THE UTILIZATION OF ZONING ORDINANCES TO PROTECT UNIQUE AND/OR ECOLOGICALLY-SENSITIVE MICRO-ENVIRONMENTS: AN INVESTIGATION

by

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CHAPTER ONE
INTRODUCTION

Unique and/or ecologically-sensitive micro-environments (UES) are defined within this study as identifiable physical areas of variable types, scales, locations, and degrees existing as constituent of more encompassing environments but exhibiting physical characteristics different from this surrounding environment. The idiosyncratic physical characteristics possessed by UES areas indicates that such areas will respond differently to land-use development -- thereby requiring select management and/or protection to avoid irrevocable physical damage or debilitating reclamation costs. Zoning ordinances appear to be the most prevalent and readily available land-use management tool with which to guide development, and possibly exist as a applicable and effective management tool for protecting UES areas. This study will explore this possibility, developing a methodology to determine whether a UES exists within a specific site, its management needs and to determine whether it can be managed within the in-place zoning ordinance structure.

The magnitude of monetary outlay required for essential environmental reclamation is increasingly being realized, often at public expense. In many cases, there are indications that the cost of restoration far exceeds the cost that measures undertaken prior to development may have incurred. Unfortunately, for some UES environments, redress is impossible due to irrevocable physical damage and/or economic infeasibility.

In this light, a more serious consideration should be given to the effects of proposed land-use actions upon the environment prior to proceeding with substantial physical change of natural land patterns -- especially those environments characteristically unique and/or ecologically-sensitive. Designations of environmental uniqueness or sensitivity should be indicative of the need for select management and/or protection. Pre-planning can offer continued land-use development in response to natural land patterns rather than in spite of natural land patterns, and often with noticeable cost savings to the developers, consumers, and governmental agencies. Governmental authorities having such special environmental resources within their jurisdiction should be first and foremost cognizant of their presence. Recognition presents the opportunity to realize and address potential problems, thereby possibly avoiding debilitating reclamation costs borne by taxpayers, as well as irrevocable physical damage upon the land. In addition, a moral obligation co-exists between the residents of a particular locality, and their elected representatives to husband the land placed within their trust if only to promote the health, safety and welfare of the inhabitants.

Technological changes; economic pressures; diminishing land availability; population increases; location, proximity, and access; and existing amenities may be noted as factors likely to increase the probability of development in UES environments. Clearly, a need exists to, first, identify unique and/or ecologically-sensitive environments, and once identified, to determine to what extent such environments may require select management or protection, and by what means authorities could provide the necessary "management" for those area. Additionally, while it is feasible that the characteristics of UES environments may be conscientiously considered in the development of site plans (provided an awareness of environmental characteristics exists), "economic pressures" may provoke the disregard of such consideration in the actual implementation of the plans. "Economic pressures" cannot, however, disregard legal controls.

It should be noted that in a broad context, "environment" commonly denotes the physical form and condition of <u>a</u> place created by the cumulative influences of climate, geology, soils, hydrology, biology, and cultural patterns. Relative to designations of "<u>UES</u>" <u>these</u> specific environments can be termed "micro-environments", as they often exist as identifiable constituents of a more encompassing environment, such as a physiographic region. These micro-environments may or may not transcend political boundaries. Ideally, if a UES transcends political boundaries, its management or protection should be conducted through an incorporation of all affected jurisdictions. In absence of such "regional land-use controls", the existence of which is nowadays largely infeasible or improbable, a question arises as to whether select management or protection of these exceptional micro-environments may be administered at a <u>local</u>

political level. Further, in view of the present trend of returning to state and local control those issues better served at the state or local level, this concern takes on greater contemporary significance. As local land-use decisions may already affect "UES" micro-environments on a local scale, consideration should be given to the effect such decisions may be having.

In addition, the diversity of identifiable and definable "UES" environments to be found in various locations points up the potential need for local control. Many of the micro-environments in question may be relatively small and their importance measured only on a local scale. A national or regional policy would be hard pressed to comprehensively embrace the individuality needed to selectively manage or protect all such local areas. Additionally, while some "unique and/or ecologically-sensitive" environments may require only select management of development in a particular locale, a similar environment elsewhere may require the prohibition of any development. Therefore, degrees of development allowed need to be considered relative to a site. Large-scale regulatory policies could not easily be equipped to handle such a discretionary degree of management. Thus, local control could offer the flexibility neccessary to address the needs of UES micro-environments within a local jurisdiction, provided local jurisdictions accept the responsibility.

Zoning ordinances appear to be the most prevalent and readily available land-use management tool within most local jurisdictions for guiding or limiting development in "UES" environments. As tools affecting land-use decisions, zoning ordinances need to be examined to determine if they recognize UES micro-environments and whether they can be an effective method with which to manage or protect UES micro-environments facing development pressures. Preliminary study suggests that traditionally zoning has not been flexible enough.

> The law itself all too often is the villain in the piece. The courts hold that the property owner is entitled to, "the highest and best" use of his land. The permit-issuing authority can argue until it is blue in the face that the proposed subdivision includes a bog, but if the adjoining acreage is zoned for four lots to the acre, that is the density the judge at the county seat will award the owner who stands before him.
>
> The consumerist and environmental movements are making the law more aware of the importance of soil science and geological principles in land use decisions, but this awareness has only slowly been translated into case law at the local level (Robinson,1977,p.70).

The issue of local jurisdictional management of UES micro-environments involves social, political, environmental, and developmental aspects. Landscape Architects have an ideal professional background from which to consider each of these aspects in regard to this issue, and beyond, to provide a vehicle for coordinating the interaction of other involved professions (Marshall, 1981).

The basis of the landscape architecture profession is land planning at various scales, which incorporates elements of ecology, engineering, architecture and social planning. A comprehension of how these elements may interrelate would contribute to an investigation involving environments and their management. A recent publication by the American Society of Landscape Architects (1984) stressed that:

> Providing the best natural and built environment requires a special understanding of both human needs and natural resources. The landscape architect understands the relationship of people to their surroundings as well as the potential environmental impact that certain forms of development can bring. This knowledge makes the landscape architect uniquely qualified to meet today's environmental planning and design challenges.

Further, a landscape in transition and the resulting impact upon that landscape, as well as the public health, safety and welfare, is of major concern to Landscape Architects. A UES micro-environment upon which land-use development will occur, or is occurring, is a landscape in transition which will most be likely impacted negatively without some careful, professional planning.

SUMMARY

Therefore, in order to reasonably avoid exorbitant reclamation costs or irrevocable physical damage to UES micro-environments facing development pressures, a means by which select management and/or protection of such micro-enviroments is provided, both, prior to <u>and</u> after development warrants consideration. That this select management or protection might be provided at the grassroots political level and be achieved through "in-place" management tools (i.e. zoning ordinances) also warrrants consideration.

PURPOSE OF THE STUDY

The purpose of the study is to address the utilization of local zoning ordinances in managing and/or protecting UES micro-environments under the authority of the local jurisdiction. Additionally, the study will address the effectiveness of local control, and make recommendations appropriate to the revision of local zoning ordinances found deficient.

Important support considerations contributing to the Purpose of the Study will be:

a. A means of identifying and evaluating the characteristics or interrelationships of UES micro-environments;

b. A means of identifying the "in-place" zoning ordinance components potentially applicable to managing UES micro-environments within a particular jurisdiction, if any;

c. A means of identifying possible revisions and/or additions to "in-place" zoning ordinances found deficient in managing UES micro-environments within a particular jurisdiction.

OBJECTIVES AND EXPECTATIONS

The object of this study is to develop a basis for a framework of land-use policy formation and interject anticipation planning into the zoning process regarding UES management within local jurisdictions. Additionally, the study seeks to stress the importance of "recognition" of existing UES areas by the local authorities. Without recognition of the existence of such "exceptional" micro-environments as a first step, and the resolve to manage those micro-environments effectively once identified, the impetus of this study will be lost.

It is expected that the identifiable characteristics of both exceptional micro-environments and exceptional management will dictate the appropriateness of zoning ordinances as an applicable and effective means of managing UES micro-environments. It should be noted that the characteristics of a micro-environment are inherent and relatively fixed. Thus, it is expected that the applicability and effectiveness of zoning ordinances to "manage" these "exceptional" micro-environments will be determined by the ability of zoning ordinances to defer, as much as possible, to the inherent character of a particular UES micro-environment within its jurisdiction.

DEFINITIONS

In order to provide for a greater understanding of the terms used within, and the limits of, the present study --the following definitions are presented.

MICRO-ENVIRONMENT-- Broadly defined, "environment" suggests the physical form and condition of a place created by the cumulative influences of climate, geology, soils, hydrology, biology, landform and cultural patterns. Thus a "micro-environment", as utilized within this study, signifies a smaller portion, or area, of a larger environment. Micro-environments may occur at various scales and have various physical characters, as can environments. Until specifically located and identified, "micro-environment" should be considered a non-exclusive term representing a yet undetermined physical area within a yet undetermined jurisdiction. The broadness of the term is necessary until a specific micro-environment in a specific location is considered and identified as such.

UNIQUE AND/OR ECOLOGICALLY-SENSITIVE-- Within the present study, the term "unique and/or ecologically-sensitive" has been selected to represent an exceptional physical condition(s) or physical response(s) existing within a particular micro-environment. A micro-environment may exhibit either "unique" or "ecologically-sensitive" conditions solely, or both conditions simultaneously. However, as singular terms both have in common the potential need for select management and/or protection. Throughout the study, the term "unique and/or ecologically-sensitive" is abbreviated "UES".

Specifically, the term signifies the existence of one or more exceptional physical conditions, such as: one of a kind; unusual; highly susceptible to physical changes; or a hazard. Regardless, these types of micro-environments in all probability, will not react in the same manner to imposed influences as may adjacent land areas.

MANAGEMENT NEEDS-- Those actions required to preserve the integrity or ecological stability of the specific UES area.

SELECT MANAGEMENT OR PROTECTION-- The presence of UES micro-environments within a local jurisdiction is indicative of the potential need to scrutinize, guide or prohibit development within that micro-environment. The "scrutinization, guidance or prohibition" of development may be examples of selective management methods which may be implemented by local authorities. Until specifically identified, "select management or protection" should be considered, within this study, as a non-exclusive term representing a yet undetermined specialized method of control to mitigate negative development impacts upon identified UES micro-environments.

MANAGEMENT TOOL-- Management tools (or Controls) are differentiated from "Select Management" and represent, within the study, local zoning ordinances and related controls.

DEVELOPMENT-- Development, relative to land use and as used within this study, designates a noticeable alteration in the type or degree of land use to be imposed upon a site. Those types of development recognized are residential, commercial, and industrial.

ZONING ORDINANCE-- For the purpose of the study, the term represents the zoning ordinance "proper" (i.e. the partitioning of land into zones as per state enabling legislation), as well as other controls within the control system structure (e.g. subdivision regulations) utilized by a local jurisdiction to legally control and manage land use.

AUTHORITY (IES)-- Within the study, "authority" signifies those officials or representatives of a governmental jurisdiction of given boundaries assigned the task of initiating, executing or enforcing zoning ordinances.

ASSUMPTIONS

The initial assumption made that forms the basis of the study is that UES micro-environments exist, that they can be identified -- as can their physical character -- and that, once identified, this character will indicate the need and type of select management and protection.

Second, it is assumed that zoning ordinances may, indeed, be an applicable means of managing UES micro-environments.

A third assumption suggests that a methodolgy can be developed to identify how applicable components of a zoning ordinance (or revisions thereof) may address the needs of a UES micro-environment facing development pressures, as well as measuring the effectiveness of those applicable zoning ordinance components. Understandably, the mere presence of a management method (in the form of an "in-place" zoning ordinance) is not assurance that the management needs of a UES micro-environment are addressed. The management method(s) must be utilized and utilized effectively or they do not serve the intended purpose.

An underlying assumption made throughout this study suggests that as UES micro-environments exist in a myriad of forms, types and degrees with an accompanying myriad of needs -- various forms types and degrees of management methods may be possibly applied, even though those management methods considered within the present study are confined to zoning ordinances. Still, until a time when specific UES areas and their specific needs are identified within specific locations, only _potential_ management method solutions may be forwarded. Additionally, although there are reasonable considerations concerning social and economical issues applicable to the overall study, these issues are beyond the scope of the present study.

CHAPTER TWO
REVIEW OF THE CURRENT TECHNIQUES

INTRODUCTION

In order to assess the appropriateness of zoning ordinances in managing development within UES micro-environments, there must first be (a) an understanding of what a UES is, (b) how its existence may be evidenced, and (c) how UES management can be translated into planning policy and, thus, be coordinated with zoning ordinances. Second, there must be an understanding of contemporary zoning ordinances, and an identification of those zoning ordinance components potentially applicable to addressing the management needs of UES micro-environments.

DEFINING UES MICRO-ENVIRONMENTS

Defining what may constitute a unique and/or ecologically-sensitive micro-environment is the initial step in prompting recognition of a specific UES site on a particular local level. Reiterating the broad definition of UES micro-environments, they are identifiable physical areas existing within a larger environment which exhibit physical conditions and/or physical responses different from those of the surrounding environment. They may vary in type, scale, and location, as well as in degree of uniqueness and/or ecological-sensitivity.

A distinction between the terms, "unique" and "ecologically-sensitive", may be made [i.e., a micro-environment may be ecologically-sensitive without being unique and vice versa]. However, within the context of this study the terms are combined, as the commonality between the two -- that being their potential need for select management and/or protection -- is the main concern.

As noted previously, the term <u>unique and/or ecologicially-sensitive</u> represents an exceptional physical response or physical condition existing within a particular micro-environment. Those exceptional physical conditions or responses within a micro-environment could represent a wide variance and may encompass, for example, the following scenarios:

1. A unique and/or ecologically-sensitive micro-environment possesses or exhibits characteristics and/or behaviors which are inherently and/or conspicuously different from those exhibited by the next greater environment within which that particular micro-environment lies;

2. A unique and/or ecologically-sensitive micro-environment has no comparable equivalent within the vicinity, or perhaps at all;

3. A unique and/or ecologically-sensitive micro-environment is a remnant of a prior state in which the greater environment once existed;

4. A unique and/or ecologically-sensitive micro-environment exhibits localized modifications of the physical elements (e.g. climate, soil, cultural patterns) uncharacteristic of the greater environment within which it lies.

5. A unique and/or ecologically-sensitive micro-environment is one in which the ecological equilibrium, imposed by the natural elements, is especially inflexible and is highly responsive or susceptible to changes within it;

6. A unique and/or ecologically-sensitive micro-environment is one which contains the habitats of rare or significant vegetative or wildlife species -- those species, perhaps, being intolerant of significant changes or disturbances in habitat;

7. A unique and/or ecologically-sensitive micro-environment is one which cannot easily rehabilitate itself after a disturbance;

8. A unique and/or ecologically-sensitive micro-environment is one which, in response to changes within it, a chain of reactions is set into motion affecting it and/or adjacent environments;

9. A unique and/or ecologically-sensitive micro-environment is one which functions as a maintenance factor within the equilibrium of the greater environment;

10. A unique and/or ecologically-sensitive micro-environment is one in which any of the natural elements (e.g. climate, hydrology, soils) exists in the extreme.

PREVIOUS REFERENCE TO THE UES CONCEPT

The aforementioned UES scenarios are a coherent synthesis of ideas from other works addressing the UES concept. The need for select management or protection of UES-type environments has been boldly acknowledged on a national scale over the years, such as with the inception of the National Parks System in the 1890's (Newton, 1971) and more currently the passage of the National Environmental Policy Act of 1969. Although, as Kevin Lynch (1971,p.10.) noted, that <u>all</u> sites are, "...in some measure unique", both of the aforementioned federal policies express the endorsement of special management or protection for such sites deemed extraordinary or possessing such idiosyncratic characteristics that warrant, at times, extreme measures for protection.

UES-type micro-environments have also been identified and defined in various forms by other sources. Robinson, in his 1977 Land Use Guide For Builders, Developers and Planners, recognized "Ecologically Fragile Areas" as areas, "in which the balance of nature will be greatly, and negatively, impacted by construction of any type. Marshes, ponds, flood plains, estuary areas, bogs, are included (p.215)." Chapin and Kaiser, in their 1979 Urban Land Use Planning recognized "areas of environmental concern (AECs)", as those which, "...constitute one category of suitability. These are natural areas which are particularly vulnerable to urban uses or constitute a significant hazard to life or property. Common examples are wetlands, floodplains, unstable shorelines, and historic sites (p.292)."

The Environmental Planning Resourcebook, by Lang and Armour (1980), recognized the "numerous labels" given to UES-type micro-environments as reflective of, "...the difficulty in defining 'sensitivity' (concerning the characteristics of the environmental resource) and 'significance' (which reflects a value placed on it) (p.157)." Relative to classification of UES-type areas, the Environmental Planning Resourcebook (op.cit.) noted the following categories [which are offered as examples for the purpose of this study]:

1. Fragile lands: requiring protection from human activity. These include shorelines of oceans/lakes/streams, wetlands, rare geologic formations, irreplaceable woodland resources, certain wildlife habitats, nesting grounds or migratory stop-over points, and areas of rare or endangered flora and fauna. (...).

2. Hazard lands: requiring man to be protected from the natural environment. Examples are floodplains, steep or unstable slopes, landslide-prone areas, and zones of high seismic or volcanic activities.

3. Renewable resource areas: where the natural environment needs to be protected from human activities in order to safeguard related human use. Included in this category are aquifer recharge zones (their "development" might end up polluting the water supply), prime agricultural land, mineral resource areas, forest lands, and areas particularly productive for fish and terrestrial wildlife.

4. Cultural resources: areas that require protection from man's use but, compared with (3), are less easily justified on economic grounds. This includes areas of outstanding scenic value, areas of particular scientific or educational value, certain recreational resources, and lands containing unique historic, archaeological and architectural resources (p.157).

A Waterloo, Ontario, Canada case study [also noted within the Environmental Planning Resourcebook (op.cit.)] established for designation of "environmentally sensitive" areas within its jurisdiction where there is:

a. The occurrence of significant, rare or endangered indigenous species within the designated area.

b. The identification of plant and/or animal associations and/or landforms that are unusual or of high quality regionally, provincially or nationally.

c. The classification of the area as one which is large and undisturbed, thereby potentially affording a sheltered habitat for species that are intolerant of human disturbance (p.158).

d. The classification of the area as one that is unique, with limited representation in the Region, or a small remnant of once-larger habitats that have virtually disappeared.

e. The classification of the area as one containing an unusual diversity of plant and animal communities due to a variety of geomorphological features, soils, water and microclimatic effects.

f. The identification of the area as one that provides a linking system of undisturbed forest for the movement of wildlife over a considerable distance.

g. The performance of the area in serving a vital ecological function, such as maintaining the hydrological balance over a wide area providing natural water storage or recharge.

h. The recognition of the area as one demonstrating any of the foregoing qualities but suffering reduction of its uniqueness or rareness by the intrusion of human activities (p.159).

Despite the "numerous labels", the aforementioned examples (or classifications) illustrate the existence and diversity of identifiable UES-type areas. The examples also aid in the illustration of those characteristics which may constitute a UES micro-envronment.

Classifications such as "Cultural resources" and "Hazard lands" are considered peripheral to the focus of this study, however, it is acknowledged that instances may exist where, for example, historic or scientific areas occur within UES areas, or UES micro-environments occur within historic or scientific areas.

UES micro-environments may be intially designated as such by virtue of their distinct characteristics by public, governmental, or professional edict. UES areas possessing more subtle characteristics may require substantiation. While some obvious UES micro-environments may be recognized and their management needs established more easily than others, in the majority of cases, a micro-environment would require an environmental analysis to determine, its existence, or as a prelude to determining management needs. Management needs, once established, should provide the means by which the uniqueness and/or ecolgical-sensitivity of the subject areas may be translated into planning policy and, thus, be coordinated with zoning ordinances.

REVIEW OF ENVIRONMENTAL ANALYSIS TECHNIQUES

The ability to determine whether a site constitutes UES status is the first priority in order to determine the need for continuation of the study. This determination is best accomplished by means of an environmental analysis -- a systematic examination of the biological, physical, and cultural elements of a particular environment. The elements are examined both singularly and collectively to determine the dynamics of the individual elements as they comprehensively affect that "particular" environment, and how the dynamics may influence or react to imposed human land use.

Noting the need for environmental analysis in Urban Land Use Planning, Chapin and Kaiser (1979) submitted that:

> ...planners have begun to recognize that the natural environment is a complex organization of interdependent processes with a logic of its own. This logic or balance cannot be unduly disrupted by man's activity without the danger of interrupting, perhaps permanently, essential life resources. The realization is growing that it is as important to protect the environment, particularly fragile environments, from man as it is to protect man from the environment (p.289).

Lynch, in his 1971 Site Planning, also advocated the need for environmental analysis:

> The site is analyzed for fitness to our purposes but also in its own right as a living, changing community of plants and animals. This community has its own interests in the site. In our anthropocentric way, we want our human interests to prevail, yet we must at least consider those of the existing occupants. Such consideration is vital even in selfish terms, since if we know the interconnections of this existing system, we are less likely to set off some inadvertent disaster: severe erosion, an explosive invasion of weeds, or a drop in the water table. Thus site analysis has two elements -- the one oriented to human purpose and the other to the site itself as an ongoing system (p.9).

TECHNIQUE SELECTION CONSIDERATIONS

Numerous and variable environmental analysis techniques exist. A jurisdiction may select, or possibly adapt an established technique, or devise a technique of its own. Regardless of choice, the technique should be one which serves the intended purpose, and one which the jurisdiction (or its chosen analyst) is capable of conducting. The most significant considerations in the selection of an environmental analysis technique include:

data availability	analysis unit
complexity	intended use
subject matter	data interpretation

Assessing fifteen contemporary environmental analysis techniques in his January, 1970 article in Landscape Architecture, Carl Steinitz found that these techniques varied in complexity, subject matter, analysis unit, intended use, and data interpretation.

With regard to the selection of an environmental analysis technique, Chapin and Kaiser (1979) suggested that:

> The design of the environmental inventory and analysis system should depend fundamentally upon the community's goals, planning program functions, and clients to be served, the agency's manpower and computer resources, the scope of its responsibilities, the type of plan and guidance strategy contemplated, and the availability of data (p.209).

DATA AVAILABILITY. Acknowledging the importance of data availability and data inventory to environmental analysis, Lynch (1971) observed:

> Knowledge of the site is essential to design, but information is expensive to gather and expensive to use. As site data are potentially infinite, a thorough survey can paralyze action. One plans initial data gathering as carefully as development itself, estimating the time and resources needed to acquire and to use each item at the specified level of detail. Will knowing something affect a decision sufficiently to justify the cost of learning? Can the data be gotten in time to be

> useful? It is efficient to confine the initial survey to bare essentials and gather special data later in the design process as new questions arise. The data store must therefore be organized to receive a steady stream of new information (p.13).

Relating data availability to execution of the environmental analysis, Steinitz (1970) suggested that:

> ...analysis must not be biased by the availability of data. The fact that one has data does not necessarily mean that one needs to use them. But, if data are not available, this does not mean that analysis must be terminated. What is needed is clearer reporting, of data used and of data which were not available and therefore limited the results of the analysis (p.102).

Data availability may be governed by the form that it is in. Information gathered from prime data sources (such as local, state, and federal agencies) may not be immediately compatible. As indicated by Chapin and Kaiser (1979), "...these data will have been designed originally to serve a variety of often quite specific needs. Thus they may be lacking in resolution (i.e., be at too small a scale) and be biased toward the original purpose they were intended to serve (p.296)." Data must be in useable form or the analyst must be able to transpose data into useable form. The more complex analytical techniques require specific, often quantifiable, data.

<u>COMPLEXITY.</u> Steinitz (1970,p.101) recognized five categories of complexity in the environmental analysis techniques he assessed -- as listed subsequently in order of increasing complexity:

1. "<u>Resource inventory</u>" methods primarily tally, and perhaps describe the character of, resources within a pre-determined analysis unit.

2. "<u>Resource-centered analysis</u>" techniques utilize a specified resource(s) as an analysis unit, wherein the nature and influence of each resource is defined.

3. "<u>Analysis linked with demand studies</u>" define a user group or an area of influence group as the analysis unit and analyze the environment within that unit with regard to the needs of that specified group.

4. "<u>Single-sector models which predict the effect of change</u>" go beyond inventory and resource analysis and consider "What if...?" questions relative to the impact of demand or use.

5. "<u>Simulation models which can interact with other models in a general planning system</u>" are often computer-based methods designed to be integrated with other factors such as economics and social issues.

The complexity of an analytical technique required is highly dependent upon the purpose of the study. If data evaluation is eventually to be linked with economic studies -- the more specific computer-based techniques may better serve the analyst.

<u>SUBJECT MATTER.</u> The content of the example techniques examined by Steinitz (op. cit.) varied from soil-type classifications, to potential (or undetermined) land uses, to specified land uses (e.g. open space or recreation), to visual impact of land use.

Subject matter is highly dependent upon the use to which the environmental analysis will be put.

<u>ANALYSIS UNIT.</u> Steinitz (op.cit.) found the analysis unit (or study area) highly variable among techniques, and cited the lack of agreement that often accompanies the determination of the analysis unit. While political boundaries (or pre-defined zones such as state parks) often constituted the study areas of most of the environmental analysis techniques considered, Steinitz noted that resources generally are not limited to political boundaries. On the other hand, consideration must be given to the party who commissioned the study and the intended use or focus of the study. The second most often utilized analysis unit found by Steinitz was watershed, which would also be an example of a <u>resource-oriented</u> (as opposed to <u>political boundary-oriented</u>) analysis unit. Another resource-oriented analysis unit Steinitz noted was forests (i.e. vegetative patterns), although he suggested that depending upon the the data source, such an analysis unit may oversimplify the actual forested area. Finally, Steinitz recognized <u>user-oriented</u> analysis units, such as area of influence and demand, which commonly define a broader area of concern and are typically related to recreation studies.

<u>INTENDED USE.</u> In regard to the purpose for which the environmental analysis is being undertaken, Steinitz (op.cit.) observed, "...a distinct relationship between the range of data inventoried and used and the specific purpose of the response analysis (p.103)." Additionally, Steinitz noted that, generally, the techniques' evaluations were conducted with a "given proposed

use" in mind. Steinitz asserts, however, "...that an inventory [of data] useable for a variety of analytic goals and purposes would be a more efficient and economical tool than one used for a single purpose (p.103)." Such "comprehensive data inventories" would also appear less likely to overlook certain data considerations.

Steinitz (op.cit.) referred to three types of analysis relative to intended use -- descriptive, static, and predictive. **Descriptive** environmental analyses identify and describe, "...zones of homogeneous character but do not make qualitative or quantitative evaluations of them (p.103)." Such analyses are primarily for later use by other concerns, may serve a variety of purposes, and are the least complex of the techniques. Steinitz regarded as **static** those environmental analyses which, "for a given proposed use the resources are evaluated on a singular basis (p.103)." Static environmental analysis lacks the flexibility to allow for changes in the data over time or changes due to human intervention, however, evaluations are made based on "present" status. **Predictive** environmental analysis articulates the probable consequences of development policies or actions within the analysis unit. Steinitz observed that the predictive evaluations ranged in complexity from broad generalizations to specific computer-based simulation model predictions.

In another interpretation of intended use relative to land use planning, Chapin and Kaiser (1979) categorized the <u>intended use</u> of an environmental analysis into 1) environmentally oriented land suitability analysis, 2) plan evaluation, and 3) project impact assessment.

Environmentally oriented land suitability analyses, according to Chapin and Kaiser (op.cit.), are pre-design/projection procedures conducted on the premise that the environmental characteristics of a land area render it, "...inherently more suitable for some land uses than for others," and that, "...it is possible to interpret environmental data to determine such suitability (p.291)." The analysis results, "...attempt to distinguish several types and degrees of suitability (p.292)," and often are expressed in map form (e.g. overlays). As stated by Chapin and Kaiser (op.cit.):

> These maps are used as inputs to the land use design process and they help suggest more optimal spatial allocations of future urban activities and open space. They can also be useful in guidance system design, suggesting areas where land use controls and public investments must account for particular environmental vulnerabilities and hazards (p.291).

Plan evaluation and project impact assessment, as delineated by Chapin and Kaiser (op.cit.) are post-design/projection procedures that, "...compare impacts of alternative plans or public or private development proposals to each other and to standards (p.292)." Evaluation and impact assessment go beyond "suitability analysis" to determine the effect of development upon environmental processes, "...either to provide feedback for improving design or to assist in making a choice among alternatives (p.292)." Chapin and Kaiser (op.cit.) differentiated <u>plan evaluation</u> from <u>project impact assessment</u> in that, "...plan evaluation applies to entire systems whereas project assessment applies to pieces of systems (p.293)."

Chapin and Kaiser (op.cit.) also pointed out that with greater sophistication in knowledge and methodology, environmental analysis techniques should facilitate in the future the establishment of the environmental carrying capacities of specific land areas -- which would incorporate, "...community goals, economic structure, land use distribution, pace of development, operative site design practices, transportation and waste treatment technologies....(p.293), into site-specific considerations. Additionally, Chapin and Kaiser (op.cit.) suggested that, "...suitability analyses might be combined with urban growth projections to identify 'hot spots' where environmental vulnerability and a high likelihood of urban development coexist. Presumably such an overlap would suggest areas where priority attention should be placed in alerting planning activists, raising public consciousness, and focusing environmental and land use controls (p.293)."

DATA INTERPRETATION. Relative to environmental analysis techniques, the interpretation of the data is largely a function of the complexity of the technique utilized and the analysis' intended use. Techniques employing point-rating evaluations may interpret similar data differently than techniques utilizing map overlay methods. Steinitz (1970), in comparing several environmental analysis techniques, noted that it appeared, "...that the several investigators are looking at the same objectively measurable data and idiosyncratically interpreting them (p.103)." Such a situation may be tempered if consideration is given to the purpose for which the study is being carried out. While the more complex analytical techniques may provide a degree of specificity that mitigates subjective evaluations, this should not associate pure conjecture with the simpler techniques. Proposed action emanating from the data interpretation of simulation model techniques and map overlay techniques may coincide, although the results are articulated at different levels of sophistication.

Steinitz (op.cit.) observed that application of point-rating systems (especially to large analytical units) demands that, "explicit specification of evaluation criteria is mandatory if others are to be able to replicate the method (p.104)." However, Steinitz also commented that, "...local and more relative resource evaluations are perhaps more important to development than consistent evaluation over such very large areas (p.104)." Less specific interpretive evaluations -- broad generalizations which take the form of map overlays and ratings of 'good/fair/poor' -- were not discounted by Steinitz given the nature of environmental data. While Steinitz considered such "broad generalizations" as "reliable", he cautioned that the analyst must provide data interpretation that is useful for implementation of policies, and thus, must strive for an accommodation of both reliability and specificity.

The environmental analysis technique selection considerations cited -- data availability, complexity, subject matter, analysis unit, intended use, data interpretation -- should be taken into account concurrently as much as possible due to their interrelatedness. The complexity of a technique selected, for example, may be constrained by the availability of data or governed by a particular analysis unit, in terms of size or form. The analysis unit, in turn, may be determined by the subject matter which may be determined by the intended use. The intended use of the environmental analysis is fundamental to the other considerations, and may, in fact, dictate overall analytic technique selection.

It should be noted that the preceeding environmental analysis technique considerations by no means epitomize all or, even in particular, the **best** of any of the analytical techniques available or developed for the evaluation of environments, but are presented as representational.

TECHNIQUE SELECTION FOR UES MICRO-ENVIRONMENTS

The choice of analytical technique relative to UES micro-environments will be dependent upon three major requirements being fulfilled. These requirements are: 1) to determine which characteristics of the study area make it unique and/or ecologically-sensitive; 2) to determine the degree of uniqueness and/or ecological-sensitivity; 3) to assess the management needs specific to the particular UES area under investigation. Thus, the intended use of the analysis technique would predetermine the subject matter, and, the end result of the technique utilized would be the necessary management needs required to protect the UES study area. As mentioned previously, the environmental analysis technique selected or devised should be one which the jurisdiction is capable of conducting and interpreting. Thus, the technique should utilize obtainable sources of data and yield undeniable results.

SIGNIFICANT DATA BASE COMPONENTS

Pertinent data must be inventoried and analyzed in order to enable the analyst to substantiate the existence of a UES micro-environment, as well as to establish the degree of uniqueness and/or ecological-sensitivity and determine the management needs. Whereas the inventory and analysis would be focused upon environmental concerns, certain basic environmental forces must be considered -- that is:

soil
climate
hydrology
geology
vegetation

These major physical elements (in varying degrees) determine the form, nature, location, and size of particular environments, thus should form the foundation upon which all other data is derived.

While the five major physical elements may constitute the basic data inventory, more important than compiling separately the characteristics of each is understanding the relationships between each element (e.g., how climate affects soil). Terming this type of analysis "an ecosystem approach", Chapin and Kaiser (1979) explained that such an approach:

> ...emphasizes an integration of the separate natural systems into an ecological whole and a greater stress on biological components. This "ecosystem" approach to environmental inventory and analysis stresses the interrelationships among components rather than treating each natural phenomenon as a separate and independent characteristic of that landscape. Ecosystems are regarded as functional units of the landscape that include all natural phenomena and that can be identified and surrounded by definite boundaries (p.305).

Relative to UES micro-environments, this understanding of the interrelationships between major physical elements is critical. The uniqueness and/or ecological-sensitivity of a particular UES micro-environment is primarily a result of idiosyncratic relationships between the five major physical elements. The relationship may, for example, create an ecological equilibrium intolerant of sudden alterations or contain habitats within it which are intolerant of disturbance.

Utilizing the five major physical elements as a data base provides the initial input into the environmental analysis. Examination of the relationships between these elements will facilitate the recognition of other or ancillary environmental attributes warranting study.

Lynch (1971), in reference to a data base and expanding upon the five major physical elements, asserted that, "past experience indicates the categories of data most likely to be useful (p.13). Those "categories" indicated were:

soil and rock	climate
groundwater	microclimate
topography	human use (of site)
slope	intangible qualities
landscape families	(visual,legal,cultural)

Chapin and Kaiser (1979) recommended for inclusion into a data base the following:

soil	climate
slope	wildlife
geology	special natural/cultural features
topography or physiography	air quality
vegetation	residuals generation (air water/land pollution)
hydrology	

A synthesis of the data base elements noted above would suggest consideration of the following components for inclusion within most environmental analysis:

soil	cultural patterns
climate	wildlife
microclimate	visual features
hydrology	environmental quality
geology	legalities (owner/mineral rights)
vegetation	economic/social/political factors
physiography (surface)	

The purpose of the analysis will determine, in part, the inclusion of some of the elements, such as legalities or economic factors. The purpose of the analysis will also, in part, determine to what extent the elements are examined, such as, what kind of information is examined pertaining to soil. A general indication of probable concerns, both positive and negative, for each of the elements may be made prior to conducting the inventory and analysis, which increases the likelihood that critical relationships between elements will be recognized and examined.

SOILS. Beyond noting soil types, composition, and their respective location, an environmental analysis should also concern itself with the characteristics of each soil type in regard to engineering properties and as plant medium. Engineering properties such as shrink-swell potential, stability, load-bearing strength, depth to bedrock and water table, permeability, drainage patterns, and soil depth, critically affect or dictate construction methods. As a plant medium, soil is highly influential concerning the presence of vegetative species, their location and growth patterns, and thus, influential concerning land use (e.g. agriculture, landscaping). Soils should also be examined for erodibility (due to wind and/or water).

CLIMATE. Climatological data for an environmental analysis should include averages pertaining to temperature, precipitation, humidity, and wind. More significant than averages however, are: the intensity and duration of wind, precipitation, and storms; minimum/maximum and ranges in temperatures; fluctuations in humidity; wind speed and direction; solar path and cloud cover; the characteristics of seasonal disturbances; and flood and drought potential. Climatic extremes are of particular interest, as are relationships of the climatic characteristics to the other elements (e.g. precipitation in regard to the hydrology or wind patterns in regard to the physiography).

MICROCLIMATE. "Each site has a general climate, which it shares with the surrounding region, and a series of microclimates, which may be peculiar to very small areas (Lynch,1971.p.16)."

Microclimates are a result of a number of elements impacting, or, in some cases, altering climatic effects. Warm or cool slopes and air drainage are associated with physiographic landforms or water bodies. Heat reflection and storage is often controlled by vegetative cover or soil type. Wind speed and direction is often a function of landforms. Temperature and precipitation vary with elevation and the presence of water.

HYDROLOGY. Hydrology designates both surface and underground water. Environmental analysis data should take into account not only recognizable water bodies, but also: surface drainage sources and patterns (watersheds); flooding potential and location; groundwater presence, table, saturated thickness, location, and recharge; availability, quantity and quality of both surface and underground water sources; and the patterns, trends, and influences relative to human consumption (e.g. man-made structures altering drainage patterns, water availability, quantity and quality, type and patterns of consumption, and floodplain location, flood frequency and severity relative to land use).

GEOLOGY. Chapin and Kaiser (1979) suggested that geological data include, "Bedrock characteristics (bearing strength, drillability, depth to bedrock); Mineral resources (e.g., gravel); geological hazards (e.g., earthquake faults, areas susceptible to slides); and Unique geologic features (e.g., cliffs) (p.295)." A proposed geologic history of a location is typically documented by federal and state Geological Surveys, and may explain soil types present (i.e. parent material), drainage patterns, origin, location and configuaration of water bodies (both surface and underground), climatological patterns, and erosion and subsidence potential.

VEGETATION. Vegetative patterns are responsive to soil, geology, microclimate (slope exposure), hydrology (drainage), climate (precipitation), physiography, and past and present land use. An environmental analysis should examine the various plant species; dominant plant communities; location; stability; age of succession; dependence upon other elements; indications of disturbances and other changes; and should note differences in natural and cultural plantings.

PHYSIOGRAPHY. Physiographical data would include information concerning topography and other surface features. Particular data should pertain to contours, slope analysis, landform patterns, relief, significant or unique features, vegetation locations, water features, elevation, exposure and orientation to climatological patterns, and drainage basins.

CULTURAL PATTERNS. Cultural patterns may embody archaeological, historical, and land use considerations. Archaeological and historical data should include significant sites, objects, structures, and/or occurrences -- physical or documented evidence illustrating past human interaction with the particular environment.

Land use -- both past and contemporary, as well as uses adjacent to a particular environment -- are often important indicators of the reaction of natural physical elements to human use. Land use can be classified (e.g. agricultural, residential), however, in addition, an environmental analysis should examine circulation patterns, utilities -- the built environment. Lynch (1971) noted that, "the more developed a site becomes, the more these man-made features of use, structure, circulation, and utilities become predominant over the factors of soil, topography, and cover (p.18)."

WILDLIFE. Data concerning wildlife is often found associated with vegetation, as animal habitats and food sources are particular to certain vegetation. Wildlife data, in addition to noting animal types, should include dominant communities, location, range of species, stability of species, dependence upon natural physical elements, rare or endangered species, pests, and sensitivity to change or disturbance.

VISUAL FEATURES. Many environments are known for their visual impact (the reaction to the cumulative effect of all natural and cultural elements). The visual impact may be negative or positive, subjective, and may affect site values, images, and perceptions of that particular environment. Analysis of visual impact gives a concept of dimension and may reveal an importance/unimportance not obtained through statistical or physical data.

ENVIRONMENTAL QUALITY. Environmental quality tends to be air-, water-, and land-related. Chapin and Kaiser (1979,p.295) suggested specific concerns pertaining to each: Air (particulates, sulfur oxides, oxides of nitrogen, carbon monoxide, hydrocarbons); Water (biological and chemical oxygen demand, toxic materials, sedimentation); Land (erosion, solid wastes).

LEGALITIES. Legal aspects of a location or environment of interest to an environmental analysis, according to Lynch (1971), may be, "...ownerships, tenacies, rights-of-way, easements of various kinds, liens, restrictions due to private covenants, mineral rights, and so on (p.18)." Legalities may also involve governmental laws, boundaries, and ordinances.

ECONOMIC/SOCIAL/POLITICAL FACTORS. Factors concerning economics, social issues and political issues may influence or have influenced land use decisions and the environment (e.g. the type of environment affects employment and taxation of an economy, such as agriculture). An inventory of these factors should consider, "community facilities and service, employment, energy use, government, housing, human services, land use, population, recreation, social patterns, taxation, and transportation (Hendler,1977,p.6)." Some of the data may be mapped, while other data requires a tabular form.

SUMMARY OF ENVIRONMENTAL ANALYSIS TECHNIQUES

In order to substantiate the existence of a UES micro-environment, delineate its characteristics, interrelationships, and management needs, an environmental analysis may be utilized. As several analytical techniques exist, the technique selected must be one which will serve the intended purpose and one which the analyst is capable of conducting. Utilizing a pre-established data base for the analysis will increase the likelihood that critical relationships between physical elements are recognized and examined. Relative to UES micro-environments, it is critically important that the analytic technique utilized should reveal the character of that micro-environment and the interrelationships between physical elements which make that micro-environment unique and/or ecologically-sensitive. Critical idiosyncratic characteristics and interrelationships should be highlighted such that the management needs of that micro-environment are articulated. The determination of management needs facilitate a translation into planning policy, which then can be linked to zoning ordinances.

REVIEW OF ZONING ORDINANCES TECHNIQUES

The premise of the study demands that in order to appropriately assess the suitability and effectiveness of zoning ordinances in guiding --and where necessary, prohibiting -- development within unique and/or ecologically-sensitive micro-environments there must be an understanding of such ordinances as they commonly exist today. Toward that effort, an examination of the typical components of an ordinance and other elements of the regulatory control system, and the intent of each is required. A review of "in-place" ordinances and "model" ordinances should reveal the typical components and, in addition, those aspects of an ordinance directly applicable to land development. Analysis of the various established zoning methods should provide insight as to whether or not zoning ordinances are an effective management tool for guiding development within UES micro-environments.

ZONING INTENT

According to the American Society of Planning Officials (1966,1), zoning is one of many planning tools generated as a response to urban growth in the early 1900s. The power to zone emanates from the "police power" of government, one of four basic delegations of authority granted by the state to local municipalities or counties (see Figure 2.1). Patterson (1979) stated that, "the police power is manifested in the enactment of regulatory legislation designed to protect and enhance the public health, safety, morals, and general welfare (p.21)." However, as Patterson further stated, "zoning ordinances must prove to be a reasonable exercise of this power or they risk being in conflict with the state or federal constitutional requirements of 'due process'(p.28)."

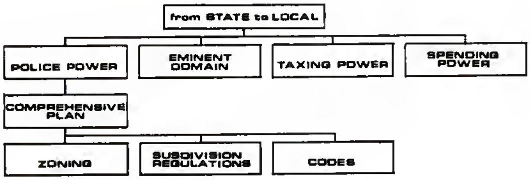


Figure 2.1.
REGULATORY CONTROL SYSTEM ELEMENTS

Figure 2.1 also illustrates that zoning is actually a system of regulatory controls, of which zoning ordinances are an element. The regulatory control system elements are:

Comprehensive Plan
Zoning Ordinances
Subdivision Regulations
Covenants and Deed Restrictions
Health, Building, and Fire Codes

The specific use of zoning ordinances may be traced back to the Standard State Enabling Act of 1926 (see Table 2.1). This act provides that local governmental units may be divided, "...into districts by categories of allowed and/or prohibited land uses...", these uses being subject to further restrictions "uniformly" within the district (Patterson,1979,27). Meshenberg (1976a) indicated that the proponents of the Standard Act envisioned that adoption of local zoning ordinances, "...would determine in advance how the community's land would be used and developed (p.3)." Robinson (1977,43) and Crawford (1974,43) suggested that the primary objective of zoning was to separate residential areas from industry. Leary, in Principles and Practice of Urban Planning (Goodman,1968) observed:

> Zoning is essentially a means of insuring that the land uses of a community are properly situated in relation to one another, providing adequate space for each type of development. It allows the control of development density in each area so that property can be adequately serviced by such governmental facilities as the street, school, recreation, and utility systems. This directs new growth into appropriate areas and protects existing property by requiring that development afford adequate light, air and privacy for persons living and working within the municipality (p.403).

TABLE 2.1
ZONING LEGISLATION

1915	-- U.S. Supreme Court upheld the use of police power to eliminate nuisance by regulation [Hadacheck v. Sebastian, 329 U.S., 394 (1915)].
1916	-- New York City adopted the first significant zoning ordinance; which noted districts with specific uses, building heights, and lot coverage within each district.
1922	-- U.S. Department of Commerce developed the Standard State Zoning Enabling Act.
1926	-- U.S. Department of Commerce revised the Standard State Zoning Enabling Act.
	Zoning is deemed a constitutional use of police power by the U.S. Supreme Court [Village of Euclid, Ohio v. Amber Reality Company, 272 U.S. 365, (1926)].
1927	-- U.S. Department of Commerce prepared related legislation to the 1926 Standard Act -- the Standard City Planning Enabling Act -- as a model for state planning and zoning enabling legislation.
1928	-- U.S. Department of Commerce revised the Standard City Planning Enabling Act to provide for independent planning commissions with the power to enact a zoning ordinance and subdivision regulations.
1930s	-- The Standard City Planning Enabling Act was adopted in some form by many state legislatures.

[**Source:** Patterson, 1979, p.26-7.]

THE COMPREHENSIVE PLAN

The Comprehensive Plan is provided for in the Standard Act of 1926, wherein zoning ordinances are to be enacted in accordance with a Comprehensive Plan. Meshenberg (1976a) and the American Society of Planning Officials (1966) cited several instances where court cases involving both traditional zoning and flexible techniques have been decided based upon whether particular restrictions were in keeping with the Comprehensive Plan. Patterson (1979) commented that, "the Comprehensive Plan itself carries weight as a statement of public intentions, especially if adopted and adhered to, and may be considered an administrative tool for implementation of the plans and policies it contains (p.23)." Black (in Goodman,1968) suggested that such a plan establishes the long-range and general policies of a community, whereas zoning ordinances, subdivision regulations and the official map are specific and short-range means of carrying out the proposals of the Comprehensive Plan. Black (op.cit.) further observed that such a plan brings development issues to light where solutions may be proposed and studied on a guided (as opposed to ad hoc) basis. The Comprehensive Plan is not an end-all document and should have periodic revisions, although this feature is often ignored (Patterson,1979,30). If conscientiously prepared and utilized, the Comprehensive Plan provides the framework upon which all other controls are based.

ZONING ORDINANCE COMPONENTS

As noted previously, the basis for zoning ordinances was generated from enabling legislation known as the Standard Act of 1926 (ASPO,1966). The Standard Act outlined purposes and procedures of zoning ordinances for the local authorities to provide consistency in control -- and thus, legal validity -- while retaining an element of flexibility to allow local interpretation.

To ascertain the basic components which are common to most zoning ordinances, four example ordinances were selected at random -- two authored as "models" and two actual documents adopted by local governments. The model zoning ordinances examined were taken from the Handbook of Zoning and Land Use Ordinances by Clan Crawford, Jr., 1974, and The Text of a Model Zoning Ordinance, 3rd ed., by the American Society of Planning Officials, 1966. The actual zoning ordinances examined were the Berks County [Pennsylvania] Zoning Ordinance of 1970, and the Pottawatamie County, Kansas Zoning Ordinance, 1980.

An analysis of the above examples has revealed those basic components common to a typical zoning ordinance. Although there appeared variation in interpretation and sequence, all examples contained the following components.

TITLE AND PURPOSE. Herein is established the legal authorization for the document. Also included are an enacting clause; a brief statement of the intent and provisions; and an official title for the document.

ADMINISTRATION/ENFORCEMENT/APPEALS. Within each example, sections designating adopted procedures for the implementation of the ordinance are spelled out. Such sections include the commissioning of officials to interpret and enforce the ordinance, and the duties and responsibilities thereof; course of action regarding violations of the ordinance; and the process for individuals seeking exception or appeal in regard to regulations applicable to specific situations.

DEFINITIONS. Precise definitions of all zoning terms and symbols utilized within the ordinance are put forth. Such definitions are necessary for legal interpretation, as well as to facilitate understanding by the citizenry.

ZONING MAP. The Zoning Map is an integral part of the zoning ordinance, as it delineates the specific zoning districts and their boundaries. Additionally, it reflects most conveniently the current status of districts.

ESTABLISHMENT OF ZONING DISTRICTS. Recognized within the examples are various classifications of zoning districts wherein the intent, permitted uses and conditional uses for each district are prescribed. Typically noted as establshed zoning districts were:

residential	agricultural
commercial	open space
industrial	public use
institutional	

Requirements within each district must be uniform, generally encompassing the following regulations:

Height, Bulk, and Placement of Structures. Such requirements are intended to maintain the character of the various districts; to provide sufficient light, air and privacy for each structure; or to provide (in terms of public health, safety and welfare) minimum standards around airports (e.g. height control) or fire protection (e.g. home placement/setback).

Density and Coverage of Land. Controlling the quantity of units or coverage within a given area is considered a common means of controlling the character of a specific district.

Nonconformities. These are, "lots, structures, uses of land and structures, and characteristics of uses, which are prohibited under the terms of the zoning ordinance but were lawful at the date of the ordinance's enactment. They are permitted to continue, or they are given time to become conforming (Meshenberg,1976b,24)."

Parking. Off-street parking and loading zones are considered in zoning ordinances as separate components so as to provide for this necessity without apportioning it out of the open space previously regulated for.

FLEXIBLE TECHNIQUES. Three of the example zoning ordinances made reference to zoning methods markedly different from the conventional form of zoning that involves districting. For the purposes of the present study, these different methods of zoning shall be known as "Flexible Techniques".

The Berks County Zoning Ordinance of 1970 contained a "Special Development Provision in R-2 Districts," which is intended to allow for a variety of housing types within that district; to increase the potential for flexibility in creative design; to reduce site improvement and future maintenance costs; to avoid development in areas characteristically unsuitable for development; and to provide for open space unattainable under conventional zoning. The "Special Provision" also set forth specific allowable variations of the zoning ordinance and subdivision regulations regarding density, lot coverage, open space, and utilities, and required that the proposed development be designed as a single project. The Berks County Ordinance also provided a "Mixed Commerce District", wherein small commercial activities may be permitted within older residential areas -- subject to specified performance standards.

Crawford (1974), in his model zoning ordinance, proposed that in situations where substantial parcels are developed, as opposed to a lot-by-lot basis, many of the requirements set forth by conventional zoning are superfluous, and, in fact, may be deterimental to quality development (p.71). He asserted that, on such parcels, a higher density of development and land use intensity may be attained, and certain use-types mixed successfully, through creative design techniques. To provide for such a situation a community may adopt "Planned Unit Development (PUD)" and/or "Cluster" Provisions, the intent of which are to permit a flexibility in zoning while keeping with the declared intent and planning goals of the community. Crawford (op. cit.) indicated that these provisions may be applied to most district uses (e.g. residential, commercial, industrial) and may be accomplished by two basic methods (p.72). The first is a PUD District (or Floating Zone) noted in the ordinance as acceptable within the community, although the District is not specifically located on the official map. Applicants must submit required plans for the project and gain approval of that proposed plan from the designated authority. Plan review is typically done on a case-by-case basis, and each plan is judged on its own merit. Another way that such provisions may be applied to most district uses, according to Crawford (op cit), is to adopt a provision wherein the conventional regulations apply. However, the Zoning Board of Appeals is permitted to grant variances [exception due to hardship] to approve PUD projects throughout the community. It must be stipulated and recognized that the proposed plan is in keeping with the planning goals and objectives -- and is in the best interest of the community (p. 73). The success of both methods depends upon the site plan review (which Crawford recommended be compulsory) and the information required for the review, and the review procedure for the review be specifically stated(p.66).

The <u>Pottawatamie County, Kansas Zoning Ordinance</u> (1980), perhaps by virtue of its being the most recent example, included the most numerous methods which offer flexibility from the standard regulation. Provided within the typical zoning districts of agricultural, residential and commmerical of the Pottawatamie County Ordinance are Planned Unit Rural Development Districts (PURD), Planned Unit Development Districts (PUD), and Planned Commercial Districts (PCD). The purpose of each of the three techniques is to allow flexibility in design and control of uses within the specialized districts, giving some reference to the settings in which such uses will occur. The techniques rely heavily upon a "site plan review" process and typically grant approval in stages of construction to facilitate a monitoring of the project's progress. This method utilized by Pottawatamie County is similar to that described within the Berks County Ordinance (1970) and by Crawford (1974) in his model ordinance, but reflects an inclusion into more districts in expanded detail and utilizes performance standards in preference to the specification standards of conventional zoning ordinances.

The Pottawatamie County Ordinance also included a "Flood Overlay District", intended to protect persons and structures located in districts designated as "Flood Hazard Areas" by the U.S. Department of Housing and Urban Development in 1977. This Overlay District utilizes site plan review and performance standards as a basis for approval or denial of a proposed development.

It appears that the use of flexible zoning techniques is increasing. Meshenberg (1976b) commented that although the conventional method of zoning still applies, zoning, "...has evolved considerably from its rudimentary forms into a complex array of techniques, procedures, and links with other devices, the results of which often bear little resemblance to the early models(p.1)."

Flexible techniques are intended, as the term implies, to add flexibility to the zoning ordinance, which in its traditional form is prospective in regulation and thus less adaptable to arising situations which were not originally considered. According to Meshenberg (1976b), flexible techniques:

> ...recognize that the appropriate use for every parcel of land cannot be predetermined; as a result, policies and criteria for decision making are established, often through performance standards, rather than specified uses and standards. Under most flexible techniques, public officials or bodies have discretion in their decisions and frequently negotiate with developers before final approval is given. Thus, while development options are broad, development permission, once granted, may be quite narrow (p.17).

Performance standards differ from **specification standards** in that they define a preferred condition as a result of development, rather than defining controls that are intended to produce the desired condition. Robinson (1977) explained that, "the movement is away from regulations that say: You can only make this use of the land. The word is now: Do anything you want, but it must meet these standards (p.209)." For example, a performance standard regarding density would indicate a desired density for the total acreage of the development, while a specification standard would predetermine lot size. Therefore, a developer may, according to a performance standard, design for cluster housing while utilizing the remaining acreage for open space -- rather than dividing the parcel into equal-sized lots and, perhaps, have little remaining "usable" open space. Should the parcel happen to include an area of developmentally-unsuitable land, such as a marsh, the developer could, utilizing the performance standard, set this land aside as open space, thereby avoiding the environmental and economic costs of rendering it buildable. Performance standards are considered by many to be not only more flexible, but more conducive to creative and diverse design solutions.

Meshenberg, in his June, 1976 publication, The Administration of Flexible Zoning Techniques, noted that these zoning devices are commonly administered through special-use permits, site plan review, and rezonings. He recognized the following techniques as those which involve a degree of administrative discretion [thus, flexibility].

PUD	Incentive zoning
Special Permit	Subdivision exactions
Overlay zoning	Transfers of Development Rights (TDRs)
Floating zoning	Impact zoning
Conditional rezoning	

As may be visualized in Figure 2.2, a technique is not autonomous. For the purpose of the present study, however, each of the above-mentioned flexible techniques will be discussed individually.

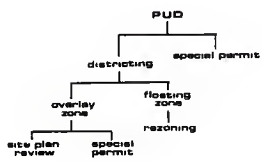


Figure 2.2.
EXAMPLE OF FLEXIBLE TECHNIQUE INTERRELATIONSHIP

1. Planned Unit Development (PUD) is perhaps the most familiar and widely used of the flexible techniques. PUD is characterized

by a unified site design which may be comprised of a single land use or a mixture of land uses and building types, a clustering of buildings, areas of common open space, and phased development. The PUD technique may be applied to residential development; an office or industrial park; a shopping center; or, upon a sufficiently large parcel, all of the above. PUD is generally considered creative in that developers are usually given more latitude in regard to absolute compliance with governing regulations. Zoning authorities may allow a developer to forego certain regulations provided s/he compensates with increased amenities (e.g. open space).

The term, PUD, also refers to the enabling process, which must be specifically stated in the PUD section of the zoning ordinance. The process mainly revolves around: 1) negotiation between the planning commission and the developer concerning aspects of the zoning ordinance and subdivision regulations; and 2) the site plan review. The PUD process is usually administered by means of a special permit or rezoning, or may involve an area predesignated as an overlay or floating zone. Because large scale projects are commonly developed in phases over longer periods of time, it is necessary to provide for future modifications of the agreed-upon site plan due to rapidly changing market conditions and lifestyles. (Meshenberg,1976b and Patterson, 1979).

<u>2.</u> <u>Floating</u> <u>Zones</u> are predesignated districts specifically described within the text of the zoning ordinance but <u>not</u> specifically located on the official map. The district usually indicates that a use, for example a shopping center, is desirable

within a section of the community, yet does not pinpoint the location, so as not to influence land values in that section. Upon application by a developer (site plan submittal and review), the particular parcel is rezoned for that use subject to compliance with applicable performance standards (Meshenberg,1976b) and Patterson,1979).

3. Overlay Zones are predesignated districts specifically described in the text of the zoning ordiance and located on the official map. Overlay Zone requirements are imposed in addition to the requirements of the underlying districts. Such zones are primarily utilized in relation to special physical conditions, such as flood plain districts, or special use conditions, such as agricultural districts. Permission to develop within Overlay Zones is granted through special permits or site plan review processes, subject to predetermined performance standards (Meshenberg,1976a).

4. Special Permits, like "variances", have their authorization originating in the Standard Act of 1926. The intent was to allow for exceptions to permitted uses within land use classification districts -- provided that those exceptions were in keeping with the general purpose and intent of the zoning ordinance and met supplementary criteria deemed necessary by officials. Meshenberg (1976a) noted that Special Permits allow the designated authority an opportunity to determine whether a particular development (e.g. a school) will create special problems (e.g. increased traffic) in a particular location (e.g. a residential district) (p.25). The permit process also allows the authorities to

determine whether potential problems created may be ameliorated by specially devised conditions (e.g. frontage roads) that would be imposed upon the development if approval is granted. Provision for Special Permits is usually made within the schedule of districts under conditional uses. The process involves submittal and review of the site plan and a negotiation of conditional standards. Special Permits may be utilized to facilitiate other flexible techniques, such as PUD.

5. __Conditional Rezoning__, according to Meshenberg (1976a), "...secures the property owner's agreement that, in exchange for the rezoning, he will accept restrictions on the use of the property beyond those of the district in which it is placed. This legally binds the owner to his commitment (p.36)." Meshenberg (1976a) suggested that the imposed restrictions are intended to insure compatability between the proposed development and adjacent land use, and to protect adjacent land uses from negative impact or loss of land value due to approval of the zoning change. The technique is commonly utilized, according to Eagleton (1981), in situations where the parcel in question lies between two separate districts or where the character of the district is changing (p.21). The restrictions imposed are typically limits on use (e.g. a limit on building size) or requirements for the developer (e.g. construction of improvements). As these restrictions are not stated within the zoning ordinance, the process involves dealing with proposed developments on a case-by-case basis where, upon submittal and review of a developer's plan, such restrictions are proposed by the designated authority to mitigate foreseeable conflicts and

problems brought about by the zoning change. Meshenberg (1976a) observed that the actual agreement to the restrictions usually takes the form of covenants or deed restrictions.

6. Incentive Zoning provides for the inclusion of amenities within a proposed development in exchange for concessions granted to the developer (Robinson,1977,52). To implement this technique, Meshenberg (1976a) suggested that the designated authority must: 1) establish the purpose for granting incentives (e.g. to improve pedestrian circulation or to increase open space), which may vary according to the project or its location; 2) select specific amenities to meet those purposes (e.g. separating pedestrian and vehicular traffic or the provision of a playground); 3) determine specifically the incentives to be offered in exchange for the amenities. This determination requires an element of technical and legal analysis, and must consider what types of incentives would be acceptable to developers. Allowances for density increases may be desirable, for example, where land costs are high, while allowances for a mixture of land uses may be more desirable where land is less expensive; and 4) give consideration to the method of administration, which may be "by right" or by "special permit". As in all of the flexible techniques, the use of Incentive Zoning must demonstate legitimate and reasonable public purpose.

7. Subdivision Exactions are intended to internalize within a proposed development those public capital and operating costs often generated from the conversion of "raw land" to a new use.

An exaction may require, for example, that a percentage of the land parcel being developed be dedicated to the community as a future school site. In lieu of a dedication, the developer usually has the option of making an "in kind" monetary payment, which would be utilized, in concept, for additional classroom space (or another such school facilities). Dedication percentages and payment amounts are typically derived from a predetermined formula defined within the ordinance. Still, there remains an element of negotiation within the "site plan review" process (Meshenberg,1976a,46).

8. <u>Transfer of Development Rights</u> (TDRs) is a concept which Meshenberg (1976a) stated is, "...predicated on the widely held premise that rights to use or develop land can be separated from the land itself...", and that these <u>rights</u> most often involve the <u>intensity</u> of the use (p.50). A landowner not wishing to develop her/his land may sell the "development rights" to another entity -- that entity, in turn, is allowed an increase in density on a particular tract named in the sale. The concept allows the original owner to avoid economic development pressure, while retaining ownership of the land and receiving compensation for such preservation. TDRs have been successful in situations, for example, where the original owner's parcel encompassed an ecologically-sensitive or historic site in need of protection from encroaching development. "Development rights" can typically be sold only once.

The process for the implementation of TDRs involves a reasonable calculation of development potential for the land parcel needing preservation and a determination of where higher densities would be permissable (Meshenberg,1976a,52).

9. Impact Zoning, or Performance Zoning, is a flexible technique Meshenberg (1976a) observed was intially conceived in the 1950s to control the effects of industry upon adjacent land. However, it has recently been, among other uses, applied to protect natural resources (p.57). The technique relies upon the ability to predict potential impact (e.g. erosion) through the use of quantitative measures (e.g. erosion or sedimentation calculations). The increased sophistication of such predictive quantitative measures over the years has expanded their use, and the use of Impact Zoning. Soil suitability tests, slope stability determinations, and formulas for calculating runoff and erosion, are examples of quantitative measures which may be utilized by authorities to determine and set desirable and/or acceptable levels of impact. The selected levels can then be applied as performance standards, which must be met by developers. Robinson (1977) pointed out that the Impact Zoning concept commonly analyzes and correlates the effects of the proposed development as it relates to the community's growth rate, infrastructure, economic picture, and natural environment.

The nine aforementioned flexible techniques are presented to illustrate the nature of these relatively recent zoning methods. Meshenberg (1976a) pointed out that to regulate impact, traditional zoning relies typically on volume (the number of units per acre) and use classification (e.g. residential or commerical), even though other factors such as timing, composition, location, and design of development significantly affect the overall impact (p.55). Flexible techniques, in various capacities, take into account these "other factors" and offer greater opportunity to both developers and political authorities to achieve desired goals while providing quality living and/or work environments for consumers/the public.

SUBDIVISION REGULATIONS

Subdivision Regulations are authorized under the Standard City Planning Enabling Act of 1928. Essentially, Subdivision Regulations become effective when a parcel of "raw land" is divided into two or more separate parcels for the purpose of lease or sale. The subsequent use of these new parcels may be for residential, commercial or industrial use. When such a subdivision of land occurs, Patterson (op.cit.) noted that certain issues immediately arise which may require the attention of community authorities, such as:

- adequate legal description of the new parcels;
- reassessment of new parcels for tax purposes;
- assurance of safe and adequate water supply;
- assurance of safe and adequate sewage treatment;
- assurance of safe and adequate drainage;
- access and water supply for firefighting;
- design, construction, and alignment of new streets, utilitities, and drainage relative to existing community infrastructure, adjacent land use, and natural land patterns;
- the procurement of potential school sites and open space;

- the potential increase in public capital and operating expenditures; and

- proposed use of the subdivision.

Subdivision Regulations address the aforementioned issues through the establishment of General Provisions, Design Standards, and Procedures, which must be met by developers of subdivided land parcels.

The General Provisions set forth the intent of the subdivision regulations, indicating required compliance with the Comprehensive Plan; that certain or all subdivision development is prohibited in areas designated as unsuitable (e.g. flood plains); and that there must be coordination and compatibility between proposed subdivision development and adjacent land uses regarding such elements as streets, utilities and drainage.

Design Standards set forth minimum accepted requirements for development based on the public health, safety and welfare (e.g. stipulating minimum street and cul-de-sac dimensions so as to provide emergency vehicle access; or requiring minimum right-of-way dimensions for inclusion and maintenance of utilities). Patterson (op.cit.) observed that design standards may affect overall subdivision layout; street layout and composition; lot shapes and dimensions; utility layout and access easements; and provision for open space or certain community facilities (p.101). Patterson also noted that in particular situations, design standards may yield to the demands of other governing entities (e.g. state and federal health agencies). The design standards may also yield to other relevant regulatory standards (e.g.

zoning ordinances or building codes). Coordination of these other control devices with subdivision regulations is a required and continuing exercise.

Subdivision regulation is typically accomplished through a "plat approval process", under which a developer may only proceed with proposed development and/or sale of parcels upon approval from the designated authorities (commonly coordinated through the planning commission). Patterson (op.cit.) noted that initially, subdivision regulations either encourage or require a preapplication meeting, wherein the subdivider presents to the administering staff a rough sketch of intent so that potential concerns of both parties may be known and considered in advance of detailed plan development (p.99). A successful preapplication meeting, Patterson observed, usually expedites the subsequent procedural requirements, which are: Preliminary plat submittal; Construction of improvements; Fee payment; and Final plat approval.

According to Patterson (op.cit.), the preliminary plat must include information specifically required within the Subdivision Regulation text (p.100). The plat is then reviewed by designated parties (e.g. the planning commission, engineering staff, or health department officials). At this point, a negotiation process may occur, wherein approval may be conditional provided the subdivider constructs agreed-upon improvements. Meshenberg (1976a) indicated that the intent of conditional approval and construction of improvements is to discourage developers from merely holding the land for speculative reasons (p.46). Upon verification that the improvements have been constructed and meet the relevant standards, the developer may submit the final plat for approval. Patterson (op.cit.) suggested that contemporary subdivision regulations acknowledge "phased development" (typical of large PUDs) by allowing a developer to submit a master plan as the Preliminary Plat and as a guide for future development, however granting approval only for that portion of the total tract the developer intends to develop at the present time (p.100).

Subdivision regulations are generally directed at a specific type of development, although, Patterson (op.cit.) recommended that these regulations be coordinated with related controls (e.g. zoning) as their intent is to be complimentary rather than contradictory (p.96). Green (op.cit.) proposed that subdivision regulations should adopt the "performance standard technique" so as to be more adaptive to the changing nature of subdivision development (p.478).

While conscientious adherence to subdivision regulations does not guarantee a particular subdivision will provide a quality living environment or protect UES areas, it does decrese the likelihood of sub-standard subdivision development, which adversely affects the municipality in which it occurs, its citizens, and other developers.

COVENANTS AND DEED RESTRICTIONS

Covenants and Deed Restrictions, as described by Meshenberg (1976b), are legal private restrictions on land use typically enumerated in the property deed (p.11). The authority to establish Covenants and/or Deed Restrictions, according to Keller (1984a), is through contract property law -- an inherent right of the landowner rather than a legislated right or power. Conformance to Covenants and/or Deed Restrictions is required upon taking title to the property in question.

Covenants are common to PUD-type developments, including residential, commercial, and/or industrial land uses. The intent of these restrictions, in many cases, is to preserve the character of the development as a means of protecting the development investment. Stipulations may address aesthetic issues regarding construction materials, house types and their upkeep, future home improvements, and/or the storage of personal belongings (vehicles). Some Covenants establish areas of recreational or open space, which may be maintained through and by a non-profit organization known as a "Homeowner's Association".

As noted in the description of Conditional Rezoning, municipalities are increasingly utilizing Covenants as a method of control over land use "after zoning". There is no public equivalent to Covenants (Keller,1984b). In certain situations, rezoning or plan approval is conditional upon the inclusion of predetermined requirements within a development's Covenants. Such an arrangement may be beneficial in that specific concerns on specific sites may be addressed (e.g. UES micro-environments).

HEALTH, BUILDING, AND FIRE CODES

Health, building, and fire codes are representative of such codes which derive their authority from the aforementioned "police power". Typically, State legislation specific to a concern (e.g. health standards) is enacted on the basis of public safety, health and welfare. This legislation may require mandatory or voluntary compliance on the part of local jurisdictions. The legislation may require that a local jurisdiction adopt an accepted National Code or stipulate that the jurisdiction develop an individualized code which meets the legislation standards. Federal authority may also influence code enactment at the state or local level, often times by withholding funding until compliance with federal standards is achieved (e.g. EPA standards and funding). Code enforcement is generally coordinated locally through one designated authority -- representatives of each concern (health, building, fire) reporting their findings to that authority. Failure to comply with these codes often means a withholding of permits or denial of approval by the designated authority.

Health, Building, and Fire Codes are discussed to illustrate how these codes control land development.

<u>HEALTH CODES</u>. address an array of concerns, although relative to land use, the concerns typically involve the location, construction and operation of Sanitary Sewer and Water Supply facilities. Health Department interests, and thus requirements, reflect the desire that such facilities operate sufficiently so as to protect the health, safety and welfare of the public.

Sanitary Sewer configurations commonly take one of two forms: 1) Sealed Collection Systems with a Central Treatment Plant; and 2) Septic Tank Systems.

1) **Sealed Collection Systems with a Central Treatment Plant** are usually required within municipalities and higher density developments. Collection systems rely primarily on gravity-flow to operate correctly and therefore must coordinate with the existing system layout. This coordination, along with regulatory standards, have a major impact upon the proposed layout of lots, streets, building sites, and other underground utilities.

2) **Septic Tank Systems** are common to low density areas and are usually on-site, self-contained units serving an individual dwelling or commercial establishment. Such a system's operation depends primarily upon percolation and absorption rates relative to the soil conditions within which the system is constructed. These rates, as determined by soil conditions, translate into dictating a calculable lot size. The required lot size is relatively large, and thus, economically infeasible in a typical development project (Willingham,1984 and Patterson,1979).

Water Supply must be adequately available, bacteriologically safe, and free of objectionable odor, color and taste. Health Department requirements are intended to insure these characteristics. Domestic water supply for higher density developments is generally obtained from a surface (e.g. river) or groundwater (e.g. aquifer) source, and apportioned through a central distribution system. Rural and low density areas typically utilize individual wells or pumps to obtain domestic water supply. In each case, the water supply must be protected from ingress of contamination. Health Department regulations mandate spacing minimums from sanitary sewers, feedlots, and/or chemical storage, and set construction standards so as to assure that systems are sealed. Regularly scheduled samplings, lab analyses, and on-site inspections facilitate continued enforcement of the above requirement.

BUILDING CODES are often adopted by municipalities to establish a degree of quality in the construction of buildings and related construction. The intent is to reasonably assure the public's health, safety and welfare. Building codes reflect acceptable standards of construction as determined by the experience and findings of professional and business associations and testing laboratories involved in various facets of the construction industry.

The International Conference of Building Officials publishes the Uniform Building Code (1982) which, "...covers the fire, life and safety aspects of all buildings and related structures." This code, widely adopted by municipalities, establishes requirements based upon occupancy (type and load); type of construction; quality and design of materials; as well as addressing specialized concerns (e.g. excavations, foundations, retaining walls; roof construction; exits; and prefabricated buildings). The code also includes Fire-resistive Standards for related construction and materials.

Beyond structural considerations which may affect development, there may be such requirements as "setbacks from property line to perimeters of grading" which affect aspects of project design layout.

FIRE CODES, such as the *National Fire Code* published by the National Fire Protection Association (1977), establish safeguards against loss of life and property by fire. Fire codes resemble Building codes in organization and enforcement, although the concerns are more narrow in scope. Building Codes generally address protection against fire to a certain extent as there are elements of fire protection which are more successful if "built-in". Thus, there is potential overlap between Building and Fire Codes, although this does not imply repetition.

The National Fire Code encompasses a myriad of systems, equipment, materials and standards -- from detection equipment to the storing of hazardous materials. As an example of how Fire Codes may affect development there is the requirement for emergency vehicle access which translates into street layout and dimension; also regulations regarding building materials influence design.

EVALUATION OF THE ZONING ORDINANCE REVIEW

Of primary concern to the study is a determination of whether zoning ordinances are an applicable and effective means of managing UES micro-environments. Toward that determination, an initial evaluation of zoning ordinance and regulatory control system data identified in the previous review and relative to managing UES areas follows.

An underlying concern not directly addressed by this study is whether zoning ordinances, and the designated authorities implementing and enforcing the zoning ordinances recognize the existence of unique and ecologically-sensitive micro-environments within their particular jurisdiction, and whether these authorities will undertake the necessary steps to control development in such environments which could promote irrevocable impacts upon such micro-environments. In absence of such recognition, utilization of zoning ordinances for guiding development in UES areas would indeed be ineffective.

In reviewing the typical components of a zoning ordinance, it was noted that ordinances have expanded to include a wider range of zoning techniques and also function in tandem with other regulatory control system elements. Thus, although certain components considered are not technically components of a zoning ordinance proper (e.g. codes), they are relevant to overall development control, and as such, are considered within this review.

Initial components of the zoning ordinance, such as <u>Title and Purpose</u>, <u>Administration/Enforcement/Appeals</u>, and <u>Definitions</u> may, in effect, be applicable to the concern of the this study, in that they set forth intentions, procedures and definitions, which are pertinent to all subsequent components of the zoning ordinance. However, within the scope of the present study, these initial components will be considered primarily an administrative element and thereby not directly applicable.

The <u>Zoning Map</u> is considered an applicable component, as it can potentially serve to specifically delineate the location and perimeters of UES areas within a jurisdiction. Additionally, the Zoning Map could reflect the current status of existing land use classification in relation to UES micro-environments rendering the Map a significant and applicable management tool.

Zoning Districts, as presently established, recognize use types (e.g. residential and commercial districts) and are intended primarily to separate uses and maintain the characters of those districts. In addressing UES micro-environments, the type of use would be subordinate to the actual implementation of that use upon the site. Consequently, for the purpose of this study, Establishment of Zoning Districts is not viewed as being significantly applicable to the study.

Flexible Techniques arose out of a need to acknowledge and accommodate the changing nature of development, which was becoming characteristically larger and more diverse. The numerous flexible techniques, many of which were created to address specific situations, have evolved -- becoming more refined, effective, and accepted as legitimate land use management tools.

These flexible techniques, by virtue of their flexibility, are potentially adaptable to various locales and local needs. Commenting on both the assenting and opposing characteristics of flexible techniques, Meshenberg (1976a) pointed out that such techniques:

> ...permit the land-use-control process to be more responsive to complex social, economic, and environmental objectives and problems;

They permit wider utilization of the most appropriate planning and development methods in a given situation;

They increase opportunity for the use of cost-saving development methods;

They more readily permit the implementation of special community objectives such as increased housing opportunity or protection of environmentally sensitive areas;

They may open up the administrative process to closer public scrutiny; and

They are much better suited to the larger scale at which most fringe area development occurs (p.1).

However, reservations concern:

The secrecy attending most negotiations, which opens up the possibility of, or at least charges of, deal making, bribery, and extortion;

Allegations that communities make arbitrary and excessive demands of developers and, conversely, that developers can often put things over on unsuspecting communities, whose citizens must then bear the resulting costs;

The inability to predict likely development and hence the inability to plan and program future public costs;

The uncertainty of present residents about what will be built nearby and its effect on their taxes; and

The opportunity to exercise facto exclusionary policies under the guise of cooperation (p.1).

Additionally, Meshenberg (1976a,6) noted that flexible techniques do complicate the development management process, primarily due to the case-by-case review. Where conventional zoning was explicit and narrow, implementation of flexible techniques requires a more sophisticated and informed administration and support staff, given to both reasonable negotiation and adherence to the planning goals established in the comprehensive plan. Still, the apparent success of flexible techniques warrants their consideration.

The Comprehensive Plan has been perceived in previous description as being the cornerstone upon which all other zoning controls are based and legally interpreted. It is in this Plan that a jurisdiction sets forth its planning goals and intentions, whereas, zoning ordinances and related tools are meant to carry out those goals and intentions. It seems essential, then, that in jurisdictions where UES micro-environments exist, the Comprehensive Plan clearly recognize a UES site's existence and the site conditions which will affect or be affected by development. Further, the Comprehensive Plan should state precisely the policies regarding the particular UES site(s). In this regard, the Comprehensive Plan is a highly applicable component of the zoning ordinance.

Subdivision Regulations become effective, in addition to zoning ordinances, when a parcel of "raw land" is divided into two or more separate parcels for the purpose of sale or lease. These regulations are established to address several issues, among them the protection of the public's health, safety and welfare; the coordination of existing community infrastructure with proposed facilities; and the coordination of a proposed project with overall community planning goals and intentions. As development often involves the subdivision of land, Subdivision

Regulations would, in turn, directly affect that development. Should a land subdivision development be proposed within a UES area, Subdivision Regulations would directly affect that area, and therefore should be considered directly applicable to the concern of the study.

The increasing complexity of contemporary development may produce deficiencies in Subdivision Regulations that warrant recognition and revision when they arise. Summarizing Patterson's (1979,108) observations there may be:

> a. a lack of coordination with related controls and thus the possibility of conflicting or redundant controls placed upon a developer;
>
> b. the lack of an allowance for unconventional design solutions (e.g. cluster housing);
>
> c. an inordinate concentration on single-family housing to the exclusion of other housing types and/or land uses; and
>
> d. a lack of recognition of varying landforms which may require an alteration of standards to accommodate development.

Health, Building and Fire Codes exist according to State legislation enacted on the basis of protecting public health, safety and welfare. Enforcement of these codes is typically coordinated within local jurisdictions through a site plan review and site inspection made by Health, Building and Fire officials prior to jurisdictional approval of a proposed project. As a related component of zoning ordinances, these codes are potentially applicable to development in UES areas. For example, Health Codes require minimum standards for sanitary sewage disposal in terms of design, operation and maintenance which may not be obtainable in certain UES micro-environments (e.g. a marsh).

<u>Covenants</u>, although private restrictions on land use, may be considered relevant to development control in UES areas due to the ability of these Covenants to be drafted in such a way to address specific site conditions within "their jurisdiction". For example, a developer cognizant of characteristics of UES areas within, or upon which, the proposed project is being built may mandate procedures within the project's Covenants that will mitigate negative impacts. Additionally, Green (in Goodman,1968,449) observed that Covenants are typically filed with the plat of a subdivision and within the plat approval process, the approval authorities may negotiate with a developer to include, in covenant form, regulations particular to the project or site.

It was noted previously that in regard to guiding development in UES micro-environments, **FLEXIBLE TECHNIQUES** offer numerous opportunities for authorities to address certain issues. The following techniques appear to have the greatest potential for applicability to UES areas.

<u>1)</u> <u>Planned Unit Development</u> offers opportunity for authorities to, for example, discourage development in a specific portion of a proposed development while allowing increased density in another portion, thereby protecting a UES area from ill-advised development. Additionally, the technique's facility for individual site plan review may allow a developer to prove to authorities that a proposed unconventional method and land use

implementation would not be deterimental to a UES area within the site of the proposed project. Further, the capacity of PUD to permit land-and-cost-effective site design (e.g. higher density with concentrations of larger open spaces) could mean less overall disturbance of a micro-environment in question. Also, as many PUDs involve phased development, and within that, modification clauses, methods of development found to be detrimental over time could be addressed and revised in later stages.

2) Overlay Zones present local authorities with the opportunity to delineate, both on the map and in the zoning text, areas of UES micro-enviroment within their jurisdiction, and to prescribe conditions to which development in these zones must comply. An example of such a zone is the "Soil Overlay District" developed by the United States Department of Agriculture's Soil Conservation Service (Robinson,1977,223). Within a "Soil Overlay District", supplemental zoning controls over development within the district are based on specific soil limitations relative to development. Such controls could take the form of performance standards.

3) Special Permits, as mentioned previously, have as their foundation the ability to address errors or unforseen situations and thereby extend a potential applicability to UES areas. Special Permits are also utilized to facilitate other flexible techniques (e.g. PUD) and therefore must be considered applicable to addressing development in UES micro-environments.

4) Conditional Zoning binds a developer to compliance with

restrictions imposed on the developer's parcel by the designated authorities. The imposed restrictions conceiveably could address the site conditions present in an UES area, and thus, effectively guide development in such micro-environments.

5) Incentive Zoning revolves around a case-by-case negotiation process between the developer and authorities, wherein amentities are secured from the developer in exchange for incentives offered by the designated authorities. There exists a potential for applicability of this technique to UES micro-environments if, for example, such a micro-enviroment is considered within the amenities desired and amentity protection is obtained in exchange for density increases.

6) The principle behind Subdivision Exactions is to internalize within a proposed development those public capital and operating costs often generated from the conversion of "raw land" to a new use. Meshenberg (1976a,47) observed that this flexible technique is also based upon the constitutional power of protecting public health, safety and welfare, thereby promoting actions which enhance public environments (e.g. physical, social and economic). Meshenberg cited as an example the public interest to prevent overcrowding of schools, which in terms of Subdivision Exactions may require that a developer dedicate a portion of the proposed project parcel towards use as a school site. In lieu of a dedication, the developer may make a monetary payment "in-kind" towards additional classroom space to the present school system. In this same vein, it would be in the public interest to protect UES areas, or avoid irrevocable impacts in such areas located within proposed development

projects. Subdivision exactions could be drafted which address this issue.

<u>7)</u> <u>Transfers of Development Rights</u> (TDRs) have proven successful in protecting historic sites and ecologically-sensitive sites. The owner of such a site sells her/his property development rights to another entity, thus receiving compensation for preservation of the site. From the time of sale on, no development may take place on that property. In situations where a UES micro-environment has been shown to be physically unreceptive to any kind of development, jurisdictions may consider the TDR concept an effective and applicable alternative.

<u>8)</u> <u>Impact Zoning</u> (Performance Zoning) relies on the increasing ability to predict development impacts (e.g. erosion) through the use of quantitative measures (e.g. erosion and runoff calulations). This flexible technique has been utilized in recent years to protect natural resources. Impact zoning, through the utilization of performance standards, offers a jurisdiction the opportunity to determine and set desirable and/or acceptable levels of development impact, which the developer must meet. As Impact Zoning may involve a determination of development impact upon the natural environment, the special characteristics of UES sites may be taken into account.

SUMMARY OF ZONING ORDINANCES

Upon reviewing zoning ordinances, it was noted that the scope and methods of zoning have evolved over the years to address the changing nature of land development. Zoning in its conventional context possesses an inherently separate purpose from that of its contemporary mechanisms. Traditional zoning is unable to provide meaningful direction to developers. With the evolution of zoning ordinances, however, come opportunities in the form of flexible techniques and performance standards for potential application in addressing development in UES micro-environments. Briefly, the most notable contemporary trends identified through the zoning ordinance review that offer opportunity for application are the following:

1) The opportunity to recognize and address the existence of UES areas through the zoning ordinance, as in the 1980 Pottawatamie County Ordinance, which identifies and prescribes defined standards for development in "Flood Overlay Districts". Such districts lie within "Flood Hazard Areas" as designated by the Federal Government, however, it is reasonable to contemplate the application of this approach towards other areas designated as UES by political, public, and/or professional decree.

2) The expanding use of Flexible Techniques, as evidenced by the presence of three PUD-type designations within the 1980 Pottawatamie County Ordinance. Flexible techniques offer opportunity for application through their adaptive nature, their facility for case-by-case evaluation, and their consideration of important development factors previously unrealized in conventional zoning. Flexible techniques also allow for a creative design approach which may be articulated by specific site conditions.

3) The increased utilization of Performance Standards, as noted in the Berks County Zoning Ordinance of 1970, rather than Specification Standards. Performance standards present opportunity for application to UES micro-environments primarily through their capability to define a preferred condition of a land area, derived in part through a study of the physical characteristics of that land area.

4) An increasing attempt to individualize zoning ordinances to reflect the status and goals within a specific jurisdiction, rather than mere adoption of a standardized zoning ordinance form. Such was apparent in the 1980 Pottawatamie County Ordinance, which recognized the rural nature of its jurisdiction and the implications and needs thereof. A conscientious effort to individualize the zoning ordinance suggests opportunity for application to UES areas as this effort may include consideration of the physical character of land types within that jurisdiction.

In evaluating the zoning ordinance review, aspects of zoning ordinances were examined to determine which components were potentially applicable in addressing development within UES micro-environments. At this point in the study, "UES micro-environments" are broadly defined and therefore assessing only "potential application" is necessary. It is expected that a more precise identification of a particular UES area will reveal characteristics that articulate which zoning ordinance components more precisely are applicable to that particular situation. It is reasonable to contemplate that the zoning ordinance components noted within the prior evaluation would be among those determined as applicable, as most noted components tend to possess an element of flexibility. Flexibility appears to be an essential ingredient in managing UES areas due to the existence of physical idiosyncrasies, which are what make that particular environment unique and/or ecologically-sensitive.

It has been noted that zoning has evolved considerably from its inception, from standardized and limited concerns, to those addressing the increased complexity of development. Much of the flexibility cited in this study stems from this development-induced evolution. As many of the flexible techniques were creative and legal solutions to localized and/or current development problems, it appears feasible to generate the same in response to concerns over UES micro-environments. It also appears likely that such solutions would take the form of flexible techniques with imposed performance standards, both of which are capable of being individualized by a jurisdiction to address those jurisdiction's individualized concerns. Therefore, flexible techniques and performance standards shall be the criteria by which in-place zoning ordinances are evaluated within this study.

It is also essential that the regulatory control system elements are carefully coordinated with each other so as to avoid unnecessary contradictions or redundancy.

SUMMARY OF CURRENT TECHNIQUES

UES micro-environments exist in a myriad of types, scales, locations and degrees. Assessing the practicality and effectiveness of utilizing local zoning ordinances to manage or protect UES areas may be accomplished through a synthesis of information aquired by means of an environmental analysis and an evaluation of the local in-place zoning ordinances.

The environmental analysis is utilized to substantiate the existence of a UES area and to articulate that particular UES area's management needs. This is accomplished through a systematic examination of biological, physical, and cultural elements required to identify the character of the micro-environment and the interrelationships between those elements. The designation of "UES" is primarily in recognition of idiosyncratic interrelationships between those biological, physical and cultural elements.

The power to enforce zoning ordinances emanates from the "police power" granted to local authorities by the Standard State Enabling Act of 1926. The scope and methods of zoning have evolved over the years since 1926 to address the changing nature of development. The more contemporary of these methods (i.e. flexible techniques and performance standards) appear to have the most potential as effective tools in managing and protecting UES micro-environments of various types and in various locations.

CHAPTER THREE
METHODOLOGY

Local government, empowered with legislated land-use management tools, such as zoning ordinances, may be in a position to provide an effective response to the management needs (i.e. those actions required to preserve the integrity or ecological stability of a particular UES) of unique and/or ecologically-sensitive micro-environments facing developmental pressures within its jurisdictional boundaries. The methodology used in this study is designed to determine the practicality and effectiveness of utilizing local zoning ordinances to manage and protect UES micro-environments.

The methodology takes a dualistic approach, examining and evaluating both physical characteristics of UES micro-environments and the application of zoning ordinances as a means of managing and protecting identified mangement needs of the UES area. The methodology proposes a means by which the major characteristics and interrelationships of an UES micro-environment may be <u>identified</u> and <u>coordinated</u> with the applicable components of a zoning ordinance (either in-place or proposed) available to local governments. Further, the methodology will attempt to recognize and consider both the potential degree of uniqueness and/or ecological-sensitivity as well as the potential degree of development allowance within a particular UES area. The degree of development may vary from a prohibition of all development to an allowance of limited density or implementation methods of development depending upon the management requirements of a particular UES micro-environment. A basic objective of methodology application would be to provide reasonable and effective management and protection without undue over-regulation.

Table 3.1 delineates several UES micro-environment scenarios, first, as a means of defining a UES micro-environment and,

TABLE 3.1
UES MICRO-ENVIRONMENT SCENARIOS

1. A unique and/or ecologically-sensitive micro-environment possesses or exhibits characteristics and/or behaviors which are inherently and/or conspicuously different from those exhibited by the next greater environment within which that particular micro-environment lies;

2. A unique and/or ecologically-sensitive micro-environment has no comparable equivalent within the vicinity, or perhaps at all;

3. A unique and/or ecologically-sensitive micro-environment is a remnant of a prior state in which the greater environment once existed;

4. A unique and/or ecologically-sensitive micro-environment exhibits localized modifications of the physical elements (e.g. climate, soil, cultural patterns) uncharacteristic of the greater environment within which it lies.

5. A unique and/or ecologically-sensitive micro-environment is one in which the ecological equilibrium, imposed by the natural elements, is especially inflexible and is highly responsive or susceptible to changes within it;

6. A unique and/or ecologically-sensitive micro-environment is one which contains the habitats of rare or significant vegetative or wildlife species -- those species, perhaps, being intolerant of significant changes or disturbances in habitat;

7. A unique and/or ecologically-sensitive micro-environment is one which cannot easily rehabilitate itself after a disturbance;

8. A unique and/or ecologically-sensitive micro-environment is one which, in response to changes within it, a chain of reactions is set into motion affecting it and/or adjacent environments;

9. A unique and/or ecologically-sensitive micro-environment is one which functions as a maintenance factor within the equilibrium of the greater environment;

10. A unique and/or ecologically-sensitive micro-environment is one in which any of the natural elements (e.g. climate, hydrology,soils) exists in the extreme.

second, as a means to organizing the initial step(s) of the methodology process. In reviewing the current state of the art in terms of environmental analysis techniques and zoning techniques available, the proposed methodology will evolve and apply a series of evaluation criteria to determine, first, the major physical and ecological characteristics, as well as their interrelationships, within UES micro-environments, and second, the applicable components of the zoning ordinances which may most effectively manage and protect those major identified characteristics and interrelationships of a particular UES micro-environment.

Tables 3.2 and 3.3 summarize in the broader context those major evaluation criteria to be considered in the scope of this study. From the evaluation criteria noted in these tables, a specific evaluation process will be developed encompassing those areas of expertise normally considered within the profession of landscape architecture (i.e. the land and its management).

TABLE 3.2 ENVIRONMENTAL ANALYSIS APPLICABLE DATA BASE COMPONENTS
soils
climate
microclimate
hydrology
geology
vegetation
physiography
cultural patterns
wildlife
visual features
environmental quality
legalities
economic/social/political factors

TABLE 3.3
APPLICABLE ZONING ORDINANCE COMPONENTS

zoning map
flexible techniques
-PUD
-overlay zones
-special permits
-conditional zoning
-incentive zoning
-subdivision exactions
-TDRs
-impact zoning
comprehensive plan
subdivision regulations
health, fire, building codes
protective covenants
performance standards

Those areas of expertise and dicipline not normally encompassed within the practice of landscape architecture, even though they may represent major considerations and impact upon the overall implementation process, such as legalities and political factors, will be considered beyond the scope of this study. The developed evaluation criteria will then be applied to a UES micro-environment in the form of a case study to determine methodology effectiveness.

The proposed methodology is comprised of four steps:

1. INITIAL DECREE of UES micro-environment existence to prompt and justify the investigation;
2. EVALUATION OF IDENTIFIED UES MICRO-ENVIRONMENT for its character and management needs using predetermined analysis criteria;
3. EVALUATION OF IN-PLACE ZONING ORDINANCES within

the associated jurisdiction in terms of applicability to identified management needs of the UES micro-environment;

4. **RECOMMENDATIONS** for UES micro-environment management regarding possible revisions or additions to in-place zoning ordinances found deficient.

1. INITIAL DECREE

Prior to a commitment to investigate a particular UES micro-environment within a given jurisdiction, there must be an initial decree of uniqueness and/or ecological-sensitivity delineating the subject micro-environment. Such a decree may originate from public, governmental, or professional judgment -- and serves to prompt the investigation and to focus investigative resources. Subsequent to the recognition of a UES micro-environment through an initial decree, it is necessary to have a commitment, both financially and otherwise, by the elected public body overseeing the jurisdiction within which a UES area has been identified. Without commitment on the part of elected officials, the methodology defined herein could not be implemented.

The judgment of "Initial Decree" would primarily be based upon the evaluation criteria found in Table 3.4, which delineates possible scenarios of UES micro-environments most appropriately studied within the scope of the landscape architectural profession as compared to the broader range of scenarios presented previously in Table 3.1.

TABLE 3.4
UES MICRO-ENVIRONMENT SCENARIOS
SCOPE -- LANDSCAPE ARCHITECTURE

1. The UES micro-environment is physically different from the larger environment within which it lies, it has no comparable equivalent in the vicinity or at all, or the natural physical condition of the micro-environment is uncharacteristic of the larger environment within which it lies;
2. The UES micro-environment is a remnant of a prior state which the larger environment once existed;
3. The UES micro-environment is physically fragile, inflexible, or cannot easily rehabilitate itself after a disturbance;
4. The UES micro-environment contains rare or significant vegetaion;
5. The UES micro-environment acts as a maintenance factor within the equilibrium of the larger environment and in response to changes within it, a chain of reactions is set into motion affecting it and/or adjacent environments;
6. The UES micro-environment is one in which any of the natural elements (e.g. climate, soils, vegetaion) exists in the extreme.

2. EVALUATION OF IDENTIFIED UES MICRO-ENVIROMENT

Once a commitment to proceed with an investigation of a particular UES micro-environment has been made, the first step in this investigation is the generation of a data base concerning the environmental conditions existing within the subject UES micro-environment. This environmental data base will be utilized to determine the major physical and ecological characteristics and their interrelationships as encompassed within the subject UES micro-environment, as well as identify possible management needs.

The environmental analysis technique is formulated and conducted in two stages by a professional landscape architect utilizing appropriate specialists and/or consultants as necessary. The environmental analysis stages are: 2A) Inventory and 2B) Evaluation.

<u>2A</u>. <u>ENVIRONMENTAL</u> <u>INVENTORY</u>. An inventory of the subject UES micro-environment's major physical and ecological characteristics, as well as their interrelationships, is conducted utilizing the checklist of predetermined applicable data base components and their associated inventory criteria noted in Table 3.5. It should be noted that specific UES micro-environments may display an idiosyncratic environmental feature (or features) relative but non-inclusive within the established "environmental data base components" noted in the Table 3.5 Checklist. In such a case, that feature(s) is considered a "<u>contingency</u> <u>component</u>(s)" and is entered into the Checklist and is inventoried and evaluated in the same manner as are the established components.

Subsequent to the Inventory of the environmental data base components, Data Inventory/Impact Sheets are prepared for <u>each</u> of the inventoried components noted in the Checklist (Table M-5) to provide a concise and consistent format for recording significant environmental data. Information derived from the Inventory of each component is summarized on the appropriate Data Inventory/Impact Sheet, noting significant characteristics and interrelationships with other components as they may relate to the uniqueness and/or ecological-sensitivity of the study area. The Data Inventory/Impact Sheets will be completed within the Evaluation portion of this investigative process, immediately following the Inventory.

TABLE 3.5
ENVIRONMENTAL DATA BASE COMPONENTS -- INVENTORY CRITERIA CHECKLIST

CLIMATE:

Temperature: seasonal > average, minimum, maximum, extremes, duration
Precipitation: seasonal > average, minimum, maximum, extremes, intensity, duration
Humidity: seasonal > average, minimum, maximum, extremes, duration
Wind: seasonal > average, minimum, maximum, extremes, intensity, duration, direction,
Solar Path: seasonal, daily
Cloud Cover: seasonal, daily
Storms: seasonal > severity, characteristics
Flood: potential
Drought: potential

HYDROLOGY:

Surface: water bodies, stream flow, surface drainage patterns, watershed, flood potential, floodplain location, supply sources, quality, quantity, trends

Underground: presence, depth to water table, saturated thickness, locations, recharge, availability, quantity, quality, trends

GEOLOGY/PHYSIOGRAPHY:

Geology: origins, parent material, bedrock characteristics (e.g. bearing strength, drillability, depth to bedrock), mineral resources, hazards (e.g. faults, slides, subsidence), features (e.g. cliffs), drainage patterns, locations and physical configuration of surface and underground water

Physiography: contours, slope analysis, landforms, relief, unique features, significant vegetation locations, ; water features, elevations, drainage patterns, solar orientation

VEGETATION:

Plant species: representatives and characteristics
Dominant communities:
Locations:
Stability of stand:
Indication of disturbance or other changes:
Cultural plantings: representatives, characteristics, location

SOILS:

Soil types represented:
Composition:
Respective location:
Engineering properties: shrink/swell potential, stability, load bearing strength, depth to bedrock, depth to ; water table, permeability, drainage patterns, soil depth
Plant medium: presence of vegetation, location of vegetation, growth patterns of vegetation, land use (e.g.agricultural, landscape)
Erodibility: water, wind

MICROCLIMATE:

Warm/cool slope effect:
Air drainage:
Heat storage, reflection and/or absorpsion:
Variations in temperature and precipitation:
Wind effects:
Presence of water bodies:

CULTURAL PATTERNS:

Historical/Archeological: Significant > sites, objects, structures, events

Land Use: types past/present/future, circulation patterns, utilities

Utilizing the inventory criteria appropriate to each data base component, as noted in Table 3.5, the environmental inventory is conducted for each of the components in the following manner:

CLIMATE. Statistical data pertaining to the individual elements (e.g. temperature, precipitation, wind) of the overall climatological makeup are noted and recorded on the Data Inventory/Impact Sheet (see Figure 3.1). This data serves as a basis from which to determine the nature of the climate as it affects the UES micro-environment study area. Forces influencing the manner in which the individual elements manifest themselves are defined, citing inclinations for extremes (e.g. storms, flood, drought). Interrelationships between climate and other data base components are determined initially through an examination of the statistical data and other noted climatological characteristics, influences, and on-site observation.

It should be noted that interrelationships between components may be further determined after all data base components are initially inventoried, or during the evaluation portions of the methodology.

Data pertaining to climate may be obtained, when available, through the National Weather Service, the National Oceanic and Atmospheric Administration, nearby university extension services, local airport officials, and related literature.

HYDROLOGY. Surface and underground water sources affecting the study area are defined and mapped showing their location. Characteristics of both surface and underground water sources, relative to presence, quality, quantity, use, and potential trends, are noted and recorded on the Data Inventory/Impact Sheet (see Figure 3.2). Interrelationships between hydrology and other data base components are determined initially through an examination of the water sources and their characteristics. Hydrological data may be obtained, when available, through the United States Geological Survey, the state Geological Survey, groundwater management districts, State Water Resource Boards, United States Soil Conservation Service, water district organizations, agricultural organizations, well drilling firms, engineering firms, remote-sensing facilities, the State Health Department, and related literature.

GEOLOGY AND PHYSIOGRAPHY. The proposed geologic history of the area within which the study area lies is summarized such that fundamental geologic processes responsible for physical configurations are determined. The physical configurations as they presently exist are noted, mapped, and recorded on the Data Inventory/Impact Sheet (see Figure 3.3). Interrelationships between the geology and physiography of the study area and other data base components are determined initially through an examination of the geologic and physiographic processes and their physical configurations, as well as by on-site observation. Sources of geologic and physiographic data are the United States and state Geological Surveys, university geology departments, remote sensing facilities, state highway departments, engineering firms, drilling firms, and related literature.

VEGETATION. Native vegetative species present within the study area, their characteristics and their respective locations are defined, mapped when appropriate, and recorded on the Data Inventory/Impact Sheet (see Figure 3.4). The vegetative patterns of the native species are delineated relative to the inventory criteria such as dominant communities, stability, recent or occurring changes. Vegetative species of cultural plantings and their location are also noted. Interrelationships between vegetation and other data base components are determined initially through an examination of the vegetative species present and their characteristics and location, and by on-site observation. Data pertaining to vegetation may be obtained, when available, through the United States Soil Conservation Service, the Agricultural Stabilization and Conservation Service, United States and state Geological Surveys, nearby university extension services, federal/state/local botanists, remote sensing facilities, local residents, and related literature.

SOILS. The soil types present within the UES micro-environment study area are defined and mapped showing their respective location within the study area, and are recorded on the Data Inventory/Impact Sheet (see Figure 3.5). The composition and characteristics of each soil type are noted relative to engineering properties, as a plant medium, and soil erodibility. Interrelationships between soils and other data base components are determined initially through an examination of the soil types, their inherent characteristics, and on-site observation. Data pertaining to soils is obtained, when available, from the Soil Conservation Service, the Agricultural Stabilization and Conservation Service, nearby university extension services, the State Department of Transportation, local engineering firms, soil testing laboratories, and related literature.

MICROCLIMATE. The microclimate of the study area will be highly influenced by other data base components, thus is inventoried subsequent to the inventory of the other components. The microclimate is initially determined relative to influences such as landform, slope, air drainage, wind direction, variations in temperature, precipitation, and the presence of water bodies. Contingency microclimatic influences noted during the inventory are defined along with applicable microclimatic influences and are recorded on the Data Inventory/Impact Sheet (see Figure 3.6). Data concerning microclimate may be obtained through other climatological sources, consultants or specialists, interviews with local residents, local experts, and on-site investigation or observation.

CULTURAL PATTERNS. The study area is inventoried for significant historical and/or archeological aspects, and current settlement patterns, to determine past and present human interaction with the subject micro-environment. Cultural pattern data, which includes present land uses within the study area, are noted, mapped when appropriate, and recorded on the **Data Inventory/Impact Sheet** (see Figure 3.7). Interrelationships between cultural patterns and environmental data base components are determined initially through an examination of the cultural patterns from aerial photography, remote sensing data or on-site observation as they appear to have affected the subject UES micro-environment to date. In addition, data pertaining to cultural patterns may be obtained, when available, through local governmental agencies, local abstract firms, local planning agencies, past and present landowners, land use maps, real estate firms, agricultural organizations, and related literature.

The following Figures (3.1 through 3.7), illustrate the individual **Data Inventory/Impact Sheets.**

CLIMATE INVENTORY:

Overall climatic type --

Weather patterns (normal) --

Weather patterns (extreme) --

Interrelationships --

CLIMATE EVALUATION:

[The evaluation summary interprets from inventoried data which climatic characteristics, patterns, or interrelationships are most influential in terms of the uniqueness and/or ecological-sensitivity of the study area, and which may influence the management of the UES area and how.]

IMPACT UPON UES STUDY AREA:

[] high impact
[] moderate impact
[] low impact
[] no impact

	INTERRELATIONSHIPS' IMPACT			
	high	moderate	low	no
climate				
hydrology				
geology/physiography				
vegetation				
soils				
microclimate				
cultural patterns				

Figure 3.1.
DATA INVENTORY/IMPACT SHEET
CLIMATE

HYDROLOGY INVENTORY:

Surface features --

Underground features --

Trends --

Interrelationships --

HYDROLOGY EVALUATION:

[The evaluation summary interprets from inventoried data, in terms of the uniqueness and/or ecological-sensitivity, which hydrological features, trends, or interrelationships are most influential and which require management and how this management may most effectively be accomplished.]

IMPACT UPON UES STUDY AREA:

[] high impact
[] moderate impact
[] low impact
[] no impact

	INTERRELATIONSHIPS' IMPACT			
	high	moderate	low	no
climate				
hydrology				
geology/physiography				
vegetation				
soils				
microclimate				
cultural patterns				

Figure 3.2.
DATA INVENTORY/IMPACT SHEET
HYDROLOGY

GEOLOGY/PHYIOGRAPHY INVENTORY:

Fundamental geologic processes --

Physical configurations --

Interrelationships --

GEOLOGY/PHYSIOGRAPHY EVALUATION:

[The evaluation summary interprets from inventoried data, in terms of uniqueness and/or ecological-sensitivity, which geologic/physiographic processes, configurations, or interrelationships are most influential and which may influence the management of the UES area and how.]

IMPACT UPON UES STUDY AREA:

[] high impact
[] moderate impact
[] low impact
[] no impact

	INTERRELATIONSHIPS' IMPACT			
	high	moderate	low	no
climate				
hydrology				
geology/physiography				
vegetation				
soils				
microclimate				
cultural patterns				

Figure 3.3.
DATA INVENTORY/IMPACT SHEET
GEOLOGY/PHYSIOGRAPHY

VEGETATION INVENTORY:

Native vegetation species, locations, characteristics --

Dominant communities --

Stability/changes --

Interrelationships --

VEGETATION EVALUATION:

[The evaluation summary interprets from inventoried data, in terms of uniqueness and/or ecological-sensitivity, which vegetative species' characteristics, communities, stability/changes, or interrelationships are most influential, which require managment and how this management may most effectively be accomplished.]

IMPACT UPON UES STUDY AREA:

- [] high impact
- [] moderate impact
- [] low impact
- [] no impact

INTERRELATIONSHIPS' IMPACT

	high	moderate	low	no
climate				
hydrology				
geology/physiography				
vegetation				
soils				
microclimate				
cultural patterns				

Figure 3.4.
DATA INVENTORY/IMPACT SHEET
VEGETATION

SOILS INVENTORY:

Soil type, composition, location --

Engineering properties --

Plant medium --

Interrelationships --

SOILS EVALUATION:

[The evaluation summary interprets from inventoried data, in terms of the uniqueness and/or ecological-sensitivity of the study area, which soil characteristics, properties, or interrelationships are most influential, which require management and how this management may most effectively be accomplished.]

IMPACT UPON UES STUDY AREA:

[] high impact
[] moderate impact
[] low impact
[] no impact

	INTERRELATIONSHIPS' IMPACT			
	high	moderate	low	no
climate				
hydrology				
geology/physiography				
vegetation				
soils				
microclimate				
cultural patterns				

Figure 3.5.
DATA INVENTORY/IMPACT SHEET
SOILS

MICROCLIMATE INVENTORY:

Landform influences --

Weather influences --

Contingency influences --

Interrelationships --

MICROCLIMATE EVALUATION:

[The evaluation summary interprets from inventoried data which microclimatic characteristics, influences, or interrelationships are most influential in terms of the uniqueness and/or ecological-sensitivity of the study area, and which may influence the managment of the UES area and how.]

IMPACT UPON UES STUDY AREA:

[] high impact
[] moderate impact
[] low impact
[] no impact

	INTERRELATIONSHIPS' IMPACT			
	high	moderate	low	no
climate				
hydrology				
geology/physiography				
vegetation				
soils				
microclimate				
cultural patterns				

Figure 3.6.
DATA INVENTORY/IMPACT SHEET
MICROCLIMATE

CULTURAL PATTERNS INVENTORY:

Significant historical/archaeological sites, objects, structures, occurrences --

Past land use --

Contemporary land use --

Interrelationships --

CULTURAL PATTERNS EVALUATION:

[The evaluation summary interprets from inventoried data, in terms of the uniqueness and/or ecological-sensitivity of the study area, which cultural pattern characteristics are important indicators of the reaction of the natural physical elements to human interaction, and which may influence the management of the UES area and how.]

IMPACT UPON UES STUDY AREA:

[] high impact
[] moderate impact
[] low impact
[] no impact

INTERRELATIONSHIPS' IMPACT

	high	moderate	low	no
climate				
hydrology				
geology/physiography				
vegetation				
soils				
microclimate				
cultural patterns				

Figure 3.7.
DATA INVENTORY/IMPACT SHEET
CULTURAL PATTERNS

2B. <u>ENVIRONMENTAL EVALUATION</u>. The Environmental Evaluation portion of the methodology is intended to interpret the significance of the data generated within the <u>Environmental Inventory</u>. Evaluation of inventoried data is primarily accomplished on three levels: 1) evaluation of individual data base components; 2) evaluation of interrelationships between individual data base components; and 3) comprehensive evaluation of the overall effect of all data base components and their interrelationships as they constitute the subject UES micro-environment. The management needs of the subject UES micro-environment are then generated from individual evaluations, interrelationships evaluations, and the comprehensive evaluation.

The Evaluation of individual data base components and the interrelationships between components defines those environmental characteristics and interrelated patterns which are most highly influential in making the study area unique and/or ecologically-sensitive. The evaluation process seeks to identify which characteristics and linkages may require protection from substantial physical alteration of the micro-environment in order to sustain the critical natural ecological patterns as defined. This evaluation is summarized on the appropriate Data Inventory/Impact Sheet introduced in the Inventory portion of this methodology. An evaluation judgment concerning the impact of an individual component upon the uniqueness and/or ecological-sensitivity of the study area in terms of <u>development</u> is required following the evaluation summary. This judgment is expressed in terms of high, moderate, low, or as having no significant impact. An evaluation judgment is also required in assessing the interrelationships between the subject component and the remaining components.

The **Comprehensive Evaluation** addresses the UES micro-environment as an entirety, assessing the overall effect of the data base components and their interrelationships. This assessment is summarized on the **Comprehensive Environmental Evaluation Sheet** (see **Figure** 3.8) noting the results of evaluations regarding individual components, their interrelationships, and their respective degree of impact. A judgment concerning **the degree of uniqueness and/or** ecological-sensitivity of the study area to a proposed development is made following the evaluation summary. The "degree" is expressed in terms of **high, moderate,** or **low.** Based upon evaluation results and established degree of uniqueness and/or ecological-sensitivity, **management** needs are identified (in terms of development) such as illustrated in the examples of management needs (see **Table** 3.6) derived from the UES micro-environment scenarios delineated previously in Table 3.4. Certain general management needs addressing most UES micro-environments should also be considered, those being: rehabilitation of a disturbed site after development implementation (e.g. revegetate, recontour); maintenance of development rates timed and at a pace commensurate with environmental adaptation; avoidance of obliterating natural site patterns (e.g. soil, vegetation, drainage); and promotion of the perception by would-be users that the site represents a UES micro-environment with special needs.

Considering the management needs as identified, an evaluation judgment concerning the degree of development allowance appropriate within the study area completes the Comprehensive Environmental Evaluation Sheet.

The Comprehensive Evaluation -- Data Inventory/Impact Sheet will be utilized in conjunction with the Evaluation of In-place Zoning Ordinance sheet with regard to assessing the Ordinance's applicability to the identified management needs.

TABLE 3.6
EXAMPLES OF MANAGEMENT NEEDS

UES SCENARIOS	REPRESENTATIVE FORM	MANAGEMENT NEEDS
1. Physically different, no comparable equivelent.	Forested area (Redwoods)	Maintain hydrologic supply and quality; Maintain vegetative succession cycle; Maintain air quality.
2. Remnant of prior environmental state.	Rare geologic formation (large underground caves)	Consider park status; Limited vehicular access; Restrict development over caves.
3. Physically fragile, inflexible, cannot easily rehabilitate itself after disturbance.	Coastal sand dunes	Protect against erosion; Preserve vegetative cover; Maintain angle of repose.
4. Rare or significant vegetation.	Flinthills grassland	Maintain vegetative cover; Guard against fire; Maintain topsoil.
5. Natural element exists in the extreme.	High water table	Guard against pollution; Restrict development implementation to acceptable methods; Maintain hydrologic cycle.

==

EVALUATION OF MICRO-ENVIRONMENT UNIQUENESS AND/OR ECOLOGICAL-SENSITIVITY:

[The evaluation summary interprets from all inventoried data, in terms of uniqueness and/or ecological-sensitivity, the overall effect of all data base components and interrelationships, and which of these may influence management and how.]

DEGREE OF UNIQUENESS AND/OR ECOLOGICAL-SENSITIVITY:

[] high
[] moderate
[] low

MANAGEMENT NEEDS:

[Management needs are listed such as illustrated in Table 3.6.]

DEGREE OF DEVELOPMENT ALLOWANCE:

[] no development (maintain undisturbed)
[] limited development (density/implementation methods defined)
[] unlimited development

==

Figure 3.8.
COMPREHENSIVE ENVIRONMENTAL EVALUATION

3. EVALUATION OF IN-PLACE ZONING ORDINANCES

Once the environmental inventory and evaluation process is completed and the character and management needs of the subject UES micro-environment have been identified, the in-place zoning ordinance (as adopted by the jurisdiction within which the UES study area lies) is inventoried and evaluated.

Within the Inventory, the in-place zoning ordinance is reviewed and examined for inclusion of those components as defined in Table 3.7 -- "Applicable Zoning Ordinance Components".

TABLE 3.7
APPLICABLE ZONING ORDINANCE COMPONENTS
SCOPE -- MOST APPLICABILITY POTENTIAL

flexible techniques
-PUD
-overlay zones
-special permits
-conditional zoning
-incentive zoning
-subdivision exactions
-TDRs
performance standards

For the purpose of this study, "Applicable Zoning Ordinance Components" are limited to those identified in Table 3.7, as these components were determined in the review of zoning ordinance components (Chapter Two) as offering the <u>most</u> potential for effectively managing UES micro-environments.

As a first step in evaluating the in-place zoning ordinances notations are made regarding the presence or absence of the Applicable Components, as well as the adaptability of those components to meet UES management needs. Applicable in-place zoning ordinance components should have the following features: 1) the flexibility of the component to adapt to the management needs of the UES study area; 2) the facility for case-by-case evaluation of development projects; and 3) the consideration of important development factors such as timing, composition, location, and design relative to the management needs of the study area. The results of the Inventory are summarized on the In-place Zoning Ordinance Data Sheet (see Figure 3.9).

The Evaluation of the in-place zoning ordinance is intended to assess each component present, and its respective characteristics, in terms of its application as a management tool to manage the subject UES micro-environment. Management needs and degree of development allowance, as delineated on the Comprehensive Environmental Evaluation Sheet, are compared with each applicable component of the in-place zoning ordinance and with applicable component characteristics in terms of the three criteria -- 1) flexibility; 2) case-by-case evaluation; and 3) important development factors). The evaluation of the in-place zoning ordinance is summarized on the In-place Zoning Ordinance Data Sheet. A judgment as to whether each characteristic of the Applicable Component is lacking, acceptable, or effective as a management tool for the UES area is made and noted in the evaluation matrix on the In-place Zoning Ordinance Data Sheet.

ZONING ORDINACE INVENTORY:

Applicable zoning ordinance components present --

[] PUD
[] Overlay zones
[] Special permits
[] Conditional zoning
[] Incentive zoning
[] Subdivision exactions
[] TDRs
[] Performance standards

Characteristics --

[] flexibility
[] case-by-case evaluation
[] important development factors

ZONING ORDINANCE EVALUATION:

[The evaluation summary assesses each component present and its characteristics in terms of applicabtion as a management tool for the subject UES micro-environment in compliance with previously established management needs and degree of development allowance.]

APPLICABLE COMPONENTS PRESENT - CHARACTERISTICS:

	lacking	acceptable	effective
flexibility			
case-by-case evaluation			
important development factors			

IN-PLACE COMPONENT APPLICABILITY:

[] high
[] moderate
[] low
[] no

Figure 3.9.
IN-PLACE ZONING ORDINANCE
DATA INVENTORY/EVALUATION SHEET

A final judgment as to whether the Applicable Components of the in-place zoning ordinance as adopted are applicable to the management needs of the subject UES area completes the Data Sheet. This judgment is expressed in terms of high, moderate, low, or no applicability.

4. RECOMMENDATIONS

Should the in-place zoning ordinance be determined to be lacking in appropriate applicable components, or should represented components be determined to be lacking in applicability to established management needs of the UES, recommendations regarding additions or revisions to the in-place zoning ordinance are made. Based upon the established management needs of the study area (as previously established in the Comprehensive Evaluation), other Applicable Components (such as noted in Table 3.7) may be recommended for consideration and inclusion into the in-place or newly proposed zoning ordinance.

CHAPTER FOUR
CASE STUDY

INTRODUCTION

PURPOSE

The case study serves as both a test of the methodology and a demonstration of its use. Applying the established methodology analysis criteria and procedures to a site-specific UES will determine the applicability and effectiveness 1) the inventory/evaluation process, and 2) zoning ordinances as a management tool for protecting UES areas.

SITE SELECTION

Chosen as the case study subject is the Sandhill area of southwest Kansas, specifically that area of Sandhills directly south of the Arkansas River within the three-mile zoning boundary of Garden City (Finney County), Kansas. [see Figure 4.1]

As representational of a UES, the Sandhills formation is physically different from and uncharacteristic of the High Plains physiographic region within which it lies. Further, the sandy soil making up the formation exists in extreme proportions, with other soil types occurring in only limited proportions. The combined effects of geographical location, climatic characteristics, existing native vegetation, and soil composition and dynamics retain the Sandhills in a relatively static equilibrium rendering it physically fragile, inflexible, and

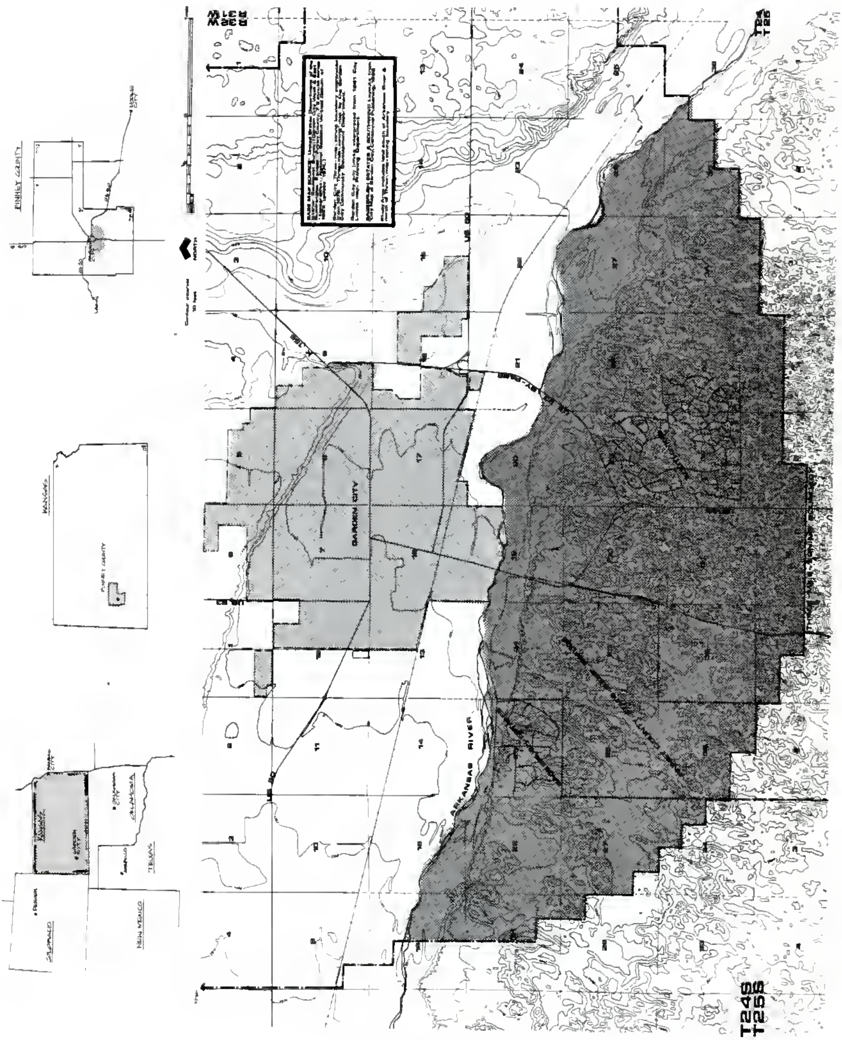


Figure 4.1.
VICINITY MAP

unable to easily rehabilitate following disturbance. Additionally, the Sandhills overlie the Ogallala aquifer, and thus, function as a premier recharge area for the aquifer.

Due to technological changes, economic conditions, population increases, its proximity and accessibility to Garden City, Kansas, and existing site amenities, portions of the Sandhill area directly south of Garden City within the case study area are presently being developed for residential land use.

BACKGROUND

The Sandhills of southwest Kansas are a unique physiographic micro-environment occurring within the High Plains physiographic region. The dune-like formations appear as isolated bands of sand amidst the more common clayey soils of the High Plains tableland. Located just south of the Arkansas and Cimarron Rivers, these sandhills are generally believed to have been created through a combination of submergence, emergence, and eolian activity, with sand material originating from the river valleys parallelling the current sandhill formations (Smith, 1940). Although sand formations occur in some form the length of both rivers through Kansas, the synthesis of arid-like climate and the perpendicular nature of the river courses to the northern wind patterns has left the most expansive dune formation in southwest Kansas, particularly south of the Arkansas River near Garden City, Kansas where the formation is distinctly continuous. "The width of the belt of sandhills ranges from about 18 miles in western Finney county and northern Haskell county to less than 3 miles at the eastern edge of Gray county" (Latta, 1944, p.73).

Garden City, Kansas is the county seat and largest city within Finney County. Recent population figures from the Garden City Area Chamber of Commerce indicate that of the near 29,000 residents living in Finney County, approximately 21,000 of those residents live within the city limits of Garden City. These figures represent a trend of steady growth over the last twenty years making Finney County one of the fastest growing areas in the state of Kansas since 1970 -- both in terms of migration rate and actual population change. The 1981 Battelle report on economic development in Finney County found that:

> Agriculture, primarily beef cattle and feed grains, has always been the basis of the economy in the Garden City - Holcomb - Finney County area, stimulating both growth and decline throughout southwest Kansas. In recent years, there has been a dramatic growth in the area, which many trace to the implementation of center-pivot irrigation. This development, which dramatically increased grain production, allowed an increase in the number of cattle which can be produced. These two agricultural changes led to other development, as industries and services to supply agriculture and to process its products were attracted to the area and brought with them further growth (p. 37).

This economic growth and population increase has, of course, expanded the city limits of Garden City. The 1981 Battelle report noted:

> Land availability may be the foremost constraint which will limit the development of housing in the future. As of July, 1978, 79.4 percent of the land area within the city was developed. Of this amount, 47 percent was

> developed for residential uses. Land adjacent to the Garden City boundary is generally characterized as not being serviced by sewer and other utilities, being zoned agricultural, increasingly high priced, and owned by large landholders who are unwilling to sell. In addition, sewerage extension to areas west of the city is limited by the inadequate slope of land in this area (p.67).

Primarily, recent housing and commercial development has been absorbed by the farmland to the north and east of Garden City, however, within the last decade residential developments have begun to spread to the south of Garden City within the case study area of the Sandhills.

INITIAL DECREE

Forasmuch as the case study area selected possesses several characteristics established in the determination of a UES area, and the study area has already experienced pockets of conventional development, the initial decree delineating the Sandhills as a UES micro-environment is made, for the purpose of this study, by the author. An inventory and evaluation of this micro-environment and its governing zoning ordinances should prove more than adequate as a test and demonstration of the methodology.

ENVIRONMENTAL INVENTORY AND EVALUATION

The selection of the Sandhill site as a case study was primarily made on the basis of unique environmental conditions present in this locale. The selection was made, also, with regard to familiarity with the Sandhills area from previous investigation, access to data, authorities, land owners, and local residents based on past aquaintances, working relationships and name recognition.

Major physical, biological and cultural influences which have contributed to the formation and thus the composition of the present Sandhill micro-environment shall be inventoried and evaluated both individually and collectively. Those major influences are climate, microclimate, geology, hydrology, vegetation, soils, sand dynamics and cultural patterns. The collective evaluation discerning the intrisic interrelationships between each of the influences relative to the total Sandhill ecosystem will be critical to the success of this study. Obviously, the interrelationships between influences will, in large part, be responsible for the UES conditions present in this Sandhill micro-environment.

An evaluation of the above-noted major influences will determine the overall uniqueness and ecological-sensitivity of the Sandhill micro-environment of the study area.

CLIMATE

The climate of the High Plains region is classified as a semi-arid to sub-humid continental climate, indicating a wide variance in weather patterns ranging from warm to hot summers and mild to cold winters. The potential for abrupt weather changes and extreme weather conditions is characteristic of the High Plains region. The Sandhills study area lies within this High Plains region, near its center.

The amount of precipitation received within the study area averages seventeen inches annually. One-fourth of the yearly rainfall may occur within one day or within one hour.

Twenty to thirty degree variances in daily temperatures are not uncommon. Thin, dry, cloud-free air is in part responsible for these temperature extremes, as this air allows for substantial solar heating after sunrise and relatively rapid heat loss after sunset.

Widely ranging weather patterns are a result also of the seasonal north-south migration of the jet stream. Weather conditions beneath the jet stream are unstable and unpredictable. Violent winds, radical drops in temperature, cloudbursts and severe weather activity (i.e. tornadoes or blizzards) may be associated with this phenomena.

A climatic boundary, the "dry-line", differentiates moist northward-moving air masses originating in the Gulf of Mexico, from dry northward-moving air masses originating in the Mexican Desert. The east-west movement of this dry-line out of its normal position may alter precipitation patterns within the High Plains region. Unstable weather conditions or drought are associated with this "dry-line".

A second climatic boundary occurs where warm air masses from the south meet cold air masses from the north. Precipitation patterns may be altered significantly within the High Plains when the boundary is north or south of its normal position. Unstable weather conditions are also associated with this warm/cold climatic boundary.

The unstable weather conditions associated with the jet stream and climatic boundaries increase the velocity of the wind within the study area. Within the study area, average wind velocities of 5 to 15 mph are common -- with extremes of 70 plus mph. As typical of the High Plains region, patterns of increased air movement are intensified by the lack of physical resistence over the relatively flat topography and the limited vegetation. This is especically true within the Sandhills, where the rolling dune-like topography and lack of more dense and taller growing woody vegetation allow the wind to blow nearer the ground surface and thus, allows greater wind velocities near the ground surface.

DATA INVENTORY/IMPACT SHEET
CLIMATE

INVENTORY:

Overall climatic type -- semi-arid to sub-humid continental climate

Weather patterns (normal) -- normal weather patterns show a wide range of variance primarily as a result of geographical location. Annual precipitation is low (approximately 17"/year), most of which is associated with a limited number of thunderstorms. 5-15 mile-per-hour winds are common on a daily basis. 20 - 30 degree variances in daily temperature are common due to the thin, dry cloud-free air which allows rapid heating and heat loss.

Weather patterns (extreme) -- extreme weather patterns are also geographically influenced, the region being located where contrasting climatic features meet. Unstable weather conditions (violent winds - 70 plus mph, radical drops in temperature - 20 to 40 degree, cloudbursts - 4 inch/hr, thunderstorms, tornadoes, or blizzards) are associated with seasonal movements of the Jet Stream and other climatic boundaries. Unstable weather conditions, severe or not, will increase the wind velocity.

Interrelatiooships -- wind velocity and low wind altitude is intensified by the lack of physical resistance over the relatively flat topography and limited vegetation. Low annual precipitation and high temperatures translate into a relatively low aquifer recharge rate. Low annual precipitation and high temperatures also inhibit the type of vegetation that will grow in the Sandhills, as well as its growth and vigor. In addition, the combination of low annual precipitation and high temperatures will inhibit the soil weathering process. Within the study area, the weathering process operates at a negligible rate. Climatic patterns were, during geologic history, integral in the formation of the Sandhills and are nowadays, in part, responsible for the preservation of the ecological equilibrium sensitivity.

EVALUATION:

Climate and its resulting weather is inherently influential upon the soils and vegetation of the Sandhills. The combination of low precipitation and high temperature coupled with the high permeability of the soil limits the species of native vegetation that can exist within the Sandhills . Extreme weather conditions, manifested in primarily increased wind velocity, can erode unstable, and sometimes even stabilized, soil. The soils of the Sandhills are almost singularly stabilized by vegetative growth. Sandhill vegetation is unable to grow on moving sand forms. Thus, it is important in the context of maintaining the ecological equilibrium within the Sandhills that vegetative growth be maintained. Maintenance of native vegetation is especially important as these species are more adaptable toward extreme weather conditions and thus more reliable for ground cover.

IMPACT UPON UES STUDY AREA:

■ high impact
[] moderate impact
[] low impact
[] no impact

INTERRELATIONSHIPS' IMPACT

	high	moderate	low	no
climate				
hydrology		■		
geology/physiography			■	
vegetation	■			
soils	■			
microclimate		■		
cultural patterns		■		
sand dynamics	■			

GEOLOGY AND PHYSIOGRAPHY

The physiography of Finney County, as interpreted by Meyer, et al (1970), is composed of five subsections within the greater High Plains physiographic province. Those are: 1. the High Plains; 2. the Finney Basin; 3. the Dissected High Plains; 4. the Arkansas Valley; and 5. the Sandhills.

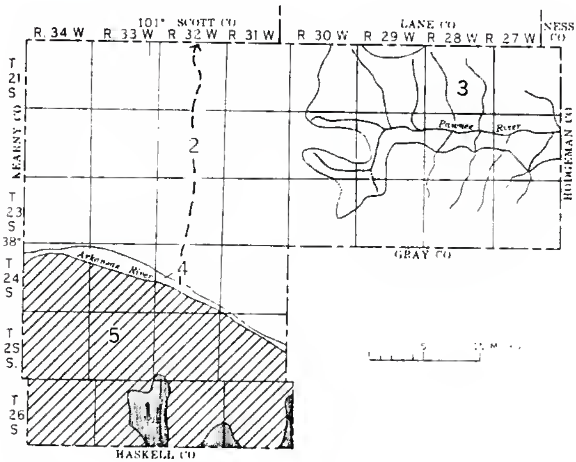


Figure 4.2.
PHYSIOGRAPHIC MAP

The case study area lies within the subsection "Sandhills", described by Meyer, et.al. (op.cit.) as expansive dune forms bordered on the north by the Arkansas River. When covered with vegetation the Sandhills are known as "Sandsage Prairie". Smith (1940) noted at the time of his study that the Sandhills showed a variance in relief, contour, soil cover and stability. These differences were partially revealed in observed areas of active dunes, bare sand and those with vegetative cover. The Sandhills possessed steep and irregular hillocks to broad subdued swells. Boundaries of the Sandhills were abrupt in some areas and gradual in others. The relief in places reached seventy feet, but generally was thirty-five feet. Actual dunes varied in length from one-hundred yards to more than a mile. Collectively, Smith found the various Sandhill features similar in having little or no surface drainage.

The geologic history of Finney County, as related by Latta (1944) and updated by Meyer, et.al. (1970), involved a series of alternating periods of submergence and emergence -- the former characterized by deposition, the latter by erosion -- as the fundemental basis of the geologic formations believed to exist at present. Subsidence (sinking of a portion of the earth) further modified the geologic structure over time and is partially responsible for the creation of the physiographic formation of the Sandhills.

The most recent geologic era, the Cenozoic, began with a folding of the strata in the northern portion of Finney County producing a north-south synclinal trough. A subsequent duration of erosional activity further abraded this area leaving the area rough and irregular. A period of deposition later filled in this rough and irregular trough with granular debris from streams headed in the Rocky Mountains, thus, leaving the area with a smoother, east-sloping surface (similar to present-day topography). This deposition of rock and gravel partially formed the Ogallala Formation -- presently known for its aquifer status as a water source for agricultural irrigation. Continued alluvial deposition over the smoother, east-sloping surface further leveled off the trough, laying down a veneer of finer-grained particles of sand, silt, clay and gravel [see Figure 4.3].

Combined areal subsidence and erosional activity within the area now known as the Arkansas River Lowland is theoretically presumed to have initiated the creation of the Sandhills. Smith (1940) proposed that study of the deposits indicated that the Arkansas River probably flowed south of its present location, near what is now the southern edge of the contemporary Sandhills. As a result of areal subsidence of the area north of the river valley, the river sought the lower elevation, and thus moved slowly parallel (in a northerly direction) to the location it now occupies. This shift in the river location left deposits of coarse sand and gravel in the abandoned river beds, which would later be covered with additional eolian (windlaid) deposits of finer-grained particles -- primarily sand with some silt and clay.

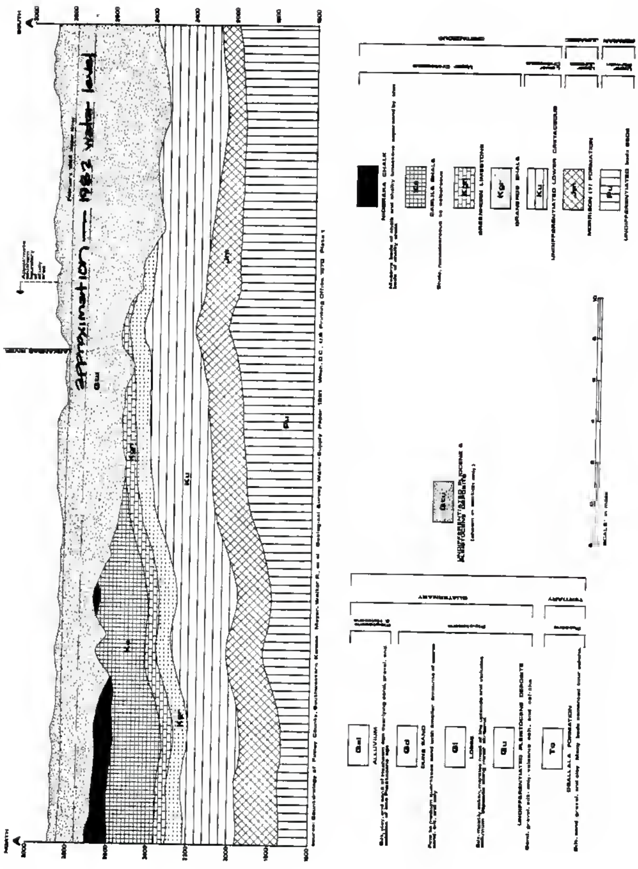


Figure 4.3.
GEOLOGIC SECTION OF FINNEY COUNTY, KANSAS

DATA INVENTORY/IMPACT SHEET
GEOLOGY/PHYSIOGRAPHY

INVENTORY:

Fundamental geologic processes -- A series of alternating periods of emergence (erosion), submergence (deposition), subsidence (sinking), and eolian activity (wind) produced a smooth, sandy wind-blown surface overlying thick granular deposits (containing groundwater aquifers) covering irregular bedrock hundreds of feet below.

Physical configurations -- Sand dune-like topography with areas covered with vegetation, areas of active dunes, or areas of bare sand. Sandhills may be steep and irregular in some areas nearer the Arkansas River, to broad and subdued at the southern boundary of the Sandhills farthest from the river. Relief may reach seventy feet, although thirty-five feet is most common.

Interrelationships -- In creating the Sandhills, the climate played an integral part along with those previously-mentioned geologic processes. Contemporary relationship between the two has little influence due to the gradual timetable within which they react. Geologic impact on soils is manifested in the existing high proportion of sandy parent material, which indicates that soils will not change significantly for an indeterminable time. The physical configuration or topography of the Sandhills, that being generally subdued dunes, allows for increased wind velocity nearer the ground and decreases the microclimatic effects within the Sandhills.

EVALUATION:

The creation of the Sandhills was primarily a function of climatic and geologic processes, thereby creating the fundamental uniqueness and ecological-sensitivity which is preserved at present by the influences of soil, climate, and vegetation. The impact of the geologic processes and the physiography, thus,is evident primarily in retrospect, and through its interrelationship with the soils present.

IMPACT UPON UES STUDY AREA:

[] high impact
■ moderate impact
[] low impact
[] no impact

INTERRELATIONSHIPS' IMPACT

	high	moderate	low	no
climate		■		
hydrology		■		
geology/physiography				
vegetation			■	
soils	■			
microclimate		■		
cultural patterns		■		
sand dynamics		■		

HYDROLOGY

According to Meyer, et al (1970), the most significant available water supply is contained within the underground aquifers present beneath Finney County. The status of surface water and precipitation in the area is unreliable in relation to its availability and cannot be considered a viable water source.

The Arkansas River, adjacent to and major contributer to the creation of the Sandhills, has not sustained a surface flow since approximately 1974 for a variety of reasons. Among these reasons are: the lowering of the water table to below the river bed elevation [see Figure 4.3]; increased control of tailwater runoff from irrigated land; alterations in the upper watershed; and a corresponding decrease in area precipitation. Amid these facts, there still exists the possibility for flooding (Illgner,1982).

On the other hand, supplies of groundwater are still present. Meyer, et.al. (1970) cited the unconsolidated Pliocene and Pleistocene deposits as locations of major underground aquifers. The Ogallala Formation is but one of those aquifers, although its name has come to imply the entire aquifer system in the Great Plains region. These deposits are often <u>interbedded and discontinuous</u>, creating situations where two wells, a relatively short distance apart, have contrasting yields. Additionally, the interbedded and discontinuous nature of these deposits highlight, in part, future groundwater availability in particular locations. Given similar groundwater usage rates, land overlying a thin aquifer will deplete its source sooner than land overlying a thicker aquifer or corresponding material content [see **Figure 4.3**]. Deeper aquifers occurring beneath the depleted aquifer may be tapped for continued water supply -- provided such deeper aquifers exist and wells drilled into these deeper aquifers are economically feasible to drill and operate.

The layered nature of these aquifers should not imply that the overall **saturated thickness** of each aquifer is not decreasing. Recent estimates by the Kansas Groundwater Management District #3 set annual recharge at one-quarter inch per year, while annual usage is dropping the water table four feet per year.

The status of groundwater in the Sandhills generally exceeds that of other areas in Finney County. Due to the highly permeable sand and to thicker deposits underlying the area, the saturated thickness of groundwater beneath the Sandhills tends to be greater -- thus so is groundwater availability. Further, as the Sandhills were not highly cultivated until the early 1970s, the aquifers beneath the Sandhills show less depletion than if the land had been farmed over an extended period prior to 1970. It should be noted that greater saturated thickness does not likewise imply a high water table.

The quality of the groundwater beneath the Sandhills is generally higher than in other parts of Finney County primarily as a result of the very permeable nature of the soil acting as a filter as water percolates through the sand formations. Meyer, et.al. (1970) found that most of the groundwater in Finney County is suitable for domestic use. The same study cautioned, however, that chemical and waste pollution will represent a major contributing factor in the lowering the groundwater quality in areas of shallow aquifers, especially in the very permeable areas. The study further concluded that there would be a deterioration in the quality of groundwater in Finney County with continued agricultural irrigation. Percolation through sand formations to aquifers of irrigation water injected with chemically-based fertilizers and surface applications of pesticides would account, primarily, for this deterioration. Irrigation, according to Kromm and White (1981) accounts for more than 90% of groundwater usage in Southwestern Kansas.

DATA INVENTORY/IMPACT SHEET
HYDROLOGY

INVENTORY:

Surface features -- The study area is bounded on the north by the Arkansas River. This river has not had a sustained flow since approximately 1974 as a result of a lowering of the water table to below river bed elevation; increased control of tailwater runoff from irrigation; alterations in the upper watershed; and a corresponding decrease in precipitation. There is no discernible surface drainage pattern within the study area, due to the permeable soil. Very concentrated flow, such as from street gutters, will cause sand to gully wash.

Underground features -- The geologic processes that took place in previous geologic eras created thick deposits of unconsolidated sand and gravel which were saturated with water. The formations within which the aquifers exist contain interbedded and discontinuous deposits which may create inconsistencies in groundwater availability to overlying, perhaps adjacent, land areas. The water table is not close to the surface in the Sandhills (greater than 60 foot depth).

Trends -- Groundwater availability within the High Plains region is decreasing. Annual recharge within the southwest Kansas area is one-quarter (1/4) inch per year, while annual groundwater usage is dropping the water table at four (4) feet per year. Overall groundwater availability within the Sandhills is greater than surrounding areas as a result of greater saturated thickness than adjacent areas. Recent irrigated cultivation of Sandhill land utilizing center-pivot systems consumes large amounts of groundwater, and is largely resposible for the dramatic drop in the water table.

Interrelationships -- River water and groundwater is generally unavailable to native vegetation without technological intervention. The location and availability of water in the Sandhills keep water sources from interacting with the soil, thereby inhibiting the soil weathering process, resulting in a high proportion of sand and giving the soil less stability. The soil present, however, increases the recharge capability of the aquifers. The percolation rate of the soil and the depth of the aquifers generally interupts the hydrologic cycle, making the climate more arid. The physiographic feature of surface drainage is virtually non-existent within the Sandhills. The availability of groundwater essentially determines land use and whether the land is inhabitable.

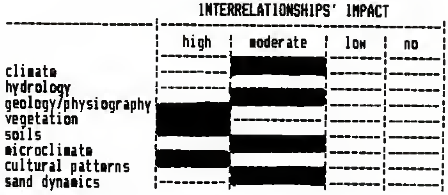
EVALUATION:

The uniqueness and ecological-sensitivity of the Sandhills area is, in part, a result of the highly permeable soils interrupting the hydrologic cycle. Generally, groundwater availability is higher in the Sandhills than in other areas in the region due to greater aquifer saturated thickness, increasing the likelihood of development upon land overlying it. The groundwater, however, is not available to Sandhill vegetation without irrigation, resulting the presence of arid-like plant material which is very sensitive to any disturbance. The Sandhills serve as a major aquifer recharge area due to the permeability and vastness of the sand deposits. Thus, major alterations that obstruct recharge could impact aquifer status. Aquifer status at present is primarily impacted by consumption through cultural land uses being significantly higher than the recharge rate.

IMPACT UPON UES STUDY AREA:

[] high impact
■ moderate impact
[] low impact
[] no impact

INTERRELATIONSHIPS' IMPACT



The natural types of vegetation found in the Sandhills exist by virtue of their ability to adapt to the extreme semi-arid conditions found here -- those conditions being primarily climatic and soil related. Although the composition and collection of plant material found inhabiting the Sandhills may be designated as "prairie association", the collection does not represent a true short-grass, mid-grass, or tall-grass prairie (Waldorf,1967). Species of all three prairie types are present, yet none dominate with sufficiency to suggest a specific classification. **Grass** species are, in fact, outnumbered by species of non-grasslike herbaceous plants known as forbs (Waldorf,1967 and Choate, et al,1981). The plants that grow in this unique locale possess characteristics or abilities that accommodate the climatic extremes, the sandy soil, and the environment created by both.

GENERAL VEGETATION CHARACTERISTICS. Wide variances in ecological conditions allow various plant types to adapt to the extreme of the Sandhill environment. For example, cool **season** grasses begin and complete their growth cycles prior to the hot and dry summer weather. Warm **season grasses** are more tolerant of the summer conditions, thus their growth cycle occurs during summer. Perennials initiate their growth in the spring from crowns or roots that have stored nutrients while dormant through the winter. Annuals, however, begin yearly from seeds and depend upon certain temperatures to germinate or on winds to broadcast seeds.

Most **grass** species have extensive fiberous root systems, which, often penetrating to a four foot depth, help secure the plant to the ground and collect moisture and nutrients permeating through the soil. Some **grasses** have the ability to regulate the transpiration of moisture by curling their blades inward, thus inhibiting moisture evaporation. Certain **grasses** may also become dormant in reaction to limited precipitation and then renew growth when sufficient precipitation occurs. There are also species of plants in this Sandhill environment which will not initiate growth of any kind unless adequate soil moisture is available (Weaver and Albertson,1956). Sexson (1982) observed that some species can prolong dormancy for seven to ten years if need be. On the other hand, **forbs** rely on deep, thick taproots five to twelve feet deep to provide similar functions. **Forbs** may initiate a similar response by curling or dropping leaves in an effort to reduce leaf-surface exposure. **Forbs**, in addition, generally have a limited amount of foliage to begin with.

The plant types present in the Sandhills generally co-exist without undue competition in large part because of their biological structure, preferred location for growth, and relatively low population per area. Weaver and Albertson (1956) pointed out that there are instances where taller plants (3 feet) may shade out some shorter plants (grasses), however, in some cases this shading may prove beneficial to shorter plant types by reducing heat stress and excessive transpiration. Plant types with extensive lateral root systems or large crown covers may also eliminate less agressive plants (Sexson,1982). Choate, et al (1981) noted that Sand Sagebrush (the only shrub native to this area) by nature of its taller and larger crown cover could possibly eliminate some plant types, while, at the same time provide cover protection for some other species. [Crown cover designates the circumference coverage of the upper part of the plant growth, while basal cover refers to the size of the major stem of the plant.] Still, most of the plant species growing in the Sandhills have relatively limited crown and basal cover, allowing adequate space for existence with other species.

Despite the numerous adaptive abilities of the plant types found in the Sandhills, they are still subject to extreme weather conditions from time to time. Weaver and Albertson (1956) noted that during the period of drought and wind storms of the 1930s many plants of the High Plains prairies showed an uncharacteristic dwarfness, intermittent growth, and/or a failure to complete growth cycles. Most young plants were unable to sustain themselves through the tenure of the drought and wind storms. Existing species, in reducing their foliage, also reduced their root growth thus becoming more susceptible to removal by wind. Shorter plant species were sometimes buried by wind-blown soil, which can be fatal at one-inch or more depth. In general, Weaver and Albertson (op. cit.) cited an overall depletion in ground coverage by vegetation in the High Plains during the 1930s. However, Waldorf (1967), in describing the Sandhills specific, noted that while not unaffected, the plants of this area were less impacted by the drought and wind of the 1930s due to their inherent nature to adapt to more "desert-like" conditions. Waldorf did not, however, imply that the Sandhills were totally unaffected.

<u>IMPORTANCE OF PLANT DIVERSITY</u>. The vegetation of the Sandhills has little problem with weeds or insects primarily as a result of the diversity of plant species present and the absence of a monoculture (Sexson,1982). Plant diversity should not be confused with plant cover, as the vegetative growth in the Sandhills rarely exceeds 20 percent total basal cover even in the peak growth months (Waldorf,1967). Still, a substantial diversity of plants exist, evidenced by Waldorf's 1967 inventory in which he collected over 40 different species from a relatively small area. A recent inventory of a nearby Sandhills area lists a total of 188 vascular plant species (Choate, et al, 1981).

Sexson (1982) observed that there is little need for the use of pesticides in the Sandhills area and their use tends to be detrimental to Sandhill wildlife. While grasshoppers may utilize the natural vegetation for a food source, this consumption does not kill the plan. Overall, the plants, insects, and wildlife act within the bounds of natural controls and check each other.

Sexson (op. cit.) further commented that there may be rare situations in the Sandhills which require the control of Sand Sagebrush (either by burning or herbicides), but that total control was undesireable. Basically, weed control in the Sandhills is limited to pasture management and for state law compliance (Bindweed and Johnson grass). Sexson observed that artificial management to maintain a certain stage of growth within the successional cycle (such as for grazing) may produce a monoculture, which can initiate greater problems. Sexson further suggested that the complete elimination of certain species within the Sandhills (noxious or not) may remove a link within the succession cycle chain which could upset the succession sequence.

Few plants in the Sandhills, if any, may actually be classified as "weeds". Dayton, in the 1948 Yearbook of Agriculture, classified as "weeds" any "plant out of place". Given this definition, few species are out of place in the Sandhills if such plants provide ground cover to stabilize the sandy soil. From an agricultural standpoint, some the plant species found in the sandhills would be considered "weedy" as they provide little value for livestock grazing. Certain species possess awns (bristles), are not palatable, or are overly agressive in that they may overrun desired grazing species. Such Sandhill species as Sand Sagebrush (Artemisia filifolia), Red Three-awn (Aristida longiseta), and Russian Thistle (Salsola pestifer/kali) may be considered noxious in terms of grazing, however, these plants tend to proliferate in Sandhill areas where other plant species will not, cannot, or do not inhabit. These three species generally proliferate in disturbed areas or in over-grazed areas. Over-population of a particular plant type in any one area primarily represents a regression in the vegetative succession cycle caused by a disturbance or denudation of the land area (Waldorf,1967).

PLANT SUCCESSION. In the previously described scenario where certain species may overpopulate an area, it is generally accepted among botanists that if the cycle of succession is left to function naturally, the vegetative environment will usually "adjust" allowing plant species of subsequent stages to inhabit the area again, as illustrated in Figure 4.3.

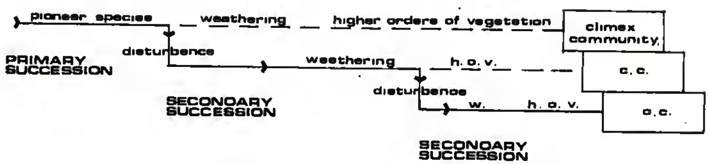


Figure 4.4.
SUCCESSION

Sand Sagebrush, Red Three-awn, and Russian Thistle, then, serve the critical purpose of holding the land in extreme climatic periods when other plants do not. If native plant cover is disturbed and natural succession is interrupted, an "imbalance" can occur resulting in severe impacts. Harlan (1956) presented an example of a potentially severe imbalance in describing a pasture that is grazed to the point of excess. Livestock consume the more palatable "dominant" and "decreaser" species, leaving a situation where species (known as "increasers") increase their numbers to take the place of the absent plants. If the increaser plants are further abused, the area is opened up to "weedy invaders". Should no reversion to the natural cycle take place, a "disclimax" is created, the condition of the affected area may become unstable, severely impacting the micro-environment through wind erosion and deposition. Ideally, an equitable proportion of dominants, decreasers, increasers, and weedy invaders is preferred to establish a more stable succession cycle, such as presented in Figure 4.5.

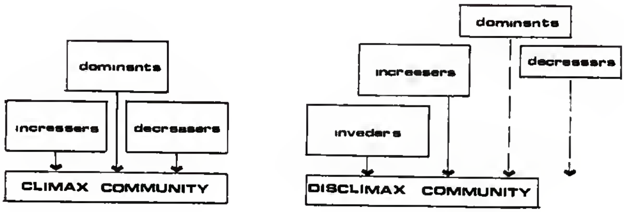


Figure 4.5.
DISCLIMAX

It may be noted that while the climax community of the Sandhills has not been specifically defined, there was a general agreement among sources consulted for this study that the climax community has not been reached at present.

<u>SANDHILL VEGETATION SPECIES</u>. Waldorf (1967) noted that although there exists ample literature concerning the different prairies of the High Plains, little of this literature addressed the specific vegetation that occupies the Sandhills south of the Arkansas River in southwest Kansas. Moreover, the information concerning the species present in the Sandhills is primarily geared toward pasture management, as this has been the predominant land use since the southwest Kansas area was settled. Still, a vegetation inventory, regardless of purpose, is beneficial -- indicating existing plant species within the

Sandhills and their ecological requirements and habits.

For the purpose of the present investigation, four vegetation inventories of the Sandhill area are presented in table form to providing an overview of vegetation existing in the case study area. Noted within Tables 4.1, 4.2, 4.3 and 4.4 are descriptions of sources, significant plant species, and findings of that source.

TABLE 4.1
SANDHILLS VEGETATIVE INVENTORY - SEXSON

SOURCE: MARK L. SEXSON -- Biologist, Kansas Fish and Game, Finney County State Game Refuge
Personal interview: 27 August 1982

SIGNIFICANT NATIVE PLANT SPECIES NOTED:

GRASSES --	Sand Bluestem (*Andropogon hallii*)	mid-grass
	Little Bluestem (*Andropogon scoparius*)	mid-grass
	Sand Dropseed (*Sporobolus cryptandrus*)	short-grass
FORBS --	Annual Sunflower (*Helianthus annus*)	
	Sand Lily (*Nuttallia nuda*)	
WOODY --	Sand Sagebrush (*Artemisia filifolia*)	woody shrub

Approximately a half-dozen cedar trees (*Juniperus virginiana*) are growing near the headquarters for the Finney County State Game Refuge and are believed by Sexson to be remnants of the National Forest Reserve project.

[The National Forest Reserve project was a federal experimental tree planting program initiated in 1906 and abandoned in 1915. Designed as a reclamation work project for Kansas, the project site extended from Garden City, Kansas to the Colorado line. A number of broadleaf and conifer tree species were planted, but the land proved unsatisfactory for self-sustained growth. The project was abandoned and all the land was restored to homestead entry with the exception of the acerage set aside for the Finney County State Game Refuge (Finney County Historical Society,1959).]

TABLE 4.2
SANDHILL VEGETATIVE INVENTORY - GESINK, TOMANEK, and HULETT

SOURCE: R. WILLIAM GESINK, G.W. TOMANEK, and G.K. HULETT

A DESCRIPTIVE SURVEY OF WOODY PHREATOPHYTES ALONG THE ARKANSAS RIVER IN KANSAS. Transactions Kansas Academy to Science, Volume 73, Number 1, November 30, 1970.

SIGNIFICANT PLANT SPECIES NOTED:

PHREATOPHYTES -- Plants which send roots down to groundwater and depend upon subsurface water supply for sustenance.

FOUND IN ARKANSAS RIVER FLOODPLAIN: Cottonwood (*Populus sargenti*)
Salt Cedar (*Tamarix ramosissima*)
Willow (*Salix spp.*)

RARE BUT PRESENT IN WESTERN TRANSECTS OF STUDY AREA (Not confirmed within Sandhills):

Russian Olive (*Eleagnus angustifolia*)
Skunkbush (*Rhus trilobata*)
False Indigobush (*Amorpha fruiticosa*)
Red Ash (*Fraxinus pennsylvanica*)

TABLE 4.3
SANDHILL VEGETATIVE INVENTORY - WALDORF

<u>SOURCE</u>: ROSCOE C. WALDORF -- Retired Professor of Biology, Garden City Community Junior College

Personal Interview: 23 August 1982 and 26 August 1982

AN ECOLOGICAL SURVEY OF THREE SANDHILLS RANGE AREAS IN FINNEY COUNTY, KANSAS. August, 1967.

[1967 study area lies within the present study area under investigation.]

<u>SIGNIFICANT PLANT SPECIES NOTED</u>:

GRASSES --	Sand Dropseed (<u>Sporobolus cryptandrus</u>)	short-grass
	Paspalum (<u>Paspalum pubescens</u>)	
	Blowout Grass (<u>Redifieldia flexuosa</u>)	
	False Buffalograss (<u>Munrosa squarrosa</u>)	
	Buffalograss (<u>Buchloe dactyloides</u>)	short-grass
	Blue Grama (<u>Bouteloua gracilis</u>)	short-grass
	Red Three-awn (<u>Aristida longiseta</u>)	short-grass
FORBS --	Pigweed (<u>Acnida tamariscina</u>)	
	Western Ragweed (<u>Ambrosia psilostachya</u>)	
	Plains Sunflower (<u>Helianthus petiolaris</u>)	
	Russian Thistle (<u>Salsola pestifer/kali</u>)	
	Western Fleabane (<u>Erigeron divaricatus</u>)	
	Camphorweed (<u>Crysopsis villosa</u>)	
SEDGE --	<u>Cyperus schweinitzii</u>	

<u>SIGNIFICANT FINDINGS</u>:

The 1967 study distinguished between grazed and ungrazed areas, the latter to serve as a control illustrating the normal state of the area.

-The highest percent of FORBS and lowest percent of GRASSES were found on <u>ungrazed</u> areas;

-FORBS generally were more palatable to livestock than GRASSES, yet more <u>intolerant of grazing</u> than GRASSES;

-FORBS characteristically possess <u>less total basal coverage</u> than GRASSES due to structural aspects of the plants;

-GRASSES show <u>greater wind resistance</u> than taprooted FORBS;

-GRASSES are generally <u>xeric</u> in adaptation, thus function well with less than 20 inches of annual rainfall;

-FORBS are generally <u>mesic</u> and favor moderately moist conditions;

-Most FORBS present in the Sandhills are annuals;

-Most GRASSES present in the Sandhills are perennials;

-The most prosperous GRASSES present are bunch-type grasses;

-The FORBS present are generally more diversified and thus better adapted to certain situations;

TABLE 4.4
SANDHILL VEGETATIVE INVENTORY - CHOATE, ELY, FLEHARTY, and HULETT

SOURCE: CHOATE, JERRY R., CHARLES A. ELY, EUGENE D. FLEHARTY, and GARY K. HULETT

BIOLOGICAL INVENTORY OF THE SAND SAGE PRAIRIE NEAR HOLCOMB, KANSAS: FINAL REPORT. Prepared for Sunflower Electric Cooperative, Inc. by the Department of Biological Sciences, Fort Hays State University, Hays, Kansas. February, 1981.

[The 1981 inventory study area is adjacent to the present study area under investigation.]

SIGNIFICANT PLANT SPECIES AND VEGETATIVE CHARACTER:

An investigation into the site's vegetation divided its area generally from north to south into plant communities, which were found to correspond closely to soil type. Four major plant community-types were delineated, as were three sub-community-types, each community revealing some differential vegetative patterns.

FLOODPLAIN
-exhibited loamy sands or sandy loams, small elevational changes, and a mixture of annual grasses and forbs;
-dominant grass was Little Barley (Hordeum pusillum);
-dominant forb was Russianthistle (Salsola pestifer/kali).

Abandoned Feedlot
-occurred within Floodplain and due to disturbance, vegetation was in a "weedy secondary successional" stage;
-Russianthistle was dominant plant.

Floodplain Edge
-soil showed presence of more gravel and elevational changes were more noticeable;
-dominant grasses were Blue Grama (Bouteloua gracilis) and Sand Dropseed (Sporobolus cryptandrus);
-dominant forb was Russianthistle (Salsola pestifer/kali);
-Sand Sagebrush (Artemisia filifolia) was scattered along southern edge.

DUNE SANDS
-appeared as a narrow band of low, undulating dunes between the Floodplain and Choppy Sand areas;
-Sand Sagebrush (Artemisia filifolia) was dominant in uniform stands;
-Blue Grama (Bouteloua gracilis) and Sand Dropseed (Sporobolus cryptandrus) were dominant groundcover;
-Small Soapweed (Yucca glauca) and Southwest Rabbitbrush (Chrysothamus pulchellus) were also present.

CHOPPY SANDS
-encompassed the largest amount of land area and showed the greater vegetative diversity (52 species);
-was present in all sections of the site and considered by Choate, et al to be typical of sandsage prairie;
-soils are Tivoli fine sands exhibiting steep dune topography that created variations in vegetation present;
-blowouts found were the result of gas and water well construction;
-Sand Sagebrush (Artemisia filifolia) was present in dense overstory (similar to "Dune Sands");
-dominant perennial grasses were Sand Dropseed and Prairie Sandreed (Calamovilfa longifolia);
-common and conspicuous in early summer was the annual Six-Weeks Fescue (Festuca octoflora);
-total basal cover was low with extensive areas of bare sand common between clumps of Sand Sagebrush;
-Sand Lovegrass (Eragrostis trichodes) and Sand Bluestem (Andropogon hallii) were present but overgrazed;
-found were pure stands of Needle-and-Thread (Stipa comata) a cool-season grass typical of sand dune vegetation further north in the Great Plains;

LEVEL SANDS
-encompassed southern one-third of site where topography was of low dunes;
-vegetation was considerably different from the other communities due to the presence of Tivoli-Vona loamy fine sands, which are finer and heavier due to increased clay and silt content;
-overall appearance was that of a short-grass prairie;
-Sand Sagebrush was dominant, although its density was lower and the plants were smaller than in other areas;
-dominant plant species was Blue Grama (Bouteloua gracilis), a common indicator of heavier soil;
-only thrity-two plant species were noted in this community.

Depressions
-occurred within the "Dune Sands" and "Choppy Sands" and were too small to be mapped;
-exhibited vegetative composition distinct from surrounding dunes due to finer-textured soil particles blown into depressions and occasional water collection;
-depression centers lacked Sand Sagebrush, supported dense stands of Blue Grama, Tumblegrass (Schedonnardus paniculatus) a weedy grass was common inside, while Needle-and-Tread formed dense stands around the rims.

A total of 188 plant species were noted within the overall site -- forbs (130 species) being most numerous. There were a total of 49 grsss species and 9 shrub species found.

DATA INVENTORY/IMPACT SHEET
VEGETATION

INVENTORY:

Native vegetation species, locations, characteristics -- Native vegetation within the Sandhills is characterized by a diverse number of species sparsely covering the ground. Grass and forb species primarily inhabit the study area, with Sand Sagebrush being the only significant woody species. Grasses tend to be of limited number and of the bunch-type with shallow fiberous root systems, while forb species generally outnumber grasses and are taprooted 5-12 feet deep. The various species have adaptive traits enabling them to survive most natural extremes, seek out more favorable conditions, and increase competition. Certain species grow during specific seasons, in certain locations, and exhibit dormancy capabilities. the greatest diversity of plant species tend to inhabit the steeper dune topography, while an increase in the finer-particled soil (sand-silt-clay) to the south seems to encourage a more true short-grass prairie environment. Certain aggressive species inhabit the more undesirable environments that have been disturbed, overgrazed, or denuded.

Stability/changes -- The stability of the Sandhill vegetation is dependent upon the magnitude and timeliness of the annual precipitation and the stability of the soil with regard to reaction to alteration of site. Vegetation weakened by weather conditions may submit to wind erosion. If soil becomes active and moving, vegetation will not grow. Aggressive species exist that will somewhat stabilize the disturbed area initially, then, in proper succession, yeild in number to other more diverse species. The vegetation succession cycle, however, is relatively slow.

Interrelationships -- Native vegetation is highly influenced by the sandy soil and the climatic conditions of the Sandhills. The vegetation relies on precipitation as its source of water, surface and groundwater sources being unavailable without technological intervention. Plant structure stabilizes the sandy soil against wind erosion to a certain extent by anchoring it with root systems and by providing a surface roughness which redirects wind. The sandy soils will not hold nutrients over a long period, thus nutrients available to Sandhill vegetation are very limited.

EVALUATION:

The vegetative composition within the Sandhills is unique to this micro-environment as the species present represent no single classifiable prairie type. The Sandhills are stabilized by the existing vegetative cover. Vegetative species, although diverse and adaptable, are dependent upon precipitation for a water source, and thereby susceptible to changes in precipitation patterns. The species diversity and adaptability, while attuned to sandy soil, are susceptible to sand movement. Common wind reduction methods, such as shelterbelt, will not work in the Sandhills as trees will not natural sustain themselves. The vegetative succession cycle will remedy natural disturbances in vegetation growth, however, its gradual timeframe may leave the area weak or very sparsely covered and susceptible to disturbances or climatic extremes. The vegetative cover maintains the stability of the Sandhills.

IMPACT UPON UES STUDY AREA:

■ high impact
[] moderate impact
[] low impact
[] no impact

INTERRELATIONSHIPS' IMPACT

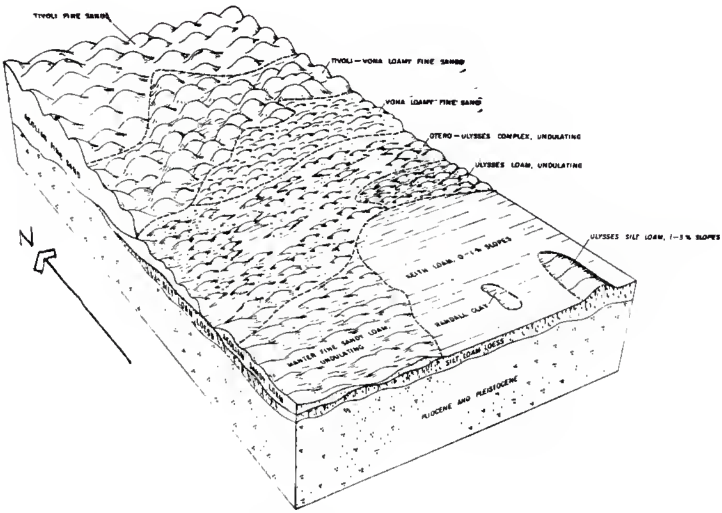
	high	moderate	low	no
climate	■			
hydrology		■		
geology/physiography			■	
vegetation				
soils	■			
microclimate		■		
cultural patterns		■		
sand dynamics	■			

SOILS

The previously-noted vegetative inventory conducted by Choate, et al (1981) revealed a distinct correlation between the vegetation present and the soil types of the Sandhill study area. To understand more thoroughly this correlation, soils of the study area are investigated. According to the Soil Conservation Service's 1965 Finney County Soil Survey (Harner,et al), the soils of the Sandhills are classified within the Tivoli-Vona Association, with the exception of Active Dunes, which command an individual category.

The 1965 Soil Survey noted that within the Active Dunes classification, the land is nearly or is devoid of vegetation. The loose sand is shifting, thereby inhibiting the establishment of plants. There is no discernible soil profile in the approximate sixty-foot thickness of the sandy soil. In certain low areas the sandy soil has been removed by wind work, exposing calcareous silty material. The Active Dunes comprise 0.1 percent of the total Sandhill acreage, occurring disjunctively within the Tivoli-Vona Association. Stabilization by vegetation inducement and activity restraint in Active Dunes is advised to mitigate further disturbance.

The primary parent material of Sandhills soils is the granular deposits and eolian deposits described previously. The soils of the Vona Series appear nearer the southern boundary of the Sandhills (see Figure 4.6) and consist of smaller-particled sand, silt and clay all of which have been transported farther from the river by wind. The Vona Series soils are heavier and show signs of "A" and "B" horizons within the soil profile. In contrast, the soils of the Tivoli Series are coarser-grained and appear nearer the Arkansas River in undulations which are more pronounced and steep, and show little profile.



source: Herner, et.el., 1965. SOIL SURVEY OF FINNEY COUNTY, KANSAS. USDA-SCS, Series 1961, No. 30.

Figure 4.6.
PERSPECTIVE OF TIVOLI-VONA SOILS ASSOCIATION

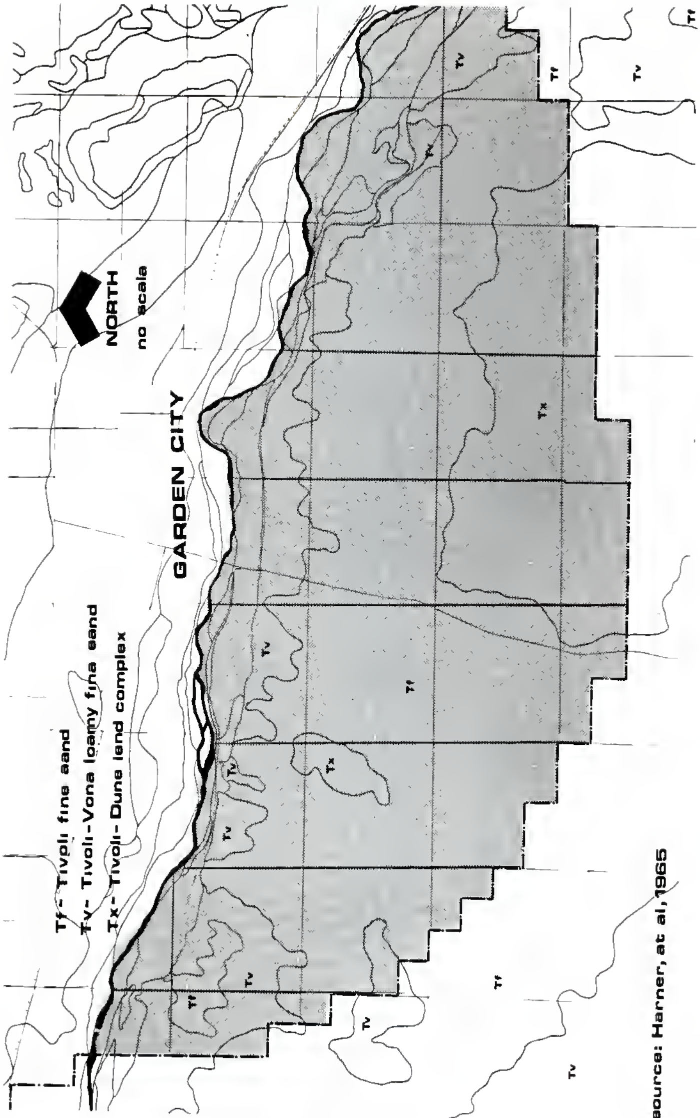


Figure 4.7.
SOILS MAP

The surface layer of the Tivoli Series is generally brown to pale-brown fine sand or loamy fine sand, two to eight inches thick. The subsoil is light yellowish-brown fine sand that has low moisture-holding capacity, although it can usually retain moisture sufficiently to make it available to native plants. Below the subsoil there is non-calcareous, fine eolian deposits. The Tivoli Series consists of Tivoli fine sand (Tf), Tivoli-Dune land complex (Tx), and Tivoli-Vona loamy fine sands (Tv), which, as illustrated in Figure 4.7, represent the soil types present within the case study area. Characteristics of these three soil types, as noted by the 1965 Soil Survey (Harner, et al), are summarized in Table 4.6

<u>ENGINEERING PROPERTIES</u>. Inasmuch as the present study addresses development within the subject area, predetermining the probable soil performance relative to structural or engineering concerns is essential. The engineering properties of the Tivoli Series are summarized in Table 4.6 from data derived from the 1980 Soil Conservation Service's <u>Soil Interpretation Record</u>.

A 1965 Kansas Department of Transportation soil survey conducted in connection with the proposed construction of a highway passing through the present investigation's case study area noted soil characteristics that would be encountered in the construction of the highway. The survey observed that the sandy soil "will present difficulties in obtaining satisfactory compaction and providing a suitable working surface....(p.1)." The sandy soils present were found to have "high stability values" and it was recommended that "they be used for subgrade

TABLE 4.5
TIVOLI SERIES SOIL TYPE CHARACTERISTICS

TIVOLI FINE SAND (Tf):

-encompasses an expansive belt just south of the Arkansas River;
-8 to 20 percent slopes;
-total thickness averages 0 to 60 feet;
-topography is "choppy and duny";
-blowouts found dispersed throughout;
-highest permeability (along with Active Dunes) of Sandhill soil types;
-Vona fine sands make up approximately 10 percent of the acreage within this soil type.

TIVOLI-DUNE LAND COMPLEX (Tx):

-is a combination of 60 to 80 percent Tivoli fine sand (Tf) and Active Dunes;
-5 to 20 percent slopes;
-permeability and thickness resemble that of its two components.

TIVOLI-VONA LOAMY FINE SAND (Tv):

-is a combination of 50 percent Tivoli loamy fine sand and 50 percent Vona loamy fine sand;
-Tivoli soils will occur in the higher areas;
-Vona soils will occur in the lower areas;
-Vona soils are less sandy and permeable than the Tivoli, are grayish-brown, have a 10-inch surface layer, and have a 14-inch calcareous subsoil containing concretions with narrow bands of lime;
-3 to 8 percent slopes.

TABLE 4.6
TIVOLI SERIES -- ENGINEERING PROPERTIES

USDA SOIL CLASSIFICATION:
0-7" depth: loamy fine sand (LFS)
0-7" depth: fine sand (FS)
7-60" depth: fine sand (FS), sand (S)

UNIFIED SOIL CLASSIFICATION:
0-7" depth: sand with 10% silt (SM)
0-7" depth: sand with 10% silt (SM), sand poorly graded (SP) [indicates poor particle internal friction]
7-60" depth: sand with 10% silt (SM), sand poorly graded (SP)

AASHTO SOIL CLASSIFICATION:
0-7" depth: (A-2) gravel with wide range of particles of fair to poor grade, with binder
0-7" depth: (A-2, A-3), deficient in soil binder, exhibit not compressibility, need confinment
7-60" depth: (A-2, A-3)

ANGLE OF REPOSE: Sand will seek 3:1 slope; slopes of 1:1 and 2:1 will erode or slump.

PERCENT OF CLAY: Clay soil never present in greater than 10 percent proportions.

PERMEABILITY: 6-20 inches/hour; classified as "rapid"; however may gulley if exposed to concentrated flow, and may act as a wick to water contained in concrete mixtures.

PH: At 0-7" depth is 6.1 - 7.8; at 7-60" depth is 6.1 - 8.4; classified as slightly acid to moderately alkaline; neutral classification (6.6 - 7.3) indicates point at which plant neutrients are most readily available and there is low corrosivity with regard to steel and concrete.

SALINITY: Negligible; moisture and nutrient absorption unimpeded.

LIQUID LIMIT: Inconsequential; insufficient moisture; sand at LL is quicksand.

PLASTICITY: Non-plastic; soil structure and permeability resists shaping.

SHRINK-SWELL POTENTIAL: Negligible; soil does not significantly expand/contract in reaction to temperature.

DEPTH TO WATER TABLE: More than 6 feet.

DEPTH TO BEDROCK: More than 60 feet.

FOR LAND USE MATRIX, INTERPRET:
Slight (SL) - soil has favorable properties to accomodate use, limitations minor and overcome easily with favorable performance and low maintenance;
Moderate (M) - soil has moderately favorable properties, limitations may be over come or modified with special treatment, design, maintenance, or planning;
Severe (S) - soil has one/more unfavorable properties, limitations require major or costly soil reclamation, special design, intensive maintenance;
Very Severe (VS) - soil has one/more unfavorable properties which are very costly or difficult to overcome or modifiy.

USE	5-7% SLOPE	7-15% SLOPE	>15% SLOPE	UNFAVORABLE PROPERTIES
SEPTIC TANK ABSORPTION FIELDS	S	S	S	poor filter, slope
SEWAGE LAGOON AREA	S	S	S	seepage, slope
SANITARY LANDFILL (TRENCH)	S	S	S	seepage,too sandy,slope
SANITARY LANDFILL (AREA)	S	S	S	seepage, slope
SHALLOW EXCAVATIONS	S	S	S	cutbanks cave, slope
DWELLINGS WITHOUT BASEMENTS	SL	M	S	slope
DWELLINGS WITH BASEMENTS	SL	M	S	slope
SMALL COMMERCIAL BUILDINGS	M	S	S	slope
LOCAL ROADS AND STREETS	SL	M	S	slope

construction and the top three (3) inches be stabilized with asphalt to provide not only a suitable working surface for construction equipment, but also to become a part of the flexible pavement (p.1)." The survey cautioned against placing heavier clay-like soils within the top twelve inches of the subgrade. The survey also found the sandy soils to be suitable for embankment construction, although with regard to shoulder and slope construction the survey advised that problems with erosion could be expected as, "past experience has proven where large areas of these non-plastic sands are exposed they will erode and blowout areas will continue to occur for several years or until they are stabilized (p.2)." To minimize erosion potential the survey recommended for disturbed areas that, "slopes be topped with four (4) inches of soil which will support vegetation. Consideration should especially be given to the areas near commercial and residential development and to large exposed areas where the deeper cuts and higher fills will exist (p.2)." This mitigation measure would require that "special borrow areas" would have to be located north or south of the Sandhills where heavier soil was available and would entail expensive transport of this soil material by truck. The survey also advocated utilization of an emulsified asphalt treatment to be applied under high pressure by gun from the road shoulder following seeding. Specialized compaction methods employing moisture control specifications were to be required throughout the project. Flexible pavement material was suggested by the survey as preferable over rigid pavement both in performance and cost, based upon similar highway facilities constructed upon like-soils in other counties.

PLANT MEDIUM. With regard to plant material, the sandy soil and related conditions may inhibit growth due to low fertility, low and inconsistent precipitation, lack of adequate topsoil, high permeability, high evapotranspiration rates, lack of concretion, and susceptibility to wind erosion. Mitigation of any of the preceeding conditions is likely to increase the survival and/or vigor of both native and cultural plant material, however, such mitigation would have to be continuous or timely, and would be costly.

DATA INVENTORY/IMPACT SHEET
SOILS

INVENTORY:

Soil type, composition, location -- Sandhill soils are of the Tivoli-Vona Association or are active dunes. Within the study area only the Tivoli Series and active dunes are present. The active dunes comprise 0.1% of total Sandhill coverage and are primarily devoid of vegetation and are moving sand. The Tivoli Series consists of Tivoli fine sand (Tf), Tivoli-Dune land complex (Tx), and Tivoli-Vona loamy fine sand (Tv). Tf are located in the choppy steep dunes near the Arkansas River. **Tx** is part Tf and part active dunes and are interspersed within the Tf. **Tv** contain more finer-particled sand, silt, and clay and become more prevalent toward the southern boundary of the Sandhills farther from the sand source.

Engineering properties -- The soils of the Tivoli Series are proportionally high in poorly-graded sand, will not compress well, and may require containment when dry. These soils are highly permeable, non-plastic, and exhibit no significant shrink-swell potential. Water table and bedrock depth are too deep to pose significant problems in construction. Problems to construction may involve the soil slope, stability, permeability, containment and erosion.

Plant medium -- Plant growth and vigor is affected by low fertility, low and inconsistent precipitation, lack of adequate topsoil, high permeability, high evapotranspiration rates, lack of concretion in the soil, and susceptibility to wind erosion.

Interrelationships -- The extreme amount and grade of sand present is the result of past geologic and climatic processes. Contemporary weather patterns (low and inconsistent rainfall, high temperature, wind presence) keep the soil weathering process at a slow rate such that topsoil is slow to form. Where surface is disturbed, topsoil that may have been formed thus far is lost. Vegetative growth keeps the majority of sand particles from succumbing to wind movement. Soil primarily negates normal microclimatic reactions. The soil present, being highly permeable, increases the hydrologic recharge capabilities of the underlying aquifer.

EVALUATION:

The extreme presence of sand makes the Sandhills unique within its location. Along with contemporary weather patterns and vegetation, the soil is repsponsible for the ecological-sensitivity. The soils exhibit low fertility, high permeability, little topsoil, lack of concretion, little change in structure over time, lingering susceptibility to wind erosion. Once soils become active and moving, they are hard to control and will most likely encroach upon non-active soils, thereby damaging plants and land uses. Soils may be naturally controlled by vegetation, which if healthy and diverse, more than adequately circumvents large erosion problems.

IMPACT UPON UES STUDY AREA:

■ high impact
[] moderate impact
[] low impact
[] no impact

INTERRELATIONSHIPS' IMPACT

	high	moderate	low	no
climate	■			
hydrology		■		
geology/physiography		■		
vegetation	■			
soils				
microclimate	■			
cultural patterns	■			
sand dynamics	■			

SAND DYNAMICS

Dune sand is a significant depositional feature of the geologic formations present within the case study area. Active Dunes exist within the case study area, therefore a basic understanding of the sand dynamics and their impact upon the Sandhills is necessary.

SAND SOURCE. In his 1940 study, Smith suggested that the source of the sand required to create the Sandhills was near its present location forasmuch as characteristics indicating migratory dune types were rare or absent. He dismissed a prior notion that the Arkansas River floodplains were the sole source of the sand, pointing out that sand movement features from the river to the Sandhills were not prominent, and that it was unlikely that sufficient amounts of sand were available in the floodplains to supply the vast area of the Sandhills in the absence of true migratory dune activity. Smith proposed that the migration of the Arkansas River northward left generous deposits of sand and gravel in the abandoned beds. These deposits would later be covered with additional eolian deposits. He submitted that a likely source for this supply of sand was therefore the older terrace deposits exposed near the river or from cuts into the Ogallala Formation. Meyer, et al (1970) offered as possible sand sources the terrace deposits below the dune sand, exposed terrace deposits near the river, and the alluvium adjacent to the river.

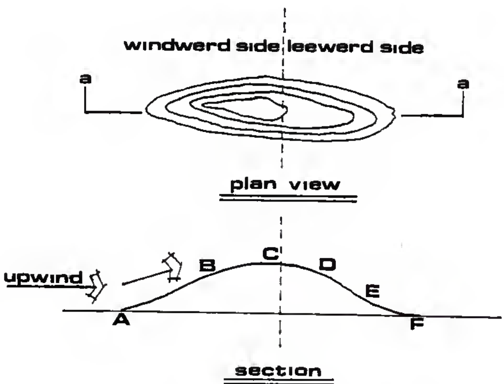
WIND DIRECTION. The manner in which the eolian deposits were laid may be deceiving if it is noted that contemporary sand-moving winds are predominantly from the southwest. Smith (1940) suggested that the dune-building process took place in a time when the effective winds in the Sandhill area were from the north. He substantiated this theory noting, first, that northerly winds were likely at the time of dune building due to the presumed presence of Pleistocene glacial activity and, second, a northerly dip in the bedding of the dunes was observed in his study of the area.

GENERAL WIND MECHANICS. It is worthwhile to understand the basic processes of eolian dune action, both to aid in explaining the formation of the area and to aid in recognition of those actions that may be present now or that may occur.

A fundamental aspect of wind mechanics on sand is that a specific wind velocity is required to initiate movement of a specific particle. If the sand grains present are larger than the capability of the wind to move them, the sand movement process is not initiated or ceases. An action termed "saltation", however, may allow a wind velocity to move larger sand particles than its capability would indicate. A lesser wind which moves smaller particles, if sustained, will allow these particles to repeatedly bounce into stationary larger particles. This continued impact loosens the heavier grains such that they are elevated up into increased air velocities, where they too may become a part of the saltation process by bouncing into even larger grains. Thus, although a certain wind speed is generally needed to begin the movement of heavier-grained sand particles, auxillary actions can prompt this movement at lower velocities.

Once wind initiates sand movement, it follows certain patterns in building actual dunes, as described by Bagnold (1941). In A Study of Global Sand Seas, McKee (1979) referred to Bagnold's 1941 publication as a "classic " description of the physical processes of blown sand and their subsequent formations that has "stood the test of time."

In considering the effects of wind work on sand dunes, Bagnold (1941) pointed out the general mechanics present in most dune shaping. Fundamental to the eolian process of dune building is that wind velocity increases with the height above the ground surface. Friction, created by the ground surface itself or by objects in or on the surface, reduces the velocity. Thus, as illustrated in Figure 4.8, the air speed at point B (on the windward side of the dune) is greater than at point A. Further,



(reproduced from: Bagnold,1941,p.198.)

Figure 4.8.
DUNE BUILDING -- PLAN/SECTION

the wind velocity drops on the lee side of point C (the crest) as the air is retarded by the divergence of flow. The velocity then resumes the steady speed past point F that it had prior to point A. The result of this wind behavior on an individual dune is that there will be sand removal on the windward side (most likely at point B) and deposition on the lee side (between points C and E). The overall effect is that the dune advances, however slightly, in the lee direction without appreciably altering its shape.

The removal and deposition pattern described above is typical of the effect of gentle winds. In a situation of strong wind, the <u>entire</u> windward face is affected. If the upwind coming toward the dune is not already loaded with sand, removal is intensified and this removed sand, rather than being deposited on the lee face, is carried farther downwind, and the dune is reduced in size. Should the upwind be loaded with sand, the dune will take on more deposition than is removed and the dune will grow in size. An average wind over an extended time period will give the dune the appearance of steady movement downwind without change in size or shape.

Bagnold (op.cit.) explained that as a dune increases in size, deposition is heaviest near the crest and this crest tends to advance quicker than the lower part of the lee face. The lee face then becomes steeper until it reaches its angle of repose (34 degrees). At this point the deposited mass shears along a less-steep plane (the angle of repose), an avalanche occurs, and a slip-face is formed. The angle of the slip-face creates a wind shadow where the air movement is nil and into which sand particles fall. This action continues until the dune again assumes the same extreme contour and the process begins anew. In the study of dunes, the slip-face is often utilized to classify dune forms.

<u>THE EFFECT OF VEGETATION ON WIND MECHANICS</u>. Bagnold (op.cit.) proposed that vegetative cover provides a surface roughness. Even a thin cover of grass raises the elevation at which the velocity of the wind is generally zero, thereby inhibiting dune growth by restricting surface movement and collecting incoming sand between the blades. Further, due to the flexibility of the blades, sand grains do not bounce off them as they do off other grains, so the saltation process is suppressed. A covered area will continually collect sand deposits and the surface will become undulating and without steep-sided dunes.

<u>CLASSIFICATION AND BEHAVIORS OF DUNE SAND</u>. A number of studies have classified dune sands. <u>A Study of Global Sand Seas</u> (McKee, 1979) compiled the accepted nomenclature of past studies (most of which were particular to a specific locale) and presented universal terms.

McKee (op.cit.) recognized two descriptive characteristics that allow classification of dunes. These are the number of slip-faces present and the shape of the dune. Both are determined by: 1) the strength and direction of the wind; 2) sand supply; 3) vegetation present or absent; 4) physical barriers; and 5) distance from the sand source. Consideration of these criteria yielded the three major dune types and eleven distinguishable forms noted in Table 4.7.

TABLE 4.7
TYPES OF DUNES

A. BASIC (Simple) DUNE TYPES

1. Barchan
2. Barchanoid ridges (coalesced barchans)
3. Transverse dunes
4. Sheets
5. Stringers
6. Dome
7. Blowout
8. Parabolic
9. Linear (seif)
10. Star
11. Reversing

B. COMPOUND -- two or more of the same basic dune types coalesced

C. COMPLEX -- two or more of different basic dune types coalesced

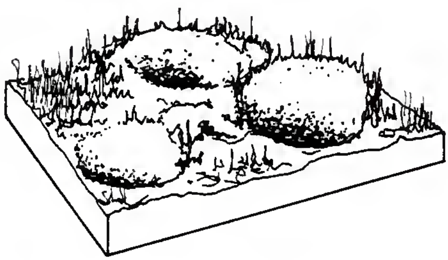
Smith (1940) recognized <u>four</u> of the simple dune types as present within the Sandhills of southwestern Kansas at the time of his study. These were: barchan, barchanoid ridges, transverse dunes, and blowouts. McKee (1979) stated that all but the blowout have a <u>cresentic shape</u> and a <u>single slip-face</u> (which indicates creation by a <u>uni-directional wind</u>), and they occur in a definite <u>sequence</u> downwind from the sand source. As illustrated in Figure 4.9, transverse dunes develop near the sand source and may appear as a continuous ridge. Individual barchans develop farther downwind from the transverse dunes where the sand supply is scarce. Barchanoid ridges occur when individual barchans, with greater sand supply available, overrun each other and become coalesced. In Landsat (ERTS) satellite images, these three dune

(reproduced from: McKee,1979,p.12.)

Figure 4.9.
FORM AND SEQUENCE OF REPRESENTATIVE DUNE TYPES

types may appear only as parallel wavy lines. It is presumed by Smith (1940) that in the creation of the Sandhill topography, these dune types existed at a much larger scale and that their forms and physical processes are responsible for the present undulating surface. Reworking of these forms over time; change in the effective wind direction, strength and duration; and the subsequent vegetative cover have altered the Sandhill dunes to their present state. Smith (op.cit.) did not find what he would consider "unmodified primary dune forms" within his study area. Smith observed that basic sand dune types will likely develop now only in situations of relatively large areas of bare sand, such as in some of the larger areal blowouts, where he noted the existence of some crescentic forms.

According to McKee (1979), blowouts are not "true" dunes, rather they appear as a circular bowl or crater within a larger expanse of sand (see Figure 4.10). They are controlled primarily by partial stabilization, as opposed to strictly wind strength and direction which are controls of the true dune forms. There may be slip-faces present in blowouts depending upon which part of the rim is free to migrate. Their size and shape may vary according to where the rims are anchored by vegetation. Prevailing winds are usually deflected in many directions within the bowl, although blowouts may evolve into a parabolic (U-shaped) dune type if sufficient winds continually advance the unstable portions of the rim. Conversely, they may also be gradually filled by deposition and stabilized by vegetative cover.



(reproduced from: McKee, 1979, p.12.)

Figure 4.10.
BLOWOUT DUNES

Blowouts, contrary to the crescentic forms, do not require a sand source and can develop wherever conditions or vegetative cover and wind allow. Blowouts are the prime contemporary dune feature within the case study area.

<u>EROSION AND DEPOSITION</u>. The Urban Land Institute (1978) noted that erosion and deposition are part of the natural weathering and building process of the earth. The process is often gradual and the balancing checks of nature generally compensate its impact. Erosion and deposition induced by human activities increases the rate of these actions and is superimposed upon the natural cycle, often straining the adjustment rate.

Harner, et al (1965) concurred, suggesting that human-induced erosion frequently represents an acceleration in the rate of soil movement. Beasley (1972) cited associated problems created by this increase in erosion activity such as damage to vegetation by particle abrasion, and root exposure or inundation of the plant base by deposition. The texture, condition and fertility of the soil can be undesirably altered as the finer particles and organic matter are carried away by the wind. The Journal of Soil and Water Conservation (1981) stated that the removal of this topsoil also lowers the water-holding capacity of the soil. Beasley (1972) also noted that severe wind erosion disrupts living environments by causing respiratory or eye infections and polluting the atmosphere. Dust and sand ingression within home environments is also noxious. Erosion never occurs without deposition, and the latter can be as harmful as the former.

Overall, erosion and deposition lowers the quality of the soil, vegetation and habitat; interrupts the vegetation succession cycle; and may initiate dune development should the process continue unchecked.

Brady (1974) and Beasley (1972) cited environmental conditions that are most conducive to wind erosion. Among those are: lack of moisture; loose and fine soil; high temperatures and evaporation rates; relatively level topography free of obstructions; sparse vegetative cover; and wind velocities sufficient to move sand particles. These conditions are present within the Sandhill case study area.

Wind speeds of ten to thirteen miles-per-hour are appreciable enough to induce sand movement (Brady, 1974; Beasley,1972). Weaver and Albertson (1956) noted that it often takes a wind speed of thirty miles-per-hour to initiate particle movement on non-sandy cultivated land, but once the soil begins to blow, a wind of only eight to twelve miles-per-hour will sustain particle movement. Sexson (1982) suggested that constant wind speeds of up to thirty miles-per-hour generally will not impact the Sandhills, however, when these winds gust or when an eighty mile-per-hour wind blows out an area, then the thirty mile-per-hour wind can be detrimental. Sexson further suggested that high velocity winds that occur on successive days are more likely to create erosion problems than isolated instances of high velocity winds.

Weaver and Albertson (1956) stated that the velocity of the wind at most soil surfaces is generally one mile-per-hour or less. Further, they suggested that a twenty to thirty mile-per-hour wind can be reduced to one-twentieth of that velocity by even short grasses. From this, the authors agreed with other ecologists who proposed that the dust storms of the 1930s did not originate from anything but bare soil. This illustrates the importance of vegetative cover in areas where conditions conducive to erosion and deposition exist.

The Sandhills possess all of the previously-listed conditions conducive to erosion and deposition. Recurrent periods of drought and high or sustained wind velocities extend the opportunity for erosion and deposition to take place and become severe if not recognized and kept in check.

DATA INVENTORY/IMPACT SHEET
SAND DYNAMICS

INVENTORY:

Surface characteristics and sand source -- The Sandhill's surface exhibits subtle undulating dune formations that range from steep and choppy near the Arkansas River to the more subdued swells toward the southern boundary of the Sandhills. Underlying deposits are remnants from former river beds abandoned as the river migrated north of its original location. Upper and surface deposits are wind blown finer particles and reworked dune remnants.

Wind direction and mechanics -- The effective dune-building winds of previous geologic eras originated from the north as a result of glacial activity. Effective contemporary sand-moving winds are of less velocity and are predominantly from the southwest. These winds over recent time have reworked the original dunes such that dune types are less recognizable and their features less pronounced to negligible.

Classification and behaviors of dune sand Dune types found to exist or to have existed in the Sandhills are barchan, barchanoid ridges, transverse dunes, and blowouts. All but the blowout dune type characteristically originate from a uni-directional wind, and appear in a definite sequence down wind of the sand source. Original dune forms have been reworked overtime by change in wind direction, strength and duration, and by establishment of vegetative cover. Blowouts, the most common contemporary dune type, may develop at any point in the Sandhills where effective winds encounter weak vegetation or bare sand.

Interrelationships -- Sand dynamics are primarily a function of sand source; wind direction, strength and duration; and presence of vegetation; thus, are effected directly by soils, climate, and vegetation, and indirectly by geology, hydrology, and cultural patterns.

EVALUATION:

Sand dynamics are in effect constant within the Sandhills, however, the degree of effect at present is distinctly less than at the time of dune-building. No appreciable dune-building is taking place at present, and reworking of the original dunes has decreased the height and individuality of specific dune types. The primary contemporary action of sand dynamics present within the Sandhills is wind erosion/deposition. The effects of wind erosion/deposition can be severe due to the inhabitation of the land area and the damage it may inflict upon land uses. Human-induced erosion/deposition frequently represents an acceleration in the rate of soil movement that cannot be compensated for naturally, thus such erosion/deposition requires abatement.

IMPACT UPON UES STUDY AREA:

■ high impact
[] moderate impact
[] low impact
[] no impact

INTERRELATIONSHIPS' IMPACT

	high	moderate	low	no
climate	■			
hydrology		■		
geology/physiography		■		
vegetation	■			
soils	■			
microclimate		■		
cultural patterns		■		
sand dynamics				

MICROCLIMATE

The microclimate within the Sandhills is highly illustrative of the intrinsic interrelationships existing between the climate of the area and the other physical influences. The limited amount of precipitation is effectively restricted in availability due to the permeability of the sandy soil and the temperature-induced high evapotranspiration (i.e. precipitation that is not readily absorbed by vegetation will quickly percolate through the sand particles or evaporate). The high permeability of the soil also contributes to the loss of available nutrients through the soil horizons due to leaching, especially during downpours. The limited precipitation also inhibits normal chemical reactions associated with the weathering process within soil, thereby decreasing generation of nutritious organic material typically present in the upper layers of the soil. The lack of vegetation also affects the weathering process as only a limited amount of decayable material is available. Vegetation growing within the Sandhills must also be able to anchor its roots within the coarser grains of a sandy environment, as well as existing with limited nutrient availability associated with sandy soil.

Another factor of Sandhill microclimate is the incoming solar radiation which heats the ground, which in turn heats the air directly above it, allowing for substantial heat buildup near the ground surface. This can produce conditions of heat stress for vegetation in the Sandhills. However, as the heated air expands, it rises and produces convection currents which mix the same air, thus providing some relief from the heat stress. Additionally, relief from heat stress may be provided by the previously-noted thin, dry air cooling rapidly after sunset and the wind movement near the ground surface, both of which mix or cool the air.

This same wind movement near the ground surface, although it may cool the vegetation found in the Sandhills study area, can also, with sufficient velocity, uproot plants from the soil. A substantial removal of vegetation from the soil by wind may initiate an erosion-deposition process.

The effect of freezing and thawing has little impact on sandy soil, as sand particles do not appreciably expand or contract due to the inability of the sandy soil to hold moisture. The weathering process is inhibited further owing to this lack of a expansion-contraction factor. The absence of a freeze-thaw characteristic within the Sandhills, however, produces little north-south slope orientation influence. North-south slope orientation influence is also minimal due to the rolling topography. As noted by Choate, et.al. (1981), vegetative species in the Sandhills are more likely to favor slopes due to their windward or leeward face rather than the north-south face. Choate (op.cit) also noted that there are certain plant species which seem to choose specific environs such as lower or higher ground, favoring specific sandy-soil conditions present and the associated moisture retention characteristics.

DATA INVENTORY/IMPACT SHEET
MICROCLIMATE

INVENTORY:

Landform influences -- The landforms present within the Sandhills are relatively lacking in vegetation and slope to significantly affect microclimate.

Weather influences -- Microclimate tends to mirror or enhance weather patterns affecting the Sandhills. Limited precipitation is further limited by the permeability of the soil and the temperature-induced evaporation. Solar radiation, which heats the ground which in turn heats the air above it, is effectively hotter as little vegetation exists to absorb solar rays. Higher wind velocities occur nearer the ground as a result of limited vegetation and this is added to by convection currents created by the increased heat exchange taking place at the ground surface.

Contingency influences -- The soil present reacting with climatic patterns and vegetation creates the most signficant microclimatic effects. The weathering process, which would produce subtle changes in the microclimate, goes on at an extremely slow rate, thus creation of topsoil is negligible.

Interrelationships -- Microclimate is essentially tied to climate and weather patterns, the soils and vegetation present. Cultural patterns which would alter vegetation and natural weather patterns (such as structures altering wind patterns and irrigated vegetative cover) will affect the microclimate.

EVALUATION:

Common microclimate impacts, such as north/south slope influences, the effect of freezing/thawing, and air drainage, are not in effect or significant within the Sandhills. Those microclimate impacts present in the study area are overshadowed by or mirror the impacts of soil, vegetation, and climate.

IMPACT UPON UES STUDY AREA:

[] high impact
■ moderate impact
[] low impact
[] no impact

INTERRELATIONSHIPS' IMPACT

	high	moderate	low	no
climate	■			
hydrology		■		
geology/physiography		■		
vegetation	■			
soils	■			
microclimate				
cultural patterns		■		
sand dynamics		■		

CULTURAL PATTERNS

Cultural land use patterns within the Sandhills and vicinity have generally reflected the agricultural basis of the economy and lifestyle. Prior to white settlement, the area was inhabited by several Indian tribes -- primarily nomadic as they migrated with the buffalo to seasonal range patterns. Subsequent land use involved cattle ranching and farming. Cattle ranching operations, too, required vast acreages for adequate grazing due to the relative unpredictability and sparseness of the vegetation. Farming enterprises were primarily concentrated near the river as irrigated crops yielded a higher return on investment. Sandhill ground, however, remained in rangeland as it could not be successfully irrigated with conventional methods at that time. Nor was it extensively grazed, as better rangeland was still available within the vicinity until farming activity increased and expanded.

From 1878, when Garden City was founded, until the late 1960s, Sandhill land use remained in rangeland with landownership shared among a few individuals (Schaller,1982). Although the Sandhills overlie one of the thickest saturations of aquifer, it was not until technology facilitated deep-well drilling, inexpensive and abundant natural gas, and the center-pivot irrigation system that Sandhill ground was able to be irrigated successfully, and thus, converted to cash-crop production (Bittinger and Green,1979). Throughout the 1970s, many of the large landholdings were purchased and irrigated for cash-crop production.

Available and inexpensive groundwater also served, in part, as an impetus for development within the Sandhills. The burgeoning agricultural economy of the 1970s and its accompanying population growth enhanced the feasibility of utilizing the Sandhills for development. At present two residential developments -- Sagebrush and Southwind -- have been undertaken within the case study area of the Sandhills.

SAGEBRUSH ESTATES. Located one and one-half miles southwest of Garden City, Kansas, Sagebrush Estates is a residential development platted upon 415 acres of Sandhill land. The development is bounded on two sides by the Finney County State Game Refuge, on the north by the Arkansas River, and has convenient access into Garden City via US Highway 83, which is one mile east of the site.

Offering single-family country estate living, Sagebrush Estates made available ninty-eight lots ranging in size from two to seven acres. At present, over half of the lots have been sold and twenty-six homes built. Some of the residents purchased more than one lot, primarily those keeping horses.

Site selection. The development of Sagebrush Estates evolved gradually through a sequence of land purchases made by those persons who would later become the developers. In 1972, the five landowners holding adjacent tracts met to discuss developing their holdings collectively. Concurring, they retained an engineer to lay out the preliminary lotting, roads, and utilities. A contractor was secured to construct the main access road.

The plat for Sagebrush Estates was approved by the Finney County Planning Commission under the condition that all roads within the development be public domain, with Finney County responsible for the future maintenance. The Developers financed the construction of the road layout with Finney County performing the actual work. Within two years all of the roads within Sagebrush received an asphaltic surface.

Each landowner is responsible for selling the lots within his holdings. Two of the original landowners have since sold their interests to other parties with basic agreements remaining in effect.

Protective Covenants and Restrictions. Purchasers of lots within Sagebrush Estates are subject to the Protective Covenants and Restrictions as set forth by the Developers. The Sagebrush Covenants are intended to: 1) preserve the aesthetic appearance of the Sandhills as much as possible; 2) insure the best and most appropriate use of each building site; and 3) protect other residents from improper or poorly developed building sites.

The Covenants restrict the construction of a dwelling to lots of two acres or more. This condition, according to Mr. Hooper (1983), is in response to a State of Kansas requirement that individual septic tank systems be provided a 2 to 2.5 acre minimum area in which to operate. Also, this minimum acreage promotes the estate-type living of the design intent of the Development.

Dwelling types may be of only the single-family character, and shall not exceed two stories in height. Selected secondary buildings, such as livestock barns or small storage buildings, are allowed provided they are constucted of new material and comply with other applicable covenants. Trailers, mobile homes or temporary structures are prohibited.

Structures may not be located within twenty-five feet of a property line.

Refuse must be placed in suitable containers within a walled space and not allowed to accumulate excessively. Disposal of refuse is the responsibility of the lot owner and must be taken care of in an acceptable sanitary manner. Incineration and open burning of any type is forbidden within the Development.

Riding horses and show cattle are allowed, but are limited to one animal per two acres of ownership -- this minimum acreage being insufficient to pasture-feed said animals, however.

Exterior dwelling construction must be completed within one year from the date upon which construction begins. A Finney County Health Department approved septic tank or other approved sanitary system must be functioning prior to occupancy.

Lots may be landscaped or left in native vegetation. Control of noxious weeds is required of the owner.

Dwellings must be properly maintained and arranged such that they enhance the appearance of the lot.

Utility placement is restricted to underground and owners must observe the attending easements designated for each utility type.

The Covenants create an Architectural Committee consisting of three to five persons (presently the Developers) to oversee the enforcement of the Covenants and to provide written approval of construction plans and specifications as required by the Covenants. Additionally, the Committee may form or cause to be formed a Homeowners' Association, to which all powers and authority of the Committee may be transferred. Upon taking title to a lot(s) within Sagebrush Estates, the owner will automatically receive membership in the Homeowners' Association. To date, a Homeowners' Association has not been organized.

The Architectural Committee does not make recommendations regarding building procedures, as this is left up to the individual lot owners and their builders. Additionally, the Covenants make no specific provision regarding time limitations on soil left exposed due to construction. However, Mr. Hooper explained that individual lot owners usually address erosion problems in a relatively short amount of time for their own benefit. Further, Mr. Hooper reported insignificant erosion problems within Sagebrush Estates due to the retention of native vegetation throughout most of the Development.

The Covenants run with the land and are binding upon all parties having title or interest in lots within Sagebrush Estates.

Utilities. Secured utilities within Sagebrush Estates are provided by Wheatland Electric, Inc.; Southwestern Bell; and Peoples Natural Gas, Inc.. Construction of sanitary sewer facilities are the responsibility of the individual lot owner, but each must have written appoval of such a facility from the Finney Count Health Department and the Architectural Committee. Domestic water supply is also the responsibility of the individual lot owner. Each must receive written approval from the Health Department and Architectural Committee regarding water wells and lines, which insures that placement of water and sanitary sewer facilities do not conflict. Water wells within the Development must penetrate a hard rock layer beneath the surface, this layer providing adequate separation between the sanitary facilities and the water source. The lot owner may drill an individual water well, or may share in the procurement of a well with a neighbor.

Open space. Approximately thirty-two acres of common or open space exists within Sagebrush Estates as one of six designated Parks. Most of this acreage lies in areas considered undesireable for construction of homes, and at present is retained in native vegetation. No immediate plans to develop these Park areas for recreation exist.

Information on Sagebrush Estates is taken from the brochure, "SAGEBRUSH ESTATES - for the Finest in Country Living", and from an interview with Edwin S. Hooper -- Developer and homeowner/Sagebrush Estates -- 15 September 1983.

SOUTHWIND. Southwind, a planned unit development, comprises approximately 1200 acres of Sandhill land located three miles south of Garden City, Kansas and is adjacent to US Highway 83 and its bypass.

Presently being developed are lots and sites designated under Phase One of the Master Plan. This Phase offers one area for office and service businesses, 96 single-family lots, 36 two-family townhouse sites, and 4 three-family townhouse sites -- many of which encircle the Southwind Country Club and its eighteen-hole golf course. The majority of lots and sites in Phase One range in size from one-half to two acres, with "equestrian lots" available that are two to almost five acres in size. To date, seven single-family lots are occupied or under construction and 26 multi-family units have been completed.

Southwind Development Company plans to develop Southwind gradually over a twenty- to thirty-year period, offering a combination of single- and multi-family housing options, along with light commercial businesses, office space, apartments, school facilities, and an executive golf course. Long range plans may also include a hotel facility, light industrial sites and an airstrip.

Site selection. The developer, Earl C. Brookover, Sr., purchased the sandhill site in 1975 with residential development in mind. Although ample groundwater exists beneath the Southwind site, Mr. Brookover was reluctant to commit this land to farming due to the quantities of groundwater such an operation would require over the years. The site has excellent vehicular access into Garden City by way of US Highway 83 and its recently completed Bypass.

Utilities. At the inception of Southwind, it was anticipated that domestic water supplies would be supplied to Garden City from a Southwind well at a prescribed cost. In exchange, Garden City would build and maintain and operate Southwind's water system. Although this concept is, in part, still under consideration, the Developers have proceeded to install a central water system without Garden City involvement. A second water well will soon be put into operation with a groundwater storage facility to be built on-site in the near future.

Facilities for **sanitary sewer** are handled in two ways. Upon taking title to a single-family lot, the Purchaser has agreed to construct a septic tank on the lot in accordance with Kansas Department of Health and Environment standards and with written approval of septic tank plans and construction from the Southwind Architectural Control Committee. The multi-family units are connected to a sanitary sewer system built and maintained by the Development. As the population of the development grows, the Master Plan calls for the construction of polishing ponds, with that water designated for reuse on the Southwind Country Club golf course.

The original layout and grading of the **streets** within the Development was completed by Southwind Development Company. Streets were paved with asphalt or, in the interim, with an all-weather clay surface. All streets are to be asphalt-paved by Southwind Development Company, although the Company reserves the right to postpone paving until a sufficient number of residences have been completed along a street such that the street will not be overly damaged by construction equipment. Through a joint agreement with Finney County, the Developer pays for paving materials and labor and the County supplies the labor and equipment to construct an asphaltic surface. As Finney County requires that the streets within Southwind be public domain, the County is responsible for further maintenance.

Structure design. Home and site design are at the discretion of the individual lot purchaser, although all construction requires written approval from the Southwind Architectural Control

Committee. This committee includes two of the developers and an architect retained by Southwind Development Company. The following information is required for review: a site plan, a floor plan, building elevations, the color scheme and intended materials of the structure, a grading plan, erosion control procedures, and a landscape plan. All of the above information must conform to the Covenants, Conditions and Restrictions applicable to the lot purchased. Individual multi-family developments will, in addition, have separate covenants with which they must comply.

Southwind Development Company encourages custom-building in preference to speculation homes. The developers have, however, given one contractor, Fairway Homes, Inc., an exclusive on the initial multi-family unit development.

Construction methods. Southwind Development Company does not outline construction procedures for a homebuilder other than as specified within the Covenants. The Southwind Homeowners' Association monitors sites under construction for erosion control and compliance with covenants.

Construction methods particular to sandhill land, as described by Mr. Terry Middleton (1983) of Fairway Homes, Inc., require construction techniques beyond that encountered in normal soil conditions.

Mr. Middleton (op.cit.) indicates that in initiating construction, vegetative cover and topsoil is stripped but not stockpiled, as would normally be the procedure. As the sandhills generally show little discernible soil profile and separating the vegetation from the topsoil would be difficult, returning the thin band of topsoil to the area is deemed infeasible. Further, having vegetation fragments within the fill dirt is also considered undesirable. Therefore, this stripped topsoil is buried in another location, on-site, where construction will not take place.

Both slab and basement construction are present within Southwind. The procedure for either, as recommended by Mr. Middleton (op.cit.), is to excavate the foundation and water flood (water pack) the excavated area for compaction. Water flooding and simultaneous utilization of a vibrator-compactor, is the only compaction method considered effective by Mr. Middleton for this sandy soil. Prior to the pouring of concrete, the soil is wetted down, forms are set, and visqueen is applied where concrete would come into contact with the soil, thus preventing the water within the concrete mixture from being absorbed by the highly permeable sandy soil. Another requirement of pouring concrete in this sandy situation prompted Southwind Development Company to purchase a concrete pumper truck to aid in the pouring of concrete. A full concrete truck cannot get close enough to the 'area-to-be-poured' to use the attached chute without getting stuck in the sand or causing the dig to collapse (due to the weight of the loaded truck). Thus, the pumper truck acts as an intermediary.

When a majority of the earthwork has been completed and the site has been rough-graded, a manure spreader is brought in to lay a solid cover of manure over the disturbed soil surface. Mr. Middleton (op.cit) indicated that this erosion control procedure usually occurs within forty-five days of the initiation of the construction.

Trenching operations, according to Mr. Middleton (op.cit.), require the use of a backhoe with slopers attached to the bucket so as to create a V-shaped ditch. In addition, the trench must be dug twice as wide as it is deep (e.g. 3' depth requires 6' width). Utilizing braces within the trench is usually not necessary if the operation is done relatively quickly.

Curb and gutter is impractical along streets within the Southwind Development. Mr. Middleton (op.cit.) explained that the sandy soil, although highly permeable, will gulley or erode if exposed to concentrated water flow. Such erosion takes with it vegetation as well as soil. Thus, sheet draining is required to allow the runoff to spread.

Finally, Mr. Middleton (op.cit) observed that it is important to lay sod as soon as possible upon the site where construction has just been completed to control wind erosion. Bluegrass sod has previously been utilized around the multi-family units. Other types of grass that are easier to maintain in the summer months are being investigated for use in the future.

<u>Southwind Covenants, Conditions and Restrictions</u>. All lots and sites within Southwind are subject to the provisions of the Southwind Covenants, Conditions and Restrictions as amended. These Covenants are set forth to provide for continuing maintenance of Southwind and for preservation of the rights of the property owners and residents. In addition, purchasers of any property within Southwind are required to become members of

the Southwind Homeowners' Association, established to fulfill the responsibilities as designated within the Covenants, including the management and maintenance of "Common or Open Space"; the setting and collection of assessments; the appointment of an Architectural Control Committee; and to promote the health, safety and welfare of the residents. The Associations are empowered with legal means to enforce their purpose by filing a property lien in response to nonpayment or noncompliance.

The Southwind Covenants, Conditions and Restrictions run with the land and are binding upon all parties having title or interest in property within the Development.

The Southwind Covenants, Conditions and Restrictions address, in part, the unique and ecologically-sensitive qualities of the Sandhills by directing actions intended to minimize the liabilities of the area and enhance the assets. For example, during any construction, soil in a disturbed condition must be mulched immediately. Land area with undisturbed native or other desirable vegetation must be protected from vehicular traffic. Further, there is provision for time limitations to be set upon completion of construction. Areas under construction are monitored by the Architectural Control Committee, which retains the right of inspection of any construction activity within the Development. Should this Committee determine that the requirements of the Covenants are not being met, legal notice and proceedings may be initiated (e.g. having an exposed soil mulched and assessing the lot owner the expense of this action).

Vehicular traffic is restricted to constructed roadways. The use of fireworks and firearms is prohibited. Grasses and weeds are to be kept mowed to a height of six inches or less -- with the exception of native vegetation. Weeds and control of such are considered as per KSA 2-1314.

The Covenants require that the structure and its surrounding property be maintained and kept in such condition as is intended by the Covenants. For single-family lots this includes, but is not limited to, the establishment and maintenance of lawn areas with a specified minimum of accompanying trees and shrubs (which require approval from the Architectural Control Committee). Within the multi-family developments, landscaping and maintenance is the responsibility of the attending Townhouse Owners' Association and is managed by them or their agent.

Included within the Covenants are those restricting land use to the specified designation (i.e. residential, common, or commercial), which must also conform with the Garden City-Holcomb-Finney County Zoning Ordinances and Subdivision Regulations. Structures to be built must comply with the applicable restrictions and written approval from the Southwind Architectural Control Committee must be given prior to initiation of construction.

Use of common or open space within Southwind is under the jurisdiction of the Owners' Associations (who are responsible for the selection and management of open space use). These uses must comply with applicable ordinances or restrictions. Presently, the majority of the open space is retained in native vegetation.

Information on Southwind Development is taken from documents filed with the Kansas Security and Exchange Commission in compliance with the Uniform Land Sale Practices Act; from interviews with Ross Thornbrugh -- partner Southwind Development Company -- on 29 August 1983, 2 September 1983, and 14 September 1983; and from interviews with Terry Middleton -- Fairway Homes, Inc. -- on 13 September 1983 and 21 September 1983.

DATA INVENTORY/IMPACT SHEET
CULTURAL PATTERNS

INVENTORY:

Past land use -- The Sandhills were primarily utilized for livestock grazing, as this micro-environment could not be successfully farmed. Use for grazing increased as surrounding land was consumed for cultivated crop production. An attempt in the early 1900s to establish a forested area within the Sandhills proved unsatisfactory. A portion of this unsuccessful-forested land area was maintained as the Finney County State Game Refuge.

Contemporary land use -- The Finney County State Game Refuge encompasses approximately four sections of land within the study area and is primarily maintained as a natural grazing area for a small herd of buffalo. Technological capabilities facilitated irrigation of the Sandhills and over the last decade have increasingly been converted to cultivated crop production. There is still a portion of the rangeland privately maintained within the Sandhills. The most recently introduced land use has been residential development.

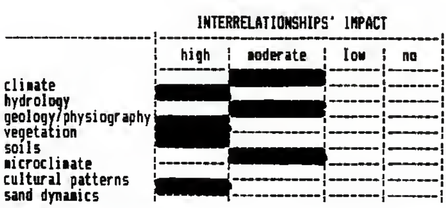
Interrelationships -- Contemporary cultural land uses within the Sandhills are linked with available groundwater. While these land uses effectively impact the soils and vegetation of the Sandhills, they are not appreciably affected by soils and vegetation as perhaps they should be -- that is, soils and vegetaion do not outwardly keep development from occurring, nor do they appear to influence development implementation methods. Technological capabilities can initially circumvent soil impact.

EVALUATION:

Past cultural patterns reflected the uniqueness and ecological-sensitivity of the Sandhills through land uses which primarily yeilded to the dictates of the environment. Recent cultural patterns are not as restrained by environmental effects due to technological capabilities facilitating land uses formerly considered infeasible or undesirable. The most significant natural influence controlling cultural patterns is hydrology and the availability of groundwater. When groundwater is depleted or becomes economically infeasible to secure, it may be assumed that the contemporary land uses will change, and a significant portion will revert to past land uses.

IMPACT UPON UES STUDY AREA:

■ high impact
[] moderate impact
[] low impact
[] no impact



ENVIRONMENTAL SUMMARY AND EVALUATION

In reviewing the character of the Sandhills, it is apparent that all of the elements or influences cited (climate, geology/physiography, hydrology, vegetation, soils, sand dynamics and microclimate) form a network of interrelationships and each plays an integral part in the state of the micro-environment as a whole. Given these interrelationships between influences, it is reasonable to assume that forces acting upon one element will affect another element or a combination thereof. Additionally, it can be assumed that certain elements are more likely to be affected.

Geologic and climatic forces can be considered the most formidable of influences in the creation of the Sandhills. Although ongoing, their influence is largely perceived in retrospect, and in the context of their effective timetable are less likely to affect noticeable modifications in the present Sandhill character. Likewise, they are unlikely to be affected by anything but extended or massive alterations.

Consideration of climate on a more limited scale (e.g. measureable changes and anticipated seasonal patterns) reveals a greater contemporary influence. Most pronounced would be the effects on the Sandhill character by the limited precipitation and the presence of periodic high or sustained wind velocities.

As noted previously, the low annual precipitation restricts the vegetative species able to exist in this environment.

Considering wind effect, it can be expected that with the vegetation in an arrested state, more ground area will be open to wind erosion should sufficient wind velocities materialize. Vegetation in the Sandhills, in general, is capable of handling all but the most severe climatic extremes. Some species may submit, while others survive seasonal patterns. There is a point where climatic conditions tax the adaptive abilities of the majority of species, and create situations where surviving species initiate monocultures and thereby restrict the ability of other species to renew themselves when favorable conditions return (as was evident during the "dust bowl" period of the 1930s and the drought years of the 1950s).

The wind can be a current problem in the Sandhills, even with a cover crop. Erosion and blowouts may occur. Mark Sexson, an official with the Kansas Fish and Game, noted (1982) that an eighty mile-per-hour wind associated with a storm in the early spring of 1982 eroded parts of the Finney County State Game Refuge, which may be said to be in better condition than most of the range areas within the Sandhills, as it supports a large diversity of vegetation, supports a limited number of buffalo, and is not grazed for profit.

Blowouts are controlled by partial stabilization with vegetation, thus in instances of well-anchored, healthy and diverse plant types, blowouts are less likely to occur. Once an area becomes vegetatively weak and is affected by wind work, sustained wind conditions may start a chain reaction of erosion and deposition actions, which may encroach upon areas of even stabilized plants. To mitigate this possiblity, vegetative cover, preferably adaptable native plant material, should be maintained wherever possible. Subseqent to a drought, Waldorf (1982) cited a two-year natural recovery time for the Sandhills. The time element needed to artificially reestablish native plant material can involve three to ten years, depending upon climatic conditions during that time (Waldorf,1982).

Weather data collected by the Garden City Experiment Station [see Appendix A] revealed an overall decrease in wind velocities since 1915. No reason for this decrease is given. Relatively recent instances of high velocity winds noted in the Experiment Station records however justify a cautious attitude toward the potential of wind to undermine the vegetative stability within the Sandhills.

Waldorf (1982) indicated that in general the wind is not harmful to vegetation unless it is moving the sand. Even with the more moderate wind velocities found to exist presently, there still exists the potential for impact. Inhibition of soil structure development is possible as the smaller soil particles that would aid in creation of an A Horizon will yield quicker to lesser wind velocities and be carried aloft. Also, according to the wind mechanics, as described by Bagnold (1941), this movement of the smaller grains can initiate the saltation process. Initiation of particle movement can be damaging to vegetation by abrading the foliage, removing soil from around the roots, or burying a plant.

The soils of the Sandhills are relatively unstable due to the granular structure of the soils, which is incohesive and susceptible to erosion. Additionally, the arrested state of the weathering process, in which no distinct A Horizon of topsoil is likely to exist for an indeterminable period, make the soil unstable and limits the independence of vegetative species. Native vegetation may be the greatest barometer of conditions within the Sandhills as it reflects the low precipitation rates and incidence of effective wind velocities which also make the soil unstable.

Hydrology is affected by high temperatures, high evapotranspiration rates, precipitation rates, and the high permeability of the soil, which in turn limits water availability to vegetation. A greater effect on the hydrology is the result of usage patterns. The status of groundwater in the Sandhills will in the future likely affect the land usage patterns.

From data presented within this investigation it appears that soil and climatic conditions are the controlling influences of the ecological-sensitivity of the Sandhills, with vegetation, the dynamics of the sandy soil, and hydrology the most likely to be affected. Climate, soils, and vegetation are so closely tied, however, that it may be moot to isolate one element over the other as being more influential. Of the three influences, vegetation is the most accessible in terms of human intervention to stabilize the environmental equilibrium of the case study area. Soils can be amended to a certain extent, and attempts to alter weather have been attempted, although the success of the attempts is undetermined.

COMPREHENSIVE EVALUATION

EVALUATION OF MICRO-ENVIRONMENT UNIQUENESS AND/OR ECOLOGICAL-SENSITIVITY:

The interacting effect of climate, soils and vegetation creates most significantly the uniqueness and ecological-sensitivity of the Sandhill study area. Forces acting upon one element will impact the status of the other two. Climate appears to be the most controlling natural influence in the status of ecological-sensitivity, however, climate is relatively inaccessible to management tools. While soils may be amended to a certain extent, vegetation is the most accessible in terms of human intervention to stabilize the environmental equilibrium within the case study area. The hydrology, more specifically the availability of groundwater is the most controlling influence over land use. Land use may also be considered a controlling influence in the status of ecological-sensitivity of the Sandhills and its impact can be far-reaching if the effect of climate, soils and vegetation are ignored.

DEGREE OF UNIQUENESS AND/OR ECOLOGICAL-SENSITIVITY:

■ high
[] moderate
[] low

MANAGEMENT NEEDS:

Significant effort should be taken to prevent and/or abate wind erosion and deposition by:

a. recognizing and delineating the specific boundaries of the Sandhills UES area;

b. maintaining, as much as possible, the native vegetative cover, including its diversity of species and various stages of succession, thereby addressing the problem without undue technological control and retaining the capability of the vegetation itself to handle extreme conditions;

c. reducing human-induced erosion/deposition so as to retain as much as possible the natural rate of soil movement;

d. leaving soil, exposed as a result of development, bare for the shortest amount of time reasonably possible;

e. applying temporary mulch or groundcover to areas of development under construction and bare of vegetation;

f. developing large tracts in small workable units that can be completed in reasonably short amounts of time;

g. keeping earthwork and its limits of grading at a minimum and removing vegetative cover only within these limits;

h. establishing reseeding programs to address areas where vegetative cover has been removed for construction or areas of moving sand within the development;

i. maintaining the aquifer recharge area or the recharge rate at a level comensurate with the natural recharge rate;

j. maintaining the natural drainage patterns to avoid erosion by water (drainage patterns does not imply only surface drainage such as streams);

k. monitoring the impacts of development and individual development methods over time, and the cumulative effects of all developments within the Sandhills;

l. support research, development and use of quick or temporary groundcovers or stabilizers for areas where vegetation is lacking or has been removed for construction;

m. support research, development and use of construction methods which are found to be acceptable techniques least likely to cause irrevocable or harmful damage to the Sandhill environment; and

n. limiting vehicular traffic to established and paved surfaces near the major highway (US 83).

DEGREE OF DEVELOPMENT ALLOWANCE:

[] no development (maintain undisturbed)
■ limited development (density/implementation methods)
[] unlimited development

IN-PLACE ZONING ORDINANCE INVENTORY AND EVALUATION

INVENTORY

The zoning ordinance now in effect for Finney County, Kansas and the three-mile zone surrounding Garden City, Kansas as adopted in 1974 [Appendix B] has been inventoried for inclusion of those applicable components established in Table 3.7. The applicable components were 1) flexible zoning techniques (namely PUD, overlay zones, special permits, conditional zoning, incentive zoning, subdivision exactions, and TDRs) and 2) performance standards.

PLANNED UNIT DEVELOPMENT

The only flexible technique noted in the Finney County Zoning Ordinace is the designation "Planned Group Development", Article 18. PGD most nearly coincides with established descriptions of Planned Unit Development, although it includes certain requirements or standards not characteristic of a typical PUD provision.

"Planned Group Developments" [PGD] are allowed on, "...any contiguous plot of land of not less than five (5) acres, unless expressly permitted by the Planning Commission (p.67)." PGDs are allowed within any of the pre-established residential, service, business, and industrial districts, however a mixture of these uses is not encouraged or permitted for certain district designations. "Where an area of fifty (50) acres or more is

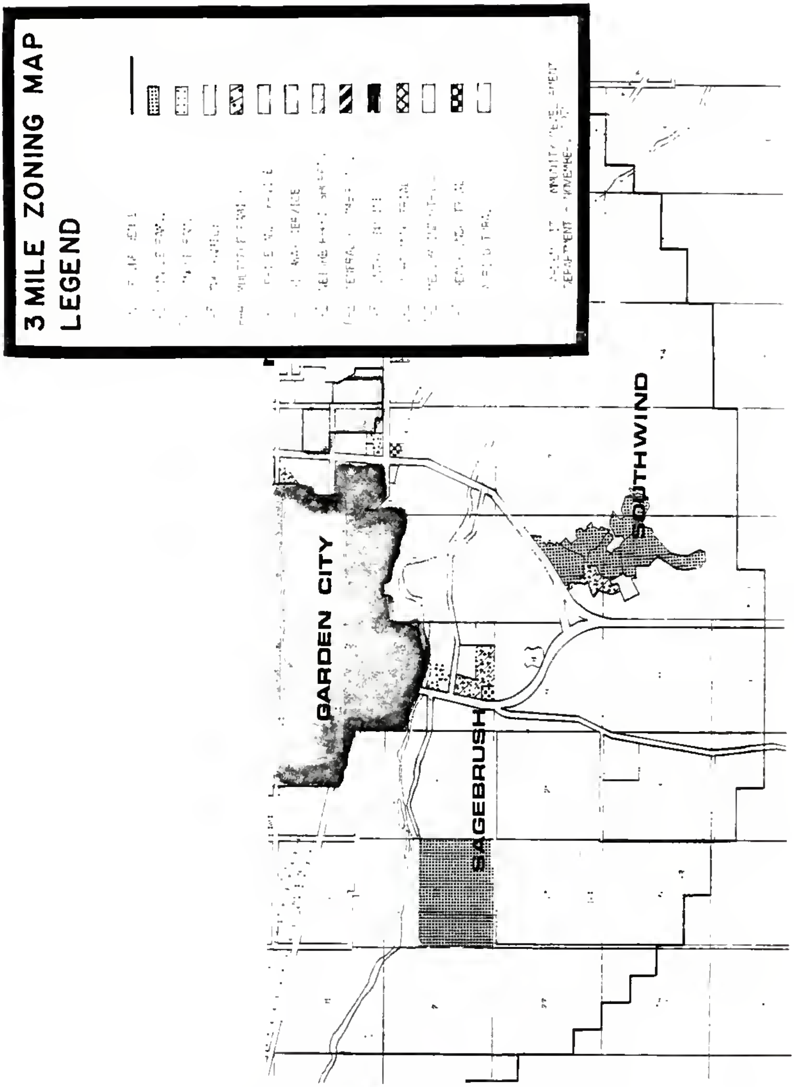


Figure 4.11.
THREE-MILE ZONING MAP -- FINNEY COUNTY

being developed in the R-1 [single-family dwelling] through R-3 [two-family dwelling] districts, a maximum of twenty (20) percent of the dwellings may be multiple dwellings, however, in no case shall there be more than four (4) dwelling units per building (p.67)." PGDs in the C-O [office and service business] and C-S [highway service] districts permit motel facilities, however, "business uses are allowed only if they are designed and used for the purpose of serving the planned group development and are a permitted accessory use within the C-O or C-S district (p.68)." Residential uses within PGDs in C-1 [neighborhood shopping], C-2 [general commercial], and C-3 [central shopping] districts, "...only if they can be shown to be an integral part of the development and such uses will meet the requirements of the residential uses normally allowed in the C-1,C-2, or C-3 districts (p.67)." Residential uses are not alllowed within an industrial PGD.

Minimum lot areas and lot frontages for single-family dwelling lots within R-1 through R-3 PGDs are delineated by the Article requiring that they should, "...not be less than two-thirds (2/3) of the normal minimum lot area and minimum lot frontage of the single-family district in which the lot is located (p.67)." Requirements as to lot sizing, lot coverage, and signage are delineated within the Industrial section of the Article.

A preliminary plan (both graphic and textual) of the proposed PGD is required by the Article, as is a public hearing wherein, "...the Planning Commission shall approve or disapprove the preliminary plan according to requirements established in this Article, but may impose additional requirements deemed reasonable and necessary (p.70)." Following approval of the preliminary plan, "...the applicant shall plat the land according to the Subdivision Regulations, however the approved preliminary plan shall be considered to be the approved preliminary subdivision plat. Therefore, the platting process shall commence with the submission of a final subdivision plat (p.70)." The final plan (both textual and graphic) is submitted along with a written guarantee for completion of the PGD within a specified time period not exceeding five years.

The preliminary plan is submitted to the Health, Fire, Water, and Engineering Departments, the Building Inspector, all Public Utilities, and the School Board for review, with reports from each agency considered by the Planning Commission before approval.

The Article states that, "the proposed development shall be designed to produce an environment of stable and desirable character not out of harmony with its surrounding neighborhood, and shall not conflict with the Comprehensive Plan or any parts thereof (p.71)." The Article also states that, "buildings with a residential, or office and institutional, planned group development may be relieved of district Zoning Regulations concerning yard size, setback, height, bulk, and other plot requirements where such requirements interfere with the overall development. However, the buildings at the perimeter of such development must maintain the requirements as established for the district (p.71)." Requirements pertaining to off-street parking, off-street loading, and signage are to be in accordance with the established articles concerning these issues.

Upon approval of the final plan by the Planning Commission, the applicant is issued a zoning permit by the Zoning Administrator. Building permit variances may be granted relative to location and gross floor area of individual buildings upon review and approval of the variance by the Planning Commission. "If the planned group development plan requires an amendment because the requested variance is deemed unreasonable by the Planning Commission, then the applicant shall proceed in the same manner established for the application of a permit for Planned Group Development (p.73)."

EVALUATION

The "Planned Group Development" provision is the only flexible technique noted within the Finney County Zoning Ordinance. In itself, the PGD provision shows some flexibility in typical zoning requirements, however, the standards for minimum lot areas and frontages reveal a significant adherence to traditional lot-by-lot zoning requirements, as does the discouragement or prohibition of mixed uses within a PGD. This lack of flexibility may be due to the status of zoning at the time the Ordinance was adopted or the status of housing needs and demands at that time.

There is no specified negotiation process between developer and Planning Commission delineated within this Article, thus it may be assumed that innovative design techniques not in compliance with designated requirements would not be considered. These innovative design techniques may be developed at any time and it would be unreasonable to expect zoning ordinances to be rewritten or amended for each technique. There should be a method incorporated into the zoning ordinance for considering each project at the time it is proposed. There is facility for case-by-case evaluation within the Article, although development factors such as timing, composition, location, and design relative to the management needs of the site do not appear to be provided for.

There exists no reference to special management needs of the Sandhills within the Article, nor is the Sandhill area singled out. Residential development within the Sandhills commenced in 1972, however the lag time between drafting of the zoning ordinance and adoption may have prevented considerations particular to Sandhill development from being included.

The lack of recognition of the uniqueness and ecological-sensitivity of the Sandhills may, in part, be attributed to the lack of performance standards regarding development within the study area. Again, the time period at which the ordinance was adopted may have prevented their inclusion.

Relative to the Sandhill study area, the flexible technique, PGD, is lacking in flexibility and consideration of significant development factors. The facility for case-by-case evaluation could be improved to include a negotiation process. The PGD Article does not provide meaningful direction to potential developers in the Sandhills.

IN-PLACE ZONING ORDINANCE
DATA INVENTORY/EVALUATION SHEET

INVENTORY:

Applicable zoning ordinance components present -- The only flexible technique noted within the Finney County Zoning Ordinance (1974) is the designation **"Planned Group Development"**. Provision for "Planned Group Development" (PGD) is made in Article 18 of the Ordinance and most nearly resembles established descriptions of PUD, although PGD includes certain requirements which distinguish it from being viewed as a typical PUD, such as references to traditional lot-by-lot type requirements and discouragement of mixed-use projects.

Characteristics -- PGD is allowed in all residential, service, business, and industrial districts, although a mixture of these uses is not encouraged or permitted within certain classifications. Minimum lot areas and lot frontages are delineated, although requirements pertaining to setback, yard size, height and bulk, may be relieved when they "interfere" with overall development except around development perimeters. PGD plan proposals must pass preliminary plan, public hearing, and final plan approval by the Planning Commission. Proposed PGDs must be designed to produce a stable environment in of harmony with adjacent neighborhoods, and shall not conflict with the Comprehensive Plan.

EVALUATION:

The PGD provision retains some of the characteristic traditional zoning requirements. This, along with the discouragement or prohibition of a mixture of use types, partially inhibits the flexibility that development within the Sandhills may require. There appears to be lacking a negotiation process or facility ofr consideration of innovative design techniques that might be proposed which are not in compliance with established requirements. Nor do development factors such as timing, composition, location, and design relative to the management needs of the site appear to be provided for. There exists, however, the facility for case-by-case evaluation, although this evaluation does not imply anything other that review for compliance with existing requirements. The PGD provision does not recognize the existence of the Sandhills or its special management needs, thus, performance standards regarding development within the Sandhills have not been established. The PGD Article does not appear to provide meaningful direction to potential developers within the Sandhills.

APPLICABLE COMPONENTS PRESENT - CHARACTERISTICS:

	lacking	acceptable	effective
flexibility	■		
case-by-case evaluation		■	
important development factors	■		

PRESENT COMPONENT APPLICABILITY:

[] high
[] moderate
■ low
[] no

RECOMMENDATIONS

Although a variation of the PUD flexible technique may be found within the Finney County Zoning Ordinance, revisions and additions to the Ordinance will increase ordinance effectiveness, both in terms of mitigating environmental impact and providing for development. Possible adjustments in the present ordinance would include the following:

RECOGNITION

It has been established that recognition of the UES is a first and major priority. Without expressed recognition of the Sandhills as a special environment with special needs the basis for all subsequent planning, regulation and policy is inconsequential. The managment needs of the Sandhills should be acknowledged and the objectives and criteria of land use within the Sandhills should be addressed in the Comprehensive Plan to provide for consistency and to substantiate future land use decisions, and to avoid charges of indiscriminate grants of favoritism.

FLEXIBLE TECHNIQUES

Flexible zoning techniques individually offer flexibility to both developer and authorities in addressing the needs of the UES area. Traditional zoning methods are unequipped to address the environmental conditions existing in the Sandhill study area. Implementation of well-thought-out and researched flexible techniques that address the management needs of the site, the planning and policy needs of the authorities, and the feasibility needs of developers are of mutual benefit to all.

An **Overlay Zone** designating the Sandhill area as a "Special District is recommended as an addition to the Ordinance. This Special District should be delineated in textual form within the Ordinance and graphically on the Official Zoning Map. Within this Special District development would be subject to supplemental performance standards based upon pre-established and specific criteria concerning management needs of the Sandhills.

It is further recommended that **Planned Unit Development** techniques be considered, allowing the opportunity for cluster or mixed density housing can mean fewer streets, larger areas of open space, shorter utility lines, less area of earthwork, and thus, less disturbance of vegetative cover or need for reestablishing vegetation after construction is completed. A PUD provision that allows for discussion or negotiation between developer, authorities, and citizens concerning development in the Sandhill area is more conducive to innovative design solutions being proposed which may facilitate development implementation without undue negative impact. Individual site plan review should allow a developer to prove that a proposed unconventional development technique or land use will not be detrimental to the Sandhills, or that the proposed project addresses all of the environmental management concerns set forth within the management needs and performance standards. A PUD provision that recognizes the phased-development of most larger projects can interject modification clauses which enable a developer or authorities to propose design revisions within the master plan in-tune with changing development needs, the market, or adjustments in planning policy found to be detrimental to the Sandhills by the authorities themselves, by the developer, or by another party.

Other flexible techniques including special permits, conditional zoning, incentive zoning, subdivision exactions, TDRs, and impact zoning -- or elements thereof may be found to be beneficial or complimentary to the the initial provision of the Overlay Zone and revised PUD recommendations.

PERFORMANCE STANDARDS

Performance standards can establish and spell out the environmental objectives and functions deemed necessary for preservation of a stable ecological equilibrium within the Sandhills. These performance standards are paramount to the success of the Overlay Zone and PUD provisions previously suggested. Performance standards are concerned with the results of development not the type or method of development. Performance standards will allow for innovative or unconventional land uses, design, or implementation techniques within the Sandhill area, provided stated management needs are met.

The management needs delineated in the environmental evaluation should be considered the initial step in determining the performance standards that will address Sandhill development. Planning authorities should encourage or commission landscape architects, planners, environmental specialists (e.g. vegetation, soils, hydrology), developers, and contractors who have already had experience in the Sandhills to participate in the drafting of the performance standards. Each has a personal expertise to contribute and representative participation of each concern should insure accuracy and reasonablness in the adopted performance standards.

Performance standards, where possible, should be quantitatively measurable. For example, the Soil Conservation Service's Soil Loss Equation enables a quantitative figure to be associated with wind and water erosion. The standards should not just reflect the normal environmental conditions, but also the extreme, especially since the extreme is likely to be the basis for management. For environmental concerns that are not quantifiable, the performance standards should make a clear statement of the desired result. Developers should have a clear, up-front understanding of what is expected of projects implemented within the Sandhills.

Finally, performance standards should consider and apply to development being implemented and the finished product. Performance standards should run with the land.

NEGOTIATION

Negotiation between developers and authorities can have a positive effect on the development process. It allows developers the opportunity to propose innovative or unconventional design proposals, and allows authorities the opportunity to determine deficiences or scrutinize each new proposal individually. The opportunity exists for successful compromise between the developer and the authorities, to the mutual benefit of both.

The negotiation process, however, may have negative consequences if an adversary relationship arises between the parties. Discretionary zoning techniques, of which flexible techniques are an example, may interject "unpredictability" into the evaluation of a project proposal. However these negative aspects of negotiation can be mitigated if: 1) the intent of the special zoning is clearly described in advance; 2) if performance standards are clear and reasonable; 3) negotiation and evaluations of development proposals are not unnecessarily delayed so as to cost the developer time, money, or marketability; 4) superficial amendments (amenities) to the proposal are not requested; and 5) if developers present reasonable proposals that consider and implement the objectives of the special zoning -- i.e. the management needs of the Sandhills.

COORDINATION

An effort should be made to coordinate the flexible techniques and performance standards with other related controls to ease enforcement, avoid contridictions and/or repetitiveness, and ease access and comprehension by developers. Regulations and standards regarding ancillary issues (health, fire, building codes), groundwater management districts, soil conservation, and other corresponding state or federal legislation should be addressed in the drafting of the special zoning. Subdivision regulations should not be contradictory to the special zoning. The facility should be established for carrying over the "Special District" Overlay Zone designated at the county level to the city should any portion of the Sandhill study area area be annexed at some future date. Covenants drafted by developers should include and reflect the established performance standards.

MONITORING AND PERIODIC REASSESSMENT

The environmental stability of the Sandhills should be monitored and periodically reassessed for changes and impacts. Likewise, the capability to monitor development in the Sandhills should be established so as to insure that performance standards and special zoning features are being complied with and are successfully accomplishing the stated objectives of the Comprehensive Plan.

The workability and success of the special zoning and performance standards should be monitored, recorded on a regualar basis, and periodically assessed. Reassessment should not hinge on political decisions.

CHAPTER FIVE
CONCLUSIONS

The purpose of this study was to investigate the applicability and effectiveness of zoning ordinances in regard to managing UES micro-environments. In the process of this investigation, a methodology was developed by which the management needs of a UES area could be identified and coordinated with in-place or proposed zoning ordinance policy.

IMPLICATIONS OF THE RESULTS

Application of the developed methodology to a site-specific UES micro-environment, both as a test of the methodology and a demonstration of its use, yeilded several conclusions. Those being:

a. Two contempory zoning ordinance components (i.e. flexible techniques and performance standards) were found to be an applicable and potentially effective management tool for UES micro-environments. This is due primarily to their flexibility in application, capacity for considering environmental needs, promotion of innovative and creative design approaches, and orientation toward "results" of land use development rather than to land use itself. Inclusion of the two components within the ordinance also make it possible to manage UES areas without having to predict future development within the UES boundaries.

b. The management needs of a specific UES area can be interpreted from the results of a systematic environmental analysis of specific data base components and their interrelationships. Once identified, these management needs can then be addressed through performance standards formulated specifically for the subject UES.

c. The success of utilizing flexible techniques and performance standards to manage UES areas is highly dependent upon a committment by the authorites responsible for enforcement of zoning ordinance policies. Their recognition of the UES area within their jurisdiction, its needs and the enforcement of management policies affecting the subject UES reflects an attitude from which developers, contractors, and the public will take their cues.

d. The methodology was found to be a workable procedure by which to identify the mangaement needs of a UES area and coordinate these needs with the zoning ordinance policy. Consistency for methodology replication is found in the inclusion of standard analysis criteria for inventory/evaluation and also in within the Data Inventory/Impact Sheet format. The provision for expanding inventory catagories to consider environmental data particular to a specific UES area proved to be a functional and necessary inclusion within the methodology.

LIMITATIONS OF THE STUDY

Variables exist which, in conclusion, should be considered limitations to the study. These conclusions are:

a. A committement from the jurisdictional authorities was determined to be necessary for the success of utilizing the designated zoning ordinance components to manage UES areas. A lack of committment, on the part of these authorities, will limit the potential effectiveness of any flexible techniques and performance standards implemented as management policy for UES areas.

b. Within the environmental analysis phase of the process, certain component data interpretation will be unquantifiable -- that is, not statistically measureable. Although these unquantifiable interpretations are no less significant than the quantifiable, the interpretations may require increased specificity to mitigate the appearance of subjectiveness.

c. The application of flexible techniques and performance standards involves an element of discretion on the part of those authorities enforcing them. Although the presence of this discretion is the primary basis for the flexiblity, it also may be the cause of abuse and administrative inconvenience, such as through arbitrary demands and the increase in consideration time for individual projects. An expressly-stated committment on the part of the authorities, as well as a precisely defined purpose and clear statement of performance standards should diminish the possibility of abuse.

d. Even with a strong committment by authorities, reinforeced with a clear statement of and enforcement of UES policies, there exists the possiblity of disregard of local policy by projects originating at the federal or state government level, or by major utilities.

e. The true effectiveness of utilizing the methodology outlined herein and, thus, flexible techniques and performance standards to manage UES micro-environments can only be determined through the monitoring and assessment of such a policy in effect within a specific jurisdiction and implemented with regard to a specific UES area.

SUGGESTIONS FOR FUTHER STUDY

In addition to further testing the validity of the methodology developed within this investigation, the need for other studies addressing related concerns became evident. Among these were:

a. The need for a study which monitors and assesses an in-place UES policy to judge the true effectiveness of such a policy.

b. As unquantifiable data interpretation may somewhat undermine the environmental analysis with the appearance of subjectiveness, a study which more definitivly outlines the interpretation of such unquantifiable interpretations would be beneficial.

c. A study which measures the economic and social costs of unmanaged development within a UES, or which determines the carrying capacity of a UES would be invaluable.

d. In regard to flexible techniques, a question arises as to whether specific flexible techniques offer specific UES types greater management potential. An investigation concerning the existence of a pattern between certain flexible techniques and certain UES types would advance this concept further.

e. Flexible techniques and performance standards allow for more freedom to be innovative in the design and use of the land. A study regarding whether implementation of flexible technique policies within an area may actually encourage development within that area would be useful.

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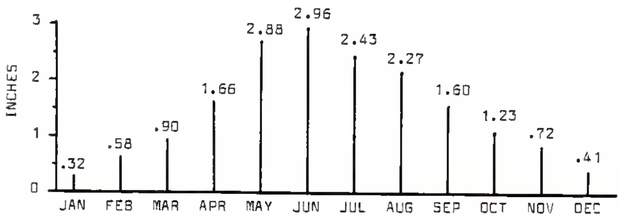
APPENDIX

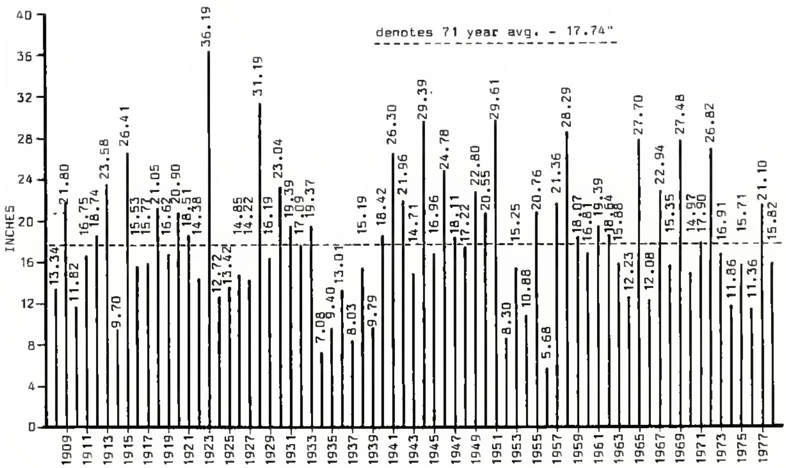
APPENDIX A
CLIMATOLOGICAL DATA

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Normal Daily Max. Temp.	°F -	45°	50°	55°	68°	77.5°	87.5°	97.5°	93°	83.5°	78°	57°	46°
Normal Daily Min. Temp.	°F -	20°	23.5°	30°	41°	51°	62°	67.5°	65.5°	57°	45°	30°	23°
Normal Daily Avg. Temp.	°F -	32.5°	35°	44°	55°	64°	75°	81°	80°	71°	59.5°	44°	35°
Normal Daily Range Temp.	°F -	25°	25°	26.5°	26°	25°	25°	26°	28°	27.5°	27.5°	25°	23°

Typical Daily Temperature Fluctuations



71 Year Average Monthly Precipitation



Annual Rainfall -- Garden City Experiment Station

Year	Seasonal Avg.	Annual Avg.	Highest Monthly Avg.	Corresponding 24 hr. avg.	Second Highest	Corresponding 24 hr. avg.	Highest 24 hr. month	Lowest Monthly avg.	Corresponding 24 hr. avg.	Second Lowest	Corresponding 24 hr. avg.
1915	7.5	7.3	MAY 9.5	17.9	MAR 9.1	19.5	JAN 21.8	AUG 4.3	8.6	OCT 5.2	10.0
1916	9.0	7.9	MAY 11.2	20.4	JUN 9.8	18.2	MAY 20.4	FEB 5.4	13.0	DEC 6.1	14.7
1917	8.6	7.8	APR 11.3	19.9	JUN 9.7	17.8	APR 19.9	JAN 5.8	15.5	N/D 6.2	18.3
1918	8.7	8.0	MAY 11.6	20.1	APR 11.3	18.1	MAY 20.1	DEC 6.3	--	JAN 6.7	17.8
1919	8.9	8.3	APR 11.4	20.9	JUL 9.2	17.0	MAY 21.0	DEC 6.7	17.7	OCT 7.6	16.2
1920	8.4	8.4	MAR 10.7	24.4	MAY 10.4	17.0	MAR 24.4	AUG 6.2	12.3	SEP 6.5	14.3
1921	6.7	6.9	MAR 11.1	23.0	APR 10.2	18.8	DEC 28.3	OCT 3.1	7.9	AUG 4.5	7.8
1922	8.6	8.8	MAR 11.6	21.7	APR 11.3	27.1	APR 27.1	AUG 6.3	10.5	DEC 6.6	14.1
1923	8.6	8.1	MAR 10.9	25.9	APR 10.6	21.0	MAR 25.9	NOV 5.6	11.0	AUG 5.8	9.7
1924	8.8	8.5	APR 10.1	21.5	MAR 9.7	25.1	FEB 33.0	NOV 6.7	14.0	DEC 7.6	27.4
1925	8.9	8.6	APR 10.4	21.0	MAR 10.3	17.0	JUN 23.4	JAN 6.8	17.1	NOV 7.1	18.7
1926	8.4	8.3	MAR 9.9	24.5	SEP 9.5	16.6	FEB 29.6	DEC 6.5	20.7	JAN 7.5	25.0
1927	9.3	9.0	MAR 12.4	30.0	MAY 11.4	23.7	MAR 30.0	AUG 6.6	12.3	OCT 7.1	17.5
1928	8.2	7.8	APR 12.1	24.0	MAR 10.0	22.8	APR 24.0	DEC 6.1	16.3	JAN 6.2	14.3
1929	8.6	7.9	APR 10.5	28.0	MAY 10.1	20.3	APR 28.0	AUG 6.1	11.5	DEC 6.2	20.7
1930	8.4	7.5	MAY 10.1	20.6	MAR 9.5	21.4	MAR 21.4	OCT 2.9	7.3	DEC 5.6	17.1
1931	8.8	8.4	MAR 10.9	31.0	APR 9.9	20.3	MAR 31.0	JAN 5.5	14.7	DEC 6.9	24.0
1932	9.3	8.5	APR 11.4	22.0	AUG 9.8	17.2	MAR 22.5	DEC 6.8	14.6	JAN 7.1	13.8
1933	9.1	8.8	MAR 12.4	23.0	APR 10.6	18.5	FEB 23.9	DEC 6.4	10.3	JAN 7.3	14.9
1934	10.2	9.2	JUN 11.2	21.4	SEP 11.1	21.1	FEB 21.5	DEC 7.0	15.1	JAN 7.7	17.9
1935	11.4	10.2	APR 13.8	33.3	JUN 12.5	20.5	APR 33.3	DEC 7.3	18.4	JAN 7.7	15.9
1936	9.6	8.9	MAY 12.1	22.0	APR 11.2	21.6	FEB 23.8	AUG 6.8	13.5	OCT 7.3	19.5
1937	10.1	9.4	MAY 11.4	20.5	APR 11.3	20.2	MAR 25.2	DEC 6.3	11.5	NOV 7.8	16.9
1938	10.1	9.3	APR 13.9	28.9	JUN 10.9	20.4	APR 28.9	SEP 6.7	12.2	DEC 7.2	17.4
1939	10.1	9.1	APR 11.5	20.6	JUN 11.1	20.6	FEB 22.5	DEC 6.1	14.3	NOV 7.3	16.4
1940	8.9	8.3	APR 11.3	22.7	MAR 9.4	24.1	MAR 24.1	DEC 6.2	12.8	JAN 6.4	17.5
1941	8.3	7.8	APR 11.0	21.6	MAR 8.9	14.8	APR 21.6	NOV 5.8	15.5	JAN 6.0	16.5
1942	9.0	7.9	APR 11.6	22.5	MAY 9.7	17.0	APR 22.5	DEC 5.8	20.5	NOV 6.2	19.4
1943	8.2	7.8	MAR 10.1	20.8	JUN 9.1	16.6	MAR 20.8	AUG 6.1	12.6	OCT 6.3	18.1
1944	8.6	7.8	APR 11.0	24.5	MAY 10.2	15.8	APR 24.5	OCT 5.0	9.8	NOV 6.1	13.6
1945	8.5	7.6	MAY 9.4	16.5	SEP 9.3	27.6	SEP 27.6	JAN 5.5	16.9	DEC 5.6	16.2
1946	9.5	8.8	JUN 11.0	18.4	MAR 10.5	24.0	MAR 24.0	DEC 5.9	15.9	JAN 6.9	15.0
1947	8.0	7.5	MAR 9.2	19.5	APR 8.8	18.0	NOV 19.8	DEC 4.6	14.0	NOV 6.5	19.8
1948	7.9	7.5	APR 10.2	19.3	MAR 8.8	20.5	NOV 21.4	JAN 5.3	16.4	DEC 6.2	18.3
1949	7.7	7.3	MAR 8.9	23.3	SEP 8.7	16.9	FEB 23.8	NOV 4.3	14.8	JUN 6.7	12.8
1950	8.2	7.5	JUN 10.4	20.6	APR 10.3	17.8	JAN 21.7	DEC 4.3	15.8	NOV 5.1	11.4
1951	8.7	7.8	APR 10.2	17.3	JUN 9.2	16.4	MAY 19.8	JAN 5.2	12.1	NOV 5.8	9.7
1952	8.6	7.7	JUL 10.8	19.6	JUN 10.7	18.6	MAR 21.5	OCT 4.3	10.0	SEP 4.7	11.5
1953	9.9	8.7	JUN 12.5	20.1	JUL 10.2	15.7	NOV 21.7	DEC 6.6	16.0	JAN 6.7	16.5
1954	9.7	8.4	JUN 13.1	19.3	APR 10.6	18.2	FEB 27.0	DEC 5.3	12.6	JAN 6.3	14.5
1955	7.5	7.1	APR 9.7	19.6	JUL 8.6	14.9	MAR 22.0	JUN 4.9	12.3	OCT 5.3	11.4
1956	7.9	7.3	MAY 9.7	18.0	JUN 9.5	15.6	MAY 18.0	DEC 5.2	12.4	JUL 5.8	11.2
1957	7.0	6.7	APR 8.8	16.4	OCT 7.6	12.8	DEC 16.5	DEC 5.2	16.5	NOV 5.6	14.4
1958	6.2	5.9	FEB 7.5	17.8	SEP 7.3	14.4	APR 16.0	AUG 4.6	7.5	OCT 5.0	9.6
1959	6.9	6.7	MAR 8.1	20.1	MAY 7.5	14.3	MAR 20.1	JAN 5.4	15.0	OCT 5.8	10.5
1960	7.0	6.5	APR 8.7	14.2	AUG 7.6	15.4	FEB 15.5	JAN 4.8	14.5	NOV 5.4	13.3
1961	6.8	6.2	MAY 8.2	13.5	MAR 7.5	14.9	MAR 14.9	AUG 4.4	9.8	JAN 4.6	12.2
1962	6.2	5.9	APR 7.7	14.8	MAR 7.3	13.6	JAN 16.0	OCT 4.6	9.9	DEC 4.7	8.6
1963	6.5	6.1	MAR 8.1	15.5	JUN 7.9	11.8	JAN 16.9	DEC 4.5	13.5	OCT 5.0	9.5
1964	6.8	6.3	MAR 7.5	20.2	MAY 7.3	14.8	MAR 20.2	DEC 4.9	13.3	NOV 5.1	12.4
1965	5.7	5.5	MAR 7.0	14.6	MAY 7.1	10.7	MAR 14.6	OCT 4.2	8.3	AUG 4.6	8.9
1966	6.0	5.6	JUN 7.7	14.7	MAR 7.1	17.9	MAR 17.9	DEC 4.5	9.9	NOV 4.6	11.7
1967	5.4	5.6	APR 7.6	14.0	MAR 6.6	12.7	JAN 13.7	NOV 4.4	7.4	JUL 4.5	9.3
1968	6.6	6.0	APR 7.8	15.5	MAR 6.9	14.8	APR 15.5	NOV 4.1	8.3	DEC 4.9	7.7
1969	5.7	5.4	APR 6.8	13.2	OCT 6.2	14.4	OCT 14.4	NOV 4.2	10.5	DEC 4.5	10.0
1970	5.6	5.0	APR 7.2	13.8	JUN 6.8	15.5	JUN 15.5	AUG 3.0	11.2	DEC 3.5	8.5
1971	5.8	5.5	JUN 7.1	15.0	MAY 6.9	12.7	FEB 19.5	JAN 3.5	15.9	AUG 4.2	8.0
1972	5.4	5.3	APR 6.8	15.4	MAR 6.5	10.8	APR 15.4	NOV 4.4	10.3	SEP 4.5	8.8
1973	5.9	5.6	MAR 7.8	17.3	MAY 6.4	20.4	MAY 20.4	JAN 4.2	16.7	OCT 4.8	10.0
1974	5.8	5.1	APR 8.0	15.7	MAY 6.3	13.7	APR 15.7	JAN 3.2	9.0	DEC 3.5	7.2
1975	5.4	5.3	APR 7.7	15.9	MAR 6.7	14.6	NOV 20.5	DEC 2.4	9.9	SEP 3.9	7.5
1976	6.0	5.6	APR 8.2	12.4	MAR 7.7	16.3	JAN 38.5	SEP 3.4	7.9	NOV 3.5	6.3
1977	5.6	5.1	MAR 7.2	16.8	MAY 6.7	13.4	MAR 16.8	JAN 3.5	10.5	FEB 3.8	10.0
1978	5.1	4.9	APR 7.4	13.6	MAY 6.1	11.4	APR 13.6	NOV 3.2	11.0	AUG 3.5	6.9
1979	5.0	5.1	MAR 7.5	14.3	APR 6.6	12.3	JAN 14.5	AUG 3.6	7.0	DEC 3.7	6.3
1980	5.7	5.7	JUN 13.1	--	MAR 6.9	13.0	MAR 13.0	DEC 3.8	8.6	MAY 4.3	10.0
1981	5.3	5.2	MAY 6.9	15.6	APR 6.8	13.9	MAY 15.6	AUG 3.2	6.3	SEP 4.0	9.0

Yearly Wind Velocities Indicating Extremes and Patterns

APPENDIX B
1974 FINNEY COUNTY ZONING ORDINANCE

As adopted in 1974.

ARTICLE XVIII
PLANNED GROUP DEVELOPMENT

SECTION 1

The owner or owners of any contiguous plot of land of not less than five (5) acres, unless expressly permitted by the Planning Commission, may make application to the Planning Commission for planned group development.

SECTION 2 - TYPES OF PLANNED GROUP DEVELOPMENT:

For the purpose of these Zoning Regulations, planned group developments are divided into four divisions:

		Districts permitted in.
1.	Residential	R-1 through R-4
2.	Service	C-O and C-S
3.	Business	C-1 through C-3
4.	Industrial	I-1 through I-3

SECTION 3 - RESIDENTIAL: (PLANNED GROUP DEVELOPMENT)

A residential planned group development may be established in any residential district.

1. The total number of dwelling units permitted in a group development shall be determined by dividing the net development area by the minimum lot area requirement of the district in which the group development is proposed to be located.

2. The area of land set aside for common open space or recreational use shall be included in the net development area. Where an area of fifty (50) acres or more is to be developed in the R-1 through R-[illegible] districts, a maximum of twenty (20) percent of the dwellings may be multiple dwellings. However, in no case shall there be more than four (4) dwelling units per building.

3. The minimum lot area and minimum lot frontage of single-family dwelling lots established within the development shall not be less than two-thirds (2/3) of the normal minimum lot area and minimum lot frontage of the single-family district in which the lot is located.

SECTION 4 - SERVICE: (PLANNED GROUP DEVELOPMENT)

A service planned group development may be established in any C-O or C-S district.

1. Motels are hereby permitted within these districts when part of a planned group development.

2. Business uses are allowed only if they are designed and used for the purpose of serving the planned group development and are a permitted accessory use within the C-O or C-S district.

SECTION 5 - BUSINESS: (PLANNED GROUP DEVELOPMENT)

A business planned group development may be established in any C-1, C-2, or C-3 district.

1. Residential uses are allowed in these developments only if they can be shown to be an integral part of the development and such uses will meet the requirements of the residential uses normally allowed in the C-1, C-2, or C-3 districts.

2. If the development faces or abuts a residential district, there shall be a landscaped buffer strip of at least fifteen (15) feet. Fencing or screening shall be established as required by the Planning Commission.

SECTION 6 - INDUSTRIAL: (PLANNED GROUP DEVELOPMENT)

An industrial planned group development may be established in any I-1, I-2, or I-3 district.

1. Residential uses shall not be allowed in these planned group developments nor shall retail uses unless they may be termed accessory in nature and are intended and designed to serve the group development.

2. There shall be no outside storage unless such storage facility is surrounded by a fence or screen of one hundred (100) per cent density and at least seven (7) feet in height.

There shall be no industrial buildings or storage enclosures permitted within one hundred (100) feet of a residential district.

All uses shall provide a front yard of at least thirty (30) feet and side yards of at least twenty (20) feet on each side.

5. At the perimeter of this group development, there shall be a twenty-five (25) foot landscaped buffer.

6. Individual lot coverage shall never exceed sixty (60) per cent.

7. Height of buildings shall never exceed forty-five (45) feet except as otherwise provided in Article XIX.

8. Billboards and advertising signs other than accessory signs of the individual establishments are not allowed in this group development.

9. Identification signs shall be of a non-flashing, unanimated type.

SECTION 6 - PRELIMINARY PLAN:

The application shall be accompanied by:

1. A preliminary plan and ten (10) copies of the proposed development showing:

   a. The area to be included in said development and abutting property lying within three hundred (300) feet drawn to a scale of not less then two hundred (200) feet to the inch;

   b. North point, scale and date of preparation.

   c. Name of proposed development (to coincide with name of consequent subdivision plat);

   d. A legal description of the property.

   e. Names and addresses of the developer, surveyor, landscape architect, architect, engineer or any other persons involved in the development.

   f. Existing conditions in the plan area showing sewers, water mains, gas mains, bridges, streets, alleys or drives and existing structures;

   g. Existing grade and contour (and proposed grade and contour) with contour intervals of not more than five (5) feet (referred to U. S. G. S. datum) also existing water courses, wooded areas, lakes, ravines and such other features as may be pertinent;

   h. The location of proposed buildings, streets, parking facilities, signs, landscaped buffer strips, and fences or screens, and other open places or facilities which may be applicable to the nature of the development;

i. All buildings and uses shall be clearly labeled as to proposed use.

2. A written text describing the proposed uses and buildings.

SECTION 7 - PUBLIC HEARING:

Not less than thirty (30) days notice of any such proposed planned group development shall be published in the official newspaper. After such notice, a hearing shall be granted to any person interested at a time and place specified in said notice. The Planning Commission shall approve or disapprove the preliminary plan according to requirements established in this Article, but may impose additional requirements deemed reasonable and necessary. If approved, the applicant shall then revise the preliminary sketch plan to meet the requirements established by the Planning Commission and submit the final planned group development plan.

SECTION 8 - FINAL PLAN:

Following approval of the preliminary planned group development plan, the applicant shall plat the land according to the Subdivision Regulations; however, the approved preliminary plan shall be considered to be the approved preliminary subdivision plat. Therefore, the platting process shall commence with the submission of a final subdivision plat.

1. If in the event the property is presently part of a subdivision plat approved and recorded in the manner prescribed in the Subdivision Regulations, the requirements for platting and the references made to subdivision plats in the following subsections shall be disregarded.

2. The final group development plan and ten (10) copies thereof shall be submitted concurrently with the filing of the final subdivision plat so that both may be considered simultaneously by the Planning Commission.

3. The final planned group development plan shall be the approved preliminary planned group development plan prepared on linen, film mylar, cronoflex or similar material providing space for the date and signatures of the following, certifying approval:

   a. Owners and developers of subject property;

   b. Chairman and Secretary of the Planning Commission;

   c. The Mayor and City Clerk or the Chairman of the Board of County Commissioners and County Clerk, whichever may have jurisdiction.

4. Along with the final planned group development plan, there shall be submitted:

   a. A written text describing the proposed uses and buildings;

   b. A written guarantee for completion of said development within a specified time.

SECTION 9 - PROCESSING OF APPLICATIONS:

The Planning Commission shall consider the following agency reports before submitting a report and determination to the Zoning Administrator.

1. a. Health Department.
   b. Fire Department.
   c. Building Inspector.
   d. Water Department.
   e. All Public Utilities.
   f. Engineering Department.
   g. School Board.

2. The preceding agencies shall be given seven (7) days following their receipt of the application to submit a report to the Planning Commission.

   If said report has not been returned to the Planning Commission within seven (7) days, it shall be considered as an affirmative report.

3. The tract or plot must be a contiguous parcel, five (5) acres or more, under one (1) ownership or held jointly by two (2) or more owners.

4. The proposed development shall be designed to produce an environment of a stable and desirable character not out of harmony with its surrounding neighborhood, and shall not conflict with the Comprehensive Plan or any parts thereof.

5. Buildings within a residential, or office and institutional, planned group development may be relieved of district Zoning Regulations concerning yard size, setback, height, bulk, and other plot re-

quirements where such requirements interfere with the overall development.

However, the buildings at the perimeter of such development must maintain the requirements as established for the district.

6. Off-street parking:
Shall be in accordance with Article XXII.

7. Off-street loading:
Shall be in accordance with Article XXIII.

8. Signs:
Shall be in accordance with Article XXI.

9. Before approval of a planned group development plan, the Planning Commission shall require a contract with safeguards guaranteeing completion of the development in a period to be specified by the Planning Commission but which period shall not exceed five (5) years unless extended by the Planning Commission for due cause.

SECTION 10 - DISAPPROVAL:

If in the event the proposed planned group development is disapproved by the Planning Commission, the applicant shall be notified and presented a written report setting forth the Planning Commission's reasons.

SECTION 11 - FILING AND RECORDING:

The signed and recorded planned group development linen shall be made part of the permanent file of the Zoning Administrator and the district zoning maps shall be corrected to show the attachment of "planned group development".

SECTION 12 - PERMIT ISSUED:

Subsequent to the filing and recording of the final planned group development linen and subdivision plat, the Planning Commission shall notify the Zoning Administrator in writing to issue a zoning permit for planned group development.

SECTION 13 - AMENDMENTS:

A building permit shall not be issued for any building within a planned group development which does not conform to the group development plan as approved and recorded, except that a reasonable variance to location and gross floor area of individual buildings may be granted after a review of said variation by the Planning Commission.

If the planned group development plan requires an amendment b[illegible] the requested variation is deemed unreasonable by the Planning C[illegible]mission, then the applicant shall proceed in the same manner established for the application of a permit for planned group development.

SECTION 14 - EXTENSION OR REVERSION:

If due cause for extension of time is not shown, the Planning Commission shall commence action to revert any zoning established in connection with a planned group development to its zoning classification prior to such amendment. At the same time, the Planning Commission shall commence action for removal of "planned group development" from the district zoning maps and render said plan null and void.

THE UTILIZATION OF ZONING ORDINANCES TO PROTECT UNIQUE AND/OR ECOLOGICALLY-SENSITIVE MICRO-ENVIRONMENTS: AN INVESTIGATION

by

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AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

Unique and ecologically-sensitive micro-environments (UES) exist in a myriad of types, scales, locations, and degrees -- the majority of which remain unprotected against insensitive intrusion and eventual destruction from such sources as development, utility or highway corridors, and agricultural practices. Many of these UES areas are significantly important both at the local and regional scale. In some cases, these UES areas are one of a kind occurrences or highly sensitive, and once disturbed, can not be reclaimed. Zoning ordinances appear to be the most readily available land-use management tool within most local jurisdictions for guiding and limiting development impacting such exceptional micro-environments. The major intent of this study is twofold -- first, to identify UES areas and the ecological patterns and systems which render them unique; and second, to determine the applicability and effectiveness of local zoning ordinances as a means by which to manage and protect UES micro-environments.

In order to evaluate the significant aspects of UES areas and the effectiveness of in-place zoning ordinances to manage and protect UES areas, a methodology was developed which comprises the following four steps: 1) INITIAL DECREE of UES micro-environment existence to prompt investigation; 2) EVALUATION OF IDENTIFIED UES MICRO-ENVIRONMENT as per methodology evaluation criteria to determine management needs; 3) EVALUATION OF IN-PLACE ZONING ORDINANCES within the associated jurisdiction in comparison to the identified management needs of the UES micro-

environment; and 4) RECOMMENDATIONS for UES micro-environment management regarding revisions or additions to the in-place zoning ordinances found deficient.

To determine validity, the methodology will be tested within the framework of a case study involving the Sandhills of Finney County, Kansas. The Sandhills are located in the southwest portion of Kansas and appear to meet the criteria for UES designation. Results from this case study will be analyzed to ascertain if, in fact, the methodology is workable in the determination of UES existence and management needs, and more specifically, in the determination of the applicability and effectiveness of zoning ordinances as a management tool for UES areas.