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Honey Hill: A Systems Analysis for Planning and the Multiple use of Controlled Water Areas

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Volume 2 of 2

HONEY HILL: A SYSTEMS ANALYSIS FOR PLANNING THE MULTIPLE USE OF CONTROLLED WATER AREAS

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VOL. 2 OF 2 HONEY HILL: A SYSTEMS ANALYSIS FOR PLANNING THE MULTIPLE USE OF CONTROLLED WATER AREAS

HONEY HILL: A SYSTEMS ANALYSIS FOR PLANNING THE MULTIPLE USE OF CONTROLLED WATER AREAS

A Report Submitted to the

U. S. Army Engineer Institute for Water Resources
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FOREWORD

PURPOSE

This research by the Department of Landscape Architecture Research Office, Harvard University, had two major aims. The first purpose was to focus attention on ways and means for measuring non-monetary social and environmental costs and benefits and comparing them with costs and benefits measurable in dollars. The second purpose was to develop better ways to plan for the multiple use of water and related land resources, with emphasis on recreation uses.

FINDINGS

The first phase of the study was an inventory by map subdivisions of the existing resources of the Honey Hill area of Swanzey, New Hampshire, for a variety of resource and resource-based uses. The data on the area were stored, analyzed and displayed using computer graphics techniques developed by the investigators.

The second phase of the study was the development of quality indices for visual quality, ecological damage, wildlife habitat, etc., which utilized pertinent parameters from the resource inventory. The quality indices were then related to possible land uses including recreation. Finally, the grid areas of Honey Hill were evaluated and ranked in terms of various uses, thus laying the basis for a planning evaluation process for site development.

The third stage of the study was the development and investigation of possible planning evaluation approaches. A simulation model was developed which allows for comparison of the effects over time of alternative plans for use of the area. The model can be run on the basis of days, weeks, months, seasons or years. Alternative plans were developed and tested in the model utilizing both "best professional judgment plans" and alternatives derived from a mathematical programming model developed by the authors. In applying the simulation model the authors assumed various levels of total use from nine combinations of income and travel time-distance to the site. Outputs of the model include: (1) the dollar income generated by the alternative; (2) the dollar costs of construction, management and maintenance; (3) the quality of recreation experience, by activity and by consumer group; and (4) resulting site resource quality.

ASSESSMENT

The techniques developed from this research appear to offer the Corps planner a powerful means for analyzing complex resource allocation problems. The study demonstrates that a variety of planning procedures can be developed from the basic components of the research: resource inventory, quality evaluations, measurements of impact, and various allocation procedures. The efficiency of utilizing a computer for these purposes has also been demonstrated. Application of the research is seen as especially useful in cases where inadequate data on demand are available and in which the "environmental carrying capacity" of the site must be pre-determined to set limits for development. The limitation of the methodology lies in the quantitative and qualitative assumptions that must be made in the absence of reliable data, or where data collection is costly. This limitation could ultimately be largely removed through research in the following basic areas: (1) the impact of various kinds and intensities of activity on different site conditions; (2) the influences of income, travel distance, and age of participants on the demand for activities; and (3) the quality of recreation experiences.

The findings, conclusions and independent judgment of the researchers are nevertheless their own. The report is not to be construed as necessarily representing the views of the federal government nor the Corps of Engineers.

STATUS

The Institute for Water Resources is currently pilot testing the techniques developed by the Harvard researchers in the Santa Ana River Basin, Los Angeles District. In this effort the data collection, modeling, programming and analysis are being carried out almost entirely by Corps' personnel. In addition to determining the workability of these techniques at the field level, this pilot test will serve to develop computer graphics skills among a team of engineers, programmers and environmentalists in the Los Angeles District. If the pilot testing should demonstrate that the planning techniques do, in fact, contribute to improved planning at the field level, the next step will be to develop procedures to bring these tools to the hands of planners throughout the Corps.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the efforts of the many people who contributed to this project. Diana Toth, Robert Berwick, Howard Slavin and Dennis Tihansky made important contributions to the development of the research. Linda Peacock, Lois Kramer, Terry Brown, C. J. Frederick, John Hepting, and members of the Harvard Computation Center were of great assistance in the production of this report. Sandra Rawlett's patience is greatly appreciated.

David Aggerholm, Ray Cason, James Evans, Joseph Ignazio, William McCarthy, John Smith and Harry Schwarz, all of the Corps of Engineers, provided creative criticism and support. And our colleagues in the Department of Landscape Architecture, faculty and students, provided the discipline of intense questioning.

Credit for this report must clearly be shared; responsibility for its shortcomings rests with the authors.

T.M., P.R., D.S., C.S., R.T., D.W.
Cambridge, Massachusetts
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APPENDIX A: THE PUBLIC DECISION-MAKING PROCESS

This Appendix, describing the public decision-making process which is one aspect of the research context, is based on informal discussions held with members of the State Planning Agency and several of the resource-oriented line agencies, members of the University of New Hampshire Resources Center, and residents of the study area.

The various interest groups and powers which influence projects such as the Honey Hill study may be examined in terms of geographical and functional roles. There is apparently a geographical hierarchy involved in the decision-making process. At the lowest level, one finds the people who are most immediately affected by the project, those whose property is being taken directly or controlled indirectly. In the Honey Hill case, all of these people are located in the town of Swanzey. In terms of local government, Swanzey has a Board of Selectmen and a town meeting, both of which would have to approve any project before it could in fact be implemented.

The next level concerns the immediate vicinity of the town of Swanzey and the project. The reservoir development lies entirely within Cheshire County, but the watershed does not. Any kind of watershed management, for example, pollution control policies, would cross county lines. Land acquisition for Honey Hill reservoir and the State park would, however, be entirely within Cheshire County. County government in New Hampshire has only a limited set of specific purposes, some of which indirectly impinge here, but most of which do not. In effect, the county level of organization is not an effective player in this situation. The State would control water pollution, not the counties. On the other hand, groups such as the Keene Chamber of Commerce or other private interest groups in the immediate vicinity would be major influencing factors. Indeed, one of the most important aspects of the decision to go ahead with such a project would be the amount of potential economic benefit perceived by the Keene Chamber of Commerce and the equivalent group of local businessmen. The benefit to the local area includes recreation benefits as well as business opportunities for the citizens of the Keene area, but benefits are primarily, in fact overwhelmingly weighted toward business opportunities.

The next level of responsible government is the State, with the intermediary between the State and the local town being the Executive Counselor. The Executive Council is geographically organized, with an Executive Counselor representing a larger region which includes this immediate project area. The Executive Counselor informally and effectively has a veto over any project in his area, and in fact acts as the referrer to the Governor on local issues. The Governor, representing the interests of the State, is the single most important actor in the process. No major public or private capital investments project goes on in the State without the concurrence of the Governor on at least an informal basis, and in the Honey Hill case, on a formal basis. The Governor is elected every two years and can succeed himself but usually does not. In addition, and because the Legislature only meets every two years, a system of strong central government does not exist. There is no strong central decision making, central planning, and central budgeting on a longer term basis. The tradition of local control, local veto, local instigation, and local voting patterns is very much the dominant pattern in New Hampshire.

The procedure of the Corps of Engineers as an outside agency would be to propose a project. In the case of Honey Hill which is proposed as part of the Connecticut River Plan, each project component of that multi-state plan is considered on an individual basis by the appropriate local and state governments. The factors that weigh in a Governor's decision to proceed or not are the mix of forces trying to influence him. In general, these can be three: first the primary persons effected, local people whose property is being taken and who would possible be against such a project; second, their allies, the conservation and recreation groups; and third, the business interests in the region which, let us assume, would be for it.

The procedures as outlined below indicate how some of their flows of influence would operate in a project like this. The initial step would be the proposal of the Corps of Engineers to create the project at Honey Hill. By law, this would go to public hearings, but only after the local and State governmental agencies with responsibility in this area had been informed. Typically, rumor precedes public hearings. The first wave of interest would probably be a negative one generated by those people at the local level whose property is being taken. These would be twofold, the property owners themselves and the town, in the case where it perceived more fiscal damage due to land being taken out of its potential tax base versus increased taxes because of money spent in the region. The local land owners would attempt to organize the town meeting and Selectmen. The town meeting and Selectmen would then be asked to take a stand against the project. If there were a high potential economic contribution locally, the town meeting and Selectmen might indeed split on the decision to go ahead with the project, with the property owners being on one side and the businessmen in the town being on the other side of the project.

The chain of influence then takes two alternative routes and typically these both occur. The first route is informal, and the informal means in this type of political situation can be very influential. The procedure would be characterized as approaching the local newspaper in order to insure adequate news coverage and editorials which in turn could be "picked up" by the Manchester newspapers. These would be read by and, hopefully, reacted to by the Governor. One could assume that newspaper as well as television and radio coverage would unite interest groups such as conservationists who might be against the project. In the case of the recreationist groups, the highly organized fishing and wildlife oriented people might be for a project of this sort because of the increased recreational opportunities. On some types of projects, particularly those in which damage to wildlife habitat is more clearly predictable, their interests might be against the project. This describes the informal route of mobilizing public opinion.

The formal procedure is somewhat more complicated. There is a Legislator who is responsible locally, and there is also an Executive Counselor who is responsible locally. If the Legislature were in session, the route to the Governor would be through the Legislature. In New Hampshire there is a tradition of "member's bills" which can block such projects from being heard and in many cases accepted, so that the first potential official obstruction could be an instruction by the Legislature in the form of a passed bill saying that the project shall not exist or that it shall not exist as proposed. However, if the Legislature is not in session, the Executive Council is the route to the Governor since it does meet with the Governor on a more regular basis. The Executive Council cannot make a directive, as it is not creating laws, but it can make a positive or negative recommendation about the project to the Governor. The Governor can also be convinced via news publicity to oppose the project, without going through either the Legislature or the Executive Council. It is the Governor who must ultimately agree to the project.

When the Governor feels that a position on a particular project is required and wants more information, the procedure is as follows. First of all, the State is not fully organized in a hierarchical manner. Typically there are line agencies with functional, not geographic, responsibility and these operate directly under the Governor or his administration. One alternative the Governor has is to ask the various Directors of line agencies for a policy statement on their own part, vis-a-vis this project. The other alternative is to call on a formalized organization, a Council of Resources and Development, which is a coordinating committee of the relevant line agencies and groups. This group could also be consulted on a project like Honey Hill for a policy. The line agencies and the coordinating committee have at their disposal, if they need them or want them, various private and technical consultants, various semi-private consultants, notably from the State University system in New Hampshire and various semi-private interest groups.

For example, the organization of agricultural interests, recreation interests and the other groups which lobby at the State level, might be asked informally of their opinion on the project. The Governor has the responsibility for coordinating these opinions unless he has delegated that responsibility to his coordinating committee. At that point one of two things may occur; either an official position paper which is then transmitted publicly to the various interested parties, or an informal political statement which is passed down the line.

The procedure as indicated above has the following major components: 1) a high degree of local autonomy, particularly in the blocking of a project; 2) a highly centralized operation in terms of approving the project (this on the part of the Governor); and 3) a highly individualized negotiation system, in that people know who their co-interested parties are personally, as set up through tradition and informal channels. The principal decision to block the project, as we interpret it, would be the mobilization of interests by the local people whose property is being taken or by the local town if they perceive the project as damaging to their long term interests. The principal factors on the positive side would be economic benefits to the local area, the immediate region and the town, and a long term sense of inter-state cooperation. On this last matter, it must be noted that the one argument which is never made in New Hampshire is that a project in New Hampshire will benefit

Massachusetts and Connecticut. The residents of the State clearly see themselves as being in the position in which their land resources are potentially exploitable by other states with insufficiently clear benefits to themselves.

In Table A.1 we have listed some of the agencies, groups or interests which have some influence in the decision to create a project such as Honey Hill. In this table, we have tried to give some qualitative and quantitative measures of the respective influences of these groups. Ideally, based upon an analysis of a proposed project, one would like to be able to identify in quantitative terms the benefits to each of the groups under various assumptions about the physical development of the project. If one had this information, it might be possible to identify the dominant coalitions for or against the various manifestations of the project. While this was outside of the scope of our project, we have considered keeping track of the benefits by origin and source so that an approach to evaluating benefits to some of the major actors could be initiated at a later stage.

TABLE A.1

INTEREST GROUPS

Interest Group	Estimated Membership	Notes
Governor	600,000±	Can block, must approve.
Corps of Engineers		Investigates, implements.
Local County (Cheshire)	45,000±	Not effective.
Local Towns (Swanzey)	10,000±	Can block, keys are fiscal, environmental quality.
Local Chamber of Commerce (Keene)	45,000±	Can promote, key is fiscal.
State Department of Parks	600,000±	Social, fees as benefits.
State D.P.W.	600,000±	Road relocation, maintain.
Monadnock Region Assoc.		Can promote as "attraction."
Project Area Property Owners	100±	Can oppose.
Adjacent Landowners	100±	Can oppose.
Conservationist Groups		Can oppose, key is environmental quality.
Recreation Groups (Fish and Wildlife)		Can support as social-recreational benefit. Can oppose for environmental quality.

Interest Group	Estimated Membership	Notes
Local and Regional Consumers (day)	within 1/2 hr+ 230,000	Not formally represented.
	within 2+ hrs. est. 10 million	Not formally represented.
External Consumers (overnight)	within 4 hrs.± est. 30 million	Not formally represented.
Connecticut Valley Plan	3,300,000 by year 2020	Not formally represented.
Upstream Water Users	100±	
Downstream Water Users	30,000±	Must be protected.
Soil Conservation Service (County level)		Regulatory and consulting roles.
Forest Department		Regulatory and consulting roles.
Bureau of Outdoor Recreation		Regulatory and consulting roles.
Federal Power Commission		Regulatory and consulting roles.
State Department of Public Health		Regulatory and consulting roles.
State Water Supply Commission		Regulatory and consulting roles.

APPENDIX B: THE CONNECTICUT RIVER BASIN PLAN

The Honey Hill Dam is one component of the Connecticut River Basin Plan. The following study report by the Connecticut River Basin Coordinating Committee, as published by the New England Division, Corps of Engineers, and the accompanying article from The Sentinel, Keene, New Hampshire, give an overview description of the scope of the project.

PREVIEW: CONNECTICUT RIVER BASIN STUDY

September 1970

INTRODUCTION TO A PLAN FOR DEVELOPMENT

This summary sets forth the results of a six-year comprehensive study of the 11,250 square mile Connecticut River Basin together with a Plan of Development of the water and related land resources. Foreseeable short and long-term resource needs are identified and a plan for the best uses of the resources to meet the needs is spelled out in the report. The study is the product of Federal, State and regional representatives working cooperatively under the broad supervision of the Connecticut River Basin Coordinating Committee. Guidance was provided by criteria of the Water Resources Council which will forward the report, together with its comments, to the President and the Congress.

Projects and programs recommended for initiation in the next 10 to 15 years are included. Potential measures designed to meet the basin needs through the year 2020 are identified.

This planning effort was brought about because of the necessity to solve the many complex water resources problems that are being produced by an ever-increasing population; by an ever-enlarging mass urbanization pattern of development; and by an ever-increasing and sophisticated technical change. Meeting this challenge effectively requires careful planning so that judgments and decisions can be made upon fact and not personal preferences, and it is to this end that this report is directed.

The following three objectives form the basis of plan formulation:

National Efficiency
Regional Efficiency
Environmental Quality

National Efficiency is getting the greatest return and economic benefits by investing in water resource restoration and development from the viewpoint of the whole country. Regional Efficiency is producing the greatest return in economic and social benefits by investing in water resource restoration and development from the viewpoint of the Connecticut River Basin. The Environmental Quality objective is the improvement of the quality of the environment through water resource investment. This objective includes not only preservation but positive measures to restore and enhance the present environment.

The Basin Plan, conceptual in nature, is not a final blue-print. It is a series of proposals or various courses of action which Federal agencies and the basin States may take individually or as a group and which can withstand future compromise. There has been unanimity in the concept but not necessarily on specifics that have resulted. The Coordinating Committee truly hopes the work accomplished is carried into some future phases of implementation. The information developed and the methods and techniques provided should have a major influence on future decisions which can be made on the basis of knowledge now available by reason of this study.

ORGANIZATION

The Connecticut River Basin Report is the product of a Coordinating Committee: a Board of Representatives of the U. S. Departments of Agriculture; Army; Commerce; Health, Education and Welfare; Interior; the Federal Power Commission; and the New England River Basins Commission, together with the States of Vermont, New Hampshire, Massachusetts and Connecticut. In accordance with Congressional directive, the New England Division, Corps of Engineers, was the chair agency.

In quest of every factor which would contribute to a valid evaluation of problems in and solutions for the Basin, the Committee gave careful consideration to meeting present and future requirements for water supply, flood control, navigation, water quality, hydroelectric power, recreation, fish and wildlife, land use and other allied purposes, all related to water resources. Guidelines for the planning effort provide for consideration of multiple objectives and multiple water resource uses. This criteria applies to regional areas as well as to specific projects such as a reservoir, or a non-structural measure such as a scenic riverway.

The plan presents a framework into which can be fitted in proper relation all other projects and programs as they are developed. It spells out a series of objectives and discusses programs and priorities within the framework and provides guidance for programs sponsored by State, Federal and regional planners. The Plan being conceptual invites coordination and separate efforts, in orderly fashion, leading to a balanced program of water and related land resource allocations.

THE CONNECTICUT RIVER BASIN

"To waste, to destroy our natural resources, to skin and exhaust the land instead of using it so as to increase its usefulness, will result in undermining, in the days of our children, the very prosperity which we ought by right to hand down to them, amplified and developed."

Theodore Roosevelt, in 1907, sent that message on conservation to Congress. The warning can be applied to the Connecticut River Basin and to similar areas now heavily taxed by human usage and demands.

The Coordinating Committee was struck with the natural wealth generated by the beautiful 400-mile river. Rising beyond the Canadian border, it flows through four states into Long Island Sound. Vermont has the largest basin land mass of the four states, 35 percent. Massachusetts has 24, New Hampshire 28 and Connecticut 13 percent. At its widest span, the basin is 60 miles. Elevations reach from sea level to 6,000 feet. Located within the Appalachian highlands of North America, the Berkshires, Green Mountains and White Mountains are important ranges.

Rain and snow average about 43 inches of water annually. Records of river discharges at Hartford show an average flow of about 18,000 cubic feet per second. This contrasts with a maximum flow of 289,000 cfs experienced in March 1936. During the drought of the sixties, a minimum flow of 1,100 cfs occurred.

There are approximately 170,000 acres of water and 7,000,000 acres of land in the study area. The distribution is as follows: 79% in forests; 9% in croplands; 4% in pastures; 4% in urban and built-up areas; and 4% carried in the "other" category. Presently, over 85% of the land is privately owned by individuals or corporations.

The best 1970 estimates indicate a current Basin population of 1,900,000. The majority of this current population, nearly 84%, live south of the northern border of Massachusetts residing in approximately 4% of the basin area. Population is expected to reach 3,100,000 in 50 years. The percentage concentrated in the Massachusetts and Connecticut portions of the Basin will increase to 89%.

The Connecticut River Basin is characterized in its entirety by a stable, prosperous economy. Employment is found in agriculture, manufacturing, trade, finance and insurance, forest products, services, recreation and tourism, and higher education. The personal income in the Basin is higher than the national average and is expected to remain so. The Connecticut River Basin economy remains more dependent on manufacturing than does the economy of the nation, with more than 40% of the area's total labor force engaged in manufacturing industries. It is interesting to note that in 1967 the total expenditures of tourism and recreation amounted to over $115,000,000 for the entire basin.

There have been substantial investments made in water resources developments which relate to land treatment, conservation, watershed protection, flood control, hydro-power, and navigation.

PROBLEMS AND NEEDS

What are the problems and needs of the Connecticut River Basin? What will be required in the immediate and long-range future in water supply, for example, and in flood control, in the improvement in water quality, in additional recreation facilities, even in the preservation and restoration of the natural beauty of the Basin if the Basin's opportunity for development is to be met and if the needs of the increasing population are to be satisfied?

WATER QUALITY - Existing water quality is seriously degraded in significant portions of the basin precluding the use of water for many desirable and legitimate uses. The most immediate and pressing need is for the construction of adequate waste water treatment facilities at all municipal and industrial waste sources. Problems of nutrient enrichment and pollution from uncontrolled sources such as produced by runoff from urban and rural watersheds are mounting. Requirements for low-flow augmentation after appropriate levels of treatment are likely if established water quality standards are to be upheld.

POWER - Development within the Basin will require ever-increasing amounts of electric energy. Although present or planned supplies will just meet demands (5,000 megawatts) through 1980, projections through 2020 indicate that 33% of the then demand (42,000 MW) will have to be met from sources outside the basin.

RECREATION - An expanding population enjoying higher standards of living, more affluency, more leisure time, and improved methods of transportation will spend more time on outdoor recreation. Overcrowding of the Basin's public and private recreational facilities is already occurring. Less than 4 percent of the area is currently publicly-owned recreation land. Improvements in the way of stream bank acquisition, access, scenic and recreational rivers and open space corridors are needed if the public is to share in the natural resources.

The demand for fishing and hunting opportunities is rapidly increasing. The needs for fishing opportunities show a major deficiency in the middle and lower basins. There is a strong desire to realize the full potential of the anadromous fishery resources of the basin. This desire is concerned chiefly with restoration of the historical runs of American shad and Atlantic salmon, to provide high quality fishing opportunities and long-term needs for sea food.

PRESERVATION OF PRICELESS SITES - There is a need for conserving archeological, historical and natural sites in the Connecticut River

Basin, and establishment of a program to identify additional sites. Unless a concerted effort is made to protect these outstanding and valuable sites, they will be lost forever.

WATER SUPPLY - There are sufficient water resources to meet the foreseeable in-basin demands for domestic and industrial water supply. Further out-of-basin diversion is a consideration.

NAVIGATION - Increased boat use of all kinds requires channel modifications for commercial and recreation craft as well as increased flows for canoeing, additional access ramps at power pools, and improved facilities at Windsor Locks.

LAND USE - TREATMENT - MANAGEMENT MEASURES - There is a need for improved use, treatment, and management of land to reduce runoff, erosion, and sediment, thereby preserving the land base and improving water quality. Such measures will strengthen the economy and improve the quality environment and natural beauty of the Basin.

FLOOD CONTROL AND FLOOD PLAIN MANAGEMENT - Much has been done to alleviate flood damages but additional measures are needed. More upstream watershed projects are required to protect agricultural and rural areas and smaller urban centers. Additional local protection projects are needed at specific tributary areas where concentration of damages makes this type of protection practical and economical. More major multiple-purpose reservoirs are needed for conservation storage, for recreation, fish and wildlife and water quality, where flood control is the primary project purpose. These latter units are required to reduce flood stages along the main stem of the Connecticut River and to provide major reductions on tributaries where these reservoirs would be located. The dams, if constructed, would control 25% of the drainage area above Hartford. This goal was established 17 years ago by the Connecticut River Valley Flood Control Compact. Without these units, there is possibility of overtopping of six existing local protection projects protecting major urban centers vital to the basin economy. Flood plain regulation is imperative throughout the basin.

EDUCATION - The foregoing needs are physical and subject to technical resolution. Of equal importance is the need for educating the public in water resources needs and solutions because there is competition between the needs of the different segments of the public.

Education is vital if communication and understanding is to be achieved, for this, in the final analysis, will be the basis for decision-making on plan elements.

A PLAN FOR DEVELOPMENT

In formulating a plan to meet the needs and desires of the people in the Connecticut River Basin, the Coordinating Committee strove to insure that all elements be compatible and that programs and projects be flexible and adaptable to unforeseen demands and changing patterns of needs. Alternatives were given due and responsible consideration.

The Committee developed a plan to accommodate two time frames, namely, an "early action" plan covering the next 10 years; and a "long range" framework type plan embracing requirements and opportunities to the year 2020. A resume of the "early action" plan is presented here.

The 1980 Basin Plan, as recommended by the Coordinating Committee, is estimated to cost $1,800,000,000 (based upon 1969 price levels). The plan is described briefly in the following paragraphs and in more detail in the report and in specific resource appendices. The proposals are presented in 10 broad element categories that in turn cover some 54 specific parts.

Element No. 1, Water Quality. This element concerns five separate parts, four of which represent the basin States. New and improved waste water treatment facilities, at least to the secondary treatment level, are an essential first step in all parts of the basin. The estimated cost of secondary treatment for known sources of pollution in the basin is $240,000,000 allocated as follows: Massachusetts $96,000,000, Connecticut $70,000,000, New Hampshire $43,000,000, and Vermont $31,000,000. Additional expenditures are also required for construction of interceptor sewers, pumping stations and collection systems. Flow augmentation storage is recommended in certain new reservoirs to serve areas where more than secondary treatment is required and where the cost of flow augmentation is less than the cost of equivalent advanced waste treatment. The fifth and final part of Element No. 1 concerns other considerations for further and future detailed studies. These are as follows:

a. The role of low-flow augmentation after implementation of the above early action four parts of Element 1. These studies would be undertaken after implementation of planned secondary treatment facilities so that these might be analyzed for their performance and evaluation could be made of new waste treatment technologies which are underway.

b. Further study of the methods of controlling effects of combined sewer discharges. Although the separation of sanitary and storm water systems or the temporary holding of these waters have in the past been considered as possible solutions, continuing research indicates combination of these and other methods, such as micro-screening, air floatation, and biological treatment may provide an adequate and more economical means of solution.

c. Further study of pollutants from rural watersheds and urban watersheds which contribute natural and man-created background pollution.

d. Further study of sewage diversions to alternate treatment plant locations and/or alternate points of discharge to larger water bodies. This would involve inter-basin or intra-basin diversion of waste water with treatment prior to or subsequent to diversion.

e. Water quality studies are needed at existing reservoirs where long-term discharge of wastes have created sludge deposits which have long-term effect upon water quality. This is particularly the case behind certain main stem power dams in the basin.

f. Further study is needed in the control of bank erosion and the undesirable effects produced by sedimentation which deprive fishery resources of valuable food areas and spawning zones. Such sediment also causes turbidity which affects the desirability of waters for recreational use or other purposes.

g. Further study is needed to evaluate the impact of multiple thermal discharges on receiving waters. Heat in combination with other natural and man-made factors, may impair aquatic life and reduce the stream's waste assimilative capacity.

Element No. 2, Power. This element involves five sources of energy, as follows: conventional hydropower; fossil fuel generation; pump storage hydro; nuclear generation; and energy to be imported from outside of the basin areas. By 1980, the supply of power in the Connecticut River Basin will more than double. A major portion of this increase will be due to the installation of pumped-storage peaking plants and expansion of base-load power capability by means of nuclear generation plants. Two new pump storage plants will provide 1,600 megawatts of peak power, while additional nuclear plant construction would add 1,800 megawatts to the system. During this period, there will be a slight increase in conventional hydro capacity but a decline in the role of conventional hydroelectric plants in supplying peaking power. Fossil fuel thermal plants, which now supply base-load generation are expected to decline in both kilowatts of capacity and percent of total supply.

Element No. 3, Outdoor Recreation. This element is presented in eight parts, four of which concern the requirements for water surface area in the four basin States. To meet the growing needs, the Committee recommends firstly the expansion of facilities and improved access at existing water bodies, and secondly, construction of new water bodies. There is need for 15,000 additional acres of water in New Hampshire; 13,000 acres of additional water needed in Vermont; 25,000 acres of additional water needed in Massachusetts; and an additional 22,000 acres of recreation water needed in the State of Connecticut. The fifth part of Element No. 3 concerns the implementation of the Bureau of Outdoor Recreation's National Recreation Area Plan, a coordinated Federal-State-community framework plan for recreation development along the main stem of the Connecticut River. Part number 6 of this element concerns the establishment of wild, scenic, and recreational stream categories. Part number 7 provides for the utilization of existing water supply reservoirs to meet recreation needs. These 7 parts to the recreation element will not only meet the outstanding needs to a great degree, but will provide for many multiple-purposes available in the control of these lands.

Element No. 4, Preservation of Sites. This element is presented in four parts and provides for the preservation of those sites of unique or unusual nature which should not be disturbed if possible by future developments within the basin. Some 850 sites of archeological, historical, or natural resource areas were identified. Historic and natural areas to be preserved in the State of Connecticut consist of 49 sites, in the Commonwealth of Massachusetts a total of 114 sites, in the State of New Hampshire a total of 57 sites, and in the State of Vermont a total of 35 sites. The concerted local, State and Federal effort, as well as a commitment on the part of the people of the valley to protect the basin's remaining heritage is one safeguard for coming urbanization and future industrialization which have already been cruelly destructive of the physical remains of the past.

Element No. 5, Anadromous Fisheries Restoration. This element is presented in five parts, and consists of the following: fish passage facilities; fish hatcheries; streambank access; interstate regulation; and low-flow augmentation and reregulation of flows. Initial action programs consists of the erection of fish ladders at the remaining four power dams, and the installation of fish hatchery facilities to provide 1,000,000 smolt (2-year old salmon) annually. The fish ladder program will greatly enhance the existing shad runs, as well as provide access for the restored salmon runs. Closely allied to these actions is a program of streambank acquisition for fishing. It would be coordinated with acquisition needs for other water uses such as outlined above in Element No. 3. In addition, interstate coordination would be maintained to insure the best operation of the hatcheries and also that each of the four basin States shares equitably in the fish harvest. Finally, adequate river flows are necessary to maintain the fisheries and the plan recommends that these be provided by releases from existing dams, together with flow augmentation from new multiple-purpose reservoirs.

Element No. 6, Resident Fish and Wildlife. This element is presented in six parts, four of which provide for those new reservoir areas and tributary requirements of the basin States. Part number 5 provides for streambank acquisition and part number 6 provides for water-oriented wildlife programs. The plan has analyzed resident fisheries, that is, with the exception of salmon and shad, in six categories namely, cold, warm and combination streams, and cold, warm and combination ponds. The plan presents over 90 small upstream reservoir sites and seven major reservoirs which together will help balance needs related to fish and wildlife, in addition to providing for other water resource needs. Land acquisition necessary for streambank access is to be coordinated with acquisition for other purposes.

Element No. 7, Water Supply. This element is presented in five parts, four of which concern water supply requirements for the four basin States and part number 5 in regard to out of basin diversion of water supply.

Water supply needs are presented for each of the basin States in detail. The study finds that the natural abundance of available surface and ground-water supplies, if properly developed, can meet all projected municipal and industrial needs of the basin. Out of basin needs for the 1980 time period can be met by flood-skimming operations such as that proposed in conjunction with the Northfield Mountain pump storage power project. Similar operations can be introduced at the existing Corps of Engineers' Tully Reservoir located in the Millers River watershed. "Flood-skimming" is a procedure for diverting surplus high river flows from a stream which are considered excess to the needs or uses within that stream at the time of occurrence.

Element No. 8, Navigation. This element is presented in four parts; the first part provides for commercial navigation from Long Island Sound to Hartford; navigation improvements from Hartford to Holyoke; recreational navigation improvements at main stem power pools; and main stem and tributary improvements for canoeing. The plan in summary provides for deepening and widening the navigation channel from the mouth of the Connecticut River to Hartford for a distance of about 52 miles. This portion of the river is used now for commercial and small boat activities. In addition, a 32-mile recreational navigation project is included from Hartford to Holyoke. Boat ramps will be constructed at various points along the river and trailer service will be established at four existing power dams to permit by-passing of these dams during the boating season, as well as improved access to these attractive water bodies. Although no reservoir storage has been specifically justified to augment flows for canoeing, some benefits will be obtained through the implementation of other multiple uses at the reservoirs that are included in the plan.

Element No. 9, Upstream Water and Related Land Resource Potential. This element is presented in five parts: Structural Measures - (1) multiple-purpose upstream watershed projects; (2) other upstream impoundments not part of watershed projects ; and (3) structural programs in national forests; Non-Structural Measures - (1) land use, treatment, and management programs; and (2) resource planning with local and state units of government. The early-action program includes eight multiple-purpose watershed projects currently being planned under Public Law 566, and nine additional potential watershed projects found to be feasible. In addition to the 78 multiple-purpose floodwater retarding structures contained in these 17 watershed projects, another 118 reservoir sites on small upstream drainage areas have been recommended to meet 1980 water resource needs. The plan further recommends three recreational impoundments and facilities and acquisition of 69,300 acres within national forests; and 1.2 million acres of land treatment to agricultural and private forest land; as well as technical assistance in resource planning to some 180 communities. Soil surveys are recommended on about 1.5 million acres of private land. Watershed analysis and soil surveys on 306,600 acres and fish and wildlife surveys and analysis on 30,500 acres in national forests are recommended.

Element No. 10, Flood Control and Large Multiple-Purpose Reservoirs. This element is presented in seven parts consisting of the following: Part number 1 is in the non-structural category and includes an effective flood plain management program providing for flood plain zoning, flood proofing, encroachment lines, flood insurance and the establishment of regional drainage codes to make existing drainage systems function properly with the rapid urbanization of watersheds. This flood plain management program to be closely allied with scenic, recreational and open space programs that will improve access for other resource activities, that would also insure retention of existing valley storage areas and, at the same time, provide for a high degree of environmental quality. Part 2 also in the non-structural category includes the enlargement and improvement of existing flood warning systems with expanded communication and coordination between the United States Weather Bureau, the Corps of Engineers, other Federal agencies, the States, local communities and those individuals located in flood-prone areas. Part 3 provides for construction of seven major reservoirs for flood control and multiple-use; namely, Victory Dam on the Moose River and Gaysville Dam on the White River, both in the State of Vermont; Bethlehem Junction Dam on the Ammonoosuc River; Claremont Dam on the Sugar River; Beaver Brook Dam and Honey Hill Dams both in the Ashuelot River Basin; all in the State of New Hampshire, and the Meadow Dam on the Deerfield River in Massachusetts. Part 4 provides for the modification of four existing Corps of Engineers' dams; namely Union Village Dam on the Ompompanoosuc River in Vermont, Tully Dam in the Millers River Basin, Barre Falls Dam in the Chicopee River Basin and Knightville Dam in the Westfield River Basin, all three in Massachusetts. Part 5 provides for construction of five local protection projects; namely, at Lancaster on the Israel River in New Hampshire, at St. Johnsbury on the Passumpsic and Sleepers Rivers, and at Hartford on the White River, both in Vermont, at Westfield on the Westfield River in Massachusetts and on the Park River in Connecticut. Part 6 provides for upstream flood control projects consisting of eight Public Law 566 watershed plans now under planning and nine potential watershed projects.

Part 7 includes incidental, but additional, flood control as provided at three major multiple-purpose reservoirs; namely, Gardner Dam in the Millers River Basin in Massachusetts, and Cold Brook on Roaring Brook and Blackledge Dam in the Salmon River watershed, both in the State of Connecticut.

CONCLUSIONS

The Committee believes that the basin needs that have been identified and analyzed reflect current population desires as expressed by public participation. Social and behavioral patterns will change over the 50-year projection period. Thus, proposals suggested for meeting 1980 requirements are more apt to reflect the nature of the needs to which the basin plan addresses itself. The Connecticut River Basin has, since its initial settlement, been dependent upon its natural resources. Its people developed these resources - not always in the wisest manner. The Coordinating Committee concludes that a more careful allocation of natural resources will be necessary if the basin is to continue to grow and still maintain a high quality in its environment. There are sufficient water and related land resources in the valley to meet the large and broad scale needs projected for the 1980 and 2020 time frames, provided that enhancement, preservation, restoration, conservation and orderly development of resources in the public and private sectors are assured. There are adequate resources to permit the preservation of areas of unusual quality and to maintain open space to balance new growth areas. The Committee finds opportunities and requirements for Federal, State, local and private action.

RECOMMENDATIONS

The Connecticut River Basin Coordinating Committee recommends:

(1) The Basin Plan, as presented and discussed in this report, be accepted and used as a guide for the development and beneficial use of the water and related land resources of the Connecticut River Basin;

(2) The projects and programs in the 10 to 15 year category, referenced as the 1980 Plan for Development, be implemented through appropriate agencies;

(3) This report be used as a supporting document for the individual agency reports which would be the basis for authorization of the various

parts of the plan with particular reference to those areas where Federal cost sharing requires authorization by the Congress;

(4) Each of the affected and concerned Federal and State agencies review periodically those segments of The Plan for which, under law, it is or may be assigned responsibility;

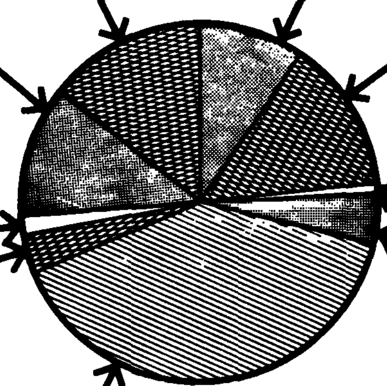
(5) Within the New England River Basins Commission there be established a Connecticut River Basin Program assigned the task of coordination of planning in the interest of a balanced management of water and related land resources. This joint Federal-State comprehensive planning organization would provide the leadership required to bring the many projects, outlined in this report, to fruition;

(6) Those areas of the development plan which are applicable to on-going Federal programs and State programs proceed as soon as possible;

(7) Those additional studies discussed in this report be made as soon as practicable; and

(8) There be initiated a broad base education program to assist in making the public more effective participants in the planning and decision making process.

TOTAL COST $1.8B



WATER QUALITY
1. Secondary Level Treatment for 1980 .... $ 240M
2. Advanced Waste Treatment for 1980 19
3. Others (Costs not available)
   - Low Flow Augmentation
   - Combined Sewer Separation
   - Uncontrolled Runoff
   - Diversion of Wastewaters
   - Bottom Deposits

Cost $259M

WATER SUPPLY
1. Northfield Mt. Diversion .... $ 60M
2. Expansion of Municipal and Industrial Supplies 125
3. Corps' Reservoirs 19
   - Beaver Brook
   - Tully
   - Honey Hill
4. Upstream Reservoirs 3

Cost $207M

ANADROMOUS RESTORATION
1. Fish Ladders at Five Existing Power Dams .... $ 13M
2. Construction of New Fish Hatchery Facilities 7
3. Streambank Acquisition 5
4. Provision of Reservoir Flow Releases 4

Cost .... $ 29M

RESIDENT FISH AND WILDLIFE
1. Improved Access at Existing Water Bodies (approx) .... $ 3M
2. Provision of New Water Bodies 37
   - Corps' Reservoirs 12 P.L. 566 Reservoirs 2
   - Other Upstream Reservoirs 23
3. Expansion of Hatchery Facilities 5
4. Extensive Streambank Acquisition Program 20

Cost .... $ 65M

POWER

Installed Capacity 3,500 megawatts
1. Conventional Hydro 2.4%
2. Pumped Storage Hydro 43.7%
3. Int. Combustion/Gas Turbine 7.1%
4. Nuclear-fueled Steam 46.8%

Cost $700M

FLOOD CONTROL
1. Corps' Dams .... $ 86M
   - Victory $ 2 — Honey Hill $ 3
   - Bethlehem Junction 5 — Meadow 41
   - Gaysville 23 — Beaver Brook 1
   - Claremont 10 — Knightville 1
2. Seventeen Upstream Watershed Projects 25
3. Other Upstream Dams 11
4. Five Local Protection Projects 51
5. Flood Plain Regulation (*estimate not possible)

Cost $173M

OUTDOOR RECREATION
1. Expansion of Existing Water Bodies .... $ 10M
2. Construction of New Water Bodies 93
   - Corps' Reservoirs $55 P.L. 566 Reservoirs $10
   - Other Upstream Reservoirs 28
3. National Recreation Area Plan 120
4. Wild and Scenic Rivers 25
5. Modification of three existing Corps' Reservoirs 5

Cost $253M

NAVIGATION
1. Long Island Sound to Hartford Commercial project .... $ 4M
2. Hartford to Holyoke Recreation project 7
3. Improvements in Main Stem Power Pools, etc. 1

Cost .... $ 12M

UPSTREAM WATER AND RELATED LAND RESOURCE MANAGEMENT (Including forest acquisition and land treatment)
1. Structural Improvements and Land Acquisitions for National Forests $25M
2. Non-Structural Land Treatment to Agricultural, Urban and Forest Land 35
3. Technical Assistance to Communities and Resource Conservation Development Programs 25

Cost $85M

PRESERVATION OF SITES
1. Archeological
2. Historical
3. Natural Resource

Cost .... *

* Estimate not possible

Fig. B.1

1980

EARLY ACTION PLAN

CONNECTICUT RIVER BASIN

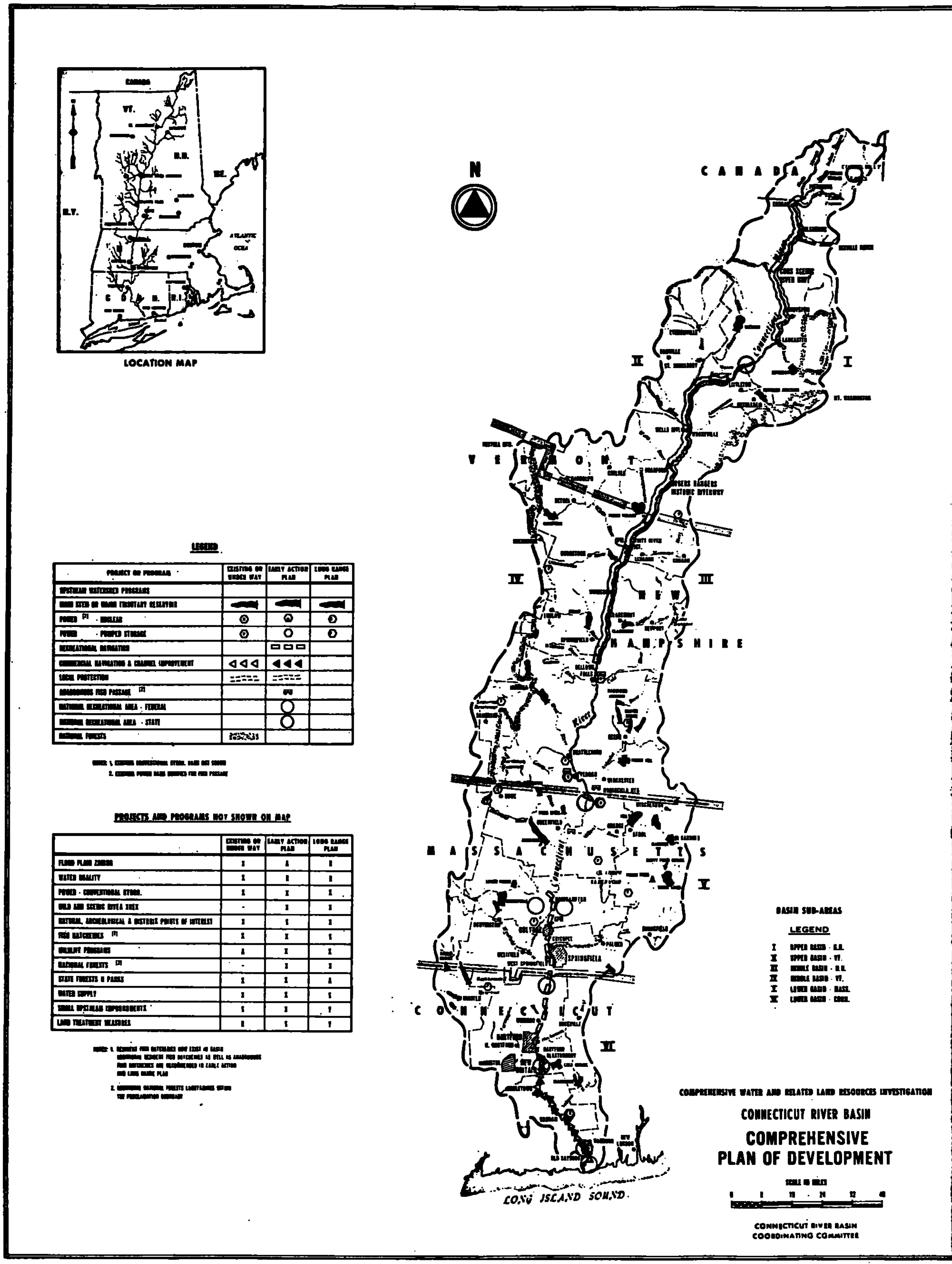


Fig. B.2
Comprehensive Plan of Development

Sentinel
Keene, New Hampshire
September 12, 1970

"FLOOD CONTROL PROJECTS ARE OUTLINED AT MEETING

By JIM HICKS
Sentinel Staff Writer

Flood control projects in East Swanzey and Gilsum were outlined during a public information meeting last night at Keene Junior High School.

Results of a six-year comprehensive study of the Connecticut River basin, including the Ashuelot River valley, were presented by the coordinating committee of the Connecticut River Basin Comprehensive Investigations.

The meeting last night was the eighth of nine public information sessions to be held by the committee. Formal public hearings on the committee plans will follow later this year and testimony given at the hearings will be included as part of the final report, to be submitted next year.

"This is the first time water resources have been thought of in a comprehensive manner," said speaker Joseph L. Ignazio, chief of the river basin planning branch, New England Division of the Corps of Engineers. The corps serves as chair agency for the study group.

Study of the 11,250-square mile river basin was authorized by the Public Works Committee of the U.S. Senate in 1962. The $3.5 million study is now completed and a report is being prepared.

Mary Louise Hancock, New Hampshire's representative on the study committee, was chairman of last night's meeting. The state director of planning said the basic objective of the study was to formulate a plan of development to serve as a direct guide to the use of water and related resources to meet present and future needs.

Ignazio said the study committee, which is scheduled to present its formal report next June, has set two target dates for development and preservation of the basin's resources. The report will define a plan for development of the basin in terms of immediate needs by 1980. Long-range planning includes provision for needs by 2020, when the basin's present 1.7 million population is expected to double.

There were three general considerations dictating the course of the study, Ignazio explained: water resources, forestry and flood control.

Included in the water resource phase of the study was consideration of future problems and future demands on the watershed. The population of the basin will reach about 3,330,000 by target date 2020, according to committee figures. Mass urbanization will create a "strip city" along the Atlantic seaboard extending up a portion of the 400-mile Connecticut River.

Concentrated population and advanced technology will create such sophisticated wastes, new methods of disposal must be planned for, Ignazio said.

Figures presented by the speaker showed of the four states containing the Connecticut basin, Massachusetts dumps the greatest volume of pollution in the river. Ignazio was quick to point out, however, that the New Hampshire waste products which reach the river are of greater concentration than those of the other three states.

The Federal Water Treatment Act of 1966 requires all interstate waters to be cleaned up, and all waste contributing towns to have adequate treatment facilities by 1970.

TREATMENT PLANTS

Ignazio said the committee's study indicated this would mean installation of secondary sewage treatment plants in all towns. Tertiary plants will probably be necessary in many of the towns, he added, to bring streams up to federal classification.

Unfortunately federal money, slated to aid towns in treatment facility construction, is tied up in Vietnam, Miss Hancock added, meaning delay in meeting federal requirements.

Ignazio estimated it will cost more than $10 billion by the year 2020 to produce the power required by the basin. Historically the river area has had exported much of it, the speaker said. But the demand within the basin will exceed the supply by 2020 according to the study.

According to a special study made in 1967, recreation in the river valley is a $115 million a year business and this figure is expected to grow to $450 million by 2020. The study, Ignazio explained, indicated New Hampshire is capturing 47 per cent of the recreation seekers in the valley.

HISTORIC RESOURCES

The preservation of historic resources received equal consideration by the study committee, he said. The National Park Service has found 184 such resources in the Connecticut valley which should be saved, 30 of these in New Hampshire.

Restoration of anadromous fishery was also a concern of the committee. Ignazio indicated four dams on the Connecticut are due for relicensing soon and plans should be made at this time for installation of fish bypasses at each site.

Flood control is a major concern of the Corps of Engineers and extensive plans for development of flood control facilities in the valley are included in the committee's report.

RECORDS BROKEN

All previous snow and water content records in the basin were broken this past winter, said Ignazio. The 16 corps operated dams were put into operation during flood times and the corps estimated the facilities saved the valley about $14 million in flood damage.

The corps estimated $1.2 million was saved in Keene alone. But this is not complete protection, Ignazio said. The committee's plan calls for eight more large dams in the basin, including facilities in East Swanzey, Claremont, Lancaster and Gilsum.

NATURAL FLOOD PLAIN

Keene, the speaker said, is a natural flood plain. Facilities at Honey Hill, in South Branch of the Ashuelot one mile west of East Swanzey, and at Hammond Hollow in Gilsum would provide year-round low flow for the Ashuelot valley towns. A third facility, already approved but awaiting design money, is scheduled for Beaver Brook.

The Honey Hill project was approved by Congress and authorized by the Flood Control Act of 1941 after serious floods in 1936 and 1938. No money was allotted, however. Construction plans call for a rolled earth dam 2,900 feet long and 65 feet above the river bed. The reservoir would cover 1,360 acres when at capacity, compared with 970 acres at Surry Mountain Dam and 365 acres at Otter Brook Dam.

The Hammond Hollow Dam, planned to be located above Surry Mountain Dam on the Ashuelot, will serve a great need in this valley for "low flow augmentation," Ignazio said.

Further consideration by the committee was given to water pollution in the Ashuelot River Valley. Low flow augmentation would aid municipalities and industries in treatment of wastes, the speaker said.

There are seven major sources of pollution along the Ashuelot, he said, including the city of Keene and several mills, and an estimated $7 million would be needed to clean up the river."

APPENDIX C: HONEY HILL: A HISTORICAL PERSPECTIVE

A. A PHYSICAL HISTORY

The following physical description of the study region is taken from A History of Swanzey, N.H., 1734-1890 by Benjamin Read, and was published in 1892.

> "The town of Swanzey lies some five miles to the south of Keene nearly in the central part of Cheshire county and in the valley of the Ashuelot upon what was once the bottom of a lake.
>
> The following extract from Professor Hitchcock's Report of the Geological Survey of the State is illustrative of the character of this valley about Swanzey:
>
> 'The principal valley of Cheshire county has its widest development in Keene and Swanzey. When the ice melted here, this basin contained for a short time a body of water somewhat larger and probably deeper than Sunapee lake, which soon became filled by the alluvium of floods which the retreating ice-sheet send down by every tributary from north, east and south. The Ashuelot river flows through this basin, lying near its east side above Keene, but crosses to its west side in the north part of Swanzey. Its west portion in Keene is drained by the last four miles of Ash Swamp brook. Three miles south from Keene the Ashuelot river finds an avenue westward, along which it is also bordered by low modified drift for several miles. The straight valley, however, continues to the south through Swanzey, being occupied by the South branch and Pond brook, with an alluvial area which decreases from one mile to one-third of a mile in width. We, thus here find a valley ten miles long from north to south, filled with nearly level deposits which are but slightly higher than the streams and bordered by steep and nearly continuous ranges of hills which rise from 400 to 600 feet upon each side. This alluvium consists, almost everywhere, of sand or fine gravel, perhaps extensively underlain by clay which is worked for brick-making near the south edge of the city of Keene. Its height is from 10 to 40 feet near

the river, and the whole plain was originally of the same height with the highest proportions, which still occupy the greatest part of the alluvial area. These are generally separated from the lower interval by steep escarpments, which show that the difference in height is due to excavation by the river. In the south part of Swanzey we find occasional terraces, which are sometimes of coarse gravel, from sixty to seventy feet above South Branch, showing that much material at first deposited here was afterwards channelled out by this stream and carried northward to the broad, low plains.'

Thus, it will be seen, that three general divisions characterize the surface of Swanzey. The first includes that which is elevated above the plains, the second the plains, the third the intervals and meadows.

The hills and mountains are of granitic formation, generally uneven, and some of them quite rough. Several of the highest elevations are designated mountains and are several hundred feet higher than the adjacent plains.

The mountains are Mount Huggins, which is in the northeast corner of the town; Mount Cresson, west of the Ashuelot river, about a mile from the Keene line; Mount Caesar near the central part of the town; Peaked mountain in the southwest corner and Franklin mountain at the northern base of which is 'Westport;' 'Pine Hill' in the northwestern part of the town, at the north spur of which 'stood the home' of Joseph Cross, and 'Cobble Hill,' near the home of the late John Grimes. All are interesting places to visit.

Everywhere upon uplands, hills and mountains are to be seen the effects of the glacial period. In many places there are extensive drift formations, of which a most noticeable one is at East Swanzey. On many of the hills and mountains the loose rocks have been swept away, leaving the underlying rocks smoothed off by the moving glacier. Boulders are profusely disturbed, large ones often lying upon the drift, having been rounded and smoothed. Many large ones are to be seen high up on the hills and mountains. A large one lies on the top of Mount Ceasar. The most conspicuous boulder is near Charles Holbrook's house. It is of immense size and lies upon a solid granite surface, only a small central part touching the rock beneath, giving it a prominent appearance. It has sheltered many flocks of sheep from the summer's heat and winter's storm.

The boulders generally come from hills and mountains not far away, but some of them came from places evidently quite distant. They must have been distributed at a period previous to the time when the surface of the lowlands was formed and are not often to be seen above the surface, having been buried to the depth of many feet under clay and sand.

After the upheavals that raised our hills and mountains; after they had been ploughed and ground by the glacier; after the glacier had distributed the earths and rocks, leaving them profusely scattered from the lowest valley to the highest mountain; after heat and frost, rain and atmosphere had disintegrated the surface rocks; after an immense amount of movable material had by mighty floods been brought into the lake, and after this material had been levelled and smoothed by the ceaseless motion of its water, then the barrier which had kept the valley a lake for ages gradually wore away and the valley ceased to be a lake.

The formation of rivers and brooks followed the draining of the lake; and from that time to the present their currents have been moulding much of the surface into its present form.

Much the largest river in Swanzey is the Ashuelot. It enters the town nearly at the centre of the north line and flows in a south and south-westerly direction. It has cut down to the primitive rocks in three places,--at Westport, at West Swanzey, and at a place less than two miles above West Swanzey. Before it was obstructed by dams, it had a fall of some twenty-four feet in passing a distance of about six miles in the town, ten feet of this fall were at Westport, ten at West Swanzey and four feet about West Swanzey. Its channel is generally deep and its movement sluggish.

Much the largest of the other streams is the South branch which enters the town from the southwest corner of Marlborough, flows some three miles in a southwesterly direction and then runs about five miles west and north, entering the Ashuelot about a mile from Keene line. It has not apparently cut down to the primitive rocks at any place. For the first three miles it has considerable fall, and its bed most of the way is stony. The rest of the way the bed is sandy and the fall light. Its fall from the Marlborough line to the Ashuelot river is probably somewhat over a hundred feet.

Pond brook pans from Swanzey pond in an easterly direction to the South branch. Its fall is slight. Two small streams enter the town from Richmond and connect with Pond brook. The east one has a slow current without falls; the west one is smaller and more rapid.

Hyponeco brook, an Indian name, has its source upon the east side of the Ashuelot range of mountains and reaches the Ashuelot river by a circuitous route, a short distance above Westport.

California brook has its source in Chesterfield. Its direction is east of south and it enters the Ashuelot between West Swanzey and Westport.

Rixford brook runs some distance through the extreme west part of Swanzey. It rises in Chesterfield and flows into the Ashuelot in Winchester some distance below Swanzey line.

Swanzey pond is a natural body of water. It is about a mile and a half southwest of Swanzey Centre. It covers about one hundred acres and is fed by small brooks and springs. The water is quite clear and pure.

The State of New Hampshire is covered with soil of four kinds. The Connecticut valley is covered with a soil derived from calcareous rocks, and it is this soil which is the richest and most valuable of the four; but as we pass to the eastward we reach a basin composed of gneissic and granite soils, which has the least value of all. It is in this basin that Swanzey lies.

The greater part of the state is underlain by gneiss,--practically the same as granite--but which produces a better soil than granite. The soluble element present is usually potash, from ten to twelve per cent, a valuable substance to be added to the soil.

When the land in Swanzey was first cleared, the soil, enriched by vegetation, produced excellent crops, but when subjected to the ordinary operations of farming soon became exhausted.

The inevitable result has been that lands once occupied as farms have been abandoned, and the cellar holes and other remains are all that exist to show where was once the home of a prosperous farmer.

There still remains, however, considerable land in the hills which produces good crops and upon which the owners still live, and there is no probability, with the improvements in farming now in vogue, that they will ever be abandoned.

The plains of the town are quite extensive, and it is upon these plains that most of the varied crops of rye, corn, beans and buckwheat have been raised, together with flax, oats and potatoes.

The quantity of hay cut upon the plains has always been comparatively small. The soil here has not sufficient clay in its composition to render it productive without constant enriching, and extended droughts, doubtless brought about by the destruction of our forests, affect the raising of good crops upon this land.

The extensive forests, especially upon hills, are the safeguard of the farmer. The rains are absorbed and held through their agency and the freshets are therefore avoided, while the evaporations take place at the spot where the rain fell, not from the lakes and ocean into which the streams, swollen by freshets pour; thus there is a more equal distribution of rain in the neighborhood of the hills.

It is a significant fact that, in the northern portion of the state which has less rain than the southern and central portions, the hay crops are often above the average the same years that the hay crops in the south are poor on account of drought. This is because the northern portions have extensive forests which hold the moisture during what would otherwise be periods of drought.

Farm buildings quite generally are located upon the plains and upon this land water may be obtained without excavating to a great depth, as there is a solid clay formation below the sand which insures a good and pure supply of water.

A mineral spring in the north part of the town on the border of Great meadow has obtained considerable notoriety.

The large amount of meadow upon the Ashuelot river, the South branch and numerous brooks, has been the foundation of most of the farming since the town was settled. Large quantities of hay are taken from these meadows annually, without the application of manure, their production being kept up by occasional overflowing of water. They generally have a clay soil, as they lie below the line which separates the clay earth from the sandy earth. They are adapted to high cultivation and are now much appreciated for this purpose."

B. A DEVELOPMENTAL HISTORY

Prior to 1732, the Squakheag Indians inhabited the area extending north along the Ashuelot, east to Mount Monadnock, south to Miller's River, and west toward the Connecticut River. Their largest settlement occurred near Sawyer's Crossing on the southeast side of the Ashuelot. Little is known about these Indians because they abandoned their villages several years before the advancement of white settlers into the region.

In 1732, the Massachusetts House of Representatives voted to open seven towns--each six miles square. The plan provided for sixty-three house lots to each township with priorities given to the construction of a meeting house, ministry, and school. Included in the terms of agreement, were stipulations that the settler must occupy his land within three years of the initial claim and within five years build a house eighteen feet square. In addition, he must "sufficiently fence and till or fit for mowing eight acres of land" or else forfeit his lot.

In fact, the actual development of these towns did not follow the terms of this grant. Speculation, disputed boundaries, and "frontier peril" made planned growth impossible. While jurisdiction of the region was given to New Hampshire in 1740, the state assembly refused to grant support and maintenance as late as 1745. Security was an acute problem. With no militia to protect them, the settlers were particularly vulnerable to Indian attack.

The year 1745 brought reverberations of the French and English War to the colonies. Squakheags, in alliance with Canada, attacked the settlements of Swanzey, Keene, Winchester, Hinsdale, Putney, and Charlestown. Since the situation was extremely dangerous, Massachusetts sent additional forces to New Hampshire, but the scattered distribution of population made survival tenuous. Since farming was the primary form of subsistance, the area was thinly settled. Repeated attacks forced the settlers to abandon their lands to gather in the small fortresses, and the land was laid waste. In 1747, most of the settlers moved to safer parts of Massachusetts, and the towns were burned shortly thereafter.

Finally after three years of relative peace, Swanzey was chartered by New Hampshire in July of 1753. While the charter was similar in content to that written by the Massachusetts Assembly, development of the town was subject to the same past difficulties. The year 1753 marked the renewal of the French and English War. Continual Indian raids necessitated the ever-presence of state militia and growth did not really occur until Quebec passed into English hands in 1759.

Settlement of Swanzey followed rather specific patterns. Land was developed first along the Ashuelot River and then continued up the South Branch. Most of the hills were not settled until nearly all other land was appropriated.

By 1800, there were many large and productive farms. Fish, rye, and Indian Corn were the principal articles of food. The production of cider was important. Most of the farmers were engaged in subsistence agriculture, using labor as the predominant commodity for barter. Money was occasionally obtained from the sale of cattle, horses, sheep, and hogs.

Lumber was the principle industry of the region. As early as 1738 plans for a sawmill and dam were made for the "Upper Great Falls" on the east side of the river. It was demolished during the Indian Wars but rebuilt in 1760. Other mills sprang up on the west side of the Ashuelot River and Swanzey pond. Much of the lumber was transported to Northfield and "rafted" down the river.

As the industry grew, the mills expanded their products to include building materials and wooden ware. Around the turn of the 19th century, attention was focused upon ways to facilitate shipping of these goods. A company was formed whose design it was to take heavy articles brought up the Connecticut River in boats, to transfer them by teams past the rapids in Hinsdale and Winchester, and then to boat them up to Keene. Locks were built at the falls in Westport and West Swanzey but the operation proved to be too expensive to operate.

As shown in Table C.1, the population of the area reached a stable plateau in the early 19th century. As agriculture declined with the movement West, and as its small industrialized base became marginally efficient, the population declined, reaching a low point at the turn of the 20th century.

Figure C.1 shows a map of Swanzey made in 1890.

TABLE C.1

Population of Swanzey and Cheshire County, New Hampshire

Date	Swanzey	Cheshire County
1767	320	
1773	536	
1775	647	
1783	957	
1786	1000	
1790	1157	19665
1800	1271	24288
1810	1400	24474
1820	1716	26843
1830	1816	27016
1840	1755	26429
1850	2106	30134
1860	1798	27434
1870	1626	27265
1880	1661	28734
1890	1600	29579
1900	1570	31321
1910	1656	30659
1920	1593	30975
1930	2066	33685
1940	2262	34953
1950	2806	38811
1960	3626	43342
1970	4316	51149

Sources: Population of New Hampshire, Part I, New Hampshire State Planning and Development Commission, Concord, N.H., 1946; U.S. Census of Population, 1950, 1960, 1970 (preliminary).

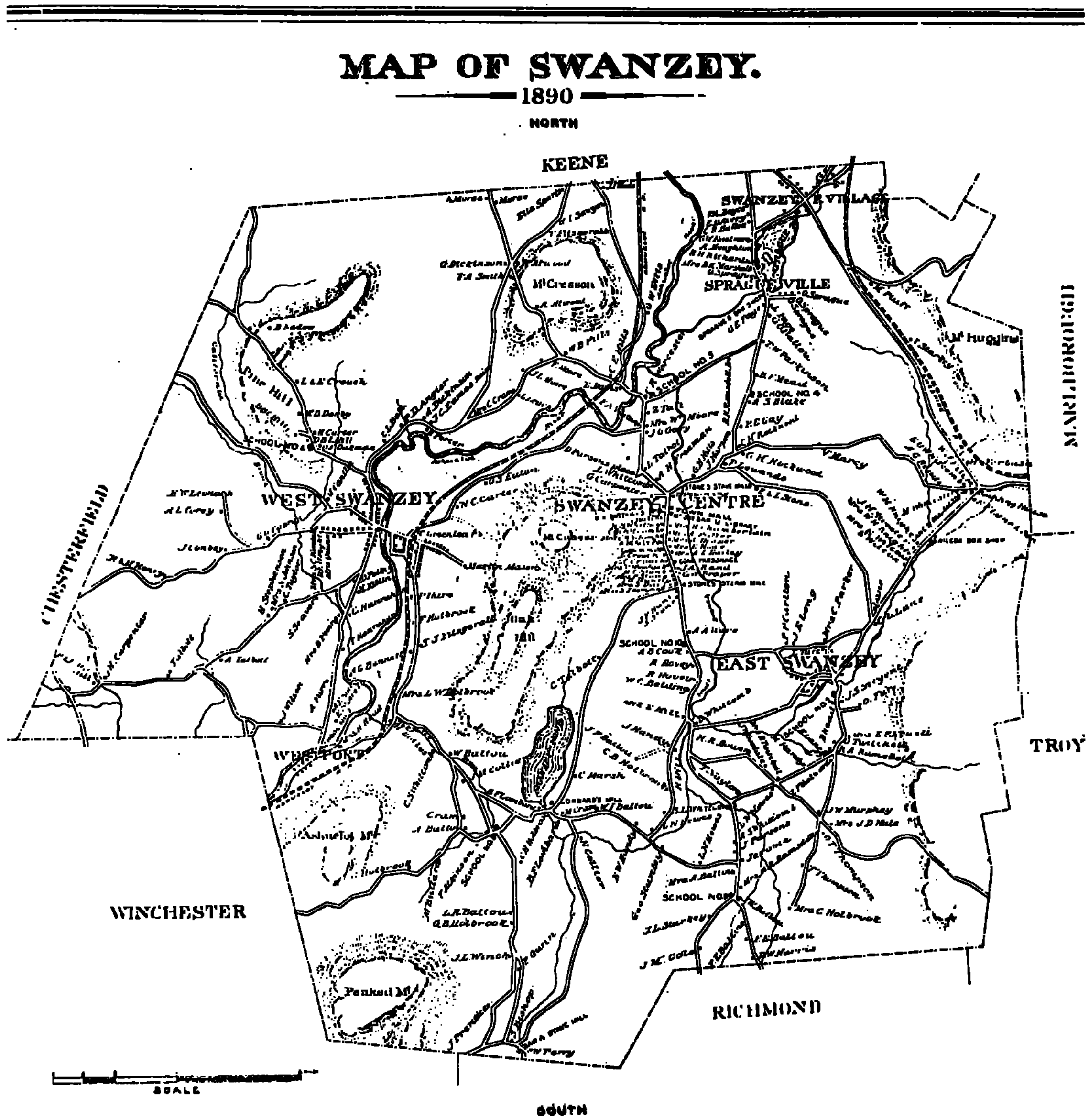


Fig. C.1
Map of Swanzey - 1890

APPENDIX D: A SURVEY OF CURRENT APPROACHES TO RESOURCE ANALYSIS

A. SELECTED RESOURCE ANALYSIS APPROACHES

A summary is presented in this appendix of selected resource analysis studies by the following individuals and groups. The summary is derived from a study by Steinitz, Murray, Sinton and Way (101.23) in which selected resource analysis projects of the following individuals and groups were described:

1. Richard Allison and Roger Leighton
2. Chester County Planning Commission
3. C. S. Christian
4. John A. Dearinger
5. G. Angus Hills
6. Philip H. Lewis, Jr.
7. R. Burton Litton, Jr.
8. Ian L. McHarg
9. PARIS: The State of California
10. RECSYS: The State of Michigan
11. Soil Conservation Service: 1
12. Soil Conservation Service: 2
13. Richard E. Toth
14. U.S. Army Corps of Engineers
15. Edward A. Williams
16. Research Planning and Design Associates
17. C. Steinitz, P. Rogers, and Associates

For a more detailed description of the selected approaches, including: their methodological goals; the constraints under which the method was developed or under which it operates; the data variables which are investigated; the logic of the analytic approach; the applicability of the method to other areas, scales, and purposes; and its principal documentation; see the cited study and the sources in the bibliography of this report (89-104).

These methods illustrate the major aspects of current resource analysis. In order of increasing complexity, these are: 1) land classification; 2) resource inventory; 3) resource-centered analysis, indicating where development changes should not occur; 4) analysis linked with demand, showing where change might or should take place; 5) single-sector models which predict the effects of change; and 6) multi-sector models in which several sectorial models can interact in a general planning system. One common method which we do not discuss is that of the "old timer"--the expert who has extensive and intensive knowledge based upon long experience in a particular geographical area or with a type of resource. One cannot underestimate or fail to respect the power of this kind of expertise, but neither can one readily teach or transfer that method.

Table D.1 presents a summary classification of the selected resource analysis studies which are representative of the various analytic approaches currently in use.

The caveats which underly this survey must be made clear. It must be constantly remembered that each approach has different goals, data requirements, scales, political constraints, time and money budgets, expertise, etc., and any comparison makes many implicit assumptions about these most important variables.

One area in which it is not possible to make comparisons of these studies, and which perhaps is one of the most crucial, is that of cost and efficiency. For a variety of reasons, most of which are obvious, the time, dollar, and manpower costs of resource analysis studies are never stated in their documentation. These surely must vary greatly. While one hesitates to apply criteria of cost effectiveness to the obvious "good" of natural resource evaluation, it is nonetheless an important factor to be considered, particularly by the public or private client.

B. METHODS OF RESOURCE ANALYSIS

1. GENERAL GOALS

The analytic goals of resource analysis methods are essentially similar, but their underlying logic and assumptions differ, as do the form of their results. In most, a problem is determined, a study area is defined, and the methods are applied, having as their goal the identification of prime areas for different purposes, typically land or other resource uses.

Many resource analysis approaches make the simplified assumption that evaluations of suitability can be directly translated into development policy and implementation, not making clear the distinction between "could" and "should." Hills' definitions (93.1, pp. 2-3) of suitability, capability, and feasibility are most useful.

Table D.1
Classification of Selected Resource Analysis Studies

	DATE	STUDY TITLE BIBLIO. CIT.	NAME
c.	1967	Evaluating Forest Campground Sites (89)	Alli-.-Lei.
	1963	Natural Environment and Planning (90)	Chester Co.
	1968	Aerial Surveys and Integrated Studies (91.1)	Christian
	1968	...Recr. Potential...Streams...Urban Areas (92)	Dearinger
	1960	Glackmeyer Report (93.7)	Hills
	1967	Upper Mississippi Comp. Basin Study (94.1)	Lewis
	1963	Landscape Analysis 1: Lake Superior S. Shore (94.7)	Lewis
	1968	Forest Landscape, Description and Inv. (95)	Litton
	1969	Staten Island Study, in: Design with Nature (96.1)	McHarg
	1963	Plan for the Valleys (96.8)	McHarg
	1966	Park and Recreation Info. System (PARIS) (97.5)	PARIS
	1966	Mich. Outdoor Recreation Demand Study, Report 6, (98.3)	RECSYS
	1960	Soil Survey, Indiana County, Penn. (99.1)	SCS:1
	1966	...Potentials for Outdoor Recreation Dev. (100)	SCS:2
	1968	...Valuable Natural Resources...TIRAC (102.1)	Toth
		Resource Inventory, Costa Rica	Corps Eng.
	1969	Open Space, Choices Before California (103)	Williams
	1967	...Visual and Cultural Envir., (prelim.) (104.3)	Res. Pl. & Des.
	1968	Urbanization and Change (101.19)	Steinitz Rogers

(TABLE D.1 cont'd.)

SPONSOR	STUDY AREA	SIZE	
N.H. Dept. of Nat. Res. Univ. N.H.	Potential Campgrounds	n.a.	Alli.-Lei.
County Govt.	Chester Co., Penn.	600 sq. mi. ±	Chester Co.
State Govts.	Large Regions, Australia	100,000 sq. mi. ±	Christian
U.S. Dept. of Interior Univ. Ky.	Lexington, Ky. Region	100 sq. mi. ±	Dearinger
Ontario Dept. of Lands and Forests	Large Regions, Canada	3,000 sq. mi. ±	Hills
Nat'l. Park Services U.S Dept. of Interior, etc.	Multi-State Region	300,000 sq. mi. ±	Lewis
Wisc. Dept of Resource Dev.	County, Wisconsin	5,000 sq. mi. ±	Lewis
Forest Service, U.S. Dept. of Agric.; Univ. of Calif., Berk.	Highway Corridors	20 mi. ±	Litton
Dept. of Parks, City of N.Y.	Staten Island, N.Y. City	100 sq. mi. ±	McHarg.
G.S.W. Valley Plan. Council (Local Citizen Group)	Baltimore Suburban Fringe	100 sq. mi. ±	McHarg
Calif. Dept. of Parks and Rec.	Calif. Metropolitan Regions	150,000 sq. mi. ±	PARIS
Mich Dept. of Commerce, Mich. State Univ.	Mich, State Parks	60,000 sq. mi. ±	RECSYS
U.S. Dept. of Agric.	County (all U.S.A.)	1,000 sq. mi. ±	SCS:1
U.S. Dept. of Agric.	Potential Recr. Areas	n.a.	SCS:2
Tocks Island Reg. Advis. Council	Townships, Penn.	1,000 sq. mi. ±	Toth
Eng. Resources Inv. Center	National, Regional	20,000 sq. mi. ±	Corps. of Eng.
Calif. State Office of Plan.	Calif. Metropolitan Regions	10,000 sq. mi. ±	Williams
N. Atlantic Reg. Water Resources Study, Coord. Comm.	Multi-State Region	150,000 sq. mi. ±	Res. Pl. & Des.
Dept. of L. Arch., Harv. Univ.	Boston Region, S.W.	400 sq. mi. ±	Steinitz Rogers

The concept that resource analysis should identify places in which natural resources constrain development rather than attract it, the latter implying a study of demand, would seem to be a potentially efficacious procedure. It may well be that the goals which unite some of the resource analysts would be better served by this more direct approach. Thus, in evaluating resources for development purposes several of the methods, notably those of Lewis (94) and McHarg (96), reverse the more typical suitability evaluation procedures and evaluate resource patterns or resource areas which "shall not" be subject to unconstrained development because of factors which would be detrimental to the interests of development itself. If the bias of an analytic technique is to be from the viewpoint of resources, it would seem that this analytic style, identifying the areas which are best left natural because of danger to other uses, would have many attractions. Certainly this is the area in which most of the resource analysts themselves can claim expertise.

The specificity of the resultant analysis evaluations will vary with the method used. These range from broad characterizations shown in the colored maps of McHarg (96) and in the ratings of excellent, good, fair, and poor that several methods use; to the descriptions of suitability, capability, and feasibility, each of which is internally dichotomous, as in Hills' method (95); to the several numerical point rating systems such as those of Allison and Leighton (89), Dearinger (92), and Lewis (94); to the most explicitly derived formula for state park attractiveness, that which is employed in the Michigan model (98); to the spatial explicitness in the multi-sector urban growth simulations of the Steinitz Rogers study (101.19).

Considering the grossness and lack of specificity originally inventoried in many of the variables, one is more comfortable with the broader characterizations of resources as being potentially excellent, good, fair, or poor for any given use, than with the very precise numerical evaluations. However, the resource analyst is pulled from the other side by the requirement that in order to be useful for implementation, his method must indeed rank order the resultant evaluations. He must identify the single best area for an activity or the single worst area, and if policy and implementation do not allow the best site to be obtained, then the second, third, ninth, and one hundred and fifteenth best sites must be identified. Thus, as in many other issues, the resource analyst may be forced to make a choice between reliability and specificity. Again, obviously, the goal is to achieve both.

Methods of resource analysis can be described as having increasing levels of complexity, specificity, and probable usefulness in land resource planning and implementation. These can be characterized as:

Descriptive
Static, Single-factor analyses;
Static, multiple-factor analyses;
Dynamic, single-sector models; and
Dynamic, multiple-sector models.

2. DESCRIPTION

The first order of resource analysis is purely a descriptive inventory. Several methods identify zones of homogeneous character based on the presence of single variables or sets of variables, but do not make qualitative or quantitative evaluations of them. It is, however, intended that their nominal descriptions be eventually evaluated for a variety of development purposes. These descriptive methods deal primarily with the supply side of natural resource analysis, and much of the work of Christian (91), Hills (93), and the Soil Conservation Service (99) would fall into this category. The studies by Litton (95) and Research Planning and Design Assoc. (104) of visual form are also essentially descriptive inventories. To the degree that it is possible, these methods attempt to establish objective measures for various resources and to avoid the introduction of subjective evaluation into the inventory stage.

The failure to recognize the distinction between objective measurement and subjective evaluation is one of the common failings of many resource studies, as evidenced in some of the methods which in the inventory stage introduce point rating evaluations. To the maximum extent possible, the inventory stage should be value free and rely on objective measurement. The Michigan RECSYS (98) study is unique in its recognition and discussion of this difference. Furthermore, it is the only one which specifically eliminates purely subjective evaluations from its analytic procedures. Clearly, substantial work must be done to increase the degree of objective measurement which can be applied to what now must still be considered subjective evaluation. The omission of important qualitative factors such as visual quality from a method which is relying upon quantitative evaluation is not the answer. Rather, one must be able to include these factors.

C. STATIC ANALYSES

Most of the currently used methods can be considered "static," in that for a given proposed use the resources are evaluated on a singular basis. Changes in the data caused by time or the intervention of man are typically not considered. Most of the investigators undoubtedly recognize that many natural resource data do change, but the technical means at hand do not allow them to include variables which are dynamic in their analyses, nor do they allow multiple analyses of a problem under differing assumptions.

1. STATIC, SINGLE-FACTOR ANALYSES

Single factor analyses are rarely found because of their obvious simplicity, but at least two kinds of data are used as primary analysis sources. One is soils, with many of the soil capability studies being based upon this single, though complex, variable. Examples are found in the work of the Soil Conservation Service (99, 100). The other example is the visual studies such as that by Litton (95), which uses topography as its principle data source.

In most cases, the single factor analyses are interpretations of descriptive data. Indeed, topographic slope is a prime example of an objectively measurable variable which is used in a variety of interpretations, notably for its impact upon urbanization. The cut-off point between good and bad slope for urbanization ranges anywhere from 9 to 45 degrees. Thus, it often appears not to be the data inventory which distinguishes a method, but the interpretation of the data.

2. STATIC, MULTIPLE-FACTOR ANALYSES

Most of the static analysis methods make use of several variables in their evaluations. The added complexity of combined multiple variables affords more confidence in the results, and some kinds of predictive analyses are often found in these methods. Thus Lewis (94), McHarg (96), Toth (102) and others identify areas on the basis of combining several resources in which they are prepared to make predictions of consequences of various development policies. Thus, among other patterns, Lewis identifies flood plains and predicts damage to urbanization should it occur here. Similarly, McHarg makes generalizations about increased air and water pollution in areas of potential industrial development in his study of the Valleys. Given the level of scientific expertise and applied ecological knowledge, these broad generalizations are often the most appropriate ones which can be made, (particularly given the meager financial resources often available to the investigators). Unfortunately, the level of technical sophistication employed in these static resource analysis methods to predict ecological and other damage to the natural environment is not at the same level as that employed by the many recent models of water and other ecological systems pollution. Even though they are rarely quantitatively or qualitatively specific, the static methods do quickly identify the essential issues to be considered.

The static analyses combine their multiple variables in one or more of a variety of techniques which can be classified as:

Overlays;
Point Rating Systems; and
Key Element Systems.

(a) OVERLAYS

The most common style of static analysis is that of using overlay methods, or "sieving," to identify areas with combinations of sought-after resources. In this technique, maps of different variables are made, typically in color on a transparent base. These are then superimposed and the various data combinations are in turn recorded either photographically or on new drawn maps. The equivalent computer program is a set of linked "if" statements.

Overlays are the fastest way to identify zones which have all of a given set of variables. However, the method does not easily identify choices which are less than best. Lewis (94), McHarg (96), Forbes (40), and others have used this method extensively. The appeal of the method rests in its simplicity and its typical graphic clarity and communicability.

Its liabilities are an inability to distinguish many levels of internal scaling of the variables, an inability to deal with large numbers of variables in one analysis, and, importantly, an inability to differentially weight the relative significance of different variables.

(b) POINT RATING SYSTEMS

Numerical point rating systems are another common method used in combining several variables in any particular analysis. In this method the presence of different variables is ascertained much as in the overlay method. However, numerical point ratings are assigned to differentially weighted variables. The points are then cumulated as the analysis incorporates additional variables, and the resultant numerical totals are assumed to be evaluations of the sought-after quality for potential development or use. The equivalent computer program is a set of weighted "if" statements.

In local studies, point rating systems are a convenient and effective method for making explicit the evaluation criteria of the analyst or his client group. However, when applying point systems to large regions, it must be recognized that explicit specification of evaluation criteria is mandatory if others are to be able to replicate the method. The common variation in point rating systems, even when applied to objectively measurable data variables, clearly indicates the degree to which personal interpretation is used in resource analysis. In analysis of very large regions, such as that in the Upper Mississippi River Basin study of Lewis (94.1) and the North Atlantic Region by Research Planning and Design Associates (104.1), and in nation-wide analyses, such as those of the Soil Conservation Service (99), the standardization of point ratings becomes a less crucial issue, since local and more relative resource evaluations are perhaps more important to development than consistent evaluation over such very large areas.

(c) KEY ELEMENT SYSTEMS

One of the uses of raw data employed by several methods such as those of Dearinger (92) and the Soil Conservation Service (100) is the rearrangement of raw data into key elements. In this method, overlays and point ratings are combined in an attempt to take a large number of relevant variables and combine them into a manageable, smaller number of "factors." Thus, several soil and topography variables might be evaluated in a "construction costs" factor, which would in turn be combined with other complex factors in the analyses. The equivalent computer program is a set of weighted "if" statements with intermediary totals.

One potential drawback of this method is that, in combining key elements, one very often finds the same basic variable appearing many times in only slightly different guises. Thus, topographic slope or landform would appear as the basis for the definition of several key elements, and the methods do not always recognize the degree to which a final cumulative measure reflects the multiple use of a few specific variables and the singular use of others. One sometimes feels that this represents an implicit weighting system of which resource analysts are not fully aware. A second danger of this concept is that the key elements often combine variables which are basically different in their manner of measurement, some of them being based on nominal descriptive scales and some based on ranking scales. Thus key elements (in addition to summary evaluations) combine what is, in essence, apples and oranges. However this approach, when properly used, would seem to be a major convenience and indeed, given the manual methods that many of the studies use in map overlaying, the consolidation of many variables into fewer is absolutely necessary.

D. DYNAMIC ANALYSES

The dynamic methods are essentially directed to the same purposes as are the static methods, but they ask a different question, namely, "What if...?"

This is the crucial question if the prediction of the consequences--the benefits and costs of alternative courses of action measured in a wide range of values--is the desired analytic goal. This is the question which is of most use in policy formulation and decision making. One cannot decide what to do unless one can evaluate the consequences of the widest range of alternatives.

These methods are therefore typically developed as system models, which can be applied in multiple evaluations of the same problem under different data conditions (such as different stages of forest growth over time) or different policy assumptions (such as the selection of the least costly versus the most scenic highway location). The dynamic character of these models and their analytic flexibility are typically derived from the use of computer technology.

1. SYSTEMS ANALYSIS MODELS

In the past few yesrs, with the increased application of the techniques of systems analysis, a fairly complex and detailed methodology for modelling has been derived. This can be seen as constituting a distinct body of knowledge. Systems analysis (or operations research) can be considered a way of looking at complex problems, and Simon (79) has made the following definition of the new field:

> "Operations research is loosely defined as the scientific method or straight thinking applied to management problems. This is similar to what had earlier been thought of as 'scientific management' except that operation researchers tend to use rather high powered mathematics. The systems approach is a set of attitudes and a frame of mind rather than a definite and explicit theory. At its vaguest, it means looking at the whole problem--again, hardly a novel idea, and not always a very helpful one. The mathematical tools of operations research (including linear programming, dynamic programming, game theory, and probability theory) have a general recipe when applied to management decision making: (1) Construct a mathematical model that satisfies the conditions of the tool to be used and which, at the same time, mirrors the important factors in the management situation to be analyzed. (2) Define the criterion function, the measure that is to be used for comparing the relative merits of various possible courses of action. (3) Obtain empirical estimates of the numerical parameters in the model that specify the particular, concrete situation to which it is to be applied. (4) Carry through the mathematical process of finding the course of action which, for the specified parameter values, maximizes the criterion function."
>
> [Simon (79), p. 16.]

The most important point of Simon's definition is that systems analysis is novel not merely because it includes more of the system, but because of its unique overall viewpoint. His definition is, however, rather idealistic in that he talks of maximizing the criterion function. In many practical cases of public planning, especially in problems of environmental quality, it is not directly possible to make optimizing models of the system. Under such circumstances, it is necessary to rely on the use of descriptive simulation models instead of analytic models. The distinction between these two types of models will be clarified later.

2. TYPES OF MODELS

Since the word model is used loosely in everyday language, it is important to define how it is used in systems analysis. Table D.2 classifies the types of models, with some examples of their use. In a systems analysis of a particular problem, we could use any one of the types of models shown in Table D.2. However as experience increases, more and more analysis has moved away from the iconic and the analog, toward the symbolic models.

TABLE D.2. CLASSIFICATION OF MODELS

Type of Model	Example
Iconic	Architect's model of house; engineering drawings; city planners' land-use maps.
Analog	Network flow analyzer using electricity as an analog for water, gas, etc.; slide rule addition of logaritms, using length as analog for number.
Symbolic	Mathematical equations, mathematical programming, digital simulation.

Lowry (56) classified the symbolic models into (1) descriptive, (2) predictive, and (3) planning models. Descriptive models attempt to replicate the relevant features of an existing environment and are useful in formulating theory. Predictive models attempt to foretell the consequences of an action. Finally there are the planning models which strive not only to predict but also to evaluate the results in terms of the planner's goals. Lowry listed the essential steps in a planning model as:

1) Specification of alternative programs or actions that might be chosen by the planner;
2) Prediction of the consequences of choosing each alternative;

3) Scoring of these consequences according to a metric of goal achievement;
4) Choosing the alternative that yields the highest score.

This is a restatement in more general terms of Simon's (79) definition of operations research.

The symbolic models used in planning analysis can be structurally distinguished as mathematical programming models (analytic models) and digital simulation models used for optimization (simulation models).

Analytic models are based on formal mathematical algorithms. An algorithm is a set of logical rules which enable one to do mathematical operations. These models are preferred by system analysts because of their mathematical elegance and simplicity. However, they do depend upon the theoretical limit of formal mathematics (usually algebra) and hence are quite often restricted to modelling only the simplest relationships. For instance, non-linear relationships are difficult to handle by these methods.

Linear Programming is an example of a method for analytical model building which has been successfully applied in many cases. Linear means that there are linear proportional relationships between the variables. These are restricted to linear relationships and linear utility and objective functions to be maximized or minimized as need be. When the system has been modelled by these linear equations, an alborithm is then applied to make a solution to the model. Provided that the equations set up as the model of the system meet some minimum requirements, the algorithm will always give you the optimal solution (the maximum or the minimum value which is sought).

Simulation models on the other hand are in general non-algorithmic. One must create for oneself the logical relationships, which in this case are not restricted to formal mathematics but can include all formal linguistic relationships. Since it is extremely difficult to construct an optimizing algorithm from such logic, the thrust of most simulation is descriptive rather than optimizing. This creates some confusion and leads many people to believe that simulation models do not optimize. This is not necessarily true, since a descriptive simulation model can be used to make "steepest ascent" approaches to the optimal solution.

An example from transportation planning may help to explain this. Consider the case of a highway planner wishing to locate a new highway. Since he is also interested in the capacity to which it will be necessary to design the highway, it is not possible to model the problem by an analytical model. There are too many variables that can take on integral values; there are too many non-linearities; and there are too many time-dependent variables for the present state of mathematical theory to handle. The planner would therefore build a simulation model of the system. To do so, he would assume that he knew where the highway was located and its capacity. He would then write a series of functions that would describe the traffic flow over time (these functions are based on empirically observed phenomena, perhaps coupled with theoretical queuing theory and analysis). These enable him to predict how the highway in the proposed location and of the assumed capacity would respond over time, both in a physical and economic sense. The planner would then make adjustments to the location, capacities, etc., based upon the results of the study, and re-run the model to see if the economic response is better than the first study. In this manner he could improve his design in a series of steps, making an "ascent" on the response surface. As it turns out, there are several different methods for achieving the hopefully-aimed-at "rate of steepest ascent." One such method is the use of repeated random samples of the capacity variables, the so-called Monte Carlo Method.

Many types of models, and in particular simulation models, rely on regression models as a primary analytic component. They are used in several of the models in the Steinitz-Rogers study (101.19). Basically, regression is a method to test hypothesis about a particular phenomenon against the observable and measurable effects of the phenomenon. Regression models allow one to make predictions about the behavior of one variable (the "dependent variable) from observations of the behavior of another variable or group of variables (called the "independent" variables). In strict statistical terms, however, we are not allowed to assume causality between the independent variables and the dependent variable.

The final choice of the model to be used depends upon the nature of the systems to be modelled, the use to which the models are to be put, the sort of questions the planning problem poses, and the level of detail required of the analysis.

3. SINGLE-SECTOR MODELS

There are now a substantial number of models having direct application to problems in land resource planning. Most of these are simulation models of single systems. Many, because they seek to show spatial changes, make use of data which are organized on the basis of a grid coordinate system. They are therefore theoretically capable of being inter-related as components of multiple sector models.

The business world and the military have for years been using mathematical models in their decision making processes. Mathematical representations of traffic systems and housing markets have also been used for several years in urban planning. Yet is is only recently that these methods have been more widely developed in land and resource planning. The lead in this application has come from hydrological studies, and in particular, studies of the effects of storms on river and waterway flooding.

(a) FLOW SYSTEMS

An example of a flow system model is that by Rogers, Russell and Sinton (101.10), in which storms are simulated over a land area. The model takes as its input the land conditions and periodic rainfall. It constructs the drainage paths from cell to cell on the base grid, the river location into which each cell drains, and the distance in cells to the point of inflow to the river. This distance can be modified by a time factor calculated along the specific path to the river and depending upon the slopes of the cells in that path. The amount of water which actually flows off each cell is also calculated as a function of the land and water conditions of that cell. This process enables the generation of flood hydrographs in the river. When this model is coupled with a simulation model which allocates development over time, it will be able to show how such development affects flooding conditions.

(b) GROWTH SYSTEMS

Resource growth processes have also been modelled in a compatible manner. Gould and O'Regan (44), among others, have developed simulation models of forest growth and change over time. Their purpose was to model the decision making process of forest management for timbering. In their model, the landowner makes decisions and gives instructions to his "manager" (a computer program) which, following his instructions, calculates, records and returns the consequences of his timbering policy. The program thus can be used to evaluate alternative timbering policies over time.

(d) DISPERSION SYSTEMS

The dynamic character of many phenomena involves spatial dispersion or diffusion. Shepard (78), in his model of air pollution, presents a good example of the utility of this form of analysis. The model simulates the dispersion of the sulfur dioxide emitted from electric power generation plants in the St. Louis area under various atmospheric and wind conditions. Using this model it is possible to investigate the impact which a newly located plant would have on the level of sulfur dioxide pollution at any point in the St. Louis area. This type of model may also be analogously applied to consideration of the spread of plant diseases or the spread of pollution in a large water body.

(e) SEARCH SYSTEMS

Amidon and Elsner (4) of The Forest Service Research Center have developed a simple search procedure for determining the inter-visibility of points on a topographic surface. A similar procedure has been developed at the Laboratory for Computer Graphics and Spatial Analysis at Harvard [VIEWS (101.14)]. These systems permit the development of models which consider visual and scenic impact of development (such as housing and highways) in a landscape. The procedures can be applied to any search procedures on three-dimensional surfaces, be they topography or conceptual fields, which exhibit the properties of a continuous surface.

4. MULTIPLE SECTOR MODELS

Several sectorial models can interact in a more general planning system, with a common data system as the basis for the interaction. This could represent the highest order of organization for analysis and prediction. The models would be considered components of the system, and themselves be capable of updating, improvement, or even rejection and sub-situation. The key advantage of this approach is that it begins to resemble a model with the necessary complexity to adequately replicate the real world of resource decision making. Thus the "What if...?" question can be asked in one of several controlled systems, and the evaluation can be traced through the resource base, in terms of its component sub-systems.

In urban planning, there are now several years of experience in the development and use of multi-sector models. Several reviews have been made of models in use, notably by Kilbridge, Teplitz and O'Block (51), and Hester (46). In larger scale resource planning, however, the development of multiple sector models is a more recent activity.

An example of the multiple sector approach within one resource area, forestry, is the study by Knode (52). Using a GRID data base, he has constructed and applied three interrelated models of forest growth: timbering, management and forest recreation. The model attempts to develop means by which land managers can identify and evaluate, over time, the financial and other consequences of policy alternatives in order to reduce the probability of activity conflict, while retaining the quality of the landscape and producing a satisfactory financial yield.

Another example, linking recreation and transportation models, can be seen in the Michigan RECSYS model (98). This computer based simulation model was designed with the goals of accurately predicting, quantitatively and by implication qualitively, the impact on the recreational experience of changes in either the condition of the resources themselves, the characteristics of population demand, and/or the linkage system as represented by the transportation networks. The RECSYS simulation model has three basic components: an origin model which describes the characteristics and county locations of the populations who will be the consumers of recreational activities; a travel model which indicates the characteristics of the highway hetwork which allows the people to travel to places of recreation; and a destination model which describes the attractiveness of the State Parks of Michigan for camping and boating.

The development of a multi-sector regional model was begun by Carl Steinitz, Peter Rogers, and others, in A Simulation Model of Urbanization and Change (101.19). It linked several evaluation models with several allocation models representing various types of urbanization pressures on the Boston Region: Southwest Sector. The simulation model began with a projected population increase for five-year iteration periods. Four allocation models were prepared: an industrial model, a residential model, a recreation and open space model, and a commercial centers model. There was also a transportation model, but as it was felt that most of the transportation routes in the region were already established, this model functioned principally as an upgrading process separated from the others. There were four evaluation models: political, fiscal, visual quality, and pollution. All the models used a common data inventory organized by the GRID computer system.

Several of the sector models rely upon linear regression models, which, their drawbacks aside, are robust and available. In this simulation model they were used for residential location, open space development, and visual analysis. The object was to get each of the allocation sectors to make an "optimal" plan within its own objective sets and with respect to its own goals. There was no single objective function to be maximized for the whole region; the sum of each of the sectors was considered the regional optimum. The residential model was essentially a model based on the point of view of the real estate market. In the recreation model, the people whose behavior was modeled were conservationists and recreationists who were maximizing their own objective function. This attitude was applied in each of the allocation models. Then each sector was evaluated by the evaluation models. Many external effects between the sectors had to be taken into account when evaluating adjustments within individual sectors.

Two simulations were run in the original studies, one a projection of current growth trends, and the second a projection of those trends under the assumption of metro-politan-regional government.

The Department of Landscape Architecture Research Team at Harvard University has been developing multi-sector models under a research contract with the U.S. Army Corps of Engineers.

The first aspect of the study is an evaluation of the quality of the resources of the Honey Hill area of Swanzey, New Hampshire, for a variety of resource-based (or constrained) allocations. This evaluation has been based on methods discussed in our earlier studies and will represent a synthesis of various resource evaluation methods in a practical application. The data for the study have been derived from air photo interpretation maps and field surveys. They are stored, analyzed and displayed using computer methods developed by the investigators. The data scale is 1/100 sq. km. (2.5 acres).

The second aspect of the study is the development of a series of quality indices, such as visual quality, ecological damage, wildlife habitat quality and others. These are being developed as models. Site attractions or constraints will then be measured in these terms for a variety of recreation types and other activities. These use-quality evaluations will be spatially specific to the grid cells and will be rank ordered, thus leading directly into a planning evaluation process for site development. The environmental quality models will be used as an integral part of the planning and evaluation system described in the third stage of the study.

The third stage of the study is to investigate the implications for environmental quality of various potential uses of a particular study area. This step involves the application of the formal mathematical models of systems analysis. Three different approaches to development of plans for the site area are being investigated.

The first approach employs the use of analytical mathematical programming models, such as linear or piece-wise linear programming models. Given certain physical, ecological, and economic constraints, the objective function of the model being formulated is the maximization of net benefits for the development of the Honey Hill reservoir. The solution consists of listing a number of decision variables which will attain the objective function. The output of the mathematical programming model will provide "optimal" development proposals within 23± predefined zones. Part of the mathematical programming analysis is a parametric study of the system response (allocation between various recreation activities) to changes in the demand parameters.

The second approach involves the use of "best professional judgment" to develop the various plans. Based in part upon the analyses produced in the first two stages of the research, the members of the research team have produced alternative proposals. The processes which these individuals used have been documented. The proposals are specific to the scale of the data grid.

The third approach is the development and utilization of a simulation model. The simulation model can be run on the basis of days, weeks, months, seasons, or years. Total demand is set exogenously, but activity preferences are keyed to nine combinations of income and travel time-distance to the site.

Output of the model includes:

1) the dollar income of the proposal,
2) the dollar costs of management and maintenance,
3) the quality of recreation experience, by activity and by consumer group, and
4) site resource quality.

The model can be used in three ways. First, it can simulate and evaluate the proposed alternatives arising from the "best professional judgment" schemes to evaluate "how well they do" in a vector sense. Second, it can test the plans implied by the linear programming model. Thus, the simulation model will be used as a laboratory for testing the first two approaches. Third, one can use the simulation model as a means of "pulling itself up by its bootstraps"--i.e., through further refinement of itself, to try to reach optimality.

E. SUMMARY

In general, the selection of methods will be a function of the condition of available data, the definition of the problem to be analyzed, the types of responses required and their specificity, and the variety of alternatives to be considered. Also to be considered will be the time, money, technology, manpower and expertise which are available.

In terms of the techniques which can be applied to resource analysis, the advantages and disciplines of computer use seem clearly demonstrated. The lack of computer use has constrained resource analysis to relatively simple techniques using broad classes of data and relatively few variables. The use of computers in resource analysis can be expected to continually evolve from fairly uncomplicated to relatively sophisticated applications.

The application of the static analysis methods to computer does not present serious programming problems, as none of these analysis methods really requires highly sophisticated programs. In their different ways, the most complex methods in terms of computer programming are the key element definitions of the Dearinger study (92), and the hierarchical classifications of Christian and Hills' (91,93). The dynamic analysis models on the other hand are obviously more complex and require more complex programming support. However, these models are often directly conceptualized as computer programs and are often presented as such for use or adaptation by others.

It would seem that the degree of complexity demanded of computer programming is related to the degree of complexity of the methods themselves, many of which are simplifications of what are unquestionably highly complex and interrelated sets of systems. Indeed, many of the static methods purposely and necessarily attempt to make simplifications, as witness and many searches for an all-purpose, all-inclusive homogeneous data zone and a short list of key element variables. In no way does this search for simplicity reflect on the capabilities or qualities of the person carrying out the method. Rather, it reflects on the types of technology that their methods employ.

One of the major potential impacts on resource analysis studies of the future will be the greater availability of more, and more accurate, data provided by the new technologies of satellite-sensing and aerial photography. These data will come to the user directly in computer compatible form and then the challenge to the resource analyst will be to devise the means of understanding, analyzing, and manipulating those data. Not only will more data be available but various analysis programs themselves will probably become packaged. The various indexes and evaluation scoring systems which are so common today can then be internally studied, so that the effects of what now must be considered essentially subjective bases of evaluation can become more objective. The time and costs required for making these analyses will drop radically through computer use, and there is every reason to believe that the quality of resource analysis will improve. The evolution of computer graphics will be accompanied by changes in the equipment and programs which will continue to grow in quantity, quality, and compatibility, with substantial concurrent reductions in unit cost.

It will obviously become increasibly important to develop an understanding of the numerous potential uses of computers for resource analysis as well as an understanding of their limitations. The dominant developing trends in environmental resource analysis are toward the kinds of systems which we have described--general data inventory and data handling systems, coupled with specialized and interrelated analysis models, all being computer compatible for analysis and graphic output.

These systems are feasible now. Prototypical systems have been designed, tested, and made operational at several scales and levels of government. Their combination of low cost in time, personnel, and dollars relative to a virtually unlimited analytic potential, make such an approach one which should be considered in almost any large and complex planning area.

APPENDIX E: THE ROLE OF COMPUTERS IN RESOURCE ANALYSIS

The use of computers in resource analysis is a fairly recent development, as is their application to the production of maps and other graphic displays. One of the first of these applications was in the 1966 Delmarva Study by Steinitz et. al. (101.15).

Computer applications in resource analysis are most likely to be beneficial under any of the following conditions:

1. large numbers of data observations,
2. internal variability of data,
3. possible geographic expansion,
4. possible data variable expansion,
5. possible data updating,
6. flexibility in analytic procedures,
7. application of mathematical models,
8. repetitive analyses over time,
9. high speed and low cost analysis, and
10. spatial accuracy and analytic precision.

A computer system for resource analysis will consist of four major component systems:

1. Input -- The provision of data in machine form,
2. Storage -- The filing system by which data are made accessible,
3. Manipulation -- The processing of data within the computer's memory according to predetermined rules, and
4. Output -- The display of the analysis in the form of tables, diagrams, maps, text, etc. The manipulated output is the reason for the existence of the system.

These represent the required capabilities for the stages in any analytic procedure, whether by hand or computer. In a computer system these subsystems must, in addition, be compatible with the computer equipment (hardware) and programs (software) with which the systems are constructed.

Computers differ greatly among manufacturers and models in capability, size, cost and availability. It is always difficult to specify the computer capability required for data processing, since programs have been written for small, medium, and large computers. However, it is safe to say that size will become more critical as the state of software programs advances. Increased file manipulation and statistical analysis prior to mapping, combined with more versatile display systems, will necessitate the use of larger more powerful equipment. Although several programs to produce computer maps have been written for the smaller computers (e.g., IBM 1401), more sophisticated and versatile programs require larger, more powerful and more expensive computers (e.g., IBM 360, CDC 3600).

A. DATA INPUT

1. PREPARATION OF DATA IN MACHINE READABLE FORM

There are three basic stages in the preparation of data input into machine readable form: the recording and/or keypunching of the data onto a medium which can be interpreted by the computer, the handling of that medium, and the long term storage of the original information.

The preparation of the data input is a time-consuming and often a costly process. However, once basic procedures have been established, many short cuts, simplifications and modifications can be devised to ease the heavy burden of the collection. In particular many short cuts can be found which involve collecting a set of information in a specialized manner and using a computer to convert it to the form in which the rest of data has been collected.

It is of the greatest importance to devise procedures that can be simply followed and do not require too much judgement on the part of the operating staff in the recording process. Quality control must be exercised at all stages of the preparation since having inaccurate and inconsistent data is often a far worse condition than having no data at all.

2. RECORDING AND KEYPUNCHING

At this time, information about natural resources is primarily derived from either existing maps or black and white aerial photographs. This information must be converted from the visual form to a numerical form and recorded on a coding sheet. The numbers that have been recorded are then keypunched onto cards or tape. This two-step procedure is necessary as the different skills involved in interpreting and keypunching tend to be mutually incompatible.

The use of digitizing equipment tc define the locations of points or boundaries eliminates the necessity of recording on paper the numeric codes and their consequent keypunching.

In general, digitizing is a more efficient procedure; however, it does require a higher level of sophistication especially with regard to the following aspects:

(a) The boundaries must be recorded on highly accurate drawings. The preparation of these drawings may be time-consuming and expensive.

(b) The digitizing hardware and recording equipment requires a reasonably high capital investment, which can only show a return with continued use.

(c) Experience has shown that unless highly skilled and very patient personnel are used, this procedure can generate errors which are time consuming to correct. In general this procedure will require a higher level of trained personnel than the simply procedure of separately recording numbers and keypunching them.

In a study with large amounts of data to be collected and on on-going process permitting the purchase of the necessary equipment and training of personnel, digitizing procedures will be efficient. For short term studies they will probably not be profitable.

Some advanced and sophisticated forms of remote sensing will record data directly in a machine readable form. Others prepare an original record such as a photo plate which can be scanned by a sensor to record the desired information. When using these forms of directly recorded information it should be realized that they often contain only an implied locational key. When this is the case, the data must be converted to a usable set of locational controls which are compatible with other information.

3. THE MEDIUM OF STORAGE

Information can be recorded in machine readable form on a variety of media such as paper tape, punched cards, magnetic tape, specially coded forms for scanners, and electrosensitive numbers. Storage media must be chosen to be efficiently useable for the technology which is being used. Paper tape should not be considered for the storage of large data files as its two major problems, fragility and deterioration, create difficulties with important and costly data which far outweigh any of its advantages.

Punched cards are by far the most widely used form of creating machine readable information and they have been proven to work efficiently and easily. They are disadvantageous in that a large scale data bank will generate vast quantities of cards which are cumbersome to work with. In general, cards would be considered only the primary level of communication and in some cases they will be used only once, for recording the card images onto tape for further use.

Magnetic tapes are used for the storage of information, but they have not had a great deal of use in the past for the preparation of the data into a machine readable form. However, a series of new recording machines have been appearing over the past four or five years which can immediately transfer data to a tape and bypass punched cards. This procedure has the advantage that it eliminates the creation of the cards, which tend to be stored long after their useful life.

Specially coded forms and electrosensitive numbers have been devised for use with specialized reading machinery. This system requires a great deal of preparatory work for satisfactory results. It would, however, be an alternative to keypunching which might be attractive in conditions where keypunching costs are high and quantities of data are large.

4. LONG-TERM PRESERVATION OF DATA

Data storage systems rely heavily on devices such as disc packs or drum files. These tend to be fragile, and a back-up system must be maintained which permits the re-establishment of data files which for some reason have been lost or damaged. The hierarchy of such a procedure usually takes the following form.

The active data, the data which are in regular use, would be frequently compared with a short term back-up data file to check for any possible errors. This second file is usually stored on the same or a similar storage unit as the active data. A third long term back-up data file would be used in cases where a system failure destroyed both the active and short-term back-up files. It is also a wise procedure to check the short term back-up data at regular intervals. This third file should be stored on a unit that is not permanently resident on the operating system. Usually it will be on tape.

The ultimate back-up to a data system are the original data. However, when the original data are in the form of cards or specially coded sheets, these sources will deteriorate and may become totally useless over a long time period. Unless specific steps are taken to preserve original data such that they will in fact be usable for machine interpretation, it may be pointless to store them, as there is wasted space and effort involved with storing data. In the long run it is probably easier to duplicate all the information that is on cards or special sheets to magnetic tape, as a record of the original data.

Magnetic tapes can also deteriorate over time. If they are used as a medium of long term storage of original data, they should be checked at regular intervals for possible deterioration. The expected life of magnetic tapes is continually being expanded. Obviously, high quality tapes should be used.

B. DATA STORAGE

1. DEFINITIONS

When describing data storage, several definitions must be made:

(a) A "word" of information refers to an elementary item of information (such as the X coordinate of a location or the type of forest at one location). A word stores one specific item of data.

(b) A "record" of information refers to a collection of words. These are processed and handled as a group and are referenced as a group. The important aspect of a record is that when it is referenced or used, all the information that is stored in the record as separate words is available for use at one time.

For efficient retrieval each record should include information that is required for processing at the same time, as it is very inefficient to have to read a file of records several times. When data are stored on cards, each card represents one record of information. However, one record can be defined as including several cards.

2. TYPES OF DATA FILES

Electronic data processing procedures have demanded the development of sophisticated approaches to data file organization for applications in business and accounting. Dodd (35) presents a detailed description of each of the following three basic approaches to the systematic storage and retrieval of data:

(a) Sequential Organization: "wherein records are stored in positions relative to other records according to a specified sequence. To order the records in a sequence, one common attribute of the records is chosen."

(b) Random Data Organization: "Wherein records are stored and retrieved on the basis of a predictable relationship between the key of the record and the direct address of the location where the record is stored. The address is used when the record is stored and used again when the record is retrieved."

(c) List Processing: "wherein the basic concept of the list is that pointers are used to divorce the logical organization from the physical organization. In a sequential organization the next logical record is also the next physical record. However, by including with each record a pointer to the next logical record, the logical and physical arrangement can be completely different."

The most commonly used approach in resource information systems is sequential processing. This is not because it is necessarily ideal for resource information but rather it is a result of the character of the technical skills and hardware required to use random access and list processing. These do not seem to have been available to most people working with resource information at this time.

3. TWO ALTERNATIVE DATA FILE STRUCTURES

All spatial data has two basic attributes, a location and a value. When defining a real world or abstract space, the locational attribute is usually expressed in an x,y coordinate system and requires two values. However, using implied locations such as forest tract numbers, only one value is needed to define the location. For point data or gridded data, many data values are usually associated with one location. On the other hand, when dealing with areal data, one value is usually associated with many locations. These locations will usually refer to the points which define the boundary of the zone. These attributes of spatial data generate two basic alternative organization structures for the data.

Alternative No. 1 has data organized by category, with each record containing all the locations required to define the spatial extent of that data category and the data value to which the record refers. This type organization is referred to as a "category data file."

The principle uses of category data files have been with the storage of areal data which are described by the boundaries of zone sets, usually as a preliminary step to internal or implicit conversion to a grid. To handle zone boundaries it is almost impossible to use any system of organization other than a category file.

Alternative No. 2 has data organized by location, with each record containing all the data values for a specific location. Each record would contain one locational reference and many data values. This type of organization is referred to as a "locational data file."

Most operational resource information systems have been based on this second alternative. This is generally due to the methods of data collection that have been used rather than any technical efficiency. The types of spatial description methods that have been included in locational files are:

(a) Point Data -- As point data only requires one locational reference it is easy to organize on the basis of that location, and for most purposes this is the most efficient procedure to use.

(b) Pseudo Point Data -- In this case data have been collected at a point, usually the centroid of the zone, and are handled as point data. This introduces many problems such as the area of influence of the point, and the relationship of one point to the next, both of which may create statistical problems in analysis.

(c) Grid Data -- This is a special form of pseudo point data. However, since each grid cell refers to a constant area and has a constant relative location to its neighbor, this eliminates the two major uncertainties that exist with pseudo point data.

(d) Implied Location Data -- These data have no real locational organization and can only be referenced by a name tag which implies location. The only purpose of the name tag is to act as the locational organization structure of the data.

(e) Linear Data -- As linear data are usually associated with two locations, the beginning and the end of the line, it presents special problems. However, most efficient files of linear data are locational, and are organized on the basis of the position of line segments in a network hierarchy.

These alternatives, category data files and locational data files, represent two extremes of data organization. In fact, most operational systems will probably be some combination of the two procedures. As a general rule the form of spatial description which has been used to collect the data will determine the type of data file that is created in the initial stages. However, once the data have been stored they can be converted to another form if necessary.

It has been found that, when handling spatial data, the number of data values to be associated with locations usually remain constant. For example, a certain fixed number of land use categories, types of forests, or demographic variables will be recorded. Conversely the number of spatial descriptions that are required to locate any one of those categories is entirely variable. Four corners are all that are necessary to describe a rectangular forest tract, whereas it may require seventy corners to describe a highly irregular soil zone. The convenience of being able to use fixed length records with locational data files often discourages users from establishing category files which require a complex structure with records of different length.

At this time the initial procedures which require a minimum of sophisticated technical resources are the collection of areal resource information on the basis of a grid, and the organization of these data as a locational sequential file with fixed length records. While this currently represents the minimal combination of methods, it by no means represents the range of potentially applicable techniques, particularly as these are all undergoing constant improvement.

4. GRID DATA FILES

When handling areal data which are organized on the basis of a grid, the data files are structured in a locational sequential manner. Each record contains the information coded to a grid cell, and to retrieve a specific piece of information about a location, one first searches for the data record which refers to that location and then finds the specific piece of information which is desired. In normal processing, data cells are in exactly the same order in which they are required for processing, for example, by the GRID program.

When using a grid, a substantial amount of the data which are available will have been collected and displayed on the basis of spatial zones not necessarily those of the grid. These data must be used, recognizing that they are more spatially generalized than the cells of the grid data base. Rather than laboriously code all these data to each grid cell, they are organized as a series of separate files. The grid data bank is the base data file and, through a series of indexes, each cell is linked to its source zone (i.e., census tract, watershed, etc.). The number of indexes is determined entirely by the number of diverse spatial zones from which data are derived. Data for these indexed zones are stored in separate "read" statements within the analysis programs. This technique saves a great deal of computer memory space and at the same time is highly efficient for the handling of the data.

C. DATA PROCESSING

Computer data processing techniques perform analyses and produce output at the scale of the data input, and precisely according to the criteria specified. There are no "fudge factors" (though there is considerable scope for producing analyses and graphic displays to meet predetermined requirements). It is in the processing stage that the computer can be a uniquely powerful analytic tool, as was discussed in the chapter on analysis methods. It must be emphasized however that the results of analysis done by the computer are only as good as the set of instructions given to the computer. Computers rarely make mistakes but programmers and analysts do, both in the logic of the programs they want to write and in the actual procedure of writing the programs. The precision that is required by the computer when analysis programs are written may well force new and more precise thinking, thus aiding in the search for new solutions to problems in the analysis of natural resources.

The processing of input and storage files in order to produce output is divided into six basic operations: recording, classifying, sorting, calculating, summarizing, and communicating. The first three operations are carried out in preparing the input and storage files for the complex operations of calculating and summarizing the data.

1) Recording -- Data must be recorded in order to feed them into the computer system or to transfer them from

one point in the system to another. [See the section on Data Input (VI.B.)]

2) Classifying -- Data are classified to identify like items for identical processing. They are usually coded by assigning numbers or symbols indicating the class or location to which they belong. [See Chapters III and IV for detailed discussions of the coding and locating of data]

3) Sorting -- The classified and coded data are then sorted by location or class codes to bring like items together in the sequence desired for efficient processing. [See Section VI.C on "Data Storage" for a discussion of the alternative methods of sorting and organizing data files.]

4) Calculating -- A most important function in data processing is calculation. Once supplied with data values for a given location, a computer is capable of performing a multitude of arithmetical and logical operations upon the data. Numeric data can be added, subtracted, multiplied, divided, exponentiated, square-rooted, factored, etc. These often create useful and otherwise unavailable new data as well as being the invaluable tools of precise analysis. In addition the computer, if appropriately programmed, is able to perform operations which use locational as well as quantitative data, including calculations based upon proximity or distance. For example, it is possible to obtain information regarding a given phenomenon within a specified radius from a point, or within the bounds of a specified area. Conversely, it is possible for the computer to determine the radius or area within which a criterion is satisfied. But whether the value mapped is one put into the computer or one derived by the computer, the resulting analysis is constructed on the basis of grid coordinate locations and numerical values associated with those coordinate locations. Exactly the same results can certainly be achieved by manual calculation. But a computer calculates more rapidly, economically and accurately than a man. For example, the complex process of interpolation and extrapolation performed by a large computer in producing a contour display by the SYMAP program (See Section VI.E) requires thousands of calculations per square foot of map. The operation is performed by the computer in less than a minute.

5) Summarizing -- Data and analyses are frequently summarized to facilitate handling and further analysis, or to provide new insights. In this way totals can be dealt with instead of voluminous details. It should be emphasized

that too much detailed output is as useless as no output. Computation can generate hundreds of pages of output which will take days to read and study. If too much detail is created without summary, the important facts may be lost in a mass of numbers and irrelevant facts. The old proverbs of "the needle in the haystack" and "not seeing the forest through the trees" are very applicable when excessive detail has been generated by a computer. Summarization of the results must therefore be included in the data processing operations.

6) Communicating -- The last operation in the process of transferring data from the processing system to the output system is communication. This stage will be described in the next section of the report (VI.E).

D. OUTPUT -- COMPUTER GRAPHICS

1. CRITERIA FOR USING COMPUTER GRAPHICS

Almost any conceivable map or display can now be prepared on a computer. However, not every map or display should be. In evaluating the possibilities of using computer mapping techniques for a given application, the characteristics of the maps desired and the characteristics of the data to be mapped must be considered. Applications most likely to benefit from the use of computer graphics have one or more of the following characteristics:

(a) a large number of maps for a given area which are needed at one time or will be needed on a recurring basis over a period of time;

(b) flexibility of size, content, scale, and data manipulation are important;

(c) uniformity of map appearance for many different types of data is desired;

(d) the time and cost required to prepare a number of maps is to be minimized;

(e) and highly accurate maps are needed.

These are common conditions when more complex and precise resource analysis methods are used.

Computer graphics output requires that the data being displayed exhibit a spatial dimension, either as geographic space on a map, statistical space as on a scatter diagram, graph, or bar chart, or three-dimensional space such as in architectural structures or conceptual surfaces. The subjects discussed in this report relate primarily to the display of data having a geographic dimension. Such data are particularly relevant to resource analysis because the spatial pattern of a given activity may be as significant as its magnitude. We are discussing, then, graphical representations for the spatial distribution of quantitative or qualitative data, i.e., maps.

Spatial patterns can be represented statically or dynamically. A static pattern is purely descriptive in that it represents a "snap shot" of a given phenomenon for a given time, for example, the distribution of forest density in 1969. Dynamic patterns are typically based upon time series data and portray changes or trends in terms of their direction, magnitude, extent, and/or rates of change. Obviously, the use of computer-generated displays can greatly enhance the ability of the analyst to identify and evaluate such dynamic patterns.

Computers can graphically display a wide variety of data and display them in two dimensions, as points, lines, tones, letters, numbers, symbols, or colors; in a third dimension, with heights above or below a standard plane or as surfaces in perspective or any other projection; or in four dimensions over time and motion, as in real time cathode ray tube, film or television displays. The actual choice of media will be a function of the human, machine, and fiscal resources available. Several comparative studies of output hardware and software combinations have been prepared, notably those by the Census Use Study (22), Goldstein Wertz, and Sweet (43), and the Laboratory for Computer Graphics and Spatial Analysis, Harvard Graduate School of Design (101.21).

2. OUTPUT HARDWARE

Any of the many available computer output devices can produce graphics in some form. However, the appearance of these graphics as well as their accessibility and equipment cost varies a great deal. The basic types of output equipment are mechanical or cathode ray tube plotters, and line printers.

(a) Plotters -- There are two types of plotters: mechanical plotters, operating either on a drum or a flatbed, and electronic plotters utilizing cathode ray tubes for image generation. Their image is transferred through exposure to film or photosensitive paper which must then be developed to obtain hard copy. Hard copy, as opposed to soft copy, is permanent in nature. Plotter operations are either incremental (digital control, digital drive) or digital to analog (digital control, analog drive). Incremental plotters respond to a set of computer instructions which call for the printing of a small line segment. Digital-to-analog plotters draw entire lines at a time by converting digital data to analog signals.

Mechanical plotters are the slowest but least expensive plotters. Flatbed plotters utilize pens which are moved over stationary paper to draw the map. They may have large, but fixed surface areas for mapping. Drum plotters move the pen in one direction and rotate the paper on a drum perpendicular to the direction of the pen movement. Plots can thus be of long dimension in one direction, but only a portion of the plot can be viewed at one time. Mechanical plotters have the ability to produce multicolored displays if the map is drawn in stages and the pen is changes to provide new colors.

CRT plotters construct a plot or drawing very rapidly. However, CRT plotters have small (up to 11 x 17 inches) drawing surface areas available. Larger plots either call for enlarged film images or spliced murals. Enlargements are generally unfeasible because of distortion or poor resolution, and splicing smaller sheets into a mural is tedious and time consuming.

Geo Space plotters made by the Geo Space Corporation of Houston, consist of a camera device which moves along a track perpendicular to the surface of a cylindrical drum. The recording medium, either film or photosensitive paper, is wrapped around the drum. The drum is 40 inches wide and can hold a sheet 60 inches long. The action of the camera is synchronized with the drum rotation, and a 4 x 60-inch strip is plotted with each drum revolution. Ten revolutions will result in a 40 x 60-inch plot.

In general plotters are capable of providing very precise and attractive output although such devices are not yet available at every computer installation. Their cost as well as the relatively infrequent use of this kind of equipment accounts for their limited availability at the present time.

CRT devices are likely to become more widely used, lower in cost than at present, and well provided with software for mapping. Their increased use will be justified by their great advantage in allowing the user to communicate directly with the computer, permitting him to actually alter the image displayed and thus rapidly evaluate alternative displays. Their usefulness will undoubtedly become widespread, especially when they are coupled with devices which can print on paper the image shown on the CRT screen. The technology already exists, as the military have been using CRT systems for several years, but nonmilitary experience has been slight. Most users are unlikely to have the opportunity to become experienced in the use of CRT systems for graphic display purposes until their cost lowers.

(b) Printers -- There are two basic types of printers. Character printers resemble typewriters, printing one character at a stroke. Line printers are substantially faster, printing one line up to 140 characters as a stroke, and 10 strokes per second.

Line printers are a necessary part of almost every computer installation. The ubiguity of the line printer makes it a convenient and economical output device for producing computer maps. Although widely available at low cost, line printers have definite limitations in the appearance of the output of which they are capable. One reason for this is that although line printers are able to produce a wide variety of computer output, they were not originally designed to print maps or other graphic displays. As a result, they cannot draw continuous lines, but may be used to roughly approximate line drawings by a series of print characters. In addition, a map prepared in this manner can represent the location of a point with a precision of only $\pm 1/2$ the size of a print character. As a result, line printers are less suited than plotters for displaying line drawings; their lines may be accurately shown, but they are not precise.

In the case of zone or area symbolism, which is the most necessary output for resource analysis, line printers are capable of providing a suitable end product, and in some ways a superior one to that produced by line plotters. Although the only characters available for use are those which appear on a given print chain, overprinting provides a wealth of possible symbols and tones. In addition, it is possible to obtain special print chains prepared with symbols more appropriate to graphic display. Printer programs are also available to generate plates for the offset printing of colored map displays.

Since line printers are designed to print alphabetic and numeric characters, they are obviously capable of printing words and numbers anywhere on the map surface. The letters are always printed horizontal to the page, just as they are on a typed page.

In sum, the line printer's graphic assets include the ability to produce patterns or tones over areas, fast operating speed, wide availability and low cost.

3. SOFTWARE

Computer programs for producing maps and other graphic displays are usually written for a particular type of output device--such as a CRT, pen plotter or printer. In all cases, the precision or "grain" of the graphic output is a function of the output device, not of the program used to instruct the computer in its calculations.

(a) Plotter Programs -- The comparative limited use of line plotters accounts for the scarcity of plotter programs as well as the special purpose nature of most existing programs. Mapping programs have been prepared by various agencies of the U.S. Government, the Department of Geography at the University of Michigan (74), the Puget Sound Regional Transportation Study (24), the Systems Development Corporation (23) (as part of the SPAN computer system), and by the staff and others at the Laboratory for Computer Graphics and Spatial Analysis, Harvard University [OTOROL, SYMVU, and OBLIX, (101.21)].

Programs for plotters are characteristically designed to locate precise values at precise locations. There are, for example, plotter programs which will reconstruct the features of a base map stored on tape, drawing such items of locational data as street names, streets, railroads, rivers, topographic contours, or property lines. In addition, quantitative data values may be added.

A pen plotter can, by drawing the great number of lines necessary for the task, be made to shade zones or the contour line levels with symbols chosen to reflect a transition from a high to low value range, as with a gray scale, but the time required to do so substantially increases the cost of the map.

CTR plotters, devices which draw with a beam of light on photosensitive paper or film, operate with such speed that the addition of shading or other supplemental symbolism to a map prepared by this method does not require a significant amount of time beyond that required for the basic line map.

In summary, programs prepared for plotting devices can generally be used on either a pen plotter or, with minor modifications, on a cathode ray tube plotter. Plotter programs in general are capable of providing very precise and aesthetically pleasing output, but at greater cost than by other means. Therefore, plotter equipment and programs are sometimes the best choice for preparing a small number of maps for use in publications or public display, but not for preparing numerous maps rapidly in the course of a study.

(b) Printer Programs -- Rather than locating values precisely at any point on a map, printer programs locate standard print symbols and combinations thereof at pre-established print positions. At first glance, this may seem a severely limiting condition, but for most applications, particularly those in large and complex resource analyses, the printer is a desirable choice because of its speed, its widespread use at almost every computer installation and its low operating cost. It is not surprising, therefore, that there are a variety of mapping programs which print, rather than plot, the output. Among these are:

(1) MAP 01, by the New York State Department of Public Works (14);

(2) MIADS, by the U.S. Forest Service Research Station at Berkeley (3);

(3) SYMAP, by H.T. Fisher and others at Northwestern University and at the Laboratory for Computer Graphics and Spatial Analysis at Harvard University (101.21);

(4) GRID, by D. Sinton and C. Steinitz at the Laboratory for Computer Graphics and Spatial Analysis at Harvard University (101.12, 101.21).

In summary, computer mapping programs written for line printers offer the user significant advantages of speed, economy, and flexibility, whereas maps produced by plotter programs and equipment are usually superior in their linear precision and aesthetic appearance.

The initial development of a computer mapping system could benefit from the use of a printer mapping program. By doing so, the user would be able to explore a wide variety of computer applications at the lowest possible cost. In most instances, the flexibility of the mapping program is of the essence: flexibility in meeting a wide range of possible applications, in data requirements, and in the kinds of maps which the program is capable of producing. On the other hand, the design of a computer mapping system should also reflect the desirability of being able to use the CRT devices, plotters and printers with a minimum amount of modification.

In any case, a graphic system should reflect the needs of the user rather than the capabilities of any specific type of hardware, existing or proposed. The system should be as machine independent as possible, being capable of use with equipment currently in widespread use as well as other devices which are likely to be widely used in the future. Machine independency is also important for the future of the system because of the rapid rate at which new computer equipment becomes available and existing devices become obsolete. Designing a system which can be used with a variety of output devices will make it possible to make flexible use of those devices which are most appropriate for any given purpose and within given resources.

E. THE GRID PROGRAM

GRID is a computer program created in 1967 by Messrs. Sinton and Steinitz specifically to provide a highly efficient means for the handling and the graphic display of large quantities of information collected on the basis of a rectangular coordinate grid. It is designed for line printer output and has also been interfaced with a variety of plotter output programs, thus making it useful for most of the currently available output hardware types. It is also available in a teletype version, making it applicable for low cost on-line use. The program is written in FORTRAN IV and is currently being operated on an IBM 7094 with a 32k memory, or an IBM 360/65 using 120k byte memory. With some internal adjustments, it can be run on a computer with a memory as small as 12k words.

The program requires two sets of data input--first, the data values associated with a spatial grid, and second, a series of instructions to the program about the particular procedures and forms that are to be used for analysis and display.

Each data value is assumed to be associated with a cell on the grid. It is essential that the values should be processed in the correct order, since the program accepts the data in the order in which it prints the maps. By the standardized printing process, the program starts at the top of the map and processes the data horizontally, row by row, and from left to right in each row. The numbers below represent the order in which 30 data values in a six by five grid will be printed and processed.

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	20

The user specifies the size and the shape of his grid. While the program is normally used in rectangular grids, it provides two methods of specifying irregular outlines. The program has been designed with an internal loop that permits an unlimited number of cells to be mapped. However, in normal usage, it is not expected that the average grid will be greater than 10,000 data points.

While the program is designed for use by persons with very little programming experience, it is necessary for the user to specify his own data format in a subroutine called FLEXIN. Since the program is designed for general use on a variety of data sources, it was felt that it is easier for diverse users to write their own input-output formats and not be constrianed by fixed formats internally specified within the program. Before printing the spatial or map diagram, the actual data values are generalized into groups, each group having a unique graphic symbol associated with it. Using options, the user can then specify the number of levels, the maximum value of the data, the minimum value of the data, and the relative size of each of the levels in the range of the data. Thus, the user has complete control over the levels into which his data are divided. The user also has control over the symbolism which is used to print the spatial diagram, e.g., a gray scale between white and black, a dot map, or any alphanumeric symbols. The program will also print specified information about the data analyses which are being mapped, and it will print the numbers of the grid coordinate system around the edges of the map.

The function of the GRID program is to provide a graphic output capability within a modular system of programs which are being developed for the analysis of resource information.

It does not contain any analysis capability of its own beyond the determination of frequency distributions within the levels. However the system does accommodate such standard statistical procedures as multiple regression analyses. It has been found that in most cases it is wiser to write a program which is designed to solve a specific program rather than to force a new problem into the form that is necessary for a program which has previously been created.

The program has been interfaced with a variety of analysis programs, notably two programs which have been developed to examine relative location on topographic surfaces:

VIEWS (101.14), a program to determine which locations can be seen from a specified location.

FLOWS (101.14), a program to determine a water flow pattern within study area by connecting the grid cells on the basis of elevation and slope.

The program has also been interfaced with a variety of graphic output programs for use on plotters. These include:

SYMVU (101.21) and OBLIX (83), which provide oblique views in a variety of projections of contour or topographic surfaces, and OTOTROL (101.21), which provides the capability for drawing pre-specified three-dimensional forms in perspective.

A version of GRID, TELE-GRID (101.21) has been developed for use on teletype terminals, thus affording a low cost on-line computer link.

Previously developed analysis programs which have used the GRID program are available for reference and, where proper, for use.

APPENDIX F: SPATIAL DATA SYSTEMS FOR RESOURCE ANALYSIS

A. MANAGEMENT ISSUES IN SYSTEMS DESIGN

1. PREVIOUS PROBLEMS

During the last ten years the establishment of data banks by planning and other governmental organizations has been a very popular activity. Unfortunately, the success of those operations has in no way equalled the enthusiasm with which they were undertaken. In most cases, planning agencies have been attracted to the computer success stories which abound in the magazines and newspapers of the every day world. Not knowing, and in some cases perhaps not wanting to know, of the requirements and costs of successful data processing applications, and more important, not knowing of the very high failure rate in such undertakings, the governmental data-banker-to-be has often been attracted to the punched card like a moth to the flame.

Typically, information systems have been concerned with recording many characteristics, such as land use, zoning, building type or assessment, for each parcel of land. The assumption behind this energetic undertaking was that once the data had been harvested it would be possible to glean from the data numerous items of immediate and long range concern to the local planning operation. However, once the data bank had been established, some of the following facts often came to light.

(a) The "wrong" data had been recorded, in that the data requested by potential users was not recorded or was recorded in a manner which reduced its usefulness.

(b) The data as recorded contained too many errors.

(c) The data was too difficult or costly to retrieve because the requirements to do so were not considered when the data were originally collected.

(d) The cost of operating the system far exceeded original estimates and the benefits derived were far less than had been expected.

(e) There was some uncertainty as to just what was recorded and how it was recorded, and,

(f) There was even greater uncertainty as to why it was recorded in the first place.

As a result, many data banks became data dumps, and when a given set of data was needed, it was often more economical to regather the data than to attempt to retrieve it from the data bank.

2. SYSTEM GOALS

The data bank problems of the past would often have been reduced or avoided if those responsible for the design and operation of the data banks had observed that automated data is in itself a useless goal; electronic data processing applications must be based upon the automation of specific, understood analysis tasks and not merely upon the data associated with these activities. The use of the system must govern the design. Computers and computer programs are capable of handling great quantities of data--but only within the extremely precise limits determined by the characteristics of the data, the storage method and the capabilities of the hardware and software used. As a result, the only way that one can have any confidence at all in being able to use the data which he proposed to place into a data bank is by first identifying the range of specific requests which he will later make of the data bank and then determining the specific stored data which will be required in the data bank to satisfy his requests. Then he must specify precisely what operations he wants the computer to perform on these data and how the computer will do this. At the same time, the goal should not be to design a system to serve a few specific functions so well that it can never be used for any other purpose in the future. Sufficient flexibility must be designed into the system to allow it to perform a variety of tasks which may be identified later as well as those specified at the very beginning. The work done must constantly reflect specific ultimate goals plus the basic immediate requirements. The work must also recognize current and probable future changes in computer technology and provide sufficient flexibility to accommodate and take advantage of such developments as they occur.

3. SOME IMPORTANT QUESTIONS

One of the first tasks normally performed in the development of a computer application must therefore be an analysis of the system which is to be automated. Such an analysis would include an initial detailed statement of the present as well as the future systems operating characteristics. In addition, such a study would describe the procedures, data, equipment, programs, and personnel which are required in order to place the entire automated system into full operation on some given future date.

Only after having labored over what one wishes to do with the data and how one proposes to do it, can answers to some very important questions be developed. Is it possible in the first place? Do computer equipment and programs exist to do the job? Is it feasible; that is, what will it cost and what is its value? At this point, a realistic estimate of the value of the task or benefits to be realized by the results should be made and compared to the cost of doing the job by computer. The cost of other methods for achieving the same goal should be known and should include alternatives, if any are applicable, which do not use computer techniques. When the task is defined, the necessary data identified, and computer methods and means are available to do the job at a cost not exceeding the value of the job, further questions about the data banks arise. The costs of alternative methods of coding and storing data should be compared and the effect of this cost upon the cost of the job considered. Also, data should not be placed into a bank until it is certain that the goals cannot be accomplished by using data in an already existing data bank.

As a general rule, these management issues are raised about a system designed to do a minimum of known and needed tasks. If this system design is judged feasible, it is because that minimum was satisfied. Once implemented, the system is available for previously unforeseen uses, many of which can be guaranteed to exist in almost all computer-based, resource analysis systems. Beyond that minimum use, everything represents clear analytic advantage as well as efficiency.

B. SPATIAL DESCRIPTION

In order to effectively describe spatially distributed data for analytic purposes, it is necessary to be able to include as data a location as well as the characteristic quantity or quality which results from each measurement. There are a number of considerations which will define the procedures used to describe and analyze spatial location. These include 1) defining the study area, 2) geocoding, and 3) measuring and recording locationally defined data.

1. DEFINING THE STUDY AREA

Defining the study area raises all the classic arguments and questions involved in defining regions. These issues are particularly relevant to public lands, whose borders rarely, if ever, reflect resource or demand system boundaries, but do reflect a control or implementation boundary.

(a) POLITICAL BORDERS

Study areas vary greatly in size, but in most instances they are politically bordered. Clearly, this decision is determined largely from the viewpoint of planning implementation. Funds are given, laws are written, political decisions are made, etc., on the basis of political jurisdictions, such as counties and states. Among the scales of political jurisdiction used are multi-state regions [Research Planning and Design Associates (104), Lewis (94)], states [Lewis (94)], counties [Chester County (90), Soil Conservation: 1 (99)], and townships [Toth (102)]. These are a convenient and often necessary simplification. Yet no natural resource arranges itself spatially on the basis of politically defined borders.

(b) PROPERTY LINE BORDERS

The equivalent problems are raised in the private sector by resource analyses of lands in which property lines of owned or controlled lands determine the borders of the study region, and in studies of public lands where the borders of the public lands define the study area. These are also suspect from the viewpoint of resource analysis. In both cases inventories can be made, but one cannot predict the consequences of action or policy, either from outside the area onto the study area, or from the study area to the adjacent lands. The smaller and more complex the study area, the more this is a problem.

(c) WATERSHED BORDERS

A popular site-defining characteristic is the watershed, and these range from the very large Upper Mississippi River Basin as studied by Lewis (94) to the smallest scale sub-watershed studied by the Dearinger (92) group. Yet demand variables are not to be found on the basis of these resource-defined units, particularly within the smaller ones.

(d) DEMAND AREA BORDERS

The resource studies which also analyze demand typically take a broader view in defining their study area. The Williams (103) and Dearinger (92) studies, and the RECSYS (98) and PARIS (97) models each recognize that demand comes from a larger area than the ultimate supply of resources to which that demand is attracted. Urban areas at distances up to 300 miles from a resource study area are typically considered in determining the area of potential demand.

(e) SOME GENERAL ISSUES

A major consideration in the definition of the study area is its influence on the accuracy of the analysis. All of the studies assume uniform accuracy within their various study areas. Yet this assumption must in many cases be doubted, particularly the edges of the geographic areas. For example, it is clear that State Parks on the edges of Michigan receive demand from neighboring states and equally clear that urban dwellers on the edges of Michigan go to neighboring states for recreational activities. This applies to almost every study both from the supply and demand sectors. Without defining an area of influence for each study area, it becomes impossible to plan accurately resource use.

In general, the "free body cut" should be made around the smallest area which encloses all the data zones and systems which impinge on the geographical area or content under study. All data systems are then assumed to be closed within this area, an assumption which, in the light of the "spaceship earth" concept, must be heavily qualified. The area for which data are available should therefore always be larger than or equal to the area of interest. Political and physiographic data borders will rarely be as satisfactory as a somewhat arbitrary larger border which will include within it the relevant political or physiographic areas of interest.

2. GEOCODING

Geocoding, or geographic coding, is a procedure for recording as a part of one's data the locations at which data are collected. For each data record, one or more geocodes such as land parcel number, county name, or latitude and longitude coordinate are added to that record in order to identify the location to which the data refers. Geocodes provide two basic capabilities: (1) referencing or identifying each record; and (2) increasing the flexibility with which one may manipulate his data.

(a) REFERENCING

During the initial data collection process it may at times be necessary to refer back to the original location from which the data was derived for the purpose of locating missing data or for verifying the accuracy of the data as recorded. In addition, at a later point in time it may be necessary to recollect the data in order to establish a second set of data which will be compared to that collected earlier. In both cases it will be necessary for the investigator to be able to identify the locations of each original data measurement.

(b) DATA MANIPULATION

The summarization of individual observations to create a total for a larger area requires that it be possible to associate each observation with the larger area of which it is a part. For example it may be necessary to aggregate measurements of land use for each parcel of land in order to calculate a county total for each land use.

The merging of data which has been collected by two or more independent agencies for the same area requires that the records of each contain location identifiers or geocodes which are or can be made compatible. The combining of U.S. Census data with that of natural resource data derived from aerial photographs illustrates this problem.

The selection of all records which contain observations recorded at a specified distance or direction from a given point requires that the relative location of each point can be known. Determining the number of acres of a particular type of land use within a five mile radius from a given point is an example of such an application.

The same criterion holds true in the calculation of distance measures within which a given criterion is satisfied. In this case, one might wish to establish the continuous extent (distance and direction) of a particular land use.

Finally, mapping is dependent upon being able to associate the locations at which the data have been collected with their location on the map which is to be produced.

Whatever system of geocodes one chooses to use, it is desirable for that system to extend beyond the limits of an initial study area. Having done so, it then becomes possible to extend the initial study area in a consistent manner at some later point in time; but even more important the data, as collected, are compatible in terms of their locational identifiers with those collected elsewhere.

(c) GEOCODING METRICS AND REFERENCING

(1) DEFINITION

A geocoding system must be based upon a consistent metric if one wishes to use his data for the purpose of deriving spatial statistics and/or the preparation of computer maps. In addition, the geocodes should be based upon a reference system which extends in a consistent fashion over, and preferably beyond, the study area. The reference codes should also be identified on maps available from governmental sources. Geocodes which meet these criteria include x-y codes based upon latitude and longitude, state plane coordinates, and the UTM grid.

Commonly used geocodes which do not by themselves exhibit these properties are street addresses, census block and forest tract numbers, county names or codes, and range, township and section designations. The lack of a consistent metric in each of these units prevents the user from being able to determine the relative location (distance and direction) of any two points which have been described by one of these latter systems. The use of codes of this type in one area has little or no consistent spatial relation to similar codes in other areas and therefore are very difficult and often impossible to interrelate.

(2) PROPERTIES OF x-y COORDINATE SYSTEMS

Any data which are to be mapped by computer must be identified by numerical x-y coordinates which describe the relative location of each geographic unit. In the evaluation of coordinate systems for the recording of large amounts of data, the following requirements should be considered:

1) the coordinates should be compatible with systems used elsewhere and should be equally convenient for use at a local or a national level;

2) the coordinates should provide a rapid method for determining a position within the accuracy desired;

3) the coordinates should be useable for existing as well as likely future applications and equipment; and

4) the coordinates should permit accurate and economical formulae for computation.

Accuracy and economy of computation are somewhat contradictory. High degrees of precision are available when geodetic formulae are used, but often only by performing complicated calculations.

As a rule, the accuracy of a coordinate system need not be any greater than that with which the associated data has been recorded or that which is required for its use.

a. LATITUDE AND LONGITUDE

The most universal system of location identifiers is latitude and longitude. The use of these codes provides a worldwide system of locational identifiers. The fact that this system is based on the earth as a sphere makes it possible to account for the curvature of the earth when one is dealing with a study area of sufficient size for this factor to be significant. Unfortunately projections of the curved earth onto a flat map sheet necessarily introduce distortions, particularly on area calculations. However, map sheets based upon a known projection with specified control points (such as USGS quadrangle sheets) make it possible to accurately calculate and compensate for the actual distortions present in such maps when one is working with a computer using data system. This is, however, an added calculating expense.

b. STATE PLANE COORDINATE SYSTEM

The orientation of this system is towards the individual states. This system is suited to the needs of the local surveyor and has been officially adopted by many local government units. State plane coordinates appear on all U.S. Geological Survey topographic maps. Either the Lambert Conformal Conic projection or the Transverse Mercator projection is employed, depending on the shape of the state. Approximately 120 zones cover the entire United States giving an accuracy in each zone of about one part in 10,000. Conversion formulae from state plane coordinates to a latitude-longitude coordinate system can be performed. However, when a study area extends across state boundaries, and therefore across state plane coordinate systems, it is necessary to convert from one state's system to another. Similarly, within a given state there may be several state planes. It should be recognized that these systems were designed for use by surveyors in describing tracts of land within a given state and not for interstate use nor for deriving spatial statistics.

c. UNIVERSAL TRANSVERSE MERCATOR

The Universal Transverse Mercator grid system, UTM, includes the area between eighty degrees north and south latitude, and extends around the world in sixty north-south zones, each zone covering six degrees with one-half degree overlap. The system is well-established and can be extended to include areas adjoining the United States. It is indicated on USGS maps. The accuracy within each zone is one part in 2500, and the size of the individual grid cell or data unit can be varied within the same system, according to user needs. The zonal nature of the UTM grid can lead to problems when a large study area includes portions of two or more zones. However, there are a variety of solutions to this problem, none of which is difficult to apply.

In addition, each UTM grid unit is square and of constant size, which aids in computer analysis and display; the coordinates are expressed metrically, which would reduce transitional difficulties if the metric system of measurement were adopted; and the UTM grid system is of global extent and availability. As a result of the last of these factors, the UTM grid system will undoubtedly be used to reference satellite photography and other remote sensor data, which may, in time, provide the major portion of natural resource data.

(3) TRANSFORMING x-y COORDINATES

The three forms of x-y coordinates discussed above are capable of being mathematically transformed from one system to another. An example of a computer program designed for this purpose is described in a technical report prepared by the U.S. Coast and Geodetic Survey (1). This particular program is capable of transforming coordinates between any two of the following systems: state plane grid systems based on the transverse Mercator or Lambert projection, geographic position (latitude and longitude), secant plane, geocentric, and Universal Transverse Mercator (UTM) grid.

3. SPATIAL TYPES

(a) TYPES OF SPATIAL DATA

Having established the characteristics of various x-y coordinate systems, it is important to note that in each case a given pair of x-y coordinates defines a point. For purposes of defining locations it is necessary to recognize two additional locational descriptors: lines and areas. Taken together, points, lines, and areas make it possible to adequately define the location of any feature or activity on the earth's surface.

(1) POINT DATA

Data which are uniquely associated with a specific location and are assumed to have no real extent are point data. The definition of "no areal extent" will vary with the scale of a study. True point data, such as the location of a specific tree or water tower, must not be confused with pseudo point data, such as the characteristics of an area like a town or forest tract which have been associated with one point, usually the central point of a large zone. Pseudo point data is a simplification which has been used a great deal because of the ease with which points can be organized. Provided that the data which are being studied can be assigned to one consistent and unique set of zones (such as census tracts or counties), it can very logically be assigned to pseudo points and analyzed as though it is point data. However, natural resource and land use information do not usually conform to a single unique set of zones.

(2) LINE DATA

Lines represent a set of points which are related by a characteristic of connectivity and often by the extra attribute of directionality. The location of lines may be defined by two or more points. Straight lines require only two pair of x-y coordinates, one at each end of the line. Lines which are continuous but composed of two or more angular straight line segments are described by coordinates defining the two extreme end points plus a coordinate at each location where the line changes direction, i.e., each vertex. Curved lines may be approximated by a series of straight line segments, with the precision of the curve as recorded being a function of the number of segments used to approximate the curve. Just as with areal information, in resource analyses, linear information usually occurs as a series of overlaid systems such as water systems and transportation systems.

(3) AREA DATA

At the finest level of generalization, all information is point data. However when studying a spatial region it is convenient to identify areas or zones of known and constant characteristics. Thus each zone can be regarded as a bounded set of points which have the same characteristics. That is, a forest zone is a set of points representing individual trees. It should be emphasized that most natural resource and land use information represents a series of overlaid sets of area zones. The definition of an area is quite similar to that of curved lines. However the first and last point defined are either implicitly connected, or the user is required to repeat the initial coordinate in order to explicitly close the area.

4. ZONES FOR DATA GROUPING

The ways in which data are spatially grouped determine how well one can retrieve the information spatially at a later time. They determine the feasible ways in which one can:

- aggregate or group the information geographically;
- examine or describe geographic relationships, such as distances between units of data;
- display geographic relationships, such as in maps, movies or three-dimensional models.

Several distinct styles or approaches can be seen in existing studies which may be categorized by the manner in which each considers the spatial nature of the data.

(a) SINGLE PREDEFINED ZONES

Several methods treat large, predefined areas as homogeneous in terms of the evaluated resources. Michigan (98) considers each State Park with a single evaluation. The Allison and Leighton (89) method and the Soil Conservation Service: 2 method (100) treat potential campsite areas similarly. The Dearinger study (92) analyzes resources for both supply and demand on the basis of subwatersheds which are assumed to be uniform, and these can be rather large given the purpose of the method. The United States Census works exclusively with a hierarchical system of predefined zones, such as blocks, tracts, towns and counties. While the assignment of a single evaluation of description to a large area greatly simplifies the task of the analyst, he also falls prey to the chance of invalidity in the assumption of homogeneity within his description. It is doubtful whether a given watershed is uniformly covered with forest or that it is uniformly excellent, good, or poor for recreation.

(b) NATURAL RESOURCE DEFINED ZONES

Several of the methods, such as those of Research and Design (104) and McHarg (96) allow the spatial spread of the resources themselves to determine the data zones. These typically use the techniques of preparing overlays for each resource, with each overlay being to a common scale and coming from whatever represents the best source of information. When overlaid with each other, these maps define areas for which the assumption of homogeneity is made. While an appealing method, this technique often makes a hidden assumption at an early stage in that most of the sources from which the overlays are made often dichotomize the data variables. Thus, on the USGS maps, areas that are considered forest are green and areas which are not in forest are other colors. If one makes an overlay with lines drawn around the forested areas, one is in fact saying that there are no forests in other areas. This is a judgement which is at a lower level of specificity than it needs to be, since several other techniques can identify different densities and types of vegetation on the basis of more areas. Clearly the person who uses somebody else's inventory in making an analysis limits his analysis by the quality of the inventory data which he is using.

The lack of specificity within the zones is a product of hand drawn technology that has been used in the past. The applications of computers to this type of system have made a major increase in the ability to handle more specific and numerous sets of areal zones.

(c) SINGLE ALL-PURPOSE ZONES

It is in the inventories of resources for large undeveloped areas, notably those which would be based upon a combination of arial photographic analysis and field work, in which the search for an all-purpose data zone becomes the key aspect of the method. 'Hills (93), Christian (91) and the Soil Conservation Service (99) among others seek, through the progressive interpretation of resource characteristics such as landform, soils, and vegetation, to identify hierarchical orders of land units which can be used for various inventory and evaluation purposes. They try to identify the smallest unit which can be efficiently used as the basis both of inventory and evaluation, as well as for planning. While their methods of identifying these levels and units vary, their goal is essentially similar. The all-purpose data zone is designed to eliminate the overlay procedures that are often used in analysis. It presupposes a set of analysis purposes as part of the data inventory procedures. For essentially undeveloped areas, this search for a resource based data zone of homogeneous character is perhaps adequate. However in a developed context in which demand analyses must be included in planning, the sources of data on the demand side cannot coincide with a zone which is defined on the basis of resources.

The predefined zones and the all-purpose zones have been used because of the immense labor that is involved with the collection and analysis of information that is collected on the basis of natural resource zones. However, digital storage and retrieval techniques provide a tool which can handle natural resource zones more efficiently.

One finds himself in a bind in deciding which data zones to identify. On the one hand, political zones which provide much of our demand data, such as those defined in the census, are unsuitable for resource analysis; and on the other, naturally defined zones which one can identify by a variety of methods are not the zones from which the sources of demand data are available. Here, depending upon the nature of the study area and the purpose of the method, one either takes his choice or, as is done by grid geocoding, attempts to approximate all of them.

5. SPATIAL ACCURACY

The scale and detail of data zones are of prime importance when data are collected and stored. A resource evaluation which combines a variety of data from a variety of sources is only accurate to the level of its coarsest component, and consistency in scale among the various data is rarely adequately considered in resource analyses. When conversion of data observations to grid coordinates is made, these considerations must be explicitly faced. Once the data have been converted, they are "locked in" and it is very difficult to disaggregate or reorganize them.

The spatial accuracy which can be achieved is constrained by the detail of the original definition of the boundaries of the data zones, and this is a function of the resolution of the grid coordinates. The optimum cell size for the data must be considered before data are stored. Too little detail will be detrimental to later analyses, and too much detail will result in excessive cost.

In every case, be it the definition of points, lines, or areas, it is important to recognize that every measurement is only an approximation of a location. The actual precision used may vary greatly, but decisions in this regard should reflect the precision required, particularly in relation to the accuracy with which other variables are being recorded at this location, the uses which will be made of the data, and the resources available (dollars, time, and people).

6. THE GRID AS THE BASIS OF DATA ORGANIZATION

There are two characteristics of a grid system that make it particularly suitable as a base for an information system. The first is that the regular nature of the grid eliminates the necessity of handling a large amount of locational information on the basis of irregular zones, which require massive amounts of software programming to be available in order to handle the necessary computational facilities. This programming is necessary to handle the variable nature of organization of records for the irregular zones, but it also has to be used to determine the relationship between zones. By using a grid file which has a regular relationship among all the zones, locational work can be handled within the computational system without ever explicitly specifying the locational indicators. Not only does this save considerable time when storing and retrieving the information, but also it simplifies much of the programming that is necessary for analysis work. The second characacteristic that makes the grid system useful is that each grid cell is a small elementary unit which remains constant over the entire region of study. This unit is anonymous in the sense that it has not been defined by any one characteristic. This means that no bias to specific conditions is built into the definition of the elementary unit which records the characteristic of the land, making it extremely useful for many analysis purposes.

(a) GRID CELL SIZE

In the decision to use the grid cell as the basic unit for all data acquisition, processing, storage, analysis, and display, and in the selection of a grid coordinate system for geographic referencing, a key decision is the size of the grid cell. Among the important factors entering into the decision on cell size are the zones at which data are available and the scale of the uses to which data analyses are to be applied. In defining the grid cell size, the rule of the least common denominator can be applied: "Find the cell size which is the smallest unit resulting from the overlay of the various data zones." This cell size can be adequately aggregated into any of the zones, and by itself will lose no data detail. Figure F.1 illustrates the schematic application of the least common denominator rule to a study area for a variety of the zones which must be considered and can be spatially superimposed. A variety of indices are used in the data bank to coordinate data cells with their appropriate aggregate source zones.

The cell size is then evaluated for its practical efficiency in data handling. There is a necessary compromise between a small basic data unit and a large one. When the data unit is small, the "natural" borders of larger data zones can be more closely approximated and the assumption of data value homogeneity, which most resource inventory methods make, is more likely to be valid. With a small unit, any study based upon the data bank can be considered in finer grain and will therefore be more useful for project planning and design. The use of the computer for data handling also affects decisions on cell size in that their ability to rapidly analyze large quantities of data allows for smaller grid cell sizes. The major advantage of a larger unit is lower data collection and analysis costs. To the degree that explicit or external processes are used, these costs can be substantial, thus arguing for a larger cell size. The scale of data use is also related to the choice of a grid unit size. For example, if one is locating industrial sites that might average 50 acres in size, it would be an advantage to have site analyses at that scale or finer. These use-sizes vary by type, regionally, and over time, and so this influence on data scale can only be based on observation and/or experience.

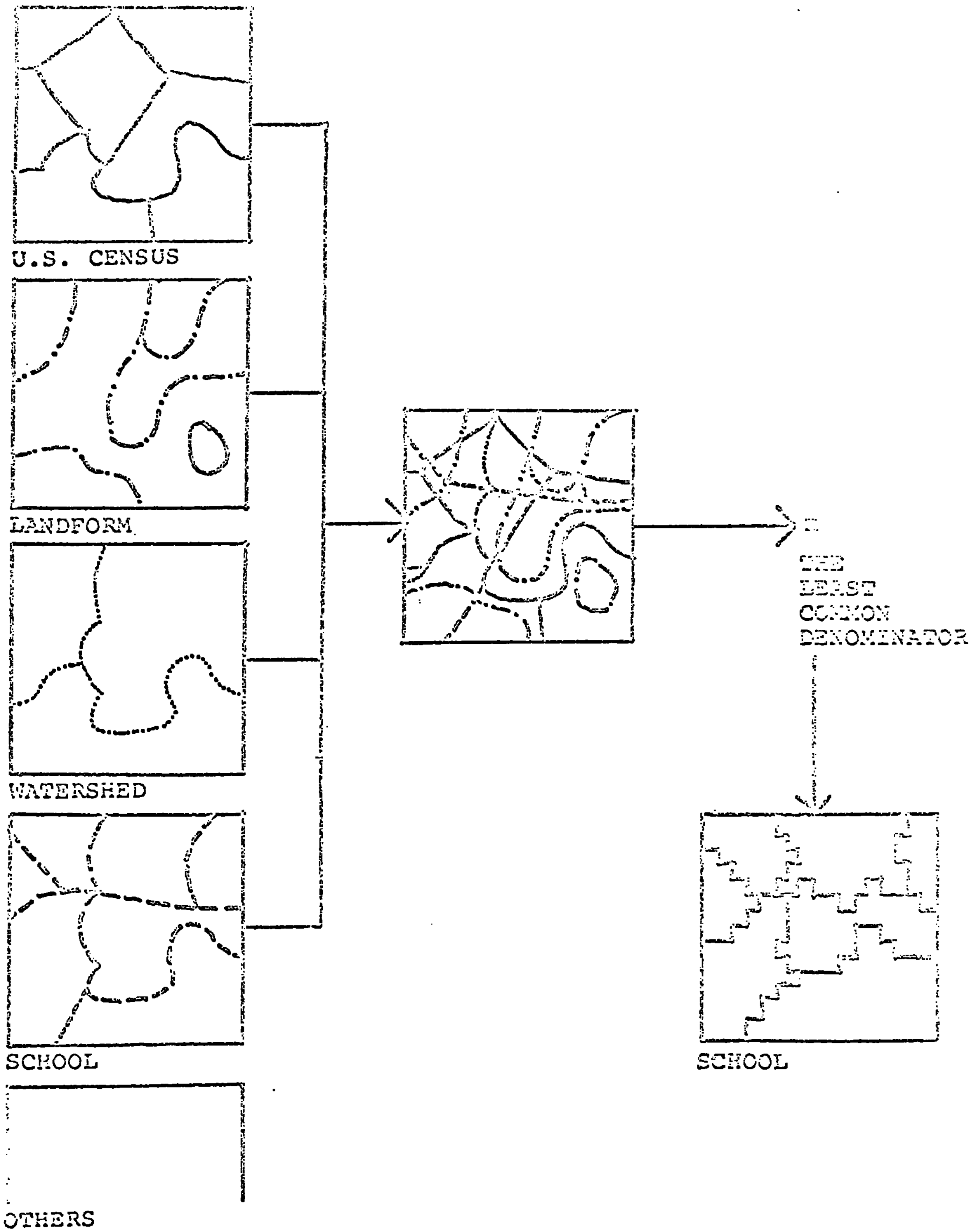


Fig. F.1
The Least Common Denominator

The spatial accuracy of data analyses are limited by the coordinate grid cell size of the stored data. Thus, for point data (for example, at a scale of 1 km. grid, the location of elementary schools), one knows the coordinates of the cell in which the point is located, but one cannot specify the location within the cell. On the other hand, it would be quite possible to specify absolute pin-point accuracy on any point data by adding extra digits to the coordinate coding system. For line data (for example, at this scale, traffic flows), one can specify flows within cells on any route but not the exact alignment location of the route within the cell, and one can specify origin and destination cells but not necessarily routes. Again, if one knew the location of a specific route between two points, it could be specified cell by cell. For area data (for example, at this scale, the percent of the cell of forest use) we can specify a value, but not the pattern of that value within the cell.

However, it is possible to identify consistent sets of geometric distribution patterns for various types of development. For data from multi-cell zones, such as census tracts, one cannot accurately disaggregate the value without a special study for each case. It is often possible to make estimated disaggregations based on other data that may have been collected for each grid cell, for example, the disaggregation of population density data on the basis of residential land use coverage. As a rule, though, any analysis derived from a combination of several variables from several types of zone is spatially accurate only to the scale of its coarsest data zone. Thus, efficiency versus accuracy judgements such as that in the selection of grid cell size must always be made in the design of a resource analysis.

(b) TWO ALTERNATIVE PROCEDURES OF GRID STORAGE

In organizing data for grid storage, a basic decision must be made as to when in the procedure the data are to be converted to the grid.

In Alternative No. 1, data are described in machine readable form in terms of their zone boundaries and are stored with this description. This requires an internal or implicit conversion of the data to a grid for processing and analysis. The Canada Land Use Inventory (86) has used this procedure, and an ideal resource system could closely replicate many of the procedures that they employ. However Alternative No. 1

has a major constraint in that it requires massive capital investment in hardware, software and manpower to make the system operational.

In Alternative No. 2, data are externally and explicitly converted to a grid before they are stored in machine readable form. The authors have used this procedure in most of their studies (See Appendix A). It has the advantages of low budgetary requirements and relatively less sophisticated manpower requirements to handle the system.

An operating system of resource analysis should be designed to maximize the efficient use of the available resources of the agency or institution which undertakes the project. The following must be considered in determining the extent to which the simplified approach of Alternative 1 is to be used, rather than the more sophisticated approach of Alternative 2.

(1) COMPUTER HARDWARE

The internal or implicit conversion of data to a grid will require computers of relatively large memory size and high capability for complex data management. The efficient storage of zone boundaries will require costly off-line equipment such as a scanner or digitizer. The quality of the spatial accuracy will be a function of quality of equipment used to measure locations.

(2) SOFTWARE OR PROGRAMMING MANPOWER

The complexity of a computer system used to store and retrieve data is highly variable. However, as the complexity increases with internal conversion, so will the requirements for more sophisticated software and in turn more skillful programmers will be required to manage the software.

(3) FIXED COSTS

Much of computer hardware and software considerations involve fixed costs. However, the more data that are involved the greater the economies of scale that can be achieved in either approach.

(4) TIME CONSIDERATIONS

The more complex the system the longer it will take to set up and become operational. Alternative 2 is now capable of producing results in a very short period of time.

(c) CODING ZONE SETS TO A GRID

There are two procedures for coding information to a grid. The first is to code the predominant category of zone in the cell and the second is to code the percent of area of each category within the cell. The basic problem is to determine at what point predominant type coding generalizes the conditions within the cell to an extent that will create a loss of specificity and create inaccuracies in subsequent analysis.

Coding the predominant type of zones that exists in the grid cell assumes that for each category the distribution of that category over the cell is homogeneous. That is, if twenty-five sub-categories of soils are being coded, only one of those sub-categories will exist within the grid cell. The assumption requires that each grid cell be smaller than the larger zones that are being defined. Because predominant type categories are the easiest to interpret, and require the least amount of storage, wherever possible they should be used. At the boundaries of zones it may be difficult to decide which category to assign to a cell. The usual rule is to use the category with the largest percentage within that grid cell. However, on occasions this may lead to the loss of important information, and more especially, if boundaries are important it is necessary to code the fact that this is a boundary cell and to indicate which are the two categories which form the boundary.

When the grid cell size is not smaller than the size of zones that are being coded, several zones can exist within the grid cell. To represent accurately the conditions in that grid cell it is necessary to measure the percent of the area that is covered by each category or sub-category of zones. If one assumes that each grid cell has an equal area, one can use the standard value range for coding information in terms of percent-of-area. However, if a specific value is measured for each sub-category, each sub-category must have space when storing the information. Because this procedure tends to generate greater requirements for storage space, it should be used only when predominant type codings create a grave loss of detail in describing the grid cell.

Several factors determine whether to use percent-of-area code or predominant-type code. The first factor is the grain of the grid cell compared to the grain of the zones being recorded. As a general rule, if most of the cells have only one type of zone within them, a predominant-type coding can be used without any loss of detail in the information. However, if the average grid cell has more than three different types of zones within it, a great deal of detail will be lost by using predominant types of coding, and some form of percent of area coding should be used. When the average cell contains two or three zones the decision is often indeterminate. A compromise solution is to code only two or three of the most extensive zones that occur within the cell. However, this does not permit the specification of the relative size of each category. It may be necessary to define the secondary characteristic as at least 30% of the cell and the tertiary characteristic as at least 10% of the cell since this will give information at least about the limiting values of the secondary and tertiary characteristics.

Another factor that could enter into this decision is the reliability of the information being coded. If the size of the zones that are being recorded are almost equal to the size of the grid cells, the decisions should be based to some extent on the reliability of the zones. That is to say, if the zone boundaries are not very accurate there is no point in using the accuracy of percent-of-area coding to record their extent. It may simply be enough to record the predominant characteristics of the cell. However, when the boundaries have been recorded accurately, the methods for recording two zones should reflect the accuracy.

(d) SOME SPECIAL CONSIDERATIONS USING GRIDS

Other information can be recorded as the basis of the grid cell; in some cases there are problems that should be carefully considered.

(1) THE MEASUREMENT OF OBJECTS OR DISCRETE EVENTS BY GRID CELLS

Methods of recording information about discrete objects and events rely on recognizable boundaries. Because the grid cell boundary is abstract, it is difficult to record or count objects in a field check on the basis of a grid. Most of the procedures that are used with grid cell systems involve overlaying the grid system on a photograph or a map and then coding the characteristics of the grid. When using aereal photographs it is possible to count discrete objects that are recognizable in the scale of the photography and record these by the number that exist within the grid cell. This makes excellent density measures of different types of activity(s). Usually, however, it is very difficult to get accurate accounts of these discrete objects and events, particularly population on the basis of grid cells. The use of a Street Address Conversion System to generate x-y coordinates for discrete events or objects provides a basic source of information. It is possible to aggregate the events over any set of spatial zones because their regular nature makes it simpler to aggregate to grid cells than any other spatial unit. As far as is possible the aggregation of counted or measured characteristics to grid cells should be a secondary conversion process as opposed to a primary collection process.

(2) LINEAR CHARACTERISTICS

If the grid cell size is small enough, it is possible to put together a perfectly good description of linear characteristics by coding the cells that lie on the line. Linear characteristics refer to such features as highways or roads. The juncture of two zones is much more important that the actual knowledge of the zones.

When linear characteristics represent a hierarchy within a network, it is sometimes possible to make an intricate representation of the network by coding its predominant type existing within the cell: for example, the highway system. Using the procedure it is possible to create a map which shows for the different parts of the region the basic highway which exists. In urban areas the basic type is streets whereas in rural areas the access to each cell may be gravel roads. By making major arteries graphically darker, one may superimpose them on this system. Note that coding linear characteristics to a grid cell represents an approximation. A line can never be adequately represented by an area unless the area is very small. The concept of coding the predominant highway within a grid cell simply indicates that the cell is served by that type of highway.

(3) DISAGGREGATING CHARACTERISTICS OF LARGER ZONES TO GRID CELLS

A great deal of information is provided by the U.S. Census Bureau and other data collection agencies on the basis of aggregation zones such as school districts or towns. This information is of extreme importance in analyzing land planning decisions. When using a grid-spatial base file, each of these larger zones for which a variety of statistics are available can be coded to a grid cell. For analysis purposes the average characteristics of the larger zone can then be assumed to be a characteristic of the grid cell. This is a simplistic approach and it is based on the assumption that the larger zone represents a homogeneous, even distribution of the characteristics being studied.

Often, however, this is not the case so that this assumption can introduce a high level of error into the analysis. A few ad hoc experiments have been carried out in recent studies which attempt better and more sophisticated methods of disaggregating information that has previously been collected by the larger zones. For example, consider the population of the tract. People are counted at their unit of residence; it is a simple assumption to say that any grid cell which has no residential land use within it will not contain any population. If a count is available on the grid cell basis of the number of residential units within an area, it is an easy matter to assign population to grid cells on the basis of the number of housing units or residential units that each grid cell contains. This is a simple procedure and it is based on the direct correlation between the number of residential units and the number of persons that live within them (note that this refers to units, not structures).

The disaggregation of more complex types of information such as income requires that less precise relationships be used. However, it is reasonable to assume that because higher income persons will live in housing of a higher quality, one can estimate the distribution of income over the grid cells in the tract. There could, of course, be the obvious exception of poor people who have inherited a very beautiful house. However, such an exception will not invalidate the general assumption. The development of better objective indicators of neighborhood quality will help this process of disaggregation. This development depends on better relationship between information that is identified on the basis of the grid cell, and aggregated data such as reported in the Census.

C. DATA CATEGORIES

1. ZONE SETS AND CLASSIFICATION

A resource information system requires the management of a wide variety of different types of information. It is convenient to consider the different categories of information as if each is a part of a specific set of zones which must entirely fill the spatial extent of the study region, each set of zones to be overlaid over the others. The zone sets describe a grouping of data categories by the general characteristics of their content. Within each of these zone sets the information must be further broken down into the detailed categories of the data which will be stored. These sets would include:

Climatic Zones
Geologic Zones
Landform Zones
Soil Type Zones
Vegetation Zones
Watershed Zones and Water Networks
Land Use Zones and Transportation Networks
Ownership Zones
Sociopolitical Zones
Economic Zones
etc.

The concept of sets of zones is very useful when organizing the general groups of data but one must realize that any specific study will be concentrating on only a few of all the possible zone sets. The rest of the zone sets will be treated only in a general sense or, in some cases, not at all. Therefore, an information system should be dynamic in that it can be continually expanded or updated. The organization of data into categories at the initial stages of creating an information system should reflect the immediate priorities for the use of the data.

Several general issues should be considered when establishing the data categories.

1) Each zone set must be fully described. Every category or condition existing within that zone set must be included in the inventory. It is usually useful to have a "junk category" which includes all the relatively insignificant conditions which do not fit into any other category.

2) The detail to which any category is recorded should be directly related to the requirements for the use of the data. Unnecessary detail just increases the time and cost associated with collection, storage, retrieval and analysis of data. It is usually more efficient to

add increased detail as the demand for its use occurs, rather than collect a great deal of unused information. In some collection procedures it may be more efficient to collect all the detailed data at once, but even in this case reasonable foresignt as to potential use must still be exercised.

3) The detailed definition of data categories should be based on a series of characteristics which can be easily identified and are relevant to the data use. Categorization for its own sake is a waste of time and will lead to problems both in the collection of data and in its later use. Two data categories that exhibit the same characteristics and are difficult to differentiate can more profitably be regarded as one category.

4) When the information system is designed for use on a digital computer system, it is very important to remember to completely describe each zone set within the system. The computer will consider the region a complete system and gaps in the data which it is given will lead to erroneous results. If a zone set only refers to a limited portion of the region or study area, the remainder of the region must be referenced as a sub-zone which lacks the relevant characteristics.

The importance of considering the various zone sets is highlighted by considering a military reservation. If coded simply as a military reservation in land use, it would be very difficult to determine the reservation's capabilities for future use if it were deactivated. Military reservation is an ownership classification and within that reservation may exist recreational, residential, semi-industrial, and just simply open space as land use classifications.

Similar problems occur with National Parks and Forests. For instance, the type of forest that exists within a region is a characteristic of the region's vegetation, while the use of that forest is characteristic of land use. As such, forest type will be coded as a vegetation zone, but the type of use made of the forest, such as management for forestry, or preservation of the forest as a wilderness area, is a land use characteristic. One must beware of confusing ownership with land use. Wilderness areas may be owned by the Forest Service or a paper company just as both organizations may also manage forests for commercial use. In general, it requires several sets of overlaid zone sets to fully describe the characteristics of an area.

2. THE SELECTION OF DATA VARIABLES

The selection of data to be included in the inventory is based upon availability and anticipated needs. Under no circumstances should a data bank be an all-inclusive data depository. Data collection is expensive and must be approached with efficiency. Since the design of the data bank must be compatible with its use and since its use is often unpredictable, the data bank must be expandable and able to be updated.

A study of resource analysis systems (101.22) has shown that, at the data inventory stage, there is in many of the studies a distinct relationship between the range of data inventoried and the breadth of purpose of the resource analysis. It was also found that technical capability in handling information was probably a constraint on the level of detail of the data collected. Table F.1 lists the major data categories which are either inventoried or used in the various methods.

It is clear from the list of data categories that while most of the studies require a general knowledge of a wide range of resource information, each study has a series of specific sets of detailed information that is quite unique. In some cases this was determined by the availability of information and in other cases it was determined by the requirements of the analysis procedure.

It must be emphasized that data inventory is a costly process. It would seem therefore that an inventory which is usable for a variety of analytic goals and purposes would in the long run be a more efficient and economical procedure than one which is used for only a single purpose. McHarg (96), Hills (93) and Christian (91) are among the other individuals who advocate comprehensive data banks and their use for analysis rather than the collection of data specific to the immediate analytic purpose at hand. However even in the initial stages of the development of a "comprehensive" information system, the priorities for the collection of data must be established in relation to the purposes for which the data will be used.

3. SCALING

Traditional methods of recording information on resources rely on alphanumeric (letter and number) codes which describe a category or condition. This information is essentially descriptive or qualitative. The use of digital computers

Table F.1
Frequency of Use of Variables

NATURAL RESOURCES	1 Alli.-Lei.	2 Chester Co.	3 Christian	4 Dearinger	5 Hills	6 Lewis	7 Litton	8 McHarg	9 PARIS	10 RECSYS	11 SCS:1	12 SCS:2	13 Toth	14 Corp Eng.	15 Williams	16 Res. Pl. & Des.	17 St. Reg. Assoc.
CLIMATE, General		X	X	X	X	X		X		X	X	X	X	X		X	
Rain		X		X				X			X			X		X	
Snow		X						X			X			X		X	
Temperature		X		X	X					X	X			X		X	
Radiation								X									
Fog				X				X									
Wind		X		X						X				X			
Frost						X		X									
Storms		X	X	X						X						X	
Air Drainage	X														X		
GEOLOGY, General			X	X	X			X		X		X	X	X		X	
Bedrock Outcrops				X		X	X	X					X				X
Bedrock Type	X		X	X	X			X		X	X		X				X
Unique Formations	X		X	X		X	X	X					X		X		
Stable Formations				X				X			X						
Depth to Bedrock	X		X	X	X			X			X		X				X
Building Materials						X					X		X				
Structural Type		X	X			X		X			X						
Structural Age		X	X					X			X						
Weathering Type			X								X						
Volcanic Activity			X														
Economic Minerals								X					X		X		
LANDFORMS, General			X			X	X				X	X	X	X	X	X	X
Unique Features			X			X	X				X	X	X				
SOILS, General			X	X	X	X		X		X	X	X	X	X	X	X	X
Soil Type		X	X	X	X			X			X		X		X		
Soil Texture		X	X	X	X			X			X		X				X
Soil Depth	X	X	X	X	X			X			X		X				X
Drainage	X	X		X	X			X			X		X				X
Erodability		X						X			X		X				
Bearing Capacity		X		X				X			X		X				
Permeability		X		X	X			X			X		X				

	1 Alli.-Lei.	2 Chester Co.	3 Christian	4 Dearinger	5 Hills	6 Lewis	7 Litton	8 McHarg	9 PARIS	10 RECSYS	11 SCS:1	12 SCS:2	13 Toth	14 Corps Eng.	15 Williams	16 Res. Pl. & Des.	17 St. Reg. Assoc.
Instability		X						X			X		X		X		
Stoniness	X	X			X						X		X				
Soil Productivity					X	X		X			X		X				
TOPOGRAPHY, General	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Elevation				X	X	X	X	X		X	X				X	X	X
Excessive to Utilities	X	X				X		X			X						
Ravines						X											
Rim of Slope						X											
Relief Variation					X	X		X		X	X				X	X	X
ORIENTATION, General		X				X	X	X			X		X				X
WATER, General		X		X		X	X	X		X		X	X	X	X	X	X
Watersheds		X		X				X					X				X
Drainage Patterns		X	X	X	X	X		X		X	X		X	X			
Ground Water			X	X		X		X			X		X	X	X	X	
Aquifers		X				X		X			X		X				
Surface Water	X	X		X		X		X					X	X	X		X
Lakes	X		X	X	X	X	X	X		X		X	X	X	X	X	X
Rivers and Streams	X	X		X		X		X		X	X	X	X	X	X		X
Wetlands				X		X		X			X		X		X		X
Springs				X		X							X				
Waterfalls				X		X							X				
Floods					X	X		X			X		X		X		
Quantity				X							X		X				
Quality	X			X		X		X		X	X		X				X
Temperature				X	X			X		X							
Dis. and Sus. Solids				X	X			X		X							
Biologic Productivity				X	X			X		X							
Shoreline Type	X				X	X				X							X
Shoreline Quality	X				X	X				X							X

	1 Alli.-Lei.	2 Chester Co.	3 Christian	4 Dearinger	5 Hills	6 Lewis	7 Litton	8 McHarg	9 PARIS	10 RECSYS	11 SCS:1	12 SCS:2	13 Toth	14 Corps Eng.	15 Williams	16 Res. Pl. & Des.	17 St. Reg. Assoc.
VEGETATION, General	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Quality		X		X	X	X		X			X						
Specimen Stands	X	X		X	X	X		X							X	X	
Shore and Bank Commun.						X					X						
Fields				X							X						
Forest Areas		X		X	X	X		X			X		X	X	X		X
Natural Associations		X			X	X		X			X		X		X		
Understory	X			X	X			X									
Overstory	X				X			X									
WILDLIFE, General	X		X	X	X	X		X			X	X	X		X	X	
Quantity	X					X						X					
Prime Habitat				X	X	X						X	X			X	
Major Ecotones				X	X			X					X		X		
Uniqueness			X	X	X	X											
Quality & Production				X	X	X									X		
Wilderness					X												
LAND USE																	
AGRICULTURE, General		X	X	X	X	X		X			X	X	X		X	X	X
REC. & OPEN SPACE, General	X			X		X		X	X	X		X	X		X	X	X
Recreation Facilities	X		X	X	X	X			X	X			X		X	X	X
Tourist Facilities	X		X			X				X				X			X
Facility Standards								X	X	X					X		
Demand Factors	X			X					X	X					X		
Water Rec. Facilities	X			X	X	X		X	X	X			X		X		X
URBANIZATION, General		X		X		X		X	X	X		X	X	X	X	X	X
RESIDENTIAL, General		X						X					X			X	X
Quality								X								X	X
Growth						X		X									X

	1 Alli.-Lei.	2 Chester Co.	3 Christian	4 Dearinger	5 Hills	6 Lewis	7 Litton	8 McHarg	9 PARIS	10 RECSYS	11 SCS:1	12 SCS:2	13 Toth	14 Corps Eng.	15 Williams	16 Res. Pl. & Des.	17 St. Rog. Assoc.
COMMERCE, General	X							X		X						X	X
INDUSTRY, General								X						X		X	X
INSTITUTIONS & SERVICES								X						X			X
UTILITIES						X		X		X				X			X
AIR TRANSPORTATION														X			X
RAIL TRANSPORTATION														X			X
WATER TRANSPORTATION								X						X			X
ROAD TRANSPORTATION	X	X		X		X	X	X	X	X		X	X	X	X	X	X
Road Type	X			X		X	X	X		X			X		X	X	X
Scenic Highways						X	X						X				
Proposed Highways						X	X	X					X				X
ACCESSIBILITY	X		X	X				X	X	X		X	X		X	X	X
ENVIRONMENTAL HAZARDS	X		X			X		X									X
HISTORICAL & CULTURAL				X	X	X		X				X	X		X	X	X
VISUAL CHARACTER	X		X	X	X	X	X	X		X			X		X	X	X
LAND COSTS	X							X							X		
POPULATION CHARACTERISTICS				X					X	X		X		X	X	X	X
Population Projections						X		X	X	X					X		
SOCIO-ECONOMIC CHARACTER.	X			X		X		X	X	X		X			X	X	X

This table is based on a variety of resource check lists and should not be taken as a model for the ordering of variables.

requires a greater sophistication in the recording of information. Computers carry out arithmetic operations with numbers and this requires that data be scaled and recorded in a manner suitable for use in arithmetic procedures. If this property of computer use is not accounted for in data categorization, problems of statistical validity of complex quantitative analysis procedures will arise.

Data variables can be internally scaled in many ways but for arithmetic manipulation there are four basic types of data scaling: nominal, ordinal, interval and ratio.

Nominal scaling is essentially qualitative; "types" are identified without being relatively ordered on a scale. Thus, Oak vs. Maple vs. Pine vs. etc., is a nominal scaling.

In ordinal scaling, relative ordering can be assigned but it implies no relative magnitude between scale values. Thus, Oak (more valuable than) Maple (more valuable than) Pine, etc., is an ordinal scale.

In interval scaling, relative distance as well as order are significant. Thus, in the interval scale: 100^{o}, 90^{o}, 60^{o}, etc., the distance between 100^{o} and 90^{o} is closer than that between 90^{o} and 60^{o}.

Ratio scaling is similar to interval, except that a fixed base value is established thus allowing quantitative values to be expressed as ratios. For example, a board foot of Oak is worth twice one of Maple and four times one of Pine. Length, density, price and many other standard measures are ratio scales. These are the highest level of measurement and can be analyzed as mathematical functions. Only interval or ratio scales may be used with most statistical analysis programs.

4. CATEGORIZATION

For any variable, it must be decided how many levels of internal differentiation should be applied. This again depends on user requirements, but as a rule, ten levels are sufficient both for most variables and as a practical maximum for map legibility. A data system which is computer based can accommodate data at a very fine internal-scaling e.g., topographic elevation to the nearest foot or percent of area to 1%, and then aggregate these into coarser levels as the user specifies.

When defining the scaling of a large number of variables it is important to remember that an analysis which combines several variables can be accurate only to the degree of specificity of its most coarsely scaled variable. In all cases, data categories must be determined on the basis of measurable characteristics of the conditions being studied. Some categories such as Soil Type have at least two very basic characteristics that are of little relation to each other (e.g., bearing capacity and productivity), and thus require multiple coding. In this example, the productivity is dependent on the organic content while the bearing capacity is dependent on the mixture of the granular structure of the soil. Thus, at the extreme, the absence of soil or open bedrock has no productivity but a very high bearing capacity. Similar problems exist with residential land use which has density characteristics as well as value characteristics, both of which are very important.

Ideally the actual value of the variable should be recorded for every point location. The technical problems of data storage are such that this is often impossible, and it becomes necessary to divide the range of values into groups which have similar ranges of characteristics. This involves a process of data generalization or rescaling of the data.

The purpose of rescaling is to identify those groups which are significant to the analysis proposed for the use of the data. A scale which is too general will be useless for analysis purposes and a scale which is too detailed will be too costly and inefficient.

It is very dangerous to make definite statements about the rescaling of specific data categories as a set of data categories relevant to one region may be irrelevant for another. Simply, what is relevant for one problem may be irrelevant for another problem.

In general, a large and well-managed information system would usually be operated on two levels. One level would consist of the original data collected in detail and stored. At its operating level, all the data would be generalized in the manner found to be most useful for the day to day operation of the system. The user's requirements would determine this. As these requirements change, the original data would then be reprocessed to create a new set of generalized data.

APPENDIX G: A SURVEY OF ACQUISITION METHODS FOR RESOURCE DATA

A. DATA ACQUISITION

To initiate any particular planning process a primary concern involves data definition and data acquisition. The specific data needed for each project will obviously vary depending upon the planning issues, site size and location, budget, schedule, accuracy, and analytic flexibility required. Data inventory is a costly process and stringent organization is needed to provide the complex range of data to be manipulated later within the planning process.

This section attempts to briefly discuss the range of data sources which are presently or potentially available to the land planning professions to aid in the data inventory stage. Each data source and sensor is briefly presented, stating the particular efficiencies that it offers. Two tables are presented to provide a basic understanding of the sources and sensors which best provide typical pre-defined categories of data. The discussion does not attempt to evaluate relative merits of using one sensor over another because of the complexity of the specific issues involved. The study is primarily aimed at describing alternative techniques or combinations that can provide the accurate, current, and relevant data required for a specific inventory.

1. SOME PAST EXPERIENCES

Considering the variety of purposes and scales of interest of resource analysis methods, one notes a substantial consistency in the sources from which data are derived. Basically, one suspects that the general rule is "Use the best data that you can get." Most existing resource analysis methods rely on data which are commonly available in published sources, such as general climatic information, topographic data, surface water and vegetation data, and basic land uses. In most cases these data sources are those publicly available documents provided by the government, notably the USGS maps and the Soil Conservation Service maps, and several methods clearly make use of these maps in creating overlays which they then combine in their various analyses. The studies that investigate demand as part of their analytic method typically make use of statistical data summarized in the U.S. Census.

On the other hand, several of the existing methods, notably those for large undeveloped areas [Hills (93), and Christian, (91)], recognize that it may be more efficient in terms of time, money, and manpower to collect data "from scratch." rather than to collect, collate, and reorganize the existing, often scanty or erroneous, data on a region. Typically these methods turn to some form of aerial photographic analysis. A substantial portion of a resource data bank can be easily derived through air photo interpretation. Both photo recognition and interpretation are used to obtain data. Recognition is basically an instantaneous visual identification, whereas interpretation involves more complex inferential processes in order to identify data types.

Several of the methods demand personal field investigation by the group making the evaluations: the Allison and Leighton (89) and the Soil Conservation Service campsite analysis methods (100, and the evaluation of the resources of State Parks in the Michigan RECSYS study (98) are examples. Several of the resource methods decentralize this process. Lewis (94) makes use of local experts, county agents, etc., to identify the extrinsic and intrinsic resources upon which he bases several of his evaluations. The Soil Conservation Service also has methods aimed at helping local groups to evaluate their own resources (99, 100).

In summary, analyses are largely governed by the data available, and often the question asked by the resource analyst is "Given the data available, how can we evaluate for _____?" But analysis must not be biased by the availability of data. Just because one has data does not necessarily mean that one needs to use it. However, if data are not available, this does not necessarily mean that analysis must be terminated.

2. SOME GENERAL ISSUES

There are many general problems that must be defined when discussing alternative data sources. The individual requirements of each job will dictate to a large extent the cost limitations on data acquisition. If little money is available for an inventory, limitations on the accuracy of acquired data must be understood and accepted. In addition, accurate data sources themselves will not provide relevant and accurate information unless they are interpreted and recorded on a professional level of confidence, e.g., an individual who has never utilized air photo interpretation principles would not be able to accurately map soil and rock conditions from air photos. Each data source and sensor examined must be accompanied by the professional expertise to manipulate it accurately for the desired information.

It is also important to realize that in gathering any data, a system of cross-checking must be maintained to provide an accuracy measure. One of the best techniques is to utilize several data sources or sensors to provide information rather than just one. While budget and schedule may severely limit the number of sources and sensors to be used, field checking should always be incorporated as a minimum control.

Each data source also has its inherent problems of accuracy and resolution. Panochromatic black and white photos as illustrated by RAND Corporation (77) can delineate 6-inch parking strips when taken at 100,000 feet. According to a study done at Raytheon (77), Airborne Radar (SLAR) can distinguish 50 foot objects and is suitable for 1:250,000 scale mapping. However, electromagnetic (long wavelength) sensors struggle for any recognizable resolutions. These problems of cost/accuracy/resolution will change over time and will be applicable to a wider range of data categories in the future.

The actual feasibility of utilizing many of the more sophisticated sensors has not yet been proven. Many of these items are still very expensive and are not readily available to the general professional public (e.g., such items are electromagnetic sensing, infrared imagery, some radar equipment, etc.). However, in future years many of these more sophisticated sensors will be incorporated in earth resource survey sensing satellites providing data that could be utilized by planning agencies. As this type of data is likely to become available it has been included in this discussion.

3. ALTERNATIVE EXISTING DATA SOURCES

(a) LOCAL AGENCIES

Depending upon the site location large amounts of existing data may be available from local, state, or governmental agencies. In most instances these data are available and free as a public service. Local data should always be investigated before any authorizations are given to procure new surveys. The amount, type, etc. of existing data will actually determine the scope of new surveys and needed photography.

(b) FIELD SURVEYS

Though more expensive per square mile, field surveys are usually the most accurate process of gathering data. They are used most efficiently in conjunction with other data sources and sensors, primarily to verify their interpretation and accuracy. Field surveys should always be a part of even the most sophisticated data gathering systen in order to provide verification of accuracy limite. These surveys can often be conducted in cooperation with the Soil Conservation Service or other county or local agencies that are familiar with the study area.

(c) GEOPHYSICAL SURVEYS

To obtain specific engineering information, selected field survey methods must be incorporated. Geophysical and auger surveys in conjunction with laboratory tests provide definitive data upon which structural engineering decisions can be made. This type of data is generally available from engineering consulting firms but is not utilized until specific sites have been selected. This type of data acquisition represents the finest, most specific scale of data gathered relating to physical conditions.

(d) THE U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey has been providing, since 1882, general purpose maps of appropriate scale and accuracy for all of the country. Many series and scales are presented to satisfy the wide range of user demands. The two map series most widely used by planners are 1:24,000 scale (2000 ft/inch) and 1:62,500 scale (5280 ft/inch) quadrangle maps. Mapping of geologic features has been completed for the whole United States at a general scale of 1:5,000,000. The map series of 1:250,000 (4 miles/inch) are sometimes utilized for large scale studies. All these maps are available from the Map Information Office in Washington, D.C. for nominal cost. Available geologic coverage for the U.S. can also be obtained in index from the Map Information Office, Washington, D.C.

(e) SOIL CONSERVATION SERVICE

The Soil Conservation Service of the U.S. Department of Agriculture has been making and publishing soil surveys since 1899. These surveys are intended to provide information on soils to the general public. These are available free of charge from the Information Division, Soil Conservation Service, Washington, D.C., to those land users or professionals who require the information. Only one-third of the United States has been mapped at this time, with the most relevant maps for planners completed after 1957. The SCS does not project the completion of mapping until after the year 2,000. A list of mapped counties can be obtained from the SCS in Washington.

The Soil Conservation Service county agents are of great value in compiling a data inventory. A local individual working in the field twenty or more years can certainly be valuable in field checking, measuring accuracy, or obtaining raw data. This is especially true for dynamic data categories such as ecology and wildlife.

(f) OTHER GOVERNMENTAL AGENCIES

Depending upon the site location, other agencies with responsibilities for land areas may be of assistance. Included are the Department of Commerce, Forest Service, Bureau of Outdoor Recreation, National Park Service, Department of Wildlife and Fisheries, etc. Usually the central office of each agency in Washington, D.C. would know the specific data available for a particular region or would direct the caller to the relevant field office.

4. ALTERNATIVE DATA SENSING METHODS

(a) PANCHROMATIC (BLACK AND WHITE) AERIAL PHOTOGRAPHY

All of the United States and its territories have been photographed in black and white photographic coverage by governmental or commercial organizations. Most of this photography is flown at 1:20,000 or 1667 ft/inch and provides sufficient detail for land use pattern recognition, landform identification and soils mapping. Agencies having aerial photographic coverage include the Agriculture Stabilization Conservation Service, Soil Conservation Service, Forest Service, Geologic Survey, and Coast and Geodetic Survey. Indexes showing the coverage of each agency can usually be obtained from the Washington, D.C. offices.

Panchromatic photography and interpretation techniques have been utilized in the past for a wide range of data acquisition. Crop patterns, trees, wildlife species and range, geology, geomorphology, soils, geography, hydrology, oceanography, etc. are a few of the data categories that can be interpreted from information derived from panchromatic photos. Many interpretation techniques from black and white photos are possible, but because of the complexities of the subject it cannot be covered here. The authors suggest "The Manual of Photographic Interpretation" (59) of the American Society of Photogrammetry which gives a comprehensive background of panchromatic interpretation techniques and applications. Such photography at this point in time yields the most accurate information of any sensor concerning the size, shape, and relative positions of objects and patterns.

(b) PHOTOGRAPHIC MOSAICS (BLACK AND WHITE)

Black and white photomosaics are generally available for any particular study area. These can be obtained from the same particular agency that has the aerial coverage. Photomosaics are generally small scale (typically 5280 ft/in) and do not offer a 3-dimensional or stereo image, thus limiting their range of application. Major landform groups, drainage patterns, urbanization, forests, broad agriculture, etc. can be generally determined. Mosaics are very inexpensive and would prove of value when studying very large areas. The mosaic can generally offer enough information to establish which areas within them justify further detailed study.

(c) INFRARED (BLACK AND WHITE) PHOTOGRAPHY

Infrared film captures the upper end or near infrared portion of the spectrum that is not normally visually apparent. Solar energy reflecting from a broad-leafed plant will reflect visible energies differently from infrared energy. Thus, vegetation inventories and soil analyses can be greatly aided by black and white infrared photographs.

(d) COLOR (NORMAL) PHOTOGRAPHY

Color aerial photography has recently become relatively inexpensive. Printing costs, however, are still high, and suitable flying weather is a problem in some areas. However, it has been proven that color aerial photography gives the best overall coverage of any sensor technique available. Qualified interpretors can extract reliable data in greater amounts and more rapidly from color than they can from regular panchromatic black and white photos or from black and white infrared. It is probably most efficient at 1:48,00 or 400 ft/inch where detailed physical information (vegetation, land use, and soils) can be extracted.

(e) COLOR (INFRARED) PHOTOGRAPHY

Color infrared has the wide tonal and hue advantage of color in addition to the specialized properties of the infrared spectrum under black and white infrared photography. Healthy vegetation, being a high reflector of infrared radiations, is recorded with a brilliant red or pink color, indicating the condition of the spongy mesophyll in the leaf structure. Crop and tree diseases, blights, fungi, etc. can readily be identified on the color infrared. Color infrared also shows detailed changes in soil moisture conditions and vegetation cover types and density. Soil mapping is more efficient and accurate if infrared color is utilized.

Color infrared is best applied when interpreted with true color aerial film and panchromatic black and white. Color and tonal shifts can then be studied in more detail to provide a system of cross-checking when identifying and measuring data variables.

(f) ULTRAVIOLET IMAGERY

Ultraviolet sensing is virtually unavailable commercially, but experiments show promising applications in providing geologic and oceanographic information. The technique senses element vapors such as mercury and iodine, capitalizing on the fact that most of the atomic absorption lines in the spectrum are contained within the ultraviolet range. At this time, and for most applications and data needed by land planners, ultraviolet sensors are not feasible.

(g) INFRARED IMAGERY OR "THERMAL SENSING"

Infrared imagery has already proven to be of great value in certain specific data acquisition projects. It detects and constructs a photographic-like image showing variation in the emitted thermal infrared radiation of objects. The resulting image will show warmer objects as light tones and cold objects as dark ones. Some specific problems of thermal activity are almost completely dependent upon this sensor for data. These sensors are being used by the U.S. Forest Service to detect and map forest fires and locate hot spots even through thick clouds of smoke (77). Ecologists are using this sensor to map thermal differences in rivers caused by power plant heat pollution, volcanic activity in Hawaii, geothermal activity in Yellowstone Park, and detection of crevasse snow bridges. Unfortunately, availability of this sensor is still somewhat limited for use in land planning.

(h) <u>RADAR IMAGERY</u>

Radar imagery has proven to have wide large-scale data acquisition capabilities. Side Looking Airborne Radar (SLAR) can continuously map large areas, reconstructing a photographic-like image from the reflected component of a self-generated radio frequency pulse. Being a radio transmission, it can be done regardless of atmospheric conditions. Night mapping and penetration through clouds, ice, and certain vegetation cover can also be accomplished with this sensor. The image formed very clearly shows surface roughness, structural geologic conditions, general moisture differences, and slopes. A NASA-supported research team coordinated by the Center of Research in Engineering Science at the University of Kansas is investigating the total range of potential radar-data capabilities and applications (71). The primary potential is in mapping large undeveloped countries or regions that cannot afford to utilize panchromatic black and white aerial coverage. This sensor can be contracted for use through several commercial firms primarily concerned with its development.

(i) <u>ELECTROMAGNETIC IMAGERY</u>

Electromagnetic sensors are still in the early stages of development but already have some very specific data acquisition capabilities. The U.S. Army Electronic Laboratories (71) has directed a task force which has successfully, with low flying electromagnetic sensors, penetrated ice up to 9300 feet. With these devices, mapping of terrain surfaces can be done through continental ice sheets.

(j) MULTISPECTRAL PHOTOGRAPHY

Through multispectral photography, the tonal discrepancies of different objects can be compared within segmented portions of the spectrum providing an overall tonal signature pattern for each object. By this technique many geologic, vegetation, and crop patterns can be automatically identified by scanners once their tonal variances across the spectrum are defined. These sensors are still in early stages of investigation and require expensive specialized equipment. However, further refinement of integrated satellite-computer-scan-storage systems will rely heavily on multispectral properties using black and white, infrared, and color images exposed simultaneously.

5. SUMMARY TABLES

To help focus the specific applications of some of the sources and sensors, the following tables have been prepared showing, on a comparative basis, a range of possible data applications for different broad data categories. It must be remembered, however, that not all of the techniques listed are presently commercially available.

In Table G.1 the overlap of sensor techniques for each broad data category can be observed.

Table G.2 incorporates a specific list of data variables found to be used in various methods of land planning (101.22). Each data source and sensor is also listed and the effectiveness of each is indicated with a 0,1,2,3 ordinal ranking. This table indicates which of the sources are currently best for supplying information on specific variables and which sensors tend to be the most efficient within certain categories.

Table G.2 indicates that multispectral photographic methods offer the greatest range and potential for data acquisition. However, because of their expense, large area surveys to be commercially contracted would not be feasible unless incorporated into a government satellite sensing program.

Air photos also offer a wide range of information especially if a combination of types is used. If not, color photos as a single source hold the greatest values. The other sensors, untraviolet, infrared imagery, and radar (SLAR) have rather specific data applications that limit their general overall

DATA GATHERING TECHNIQUE	AGRICULTURE	FORESTRY	GEOLOGY AND SOILS	HYDROLOGY	OCEANOGRAPHY	GEOGRAPHY
FIELD SURVEYS	Specific Crop Identification Identification of Crop Vigor	Specific Tree Type and Ecology General Health	Specific Rock Identification and Structural Soil type Composition and Characteristics	Flow Velocities and Volume Measurements Water Quality	Water Mineral Pollutant and Chemical Composition Depth Soundings and Turbidity	Specific Land Uses Individual Structure Identification Terrain and Veg Character
GEOPHYSICAL SURVEYS			Core Log Borings Auger Surveys Seismic Surveys Magnetic Measurements			Magnetometer Surveys Gravity Meters
U.S. GEOLOGICAL SURVEY (QUADRANGLE MAPS)	Vineyards Orchards Cranberry Bogs	Woodland Scrub Wooded Marsh	Glaciers Contours Dune Areas Sand Areas Large Washes Gravel Beaches Dry Lake Bed	Perennial Streams Springs Rapids Soundings Intermittent Streams Falls Inundated Areas Swamps	Coral Reef Rocks Foreshore Flat	Land Use Circulation Patterns Road, Rail, Air, Water Mineral Workings Structures, Buildings Bench Marks Boundaries
SOIL CONSERVATION SERVICE TECHNIQUE	Crop Production Estimates by Soil Type Erosion Problems	Woodland Management Problems by Soil Type	Soil Types Composition Characteristics Capabilities Eng. Properties	Capability of Soils for Impoundment Internal Drainage Erosion		Capability of Soils Potential Land use Development Including Utility Options
AERIAL PHOTOGRAPHY PANCHROMATIC (BLACK AND WHITE) STEREO	Crop Identification and Pattern	Vegetation Identification and Pattern Ecologic Assoc.	Identification of Surface Structure Landforms Topography General Soil Types and Characteristics	Drainage Patterns Inundated Areas Swamps Marshes Logs Gullies	Sea State Off Shore Depth Beach Erosion and Deposition Turgidity	Urban and Rural Land Use Categories Circulation Patterns Residential, Comm Industrial, Terrain, Vegetation Characteristics
AERIAL PHOTOGRAPHY INFARED BLACK AND WHITE	Crop Identification and Pattern	Vegetation Identification Confers vs. Deciduous Ecologic Assoc.	Topography Surface Structure Landforms General Soil Types and Moisture Characteristics	Water Body Identification Drainage Patterns Soil Moisture	Coastal Shoreline Moisture Variences Water Systems along Shorelines Ice Type Mapping	General Land Use Patterns
AERIAL PHOTOGRAPHY COLOR STEREO	Crop Identification and Pattern	Vegetation Type Ecologic Association	Rock Types, Attitude Soil Types Composition and Characteristics Topography	Water Bodies Drainage Pattern Water Quality Turgidity	Water State Coastal Conditions Periodicity, Beach Erosion and Deposition Coral Reefs, Off Shore Depth	Detailed Urban & Land Use Categories, Detailed Overall Terrain, Vegetation Analysis
AERIAL PHOTOGRAPHY INFARED COLOR STEREO	Crop Identification and Health Disease Identification	Vegetation Pattern and Health Disease Identification	Soil Moisture and Composition Topography	Water Bodies and Condition Algae Gullies Drainage Pattern	Living Organisms Ice Identification Shoreline Moisture Conditions	Detail Urban and Land Use Categories Detailed Overall Terrain, Vegetation Analysis
PHOTOGRAPHIC MOSAICS	Crop-Agricultural Pattern	Forest Pattern	Broad Landform Groups	General Regional Drainage Pattern	Overall Shorelines Conditions Erosion and Deposition	General Categorical Identification of Agriculture, Urban Areas, Rural Areas, and Forested Areas
ULTRAVIOLET SENSORS			Mineral Location and Identification		Detection and Measurement of Surface Marine Flora	
INFARED IMAGERY OR THERMAL SENSORS	Crop Vigor and Disease Condition	Forest Fire Detection Vegetation Vigor and Disease Condition	Mapping of Thermal Volcanic and Geothermal Activity	Identification of Areas Cooled by Evaporation	Ocean Current Mapping and Sea Ice Identification	Land Use
RADAR (SIDE LOOKING AIRBORNE RADAR) SLAR	Agriculture Pattern Soil Characteristics	General Soil Characteristics	Surface Roughness and Geologic Tectonic Mapping Regional Soil Units	Soil Moisture Content (General) Run off Slopes	Sea State Ice Identification and Thickness	Broad Patterns of Cultural Land Use
ELECTROMAGNETIC FIELD SENSORS			Measurement and Mapping of Sub-surface layering (Beneath Ice)	Snow and Ice Surveys	Sea Ice and Ocean Current Mapping	Snow and Ice Measurements
MULTI-SPECTRAL TECHNIQUES	Crop Identification and Disease Patterns	Vegetation Identification and Disease Patterns	Soil Types and Composition Geologic Surface Conditions Landform	Soil Moisture Content Gullies Drainage Pattern	Sea Color Indicating Living Organisms	Urban and Rural Land Use Patterns Terrain and Veg Characteristics

Table G.1
Applications of Data Acquisition Techniques & Sources

TABLE G.2

THE RELATIVE EFFECTIVENESS OF DATA SOURCES FOR VARIABLES TYPICALLY ENCOUNTERED IN LAND PLANNING DATA INVENTORIES.

NATURAL RESOURCES	FIELD SURVEYS	GEOPHYSICAL SURVEYS	LOCAL OR OTHER GOVERNMENTAL SURVEYS	U.S. GEOLOGIC SURVEY	SOIL CONSERVATION SERVICE	AERIAL B&W PANCHROMATIC	AERIAL INFRARED B&W PHO.	AERIAL COLOR PHOTOGRAPHY	AERIAL INFRARED COLOR PHO.	PHOTOMOSAICS	ULTRAVIOLET SENSORS	INFRARED IMAGERY (THERMAL)	RADAR (SLAR) IMAGERY	ELECTROMAGNETIC IMAGERY	MULTISPECTRAL IMAGERY
CLIMATE															
RAIN			3												
SNOW			3									3		3	
TEMPERATURE	2		2												
RADIATION	1		2									2			
FOG	1		2												
WIND	1		3												
FROST	1		2									1			
STORMS			3										2		
AIR DRAINAGE	1		2												
GEOLOGY															
BEDROCK OUTCROPS	1	1	1	1	1	2	1	2	2	0			2		2
BEDROCK TYPE	3	3	3	2	2	2	1	2	2	1			3		2
UNIQUE FORMATIONS	3	3	3	3	3	2	1	2	2	1			3		2
STABLE FORMATIONS	3	3	3	3	3	2	1	2	2	1			3		2
DEPTH TO BEDROCK	3	3	1	1	3	2	1	2	2	1			0		2
BUILDING MATERIALS															
STRUCTURAL TYPE															
STRUCTURAL AGE	3	3	3	3	2	1	1	1	1	0			1		
WEATHERING TYPE															
VOLCANIC ACTIVITY	1	3	1	2	1							3			
ECONOMIC MINERALS	1	3	1	2	1	1	1	1	1	1	2		1		1
LANDFORMS-TYPE	2	2	1	2	2	3	2	3	2	1			2		3
UNIQUE FEATURES															
SOILS															
SOIL TYPE	3	3	1		3	2	2	3	2	1			1		3
SOIL TEXTURE	3	3	1		3	2	2	3	2	1			1		3
SOIL DEPTH	3	3	1		2	2	2	2	2	0			1		2
INTERNAL DRAINAGE	3	1	1		3	2	2	3	2	1					2
ERODABILITY	2	1	2		3	2	2	3	2						2
BEARING CAPACITY		3	2		3	1	1	1	1						1
PERMEABILITY	2	3	2		3	1	1	1	1						1
INSTABILITY	1	3	2		3	1	1	2	1						2
STONINESS	3	3	2		3	1	1	1	1						1
PRODUCTIVITY	1		2		3	1	1	1	1						1

NATURAL RESOURCES (CONTD)	FIELD SURVEYS	GEOPHYSICAL SURVEYS	LOCAL OR OTHER GOVERNMENTAL SURVEYS	U.S. GEOLOGIC SURVEY	SOIL CONSERVATION SERVICE	AERIAL B&W PANCHROMATIC	AERIAL INFRARED B&W PHO.	AERIAL COLOR PHOTOGRAPHY	AERIAL INFRARED COLOR PHO.	PHOTOMOSAICS	ULTRAVIOLET SENSORS	INFRARED IMAGERY (THERMAL)	RADAR (SLAR) IMAGERY	ELECTROMAGNETIC IMAGERY	MULTISPECTRAL IMAGERY
TOPOGRAPHY															
ELEVATION	1		1	3		3	3	3	3						3
EXCESSIVE TO UTILITIES															
RAVINES	2		1	2	1	3	3	3	3	1		1	1		3
SLOPES	2		1	3	1	2	2	2	2				1		2
RIM OF SLOPE	1			3		3	3	3	3				1		3
RELIEF VARIATION	2			3		3	3	3	3			2	2		3
ORIENTATION	1			3		3	3	3	3			3	2		3
WATER															
WATERSHEDS	1	1	1	3	1	3	3	3	3	3		3	3		3
DRAINAGE PATTERNS	1	1	1	3	1	3	3	3	3	3		3	3		3
GROUND WATER	1	3	3	3	2	2	2	2	2	1		1	1	1	2
AQUIFERS	1	3	3	3	3	1	1	1	1	1		1	1	1	1
LAKES	3		3	3	3	3	3	3	3	3		3	3		3
RIVERS-STREAMS	3		3	3	3	3	3	3	3	3		2	2		3
WETLANDS	3		3	3	3	3	3	3	3	2		2	2		3
SPRINGS	3	3	3	3	3	2	2	2	2	0		3	0		2
WATERFALLS	3		3	3	3	2	2	2	2	0		1	0		2
FLOODS (POTENTIAL)			3	1	1										
WATER QUANTITY	3	3	3	3		2	2	2	2	0		1	1	1	2
WATER QUALITY	3	3	3			2	2	2	2	0	1				3
WATER TEMPERATURE	3	3	3									3			
DIS. & SUS. SOLIDS	3	3	3			2	2	2	2	0					2
BIOLOGIC PRODUCTIVITY	3	3	3			1	1	1	1	0					2
SHORELINE TYPE (USE)	3		2	1		2	2	3	2	1			1		3
SHORELINE QUALITY	3		1			2	2	3	2	0					3
VEGETATION															
VEGETATION TYPE	3		3		3	2	2	3	2	1		1			3
VEGETATION QUALITY	3		3		3	2	2	3	3	0		1			3
SPECIMAN STANDS	3		3		3	2	2	3	3	0					3
SHORE & BANK COMM.	3		3		3	3	3	3	3	1					3
FIELDS	3		3	1	3	3	3	3	3	3		1	2		3
FOREST AREAS	3		3	3	3	3	3	3	3	3		1	1		3
NATURAL ASSOCIATIONS	3		3		3	1	1	1	1	0					2
UNDERSTORY	3		3		3	1	1	3	2	0		1			3
OVERSTORY	3		3	1	3	2	2	3	2	0		0			3

NATURAL RESOURCES (CONTD)	FIELD SURVEYS	GEOPHYSICAL SURVEYS	LOCAL OR OTHER GOVERNMENTAL SURVEYS	U.S. GEOLOGIC SURVEY	SOIL CONSERVATION SERVICE	AERIAL B&W PANCHROMATIC	AERIAL INFRARED B&W PHO.	AERIAL COLOR PHOTOGRAPHY	AERIAL INFRARED COLOR PHO.	PHOTOMOSAICS	ULTRAVIOLET SENSORS	INFRARED IMAGERY (THERMAL)	RADAR (SLAR) IMAGERY	ELECTROMAGNETIC IMAGERY	MULTISPECTRAL IMAGERY
WILDLIFE															
WILDLIFE TYPE	3		3		3	1	1	1	1	1					2
WILDLIFE QUANTITY	3		3		3	1	1	1	1	0					2
PRIME HABITAT	3		3		3	1	1	1	1	0					2
MAJOR ECOTONES	3		3		3										
UNIQUENESS	3		3		3										
QUALITY & PRODUCTION	3		3		3										
WILDERNESS	3		3		3	3	2	3	2	1					3
LAND USE															
AGRICULTURE TYPE	3		3		3	2	2	3	2	1		1	2		3
AGRICULTURE QUALITY	3		3		3	1	1	3	3	0		3			3
RECREATION & OPEN SPACE TYPE	3		3	1	2	2	2	3	2	1					3
RECREATION FACILITIES	3		3	1	3	3	2	3	2	0					3
TOURIST FACILITIES	3		3	1	2	2	2	2	2	0					2
FACILITY STANDARDS			3												
DEMAND STANDARDS			3												
DEMAND FACTORS			3												
WATER REC. FACILITIES	3		3	1	2	2	2	2	2	0					2
URBANIZATION PATTERN (GEN.)	1		3	3	2	3	2	3	3	2		2	2		3
RESIDENTIAL TYPE	3		3			3	3	3	3	1		1	1		3
RESIDENTIAL QUALITY	3		1			2	2	3	3	0					3
RESIDENTIAL DENSITY	3		3			3	3	3	3	1			1		3
RESIDENTIAL GROWTH	1		3			2	2	2	2	1					2
RESIDENTIAL AGE	3		3			2	2	2	2	1					2
COMMERCE TYPE	3		3			3	3	3	3	2		1	1		3
INDUSTRY TYPE	3		3			3	3	3	3	2		1	1		3
INSTITUTIONS & SERVICES	3		3	2		3	3	3	3	1					3
UTILITIES	3		3	2		3	3	3	3	1					3
AIR TRANSPORT	3		3	3		3	3	3	3	3			1		3
RAIL TRANSPORT	3		3	3		3	3	3	3	2					3
WATER TRANSPORT	3		3	1		3	3	3	3	1					3
ROAD TYPE	3		3	3		2	2	3	2	1					3
SCENIC HIGHWAYS	3		3	1		2	2	3	2	1					3
PROPOSED HIGHWAYS			3	1											
ACCESSIBILITY	1		3	1		2	2	2	2	1					2
ENVIRONMENTAL HAZARDS	3		3			2	2	3	2	1					3

NATURAL RESOURCES (CONTD)	FIELD SURVEYS	GEOPHYSICAL SURVEYS	LOCAL OR OTHER GOVERNMENTAL SURVEYS	U.S. GEOLOGIC SURVEY	SOIL CONSERVATION SERVICE	AERIAL B&W PANCHROMATIC	AERIAL INFRARED B&W PHO.	AERIAL COLOR PHOTOGRAPHY	AERIAL INFRARED COLOR PHO.	PHOTOMOSAICS	ULTRAVIOLET SENSORS	INFRARED IMAGERY (THERMAL)	RADAR (SLAR) IMAGERY	ELECTROMAGNETIC IMAGERY	MULTISPECTRAL IMAGERY
LAND USE (CONTD)															
HISTORICAL & CULTURAL	3		3	1		2	2	2	2	0					0
VISUAL CHARACTER	3					2	2	3	2	1		1	2		3
LAND COSTS			3			1	1	1	1	1			1		1
POPULATION CHAR.	1		3			1	1	1	1	1			1		1
SOCIO-ECONOMIC CHAR.	1		3			1	1	1	1	1			1		1

KEY

3 = EXCELLENT CAPABILITY (BEST SINGLE SOURCE)
2 = GOOD BUT NEEDS SUPPORTING INFORMATION
1 = LIMITED USE AND NEEDS OTHER SOURCES
0 = RESOLUTION SCALE OF LIMITED VALUE
BLANK = NOT APPLICABLE

This table is based upon a variety of resource check lists (101.22) and should not be taken as a model for the classification of resource variables. The evaluations on this table reflect the opinion of Douglas Way as of January, 1970. As in all technical systems, the capabilities are subject to change.

use. Local data sources such as Soil Conservation Service field agents and Weather Bureau stations are able to supply accurately most of the general data providing accuracy checks on interpretation.

To make final selections of data sources and sensors, each specific planning project has to be examined carefully. The site location, its size, the amount, relevance and accuracy of existing information, the detail of information and accuracy needed, the schedule and budget, and the analytic flexibility required are some of the major factors that influence the final form of data acquisition.

6. DATA ON DEMAND FACTORS

A resource information system typically concentrates on the recording and analysis of the supply of resources. This analysis will always be of limited usefulness if there is no information on the potential demand for the resource supply. In general it is the case that a great deal of data exists on demand factors at both the local and national levels. As much as is appropriate and possible these sources of data on demand should be incorporated and utilized. These data would include the range of information available in the U.S. Census, such as basic demographic, economic, and social data. A data system for planning purposes also should include a property file for the area served by the data bank, containing data relating to individual parcels of property. Local government and private sources such as gas, electric, transportation and telecommunication companies are valuable sources of these demand data.

The development of resource information systems is usually carried out by persons with little experience and few skills in the handling of demand data. As such it would appear to be imperative that a resource system should rely on demand data which have been collected by other agencies. As this required no investment in data collection, the cost that is involved with the conversion of other agencies' data files to a set of spatial descriptions that are compatible with the resource information will amply repay the effort.

APPENDIX H: PROFESSIONAL JUDGMENT "A" PLANS

Appendix H presents the initial plans made by several members of the research team as part of the first plan-making exercise. For each of the plans, a table is presented which describes the initial site criteria which form the basic design concept of the proposal. This is followed by maps of the summer and winter plans, and maps and tables which evaluate the proposal via the simulation model. For two of the plans, Steinitz "A" and Toth "A", the simulation model was run under demands varying from N=1000 through N=3000. For both of these plans the capacity of the site, the point at which the summary evaluations underwent major change, was around N=3000.

The following plans and evaluations are presented:

H.A Steinitz "A"
H.B Toth "A"
H.C Way "A"
H.D Peacock "A"

TABLE H.1

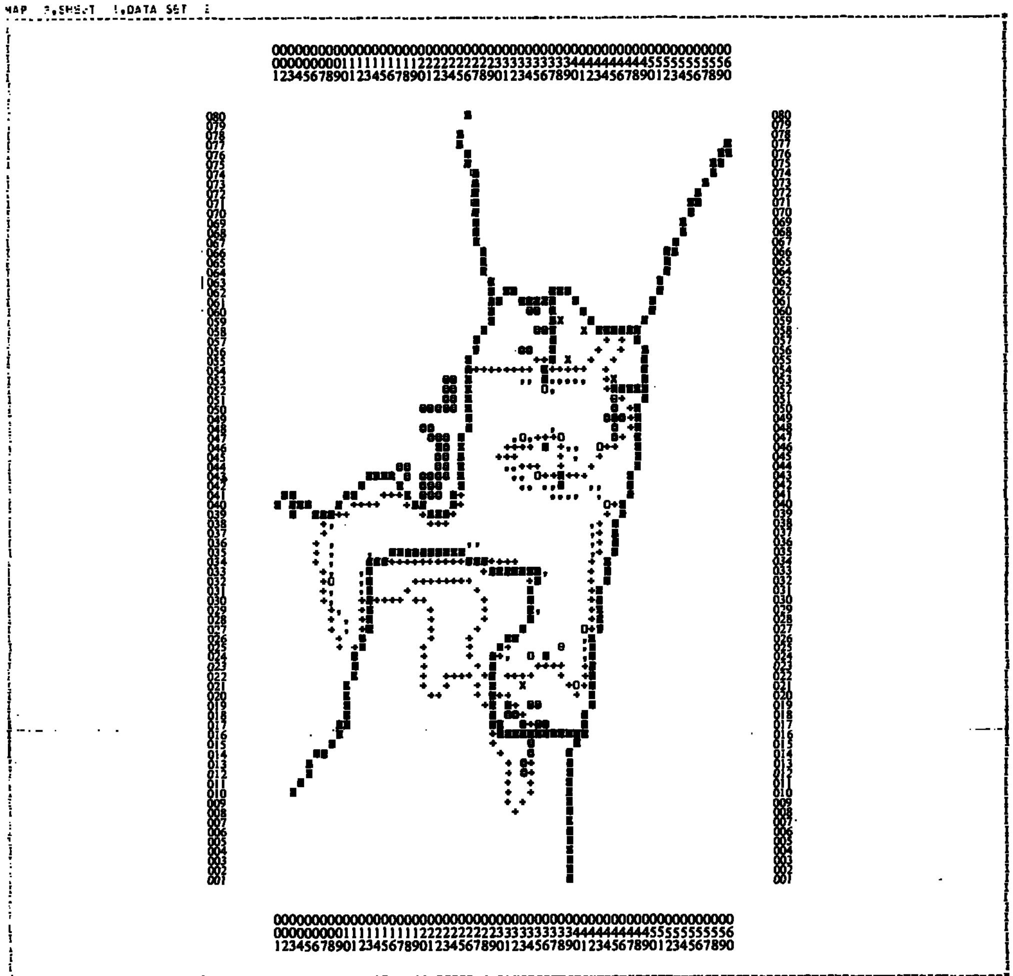
PROFESSIONAL JUDGMENT PLANS
INITIAL SITE CRITERIA: STEINITZ

Activity	Criteria
1. Summer	
1.1 Hunting	May ban or limit to outside areas
1.2 Fishing	All over but limit access
1.3 Swimming	Near town, near shops, near parking, near camping
1.4 Hiking trails	Variation in views - sloping and flat topo
1.5 Camping	2 types, crowded and isolated
1.6 Picnicking	Quiet areas, water view, near fishing, road access, trees
1.7 Waterskiing	Zones in an active area
1.8 Residential	
1.8.1 Water View Lots	Water view, access, utilities, trees, SE-SW orientation
1.8.2 Wood View Lots	Trees, utilities, access, SE-SW orientation
1.8.3 Farmsteads	Trees, water view, SE-SW slopes, access, utilities
1.8.4 Condominium	Trees, water view, SE-SW slopes, access, utilities
2. Winter	
2.5 Snowmobiles	Ban in area

TABLE H.1
(Continued)

	Activity	Criteria
2.6	Downhill skiing	SW slope, steepness but varied
2.7	Ice skating	Near town and all over

MAP 2, SHEET 1, DATA SET 1



PLAN A - SUMMER

PROFESSIONAL JUDGEMENT - STEINITZ

HENRY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

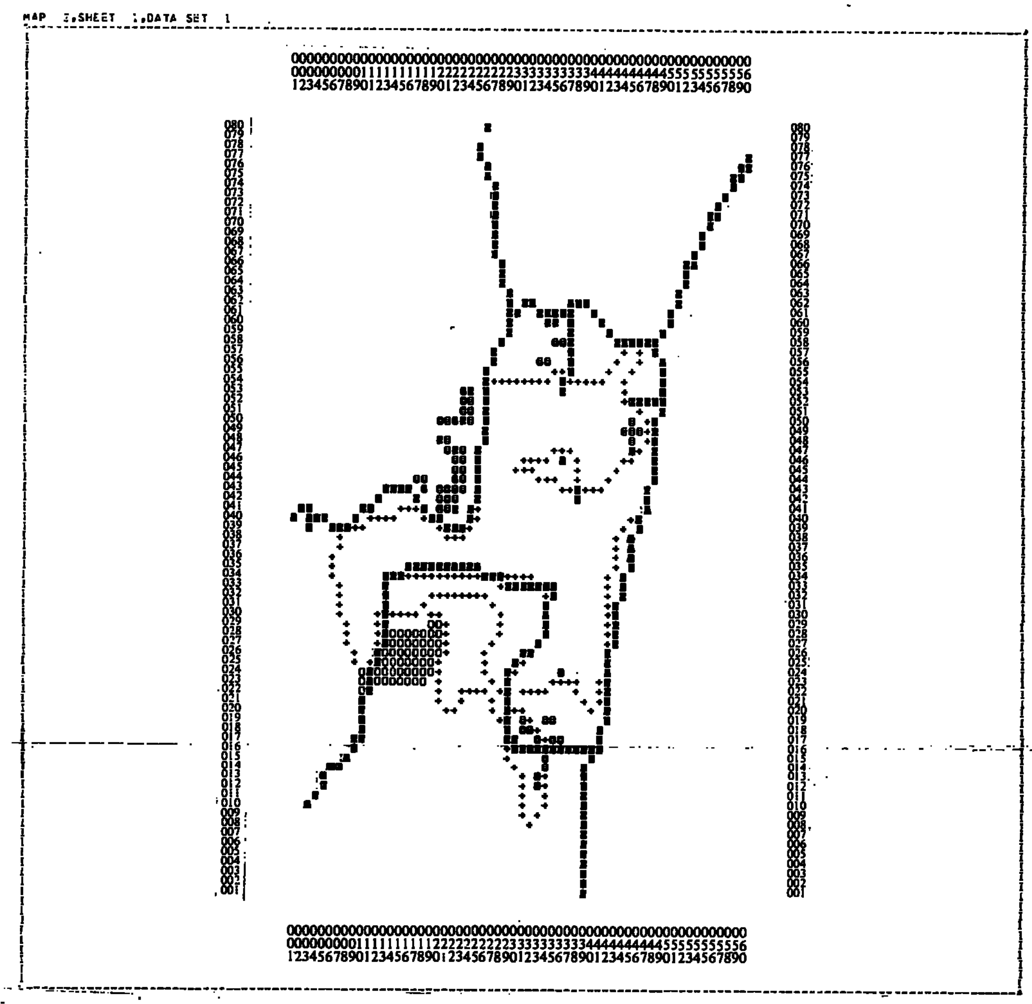
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS					++++++++	XXXXXXXX	OOOOOOOO					
FREQUENCY	3785	4	18	18	199	5	10	2	59	5	254	0

Fig. H.1.1
Steinitz "A" - Summer Plan



PLAN A. - WINTER

PROFESSIONAL JUDGEMENT - STEINITZ

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

	1	2	3	4	5	6	7	8	9	10
MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

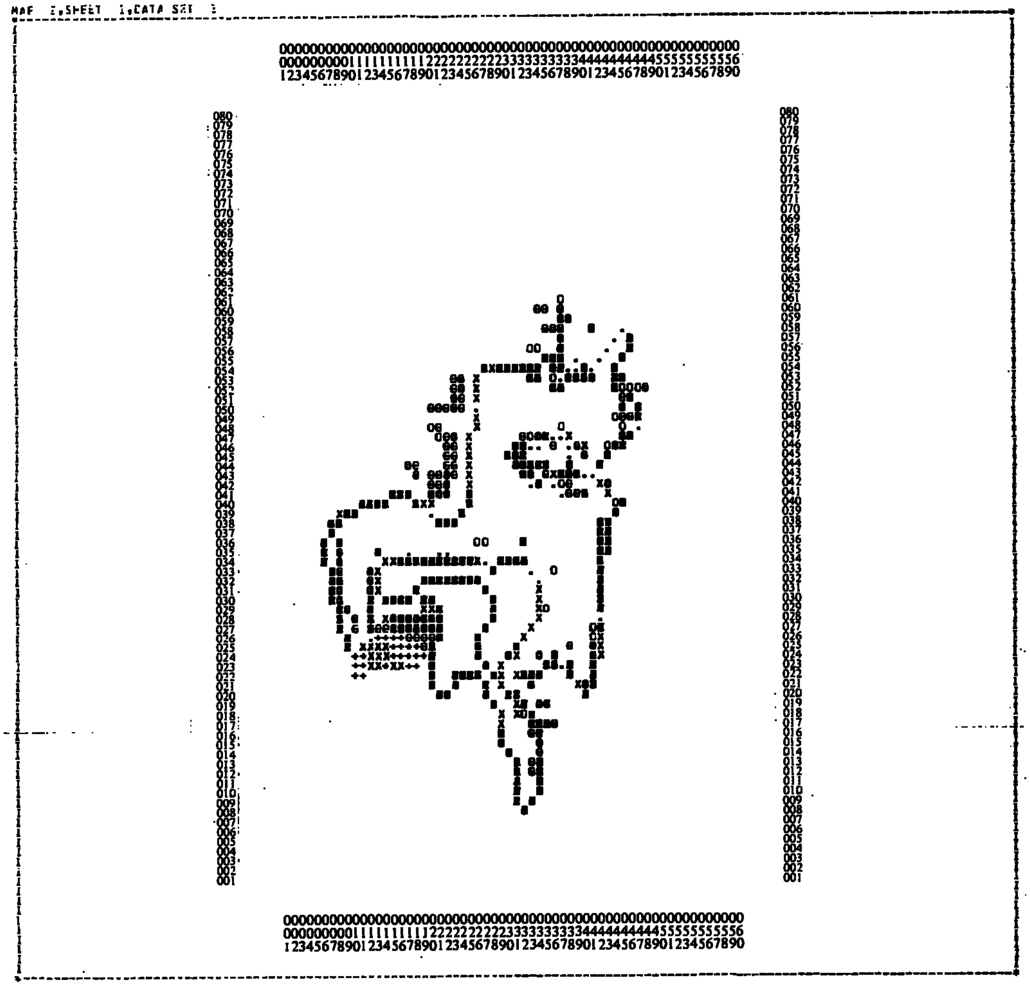
1	2	3	4	5	6	7	8	9	10
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	:::::::::	+++++++++	XXXXXXXXX	000000000	888888888	[illegible]	[illegible]	[illegible]	
FREQUENCY	3EC9	0	0	0	199	0	49	0	55	5	254	0

Fig. H.1.2
Steinitz "A" - Winter Plan

MAP 1, SHEET 1, DATA SET 3



ATTRACTIVENESS EVALUATION - PLAN A

PROFESSIONAL JUDGEMENT - STEINITZ

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

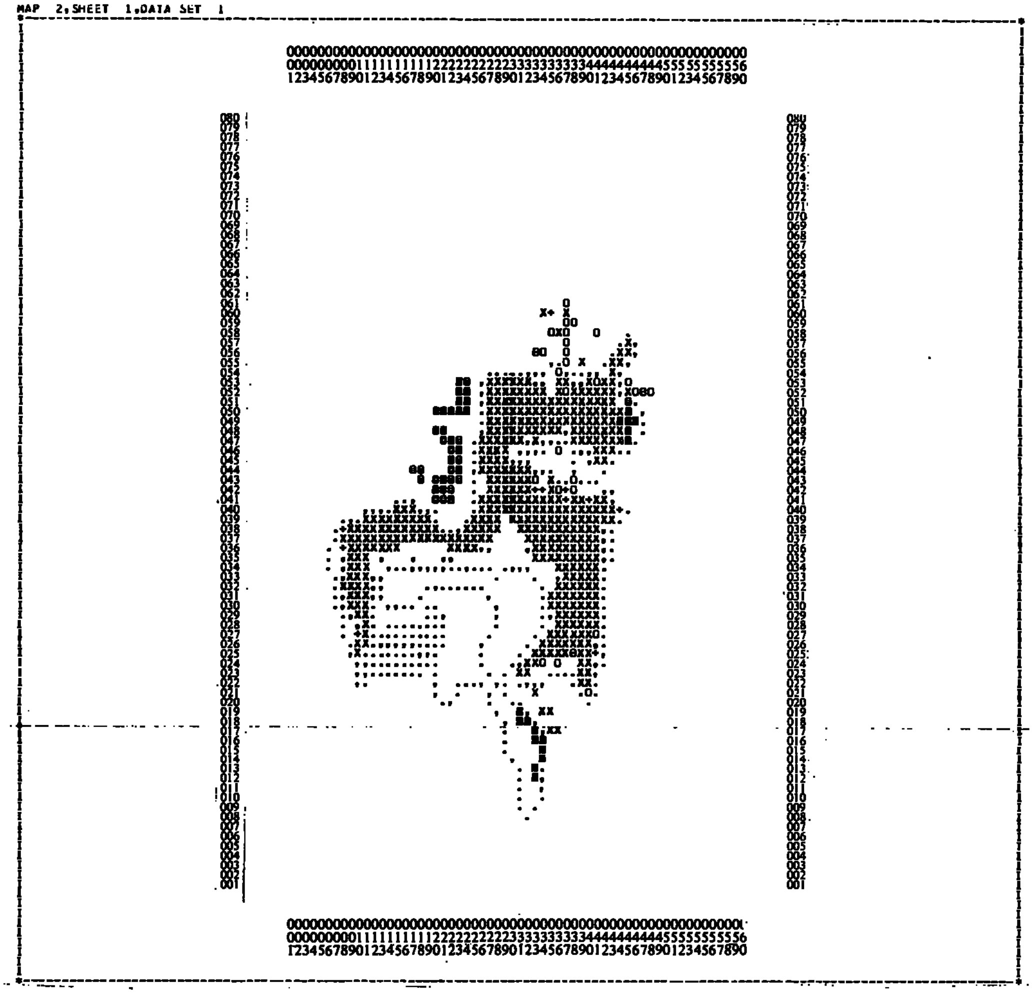
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	'	•	+	X	0	@			
FREQUENCY	32	0	0	22	59	23	47	41	46	176

Fig. H.1.3
Steinitz "A" - Attractiveness Evaluation

MAP 2, SHEET 1, DATA SET 1



EVALUATION OF PLAN A - STEINITZ

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
10
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 24.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	2.00	4.20	6.40	8.60	10.80	13.00	15.20	17.40	19.60	21.80
MAXIMUM	4.20	6.40	8.60	10.00	13.00	15.20	17.40	19.60	21.80	24.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

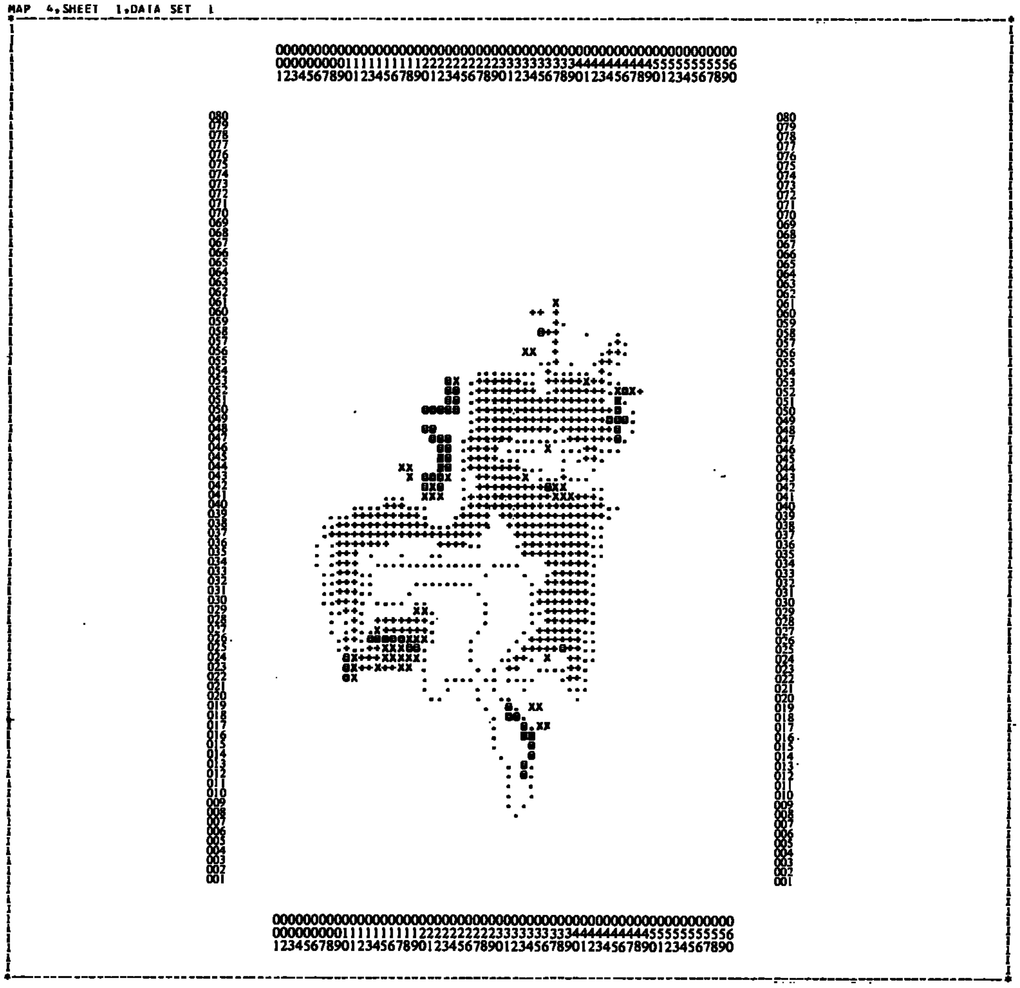
10.00	10.80	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	....	'''''''''	,,,,,,,,,	+++++++++	XXXXXXXXX	OOOOOOOOO	888888888	888888888	■■■■■■■■■	■■■■■■■■■
FREQUENCY	202	99	30	11	400	25	3	17	20	15

Fig. H.1.4
Steinitz "A" - Total Impact

MAP 4, SHEET 1, DATA SET 1



PLAN A - IMPACT ON SURFACE WATER SYSTEM

PROFESSIONAL JUDGEMENT - STEINITZ

HONEY HILL CASE STUDY

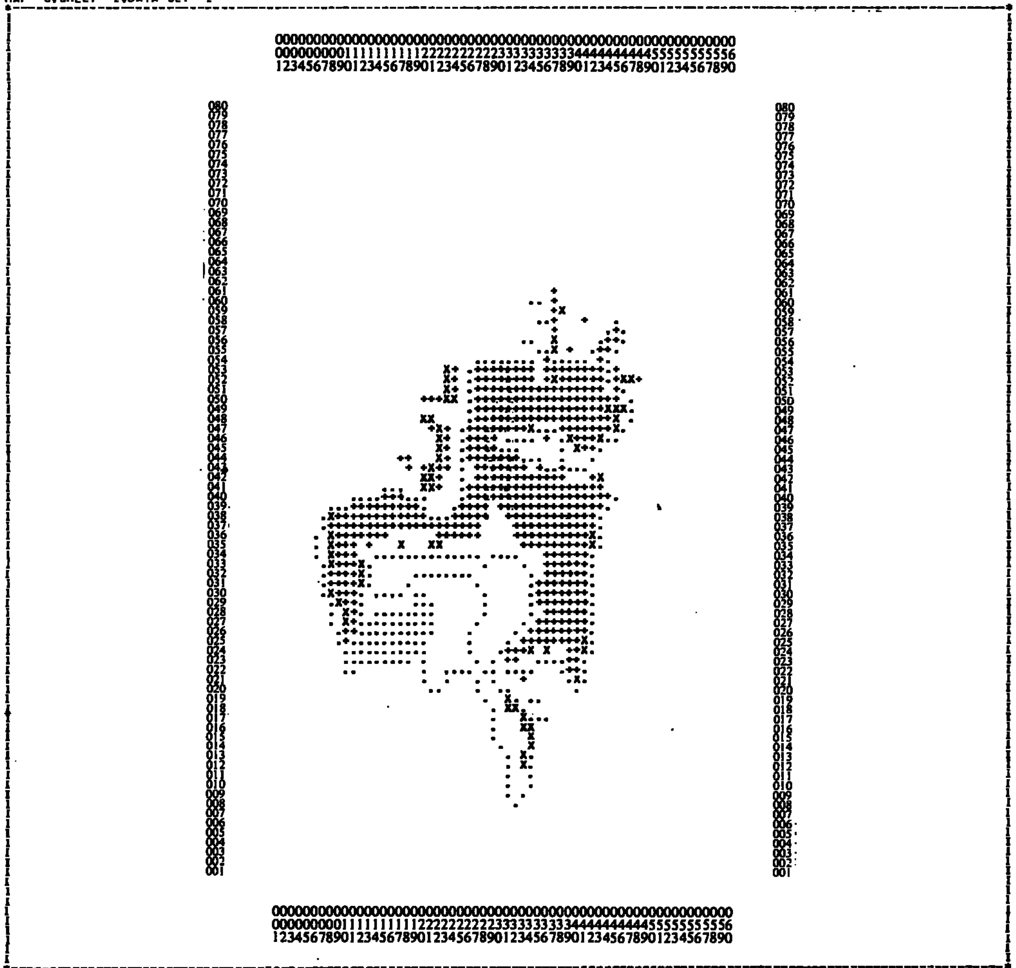
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXX	@@@@@@@@	■■■■■■■■
FREQUENCY	296	430	47	52	5

Fig. H.1.5
Steinitz "A" - Impact on Surface Water System

MAP 6.SHEET 1.DATA SET 1



PLAN A - IMPACT ON WILDLIFE HABITAT

PROFESSIONAL JUDGEMENT - STEINITZ

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	++++++++	XXXXXXXX		
FREQUENCY	302	464	64	0	0

Fig. H.1.6
Steinitz "A" - Impact on Wildlife Habitat

Steinitz "A"
Table H.1.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	218.0
3	14.0	0.0	0.0	0.0
4	0.0	0.0	0.0	215.0
5	0.0	0.0	0.0	4.0
6	0.0	0.0	0.0	10.0
7	0.0	0.0	0.0	2.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	14.0	0.0	0.0	449.0

Steinitz "A"
Table H.1.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	1604.1	19.8
3	12080.8	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	1007.8	7.1
5	0.0	0.0	0.0	240.0	81.9
6	0.0	0.0	0.0	1500.0	435.9
7	0.0	0.0	0.0	600.0	975.6
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	12080.8	0.0	0.0	4951.9	1520.3

Steinitz "A"
Table H.1.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	11581.6	31965.1
3	27785.8	76688.7
4	7276.4	20082.9
5	1392.0	2756.2
6	8700.0	17226.0
7	4332.0	11956.3
8	0.0	0.0
9	0.0	0.0
TOTAL	61067.7	160674.9

Steinitz "A"
Table H.1.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	230.0	20.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	215.0
5	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	52.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	230.0	20.0	0.0	267.0

Steinitz "A"
Table H.1.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	901.8	117.6	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	1007.8	14.4
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	5589.5	38.5
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	901.8	117.6	0.0	6597.3	52.9

Steinitz "A"
Table H.1.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	5912.4	11706.5
3	0.0	0.0
4	7276.4	20082.9
5	0.0	0.0
6	94853.1	261794.4
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	108041.8	293583.8

Steinitz "A"
Table H.1.7: Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	0	0.0
2	38	0.0
3	18	66.11
4	199	89.20
5	5	64.80
6	10	70.00
7	2	81.00
8	59	68.00
9	5	68.00
10	254	3.51
TOTAL	590	43.00

WINTER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
11	0	0.0
12	0	0.0
13	0	0.0
14	199	89.20
15	0	0.0
16	49	53.45
17	0	0.0
18	59	68.00
19	5	68.00
20	254	3.51
TOTAL	566	45.25

Steinitz "A"
Table H.1.8: Plan Impact

TOTAL IMPACT = 7809.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	252	34	89	236	28	1.615
2	296	291	47	5	0	0.626
3	255	300	84	0	0	0.732
4	248	228	154	9	0	0.881
5	286	60	289	3	1	1.019
6	54	127	226	232	0	1.995
7	248	7	126	251	7	1.628
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	49	69	300	42	179	2.365
11	255	69	156	148	11	1.360
TOTAL	1943	1185	1471	926	226	1.358

Steinitz "A"
Table H.1.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	381 15	0 0
4	39 80	39 80
5	125 00	0 0
6	43 75	392 00
7	12 00	0 0
8	17700 00	17700 00
9	196 63	196 63
10	518 16	518 16
TOTAL	19016048	18846058

TABLE H.1.10

STEINITZ "A": INITIAL PLAN: SUMMARY UNDER DEMANDS N=1000 THROUGH N=3000

	N=1000	N=1500	N=2000	N=2500	N=3000
1. **Summer Plan**					
Attractiveness (mean mean)	43.00	43.00	43.00	43.00	43.00
Impact (mean mean)	1.358	1.358	1.358	1.358	1.358
No. of people crowded	0	0	267	2,987	4,952
No. of people turned away	0	0	0	9	1,520
$ local income	22,616	33,924	45,232	56,087	61,068
$ regional income	55,847	83,770	111,694	138,443	160,675
$ capital cost	19,016,048	19,016,048	19,016,048	19,017,048	19,016,048
$ capital cost w/o res.	1,316,048	1,316,048	1,316,048	1,316,048	1,316,048
2. **Winter Plan**					
Attractiveness (mean mean)	45.25	45.25	45.25	45.25	45.25
Impact (mean mean)	1.358	1.358	1.358	1.358	1.358
No. of people crowded	0	0	0	0	6,597
No. of people turned away	0	0	0	0	53
$ local income	48,141	72,212	96,282	120,353	108,042
$ regional income	131,348	197,023	262,697	328,371	293,589
$ capital cost	18,846,058	18,846,058	18,846,058	18,846,058	18,846,058
$ capital cost w/o res.	1,146,058	1,146,058	1,146,058	1,146,058	1,146,058

TABLE H.2

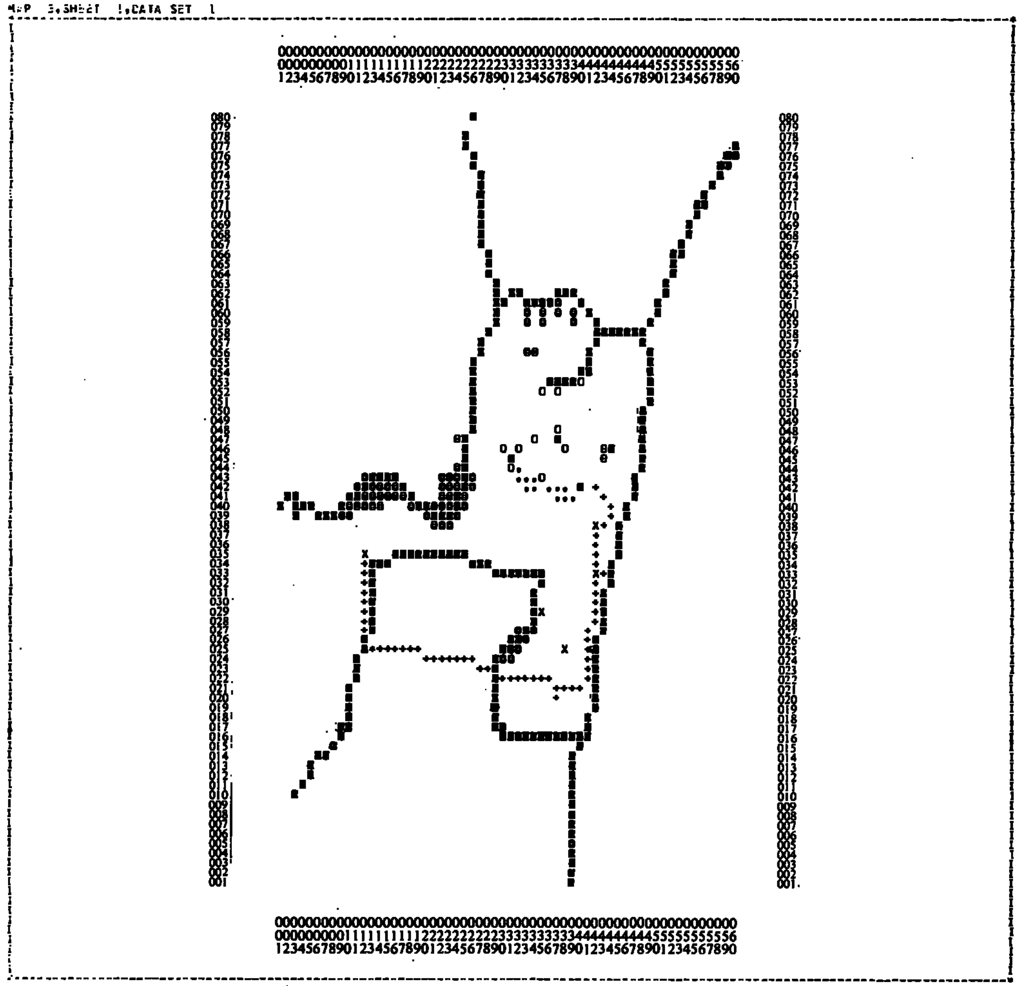
PROFESSIONAL JUDGMENT PLANS:
INITIAL SITE CRITERIA: TOTH

Activity		Criteria
1.	Summer	
1.1	Hunting	Isolation, topo variation, near farmsteads, near camp sites
1.2	Fishing	Near stream entrees, diverse shoreline (no waterskiing)
1.3	Swimming	S. orientation, dec. trees, 4% slope, near housing
1.4	Hiking Trails	High points and shoreline
1.5	Camping	Dec. trees, isolation from housing, 15% slope, water edge
1.6	Picnicking	Dec.-Con. mix, near water, access, isolation from farms and res., near swimming
1.7	Waterskiing	OK, not zoned
1.8	Residential	
1.8.1	Water View Lots	Dec. trees. 10' to rock, kame terraces, S-SE slopes, 8% slope, sand and gravel
1.8.2	Wood View Lots	Veg. enclosure, SE slope, 10' to rock, kame-sand-gravel, 8% slope
1.8.3	Farmsteads	Open fields, 8% slope, flood plain, lake view, screened from road
1.8.4	Condominium	Dec. trees, 10' rock, kame terraces, SE slope, sand-gravel, 8% slope

TABLE H.2
(Continued)

Activity	Criteria
2. Winter	
2.6 Downhill skiing	SE slope, near housing, access
2.7 Ice skating	All lake

MAP 3,SHEET 1,DATA SET 1



PLAN A - SUMMER

PROFESSIONAL JUDGEMENT - TOTH

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

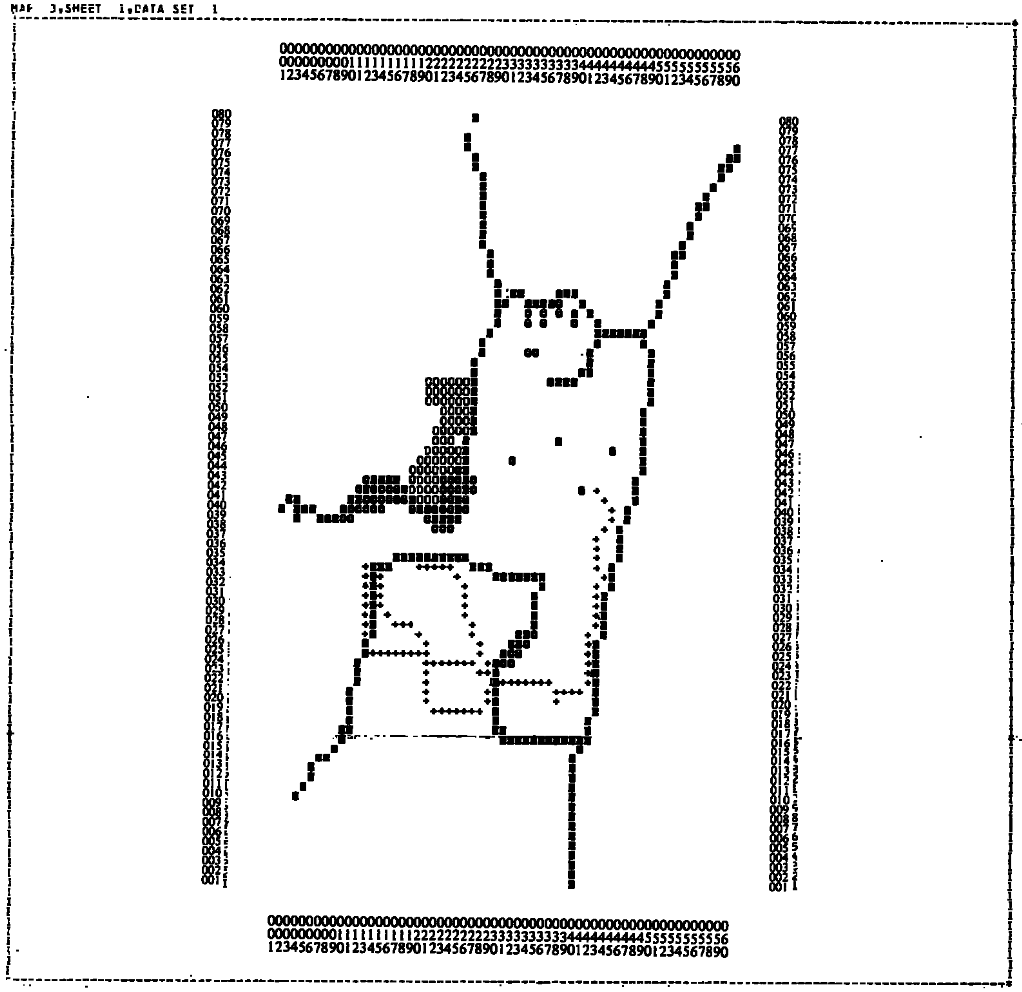
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	•••••••••	+++++++++	XXXXXXXX	000000000	888888888	[illegible]	[illegible]	[illegible]	
FREQUENCY	3974	0	0	12	57	5	10	3	58	5	251	0

Fig. H.2.1
Toth "A": Summer Plan

MAP 3,SHEET 1,DATA SET 1



PLAN A - WINTER

PROFESSIONAL JUDGEMENT - TOTH

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
A = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

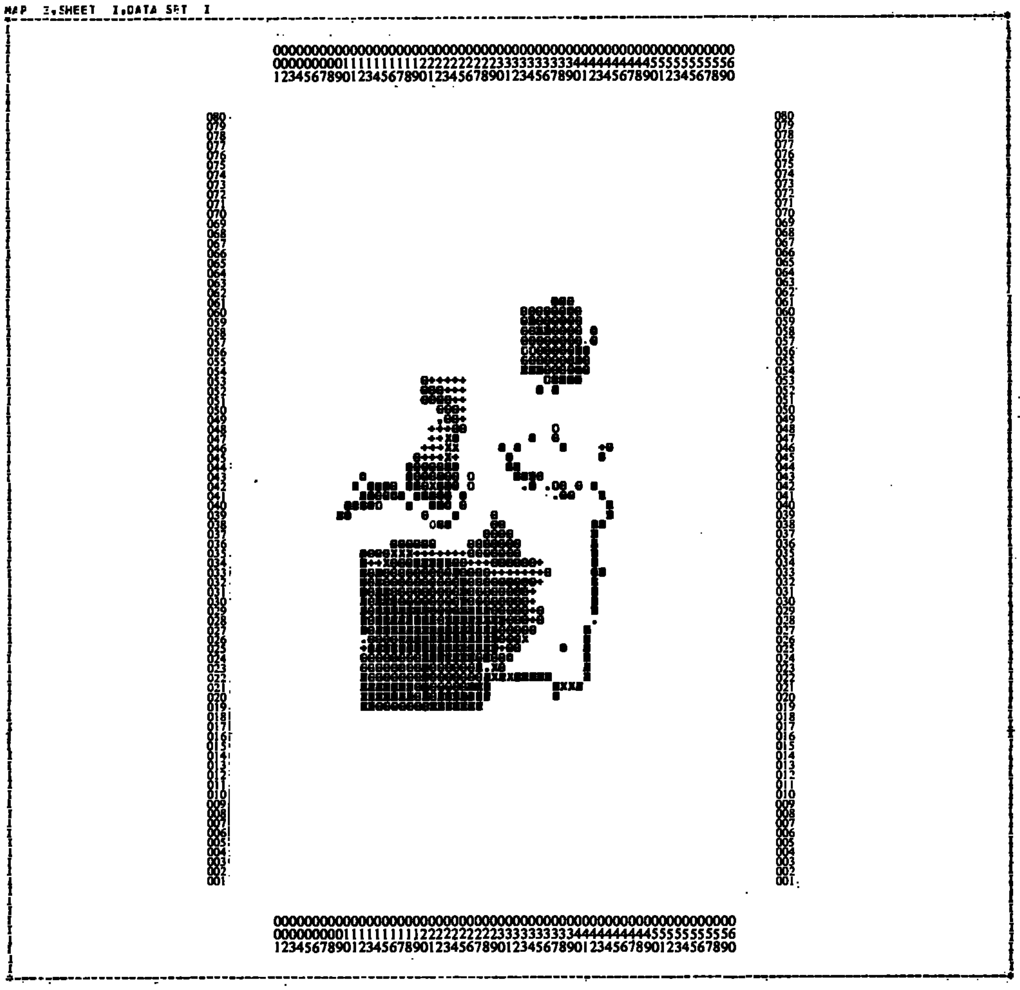
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.80	18.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	•••••••••	+++++++++	XXXXXXXXX	OOOOOOOOO	ØØØØØØØØØ	■■■■■■■■■	■■■■■■■■■	■■■■■■■■■	
FREQUENCY	3903	0	0	0	96	0	62	0	58	5	251	0

Fig. H.2.2
Toth "A": Winter Plan



ATTRACTIVENESS EVALUATION - PLAN A

PROFESSIONAL JUDGEMENT - TOTH

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

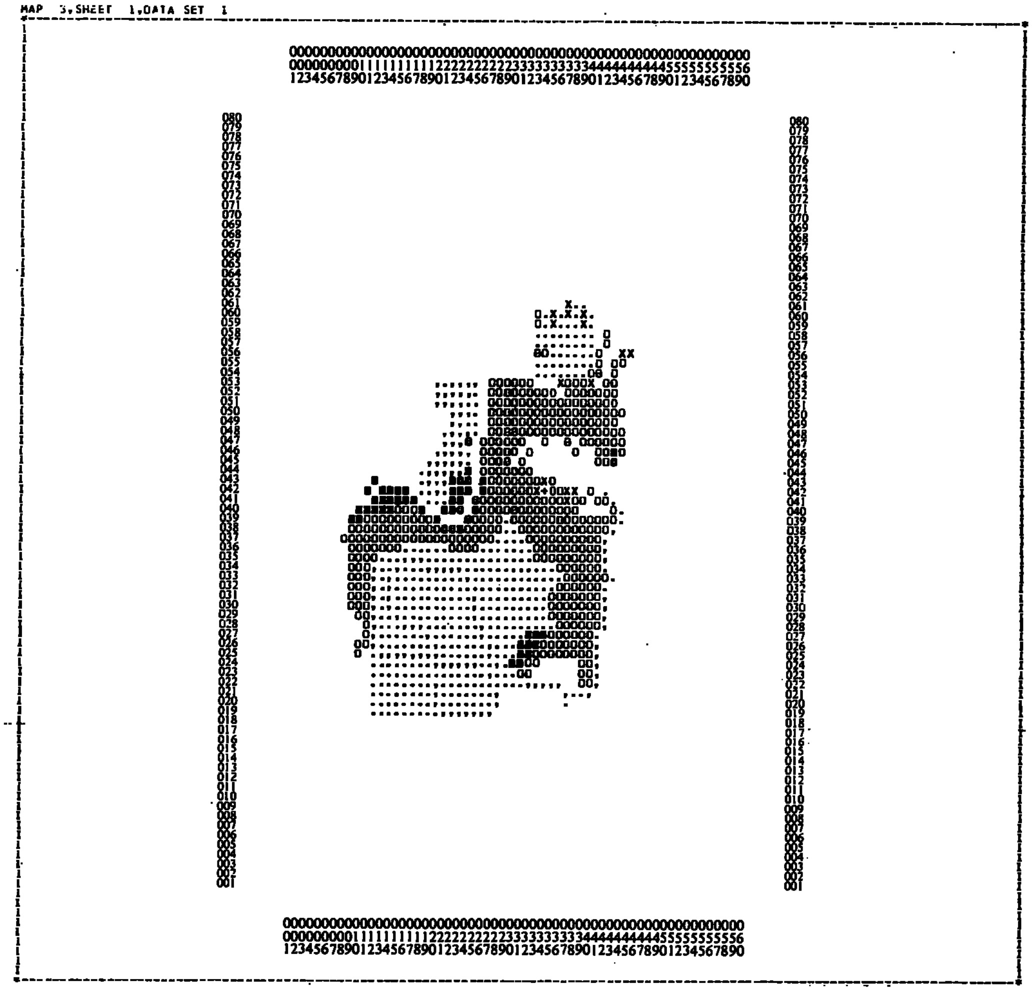
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS				++++	XXXX	0000				
FREQUENCY	6	1	0	52	15	9	286	25	39	184

Fig. H.2.3
Toth "A": Attractiveness Evaluation

MAP 3,SHEET 1,DATA SET 1



EVALUATION OF PLAN A - TOTH

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 1.00 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	1.00	3.20	5.40	7.60	9.80	12.00	14.20	16.40	18.60	20.80
MAXIMUM	3.20	5.40	7.60	9.80	12.00	14.20	16.40	18.60	20.00	23.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

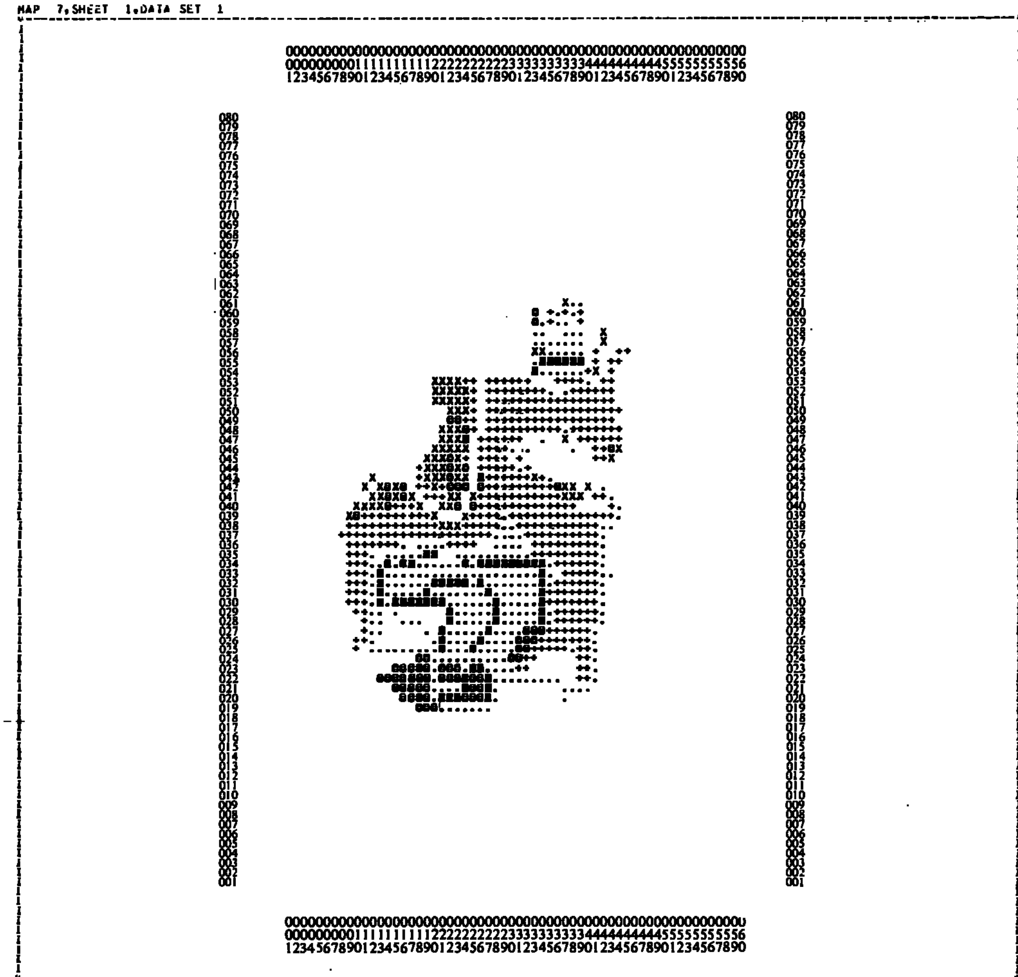
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.08

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	....	[illegible]	[illegible]	+++++++++	XXXXXXXXX	OOOOOOOOO	888888888	[illegible]	[illegible]	[illegible]
FREQUENCY	380	130	2	1	15	411	3	9	26	19

Fig. H.2.4
Toth "A": Total Impact

MAP 7, SHEET 1, DATA SET 1



PLAN A - IMPACT ON SURFACE WAIER SYSIEM

PROFESSIONAL JUDGEMENI - TOTH

HONEY HILL CASE STUDY

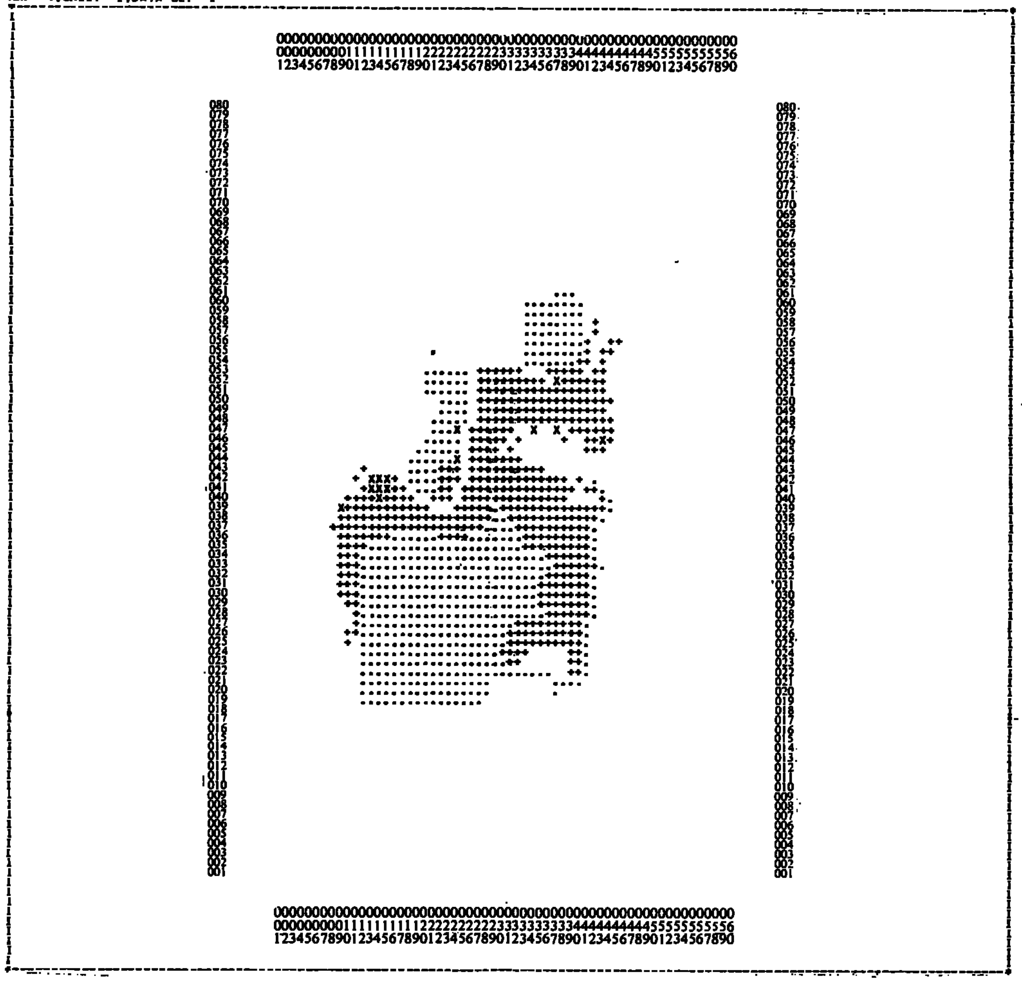
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXXX	●●●●●●●●●	■■■■■■■■■
FREQUENCY	292	414	82	72	7C

Fig. H.2.5
Toth "A": Impact on Surface Water System

MAP 9, SHEET 1, DATA SET 1



PLAN A - IMPACT ON WILDLIFE HABITAT

PROFESSIONAL JUDGEMENT - TOTH

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXX	[illegible]	[illegible]
FREQUENCY	522	460	14	0	0

Fig. H.2.6
Toth "A": Impact on Wildlife Habitat

Toth "A"
Table H.2.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	46.0	0.0	87.0	84.0
3	9.0	0.0	0.0	0.0
4	0.0	0.0	0.0	100.0
5	0.0	1.0	4.0	0.0
6	0.0	0.0	0.0	10.0
7	0.0	0.0	0.0	1.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	55.0	1.0	91.0	195.0

Toth "A"
Table H.2.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	315.4	0.0	1192.9	1575.0	8.7
3	12080.8	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	1171.9	12.3
5	0.0	96.9	470.7	0.0	0.0
6	0.0	0.0	0.0	3741.2	52.2
7	0.0	0.0	0.0	750.0	1546.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	12396.1	96.9	1663.6	7238.1	1619.2

Toth "A"
Table H.2.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	22260.8	61439.7
3	27785.8	76688.7
4	8460.9	23352.2
5	3292.3	6518.8
6	21698.9	42963.7
7	5415.0	14945.4
8	0.0	0.0
9	0.0	0.0
TOTAL	88913.6	225908.3

Toth "A"
Table H.2.4: "Winter N=3000"
No. cells/Activity/Crowding

ACT. #	C-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	246.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	100.0
5	0.0	0.0	0.0	0.0
6	30.0	24.0	8.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	276.0	24.0	8.0	100.0

Toth "A"
Table H.2.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	1019.4	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	1171.9	27.3
5	0.0	0.0	0.0	0.0	0.0
6	2641.3	3961.9	1650.8	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	3660.7	3961.9	1650.8	1171.9	27.3

Toth "A"
Table H.2.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	5912.4	11706.5
3	0.0	0.0
4	8460.9	23352.2
5	0.0	0.0
6	140069.8	386592.5
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	154443.1	421651.2

Toth "A"
Table H.2.7: Summary Attractiveness

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	0	0.0
2	0	0.0
3	12	60.83
4	96	96.35
5	5	73.60
6	10	84.00
7	3	33.33
8	58	72.33
9	5	70.00
10	251	3.55
TOTAL	440	38.01

WINTER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
11	0	0.0
12	0	0.0
13	0	0.0
14	96	96.35
15	0	0.0
16	62	53.32
17	0	0.0
18	58	72.33
19	5	70.00
20	251	3.55
TOTAL	472	38.12

Toth "A"
Table H.2.8: Plan Impact

TOTAL IMPACT = 7044.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	111	24	128	213	26	2.038
2	168	263	64	7	0	0.821
3	108	300	94	0	0	0.972
4	158	224	111	9	0	0.942
5	158	65	274	4	1	1.253
6	67	99	162	174	0	1.882
7	158	2	84	247	11	1.902
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	62	35	203	44	158	2.400
11	108	70	146	160	18	1.821
TOTAL	1098	1082	1266	858	214	1.559

Toth "A"
Table H.2.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	254 10	0 0
4	19 20	19 20
5	125 00	0 0
6	43 75	496 00
7	18 00	0 0
8	17400 00	17400 00
9	196 63	196 63
10	512 04	512 04
TOTAL	18568071	18623086

TABLE H.2.10

TOTH "A": INITIAL PLAN: SUMMARY UNDER DEMANDS N=1000 THROUGH N=3000

	N=1000	N=1500	N=2000	N=2500	N=3000
1. Summer Plan					
Attractiveness (mean mean)	38.01	38.01	38.01	38.01	38.01
Impact (mean mean)	1.559	1.559	1.559	1.559	1.559
No. of people crowded	0	0	0	0	7,238
No. of people turned away	0	0	0	0	1,619
$ local income	22,616	33,924	45,232	56,511	88,914
$ regional income	55,847	83,770	111,693	139,617	225,908
$ capital cost	18,568,071	18,568,071	18,568,071	18,568,071	18,568,071
$ capital cost w/o res.	1,168,071	1,168,071	1,168,071	1,168,071	1,168,071
2. Winter Plan					
Attractiveness (mean mean)	38.12	38.12	38.12	38.12	38.12
Impact (mean mean)	1.559	1.559	1.559	1.559	1.559
No. of people crowded	0	0	0	0	1,172
No. of people turned away	0	0	0	0	27
$ local income	48,141	72,212	96,282	120,352	154,443
$ regional income	131,348	197,023	262,697	328,370	421,651
$ capital cost	18,623,086	18,623,086	18,623,086	18,623,086	18,623,086
$ capital cost w/o res.	1,223,086	1,223,086	1,223,086	1,223,086	1,223,086

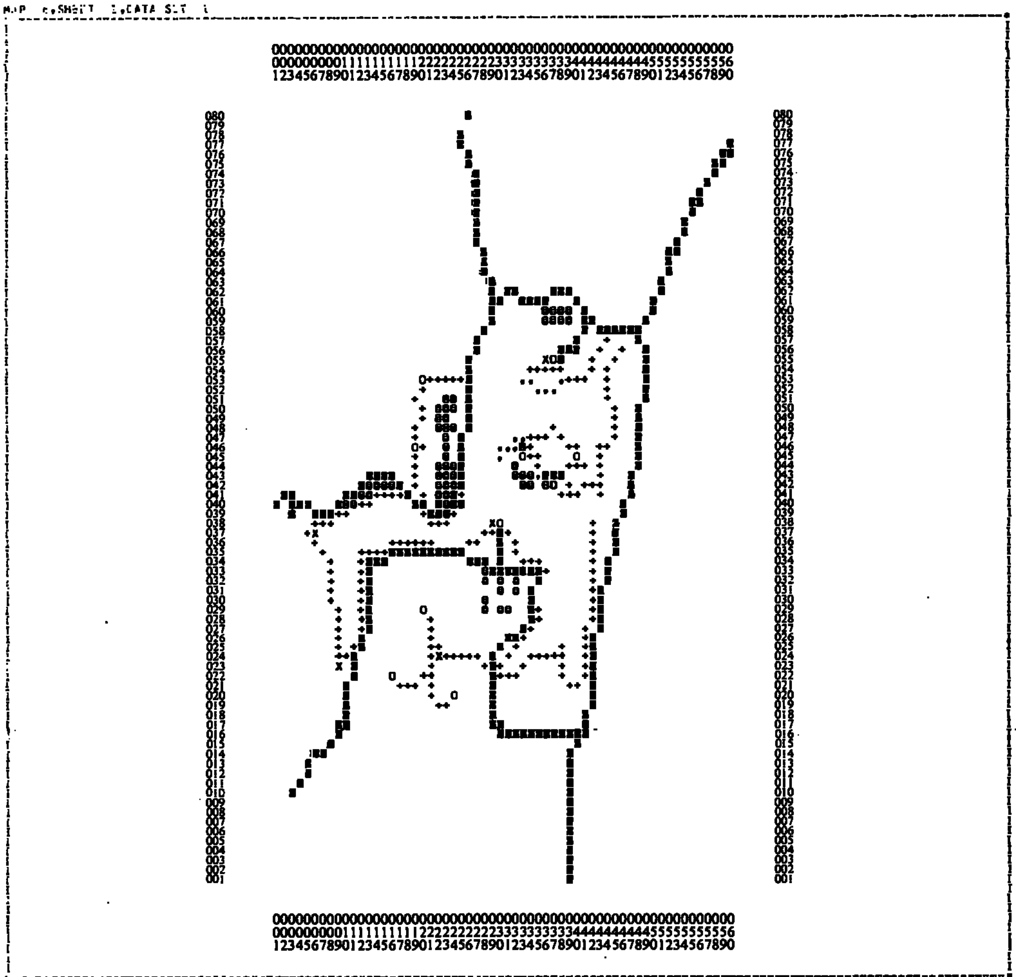
TABLE H.3

PROFESSIONAL JUDGMENT PLANS:
INITIAL SITE CRITERIA: WAY

Activity		Criteria
1. Summer		
1.1	Hunting	Follow state regulations
1.2	Fishing	Boat rental at condominium, fishing anywhere except swim areas
1.3	Swimming	Natural sandy areas, low sub-surface slope, S. orientation
1.4	Hiking trails	Links unique and prominent view areas and features - runs ridges and around lake
1.5	Camping	Unique features, many assoc. to water, provide diversity, views
1.6	Picnicking	Near unique features - coves, terraces, cliffs, providing diversity
1.7	Waterskiing	OK, not zoned
1.8	Residential	
1.8.1	Water View Lots	View to water, walking access, good septic soils, S-SE orientation, back from shore
1.8.2	Wood View Lots	Dense evergreens (internal char.), good septic soils, visually separate from lake, water table 5'
1.8.3	Farmsteads	Preserve open pastures, put structure above crest, 5' to water table, good septic soils

TABLE H.3
(Continued)

Activity		Criteria
1.8	Residential (Cont'd)	
	1.8.4 Condominium	Access to water, peninsula because of existing infra-structure, good septic tank
2.	Winter	
2.2	Snowshoeing	Anywhere
2.3	Cross-Country skiing	Follows upland trail system
2.5	Snowmobiles	Around lake only
2.6	Downhill skiing	NW-N-SW orientation, 400-700' drop, 25% slope
2.7	Ice skating	Anywhere - maintained at condominium and ski facility



PLAN A - SUMMER

PROFESSIONAL JUDGEMENT - WAY

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

D.T. MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

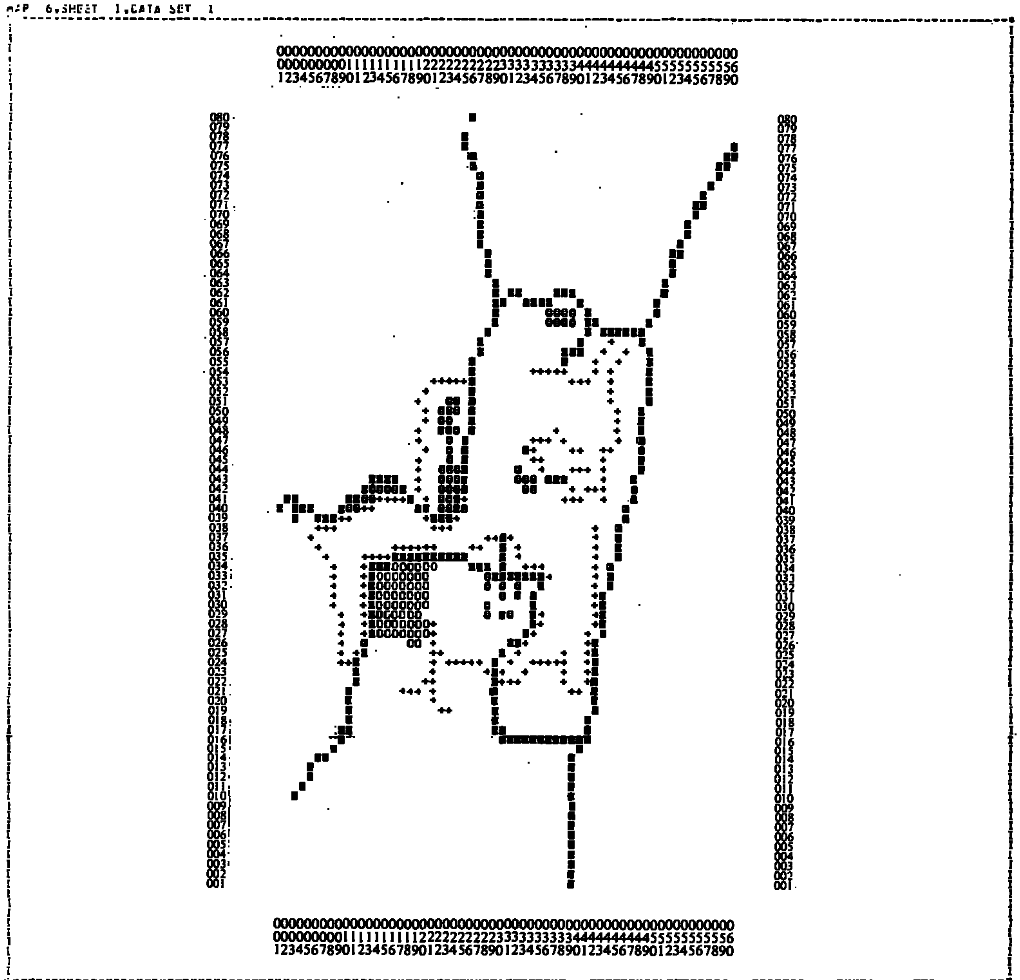
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	+++++++++	XXXXXXXXX	000000000	888888888					
FREQUENCY	3842	0	1	12	188	5	16	1	58	5	253	0

Fig. H.3.1
Way "A": Summer Plan

MAP 6,SHEET 1,DATA SET 1



PLAN A - WINTER

PROFESSIONAL JUDGEMENT - WAY

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

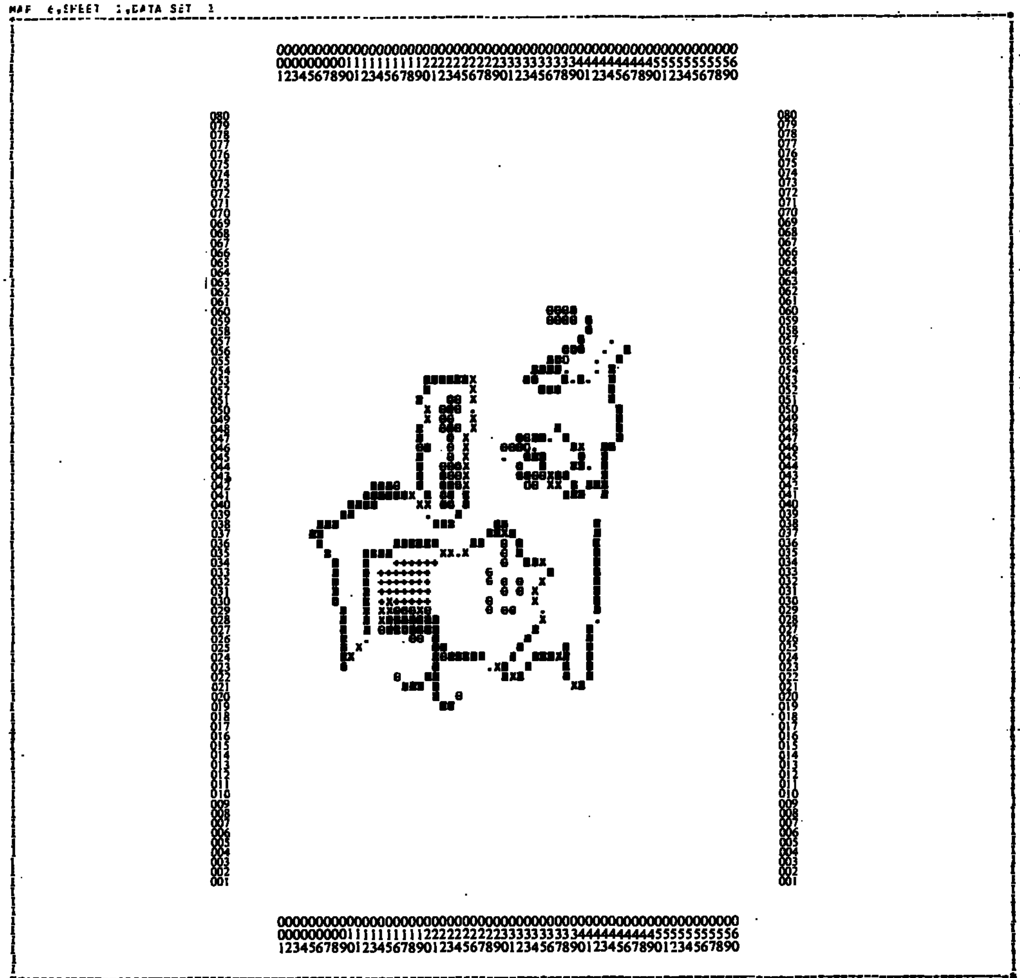
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		·········	'''''''''	·········	+++++++++	XXXXXXXXX	OOOOOOOOO	ØØØØØØØØØ	ØØØØØØØØØ	■■■■■■■■■	■■■■■■■■■	
FREQUENCY	3E15	0	0	0	186	0	56	0	58	5	253	0

Fig. H.3.2
Way "A": Winter Plan

MAP 6,SHEET 1,DATA SET 1



ATTRACTIVENESS EVALUATION.- PLAN A

PROFESSIONAL JUDGEMENT - WAY

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

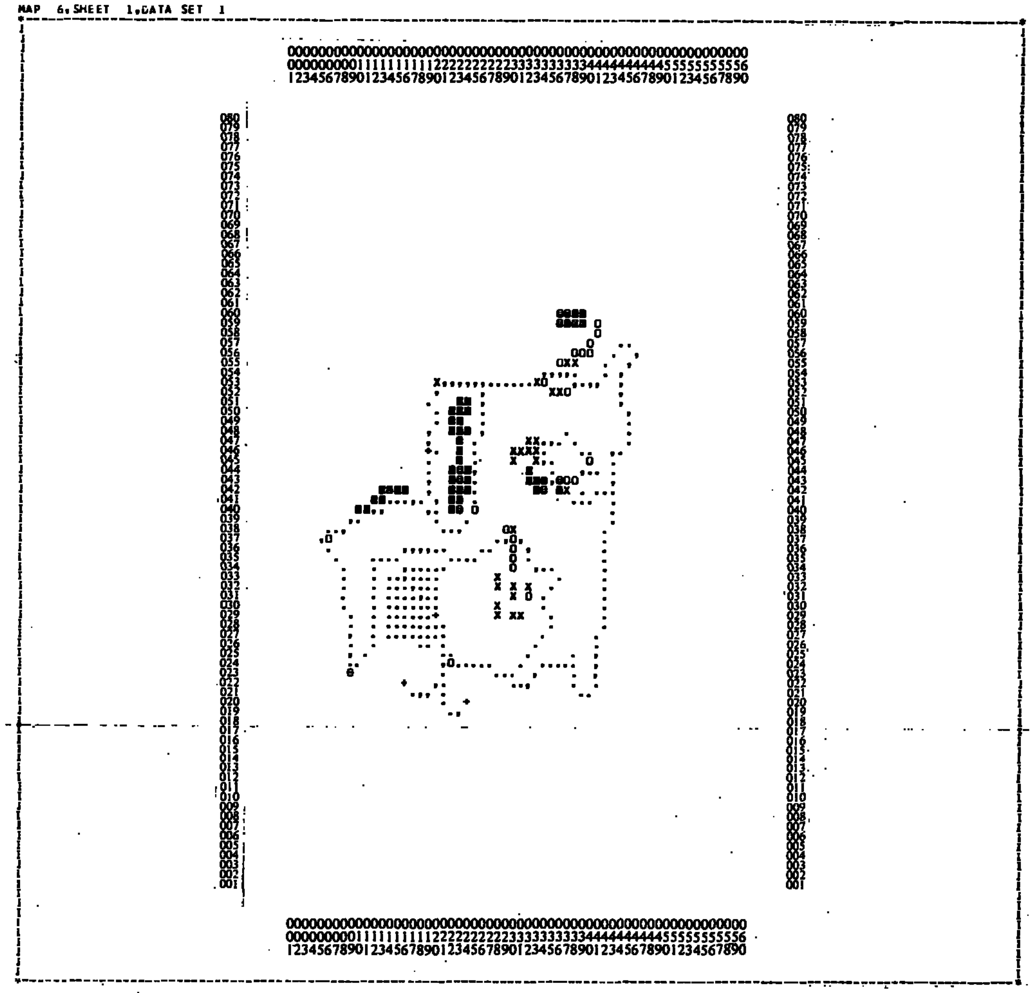
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	'	•	+	X	0	@	[illegible]	[illegible]	[illegible]
FREQUENCY	18	0	0	33	40	3	52	22	37	166

Fig. H.3.3
Way "A": Attractiveness Evaluation

MAP 6. SHEET 1. DATA SET 1



EVALUATION OF PLAN A - WAY

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 22.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	28.00
MAXIMUM	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

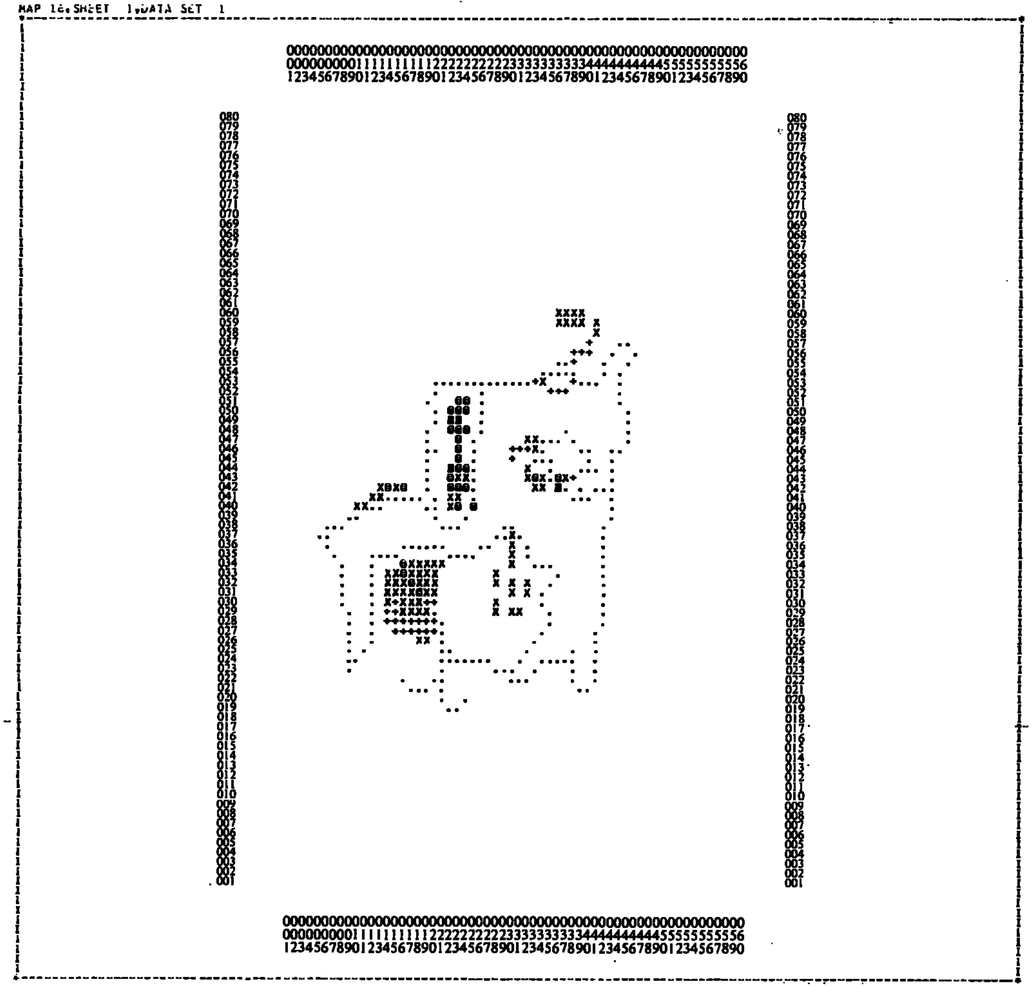
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.80

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	....	'''''''''	'''''''''	+++++++++	XXXXXXXXX	OOOOOOOOO	888888888	[illegible]	[illegible]	[illegible]
FREQUENCY	210	63	1	4	25	21	1	9	24	17

Fig. H.3.4
Way "A": Total Impact

MAP 16, SHEET 1, DATA SET 1



PLAN A - IMPACT ON SURFACE WATER SYSTEM

PROFESSIONAL JUDGEMENT - WAY

HONEY HILL CASE STUDY

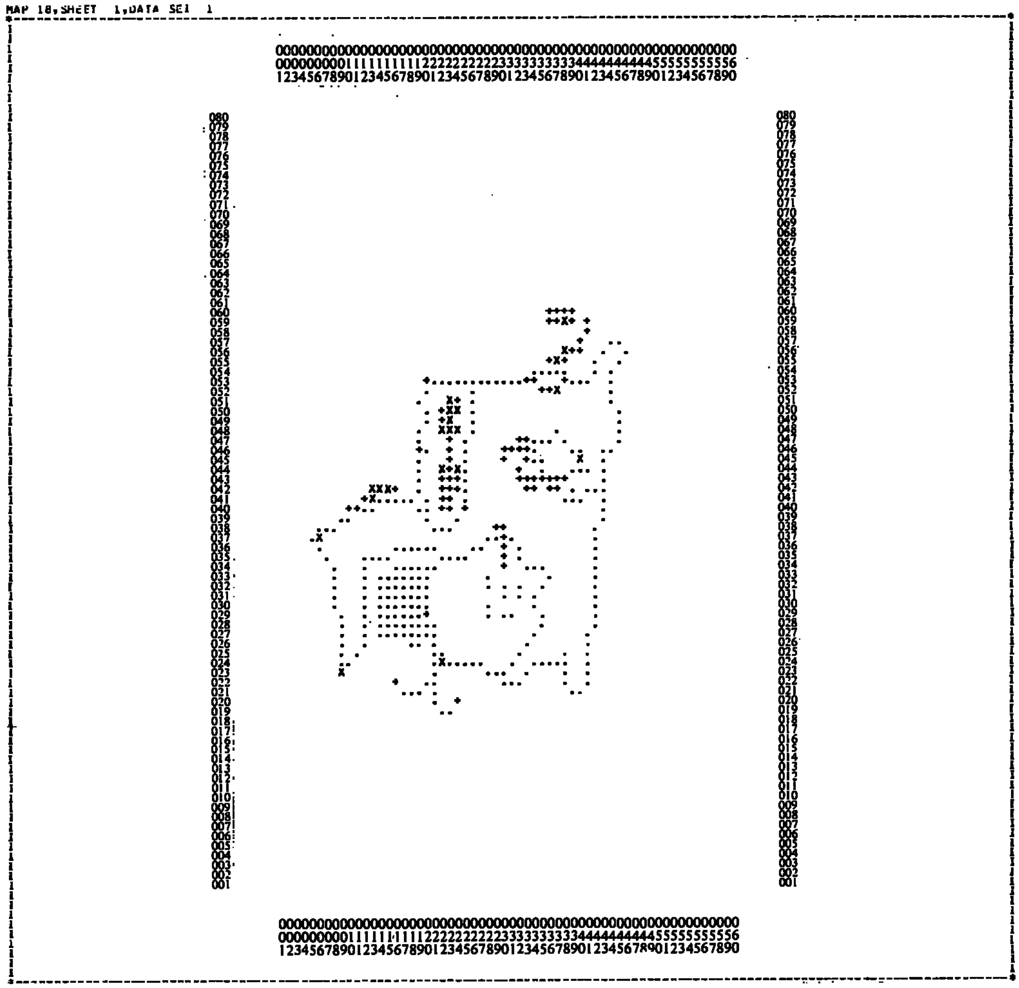
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXXX	@@@@@@@@@	■■■■■■■■■
FREQUENCY	237	33	78	27	4

Fig. H.3.5
Way "A": Impact on Surface Water System

MAP 18, SHEET 1, DATA SET 1



PLAN A - IMPACT ON WILDLIFE HABITAT

PROFESSIONAL JUDGEMENT - WAY

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXX	@@@@@@@@@	■■■■■■■■■
FREQUENCY	267	72	21	0	0

Fig. H.3.6
Way "A": Impact on Wildlife Habitat

TABLE H.4

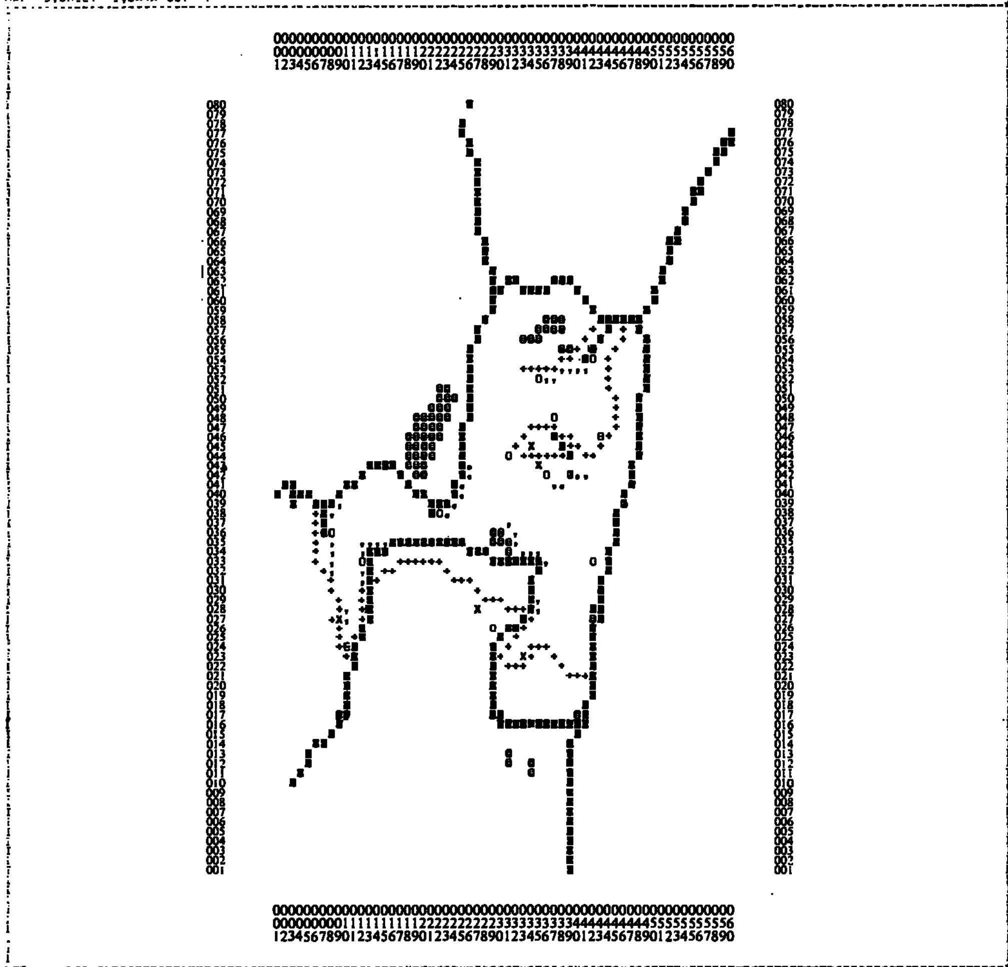
PROFESSIONAL JUDGMENT PLANS:
INITIAL SITE CRITERIA: PEACOCK

Activity	Criteria
1. Summer	
1.1 Hunting	In passive areas except ski area
1.2 Fishing	Accessible to camp areas
1.3 Swimming	Near water view lots and campsite
1.4 Hiking trails	In trees, away from water, not next to water related activities
1.5 Camping	Access, separate from housing
1.8 Residential	
1.8.1 Water View Lots	Elevated view of water, view to east
1.8.2 Wood View Lots	In trees, away from water, not next to water related activities
1.8.4 Condominium	Access to water, accessible to skiing
2. Winter	
2.2 Snowshoeing	Unpopulated areas
2.3 Cross-Country Skiing	Unpopulated areas
2.5 Snowmobiles	May ban

TABLE H.4
(Continued)

	Activity	Criteria
2.6	Downhill skiing	Highest elevation and largest area available
2.7	Ice skating	Access, next to boat facility, view from ski slope

MAP 1, SHEET 1, DATA SET 1



PLAN A - SUMMER

PROFESSIONAL JUDGEMENT - PEACOCK

HENRY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

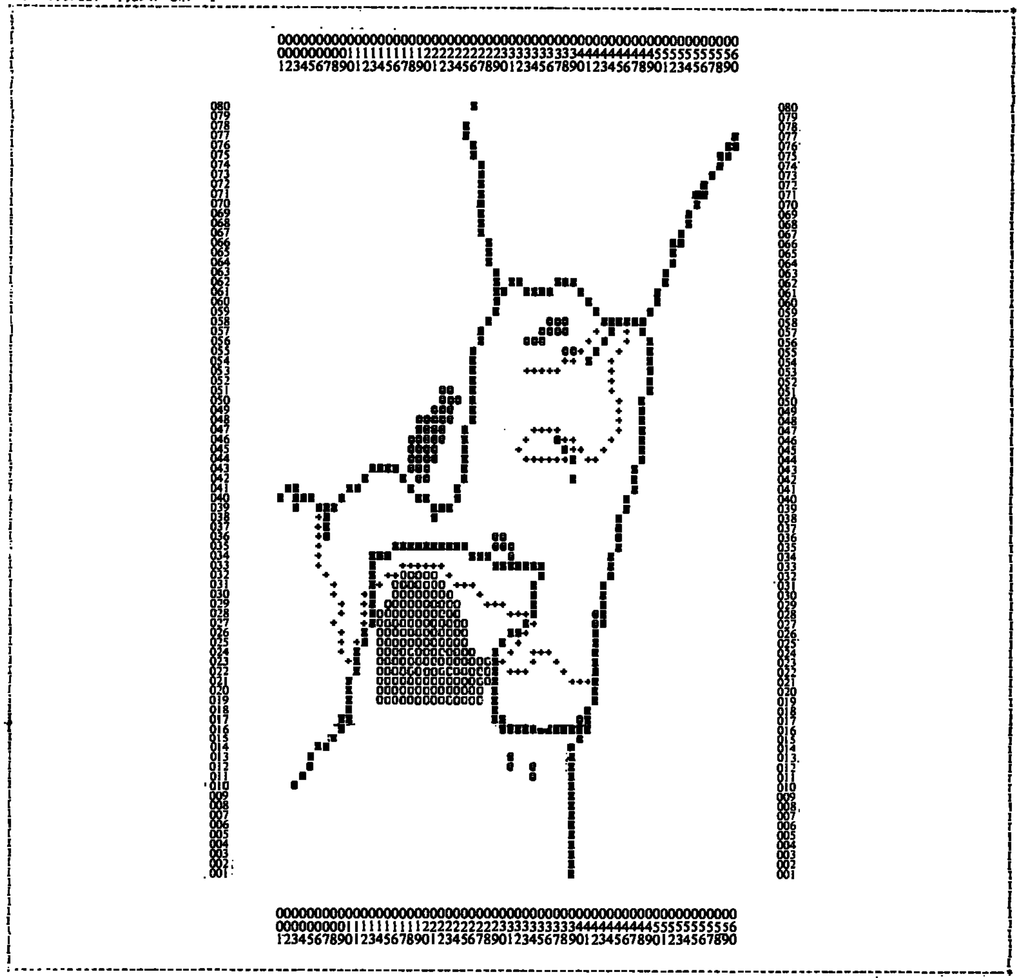
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		[illegible]	[illegible]	[illegible]	++++++++	XXXXXXXX	OOOOOOOO	@@@@@@@@	[illegible]	[illegible]	[illegible]	
FREQUENCY	3505	0	30	10	99	5	10	2	60	5	249	0

Fig. H.4.1
Peacock "A": Summer Plan

MAP 5,SHEET 1,DATA SET 1



PLAN A - WINTER

PROFESSIONAL JUDGEMENT - PEACOCK

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

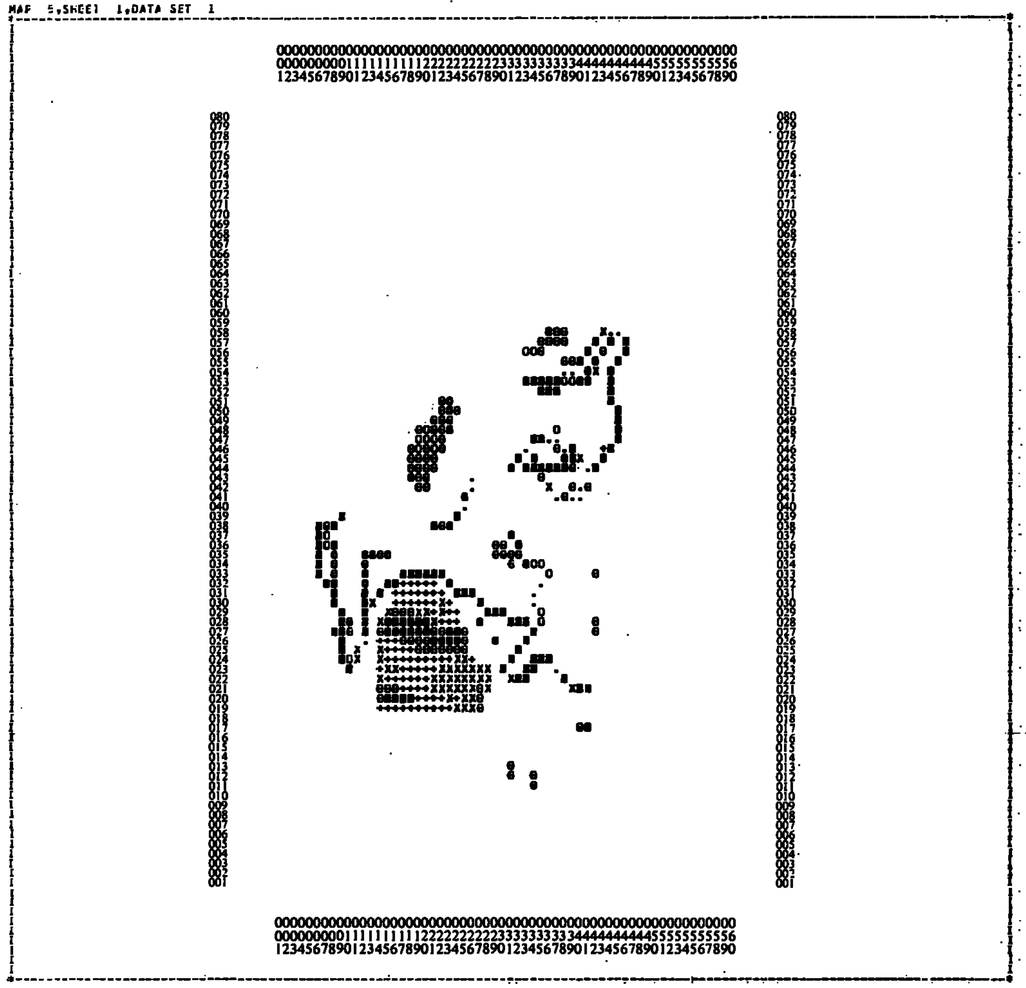
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	....	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	@@@@@@@@@	■■■■■■■■■	■■■■■■■■■	
FREQUENCY	3799	0	0	0	99	0	163	0	60	5	249	0

Fig. H.4.2
Peacock "A": Winter Plan

MAP 5,SHEET 1,DATA SET 1



ATTRACTIVENESS EVALUATION - PLAN A

PROFESSIONAL JUDGEMENT - PEACOCK

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

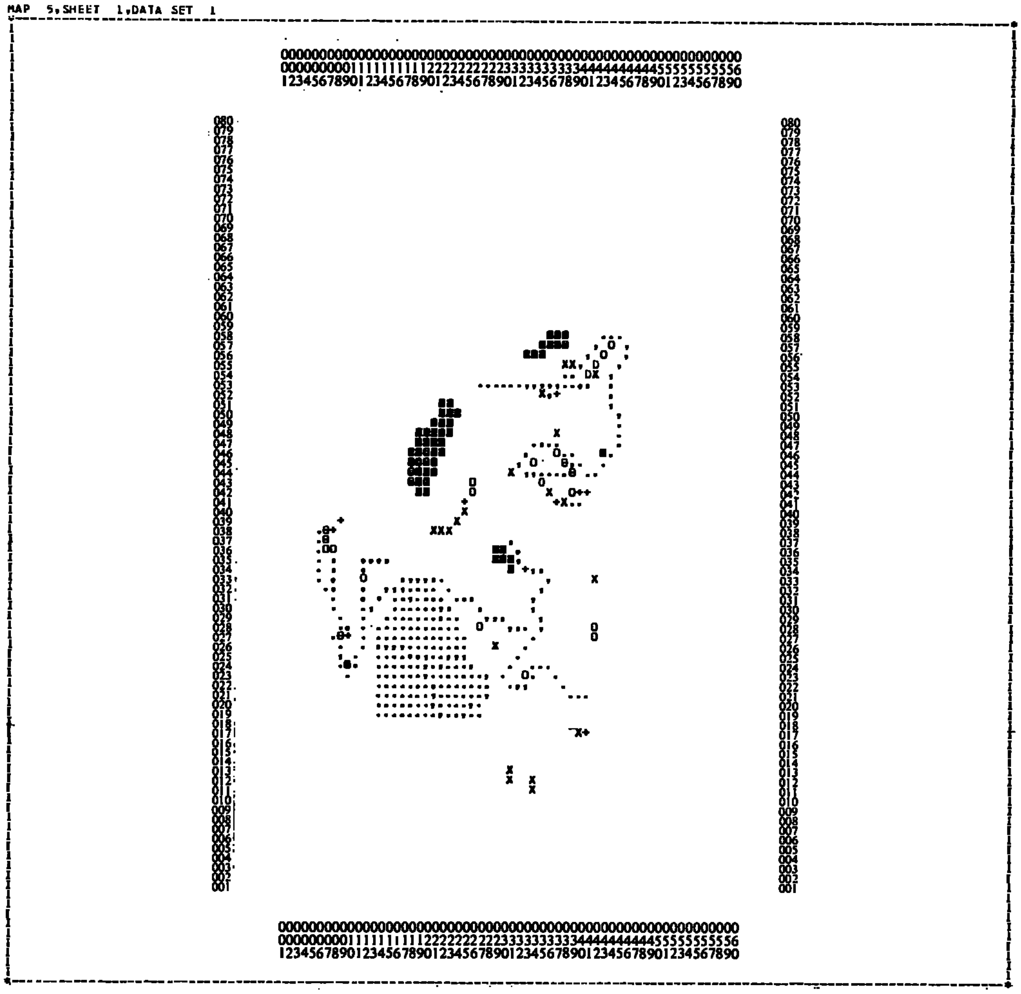
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	....	'''''''''	=========	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	21	0	0	74	51	19	65	16	48	89

Fig. H.4.3
Peacock "A": Attractiveness

MAP 5,SHEET 1,DATA SET 1



EVALUATION OF PLAN A - PEACOCK

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
IO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN IC LEVELS BETWEEN EXTREME VALUES OF 2.CO AND 22.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	2.00	4.00	6.00	0.00	1C.00	12.00	14.00	16.00	18.00	20.00
MAXIMUM	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

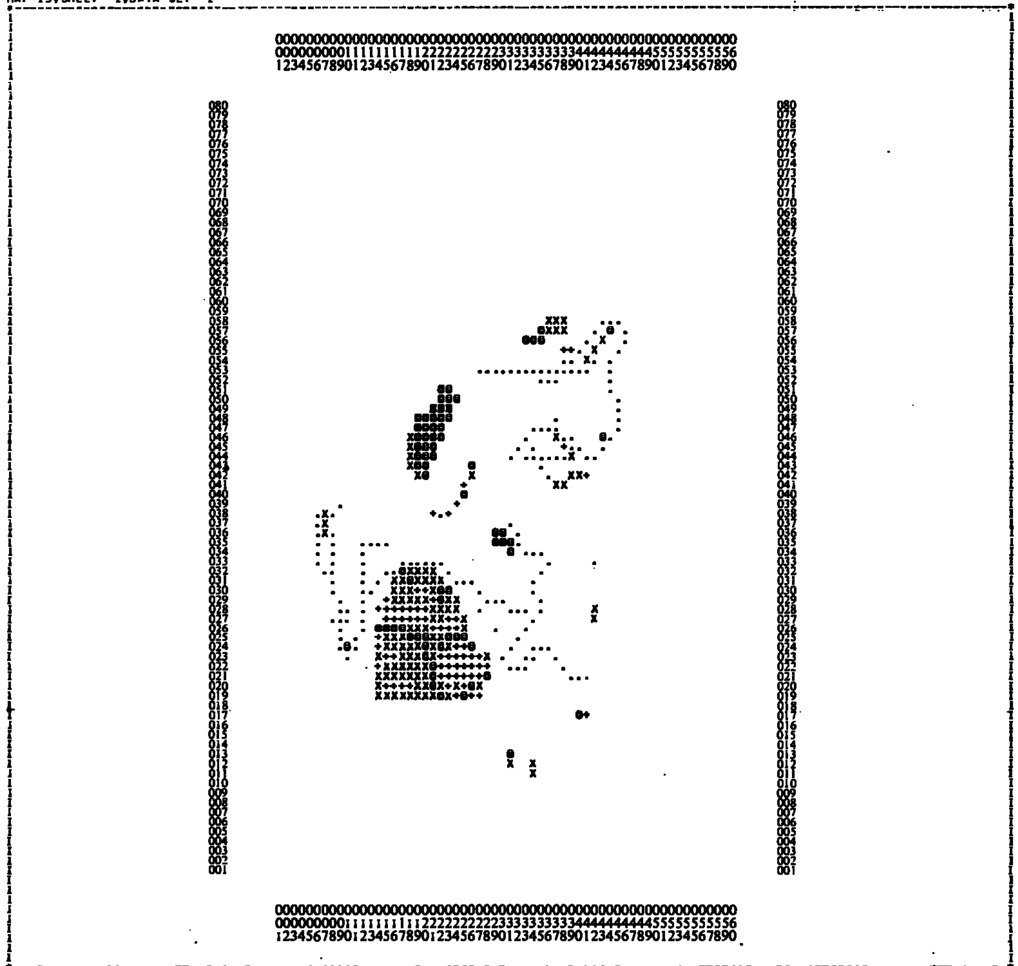
10.00	1C.00	1C.00	10.00	10.00	10.00	10.00	10.00	1C.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	0	9
SYMBOLS	....	'''''''''	•••••••••	+++++++++	XXXXXXXXX	OOOOOOOOO	ØØØØØØØØØ	ØØØØØØØØØ	■■■■■■■■■	■■■■■■■■■
FREQUENCY	2C0	78	18	1C	2C	17	5	5	26	22

Fig. H.4.4
Peacock "A": Total Impact

MAP 13, SHEET 1, DATA SET 1



PLAN A - IMPACT ON SURFACE WATER SYSTEM

PROFESSIONAL JUDGEMENT - PEACOCK

HONEY HILL CASE STUDY

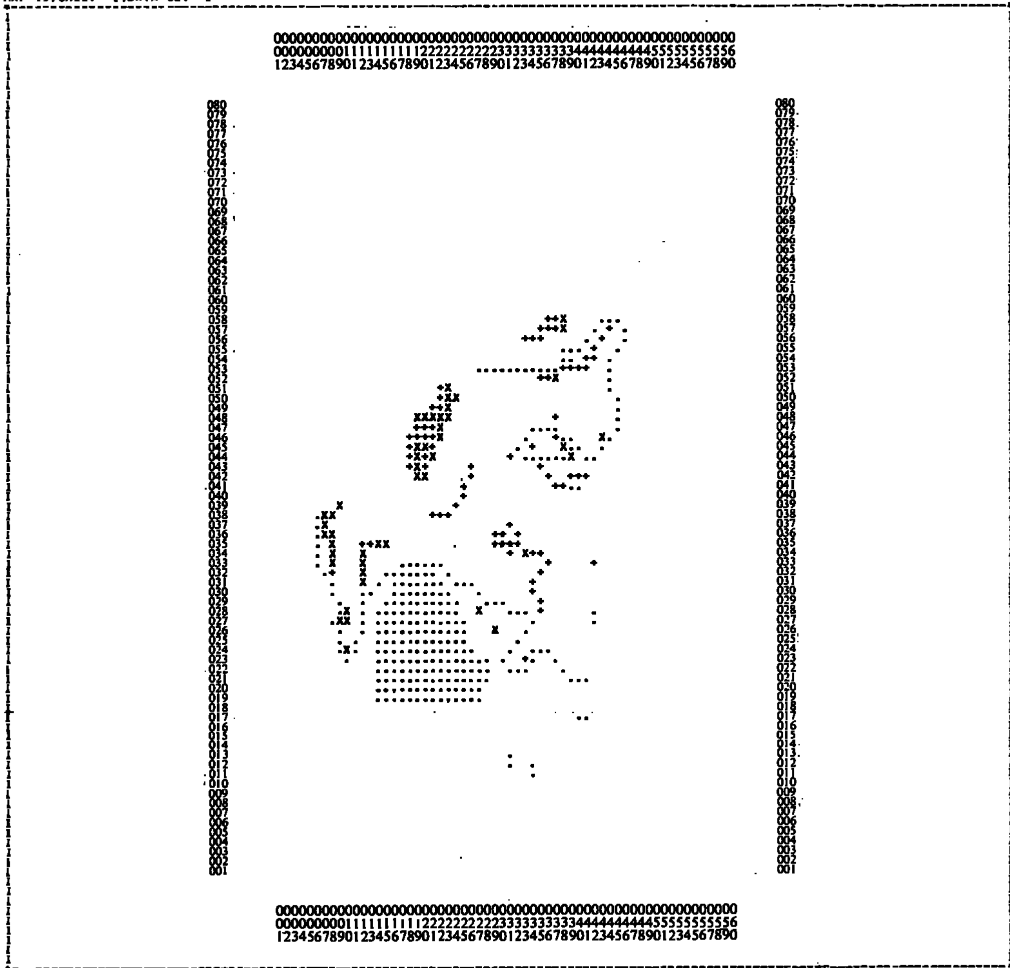
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXX	@@@@@@@@@	████████
FREQUENCY	159	67	107	70	3

Fig. H.4.5
Peacock "A": Impact on Surface Water System

MAP 15, SHEET 1, DATA SET 1



PLAN A - IMPACT ON WILDLIFE HABITAT

PROFESSIONAL JUDGEMENT - PEACOCK

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXX	@@@@@@@@@	■■■■■■■■■
FREQUENCY	286	77	46	0	0

Fig. H.4.6
Peacock "A": Impact on Wildlife Habitat

APPENDIX I: PROFESSIONAL JUDGEMENT "B" PLANS

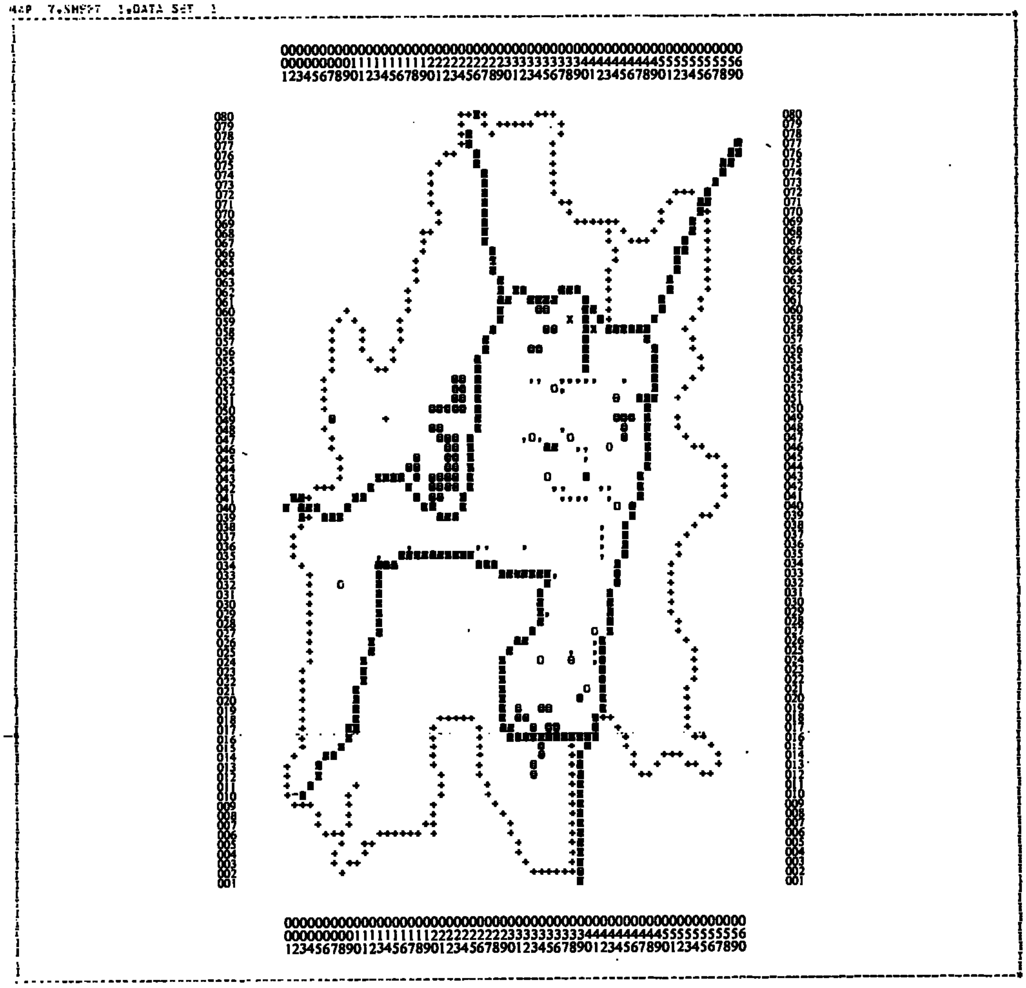
Appendix I presents the plans made under the "B" assumption by the members of the research team in the initial plan-making exercise. Four plans are presented along with their evaluation maps and tables. These are:

I.A Steinitz "B"
I.B Toth "B"
I.C Way "B"
I.D Peacock "B"

The Murray "B" plan appears in Appendix J.A.

The principal difference exhibited between the "B" and "A" plans is that several of the activities tended to be consistently located outside the Federal and State land holding. Downhill skiing was the activity most often taken out of the State park. Trails, snowmobiling, hunting and residence were also often relocated. On the other hand, the activities which relied on water use or water views most often remained within the defined site area. This pattern was not inconsistent with the general goals of the Corps of Engineers. However, it does point out an important possibility in initial site selection for private and public developers who would be considering a full range of activities. Since the "B" scheme allowed the activities to be located where sites had a greater attractiveness and/or resulted in less impact, one could easily foresee a "B" plan being made for a proposed development with the site to be sought for acquisition being determined by the resultant plan. Had this been done, the summary evaluations might have shown improvement and the land holdings to be acquired would have been different. Another interpretation which could be made from the differences between the "A" and "B" plans is that if the "A" plan is to be developed, there are areas outside of the proposed project area in which private enterprise could probably compete successfully with the public development.

MAP 7.SHEET 1.DATA SET 1



PLAN B - SUMMER

PROFESSIONAL JUDGEMENT - STEINITZ

HENRY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

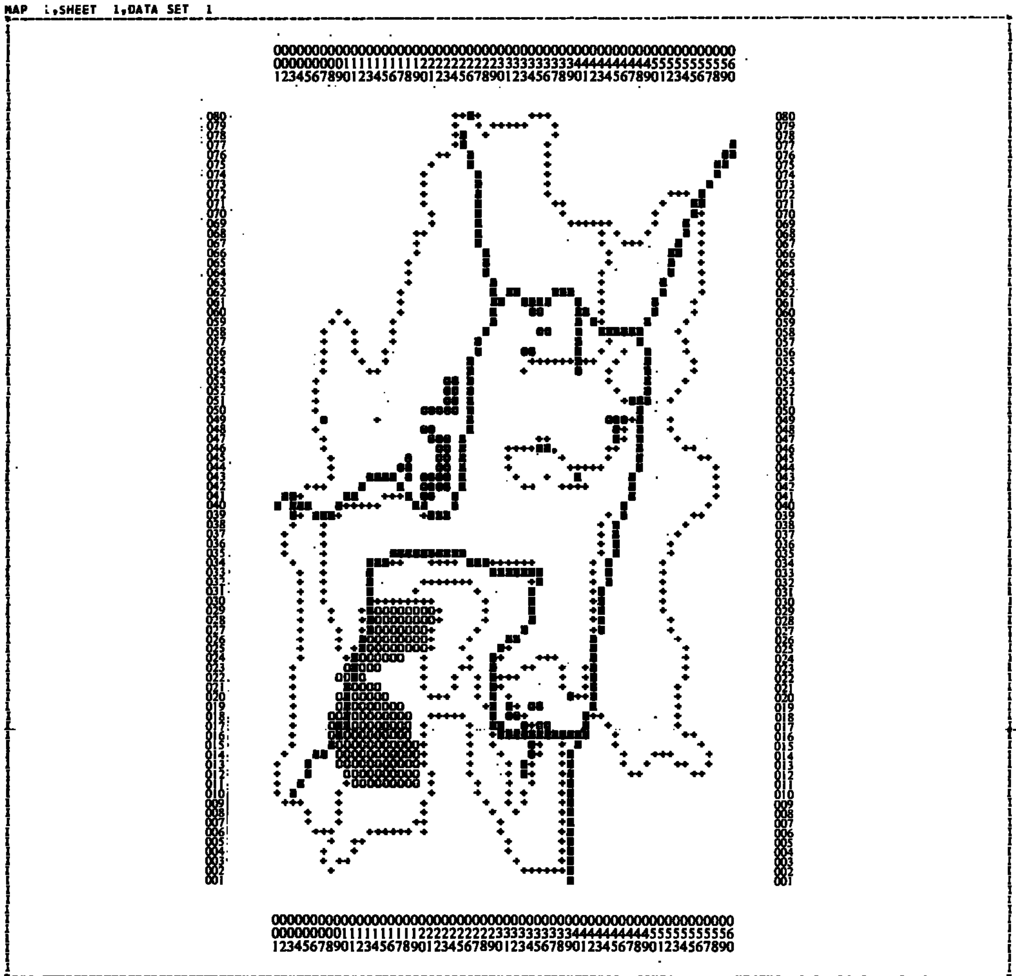
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	'''''''''	+++++++++	XXXXXXXXX	OOOOOOOOO	ØØØØØØØØØ	[illegible]	[illegible]	[illegible]	
FREQUENCY	3712	0	26	13	295	2	10	2	60	5	250	0

Fig. I.1.1
Steinitz "A": Summer Plan

MAP 1,SHEET 1,DATA SET 1



PLAN B - WINTER

PROFESSIONAL JUDGEMENT - STEINITZ

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROABS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

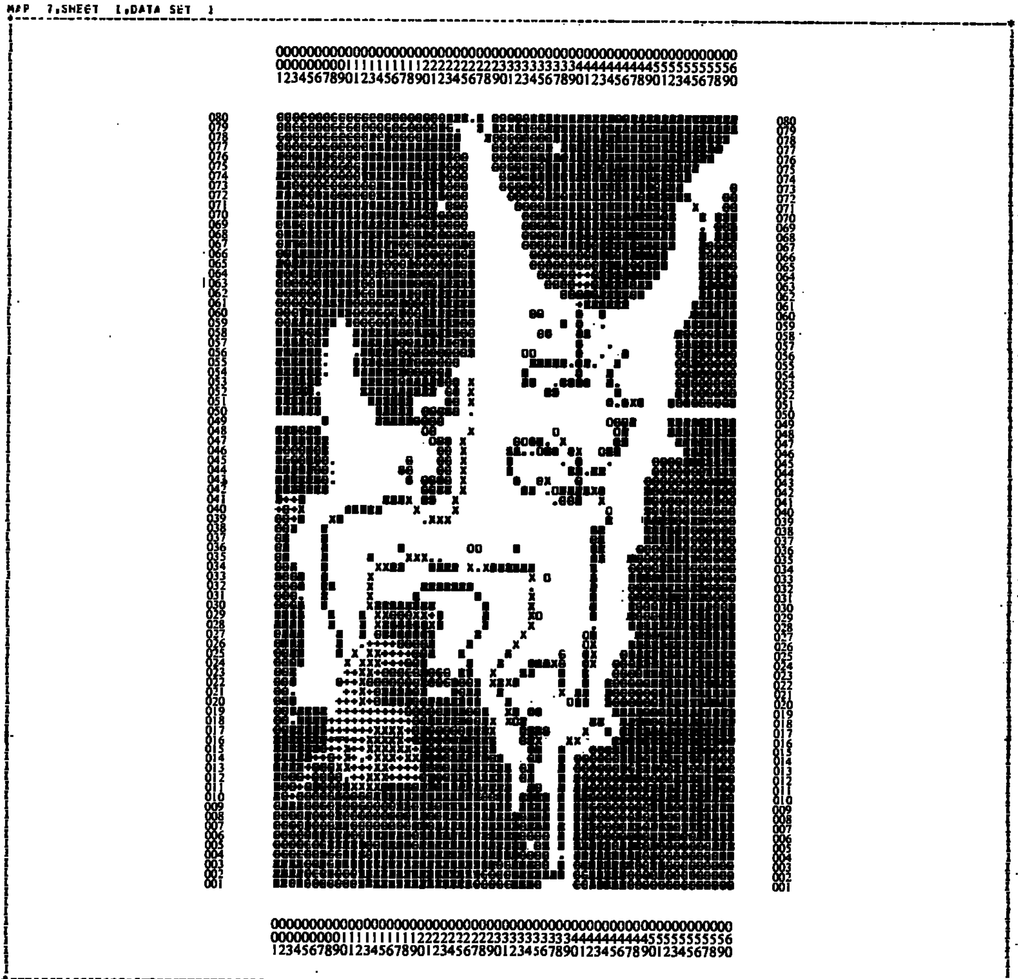
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		[illegible]	[illegible]	[illegible]	+++++++++	XXXXXXXX	000000000	[illegible]	[illegible]	[illegible]	[illegible]	
FREQUENCY	3430	0	8	1	478	0	151	0	60	5	250	0

Fig. I.1.2
Steinitz "B": Winter Plan

MAP 7,SHEET 1,DATA SET 1



ATTRACTIVENESS EVALUATION - PLAN B

PROFESSIONAL JUDGEMENT - STEINITZ

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

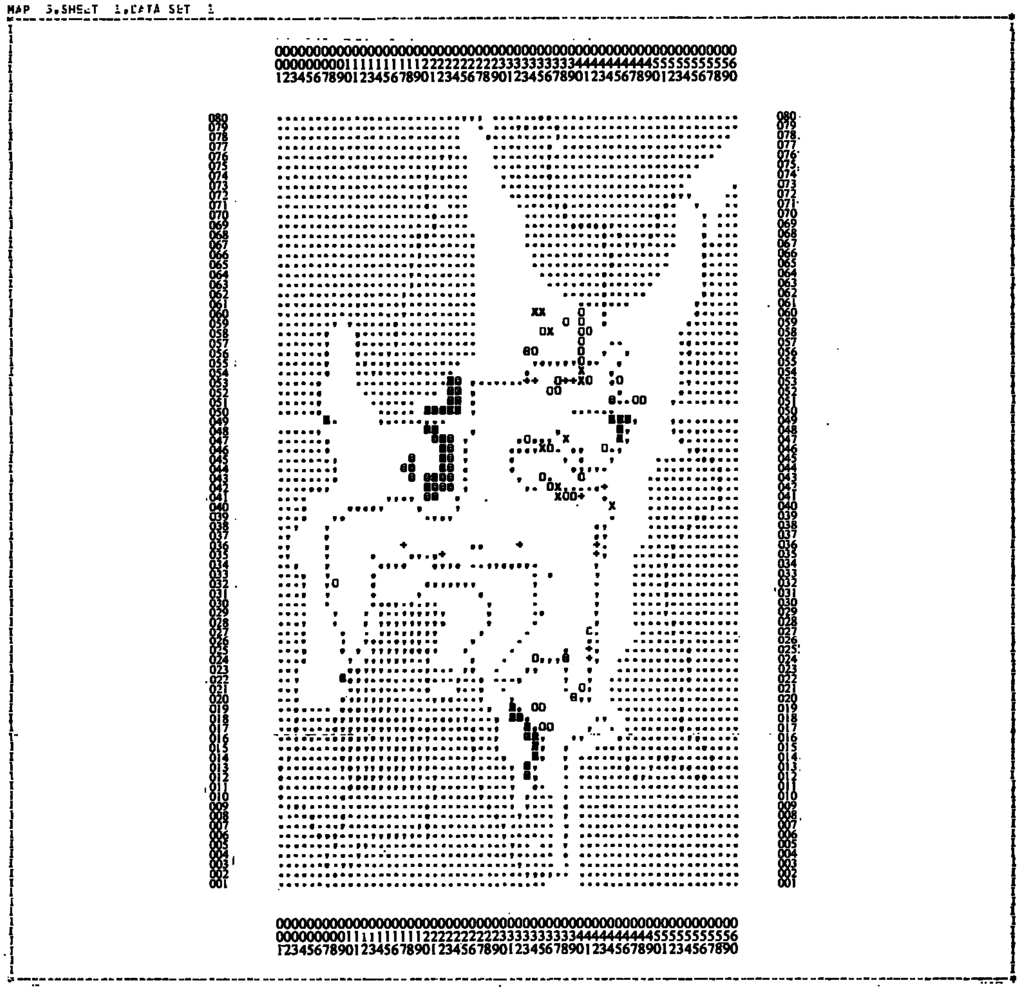
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	....	'''''''''	•••••••••	+++++++++	XXXXXXXX	OOOOOOOOO	ØØØØØØØØØ	■■■■■■■■	■■■■■■■■	■■■■■■■■
FREQUENCY	39	2	0	95	113	20	1108	35	41	1839

Fig. I.1.3
Steinitz "B": Attractiveness



EVALUATION OF PLAN B - STEINITZ

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 24.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60
MAXIMUM	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60	24.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS				++++	XXXX	0000	0000			
FREQUENCY	2539	584	171	13	15	33	2	20	18	17

Fig. I.1.4
Steinitz "B"; Total Impact

Steinitz "B"
Table I.1.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	9.0	0.0	0.0	0.0
4	499.0	0.0	0.0	0.0
5	2.0	0.0	0.0	0.0
6	10.0	0.0	0.0	0.0
7	2.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	522.0	0.0	0.0	0.0

Steinitz "B"
Table H.1.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	5126.6	0.0	0.0	0.0	0.0
7	2296.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	22367.0	0.0	0.0	0.0	0.0

Steinitz "B"
Table I.1.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	0.0	0.0
3	27785.8	76688.8
4	16577.0	45752.6
5	3292.3	6518.8
6	29734.1	58873.5
7	16577.2	45753.1
8	0.0	0.0
9	0.0	0.0
TOTAL	93966.4	233586.6

Steinitz "B"
Table I.1.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	1.0	0.0	0.0
4	499.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6	159.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	658.0	1.0	0.0	0.0

Steinitz "B"
Table I.1.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	0.0	1650.8	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	8253.9	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	11976.4	1650.8	0.0	0.0	0.0

Steinitz "B"
Table I.1.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	0.0	0.0
3	11506.0	31756.6
4	26876.6	74179.4
5	0.0	0.0
6	140067.9	386587.2
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	178450.5	492523.2

Steinitz "B"
Table I.1.7: Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	0	0.0
2	26	0.0
3	13	56.92
4	487	91.58
5	2	81.00
6	10	70.00
7	2	85.50
8	61	68.15
9	5	64.00
10	250	3.57
TOTAL	856	60.45

WINTER PLAN ATTRACTIVENESS

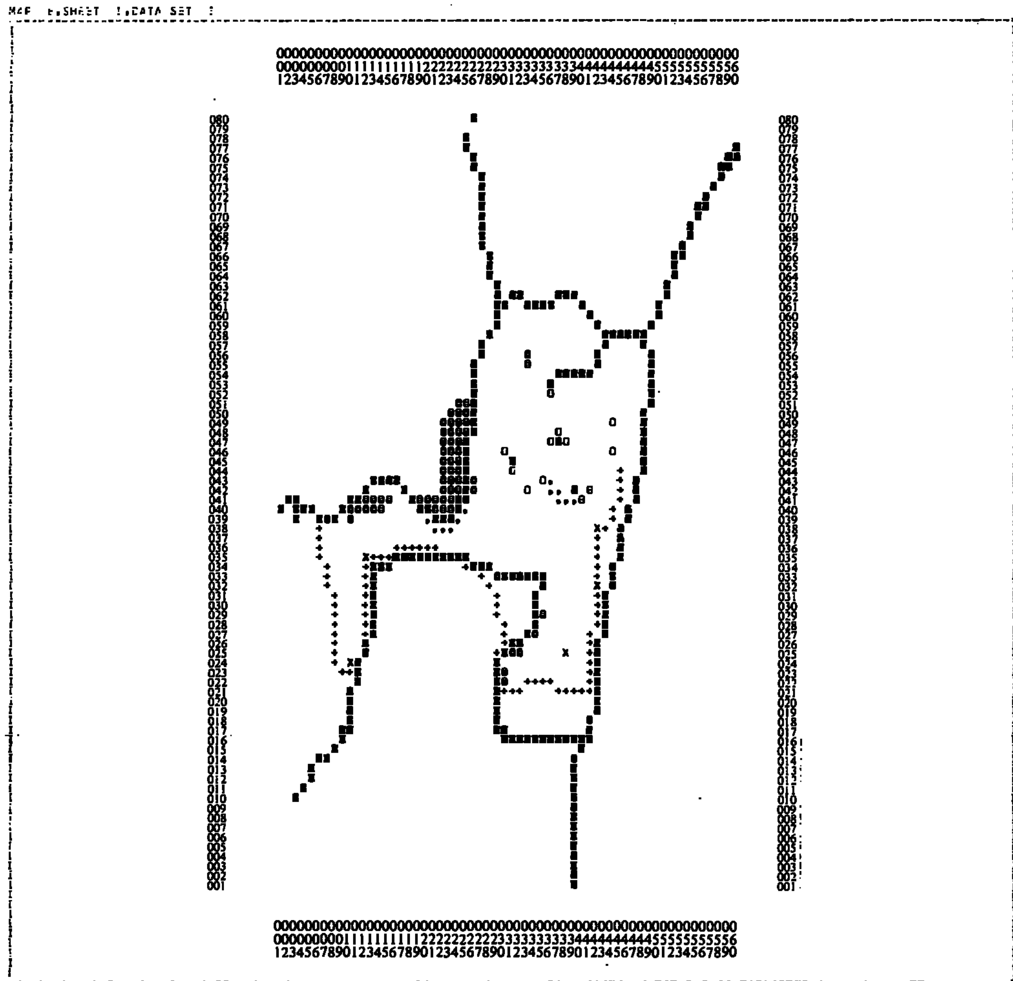
ACTIVITY	# OF CELLS	MEAN
11	0	0.0
12	0	0.0
13	1	75.00
14	487	91.58
15	0	0.0
16	150	46.85
17	0	0.0
18	61	68.15
19	5	64.00
20	250	3.57
TOTAL	954	59.82

Steinitz "B"
Table I.1.8: Plan Impact TOTAL IMPACT = 9199.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	526	73	122	259	27	1.194
2	674	279	49	5	0	0.389
3	527	396	84	0	0	0.560
4	638	218	142	9	0	0.525
5	664	55	284	3	1	0.632
6	156	156	325	370	0	1.903
7	638	6	109	247	7	0.986
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	151	106	526	46	178	1.994
11	527	170	152	147	11	0.952
TOTAL	4501	1459	1793	1086	224	1.015

Steinitz "B"
Table I.1.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	275 27	0 0
4	97 40	97 40
5	50 00	0 0
6	43 75	1200 00
7	12 00	0 0
8	18300 00	18300 00
9	196 63	196 63
10	510 00	510 00
TOTAL	19485 05	20304 02



PLAN B – SUMMER

PROFESSIONAL JUDGEMENT – TOTH

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

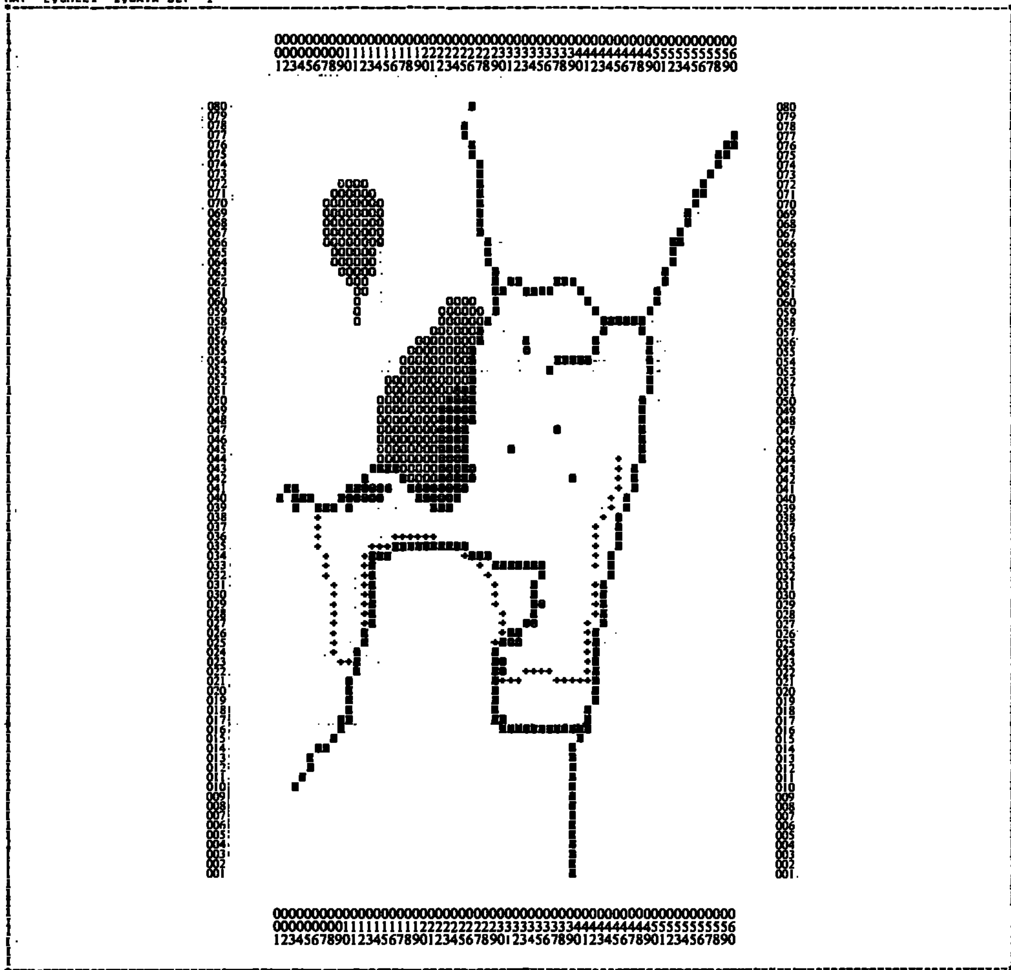
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		·········	'''''''''	·········	+++++++++	XXXXXXXXX	OOOOOOOOO	ØØØØØØØØØ	ØØØØØØØØØ	■■■■■■■■■	■■■■■■■■■	
FREQUENCY	3554	2	0	12	78	5	10	2	59	5	250	0

Fig. I.2.1
Toth "B": Summer Plan

MAP 2,SHEET 1,DATA SET 1



PLAN B.- WINTER

PROFESSIONAL JUDGEMENT - TOTH

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

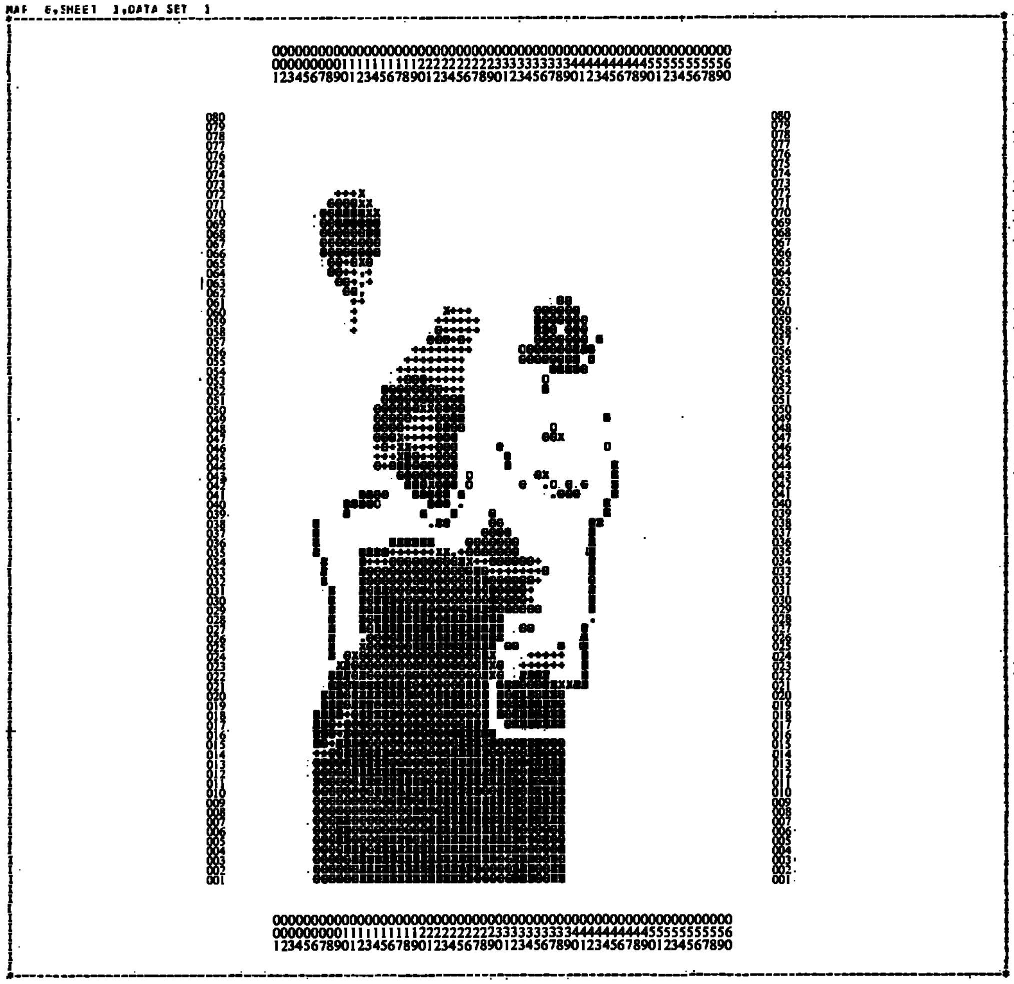
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		[illegible]	[illegible]	[illegible]	+++++++++	XXXXXXXXX	000000000	[illegible]	[illegible]	[illegible]	[illegible]	
FREQUENCY	3766	0	0	0	78	0	217	0	59	5	250	0

Fig. I.2.2
Toth "B": Winter Plan



ATTRACTIVENESS EVALUATION - PLAN B

PROFESSIONAL JUDGEMENT - TOTH

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES .

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF C.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

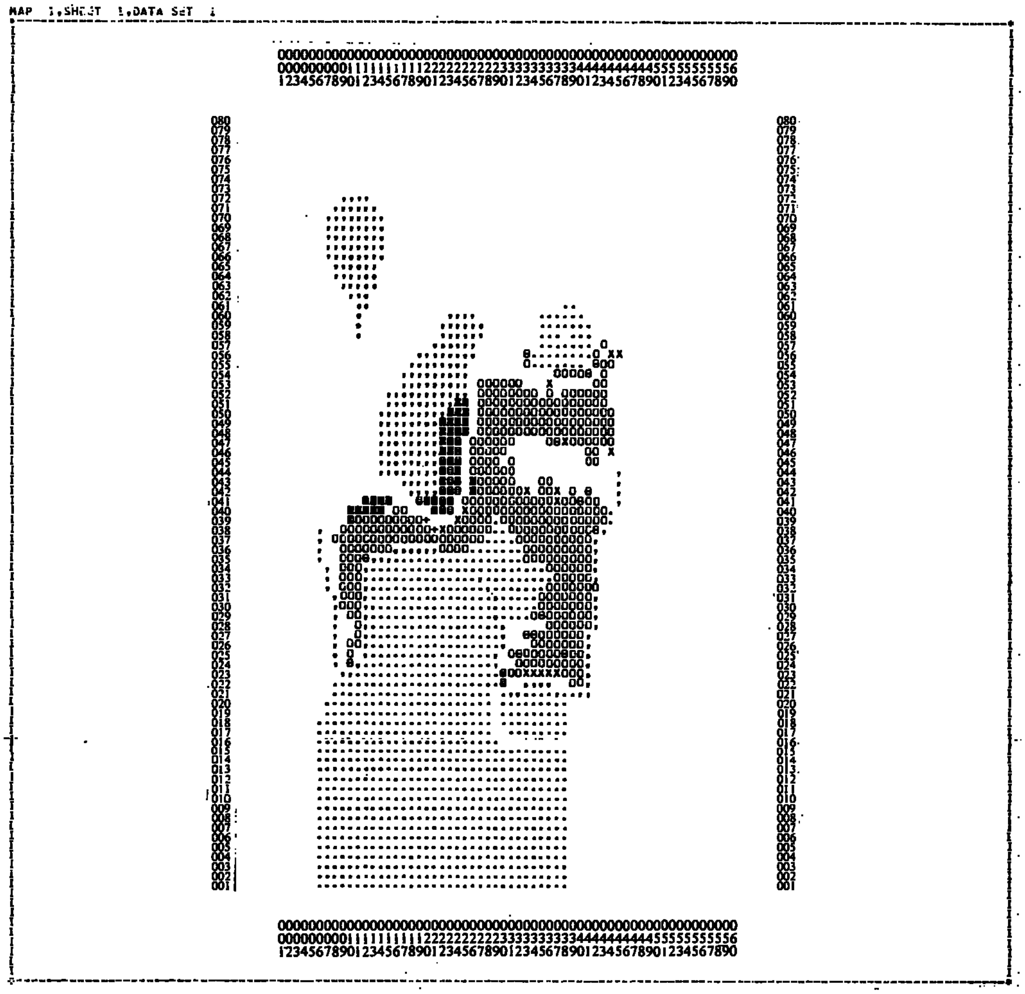
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	'	[illegible]	+	X	O	[illegible]	[illegible]	[illegible]	[illegible]
FREQUENCY	7	3	0	126	27	8	642	18	45	534

Fig. I.2.3
Toth "B": Attractiveness

MAP 1,SHEET 1,DATA SET 1



EVALUATION OF PLAN B - TOTH

TOTAL IMPACT ON ALL RESOURCE SYSTEM

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70
MAXIMUM	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70	23.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	'	•	+	X	O	Θ	Θ	█	█
FREQUENCY	1002	225	65	2	16	411	14	7	23	23

Fig. I.2.4
Toth "B": Total Impact

Toth "B"
Table I.2.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	217.0	0.0	0.0	0.0
3	8.0	0.0	0.0	0.0
4	85.0	0.0	0.0	0.0
5	5.0	0.0	0.0	0.0
6	10.0	0.0	0.0	0.0
7	2.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	327.0	0.0	0.0	0.0

Toth "B"
Table I.2.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	3441.4	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	5126.6	0.0	0.0	0.0	0.0
7	2296.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	25808.5	0.0	0.0	0.0	0.0

Toth "B"
Table I.2.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	24847.3	68578.4
3	27785.8	76668.8
4	16577.2	45753.0
5	3292.3	6518.8
6	29734.1	58873.5
7	16577.2	45753.1
8	0.0	0.0
9	0.0	0.0
TOTAL	118813.7	302165.4

Toth "B"
Table I.2.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	260.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	85.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6	217.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	562.0	0.0	0.0	0.0

Toth "B"
Table I.2.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	1019.4	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	8253.9	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	12995.8	0.0	0.0	0.0	0.0

Toth "B"
Table I.2.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	5912.5	11706.7
3	0.0	0.0
4	26876.6	74179.4
5	0.0	0.0
6	140069.1	386590.6
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	172858.2	472476.7

Toth "B"

Table I.2.7: Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	0	0.0
2	0	0.0
3	12	52.50
4	78	96.79
5	5	72.00
6	10	74.00
7	2	90.00
8	59	71.93
9	5	74.00
10	250	3.57
TOTAL	421	35.55

WINTER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
11	0	0.0
12	0	0.0
13	0	0.0
14	78	96.79
15	0	0.0
16	217	52.76
17	0	0.0
18	59	71.93
19	5	74.00
20	250	3.57
TOTAL	609	40.24

Toth "B"

Table I.2.8: Plan Impact

TOTAL IMPACT = 7589.

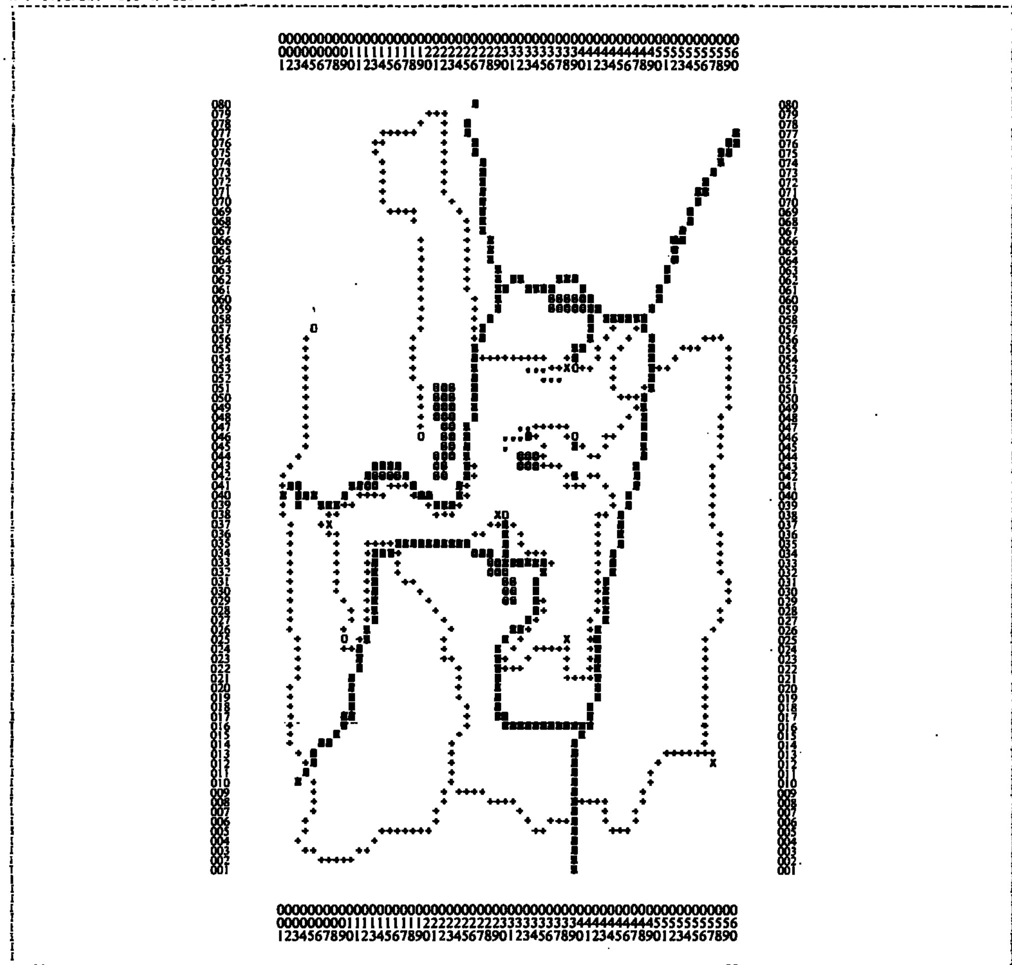
SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	93	59	204	250	32	2.108
2	305	269	58	6	0	0.632
3	90	456	92	0	0	1.003
4	295	212	122	9	0	0.757
5	295	55	283	4	1	0.998
6	222	104	163	149	0	1.375
7	295	2	83	245	13	1.497
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	217	26	193	40	162	1.850
11	90	216	158	159	15	1.676
TOTAL	1902	1399	1356	862	223	1.322

Toth "B"

Table I.2.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	254 10	0 0
4	15 60	15 60
5	125 00	0 0
6	43 75	1736 00
7	12 00	0 0
8	17700 00	17700 00
9	196 63	196 63
10	510 00	510 00
TOTAL	18857 07	20158 22

MAP 1.,SHEET 1.,DATA SET 1



PLAN B - SUMMER

PROFESSIONAL JUDGEMENT - WAY

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

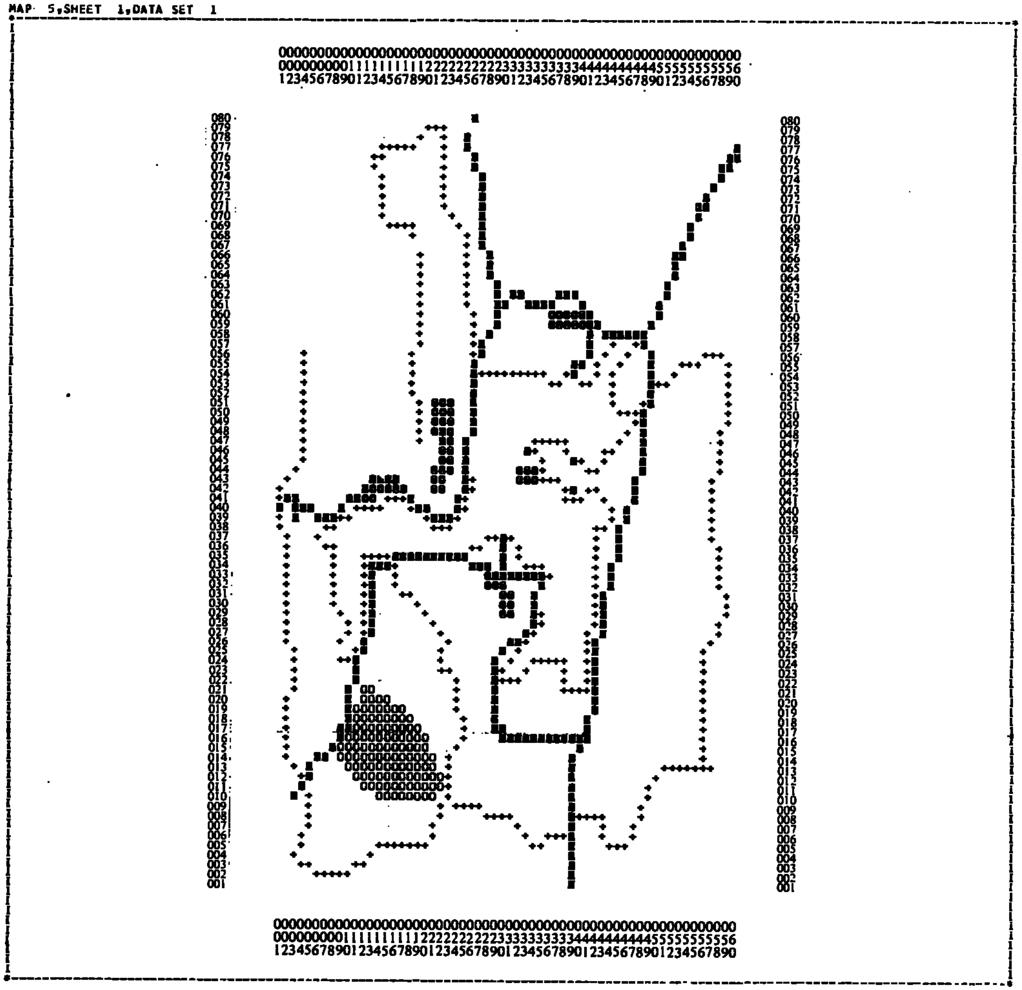
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	'''''''''	+++++++++	XXXXXXXXX	000000000	888888888				
FREQUENCY	3627	0	0	12	412	5	6	0	57	5	251	0

Fig. I.3.1
Way "B": Summer Plan

MAP 5,SHEET 1,DATA SET 1



PLAN B - WINTER

PROFESSIONAL JUDGEMENT - WAY

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

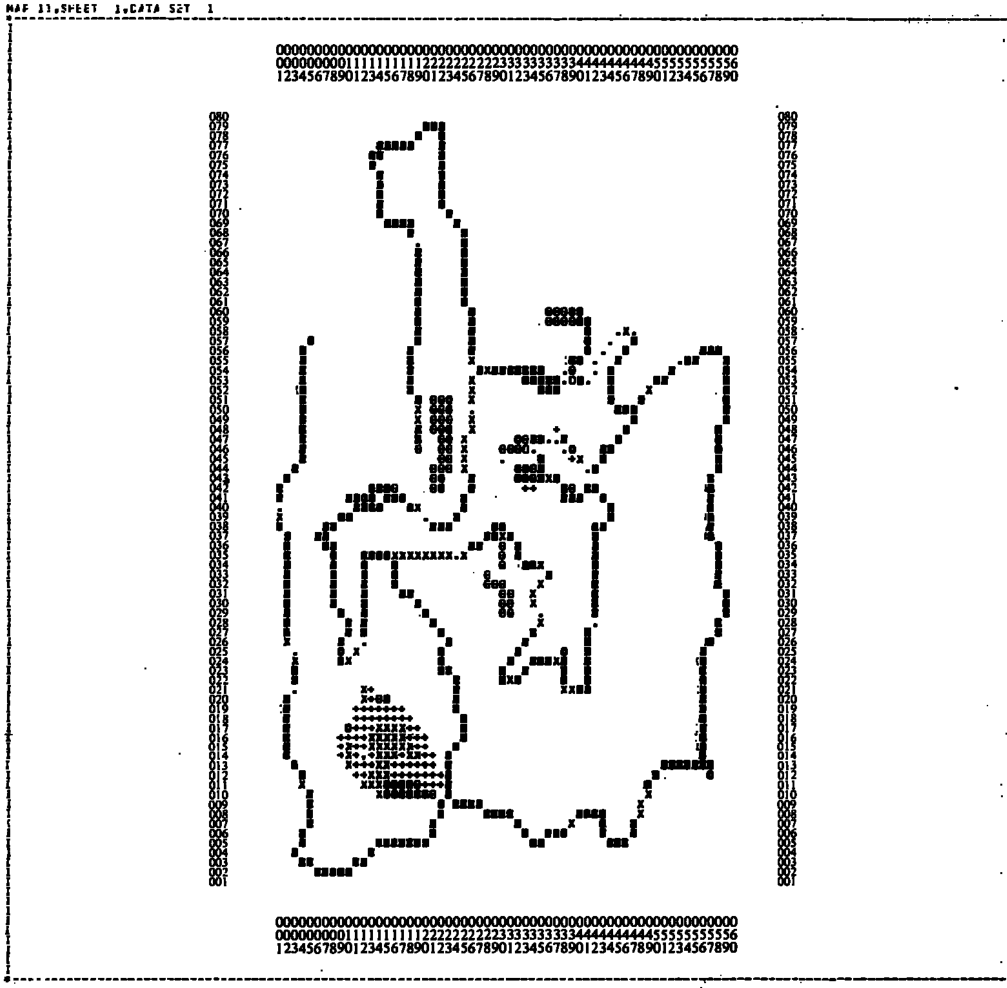
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS					+++++++++	XXXXXXXXX	OOOOOOOOO					
FREQUENCY	3541	0	0	0	412	0	109	0	57	5	251	[illegible]

Fig. I.3.2
Way "B": Winter Plan

MAP 11,SHEET 1,DATA SET 1



ATTRACTIVENESS EVALUATION - PLAN B

PROFESSIONAL JUDGEMENT - WAY

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

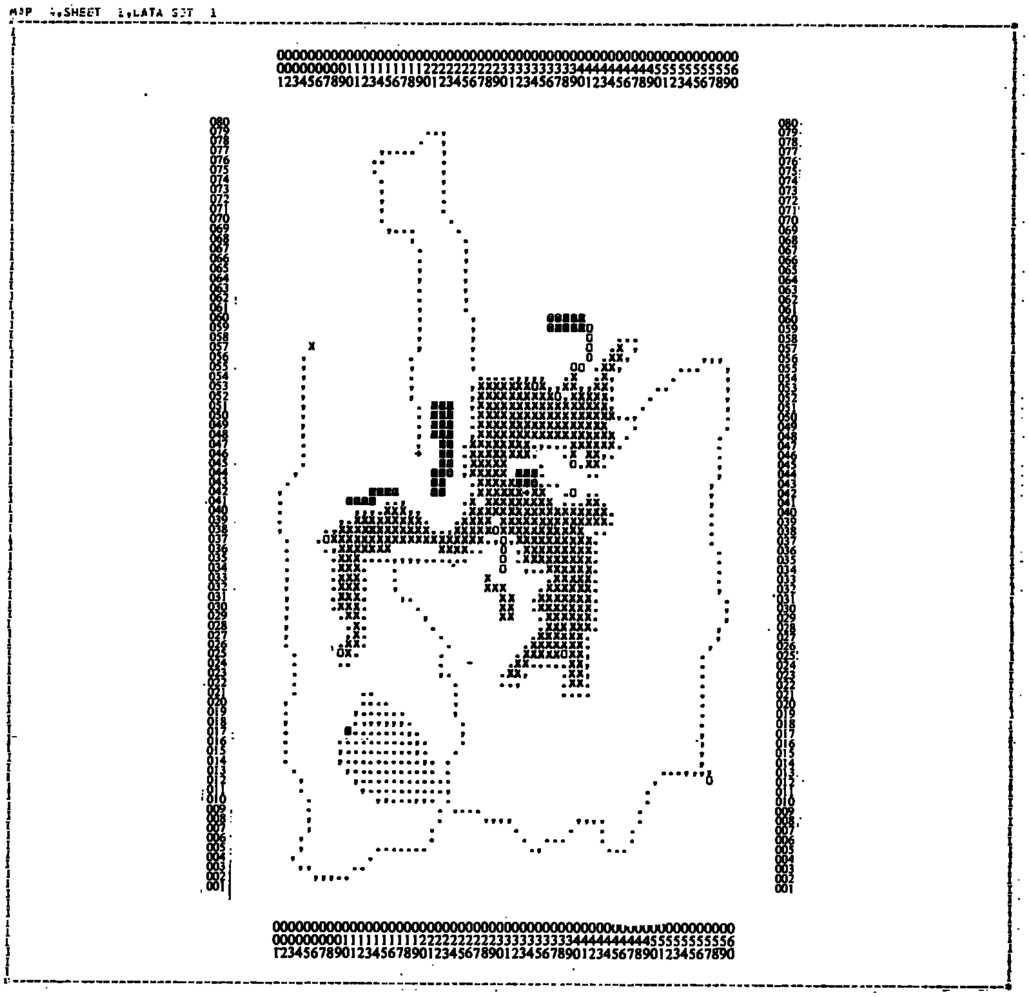
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	....	'''''''''	•••••••••	+++++++++	XXXXXXXXX	OOOOOOOOO	[illegible]	[illegible]	[illegible]	[illegible]
FREQUENCY	26	1	0	65	81	2	52	22	27	380

Fig. I.3.3
Way "B": Attractiveness



EVALUATION OF PLAN B - WAY

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 22.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00
MAXIMUM	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00

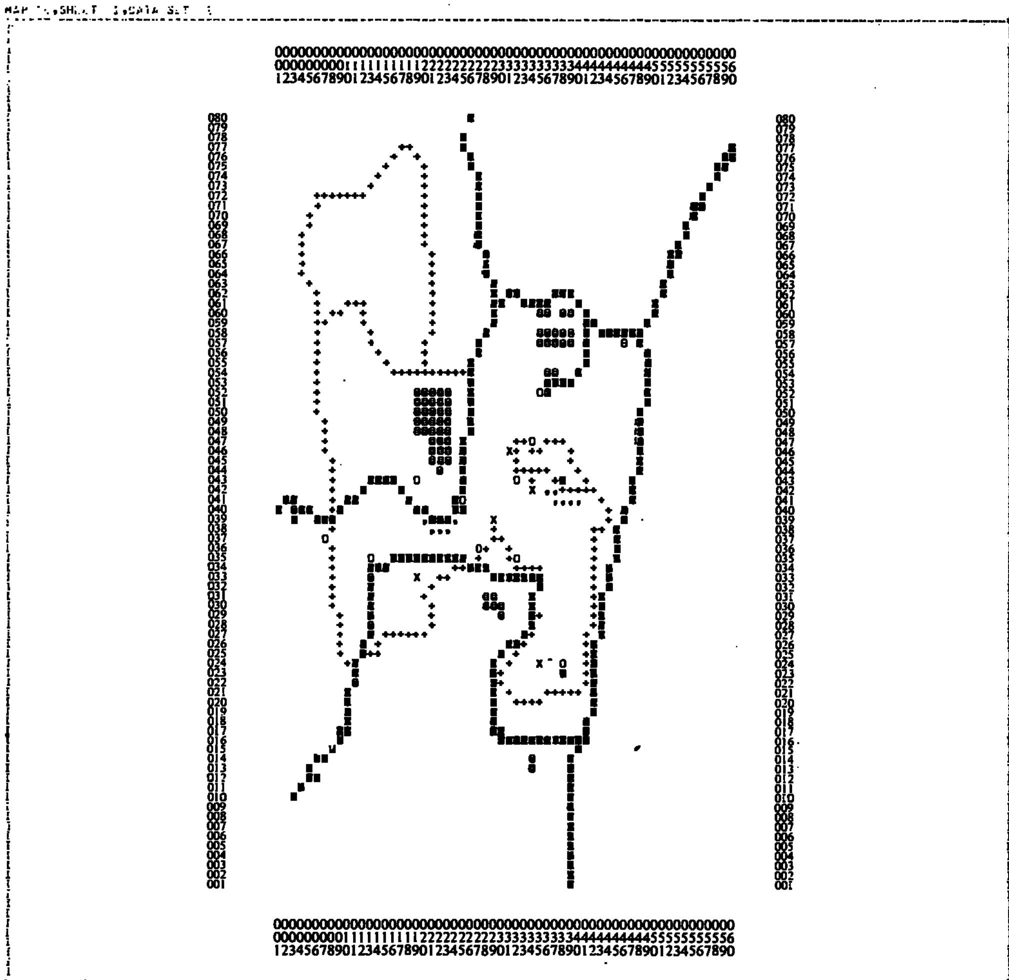
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	·········	'''''''''	·········	+++++++++	XXXXXXXX	000000000	888888888	888888888	■■■■■■■■	■■■■■■■■
FREQUENCY	379	176	0	2	410	19	0	5	15	20

Fig. I.3.4
Way "B": Total Impact



PLAN B - SUMMER

PROFESSIONAL JUDGEMENT - PEACOCK

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

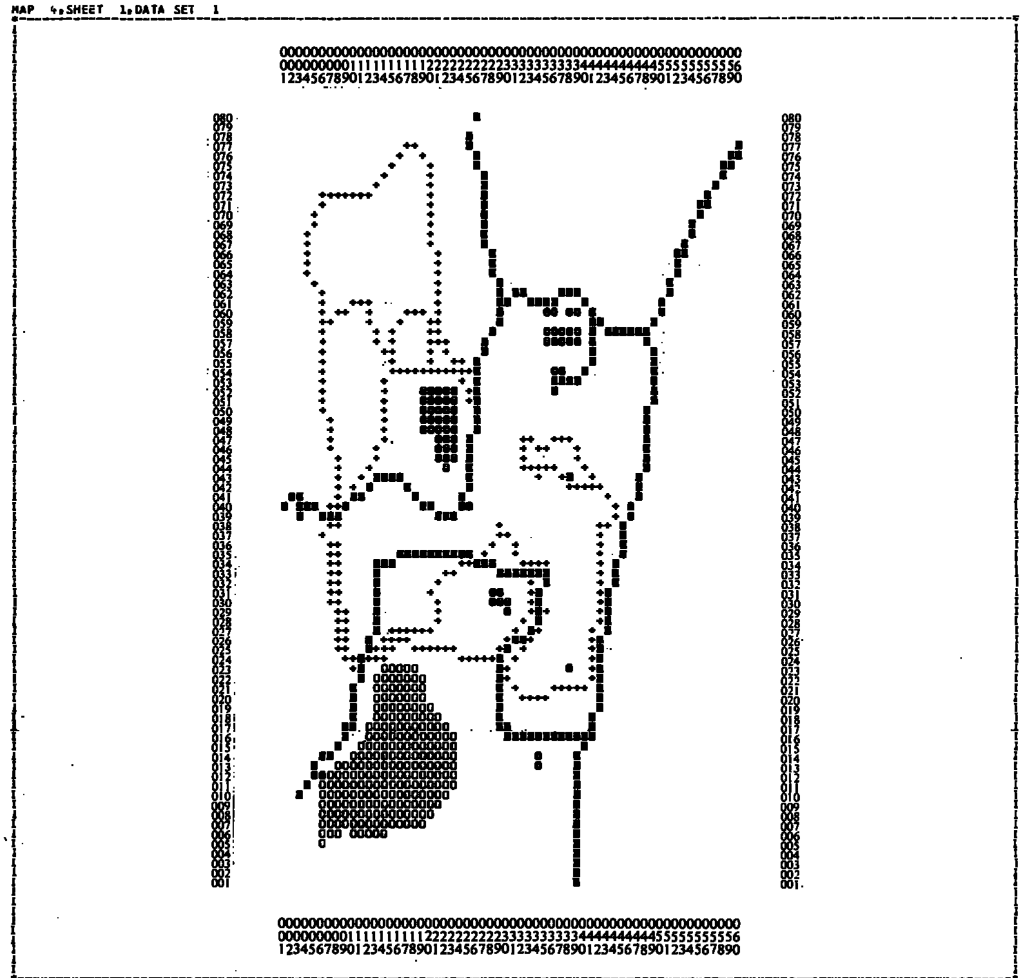
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		[illegible]	[illegible]	[illegible]	++++++++	XXXXXXXX	00000000	@@@@@@@@	[illegible]	[illegible]	[illegible]	
FREQUENCY	3837	0	0	11	195	5	10	1	59	5	252	0

Fig. I.4.1
Peacock "B": Summer Plan

MAP 4, SHEET 1, DATA SET 1



PLAN B - WINTER

PROFESSIONAL JUDGEMENT - PEACOCK

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CRCSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

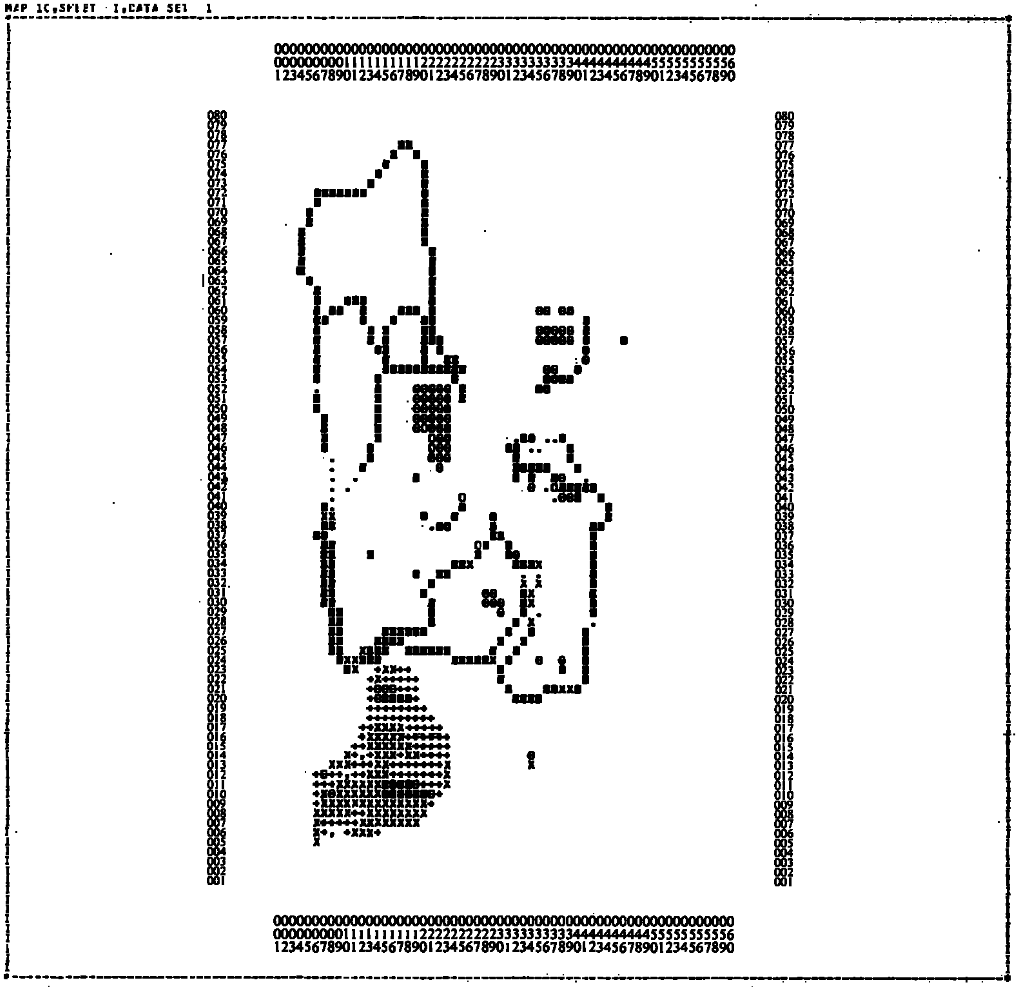
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		•••••••••	'''''''''	'''''''''	+++++++++	XXXXXXXXX	OOOOOOOOO	888888888	[illegible]	[illegible]	[illegible]	
FREQUENCY	3576	0	0	0	268	0	215	0	59	5	252	0

Fig. I.4.2
Peacock "B": Winter Plan

MAP 1C, SPLET I, DATA SET 1



ATTRACTIVENESS EVALUATION.- PLAN B

PROFESSIONAL JUDGEMENT - PEACOCK

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

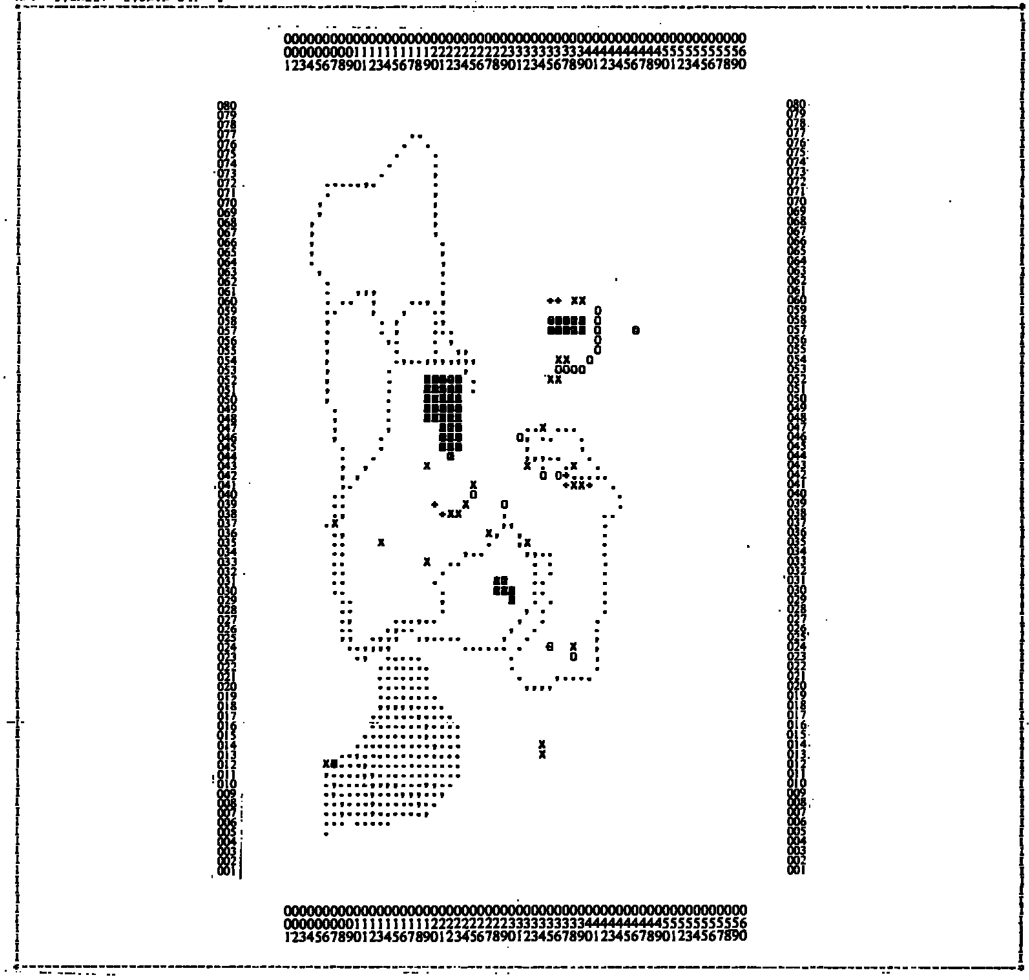
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	'	•	+	X	O	Ø	■	■	■
FREQUENCY	22	2	0	102	106	6	65	16	29	248

Fig. I.4.3
Peacock "B": Attractiveness

MAP 3, SHEET 1, CAT. S:1 1



EVALUATION OF PLAN 8 - PEACOCK

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 22.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00
MAXIMUM	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	'	•	+	X	0	@	@	█	█
FREQUENCY	357	139	0	7	25	16	1	3	25	25

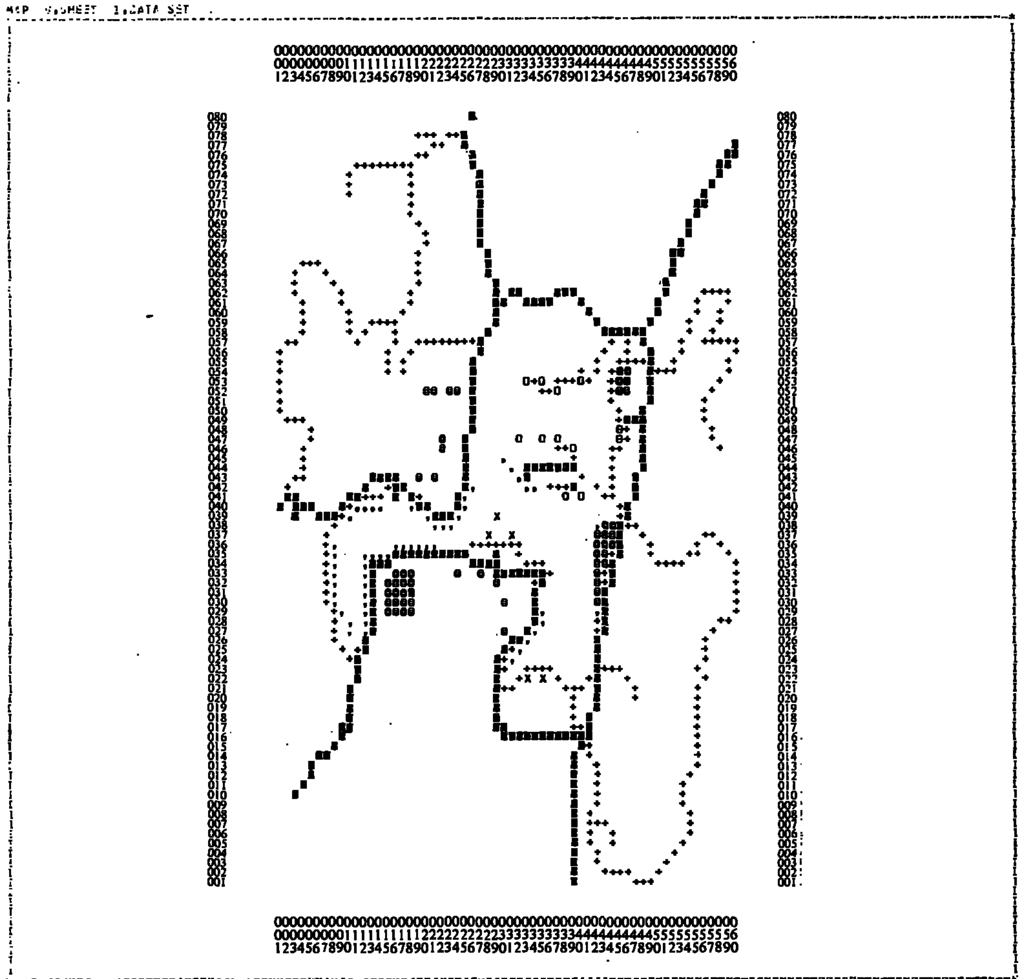
Fig. I.4.4
Peacock "B": Total Impact

APPENDIX J: IMPROVING THE PROFESSIONAL JUDGMENT "B" PLANS

Appendix J presents the various stages through which the initial plan for the "B" assumption made by Murray was improved through the introduction of the impact evaluations, the attractiveness evaluations, and simulation model. As seen in Table J.D.10, the final version of the Murray "B" plan has a greater site attractiveness and creates a lesser impact in both the summer and winter conditions. The final plan also produces more local and regional dollar income, however, its capital costs are slightly greater. The increased costs are seen as being more than offset by the increased income and the improved quality of the solution.

Four stages of the plan are presented:

J.A Murray "B": Initial Plan
J.B Murray "B": Improved via Impact Evaluations
J.C Murray "B": Improved via Attractiveness Evaluations
J.D Murray "B": Improved via Simulation Model Evaluations



PLAN B - SUMMER

PROFESSIONAL JUDGEMENT - MURRAY

HENRY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING
3 = SWIMMING
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	[illegible]	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	[illegible]	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

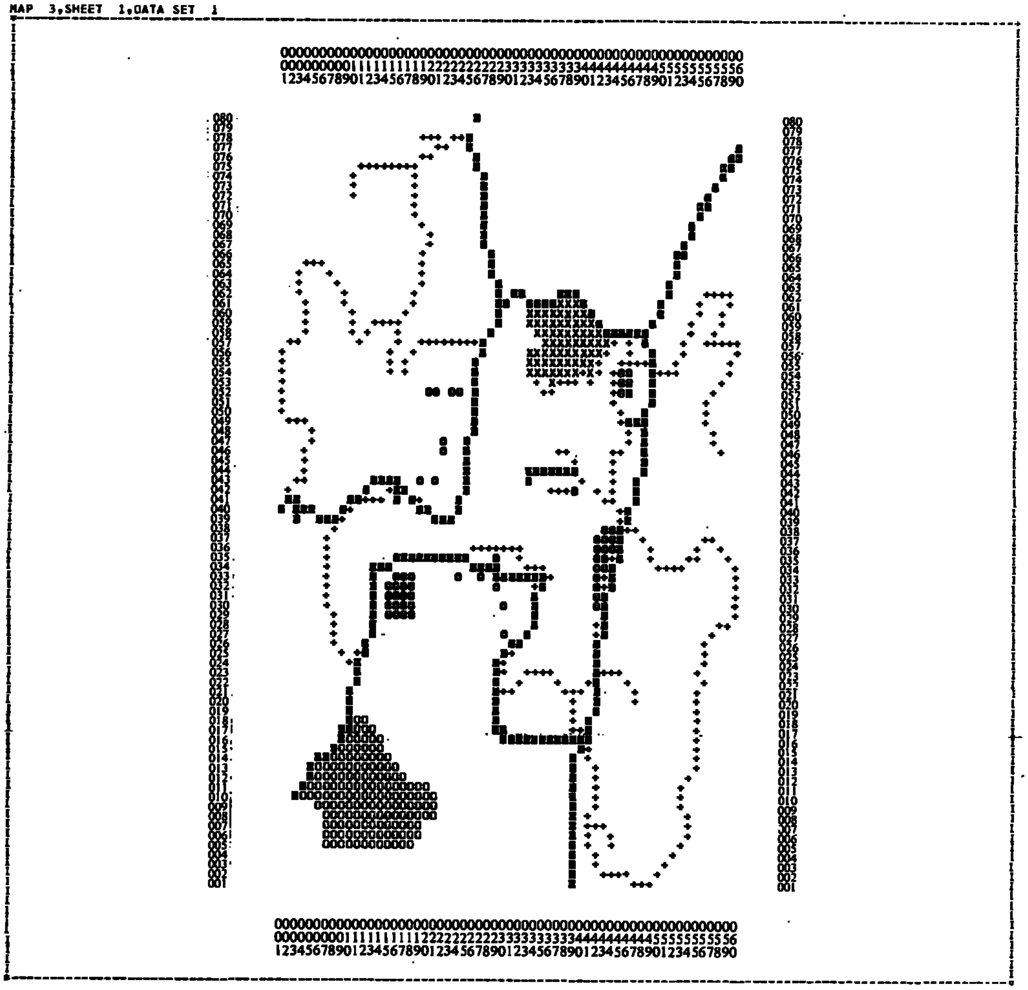
[illegible]	[illegible]	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	'''''''''	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@	@@@@@@@@@	■■■■■■■■■	■■■■■■■■■	
FREQUENCY	3679	[illegible]	45	10	313	5	[illegible]	2	54	5	232	0

Fig. J.1.1
Murray "B": Summer Plan

MAP 3,SHEET 1,DATA SET 1



PLAN B - WINTER

PROFESSIONAL JUDGEMENT - MURRAY

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

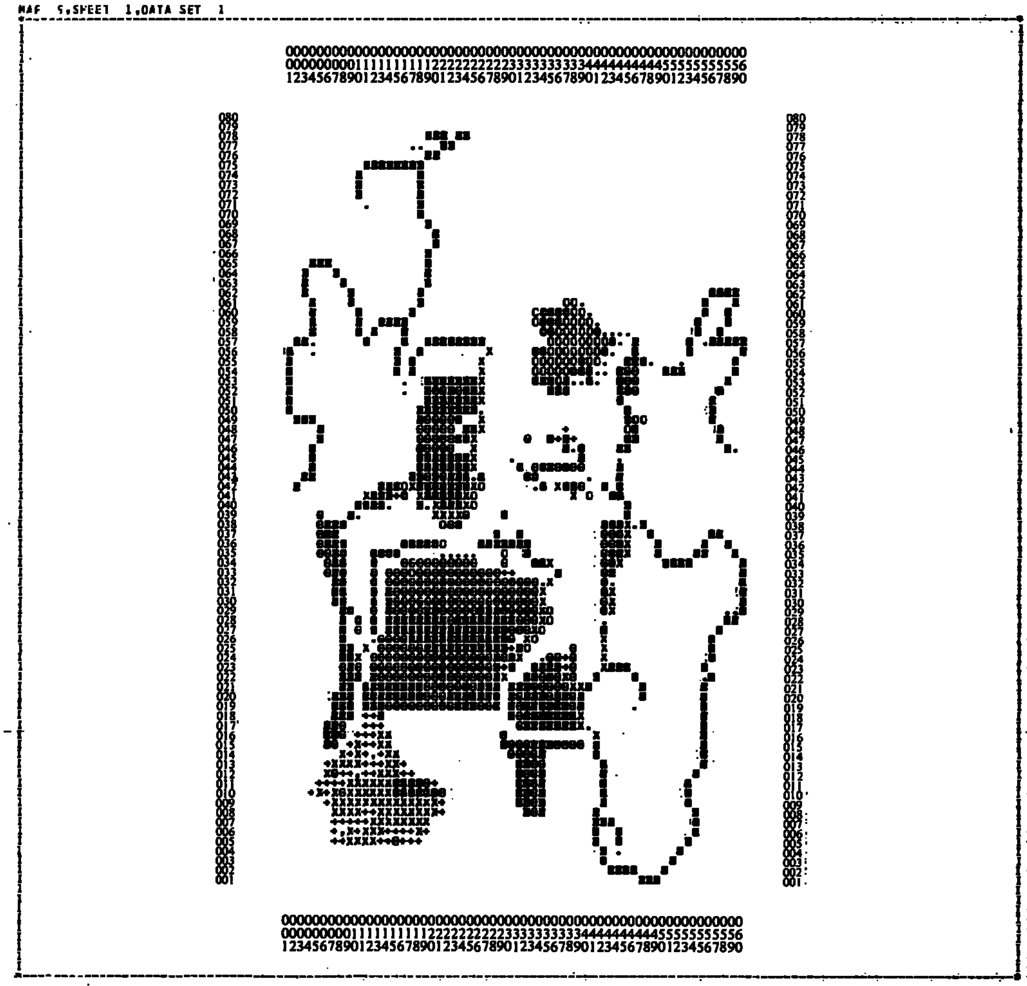
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	'''''''''	+++++++++	XXXXXXXXX	OOOOOOOOO	888888888				
FREQUENCY	3535	0	0	0	313	66	150	0	54	5	252	0

Fig. J.1.2
Murray "B": Winter Plan

MAP 5, SHEET 1, DATA SET 1



ATTRACTIVENESS EVALUATION - PLAN B

PROFESSIONAL JUDGEMENT - MURRAY

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

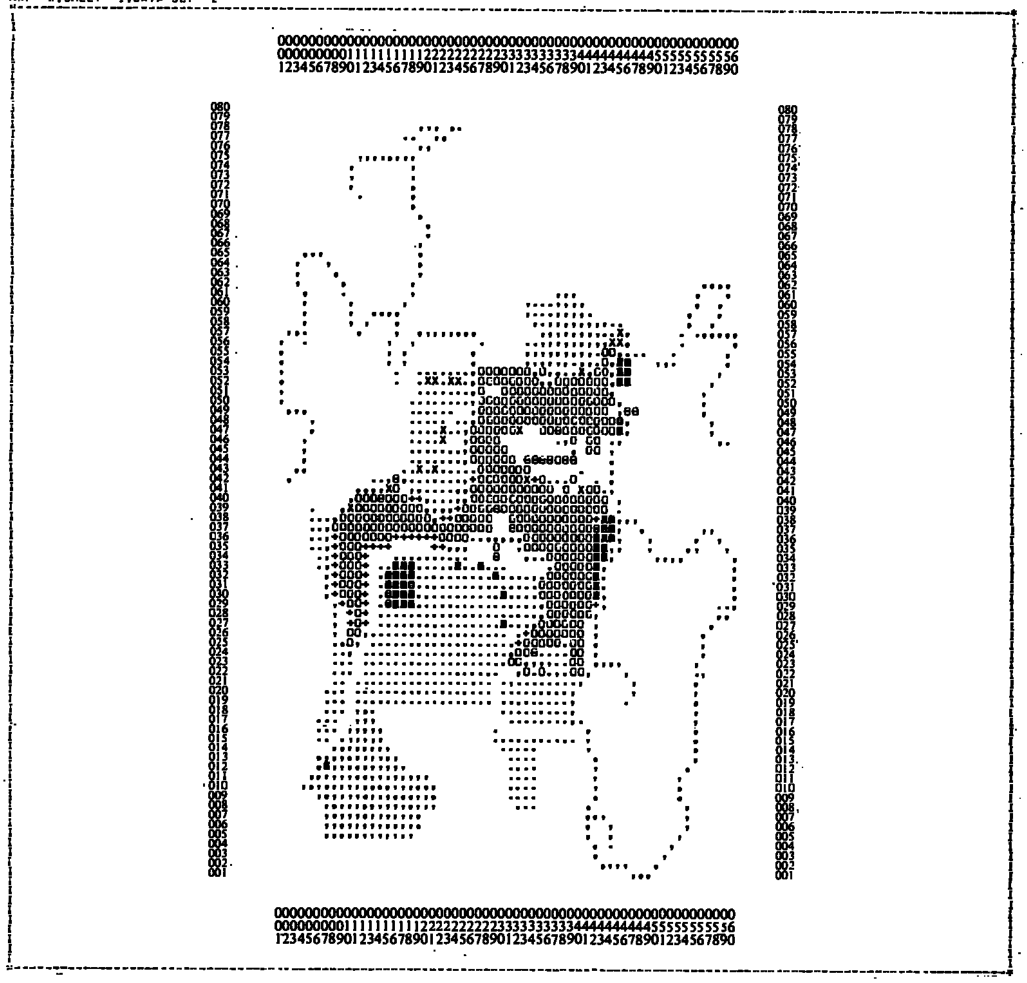
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	·········	'''''''''	:::::::::	+++++++++	XXXXXXXX	000000000	●●●●●●●●●	●●●●●●●●●	■■■■■■■■	■■■■■■■■
FREQUENCY	53	3	0	66	131	61	288	43	46	535

Fig. J.1.3
Murray "B": Attractiveness

MAP 2,SHEET 1,DATA SET 1



EVALUATION OF PLAN B - MURRAY

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70
MAXIMUM	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70	23.00

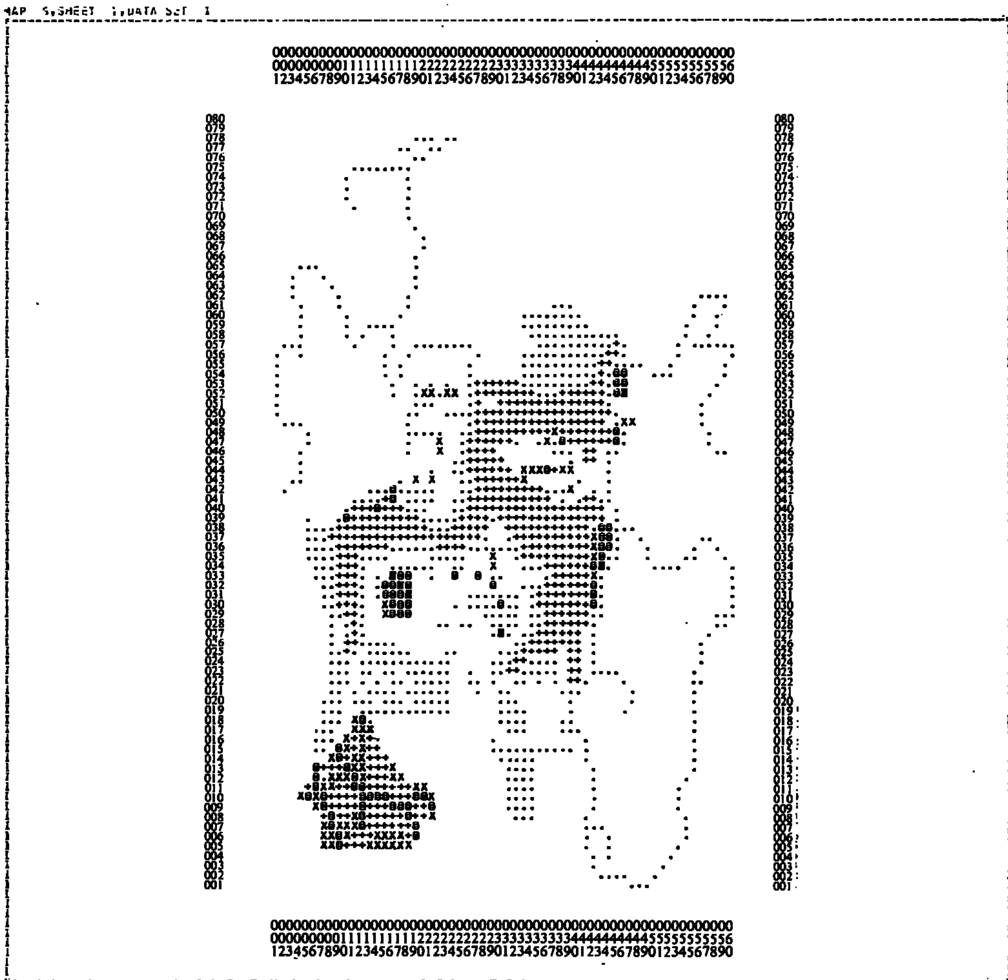
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	....	'''''''''	....	+++++++++	XXXXXXXXX	000000000	888888888	888888888	█████████	█████████
FREQUENCY	557	341	184	41	17	402	15	5	26	19

Fig. J.1.4
Murray "B": Total Impact



MURRAY B

IMPACT ON SURFACE WATER SYSTEM

HONEY HILL CASE STUDY

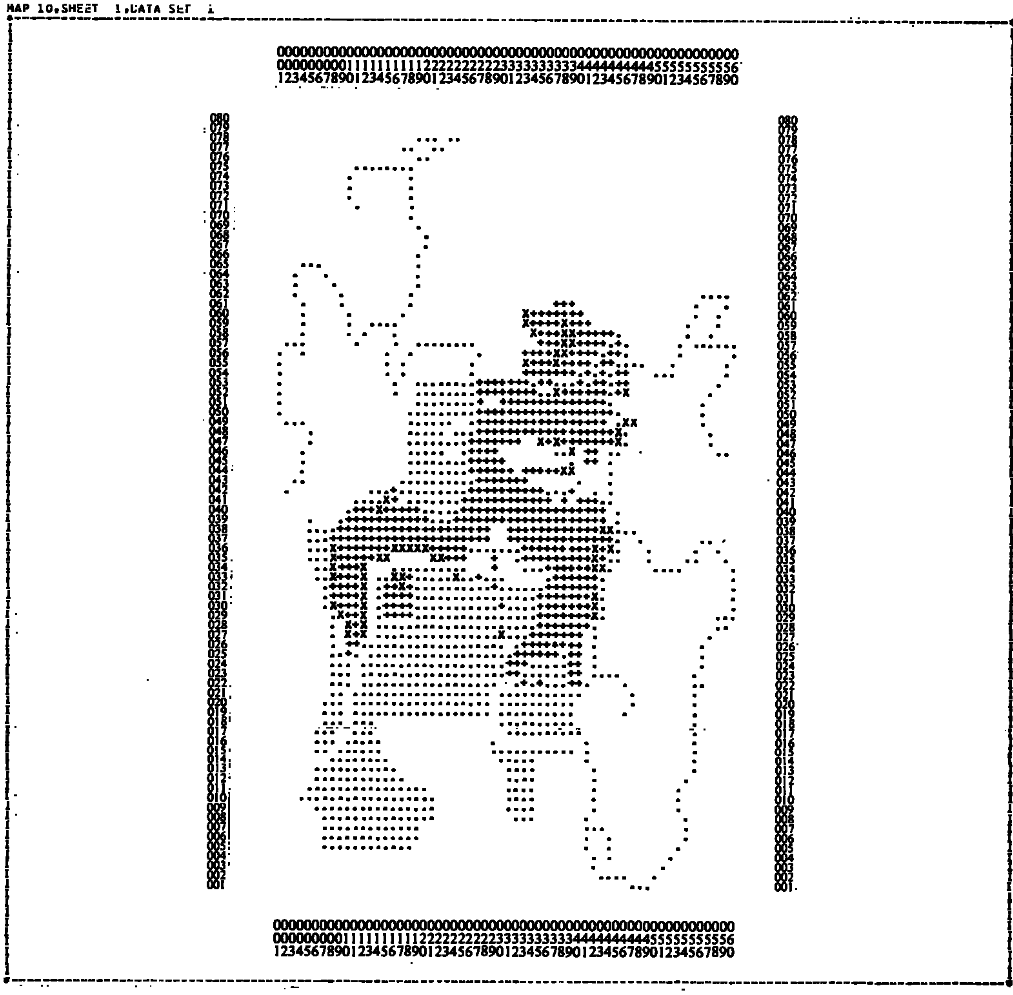
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXXX	@@@@@@@@@	■■■■■■■■■
FREQUENCY	77?	459	76	75	6

Fig. J.1.5
Murray "B": Impact on Surface Water Systems

MAP 10,SHEET 1,DATA SET 1



MURRAY B

IMPACT ON WILDLIFE HABITAT

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXXX	@@@@@@@@@	■■■■■■■■■
FREQUENCY	1013	528	65	0	0

Fig. J.1.6
Murray "B": Impact on Wildlife Habitat

Murray "B"
Table J.1.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	235.0	0.0	0.0	0.0
3	6.0	0.0	0.0	0.0
4	341.0	0.0	0.0	0.0
5	5.0	0.0	0.0	0.0
6	10.0	0.0	0.0	0.0
7	1.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	598.0	0.0	0.0	0.0

Murray "B"
Table J.1.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	3441.5	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	5126.6	0.0	0.0	0.0	0.0
7	2296.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	25808.4	0.0	0.0	0.0	0.0

Murray "B"
Table J.1.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	24847.3	68578.5
3	27785.8	76688.8
4	16576.9	45752.3
5	3292.3	6518.8
6	29734.1	58873.5
7	16577.2	45753.1
8	0.0	0.0
9	0.0	0.0
TOTAL	118813.5	302164.8

Murray "B"
Table J.1.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	269.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	341.0	0.0	0.0	0.0
5	61.0	0.0	0.0	0.0
6	149.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	820.0	0.0	0.0	0.0

Murray "B"
Table J.1.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	1019.4	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	2827.0	0.0	0.0	0.0	0.0
6	8253.8	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	15822.6	0.0	0.0	0.0	0.0

Murray "B"
Table J.1.6: "Winter N=3000
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	5912.3	11706.3
3	0.0	0.0
4	26876.3	74178.5
5	16396.4	32464.9
6	140066.3	386582.8
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	189251.3	504932.5

Murray "B"
Table J.1.7: Attractiveness Summary

SUMMER PLAN ACTIVITY	ATTRACTIVENESS # OF CELLS	MEAN
1	0	0.0
2	45	0.0
3	10	54.00
4	313	53.13
5	5	81.00
6	10	80.00
7	2	45.00
8	55	67.51
9	5	70.00
10	252	3.74
TOTAL	697	51.64

WINTER PLAN ACTIVITY	ATTRACTIVENESS # OF CELLS	MEAN
11	0	0.0
12	1	100.00
13	0	0.0
14	313	53.13
15	66	60.61
16	149	45.57
17	0	0.0
18	55	67.51
19	5	70.00
20	252	3.74
TOTAL	841	53.56

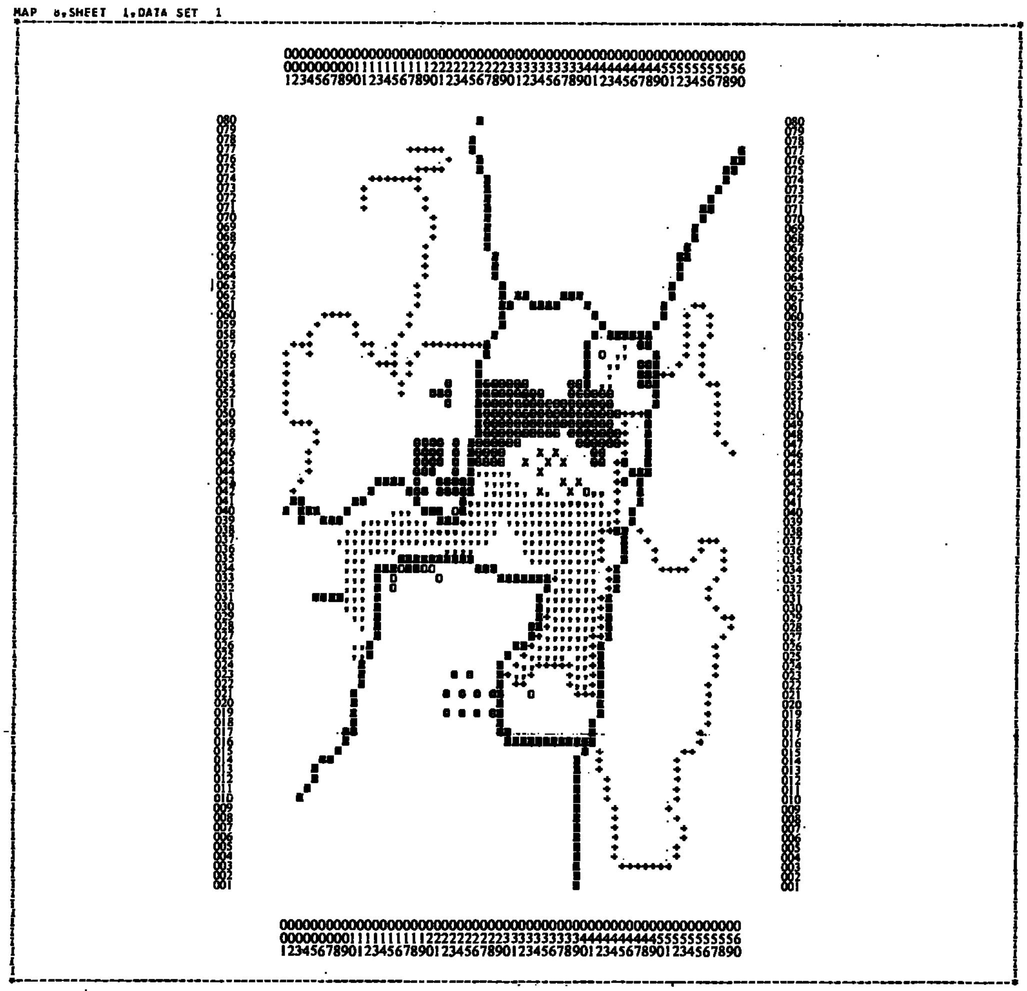
Murray "B"
Table J.1.8: Plan Impact

TOTAL IMPACT = 8720.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	440	75	101	266	31	1.313
2	584	287	42	0	0	0.406
3	435	397	81	0	0	0.612
4	463	279	162	9	0	0.690
5	574	48	287	3	1	0.696
6	221	127	273	292	0	1.697
7	529	6	137	237	4	1.103
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	150	99	446	46	172	1.990
11	435	167	157	144	10	1.044
TOTAL	3631	1485	1666	997	218	1.061

Murray "B"
Table J.1.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	211 75	0 0
4	62 60	62 60
5	125 00	0 0
6	43 75	1192 00
7	12 00	0 0
8	16500 00	16500 00
9	196 63	196 63
10	514 08	514 08
TOTAL	17665080	18465030



MURRAY B + IMPACT EVALUATIONS

SUMMER PLAN

HUNEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANCEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.58	7.50	8.50	9.58
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

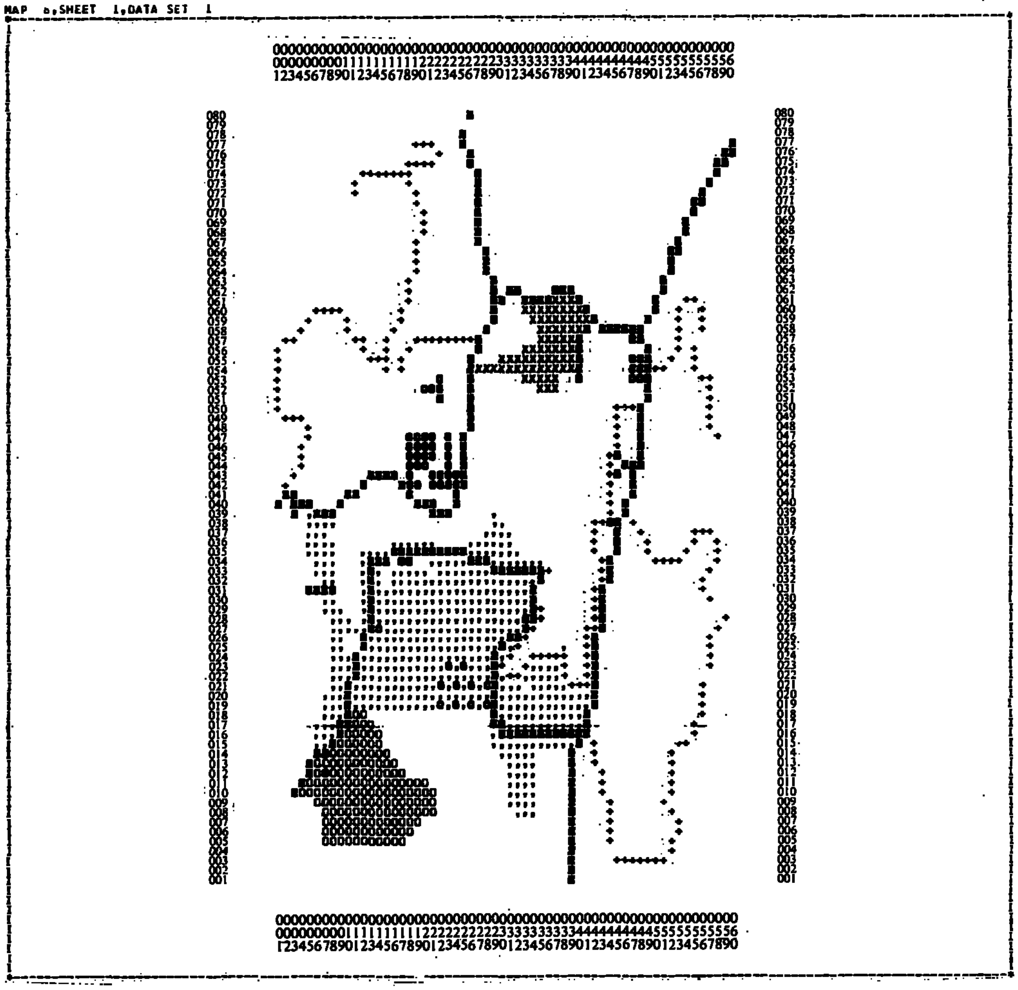
10.00	18.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		•••••••••	'''''''''	•••••••••	+++++++++	XXXXXXXXX	000000000	■■■■■■■■■	■■■■■■■■■	■■■■■■■■■	■■■■■■■■■	
FREQUENCY	3834	0	272	12	234	10	10	115	51	10	252	0

Fig. J.2.1
Murray "B" + Impact Evaluations: Summer Plan

MAP 6,SHEET 1,DATA SET 1



MURRAY B + IMPACT EVALUATIONS

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.58	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

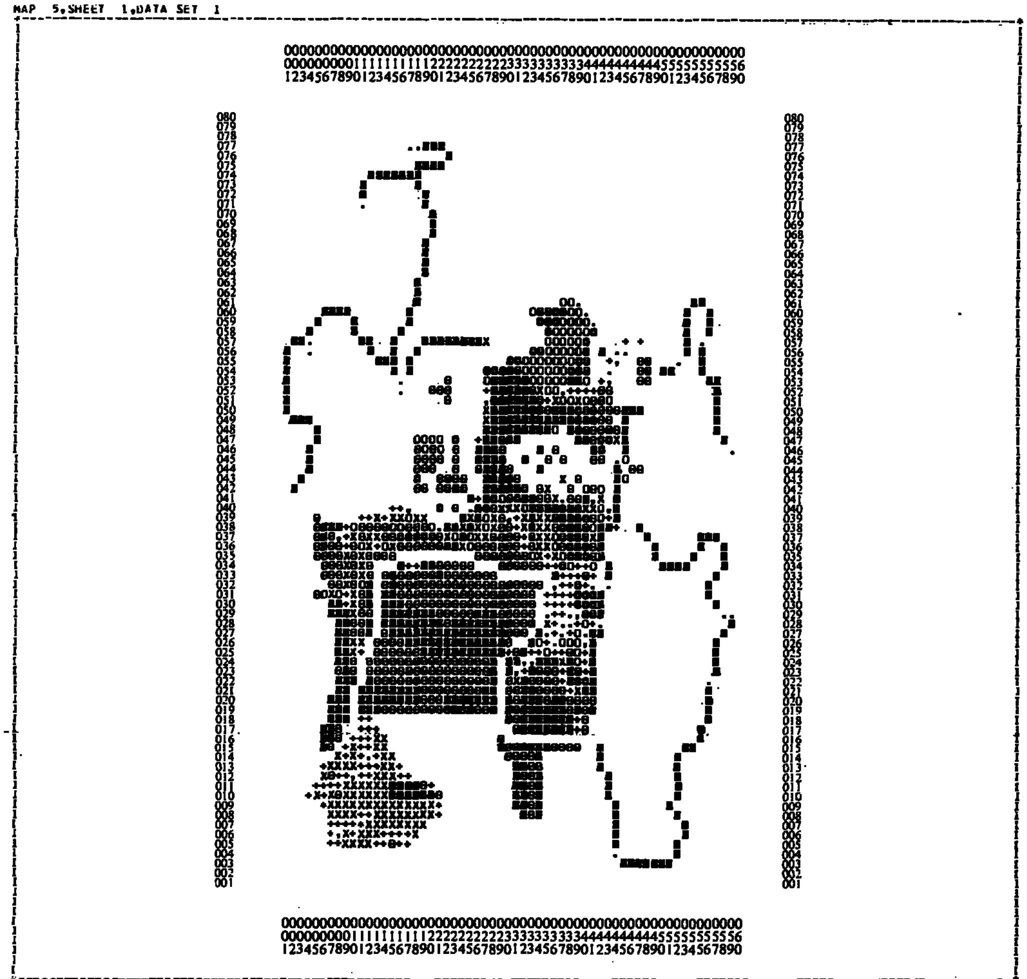
10.00	10.00	18.00	10.00	10.00	10.00	10.00	10.00	10.80	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS												
FREQUENCY	3565	0	484	0	221	68	147	0	53	10	252	0

Fig. J.2.2
Murray "B" + Impact Evaluations: Winter Plan

MAP 5,SHEET 1,DATA SET 1



MURRAY - B WITH IMPACT EVALUATION

ATTRACTIVENESS EVALUATION

HUNEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	68.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

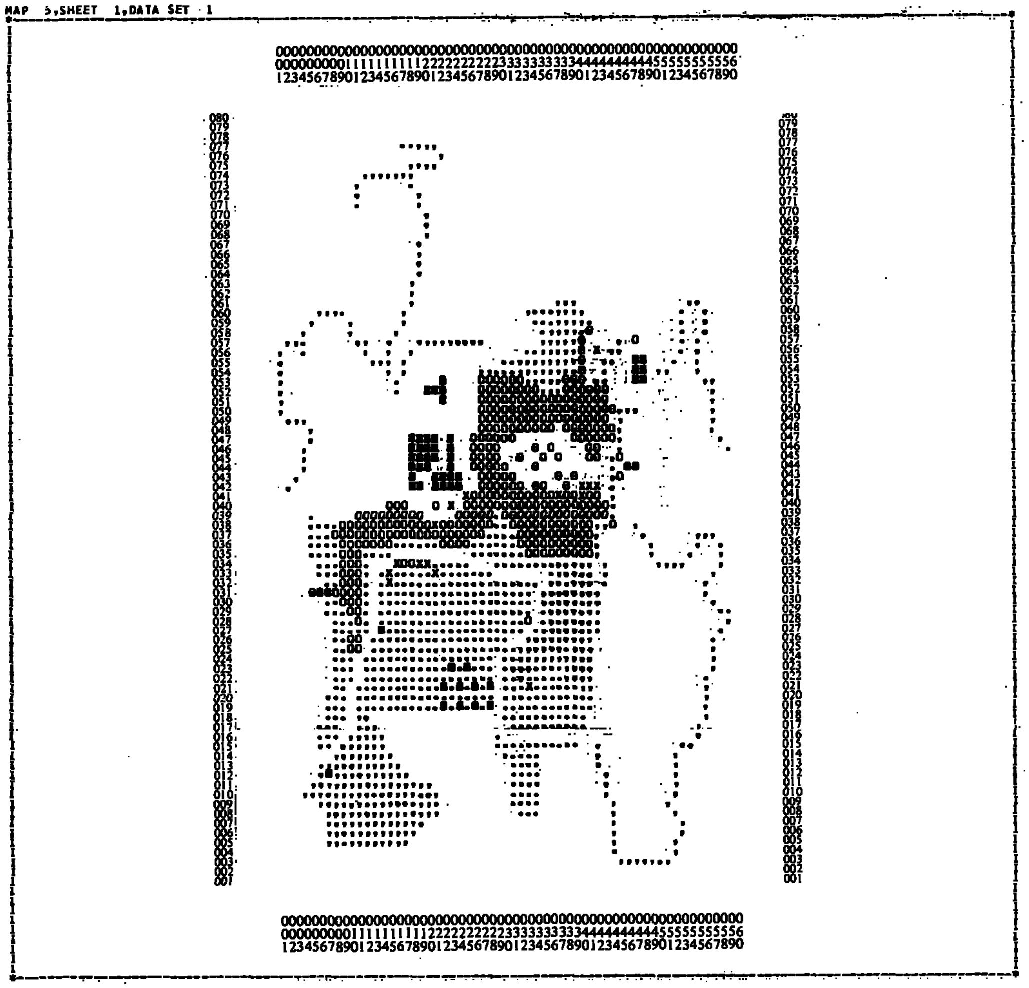
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	[illegible]	[illegible]	[illegible]	++++++++	XXXXXXXX	OOOOOOOO	[illegible]	[illegible]	[illegible]	[illegible]
FREQUENCY	36	12	5	128	142	96	383	85	66	474

Fig. J.2.3
Murray "B" + Impact Evaluations: Attractiveness

MAP 5,SHEET 1,DATA SET 1



MURRAY - B WITH IMPACT EVALUATION

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 21.00.

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	2.10	4.20	6.30	8.40	10.50	12.60	14.70	16.80	18.90
MAXIMUM	2.10	4.20	6.30	8.40	10.50	12.60	14.70	16.80	18.90	21.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.80	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	'	.	+	X	O	[illegible]	[illegible]	[illegible]	[illegible]
FREQUENCY	532	308	176	0	16	323	15	4	20	33

Fig. J.2.4
Murray "B" + Impact Evaluations: Total Impact

Murray "B" + Impact Evaluations
Table J.2.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	235.0	0.0	0.0	0.0
3	9.0	0.0	0.0	0.0
4	217.0	0.0	0.0	0.0
5	10.0	0.0	0.0	0.0
6	10.0	0.0	0.0	0.0
7	2.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	483.0	0.0	0.0	0.0

Murray "B" + Impact Evaluations
Table J.2.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	3441.5	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	5126.6	0.0	0.0	0.0	0.0
7	2296.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	25808.4	0.0	0.0	0.0	0.0

Murray "B" + Impact Evaluations
Table J.2.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	24847.3	68578.4
3	27785.8	76688.8
4	16577.0	45752.4
5	3292.3	6518.8
6	29734.1	58873.5
7	16577.2	45753.1
8	0.0	0.0
9	0.0	0.0
TOTAL	118813.5	302164.8

Murray "B" + Impact Evaluations
Table J.2.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	191.0	0.0	0.0	0.0
3	113.0	0.0	0.0	0.0
4	217.0	0.0	0.0	0.0
5	64.0	0.0	0.0	0.0
6	147.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	732.0	0.0	0.0	0.0

Murray "B" + Impact Evaluations
Table J.2.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	1019.4	0.0	0.0	0.0	0.0
3	1650.8	0.0	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	2827.0	0.0	0.0	0.0	0.0
6	8253.9	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	17473.6	0.0	0.0	0.0	0.0

Murray "B" + Impact Evaluations
Table J.2.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	5912.3	11706.3
3	11506.0	31756.4
4	26876.7	74179.7
5	16396.5	32465.0
6	140068.8	386589.7
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	200760.1	536696.9

Murray "B" + Impact Evaluations
Table J.2.7: Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	0	0.0
2	81	42.22
3	12	61.67
4	221	96.83
5	10	66.60
6	10	85.00
7	2	90.00
8	53	66.11
9	10	57.00
10	252	3.54
TOTAL	651	49.50

WINTER PLAN ATTRACTIVENESS

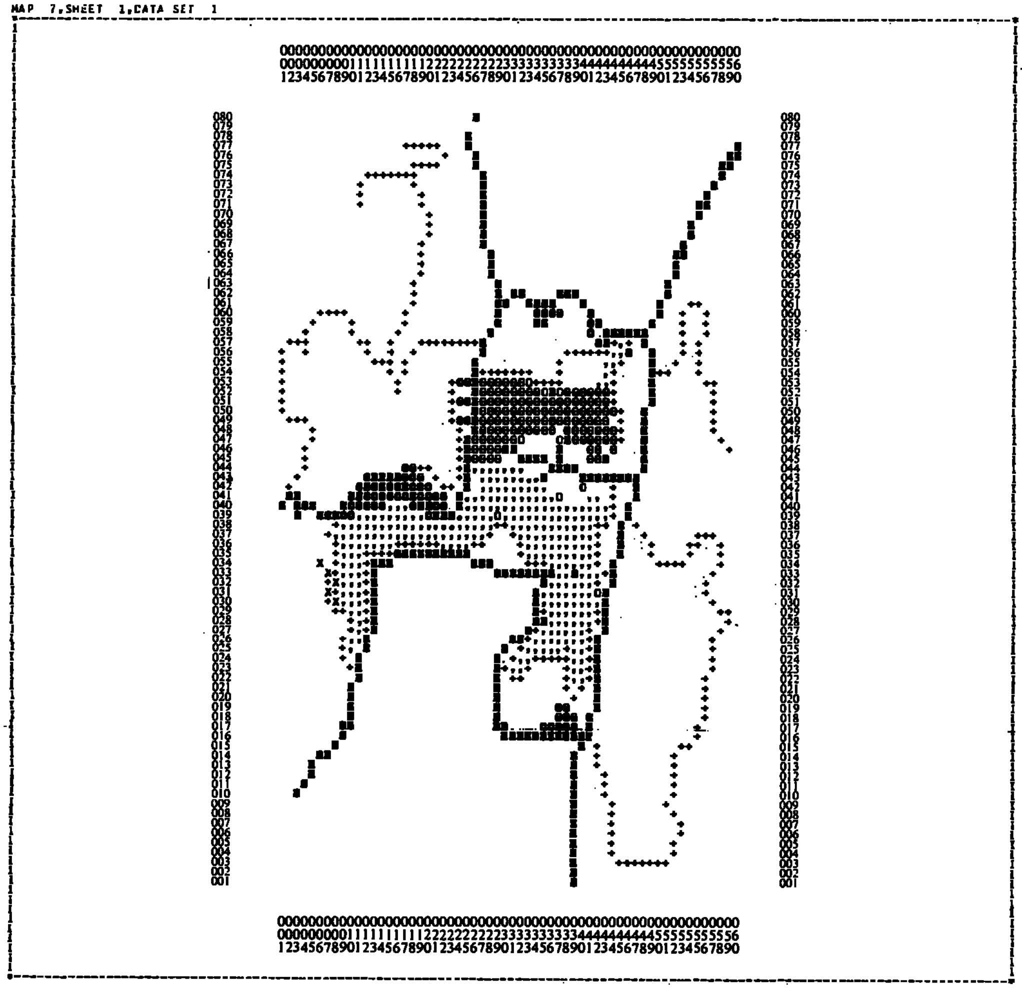
ACTIVITY	# OF CELLS	MEAN
11	0	0.0
12	0	0.0
13	0	0.0
14	221	96.83
15	68	62.35
16	147	45.74
17	0	0.0
18	53	66.11
19	10	57.00
20	252	3.54
TOTAL	751	49.71

Murray "B" + Impact Evaluations
Table J.2.8: Plan Impact TOTAL IMPACT = 8444.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	390	77	127	246	26	1.355
2	527	309	30	0	0	0.426
3	382	396	88	0	0	0.661
4	368	362	127	9	0	0.742
5	517	61	284	3	1	0.741
6	225	195	242	204	0	1.491
7	436	13	107	305	5	1.342
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	147	168	342	40	169	1.903
11	382	180	158	136	10	1.090
TOTAL	3374	1761	1505	943	211	1.083

Murray "B" + Impact Evaluations
Table J.2.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	254 10	0 0
4	44 20	44 20
5	250 00	0 0
6	43 75	1176 00
7	12 00	0 0
8	15900 00	15900 00
9	393 25	393 25
10	514 08	514 08
TOTAL	17411038	18027053



MURRAY B + ATTRACTIVENESS EVALUATICNS

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING ANC CANCEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESICENTIAL
9 = PARKING
10= MAJCR RCADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

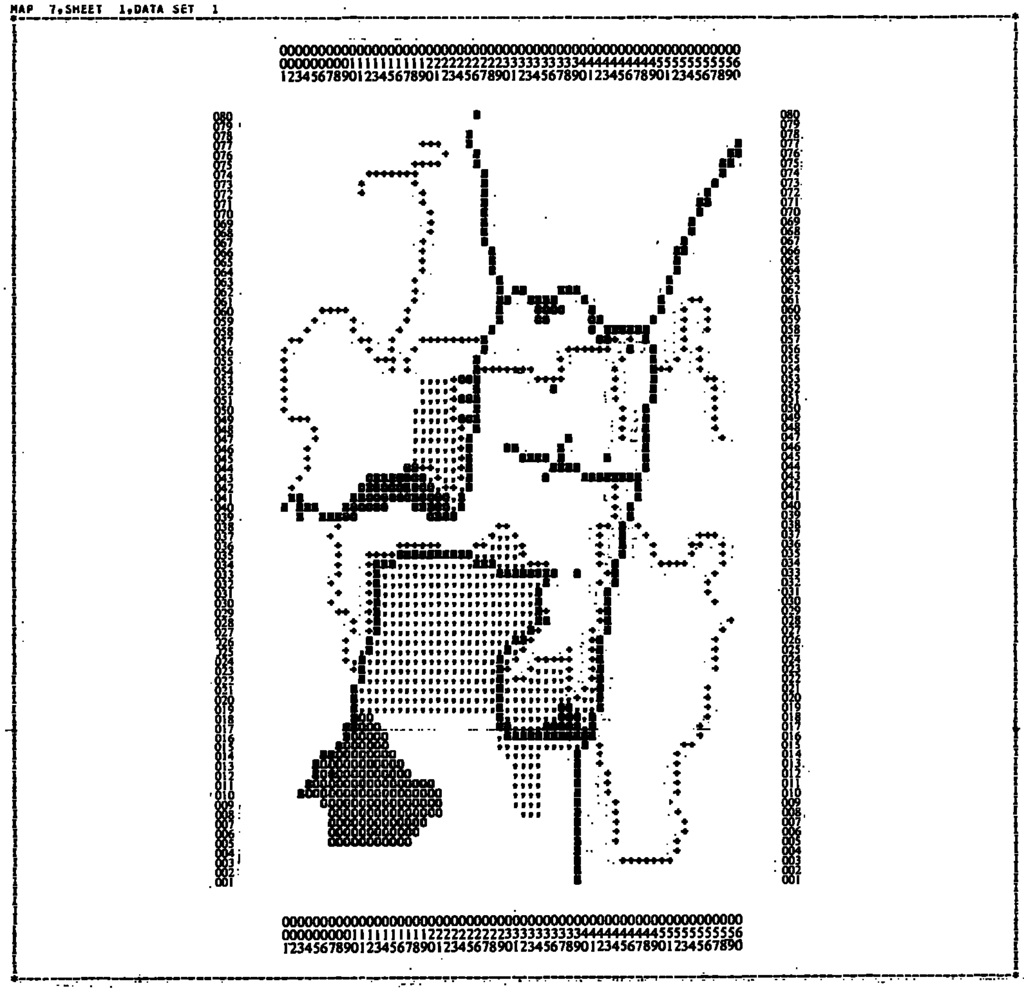
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	[illegible]	[illegible]	+++++++++	XXXXXXXX	OOOOOOOOO	[illegible]	[illegible]	[illegible]	[illegible]	
FREQUENCY	3744	0	273	12	313	5	9	114	61	9	260	0

Fig. J.3.1
Murray "B" + Attractiveness Evaluations:
Summer Plan

MAP 7,SHEET 1,DATA SET 1



MURRAY B + ATTRACTIVENESS EVALUATIONS

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

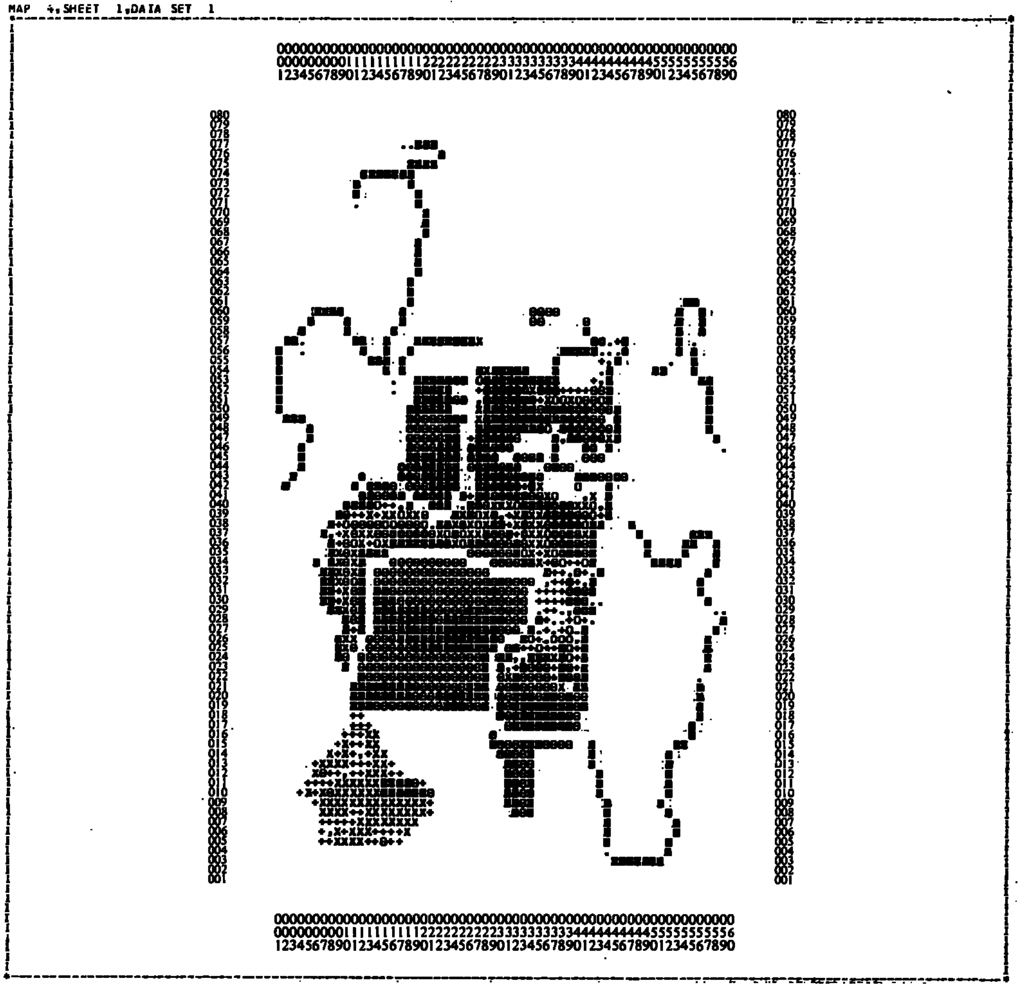
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0 (LOW VALUES)	1	2	3	4	5	6	7	8	9	10	11 (HIGH VALUES)
SYMBOLS												
FREQUENCY	3568	0	454	0	300	0	147	0	62	9	260	0

Fig. J.3.2
Murray "B" + Attractiveness Evaluations:
Winter Plan

MAP 4,SHEET 1,DATA SET 1



MURRAY - B WITH ATTRACTIVENESS EVALUATION

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

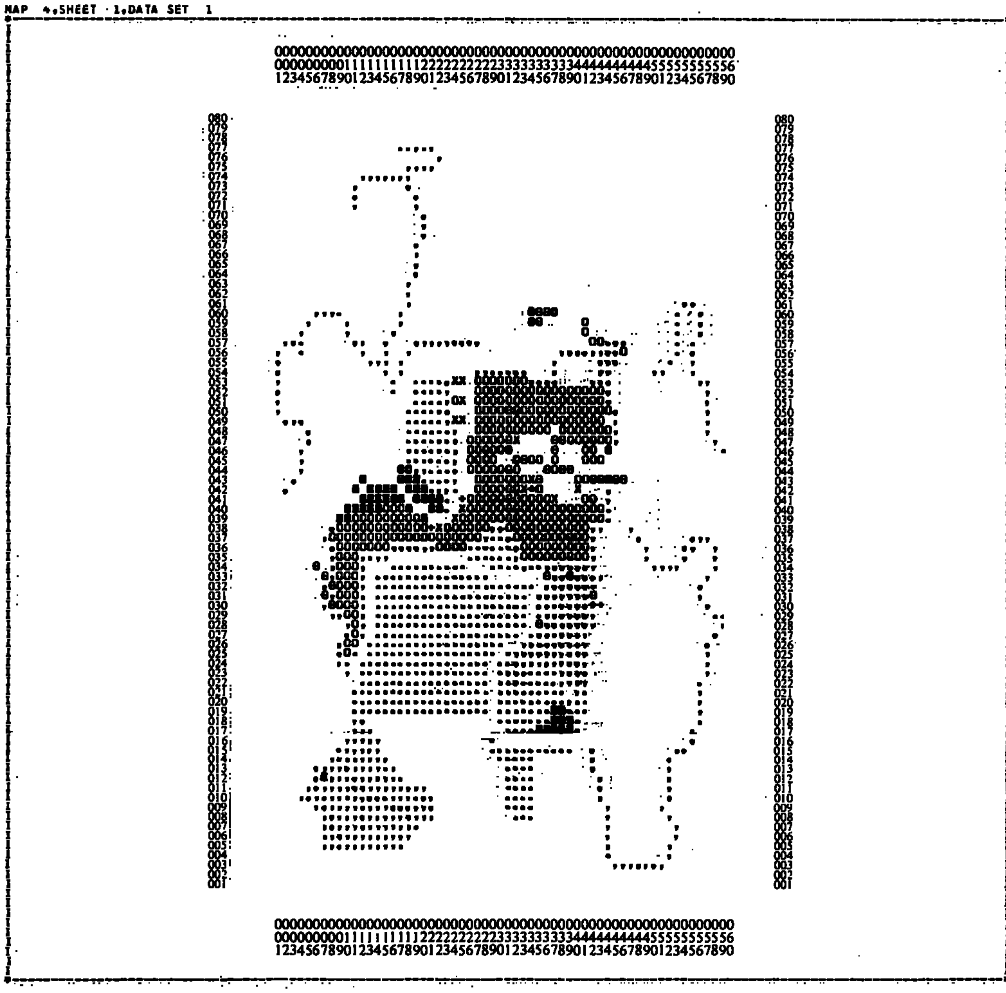
10.00	10.00	10.08	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	[illegible]	[illegible]	[illegible]	+	X	0	[illegible]	[illegible]	[illegible]	[illegible]
FREQUENCY	35	12	6	118	141	42	340	73	96	555

Fig. J.3.3
Murray "B" + Attractiveness Evaluations:
Attractiveness

MAP 4.SHEET 1.DATA SET 1



MURRAY - B WITH ATTRACTIVENESS EVALUATION

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70
MAXIMUM	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70	23.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS										
FREQUENCY	491	299	206	5	13	329	24	10	20	21

Fig. J.3.4
Murray "B" + Attractiveness Evaluations:
Total Impact

Murray "B" + Attractiveness Evaluations
Table J.3.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	235.0	0.0	0.0	0.0
3	10.0	0.0	0.0	0.0
4	296.0	0.0	0.0	0.0
5	5.0	0.0	0.0	0.0
6	9.0	0.0	0.0	0.0
7	1.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	556.0	0.0	0.0	0.0

Murray "B" + Attractiveness Evaluations
Table J.3.2: "Summer N=3000
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	3441.5	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	5126.6	0.0	0.0	0.0	0.0
7	2296.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	25808.4	0.0	0.0	0.0	0.0

Murray "B" + Attractiveness Evaluations
Table J.3.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	24847.3	68578.5
3	27785.8	76688.7
4	16577.1	45752.9
5	3292.3	6518.8
6	29734.1	58873.5
7	16577.2	45753.1
8	0.0	0.0
9	0.0	0.0
TOTAL	118813.8	302165.3

Murray "B" + Attractiveness Evaluations
Table J.3.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	3.0	0.0	0.0	0.0
2	247.0	0.0	0.0	0.0
3	113.0	0.0	0.0	0.0
4	296.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6	147.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	806.0	0.0	0.0	0.0

Murray "B" + Attractiveness Evaluations
Table J.3.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	2026.3	0.0	0.0	0.0	0.0
2	1019.4	0.0	0.0	0.0	0.0
3	1650.8	0.0	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	8253.9	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	16672.9	0.0	0.0	0.0	0.0

Murray "B" + Attractiveness Evaluations
Table J.3.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	12401.3	34227.4
2	5912.3	11706.3
3	11506.0	31756.4
4	26876.6	74179.3
5	0.0	0.0
6	140068.8	386589.7
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	196764.8	538459.1

Murray "B" + Attractiveness Evaluations
Table J.3.7: Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	0	0.0
2	82	41.22
3	12	77.50
4	300	97.50
5	5	90.00
6	9	81.11
7	1	90.00
8	62	77.85
9	9	66.67
10	260	3.57
TOTAL	740	55.66

WINTER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
11	0	0.0
12	56	89.68
13	0	0.0
14	300	97.50
15	0	0.0
16	147	45.74
17	0	0.0
18	62	77.85
19	9	66.67
20	260	3.57
TOTAL	834	56.78

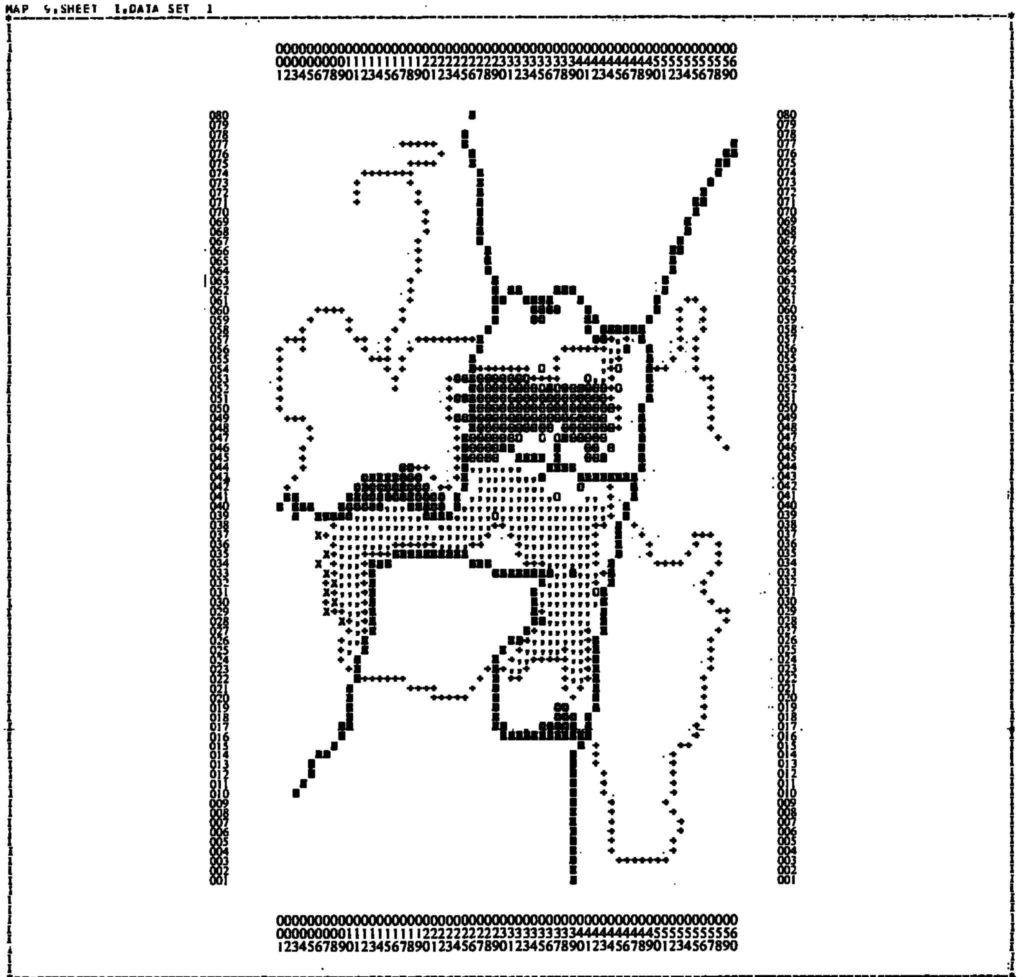
Murray "B" + Attractiveness Evaluations
Table J.3.8: Plan Impact TOTAL IMPACT = 8927.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	452	81	136	248	26	1.274
2	594	286	62	1	0	0.438
3	450	393	100	0	0	0.629
4	503	302	129	9	0	0.622
5	585	59	295	3	1	0.702
6	212	200	274	257	0	1.611
7	503	2	96	338	4	1.298
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	203	156	367	37	180	1.825
11	450	168	149	163	13	1.068
TOTAL	3952	1647	1608	1056	224	1.052

Murray "B" + Attractiveness Evaluations
Table J.3.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	254 10	0 0
4	60 00	60 00
5	125 00	0 0
6	39 38	1176 00
7	6 00	0 0
8	18600 00	18600 00
9	353 92	353 92
10	530 40	530 40
TOTAL	19968079	20720032

MAP 9, SHEET 1, DATA SET 1



MURRAY B + ATTRACT EVAL + IMPACT EVAL + SIMULATION EVAL, IA=3000)

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING ANC CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESICENTIAL
9 = PARKING
10= MAJOR RCADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

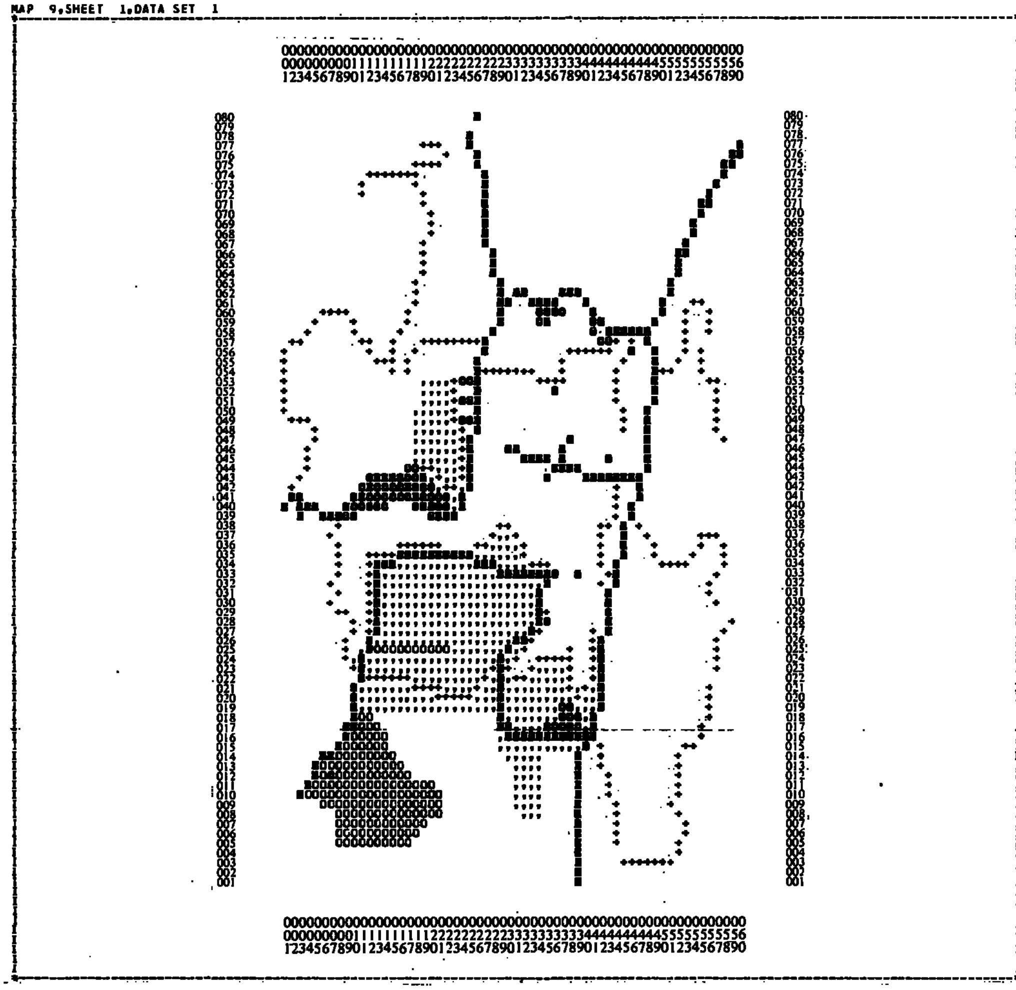
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		·········	'''''''''	•••••••••	+++++++++	XXXXXXXXX	OOOOOOOOO	[illegible]	[illegible]	[illegible]	[illegible]	
FREQUENCY	3724	0	273	10	327	9	14	113	61	9	260	0

Fig. J.4.1
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Summer Plan



MURRAY 8 + ATTRACT EVAL + IMPACT EVAL + SIMULATION EVAL . 1N=3000I

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
0 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

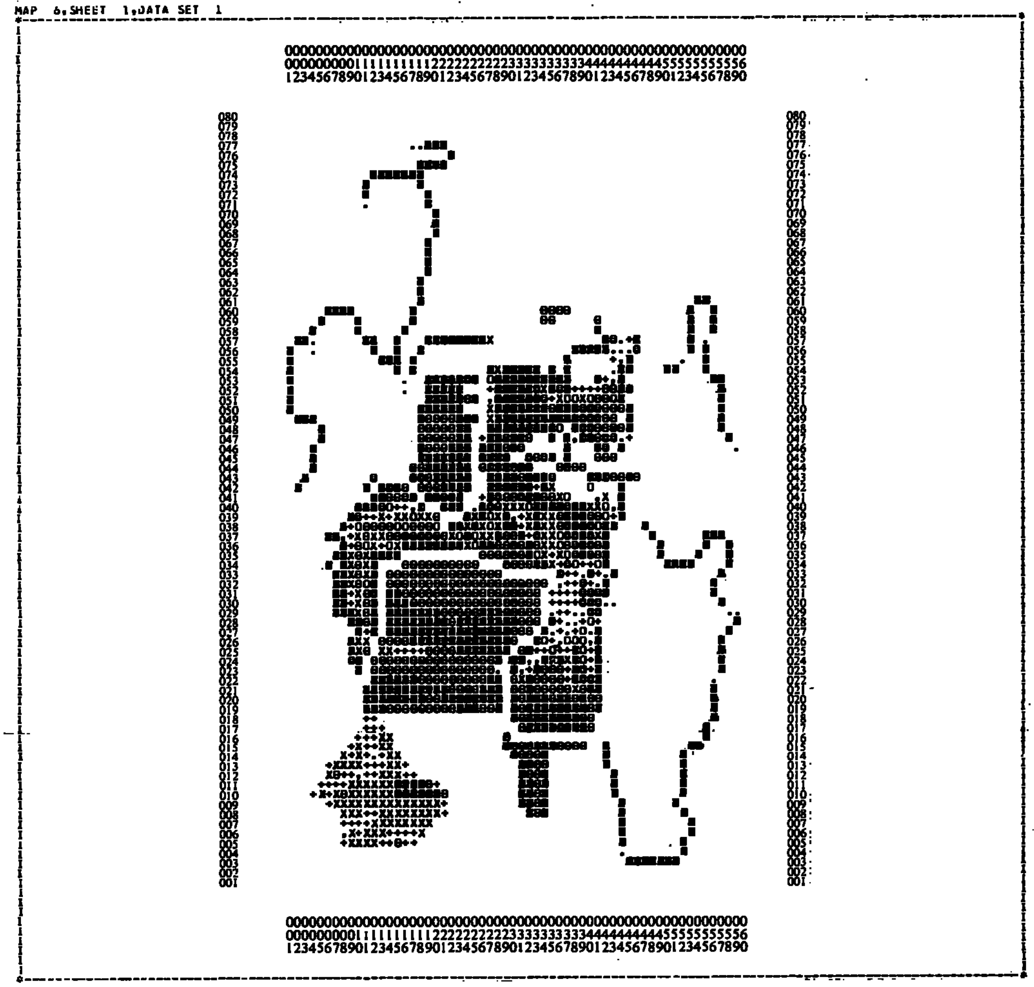
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		[illegible]	[illegible]	[illegible]	++++++++	XXXXXXXX	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
FREQUENCY	3575	0	427	0	314	0	153	0	62	9	260	0

Fig. J.4.2
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Winter Plan

MAP 6,SHEET 1,DATA SET 1



MURRAY - B WITH ATTRACTIVENESS AND IMPACT EVAL + SIMULATION EVAL

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

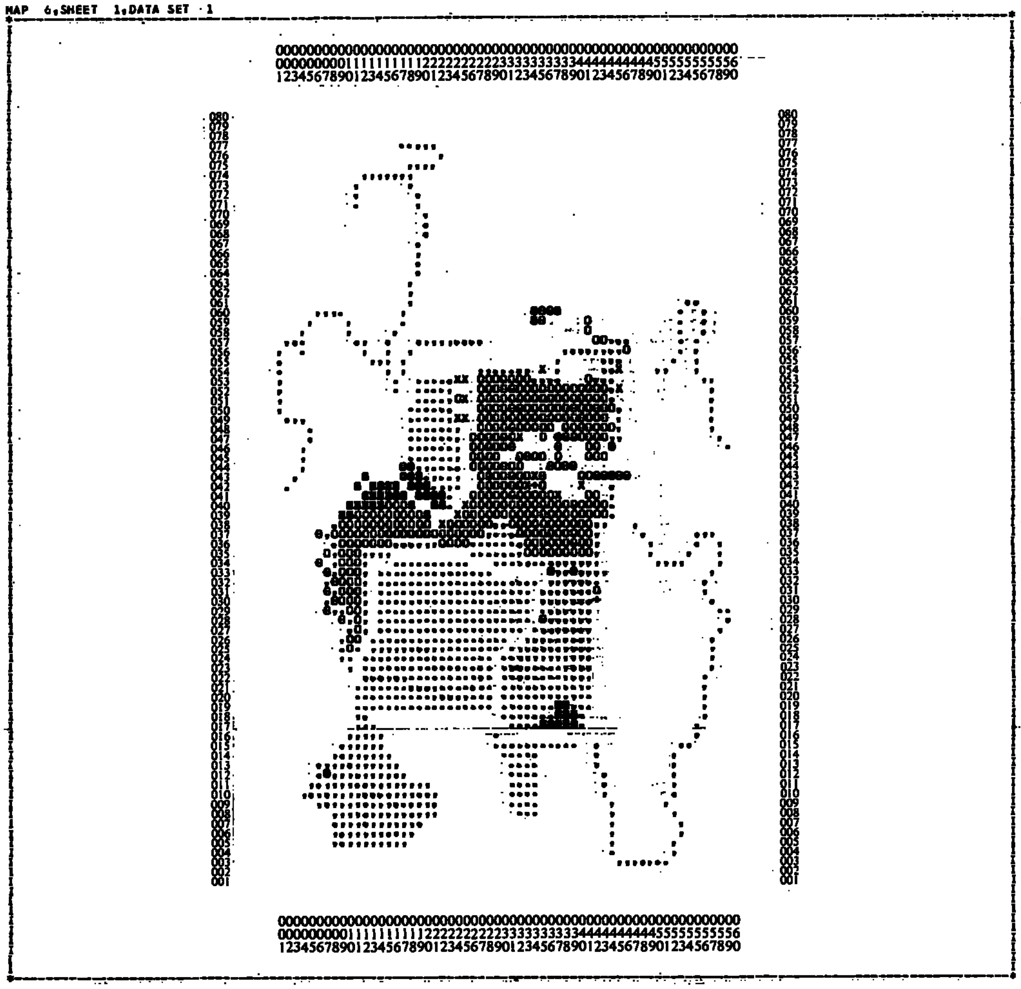
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
FREQUENCY	35	12	6	120	141	42	329	73	100	581

Fig. J.4.3
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Attractiveness

MAP 6,SHEET 1,DATA SET 1



MURRAY - B WITH ATTRACTIVENESS AND IMPACT EVAL + SIMULATION EVAL

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70
MAXIMUM	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70	23.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

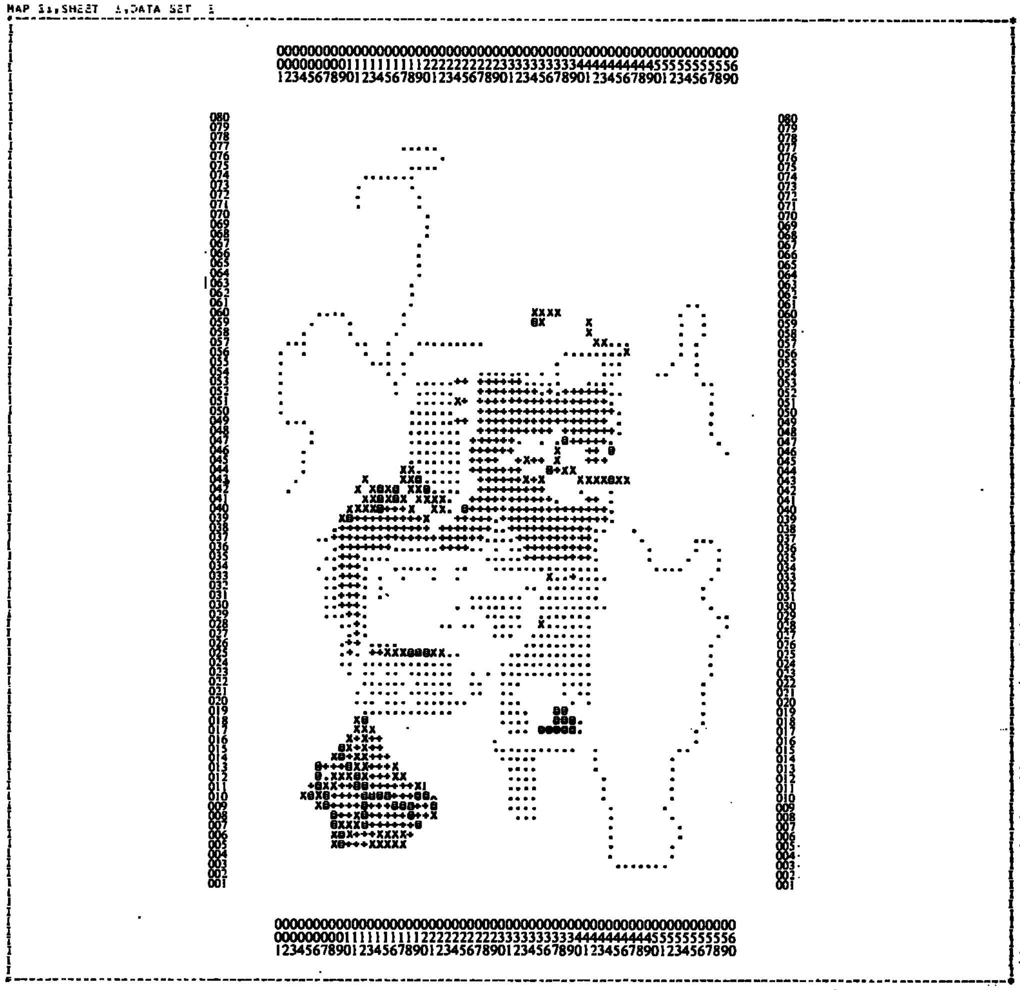
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS										
FREQUENCY	465	306	220	3	16	331	27	10	20	21

Fig. J.4.4
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Total Impact

MAP 1, SHEET 1, DATA SET 1



MURRAY B + ATTRACTIVENESS + SIMULATION EVALUATION

IMPACT ON SURFACE WATER SYSTEM

HONEY HILL CASE STUDY

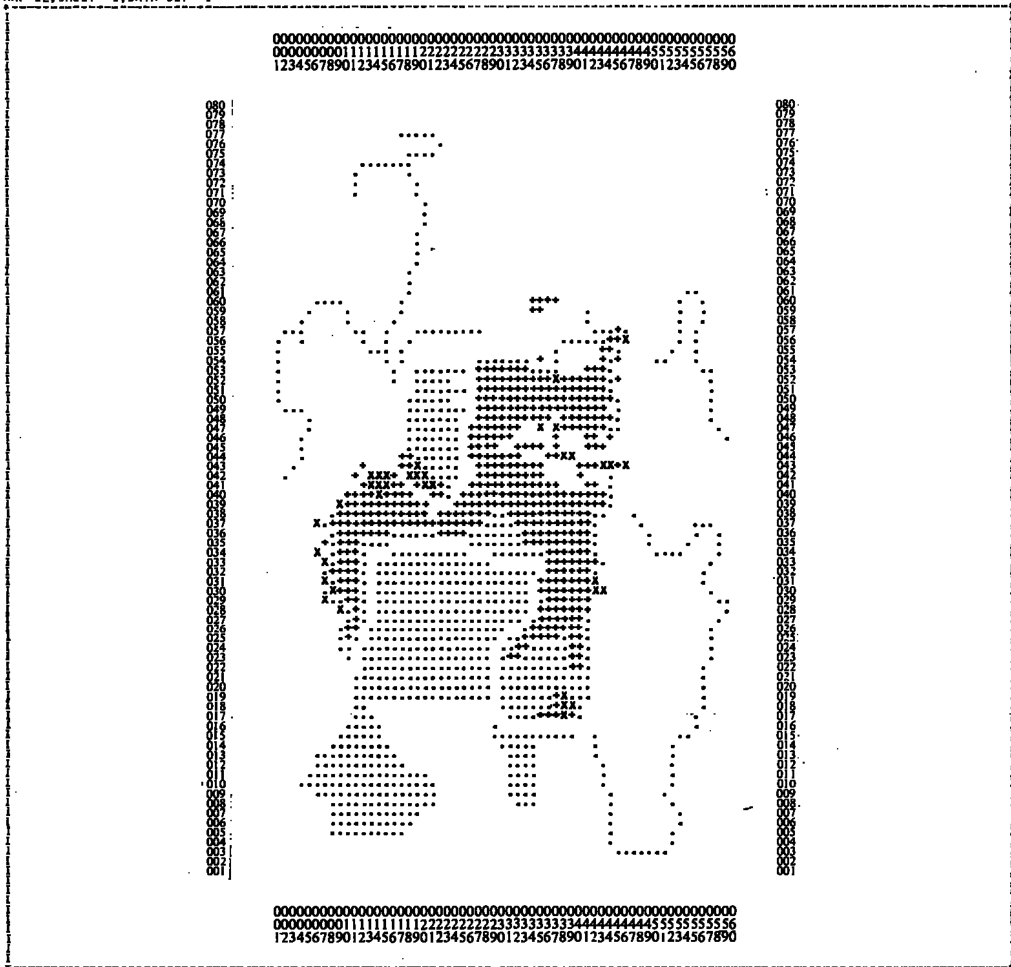
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXXX	@@@@@@@@@	■■■■■■■■■
FREQUENCY	[illegible]	393	103	59	0

Fig. J.4.5
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Impact on Surface Water System

MAP [illegible], SHEET 1, DATA SET 1



MURRAY B + ATTRACTIVENESS + SIMULATION EVALUATION

IMPACT ON WILDLIFE HABITAT

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXX	@@@@@@@@	████████
FREQUENCY	9[illegible]	[illegible]6[illegible]	37	0	0

Fig. J.4.6
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Impact on Wildlife Habitat

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	0.0	0.0	0.0	0.0
2	235.0	0.0	0.0	0.0
3	9.0	0.0	0.0	0.0
4	310.0	0.0	0.0	0.0
5	9.0	0.0	0.0	0.0
6	14.0	0.0	0.0	0.0
7	1.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	578.0	0.0	0.0	0.0

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	0.0	0.0	0.0	0.0	0.0
2	3441.5	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	5126.6	0.0	0.0	0.0	0.0
7	2296.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	25808.4	0.0	0.0	0.0	0.0

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	0.0	0.0
2	24847.3	68578.5
3	27785.8	76688.7
4	16577.0	45752.5
5	3292.3	6518.8
6	29734.1	58873.5
7	16577.2	45753.1
8	0.0	0.0
9	0.0	0.0
TOTAL	118813.6	302164.9

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	3.0	0.0	0.0	0.0
2	247.0	0.0	0.0	0.0
3	112.0	0.0	0.0	0.0
4	310.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6	153.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	825.0	0.0	0.0	0.0

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	2026.3	0.0	0.0	0.0	0.0
2	1019.4	0.0	0.0	0.0	0.0
3	1650.8	0.0	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	8253.9	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	16672.9	0.0	0.0	0.0	0.0

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	12401.3	34227.4
2	5912.3	11706.3
3	11505.9	31756.2
4	26876.6	74179.4
5	0.0	0.0
6	140068.1	386587.9
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	196764.1	538457.3

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.7: Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	0	0.0
2	82	41.22
3	10	84.00
4	314	97.61
5	9	90.00
6	14	84.29
7	1	90.00
8	62	77.85
9	9	66.67
10	260	3.57
TOTAL	761	56.91

WINTER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
11	0	0.0
12	56	89.68
13	0	0.0
14	314	97.61
15	0	0.0
16	153	46.22
17	0	0.0
18	62	77.85
19	9	66.67
20	260	3.57
TOTAL	854	57.49

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.8: Plan Impact TOTAL IMPACT = 9112.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	475	80	138	251	26	1.251
2	619	288	62	1	0	0.428
3	462	408	100	0	0	0.627
4	523	305	133	9	0	0.616
5	605	62	299	3	1	0.694
6	218	199	275	278	0	1.632
7	523	3	104	336	4	1.273
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	209	157	387	37	180	1.816
11	462	180	152	163	13	1.057
TOTAL	4096	1682	1650	1078	224	1.044

Murray "B" + Attractiveness Evaluation +
Simulation Model
Table J.4.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	211 75	0 0
4	62 80	62 80
5	225 00	0 0
6	61 25	1224 00
7	6 00	0 0
8	18600 00	18600 00
9	353 92	353 92
10	530 40	530 40
TOTAL	20051 12	20771 12

TABLE J.D.10

MURRAY "B" PLAN: IMPROVEMENTS, N=3000

	Initial Plan	+ Impact Evaluations	+ Attractiveness Evaluations	+ Simulation Evaluations
1. SUMMER PLAN				
Attractiveness (mean mean)	51.64	49.50	55.66	56.91
Impact (mean mean)	1.061	1.083	1.052	1.044
No. of people crowded	0	0	0	0
No. of people turned away	0	0	0	0
$ local income	118,813	118,813	118,813	118,813
$ regional income	302,169	302,165	302,165	302,165
$ capital cost	17,665,080	17,411,038	19,968,079	20,051,012
$ capital cost w/o res.	1,165,080	1,511,038	1,368,079	1,451,012
2. WINTER PLAN				
Attractiveness (mean mean)	53.56	49.71	56.78	57.49
Impact (mean mean)	1.061	1.083	1.052	1.044
No. of people crowded	0	0	0	0
No. of people turned away	0	0	0	0
$ local income	189,251	200,760	196,764	196.764
$ regional income	504,936	536,697	538,459	538,457
$ capital cost	18,465,030	18,027,053	20,720,032	20,771,012
$ capital cost w/o res.	1,965,030	2,127,053	2,120,032	2,171,012

APPENDIX K: LINEAR PROGRAM "B" PLAN AND IMPROVED PLAN

Appendix K presents the initial plan and its improvements as developed from the output of the linear program "B" assumption. The first stage of improvement was the addition of the program requirements for those activities which the linear program did not include. This second plan, which is comparable with the others developed in this research, was then evaluated by the simulation model and the final version of the linear program "B" plan was produced, mapped, and evaluated. Table K.3.10 presents the summary evaluations of the improvements in the linear program "B" plan at N=3000. As was the case in the improvement of the linear program "A" plan, the addition of the program requirements in the second plan caused a major increase in capital costs due to the addition of residential development. However, comparison of the final version of the linear program "B" plan with the initial and second stages of the plan show important improvements in every category of the summary evaluations of both the summer and winter plans. The site attractiveness has undergone a major increase, particularly in the winter plan. The impacts of the plans are substantially less. No one is crowded and no one is turned away. The dollar income of the local area and the region has been increased, particularly in the summer plan, and the capital costs of the plan have been decreased.

This appendix presents the plans and evaluation maps and tables for the three stages of the linear program "B" plan:

K.A Linear Program "B": Initial Plan
K.B Linear Program "B" + Program "A"
K.C Linear Program "B" Improved via Simulation Evaluation

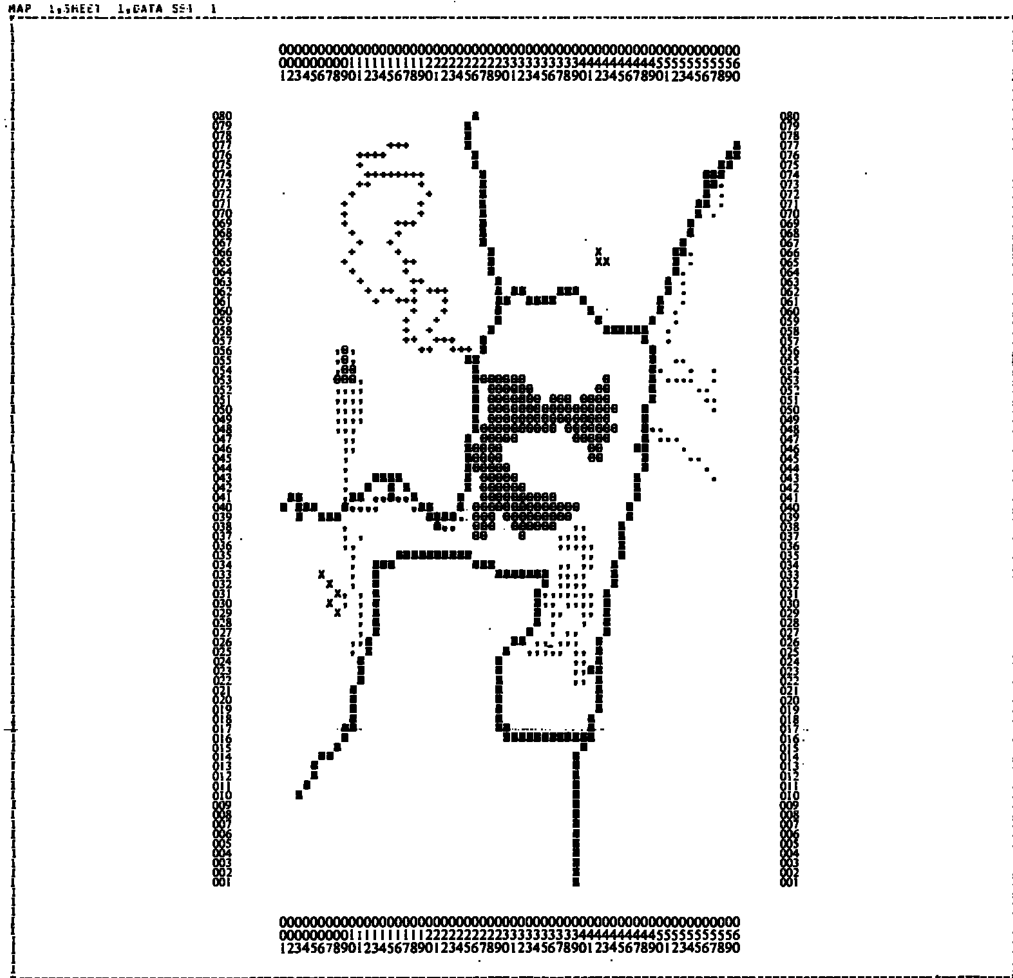
TABLE K.A.1

LINEAR PROGRAM "B": PROGRAM FOR THE INITIAL PLAN, N=3000

Activity*	Zone*	Man/days*	Persons/acre	Cells (2.5 acres) Required
1.2 Fishing	10	602	2	120
1.3 Swimming	11	2811	2000	1 (water) 12 (beach)
1.4 Hiking	1	534	3	71
1.5 Camping	2 11	132 195	16 16	3 5
1.7 Boating	10 12	22 529	1.25 1.25	7 165
2.1 Hunting	4	798	8	40
2.5 Snowmobiling	3	1401	1.5	151
2.6 Downhill Skiing	3	4098	30	55
2.9 Parking				10
2.10 Major Roads				as given

* Output of L. P., see Table XI.9.

MAP 1,SHEET 1,DATA SET 1



LINEAR PROGRAM B (N=3000)

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

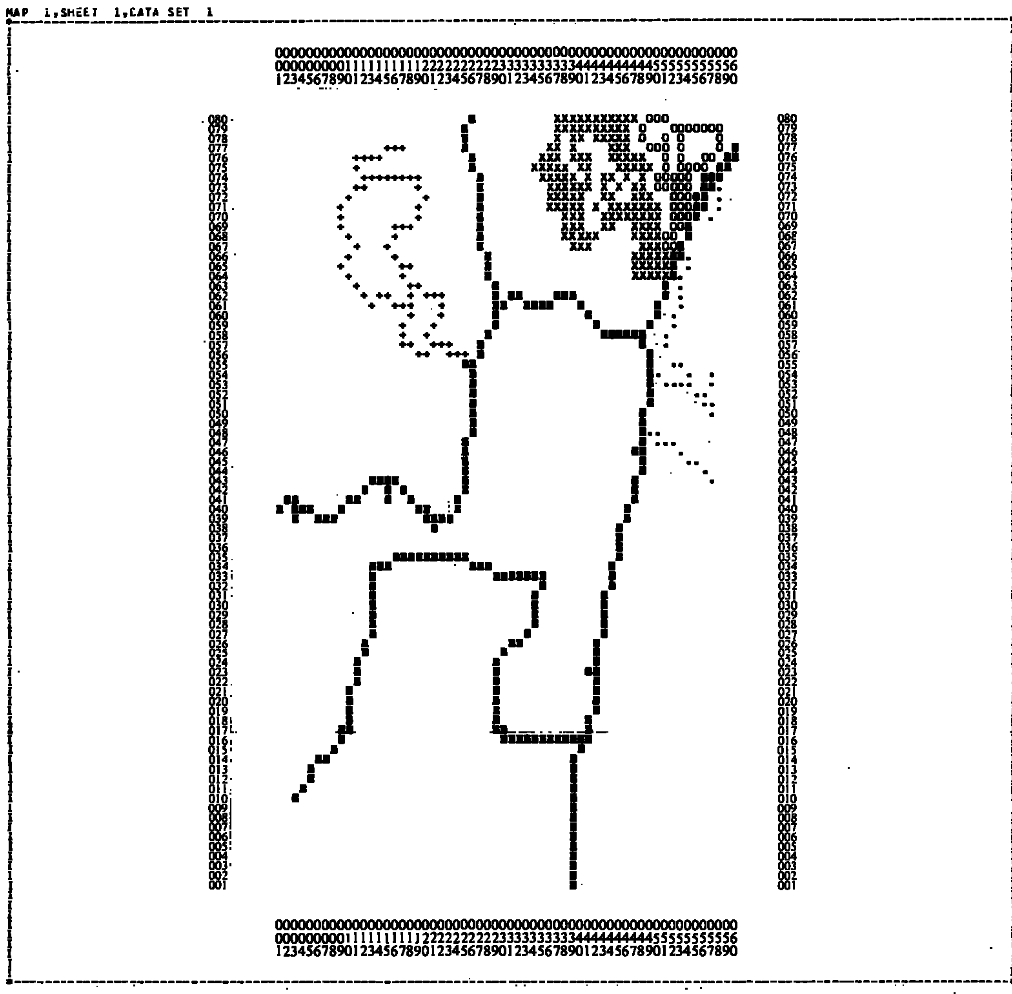
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	+++++++++	=========	XXXXXXXX	OOOOOOOOO	888888888	@@@@@@@@@			
FREQUENCY	4127	39	118	12	71	8	0	172	0	10	243	0

Fig. K.1.1
Linear Program "B" N=3000: Summer



LINEAR PROGRAM B (N=3000)

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENIIAL
9 = PARKING
10 = MAJOR ROACS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.5C	3.50	4.5C	5.58	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

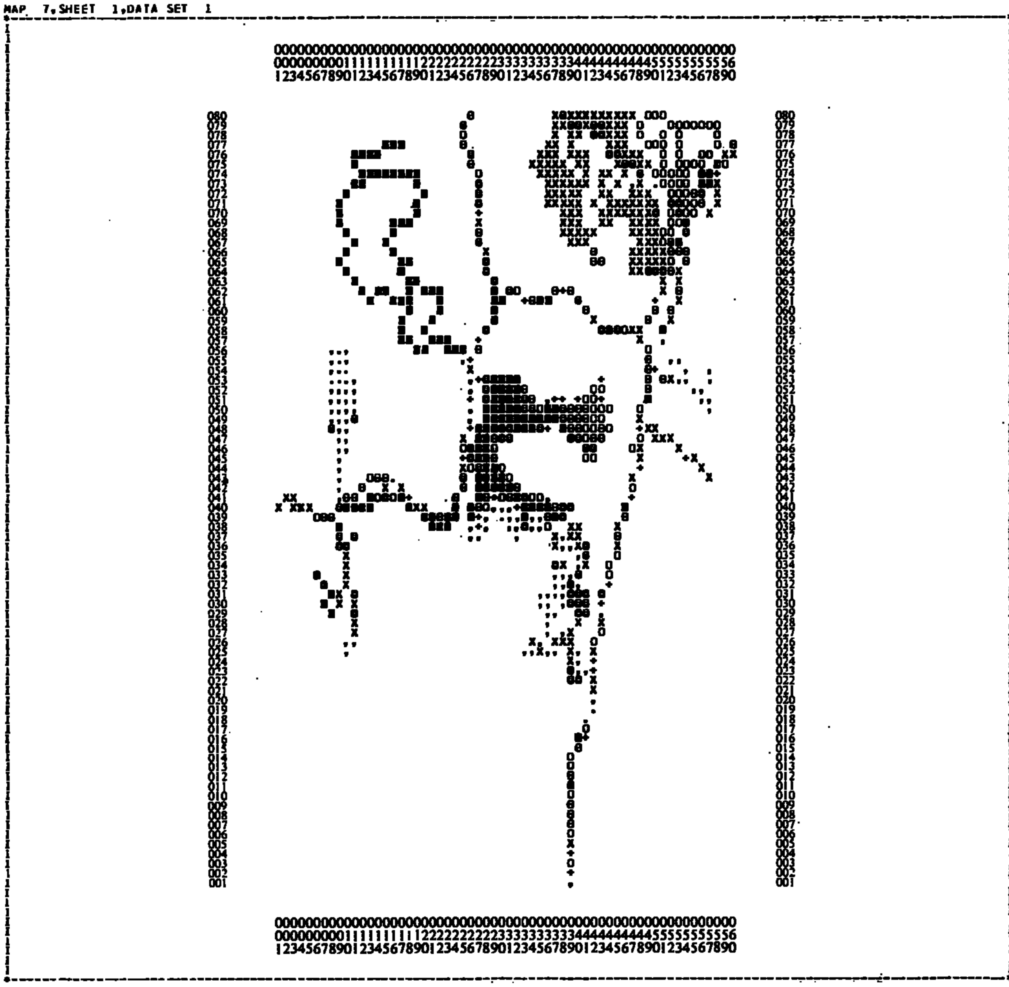
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.08

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		•••••••••	'''''''''	•••••••••	+++++++++	XXXXXXXX	000000000	888888888	88888888	■■■■■■■■	■■■■■■■■	
FREQUENCY	4231	39	0	0	71	151	54	0	1	10	243	0

Fig. K.1.2
Linear Program "B" N=3000: Winter

MAP 7,SHEET 1,DATA SET 1



LINEAR PROGRAM - 8

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 27.27 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	27.27	34.55	41.82	49.09	56.36	63.64	70.91	78.18	85.45	92.73
MAXIMUM	34.55	41.82	49.09	56.36	63.64	70.91	78.18	85.45	92.73	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

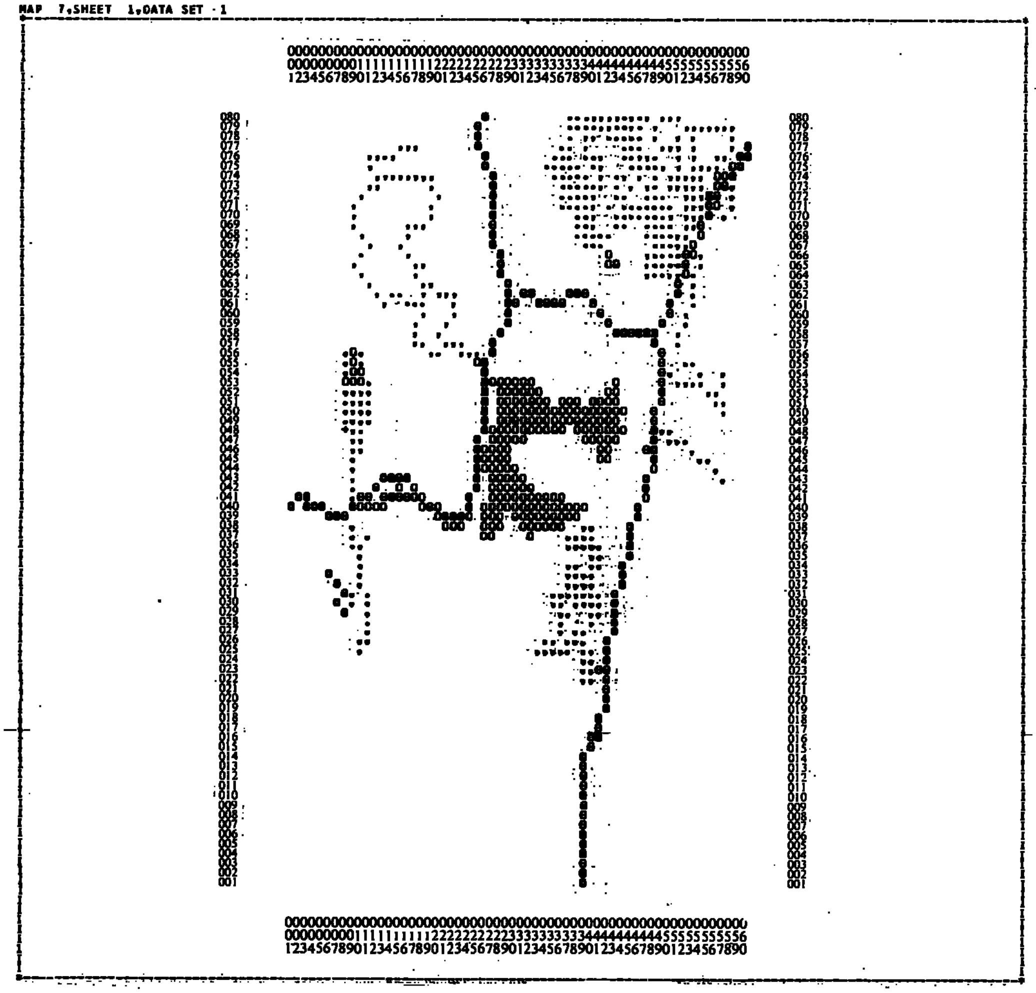
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	'	;	+	X	O	Ø	▪	▪	█
FREQUENCY	12	85	23	34	213	101	69	93	69	102

Fig. K.1.3
Linear Program "B": Attractiveness

MAP 7,SHEET 1,DATA SET 1



LINEAR PRCGRAM. - 8

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF 7HIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 19.0D

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	2.00	3.70	5.40	7.10	8.80	10.50	12.20	13.90	15.60	17.30
MAXIMUM	3.70	5.40	7.10	8.80	10.50	12.20	13.90	15.60	17.30	19.00

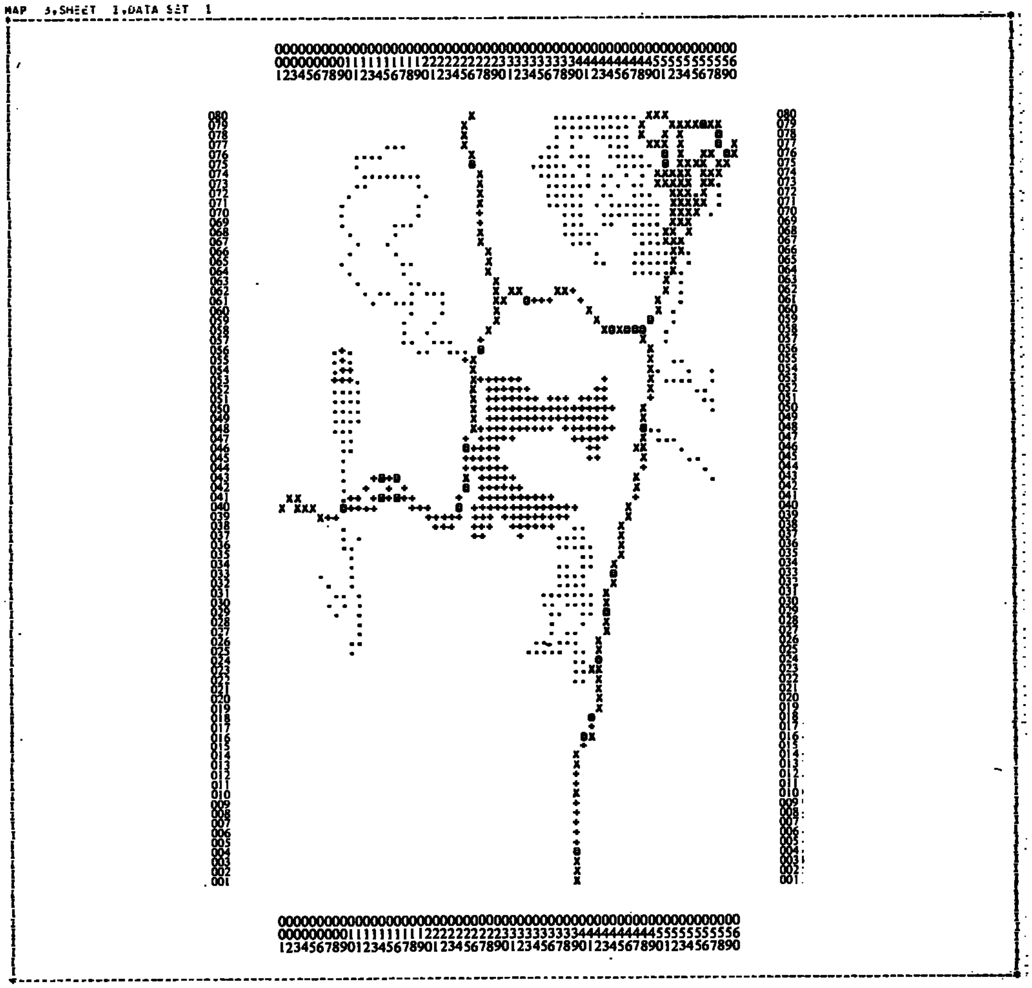
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS										
FREQUENCY	130	164	130	1	0	203	40	100	16	1

Fig. K.1.4
Linear Program "B": Total Impact



LINEAR PROGRAM B

IMPACT ON SURFACE WATER SYSTEM

HONEY HILL CASE STUDY

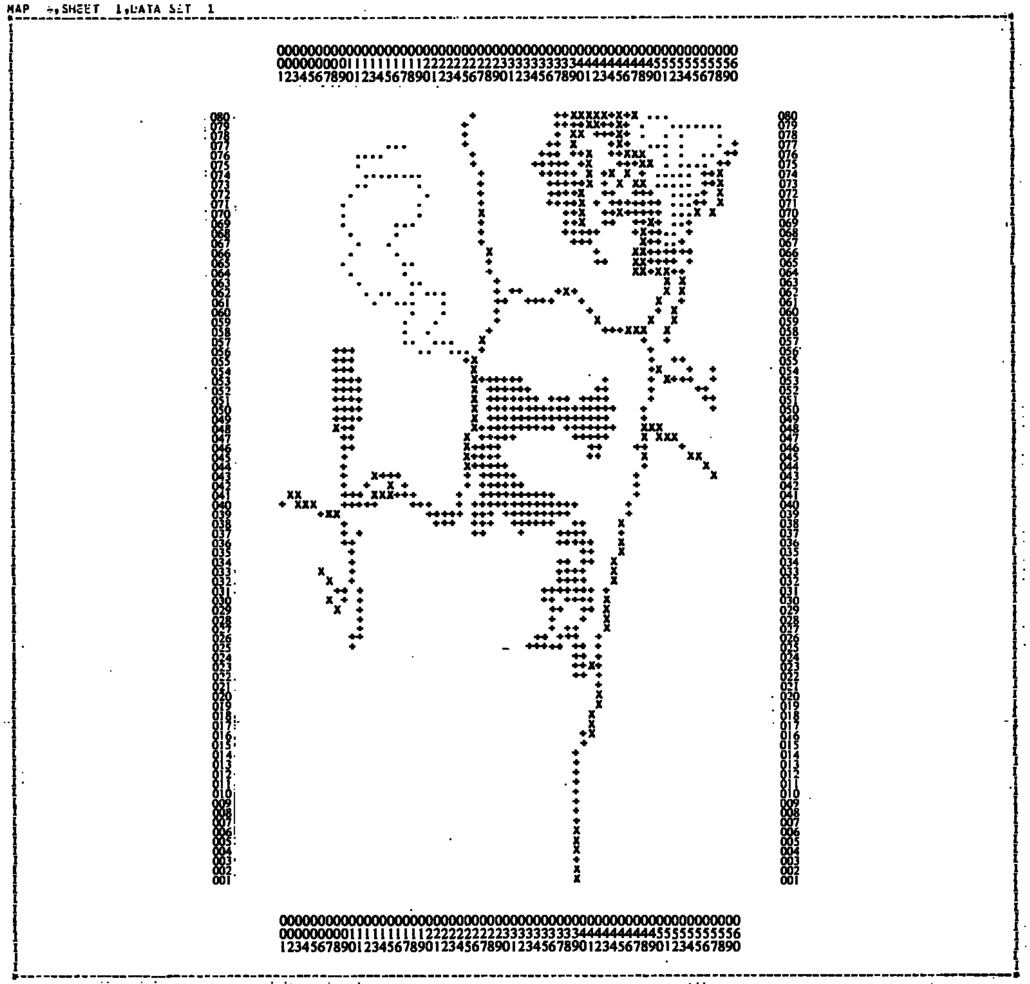
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	.	+	X	@	■
FREQUENCY	386	225	159	29	0

Fig. K.1.5
Linear Program "B": Impact on Surface Water System

MAP 4, SHEET 1, DATA SET 1



LINEAR PROGRAM B

IMPACT ON WILDLIFE HABITAT

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXXX	@@@@@@@@@	■■■■■■■■■
FREQUENCY	128	543	132	0	0

Fig. K.1.6
Linear Program "B": Impact on Wildlife Habitat

Linear Program "B": Initial Plan
Table K.1.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	39.0	0.0	0.0	0.0
2	118.0	0.0	0.0	0.0
3	12.0	0.0	0.0	0.0
4	71.0	0.0	0.0	0.0
5	8.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	248.0	0.0	0.0	0.0

Linear Program "B": Initial Plan
Table K.1.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	3441.5	0.0	0.0	0.0	0.0
2	3441.5	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	21827.4	0.0	0.0	0.0	0.0

Linear Program "B": Initial Plan
Table K.1.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	24847.4	68578.8
2	24847.4	68578.6
3	27785.8	76688.7
4	16577.2	45753.0
5	3292.3	6518.8
6	0.0	0.0
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	97349.9	266117.8

Linear Program "B": Initial Plan
Table K.1.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	39.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	172.0	0.0	0.0	0.0
4	71.0	0.0	0.0	0.0
5	151.0	0.0	0.0	0.0
6	54.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	487.0	0.0	0.0	0.0

Linear Program "B": Initial Plan
Table K.1.5: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	2026.3	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	1650.8	0.0	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	2827.0	0.0	0.0	0.0	0.0
6	8254.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	18480.6	0.0	0.0	0.0	0.0

Linear Program "B": Initial Plan
Table K.1.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	12401.2	34227.4
2	0.0	0.0
3	11505.8	31756.1
4	26876.6	74179.4
5	16396.4	32464.9
6	140069.7	386592.3
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	207249.8	559220.1

Linear Program "B": Initial Plan
Table K.1.7: Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	39	55.36
2	118	53.22
3	12	88.33
4	71	100.00
5	8	83.25
6	0	0.0
7	0	0.0
8	1	76.00
9	10	74.00
10	243	3.67
TOTAL	502	37.79

WINTER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
11	39	55.36
12	0	0.0
13	0	0.0
14	71	100.00
15	151	61.99
16	54	66.65
17	0	0.0
18	1	76.00
19	10	74.00
20	243	3.67
TOTAL	569	42.05

Linear Program "B": Initial Plan
Table K.1.8: Plan Impact

TOTAL IMPACT = 6936.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	387	15	95	186	24	1.215
2	433	261	13	0	0	0.406
3	391	238	78	0	0	0.557
4	125	403	170	9	0	1.089
5	433	43	227	3	1	0.721
6	215	191	183	118	0	1.289
7	315	5	72	312	3	1.552
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	54	180	309	35	129	2.007
11	391	83	103	120	10	0.975
TOTAL	2744	1419	1250	783	167	1.090

Linear Program "B": Initial Plan
Table K.1.9: Capital Costs

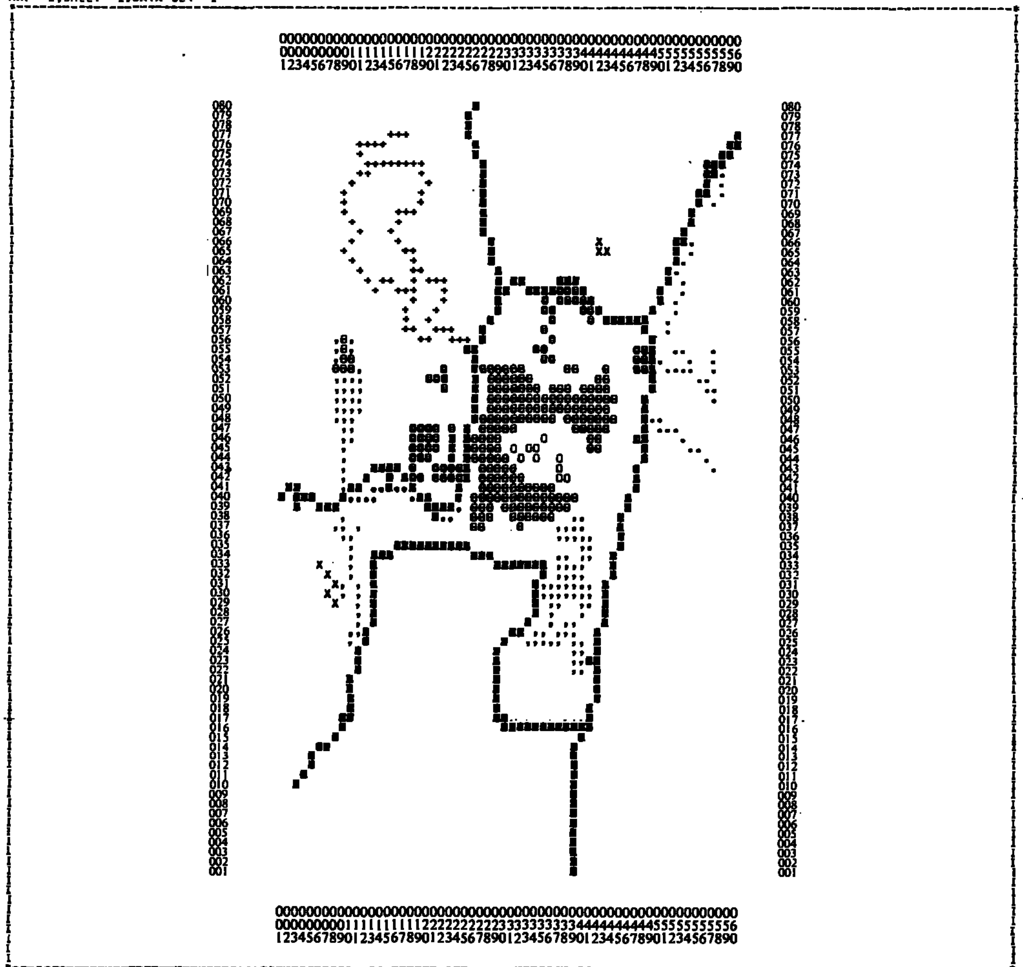
ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	254 10	0 0
4	14 20	14 20
5	200 00	0 0
6	0 0	432 00
7	0 0	0 0
8	300 00	300 00
9	393 25	393 25
10	495 72	495 72
TOTAL	1657027	1635017

TABLE K.B.1

LINEAR PROGRAM "B": ADDITIONAL PROGRAM REQUIREMENTS

Activity	Additional Program Requirements
1.5 Camping	5 separated cells
1.6 Picnicking	10 separated cells
1.7 Boating	1 cell launching facility 1 cell rental facility
1.8 Residential	Total 61 cells:
1.8.1 Water view	35 cells
1.8.2 Wood view	10 cells
1.8.3 Farmstead	5 areas of 2 cells each
1.8.4 Condominium	6 adjacent cells

MAP 2,SHEET 1,DATA SET 1



LINEAR PROGRAM B (N=3000) + PROGRAM A

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.58	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

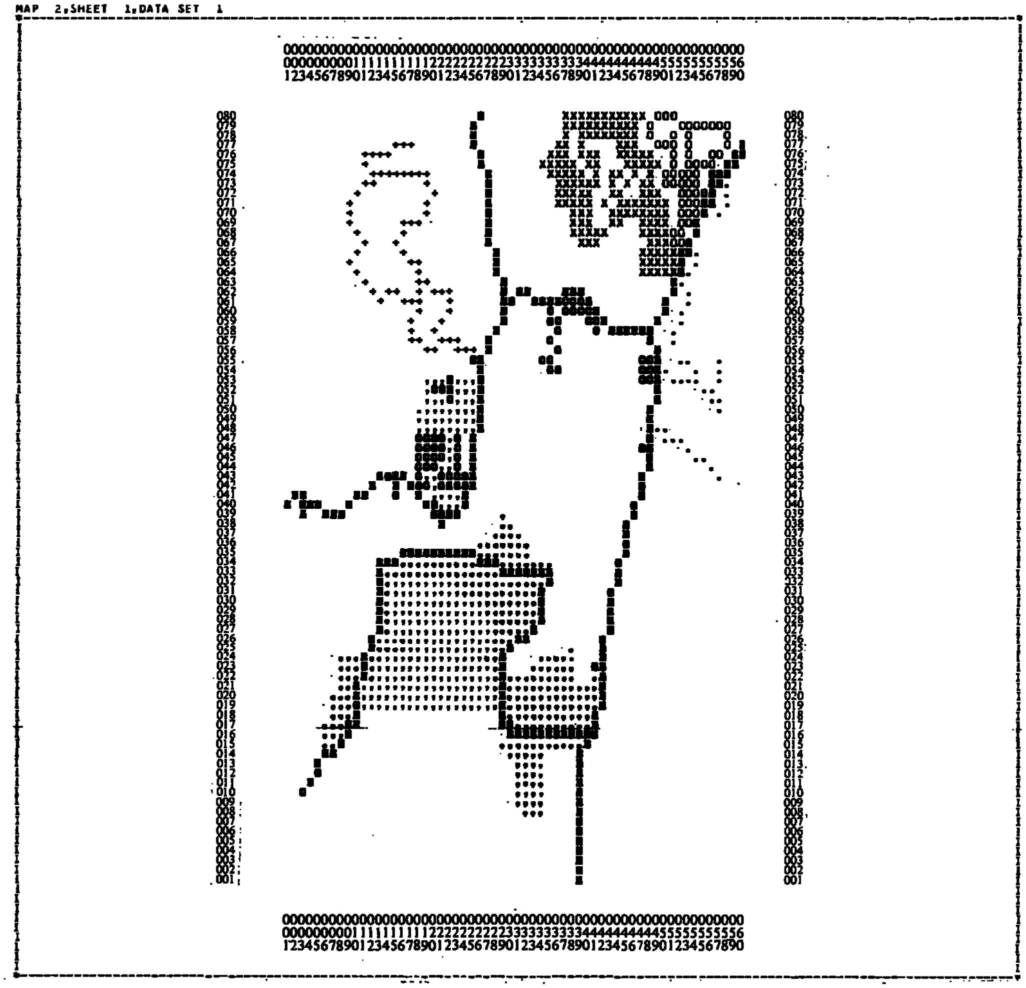
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	....	+++++++++	XXXXXXXXX	OOOOOOOOO	[illegible]	[illegible]	[illegible]	[illegible]	
FREQUENCY	4051	40	120	12	71	8	10	174	61	10	243	0

Fig. K.2.1
Linear Program "B" (N=3000) + Program "A":
Summer

MAP 2, SHEET 1, DATA SET 1



LINEAR PROGRAM B (N=3000) + PROGRAM A

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

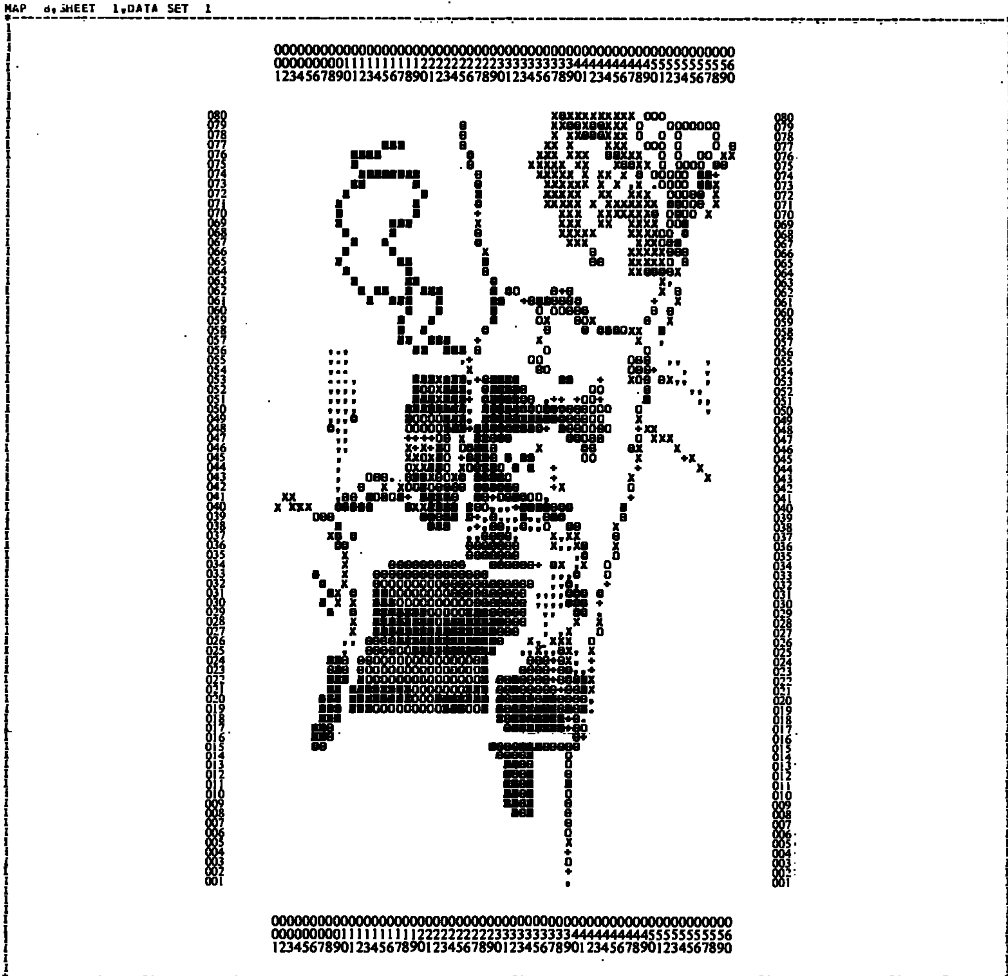
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS												
FREQUENCY	3654	40	240	274	71	152	54	0	62	10	243	0

Fig. K.2.2
Linear Program "B" (N=3000) + Program "A":
Winter

MAP d, SHEET 1, DATA SET 1



LINEAR PROGRAM - B + PROGRAM A

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 27.27 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	27.27	34.55	41.82	49.09	56.36	63.64	70.91	78.18	85.45	92.73
MAXIMUM	34.55	41.82	49.09	56.36	63.64	70.91	78.18	85.45	92.73	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

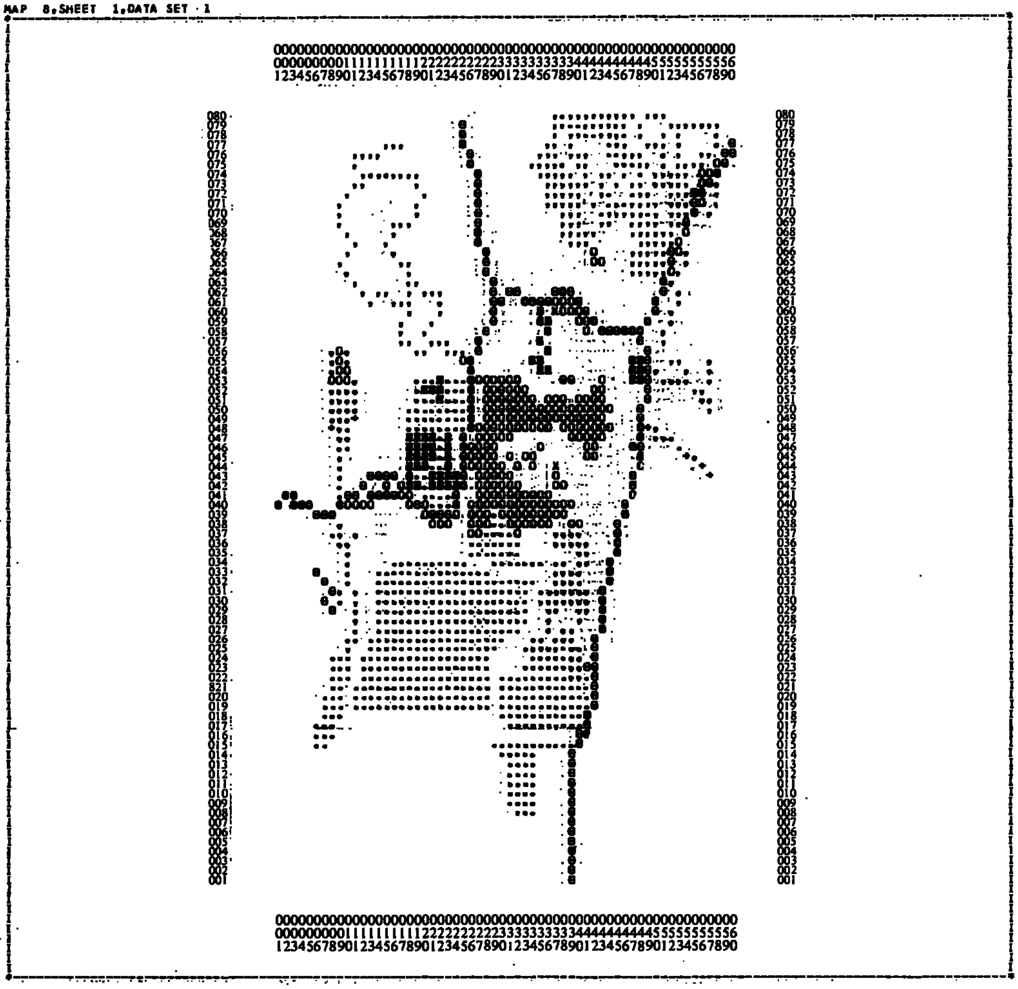
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	.	[illegible]	[illegible]	+	X	0	8	[illegible]	[illegible]	[illegible]
FREQUENCY	12	88	23	50	228	232	255	97	75	331

Fig. K.2.3
Linear Program "B" + Program "A":
Attractiveness

MAP 8,SHEET 1,DATA SET 1



LINEAR PROGRAM - B + PROGRAM A

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSEB BY PLANNEO LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.D AND 20.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	2.00	4.00	6.00	8.00	10.B0	12.00	14.D0	16.00	18.00
MAXIMUM	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS	....	'''''''''	'''''''''	+++++++++	XXXXXXXXX	OOOOOOOOO	[illegible]	[illegible]	[illegible]	[illegible]
FREQUENCY	533	252	158	6	2	222	113	53	16	36

Fig. K.2.4
Linear Program "B" + Program "A": Total Impact

Linear Program "B" + Program "A"
Table K.2.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	40.0	0.0	0.0	0.0
2	120.0	0.0	0.0	0.0
3	12.0	0.0	0.0	0.0
4	71.0	0.0	0.0	0.0
5	8.0	0.0	0.0	0.0
6	10.0	0.0	0.0	0.0
7	2.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	263.0	0.0	0.0	0.0

Linear Program "B" + Program "A"
Table K.2.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	3441.5	0.0	0.0	0.0	0.0
2	3441.5	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	5126.6	0.0	0.0	0.0	0.0
7	2296.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	29249.9	0.0	0.0	0.0	0.0

Linear Program "B" + Program "A"
Table K.2.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	24847.4	68578.9
2	24847.3	68578.4
3	27785.8	76688.7
4	16577.2	45753.0
5	3292.3	6518.8
6	29734.1	58873.5
7	16577.2	45753.1
8	0.0	0.0
9	0.0	0.0
TOTAL	143661.1	370744.1

Linear Program "B" + Program "A"
Table K.2.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	40.0	0.0	0.0	0.0
2	242.0	0.0	0.0	0.0
3	446.0	0.0	0.0	0.0
4	71.0	0.0	0.0	0.0
5	152.0	0.0	0.0	0.0
6	54.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	1005.0	0.0	0.0	0.0

Linear Program "B" + Program "A"
Table K.2.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	2026.3	0.0	0.0	0.0	0.0
2	1019.4	0.0	0.0	0.0	0.0
3	1650.8	0.0	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	2827.0	0.0	0.0	0.0	0.0
6	8254.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	19499.9	0.0	0.0	0.0	0.0

Linear Program "B" + Program "A"
Table K.2.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	12401.2	34227.3
2	5912.3	11706.3
3	11505.8	31756.1
4	26876.6	74179.4
5	16396.4	32464.9
6	140069.7	386592.3
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	213162.0	570926.3

Linear Program "B" + Program "A"
Table K.2.7: Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	40	54.27
2	118	53.05
3	12	88.33
4	71	100.00
5	8	83.25
6	10	72.00
7	2	90.00
8	62	67.81
9	10	74.00
10	243	3.67
TOTAL	576	41.65

WINTER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
11	40	54.27
12	240	84.70
13	274	83.21
14	71	100.00
15	152	62.11
16	54	66.65
17	0	0.0
18	62	67.81
19	10	74.00
20	243	3.67
TOTAL	1146	62.19

Linear Program "B" + Program "A"
Table K.2.8: Plan Impact TOTAL IMPACT = 8239.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	913	15	124	219	25	0.787
2	959	291	46	0	0	0.296
3	907	292	97	0	0	0.375
4	639	471	177	9	0	0.657
5	949	69	274	3	1	0.486
6	730	199	202	165	0	0.847
7	831	5	111	346	3	0.985
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	568	188	334	41	165	1.265
11	907	87	149	143	10	0.659
TOTAL	7403	1617	1514	926	204	0.706

Linear Program "B" + Program "A"
Table K.2.9: Capital Costs of Plan

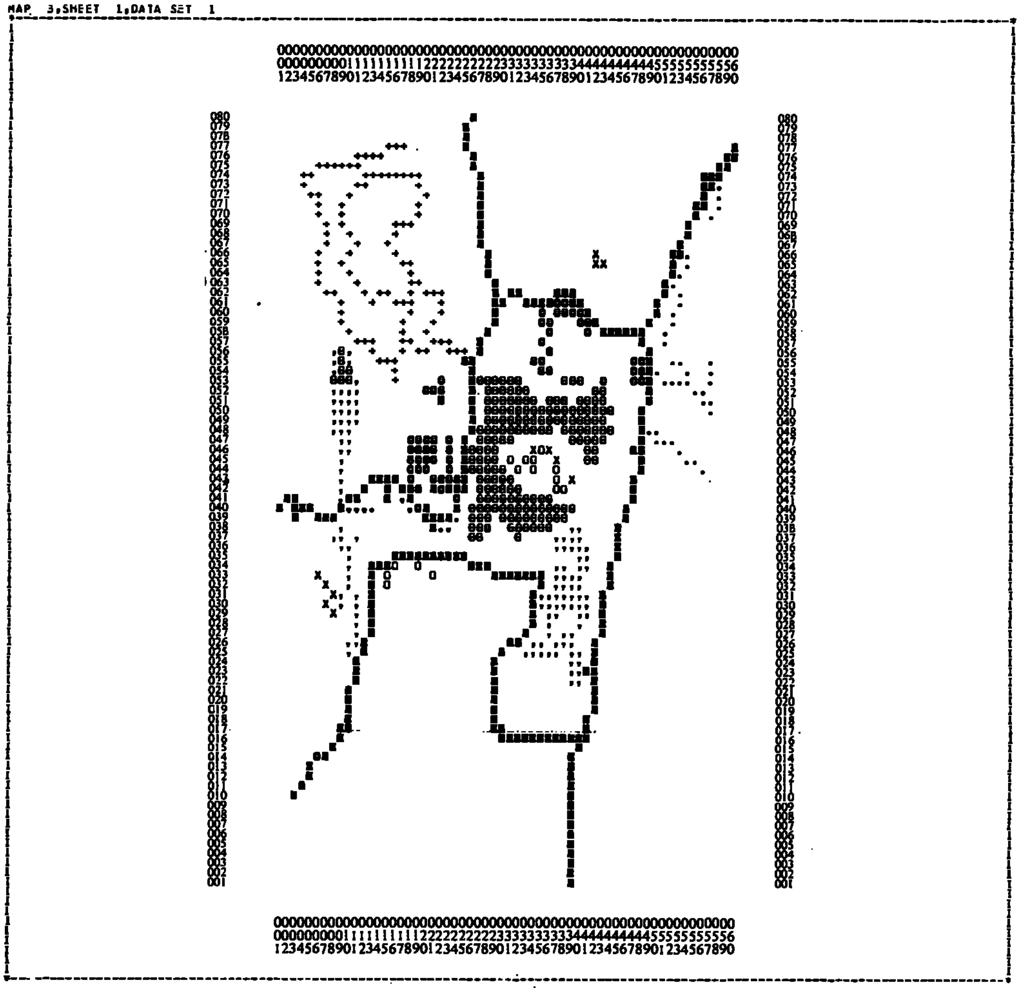
ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	254 10	0 0
4	14 20	14 20
5	200 00	0 0
6	43 75	432 00
7	12 00	0 0
8	18600 00	18600 00
9	393 25	393 25
10	495 72	495 72
TOTAL	20013002	19935017

TABLE K.C.1

LINEAR PROGRAM "B": PROPOSED PROGRAM CHANGES FROM SIMULATION MODEL EVALUATION

Activity	Proposed Change
1. SUMMER	
1.3 Swimming	omit 3 cells
1.4 Trail hiking	add 30 cells
1.5 Camping	add 4 cells
1.6 Picnicking	add 5 cells
1.7 Boating	add 1 cell launch area
2. WINTER	
2.6 Downhill Skiing	add 25 cells

MAP 3,SHEET 1,DATA SET 1



LINEAR PROGRAM B + PROGRAM A + SIMULATION EVALUATION (N=3000)

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

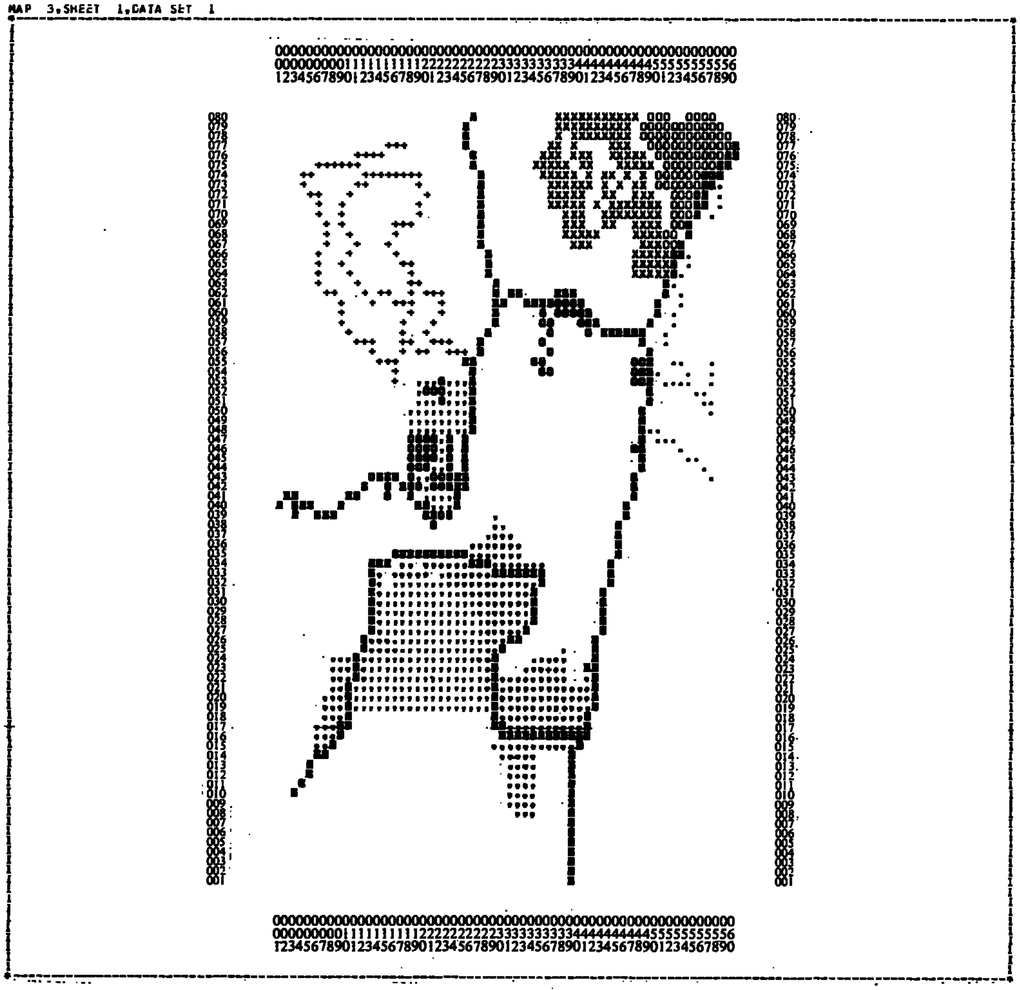
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		....	'''''''''	....	+++++++++	XXXXXXXX	OOOOOOOOO					
FREQUENCY	4009	40	120	5	106	12	15	175	61	10	243	0

Fig. K.3.1
Linear Program "B" + Program "A" + Simulation Evaluation (N=3000): Summer

MAP 3,SHEET 1,DATA SET 1



LINEAR PROGRAM B + PROGRAM A + SIMULATION EVALUATION IN=3000I

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNCW SHCEING
3 = CRCSS CCUNTRY SKIING
4 = TRAILS
5 = SNCW MOBILING
6 = DCWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJCR ROACS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50
MAXIMUM	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

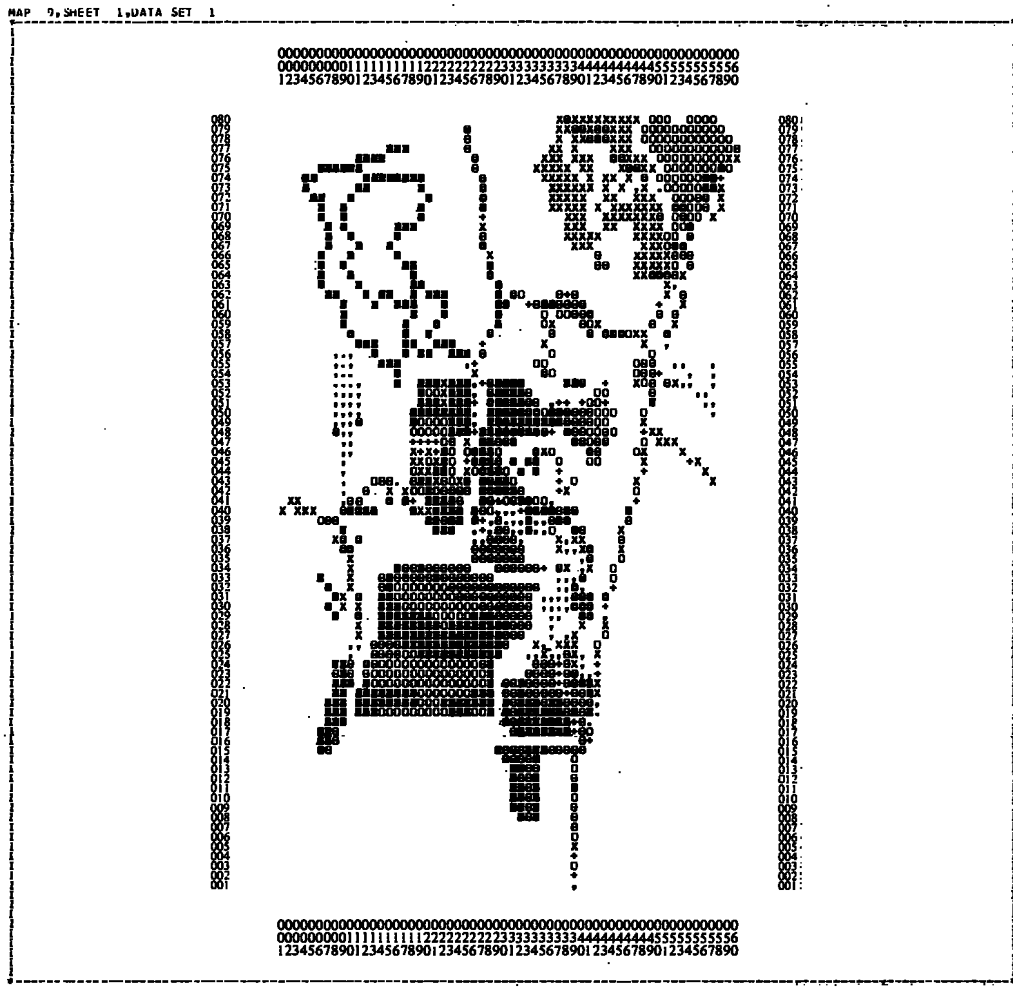
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	LOW VALUES 0	1	2	3	4	5	6	7	8	9	10	HIGH VALUES 11
SYMBOLS		•••••••••	'''''''''	•••••••••	+++++++++	XXXXXXXXX	000000000	■■■■■■■■■	■■■■■■■■■	■■■■■■■■■	■■■■■■■■■	
FREQUENCY	3594	40	239	270	106	152	84	0	62	10	243	0

Fig. K.3.2
Linear Program "B" + Program "A" + Simulation Evaluation (N=3000): Winter

MAP 9, SHEET 1, DATA SET 1



ATTRACTIVENESS EVALUATION

LINEAR PROGRAM - B + PROGRAM A + SIMULATION EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 27.27 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	27.27	34.55	41.82	49.09	56.36	63.64	70.91	78.18	85.45	92.73
MAXIMUM	34.55	41.82	49.09	56.36	63.64	70.91	78.18	85.45	92.73	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS										
FREQUENCY	12	88	23	50	228	262	251	99	79	368

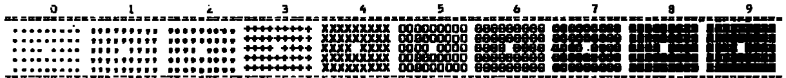
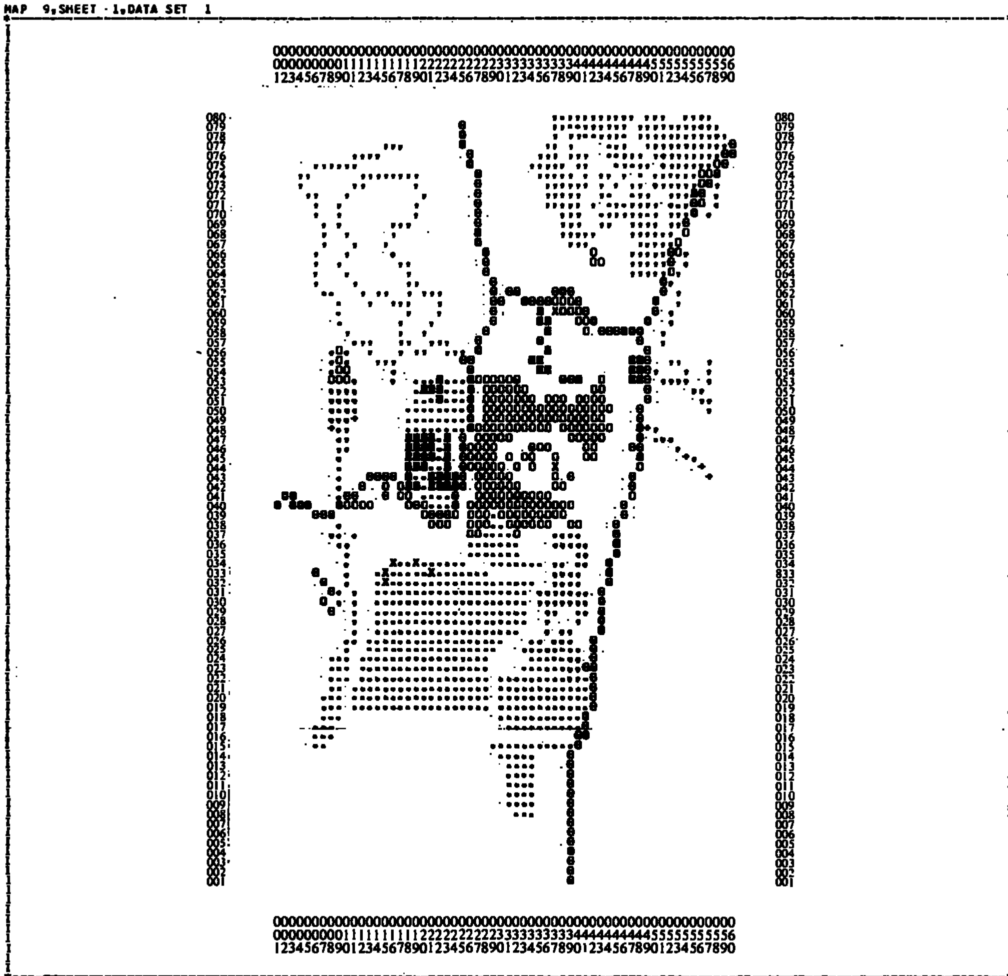


Fig. K.3.3
Linear Program "B" + Program "A" + Simulation Evaluation: Attractiveness

MAP 9, SHEET 1, DATA SET 1



LINEAR PROGRAM - B + PROGRAM A + SIMULATION EVALUATION

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 20.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.0	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00
MAXIMUM	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

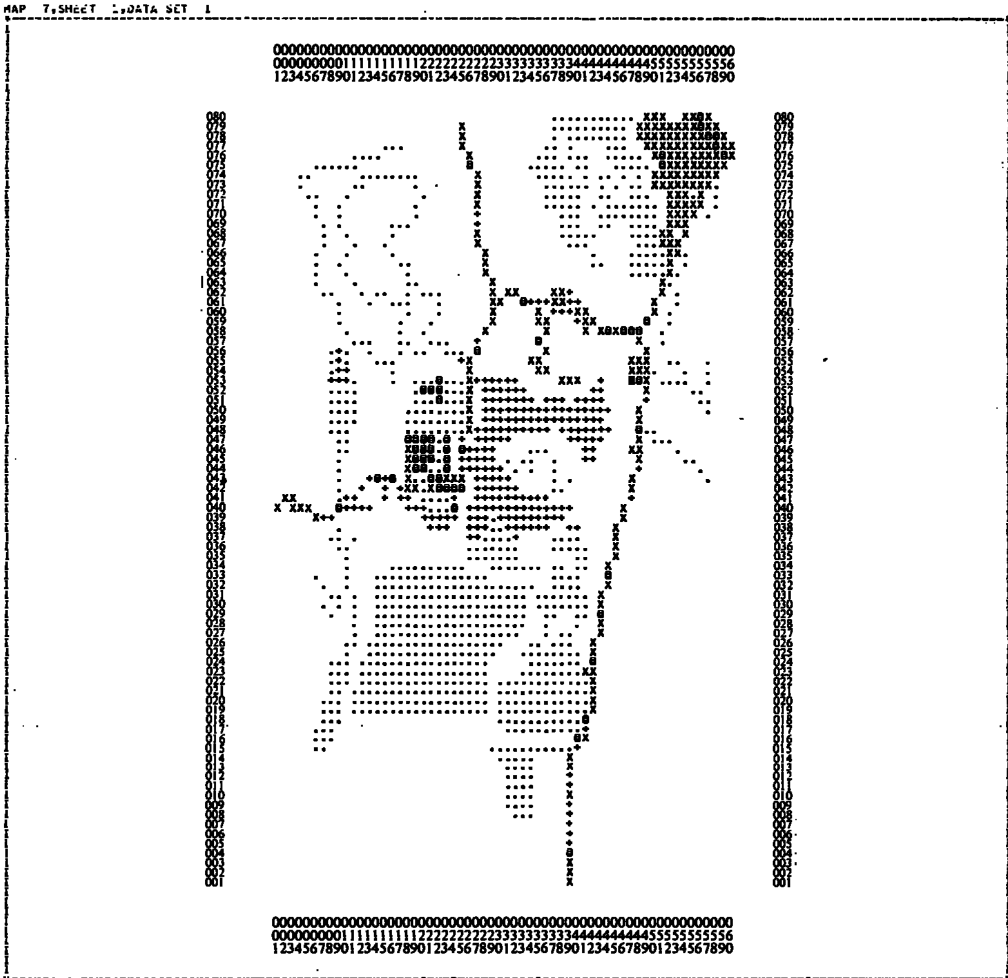
10.00	10.00	10.00	10.88	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9
SYMBOLS										
FREQUENCY	532	307	164	6	7	224	112	53	17	36

Fig. K.3.4
Linear Program "B" + Program "A" + Simulation Evaluation: Total Impact

MAP 7, SHEET 1, DATA SET 1



LINEAR PROGRAM B + PROGRAM A + SIMULATION EVALUATION

IMPACT ON SURFACE WATER SYSTEM

HONEY HILL CASE STUDY

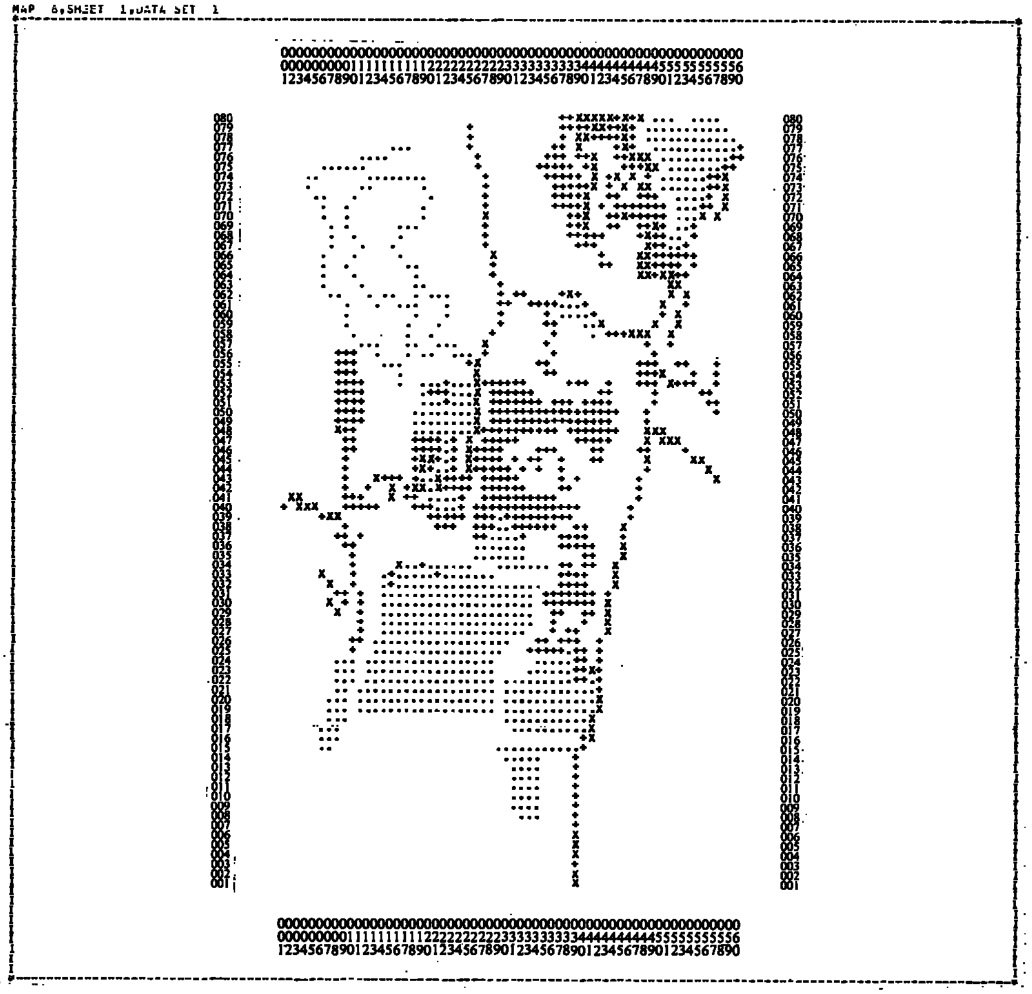
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS	....	+++++++++	XXXXXXXXX	@@@@@@@@@	[illegible]
FREQUENCY	953	221	216	57	1

Fig. K.3.5
Linear Program "B" + Program "A" + Simulation Evaluation: Impact on Surface Water

MAP 6,SHEET 1,DATA SET 1



LINEAR PROGRAM B + PROGRAM A + SIMULATION EVALUATION

IMPACT ON WILDLIFE HABITAT

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

LEVELS	0	1	2	3	4
SYMBOLS					
FREQUENCY	710	610	136	0	0

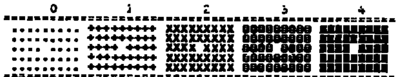


Fig. K.3.6
Linear Program "B" + Program "A" + Simulation Evaluation: Impact on Wildlife Habitat

Linear Program "B" + Simulation Evaluation
Table K.3.1: "Summer N=3000"
No. Cells/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%
1	40.0	0.0	0.0	0.0
2	120.0	0.0	0.0	0.0
3	9.0	0.0	0.0	0.0
4	106.0	0.0	0.0	0.0
5	12.0	0.0	0.0	0.0
6	15.0	0.0	0.0	0.0
7	3.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	305.0	0.0	0.0	0.0

Linear Program "B" + Simulation Evaluation
Table K.3.2: "Summer N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	3441.5	0.0	0.0	0.0	0.0
2	3441.5	0.0	0.0	0.0	0.0
3	12080.8	0.0	0.0	0.0	0.0
4	2296.0	0.0	0.0	0.0	0.0
5	567.6	0.0	0.0	0.0	0.0
6	5126.6	0.0	0.0	0.0	0.0
7	2296.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	29249.9	0.0	0.0	0.0	0.0

Linear Program "B" + Simulation Evaluation
Table K.3.3: "Summer N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	24847.4	68578.9
2	24847.3	68578.4
3	27785.8	76688.8
4	16577.1	45752.9
5	3292.3	6518.8
6	29734.1	58873.5
7	16577.2	45753.1
8	0.0	0.0
9	0.0	0.0
TOTAL	143661.1	370744.2

Linear Program "B" + Simulation Evaluation
Table K.3.4: "Winter N=3000"
No. Cells/Activity/Crowding

ACT. #	C-75%	75-100%	100-125%	125-150%
1	40.0	0.0	0.0	0.0
2	241.0	0.0	0.0	0.0
3	442.0	0.0	0.0	0.0
4	106.0	0.0	0.0	0.0
5	152.0	0.0	0.0	0.0
6	84.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
TOTAL	1065.0	0.0	0.0	0.0

Linear Program "B" + Simulation Evaluation
Table K.3.5: "Winter N=3000"
No. People/Activity/Crowding

ACT. #	0-75%	75-100%	100-125%	125-150%	TURNED AWAY
1	2026.3	0.0	0.0	0.0	0.0
2	1019.3	0.0	0.0	0.0	0.0
3	1650.8	0.0	0.0	0.0	0.0
4	3722.5	0.0	0.0	0.0	0.0
5	2827.0	0.0	0.0	0.0	0.0
6	8254.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	19499.9	0.0	0.0	0.0	0.0

Linear Program "B" + Simulation Evaluation
Table K.3.6: "Winter N=3000"
Income/Activity

ACT. #	LOCAL	REGIONAL
1	12401.2	34227.3
2	5912.2	11706.2
3	11505.8	31755.9
4	26876.6	74179.4
5	16396.4	32464.9
6	140069.9	386593.0
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
TOTAL	213162.1	570926.7

Linear Program "B" + Simulation Evaluation
Table K.3.7: Summary

SUMMER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
1	40	54.27
2	118	53.05
3	9	92.22
4	106	100.00
5	12	78.00
6	15	78.00
7	3	87.00
8	62	67.81
9	10	74.00
10	243	3.67
TOTAL	618	45.41

WINTER PLAN ATTRACTIVENESS

ACTIVITY	# OF CELLS	MEAN
11	40	54.27
12	239	84.78
13	270	83.33
14	106	100.00
15	152	62.11
16	84	66.42
17	0	0.0
18	62	67.81
19	10	74.00
20	243	3.67
TOTAL	1206	63.34

Linear Program "B" + Simulation Evaluation
Table K.3.8: Plan Impact

TOTAL IMPACT = 8573.

SYSTEM	NULL	COMPAT.	MODERATE	SEVERE	TERMINAL	MEAN
1	952	14	153	219	25	0.790
2	1024	293	46	0	0	0.282
3	934	330	59	0	0	0.387
4	699	479	176	9	0	0.629
5	1009	71	279	3	1	0.471
6	755	205	229	174	0	0.869
7	891	10	116	343	3	0.941
8	0	0	0	0	0	0.0
9	0	0	0	0	0	0.0
10	593	196	368	41	165	1.258
11	934	122	153	144	10	0.660
TOTAL	7791	1720	1619	933	204	0.699

Linear Program "B" + Simulation Evaluation
Table K.3.9: Capital Costs of Plan

ACTIVITY #	SUMMER	WINTER
1	0 0	0 0
2	0 0	0 0
3	190 57	0 0
4	21 20	21 20
5	300 00	0 0
6	65 63	672 00
7	18 00	0 0
8	18600 00	18600 00
9	393 25	393 25
10	495 72	495 72
TOTAL	20084037	20182017

TABLE K.3.10

LINEAR PROGRAM "B" PLAN: IMPROVEMENTS, N=3000

	Initial L. P. Plan	+ Program "B"	+ Simulation Evaluation
1. SUMMER PLAN			
Attractiveness (mean mean)	37.79	41.65	45.41
Impact (mean mean)	1.090	0.706	0.699
No. of people crowded	0	0	0
No. of people turned away	0	0	0
$ local income	97,349	143,661	143,661
$ regional income	266,117	370,744	370,744
$ capital cost	1,657,027	20,013,002	20,084,037
$ capital cost w/o residence	1,657,027	1,413,002	1,484,037
2. WINTER PLAN			
Attractiveness (mean mean)	42.05	62.19	63.34
Impact (mean mean)	1.090	0.706	0.699
No. of people crowded	0	0	0
No. of people turned away	0	0	0
$ local income	207,249	213,162	213,162
$ regional income	559,220	570,926	570,926
$ capital cost	1,635,017	19,935,017	20,182,017
$ capital cost w/o residence	1,635,017	1,335,017	1,582,017

APPENDIX L: GRID: USERS REFERENCE MANUAL

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7. THE "GRID" PROGRAM

7.1. INTRODUCTION

GRID is a computer program which has been created to provide a highly efficient means for graphic display of information collected on the basis of a rectangular coordinate grid. The "GRID" Program is designed for use by persons with very little programming experience. However, it is usually necessary for the user to specify his own data formats in Subroutine FLEXIN and this requires an elementary knowledge of FORTRAN IV.

The program is written in FORTRAN IV and is currently being operated on an I. B. M. 360/65 computer at Harvard using 150K bytes. With small programming changes it can be operated on the I. B. M. 7094 with 32K memory. It is possible to operate this program on a smaller machine--with a memory of at least 12K words.

7.1.1. Basic Principles

Each data value is assumed to be associated with a cell on a grid. It is essential that the values should be processed in the correct order, since the program accepts the data in the order in which it prints the map. By the standardized printing process, the program starts at the top of the map and processes the data horizontally row by row and from left to right in each row. Thus the numbers below represent the order in which thrity data values on a 6 x 5 grid will be processed and printed.

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30

The size and shape of the user's grid must be specified using Elective 1.

In the mapping process, the actual data values are generalized into groups, each group having a unique graphic symbol associated with it. The groups into which data are to be placed and the associated symbols may be specified by the user, using Electives 3 through 6. Two types of symbolism are available: a grey scale of symbolism from light-dark which must be specified by the user, or a dot map in half inch square cells. The coordinates of each grid cell location may also be printed. Most of the SYMAP electives for scale generalization are available on GRID.

7.1.2. Required Input

To obtain a graphic display (or map), the user must provide three sets of instructions and has the option of providing a fourth set. The instructions are prepared in the following packages: Data Package (usually a separate tape), Map Package, Irregular Outlines Package (Optional), and Subroutine Flexin.

(i) The Data Package contains the data or numermical information which generates the graphic display. The program is written for a maximum of 10,000 grid cells, but the Multiple Data Set Option permits the user to handle unlimited numbers of data cells.

(ii) The Map Package permits the user to specify the precise form of the map output in terms of various electives.

(iii) The Irregular Outline Option allows the user to specify the boundaries of the study area, if he is dealing with a grid which is not rectangularly bounded.

(iv) Subroutine Flexin is a fortran subroutine which allows the user to specify the format of the DATA. (In a special case described under Data Input Section, it is not necessary to provide this subroutine).

In the following sections, first the content and then the format of each set of inputs is described. At the end there is a description of the organization of a complete submission for the computer.

7.2. DATA PACKAGE

The GRID program provides two separate and distinct input procedures for the data. These are designed to optimize the efficient use of the program under two different types of operation.

7.2.1. Data Option A

Option A uses GRID as an independent program, in which Subroutine FLEXIN is used (i) to read the data from any file format and, (ii) to perform relatively simple statistical calculations on the data so as to generate the value to be mapped. In this case the data is processed one cell at a time. This option permits a wide range of flexibility in the organization of the data.

It is recommended that people who have limited experience with the computer use this option initially. The section on Subroutine FLEXIN describes the details of the procedures in detail. A data file often contains many different variables referring to each grid cell. As there is not enough memory space available to store each variable, it is necessary to read the basic data file each time a map is made. Since it is inefficient with large sets of data to submit a card file for each separate map, it is recommended that such files be prestored on a disc or tape. This permits the user to rewind the files between maps.

The GRID program will automatically rewind a file being read on Fortran Logical I/O unit 12 between each map.

This option is activated by specifying a number greater than zero in field 1 of Elective 2 (see Map Package). The user is cautioned to note the further optional use of this number as described under Elective 2 and Subroutine FLEXIN.

7.2.2. Data Option B

Option B uses GRID as the final 'job step' in a series of 'job steps' made up of complex statistical manipulation routines. In this case the data used to create the graphic display is transferred to the GRID program as a series of Binary arrays with one array (or logical record) for each row of the map. The program will expect one real value in the array for each cell in a row (Note that if an irregular outline is used, there will be variable length records).

The data will only be accepted in this mode under this option. This option is used automatically if Elective 2 is <u>not</u> specified; it is also used if zero is specified in field 1 of Elective 2.

When using this option the data is transferred to GRID using Fortran Logical I/O unit number 20.

7.2.3. Assigning Data to Map Levels

The GRID program internally assigns the value for each grid cell to a level or group. The maximum number of levels is 10, numbered 0-9. If the data is already prescaled such that it has integer values from 0 thru 9, this section of the program may be bypassed by using Elective 14. When large numbers of grid cells are involved, there may be significant time savings.

When the dot map option is used the maximum number of levels is 20, numbered 0-19.

7.2.4. Multiple Data Sets

In its standard form this program is limited to 10,000 data cells. On the IBM 7094 there is, in fact, memory space for about 15,000 data cells. On smaller machines there may be space for less than 10,000 cells. An experienced programmer may adjust this limit by changing the size of "COMMON P (10,000)".

This program was written to handle nearly unlimited amounts of data. An internal loop has been built into the program which permits the user to map as many data cells as necessary on one map. In order to do this, larger data files should be divided into "sets" which have less than 10,000 cells each. The data sets should each refer to a basic grid which is the same size and shape.

When multiple data sets are used, each set is processed separately. Therefore, it is essential that the maximum and minimum of the data ranges (electives 4 and 5) be specified, as there is no guarantee that all data sets will have the same value range. When using multiple data sets, specify the number of sets to be mapped in field 3 of elective 2.

If no irregular outline is used, then data sets may be above, below, or beside each other; the order and spatial relationships are not important. However, when an irregular outline is used, the complete outline must be stored prior to the processing of all the data sets. It is suggested that data sets with an irregular outline be organized such that the first set is the top section of the map and the last set the bottom section of the map, with each set being the full width of the map.

Experienced programmers may want to differentiate between each data set during the processing of Subroutine Flexin. A fourth calling "argument" for Flexin is transfered in the "CALL" statement, following the value of FIRST. This argument gives the number of the data set being mapped.

7.3. MAP PACKAGE

This package instructs the computer to make a map based on the data supplied. It is used to specify the precise form of the map in terms of certain available map electives.

It is most important to remember that:

(i) Once an elective has been specified, it will be carried on to successive maps unless it is changed, and,

(ii) Electives 1 and 7 must be included with the first map of a submission as no standard condition is created by the program for these electives.

On the first card of this package, punch "MAP" in columns 1-3. On the last card, punch the number "99999" in columns 1-5.

On the second, third and fourth cards, punch the title you wish to have appear below the map.

Be sure your title is clearly descriptive so as to differentiate the particular map from all other maps of a similar nature which may be run. One or more of these three cards may be left blank if desired, but all three cards must be included.

On the other cards--to be inserted between the fourth and last card--punch any "electives" desired. Whenever a map elective is not specifically called for, the standard result described under each elective will automatically occur. Therefore, use an elective if you wish to procure a result different from the standard.

7.3.1. Standard Format

A standard format is used for the electives with the exception of electives 7, 10, and 13. It is:

(i) the elective number is punched as an integer in columns 4 and 5 (right justified).

(ii) columns 6-10 are left blank

(iii) six fields of ten columns are defined as follows:

Field	Columns
1	11-20
2	21-30
3	31-40
4	41-50
5	51-60
6	61-70

NOTE:

--A "field" is a set of columns. (These are shown on the computer cards to be punched.) The computer expects to read one variable from each field.

--Integer numbers may not contain decimal points. When punching integer numbers in a field, the lowest end of the number (e.g.: if the number is 339, the nine) must be in the right hand column of the field. The number is then right justified.

--The six fields specified for the elective cards are real numbers and should contain a decimal point. They may be located anywhere within the defined columns. The decimal point may be omitted if the number is right justified.

7.3.2 Elective 1:
Grid (1 card)

This elective specifies the parameters for the rectangular grid that is to be mapped. In field 1 specify the number of rows of grid cells down the map and in field 2 specify the number of columns of grid cells across the map. In fields 3 and 4 specify the size of each printed grid cell, in terms of the number of characters down (field 3) and across (field 4). (Remember that each character to be printed measures 1/8" down and 1/10" across.) If fields 3 and 4 are left blank the printed cell size will be 4x5 or 1/2" square.

Enter the numbers in all four fields as decimal numbers. The elective number should be entered as an integer, in column 5.

7.3.3. Elective 2:
Data (1 card)

This elective controls the input options for the data. To activate Data Option A (See section on the Data package), specify a number greater than zero in field 1. To return to Option B, specify zero in field 1. Field 2 is not used. If the multiple data set option is to be used, specify in field 3 the number of data sets to be mapped. Standard is one data set and data input option B. The number specified in field 1 (for Data Option A) is transferred to Subroutine Flexin as the value for IFORM. The use of IFORM is discussed in the section on Subroutine Flexin.

7.3.4. Elective 3:
Number of Levels (1 card)

To specify the number of levels or class intervals into which the total value range is to be divided (from 2 to 10), punch the decimal number desired in field 1. Standard is ten levels.

7.3.5. Elective 4:
Value Range Minimum (1 card)

To specify a number to be used as the minimum value of the total value range, punch the decimal number desired in field 1. Standard is to use the minimum value of the data. To return to standard, specify 1.0 in field 2.

7.3.6. Elective 5:
Value Range Maximum (1 card)

To specify a number to be used as the maximum value of the total value range, punch the decimal number desired in field 1. Standard is to use the maximum value of the data. To return to this standard, specify 1.0 in field 2.

7.3.7. Elective 6:
Value Range Intervals (1 to 2 cards)

This elective controls the value range for each level or interval. The total value range of the data (as modified by the minimum and maximum of Electives 4 and 5) will be divided up into the number of levels specified in Elective 3. Standard is to have each level or interval assigned an equal range. (See Example 7-1)

To specify the desired range for each level, values proportionate to the size of the desired ranges are used. These should be punched as decimal numbers: in field 1 for the level, etc. (See Example 7-2) Only if there are more than 6 levels, continue on a second card, punching the number for the seventh level in field 1, for the eighth level in field 2, etc. (See Example 7-3) There is a maximum of ten levels for grey scale symbolism and twenty levels for a DOT symbolism.

To return to the standard, specify 0.0 in field 1.

7.3.8. Elective 7:
Symbolism (5 cards)

This elective specifies the grey scale symbolism that will be printed on the map. Because no standard symbolism is stored in the program, this elective must be included on the first map of any submission. All five cards must be included each time it is used.

On the first card punch the identifying elective number "7" in column 5.

On the second card punch in the columns listed below the basic characters desired. Any printer characters may be used.

On the third, fourth and fifth cards punch in the columns listed below any overprint characters desired. If no over-printing is desired, these three cards will be blank.

Example 7-1
Equal Value Range Levels

Using 3 levels with values ranging from a minimum of 0 to a maximum of 30,
--the first level will contain values from 0 thru 10,
--the second level will contain values from 10 thru 20, and
--the third level will contain values from 20 thru 30.
If a data value is exactly equal to a level limit (10, 20, or 30 in this case) it will be assigned to the lower level; e.g. 20 would be assigned to the 10 thru 20 level.

Example 7-2
Unequal Value Range Levels
Four Levels

If the data is to be divided into four groups--the lowest 10%, the next 25%, the next 35%, and the remainder--the one card for elective 6 would be punched as follows:

Column 5	11-20	21-30	31-40	41-50
6.	10.	25.	35.	30.

Example 7-3
Unequal Value Range Levels
<u>Seven Levels</u>

To specify these value range intervals --

Level 1	0-150
Level 2	150-200
Level 3	200-271
Level 4	271-500
Level 5	500-750
Level 6	750-889
Level 7	889-1000

--punch the <u>two cards</u> for elective 6 as follows:

Column 5	11-20	21-30	31-40	41-50	51-60	61-70
6	150.	50.	71.	229.	250.	139.
	111.					

Columns 1-10 are used to specify the general symbolism for each level (column 1 for the symbol to designate the first level, etc.--for as many levels as are to be used.)

Columns 11-20 are used to specify the special symbolism for the respective flag points (column 11 for the symbol to designate flag points in the first level, etc.). The flag point is the central character of a grid cell.

Column 21 is used to specify the symbolism for a value less than the minimum specified in Elective 4.

Column 22 is used to specify the flag point symbolism for a low value.

Column 23 is used to specify the symbolism for a value greater than the maximum specified in Elective 5.

Column 24 is used to specify the flag point symbolism for a high value.

Column 25 is used to specify background symbolism--the symbolism to appear outside the outline of the study area.

Example 7-4 shows a grey scale for ten levels of symbolism.

7.3.9. Elective 8: Flag Point (1 card)

The flag point is the central character of a grid cell. The special symbolism specified in elective 7 is printed at this flag point. To suppress the printing of

Example 7-4
Level Symbol Specification

This example shows:

-- a grey scale for ten levels of symbolism
(columns 1-10)

-- flag point svmbolism for the ten levels
(columns 11-20),

-- blank low value symbolism and flag point
(columns 21 and 22),

-- blank high value symbolism and flag point
(columns 23 and 24), and

-- blank background symbolism (column 25).

Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
card 1					7																				
card 2	.	,	,	+	X	O	O	O	O	O	Ø	1	2	3	4	5	6	7	8	9					
card 3			.	-	X	O	O	O	O	A															
card 4							-	+	X	X															
card 5										V															

To create a grey scale for less than ten levels it is suggested that the level symbols should be eliminated in the following order:

for:	9 levels	eliminate: 2
	8 levels	2, 9
	7 levels	2, 9, 8
	6 levels	2, 9, 8, 3
	5 levels	2, 9, 8, 3, 6

The flag point symbolism should be adjusted accordingly.

special symbolism at the flag point specify 1.0 in field 1. If it is desired to reinstate the flag point in subsequent maps, specify 0.0 in field 1.

When a map is made with a 1 x 1 character grid, the flag point is automatically suppressed and it must be reinstated for subsequent maps. Standard is the special symbolism at the flag point.

7.3.10 Elective 9: Histogram (1 card)

This Elective controls the printing at the bottom of the map. Specify 1.0 in field 1 to generate a histogram bar chart at the bottom of the map. This bar chart shows the frequency of grid cells in each level. Specify 1.0 in field 2 to suppress the numeric information which is printed with levels. Standard is no Bar chart and inclusion of numeric information. To return to the standard, specify 0.0 in the relevant field.

7.3.11. Elective 10: Text (1-32 cards)

If additional explanatory information is desired--beyond that contained in the map title--this elective may be used to print up to 30 lines of text below the map.

On the first card punch the identifying elective number "10" in columns 4-5.

On not more than 30 other cards, to be inserted between the first and last, punch in columns 1-72 any supplementary information likely to be helpful for future reference, such as source and date of data or the name of the person running the map.

On the last card, punch "ENDTEXT" in columns 1-7. Standard is to have no text, but, generally, some explanatory text is desirable.

7.3.12 Elective 11:
Data Record (1 card)

If a printout of the data values--before scaling--is desired, punch 1.0 in field 1. If a punched deck of the data values is desired, punch 1.0 in field 2. If a punched deck of the level numbers to which the data has been assigned is desired, punch 1.0 in field 3. The Standard is no print or punch. To return to the standard, specify 0.0 in the relevant field.

7.3.13. Elective 12:
Dot Map (1 card)

As an alternative to the normal symbolism, a dot map can be produced using 4 x 5 grid cells, and the symbol Ø. The data range may be divided into twenty levels (19 if a maximum value is specified in elective 5). The number of characters printed in the cell is equal to the number of the level: if the value falls in level 1, only one of the 20 characters is printed, but if it falls in the 20th level, all 20 characters are printed.

This elective supercedes the specifications of grid cell size in elective 1 and the number of levels in elective 3.

To specify DOT symbolism, punch 1.0 in field 1. To reinstate the grey scale symbolism (specified in elective 7) punch 0.0 in field 1. The grey scale symbolism is standard.

7.3.14 Elective 13:
Grid Numbering (1 to 2 cards)

This elective generates row and column numbers on all four sides of the grid to assist the user in locating individual cells on the map.

The top left hand cell of the grid is called the Reference Grid Cell (RGC). It provides the coordinates from which all the rows and columns are numbered. If the coordinates of the RGC are not specified, the program assumes them to be:

Column = 1
Row = N

where N is the number of rows specified in elective 1.

In field 1 specify 1.0 for grid numbering. In field 2 specify the column number of the RGC and in field 3 specify the row number. The standard is no numbering. To return to the standard on subsequent maps, specify 0.0 in field 1.

For some specialized uses the basic grid may be subdivided into parts, such as halves or thirds, and a non-continuous numbering system used. For example, a grid may be numbered in the following manner:

	3	3	3	3	3	3	3
	4	4	4	4	4	4	4
	0	0	0	1	1	1	2
	1	4	7	1	4	7	1
3807	.	.	.	.	.	.	.
3804	.	.	.	.	.	.	.
3801	.	.	.	.	.	.	.
3797	.	.	.	.	.	.	.
3794	.	.	.	.	.	.	.
3791	.	.	.	.	.	.	.
3787	.	.	.	.	.	.	.

The basic grid has a R.G.C. of 340,380. There are three subdivisions numbered 1, 4, and 7; this number of subdivisions is specified in field 1. When field 1 contains a number greater than one, the program will read an extra card to find out how to number the subdivisions. Example 7-5 shows how to specify the two cards for this grid.

7.3.15. Elective 14:
Prescaled Data (1 card)

This elective bypasses the routine which assigns the data values to levels, as described in the section on the data package. To activate this option, specify 1.0 in field 1. This option will automatically suppress numeric information below the map. The standard is to have the program scale the data.

On subsequent maps, the normal processing is reinstated by specifying 0.0 in field1; the numeric information should also be reinstated using elective 9.

Example 7-5
Grid Numbering
Subdivided Grid

For a basic grid with an R.G.C. of 340, 380 and subdivisions numbered 1, 4, and 7, Elective 13 should be specified as follows:

```
                          1111111111222222222233333333334 -- 8
Column Number    1234567890123456789012345678901234567890     0
-------------------------------------------------------------------
Card 1              13                3.0       340.0      380.0
Card 2           147
```

The first card is in the standard format:

-- elective number 13 in columns 4 and 5.

-- number of subdivisions in field 1

-- R.G.C. column and row numbers in fields 2 and 3.

The second card contains the numbers (0-9) for the subdivisions, the first subdivision in column 1, second in column 2, etc.

7.3.16 <u>Elective 15:</u>
Timer (1 card)

This elective causes the executive times for various stages of the program to be printed with the map package information. To activate this option, specify 1.0 in field 1. <u>The standard is not to have the times printed.</u>

(at installations other than Harvard the calls to the clock routine may require modifications).

7.3.17. <u>Elective 16:</u> (only available in a special version of the program)
Legends (1 card)

This elective causes a legend tape--created by the SYMAP Program--to be read and the legends to be printed on the GRID map. To activate this option, specify 1.0 in field 1. The program must know when to stop reading the tape;

--Specify in field 2 the last row that contains a legend;
--Specify in field 3 the last column (in that row) that contains a legend.

<u>The standard is not to have legends printed on the map.</u>

The last card of the map package should have "99999" punched in columns 1-5.

7.4. IRREGULAR OUTLINES

Although the data has been collected on the basis of a regular grid, the outline of the study area may not be rectangular. There are two methods for handling this problem in "GRID":

7.4.1. Filling in the Rectangle.

The program expects to read a data value for each cell. When an irregular outline exists, the user may complete the rectangle with data records (generally, one grid cell data record per card) which indicate that the cell should be printed in the background symbolism. As the data values are read in Subroutine Flexin, the occurrence of the blank or background cells must be checked. When a background cell occurs, it should be assigned a data value of -999999.0. This value activates the background symbolism routine and causes the cell to be printed as background.

The easiest background indicator to code is a zero, or blank, unless zero is a valid value. For simplicity the data value of - 999999.0 can be coded directly.

7.4.2. Irregular Outline Package

To simplify the handling of irregular outlines a small routine has been built into the program so that the user can specify the shape of the outline without filling up the rectangle with data records. The irregular outline is specified in terms of the number of cells from the vertical edges of the grid--left and right borders--that are to be left blank in each row. Background symbolism will automatically be assigned to these cells.

The information is given to the computer in a separate package called the Irregular Outline Package.

It is specified as follows:

On the first card IRREGULAR OUTLINE is punched in columns 1-17.

On the last card 99999 is punched in columns 1-5.

Between the first and last card a series of cards is punched with the following format:

> In columns 1-5 the number of successive rows for which the particular format is repeated;
> In columns 6-10 the number of blank cells at the beginning of the row; and,
> In columns 11-15 the number of blank cells at the end of the row.

These numbers are integer numbers; they must be right justified and contain no decimal points. Since the program processes these cards in order, the first card refers to the top row (or rows, as specified in columns 1-5), the second card refers to the second row (or, first format change)

Example 7-6 shows how such an irregular outline package would be used.

This package must precede the first Map Package to which it refers. Once it has been entered, it will be used on all successive maps until it is replaced by a new package or deleted by a blank package. A blank package contains only the first and last cards; it restores the rectangular grid as the outline.

This routine is limited in that it can only handle irregularities which are contiguous to a vertical edge of the grid. In some cases--such as indentations at the

Example 7-6
Irregular Outline Package

Assume that we wish to produce a map as in the diagram below. The numbers show the order in which the data values would be read in, if we use an irregular outline package.

(Row)							(Number of Background Cells per row)
1	*	*	*	1	2	3	3
2	*	*	*	4	5	*	4
3	*	*	6	7	*	*	4
4	*	8	9	10	*	*	3
5	11	12	13	14	15	*	1
6	16	17	18	19	20	*	1
7	21	22	23	24	25	26	0
8	*	27	28	29	30	31	1
9	*	32	33	34	35	36	1

The astricks represent the blank cells. Their location would be specified in the irregular outline package as follows:

(Row)	Column 11111111 12345678901234567 IRREGULAR OUTLINE			(Number of Background Cells per row)
1	1	3	0	3
2	1	3	1	4
3	1	2	2	4
4	1	1	2	3
5 and 6	2	0	1	1
7	1	0	0	0
8 and 9	2	1	0	1
	99999			

The information for the nine rows on the map is supplied on only seven cards, since the same formate is used successively in two cases. The numbers in columns 1-5 must add up to the total number of rows, or the program will stop. Every row must be accounted for in this package, even if it has no blank cells.

If the first method of specifying an irregular outline is used--filling in the rectangle, the data values would be read in in the order shown below:

(Row)							(Number of Background Cells per row)
1	(1)	(2)	(3)	4	5	6	3
2	(7)	(8)	(9)	10	11	(12)	4
3	(13)	(14)	15	16	(17)	(18)	4
4	(19)	20	21	22	(23)	(24)	3
5	25	26	27	28	29	(30)	1
6	31	32	33	34	35	(36)	1
7	37	38	39	40	41	42	0
8	(43)	44	45	46	47	48	1
9	(49)	50	51	52	53	54	1

The numbers in brackets would have values which indicate that the cell should be printed in the background symbolism.

top or bottom of the grid or blank areas in the middle of the map--it is necessary to fill in these areas, with background cells as specified in A, the first method for handling irregular outlines.

7.5. SUBROUTINE FLEXIN

FLEXIN is a FORTRAN IV subroutine which is used to specify instructions about the data value to be mapped for each grid cell. These instructions may specify:

(i) where the value to be mapped is located on a data card or in a data file on tape or disk; or,

(ii) what statistical analysis is to be performed on a variable, or variables, to derive the value to be mapped.

This subroutine is called by the main program once for each data cell that is to be mapped. Each time it is called, it reads the data card or file which refers to the data cell. Example 7-7 shows the simplest use of subroutine Flexin: specifying where the value to be mapped is located on a data card. Example 7-8 shows more complicated uses of the Subroutine--where statistical analysis is performed on variables and where data for more than one map must be read in.

These examples of the use of Subroutine Flexin are only intended to demonstrate the utilization of the arguments of the Subroutine (IFORM, T, FIRST). The user who is familar with FORTRAN IV should be able

Example 7-7

Simplest Use of Subroutine Flexin

```
                  1111111111222222222233333333334   8
Columns  12345678901234567890123456789012345678 90...0

               SUBROUTINE FLEXIN (IFORM,T,FIRST)
               READ (5,100) T
           100 FORMAT (5X,F5.2)
               RETURN
               END
```

This routine instructs the program to read the variable T from cards (the unit 5 specified in the read statement is the card reader) according to the format found in statement number 100. This format says that the value will be found in columns 6-10 on each card. Each time that the Subroutine is called--once for each data cell--a new value for the variable T will be read and returned to the main program as the value to be mapped for that data cell.

Example 7-8
Multiple Uses of Subroutine Flexin

```
                    1111111111222222222233333333334    Explanatory
Columns    1234567890123456789012345678901234567890      Notes:

                 SUBROUTINE FLEXIN (IFORM,T,FIRST)           1
                 DIMENSION CONST(10)                         2
                 LOGICAL FIRST                               3
                 GOTO (1, 2, 3, 4, 5), IFORM                 4
               1 CONTINUE                                    5
                 READ(5,100)AREA,POP
             100 FORMAT (2F5.0)
                 T=POP/AREA
                 RETURN
               2 CONTINUE                                    6
                 IF(.NOT.FIRST)GOTO 21
                 READ(5,200) (CONST(I),I=1,10)               7
             200 FORMAT(10F5.2)
                 REWIND 12
              21 READ( 12)I,PICNIC,CAMPER                    8
                 T=PICNIC+CAMPER*CONST(I)
                 RETURN
               3 CONTINUE
                 RETURN
               4 CONTINUE
                 RETURN
               5 CONTINUE
                 RETURN
                 END
```

Example 7-8
Multiple Uses of Subroutine Flexin
(Continued)

NOTES:

(1) The variables IFORM and FIRST are carried into the subroutine as control variables. The data value to be mapped is carried back to the main program as T. (Remember that subroutine Flexin is called once for every value to be mapped.)

(2) Storage space is created for ten values of the array CONST.

(3) The variable FIRST is declared to be a logical variable. It is "true" on the first entry to Flexin and "false" on all other entries from the main program. This is set outside the Subroutine.

(4) As more than one map is to be made and as each requires a different routine to read in the data, the rest of Flexin is broken down into segments named 1, 2, 3, 4, 5. The variable IFORM is given its value for each map in Elective 2, field 1. After reading this statement the program jumps to the statement N CONTINUE where N is the value of IFORM. In the example above there are only two routines, but there is space for three more if needed. By extending the "GOTO" statement, as many routines as needed may be used. Each routine is sandwiched between a CONTINUE statement (which indicates the beginning of each routine) and a RETURN statement (which sends the value T back to the main program).

(5) The first segment is an extension of Example 7-7. In this case two data values are read, AREA and POP(ulation), and from them the population density is calculated and returned to the main program as the value to be mapped.

Example 7-8
(Continued)

(6) The second segment is intended to create a value showing the amount of use a park receives each day. The variable PICNIC is the average number of picnics per day; the variable CAMPER is the average number of campers entering the park each day. Campers tend to stay for different lengths of time in different types of parks, so the number of campers entering daily is weighted for each of ten types of parks.

(7) The ten different weights are read from one data card at the beginning of the data deck on the first entry to Subroutine Flexin. In all successive entries the logical variable FIRST will be "False", and this section will be by-passed: the program will jump from statement number 2 to statement number 21. The logical unit 12 is also rewound on this first call to Flexin. By rewinding the file we ensure that the first record read in statement number 21 is the first data record desired.

(8) In each entry to Flexin the program reads the variable I (the type of park), PICNIC (Number of picnickers) and CAMPER (number of campers). This data is on a disk file mounted on logical Unit 12, rather than on cards. The park type (I) specifies which pre-stored value of CONST is to be used to calculate the value to be mapped.

to devise more sophisticated analysis and statistical routines to be applied to his data.

7.6. COMPUTER SUBMISSIONS

After the packages have been prepared, they must be placed in the correct order together with the control cards needed for submission to the computer. The normal order of a deck of cards for submission to an IBM 360 computer is:

Control Cards
Fortran Program (including Subroutine FLEXIN)
More Control Cards
Data on which the program is to operate

As procedures vary at each installation, the user is advised to consult with a programmer who knows how his own installation handles the control cards and its exact procedures.

The data on which the program operates consists of IRREGULAR OUTLINES PACKAGE, the MAP PACKAGE, and the DATA INPUT. These packages must be in the correct position with respect to each other in the card input deck:

(i) The IRREGULAR OUTLINES package must <u>precede</u> the MAP package to which it refers. Once an IRREGULAR OUTLINE has been specified it will be used for every MAP package until it is supressed.

(ii) Each time the program reads a MAP package it will attempt to make a map. There is no limit to the number of MAP packages in any one submission.

(iii) If the DATA INPUT is being read from cards, it must immediately follow the MAP package.

The end of the data input is signaled by a card with "END" punched in columns 1-3 immediately following the last MAP PACKAGE--or the last data card, if the data is on cards. Example 7-9 shows a typical submission where four maps are required, the data input is on cards for one map and tape or disk for the other three, and an irregular outline is specified for two maps but not for the other two.

Example 7-9
Sample Submission for Four Maps

Control Cards .		
Fortran Programs .		
Control Cards .		
Data .	IRREGULAR OUTLINES	. irregular out-
	--	lines for first
	--	map
	--	
	--	
	99999	
	MAP	. first map
	--	package
	--	
	--	
	--	. irregular out-
Data input for first map .	99999	line retained
on tape or disk	MAP	for second map.
	--	. second map
	--	package
	--	
	--	
Data input for second .	99999	. Outline removed
map on tape or disk	IRREGULAR OUTLINE	for third map
	99999	with blank package
	MAP	. third map
	--	package
	--	
	--	
	--	
Data input for third .	99999	
map on cards	9.0 17.2	
	10.0 18.1	
	- - - - - - - -	
	- - - - - - - -	
	- - - - - - - -	. fourth map
	7.1 20.3	package
	MAP	
	--	
	--	
	--	
Data input for fourth .	--	. indicates end
map on tape or disk	99999	of data.
	END	

APPENDIX M: DATA FILES

M.A HONYHIL3: Original data inventory

M.B NRMACT10: Normalized site attractiveness scores for each activity

M.C HONEYMTX: Impact values for each activity on each site resource system

M.D IMPACT2: Total impact of each activity on all site resource systems, and total impact on each site resource system by all activities

M.E HONYHL11: Professional Judgment Plans

M.F NEWPLN18: Plans for simulation model evaluations

M.A Data File: HONYHIL3

Size: IA(49)

Data: Original data bank

1 CENTROID ELEVATION
XXX = Coded to nearest 5'

2 TOPOGRAPHY--ORIENTATION (ORNT)
0 = Water
1 = Flat
2 = North
3 = N.E.
4 = N.W.
5 = East
6 = West
7 = S.E.
8 = S.W.
9 = South

3 & 4 TOPOGRAPHIC SLOPE (SLP2)
0 = No Slope
1 = 0-4%
2 = 4-8%
4 = 8-10%
5 = 10-12%
6 = 12-15%
7 = 15-25%
8 = 25-35%
9 = 35+%

5 LANDFORM (SURFICAL) (LDFM)
1 = Outwash
3 = Till
4 = Kame Terraces
5 = Kame
6 = Flood Plain
7 = Organic
9 = Rock

6 SOIL TYPE (SOIL)
0 = Water
1 = Gravel - Course

6 SOIL TYPE (SOIL) (Cont'd)

2 = Gravel - Fine
3 = Sand - Course
4 = Sand - Fine
5 = Silts and Clays liq <50
6 = Silts and Clays liq >50
7 = Peat

7 BED ROCK DEPTH (BDRK)

1 = Exposed
3 = 0-1'
5 = 1'-3'
7 = 3'-10'
9 = >10'

8 SOIL MOISTURE (SMST)

0 = Water
3 = Wet
5 = Moist
7 = Fresh
9 = Dry

9 WATER (SUB-SURFACE) (SWAT)

1 = None (unless in rock)
5 = 5' to water table
7 = 5' to table
9 = 5' to table on pan

10 WATER--PREDOMINANT TYPE (WATY)

0 = None
1 = Swales
2 = Wetlands
3 = Small Streams
4 = 1st Order Streams
5 = Ponds
6 = Reservoirs
7 = Lakes
8 = Minor Rivers
9 = Major Rivers

11 FOREST TYPE (FTYP)

0 = None
2 = Cut and regrowth Area
5 = Deciduous
9 = Coniferous

12 FOREST--DENSITY (FDEN)

0 = None
2 = 30% Crown Coverage
4 = 31-50% Crown Coverage
6 = 51-80% Crown Coverage
8 = 81-100% Crown Coverage

13 FOREST--HEIGHT (FHGT)

0 = None
1 = Less than 20'
3 = 21-40'
5 = 41-60'
7 = 61-80'
9 = Greater than 80'

14 AGRICULTURAL ACTIVITY (AGAL)

0 = None
3 =
6 =
9 = Farmstead

15 RESIDENTIAL ACTIVITY (REAC)

0 = None
3 = Miscellaneous Land Associated with Residences
9 = Residence

16 DEVELOPMENT ACTIVITY (DEAC)

0 = None
2 = Recreation
4 = Public Building
5 = Cemetary
7 = Gravel Activity
8 = Industry
9 = Power Line

17 & 18 TRANSPORTATION--ROAD TYPE (ROD2)

0 = None
1 = Jeep Track
2 = Unimproved Roads
3 = Gravel Road
4 = Light Duty Paved Roads
5 = Medium Duty Paved Roads
6 = Urban Streets
7 = Heavy Duty Paved Roads
8 = Limited Access Highway
9 = Interchange or limited Access Highways

23 PROXIMITY TO ROADS - OLD (RPX1)

(Road is defined as type 5 or greater)

0 = No Road Within 6 kms.
1 = Nearest Road 4-6 kms.
2 = Nearest Road 3-4 kms.
3 = Nearest Road 2-3 kms.
4 = Nearest Road 1 1/2-2 kms.
5 = Nearest Road 1-1 1/2 kms.
6 = Nearest Road 5/10-1 km.
7 = Nearest Road 2/10-5/10
8 = Nearest Road in neighborhood
9 = Road in Grid Cell

24 PROXIMITY TO ROADS - PROPOSED

(Road defined as #3 or greater)

0 = Nearest road over 1 1/2 kms.
1 = Nearest road over 1.4-1.5 kms.
2 = Nearest road over 1.2-1.3 kms.
3 = Nearest road over 1.0-1.1 kms.
4 = Nearest road over .8-.5
5 = Nearest road over .6-.7
6 = Nearest road over .4-.5
7 = Nearest road over .2-.3
8 = Nearest road in neighboring cell
9 = Road in Grid Cell

25 WATERSHEDS--3 DIGIT CODING

0 = Watersheds outside area
first digit = Major Watershed (1-4)
second digit = Subwatersheds
third digit - 0 = free drain area
1-4 = first order Watersheds

26 & 27 PROXIMITY TO WATER

(Water is defined as type 6 or greater)

0 = No water within 6 kms.
1 = Nearest water 4-6 kms.
2 = Nearest water 3-4 kms.
3 = Nearest water 2-3 kms.
4 = Nearest water 1 1/2-2 kms.
5 = Nearest water 1 - 1/2 kms.
6 = Nearest water 5/10 - 1 km.
7 = Nearest water 2/10 - 5/10 kms.
8 = Nearest water in neighboring cell
9 = Water in Cell

28 PROPOSED RESERVOIR AND RECREATION FACILITY

- 0 = Outside Proposed area
- 1 = June pool @ 511.0
- 3 = Pool Crest @ 524.0
- 5 = Federal land laking around crest
- 7 = State land
- 9 = Dorm

M.B Data File: NRMACT10

Size: A(18)

Data: Normalized Site Attractiveness Scores for Each Activity

A(1) = Least cost highway corridor

A(2) = Least ecological damage

A(3) = Hunting

A(4) = Downhill skiing

A(5) = Snow mobiling

A(6) = Snow shoeing

A(7) = Cross-country skiing

A(8) = Picnicking

A(9) = Residential

A(10) = Boating (water)

A(11) = Beaches

A(12) = Marinas

A(13) = General field sports and activities

A(14) = Parking

A(15) = Fishing (water)

A(16) = Swimming (water)

A(17) = Camping

A(18) = Hiking

M.C Data File: HONEYMTX

Size: IA(27,11)

Data: Impact Values for Each Activity on Each Site Resource System, Coded as follows:

0 = no impact
1 = compatible
2 = moderate
3 = severe
4 = threshold

Activities	Site Resource Systems
1. Camping	1. Surface Water
2. Beaches	2. Surficial Aquifer
3. Marinas	3. Soils
4. Parking	4. Wildlife
5. Picnic	5. Insects
6. Residential 12u/ac.	6. Vegetation
7. Residential 2u/ac.	7. Shoreline
8. Hiking	8. Dry Beach
9. Roads, Primary	9. Wet Beach
10. Roads, Secondary	10. Scientific Resources
11. Fishing	11. Scenic Resources
12. Field Sports	
13. Swimming	
14. Boating	
15. Agriculture	
16. Parking	
17. Residential 12u/ac.	
18. Residential 2u/ac.	
19. Snowshoe	
20. X-Country/Ski	
21. Snowmobile	
22. Roads, Primary	
23. Roads, Secondary	
24. Hunting	
25. Downhill Ski	
26. Reservoir Operation - Daily Fluctuation	
27. Reservoir Operation - As Planned	

M.D Data File: IMPACT2

Size: IXL(27,2) IXS(11,2)

Data: Total Impact of each Activity on all Site Resource Systems and Total Impact on each Site Resource System by all Activities

Activities

1. Camping
2. Beaches
3. Marinas
4. Parking
5. Picnic
6. Residential 12u/ac.
7. Residential 2u/ac.
8. Hiking
9. Roads, Primary
10. Roads, Secondary
11. Fishing
12. Field Sports
13. Swimming
14. Boating
15. Agriculture
16. Parking
17. Residential 12u/ac.
18. Residential 2u/ac.
19. Snowshoe
20. X-Country/Ski
21. Snowmobile
22. Roads, Primary
23. Roads, Secondary
24. Hunting
25. Downhill Ski
26. Reservoir Operation - Daily Fluctuation
27. Reservoir Operation - As Planned

Site Resource Systems

1. Surface Water
2. Surficial Aquifer
3. Soils
4. Wildlife
5. Insects
6. Vegetation
7. Shoreline
8. Dry Beach
9. Wet Beach
10. Scientific Resources
11. Scenic Resources

M.E Data File: HONYHL11

Size: IA(16)

Data: Professional Judgment Plans

1. Rogers A
2. Steinitz A
3. Toth A
4. Murray A
5. Peacock A
6. Way A
7. Toth B
8. Murray B
9. Peacock B
10. Way B
11. Steinitz C
12. Toth C
13. Murray C
14. Peacock C
15. Way C
16. Steinitz B

<u>Activity Key for Plans</u>

00	<u>WATER AREA</u>
01	fishing
02	canoeing
03	boating
04	multi-use

10	SWIMMING
20	WATER SPECIAL
21	motorboating
22	waterskiing
30	WINTER AREA LAND
31	cross-country skiing
32	snowshoeing
33	hunting
34	ice skating
40	WINTER LINEAR LAND
41	cross country skiing
42	snowshoeing
43	hiking trail
44	multi-use trails
50	WINTER SPECIAL
51	snow mobile - including lakes
52	downhill skiing
60	SUMMER AREA LAND
61	picnic
62	camping
63	fishing
64	swimming beach
65	launch area - dock
66	trail rest area
70	SUMMER LINEAR LAND
71	hiking
80	HUNTING
88	parking
89	access roads
90	RESIDENTIAL AND OTHER STRUCTURES
91	trail shelter
92	ski shelter
93	marina
94	skating shelter
95	water view homes
96	wood view homes
97	condiminium homes
98	farmsteads
99	group lodge

M.F Data File: NEWPLN18

Size: IA(18)

Data: Plans Used in Evaluations

1. Steinitz A
2. Toth A
3. Murray A
4. Murray A with Attractiveness
5. Murray - A with Impact
6. Murray - A with Attractiveness and Simulation
7. Steinitz B
8. Toth B
9. Murray B
10. Murray B with Attractiveness
11. Murray B with Impact
12. Murray B with Attractiveness and Simulation
13. Linear Program B
14. Linear Program B with Program A
15. Linear Program B + Program A + Simulation
16. Linear Program A
17. Linear Program A + Program A
18. Linear Program A + Program A + Simulation

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13. ABSTRACT

The first purpose of this research was to focus attention on ways and means for measuring non-monetary social and environmental costs and benefits and comparing them with costs and benefits measurable in dollars. The second purpose was to develop better ways to plan for the multiple use of water and related land resources, with emphasis on recreation uses.

The data on the area were stored, analyzed and displayed using computer graphics techniques developed by the investigators. The study developed sets of quality indices for visual quality, ecological damage, wildlife habitat, etc. Grid areas were evaluated and ranked in terms of various uses, thus laying the basis for a planning evaluation process for site development. A simulation model was developed which allows for comparison of the effects over time of alternative recreation plans. Alternatives were developed and tested in the model utilizing both "best professional judgment plans" and alternatives derived from a mathematical programming model developed by the authors.

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