6-1971

Measuring the Intangible Values of Natural Streams, Part I

Digital Object Identifier: https://doi.org/10.13023/kwrri.rr.40

John A. Dearinger
University of Kentucky

George M. Woolwine
University of Kentucky

Research Report Number 40

MEASURING THE INTANGIBLE VALUES OF NATURAL STREAMS, PART I

Application of the Uniqueness Concept

By

John A. Dearinger
Principal Investigator

and

George M. Woolwine
Research Assistant

University of Kentucky Water Resources Institute
Lexington, Kentucky

Project Number B-015-KY
Agreement Number 14-31-0001-3086
July 1969 - June 1971

June 1971

The work upon which this report is based was supported by funds provided by the United States Department of the Interior, Office of Water Resources Research, as authorized under the Water Resources Research Act of 1964.

PREFACE

"Measuring the Intangible Values of Natural Streams; Part I, Application of the Uniqueness Concept" (OWRR, B-015-KY) is the first of two reports on a project sponsored by the University of Kentucky Water Resources Institute and supported by funds provided by the United States Department of the Interior, Office of Water Resources Research, as authorized under the Water Resources Research Act of 1964.

Work on Part I was started in September 1969 and was completed in February 1971 by one graduate assistant and five part-time, undergraduate students. Work on Part II started in April 1970 and is continuing. Completion date for the entire project is June 30, 1972.

Impetus for originating the project stemmed from the need for improved planning and decision-making procedures in engineering or developmental projects affecting small natural streams and their watersheds. The major decision-making tool for such projects has long been the Benefit-Cost ratio. This procedure affords little or no consideration of the esthetic values or possible intangible benefits that exist in the affected area. Consequently, small streams and other naturalistic areas are often damaged or destroyed with little or no thought being given to their potential for other uses.

It was concluded from this part of the study that; the "uniqueness ratio" could successfully be used to evaluate relative uniqueness within a group of streams, that the uniqueness concept provided a way of objectively comparing the physical and esthetic attributes of various streams and that a measure of uniqueness could and should be considered in Benefit-Cost formulations.

The methodology that evolved from the study was applied to fifty-eight streams located throughout the state of Kentucky.

Reader comments or criticisms on the problem, the described procedures or the findings presented should be directed to the principal investigator.

ACKNOWLEDGMENTS

Thanks are due to:

Dr. Edward Foree and Dr. Robert A. Lauderdale, Department of Civil Engineering, University of Kentucky for permission to use and their assistance in using the Civil Engineering sanitation laboratory.

Dr. Robert A. Kuehne and Mrs. Chris Sperka, Department of Zoology, University of Kentucky for their assistance in identifying the invertebrate species collected in the stream kick samples.

Mr. Doug Adkins, Mr. Jim Newsom, Mr. Bruce Waespe, and Mr. Charles Scroggin, engineering students, University of Kentucky, for their help in compiling the watershed measurements for the study streams.

Mr. Richard Moreno, student assistant, for his assistance in gathering and recording the field data.

The Commonwealth of Kentucky, Department of Natural Resources, Division of Water and the U.S. Department of Agriculture, Soil Conservation Service for the use of their facilities and information sources in the preparation of the thesis.

Mr. James Coyle, Physical Plant Division, University of Kentucky for his help in reproducing the extensive tables and figures.

Miss Pat Miller and Miss Nancy Crewe, secretaries for the Water Resources Institute of the University of Kentucky, for their help and patience during the reproduction of this publication.

ABSTRACT

The purpose of this study was to apply the "uniqueness concept" to the quantification of the intangible values of natural streams. The methodology is based on procedures developed by Luna B. Leopold and Maria O. Marchand of the U.S. Geological Survey. It involves the evaluation of a set of characteristics or factors for selected stream sites. Each factor is rated for each site on a numerical scale indicative of the range of possible "values" for that factor. An "uniqueness ratio" (the reciprocal of the number of stream sites sharing a given category rating) is then computed for each stream for each factor in the set. Summing the "uniqueness ratios" for all the factors for a given stream yields a "total uniqueness ratio". Those streams with the highest "total uniqueness ratio" are considered to be the most unique. The present study utilized an inventory of fifty-four factors which were evaluated for each study stream. The inventory was divided into five factor groups: Physical Measures, Land Use Measures, Water Quality Measures, Disvalues and Esthetic Impression Measures.

Two types of streams were studied: Preference streams and Random streams. Sixteen Preference streams were selected from lists of wild, scenic and recreational streams prepared by two state agencies. Forty-two Random streams were selected, using a random number table, from a small watershed inventory prepared by the U.S. Soil Conservation Service. The sampling process insured that streams be selected from each of the eight physiographic regions of Kentucky. Thus, a total of fifty-eight streams were studied.

Conclusions reached were:

(1) The "uniqueness ratio" concept can successfully be used to evaluate "relative uniqueness" within a group of streams.

(2) Higher values of the "total uniqueness ratio" were obtained for those streams that were in "bad" condition or that had been abused by man's activities than for those streams that were of relatively high quality.

(3) Some of the streams ranking highest in "total uniqueness" were those situated in highly developed areas, an indication of the essentially rural nature of the state of Kentucky and the effects of development and urbanization on the environmental quality of small watersheds.

(4) Streams located in the Eastern Coal Field generally represented the most natural, rugged, and esthetic streams of the study.

(5) The streams located in the Western Coal Field generally represented the most highly exploited and least esthetic streams of the study.

TABLE OF CONTENTS

		Page
PREFACE		iii
ABSTRACT		v
LIST OF TABLES		ix
LIST OF ILLUSTRATIONS		xi
CHAPTER		
I.	INTRODUCTION	1
	Background	1
	Benefit-Cost Ratio	2
	Related Research	4
	Uniqueness Concept	9
II.	PURPOSE AND SCOPE	12
III.	PROCEDURES	19
	Watershed Factors	20
	Physical	20
	Cultural	26
	Transect Factors	28
	Physical	28
	Water Quality	30
	Aquatic Habitat	34
	Terrestial Habitat	37
	Human Use and Interest	37
IV.	RESULTS AND ANALYSES	42
	Preliminary Work	42
	Correlations	43
	Eliminations	43
	Factor Analysis	46

Application of Methodology 56
Analysis - Uniqueness Rankings 56
Preference Streams 62
Random Streams 65
All Streams 69
Graphical Analysis - Uniqueness Groupings. . . . 71
Preference Streams 72
Random Streams. 73
All Streams 76

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS . 79

Summary. 79
Conclusions 80
Recommendations for Further Research 81

REFERENCES 83

BIBLIOGRAPHY

LIST OF TABLES

Table		Page
2.1	Study Streams	16
3.1	Original Factors by Groups and Subgroups	21
4.1	Original Evaluative Factors - Correlations ($r \geq \|0.65\|$)	44
4.2	Varimax Factor Loadings - Revised List of Evaluative Factors	47
4.3	Revised Factor List	49
4.4	Varimax Factor Loadings - All Study Streams	53
4.5	Preference Streams, Category Ratings on Each Factor	57
4.6	Random Streams, Category Ratings on Each Factor	58
4.7	Number of Streams in Each Category	59
4.8	Preference Streams, Uniqueness Ratios	60
4.9	Random Streams, Uniqueness Ratios	61
4.10	Ranking of Preference Streams Based on Groups of Factors and All Factors	63
4.11	Ranking of Random Streams Based on Groups of Factors and All Factors	66
4.12	Ranking of All Streams Based on Groups of Factors and All Factors	70

LIST OF ILLUSTRATIONS

Figure		Page
2.1	Map of Kentucky Showing Study Stream Locations	14
2.2	Map of Kentucky Showing Physiographic Regions	15
4.1	Graphical Representation of "Relative Uniqueness" for Preference Streams	73
4.2	Graphical Representation of "Relative Uniqueness" for Random Streams	75
4.3	Graphical Representation of "Relative Uniqueness" for All Streams	77

CHAPTER I

INTRODUCTION

For many years engineering decisions have been based primarily on a dollar and cents evaluation of the efficiency and economy of a project. The alternative site or design yielding the greatest benefits at the lowest cost is usually selected regardless of the projects' effects on the culture, esthetics, or ecology of the surrounding area. As a result, many desirable, rural and sub-urban locations have been blighted by the noise, dirt, and confusion of a new freeway or jet port and a number of stream valleys and other natural areas have been destroyed by impoundments, urbanization, and pollution. Today's society, viewing its crowded, deteriorating environment, is demanding that esthetic quality, cultural values, recreational potential, ecological consequences and other intangibles (or "unmeasurables") be considered, along with economics, in the decision-making process.

Indications of the American public's concern about the effects of its works are evidenced by many recent controversies over proposed dams, roads, airports, pipe and power lines, canals, etc. This new public awareness and the pressures created by it through various organizations and individuals, have brought about delays, postponement, relocation, and outright cancellation of some "economically feasible" projects. Construction of the Cross-Florida Barge Canal, which threatened the existence of the wild, semi-tropical Oklawaha River, has been halted by presidential decree (26).[1] The proposed

---

[1] Underlined numbers in parentheses refer to the List of References at the end of this report.

site for the Dade County, Florida International Airport has been abandoned because of possible damage to Everglades National Park. Similar conflicts are brewing in other parts of the country where large airports are being contemplated. In Kentucky a Corps of Engineers dam, proposed for the Red River in Powell, Wolfe, and Menifee counties, has been relocated further downstream to preserve the historic and ecologically unique Red River Gorge.

Consideration of intangible values is particularly significant in the case of small natural streams and their watersheds. Seldom can the protection or preservation of such areas be justified on economic grounds alone. Dollarwise, the "highest and best use" of a small stream will nearly always be to dam it, channelize it, pipe it, or pollute it.

Because of the delicate ecological balance that exists in small watersheds, every change in land use has an effect which may range from minor detriment to total destruction. Identification and evaluation of the intangibles peculiar to small watersheds are necessary if good decisions are to be made about the fate of these areas.

The Benefit-Cost Ratio

Engineering decision-making follows (or should follow) a logical sequence of goal-setting, data-gathering, alternative-evaluating, etc. like that outlined by Winfrey (34). If intangible values are to be included, they must be subsumed in the calculation of the "figure of merit", the number that expresses the relative desirability of one alternative project, plan or design with respect to the others being considered.

The most widely used method of comparing alternatives is the Benefit-Cost Ratio. This method relates the equivalent uniform annual benefit (present worth) to the equivalent uniform annual cost (present worth). Any alternative that has a benefit/cost ratio greater than 1.0 is considered to be economically feasible, and the alternative that has the highest incremental B/C ratio is indicated as the preferred solution. The classic legal reference to benefit cost analysis is in the United States Flood Control Act of June 22, 1936 "... if the benefits to whomsoever they may accure are in excess of the estimates costs..." (34). Since this legislation became effective, the Corps of Engineers, and other governmental agencies have extensively used the B/C ratio to justify many types of public works projects.

The validity of the B/C analysis as a decision making tool depends upon the reliability of the estimates of benefits and costs. Since project costs are easier to estimate than are benefits, the reliability of the cost figures is greater. The usual and rather natural tendency is for agency planners to over-estimate the benefits and under-estimate the costs. This built-in fallacy of the B/C ratio has, after subsequent evaluation, shown some past decisions based upon it to be highly suspect.

The denominator of the B/C ratio includes all public financial costs such as initial investment and after-installation costs. Initial investment includes construction costs, engineering and administration cost, right of way costs, the cost of relocating facilities and other minor costs. After-installation costs are the continuing costs of operation, maintenance and replacement.

The numerator of the B/C ratio consists of the algebraic sum of all values of beneficial and adverse project consequences, (both tangible and intangible) to private parties. Tangible benefits result from consequences to private parties which can be assigned a monetary value. These benefits can be broken down into four groups; primary, secondary, employment and public. Examples of primary benefits include; the value of the goods and services produced by the project, reduction of physical damage due to flood water, and increased land production made possible by the project. Secondary benefits indicate the value added to activities influenced by the project through economic rather than technological causes. Employment benefits indicate the economic value gained from the increased employment opportunity from new jobs created to construct, maintain, or operate the project. Public benefits are realized in achievement of goals other than economic efficiency and thus can be evaluated only by means of a value judgment on the relative desirability of the goal (6).

Intangible benefits are amenities or consequences which cannot be assigned a monetary value, for example; improved environmental conditions, preservation or destruction of old neighborhoods, natural and scenic areas, places of historical or scientific interest, etc. It is with the measurement of the value of these intangible benefits or consequences, as they accrue in small watersheds, that the present study is concerned.

RELATED RESEARCH

Impetus was given to research on the evaluation of intangibles by passage of the Wilderness Act of 1964 (27) and the Wild and Scenic Rivers Act of 1968 (28). These laws require that a good case be made for each wild area or river proposed for inclusion in the Wilderness or Wild River systems. It is obvious that the establishment of such a case must include consideration of some values not previously thought of as measurable and some probably not thought of at all.

The afore-mentioned public concern about the environment (plus the availability of Federal money) has also helped to inspire various governmental agencies, academicians and private consultants to think, research and write about these matters. The result has been a kind of semi-controlled, inter-disciplinary effort that has yielded some apparently significant approaches and methodologies. The following review of these research efforts is restricted generally to studies about naturalistic streams and their watersheds.

Craighead and Craighead (3): This 1962 study proposed that the nation's waterways be inventoried and categorized into four classes: wild rivers, semi-wild rivers, semi-harnessed - developed rivers, and harnessed - developed rivers. Twelve to fourteen criteria were suggested for use in evaluating a given stream's potential for fishing, boating, and hunting. An "environmental effect" criterion was also included as an expression of the scenic or esthetic quality of the stream and its surroundings.

Morisawa and Murie (12): The aim of this work was to develop data-gathering methods for evaluating the environment of natural rivers. Two rivers; the Little Miami in Ohio and the Green in Wyoming were studied in detail. A number of transects were observed on each stream to supply the data needed to evaluate the hydrologic, geologic, biotic, esthetic and cultural aspects of the rivers.

Water Resources Engineers, Inc. (32): This recently completed research yielded two economics-oriented methodologies for valuing wild rivers:

(1) The "benefits foregone-subjective decision" method and

(2) The "non-monetary expression of benefits" method

The purpose of these methods is to guide judgement regarding the most advantageous degree of development for river basins especially those which are currently undeveloped. The Skagit River in Washington was used as a test case.

Water Resources Research Institute, University of Idaho (18): Currently underway at this Institute is a project on the evaluation of wild and scenic rivers. This study seeks to establish criteria which can be used to identify and estimate economic, aesthetic, social, and other values connected with selected study rivers. The methodology involves fourteen subprojects each of which is concerned with a river-related activity. These subprojects are being investigated independently and will later be combined to develop economic models with which to evaluate alternative uses of resources in the river basins. Both objective and subjective data will be utilized in the methodology.

Dearinger, Harper, and James (4): This study attempted to evaluate the aesthetic and recreational potential of small suburban streams and their watersheds. Research was limited to naturalistic streams with drainage areas under 100 square miles and located within 25 miles of a city. A methodology based on a rating procedure originated by the Soil Conservation Service (29), and the principles or concepts of terrain analysis, landscape planning, value judgment philosophy, and the economics of outdoor recreation was developed and applied in detail to several creeks in the Lexington, Kentucky area.

The methodology was made up at two major phases; inventory, and analysis and evaluation. The inventory phase included the collection and presentation of pertinent data on the watershed and the adjacent urban area.

The inventory data was then used as input to an evaluation procedure designed to establish a watershed's potential for thirteen different recreational activities and the establishment of three types of areas; scenic, natural, and historic.

Whitman (33): This research, sponsored by the Baltimore District Corps of Engineers, investigated the uses of small urban river valleys. A methodology was developed for rating quality of "natural environment" in urban areas and was applied to stream valleys in Milwaukee and Washington, D. C. The degree of environmental quality was evaluated using seven subjective factors thought to be appropriate to urban stream valleys. The rating factors considered two aspects of the natural environment: (1) what is actually there and (2) what is seen by the park user. The factors were evaluated subjectively during field trips to each site.

Krumholz and Neff (8): This is a current study of the biological, social, and economic changes that occur when an impoundment is constructed within a watershed. Detailed physical, chemical, and biological pre-impoundment information is being collected at sampling stations in the Salt River Basin of Kentucky, site of the proposed Taylorsville Dam (Corps of Engineers). The data-collection stations are located so they can be used to check pre-and post-impoundment conditions. The data collected at these stations will enable the investigators to appraise any changes that occur in the river ecosystem during the construction of the dam and the flooding of the valley. Interviews have also been conducted with residents in the affected area to evaluate the possible social and economic impacts of the reservoir construction.

Leopold and Marchand (11): This first paper on the "uniqueness" concept describes an attempt to quantify the aesthetic worth of a "riverscape" (a contraction of "river landscape"). It is a preliminary approach to a numerical description of the riverscape using social or aesthetically related measures rather than monetary ones. In the study, test sites were observed on twenty-four different streams in northern California. These sites were evaluated using a twenty-eight factor inventory composed of three factor groups: (1) physical and chemical, (2) biological, and (3) human use and interest. Each factor for every stream was assigned a category rating ranging from one to five depending upon the respective measurement or evaluation. The "uniqueness ratio" for each stream factor was then computed by taking the reciprocal of the number of stream sites sharing the same category rating. For example; if six streams fell into category rating "one" for stream width, each of these streams "uniqueness ratio" for that particular factor would be 1/6 or 0.16. Adding the "uniqueness ratios" for all the factors for a given stream site yielded a "total uniqueness ratio". This "total uniqueness ratio" computation was done for every stream site; the results were compared and the streams were ranked accordingly. Those sites with the highest "total uniqueness ratio" were considered the most unique. Subtotal uniqueness ratios were also computed for each stream for each of the three factor groups.

To quote from Leopold: "Unique is a word meaning without like or equal. For things society judges to be desirable, relative scarcity or uniqueness increases its value to society." In this study the relative good or bad value of uniqueness was not considered. Its purpose was to devise a quantitative method for determining a uniqueness scale. As a result, the "total" uniqueness ratio" is simply a method for quantifying uniqueness. It does not indicate whether a stream is unique in a positive - negative or good - bad sense.

In this first study it was concluded that some kind of classification of scarcity or uniqueness was feasible and might be applied in the decision-making of river basin development.

Leopold and Marchand noted several weaknesses in their method and made some suggestions about its future use:

(1) The list of inventoried factors may have been too dissimiliar, that is some of them were easier to measure or calculate objectively than others.

(2) The inventory of factors may have been incomplete or should have been regrouped to get more meaningful results.

(3) The inventory factors should be as objective as possible to minimize the effect of personal bias or preference in the quantitative rating procedure.

(4) The study considered neither the "relative desirability" or good versus bad of the streams uniqueness nor the effects of other possible combinations of factors.

(5) Adding the unweighted "uniqueness ratios" of the streams tended to average out any significance among them; further study should be directed toward the effects of averaging.

The paper concluded that measurement of the aesthetic reaction to riverscape should involve two separate stages. The first stage should be a quantitative or numerical description of aesthetic worth such as the "uniqueness ratio." The second stage should be a separate psychometrical method for public preference determination similar to those suggested by the work of Sonnenfeld (20), Sargent (17), Shafer (19), Wohlwill (35) and others.

Leopold (10): Leopold's second paper describes an application of the uniqueness concept to the Hell's Canyon area of the Snake River and eleven other streams in central Idaho. The purpose of this paper was to quantify and evaluate the esthetic features of the Hell's Canyon area to see if it possessed, in its present natural condition, any unique or scarce qualities not found in the other stream sites. A large hydropower dam has long been proposed for Hell's Canyon. It was hoped that an "uniqueness" evaluation of this area could be applied in the planning and decision-making phase of the project.

For the Hell's Canyon application, Leopold increased the number of factors to forty-six and rearranged the factor groupings. The forty-six factors were evaluated at each of the twelve stream sites and a "total uniqueness ratio" was computed for each site.

Selected groups of factors were chosen from the inventory to emphasize specific aspects of the study streams and their watersheds. A semi-graphical procedure was developed relating scales of "valley character", "scenic outlook", urbanization, etc. The procedure tended to isolate those streams that were "unique" either in a "bad" sense or a "good" sense. The Hell's Canyon of the Snake River was the most "uniquely good" under this system. A polluted section of the Salmon River, however, had the highest total uniqueness ratio.

Another series of computations were made comparing the Hell's Canyon area with four famous National Park streams. The results showed that the Hell's Canyon area ranked second only to the Grand Canyon section of the Colorado River in esthetic beauty and environmental quality.

A general conclusion was that: "The result of the data collection and analysis indicates that it is possible to set up a list of factors that influence the esthetic nature of a given location. The factors can be considered all together in the case of the total uniqueness ratio or they can be selected and used in various combinations to express certain aspects of a landscape's characteristics."

THE UNIQUENESS CONCEPT

The philosophy, procedure, analysis and methodological critiques presented in the two Leopold papers and the results of a previous OWRR project in this area (4) form the principal guidelines for the first phase of the present project and the work with which this report is specifically concerned. The general hypothesis is that value is related to scarcity and that unique things are, by definition, scarce. Therefore, if uniqueness can be measured, an expression of value can be obtained.

The relationship of value to uniqueness is fairly well documented in the literature of Economics. For example, the Law of Scarcity (16) states "What to produce, how, and for whom would not be problems if resources were unlimited: if an infinite amount of every good could be produced, or if human wants were fully satisfied, it would not then matter if too much of any particular good were produced. Nor would it matter if labor and materials were combined unwisely. Since everyone could have as much as he pleased, it would not matter how goods and incomes were distributed among different individuals and families."

Paraphrasing this law in the present context; what project to build, where to construct it, and for whom it is to be built would not be problems if natural resources, wildlife, and unique, natural areas were unlimited. Unfortunately, however, the supply of these resources is limited and is decreasing every year.

Another relevant concept pertaining to scarcity has been introduced by Krutilla (9) as the "option demand".

"This demand is characterized as a willingness to pay for retaining an option to use an area or facility that would be difficult or impossible to replace and for which no close substitute is available. Moreover, such a demand may exist even though there is no intention to use the area or facility in question and the option may never be exercised."[1]

Krutilla also recognized the need to modify or replace the present B/C ratio procedure and to establish a new methodology on which to base decision-making. He proposed several interim measures to be implemented by conservationists and government agencies until this new methodology could be devised. One of his proposals advocates setting aside small acreages

[1] Emphasis added.

of unique lands as a "minimum reserve" to avoid the possibility of the total destruction of unique, natural landscapes. He advocated similar minimum reserves for aquatic environment and outdoor recreational areas. These are, essentially, the measures now being undertaken by private groups such as the Nature Conservancy and the Audubon Society and by state and Federal governments through the Wilderness, Wild River, Outdoor Recreation Acts, and similar legislation.

Phase One of this project is related to Leopold's first "aspect" of the aesthetic reaction to riverscapes, that involving the further application, development and analysis of the uniqueness ratio procedure. Phase Two will be concerned with the second aspect; the reactions and preferences of the viewer of the riverscape.

CHAPTER II

PURPOSE AND SCOPE

The purposes of this phase of the project are:

(1) To identify, measure, and evaluate the significance of those characteristics of a natural stream that determine its relative uniqueness in a group of such streams.

(2) To isolate the factors underlying the concept of uniqueness and to develop from these factors a simplified, efficient method of estimating a uniqueness measure or rating for any stream.

(3) To apply the procedure to a test case and evaluate the results.

The research described in this report was limited to Kentucky streams of fifth order (5) or less, with a maximum drainage area of 250 square miles.

The streams studied in this project are of two types. The first type, the "preference streams" were selected from lists compiled by the developers of the Kentucky Outdoor Recreation Plan (21, 22) and the Kentucky Wild Rivers Commission (1). The sixteen streams picked from these lists include natural, relatively undisturbed streams and watersheds within the state.

The second type, "random streams", were chosen from a small watershed inventory prepared by the U.S. Soil Conservation Service (30). After eliminating from consideration the sixteen preference streams and all other streams on which impoundments were currently planned or under construction, a ten percent sample of streams was drawn, by means of a random number table, from the total remaining number of streams in each of the eight physiographic regions of the state. This procedure yielded a total of forty-two streams with a random distribution over each physiographic region except one, the Jackson Purchase.[1] In all, a total of fifty-eight streams were selected. The location of the two types of study streams and the boundaries of the physiographic regions of Kentucky are shown on Figures 2.1 and 2.2. The study streams are also listed by type and location and assigned an identification number in Table 2.1. Field data on the respective streams were gathered during the summer of 1970. An effort was made to insure that physical and biological data sensitive to seasonal and climatic changes be obtained, for all study streams, under approximately the same prevailing conditions. Where this was not possible, appropriate adjustments or eliminations were made. See Chapters III and IV.

Cultural and topographic data were acquired by inspection and measurement from the latest editions of the U. S. G. S. 1:24000, 7 1/2 minute series quadrangle maps. Cultural changes not appearing on these maps were evaluated where possible by ground inspection and aerial photographs. Considering the voluminous amount of data collected during this phase of the project, the level of data accuracy was, in general, equal to or better than that required by the methodology which finally evolved from the research.

---

[1] Only one stream was eligible for selection from this region - see Table 1.

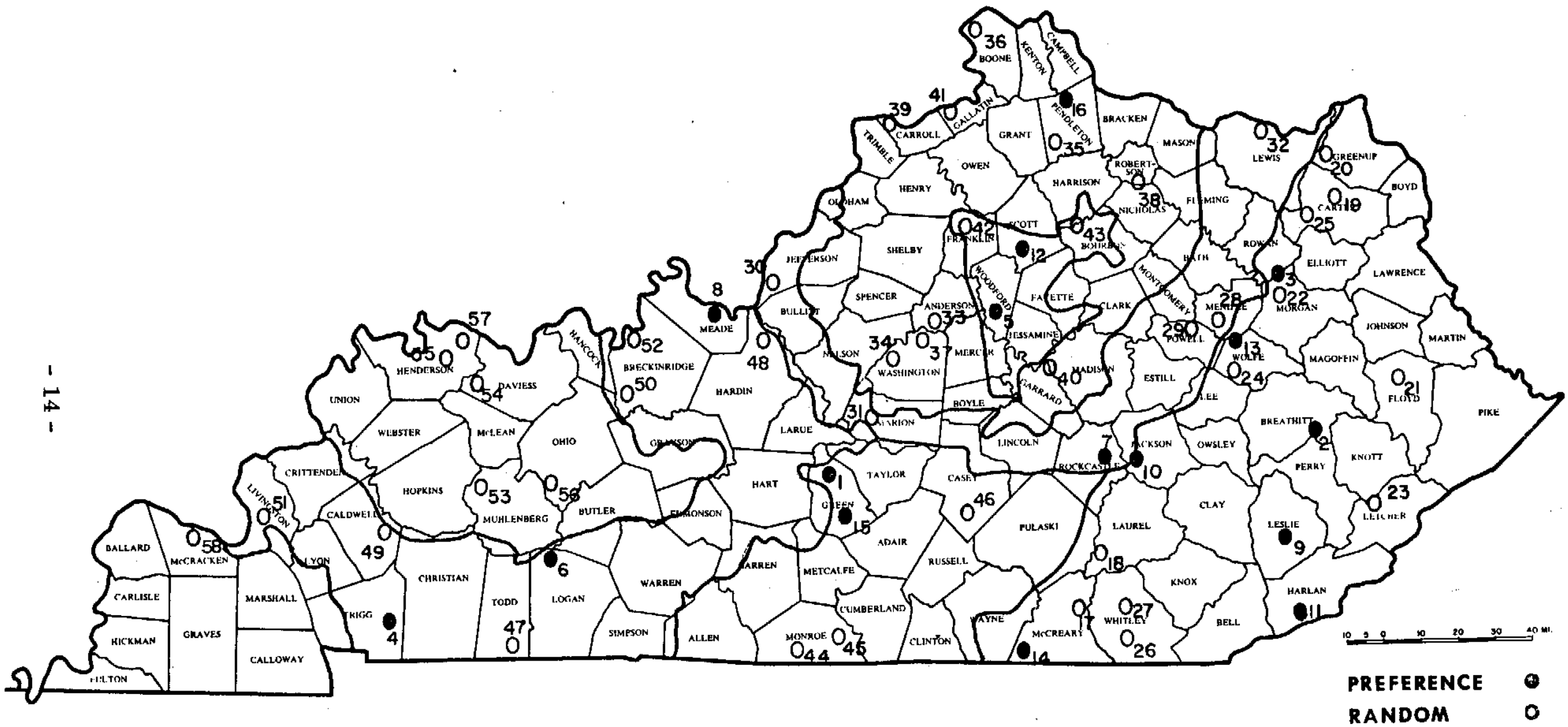


FIGURE 2.1 Map of Kentucky Showing Study Stream Locations

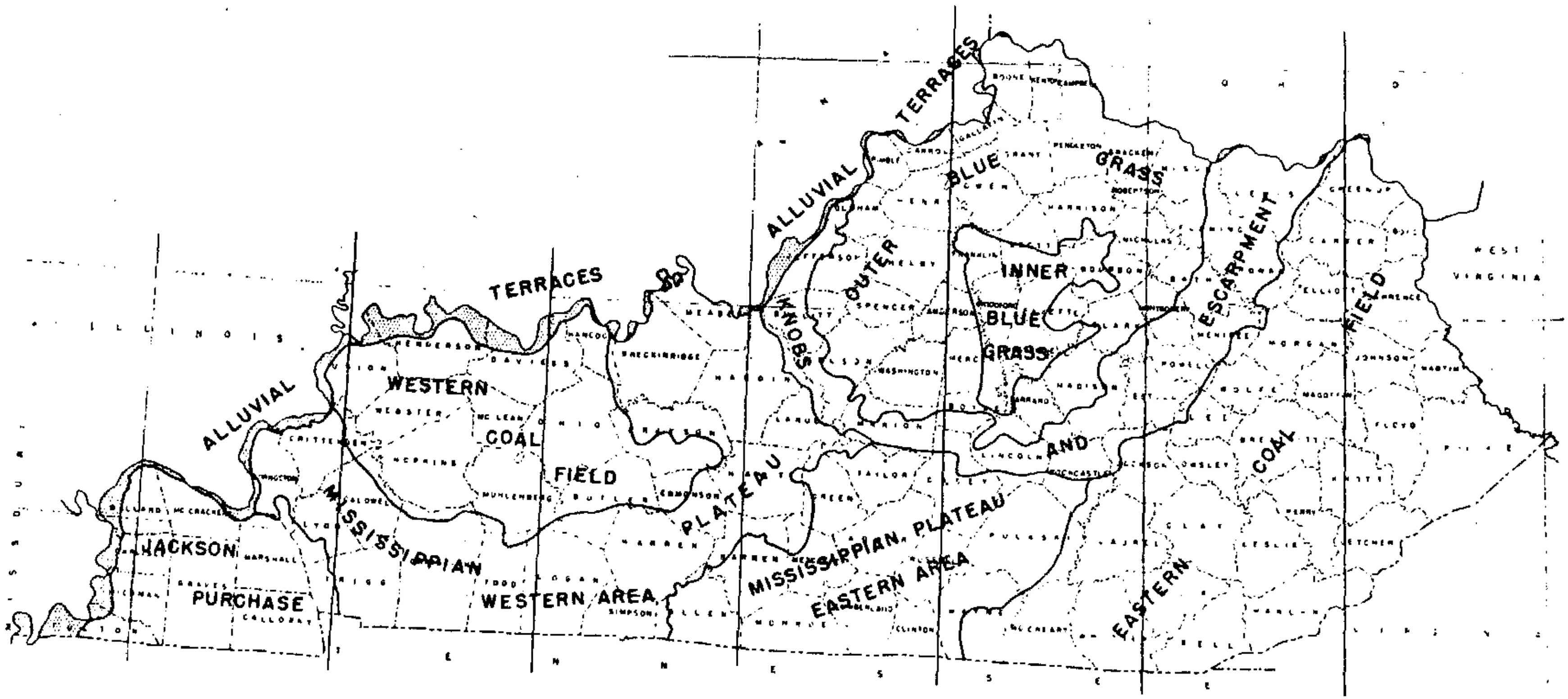


FIGURE 2.2 Map of Kentucky Showing Physiographic Regions

TABLE 2.1

STUDY STREAMS

No.	Name of Stream	Location (County)	Drainage Area (Sq. Miles)
		Preference Streams	
1	Big Brush Creek	Green, Taylor	83
2	Buckhorn Creek	Breathitt, Knott	45
3	Caney Creek	Rowan	17
4	Casey Creek	Trigg	30
5	Clear Creek	Jessamine, Woodford	65
6	Clifty Creek	Todd, Logan	41
7	Crooked Creek	Rockcastle	21
8	Doe Run	Meade	12
9	Greasy Creek	Leslie, Harlan	93
10	Laurel Fork	Jackson	33
11	Martin's Fork	Harlan, Bell	10
12	North Elkhorn Creek	Fayette, Scott	160
13	Red River	Menifee, Wolfe	141
14	Rock Creek	McCreary	48
15	Russell Creek	Green, Taylor, Adair, Russell	287
16	South Fork Grassy Creek	Grant, Pendleton	48
		Random Streams: Eastern Coalfield	
17	Barren Fork Indian Creek	McCreary	41
18	Cane Creek (Laurel County)	Laurel	20
19	Everman Creek	Carter	14
20	Leatherwood Branch	Greenup	13
21	Middle Creek (Floyd County)	Floyd	65

TABLE 2.1 (Continued)

No.	Name of Stream	Location (County)	Drainage Area (Sq. Miles)
		Random Streams: Eastern Coalfield (Con't)	
22	Pleasant Run	Morgan	7
23	Rockhouse Creek	Letcher	60
24	Upper Devil Creek	Wolfe	22
25	Upper Tygarts Creek	Carter	68
26	Wolf Creek	Whitley	16
27	Young's Creek	Whitley	10
		Random Streams: Knobs and Escarpment	
28	Beaver Creek	Menifee	74
29	Cane Creek	Menifee, Powell, Montgomery	16
30	Pond Creek	Jefferson	91
31	Prather Creek	Marion	22
32	Quicks Run	Lewis	26
		Random Streams: Outer Blue Grass	
33	Beaver Creek	Anderson	31
34	Little Beech Fork	Marion, Washington	159
35	Fork Lick Creek	Grant, Pendleton	56
36	Garrison Creek	Boone	6
37	Glens Creek	Washington, Mercer	36
38	Johnson Creek	Robertson, Mason, Fleming	76
39	Locust Creek	Trimble, Carroll	15
40	Paint Lick Creek	Garrard, Madison	107
41	Stephans Creek	Carroll, Gallatin	10

TABLE 2.1 (Continued)

No.	Name of Stream	Location (County)	Drainage Area (Sq. Miles)
	Random Streams: Inner Blue Grass		
42	Stoney Creek	Franklin	8
43	Townsend Creek	Harrison, Bourbon	39
	Random Streams: Mississippian Eastern Plateau		
44	East Fork Barren River	Monroe	79
45	Meshack Creek	Monroe, Cumberland	25
46	South Fork	Casey	73
	Random Streams: Mississippian Western Plateau		
47	Elk Fork	Todd, Logan	67
48	Mill Creek	Hardin	47
49	Montgomery Creek	Caldwell	13
50	Rock Lick Creek	Breckinridge	44
51	Sugar Creek	Livingston	14
52	Town Creek	Breckinridge	6
	Random Streams: Western Coal Field		
53	Issacs Creek	Muhlenberg	13
54	Knoblick Creek	McLean, Daviess	25
55	Lick Creek	Henderson	31
56	Pond Run	Ohio	12
57	Richland Slough	Henderson	14
	Random Streams: Jackson Purchase		
58	Perkins Creek	McCracken	15

CHAPTER III

PROCEDURES

This chapter describes the evaluative factors initially selected for the uniqueness determinations, their significance, and the procedures employed to quantify them for the fifty-eight streams studied. Most of the factors were taken from Leopold (10), (11) with modifications appropriate to the geographical and fluviological differences between Idaho or California and Kentucky. Several subjective, esthetic rating factors used by Morisawa (12) and land use classification categories suggested by Research Planning and Design Associates (14) were included. Among those factors added to the list by the present investigators were certain water quality measures, historical and geological values, a remoteness measure and an evaluation of the stream's potential for boating (floatability).

Two classifications of factors were initally developed; Watershed and Transect. The Watershed factors were, for the most part, measured from topographic maps or acquired from other information sources. The group of Watershed factors was broken down into two subgroups; (A) Physical and (B) Cultural.

The Transect factors were determined from field observations at one or more specific locations on each stream. The Transect factors were broken down into five subgroups (A) Physical, (B) Water Quality, (C) Aquatic Habitat, (D) Terrestial Habitat, and (E) Human Use and Interest. Most of the Transect factors were determined by direct measurement, observation or laboratory procedures. Some of the factors, however, were estimated subjectively in the field by two or three evaluators, working independently. Altogether a total of sixty-four factors were initially evaluated for each stream. These factors are listed in Table 3.1.

WATERSHED FACTORS

The Watershed factors are those pertaining to the entire drainage basin of the stream. Interpretation of these data provides insight into the overall physical and cultural aspects of the watershed and their relation on the quality of the stream.

A PHYSICAL

Most of these Watershed factors were evaluated using U.S.G.S., 7.5 minute series, 1:24,000 scale, topographic maps.

(1) Drainage Area (mi^2): Each stream's drainage basin was outlined on the topo maps and its area determined by planimeter.

(2) Stream Order: Each stream in the drainage basin was ranked according to Strahler's modification of the Horton System (5), (24). This system begins with the smallest headwater streams which are designated as First Order. The merging of two First Order streams in turn forms a Second Order stream. The system is designed so that whenever two streams of equal order join, they form a stream of the next highest order. If two streams of unequal order join, the larger order prevails.

(3) Average Gradient (ft/mi): The average gradient was computed by dividing the total relief by the length of main channel from its mouth to the point where two First Order streams merge.

(4) Total Relief (ft): The total relief was determined by recording the vertical elevation rise between the streams mouth and the point on the main channel where two First Order streams merge.

(5) Average Flood Plain Width (ft): The average flood plain width was determined by measuring the flood plain width at random locations along the main channel from the streams mouth to the point where two First Order streams merged. The number of measurements taken was dependent upon the stream length. Usually three to six values were obtained.

TABLE 3.1

ORIGINAL FACTORS BY GROUPS AND SUBGROUPS

I. WATERSHED FACTORS

		Rating Categories				
		1	2	3	4	5
	(A) PHYSICAL					
1.	Drainage Area (sq. miles)	≤ 10	11-50	51-100	101-150	> 150
2.	Stream Order (highest in basin)	≤ 2	3	4	5	≥ 6
3.	Average Gradient (ft./mi.)	< 3	3-5	5-25	25-50	> 50
4.	Total Relief, Source to mouth (ft.)	≤ 100	101-250	251-400	401-700	> 700
5.	Average Flood Plain Width (ft.)	≤ 200	201-400	401-700	701-1500	> 1500
6.	Average Valley Height/ Average Valley Width	≤ 0.1	0.11-0.5	0.51-1.0	1.01-1.80	> 1.8
7.	Forest Cover (% of total area)	0-20	20-40	40-60	60-80	80-100
8.	Slopes (% of total area > 20%)	0-20	20-40	40-60	60-80	80-100
9.	Geological Values	None		Few		Many
	(B) CULTURAL					
10.	Land Use (watershed landscape unit)	Town/ Farm	Farm	Farm/ Forest	Mined/ Disturbed Land	Forest/ Wildland
11.	Visual Pattern Quality	Low		Medical		High
12.	Historical Values	None		Local Signif.	Regional Signif.	National Signif.

TABLE 3.1 (Continued)

		Rating Categories 1	2	3	4	5
13.	Land Husbandry	Low		Medial		High
14.	Remoteness*	0-20	20-40	40-60	60-80	80-100
15.	Misfits or Disvalues	None		Few		Many
16.	Artificial Controls	Free				Controlled
17.	Water Supply System	None	1	2	3	≥ 4
18.	Sewage Treatment Plant	None	1	2	3	≥ 4
19.	Productive Industry	None	1	2	3	≥ 4
20.	Extractive Industry	None	1	2	3	≥ 4
	II. TRANSECT FACTORS					
	(A) PHYSICAL					
21.	Width (ft.)	< 10	10-25	25-50	50-75	> 75
22.	Depth (ft.)	< 0.5	0.5-1.0	1.0-2.0	2.0-3.0	> 3.0
23.	Velocity (ft/sec)	0	0.01-0.5	0.51-0.75	0.76-1.50	> 1.50
24.	River Pattern	Torrent	Pool and Riffle	No Riffle	Meander	Braided
25.	Bed Material	Clay or Silt	Sand	Sand - Gravel	Sand Gravel & Rock	Bed Rock
26.	Flow Variability	Little		Normal		Large

TABLE 3.1 (Continued)

		Rating Categories 1	2	3	4	5
27.	Bank Erosion	Stable		Slumping		Eroding
28.	Sedimentation	Stable				Large Scale
	(B) WATER QUALITY					
29.	Color	Clear	Dingy	Greenish	Brown	Black
30.	Temperature (°F)	≤ 65°	66°-70°	71°-75°	76°-80°	> 80°
31.	Turbidity (JTU)	≤ 6	7-25	26-50	51-100	> 100
32.	Dissolved Oxygen (mg/l)	≤ 3.0	3.01-6.0	6.01-8.0	8.01-11.0	> 11.0
33.	pH	≤ 5.0	5.01-6.5	6.51-7.5	7.51-8.5	> 8.5
34.	Alkalinity (as mg/l Ca CO_3)	< 30	30-90	90-140	140-190	> 190
35.	Total Hardness (as mg/l Ca CO_3)	< 50	50-100	100-200	200-400	> 400
36.	Nitrates (mg/l)	≤ 0.1	0.11-0.5	0.51-1.0	1.01-1.75	> 1.75
37.	Otho-phosphates (mg/l)	≤ 0.1	0.11-0.2	0.21-0.3	0.31-0.9	> 0.9
38.	Ammonia (mg/l)	≤ 0.1	0.11-0.2	0.21-0.3	0.31-0.5	> 0.5
39.	Conductivity (micromhos/cm)	≤ 100	101-200	201-400	401-600	> 600
40.	Visual Pollution Evidence	None				Evident
41.	Floating Material	None	Vegetation	Foamy	Oily	Variety

TABLE 3.1 (Continued)

		Rating Categories				
		1	2	3	4	5
	(C) AQUATIC HABITAT					
42.	Algae - Amount	Absent				Profuse
43.	Algae - Type	Green	Blue-Green	Diatom	Filamentous Green	None
44.	Other Water Plants-Amount	Absent				Profuse
45.	Invertebrates - Total Numbers	≤ 50	51-200	201-350	351-500	> 500
46.	Invertebrates - Diversity, Number of Species	≤ 5	6-10	11-15	16-20	> 20
47.	Vertebrates- Total Numbers	0	1	2	3	> 3
48.	Vertebrates- Diversity, Number of Species	0	1	2	3	> 3
	(D) TERRESTRIAL HABITAT					
49.	Valley	Cultivated	Pasture	Abandoned	Disturbed	Wooded
50.	Hillsides	Cultivated	Pasture	Abandoned	Disturbed	Wooded
51.	Diversity - Flora and Fauna	Small				Great
	(E) HUMAN USE AND INTEREST					
52.	Litter - Metal**	< 2	2-5	5-10	10-50	> 50
53.	Litter - Paper**	< 2	2-5	5-10	10-50	> 50
54.	Litter - Plastic**	< 2	2-5	5-10	10-50	> 50

TABLE 3.1 (Continued)

		Rating Categories 1	2	3	4	5
55.	Litter - Glass**	< 2	2-5	5-10	10-50	> 50
56.	Removability of Litter	Easily				Difficult
57.	Degree of Change	Original				Altered Greatly
58.	Recovery Potential	Likely				Unlikely
59.	Local Scene	Diverse Views				Little Diversity
60.	View Confinement	Open				Closed
61.	Serenity	Serene				Disturbing
62.	Naturalness	Natural				Man-Made
63.	Color	Colorful				Drab
64.	Floatability	Never	With Difficulty	During Flood Only	Long Pools	Always

* (% of total length of main channel > 0.25 miles from a road or human habitation

** Number of pieces per 100 foot reach.

(6) Average Valley Height/Average Valley Width Ratio: The average valley height was determined from random measurements of the total elevation rise between the stream surface and the hill or ridge line directly adjacent to it. The number of these measurements taken was dependent upon the stream length.

This ratio generally represents the degree of ruggedness of the watershed.

(7) Forest Cover (% of total drainage area):

(8) Slopes (% of total area > 20%): Both the forest cover and slope determinations were made by a sampling process. After the drainage basin was outlined on the topographic maps, it was divided into 4 inch by 4 inch blocks. Each whole block was given a number and 10% of these numbers were chosen randomly to determine which blocks would be used for the measurements. Areas of forested land and steeply terrain (>20%) were then determined for the selected blocks using a dot counting process. The resulting areas were converted to percentages representing forest cover and slope conditions for the entire watershed.

(9) Geological Values: The geological values for each stream were determined from ground observation at the stream site and from inspection of the topographic and geologic maps of the drainage basin. Geological values include caves, waterfalls, rock overhangs, natural arches, etc.

B CULTURAL

The Cultural subgroup of Watershed factors was determined by ground observation at each stream site and inspection of the topographic maps. Most of these factors were not measured as such but were subjectively evaluated or merely counted.

(1) Land Use: The land use for each stream basin was classified by the landscape unit categories outlined in the North Atlantic Regional Water Resources Study of Visual and Cultural Environment, Volume 2 (14). In this study the land use classification was based upon three criteria:

(a) Population Intensity, the number of persons per mi^2

(b) Intensity of Farming, the percentage of total watersheds in farming

(c) Forest Cover, the percentage of total watershed in forest.

The classification categories for this factor ranged from landscape units entitled "farm" to "forest wildland."

(2) Visual Pattern Quality:

(3) Historical Values:

(4) Land Husbandry:

Visual pattern quality and land husbandry ratings were determined by subjective judgments based on ground observations in each watershed. The categories for these factors ranged from low to high. The significance of the historical values in each watershed was established from published local histories and other formal and informal sources.

(5) Remoteness: The "remoteness" of a stream was defined as the percentage of the length of the main stream channel (from its mouth to the point on the main channel where two First Order streams merge) which lay more than 1/4 mile from a road, railroad, or human habitation. This factor was measured by using a transparent plastic template containing a circle at map scale of 1/4 mile radius. The circle template was moved along the map following the entire length of the main channel. Any section of stream in which a road, house, or railroad fell outside the 1/4 mile radius was considered remote. If these entities fell inside the 1/4 mile radius, the section was not considered remote. If a stream was rated 100% remote, it implied that along the entire length of stream, houses, roads, and railroads were greater than 1/4 mile from the channel.

(6) Misfits or Disvalues: The misfits and disvalues were determined by ground observation. A stream with excessive litter, severely disturbed landscape, or highly urbanized area was considered to be high in misfits or disvalues.

(7) Artificial Control: The extent of artificial control was determined by ground inspection of the stream and by topographic map inspection. Artificial controls include: dams, levees, channel dredging and channel straightening.

(8) Water Supply Systems:

(9) Sewage Treatment Plants:

(10) Productive Industry:

(11) Extractive Industry:

The number of water supply systems, sewage treatment plants, productive industries, and extractive industries were ascertained for each watershed from maps and ground observation. A productive industry is defined as any manufacturing or consumer product industry. Extractive industries include: stone quarries, oil wells, gas well, and mines.

TRANSECT FACTORS

The Transect factors were determined for each stream from observations, samples, and measurements collected in the field. At least one transect or sampling site was chosen for each stream. For the "preference streams" two or three transects were observed. Most of the transects were located at points on the stream accessible by car and were considered to be generally representative of the stream's physical and esthetic character. At each transect, a one hundred foot reach of the stream was marked off and the sampling and physical measurements were made within this reach. Those transect factors of a judgmental nature were referred generally to a three hundred foot reach centered on the transect site.

A PHYSICAL

As with the Watershed factors, the Physical subgroup of Transect factors was objectively measured or observed.

(1) Width (ft.): The width was measured two to four times with a tape within each one hundred foot reach. The average, to the nearest 1/2 foot, of the values was taken as the width at the transect.

(2) Depth (ft.): At each point in the section where the width was measured, the depth was also measured at three to four points in the cross-section. The average was taken as the depth of the transect.

(3) Velocity (ft/sec): The average velocity of each stream was calculated by recording the time it took a small wooden block to move a measured

distance. The distance depended upon the apparent speed of the stream, the presence of riffles and large rocks, etc. If the stream appeared to be moving slowly, a 25 foot distance was marked using surveyors chain and rnage poles. When the stream appeared to be moving rapidly a 50 foot or 100 foot distance was marked off. The time was recorded at 3 or 4 different points on the stream cross-section and the average was taken for the velocity.

When stream velocity was so low that satisfactory results were not obtained with the block float, an alternative method was used. A fish float was attached to a 5-foot length of monofilament fishing line and the time was recorded to go through the 5-foot distance. In some instances, during the summer dry period, a study stream was in pool stage and the apparent velocity was nil.

(4) River Pattern:

(5) Bed Material:

The river pattern and bed material were determined by ground observation at each site. A pool and riffle pattern was most common.

The bed material categories ranged from clay and silt bottom to solid bedrock. The majority of the streams studied had a sand and gravel bottom.

(6) Flow Variability:

(7) Bank Erosion:

(8) Sedimentation:

Flow variability, bank erosion and sedimentation were all determined by ground observation at the transect. If evidence such as debris, leaves, etc. could be seen in tree tops, flow variability was rated high (No actual flood stage measurements were made). If no such indication could be found, normal or near normal flow variability was indicated. Bank erosion and sedimentation were evaluated judgmentally based upon the condition of the stream banks and the appearance of the stream bottom respectively.

B WATER QUALITY

Of the thirteen factors in the Water Quality subgroup, four were evaluated at the stream site by ground observation and measurement: temperature (°F), color, visual pollution evidence and floating material.

The remaining nine factors were determined by standard tests in the Sanitation Lab of the Civil Engineering Department at the University of Kentucky. The water samples for these tests were collected at the transects in plastic, one quart bottles. These samples were kept cool until they could be returned to the laboratory and placed into a refrigerator at 1°C to await chemical testing.

(1) Color: The color of the stream water at the various transect sites was classified in a range from clear to black.

(2) Temperature (°F): The temperature of each stream was measured by immersing a Farenheit thermometer into the water and leaving it for approximately one minute. The thermometer was then read to see if a further temperature drop would result if it remained immersed. When the lowest temperature reading was established, that value was read and recorded.

Stream temperature is a very important factor in determining the quality of the aquatic habitat. Various species of fish are extremely sensitive to temperature and are able to survive only if the favorable temperature ranges exist. Temperature also has an important effect upon the dissolved oxygen concentration in the stream.

(3) Turbidity (JTU): Turbidity is defined as the cloudy or opaque appearance of water due to fine suspended material. The turbidity of each sample was measured using the Hach 2100 Turbidimeter.

A sample with a turbidimeter reading of $\leq$ 5.0 JTU (Jackson Turbidity Units) is relatively clear. A sample with a reading between 6.0 JTU and 20 JTU has a dingy or greenish appearance. As the turbidity reading increases above 20.0 JTU, an increased level of turbidity is indicated.

The extent of turbidity present in a stream affects the depth to which sunlight will penetrate. When stream turbidity is high, sunlight cannot penetrate as deeply into the stream. If little or no turbidity is present, however, sunlight will easily reach the stream bottom. The amount of turbidity and the amount of available sunlight has a significant effect upon stream algae which require sunlight for photosynthesis and oxygen production.

(4) Dissolved Oxygen (mg/l): The dissolved oxygen concentration in milligrams per liter at each transect site was initially determined using a Yellow Springs Dissolved Oxygen Meter USI Model 542C. Due to complications encountered, this method was abandoned and the Azide Modification of the Iodometric Method for the determination of dissolved oxygen was used. In this process a 300 ml BOD bottle was filled with water at each transect site and 2 ml of manganeous sulfate, 2 ml of potassium iodide, and 2 ml of concentrated H_2SO_4 were added immediately to tie up the dissolved oxygen into a stable form. The samples were then returned to the laboratory and the procedure was continued according to Standard Methods (23), pp. 406-410.

The concentration of dissolved oxygen within each stream is a controlling factor for the number of and kinds of aquatic species present. For example, Large Mouth Bass require a minimum of 7.0 mg/l of dissolved oxygen to live and spawn. Generally, if a constant, relatively high D.O. concentration is maintained within a stream, the diversity of aquatic species will be large thus indicating a healthy stream. Conversely, if the D.O. concentration is low or constantly fluctuating, the number of species able to tolerate these changes is less; therefore the diversity of aquatic life will be less, indicating a polluted or degraded stream.

The amount of algae present plays a major role in the D.O. concentration in a stream. When profuse growths of algae are present, the D.O. may vary widely from a supersaturated state in the daylight hours when photosynthesis is occurring to a low or in some instances even an oxygen-free state at night when only algal respiration is occurring.

Temperature and D.O. solubility in water are inversely related. Thus, other factors being equal, higher D.O. concentrations occur in streams in the winter and lower concentrations in the summer. At a given temperature, the D.O. concentration in a stream is affected by various sinks (decreased) and sources (increased).

Most D. O. sinks in a stream are of a biochemical nature. Generally, the most significant sink is the utilization of dissolved oxygen by microorganisms for the metabolic stabilization of dissolved and/or finely suspended organic material in the stream water. The significance of this process is measured by the biochemical oxygen demand (BOD) test. Other important D. O. sinks are the microbial stabilization of organic sludge or bottom deposits (benthic demand), algal respiration, and microbial oxidation of inorganic substances. A common example of the latter is the oxidation of ammonia-nitrogen to nitrate-nitrogen by a special group of bacteria, a process called nutrification.

The two most important D. O. sources in a stream are natural reaeration and algal photosynthesis. The rate of natural reaeration is proportional to the D. O. defiet (saturation minus actual concentration), and the proportionality constant, in turn, has been found to be proportional to the 1/2 power of the stream velocity and inversely proportional to the 3/2 power of the stream depth. The rate of photosynthetic oxygen production is usually estimated as being constant over the daylight hours or to follow a positive sine function with zero rates at sunrise and sunset and a maximum rate at noon.

Incomplete dissolved oxygen data for 10 streams resulted from the malfunction of the Yellow Springs Dissolved oxygen meter. Estimates were made for the missing dissolved oxygen data by comparing these streams to nearby streams or streams with similar physical characteristics.

(5) pH:

(6) Alkalinity (as mg/l $CaCO_3$):

The pH and alkalinity tests were run using a Corning pH Meter Model 10. The alkalinity concentration was calculated using the Methyl Orange Indicator Method as found in Standard Methods (23), p. 51.

Alkalinity is indirectly related to pH in that it acts as a buffer or preventative measure to insure that pH does not change rapidly. Most species of aquatic organisms survive and propagate best at close to neutral pH (7. 0). Only a few highly tolerant species are able to survive at extremely low or high pH.

(7) Hardness (as mg/l $CaCO_3$): The total hardness concentration in milligrams per liter was determined using the EDTA Titrimetric Procedure as found in Standards Methods (23), pp. 147-152.

(8) Nitrate (mg/l): The nitrate nitrogen concentration in milligrams per liter was determined using the Beckman DB-G Grating Spectrophotometer and the Ultraviolet Spectrophotometric Method as outlined in Standard Methods (23), pp. 200-202. One modification was made in the procedure. In calculating the correction for dissolved organic matter, a factor of 1.00 was used.

Nitrate has been found to be one of the limiting factors or required substances necessary for the growth of algae. If this nutrient is available in sufficient concentration in a stream profuse algal blooms could result.

(9) Ortho-Phosphate (mg/l): The ortho-phosphate concentration was determined using the Bausch & Lomb Spectronic 20 Spectrophotometer and the Stannous Chloride Method as found in Standard Methods (23), pp. 234-236. The ortho-phosphate content of each sample was converted from percent transmittance to mg P by using a predetermined calibration curve. The ortho-phosphate concentration was then calculated as shown in Standard Methods (23), p. 234.

Phosphate is also in many cases a regulating nutrient for algal growth. When it is abundant in a stream water, dense growths of algae and other aquatic plants result.

(10) Ammonia Nitrogen (mg/l): The ammonia nitrogen concentration was determined using the Direct Nesslerization Method as found in Standard Methods (23), pp. 193-194. One ml EDTA reagent was added to each sample to prevent interferences of precipitates with the test. As in the ortho-phosphate test, the Bausch & Lomb Spectronic 20 Spectrophotometer was used to measure the color photometrically. The concentration of ammonia nitrogen was calculated as shown in Standard Methods (23), p. 194.

(11) Conductivity (micromhos/cm): The conductivity was measured using a Beckman Model RC 16B2 conductivity meter. The conductivity is an indirect measurement of the dissolved solids concentration of the stream. If a stream water has a high conductivity reading, it contains a large concentration of dissolved solids (primarily inorganic salts). For most Kentucky surface waters, the total dissolved solids concentration in mg/l can be estimated by multiplying the conductivity in micromhos/cm by 0.7. Conductivity is a function of temperature, increasing slightly with increasing temperature.

(12) Visual Pollution Evidence:

(13) Floating Material:

The visual pollution evidence and floating material factors were determined by ground observation at each stream site.

C AQUATIC HABITAT

The Aquatic Habitat subgroup of Transect factors were determined by ground observation and by biological "kick" samples. At each stream, a two minute kick sample taken on a riffle was used to quantify the invertebrate species present. The standard, Surber bottom sampler, used in collecting the aquatic specimens, consists of a nylon mesh net connected to a metal frame with an opening of 12" x 12". The sampler was placed into the stream at a riffle with the opening facing upstream. The collector would then kick and overturn rocks immediately upstream from the sampler while moving across the riffle. This procedure was continued for two minutes. The collections were then transferred from the specimen sampler to a larger rectangular pan. The net was inspected for any material which had not fallen into the pan and was still clinging to the net sides. The collection was then transferred again to a wide mouth plastic one quart jar where a 10% formaldehyde solution was added to preserve the specimens until lab sorting could be done. Returning to the laboratory, each collection was run through sifting pans of various size openings to retain any macro-ortanism collected. The vertebrates and invertebrates were then sorted, counted, and recorded (13), (31).

During the latter part of the summer, problems were encountered in finding adequate riffles with which to take a biological sample. For these streams, no biological testing could be made due to two reasons (1) inadequate stream flow, (2) unsuitable clay or silt bottom.

In order to get a representative kick sample of the aquatic habitat, there has to be an adequate stream flow to wash any organisms hiding under the rocks into the sampler. If the flow is not sufficient to wash the organisms into the sampler, few organisms will be caught, thus giving a poor indication of the aquatic species actually present. Similarly, if the stream has other than a sand and gravel bottom, the organisms normally collected by kick sampling will not be present.

Incomplete biological data were estimated by comparing those streams with nearby ones or streams with similar physical and chemical data where representative samples had been taken.

(1) <u>Algae-Amount:</u>

(2) <u>Algae-Type:</u>

(3) <u>Other Water Plants:</u>

The algae amount, algae type and other water plants amount were determined by observation at each site.

The relative amounts of algae and other water plants give an indirect indication of the concentrations of phosphorus and nitrogen nutrients available in the stream. If these nutrients are available in sufficient concentration, profuse growths of algae and water plants may result. If a relatively small concentration of these nutrients are present, a much lesser degree of algal growth may be expected.

(4) <u>Invertebrates-Numbers:</u>

(5) <u>Invertebrates-Diversity:</u>

(6) <u>Vertebrates-Numbers:</u>

(7) <u>Vertebrates-Diversity:</u>

These factors were evaluated by counting and classifying the organisms collected in a two minute kick sample. The term "numbers" applies to the total number of organisms of all species for both invertebrates and vertebrates, respectively. The term "diversity" refers to the total number of different species of both invertebrates and vertebrates represented in the stream biological sample.

The kick sample was designed primarily to capture invertebrates and smaller vertebrates such as minnows, darters, etc., that are found near the bottom in riffle areas. Larger vertebrates could not be collected in this manner.

The diversity of the aquatic life in a stream is a good indicator of the water quality and degree of pollution of a stream. When a stream contains a large diversity of aquatic species, and an average number of organisms per species, a relatively pure, pollution free, aquatic habitat exists. As the number of species found in the stream decreases and the number of organisms per species drastically increases, the stream is experiencing some degree of pollution. A stream that is grossly polluted contains several highly tolerant to pollution species with a large number of organisms to each one (2), (15).

In addition to diversity of species as an indicator of pollution, certain species of organisms are known to be more acclimated or tolerant to pollution than others. Species indigent to grossly polluted waters include: (1) rat tailed maggot, (2) sludge worm, (3) blood worm, and (4) sewage fly larva. Species found only in clear unpolluted water include (1) game fish, (2) minnows, (3) caddis fly, (4) may fly, (5) stone fly, and (6) hellgrammite.

D TERRESTRIAL HABITAT

The Terrestrial Habitat subgroup of characteristics were determined by ground observation of the landscape bordering the stream transect. These characteristics were designed to give the evaluator an idea of the type of landscape in the vicinity of the transect. Categories ranged from "cultivated" and "pasture" lands, to "disturbed" and "wooded" lands. On the streams where more than one category applied, the category thought to be most characteristic of the immediate area was used.

(1) Valley:

(2) Hillside:

(3) Diversity - Flora & Fauna:

These factors were determined by ground observation at each stream site. The term "valley" refers to the valley through which the stream flows. The term "hillside" refers to the hills or ridgeline directly adjacent to the stream valley. The diversity of flora and fauna of the terrestial habitat is dependent upon the character of the surrounding landscape. A pasture or farm area would have small terrestial diversity whereas a mountain forest could have great terrestial diversity.

E HUMAN USE AND INTEREST

The Human Use and Interest subgroup of Transect factors was determined predominately by subjective judgment at each transect. The quantification of these factors was more difficult than any other subgroup because there are no objective means to evaluate such factors as degree of change, serenity, naturalness, color, etc.

(1) Litter-Metal: Number of pieces per 100 ft. reach.

(2) Litter-Paper: Number of pieces per 100 ft. reach.

(3) Litter-Plastic: Number of pieces per 100 ft. reach.

(4) Litter-Glass: Number of pieces per 100 ft. reach.

The amount of each type of litter; metal, paper, plastic, and glass was determined by inspecting the stream channel and both banks. Any litter in view from the top of the banks within the 100 ft. reach was counted. In some instances forms of litter other than those listed were encountered, e.g., old tires. In this case the artifact was listed in the litter-plastic category.

Most of the stream transects were located near roads or bridges to facilitate getting the necessary sampling equipment to the stream. As a result, many of the streams had more litter at these sites than might have been found at more remote locations along the stream.

(5) Removability of Litter: The removability of litter was determined by subjective judgment on the extent of litter present, the location of the litter, and the type of litter found in the stream. The category rating for removability of litter ranged from easy to difficult. If enough litter was present to the extent it was a regularly used dump, the transect received a difficult or near difficult rating. Likewise, if the stream were located in a deep ravine and had wrecked automobiles or heavy machine parts strewn about, it would also receive a "difficult" rating. On the other hand, if the extent of litter was not excessive within the area and the stream was easily accessible, it would be rated near the "easily removed" category.

(6) Degree if Change: The degree of change of each transect was determined subjectively by inspecting the stream and surrounding area for any type of stream improvements or development of any kind. The ratings for the degree of change characteristic ranged from "original" to "altered". Human habitation within the immediate proximity, channel dredging, strip mining, or any man made structure built to regulate the flow of the stream were all considered to alter the stream and surrounding area. A stream that existed in a natural or near natural state was rated toward the "original" end of the scale.

(7) Recovery Potential: The recovery potential was determined subjectively by inspecting the present stream conditions and those of the surrounding landscape. The ratings of the recovery potential scale ranged from "likely" to "unlikely". Streams that were altered or otherwise effected by man were rated toward the unlikely scale. Those streams showed little or no effect of man's development were rated toward the "likely" scale.

(8) Local Scene: The local scene was determined by a subjective evaluation of the surrounding landscapes. The ratings for the local scene scale ranged from "diverse" views to "little" or "no diversity" of views. If the

view from the stream bank yielded a variety of views, e.g., farm lands bordered by a dense forest, it was rated near the diverse view scale. A stream that was situated in the middle of cleared pasture with few trees around or a stream completely surrounded by dense forest with no cleared land surrounding it was rated toward the "little diversity" end of the scale.

(9) View Confinement: The degree of view confinement for each stream was determined by subjective judgment of the evaluator while standing at the stream's edge. The ratings for the view confinement scale ranged from "open" to "closed". If the stream had low banks and the landscape bordering the stream was clearly visible, it was rated an open view confinement. When the view from the stream was restricted due to high banks or very dense vegetation bordering the stream, the view was rated closed view confinement. Most of the streams visited were rated near the mid point between the two extremes.

(10) Serenity:

(11) Naturalness:

(12) Color:

The serenity, naturalness, and color factors of each stream were subjectively evaluated using the sights, sounds, odors and general feeling experienced independently by three observers at each transect.

Serenity was rated on a scale from "serene" to "disturbing". At each stream that was given a serene rating, only sounds characteristic of nature, e.g., the song of a bird or the flowing of a stream were evident. If a stream was located adjacent to a bush highway or any other source of man induced noise, it received a rating toward the "disturbing" end of the scale.

The ratings of naturalness ranged from "natural" to "manmade". When a stream transect was taken in an area where evidence of man's presence was not dominant, or where the apparent original condition prevailed, the stream was given a natural rating. A stream bordered by houses, surrounded by strip-mines or changed by channelization was rated nearer the manmade end of the scale.

The "color" at each transect was determined by the diversity of vegetation, the naturalness and quietness of the surroundings, the occurrence of geological factors as well as other intangible judgment factors. The ratings for color ranged from "drab" to "colorful".

The serenity, naturalness, and color of each stream were the most subjective factors on which evaluation was attempted. Every person's evaluation of these factors for a particular stream would be somewhat different. Those qualities which might be colorful to one individual might be less colorful to another. The attitudes each person acquires in life which are used to evaluate esthetic qualities are dependent upon such things as family background, education level and inherent artistic sensitivity. However, independent judgmental ratings for these subjective factors by three persons (one professor, two students) did not vary more than one unit either way at transects on the sixteen preference streams.

In being restricted to the easily accessible transect sites, the ratings on these factors were probably shifted toward the manmade end of the rating scale. If the transects could have been taken in more remote sections of the streams, this bias might have been avoided.

(13) Floatability: The floatability of a stream was determined by ground observation at each transect. Each stream was rated on the floatability factor by the portion of the year the stream could be used for canoeing or raft floating. The ratings for the floatability scale ranged from "never" thru "during flood only" to "always floatable". Many of the streams visited were too small to be used in this capacity even during the wet spring months. These streams were therefore rated "never floatable". Several of the streams had adequate flow for canoeing and raft floating only during the wet months of the year. These streams were rated "during floods only". A few streams were much larger than the rest, and although they could not always be used, had long pools that would enable canoeing and floating much of the time.

The evaluative factors described above were selected to provide a comprehensive expression of those attributes of a stream thought to be most significant to man and his decision-making processes. An attempt was made to use factors that could be measured, calculated or otherwise objectively determined. For those factors requiring subjective judgment, opinions were obtained from at least three evaluators.

CHAPTER IV

RESULTS AND ANALYSES

PRELIMINARY WORK

After the field and office data were assembled and checked for each of the fifty-eight streams, a category rating was assigned to each of the sixty-four evaluative factors. The category ratings ranged from one to five depending upon the respective factor measurements or evaluations (See Tables 4.5 and 4.6). This process yielded a 64 x 58 matrix of whole numbers (ratings). The number of streams sharing the same category rating was next determined for each factor. This was done separately for each of the three stream classifications: (a) the sixteen Preference Streams, (b) the forty-two Random Streams, and (c) all fifty-eight streams combined. An "uniqueness ratio" (the reciprocal of the number of streams sharing the same category rating) was then computed for each stream factor at each study stream. Summing the "uniqueness ratios" for each of the five factor groups and for all the factors of the inventory, yielded a "uniqueness ratio sum" and "total uniqueness ratio" for each stream in each classification. The streams were then ranked by group uniqueness and total uniqueness in descending order beginning with the most unique.

When the data and the results of the above procedure were examined in detail, it appeared that:

(1) some of the evaluative factors were duplicative and/or highly correlated,

(2) some of the factors were inappropriate or insignificant, i.e., for some factors, nearly all the study streams were clustered about one or two category ratings,

(3) data for some of the factors were of doubtful accuracy because of misinterpretations of meaning by the evaluators or the effects of climate or other ambient conditions on the field measurement or judgment; and that,

(4) a reduction in the total number of factors and the number of sub-groups would be desirable.

CORRELATIONS:

To further investigate these problems, a matrix of simple correlation coefficients (r) was computed (25), relating each factor to every other factor. This matrix was scanned for all factor pairs exhibiting a correlation coefficient, r, $\geq$ 0.65. These pairs and their correlation coefficients are shown in Table 4.1.

It was not considered logical to eliminate every variable that was correlated with another, so the only changes made at this point were to combine the water plant-sewage plant factors and to remove the landscape "color" factor as being highly correlated with "naturalness".

ELIMINATIONS:

The river pattern and bank erosion factors were removed from the inventory because they seemed inappropriate to the types of streams studied. Stream patterns observed were nearly all in the pool-riffle category and bank erosion was practically non-existent.

Flow variability and floating material were eliminated as factors because of the evaluators misinterpretation of the terms. Algae type, number and diversity of aquatic vertebrates were removed from the inventory because of unreliable or insufficient data.

The water color factor was dropped due to categorization difficulties encountered when a transect was evaluated after a heavy rainstorm. A flooded stream might be categorized as brown or dingy when its normal color was actually clear, green or even black.

It is obvious that several other factors could have been removed from the inventory for the reasons given but it was felt that ratings for the remaining

TABLE 4.1

ORIGINAL EVALUATIVE FACTORS - CORRELATIONS ($r \geq |0.65|$)

FACTOR NUMBERS	FACTORS	r
1 - 64	Drainage Area - Floatability	0.72
1 - 21	Drainage Area - Stream Width	0.66
5 - 6	Plain Width - Ht./Width	0.65
6 - 8	Ht./Width - Slopes	0.77
6 - 10	Ht./Width - Land Use	0.73
7 - 8	Forest Cover - Slopes	0.73
7 - 10	Forest Cover - Land Use	0.76
8 - 10	Slopes - Land Use	0.68
9 - 51	Geological Values - Diversity Flora & Fauna	0.68
11 - 58	Visual Quality - Recovery Potential	0.66
11 - 62	Visual Quality - Naturalness	0.77
11 - 63	Visual Quality - Color	0.84
15 - 40	Misfits - Visual Pollution	0.71
17 - 18	Water Supply & Sewage Plants	0.65
17 - 19	Water Supply - Productive Industry	0.74
18 - 19	Sewage Plants - Productive Industry	0.69
28 - 29	Sedimentation - Water Color	0.71
33 - 34	pH - Alkalinity	0.69
34 - 35	Alkalinity - Hardness	0.68
35 - 39	Hardness - Dissolved Solids	0.83
40 - 41	Visual Pollution - Floating Material	0.74
47 - 48	Vertebrate No. - Vertebrate Diversity	0.75

TABLE 4.1 (Continued)

FACTOR NUMBERS	FACTORS	r
51 - 63	Diversity Flora & Fauna— Color	0.68
52 - 53	Litter Metal - Litter Paper	0.66
57 - 58	Degree of Change - Recovery Potential	0.80
57 - 61	Degree of Change - Serenity	0.68
57 - 62	Degree of Change - Naturalness	0.81
57 - 63	Degree of Change - Color	0.72
58 - 62	Recovery Potential - Naturalness	0.79
58 - 63	Recovery Potential - Color	0.74
61 - 62	Serenity - Naturalness	0.68
62 - 63	Naturalness - Color	0.81

fifty-four factors were based on reasonably reliable data and that further reduction might tend to obscure some important differences among the study streams and their attributes.

FACTOR ANALYSIS:

To provide additional insight for the overall analysis and a guide to regrouping the evaluative factors, the basic data (category ratings) for the 58 streams and the 54 remaining evaluative factors were compiled and factor analyzed by the principal axis method with varimax rotation. Analyses were performed over both rows (evaluative factors) and columns (streams). In the factor analysis over rows, the computer program (25) extracted twenty-two Factors which together accounted for about 91% of the variation in the mean ratings of the evaluative factors.

Four of the first five Factors (accounting for about 40% of the variation) seemed to lend themselves to interpretation. Individual loadings of the various stream measures on these Factors are shown in Table 4. 2. The four Factors were tentatively designated as: "Esthetic Quality", "Size", "Litter" and "Land Use". Application of these findings toward a regrouping of the fifty-four evaluative factors resulted in the five-group arrangement shown in Table 4. 3.

The factor analysis over columns (streams) extracted eighteen Factors which together accounted for about 90% of the total variance. Of these Factors, the first four accounted for about 35% of tht total variance and were interpretable in terms of the eight physiographic regions of the State as shown in Table 4.4. Factors I and II also seemed to be related somehow to those types of streams that would generally be considered "desirable" and "undesirable", respectively. The "Eastern Kentucky" (Eastern Coal Field, Knobs and Escarpment) Factor for example, carries high loadings on seven of the sixteen Preference streams while Factor II, "Western Kentucky", is heavily loaded with urbanized or damaged streams of the Western Coal Fields. Factors I and II are also quite obviously related to fast and slow stream velocities, mountains and flat terrain and other

TABLE 4.2

VARIMAX FACTOR LOADINGS* - REVISED LIST OF EVALUATIVE FACTORS

FACTOR I (14.8%)**

" ESTHETIC QUALITY"		
No.	Evaluative Factor	Loading
51	Naturalness	0.91
46	Degree of Change	0.89
47	Recovery Potential	0.82
50	Serenity	0.77
44	Visual Pattern Quality	0.74
54	Diversity, Flora & Fauna	0.66
20	Valley Habitat	0.59
37	Misfits or Disvalues	0.57
25	Dissolved Solids	0.53
38	Visual Pollution Evidence	0.50
36	Diversity - Invertebrates	0.50

FACTOR II (6.9%)

"SIZE"		
No.	Evaluative Factor	Loading
11	Floatability	0.84
1	Drainage Area	0.82
53	Historical Values	0.68
7	Stream Width	0.63
2	Stream Order	0.44
4	Total Relief	0.38
17	Water - Sewage Systems	0.36

* Absolute Values

** Percent of total variance "explained" by factor

TABLE 4.2 (Continued)

FACTOR III (7.8%)

"LITTER"		
No.	Evaluative Factor	Loading
39	Litter - Metal	0.89
40	Litter - Paper	0.82
41	Litter - Plastic	0.81
43	Removability - Litter	0.74
42	Litter - Glass	0.64
38	Visual Pollution	0.40
26	pH	0.37

FACTOR IV (10.5%)

"LAND USE"		
No.	Evaluative Factor	Loading
13	Slopes	0.85
14	Land Use	0.85
12	Forest Cover	0.84
6	Ht./Width Ratio	0.76
29	Nitrates	0.62
30	Ortho-phosphates	0.60
3	Gradient	0.42
4	Total Relief	0.41
52	Geologic Values	0.36

TABLE 4.3

REVISED FACTOR LIST

		Rating Categories 1	2	3	4	5
I. PHYSICAL MEASURES						
1	Drainage Area (sq. miles)	≤ 10	11-50	51-100	101-150	> 150
2	Stream Order (highest in basin)	≤ 2	3	4	5	≥ 6
3	Average Gradient (ft/mi)	< 3	3-5	5-25	25-50	> 50
4	Total Relief (ft.)	≤ 100	101-250	251-400	401-700	> 700
5	Average Flood Plain Width (ft.)	≤ 200	201-400	401-700	701-1500	> 1500
6	Average Valley Height/ Average Valley Width	≤ 0.1	0.11-0.5	0.51-1.00	1.01-1.80	> 1.80
7	Stream Width (ft.)	< 10	10-25	25-50	50-75	> 75
8	Stream Depth (ft.)	< 0.5	0.5-1.0	1.0-2.0	2.0-3.0	> 3.0
9	Stream Velocity (ft/sec)	0	0.01-0.5	0.51-0.75	0.76-1.50	> 1.50
10	Bed Material	Clay or Silt	Sand	Sand-Gravel	Sand Gravel & Rock	Bed Rock
11	Floatability	Never	With Difficulty	During Floods Only	Long Pools	Always

TABLE 4.3 (Continued)

		Rating Categories				
		1	2	3	4	5
II. LAND USE MEASURES						
12	Forest Cover (% of total area)	0-20	20-40	40-60	60-80	80-100
13	Slopes (% of total area > 20%)	0-20	20-40	40-60	60-80	80-100
14	Land Use (watershed land-scape unit)	Town/Farm	Farm	Farm/Forest	Mined/Disturbed Land	Forest/Wild-land
15	Remoteness*	0-20	20-40	40-60	60-80	80-100
16	Artificial Controls	Free				Controlled
17	Water Supply & Sewage Plants	None	1-2	3-4	5-6	≥ 7
18	Productive Industry	None	1	2	3	≥ 4
19	Extractive Industry	None	1	2	3	≥ 4
20	Valley Terrestial Habitat	Cultivated	Pasture	Abandoned	Disturbed	Wooded
21	Hillside Terrestial Habitat	Cultivated	Pasture	Abandoned	Disturbed	Wooded
III. WATER QUALITY MEASURES						
22	Temperature (°F)	$\leq 65°$	66°-70°	71°-75°	76°-80°	> 80°
23	Sedimentation	Stable				Large Scale
24	Turbidity (JTU)	≤ 6	7-25	26-50	51-100	> 100

27	Alkalinity (as mg/l $CaCO_3$)	< 30	30-90	90-140	140-190	> 190
28	Total Hardness (as mg/l $CaCO_3$)	< 50	50-100	100-200	200-400	> 400
29	Nitrates (mg/l)	≤ 0.1	0.11-0.50	0.51-1.0	1.01-1.75	> 1.75
30	Ortho-phosphates (mg/l)	≤ 0.1	0.11-0.2	0.21-0.3	0.31-0.9	> 0.9
31	Ammonia (mg/l)	≤ 0.1	0.11-0.2	0.21-0.3	0.31-0.5	> 0.5
32	Conductivity (micromhos/cm)	≤ 100	101-200	201-400	401-600	> 600
33	Algae - Amount	Absent				Profuse
34	Other Water Plants - Amount	Absent				Profuse
35	Invertebrates - Total Number	≤ 50	51-200	201-350	351-500	> 500
36	Invetrebrates - Diversity	≤ 5	6-10	11-15	16-20	> 20

IV. DISVALUES

37	Misfits or Disvalues	None		Few		Many
38	Visual Pollution Evidence	None				Evident
39	Litter - Metal**	< 2	2-5	5-10	10-50	> 50
40	Litter - Paper**	< 2	2-5	5-10	10-50	> 50
41	Litter - Plastic**	< 2	2-5	5-10	10-50	> 50

TABLE 4.3 (Continued)

		Rating Categories				
		1	2	3	4	5
25	Dissolved Oxygen (mg/l)	$\leq$ 3.0	3.01-6.0	6.01-8.0	8.01-11.0	> 11.0
26	pH	$\leq$ 5.0	5.01-6.5	6.51-7.5	7.51-8.5	> 8.5
27	Alkalinity (as mg/l $CaCO_3$)	< 30	30-90	90-140	140-190	> 190
28	Total Hardness (as mg/l $CaCO_3$)	< 50	50-100	100-200	200-400	> 400
29	Nitrates (mg/l)	$\leq$ 0.1	0.11-0.50	0.51-1.0	1.01-1.75	> 1.75
30	Ortho-phosphates (mg/l)	$\leq$ 0.1	0.11-0.2	0.21-0.3	0.31-0.9	> 0.9
31	Ammonia (mg/l)	$\leq$ 0.1	0.11-0.2	0.21-0.3	0.31-0.5	> 0.5
32	Conductivity (micromhos/cm)	$\leq$ 100	101-200	201-400	401-600	> 600
33	Algae - Amount	Absent				Profuse
34	Other Water Plants - Amount	Absent				Profuse
35	Invertebrates - Total Number	$\leq$ 50	51-200	201-350	351-500	> 500
36	Invetrebrates - Diversity	$\leq$ 5	6-10	11-15	16-20	> 20
IV.	DISVALUES					
37	Misfits or Disvalues	None		Few		Many
38	Visual Pollution Evidence	None				Evident
39	Litter - Metal**	< 2	2-5	5-10	10-50	> 50
40	Litter - Paper**	< 2	2-5	5-10	10-50	> 50
41	Litter - Plastic**	< 2	2-5	5-10	10-50	> 50

TABLE 4.3 (Continued)

		Rating Categories				
		1	2	3	4	5
42	Litter - Glass**	< 2	2-5	5-10	10-50	> 50
43	Removability of Litter	Easily				Difficult
V.	ESTHETIC IMPRESSION					
44	Visual Pattern Quality	Low		Medial		High
45	Land Husbandry	Low		Medial		High
46	Degree of Change	Original				Altered Greatly
47	Recovery Potential	Likely				Unlikely
48	Local Scene	Diverse Views				Little Diversity
49	View Confinement	Open				Closed
50	Serenity	Serene				Disturbing
51	Naturalness	Natural				Man-Made
52	Geological Values	None		Few		Many
53	Historical Values	None		Local Significance	Regional Significance	National Significance
54	Diversity - Flora & Fauna	Small				Great

* (% of total length of main channel > 0.25 miles from a road or human habitation)
** Number of pieces per 100 foot section.

TABLE 4.4

VARIMAX FACTOR LOADINGS - ALL STUDY STREAMS

FACTOR I (21.9%)**

"EASTERN KENTUCKY"

No.	Stream	Loading
2*	Buckhorn Creek	0.90
14*	Rock Creek	0.90
18	Cane Creek (Laurel County)	0.90
17	Barren Fork Indian Creek	0.88
11*	Martin's Fork	0.86
27	Young's Creek	0.84
24	Upper Devil Creek	0.83
10*	Laurel Fork	0.82
3*	Caney Creek	0.79
7*	Crooked Creek	0.67
13*	Red River	0.63
20	Leatherwood Branch	0.60
29	Cane Creek (Powell County)	0.54
28	Beaver Creek (Menifee County)	0.54
26	Wolf Creek	0.50

* Preference Streams

** Percent of total variance "explained" by factor

TABLE 4.4 (Continued)

FACTOR II (5.6%)

"WESTERN KENTUCKY"		
No.	Stream	Loading
52	Town Creek	0.78
56	Pond Run	0.67
50	Rock Lick Creek	0.59
58	Perkins Creek	0.54
48	Mill Creek	0.42
55	Lick Creek	0.37

FACTOR III (6.6%)

"MISSISSIPPIAN PLATEAUS"		
No.	Stream	Loading
4*	Casey Creek	0.87
1*	Big Brush Creek	0.73
5*	Clear Creek	0.59
47	Elk Fork	0.54
15*	Russell Creek	0.41
35	Fork Lick Creek	0.39

FACTOR IV (11.2%)

"OUTER BLUEGRASS"		
No.	Stream	Loading
42	Stoney Creek	0.83
39	Locust Creek	0.78
37	Glens Creek	0.67
41	Stephans Creek	0.64
31	Prather Creek	0.64
38	Johnson Creek	0.61
7	Pleasant Run	0.53
36	Garrison Creek	0.48
32	Quicks Run	0.48
51	Sugar Creek	0.48
40	Paint Lick Creek	0.43

antonymous physical measures. Factors III and IV separate, more or less precisely, streams of the Eastern and Western Mississippian Plateau and the rolling, shale hills of the Outer Blue Grass. The results of this "reverse" factor analysis are significant in that they tend to support the assumption that there are real differences, physical and esthetic, among the streams of the various physiographic regions.

APPLICATION OF METHODOLOGY

As indicated in Table 4. 3, the revised list of evaluative factors omits the two general classifications of factors (Watershed factors and Transect factors) and regroups the 54 factors into five more unified and related groups. The revised listing classifies the objective, measurable factors into four groups: (1) Physical Measures, (2) Land Use Measures (3) Water Quality Measures and (4) Disvalues. The subjective factors were placed into a fifth group, Esthetic Impression.

Using the revised list of fifty-four evaluative factors, category ratings were compiled for the Preference streams (Table 4. 5) and the Random streams (Table 4. 6)[1]. Following the procedure described at the beginning of this chapter, the number of streams by type (Preference, Random, All) in each category was determined for each evaluative factor (Table 4. 7), uniqueness ratios computed and summed (Tables 4. 8 and 4. 9)[2] and the streams ranked by type over all factors and by the five factor groupings (Tables 4. 10, 4. 11 and 4. 12).

ANALYSIS - UNIQUENESS RANKINGS

The uniqueness ratio concept does not distinguish whether a stream site is unique in a good or bad, positive or negative sense. It is simply a numerical way of expressing the "relative uniqueness" of each site and consequently its

[1] Category ratios for "all" streams were not tabulated separately but can be obtained from 4. 5 and 4. 6 combined.

[2] Uniqueness ratios for "all" streams were computed but not tabulated for this report. The ratios can, of course, be computed from Table 4. 7.

TABLE 4.5

PREFERENCE STREAMS

CATEGORY RATINGS ON EACH FACTOR

Factor		Stream Numbers 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I.	Physical Measures																
1	Drainage Area	3	2	2	2	3	2	2	2	3	2	1	5	4	2	5	2
2	Stream Order	5	4	4	4	5	5	3	3	4	5	4	5	5	3	5	4
3	Average Gradient	3	3	3	3	3	3	3	4	4	4	5	3	3	4	3	3
4	Total Relief	3	3	2	2	4	2	2	2	5	3	5	3	3	5	4	3
5	Average Flood Plain Width	2	2	1	3	2	4	1	3	2	2	1	2	4	2	3	2
6	Average Valley Ht./ Average Valley Width	2	5	5	2	2	2	5	2	5	4	5	2	2	4	2	3
7	Stream Width	3	3	3	3	3	2	2	3	4	3	2	5	4	3	5	4
8	Stream Depth	3	3	3	4	3	2	2	3	3	2	2	3	2	3	4	4
9	Stream Velocity (ft./ sec.)	5	1	1	4	2	2	1	5	2	1	2	2	4	2	3	1
10	Bed Material	4	2	3	3	5	1	3	5	3	5	4	3	5	3	3	1
11	Floatability	2	1	1	2	2	1	1	2	3	2	1	2	3	1	4	2
II.	Land Use Measures																
12	Forest Cover	2	5	4	2	1	4	4	3	5	4	5	1	4	5	2	2
13	Slopes	1	5	4	1	1	2	5	1	5	3	5	1	4	3	2	3
14	Land Use	2	5	5	2	2	2	5	3	5	3	5	2	3	5	2	2
15	Remoteness	2	3	2	3	1	3	1	1	1	1	5	1	1	2	1	1
16	Artificial Controls	1	1	1	1	1	1	1	4	1	1	1	3	1	2	1	2
17	Water Supply & Sewage Plants	1	1	1	1	1	1	1	1	1	1	1	3	2	1	2	2
18	Productive Industry	2	1	1	1	1	1	1	2	1	1	1	5	1	1	1	1
19	Extractive Industry	5	3	5	1	2	1	5	5	3	5	1	4	5	4	4	1
20	Valley Terrestial Habitat	5	5	5	5	5	2	2	2	5	2	5	2	5	5	2	2
21	Hillside Terrestial Habitat	2	5	5	2	5	5	5	5	5	5	5	2	5	5	5	2
III.	Water Quality Measures																
22	Temperature	3	3	2	1	4	2	3	1	4	2	3	5	4	2	1	2
23	Sedimentation	1	1	1	1	1	2	1	2	1	1	1	1	2	1	1	2
24	Turbidity	1	1	1	1	1	3	1	2	1	1	1	1	2	1	1	1
25	Dissolved Oxygen (mg/l)	4	4	4	4	4	2	3	4	3	4	4	3	4	3	4	2
26	pH	4	3	4	4	5	3	4	3	3	2	2	4	3	3	4	4
27	Alkalinity	3	2	3	3	4	2	3	5	2	1	1	4	2	2	3	4
28	Total Hardness	3	1	3	3	3	2	3	4	2	1	1	4	2	1	2	3
29	Nitrates	3	1	1	4	3	2	2	5	1	1	1	4	3	1	3	2
30	Ortho-phosphates (mg/l)	1	1	1	1	4	1	1	2	1	1	1	4	2	1	1	2
31	Ammonia	2	2	1	2	1	4	1	2	2	3	1	2	2	1	3	3
32	Conductivity (micrombos/cm)	2	1	2	2	3	2	2	3	1	1	1	3	1	1	2	3
33	Algae – Amount	2	2	2	1	3	1	3	2	1	2	2	2	3	4	2	1
34	Other Water Plants Amount	1	2	1	1	1	4	2	2	1	3	1	4	3	2	1	4
35	Invertebrates – Total No.	2	1	2	4	3	2	2	5	3	2	2	3	5	2	2	4
36	Invertebrates – Diversity	3	2	4	3	4	2	3	3	3	4	3	3	3	3	3	3
IV.	Disvalues																
37	Misfits or Dis-Values	2	2	2	2	2	2	2	2	2	2	2	3	3	3	2	2
38	Visual Pollution Evidence	1	1	2	2	2	1	1	1	1	1	1	2	1	1	1	1
39	Litter-Metal	4	1	5	4	5	3	4	1	4	1	4	5	3	1	3	2
40	Litter-Paper	2	1	5	4	4	2	1	1	1	1	2	2	2	1	2	1
41	Litter-Plastic	2	1	3	2	3	2	1	1	2	1	3	1	2	1	2	2
42	Litter-Glass	1	2	3	1	2	2	1	1	1	1	1	5	1	1	1	1
43	Removability of Litter	1	1	3	2	3	1	1	1	1	1	1	4	1	1	1	1
V.	Esthetic Impression Measures																
44	Visual Pattern Quality	4	4	4	4	4	3	3	3	5	4	5	4	4	5	4	3
45	Land Husbandry	3	4	4	3	4	3	3	4	5	4	5	4	5	5	3	3
46	Degree of Change	2	2	1	1	2	2	3	2	2	1	1	4	2	2	3	3
47	Recovery Potential	1	1	2	1	1	2	3	2	2	1	1	4	1	1	1	3
48	Local Scene	1	5	4	2	3	2	2	1	5	4	4	3	2	4	2	4
49	View Confinement	2	4	4	3	4	2	4	4	1	5	5	4	4	3	2	4
50	Serenity	1	1	1	1	2	1	2	1	1	1	1	2	1	1	2	2
51	Naturalness	1	1	1	1	1	3	3	2	1	1	1	2	1	2	2	3
52	Geological Values	3	3	3	2	2	1	3	2	3	2	4	2	4	4	1	1
53	Historical Values	2	3	1	3	3	1	1	4	3	1	4	4	4	2	3	1
54	Diversity – Flora & Fauna	4	4	5	2	3	3	4	4	5	4	5	2	5	5	3	2

TABLE 4.8

RANDOM STREAMS
CATEGORY RATINGS ON EACH FACTOR

Factor	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
I. Physical Measures																																										
1 Drainage Area	3	2	2	2	3	1	3	3	3	3	3	3	2	3	2	2	2	5	3	1	2	1	2	4	1	1	2	3	2	3	3	2	2	2	2	1	3	2	2	2	2	2
2 Stream Order	5	4	4	4	3	3	4	4	5	3	3	4	4	5	4	3	4	5	5	3	4	5	3	5	4	3	4	4	4	5	4	4	4	4	4	3	3	4	5	2	3	3
3 Average Gradient	4	4	4	4	3	4	3	4	3	4	4	3	4	3	3	3	3	3	3	5	3	3	5	3	4	4	3	3	4	3	3	3	3	3	3	3	3	3	3	3	2	3
4 Total Relief	3	3	3	3	3	2	4	3	3	3	2	3	3	2	3	3	2	3	2	3	2	3	3	3	3	2	2	3	3	3	3	4	2	2	2	2	1	1	1	1	1	1
5 Average Flood Plain Width	1	1	3	3	3	2	3	3	3	4	2	4	4	3	3	4	3	4	4	1	3	3	3	4	2	2	3	4	3	3	3	4	3	4	4	3	4	5	4	4	4	3
6 Average Valley Ht./ Average Valley Width	4	4	3	3	3	3	4	4	2	3	3	3	3	2	2	3	3	2	2	4	2	2	3	2	3	3	2	2	2	3	2	3	2	2	1	2	2	1	1	1	1	1
7 Stream Width	4	2	1	2	3	2	2	3	3	1	2	3	2	3	3	3	3	4	4	2	3	4	2	3	3	3	3	3	3	3	3	4	2	3	2	2	2	2	3	2	2	3
8 Stream Depth	4	1	1	1	2	2	3	2	3	2	2	4	3	3	3	5	2	3	3	3	3	2	3	3	3	3	2	2	4	3	2	4	3	2	5	3	1	3	2	3	3	2
9 Stream Velocity (ft/sec.)	2	2	1	1	2	1	2	1	2	2	2	2	2	5	2	1	2	2	2	1	2	1	1	1	1	1	1	2	2	1	2	4	2	4	1	5	4	2	3	4	2	2
10 Bed Material	5	5	3	3	3	1	3	5	3	1	5	5	3	1	4	3	5	2	3	4	3	5	3	5	3	5	3	3	3	4	3	5	3	1	1	1	3	1	3	1	1	3
11 Floatability	2	1	1	1	1	1	2	1	1	1	1	2	1	2	1	1	1	4	2	1	1	1	1	3	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	1	1
II. Land Use Measures																																										
12 Forest Cover	5	5	4	4	5	4	4	3	3	4	3	5	5	1	1	4	2	1	2	2	2	1	2	1	2	3	1	2	4	4	1	3	4	2	3	3	4	1	1	2	2	1
13 Slopes	3	4	4	4	5	4	4	4	3	5	5	4	5	1	1	4	4	1	2	3	3	2	4	2	3	2	1	2	3	2	1	1	3	2	1	3	2	1	1	1	1	1
14 Land Use	5	5	3	3	4	3	3	3	2	3	3	5	5	1	2	3	2	2	2	3	2	2	3	2	2	2	2	2	3	3	2	1	1	2	2	2	4	2	2	4	2	1
15 Remoteness	3	4	1	1	1	3	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1	1	1	2	2	2	2	3	1	1	1	3	4	1	2	5	1	1
16 Artificial Controls	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	2	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	2	1	1	4	4	4	4	4	1
17 Water Supply & Sewage Plants	1	1	1	1	1	1	1	1	2	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	3	1	1	1	1	1	1	1	1	1	1
18 Productive Industry	1	1	1	1	1	1	1	1	3	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19 Extractive Industry	1	1	1	1	2	1	5	4	5	4	1	5	5	3	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	5	2	5	1	1	5	5	5	5	5	3
20 Valley Terrestial Habitat	5	5	1	2	4	5	1	5	5	1	5	1	2	3	2	2	1	1	5	5	2	2	2	2	1	1	2	1	2	2	5	2	2	1	2	2	4	2	5	1	1	2
21 Hillside Terrestial Habitat	5	5	1	5	5	5	5	5	5	5	5	5	5	5	5	3	1	5	2	5	5	5	5	5	5	5	2	1	6	1	1	5	5	5	2	5	4	1	5	4	1	5
III. Water Quality Measures																																										
22 Temperature	4	1	5	4	2	2	3	2	2	2	2	3	2	2	3	2	4	3	4	1	3	3	2	4	1	2	5	4	4	3	2	3	2	2	2	2	5	5	2	5	2	1
23 Sedimentation	1	1	1	1	5	3	2	1	2	2	3	1	2	4	1	1	2	4	2	5	1	1	2	3	2	1	2	1	1	1	2	4	1	4	4	5	5	3	4	1	4	1
24 Turbidity	1	1	3	1	2	3	1	1	2	1	2	1	2	4	2	2	2	4	2	4	2	1	1	1	1	1	2	2	1	1	2	3	1	2	2	5	1	1	2	1	2	1
25 Dissolved Oxygen (mg/l)	4	4	4	3	3	3	4	4	4	4	4	4	3	3	4	3	2	4	4	4	3	4	2	5	3	2	4	4	5	3	3	4	4	2	3	3	5	4	3	4	3	4
26 pH	2	3	3	3	3	4	4	4	4	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	3	3	3	1	4	3	3	3	3
27 Alkalinity	1	1	2	3	2	3	2	3	3	2	1	2	3	3	4	5	4	3	3	4	4	3	5	3	4	4	3	4	3	2	4	4	4	2	2	3	2	5	3	3	4	2
28 Total Hardness	1	1	2	3	3	3	4	3	3	3	1	2	3	3	3	4	2	3	3	4	4	3	4	4	4	4	3	3	3	2	3	3	3	2	2	2	6	5	3	3	3	1
29 Nitrates	1	1	1	2	2	2	1	1	1	2	2	1	2	4	3	2	3	4	3	3	2	2	2	2	2	2	2	2	2	1	5	3	2	5	1	4	4	2	4	2	2	5
30 Ortho-phosphates (mg/l)	1	1	1	1	1	1	1	1	2	1	1	1	1	4	1	1	2	4	2	2	2	2	1	1	2	1	3	1	1	1	3	3	1	1	1	3	2	1	1	1	3	5
31 Ammonia	1	2	1	1	3	4	2	2	3	2	2	1	1	5	5	1	1	2	2	4	2	3	4	4	4	3	1	2	1	1	2	4	1	2	1	3	5	3	1	5	2	1
32 Conductivity (micromhos/cm)	1	1	2	1	4	2	5	2	3	2	1	3	2	3	3	3	3	3	2	3	2	2	3	3	3	3	3	3	2	2	3	3	3	3	2	2	5	5	4	5	3	2
33 Algae - Amount	2	2	1	1	1	2	2	2	1	3	2	1	1	1	2	1	2	2	1	2	2	4	2	2	2	2	2	2	2	2	3	1	2	1	1	1	3	1	1	5	1	1
34 Other Water Plants Amount	2	1	1	1	1	1	3	1	1	1	1	2	1	1	2	1	4	2	3	1	2	1	1	2	1	1	4	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
35 Invertebrates - Total No.	2	1	1	1	1	1	2	1	5	2	2	2	1	2	3	3	2	3	3	2	2	2	2	2	2	1	5	2	2	2	5	3	2	3	1	1	2	5	1	1	1	1
36 Invertebrates - Diversity	3	2	1	2	1	2	2	2	2	2	2	3	2	2	3	4	2	1	3	4	2	1	3	1	2	1	3	3	4	2	4	3	2	2	1	1	1	2	1	1	1	1
IV. Disvalues																																										
37 Misfits or Dis-Values	1	2	3	2	4	3	4	2	4	3	1	2	3	4	2	3	1	2	1	2	3	2	3	2	2	2	2	2	2	2	1	4	2	3	2	4	5	2	4	4	5	2
38 Visual Pollution Evidence	1	1	1	1	5	3	3	1	3	1	1	1	1	2	3	2	2	1	1	2	2	2	2	2	2	1	2	1	2	1	1	3	2	1	1	2	5	2	2	2	5	1
39 Litter-Metal	1	1	4	2	5	5	5	2	4	1	1	3	4	4	3	4	2	2	1	2	5	4	2	2	1	2	1	3	3	2	1	2	2	1	1	2	1	2	1	4	3	2
40 Litter-Paper	1	1	2	1	2	4	4	1	3	1	1	4	2	3	2	1	2	1	1	1	3	3	2	1	2	3	1	1	2	1	1	2	1	2	1	1	1	1	1	2	2	1
41 Litter-Plastic	1	1	3	3	2	3	5	1	4	1	1	1	1	3	2	1	2	1	1	2	3	3	4	1	1	3	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1
42 Litter-Glass	1	1	3	2	3	3	5	1	3	1	1	1	2	4	5	1	1	1	1	1	1	2	2	1	2	2	1	1	1	1	1	2	2	1	1	1	1	1	2	1	2	2
43 Removability of Litter	1	1	1	1	4	4	3	1	4	1	1	1	1	4	2	1	5	1	1	1	2	3	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
V. Esthetic Impression Measures																																										
44 Visual Pattern Quality	4	5	2	3	1	4	3	5	2	3	4	3	3	1	3	3	3	3	3	3	4	3	3	4	3	4	3	3	3	3	4	3	3	2	2	1	1	3	3	1	1	3
45 Land Husbandry	3	4	3	3	2	3	3	5	3	4	4	3	3	3	3	3	3	3	3	3	3	4	4	4	3	4	3	3	3	4	4	3	4	3	2	3	1	4	3	3	3	2
46 Degree of Change	2	2	3	3	4	3	3	1	3	3	1	2	3	3	4	2	4	4	2	2	3	3	4	3	3	2	3	3	4	2	2	4	2	4	4	4	5	4	2	5	3	2
47 Recovery Potential	1	1	4	2	3	3	3	1	3	3	1	3	3	3	4	1	4	3	2	2	3	3	3	3	2	3	3	2	2	2	1	3	2	3	4	4	5	4	1	4	4	1
48 Local Scene	3	3	2	2	3	4	2	4	4	2	4	2	2	4	2	3	4	3	3	3	2	2	2	2	5	2	4	3	2	3	4	2	2	2	4	3	5	5	2	4	5	2
49 View Confinement	4	3	2	1	4	4	1	4	5	4	4	1	5	4	2	3	2	1	1	3	2	1	4	1	5	3	2	4	1	2	4	1	1	2	4	4	2	4	4	5	4	5
50 Serenity	1	1	1	3	2	2	4	1	4	4	1	1	3	3	4	1	3	2	1	3	2	2	1	1	1	1	3	2	3	1	1	4	2	2	3	3	5	3	1	3	1	3
51 Naturalness	1	1	3	3	4	2	4	1	4	3	1	2	3	3	4	2	4	3	2	1	3	4	3	2	2	2	3	2	4	2	1	3	3	3	3	5	5	3	2	5	4	2
52 Geological Values	4	4	1	2	2	4	3	4	1	3	4	1	2	1	3	1	1	1	1	1	2	1	1	1	2	3	1	1	3	1	2	1	1	1	1	1	1	1	3	1	1	1
53 Historical Values	2	2	1	1	3	1	2	3	3	1	2	1	2	1	2	1	1	3	2	1	2	2	1	3	1	2	2	2	1	2	3	2	2	1	2	1	1	1	1	1	1	2
54 Diversity - Flora & Fauna	4	4	2	3	[illegible]	4	4	5	3	2	4	3	3	3	3	4	1	3	2	4	4	3	3	3	4	4	2	1	2	2	3	4	3	2	1	2	1	1	4	1	1	3

TABLE 4.7

NUMBER OF STREAMS IN EACH CATEGORY

FACTOR	ALL STREAMS					RANDOM STREAMS					PREFERENCE STREAMS				
1	7	33	13	2	3	6	24	10	1	1	1	9	3	1	2
2	0	1	15	26	16	0	1	12	20	9	0	0	3	6	7
3	0	1	38	16	3	0	1	27	12	2	0	0	11	4	1
4	6	20	25	4	3	6	14	20	2	0	0	6	5	2	3
5	6	17	16	17	2	3	9	13	15	2	3	8	3	2	0
6	6	25	15	7	5	6	17	14	5	0	0	8	1	2	5
7	3	20	25	8	2	3	17	17	5	0	0	3	8	3	2
8	5	18	27	7	1	5	13	19	4	1	0	5	8	3	0
9	19	26	3	6	4	14	20	2	4	2	5	6	1	2	2
10	11	1	26	5	15	9	0	19	3	11	2	1	7	2	4
11	39	14	3	2	0	33	7	1	1	0	6	7	2	1	0
12	12	14	8	15	9	10	10	7	10	5	2	4	1	5	4
13	17	11	10	12	8	12	9	7	10	4	5	2	3	2	4
14	4	26	15	3	10	4	19	12	3	4	0	7	3	0	6
15	36	11	7	2	2	27	8	4	2	1	9	3	3	0	1
16	43	7	1	7	0	31	5	0	6	0	12	2	1	1	0
17	49	6	2	0	1	37	3	1	0	1	12	3	1	0	0
18	53	2	1	0	2	40	0	1	0	1	13	2	0	0	1
19	27	5	4	5	17	23	4	2	2	11	4	1	2	3	6
20	12	24	1	2	19	12	17	1	2	10	0	7	0	0	9
21	7	7	0	2	42	7	3	0	2	30	0	4	0	0	12
22	7	23	12	10	6	4	18	8	7	5	3	5	4	3	1
23	30	14	3	7	4	18	10	3	7	4	12	4	0	0	0
24	32	18	4	3	1	19	16	3	3	1	13	2	1	0	0
25	0	6	18	31	3	0	4	14	21	3	0	2	4	10	0
26	1	3	20	33	1	1	1	14	26	0	0	2	6	7	1
27	6	15	19	14	4	4	10	14	11	3	2	5	5	3	1
28	8	12	25	10	3	4	8	19	8	3	4	4	6	2	0
29	15	24	8	7	4	9	21	4	5	3	6	3	4	2	1
30	37	11	5	4	1	26	8	5	2	1	11	3	0	2	0
31	19	19	8	7	5	14	12	5	6	5	5	7	3	1	0
32	10	18	24	2	4	4	12	20	2	4	6	6	4	0	0
33	21	27	7	2	1	17	19	4	1	1	4	8	3	1	0
34	38	11	4	5	0	31	7	2	2	0	7	4	2	3	0
35	16	25	9	2	6	15	17	6	0	4	1	8	3	2	2
36	10	18	23	7	0	10	16	12	4	0	0	2	11	3	0
37	4	32	12	8	2	4	19	9	8	2	0	13	3	0	0
38	30	20	5	0	3	18	16	5	0	3	12	4	0	0	0
39	16	14	7	12	9	12	13	4	7	6	4	1	3	5	3
40	29	19	4	5	1	22	13	4	3	0	7	6	0	2	1
41	32	13	10	2	1	26	6	7	2	1	6	7	3	0	0
42	35	14	5	1	3	24	11	4	1	2	11	3	1	0	1
43	42	6	4	5	1	30	5	2	4	1	12	1	2	1	0
44	6	4	27	16	5	6	4	23	7	2	0	0	4	9	3
45	1	3	32	17	5	1	3	26	11	1	0	0	6	6	4
46	6	21	17	12	2	2	13	14	11	2	4	8	3	1	0
47	17	12	19	9	1	8	8	17	8	1	9	4	2	1	0
48	2	23	12	15	6	0	18	10	10	4	2	5	2	5	2
49	10	11	7	23	7	9	8	5	15	5	1	3	2	8	2
50	27	12	13	5	1	16	7	13	5	1	11	5	0	0	0
51	15	15	17	8	3	6	11	14	8	3	9	4	3	0	0
52	28	11	11	8	0	25	6	6	5	0	3	5	5	3	0
53	24	19	11	4	0	19	17	6	0	0	5	2	5	4	0
54	7	10	18	17	6	7	7	15	12	1	0	3	3	5	5

TABLE 4.8

PREFERENCE STREAMS

UNIQUENESS RATIOS

	Factor	Stream Numbers 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I.	Physical Measures																
1	Drainage Area	.33	.11	.11	.11	.33	.11	.11	.11	.33	.11	1.00	.50	1.00	.11	.50	.11
2	Stream Order	.14	.17	.17	.17	.14	.14	.33	.33	.17	.14	.17	.14	.14	.33	.14	.17
3	Average Gradient	.09	.09	.09	.09	.09	.09	.09	.25	.25	.25	1.00	.09	.09	.25	.09	.09
4	Total Relief	.20	.20	.17	.17	.50	.17	.17	.17	.33	.20	.33	.17	.20	.33	.50	.20
5	Average Flood Plain Width	.13	.13	.33	.33	.13	.50	.33	.33	.13	.13	.33	.13	.50	.13	.33	.13
6	Average Valley Ht./ Average Valley Width	.13	.20	.20	.13	.13	.13	.20	.13	.20	.50	.20	.13	.13	.50	.13	1.00
7	Stream Width	.13	.13	.13	.13	.13	.33	.33	.13	.33	.13	.33	.50	.33	.13	.50	.33
8	Stream Depth	.13	.13	.13	.33	.13	.20	.20	.13	.13	.20	.20	.13	.20	.13	.33	.33
9	Stream Velocity (ft./ sec.)	.50	.20	.20	.50	.17	.17	.20	.50	.17	.20	.17	.17	.50	.17	1.00	.20
10	Bed Material	.50	1.00	.14	.14	.25	.50	.14	.25	.14	.25	.50	.14	.25	.14	.14	.50
11	Floatability	.14	.17	.17	.14	.14	.17	.17	.14	.50	.14	.17	.14	.50	.17	1.00	.14
	Group Total	2.42	2.53	1.84	2.24	2.14	2.51	2.27	2.47	2.68	2.25	4.40	2.24	3.64	2.39	4.66	3.20
II.	Land Use Measures																
12	Forest Cover	.25	.25	.20	.25	.50	.20	.20	1.00	.25	.20	.25	.50	.20	.25	.25	.25
13	Slopes	.20	.25	.50	.20	.20	.50	.25	.20	.25	.33	.25	.20	.50	.33	.50	.33
14	Land Use	.14	.17	.17	.14	.14	.14	.17	.33	.17	.33	.17	.14	.33	.17	.14	.14
15	Remoteness	.33	.33	.33	.33	.11	.33	.11	.11	.11	.11	1.00	.11	.11	.33	.11	.11
16	Artificial Controls	.08	.08	.08	.08	.08	.08	.08	1.00	.08	.08	.08	1.00	.08	.50	.08	.50
17	Water Supply & Sewage Plants	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	1.00	.33	.08	.33	.33
18	Productive Industry	.50	.08	.08	.08	.08	.08	.08	.50	.08	.08	.08	1.00	.08	.08	.08	.08
19	Extractive Industry	.17	.50	.17	.25	1.00	.25	.17	.17	.50	.17	.25	.33	.17	.33	.33	.25
20	Valley Terrestial Habitat	.11	.11	.11	.11	.11	.14	.14	.14	.11	.14	.11	.14	.11	.11	.14	.14
21	Hillside Terrestial Habitat	.25	.09	.09	.25	.09	.09	.09	.09	.09	.09	.09	.25	.09	.09	.09	.25
	Group Total	2.11	1.94	1.81	1.77	2.39	1.89	1.37	3.62	1.72	1.61	2.36	4.67	2.00	2.27	2.05	2.38
III.	Water Quality Measures																
22	Temperature	.25	.25	.20	.33	.33	.20	.25	.33	.33	.20	.25	1.00	.33	.20	.33	.20
23	Sedimentation	.08	.08	.08	.08	.08	.25	.08	.25	.08	.08	.08	.08	.25	.08	.08	.25
24	Turbidity	.08	.08	.08	.08	.08	1.00	.08	.50	.08	.08	.08	.08	.50	.08	.08	.08
25	Dissolved Oxygen (mg/l)	.10	.10	.10	.10	.10	.50	.25	.10	.25	.10	.10	.25	.10	.25	.10	.50
26	pH	.14	.17	.14	.14	1.00	.17	.14	.17	.17	.50	.50	.14	.17	.17	.14	.14
27	Alkalinity	.20	.20	.20	.20	.33	.20	.20	1.00	.20	.50	.50	.33	.20	.20	.20	.33
28	Total Hardness	.17	.25	.17	.17	.17	.25	.17	.50	.25	.25	.25	.50	.25	.25	.25	.17
29	Nitrates	.25	.17	.17	.50	.25	.33	.33	1.00	.17	.17	.17	.50	.25	.17	.25	.33
30	Ortho-phosphates (mg/l)	.09	.09	.09	.09	.50	.09	.09	.33	.09	.09	.09	.50	.33	.09	.09	.33
31	Ammonia	.14	.14	.20	.14	.20	1.00	.20	.14	.14	.33	.20	.14	.14	.20	.33	.33
32	Conductivity (micrombos/cm)	.17	.17	.17	.17	.25	.17	.17	.25	.17	.17	.17	.25	.17	.17	.17	.25
33	Algae - Amount	.13	.13	.13	.25	.33	.25	.33	.13	.25	.13	.13	.13	.33	1.00	.13	.25
34	Other Water Plants Amount	.14	.25	.14	.14	.14	.33	.25	.25	.14	.50	.14	.33	.50	.25	.14	.33
35	Invertebrates - Total No.	.13	1.00	.13	.50	.33	.13	.13	.50	.33	.13	.13	.33	.50	.13	.13	.50
36	Invertebrates - Diversity	.09	.50	.33	.09	.33	.50	.09	.09	.09	.33	.09	.09	.09	.09	.09	.09
	Group Total	2.16	3.56	2.33	2.98	4.42	5.37	2.76	5.54	2.74	3.56	2.88	4.65	4.11	3.33	2.51	4.08
IV.	Disvalues																
37	Misfits or Dis-Values	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.33	.33	.33	.08	.08
38	Visual Pollution Evidence	.08	.08	.25	.25	.25	.08	.08	.08	.08	.08	.08	.25	.08	.08	.08	.08
39	Litter - Metal	.20	.25	.33	.20	.33	.33	.20	.25	.20	.25	.20	.33	.33	.25	.33	1.00
40	Litter - Paper	.17	.14	1.00	.50	.50	.17	.14	.14	.14	.14	.17	.17	.17	.14	.17	.14
41	Litter - Plastic	.14	.17	.33	.14	.33	.14	.17	.17	.14	.17	.33	.17	.14	.17	.14	.14
42	Litter - Glass	.09	.33	1.00	.09	.33	.33	.09	.09	.09	.09	.09	1.00	.09	.09	.09	.09
43	Removability of Litter	.08	.08	.50	1.00	.50	.08	.08	.08	.08	.08	.08	1.00	.08	.08	.08	.08
	Group Total	0.84	1.13	3.49	2.26	2.32	1.21	0.84	0.89	0.81	0.89	1.03	3.25	1.22	1.14	0.97	1.61
V.	Esthetic Impression Measures																
44	Visual Pattern Quality	.11	.11	.11	.11	.11	.25	.25	.25	.33	.11	.33	.11	.11	.33	.11	.25
45	Land Husbandry	.17	.17	.17	.17	.17	.17	.17	.17	.25	.17	.25	.17	.25	.25	.17	.17
46	Degree of Change	.13	.13	.25	.25	.13	.13	.33	.13	.13	.25	.25	1.00	.13	.13	.33	.33
47	Recovery Potential	.11	.11	.25	.11	.11	.25	.50	.25	.25	.11	.11	1.00	.11	.11	.11	.50
48	Local Scene	.50	.50	.20	.20	.50	.20	.20	.50	.50	.20	.20	.50	.20	.20	.20	.20
49	View Confinement	.33	.13	.13	.50	.13	.33	.13	.13	1.00	.50	.50	.13	.13	.50	.33	.13
50	Serenity	.09	.09	.09	.09	.20	.09	.20	.09	.09	.09	.09	.20	.09	.09	.20	.20
51	Naturalness	.11	.11	.11	.11	.11	.33	.33	.25	.11	.11	.11	.25	.11	.25	.25	.33
52	Geological Values	.20	.20	.20	.20	.20	.33	.20	.20	.20	.20	.33	.20	.33	.33	.33	.33
53	Historical Values	.50	.20	.20	.20	.20	.20	.20	.25	.20	.20	.25	.25	.25	.50	.20	.20
54	Diversity - Flora & Fauna	.20	.20	.20	.33	.33	.33	.20	.20	.20	.20	.20	.33	.20	.20	.33	.33
	Group Total	2.45	1.95	1.91	2.27	2.16	2.61	2.71	2.42	3.28	2.14	2.62	4.14	1.91	2.89	2.56	2.97
	Grand Total	9.98	11.13	11.38	11.52	13.43	13.59	9.95	14.94	11.21	10.45	13.29	18.95	13.08	12.02	12.75	14.24
	Rank	15	13	11	10	5	4	16	2	12	14	6	1	7	9	8	3

TABLE 4.9

RANDOM STREAMS
UNIQUENESS RATIOS

Factor	Stream Numbers																																								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
I. Physical Measures																																										
1 Drainage Area	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 Stream Order	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3 Average Gradient	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4 Total Relief	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5 Average Flood Plain Width	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6 Average Valley Height/Average Valley Width	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7 Stream Width	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8 Stream Depth	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9 Stream Velocity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10 Bed Material	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11 Floatability	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Group Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
II. Land Use Measures																																										
12 Forest Cover	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13 Slopes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14 Land Use	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15 Remoteness	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16 Artificial Controls	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17 Water Supply & Sewage Plants	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18 Productive Industry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19 Extractive Industry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20 Valley Terrestrial Habitat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21 Hillsides Terrestrial Habitat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Group Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
III. Water Quality Measures																																										
22 Temperature	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23 Sedimentation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24 Turbidity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25 Dissolved Oxygen	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26 pH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27 Alkalinity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28 Total Hardness	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29 Nitrates	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30 Ortho-Phosphates (mg/l)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31 Ammonia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32 Conductivity (micromhos/cm)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
33 Algae - Amount	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
34 Other Water Plants - Amount	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35 Invertebrates - Total No.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36 Invertebrates - Diversity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Group Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
IV. Disvalues																																										
37 Misfits or Disvalues	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38 Visual Pollution Evidence	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39 Litter - Metal	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40 Litter - Paper	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
41 Litter - Plastic	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
42 Litter - Glass	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43 Removability of Litter	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Group Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
V. Esthetic Impression Measures																																										
44 Visual Pattern Quality	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
45 Land Husbandry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
46 Degree of Change	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
47 Recovery Potential	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
48 Local Scene	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
49 View Confinement	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50 Scenery	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51 Naturalness	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
52 Geological Values	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
53 Historical Values	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
54 Diversity - Flora & Fauna	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Group Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Grand Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ranking	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

possible importance to man. To quote from Leopold (10) "a landscape that is unique either in a positive or negative way is of more significance to society than one that is common". A stream unique in a positive sense maybe undeveloped, natural and esthetically pleasing. On the other hand, a stream unique in a negative sense maybe highly developed, grossly polluted, and very unesthetic in character.

In observing the "total uniqueness ratios" for all of the streams of the three stream classifications, the most unique streams (those with the greatest "total uniqueness ratio") were unique in a negative sense. The most unique stream of the entire study was Isaacs Creek in the Western Coal Field, a stream heavily damaged by surface mining operations.

Preference Streams: Looking first at Table 4.10 which shows the rankings of the Preference streams, it can be seen that North Elkhorn Creek in the Inner Blue Grass region was the most unique stream of this type. Its uniqueness can be attributed to several factors. First, North Elkhorn is the only stream in the Preference classification that contains two highly urbanized areas within its watershed, Lexington and Georgetown, Kentucky. Secondly, its flow is controlled to a greater extent than those of other Preference streams due to the presence of several small dams. Thirdly, the water quality is affected by the presence of sewage effluent emptied into the stream by an Army depot installation and the city of Georgetown, Kentucky. Finally, compared to the other Preference streams, North Elkhorn is one of the few situated in a predominately open pasture-like watershed with little rough terrain or forests. North Elkhorn Creek ranked first in uniqueness in the Land Use and Esthetic Impression factor groups, second in Disvalues, third in the Water Quality Measures group, and thirteenth in the Physical Measures group uniqueness.

Other streams exhibiting high uniqueness based upon the "total uniqueness ratio" in descending order are: Doe Run in the Mississippian Western Plateau, South Fork of Grassy Creek in the Outer Blue Grass, Clifty

TABLE 4.10

RANKING OF PREFERENCE STREAMS BASED ON
GROUPS OF FACTORS AND ALL FACTORS

	Stream Name	Physical	Land Use	Water Quality	Disvalues	Esthetic Impression	All
1	Big Brush Creek	9	7	16	13	9	15
2	Buckhorn Creek	6	10	7	9	14	13
3	Caney Creek	15	12	15	1	15	11
4	Casey Creek	13	13	10	4	11	10
5	Clear Creek	14	3	4	3	12	5
6	Clifty Creek	7	11	2	7	7	4
7	Crooked Creek	11	16	12	13	5	16
8	Doe Run	8	2	1	12	10	2
9	Greasy Creek	5	14	13	14	2	12
10	Laurel Fork	12	15	8	12	13	14
11	Martin's Fork	2	5	11	10	6	6
12	North Elkhorn Creek	13	1	3	2	1	1
13	Red River	3	9	5	6	15	7
14	Rock Creek	10	6	9	8	4	9
15	Russell Creek	1	8	14	11	8	8
16	South Fork Grassey Creek	4	4	6	5	3	3

Creek in the Mississippian Western Plateau, Clear Creek in the Inner Blue Grass, Martin's Fork and Red River in the Eastern Coal Field, and Russell Creek in the Mississippian Eastern Plateau.

Doe Run, located in Meade County, is formed from the discharge of two large springs. Through the years various grist mills have utilized the water of Doe Run as a source of power, thus giving the stream local and regional historic value. The flow of Doe Run is somewhat controlled by a series of small mill dams. The lower reaches of the stream have recently been inundated by a large lake on which is being developed an extensive residential-recreational complex.

The South Fork of Grassy Creek is a relatively sluggish stream situated in the "Eden Hills", a rolling pasture land of the Outer Blue Grass. Its watershed is relatively unforested. One upstream tributary has been dammed to form a recreational and water supply reservoir for Williamstown, Kentucky.

Clifty Creek, located in Todd and Logan Counties, was the most unesthetic and drab of the Preference streams. In Water Quality group uniqueness, Clifty Creek ranked second only to Doe Run.

Clear Creek, located in Jessamine and Woodford Counties, is a reasonably clean stream with numerous springs along its length. Several species of game fish are common in the lower reaches of the stream. Clear Creek ranked third in the Land Use and Disvalues group uniqueness and fourth in the Water Quality group uniqueness.

Martin's Fork was the most rugged, and undeveloped of the Preference streams. Its waters are clear and cold enough to support a trout stocking program. The headwaters of Martin's Fork are located in Cumberland Gap National Park.

A portion of the Red River, located in Wolfe and Menifee Counties, flows through a natural canyon or gorge which gives the stream a distinctive esthetic character. The Red River Gorge is noted for numerous unique plant and animal communities. Also within the gorge area are many natural arches, as well as, other unique geological features. The upper portion of the Red River, however, flows through some heavily used agricultural land and this tends to reduce the overall quality of the stream.

Russell Creek, located in Green, Taylor, Adair and Russell Counties, is one of the largest of the Preference streams. It ranked first in Physical group uniqueness and eighth in the "total uniqueness ratio" ranking. Russell Creek is situated in the predominately flat farm land of south central Kentucky.

The Preference stream with the lowest uniqueness ranking was Crooked Creek located in Rockcastle County. This stream ranked low in every group except Esthetic Impression where it ranked fifth.

It is important to note the streams ranked in the lower positions of the ranking tables are by no means of little or no value. On the contrary most of them were of high quality and deserving of consideration for possible preservation.

Random Streams: In the rankings of Random streams (Table 4.11), Isaacs Creek in Muhlenberg County, was the most unique. It was unique in several ways. First, Isaacs Creek was completely devoid of any aquatic life due to acid mine drainage and siltation from the surrounding strip mines. Secondly, it contained an excessive amount of reddish brown sediment in the form of iron oxide and had the lowest pH of any stream studied. Thirdly, active strip mine operations border large portions of the stream thus reducing or eliminating any potential for recovery. Isaacs Creek was the most unique stream investigated since it was the most grossly polluted and most greatly altered from its original condition. Isaacs Creek ranked first in Water Quality and Esthetic Impression group uniqueness, third in Land Use group uniqueness, tenth in Disvalues group uniqueness and seventeenth in Physical group uniqueness.

TABLE 4.11

RANKING OF RANDOM STREAMS BASED ON GROUPS OF FACTORS AND ALL FACTORS

	Stream Name	Physical	Land Use	Water Quality	Disvalues	Esthetic Impression	All
17	Barren Fork Indian Creek	8	11	2	23	19	9
18	Cane Creek (Laurel County)	15	7	17	28	4	12
19	Everman Creek	16	28	20	13	18	25
20	Leatherwood Branch	28	34	29	19	28	38
21	Middle Creek	29	6	16	6	6	8
22	Pleasant Run	21	23	20	5	18	18
23	Rockhouse Creek	10	31	14	1	20	4
24	Upper Devil	24	12	36	28	2	5
25	Upper Tygarts	30	5	26	3	8	7
26	Wolf Creek	18	9	30	26	20	27
27	Youngs Creek	23	24	22	16	5	22
28	Beaver Creek (Menifee County)	19	18	34	14	34	30
29	Cane Creek (Powell County)	34	14	38	20	26	39
30	Pond Creek	11	1	8	2	33	2
31	Prather Creek	24	37	28	7	14	25
32	Quicks Run	32	27	23	22	27	36
33	Beaver Creek (Anderson County)	29	17	9	4	23	16
34	Little Beech Fork	1	36	7	28	25	6
35	Fork Lick Creek	20	19	12	16	28	26
36	Garrison Creek	4	30	6	17	21	13
37	Glens Creek	33	29	31	14	20	34
38	Johnson Creek	22	38	7	8	29	19
39	Locust Creek	16	22	21	9	34	24
40	Paint Lick Creek	2	35	15	28	24	14
41	Stephens Creek	27	33	25	25	10	33
42	Stoney Creek	13	32	27	11	15	23
43	Townsend Creek	32	15	13	28	32	29
44	East Fork Barren River	31	8	37	18	26	35
45	Meshack Creek	26	28	24	16	23	32
46	South Fork	9	26	35	28	30	31
47	Elk Fork Creek	30	13	10	16	9	21
48	Mill Creek	7	4	11	15	31	5
49	Montgomery Creek	35	16	39	12	22	37
50	Rock Lick Creek	24	25	18	24	16	28
51	Sugar Creek	6	20	32	28	7	20
52	Town Creek	14	22	3	25	12	11
53	Isaacs Creek	17	3	1	10	1	1
54	Kashlick Creek	12	23	5	28	17	17
55	Lick Creek	11	21	19	21	29	26
56	Pond Run	3	2	4	16	3	3
57	Richland Slough	5	21	33	4	13	10
58	Perkins Creek	25	10	4	27	11	15

Other Random streams ranking high in "total uniqueness" in a negative sense include: Pond Creek in the Knobs and Escarpment, Pond Run and Richland Slough in the Western Coal Field, and Middle Creek and Rockhouse Creek in the Eastern Coal Field.

Pond Creek, located in Jefferson County, was the only stream in the Random classification situated in a highly urbanized area. It flows directly through the Louisville area and contains numerous water plants, sewage plants, and productive industries within its watershed. Pond Creek ranked first in Land Use group uniqueness, second in Disvalues group uniqueness, eighth in Water Quality group uniqueness, eleventh in Physical group uniqueness and thirty-third in Esthetic Impression group uniqueness. Pond Creek ranked second in "total uniqueness ratio".

Pond Run, located in Ohio County, was another stream greatly altered by strip mining operations. It empties directly into the Green River in the vicinity of TVA's massive fossil (coal) fuel stream generation power plant at Paradise. Large sections of the stream channel have been dredged and straightened. Pond Run ranked second in Land Use group uniqueness, third in Physical and Esthetic Impression group uniqueness, fourth in Water Quality group uniqueness and eighteenth in Disvalues group uniqueness. Pond Run ranked third in "total uniqueness ratio".

Rockhouse Creek, located in Letcher County, ranked first in Disvalues group uniqueness due to the excessive amount of litter strown about its banks. The litter was from dewllings and highways adjacent to the creek. Rockhouse Creek also ranked tenth in Physical group uniqueness, fourteenth in Water Quality group uniqueness, tenth in Esthetic Impression group uniqueness and thirty-first in Land Use group uniqueness. The high score in Disvalues group uniqueness enabled Rockhouse Creek to be ranked fourth in "total uniqueness ratio".

Middle Creek, located in the Prestonburg area of Floyd County, was another stream altered by coak mining. The development in its upper reaches produced thick mats of reddish brown sediment so characteristic of streams in coal mining areas. Middle Creek also had excessive litter along its banks especially in the Archer Park area. Middle Creek ranked eighth in "total uniqueness ratio".

Richland Slough, located in Henderson County, was one of the more unesthetic streams of the Random stream classification. It had large portions of its channel dredged and straightened and the water was very murky and slow moving. Richland Slough ranked tenth in "total uniqueness ratio".

Random streams ranking high in "total uniqueness ratio" in the positive sense include: Upper Devil, Upper Tygarts, Barren Fork of Indian Creek and Cane Creek (Laurel County) in the Eastern Coal Field and Little Beech Fork in the Outer Blue Grass.

Upper Devil Creek, located in Wolfe County, was the most unique stream in a positive scene of the Random classification. It's watershed has been maintained in a highly esthetic condition due to its highly forested and steeply sloped hills that are relatively remote and undeveloped. Upper Devil ranked second in Esthetic Impression group uniqueness, twelfth in Land Use group uniqueness, twenty-fourth in Physical group uniqueness, twenty-eighth in Disvalues and thirty-sixth in Water Quality group uniqueness. It ranked fifth in "total uniqueness ratio".

Upper Tygarts Creek in the Olive Hill area of Carter County, was littered to an excessive extent. The scattered litter tarnished the streams potentially esthetic character. It ranked third in Disvalues group uniqueness, fifth in Land Use group uniqueness, eighth in Esthetic Impression group uniqueness, twenty-sixth in Water Quality group uniqueness and thirtieth in Physical group uniqueness. Upper Tygarts Creek ranked seventh in "total uniqueness ratio".

Barren Fork of Indian Creek, located in McCreary County, empties into the Cumberland River just above Cumberland Falls. Being located in Daniel Boone National Forest, the stream is situated in a forested, steeply sloped area with little or no development. Barren Fork of Indian Creek ranked ninth in "total uniqueness ratio".

Cane Creek in Laurel County, is also located in the Daniel Boone National Forest. It is natural, serene and a popular fishing spot. Like some of the other Preference streams, its waters are clear, cold, and pure enough to support trout. Cane Creek ranked twelfth in "total uniqueness ratio".

Little Beech Fork, located in Marion and Washington counties, is one of the largest streams studied in the Random stream classification. It ranked first in the Physical group uniqueness, seventh in the Water Quality group uniqueness, twenty-fifth in the Esthetic Impression group uniqueness, twenty-eighth in the Disvalues group uniqueness and thirty-sixth in the Land Use group uniqueness. Little Beech Fork ranked sixth in the "total uniqueness ratio" ranking. The high score on the Physical factors was responsible for the high "total uniqueness ratio" ranking of Little Beech Fork.

Isaacs Creek and Upper Devil Creek represent the opposite ends of the Random stream uniqueness spectrum. In the negative sense Isaacs Creek is the most developed, grossly polluted and unesthetic stream of the study. It has been completely destroyed and is probably incapable of ever being returned to its original condition. On the other end of the spectrum is Upper Devil Creek which still exists in a primitive, untamed, naturally esthetic state. Between these two extremes the other forty streams fall into place.

<u>All Streams:</u> After having studied the Preference and Random stream classifications independently in detail, both of these classifications were combined to form the "All" stream classification. Table 4.12 presents the rankings for all the streams of the study. As noted previously, Isaacs Creek maintains the distinction of being the most unique stream studied. It is followed

TABLE 4.12

RANKING OF ALL STREAMS BASED ON GROUPS
OF FACTORS AND ALL FACTORS

	Stream Name	Physical	Land Use	Water Quality	Diversity	Esthetic Impression	All
1	Big Brush Creek	15	9	49	39	11	38
2	Buckhorn Creek	7	13	39	34	22	33
3	Caney Creek	29	33	49	3	18	19
4	Caney Creek	30	36	30	16	18	20
5	Clear Creek	28	31	4	14	26	11
6	Clifty Creek	41	35	17	13	35	43
7	Crooked Creek	38	34	45	36	34	51
8	Dee Run	38	8	13	36	4	16
9	Greasy Creek	9	17	40	31	5	26
10	Laurel Fork	32	39	8	38	19	35
11	Martin's Fork	6	10	24	28	3	8
12	North Elkhorn Creek	16	2	16	12	13	4
13	Red River	8	27	14	22	10	12
14	Rock Creek	20	14	18	23	8	21
15	Russell Creek	1	20	41	26	30	14
16	South Fork Grassey Creek	38	15	9	32	33	31
17	Barren Fork Indian Creek	17	28	17	21	31	30
18	Cane Creek (Laurel County)	21	11	33	38	16	39
19	Everman Creek	16	29	28	19	19	27
20	Leatherwood Branch	33	41	43	27	30	50
21	Middle Creek	40	6	10	7	7	6
22	Pleasant Run	28	32	19	6	29	25
23	Rockhouse Creek	23	37	24	1	20	9
24	Upper Devil Creek	36	23	47	37	7	38
25	Upper Tygarts Creek	44	5	35	4	9	6
26	Wolf Creek	20	21	44	33	23	41
27	Youngs Creek	31	32	38	21	21	42
28	Beaver Creek (Menifee County)	32	31	46	20	34	49
29	Cane Creek (Powell County)	44	30	45	36	28	53
30	Pond Creek	24	1	11	2	25	2
31	Prather Creek	38	45	38	11	17	34
32	Quicks Run	43	32	30	29	32	48
33	Beaver Creek (Anderson County)	42	16	25	5	20	17
34	Little Beech Fork	5	41	13	37	27	22
35	Fork Lick Creek	35	33	27	21	29	40
36	Garrison Creek	10	40	7	26	27	24
37	Glens Creek	47	38	42	18	31	49
38	Johnson Creek	34	42	23	13	37	33
39	Locust Creek	34	37	29	10	36	29
40	Paint Lick Creek	16	42	14	35	31	30
41	Stephens Creek	37	40	24	30	21	46
42	Stoney Creek	13	36	37	15	27	28
43	Townsend Creek	46	22	22	36	31	44
44	East Fork Barren River	44	12	50	30	21	47
45	Meshack Creek	39	36	31	27	24	45
46	South Fork	12	26	40	37	28	39
47	Elk Fork Creek	44	19	17	21	29	36
48	Mill Creek	18	7	26	17	25	15
49	Montgomery Creek	46	16	51	31	28	52
50	Rock Lick Creek	34	29	21	31	19	37
51	Sugar Creek	4	31	36	38	6	18
52	Town Creek	22	29	3	28	12	10
53	Isaacs Creek	19	3	1	9	1	1
54	Knoblick Creek	11	24	6	35	19	13
55	Lick Creek	14	28	15	34	36	32
56	Pond Run	2	4	2	24	2	3
57	Richland Slough	3	21	32	6	14	7
58	Perkins Creek	27	15	5	33	15	15

by Pond Creek, Pond Run, North Elkhorn Creek, Middle Creek, Upper Tygarts Creek, Richland Slough, Martin's Fork, Rockhouse Creek, and Town Creek.

As was the case with both the Preference and Random stream classifications, the negatively unique streams dominate the higher rankings. The first stream that even approaches the positive uniqueness level is Upper Tygarts Creek, however; it has detriments due to the excessive amount of litter found in the Olive Hill area. The first positively unique stream of high esthetic character is eighth ranked Martin's Fork. The other more esthetic Preference streams ranked in the top twenty.

Isaacs Creek and Martin's Fork represent the opposite ends of the All stream classification uniqueness spectrum. At one extreme is Isaacs Creek, completely devoid of aquatic life, tainted with thick layer of iron oxide sediment and very acid. At the other end of the scale is Martin s Fork, briming with many diverse species of aquatic life, crystal clear, and of suitable pH to support aquatic life. The other streams fall into slots between these two extremes.

GRAPHICAL ANALYSIS - UNIQUENESS GROUPINGS

In order to graphically demonstrate the "relative uniqueness" between the streams in each classification, a series of graphs was developed. These plots are two dimensional, with the combined Water Quality and Physical group "uniqueness ratio sums" plotted on the horizontal axis and the Esthetic Impression "uniqueness ratio sum" on the vertical axis. In order to keep the plots as straightforward and interpretable as possible, the third co-ordinate, a combination of the Land Use and Disvalues group "uniqueness ratio sums", is listed in tabular form by stream number to the side of the graph.

In this representation the more unique streams appear removed and isolated from the remaining streams while the less unique sites tend to congregate together in scattered clumps or groupings. It is important to note that the graphical plots are based upon three of the five evaluative factor groups of the revised inventory. The streams appearing in the arbitrary groupings delineated on the graphs are therefore similar in those three evaluative factor groups only. In order to get a total picture of the "relative uniqueness", it is necessary to consider all five factor groups as was previously done in the "total uniqueness ratio" analysis. It is felt, however, that the three-group graphical interpretations will be helpful in pointing out the more unique streams of each classification.

PREFERENCE STREAMS: The "relative uniqueness" between streams in the Preference classification is graphically presented in Figure 4.1. In this figure, three arbitrary clumps or groupings of streams are noticeable. Grouping I consists of only one stream, North Elkhorn Creek, the most unique stream in the Preference classification. Grouping II consists of South Fork Grassy Creek, Russell Creek, Martin's Fork, Clifty Creek, Doe Run, and Red River. Grouping III is comprised of Greasy Creek, Rock Creek, Crooked Creek, Big Brush Creek, Casey Creek, Laurel Fork, Clear Creek, Buckhorn Creek, and Caney Creek. These arbitrary groupings designate those streams with similar Physical, Water Quality, and Esthetic Impression factors. The Land Use-Disvalues factor groups are independent of, and not a cause of the resultant stream groupings.

In Figure 4.1 the stream appearing the most isolated and unique in the Preference stream classification is North Elkhorn Creek of Grouping I. The major reason that North Elkhorn is the most unique stream in the Preference classification is due to its higher degree of watershed development and urbanization. The majority of the Preference streams visited were situated in rural, predominantly forested, undeveloped areas.

Grouping II represents the clump of streams with the next highest "total uniqueness ratio". The drainage basins of these streams vary from moderately developed as Russell Creek and Doe Run to completely undeveloped as is Martin's Fork.

Grouping III represents the least unique streams in the Preference classification. Although these streams were the least unique they ranked high

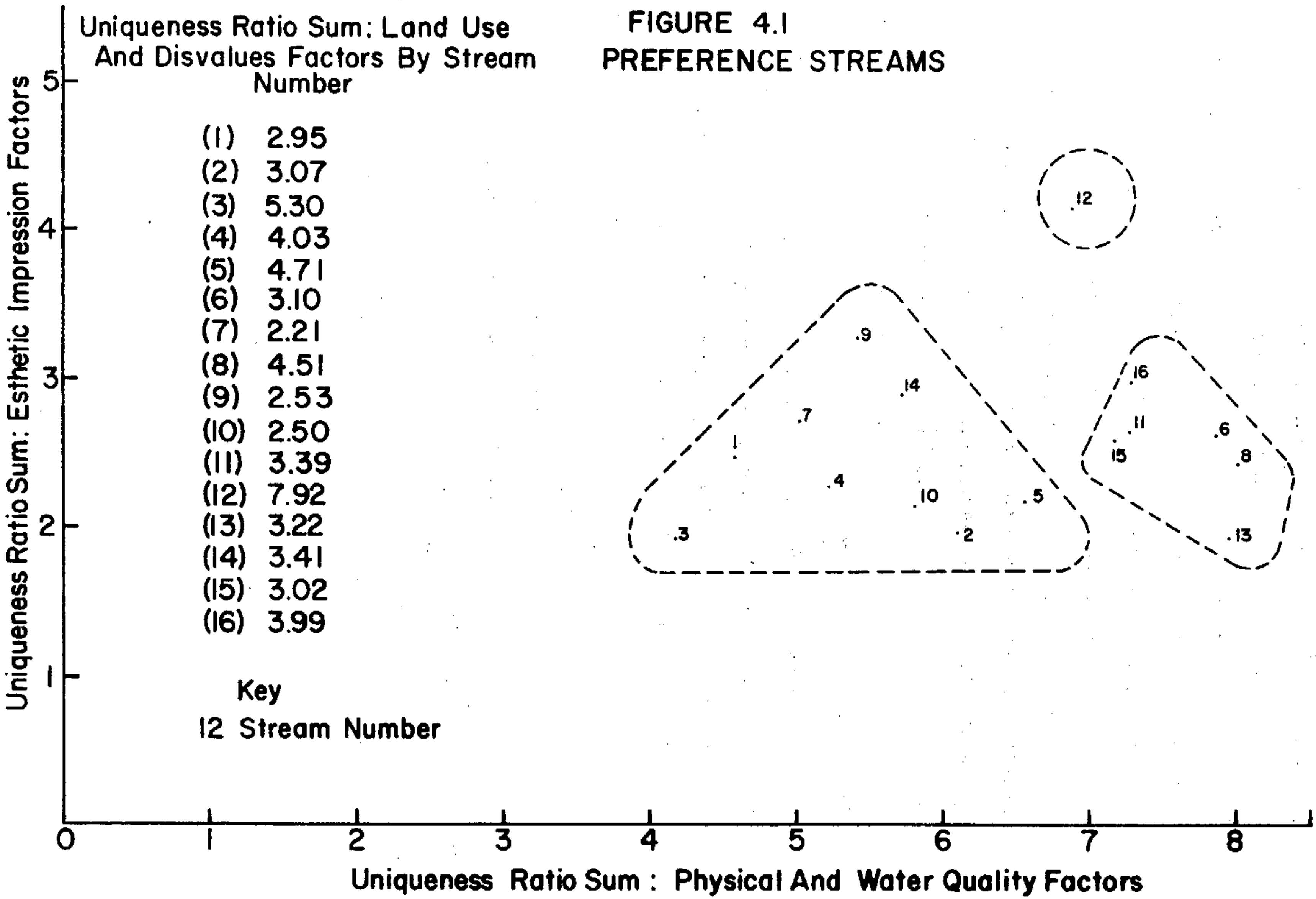


FIGURE 4.1
PREFERENCE STREAMS

in esthetic character. Greasy and Rock Creeks of the Eastern Coal Field represented two of the most esthetically appealing streams visited. The steep sloped and heavily forested watershed areas were equaled by few other streams. Casey Creek in the Mississippian Western Plateau physiographic region, was one of several streams supplied by large springs in its headwaters. The waters of Casey Creek are very pure and capable of supporting trout.

The stream appearing least unique in the Physical, Water Quality and Esthetic Impression "relative uniqueness" figure is Caney Creek. This is misleading since the stream being least unique in "total uniqueness ratio" is Crooked Creek (also in Grouping III). It is important to note that Caney Creek ranked high in Land Use and Disvalues factors and thereby pulled its ranking up in the "total uniqueness ratio".

RANDOM STREAMS: Figure 4.2 represents the "relative uniqueness" between the streams of the Random stream classification. The figure is divided into three groupings as was the Preference classification plot. Grouping I includes most of these higher ranking stream sites, Grouping II includes most of the mid-range ranking stream sites and Grouping III includes most of the lower ranking streams of the Random classification.

Looking at Grouping I the opposite ends of the "total uniqueness ratio" spectrum are represented. The streams unique in a positive sense are Upper Devil Creek and Cane Creek (Laurel Co.). These two streams ranked very high in naturalness, serenity, geological values, and esthetic appeal. The negatively unique streams are Isaacs Creek and Pond Run. Being located in active strip mine areas, they both ranked very low in naturalness, serenity, geological values and especially esthetic appeal. The other stream of Grouping I is Little Beech Fork being the most unique stream in Physical and Water Quality group uniqueness. These results complement those previously introduced in the "total uniqueness ratio" analysis.

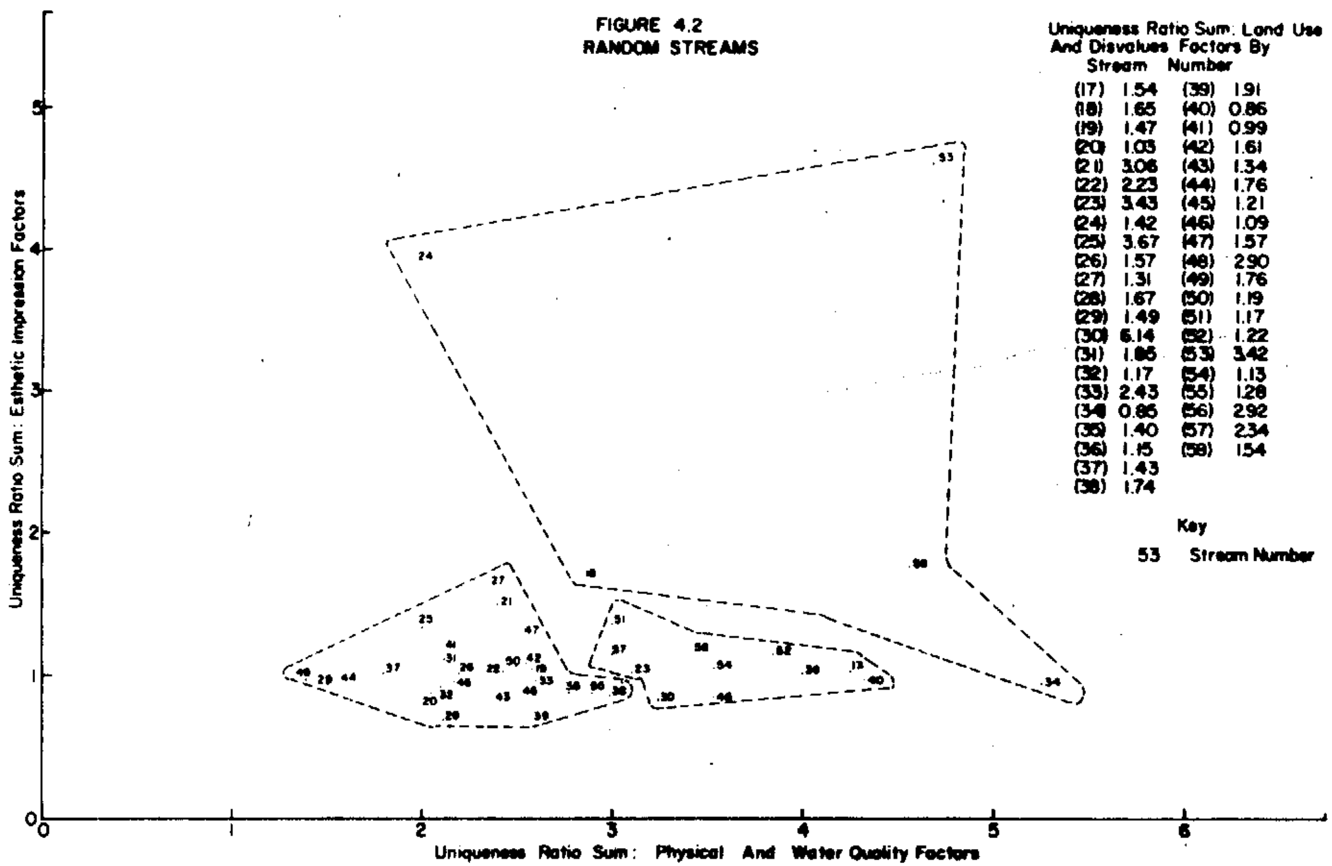


FIGURE 4.2
RANDOM STREAMS

Uniqueness Ratio Sum: Land Use And Disvalues Factors By Stream Number

Stream		Stream	
(17)	1.54	(39)	1.91
(18)	1.65	(40)	0.86
(19)	1.47	(41)	0.99
(20)	1.03	(42)	1.61
(21)	3.06	(43)	1.34
(22)	2.23	(44)	1.76
(23)	3.43	(45)	1.21
(24)	1.42	(46)	1.09
(25)	3.67	(47)	1.57
(26)	1.57	(48)	2.90
(27)	1.31	(49)	1.76
(28)	1.67	(50)	1.19
(29)	1.49	(51)	1.17
(30)	6.14	(52)	1.22
(31)	1.86	(53)	3.42
(32)	1.17	(54)	1.13
(33)	2.43	(55)	1.28
(34)	0.86	(56)	2.92
(35)	1.40	(57)	2.34
(36)	1.15	(58)	1.54
(37)	1.43		
(38)	1.74		

Grouping II represents the grouping of streams with the next highest "total uniqueness ratios". Streams unique in a negative sense such as Richland Slough and Knoblick Creek are found in this grouping as well as those unique in a positive sense such as Barren Fork Indian Creek. A total of nine streams fit into this grouping.

As can be seen in Figure 4.2, the majority of the streams fall into Grouping III. These streams represent the typical stream one might expect to find anywhere in the state of Kentucky. An unusual aspect of this grouping is that many of the lowest ranked streams such as Montgomery Creek and Elk Fork in the Mississippian Western Plateau, Meshack Creek in the Mississippian Eastern Plateau ... etc., ranked very high in esthetic potential. A conclusion from this finding might be that most of Kentucky's streams are in relatively good condition with high esthetic appeal.

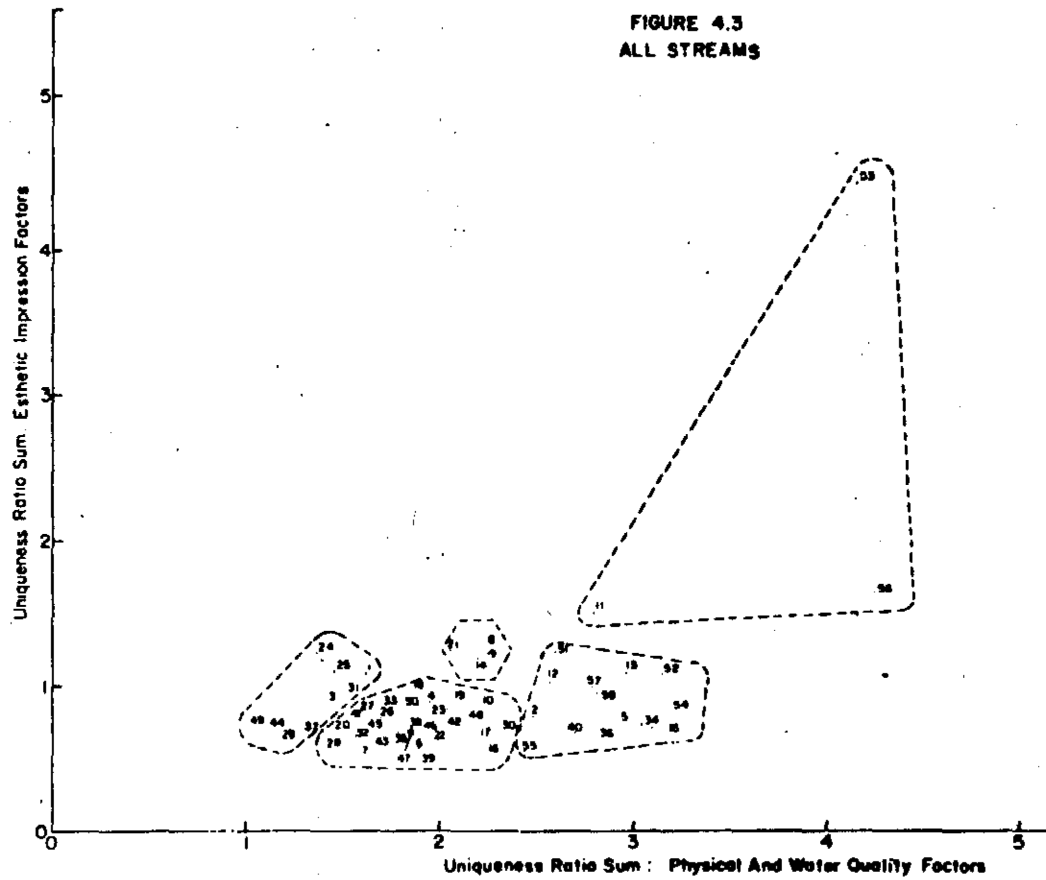
<u>ALL STREAMS:</u> Figure 4.3 represents the "relative uniqueness" between the streams of the "All" streams classification. The figure has been arbitrarily divided into five groupings. Grouping I includes the higher ranking stream sites, Grouping II, III, IV include the mid-range rankings and Grouping V includes the lower ranking stream sites.

Grouping I, composed of Isaacs Creek, Pond Run, and Martin's Fork, again represents the opposite ends of the "uniqueness ratio" spectrum. Isaacs Creek and Pond Run adversely effected by active strip mine operations, are the most unique streams of the negative sense. Martin's Fork, highly undeveloped, rugged and natural, is the most unique stream of the positive sense.

Groupings II, III, and IV include a wide variety of stream rankings from third ranked Pond Creek to forty-third ranked Clifty Creek. The bulk of the streams fell into grouping IV which was the mose dense grouping of the figure.

Grouping V included most of the lower ranking streams such as fifty-third ranked Cane Creek, fifty-second ranked Montgomery Creek, forty-ninth

FIGURE 4.3
ALL STREAMS



Uniqueness Ratio Sum: Land Use And Disvalues Factors By Stream Number

(1)	1.37	(30)	5.14
(2)	1.13	(31)	1.34
(3)	2.27	(32)	0.85
(4)	1.24	(33)	2.08
(5)	1.35	(34)	0.65
(6)	0.92	(35)	0.97
(7)	0.78	(36)	0.80
(8)	1.30	(37)	1.05
(9)	1.05	(38)	1.23
(10)	0.68	(39)	1.53
(11)	1.35	(40)	0.66
(12)	3.44	(41)	0.75
(13)	1.02	(42)	1.28
(14)	1.13	(43)	0.90
(15)	1.08	(44)	1.23
(16)	1.08	(45)	0.84
(17)	1.07	(46)	0.84
(18)	1.19	(47)	1.16
(19)	1.13	(48)	1.98
(20)	0.78	(49)	1.06
(21)	2.48	(50)	0.87
(22)	1.82	(51)	0.77
(23)	2.69	(52)	0.93
(24)	0.83	(53)	3.23
(25)	3.18	(54)	0.09
(26)	0.94	(55)	0.97
(27)	0.98	(56)	2.17
(28)	1.02	(57)	1.97
(29)	0.86	(58)	1.07

Key

53 Stream Number

ranked Glens Creek and forty-seventh ranked East Fork of the Barren River. The other streams appearing in this grouping achieved their higher ranking by having higher scores on the Land Use and Disvalues group "uniqueness ratio sums".

The "uniqueness ratio" procedure, as applied to the fifty-eight study streams, proved to be a satisfactory tool in determining the "relative uniqueness" within a group of streams. The quantitative number derived from this methodology does not distinguish between the uniquely esthetic or unesthetic streams; however, it does isolate or point out attributes of those streams most significant to man. The "uniqueness ratio" concept provides a much needed tool for those who favor protection of the environment, because for the first time their arguments to preserve a natural stream, forest or wild land can be backed up with a quantitative (though relative) expression of value. The uniqueness concept presents a quantitative challenge to that much used (and abused) measure of economic worth, the Benefit-Cost ratio.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

The purpose of this study was to apply the uniqueness concept to the quantification of the intangible values of natural streams. In the project, three classifications of streams were studied. These were termed Preference, Random, and All (Preference and Random, combined). The sixteen Preference streams were selected from lists of wild, scenic, and recreational streams compiled by the Kentucky Outdoor Recreation Plan and the Kentucky Wild Rivers Commission. They were distributed over six of the eight physiographic regions of the state. The forty-two Random streams were selected using a random number process and these were distributed throughout seven of the eight physiographic regions. Combining the sixteen Preference streams and the forty-two Random streams formed a total of fifty-eight streams in the "All" stream classification.

After the study streams had been selected, measurements and evaluations were made on each using a factor inventory of sixty-four factors. After some preliminary analyses, the inventory was reduced to fifty-four factors. Each factor was evaluated for each stream, using a categorized rating scale of 1 to 5. The category rating was based on a range of possible values that had been established for that factor. Some of the factors (drainage area, percent of forested land, average gradient, etc.) were measured directly from topographic maps. The remaining factors were determined by field measurements and observations during the summer months of 1970.

(3) Generally the streams in the Western Coal Field represented the least esthetic streams of the study. The Western Coal Field is characterized by very wide, flat stream valleys with little land in forest cover. Most of the streams in this physiographic region showed signs of being adversely effected by extensive surface mining operations and other development.

(4) The majority of Preference streams did actually represent the most undeveloped, scenic, and esthetic stream sites of the study.

(5) Most of the study streams were found to be in relatively good condition, an indication that the state still has many high quality streams and watersheds. It is obvious, therefore, that now is the time to apply a "decision methodology" to the problem of whether or not to develop these watersheds. Once the water basins are developed and their streams are adversely affected, they can never be returned to their natural state.

(6) The "uniqueness ratio" concept can successfully be used to evaluate the "relative uniqueness" within a group of streams. It presents a way for objectively comparing quality variations in a group of streams.

(7) Many of the Preference streams with high esthetic potential ranked low on the "total uniqueness ratio". Since most of the streams in this classification were chosen from lists by various committees recognizing them as natural streams, only the ones with a higher degree of development and urbanization stood out.

(8) The Streams situated in highly urbanized areas ranked high in "total uniqueness" since most of the study streams were located in rural, undeveloped watersheds.

RECOMMENDATIONS FOR FURTHER RESEARCH

(1) Investigate ways of simplifying or reducing the number of factors in the factor inventory. Only those factors most directly related to stream

uniqueness should be included in the inventory. One possible means of satisfying this recommendation would be further experimentation with factor analyses.

(2) Program "uniqueness ratio", "total uniqueness ratio" and the ranking calculations, so that the relative uniqueness of any number of streams could be rapidly determined by feeding the basic data into a computer. This would greatly reduce the routine work involved in the uniqueness ratio computations and permit a greater number of combinations to be examined.

(3) Perform studies to compare the objective, quantitative results of the uniqueness ratio concept to subjective, preference determination methodologies such as those suggested by Shafer (19), Sargent (17), and Wohlwill (35), etc.

REFERENCES

1. Advisory Commission on Wild Rivers. Natural Streams in Kentucky. Report to Governor Louie B. Nunn and the citizens of the Commonwealth of Kentucky, Frankfort, Kentucky, January 19, 1970. Frankfort, Kentucky: Department of Natural Resources, 1970.

2. Bartsch, Alfred, F., and Ingram, W. M. "Stream Life and the Pollution Environment," Biology of Water Pollution: A Collection of Papers on Stream Pollution, Waste Water and Water Treatment. U. S. Department of the Interior, FWPCA, 1967, pp. 119-127.

3. Craighead, Frank C., Jr. and Craighead, J. J. "Rivers Systems: Recreational Classification, Inventory and Evaluation." Naturalist, Journal of the Natural History Society of Minnesota, Vol. 13, No. 2 (Summer 1962), pp. 2-19.

4. Dearinger, John A. and Harper, K. R. Esthetic and Recreational Potential of Small Naturalistic Streams Near Urban Areas. Research Report No. 13, Water Resources Institute, University of Kentucky, 1968.

5. Horton, Robert H. "Erosional Development of Streams and Their Drainage Basins: Hydrophysical Approach to Quantitative Morphology." Bulletin of the Geological Society of America, Vol. 56 (March, 1945), pp. 275-370.

6. James, L. Douglas, and Lee, R. R. Economics of Water Resource Planning. New York: McGraw Hill, 1971, pp. 164-174.

7. Johnson, Hugh A. and Huff, J. M. "Toward Measuring the Intangible Values of Natural Beauty." Paper presented at the annual meeting of the Soil Conservation Society of America, Albuquerque, New Mexico, August 14-17, 1966.

8. Krumholz, Louis A. and Neff, S. E. "Preliminary Ecological Study of Areas to be Impounded in the Salt River Basin of Kentucky." Report of the University of Kentucky Water Resources Institute for Fiscal Year 1970, Report prepared for the Department of the Interior, Office of Water Resources Research, Lexington, Kentucky: University of Kentucky Water Resources Institute, July 1970, pp. 253-275.

9. Krutilla, John V. "Conservation Considered." The American Economic Review, Vol. 57, No. 4 (September, 1967), pp. 777-786.

10. Leopold, Luna B. "Landscape Esthetics." Natural History, Vol. 78, No. 8 (October, 1969), pp. 36-45.

11. Leopold, Luna B. and Marchand, M. O. "On the Quantitative Inventory of the Riverscape." Water Resources Research, Vol. 4, No. 4 (August, 1968), pp. 709-717.

12. Morisawa, Marie and Murie, M. Evaluation of Natural Rivers, U.S. Department of the Interior, Office of Water Resources Research Project C-1314, Antioch College, Yellow Springs, Ohio, 1969.

13. Pennak, Robert W. Freshwater Invertebrates of the United States. New York: Ronald Press Co., 1953.

14. Research Planning and Design Associates, Inc. Study of Visual and Cultural Environment. The North Atlantic Regional Water Resources Study, Vol. 2, Amherst, Massachusetts: Research Planning and Design Associates Inc., January 1969, pp. 1-4.

15. Ruttner, Franz. Fundamentals of Limnology. Third edition Canada: University of Toronto Press. 1963.

16. Samuelson, Paul A. Economics: An Introductory Analysis. Seventh edition, New York: McGraw Hill, 1967, pp. 16-17.

17. Sargent, F. O. "Scenery Classification." Vermont Resources Research Center Report 18, 1967, 27 p. (Mimeographed.)

18. Scenic Rivers Study Unit. A Methodology for Evaluation of Wild and Scenic Rivers. Water Resources Institute, University of Idaho, September, 1970.

19. Shafer, E. L.; Hamilton, J. F.; and Schmidt, E. A. A Quantitative Model for Landscape References. U.S. Department of Agriculture, Forest Service Northeastern Experiment Station, 1967. (Duplicated).

20. Sonnenfeld, J. "Variable Values in Space and Landscape: An Inquiry Into the Nature of Environmental Necessity." Journal Social Issues, Vol. 22, No. 4 (1966), pp. 71-82.

21. Spindletop Research Center. Kentucky Outdoor Recreation Plan. Report to the Commissioner of Finance of the Commonwealth of Kentucky, Lexington, Kentucky: Spindletop Research Center, 1965.

22. Spindletop Research Center. Supplement No. 1 to the Preliminary Outdoor Recreation Plan. Report to the Commissioner of Finance of the Commonwealth of Kentucky, Lexington, Kentucky: Spindletop Research Center, 1967.

23. Standard Methods for the Examination of Water and Wastewater. 12th ed. New York: American Public Health Association, 1965.

24. Strahler, Arthur N., "Hyposometric (Area-Altitude) Analysis of Erosional Topography." Bulletin of the Geological Society of America, Vol. 63 (November, 1952), pp. 1117-1142.

25. University of Kentucky Computing Center. "Principal Axis Factor Analysis." Statistical Library for the s/360 Programs and Subroutines, September, 1968, pp. 188-195.

26. U.S. Army, Corps of Engineers. Water Spectrum, Vol. 3, No. 1 (Spring 1971), p. 40.

27. U.S. Congress. Wilderness Act. Pub. L. 88-577, 88th Congress, second session, September 1964, 6 p.

28. U.S. Congress. Wild and Scenic Rivers Act. Pub. L. 90-542, 90th Congress, S. 119, October 1968, 12 p.

29. U.S. Department of Agriculture, Soil Conservation Service. Guide to Making Appraisals of Potentials for Outdoor Recreation Developments. Washington, D. C.: Soil Conservation Service, July, 1966.

30. U.S. Department of Agriculture, Soil Conservation Service. "Soil and Water Conservation Needs Inventory." Unpublished watershed and stream map of Kentucky, Revised edition, 1966.

31. Ward, Henry B. and Whipple, G. C. Fresh Water Biology. New York: John Wiley & Sons Inc., 1959.

32. Water Resources Engineers, Inc. Wild Rivers Methods for Evaluation. Research Report prepared for the U.S. Department of Interior, Office of Water Resources Research. Walnut Creek Cal.: Water Resources Engineers Inc., October 1970.

33. Whitman, Ira L. Uses of Small Urban River Valleys. Baltimore: Baltimore District Corps of Engineers, April, 1968.

34. Winfrey, Robley. Economic Analysis for Highways. Scranton, Pennsylvania: International Textbook Company, 1969, pp. 126-151.

35. Wohlwill, J. F. "The Physical Environment: A Problem for a Psychology of Stimulation." Journal Social Issues, Vol. 22, No. 4 (1966), pp. 29-38.