

SCIENCE AND PERCEPTION RELATED TO THE
ENVIRONMENT AS AN ETHICAL CONCERN

by

Janice L. Pappas

Approved by Committee

Michael E. Myszewski
Michael E. Myszewski

Harold D. Swanson
Harold Swanson

Jon Torgerson
Jon Torgerson

Norman R. Hane
Norman R. Hane
Associate Dean for Liberal Arts
College of Arts and Sciences

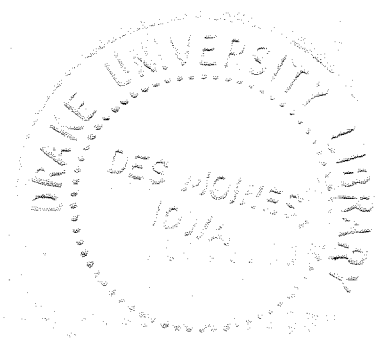


TABLE OF CONTENTS

	PAGE
GENERAL INTRODUCTION TO THE THREE SECTIONS.....	1
SECTION 1. TRACE METAL POLLUTION IN CREEK SEDIMENTS-- AN ENVIRONMENTAL PROBLEM STUDIED.....	8
INTRODUCTION AND REVIEW OF THE LITERATURE.....	9
MATERIALS AND METHODS.....	44
RESULTS.....	52
DISCUSSION.....	72
CONCLUSIONS.....	80
SECTION 2. SOCIAL SURVEY OF ENVIRONMENTAL PERCEPTIONS, ATTITUDES, PERSPECTIVES, AND VALUES OF THE ENVIRONMENTAL PROBLEM.....	94
INTRODUCTION AND REVIEW OF THE LITERATURE.....	95
MATERIALS AND METHODS.....	116
RESULTS.....	122
DISCUSSION.....	136
CONCLUSIONS.....	139
SECTION 3. PHILOSOPHICAL DISCUSSION OF ENVIRONMENTAL ETHICS WITH RESPECT TO REMEDYING AN ENVIRONMENTAL PROBLEM.....	144
INTRODUCTION.....	145
DISCUSSION:	
Hardin's position.....	146
The systems approach.....	158
An alternative position.....	185
Environmental ethics and action.....	214

SUMMARY.....	231
GENERAL SUMMARY INTEGRATING THE THREE SECTIONS.....	233
LITERATURE CITED.....	259
APPENDIX.....	278

LIST OF TABLES

TABLE	PAGE
1. Type 2 soil: gently sloping to steep, light colored to moderately dark colored soils formed from glacial till (USDA/Iowa Agricultural Experiment Station 1960).....	37
2. Type 6 soil: gently sloping to steep sandy soils (USDA/Iowa Agricultural Experiment Station 1960).....	38
3. Type 1 soil: level to gently sloping, dark soils formed from glacial till (USDA/Iowa Agricultural Experiment Station 1960).....	39
4. Type 3 soil: nearly level soils formed from outwash and alluvium (USDA/Iowa Agricultural Experiment Station 1960).....	41
5. BWMP Iowa study of Des Moines River sediments (mg kg ⁻¹ dry weight) for June 16, 1981.....	42
6. STORET (USEPA) sediment data (mg kg ⁻¹ dry weight) for Des Moines River, 1981 and 1982.....	43
7. Field data and sediment characteristics for Wafley Creek, August 3, 1982.....	53
8. Field data and sediment characteristics for Saylor Creek, August 3, 1982.....	54
9. Major grain size fraction percentages for sediment samples.....	56
10. Percent loss on ignition.....	58
11. Slope, y-intercept, correlation coefficient, and when applicable, standard percent error for each run for each metal.....	60
12. Mean readability error percent.....	61
13. Mean limit of detection for sediment samples and Perkin-Elmer limit of detection data for water samples in ug ml ⁻¹	62

14.	Mean extracted blank concentration in mg kg ⁻¹	63
15.	Sample weight, weight of insoluble fraction and the percent insoluble fraction.....	64
16.	Trace metal concentrations in mg kg ⁻¹ for Wafley Creek sediments.....	65
17.	Standard error and standard error percent for replicates of trace metal concentrations.....	66
18.	Trace metal concentrations in mg kg ⁻¹ for Saylor Creek sediments.....	69
19.	Coefficient correlation matrix (positive correlations only) for trace metal concentrations and other sediment parameters.....	73
20.	Coefficient correlation matrix (positive correlations only) for major ion concentrations and other sediment parameters.....	75
21.	Coefficient correlation matrix (positive correlations only) of trace metals and their interrelationship.....	77
22.	Mean square ratios for trace metal data from Wafley and Saylor Creeks.....	79
23.	USEPA Region V (1977) pollution classification of sediments.....	83
24.	USEPA Region VI (1980) pollution classification of sediments.....	85
25.	Percentages of ranking on who is responsible for clean up of pollution of Saylor and Wafley Creeks (question 8).....	126
26.	Mean rank scale and majority percent ranking for question 8.....	128
27.	Percentages of ranking on who is responsible for assuring Saylor and Wafley Creeks remain clean (question 9).....	128
28.	Mean rank scale and majority percent ranking for question 9.....	129

29.	Percentages of ranking on who should pay the costs of clean up of Saylor and Wafley Creeks (question 10).....	131
30.	Mean rank scale and majority percent ranking for question 10.....	131
31.	Spearman's r for questions 8, 9, and 10.....	132

LIST OF FIGURES

FIGURE		PAGE
1.	General soil areas of Wafley and Saylor Creeks, Polk County, Iowa. 1 = Clarion, Nicollet and Webster; 2 = Hayden and Lester; 3 = Colo, Waukegan, Dickinson and Dorchester; 6 = Hagener, Farrar and Chelsea (USDA/Iowa Agricultural Experiment Station 1960).....	36
2.	Numbered sampling sites on Wafley and Saylor Creeks, Polk County, Iowa. F = Firestone Tire and Rubber Company; A = Ankeny Sewage Treatment Plant.....	45

GENERAL INTRODUCTION TO THE THREE SECTIONS

The environment has been of interest to many people in many ways. In recent times, questions have been raised as to how we treat the environment. These questions stem from the environmental decade (the late 1960's through the 1970's) when the environment gained legal standing. The Environmental Protection Agency (EPA), the National Environmental Policy Act, and the Council on Environmental Quality came into being at this time. The environment became an entity for administrative and judicial review.

Legally and politically, the environment is defined as the air, water, and land that make up our surroundings. Such laws as the Clean Air and Clean Water Acts and the Toxic Substances Control Act are examples of this. The environment is what the courts and the EPA say it is. Scientific data on the environment have made it possible to make judgments on the physical quality of the environment. Without scientific data we would not know if an environmental problem existed or be able to determine physical remedies. Environmental problems would not be brought to our attention without a scientific definition of the condition of the environment.

Environmental studies, especially those of the 1970's, have displayed a lack of attention to social and ethical considerations. The scientific, legal, and political assessments of environmental problems have not necessarily

provided a complete or coherent picture. Shrader-Frechette (1982) states that current environmental impact analysis includes only technological solutions since it assumes environmental problems to be technological problems. This is what Keniston (in Shrader-Frechette 1982) called the "fallacy of unfinished business." That is, a complete environmental impact analysis should include social and ethical solutions as well as technological ones (Shrader-Frechette 1982).

The fallacy of unfinished business is related to a version of the naturalistic fallacy. This fallacy can be stated by the following: if something is natural, it is good; if something is unnatural, it is bad. However, whether what is natural is also good, is an open question. The naturalistic fallacy implies that scientific reasons are a sufficient justification for ethical beliefs. That is, one tries to derive "ought" statements from "is" statements (Shrader-Frechette 1982). Scientific data cannot dictate what ought to be the place of humans in nature, or how one should treat nature. In fact, humans must determine what ought to be their place in nature, and how they should treat it.

Generally, the naturalistic fallacy has been a part of environmental analysis and policy making. When environmental policy decisions are made, values are put into objective measurements as quantified human preferences. These measurements are used in environmental impact statements and

computer modelling. This has been called the scientific approach, and it entails the assumption that empirical data can represent values, and public officials can assemble the information into responsible decisions (Andrews 1981).

This approach does not work in making effective environmental policy since values cannot be quantified. Moreover, computer modelling has been a source of uncertainty when trying to assess the environment.

Uncertainty arguments have been levelled against scientific studies because the outcomes of environmental problems cannot always be predicted with certainty. Exponents of scientific studies say that the uncertainty arises from incompleteness. Such incomplete studies call into question the credibility of the scientists who performed them; these studies should not be applied to environmental policy (Thompson 1986).

One way to offset the scientific approach to environmental analysis and policy is the democratic approach. Emphasis is placed on consideration of values via direct involvement of persons affected by proposed decisions on an environmental problem. Involvement would occur through information on the problem, negotiation, or collaborative problem solving (Andrews 1981).

This approach has been used on an interagency and intergovernmental basis, negotiation via ad hoc involvement of citizens and organizations, litigation, and mediation.

Negotiated decisions involving affected persons may be more effective than the scientific approach in policy making. Involvement also serves to check or make accountable scientists and administrators (Andrews 1981). However, involvement does not necessarily occur on a routine basis.

If utilized by itself, this approach may involve persons who may not have the knowledge or skills to negotiate for their values. The outcome of the negotiation may not serve the citizens who were affected by the environmental problem. In addition, an agreement may not be reached. If an agreement is reached, it may be difficult to achieve compliance (Andrews 1981).

Another alternative is the authoritarian approach. This involves the use of laws such as the Clean Air Act or the administrative discretion of an agency to determine what is valuable in a given environmental case. In this case, environmental analysis is secondary as the authority makes a ruling regardless of the quality of the analysis. In subsequent cases, values are constricted since the law represents the only value which is legitimate (Andrews 1981).

This approach relies on standards and regulations. Legal changes can be made only by Congress. The authority is accountable to Congress rather than the individuals affected by a given environmental problem (Andrews 1981).

The problems associated with the scientific, democratic, and authoritarian approaches shows that there is a need for a

combination of the best parts of these approaches for environmental analysis and policy making (Andrews 1981). To reiterate, uncertainty arguments are made against scientific studies because they are incomplete; they call into question the credibility of scientists. Such studies should not be applied to public policy. If uncertainty arguments can be offset, some notion as to what part scientific studies have in environmental analysis will be determined.

What part does democratic involvement and authority have in environmental analysis and policy making? This question must also be answered to determine what combination of science, democracy, and authority will provide the best environmental analysis and policy decisions.

A complete environmental analysis of a particular problem can be achieved only by including different disciplines and synthesizing the findings. The scientific approach is useful for fact-finding of physical data about a particular environment. These facts are used in conjunction with existing statutes and administrative rules, thereby including the authoritarian approach.

Social research embodied in surveys is useful for determining what the public perception is of that particular environment. Public perception is key to the democratic approach. In addition, the social survey as an empirical study is a scientific approach.

The ethical implications of environmental concern may be linked to what can be done about that particular environment if some problem exists. This is a major part of the democratic approach with respect to action on behalf of the environment.

What is the contribution of facts, perceptions, and values to environmental issues? How are facts, perceptions, and values related in environmental analysis? The purpose of this work is to provide a framework for analyzing environmental problems from the scientific, social, and ethical positions, and to synthesize these three positions. The synthesis of these positions will also provide some implications for remedying environmental problems. This framework will provide a procedural approach to environmental analysis for producing better, long-lasting, workable solutions to environmental problems.

Overall, the public's perception in the everyday world is the backdrop to both science and ethics. Science uses a particular framework to categorize perceptions to produce a special picture of the environment. Ethics with respect to the environment involves the concept that the environment is a matter of perspective. Ethics involves a special class of decisions based on perceptions. From this view, this work will be presented.

Because this work encompasses three distinct subjects, it is presented in three sections. Each section is a

complete study in itself.

The first will deal with facts and involves a scientific study of a particular environmental problem-- trace metal pollution in sediments in two Des Moines area creeks.

Looking ahead, the third section will deal with values and involves a philosophical discussion of three different positions on environmental ethics. A discussion of possible remedies for an environmental problem based on ethics will also be presented.

The bridge between the facts and values will be provided by the second section. This section consists of a social survey of the perceptions, attitudes and perspectives of the public about the environmental problem with implications about values toward the environment.

Finally, a general summary of the three sections will be presented showing how facts, perceptions, and values are integrated with respect to analyzing the environment. Implications for remedying an environmental problem are also presented.

SECTION 1. TRACE METAL POLLUTION IN CREEK SEDIMENTS--
AN ENVIRONMENTAL PROBLEM STUDIED

INTRODUCTION AND REVIEW OF THE LITERATURE

On July 30, 1981, the Des Moines Register published an article about a possible pollution problem at three sites in the Des Moines area. The EPA reported that Saylor, Wafley, and Yeader Creeks were contaminated with trace metals. More specifically, Saylor Creek was reported to contain cadmium, copper, mercury, zinc, and other contaminants. Wafley Creek reportedly contained arsenic, cadmium, mercury, nickel, selenium, silver, thallium, zinc, and other contaminants. Yeader Creek reportedly contained cadmium, copper, mercury, nickel, zinc, and other contaminants. Ankeny Sewage Treatment Plant, Firestone Tire and Rubber Company, and Des Moines Sewage Treatment Plant were cited as possible sources of contamination. Discharges into Wafley Creek by the Iowa Fund Inc. sewerage system were also noted. A spokesperson for Firestone said he did not think the plant was to blame for the pollution. However, he also said that Firestone is required to test only for oil and grease discharges. The EPA was to monitor the creeks and develop a way to curtail trace metal discharges by the end of 1981. In this article there was no mention of actual concentrations of trace metals as well as no indication of the monitoring procedures to be used (Risser and Gemoules 1981).

On July 31, 1981, the Des Moines Register published a follow-up article on the possibility of a trace metal pollution problem. The EPA report was based on "a computer

analysis of businesses and industries located near streams and the types of wastes such plants produce." No water tests were conducted. The EPA was compelled to identify pollution problems and release a report as well as find remedies for the problems by the end of 1981. A lawsuit brought by the Natural Resources Defense Council in 1976 was the impetus for the EPA report. A top water quality official in the Department of Environmental Quality (now the Department of Water, Air, and Waste Management) said that the EPA jumped to conclusions about the pollution problem and its possible sources. He also said that, if necessary, water tests would be conducted. Officials at Ankeny Sewage Treatment Plant, Firestone Tire and Rubber Company, and Des Moines Sewage Treatment Plant denied that their plants are polluting Saylor, Wafley, and Yeader Creeks, respectively (Evans 1981).

Water tests were performed in September, 1981, by the EPA. Except for the major ions, iron and manganese, the data were below limit of detection. Two groups of samples from Wafley Creek and one group from Saylor Creek were obtained. No testing of the sediments have been or will be performed. In addition, the Natural Resources Defense Council has no information on this pollution issue concerning Saylor and Wafley Creeks.

In an aquatic setting the sediments are an important component of that environment. High concentrations of trace metals have been found to be toxic to living organisms.

Trace metals are rapidly deposited in the sediments from the water (Rabitti et al 1983). Eventually, they are released back into the water. The concentrations of such metals in sediments may be an indication of cultural inputs (Warren 1981; Hamilton-Taylor 1979; Cline and Chambers 1977; Oliver 1973). Sediments can be useful in detecting pollution sources (Badri and Aston 1983) or indicating the degree of contamination of various bodies of water (Ndiokwere 1984). In fact, sediments can be viewed as a permanent record of dumping into a river. Sediment analyses may be preferable to periodic water analyses (Oliver 1973). The sediments constitute a constant record of trace metal accumulation. Sediments also contain higher concentrations of trace metals than water, thereby reducing analytical problems (Fitchko and Hutchinson 1975; Aston et al 1974). As a result, this study will focus on trace metals in sediments.

This study has two purposes. The first one is to determine if Wafley and Saylor Creeks are polluted by trace metals. Based on the EPA allegations in the Des Moines Register article, the trace metals to be studied are arsenic (As), cadmium (Cd), copper (Cu), nickel (Ni), selenium (Se), and zinc (Zn). In addition, other trace metals to be studied are chromium (Cr), iron (Fe), lead (Pb), manganese (Mn), and tin (Sn) as well as other sediment parameters. These sediment parameters are redox potential (Eh), hydrogen ion activity (pH), temperature, color, texture, visual content,

grain size, major ions, and volatile solids or loss on ignition. Loss on ignition (LOI) is a summation of organic matter oxidizing to CO_2 and water, carbonates being converted to oxides and CO_2 , and hydroxides forming oxides and water (Rossmann and Seibel 1977).

The second purpose of this study is to determine if Firestone Tire and Rubber Company has polluted Wafley Creek, and if Ankeny Sewage Treatment Plant has polluted Saylor Creek with trace metals.

The potential for contamination of the environment by trace metals is evident from the rubber and tire manufacturing process. Initially, the process consists of compounding natural and synthetic rubber with carbon black (toughener) and pigments. This mixture is then sent through a pelletizer to make pellets or an extruder to form a continuous sheet. Sulfur and accelerators are added to cure this rubber. The mixture is then extruded a second time and is ready to be processed into tires (Firestone Tire and Rubber Company 1983).

Pigments containing trace metals may be used in the rubber making process. The pigments are antimony sulfide, magnesium carbonate, ferric oxide, white lead, titanium oxide, zinc oxide, zinc sulfide, ultramarine, chrome green, lithopone (zinc sulfate and barium sulfide), cadmium sulfide, and arsenic sulfide. Those considered to be the best pigments include ferric oxide, antimony sulfide, zinc oxide,

zinc sulfide, lithopone, titanium oxide, and chrome green. Other trace metals may be found as additives in the rubber making process. Zinc oxide may be added to increase resistance to pressure, improve mechanical strength, improve insulation resistance, and improve resistance to oil. Antimony sulfide may also be used to improve insulation resistance. The accelerators that are generally used are organic compounds used in small amounts. However, zinc oxide may also be used (Schidrowitz and Dawson 1952).

The sewage treatment process also has the potential of producing environmental contaminants. Sewage has domestic and industrial sources. The waste water treatment process involves effluent and sludge. Primary treatment removes bacteria. Secondary treatment removes nutrients such as phosphorus and nitrogen via activated sludge (Hawkes 1963).

Microorganisms are used to break down the sewage. Trace metals are used with these organisms as enzymes to make coenzyme catalysts. Trace metals used for this purpose are manganese, molybdenum, cobalt and zinc. Microorganisms may require other trace metals such as iron and copper as well as the major ions or elements potassium, calcium and magnesium, and other nutrients. Sewage is treated prior to the treatment process so that the microorganisms will have the right amount of nutrients and metals to digest the sewage properly. The resultant sludge and treated water might contain large quantities of metals from the treatment

process and the water since metals are not removed at any stage of the process (Hawkes 1963).

Inorganic constituents may be added to effluent through domestic use. Such constituents include sodium, potassium, calcium and magnesium (Hunter and Kotalik 1973). Petroleum and chemical sludges, scales and deposits in industrial waste water may contain iron, lead, copper, chromium, nickel, zinc, other trace metals as well as sodium, calcium, and magnesium (McCoy 1969).

Many studies have cited waste water from industrial and domestic inputs as sources of trace metal pollution. These as well as other studies comparable to the present one will be presented. Some of the studies will also describe the relationship between trace metals and other sediment parameters. For all studies presented, investigators used acid digestion in preparation of sediment samples. Investigators utilized atomic absorption spectrophotometry for trace metal analysis with the exception of Pasternak (1974) who used emission spectroscopy. Background information will also be given on the area surrounding the creeks to be studied.

High rates of input of some trace metals such as lead, zinc, cadmium, copper and tin may be man-induced. Domestic waste water discharge from sewage works is a recognized source of trace metals. Copper, zinc, chromium, nickel and cadmium have been found in New York city waste water. Good

quality secondary treated effluent, mostly domestic in origin, caused increased sediment concentrations of copper, lead, zinc and cadmium in the Black River, Maryland (Rippey 1982).

Trace metal interrelationships were examined to determine the pattern of incorporation of trace metals into sediments. Subsurface samples (not contaminated) were compared to surficial sediments (contaminated) for copper, zinc, lead and nickel. The subsurface samples exhibited a linear relationship except for nickel. The surficial samples were similar for zinc and lead. However, copper was determined to be incorporated into the sediments at a faster rate than zinc or lead (Rippey 1982).

Most trace metals adsorb to sediment rather than precipitate out when water-sediment interactions occur. This is especially true for zinc and lead and for copper in a pH range of 6.2 to 8.2 (Rippey 1982).

Trace metal profiles in sediments have been used as indicators of the history of metal pollution in many areas. Sewage discharge is a known point-source of trace metals (Hamilton-Taylor 1979).

Cores were taken from Windemere Lake, England, and analyzed for trace metals. The first core had a transition zone of black ooze between the surficial sediment and the rest of the core which was brown mud. The black ooze was enriched in zinc, lead and copper. Surface sediment

contained elevated levels of iron and manganese, but even higher concentrations of these trace metals were found in the black ooze. Increased amounts of lead were also found in the brown mud (Hamilton-Taylor 1979).

Recycling of trace metals occurs from lower depths to the surface sediments. Different concentrations in the black ooze may reflect changing deposition rates of non-metal components (Hamilton-Taylor 1979). Cline and Chambers (1977) determined that there is a high rate of mobility of trace metals from deeper sediments migrating to surficial sediments in their study at Sleeping Bear Point, Michigan. Both studies reflect that increased metal concentrations of surficial sediments may not be the result of recent discharges.

Hamilton-Taylor (1979), however, goes on to discuss the possibility of recent inputs. There is also evidence that zinc, lead and copper concentrations fluctuate because of man-induced inputs. One of the most likely sources of this is direct sewage discharge supplied by rivers to Windemere. There are no metal industries and little in the way of copper or lead mining history in the Windemere catchment area. River inputs of lakes may contribute to trace metal pollution. Incorporation of metals in sediments occurs by deposition of metal rich particles rather than sorption at the water-sediment interface in this study.

Municipal and industrial waste water discharges are

related to trace metal pollution in water and an accumulation of these metals in the sediments. A sediment sample near a sewage treatment plant had high concentrations of lead, zinc, copper and nickel. The source of this may be industrial effluent deposited into the municipal sewage system (Oliver 1973).

High concentrations of lead, zinc, copper, nickel, iron, manganese and chromium were found in the Ottawa and Rideau Rivers, Canada. The high concentrations were determined to be associated with the finer grained sediments. This association was a result of adsorption. For nickel, adsorption to high surface area particles such as clays is the only means for accumulation. The area where sediment samples were taken has not received any large discharge of nickel into the water (Oliver 1973).

Both Toronto and Hamilton Harbors receive input from industrial sources, treated domestic waste waters and untreated storm sewer overflows. Toronto Harbor is fed by the Don River via the Keating Channel. Hamilton Harbor is fed by several creeks, sewage and storm water discharges (Nriagu et al. 1983).

High concentrations of lead, iron, manganese, zinc and chromium were found in Hamilton Harbor. All the trace metals except lead are from iron and steel industries. Lead is from domestic effluents and storm waters. Copper and nickel have also been found to be slightly higher than normal

in concentration. Because of the Keating Channel and dredging operations, Toronto Harbor has lower concentrations of trace metals and has remained this way for the past 30 to 40 years (Nriagu et al. 1983).

Industrial and municipal pollution in a rural water area was studied for possible zinc and mercury content. The terrain of the watershed is principally sedimentary rock. Keuka Outlet as well as the Seneca River contribute to the input of the pollution flow into Seneca Lake (Blackburn et al. 1980).

In the Keuka Outlet sediments are frequently scoured downstream. The Seneca River, by comparison, is very slow moving and was considered to vary little over time (Blackburn et al. 1980).

The Seneca River is chiefly polluted with mercury. It receives municipal sewage as well as other inputs. The sediments are high in iron sulfides and are present as black in color. Upon exposure to the air these sediments become hydrated as iron oxides and turn orange. Keuka Outlet has both zinc and mercury pollution at times of high content loads. Unlike the Seneca River, these loads are rapidly driven downstream (Blackburn et al. 1980).

Suzuki et al. (1978) stated that rivers near big cities usually have bottom sediments composed chiefly of organic matter. Trace metal inputs from sewage or industrial activities are affected by this organic matter.

Organic matter significantly adsorbed cadmium from the waters of the Tama River, Japan. These researchers found that 35 ug of cadmium accumulated per gram of organic matter (loss on ignition).

Samples were also taken from a branch stream of the Tama River originally used for agricultural irrigation. One of the samples was from a site where domestic sewage inflow occurs. The results from these samples agree with those found for the Tama River. In addition, cadmium was determined to be proportional to zinc by 1:150 which is twice that found in natural soils. The Tama River was determined to have a cadmium pollution problem (Suzuki et al. 1978).

Pfeiffer et al. (1980) found that there was a significant increase in the chromium concentration in sediments in a tributary of the Irajá River, Rio de Janeiro, Brazil. Chromium, especially Cr^{6+} , adsorbs to particles and is toxic to living organisms. It can be released into the water by resuspension of sediments. Chromium⁶⁺ predominates in aerobic conditions at the normal pH range of waters. It may be complexed and precipitated as chromium (VI) hydroxide or adsorbed to organic or even inorganic particles such as ferric hydroxide.

Two stations upstream from an electroplating plant were found to be without industrial or domestic sewage inputs. Three stations were sampled downstream. The one closest to the plant had no domestic sewage input. The remaining

stations had domestic sewage input and were considered polluted. The total chromium concentrations in the sediments were determined to range from 1420 to 54300 ppm. The overall pH was 6.3. Where rapid release of chromium from the plant occurred, chromium concentrated in the water is quickly removed and retained mainly by bottom sediments as well as by suspended particles (Pfeiffer et al. 1980).

Sediments of the Titabawassee River in Michigan were found to be polluted with iron, lead, copper, manganese, nickel, and especially with arsenic and chromium as well as other trace metals. Samples were taken during or just after a period of high water flow. Therefore, the results may be an underestimation of actual trace metal concentrations. The highest levels of trace metal pollution were found downstream of the Ames Drain and the Titabawassee Township waste water treatment plant. In addition, trace metals found to be associated with organic carbon included arsenic, cadmium, chromium, and to some extent, lead, zinc, copper, tin, and nickel. These trace metals were found to be most easily mobilized during times of increased river flow (Rossmann et al. 1983).

Sediment samples were analyzed for trace metals from the River Tawe, River Neath and Gwendraeth Fach, South Wales. The river bed of the Tawe is chiefly sandstones, limestone, grits and shale, floored with a thick layer of alluvium. The Gwendraeth Fach catchment area is unpolluted by trace metals

despite the presence of fine-grained sediments. The Neath and especially the River Tawe's sediments are polluted with cadmium, copper, nickel, lead and zinc. The source of the pollution may be industrial (Vivian and Massie 1977).

Maxfield et al. (1974) found that there is mostly fine silt at the delta of the Coeur D'Alene River, Idaho. Clay, sand and organic matter were also found. High concentrations of cadmium, copper, lead and zinc among other metals were found in the sediments. Cadmium was high in concentration in silt. Other grain-size fractions and organic matter had the same levels of cadmium. Lead occurred mostly in clay, then in organic matter, then in silt, and least of all in sand. Zinc occurred mostly in clay, then silt, organic matter, and least of all in sand.

Trace metal polluted sediments were found to exist to a depth of 52 cm. The entire bay area covered by the delta was found to be polluted. Concentrations of lead, zinc, cadmium and copper were constant within a 900 m radius. This is another indication that sediments can be used as records of trace metal pollution (Maxfield et al. 1974).

Foundry Cove, New York is a shallow embayment of the Hudson River. One hundred meters from the outfall area, high concentrations of cadmium and nickel were found to be associated with the organic fraction or fine particles in the sediments. Nickel is more readily removed since it is associated with a less dense organic fraction. Cadmium will

tend to form cadmium carbonate. Fine particles are the vehicle of the predominant transport process of cadmium and nickel. Copper, lead and zinc were found to be at twice pre-industrial levels for this area. This study established baseline data on the distribution of cadmium and nickel in sediments for the cove as well as current levels of copper, lead and zinc (Bower et al. 1978).

Ndiokwere (1984) states that the majority of trace metals are bound to silt particles. He found that the River Niger had high concentrations of manganese, lead and zinc. The source of manganese and zinc is urban drainages and various small scale industries. High concentrations of lead may have resulted from airborne lead particulates.

Sly (1983) did a study of Niagara River sediments and trace metal content. He studied Eh, ph, grain size and organic carbon as well as trace and major elements.

Large amounts of calcium and magnesium found indicate the presence of small fragments of carbonate rock. An increase in calcium occurs with an increase in inorganic carbon. This indicates the presence of calcium carbonate associated with silts (Sly 1983).

Enrichment by a cultural source may be indicated by an increase in organic carbon with an associated increase in chromium, nickel, lead, zinc and other trace metals. In sandy sediments with no carbonates present an increase in clays occur with an increase in iron, potassium and

magnesium. In the sandy Niagara River high concentrations of copper, chromium, lead and zinc are present. There is a slight increase in cadmium concentrations. Organic carbon was determined to be strongly associated with copper, zinc and chromium. The Niagara River was in fact determined to be culturally enriched in trace metals (Sly 1983).

Sly (1983) determined other relationships between trace metals and other variables in sediments with cultural inputs. Trace metals were strongly associated with iron and potassium which indicated clays were present. Organic carbon was strongly associated with iron, zinc, copper and other trace metals. Silts were strongly associated with trace metals.

Sly (1983) also studied the silty clays sediment fraction. The results from this fraction were variable. Iron and potassium were strongly associated with copper and manganese. Organic carbon was moderately correlated with zinc, lead, copper and manganese. Iron was moderately correlated with copper, lead, zinc and nickel. These results reflect that silty clays are slow settling particles whereas silts are fast settling particles. In addition, silty clays respond to redox and pH conditions more readily.

Bugenyi (1982) conducted a study with nine sampling sites for water and sediment analyses. These sites were established on the River Nyamwamba, Lake George, Kazinga Channel and Lake Edward, Uganda, which are sequentially connected bodies of water.

Copper, cadmium and iron amounts were determined in the sediments. Iron was found to sorb Cu^{2+} to oxides in Lake George and Kazinga Channel. In contrast, volatile organic carbon (loss on ignition) was found to control copper cycling from the sediments to the water in Lake Edward. In all bodies of water, iron controlled the ionic activity of cadmium in sediments. Sediment concentrations of copper, cadmium and iron ranged from their highest in Lake George to their next highest in Kazinga Channel to their lowest in Lake Edward. The major copper mining industries are closest to Lake George. The sediments act as a natural sink for trace metals (Bugenyi 1982).

Pasternak (1974) found that the concentration of trace metals in sediments depends on the degree of pollution in the water rather than the amount of organic matter and silts in the sediments. The concentration of trace metals in sediments is a good indicator of the spreading of mineral pollution by the water. Evaluating water for the degree of trace metal contamination cannot always give precise data since the metals in water are often distributed via suspended materials and accumulate in the bottom sediment.

The River Biala Przemsza is composed of loose and weakly loamy sands on glacial sands over limestones, marls, dolomites, carbon shist and sandstones. Sediment samples were taken during normal and high water levels. The river has two tributaries, the Biala and the Sztola with the Hutka.

Both streams carry industrial wastes; the Biala also carries domestic wastes. Large amounts of organic matter were found in the Biala, where domestic wastes were added to the water (Pasternak 1974).

The sediment of the River Biala Przemsza contains a small amount of silty fractions, being mostly sandy. No appreciable sorption of trace metals occurs because of the high concentration of calcium present. The River Biala Przemsza was determined to be low in organic matter (Pasternak 1974).

Before input from the Biala, the River Biala Przemsza has, with the exception of copper, trace metal concentrations that are slightly higher than those for clean river sediments. Just at its entry point in the River Biala Przemsza, the Biala has concentrations of lead, zinc, copper, manganese and other trace metals that increased sharply. However, at a point downstream from this input, the River Biala Przemsza has only high zinc and lead concentrations with chromium decreasing (Pasternak 1974).

Input before the Sztola-Biala Przemsza convergence exhibits high concentrations of zinc and lead as well as other trace metals. The Sztola inputs zinc, lead and manganese as well as other trace metals (Pasternak 1974).

Farther downstream on the Biala Przemsza zinc, lead, chromium and copper are high in concentration. Even farther downstream concentrations drop off but are still higher than

those for comparable sandy sediments from clean rivers. Zinc was found to highly mobile in water compared to other trace metals (Pasternak 1974).

Fitchko and Hutchinson (1975) did a study of the trace metal content of the sediments of all the tributaries to the Great Lakes. They also studied the relationship between trace metals and grain size and organic matter or loss on ignition. For the most part, adsorption and complexation are expected to occur with organic matter in the sediments of small rivers, streams and creeks. In addition, sands and gravels are deposited first, then the finer materials are deposited as the flow rate decreases. Most of the trace metal pollution was attributed to industrial sources, although geological make-up may also be a source in some cases. Overall, mercury was a contaminant for most of the tributaries of all the Great Lakes. Silver and, to a lesser degree, cobalt were also determined to be sporadic contaminants (Fitchko and Hutchinson 1975).

For Lake Superior, some of the tributaries had high copper concentrations. This was true for the Nipigon, Current, McIntyre, Kaministikwia, McKellar, and Mission Rivers and the Upper Keweenaw Entry. Chromium amounts were considered to be a problem in the Nipigon River. Lead concentrations were also high in the Nipigon as well as in the Current River. High nickel concentrations were found in the Upper Keweenaw Entry (Fitchko and Hutchinson 1975).

Lake Michigan tributaries had lead as the predominant pollutant. High concentrations were found in the St. Joseph, Black, Grand, Milwaukee, Menominee, Kinnickinnic, Calumet, Root, Sheboygan, and Twin Rivers and in Sauk Creek. High copper concentrations were found in all of these tributaries except the St. Joseph, Black, Sheboygan and Twin Rivers. Cadmium was found in large amounts in the Grand, Calumet and Twin Rivers and Sauk Creek. High chromium concentrations were found in the Black, Calumet and Sheboygan Rivers and Sauk Creek. In the Grand, Milwaukee, and Calumet Rivers, high zinc concentrations were found. High nickel concentrations were found in the Grand River, and high manganese concentrations were found in the Calumet River (Fitchko and Hutchinson 1975).

For ease of descriptive purposes, Lake Huron was studied in parts. The first part is the North Channel and Georgian Bay. High levels of lead, copper, chromium and zinc were among those trace metals found in the French River, a tributary of Georgian Bay. For tributaries of the North Channel, high concentrations of zinc and manganese were found in the Magnetawan and Moon Rivers. In addition, high copper levels were found in the Magnetawan River, while high cadmium levels were found in the Moon River. In the Seguin River, lead occurred in large amounts (Fitchko and Hutchinson 1975).

The second part is the rest of Lake Huron. High lead

concentrations were found in the Penetangore, Maitland and Cheboygan Rivers. High levels of copper and zinc were also found in the Cheboygan River (Fitchko and Hutchinson 1975).

The third part includes the St. Clair and Detroit River tributaries. High copper levels occurred in the Black River, and high cadmium levels occurred in Talford Creek. Both are tributaries of the St. Clair River. The Detroit River tributaries include the Rouge River and the Rouge Canal. High concentrations of cadmium, copper, chromium, nickel, zinc, and lead occurred in the Rouge River (Fitchko and Hutchinson 1975).

For Lake Erie, many trace metals occurred in large amounts. High concentrations of cadmium, copper and chromium were found in Kettle Creek and the Raisin, Maumee, Black, Cuyahoga and Ashtabula Rivers. High lead levels were found in all these tributaries except for the Ashtabula River. High zinc levels were found in all these tributaries except for Kettle Creek. High cadmium levels occurred as did copper levels in some cases for the Portage, Vermillion, Conneaut and Grand Rivers and Catfish Creek. The Conneaut River had high chromium levels, while the Cuyahoga, Raisin and Maumee Rivers had high nickel concentrations (Fitchko and Hutchinson 1975).

Lake Ontario had many tributaries with high lead and/or cadmium concentrations. They are the Genesee, Oswego, Don, Humber, Credit, Trent, Moira and Napanee Rivers and Oshawa,

Oakville and Etiobicoke Creeks. High chromium and/or copper levels occurred in the Oswego, Don, Trent, Moira, and Napanee Rivers and Oakville, Etiobicoke, and Oshawa Creeks. High zinc concentrations were found in the Genessee, Trent, Moira, and Napanee Rivers (Fitchko and Hutchinson 1975).

In general, the biggest difference between the Upper and Lower Great Lakes is the input of cadmium and chromium by tributaries. Lakes Erie and Ontario tributaries and rivers on the western side of Lake Michigan had the highest metal concentrations. Significant correlations were found between lead, copper, nickel, zinc, and manganese and both loss on ignition and percent clay content. No significant correlation was found between chromium and loss on ignition or percent clay content. Adsorption or complexation was determined to be the mode of trace metal-sediment interaction (Fitchko and Hutchinson 1975).

Aston et al. (1974) studied the sediments of the Fowey, Gannel, Carnon, and Red Rivers, England for trace metal content. The Fowey River was found to be mostly uncontaminated. The Gannel, Carnon, and Red Rivers had high concentrations of copper, lead, zinc, cadmium, tin, and arsenic. High concentrations of iron and manganese were also found in the Carnon which may be attributable to the low pH present. High copper and zinc concentrations may also be a result of a low pH. In contrast, the Red River has a high pH. Regardless, trace metal concentrations were found to be

high. The soil near these river beds is chiefly clay-loams and may influence the occurrence of trace metals. The contamination of the Gannel, Carnon, and Red Rivers may be a result of the geology in the area and past and present mining.

In the River Ystwyth, Wales, Bradley and Lewin (1982) have determined that Fe/Mn coatings on surface sediments sorb metals, especially ferrous oxide and ferric oxide at times of high water discharges. Sorption occurs in preference to complexing with organic matter. Both lead phosphate and zinc phosphate are formed and are seen to be controls in the cycling of lead and zinc. Magnesium is more diluted than calcium with increased flow from discharge. Sodium has a limited range of fluctuation over time.

The River Ystwyth has metal-rich sediments. For effective removal of such sediments, flood conditions are needed. Flushing and dilution of sediments has occurred in this way with zinc. Lead, cadmium and iron as well as zinc were at their lowest concentrations during higher discharges because of dilution by clean sediment (Bradley and Lewin 1982).

Some general observations may be presented with respect to trace metals and related parameters. Warren (1981) states that Eh, pH, temperature, the nature and amount of organic matter and grain-size are the most important sediment parameters influencing the types and concentrations of trace

metals found. The lower the Eh, the more difficult it is for Fe and Mn to become oxidized and released into the water (Wetzel 1975).

The deposition of sediments is influenced by water movements. Fine grain sediments signify accumulation of suspended materials indicating a slow moving stream. Course grain sediments signify erosion resulting from swiftly flowing waters. "Temporary" depositional areas of sediments are intermediary (Warren 1981).

Trace metals reach the sediments in three principal ways: suspended particles in the water which settle; suspended particles along the bottom sediments; sorption of dissolved metals from interstitial waters. Particles are defined as detrital, biogenous, and precipitated. Deposited particles will, at first, sit loosely at the sediment surface. Eventually, new sediment buries the remains of the old sediment, and the old remains become more permanent (Warren 1981).

Suspended particles carried by rivers then deposited as sediment have been found to contain high concentrations of lead, zinc and cadmium. This has occurred in rivers such as the Amazon, Congo, Ganges, Mekong, Wilton Creek in Ontario, and Crooked Creek in Missouri. Storm run-off often transports these particles. Sewage, urban and agricultural run-off, non-ferrous metal production, and many other industries discharge suspended particles containing lead,

zinc, and cadmium. Rivers can dilute the metal-rich effluent when discharges are infrequent (Warren 1981).

Silts and clays tend to be horizontally transported along the sediments for a longer period of time than coarser particles. Deeper parts of streams weaken the transport of particles and act as sediment traps for silts and clays. These sediment traps tend to contain high concentrations of lead and zinc (Warren 1981).

Color is an important indicator of sediment conditions. In general, sediments are deposited during oxidizing (aerobic) or reducing (anaerobic) conditions. Brownish sediments contain iron oxides which indicate an aerated environment. Grey or black sediments contain iron sulfides and are oxygen deficient. A high pH favors precipitation, and a low pH favors higher solubility. Colder temperatures favor solubility of calcium carbonate, while warmer temperatures favor precipitation (Warren 1981).

In general, carbonaceous shales contain the highest levels of trace metals followed by siltstones and shales, sandstones and limestones (Warren 1981).

Iron and manganese which occur as Fe^{3+} and Mn^{4+} hydroxides and oxides in aerobic surficial sediments may be reduced to Fe^{2+} and Mn^{2+} . These ions become part of deeper sediments, but they will migrate to the surface and reprecipitate as Fe^{3+} and Mn^{4+} . This does not occur with lead, zinc, and cadmium. In addition, recycling of lead,

zinc, and cadmium does not occur in reducing conditions. Once these trace metals are precipitated as sulfides they become unavailable to the water. If conditions become aerated with resuspension of sediments occurring, some dissolution may occur, remobilizing these trace metals (Warren 1981).

Cline and Chambers (1977) studied Sleeping Bear Point on Lake Michigan because of its periodic coastal slumpings interspersed with its usual quiet shallow basin. Sediment cores taken were 10 cm in length. Direct electrode insertion for pH and Eh was used at the site of sample collection. They studied trace metal concentrations and their relation to other parameters.

Once metals are in the water, they are rapidly dissolved and incorporated into suspended and bottom sediments. Metal loading on the sediments can usually indicate how far away the source is. Adsorption is grain-size related. Higher trace metal concentrations occur with finer grain sizes. The concentrations of manganese, copper, chromium, nickel, cadmium, and zinc were found to be significantly correlated to grain-size (Cline and Chambers 1977).

Cline and Chambers (1977) also determined the following from their study. More sandy sediments have more permeability. Manganese, cadmium, and zinc most likely react and concentrate together in sediments. Sand, clay, and organic carbon did not correlate with manganese. Zinc,

copper, and chromium were significantly correlated to percent clay (%clay). Copper and organic carbon are highly correlated as are cadmium and chromium to organic carbon. Zinc, manganese, and cadmium have low reducing potential. Low Eh contributes some to trace metal distribution. Chromium, cadmium, zinc, and copper were highly correlated to manganese.

Some final general relations between trace metals and other parameters may be presented. A decrease in grain size means an increase in elemental concentrations. When expressed as weight percent of the total sample, manganese, nickel, copper, zinc, calcium, sodium, chromium, potassium, magnesium, iron as well as total carbon, inorganic carbon, organic carbon, and loss on ignition (LOI) at 1000°C are associated with silts and clays. However, when expressed as weight percent of the soluble fraction, only calcium, magnesium, inorganic carbon, and copper increase in concentration with a decrease in grain size. Iron, manganese, nickel, zinc, sodium, potassium, chromium, and organic carbon are associated with the sand fraction (Rossmann and Seibel 1977).

In terms of background information, no historical data exists on Wafley or Saylor Creeks which characterize the sediments. There have been no measurements on the seasonal flow rates of either creek. There is no information on trace metal and major ion content, ion-exchange capacity, volatile

solids, organic carbon, pH, Eh, carbonate content, mineral content, and rates of sediment deposition. The lack of historical data has been confirmed through the Iowa Department of Water, Air and Waste Management, Iowa State University and the U.S. Geologic Survey. In terms of water quality, Wafley and Saylor Creeks have not been classified as "high quality," and they have not been designated by class as either A or B (Iowa Department of Water, Air and Waste Management 1983).

Despite the lack of historical data, information on the soil composition of the surrounding areas may be used to characterize Wafley and Saylor Creek sediments. The groups of soil types are indicated in Figure 1 (USDA/Iowa Agricultural Experiment Station 1960).

There are three groups of soil types for Wafley Creek. One group is Hayden and Lester soils. These soils are chiefly loam. The other two groups are Hagener, Farrar, and Chelsea soils and Clarion, Nicollet, and Webster soils. The former are mainly sand while the latter are mainly loam. The specific characteristics of these groups are given in Tables 1, 2, and 3 (USDA/Iowa Agricultural Experiment Station 1960).

There are two groups of soil types for Saylor Creek. One group is Colo, Waukegan, Dickinson, and Dorchester soils. These soils are chiefly alluvial over sand and gravel. The other group is Hayden and Lester soils already mentioned.

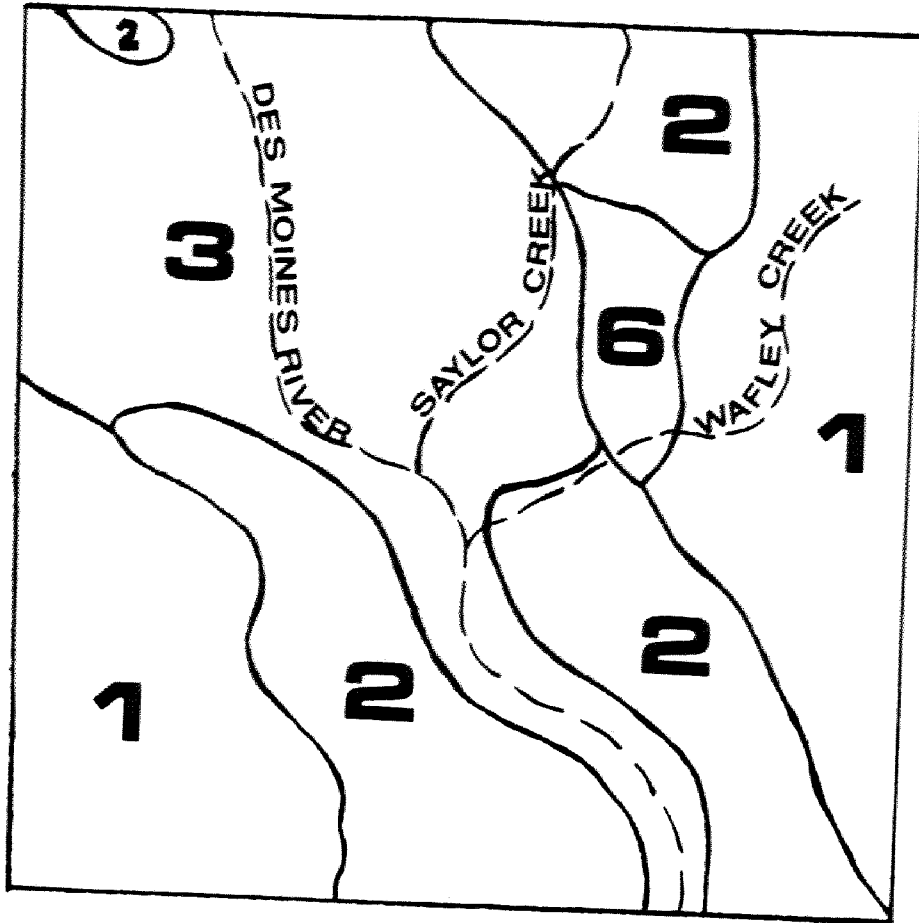


Figure 1. General soil areas of Wafley and Saylor Creeks, Polk County, Iowa. 1 = Clarion, Nicollet and Webster; 2 = Hayden and Lester; 3 = Colo, Waukegan, Dickinson and Dorchester; 6 = Hagenner, Farrar and Chelsea (USDA/Iowa Agricultural Experiment Station 1960).

Table 1. Type 2 soil: gently sloping to steep, light colored to moderately dark colored soils formed from glacial till (USDA/Iowa Agricultural Experiment Station 1960).

	Soils	
	Hayden	Lester
soil	loam	loam
parent material	Cary glacial loam till	Cary glacial loam till
surface layer A horizon	very dark grayish-brown loam; brown subsurface layer	very dark grayish-brown
subsoil B horizon loam	yellowish-brown clay loam	dark brown and dark yellowish-brown and clay loam
dominant natural drainage	good	good

Table 2. Type 6 soil: gently sloping to steep sandy soils (USDA/Iowa Agricultural Experiment Station 1960).

	Soils		
	Hagener	Farrar	Chelsea
soil	loamy fine sand	fine sandy loam	loamy fine sand
parent material	windblown sands over Cary glacial loam till	windblown sandy loam	wind-deposited sands
surface layer A horizon	very dark grayish-brown loamy fine sand	very dark brown fine sandy loam	very dark brown loamy fine sand; dark gray sub-surface layer
subsoil B horizon	dark grayish-brown to brown loamy fine sand	dark yellowish-brown and dark brown fine sandy loam in upper part; loam in lower part	yellowish-brown loamy fine sand
dominant natural drainage	good	good	good

Table 3. Type 1 soil: level to gently sloping , dark soils formed from glacial till (USDA/Iowa Agricultural Experiment Station 1960).

	Soils		
	Clarion	Nicollet	Webster
soil	loam/ silt loam	loam	silty clay loam
parent material	Cary glacial loam till/ Cary and some wind-deposited silt	Cary glacial loam till	Cary loam till and loam outwash
surface layer A horizon	very dark brown loam/ very dark brown silt loam	very dark brown silt loam to silt loam	black silty clay loam
subsoil B horizon	dark brown loam/ dark brown silt loam or loam	mottled very dark grayish- brown loam to clay loam	olive-gray and dark grayish- brown silty clay loam and clay loam
dominant natural drainage	good	intermediate	poor

The specific characteristics of these groups are given in Tables 1 and 4 (USDA/Iowa Agricultural Experiment Station 1960).

Some data exists on metal concentration for the Des Moines River for 1981 and 1982. This data is presented in Tables 5 and 6 from the Iowa Department of Water, Air and Waste Management and USEPA (1981 and 1982) STORET files, respectively.

Table 4. Type 3 soil: nearly level soils formed from outwash and alluvium (USDA/Iowa Agricultural Experiment Station 1960).

Soils				
	Colo	Waukegan	Dickinson	Dorchester
soil	silty clay loam/loamy subsoil variant	loam, moderately deep over sand and gravel/loamy deep over sand and gravel	fine sandy loam/loamy sandy loam, bench position	silt loam/silt loam, moderately shallow over sand/silt loam, deep over sand
parent material	alluvium (stream deposits)	loamy Cary glacial outwash over sand and gravel/loamy glacial outwash over sand and gravel	sandy	fresh stream deposits/fresh stream deposits over sand/fresh stream deposits over sand
surface layer A horizon	black to very dark gray silty clay loam/very dark gray loam to clay loam	very dark brown loam/very dark brown loam to silt loam	very dark grayish-brown, fine sandy loam/very dark grayish-brown loam/very dark grayish-brown sandy loam	very dark gray silt loam; calcareous
subsoil B horizon	very dark grayish-brown and very dark gray silty clay loam/very dark grayish-brown and very dark gray clay loam	brown loam/dark brown to yellowish-brown loam to silty clay loam	dark brown fine sandy loam/dark brown fine sandy loam/dark brown sandy loam	no B horizon/dark grayish-brown sand at depths of 12 to 14 inches/dark grayish-brown sand at depths of 30 to 60 inches
dominant natural drainage	poor	good	good	intermediate/good/good

Table 5. BWMP Iowa Study of Des Moines River sediments (mg kg⁻¹ dry weight) for June 16, 1981.

	Upstream*	Dig QC**	Downstream*	QC**
LAB NUMBER	VF1156	VF1156	VF1157	VF1156
Silver	<1.0	<1.0	<1.0	<1.0
Aluminum	3720.0	2150.0	7530.0	3920.0
Arsenic	<50	<50	<50	<50
Barium	43.1	44.2	84.9	42.1
Beryllium	<1.0	<1.0	<1.0	<1.0
Cadmium	<1.0	<1.0	<1.0	<1.0
Chromium	7.2	5.7	29.7	7.2
Copper	4.8	3.0	17.0	4.8
Iron	7860.0	8050.0	12500.0	8180.0
Manganese	397.0	481.0	426.0	388.0
Nickel	8.2	6.3	13.4	7.5
Lead	<5.0	<5.0	<15.4	<5.0
Antimony	<50	<50	<50	<50
Selenium	<50	<50	<50	<50
Thallium	no value	no value	no value	no value
Zinc	17.7	15.0	66.7	17.6
Calcium	24800.0	23600.0	22100.0	25600.0
Magnesium	7800.0	8420.0	7750.0	8010.0
Sodium	274.0	51.0	140.0	289.0
Mercury	0.02	0.02***	0.08	no value***

* upstream at Euclid Ave. bridge; downstream at Hwy.46 bridge,
downstream from the Des Moines Wastewater Treatment Plant.

** quality control samples

*** quality assurance samples as replicates

Table 6. STORET (USEPA) sediment data (mg kg⁻¹ dry weight) for the Des Moines River, 1981 and 1982.

	Upstream*		Downstream**	
	May 6, 1981	August 17, 1982	May 5, 1981	August 7, 1982
As	50.0 K	14.30 U	50.0 K	13.10 U
Be	1.00 K	0.20	1.00 K	0.10 U
Cd	1.00 K	2.60	1.00 K	1.20
Cr	7.20	11.00	29.70	7.50
Cu	4.80	10.70	17.00	6.10
Pb	5.00 K	24.60	15.00 K	2.30
Ni	8.20	15.50	13.40	7.90
Ag	1.00 K	0.10 U	1.00 K	0.10 U
Zn	17.70	41.80	66.70	25.80
Sb	50.00 K	1.00 U	50.00 K	1.00 U
Se	50.00 K	14.30 U	50.00 K	13.10 U
Th	no value	no value	no value	no value
Hg	0.02	0.04	0.1	0.02

* Des Moines River at Euclid Ave. bridge

** Des Moines River downstream at sewage treatment plant outfall

K limit of detection

U limit of detection

MATERIALS AND METHODS

On August 3, 1982, sediment samples were collected from Saylor and Wafley Creeks. In Saylor Creek three sampling sites were chosen upstream from the Ankeny Sewage Treatment Plant, and five sites were chosen downstream. In Wafley Creek three sampling sites were chosen upstream from Firestone Tire and Rubber Company, and four sites were chosen downstream. Sampling sites were chosen based on accessibility. The locations of these sites are depicted in Figure 2.

The following parameters were measured: trace metals -- As, Cd, Cu, Cr, Fe, Pb, Mn, Ni, Se, Sn, and Zn; major ions-- Ca, K, Mg, and Na; Eh; pH; temperature; grain-size; color; volatile solids (loss on ignition).

In the field, samples were obtained by hand inserting a plexiglass tube, 67 mm diameter, with centimeter gradations, into the sediments. A minimum of 2.5 cm of sediments was collected and dislodged from the tube and sealed in plastic bags. Samples were then kept cold in an ice chest. In addition, a subsample of the sediment from the same site was placed in a plastic tub and analyzed for pH, Eh, temperature, color, texture, and visible content (Rossmann 1975).

The pH of the sediment was measured with a Corning 610A pH meter. The pH and reference electrodes were inserted into the subsample and the value was recorded after the meter had equilibrated. Calibration of the meter was accomplished with use of standard pH buffers 4 and 10. The Eh was measured

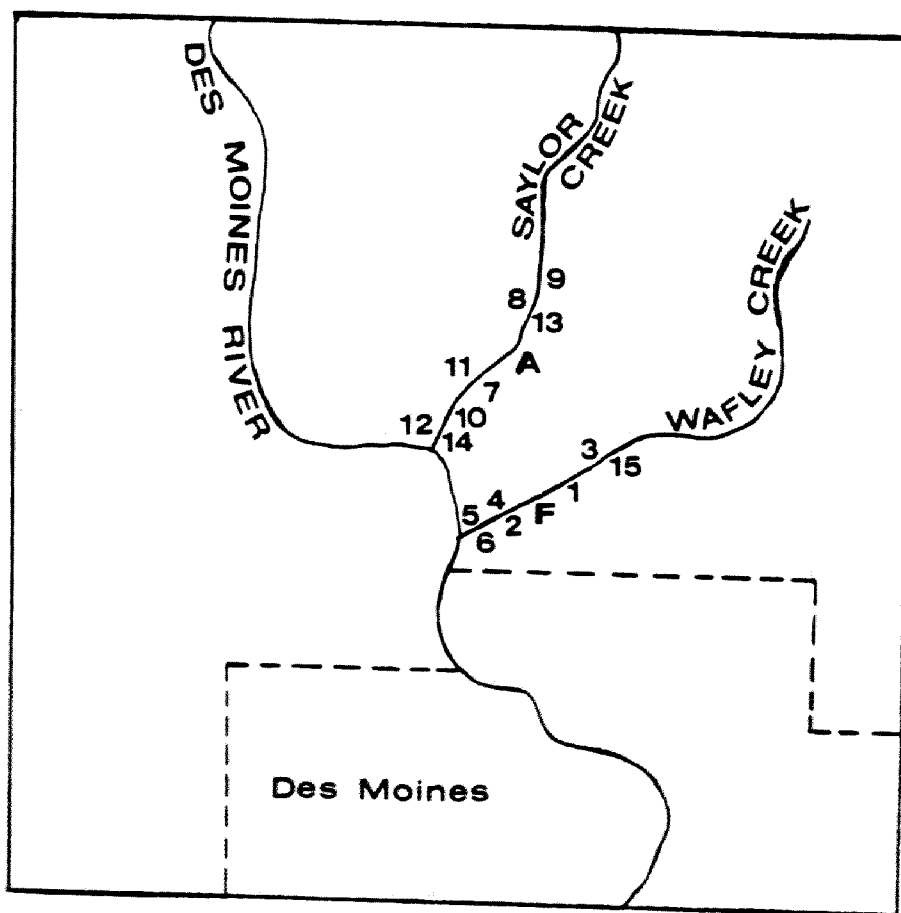


Figure 2. Numbered sampling sites on Wafley and Saylor Creeks, Polk County, Iowa. F = Firestone Tire and Rubber Company; A = Ankeny Sewage Treatment Plant.

with the same meter, equipped with an Eh electrode, in a similar fashion. Calibration for Eh was accomplished using ZoBell's (1946) solution. The temperature was measured with a thermometer. The color, texture, and visible content of the sediment were observed (Rossman 1975).

All the glassware and plasticware used in the laboratory were never used previously. All glassware and plasticware were initially acid soaked (5% v/v HNO₃) overnight, triple-rinsed with distilled water and oven dried at 110°C for 24 hours, then stored in desiccators. Subsequent uses of this glassware and plasticware involved acid-cleaning (5% v/v HNO₃), triple-rinsing with distilled water, and oven drying at 110°C for 24 hours, then storing in desiccators. In addition, all glassware was handled at all times with vinyl glove-covered hands.

Sediment samples were extracted for trace metal analysis. Sample preparation was done at Drake University. Obtaining a subsample of sediment was accomplished using a plastic spatula. A homogenized 20 g portion of wet sediment was oven-dried at 110°C for 24 hours. This dried sediment was finely ground with a glass mortar and pestle for five minutes, then stored in Whirl-pak bags. From this, a 2.0000 + 0.0005 g portion was weighed out on a Mettler H32 analytical balance. This sediment portion was extracted on a hot plate in a 250 ml Erlenmeyer flask with 100 ml 10% (v/v) HCl and 4- 2 ml additions of 50% H₂O₂ over a

40 hour period. The H_2O_2 was added to release organic materials. Each time the 100ml of 10% (v/v) HCl boiled down to 50 ml, a 2 ml portion of 50% H_2O_2 was added. The volume of extract was then adjusted to 100 ml with 10% (v/v) HCl. Blanks (100 ml of 10% (v/v) HCl) were run with each set of samples extracted to obtain a correction factor. The extract was allowed to boil down to just under 50 ml. For the final extract, filtering was accomplished by using pre-weighed, acid-cleaned fine-fritted glass funnels which had been stored in a desiccator. Adjustment of the final volume was accomplished using a 50 ml volumetric flask. The extract was stored in acid-cleaned 100 ml polyethylene bottles. The fritted funnels were weighed after being oven-dried (at least 24 hours) for the determination of the residue weight for calculation of the %insoluble fraction as:

$$\% \text{insoluble} = \frac{\text{initial weight of sample extracted (g)} - \text{weight of residue (g)}}{\text{initial weight sample extracted (g)}} \times 100$$

At Great Lakes Research Division, University of Michigan, Ann Arbor, Michigan, each extract was analyzed for Cd, Cu, Cr, Fe, Pb, Mn, Ni, Sn, Zn as well as Na, K, Ca, and Mg by using Perkin-Elmer Atomic Absorption Spectro-

photometers 403 and 290B utilizing flame techniques in accordance with the manufacturer's specifications (Perkin-Elmer 1982). A Perkin-Elmer Atomic Absorption Spectrophotometer 5000 with a MHS-20 Hydride system was used to analyze As and Se (Perkin-Elmer 1982 and 1981). Background correction was used for all metals except Fe, and the major ions when analyzed on the Perkin-Elmer 290B. When analyzed manually, samples were run in triplicate, and maximum absorbance was indicated as the digital readout in absorbance units. A mean and standard deviation were calculated for these samples. When applicable average maximum absorbance was indicated as peak height on a strip-chart recorder. In addition, at least one sample was analyzed twice for each metal to determine the reproducibility of absorbance values. For sample replicates a maximum standard error of 5% was considered to be acceptable (Rossmann, Great Lakes Research Division, personal communication). The absorbance values were converted to concentration values. This was done using a calibration curve established by running a set of standards before and after each set of samples analyzed for a given metal. A linear regression (least squares method) was performed on the standard sets. A minimum Pearson correlation coefficient of .985 was considered to be acceptable (Rossmann, Great Lakes Research Division, personal communication). Standard percent errors were calculated for

those standards which were not obviously high or low. A standard percent error of <10% was considered acceptable (Rossmann, Great Lakes Research Division, personal communication). Quality control was assured by comparison testing of independently made working standards with records of standards made at an earlier date. The final concentration of each sample was expressed as mg (metal) kg⁻¹ (dry weight sediment) (Rossmann, Great Lakes Research Division, personal communication).

For digital output and strip-chart readings, the limit of detection was calculated as twice the standard deviation of the mean background noise (Perkin-Elmer 1982; Rossmann, Great Lakes Research Division, personal communication; Oliver 1973). Background was considered to be autozero readings for digital output, and peak height recordings of distilled water for strip-chart readings. For digital output the readability error % was calculated as one-half the sum of the whole number representations of the difference between the maximum and minimum values for each distilled water blank, divided by the number of differences. A value of < 10% was considered acceptable. For strip-chart readings readability error % was calculated using peak height recordings of distilled water. A value of < 10% was considered to be acceptable (Rossmann, Great Lakes Research Division, personal communication).

For grain-size analysis, sieves with eight

standard sized meshes were used to separate the different particle fractions. The wet subsamples were oven-dried at 110°C for at least 24 hours. The 30.0 - 50.0 g dried subsample was emptied into the stacked eight sieves and shook for ten minutes in a Ro-Tap automatic shaker (Rossmann 1975). Weights of each particle fraction were used to calculate %sand or %silt and clay as:

$$W = \frac{\text{dry weight (g) of F}}{\text{total dry weight (g) of subsample}} \times 100$$

where W represents % sand or % silt and clay, and F represents fraction of sand or silt and clay.

Volatile solids were determined by using a wet subsample oven-dried at 110°C for 24 hours. Measurement was accomplished by weighing the 2.0 - 5.0 g dried subsample before and after it had been ignited at 600°C for one hour in a Thermolyne type 1300 muffle furnace (American Public Health Association 1975). After ignition the subsample was allowed to cool in the muffle furnace for one-half hour, then stored in a desiccator. The subsample was then weighed. The volatile solids as % loss on ignition (%LOI) was calculated as:

$$\% \text{ loss on ignition} = \frac{\text{weight of dry subsample (mg)} - \text{weight of ash (mg)}}{\text{weight dry subsample (mg)}} \times 100$$

All methods used are in compliance with EPA methods (Plumb 1981).

All calculations were accomplished by using self-written computer programs in CBASIC2 with a CP/M operating system on an Osborne Executive Computer. These calculations include linear regression (least squares), limit of detection, readability error percent, standard percent error, standard error, and one-way analysis of variance (ANOVA) with reference to Box et al (1978), CRC Basic Statistical Tables (1971), and Noether (1971). Correlation matrices were calculated by using a Compaq Plus computer with a MS-DOS operating system, BASICA language, and a program by Dean F. Tucker, North Carolina State University.

RESULTS

On August 3, 1982, Wafley Creek samples and field data were collected from 5:30 pm to 6:30 pm CDT. Three samples were collected upstream and four samples downstream from Firestone Tire and Rubber Company. On the same day Saylor Creek samples and field data were collected from 7:07 pm to 8:00 pm CDT. Three samples were collected upstream and five samples downstream from the Ankeny Sewage Treatment Plant. Samples from both creeks were collected from downstream stations first. Field data for Wafley and Saylor Creeks are in Tables 7 and 8, respectively.

Farthest downstream Wafley Creek sediments were dark brown to black and sandy with shallow waters present. Downstream but closer to Firestone Tire and Rubber Company, there were black, clayey sediments. Downstream sediment cores ranged from 11 to 10 cm in length. Downstream sediments were 29°C, had a redox potential of +480 mV, and had a pH of 6.6.

Upstream Wafley Creek sediments were black and sandy to clayey with very shallow waters present. Upstream sediment cores were 10.5 cm each in length. These sediments were 28°C, had a redox potential of +530 mv, and had a pH of 7.3.

Most of the downstream Saylor Creek sediments were medium to dark brown and sandy to clayey. Samples taken at the closest and farthest points from the Ankeny Sewage Treatment Plant were medium brown, sandy sediments. Very

Table 7. Field data and sediment characteristics for Wafley Creek, August 3, 1982.

Sample number	Sample I.D.	Sandy	Silty	Clayey	Approx.		Core length (cm)	Color	Eh (mV)	pH	Comments on other characteristics of sample:	
					time (CDT pm)	Temp. (°C)						
4	1F-D PS			X		5:30	29.0	10.0	black	+480	6.6	Forms good ribbon; a few twigs present.
2	1F-D T			X		5:30	29.0	10.0	black	+480	6.6	
5	1F-D V			X		5:30	29.0	10.0	black	+480	6.6	
6	2F-D T	X				5:30	29.0	11.0	dark brown to black	+480	6.6	Sandy and dark; shallow waters present.
1	1F-U PS	X	----	to	----	6:30	28.0	10.5	black	+530	7.3	Mostly sandy to clayey; a few twigs present; very shallow waters, not flowing in some places, but a few minnows present; forms ribbons somewhat, but not very well; old barrel in creek; ditch upstream, inflow to creek.
3	1F-U T	X	----	to	----	6:30	28.0	10.5	black	+530	7.3	
15	1F-U V	X	----	to	----	6:30	28.0	10.5	black	+530	7.3	

Table 8. Field data and sediment characteristics for Saylor Creek, August 3, 1982.

Sample number	Sample I.D.	Approx. time (CDT)			Temp. (°C)	Core length (cm)	Color	Eh (mV)	pH	Comments on other characteristics of sample:	
		Sandy	Silty	Clayey							
14	1A-D PS	X	---	X	7:07	26.0	11.0	med. to dk. brown	+103	8.6	Sandy to clayey at 11 cm or deeper; no ribbons formed; many very small pebbles present; very shallow waters, not flowing in some parts; however, a lot of minnows present.
10	2A-D V	X	---	X	7:07	26.0	11.0		+103	8.6	
7	3A-D V	X	---	X	7:07	26.0	17.0		+103	8.6	
12	3A-D PS	X			7:07	26.0	17.0	med. brown	+103	8.6	Sandy only; see previous description.
11	2A-D PS	X			7:07	26.0	17.0		+103	8.6	
13	1A-U V	X			8:00	21.0	14.0	dk. brown	+200	7.7	Very rocky; large stones present; very little to no water flow; boulders and large pieces of concrete in stream.
8	2A-U T	X			8:00	21.0	9.0		+200	7.7	
9	3A-U T	X			8:00	21.0	9.0		+200	7.7	

shallow waters were present. Downstream sediment cores ranged from 11 to 17 cm in length. These sediments were 26°C, had a redox potential of +103 mV, and had a pH of 8.6.

Upstream Saylor Creek sediments were dark brown and very rocky. Very little to no water was present. Upstream sediment cores were 9 to 14 cm in length. These sediments were 21°C, had a redox potential of +200 mV, and had a pH of 7.7.

Grain-size fractions were determined in the laboratory (Table 9). In general, Wafley Creek samples were mostly composed of sand. However, sample 15, farthest upstream, was 1.4% gravel, 57.8% sand and 40.8% silt and clay. This is in contrast to sample 3 which had approximately 1% gravel, 93% sand and 5% silt and clay. This is also in contrast to sample 1 (closest to Firestone Tire and Rubber Company) which had approximately 6% gravel, 89% sand and 5% silt and clay.

Downstream the trend is reversed. Closest to Firestone Tire and Rubber Company, sample 4 had approximately 13% gravel, 63% sand and 23% silt and clay. Each of the next two closest samples, 2 and 5, had approximately 9% gravel, 72% sand and 19% silt and clay. Samples 4, 2 and 5 have approximately twice as much silt and clay as sample 6 (farthest downstream) which had approximately 3% gravel, 89% sand and 9% silt and clay.

In general, Saylor Creek sediments are sandy but contain a sizeable amount of gravel. From the farthest point

Table 9. Major grain size fraction percentages for sediment samples.

Sample number	% Gravels	% Sands	% Silts and Clays
1	5.8	89.3	4.9
2	8.9	71.4	19.7
3	1.3	93.3	5.4
4	13.8	63.1	23.2
5	8.5	73.1	18.4
6	2.5	88.7	8.8
7	48.3	48.6	3.1
8	49.8	48.3	2.0
9	30.5	66.4	3.1
10	18.1	76.9	5.2
11	36.5	61.5	2.0
12	38.0	60.6	1.4
13	19.5	79.4	1.1
14	47.4	43.6	8.9
15	1.4	57.8	40.8

upstream to the closest point to the Ankeny Sewage Treatment Plant, upstream samples 9, 8 and 13 are approximately one-third gravel and two-thirds sand. Downstream, closest to the Ankeny Sewage Treatment Plant, the ratios for gravel to sand are about the same. The total amount of silt and clay downstream is approximately 5%.

In the laboratory, samples were also tested for % LOI (Table 10). In Wafley Creek, upstream samples (15, 3 and 1) had approximately 5% LOI. However, downstream samples (4, 2, 5 and 6) ranged from approximately 8% LOI closest to Firestone Tire and Rubber Company to approximately 4% LOI at the farthest point.

In Saylor Creek, upstream samples (9, 8 and 13) had approximately 6% LOI. Except for sample 7 at 7% LOI (nearest the Ankeny Sewage Treatment Plant), other downstream samples (11, 10, 14 and 12) had approximately 3% LOI.

Samples from the field, extracted for trace metal and major ion analyses, were measured against standard curves for each metal. Pearson correlation coefficients were calculated for each run of each metal for each standard curve (Table 11). Standards were included in the curve if they were not obviously high or low for a given concentration when depicted on a graph. For the first nickel run and the second zinc run, the correlation coefficients were less than .985. Therefore, a standard percent error was calculated for those sets of standards for each run. If a standard percent error

Table 10. Percent loss on ignition.

Sample number	Dried sample weight (g)	Ashed sample weight (g)	% Loss on ignition
1	3.1900	3.0761	3.5705
2	2.3244	2.1334	8.2172
3	2.5814	2.4573	4.8075
4	2.6212	2.4000	8.4389
5	3.1592	2.9564	6.4193
6	3.3194	3.1998	3.6031
7	2.7946	2.5947	7.1531
8	2.8124	2.6601	5.4153
9	3.0481	2.8235	7.3685
10	4.0811	3.9733	2.6414
11	4.9357	4.7941	2.8689
12	3.8277	3.6726	4.0520
13	3.7021	3.4709	6.2451
14	3.7346	3.5677	4.4690
15	3.2255	3.0406	5.7324
Replicate 1	2.7124	2.6037	4.0075
Replicate 4	3.3387	3.0313	9.2072

was greater than 10%, the standard was not included in the curve. The corrected correlation coefficients for the first nickel run and the second zinc run are also included in Table 11.

The readability error percent for all strip-chart recordings was calculated to be less than 1%. All mean readability error percents for manual readouts were calculated to be less than 10% (Table 12). Therefore, all runs were acceptable.

The mean limits of detection for each metal are not absolute limits (Table 13). Therefore, the limits of detection may actually be lower.

The mean extracted blank for each metal was calculated for use in standard curves (as y-intercepts) (Table 14). They were also calculated as correction factors for those samples which had a mean limit of detection below the mean extracted blank value.

The sample weights used for extraction and the % insoluble fraction from extraction were calculated (Table 15).

The concentrations of metals found in Wafley Creek samples are presented in Table 16. Replicates for samples were also run for the purpose of reproducibility (Table 17). Two downstream samples had arsenic concentrations of approximately 10 mg kg^{-1} while upstream samples had 1 to 3 mg kg^{-1} . All downstream samples had approximately twice the

Table 11. Slope, y-intercept, correlation coefficient, and when applicable, standard percent error for each run for each metal.

Trace metal	Run number	Slope	Y-intercept ***	Correlation coefficient	Standard percent error
As	1	0.156	2.227	.993	
As	2	0.145	3.857	.990	
Cd	1	132.6	2.429	.997	
Cd	2	139.4	2.681	.999	
Cd	3	358.7	2.287	.995	
Cr	1	0.039	0.018	.992	
Cr	2	0.038	0.019	.997	
Cr	3	15.16	4.170	.997	
Cu	1	0.264	0.016	1.000	
Cu	2	0.268	0.017	1.000	
Cu	3	25.08	1.728	.998	
Fe	1	1.203	5.492	.997	
Fe	2	1.188	6.128	.997	
Fe	3	1.203	5.492	.997	
Fe	4	3.630	4.225	.998	
Pb	1	4.385	0.699	.999	
Pb	2	4.560	0.682	.998	
Pb	3	7.698	0.141	1.000	
Mn	1	0.011	0.021	.999	
Mn	2	0.011	0.019	.999	
Mn	3	1.257	0.138	.999	
Ni *	1	0.076	0.016 ****	.975	12.37
Ni **	1	0.078	0.016 ****	.992	
Ni	2	0.077	0.017 ****	.991	
Ni	3	17.86	-0.063	.999	
Sn	1	2.183	5.133	.995	
Zn	1	0.032	0.018	.999	
Zn *	2	0.030	0.018	.981	10.47
Zn **	2	0.031	0.018 ****	.992	
Zn	3	2.684	54.18	.985	
Zn	4	1.057	35.70	.998	
Ca	1	2.696	2.013	.999	
Ca	2	1.306	4.555	.993	
K	1	17.56	-4.231	.997	
K	2	0.825	-0.667	.994	
Mg	1	10.22	0.527	.998	
Na	1	2.820	-0.520	.999	

* Original run including standard percent error for 0.50 ppm Ni standard and 5.00 ppm Zn standard.

** Repeat of run after removal of questionable standard.

*** Calculated y-intercept unless otherwise noted.

**** Mean y-intercept.

Table 12. Mean readability error percent.

Trace Metal	Mean Readability error % ^a		
As ^b	1.8		
Cd ^b	0.76 ^c	1.23	
	1.7 ^d		
Cr	1.54		
Cu	2.34		
Fe ^e	1.1		
Na ^f	0.33		
Ni	2.79		
Sn ^b	3.1		
Zn	4.79 ^c	0.712 ^{d,f}	1.54 ^{f,g}

^a Based on manual readouts of distilled water blanks and autozeros of 0.00 ppm standards; all other readability error percentages are <1.

^b Based on one-half the baseline signal from strip-chart recordings.

^c Based on first and second runs only.

^d Based on third run only.

^e Based on blank 10% HCl readouts.

^f Based on distilled water blank readouts.

^g Based on fourth run only.

Table 13. Mean limit of detection for sediment samples and Perkin-Elmer limit of detection data for water samples in mg l⁻¹.

Trace Metal	Mean limit of detection*	Perkin-Elmer 403 limit of detection
As	0.00593 ^a	0.1 ^a
Ca	0.0131	0.001
Cd	0.00753 ^b 0.00859 ^c	0.00788 0.001
Cr	0.198 ^b 0.00330 ^c	0.133 0.003
Cu	0.0226	0.002
Fe	0.603 ^d 0.0275 ^e	0.411 0.01
K	0.0195	0.005
Mg	0.00098	0.0001
Mn	0.378	0.002
Na	0.00409 ^d	0.002
Ni	0.0491	0.01
Pb	0.0197	0.02
Se	no value	0.1 ^a
Sn	1.66 ^f	0.02 ^a
Zn	0.189 ^b 0.165 ^c 1.06 ^g	0.401 0.002

* Determined with Perkin-Elmer 403 unless otherwise noted

^a Determined by hydride generation

^b First and second runs only ^c Third run only

^d Determined with Perkin-Elmer 290B

^e Determined with Perkin-Elmer 403

^f Determined by air-acetylene flame ^g Fourth run only

Table 14. Mean extracted blank concentration in mg kg^{-1} .

Trace Metal	Mean extracted blank		
As	0.00		
Ca	- 20.652		
Cd	- 0.161 ^a	0.078	
	0.796 ^b		
Cr	- 19.986		
Cu	- 0.228		
Fe	- 61.784		
K	0.00		
Mg ^c	-----		
Mn	- 35.125		
Na	124.472		
Ni	0.172		
Pb	- 0.525		
Se	no value		
Sn	165.664		
Zn	19.884	10.098 ^a	-1125.914 ^d
	- 9.474		

^a Extracted blanks for first and second runs only
^b Extracted blanks for third run only
^c Extracted blanks were not run
^d Extracted blanks for third and fourth runs only

Table 15. Sample weight, weight of insoluble fraction and the percent insoluble fraction.

Sample number	Sample Weight (g)	Weight of the insoluble fraction (g)	% Insoluble fraction
1	2.0000	1.7731	11.345
2	2.0005	1.6237	18.835
3	2.0000	1.7552	12.240
4	2.0003	1.6805	15.988
5	2.0000	1.6860	15.700
6	2.0000	1.8023	9.885
7	2.0000	1.6559	17.205
8	2.0000	1.5924	20.380
9	2.0002	1.6181	19.104
10	2.0002	1.7871	10.654
11	2.0004	1.7109	14.472
12	2.0000	1.5199	24.005
13	2.0005	1.6629	16.876
14	2.0000	1.6790	16.050
15	2.0002	1.7005	14.984

Table 16. Trace metal concentrations in mg kg^{-1} for Wafley Creek sediments.

	Upstream		F		Downstream		
	15	3	Sample Number 1	4	2	5	6
As	2.03	2.71	1.10	9.60	10.80	5.59	0.54
Cd	0.522	0.296	0.391	1.408	1.050	0.692	1.032
Cu	15.57	16.16	7.22	23.71	22.62	14.28	7.06
Cr	40.00	31.83	24.56	45.60	62.33	49.85	27.13
Fe	15369.7	6365.5	4776.2	29382.0	14837.7	13252.2	8484.5
Pb	71.27	63.87	69.00	99.20	98.05	44.48	28.51
Mn	281.32	278.43	263.44	341.07	353.57	403.80	188.00
Ni **	20.96	17.87	15.55	33.39	44.01	25.65	15.77
Se ***	----	----	----	----	----	----	----
Sn **	130.52	48.10	-18.32*	11.43	-19.50*	-8.02*	107.65
Zn	119.97	110.53	91.92	255.08	215.10	183.61	110.06
Ca	25824.6	18487.6	20568.8	11485.6	9924.0	10730.6	13284.7
K	1489.22	96.02	80.22	2455.86	2822.27	2856.31	80.93
Mg	5111.7	2816.4	3727.2	4026.1	4137.9	3951.8	2866.3
Na **	168.23	97.34	154.96	242.67	261.25	132.80	50.35

F Firestone Tire and Rubber Company

* Below limit of detection

** Corrected values; extracted blanks were greater than the limit of detection.

*** No reading

Table 17. Standard error and standard error percent for replicates of trace metal concentrations.

Trace Metal	Sample number	1st run conc. (mg kg ⁻¹)	Replicate run conc. (mg kg ⁻¹)	Standard error	Standard error %
As *	--	--	--	--	--
Ca	9	44964.8	47406.1	1220.86	2.64
Cd **	11	.1469	1.457	--	--
Cr	13	12.200	11.256	.472	4.02
Cu	3	16.155	16.219	.0319	0.20
Fe	7	7954.71	7472.62	241.08	3.13
K	9	77.646	81.491	1.92	2.42
Mg	4	4026.09	4163.31	68.62	1.68
Mn	8	601.73	635.64	16.96	2.74
Na	6	50.352	41.486	4.43	2.60
Ni	1	15.545	14.890	.328	2.13
Pb	5	44.480	47.603	1.56	3.39
Sn	6	107.645	95.049	6.30	2.36
Zn ***	--	--	--	--	--

* No replicate run

** Replicate was run at 4mA rather than 8mA as in the 1st run

*** Replicates were contaminated

cadmium concentration of the upstream samples with 0.7 to 1.4 mg kg⁻¹. Downstream samples had approximately 23 mg kg⁻¹ copper and 46 to 62 mg kg⁻¹ chromium, which were mostly higher than samples upstream.

One downstream sample, at over 29000 mg kg⁻¹ iron, was much more concentrated than upstream samples at 5000 to 15000 mg kg⁻¹ iron. Two downstream samples had higher lead concentrations (approximately 98 mg kg⁻¹) than upstream samples which ranged from 64 to 71 mg kg⁻¹. Both manganese and nickel concentrations were variable in distribution among upstream and downstream samples. The ranges were 188 to 404 mg kg⁻¹ manganese and 16 to 44 mg kg⁻¹ nickel.

Tin exhibited highly variable results since it was not analyzed using a hydride system. Of those values above the limit of detection, upstream samples had 48 and 131 mg kg⁻¹ tin, and downstream samples had 11 and 108 mg kg⁻¹ tin. For zinc three downstream samples were higher at 183 to 255 mg kg⁻¹ than upstream samples at 92 to 120 mg kg⁻¹. Samples 2, 4, 5 and 15 which had fine grained sediments were analyzed for selenium. The values could not be distinguished from background distilled water readings.

For major ion concentrations, calcium was almost twice as high upstream with 18000 to 26000 mg kg⁻¹ than downstream with 10000 to 13000 mg kg⁻¹. Potassium ranged from 80 to 96 mg kg⁻¹ in two upstream samples (1 and 3) and one downstream sample (6). All other samples were at approximately 1500 mg

kg^{-1} upstream and 2500 to 2900 mg kg^{-1} potassium downstream. The farthest upstream sample (15) gave the highest magnesium concentration at over 5000 mg kg^{-1} ; all other samples ranged from 2800 to 4100 mg kg^{-1} magnesium. Downstream, two samples (4 and 2) had high concentrations of sodium at 243 and 261 mg kg^{-1} . Upstream the samples ranged from 97 to 168 mg kg^{-1} , while the other downstream samples were 50 and 133 mg kg^{-1} sodium.

The concentration of metals found in Saylor Creek samples are presented in Table 18. Reproducibility results are in Table 17. It should be noted that sample 13 results were artificially lower because of the loss of 5 to 10 ml of the extract during the filtration process. As Table 18 indicates, all values for sample 13 are approximately half that for the other upstream samples. Therefore, discussion of this sample will be minimal.

Except for two samples downstream at 8 and 12 mg kg^{-1} , arsenic concentrations ranged from 1 to 4 mg kg^{-1} . Both cadmium and copper had variable ranges in concentrations with 0.1 to 1.5 mg kg^{-1} for cadmium and 3 to 10 mg kg^{-1} for copper. However, cadmium samples were slightly more concentrated upstream at 1.3 to 1.5 mg kg^{-1} compared to 1.1 mg kg^{-1} for the most concentrated sample downstream. Chromium concentrations were somewhat higher downstream with two samples at approximately 43 mg kg^{-1} . Upstream samples ranged from 25 to 29 mg kg^{-1} chromium.

Table 18. Trace metal concentrations in mg kg^{-1} for Saylor Creek sediments.

	Upstream		A	Downstream				
	9	8	Sample Number 13	7	11	10	14	12
As	2.22	4.36	-1.52*	8.00	4.27	11.53	1.42	2.72
Cd	1.331	1.492	0.344	1.145	0.147	0.506	0.739	0.882
Cu	7.54	4.80	2.53	9.52	4.68	3.61	5.33	4.49
Cr	25.48	29.47	12.20	42.78	28.80	27.94	44.74	22.43
Fe	11661.8	9014.2	2656.6	7954.7	11131.0	18018.1	16324.7	12086.8
Pb	25.86	86.72	22.02	23.95	15.99	8.87	17.64	9.97
Mn	505.55	601.73	248.01	2102.9	938.32	467.81	1381.3	1936.4
Ni **	18.45	18.03	9.67	33.81	21.37	20.20	21.28	26.48
Se ***	----	----	----	----	----	----	----	----
Sn **	396.55	654.26	108.72	178.65	86.98	85.86	183.23	108.79
Zn	120.83	124.91	87.13	130.55	82.25	44.02	101.31	90.16
Ca	44964.8	52880.0	28749.9	22602.6	21746.9	24823.2	26315.5	17447.0
K	77.65	71.39	34.35	1956.13	79.49	79.35	1422.68	75.38
Mg	7170.2	7857.1	3451.9	5923.2	6221.4	4737.4	8181.5	5923.2
Na **	130.11	106.20	91.76	212.58	181.50	110.61	261.34	154.96

A Ankeny Sewage Treatment Plant

* Below limit of detection

** Corrected values; extracted blanks were greater than the limit of detection.

*** No reading

Two samples downstream were approximately one and one-half times the highest iron concentrations upstream (9000 to 12000 mg kg⁻¹). Manganese concentrations were much higher in downstream samples. The higher values ranged from 938 to 2103 mg kg⁻¹ while upstream samples had 506 and 602 mg kg⁻¹ manganese. Lead was just the opposite. Upstream samples ranging from approximately 20 to 90 mg kg⁻¹ were higher than downstream samples at 9 to 24 mg kg⁻¹ lead. Nickel concentrations were slightly higher downstream with 20 to 30 mg kg⁻¹. Upstream concentrations were approximately 18 mg kg⁻¹ nickel.

Two upstream samples had extremely high tin concentrations at 397 and 654 mg kg⁻¹. All other samples ranged from 86 to 183 mg kg⁻¹ tin. Tin values, though, were erratic because a hydride system was not used during the analysis. Zinc concentrations varied upstream and downstream in the range of 44 to 131 mg kg⁻¹. Sample 7 was analyzed for selenium with the result being indistinguishable from background distilled water readings.

Major ion concentrations were mostly varied upstream and downstream for magnesium and sodium. The concentrations for magnesium ranged from 3500 to 8200 mg kg⁻¹. For sodium the concentrations ranged from 92 to 261 mg kg⁻¹ with samples downstream being somewhat higher in concentration. For calcium and potassium there were striking differences in concentrations. Two samples farthest upstream (9 and 8) had

twice the calcium concentration (45000 and 53000 mg kg⁻¹) of all other samples. Most samples had potassium concentrations ranging from 71 to 79 mg kg⁻¹. However, two samples downstream (14 and 7) had concentrations of 1400 and 2000 mg kg⁻¹ potassium.

DISCUSSION

In order to investigate the relationship of trace metals with related variables, a correlation matrix was constructed (Table 19). The most important relationships to establish involve each trace metal with grain-size, % LOI, iron, manganese and major ions. Field data of Eh, pH and temperature provide some indication of trace metals present as well as information on the conditions of the stream sediment at the time of sampling.

Five metals are significantly positively correlated with % silt and clay. They are copper, chromium, iron, lead and zinc. This has implications for another relationship indicated by the matrix. Cadmium, copper, chromium, lead, nickel and zinc are significantly positively correlated with % LOI. Organic carbon is typically linked to finer grained sediments (Sly 1983; Warren 1981; Bower et al. 1978; Suzuki et al. 1978; Rossmann and Seibel 1977; Vivian and Massie 1977; Cline and Chambers 1977; Fitchko and Hutchinson 1975; Maxfield et al. 1974; Pasternak 1974; Ndiokwere 1984; Oliver 1973).

Five trace metals, arsenic, copper chromium, nickel and zinc, were strongly positively correlated with iron. This pattern has been seen elsewhere (Bradley and Lewin 1982).

There are no significant positive correlations of trace metals to manganese. However, both manganese and tin are significantly positively correlated with % gravel and

Table 19. Coefficient correlation matrix (positive correlations only) for trace metal concentrations and other sediment parameters.

	%sands	%gravels	%LOI	Eh	pH	temp.	Fe	Mn	Ca	K	Mg	Na	%insoluble
As	.20	-.17	.03	-.04	-.04	.32	.62	.09	-.27	.53	-.01	.44	.03
Cd	.05	-.43	.34	-.05	-.23	-.18	.37	.16	.28	.30	.35	.19	.49
Cu	.70	.09	-.51	.71	-.69	.62	.53	-.31	-.51	.75	-.39	.46	-.01
Cr	.60	-.31	-.11	.34	-.37	.58	.53	.04	-.43	.91	.03	.70	.08
Fe	.54	-.35	-.03	.07	-.15	.37	---	-.02	-.26	.54	.13	.55	.07
Pb	.54	.06	-.38	.70	-.70	.30	.28	-.49	-.08	.44	-.23	.27	.04
Mn	-.35	-.64	.76	-.69	.72	-.13	-.02	---	.03	.05	.56	.39	.51
Ni	.36	-.34	.07	.09	-.17	.46	.53	.32	-.46	.78	.04	.74	.36
Sn	-.31	-.51	.62	-.44	.28	-.77	-.17	.15	.92	-.36	.71	-.24	.43
Zn	.54	-.13	-.22	.51	-.69	.40	.55	-.19	-.37	.81	-.18	.50	.24

a r @ .05 = .441

b r @ .01 = .592

c r @ .005 = .641

d r @ .0005 = .760

magnesium. Tin is also strongly positively correlated with calcium. This indicates a strong association between manganese and tin with the inorganic component of the sediments, or hard water conditions. Manganese and cadmium are also strongly positively correlated with the % insoluble fraction.

Arsenic, copper, chromium, iron, nickel and zinc are strongly positively correlated with potassium. Except for arsenic the same trace metals are strongly positively correlated with sodium.

The results presented in the correlation matrix also indicate some general conditions of Wafley and Saylor Creek sediments. Iron is found to be practically unassociated with Eh, while manganese is strongly negatively correlated with Eh. Iron and manganese found at low redox potentials or in reducing conditions has been reported by other investigators (Warren 1981; Cline and Chambers 1977). Copper, lead and zinc are significantly positively correlated with Eh.

Only manganese is strongly positively correlated with pH. Lead and zinc are strongly negatively correlated with pH. Copper, chromium and nickel are significantly positively correlated with temperature.

In Table 20 the relationships between the major ions and related parameters are given to support the previous correlations. Potassium is strongly positively correlated

Table 20. Coefficient correlation matrix (positive correlations only) for major ion concentrations and other sediment parameters.

	%silts and									
Metal	clays	%sands	%gravels	%LOI	Eh	pH	temp.	Fe	Mn	%insoluble
Ca	-.34	-.39	.54 ^a	-.03	-.46	.37	-.88	-.26	.03	.31
K	.64 ^b	-.30	-.14	.68 ^c	.34	-.42	.52 ^a	.54 ^a	.05	.16
Mg	-.21	-.85	.86 ^d	-.02	-.69	.62 ^b	-.55	.13	.56 ^a	.55 ^a
Na	.34	-.57	.28	.43	-.08	.11	.30	.55 ^a	.39	.31

^a $r @ .05 = .441$

^b $r @ .01 = .592$

^c $r @ .005 = .641$

^d $r @ .0005 = .760$

with %silt and clay, % LOI, temperature and iron. This concurs with the association of copper, chromium, iron and zinc associated with both potassium and %silt and clay. This agrees with the associations between potassium and % LOI with copper, chromium, nickel and zinc. This also concurs with the association of potassium, temperature and copper, chromium and nickel. For iron there is a strong positive correlation with arsenic, copper, chromium, nickel and zinc.

Both calcium and magnesium are strongly positively correlated with %gravel as is manganese and tin which has already been mentioned. Magnesium and pH, just as manganese and pH, are also strongly positively correlated. Except for cadmium, lead and tin, a significant positive correlation exists between iron and sodium and the other trace metals. This is indicated by the strong positive correlation of iron and sodium.

A second correlation matrix was constructed to investigate the interrelationship among the trace metals (except for iron and manganese) (Table 21). Copper and chromium are each significantly positively correlated with arsenic, lead, nickel and zinc. Zinc is significantly positively correlated with cadmium, copper, chromium, lead and nickel. Only cadmium is significantly positively correlated with tin.

A one-way analysis of variance was used to determine the significance of variation in trace metal and major ion

Table 21. Correlation coefficient matrix (positive correlations only) of trace metals and their interrelationship.

	As	Cd	Cu	Cr	Pb	Ni	Sn	Zn
As	--	.31	.47 ^a	.61 ^b	.28	.76 ^d	-.18	.44
Cd	.31	--	.25	.30	.34	.42	.53 ^a	.55 ^a
Cu	.47 ^a	.25	--	.75 ^c	.76 ^d	.67 ^c	-.41	.86 ^d
Cr	.61 ^b	.30	.75 ^c	--	.49 ^a	.82 ^d	-.27	.73 ^c
Pb	.28	.34	.76 ^d	.49 ^a	--	.38	-.01	.71 ^c
Ni	.76 ^d	.42	.67 ^c	.82 ^d	.38	--	-.28	.70 ^c
Sn	-.18	.53 ^a	-.41	-.27	-.01	-.28	--	-.19
Zn	.44	.55 ^a	.86 ^d	.73 ^c	.71 ^c	.70 ^c	-.19	--

^a r @ .05 = .441
^b r @ .01 = .592
^c r @ .005 = .641
^d r @ .0005 = .760

concentrations upstream and downstream in each creek.

The null hypothesis is: The same concentrations of metals are found both upstream and downstream, or all samples are from the same population. The alternate hypothesis is: There are different metal concentrations upstream and downstream, or the samples upstream are not from the same population as the samples downstream.

The calculated mean square ratios for Wafley Creek metals are summarized in Table 22. They exceed the F-statistic for all metals except copper, manganese, lead, tin, magnesium and sodium. These concentrations reflect a significant difference between upstream and downstream samples. Only calcium is more concentrated upstream than downstream. Arsenic, cadmium, chromium, iron, nickel, zinc and potassium concentrations are significantly higher downstream.

The calculated mean square ratios for Saylor Creek metals are also summarized in Table 22. All metals exceed the F-statistic. However, cadmium, copper, zinc and magnesium are so close to F at $.05 = 5.99$ that it is not clear whether there is a difference between upstream and downstream samples. Lead, tin and calcium are more concentrated upstream than downstream. Arsenic, chromium, iron, manganese, nickel, potassium and sodium are significantly higher in concentration downstream.

Table 22. Mean square ratios for trace metal data from Wafley and Saylor Creeks.

Metal	Wafley Creek data mean square ratio*	Saylor Creek data mean square ratio**
As	7.87 a	7.99 d
Cd	17.53 c	7.15 d ***
Cr	7.25 a	8.45 d
Cu	5.57	6.11 d
Fe	6.63 a	8.93 e
Mn	5.73	10.88 e
Ni	7.59 a	11.39 e
Pb	5.00	9.53 e ***
Sn	5.38	10.72 e ***
Zn	10.11 b	7.06 d
Ca	31.00 c ***	18.41 f ***
K	7.92 a	7.51 d
Mg	5.04	6.00 d
Na	5.27	10.57 e

* degrees of freedom: numerator = 1; denominator = 5

** degrees of freedom: numerator = 1; denominator = 6

*** upstream samples more concentrated than downstream samples

a F @ .05 = 6.61
b F @ .025 = 10.01
c F @ .01 = 16.26
d F @ .05 = 5.99
e F @ .025 = 8.81
f F @ .01 = 13.75

CONCLUSIONS

This study was devised to determine two issues. First, are Wafley and Saylor Creeks polluted with trace metals? Second, are Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant trace metal polluters of Wafley and Saylor Creeks, respectively?

The first issue involves the overall question of pollution. A general comparison of trace metals in sediments between Wafley and Saylor Creeks and the Des Moines River may provide a starting point. The data for comparison are in Tables 5, 16, and 18.

Except for one Wafley Creek sample, arsenic values for both creeks exceeded those for the Des Moines River. Most cadmium values in downstream Wafley Creek, and some samples upstream and downstream in Saylor Creek exceeded those for the river. Upstream Wafley Creek samples and one upstream Saylor Creek sample exceeded copper values for the upstream Des Moines River. Some downstream Wafley Creek samples exceeded the downstream Des Moines River sample for copper. All downstream Saylor Creek samples were lower in copper concentration than the Des Moines River sample. Most of the samples from the creeks exceeded that for the downstream Des Moines River value for chromium. Iron concentrations were mostly similar for the creeks and river. However, creek samples had somewhat higher downstream iron concentrations.

Lead values for both creeks exceeded those for the river. Most of the Wafley Creek manganese values were below Des Moines River values. Most of the Saylor Creek manganese values exceeded those for the river. Nickel and zinc values for both creeks exceeded those for the Des Moines River. Calcium, magnesium and sodium values were mostly similar in the creeks and river.

From the comparison made, Wafley and Saylor Creeks are generally higher in trace metal content in sediments than the Des Moines River. This comparison only provides information on conditions in the area studied. However, it does not mean that a pollution problem exists in the creeks.

No federal standards exist. The state of Iowa uses two sets of classification to determine the level of pollution in sediments. The first classification set used by Iowa is the USEPA or EPA Region V guidelines for pollution of Great Lakes sediments. Sediments are classified as heavily polluted, moderately polluted, or non-polluted. This classification is based on the predominant categorization of individual parameters including trace metal concentration. Other parameters considered include particle size distribution, color, odor, and source of contamination. According to EPA Region V (1977), "[t]hese factors are interrelated in a complex matter and their interpretation is necessarily somewhat subjective."

The classification ranges are based on compilations from

over 100 Great Lakes harbors since 1967, and 260 samples from thirty-four harbors tested from 1974 and 1975 (EPA 1977). The pertinent classification data is given in Table 23.

According to EPA Region V (1977) the sources of sediment contamination are usually evident. "Sediments reflect the inputs of paper mills, steel mills, sewage discharges, and heavy industry very faithfully." Field observations are a "most reliable indicator of sediment condition."

Important factors for consideration include color, texture, and presence of detritus. Guidelines for these categories have been enumerated. In general, the "lighter the color the cleaner the sediment. In terms of texture "the finer the material the more polluted it is." Sands and gravels will usually have lower concentrations of pollutants while silts will usually have higher concentrations. Large amounts of detritus may produce high volatile solids values. If such high values are indicated, and high trace metals values are also indicated, the source of pollution is considered to be man-made (EPA 1977).

The second classification is the USEPA or EPA Region VI (1980) sediment alert levels. While these levels provide a "concise and comprehensive" way to evaluate pollution, the final decision about whether or not pollution exists belongs to those who actually make decisions on such matters. If a decision maker suspects that a water pollution problem exists

Table 23. USEPA Region V (1977) pollution classification of sediments.

PARAMETER	CATEGORY		
	NON-POLLUTED	MODERATELY POLLUTED	HEAVILY POLLUTED
Volatile Solids (%)	<5	5-8	>8
Trace Metals (mg kg ⁻¹ dry wt.)			
Pb	<40	40-60	>60
Zn	<90	90-200	>200
Fe	<17000	17000-25000	>25000
Ni	<20	20-50	>50
Mn	<300	300-500	>500
As	<3	3-8	>8
Cd	**	**	>6
Cr	<25	25-75	>75
Cu	<25	25-50	>50

** Lower limits not established

but the water data do not indicate this condition, a program may be started to study the sediments. A study of the sediments may provide the information to actually make decisions.

The EPA Region VI (1980) sediment alert levels are given in Table 24. These levels are based on the 24 hour average for water levels as given in the Federal Register, vol. 45, no. 231, Friday, November 28, 1980. If the 24 hour levels were not available, maximum levels were used. No field data of sediment samples is utilized in compiling these standards. In some cases the value for water hardness is necessary in order to determine the sediment alert level. The U.S. Geologic Survey sediment alert levels are also reported in Table 24.

Trace metal concentrations may be compared to EPA Region V criteria. The pertinent data are in Tables 16, 18 and 23. Using these criteria, Wafley Creek sediments are moderately to heavily polluted with arsenic, chromium, lead, manganese, nickel and zinc. Saylor Creek sediments are moderately to heavily polluted with arsenic, chromium, manganese and nickel. Zinc is somewhat moderately polluting. This information indicates that Wafley and Saylor Creeks have trace metal pollution problems in sediments.

By examining the trace metal data upstream and downstream, the scope of the pollution problem for Wafley and Saylor Creeks changes. Wafley Creek sediments downstream are

Table 24. USEPA Region VI (1980) pollution classification for sediments.

Parameter	EPA criteria for fresh water (a,b)		Region VI alert levels for sediments (a)	U.S. Geological Survey alert levels for sediments (c)
	24 h ave.	max. level		
As	----	440 (As +3)	440 (As +3)	200
Cd	e 1	e 2	24 h ave.	20
Cr	III ----	e 3	max. level	200 (d)
VI	0.29 (e)	21	0.29	
Cu	5.6 (e)	e 4	5.6	2000
Fe	----	----	----	----
Pb	e 5	e 6	24 h ave.	500
Mn	----	----	----	----
Ni	e 7	e 8	24 h ave.	2000
Zn	47	e 10	47	5000

(a) values reported in $\mu\text{g l}^{-1}$

(b) e-values are based on the natural logarithm of the hardness value for water (hd):

$$1 = (1.05 \ln(\text{hd}) - 8.53); 2 = (1.05 \ln(\text{hd}) - 3.73);$$

$$3 = (1.08 \ln(\text{hd}) + 3.48); 4 = (0.94 \ln(\text{hd}) - 1.23);$$

$$5 = (2.35 \ln(\text{hd}) - 9.48); 6 = (1.22 \ln(\text{hd}) - 0.47);$$

$$7 = (0.76 \ln(\text{hd}) + 1.06); 8 = (0.76 \ln(\text{hd}) + 4.02);$$

$$10 = (0.83 \ln(\text{hd}) + 1.95).$$

(c) values reported in mg kg^{-1}

(d) total chromium

(e) below limit of detection

moderately to heavily polluted with arsenic, manganese and nickel. These sediments are generally not polluted upstream for the same trace metals. Zinc is moderately to heavily polluting downstream, slightly different from the moderately polluting conditions upstream. Chromium and lead are consistently moderately to heavily polluting throughout the creek bed. Only one sample downstream in Wafley Creek is heavily polluted with iron.

Saylor Creek sediments downstream are moderately to heavily polluted with arsenic and nickel. Upstream, practically no pollution of these trace metals exist. Chromium and manganese are moderately to heavily polluting throughout the creek bed. Iron is moderately polluting in only one sample downstream. Lead is heavily polluting in only one sample upstream in Saylor Creek sediments.

The comparison of upstream and downstream samples for levels of pollution has implications for possible point-sources. According to EPA Region V criteria, Firestone Tire and Rubber Company may be polluting Wafley Creek with arsenic, manganese and nickel. Ankeny Sewage Treatment Plant may be polluting Saylor Creek with arsenic and nickel. However, EPA guidelines and criteria are only a means for "assessing impacts" of pollutants rather than actually identifying a point-source for "regulatory action." Additional evaluations of the trace metals are warranted.

Wafley Creek sediments may be evaluated in terms of

trace metals and other sediment parameters. According to the soil types for the area, Wafley Creek sediments would contain sand and loam components. The creek contains a large amount of fine grained sediments (Table 9). The associated high trace metal concentrations found were, therefore, not surprising. Wafley Creek sediments contain an even larger portion of sands than silts and clays (Table 9). Sandy creeks often have a scouring effect during times of high water flow. Such creeks are considered clean. Wafley Creek is not such a creek. However, samples were obtained during a time of low water flow. Fine grained sediments signify accumulation of suspended materials indicating a slow moving stream (Warren 1981). Fine grained sediments drift more than sands and settle in sediment traps. The trace metals probably adsorbed to fine grained sediments. Sorption occurs in preference to complexing with organic matter (Bradley and Lewin 1982; Rippey 1982; Oliver 1973). The occurrence of fine grained sediments with high trace metal concentrations indicates cultural inputs (Sly 1983).

Another condition of the sediments may further explain the status of Wafley Creek. In downstream samples 4, 2 and 5, %LOI was three to four times higher than upstream values (Table 16). High organic matter content associated with high trace metal concentrations indicates man-made pollution according to the EPA Region V Report (1977).

Mostly black sediments were found in Wafley Creek.

Coupled with the negative to zero correlation of Eh with iron and manganese, reducing conditions exist (Table 19). Iron would not have been easily released from the sediments to the water (Wetzel 1975). Therefore, iron was found in high concentrations. Downstream, sample 4 (closest to Firestone Tire and Rubber Company) had an iron concentration twice that of samples 2 and 5 (Table 16). Sample 4 had an iron concentration three and one-half times the concentration of the sample farthest downstream (Table 16). The distribution of iron downstream suggests that cultural inputs have occurred.

The distribution of iron concentrations upstream in Wafley Creek may lend support to the possibility of cultural inputs. Sample 15 (farthest from Firestone Tire and Rubber Company) had an iron concentration two to three times that for other upstream samples (Table 16). With little water flow resuspension of iron-enriched sediment is unlikely. In addition, sample 15 had the highest %silts and clays which indicates the presence of a sediment trap for iron. Despite this, sample 4 downstream still had an iron concentration twice that of sample 15 (Table 16).

Iron was also associated with other trace metals. Arsenic, chromium, nickel and zinc occur with iron (Table 19). This has been determined by other investigators (Sly 1983; Warren 1981).

The pH range of 6.6 to 7.3 for Wafley Creek indicates

that adsorption of trace metals to sediments occurs over precipitation (Rippey 1982). This coincides with the association of trace metals with fine grained sediments. This pH range means conditions for the accumulation of trace metals exist.

Of the major ions only potassium was found in high concentrations downstream in Wafley Creek (Table 16). This agrees with the high concentrations of iron found and the fine grained sediments present in a mostly sandy creek bed. Trace metals are also associated with potassium (Sly 1983). High concentrations of trace metals were also found. Trace metals and potassium occur together (Table 19).

Interrelationships between metals may also aid in explaining the high metals levels downstream in Wafley Creek (Table 21). Zinc is associated with cadmium, chromium and nickel. The correlation coefficient for the arsenic and zinc association is .44, which may indicate possible significance since r at .05 = .441. High concentrations of trace metals occur with high concentrations of zinc (Table 21).

Saylor Creek sediments may be evaluated in terms of trace metals and other parameters. Saylor Creek contains mostly sand and some gravel (Table 9). Based on the soil types in this area, this result was expected. High trace metal concentrations are not typically associated with this kind of sediment. However, Saylor Creek had high

concentrations for all trace metals except for lead and tin. Cadmium, copper and zinc are not unequivocally pollutants in this case (Table 22). Regardless, the trace metals found in high concentrations may be attributable to man-induced inputs.

At the time of sampling little to no water flow was present. In effect, no scouring occurred at that time. However, scouring must be a regular feature of Saylor Creek since the sediment bed is coarse grained. Small amounts of fine grained sediments are present for sorption of trace metals. It is likely that high flow water conditions exist, but the small amounts of fine grained sediment must be in traps. This suggests that trace metal inputs are man-induced.

The %LOI was somewhat lower downstream (approximately 4%) than upstream (approximately 6%). This does not coincide with the low trace metal concentrations found upstream, and the high trace metal concentrations found downstream. However, the association of fine grained sediment with %LOI may indicate that any sorbed trace metals would be in sediment traps.

Saylor Creek sediments are medium to dark brown. This indicates somewhat aerated sediments with redox potentials being somewhat low (Table 8). Iron and manganese concentrations were high, which indicates that the sediments were not aerated enough to allow iron and manganese to become

oxidized and released to the water (Warren 1981). Samples 10 and 14 had the highest iron content though they were not directly downstream from Ankeny Sewage Treatment Plant. The highest manganese concentrations downstream are approximately the same despite sample 7 being closest to and sample 12 being farthest from Ankeny Sewage Treatment Plant (Table 18).

High iron concentrations may be an important factor to explain the high concentrations of other trace metals. Iron was significantly correlated to arsenic, chromium and nickel (Table 19). Therefore, these trace metals likely occur with iron.

The pH range for Saylor Creek is 7.7 to 8.6. The downstream samples at pH = 8.6 are beyond the range for trace metal sorption to sediments (Rippey 1982). Precipitates will form instead. However, with little to no water flow at the time of sampling, metal precipitates will likely remain in the creek bed.

Potassium and sodium were found in high concentrations downstream in Saylor Creek (Table 18). Samples 7 and 14 show definite potassium enrichment, and to a lesser degree, sodium enrichment of the sediments. The high potassium concentrations are associated with high iron concentrations and fine grained sediments in a sandy creek bed. Trace metals are also associated with potassium (Sly 1983). High trace metal concentrations were found. Trace metals and potassium occur together (Table 19).

Interrelationships between metals may also aid in explaining high metals levels found downstream in Saylor Creek (Table 21). Arsenic is associated with chromium and nickel. Zinc is associated with cadmium and copper (and possibly arsenic) as well as with chromium and nickel. High concentrations of trace metals occur with high concentrations of zinc.

Further evaluations of the creeks sediments may be made. The mean square ratios from the ANOVA tables provide a means to judge possible point-sources. In Wafley Creek arsenic, cadmium, chromium, iron, nickel, zinc and potassium may be called pollutants. In Saylor Creek arsenic, chromium, iron, manganese, nickel, potassium and sodium may be called pollutants. The mean square ratios indicate the significance in the difference between upstream and downstream concentrations for the metals given for each creek. In order for a significant increase in metal concentrations to occur downstream, inputs must have been made by a point-source directly upstream. This would imply that Firestone Tire and Rubber Company is a trace metal polluter of Wafley Creek. This would also imply that Ankeny Sewage Treatment Plant is a trace metal polluter of Saylor Creek. Despite this, it cannot be stated definitively that Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant are causes of trace metal pollution. The mean square ratios can be used only to suggest that these two plants are point-sources of trace

metal pollution in Wafley and Saylor Creeks.

In sum, there is agreement among the criteria discussed that several of the trace metals studied are a pollution problem. For both creeks, arsenic and nickel are pollutants according to EPA criteria, the mean square ratios from the ANOVA tables, and their occurrence with iron, fine grained sediments, %LOI and potassium. For both creeks, chromium is a pollutant according to the mean square ratios and its occurrence with iron, fine grained sediments, %LOI and potassium. For Wafley Creek, zinc is a pollutant according to the mean square ratio and its occurrence with iron, fine grained sediments, %LOI and potassium. Iron and potassium occurred in high amounts in both creeks, and they were determined to be pollutants from the mean square ratios. They occur with each other, and they occur with fine grained sediments. Potassium also occurs with %LOI. Other trace metals and major ions determined to be pollutants with only mean square ratios are not necessarily representative of their actual status in the sediments.

From this, Wafley and Saylor Creeks are polluted with some trace metals. However, it is not absolutely clear that Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant caused the pollution of these creeks. The best that can be said is that Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant likely contributed to the trace metal pollution in Wafley and Saylor Creeks, respectively.

SECTION 2. SOCIAL SURVEY OF ENVIRONMENTAL PERCEPTIONS,
ATTITUDES, PERSPECTIVES, AND VALUES OF THE
ENVIRONMENTAL PROBLEM

INTRODUCTION AND REVIEW OF THE LITERATURE

In the course of sampling sediments, an individual came to me and described Wafley Creek by saying that it stinks and there is an oil slick on the water's surface. This was in August, 1981. Having no expert knowledge on "pollution," this individual had voiced his perception of this environment. This person went on to say that he wished that Firestone would clean up their mess. This indicates his attitude toward a suspected polluter. Studying the environment not only involves scientific data gathering, but also involves determining people's perceptions and/or attitudes of that environment. The purpose of this section is to determine what are the public perceptions of the pollution problem at Wafley and Saylor Creeks. A survey was conducted to find out opinions which reflect three particular types of perceptions: whether or not a pollution problem exists, and if so, who is the polluter; if pollution exists, the extent there is a health concern for oneself, one's children, and future generations; if pollution exists, who should be responsible for clean up, and who should maintain the clean environment.

For the most part, there has been little research on perception of social issues, especially as it concerns environmental problems (Wysor 1983; Dabelko 1981; Lowenthal 1972). Two major areas of social research provide the basis for my survey on perception and the environment. One

area involves the various ways to measure perception of the environment. The other area involves public opinion poll results on the environment as an issue of concern.

Usually measures of environmental concern are made based on a broad definition of the word "environment." According to Van Liere and Dunlap (1981) measurement of environmental concern involves differences in "substantive issues" and "theoretical concerns." That is, there are differences between the environmental issues themselves (as substantive or objective considerations) and the perception of the seriousness of environmental problems (as theoretical or subjective considerations). Substantive issues include pollution, natural resources, and population. Theoretical concerns include attitudes, support for government regulations and spending priorities, and behavior (Van Liere and Dunlap 1981).

Van Liere and Dunlap (1981) mailed questionnaires to obtain information on different perceptions in terms of substantive issues and theoretical conceptualizations. They constructed three scales differing in the substantive issues, and three measures based on the different theoretical conceptions for one substantive issue. They found that the various environmental issues should be measured separately rather than being combined. In particular, they found that while people's viewpoints on pollution were representative of broad-based environmental concern, population issues were

not. Similarly, behavioral involvement was found to be unrelated to overall environmental concern in contrast to other theoretical conceptions. Van Liere and Dunlap (1981) claim that their findings are consistent with similar studies (Lowenthal 1972). They also insist that the reasons for and the ways to strengthen the weak relationship between environmental behavior and attitudes warrants further study.

"Quality of life" has been measured in social research in many ways including the examination of the social burdens of pollution. According to Cutter (1981) attitudes toward pollution vary among social groups and the levels of pollution. To date, there have been no consistent results on relating attitudes to pollution levels.

Cutter (1981) examined communities in the Chicago area. She compared various types of pollution problems (namely, air, water, noise, and solid-waste pollution) with various social groups (namely, black, white, the rich, and the poor), and with attitudes. The attitudes were based on responses to such questions as how often did the respondent worry about the pollution, how serious was the pollution, and how the pollution made the respondent feel (such as being annoyed or angry).

She found that unstable communities with high population densities exhibited the most concern about pollution. There was more concern on the part of blacks and the poor than with upper middle class whites. In addition, she found that the

closer one lives to the pollution, the more concerned one is. In particular, she found that this is true when water pollution is considered, regardless of the type of pollution and corresponding levels given. (Water quality parameters given included trace metal concentrations). In general, both social factors and environmental measurements are equally important in determining community concern about pollution (Cutter 1981).

Wysor (1983) claims that attitudes and beliefs are the basis of environmental problems. These same attitudes and beliefs are also the basis for determining which "environmental modifications we will view as being both acceptable and permissible, given the goal of preserving an environment of the desired quality."

In general, people profess to be committed to resolving environmental problems, but they do not actively carry out that commitment or have actual knowledge of the environment (Wysor 1983). Wysor (1983) suggests that education is necessary to increase pro-environmental behavior.

Wysor (1983) intentionally surveyed pro-environmental and non-environmental students in the Bellingham, Washington area. Those who recycled materials were found to believe that they controlled events in their own life, thus improving the environment was very much possible. This group also was concerned with future outcomes due to present policies, and thought that action now should be taken. Those who were

members of environmental organization showed a greater social responsibility toward environmental issues.

Of those who were unconcerned about the environment, no one expressed disapproval of the "environmental movement" itself. Of all the students questioned many blamed society for environmental degradation, but said reparation was an individual's responsibility. Further, despite respondents saying that social values are the cause of environmental problems, solutions were viewed as necessarily technological. Generally, many described environmental concern as "support for pollution control or conservation of nature instead of viewing it as a broad issue concerned with quality of life (Wysor 1983)."

Leff (in Wysor 1983), Bowman (in Wysor 1983) and Wysor (1983) contend that the ultimate solution to environmental problems is to reorganize our attitudes and values. In order to measure perceptions surveys should consist of questions dealing with the respondent's everyday environment rather than remote environmental issues. In this regard it is difficult to determine from attitudinal questionnaires what is actually being measured in terms of knowledge and concern of the environment (Wysor 1983; Roper 1983). Wysor (1983) also wonders whether attitudinal questionnaires spur individuals' awareness of new views toward the environment, or are environmental issues forgotten as soon as such questionnaires are completed.

Wysor (1983) concludes that the environment is a "value-laden" issue. Perceiving environmental problems to be a part of everyday living promotes action on behalf of the environment, especially as it concerns local issues. Such a perception is directly related to education and knowledge of the environment.

Maggiotto and Bowman (1982) did a study on the way in which perception and definition can shape environmental attitudes of legislators. They surveyed Florida's legislators and found that a legislator perceives and defines an environmental issue to determine the actions he is willing to take. More succinctly, a legislator's perceptions will determine the kind of solution and amount of resources he is willing to commit to resolving an environmental problem.

Maggiotto and Bowman (1982) admit that other factors influence a legislator's actions. However, perception and definition of an issue are the primary activities involved in determining the other kinds of factors that may be involved, such as constituency pressure and party affiliation. Legislators attempt to interpret environmental issues in order to gain consistency in actions taken.

The environmental issue chosen for survey purposes was air pollution in Florida. The scientific research indicated that air pollution was not a serious problem. Legislators generally believed that air pollution was not a problem in Florida, and that they accomplished a lot in terms of making

adequate environmental laws. However, air pollution has remained a part of the political agenda and is, therefore, a constant concern (Maggiotto and Bowman 1982).

Two perspectives were representative of the legislators. Some viewed air pollution to be a matter of economics. Others viewed it to be a health and environmental issue. Maggiotto and Bowman (1982) found that those who were economically orientated did not consider air pollution to be a high priority, or of "value." Those interested in health and environment thought improvements where necessary were in order. In fact, some of the pro-environment legislators took a "moral" stance saying they would vote "across the board" for environmental laws. While economically orientated legislators wanted no government involvement, pro-environment legislators wanted more government action (Maggiotto and Bowman 1982).

When trying to determine if a pro-environmental stance on air pollution meant an overall pro-environmental view, the results were different. Only on specific issues can particular perceptions be linked to particular remedial actions. It is unclear what the relationship is between specific issues and an overall pro-environmental view (Maggiotto and Bowman 1982).

In essence, policy resolutions depend on perspectives of legislators and the values they hold. In order to achieve consistency, legislators' solutions are put into action

within the context of what the state is already doing (Maggiotto and Bowman 1982).

Dabelko (1981) states that it is possible to manipulate people's evaluations of environmental quality. This interpretation of public sentiment has implications for the basis and direction of public policy. Thomas (in Dabelko 1981) claims that the development of environmental quality standards serves the purpose of informing the public about issues, both social and political, which are associated with environmental quality. In addition, more public awareness of such issues contributes to holding government officials accountable for policy performance.

Presently, some researchers have begun to redirect their studies on citizen views on the environment toward subjective evaluation of people's perceptions, rather than objective measures of environmental quality. Edelman (in Dabelko 1981) has determined that a government body, such as EPA, can alter public policy standards. This occurs, not because EPA changes actual environmental quality standards, but because the agency reassures the public that it is adequately dealing with the policy problem at hand.

Environmental quality standards and government manipulation of public perception are constantly at loggerheads with each other. Dabelko (1981) suggests that citizens can also utilize environmental quality standards to manipulate environmental policy by focusing on a particular

standard for public discussion. This is contrary to current practices of pitting environmental quality versus economic costs.

Keeter (1984) did a general study of several different measures of the public's perceptions and attitudes about the environment. He used a "split-ballot" or trade-off question polling format to measure "ideological" belief. The results showed that regardless of the form or wording of the questions, opinion was supportive of the environment. People preferred to not choose between a clean environment and, for instance, job security. However, when confronted with such a trade-off, people were supportive of the environment.

Although the public wanted a clean environment, the support was not found to be strong. The weak overall attitude of people is attributable to the lack of a current clearly voiced unity representative of the public. Another reason is that the environment is currently a national issue with a low profile (Keeter 1984).

Over time and across different kinds of surveys, environmental attitudes and public support has been mostly consistent as well as persistent. Such attitudes lack class alignment suggesting "public values unlike those commonly assumed to guide mass political choices" (Keeter 1984). Personal or private concerns were determined to be less important than a public good, the environment.

Essentially, attitudes or perceptions about the environment are difficult to measure (Roper 1983). Attitudes and perceptions may span a wide area interpretation (Costantini and Hanf 1972). Yet this aspect of social survey research is most important to determine what the environment is to people. The various ways to measure perceptions about the environment have been given. From this, what are the general attitudes or perceptions of the public about the environment over time? The following provides the results of public opinion polls on the nation's and other countries' people for the 1970's through 1984 and on Iowa's people comparing results from 1970 and 1984 on environmental concern.

In 1972 Downs (in Anthony 1982) claimed that environmental issues would be a public concern for some time. However, the public may become less interested in environmental issues unless they focus on something that poses a threat, or provides a benefit to a large number of people, or is viewed as highly unjust. The same may be said today.

An indication of this are public opinion polls results. The results reflect people's view of the environment. Environmental issues may be viewed as air and water pollution, or protecting wildlife habitat or national parks, or something else. Whatever one's view is of the environment, the polls can roughly measure public sentiment

(Anthony 1982).

As of late 1981 there was broad-based support for protection of the environment. In September, 1981, a CBS/New York Times poll showed that 67% of the respondents chose the following statement as representative of their feelings: "We need to maintain present environmental laws in order to preserve the environment for future generations." Only 21% chose the statement: "We need to relax our environmental laws in order to achieve economic growth." There were also 12% undecided responses (Anthony 1982).

How strong is the support for environmental protection? Pollsters have used "trade-off" questions or ranking of issues to gauge the intensity of support in the context of other issues. For instance, the Roper Organization asked respondents, "Which two or three (issues) are you personally most concerned about today?" In January, 1974, 12% chose air and water pollution. In January, 1981, 10% chose this issue. In the interim the percentage choosing this issue did not vary more than three points. On a question about the amount of money spent on the environment, respondents had maintained their opinions over a seven year period. In December, 1973, 45% said "too little" was spent, and in 1980, 48% said the same. The responses to questions like these shows a steady support for the environment despite changes in inflation, jobs, and the economy. It should be noted that the results from the Roper polls differed from a CEQ poll sponsored at

the same time. This indicates that polling does not necessarily provide unchanging opinions (Anthony 1982).

Despite this, a number of polls have shown that there is broad-based support for the environment from all age groups, races and income levels. However, environmental issues, once viewed to be supported by both Democrats and Republicans, are beginning to be seen as an issue favored by the Democrats (Anthony 1982).

One area of concern is "backlash," or that environmental controls are seen as too strict or that too much environmental concern hurts the economy. On eight different occasions the Roper polls showed that 66% to 69% thought that environmental regulations did not go "far enough" or were "just right." In other polls 61% to 68% throughout the period of 1978 to 1981 said they were active in or sympathetic to environmental issues. Only 4% to 8% said they were unsympathetic (Anthony 1982).

Essentially, the environment as an issue is one of the lasting concerns of the public. Only an environmental "crisis" would trigger a high intensity of this sentiment. The environment as a lasting concern means that politicians view the relaxing of environmental standards as "politically dangerous." A March, 1982 Harris poll found that environmental concerns may be a basis for the "single-issue" voter. That is, some people will vote for a pro-environment candidate regardless of the stance that candidate would take

on other issues. All of this indicates that the environment as an issue is here to stay (Anthony 1982).

The environment as an issue of concern is evident in countries other than the United States. A 1980-1981 cross-national study was conducted to report on environmental beliefs and values. Questionnaires were mailed to people in England, Germany, Australia, and the United States (U.S.). People were randomly chosen from particular groups in each country. In some cases, answers for each question were not available as representative responses for some questions in some of the countries. Results were available from all countries except Australia. These results focused on value preferences for the future direction of society (Milbrath 1981).

The first question asked whether people felt there was a need for social change in order to deal with environmental problems. In all three countries, the majority of the general public said yes. In the U.S. and England, business and labor leaders and public officials agreed (Milbrath 1981).

A related question to the first one was asked in the U.S. survey only. The question asked whether effective long-range solutions to environmental problems requires life-style changes or developing better technology. The general public as well as public officials showed no consensus on this matter. Environmentalists were for life-style changes, and

business leaders were for better technology. Labor leaders marginally supported better technology (Milbrath 1981).

Another question asked whether we should be careful not to harm nature or use nature to produce more consumer goods. In the U.S. and England, there was a very favorable response by the general public not to harm nature. In Germany, the general public was somewhat favorable to this. No consensus was found with other groups. However, a slightly favorable response was attributable to these groups not to harm nature (Milbrath 1981).

The next question involved whether the free market or foresight and planning are necessary to bring about the public good. In the U.S. and England, the preference was clearly for foresight and planning in all groups except business leaders (Milbrath 1981).

Related to this, a question was asked in the U.S. survey only. This dealt with whether taxes should be used to insure that public goods (such as parks and clean air) are well provided, or minimize taxes and allow individuals to be paid maximum personal incomes. Paying taxes was the favorable response for insuring that public goods are well provided by all groups (Milbrath 1981).

Another question in the U.S. survey only asked whether we should save resources for future generations or use resources to benefit present generations. The general public was very favorable toward saving resources for future

generations. Of the other groups, only business leaders were marginally favorable toward saving resources for future generations (Milbrath 1981).

The next question was also in the U.S. survey only. It dealt with whether cooperation or competition produces the best society. All groups except business leaders favored cooperation (Milbrath 1981).

The next question for all three countries asked whether planning to avoid risk or recognizing risk as unavoidable in the production of goods should be a part of a good society. In the U.S., no consensus was found for the general public. The English public only slightly favored planning to avoid risk. In Germany, the general public provided a clear consensus to plan to avoid risk. In the U.S. and England, only business leaders thought recognizing risks was necessary. Other groups favored planning (Milbrath 1981).

Another question asked whether economic growth or environmental protection was favored (assuming the two to be opposites). In all countries, the general public counted environmental protection as the more highly valued. All groups except business leaders valued environmental protection. Business leaders were neutral on this question rather than favoring economic growth (Milbrath 1981).

The last question for all countries asked whether jobs or the environment was more important (assuming the two to be opposites). In all countries, no consensus was provided. In

the U.S. and England, business leaders and public officials were also uncertain on this question. Labor leaders were somewhat in favor of jobs in these two countries (Milbrath 1981).

Another question was asked in the U.S. survey only. It asked whether conserving or increasing production of energy was desired. All groups except business leaders showed a strong preference for conservation. Business leaders were uncertain (Milbrath 1981).

This cross-national survey provided rudimentary evidence that the environment is a matter of concern. This concern indicates a willingness by people to engage in social changes as well as changes in values (Milbrath 1981).

In the U.S., as of November, 1983, a Harris Poll found that 62% of the respondents favored making the Clean Air and Clean Water Acts stricter. Only 5% favored relaxing the air and water standards. Those who favored easing controls on factories to save jobs amounted to 13%. Overall, 74% opposed relaxing auto pollution standards, 80% opposed relaxing rules for smoke stack pollution, and 86% opposed relaxing the standards for hazardous waste in 1983 (Watt's departure is helping Reagan 1983). Similar results were found from other studies (Currents 1983; Bloomgarden 1983).

Bloomgarden (1983) conducted a more in-depth study of public opinion of the environment for 1983. She begins by saying "those who say that goals of economic development and

environmental preservation are irreconcilable...are out of touch with public sentiment and out of touch with what is actually taking place in the nation's communities." Her survey results substantiate her views.

Most Americans believed that they can better their economic situation by "personal resourcefulness" and "hard work." While 79% believed in capitalism, 70% said that regulation of business by government does more harm than good. In addition, 52% said less government involvement in the economy is best for the country. The same respondents, numbering 60%, said that pollution is one of the nation's most serious problems. In particular: 84% believed human activity can easily upset "nature's balance;" 79% believed that the extinction of animals should be prevented even if it meant people "sacrificing some things for ourselves;" 72% believed that American values are a basic cause of environmental problems. The environment as a general issue was measured. However, problems were encountered in respondents' understanding of particular environmental issues (Bloomgarden 1983).

Bloomgarden (1983) found that the public perceives the environment to be a management rather than a crisis issue. Approximately 64% of the respondents said that pollution does not actually affect their lives compared to 35% who said it does. Environmental quality is viewed to be improved or staying the same by 57% compared to 41% who said it has

gotten worse. The environment as a lasting concern is a matter of good management (Bloomgarden 1983).

Contrary to popular belief, business executives were not found to be antagonistic toward environmental issues. In fact, business executives shared the same concerns with the general public. However, business executives' opinions were found to be the opposite of environmentalists' opinions. The differences were found to be based on differences in values (Bloomgarden 1983).

Bloomgarden (1983) also measured the strength of public commitment to the environment. She used "trade-off" questions as Anthony (1982) did and got similar results. In terms of land use, 65% favored leaving parts of the country in their natural state, and 28% favored resource development. In terms of environmental clean up, 60% favored such action even if it meant that companies would increase prices for products or services, and 35% favored lower prices. Auto fuel should be low in lead content, said 79% of the respondents, while 16% believed lower prices of fuel come first, regardless of the air pollution generated. In terms of energy production, 56% said that environmental protection regulations should be maintained even if energy production is slowed, and 35% said to relax regulations.

Except for issues concerning jobs and energy production, the business community more closely sided with the public than with environmentalists. Overall, the public's opinions

were found to be indicative of maintaining a stable economy and a sound environment (Bloomgarden 1983).

In a 1984 Gallup Poll that covered various issues, the concern for the environment continued. Respondents were asked if they would generally favor or oppose relaxing pollution controls to reduce costs to industry. The results were that 33% favored relaxing controls while 64% were opposed. Across all demographic groups, most people opposed relaxing pollution controls. Overall, people are concerned about the environment (The Gallup Poll 1984).

On June 24, 1984, the Des Moines Register reported on how Iowans felt about the environment. Iowans see pollution from farm chemicals as a more serious threat in 1984 than they did in 1970. Iowans are also more worried about the purity of the food they eat and the water they drink than about air pollution or hazardous substances where they work. "Iowans may not be knocking down federal doors demanding action, as one frustrated state official noted..., but they are concerned and they do want action" (Elbert 1984).

In particular, 72% believed that the federal government is doing too little about hazardous wastes and toxic chemicals, 18% believed that it is doing enough, and 3% believed it is doing too much. Dissatisfaction with federal action is strongest (90%) among those who feel they are most threatened by the pollution in their own communities. Among those who do not feel personally threatened, 64% say the

federal government is not doing enough (Elbert 1984).

Comparisons were given on past and present concerns of the environment. In 1984, 52% said air and water pollution in their areas is a serious problem, compared to 40% in 1970. Of those who view air and water pollution in their hometown as a problem, 20% said it is "very serious" in both 1970 and 1984, and 41% said it is "fairly serious" in 1984 compared to 31% in 1970. In 1984, 92% are concerned about the use of farm chemicals and pesticides compared to 73% in 1970 (Elbert 1984).

In terms of one's personal environment in 1984, Iowans are concerned about particular issues. Fifty-eight percent are very concerned about farm chemicals. About 34% are somewhat concerned, and 7% are not concerned at all. On pollution of Iowa streams, rivers and lakes, 52% are very concerned, 36% are somewhat concerned, and 11% are not concerned at all. On harmful substances in foods, 45% are very concerned, 35% are somewhat concerned, and 19% are not concerned at all. On drinking water, 42% are very concerned, 38% are somewhat concerned, and 20% are not concerned at all. On air pollution, 32% are very concerned, 23% are somewhat concerned, and 41% are not concerned at all. Except for air pollution, concern for the environment exists (Elbert 1984).

This study also included measurement of environmental concern with respect to various demographic data. Eighteen to 29 year olds are more likely to be very concerned about

harmful substances in food (53%) than are those who are 50 years old or older (36%). Concerns about drinking water were highest in towns with a population of 2,500 or greater, the least likely towns to have water treatment facilities. Air pollution concerns were highest in cities with a population of 50,000 or greater. Forty percent of each group of blue collar workers and union members are very concerned about hazardous substances where they work. This compares to 32% for each group of white collar workers and farmers. Farmers in particular are a little less likely to be concerned about pollution from farm chemicals and pesticides (51%) than other Iowans (58%) (Elbert 1984).

Essentially, the environment is an issue of social concern. From the public opinion polls, the environment is clearly an ongoing concern of people.

MATERIALS AND METHODS

The type of survey chosen was a mailing because of the straight-forward, one-time questioning of respondents it provides. The survey was conducted in the surrounding area of Wafley and Saylor Creeks, the sites of the trace metal in sediments study. The geographic regions chosen to cover the area were Saylor and Crocker Townships. Firestone Tire and Rubber Company is not technically in the city of Des Moines, but in Saylor Township. Ankeny Sewage Treatment Plant is not technically in Ankeny, but north of Saylor Township, or in Crocker Township (Merkley, Drake University, personal communication). To obtain an adequate representation of people's opinions and perceptions, 300 questionnaires were mailed. This is an adequate sample size for this survey (Arslaner, Drake University, personal communication) since the group of people chosen for questioning represent a highly selective sample (Costantini and Hanf 1972), namely, people in a specific geographical area near the environment in question. In addition, the sample size coincides with the scope and cost of conducting this survey which is an important consideration (Dillman 1983). The questionnaire was developed directly with the help of both Dr. Arslaner and Dr. Merkley at Drake University.

A number of the tenets of Total Design Method (TDM) were incorporated into this survey. One way to aid in getting a

good response rate in mail surveys is to use TDM. This method includes using: pre-paid envelopes; letterhead stationery to provide authority; a cover letter that is personal and hand signed; illustrations when appropriate; the most interesting questions at the beginning of the survey; the first question as a lead-in which is applicable to everyone; a booklet format with the questions printed on white paper; arrows, indentations, and spacing to provide direction for answering questions; transitions to go from one set of questions to another set; questions which do not overlap from one page to the next; a cover page which is eye-catching and a back page when appropriate; a final question which asks the respondent if he has any additional comments (Dillman 1983). In this survey an "additional comments" question was not considered to necessary, and was therefore, not included (Arslaner, personal communication).

Dillman (1983) says that low response rates are characteristic of mail surveys. He states that low response rates may be a result of: uneducated respondents (people who lack reading skills); respondents not understanding the questions; no one being present to prod the respondents to answer questions as in face-to-face interviews; the questions are viewed as "boring"; there is lack of personalization; difficulty in handling open-ended questions.

Despite the inherent problems with mail surveys, they are used because of the low cost involved and they require

less time in acquiring the data. However, it should be noted that mail surveys require extra effort in terms of preparation (Dillman 1983).

TDM is successful but ultimately does not guarantee one in getting a good response rate. Further, precise mail out dates, first class postage, mailing labels, and definite return dates will not ensure a good response rate (Dillman 1983).

The respondents from Saylor and Crocker Townships were randomly chosen from the 1984-1985 Des Moines area telephone directory. A total of 1703 people and businesses were listed as being in Saylor or Crocker Townships. Using this type of listing to obtain a sample has been used by other survey researchers (Van Liere and Dunlap 1981; Cutter 1981). The questionnaires were sent on May 13, 1985, and were to be completed and returned by respondents around June 3, 1985, as indicated in a hand-signed cover letter accompanying each questionnaire. In addition, addressed return envelopes were included for the respondent's convenience. Due to cost constraints return postage was not included on the return envelopes. However, each survey package was sent by first-class postage to ensure delivery (R. Rogers, Drake University, personal communication). A copy of the cover letter and questionnaire is in the appendix. The questionnaire for area business workers was slightly different from that for area residents in demographic data

only.

Two types of questions were used. One type was "open-ended or unstructured" questions (Costantini and Hanf 1972). With this type of question respondents were able to express themselves without restraint. As Roper (1983) says, asking questions on "ill-defined or remote issues" is not the major problem in social research. Interpreting and reporting the results is the greatest concern. In this regard the wording of questions is important (Roper 1983). The other type was rank-order questions. Respondents were to assign five ranks to five categories. One of the categories was denoted "other" which allowed respondents to include any group not mentioned.

The results of the survey will be compiled by the comparison of the percentages of yes responses to no responses. For the ranking questions percentages will be calculated for each category to be ranked. The largest percentage will represent the rank to be assigned to the category. In addition, Spearman's r will be calculated for each respondent's rankings. A mean rank value will be calculated from the ranks and assigned to blanks where respondents should have included a rank. Costantini and Hanf (1972) warn that mean rank values may bias the results. However, mean ranks are typical in survey research (Van Liere and Dunlap 1981). Mean scale ratings will be calculated for each category's ranks for each question in order to construct

a scale to be compared to each respondent's rankings (Schroeder 1984). The mean scale rating has been shown to be as accurate and precise as other more sophisticated rating scales (Schroeder 1984). A modified Spearman's r (Siegel in Cohen and Holliday 1982) will be used since the mean rank values will produce excessive ties among a given respondent's ranks. This modified equation for Spearman's r is:

$$r = \frac{\Sigma X^2 + \Sigma Y^2 - \Sigma D^2}{2 \sqrt{\Sigma X^2 \Sigma Y^2}}$$

where $\Sigma X^2 = \frac{n^3 - n}{12} - \Sigma T_x$ for one set of ranks

and $\Sigma Y^2 = \frac{n^3 - n}{12} - \Sigma T_y$ for the other set of ranks

ΣD^2 = difference between ranks for each category

n = number of ranks/respondent

$\Sigma T_x = \frac{t^3 - t}{12}$ for one set of ranks

and $\Sigma T_y = \frac{t^3 - t}{12}$ for the other set of ranks

t = number of observations tied at a given rank

Reporting results as percentages (Wysor 1983; Bloomgarden 1983; Costantini and Hanf 1972; Anthony 1982) and in terms of Spearman's r (Maggiotto and Bowman 1982; Van Liere and Dunlap 1981; Cutter 1981) are typically used in survey research. Both types of results for these questions will be compared. The questions will also be discussed in terms of the comments given by the respondents to facilitate interpretation and reporting of the results (Roper 1983).

A special questionnaire was sent to both Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant to illicit their answers to questions similar to those in the Saylor and Crocker Township surveys. Only open-ended questions were used. These two questionnaires were sent on October 17, 1985, and were to be completed and returned by November 1, 1985, as indicated in a cover letter. The results will be given and interpreted to determine the position of each business.

RESULTS

People in Saylor and Crocker Townships gave their opinions and perceptions of the pollution problem in Wafley and Saylor Creeks. Of the three hundred questionnaires sent fifteen were returned as undeliverable. Therefore, 285 questionnaires were actually received by residents and businesses.

Only 15.1% of the residents and businesses returned completed questionnaires around June 3, 1985. Returned unanswered questionnaires amounted to 1.1%. Some of these respondents claimed that they did not know where Wafley or Saylor Creeks were located. For example, one respondent claimed that he has lived in Saylor Township for 25 years and did not know where Wafley or Saylor Creeks were. Others claimed that they were not qualified to answer the questionnaire. The raw data collected from the survey represents 43 respondents (34 residential and 9 business) and percentages reported are based on this total.

Demographic data was gathered to characterize the respondents. Data given represent only those who gave a response. The average age of the respondents is 46.6 years. Most of the respondents are males (70.0%) with 23.3% representing the female respondents. In terms of race 86.0% identified themselves as white, and no other category of race was given. The majority is married (72.1%). The average income level is approximately \$33,700. The majority of

respondents has had some college education (41.9%). Of the residents, respondents have an average of 2 children.

On the average respondents live 1.25 miles from the creek in their township. Of those who work, the average distance from the creek in the township where they work to the place where they work is one mile.

The first essay question (#1 for residents and #2 for businesses) asked, "Do you feel that Saylor/Wafley Creek is polluted?" The responses were: 30.2% yes; 25.6% no; 18.6% do not know; 25.6% no answer. For those who answered yes, the second part of the question asked, "What is the nature of the pollution?" The Crocker Township residents' responses included: oil and junk, sewage plant effluent, farm chemicals, and John Deere chrome plating chemicals; surface drainage; bacteria. The Saylor Township residents' responses included: runoff from the areas of truck service; hot waste water from Firestone and "some kind of chemical floating on top [Wafley Creek]"; stagnation and improper garbage dumping; runoff with insecticides and fertilizer; discharge from Firestone. The business responses from Saylor Township included: McMillan Oil or Firestone; lawn treatments, agricultural chemicals, and household wastes; heat.

The second essay question (#2 for residents and #3 for businesses) asked whether Ankeny Sewage Treatment Plant or Firestone Tire and Rubber Company was polluting Saylor or

Wafley Creeks, respectively. The responses were: 20.9% yes; 39.5% no; 18.6% do not know; 20.9% no answer. One respondent claimed that Ankeny Sewage Treatment Plant was not "to my knowledge" polluting Saylor Creek, but it would be no surprise if they were the cause of pollution. A Saylor Township resident claimed that Firestone was "definitely not" polluting Wafley Creek. For those who answered yes, the second part of the question asked, what is the major source of the pollution? Crocker Township residents said: "chemicals from fields" and "insufficient capacity and ability to treat pollutants." Saylor Township residents said: hot waste water and chemicals. One resident claimed that as a former worker at Firestone he knew of "holding tanks and pens to limit the pollution." He also said that "very little" pollution did occur from Firestone. Another resident said to have "funny smelling" water at home believed to be a result of Firestone's doing. Yet another resident claimed that the source of possible polluting by Firestone is "capitalistic industrialism" and Reaganistic Republicans." One Saylor Township worker said that heat from Firestone is the source of pollution of Wafley Creek.

The third essay question (#4 for residents and #5 for businesses) asked, "Do you feel that there is a health hazard to yourself from Saylor/Wafley Creek?" The responses were: 11.6% yes; 55.8% no; 9.3% do not know; 23.3% no answer. The fourth essay question (#5) asked residents, "Do you feel that

there is a health threat to your child (or children) from Saylor/Wafley Creek?" The responses were: 17.6% yes; 44.1% no; 5.9% do not know; 32.4% no answer. Continuing along the same line, the fifth essay question (#6 residents and businesses) asked respondents if they felt that a pollution or health threat from Saylor/Wafley Creek may exist for future generations. The responses were: 32.6% yes; 23.3% no; 16.3% do not know; 27.9% no answer.

The sixth essay question (#7) asked, "Do you feel you have an obligation to provide a healthy environment for future generations?" The responses were: 72.1% yes; 4.7% no; 0.0% do not know; 23.3% no answer. Some of the comments included: "the need to clean up is now"; "I think we should all work for this"; "support politicians who believe in a healthy environment" since they make the laws "all of us have to live by"; "God has instructed me to take care of the earth."

The next three questions (#8, #9, and #10) asked respondents to rank five choices from 1-- most responsible to 5-- least responsible in answering the questions. The first of these questions asked, "If there is pollution in Saylor/Wafley Creek, who do you feel should clean it up?" A compilation of the percentages is in Table 25. The choice of most responsible parties was 27.9% for the corporation and 20.9% for the community. The ranking from the second to

Table 25. Percentages of ranking on who is responsible for clean up of pollution in Saylor and Wafley Creeks (question 8).

Rank*	Category				
	Government	Corporation	Community	Individuals	Other
1	18.6	27.9	20.9	2.3	2.3
2	27.9	16.3	14.0	4.7	0.0
3	11.6	11.6	18.6	16.3	0.0
4	11.6	4.7	7.0	32.6	0.0
5	0.0	0.0	0.0	0.0	46.5
No Answer	30.2	39.5	39.5	44.2	51.2

* rank: 1 = most responsible, 2 = second most responsible, 3 = third most responsible, 4 = fourth most responsible, 5 = least responsible.

least responsible parties gave the following percentages: 27.9% for the government; 32.6% for individuals; 46.5% for others. The mean scale ratings and Spearman's r affirm these results (Tables 26 and 31).

Some of the comments were: "whoever is contributing to the supposed pollution"; federal government should not be responsible, rather local government and the community should be responsible for "all they can." Another respondent said that at several truck terminals near Wafley Creek the trucks are washed and serviced, and the water is drained to ditches which drain into Wafley Creek. He says that he personally knows of one such operation on 2nd Avenue just south of Interstate 80. These people are responsible.

The next question (#9) asked, "Who do you feel is responsible for assuring that Saylor/Wafley Creek remains clean?" The percentages are given in Table 27. Respondents chose the government, corporation, and the community as most responsible with percentages of 39.5%, 18.6%, and 20.9%, respectively. Individuals at 20.9% followed by others at 41.9% are the next and least responsible parties. The mean scale ratings and Spearman's r confirm these results (Tables 28 and 31).

Table 26. Mean rank scale and majority percent ranking for question 8.

	Category				
	Government	Corporation	Community	Individuals	Other
Mean rank scale	2.5	2.3	2.5	3.2	3.9
Majority percent ranking	2	1	1	4	5

Table 27. Percentages of ranking on who is responsible for assuring Saylor and Wafley Creeks remain clean (question 9).

Rank*	Category				
	Government	Corporation	Community	Individuals	Other
1	39.5	18.6	20.9	2.3	0.0
2	16.3	14.0	18.6	7.0	0.0
3	9.3	9.3	16.3	18.6	0.0
4	7.0	14.0	4.7	20.9	4.7
5	2.3	0.0	0.0	2.3	41.9
No Answer	25.6	44.2	39.5	48.8	53.5

* rank: 1 = most responsible, 2 = second most responsible, 3 = third most responsible, 4 = fourth most responsible, 5 = least responsible.

Table 28. Mean rank scale and majority percent ranking for question 9.

	Category				
	Government	Corporation	Community	Individuals	Other
Mean rank scale	2.2	2.6	2.4	3.1	3.9
Majority percent ranking	1	1	1	4	5

The comments given may be summarized by saying that the respondents claimed that those involved in the polluting should assure that the creeks remain clean.

The last question (#10) in this series asked, if there is a pollution problem, who should pay for the clean up? The percentages are given in Table 29. The corporation, with 32.6%, was chosen as most responsible followed by 27.9% for the government, and the community 27.9%. Again, individuals and others were chosen as the least responsible parties with 27.9% and 41.9%, respectively. The mean scale ratings and Spearman's r agree with these findings (Tables 30 and 31).

Again, comments were that those involved should pay clean up costs. However, one respondent said that the government should tax property owners to pay clean up costs.

The last question in the survey (#11) asked, if there is pollution in Saylor/Wafley Creek, would you be willing to pay your fair share for clean up? The responses were: 44.2% yes; 25.6% no; 0.0% do not know; 27.9% no answer; 2.4% undetermined.

By far, the most lengthy comments were given in response to this question. Some of the Crocker Township residents said that those who cause the pollution should pay for clean up. However, one resident said that he would pay his fair share through county taxes. Another resident said: "If there is pollution in Saylor Creek, I would be willing to pay my fair share on the condition that the source of the

Table 29. Percentages of rankings on who should pay the costs of clean up of Saylor and Wafley Creeks (question 10).

Rank*	Category				
	Government	Corporation	Community	Individuals	Other
1	23.3	32.6	16.3	0.0	2.3
2	27.9	11.6	4.7	11.6	0.0
3	4.7	9.3	27.9	9.3	0.0
4	11.6	2.3	7.0	27.9	2.3
5	2.3	0.0	2.3	2.3	41.9
No Answer	30.2	44.2	41.9	48.8	53.5

* rank: 1 = most responsible, 2 = second most responsible, 3 = third most responsible, 4 = fourth most responsible, 5 = least responsible.

Table 30. Mean rank scale and majority percent ranking for question 10.

	Category				
	Government	Corporation	Community	Individuals	Other
Mean rank scale	2.4	2.3	2.7	3.2	3.8
Majority percent ranking	2	1	3	4	5

Table 31. Spearman's r for questions 8,9, and 10.

Question number	Spearman's r
8	.682
9	.560
10	.799

problems, and I do feel there are more then (sic) (one) reason, ...were taken care of so it wouldn't happen again. We would want to eliminate all possibilities so it wouldn't happen again."

Both a Saylor Township worker and resident said that those who cause the pollution should pay for clean up, echoing earlier comments. Other Saylor Township residents also had something to say. One respondent said he did not want to pay more taxes. However, another respondent said he would pay his fair share despite his feeling that he had not contributed to the supposed pollution. Yet another respondent said he would donate his time, but not pay in terms of money for clean up. One respondent asked how does one determine "fair share," and said that he kept his property "tidy and clean." He also said that problems did not occur in his area until there was paving of large areas. Finally, a Saylor Township resident said about her paying her fair share: "Only if they can make Firestone accept that they are polluting and have to do something different to stop it. When there is nothing living down stream from a large or even small factory they are causing some kind of pollution. If they had to cool the water they dump first that could help greatly. The Creek (Wafley) never freezes and has steam rising in the winter and stinks in the summer. That to me is pollution. I inquired about it to the Pollution Control and they said tests show safe levels! Why is there no life in it

then. I would pay only if I had no choice because they are the cause and they should clean it up and pay to keep it clean."

Of the two questionnaires sent to the possible polluters, only Ankeny Sewage Treatment Plant responded. The first part of the first question asked if the place of business has caused any pollution. The response was that water pollution has resulted. During heavy rains or snow melts, the sewers and the Plant become overloaded. The second part of this question asked, if pollution occurred, what is the nature of the pollution? "Hydraulic overloads cause some bypassing of domestic sewage to overflow into area streams," was the response.

The second question asked, if pollution has occurred, have any of the surrounding areas been affected? The Ankeny Plant response was that their testing has shown "no detrimental affects." In line with this, the third question asked if any of the residents in this area had been affected. The response was "not to our knowledge."

The fourth question asked in two parts, if pollution has occurred, what remedies and maintenance of those remedies has resulted? Larger sewer mains are currently being constructed, and a larger wastewater plant is scheduled to commence being built during the beginning of 1986, was the response.

The fifth question was asked in three parts. First,

what responsibility does the place of business has to maintain a clean environment? The response was that approximately 20 million dollars are being spent "to ensure as clean as an environment as possible." In addition, operator training is an ongoing process to have the best staff to meet needs. The second and third parts of this question asked, what responsibility the place of business has to residents in the area and for future generations, respectively? The response was "We feel it is our responsibility to do the best we can to protect our area waterways for all citizens."

The sixth question asked, "to whom does your place of business feel accountable to?" The Ankeny Plant responded by saying that they are accountable to "all EPA and state regulations but more importantly to all citizens including our own to keep pollution held to minimums."

DISCUSSION

The Saylor and Crocker Township mail survey included the appropriate guidelines from the TDM. Despite this a low response rate occurred perhaps as a result of the pitfalls of this type of survey.

In this type of survey there are two types of errors which may occur. One type is the response error as just mentioned. This is primarily due to the limits of cost. The second type is sampling error. This involves selection based on certain observations about a population for sampling purposes (Hansen et al. 1953). Roper (1983) contends that sampling error is not the most important feature of the validity of the results.

The telephone directory was used to obtain the sample. In a survey, the sample drawn from the listing is no more representative of the population than the listing itself (Hansen et al. 1953). The telephone directory is an incomplete listing (Dillman 1983). However, the time required to compile a more complete listing would not necessarily ensure better results, and therefore, is not warranted. Despite possible problems in using the telephone directory for obtaining a survey sample, this practice continues to be widely used (Van Liere and Dunlap 1981).

As in this case, if the number of non-respondents is high, then the person conducting the survey should find out

and provide information about these people in order to lend some degree of confidence in the survey results (Hansen et al. 1953). The non-respondents in the Saylor and Crocker Township areas are, by and large, second and third generations of families which have remained in the same area. They are employed in both skilled and unskilled labor. These observations are based on the telephone listings, types of business in the two townships, and characteristics of the respondents. More information on the non-respondents was not obtained due to limited funds.

Another speculation may be given. Currently, Firestone Tire and Rubber Company has undergone some difficulties in terms of lay-offs and even a possible plant closing. Most of the respondents, as it happens, were chosen from Saylor Township. Perhaps these respondents did not think it was in their employment interests to answer a questionnaire about a possible problem with their place of employment. A similar reason may be given for the non-response by Firestone Tire and Rubber Company to a questionnaire.

Despite the low response rate, the perceptions of these respondents are representative of the populations in Saylor and Crocker Townships. Overall, there is widespread concern for the environment. In fact, this is an ongoing concern which has not changed dramatically since the beginning of the environmental decade (Anthony 1982). The responses of the survey reflect the general trend of environmental concern.

Respondents in this survey were mostly concerned for future generations. This is also the opinion of people in this and other countries (Milbrath 1981).

The responses of this survey are also in line with the opinions of Iowans as given in the 1984 Des Moines Register poll. Iowans in general and residents near Wafley and Saylor Creeks in particular are concerned about the environment. Iowans did not think the government is doing enough about pollution in their communities. Wafley and Saylor Creek respondents thought that the government was responsible for assuring that their nearby environment remains clean.

In addition, most Iowans were concerned about pollution in lakes, rivers and streams, and this was reflected by respondents near Wafley and Saylor Creeks. The respondents live or work an average of one to one and one-quarter miles from either creek. They were in a position that was not too close or too far from either creek which provided a view consistent with the 1984 poll. In sum, this survey served its purpose, to obtain the perceptions of people living in Saylor and Crocker Townships about a pollution problem in Wafley and Saylor Creeks. In addition, an official position was given by Ankeny Sewage Treatment Plant.

CONCLUSIONS

The purpose of this survey was to determine people's perceptions of a pollution problem. The low response rate may be compensated for by comparison of responses with other data. Despite this, another source of bias may be present. Most of the respondents are married, white males suggesting a possible bias (Van Liere and Dunlap 1981). However, this does not mean that the results are entirely non-representative of the population (Roper 1983; Maggiotto and Bowman 1982). There is no consistent way to report results from surveys on perceptions and the environment (Van Liere and Dunlap 1981; Costantini and Hanf 1972; Lowenthal 1972). However, some interesting information can be gleaned from this survey.

Three distinct areas of questions were asked of the respondents. The first area dealt with whether or not pollution was a perceived problem, and who was the perceived polluter. There was not an overwhelming majority who believed either creek to be polluted. Nonetheless, there is the perception that pollution in either creek exists. There was a two to one margin of those who believed that neither Firestone Tire and Rubber Company nor Ankeny Sewage Treatment Plant were the polluters.

Perceiving a pollution problem to exist is supported by only one part of the second area of questions. These

questions dealt with how either creek as a pollution problem is perceived as a personal concern. There was clearly a majority who believed that no health hazard exists for themselves or their children. However, there was also a majority who believed that a health hazard to future generations exists. In fact, respondents believed that they have an obligation to provide a healthy environment for future generations, constituting the largest recorded majority. The concern for future generations and the environment is evident.

These questions identifying water pollution as a health hazard may have indicated to respondents that this was a management issue rather than a "crisis" issue. Costantini and Hanf (1972) found that when pollution is defined in terms of health hazards, respondents are not as concerned about environmental problems. Instead, the concern is centered around the water quality itself. This implies that the respondents of my survey are concerned about the creeks as a separate issue rather than as a "quality of life" issue in terms of a crisis to themselves. Being concerned with only the pollution of the water implies that this problem is a matter to be remedied by better environmental management.

This leads to the third area of questions dealing with responsibility for either creek. Respondents believed that the corporation or business and the community is most responsible for cleaning up pollution. The government is

viewed as being secondarily responsible, while individuals and other groups are viewed as least responsible.

In terms of assuring maintainance of relatively clean creeks, a mixed view was given by the respondents. Government, community, and corporation or business were all viewed as each being most responsible. Individuals and other groups were viewed as being least responsible.

Payment for clean up of either creek was viewed as the responsibility of the corporation or business. The government is believed to be secondarily responsible, while the community is believed to be thirdly responsible. Again, individuals and other groups were viewed to be least responsible.

Overall, the corporation or business is viewed as the responsible party for remedying a pollution problem. Written comments by respondents indicate that whoever is doing the pollution is responsible for clean up. Therefore, the corporation or business is viewed as the polluter. However, neither Firestone Tire and Rubber Company nor Ankeny Sewage Treatment Plant were seen as polluters. This does not necessarily indicate an inconsistency, just that a particular corporation or business was not identified by respondents.

The community was also identified as being one of the most responsible for remedying a pollution problem. This relates to Bloomgarden's (1983) study. Both business and the community have the willingness to share in the costs and

cooperate in efforts to remedy a pollution problem in Wafley and Saylor Creeks.

The majority of respondents claimed that they would be willing to pay their "fair share" for clean up of either creek despite saying that they are not polluters. This is the only indication that individuals have some responsibility for the environment. The overall view is that individuals have little responsibility. It is this view that hinders action on behalf of the environment. This is supported by other studies (Wysor 1983; Van Liere and Dunlap 1981; Lowenthal 1972).

All in all, Saylor and Crocker Township people are concerned about Wafley and Saylor Creeks. This concern is consistent with the trend of concern for the environment as expressed in public opinion polls for the nation and for the state of Iowa. This concern has yet to be transformed into remedial action.

The lack of action by individuals may be linked to the Ankeny Sewage Treatment Plant position. This position indicates that all that is possible is being done on behalf of the environment and citizens. This in turn is for the benefit of future generations. This position is based on the contingency that as long as "no detrimental affects" are present, then all is well. This does not account for or actually project anything about the future. A reason for action on behalf of future generations, hence, does not

exist. Therefore, individuals and the Ankeny Plant maintain their present, everyday way of dealing with a potential environmental problem.

SECTION 3. PHILOSOPHICAL DISCUSSION OF ENVIRONMENTAL
ETHICS WITH RESPECT TO REMEDYING AN
ENVIRONMENTAL PROBLEM

INTRODUCTION

"The environmental crisis is an outward manifestation of a crisis of mind and spirit. There could be no greater misconception of its meaning than to believe it to be concerned only with endangered wildlife, man-made ugliness, and pollution. These are a part of it, but more importantly, the crisis is concerned with the kind of creature that man is and what we must become in order to survive" (Caldwell in Miller 1975). Caldwell's statement indicates that current methods for solving environmental problems are inadequate. Since the "environmental decade" doomsday theories, technological approaches, and administrative rules have been characteristic of environmental matters. Caldwell's statement also implies that human values must be thrust into the situation of solving environmental problems. The purpose of this section is to develop an ethics with respect to the environment and provide some applications consistent with environmental ethics.

To do this, Garrett Hardin's position and the systems approach will be explicated and evaluated. It will be determined that these two positions are inadequate. From this, alternative concepts will be presented to develop an environmental ethics. Applications of this ethics will be presented as actions for environmental involvement.

DISCUSSION

Hardin's position. Garrett Hardin published his famous paper "The Tragedy of the Commons" in 1968. In this paper Hardin attempted to show what the source of an environmental problem is, and the conventional attitudes that perpetuate it. He also attempted to provide a solution to the attitudes, and therefore, to environmental problems and their source. In addition, Hardin (1977) has provided his ethics for the environment in his paper "Living on a Lifeboat." His aim is to provide a framework for action that will protect the interests of future generations as well as the environment.

In the "Tragedy of the Commons" Hardin states that overpopulation is a key environmental problem, and that there are no technological solutions to this problem. Until zero population growth is reached, Bentham's goal of the "greatest good for the greatest number" cannot be realized. In order to "maximize the good per person," the "good" can be determined by a criterion of judgment and a system of weighting patterned after the concept of survival and natural selection. Hardin admits that the good is "unconsciously" determined in this way by humans, but simultaneously, it is assumed that individual decisions will be the best for society as a whole. At this stage Hardin (1968) describes a situation to elucidate his point.

He begins by describing a "commons," a tract of pasture land. Each herdsman keeps a number of cattle on the commons. Each herdsman also wants to maximize his gains; therefore, each herdsman adds one more animal to his herd. Each herdsman will gain in terms of the additional animal, but an individual herdsman's extra animal causes overgrazing of the commons, an effect felt by all the herdsmen. This is the tragedy. According to Hardin, "freedom in a commons brings ruin to all." He continues by stating that pollution is, in a reverse way, a tragedy of the commons, also. Pollution is a consequence of the population problem (Hardin 1968).

The tragedy of the commons applies specifically to particular nations when one likens nations to lifeboats which hold the nation's peoples. According to Hardin, each nation, and therefore, each lifeboat, has a carrying capacity. Carrying capacity is the maximum population which can be supported in a given territory for which irreparable damage would not occur. This is strictly a biological term most often utilized by "neo-Malthusians" and "ecologically orientated ethicists." It is also the determining factor in the institution of triage as given in Hardin's "Living on a Lifeboat." To give food to starving persons in third world nations means decreasing the death rate, increasing the birth rate, and thereby, contributing to those nations exceeding their carrying capacities (Hardin 1977).

Hardin claims this is morally wrong. He elucidates this point by likening the earth to be a lifeboat and describing who is entitled to be in the lifeboat. Nations which continue to engage in uncontrolled population growth are continually trying to get the finite supply of food aboard the lifeboat. These nations are analogous to the most critically wounded as described in the French military practice known as triage. These nations should be allowed to expire. There is another group of nations which may be given food assistance as supplies permit. This group is analogous to the intermediate group of triage. A third group of nations whose prosperity guarantees its salvation is analogous to the first priority group of triage. These nations possess the food that everyone wants and needs to survive. All in all, rich nations feeding poor nations creates a commons (Fritsch 1980; Hardin 1977). "Every life saved...in a poor country diminishes the quality of life for subsequent generations. The 'sharing ethics'...leads to the tragedy of the commons" (Hardin 1977).

Hardin uses Fletcher's definition of ethics in determining who is responsible for effecting changes for the betterment of the commons (as well as a basis for his lifeboat ethics). The definition is: "the morality of an act is a function of the state of the system at the time it is performed" (Hardin 1968). Hardin (1973) states that this is situation or relative ethics.

Hardin provides some remedies to the commons problem. He says administrators can adequately govern the "state of the system" provided that there are corrective feedbacks to keep the administrators honest (Hardin 1968). Hardin (1973) admits that successful implementation of this a problem. In this regard, Hardin says that "inventiveness is called for."

In addition, Hardin says that an appeal to a person's conscience will not work in the long run. The human conscience is, in a general sense, hereditary, and if we rely on individual consciences even in the short run, individual freedoms will continue to exploit the commons and bring ruin to all. The human conscience is "self-eliminating" or "self-defeating." Hardin (1968) also says that conscience and responsibility are equivalent terms.

Since the human conscience is not dependable, Hardin's (1968) working solution to the tragedy of the commons is "mutual coercion mutually agreed upon by the majority of the people affected." He describes this concept by an illustration: We accept compulsory taxes rather than voluntary taxes, since the latter would "favor the conscienceless." That is, political, legal and economic rules protect people from each other as well as protect the commons. Moreover, Hardin claims that this "alternative to the commons need not be perfectly just to be preferable" since there are other injustices in legal systems. That is,

we have no obligation to justice (Shrader-Frechette 1983b). "Injustice is preferable to total ruin." In essence, Hardin says that once we see the "necessity of mutual coercion," we will then "preserve other freedoms," control the population problem, and save the commons for all (Hardin 1968).

Many difficulties arise from Hardin's position as basis for an environmental ethics. These difficulties specifically arise from Hardin's conception of the commons, carrying capacity and lifeboat ethics, relative ethics, conscience as self-defeating, and mutual coercion.

The first difficulty concerns Hardin's perspective on the commons. The term "commons" has several meanings. It was originally used in medieval and post-medieval England and was created by William Forster Lloyd in 1832. A medieval commons was defined as lands that only certain individuals were able to use since these individuals inherited or were granted a right to the land. The land was regulated by these individuals. They were considered to be communal herders or farmers. The demise of the commons occurred because of a change in agricultural methods, enclosure of the land, the industrial revolution, and the exploitation of the poor by the rich, not because of the commons mode of land use itself (Cox 1985). Despite social changes, though, communal farming still exists among some peoples such as the Hutterites (Peter and Whitaker 1984).

The modern definition of commons refers to public

access. Public access is a function of government policy, which involves limited access to the commons. In either definition of the commons, access to the commons is limited and not free to everyone as Hardin would have us believe. There is no historical evidence to support the notion that the commons land use policy means free access or "tragedy" to the commons (Cox 1985). In essence, Hardin's use of the term commons is not representative of the actual relationship of people to the environment.

There are also many problems with lifeboat ethics. One problem is the assumption that politically bounded entities, nations, are "environmental units" to be or not to be given food assistance. From a biological perspective, ecosystem boundaries in relation to population do not necessarily coincide with political boundaries. From a moral perspective, political boundaries may not be indicative of the groups of people who should receive aid. Hardin gives no justification that political boundaries disqualify people from receiving aid (Aiken 1980). No reason is given as to why some nations are morally obligated to institute triage while others are not.

In spite of this, granting the assumption, there are still other problems with the triage viewpoint. First, Hardin's biological carrying capacity ignores the fact that the international purchasing power of any nation extends that nation's carrying capacity (Aiken 1980). As Fife (1977) has

remarked, "freedom in a commons brings death to the commons," but freedom in the commons may or may not bring ruin to the entrepreneurs (herdsmen). There is no such thing as a nation that is not involved in world trade; no nation is self-sufficient. Obviously, the United States (U.S.) carrying capacity has been extended via trade. Carrying capacity is not a fixed trait of nature, but is affected by social, economic and political factors. It is admittedly possible to estimate a nation's carrying capacity before it is exceeded. However, this is not a simple calculation of geometric population growth versus food supply (Aiken 1980). In fact, when making long term projections of carrying capacity, the longer the time span, the less likely the projections will be true (Richardson 1981).

Richardson (1981) was among the global modellers who reviewed some of the most recent and best efforts at global modelling from the Eighth Global Modelling Conference. These include the Mesarovic-Pestel model, Model of International Relations in Agriculture, Future of Global Interdependence Model, Project LINK, and the GLOBUS model. Some general themes were determined from the models.

First, it was found that basic needs can be supplied for all people in the foreseeable future with respect to physical and technical aspects of needs. Such needs are not currently being met due to social and

political factors, values, norms and world-views, not because of absolute physical scarcities (Richardson 1981).

Second, "there is no reliable and complete information about the degree to which the earth's physical environment can absorb and meet the needs of further growth in population and capital." However, population and capital cannot be allowed to grow forever (Richardson 1981).

Third, interdependencies amongst peoples and nations are much greater than anyone has imagined; thus, it may not be possible to precisely predict far-reaching consequences using computer models. Recent global models tend to be less comprehensive, utilize shorter time spans, have more technical complexity (with respect to engineering and econometrics), and be less concerned with "fundamental issues facing the human race" (Richardson 1981).

Fourth, even if global modelling analysts could overcome the deficiencies of models, such models will incorporate the biases of the modeller. In other words, "the world will be shaped by our decisions, no matter what" (Richardson 1981). As Callahan (1983) says "so many variables come into play that it may be possible to do no more than specify a direction...(as to) the desirability of a lower (growth rate)."

Another criticism of Hardin's view involves those nations which have apparently already exceeded their carrying

capacities. Again, Hardin ignores the social, economic and political policies affecting such nations. First world nations have exploited third world nations in order to achieve the appearance of self-sufficiency. The carrying capacity notion necessarily assumes that there will be unchanging social, economic and political policies. How many starving people constitute a nation which should not receive food assistance?

In addition, are first world development and nations representative of the "quality of life" for each and every person as Hardin assumes (Fritsch 1980)? That is, what is the basis for Hardin's assumption that there should be "restrictive property rights to surplus goods" to determine who survives (Sterba 1980)? If first world nations represent a good quality of life, then we should endorse and perhaps even promote resource depletion, air, water and land pollution, and the ever widening gap between the rich and the poor in our United States. If Hardin had looked at social, economic and political factors in the nations of the world, even he would have noticed that his lifeboat ethics reeks of racism (Fritsch 1980).

The evidence shows that if people are given enough food, water, medical assistance, and help in developing their own agricultural methods, they will engage in work rather than procreation. The need for having many offspring will diminish. The United States is a good example of this.

Moreover, ability to buy agricultural technology depends on economics, not on environmental or technological matters (Aiken 1980). Hardin's own use of the tragedy of the commons provides evidence that the poor, when left to starve, have not decreased their populations (Shrader-Frechette 1983b).

Despite all of these criticisms of the triage view, one may still want to think that this view is viable for the future. In that case, given the international situation involving food supplies, one may ask, "who will 'triage' whom?" It cannot be assumed that the United States will be in control when talking about food supplies in the future (ReVelle and ReVelle 1981).

Finally, lifeboat ethics cannot guarantee that because rich nations will not help poor nations that political instability will not result. Political instability in poor nations may be a threat to the welfare of future generations. The people of poor nations in this situation would not begin to be able to take care of themselves let alone think about future generations (Shrader-Frechette 1983b). Hardin's ethics may undermine what it is he is interested in accomplishing.

Hardin's relative ethics was supposed to provide assurance to meet the needs of future generations. However, questions such as the following must be answered in order for such an ethics to work: What constitutes a changed

situation? Who decides when a change in morals is to be made? Will the "right" quality of life be promoted for future generations, or will competing perceptions and values be a problem?

Hardin's relative ethics or ethical relativism can be presented in a more general statement. Ethical relativism is the doctrine that values, moral beliefs, and norms "vary from place to place and from time to time (Singer 1971). "When conflicts arise between different moral beliefs, there is no way to settle the conflict. 'Right' and 'wrong' cannot be truly ascribed to anything since there is no basis for such judgments" (Singer 1971). Ethical relativism is a form of moral skepticism.

Aiken (1985) adds to the criticism of Hardin's ethics. He says that Hardin's desire to protect future generations is undermined by relative ethics. Hardin's desire cannot be judged to be any better than any other consideration. Callicott (in Aiken 1985) says that "the collapse of human 'civilization' is ecologically speaking, a very good thing. This goal is best for the biosphere." The very existence of humans is problematic with respect to Hardin's views.

Hardin's view of conscience does not provide an accurate assessment. He claimed that conscience is self-eliminating. He failed to recognize that appeals to conscience are the only way to institute any ethics, including mutual coercion or triage. People must accept Hardin's views as the "good"

in their consciences in order to act on that moral judgment. Conscience literally means that a person "acts by means of (con) his knowledge (scientia) in matters of right and wrong (Castell 1966)." That is, "rightness" is embodied in conduct (Castell 1966). Hardin's conception of conscience presumes that conscience is merely a psychological process or physiological reaction, an effect of an hereditary cause. This is not a fact, but a limited, unverifiable conception of conscience.

Hardin's view of conscience also does not ensure that his solution of mutual coercion will work. He has entangled his Hobbesian views of human conscience, human nature and the U.S. legal system (Rolston 1978; Hield 1967). Law is not instituted for purposes of coercion. If one characterizes society in the U.S. as good, as Hardin does not, such a society makes laws that express the wills of the people as good. Laws require people to perform acts that they would perform anyway, if people have good wills (Castell 1966).

Even if one would allow for the institution of coercion, Crowe (1977) asks if sufficient coercion can be agreed upon, and if coercion can be effectively administered and enforced. In addition, if justice is dispensable, then no reason could be given for rich nations to stop exploiting poor nations (Shrader-Frechette 1983b). Equity among the nations' peoples rather than saving the commons may be preferable (Shrader-Frechette 1983b).

This indicates the overall problem with Hardin's position. Hardin advocates saving the commons at all cost, especially for future generations. Although his means to accomplish his goal will not necessarily ensure success, his means are directly opposite that of distributive justice.

To offset the shortcomings of Hardin's position, a number of concepts may be presented as a foundation for environmental ethics including the necessity of justice. Justice must be intergenerational rather than using mutual coercion and lifeboat ethics. Appeals to conscience and sacrificing (as altruistic behavior) may be used in place of conscience as self-defeating. Individuals rather than nations are the source of ethics. Intuitionist moral theory is an alternative to relative ethics.

The alternatives to be explicated will be presented after explicating and evaluating the systems philosophy approach. This approach will be determined to be inadequate. However, from the evaluation, other concepts for an environmental ethics will be brought forth.

The systems approach. The position to be examined is systems philosophy. This philosophy has been developed to offset common sense knowledge and ordinary language approaches to gain information. Systems proponents claim that this philosophy is grounded in the empirical sciences and counteracts the trend of specialization in modern science called reductionism. Systems proponents also claim that

this philosophy is to be useful in problem solving because it is holistic and interdisciplinary. As such, the systems approach is supposed to be synthetic rather than analytic in nature.

Bertalanffy, Laszlo, Weiss, and a host of others are the proponents of systems philosophy. Laszlo (1973) defines General Systems Theory (GST) as "the attempt to formulate a set of concepts, mathematical, cybernetical, information, game, decision or network-theoretical, or even philosophical in nature, through which the significantly recurrent regularities of phenomena in diverse realms of investigation could be exhibited as isomorphisms at the level of basic invariances (laws). The attempt is not trivial in that quantitatively exact formulations can be shown to apply equally to phenomenally divergent entities, and it is not reductionist in that qualitative differentiation is allowed for in the (non-metaphysical) emergence of qualities associated with different levels of complexity and with different transformations of a basic invariance."

Weiss (in Seidler 1979) is the only one who gives a definition of the word system. He says that "[p]ragmatically defined, a system is a rather circumscribed complex of relatively bound phenomena, which, within those bounds retains a relatively stationary pattern of structure in space or of sequential configuration in time in spite of a high degree of variability in details of distribution and

interrelations among its constituents of lower order. Not only does the system maintain its configuration and integral operation in an essentially constant environment, but it responds to alterations of the environment by an adaptive redirection of its componental processes in such a way as to counter the external change in the direction of optimum perservation (sic) of its systemic activity."

All systems philosophers depend on empirical science as the source for validating their views. Laszlo (1973) and Bertalanffy (1967) believe in the covering law model of scientific explanation. This model entails two parts. One is that scientific explanation is given if and only if the law or event to be explained is "covered" by a law expressing a general regularity. The other part is that such scientific explanations are the only genuine explanations (Laszlo 1973; Ferre 1972; Bertalanffy 1967).

In addition, systems philosophers try to tie themselves to science by utilizing analogies, homologies, and whenever possible, to modes of description as explanation of phenomena (Bertalanffy 1967). Ideally, all phenomena would be explicable by "mathematical-algorithmic" representations (Laszlo 1973; Bertalanffy 1967).

Laszlo (1973) claims that "a philosophy based on sense experience and introspection alone is not worth very much" in contrast to systems philosophy. He says: "I confess that I do not see a scintilla of evidence in anything produced by

philosophers' analyzing common-sense knowledge and ordinary language which would justify their efforts to come up with theories that could be read as serious recommendations to believe what the objects of knowledge, the nature of mind, beauty, religious significance, or moral values, may be. To try to piece together a concept of the world, of man and mind, and of the adventures of mindful man in the world, on the basis of information obtained by observing what oneself and others are doing, is like trying to reconstruct the principles of automotive engineering from the observation of what one does when he drives a car. Such an attempt is foredoomed to failure, especially when we consider that an automobile is simplicity itself compared to the workings of nature, the human body, and the mind."

Systems may be open or closed. Open systems mean those systems and their environments which exhibit dynamic processes of inputs and outputs such that the outputs serve as inputs of matter and energy. Closed systems mean those systems and which exhibit dynamic processes such that the inputs drive the outputs in one direction only (Seidler 1979; Laszlo 1973).

Examples of systems philosophy almost always are taken from the descriptions of organisms in the biological sciences. Social science has attempted to use systems thinking in the analysis of social phenomena with respect to structure and function (Laszlo 1973; Bertalanffy 1967).

Systems have a number of characteristics. They include ordered wholeness (and differentiation), self-stabilization or homeostasis (a form of adaptation with respect to steady-states and goal-directedness), self-organization (as a form of adaptation with respect to stability), finality, equifinality, hierarchization, and adaptation (Seidler 1979; Laszlo 1973). Other important characteristics are nature as telic (Short 1983) and emergence (Klee 1984; Pepper 1926).

Ordered wholeness involves the notion that the parts of a system do not merely add up to the whole system. The whole and its parts obey different laws. Due to the interrelation of the whole and its parts, some wholes are greater than or less than the sum of their parts (Seidler 1979; Laszlo 1973). The parts may be represented as levels of systems. Systems exhibit differentiation (Bertalanffy 1972).

Self-organization means that a system is capable of developing "new stationary states" such that it becomes more complex and able to "cope" with its environment (Seidler 1979; Laszlo 1973). This means that systems tend toward stability (Bertalanffy 1972).

Self-stabilization or homeostasis is synonymous with the term "dynamic equilibrium." This term refers to the ability of a system to reorient itself after being perturbed by some outside source (Laszlo 1973). The approach to and maintenance of steady states indicates goal-directedness of

systems (Bertalanffy 1972).

Both self-stabilization and self-organization indicate finality and equifinality, respectively. Finality is "dynamic directedness based on structure." Certain structures are present in systems such that certain outcomes are assured. Equifinality is the "tendency towards a characteristic final state from different initial states in different ways, based upon dynamic interaction in an open system attaining a steady state" (Bertalanffy 1967). Reciprocally, equifinality involves self-organization (Seidler 1979).

Hierarchization refers to systems being subsystems of larger systems while simultaneously being suprasystems of smaller systems. When speaking of one system as a part of another system, the system as a "part" may be called a level of another system. Simple systems may develop into more complex ones. This coincides with the concept of self-organization (Laszlo 1973; Bertalanffy 1972).

Systems exhibit adaptation. Adaptation is considered the highest "value" to be attained. There are degrees of adaptation to the environment which represent values. Adaptation presupposes the knowledge of norms and the technical skills to bring about these norms. The hierarchy of systems is the highest suprasystem or norm which indicates adaptation to achieve homeostasis (Laszlo 1973).

Morality is objective in that norms founded on social

existence are external to the individual. Knowledge about these norms are "within" the individual. Empirically, systems thinkers claim that adaptation involves one's percepts matching one's constructs. Overall, this normative ethics is based on the "integration of data from a wide variety of scientific fields, the differential between the advocated natural norm, adaptation, and the observed diversity of values" (Laszlo 1973).

Nature as telic refers to function as purposeful. Nature must be self-sustaining and self-replicating as a finious process directed by a final cause (Short 1983). Evolution is "end-directed" which produces certain entities to be functional. These claims may be plausible if and only if two assumptions are accepted. First, for nature and natural selection to be "goal-orientated," the definition of goal must be anything which recurs often enough to be considered as a tendency toward a final state (equifinality). Second, teleological process is not to be identified with mere mechanistic and empirical patterns in nature (Short 1983).

Emergence is important in systems philosophy. Some biologists contend that emergence is characteristic of properties and laws in nature (Klee 1984). Pepper (1926) has provided a definition of emergence which consists of two parts. First, there are "marks" of at least one higher level of organization in a given system which

distinguishes the higher level from the lower levels of organization above mere degrees of complexity. Second, the "marks" of the higher level are not deducible or cannot be drawn by inference from even the most complete knowledge of the lower levels (Pepper 1926).

Unpredictability is characteristic of emergence (Klee 1984; Pepper 1926). The development of diversity is predictable and particular forms of complexity are unpredictable (Short 1983).

The emergence of properties differs from the emergence of laws. In other words, properties and laws are two distinct "marks" of emergence (Klee 1984).

The emergence of laws means that in a higher level of organization with respect to lower levels of organization there is the discovery of a novel regularity in the higher level that does not involve new emergent properties. That is, lower level structures may constitute a higher level novel regularity discovered in a higher level of organization (Klee 1984).

Emergent properties also exhibit invariance and constancy. These additional characteristics are important since they play a part in connecting higher and lower levels of organization in terms of stability within a system (Klee 1984).

Different systems philosophers ascribe different meanings to some of the characteristics of systems. This can

best be brought out by discussion with respect to nature as telic.

Although Short (1983) agrees with Laszlo (1973) that function is the source of teleological process in nature, he disagrees with Laszlo on two points. First, Short claims that statistical mechanics is useful for explaining the unknowable events in a process. This view encompasses "chance" in nature. Second, the order found in biological evolution is very different from the order or disorder associated with entropy. Both processes are irreversible, though, and can be explained only by statistical reasoning (Short 1983).

Different interpretations of the concept of emergence also exist among systems philosophers. Klee (1984) contends that most scientists believe that in systems in nature, higher levels are determined, and therefore, explained by lower levels of organization. Short (1983) agrees with this point stating that this means the parts determine the whole. Laszlo (1973) does not agree. Klee (1984) says that the concepts of emergence and micro-determinism (the parts determine the whole) must be shown to be compatible if systems theory is to be made coherent and plausible.

The only way to explain emergence is in terms of open systems which exchange degraded forms of energy for higher forms of energy while maintaining a low state of entropy in spite of producing entropy. This is order through

fluctuations which necessarily include chance and determinism. Order through fluctuations implies that homeostasis is not necessarily characteristic of systems (Klee 1984).

With respect to properties, Polyani (in Klee 1984) gives another definition of emergence. "Boundary conditions" emerge into higher levels of organization which constrain lower levels of organization. However, Polyani's claim has been contested by Giere (1968). He says that lower levels of organization such as physical-chemical processes are present throughout all levels of organization. Therefore, the hierarchy of systems is merely a synthetic mode of categorization. Even Klee (1984) admits that Polyani's definition may be construed as differing degrees of complexity of properties from lower levels to higher levels of organization. This claim weakens the concept of emergence (Klee 1984).

Ernest Nagel (in Klee 1984) says that Polyani's definition of emergence is incorrect since the novel regularity would be predictable, in principle, based on the lower level structures. Unpredictability is supposed to be a characteristic of emergent properties (Klee 1984; Pepper 1926).

From this discussion, a number of problems arise from systems philosophy. One problem, just discussed, is that systems philosophy has internally inconsistent concepts

(Seidler 1979).

Aside from this, there are other problems. Systems philosophers are opposed to common sense knowledge and ordinary language. Laszlo (1972) assumes that there is some alternative to piece together a conception of the world in contrast to observing what oneself and others are doing. He fails to realize that the scientist as well as the poet invent their ways of seeing (Thayer 1972).

The systems philosopher also invents his way of seeing the world. In systems thinking, phenomena cannot be identified as "systematic" until they have come to pass (Seidler 1979).

There is no viewpoint which transcends the person making the observation. Even Laszlo and other systems thinkers do claim that systems concepts are useful, but not necessarily corresponding to reality (Laszlo 1973).

In terms of the role of perception and systems constructs, systems philosophy may be characterized by the following: "(systems philosophy) is...only a sort of regulative ideal, and can be approached only asymptotically. Even if completed, it would only mirror certain aspects of reality. The main problem with suggestions such as this is trying to understand why (systems philosophers) wish to be taken seriously" (Seidler 1979).

"The next difficulty is that they tend to be 'reductionistic,' at least in tone. If science and systems

philosophy deal with 'constructs' and 'postulates,' and if there are plural modes of perception, then why does science turn out to be so important, so all-important even? And furthermore, how can one totally (even in principle) de-anthropomorphize anything, when 'people' will be involved in the very attempt" (Seidler 1979)?

"Again, man cannot transcend himself in this sense, so that no matter what modes of perception or what sorts of world-interpretation he chooses, they are still his own. This is not to deny that there is a modal plurality of views, but it tempers the charges of 'prejudice' directed against certain modes of experience, as if they were evidently inferior to other modes" (Seidler 1979).

From this, a number of points may be made. One point is that systems concepts involve relativism. This can be seen by elucidating specific concerns about some systems characteristics. One such concern is how to account for a connection between systems (Klee 1984).

Another concern involves levels within systems. Micro-determinism may be used to explain the connection amongst unpredictability, novelty, invariance, and constancy (Klee 1984). What is problematic is whether there is any intrinsic reason to say that higher levels cause lower levels (Campbell in Klee 1984), or that lower levels cause higher levels of organization. Most scientists assume the former, especially in the case of natural selection (Klee 1984). This is

directly opposite the claim that the parts determine the whole. Therefore, the role of emergence in systems thinking is vague, and depends on the individuals view.

This leads to another concern. It is difficult to account for the difference between guessing and prediction. An outcome may be arrived at by different means. There is no way to determine if an outcome may have been predicted or is just a guess. From the systems viewpoint, no change is predictable since one event is not necessarily deducible from another. This conception has the effect of eliminating projections about the future (Seidler 1979).

A related concern involves identifying the earth as the higher level of organization with the relationship between independent systems being ignored. This raises the question, what is the difference between a level and a system? Individual cells may be thought of as independent systems. A foot cannot be called a system, but a human body can. Labels such as the nervous system are historical. Intuitively, this is a peculiar way to theorize about natural things. More appropriately, the nervous system is thought of as only a level within the human body (Klee 1984).

On the whole, systems philosophy is as relativistic as its particular concepts. Systems theory does not explain the correctness of a systems interpretation of the world over other possible interpretations such as reductionism. Systems theory is descriptive, not explanatory in nature (Seidler

1979).

A second point raised as a problem with systems philosophy involves reductionism. Since systems philosophy is grounded in empirical science, and its ultimate aim is to arrive at a mathematical ideal, it is necessarily analytical in nature. Systems constructs are a mask for the analytical. Systems philosophy does not negate reductionism.

In addition, systems philosophers invent or discover invariances (laws) based on systems characteristics. This shows confusion on the part of systems thinkers in that scientific laws are not objects to be discovered in the external world. Such laws are invented by humans. If such laws are invented in terms of systems concepts, the world is reduced to that particular view.

Seeing wholes rather than parts, or thinking of relations rather than elements is always an option. However, one way of seeing things or thinking about things is not inherently better than the other. What is holistic at one level is atomistic at another (Thayer 1972). Reductionism is when you go from any level of organization to any lower one. "Is the human 'nothing but' another system in an interlocking hierarchy of systems from the atom to the universe" (Thayer 1972)?

Another problem with respect to systems philosophy involves anthropomorphism. There is no way to discern which percepts are to be regarded as the best. Therefore, the

judgment is left to the individual systems thinker. It is a matter of preference. One may ask what is the role of perception in analyzing the world? What is the precise connection between perceiving the macroscopic world and the microscopic world? Which systems constructs are appropriate with respect to which hierarchical interpretation? Which percepts should receive privileged status? Systems philosophers are unclear about the answers to such questions. Ultimately, the answers are a matter of individual preference (Seidler 1979).

Another way to view systems philosophy may be presented from the social sciences. These systems viewpoints reflect the difficulties of systems philosophy from a different perspective.

Systems characteristics have been applied to sociological research. Systems concepts are mental constructs that may be useful with respect to analyzing phenomena. Systems concepts enable the sociologist to expect to find, for instance, a relationship between work roles and family interaction (Abrahamson 1978).

Systems thinking in sociological research entails three assumptions. First, the elements of a system are functionally interrelated. Functionalism necessarily means systems are highly integrated and stable (self-organization). Further, the integration of parts of systems is harmonious with little friction leading to homeostasis. The

relationship among components change little over time. Fundamental changes are sporadic and inherently resisted by systems. Such changes are seen as problematic. Systems needs are seen to be inherent, not intended. However, systems do not need to include functionalism. Transactions or exchanges (processes) may be emphasized rather than functions. Integration and homeostasis may not be necessary in analyses of systems. Systems are analyzed according to the perspective of the person in terms of the organization perceived in the system (Abrahamson 1978).

Second, the components of a system generally contribute positively to the continued operation of that system (finality and equifinality). Finally, most systems affect other systems, and may be viewed as subsystems of the entire organism (hierarchization) (Abrahamson 1978).

In terms of invariants, a good system of classification will reduce the number of variables that have to be considered. Generally, sociological theories have been either highly abstract with no relation to empirical data, or there is a generation of empirical data which does not relate to social theory. Systems constructs are supposed to reconcile the differences between the data and theory (Abrahamson 1978).

Such a reconciliation does not necessarily occur with respect to using systems constructs in sociological analysis. In general, systems constructs may be viewed as arbitrary,

thereby obscuring analyses of phenomena (Abrahamson 1978).

There are two problems that may develop. One is that alternative conceptions tend to be ignored since the sociological data must be fit into the systems framework. The other problem is that useless studies are performed repeatedly as is the case in the biological sciences. For example, the role of the human appendix in the digestive system has been studied repeatedly with no worthwhile data as a result. Systems concepts encourage speculation and research which may prove to be fruitless. These concepts may obscure more than they illuminate with respect to findings of research, but this is the risk that the researcher takes (Abrahamson 1978).

These two problems lead to the systems methodology paradox. To solve a problem, one must construct adequate knowledge about certain systems on the basis of the methodology of systems research. However, such a methodology can only be arrived at only by an adequate description of the systems which fulfill the requirements of systems methodology (Sadovsky in Seidler 1979). The same sort of paradox applies to the conceptions of hierarchiality and ordered wholeness (Sadovsky in Seidler 1979), and in terms of the distinction between levels and systems (Klee 1984).

The problem with using systems concepts in sociological analysis may be presented in another way. Characterizing society with respect to systems concepts means comparing

society to utopias. Utopias are societies from which fundamental change is absent (Dahrendorf 1967).

First, utopias do not grow out of the real world from real patterns of existence and development; that is, time stands still in that historical references are absent as are future possibilities. Second, utopian societies have uniformity with respect to values with no essential conflict or perturbation of this consensus. Third, utopian societies usually have a "deviant" or "outsider" with respect to the society's values in order to present a sort of realism. However, the deviant ultimately does not disturb the unity of the utopia. Fourth, all processes going on in utopian societies follow recurrent patterns and occur within and as a part of the design of the whole. Finally, utopian societies are isolated from other communities; that is, utopias are isolated in space (Dahrendorf 1967).

The systems approach in sociological theory encompasses analyses of social structure as an immobile entity or utopia. The social system is characterized as a general model from which analysis of society is made. Such an analysis involves assuming that societies are held together by an integrating value consensus. A unified value consensus does not actually represent society (Hilbert 1981; Dahrendorf 1967).

This leads to a social theory which does not allow for structurally generated conflicts or disagreement about values, and subsequently, cooperation or compromising. Even

admitting dysfunction as a part of society fails to allow for conflicts. What it does allow for is the existence of the deviant of utopian societies (Dahrendorf 1967). This outside source perturbs the system or institutionalized normative patterns (Parsons in Dahrendorf 1967), and the system reequilibrates itself via social controls (Dahrendorf 1967).

A social theory of conflictlessness encompasses the related problems of reproduction, socialization, and role allocation, or on an institutional level, the family, the educational system, and the division of labor. Conflictlessness, the utopian society, means achieving homeostasis. That is, while variations may occur in systems, conflict or dysfunction are "bad" in a system.

Relativism with respect to adaptation in systems results. Judgments amongst systems cannot be made since one system that exhibits adaptation is no better than any other system that exhibits adaptation. Struggle is indispensable for a true community. Struggle and communication go hand-in-hand. There is no uniformity or the desire for uniformity among all people and nations. Likewise, "[c]ommunity and individuality do not undercut each other...[E]ach contributes something essential to the other's being" (Dauenhauer 1984).

"There is nothing logically wrong with the term 'system.' It begins to give birth to all kinds of undesirable consequences only when it is applied to total

societies and is made the ultimate frame of reference of analysis. It is certainly true that sociology deals with society. But it is equally true that physics deals with nature, and yet physicists would hardly see an advance in calling nature a system and trying to analyze it as such. In fact, the attempt to do so would probably --and justly-- be discarded as metaphysics" (Dahrendorf 1967).

In general, the systems concepts as applied to sociological analysis are not necessarily desirable or feasible. Society is geared to preventing chaos and collapse, and may be viewed as trying to control changes. "[T]emporary stasis between resources and use is no guarantee of social stability and long-term survival." In the short run homeostasis might be maintained at the expense of inputs of new ideas and knowledge and cause "personal and cultural suffering" (Clements 1976).

Homeostasis as control means advocating coercion, sanctions and indoctrination so that society will not collapse. However, homeostasis always fails. Since we want a stable society and change is inevitable, there is a limit to which people in a society are willing to sacrifice for, be it for the present or future society. Homeostasis cannot and should not be maintained at any cost (Clements 1976).

In addition, adaptation has not been found in social processes. Social scientists do not know how people adapt. People do not adapt as a matter of course. It is not known

when people will or will not adapt. Hence, as long as adaptation is used, social scientists will be hindered rather than helped in finding solutions to environmental problems as particular cases of social problems (Spooner 1982).

Systems philosophy fails to ultimately integrate empirical data with theoretical aspects. The search for similar properties in systems theory ignores the significance of differences and perpetuates the problems in current sociological research (Abrahamson 1978). As a frame of reference for sociological analysis, systems are "self-sufficient, internally consistent, and closed to the outside." Systems concepts do not provide insight, analytically, into sociological research and theory (Dahrendorf 1967).

Just as role of some systems concepts were examined in sociological theory, dynamic equilibrium may be analyzed in economic theory.

In economic theory there are analytical, descriptive, and evaluative concepts which refer to dynamic equilibrium. (It is assumed that whenever the term equilibrium is used, it refers to dynamic equilibrium.) Analytical equilibrium is "a constellation of selected interrelated variables so adjusted to one another that no inherent tendency to change prevails in the model which they constitute." Both the model and the equilibria are "mental constructions" which are based on "abstraction and invention." Descriptive and evaluative

equilibrium are just what their names imply (Machlup 1967).

Equilibrium is useful for theoretical analysis but not as an operational concept. All models assume certain interrelations and will always fall short of what happens in the real world. "...[E]quilibrium could not be observed even if each of the variables had an observable counterpart in the real world" (Machlup 1967). A good example of the problem of the equilibrium concept is that such a feature of systems is not recognizable in international trade (Machlup 1967). Equilibrium does not represent system integration, but instead, complete disorder or disintegration (Bailey 1984).

Using the analytical equilibrium concept as a designation of a concrete, historical situation is a misunderstanding of the concept. Any number and combination of variables may be chosen for the model used. Therefore, any model may be "found to 'fit' a concrete situation in one way or another, and the choice is not dictated either by any so-called realities of life or by any conventions of the analysts." This points out the "relativity of equilibrium" (Machlup 1967).

Another point is that equilibrium is not the same as stability or invariance over time with respect to economics. Stability is presupposed for the duration of a given process that is being depicted as being in equilibrium in a model (Machlup 1967).

A third point is that equilibrium is not a "good" thing and disequilibrium a "bad" thing, nor is it a "reference to a 'desired state of affairs.'" Identifying equilibrium as a "moral value-variable" would not provide any additional aid in economic modelling. All this does is to give economic analyses a false evaluative tone (Machlup 1967).

Finally, the equilibrium concept may be given such a restrictive meaning that some economists may be persuaded that it "fits" their model. However, as long as the economist realizes this, then the equilibrium concept will not be falsely used as a foundation for economic analysis (Machlup 1967).

Overall, systems philosophers ascribe fundamentally different meanings to the many systems concepts. The confusion surrounding the terms order, system, level and emergence as well as the characteristics of systems is quite evident. Systems theorists do not "get down from higher generalities to problems in their historical...contexts" (Mills 1967). They partake in an "endless elaboration of distinctions, which neither enlarge our understanding nor make our experience more sensible" (Mills 1967).

The systems approach relies on science. As stated previously, the aim of systems philosophy is to represent all phenomena as mathematical or invariant. In terms of emergence, higher levels are determined by lower levels of organization. According to some systems philosophers, this

is the only way to make their philosophy coherent and plausible. Adaptation as the empirical meaning of value indicates that science is ultimately the basis for ethics. This basis for ethics means committing the naturalistic fallacy. To avoid this fallacy, some additional points about homeostasis and science will be presented as well as characterizing the human to develop his relationship with the environment.

The homeostasis principle is "no longer tenable as an over-all law within biology; and even less is this the case in psychology" (Frankl 1969; Bertalanffy 1967). The "homeostasis principle is actually an indication of disease, ...not of a normal state" (Frankl 1969). According to the homeostasis view, "[m]an is depicted as a being primarily and basically concerned with his inner equilibrium or something within himself, be it pleasure or anything else" (Frankl 1969).

Homeostasis is an unnatural value. When one ecosystem collapses, another replaces it. Therefore, there is no "normal" level at which succession should be maintained. Nature consists of breakdowns in ecosystems, not stability. In fact, ecosystems should be characterized as "controlled-state" equilibria and not as steady-states. Only breakdowns in ecosystems provide change, and such changes are only perceived by humans to be valuable or not valuable (Clements 1976).

Being human means being directed at something or someone other than oneself. This directedness is involved in finding meaning in one's life or encountering other human beings. Because man is directed, he is not concerned primarily with happiness or pleasure. This is the opposite of positions held by psychological egoists, ethical egoists, and some utilitarians. The happiness or pleasure one experiences is because of fulfilling a meaning or encountering another human in one's life. One has a reason to be happy as a result. Happiness and pleasure are merely "side-effects" of the "will to meaning" (Frankl 1969).

With respect to this Frankl says that "self-actualization is a good thing." We can actualize ourselves to the extent and only to the extent that meaning has been fulfilled or another human being has been encountered. However, when finding meaning one no longer has a basis for self-actualizing. This is characteristic of human action (Frankl 1969).

The scientist is ultimately not in a position to define human existence, and the particular human activity of creating an ethics (Frankl 1969). Another way to state this is by the following: "An ecological problem is not, in the first place, the same thing as a problem in ecology. A problem in ecology is purely a scientific problem, arising out of the fact that scientists do not understand some

particular ecological phenomenon....Its solution brings them understanding. An ecological problem, in contrast, is a special type of social problem. (We can easily be led to suppose otherwise because most books on ecological problems are written by scientists.) To speak of a phenomenon as a 'social problem' is not to suggest merely, or perhaps at all, that we do not understand how it comes about; it is labelled a problem not because, like a scientific problem, it presents an obstacle to our understanding of the world but rather because...we believe that our society would be better off without it" (Passmore in Spooner 1982).

This can be presented in another way. "Nature, though it is a thing that really exists, is not a thing that exists in itself...,but a thing which depends for its existence upon something else." Similarly, natural science depends on "some other form of thought" for its existence. There are inherent problems of natural science philosophies based on structure and function among other attributes. The usual assumption is that nature can only be known by the natural sciences. However, the "something else" that nature depends on can be found by examining the "some other form of thought" that natural science depends on (Collingwood 1960).

Current scientists depend on the data gathering and recording of nature by scientists who existed before them. They depend on the work of previous scientists to be made by trustworthy individuals producing valid information according

to the tenets of the scientific method. Current scientists must consult and interpret the records left by previous scientists. In this way scientists are engaging in historical work (Collingwood 1960).

"A 'scientific fact' is a class of historical facts... The same is true of theories. A scientific theory not only rests on certain historical facts; it is itself an historical fact, namely, the fact that someone has propounded or accepted [or] verified or disproved, that theory" (Collingwood 1960). The "something else" that nature depends on is human history. "Natural science as a form of thought exists and always has existed in a context of history, and depends on historical thought for its existence" (Collingwood 1960).

From the evaluation of the systems approach, a number of alternatives may be presented with respect to ethics and the environment. Systems philosophy entails the naturalistic fallacy. This does not allow for solutions to environmental problems that are different from those presently in use. That is, for the most part, technological solutions are used with respect to environmental problems. Instead of fitting the environment into relativistic systems constructs as a mask for reductionism, the starting point should be that the environment is a matter of perspective. Common sense knowledge is important in determining one's perception of the environment. Rather than adaptation as the highest value, Heidegger's concept of "let beings be" is an overall value.

In addition, to act for the environment as an ethical concern means engaging in political activities.

From Hardin's position and the systems approach, a number of alternatives were presented as concepts for environmental ethics. To reiterate, these concepts were: appeals to conscience; sacrificial behavior; ethics originates with individuals; intuitionist moral theory; intergenerational justice; the environment is a matter of perspective; Heidegger's "let beings be;" political activism on behalf of the environment.

An alternative position. The starting point for an alternative position involves the appeal to conscience. One definition of the phrase "appeals to conscience" can be stated as "the invocation of one's own conscience to interpret and justify one's conduct to others" (Childress 1979). Appeals to conscience are necessarily interrelated to moral or value considerations. Questions are raised about implications for public policy when appeals to conscience are made contrary to the norm, or conscientious objection is invoked.

When someone appeals to his conscience, he makes the claim that if he were to act contrary to his conscience, he would not only feel guilty, but also experience a "fundamental loss of integrity, wholeness, and harmony in the self." In addition, this appeal to conscience follows an act

of rightness or wrongness (Childress 1979).

A conflict of conscience occurs when someone is faced with invoking one of two moral standards which results in the partial violation of either standard no matter which standard is invoked. That is, the contention arises that, "I believe that I ought to do that, but my conscience tells me not to" (Childress 1979). This situation also indicates that a person's appeal to conscience is an attempt to unify and attain harmony and consistency between one's beliefs and actions. Appeals to conscience are invoked only when a situation is viewed to provide a setting contrary to one's moral standards (Childress 1979).

It should be noted that having a bad conscience (or acting against one's standards) is not identical to having guilty feelings for performing an act. A person may feel guilty for committing an act, but feel that the violation of his moral standard was necessary in a given situation (conflict of conscience). That is, a person may feel remorse for going against his conscience. If one appeals to his conscience, he is a spectator to himself and cannot deny responsibility for an act. "In most cases of conscientious objection,...the agents hold that even coercion does not relieve them of their responsibility" (Childress 1979). "True conscience has nothing to do with the mere fear of punishment or longing for reward" (Frankl 1969).

With respect to public policy and conscientious

objection, conscience is understood not as an authority, but rather as a personal sanction. The state has the burden of proof in showing its overriding interests are more important than the violation of a person's conscience in establishing a particular public policy. In other words, the freedom and protection of someone's conscience should have priority over the state's interests in public policy (May 1983; Childress 1979).

In sum, appeals to conscience are, in fact, a starting point of ethics. Everyone must appeal to his conscience in order to act.

From the discussion on appeals to conscience, individuals are the focal point. In particular, how are society's members related to problems and solutions?

The persistence of evil in societies has been a glaring observation of historians and those interested in human history. There are many theories of individualism (and collectivism) which place the individual above everything else as selfish; therefore, the origin of evil occurs. Such theories ignore the consequences of the relationships between individuality and society. That is, the relationships between what is peculiar to the individual alone and what is common and similar in all members of society has not been fully explored (Szczepanski 1981).

The role of individuality in the history of societies has been the exercise of control of individuals and

manifestations of individuality (through reformation and revolution). Every group of people creates customs, pressures of opinion, penalties and rewards "for conformist behavior within the bounds of what is common and similar" (Szczepanski 1981). The revolutionary or reformer is viewed as immoral or a perturbation of the conformist, moral standards (Szczepanski 1981).

Humans are the only individuals which can self-reflect or consult their inner selves. In contrast, society is viewed as a collection of personalities as objects in the world. Individuals are the only chance for effectuating reforms in a conformist world (Szczepanski 1981). Individuals are the only means to achieving an environmental ethics.

How can individuals orient themselves to face a problem in order to effectively deal with that problem? Generally, people have no difficulty in viewing themselves as agents capable of free choice. What is troublesome is that people's choices may not be indicative or expressive of their intentions. Self-awareness, and authentic motivations are used by people to combat self-deception and weakness of will and ambivalence (Young 1980).

Remorsefulness may be the only evidence of one's true motives. Unlike purely negative guilt feelings or feelings of regret, remorse is the response that one wished he had not committed a particular act, that one failed to act as one had

believed he ought to act. To not show remorse is self-deception, and at the same time, one may regret this lack of autonomy. These ingenuine motivations can be self-defeating (Young 1980).

One's perspective of a lack of autonomy may be related to a weakness of will. Behaviorally, this is indicated by a lack of a self-controlled life. One lacks an inner coherence among one's intuitions because of a conflict of conscience. However, this does not negate the possibility of one's acting conscientiously. One may, through self-awareness, "put forth genuine efforts to make amends and alter future conduct" (Young 1980). Hence, weakness of will accounts for conflict between intentions and behavior, not a lack of autonomy.

Compulsive motivation may be viewed as contrary to autonomy. As with weakness of will, a mere behavioral interpretation is insufficient. Showing remorse is the crucial point between lacking autonomy and having autonomy. Essentially, people have degrees of freedom (Young 1980).

"Whether a policy gets called egoistic or altruistic depends on the concept of the individual we adopt" (Oldenquist 1980). An individual may be viewed as altruistic, while a group of people may be viewed as egoistic. The reverse is also true. Altruism is a mode of self-sacrificial behavior (Oldenquist 1980).

The discussion thus far raises another question. How are people and ethics related in order to produce ethical

conduct? Appeals to conscience and altruism as underlying concepts for individuals may be extended to intuitionist moral theory. One's moral beliefs are grounded in moral intuitions, and one's remorse reflects one's appeal to his conscience (Young 1980; Childress 1979).

Intuitionist moral theory does not rely on objective principles. That is, moral rules are not absolute truths. Moral rules are not relativistic either. This theory also does not rely on consensus; however, consistency is important (Shaw 1980).

Contemporary intuitionism employs three lines of argument. First, the appeal to intuition is made when the acceptability of a principle is to be judged. If this principle prescribes conduct which conflicts with what we think is intuitively correct, then there are grounds for rejecting the principle (Shaw 1980).

Second, we appeal to intuition to construct general moral principles in particular cases to account for some set of moral judgments that we presumably share. We use principles which we determine to be the basis of those judgments in which we are confident as a way to judge difficult cases. This provides consistency in our ethical behavior (Shaw 1980).

Finally, commonly held moral principles are based on conditional proofs. Such principles become a part of one's intuitive moral make-up. That is, intuitive principles are

not necessarily self-evident, but they are dependent on a condition being fulfilled. For example, a conditional proof would start off with: "if we assume that humans have a right to life, then...." In contrast, self-evidence may be given by this example: "since it is self-evident that humans have a right to life, then...." (Shaw 1980).

Moral judgments include a number of characteristics. The act and its consequences are inseparable; therefore, they are both important in moral judgments (Shaw 1980). There are rights which have widespread agreement. Such rights include the right to life, property, freedom (Hart 1955), not to be coerced (Mack 1979), not to be tortured, not to partake in cruelty and not to partake in human slavery (Shaw 1980).

By collecting intuitions about specific cases, we can also derive certain general propositions and refine already accepted ones. When dealing with a moral problem one may utilize "factual information, general truths, general principles derived from intuitively clear cases, and any intuition-based changes in these principles" (Shaw 1980). Reflective thinking on one's principles evokes thoughts of commonly shared assumptions based on experience. People have a "sense of justice" (Shaw 1980).

Intuition involves "sincerely-held moral judgments." While it is admittedly difficult to institute intuitionism, it is preferable to other ways of making moral judgments. Other ethical theories must ultimately appeal to intuitionism

to confirm their possibility of being viable (Shaw 1980).

To lend credibility to the intuitionist moral theory, a number of criticisms of the theory will be discussed. First, critics charge that moral intuitions differ and change over time. This is true given particular situations. However, such rights as those given earlier would be voiced by most people as commonly held assumptions regardless of the time frame of reference. The only way people could arrive at such assumptions would be after reflective thinking with respect to one's moral convictions (Shaw 1980).

Second, the conflict amongst moral intuitions is another criticism of intuitionism. However, as stated above such conflicts are ultimately resolved when one performs a particular act. The act is a reflection of one's moral judgment. Responsibility for that act is one's moral choice based on one's moral intuitions (Shaw 1980).

To reiterate, morality is a creation of humans, not an objective entity to be discovered in the external world. The intuitionist view consists of constructing or creating a moral code where revisions are an inherent feature of such a code. Again, it is consistency, not consensus, which provides a coherent moral picture and a plausible morality at that. After all, we are ultimately subject to our intuitive apprehensions when making difficult moral judgments. Therefore, we have no reason not to utilize our moral intuitions to produce practical results (Shaw 1980).

Constructing a moral code does not start from a "blank slate." Humans are historical beings, and society could not function without truth-telling and promise keeping. Intuitionism supports the view that we necessarily work with, rather than against, the existing moralities by comparing current moral codes. Any other view against human experience would be seen as unreasonable, psychologically untenable, and socially unendorsable (Shaw 1980).

This is essentially the background on ethics that is necessary to link individuals with ethical action. Intuitionist moral theory may be used as a goad to concern for the environment. In this regard, the relation of the individual to the environment will be explored as a means to surface an environmental ethics.

Individuals perceive the environment. The environment as a perspective by an individual may have temporary and non-encompassing boundaries. Typically, the environment has been equated with nature. Therefore, the environment has been described as possessing objects or having only physical attributes. Even people as part of the environment are connoted as objects. To truly relate individuals to the environment, humans need to be described and viewed as more than mere objects.

We have a responsibility to relate to ourselves, others, and the environment. If we do not develop these relationships, a sense of something being wrong will arise.

An inner discomfort or preoccupation with a lack of relating to oneself, others, and the environment occurs, demanding that one do something about this lack. Humans will feel remorse for not acting on this inner discomfort, and this will lead to what Frankl described as the feeling of the meaninglessness in one's life. To refuse to act on one's remorse feelings means the more persistently one experiences the urge to be responsible (Sternig 1984).

From the perspective of the individual, other people are part of one's immediate and remote environment. One's remote environment includes people from distant lands and people in distant times or future generations.

By "future generations" it is meant that both near and remote persons are included. For the purposes of this discussion, future generations have a right to exist, or present generations have a duty or an obligation to make sure that future generations exist. This is, by and large, a commonly held assumption (Partridge 1981). Evidence includes the existence of national forests, parks and monuments, educational foundations, and trust funds as examples of care for future generations (Partridge 1981).

"Quality of life" is the main link between the environment and future generations. Moreover, it is assumed that similar values are intergenerational. Therefore, a sense of justice and justice itself must be a value held from generation to generation, otherwise the continued

existence of people becomes doubtful. Justice is a prerequisite for maintaining an environment which provides some level of quality of life (Bayles 1981).

The discussion on selfishness and altruism (Oldenquist 1980) showed that sacrifice is a mode of behavior that may produce a "good" quality of life. Sacrificing may be viewed as a "willingness" on the part of individuals. To be willing to sacrifice is part of the possibilities for acting for the future. "[A] man preserves the disposal of his future, if the situation opens up more possibilities to him" (Beauvoir 1948). Individuals who see that whatever they do currently affects individuals in the future will want to perform those acts which will lead to future individuals being able to preserve their future (that is, even more distant future individuals) (Boulding in Partridge 1981).

This sort of activity is indicative of a meaningful existence. Leading a meaningful life involves doing a deed, experiencing what is good, beautiful and true in the world, or turning tragedy into triumph (Frankl 1969). At a minimum, then, commitment to the welfare of future generations requires present generations to ensure that future generations will be able to take care of their basic needs (Sterba 1980).

Present generations may view the situation of the future as follows: "The destruction of the future is suicidal by virtue of its radical alteration of significance and

possibilities of the present. The meaning of the present depends upon the vision of the future as well as the remembrance of the past. This is so in part because all projects require the future, and to foreclose projects is effectively to reduce the present to emptiness" (Delattre in Partridge 1981).

This is a burdensome responsibility. However, people do act with concern for future generations. Passmore (in Partridge 1981) states: "When men act for the sake of a future they will not live to see, it is for the most part out of love for persons, places, and form of activity, a cherishing of them, nothing more grandiose. It is indeed self-contradictory to say: 'I love him or her or that place or that institution or that activity, but I don't care what happens to it after my death.' To love is, amongst other things, to care about the future of what we love....This is most obvious when we love our wife, our children, our grandchildren. But it is also true in the case of our more impersonal loves: our love for places, institutions and forms of activity. There is...no novelty in a concern for posterity, when posterity is thought of not abstractly-- as 'the future of mankind'-- but as a world inhabited by individuals we love or feel a special interest in, a world containing institutions, social movements, forms of life to which we are devoted-- or even, a world made up of persons some of whom might admire us."

Hartmann (in Partridge 1981) echoes Passmore's sentiments. He says that humans pass their work on to others in the future. That one's work survive him is indicative of one's realization of his mortality and a projection of his concern for future generations. Preserving future generations indicates a concern for the future environment. Concern for the future environment requires channeling one's intuitions and feelings as an ethics of the environment.

Heidegger may be the original source for an "ethos" of the environment (Zimmerman 1983). He states that we should "get back to the original things" or "let beings be" (Zimmerman 1983; Heidegger 1962). By this he means that in our everyday life we go about our business and do not pay attention to our relation to things; we should become more aware of our relation to things. (In this context, "things" refer to phenomena as any entity with which one may have a "personal" relationship; things are not just objects as sense perceptions.) This view emphasizes the "field" or context in which the human exists as important rather than the individual as an observer outside of the environment (Heidegger 1962).

Husserl (in Stewart and Mickunas 1974) has a similar view. He says that we should "get to the things themselves." That is, we should get to the essence of things, not merely the appearances of things or sense perceptions of

phenomena. According to Husserl phenomena means anything which we are conscious of. Therefore, all human experience is important. Human experience with respect to the environment would include "...the 'individuality' of objects, plants, animals, groups and whole nations" as well as of people (Szczepanski 1981). The necessity of the individual person putting himself in the place of other entities in order to derive his relation to the environment stems from this view.

Husserl (in Stewart and Mickunas 1974) adds to this viewpoint. Each phenomenon should be viewed as "a point on the horizon of potentiality"; that is, each phenomena has a multitude of meanings. This shows how "environment" depends on perspective. Changes in attitudes (perspectives) are important in one's relation to the environment, not merely changes in objects in the environment itself.

Initially, Heidegger (1962) characterizes the relationship one has with the environment in the following way. "...[I]n the environment certain entities become accessible which are always [present] but which, in themselves, do not need to be produced." These are the entities of nature themselves. The world's "things" are "tools" or "equipment" (Cave 1982). That is, nature's entities may be tools. "In equipment that is used, 'Nature' is discovered along with it by that use-- the 'Nature' we find in natural products" such as products taken from

animals.

The world interpreted in terms of space and time is in terms of Nature. Nature is a limiting case of the existence of the possible entities within the world. Only in some definite mode can entities be discovered as Nature (Heidegger 1962). The everyday world includes Nature, and it is also one's public life. "To lose oneself walking down a country lane is, literally, to lose the self that is split off from nature" (Barrett 1958). That is, one regains his relation to nature rather than being "caught up" in everyday, public life. Nature and environment merge, or nature is the "essence" of the environment.

"As the 'environment' is discovered, the 'Nature' thus discovered is encountered, too"; that is, the woods is a forest of timber, or the mountain is a quarry of rock. "In roads, streets, . . . , our concern discovers Nature as having some definite direction. . . ." Along with the public world, Nature is discovered and is accessible to everyone (Heidegger 1962).

In discovering the environment "...when something ready-to-hand is found missing, though its everyday presence has been so obvious that we have never taken any notice of it (Nature), this makes a break in those referential contexts which circumspection discovers" (Heidegger 1962). This means that we unintentionally ignore nature; however, we at some point become aware of nature. We then become aware that we

are engaging in careful reflection of nature.

"[T]hrough circumspection we now see for the first time what the missing article was....The environment announces itself afresh" (Heidegger 1962). This means that we have focused our attention on the essence or "nature" of our surroundings (environment). We have realized the existence of the environment, and we are aware of that realization. This is the essence of one's relation to the environment. This is meditative thinking. It is in opposition to calculative thinking or the man-imposed ordering indicative of science (Heidegger 1971).

The original concept of "physis" (physics) meant "self-blossoming," not just our present scientific conception of nature (Heidegger 1971). When nature is viewed as "self-blossoming" it is noticed by the individual (Heidegger 1962).

Related to physis is the word "techne" which means "letting beings manifest themselves with the least interference and the most cooperation" (Zimmerman 1983). For example, the windmill cooperates with the wind and lets the wind remain what it is. In contrast, the energy in coal must be "exposed" by humans, then changed into another form for storage for use (Zimmerman 1983). Techne is the disclosure of physis. Because of such disclosure, people may change their behavior such that technical devices be created to work in harmony with nature. The position of interrelated energy transfers is only a narrow sense of the relation of physis

and techne (Zimmerman 1983).

In addition, the earth is a dimension of physis. Earth is not just a mass of matter as a planet. Earth is the "ground" on which things arise and where man dwells. To dwell means "to be set at peace." Peace means "the free." To free means to spare. To spare means "let beings be" or to preserve (Heidegger 1971).

With Earth present, the world opens itself up to man while also being "set up." "World" is not just a collection of objects. It is the "ever-nonobjective to which we are subject as long as the paths of birth and death, blessing and curse keep us transported" into all that is. "The world grounds itself on the earth, and earth juts through the world" (Heidegger 1971). This perception encompasses the essence of how one may view earth, world, and environment.

For example, "[i]f we try to lay hold of the stone's heaviness...by placing the stone on a balance, we merely bring the heaviness into the form of a calculated weight. This perhaps very precise determination of the stone remains a number, but the weight's burden has escaped us....This may herald itself under the appearance of mastery and of progress in the form of the technical-scientific objectivization of nature, but this mastery nevertheless remains an impotence of will" (Heidegger 1971).

This ethos includes the "fourfold." The fourfold is

earth and sky, divinities and mortals. Dwelling in the fourfold means "cherishing" in the sense of preserving and caring for things. Again, dwelling includes sparing, and to spare is to "let beings be" or "leave something beforehand in its own nature" as well as not harming something (Heidegger 1971). To dwell or remain within our limits means saving the earth (Zimmerman 1983). Further, to dwell means realizing that "'on the earth' already means 'under the sky.'" Both of these also mean 'remaining before the divinities ' and include a 'belonging to men's being with one another'" (Heidegger 1971). Essentially, when humans are aware of their relation to the environment, they are showing humility (rather than dominance or arrogance) for their environment as an ethos of the environment.

Individual will is in contrast to the direction of the "collective" will of today (as being conformist). This direction entails that of purposeful self-assertion that "posits the world as the whole of producible objects" (Heidegger 1971). Man forces everything under his dominion and tries to order the world. Modern science and technology are consequences of "collective" willing. Man's current will means that man is losing his "self" and his grasp of ideas as "personal" (Heidegger 1971). His actions portray the "mass-manufactured," "ready-made" life of stereotypes, conformity, and non-reflective thinking (Barrett 1958).

There may be some people yet capable of seeing the

threat and assault of technological production. "Any salvation by makeshift, however well-intentioned, remains for the duration of his destiny an insubstantial illusion for man, who is endangered in his nature" (Heidegger 1971). The salvation must come from those who are not selfish, not interested in self-gain or self-interest. This activity to save nature is creativity or willing more strongly than self-assertion (Heidegger 1971). Humans cannot will an ethos of the environment to come about, but they can be receptive to it (Zimmerman 1983).

Saving nature as creativity means "fetching from the source." For creativity, "logic of the heart" is the source that is needed. This innermost part of one's heart is one inclined toward loving those who are to come (Heidegger 1971).

An ethos of the environment is an encompassing directive in one's attitude toward the environment. Such an attitude requires action on the part of individuals. Such individuals may be identified as "concernful doers" involved with (not in) the world (Cave 1982).

"We are on the verge of losing our humanity" (Heidegger 1971). We have depended on the science and technology in the Western tradition, or "one-track thinking." To act and live as we do today with technological change is to deprive ourselves of human dignity and the human needs of privacy, "space," and freedom of choice (Proshansky 1983).

However, we also have the possibility of reforming our current patterns of thought. "There are 'seeds' in the Western thinker which the reformer can hope to bring into full flower (Passmore in Zimmerman 1983)." Actions taken to preserve and accept natural areas, decentralize power, conserve energy, and change to less consumptive life styles are indicative of trends favorable for the environment. Eliminating all technology is impossible and not necessarily desirable. To reiterate, our attitudes of dependence on technology are destructive to our being environmentally responsible (Zimmerman 1983).

One may try to construe Heidegger's views as compatible with Leopold's (1966) land ethic. This ethic is: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1966). Heidegger would say that only humans are capable of the self-will needed to exceed nature, and non-humans are not capable of surpassing their natural limits. Only humans can wrong nature (Zimmerman 1983).

Justice is the key to a truly harmonious relation among humans, non-humans and the environment. "The community of the biosphere is being destroyed now because one of its members, humankind, is not acting in accordance with the dictates of 'justice....' [J]ustice occurs when all the elements of a community function in accordance with their

limits" (Zimmerman 1983). To be mechanized or dehumanized means pushing living beings beyond their limits. Only by letting beings be within their own limits can humans blossom within their limits.

With respect to an ethos of the environment, Heidegger has a novel conception of "time." The "future...is primary because it is the region toward which man projects and in which he defines his own being....Man looks ever forward, toward the open region of the future, and in so looking he takes upon himself the burden of the past...and thereby orients himself in a certain way to his present and actual situation in life" (Barrett 1958). The world is not perceived as "mine" but as "ours." Husserl (in Stewart and Mickunas 1974) says that the lived-world is open to the past and to the future which is "partially 'ours' but to a greater extent is also 'theirs,'" or those who belong to future generations.

To reiterate, "[h]istory contains the ethical seeds of a strong tradition of environmental protection" (Shrader-Frechette 1983a). However, individuals must be aware of, rather than oblivious to, these traditions. When values and past judgments are brought to conscious attention to make decisions, there is a fitting relationship between values, facts, and actions. The moral implications of such a world view are binding and universalizable, and are the basis for moral judgments (Marietta 1982).

It should be apparent that an environmental ethics is not a new ethics at all. An environmental ethics means returning to justice. It is a mistake to believe that constructing a new ethics ensures that people will follow it correctly. Or that if people do not follow an old ethics, there is a need for a new ethics (Shrader-Frechette 1983a). What does matter is people's interpretations of ethics, the intuitive sense in applying or acting on an ethics, and being open to Heidegger's sense of relating to the environment as "refraining from" harming the environment or to "let beings be."

There are at least three auxiliary issues to consider, though, to determine the prospects for action. These issues may undercut any environmental ethics. First, there is the issue of justice. As stated previously, justice must be presumed to be an intergenerational attribute of people. However, do justice and "best interests" always coincide? Perhaps justice would be, as Callicott (in Aiken 1985) said, to allow for the collapse of human civilization in the best interests of the biosphere. The only defense for intergenerational justice would be that unless current generations have concern for future generations by caring for the environment, there would be no point to have concern for the environment. Humans are as much a part of the environment as any other aspect of the environment. The preservation of humans makes the environment a viable

concern for most people (Partridge 1981).

The second issue may be phrased by the question, "Is nature always right?" That is, what is natural is not necessarily what is right or the "good." It is doubtful that human life or many other forms of life will be destroyed by industrial civilization, except of in the event of nuclear warfare. Man can survive despite food shortages, crowded poverty-stricken living conditions, and exposure to pollutants. The quality of life is the issue tied to the environment (Dubos 1975).

During the environmental decade the attitude to have was that "nature knows best." However, "nature left to itself does not know how to give full expression to the potential diversity of the earth" (Dubos 1975). It "does not know how to maintain man-made environments in a healthy state" (Dubos 1975). Until man's existence, much of the temperate zone exhibited little diversity, being a region of forests and marshes. Civilized regions in Africa, when left to nature, become "mosquito-infested malarious" regions (Dubos 1975).

In nature there are no problems, only natural events which have natural outcomes. Natural solutions may even be poor or awkward. For example: nature causes crashes to limit animal populations; nature allowed large herds of bison to damage prairies by over-grazing; nature failed to recycle by allowing accumulation of organic materials such as coal, oil and guano (Dubos 1975).

Failure to recycle is also an activity of man. As such, it is a "natural" activity which has occurred throughout human history. Failure to recycle does not really have any natural solution. So technology and changes in behavior are the only means to institute recycling of materials. "Human ways of life must of course be compatible with natural laws, but they cannot be the ways of nature (Dubos 1975)."

Technology cannot be eliminated from the world of today. With technology humans will be able to "buy time" for future generations. Environmental problems have, at least partially, technological solutions. However, environmental problems are also "quality of life" problems. Using technology to manage the environment is acceptable only if the environment, as essential to the quality of life in the present and the future, is the chief consideration. Humans must be able to discern where their contribution to nature is best, and when it is best to allow nature to take its course (Dubos 1975).

The third issue stems from not viewing environmental problems to be ethical concerns. This issue may be represented by the question, why are individuals generally not motivated to act on behalf of the environment?

The problem originates with the motivation of ordinary people. For the most part people are not egoists or knaves. Those who are represent an extreme. There are things that the individual in a free society believes that are owed to

himself or herself. "A person who takes seriously his or her personal development and the well-being of those closest to him or her is not thereby morally unserious" (Care 1982). This affects how much a person can actually sacrifice for future generations.

It is easy to label people as egoists or knaves, and difficult to account for the positive motivation of ordinary people. That is why the question of motivation is a problem to be solved. People must be "moved" deeply enough to affect their actions directed to being responsible to and for future generations (Care 1982).

There are five features of those "moved" to action. First, the person has a policy of sacrifice as a presumption of conduct. Second, motivation is an internal, not external phenomenon. Third, a person so moved is considered a "decent or good person." Fourth, motivation of a person is viewed by the person as not as that of self-interest. Finally, certain "feeling tones" are associated with motivation.

Why are some people motivated to sacrifice for future generations? Three reasons may be given, although these reasons may be insufficient for one being motivated into action (Care 1982).

First, one may rely on love and concern for future generations. This is insufficient for motivation since future generations are faceless and impersonal. Morally, one may reason that we should be concerned for future gene-

rations. However, this does not help us understand "what motivates us to do what morality requires" (Care 1982).

Second, motivation may take the form of "community bonding." This involves having a "sense of belonging to some joint enterprise" which moves one to act in line with moral principles regarding other persons, living now or in the future. Again, this does not provide sufficient motivation for people to act on behalf of future generations. Current generations are not able to share ideas or make decisions jointly with each other let alone future generations (Care 1982).

Finally, motivation may arise from a "sense of common humanity." This means that humans belong together regardless of "differences in time and location among them." This form of motivation does not require that all people engage in an exchange of ideas, or actually have an idea of "community." Only a few people need qualify as motivated by the "shared-fate" idea. This may be insufficient motivation. It is questionable whether the shared-fate idea can be cultivated and accepted in light of the notion that current actions may hurt current people with regard to future generations (Care 1982).

All of the doubts about motivation have some merit. However, if these doubts were true, no action on behalf of future generations would exist. Indeed, there are people who have acted and continue to act on behalf of future

generations and the environment. But the doubts about motivation remain. A response may be presented.

As previously stated, we assume that all problems "will yield to technical answers designed by outside experts" (Wirth 1985). Efficiency in education-- measurable inputs and outputs, behavioral objectives, and competency testing-- turns teaching and learning into a mechanical process. The same is true for efficiency in work as managers and technicians are the only decision-makers. Only technological and management problems are real (Wirth 1985).

To discover alternatives to the current mode of dealing with problems or to acquire motivation for dealing with problems means dealing with "learned helplessness." This means that people need to recognize that they need not go through life thinking that nothing can be done about a given situation. "If we live from the primary concern of asking 'what can I bring to this moment-- this situation?' it means we can live with a sense of deep honor and respect for what is represented in ourselves and all other people." This is living from a base of self-acceptance, a kind of humility (Wirth 1985).

When we lose something we ask, "How much is lost?" or "What should I have done?" This leads to a feeling of responsibility for an unchangable past, and negative guilt feelings surface. Instead, we should think and ask, "How much is left?" Then we would feel responsibility for the

future and have something as a basis to act upon (Takashima 1985).

The technical and managerial problem solving methods and the concept of learned helplessness are linked to our mode of education. Education for responsibility is missing in our learning. "The mindless qualities in classrooms derive in large part, from insipid 'right answer' games in which teachers elicit monosyllabic answers to questions (Wirth 1985)...." The responsibility for learning must be shifted to the learners. In this way the teacher becomes a facilitator (Wirth 1985). More importantly, "values cannot be taught, they must be lived" (Eisenberg 1985). People are not bodies which merely receive stimuli, process it and spew out a stimulus. They are "meaning seekers and meaning makers" (Wirth 1985).

A similar statement can be made about our work situation. The current mode of "uniform mass production" and "hierarchical, top-down style of scientific management" are contributing to sustaining the present situation (Wirth 1985).

Another response may be given with respect to the motivation problem. "How is it that individuals come to evaluate human actions which affect the environment in terms of internal standards of right and wrong" (Heberlein 1977)? "Activation" and "deactivation" of one's morals involves "awareness of interpersonal consequences and ascription of

responsibility to self" (Heberlein 1977). An increase in this awareness and responsibility means an increase in action on behalf of the environment as a moral obligation. In addition, moral concerns stem from concern about human welfare. The awareness and responsibility factors are also behind altruistic behavior (Heberlein 1977).

After the environmental decade both the awareness and responsibility factors have decreased. This is because environmental problems produce jobs for abatement equipment and are viewed to be "taken care of" by administrative agencies and other legal means. However, there are some people whose actions show concern for human welfare. There are even some people who are moved to engage in pro-environmental behavior, such as granting rights to wildlife, without concern for interpersonal consequences or human welfare. It is these people who make it possible for the environment to be recognized as an ethical concern (Heberlein 1977).

Environmental ethics may be used as a foundation for individual or collective action. Actually changing one's life style to "let beings be" is a mode of behavior that animates one's ethos of the environment. Political activism is a mode of behavior which animates one's environmental ethics. As Fritsch (1980) says, "[s]ometimes being responsible means that we take an action before damage is done...."

Environmental ethics and action. Mindful of both present and future generations, "humanity" must be given legal standing. Further, non-human animals, plants, and other entities must also be given legal standing. Acquiring legal standing should not depend on the value humans place on a given entity. Rather, any entity has worth entirely independent of human judgment. Humans must also be spokesmen for non-human groups.

A special "entity" that needs to be discussed with respect to legal standing is corporations. Popular belief is that the business community is one of the most notable groups which is least closest to an ethos of the environment.

French (1979) claims that corporations have moral responsibility. They are collectives which are given rights just as individual persons are given rights.

There are at least two types of responsibility that may have moral overtones. First, a person or collective may exhibit responsibility "for" (French 1979). This means that one who is capable of action has a correlative responsibility for that action. Responsibility "for" may entail appeals to conscience. Second, a person or a collective may be responsible "to." This entails the notion of accountability (French 1979).

Responsibility relationships are created, for example, through promises, hirings, contracts, appointments, or assignments. Moral responsibility relationships "hold

reciprocally and without prior agreement among all moral persons (including collectives)" (French 1979). In sum, moral responsibility is neither optional nor contractual.

Corporations may exhibit intentionality with respect to actions. Such intentions are not just the intentions of individuals who work for a corporation. Corporations have internal decision structures which include: a responsibility flow chart with respect to stations with the corporate power structure; "corporate decision recognition rules" or that corporate policy is recognized internally by the way corporate decisions are made and by the policy a decision-making process initiates. "When the corporate act is consistent with, an instantiation or an implementation of established corporate policy, then it is proper to describe it as having been done for corporate reasons, as having been caused by a corporate desire coupled with a corporate belief and so, in other words, as corporate intentional" (French 1979).

Corporate policies are relatively stable over time. Only side issues are amended; therefore, corporate policy is representative of corporate intentions. This is quite evident in the way corporations regard and treat environmental matters.

Copp (1979) has a somewhat altered, but complimentary view to French's views. Collectives do perform actions. Corporations as collectives do not act independently of

persons actions. However, "the action of a collective is 'constituted' by the action of the person (or persons)...in question" (Copp 1979). For example, a person of authority within a corporation may perform an act, and that act represents the corporation even though the corporation itself did not perform the act. This notion is related to French's corporate intentionality. Copp (1979) goes on to say that collective actions as constituted are not necessarily causal in nature. This point relates to French's discussion on responsibility relationships. Finally, Copp (1979) says that the mereological sum of persons' actions may also be viewed as individuals actions which constitute a collective action. His point is that a person (or persons) on behalf of a collective or the mereological sum of actions of persons constitutes action worthy of moral judgment. This implies that corporations may be held responsible for their actions and policies on moral grounds.

Legally and politically, how can individuals and collectives as corporations resolve environmental matters? First, options for individual actions will be given. Then, the responsibility relationship between individuals and corporations will be explained.

Public participation is a basic ingredient in the U.S. political process. Voting, petition drives, letter writing, joining organizations, and lobbying are typical modes of participation in environmental matters. In fact, one of the

strongest modes of action is joining a special interest environmental group. Special interest groups are the lobbyists for all people. In addition, attending hearings or being involved in court cases, individually or by class action suits, are other features of participation in environmental matters.

This is not the end of the participatory function. Citizens may be appointed to commissions. In fact, Stewart et al. (1984) says that citizen participation in local planning commissions is currently emphasized since planning requires judgments that include values and technical knowledge. It is not a question of "if" but "how" citizens should participate in policy making.

Citizens may also participate in decision-making in state implementation plans. Such participation may be required by statute or regulation (Stewart et al. 1984).

Stewart et al. (1984) claims that decision-making by citizens may include rating alternative strategies presented by local planning commissioners or state officials as solutions to an environmental problem. This condenses technical information into useful information for citizens to make judgments consistent with their values. Alternatively, "weighting" of the various factors reflecting the values of various groups (technical experts and citizens) with different interests may be made by the citizens themselves. Then, a ranking of strategies may be performed by a planning board.

Citizens and corporations have a special relationship in terms of environmental matters. This relationship entails French's notion of accountability. How might corporate accountability be attained to assure a quality environment? Miller (1973) explains that it is not an easy task.

American corporations are analogues to the government in many ways. In recent times corporations have realized that they have "responsibilities larger than merely making profits for stockholders (Miller 1973)...." In practice, however, corporations have not necessarily taken responsibility for their impact on the environment, the nearby community, society, and the public interest. The resources for solving environmental and social problems are mostly controlled by corporations. Corporations' representatives will say that big business has responsibilities to society. However, big business has utilized the responsibility notion by giving empty public relations speeches and being charitable to institutions in order to control a particular segment of a community (Henning 1973). Government has not required corporations to be accountable (Miller 1973).

The courts have recognized that corporations are "legal persons." For the most part, the courts have protected business interests. Business manipulates Congress so that court action is by-passed in any case. So-called independent commissions, the licensed watchdogs of the business community, experience "capture" by those who are supposed to

be regulated. That is, commissions become representatives of corporate, not public, interests (Miller 1973).

Shareholders have no say in corporate policy in social or environmental matters. Corporate law demands that shareholders can be involved only in direct corporate procedures. Requirements by the Securities and Exchange Commission (SEC) for more broadly defined disclosure on corporate policy may produce greater involvement by shareholders in corporate proceedings. Shareholders' proposals with social or environmental overtones would become part of the proxy statements whereby shareholders may vote on the proposal. Not only would shareholders have an affect on corporate responsibility, but also they would bring matters of social and environmental consequence to the public's attention. Clearly, equalizing "power" among corporation, shareholder, and the public at large is essential for corporate accountability (Henning 1973).

In order to achieve corporate accountability, the legal process needs to be opened up to greater numbers and varieties of plaintiffs. Class action suits must be made a simple, accessible option for the individual in either judicial or administrative cases. Individuals in a community dominated by a particular corporation and /or individuals who work for a corporation's top management need to be able to gain standing in judicial and administrative cases (Miller 1973).

Another remedy to effect corporate responsibility is qui tam. This civil action means that a suit may be filed by a private citizen against a corporation with respect to violations of the Refuse Act of 1899. This action must be taken because a corporation does not have a permit, or does not act in accordance with the terms of a permit to deposit refuse. If the person filing the suit is successful, he may receive payments for such action. However, the courts have not used this interpretation of the law against corporations. The Corps of Engineers is responsible for issuing permits, and they have not enforced the qui tam (Miller 1973).

Aside from federal action, state involvement is also necessary for corporate accountability. States need to recognize that corporations are like private governments; then constitutional limitations may be applied to corporations. The state Supreme Courts have upheld lower court decisions in a very few of these cases (Miller 1973).

There are three notable shortcomings in dependence on the courts for corporate accountability. First, the courts perpetuate an adversary relationship between corporation and other individuals. One side "wins," the other "loses." Second, judges do not have expertise in environmental or social matters. They are lawyers who are, by and large, chosen from the business community. Finally, judicial decisions have become less and less important, giving way to

legislative, and ultimately, public administration rules (Miller 1973).

More can be said of the relationship of citizens to corporations. Two negative relationships may exist between a corporation and a community. Either there is an absentee-owned corporation which ignores the community, or there is a local corporation which dominates a community. The result is the same. The community is forced to be polluted and intimidated and discriminated against (Green 1973).

Such relations take various forms. A corporation may contribute to local programs which the community depends on. In contrast, a corporation may utilize local lawyers, accountants, and bankers as well as employing a majority of people from a local community, but not contribute to that community's welfare. Corporations are typically underassessed with respect to taxes, and this puts a drain on a community (Green 1973).

The usual pattern which produces a negative result on a community is that a corporation promises a community prosperity, when in fact the opposite occurs. One can look at such towns as Gary, Indiana (U.S. Steel), Savannah, Georgia (American Cyanamid), and Mansville, New Jersey (Johns-Mansville), and even the state of Delaware (DuPont) to see that this is true (Green 1973).

A number of changes may be sought by individuals negatively affected by corporations. Tax laws need to be

changed and enforced so that corporations pay their fair share. Direct corporate involvement in community programs should be abolished. Instead, corporate contributions may be given to independent, local boards or committees, and public hearings should be held to determine how those funds are to be used. Corporate pollution should be monitored with respect to the health of children, for instance, and such findings should be publicized (Green 1973). Penalties for polluting should include a corporation's direct payment to a community. Citizens should form ad hoc committees of injured persons to petition for environmental changes (Fritsch 1980). Anti-trust suits should be made an accessible means of recourse for a community (Green 1973). Finally, corporations, not the government, should insure themselves in order to operate, for instance, a nuclear power plant (Fritsch 1980). Presumably, self-insurance could be applied to any corporation that has historically caused pollution.

Green's (1973) point is that the corporation should be more responsible to citizens (along with government) for public welfare, and measures should be taken to ensure accountability.

Accountability measures are one way to put environmental ethics in action. Another way is to change public policy for the betterment of the environment.

For the most part, public policy remains constant over time. Changes occur in increments, and they are due to

special interest groups, governmental agencies, and legislation (Sabatier and Mazmanian 1979).

Sabatier and Mazmanian (1979) have determined that there are five necessary and sufficient conditions which can effectuate substantive policy changes with respect to statute or judicial review. These conditions are: policy changes based on a well thought-out program relating valid scientific and technical data to achieving compliance; policy contains clear directives such that there is, in all likelihood, compliance; leaders of the implementing agencies possess the skill and commitment to ensure compliance; policy changes are supported by citizens, constituency groups, and a few key legislators or members of the executive branch; implemented policy changes are not undermined over time due to changes in other policy priorities or socioeconomic conditions.

These conditions describe policy action under the most favorable circumstances. However, policy objectives may be realized in less favorable situations. If valid scientific and technical data do not exist, an open decision process with contributions from many different groups should determine the extent of an ensuing environmental problem. If legislation is inadequate to promote enforcement of the policy, the courts may be used to invalidate that legislation as unconstitutional; or new legislation may be generated. If agencies will not actively support policy implementation, citizen intervention and accountability

measures must be increased. The mobilization of a supportive group is always desirable and necessary. Supportive officials may find or mobilize such a group. If a key legislative or executive supporter is not evident, one may be found by constituency groups. Moreover, reorganization of committee jurisdictions may aid support for policy implementation. Over time policy support may be achieved by promoting the perception that the policy conforms to the mandates of agencies. Successful implementation would then be an ongoing process. Perception is the key to overall policy success (Sabatier and Mazmanian 1979).

Along with accountability measures and public policy changes, environmental mediation provides an additional way to act on environmental concerns.

Environmental mediation involves the application of a third party to aid in the resolution of environmental disputes. Such disputes have three typical characteristics. First, they involve many parties ranging from corporation to citizens to elected officials to public agencies. Second, the framework and third party intervention is a part of the dispute resolution process itself. There is no set configuration to represent the implementation of resolution. Lastly, environmental disputes involve issues which are mostly irreversible once a solution has been implemented (Cormick and Patton 1980).

The mediation process itself may be operationally

defined as follows: Mediation is a voluntary process in which those involved in a dispute jointly explore and reconcile their differences. The mediator has no authority to impose a settlement. His or her strength lies in the ability to assist the parties in resolving their own differences. The mediated dispute is settled when the parties themselves reach what they consider to be a workable solution (Cormick and Patton 1980).

All parties involved in an environmental dispute must meet face-to-face as well as voluntarily (Cormick and Patton 1980). "The great virtue of this procedure is its human quality (Strauss 1980)." There may be one or more environmental mediators at a given session. The environmental mediator would be called into a situation to initiate the negotiating process. That is, once a problem has been identified the mediation process may be the chosen route for resolution of a dispute (Cormick and Patton 1980). Local resources disputes and balancing competing values are features of a typical problem for mediation (Hileman 1983). Mediation may also be instrumental in conflicts between a corporation and a community where citizens want to resolve a current environmental problem before it becomes worse (Cormick and Patton 1980).

The mediator facilitates the negotiations, but does not impose any settlement. The mediator does assist in creating a joint implementation plan (Cormick and Patton 1980). The

environmental mediator is also a conciliator and facilitator. A good mediator not only schedules conferences to keep disputants talking and remain willing participants, but also he makes certain that progress is actually being made to resolve a dispute (Hileman 1983; Strauss 1980). This is especially important in resolving environmental disputes since the conflicting parties may not have any institutional relationship. Environmental mediation is concerned with finding solutions that are politically, physically and financially feasible (Cormick and Patton 1980).

There are some additional guidelines with respect to environmental mediation. First, the mediator must be impartial. This is quite the opposite from lawyers advocating sides in judicial cases. If the mediator is perceived to be biased by any of the conflicting parties, the mediation process will fail (Hileman 1983; Cormick and Patton 1980).

Second, mediation is a decision-making process. Therefore, cooperation from the relevant agencies and implementation bodies is necessary to ensure that a decision will result from mediation (Cormick and Patton 1980).

Third, the parties involved in the dispute must be willing to enter into the mediation process with "good faith" to ensure that the agreement is carried out (Cormick and Patton 1980). The parties must have nothing to gain by not settling the dispute (Hileman 1983). Legislation has made it

possible for citizens via environmental groups to be almost equivalent in power to corporations. For example, environmental groups can delay a corporate project by public hearings, the permit process and the courts. Delays can escalate corporate costs and possibly render a project economically unfeasible. Corporations, though, may obtain variances or appeals to delay implementation of pollution equipment to meet emission standards. Both environmental groups and corporations can exercise "veto power," and each group may get bad publicity for whatever stand they take. The mediation process can eliminate the adversarial label on each of the parties by a "good faith" agreement (Cormick and Patton 1980).

Fourth, the mediation process creates a tie amongst conflicting parties when the issues are defined, the parties are visible (in terms of the media) and highly involved, there is an urgent need to resolve a situation, and no one side can unilaterally "win" (Hileman 1983; Cormick and Patton 1980).

Finally, mediation will produce compromises. If an agreement can be mediated, it is presumed that the parties involved will be better off than they would have been if the conflict were resolved through administrative or judicial review. No party wins or loses. In this sense of compromise, an agreement is tantamount to determining what is best (Cormick and Patton 1980).

The mediation process begins by preliminary discussions between mediators and the various parties. At this time it is determined if the mediation process would be supported. Once it has been established that the parties want to come to a mediated agreement, representatives for each of the parties is sought. An agreement reached means support by all parties, and this serves to bind the parties to the agreement (Cormick and Patton 1980). Confidentiality of mediation sessions must be maintained. The parties involved must be able to feel that they can express themselves freely. Only after the mediation process would the media be allowed to cover this event. Media coverage of the agreement further strengthens and assures successful implementation of the agreement. All parties must implement their part of the agreement in synchronicity. The agreement may include provisions for committees composed of citizens, corporate representatives, and government officials to aid in planning and overseeing implementation (Cormick and Patton 1980).

There are, however, some impediments to mediation such as lack of funding, lack of expert advise on technical matters, and difficulty of communication by all those involved. In addition, parties may elect to use the courts due to fear of los of their constituency (or not appearing to hold a hard and fast position), fear that tactical objectives will be lost, and one party fearing that the other will not

uphold the agreement (Hileman 1983).

Mediation is not a replacement for court action, but an additional means for resolving environmental conflicts. Mediation is a part of environmental management. Since many decisions to protect the environment require sacrifices today to avoid catastrophes or to enhance the quality of living tomorrow, part of the art of environmental management is the skill of making the future consequences of an action seem as real as if they had been experienced. If the decision is to be acceptable, all concerned citizens, or at least those who lead and influence the opinions of others, must be persuaded that these difficult trade-offs are valid, equitable and wise. Therefore, early citizen involvement has been built into procedures, with all disputes resolved as soon as perceived. Citizen involvement is not only necessary as a practical matter, it is also becoming a standard feature in our legal structure of environmental management (Cormick and Patton 1980).

Mediation might also be useful in rule making. Rules made by EPA would be negotiated by interested parties throughout the rule making process rather than having negotiations occur after a rule is made. However, EPA would have to determine how to be impartial in the rule making process as initiators, yet have representatives at the negotiations. In addition, the Federal Advisory Committee Act and the Administrative Procedure Act limit private

meetings thereby undermining confidentiality on the part of interested participants. If these problems could be worked out, mediated rule making would be an improvement over the current situation of EPA making rules, then being taken to court by the parties affected (Hileman 1983).

Thus far, there are eight states with twenty-four environmental mediation centers where seventy disputes have been resolved. It has been predicted that in ten years more environmental disputes will be mediated than settled in the courts (Hileman 1983).

In sum, through environmental mediation it is hoped that all participants will benefit (whether it be in environmental disputes or possibly rule making) and better quality decisions about the environment will have been made.

SUMMARY

What is an environmental ethic? It is not the same as an ecological ethic which would be solely to preserve ecosystems. An environmental ethic makes use of ethics as involving acts of conscience, intuition, and altruistic behavior.

Environmental ethics includes some prescriptions such as Heidegger's "let beings be" to signify what individuals can do to minimize environmental damage passively. Actively engaging in political, social, and business matters can promote sound environmental practices. In this regard justice must be an intergenerational value. That is, it is worth it to have concern for future generations. To act on behalf of the environment is to act on behalf of future generations. To act for future generations is to sacrifice by present generations, or act altruistically and provide oneself with a meaningful life.

The individual is the important vehicle for environmental ethics. It is the individual who must recognize and acknowledge responsibility for the environment, then act responsibly for the environment (Partridge 1981). Action implies a looking to the future. Being responsible for one's actions projects to the future (Tuan 1972). However, it must be decided whether the environment should be of primary importance at all costs. Again, the environment as an

ethical concern is the responsibility of individuals.

Individuals are the source of environmental ethics. Until environmental issues are seen to involve moral concerns and everyday life, action on behalf of the environment will not become a part of an individual's way of living. Lasting effects will not be forthcoming.

GENERAL SUMMARY INTEGRATING THE THREE SECTIONS

This work as an environmental analysis encompassed three subject matters (each a complete study in itself) for the purpose of integrating facts, values, and perceptions with respect to an environmental issue. The first section was scientific and can be termed factual. The second section was a social survey dealing with perceptions, attitudes, perspectives, and implications for values. The third section was a philosophical discussion of ethics or values and the environment. Facts, perceptions and values will be shown to be related in a general framework.

The scientific or factual part of the study involved a trace metal pollution problem in Wafley and Saylor Creeks. Physical and chemical analyses and statistical interpretation were utilized to establish that a pollution problem exists in the creeks. Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant were implicated as polluters of Wafley and Saylor Creeks, respectively. However, the major perception of the people in the surrounding areas is that these creeks pose no immediate health threat, and therefore, do not constitute an environmental problem. A difference between the facts and the perceptions resulted between the scientific and survey parts of the study. This can be stated as the problem of the connection between the scientific world and the perceived world.

Science has its roots in the perceived world of everyday life and experience. That is, the world as perceived is the foundation and precondition for science. The everyday world of ordinary perceptions and actions is where science occurs. This does not mean that science is reducible to mere perceptible phenomena. Perception may be understood to be "active openness to a meaningful world already and constantly at hand, a world revealed through the mutual implications of perspectives, inexhaustible in its novelty, and engaged in a lived interaction with our bodies" (Compton 1967). In this way, it is evident how scientific study can occur, and how science and the perceived world are related.

The relation between the scientific and perceived worlds may be applied in a broader sense to "nature." As already stated, perception is the foundation for science. There are four implications of the primacy of perception in relation to nature.

First, scientific activity always has and always will occur in a world of things "already there" in nature. That is, science will always have a background. This background is only partially disclosed. The perceived world always presents further possibilities of analysis to science; science will never exhaust the possibilities. However, because of the background scientific activity becomes "independent" of the perceived world. Scientific work is, therefore, considered to be true in the sense of being

detached (Compton 1967). The factual determination of the scientific part of the study made it independent of the people's perception of the pollution status of the creeks. Not all of the people's perceptions were decidedly that the creeks were unpolluted. A few people were very concerned, and it is this viewpoint which may eventually produce continuity between the factual and perceptual aspects of this environmental matter.

Second, the scientific and perceived worlds exhibit some conformality. Natural entities respond to investigation. Science measures this and produces an "independent" quality of nature. Natural objects have boundaries and are in some sense, "individuals" which science can study (Compton 1967). Wafley and Saylor Creeks were scientifically studied as "individuals" separate from the rest of the environment. People perceived of the creeks as "individuals" that are a part of their environment. Nature, as studied by science, is done so in relation to lived space-time. Nature is experienced in the perceived world as continuous over time (Compton 1967).

Third, from the first two points, nature is an open concept (Compton 1967). Nature and environment are a matter of "perspective." One's perspective indicates one's relationship to nature and the environment. This does not mean that "nature" and "environment" are arbitrarily definable. At the same time, "nature" and "environment"

are more than what science says they are. The factual content of nature derived from scientific investigation may be used to interpret nature as perceived. The perceived world is the reference of scientific study. Yet the factual and perceived aspects of the environment, the creeks, show that more than one interpretation of the environment may be given and may be valid to some degree.

Finally, the "pattern of discovery" used by science is the same as that used in ordinary lived experience. This pattern is essentially a preoccupation with perceived things (Compton 1967). Scientists meditate about the data of an actual experiment or observation. In this regard, Wafley and Saylor Creeks were determined to be polluted with trace metals. A perceiver tries to discern the meaning of an object or situation. People in the surrounding areas perceived that the creeks posed no current environmental problem.

The relationships and differences between the scientific and perceived worlds have been presented. The next step is to determine and explicate the relationship between facts and perceptions and ethics or values. The four implications for the primacy of perception for nature may be extended to values. The first was on nature and perception as background. Values, like science, are a part of the perceived world. Values, as a part of lived experience, may be values said of nature. Wafley and Saylor Creeks may be

said to be "valuable" since they affect the people in the surrounding areas in their everyday life. This "valuable" environment should be taken care of.

The second implication dealt with conformality. Parts of nature are viewed as "individuals." These "individuals" are considered to be "valuable." Wafley and Saylor Creeks exhibit conformality whether studied by science, perceived by people, or said to be of value.

The third implication was that nature is an open concept. This implication allows for the inclusion of new perceptions, interpretations, and prescriptions. A new perception may be given by the following: people should ask, "how does this industry or business impinge on our community in terms of the environment?" rather than "how can the environment be used by this industry or business?" A new interpretation may be that actions taken on behalf of the environment need to be constantly evaluated. Personal or individual action on oneself compared to the effect of an individual's actions on others must always be considered. A new prescription may be that one should incorporate action on behalf of the environment into one's life-style. A judgment would occur such that the environment in question has "value." Subsequently, action on behalf of the environment as an ethical concern may occur.

The final implication of the primacy of perception involves the "pattern of discovery." This along with the

third implication allows for the inclusion of new perceptions to replace old ones so that an ethics based on the environment, as well as action on behalf of the environment as an ethical concern, may occur. There are points of intersection between facts, perceptions and values.

What is the relationship between concern and action for the environment? The people in the Wafley and Saylor Creek areas expressed concern for future generations. These people also claimed they had an obligation to future generations to assure a clean environment. However, these people did not perceive themselves to be responsible for the environment. The corporation or business was perceived to be the likely polluter, and therefore, the major party responsible for the environment. The corporation was the party to remedy the pollution problem and pay for and maintain a clean environment. However, people did say they were willing to pay their "fair share" for clean up costs.

People see the environment as an everyday concern, but have not yet gone beyond this to have an active ethical concern for the environment. Both obligation and responsibility were a part of people's perceptions. Having an obligation implies ethical concerns. Responsibility also involves ethical concerns. Facts, perceptions and values may be discussed in another way to elucidate this problem between ethical concern and action.

There are two very general ways to relate to the world. One may do so as a contemplator or spectator, or one may be a participant. Contemplators and spectators deal with facts; reality is a matter of fact isolated from its value. Contemplators and spectators view the world as mere phenomena and are, therefore, detached. Participants deal with values. They experience everyday life in the world where they confront their values. The perceived world is the background for everyday experience and values. A conflict exists between contemplators and spectators, which produce scientific knowledge, and participants in the perceived world of everyday experience (Monasterio 1981).

One way to resolve the conflict is by the following: "[T]he common separation of facts from values, in which objectivity is supposed to consist, is nonsensical, for what is meant by value is...the distinctive call by objects-for-response on subjects who have to respond" (Monasterio 1981). Value is the "call for response." Everyday experiences are "objects for response." If value is removed from everyday experience, such experience becomes mere phenomena. For science to be practiced, values must be stripped from everyday experience. Therefore, science can never judge values.

Surveyed individuals believe they are spectators. This exhibits detachment. They also believe that the corporation is the participant. This exhibits attachment. However, even

spectators are actually participants in the world. The view of detachment allows for individuals not being responsible or not fulfilling their obligations. All individuals need to realize that they are always, in some way, participants, even when they do nothing. Everyone's actions reflect some degree of responsibility and ethical concern. The corporation needs to be viewed as an "individual" on equal footing with the community as an "individual." This may produce participation by people on behalf of the environment. The detachment of the people "removes" them from their environment, the creeks.

The commonality of perception in nature as scientifically studied and as lived experience is also extended to ethics via judgments. Facts and perceptions about the creeks induced judgments, which may include ethical ones.

As previously stated, people perceived that they had an obligation to future generations to assure a clean environment. This ethical concern can be expanded to environmental ethics. Such an ethics has a number of components. As discussed in the philosophical section, environmental ethics generally implied that individuals were the primary party responsible for the environment. Environmental ethics also included Heidegger's "let beings be" or that entities in nature are worthwhile and meaningful in and of themselves, intergenerational justice, and decision

making (or nature does not necessarily know best). These are the ethical judgments one must make to begin to act on an environmental ethics.

The motivation problem as discussed in the philosophical section is a reflection of the lack of action on the part of individuals. The low response rate also reflects lack of involvement by individuals. This problem exists despite the avenues of recourse discussed which are available to the individual. Although more education may help alleviate the motivation problem, at least one obstacle must be overcome in order to act on an environmental ethics. Individuals must take responsibility for the environment as a part of everyday life. In this way can the motivation to act for the environment begin to arise. In addition, the "readiness for action" that people possess in times of environmental crises is also a part of motivation. Essentially, one must live as an example of one who is ethically concerned for the environment.

However, in this case, action on behalf of the environment is "put off" until the future. Action must be a current and constant example of being ethically concerned for the environment. Perhaps action will occur in the future since people were concerned about the future status of the creeks.

On factual questions people perceive what is. On ethical questions people perceive what should be. Both

perceptions are grounded in perceptions of the everyday world as people relate to the environment. The environment is a matter of perspective as a result of perceptions by individuals. People are a part of the environment just as land, air and water are. People as a part of a particular environment were asked about that environment with respect to themselves and others. The environment affects people just as people affect the environment.

The previous discussion served to describe the relationship among facts, values and perceptions. It also served to describe, in a general way, the contribution of facts, values and perceptions to an environmental analysis. Such an analysis must contain these components to be complete. The part each component plays in an environmental analysis can be explained in light of the problem of uncertainty arguments.

Any scientific study, such as the one of Wafley and Saylor Creeks, will be inherently incomplete. However, at this time, this is the best possible information on these particular environments. Therefore, it is the opponents who have the burden of proof that this study does not provide reliable, accurate results. That is, the judgment on this study should be concerned with reliability and accuracy rather than incompleteness. As a result, this scientific information must necessarily be included in environmental policy making (Thompson 1986).

In environmental analysis and policy making, scientific studies such as the one of Wafley and Saylor Creeks are necessary to measure risks as a way to define the environment being considered. Open, public involvement is necessary to evaluate the acceptability of risks. This environmental analysis makes the pollution issue in question definable and resolvable in fact and value terms.

The social survey was a way to bring the pollution issue of Wafley and Saylor Creeks to the attention of people most likely to be affected by this environment. It was also an initial way to achieve public involvement in the pollution issue.

For more effective environmental analysis and policy making, people near Wafley and Saylor Creeks would need to be better informed on the environmental issue being considered. People need to become literate on what constitutes evidence or what is meant by uncertainty. Scientists should make concise statements about the environment in question, and this information should be accessible to the public (Thompson 1986).

This is a prerequisite for the possibility of action on behalf of the environment, Wafley and Saylor Creeks. When the public can scrutinize the validity of a scientific study, perception is a key. The more knowledgeable the public is on an environmental issue (such as the one studied), better decisions for policy will likely occur (Andrews 1981).

Essentially, a more complete environmental analysis will provide better environmental policy and alleviate the problems associated with uncertainty arguments. Such policy must be made within a given time-frame. Action will more readily occur with specified time-frames. Inaction may result from claims about incomplete studies and uncertainties (Thompson 1986).

This discussion on uncertainty arguments and the working relationship between the scientific as factual, the social as perceptual, and values may be presented in more detail. From the particular results of each section of this environmental analysis, the parts that facts, perceptions and values play may be discussed.

This synthesis of the three subject matters is more complete than current methods for assessing environmental impact. What does this analysis show that a purely scientific, social or ethical analysis would not show? If only a scientific study of Wafley and Saylor Creeks had been done, no remedy for the trace metal pollution problem would be instituted. These creeks have not been classified for drinking or recreational (swimming) purposes. Therefore, the Iowa Department of Water, Air and Waste Management does not have legal authority to strictly regulate the creeks. The results from the trace metal study determined that although pollution is indicated, the source of the pollution is unclear. Firestone Tire and Rubber Company and Ankeny Sewage

Treatment Plant were found to be likely contributors, but not solely responsible for the trace metal pollution problem. Responsibility for an apparent non-point source pollution problem is difficult to determine.

In addition, the EPA did perform trace metal analyses of water samples from the two creeks (two sets of samples from Wafley Creek and one set of samples from Saylor Creek) in September, 1981. These limited tests provided results that were mostly below limit of detection (USEPA 1981). Despite this, arsenic, copper, lead and zinc concentrations may exceed national standards (Federal Register/EPA 1980). Further tests are warranted. It should also be noted that the limits of detection for the trace metals were higher than the standards themselves; therefore, results below limit of detection are not necessarily indicative of pollution free waters. To date, the Iowa Department of Water, Air and Waste Management has taken no action on the pollution problem in the creeks.

With no remedial action instituted for the creek's pollution, a health risk may exist. However, even if the scientific data provide evidence for this risk, resolving the matter is unlikely. Scientific data do not prescribe remedies. How could the people and businesses as well as administrative and legal rules be mitigated only on the basis of comparisons of trace metal concentrations? So many milligrams of trace metal per kilogram of sediment does not

indicate what ought to be done to remedy trace metal pollution. Moreover, particular scientific standards may be viewed as a "license to pollute." That is, pollution of an environment such as a creek may continue provided that monitoring studies of the pollution show that standards have not been exceeded.

Another point may be presented with respect to the particular trace metals and major ions determined to be pollutants in the creeks. Arsenic, chromium, iron and zinc are directly found in the rubber and tire manufacturing process as well as in Wafley Creek sediments. Chromium, nickel, iron and potassium are directly found in the sewage treatment process as well as in Saylor Creek sediments. Despite this, Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant cannot be cited as sole trace metal (or major ion) polluters of Wafley and Saylor Creeks, respectively. This is another way that scientific data may be construed to be insufficient for use in making a judgment about a particular environment.

This leads to the question, if the social survey study had been the only analysis done, what would have been the result? According to the majority of people surveyed, no health threat exists for themselves or their children from Wafley or Saylor Creeks. People were concerned for future generations. Any current pollution was viewed as a future problem.

The results of this social survey study would indicate that no remedy of the pollution problem is immediately necessary. However, some of the respondents thought that the creeks were a current health threat. Those believing that there is pollution may be willing to institute actions to remedy this environmental problem. The drawback people face is that they have no scientific data to back-up their claims. It may be possible to utilize historical data for the area. However, in this case, the water data provide a shallow basis for action.

The discussion on environmental ethics may also be viewed as an environmental analysis. If this study had been the only one done, arguments could be made for remedying an environmental problem. Actions for remedying an environmental problem could also be prescribed. However, it would be difficult to apply this general environmental ethics to a specific environmental problem. One must have knowledge of the environment and/or the support of people's opinions to make general arguments apply to a particular problem. This analysis would provide a general prescription for people to follow if they want to be environmentally concerned. By itself it would not provide a basis for specific actions that may be necessary at a given time for a given environmental problem.

Either a scientific, social or ethical study, alone, has been determined to be inadequate in environmental analysis.

A synthesis of all these approaches results in a more complete analysis which provides for a more sound basis for promoting remedial action for environmental problems.

This work provided a data base to define the quality of the environment studied-- Wafley and Saylor Creeks. This yielded factual information to be compared with the survey data on prevailing perceptions of the people in the vicinities of the creeks. The comparison was useful in determining if discrepancies existed between facts and perceptions. If there were no discrepancies, remedial action toward the environment would have been more likely. The public's concerns would have been justified to some extent by the scientific data. Further, the survey results are necessary to offset uncertainty arguments that may be made against the scientific study.

In this case, there were discrepancies between the facts and perceptions. These discrepancies provided the fruits for discovering what may be the reasons that action on behalf of the environment was not taken. These reasons were determined (based on the social survey results) to be ethical concerns. These ethical concerns were provided by people's perceptions of responsibility for the environment and obligations toward future generations. The philosophical discussion provided explication of how people go about making moral judgments and how such judgments involve the environment. If people were ethically concerned about the environment, actions to remedy

an environmental problem would be forthcoming. In essence, people viewed the pollution of the creeks to be a future problem, but ethical action must occur in the present for the future.

It should be restated that environmental ethics is not a new ethics. Rather, ethical judgments are made in light of a consideration for the environment. To review, environmental ethics includes such concepts as intergenerational justice, nature does not always know best, and "let beings be" and political activism reflecting an individual's life-style and environmental concern.

As stated previously, the survey results showed that the corporation was the major party responsible for the creeks. However, the full implications of the results may provide more information upon closer inspection.

The community was also determined to be responsible for clean up of pollution (Table 26). Assuring that the creeks remain clean was determined to be the responsibility of the government and the community as well as the corporation (Table 28). Payment for clean up costs was determined to be solely the responsibility of the corporation (Table 30). However, people did indicate that they were willing to pay their fair share.

Fair share payment is an indispensable concept for present and future generations, and this reflects the need for intergenerational justice. The indicated shared

responsibility and fair share payments may indirectly indicate that nature does not always know what is best. Nature does not know how to offset man-induced inputs of trace metals. People must be willing to clean up the pollution, and successful, long-term clean up may be ensured by all the responsible parties involved. Fair share payments by citizens and the corporation can make up for what nature may be viewed to lack.

The difficulty arises with the notion of fair share. The survey results indirectly project that people do not have confidence in a corporation's ability to determine fair share. Corporate accountability would aid in determining just what would be fair share payments. (A more detailed discussion of the role of accountability measures will be presented later).

People felt they were partially responsible for clean up and maintenance of the creeks. This willingness to take partial responsibility may reflect, in a general way, people's ethical concern for the environment. This concern may be attributed to the community. However, the people may not recognize their concern as ethical. The recognition that an active role in environmental issues may exemplify ethics is lacking.

This lack of recognition is also related to the likely acceptance of Ankeny Sewage Treatment Plant's expansion efforts. This expansion is to take care of the sewage

treatment plants's overload problem. In this way, accountability has been given by an admission to the people of the community that the sewage treatment plant cannot handle all the waste it gets. This is, however, a technological solution. Trace metal pollution may not even be alleviated by this solution. In addition, the people may decide that since the sewage treatment plant is going to expand its works, they are absolved of any further input and responsibility. A technological solution is the current, acceptable way to deal with an environmental problem. Ethical concern would provide the impetus for continuous action on behalf of the environment. Only in this way could people show their concern for future generations.

The general relationship between the corporation and the community may also be related to people's lack of recognition of their ethical stake in the environment. To view environmental problems as only technological problems is to close possible avenues for remedial action.

Advocacy of the environment means putting moral beliefs into legal and political action. Such actions need to be made more accessible to individuals. Laws need to be made and/or administered to make it possible for individuals to act on behalf of the environment. It is the very same individuals, though, who must push for such changes.

Currently, people are not involved in the environmental issue at hand. According to the survey some people are aware

of some kind of pollution problem. Most are satisfied that no pollution problem exists. Of those who think there may be a problem, only one person said she contacted officials for an authoritative assessment of the creeks. This person was not convinced of the official response. She was still concerned about the possibility of pollution. These results indicate that most people do not take initiatives to find out the facts of the case. Even when someone tries to take the initiative, the best possible information may not be available to the public.

This points to the problems individuals face when trying to take initiatives to remedy any environmental problem. An independent synthetic study lends itself to provide individuals with specific remedies for effective action. From this work, if the people are made aware of the scientific data, and the public's views are widely known, and if the public, in some way, can recognize their ethical concern for the environment, specific actions on behalf of the environment are more likely to occur.

The relationship between the community and the corporation is important for remedial environmental action. Accountability must be consistently practiced by corporations. Currently, corporate accountability is sporadic. Ethical concern for the environment entails everyone taking responsibility.

As discussed in the philosophical section, the

corporation is currently defined as a legal person. To enhance the likelihood of accountability, the corporation needs to be defined with respect to ethics. The corporation is composed of people, and people are moral agents. The corporation is represented by its employees; therefore, the corporation and its internal policy can never be exclusively separate from its employees. The employees are representatives, and even in some way, advocates of corporate policy. The interrelationship between employees and the corporation strengthens the case for the corporation being held morally responsible for its actions.

This provides a framework for judging corporate intentions via policy to ensure accountability. Citizens would have a means to judge Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant (as a governmental corporation). The judgment should not result from citizens having to do the work of finding all of the pertinent information. The burden of proof of not polluting should be on the businesses in question or any other business that may be involved. Knowledge of corporate policy and corporate employees being held partially responsible for that policy on a routine basis would aid the public in being ethically concerned for the environment. This would provide some motivation for people near Wafley and Saylor Creeks to act on behalf of the environment.

More specific policies may aid in corporate

accountability and citizen involvement. First, the SEC should more broadly define disclosure on corporate policy so that shareholders may be allowed greater involvement in social and environmental affairs. This would aid in judgments about Firestone Tire and Rubber Company.

Second, potential litigants in suits should be allowed easier access to the courts. Class action suits, anti-trust suits, more cases using qui tam, and legislative definitions by the states on constitutional limits for corporations are among the means to ensure corporate accountability via the courts. These remedies represent a broad-based approach that could be used after attempts at other remedies were exhausted. The people near Wafley and Saylor Creeks would not need to use these remedies unless alternatives were found to be inadequate.

Finally, statutory changes in corporate tax laws would aid indirectly in fair share payments for using the environment. The corporation should pay penalties for polluting to the community affected. The corporation should also pay for its own insurance against contributing to pollution. Monitoring pollution should be done with the results widely publicized. Again, the burden of proof is the responsibility of the corporation. In addition, injured citizen committees should be formed to petition for environmental change. General involvement in decision-making for state implementation plans and local planning committees

with respect to environmental issues would indirectly aid in achieving corporate accountability. All or part of this group of actions could change policy in favor of individuals who want to act on behalf of remedying the pollution problem in Wafley and Saylor Creeks.

Policy changes can aid the people near Wafley and Saylor Creeks, but the people must want to change policy in the first place. This involves satisfying the conditions for policy changes as stated by Sabatier and Mazmanian (1979).

Scientific data do exist for Wafley and Saylor Creeks. However, there is not a large volume of data. The USEPA (1981) STORET water data are inconclusive, and this is the data that the Iowa Department of Water, Air and Waste Management relies upon for judgments. The department is not actively monitoring the creeks, and therefore, is only passively concerned about ensuring compliance by Firestone Tire and Rubber Company and Ankeny Sewage Treatment Plant. By gaining knowledge about the pollution in the creeks, citizen involvement would be able to mobilize a support group. In addition, a sympathetic legislator or administrator may aid the citizens' efforts. However, most citizens were satisfied that pollution is not a current problem in Wafley and Saylor Creeks. As Sabatier and Mazmanian (1979) stated, "perception is the key to overall policy success."

If there was actually a point at which citizens near Wafley and Saylor Creeks knew about and wanted to act to

remedy the pollution problem, environmental mediation may be the best means. Early citizen involvement is critical to achieving a successfully mediated agreement. Such involvement means that people near Wafley and Saylor Creeks want to resolve the pollution problem before it gets worse. This case would be one of competing values (citizens wanting a clean, healthy environment and the corporation wanting to conduct its business as policy dictates) with respect to the creeks. Such cases are prime candidates for resolution via environmental mediation.

Representatives from the citizens of Saylor Township and Firestone Tire and Rubber Company, and citizens from Crocker Township and Ankeny Sewage Treatment Plant would meet separately. After reaching an agreement, each group may want to meet jointly, if it has been determined that compliance would more adequately be ensured. An agreement may include disclosure on wastes products for public review, time scales for instituting clean-up, penalties paid to Saylor and Crocker Townships for past pollution, citizens contributing to the payment of the clean up as part of fair share payments, and public and administrative review on a regular basis if questions about possible pollution should arise. Public participation can be expressed by the willingness of people to partake in fair share payments (Mann 1981).

Environmental mediation means depending on good faith agreements that are equitable. This means depending on indi-

viduals with different perspectives having ethical overtones. The corporation's representatives must also be willing to comply with a good faith agreement.

Suppose the people in the Wafley and Saylor Creek areas decided to act ethically (and continuously) on behalf of the environment. To what extent should this be carried, or what should people sacrifice for the environment and future generations? Similarly, we should "let beings be," yet we wish to "see" and "interact" with, for instance, wilderness. How often and to what extent should this be allowed to occur? Individuals are responsible for the actions taken, and to act on behalf of the environment with an ethical basis is a step toward determining which actions are acceptable and to what degree such actions should be taken.

Some general observations may be made about this work. It does have some shortcomings. While it is more complete than ordinary environmental studies, it still lacks analyses on other facets of environmental issues. Additional analyses on economic aspects may provide an even better assessment of the impact on the environment. Scientific studies on micro-organism populations and other chemical components of the sediments may prove to be useful. In addition, the best way to determine the efficacy of this work is to actually put it into practice. This may be a difficult matter to achieve.

The disadvantages of using this work as a basis for practical applications include the amount of time required to

produce such a study, the requirement of expertise in many disciplines, the involvement of many people whose opinions must be dealt with, and the inclusion of non-quantifiable entities such as everyday perceptions and ethics.

The advantage of using this work as a basis for practical applications is that the kinds of environmental remedies sought would be long-lasting and would likely provide some consistency. Including people themselves in decision-making about the environment is the best way to ensure considerations for future generations.

What recommendations does this work make? A more complete environmental impact analysis should be used to obtain a more complete picture of the environmental issue at hand. Environmental issues have been shown to be multifaceted, or interdisciplinary; therefore, environmental analyses should reflect this. This work showed how to include social and ethical considerations as well as scientific data and legislative and administrative rules in environmental issues. It overcame the naturalistic fallacy by the synthesis of three distinct areas of study rather than trying to define values in terms of scientific data. This analysis provided a better understanding of the underlying aspects which contribute to decisions about impacts on the environment. From this, it is hoped that effective, long-lasting action on behalf of the environment would become the usual protocol for environmental matters.

LITERATURE CITED

- Abrahamson, M. Functionalism. Englewood Cliffs, NJ: Prentice-Hall, Inc.; 1978.
- Aiken, W. Book review of Naked emperors: essays of a taboo stalker, by Hardin, G. *Env Eth* 7(1):75-79; 1985.
- Aiken, W. The "carrying capacity" equivocation. *Soc Theory and Practice* 6(1):1-11; 1980.
- American Public Health Association. Standard methods for the examination of water and waste water. 14th ed. New York: American Public Health Association; 1975.
- Andrews, R.N.L. Values analysis in environmental policy. In: Mann, D.E., ed. *Environmental policy formation*. Lexington, MA: D.C. Heath and Company; 1981:pp. 137-147.
- Anthony, R. Polls, pollution and politics: trends in public opinion on the environment. *Environ* 24(4): 14-34; 1982.
- Aston, S.R.; Thornton, I.; Webb, J.S.; Purves, J.B.; Milford, B.L. Stream sediment composition: an aid to water quality assessment. *Water Air Soil Pollut* 3: 321-325; 1974.
- Badri, M.A.; Aston, S.R. Observations on heavy metal geochemical associations in polluted and non-polluted estuarine sediments. *Environ Pollut (Series B)* 6(3):181-193; 1983.
- Bailey, K. Beyond functionalism. *British J of Sociol*

- 35(1):1-18; 1984.
- Barrett, W. Irrational man. Garden City, NY: Doubleday & Co., Inc.; 1958.
- Bayles, M.D. Famine or food: sacrificing for future or present generations. In: Partridge, E. ed. Responsibilities to Future Generations. Buffalo, NY: Prometheus; 1981: pp. 239-245.
- Beauvoir, S. de. The ethics of ambiguity. New York: Philosophical Library; 1948. Frechtman, B., trans.
- Bertalanffy, L. von. The quest for systems philosophy. *Metaphilos* 3(2): 142-145; 1972.
- Bertalanffy, L. von. General system theory. In: Demerath, N.J., III; Peterson, R.A., eds. System, change and conflict. New York: The Free Press; 1967: pp. 115-129.
- Blackburn, T.R.; Cornwell, J.C.; Fogg, T.R. Mercury and zinc in the sediments of Seneca Lake, Seneca River, and Keuka Outlet, New York. *J Great Lakes Res* 6(1): 68-75; 1980.
- Bloomgarden, K. Managing the environment: the public's view. *Publ Opinion* Feb/Mar: 47-51; 1983.
- Boulding, K. The economics of the coming spaceship Earth. In: Partridge, E., ed. Responsibilities to future generations. Buffalo, NY: Prometheus; 1981: p. 217.
- Bower, P.M.; Simpson, H.J.; Williams, S.C.; Hui Li, Y. Heavy metals in the sediments of Foundry Cove,

- Cold Spring, New York. *Environ Sci Technol* 12(6): 683-687; 1978.
- Bowman, L.S. Public opinion and the environment. *Environ Behav* 9: 385-411; 1977. Taken from: *Environ Behav* 15(5): 615-645; 1983.
- Box, G.E.P.; Hunter, W.G.; Hunter, J.S. *Statistics for experimenters*. New York: John Wiley & Sons; 1978.
- Bradley, S.B.; Lewin, J. Transport of heavy metals on suspended sediments under high flow conditions in a mineralised region of Wales. *Environ Pollut (Series B)* 4: 257-267; 1982.
- Bugenyi, F.W.B. Copper pollution studies in Lakes George and Edward, Uganda: the distribution of Cu, Cd and Fe in the water and sediments. *Environ Pollut (Series B)* 3: 129-138; 1982.
- Callahan, D. Ethics and population limitation. In: Shrader-Frechette, K.S., ed. *Environmental ethics*. Pacific Grove, CA: The Boxwood Press; 1983: pp. 253-267.
- Caldwell, L.K. In: Miller, G.T. *Living in the environment: concepts, problems, and alternatives*. Belmont, CA: Wadsworth Publishing; 1975.
- Callicott, J.B. Elements of an environmental ethic: moral considerability and the biotic community. *Env Eth* 1(1): 71-81; 1979. Taken from: *Env Eth* 7(1): 75-79; 1985.
- Campbell, D.T. "Downward causation" in hierarchically organized biological systems. Taken from: *Philos of*

- Science 51: 44-63; 1984.
- Care, N.S. Future generations and the motivation problem. *Env Eth* 4(3): 195-213; 1982.
- Cave, G.P. Animals, Heidegger, and the right to life. *Env Eth* 4(3): 249-254; 1982.
- Castell, A. The self in philosophy. New York: The Macmillan Company; 1966.
- Childress, J.F. Appeals to conscience. *Ethics* 89: 315-335; 1979.
- Clements, C.D. Stasis: the unnatural value. *Ethics* 86: 136-144; 1976.
- Cline, J.T.; Chambers, R.L. Spatial and temporal distribution of heavy metals in lake sediments near Sleeping Bear Point, Michigan. *J Sediment Petrol* 44 (2): 716-727; 1977.
- Cohen, L.; Holliday, M. Statistics for social scientists. London: Harper & Row, Publishers; 1982.
- Collingwood, R.G. The idea of nature. New York: Oxford University Press; 1960.
- Compton, J.J. Natural science and the experience of nature. In: Edie, J., ed. *Phenomenology in America*. Chicago: Quadrangle Books; 1967: pp. 80-95.
- Copp, D. II. Collective actions and secondary actions. *Amer Philos Quart* 16(3): 177-186; 1979.
- Cormick, G.W.; Patton, L.K. Environmental mediation: defining the process through experience.

- In: Lake, L.M., ed. *The Search for Consensus*.
Boulder, CO: Westview Press; 1980: pp. 76-97.
- Costantini, E.; Hanf, K. A study of elite
perceptions, backgrounds, and attitudes. *Environ Behav*
4: 209-242; 1972.
- Cox, S.J.B. No tragedy on the commons. *Env Eth* 7(1):
49-61; 1985.
- CRC Basic statistical tables. Beyer, W.H., ed. Cleveland:
The Chemical Rubber Co.; 1971.
- Crowe, B.L. The tragedy of the commons revisited. In:
Hardin, G.; Baden, J., eds. *Managing the commons*.
San Francisco: W.H. Freeman and Co; 1977: pp. 53-65.
- Currents. *Environ Sci Technol* 17(2): 65A; 1983.
- Cutter, S.C. Community concern for pollution: social
and environmental influences. *Environ Behav* 13(1):
105-124; 1981.
- Dabelko, D.D. Political aspects of environmental quality.
Environ Behav 13(2): 225-238; 1981.
- Dahrendorf, R. Out of utopia. In: Demerath, N.J., III;
Peterson, R.A., eds. *System, change and conflict*.
New York: The Free Press; 1967: pp. 465-480.
- Delattre, E. Responsibilities and future persons. In:
Partridge, E., ed. *Responsibilities to future
generations*. Buffalo, NY: Prometheus; 1981: p. 205.
- Dillman, D.A. Mail and other self-administered
questionnaires. In: Rossi, P.H.; Wright, J.D.;

- Anderson, A.B., eds. Handbook of survey research. New York: Academic Press; 1983: pp. 359-377.
- Downs, A. Up and down with ecology-- the issue-attention cycle. Publ Interest No. 28: 38-51; 1972. Taken from: Environ 24(4): 14-34; 1982.
- Dubos, R. Nature does not always know best. In: Miller, G.T. Living in the environment: concepts, problems, and alternatives. Belmont, CA: Wadsworth Publishing; 1975: pp. 39-40.
- Edelman, M. Politics as symbolic action: mass arousal and quiescence. Chicago: Markham; 1971. Taken from: Environ Behav 13(2): 225-238; 1981.
- Eisenberg, M. Rehumanizing university teaching. Internat Forum Logotherapy 8(1): 44-46; 1985.
- Elbert, D. Poll: Iowans worry about pollution. The Des Moines Register. 1984 June 24: 1B (col. 6), 2B (col. 1, 2, and 3).
- Evans, R. EPA to check 3 streams for pollution. The Des Moines Register. 1981 Jul. 31: 3A (col. 1).
- Federal Register/EPA. Water quality criteria documents. Available from: Washington, D.C. 1980 Nov. 28. pp. 79318-79379.
- Ferre, F. Explanation in science and theology. In: Barbour, I.G., ed. Earth might be fair. Englewood Cliffs, NJ: Prentice-Hall, Inc.; 1972: pp. 14-32.
- Fife, D. Killing the goose. Managing the commons

- Hardin, G.; Baden, J., eds. San Francisco: W.H. Freeman and Co.; 1977: pp. 76-81.
- Firestone Tire and Rubber Company. Building Firestone tires for a nation on wheels. [18 p]; 1983.
- Fitchko, J.; Hutchinson, T.C. A comparative study of heavy metal concentrations in river mouth sediments around the Great Lakes. *J Great Lakes Res* 1(1): 46-78; 1975.
- Frankl, V.E. Reductionism and nihilism. In: Koestler, A.; Smythies, J.R., eds. *Beyond reductionism: new perspectives in the life sciences*. New York: Macmillan; 1969: pp. 396-427.
- French, P.A. V. The corporation as a moral person. *Amer Philos Quart* 16(3): 207-215; 1979.
- Fritsch, A.J. *Environmental ethics*. Garden City, NY: Anchor Press; 1980.
- Gallup Poll, The. Public opinion referendum: relaxed pollution controls. *The Gallup Report* No. 229: 12; 1984 Oct.
- Giere, R. Structure of an organism. *Science* 162: 410; 1968.
- Green, M. The corporation and the community. In: Nader, R.; Green, M.J., eds. *Corporate power in America*. New York: Grossman; 1973: pp. 42-64.
- Hamilton-Taylor, J. Enrichments of zinc, lead, and copper in recent sediments of Windemere, England. *Environ Sci Technol* 13(6): 693-697; 1979.

- Hansen, M.H.; Hurwitz, W.N.; Madow, W.G. Sample survey methods and theory. New York: John Wiley & Sons, Inc.; 1953. 2 vol.
- Hardin, G. Living on a lifeboat. In: Hardin, G.; Baden, J., eds. Managing the commons. San Francisco: W.H. Freeman and Co; 1977: pp. 261-279.
- Hardin, G. Stalking the wild taboo. Los Altos, CA: William Kaufmann, Inc.; 1973.
- Hardin, G. The tragedy of the commons. Science 162: 1243-1248; 1968.
- Hart, H.L.A. Are there any natural rights? Philos Review 64: 175-191; 1955.
- Hartmann, N. Ethics, vol.2: moral values. In: Partridge, E., ed. Responsibilities to future generations. Buffalo, NY: Prometheus; 1981: pp. 209-210.
- Hawkes, H.A. The ecology of waste water treatment. New York: The Macmillan Company; 1963.
- Heberlein, T. A. Norm activation and environmental action: a rejoinder to R.E. Dunlap and K.D. Van Liere. J Social Issues 3: 207-211; 1977.
- Heidegger, M. Poetry, language, thought. New York: Harper & Row; 1971. Hofstadter, A. trans.
- Heidegger, M. Being and time. London: SMC Press; 1962.
- Henning, J.F. Corporate social responsibility: shell game for the seventies? In: Nader, R.; Green, M.J., eds. Corporate power in America. New York: Grossman;

1973: pp. 151-170.

Hield, W. The study of change in social science.

In: Demerath, N.J., III; Peterson, R.A. System, change and conflict. New York: The Free Press; 1967: pp. 251-259.

Hilbert, R.A. Toward an improved understanding of

"role." Theory and Society 10(2): 207-226; 1981.

Hileman, B. Environmental dispute resolution. Environ

Sci Technol 17(4): 165A-168A; 1983.

Hunter, J.V.; Kotalik, T.A. Chemical and biological quality

of treated sewage effluents. In: Sopper, W.E.; Kardos, L.T., eds. Recycling treated municipal wastewater and sludge through forest and cropland. Philadelphia: The Pennsylvania State University Press; 1973: pp. 6-25.

Husserl, E. The Paris Lectures. In: Stewart, D.; Mickunas,

A. Exploring phenomenology. Chicago: American Library Association; 1974.

Iowa Department of Water, Air and Waste Management.

Chapter 61 water quality standards. pp. 1 and 4; 1983.

Iowa Department of Water, Air and Waste Management.

BWMP-- Iowa study: Inductively coupled plasma data-- sediment (mg kg⁻¹) dry weight. [lp]; 1981.

Keeter, S. Problematical pollution polls: validity in

the measurement of public opinion on environment issues.

Pol Methodol 10(3): 267-291; 1984.

Keniston, K. Toward a more humane society. Taken from: Env

- Eth 4(1): 37-47; 1982.
- Klee, R.L. Micro-determinism and the concept of emergence. *Philos of Science* 51: 44-63; 1984.
- Laszlo, E. Introduction to systems philosophy. New York: Harper & Row; 1973.
- Laszlo, E. The case for systems philosophy. *Metaphilos* 3(2): 123-141; 1972.
- Leff, H.L. Experience, environment, and human potentials. New York: Oxford Univ. Press; 1978. Taken from: *Environ Behav* 15(5): 615-645; 1983.
- Leopold, A. A sand county almanac. New York: Ballantine; 1966.
- Lowenthal, D. Research in environmental perception and behavior. *Environ Behav* 4: 333-342; 1972.
- Machlup, F. Equilibrium and disequilibrium: misplaced concreteness and disguised politics. In: Demerath, N.J., III; Peterson, R.A., eds. *System, change and conflict*. New York: The Free Press; 1967: pp. 445-454.
- Mack, E. Natural and contractual rights. *Ethics* 89: 153-159; 1979.
- Maggiotto, M.A.; Bowman, A. Policy orientations and environmental regulation: a case study of Florida's legislators. *Environ Behav* 14(2): 155-170; 1982.
- Mann, D.E. Introduction. In: Mann, D.E. *Environmental policy formation*. Lexington, MA: D.C. Heath and Company; 1981: pp. 1-27.

- Marietta, D.E., Jr. The interrelationship of ecological science and environmental ethics. *Env Eth* 1(3): 195-207; 1982.
- Maxfield, D.; Rodriguez, J.M.; Buettner, M.; Davis, J.; Forbes, L.; Kovacs, R.; Russel, W.; Schultz, L.; Smith, R.; Stanton, J.; Wai, C.M. Heavy metal pollution in the sediments of the Coeur D'Alene River delta. *Environ Pollut* 7: 1-6; 1974.
- May, L. On conscience. *Amer Philos Quart* 20(1): 57-67; 1983.
- McCoy, J.W. Chemical analysis of industrial water. New York: Chemical Publishing Co., Inc.; 1969.
- Milbrath, L.W. Environmental values and beliefs of the general public and leaders in the United States, England and Germany. In: Mann, D.E., ed. *Environmental policy formation*. Lexington, MA: D.C. Heath and Company; 1981: pp. 43-61.
- Miller, A.S. Courts and corporate accountability. In: Nader, R.; Green, M.J., eds. *Corporate power in America*. New York: Grossman; 1973: pp. 198-214.
- Miller, G.T. Living in the environment: concepts, problems, and alternatives. Belmont, CA: Wadsworth Publishing; 1975.
- Mills, C.W. Grand theory. In: Demerath, N.J., III; Peterson, R.A., eds. *System, change and conflict*. New York: The Free Press; 1967: pp. 171-183.

- Monasterio, X.O. Sartre and the existential approach.
Inter Philos Quart 21: 71-82; 1981.
- Nagel, E. The structure of science. New York: Harcourt,
Brace & World; 1961. Taken from: Philos of Science 51:
44-63; 1984.
- Ndiokwere, C.L. An investigation of the heavy metal
content of sediments and algae from the River Niger and
Nigerian Atlantic coastal waters. Environ Pollut (Series
B) 7: 247-254; 1984.
- Noether, G. Introduction to statistics: a fresh approach.
Boston: Houghton Mifflin Co.; 1971.
- Nriagu, J.O.; Wong, H.K.T.; Snodgrass, W.J. Historical
records of metal pollution in sediments of Toronto and
Hamilton harbours. J Great Lakes Res 9(3): 365-373;
1983.
- Oldenquist, A. The possibility of selfishness. Amer
Philos Quart 17(1): 25-33; 1980.
- Oliver, B.G. Heavy metal levels of Ottawa and Rideau River
sediments. Environ Sci Technol 7(2): 135-137; 1973.
- Parsons, T. The social system. In: Demerath, N.J., III;
Peterson, R.A., eds. System, change and conflict. New
York: The Free Press; 1967: pp. 465-480.
- Partridge, E. Why care about the future? In: Partridge, E.,
ed. Responsibilities to future generations. Buffalo, NY:
Prometheus; 1981: pp. 203-220.
- Passmore, J. Man's responsibility for nature. New York:

- Scribner; 1974. Taken from: *Env Eth* 5(2): 99-132; 1983.
- Passmore, J. *Man's responsibility for nature*. New York: Scribner; 1974. Taken from: *Inter Soc Sci J* 395-410; 1982.
- Passmore, J. *Man's responsibility for nature*. In: Partridge, E., ed. *Responsibilities to future generations*. Buffalo, NY: Prometheus; 1981: pp. 207-208.
- Pasternak, K. The accumulation of heavy metals in the bottom sediments of the River Biala Przemsza as an indicator of their spreading by water courses from the centre of the zinc and lead mining and smelting industries. *Acta Hydrobiol* 16(1): 51-63; 1974.
- Pepper, S. *Emergence*. *J of Philos* 23: 241-245; 1926.
- Perkin-Elmer. *Analytical methods for atomic absorption spectrophotometry*. Models 403 and 5000 with background correction and model 290B. Norwalk, CT: Perkin-Elmer Corporation; 1982.
- Perkin-Elmer. *Analytical methods for atomic absorption spectroscopy using the MHS mercury/hydride system*. GmbH, West Germany: Bodenseewerk Perkin-Elmer & Co.; 1981.
- Peter, K.; Whitaker, I. Hutterite perceptions of psychophysiological characteristics. *J Social Biolog Struct* 7(1): 1-8; 1984.
- Pfeiffer, W.C.; Fiszman, M.; Carbonell, N. Fate of chromium in a tributary of the Irajá River, Rio de

- Janero. Environ Pollut (Series B) 1: 117-126; 1980.
- Plumb, R.H., Jr. Procedures for handling and chemical analysis of sediment and water samples. Vicksburg, MS: Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station; 1981: pp. 25-47.
- Polyani, M. Life's irreducible structure. Science 160: 1308-1312; 1968. Taken from: Philos of Science 51: 44-63; 1978.
- Proshansky, H.M. The environmental crisis in human dignity. J Social Issues 39(4): 207-224; 1983.
- Rabitti, S.; Boldrin, A.; Vitturi, L.M. Relationships between surface area and grain size in bottom sediments. J Sediment Petrol 53: 665-667; 1983.
- Revelle, P.; Revelle, C. The environment: issues and choices for society. New York: D. Van Nostrand Company; 1981.
- Richardson, J.M., Jr. Global modelling in the 1980s. Impact of Science on Society 31(4): 401-412; 1981.
- Rippey, B. Sediment-water interactions of Cu, Zn and Pb discharged from a domestic waste water source into a bay of Lough Neagh, Northern Ireland. Environ Pollut (Series B) 3: 199-214; 1982.
- Risser, J.; Gemoules, C. Three Des Moines-area streams 'seriously contaminated.' The Des Moines Register. 1981 Jul. 30: 13A (col. 1, 2, 3, and 4).
- Rolston, H., III. Is there an ecological ethic?

- Ethics 88: 93-108; 1978.
- Roper, B.W. Some things that concern me. Publ Opinion Quart 47: 303-309; 1983.
- Rossmann, R.; Rice, C.P.; Simmons, M.S. The impact of pollutants on the Tittabawassee River, final report, [161 p]; 1983. Prepared for USEPA.
- Rossmann, R.; Seibel, E. Surficial sediment redistribution by wave energy: element-grain size relationships. J Great Lakes Res 3(3-4): 258-262; 1977.
- Rossmann, R. Chemistry of nearshore surficial sediments from southeastern Lake Michigan. Univ. Michigan, Great Lakes Res. Div., Spec. Rpt. No. 57.; 1975.
- Sabatier, P.; Mazmanian; D. The conditions of effective implementation: a guide to accomplishing policy objectives. Policy Anal 5(4): 481-504; 1979.
- Sadovsky, V.N. Problems of a general systems theory as a metatheory. Ratio 16: 33-50; 1974. Taken from: Inter Philos Quart 19: 29-60; 1979.
- Schidrowitz, P.; Dawson, T.R., editors. History of the rubber industry. Cambridge: W. Heffer & Sons Ltd.; 1952.
- Schroeder, H.W. Environmental perception rating scales: a case for simple methods of analysis. Environ Behav 16(5): 573-598; 1984.
- Seidler, M. Problems of systems epistemology. Inter Philos Quart 19: 29-60; 1979.

- Shaw, W.H. Intuition and moral philosophy. *Amer Philos Quart* 17(2): 127-134; 1980.
- Short, T.L. Teleology in nature. *Amer Philos Quart* 20(4): 311-320; 1983.
- Shrader-Frechette, K.S. Environmental responsibility and classical ethical theories. In: Shrader-Frechette, K.S., ed. *Environmental ethics*. Pacific Grove, CA: The Boxwood Press; 1983a: pp. 16-25.
- Shrader-Frechette, K.S. "Frontier ethics" and "lifeboat ethics." In: Shrader-Frechette, K.S., ed. *Environmental ethics*. Pacific Grove, CA: The Boxwood Press; 1983b: pp. 31-44.
- Shrader-Frechette, K.S. Environmental impact assessment and the fallacy of unfinished business. *Env Eth* 4(1): 37-47; 1982.
- Siegel, S. In: Cohen, L.; Holliday, M. *Statistics for social scientists*. London: Harper & Row, Publishers; 1982.
- Singer, M.G. Moral skepticism. A lecture at Marquette University; 1971.
- Sly, P.G. Sedimentology and geochemistry of recent sediments off the mouth of the Niagara River, Lake Ontario. *J Great Lakes Res* 9(2): 134-159; 1983.
- Spooner, B. Ecology in perspective: the human context of ecological research. *Inter Soc Sci J* 395-410; 1982.
- Sterba, J.P. Abortion, distant peoples, and future generations. *J of Philos* 77: 424-440; 1980.

- Sternig, P.J. Finding meaning through existential guilt. *Internat Forum Logotherapy* 7(1): 46-49; 1984.
- Stewart, D.; Mickunas, A. Exploring phenomenology. Chicago: American Library Association; 1974.
- Stewart, T.R.; Dennis, R.L.; Ely, D.W. Citizen participation and judgment in policy analysis: a case study of urban air quality policy. *Policy Sci* 17(1): 67-87; 1984.
- Strauss, D.B. Mediating environmental, energy, and economic tradeoffs: a search for improved tools for coastal zone planning. In: Lake, L.M., ed. *Environmental mediation: the search for consensus*. Boulder, CO: Westview Press; 1980: pp.123-146.
- Suzuki, M.; Yamada, T.; Miyazaki, T.; Kawazoe, K. Sorption and accumulation of cadmium in the sediment of the Tama River. *Water Research* 13: 57-63; 1978.
- Szczepanski, J. Individuality and society. *Impact of Science on Society* 31(4): 461-466; 1981.
- Takashima, H. Logotherapy and Buddhistic thought. *Internat Forum Logotherapy* 8(1): 54-56; 1985.
- Thayer, L. A commentary on Laszlo's "case for systems philosophy." *Metaphilos* 3(2): 146-150; 1972.
- Thomas, W.A. Indicator of environmental quality: an overview. Taken from: *Environ Behav* 13(2): 225-238; 1981.
- Thompson, P.B. Uncertainty arguments in environmental

- issues. *Env Eth* 8(1): 59-75; 1986.
- Tuan, Y. Structuralism, existentialism, and environmental perception. *Environ Behav* 4: 319-331; 1972.
- USDA/ Iowa Agricultural Experiment Station. Soil survey, Polk County, Iowa. Series 1953, No. 9, pp. 7-10, 52-57, 335; 1960.
- USEPA. Unpublished STORET data of trace metals in Des Moines River sediments. Available from: Kansas City, MO; 1981 and 1982.
- USEPA. Unpublished STORET data of trace metals in Wafley and Saylor Creek waters. Available from: Kansas City, MO; 1981.
- USEPA Region V. Guidelines for the pollution classification of Great Lakes harbor sediments. pp. 1-7; 1977. Available from: Chicago, IL.
- USEPA Region VI. Arkansas, Oklahoma, Louisiana, New Mexico, and Texas sediment alert levels. [9p]; 1980. Available from: Dallas, TX.
- Van Liere, K.D.; Dunlap, R.E. Environmental concern: does it make a difference how it's measured? *Environ Behav* 13(6): 651-676; 1981.
- Vivian, C.M.G.; Massie, K.S. Trace metals in waters and sediments of the River Tawe, South Wales, in relation to local sources. *Environ Pollut* 14: 47-61; 1977.
- Warren, L.J. Contamination of sediments by lead, zinc

- and cadmium: a review. *Environ Pollut (Series B)* 2: 401-436; 1981.
- Watt's departure is helping Reagan. *Bus Week* p. 14; 1983 Dec. 19.
- Weiss, P.A. The living system: determinism stratified. In: Koestler, A.; Smythies, J.R., eds. *Beyond reductionism: new perspectives in the life sciences*. New York: Macmillan; 1969: pp. 396-427.
- Wetzel, R.G. *Limnology*. Philadelphia: W.B. Saunders Co; 1975.
- Wirth, A.G. Education for a synthetic planet: logotherapy and learning for responsibility. *Internat Forum Logotherapy* 8(1): 34-40; 1985.
- Wysor, M.S. Comparing college students' environmental perceptions and attitudes. *Environ Behav* 15(5): 615-645; 1983.
- Young, R. Autonomy and the inner self. *Amer Philos Quart* 17(1): 35-43; 1980.
- Zimmerman, M.E. Toward a Heideggerian ethos for radical environmentalism. *Env Eth* 5(2): 99-132; 1983.
- ZoBell, C.E. Studies of redox potential of marine sediments. *Bull Am Assoc Petrol Geol* 30: 477-513; 1946.

APPENDIX: COVER LETTER AND QUESTIONNAIRE
SENT TO SOME OF THE SAYLOR AND
CROCKER TOWNSHIP RESPONDENTS

May 13, 1985

Dear Des Moines Area Worker:

I am a graduate student in the biology department at Drake University. Enclosed is a survey that is a part of my master's thesis work. I am interested in the environmental sciences, and I hope my thesis work will aid me in getting a job in this area. It is of the utmost importance that you or another adult at this address fill out and return the survey. I cannot complete my thesis work without your response. Only 300 surveys will be sent out, so I am counting on you to respond.

The results of this survey will be strictly confidential. This is to preserve your anonymity, and provide an unbiased assessment of the results. If there are questions that you do not feel comfortable about answering, skip them and complete the rest of the survey. Please send your completed survey by JUNE 3, 1985 in the envelope provided. If need be, send it a day or two later. It is most important that I actually receive your response.

Thank you so very much for the time you have taken to complete this survey and help me in my education.

Sincerely,

Janice Pappas

SURVEY, 1985
DRAKE UNIVERSITY

AGE _____
 SEX _____
 RACE _____
 MARITAL STATUS _____
 INCOME LEVEL \$ _____ (annual salary)
 EDUCATION LEVEL _____ (type of school
 last attended)

General Instructions:

If you work in Saylor Township, answer the questions about Wafley Creek. If you work in Crocker Township, answer the questions about Saylor Creek. Please feel free to write as much as you want to answer the questions.

Answer either (a) or (b):

1. (a). Do you live near Saylor Creek?
 If so, approximately how many miles? _____
- (b). Do you live near Wafley Creek?
 If so, approximately how many miles? _____

2. (a). Do you feel that Saylor Creek is polluted?
 If you answered yes, what is the nature of this pollution?

- (b). Do you feel that Wafley Creek is polluted?
 If you answered yes, what is the nature of this pollution?

3. (a). To your knowledge, is Ankeny Sewage Treatment Plant polluting Saylor Creek?

If you answered yes, what do you think is the major source?

- (b). To your knowledge, is Firestone Tire and Rubber Company polluting Wafley Creek?

If you answered yes, what do you think is the major source?

4. (a). How far do you work from Saylor Creek?

Approximately _____ miles

- (b). How far do you work from Wafley Creek?

Approximately _____ miles

5. (a). Do you feel that there is a health hazard to yourself from Saylor Creek?

(b). Do you feel that there is a health hazard to yourself from Wafley Creek?

6. (a). Do you feel that there may be a pollution or health threat to future generations from Saylor Creek?

(b). Do you feel that there may be a pollution or health threat to future generations from Wafley Creek?

Answer question 7:

7. Do you feel that you have an obligation to provide a healthy environment for future generations?

Answer questions 8, 9, and 10 by numbering your responses in the following way:

- 1 = most responsible
- 2 = second most responsible
- 3 = third most responsible
- 4 = fourth most responsible
- 5 = least responsible

Answer either (a) or (b):

8. (a). If there is pollution in Saylor Creek, who do you feel should clean up the pollution?

- _____ government (federal, state, or local)
- _____ corporation or business
- _____ community
- _____ individuals
- _____ other

- (b). If there is pollution in Wafley Creek, who do you feel should clean up the pollution?

- _____ government (federal, state, or local)
- _____ corporation or business
- _____ community
- _____ individuals
- _____ other

9. (a). Who do you feel is responsible for assuring that Saylor Creek remains clean?

_____ government (federal, state, or local)
 _____ corporation or business
 _____ community
 _____ individuals
 _____ other

- (b). Who do you feel is responsible for assuring that Wafley Creek remains clean?

_____ government (federal, state, or local)
 _____ corporation or business
 _____ community
 _____ individuals
 _____ other

10. (a). If there is pollution in Saylor Creek, who do you feel should pay for clean up of the pollution?

_____ government (federal, state, or local)
 _____ corporation or business
 _____ community
 _____ individuals
 _____ other

- (b). If there is pollution in Wafley Creek, who do you feel should pay for clean up of the pollution?

_____ government (federal, state, or local)
 _____ corporation or business
 _____ community
 _____ individuals
 _____ other

11. (a). If there is pollution in Saylor Creek, would you be willing to pay your fair share for clean up of the pollution?

(b). If there is pollution in Wafley Creek, would you be willing to pay your fair share for clean up of the pollution?