0.0136	0.0014	0.0061	0.0242	240.17
SLUDGE FODDER AVE...		44.0691	179.9578	58.7597	48.9820	1.1346	1.6558	0.5242	0.6949	0.9802	0.0760	0.0828	0.0137	0.0012	0.0064	0.0206	235.71
STD...		4.7629	27.4765	8.0278	6.2988	0.2320	0.2916	0.0743	0.1638	0.2832	0.0133	0.0055	0.0020	0.0003	0.0017	0.0040	17.11
MIN...		38.1829	150.1340	45.4100	39.8149	0.7581	1.1647	0.4378	0.4484	0.7414	0.0536	0.0721	0.0115	0.0009	0.0039	0.0151	204.79
MAX...		53.2579	231.6327	68.2322	55.6040	1.3851	2.0434	0.6244	0.9763	1.4517	0.0910	0.0895	0.0166	0.0017	0.0089	0.0254	255.91
N...		6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	
- CONTROL -																	
G	4 1	21.9550	35.4083	0.4894	12.2973	0.0195	0.1603	0.1636	0.0712	0.1914	0.0175	0.0211	0.0031	0.0002	0.0018	0.0003	117.28
S	4 1	7.0075	82.8821	41.9175	37.5123	0.5501	0.7962	0.2247	0.7514	0.1132	0.0516	0.0437	0.0068	0.0005	0.0050	0.0076	79.30
C	4 1	0.2672	7.7968	0.1456	0.5837	0.0035	0.0204	0.0322	0.0172	0.0170	0.0030	0.0025	0.0025	0.0000	0.0001	0.0032	2.66
FODDER		29.2297	126.0872	42.5525	50.3933	0.5731	0.9770	0.4205	0.8399	0.3216	0.0721	0.0673	0.0124	0.0008	0.0068	0.0111	199.26
G	4 2	28.2540	40.2544	0.4624	13.9221	0.0244	0.1863	0.2018	0.0742	0.2420	0.0222	0.0249	0.0042	0.0002	0.0026	0.0003	126.82
S	4 2	7.9925	101.6772	56.2788	40.4270	0.6542	0.9756	0.2357	0.9645	0.1985	0.0512	0.0505	0.0079	0.0005	0.0017	0.0114	82.20
C	4 2	0.1885	8.7072	0.0819	0.2653	0.0033	0.0184	0.0343	0.0131	0.0228	0.0021	0.0023	0.0023	0.0000	0.0001	0.0030	2.68
FODDER		36.4350	150.6387	56.8232	54.6144	0.6820	1.1803	0.4718	1.0518	0.4632	0.0754	0.0777	0.0144	0.0007	0.0044	0.0148	211.70
G	4 4	26.8872	38.6046	0.4314	13.9989	0.0158	0.1729	0.1952	0.0740	0.2246	0.0161	0.0219	0.0030	0.0002	0.0010	0.0003	131.80
S	4 4	10.6120	119.0279	60.5171	43.3030	0.7928	1.1485	0.2458	0.8810	0.1863	0.0523	0.0575	0.0064	0.0008	0.0040	0.0122	85.57
C	4 4	0.3124	8.0129	0.1120	0.3549	0.0029	0.0197	0.0341	0.0161	0.0279	0.0028	0.0027	0.0025	0.0000	0.0001	0.0032	4.24
FODDER		37.8116	165.6454	61.0605	57.6568	0.8116	1.3411	0.4751	0.9712	0.4388	0.0712	0.0821	0.0119	0.0010	0.0052	0.0157	221.61
TERRACE MEAN...		24.7489	105.4280	39.2945	37.4237	0.4979	0.8405	0.3156	0.6743	0.3007	0.0489	0.0533	0.0087	0.0006	0.0032	0.0102	144.44
CONTROL FODDER AVE...		34.4921	147.4571	53.4787	54.2215	0.6889	1.1661	0.4558	0.9543	0.4079	0.0729	0.0757	0.0129	0.0008	0.0055	0.0139	210.86
STD...		3.7633	16.3055	7.9173	2.9783	0.0975	0.1490	0.0250	0.0874	0.0618	0.0018	0.0062	0.0011	0.0001	0.0010	0.0020	9.14
MIN...		29.2297	126.0872	42.5525	50.3933	0.5731	0.9770	0.4205	0.8399	0.3216	0.0712	0.0673	0.0119	0.0007	0.0044	0.0111	199.26
MAX...		37.8116	165.6454	61.0605	57.6568	0.8116	1.3411	0.4751	1.0518	0.4632	0.0754	0.0821	0.0144	0.0010	0.0068	0.0157	221.61
N...		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

-- 1982 MEANS --		ELEMENTS REMOVED														
TISSUE	TREATMENT	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha)	=====>>>>>														
GRAIN	SLUDGE	32.7329	41.3570	0.5018	15.3621	0.0171	0.2129	0.2067	0.0768	0.3320	0.0144	0.0241	0.0032	0.0002	0.0013	0.0005	145.19
STOVER	SLUDGE	11.0811	130.9448	58.1804	33.2576	1.1150	1.4274	0.2834	0.6074	0.5834	0.0591	0.0564	0.0083	0.0010	0.0049	0.0196	87.00
COB	SLUDGE	0.2551	7.6559	0.0775	0.3622	0.0025	0.0156	0.0340	0.0107	0.0648	0.0025	0.0023	0.0022	0.0000	0.0002	0.0025	3.51
FODDER	SLUDGE	44.0691	179.9578	58.7597	48.9820	1.1346	1.6558	0.5242	0.6949	0.9802	0.0760	0.0828	0.0137	0.0012	0.0064	0.0219	235.71
GRAIN	CONTROL	25.6987	38.0891	0.4611	13.4061	0.0199	0.1732	0.1869	0.0731	0.2193	0.0186	0.0227	0.0034	0.0002	0.0018	0.0003	125.30
STOVER	CONTROL	8.5373	101.1957	52.9045	40.4141	0.6657	0.9734	0.2354	0.8657	0.1660	0.0517	0.0506	0.0070	0.0006	0.0036	0.0104	82.35
COB	CONTROL	0.2560	8.1723	0.1132	0.4013	0.0032	0.0195	0.0335	0.0155	0.0226	0.0026	0.0025	0.0024	0.0000	0.0001	0.0031	3.20
FODDER	CONTROL	34.4921	147.4571	53.4787	54.2215	0.6889	1.1661	0.4558	0.9543	0.4079	0.0729	0.0757	0.0129	0.0008	0.0055	0.0139	210.86

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1983 TISSUE	ID	ELEMENTS REMOVED P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha) ====>>>>>															
- SLUDGE -																	
GRAIN	6 2	21.5731	25.7375	0.2403	9.9220	0.0343	0.1587	0.0195	0.0454	0.2108	0.0159	0.0188	0.0013	0.0031	0.0033	0.0005	106.04
STOVER	6 2	5.2475	71.9073	27.0019	15.3464	1.5905	1.6815	0.3016	0.2446	0.2358	0.0322	0.0404	0.0057	0.0007	0.0069	0.0293	42.71
COB	6 2	0.2436	4.4125	0.1011	0.5190	0.0177	0.0197	0.0030	0.0071	0.0616	0.0086	0.0024	0.0005	0.0005	0.0005	0.0007	2.36
FODDER		27.0642	102.0573	27.3433	25.7874	1.6425	1.8599	0.3240	0.2971	0.5083	0.0567	0.0617	0.0075	0.0043	0.0107	0.0306	151.12
G	6 4	20.1499	27.6771	0.2624	10.0895	0.0312	0.1640	0.0795	0.0433	0.1837	0.0143	0.0213	0.0011	0.0035	0.0036	0.0006	112.85
S	6 4	4.0184	66.3205	36.7597	18.5519	0.9780	1.2014	0.0839	0.3266	0.1858	0.0388	0.0427	0.0039	0.0006	0.0046	0.0214	48.13
C	6 4	0.2510	5.6214	0.0816	0.3677	0.0188	0.0234	0.0044	0.0070	0.0315	0.0091	0.0026	0.0004	0.0005	0.0006	0.0006	2.84
FODDER		24.4192	99.6189	37.1037	29.0091	1.0280	1.3888	0.1678	0.3769	0.4010	0.0622	0.0666	0.0054	0.0046	0.0088	0.0226	163.83
G	6 5	28.7991	35.8414	0.3457	12.8939	0.0515	0.2163	0.0772	0.0595	0.2363	0.0191	0.0293	0.0019	0.0042	0.0047	0.0006	141.67
S	6 5	7.8973	132.7917	43.2522	17.0989	1.3278	1.5254	0.1993	0.3418	0.2424	0.0484	0.0533	0.0051	0.0009	0.0037	0.0267	77.28
C	6 5	0.2835	7.0127	0.0753	0.3668	0.0194	0.0247	0.0042	0.0074	0.0363	0.0115	0.0032	0.0006	0.0007	0.0007	NA	3.21
FODDER		36.9799	175.6458	43.6733	30.3596	1.3987	1.7663	0.2808	0.4087	0.5150	0.0790	0.0858	0.0077	0.0058	0.0090	NA	222.17
TERRACE MEAN...		29.4878	125.7740	36.0401	28.3854	1.3564	1.6717	0.2575	0.3609	0.4748	0.0660	0.0714	0.0069	0.0049	0.0095	NA	179.04
G	7 2	22.9162	29.4808	0.3353	10.9544	0.0345	0.1901	0.0498	0.0560	0.2034	0.0178	0.0224	0.0026	0.0038	0.0040	0.0006	122.88
S	7 2	6.9024	80.2721	35.9003	18.8540	1.6590	1.8332	0.0966	0.3456	0.2981	0.0458	0.0454	0.0098	0.0008	0.0063	0.0325	60.04
C	7 2	0.2143	5.0384	0.0936	0.4007	0.0177	0.0244	0.0035	0.0077	0.0355	0.0100	0.0025	0.0003	0.0006	0.0007	0.0005	2.67
FODDER		30.0329	114.7914	36.3292	30.2091	1.7113	2.0477	0.1498	0.4093	0.5370	0.0735	0.0703	0.0127	0.0051	0.0110	0.0336	185.60
G	7 4	26.0996	32.2186	0.3382	12.0424	0.0333	0.2022	0.0681	0.0586	0.2665	0.0182	0.0256	0.0015	0.0041	0.0055	0.0008	137.88
S	7 4	8.7588	75.6559	43.8638	25.3543	1.1535	1.3008	0.1535	0.2785	0.6020	0.0402	0.0451	0.0053	0.0008	0.0057	0.0249	68.53
C	7 4	0.2799	6.7476	0.1397	0.4858	0.0196	0.0439	0.0322	0.0096	0.0785	0.0096	0.0031	0.0005	0.0007	0.0007	0.0006	3.03
FODDER		35.1383	114.6222	44.3418	37.8825	1.2064	1.5469	0.2537	0.3468	0.9470	0.0680	0.0739	0.0074	0.0055	0.0118	0.0263	209.45
G	7 6	28.1908	33.6847	0.3134	11.6325	0.0378	0.2166	0.0818	0.0610	0.3037	0.0149	0.0261	0.0030	0.0042	0.0044	0.0007	135.96
S	7 6	13.0646	140.6626	36.0259	14.8442	1.5890	1.8086	0.2755	0.4332	0.6035	0.0402	0.0551	0.0083	0.0012	0.0046	NA	74.08
C	7 6	0.3655	6.8369	0.1242	0.4403	0.0284	0.0504	0.0216	0.0147	0.1089	0.0168	0.0033	0.0010	0.0007	0.0007	0.0010	3.92
FODDER		41.6209	181.1842	36.4634	26.9170	1.6552	2.0756	0.3789	0.5089	1.0162	0.0719	0.0845	0.0123	0.0061	0.0098	NA	213.98
TERRACE MEAN...		35.5974	136.8659	39.0448	31.6695	1.5243	1.8901	0.2608	0.4217	0.8334	0.0711	0.0762	0.0108	0.0056	0.0109	NA	203.01
SLUDGE FODDER AVE...		32.5426	131.3199	37.5424	30.0275	1.4403	1.7809	0.2592	0.3913	0.6541	0.0685	0.0738	0.0088	0.0052	0.0102	0.0283	191.03
STD...		5.9322	33.8243	5.6372	3.8845	0.2539	0.2493	0.0810	0.0652	0.2364	0.0074	0.0088	0.0027	0.0006	0.0011	0.0042	26.45
MIN...		24.4192	99.6189	27.3433	25.7874	1.0280	1.3888	0.1498	0.2971	0.4010	0.0567	0.0617	0.0054	0.0043	0.0088	0.0226	151.12
MAX...		41.6209	181.1842	44.3418	37.8825	1.7113	2.0756	0.3789	0.5089	1.0162	0.0790	0.0858	0.0127	0.0061	0.0118	0.0336	222.17
N...		6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	4.0000	6.00
- CONTROL -																	
G	4 1	20.3336	29.1264	0.2810	10.0542	0.0518	0.1720	0.0282	0.0556	0.1496	0.0254	0.0202	0.0014	0.0038	0.0048	0.0006	115.22
S	4 1	6.1807	94.3260	37.5137	25.5352	1.0439	1.2054	0.1294	0.7813	0.0957	0.0509	0.0515	0.0063	0.0007	0.0057	0.0080	73.13
C	4 1	0.2480	6.3650	0.0820	0.3581	0.0310	0.1038	0.0078	0.0112	0.0138	0.0176	0.0047	0.0006	0.0007	0.0007	0.0006	3.13
FODDER		26.7623	129.8174	37.8767	35.9475	1.1266	1.4813	0.1654	0.8481	0.2591	0.0939	0.0764	0.0082	0.0052	0.0112	0.0092	191.48
G	4 2	23.2099	33.2093	0.3441	11.6041	0.0384	0.2218	0.0248	0.0656	0.1835	0.0551	0.0240	0.0013	0.0042	0.0044	0.0009	126.09
S	4 2	5.7248	96.1505	38.3446	27.1582	0.7704	0.9589	0.1491	0.7343	0.1005	0.0501	0.0447	0.0054	0.0004	0.0032	0.0351	69.64
C	4 2	0.2827	7.9484	0.0914	0.3829	0.0270	0.0343	0.0050	0.0117	0.0180	0.0132	0.0037	0.0009	0.0007	0.0007	0.0013	3.55
FODDER		29.2174	137.3081	38.7801	39.1452	0.8358	1.2151	0.1789	0.8116	0.3020	0.1184	0.0724	0.0076	0.0053	0.0083	0.0372	199.30
G	4 4	23.6438	31.5578	0.3347	11.1952	0.0346	0.1755	0.0820	0.0590	0.1666	0.0199	0.0239	0.0012	0.0041	0.0043	0.0009	135.63
S	4 4	6.3050	98.2654	37.6668	26.3497	0.8135	1.1368	0.3227	0.5124	0.1199	0.0385	0.0478	0.0040	0.0006	0.0112	0.0166	69.15
C	4 4	0.2383	7.4593	0.0763	0.3628	0.0276	0.0354	0.0043	0.0096	0.0224	0.0147	0.0034	0.0008	0.0007	0.0007	0.0010	3.16
FODDER		30.1872	137.2825	38.0778	37.9077	0.8758	1.3476	0.4089	0.5811	0.3089	0.0731	0.0752	0.0060	0.0054	0.0162	0.0186	207.95
TERRACE MEAN...		19.8015	91.5302	25.6193	25.6843	0.5705	0.8542	0.1960	0.4642	0.2037	0.0638	0.0492	0.0045	0.0036	0.0082	0.0186	135.75
CONTROL FODDER AVE...		28.7223	134.8027	38.2448	37.6668	0.9461	1.3480	0.2511	0.7469	0.2900	0.0951	0.0747	0.0073	0.0053	0.0119	0.0217	199.57
STD...		1.4414	3.5251	0.3873	1.3165	0.1287	0.1087	0.1118	0.1182	0.0220	0.0185	0.0017	0.0009	0.0001	0.0033	0.0116	6.72
MIN...		26.7623	129.8174	37.8767	35.9475	0.8358	1.2151	0.1654	0.5811	0.2591	0.0731	0.0724	0.0060	0.0052	0.0083	0.0092	191.48
MAX...		30.1872	137.3081	38.7801	39.1452	1.1266	1.4813	0.4089	0.8481	0.3089	0.1184	0.0764	0.0082	0.0054	0.0162	0.0372	207.95
N...		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.00

-- 1983 MEANS - TISSUE	TREATMENT	ELEMENTS REMOVED P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
		(kg/ha) ====>>>>>															
GRAIN	SLUDGE	24.6215	30.7733	0.3059	11.2558	0.0371	0.1913	0.0626	0.0540	0.2341	0.0167	0.0239	0.0019	0.0038	0.0042	0.0006	126.21
STOVER	SLUDGE	7.6482	94.6017	37.1340	18.3416	1.3830	1.5585	0.1850	0.3284	0.3613	0.0409	0.0470	0.0063	0.0008	0.0053	0.0270	61.80
COB	SLUDGE	0.2729	5.9449	0.1026	0.4300	0.0203	0.0311	0.0115	0.0089	0.0587	0.0109	0.0029	0.0006	0.0006	0.0006	0.0007	3.00
FODDER	SLUDGE	32.5426	131.3199	37.5424	30.0275	1.4403	1.7809	0.2592	0.3913	0.6541	0.0685	0.0738	0.0088	0.0052	0.0102	0.0283	191.03
GRAIN	CONTROL	22.3958	31.2978	0.3199	10.9512	0.0416	0.1898	0.0450	0.0601	0.1666	0.0335	0.0227	0.0013	0.0040	0.0045	0.0008	125.64
STOVER	CONTROL	6.0702	96.2473	37.8417	26.3477	0.8759	1.1004	0.2004	0.6760	0.1054	0.0465	0.0480	0.0052	0.0006	0.0067	0.0199	70.64
COB	CONTROL	0.2564	7.2576	0.0832	0.3679	0.0285	0.0578	0.0057	0.0108	0.0181	0.0152	0.0039	0.0008	0.0007	0.0007	0.0010	3.28
FODDER	CONTROL	28.7223	134.8027	38.2448	37.6668	0.9461	1.3480	0.2511	0.7469	0.2900	0.0951	0.0747	0.0073	0.0053	0.0119	0.0217	199.57

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1984 TISSUE	ID	ELEMENTS REMOVED P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	CR	PB	N
		(kg/ha) ===>>>															
G	3 6	32.1994	38.0115	0.2720	13.1837	0.0342	0.1905	0.0429	0.0478	0.2178	0.0392	0.0327	0.0012	0.0047	0.0012	0.0010	138.50
S		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C	3 6	0.7448	4.3454	0.0841	0.3348	0.0273	0.0235	0.0009	0.0058	0.0471	0.0128	0.0029	0.0004	0.0028	0.0005	0.0002	3.50
FODDER		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G	3 9	24.4152	30.8089	0.2658	10.1482	0.0256	0.1574	0.0285	0.0356	0.1703	0.0256	0.0281	0.0010	0.0036	0.0009	0.0007	107.09
S	3 9	15.5088	101.2534	31.3067	22.3834	0.4044	0.5959	0.6184	0.2399	0.3639	0.0611	0.0667	0.0021	0.0016	0.0053	0.0070	75.36
C	3 9	0.7892	4.4870	0.0858	0.3070	0.0212	0.0207	0.0021	0.0049	0.0410	0.0108	0.0028	0.0005	0.0021	0.0004	0.0001	2.83
FODDER		40.7133	136.5494	31.6582	32.8386	0.4512	0.7740	0.6489	0.2804	0.5752	0.0975	0.0976	0.0036	0.0073	0.0066	0.0078	185.29
G	3 10	23.3039	29.7904	0.2655	9.7917	0.0221	0.1345	0.0237	0.0340	0.1291	0.0641	0.0231	0.0010	0.0035	0.0008	0.0009	107.85
S	3 10	12.6735	72.9567	25.8853	24.8086	0.7701	0.7126	0.5879	0.1931	0.1940	0.0840	0.0583	0.0031	0.0017	0.0050	0.0039	62.03
C	3 10	0.4644	3.4173	0.0738	0.3017	0.0280	0.0238	0.0016	0.0045	0.0170	0.0112	0.0025	0.0005	0.0025	0.0004	0.0001	3.18
FODDER		36.4418	106.1644	26.2245	34.9020	0.8201	0.8709	0.6132	0.2316	0.3402	0.1593	0.0840	0.0046	0.0078	0.0062	0.0050	173.06
	TERRACE MEAN...	38.5775	121.3569	28.9414	33.8703	0.6357	0.8225	0.6311	0.2560	0.4577	0.1284	0.0908	0.0041	0.0075	0.0064	0.0064	179.17
G	4 6	29.5595	36.2000	0.2716	11.9456	0.0252	0.1778	0.0299	0.0406	0.2032	0.0482	0.0300	0.0017	0.0040	0.0012	0.0010	143.14
S	4 6	22.4743	168.6016	38.3744	22.0244	0.5015	0.6958	0.4261	0.2350	0.4271	0.0901	0.0999	0.0016	0.0020	0.0064	0.0037	93.72
C	4 6	0.7166	3.6737	0.0982	0.3155	0.1054	0.0335	0.0029	0.0060	0.0502	0.0174	0.0029	0.0006	0.0032	0.0005	0.0002	3.93
FODDER		52.7505	208.4753	38.7442	34.2854	0.6321	0.9071	0.4589	0.2817	0.6805	0.1557	0.1329	0.0038	0.0092	0.0081	0.0049	240.80
G	4 11	30.0397	35.6503	0.2942	12.9278	0.0291	0.1930	0.0360	0.0495	0.2260	0.0524	0.0326	0.0019	0.0045	0.0008	0.0012	141.21
S	4 11	13.8919	95.1331	37.4610	26.9834	0.4085	0.5984	0.0786	0.2931	0.6011	0.0778	0.0914	0.0020	0.0016	0.0052	0.0034	76.93
C	4 11	0.4963	2.8057	0.1019	0.3406	0.0234	0.0237	0.0021	0.0054	0.0485	0.0108	0.0028	0.0002	0.0036	0.0004	0.0001	3.91
FODDER		44.4280	133.5891	37.8572	40.2518	0.4610	0.8150	0.1168	0.3480	0.8755	0.1410	0.1267	0.0041	0.0097	0.0065	0.0048	222.05
	TERRACE MEAN...	48.5892	171.0322	38.3007	37.2686	0.5465	0.8610	0.2878	0.3148	0.7780	0.1483	0.1298	0.0040	0.0095	0.0073	0.0048	231.43
G	5 2	27.5048	33.5634	0.3445	11.6239	0.0322	0.1734	0.0338	0.0524	0.2836	0.0920	0.0227	0.0066	0.0039	0.0013	0.0029	124.05
S	5 2	10.9889	64.7079	32.2664	20.5341	0.3855	0.5526	0.2979	0.2112	0.2251	0.0572	0.0484	0.0016	0.0016	0.0052	NA	47.90
C	5 2	0.2866	4.1210	0.0590	0.2356	0.0258	0.0210	0.0035	0.0055	0.0359	0.0110	0.0023	0.0004	0.0032	0.0006	0.0001	2.54
FODDER		38.7803	102.3923	32.6699	32.3936	0.4435	0.7470	0.3352	0.2692	0.5446	0.1602	0.0734	0.0086	0.0088	0.0071	NA	174.50
G	5 3	19.5244	22.7951	0.2080	8.8149	0.0227	0.1326	0.0195	0.0365	0.1711	0.0317	0.0178	0.0015	0.0035	0.0006	0.0015	98.40
S	5 3	6.9317	56.9031	28.5761	21.2382	0.6291	0.7606	0.0358	0.1902	0.1988	0.0483	0.0464	0.0037	0.0017	0.0101	0.0030	33.81
C	5 3	0.2113	2.4211	0.0631	0.3228	0.0212	0.0213	0.0051	0.0046	0.0294	0.0102	0.0021	0.0004	0.0025	0.0004	0.0001	2.16
FODDER		26.6673	82.1193	28.8471	30.3759	0.6729	0.9146	0.0603	0.2313	0.3992	0.0902	0.0663	0.0056	0.0076	0.0111	0.0046	134.38
G	5 6	26.3380	30.0374	0.2357	11.1015	0.0212	0.1468	0.0224	0.0480	0.1859	0.0318	0.0222	0.0012	0.0044	0.0007	0.0017	125.06
S	5 6	6.6323	65.9535	20.6051	14.9710	0.3556	0.4248	0.0532	0.1180	0.1059	0.0338	0.0423	0.0008	0.0008	0.0044	0.0017	33.42
C	5 6	0.3119	2.8808	0.0626	0.3435	0.0355	0.0182	0.0020	0.0052	0.0360	0.0088	0.0019	0.0007	0.0019	0.0005	0.0001	2.51
FODDER		33.2821	98.8717	20.9034	26.4160	0.4123	0.5897	0.0775	0.1712	0.3278	0.0744	0.0663	0.0027	0.0070	0.0057	0.0036	161.00
	TERRACE MEAN...	32.9099	94.4611	27.4735	29.7285	0.5096	0.7504	0.1577	0.1239	0.4239	0.1083	0.0687	0.0056	0.0078	0.0080	NA	156.63
G	6 2	19.2205	23.0264	0.2169	7.9200	0.0224	0.1215	0.0286	0.0330	0.1482	0.0357	0.0195	0.0013	0.0040	0.0006	0.0007	96.75
S	6 2	4.7681	71.1845	24.7104	20.2144	0.4144	0.4894	0.2195	0.1284	0.0912	0.0379	0.0399	0.0008	0.0009	0.0050	0.0015	35.64
C	6 2	0.2345	3.0528	0.0648	0.2968	0.0246	0.0196	0.0006	0.0045	0.0320	0.0094	0.0021	0.0005	0.0037	0.0005	0.0002	2.64
FODDER		24.2231	97.2637	24.9920	28.4312	0.4615	0.6306	0.2487	0.1659	0.2715	0.0830	0.0614	0.0026	0.0087	0.0061	0.0023	135.04
G	6 4	24.6497	28.8976	0.2746	10.9898	0.0279	0.1696	0.0366	0.0547	0.2080	0.0417	0.0211	0.0012	0.0046	0.0009	0.0017	115.03
S	6 4	6.6536	68.1371	31.3107	24.2354	0.5355	0.6319	0.0599	0.1972	0.2090	0.0516	0.0550	0.0009	0.0009	0.0074	0.0018	42.10
C	6 4	0.2357	3.5580	0.0503	0.2840	0.0192	0.0169	0.0006	0.0044	0.0252	0.0073	0.0018	0.0007	0.0018	0.0005	0.0004	2.46
FODDER		31.5390	100.5927	31.6356	35.5091	0.5826	0.8184	0.0971	0.2563	0.4421	0.1006	0.0779	0.0028	0.0074	0.0087	0.0039	159.60
G	6 5	27.2792	31.9539	0.2635	10.5582	0.0272	0.1470	0.0357	0.0441	0.1852	0.0560	0.0249	0.0013	0.0050	0.0008	0.0009	136.34
S	6 5	9.2100	90.8070	21.9877	13.6271	0.3734	0.4645	0.2520	0.1439	0.1101	0.0482	0.0535	0.0013	0.0009	0.0045	0.0012	46.09
C	6 5	0.2875	3.4285	0.0528	0.1806	0.0235	0.0201	0.0009	0.0045	0.0246	0.0086	0.0020	0.0005	0.0015	0.0006	0.0001	2.59
FODDER		36.7766	126.1894	22.3040	24.3660	0.4241	0.6315	0.2885	0.1925	0.3199	0.1128	0.0804	0.0032	0.0073	0.0059	0.0022	185.03
	TERRACE MEAN...	30.8462	108.0153	26.3106	29.4354	0.4894	0.6935	0.2114	0.2049	0.3445	0.0988	0.0733	0.0029	0.0078	0.0069	0.0028	159.89
G	7 2	30.5758	34.4604	0.3209	13.0635	0.0337	0.2005	0.0503	0.0631	0.2376	0.0576	0.0247	0.0015	0.0057	0.0008	0.0010	154.10
S	7 2	7.1368	96.2620	34.6947	22.7951	0.4982	0.6327	0.0868	0.2338	0.1659	0.0552	0.0562	0.0011	0.0011	0.0068	0.0033	60.32
C	7 2	0.3173	3.6529	0.0673	0.4029	0.0183	0.0167	0.0034	0.0066	0.0401	0.0078	0.0024	0.0003	0.0017	0.0005	0.0001	3.22
FODDER		38.0299	134.3754	35.0829	36.2614	0.5501	0.8499	0.1404	0.3035	0.4435	0.1206	0.0833	0.0028	0.0085	0.0080	0.0044	217.65
G	7 4	28.3313	31.3207	0.2778	11.8778	0.0263	0.1687	0.0398	0.0527	0.2295	0.0106	0.0243	0.0013	0.0058	0.0008	0.0017	131.34
S	7 4	9.7863	65.4180	41.7428	31.1016	0.5710	0.6337	0.3252	0.2005	0.2900	0.0476	0.0587	0.0020	0.0021	0.0075	0.0028	60.90
C	7 4	0.2839	3.0806	0.0717	0.3010	0.0205	0.0201	0.0022	0.0052	0.0479	0.0087	0.0022	0.0008	0.0013	0.0008	0.0001	2.61
FODDER		38.4015	99.8194	42.0923	43.2803	0.6178	0.8224	0.3672	0.2584	0.5675	0.0669	0.0852	0.0041	0.0092	0.0091	0.0046	194.86
G	7 6	27.8124	32.1170	0.2829	11.6020	0.0224	0.1692	0.0372	0.0512	0.2372	0.0173	0.0274	0.0013	0.0049	0.0012	0.0021	129.49
S	7 6	11.7095	92.8274	25.8310	15.2724	0.3753	0.4836	0.1407	0.2084	0.2014	0.0397	0.0536	0.0010	0.0021	0.0045	0.0017	61.85
C	7 6	0.4428	4.1876	0.0814	0.2762	0.0202	0.0265	0.0024	0.0062	0.0569	0.0093	0.0022	0.0004	0.0008	0.0006	0.0002	2.90
FODDER		39.9647	129.1320	26.1953	27.1506	0.4179	0.6793	0.1804	0.2658	0.4955	0.0662	0.0833	0.0027	0.0078	0.0063	0.0040	194.25
	TERRACE MEAN...	38.7987	121.1089	34.4569	35.5641	0.5286	0.7839	0.2293	0.2759	0.5022	0.0846	0.0839	0.0032	0.0085	0.0078	0.0043	202.25

Rosemount Terraces : Elements Removed by Corn

Continued from previous page

ROSEMOUNT WATERSHED CORN DATA 1984 TISSUE		ID	ELEMENTS REMOVED P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	CR	PB	N
			(kg/ha) ===>>>															
G		8 2	27.2075	33.2380	0.2744	11.0358	0.0208	0.1466	0.0177	0.0502	0.2194	0.0193	0.0254	0.0013	0.0050	0.0013	0.0008	129.71
S		8 2	10.5458	122.7635	30.3347	19.3609	0.4236	0.5845	0.1109	0.1980	0.2482	0.0542	0.0594	0.0011	0.0016	0.0052	0.0021	63.32
C		8 2	0.3388	3.3525	0.0686	0.2592	0.0249	0.0316	0.0023	0.0062	0.0386	0.0129	0.0021	0.0003	0.0009	0.0006	0.0002	2.57
FODDER			38.0921	159.3539	30.6777	30.6559	0.4694	0.7627	0.1308	0.2544	0.5062	0.0865	0.0870	0.0027	0.0075	0.0071	0.0031	195.62
G		8 4	25.4241	32.0590	0.2885	10.5135	0.5758	1.5102	0.0140	0.0945	0.2253	0.5157	0.0270	0.0060	0.0048	0.0019	0.0006	118.12
S		8 4	8.2881	75.7379	39.6553	21.7539	0.4696	0.5904	0.3237	0.2226	0.2909	0.0549	0.0614	0.0011	0.0021	0.0057	0.0016	68.27
C		8 4	0.2984	3.6418	0.0727	0.2420	0.0188	0.0191	0.0028	0.0052	0.0378	0.0079	0.0021	0.0003	0.0011	0.0006	0.0001	2.16
FODDER			34.0105	111.4387	40.0166	32.5094	1.0641	2.1197	0.3406	0.3223	0.5540	0.5786	0.0905	0.0074	0.0079	0.0081	0.0025	188.56
G		8 5	27.5463	33.0216	0.3061	11.9082	0.5060	1.1532	0.0179	0.0779	0.2284	0.4149	0.0275	0.0087	0.0049	0.0020	0.0009	128.38
S		8 5	11.6497	95.2766	41.9564	30.0953	0.4914	0.6789	0.8060	0.2076	0.2249	0.0505	0.0650	0.0013	0.0015	0.0058	0.0018	74.74
C		8 5	0.2461	3.4828	0.0697	0.2474	0.0184	0.0155	0.0027	0.0056	0.0358	0.0063	0.0021	0.0004	0.0008	0.0006	0.0001	2.39
FODDER			39.4422	131.7811	42.3321	42.2510	1.0158	1.8476	0.8267	0.2911	0.4891	0.4717	0.0946	0.0104	0.0072	0.0084	0.0028	205.52
	TERRACE MEAN...		37.1816	134.1912	37.6755	35.1388	0.8498	1.5766	0.4327	0.2893	0.5164	0.3789	0.0907	0.0068	0.0075	0.0079	0.0028	196.57
SLUDGE	FODDER	AVE...	37.0964	122.3817	32.0146	33.2424	0.5935	0.9238	0.3082	0.2577	0.4895	0.1603	0.0869	0.0045	0.0081	0.0074	0.0040	185.45
		STD...	6.4323	29.5471	6.6514	5.3099	0.2011	0.4144	0.2210	0.0490	0.1466	0.1425	0.0189	0.0023	0.0008	0.0014	0.0014	28.29
		MIN...	24.2231	82.1193	20.9034	24.3660	0.4123	0.5897	0.0603	0.1659	0.2715	0.0662	0.0614	0.0026	0.0070	0.0057	0.0022	134.38
		MAX...	52.7505	208.4753	42.3321	43.2803	1.0641	2.1197	0.8267	0.3480	0.8755	0.5786	0.1329	0.0104	0.0097	0.0111	0.0078	240.80
		N...	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	16.0000	15.0000	16.00
G		3 1	21.7185	30.6720	0.2819	9.6490	0.0961	0.2586	0.0267	0.0442	0.1486	0.0787	0.0262	0.0029	0.0028	0.0010	0.0017	120.42
S		3 1	5.0993	118.7625	23.5004	19.3603	0.3690	0.4820	0.7041	0.6861	0.1216	0.0723	0.0592	0.0017	0.0013	0.0035	0.0042	59.57
C		3 1	0.4943	5.1047	0.0888	0.2889	0.0821	0.0465	0.0022	0.0069	0.0213	0.0229	0.0037	0.0006	0.0045	0.0006	0.0002	3.45
FODDER			27.3121	154.5392	23.8712	29.2982	0.5473	0.7872	0.7330	0.7373	0.2915	0.1738	0.0891	0.0052	0.0086	0.0051	0.0061	183.45
G		3 2	23.1405	32.0500	0.2715	10.4356	0.0424	0.2023	0.0228	0.0452	0.1669	0.0508	0.0284	0.0043	0.0026	0.0012	0.0018	118.69
S		3 2	6.5841	133.6996	27.0604	20.0103	0.4352	0.5807	0.5989	0.6620	0.1534	0.0930	0.0725	0.0010	0.0013	0.0039	0.0051	73.44
C		3 2	0.3933	4.8668	0.0826	0.2701	0.0240	0.0269	0.0024	0.0057	0.0209	0.0116	0.0030	0.0004	0.0035	0.0004	0.0001	3.25
FODDER			30.1180	170.6164	27.4145	30.7160	0.5016	0.8098	0.6241	0.7130	0.3412	0.1554	0.1040	0.0058	0.0074	0.0055	0.0071	195.39
G		3 4	24.9745	32.2243	0.2511	10.9576	0.0351	0.1952	0.0293	0.0445	0.1704	0.0388	0.0301	0.0035	0.0032	0.0010	0.0008	115.81
S		3 4	8.8316	126.0826	27.9759	20.6415	0.3664	0.5348	0.7765	0.4446	0.1389	0.0728	0.0652	0.0012	0.0012	0.0035	0.0033	74.77
C		3 4	0.4985	4.9950	0.0788	0.2421	0.0326	0.0279	0.0019	0.0072	0.0218	0.0143	0.0033	0.0003	0.0043	0.0005	0.0002	3.40
FODDER			34.3046	163.3019	28.3059	31.8412	0.4342	0.7579	0.8077	0.4963	0.3311	0.1258	0.0986	0.0050	0.0087	0.0050	0.0043	193.99
	TERRACE MEAN...		30.5782	162.8192	26.5305	30.6184	0.4944	0.7850	0.7216	0.6488	0.3213	0.1517	0.0972	0.0053	0.0082	0.0052	0.0058	190.94
G		4 1	16.4295	23.3500	0.2309	8.8509	0.0287	0.1689	0.0283	0.0409	0.1297	0.0400	0.0183	0.0032	0.0033	0.0009	0.0012	99.81
S		4 1	5.1204	84.0572	31.8975	27.7080	0.4667	0.6521	0.4241	0.7311	0.1014	0.0768	0.0461	0.0028	0.0012	0.0033	0.0049	69.93
C		4 1	0.3203	4.0114	0.1051	0.3315	0.0230	0.0363	0.0017	0.0077	0.0171	0.0161	0.0028	0.0005	0.0026	0.0004	0.0001	2.59
FODDER			21.8702	111.4186	32.2336	36.8904	0.5185	0.8572	0.4541	0.7798	0.2481	0.1329	0.0672	0.0065	0.0072	0.0046	0.0062	172.34
G		4 2	20.5350	28.2132	0.2399	10.1783	0.0255	0.1615	0.0431	0.0492	0.1332	0.0282	0.0217	0.0042	0.0033	0.0011	0.0007	113.43
S		4 2	4.4347	80.9047	19.9759	16.4309	0.2806	0.4107	0.4855	0.4649	0.0933	0.0599	0.0361	0.0008	0.0023	0.0025	0.0032	49.88
C		4 2	0.3460	3.9290	0.1139	0.2963	0.0279	0.0229	0.0015	0.0091	0.0183	0.0133	0.0030	0.0007	0.0026	0.0004	0.0001	2.71
FODDER			25.3158	113.0469	20.3297	26.9055	0.3340	0.5951	0.5301	0.5232	0.2448	0.1014	0.0608	0.0057	0.0083	0.0040	0.0040	166.03
G		4 4	19.6534	28.0743	0.2589	9.5804	0.0285	0.1590	0.0460	0.0312	0.1284	0.0354	0.0224	0.0011	0.0033	0.0010	0.0015	104.52
S		4 4	5.8115	76.7064	32.1958	29.1893	0.4536	0.6080	0.3670	0.3130	0.1464	0.0764	0.0472	0.0011	0.0011	0.0036	0.0042	68.30
C		4 4	0.3745	5.6895	0.0978	0.2811	0.0257	0.0243	0.0009	0.0058	0.0178	0.0137	0.0032	0.0003	0.0032	0.0005	0.0001	3.08
FODDER			25.8394	110.4703	32.5526	39.0508	0.5078	0.7913	0.4138	0.3499	0.2926	0.1255	0.0727	0.0025	0.0075	0.0050	0.0058	175.91
	TERRACE MEAN...		24.3418	111.6453	28.3720	34.2822	0.4534	0.7479	0.4660	0.5510	0.2618	0.1199	0.0669	0.0049	0.0077	0.0045	0.0054	171.43
CONTROL	FODDER	AVE...	27.4600	137.2322	27.4512	32.4503	0.4739	0.7664	0.5938	0.5999	0.2916	0.1358	0.0821	0.0051	0.0079	0.0049	0.0056	181.18
		STD...	3.9244	26.0165	4.3428	4.2297	0.0712	0.0823	0.1426	0.1544	0.0368	0.0232	0.0161	0.0013	0.0006	0.0005	0.0011	10.85
		MIN...	21.8702	110.4703	20.3297	26.9055	0.3340	0.5951	0.4138	0.3499	0.2448	0.1014	0.0608	0.0025	0.0072	0.0040	0.0040	166.03
		MAX...	34.3046	170.6164	32.5526	39.0508	0.5473	0.8572	0.8077	0.7798	0.3412	0.1738	0.1040	0.0065	0.0087	0.0055	0.0071	195.39
		N...	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.00
- - - -	1984 MEANS - - - -																	
GRAIN	SLUDGE		26.5254	31.5854	0.2743	11.1180	0.0868	0.2996	0.0303	0.0509	0.2062	0.0914	0.0254	0.0024	0.0045	0.0010	0.0013	124.97
STOVER	SLUDGE		10.5531	87.7452	31.6687	21.9624	0.4754	0.5956	0.2764	0.2013	0.2467	0.0558	0.0598	0.0016	0.0015	0.0059	0.0027	58.53
COB	SLUDGE		0.3945	3.5053	0.0722	0.2936	0.0280	0.0219	0.0022	0.0053	0.0379	0.0101	0.0023	0.0005	0.0021	0.0005	0.0002	2.83
FODDER	SLUDGE		37.0964	122.3817	32.0146	33.2424	0.5935	0.9238	0.3082	0.2577	0.4895	0.1603	0.0869	0.0045	0.0081	0.0074	0.0040	185.45
GRAIN	CONTROL		21.0752	29.0973	0.2557	9.9420	0.0427	0.1909	0.0327	0.0426	0.1462	0.0453	0.0245	0.0032	0.0031	0.0010	0.0013	112.11
STOVER	CONTROL		5.9803	103.3688	27.1010	22.2234	0.3953	0.5447	0.5593	0.5503	0.1258	0.0752	0.0544	0.0014	0.0014	0.0034	0.0042	65.98
COB	CONTROL		0.4045	4.7661	0.0945	0.2850	0.0359	0.0308	0.0017	0.0071	0.0195	0.0153	0.0032	0.0005	0.0034	0.0005	0.0002	3.08
FODDER	CONTROL		27.4600	137.2322	27.4512	32.4503	0.4739	0.7664	0.5938	0.5999	0.2916	0.1358	0.0821	0.0051	0.0079	0.0049	0.0056	181.18

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1985 TISSUE	ID	ELEMENTS REMOVED P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	CR	PB	N
- SLUDGE TREATMENT -		(kg/ha)	=====>>>>>														
GRAIN	3 6	23.2421	29.9956	0.4275	11.1525	0.2352	0.4188	0.0038	0.0633	0.2743	0.1093	0.0188	0.0013	0.0024	0.0012	0.0028	135.93
STOVER	3 6	10.0796	85.9665	40.3591	22.9904	1.2568	1.2830	0.1210	0.2694	0.5776	0.0532	0.0329	0.0026	0.0016	0.0315	0.0023	52.00
COB	3 6	0.3282	7.0693	0.0970	0.4001	0.0156	0.0227	0.0081	0.0094	0.1120	0.0091	0.0028	0.0007	0.0020	0.0008	0.0005	3.23
FODDER		33.6499	123.0314	40.8836	34.5430	1.5076	1.7246	0.1328	0.3421	0.9640	0.1716	0.0544	0.0045	0.0060	0.0335	0.0056	191.17
G	3 9	24.0003	27.9156	0.3407	11.3958	0.0548	0.1994	0.0034	0.0596	0.3326	0.0233	0.0189	0.0020	0.0028	0.0011	0.0025	126.93
S	3 9	11.9474	97.3782	36.5083	21.3847	0.8923	0.9717	0.1019	0.2869	0.8008	0.0605	0.0314	0.0011	0.0018	0.0151	0.0029	60.85
C	3 9	0.3756	6.4462	0.0853	0.3775	0.0133	0.0156	0.0072	0.0094	0.1289	0.0078	0.0027	0.0006	0.0017	0.0005	0.0004	3.64
FODDER		36.3233	131.7399	36.9343	33.1579	0.9604	1.1867	0.1126	0.3558	1.2623	0.0917	0.0530	0.0037	0.0063	0.0167	0.0058	191.42
G	3 10	29.0728	35.2974	0.4591	13.3627	0.0650	0.2530	0.0042	0.0620	0.3144	0.0273	0.0242	0.0014	0.0030	0.0014	0.0032	149.25
S	3 10	7.7909	70.6277	45.5771	30.8786	1.1679	1.2814	1.3721	0.2250	0.3771	0.0742	0.0364	0.0017	0.0013	0.0279	0.0025	64.28
C	3 10	0.2709	9.3175	0.0969	0.2427	0.0254	0.0750	0.0084	0.0085	0.0677	0.0146	0.0037	0.0009	0.0024	0.0012	0.0006	3.74
FODDER		37.1346	115.2426	46.1331	44.4839	1.2583	1.6094	1.3847	0.2956	0.7592	0.1162	0.0643	0.0039	0.0067	0.0305	0.0062	217.28
TERRACE MEAN...		35.7026	123.3380	41.3170	37.3949	1.2421	1.5069	0.5434	0.3312	0.9952	0.1265	0.0572	0.0040	0.0063	0.0269	0.0059	199.96
G	4 6	27.5630	33.2387	0.3847	12.5131	0.0575	0.2249	0.0214	0.0691	0.3353	0.0210	0.0195	0.0029	0.0023	0.0007	0.0029	132.14
S	4 6	6.7239	94.7223	34.2548	19.0506	0.7856	0.8491	0.0664	0.3697	0.5659	0.0471	0.0263	0.0009	0.0015	0.0096	0.0028	46.94
C	4 6	0.2722	8.1884	0.0976	0.3662	0.0200	0.0578	0.0096	0.0111	0.1035	0.0108	0.0032	0.0010	0.0021	0.0011	0.0005	3.04
FODDER		34.5590	136.1494	34.7371	31.9299	0.8631	1.1318	0.0975	0.4499	1.0047	0.0789	0.0490	0.0049	0.0059	0.0114	0.0061	182.13
G	4 9	29.3204	35.5283	0.4514	13.2422	0.0632	0.2223	0.0554	0.0542	0.3240	0.0222	0.0261	0.0050	0.0020	0.0007	0.0032	145.33
S	4 9	10.0204	87.4908	40.5525	27.4096	0.8988	0.9981	0.0667	0.1899	0.4312	0.0544	0.0350	0.0017	0.0019	0.0132	0.0024	60.73
C	4 9	0.2436	9.4160	0.1062	0.2640	0.0242	0.0314	0.0078	0.0082	0.0790	0.0125	0.0036	0.0013	0.0023	0.0013	0.0005	3.19
FODDER		39.5844	132.4351	41.1101	40.9158	0.9862	1.2518	0.1299	0.2523	0.8341	0.0891	0.0647	0.0079	0.0062	0.0152	0.0062	209.26
G	4 11	27.5566	33.7134	0.4912	12.5312	0.0593	0.2134	0.0406	0.0613	0.2548	0.0223	0.0252	0.0026	0.0017	0.0007	0.0032	141.82
S	4 11	8.5795	83.4082	42.0933	33.7033	1.1958	1.3491	0.0940	0.4681	0.2326	0.0716	0.0414	0.0011	0.0019	0.0155	0.0035	58.60
C	4 11	0.2659	8.7961	0.0886	0.2723	0.0247	0.0448	0.0080	0.0092	0.0437	0.0146	0.0033	0.0011	0.0024	0.0013	0.0006	4.02
FODDER		36.4020	125.9177	42.6731	46.5068	1.2798	1.6073	0.1426	0.5386	0.5312	0.1085	0.0700	0.0048	0.0061	0.0176	0.0073	204.45
TERRACE MEAN...		36.8485	131.5007	39.5068	39.7842	1.0430	1.3303	0.1233	0.4136	0.7900	0.0921	0.0613	0.0059	0.0061	0.0147	0.0065	198.61
G	5 2	18.6791	23.4072	0.3377	9.3333	0.0420	0.1588	0.0385	0.0476	0.1671	0.0181	0.0157	0.0016	0.0018	0.0006	0.0024	104.48
S	5 2	3.5761	41.6885	35.7138	21.7212	1.6776	2.3842	0.0818	0.3811	0.1110	0.0837	0.0268	0.0020	0.0018	0.0266	0.0056	37.61
C	5 2	0.2081	5.7942	0.0842	0.3318	0.0594	0.0156	0.0059	0.0069	0.0188	0.0069	0.0021	0.0005	0.0015	0.0006	0.0006	3.37
FODDER		22.4634	70.8898	36.1357	31.3863	1.7789	2.5586	0.1262	0.4356	0.2969	0.1086	0.0447	0.0041	0.0051	0.0277	0.0086	145.47
G	5 3	21.1719	25.3912	0.3447	10.6289	0.0429	0.1770	0.0374	0.0537	0.2218	0.0189	0.0177	0.0020	0.0020	0.0006	0.0025	112.00
S	5 3	3.2837	64.8650	33.1788	23.6311	1.4364	1.7140	0.1077	0.2548	0.1864	0.0830	0.0282	0.0013	0.0013	0.0157	0.0022	36.02
C	5 3	0.2200	5.4665	0.0889	0.4644	0.0113	0.0173	0.0056	0.0083	0.0414	0.0077	0.0021	0.0005	0.0014	0.0006	0.0004	3.12
FODDER		24.6757	95.7227	33.6125	34.7244	1.4905	1.9083	0.1507	0.3168	0.4496	0.1095	0.0480	0.0037	0.0047	0.0169	0.0051	151.15
G	5 6	25.8207	31.6822	0.3393	12.7438	0.0658	0.2151	0.0371	0.0648	0.2784	0.0222	0.0205	0.0023	0.0027	0.0007	0.0030	128.62
S	5 6	6.5551	96.2512	35.1876	21.8585	1.9966	1.4420	0.2648	0.2501	0.2038	0.0832	0.0302	0.0009	0.0018	0.0193	0.0052	55.32
C	5 6	0.2333	7.8699	0.1034	0.4091	0.0131	0.0174	0.0060	0.0099	0.0547	0.0077	0.0027	0.0005	0.0018	0.0006	0.0005	3.32
FODDER		32.6091	135.8033	35.6304	35.0114	2.0754	1.6745	0.3079	0.3249	0.5369	0.1131	0.0534	0.0038	0.0063	0.0205	0.0087	187.27
TERRACE MEAN...		26.5827	100.8053	35.1262	33.7074	1.7816	2.0471	0.1949	0.3591	0.4278	0.1104	0.0487	0.0039	0.0053	0.0217	0.0075	161.30
G	6 2	20.8358	24.0918	0.3020	10.1872	0.0491	0.1524	0.0304	0.0556	0.2221	0.0158	0.0158	0.0023	0.0021	0.0009	0.0024	115.20
S	6 2	10.5098	61.9423	32.9589	28.2694	1.2679	1.6174	0.1139	0.2210	0.3466	0.1185	0.0334	0.0017	0.0027	0.0156	0.0050	63.08
C	6 2	0.2715	4.7997	0.1140	0.6307	0.0102	0.0112	0.0057	0.0093	0.0523	0.0061	0.0021	0.0003	0.0015	0.0004	0.0004	3.10
FODDER		31.6171	90.8339	33.3750	39.0873	1.3272	1.7810	0.1499	0.2859	0.6210	0.1404	0.0513	0.0044	0.0063	0.0169	0.0079	181.39
G	6 4	17.5284	21.1959	0.3104	8.7814	0.0388	0.1337	0.0336	0.0463	0.1646	0.0145	0.0149	0.0018	0.0016	0.0007	0.0020	88.06
S	6 4	6.0895	45.1772	29.7696	19.4683	0.9087	1.1264	0.0716	0.2247	0.1597	0.0724	0.0220	0.0013	0.0012	0.0161	0.0037	44.16
C	6 4	0.1559	4.6275	0.0583	0.2612	0.0088	0.0137	0.0045	0.0059	0.0231	0.0056	0.0016	0.0003	0.0013	0.0005	0.0003	2.26
FODDER		23.7739	71.0007	30.1383	28.5109	0.9563	1.2738	0.1096	0.2768	0.3474	0.0926	0.0385	0.0034	0.0042	0.0173	0.0060	134.49
G	6 5	31.6583	36.7529	0.4064	14.4475	0.0654	0.2325	0.0602	0.0679	0.2712	0.0218	0.0278	0.0045	0.0028	0.0009	0.0045	168.75
S	6 5	5.5297	97.0477	43.2615	23.1977	1.3357	1.5443	0.1273	0.2702	0.1601	0.0739	0.0317	0.0014	0.0016	0.0196	0.0056	48.85
C	6 5	0.2676	9.1306	0.0927	0.3313	0.0141	0.0250	0.0086	0.0092	0.0347	0.0085	0.0032	0.0007	0.0026	0.0008	0.0006	4.02
FODDER		37.4556	142.9312	43.7605	37.9765	1.4152	1.8018	0.1961	0.3473	0.4659	0.1043	0.0627	0.0066	0.0069	0.0212	0.0107	221.62
TERRACE MEAN...		30.9489	101.5886	35.7580	35.1916	1.2329	1.6189	0.1519	0.3033	0.4781	0.1124	0.0508	0.0048	0.0058	0.0185	0.0082	179.17
G	7 2	22.8418	28.3086	0.3418	10.9612	0.0464	0.1656	0.0338	0.0514	0.2289	0.0152	0.0191	0.0025	0.0023	0.0018	0.0027	120.32
S	7 2	7.3868	82.4445	34.6223	25.7572	1.4801	1.5951	0.1229	0.2295	0.2779	0.0767	0.0281	0.0021	0.0012	0.0297	0.0045	46.14
C	7 2	0.1952	6.6438	0.0797	0.3052	0.0136	0.0174	0.0058	0.0082	0.0463	0.0071	0.0022	0.0004	0.0016	0.0007	0.0004	2.67
FODDER		30.4238	117.3969	35.0438	37.0237	1.5401	1.7782	0.1625	0.2892	0.5531	0.0990	0.0495	0.0050	0.0051	0.0322	0.0076	169.14
G	7 4	24.1648	27.9739	0.3553	11.4220	0.0655	0.1823	0.0424	0.0592	0.2711	0.0142	0.0185	0.0031	0.0020	0.0008	0.0026	121.85
S	7 4	7.1179	68.0298	41.6974	26.6658	1.3112	1.3763	0.0752	0.3805	0.4504	0.0599	0.0332	0.0020	0.0015	0.0196	0.0035	48.51
C	7 4	0.2181	6.0504	0.0847	0.3875	0.0116	0.0142	0.0087	0.0086	0.0670	0.0062	0.0021	0.0004	0.0016	0.0006	0.0004	2.911
FODDER		31.5008	102.0541	42.1374	38.4753	1.3883	1.5727	0.1263	0.4483	0.7885	0.0803	0.0539	0.0055	0.0051	0.0209	0.0066	173.28
G	7 6	28.1136	32.5235	0.3300	13.2663	0.0674	0.2278	0.0455	0.0613	0.2874	0.0167	0.0202	0.0030	0.0023	0.0017	0.0030	141.13
S	7 6	6.5490	81.4040	44.2667	25.9469	1.4916	1.5825	0.0788	0.3708	0.3244	0.0989	0.0356	0.0021	0.0014	0.0229	0.0049	58.63
C	7 6	0.2321	7.6461	0.0766	0.3530	0.0116	0.0160	0.0091	0.0079	0.0545	0.0069	0.0025	0.0003	0.0021	0.0007	0.0005	3.30
FODDER		34.8947	121.5737	44.6733	39.5661	1.5706	1.8264	0.1335	0.4399	0.6664	0.1226	0.0583	0.0054	0.0057	0.0253	0.0085	203.07
TERRACE MEAN...		32.2731	113.6749	40.6182	38.3550	1.4997	1.7258	0.1408	0.3925	0.6693	0.1006	0.0539	0.0053	0.0053	0.0261	0.0075	181.83

Rosemount Terraces : Elements Removed by Corn

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ROSEMOUNT WATERSHED CORN DATA 1985 TISSUE	ID	ELEMENTS REMOVED P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	CR	PB	N
		(kg/ha) =====>>>>>															
G	8 2	26.3843	33.1503	0.3982	12.6496	0.0620	0.2003	0.0427	0.0543	0.2531	0.0107	0.0219	0.0021	0.0028	0.0010	0.0031	136.33
S	8 2	5.5378	117.3511	37.7687	16.0607	1.7422	1.9495	0.1081	0.2980	0.2569	0.0878	0.0317	0.0027	0.0015	0.0317	0.0041	55.19
C	8 2	0.2223	9.0970	0.0810	0.2850	0.0171	0.0236	0.0087	0.0083	0.0414	0.0092	0.0025	0.0007	0.0020	0.0008	0.0005	2.85
FODDER		32.1445	159.5985	38.2480	28.9954	1.8213	2.1735	0.1594	0.3606	0.5515	0.1077	0.0560	0.0055	0.0063	0.0334	0.0077	194.38
G	8 4	26.1656	32.5023	0.4436	12.4794	0.0643	0.2158	0.0562	0.0610	0.2605	0.0237	0.0222	0.0029	0.0028	0.0015	0.0031	131.36
S	8 4	8.0626	83.2084	46.2548	29.8430	2.4374	2.6109	0.0966	0.3522	0.3765	0.1067	0.0363	0.0033	0.0021	0.0505	0.0084	66.94
C	8 4	0.2190	8.7055	0.0818	0.2597	0.0176	0.0263	0.0074	0.0078	0.0417	0.0096	0.0025	0.0006	0.0020	0.0009	0.0005	2.82
FODDER		34.4473	124.4163	46.7802	42.5821	2.5193	2.8530	0.1602	0.4209	0.6788	0.1400	0.0610	0.0068	0.0068	0.0529	0.0120	201.13
G	8 5	32.2074	37.8084	0.4135	15.6126	0.0639	0.2488	0.0619	0.0767	0.3354	0.0188	0.0238	0.0052	0.0044	0.0024	0.0035	155.19
S	8 5	6.7281	84.6280	36.1045	19.5338	2.0810	2.3184	0.0747	0.3325	0.3619	0.1182	0.0287	0.0025	0.0025	0.0497	0.0094	45.74
C	8 5	0.2569	8.2032	0.1228	0.5082	0.0195	0.0264	0.0068	0.0100	0.0605	0.0097	0.0031	0.0007	0.0022	0.0011	0.0007	3.86
FODDER		39.1923	130.6396	36.6408	35.6545	2.1644	2.5937	0.1434	0.4192	0.7577	0.1467	0.0556	0.0084	0.0092	0.0531	0.0136	204.80
TERRACE MEAN...		35.2613	138.2181	40.5563	35.7440	2.1683	2.5400	0.1543	0.4002	0.6627	0.1315	0.0575	0.0069	0.0074	0.0465	0.0111	200.10
G	3 1	13.0272	22.3442	0.5025	7.3776	0.1034	0.2335	0.0028	0.0558	0.1454	0.0611	0.0162	0.0018	0.0008	0.0012	0.0021	89.13
S	3 1	5.0311	75.8491	33.4622	21.0585	0.9350	1.0064	0.0798	0.5932	0.1077	0.0880	0.0305	0.0023	0.0016	0.0056	0.0041	53.64
C	3 1	0.2538	7.4019	0.1052	0.3256	0.0223	0.0330	0.0092	0.0100	0.0252	0.0111	0.0027	0.0007	0.0023	0.0006	0.0005	3.14
FODDER		18.3121	105.5953	34.0699	28.7617	1.0607	1.2729	0.0919	0.6591	0.2783	0.1603	0.0494	0.0048	0.0047	0.0074	0.0067	145.92
G	3 2	24.4466	31.9793	0.4221	12.3568	0.0970	0.3001	0.0041	0.0777	0.2533	0.0683	0.0251	0.0013	0.0020	0.0023	0.0030	140.52
S	3 2	4.5217	125.6963	28.5267	18.9582	0.8224	1.2097	0.1265	0.6357	0.1475	0.0902	0.0322	0.0010	0.0018	0.0049	0.0036	54.75
C	3 2	0.1969	5.9791	0.0628	0.2969	0.0160	0.0221	0.0066	0.0092	0.0319	0.0084	0.0023	0.0007	0.0022	0.0005	0.0005	3.03
FODDER		29.1652	163.6548	29.0116	31.6120	0.9354	1.5320	0.1372	0.7227	0.4327	0.1669	0.0596	0.0030	0.0059	0.0078	0.0071	198.31
G	3 4	21.1050	28.0463	0.4598	10.4921	0.2429	0.4184	0.0157	0.0642	0.2175	0.1129	0.0205	0.0017	0.0036	0.0016	0.0027	117.11
S	3 4	4.0893	94.2427	30.2077	18.8502	0.6780	0.8408	0.0658	0.4914	0.1502	0.0654	0.0286	0.0008	0.0015	0.0049	0.0029	49.85
C	3 4	0.2526	7.5614	0.0740	0.2923	0.0189	0.0244	0.0075	0.0091	0.0310	0.0104	0.0027	0.0010	0.0023	0.0011	0.0005	3.96
FODDER		25.4469	129.8503	30.7415	29.6347	0.9398	1.2837	0.0891	0.5648	0.3986	0.1887	0.0518	0.0036	0.0075	0.0076	0.0061	170.93
TERRACE MEAN...		24.3081	133.0334	31.2743	30.0028	0.9786	1.3628	0.1060	0.6488	0.3699	0.1720	0.0536	0.0038	0.0060	0.0076	0.0066	171.72
SLUDGE FODDER AVE...		31.7036	120.3084	37.7367	35.7400	1.4209	1.7331	0.2021	0.4070	0.6276	0.1208	0.0547	0.0049	0.0060	0.0231	0.0076	184.67
STD...		5.6867	23.7936	5.1609	5.1170	0.4422	0.4647	0.2682	0.1235	0.2442	0.0307	0.0072	0.0014	0.0011	0.0125	0.0021	23.97
MIN...		18.3121	70.8898	29.0116	28.5109	0.8631	1.1318	0.0891	0.2523	0.2783	0.0789	0.0385	0.0030	0.0042	0.0074	0.0051	134.49
MAX...		39.5844	163.6548	46.7802	46.5068	2.5193	2.8530	1.3847	0.7227	1.2623	0.1887	0.0700	0.0084	0.0092	0.0531	0.0136	221.62
N...		21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.00
- CONTROL -																	
G	4 1	8.5042	16.2581	0.3191	5.2609	0.0497	0.1108	0.0023	0.0432	0.1018	0.0229	0.0142	0.0007	0.0014	0.0012	0.0017	81.32
S	4 1	2.2510	38.5085	28.8413	21.4301	0.7622	0.7311	0.0337	0.5967	0.0574	0.0497	0.0227	0.0012	0.0007	0.0009	0.0034	36.22
C	4 1	0.2363	6.2982	0.1033	0.3605	0.0151	0.1209	0.0050	0.0083	0.0132	0.0072	0.0028	0.0005	0.0012	0.0005	0.0004	3.03
FODDER		10.9915	61.0648	29.2636	27.0515	0.8270	0.9627	0.0410	0.6481	0.1725	0.0798	0.0398	0.0024	0.0033	0.0026	0.0055	120.59
G	4 2	13.8116	23.1135	0.3599	7.4317	0.0582	0.1527	0.0031	0.0534	0.1398	0.0284	0.0157	0.0013	0.0016	0.0005	0.0023	102.08
S	4 2	4.2438	71.4130	31.4987	20.7611	1.2562	1.3065	0.0462	0.8890	0.1002	0.0672	0.0278	0.0013	0.0007	0.0013	0.0031	56.69
C	4 2	0.2227	6.4419	0.0786	0.2943	0.0233	0.0346	0.0065	0.0082	0.0155	0.0132	0.0025	0.0007	0.0025	0.0007	0.0005	2.79
FODDER		18.2782	100.9683	31.9372	28.4871	1.3378	1.4937	0.0558	0.9506	0.2554	0.1088	0.0460	0.0033	0.0049	0.0025	0.0059	161.58
G	4 4	20.8651	28.6629	0.3447	10.8557	0.0513	0.1888	0.0037	0.0662	0.1868	0.0250	0.0197	0.0012	0.0021	0.0013	0.0042	130.98
S	4 4	6.6520	82.4347	39.7041	29.1972	1.2290	1.3947	0.0580	0.4139	0.1104	0.0909	0.0358	0.0020	0.0009	0.0046	0.0038	63.56
C	4 4	0.2407	6.3395	0.0701	0.3915	0.0173	0.0194	0.0078	0.0076	0.0206	0.0088	0.0025	0.0007	0.0020	0.0006	0.0005	3.60
FODDER		27.7577	117.4371	40.1189	40.4444	1.2976	1.6030	0.0695	0.4877	0.3178	0.1248	0.0581	0.0038	0.0050	0.0066	0.0085	198.15
TERRACE MEAN...		19.0091	93.1567	33.7732	31.9943	1.1541	1.3531	0.0554	0.6955	0.2486	0.1044	0.0480	0.0032	0.0044	0.0039	0.0066	160.10
CONTROL FODDER AVE...		19.0091	93.1567	33.7732	31.9943	1.1541	1.3531	0.0554	0.6955	0.2486	0.1044	0.0480	0.0032	0.0044	0.0039	0.0066	160.10
STD...		6.8642	23.6675	4.6179	6.0038	0.2319	0.2797	0.0116	0.1919	0.0595	0.0186	0.0076	0.0006	0.0008	0.0019	0.0013	31.68
MIN...		10.9915	61.0648	29.2636	27.0515	0.8270	0.9627	0.0410	0.4877	0.1725	0.0798	0.0398	0.0024	0.0033	0.0025	0.0055	120.59
MAX...		27.7577	117.4371	40.1189	40.4444	1.3378	1.6030	0.0695	0.9506	0.3178	0.1248	0.0581	0.0038	0.0050	0.0066	0.0085	198.15
N...		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.00
- - - 1985 MEANS - - -																	
GRAIN SLUDGE		24.5193	30.1356	0.3934	11.7589	0.0787	0.2283	0.0319	0.0603	0.2578	0.0323	0.0206	0.0025	0.0024	0.0012	0.0029	128.64
STOVER SLUDGE		6.9386	82.8295	37.2536	23.6304	1.3238	1.4786	0.1627	0.3379	0.3146	0.0794	0.0315	0.0017	0.0017	0.0212	0.0042	52.75
COB SLUDGE		0.2457	7.3434	0.0896	0.3507	0.0185	0.0263	0.0074	0.0088	0.0552	0.0091	0.0027	0.0007	0.0020	0.0008	0.0005	3.27
FODDER SLUDGE		31.7036	120.3084	37.7367	35.7400	1.4209	1.7331	0.2021	0.4070	0.6276	0.1208	0.0547	0.0049	0.0060	0.0231	0.0076	184.67
GRAIN CONTROL		14.3936	22.6782	0.3412	7.8494	0.0530	0.1508	0.0030	0.0543	0.1428	0.0254	0.0166	0.0011	0.0017	0.0010	0.0027	104.79
STOVER CONTROL		4.3823	64.1187	33.3480	23.7961	1.0825	1.1441	0.0459	0.6332	0.0893	0.0693	0.0288	0.0015	0.0008	0.0023	0.0034	52.16
COB CONTROL		0.2332	6.3599	0.0840	0.3488	0.0186	0.0583	0.0064	0.0080	0.0165	0.0097	0.0026	0.0006	0.0019	0.0006	0.0005	3.14
FODDER CONTROL		19.0091	93.1567	33.7732	31.9943	1.1541	1.3531	0.0554	0.6955	0.2486	0.1044	0.0480	0.0032	0.0044	0.0039	0.0066	160.10

Rosemount Terraces : Elements Removed by Corn

ROSEMOUNT WATERSHED CORN DATA 1986 TISSUE	ID	ELEMENTS REMOVED Q (kg/ha)	K	CA	MG	AL	FE	MN	MN	ZN	CU	B	PB	NI	CR	CD	N
- SLUDGE -		==========>>>>>															
G	1 2	29.7431	36.5477	0.4507	12.2887	0.0891	0.1938	0.0170	0.0491	0.2280	0.0195	0.0346	0.0037	0.0013	0.0006	0.0043	123.90
S	1 2	13.6967	145.1218	47.0329	17.0886	0.9052	1.3934	0.1102	0.4309	0.3228	0.0722	0.0508	0.0040	0.0041	0.0167	0.0011	61.75
C	1 2	0.3286	10.9019	0.0736	0.2263	0.0421	0.0332	0.0042	0.0067	0.0278	0.0111	0.0062	0.0005	0.0003	0.0007	0.0015	3.73
FODDER		43.7684	192.5714	47.5572	29.6035	1.0365	1.6204	0.1313	0.4868	0.5786	0.1028	0.0915	0.0083	0.0056	0.0180	0.0069	189.39
G	1 4	21.4950	26.8094	0.3523	9.5661	0.0647	0.1656	0.0180	0.0542	0.2295	0.0169	0.0242	0.0030	0.0010	0.0007	0.0039	102.27
S	1 4	20.3771	116.2090	30.5606	19.3839	0.7396	0.9560	0.1462	0.3837	0.3868	0.0350	0.0364	0.0032	0.0011	0.0134	0.0014	51.59
C	1 4	0.2954	6.3241	0.0736	0.3288	0.0286	0.0244	0.0023	0.0088	0.0511	0.0096	0.0060	0.0006	0.0002	0.0006	0.0015	3.18
FODDER		42.1674	149.3424	30.9865	29.2789	0.8328	1.1460	0.1665	0.4467	0.6674	0.0615	0.0666	0.0068	0.0023	0.0146	0.0068	157.05
G	1 7	28.4063	34.8297	0.4107	11.8543	0.0854	0.1937	0.0419	0.0474	0.2589	0.0198	0.0340	0.0038	0.0019	0.0010	0.0046	120.05
S	1 7	16.5329	140.1452	40.9862	20.7790	1.0493	1.2939	0.1712	0.4091	0.3219	0.0691	0.0481	0.0040	0.0021	0.0183	0.0011	68.04
C	1 7	0.3354	12.5819	0.0848	0.2740	0.0353	0.0413	0.0047	0.0093	0.0528	0.0142	0.0072	0.0008	0.0003	0.0008	0.0021	4.42
FODDER		45.2746	187.5568	41.4817	32.9074	1.1701	1.5289	0.2178	0.4658	0.6336	0.1030	0.0893	0.0086	0.0043	0.0201	0.0078	192.51
TERRACE MEAN...		43.7368	176.4902	40.0085	30.5966	1.0131	1.4318	0.1719	0.4664	0.6266	0.0891	0.0825	0.0079	0.0041	0.0176	0.0072	179.65
G	2 3	29.9814	35.9900	0.4720	12.5717	0.0594	0.2077	0.0334	0.0577	0.3011	0.0158	0.0298	0.0037	0.0013	0.0011	0.0043	138.01
S	2 3	16.2503	191.7775	48.8972	18.5446	0.9478	1.5395	0.1936	0.5191	0.4074	0.0674	0.0518	0.0044	0.0015	0.0199	0.0010	90.45
C	2 3	0.3443	7.9376	0.1186	0.4330	0.0322	0.0347	0.0064	0.0150	0.0813	0.0138	0.0051	0.0007	0.0004	0.0007	0.0019	3.89
FODDER		46.5761	235.7051	49.4878	31.5493	1.0394	1.7819	0.2334	0.5918	0.7897	0.0970	0.0867	0.0088	0.0032	0.0217	0.0073	232.36
G	2 5	31.6312	38.2182	0.4602	13.8596	0.0793	0.2159	0.0315	0.0661	0.3939	0.0185	0.0352	0.0043	0.0015	0.0014	0.0056	153.87
S	2 5	15.3064	167.7636	57.9841	19.8776	1.1781	1.3905	0.1186	0.7130	0.9327	0.1028	0.0573	0.0040	0.0032	0.0185	0.0025	101.72
C	2 5	0.3283	9.6214	0.0633	0.2984	0.0228	0.0279	0.0288	0.0086	0.0946	0.0098	0.0055	0.0006	0.0003	0.0006	0.0013	4.05
FODDER		47.2659	215.6031	58.5076	34.0356	1.2802	1.6344	0.1789	0.7876	1.4211	0.1311	0.0980	0.0090	0.0050	0.0205	0.0094	259.65
G	2 8	31.0987	37.8824	0.4717	12.6909	0.0623	0.2248	0.0326	0.0595	0.3076	0.0198	0.0337	0.0044	0.0015	0.0014	0.0052	129.75
S	2 8	14.1050	175.2909	43.5131	17.3433	0.8129	1.0848	0.1457	0.6074	0.5123	0.0650	0.0464	0.0043	0.0015	0.0120	0.0015	80.58
C	2 8	0.2898	7.4578	0.0465	0.1331	0.0192	0.0257	0.0048	0.0057	0.0426	0.0086	0.0077	0.0006	0.0003	0.0005	0.0011	3.57
FODDER		45.4936	220.6311	44.0313	30.1673	0.8944	1.3353	0.1831	0.6725	0.8626	0.0934	0.0877	0.0093	0.0032	0.0139	0.0079	213.91
TERRACE MEAN...		46.4452	223.9798	50.6756	31.9174	1.0713	1.5839	0.1985	0.6840	1.0245	0.1072	0.0908	0.0090	0.0038	0.0187	0.0082	235.31
G	3 1	23.4677	29.1137	0.3842	11.6241	0.0606	0.1738	0.0365	0.0740	0.2394	0.0167	0.0248	0.0037	0.0024	0.0011	0.0041	128.47
S	3 1	5.1802	143.7459	36.9244	20.4690	1.0463	1.2217	0.1031	0.5903	0.2198	0.0800	0.0505	0.0031	0.0016	0.0080	0.0018	69.52
C	3 1	0.1808	7.8780	0.0594	0.2880	0.0162	0.0206	0.0029	0.0105	0.0344	0.0086	0.0057	0.0006	0.0002	0.0005	0.0012	3.17
FODDER		28.8286	180.7376	37.3680	32.3811	1.1232	1.4160	0.1426	0.6747	0.4936	0.1053	0.0809	0.0073	0.0042	0.0096	0.0071	201.16
G	3 2	24.4489	34.2059	0.4111	12.8216	0.0676	0.2588	0.0334	0.0629	0.2570	0.0232	0.0265	0.0040	0.0014	0.0013	0.0057	122.40
S	3 2	6.0085	177.2415	36.0028	15.2383	0.7766	1.2807	0.1063	0.7689	0.2762	0.0732	0.0439	0.0032	0.0013	0.0089	0.0020	71.69
C	3 2	0.1673	10.4843	0.0538	0.2360	0.0202	0.0212	0.0035	0.0077	0.0248	0.0071	0.0052	0.0007	0.0002	0.0006	0.0012	3.39
FODDER		30.6246	221.9316	36.4677	28.2960	0.8644	1.5608	0.1432	0.8395	0.5580	0.1036	0.0756	0.0078	0.0029	0.0107	0.0089	197.49
G	3 4	25.7602	32.6590	0.3892	11.1026	0.0542	0.2039	0.0352	0.0510	0.2106	0.0184	0.0297	0.0040	0.0014	0.0015	0.0059	125.73
S	3 4	7.7498	149.4354	38.4469	19.9401	0.9345	1.0991	0.0769	0.4574	0.1701	0.0746	0.0418	0.0033	0.0011	0.0075	0.0012	76.31
C	3 4	0.2518	6.3409	0.0636	0.3437	0.0300	0.0240	0.0023	0.0075	0.0198	0.0095	0.0041	0.0006	0.0004	0.0007	0.0014	3.77
FODDER		33.7619	188.4353	38.8997	31.3864	1.0186	1.3270	0.1144	0.5159	0.4005	0.1025	0.0756	0.0079	0.0029	0.0097	0.0085	205.82
TERRACE MEAN...		31.0717	197.0348	37.5785	30.6878	1.0021	1.4346	0.1334	0.6767	0.4840	0.1038	0.0774	0.0077	0.0034	0.0100	0.0082	201.49
G	3 6	38.4295	42.9153	0.5152	17.3224	0.0513	0.2582	0.0242	0.0681	0.4450	0.0166	0.0295	0.0044	0.0015	0.0018	0.0061	138.82
S	3 6	12.6528	110.8664	38.9743	25.0587	0.4133	0.5696	0.0504	0.2686	0.9657	0.0477	0.0344	0.0034	0.0011	0.0088	0.0014	61.73
C	3 6	0.2104	8.6896	0.0675	0.2389	0.0310	0.0331	0.0025	0.0093	0.1126	0.0130	0.0055	0.0007	0.0006	0.0009	0.0016	3.00
FODDER		51.2927	162.4713	39.5570	42.6201	0.4956	0.8610	0.0772	0.3460	1.5233	0.0774	0.0695	0.0085	0.0032	0.0116	0.0091	203.56
G	3 9	31.1102	38.9113	0.4648	13.6981	0.0504	0.1995	0.0195	0.0495	0.3528	0.0161	0.0299	0.0041	0.0014	0.0019	0.0052	133.93
S	3 9	11.9861	165.2368	45.4338	29.6855	0.7293	0.8748	0.1051	0.3334	0.6737	0.0773	0.0486	0.0038	0.0013	0.0171	0.0019	75.71
C	3 9	0.2497	11.7943	0.0724	0.2080	0.0256	0.0302	0.0051	0.0080	0.0795	0.0125	0.0055	0.0006	0.0006	0.0009	0.0014	3.13
FODDER		43.3461	215.9424	45.9710	43.5916	0.8053	1.1045	0.1298	0.3909	1.1059	0.1059	0.0840	0.0085	0.0033	0.0199	0.0085	212.79
G	3 10	30.0492	36.3918	0.4990	13.7121	0.0467	0.1954	0.0329	0.0529	0.2782	0.0160	0.0286	0.0045	0.0015	0.0011	0.0051	145.37
S	3 10	7.7272	120.8277	41.2718	26.0696	0.6570	0.8044	0.0690	0.1986	0.2935	0.0701	0.0375	0.0034	0.0012	0.0166	0.0020	57.20
C	3 10	0.1903	8.2411	0.0831	0.3236	0.0268	0.0320	0.0039	0.0075	0.0554	0.0116	0.0068	0.0006	0.0005	0.0009	0.0013	3.70
FODDER		37.9667	165.4606	41.8539	40.1054	0.7304	1.0318	0.1059	0.2590	0.6272	0.0976	0.0728	0.0085	0.0032	0.0186	0.0084	206.28
TERRACE MEAN...		44.2018	181.2915	42.4606	42.1057	0.6771	0.9991	0.1043	0.3320	1.0855	0.0936	0.0754	0.0085	0.0032	0.0167	0.0087	207.54
G	4 6	31.7261	38.4693	0.4709	13.3454	0.0530	0.2327	0.0238	0.0530	0.3415	0.0149	0.0295	0.0042	0.0014	0.0013	0.0051	126.80
S	4 6	10.8515	114.2556	50.8805	28.7715	0.6151	0.8925	0.0777	0.3494	0.6616	0.0634	0.0389	0.0034	0.0012	0.0081	0.0016	64.91
C	4 6	0.3558	10.7133	0.0964	0.2557	0.0271	0.0247	0.0030	0.0079	0.0703	0.0102	0.0056	0.0006	0.0002	0.0006	0.0012	4.07
FODDER		42.9333	163.4381	51.4478	42.3727	0.6952	1.1499	0.1045	0.4102	1.0734	0.0885	0.0740	0.0082	0.0028	0.0101	0.0079	195.79
G	4 9	27.3302	30.2316	0.3413	12.7021	0.0433	0.1863	0.0284	0.0523	0.2598	0.0106	0.0219	0.0035	0.0012	0.0011	0.0047	121.55
S	4 9	11.6991	121.3241	36.0928	27.4393	0.5033	0.6932	0.0569	0.1731	0.2572	0.0514	0.0392	0.0036	0.0012	0.0104	0.0011	58.75
C	4 9	0.3573	9.2476	0.1199	0.5733	0.0412	0.0510	0.0066	0.0131	0.0955	0.0184	0.0051	0.0008	0.0008	0.0011	0.0022	4.93
FODDER		39.3865	160.8033	36.5540	40.7147	0.5878	0.9305	0.0919	0.2386	0.6125	0.0804	0.0662	0.0079	0.0032	0.0126	0.0081	185.24
G	4 11	25.5453	30.0609	0.3370	11.8166	0.0382	0.1723	0.0357	0.0490	0.2418	0.0119	0.0229	0.0035	0.0012	0.0010	0.0051	114.27
S	4 11	10.1206	99.4034	35.4078	20.7205	0.6060	0.7825	0.0990	0.3004	0.3289	0.0637	0.0326	0.0031	0.0010	0.0127	0.0018	53.79
C	4 11	0.2395	5.8527	0.0624	0.3172	0.0265	0.0366	0.0052	0.0071	0.0423	0.0113	0.0039	0.0006	0.0003	0.0006	0.0018	3.22
FODDER		35.9053	135.3170	35.8072	32.8542	0.6707	0.9914	0.1399	0.3566	0.6129	0.0870	0.0593	0.0072	0.0026	0.0144	0.0087	171.30
TERRACE MEAN...		39.4084	153.1862	41.2697	38.6472	0.6512	1.0239	0.1121	0.3351	0.7663	0.0853	0.0665	0.0078	0.0029	0.0123	0.0082	184.11

Rosemount Terraces : Elements Removed by Corn *Continued from previous page*

ROSEMOUNT WATERSHED CORN DATA 1986 TISSUE	ID	ELEMENTS REMOVED P (kg/ha)	K =====>>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	PB	NI	CR	CD	N
G	5 2	23.6830	29.7062	0.3496	10.6916	0.0340	0.1609	0.0185	0.0411	0.1816	0.0133	0.0251	0.0035	0.0012	0.0011	0.0043	119.02
S	5 2	3.7354	69.2902	29.5690	19.2177	0.5964	1.8567	0.1511	0.2943	0.2884	0.0797	0.0316	0.0059	0.0045	0.0119	0.0024	40.18
C	5 2	0.1852	7.6826	0.0554	0.1697	0.0226	0.0266	0.0055	0.0055	0.0162	0.0074	0.0037	0.0005	0.0003	0.0007	0.0013	3.22
FODDER		27.6036	106.6790	29.9740	30.0789	0.6529	2.0441	0.1750	0.3409	0.4862	0.1003	0.0604	0.0100	0.0060	0.0138	0.0079	162.43
G	5 3	16.0866	18.8396	0.2513	7.0507	0.0344	0.1505	0.0358	0.0413	0.1432	0.0129	0.0164	0.0021	0.0026	0.0012	0.0033	64.02
S	5 3	5.5626	33.3603	12.2598	10.5960	0.2404	0.3937	0.0705	0.1025	0.1220	0.0290	0.0167	0.0012	0.0004	0.0042	0.0007	21.18
C	5 3	0.1353	3.0521	0.0299	0.1668	0.0137	0.0121	0.0030	0.0034	0.0238	0.0046	0.0015	0.0003	0.0001	0.0003	0.0008	1.79
FODDER		21.7844	55.2520	12.5410	17.8135	0.2885	0.5562	0.1092	0.1472	0.2889	0.0464	0.0346	0.0037	0.0031	0.0057	0.0048	87.01
G	5 6	26.0939	32.0393	0.3642	10.8260	0.0565	0.2576	0.0418	0.0585	0.2327	0.0244	0.0305	0.0039	0.0052	0.0019	0.0064	114.77
S	5 6	8.5608	108.2863	25.5290	19.9640	0.4715	0.6504	0.0688	0.2151	0.2894	0.0659	0.0322	0.0025	0.0008	0.0077	0.0016	46.66
C	5 6	0.2260	5.0375	0.0402	0.2337	0.0324	0.0313	0.0032	0.0054	0.0474	0.0078	0.0021	0.0005	0.0003	0.0005	0.0013	2.83
FODDER		34.8807	145.3631	25.9334	31.0237	0.5604	0.9393	0.1138	0.2790	0.5695	0.0981	0.0648	0.0068	0.0063	0.0101	0.0093	164.27
TERRACE MEAN...		28.0896	102.4313	22.8161	26.3054	0.5006	1.1799	0.1327	0.2557	0.4482	0.0816	0.0533	0.0068	0.0052	0.0098	0.0073	137.90
G	6 2	30.9873	34.1204	0.3857	14.7410	0.0515	0.2298	0.0355	0.0586	0.2986	0.0114	0.0257	0.0039	0.0013	0.0014	0.0063	137.65
S	6 2	5.7284	53.5670	26.5254	17.7135	0.2231	0.3873	0.0357	0.1755	0.2967	0.0427	0.0257	0.0018	0.0006	0.0032	0.0010	37.85
C	6 2	0.2269	7.1420	0.0547	0.3337	0.0232	0.0246	0.0029	0.0082	0.0646	0.0090	0.0033	0.0006	0.0002	0.0006	0.0016	3.65
FODDER		36.9427	94.8294	26.9658	32.7883	0.2978	0.6417	0.0741	0.2423	0.6599	0.0632	0.0547	0.0063	0.0022	0.0053	0.0088	179.17
G	6 4	27.6420	32.7915	0.4266	13.6428	0.0790	0.1938	0.0268	0.0488	0.2327	0.0181	0.0256	0.0040	0.0014	0.0016	0.0062	138.33
S	6 4	3.6444	33.8588	22.2143	9.4768	0.2090	0.3391	0.0262	0.1658	0.0936	0.0350	0.0163	0.0012	0.0005	0.0034	0.0007	31.58
C	6 4	0.2086	7.3172	0.0591	0.3310	0.0343	0.0237	0.0055	0.0071	0.0288	0.0085	0.0040	0.0006	0.0003	0.0007	0.0015	3.59
FODDER		31.4950	73.9675	22.7000	23.4507	0.3223	0.5565	0.0585	0.2217	0.3551	0.0616	0.0459	0.0058	0.0022	0.0057	0.0084	173.51
G	6 5	24.7671	29.5066	0.2989	10.9902	0.0455	0.1583	0.0265	0.0407	0.2053	0.0148	0.0208	0.0034	0.0012	0.0014	0.0045	110.65
S	6 5	4.3274	83.0820	19.9021	10.6175	0.3691	0.5670	0.0448	0.1612	0.1477	0.0515	0.0222	0.0020	0.0013	0.0060	0.0015	34.77
C	6 5	0.1917	6.4270	0.0450	0.1924	0.0145	0.0177	0.0070	0.0051	0.0259	0.0066	0.0051	0.0006	0.0002	0.0005	0.0012	3.01
FODDER		29.2862	119.0156	20.2461	21.8001	0.4291	0.7430	0.0783	0.2070	0.3788	0.0730	0.0481	0.0060	0.0026	0.0079	0.0072	148.44
TERRACE MEAN...		32.5746	95.9375	23.3040	26.0130	0.3497	0.6471	0.0703	0.2237	0.4646	0.0659	0.0495	0.0061	0.0023	0.0063	0.0082	167.04
G	7 2	24.0180	28.7293	0.3839	11.6978	0.0658	0.1822	0.0306	0.0467	0.1978	0.0179	0.0188	0.0033	0.0011	0.0014	0.0050	108.13
S	7 2	3.7395	74.3263	26.7394	13.9296	0.3426	0.4097	0.0393	0.1840	0.1628	0.1033	0.0255	0.0025	0.0011	0.0049	0.0014	36.13
C	7 2	0.1676	6.8491	0.0514	0.2496	0.0239	0.0201	0.0056	0.0062	0.0206	0.0077	0.0049	0.0005	0.0004	0.0005	0.0011	2.57
FODDER		27.9251	109.9047	27.1747	25.8769	0.4322	0.6119	0.0754	0.2369	0.3812	0.1289	0.0492	0.0063	0.0026	0.0068	0.0075	146.84
G	7 4	28.6109	32.6067	0.4349	12.6606	0.0452	0.2280	0.0334	0.0511	0.2981	0.0178	0.0223	0.0035	0.0012	0.0014	0.0062	117.66
S	7 4	11.2192	93.7306	40.1358	28.3117	0.4037	0.6178	0.0749	0.3932	0.8653	0.0750	0.0335	0.0029	0.0010	0.0069	0.0030	58.15
C	7 4	0.2104	7.7927	0.0656	0.2906	0.0267	0.0231	0.0067	0.0075	0.0728	0.0093	0.0061	0.0006	0.0003	0.0005	0.0012	3.09
FODDER		40.0405	134.1300	40.6363	41.2629	0.4757	0.8689	0.1150	0.4518	1.2362	0.1020	0.0619	0.0071	0.0025	0.0089	0.0104	178.91
G	7 6	32.5345	35.5138	0.4474	15.2335	0.0556	0.2368	0.0351	0.0726	0.3965	0.0137	0.0226	0.0039	0.0013	0.0039	0.0069	141.53
S	7 6	12.6521	127.4133	35.0147	12.5424	0.5304	0.7664	0.0543	0.3688	0.7494	0.0768	0.0306	0.0027	0.0009	0.0092	0.0025	59.06
C	7 6	0.2409	8.1475	0.0828	0.3456	0.0269	0.0291	0.0073	0.0130	0.1211	0.0120	0.0043	0.0006	0.0005	0.0008	0.0014	3.10
FODDER		45.4275	171.0746	35.5449	28.1216	0.6129	1.0322	0.0967	0.4544	1.2669	0.1026	0.0575	0.0072	0.0027	0.0139	0.0109	203.69
TERRACE MEAN...		37.7977	138.3698	34.4520	31.7538	0.5069	0.8377	0.0957	0.3810	0.9614	0.1112	0.0562	0.0069	0.0026	0.0099	0.0096	176.48
G	8 2	31.0709	34.8355	0.4492	14.5659	0.0647	0.2088	0.0514	0.0583	0.2509	0.0189	0.0240	0.0041	0.0014	0.0020	0.0067	136.91
S	8 2	11.0963	169.0878	38.2059	22.1716	0.9879	1.2640	0.2183	0.3181	0.2754	0.0982	0.0409	0.0036	0.0034	0.0233	0.0026	69.01
C	8 2	0.2038	7.1795	0.0671	0.3510	0.0282	0.0225	0.0058	0.0078	0.0265	0.0092	0.0045	0.0006	0.0002	0.0007	0.0014	3.74
FODDER		42.3710	211.1027	38.7222	37.0884	1.0809	1.4953	0.2755	0.3842	0.5528	0.1263	0.0694	0.0083	0.0050	0.0261	0.0107	209.67
G	8 4	23.1883	27.0081	0.3168	10.1636	0.0315	0.1478	0.0165	0.0430	0.2500	0.0130	0.0176	0.0031	0.0024	0.0010	0.0047	100.53
S	8 4	13.9618	98.6416	34.7905	24.9194	0.4766	0.6955	0.0903	0.3145	0.5074	0.0578	0.0304	0.0030	0.0010	0.0103	0.0024	64.31
C	8 4	0.2057	6.4883	0.0400	0.1924	0.0220	0.0188	0.0026	0.0054	0.0562	0.0076	0.0040	0.0005	0.0003	0.0005	0.0010	2.45
FODDER		37.3558	132.1379	35.1473	35.2754	0.5300	0.8622	0.1094	0.3629	0.8136	0.0784	0.0520	0.0066	0.0038	0.0118	0.0081	167.31
G	8 5	32.5462	38.7839	0.4143	14.3048	0.0488	0.2120	0.0300	0.0538	0.3538	0.0147	0.0263	0.0044	0.0015	0.0016	0.0061	141.65
S	8 5	14.1349	137.9367	53.2823	23.0131	0.8185	1.2375	0.4748	0.3356	0.7534	0.0811	0.0367	0.0036	0.0012	0.0168	0.0026	79.18
C	8 5	0.2276	10.2878	0.0672	0.2145	0.0275	0.0268	0.0037	0.0081	0.0741	0.0100	0.0058	0.0007	0.0006	0.0011	0.0014	4.05
FODDER		46.9087	187.0084	53.7638	37.5325	0.8949	1.4762	0.5086	0.3975	1.1813	0.1057	0.0688	0.0086	0.0033	0.0195	0.0101	224.89
TERRACE MEAN...		42.2118	176.7497	42.5444	36.6321	0.8353	1.2779	0.2978	0.3815	0.8492	0.1035	0.0634	0.0079	0.0040	0.0191	0.0096	200.62
SLUDGE FODDER AVE...		38.3931	160.6079	37.2344	32.7399	0.7341	1.1573	0.1463	0.4151	0.7456	0.0935	0.0683	0.0076	0.0035	0.0134	0.0083	187.79
STD...		7.3716	46.3725	10.3894	6.4045	0.2786	0.3915	0.0875	0.1734	0.3392	0.0203	0.0153	0.0013	0.0011	0.0054	0.0013	32.44
MIN...		21.7844	55.2520	12.5410	17.8135	0.2885	0.5562	0.0585	0.1472	0.2889	0.0464	0.0346	0.0037	0.0022	0.0053	0.0048	87.01
MAX...		51.2927	235.7051	58.5076	43.5916	1.2802	2.0441	0.5086	0.3395	1.5233	0.1311	0.0980	0.0100	0.0063	0.0261	0.0109	259.65
N...		27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.0000	27.00

Rosemount Terraces : Elements Removed by Corn

Continued from previous page

ROSEMOUNT WATERSHED CORN DATA 1986 TISSUE	ID	ELEMENTS REMOVED P (kg/ha)	K ==========>	CA	MG	AL	FE	NA	MN	ZN	CU	B	PB	NI	CR	CD	N
- CONTROL -																	
G	4 1	19.1041	29.4897	0.3938	10.8573	0.0641	0.1684	0.0311	0.0544	0.1959	0.0179	0.0214	0.0036	0.0012	0.0009	0.0043	116.66
S	4 1	3.6338	114.3145	29.7166	24.6555	0.7229	0.9140	0.1114	0.5497	0.1103	0.0715	0.0343	0.0029	0.0010	0.0073	0.0025	62.82
C	4 1	0.1896	9.7679	0.0676	0.2972	0.0270	0.0222	0.0051	0.0083	0.0190	0.0082	0.0041	0.0006	0.0002	0.0007	0.0012	3.88
FODDER		22.9274	153.5722	30.1780	35.8100	0.8140	1.1045	0.1477	0.6124	0.3252	0.0976	0.0598	0.0072	0.0025	0.0089	0.0080	183.37
G	4 2	18.9907	30.1821	0.4202	9.8529	0.0682	0.1900	0.0391	0.0496	0.1806	0.0189	0.0229	0.0040	0.0014	0.0011	0.0054	112.46
S	4 2	5.1480	144.4137	24.1540	17.4183	0.6425	0.8984	0.0744	0.5862	0.1417	0.0742	0.0390	0.0031	0.0010	0.0058	0.0029	65.32
C	4 2	0.1837	9.0694	0.0427	0.2832	0.0231	0.0242	0.0041	0.0062	0.0159	0.0082	0.0042	0.0006	0.0003	0.0005	0.0014	3.47
FODDER		24.3224	183.6653	24.6168	27.5544	0.7338	1.1126	0.1176	0.6420	0.3381	0.1014	0.0660	0.0077	0.0027	0.0074	0.0097	181.25
G	4 4	14.7183	23.6543	0.2907	7.7171	0.0443	0.2148	0.0252	0.0363	0.1543	0.0196	0.0203	0.0032	0.0012	0.0008	0.0040	90.66
S	4 4	2.4120	79.5809	20.3928	18.4713	0.4197	0.6177	0.0522	0.2507	0.0967	0.0609	0.0253	0.0022	0.0014	0.0051	0.0013	39.62
C	4 4	0.1504	6.2168	0.0304	0.2319	0.0190	0.0177	0.0026	0.0035	0.0145	0.0065	0.0034	0.0006	0.0002	0.0004	0.0011	2.85
FODDER		17.2807	109.4520	20.7139	26.4203	0.4831	0.8502	0.0800	0.2905	0.2655	0.0870	0.0490	0.0059	0.0027	0.0062	0.0063	133.14
TERRACE MEAN...		13.9436	101.1350	15.1326	18.0631	0.4148	0.6632	0.0671	0.3135	0.2259	0.0661	0.0403	0.0048	0.0020	0.0049	0.0058	106.15
CONTROL FODDER AVE...		21.5102	148.8965	25.1696	29.9282	0.6770	1.0224	0.1151	0.5150	0.3096	0.0953	0.0583	0.0069	0.0026	0.0075	0.0080	165.92
STD...		3.0445	30.4773	3.8834	4.1847	0.1409	0.1218	0.0277	0.1592	0.0317	0.0061	0.0070	0.0007	0.0001	0.0011	0.0014	23.19
MIN...		17.2807	109.4520	20.7139	26.4203	0.4831	0.8502	0.0800	0.2905	0.2655	0.0870	0.0490	0.0059	0.0025	0.0062	0.0063	133.14
MAX...		24.3224	183.6653	30.1780	35.8100	0.8140	1.1126	0.1477	0.6420	0.3381	0.1014	0.0660	0.0077	0.0027	0.0089	0.0097	183.37
N...		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.00

- 1986 MEANS - TISSUE	TREATMENT	ELEMENTS REMOVED P (kg/ha)	K ==========>	CA	MG	AL	FE	NA	MN	ZN	CU	B	PB	NI	CR	CD	N
GRAIN	SLUDGE	27.8315	33.2488	0.4057	12.5017	0.0562	0.2018	0.0306	0.0541	0.2736	0.0165	0.0263	0.0038	0.0016	0.0014	0.0052	124.30
STOVER	SLUDGE	10.3188	119.3046	36.7621	19.9586	0.6512	0.9282	0.1103	0.3530	0.4178	0.0670	0.0371	0.0032	0.0015	0.0113	0.0017	60.07
COB	SLUDGE	0.2427	8.0544	0.0666	0.2796	0.0267	0.0273	0.0054	0.0080	0.0542	0.0100	0.0050	0.0006	0.0003	0.0007	0.0014	3.42
FODDER	SLUDGE	38.3931	160.6079	37.2344	32.7399	0.7341	1.1573	0.1463	0.4151	0.7456	0.0935	0.0683	0.0076	0.0035	0.0134	0.0083	187.79
GRAIN	CONTROL	17.6044	27.7754	0.3683	9.4758	0.0589	0.1911	0.0318	0.0468	0.1769	0.0188	0.0215	0.0036	0.0013	0.0009	0.0046	106.59
STOVER	CONTROL	3.7313	112.7697	24.7544	20.1817	0.5951	0.8100	0.0793	0.4622	0.1162	0.0689	0.0328	0.0027	0.0011	0.0060	0.0022	55.92
COB	CONTROL	0.1746	8.3514	0.0469	0.2708	0.0230	0.0214	0.0039	0.0060	0.0164	0.0077	0.0039	0.0006	0.0002	0.0005	0.0012	3.40
FODDER	CONTROL	21.5102	148.8965	25.1696	29.9282	0.6770	1.0224	0.1151	0.5150	0.3096	0.0953	0.0583	0.0069	0.0026	0.0075	0.0080	165.92

APPENDIX E

Average Concentration of Selected Elements in Crop Tissue — Rosemount Watershed

Data found in the following tables are mean values representing selected elemental concentrations of corn and grass tissue from sludge and control treatment areas of the Rosemount Watershed study.

Table E.1 Average elemental concentration of corn leaf tissue at silking from sludge treatment areas, Rosemount Watershed .

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1974	2.96	0.34	2.45	28.0	51.0	9.9	—	0.70	2.40	0.20	0.14
1975	3.25	0.34	2.04	23.0	41.0	10.0	4.0	0.40	1.20	0.01	0.06
1976	2.64	0.30	1.96	46.7	55.2	11.0	15.1	1.40	4.00	0.90	0.01
1977	3.25	0.32	2.02	47.7	49.2	10.3	8.5	0.40	0.80	0.60	0.16
1978	3.43	0.38	2.28	43.5	48.3	10.8	6.2	0.60	1.43	0.10	0.10
1979	3.55	0.34	1.99	57.2	44.0	12.0	11.2	0.60	1.00	0.40	0.12
1982	3.15	0.35	1.73	92.4	58.0	8.6	9.4	0.31	0.12	0.26	0.17
1983	3.02	0.33	2.08	54.7	37.4	10.6	8.3	0.66	0.74	0.24	0.11
Ave	3.16	0.34	2.07	49.1	48.0	10.4	9.0	0.63	1.46	0.34	0.11

Table E.2 Average elemental concentration of corn leaf tissue at silking from control treatment area, Rosemount Watershed .

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1974	3.11	0.33	2.42	32.0	49.0	8.0	—	0.80	2.40	0.30	0.16
1975	3.22	0.32	2.01	23.0	61.0	7.0	6.0	0.50	1.30	0.40	0.07
1976	2.80	0.28	2.23	29.1	82.6	7.9	13.0	1.00	2.90	1.00	0.01
1977	3.04	0.31	2.36	25.3	72.9	7.9	7.6	0.30	0.01	1.00	0.01
1978	3.43	0.32	2.11	22.5	80.1	7.8	5.1	0.68	1.61	0.10	0.01
1979	3.52	0.32	1.93	30.4	130.0	10.1	8.5	0.60	0.70	0.90	0.07
1982	3.17	0.29	1.81	31.0	82.1	9.4	7.3	0.36	0.32	0.44	0.08
1983	3.20	0.30	1.96	23.5	89.6	10.9	8.1	—	0.44	0.19	0.08
Ave	3.19	0.31	2.10	27.1	80.9	8.6	7.9	0.61	1.21	0.54	0.06

Table E.3 Average elemental concentration of corn fodder from sludge treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1974	1.13	0.22	1.04	16.7	—	3.5	4.9	0.61	0.87	0.32	0.07
1975	1.39	0.24	0.83	20.2	26.0	3.6	2.9	0.47	0.60	0.39	0.04
1976	1.29	0.21	0.83	33.4	28.0	5.0	6.5	1.00	1.95	0.97	0.16
1977	1.26	0.22	0.93	28.3	24.5	3.0	3.9	0.70	1.14	0.75	0.16
1978	1.24	0.23	0.84	21.5	16.8	2.6	3.7	0.84	0.99	0.29	0.26
1979	1.22	0.23	0.98	31.7	19.8	3.7	3.0	1.48	0.92	1.12	0.10
1980	1.31	0.24	0.84	37.1	22.1	3.1	3.6	1.37	0.51	0.78	0.10
1981	1.28	0.25	1.01	42.8	37.7	4.0	5.2	0.61	0.37	0.43	0.44
1982	1.33	0.25	1.01	54.7	38.9	4.3	4.7	1.26	0.37	0.77	0.07
1983	1.28	0.22	0.87	43.4	26.3	4.6	4.6	2.06	0.70	0.59	0.35
1984	1.13	0.23	0.74	29.6	15.7	9.6	5.3	0.46	0.25	0.27	0.50
1985	1.18	0.20	0.77	40.2	26.5	7.9	3.5	1.47	0.49	0.31	0.39
1986	1.11	0.23	0.93	43.3	24.0	5.6	4.0	0.77	0.45	0.21	0.50
Ave	1.24	0.23	0.89	34.1	25.5	4.6	4.3	1.01	0.74	0.55	0.24

Table E.4 Average elemental concentration of corn fodder from control treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1974	1.17	0.21	1.12	17.0	33.5	3.1	5.4	0.79	0.78	0.48	0.07
1975	1.34	0.18	0.82	17.6	30.6	3.5	3.6	0.47	0.85	0.42	0.04
1976	1.16	0.18	0.79	25.2	28.8	4.8	6.3	0.90	2.02	0.90	0.14
1977	1.13	0.18	0.90	18.9	26.6	2.5	3.8	0.84	0.85	0.65	0.14
1978	1.05	0.17	0.75	13.7	20.9	2.8	4.0	0.38	0.86	0.45	0.25
1979	1.18	0.18	1.01	16.8	32.7	4.0	2.9	0.68	0.94	0.65	0.07
1980	1.23	0.20	0.76	22.2	37.0	2.7	3.4	0.99	0.38	0.83	0.06
1981	1.25	0.24	1.12	46.8	35.3	5.3	5.5	0.83	0.50	0.51	0.48
1982	1.32	0.21	0.92	25.4	59.5	4.6	4.7	0.86	0.35	0.81	0.05
1983	1.23	0.18	0.83	17.9	46.1	5.9	4.6	1.32	0.74	0.45	0.33
1984	1.17	0.18	0.88	18.7	38.8	8.7	5.3	0.31	0.36	0.33	0.51
1985	1.20	0.14	0.69	18.5	54.6	7.9	3.6	0.28	0.50	0.24	0.33
1986	1.05	0.14	0.94	19.7	32.0	6.1	3.7	0.48	0.44	0.17	0.51
Ave	1.19	0.18	0.89	21.4	36.6	4.8	4.4	0.7	0.74	0.53	0.23

Table E.5 Average elemental concentration of corn grain from sludge treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
		%					μg g^{-1}				
1974	1.55	0.38	0.59	22.1	—	1.4	3.3	0.35	0.30	0.20	0.02
1975	1.80	0.38	0.55	21.7	—	2.0	1.1	0.15	—	0.29	0.01
1976	1.78	0.35	0.42	38.2	9.6	4.0	3.2	0.19	0.91	0.38	0.04
1977	1.61	0.34	0.39	28.1	6.4	0.1	1.3	0.26	0.70	0.23	0.03
1978	1.66	0.34	0.39	24.6	6.6	0.3	1.7	0.23	0.74	0.23	0.25
1979	1.57	0.36	0.44	26.5	6.0	0.7	1.5	0.30	0.32	0.16	0.04
1980	1.76	0.37	0.41	34.5	8.0	1.4	2.0	0.30	0.30	0.32	0.04
1981	1.58	0.37	0.49	34.0	7.2	2.1	3.1	0.13	0.11	0.23	0.74
1982	1.58	0.36	0.45	36.1	8.4	1.6	2.6	0.06	0.14	0.35	0.02
1983	1.66	0.32	0.40	30.8	7.1	2.2	0.6	0.09	0.56	0.25	0.50
1984	1.53	0.33	0.39	25.3	6.2	11.1	3.1	0.13	0.16	0.28	0.56
1985	1.58	0.30	0.37	31.7	7.5	4.1	2.5	0.14	0.35	0.31	0.29
1986	1.45	0.32	0.39	31.7	6.4	1.9	3.1	0.17	0.44	0.20	0.61
Ave	1.62	0.35	0.44	29.6	7.2	2.5	2.2	0.19	0.42	0.26	0.24

Table E.6 Average elemental concentration of corn grain from control treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
		%					μg g^{-1}				
1974	1.59	0.34	0.53	18.8	13.6	1.4	3.0	0.23	0.32	0.21	0.02
1975	1.72	0.26	0.47	15.3	—	1.3	2.4	0.19	—	0.32	0.01
1976	1.68	0.32	0.38	32.1	9.7	3.9	3.0	0.29	0.87	0.65	0.05
1977	1.55	0.31	0.38	24.5	5.8	0.8	1.7	0.25	0.62	0.20	0.13
1978	1.55	0.28	0.35	18.9	5.8	0.9	1.8	0.23	0.74	0.43	0.25
1979	1.50	0.31	0.42	21.3	6.2	2.5	1.7	0.30	0.32	0.15	0.04
1980	1.60	0.31	0.36	26.2	7.9	1.3	1.9	0.30	0.30	0.42	0.04
1981	1.59	0.32	0.54	22.1	8.3	2.9	3.0	0.12	0.25	0.29	0.78
1982	1.55	0.32	0.47	27.1	9.1	2.3	2.8	0.04	0.22	0.42	0.02
1983	1.56	0.28	0.39	20.6	7.4	4.1	2.8	0.10	0.56	0.16	0.50
1984	1.57	0.29	0.41	20.5	6.0	6.3	3.4	0.15	0.18	0.45	0.44
1985	1.62	0.22	0.35	21.8	8.4	4.0	2.6	0.17	0.41	0.17	0.27
1986	1.30	0.21	0.34	21.6	5.7	2.3	2.6	0.11	0.44	0.15	0.55
Ave	1.57	0.29	0.41	22.4	7.8	2.6	2.5	0.19	0.44	0.31	0.24

Table E.7 Average elemental concentration of corn cob from sludge treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1974	0.30	0.04	0.75	11.2	—	3.4	4.3	1.36	0.30	0.89	0.04
1975	0.32	0.04	0.44	8.4	—	2.1	—	0.39	—	0.38	—
1976	0.31	0.03	0.40	20.1	5.5	2.7	2.1	1.21	—	1.04	—
1977	0.29	0.03	0.47	18.5	4.2	2.5	1.4	0.35	0.60	1.29	0.10
1978	0.29	0.02	0.39	10.8	4.8	2.6	1.4	1.32	0.74	0.79	0.25
1979	0.34	0.03	0.51	17.1	5.1	2.8	1.5	2.65	0.32	2.62	0.04
1980	0.27	0.03	0.45	26.3	6.1	2.5	1.8	2.60	0.30	2.24	0.04
1981	0.27	0.04	0.62	58.4	8.6	2.0	1.4	1.89	0.30	1.45	0.04
1982	0.25	0.02	0.55	45.3	7.6	1.8	1.6	1.69	0.12	1.56	0.02
1983	0.25	0.02	4.93	48.1	7.4	9.0	2.4	0.57	0.54	0.46	0.50
1984	0.22	0.03	0.27	29.2	4.1	7.8	1.8	0.41	0.12	0.37	1.60
1985	0.23	0.02	0.52	39.5	6.3	6.4	1.9	0.54	0.36	0.46	1.40
1986	0.25	0.02	0.59	38.9	5.8	7.2	3.6	0.49	0.44	0.25	1.03
Ave	0.28	0.03	0.84	28.6	6.0	4.1	1.9	1.19	0.38	1.06	0.46

Table E.8 Average elemental concentration of corn cob from control treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1974	0.31	0.04	0.70	13.1	12.4	3.4	3.5	1.41	0.30	0.91	0.09
1975	0.33	0.04	0.51	10.1	—	3.1	—	0.65	—	0.47	—
1976	0.31	0.03	0.43	11.4	6.3	2.5	2.7	1.50	—	1.35	—
1977	0.31	0.03	0.36	13.3	4.7	2.4	1.5	1.34	0.60	1.12	0.15
1978	0.29	0.02	0.37	6.6	5.0	2.2	1.5	1.18	0.74	1.05	0.25
1979	0.33	0.03	0.59	10.4	5.4	2.9	1.8	2.40	0.32	2.64	0.04
1980	0.24	0.02	0.40	15.8	7.0	2.4	1.9	3.80	0.30	3.26	0.04
1981	0.27	0.03	0.57	11.5	8.3	2.0	1.7	2.00	0.30	1.67	0.03
1982	0.23	0.02	0.58	16.0	11.1	1.9	1.8	2.23	0.10	1.74	0.02
1983	0.24	0.02	0.54	13.3	8.1	11.3	2.9	0.72	0.53	0.57	0.50
1984	0.22	0.03	0.33	13.7	5.0	10.6	2.2	0.32	0.11	0.33	2.39
1985	0.24	0.02	0.49	12.4	6.2	7.4	2.0	0.45	0.36	0.45	1.41
1986	0.26	0.01	0.63	12.4	4.4	5.8	3.0	0.39	0.46	0.16	0.93
Ave	0.28	0.03	0.50	12.3	7.0	4.4	2.0	1.41	0.37	1.21	0.53

Table E.9 Average elemental concentration of corn stover from sludge treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1974	0.92	0.12	1.44	13.3	62.0	5.1	6.3	0.72	1.41	0.34	0.12
1975	1.21	0.15	1.14	20.6	51.9	5.2	4.9	0.76	1.20	0.48	0.08
1976	1.05	0.12	1.21	31.4	45.4	6.2	9.8	1.62	3.10	1.45	0.28
1977	1.05	0.11	1.63	30.4	48.4	6.4	7.4	1.27	1.74	1.23	0.20
1978	0.85	0.12	1.56	19.3	34.0	6.1	7.0	1.66	1.41	0.28	0.27
1979	0.98	0.12	1.67	39.7	37.8	7.2	5.0	2.55	1.70	1.90	0.17
1980	0.91	0.11	1.54	43.4	45.7	5.7	6.2	2.60	0.85	1.11	0.19
1981	1.15	0.16	1.64	50.0	74.8	6.3	7.9	0.90	0.66	0.46	0.20
1982	1.22	0.15	1.82	80.4	84.8	8.4	8.0	2.73	0.71	1.16	0.14
1983	1.01	0.12	1.52	58.6	54.3	6.8	7.8	4.68	0.91	1.06	0.14
1984	0.83	0.15	1.25	34.4	29.1	8.0	8.5	0.87	0.39	0.24	0.22
1985	0.87	0.11	1.36	51.5	56.5	13.3	5.2	3.49	0.70	0.29	0.28
1986	0.86	0.15	1.67	58.9	49.9	10.1	5.3	1.56	0.47	0.22	0.25
Ave	0.99	0.13	1.50	40.9	51.9	7.3	6.9	1.95	1.17	0.78	0.20

Table E.10 Average elemental concentration of corn stover from control treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1974	0.96	0.13	1.62	16.1	51.2	4.3	7.4	1.13	1.18	0.63	0.11
1975	1.20	0.13	1.11	20.2	56.4	5.1	4.9	0.65	1.56	0.49	0.08
1976	0.84	0.08	1.23	21.6	50.2	6.1	9.9	1.34	3.43	1.04	0.25
1977	0.80	0.06	1.61	13.4	54.6	4.4	6.7	1.43	2.51	1.07	0.14
1978	0.65	0.07	1.26	9.4	40.5	5.0	6.7	0.41	1.01	0.37	0.26
1979	1.03	0.09	1.59	13.8	59.9	5.6	4.2	0.77	1.57	0.80	0.10
1980	0.95	0.11	1.37	18.4	82.1	4.6	5.6	1.30	0.50	0.85	0.09
1981	1.11	0.19	1.72	74.2	63.8	8.0	8.2	1.29	0.75	0.52	0.27
1982	1.26	0.13	1.55	25.3	132.4	7.9	7.7	1.59	0.55	1.08	0.09
1983	1.04	0.09	1.42	15.5	99.2	6.8	7.1	2.91	1.00	0.77	0.08
1984	0.95	0.09	1.48	18.0	79.6	10.8	7.8	0.49	0.60	0.21	0.21
1985	0.94	0.08	1.14	16.1	120.8	12.5	5.3	0.38	0.65	0.27	0.14
1986	0.89	0.06	1.80	18.8	72.4	11.2	5.3	0.98	0.44	0.19	0.35
Ave	0.97	0.10	1.45	21.6	74.1	7.1	6.7	1.13	1.21	0.64	0.17

Table E.11 Average elemental concentration of reed canarygrass from sludge treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1976	3.03	0.30	3.55	40.1	61.1	8.2	5.8	8.10	1.90	2.60	0.12
1977	3.28	0.38	3.18	51.6	79.5	9.4	4.1	4.80	1.20	2.00	0.11
1978	3.26	0.45	3.30	66.9	70.5	10.7	4.4	10.33	1.73	1.56	0.16
1979	3.45	0.43	2.95	64.2	59.9	15.6	4.3	25.90	2.50	1.90	0.01
1980	3.18	0.42	2.89	58.5	57.0	15.1	4.5	58.50	1.08	1.84	0.11
1981	3.09	0.45	3.43	75.6	59.3	23.7	5.0	43.36	2.32	2.39	0.13
1982	3.29	0.46	3.47	57.9	53.2	15.1	4.4	19.86	1.40	1.41	0.08
1983	2.17	0.42	3.23	58.7	—	13.6	—	43.60	1.60	2.00	0.11
Ave	3.09	0.41	3.25	59.2	63.0	13.9	4.7	26.81	1.72	1.96	0.10

Table E.12 Average elemental concentration of reed canarygrass from control treatment area, Rosemount Watershed study.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	%			μg g^{-1}							
1976	3.12	0.27	3.07	27.0	66.8	5.9	5.6	1.50	1.40	2.40	0.09
1977	2.84	0.31	2.91	25.7	76.7	5.2	4.2	1.00	0.80	2.00	0.11
1978	3.02	0.34	3.02	31.9	85.5	5.8	4.0	0.63	1.17	2.04	0.10
1979	3.56	0.35	3.10	30.5	121.0	6.4	3.9	0.01	0.90	1.60	0.01
1980	3.03	0.35	2.75	29.0	112.6	5.4	4.0	1.40	0.01	2.14	0.04
1981	3.00	0.32	2.89	21.3	98.2	6.9	4.0	1.80	0.38	3.19	0.03
1982	3.41	0.31	3.00	27.6	101.9	6.2	3.7	0.90	0.42	1.52	0.01
1983	2.16	0.32	2.99	27.5	—	6.0	—	2.50	0.80	2.10	0.06
Ave	3.02	0.32	2.97	27.6	94.6	6.0	4.2	1.22	0.74	2.12	0.06

APPENDIX F

Total Elements Removed by Crops — Rosemount Watershed

Data found in the following tables are mean annual values representing total amounts of elements removed by corn and grass crops from sludge and control treatment areas of the Rosemount Watershed study.

Table F.1 Total elements removed by corn fodder from sludge treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	— kg ha^{-1} —			— g ha^{-1} —							
1974	174	34	160	257	493	53.2	75.3	9.4	13.4	5.0	1.0
1975	197	34	119	286	370	51.5	47.1	6.7	8.5	5.5	0.6
1976	187	30	120	485	405	73.1	94.7	14.5	28.5	14.1	2.3
1977	230	39	169	514	445	54.5	71.4	12.7	20.7	13.5	2.9
1978	246	46	171	426	346	52.3	73.8	9.8	13.8	5.8	3.8
1979	219	41	177	570	359	66.3	54.4	14.8	9.7	20.2	1.0
1980	151	33	113	500	298	42.1	47.8	10.3	4.5	10.5	0.8
1981	244	47	193	818	711	75.6	97.5	6.3	3.9	8.1	7.5
1982	236	44	180	980	695	76.0	82.8	22.6	6.4	13.7	1.2
1983	191	33	131	654	391	68.6	73.8	28.3	10.1	8.8	5.2
1984	186	37	123	491	258	157.3	87.5	7.4	4.2	4.5	8.1
1985	185	32	120	628	407	120.8	54.7	23.1	7.6	4.9	6.1
1986	188	38	161	746	415	93.5	68.3	13.4	7.6	3.4	8.3
Sum	2634	488	1938	7355	5592	984.8	929.1	179.3	138.9	118.0	48.8

Table F.2 Total elements removed by corn fodder from control treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	— kg ha^{-1} —			— g ha^{-1} —							
1974	170	30	163	247	488	44.9	78.4	11.4	11.3	7.0	1.1
1975	153	20	94	201	349	39.3	40.8	5.3	9.6	4.8	0.5
1976	186	28	127	404	462	76.7	101.4	14.4	32.4	14.4	2.3
1977	214	34	171	357	503	46.8	72.6	15.9	16.1	12.3	2.5
1978	217	35	156	285	431	57.7	82.4	4.9	12.4	9.3	3.8
1979	201	31	171	286	554	68.2	49.6	6.9	9.1	11.1	0.7
1980	123	24	91	266	443	32.6	39.9	6.9	3.3	9.9	0.4
1981	207	39	183	780	582	87.4	89.5	7.4	5.0	8.3	6.8
1982	211	34	147	408	954	72.9	75.8	13.8	5.5	12.8	0.8
1983	200	29	135	290	747	95.2	74.6	21.7	11.9	7.3	5.3
1984	181	27	137	292	600	135.8	82.1	4.9	5.6	5.1	7.9
1985	160	19	93	249	695	104.4	48.0	3.9	6.6	3.2	4.4
1986	166	22	149	310	515	95.4	58.2	7.5	6.9	2.6	8.0
Sum	2387	373	1817	4374	7323	957.3	893.2	124.9	135.7	108.1	44.5

Table F.3 Total elements removed by corn grain from sludge treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	— kg ha^{-1} —			— g ha^{-1} —							
1974	98	24	37	139	—	8.7	20.5	2.2	1.9	1.3	0.1
1975	108	23	33	131	—	12.2	12.0	0.9	—	1.7	—
1976	105	21	25	227	58	23.7	19.2	1.1	5.4	2.2	0.2
1977	143	30	34	250	57	1.0	11.7	2.3	6.2	2.0	1.2
1978	175	36	41	259	69	3.4	18.2	2.4	7.8	2.4	2.6
1979	137	31	38	231	53	6.0	12.7	2.6	2.8	1.4	0.3
1980	127	27	29	249	58	10.3	14.3	2.2	2.2	2.3	0.3
1981	142	33	44	307	65	19.2	28.3	1.1	0.9	2.0	6.7
1982	145	33	41	332	77	14.4	24.1	0.5	1.3	3.2	0.2
1983	126	25	31	234	54	16.7	23.9	0.6	4.2	1.9	3.8
1984	125	27	32	206	51	91.4	25.4	1.0	1.3	2.4	4.5
1985	129	25	30	258	60	32.3	20.6	1.2	2.9	2.5	2.4
1986	124	28	33	274	54	16.5	26.3	1.4	3.8	1.6	5.2
Sum	1684	361	449	3095	655	255.8	257.2	19.5	40.7	26.9	27.5

Table F.4 Total elements removed by corn grain from control treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	— kg ha^{-1} —			— g ha^{-1} —							
1974	92	20	31	109	79	8.0	17.7	1.3	1.9	1.2	0.1
1975	76	12	21	68	—	5.5	10.7	0.8	—	1.4	—
1976	116	22	26	222	67	26.7	21.0	2.0	6.0	4.5	0.3
1977	144	29	35	228	54	7.6	15.8	2.3	5.8	1.9	1.2
1978	151	27	34	185	57	8.5	17.8	2.2	7.2	4.3	2.4
1979	111	23	31	158	46	18.2	12.6	2.2	2.4	1.1	0.3
1980	100	19	23	163	49	8.3	11.5	1.9	1.9	2.6	0.2
1981	115	23	39	160	59	20.6	21.9	0.9	1.8	2.0	5.7
1982	125	26	38	219	73	18.6	22.7	0.3	1.8	3.4	0.2
1983	126	22	31	167	60	33.5	22.7	0.8	4.5	1.3	4.0
1984	112	21	29	146	43	45.3	24.5	1.0	1.3	3.2	3.1
1985	105	14	23	143	54	25.4	16.6	1.0	2.7	1.1	1.7
1986	107	18	28	177	47	18.8	21.5	0.9	3.6	1.3	4.6
Sum	1480	276	388	2144	688	245.0	237.0	17.6	40.9	29.3	23.9

Table F.5 Total elements removed by corn cob from sludge treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	— kg ha^{-1} —			g ha^{-1}							
1974	3	<1	8	12	—	3.8	4.8	1.5	0.3	1.0	<0.1
1975	3	<1	5	9	—	2.3	—	0.4	<0.1	0.4	<0.1
1976	3	<1	4	21	6	2.8	2.2	1.3	<0.1	1.1	<0.1
1977	4	<1	7	27	6	3.6	2.0	0.5	0.9	1.9	0.1
1978	5	<1	7	19	8	4.5	2.4	1.2	0.6	1.4	0.2
1979	5	<1	7	24	7	3.9	2.2	1.9	0.2	3.7	<0.1
1980	2	<1	5	30	7	2.9	2.0	1.5	0.2	2.6	<0.1
1981	4	1	9	87	13	3.1	2.2	1.4	0.2	2.2	<0.1
1982	4	<1	8	65	11	2.5	2.3	2.5	0.2	2.2	<0.1
1983	3	<1	6	59	9	11.0	3.0	0.7	0.6	0.6	0.6
1984	3	<1	4	38	5	10.1	2.3	0.5	0.2	0.5	2.1
1985	3	<1	7	55	9	9.1	2.7	0.8	0.5	0.7	2.0
1986	3	<1	8	54	8	10.0	5.0	0.7	0.6	0.3	1.4
Sum	46	5	85	501	89	69.5	33.1	14.9	4.5	18.5	6.4

Table F.6 Total elements removed by corn cob from control treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	— kg ha^{-1} —			g ha^{-1}							
1974	3	<1	7	14	13	3.5	3.6	1.4	0.3	0.9	0.1
1975	3	<1	4	8	—	2.4	—	0.5	—	0.4	<0.1
1976	4	<1	6	16	9	3.4	3.9	2.1	—	1.9	<0.1
1977	5	<1	5	20	7	3.7	2.3	2.0	0.9	1.7	0.2
1978	5	<1	6	12	9	3.8	2.5	1.0	0.6	1.8	0.2
1979	4	<1	7	13	7	3.5	2.3	1.5	0.2	3.3	<0.1
1980	1	<1	4	16	7	2.5	1.9	1.9	0.2	3.3	<0.1
1981	3	<1	7	15	11	2.5	2.2	1.3	0.2	2.1	<0.1
1982	3	<1	8	23	16	2.6	2.5	3.1	0.1	2.4	<0.1
1983	3	<1	7	18	11	15.2	3.9	1.0	0.7	0.8	0.7
1984	3	<1	5	20	7	15.3	3.2	0.5	0.2	0.5	3.4
1985	3	<1	6	16	8	9.7	2.6	0.6	0.5	0.6	1.9
1986	3	<1	8	16	6	7.7	3.9	0.5	0.6	0.2	1.2
Sum	45	4	83	207	109	75.8	34.8	17.4	4.4	19.9	7.7

Table F.7 Total elements removed by corn stover from sludge treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	— kg ha^{-1} —			g ha^{-1}							
1974	73	9	114	106	493	40.8	50.0	5.7	11.2	2.7	0.9
1975	86	11	82	147	370	37.0	35.1	5.4	8.5	3.4	0.6
1976	79	9	91	237	342	46.6	73.3	12.1	23.1	10.8	2.1
1977	82	9	128	238	382	49.9	57.7	9.9	13.6	9.6	1.6
1978	66	10	123	148	268	44.4	53.2	6.2	5.4	2.0	1.0
1979	77	9	132	315	300	56.4	39.5	10.3	6.7	15.1	0.7
1980	23	6	79	221	234	28.9	31.5	6.6	2.1	5.6	0.5
1981	98	14	139	424	633	53.3	67.1	3.8	2.8	3.9	0.8
1982	87	11	131	583	607	59.1	56.4	19.6	4.9	8.3	1.0
1983	62	8	95	361	328	40.9	47.0	27.0	5.3	6.3	0.8
1984	59	11	88	247	201	55.8	59.8	5.9	2.7	1.6	1.5
1985	53	7	83	315	338	79.4	31.5	21.2	4.2	1.7	1.7
1986	60	10	119	418	353	67.0	37.1	11.3	3.2	1.5	1.7
Sum	905	122	1403	3759	4848	659.5	639.1	145.0	93.7	72.5	14.9

Table F.8 Total elements removed by corn stover from control treatment areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	— kg ha^{-1} —			g ha^{-1}							
1974	74	10	125	125	396	33.4	57.1	8.7	9.1	4.9	0.9
1975	74	8	69	125	349	31.4	30.1	4.0	9.6	3.0	0.5
1976	65	6	95	166	386	46.6	76.5	10.3	26.4	8.0	2.0
1977	65	5	131	109	442	35.5	54.5	11.6	9.4	8.7	1.1
1978	60	7	116	89	366	45.4	62.1	1.7	4.6	3.2	1.2
1979	86	8	133	115	501	46.5	34.7	3.2	6.5	6.7	0.4
1980	22	5	65	87	386	21.8	26.5	3.1	1.2	4.0	0.2
1981	89	15	136	605	512	64.3	65.4	5.2	3.0	4.2	1.1
1982	82	9	101	166	866	51.7	50.6	10.4	3.6	7.0	0.6
1983	71	6	96	105	676	46.5	48.0	19.9	6.7	5.2	0.6
1984	66	6	103	126	550	75.2	54.4	3.4	4.2	1.4	1.4
1985	52	4	64	89	633	69.3	28.8	2.3	3.4	1.5	0.8
1986	56	4	113	116	462	68.9	32.8	6.0	2.7	1.1	2.2
Sum	863	93	1346	2023	6526	636.5	621.5	89.8	90.4	58.9	13.0

Table F.9 Total elements removed by reed canarygrass from sludge areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	kg ha^{-1}			g ha^{-1}							
1976	291	28	327	400.0	620.0	80.0	50.0	80.0	20.0	20.0	1.0
1977	428	48	406	660.0	1000.0	120.0	50.0	60.0	20.0	20.0	1.0
1978	317	43	316	642.3	654.5	101.3	41.7	100.0	17.0	15.0	1.6
1979	353	44	301	690.0	640.0	170.0	50.0	280.0	30.0	20.0	1.0
1980	334	44	303	580.0	550.0	130.0	40.0	205.0	7.6	20.0	1.0
1981	389	57	445	945.8	750.0	302.8	62.3	608.9	31.6	35.8	1.6
1982	378	54	436	679.2	593.8	181.8	51.1	231.2	15.6	16.8	0.9
1983	215	42	320	581.1	—	134.6	—	431.6	15.8	19.8	1.1
Sum	2705	360	2855	5178.4	4808.3	1220.5	345.1	1996.7	157.6	167.4	9.2

Table F.10 Total elements removed by reed canarygrass from control areas.

Year	N	P	K	Zn	Mn	Cu	B	Cr	Pb	Ni	Cd
	kg ha^{-1}			g ha^{-1}							
1976	242	27	311	220.0	500.0	40.0	40.0	10.0	10.0	20.0	1.0
1977	293	32	299	260.0	770.0	50.0	40.0	100.0	10.0	20.0	1.0
1978	312	35	311	328.0	872.2	58.9	40.7	6.3	12.0	20.9	1.0
1979	329	32	287	280.0	1100.0	60.0	40.0	10.0	10.0	20.0	1.0
1980	276	32	250	260.0	980.0	50.0	30.0	10.0	5.0	20.0	0.1
1981	340	38	356	254.7	1120.0	77.1	47.8	16.9	4.3	34.7	0.4
1982	320	31	330	265.3	948.7	60.8	35.6	9.8	3.8	14.9	0.1
1983	207	31	287	264.0	—	57.6	—	24.0	7.7	20.2	0.6
Sum	2318	257	2432	2132.0	6290.9	454.4	274.1	187.0	62.8	170.7	5.2

APPENDIX G

Elements Concentrated in and Removed by Grass — Rosemount Watershed

Data in the following tables are examples of elemental concentrations in reed canarygrass tissue in the fourth year of the stand. Harvest consisted of three cuttings during the growing season.

ROSEMOUNT REED CANARY GRASS 1978

CUTTING	YEAR	ID	P (ug/g)	K ====>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	%N
- - - - CONTROL - - - -																		
1ST	1978	3-1	3681.80	28694.00	3453.80	3366.50	16.94	72.66	39.23	88.11	32.26	6.72	4.42	1.85	0.10	1.41	0.97	2.94
	1978	3-1	3641.40	28820.00	3525.70	3435.60	17.12	73.76	40.31	89.08	32.86	6.89	4.24	2.68				
2ND	1978	3-1	3425.50	31235.00	3214.60	2741.10	15.79	68.60	23.43	97.21	32.00	6.86	3.99	2.68	0.07	0.97	1.03	2.76
	1978	3-1	3411.60	30767.00	3171.20	2732.90	14.91	67.97	23.73	96.01	33.12	6.79	3.97	1.97				
3RD	1978	3-1	3458.50	32320.00	2663.40	2248.40	14.66	66.10	15.96	109.90	28.86	5.99	3.97	2.61	0.10	1.03	0.90	2.66
	1978	3-1	3415.10	31968.00	2623.20	2227.00	13.86	65.63	16.15	109.81	28.93	5.95	3.90	2.43				
1ST	1978	3-2	3314.00	27531.00	3335.10	3367.90	13.80	72.55	51.59	88.03	35.91	5.03	3.88	1.50	0.10	1.16	0.29	3.39
	1978	3-2	3324.30	27155.00	3368.80	3391.20	14.47	74.09	48.96	88.41	35.48	5.04	3.87	1.67				
2ND	1978	3-2	3262.10	32138.00	3720.00	3294.20	10.45	73.05	56.67	108.54	34.26	7.47	4.16	3.17	0.10	1.29	0.22	2.55
	1978	3-2	3351.30	32207.00	3790.70	3327.20	10.92	74.69	56.94	109.33	33.33	7.42	4.21	2.52				
3RD	1978	3-2	3609.80	32028.00	3115.30	3039.40	13.70	73.66	23.66	93.77	28.15	5.05	4.20	1.41	0.10	1.10	0.29	3.48
	1978	3-2	3548.80	31626.00	3034.70	2978.10	13.80	71.92	22.83	91.87	27.59	4.78	4.16	2.34				
1ST	1978	3-4	3220.60	30871.00	3402.30	3044.30	10.62	67.69	44.92	73.84	31.85	5.31	3.61	1.48	0.10	1.10	0.63	2.92
	1978	3-4	3206.10	30888.00	3439.50	3031.60	10.09	67.22	44.95	74.33	31.39	5.26	3.57	2.04				
2ND	1978	3-4	3162.70	28871.00	4143.70	3424.30	10.24	71.47	36.29	67.53	33.41	4.33	3.80	1.76	0.10	1.22	0.63	3.28
	1978	3-4	3181.80	29275.00	4055.60	3352.00	10.72	71.07	37.15	67.07	32.23	4.39	3.92	1.50				
3RD	1978	3-4	3303.20	32627.00	4084.30	2787.20	8.28	67.39	27.48	39.22	23.41	4.31	3.72	1.44	0.10	1.03	0.63	3.32
	1978	3-4	3323.60	32567.00	4140.70	2819.60	8.74	68.42	27.01	38.70	23.22	4.34	3.82	2.17				
- - - -SLUDGE - - - -																		
1ST	1978	2-3	4071.00	35767.00	3668.90	2367.80	13.70	68.64	113.28	55.63	53.39	7.59	3.56	0.92	0.12	1.29	2.05	3.28
	1978	2-3	4044.90	35325.00	3725.10	2432.00	14.75	70.23	115.28	56.89	55.45	7.73	3.68	1.06				
2ND	1978	2-3	4684.30	32558.00	5232.00	3078.90	27.35	86.07	396.90	57.44	63.34	10.45	4.55	1.57	0.15	1.54	6.78	3.06
	1978	2-3	4647.20	32467.00	5257.60	3107.00	28.62	87.90	403.06	57.28	65.78	10.58	4.52	1.48				
3RD	1978	2-3	4104.40	35490.00	4110.00	2868.00	15.10	78.23	136.72	49.91	48.87	8.22	4.16	1.58	0.10	1.35	1.71	3.39
	1978	2-3	4069.30	35620.00	4060.30	2845.90	15.10	76.72	135.81	49.96	47.85	8.00	3.97	1.87				
1ST	1978	2-5	4146.80	30411.00	4394.00	3012.50	113.50	131.54	660.50	53.37	59.80	12.53	4.65	1.36	0.19	2.62	27.86	2.84
	1978	2-5	4145.10	30268.00	4357.20	3006.30	109.76	130.41	647.66	53.93	58.30	12.62	4.49	1.29				
2ND	1978	2-5	4316.00	37003.00	3373.30	2382.80	11.26	66.42	238.47	48.83	48.71	8.52	4.01	1.53	0.12	1.10	2.12	3.13
	1978	2-5	4271.00	36552.00	3368.20	2357.40	11.06	71.89	233.37	47.96	46.55	8.58	3.95	3.06				
3RD	1978	2-5	4772.60	35949.00	4239.90	2727.30	79.62	138.56	496.02	71.70	66.94	12.67	4.64	3.19	0.15	2.50	17.76	3.34
	1978	2-5	4784.20	35884.00	4179.20	2717.70	77.37	128.00	518.99	70.70	71.45	12.73	4.60	1.69				
1ST	1978	2-8	4697.50	35855.00	4605.60	3181.40	41.08	98.27	276.94	77.81	78.63	10.38	5.15	1.95	0.20	1.86	8.48	3.36
	1978	2-8	4616.10	34900.00	4417.10	3124.30	38.46	95.03	269.26	75.09	76.46	9.90	4.97	1.64				
2ND	1978	2-8	4491.90	32136.00	4103.90	3163.30	17.71	78.01	341.16	93.25	76.43	9.88	4.22	1.14	0.17	1.22	2.94	3.31
	1978	2-8	4551.20	32740.00	4083.90	3167.60	16.71	77.65	339.30	93.71	79.62	10.16	4.13	2.04				
3RD	1978	2-8	4107.10	27706.00	4371.10	3544.80	13.09	70.67	444.61	67.47	61.33	9.46	3.79	1.51	0.14	1.22	2.39	3.28
	1978	2-8	4276.60	29420.00	4712.90	3691.80	13.06	73.75	480.61	69.86	62.17	9.88	4.15	1.93				
1ST	1978	3-6	4768.90	34007.00	4148.70	3063.10	21.19	78.23	362.43	66.56	85.26	9.43	4.29	1.81	0.16	1.67	4.20	3.27
	1978	3-6	4825.90	34748.00	4253.50	3130.90	21.27	81.12	359.08	68.27	87.94	9.84	4.32	1.41				
2ND	1978	3-6	4856.40	30438.00	5021.10	3761.40	16.72	79.48	534.46	73.25	81.91	9.38	4.39	2.03	0.15	1.41	2.67	3.34
	1978	3-6	4838.10	30506.00	5028.20	3782.50	16.93	79.61	536.97	73.23	83.29	9.45	4.37	2.31				
3RD	1978	3-6	4629.70	33741.00	4691.70	3092.50	23.28	84.31	274.49	84.22	69.07	10.85	4.56	1.70	0.16	1.16	3.91	3.28
	1978	3-6	4589.20	33292.00	4730.40	3068.30	24.19	84.07	279.32	83.85	67.89	10.88	4.36	0.57				
1ST	1978	3-9	4193.00	34225.00	4004.10	2683.40	17.68	75.87	343.62	86.20	73.13	10.32	4.15	2.19	0.15	1.10	2.60	3.35
	1978	3-9	4197.40	33710.00	3954.70	2663.30	16.56	75.31	341.53	86.08	74.38	10.23	4.12	1.59				
2ND	1978	3-9	4405.00	31156.00	4737.90	3508.00	44.81	95.19	415.76	78.34	64.09	10.30	4.30	1.74	0.16	1.35	8.55	3.24
	1978	3-9	4381.90	30961.00	4781.40	3504.70	45.80	95.54	418.74	77.51	64.10	10.19	4.15	1.61				
3RD	1978	3-9	4855.70	34731.00	4331.10	2983.80	12.93	74.29	271.33	118.82	87.93	12.07	4.31	2.20	0.16	1.10	1.99	3.32
	1978	3-9	4888.90	34468.00	4423.60	3024.00	13.13	74.74	272.85	110.89	88.36	12.25	4.26	2.69				
1ST	1978	3-10	4427.90	27418.00	5487.20	3420.20	154.06	170.24	989.02	57.11	54.44	13.99	4.27	0.95	0.19	3.00	34.49	3.28
	1978	3-10	4401.70	27788.00	5512.60	3399.10	157.35	170.37	982.20	57.17	53.97	14.04	4.37	1.07				
2ND	1978	3-10	4836.90	34348.00	5720.00	2630.30	58.30	114.44	313.01	59.73	48.49	12.11	4.86	0.77	0.17	1.73	11.79	3.64
	1978	3-10	4874.20	35126.00	5683.40	2662.90	60.29	116.75	318.78	61.94	50.18	12.05	5.00	0.15				
3RD	1978	3-10	4812.30	33962.00	5155.10	3171.90	68.51	114.11	512.06	83.29	61.72	13.03	4.49	0.93	0.21	2.05	16.00	3.25
Control lines		3-1	3535.04	30138.49	3242.29	2966.08	15.96	70.19	29.92	95.62	31.96	6.68	4.14	2.33	0.09	1.19	0.98	2.83
weighted means		3-2	3366.67	29867.66	3433.28	3282.54	12.89	73.40	47.11	96.14	33.50	5.83	4.04	2.07	0.10	1.19	0.27	3.12
		3-4	3221.99	30699.05	3768.18	3093.50	10.01	68.69	38.78	64.72	30.24	4.81	3.71	1.73	0.10	1.12	0.63	3.11
Sludge lines		2-3	4240.31	34667.34	4225.99	2694.94	18.40	76.18	201.72	55.28	56.12	8.58	3.98	1.30	0.12	1.37	3.35	3.24
weighted means		2-5	4343.50	33268.36	4100.51	2787.54	79.85	117.29	519.58	56.97	59.29	11.68	4.45	1.84	0.16	2.24	19.30	3.04
		2-8	4518.68	33084.96	4401.01	3256.72	27.70	86.11	332.76	79.54	74.27	10.01	4.58	1.72	0.18	1.54	5.62	3.33
		3-6	4772.11	33295.61	4493.78	3251.47	20.69	80.53	385.16	72.04	82.10	9.83	4.35	1.65	0.16	1.51	3.79	3.29
		3-9	4531.29	32871.88	4479.26	3172.77	28.47	84.21	351.00	94.46	74.58	10.95	4.23	1.90	0.16	1.21	5.09	3.29
		3-10	4611.59	30769.93	5460.69	3179.52	112.60	144.19	718.60	64.39	54.95	13.34	4.50	0.87	0.19	2.48	24.84	3.35

Means for 1978 Reed Canarygrass (all cuttings; weighted by yield per cutting)

		OBS	Tissue Concentration P (ug/g)	K ====>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	%N
Sludge	1978	35	4502.91	32993.01	4526.87	3057.16	47.95	98.09	418.14	70.45	66.89	10.73	4.35	1.56	0.16	1.73	10.33	3.26
			3374.57	30235.07	3481.25	3114.04	12.95	70.76	38.60	85.49	31.90	5.77	3.96	2.04	0.10	1.17	0.63	3.02

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Control 1978 18	P (ug/g)	K ====>>>>	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	%N
By Cutting (not weighted by yield) Sludge																
1st	4378.02	32868.50	4377.39	2957.03	59.95	103.77	455.07	66.18	67.60	10.72	4.34	1.44	0.17	1.92	13.28	3.23
2nd	4596.18	32999.25	4699.24	3092.23	29.63	87.41	374.17	68.54	64.37	10.14	4.37	1.62	0.15	1.39	5.81	3.29
3rd	4535.45	33660.27	4455.03	3066.91	32.31	90.68	347.53	79.06	66.87	10.91	4.30	1.81	0.15	1.56	7.29	3.31
Control																
1st	3398.03	28993.17	3420.87	3272.85	13.84	71.33	44.99	83.80	33.29	5.71	3.93	1.87	0.10	1.22	0.63	3.08
2nd	3299.17	30748.83	3682.63	3145.28	12.17	71.14	39.04	91.28	33.06	6.21	4.01	2.27	0.09	1.16	0.63	2.86
	3443.17	32189.33	3276.93	2683.28	12.17	68.85	22.18	80.55	26.69	5.07	3.96	2.07	0.10	1.05	0.61	3.15

ROSEMOUNT REED CANARY GRASS 1978

CUTTING	YEAR	ID	YIELDS	P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
				(kg/ha) ====>>>>>															
- - - - CONTROL - - - -			Mg/ha																
1ST	1978	3-1	4.40	16.1110	126.5308	15.3549	14.9646	0.0749	0.3221	0.1750	0.3920	0.1433	0.0299	0.0191	0.0100	0.0004	0.0062	0.0043	129.3600
2ND	1978	3-1	3.49	11.9307	108.1935	11.1432	9.5521	0.0536	0.2383	0.0823	0.3407	0.1136	0.0238	0.0139	0.0081	0.0002	0.0034	0.0036	96.3240
3RD	1978	3-1	1.53	5.2583	49.1803	4.0442	3.4237	0.0218	0.1008	0.0246	0.1681	0.0442	0.0091	0.0060	0.0039	0.0002	0.0016	0.0014	40.6980
1ST	1978	3-2	4.82	15.9983	131.7933	16.1564	16.2894	0.0681	0.3534	0.2423	0.4252	0.1720	0.0243	0.0187	0.0076	0.0005	0.0056	0.0014	163.3980
2ND	1978	3-2	3.52	11.6396	113.2472	13.2188	11.6537	0.0376	0.2600	0.2000	0.3835	0.1190	0.0262	0.0147	0.0100	0.0004	0.0045	0.0008	89.7600
3RD	1978	3-2	2.07	7.4092	65.8819	6.3653	6.2281	0.0285	0.1507	0.0481	0.1921	0.0577	0.0102	0.0087	0.0039	0.0002	0.0023	0.0006	72.0360
1ST	1978	3-4	5.44	17.4806	167.9845	18.6097	16.5264	0.0563	0.3670	0.2444	0.4030	0.1720	0.0288	0.0195	0.0096	0.0005	0.0060	0.0034	158.8480
2ND	1978	3-4	3.30	10.4684	95.9409	13.5288	11.1809	0.0346	0.2352	0.1212	0.2221	0.1083	0.0144	0.0127	0.0054	0.0003	0.0040	0.0021	108.2400
3RD	1978	3-4	2.31	7.6540	75.2991	9.4999	6.4759	0.0197	0.1569	0.0629	0.0900	0.0539	0.0100	0.0087	0.0042	0.0002	0.0024	0.0015	76.6920
- - - - SLUDGE - - - -																			
1ST	1978	2-3	5.23	21.2231	185.9056	19.3353	12.5515	0.0744	0.3631	0.5977	0.2942	0.2846	0.0401	0.0189	0.0052	0.0006	0.0067	0.0107	171.5440
2ND	1978	2-3	3.01	14.0439	97.8626	15.7868	9.3098	0.0842	0.2618	1.2039	0.1727	0.1943	0.0317	0.0137	0.0046	0.0005	0.0046	0.0204	92.1060
3RD	1978	2-3	2.13	8.7050	75.7322	8.7014	6.0853	0.0322	0.1650	0.2902	0.1064	0.1030	0.0173	0.0087	0.0037	0.0002	0.0029	0.0036	72.2070
1ST	1978	2-5	5.59	23.1759	169.5978	24.4596	16.8225	0.6240	0.7322	3.6563	0.2999	0.3301	0.0703	0.0255	0.0074	0.0011	0.0146	0.1557	158.7560
2ND	1978	2-5	2.53	10.8626	93.0471	8.5280	5.9964	0.0282	0.1750	0.5969	0.1224	0.1205	0.0216	0.0101	0.0058	0.0003	0.0028	0.0054	79.1890
3RD	1978	2-5	2.83	13.5229	101.6437	11.9130	7.7047	0.2221	0.3772	1.4362	0.2015	0.1987	0.0359	0.0131	0.0069	0.0004	0.0071	0.0503	94.5220
1ST	1978	2-8	5.31	24.7276	187.8545	23.9553	16.7416	0.2112	0.5132	1.4502	0.4059	0.4118	0.0538	0.0269	0.0095	0.0011	0.0099	0.0450	178.4160
2ND	1978	2-8	2.95	13.3386	95.6921	12.0770	9.3381	0.0508	0.2296	1.0037	0.2758	0.2302	0.0296	0.0123	0.0047	0.0005	0.0036	0.0087	97.6450
3RD	1978	2-8	2.27	9.5155	64.8380	10.3103	8.2135	0.0297	0.1639	1.0501	0.1559	0.1402	0.0220	0.0090	0.0039	0.0003	0.0028	0.0054	74.4560
1ST	1978	3-6	6.90	33.1021	237.2048	28.9876	21.3693	0.1465	0.5498	2.4892	0.4652	0.5975	0.0665	0.0297	0.0111	0.0011	0.0115	0.0290	225.6300
2ND	1978	3-6	2.83	13.7177	86.2358	14.2198	10.6746	0.0476	0.2251	1.5161	0.2073	0.2338	0.0266	0.0124	0.0061	0.0004	0.0040	0.0076	94.5220
3RD	1978	3-6	2.38	10.9705	79.7693	11.2123	7.3314	0.0565	0.2004	0.6590	0.2000	0.1630	0.0259	0.0106	0.0027	0.0004	0.0028	0.0093	78.0640
1ST	1978	3-9	1.04	4.3630	35.3262	4.1386	2.7803	0.0178	0.0786	0.3563	0.0896	0.0767	0.0107	0.0043	0.0020	0.0002	0.0011	0.0027	34.8400
2ND	1978	3-9	2.61	11.4669	81.0627	12.4227	9.1516	0.1182	0.2489	1.0890	0.2034	0.1673	0.0267	0.0110	0.0044	0.0004	0.0035	0.0223	84.5640
3RD	1978	3-9	2.08	10.1344	71.9670	9.1049	6.2481	0.0271	0.1550	0.5659	0.2483	0.1833	0.0253	0.0089	0.0051	0.0003	0.0023	0.0041	69.0560
1ST	1978	3-10	4.68	20.6613	129.1820	25.7395	15.9572	0.7287	0.7970	4.6127	0.2674	0.2537	0.0656	0.0202	0.0047	0.0009	0.0140	0.1614	153.5040
2ND	1978	3-10	1.99	9.6625	69.1266	11.3464	5.2667	0.1180	0.2300	0.6286	0.1211	0.0982	0.0240	0.0098	0.0009	0.0003	0.0034	0.0235	72.4360
3RD	1978	3-10	2.17	5.2213	36.8488	5.5933	3.4415	0.0743	0.1238	0.5556	0.0904	0.0670	0.0141	0.0049	0.0010	0.0005	0.0044	0.0347	70.5250

Means for 1978 Reed Canarygrass (all cuttings; weighted by yield per cutting)

		OBS	YIELDS	Elements Removed P	K	CA	MG	AL	FE	NA	MN	ZN	CU	B	NI	CD	PB	CR	N
				(kg/ha) ====>>>>															
Sludge	1978	35	9.76	43.07	316.48	42.97	29.16	0.45	0.93	3.96	0.65	0.64	0.10	0.04	0.01	0.00	0.02	0.10	317.00
Control	1978	18	10.29	34.65	311.35	35.97	32.10	0.13	0.73	0.40	0.87	0.33	0.06	0.04	0.02	0.00	0.01	0.01	311.79

By Cutting (not weighted by yield)

Sludge																			
	1st		4.79	21.21	157.51	21.10	14.37	0.30	0.51	2.19	0.30	0.33	0.05	0.02	0.01	0.00	0.01	0.07	153.78
	2nd		2.65	12.18	87.17	12.40	8.29	0.07	0.23	1.01	0.18	0.17	0.03	0.01	0.00	0.00	0.00	0.01	86.74
	3rd		2.31	9.68	71.80	9.47	6.50	0.07	0.20	0.76	0.17	0.14	0.02	0.01	0.00	0.00	0.00	0.02	76.47
Control																			
	1st		4.89	16.53	142.10	16.71	15.93	0.07	0.35	0.22	0.41	0.16	0.03	0.02	0.01	0.00	0.01	0.00	150.54
	2nd		3.44	11.35	105.79	12.63	10.80	0.04	0.24	0.13	0.32	0.11	0.02	0.01	0.01	0.00	0.00	0.00	98.11
	3rd		1.97	6.77	63.45	6.64	5.38	0.02	0.14	0.05	0.15	0.05	0.01	0.01	0.00	0.00	0.00	0.00	63.14