



digitalconservancy

UNIVERSITY OF MINNESOTA

Deposit Agreement

I represent that I am the creator of the digital material identified herein (“Work”). I represent that the Work is original and that I either own all rights of copyright or have the right to deposit the copy in a digital archive such as the Conservancy. I represent that the regard to any non-original material included in the Work I have secured written permission of the copyright owner(s) for this use or believe this use to be allowed by law. I further represent that I have included all appropriate credits and attributions. I hereby grant to the Regents of the University of Minnesota (“University”), through its University Digital conservancy, a non-exclusive right to access, reproduce and distribute the Work, in whole or in part, for the purposes of security, preservation and perpetual access. I grant the University a limited non-exclusive right to make derivative works for the purpose of migrating the Work to other media or formats in order to preserve access to the Work. I do not transfer or intend to transfer any right of copyright or other intellectual property to the University.

Work(s) to be deposited:

Title: **McHarg and the Metropolitan Council: An (Un)likely Romance**

Author’s Name*:

Lindsay Carrera

Print

Signature of Author or Authorized Representative

*(See back page for additional names and signatures if there is more than one author)

Name (please print): Lindsay Carrera

Address: 2556 DuPont Ave S #2, Minneapolis MN 55405

Date: December 19th, 2018

If the Deposit Agreement is executed by the Author’s Representative, the Representative shall separately execute the following representation.

I represent that I am authorized by the Author to execute this Deposit Agreement on behalf of the Author.

N/A

Author’s Representative Signature

Date: _____



digitalconservancy

UNIVERSITY OF MINNESOTA

Additional Author's Name: Print and Signatures (s):

Lindsay Carrera
Print

Signature

Kowsar Mohamed
Print

Signature

Athena Adkins
Print

Signature

Julie Barton
Print

Signature

James Williams
Print

Signature



McHarg and the Metropolitan Council: An (Un)likely Romance

MPA, MPP, & MURP Capstone Paper

In Partial Fulfillment of the Master of Public Affairs, Master of Public Policy, and Master of Urban and
Regional Planning Degree Requirements

The Hubert H. Humphrey School of Public Affairs
The University of Minnesota

Athena Adkins, Master of Public Affairs
Julie Barton, Master of Public Affairs
Lindsay Carrera, Master of Public Policy, Master of Social Work
Kowsar Mohamed, Master of Urban and Regional Planning
James Williams, Master of Public Affairs
December 11th, 2018

Signature below of Capstone Instructor certifies successful completion of oral presentation **and** completion
of final written version:

Dan Milz, PhD, Capstone Instructor

December 11, 2018
Date, oral presentation

December 18, 2018
Date, paper completion

Mark VanderSchaaf, PhD, Client
Retired, Metropolitan Council

Date

Acknowledgements

McHarg and the Metropolitan Council: An (Un)likely Romance is a report prepared by Athena Adkins, Julie Barton, Lindsay Carrera, Kowsar Mohamed, and James Williams for Dr. Mark VanderSchaaf of Placemaking Consulting. This report serves as a capstone project in fulfillment of the Master of Public Affairs, Master of Public Policy, and Master of Urban and Regional Planning Degree Requirements at the Humphrey School of Public Affairs, University of Minnesota. We would like to acknowledge the assistance and guidance of the following individuals throughout the project process.

Thank you to everyone who provided technical assistance.

Dan Milz, PhD

Assistant Professor
University of Minnesota
Hubert H. Humphrey School of Public Affairs

John Adams, PhD

Professor Emeritus
University of Minnesota
Hubert H. Humphrey School of Public Affairs

Marcel Jouseau

Metropolitan Council (retired)

Ed Maranda

Metropolitan Council (retired)

Dan Marckel

Metropolitan Council

Jan Price, MLIS

Metropolitan Council

Mark VanderSchaaf, PhD

Placemaking Consulting

Libby Starling, MP

Metropolitan Council

TABLE OF CONTENTS

Introduction	4
Literature Review	6
Examining the Influence of the 1969 WMRT Ecological Assessment on the Twin Cities Landscape	9
Case Description	17
Methodology	18
Data Sources:	18
WMRT Report	18
Video: Multiply and Subdue the Earth	19
Planning Guides and Metropolitan Council Primary Sources	19
Interviews	19
Marcel R. Jouseau	19
John Adams, PhD	20
Ed Maranda	20
Timeline	22
Social, Political, and Economic Context	22
McHarg’s Recommendations to the Metropolitan Council	26
Findings	28
Evidence of McHarg’s Influence on Metropolitan Council	28
Alignment: McHarg Recommendations and Metropolitan Open Space Statements	32
Discussion	38
Areas for Further Study	39
Limitations	40
Conclusion	41
Works Cited	43
Appendices	45

*“This is a great and glorious region. It is fishing with lakes. It is transected by three great rivers; the Mississippi, the Minnesota and the St. Croix. There isn't any doubt about the value of these. There isn't any doubt about their beauty either. Is it inevitable that they have to try all the crummiest, most disgusting and ugly industries and uses? ... Almost every land use can exist;... But you have to learn I insist in the first case of the river is noble and the land use be deferential to the river. There isn't any reason why industry and commerce cannot, in fact, impinge upon the river but do this with some deference.” (McHarg, *Multiply and Subdue the Earth*).*

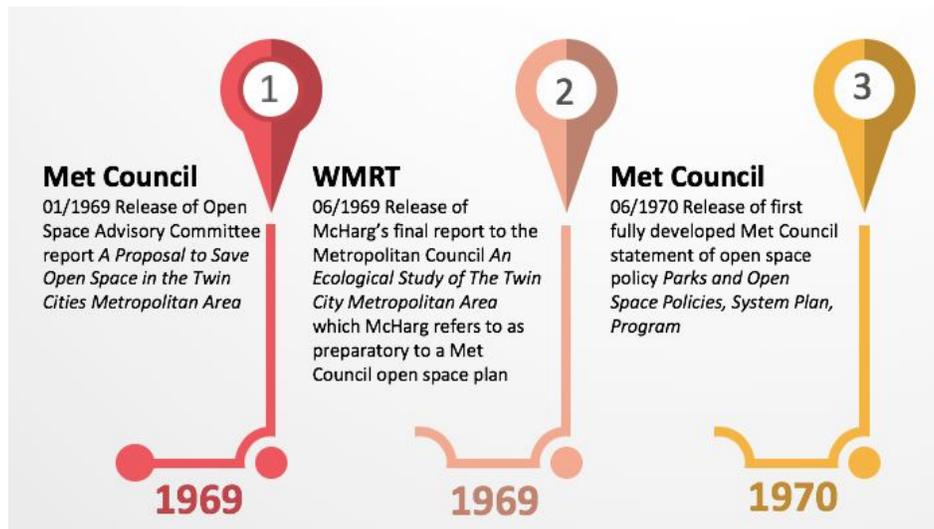
Introduction

Urban planning concerns itself with the organization of grids, systems, flow; of where people are, where people should be, and what they should do there. Ecologists study relationships between living things and the environment. Fifty years ago, Scottish landscape architect, author, and TV personality Ian McHarg wrote his seminal book, *Design with Nature*. That same year, he also delivered a report to the Metropolitan Council of the Twin Cities, *An Ecological Study of the Twin Cities* (Wallace et al, 1969). The Metropolitan Council had taken a bold step in thinking about their work differently--from an “ecology-first” perspective rather than an “economic-growth first” perspective. McHarg considered the grids, system, flow, and most importantly, where people were and where they *should* be, primarily through the lens of the relationships between all of the living things in the region and the land. The overall purpose of this report is to determine what impact, if any, McHarg’s report--and his ecology-first perspective--had on Metropolitan Council policymaking.

McHarg spoke and wrote powerfully to what many considered the foremost planning challenge of the era, that of inadequate management of burgeoning economic growth. He also gave special attention to one of the most visible costs of poorly managed growth -- unconsidered destruction of sensitive open space and attendant harm to natural systems. In essence, McHarg believed that if planners took an “ecology-first” approach, the other goals of economic growth, housing, and transportation could all be realized, resulting in healthier and safer communities.

The Metropolitan Council of the Twin Cities was a first-of-its-kind regional governing body for the seven-county area. Within two years of its inception, the Council chose to commission McHarg to write a report assessing the area. Like McHarg, Twin Cities leaders were deeply concerned about the harmful effects of poorly managed growth, particularly the destruction of open space. In a 1967 report calling for the creation of the Metropolitan Council, the Citizens League identified open space protection among the most important functions of the envisioned body and warned, “Unless large tracts of parks and open space are acquired promptly, the land will be taken over by developers and lost for public purposes forever” (Citizens League, 1967).

McHarg was also a first of his kind. He was a landscape architect who moved away from the aesthetic dogma of modernism and instead believed that ecology-first ideals should drive practice. This melding of an untested regional model of government with a landscape architect proposing to make ecological principles actionable through a planning process gives us a rare opportunity to conduct a policy analysis of McHarg's impact on the region through policy and planning.



The timing of the 1969 McHarg report, one year prior to the Metropolitan Council's first open space policy statement, begs a number of questions:

What was the social, political, and economic context for McHarg and the Metropolitan Council's thinking about open space? How was it possible that a unique form of regional government and a celebrity landscape architect came to work together on a new ecologically based approach to planning? What were McHarg's recommendations to the Metropolitan Council with regard to the protection of open space, and how did those recommendations influence the formulation of Metropolitan Council open space policy? Finally, is there evidence of alignment between McHarg's open space recommendations and early Metropolitan Council open space policy statements?

To answer these questions, a senior planner who was at the Metropolitan Council at the time of McHarg's work was interviewed, along with a former student of McHarg's who went on to play a significant role at the Metropolitan Council, and also an early Citizen's League board member with ties to both the Humphrey Institute and the Metropolitan Council. Years of data stored on microfiche at the Metropolitan Council was reviewed, including meeting minutes and internal memos from 1968-1971 as well as reports and notes from open meetings. To provide context from the time, we relied on Ian McHarg's autobiography as well as information about the formation of

the Metropolitan Council from the Citizen's League and other texts that demonstrate the context of these events..

The findings strongly suggest that McHarg's recommendations did influence the Council's approach to regional planning. Metropolitan Council staff relied on McHarg's analysis as the primary basis for its foundational 1970 open space policy statement. The Council's *Metropolitan Development Guide* (MDG) for the first time bound nearly 300 units of local government to conform to a regional open space protection strategy for the Twin Cities (Metropolitan Council [MC], 1970). This inaugural open space policy served as the starting point for the next five decades of Twin Cities open space policy making, and, over time, reshaped the Twin Cities landscape in its image. If you look around the Twin Cities region today -- the grids, the systems, the flow; where people are and what they are doing there -- you will see the influence and ideas of Ian McHarg. This is important because we have the opportunity to observe, over a long period of time, how and to what extent this early planning resonates today. Rather than existing only on paper, in a library or buried in microfiche, this report, because of the direction and weight it was given by the Metropolitan Council, put theory into action.

In addition to discussing McHarg's influence on urban and regional planning in the Twin Cities region, we will place his work within the broader context of urban planning, discuss his impact within his field and discuss the comparative and historical analysis we used as a basis for our conclusions. To date, relatively few regional-scale plan evaluations have been conducted. When they are, they are typically geographic analyses. This approach is unique because it focuses on how McHarg's recommendations affected Metropolitan Council policy rather than simply the ecology of the region. We will discuss Metropolitan Council history and how it came to be that a celebrity landscape architect with a penchant for fiery environmental polemic was tasked with advising the Council on its approach to land use planning and open space protection. We will review our findings and we will offer some ideas on why and how McHarg's recommendations were massaged to meet the needs of many stakeholders. Finally, we will outline the limitations of our work and offer several compelling areas for potential further study.

Literature Review

Wallace, McHarg, Roberts, and Todd's (WMRT) 1969 report, *An Ecological Study of The Twin Cities Metropolitan Area*, prescribes the optimal use of all lands in the Twin Cities metro area on the basis of a comprehensive inventory of the natural resource characteristics of the regional landscape and an elaborate system for identifying optimal land uses by reference to those characteristics (Wallace et al., 1969). The report and McHarg's contemporaneous book, *Design with Nature*, were the apotheosis of two decades of personal reflection, scholarship, and practice focused on the development of an ecology-based approach to urban planning.

As an academic, designer, author and practitioner, McHarg believed that all land use design decisions should incorporate ecological understanding and awareness. Wahl (2017) states that McHarg made sure that his design considerations and recommendations expressed “a culture-nature symbiosis and [met] human needs while being beneficial to life as a whole.”

McHarg’s concept of ecology was not simply of a science but of a worldview in which a number of assumed facts about the world are held preeminent:

1. The world is a complex system of interactive natural processes.
2. Human beings are embedded in this complex, affected by (and affecting) natural processes in all that we do.
3. The natural processes in place on the landscape support certain human uses and constrain others.
4. Natural processes provide services (which McHarg calls values) that are beneficial to human beings.
5. Land uses impact natural processes and may diminish the capacity of natural processes to provide future value to people.

On the basis of this worldview, McHarg argues that the principal aim of urban planning should be to optimize the fit between land uses and natural processes in specific places or, in his exact words, to match “the proclivities of the land... to the requirements of demand” and to do so in a manner that does not compromise the capacity of the land to continue providing value in the future (Wallace et al, 1969). His theory of human ecological planning is an instrument for “revealing regions as interacting and dynamic natural systems having intrinsic opportunities and constraints for all human uses” (McHarg, 1981).

Before beginning his work in the Twin Cities, McHarg honed the concepts and methods of ecological planning via a series of land use plans and case studies prepared by his firm Wallace, McHarg, Roberts, and Todd for areas including downtown Baltimore, Manhattan, the Potomac River basin, Staten Island, Philadelphia, and the New Jersey shore. In his book *Design with Nature* (McHarg, 1969), he presents conceptual and methodological models for a new kind of ecological planning.

McHarg’s conceptions and use of science as an explanatory model for understanding nature and people became the driving force for using “science in the design of regional landscapes” (Herrington, 2010). He advanced the map-overlay method, by creating his design concept called “layer cake” maps (See Figure 1). This model would become the predecessor to the computerized Geographic Information Systems (GIS) system; a gathering process utilizing data maps to create big

pictures. The “layer cake” method became key to the ecological model being used to identify and interpret ecological parameters in various American cities including the Twin Cities region.

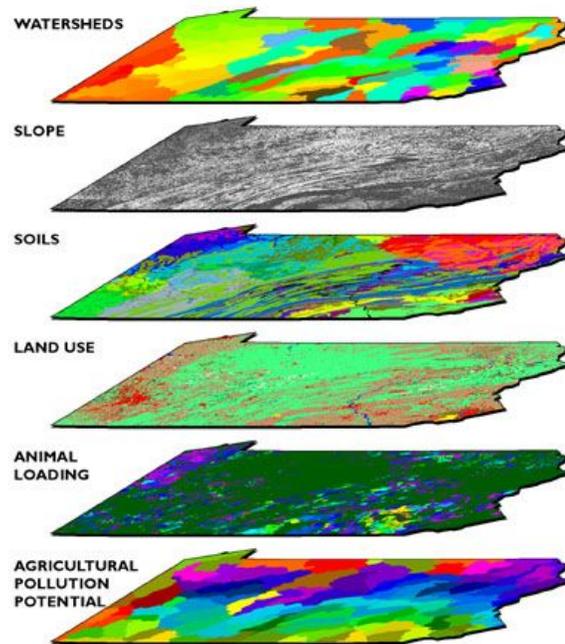


Figure 1 – Layer Cake Map (Source: https://www.e-education.psu.edu/natureofgeoinfo/sites/www.e-education.psu.edu.natureofgeoinfo/files/image/pa_layers.jpg)

McHarg described his ecological method for interpreting and identifying the ecological parameters of the region as a two-step ecological inventory process. The first step is the interpretation of the existing and potential ecological parameters of the region. Prior to engaging with the interpretation process he elaborately evaluated the conditions of existing ecological features throughout the region and categorized each based on their specific ecological characteristics. The map-overlay technique utilized by McHarg to develop the ecological model relied heavily upon the “the integration of social and natural information” to project future development in ways that adhered to “nature’s intrinsic progression towards stability” (Harrington, 2010).

This photo-GIS method, partnered with his ecology-based approach to planning, resulted in an instrument to develop and review land and design characterizations as well as the opportunity to produce the 1969 WMRT report (The McHarg Center, 2018). It produced the recommendations to develop a technical report which proposed suitability matrices and techniques to attend to nature's processes in various sites and stages throughout the Twin Cities region. The report’s approach to providing actionable guidance led to the council’s need to translate this analysis into action. It provided a basis to interpret and identify prospective land uses but also helped the Metropolitan Council and other parties to understand how these major categories function throughout the region.

Subsequently, we analyzed the WMRT 1969 report, *An Ecological Study of The Twin Cities Metropolitan Area*, with the understanding that McHarg's ecological method has led to instruments to develop and review land and design characterizations (The McHarg Center, 2018). Despite this fact, none of the scholars, authors, and supporters reviewed here have examined McHarg's direct impact on the Twin Cities regional plan. We find it quite difficult to identify regional policy evaluation and analysis throughout the United States. Much of the existing literature supports European regional policy evaluation and analysis. It mentions the establishment of regional policy structures, but misses the opportunity to truly evaluate regional development policies for what they are worth. Our historical policy analysis approach is something of a new evaluation model compared to those commonly used to examine policy development and change (Diez et al., 2002). The research this study inaugurates is currently not comparable to other work that is available today. We have found that much of the discussions surrounding McHarg focus on his contributions to landscape architecture and planning overall. There is a significant disparity between the current knowledge available on the Twin Cities regional history and public design as it relates to McHarg's regional plan recommendations, as well as regional policy evaluation in the United States as a whole.

Examining the Influence of the 1969 WMRT Ecological Assessment on the Twin Cities Landscape

The 1969 WMRT report *An Ecological Study of the Twin Cities* is believed to have been an echo of the work conducted previously by landscape architect Horace Cleveland, who convinced City of Minneapolis business leaders to develop a new kind of park system which would link natural resources such as lakes and rivers to one another (Smith, 2008). Cleveland's vision for the metropolitan area was to see the two major cities (Minneapolis and St. Paul) connected through parkways and regional design mechanisms (Martin, 2017). Unlike Fredrick Law Olmstead Jr., Cleveland's approach valued nature in a way that saw the risk urban development posed on the natural landscapes of the West, which the Midwest was considered a part of during this time. He saw the importance of protecting natural areas from development not only for their recreational purposes and accessibility but for their intrinsic values as well.

Many years later, the Twin Cities saw the rise of a first of its type regional governance body -- the Metropolitan Council -- which exercised power in significant part by guiding local land use planning and zoning. One impetus for creation of the Council was widespread nitrate contamination of drinking water supplies that could cause potentially fatal methemoglobinemia, or "Blue Baby Syndrome". The Metropolitan Council was established to determine the best use of land and water resources. This contamination directly influenced the council to consult with McHarg and his firm to determine how to best address land use and water resource issues in the region (McCormick, 1968).

As we know now, McHarg's conception of ecology was not just as a science but a worldview. On the basis of this worldview, McHarg argued that the principal aim of urban planning should be to optimize the fit between land uses and natural processes in specific places and to do so in a manner that does not compromise the capacity of the land to continue providing value in the future (McHarg, 1996)

Returning to discuss McHarg's approach to the ecological method, we examine the second step in this process. The focal point of this two-step ecological inventory system was the development of an ecological criteria for prospective land uses by "identifying the relevance of elements of geology, physiography, hydrology, soils, vegetation, wildlife, and existing land uses to the four land use groups" (Wallace et al., 1969). The prospective land uses McHarg identified are production, protection, recreation, and urbanization (See Table 1).

Four maps were produced to illustrate intrinsic suitability for these uses (See Figure 2) (Wallace et al., 1969). McHarg 1969 directly states that the "data gathered from the ecological inventory has a value in its own right because it can be reinterpreted for objectives not considered in this study." This is significant because we have identified areas in the Metropolitan Council 1970 Metropolitan Development Guide: Parks and Open Space – Policies, System Plan, Program (MDG) where his recommendations were considered.

Each ecological feature was listed and evaluated based on its relationship to the prospective land use groups. McHarg's reasoning for analyzing existing land uses was to determine which cultural features have "recreational value or require protection" (Wallace et al., 1969). He used aerial photographs to identify non-urban lands such as "cultivated fields, meadows, pastures, and forests" (Wallace et al., 1969). Other features like historical sites and public and private recreational areas were identified by information provided by the Metropolitan Council (Wallace et al., 1969).

Table 1: McHarg's "Ecological Parameters" Prospective Land Uses	
Production	Land uses related to production from the land Examples: agriculture, forestry, wildlife propagation, and mineral extractive industries
Protection	Land uses whose primary purposes are to preserve, protect, and conserve those elements of the natural environment considered to be unique, scarce, or vulnerable or constitute a hazard to life and health. Examples: erodible slopes, flood plains, and aquifer recharge areas
Recreation	Land uses whose purposes are to enable the constructive use of leisure time in an active or passive manner.
Urbanization	Land uses related to residential, commercial, institutional, and industrial development.

Source: 1969 WMRT Ecological Assessment on the Twin Cities Landscape, Page 36



Figure 2 - 1969 WMRT McHarg Composite Intrinsic Suitability Map (Source: Wallace et al., 1969)

The second step of this process focuses on the “development of ecological criteria... [to interpret] ecological parameters with respect to land uses” (Wallace et al., 1969). McHarg used a value rating system to identify best conditions and least desirable conditions. This identification scheme guided the development of the ecological criteria which determined land use suitability (Wallace et al., 1969). The combining of different ecological criteria into ‘suitability classes’ was the result of the development of ecological criteria. On that account, McHarg proposed regulation to protect what he would call the ‘ecological phenomenon and processes.’ A spectrum of regulatory alternatives were constructed to indicate the “devices that might be appropriately employed in the Twin Cities Metropolitan Area” (Wallace et al., 1969) (See Figures 3 and 4).

McHarg’s recommended identification and categorization of land uses for protection compatibility and permitting can be examined in Images 3 and 4. The regulator devices and recommended permitted uses from the 1969 WMRT report were policy suggestions that remained straightforward. These policy suggestions were based on McHarg’s recognition of recurring phenomena and processes in the region and prescribing ecological, preservation- motivated regulatory approaches. For “#23 proposed parks”, McHarg recommended public acquisition as a regulatory device to preserve such spaces (Wallace et al., 1969). This public acquisition could be an outright purchase, installment purchase, purchase and leaseback, or excess condemnation.

PHENOMENA & PROCESSES	REGULATORY DEVICES		RECOMMENDED PERMITTED USES	
	Acquisition	Zoning	Acquisition	Regulation
1. Wooded Swamps	■	■	1. No development. Preserved by purchase, acquisition of development rights, easements, the appropriate zoning category and agricultural preferential assessment and subject to public health regulations.	1. No development. Preserved by purchase, acquisition of development rights, easements, the appropriate zoning category and agricultural preferential assessment and subject to public health regulations.
2. Marshes	■	■	2. As above	2. As above
3. Wet Meadows	■	■	3. No urban development permitted. Recreation, agriculture, forestry permitted. Flood Plain Zoning employed as the regulatory device.	3. Subject to Public Health Regulations. Riparian Zoning which demands treatment of edges, plus scenic, unique ecology. Zoning where applicable.
4. Flood Plains	■	■	4. As above	4. As above
5. Lakes	■	■	5. As above	5. As above
6. Rivers & Major Streams	■	■	6. Subject to Public Health Regulations, Subdivision Controls should determine land uses permitted.	6. Subject to Forest Zoning and Agricultural Preferential Assessment, plus scenic and unique ecology. Zoning where applicable.
7. Streams	■	■	7. As above	7. As above
8. Intermittent Streams	■	■	8. As above	8. As above
9. Aquifer Recharge	■	■	9. Subject to Public Health Regulations, Subdivision Controls should determine land uses permitted.	9. Subject to Forest Zoning and Agricultural Preferential Assessment, plus scenic and unique ecology. Zoning where applicable.
10. Forest	■	■	10. Neither urban development nor agriculture regulated through Subdivision Controls and USDA. Soil Conservation Service.	10. Neither urban development nor crop agriculture. Regulation through Subdivision Controls and USDA.
11. Slopes > 25% on sands and gravels	■	■	11. Limited Agriculture Residential Development limited by Density Zoning, Subdivision Regulations	11. No development, preserved by purchase of fee or development rights, prohibited for extraction.
12. Slopes 12½-24% & 5%-12½% slopes on drifts and sands	■	■	12. As above	12. As above
13. Slopes 5-12½%	■	■	13. Regulated by unique ecology and suited for zoning.	13. Regulated by Agriculture & Extraction Zoning, Subdivision Controls and Building Codes.
14. Unique Features (Bluffs & Escarpments)	■	■	14. No development, preserved by purchase of fee or development rights, prohibited for extraction.	14. Prohibited for extraction, preserved by Extraction Zoning.
15. Eskers & Kames	■	■	15. No development, preserved by purchase of fee, development rights or easements and appropriate zoning.	15. As above
16. Terrace Edges, Valleys & Gorges	■	■	16. As above	16. As above
17. Ridges, Hills, Promontories	■	■	17. Regulated by unique ecology and suited for zoning.	17. Regulated by Agriculture & Extraction Zoning, Subdivision Controls and Building Codes.
18. Limits of Occupation	■	■	18. No development, preserved by purchase of fee or development rights, prohibited for extraction.	18. Prohibited for extraction, preserved by Extraction Zoning.
19. Peat & Clay Deposits	■	■	19. No development, preserved by purchase of fee, development rights or easements and appropriate zoning.	19. As above
20. Bedrock in River Plain	■	■	20. As above	20. As above
21. Galena Limestone, Decorah Shale & Conglom.	■	■	21. No development, preserved by purchase of fee or development rights, prohibited for extraction.	21. Prohibited for extraction, preserved by Extraction Zoning.
22. Parks & Wildlife Refuges	■	■	22. Regulated through Flood Plain, Riparian and Extractive Zoning.	22. Regulated through Flood Plain, Riparian and Extractive Zoning.
23. Proposed parks, etc.	■	■	23. Regulated by unique Ecology and Scientific and Extractive Zoning.	23. In public ownership, zoned Institutional Fee or rights to the acquired, zoned Institutional.
24. Country clubs, Golf Courses, etc.	■	■	24. Zoned Institutional.	24. Zoned Institutional.

Images 3 and 4 – Images of Regulatory Devices and Recommended Permitted Uses (Source: 1969 WMRT Report). Full Page in the appendix

This point is sustained by the 1970 MDG policies, which directly state in Policy Actions #5 that the Metropolitan Council must “acquire or preserve park and open space lands through means that are consistent with the anticipated use(s) of the land”; and #6, “acquire or preserve sufficient park and open space land to fulfill the needs of the present population and projected future population” (MDG, 1970).

An equally significant aspect is McHarg’s ecological assessment, where he found that the “preferential assessment has failed to permanently reserve open space, and in some instances, it has actually encouraged leap-frogging rather than curtail it” (Wallace et al., 1969). This account suggests that the Twin Cities area fell short in opportunities to stimulate development in specified areas that would encourage open space preservation and urbanization in others. He suggested the implementation of an open space system which combats the patterns of urbanization that undervalue natural processes.

In the 1969 WMRT report, McHarg utilized a working hypothesis to establish a hierarchy of land use preferences. This process assisted him with order preference for land-use categories, in which he found protection of open space systems coming before urbanization (Wallace et al., 1969). He stated that his map revealed natural diversity “instead of bland areas with little character, either good or bad, which are normally selected for urbanization, this map professes a diversity appropriate to a variety of needs” (Wallace et al., 1969). Through his recommended open space system he clearly stated that open space has played a “passive role in the transformation of land [and] urbanization has been the active force” (Wallace et al., 1969). This statement alone shows that the preservation of open space trumping urbanization was McHarg’s ultimate goal in maintaining valued attribution of land uses.

A series of identification criterion were developed as well as sub-processes and a supplemental “Protection” map; a finding which we found provided the basis for a proposed Twin Cities Metropolitan Area Open Space System. Utilizing the ecological inventory and analysis, McHarg identified various functions of land uses that would require protection and regulation. His primary focus was on preserving, conserving, and regulating the natural processes existing in the area. He believed that if the protection for natural resources and phenomenon “is an accepted objective, it must then be integrated with the metropolitan planning process by constituent levels of government and by the private sector” (Wallace et al., 1969). Based on this belief, he found that introducing such a device would lead to a “panoply of devices” that could be employed and implemented to supplement the open space policy. The suggestions provided for the panoply are shown in Images 3 and 4.

The regulator devices suggested are acquisition, zoning, taxation, and regulation- related. McHarg specified the importance of instrumentalizing regulatory devices such as taxes to implement

land use planning and the aggregation of land to further support this policy device. An example McHarg provides of a regulatory device is fee acquisitions being utilized for the preservation of 'phenomenons and processes' (i.e. open space.):

“The most effective means of preserving open space is the outright acquisition of land. William Whyte has pointed out that if a local government has the power of eminent domain, it is in a better position to persuade landowners and developers to cooperate on measures that will make condemnation unnecessary. In his words, "The stronger the stick, the less need to use it". Many acquisition programs have necessarily been aimed at saving those open spaces most threatened by urbanization. The soaring prices of such lands are frequently creating serious predicaments in which agencies find that they must pay much more for land than was contemplated in their appropriations. That situation has suggested alternative acquisition schemes such as installment purchase, purchase and lease-back, and purchase and sell-back” (Wallace et al., 1969).

Complementary to the 1969 WMRT report, the 1970 Metropolitan Council *Metropolitan Development Guide: Parks and Open Space – Policies, System Plan, Program* (MDG) report was adopted. This report operates as a “comprehensive plan for metropolitan parks and open space [as] part of the Council’s Metropolitan Development Guide” (Metropolitan Council [MC], 1970). It contains guidance on long-range planning policies to ensure the proper operation of open space in the metro and a system plan that describes the specific needs of suggested open spaces while identifying areas recommended for preservation, acquisition, and development. Additionally, it contains information on the development program that would implement the suggested parks and open space comprehensive plan.

Much like the 1969 WMRT report, the 1970 MDG states that “tax resources, population characteristics, and social needs are not neatly distributed on the basis of governmental hierarchy, a descriptive breakdown of responsibilities will not help solve the basic problem: the shortage of adequate recreation open space” (Metropolitan Council, 1970). McHarg points out Connecticut and Maryland as states that had enacted tax devices to preserve open space. The criticism of the device is expressed but overall he suggests it is a useful stimulant to development in areas where urbanization is sought; and as an instrument if used in conjunction with other regulator devices that could lead to protected ecological land use plans that are effective (Wallece et al., 1969) This demonstrates that McHarg’s suggestion of instrumentalizing tax devices to implement land use policy and planning to preserve spaces is essential to providing a diversified park and open space system to serve the public. Comparable to McHarg’s judgement on population projections guiding the region towards a realm to address land use priorities, the MDG also suggests determining priorities based on population projections and assumptions of future uses and fiscal resource availability.

The 1970 MDG report illustrates the proposed recreation and protection of open space system plan as a map, which represents these two aspects of open space (See Figure 5). It displays the physical, biological, and social actions that contributed to the character of the region at the time as well as potential opportunities available for open space. In the area of recreation the report highlights the usage of recreational areas outside the metropolitan boundaries, the difficulty of identifying the role for different levels of government and the need for substantial investment on identified recreational activities. This segment focuses mainly on the necessity to address the demands “based on user surveys, population projects, and assumptions as to future uses and fiscal resources” (Metropolitan Council, 1970). Determining recreational priorities is the greatest challenge reported in the guide.

Protection of open space is the second segment of the development guide and it focuses on developing effective policies to work and yield the greatest benefits to man (Metropolitan Council, 1970). The importance of keeping spaces free from development is addressed as is the necessity of assuring properly functioning water systems. Determining whether natural conditions in the Metropolitan Area are protected is also recommended throughout the report. The protection of open space in the report is stated to be facing challenges with development, with few protection elements in place to preserve existing or potential natural open spaces. This segment exists to provide identification of designated protection elements, locations and possible measurements through criteria and a map (See Image 5).

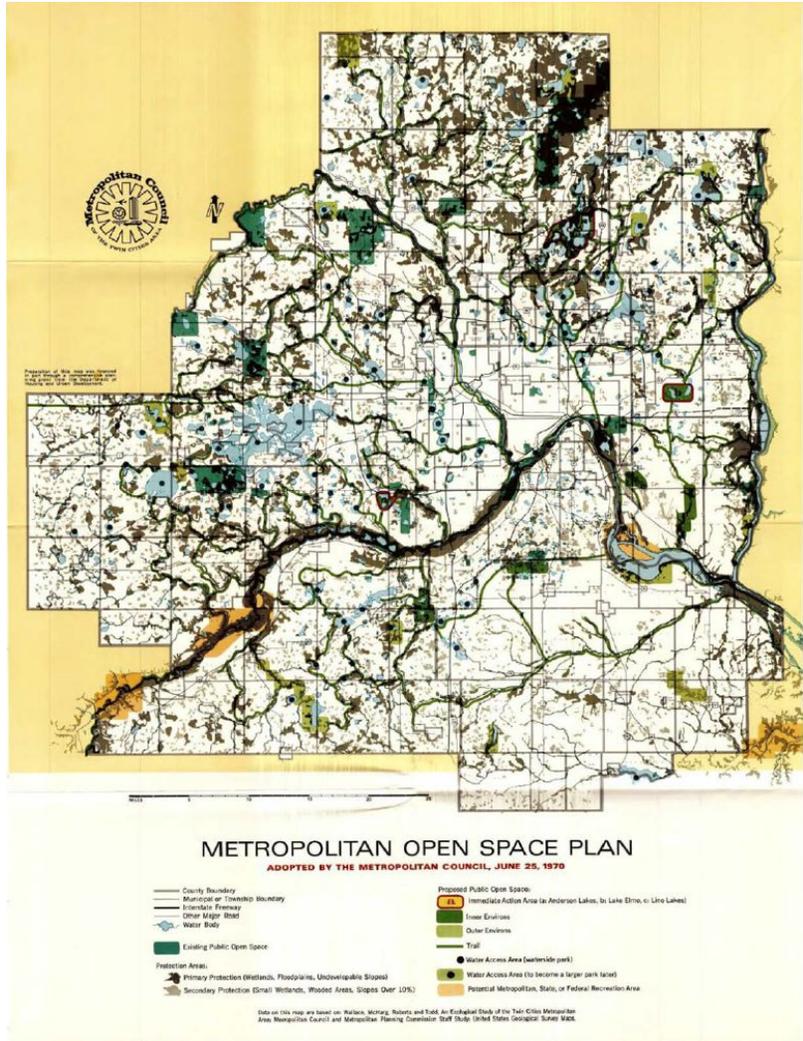


Image 5 – 1970 Metropolitan Development Guide Open Space Plan Map (Source: 1970 MDG)

This segment also serves as a guiding principle to reverse the negative social consequences of human action. The 1970 report states that “from the very earliest geologic activity to the most recent modifications of the landscape by man -- has served to define and limit the character, qualities, and capabilities of the various elements” (Metropolitan Council, 1970). This statement proves that the focus to preserve and protect recreational spaces is based on the effect social conditions have had on natural features in the area as suggested by McHarg’s earlier work in the 1969 WMRT report. This body of work determined which areas should be acquired and developed as metropolitan areas of preservation, recreation and conservation, with great attention given to the quality of existing and potential natural features as well as the accessibility of the built environment in the metropolitan area (Metropolitan Council, 1970).

Case Description

The Metropolitan Council's work with Ian McHarg necessitates an understanding of the origin and evolution of the Council and its relationship to planning. The Twin Cities metropolitan area is unique in suburban development, in that it is more orderly than most other American metropolitan areas because of the development of a review authority relatively early in its suburbanization process (Adams & VonDrasek, 1993).

Through national trends relating to planning, specifically the Federal Aid Highway Act of 1965, highway funds would be supplied only to metropolitan areas which had a comprehensive transportation planning process that could interrelate factors (Harrigan & Johnson, 1978). 1966 saw the Demonstration Cities and Metropolitan Development Act, aimed at creating model cities which extended representation to inner suburbs. The Act included review of projects related to open space such as hospitals, airports, libraries, and water and sanitation (Harrigan & Johnson, 1978). Stakeholders had an incentive to cooperate regionally, given the regulations of federal funding for development projects. Additionally, the bifurcation of the Twin Cities themselves presented a need for cooperation as developments progressed, ranging from growth issues to transit (Adams & VonDrasek, 1993).

Aside from timely progress in addressing regional issues, the Metropolitan Council's creation and subsequent work with Ian McHarg was rooted in confronting the "practical concern for some immediate problems that could not be dealt with effectively under the existing governmental apparatus" (Harrigan & Johnson, 1978). These included pollution and preservation concerns in the region. By the time the Council had formed in 1967, rudimentary iterations of a regional development guide overarching primary planning issues entered a stage of refinement. The planning firm of Wallace, McHarg, Roberts, and Todd was selected to improve the existing open space

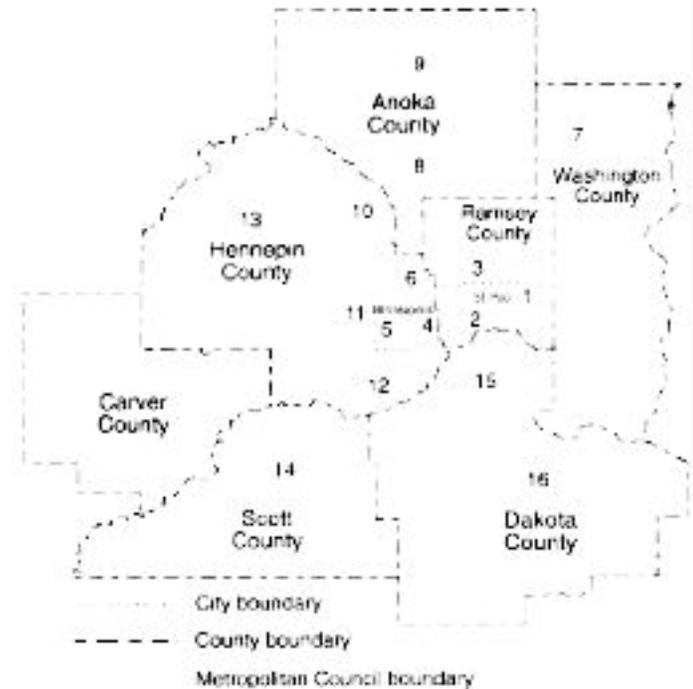


FIGURE 11. Metropolitan council districts. The seven-county Metro Council area (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, Washington) covers about 3,000 square miles and contains almost two hundred separate municipalities. There are sixteen districts, each represented by a council member appointed by the governor, who also appoints the council chair.
SOURCE: METROPOLITAN COUNCIL.

frameworks. In our examination of the role of the 1969 report, the perspective of varying contributors and stakeholders will be examined, along with notable impacts on policy.

Current discussions largely focus on McHarg's study of the link between organisms and the environment as well as human design decisions' lack of ecological awareness. What literature pieces miss entirely is a critical analysis of the several inventories he produced for cities throughout the nation. In examining the 1969 WMRT report through a policy lens, it is possible to launch a discussion on whether McHarg's ecological assessment of the region sparked investment in preserving areas identified as 'ecologically sensitive.' Our review will focus solely on McHarg's ecological inventory recommendations to the Metropolitan Council. The goal of the 1969 WMRT report was to "identify the major physical and biological processes which caused the Twin Cities Metropolitan Region to be and [what] operate[s] there now" and to provide sound, ecologically-aware guidance on landscape preservation in the region. By revisiting the methods and parameters McHarg utilized to arrive at the recommendations he made and comparing his guidance to what came after, the research will explore the conclusion of an explanatory factor in the development and design of the current metro area.

Methodology

We conducted a historical policy analysis using qualitative methods. We primarily relied on documentary evidence from the Metropolitan Council archives, and conducted first-person interviews with individuals who were working in the region during this time period and other experts in order to corroborate findings from our documentary analysis. We limited our analysis to a five year period (1969 - 1974) because we assumed that any major regional policy impacts would have most likely occurred during the first half-decade after the WMRT report was adopted by the Metropolitan Council.

Data Sources:

WMRT Report

The 1969 Wallace, McHarg, Roberts and Todd (WMRT) report is the grounding source. As an original primary source publication, it provides a frame of reference for the evaluation criteria and research questions presented. The report was historically analyzed based on its breadth of content of open space recommendations and land use policy advice. The analysis was done in order to create a frame of reference for the later comparative analyses.

Video: *Multiply and Subdue the Earth*

A second source for determining impact includes analytical review of the draft report's formal presentation by McHarg himself to the Metropolitan Council in 1968. Video footage of the report was recorded by National Education Television for presentation sometime in March of 1969 on educational channels. While the original footage could not be found, portions of the footage were later used in a 1969 documentary entitled *Multiply and Subdue the Earth* authored by Austin Hoyt, John B. Calhoun, Ian L. McHarg, and WGBH Educational Foundation, and distributed by National Educational Television and Radio Center.

Planning Guides and Metropolitan Council Primary Sources

A comparative analysis was conducted across evolutionary open space planning guides utilized by the region. This was done in order to determine causal shifts in public policy which may have been influenced by the report in question.

Thorough document analysis and review, in the form of primary sources, was the principal method. Sources reviewed include Metropolitan Council original meeting minutes between 1968-1971 and bimonthly printed newsletters ranging from 1967-1972. Additionally, original publications of the Metropolitan Council in the relevant time frame were evaluated for relevance to the original report.

Interviews

Interactive in-person interviews were conducted with three community members with vast experience relating to Council planning. One interviewee was a Council Manager with over 25 years' experience, another a stakeholder for the Citizen's League, and the third a Metropolitan Council Principal Planner.

Marcel R. Jouseau

On November 14, 2018, Lindsay Carrera met with scientist and former Metropolitan Council Manager of Water Resources Management Marcel R. Jouseau. Active with the Council from 1974-2009, Mr. Jouseau is now retired and living in St. Paul. He began his graduate career as an advisee of Ian McHarg at the University of Pennsylvania. Some of his classmates, who were fellow research assistants, assisted in the creation of the phenomenal map collection included in the 1969 report. His career in geological surveying and city planning was therefore inextricably linked to McHarg's work.

The interview covered topics including Jouseau's perspective on the influence of land planning data and the larger development community's slow adaptation to acknowledging ecological impacts. Additionally, Mr. Jouseau highlighted the importance of federal regulations and emerging environmental movements at the time. His perception of the Council's work is positive, aiming to create a better world for an area he considers undoubtedly beautiful and well maintained.

John Adams, PhD

On November 6, 2018, Athena Adkins met with Humphrey Professor Emeritus John Adams. He is Professor Emeritus of Geography, Planning & Public Affairs, University of Minnesota, and was recently a senior research associate with the University Metropolitan Consortium. He served as interim Associate Dean of the Humphrey Institute after retiring from the Geography Department, College of Liberal Arts, in 2007. He was awarded the Fesler-Lampert Chair in Urban & Regional Affairs in 2000. In Winter 1999 he was a visiting professor at Olsztyn University of Agriculture & Technology in Poland; in 1997 he was a visiting professor of geography at Marie Curie-Sklodowska University, also in Poland; in 1990-91 he was visiting professor of geography and environmental engineering at the U.S. Military Academy at West Point, New York; and in 1988 he was a Fulbright Professor of Geography at Moscow State University in the former Soviet Union.

The conversation ranged from why the Metropolitan Council was originally formed (due to the need for a regional sewer system to prevent groundwater contamination) to McHarg's recommendations influencing planning at the Metropolitan Council ("Of course"). As planning and policy grew from those early days, they discussed why the McHarg recommendations were "watered down" (primarily due to local municipal finance and private property rights). While Dr. Adams was comfortable discussing the larger themes and trends of the time, he felt he was not well informed on what McHarg contributed to planning at the Metropolitan Council. Subsequent email conversations revealed names of other people who may have had informed first-hand accounts of the McHarg recommendations and some of the Metropolitan Council policy decisions that followed. Unfortunately, many people who were involved in those days are either not alive, not available or difficult to find. We will talk about this more in evaluating our study limitations and areas of further study. He also pointed the group to a few publications, including *Governing the Twin Cities Region: The Metropolitan Council in Comparative Perspective* by Harrigan and Johnson as well as his own 1983 book, *Minneapolis St. Paul: People, Places, and Public Life*.

Ed Maranda

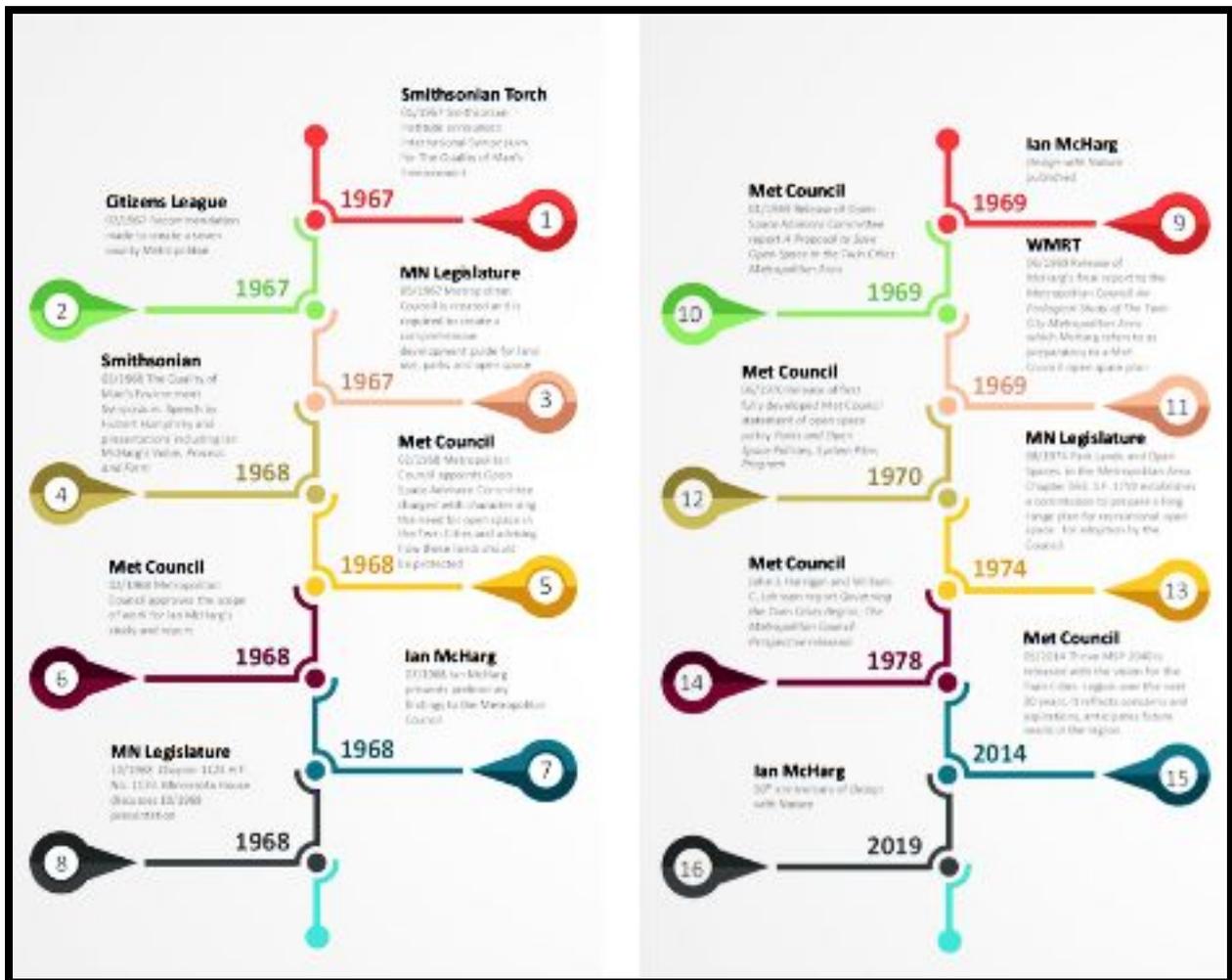
Ed Maranda's first involvement with the Metropolitan Council came in 1965. He was mentioned in an early Citizen's League Report (#182) entitled "*The Future Role of the Metropolitan Planning Commission*," which laid out the case for the Metropolitan Council, and called for a broad

look at the region and the complex nature of overlapping and contradictory demands. He retired as the principal planner for the Metropolitan Council in the late 1990s. Athena reached out to him at the suggestion of Dr. Adams. They spoke by phone on December 1, 2018. They had a brief conversation that centered around the question, “Did McHarg’s recommendations influence Metropolitan Council policy--specifically Open Space policy?” He answered, “Not really” (personal communication, December 2, 2018).

Maranda gave two main reasons why he felt McHarg’s influence was limited: First, while the many overlays that McHarg used to create his maps were interesting, his final recommendations outlined areas that were not suitable for development which had already been developed. This did little to endear McHarg to Metropolitan Council members. The second reason played out in the pages of the *St. Paul Pioneer Press and Dispatch*, *Minneapolis Star* and *Minneapolis Tribune* newspapers. On Wednesday, July 24, 1968, George McCormick reported that McHarg told the Metropolitan Council the previous day that the Jordan water table contained concerningly high levels of nitrates that could cause fatalities in children. McHarg urged immediate investigation and warned the council that any attempts to impose controls [on water quality] would run into opposition by saying “the freedom to despoil is a long cherished right.” (McCormick, 1969)

Maranda encouraged Adkins to review the cities’ daily papers. At his direction, she found a story from Saturday, July 27th, appearing in the *The Minneapolis Tribune* headlined *Water Pollution Report Disputed*. The article reports that the Minnesota Department of Health labeled McHarg’s reports false and chalked it up to his inexperience with hydrology. Finally, the Saturday, August 3rd edition of the *Minneapolis Star* also contained an article disputing McHarg’s findings, saying that McHarg misinterpreted the data. Maranda said the loss of trust generated by these two incidents critically impacted McHarg’s opportunity to influence Metropolitan Council policy. He did think, though, that if McHarg did have any influence it would have been through his star pupil Marcel Jouseau. Mr. Jouseau’s interview appears at the beginning of this section.

Timeline



Social, Political, and Economic Context

What was the social, political, and economic context for McHarg and the Metropolitan Council's thinking about open space? The McHarg report to the Metropolitan Council was released at a time of intensifying concern about the environmental destruction wrought by uncontrolled metro area growth. After formally calling for the creation of the Metropolitan Council in 1967, the Citizens League's next major report urged the Council to create a Parks and Open Space Commission and recommended that its first task should be to create a regional plan for the protection of open space (Citizens League, 1968).

In their report *Preserving Green Space in Metropolitan Development*, the Citizens League described a pattern of disregard for natural resources that, if left unchecked, threatened to reduce quality of life, economic growth, and water quality:

“Land which should be kept in an open state is being developed without any consideration being given to the additional public costs which will result in the future because of flood damage, flood control projects, or pollution of water, for example. Prime potential park and recreation areas along our many lakes and streams and in wooded, hilly areas are being preempted for private purpose rather than for public use. Residential subdivisions are planned with virtually all of the open space parceled equally on each lot rather than concentrating the open space together to make it more enjoyable, useful, and less work” (Citizens League, 1968).

While praising the work of local government to create small-scale developed parks, they argued for a broader perspective on open space.

“Parks and playgrounds...are not the only type of open space needed in the metro area. An appropriate open space action policy will cover all land which should not be used for urban development” (Citizens League, 1968).

And, they argued, these non-park open spaces needed to be reconceived not as temporarily dormant land awaiting development but as public assets most valuable to society if permanently *withheld* from development:

“[Open space] is not simply left-over, unbuilt-upon land but land that serves to protect the environment, to conserve resources, to provide amenities and aesthetics in the area, and to provide recreational areas” (Citizens League, 1968).

The open space system they envisioned was truly regional in nature, spanning the entire seven-county metro area without regard to local boundaries. Only regional government, the Citizens League argued, could be relied upon to create and preserve this essentially regional open space system.

The missing piece was an open space protection plan:

“[B]ecause this area today has no comprehensive open space plan, no policy for preservation of open land nor any vehicle for carrying out such a policy, there is no way to assure that urban development will be kept away from land which should remain open” (Citizens League, 1968).

The Minnesota Legislature had recognized the same need two years earlier when it created the Metropolitan Council, and charged it with drafting a comprehensive development guide including policies, plans, and programs for land use, parks, and open space. The Council began laying the groundwork for an open space plan by creating an Open Space Advisory Committee in February 1968 and immediately tasked it to advise the Council on the regional need for different types of open space, the roles each level of government should play in the creation and management of the system, and the policy strategies those agencies should employ.

The resultant January 1969 report, *Proposals for Preserving a Metropolitan Open Space System*, echoed the worries of the Citizens League (Metropolitan Council, 1969). The Committee described development gobbling up sensitive open space heedless of the consequences for natural systems or future generations. Looking back admiringly at the creation of St Paul and Minneapolis' extensive park systems, they worried that the opportunity to do the same for Twin Cities suburbs would soon be gone.

“Our options are rapidly expiring. We must make our commitment to preserve selected open space now. The present undeveloped land must be considered as the last available that can function as permanent open space. Because, for us, it is” (Metropolitan Council, 1969).

Fueled by this worry, the Open Space Advisory Committee built a comprehensive conceptual foundation for metro area open space protection. They inclusively conceived of open space as “land that has not been built upon” (Metropolitan Council, 1969). Under this broad umbrella, they identified five overlapping types of open space - Conservation, Protection, Production, Recreation-Education, and Amenity - each defined by the benefits those lands will deliver to society if left substantially undisturbed.

1. **Conservation open space** refers to expansive, ecologically intact landscapes where natural systems operate on a sufficient scale to provide fishing, hunting, and wilderness experiences and preserve species that require extensive pristine habitat. Examples include game refuges and wilderness preserves.
2. **Protection open space** refers to lands that are intrinsically unsuitable for urban development that, if protected, provide services that protect human health and safety. Examples include flood plains, steep slopes, wetlands, and drainage ways; all of which protect against flooding and erosion if not developed.
3. **Production open space** refers to presently undeveloped lands that are used, or could be used, for resource extraction - logging, agriculture, or mining - and could be converted in the future to another functional type of open space.

4. **Amenity open space** refers to lands whose exceptional scenic qualities and fortuitous location vis-a-vis parkways and prospects lend beauty to daily life if protected.
5. **Recreation-Education open space** refers to lands needed to meet the recreational needs of current and future residents of the metro area.

For each type of open space, the Committee prescribed distinct management goals, agency roles, and policy strategies. Protection open space, defined in part by its complete intolerance to urbanization, must be entirely withheld from development, they asserted. Because swift public acquisition of hundreds of thousands of acres of Protection open space is financially prohibitive, the Committee prescribed the use of state, regional, and local planning and zoning laws as a cost-effective means to prevent development of privately owned Protection open space in the absence of public ownership.

In contrast, Recreation-Education open space has the more limited purpose of meeting finite recreational needs computed on the basis of per capita recreation open space needs and projected population growth. The Committee calculated a need to acquire an additional 40,000 acres of Recreation-Education open space to meet the recreational needs of the anticipated metro area population in the year 2000. The Committee prescribed acquisition as the most suitable tool to preserve and provide unfettered public access to Recreation-Education open space.

For all types of open space, the Committee prescribed close coordination between levels of government with state and metropolitan governments generally assigned to promulgate and enforce standards and localities assigned to meet them.

The Open Space Advisory Committee elevated acquisition of Recreation-Education open space as the most urgent open space preservation priority. They identified 24,000 acres necessary to meet near-term recreational needs for immediate acquisition and another 14,000 acres to meet the long-term recreational needs of a growing population. Most urgent was acquisition of shoreline on the region's lakes and rivers, very little of which was in public ownership at the time. Working in concert with the Committee, Metropolitan Council staff identified 26 major regional parks, 19 regional water access sites, 31 local water access sites, and three state parks for priority acquisition, all represented in a prioritized Recreation-Education open space acquisition map that accompanied the report.

The McHarg report arrived in this context with the express purpose of advising the Metropolitan Council on how to determine which lands should be protected as open space.

McHarg's Recommendations to the Metropolitan Council

What did McHarg recommend to the Metropolitan Council with regard to the protection of open space? The genesis of the McHarg report to the Metropolitan Council was a separate McHarg report on open space planning. In McHarg's 1996 autobiography, he says:

“My first encounter with metropolitan planning was with the open space study for the Philadelphia metropolitan region performed for the Urban Renewal Administration. The presentation I made to Alan Boyd, acting secretary of the Department of Transportation, came to the attention of Vice President Hubert Humphrey.” (McHarg, 1996).

Humphrey believed the same method needed to be applied to his native Twin Cities and arranged for the Department of Housing and Urban Development to finance and supervise such a study (McHarg, 1996).

The Metropolitan Council hired McHarg to develop a methodology for land use planning, to apply that methodology to the Twin Cities metro area landscape, and produce prescriptive land use maps that could serve as a basis for an anticipated Metropolitan Council open space plan.

McHarg was not a conventional choice for this assignment. His services were engaged shortly after the release of his seminal book *Design with Nature*, an environmental call to arms that urged design professionals to design in harmony with nature. Normally, a local government planning agency seeking technical guidance would engage a credentialed expert, usually little known outside of professional circles. Instead, the Metropolitan Council hired a globally famous public intellectual with a penchant for fiery environmental polemic who referred to environmentally destructive urban development with words like “excretions”, “entrails”, and “mutilations” (McHarg, 1969).

On first read, it is surprising that this most unconventional government contractor appears to have written a conventional technical manual. Billed by McHarg as a science-based methodology for land use planning, the bulk of the report explains that method in mind-numbing detail expressed in dry procedural language. While wordy, the underlying prescription is radical and quintessentially McHarg. He advocated that the Metropolitan Council adopt “ecology,” rather than economics, as the foundation of urban planning (McHarg, 1969).

Here is where convention leaves the room. The man who decried the industrial revolution's desecration of the natural world in *Design with Nature* here crafted a step-by-step guide for planners to restore harmony between humanity and nature. So, when taking the era, the groundbreaking

regional government that is the Metropolitan Council, and the profoundly radical idea of advocating for ecology first rather than economy first all into consideration, we have a truly historic moment.

To restore the harmony between humanity and nature, McHarg urged that we forego subjective judgment in favor of a science-based understanding of the benefits that natural processes confer, the constraints they impose, and the impacts they are likely to incur from various land use types. Constructing an understanding of Twin Cities natural processes from the best available science of the day, McHarg revealed a landscape where it is commonplace to encounter natural processes that are rare, vital to human health and well-being, and/or vulnerable to harm from development including:

1. Finite subterranean water sources (aquifers) that can only be replenished if porous recharge zones remain substantially undeveloped.
2. Steep slopes that are prone to erode into sensitive surface water when developed.
3. Wetlands that must be destroyed in order to be built upon.

All are examples of lands that McHarg believed could not be developed in any meaningful sense without unacceptably diminishing the capacity of the land to provide continued natural value in the future. For all such lands, McHarg prescribed a category of land use he called “protection”, or, “[t]hose land uses whose primary purposes are to preserve, protect, and conserve those elements of the natural environment considered to be unique, scarce, or vulnerable” or essential to public health and safety” (Wallace et. al, 1969).

McHarg prescribed protection for large swaths of the Twin Cities metro area, more than has been recommended for protection or actually protected in the subsequent 50 years. McHarg designated all of the following natural resources for protection (listed in order of priority): water, wetlands, aquifer recharge zones, quality forested areas, lands with significant slopes, unique natural features, and unique cultural features.

The technocratic tone of McHarg’s report to the Council belied his passionate personal perspective on the redeeming power of the natural world. In *Design with Nature*, McHarg depicted a simplified moral universe in which disharmony with nature is darkness and harmony with nature is light. Perhaps because he was operating from that moralized perspective on environmental protection, McHarg’s position on protection seems puritanical: all lands suitable for protection should be designated as such, regardless of the other uses to which they could put, and should be exempt from nearly all human uses except passive recreation, hunting, and fishing. Applying this perspective at the landscape level, McHarg’s 1969 report to the Council prescribed a sprawling open space system for the Twin Cities far exceeding in expanse and scope the actual open space system in place today. He described the final product of his methodology as “a system of two intertwining

nets, one composed of present and future developed land, and the second consisting of open space in a natural or near-natural state” (Wallace et. al, 1969).

McHarg’s method reinforced the value he placed on protection by reducing his priorities to a science-based formula not subject to adjustment on the basis of practicability, affordability, or politics. The criteria for protection were uniqueness, scarcity, vulnerability, and importance to life and health. For each of these, McHarg selected a metric and set a threshold to designate a property for protection. In many cases, the threshold was set quite low. For example, McHarg declared that one measure of vulnerability should be slope and that slopes as shallow as five percent grade could be sufficient to mitigate in favor of protection. McHarg’s decision guidelines then dictated that all properties that met criteria for protection should be designated for protection regardless of the other uses to which they could be put. The result is a systematic methodology that supported McHarg’s spiritual conviction that many natural places should be inviolate.

Findings

“I’ve yet to meet any scientists who know very much about planning, and if you talk about design, they run away screaming” (McHarg, 1995).

Evidence of McHarg’s Influence on Metropolitan Council

What is the evidence that the McHarg report directly influenced the formulation of Metropolitan Council open space policy? While the documentary evidence that the McHarg report influenced subsequent open space planning is plentiful, direct evidence indicating precisely *how* the report influenced open space policy is limited. Other than stating and restating the nature and purpose of the report, Metropolitan Council minutes, newsletters, memoranda, and plans say little about the policy directly borne of it.

The implicit evidence that the McHarg report directly influenced the formulation of Metropolitan Council open space policy is encompassed in various formats: language used in primary sources, references in publications, and reactions and perspectives of external stakeholders. A consistent line can be inferred that the report was one of many explanatory threads in grander open space visibility. However, examining impact requires a comprehensive perspective, including the general anticipation of the report and its subsequent responses, both positive and negative. Through this triangulation, the potential significance of the recommendations can also be inferred.

The general purpose of the McHarg report was to utilize ecological analysis to prescribe optimal metropolitan area land uses. A specific purpose was to provide the basis for a future Metropolitan Council open space plan. This explicit goal is summarized in the introduction of the

report and its subsequent recommendations. The McHarg report reiterates these two purposes and their function by alluding to its use “in support of general land use planning” and prescribing optimal use of land throughout the metro area by inventorying the ecological characteristics of specific landscapes and using that inventory to “match the proclivities of the land to the requirements of demand” (Wallace et. al, 1969). The verbage indicates a level of certainty that the commissioned purpose was agreed upon by both the firm and the Council to serve as the vital informing guide.

Aside from the report’s own stated purpose, historical findings of the Metropolitan Council’s shift in work plan and open space committee formal reports are another indicator of a significant impact. In the 1968 Council Work Plan, it is stated the general purpose of the McHarg report was to “identify the best use of land from an ecological standpoint” and that it would be used to identify land that should be designated as protected open space in the Metropolitan Council’s first development guide (Metropolitan Council, 1968). The utilization of the report was premeditated by members of the Council in their communications. The anticipation of its receipt is referenced again in May 1968 in internal memos, where Council Executive Director Robert Jarvis states the purpose of the report was to give the Council “a fact basis for decisions as to the optimum locations for housing, industry, open space, and transportation-circulation facilities” (add citation). Most importantly, the absence of other highly lauded commissioned reports demonstrates the Council’s commitment to, and expectations from, the findings of the report.

The reception of the report is another evidentiary component of its relative importance and influence. In the later-recorded and televised October 24, 1968 presentation given by McHarg and his assistant Narendra Juneja, meeting notes illuminate the pomp surrounding McHarg’s work and the eagerness of the members present. Immediately after presenting, the notes indicate a member presenting a motion “that the Council accept Mr. McHarg’s report with enthusiasm and direct its staff to proceed with its review of this tremendous undertaking and to make recommendations for its use in connection with the several programmes of the Council” (Metropolitan Council, 1968). The motion was then immediately carried. The film of the presentation, whose original copy could not be located, is used in a later 1969 educational documentary, *Multiply and Subdue the Earth*, which the team was able to transcribe. While the documentary surveys the Twin Cities area amongst several others, it does reference the actions regarding the report as “a rare move in urban America... to deal with problems which concern the entire region...” and that “The Council commissioned the first ecological study to be undertaken for a metropolitan area” (Hoyt, 1969). The inference can be made that the Council received the report’s findings with seriousness, recognizing the need and use for data which could shift the direction of open space planning. The narrator, after the Council accepts the findings with gratitude and enthusiasm, acknowledges, “the realization of these ideas is not going to be easy” (Hoyt, 1969). The choice for the Council to incorporate McHarg’s report findings as a primary source of influence sits on the basis of their understanding of the difficulties it would

produce. Their choice to move forward regardless provides evidence of the innate absorption of the content into Council policy.

By the time the Metropolitan Council published the first formalized version of the *Metropolitan Development Guide* (MDG) in June 1970, the Council had established many of its recommendations in research findings and legitimate avenues for community development. The variation between earlier iterations is stark; not only is the definition of open space expanded to include differentiation of types, but immediate and long-term action areas are identified. The open space plan maps are greatly detailed in the 1970 *MDG*, compared to the rather elementary infographic in the 1969 Open Space Plan. Most importantly, the final page reference map, entitled *Metropolitan Open Space Plan Adopted by the Metropolitan Council June 25, 1970* lists the McHarg report as the only source. Whether or not the report language is embedded in the MDG is less visible; however, the entirety of the plan is grounded in the McHarg data.

In framing the dissemination of the *MDG*, the equally important reaction of the various metropolitan counties lends itself to the tangible yet elusive impact of the policy suggestions. In June of 1970, the MDG Committee hosted an Open Space Plan public meeting to gather public opinion from various stakeholders. These stakeholders included city and county level municipality representatives, park and recreation boards, park reserve districts representatives, and county auditors. In several instances, stakeholders pushed back on the policy guide. Within the hearing report, the committee added their clear intent. The City of Coon Rapids took issue with the research, calling for “additional research in determining the wetlands-water recharge relationship” (Metropolitan Council 1970). Anoka County suggested “Where feasible” be added to the beginning of policies 7 and 9, and the committee added after the comment “(the two words would weaken the policy intent considerably)” (Metropolitan Council, 1970). Similar modifications were recommended for policy 11, in which Anoka County advocates an entire revision of the policy, which the report immediately counters in writing with “this would permit the further indiscriminate conversion of natural drainageways into covered storm sewers or concrete drains—one of the primary acts which the Guide seeks to discontinue” (Metropolitan Council, 1970). Towards the end of the 73 points, the polarization is even more clear. Point 55 indicates Anoka County asking for modifications to the protection elements which “merit immediate preservation action, supposing it is not supported” (Metropolitan Council, 1970). The committee responds that “the protection areas have been determined by using the most sophisticated techniques which are available and their existence is fact, not opinion.” The collection of stipulations and light challenges to the data presented point to a reaction not seen before in Council policy reception. The extensive preparation and dialogue around the interpretation indicates a high-stakes approach by the Council in maintaining the integrity of the original recommendations.

The resistance was compounded by what are apparently limitations of city finance structures. Anoka County, League of Municipalities, City of Coon Rapids, City of Anoka, City of Blaine, Anoka Area Chamber of Commerce, and Anoka County League of Municipalities all called for “changes in fiscal matters relating to open space and other areas of concern” (Metropolitan Council, 1970). Discussions of tax incentives and concessions to landowners allude to the difficulty in organizing revenues around open space, a challenge the Council acknowledged as a first priority. The Council entered the battle for the *Development Guide* to be implemented and prepared to address the issue, immediately after the McHarg report. Given the quick progression of a report adapted into framework and immediately posited to the greater community, it is a fair assumption that the report lent credibility to the open space movements.

Most of the principal participants in the drafting, receipt, and application of the McHarg report have passed away or were not available for interviews. Marcel Jouseau was a graduate student of McHarg’s at the University of Pennsylvania during the preparation of the McHarg report and joined the Metropolitan Council staff in 1974. Mr. Jouseau acknowledges that finding a direct link connection “... is very difficult. You have Ian’s [McHarg] study, which is useful in the sense of demonstrating the importance of the environment but the basis of the map is very coarse. Back then there was not a great deal of data” (personal communication, November 14, 2018). After discussing his experience with the Council’s evolutionary development frameworks, Mr. Jouseau said that between the years of 1969-1975, “nothing really happened with McHarg’s stuff. Really rinky-dink stuff” (personal communication, November 14, 2018).

After diving deeper into the role of the Council, the more dynamic connection of the report to broader policy becomes apparent. While undoubtedly clear that federal regulations at the time fostered the environment for umbrella ‘conservation’ policy, Mr. Jouseau cannot deny the role of the McHarg report:

“I would credit Ian McHarg because of the study, it raised the level of consciousness. People before that didn't really care. You put your waste in the ground and you don't care until you get somebody sick because of your well. I am saying this not because he was my advisor, truly it was important, but after that, it was really opportunistic in the sense that we had the Federal Clean Water Act, which caused regions like us to worry about our water and do something about our water” (personal communication, November 14, 2018).

The overall expressed intents and expectations around the report, along with later dissent and momentum towards legitimized development frameworks allow the team to conclude that there is a sufficient amount of evidence indicating McHarg’s report was influential in the open space policies proposed by the Metropolitan Council, and later adopted by multilateral agencies.

Alignment: McHarg Recommendations and Metropolitan Open Space Statements

What is the level of alignment between McHarg's open space recommendations and early Metropolitan Council open space policy statements? The Metropolitan Council published its *Metropolitan Development Guide - Parks and Open Space* in June of 1970, one year after McHarg's report to the Metropolitan Council. That McHarg's report influenced the inaugural Metropolitan Council open space plan is beyond question as both documents state that McHarg's map of lands prescribed for protection was a basis for the map in the Metropolitan Council report depicting lands prescribed for open space.

How and to what extent McHarg influenced the entirety of the inaugural Metropolitan Council open space plan is less clear as the two documents make no other references to each other, use distinctive terminology, and, in some cases, reach divergent conclusions.

Knowing that the McHarg report was intended to inform the Metropolitan Council open space plan but lacking explicit evidence that it did so, we look for implicit evidence of relatedness by assessing the level of alignment between the content of two documents.

At a superficial level, the two documents appear at first to be aligned in many respects. Both documents:

1. Ground open spacing planning in a science-based understanding of the natural functions the land performs.
2. Adopt an ecology-based appreciation of the value and vulnerability of intact natural processes in urban areas.
3. Prescribe open space protection for lands that deliver vital services to society if maintained in their natural state.
4. Designate similar inclusion criteria and metrics for open space protection e.g. vulnerability to harm from urban development as measured by slopes, soils, water resources, etc.

McHarg's conceptual echoes are most evident in the way the two documents attempt to elevate the status of open space in land use planning and reconceptualize the practice of open space protection. In an era when many viewed open space as temporarily dormant land awaiting future development, McHarg and the Metropolitan Council adopted the view that open space provides services essential to urban vitality and should be intentionally and permanently protected.

McHarg wrote:

“Heretofore, open space has played a passive role in the transformation of land. Urbanization has been the active force. Little if any value has been attributed to open space and the processes it helps to maintain. This situation has deterred the preservation or creation of a metropolitan open space system complementary to urban development” (Wallace et. al, 1969).

Developing these ideas further, the Metropolitan Council Open Space plan states that:

“Open space has generally been treated as a residual use of the area’s resources after other development demands have been met. However, open space is not a residual use of land but a vital component of an orderly urban environment that serves many irreplaceable functions. A metropolitan open space system that has equal status with other land uses is needed to prevent ill-advised or destructive development” (Metropolitan Council, 1970).

Though they have similar foundations, the two documents come to significantly divergent conclusions. In general, McHarg places a much higher priority on open space protection. He recommended protection as a suitable use for larger swaths of the Twin Cities landscape and then declared that all such lands must be protected as open space and were ineligible for significant development.

The difference in the priority of open space protection between the two documents manifests in numerous ways. On McHarg’s recommended open space protection map, greater acreage is designated for protection and those lands are not differentiated as to priority for protection. In contrast, the 1970 Metropolitan Council open space map recommends some of McHarg’s open space acreage for uses other than protection and divides the remainder into two tiers of importance - Primary Protection and Secondary Protection. This is part of a larger tendency in the Metropolitan Council report to hedge and compromise where McHarg makes unqualified protection commitments. Where McHarg designates all shoreline and steep slopes for protection, without provision for exception, the Metropolitan Council qualifies its otherwise similar recommendations by stating that they should only “generally” apply and only for “certain shorelines and steep slopes.”

North Metro Open Space Maps



McHarg 1968
(Protection shaded green)



Met Council 1970
(Protection shaded black and brown)

Figures 6 & 7 – Left: 1969 WMRT Protection Map, Right: 1970 Metropolitan Development Guide Open Space Plan Map (Sources: Wallace et. al, 1969, and Metropolitan Council, 1970)

We believe the formulation of this guide was driven by McHarg’s recommendations that land uses should be preserved and combined with guided recognition of human impact on the built environment or an uncontrolled growth model where social demands are understood. McHarg concludes that:

“...Logically, the next step would be to establish policies and prepare a plan to guide social processes in a manner that would protect the region's natural environment. The final task would be the formulation of those public and private powers needed for the realization of a regional plan. It is hoped that the Council will be able to follow such a planning sequence. Only the ecological study has been completed.” (Wallace et al., 1969).

The sentiment expressed in the quotation is supported by the Metropolitan Council’s development guide as it proves that the processes they took to address protection and preservation of natural resources as well as needs are directly impacted by McHarg’s 1969 WMRT recommendations.

In the 1969 WMRT report, we find that maintaining equilibrium of the various natural features available to the region is quite difficult to program. Recognizing this challenge, the Twin Cities region was advised to focus on overseeing and administering the smaller rivers, streams, lakes,

ponds, wet meadows, commerce, recreation, industry, residences, projected population, etc. Ideally this would be done by establishing a metropolitan policy that incorporated the preservation and enhancement of natural features which assured protection against exploitation and allowed for the maximum valuation of sites. In the 1970 MDG report we find this exact process being implemented.

A fine explanation of what influenced the 1970 MDG report is McHarg's stance on open space where he describes its role in the region and need for implementation:

“Open space has played a passive role in the transformation of land. Urbanization has been the active force. Little if any value has been attributed to open space and the processes it helps maintain. This situation has deterred the preservation or creation of a metropolitan open space system complementary to urban development. Land use regulations are necessary to protect the public from the damaging consequences of private acts which incur both costs and losses to the public when those acts violate and interrupt natural processes. Policies based on an understanding of the natural processes will allow those processes to perpetrate at little if any cost to man. They provide a defensible basis for an open space system which goes far toward making our metropolitan region livable and beautiful” (Wallace et. al, 1969).

It is important to note that McHarg and his team created their maps by hand. While visually stunning and necessary, they were limited in their ability to work in “real-time.” This led to one of the major criticisms of the work by Metropolitan Council members. Ed Maranda, Senior Metropolitan Planner, reported in an interview with Adkins that McHarg's ecological analysis of the region included areas he deemed unsuitable for development that had already been developed. It can be assumed that this led to a lack of trust between McHarg and Metropolitan Council members, leading to questions about the definition of unsuitable and for whom--especially in light of how cities raised money.

This interpretation of open space preservation and conservancy expresses sentiments that are indistinguishable from those that make up the 1970 MDG adopted report. Subsequently we can verify that McHarg's theory of human ecological planning and the 1969 WMRT report directly impacted the foundation of the parks and open space assessment. It can be seen in fine print on Figure 5, where map language states: “data on this map are based on: Wallace, McHarg, Roberts, and Todd, An Ecological Study of the Twin Cities Metropolitan Area: Metropolitan Council and Metropolitan Planning Commission Staff Study, United States Geological Survey Maps” (Metropolitan Council, 1970). Furthermore, we have compared two side-by-side divisions of the maps provided by the 1969 WMRT report and the 1970 MDG report (See Figures 6 and 7).

Through this comparison we have found that a relative amount of uniformity exists between the maps, especially in areas that are identified as “primary protection” sites presented in light green for Figure 6 and dark green in Figure 7. This suggests to us that there was a considerable amount of directly informed development from the 1969 WMRT report to create the 1970 MDG.

These differences are representative of the divergent worldviews that McHarg and the Metropolitan Council brought to the task of open space planning. For McHarg, protection was preeminent - the only acceptable use for large swaths of the landscape - and government is presumed to have the capacity and the will to actually protect those lands. In contrast, the practitioners at the Metropolitan Council came to the question of open space protection with a broad public charge, the perception of severe resource constraints, and a closer familiarity with the political nature of public decision-making and the rapid pace of urban growth. As a result, the Metropolitan Council report treats open space protection as just one of several valuable land uses and assumes that not all environmentally sensitive lands can or should be saved.

There are benefits and costs to the 1970 Metropolitan Council report’s more pragmatic perspective. The presumption that not all lands suitable for protection can actually be protected necessitates careful thinking about acquisition priorities. Accordingly, the Metropolitan Council report helpfully recommends that leaders prioritize for acquisition those lands that perform several natural functions, have recreational value for the largest swath of the metro area, and/or are at imminent risk of harm from inappropriate use. The report goes on to list specific properties that should be prioritized for acquisition. Similarly, the Metropolitan Council’s presumption that some lands that are inappropriate for development will nonetheless be developed prompts them to think productively about how to mitigate the resultant harms via building and zoning codes and even ecological restoration. Such strategies for navigating a world of finite government resources and compromised landscapes are largely absent from McHarg’s thinking.

The Metropolitan Council also differs from McHarg in not just accepting development of some lands suitable for protection but advocating for their development. Minimizing the significance of the 100 square miles of open space they expected to be developed in the 1970s, they wrote: “Open space, like the diamond, can frequently be divided or changed in use and still keep beauty and purpose”(Metropolitan Council, 1970).

Where the Metropolitan Council’s broad view of the public good sometimes led them to compromise open space protection, it also prompted a greater appreciation of the recreational, scenic, educational, and social benefits of open space protection. McHarg, with his focus in his Metropolitan Council report on science-based measurement of the benefits of natural processes, tended to emphasize benefits measurable by the hard sciences like clean water and biological diversity at the expense of the more difficult to measure benefits to citizens’ mental, physical, and

spiritual well-being. Given McHarg's lengthy autobiographical paeans to the redemptive powers of nature in *Design with Nature*, the absence of this emphasis in his report to the Metropolitan Council was likely a byproduct of the methodology he employed.

Most of the 1970 Metropolitan Council report, by page count, is focused on acquisition and improvement of recreational open space. For them, human enjoyment of open space – whether for scenery, recreation, or education – was a critically important end in itself. By contrast, McHarg characterized passive recreational enjoyment of protected open space as a happy and relatively benign byproduct of his primary end – protecting the integrity of natural processes. As a result, the Metropolitan Council Report has much more to say about recreational open space.

The Metropolitan Council report examines the multi-faceted social and psychological benefits of open space protection. Open space is needed to “assure a quality environment for living; to provide suitable space and appropriate sites to meet the recreation needs of the present and future population; and to provide a socially desirable environment for all the people of this area” (add citation). Rare or unusually intact natural resources also have value for education and research. In this context, the Metropolitan Council gives significant emphasis to providing access to open space for all citizens by:

- Prioritizing acquisition dollars to ensure that citizens throughout the metro area have protected open space reasonably close by.
- Seeking to match the supply of open space and specific recreational improvements to current and anticipated demand in all geographic areas with the guideline to “give the greatest attention to those facilities and activities deemed important by the largest numbers of people.”
- Emphasizing, and disproportionately investing in, recreational facilities that do not require citizens to buy costly equipment, pay significant user fees, or travel significant distances.

By contrast, McHarg makes no mention of the importance of providing convenient, affordable recreation for all citizens regardless of income or place of residence prioritizing lands for protection exclusively on the basis of his criteria of uniqueness, scarcity, vulnerability, and importance to human health and safety. There is no provision to protect unnoteworthy open space simply because it is close to people in an area otherwise lacking open space. Ironically, the one special provision for access to open space articulated by McHarg is his repeated suggestion that lands next to rivers, lakes, and forests should be prioritized for what he called “prestige housing.”

Discussion

“And after we consider all the primary lands, we simply applied the same procedure to the lands of secondary and lower suitability. And so tediously and slowly we map this fantasy and remember that we didn't know the answer as we proceeded but finally we assembled all of this information and there it was done” (Hoyt & Blau, 1969).

The findings discussed point to a common theme; undoubtedly McHarg's report was received with earnest consideration and to some extent, in reverence. While McHarg's perspectives on the purpose of open space may have been even more radically pronounced than any actions the Metropolitan Council had the capacity or desire to implement, the hard line he drew set an undeniable frame of reference for the evolution of policy. While the shift in formal open space planning is markedly clear between the report and the subsequent *Metropolitan Development Guide* (MDG), the level of activity surrounding the report signifies the weight of consideration given to it. While explicit communications connecting the report to policy were not present, it can be inferred the actions immediately following were influenced by the report, which resulted in a trajectory of open space policy evolving shortly after at the local and state level.

Like any good story, this one contains a fair amount of nuance. As discussed in Ed Maranda's interview, not everyone felt that McHarg had influence. Between naming areas unsuitable for development that were already developed, raising the alarm of dangerously high nitrogen levels in northern suburban water -- which turned out to be inaccurate -- his ignorance of, and blatant disregard for, local politics, his occasionally arrogant nature and his perceived delight in pushing buttons would all seem to dampen his influence. However, his deep commitment to methods, maps and perspective and the level of alignment between actual Council policies and those three McHarg priorities give the writing team a strong suspicion that his influence was greater than some of the sources may suggest. Essentially, he was at least as influential due to his celebrity and passion as he was opposed due to his persona.

When considering the implications for future policy makers, delineating the nuance of impact can guide governing bodies towards better practice. Given the alignment of the report to the foundational development guides, documented evidence of enthusiasm for the work (albeit perhaps not for McHarg himself), and the atmosphere of rising consciousness surrounding ecological issues, one can begin to triangulate the composition of policy change. While in the short term, McHarg's report may have been a drop in water to those most near the work, time illustrates a broader perspective and equation for informed planning practice.

It provides evidence of a few corresponding factors with the potential to propel forward pragmatic and progressive change; adopting outstanding technical specs, momentum of current sociopolitical rhetoric, and perhaps a hint of notoriety.

Additionally, the decelerating factors ranging from personality differences to local tax structure and municipal autonomy battles may present themselves as longstanding and unchanging barriers. When one examines the historical implications, it begs for consideration. Had the open space and land preservation movement been able to remove these negative social, political, and economic headwinds tainting the full embrace of McHarg's ideas and plans, would the current day look differently? What would the region look like if a policy could overcome multilateral negotiations more efficiently and stakeholders with varying agendas, with a governing body aimed to do good? Lastly, knowing Hubert Humphrey played a role, it may raise another question of inputting lauded figures and their opinions and the impact on policy adoption.

The findings indicate that through this non-linear, often problematic and contentious push and pull of regional issues and a larger cacophony of noise, open space regional planning based in theory can be successful. The process may look in a compressed timeframe as diverging interests without hope for alignment, but in reality the short time space saw successful adoption of somewhat radical contemporary policy motives.

Areas for Further Study

Given the breadth of materials spanning across 50 years and seven counties, there were a number of areas of further potential research raised. First, further in-depth research including interviews with primary sources into what the true intention was behind the commissioned report may be warranted. It would be of value to determine whether McHarg's work validated and legitimized the Council in asserting its agenda across the region, and to what extent the evidence supports that theory. Alternatively, if the report was thrust upon the Council, resulting in a revisit of the original plans, the role of the report may have been less significant (albeit, still remarkably useful). The factual narrative surrounding the report's inception could provide insight into the level of understanding of ecological preservation by non-academics and non-scientists, signaling a better understanding of whether McHarg's report was monumental or opportunistic.

Second, if the intention behind the report was to bolster an eventual push by the Council towards more progressive conservation efforts, determining how idealistically the Council perceived the report is valuable. If further interviews could be conducted throughout later dates, the lasting impact of the report's recommendations as a moving goalpost of sorts could provide insight to the policy mechanisms employed by the Council. If the intentional placement of lofty and challenging

goals helped the modern Twin Cities region gain a reputation as an ecological leader, it would greatly lend support to future best practices.

Third, it may be instructive to further examine the extent to which the Council diluted the original policies of the McHarg report and their motivations for doing so. This point is especially interesting given that after major pushback from the regional stakeholders, the Council seemed to ground itself more firmly in the strict interpretation of its guidance. Determining whether the acting members had outstanding insight into feasibility or the positive changes were brought about by chance could suggest how today's regional and urban planners can interpret the role of these figures and their influence.

Fourth, and in conjunction with the following points, research into the systematic rise of similar preservation efforts and their underlying causes would provide a better understanding of the environment necessary to advance an ecology-based policy reform. The time period is special, as elaborated in the Jouseau interview, with the rise in federal oversight stemming from the creation of the Environmental Protection Agency in 1970, including the Clean Water Act of 1972. Implementers of today's further water and antipollution policies could learn from the range of factors present in that time period.

Finally, conducting a thorough qualitative analysis of the early open space policies with more current versions of Metropolitan Council policy could reveal great insight into variations and influential turning points. As it stands now, the Council's *THRIVE MSP 2040* plan emphasizes five areas of notable outcomes: stewardship, prosperity, equity, livability, and sustainability (Metropolitan Council, 2018). The ability to pinpoint the progression of each priority may provide further insight into the long-term role a forward-thinking report such as McHarg's may have had on the region's policymakers.

Limitations

One of our main limitations was the ability of the research team to analyze five decades of open space policy in a timely manner. Thus our scope was limited mainly to the Metropolitan Council's role, raising the question of the roles of other regional entities such as cities, counties, boards, and community-based representatives.

Another limitation was the preservation method of some valuable and potentially insightful information. Microfiche was the principal method used to archive the meeting notes, including minority reports and submitted memos. In conducting the research, the team found some content indecipherable due to the low quality of the microfiche print taken. In particular, a minority report was submitted directly after McHarg presented to the Council in 1968 which was lost entirely. While

there may be more sophisticated tools to restore them, such methods were not available or known to the team.

Too, the lack of primary sources in the historical timeframe limited the team's ability to systematically survey members present during this time of historic change. Given that these events occurred 49 years ago as of this writing, few traceable and surviving leaders were able to be found or interviewed in the short time span of the research period.

Conclusion

2019 is the 50th anniversary of Ian McHarg's seminal book, *Design with Nature*. There will likely be many opportunities to revisit his life and his work. The hope of this report is that during this time of celebration and retrospection, the public will also consider McHarg's little known report, *An Ecological Study of the Twin Cities*. McHarg focused his work on illuminating the unconsidered destruction of sensitive open space and its attendant harm to natural systems. The Metropolitan Council was focused on the harmful effects of poorly managed growth including destruction of open space.

The team's formative conclusion is that the Metropolitan Council used McHarg's report to help them create their 1970 *Open Space Policy and Metropolitan Development Guide*, spurring an evolution of inextricably linked policies and structures to ensure the preservation of the region. While McHarg and the Metropolitan Council diverged in their final analysis of what would be protected, there is no doubt that McHarg's work contributed significantly to the Metropolitan Council's recommendations and that the Council staff and board used McHarg's recommendations as support for pushing back on local municipalities who sought to soften the policy language.

The Metropolitan Council organization is unique, not without controversy, and a valuable regional resource. According to the *No need to mess with the Metropolitan Council* op-ed in the *Minneapolis Star Tribune* on May 4, 2018 written by James Hovland, Elizabeth Kautz and Janet Williams:

“The Metropolitan Council was created 50 years ago to solve significant problems. The Twin Cities region faced sewage, development and transit crises, and many communities were unable to provide essential services to their residents.

Local officials were unable to resolve these issues on their own, and policymakers saw the need for a regional governing body that could manage regional issues that transcended local boundaries.

Governed by appointed citizens, the council put Minnesota on the map for its innovative metropolitan problem-solving strategy. It continues to be the envy of many regions across the country.

The council today is responsible for coordinated services that include a regional wastewater management system renowned for high standards and low rates and a regional transit system that provided 81 million trips in 2017. It assists local governments on developing local comprehensive plans — shared between and approved by neighboring communities — to create a regional vision and provide cost-effective investments in transportation, wastewater treatment and parks.”

In his interview, Marcel Jouseau mentions that the community leaders appointed to the early Council were, “very dedicated people, they wanted to do the right thing for the world” (Jouseau, personal communication, November 14, 2018). While the formula for decisively creating a region as special and functional as the Twin Cities region may never be fully known, the collaboration produced by the Council’s partnership with Ian McHarg certainly made significant impact in the course of policy actions whose resonating effects are still seen today.

Works Cited

1. Adams, J. S., & VanDrasek, B. J. (1993). *Minneapolis-St. Paul: People, place, and public life*. Minneapolis. University of Minnesota Press.
2. Citizens League (1967). *A Metropolitan Council for the Twin Cities Area*.
3. Citizens League (1968). *Preserving Green Space in Metropolitan Development: A Parks and Open Space Commission for the Twin Cities Area*.
4. Díez, M. Á, Izquierdo, B., & Malagón, E. (2002). How to evaluate regional development policies? The potential of a theory of change approach. 2-14. Retrieved December 4, 2018, from https://www.researchgate.net/publication/237762786_How_to_evaluate_regional_development_policies_The_potential_of_a_theory_of_change_approach.
5. Harrigan, J., & Johnson, W. (1978). *Governing the Twin Cities region: The Metropolitan Council in comparative perspective*. University of Minnesota Press. Retrieved from <http://www.jstor.org/stable/10.5749/j.ctttsmnw>
6. Herrington, S. (2010). The nature of Ian McHarg's science. *Landscape Journal*, 29(1), 1-20. Retrieved from <http://www.jstor.org/stable/43323861>
7. Hoyt, A. & Blau, R. (1969). *Multiply and Subdue the Earth*. United States: WGBH Educational Foundation. Boston, Massachusetts. Retrieved from http://openvault.wgbh.org/catalog/V_61A6468E2EE44DFE8C098659C38EC075
8. Martin, F. (2017). *Regional history and public design—before designing for the future, it helps to know the past*. Retrieved from <https://frankedgertonmartin.wordpress.com/2017/06/07/regional-history-and-public-design-before-designing-for-the-future-it-helps-to-know-the-past/>
9. McHarg, I., & American Museum of Natural History. (1971). *Design with nature*. New York: Published for the American Museum of Natural History.
10. McHarg, I. (1981). Human ecological planning at Pennsylvania. *Landscape Planning*, 8: 109-120.
11. McHarg, 1995. Ian McHarg reflects on the past, present and future of GIS. *GIS World*, 8:46-49.
12. McHarg, I. (1996). *A Quest for life: An autobiography*. New York: John Wiley & Sons.
13. Metropolitan Council of the Twin Cities. (1968). Meeting title as listed on minutes. Metropolitan Council Library Archive, Saint Paul.
14. Metropolitan Council of the Twin Cities. (1968). Meeting title as listed on minutes. Metropolitan Council Library Archive, Saint Paul.
15. Metropolitan Council of the Twin Cities. (1968). Meeting title as listed on minutes. Metropolitan Council Library Archive, Saint Paul.

16. Metropolitan Council of the Twin Cities. (1969). *Proposals for preserving a metropolitan open space system*.
17. Metropolitan Council of the Twin Cities. (1970). *Metropolitan development guide: Parks and open space policies, system plan, program*. Minnesota: Metropolitan Council.
18. Metropolitan Council of the Twin Cities. (n.d.). Who we are. Saint Paul, Minnesota. No author. Retrieved November 24, 2018, from <https://metro council.org/About-Us/Who-We-Are.aspx>
19. Smith, David C. 2008. *City of Parks: The Story of Minneapolis Parks*. First edition edition. Minneapolis, MN: Foundation for Minneapolis Parks.
20. Steiner, F. (2017). Healing the Earth: The Relevance of Ian McHarg's Work for the Future. *Human Ecology Review*, 23(2), 75-85. doi:10.22459/her.23.02.2017.08
21. Wahl, D. (2017). *Visionaries of regenerative design IV: Ian L. McHarg (1920–2001)*. Retrieved from <https://medium.com/age-of-awareness/visionaries-of-regenerative-design-iv-ian-l-mcharg-1920-2001-ea6da90b1958>
22. Wallace, D., McHarg, I., Roberts, W., and Todd, T. (1969). An ecological study of the Twin Cities metropolitan area prepared for the Metropolitan Council of the Twin Cities. Metropolitan Council of the Twin Cities. Minnesota.
23. Water pollution report distributed. (July 27, 1968) *The Minneapolis Tribune*. P 12.
24. Warning on Nitrates Disputed. (August 3, 1968) *The Minneapolis Star*. P 14A
25. Yang, B., & Li, S. (2016). Design with nature: Ian McHarg's ecological wisdom as actionable and practical knowledge. *Landscape and Urban Planning*, 155, 21-32. doi:10.1016/j.landurbplan.2016.04.010

Appendices

FINAL REPORT

AN ECOLOGICAL STUDY OF THE TWIN CITIES METROPOLITAN AREA

PREPARED FOR THE METROPOLITAN COUNCIL OF THE TWIN CITIES



JUNE 1969

WALLACE, MCHARG, ROBERTS and TODD

Architects/Landscape Architects/City and Regional Planning
1740 Cherry Street, Philadelphia, Pennsylvania 19103 / LO-3-0890

The preparation of this report was financed
in part through an urban planning grant
from the Housing and Home Finance Agency
under the provisions of Section 701 of the
Housing Act of 1954 as amended.

TABLE OF CONTENTS

	Page
FOREWARD	1
INTRODUCTION	1
<u>THE ECOLOGICAL INVENTORY</u>	
Climate	10
Historical Geology	11
Bedrock Geology	11
Surficial Geology	14
Foundation Conditions	15
Economic Minerals	16
Physiography	17
Hydrology	
Surface Water	19
Ground Water	20
Pedology	22
Plant Associations	24
Fish and Wildlife	29
Existing Land Use	34
<u>ECOLOGICAL INTERPRETATIONS</u>	
Prospective Land Uses	36
Identification of Ecological Parameters	36
Interpretation of Ecological Parameters	54
Determination of Land Use Suitability Classes	66
Production	66
Protection	70
Recreation	72
Urbanization	75
Composite Intrinsic Suitability	77
AN OPEN SPACE SYSTEM AND ITS IMPLEMENTATION	96
CONCLUSIONS	104
APPENDICES	
A - List of Maps and Charts	
B - Correspondence Pertaining to Quality of Ground Water	
C - Bibliography	
CREDITS	

LIST OF TABLES

<u>No.</u>		<u>Page</u>
1	Rating of Fish and Wildlife Habitats	33
2	Relationship of Natural Process to Land Use	
2A	Geology - Bedrock	37
2B	Geology - Surficial	38
2C	Physiography - Slope	40
2D	Hydrology	41
2E	Soils	44
2F	Vegetation	46
2G	Wildlife Habitats	49
2H	Land Use (Existing)	53
3	Ratings of Ecological Features	
3A	Production - Agriculture	55
3B	Production - Forest	56
3C	Production - Wildlife	57
3D	Production - Extraction	58
3E	Protection - Unique Resource	59
3F	Protection - Scarce Resource	60
3G	Protection - Vulnerable Resource	61
3H	Recreation - Passive	62
3I	Recreation - Active	63
3J	Urbanization - Residential	64
3K	Urbanization - Industrial	65
4	Criteria for Agricultural Suitability Classes	67
5	Criteria for Forestry Suitability Classes	68
6	Criteria for Wildlife Suitability Classes	69
7	Criteria for Extraction Suitability Classes	70
8	Criteria for Recreation Suitability Classes	74
9	Criteria for Urban Suitability Classes	76
10	Matrix I	78
11	Land Use Compatibility Tables	
11A	Agriculture	79
11B	Forestry	80
11C	Wildlife	81
11D	Extraction	82
11E	Protection	83
11F	Recreation - General	90
11G	Recreation - Passive	91
11H	Urbanization	92
12	Matrix II	94
13	Composite Suitability	95
14	Regulatory Devices and Recommended Permitted Uses	103

FORWARD

The opportunity to prepare an ecological study for the Twin Cities Metropolitan Region has been at once an honor and a challenge. As far as is known, this is the first time a metropolitan region has undertaken such a study. It is therefore a landmark.

Great credit should be given to the staff of the Council for their imagination and courage in initiating this venture. They are to be commended for both the concept and the formulation of the program. Specifically, Mr. Maranda deserves mention for his role in designing the project, Mr. Einsweiler for his perceptive advice during the conduct of the study, and Mr. Peterson for his continuous participation and his individual contributions to the product.

The data made available to the study were of unusual extensiveness and quality. The many agencies which contributed information deserve the gratitude of both the consultant and the Council. The significant contributions of Dr. Rudolph K. Hogberg of the Minnesota Geological Survey, and Dr. Breckenridge of the Natural History Museum, deserve signal commendation.

INTRODUCTION

The undertaking of an ecological inventory for a metropolitan region is a landmark in American planning. It is remarkable as the first instance where a comprehensive analysis of biophysical phenomena and processes has been made prior to the formulation of a regional plan. Thus, the planning process asks nature to advise man as to the form and pattern of metropolitan growth. When this is known it becomes necessary to identify demand - the future needs for housing, industry, commerce, and recreation, - and their locational and spatial requirements. The formulation of a plan will result when the proclivities of the land are matched to the requirements of demand, and both to the capacity of the society to achieve its objectives.

The purpose of the ecological plan is to inventory phenomena and natural processes, to reconstitute these as a value system, and to perceive the degree to which land, air and water processes offer both opportunities and restraints to single and combined prospective land uses. An open space system for the region is one such land use.

While this study is not a plan, it does contain information and interpretations which are almost uniformly absent from most plans. It does have some virtues which justify examination. The first of these is that it is a rational method. The evidence which it employs is derived almost entirely, from the biological and physical sciences. The statements made on the major subjects - geology, hydrology, pedology, and ecology, are collected from substantial sources and are unlikely to contain major errors. The same holds true for the interpretations such as flood inundation, rocks in terms of compressive strength, and soil drainage.

In addition to being rational, the method is explicit. It is suggested that any other person, accepting the method and the evidence, is likely to reach the same conclusions as are demonstrated in the study. This is in direct contrast to the bulk of planning where the criteria are often obscure and covert. Moreover, this method permits one most important improvement in planning method -- that is that the community can establish its own value system for employment in the method. Those areas, places, buildings or spaces which it cherishes can be so identified and incorporated into the value system of the method. Today many planning processes, notably highway planning, are unable to incorporate the value system of the community to be transected. At best the planner supplies his own distant judgement.

The basic proposition employed is that any place is the sum of historical, physical and biological processes, that these are dynamic, that they constitute social values, that each area has an intrinsic suitability for certain land uses, and, finally, that certain areas lend themselves to multiple coexisting land uses. Let us examine each part of this proposition.

THE PLACE IS THE SUM OF HISTORICAL, PHYSICAL AND BIOLOGICAL PROCESSES

In order to understand a place sufficiently to diagnose and prescribe, it is necessary to appreciate the major physical and biological processes which have occurred in the past and are operative today. This involves consideration of climate, historical and surficial geology, physiography, hydrology, soils, plant ecology, wildlife habitats (both terrestrial and aquatic), and human land use.

The geomorphology of the Twin Cities Region can only be understood in terms of ancient seas revealed by historical geology. The superficial expression of the region is a consequence of successive glaciations. The climatic processes over time have modified the geological formations, which account for current physiography, drainage and

distribution of soils. Varying associations of plant species occupy the place making it possible for a myriad of animal species to exist. Human occupation of the place responds to those same processes and modifies them by its own contribution.

PHYSICAL AND BIOLOGICAL PROCESSES ARE DYNAMIC

The place has come to be as a result of the dynamism which is inherent to all natural processes. The place is a mute record of ancient seas and the deposition of sandstone, limestone and shale strata. Glaciers have advanced and retreated, leaving their signature in hills, kames, kettles, and a myriad of glacial lakes. But the seasons of the year, the hydrologic cycle, and the recycling of vital nutrients are still going on. Hills are eroded and the sediments follow gravitational paths, and rivers change their courses over time. It is important to recognize the dynamism of physical and biological processes, and more important, that these affect man and are affected by his intervention.

NATURAL PROCESS REPRESENT SOCIAL VALUES

An ecological inventory reveals natural processes. These constitute social values. Geological data may be reflected in foundation savings or in the scenic value of the Grand Canyon. Climatic factors may explain population migrations to California and Florida, or successful agriculture. Physiography and hydrology help explain the paucity of population in mountains and deserts and the low value of land, while the characteristics of soils make clearer the patterns of agriculture. Plant and animal ecology can be viewed as scenic, scientific and recreational values. All of these processes are interacting. For instance, a single drop of water may occur in clouds, river, lake, rain, snow, dew, frost, fog. It may participate in plant or animal metabolism, in respiration, combustion, as sweat or tears, in industry, commerce, urbanization, agriculture, forestry, mining or recreation; it may be considered in problems of flood, drought, water supply, erosion control, navigation, hydro-electric power, food processing, and manufacturing.

These factors are, clearly ecological values but they are also economic values. They manifest a value system in which elements of land, water, air and life exist in variable degrees in various locations. Thus, the elements of nature can be seen first as phenomena, and then as processes. Next it is seen that these processes are interacting. Finally, they are seen as a social value system constituting intrinsic opportunities

and constraints for all human uses. A recognition of these social values which are inherent in natural processes is basic before any prescription is made for the utilization of natural resources.

EACH AREA HAS INTRINSIC SUITABILITY FOR HUMAN USE

Once it has been accepted that the place is a sum of natural processes and that these processes constitute social values, inferences can be drawn regarding the utilization of the place to ensure its optimum use and enhancement. It is possible to identify those attributes of land, water and air most propitious for every prospective land use. When these are found, there is revealed the intrinsic use or value of the land.

CERTAIN AREAS ARE SUITABLE FOR MULTIPLE COEXISTING LAND USES

Natural processes more often than otherwise are inherently suitable for a multiplicity of human uses. Flat well-drained land with deep soils is intrinsically suitable for active recreation as well as commercial-industrial development. These apparent conflicts may be resolved in a number of ways. Certain resources because of their scarcity and vulnerability, may represent such high value that other uses should be excluded. While in other areas, multiple uses may be permitted where the representative social values are not compromised.

NATURAL PROCESS AS SOCIAL VALUES IN METROPOLITAN PLANNING

Absolute economic values cover only a small range of social values. By employing a relative system of most to least, it is possible to include all of the important social values and circumvent the economist's narrow pricing system. While this denies an illusory precision of cost-benefit analysis it does show the maximum concurrence of positive factors or their relative absence. Even though it is difficult to assign precise money values to natural processes, it is safe to assume that, in the absence of any supervening value, the concurrence of the majority of positive factors in any one location does indicate its intrinsic suitability for the land use or uses recommended.

One further value is that the data so compiled and interpreted constitutes the base data required to subject any planning proposal to the test of least

cost-maximum benefit. The values of the area in question have been identified and the degree to which any proposal will destroy or enhance these can be quickly determined. Moreover, these same data simplify the quest for least social cost locations. By making explicit the factors employed it is then possible for both individuals and society to insist that the development process, both public and private, respond to these values.

Perhaps one of the most valuable innovations of the method is the concept of complementary land uses, and the recognition of those areas which can support more than one use. This tends to be in conflict with the principle of zoning which enforces segregation of land uses. That certain areas are intrinsically suitable for several land uses can either be seen as a conflict or as an opportunity to combine uses in a way that is socially desirable.

THE METHOD

How does one proceed with this task? We will employ the proposition that nature is process and value, exhibiting both opportunities and limitations to human use. Therefore we must identify the major physical and biological processes which caused the Twin Cities Metropolitan Region to be and which operate there now. In this instance, we must identify the entire area for its intrinsic suitability for all prospective land uses. Basic data were compiled and mapped for climate, historical and surficial geology, physiography, hydrology, soils, plant ecology, wildlife habitats, and land use. These data are not useful until they are interpreted and evaluated. For instance, general data on climate is of little significance but the probability of floods and the resultant inundation are vital. We can then identify gradients of susceptibility to inundation. The basic data is thus interpreted and reconstituted within a value system. Similarly, interstate highways generally do not exceed a three percent slope. Thus existing slopes in excess of this constitutes a penalty; slopes of three percent or less are a saving. Further, it costs more to excavate rock than it does sand or gravel. Moreover, the presence of these latter materials may well be a saving as they can be employed for highway construction.

From each of the major data categories, pertinent factors are selected and evaluated. From geology we identify features of geologic, scientific and educational value, and grade these from unique to abundant; rocks are evaluated for their compressive strength for foundations, and so on for every category. For certain land uses the maximum condition will be preferable, for others

it will be the minimum that has the highest value. The least erodible soil is to be preferred but the highest scenic quality if the greatest value.

Development of Ecological Criteria for Land Use

Each of the major categories of geology (historical and surficial), physiography, hydrology (ground and surface water), soils, plant ecology, and wildlife habitats (terrestrial and aquatic), are mapped. These major subject areas are then searched for attributes of relevance to prospective land uses. Ecological phenomena such as rock types, slopes, rivers, lakes, streams, aquifers, soil types, forest associations, wildlife habitats, and scenic, scientific and historic values, are mapped. These data are then related to the major prospective land use groups: Production - including agriculture, forestry wildlife and extractive minerals; Protection - including unique, scarce or vulnerable resources; Recreation - both active and passive; and two categories of Urbanization - residential and industrial-commercial.

The relevance of these data to the prospective land use groups is understood by evaluating their attributes from most to least, in which value 1 is the highest, value 5 is the lowest. Using geology as an example: bedrock; flat land on sands and gravels; flatland on drift; sloping land on sands and gravels; sloping land on drift; and alluvium, lake deposits, eskers, and kames; are given successively lower values as foundation materials. Other data are similarly evaluated for the other prospective land use categories.

Determination of Land Use Suitabilities

The next step is the incorporation of relevant natural phenomena and processes into suitability classes. This is done for each of the major land uses and their subdivisions. This constitutes the program which permits the research of the data to reveal intrinsic suitabilities for Production, Protection, Recreation, and Urbanization. These are then mapped.

A single map for protection is prepared by identifying those elements of land and water representing constraints upon land uses. Work maps of single intrinsic suitability for each prospective land use are prepared. These are then incorporated into work maps of intrinsic suitability for each of the groups of land uses. For example, individual suitability maps for agriculture, forestry, wildlife production and extractive minerals are combined into one map designated as Production.

Protection subsumed passive recreation so that only active recreation constituted the intrinsic suitability for that category. Suitability for residential and industrial-commercial are constituted into a single map entitled Urbanization. At this stage, we have four maps of intrinsic suitability for Production, Protection, Recreation and Urbanization.

Synthesis And Intrinsic Suitabilities

The final objective of the study is to produce a synthesis of data to reveal not only single intrinsic prospective land uses but complementary and competitive uses. To this end, a synthesis map was prepared. It employs the pre-emptive method linked to a value judgement as to the relative importance of prospective land uses. For the purpose of this study, the rank order employed was as follows:

1. Protection
2. Urbanization
3. Agriculture
4. Active Recreation
5. Forestry
6. Extraction

A matrix is prepared in which all land uses are listed on each coordinate. Those which were compatible if co-existing are so identified as are those that are incompatible. Mapping proceeds by identifying the category of Protection with the compatible and permitted land uses. Thereafter, all prime urban land not in competition with any other category is mapped. Prime urban is next mapped showing competition with prime Agriculture and prime Recreation. This procedure is followed through the hierarchy of the matrix. The final map reveals not only single intrinsic land uses, but those that are complementary and competitive, in a range of values.

The data generated from the ecological inventory has a value in its own right because it can be reinterpreted for objectives not considered in this study. For instance, the search for a site for a zoo could examine the data to locate the maximum environmental diversity. Similarly, the interpretations of data would be useful for planning objectives not envisaged in this study. The suitability classes and maps of intrinsic suitability have their own independent justification. The

map of Protection identifies the intolerance of natural process to prospective land uses but it is also the basis for a Metropolitan Open Space plan.

This is a summary description of the method employed. It is more elaborately described in the ensuing text. It is a reflection of natural processes as values constituting opportunities and constraints, and having implications for the pattern of metropolitan development. The plan is an elaborate mosaic but only because we have asked nature to reveal natural diversity. As a result new eyes are required to understand this map. Instead of bland areas with little character, either good or bad, which are normally selected for urbanization, this map professes a diversity appropriate to a variety of needs. It suggests environmental diversity suitable for various residential densities, a wide variety of recreational opportunity, a continuous structure of open space, and locations propitious for industry and commerce. The map must be scanned not for single intrinsic land uses but for mixes of those which can lead to richness of the environment.

THE ECOLOGICAL INVENTORY

CLIMATE

Seasonal Variations. The only available data on climate are at a gross statewide scale. These do not reveal any marked variability within the metropolitan area. However, in general, the winters are cold and dry. Mean temperatures are between 15 and 18 degrees (fahrenheit), and mean seasonal precipitation is between 2 and 2.5 inches. The spring months are cool with mean temperatures between 43 and 45 degrees and mean seasonal precipitation between 7 and 7.5 inches. The summers are warm and relatively wet, with a mean temperature range of 69 to 71 degrees and mean precipitation of 11 to 12 inches. Autumns are cool, with mean temperatures between 46 and 48 degrees and mean seasonal precipitation between 5.5 and 6 inches.

The recorded temperature extremes in the metropolitan area are 110 degrees in the summer and -37 degrees in the winter. High humidity is not a serious problem anywhere in metropolitan area. Snowfall is generally heaviest in March, the recorded extremes exceed 35 inches. An average of 150 days in the year are frost free. Prevailing winds (at 1,500 feet elevation) tend to be westerly in the winter, northwesterly in the spring, and southwesterly in the summer and fall. The Area is subject to tornadoes about once every 11 to 13 years. When they occur, tornadoes generally sweep in from the southwest, although such a path is not entirely reliable because of the surface obstructions such as windbreaks which may, among other things, cause a tornado to frequently change course.

October and December are the months when fog is most likely to occur. However, even in those months fog is relatively inconsequential. Atmospheric inversions are also quite rare. Although no detailed studies exist which show those areas vulnerable to frost, it may be assumed that lowlands, particularly those in the morainal section of the metropolitan area, could very well be frost pockets.

Variations in the Metropolitan Area. Because of only slight climatic variations within the metropolitan area, it is difficult to discern climatic zones. However, the eastern edge of the Area appears to have slightly more precipitation. As would be expected, there is a minor temperature gradient from north to south with cooler temperatures in the north and warmer temperatures in the south. For mean low temperatures, the north-south gradient is broken by a zone around the cities of Minneapolis and St. Paul which appears to be somewhat warmer than the area immediately south of those cities. Such a deviation is perhaps explained by winter heating systems and thermal releases from industry. The average number of frost free days also appears to be slightly higher in the vicinity of the major cities of the metropolitan area.

HISTORICAL GEOLOGY

Bedrock in the Twin Cities Area is sedimentary, the origin of which were Cambrian and Ordovician seas which entered the area from the south. As a result, sedimentary formations are thickest in the south, and thin out and finally disappear in the north. The sedimentary rocks overlay older crystalline igneous and metamorphic rocks of pre-Cambrian age. The structure of the crystalline rocks is complex and their surfaces were deeply eroded prior to the Cambrian period.

The Cambrian seas produced a system of sandstones and dolomites having a maximum thickness of about 1,000 feet. Their beds are nearly horizontal and they thin out toward the north where they abut the older crystalline rocks. A similar Ordovician system consists of thin formations of limestone, dolomites, shale, and sandstone. The Ordovician deposits were laid down upon the Cambrian rocks, but to the north they have been removed by erosion. Consequently, the Ordovician rocks do not extend as far north as the Cambrian. In fact, each formation of the Ordovician system is less widespread than the next underlying one.

During the Silurian and later periods the Area was a low coastal plain separating the northern Laurentian Highlands from southern seas. During the Carboniferous, Triassic, and Jurassic periods, the seas receded to the south.

Cretaceous fluvialate and estuarine beds made up of unconsolidated sands and clays are represented by one peat deposit in the southwestern part of the metropolitan area. During the following period, which was the Tertiary, the present Mississippi drainage was established and the valleys were eroded deeper than they are now. No Tertiary deposits are known in the Area.

The Quaternary system is widespread. Glacial drift, including unconsolidated deposits from melting ice, rivers, and lakes, cover the greater part of the surface and in some sections it is several hundred feet thick.

BEDROCK GEOLOGY

The structure of the bedrock in the Twin Cities area is relatively simple. The formations are not quite horizontal, but form a shallow artesian basin slightly elongated in a northeast-southwest direction. The bedrock surface, which for the most part is buried below glacial

fill, is similar to a rolling topography with about 80 feet relief. That surface is cut by an intricate network of steep-sided, narrow valleys formed during pre-Pleistocene periods of erosion. Formations found in the Twin Cities Area are summarized below.

CAMBRIAN FORMATIONS (St. Croix Group)

Dresbach formation

This formation is made up of gray shales and thick layers of soft fine white, gray, or green sandstones, overlain by a coarse, white water-bearing sandstone and much fine green and blue shale. It is not exposed in the Area except as an outcrop in the St. Croix and Mississippi Valleys. It has been penetrated by many wells so it is known to underlie the entire area.

Franconia sandstone

This is normally a rather pure white to yellow, coarse, water-bearing sandstone, but it contains some scattered glauconite at various horizons. There are no outcrops in the Area as far as is known. It has been found in many wells so its presence under the entire area is undoubted. It occurs immediately beneath the deep glacial drift in the area west of Lake Minnetonka, but in the Minneapolis-St. Paul area it is overlaid by younger formations. It averages 65 to 100 feet thick

Saint Lawrence formation

This is a series of shales, dolomites, sandstones, and greensands which form a definite lithologic unit between the Franconia below and the Jordan above. It is exposed in the St. Croix Valley from Afton to Marine, and is penetrated by many wells in Minneapolis-St. Paul. It lies immediately beneath the drift in the vicinity of and north of Anoka, and in the southwest to the extreme west end of Lake Minnetonka. Well logs indicate that it thickens to the south.

Jordan sandstone

This water bearing stratum is the prime source of artesian water in the Twin Cities Area. It is a medium grained, white to yellow to brown sandstone, massive to thin bedded, and poorly cemented. It is exposed in the Minnesota

and Mississippi valleys and to a lesser extent in the St. Croix valley. North and west of Minneapolis and St. Paul, the Jordan sandstone lies immediately under the glacial debris. From the St. Croix to the middle of Lake Minnetonka, and from Anoka to the Mississippi and Minnesota rivers, it lies beneath a cover of Oneota dolomite. It is from 80 to 115 feet thick.

ORDOVICIAN FORMATIONS

Oneota and Shakopee dolomites

The Oneota beds consist chiefly of dolomite with sandy beds near the top and oolitic dolomite in some horizons. It is usually thick bedded, gray, pink, or buff in color. Fossils are not abundant. It is exposed in the three major river valleys, and it is extensively quarried for building stone. Shakopee dolomite is a gray to buff dolomitic limestone, massive to thin bedded, often cherty and sandy, and frequently oolitic. It also outcrops in all three river valleys.

St. Peter Sandstone

This is a very white, water-bearing sandstone. It contains little cementing material or other impurities. It outcrops in the three major valleys in steep escarpments. It is exposed extensively in southern and central Dakota County where it forms isolated pinnacles of castle and chimney rocks. It occurs as a narrow belt around all areas underlain by Platteville limestone, but it is generally covered by deep glacial drift. It varies in thickness from 145 to 165 feet.

Platteville limestone

This limestone is exposed more-or-less continuously along the Mississippi River, from St. Anthony's Falls to the Robert Street Bridge in St. Paul, and on both sides of the Minnesota for a short distance above its mouth. It outcrops in northeast Minneapolis and at many places in Washington and Dakota counties. In the Twin Cities area the Platteville is about 30 feet thick and is the hard layer over which the Mississippi River falls at St. Anthony's Falls. It is rich in fossils.

Decorah shale

This formation is a series of shales interbedded with limestone. It is exposed at a few places in Minneapolis

and St. Paul, and on the south side of the Mississippi from Mendota to St. Paul. Its existence may be attributed to the basin-like structure of the Twin Cities area, in which this formation is located below the normal plain of erosion. It is about 75 feet thick and is the most fossiliferous of any formation in the Twin City area.

Galena limestone

In the Metropolitan Area this formation occurs only in the vicinity of St. Paul where it is scantily exposed on both sides of the Mississippi River. It is about 15 feet thick and has been preserved because of the basin-like structure of the region.

SURFICIAL GEOLOGY

Except where it outcrops at the surface, the Paleozoic bedrock is covered by glacial and post-glacial deposits to depths as great as 500 feet. Glacial epochs have been identified as the Nebraskan, Kansan, Illinoian, Iowan, and Wisconsin; each named for the state of its furthest penetration. With the exception of the Nebraskan, the Twin Cities area contains evidence of each glacial epoch. The area glaciated by the Nebraskan was covered by succeeding glaciers which obliterated its deposits.

Kansan drift

The Minneapolis-St. Paul area was well-covered by the Kansan glacier and much debris was left during its retreat. The Kansan ice sheet emanated from the Keewatin Center west of Hudson Bay. It left the Twin Cities area covered with a blanket of gray colored drift. It is extensively exposed in the bluffs of the Minnesota Valley and is at the surface in the eastern part of Dakota County where it is deeply dissected by surface drainage.

In the long interglacial period that followed the Kansan Epoch, the surface became highly eroded, and drainage was far more mature than it is today.

Illinoian drift

The Illinoian sheet entered the Twin Cities area from the northeast. Its deposits, called "Old Red," may be seen in southern Washington County, and in Dakota County south of the Vermillion River. It is generally about 10 feet deep, but from Hampton southeastward it forms a prominent moraine with hills 190 feet high. Illinoian drift is similar to that of the Kansan. However, it is not as deeply dissected. It

is characteristically reddish in color, but it does not have the limestone pebbles which characterize the red Wisconsin drift.

Iowan drift

The Iowan epoch followed a second interglacial period. Today, there are no Iowan surface deposits in the Twin Cities area.

Wisconsin drift

Three ice sheets of the Wisconsin invaded the Area. The first sheet originated in the Patrician Center south of Hudson Bay and moved southwest over the Twin Cities area, leaving deposits known as Patrician or young red drift. Patrician drift is found at the surface mainly in Washington, southwestern Ramsey, and northern Dakota counties.

The second ice sheet came from the northwest in the Keewatin Center, and its deposits are known as the Keewatin or young gray drift. The Keewatin drift is the most extensively exposed of any of the surficial deposits in the Area. It was deposited over almost all of Hennepin, Carver, and Scott counties, and in parts of Washington, Ramsey and Dakota counties. Unlike the red Patrician, the gray Keewatin characterized by many closed basins, an abundance of conspicuous terminal moraines, and more outwash plains.

Most of the areas where the first two phases of Wisconsin drift are exposed are characterized by a strong moraine topography, reflecting a freshness of glacial form compared to the earlier glaciations. During the third and last invasion from the Keewatin Center, a lobe extended eastward to Wisconsin from the main part of the glacier in central Minnesota. It passed through Anoka County, and during its retreat it deposited extensive outwash material over a wide area in Anoka County and adjacent areas. This material is known as the Anoka sand plain.

FOUNDATION CONDITIONS

Bedrock is generally too far below the surface to be used for building foundations. In places where it outcrops it may provide excellent foundations. However, the cost of blasting would be often prohibitive for all but high intensity development.

Platteville limestone provides the best foundation

conditions; Decorah shale provides the worst, as it is likely to cause slippage and frost heaving. St. Peter sandstone is crumbly and susceptible to erosion. The most dangerous foundation conditions exist over pre-glacial valleys filled with unconsolidated sediments. Because of incidents of structures sinking, the foundation conditions over such buried valleys should be considered as hazardous. As can be seen on the Subsurface Geologic Features map, the central part of the Twin Cities area contains a number of buried valleys. Such valleys may exist elsewhere in the Area. However, information on their locations is not available.

Surficial geologic conditions are of immediate concern with respect to foundations. Based on information obtained from R.K. Hogberg of the Minnesota Geological Survey, the foundation suitabilities of surface deposits are summarized below (also see Surficial Geology Map for locations of surface deposits).¹

<u>Material</u>	<u>Foundation Suitability</u>
Outwash Sands and Gravels:	Good, except on steep slopes where slippage and erodibility are problems.
Glacial Drift:	Moderately good, except on slopes where clay layers in the drift may be hazardous because of slippage.
Lake Deposits & Alluvium:	Generally such deposits are very poor for foundations because of their high clay content. Heaving and slippage may occur.

ECONOMIC MINERALS

Summarized below are the existing or potential values of certain formations and unconsolidated materials in the Twin Cities area.

<u>Material</u>	<u>Economic Value</u>
Platteville Limestone:	A good building stone. However, it has only limited demand. Ideally, it is obtainable in bedrock outcrops and bluffs. It is obtainable in other areas only when the overburden is sufficiently shallow to permit economical quarrying.

¹Personal communication between Narendra Juneja of Wallace, McHarg, Roberts and Todd, and R. K. Hogberg, Assistant to the Director, Minnesota Geological Survey.

<u>Material</u>	<u>Economic Value</u>
Shakopee and Oneota Dolomites:	It has only limited demand and is economically available only in bedrock outcrops, particularly in the Minnesota River plain and in bluffs.
Decorah Shale:	This shale was once used extensively for brick making. However, supplies are generally exhausted.
St. Peter Sandstone:	Although of poor quality, it was once used as sand. It is no longer quarried to any great extent.
Sand and Gravel:	Outwash sands and gravels are most suitable for road construction and fill. Sands and gravels located within glacial drift, kames, and eskers are generally suitable. Valley train sands and gravels are of secondary importance.
Clay:	Economically not very important.

PHYSIOGRAPHY

The physiography of the Twin Cities Area is varied. Anoka County is dominated by a flat sand plain. In the eastern part of the Area, high ridges bound the St. Croix River. The central part of the Area is characterized by hills and hollows. Bluffs and terraces occur along all of the major rivers. Large deep glacial lakes are found in the southwest, west, and northeast. The Area contains extensive marshes and a myriad of shallow ponds. Elevations (above mean sea level) vary from about 650 feet in the Mississippi valley to almost 1,200 feet at a point in Dakota and Scott counties.

Physiography in the Twin Cities Area can in large part be explained by the glaciation and fluvial processes that have occurred. A summary of the physiographic provinces shown on the physiography map is given below. The order in which those provinces are described coincides with their age, from oldest to most recent.

Older Plain. An Illinoian glacial drift area in Dakota and southern Washington counties, characterized by high hills.

Lesser Hills. An Early Wisconsin drift area, identified on the surface geology map as Patrician drift. It covers parts of Washington, Ramsey and Dakota counties. The area is characterized by complex topography which is somewhat lower and less hilly than that of the Greater Hills drift discussed below. Similarly, it contains fewer but larger lakes.

Greater Hills. A Middle Wisconsin drift area identified on the surface geology map as Gray Keewatin drift. It covers almost all of Hennepin and Scott counties. It is characterized by a pronounced undulating surface consisting of prominent knolls and intervening deep kettle holes. The area contains many ponds and lakes.

Newer Plain. A Middle Wisconsin drift area covering western Carver County. It is characterized by a very gently undulating topography.

Sand Plain. A Late Wisconsin outwash area in Anoka County. It is relatively flat and contains low sand dunes, marshes, and lakes.

River Terraces. These terraces were formed by glacial rivers in the late Wisconsin period, and border the present channels and flood plains of the Mississippi and Minnesota Rivers. Such terraces are flat plains which, in places, may be as wide as two miles. They are frequently bounded by sharp escarpments.

River Plain. River plains are the current flood plains of the major rivers in the Twin Cities area.

That aspect of physiography that affects most land uses is slope. For the Twin Cities area, five classes of slope were identified and mapped. Those classes are: less than 2½ percent, 2½ to 5 percent, 5 to 12½ percent, 12½ to 25 percent, and 25 percent and over. Associated with each of those classes are appropriate land uses which, when undertaken, will be economically advantageous as well as consistent with natural processes. Clearly, slopes under 5 percent are generally preferred for most land uses. Slopes between 5 and 12½ percent may be suitable, for example, for certain kinds of urban developments and agriculture but they may impose additional construction costs or be less productive. Similarly, most slopes over 12½ percent, if used for highways or industry, may significantly increase costs. Finally, development of slopes over 25 percent may result in severe economic and ecological penalties. Explicit slope criteria for land use will be presented later in this report.

HYDROLOGY

SURFACE WATER

General. The most distinctive surface water features of the Area are its three major rivers and a myriad of lakes. Each of the major rivers within the metropolitan area is distinctive in its flow character. The Minnesota is meandering and sluggish and occupies a wide river plain. The Mississippi has fast currents and occupies the bed of a gorge in its upper section. Below the point where the Mississippi is joined by the Minnesota (at Fort Snelling), it becomes slow and it meanders within a river plain. In its upper reaches north of the metropolitan area, the St. Croix is a fast flowing mountain river, and that section has been designated as a National Wild River by the U.S. Department of the Interior. For its length within the metropolitan area, the St. Croix is generally slow moving because of the lock and dam system of the Mississippi River, and a pre-glacial deep lake basin located near its confluence with the Mississippi.

Navigation. Navigable channels are maintained by the U.S. Army Corps of Engineers on all three rivers. As shown on the Navigability map, a nine feet channel extends up the St. Croix River to Stillwater, above which a four feet channel extends north of the metropolitan area. From its southeastern limits in the Area, the Mississippi River has a nine feet channel to a point about one mile south of Brooklyn Center. From its confluence with the Mississippi, the Minnesota River has a nine feet channel to a point near the Community of Savage, above which a four feet channel extends to a point near the community of Shakopee.

Drainage. Other major streams in the Area are the Rum, the Crow, and the Cannon rivers. All of these have extensive drainage areas extending beyond the metropolitan area's boundaries. The drainage patterns of other permanent streams and their intermittent tributaries in the Area reveal a distribution pattern related to the geo-physical regions in which they are located. For example, drainage is not well developed in the Older Plain and along the high elevation areas of the terminal moraines. Conversely, well defined stream patterns exist on either side of the upper part of the Mississippi and the Minnesota rivers. In other areas, glacial lakes receive the drainage of surrounding lands. Such lakes are numerous in the Greater Hills and Lesser Hills areas.

Lakes. The lakes in the region vary greatly in surface area and depth: from less than 10 acres to almost 14,500 acres, and from less than three feet to more than 80 feet in maximum depth. Most of the lakes are of glacial origin. Some of the deepest lakes are linked to bedrock aquifers.

However, most of the lake basins do not extend below the glacial drift. Some of the smaller lakes are sealed off from the underlying geology because of the presence of clay layers. In such instances, water recharge comes from surface runoff entirely. No data exist which would permit the differentiation of lakes with respect to their water regimens. However, a useful classification of water areas was made by the Minnesota Conservation Department for the purpose of identifying the wildlife potential of the metropolitan area.¹

Flood Plains. Flood plains representing the limits of the spring 1965 flood were delineated for the Minnesota, Mississippi, and St. Croix rivers and some of their tributaries. Flood plain data were provided by the Metropolitan Council.

Water Quality. In a report of its study of the pollution of the upper Mississippi River and its tributaries, the Federal Water Pollution Control Administration described the water quality of the Twin Cities Area.² For the Mississippi, Minnesota, and St. Croix rivers, that report provided information on industrial discharges, municipal sewage discharges, relative amounts of oxygen, ammonia nitrogen, nitrate nitrogen, phosphates, coliforms, biological oxygen demand (b.o.d.), as well as other data on water quality. The findings of the study indicate that for the St. Croix, an area between the communities of Stillwater and Afton contains organic enrichment from quantities of nitrate and ammonia nitrogen, phosphates, and b.o.d.'s exceeding 2 mg/liter. The St. Croix, although showing enrichment, appears to be in better condition than the Minnesota and Mississippi rivers. The Minnesota, from its confluence with the Mississippi to a point about 30 miles upstream, contains some organic enrichment from ammonia nitrogen, phosphates, coliforms, and b.o.d.'s. Similarly, from its confluence with the Minnesota to a point at least 30 miles downstream, organic enrichment of the Mississippi River is relatively heavy.

As is discussed in the Appendix, certain water quality data were obtained for the purpose of assisting other consultants to the Metropolitan Council who are responsible for the preparation of a metropolitan sewer plan.

GROUND WATER

Hydrologic Units. The metropolitan area is a synclinal basin made up of layers of sedimentary rocks which go to a depth of over 1000 feet. Most of those strata are waterbearing

¹That classification system will be further described in the wildlife section of this report.

²U.S. Dept. of the Interior, A Report on Pollution of the Upper Mississippi River and its Tributaries, Federal Water Pollution Control Admin., Twin Cities - Upper Mississippi Project, Chicago, July 1966.

sandstones, limestones, and dolomites. Minor thicknesses of shaley rock layers exist at varying depths which serve as aquitards and create distinct hydrologic units.

The yields of the major hydrologic units are given below in the sequence that they are found in situ, from the surface to approximately 200 feet below mean sea level.

Glacial Drift. Surficial glacial deposits cover practically the entire metropolitan area and in places are over 500 feet thick. Such deposits may yield as much as 20 mgd from relatively shallow wells.

Decorah and Platteville Formations. Yield - 20mgd

St. Peter Sandstone. Yield - 20 mgd.

Prarie du Chien Formation and Jordan Sandstone. Yield - 130 mgd. This unit, which is 200 to 300 feet thick, is the most important aquifer in the Area.

Franconia Formation. Yield - 20 mgd. This formation is too deep and its yield is too low to be of much use.

Mt. Simon and Hinckley Sandstones. This formation has a moderately high yield and may be as much as 400 feet thick. However, it is too deep to be economically used at this time.

Because of the synclinal nature of the formations, the Area contains artesian water. The piezometric surface of the Jordan Sandstone aquifer is generally quite close to the ground surface, while that of the other major aquifer -- the Mt. Simon and Hinckley sandstones, is only about another 50 to 100 feet below the Jordan piezometric surface.

Ground Water Movement. It is generally assumed that the movement of water through unconsolidated surficial material is vertically downwards and an important source of recharge for underlying aquifers. Similarly, water movement within aquifers is predominantly downwards although lateral movement also occurs. Lateral movement is thought to occur via buried pre-glacial valleys now filled with Pleistocene sands and gravels. Many of those valleys are sufficiently deep to cut through a number of hydrologic units, thereby enabling lateral movement of water from one unit to another.

Aquifer Recharge.¹ Aquifer recharge may occur under one or more circumstances. One aquifer may be recharged by another via lateral flow. Recharge may occur directly from precipitation if an aquifer outcrops near the surface. However, the most common phenomenon in the metropolitan area is recharge from precipitation that percolates through the

¹Information of aquifer recharge was obtained from R. K. Hogberg, Assistant to the Director, Minnesota Geological Survey.

surficial deposits. The percolation rates of those deposits are important determinants of the extent to which recharge occurs. Surface deposits were classified according to their percolation rates, as is summarized below.

High Recharge Zones - Wind deposited sands, outwash sands, and gravels, and bedrock outcrops.

Moderately High Recharge Zones - Valley train sands and gravels, and reddish brown till.

Low Recharge Zones - Clayey till.

Very Low Recharge Zones - Lake deposits and alluvium.

Chemical Quality. Information on chemical quality includes data on: the amount of total dissolved solids in the ground water, hardness as indicated by the amount of calcium carbonate, and toxic pollution as indicated by nitrate concentration. Of all those factors the nitrate pollution is of particular concern because it can be a serious health hazard. Nitrate concentrations of 45 parts per million (ppm), which may cause cyanosis in babies,¹ have been recorded in certain surficial formations in the metropolitan area. Specifically, high nitrate concentrations have been found in the glacial drift and the underlying St. Peter, Shakopee and Oneota aquifers. There is also evidence that similar concentrations may exist in the Jordan Sandstone because of its hydraulic connection with upper strata.²

PEDOLOGY

Two sources of soils data were utilized. The Agricultural Extension Service provided general information on the type of agriculture appropriate for different soil groups³, and the Joint Program for the Twin Cities Metropolitan Area provided data on the suitability of soils for urban purposes.⁴ For urbanization, data on drainage, texture, fertility, workability, and erodibility were available for each soil group. However, data were not available for urban interpretation of soils in the western part of Carver County.

¹This value was given by the U.S. Public Health Service for drinking water standards, (Federal Register, March 6, 1962, 2152-2155).

²Nitrate concentrations are more thoroughly described in the water quality appendix.

³H. E. Arneman, Soils of Minnesota, Agricultural Extension Service, U.S.D.A., June 1963.

⁴Clement D. Springer, Interpretation of Soils for Urban Purposes. The Joint Program for the Twin Cities Metropolitan Area, St. Paul, Minn. Paper No. 11, rev. September 24, 1964.

Summarized below are the soil groups that were mapped and interpreted for urban and agricultural purposes.¹

Group 1. This group is associated with level to gently sloping outwash terraces and is the most extensive of all the soil groups in the area. "These soils are concentrated in an area north of Minneapolis in northeastern Hennepin County and western and southern Anoka County. Another extensive area reaches from southern Minneapolis through Richfield and the eastern two thirds of Bloomington, and then follows along the top of the river bluffs into Eden Prairie. A third and smaller area is found in the southeastern part of Cottage Grove Townships and parts of Grey Cloud Township. In addition to these concentrations, there is a liberal sprinkling of pockets of this soil group found in northern Ramsey County and the northern half of Washington County." These soils are generally coarse textured and very well drained. They have low fertility but are workable throughout the year.

Group 2. This group is found in outwash slopes of less than 12 percent. Group 2, which is the second most extensive of all the soil groups, "...strongly predominates over all northern Dakota County, and is very evident in the southern three-fourths of Washington County. A small belt extends westward from Minneapolis through Hopkins and Minnetonka, and another area follows along the Minnesota River in northern Scott County." With the exception of having finer textured surface horizons and higher fertility, Group 2 soils are very similar to those of Group 1.

Group 3. These soils are associated with rolling or hilly topography and are found generally on slopes exceeding 12 percent. Their surface horizons vary from sand to loam. Their substrata are generally coarse textured. "There are very few extensive areas where Group 3 soils predominate. The largest area is found in northern Dakota County where they are found mixed with Group 2 soils in the recessional moraine area. There is one concentrated area in the western part of Minnetonka Village and another that winds itself through Saint Paul, north and east of the State Capital. In almost all other places Group 3 soils form little ribbons along bluffs and in recessional moraines." Group 3 soils have good fertility and are workable throughout the year..

Group 4. These soils are associated with level to gently rolling topography and are found on slopes of less than 12 percent. Their texture ranges from fine to medium. However, because the parent material of Group 4 consists of unsorted and unstratified drift, its texture is extremely variable. "Group 4 is one of the most prevalent groups in the Area. It covers about 75 percent of the land area of Hennepin County, about 90 percent of Carver County, and about 70 percent in Scott County. Extensive areas are also found in suburban Ramsey County and parts of Washington County."

¹The soil group summaries are based on information contained in the Joint Program report cited in the preceding footnote. Descriptions of the distributions of soil groups were taken directly from the report, as indicated by quotation marks.

The drainage of Group 4 soils varies from moderate to rapid. Their fertility is medium to high, and they are not workable throughout the year.

Group 5. These soils are associated with rolling to hilly topography. Their texture ranges from fine to medium. "Group 5 soils occur in only about one or two percent of the Area and are usually found as pockets within Group 4 soils, or along stream and river valleys. The most extensive areas, small as they are, are found around Lake Minnetonka and Prior Lake." Group 5 soils are the same as those of Group 4, except that they occur on slopes over 12 percent.

Group 6. These are wet soils of variable textures, and are subject to flooding. They are found in depressed lowlands, level areas, and flood plains. "Extensive areas of these poorly drained soils are found in the peat deposits in Anoka County. The bottomlands of the Minnesota River which are subject to flooding, compose another major area. Poorly drained mineral soils together with shallow peat deposits occur frequently in Scott, Hennepin and Carver counties. However, the total acreage is not large in those counties and is distributed widely in small potholes and sloughs." Such soils are variable in their fertility and are not workable throughout the year.

Group 7. These are fine textured and poorly drained soils that occur on lands that are nearly level. "The soils of this nature are very limited in extent, occupying a fraction of one percent of the area. The largest single area of this soil group is found in Vadnais Heights and Little Canada." These soils are of medium to high fertility but they are not workable throughout the year.

Group 8. This group consists of shallow soils underlain by bedrock. This group is very limited in extent and is found in two types of locations. "The most extensive areas are located in the river bottoms or terraces of the Minnesota and Mississippi rivers. In south Washington County the second situation is found. Here the bedrock has had a thin layer of glacial deposits on the surface and bedrock outcroppings occur around the edges of the resistant upland rock." The texture, drainage, and fertility of this group are quite variable because the soils may occur on limestone, sandstone or shale parent material.

PLANT ASSOCIATIONS

Indigenous Associations Prior to European Settlement.
Prior to European settlement, the metropolitan area was dominated generally by those species associated with the northern hardwood forest. A major exception is a northern extension

of the prairies which intrude into the southeastern part of the Area and extend in a northwesterly direction up the Pleistocene terraces of the Mississippi River. Traces of the northern boreal forest may also be found in the northern part of the Area as well as in wetland sites.

Where edaphic conditions permit, the climax species of the northern hardwood forest are sugar maple, basswood, white and slippery elms, and red oak. Close associates are species such as green ash, butternut, and bur oak. Pure oak stands are found mostly on the drier sites. The most notable example of the northern hardwood forest is a tract called the "big woods" that was once nearly 100 miles long and about 40 miles wide, located mostly to the west of the metropolitan area, which included the western third of Hennepin County and adjacent parts of Wright, Carver, and Scott counties. East of the "big woods" in the east-central part of the metropolitan area is an area dominated largely by oak. Confined primarily to Patrician red drift, extensive oak forests were once common throughout the central parts of Hennepin County, northern Dakota County, and parts of Ramsey and Washington counties. Although presented herein as a member of the northern hardwood forest, the oak woodlands, which were dominated by the white oak group, could also be considered as part of the central forest. The oak forest was probably never as impressive as the "big woods." However, on the better sites, white oak once provided excellent sawtimber. In other parts of the Area, the oak forest was fairly scrubby. Much of the Anoka sand plain and other sandy areas contained thin and stunted stands. Another deciduous forest type found in the metropolitan area are the river bottom forests of the Mississippi and St. Croix rivers. Such forests typically consisted of large cottonwoods near the water's edge, behind which was a mixture of white elm and soft maple.

The prairies, as described by Schwartz¹, occupied an extensive area, particularly in the outwash plains along the Mississippi and in that portion of Dakota County south of the St. Croix moraines. Prairie-like openings were also found in parts of the oak woods. Much of the city of Minneapolis was originally prairie. Schwartz has stated that most of the prairies seem to have owed their existence to gravelly subsoils too porous to hold a reasonable supply of water through a season of drought. Rosendahl² has described the prairie of the metropolitan area as resembling savannah and containing groves of species similar to those found in the adjacent hardwood forest. However, species diversity and the biomass of the prairies was less than that of the deciduous forest.

A map of the vegetation cover believed to exist in the mid-19th century was obtained from the North Central Forest

¹George M. Schwartz. The Geology of the Minneapolis St. Paul Metropolitan Area, University of Minnesota Press, Minneapolis, 1936.

²Carl Rosendahl. Trees and Shrubs of the Upper Midwest, University of Minnesota Press, Minneapolis, 1963.

Experiment Station of the U.S. Forest Service. That map, drawn from information collected from the records of early land surveyors, indicates the extent and distribution of the plant associations discussed above. A list of species native to the metropolitan area is presented in Table 1.

Current Conditions. Today, the "indigenous" plant associations of the metropolitan area are only remnants of what they once were. Logging, agriculture, and urbanization, probably in that order, have greatly reduced the original acreages of those associations. Species diversity has probably also diminished. Today, forest lands are commonly restricted to those areas that are not well suited for agriculture and urbanization. Such areas include steep slopes, wet lands, and poor soils. Although hardly offsetting the loss of natural vegetation, past and present residents of the metropolitan area have introduced vegetative forms such as coniferous plantations, shelter belts, and windbreaks.

Vegetation of Scenic and Scientific Interest. As suggested above, evidence of the northern boreal forest may be found in northeastern Anoka County where small stands of jack pine may be found on the sandy uplands, and black spruce and tamarack may be seen in certain swamps. Anoka county also has a few remaining cedar bogs.

Moving sand dunes may be found in the Columbia Heights area north of Minneapolis. Such dunes, which are sometimes occupied by dwarf vegetation, are rapidly being destroyed.

Values. Forests in the Area have relatively low commercial value. Pulpwood and large scale logging operations have more profitable forest resources available to them elsewhere in the state. Only marginal demand exists for local timber which, in such cases, is limited usually to walnut veneer logs. Orchards in the metropolitan area are rare, probably because the climate is not particularly suitable for such enterprises. Maple syrup is produced locally from sugar maple. Wild rice may be found in certain wetland areas.

Collectively, the vegetation of the Area is important to watershed and wildlife management, outdoor recreation, and in some cases, it is highly valued for residential development. In summary, the presence of vegetation, particularly in highly erodible areas, contributes greatly to erosion control. Vegetation provides habitat for all wildlife in the metropolitan area. The scenic qualities of plant communities are common knowledge. Forest lands have been utilized extensively for outdoor recreation facilities. Forest types such as aspen-birch have provided aesthetic surroundings for prestige residential neighborhoods.

Indigenous Plant Species Of The
Twin Cities Metropolitan Area

HARDWOOD FORESTS

Tree Species

Sugar Maple	}	MAJOR IMPORTANCE
Basswood		
Red Oak		
White Elm		
Red Elm		
Butternut		
Green Ash		
Red Cedar		
Black Oak		
Black Walnut		
Shellbark Hickory		
White Oak		
Bur Oak		
Scarlet Oak		
Northern Pin Oak		
Tamarack		
Kentucky Coffee Tree		
White Pine		

Shrubs

Dogwood
Iron Wood
Thorn Apples
Black Haw
Rosa Blanda
Hazel
Smooth Sumac

Vines

Virginia Creeper
Smilax
Frost Grape
Bittersweet

Wild Flowers

Hepatica
Wood Anemone
Blood Root
Dutchman's Breeches
Bellwort
Trilliums

BORDER REGION

Bur Oak
Choke Cherry
Black Cherry
Plum
Aspen
Elm
Balsam Poplar
Pin Cherry
Willows

SAVANNA

Bur Oak (Calcareous)
White Oak (Non-Calcareous)
Hill's Oak (Sandy)

PRAIRIE

Cottonwood	}	NEAR WATER
Box Elder		
White Elm		
Bur Oak		
Prairie Grasses		
Lead Plant		
Wild Roses		
Hazel		
Wolfberry		
Puccoons		
Bird's Foot Violets		
Prairie Phloxes		
Sun Flowers		
Blazing Stars		
Golden Rods		
Asters		

CONIFEROUS FOREST - North Eastern Anoka County
(Cedar Creek Forest)

Jack Pine (Sandy Upland)
Black Spruce
Tamarack Swamp
Cedar Swamps

FISH AND WILDLIFE

The analysis of fish and wildlife consisted of three steps. First, an inventory was made of habitats and associated species expected to be found in the metropolitan area. Habitats were then evaluated according to their scarcity, as well as the diversity and scarcity of the species utilizing them. Finally, habitats were given priority ratings to indicate their relative importance with respect to preservation and management.

Four major habitat groups were identified: water areas, wetlands, forests, and grasslands. In addition to the published data, Dr. Breckenridge, Director of the Minnesota Museum of Natural History, provided valuable guidance by reviewing and revising the compilations of habitats and species.¹ The results of the inventory are given below.

Water Habitats

*Fish Lakes: "Lakes having open water of sufficient depths to be normally capable of supporting a permanent game fish population."

*Marginal Fish-Game Lakes: "Lakes with water depths from six to fifteen feet. Include freeze-out lakes but have excessive depth for optimum game use."

Frogs, salamanders, toads, common newt, common water snake, wood turtle, Blandings turtle, and false map turtle, (Some of these species require undisturbed forest edge.) Ducks, geese & swans in migration, coots, muskrats, loons.

Rivers and Streams:

Major rivers, major streams, and permanent streams.

Trout, Bass, pan fish, buffalo fish, drum (sheep's head), channel catfish, sturgeon, black bass, rock sturgeon, walleyed pike, northern pike, rock bass, perch, white bass, and sauger.

¹Published data used in the inventory include: Metropolitan Lake Inventory (Minn. Dept. of Conservation); The Mammals of Minnesota (Gunderson & Beer); and Reptiles and Amphibians of Minnesota (Breckenridge). Full citations are given in the bibliography.

*Designations taken directly from Appendix B of Metropolitan Lake Inventory (Minn. Dept. of Conservation). Quoted descriptions are from p. 123 of that report.

Mudflats, Sandy
Shores & Bogs:

Rare in the metropolitan area.
Often included in the river
bottom category.

- veg. Varies greatly. Some areas contain smartweeds, wild millet, fall panicum, teal grass, cockleburrs, heath shrubs, sphagnum moss, sedges, leather leaf, labrador tea, cranberry, carex, cottongrass.
- spp. Deer, songbirds, small mammals, nesting ducks. Marsh and shore birds.

Wooded and
Shrub Swamps:

- veg. Woody: alder, willow, tamarack, white cedar, black spruce, balsam fir, red maple, black ash.
- Undergrowth: moss, duck weed, smart weed, and others.
- spp. Beaver, mink, raccoon, woodcock, marsh and song birds, spring peeper, swamp tree frogs, nesting wood duck, herons, deer, small rodents and shrews.

Forests Habitats

River Bottom Forest:

Forests that occur adjacent to the rivers and mainly on flood plains.

- veg. Woody: elm, ash, cottonwood, box elder, oaks, basswood, soft maple, willow, aspen, hackberry, with occasional pines and arbor vitae in the pine region.

Herbaceous: some smart weed, wild millet, fall panicum, teal grass, and cocklebur.

- spp. Raccoon, green frogs, upland game birds, white tailed deer, cottontail rabbits, wood ducks, forest song birds, gray fox, salamanders, snakes, turtles.

Upland Hardwoods
(Big Woods and
aspen-birch):

- veg. Woody: big woods - oaks (bur, white, red & black), elm, basswood and maple dominant; with

ash, hornbeam, aspen, birch,
wild cherry, hickory, butternut,
black walnut.

Aspen-birch -- eventually
become hardwood forests, includes
ash, elm, maple, basswood oaks.

spp. Gray, red, fox, and flying
squirrel; raccoons; white-tail
deer; gray fox; snakes -- include
pilot black snake, Brocon snake,
red-bellied snake; salamanders;
wood frogs; ruffed grouse.

Dry Oak, Savannah &
Dry Uplands (Oak
openings, barrens &
aspen-oak) & Transition
Zones:

veg. Woody: oak openings & barrens -
scattered trees and groves of
oaks (mostly bur oak) of scrubby
form with some brush and thickets
and occasionally with pines.

Aspen-Oak Lard: aspen, generally
dense, but small in most places,
with scattered oaks and few elms,
ash, and basswood.

spp. Pheasant, deer, ruffed grouse,
spotted and striped skunk, wood
chicks, prairie skunks, red fox,
and snakes.

Grassland Habitats

Grassy Meadows
(Prairie):

veg. willow prairie, prairie with
clumps of willows, grass.

spp. striped and Franklin ground
squirrels, hog-nosed snakes,
upland plover, badger builder,
white-tailed jack rabbit,
Hungarian partridge.

Brush Prairie:

veg. grass and brush of aspen, balm
of Gilead and a little oak and
hazel in the north; but mainly
oak and hazel in the south.

spp. Some prairie songbirds: horned
lark, bobolink, vesper sparrow,
lark sparrow, kill deer.

Wetlands Habitats

*Deep Marshes:

Marshes containing from 1 to 3 feet of water during the growing season.

veg. cattails, bulrushes, reeds, round stemmed bulrush, and wild rice. In open areas: pond weed, nariad coontail, water milfoil, water weeds, duch weed, water lilies, spatter dock and other aquatics.

spp. mallard, muskrat, mink, blue-winged teal, grebes, coots, marsh birds-blackbirds, rails, herons, black terns, water snakes, several turtle and frog species.

*Shallow Marshes:

"Marshes containing up to 12 inches of water until approximately mid-summer."

veg. grasses, bulrushes, spikerushes, cattails, arrowhead, pickeral weed, smartweed, reeds, white top, ricecut grass, carex and giant bur-reed, and wet willow growths.

spp. migrating ducks, pheasant, muskrat, mink, deer, grebes, coots, blue-winged teal, nesting mallard, frogs, toads, snakes and other reptiles and amphibians.

*Wet Meadows:

"Shallow depressions without standing water but water-logged within at least a few inches of the surface."

veg. grasses, sedges, rushes and various broad-leaved plants-carex, rushes, reed grass, mannagrass, prairie cord grass, mint, and willow.

spp. nesting waterfowl, pheasant, deer, marsh songbirds, leopard frogs, red fox, herons, snakes, salamanders, and other reptiles and amphibians.

*Ibid.

Farmland and Old Fields: veg. grassland, woodlots, sloughs, and shelter belts.

spp. pheasant, prairie songbirds, horned bobolink, vesper sparrows, lark sparrow, killdeer.

Habitats were rated for their general utility to waterfowl, small game, and fish. As is shown below, a rating scale of 1 to 5 was used in the evaluation of each habitat. Rating 1 is the best and Rating 5 is the least desirable.

Table 1 Rating of Fish and Wildlife Habitats

	Waterfowl	Small Game	Fish
Fish Lakes	1	1	1
Marginal fish-game lakes (Periodic stocking of fish may be necessary)	1	1	2
Small lakes, ponds, etc.	1	1	2
Rivers	1	1	2
Streams	2	1	1 or 2
Deep Marshes	1	2	n
Shallow Marshes	2	2	n
Wet Meadows	4	3	n
Mudflats and Sandy shores	4	3	n
Swamps	3	1	n
River Bottom			
Forest	2	2	n
Upland Hardwood	2	2	n
Dry Oak Savannah	4	2	n
Coniferous Plantation	n	4	n
Grass Meadow	3	3	n
Brush Prairie (Aspen Oak)	v	3	n
Farmland	v	1	n
Urban with trees	5	5	n

n - non-applicable

v - variable depending upon conditions and species.

EXISTING LAND USE

An analysis of existing land use was made to determine those cultural features which have recreation value or require protection. Non-urban lands such as cultivated fields, meadows, pastures, and forests, were identified from interpretation of aerial photographs. The Metropolitan Council provided information on other features such as historical sites and public and private recreation areas.

It would have been desirable to delineate the high decibel areas around existing airports, as such zones are considered to be undesirable locations for many urban land uses. Unfortunately, information available was insufficient.

ECOLOGICAL INTERPRETATIONS

PROSPECTIVE LAND USES

Ecological parameters were related to four broad groups of land use which are described in detail in the next section of this report. However, for the purpose of presenting the relationships between natural processes and land use, those groups are summarized below.

Production. Those land uses related to production from the land. Examples are: agriculture, forestry, wildlife propagation, and mineral extractive industries.

Protection. Those land uses whose primary purposes are to preserve, protect, and conserve those elements of the natural environment considered to be unique, scarce, or vulnerable or constitute a hazard to life and health. Such resources may include erodible slopes, flood plains, and aquifer recharge areas.

Recreation. Those land uses whose purposes are to enable the constructive use of leisure time in an active or passive manner.

Urbanization. Those land uses related to residential, commercial, institutional, and industrial developments.

IDENTIFICATION OF ECOLOGICAL PARAMETERS

In the development of ecological criteria for prospective land uses, the first step consisted of identifying the relevance of elements of geology, physiography, hydrology, soils, vegetation, wildlife, and existing land use to the four land use groups. In the tables that follow, phenomena associated with those ecological features just cited are listed and evaluated with respect to their relationship to each of the land use groups. As shown in the first table, the St. Croix Group of geologic strata has no relevance to any of the land use groups, as indicated by a small "x" placed in each of the columns. However, listed below the St. Croix groups are the Shakopee and Oneota Dolomites which are related to four of the land use groups. Specifically, such dolomites may be quarried along river bluffs, they may constitute a relatively unique resource, and under certain circumstances, they may be important to aquifer recharge. Finally, such dolomites offer caves and bluffs which may be considered as recreation resources. Each ecological parameter has been identified in the same manner. In some cases it is difficult to ascertain the relationship of a parameter to a prospective land use. For example, Group 1 soils may or may not be important to wildlife management. In such instances, a question mark (?) has been placed to indicate that situation.

GEOLOGY-BEDROCK

NATURAL PROCESS

PHENOMENON	PRODUCTION				UNIQUE	PROTECTION		RECREATION		URBANIZATION	
	AG.	FOREST	WILDLIFE	EXTRACT.		SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
St. Croix Group	x	x	x	x	x	x	x	x	x	x	x
Shakopee & Onieta Dolomites	x	x	x	Quarrying along river bluffs	Exposed rock along bluffs	x	Aquifer thru quarries in flood pl.	Pits & recharge caves	x	x	x
St. Peter Sandstone	x	x	x	x	Exposed along bluffs	x	Erodible Bluffs-scenic	x	x	x	x
Plattville Limestone	x	x	x	Quarrying along bluffs & shallow overburden	Exposed along bluffs	x	x	Bluffs-scenic	x	Excellent foundation conditions	
Decorah Shale	x	x	x	Quarrying for bricks almost exhausted	x	x	?	x	x	Poor foundation conditions	
Galina Limestone	x	x	x	x	x	?	x	x	x	x	x
Conglomerate	x	x	x	x	x	?	x	x	x	x	x

TABLE 2A GEOLOGY-BEDROCK

GEOLOGY - SURFICIAL

TABLE 2B GEOLOGY - SURFICIAL

NATURAL PROCESS PHENOMENON	PRODUCTION			PROTECTION		RECREATION		URBANIZATION			
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Alluvium	x	x	x	x	x	x	x	River plain - scenic	?	Poor foundation conditions	
Alluvial Terrace	x	x	x	x	?	x	x	Scenic	x	Poor foundation conditions	
Wind Deposited Sand	x	x	x	x	x	Yes	Erodible high re-charge value	? Scenic	x	Good foundation conditions	
Valley Train Sand and Gravel Terraces	x	x	x	Sand and gravels	Yes.	x	Moderate recharge value	Scenic edges	x	Good foundation conditions (except on slopes)	
Lake Deposit	x	x	x	Clay (not very important)	x?	x	x	x	x	Poor foundation conditions	
Outwash Sand & Gravel	x	x	x	Sand & gravel	Sand Plain	x	High re-charge value	x	x	Good foundation conditions (except on slopes)	
Clayey Till	x	x	x	x	x	x	x	x	x	Moderate foundation conditions (except on slopes)	
Reddish Brown Till	x	x	x	x	x	x	Moderate recharge value	x	x	Moderate foundation conditions (except on slopes)	
Outwash Sand & Gravel	x	x	x	Sand & gravel	x	x	High re-charge value	x	x	Good foundation conditions (except on slopes)	
Glacial Drift	x	x	x	x	x	x	?	x	x	Moderate foundation conditions (except on slopes)	

NATURAL PROCESS PHENOMENON	GEOLOGY - SURFICIAL						PROTECTION SCARCE	VUL.	RECREATION		URBANIZATION	
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE			PASSIVE	ACTIVE	RES.	INDUS.
Bedrock	x	x	x	Possible limestone quarrying	Exposed rock	Yes	x	x		Excellent foundation conditions		
Esker Deposit Kame Deposit	x	x	x	Possible sand & gravel	Yes	Yes	x	Scenic ? Educational	x		x	

PHYSIOGRAPHY - SLOPE

TABLE 2C PHYSIOGRAPHY - SLOPE

NATURAL PROCESS PHENOMENON	PRODUCTION				PROTECTION			RECREATION		URBANIZATION	
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Over 25%	Prohibi- tive	Prohibi- tive for commercial use May be desirable for scenic reasons	Bluffs im- portant for some species	im-Prohibi- tive	Bluffs	x	Erosion suscepti- ble	Scenic	Prohibi- tive	Low (ex- cept on bluffs)	Prohibi- tive
25-12½%	Pasture only	x	x	Prohibi- tive	x	x	Slippage possibili- ty on drift. Erodible on sands and gravels	x	Prohibi- tive	Low	Prohibi- tive
12½-5%	Limited	x	x	Limited	x	x	Slippage possibili- ty on drift. Erodible on sands and gravels	x	Limited	Medium	Limited
5-2½%	Moderately good	x	x	Permissive	x	x	x	x	Moderately good	Permis- sive	Generally permis- sive
Less than 2½%	No restric- tion	x	x	No restric- tion	x	x	x	x	Fully permissive	No restric- tion	No restric- tion

HYDROLOGY

NATURAL PROCESS

TABLE 2D HYDROLOGY

PHENOMENON	PRODUCTION			EXTRACT.	UNIQUE	PROTECTION		RECREATION		URBANIZATION	
	AG.	FOREST	WILDLIFE			SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Major Rivers	Commercial fishing	x	Waterfowl, Small game, fish	Waterfowl? Bottom sediments from dredging	Yes	x	Control of water quality, quantity. Protection of edge & the scenic corridor.	Yes	Desirable location for views for navigable water supply, sewage disposal.	Desirable location for views for navigable water supply, sewage disposal.	Desirable location for views for navigable water supply, sewage disposal.
Major Streams		x	Small game, fish, waterfowl		x	x	Control of water quality, quantity. Protection of edge & the scenic corridor.	Yes	Desirable location for views for water supply & sewage disposal.	Desirable location for views for water supply & sewage disposal.	Maybe desirable location for water supply & sewage disposal.
Other Permanent Streams		x	Small game, fish, waterfowl		x	x	Control of water quality & quantity. Protection of edge.	Yes	Desirable location	Desirable location	Maybe desirable location for water supply & sewage disposal.
Intermittent Streams		x	Small game		x	x	Protection of edges	Yes	Maybe desirable location	Maybe desirable location	x
Large Deep Lakes		x	Fish, waterfowl, small game		x	x	Control of water quality quantity. Protection of edge	Yes	Desirable location	Desirable location	Maybe desirable location for water supply & sewage disposal.

NATURAL PROCESS HYDROLOGY

PHENOMENON	PRODUCTION			PROTECTION		RECREATION		URBANIZATION			
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Large Shallow Lakes	x	x	Waterfowl small game, fish	x	x	x	Control of water quality & quantity. Protec- tion of edge	Yes	Yes	Desirable location	May want to locate for water use
Small Lakes, Ponds	x	x	Waterfowl small game, fish	x	x	x	Control of water quality & quantity. Protec- tion of edge	Yes	x	Desirable location	
Deep Marsh	Maybe wildrice	x	Waterfowl small game, fish	x	x	x	Control of water quality & quantity. Protec- tion of edge	Yes	x		
Shallow Marsh	Maybe wildrice	x	Waterfowl small game, fish	x	x	x	Control of water quality & quantity. Protec- tion of edge	Yes	x		

NATURAL PROCESS	HYDROLOGY				PRODUCTION		PROTECTION		RECREATION		URBANIZATION	
	PHENOMENON	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Swamps & Wetlands	x	Wooded swamps may be useful for cedar wood	Small game waterfowl	x		x	Yes	Control of water quality & quantity. Protection of edge for swamps. Availability of water important for wet meadows	Yes	x	x	x
Flood Plains		Localized use for grains, livestock or truck crops	Small game fowl		Localized limestone quarries & sand & gravel pits	x		Danger to life & property, obstruction of water course, siltation	Yes			Desirable location but prone to flood damage

NATURAL PROCESS SOILS

URBANIZATION

INDUS.

RECREATION

PROTECTION

PRODUCTION

AG.

PHENOMENON

PHENOMENON	AG.	PRODUCTION			UNIQUE	SCARCE	VUL.	RECREATION		INDUS.
		FOREST	WILDLIFE	EXTRACT.				PASSIVE	ACTIVE	
Group 1: *Coarse **Rapid Low fertility Workable year round	Poor	Poor	?	x	Sand plain, dunes, etc	x	Highly erodible. High water table likely	Scenic Sand dunes, etc	Yes	Good foundation conditions for on-site sewage disposal & low excavation & grading costs
Group 2: Medium/coarse Rapid Good fertility Workable year round	Good	Good	?	x		x			Yes	Very good foundation conditions, for on-site sewage disposal. Low excavation and grading costs.
Group 3: Same as 2, but over 12% slopes	Limited	Good	?	x		x	Erosion may be a problem, Rocks & boulders may be present	Yes Scenic	Not suitable	Limited - grading cost high
Group 4: Medium/Moderate fine Moderate to rapid Medium/High fertility Not workable year round	Moderate conservation practices necessary	Excellent	?	x		x	Subject to compaction, slippage a problem, Frost heaving, water logging		Moderate	On-site sewage disposal requires bigger drain fields. Excavation, grading costs high. Low bearing capacity when wet.

TABLE 2E SOILS

* Texture
** Drainage

SOILS

NATURAL PROCESS

PHENOMENON	PRODUCTION			PROTECTION		RECREATION		URBANIZATION			
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Group 5: Same as 4, but over 12% slopes	Poor	Excellent	?	x	x	x	Erosion a problem in addi- tion to slippage, frost heaving & compaction	Yes Scenic	Unsuitable	Extreme limita- tions	Prohibi- tive
Group 6: Variable tex- ture Slow/Very slow Variable fertility Not workable year round	Generally poor, but good in parts specially for truck farming & sod farming	Good, but not commercial maybe for scenic or wildlife	?	Peat soil- in parts only	Peat formations	x	High water table, Frost suscepti- ble, Erodible when dry, subject to flooding	x	Suitable in parts	Very low bearing capacity. Unsuitable for on- site sewage dis- posal.	
Group 7: Fine Very slow Medium to high fertility Not workable year round	Limited (special- ized agri- culture only)	Good, but not com- mercial maybe for scenic or wildlife	?	Clay	x	x	High water table, Frost suscepti- ble	x	x	Very low bearing capacity. Unsuitable for on- site sewage dis- posal. Poor drainage.	
Group 8: Variable over rock	Generally unsuitable	Generally unsuitable	?	x	Rocks outcrops	x	Erodible	x	x	Excellent bearing capacity. Unsuitable for on- site sewage dis- posal.	

TABLE 2E (Cont'd)

VEGETATION

NATURAL PROCESS

TABLE 2F VEGETATION

PHENOMENON	PRODUCTION				PROTECTION		RECREATION		URBANIZATION		
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Big Woods: (A) Oak, Elms, Maple, etc.	x	Desirable lumber, veneer, etc.	#2 for small game #2 for fowl	x	x	Yes	x	Yes	x	Prestige housing	Maybe for lumber, veneer, etc.
Big Woods: (B)	x	x	#2 for small game #2 for fowl	x	x	Yes	x	Yes	x	Prestige housing	x
River Bottom: (A) Elm, Basswood	x	Limited lumber or special wood	#2 for small game #2 for fowl	x	x	Yes	x	Yes	x	x	x?
River Bottom: (B)	x	x	#2 for small game #2 for fowl	x	x	Yes	x	Yes	x	x	x
Aspen Birch: (A) (Succession into Big Woods)	x	Limited special wood	#2 for small game #2 for fowl	x	x	Yes	x	Yes	x	x	x?
Aspen Birch (B)	x	x	#2 for small game #2 for fowl	x	x	Yes	x	Yes	x	x	x
Evergreen Swamps	x	Cedar wood	#1 for small game #4 for fish #5 for waterfowl	x	Yes	Yes	Water quality & quantity control needed	Yes	x	x	x
Coniferous Plantations	x	Lumber	Low value	x	x	Yes	x	Yes	x	?	Maybe for lumber

VEGETATION

NATURAL PROCESS

PHENOMENON	PRODUCTION			PROTECTION			RECREATION		URBANIZATION		
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Oak opening- (A&B) barrrens: Oaks, some Pines	x	x	#2 for small game #4 for fowl	x	x	Yes	x	Yes	x	x	x
Aspen-Oak	x	x	#1 for fowl #3 for small game	x	x	Yes	x	Yes	x	x	x
Wet Meadow	x	x	#3 for small game #4 for waterfowl	x	x	Yes	Availability of water important	Yes	x	x	x
Grass, Meadow, Pasture, etc.	Hay, livestock	x	#3 for small game #3 for fowl	x	x		x	Yes	x	x	x
Cultivated Land	Grains, livestock, truck crops	x	#1 for fowl #3 for small game	x	x		x	Yes	x	x	Maybe light industry flour mills dairies
Marsh	Could be wildrice	x	#1 for waterfowl #2 for small game #3 for fish	x	x	Yes	Water quality & quantity control needed	Yes	x	x	x
Mudflats and Sandy Shores	x	x	#3 for waterfowl #6 for small game	x	x		x	Yes	x	x	x

TABLE 2F (Cont'd)

NATURAL PROCESS	VEGETATION				PRODUCTION		PROTECTION		RECREATION		URBANIZATION	
	PHENOMENON	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Open Water	Fish	x	x	#1 for waterfowl #1 for fish #1 for small game	x	x	x	Yes	x	x	x	x
Urban with trees	x	x	x	Low value	x	x	?	x	Yes	x	Prestige housing	x
Urban	x	x	x	x	x	x	x	x	x	x	x	x

TABLE 2G WILDLIFE HABITATS

NATURAL PROCESS	WILDLIFE HABITATS													
	PRODUCTION					PROTECTION					RECREATION		URBANIZATION	
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.			
Fish Lakes	x	x	#1 for fish #1 for waterfowl #1 for fowl #1 for small game	x	For game fish	x	Quality & Yes quantity of water, Protection of edge. Overuse of lake for rec.	Yes	Desirable location	x				
Marginal fish-game lakes (Periodic stocking of fish maybe necessary)	x	x	#1 for waterfowl #1 for small game #2 for fish	x	High diversity	x	Quality & Yes quantity of water, Protection of edge. Overuse of lake for rec.	Yes	Desirable location	x				
Small lakes, ponds, etc.	x	x	#1 for waterfowl #1 for small game #3 for fish	x	High diversity	x	Quality & Yes quantity of water, Protection of edge. Overuse of lake for rec.	x	Desirable location	x				
Rivers	Commercial fishing	x	#1 for waterfowl #1 for small game #2 for fish	x	Migrating fowl	x	Quality & Yes quantity of water, Protection of edge. Overuse of lake for rec.	Yes	Desirable location	x				

NATURAL PROCESS	WILDLIFE HABITATS					PROTECTION		RECREATION		URBANIZATION	
	PHENOMENON	PRODUCTION		EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
		AG.	FOREST								
Streams	x	x	#1 for small game #1 or 2 for fish #2 for waterfowl	x	x	x	Quality & quantity of water, Protection of edge	Yes	x	Desirable Location	x
Deep Marshes	Could be wildrice	x	#1 for waterfowl #2 for small game #3 for fish	x	High diversity and marsh birds	Yes	Quality & quantity of water Protection of edge	Yes	x	x	x
Shallow Marshes	Could be wildrice	x	#2 for waterfowl #2 for small game #4 for fish	x	High diversity and migrating fowl	x	Quality & quantity of water, Protection of edge	Yes	x	x	x
Wet Meadows	x	x	#3 for small game #4 for waterfowl	x	Highest diversity	Yes	Availability of water	Yes	x	x	x
Mudflats and Sandy shores	x	x	#3 for waterfowl #4 for small game	x	Songbirds, shorebirds and small mammals	x	Protection of edge	Yes	x	x	x
Wooded swamps	x	Cedar wood	#1 for small game #3 for fowl #4 for fish #5 for waterfowl	x	High diversity	Yes	Water quality & quantity, Protection of edge	Yes	x	x	x

WILDLIFE HABITATS

NATURAL PROCESS

TABLE 2G (Cont'd)

PHENOMENON	PRODUCTION			PROTECTION			RECREATION			URBANIZATION	
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
River Bottom Forest	x	x	#2 for small game #2 for fowl	x	Deer & wood duck	Yes	x	Yes	x	x	x
Upland Hardwood	Sugar maple	Desirable lumber, veneer, etc.	#2 for small game #2 for fowl	x	Ruffed grouse	Yes	x	Yes	x	Desirable for housing	x
Dry Oak Savannah	x	x	#2 for small game #4 for fowl	x	Ruffed grouse	Yes	x	Yes	x	x	x
Coniferous Plantation	x	Lumber	Low value	x	x	Yes	x	Yes	x	?	x
Grass Meadow	Hay livestock	x	#3 for small game #3 for fowl	x	Partridge habitat	x	x	Yes	x	x	x
Brush Prairie (Aspen Oak)	x	x	#1 for fowl #3 for small game	x	Excellent for song-birds	Yes	x	Yes	x	x	x
Farmland	Grains, livestock truck crops	x	#1 for fowl #3 for small game	x	Excellent for song-birds & pheasant	x	x	Yes	x	x	x

NATURAL PROCESS	WILDLIFE HABITATS					PRODUCTION			PROTECTION			RECREATION		URBANIZATION	
	PHENOMENON	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.			
Urban with Trees	x	x	Low value	x	x	x	?	x	x	x	x	x			
Urban	x	x	x	x	x	x	x	x	x	x	x	x			

LAND USE (EXISTING)

TABLE 2H LAND USE (EXISTING)

PHENOMENON	PRODUCTION			PROTECTION			RECREATION		URBANIZATION		
	AG.	FOREST	WILDLIFE	EXTRACT.	UNIQUE	SCARCE	VUL.	PASSIVE	ACTIVE	RES.	INDUS.
Urban Core	x	x	x	x	Yes	x	x	Yes	x	x	x
Residential	x	x	Low value	x	x	x	x	Yes	x	Yes	x
Commercial	x	x	x	x	x	x	x	Yes	x	x	x
Industrial	x	x	x	x	x	x	x	Yes?	x	x	Yes
Institutional	x	x	May have high value	x	Maybe Yes	x	x	Yes	Maybe yes	Maybe a desirable location	x
Parkland	x	x	May have high value	x	Maybe Yes	Maybe yes	Yes	Yes	Yes	Desirable location	x
Recreational Sites	x	x	x	x	Yes	?	Yes	Yes	Yes	Desirable location	x
Forest	Maybe Yes	Yes	Yes	x	x	Yes	Yes	Yes	x?	Desirable location	x
Farmland	Yes	Maybe Yes	Yes	x	x	x	Yes	Yes	x	x	x
Other Open Areas	Yes	Yes	Yes	Yes	x	x	Yes	Yes	Yes	Yes	Yes

INTERPRETATION OF ECOLOGICAL PARAMETERS

The second step in the development of ecological criteria is the interpretation of ecological parameters with respect to land uses. The major subdivisions of each land use group were each given five ratings. The five ratings constitute a value gradient in which Rating I represents the best conditions and Rating V represents the least desirable conditions. For a given land use, the gradient is relatively uniform, e.g., the value increment between ratings I and II is the same as that between ratings IV and V.

As shown in the following tables, each parameter related to a given land use was assigned to one of the five ratings. As shown on the first table, bedrock and surficial geology do not directly influence agriculture, a fact that was actually determined in the first step of the interpretive sequence but which is shown in the table as a small "x". Physiography, which is shown below geology, is clearly related to agriculture in that increases in slope impose successively severe penalties. Slopes of less than five percent are infinitely more suitable for agriculture than slopes over 25 percent. Similarly, elements of hydrology, soils, existing vegetation, wildlife habitats, and existing land use were evaluated and assigned to one of the five ratings. The other prospective land uses associated with production, protection, recreation, and urbanization have been treated in the same manner.

PRODUCTION - AGRICULTURE

NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY				OTHER DATA REQUIRED
	I	II	III	IV	
GEOLOGY-BEDROCK	x	x	x	x	x
GEOLOGY-SURFICIAL	x	x	x	x	x
PHYSIOGRAPHY-SLOPES Less than 2½%		2½-5%	5-12½%	12½-25%	Over 25%
HYDROLOGY			1. Major rivers 2. Flood plains	Deep & shallow marshes	
SOILS	Groups 2 & 4	Group 6	Groups 3 & 5	Group 1	Groups 7 & 8
VEGETATION	Cultivated land	Grass meadow, pasture, etc.	Open water	1. Marshes 2. Big woods	
WILDLIFE HABITATS	Cultivated	Grass meadow, pasture, etc.	Open water	1. Marshes 2. Big woods	
EXISTING LAND USE	Farmland	Other open areas	Forest		Urbanized areas

TABLE 3B PRODUCTION - FOREST

NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
	I	II	III	IV	V	
GEOLOGY-BEDROCK	x	x	x	x	x	
GEOLOGY-SURFICIAL	x	x	x	x	x	
PHYSIOGRAPHY-SLOPES	x	x	x	x	Over 25% slope prohibitive for commercial forest	
HYDROLOGY				Wooded swamps		
SOILS	Groups 4 & 5	Groups 2 & 3	Groups 6 & 7	Group 1	Group 8	
VEGETATION	Big Woods	1. River Bottom 2. Aspen birch	Coniferous plantations	Wooded swamps	1. Other forest types 2. Unforested	
WILDLIFE HABITATS	Big Woods	1. River Bottom 2. Aspen birch	Coniferous plantations	Wooded swamps	1. Other forest types 2. Unforested	
EXISTING LAND USE	Forest	Other open areas	Farmland		Urbanized areas	

PRODUCTION - WILDLIFE

TABLE 3C PRODUCTION - WILDLIFE

NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
	I	II	III	IV	V	
GEOLOGY-BEDROCK	x	x	x	x	x	
GEOLOGY-SURFICIAL	x	x	x	x	x	
PHYSIOGRAPHY-SLOPES Bluffs (over 25%)						
HYDROLOGY	1. Major rivers 2. Large deep lakes	1. Other lakes, ponds, etc. 2. Deep & shallow marshes	Streams -- major and other permanent	1. Swamps & wetlands 2. Flood plains	Intermittent streams	
SOILS	x	x	x	x	x	
VEGETATION	1. Open Water 2. Marshes 3. Wooded swamps	1. Forest of all types 2. Farmland 3. Aspen-oak	1. Oak-opening barrens 2. Meadows -- wet and grass	1. Coniferous Plantations 2. Urban -- with trees	General urban	
WILDLIFE HABITATS	1. Open Water 2. Marshes 3. Wooded swamps	1. Forests of all types 2. Farmland 3. Aspen-oak	1. Oak-opening barrens 2. Meadows -- wet and grass	1. Coniferous plantations 2. Urban -- with trees	General urban	
WATER HABITATS	Large lakes	Rivers & streams	Small lakes & ponds	Marshes & wooded swamps	Wet meadow and mudflats	
EXISTING LAND USE	Open areas	Forest	Farmland	1. Parkland 2. Institutional	Urbanized areas	

PRODUCTION - EXTRACTION

TABLE 3D PRODUCTION - EXTRACTION

NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
	I	II	III	IV	V	
GEOLOGY-BEDROCK	Shakopee & Onieta Dolomites along bluffs and river plain	Plattville Limestone along bluffs	Plattville Limestone with shallow burden	Decorah shale		
GEOLOGY-SURFICIAL	Outwash sands and gravels	Valley train sands and gravels	Bedrock	1. Esker & Kame deposits 2. Lake deposits		
PHYSIOGRAPHY-SLOPES	Less than 2½%	2½-5%	5-12½%		Over 12½%	
HYDROLOGY			Flood Plains	River bottoms		
SOILS			Group 6 (peat)	Group 7 (clay)		
VEGETATION	x	x	x	x	x	
WILDLIFE HABITATS	x	x	x	x	x	
EXISTING LAND USE	Open areas					

PROTECTION - UNIQUE RESOURCE

		PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
		I	II	III	IV	V	
NATURAL PROCESS		Shakopee & Onietta; St. Peter and Plattville formations along bluffs					1. Caves, caverns, waterfalls, etc 2. Rare mineral & fossil sites
GEOLOGY-BEDROCK							
GEOLOGY-SURFICIAL		Esker & Kame deposits	Limit of glaciation	1. Sand & gravel terraces 2. Alluvial terraces	1. Sand plain 2. Lake deposit 3. Exposed bedrock		1. Buried valleys 2. Indicators of glacial movement
PHYSIOGRAPHY-SLOPES		Bluffs (over 25%)					Gorges, terraces, etc.
HYDROLOGY		Major rivers					Lakes by type: Deep, water-table related, perched, etc.
SOILS		Dunes (Group 1)	Sand plain (Group 1)	Peat (Group 6)	Rock Outcrops (Group 8)		
VEGETATION		Evergreen swamps					Areas of high diversity
WILDLIFE HABITATS		1. Lakes, ponds, etc. 2. Marshes & wooded swamps 3. Wet meadow	1. Fish lakes 2. Forests 3. Farmland 4. Grass meadow	1. Rivers 2. Marshes	1. Mudflats & sandy shores 2. Aspen-oak		
EXISTING LAND USE		1. Recreational sites 2. Historical sites	Parkland	Institutional	Urban Core		

TABLE 3E PROTECTION - UNIQUE RESOURCE

PROTECTION - SCARCE RESOURCE

TABLE 3F PROTECTION - SCARCE RESOURCE

NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
	I	II	III	IV	V	
GEOLOGY-BEDROCK				1. Galena limestone 2. Conglomerate		
GEOLOGY-SURFICIAL	Esker & Kame deposits	Wind deposited sand		Exposed bedrock		
PHYSIOGRAPHY-SLOPES	x	x	x	x	x	1. High hills 2. Deeply dissected valleys
HYDROLOGY	Swamps	Wetlands				
SOILS	x	x	x	x	x	
VEGETATION	Brush Prairie (may not occur within the Metro area)	Forests of all types	Marshes			
WILDLIFE HABITATS	Brush Prairie (May not occur within the Metro area)	Forests of all types	Marshes			
EXISTING LAND USE	Parkland	Recreation sites				

TABLE 3G PROTECTION -

PROTECTION - VULNERABLE RESOURCE

NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
	I	II	III	IV	V	
GEOLOGY-BEDROCK	Exposed bedrock in River Plain	Exposed bluffs of St. Peter sandstone		Decorah shale		
GEOLOGY-SURFICIAL	Wind deposited sand	Outwash sands and gravels	Valley train sand and gravel	Reddish brown till		
PHYSIOGRAPHY-SLOPES	1. Over 25% slope 2. 12½-25% slopes on drift and sandys & gravels	1. 12½-25% slopes 2. 5-12½% slopes on drift and sands and gravels		5-12½% slopes		
HYDROLOGY	1. Flood plains 2. Major Rivers	1. Streams 2. Lakes, ponds, etc. 3. Marshes 4. Wooded swamps	Intermittent streams	Wetlands		
SOILS	Group 1	Groups 6 & 7 & 8	Groups 3 & 5	Group 4	Group 2	
VEGETATION	Open water	1. Wooded swamps 2. Marshes	Wet meadow			
WILDLIFE HABITATS	Open water	1. Wooded swamps 2. Marshes	Wet meadow			
EXISTING LAND USE	Recreational sites	1. Forest 2. Farmland	Other open areas	Parkland		

TABLE 3H RECREATION - PASSIVE

RECREATION - PASSIVE	PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
	I	II	III	IV	V	
NATURAL PROCESS						
GEOLOGY-BEDROCK	x		x	x	x	Pits, caves, etc.
GEOLOGY-SURFICIAL	Sand & Gravel Terraces	Alluvium (River Plain) & Alluvial Terraces	Limit of glacier	Esker & Kame deposits		
PHYSIOGRAPHY-SLOPES	Bluffs (over 25%)	Over 25% slopes				Hills, valleys terraces, etc.
HYDROLOGY	1. Major Rivers 2. Large lakes	1. Major streams 2. Small lakes, ponds, etc. 3. Swamps	1. Other permanent streams 2. Marshes	1. Intermittent streams 2. Wetlands	3. Flood plains	
SOILS	Group 1 (sand dunes)	Group 1 (sand plain)		Groups 3 & 5 (slopes)		
VEGETATION	1. Big Woods 2. Wooded Swamps 3. River bottom	1. Aspen-Birch 2. Coniferous plantations	1. Oak-openings barrens 2. Aspen-oak 3. Wet meadow 4. Grass meadow	1. Marsh 2. Farmland		
WILDLIFE HABITATS	1. Large lakes 2. Rivers 3. Streams	1. Forests of all types 2. Small lakes & ponds 3. Wooded swamps	1. Marshes 2. Wet meadow 3. Oak-openings barrens 4. Aspen-oak	1. Grass meadow 2. Mudflats & sandy shores 3. Farmland	Urban	
EXISTING LAND USE	Forest	1. Farmland 2. Other open areas	1. Parkland 2. Recreational sites	1. Institutional 2. Urban core	Other urban	

TABLE 31 RECREATION - ACTIVE

RECREATION - ACTIVE NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
	I	II	III	IV	V	
GEOLOGY-BEDROCK	x	x	x	x	x	
GEOLOGY-SURFICIAL	x	x	x	x	x	
PHYSIOGRAPHY-SLOPES	Less than 2½%	2½-5%	5-12½%		Over 12½%	
HYDROLOGY	Large Lakes	Major River	Flood Plain			
SOILS	Groups 1 & 2	Group 4	Group 6	Groups 3 & 5 & 8	Group 7	
VEGETATION						
WILDLIFE HABITATS						
EXISTING LAND USE	Recreational sites	Parkland	Other open areas	Institutional		

URBANIZATION - RESIDENTIAL

TABLE 3J URBANIZATION - RESIDENTIAL

NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY				OTHER DATA REQUIRED
	I	II	III	IV	
GEOLOGY-BEDROCK	Platville Formation			Decorah shale	
GEOLOGY-SURFICIAL	Bedrock	Flat land on sands & gravels	Flat land on drift	Sloping land on sands & gravels & drift	1. Alluvium 2. Lake Deposits 3. Esker & Kame deposits
PHYSIOGRAPHY-SLOPES	Less than 2%	2 1/2 - 5%	5 - 12 1/2%	12 1/2 - 25%	Over 25%
HYDROLOGY (Desirable Locations)	1. Major Rivers 2. Large lakes	1. Major & other permanent streams 2. Small lakes & ponds	Intermittent Streams		Desirable locations viz. hills, valleys, etc.
SOILS	1. Foundation Groups 2 & 8 2. On-site sewage Group 2 3. Excavation & grading Group 1	Group 1 Group 1 Group 2	Group 4 Group 4 Group 4	Groups 3 & 5 Groups 3 & 5 Groups 3 & 5	Group 6 & 7 Group 6 & 7 & 8 Group 8
VEGETATION (Desirable locations)	Big Woods	Coniferous plantations		Urban with trees	
WILDLIFE HABITATS (Desirable Locations)	Fish Lakes	Marginal Fish Lakes	Rivers, Streams, Lakes, ponds, etc.	Forests	
EXISTING LAND USE (Desirable Locations)	Recreational Sites	1. Parkland 2. Forest	Other open areas	Institutional	

TABLE 3K URBANIZATION - INDUSTRIAL

NATURAL PROCESS	PHENOMENA RANKED FOR SUITABILITY					OTHER DATA REQUIRED
	I	II	III	IV	V	
GEOLOGY-BEDROCK	Platville Formation				Decorah Shale	
GEOLOGY-SURFICIAL	Bedrock	Flat land on sands & gravels	Flat land on drift	Sloping land on sands & gravels & drift	1. Alluvium 2. Lake deposits 3. Esker & Kame deposits	
PHYSIOGRAPHY-SLOPES	Less than 2%	2 1/2-5%		5-12 1/2%	Over 12 1/2%	
HYDROLOGY (Water using Industry only)	1. Major Rivers 2. Flood plains	Large Lakes	Major Streams	Other permanent streams		
SOILS 1. Foundation 2. On-site 3. Excavation & Grading	Groups 2 & 8 Group 2 Group 1	Group 1 Group 1 Group 2	Group 4 Group 4 Group 4			
VEGETATION (Forest & Farm related Industry only)	Cultivated Land	Big Woods	Coniferous Plantations			
WILDLIFE HABITATS	x	x	x	x	x	
EXISTING LAND USE	Industrial	Other Open areas				

DETERMINATION OF LAND USE SUITABILITY CLASSES

The third step in the development of ecological criteria for land use is the determination of land use suitabilities. This step is accomplished by combining different ecological parameters into groups called suitability classes. Parameters are grouped according to their similarity with respect to permitting or restraining a given land use. Collectively, for a given land use, the groups represent a spectrum of features which at one extreme are highly conducive and at the other extreme are highly restrictive. The determination of suitability classes is explained in the following pages for each of the four land use groups.

PRODUCTION

Agriculture

Six suitability classes were developed for agriculture.

<u>Suitability Class</u>	<u>Description</u>
I	General farming with no restriction.
II	General farming with some restrictions. Certain conservation measures are necessary, such as contour ploughing and strip cropping.
III	Agriculture is limited. Moderate conservation measures are necessary, such as permanent cover and rotation cropping.
IV	Poor for agriculture. Only marginal farming is practicable with extensive conservation measures.
V	Generally unsuitable for agriculture.
Special	Specialized agriculture, including but not limited to commercial fishing, cultivation of wild rice, sod-farming, and production of maple syrup.

Although the six classes given above resemble the standard capability categories of the Soil Conservation Service, they do not exactly conform to those categories because the available soil data were too generalized. Soil and slope information was utilized in determining the agricultural suitability classes. Soils are important with respect to their fertility, drainage conditions, and erodibility. Slopes determine cultivation practices and the extent to which conservation measures are needed. Existing land use is also a qualifying element in that land already cleared for agriculture is preferable in most instances to land which has not been cleared.

The criteria actually used for each agricultural suitability class are given in Table 4.

Table 4. Criteria For Agricultural Suitability Classes

Suitability Class	C r i t e r i a		
	Soil Group	Slope	Existing Land Use
I	2+3	0-2½%	Farmland
	4+5	"	Meadow
II	2+3	2½-5%	Farmland
	4+5	"	Meadow
III	2+3	0-5%	Forest
	4+5	5-12½%	Farmland
	6	0-12½%	Meadow
	8	"	Forest
IV	2+3	12½-25%	Farmland
	4+5	"	Meadow
	6	"	Forest
	8	"	
	1	0-5%	
V	2+3	Over 25%	Farmland
	4+5	"	Meadow
	6	"	Forest
	8	"	Urban
	1	Over 5%	
Special	7		Rivers, Marshes, Big Woods

Forestry

The timber products considered of value in the region are high grade veneer and some lumber for local needs. Commercial tree species native to the Area are:

- For veneer -- Black walnut and butternut.
- For pulp -- Aspen and birch
- For lumber -- White and red oak, and basswood.

The above species are present in the "Big Woods", and to a lesser extent in the "River Bottom" forest type. The forestry suitability classes are:

<u>Suitability Class</u>	<u>Description</u>
Fh	High Potential for forestry.
Fi	Intermediate potential for forestry.
Fl	Low potential for forestry.

The criteria for the forestry suitability classes are given in Table 5.

Table 5. Criteria For Forestry Suitability Classes

<u>Suitability Class</u>	<u>C r i t e r i a</u>	
	<u>Forest Type Range</u>	<u>Soil Group</u>
Fh	Big Woods Aspen-Birch	4 + 5 "
Fi	Big Woods Aspen-Birch	2 + 3
	River Bottom	
<u>a/</u> Fl	Big Woods Aspen-Birch	6, 7

a/ Fl does not occur within the Area because the related forest types do not extend over soil groups 6 + 7.

Wildlife

Wildlife suitability classes were derived from data contained in a Minnesota Conservation Department report entitled Metropolitan Lake Inventory. The data are described in detail in the data section of this report. As shown in the following table, three groups of habitats - water, forested lands, and unforested lands, were evaluated for their suitability for six groups of wildlife. The aggregate potential value or suitability class for each habitat was then identified as high, intermediate, low or negligible, as is shown in Table 6.

Extraction.

The extractable materials in the Area are sands, gravels, shale, dolomite, limestone, peat, and clay. From the available information, two suitability classes were identified.

Eg Extraction can occur generally anywhere over a given extractable material.

Esp Extraction can occur only on specific sites over a given extractable material.

The criteria for the suitability classes are given in Table 7.

<u>Habitat</u>	<u>Wildlife Groups</u>				<u>Suitability Class</u>	
	Fish	Water- fowl	Fowl	Small game	High Diversity or Unique Species	Special Value
<u>Water</u>						
<u>Fish Lakes</u>	High	High		High	Diverse	Game Fish
Marginal Fish Lakes	Inter.	High		High	Diverse	High
Small Lakes & Ponds	Inter.	High		High	Diverse	High
Major Rivers	Inter.	High		High	Migratory	High
Streams	Inter.	Inter.		High	Unique Spp.	High
Deep Marshes	Inter.	High		Inter.	Diverse	Intermediate
Shallow Marshes	Low	Inter.		Inter.	Migratory Spp.	Intermediate
Wooded Swamps	Low	Low		High	Diverse	Low
Wet Meadow	Low	Inter.		Inter.	Highly Diverse	Intermediate
Mudflats & Sandy Shores	Inter.	Inter.		Low	Unique Spp.	Low
<u>Land (Forest)</u>						
River Bottom						
Upland Hardwood						
Dry Oak, Savannah						
<u>Land (Unforested)</u>						
<u>Grass Meadow</u>						
Brush Prairie						
Farmland						
Urban with Trees						
Urban						

Table 6. Criteria For Wildlife Suitability Classes

Table 7. Criteria For Extraction Suitability Classes

<u>Suitability Class</u>	<u>C r i t e r i a</u>	
	<u>Material</u>	<u>Location</u>
Eg	Wind-blown Sand	Wherever they occur in the Area
"	Outwash Sands & Gravels	
"	Valley Trains Sands & Gravels	
"	Eskers & Kames	
"	Soil Group 6 (peat)	
"	Soil Group 7	
"	Decorah Shale	
Esp	Shakopee and Oneota dolomites	Minnesota River Plain Bedrock areas Bluffs
"	Platville Limestones	Bluffs Bedrock areas

PROTECTION

Ecological elements which represent a hazard to life and health and those which are unique, scarce, or vulnerable, are considered to be worthy of identification. Those elements are described below in their order of priority for protection.

Water and Wetlands

1. Wooded Swamps. These are extremely scarce and vulnerable. Wooded swamps are unique with respect to wildlife, scenic experiences, and the natural history that they offer. They are vulnerable to irreparable damage from deterioration of their water supply and water quality.
2. Marshes. Marshes are highly unique and vulnerable. They are becoming increasingly scarce, the result of which will be a loss of valuable wildlife habitat and flood-water storage.
3. Wet Meadows. These are unique and are becoming increasingly scarce. Wet meadows are important to wildlife. They are also a vulnerable part of the Area's water regimen.
4. Flood Plains. Flood plains are vulnerable to any development that interferes with the natural function of flood plains during periods of peak flow. People and property located on flood plains are endangered during flood periods.
5. Major Rivers, Lakes, and Ponds. These are unique resources vulnerable to pollution. Such resources are valuable for their wildlife, recreational, and scenic potential.

6. Streams. In addition to being unique resources for wildlife, recreation, and scenic experiences, streams are an important element of the hydrologic process. Streams must be protected from those land uses that can cause their degradation.
7. Intermittent Streams. These streams carry surface runoff during periods of peak flow. Their presence may indirectly lessen erosion and the destructive effects of downstream flooding.

Aquifer Recharge Zones

1. Wind Deposited Sand. Because of its high permeability, wind deposited sand is highly valuable to aquifer recharge. It is highly vulnerable to erosion and needs to be protected from pollution and urban developments which would reduce its effective surface area.
2. Sand Plains. Sand plains are highly permeable, and therefore, are of high recharge value. They need protection from pollution and erosion.
3. Outwash Sands and Gravels, and Exposed Bedrock. Generally these have high permeability and high recharge value. They need protection from pollution.
4. Valley Train Sands and Gravels. Generally, these have good permeability and moderately high recharge value. They need protection from pollution.
5. Reddish Brown Till. This till has moderately good permeability and moderate recharge value. It needs protection from pollution.

Forests and Slopes

1. Forests. In the metropolitan area, forests are valuable particularly for recreation, wildlife, and scenic experiences. Their presence also minimizes soil erosion. Forests are becoming scarce as a result of depletion by encroaching urban development.
2. All Slopes Exceeding 25 Percent, and 12½ to 25 Percent Slopes on Drift, Sands, and Gravels. Such slopes are all highly vulnerable to erosion. The 12½ to 25 percent slopes are hazardous to life and property because foundation slippage may occur as a result of the unconsolidated nature of sands and gravels, and clay layers in the glacial drift.
3. All 12½ to 25 Percent Slopes, and 5 to 12½ Percent Slopes on Drift, Sands, and Gravel. All of these slopes are moderately vulnerable to erosion. Foundation slippage may occur on the drift, sands and gravels.
4. Slopes 5 to 12½ Percent. The slopes are somewhat vulnerable to erosion, and moderate protection is necessary.

Unique Natural Features

1. Bluffs and Escarpments. These are scenic and provide diverse habitats for wildlife. They are highly vulnerable to erosion.
2. Eskers and Kames. These are scarce and have high value for educational and scientific study. They are vulnerable to obliteration.
3. Ferrace-Edges, Valleys, and Gorges. These provide unique scenic experiences. Valleys and gorges provide unique habitats for scarce plants and wildlife. They are vulnerable to obliteration.
4. Ridges, Hills, and Promontories. These are scarce and are of high value for scenic experiences. They are vulnerable to obliteration.
5. Limits of Glaciation. Limits of glaciation and the interfaces of different kinds of glacial drift have high value for education, and provide unique scenic experiences. They are vulnerable to obliteration.
6. Peat and Clay Deposits. Peat deposits (Group 6 soils), are valuable for extraction and special uses such as sod farming. Clay deposits (Group 7 soils) are scarce and valuable for extraction. Both deposits are subject to frost heaving and slippage, and therefore, are not desirable sites for construction.
7. Bedrock In River Plain. Such bedrock has high value for extraction. Because of its location, it is subject to flooding from contaminated waters that may pollute aquifers associated with the bedrock.
8. Galena Limestone, Decorah Shale, and Conglomerates. These are scarce geologic features which are valuable for both extraction and scientific study. They could be depleted by extraction.

Unique Cultural Features

1. Parks and Wildlife Refuges. These are relatively few in number, and are important recreation, wildlife, and scenic resources. They are vulnerable to encroachment by incompatible land uses.
2. Private Open Space. Private open space such as country clubs, golf courses, and skiing areas are important resources whose value may be degraded by nearby incompatible land uses.

RECREATION

Recreation was considered in terms of the recreationist and the resources he requires. Two basic kinds of recreation activities were identified: passive and active. Passive recreation is that form involving relatively few recreationists at any one time,

and which requires relatively few permanent facilities. Examples are: hiking, bicycling, horseback riding, and wilderness camping. Active recreation involves larger numbers of people and usually requires certain kinds of permanent facilities. Examples are: organized sports, intensively-used campgrounds and swimming beaches, golf courses, and race tracks. Active recreation can be divided further into those types requiring a natural environment and those that do not.

Recreation resources may also be categorized. For example, a distinction could be made between those resources that are needed for either passive or active recreation. However, in certain instances, both recreation forms could use the same resource. A more useful distinction can be made between resources that are either land-related or water-related. Elements included under each of those categories are listed below in the order of their importance.

Water-Related Resources

Major rivers and large lakes
Major streams
Small lakes and ponds
Marshes
Wet meadows
Mudflats and sandy shores

Land-Related Resources

Forests: (by type)
Big woods
River bottom
Wooded swamps
Aspen-birch
Coniferous plantations
Oak openings
Aspen-Oak
Grass Meadows
Farmland

In addition to the resource classification given above, there are certain unique resources which warrant separate recognition. They have been identified as:

Ecological Features

Caves
Waterfalls
Bluffs
Eskers
Kames
Sand Dunes
Limits of Glaciation
Terrace Edges
Valleys
Hills
Flood Plains
Steep Slopes

Existing Open Space

Public Recreation Areas
Wildlife Refuges
Private Recreation Areas
Institutional Lands

Cultural Areas

Historic Landmarks
Memorial Highways
Urban Cultural Centers

Classification of recreation activities and resources was followed by an evaluation of the development suitabilities of the recreation resources in the Metropolitan Area. Development suitability is particularly important for those recreation activities requiring permanent facilities. Recreation suitability was expressed in terms of the five classes listed below.

<u>Suitability Class</u>	<u>Description</u>
I	Most suitable with no restrictions.
II	Suitable with no restrictions.
III	Suitable with some restrictions.
IV	Moderately suitable, with many localized restrictions.
V	Low suitability, with extensive restrictions

Soil and slope criteria were used to distinguish each of the suitability classes. The soil analysis considered soil drainage, texture, and workability. Slopes were classified according to their effect on construction costs. The soil and slope criteria used for each recreation suitability class are shown in Table 8.

Table 8. Criteria For Recreation Suitability Classes

<u>Suitability Class</u>	<u>C r i t e r i a</u>	
	<u>Slope</u>	<u>Soil</u>
I	0-2½%	1
	"	2+3
II	0-2½%	4+5
III	0-2½%	6
	"	8
IV	2½-5%	1
	"	2+3
	"	4+5
	"	6
V	2½-5%	8
	5-12½%	1
	"	2+3
	"	4+5
	"	6

URBANIZATION

Five suitability classes were developed for urbanization, and are described below for residential development.

<u>Suitability Class</u>	<u>Description</u>
I	Multiple family Multi-storied Sewered Upper limit depends upon desirable density (possible limit 120 du/acre)
II	Multiple family 2-3 storied Sewered Upper limit set by housing type and requirements of site coverage, parking, etc. (possible limit 20 du/acre)
III	Single family Detached, Clustered or Terraced Sewered No lower limit of density Upper limit set by house type, space requirement etc. (possible limit 8 du/acre)
IV	Single family Detached On-site sewage disposal Upper limit set by percolation rate of individual soils for satisfactory working of septic fields (possible lower limit 1 du/3 acres may even be less in certain areas)
V	Essentially non-urban

The urban suitability classes were also related to non-residential urban uses, as shown below.

<u>Non-Residential Urban Uses</u>	<u>Suitability Class</u>				
	I	II	III	IV	V
Heavy Industry					
Light Industry					
Major Commercial					
Minor Commercial					
Institutional					

Criteria for urban suitability were developed from data on slopes, soils, and geology. Slopes expected to impose limitations or additional costs on highway and building construction were identified. A similar analysis was made of the stability, drainage, and workability of each soil group. The foundation suitability of surface and bedrock geology was determined from analyses of the compressive strengths and expected foundation slippage associated with various formations and surficial deposits. Suitability classes were then established as shown in Table 9.

Table 9. Criteria for Urban Suitability Classes

<u>Suitability Class</u>	<u>Slope</u>	<u>C r i t e r i a</u>	
		<u>Soil Group</u>	<u>Surficial Geology</u>
I	0-2½%	2	Sands & Gravels
	"	8	Bedrock
I (Secondary Choice)	2½-5%	2	Bedrock
	"	8	"
II	2½- 5%	2	Sands & Gravels
	"	1	" "
	0-5%	2	Drift
	"	1	"
III	5-12½%	2	Sands & Gravels
	"	1	Drift
	0-12½%	4	"
IV	12½%-25%	2	Sands & Gravels
	"	1	Drift
	"	4	"
	0-25%	2	Alluvium
	"	1	Lake Deposits
	"	4	Decorah Shale
V	Over 25%	All	All

Other ecological determinants of residential location which could not be included in the suitability classes are areas having high aesthetic values. They have been identified as:

- Shorelines of large lakes
- Tops of bluffs
- Edges of smaller lakes, ponds, and streams
- Scenic hills and valleys
- Forests, especially the "big woods" and coniferous plantations
- Areas adjacent to parks and other public open space.

COMPOSITE INTRINSIC SUITABILITY

The final step of the ecological study is the recognition of areas having either single or composite intrinsic suitability for one or more land uses. As described in the preceding pages, the metropolitan area was classified into land-use suitability classes. That analysis suggests that certain lands may be pre-eminently suitable for one use while others may be equally suitable for perhaps several land uses. Similarly, certain land uses are compatible with each other while others are not.

Matrix I (see Table 10) identifies the degree of compatibility between various land use suitabilities. From Matrix I it is possible to identify for any given suitability class, all other land uses with which it is compatible - this is shown in Table 11.

AGRICULTURAL
SUITABILITY
CLASS

O T H E R C O M P A T I B L E L A N D U S E S

	<u>Production</u>	<u>Recreation</u>	<u>Urbanization</u>
Ag I	Inter. Wildlife	Scenic	
Ag II	Inter. Wildlife	Scenic; Limited Active	
Ag III	Inter. Wildlife; Low Forestry; Limited Extraction	Scenic; Diverse; Limited Active; Riding, Camping etc.	Low Density
Ag IV	Inter. Wildlife; Low Forestry; Limited Extraction	Scenic; Diverse; Active Rec. Riding, Trails etc.	Medium Density
Ag V	Wildlife, Forestry, Extraction	All forms	All forms
SPECIAL	SEE UNDER PROTECTION		

TABLE 11A AGRICULTURE AND OTHER COMPATIBLE LAND USES

FOREST
SUITABILITY
CLASS

O T H E R C O M P A T I B L E L A N D U S E S

	<u>Production</u>	<u>Recreation</u>	<u>Urbanization</u>
High	Inter. Wildlife	Scenic, Wildlife observation; Specific activities	
Intermediate	Inter. Wildlife Limited Extraction	Scenic, Wildlife observation, Specific activities	

TABLE 11B FORESTRY AND OTHER COMPATIBLE LAND USES

WILDLIFE SUITABILITY
CLASS

O T H E R C O M P A T I B L E L A N D U S E S

	<u>Production</u>	<u>Recreation</u>	<u>Urbanization</u>
High	Low Forestry, Limited Extraction	Scenic, Diverse, Wildlife observation and specific activities	
Inter.	Agriculture, Forestry, Limited Extraction	Scenic, Diverse, Wildlife observation, Special activities and limited active	
Low	Agriculture, Forestry, Limited Extraction	Scenic, Diverse, Wildlife observation, special activities and limited active	Medium Density

TABLE 11C WILDLIFE AND OTHER COMPATIBLE LAND USES

EXTRACTION
SUITABILITY
CLASS

O T H E R C O M P A T I B L E L A N D U S E S

Production Recreation Urbanization

General

No other land use

Specific

Limited Agriculture Educational and
Inter. Forest, High Wildlife observation
Wildlife, possible
passive

TABLE 11D EXTRACTION AND OTHER COMPATIBLE LAND USES

ELEMENT

PROTECTION CLASS

O T H E R C O M P A T I B L E L A N D U S E S

Production Recreation Urbanization

Valley Train Sands
and Gravels

Forest;
Extraction;
Agriculture-without
use of chemical
fertilizers; Wildlife

All forms

Only high
density to ensure
leak-proof sewerage

Reddish Brown Till

Forest;
Agriculture;
Extraction;
Wildlife

All forms

With sewers only

Soils

Group 6

Special agriculture;
Extraction (peat);
Forest and Wildlife

Limited use

Group 7

Extraction (clay);
Forest and Wildlife;
Marginal Agriculture

Limited use

Land
Management

Forests

Specialised agriculture
(Maple syrup) in
"Big Woods" association;
Forest-low potential;
Wildlife-low potential

Scenic;
Wildlife diversity

Desirable locations
for residences
(Specially "Big
Woods" and coniferous
plantations)

ELEMENTPROTECTION CLASSOTHER COMPATIBLE LAND USESProduction Recreation UrbanizationSlopes over
25 PercentForest;
Specialised
Agriculture; WildlifeScenic; Specialised
activities viz
Skiing, Sledding, etcSlopes over 12-1/2
Percent on Drifts,
Sands, and GravelsForest; Limited
agriculture; WildlifeSpecialised
activities only12½-25 Percent
SlopesForest; Limited
agriculture; Wildlife

Limited use

Low density

5 to 12-1/2 Percent
Slopes on Drifts,
Sands & GravelsForest;
Limited agriculture;
Wildlife

Limited use

Low density

5-12½ Percent Slopes

Forest;
Agriculture, Limited
extraction, Wildlife

All forms

Intermediate
densityUnique
Natural
FeaturesBluffs and
Escarpments

Limited extraction

Scenic; Diverse
Wildlife-diversity
Rock ClimbingTop of bluffs
desirable location
for residences

TABLE 11E (Cont'd)

ELEMENT

PROTECTION CLASS

O T H E R C O M P A T I B L E L A N D U S E S

	<u>Production</u>	<u>Recreation</u>	<u>Urbanization</u>
Waterfalls & Caves		Scenic; Diverse; Possible unique Wildlife	
Eskers & Kames	Limited extraction; Forest; Limited Agriculture; Wildlife	Scenic; Diverse; Educational	May be desirable locations for residences
Limit of Glaciation	Agriculture; Forest; Limited extraction; Wildlife	Scenic; Diverse; Educational; Hiking and Trails	
Ridges Promontories, and Hills	Agriculture; Forest; Limited extraction; Wildlife	Scenic; Diverse; Intensive-active	Desirable locations for residences
Edges of River Terraces	Limited extraction; Forest; Agriculture; Wildlife	Scenic; Trails- drives; Intensive- active	Desirable locations for residences
Alluvial Terraces	Agriculture; Forest; Wildlife; Limited extraction	Scenic; Diverse; Intensive-active	Maybe desirable location for residences

TABLE 11E (Cont'd)

ELEMENTPROTECTION CLASSO T H E R C O M P A T I B L E L A N D U S E S

<u>ELEMENT</u>	<u>PROTECTION CLASS</u>	<u>Production</u>	<u>Recreation</u>	<u>Urbanization</u>
	Bedrock Within River Plain	Extraction; Forest; Agriculture; Wildlife	All Forms	Only high density to ensure leak-proof sewerage
	Conglomerate and Galena Limestone	Agriculture; Extraction; Forest; Wildlife	Educational; Intensive-active	Special form
	Decorah Shale	Extraction; Forest; Agriculture; Wildlife	All forms	Low Density
	Parks and Wildlife Refuges	Wildlife; Forest-low potential; Limited Agriculture	Scenic; Diverse; Wildlife; Possible-intensive active	Edges-desirable locations for residences
Unique Cultural Feature	Country Clubs, Golf Courses, Skiing Sites, etc.	Wildlife	Scenic; Specialised activities	Edges-desirable locations for residences
	Water Related Recreation Sites	Wildlife	Scenic; Specialised activities	Desirable locations for residences

TABLE 11E (Cont'd)

<u>ELEMENT</u>	<u>PROTECTION CLASS</u>	<u>OTHER COMPATIBLE LAND USES</u>		
		<u>Production</u>	<u>Recreation</u>	<u>Urbanization</u>
Historic Site			Educational; Maybe Scenic	
Memorial Highways			Scenic; Educational	May be desirable location for residences
Urban Cores			Specialised activities	Maybe desirable locations for residences
High Decibel Area Around Airports		Agriculture Extraction; Forest; Wildlife	All forms	

TABLE 11E (Cont'd)

RECREATION SUITABILITY
CLASSES - ACTIVE

O T H E R C O M P A T I B L E L A N D U S E S

	<u>Production</u>	<u>Recreation</u>	<u>Urbanization</u>
I			
II			
III	Limited Agriculture		
IV	Limited Agriculture Low Wildlife	Scenic, Diverse, Special Activities	Low Density
V	Agriculture Low Forestry Inter. Wildlife	Scenic, Diverse Special Activities	Medium Density

TABLE 11F RECREATION - , AND OTHER COMPATIBLE LAND USES

RECREATION SUITABILITY
CLASSES - PASSIVE

O T H E R C O M P A T I B L E L A N D U S E S

	<u>Production</u>	<u>Recreation</u>	<u>Urbanization</u>
Recreation - Diversity	Agriculture III High Wildlife		Urban IV
Recreation - Scenic	Agriculture I High Forestry High Wildlife	Active Recreation IV	Urban IV
Recreation - Wildlife	Agriculture I High Forestry High Wildlife		Urban IV
Recreation - Education	High Wildlife	Active Recreation IV	Urban IV

TABLE 11G RECREATION - PASSIVE, AND OTHER COMPATIBLE LAND USES

URBAN SUITABILITY
CLASSES

O T H E R C O M P A T I B L E L A N D U S E S

Production Recreation Urbanization

I		
II		
III	Marginal Agriculture Low Wildlife	Limited Active
IV	Limited Agriculture Low Forestry Inter. Wildlife	Scenic, Wildlife observation Limited Active
V	Agriculture, Forestry Wildlife, Extraction	All forms

PREFERRED
SCENIC
LOCATIONS

SEE PROTECTION

TABLE 11H URBANIZATION AND OTHER COMPATIBLE LAND USES

For those land uses which are incompatible with each other, a working hypothesis was adopted, establishing a hierarchy of land-use preferences. That hierarchy discerns certain land-use categories which are preferred over others. The preferred categories preempt all others except those of equal importance. Matrix II (Table 12) shows the hierarchy. The order of preference is: protection, urbanization, agriculture, active recreation, forestry, and extraction. It was decided that passive recreation and wildlife production could coexist with protection, and, were included in that category. Suitability classes within each of the major land use classifications also assume hierarchical importance in the order that they are listed.

Each row of the matrix contains co-equal incompatible land use classes. Each row of competing land uses has preference over the rows below it. For example the top row of the matrix indicates that all classes of protection have priority over all over land uses. Similarly, the second row indicates that Urban I, Agriculture I, and Recreation I are co-equal competitive land uses, and so on. Within a row, there may be one or more competing classes that are asterisked. It was found that in the metropolitan area, those land uses are mutually exclusive, i.e., they will not occur simultaneously because their locational criteria are different. Nevertheless, the asterisked classes are potentially competitive, and in another part of the country with different ecological conditions that fact may have been manifested.

As may be observed in Matrix II, there are numerous conflicts between urbanization and the other land uses. All of those conflicts are given below.

U I : U I/Ag I; U I/Rec I; UI/Ag I/Rec I

U II : U II/Ag I; U II/Rec I

U III : U III/Ag I; U III/Ag II; U III/Ag III
 U III/Rec II; U III/Rec IV; U III/Fh; U III/Esp
 U III/Ag II/Fh; U III/Ag III/Fh; U III/Ag III/Esp
 U III/Rec III/Fh; U III/Rec II/Esp
 U III/Rec IV/Fh; U III/Rec IV/Esp; U III/Fh/Esp

U IV : U IV/Ag IV; U IV/Fh; U IV/Fi; U IV/ESp; U IV/Eg
 U IV/Ag IV/Fh; U IV/Ag IV/Fi; U IV/Ag IV/Esp; U IV/Ag
 IV/Eg
 U IV/Fh/Esp; U IV/Fi/Esp; U IV/Fi/Eg

U V : Ag IV; Rec III; Rec IV; Rec V; Fh; Fi; Esp; Eg
 Ag IV/Rec IV; Ag IV/Fh; Ag IV/Fi; Ag IV/Esp; Ag IV/Eg
 Rec IV/Fh; Rec IV/Fi; Rec IV/Esp; Rec IV/Eg
 Rec V/Fh; Rec V/Fi; Rec V/Esp; Rec V/Eg
 Fh/Esp; Fi/Esp; Fi/Eg

The large number of conflicts associated with urban classes III, IV, and V, were reduced by establishing three groups of co-dominant land uses. Within those groups the urban classes were made co-equal with higher suitability classes of recreation and/or agriculture. The composite suitability classes used for the metropolitan area are shown in the Table 12.

Where they occur over prime aquifer recharge zones the Urban I and II classes are subject to ground water pollution restrictions, namely, that all developments must be properly sewered. The lower urban suitability classes are restricted altogether from aquifer recharge zones. Similarly, when they occur over prime aquifer recharge zones, agricultural classes I and II should be restricted from using certain fertilizers.

TABLE 12

MATRIX II	PROTECTION					URBANIZATION					AGRICULTURE					ACTIVE RECREATION					FORESTRY		EXTRACTION				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	High	Low	Gen.	Sp.			
PROTECTION																											
URBANIZATION						●					●	●	●	●	●												
I																											
II						●					●	●	●	●	●												
III						●					●	●	●	●	●												
IV						●					●	●	●	●	●												
V						●					●	●	●	●	●												
AGRICULTURE																											
I																											
II																											
III																											
IV																											
V																											
ACTIVE RECREATION																											
I																											
II																											
III																											
IV																											
V																											
FORESTRY																											
High																											
Low																											
EXTRACTION																											
(General)																											
(Specialized)																											

● = Competitive
 ● = Competitive but mutually exclusive because of criteria used for the specific category land use

TABLE 13. COMPOSITE SUITABILITY

DOMINANT LAND USE

SUBSIDIARY LAND USES

Protection

All categories

Urbanization

U I
U II
U III
U IV
U V

Rec IV
Ag IV, Fi, Esp

Agriculture

Ag I
Ag I
Ag II

U III
U III, Rec II

Recreation

Rec I
Rec II
Rec III
Rec IV and V

Fh, Esp
Ag IV, Fi

Forestry

Fh
Fi
Fi

U IV, Ag IV, Rec IV, Rec V, Esp
U III, Ag III, Esp
U III, Ag II, Rec II, Esp

Extraction

Esp, Eg
Eg
Eg

Ag IV, Rec IV, Fi
Fi
U IV, Ag IV, Fi

CO-DOMINANT LAND USES

Urbanization - Agriculture

U I, Ag I
U II, Ag II
U III, Ag III

Urbanization - Recreation

U I, Rec I
U II, Rec I

Urbanization - Agriculture - Recreation

U I, Ag I, Rec I
U II, Ag I, Rec I

AN OPEN SPACE SYSTEM AND ITS IMPLEMENTATION

The pattern of metropolitan urbanization dramatizes the need for an objective and systematic method of land-use and open-space planning. The criteria should evolve from an understanding of natural processes, their value, their permissiveness, and their prohibition to land uses.

Planning for natural process must start with the identification of discrete sub-processes, then determine the value of these sub-processes to man, and finally establish principles of development based upon preserving and enhancing the tolerance and intolerance of natural process to various aspects of urbanization. When the operation of these major processes -- both physical and biological -- is understood, a structure for metropolitan growth and a matrix of open spaces of inestimable value for amenity and recreation can be established. The planner would select open space lands which perform important work in their natural condition, are relatively unsuitable for development, are self-maintaining which often requires only regulation rather than public purchase, and which occur in a desirable pattern of interfusion with the urban fabric. The optimum result would be a system of two intertwining nets, one composed of present and future developed land and the second consisting of open space in a natural or near-natural state.

Heretofore, open space has played a passive role in the transformation of land. Urbanization has been the active force. Little if any value has been attributed to open space and the processes it helps maintain. This situation has deterred the preservation or creation of a metropolitan open space system complementary to urban development. Land use regulations are necessary to protect the public from the damaging consequences of private acts which incur both costs and losses to the public when those acts violate and interrupt natural processes. Policies based on an understanding of the natural processes will allow those processes to perpetrate at little if any cost to man. They provide a defensible basis for an open space system which goes far toward making our metropolitan region livable and beautiful.

The subsequent proposals and the map entitled "Protection" provide the basis for a Metropolitan open Space System. The ecological inventory and analysis have determined the following phenomena and processes to be requiring of protection and regulation.

- Wooded Swamps
- Marshes
- Wet Meadows
- Flood Plains
- Lakes
- Major Rivers & Streams
- Intermittent Streams
- Aquifer Recharge areas 1,2,3, & 4
- Forest
- Slopes over 25% on Sands & Gravels
- Slopes 12½-25% & 5-12½ on Drift and Sands
- Slopes 5-12%

Unique Features, Bluffs &
Escarpments
Eskers & Kames
Terrace Edges, Valleys & Gorges
Ridges, Hills & Promontories
Limits of Glaciation
Peat & Clay Deposits
Group 6&7 Soils
Bedrock on River Plain
Galena Limestone
Parks & Wildlife Refuges
Country Clubs, and other private open space

It is of primary importance to recognize that these discrete phenomena and processes are interacting and thus must be subject to a unified concept of preservation, conservation, and regulation.

If providing protection for natural processes and phenomena is an accepted objective, it must then be integrated with the metropolitan planning process by constituent levels of government and by the private sector. The major devices for inducing development in propitious locations and restraining it in others, lie in major capital expenditures for highways, sewers, electricity -- by both the public and the private sectors. Once public policy has been determined, there is a panaply of devices which can be employed to implement that policy. Those devices as they are related to natural phenomena, are summarized below:

ACQUISITION OF PROPERTY RIGHTS

Fee Acquisition

The most effective means of preserving open space is the outright acquisition of land. William Whyte,¹ has pointed out that if a local government has the power of eminent domain, it is in a better position to persuade landowners and developers to cooperate on measures that will make condemnation unnecessary. In his words, "The stronger the stick, the less need to use it". Many acquisition programs have necessarily been aimed at saving those open spaces most threatened by urbanization. The soaring prices of such lands are frequently creating serious predicaments in which agencies find that they must pay much more for land than was contemplated in their appropriations.² That situation has suggested alternative acquisition schemes such as installment purchase, purchase and lease-back, and purchase and sell-back.

1. William H. Whyte, The Last Landscape (Garden City: Doubleday, 1968).
2. Whyte, Ibid, p. 59, discusses the revolving fund as a solution for making tactical purchases of land to avoid inflated prices. The technique has apparently been successfully used by the California Highway Commission.

Installment purchase is simply the acquisition of land over time. According to Whyte, advantages of this approach to a government agency is that it can nail down the land for only a fraction of the money it ordinarily would have to put up, and it freezes the cost of subsequent payments. Similarly, the private landowner benefits by being able to remain on the land during the installment purchase period, he may get his capital gains spread over ten years instead of one, and he can reduce his property taxes after selling each parcel of land.

Purchase and lease-back is another variant in which land is acquired in fee and then leased back with appropriate controls to the previous owner or others. It is particularly useful for those open space programs aimed at acquiring lands at reasonable prices which are located on the rural fringe of urban growth. The lease-back provision provides public revenue and also permits a landowner, e.g., a farmer, to continue using his land until the time that it is actually needed for public development. According to Whyte, the Ottawa Green Belt program has made good use of this device. The National Park Service has made extensive use of an arrangement in which the previous owner is given life-tenancy.

Purchase and sell-back may offer the most advantages for the planner because, short of permanent public acquisition, it offers the greatest control over future land use. Such an arrangement has been widely used (and upheld by the U.S. Supreme Court) in urban renewal projects, but it has received limited attention as a device to control urban sprawl. The firm of Wallace, McHarg, Roberts and Todd advocated a variant of this approach for the Green Spring and Worthington Valleys, located north of Baltimore, Maryland. There, it was suggested that a private real estate syndicate be established, the purpose of which was to control the timing and location of development in the valleys, and to secure an equitable distribution of the profits of development. It was proposed that the landowners of the valleys act in concert through an organization which was to invest in, manage, and sell real estate. Principals of the organization (consisting of several or more partners) would enter into agreements with property owners desiring to participate in the syndicate. A principal would enter into a participating agreement with such persons and act as agent for them. The syndicate would acquire an interest in those properties set aside for protection in the ecological plan that was prepared for the valleys. Those lands would thereafter remain undeveloped. The syndicate would acquire interest in such lands from its holdings elsewhere in the valleys which it owned and/or developed.

By excess condemnation, interest may be acquired in certain lands adjacent and indirectly-related to public works projects at the same time that real estate directly-related to those projects is being acquired. This device is useful in acquiring lands adjacent to outdoor recreation areas, highways, and reservoirs which are subject to undesirable developments.

The technique of pre-emptive buying is discussed by Whyte,¹

1. Ibid, p 69f

in which he cites the case of a semi-derelict area consisting of marshland and an abandoned gravel pit, which, together, would make an ideal park. If the public agency did not have sufficient funds to buy all the land immediately, it could buy a few strategically-placed parcels and "raise legal mischief" to enjoin surrounding development until it was able to proceed with additional acquisition. Whyte indicates that the fish and game department of one New England state has become especially adept with this device in forestalling development on some of its prime wetlands.

A number of private groups have been very successful in acquiring open space. The Nature Conservancy, though its own revolving fund, purchases land which a public agency wants but does not have the immediate funds to acquire. When funds become available, the Conservancy then sells the lands to the agency. Through such practices, prime lands can be removed from speculators. Other groups such as the Philadelphia Conservationists have been very successful in acquiring vulnerable marshes along the New Jersey coast. The Open Space Action Institute, a non-profit organization formed in 1963, has undertaken a program called "Stewardship". The Institute assists landowners in the tri-state New York Metropolitan region who, for various reasons, are interested in donating or selling their properties to agencies or institutions who will maintain them in perpetuity as open space. The Institute has successfully offered its services as the landowner's agent.

Less-Than-Fee Acquisition

Less-than fee acquisition provides opportunities for open space preservation which are of mutual benefit to the public and the landowner.¹ This approach, usually referred to as "easements" or "development rights", may have two kinds of objectives. One objective is to acquire the right to develop all or part of a given property for public purposes such as footpaths, hiking and bicycle trails, sewer lines, or roads. A second objective is to acquire an easement in which the landowner relinquishes all or certain rights to develop his land, which is perhaps more pertinent to open space preservation.

1. The following publications give many examples of less-than-fee acquisition.

Charles E. Little, Challenge of the Land (New York: Open Space Action Institute, 1968).

William H. Whyte, Securing Open space for Urban America: Conservation Easements (Wash. D.C.: Urban Land Institute, 1959)

Open Space Action. Outdoor Recreation Resources Review Commission Study Rpt. No. 15 (Wash., D.C.: U.S. Govt. Printing Office, 1962).

Various states such as California, Connecticut, Maryland, Massachusetts, and New York have enacted statutes enabling the power of less-than-fee acquisition to local governments for preservation of open space and other related public purposes. Those states and others have also used less than fee acquisition directly through their agencies. Wisconsin in particular has used an assortment of conservation easements for public access (e.g., for fishing and hiking trails) and for preservation of scenery, wetlands and other riparian lands.

THE POLICE POWER

Zoning

Today, zoning is still the most popular land-use control in this country. As described by Haar,¹ it has been the workhorse of the planning movement. The segregation of land uses in the interest of the public health, safety, morals and general welfare, has been the traditional basis for zoning. However, it has been limited largely to the establishment of residential, commercial, and industrial districts. Only fairly recently has it been applied to other uses such as agriculture, and then, with mixed results. Except for flood plains, it has received little attention as a device for protecting natural processes and preserving open space.

A requisite to determining the usefulness of zoning in the implementation of an ecological plan is an understanding of some of its limitations. Zoning may legitimately require an individual property owner to relinquish in the public interest certain prerogatives that he may otherwise enjoy. However, an ordinance may not restrict a property owner to the extent that he is deprived of all reasonable uses of his land. In such instances, the courts have held that the ordinance was confiscatory and represented a taking without just compensation, and was therefore unconstitutional.

Because of the urban flood problem, the flood plain and wetland are practically the only ecological elements that have been zoned. Where established, flood plain districts have imposed various restrictions on land use and structures allowed thereon for the purpose of minimizing flood damages. With the exception of Hawaii's State Regulations, flood plain zoning has been local. Relatively few court cases have dealt with flood plain zoning, but it appears that if carefully written, the ordinances can withstand constitutional attack. However, like other kinds of zoning, it has been declared invalid in instances in which the courts found that as applied to a particular landowner, it was unreasonable and confiscatory.²

1. Charles M. Haar, Land-Use Planning: A Casebook on the Use Misuse, and Re-Use of Urban Land (Boston: Little, Brown & Co., 1959).

2. For additional information on flood plains, see the following papers:
- a. Francis C. Murphy, "Regulating Flood-Plain Development" (University of Chicago Dept. of Geography Research Paper No. 56, 1958)
 - b. Allison Dunham, Flood Control Via the Police Power (107 U. Pa., L. Rev. 1098, 1959)

The use of zoning in implementing an ecological plan must be further investigated. Possibilities exist for establishing various kinds of natural resource zones to protect lands of ecological, scenic, and scientific value. If enacted, each zone would have its own appropriate regulations. Certain woodland districts, for example, might have cutting restrictions and maximum housing densities. Riparian land districts would have development regulations which would minimize the risk of water pollution of surface waters in the watershed. Aquifer recharge districts depending upon their vulnerability, would limit and control density and sewage disposal, respectively, or restrict most developments altogether. Historic districts would prohibit the introduction of uses incompatible with areas and structures of historical significance.

Density regulations should be a concomitant feature of most of the natural resource zoning ordinance. The protection elements of the ecological plan, for example, riparian lands, forests, and aquifer recharge areas, should have relating high minimum acre requirements. However, other lands, particularly those most suited for urban development, might have maximum lot sizes in order that such lands could accommodate as much of the region's growth as possible. Related to density zoning is the planned unit development district which provides the flexibility necessary for establishing density patterns which reflect varying development suitabilities of contiguous land parcels.

Subdivision Controls, Health Regulations, Building Codes.

Subdivision controls, health regulations, and building codes have proven to be reasonably effective regulators of the location, design and construction of new developments. Regulations can guide or in some circumstances prevent construction on soils which are undesirable for building foundations, septic tanks, and on lands subject to flooding or having steep slopes. Regarding erosion drainage, and the alteration of vegetation may also be regulated. Subdivision controls may require that the developer provide permanent open space or make money payments in lieu of land dedication. The developer may also be required to give various considerations to the preservation of features such as large trees, scenic areas, surface waters, and historic sites.

TAX POLICIES

Preferential assessment, tax deferral and tax exemption have been advocated as potentially useful devices for open space preservation. Connecticut, Maryland and other states have enacted

1. For a review of natural resource zoning, see the following publications.

Ann Louise Strong, Open Space for Urban America, Dept. of Housing and Urban Development (Wash., D.C. U.S. Govt. Print. Office, 1965)

David A. Wallace, Ian McHarg, William Roberts, and others, Metropolitan Open Space from Natural Processes (Phila.,: U. Pa., Inst. for Environmental Studies, 1967) Mimeo.

Dept. of Commerce, Zoning for Small Towns and Rural Counties (Wash., D.C., U.S. Govt. Print. Office, 1959).

legislation enabling preferential assessment of agricultural lands. Although the effectiveness of such tax policies has been in dispute, it appears that as used thus far, preferential assessment has failed to permanently preserve open space, and in some instances, it has actually encouraged leap-frogging rather than curtail it. Abuse of preferential assessment by speculators and some farmers, suggests that tax deferral provisions may be a better device. Conversely, high assessments may be particularly useful as a means of stimulating development in areas where urbanization should be encouraged. Although the tax approach has been criticized, it could be an effective instrument if used in conjunction with other regulatory devices in the implementation of a land use plan.

REGULATION TO PROTECT ECOLOGICAL PHENOMENA AND PROCESSES

As described above, regulatory devices vary in their appropriateness for preserving ecological phenomena and processes. For certain features such as marshes and swamps, public acquisition in fee may be the only satisfactory means of protection. For features such as flood plains, shorelines, streams and aquifer recharge areas, easements and other regulatory devices may be sufficient. For other areas, perhaps subdivision regulations and preferential assessments would accomplish the desired objectives. In most situations it is probable that a panoply of devices should be considered. Such a spectrum of regulatory alternatives is shown in Table 14, which was prepared to indicate the devices that might be appropriately employed in the Twin Cities Metropolitan Area. The land use controls recommended for the various protection elements are mainly suggestive of the kinds of tools that must be explored. Some of those mentioned, namely, the natural resource zoning districts, have received little use. Obviously the full implications of such controls must be fully explored.

TABLE 14

REGULATORY DEVICES AND RECOMMENDED
PERMITTED USES

P R O T E C T I O N

PHENOMENA & PROCESSES

REGULATORY DEVICES

REGULATORY DEVICES

■ - signifies optional device

□ - signifies recommended

Of all devices recommended the most stringent would be selected as the appropriate constraint

	Aquisition						Zoning											
	Outright Purchase	Installment Purchase	Purchase & Leaseback	Excess Condemnation	Development Rights	Easements, etc.	Public Works Loans	Unique Ecology	Agricultural	Institutional	Scenic	Scientific	Forest	Flood Plain	Riparian	Historic	Extractive (ind.)	Density
1. Wooded Swamps	□	□	□	□	■	■		■			■		■	□	□			
2. Marshes	□	□	□	□	■	■		□	■		□			□	□			
3. Wet Meadows			□		■	□								□				
4. Flood Plains			□		■	□								■	■			
5. Lakes	■	□	□	□	□	■		□			■				□			
6. Rivers & Major Streams					□	■		□			■			■	■			
7. Streams					□	□					■			■	■			
8. Intermittent Streams					□	□					□			■	□			
9. Aquifer Recharge			□	□	■	□												
10. Forest	■	□	□	□	■	■		■			■		■					■
11. Slopes + 25% on sands and gravels					□						□		□					
12. Slopes 12½%-24% & 5%-12½%, slopes on drifts and sands					□						□		□					□
13. Slopes 5-12½%					□						□		□					□
14. Unique features (Bluffs & Escarpments)	■	■	□	□	■	■	□	■			■		□		□			
15. Eskers & Kames				□	□			■			□	□			□	■		
16. Terrace Edges, Valleys & Gorges	□	□	□	□	■													
17. Ridges, Hills, Promont.	■	□	■	□	■	□		□	□		■		□				□	□
18. Limits of Glaciation						□		□				□					□	
19. Peat & Clay Deposits									■								■	
20. Bedrock in River Plain								□			□		□	■		■		
21. Galena Limestone, Decorah Shale & Conglom.								□				□					■	
22. Parks & Wildlife Refuges										□								
23. Proposed parks, etc.	■	■	■	■		□		□		□								
24. Country Clubs, Golf Courses, etc.										□								

CONCLUSIONS

Such is the ecological study for the Twin Cities Metropolitan Region. It contributes an enormously valuable resource of data, obtained largely from published sources but integrated through the ecological view. A large part of these data are enduring i.e., information on geology, physiography and soil types will retain their utility for some time. Other data on hydrology, plant ecology, wildlife habitats and land use are dynamic and must be revised on a continuing basis to maintain their value. The suitability classes can be re-used, expanded and improved to facilitate land use decisions. New scanning and digitizer devices offer the promise of an effective method for digitizing, scanning, programming and mapping. In fact, the ecological planning method employed in this study may be fully computerized within a year. This offers opportunities for enriching and updating data, and employing linear programming in resource allocations.

It is clear that the ecological inventory has considerable value in revealing intrinsic opportunities for all prospective land uses. However, its value cannot be fully realized until social demands are understood. This requires an examination of the characteristics of existing and projected population, industry, residences, commerce, and recreation. Given that information, an uncontrolled growth model may be constructed to reveal the effect of future growth on natural phenomena and processes. Logically, the next step would be to establish policies and prepare a plan to guide social processes in a manner that would protect the region's natural environment. The final task would be the formulation of those public and private powers needed for the realization of a regional plan. It is hoped that the Council will be able to follow such a planning sequence.

Only the ecological study has been completed. While not a plan it still has strong implications for planning and management. The Spring floods of 1969, and the resultant 77 million dollar damages and the memory of 3,000 homeless families adds meaning to the identification of flood plains. Flood plain zoning is a proper exercise of the police power to safeguard life and social values. To maintain equilibrium of the great Mississippi, Minnesota and St. Croix is perhaps beyond the powers of the Twin Cities Region, but the smaller rivers, streams, lakes, ponds, wet meadows and phantom drainage systems can be made more stable by programs of stream bank stabilization, afforestation, strip cropping, contour plowing and other conservation practices. Prohibiting encroachments along natural water courses can also help maintain equilibrium.

The problem of nitrates in aquifers must cause grave reflection on management of water resources for public health. It appears that nitrates derived from agricultural fertilizers and from sewage are approaching dangerous levels in the glacial drift and the underlying St. Peter, Shakopee and Oneota aquifers. There is also evidence that high concentrations may exist in the Jordan Sandstone because of its hydraulic connection with upper strata. Gravity operates in the Twin-Cities Region as elsewhere, and the polluted waters from above percolate into deeper aquifers. No biological processes operate in these aquifers to reduce nitrogen levels. Therefore, ground

water management programs must take land use into account. Aquifer recharge areas are particularly susceptible and need protection from sewage pollution and fertilizers. The removal of nitrates in streams, lakes, and ponds can only be partly accomplished by plants and animals. Secondary and tertiary sewage systems, preferably decentralized, will also be required. Adequately treated effluents have the added advantage of being useful for augmenting stream flow and aquifer recharge.

Regional scenic, scientific, and historic resources demand a positive metropolitan policy to assure their preservation and enhancement. Moreover, the identification of particularly propitious sites for various land uses suggest that the Council should protect them from inferior exploitation and reserve such sites for their maximum values.

The map of protection has an immediate utility as it identifies the region as having degrees of tolerance for certain prospective land uses. The exercise of appropriate constraints such as public health regulations, zoning, and subdivision and building regulations can protect the public health and safety and perpetuate social values to a very large degree. The perpetuation of such processes will ensure a continuous structure of open space in the metropolitan region. These lands, together with areas especially suited for recreation can constitute the basis for a metropolitan open space plan.

The Twin-Cities Metropolitan Council is the vanguard of metropolitan planning in the United States. The ecological study which it commissioned is the first of its kind in the country. It is believed that this initiative and imagination will continue and that the Twin-Cities Metropolitan Council will demonstrate the development of a rich, diverse and beautiful region with intelligence and art. The United States awaits such a demonstration. It is hoped that this ecological study will be of value to this important venture.

APPENDIX A

LIST OF MAPS AND CHARTS

- A BASE MAP
- * AA BASE MAP
 - 1. Work Performance Stages (Chart)
 - 2. Work Schedule (Chart)
 - 3. Natural Process Phenomena Affecting Determination of Land Use Suitabilities (Chart)
 - 4. Climate Data: Spring
 - 5. Climate Data: Summer
 - 6. Climate Data: Fall
 - 7. Climate Data: Winter
 - 8. Average Annual Precipitation
 - 9. Annual Precipitation - 1965
 - 10. Average Number of Frost-Free Days
 - 11. High Temperature Zones
 - 12. Low Temperature Zones
 - 13. Precipitation Zones
 - 14. Bedrock Geology
 - 15. Geological Sections
 - 16. Geological Sections
 - 17. Surficial Geology (Superceded by Map A)
- A SURFICIAL GEOLOGY
 - 18. Foundation Conditions
 - 19. Sub-surface Geologic Features
 - 20. Economic Minerals
 - 21. Glaciation Movements
 - 22. Relief
 - 23. Physiographic Regions
- B PHYSIOGRAPHY
 - 24. Slope
- * C SLOPE
- * CC SLOPE-GENERALISED
- D HYDROLOGY
 - 25. Navigability
 - 26. Major Rivers - Water Quantity
 - 27. Major Rivers - Water Quality: Biological
 - 28. Major Rivers - Water Quality: Chemical
- * E WATER QUALITY - MAJOR RIVERS
 - 29. Generalised Geologic Section - Aquifers and Ground Water Movement
 - 30. Geologic Units and Aquifers
 - 31. Aquifer Recharge Zones
 - 32. Soils - Generalised for Agricultural Purposes
 - 33. Agricultural Production by Type
 - 34. Soils Generalised for Urban Purposes
- F SOILS - GENERALISED
 - 35. Existing Forest Cover and Forest Related Industry
 - 36. Natural Forest Regions
 - 37. Ecological Forest Communities
- G EXISTING FOREST COVER (Superceded)
- * H EXISTING VEGETATION
- * HH EXISTING VEGETATION
 - 38. Wildlife Habitat - Water
 - 39. Existing Urbanisation
 - 40. Historical Landmarks
 - 41. Recreation Sites
- a SUITABILITY FOR AGRICULTURE
 - 42. Suitability for Forestry
 - 43. Suitability for Extraction

LIST OF MAPS (continued)

- b SUITABILITY FOR RECREATION
 - c SUITABILITY FOR URBANISATION
 - 44. Composite Intrinsic Suitability - Matrix I
 - 45. Composite Intrinsic Suitability - Matrix II
 - J COMPOSITE INTRINSIC SUITABILITY
 - JJ COMPOSITE INTRINSIC SUITABILITY
 - * L PROTECTION
 - 46. Protection - Regulatory Devices
 - M COMPOSITE INTRINSIC SUITABILITY WITHIN THE RIVER CORRIDORS
-

SUMMARY +

- 46 Maps & Charts, Scale 1:250,000, identified with numerals 1 through 46
- 11 Maps, Scale 1:62,500, identified with alphabets A through M
- 4 Reproducible Maps, Scale 1:62,500, identified as AA, CC, FF, HH and JJ
- 3 Rough Maps (not submitted), Scale 1:62,500 identified as a, b, c.

* Indicates that the maps are reproducible

- 24 Slides illustrating intrinsic suitabilities for Urb, Ag, Rec.
- 53 Slides illustrating composite intrinsic suitability.

APPENDIX B

CORRESPONDENCE PERTAINING TO
QUALITY OF GROUND WATER

1. Letter dated 26 August 1968, from Ian McHarg to Director of the U.S. Geological Survey.
2. Letter dated 11 September 1968, from Arthur Baker, Acting Director of U.S. Geological Survey, to Ian McHarg.
3. Letter dated 18 September 1968 from Charles Collier, District Chief, U. S. Geological Survey, St. Paul, to Ian McHarg.
4. Letter dated 23 September 1968 from Charles Johnson, Jr. Administrator, Department of Health, Education, and Welfare, to Ian McHarg.

MLH

WALLACE, McHARG, R BERTS AND TODD

ARCHITECTS / LANDSCAPE ARCHITECTS / CITY AND REGIONAL PLANNERS
1740 CHERRY STREET, PHILADELPHIA, PENNSYLVANIA 19103 / LO 3-0890

August 26, 1968

The Director
The U.S. Geological Survey
Washington, D. C.

Dear Sir:

I am well known to a number of your colleagues, John Hack, Luna Leopold and others but we have not met. I am Chairman of the Department of Landscape Architecture and Regional Planning at the University of Pennsylvania and a partner in this office of architects, landscape architects and planners. It is in this latter capacity that I write to you now. I have been retained by the Twin Cities Metropolitan Council to do an ecological study and plan for the Minneapolis-St. Paul Metropolitan Region.

In the course of this study we compiled hydrological information and encountered the problem of nitrate concentrations in ground water -- a threat of haemoglobin anemia or blue babies. The public danger of cyanosis which can result from nitrate concentrations in excess of 45 ppm constitutes a matter of grave importance. It is incontrovertible that cases of cyanosis have occurred in the region. There seems to be no question that nitrates in excess of the threshold occur in the glacial drift. There also seems little doubt that high concentrations occur in the St. Peter, Shakopee and Oneota aquifers. The information on the Jordan aquifer is more ambiguous, but it is linked with the high levels observed in the upper aquifers. The hydraulic connection between these and the Jordan seems to have been established as has the migration of water from the glacial drift to the Jordan.

The Jordan aquifer is a principal source of water supply in the region. The high present levels of nitrates and the threat of higher and dangerous levels is a matter of great seriousness. It seems essential to obtain a statement of the precise situation and its dynamics. In short, is the Jordan aquifer now dangerous in any location? Further, is the Jordan aquifer likely to become more dangerous?

I have excerpted a number of quotations and reproduced these below. It is from these that all of the evidence has been collected. If there is new, unpublished, information which qualifies or contradicts these data, I would be pleased to receive it.

W. A. Wallace, FAIA, AIP/Ian L. McHarg, ASLA, AMTPI/William H. Roberts, RIBA, ASLA/Thomas A. Todd, AIA
C. Hamm/ Narendra Juneja, AIA/Associates

Bulletin 21, Division of Waters, Minnesota
Quality of Waters, Minnesota. A Compilation 1955-62 by
Marion L. Madrink, (June 1963) pp 14-15.

"Nitrate in ground water has received much attention in recent years; high concentrations of nitrate indicate contamination of a water supply. In 1960 and 1961 some data on the nitrate and detergent content of the ground water in Richfield and Brooklyn Park were obtained. At that time neither community had municipal water or municipal sewage systems. The average concentrations of nitrate were 4.0 ppm in Richfield and 18 ppm in Brooklyn Park; however, as much as 58 ppm in Richfield and 82 ppm in Brooklyn Park were measured. Of the 41 wells sampled in the two communities, the water from 6 wells had nitrate concentrations of more than the recommended maximum of 45 ppm (U.S. Public Health Service, 1962) and the water from 11 wells had concentrations of more than 4.0 ppm. If such water is used for infant feeding, cyanosis may result.

Nitrate in the water from the four aquifers ranged from 0.0 to 127 ppm. Concentrations of more than 45 ppm were observed mainly in the water from the glacial drift and the St. Peter, Shakopee, Oneota and Jordan. In the aquifer in the St. Peter, Shakopee, Oneota, and Jordan most of the nitrate was observed in wells that obtained water from the Shakopee and Oneota Dolomites."

Bulletin 23, Division of Waters, Minnesota Conservation Department,
Chemical Quality of Ground Water in the Minneapolis-St. Paul Area,
Minnesota by M.L. Maderak, U.S. Geological Survey, (August 1965),
pp 36, 38, and 40.

"With time contamination of the surface water and of the water in the glacial drift can have an effect on the quality of water in the underlying aquifers. In 1960 and 1961 some quality data of ground water from Richfield and Brooklyn Park were obtained to determine the amount of contamination from domestic wastes and to determine the possible effect of contamination on the quality of water in the deep aquifers. At that time, neither community had municipal water nor municipal sewage systems. Although the wells sampled were picked at random, the distribution of the wells was fairly uniform in both communities. The results of the laboratory analyses are given by Maderak (1963).

Contamination of ground water, as indicated by nitrate concentrations (table 2), is fairly widespread in both communities. In Richfield, nitrate was detected at depths less than 201 feet; and in Brooklyn Park, at depths of 100 feet or less. Nitrate, however, was more

widespread at Brooklyn Park than Richfield. Of the 41 wells sampled in the two communities, the water from 6 wells had nitrate concentrations of more than the recommended maximum of 45 ppm (U.S. Dept. Health, Education and Welfare, 1962), and the water from 11 wells had concentrations of more than 4.0 ppm. The maximum concentrations of nitrate were 58 ppm in Richfield and 82 ppm in Brooklyn Park.

Most of the wells in the two communities obtain water from the glacial drift, which has very good porosity and permeability. The vertical permeability in the Richfield area is high, and water may move downward from the drift through the St. Peter Sandstone and the Shakopee and Oneota Dolomites to the Jordan Sandstone. In the Brooklyn Park area the Oneota forms a partial aquiclude, which undoubtedly prevents migration of large quantities of water to the Jordan. The lateral or vertical migration of water in the St. Peter probably does not exceed several hundred feet per year; however, water in the dolomites may migrate laterally as much as 500 or 600 feet per month. The rate of movement is especially high where the Jordan is heavily pumped and where much of the recharge is directly from the overlying formations. Thus, contamination should not be allowed to occur in the recharge areas and in the areas having large vertical permeabilities if the water in the Jordan is to retain its good quality."

Ibid, p. 6

"In many parts of the basin the Shakopee, Oneota, and Jordan are hydraulically connected. According to Liesch (1961, p. 12-15), in the central or downtown Minneapolis-St. Paul part of the basin water can move directly from the St. Peter through the dolomite sequence to the Jordan. In other parts of the basin, except for the recharge areas, some water is partly confined in the formations overlying the Jordan because of a shale or siltstone at the base of the Oneota."

Source: Ground Water, First Draft, April 1968, Prepared for Water Resources Coordinating Committee, State Planning Agency by R.K. Hogberg and W.C. Walton.

"The Jordan Sandstone of Cambrian age and the overlying Prairie du Chien Group of Ordovician age are considered together as one aquifer unit because of the extensive movement of water between the two geologic units. In most of the area (Figure 21), recharge to the Jordan Sandstone is mainly through the Prairie du Chien Group. Wells tapping these rocks are most often completed in the Jordan Sandstone, thus benefitting from the yield of both rock units."

August 26, 1968

While I am not a hydrologist, all of the information compiled was developed from published references by distinguished practitioners. Moreover, the interpretation of these data was performed for me by the very distinguished Dr. Ruth Patrick, curator of limnology of the Pennsylvania Academy of Natural Sciences.

Resolution of many urgent planning problems hinges upon this information -- plans for sewage treatment and solid waste disposal among others.

Further, I have read that the Federal Water Control Administration has awarded a grant of \$285,000 to the City of South St. Paul to demonstrate the feasibility of using aquifers for underground storage of storm and combined sewage. Any decision on this must surely await conclusive information on nitrates in aquifers.

We are required to conclude our study by the end of September. Therefore, I would be most grateful for a statement which could be employed by the Metropolitan Planning Council and its several consultants as soon as possible.

Sincerely,



IAN L. MCHARG

ILMcH:njc

cc: Mr. Robert Jorvig
Mr. Gene Geer

Dec: Dr. W C. Walton



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON, D.C. 20242

SEP 11 1968

Mr. Ian L. McHarg
Wallace, McHarg, Roberts and Todd
1740 Cherry Street
Philadelphia, Pennsylvania 19103

SEP 13 1968

Dear Mr. McHarg:

We acknowledge with appreciation your informative letter of August 26 about your ecological study and plan for the Minneapolis-St. Paul metropolitan area.

The quotations that you have given from Bulletin 21 and Bulletin 23, Division of Waters, Minnesota Conservation Department, by M. L. Maderak of the Geological Survey, appear to be an appropriate statement of the situation at that time (1963 and 1965), to which very little can be added. It should be pointed out, however, that most of the observed nitrate was in samples from the shallow zones, mainly the glacial drift.

We have discussed the matter with Mr. Charles R. Collier, our District Chief, Water Resources Division, St. Paul, who reports that data obtained subsequent to the studies of Maderak appear to verify observations of excessive nitrate contamination in water obtained from shallow wells in the glacial drift in substantial parts of the metropolitan area. This is a condition commonly found in the Midwest, where human and animal wastes and fertilizer are large-scale sources of nitrogen, a part of which reaches the water table by infiltration of rainwater and snowmelt.

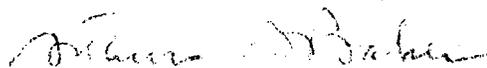
Few data are available in the files of the Geological Survey for the Jordan Sandstone during the period since the aforementioned reports were prepared. Consequently, there is no way we can assess the overall extent of contamination in the Jordan Sandstone, especially in the core of the metropolitan area. Mr. Collier reports that in 10 water samples obtained from wells in the Jordan in towns in or adjacent to the Twin Cities, nitrate (NO_3) ranged from 0.1 to 2.7 ppm. At Hastings, where the Jordan Sandstone is near the surface and is exposed along the St. Croix River, nitrate in a single sample was 17 ppm.

Our current impression, based on limited data, is that nitrate contamination of the Jordan Sandstone is confined mainly to local situations where leakage of a contaminant from the St. Peter Sandstone or the

overlying aquifers occurs by lateral or vertical migration of water from the land surface or through or along wells whose casings have rusted out or are ungrouted or inadequately grouted. This would be especially true in places where the deeper formation is heavily pumped and there is a substantial difference in hydraulic head to cause contaminated water to drain to the Jordan from shallow sources. Whether there is mass movement of nitrate-bearing water through the deeper aquifers, from either point sources or broad surface areas, could be determined only by additional detailed investigation.

By copy of your letter and our reply, I am requesting that Mr. Collier send you recent nitrate data for the Jordan Sandstone and any additional evaluation of the data he may be able to make.

Sincerely yours,



Acting Director



IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

1002 Post Office Building
St. Paul, Minnesota 55101

September 18, 1968

SEP 20 1968

Mr. Ian L. McHarg
Wallace, McHarg, Roberts and Todd
1740 Cherry Street
Philadelphia, Pennsylvania 19103

Dear Mr. McHarg:

As requested by the Director, U. S. Geological Survey, in his letter to you dated September 6, 1968, I have attached a table of chemical analyses of water from the Jordan aquifer obtained in 1963 and 1967. These analyses are from localities surrounding the Twin Cities.

These limited data do not allow further evaluation beyond that already given. It has been our experience that problems of high nitrates (NO_3) in ground waters in the Twin Cities metropolitan area have been limited to wells in the surficial glacial drift deposits. It is most serious where development occurs in outlying unincorporated areas beyond the limits of municipal water and sewer lines.

Please let me know if we can be of further assistance.

Very truly yours,

Charles R. Collier
District Chief

Enclosure
cc: The Director, USGS
Washington, D. C.

Che al l yse wa fr ne an fer inn lis Pa meti liti rea

Location	Mendota Heights	Hastings	Richfield	Minnetonka	Wayzata	Plymouth	Champlin	Twin City Arsenal	Bellaire
Date Sampled	6-19-63	6-17-63	6-19-63	6-19-63	6-18-63	6-18-63	6-18-63	9-8-67	6-17-63
Depth of Well (feet)	400	301	437	619	393	476	320	432	445
Silica SiO ₂	11	17	16	19	18	21	17	20	13
Iron Fe	.00	.01	.13	.98	.68	.42	1.3	3.0	.15
Manganese Mn	.00	.00	.00	.06	.06	.00	.09	----	.01
Calcium Ca	60	55	67	62	39	69	64	60	39
Magnesium Mg	21	24	26	30	18	30	38	30	14
Sodium Na	4.1	2.7	4.9	5.1	4.3	4.7	9.3	----	3.3
Potassium K	3.6	.8	1.6	1.6	3.2	1.8	2.2	----	1.4
Bicarbonate HCO ₃	288	258	334	336	226	368	376	486	196
Carbonate CO ₃	0	0	0	0	0	0	0	0	0
Sulfate SO ₄	14	16	6.8	10	3.8	3.0	28	38	4.0
Chloride Cl	.5	2.4	1.0	1.1	1.1	.5	2.3	3.5	.4
Fluoride F	.3	.1	.2	.2	.3	.3	.2	4.3	.2
Nitrate NO ₃	1.7	17	.3	.6	.3	.7	.5	.5	.2
Boron B	.05	.00	.02	.00	.00	.00	.03	----	.00
Dissolved Solids	255	263	286	301	201	319	356	480	173
Hardness as CaCO ₃									
calcium, magnesium	236	234	272	278	173	295	317	273	156
noncarbonate	0	22	0	2	0	0	9	0	0
Specific Conductance									
micromhoes at 25 degrees C	456	445	494	520	345	538	606	735	309
pH	7.7	7.7	7.7	7.8	7.6	7.6	7.6	7.9	7.7



OFFICE OF THE
ADMINISTRATOR

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CONSUMER PROTECTION AND ENVIRONMENTAL HEALTH SERVICE
WASHINGTON, D.C. 20204

SEP 28 1968

SEP 26 1968

Dear Mr. McHarg:

This is in reply to your letter of August 26, 1968, to Secretary Cohen regarding the problem of nitrate concentrations in ground waters in the Minneapolis-St. Paul Metropolitan Region. The Secretary has requested that I reply to your letter.

Specifically, you ask, "Is the Jordan aquifer now dangerous in any location?" I would suggest that your best source of current information on this question would be the Director of the Minnesota State Board of Health, and I note that a copy of your letter was sent to him. I assume you will receive his reply in due time. I would state, however, that based on the excerpts cited in your letter, the potential hazard of local contamination of ground water aquifers does exist.

You further ask, "Is the Jordan aquifer likely to become more dangerous?" This question is very difficult to answer in the absence of detailed information on the hydrologic situation which exists in the area, the source of existing pollution, the input of future activities such as increased pumping from aquifers in the area, and the introduction of additional waste loads to ground water. Certainly the collection and proper disposal of wastes formerly discharged to ground waters from individual home disposal systems will tend to improve ground water quality in the area. The introduction to ground water aquifers of waters such as treated or untreated domestic or industrial wastes, storm water, and other sources which contain potentially harmful substances must be approached with caution. Whereas certain studies have indicated that a reduction in bacterial concentration can be obtained by the recharging of certain aquifers, evidence is not readily available to enable us to make the same statement with regard to chemical pollutants.

As you have stated, the Federal Water Pollution Control Administration has awarded a grant to the city of South St. Paul to demonstrate the feasibility of using aquifers for underground storage of storm and combined sewage. As the Department of Health, Education, and Welfare is responsible, by Memorandum of Agreement with the Department of the Interior, for the health aspects of water pollution, I propose to contact the Federal Water Pollution Control Administration to assure that the health aspects of this project are given adequate consideration.

I certainly appreciate your concern with the health problems inherent in the development of an ecological study for the Minneapolis-St. Paul Metropolitan Region, and I hope these comments will be of some value to you.

Sincerely yours,



Charles C. Johnson, Jr.
Administrator

Mr. Ian L. McHarg
Wallace, McHarg, Roberts and Todd
1740 Cherry Street
Philadelphia, Pennsylvania 19103

APPENDIX C

SELECTED BIBLIOGRAPHY

CLIMATE

- Baker, Donald G., Summary of Climatological and Microclimatological Investigations, 1964, Soil Series 72. (Minnesota: University of Minnesota, Agricultural Experiment Station, 1964)
- Baker, Donald G., Joseph H. Strub, Jr., "Part I, Probability of Occurance in the Spring and Fall of Selected Low Temperature," Climate of Minnesota, Technical Bulletin 243. (Minnesota: University of Minnesota Agricultural Experiment Station, 1963).
- Baker, Donald G., Joseph H. Strub, Jr., "Part II, The Agricultural and Minimum Temperature Free Seasons", Climate of Minnesota, Technical Bulletin. (Minnesota: the University of Minnesota Agricultural Station, 1963).
- Baker, Donald G., Joseph H. Strub, Jr., "Part III, Temperature and its Application", Climate of Minnesota, Technical Bulletin 248, (Minnesota: University of Minnesota Agricultural Experiment Station, 1965).
- Baker, Donald G., James B. Swan, "Part IV Spring Soil Temperatures", Climate of Minnesota, Miscellaneous Report 67. (Minnesota: University of Minnesota Agricultural Experiment Station 1966).
- Baker, Donald G., Donald A. Haines, Joseph H. Strub, Jr., "Part V, Precipitation, Facts, Normals, and Extremes", Climate of Minnesota, Technical Bulletin 254. (Minnesota: University of Minnesota Agricultural Experiment Station, 1967).
- Connor, John T., Storm Data, Volume 7, Number 5 (Ashville: United Stated Department of Commerce, May 1965).
- Strub, Joseph, Tornado Occurances in Minnesota. (Minneapolis: The Aerological Office, Naval Air Station, Minneapolis, and Weather Bureau State Climatologist, Weather Bureau Office, Minneapolis, for 1916-1954).
- U. S. Department of Commerce, Weather Bureau, Local Climatological Data with Comparative Data, Minneapolis. (St. Paul: U.S. Department of Commerce, Weather Bureau, 1964).

GEOLOGY

- Craddock, Campbell, Edward C. Thiel, Barton Gross, A Gravity Investigation of the Precambrian of S.E. Minnesota and Western Wisconsin, Volume 68, Number 21. (Minnesota: University of Minnesota, Minnesota Geological Survey, 1963).
- Grout, F. F., "Minnesota Building Brick and Tile", Minnesota Geologic Survey Summary Report 2. (Minnesota: University of Minnesota, April 1947).
- Hogberg, R. K., Aggregate and Urban Growth southwest of Twin Cities. (Minnesota: University of Minnesota, Minnesota Geological Survey, 1966).

GEOLOGY (Con't.)

- Hogberg, R. K., T. N. Bayer, Guide to the Caves of Minnesota. (Minnesota: Minnesota Geological Survey, ED. Series 4, 1967).
- Johnson, Elden. An Archaeology Program for Minnesota. (St. Paul: Minnesota Outdoor Recreation Resources Comm.)
- Minnesota Geologic Survey, Geologic Map of Minnesota, St. Paul Sheet. (Minnesota: University of Minnesota 1966).
- Minnesota Geological Survey, Directory of Minnesota Mineral Producers, 1964, Information Circular 4. (University of Minnesota and Minnesota Geological Survey, 1966).
- Minnesota Geological Survey Bulletin, Structural Contour Map of the Minneapolis - St. Paul Basin. (Minnesota Geological Survey Bulletin 27).
- Parham, Walter E., Lateral Variations of Clay Mineral Assemblages in Modern and Ancient Sediments. (Minnesota: Minnesota Geological Survey and University of Minnesota, 1966).
- Payne, C. Marshall, Bedrock Geology Map of Minneapolis, St. Paul and Vicinity. (University of Minnesota, Minnesota Geological Survey, 1966).
- Payne, C. Marshall, "Map of the Bedrock Topography of Minneapolis, St. Paul and Vicinity", Miscellaneous Map Series M-1. (1965)
- Rapp, G.R., Jr., D. T. Wallace, Guide to Mineral Collecting in Minnesota, Education Series 2. (Minnesota Geological Survey, 1966).
- Riley, Charles M., The Possibilities of Bloating Clays in Minnesota. (Minnesota: University of Minnesota, Minnesota Geological Survey, 1950).
- Schwartz, G The Geology of the Minneapolis - St. Paul Metropolitan Area. (Minneapolis: University of Minnesota Press, 1936).
- Schwartz, G. M., Geological Map of Minneapolis - St. Paul Metropolitan District. (Minnesota: University of Minnesota, Minnesota Geological Survey, 1935).
- Schwartz, G. M., Map of the Glacial and Preglacial River Valleys of the Metropolitan Area. (1936).
- Stauffer, Clinton R., "the High Magnesium Dolomities and Dolomitic Limestones of Minnesota", Minnesota Geologic Survey Summary Report 4. (Minnesota: University of Minnesota, January, 1950).
- Stauffer, Clinton R., G. A. Thiel, "The High Calcium Limestones of Minnesota", Minnesota Geologic Survey Summary, Report 1, (Minnesota: University of Minnesota, January, 1947).
- Stone, John E., "Surficial Geology of the New Brighton Quadrangle, Minnesota", GM 2 Geologic Map Series. (Minneapolis: University of Minnesota Press, 1966).

GEOLOGY (Con't)

Stone, J. E., Reconnaissance Map of the Surficial Geology of the Minneapolis - St. Paul Area. 1966

Thiel, G. A., G. M. Schwartz, "Structural Contour Map of S.E. Minnesota on the Jordan Oneota Contract", Geol. Soc. America Bulletin, Volume 52, 1941.

University of Minnesota, Our Land and Mineral Resources, A Long Range Plan for Geologic Research in Minnesota. (Minnesota: University of Minnesota, Minnesota Geological Survey, 1965).

HYDROLOGY

Ackroyd, E. A., W. C. Walton, D. L. Hills, Ground Water Contribution to Stream Flow and its Relation to Basin Characteristics in Minnesota. (Minnesota Geological Society, University of Minnesota, 1967).

Daley, Stanley, Richard Carlson, Metropolitan Lake Inventory, Special Publication Number 45. (Minneapolis: Minnesota Conservation Department, Division of Game and Fish, October 1967).

Federal Water Pollution Control Administration, Pollution of the Upper Mississippi River and Major Tributaries, Twin Cities-Upper Mississippi River Project. (1966).

Federal Water Pollution Control Administration, Report on Water Quality Investigations of the Mississippi, Minnesota, St. Croix Rivers, Twin Cities-Upper Mississippi River Project (June, 1966).

Hibbard, Edmund A., Control of Aquatic Nuisance Organisms in Minn., MORRC Report # 9. (St. Paul: Minnesota Outdoor Recreation Resources Commission).

Hill, Hibbert, Industrial Uses of Water in Hennepin County, a talk by Hibbert Hill of Northern States Power Company before The Water Forum (October 1965).

Hogberg, R. K., W. C. Walton, Ground Water. Prepared for Water Resources Coordinating Committee, State Planning Agency, Minnesota. (April 1968).

Matros, Ronald, Policies and Actions Affecting the Development of Streams in the Metropolitan Area, Physical Dev. Section, Paper No. P-20 (VIII-C). (March, 1967)

Minnesota Dept. of Construction, Division of Waters. Floods in Minnesota - Magnitude and Frequency, Bulletin No. 12. (St. Paul, 1961).

Minnesota Conservation Dept., Division of Waters, Hydrologic Atlas of Minnesota, Bulletin 10.

HYDROLOGY (con't)

- Minnesota Department of Conservation, Power Development in Minnesota, Bulletin 20. (July, 1962).
- Minnesota Department of Conservation, Division of Waters, Water Resources of the Minneapolis - St. Paul Metropolitan Area, Bulletin 11. (August 1961).
- Minn. Department of Conservation, Division of Waters, Water use for Irrigation in Minnesota, Bulletin 17. (St. Paul, 1962).
- Prior, C. H., Robert Schneider, W. H. Durum, Water Resources of the Minneapolis - St. Paul Area, Geological Survey Circular 274. (Washington D. C.: U. S. Geologic Survey, 1953).
- Progress Report Committee on Water Resources Planning, Hydraulic Division, Basic Considerations in Water Resources Planning, Information Circular #81. (Minnesota: Univ. of Minn. Grad. School, Water Resources Research Center).
- Ramsey County League of Municipalities, Stormwater and Drainage Study Committee, Municipal Drainage Problems in Using County Ditches. (Minn.: Univ. of Minnesota).
- Secretary of the Army, Minnesota River > Navigation, 84th Congress, Second Session, House Document 144. (Washington: U.S. Govt. Printing Office 1957).
- Secretary of Army, Mississippi River at St. Paul and South St. Paul, 85th Congress, Second Session, House Document 223. (Washington: U.S. Govt. Printing Office, 1957).
- Tyler, Stanley R., Accelerated Program for Hydrologic Studies in Minnesota, MORRC Report #8. (St. Paul: Minnesota Outdoor Recreation Resources Commission).
- U. S. Army Corps of Engineers, Water Resources Development in Minnesota. (Chicago North Central Division, 1967).
- U. S. Geological Survey, Minn. Conservation Dept., Chemical Quality of the Ground Water in the Minneapolis - St. Paul Area, Bull. 23 (Washington, D. C., 1965).
- U. S. Geological Survey, "Part I- Surface Water Records, Part II - Water Quality Records", Water Resources Data for Minnesota. (1966).
- U. S. Geological Survey, Quality of Waters, Minnesota, Compilation, 1955-62. Bulletin 21. (Minn.: U. S. Geological Survey, Minn. Conservation Dept., 1963).
- U. S. Geological Survey, Minnesota Dept. of Conservation, Water Resources Investigations in Minnesota. (1965).
- Water Resources Research Center. Ground Water Resource Investigations and Research Needs in the Minn.-St. Paul Area. A Report of a Task Group of the Consulting Council of the Water Resources Research Center. (Minneapolis: Univ. of Minnesota Grad. School, February, 1967).

HYDROLOGY (con't)

Zumberge, James H., The Lakes of Minnesota, their Origin and Classification, (Minneapolis: University of Minn. Geological Survey Bulletin, The University of Minnesota Press, 1952).

PEDOLOGY

Arneman, H. F., Soils of Minnesota, Extension Bulletin 278. (Agricultural Extension Service, University of Minnesota, June, 1963).

Blake, G. R. , E. R. Allred, C. M. Van Bavel, F. D. Whisler, Agricultural Drought and Moisture Excesses in Minn., Technical Bulletin 235. Univ. of Minn. Agricultural Experiment Station, and Soil and Water Conservation Division, AGS, USDA. (May 1960).

Bonsteel, J. A., G. A. Simpson, Physical Land Conditions in Washington County Minn. - Physical Land Survey No. 36. (Washington D. C.: Soil Conservation Service, 1944).

Hanson, Lowell D., Clement D. Springer, Rouse S. Farnham, Alexander S. Robertson, Evan R. Allred, Soils of the Twin City Metropolitan Area, Extension Bulletin 320. Agricultural Extension Service , Univ. of Minn., (February 1966).

The Joint Program, Interpretations of Soils for Urban Purposes, Paper No. 11. (June 1964).

U. S. Dept. of Agriculture, Soil Conservation Service, Soil Survey - Dakota County, Series 1955, No. 10. (August, 1966).

U. S. Dept. of Agriculture, Soil Conservation Service, Hennepin County Interim Soil Survey Report, 1967. (U.S. Dept. of Agriculture, Soil).

U. S. Dept. of Agriculture, Soil Conservation Service, Soil Survey - Scott County, Minn., Series 1955 No. 4. (October, 1959).

VEGETATION

Deters, Merrill E., The Northern Relict Vegetation of the Anoka Sand Plain, University of Minnesota (1931).

Hard, C. Gustav, Perennials for Minnesota, University of Minnesota Agriculture Extension Service (1963).

Hard, C. Gustav, Woody Plants for Minnesota, University of Minnesota Agriculture Extension Service (1966).

Marshall, William H. , Cedar Creek Natural History Area. University of Minnesota. (1963).

VEGETATION (con't)

- Pierce, Richard L., Vegetation Cover Types and Land Use History of the Cedar Creek Natural History Reservation, (Thesis University of Minnesota, 1954)
- Stone, Robert N., A Third Look At Minnesota's Timber, U. S. Forest Service, Bulletin NC-1, North Central Forest Experiment Station.
- U.S. Forest Service, Forest Area Trends in Minnesota Counties, Research Note LS-25, Lake States Forest Experiment Station (July 1963).
- U.S. Forest Service, Map of Forest Regions of the United States (1948).
- U.S. Forest Service, Forest Type Areas by Counties, Lake States Forest Experiment Station. (1962).
- University of Minnesota, School of Forestry and Division of Forestry, Minn. Dept. of Conservation. Directory of Minnesota Wood Processors and Users. (1966).

WILDLIFE

- Breckenridge, W.J., A Guidebook to the James Ford Bell Museum of Natural History (University of Minnesota Press).
- Breckenridge, W. J., Reptiles and Amphibians of Minnesota. Minnesota Museum of Natural History. (Minneapolis: Univ. of Minnesota Press, 1958).
- Dodge, Anne Winton, Helen Ford Fullerton, W. J. Breckenridge, D.W. Warner, Birds of the Minneapolis - St. Paul Region, Combined Field Check List and Migration Chart, Pamphlet Series No. 1, Minnesota Museum of Natural History, (Minneapolis: Univ. Of Minnesota Press, 1966).
- Gunderson, Harvey, James Beer, The Mammals of Minnesota, Occasional Papers, Minnesota Museum of Natural History.
- Minnesota Department of Conservation, Div. of Game and Fish, Waterfowl in Minnesota, Technical Bulletin No. 7. (April 1964).
- Minnesota Outdoor Recreation Resources Commission, A Study of Hunting and Fishing in Minnesota. (St. Paul: 1967).
- Minnesota Outdoor Recreation Resources Committee, Acquisition of Wildlife Land in Minnesota, Wetlands Program. (St. Paul: October 2, 1962).
- Outdoor Recreation Resources Review Commission, Sport Fishing Today and Tomorrow, Report No. 9. (Washington D.C.: U.S. Gov't Printing Office, 1962).

WILDLIFE (con't)

Statewide Minnesota Outdoor Recreation Preliminary Plan, List of Rare and Endangered Species. (1965).

Tester, John R., William H. Marshall, A Study of Certain Plant and Animal Interrelations on a Native Prairie in Northwestern Minn., Occasional Paper No. 3. Minnesota Museum of Natural History, (University of Minnesota Press, 1961).

HISTORY

Fridley, Russel W., A Selected List of Historic Sites in the Twin Cities Area, Information Bulletin No. 1. (St. Paul: Minn. Historical Society, 1960).

Fridley, Russel W., June Holmquist, History Along the Highways - An Official Guide to Minnesota's Markers and Monuments. Minnesota Historical Society (1967).

Holmquist, June D., Susan E. Holbert, A History Tour of 50 Twin City Landmarks, Minnesota Historic Pamphlets, Series No. 2 (1966).

Koeper, H.F., Eugene D. Becker, Historic St. Paul Buildings, St. Paul City Planning Board. (1964).

Minnesota Outdoor Recreation Resource Commission, A Historic Sites Program for Minnesota. Minnesota Historic Society, Minnesota Highway Dept., Conservation Dept. Division State Parks (1964).

Minnesota Outdoor Recreation Resource Commission, A Paleontology Program for Minnesota, Report No. 6.

Minnesota Outdoor Recreation Resource Commission, Fort Snelling Report No. 15. (1965).

Minnesota Outdoor Recreation Resource Commission, Minnesota's Historic Sites, Report No. 1. (1963)

Norquist, Carla, Roster of Excavated Prehistoric Sites in Minnesota. University of Minnesota, Minnesota Historical Society. (1967).

CREDITS

This study was commissioned by the Metropolitan Council of the Twin Cities, and conducted under the supervision of Ian L. McHarg and Narendra Juneja, who were assisted by the following staff:

Ravindra Bhan
Charles Meyers
Derik Sutphin
James Veltman
Michael Clarke

Hydrology
Vegetation, Soils
Geology, Physiography, History
Climate, Wildlife
Report

Thomas Dickert
Robert Drummond
Keith Grey
Anthony Neville
Richard Ragan
Mark Turnbull

of

WALLACE, Mc HARG, ROBERTS and TODD
Architects/Landscape Architects/City and Regional Planners
1740 Cherry Street, Philadelphia, Pennsylvania 19103

P R O T E C T I O N

PHENOMENA & PROCESSES

REGULATORY DEVICES

RECOMMENDED PERMITTED USES

REGULATORY DEVICES

■ - signifies optional device
 □ - signifies recommended

Of all devices recommended the most stringent would be selected as the appropriate constraint

PHENOMENA & PROCESSES	REGULATORY DEVICES										Taxation		Regulation		RECOMMENDED PERMITTED USES							
	Aquisition					Zoning					Agricultural Pref. Assess.	Institutional Pref. Assess.	Public Health Regulation	Subdivision Controls		Building Codes						
	Outright Purchase	Installment Purchase	Purchase & Leaseback	Excess Condemnation	Development Rights	Easements, etc.	Public Works Loans	Unique Ecology	Agricultural Institutional	Scenic	Forest	Flood Plain	Riparian	Historic	Extractive (ind.)	Density						
1. Wooded Swamps	□	□	□	□	■	■	■	■	■	■	■	■	■	■	■	■	■	□	■	■	■	1. No development. Preserved by purchase, acquisition of development rights, comments, the appropriate zoning category and agricultural preferential assessment and subject to public health regulations.
2. Marshes	□	□	□	□	■	■	■	□	■	□	■	■	■	■	■	■	□	□	■	■	■	2. As above
3. Wet Meadows			□	□	■	■	■										□	□	□	□	□	3. As above
4. Flood Plains			□	■	■	■	■						■	■	■	■	□	■	■	■	■	4. No urban development permitted. Recreation, agriculture, forestry permitted. Flood Plain Zoning employed as the regulatory device.
5. Lakes	■	□	□	□	□	■	■	□	■	■	■	■	■	■	■	■	□	■	□	□	□	5. Subject to Public Health Regulations. Riparian Zoning which demands treatment of edges, plus scenic, unique ecology. Zoning where applicable.
6. Rivers & Major Streams				□	■	■	■	□	■	■	■	■	■	■	■	■	□	■	□	□	□	6. As above
7. Streams				□	□	■	■										□	■	□	□	□	7. As above
8. Intermittent Streams				□	□	■	■										□	■	□	□	□	8. As above
9. Aquifer Recharge			□	□	□	■	■										□	■	■	■	■	9. Subject to Public Health Regulations, Subdivision Controls should determine land uses permitted.
10. Forest	■	□	□	□	■	■	■	■	■	■	■	■	■	■	■	■	■	□	■	■	■	10. Subject to Forest Zoning and Agricultural Preferential Assessment, plus scenic and unique ecology. Zoning where applicable.
11. Slopes + 25% on sands and gravels				□	■	■	■										□	□	■	■	■	11. Neither urban development nor agriculture. Regulated through Subdivision Controls and USDA. Soil Conservation Service.
12. Slopes 12½-24% & 5%-12½, slopes on drifts and sands				□	■	■	■										□	□	■	■	■	12. Neither urban development nor crop agriculture. Regulation through Subdivision Controls and USDA. Soil Conservation Service.
13. Slopes 5-12½				□	■	■	■										□	□	■	■	■	13. Limited Agriculture Residential Development limited by Density Zoning, Subdivision Regulations.
14. Unique features (Bluffs & Escarpments)	■	□	□	□	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	14. No development, preserved by purchase of fee or development rights, prohibited for extraction.
15. Eskers & Kames			□	□	■	■	■										□	□	□	□	□	15. Prohibited for extraction, preserved by Extraction Zoning.
16. Terrace Edges, Valleys & Gorges	□	□	□	□	■	■	■										□	□	■	■	■	16. No development, preserved by purchase of fee, development rights or easements and appropriate zoning.
17. Ridges, Hills, Promont.	■	■	■	■	■	■	■	□	□	■	■	■	■	■	■	■	□	□	■	■	■	17. As above
18. Limits of Glaciation				□	■	■	■										■	■	■	■	■	18. Regulated by unique ecology and suited for zoning.
19. Peat & Clay Deposits					■	■	■										■	■	■	■	■	19. Regulated by Agriculture & Extraction Zoning, Subdivision Controls and Building Codes.
20. Bedrock in River Plain					□	■	■	□	□	■	■	■	■	■	■	■	□	■	□	□	□	20. Regulated through Flood Plain, Riparian and Extractive Zoning.
21. Galena Limestone, Deorah Shale & Conglom.					□	■	■	□	□	■	■	■	■	■	■	■	□	■	□	□	□	21. Regulated by Unique Ecology and Scientific and Extractive Zoning.
22. Parks & Wildlife Refuges					□	■	■										□	■	□	□	□	22. In public ownership, zoned Institutional Fee or rights to the acquired, zoned Institutional.
23. Proposed parks, etc.	■	■	■	■	■	■	■	□	□	■	■	■	■	■	■	■	□	■	□	□	□	23. Zoned Institutional.
24. Country Clubs, Golf Courses, etc.					□	■	■										□	■	□	□	□	

METROPOLITAN COUNCIL
Suite 101 Capitol Square Building, Saint Paul, Minnesota 55101
227-9421

MINUTES OF THE METROPOLITAN COUNCIL MEETING
Thursday, June 25, 1970
Council Chambers
2:00 P.M.

*Shows amendments
to draft open
space plan*

PART I - NARRATIVE

ATTENDANCE: Members Present - James L. Hetland, Jr., Chairman; Marvin F. Borgelt, Vice-Chairman; George W. Martens, Treasurer; Joseph A. Craig, Donald C. Dayton, James L. Dorr, E. Peter Gillette, Jr., Reverend Norbert E. Johnson, Milton L. Knoll, Jr., Clayton L. LeFevre, Joseph A. Maun, Glenn G. C. Olson, Mrs. James L. Taylor.

Members Absent - Dennis W. Dunne, George T. Pennock

Staff - Robert T. Jorvig, Executive Director

Roll call was taken and a quorum being present, Chairman Hetland called the meeting to order at 2:10 p.m. The agenda was approved as mailed.

Mr. Gillette noted an error on the June 15, 1970, Council minutes on both the cover page and the first page of the minutes. Instead of reading Thursday, June 15, 1970, the minutes should read Monday, June 15, 1970. Mr. Martens moved and it was seconded that the June 11, 1970, minutes be approved as mailed and that the June 15, 1970, minutes be approved as amended. Motion carried.

313 COMMUNICATIONS

313.1 Owatonna Chamber of Commerce re Airport Site. Received and placed on file was a letter dated June 15, 1970, from Ted G. Ringhofer, Executive Vice President of the Owatonna Chamber of Commerce, favoring a southern site for the proposed new major airport.

314 BUSINESS

314.1 Referrals

314.1.1 Pro Forma Referrals (Exhibits "A" and "B") Chairman Hetland noted one PNRS Referral, St. Paul Park - Park Acquisition, File No. 408; and two referrals not requiring Referral Committee or Metropolitan Council review-- Minnesota Highway Department - CSAH 62 and TH 36 Interchange (Hennepin Co.), File No. 476, and Minnesota Highway Department - Additional 1970 Interstate and Regular Trunk Highway Projects, File No. 490. Mr. Martens moved and Mr. Borgelt seconded

"That the Council approve the chairman's recommendations on the pro forma referrals."

Motion carried.

314.1.2 Committee Reports

314.1.2.1 Review of PCA Permit Application from Johnson Bros. Construction Company for Sanitary Landfill in Blaine, Ref. File #489 (Exhibit "C") Mr. Gillette went over the Committee's report and their action for Council members. He then moved and Mr. Craig seconded

"That the Council approve the Referral Committee's recommendation to approve the Johnson Bros. Construction Company permit application for a sanitary landfill in Blaine on the basis that it is consistent with the Metropolitan Development Guide Solid Waste Management Policies, System Plan, and Program, but this approval be subject to the contractor meeting the conditions contained in their report; and with the understanding that the approval of the sanitary landfill project does not include and is not intended to convey approval of residential development in the lower 80 acres of the site."

Motion carried.

314.1.2.2 Review of PCA Permit Application from 3M Corporation for Industrial Waste Incineration System in Cottage Grove, Ref. File No. 494. (Exhibit "D") Mr. Gillette briefed Council members on the action of the Referral Committee on this matter. He then moved and Mr. Knoll seconded

"That the Council approve the Referral Committee recommendation to approve the wet scrap incinerator application of the 3M Company as being consistent with the Metropolitan Development Guide's Solid Waste Disposal Management Policy, System Plan, and Program."

Motion carried.

314.1.2.3 City of Anoka Northeast Interceptor Construction, Ref. File #491. (Exhibit "E") Mr. Gillette advised Council members on the content of the Committee's report. He then moved and Mr. Craig seconded

"That the Council approve the Referral Committee's recommendation to approve the City of Anoka application for funds to assist in construction of the Northeast Trunk Sanitary Sewer as being consistent with the Sanitary Sewers Section of the Metropolitan Development Guide."

Motion carried.

314.1.2.4 Carver County Application for Acquisition of a Park Site at Eagle Lake, Ref. File #411. (Exhibit "F") Mr. Gillette briefed Council members on the Referral Committee report. He then moved and Mrs. Taylor seconded

"That the Council approve the Referral Committee recommendation that the following comments be submitted to Carver County for attachment to its application for HUD funds to assist in acquisition of the Eagle Lake park site:

'The acquisition of the Eagle Lake park site is mentioned specifically in the proposed Park and Open Space Section of the Metropolitan Development Guide as a water access area of metropolitan significance. This area should be developed to provide at least swimming, boat launching, picnicking activity, and contain adequate sanitary facilities. The acquisition of water access areas in the metropolitan area is a matter of highest priority.'

and also approve the Committee's recommendation that Carver County be commended for its cooperation and assistance in the accomplishment of this park and open space project of metropolitan significance."

Motion carried.

Mr. LeFevre then moved and Mr. Gillette seconded

"That the Council commend Carver County for its cooperation and assistance in securing this park site at Eagle Lake."

Motion carried.

314.1.2.5 Review of Proposed Minnesota Zoological Garden Site, Ref. File #488. (Exhibits "G" and "H") Mr. Gillette explained that the Referral Committee had met just prior to the Council meeting on this matter and briefed Council on the action of the Committee.

"That the Council approve the Referral Committee's recommendation that the proposed Lebanon Hills site be approved as the location of the Minnesota Zoological Garden, and that the State Zoo Board be asked to commit itself to work for provision of bus service, to work with the Transportation Planning Program on coordinating metropolitan thoroughfare construction with the zoo development, and to give serious consideration to the Council's concerns of fees and on detailed site design; and that the Council pass the recommended resolution regarding the zoo site." (See Exhibit "G")

Motion carried.

Mr. Hetland congratulated the Minnesota Zoological Board for implementation of the Development Guide principles to the selection of the zoo site.

Mr. Gillette briefly went over the content of the proposed resolution for the Council members pointing out that it approved the plan for the site location but not the development plan. He then moved and Mr. Knoll seconded

"That the Council approve Resolution 70-20 approving the Minnesota Zoological Board's recommendation for site location of the Minnesota Zoological Garden." (See Exhibit "H")

Motion carried.

314.2 Open Space Section of the Development Guide. (Exhibits "I" and "J")
Mr. Dorr briefed the Council on the resolution adopting this portion of the Development Guide. He then moved and Mrs. Taylor seconded

"That the Council approve Resolution No. 70-21 adopting Metropolitan Development Guide Section and Comprehensive Plan for the Preservation, Acquisition, Development and Regulation of Parks and Open Space in the Metropolitan Area." (Ex. "J")

Mr. Hetland noted that several changes had been suggested by the Hennepin County Park Reserve Board and by Mr. Morgan of the Metropolitan Park Reserve Board. He then briefed Council on the proposed changes and the following motions were made.

Mr. Borgelt moved and Mr. Craig seconded

"That the Council approve the following changes on Page 16:

Paragraph 2, delete the words 'highly metropolitan in nature since they will be' and insert 'generally close in to existing or developing urbanization and'; and

Paragraph 3, changed to read as follows: "The areas in the next grouping contains distinctive and valuable natural features and, though farther away from the populous parts of the Metropolitan Area and at this time less accessible to most residents, they should also be acquired or expanded to help serve present and future recreation needs."

Motion carried.

Mr. Dayton moved and it was seconded

"That the 3 sites noted in parenthesis after the listing of Mississippi River under Hennepin County on Page 18 be specified and listed."

Motion carried.

Mr. LeFevre moved

"That on Page 16 Lake Rebecca and Baker Lake be moved from the second category to the first category and that the Blue Lake-Eagle Creek listing in the first category also include Fisher Lake and Rice Lake."

Motion carried.

Mr. Gillette moved and Mr. Knoll seconded

"That the first sentence in Paragraph 1 of the 'Introduction' on Page 2, should be amended to read,

'This comprehensive plan for metropolitan parks and open space is part of the Council's Metropolitan Development Guide and is intended also to carry out the Council's responsibilities under Laws 1969, Chapter 1124.'

Motion carried.

A vote was then taken on the original motion to adopt the resolution adopting this section of the Guide. Motion carried.

314.3 Assignment of Additional Duties to the Transportation Planning Program Policy Advisory Committee. (Exhibit "K") Chairman Hetland noted that action on this matter had been tabled at the last meeting and a motion was needed to lift it from the table for consideration at this time. Mr. Borgelt moved and Mrs. Taylor seconded

"That the Transportation Planning Program Policy Advisory Committee matter be taken off the table for consideration at this time."

Motion carried.

Mr. Hetland explained the proposed assignment of additional duties and procedures as to appointment of members and terms thereof. In the discussion, it was noted that Item #3 on top of Page 2 that the words "City Council of" should be inserted after the first "The" in the sentence.

METROPOLITAN COUNCIL
Suite 101 Capitol Square Building, Saint Paul, Minnesota 55101
227-9421

MINUTES OF THE DEVELOPMENT GUIDE COMMITTEE

Thursday, June 18, 1970
Council Offices
2:00 P.M.

*Discusses
Changes
to the 1970
Guide*

Attendance: Members Present: Donald Dayton, James Hetland, Glenn G.C. Olson

Members Absent: James Dorr, Clayton LeFevre, Joseph A. Maun, Mrs. James Taylor

Staff: Robert Jorvig, Ed Maranda, Barry Peterson, Arnold Alanen, Sandy Dean, Ken Reddick, Josephine Groettum

Guests: Samuel Morgan, Chairman, Metropolitan Park Reserve Board

Press: Sharon Blinco, Peter Ackerberg, John Kelly

Mr. Hetland, Acting Chairman, called the meeting to order at 2:00 P.M. He told the members of the Committee that the main subject for review today were the changes to the Development Guide Chapter on Open Space suggested as a response to the Public Hearing on May 28, 1970.

Mr. Hetland said he felt that the government responsibility should be defined in the introduction. He said that the municipalities and counties want to know who has the responsibility for doing what. Mr. Hetland then read a statement which he had prepared defining and explaining the levels of service. It was the consensus of the members of the Committee that this statement should be included in the revised Chapter of the Guide in the introduction.

A memorandum was distributed to the members of the Committee including a few additional suggested changes. One of the changes was an expanded list of "First Priority" sites together with added designations. Mr. Morgan made comments on each of the sites explaining that the Board members had visited most of them. He felt that the MDG should concern itself with all major park sites, not only those close in to the Cities, but also where there may be development in the more distant future.

After discussion, the members of the Committee and Mr. Morgan suggested that Minnesota River Valley Trail be added to the list of First Priority.

There was discussion concerning the advisability of using the designations "First Priority", "Second Priority" and "Third Priority." It was felt that it might discourage communities from involving themselves actively in acquiring sites, if their site were designated as a Second or Third Priority.

whereas the purpose is to encourage such activity. Mr. Morgan said that the MPRB did not feel strongly about this. He said when they developed their five-year plan for presentation to the Legislature, they would have to have a Plan. Mr. Morgan said the Board wanted to take action on Anderson Lake, Lake Elmo and the Rice Creek Watershed during the next year. With their five-year program, they would hope to receive bonding authority and funds from the Legislature, which might be available in October of 1971.

It was the consensus of the Committee members that in the Systems Plan the listing of priorities be abolished and sites be grouped instead on the basis of their accessibility and natural attributes.

It was further agreed that in the Program section of the Guide the Lake Elmo, Anderson Lakes and Rice Creek-Lino Lakes locations be listed as places where the Park Reserve Board would concentrate their efforts during the July 1, 1970 - June 30, 1971 period.

The members of the Committee suggested that the Map of the Metropolitan Open Space Plan should have a date on it and also that the primary source/s of the information be printed on the Map. Other changes necessary to clarify the intent of the map will also be made.

The Committee then went over the comments and suggestions of the staff and recommended changes were noted. The staff will prepare a revised draft of the Metropolitan Development Guide for Parks and Open Space in accordance with these recommended changes and submit this to the Council for approval.

Mr. Maranda presented a suggested Schedule for the Development Guide Committee for July thru December, 1970. It was decided to follow this after changing the discussion on Government Structure to October 1 and 15, and that on Finance to November 5 and 19.

Mr. Hetland suggested that because of the deadline for the publication of the chapters of the MDG, the Guide Committee may have to set up a day-long meeting to expedite matters.

The next meeting of the MDG Committee will be on July 9, 1970 at 2:00 P.M. The subject for discussion will be The Transportation Element of the Physical Development Structure.

The meeting was adjourned at 5:10 P.M.

/jg
6.19.70

METROPOLITAN COUNCIL
Suite 101 Capitol Square Building, Saint Paul, Minnesota 55101

RESOLUTION NO. 70-

RESOLUTION ADOPTING METROPOLITAN DEVELOPMENT GUIDE SECTION AND COMPREHENSIVE PLAN FOR THE PRESERVATION, ACQUISITION, DEVELOPMENT AND REGULATION OF PARKS AND OPEN SPACE IN THE METROPOLITAN AREA.

BE IT RESOLVED as follows:

1. The Metropolitan Council is authorized and directed by Minnesota Statutes, Section 473B.06, after appropriate study and such public hearings as may be necessary, to prepare and adopt a comprehensive development guide for the metropolitan area; and is authorized and directed by Minnesota Laws 1969, Chapter 1124, Section 3, after public hearing, to prepare and adopt a comprehensive plan for the preservation, acquisition, development and regulation of parks and open space in the metropolitan area.

2. The Council has studied the past and probable future development of the metropolitan area, and has considered the best and most economical use of land and other natural resources in the area. The Council has also held a public hearing on its proposed comprehensive plan for the preservation, acquisition, and regulation of parks and open space in the metropolitan area, comprising that portion of its proposed comprehensive development guide for the metropolitan area which relates to parks and open space, upon notice published as required by law, at which hearing it has allowed all interested persons to present their views.

3. The Council has examined the comments and suggestions made at the hearing with respect to the proposed comprehensive plan and development guide and has made certain changes in the proposed comprehensive plan and development guide to give effect to some of these comments and suggestions, by clarifying and modifying some of the policies and statements in the plan and guide. A revised comprehensive parks and open space plan and development guide section containing such changes and dated June 25, 1970 has been prepared and presented to the Council, together with a statement of the reasons for such changes.

4. The parks and open space comprehensive plan and development guide section, as revised and dated June 25, 1970, is reasonable and lawful, and should be and is hereby adopted pursuant to Minnesota Laws 1969, Chapter 1124, Section 3 and Minnesota Statutes, Section 473B.06, respectively.

Approved by the Metropolitan Council

This 25th day of June, 1970.

By _____
James L. Hetland, Jr., Chairman

By _____
Robert T. Jorvig, Executive Director

ama
6.24.70

METROPOLITAN COUNCIL
Suite 101 Capitol Square Building, Saint Paul, Minnesota 55101
227-9421

MEMORANDUM

June 12, 1970

SUBJECT: Comments from the May 28th Public Hearing Relative to the Open Space Plan

The following comments are summarized accounts of suggestions made by various individuals and groups at the May 28th public hearing. In addition, subsequent comments which have been made by a four member committee of the Metropolitan Park Reserve Board are included. Staff suggestions are found within the parenthesis, while the revised copy of the Guide spells out the changes in detail.

1. Cover page and page 2: The Minnesota Recreation and Park Association and Hennepin County Park Reserve District (HCPRB) recommend that the word "parks" be deleted. (Given the nature of the enabling legislation, this should not have to be debated further; however, in certain parts of the text, the words "open space" should be used without the modifier "parks.")
2. Page 2: Metropolitan Park Reserve Board (MPRB) suggests that the third paragraph read: "Part II contains the parks and open space system plan so far as it relates to conservation and recreation open space. It describes specific needs and identifies sites recommended for preservation, acquisition and development for recreation and conservation purposes. As new information becomes available through additional research and experience, additions and amendments may be made to both the system plan and policies, and as amenity and production open space studies develop, further additions will be made to the system plan incorporating those elements to the extent deemed appropriate." (Although defining and spelling out the various components of an open space system in the introduction is basically a good idea, it is quite obvious that the average reader of this Guide, without further descriptive material, might have difficulty in determining what is meant by the various categories of open space. Therefore, it is recommended that any mention of open space functions be left for the following sections of the Guide where they can be explained in greater detail. The suggestion to change "protection open space" to "conservation open space" would modify the entire meaning of the Guide since protection open space refers to the management of open space areas for

the protection of man and his environment; conservation open space relates to the management of areas for their scientific and educational value).

3. Page 2. Minneapolis Planning Commission recommends that the last sentence, "It is hoped for specific planning and development," be deleted from this section of the guide and included in the general introduction to the entire Guide. (This is the same format that has been used throughout the Development Guide).
4. Page 3: HCPRD wants to know what is meant by a "natural vital function for man." (The wording is awkward and could be clarified by stating "natural functions vital to man.")
5. Pages 3 and 4: HCPRD argues that recreation should be the primary purpose for expending public open space funds and by preserving "park open space" they feel most of the protection objectives will be realized as well. They also are concerned with the reasons for open space listed on pages 3 and 4. By listing "recreation" along with "visual relief", they claim that recreation doesn't appear to be capable of standing by itself. Minneapolis Planning Commission also states that all open space should be people-oriented and all policies should be directed to this issue. (Several changes in language are recommended but taken as a whole, the system introduction does not seem to require further change.)
6. Page 5: HCPRD wants to know who is to identify and supply the recreation facilities to meet the "needs of the people who live there." (Although it is not the intent of this section to point out specific roles, it is recommended that a paragraph be added: "Development of a metropolitan open space system depends upon active participation by all levels of government. No single agency has sufficient resources to acquire or preserve the entire system, but through cooperation and joint funding, an extensive open space system can be developed. Participation by many public agencies and units of government will also assure that the system is responsive to a variety of needs throughout the metropolitan community.")
7. Page 5: HCPRD wants to know why intense use of open space facilities in the central city is mentioned as a fact when the plan contains no such facilities. (The plan does not depict "intensities"; a local facility would most likely be intensively used. Also, the same sentence mentions the need for providing public transportation to open space areas further away).

8. Page 5, Policy I: HCPRD wants the first policy statement to recognize that a metropolitan park and recreation system should be the primary component of a public open space system. (No. This would require an entirely different orientation for this section of the Guide.)
9. Policy I: Minneapolis Planning Commission feels that the policy doesn't spell out if the metropolitan agency or combined local and regional units in the area are to implement the plan; suggest that "operate" be replaced with "coordinate." (To conform to the enabling legislation, it is suggested that the policy read: "PLAN, COORDINATE, DEVELOP AND OPERATE AN OPEN SPACE SYSTEM THAT MEETS LOCAL AND METROPOLITAN OPEN SPACE NEEDS. THE SYSTEM SHOULD BE BASED ON THE NATURAL CHARACTERISTICS AND FUNCTIONS THAT THE LAND PERFORMS.").
10. Policy 2: Anoka County recommends that the words "to the extent that they are financially capable of doing so" be added to end of sentence. (This thought is implied in the present policy and should not have to be spelled out).
11. Policy 5: ^(now pg. 6) Anoka County suggests replacing the word "most" with "economically". (The best use of open space is not based solely on economics; however, the first "the" and the word "most" should be eliminated for purposes of clarification).
12. Policy 6: Anoka County recommends extra sentence, "Projected future population for this purpose shall be based on published and adopted (after appropriate hearings) land use assumptions of the Metropolitan Council." (A statement relating to the entire Development Guide -- which will be adopted after public hearings -- would appear to be better located elsewhere in the Guide).
13. Page 5, New Policy and Paragraph: Anoka County; Representative Vernon Plaisance; Metropolitan Section, League of Municipalities; City of Coon Rapids; Anoka County League of Municipalities; City of Anoka; Anoka Area Chamber of Commerce and City of Blaine call for changes in fiscal matters relating to open space and other areas of concern. (This is an issue of foremost significance and is currently being studied by the Metropolitan Council. Additional material in the text, as well as a new policy should be included. A new paragraph after the first three lines on page 5, should read: "Tax incentives and concessions to land owners would help relieve some of the economic pressures that force prime open space land into development. Over short periods of time, the use of tax concessions may conflict with the need of local units to raise revenue; however, the loss of some current revenue through tax

concessions may, in the long run, save considerable amounts of money by reducing future expenditures for open space. In addition, tax base disparities can occur when a significant part of a community is reserved as a large open space facility, therefore removing it from the tax base. Real or imagined disparities, however, must be evaluated in light of the broader view of fiscal disparities that exist in the whole Metropolitan Area, and corrective action should be taken through a comprehensive program of tax and revenue reform rather than on a piece-meal basis."

New Policy 8 ENCOURAGE TAX CONCESSIONS FOR LAND PERMANENTLY COMMITTED TO OPEN SPACE USE THAT IS CONSISTENT WITH THE METROPOLITAN OPEN SPACE PLAN.

Policy 9: NOTE ADDITIONAL WORDS RECOMMENDED BY MPRB.

14. MPRB calls for the inclusion of a new policy: "Plan for the preservation, through coordinated planning of recreational, production and amenity open space, and through the use of all appropriate tools -- fee acquisition, acquisition of scenic easement or development rights, tax policy, zoning, subdivision regulations, building permit policy, sewer, highway and major centers planning -- for the preservation of a large part of the metropolitan area as open space to define and shape urban areas and to bring "country" close to as many of our citizens as possible." (The first part of the policy focuses upon issues which are explained in following portions of the Guide; the latter portion of the policy was already subjected to considerable discussion during February).
15. Page 6: MPRB recommends that the heading "Compatibility With Urban Development" be changed to "Conservation Open Space" (The difficulty of changing the functional category of "protection open space" to "conservation open space" has been discussed in comment Number 2. However, several of the current titles do not directly describe the open space function contained in the discussion; therefore, it is recommended that the title read "Protection of Man and His Environment").
16. Page 6: City of Coon Rapids calls for additional research in determining the wetlands-water recharge relationship. (The FIRST PARAGRAPH ON Pg. 7 and Program 10g meet this request.)
17. Pages 6 and 7 and elsewhere with respect to protection open space: City of Coon Rapids states that development of wetlands is occurring and will continue unless vast acreages come under public ownership; suggest that any new development be "compatible" development - i.e., low density residential not requiring extensive draining. (The text should state that most protection areas will not be incorporated into the open space system through purchase. Two sentences after the first sentence in the last paragraph of page 7 should be added: "Zoning and subdivision regulations which seek to protect such areas from incompatible forms of development, should be adopted and enforced by all units of government. However, certain key natural process areas and areas which will be subject to other, more intensive open space uses, as trails, will have

to be protected through the purchase of easements or, if necessary, full rights").

18. Page 7, Policy 9: ^(New Policy 10) ^ Anoka County suggests "Where feasible" be added to beginning of policy. (The two words would weaken the policy intent considerably).
19. Policy 10: ^(New Policy 12) ^ Anoka County advocates a complete revision of the policy to read as follows: "Zone unprotected parts of floodplains to minimize restriction of water carrying capacity and public hazards resulting from inundation." (The word "minimize" qualifies the statement too much and would weaken most floodplain legislation. Original language is consistent with state law.)
20. Policy 11: ^(New Policy 13) ^ Anoka County recommends that "Where feasible" be placed at beginning of sentence and "where feasible" after first comma be removed. (This would permit the further indiscriminate conversion of natural drainageways into covered storm sewers or concrete drains -- one of the primary acts which the Guide seeks to discontinue).
21. Policy 12: ^(New Policy 15) ^ Anoka County wishes to add "wherever feasible" to the end of the policy. The City of Coon Rapids recommends that the policy read: Preserve and manage the use of "those wetlands for which there is no economically feasible development or which do not have a higher and better use" and major (The wording ".....to ensure the continued performance of their natural functions", does not preclude all development, only development that would interfere with "continued performance.").
22. Policy 12: ^(New Policy 15) ^ The League of Municipalities recommends that the policy begin with the word "Identify" since it is impossible to preserve and manage aquifer recharge areas until they are identified. (The policy is a logical response to the problem statement and the "identification" is included in Program 10g.).
23. Policy 14: ^(New Policy 11) ^ Anoka County advocates a rather complete revision of the policy which would state: "Wherever a critical protection open space need is shown, restrict development therein to types that are consistent with critical natural protection functions." (This would weaken the policy considerably since it would probably permit development in all protection areas.)
24. Policy 15: ^(New Policy 11) ^ Anoka County wishes to add the words, "to insure development consistent with critical natural protection functions" at the end of the policy statement. (This would involve an argument for a policy within the policy itself, which is inconsistent with the format adopted thus far.)

New Policy 16 New Policy 11

25. Policies 13, 14, 15: The League of Municipalities recommends that the three policies be combined into one to read: "Adopt and apply development location, design and operating controls for all designated protection open space areas." (Policy 13 should be retained since it refers to specific conditions of a particular protection open space element; the words "and avoid slope slippage", should be added at the end of the sentence for further clarification. Policies 14 and 15 can be combined, however, into a new statement: ADOPT AND APPLY DEVELOPMENT, LOCATION, DESIGN AND OPERATING REGULATIONS TO CONTROL DEVELOPMENT IN DESIGNATED PROTECTION OPEN SPACE AREAS.

New Policy 14

26. Page 8, Policy 17: [^] Anoka County suggests that "adoption" be crossed out and "preparation of model" be added. ("ADOPT REGULATIONS TO MANAGE DEVELOPMENT OF DRAINAGEWAYS, RIVERS AND STREAMS". As written, supports Program 10a, which calls for preparation of models).
27. Page 8: MPRB recommends that heading, "Natural Resource Based Production" be changed to "Production Open Space." (To conform with other headings, the title should read, "Open Space for Production").
28. Page 8: MPRB recommends that the words "solely for its production value," be added between the words "time" and "since" in the second sentence of the third paragraph. (Agreed)
29. Page 8: ^{New Page ?} [^] MPRB suggests that heading, "Scenic Areas" be changed to "Amenity Open Space." (Agreed: The heading on Page 9 should also read, "Conservation of Natural Resources and Historic Areas").
30. Page 8: ^{New Page ?} [^] MPRB says farm lands should be added to the list of scenic or amenity areas.
31. Page 9: MPRB recommends that the first sentence be eliminated. (Agreed).
32. Policy 19: MPRB suggests that the policy state: "Preserve amenity open space both, a) for its own sake and b) as an important element in "urban shaping." (Point a is inferred in the policy as it currently reads; for point b, refer to the staff comment in the latter part of Number 14).

33. Page 9, Policies 19 and 20: Anoka County wishes to add "Where feasible" at the beginning of the policies. (This appears to be unnecessary since it is implied in the policy already.)
34. Page 10, Policy 22: Anoka County suggests that the word "appropriate" be added between "maintain" and "conservation." (The word does not add to the meaning of the policy).
35. Policy 24: Anoka County calls for the words "as appropriate with respect to total need and location" at the end of policy. (Same reason as above).
36. Policy 26: Anoka County recommends that "Where feasible" be added at the beginning. (Same reason as policies 19 and 20).
37. Page 10: ^{New Pages 10 + 11} HCPRD says the statement which refers to parks being designed to serve local populations does not recognize the nature and purpose of HCPRD sites. (The text says: "Most of the existing close-in parks where the bulk of the major recreational facilities are located....." This appears to be sufficiently clear.)
38. Page 11. HCPRD wants to know why only Hyland of the HCPRD sites is listed and what criteria were used to lump Minnehaha, Fort Snelling and Hyland together. (There was no intent to make an exhaustive list of facilities serving regional or wider area needs; these sites are only listed as examples).
39. Page 11: HCPRD recommends that entire third paragraph be re-written since the words "it is possible" contain a very erroneous thought. (Although the words "it is possible" are not found in the text, it is assumed that the HCPRD is referring to the words "...it seems pointless"... Refer to comments in Number 41.)
40. Page 11: Dakota County, Izaak Walton League, Minnesota Recreation and Park Association, Minneapolis Planning Commission and HCPRD, referring to paragraph 3 and other sections of the Guide, request that the open space roles of various governmental units be spelled out in detail. (Doing this at the present time would result in a very rigid, non-flexible hierarchy. It is difficult to see how such a system could be agreed upon by the various governmental units, given the vast differences in needs and resources. However, refer to the comment in Number 41.)
41. Page 11: Minneapolis Planning Commission is focusing upon the first 4 words of the 3rd paragraph, "Population and tax resources...", asks why there is only a reference to tax resources and no comment as to the quantity of the population or the financial characteristics of that population. (It is suggested that the following changes be made in the

third paragraph: "At this point in the development of a metropolitan open space system, it is impossible to identify various responsibilities for different levels of government. Since tax resources, population characteristics and social needs are not neatly distributed on the basis of governmental hierarchy, a descriptive breakdown of responsibilities will not help solve the basic problem: the shortage of adequate recreation open space. All levels of government, municipal, county, state, and federal -- should continue to develop recreation facilities that are of significance for the entire Metropolitan Area. For this reason it is important that planning for facilities be done on a metropolitan scale and that the metropolitan recreation open space plan be followed by all levels of government interested in providing open space facilities to serve the metropolitan population or a major segment of it".)

42. Page 12: HCPRD wants to know if it is appropriate to advocate high cost recreation activities for low income residents without defining the problem or recommending solutions. (The text does not recommend high cost recreation activities for low income population, but rather the reverse -- see Policy 29 and the comment for Number 43.).
43. Page 12 and entire recreation section: Thomas Kelley, Ramsey County Auditor, says the needs of people -- and especially the poor -- should be considered to a greater extent. Funding should be based on social needs with smaller, inner-city areas being considered for metropolitan funding. (The third and fourth sentences of the first full paragraph on page 12 should be replaced with the following: "In addition, residents of densely settled urban areas have very little open space and few recreational facilities available. Therefore, recreational facilities for the Metropolitan Area must be evaluated on the extent to which it actually serves the needs of the people, without costly travel or substantial personal outlay for equipment and user fees.").
44. Page 13, Policy 29: Anoka County advocates that "priority" be replaced with "appropriate consideration" (It seems appropriate to first meet the needs of the greatest number of people.)
(New Policy 32)
45. Policy 31: Anoka County wishes to add a new sentence, "Water bodies qualifying as public access priority shall be designated on the basis of criteria adopted by the Metropolitan Council (after appropriate hearings). (This appears to be irrelevant since water access areas -- along with other open space elements -- are all subject to review through the public hearing procedure and will be acquired only after consultation with affected local officials).

(New Policy 31)

46. Policy 32: ^ Anoka County recommends that an additional sentence be included, "Criteria for location of such facilities shall include consideration for a balance of accessibility throughout the Metropolitan Area." (If the request is for an equal degree of accessibility throughout the Area, the comment is best directed to the appropriate Guide chapter).

(New Policy 34)

47. Policy 33: ^ Anoka County wishes to add, "except in those instances where the public funds are purely local" at the end of the policy. (Although this does have merit in certain instances, such a qualifying statement should not appear in the Guide).

(New Policy 35)

48. Policy 34: ^ Anoka County suggests that the word "plan" at the end of the sentence be replaced by "planning process." (Coordination should be based on specific, adopted material).

(New Policy 36)

49. Policy 35: ^ League of Municipalities suggests that the word "exclusively" be deleted since many projects of local significance are often of greater geographical significance; suggestion that "sub-metropolitan" or "sub-regional" might be better than local. (The word "exclusively" should be removed).

50. Page 14: HCPRD says that the trail system should receive further consideration. (Recommend additional policy relating to trails: Policy 33: WHEREVER FEASIBLE AND WHEN CONSISTENT WITH THE METROPOLITAN OPEN SPACE PLAN, ACQUIRE TRAIL-RIGHTS-OF-WAY WITH SEWER AND OTHER UTILITY EASEMENTS. In addition, a number of potential trails should be added to the plan map and a supporting paragraph at the top of page 13 included: ("At the present time, the Area does not have an extensive trail network for hiking, bicycling, snow-mobiling, snow-shoeing, cross-country skiing, and horseback riding. Many of the linear features of the landscape, such as stream and river valleys, bluff lines and utility and railroad rights-of-way are under-utilized. These could be developed into a quality trail system connecting major open space areas at a relatively low expenditure, thus opening a whole new range of recreational opportunity within the Metropolitan Area.").

- 51: MPRB wishes to add the following to the recreation section: "The metropolitan open space plan must include and take into account all types of recreational facilities -- from tot lots and small municipal nature sanctuaries through county and regional facilities to state and federal parks and recreation areas.

On the other hand the Metropolitan Park Reserve Board must determine

those areas of recreational open space needs it will assume direct responsibility for -- that is, what the kinds of need it will meet through its own programs of fee and easement acquisition and development and operation.

Existing and presently planned programs suggest general lines of division.

Playgrounds, athletic fields, tot lots, ice arenas, city type parks, even, often public swimming facilities, particularly swimming pools are generally people-oriented rather than nature oriented. Communities and counties have largely assumed these responsibilities. They should continue to bear them.

On the other hand, the state and federal governments are already playing important roles in the protection of our major rivers. The St. Croix, in the metropolitan area is under study for inclusion in the federal scenic river program. The federal government has a primary type scenic area recreational study under way. The States of Minnesota and Wisconsin have and are acquiring major park lands on the St. Croix, e.g. Afton. On the Mississippi the state has acquired a large area, Fort Snelling State Park, at the confluence of the Minnesota and Mississippi and a Minnesota Valley State Trail and park system has been authorized by the Legislature for the Lower Minnesota River.

However, only The Metropolitan Park Reserve Board can be the agency to acquire, particularly outside the river valleys, the major park reserves. Only this Board can plan and see to the implementation of a metropolitan system of trails and probably only through metropolitan level action can an adequate number of public water access sites be secured.

POLICIES: Recreation Open Space

1. Define generally the areas of primary direct governmental responsibilities for recreation open space and facilities establishing kinds and levels, namely:
 - a. Encourage strong federal and state participation in acquiring and developing conservation and recreation open space in the three major river valleys.
 - b. The Metropolitan Park Reserve Board responsibilities will be primarily the establishment of (1) large park

reserves, (2) certain water access sites, (3) metropolitan trail system. Specialized facilities, such as zoo, ice arenas, etc. will be largely the responsibilities of other agencies.

- c. The primary county responsibilities would include establishing and maintaining bathing beaches and specialized and intensive recreational facilities such as golf courses, ice arenas, etc.
 - d. The primary municipal responsibility would be establishing and maintaining city type pools, playgrounds, tot lots, city parkways, etc.
2. Establish and apply criteria for park reserves and their development including the following:
- a. Acquire, generally, areas of sufficient size and natural attractiveness to make feasible preservation of the park area in primarily a natural condition.
 - b. In development minimize disturbance of natural environment and features.
 - c. Generally limit development for intensive recreational use and ancillary parking and roads to no more than 20% of major metropolitan park reserves.
 - d. Give priority in the expenditure of limited funds to acquisition over development until substantial areas have been acquired for the metropolitan administered system.
3. IDENTIFY AT THE METROPOLITAN LEVEL THOSE RECREATION FACILITIES LIKELY TO ATTRACT USERS FROM THROUGHOUT THE METROPOLITAN AREA AND COORDINATE ACQUISITION AND DEVELOPMENT OF SUCH FACILITIES.
4. ENCOURAGE AGENCIES AND ORGANIZATIONS WITH AUTHORITY TO PLAN AND ACQUIRE RECREATION AREAS ADJACENT TO THE METROPOLITAN AREA BUT OUTSIDE ITS BOUNDARIES TO DO SO.

(These comments were discussed by the Development Guide Committee when the Guide was being drafted in February and March.)

52. Page 15: HCPRD recommends that the entire system plan portion be rewritten relating to the various roles of government (As defined in the policies section this is not the intent of the Guide at present.)
53. Page 15: MPRB recommends that editorial revisions be made in the first two paragraphs. (see Guide text).
54. Page 18: ^(Now Page 15) Metropolitan Park Reserve Board recommends that the protection and recreation sections of the system plan be reversed in order. (This is a logical assumption since most effort -- in terms of Park Board activity at this time -- will focus upon acquisition of sites listed in the recreation section).
55. Page 16: ^(Now Page 20) Anoka County points to the 3rd paragraph which states that the largest concentration of protection elements is found in Anoka County. They feel that since the Guide states that such areas "merit immediate preservation action", the supposition is not supported by further narrative within the Guide or by any professional study (The protection areas have been determined by using the most sophisticated techniques which are available and their existence is fact, not opinion. The "immediate preservation" refers to area all around the region that is under the greatest development pressure. Reference to Anoka County is deleted in Guide).
56. Page 16 and 17: ^(Now Page 21) Anoka County seemed to think that the entire watershed is to be protected. (The text should emphasize that it is the protection elements within the watershed which are of concern. The last sentence in the paragraph could read: "It should be emphasized that it is the protection elements within these general areas which require immediate protection action").
57. Page 17: ^(Now Page 22) League of Municipalities, in considering the last sentence, takes exception to the words ".....it will be necessary that uniform policies and regulations be adopted and enforced by all units of government!" They suggest that the text should emphasize policies and regulations which meet, exceed or are not in conflict with state and regional regulations. (The sentence could read, "Since mostthrough regulatory action, all units of government that manage land development will have to adopt and enforce development regulations that meet or exceed state and regional standards or models."
58. Page 15 - 18: ^(Protection Section) City of Blaine, Anoka County, City of Coon Rapids, Anoka Area Chamber of Commerce indicate once again that the protection areas should not be designated unless it is intended to purchase all areas. (To alleviate this misinterpretation somewhat, it is recommended that protection open space not be indicated as public open space on the map.)

(Now Page 15)

59. Page 18: ^ Minnesota Recreation Association says that recreation open space appears to be oriented toward passive activities; they feel that if active recreation is to be left out, it should be indicated. (It would appear that the MRA may be defining "Active Recreation" as games and group sports activities. If this is true, it is not intended that the Board be involved significantly in providing playground-type facilities and, as is stated on page 11, first paragraph, these should continue to be provided by municipalities.)
60. Pages 18 and 19: ^ (Now Pages 16, 17) Metropolitan Park Reserve Board and HCPRD recommend certain changes in park priorities; the HCPRD also wants their existing sites incorporated into the scheme. St. Paul, Minneapolis Planning, and Ramsey had similar concerns relating to parks and water access areas. (Suggested priority system is listed in the Guide).
61. Page 20: ^ (Now Page 17) City of Coon Rapids wishes to remove the Crooked Lake water access area from the list since they feel it is a small, relatively shallow lake. Coon Rapids currently has a small access site along the lake and only permits the launching of boats which are carried by hand to the shore. (Both the Council's ecological study and the Minnesota Department of Conservation list Crooked Lake as a high quality fish lake. Since qualitative as well as quantitative factors have been considered in determining the water access areas, it does not seem appropriate to eliminate Crooked Lake without doing the same to a number of other relatively small, but high quality lakes. Funding for projects on such lakes should be aided by metropolitan status).
62. Page 21: ^ (Now Page 19) MPRB recommends new sentence at the end of the water access area discussion: "In most instances, these water access areas should be acquired and operated by counties or municipalities." (Included in revised Guide).
63. Page 22: ^ (Now Page 19) MPRB suggests additional sentence in describing the trail network: "The network as shown on the map, therefore, is subject to changes in general location as detailed plans begin to be developed in cooperation with local governments." (Included in the Guide).
64. Page 26: The Minnesota Recreation and Park Association hopes that all plans, goals and objectives will be outlined and reviewed annually. (This will be stated in the introduction to the entire Guide.)

GENERAL COMMENTS

65. The City of Blaine recommends that the Council request legislation which places a limit on the amount of money the Metropolitan Council can spend for open space acquisition and that the Council recover and destroy all copies of the proposed open space plan map.
66. St. Paul Port Authority claims that sufficient liaison has not been established and requests no final action until possible conflicts between the open space plan and the Authority's development programs for Pig's Eye Lake and the Northport areas have been resolved.
67. Dakota County, City of Minneapolis, Anoka County League of Municipalities and the City of Anoka, and the City of Coon Rapids feel that the input of local professional staffs and elected officials should be considered to a greater extent.
68. HCPRD feels the Council should propose what future status of the HCPRD will be.
69. HCPRD feels that responsibility for shaping and guiding urban development is delegated to the Park Reserve and feels that the Board should focus on parks and recreation.
70. Minneapolis Planning Commission believes that the "shaping" of urban development should be stressed to a greater extent.
71. HCPRD states that the Guide has to assign responsibilities and define procedures. Specifically this includes the 1) identification of assets (natural, personnel, management, operational and facilities) to be included in the system plan, 2) recognition and ratification of other agency's plans in the system plan, 3) definition of the responsibilities and authority of existing agencies in implementing the system plan.)
72. Minneapolis Planning Commission feels that local units which finance open space facilities that serve regional needs should be excused from meeting the cost of acquiring new metropolitan facilities and/or have their operations financed at the metropolitan level.
73. MPRB recommends additional program item: "Initiate immediately, in collaboration with Ramsey, Anoka and Washington Counties, the Rice Creek Watershed District, and local governments concerned, a comprehensive plan for protection of the Rice Creek-Line Lakes Watershed, including related public ownership areas within the area.

Metropolitan Development Guide

PARKS and OPEN SPACE Policies, System Plan, Program



Adopted by the Metropolitan Council June 25th, 1970

TABLE OF CONTENTS

	Page
Introduction.....	2
Policy Index.....	3
Part I: Long-Range Policies.....	4
Metropolitan Park and Open Space System.....	4
Protection of Man and His Environment.....	7
Open Space for Production.....	9
Scenic Open Space.....	10
Conservation of Natural Resources and Historic Areas.....	11
Open Space for Recreation.....	12
Part II: System Plan.....	16
Open Space for Recreation.....	16
Trail Network.....	21
Protection Open Space,.....	21
Part III: Program.....	25
Long-Range Objectives.....	25
Short-Range Objectives.....	25
Definitions.....	28

Preparation of this report was financed
in part through a comprehensive plan-
ning grant from the Department of
Housing and Urban Development.

INTRODUCTION

This comprehensive plan for metropolitan parks and open space is part of the Council's Metropolitan Development Guide and is intended also to carry out the Council's responsibilities under Chapter 896, Session Laws of 1967, and Chapter 879, Section 4, Subdivision 4, Session Laws of 1969. The parks and open space plan consists of three parts, setting forth policies, a system plan, and a development program.

Part I contains long-range policies as general guidelines to ensure proper planning for the use of open space in the Metropolitan Area. The text specifies a wide range of open space-related problems and deficiencies that can be corrected if the Council, the Metropolitan Park Reserve Board local government units, and private developers in the Metropolitan Area implement the parks and open space policies.

Part II contains the parks and open space system plan. It describes specific needs and identifies sites recommended for preservation, acquisition, and development. As new information becomes available through additional research and experience, additions and amendments may be made to both the system plan and the policies.

Part III contains the development program; the timetable for the implementation of the comprehensive plan.

The Metropolitan Park Reserve Board, a seven-member advisory body appointed by the Council, assists and advises the Council in the preparation of the plan. The Park Reserve Board will, based upon the Parks and Open Space Chapter of the Development Guide, assist the Council in coordinating the acquisition, development, and regulation of the metropolitan parks and open space system. The Council and the Board will cooperate with and provide technical assistance and advice to local government units. The Council will use the parks and open space chapter and other relevant parts of the Guide to review referrals from governmental units. It is hoped that private decision makers will use the Guide for specific planning and development.

Due to limitations of existing legislative directives and authority, it is not possible at this time to determine ways to assign state, metropolitan, county, or local governmental levels with responsibility for implementing parts of this plan through land acquisition or management. Until specific responsibilities are authorized or agreed upon, it is hoped that all levels of government and private organizations interested in or charged with responsibility for providing or maintaining park and open space areas will undertake to implement this plan or coordinate their plans with it.

POLICY INDEX

This is an index to the policies contained in this parks and open space chapter of the Metropolitan Development Guide. Policies are grouped by topic in order to aid the user in quickly locating all policies bearing on a particular subject area.

SUBJECT	POLICY	PAGE	SUBJECT	POLICY	PAGE
Beautification	19	10	priorities for preservation and acquisition	4	7
	20	10		29	15
Educational Programs	23	12		32	15
	25	12		36	15
Historic Areas	26	12	taxation of	8	7
Conservation	22	12	conversion to other land-use	9	7
	23	12			
	24	12			
Lakes	32	15	Parks (see Recreation facilities)		
Mining	18	10	Recreation facilities (see also Trail System)	27	15
				29	15
Flood Plains	12	9		30	15
				32	15
				34	15
Open Space coordinated planning and development	1 2 3 6 7 28 35	6 6 7 7 7 15 15	location of	31	15
			coordination of	35	15
			priorities for		
			acquiring	36	15
			Rivers (see Floodplains)		
			Storm water runoff	13	9
				14	9
				17	9
Land-Use Controls means of preservation	5 10 11 12 13 15 16 33	7 9 9 9 9 9 9 15	Trail System	33	15
			Urban Development		
			compatibility with natural surroundings	10	9
				11	9
				15	9
				16	9
				21	9
			Utility Easements	14	34
			Wetlands	8	16
			Zoning (see Open Space - means preservation)		

PART I: POLICIES

A METROPOLITAN PARK AND OPEN SPACE SYSTEM

Open space is "breathing space." It is open land noted for its natural beauty and scenic value. It is open land for recreation, and land where our resources are protected, preserved, or put to productive use. It is land that performs natural functions vital to man.

Open space, like the diamond, can frequently be divided or changed in use and still keep beauty and purpose, but only after carefully weighing the effect of such changes on the total quality of the Metropolitan Area.

That change will take place is inevitable. During the next decade, about 100 square miles of open land within the Seven-County Metropolitan Area will be converted to urban use for industrial sites, housing subdivisions, commercial centers, roads, and utilities. On a yearly average, this figure represents the total land area of the city of St. Louis Park or approximately ten times the land area of downtown Minneapolis. The figure, while large, is not in itself alarming since the Metropolitan Area has about 3,000 square miles of land, about 85 per cent of which is as yet undeveloped.

However, all of the Area's existing land reservoir is not suitable for urban development. Generally, uncontrolled urban development should not occur in wetlands, flood plains, on certain shorelines and steep slopes, over vital mineral deposits, or in natural areas needed for educational or recreational purposes. Yet, without public action, development has occurred and is now occurring in these locations and can be managed in the future only through the adoption and implementation of a far sighted metropolitan open space plan.

Management of significant open space is needed now: to protect flood plains, shorelines, steep slopes, selected wooded areas, wetlands, recharge areas, and perhaps prime agricultural lands from damage and destruction; in order to make optimum use of our natural resources and assure a quality environment for living; to provide suitable space and appropriate sites to meet the recreation needs of the present and future population; and to provide a socially-desirable environment for all the people of this Area by assuring a significant amount of open space interspersed throughout the urban area to avoid a pattern of unbroken urbanization.

Wetlands, flood plains, and steep slopes are important in managing the runoff of surface water. Industrial or residential development in flood plains run the risk of periodic flooding, with associated health and safety problems, and high community costs. Equally important, such developments alter the natural flood carrying and storage capacity of the flood plain, thereby increasing flood severity and raising flood levels. Development on steep slopes for which it is necessary to cut down trees and remove low vegetation can contribute to additional surface water runoff, soil erosion, and injury to structures not compatible with the conditions of the site.

In the Metropolitan Area in 1967, only 32 of 310 miles of shoreline on the three major rivers were in public holdings; only 47 of a total of 704 lakes were fronted by a public park of 15 or more acres; and only 40 lakes had either public or commercial beaches.

Urban development, highways, or road design based solely on engineering considerations have cropped unique hills or bluff formations, eliminated natural areas, marred scenic areas, and divided parcels of land with a higher value for other uses. Such areas merit preservation for their educational, scientific, and scenic value. In addition, existing park and public open space is often threatened by conversion to other uses, particularly for transportation right of way.

Finally, park and open space lands are needed to serve the ever-increasing demand for recreation and visual relief.

With some notable exceptions at the local and county level, open space has generally been treated as a residual use of the Area's resources after other development demands have been met. However, open space is not a residual use of land but a vital component of an orderly urban environment that serves many irreplaceable functions. A metropolitan open space system that has equal status with other land-uses is needed to prevent ill-advised or destructive development and to ensure a more liveable and enjoyable environment. Those elements of the system threatened by encroaching urban development need immediate protection.

To get maximum benefit from open spaces, sites that serve more than one function are preferable. For example, preservation of stream banks and flood ways will assure the integrity of the drainage way, provide recreation areas if appropriate rights are acquired, protect urban development, and afford visual relief from the urban scene.

Trails and some unique areas may be preserved by purchase of easements or development rights rather than fee title. In addition, much of the land that must remain undeveloped to prevent loss of life or property, or cause pollution -- such as flood plains and steep slopes -- may be preserved through zoning, subdivision regulations, and building codes.

However, the cooperation and coordination of all units of government is necessary to use regulatory powers to implement the plan.

Tax incentives and tax relief to landowners would help ameliorate some of the economic pressures that force prime open space land into development. Over short periods of time, tax relief may conflict with the need of local units to raise revenue; however, the loss of some current revenue through tax relief may, in the long run, save considerable amounts of money by reducing future expenditures for open space. In addition, tax base disparities among communities can occur when a significant part of one community is reserved as a large open space facility, therefore removing it from the tax base. Real or imagined disparities, however, must be evaluated in light of the broader view of fiscal disparities that exist in the whole Metropolitan Area, and corrective action should be taken through a comprehensive program of tax and revenue reform rather than on a piecemeal basis.

Recreation facilities within the open space system should be located to serve all the population. Lack of a wide range of recreation facilities in the builtup parts of the Metropolitan Area requires that particular attention be given to the needs of people who live there. This may require intense use of open spaces in central areas or public transportation to recreational open spaces away from the core and, perhaps, user-fee adjustments for lower income residents. Although private facilities such as country clubs are part of the metropolitan open space system, they cannot be used to satisfy public open space recreational needs due to the limited nature of their membership and use.

Development of a metropolitan open space system depends upon active participation by all levels of government. No single agency has sufficient resources to acquire or preserve the entire system, but through cooperation and joint funding, an extensive open space system can be developed. Participation by many public agencies and units of government will also assure that the system is responsive to a variety of needs throughout the metropolitan community.

POLICIES

1. PLAN, COORDINATE, DEVELOP, AND OPERATE AN OPEN SPACE SYSTEM THAT MEETS LOCAL AND METROPOLITAN OPEN SPACE NEEDS. THE SYSTEM SHOULD BE BASED ON THE NATURAL CHARACTERISTICS AND FUNCTIONS THAT THE LAND PERFORMS.
2. ENCOURAGE ALL LEVELS OF GOVERNMENT TO PARTICIPATE ACTIVELY IN THE PLANNING, DEVELOPMENT, AND OPERATION OF A CO-ORDINATED OPEN SPACE SYSTEM.

3. LOOK FOR THE FOLLOWING QUALITIES IN SELECTING LAND FOR PARK AND OPEN SPACE ACQUISITION AND PRESERVATION:
 - POSSESSES SCENIC AND/OR UNIQUE NATURAL FEATURES.
 - PERFORMS IMPORTANT NATURAL FUNCTIONS.
 - FULFILLS SEVERAL OPEN SPACE FUNCTIONS.
4. GIVE SPECIAL ATTENTION TO THE ACQUISITION AND/OR PRESERVATION OF DESIRED OPEN SPACE THAT IS LIKELY TO GO INTO INCOMPATIBLE USE(S) IN THE NEAR FUTURE.
5. ACQUIRE OR PRESERVE PARK AND OPEN SPACE LANDS THROUGH MEANS THAT ARE CONSISTENT WITH THE ANTICIPATED USE(S) OF THE LAND.
6. ACQUIRE OR PRESERVE SUFFICIENT PARK AND OPEN SPACE LAND TO FULFILL THE NEEDS OF THE PRESENT POPULATION AND OF PROJECTED FUTURE POPULATION.
7. DEVELOP PARK AND OPEN SPACE FACILITIES AT A RATE AND LEVEL COMMENSURATE WITH THE NEEDS OF THE POPULATION.
8. ENCOURAGE TAX RELIEF FOR LAND PERMANENTLY COMMITTED TO OPEN SPACE THAT IS CONSISTENT WITH THE METROPOLITAN OPEN SPACE PLAN.
9. ALLOW THE CONVERSION OF PARK AND PUBLIC OPEN SPACE LANDS TO OTHER USES ONLY WHEN NO FEASIBLE ALTERNATIVE EXISTS. WHEN SUCH CONVERSION IS UNAVOIDABLE, THE TAKING AGENCY SHOULD PAY FOR THE REPLACEMENT OF EQUIVALENT LAND AND FACILITIES.

PROTECTION OF MAN AND HIS ENVIRONMENT

Some open land safeguards urban development from natural and man-made hazards. Generally classified as protection open space, these are areas where natural processes should be carried out unimpeded. The urban area depends upon floodways and drainageways to channel off storm water and prevent flood and water damage in developed areas. Flood plains need to be kept free from permanent urban development that would affect the capability of the flood plain to carry water in order to protect life and property. Flood control structures and impoundment reservoirs are costly to build, and not necessary in the Area if flood plains are preserved.

Similarly, drainageways accommodate runoff from developed land within a watershed. Urban development in drainageways and adjacent wetlands will alter the drainage pattern of a watershed, resulting in increased

flooding, siltation, water pollution, damage to buildings, and increased costs for storm sewers and other storm water control structures. Converted natural drainageways can often be restored to their natural state at low cost when the area it drains is redeveloped.

Modification of drainage areas outside the Metropolitan Area may adversely affect stream flows within the Area. Therefore, interjurisdictional cooperation to adopt and enforce uniform controls would ensure the continued usefulness of the natural hydrologic system.

Ground water is a vital resource in the Area, which may become inadequate in the future without adequate recharging. High density development in remaining open recharge areas would increase surface water runoff and hasten depletion of the ground water system. Study is necessary to identify the locations of major existing recharge areas in the Metropolitan Area and to promulgate criteria for the proper type and density of development in such areas.

In addition to recharging the water table, wetland areas help to absorb flood water and to stabilize storm water runoff, thus reducing erosion and siltation. They also provide locales where wildlife thrive and, consequently, opportunities for educational benefit. Urban development in wetlands would be expensive due to the peat and muck soil base. Wetlands are often initially by-passed due to high construction costs as development moves outward. However, rising land values may later make filling and urban development of wetlands profitable, as is now occurring in built-up parts of the Area. Special regulatory policies are needed to maintain wetlands so they can perform their vital functions.

Slopes exceeding 10 per cent grade and even more moderate slopes over glacial drift, sands, and gravel are highly vulnerable to erosion. Urban development on these hills without proper architectural, construction, and maintenance safeguards is hazardous because soil erosion and foundation slippage may occur.

Protection open space lands should be managed to protect their natural processes. Zoning and subdivision regulations which seek to protect such areas from incompatible forms of development should be adopted and enforced by all units of government. However, certain key natural process areas and areas which will be subject to other, more intensive open space uses, such as trails, will have to be protected through the purchase of easements or, if necessary, full rights. Development that cannot demonstrate a critical need to locate in protection areas should not locate there. However, linear systems such as utility lines or highways may need to cross protection areas. These linear crossings should be designed and constructed to respect the integrity of the environment.

POLICIES

10. MANAGE OR PROHIBIT DEVELOPMENT IN THOSE AREAS THAT PERFORM IMPORTANT PROTECTION FUNCTIONS IN THEIR NATURAL STATE.
11. ADOPT AND APPLY LOCATION, DESIGN, AND OPERATING REGULATIONS TO MANAGE DEVELOPMENT IN DESIGNATED PROTECTION OPEN SPACE AREAS.
12. ZONE UNPROTECTED PARTS OF FLOODPLAINS FOR USES THAT WILL NOT RESTRICT THEIR WATER CARRYING CAPACITY AND WILL NOT CAUSE A PUBLIC HAZARD IF INUNDATED. (GUIDELINES FOR FLOODPLAIN ZONING HAVE BEEN PROMULGATED BY THE MINNESOTA CONSERVATION DEPARTMENT PURSUANT TO CHAPTER 590, 1969 SESSION LAWS, THE FLOODPLAIN MANAGEMENT ACT.)
13. PRESERVE NATURAL DRAINAGEWAYS AND, WHERE FEASIBLE, RECONSTRUCT FORMER NATURAL DRAINAGEWAYS TO HANDLE STORM WATER RUNOFF.
14. ADOPT AND ENFORCE REGULATIONS TO MANAGE DEVELOPMENT OF DRAINAGEWAYS, RIVERS AND STREAMS THAT MEET OR EXCEED STATE AND REGIONAL STANDARDS OR MODELS.
15. PRESERVE AND MANAGE THE USE OF WETLANDS AND MAJOR AQUIFER RECHARGE AREAS TO ENSURE THE CONTINUED PERFORMANCE OF THEIR NATURAL FUNCTIONS.
16. REQUIRE DEVELOPMENT ON SLOPES OF 10 PER CENT AND OVER TO BE DESIGNED, CONSTRUCTED, AND MANAGED IN A MANNER THAT WILL MINIMIZE EROSION POTENTIAL AND AVOID SLOPE SLIPPAGE.
17. ENCOURAGE RESIDENTIAL AND AGRICULTURAL SOIL MANAGEMENT PRACTICES THAT MINIMIZE SILTATION AND POLLUTION OF RIVERS, LAKES, AND STREAMS.

OPEN SPACE FOR PRODUCTION

A significant part of the Area's open space land is used to produce materials for the construction industry or for agricultural activity. Prominent examples of the former are sand, gravel, and building stone operations that supply a basic raw material necessary for the growth of the Metropolitan Area. The availability of locally-produced raw materials at lower cost than would be possible if materials had to be shipped long distances is an important asset to the local construction industry.

However, when sand and gravel operations are completed, the abandoned site often leaves a scar on the landscape. To ensure that mineral sites will be refilled, regraded, planted, or otherwise reclaimed for an appropriate reuse, mineral deposit reuse needs should be planned before excavation begins.

Agricultural and forest land presently represents a reserve of land that eventually may be used for urban development or for permanent open space. Much of the production land does not qualify for preservation at this time, solely for its production value, since agricultural and forest products can be brought in with relative ease. Additional research is required, however, before the long-term status of agriculture and forestry needs in the Metropolitan Area can be determined.

POLICIES

18. PLAN FOR THE RECLAMATION AND REUSE OF MINERAL EXCAVATION SITES BEFORE MINING OPERATIONS BEGIN.

SCENIC OPEN SPACE

The scenic resources that are abundant in the Metropolitan Area are constantly sacrificed to inadequately planned urban development. Scenic hills, woods, and river bluffs give way to excavation for highways and housing tracts; poor location and design of structures such as powerlines, sewage disposal plants, and bridges can mar scenic views and skylines; and development that crowds highway right of ways may spoil roadside vistas. Esthetic enjoyment is a highly-personal subjective experience, yet it is important that agreement be reached on what elements of the landscape are worthy of preservation for their amenity.

Public funds are not sufficient to keep all scenic areas within the public domain, but selective use of easements, purchase of development rights, and subdivision regulations that set design requirements for building in scenic areas will help to preserve the environment for long-term public enjoyment. It is the responsibility of all levels of government to consider carefully the importance of preserving natural amenities when planning, designing, and constructing public works or promulgating development regulations.

POLICIES

19. PRESERVE SCENIC OPEN SPACE.
20. ACQUIRE SCENIC LAND OR EASEMENTS ALONG ROADWAYS WHEN RIGHTS-OF-WAYS ARE ACQUIRED.

21. ENCOURAGE HIGH QUALITY LOCATIONAL AND DESIGN STANDARDS FOR BOTH PUBLIC IMPROVEMENTS AND PRIVATE DEVELOPMENT TO ENSURE COMPATIBILITY WITH THE NATURAL SURROUNDINGS.

CONSERVATION OF NATURAL RESOURCES AND HISTORIC AREAS

Scarce or unique environmental features such as forested areas, areas supporting native wildlife, unique areas where natural process go on undisturbed, and historic areas are vulnerable to extinction in the face of onrushing urban development. Although the need for urban development is unquestionable, its location requirements are somewhat flexible. In contrast, these unique natural or historic conservation open space areas occur only in specific locations that can rarely be duplicated elsewhere, and should be conserved.

The state has a conservation open space system but only a small part of the total state-wide conservation open space system lies within an hour's driving time of the Metropolitan Area. More conservation areas are needed within and near the Area, where they will be accessible to a large urban population. All units of government that are able to acquire and manage these areas should do so, and educational institutions should also be encouraged to acquire conservation sites as part of their educational programs.

The perpetuation of wildlife areas, forested areas, and other conservation open space provides unique opportunities for studying the native environment in an undisturbed setting. The educational-instructional role of conservation open space will become even more important as the Area continues to urbanize.

The educational benefits of areas where the native environment is conserved will be greatly enhanced if experts are available to explain the process of nature at work. The potential heavy use of such facilities will require careful management and scheduled use.

Areas noted for their archeological or historical significance in the development of the Metropolitan Area are also worthy of preservation. It is important to capture for public enjoyment the proper environmental setting within which the historic event took place. Adjacent land or whole areas, if added to the site proper, could help accomplish the framework needed for public appreciation and understanding. Also, new development or redevelopment near historic sites should be compatible with their historic character. Historic sites and buildings may require restoration before their education value is complete. The acquisition, restoration, and management of historic areas is frequently accomplished by private foundations and historical societies but may be carried on by any governmental unit with the authority to do so.

POLICIES

22. ESTABLISH AND MAINTAIN CONSERVATION AREAS FOR WILDLIFE MANAGEMENT AND EDUCATIONAL AND SCIENTIFIC PURPOSES.
23. ENCOURAGE EDUCATIONAL INSTITUTIONS AND OTHER ORGANIZATIONS TO ACQUIRE, MANAGE, AND OPERATE CONSERVATION SITES AS PART OF THEIR EDUCATIONAL PROGRAMS.
24. ENCOURAGE STATE AND FEDERAL ACQUISITION OF CONSERVATION AREAS READILY ACCESSIBLE TO THE METROPOLITAN AREA.
25. PROVIDE PROFESSIONAL SERVICES IN CONSERVATION AREAS TO FURTHER PUBLIC UNDERSTANDING OF ECOLOGY AND ENVIRONMENTAL MANAGEMENT.
26. PRESERVE HISTORIC AND ARCHEOLOGICAL SITES AND THEIR ENVIRONMENTAL SETTING, AND RESTORE FACILITIES WHERE SUCH ACTION CAN SUBSTANTIALLY ENHANCE APPRECIATION AND UNDERSTANDING.

OPEN SPACE FOR RECREATION

The Area takes justified pride in the beauty and abundance of its open land, a part of which has been permanently preserved as parks and recreational facilities. Most of the existing close in parks where the bulk of the major recreational facilities are located were originally planned and developed to serve the local population. Many of these planned local facilities, due to their size, uniqueness, or location, have been used extensively by residents from throughout the Area. As population increases, however, these facilities will be severely strained; a situation now common during the summer months when public golf courses, beaches, and picnic grounds are often nearly obliterated in a mass of humanity.

Existing park and recreational facilities and the activities occurring at them run the gamut from the small tot lot to the one-of-a-kind professional sports arena. Some such facilities, due to the nature and extent of their demand, plus the size and scope of development, operation, and maintenance, are found throughout the Metropolitan Area. These include such things as tot lots, play grounds, softball fields, outdoor skating rinks, and sledding hills. They are by use, development, and operation local in nature. While these facilities should not be incorporated into a metropolitan recreational open space system plan, sufficient criteria should be determined to give general guidance for preparing and reviewing requests for grants in aid.

Metropolitan park and recreation facilities are those characterized by users from throughout the Area and, frequently, by moderate-to-very high cost of acquisition, development, operation, and maintenance. Also, at the present time they are operated by a variety of levels of government. Examples of such facilities are St. Paul's Como Park, Minneapolis' Minnehaha Park, Anoka County's Bunker Prairie Park, Hennepin County Park Reserve District's Hyland Lake Park, and Fort Snelling State Park.

At this point in the development of a metropolitan open space system, it is impossible to define responsibilities for different levels of government. Since tax resources, population characteristics, and social needs are not neatly distributed on the basis of governmental hierarchy, a descriptive breakdown of responsibilities will not help solve the basic problem: the shortage of adequate recreation open space. All levels of government -- municipal, county, state, and federal -- should continue to develop recreation facilities. For this reason it is important that planning for facilities be done on a metropolitan scale and that the metropolitan recreation open space facilities serve the metropolitan population or a major segment of it. By taking into account all types of recreational facilities provided by municipal, county, state, and federal government, the metropolitan plan will enable the Metropolitan Council to cooperate with other units of government in providing a diversified park and open space system to serve the Metropolitan Area.

A number of recreational areas currently used by the metropolitan population lie outside the Area's political boundaries. These areas have been developed by federal, state, local, or private organizations, and their continued efforts should be encouraged.

Private facilities that limit users, such as a golf course, a yacht club, a sports club, or a company recreation area do not serve the needs of the general public for recreational areas. Private facilities do, however, reduce the demand that must be met by public facilities and may provide extra scenic open space in the Area.

Ideally, all residents of the Metropolitan Area should choose the recreational activities they prefer. However, participation in some recreational activities, such as golfing, skiing, and boating, involves substantial investment in equipment. In addition, residents of densely settled urban areas have need for additional open space and more recreational facilities. Therefore, funding of new recreational facilities within the Metropolitan Area must be evaluated on the extent to which they actually serve the needs of the people, without costly travel or substantial personal outlay for equipment and user fees.

The need for the various components in the metropolitan recreation open space system can be determined by projecting demand based on user surveys, population projections, and assumptions as to future uses and fiscal resources. Such projections, however, result in a demand schedule that cannot be met in the immediately-foreseeable future due to limited fiscal resources at any one period of time; thus, priorities must be set. Determining priorities is always a problem since recreational substitution is difficult. For example, a confirmed golfer cannot pursue his aspirations on an indoor ice rink, nor can a swimmer or boater transfer his preferred activities to the football field. In like manner, the skater or the golfer presumably would rather have one or more skating and golfing facilities within a ten-to-fifteen minute drive from his home rather than thirty-to-forty minutes away. Thus, two demand problems, that of choice between types of facilities and that of the distribution of the facilities must be weighed. The parks and recreation system should give the greatest attention to those facilities and activities deemed important by the largest numbers of people, while also providing minimum facilities for other uses that have less demand. Those facilities that are not tied to the unique features of a site can be located anywhere. In such cases, accessibility to the population should be a major factor in selecting their location.

This Area also has a very high demand for unique sites for water-associated activities like swimming, boating, and fishing. Many of the larger lakes in the Metropolitan Area such as Minnetonka, White Bear, Forest and Medicine are already nearly surrounded by private structures with very limited public access and virtually no public shoreline, a situation which is also apparent along stretches of the St. Croix and Mississippi rivers. Since these water resources are so much in public demand, high priority should be given to ensuring access to and use by the public of the shores and waters of the Area's more attractive and usable lakes, rivers, and streams. Initial priority should be given to acquiring access on the larger lakes and streams that are capable of accommodating the greatest use.

At the present time, the Area does not have an extensive trail network for hiking, bicycling, snow-mobiling, snow-shoeing, cross-country skiing, and horseback riding. Many of the linear features of the landscape, such as stream and river valleys, bluff lines, and utility and railroad rights-of-way, are under-utilized. These could be developed into a quality trail system connecting major open space areas at a relatively low expenditure, thus opening a whole new range of recreational opportunity within the Metropolitan Area.

Wherever public funds other than local are to be used in developing recreational open space facilities at the metropolitan level, the proposals should not be in conflict with the metropolitan plan and the facilities must be opened to the general public. In the case of private investments to be opened to the public, the government of the host community should, through its planning and land-use control powers, assure that there will be no conflict with the metropolitan plan.

POLICIES

27. COORDINATE AT THE METROPOLITAN LEVEL THE ACQUISITION AND DEVELOPMENT OF THOSE RECREATION FACILITIES LIKELY TO ATTRACT USERS FROM THROUGHOUT THE METROPOLITAN AREA.
28. ENCOURAGE AGENCIES AND ORGANIZATIONS WITH AUTHORITY TO PLAN AND ACQUIRE RECREATION AREAS ADJACENT TO THE METROPOLITAN AREA BUT OUTSIDE ITS BOUNDARIES TO DO SO.
29. GIVE PRIORITY TO THOSE FACILITIES IN DEMAND BY THE LARGEST NUMBER OF PEOPLE AND CAPABLE OF BEING USED WITH LOW PERSONAL FINANCIAL OUTLAY.
30. PROVIDE AT LEAST MINIMUM FACILITIES FOR ALL RECOGNIZED OUTDOOR RECREATIONAL ACTIVITIES.
31. LOCATE RECREATIONAL FACILITIES NOT HAVING UNIQUE LAND REQUIREMENTS (SUCH AS ICE ARENAS, GOLF COURSES, AND SPORTS STADIA) IN AREAS HIGHLY ACCESSIBLE TO THE URBAN POPULATION.
32. GIVE HIGH PRIORITY TO THE PROVISION OF PUBLIC ACCESS TO THE WATER AND PUBLIC USE OF THE SHORELINES AT HIGH QUALITY LAKES, RIVERS, AND STREAMS.
33. WHEN CONSISTENT WITH THE METROPOLITAN OPEN SPACE PLAN, ACQUIRE TRAIL RIGHTS-OF-WAY WITH SEWER AND OTHER UTILITY EASEMENTS.
34. OPEN ALL RECREATIONAL FACILITIES SUPPORTED BY PUBLIC FUNDS TO USE BY THE GENERAL PUBLIC.
35. ENCOURAGE ALL LEVELS OF GOVERNMENT TO COORDINATE THEIR RECREATIONAL LAND-USE PLANS AND DEVELOPMENT REGULATIONS WITH THE METROPOLITAN PARK AND OPEN SPACE PLAN.
36. UTILIZE THE FOLLOWING PRIORITIES IN ALLOCATING METROPOLITAN, STATE, AND FEDERAL FUNDS FOR ACQUISITION AND DEVELOPMENT OF RECREATIONAL LANDS AND FACILITIES:

FIRST -- PROJECTS OF METROPOLITAN SIGNIFICANCE THAT ARE CURRENTLY PROGRAMMED IN THE METROPOLITAN DEVELOPMENT GUIDE, AND PROJECTS OF LOCAL SIGNIFICANCE THAT ARE NOT IN CONFLICT WITH THE METROPOLITAN PLAN.

SECOND-- PROJECTS OF METROPOLITAN SIGNIFICANCE THAT ARE INCLUDED IN THE METROPOLITAN PLAN BUT THAT ARE NOT CURRENTLY PROGRAMMED THEREIN.

THIRD -- PROJECTS OF METROPOLITAN SIGNIFICANCE THAT ARE NOT INCLUDED IN THE METROPOLITAN PLAN AND THAT ARE NOT IN CONFLICT WITH THAT PLAN.

PART II

SYSTEM PLAN

The open space system plan focuses upon recreation and protection. Conservation, amenity, and production open space require further study and will be the subject of further additions to the system plan. At the same time, however, many of the recreation and protection elements embrace features that are compatible with the other open space functions (especially conservation and amenity). This plan is primarily concerned with the preservation of those recreation and protection open space elements directly threatened by urbanization. Therefore, preservation of the elements listed in the plan should not be delayed.

For purposes of illustration, the recreation and protection open space system plan is presented on the attached map. While the map represents these two aspects of open space, it also reflects the physical, biological, and human actions that contribute to the present and potential metropolitan open space network. The entire web of events -- from the very earliest geologic activity to the most recent modifications of the landscape by man -- has served to define and limit the character, qualities, and capabilities of the various elements.

Open Space for Recreation

The recreation portion of the metropolitan open space plan is based on natural features and includes existing and potential metropolitan, federal, and state park sites, lake access points, and an extensive trail network. Twelve existing areas whose acquisition and development should be completed and 22 potential areas embrace characteristics that make them suitable for major metropolitan park consideration. Also, 107 water access areas (waterside park) should be acquired and developed. These locations are shown on the appended map.

In addition, two sites along the Minnesota River, one in Scott County (Blakely Township) and the other in Carver County (San Francisco Township), should be considered for acquisition by state, federal, metropolitan, or joint governmental action. Also shown on the map are two areas that are currently being studied as potential federal recreation areas. While several of these sites lie either partially or entirely outside of the Metropolitan Area, they will provide recreational services for the entire Area. However, since the Metropolitan Council does not at this time possess legal authority to acquire land outside the seven county Area,

) acquisition will have to be undertaken by state and federal authorities or by joint governmental action.

In determining which areas should be acquired and developed as a metropolitan recreation system, attention was given to the quality of an area's natural features and to its accessibility to the built up part of the Metropolitan Area. Recreation areas, more than any other functional aspect of open space, are oriented toward human activities, demands, and preferences. To satisfy these requirements throughout the Metropolitan Area means that all segments of the population have to be served. Therefore, the site accessibility was considered in light of existing and projected urban development and the transportation network.

The following areas are generally close-in to existing urbanization and are accessible to a large number of people, are of sufficient size to support a number of recreational activities, are distinctive natural resources, and embrace characteristics which make them suitable for open space functions other than just recreation.

Afton
Anderson Lakes
Bailey Farm
Battle Creek
Blue, Fisher, Rice Lakes - Eagle Creek
Bunker Prairie
Carver (Hennepin)
Cottage Grove Ravine
Elm Creek
Fort Snelling
Hyland Lake
Lake Elmo
Lebanon Hills
Lino Lakes
Minnesota River Valley Trail
Murphy Lake

The areas in the next grouping also contain distinctive and valuable natural features and though farther away from the populous parts of the Metropolitan Area and at this time less accessible to most residents, they should also be acquired or expanded to help serve present and future needs.

Big Marine Lake
Chub Lake
Crow-Hassan Park
Rebecca Park
Baker Park
Lake Waconia
Linwood Lake
Loon Lake
New Trier Woods
Sand Creek-Cedar Lake
Spring Lake
Wm. O'Brien Park

The majority of sites listed in these two groupings are situated on water bodies. Since lake and river shore property is a highly-prized commodity in the Metropolitan Area, initial acquisition efforts should, therefore, focus upon the shoreline portion of these sites. In addition, the following six areas should initially be preserved and developed as water access facilities. However, these areas also contain distinctive natural features, and it may be desirable in the future to expand these areas into metropolitan parks.

Cleary Lake
Diamond Lake (Dayton Twp.)
Mud and Oak Lake
Niger Lake (St. Francis Hills)
Oneka Lake
St. Croix River (Denmark Twp.)

The individual water access areas of metropolitan significance should provide swimming, boat launching, picnicking activities, and contain adequate sanitary facilities. If the existing water access areas in the following list do not currently meet these requirements, they should be upgraded in the near future. The size, quality, and recreation potential of the water body will determine the size of the access area. In some instances, areas could be large enough for county or sub-regional parks. Six of the potential water access areas which should eventually be expanded into metropolitan park facilities, are noted in the following listing with an asterisk.

Water Access Areas

Anoka County

Coon Lake
Coon Rapids Dam
Crooked Lake
Ham Lake
Lake George
Martin Lake
Niger Lake (St. Francis Hills)*
Mississippi River (Ramsey Twp.)
Round Lake
Rum River
Twin Lake
Typo Lake

Carver County

Crow River
Eagle Lake
Goose Lake
Hydes Lake
Lake Auburn
Lake Minnewashta
Lake Riley
Lake Susan
Lake Waconia
Lake Zumbra
Lotus Lake
Mud and Oak Lakes*
Parley Lake
Piersons Lake
Reitz Lake
Stieger Lake
Swede Lake
Waterman Lake

Dakota County

Alimagnet Lake
Crystal Lake
Lake Byllesby
Marion Lake
Mississippi River (Lilydale)
Orchard Lake

Scott County

Cleary Lake*
Cynthia Lake
Fish Lake
O'Dowd Lake
Pleasant Lake
Prior Lake
Spring Lake
Sutton Lake

Washington County

Big Carnelian Lake
Big Marine Lake
Bone Lake
Carver Lake
Clear Lake
Forest Lake (2 sites)
Lake DeMontreville
Lake Edith
Long Lake
Mississippi River (Grey Cloud)
Oneka Lake*
Pine Tree Lake
Square Lake
St. Croix River (5 sites)
St. Croix River*
Sunset Lake
White Bear Lake

Hennepin County

Bass Lake
Bryant Lake
Cedar Island Lake
Cedar Lake
Coon Rapids Dam
Diamond Lake* (Dayton Township)
Eagle Lake
Fish Lake
Lake Calhoun
Lake Harriet
Lake Minnetonka (3 sites)
Lake Nokomis
Lake Sarah
Long Lake
Medicine Lake
Mississippi River (Dayton)
Mississippi River (Camden)
Mitchell Lake
Mud Lake
Parkers Lake
Staring Lake
Sweeney Lake
Twin Lakes
Weaver Lake
Whaletail Lake

Ramsey County

Bald Eagle Lake
Crosby Lake
Gervais-Keller Lakes
Harriet Island
Hidden Falls
Lake Johanna
Lake Owasso
Lake Josephine
Long Lake
Otter Lake
Pig's Eye Lake
Pleasant Lake
Snail Lake
Vadnais Lake

*Eventual expansion to metropolitan park sites.

The preceding has dealt with sites that, since they will experience a high intensity of use, should generally be acquired outright. The purchase of easements or partial property rights should be considered principally as an initial acquisition measure or as a way to protect supporting environmental features or buffer areas. In most instances, these water access areas should be acquired and operated by counties or municipalities.

Any unit of government could acquire part or all of any site in the metropolitan system and participate in its development. The Metropolitan Council cannot acquire ownership of sites and has only limited funds for aiding other government units in land acquisition. Therefore, it will be necessary to have cooperation within and by the other governmental units in the area in carrying out the metropolitan plan.

Trail Network

The third recreational element proposed as part of this open space system plan is a trail network. The trails, which generally follow stream and river rights-of-way, bluff lines, and utility or transportation rights-of-way, (major park sites are also connected), could be used for a host of year-around activities such as hiking, horseback riding, bicycling, snow-mobiling, snowshoeing, and cross-county skiing. The purchase of easements and development rights should be used when acquiring the trail system. Whenever possible, local units of government should acquire and operate parts of the trail system; metropolitan level efforts will focus upon the major links in the network. At certain places along the trail system, especially by a lake, river, stream or major thoroughfare, the outright purchase of small land areas for access or support facilities may be needed. Since a trail network calls for detailed analysis of individual trail segments, the actual delineation of trail rights-of-way will require further study. The network as shown on the map, therefore, is subject to changes in general location as detailed plans begin to be developed in cooperation with local governments.

Protection Open Space

The policies section lists several open space elements that perform their most effective work and yield the greatest benefit to man if managed to ensure their continued performance. The elements in this category include ponds, lakes, creeks, streams, rivers, drainageways, floodplains, marshes, wooded swamps, wet meadows, and steep slopes.

Generally, the elements which are of the greatest benefit if kept free of any development are those that are necessary to assure proper functioning of the hydrologic system such as creeks, streams, rivers, floodways, ponds, and lakes, and in many instances, marshes, wooded swamps and wet meadows. In determining the extent to which steep slope areas can function effectively and still support development, it is necessary to evaluate the soil and surficial geology as well as degree or grade of slope. Floodplains can also support certain types of development that do not lead to health or safety hazards or unacceptable damages due to periodic flooding.

In certain parts of the Metropolitan Area, natural conditions are such that the individual protection elements occur as spacious sites or lengthy thin spaces; in other locations, the elements are smaller and more isolated. In combination, the elements act as an important structuring feature for the entire Area by providing a quality environmental setting for development.

The major regional-scale open space elements in the Metropolitan Area lie along the Mississippi, Minnesota, and St. Croix rivers and their

tributary streams. In addition, the protection features associated with the smaller creeks, streams, and rivers in the Metropolitan Area, though not as extensive, are equally important; not only do they form part of the over-all metropolitan framework, but they also serve as smaller, local linkages in the open space network. Several are intermittent streams that flow only during periods of run-off or high water table, while others have been converted into concrete ditches or underground sewers. Consideration should be given to the restoration of those converted creeks and streams whenever re-use or re-development programs are undertaken, if the benefits of such action exceed expenditures in time, cost, and effort.

Located between the major linear features of the protection open space system are a host of other protection elements. These elements, which generally consist of wetland areas and some steep slopes, are situated in small and large concentrations throughout the Metropolitan Area.

The largest areal concentration of protection elements (generally marshes, wet meadows, and swamps) is found in the northern part of the Area. A large part of this area is already preserved as part of the Carlos Avery Wildlife Management Area. Although the non-stream associated protection elements in the southern part of the Metropolitan Area are generally smaller and fewer in number, they are equally important in maintaining the viability of the natural system. In many cases, the relative isolation and small size of these elements makes them more vulnerable to development.

The existence or lack of protection elements also indicates the intensity of development that has occurred within certain parts of the Metropolitan Area. The most highly urbanized areas contain relatively few protection elements while the less developed parts contain the largest number. The situation in most of the urbanized area indicates how essential it is that the features of the natural system be preserved in the less-urbanized parts of the Metropolitan Area if they are to retain their environmental quality after urbanization.

The continued existence of as many of the designated protection elements locations as possible ought to be ensured immediately.

The following is a list of the geographic areas that merit preservation action. Only the general titles and locations are listed. It should be emphasized that it is the protection areas within these general areas which require immediate preservation action.

Bassett Creek Watershed
Blaine-Ham Lake bog area
Bluff Creek Watershed
Carver Creek Watershed
Chaska Creek Watershed
Coon Creek Watershed
Cottage Grove Ravine drainage area
Credit River Watershed
Crow River Watershed (southeastern half)
Elm Creek Watershed
Hardwood Creek Watershed
Hazeltine-Bavaria Creek Watershed
Lino Lakes chain
Minnehaha Creek Watershed (upstream part)
Minnesota River
Mississippi River
Nine Mile Creek Watershed (upper part)
Prior Lake-Eagle Creek Watershed
Purgatory Creek Watershed
Rice Creek Watershed
Riley Creek Watershed
St. Croix River Watershed
Shingle Creek Watershed
Sunrise River Watershed
Valley Branch Watershed
Vermillion River Watershed

The total protection system is a matter of metropolitan, regional, state, or even inter-state concern; however, the actual protection of these elements can only be accomplished if all levels of government (from local to state) participate. Since most of the elements will have to be protected through regulatory action, all units of government that manage land development will have to adopt and enforce development regulations that meet or exceed state and regional standards or models.

A host of smaller scale protection elements also exist outside the metropolitan framework. They have less significance in the regional hydrologic cycle; on the other hand, the smaller elements may help maintain the viability of the hydrologic system and are of major importance to the quality of the environment within the communities. These elements include small wetlands, wooded areas, phantom drainageways, and developable slope areas.

The small wetlands and wooded areas act as "humanizing" elements within the urban fabric and also serve as a protective cover in areas that would otherwise be susceptible to intensive water run-off and soil erosion. The Metropolitan Area has an extensive network of phantom drainageways that are important to maintain environmental quality and water management, including storm water management. The steep slope areas in the Metropolitan Area that should not be developed because of their grade, soil, and geologic conditions are included in the metropolitan level protection open space system; however, there are additional slope areas that may safely support varying intensities of development. A study which focuses on soil conditions and surficial geology would probably reveal only limited development potential for these slopes.

While the above mentioned protection elements can support some forms of urban development, land management and development techniques that recognize specific site capabilities and limitations will have to be employed. Each municipality should make an inventory of its protection elements and base any development decision upon a complete evaluation of both public and private costs and benefits.

PART III

PROGRAM

The following program delineates a number of broad long-range objectives and a series of short-range objectives or actions that are important elements in implementing the metropolitan parks and open space plan. Achievement of these objectives will require the cooperative effort of the Metropolitan Council, its advisory Board, and the other public and private agencies concerned with parks and open space development and operation in the Area.

Long-Range Objectives

1. Provide a quality environment for the Metropolitan Area through the optimum use of our natural resources.
2. Maintain the integrity of the natural hydrologic system to prevent pollution, siltation, and flood damage.
3. Conserve natural areas and develop related educational programs.
4. Provide adequate recreation areas, trails, and facilities for the metropolitan population.
5. Preserve "breathing spaces" interspersed throughout the area of urban development.

Short-Range Objectives

1. During the period July, 1970 through June, 1971, the Metropolitan Council and its advisory Board should stimulate and coordinate governmental efforts to acquire these park areas or acquire them itself.

Anderson Lakes

Lake Elmo

Lino Lakes (comprehensive plan for entire Rice Creek Watershed needed.)

In addition, the Council with its advisory Board will assist and coordinate local governments and other agencies in efforts to preserve the other recreation areas listed in the plan.

2. Begin to effect the acquisition and development of the following top priority water access areas:

Bald Eagle Lake
Lake Minnetonka
Medicine Lake
Otter Lake
St. Croix River
White Bear Lake

3. Work with the Minnesota Department of Conservation and local governmental units to develop and/or implement zoning ordinances and subdivision controls to protect floodplains, wetlands, slopes, and other protection elements in the following areas:

- Bassett Creek Watershed
- Blaine-Ham Lake bog area
- Bluff Creek Watershed
- Coon Creek Watershed
- Cottage Grove Ravine drainage area
- Credit River Watershed
- Elm Creek Watershed (southeastern half)
- Hazeltine-Bavaria Creek Watershed
- Lino Lakes chain
- Minnehaha Creek Watershed (upstream part)
- Minnesota River
- Mississippi River
- Nine Mile Creek Watershed (upper part)
- Prior Lake-Eagle Creek Watershed
- Purgatory Creek Watershed
- Rice Creek Watershed
- Riley Creek Watershed
- St. Croix Watershed
- Shingle Creek Watershed
- Valley Branch Watershed
- Vermillion River Watershed (northerly part)

4. Define the precise trail rights of way of certain trails and start a program of easement and development rights acquisition to establish a trail network.
5. Explore all possible areas where immediate regulatory action might be taken to preserve open space; where acquisition is determined to be necessary, fully assess the feasibility of less than fee title purchase.
6. Locate significant conservation and historic areas in the Metropolitan Area and recommend preservation action by the appropriate groups and agencies.
7. Identify significant open space elements adjacent to but outside the political limits of the Metropolitan Area, and cooperate with appropriate state, local, and federal organizations to reserve this land for open space purposes.
8. Prepare draft legislation to provide adequate legal and financial tools for the implementation of a metropolitan parks and open space system plan, including financing for operations; bonding authority; sources of funds for operations, acquisitions, bond interest and amortization; tax reimbursement; and powers of condemnation.

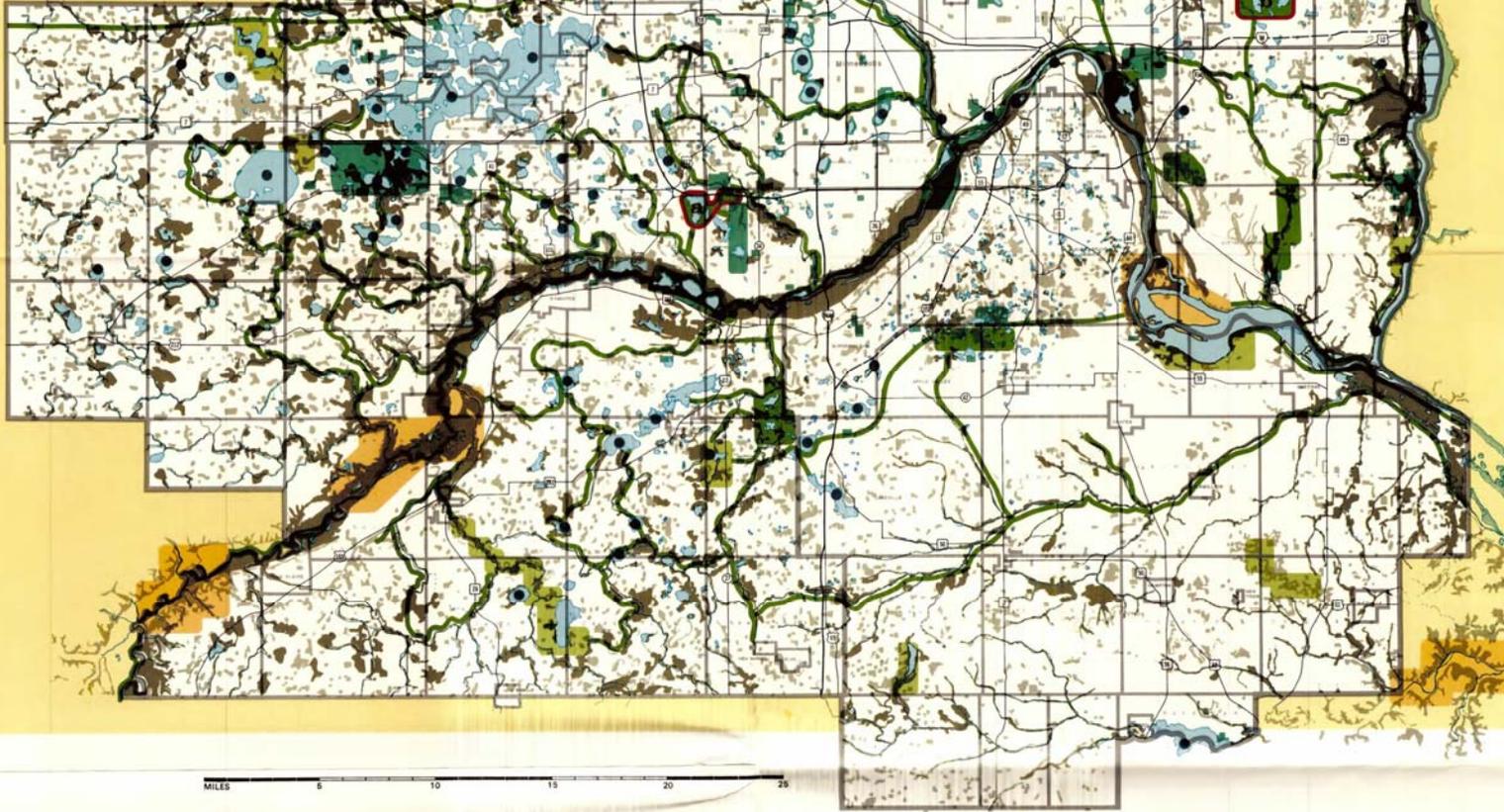
9. Develop sources of financing to make possible the immediate acquisition of prime open space threatened with immediate loss.
10. Initiate or continue work on the following study items:
 - a. Development of model zoning ordinances and subdivision controls, which include adequate natural resource considerations, that governmental units can use to perpetuate significant protection open space.
 - b. Continued re-evaluation of the recreation open space needs and requirements of the Metropolitan Area in terms of projected population growth, accessibility, and demand.
 - c. Identification of significant amenity open space elements in the Metropolitan Area and recommend measures for preservation.
 - d. Determination of which, if any, agricultural areas should be included as part of the permanent open space system.
 - e. Analysis of the soil conditions and surficial geology of slope areas to determine development capabilities.
 - f. Investigation of new techniques (such as remote sensing) to locate, define, and monitor open space features and adopt where feasible.
 - g. Continued development of geologic and hydrologic information necessary to determine specific capability and limits of protection elements.
 - h. Development of standards, criteria, and methods that could be used in managing mineral extraction sites for eventual open space (or other) land-use purposes.
 - i. Further definition of the role of private endeavor in implementing the open space system plan.
 - j. Initiation and maintenance of a data storage and retrieval system of all local, county, metropolitan, and state open space elements in the Metropolitan Area, both existing and projected.
 - k. Establishment of additional criteria (especially for local areas) which can be used to evaluate open space proposals coming to the Metropolitan Council for referral action.

DEFINITIONS

1. Metropolitan Area - The area over which the Metropolitan Council has jurisdiction, comprising the counties of Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington (MSA 473 B.01).
2. Open Space - That area which is retained in or restored to a condition where nature predominates and which may be used for recreation or recreation facilities, conservation, and preservation of scenic or historic sites.
3. Protection Open Space - Land that safeguards man from both the normal effects of nature and the effects of short-sighted human alteration of natural environmental features such as floodplains, wetlands, and drainageways.
4. Conservation Open Space - Unique resource areas where plants, animals, water, air, and soil have been left in an undisturbed state or areas of historical value.
5. Amenity Open Space - Undeveloped land and natural features worthy of preservation primarily for their scenic or esthetic value.
6. Recreation Open Space - Parks, trails, water access sites, and various other recreational facilities that meet the recreation needs of Metropolitan Area residents.
7. Production Open Space - Land presently committed to or suitable for managed resource production, such as agriculture and mining, or other, primarily resource-based, extractive activities.
8. Flood Plain - The areas adjoining a watercourse which have been or hereafter may be covered by a flood that could be expected to have about a one per cent chance of occurring annually.
9. Wetlands - Lowlands covered with shallow and sometimes temporary, intermittent waters, including marshes, swamps, bogs, wet meadows, potholes, sloughs, river overflow lands, and shallow lakes and ponds usually with emergent vegetation as a conspicuous feature.
10. Hydrologic Cycle - The process by which water is circulated and distributed on the surface of the land, in the soil, underlying rocks, and in the atmosphere.
11. Phantom Drainageways - Temporary or ephemeral drainageways which are part of the total drainage system but visible only during periods of high water run-off.
12. Remote Sensing of the Environment - The utilization of techniques such as aerial infrared photography and radar to determine the identity, location, and viability of certain environmental features.
13. Acquisition - Purchase, gift, condemnation, construction, and acquisition of necessary land, easements, buildings, structures, machinery or equipment.



Preparation of this map was financed in part through a comprehensive planning grant from the Department of Housing and Urban Development.



METROPOLITAN OPEN SPACE PLAN

ADOPTED BY THE METROPOLITAN COUNCIL, JUNE 25, 1970

- County Boundary
- Municipal or Township Boundary
- Interstate Freeway
- Other Major Road
- Water Body

- Existing Public Open Space
- Protection Areas:**
- Primary Protection (Wetlands, Floodplains, Undevelopable Slopes)
- Secondary Protection (Small Wetlands, Wooded Areas, Slopes Over 10%)

- Proposed Public Open Space:**
- Immediate Action Area (a: Anderson Lakes, b: Lake Elmo, c: Lino Lakes)
- Inner Environs
- Outer Environs
- Trail
- Water Access Area (waterside park)
- Water Access Area (to become a larger park later)
- Potential Metropolitan, State, or Federal Recreation Area

Data on this map are based on: Wallace, McHarg, Roberts and Todd, An Ecological Study of the Twin Cities Metropolitan Area; Metropolitan Council and Metropolitan Planning Commission Staff Study; United States Geological Survey Maps.



Capitol Square Building,
Cedar Street at 10th Street,
Saint Paul, Minnesota 55101

BULK RATE
U.S. POSTAGE
PAID
St. Paul, Minn.
Permit No. 964

