Long-Range Plan
Development Guidelines
and
Exhibit Scenarios

Woodland Park Zoo

City of Seattle
Department of Parks and Recreation

Prepared by
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1976

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Foreword

The value of this report will become increasingly evident in the years to come as we move ahead with implementation of the Long-Range Plan for Woodland Park Zoo. It is more than just a document outlining a plan - it is a synthesis of an ideal and an idea formulated by the Zoo Action Task Force; it is an account of the analysis and objectives of the planning process; and it will be an invaluable resource for future decision making.

Indeed its resource potential will, I am sure, be recognized by other zoos and zoo planners. The concepts of this plan are unique. They have not been attempted before. Zoo exhibits in the past have traditionally been designed around the requirements for hygiene, people convenience and ease of maintenance, rather than the behavioral and psychological needs of the animal.

In the past decade there has been a major revision in our attitudes to wildlife, and a wealth of new information on ecology and ethology. We are able to benefit from these changes.

The concept for the Long-Range Plan recognizes that nature is the norm. We have made all attempts, and will continue, to ensure that the rules and orders of nature prevail. These express themselves in the Exhibition Theme of Social Biology and the Presentation Theme of Bioclimatic Zones. They are also apparent in the specific choices set down for terrain, soil, visual characteristics and vegetation types within exhibit areas; the relationships between exhibits; and the "geographical tours" linking several exhibits within the whole pattern.

The simplicity of this concept is built upon a complex reality, but this has ensured that there is maximum flexibility within the Long-Range Plan to accommodate future, more pragmatic, unknowns. For example, a forest edge habitat was required to make an orderly transition from Taiga to Tundra exhibits. The caribou and musk ox exhibit was therefore designated as a linking exhibit within that transition. Even if these animals did not become available until the future, that specific part of the zoo would nonetheless be planted and designed as caribou and musk ox habitat, thus ensuring the necessary authenticity of continuity.

Funding for completion of this plan, it must be stressed, is not available at this time. The plan will have to grow on what has been described as a 'pay as you go' basis. But for the first time Woodland Park Zoological Gardens has a coherent and complete plan for all future development.

A significant portion of that plan will be developed with Forward Thrust monies. Because the plan is based on landscape solutions rather than architectural designs, those Forward Thrust elements will provide more opportunity for the animal's behavioral requirements and more opportunity for people's visual interaction than any other type of design solution that I can imagine.

When Forward Thrust is complete, there will still remain several unfunded needs. But by contemporary standards the people of Seattle will have a zoo to be proud of. Moreover, the layout of the Forward Thrust exhibits has been cleverly conceived by the designers to ensure a delightful integration with the remaining facilities.

After completion of Forward Thrust, then, the zoo could, as it has been expressed, "stand on its own". I anticipate, however, that the great improvement in quality of the new exhibits will stimulate enthusiasm for continuation of the plan.

The zoo will seek philanthropic support for funding of new exhibits. In this way, as and when funds become available, we can assemble future pieces of the jig-saw, having a clear recognition of the total picture to be achieved.

Developing this plan is an exciting prospect. It is my sincere hope and belief that that excitement will be evident in the final results, and will match something of the splendour and drama of Wildlife.

David Hancocks
December 1976

Preface

This report is developed from the belief that as designers we must discover and reveal the fundamental structure of nature, both in process and form, and that the values which emerge in that interaction must preside over design.

The design principles developed in this report are in their application changing the face of Seattle's Woodland Park Zoological Gardens. They evolved both from our search for a new aesthetic and in our response to display the infinite richness of wild life.

The report documents the work of Jones & Jones and its consultants during 1976, for Seattle's Department of Parks and Recreation. It records the inventory, research, analysis and design, and the synthesis of a Comprehensive Plan adopted by the Seattle City Council to establish the basis for various funded projects, now being executed. The report is also a detailed though flexible sourcebook of programs for site and exhibit development which sets forth, in the form of guidelines and exhibit scenarios, the fundamentals for design of future zoo projects over time.

Inevitably, an ecological approach to zoo design must be commonplace. But traditionally, zoos have developed as menageries for entertainment, and that tradition may yet persist. Notwithstanding the efficacy of that tradition or future changing tastes, nature has been an operator of constancy and predictability; it has been our ability as translators that has been the variable element in the relation.

This report responds to a change in tradition. Over at least two decades an ecological design approach has evolved through application at various scales, principally by landscape architects working in association with natural scientists. Yet the working principles of the approach have not been widely applied in zoos, except perhaps at Basel, where over the same period, Dr. Ernst Lang has been pioneering an extraordinary zoo, and in the visionary plan, Pardisan, recently proposed to the Imperial Government of Iran by Ian McHarg.

The long-range plan offered herein demonstrates, as in Basel, that neither large areas nor pristine beginnings are essential to the implementation of a holistic plan organized around ecological principles. Older facilities, generally developed sporadically in a diffused and scattered pattern, can benefit, as in Seattle, from application of a unifying organizational theme.

The plan for Woodland Park evolves from a dialogue with nature. We asked the site to reveal its own potentialities as natural habitat, rather than dictating any preconceptions or depending on technological solutions. Given a choice of working with or against nature, it is prudent to adopt the former, to follow the line of least resistance, the results predictably being more flexible and congruent, cost-effective, and timeless.

With exhibits organized around ecological and ethological themes, and by working within the essential requirements of each habitat, we can arrange both plants and animals by natural association; the animals living in social groups in the context of appropriate vegetation and terrain, organized both bioclimatically and zoogeographically. The educational, and therefore recreational, possibilities are unlimited. Each replicated habitat will provide an organizational theme for demonstration of animal behavior and adaptation, as well as an opportunity to illustrate man's role in nature through history.

We firmly believe this process has led to a fundamentally logical arrangement, one which is extremely flexible but has an inherent order, taking the cue from nature to evolve its own natural assets. We are confident that the new zoo will enrich the cultural fabric of the city, heighten our awareness and enjoyment of animals in nature and thus contribute toward their conservation. Perhaps more important, the new zoo will be a lifetime experience for the people of Seattle and the region.

G.R.J.

Seattle
December 1976

Table of Contents

Long-Range Plan

Development Guidelines

Exhibit Scenarios

Introduction

The purpose of this report is to provide a creative, well-reasoned and factually substantiated basis for the organization of Woodland Park Zoo and to provide guidelines for its development. This development should follow the goals and priorities of the Mayor's Zoo Action Task Force and the Zoo Director, in particular the bioclimatic-zone presentation theme and the sociobiological exhibit theme.

The findings of this study are presented in the form of long-range comprehensive guidelines and detailed exhibit scenarios, with emphasis on the wholeness and mutualistic integrity of all aspects of the zoo/park development.

Design recommendations are consistently developed at all levels to provide a flexible yet workable basis for interpretation in future detailed design development and implementation.

Objectives for the Woodland Park Zoo

By The Zoo Action Task Force, April 1975

The Woodland Park Zoological Garden should be a Life Science Institution demonstrating the value and beauty as well as behavioral and physical adaptations of animal life. As such, primary emphasis should be placed on fostering public understanding of the history of animal life and its relationship to ecological systems.

Visiting the zoo and gaining this understanding should be an enjoyable experience. Recreational opportunities should be provided for the refreshment of body and mind and consistent with these purposes of the zoo. The zoo should promote the conservation of wildlife through care and propagation of selected species and through enhancement of public awareness of human impact on animals and their environments. The zoo should conduct and encourage research which promotes the above educational and conservation purposes, and which supports the welfare of its animals.

The Woodland Park Zoo should display a representative cross section of the world's animal life, including wildlife of the Pacific Northwest.

Design Policy for the Woodland Park Zoo

In December 1975 the Seattle Design Commission reviewed and approved the Long-Range Plan Concept, illustrated in this report. As a result, the following Design Policies have been developed.

Future developments at the zoo will be based upon the Social Biology Exhibition Theme and the Bioclimatic-Zone Presentation Theme. To satisfy these requirements, several specific design principles will be incorporated into the development of the comprehensive plan for the zoo.

All new habitat reconstructions will be designed to give as natural an appearance as possible in order to visually replicate the animals' native environment. The location of any of these habitats will be determined by reference to the bioclimatic-zone maps revealed in the long-range plan prepared by Jones & Jones and elaborated below.

The animal collections within these exhibits will reflect an emphasis on social groupings through representing natural-sized groups as much as possible. Thus, areas given to animals will invariably be larger than in the traditional zoo concept, with fewer species represented but with a larger number of individuals.

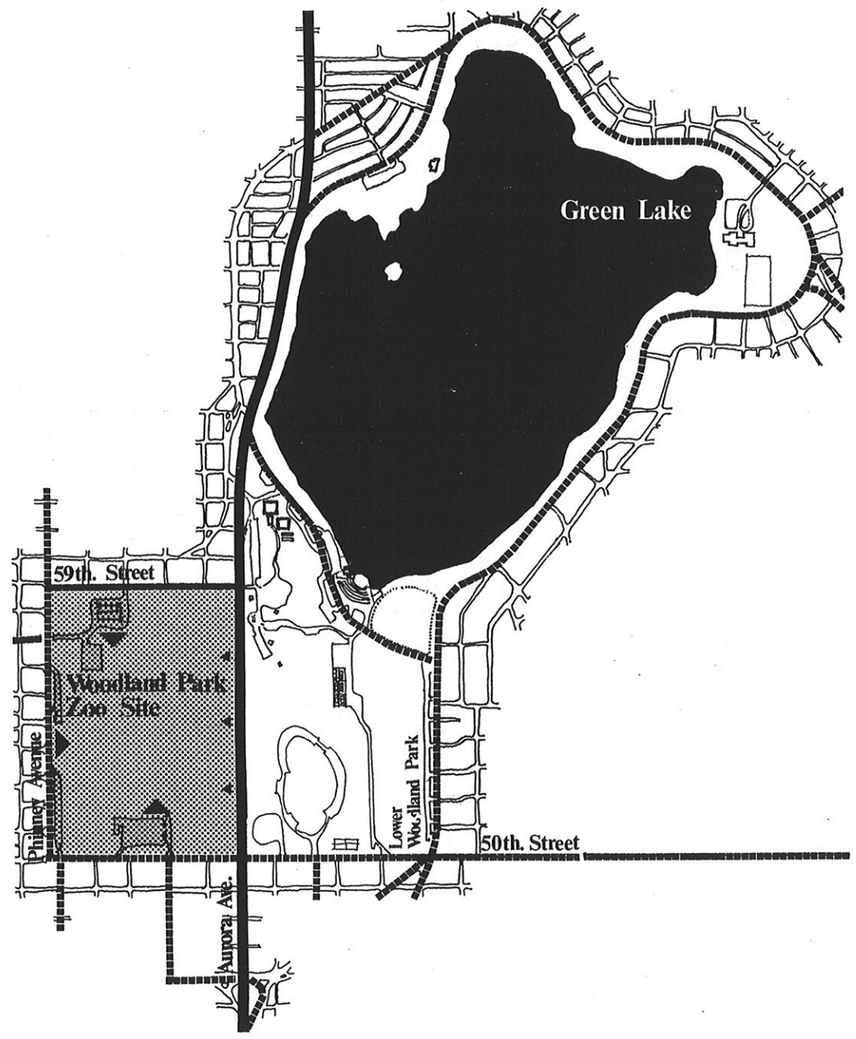
To benefit public viewing of the animals, all attempts will be made to avoid visual barriers, with viewing areas chosen for the most sympathetic appreciation of the habitat experience. All attempts will be made to create situations where the exhibition of the animals can be achieved through a landscape solution, thereby eliminating "exhibition houses" unless essential.

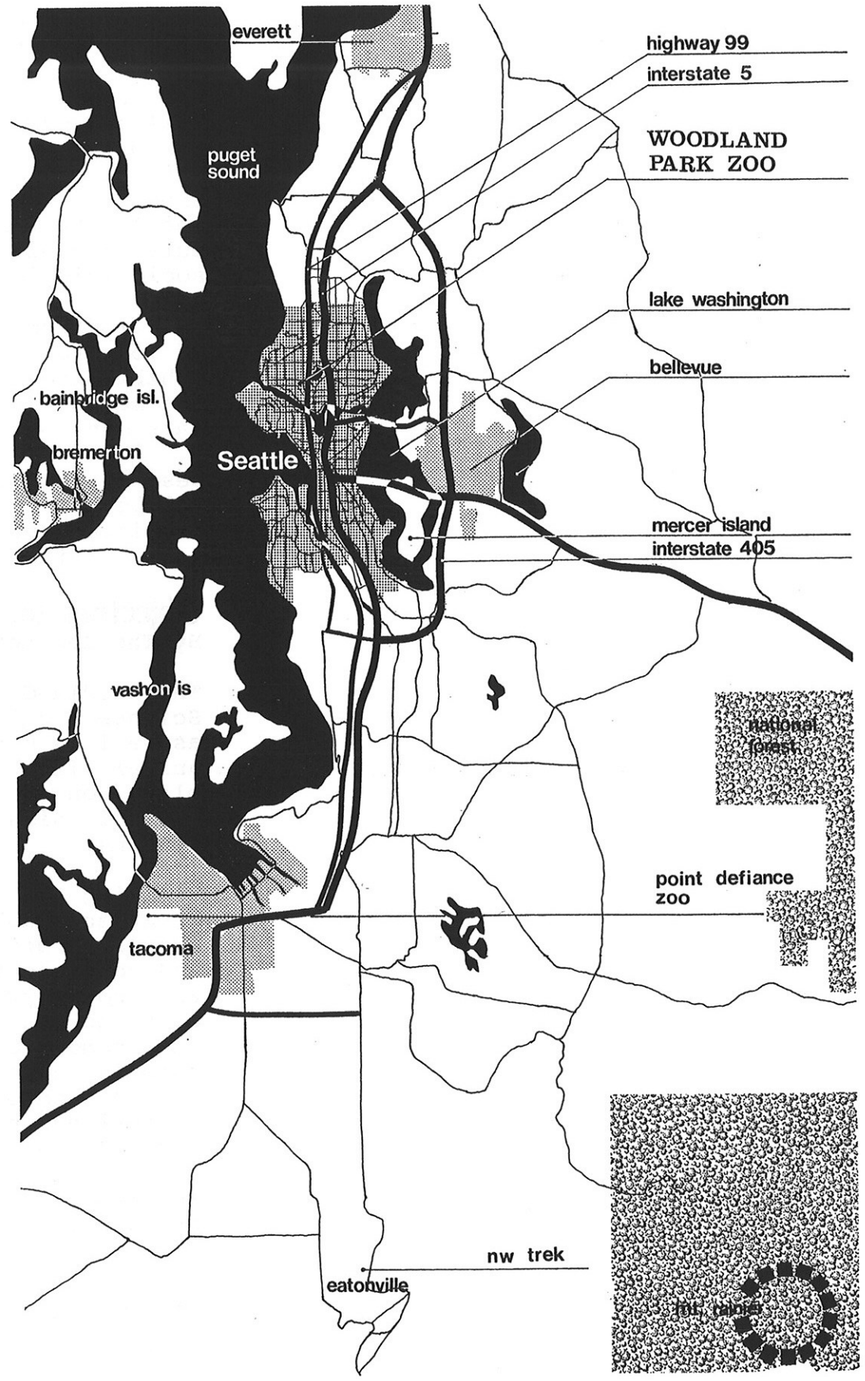
Because of the desire to emphasize the ecological aspects of the Zoo site, all recreational activities which are not related to the Zoo experience, or are of an energetically active nature, will be excluded. However, at the perimeter of the site, the environmental zones will all be designed to reflect northwest landscapes and will be integrated to benefit the surrounding community, by contributing towards its passive recreational needs.

These design principles are not intended to be exclusive but are presented as an indication of the essential goals for the Zoo as regards the visitor experience. The general intention is to move away from the traditional concept of exhibiting animals as mere objects. All planning and design work will attempt to produce a final result in which the visitor will have a total environmental experience, viewing wild animals as a living part of a naturalistic habitat.

Site Location

Seattle's Woodland Park Zoo was established sixty-five years ago on Phinney Ridge in the northwest sector of the city. Ninety acres in size, the ample site is diverse in topography and aspect, having well-established vegetation communities throughout and buffering its four sides. It is sharply bounded on the east by a primary state highway, Aurora Avenue, and on the west by a secondary arterial, Phinney Avenue. Southern and northern boundaries interface comfortably with the residential community. The site provides a rich spatial and botanical framework for future exhibit development.





History of the Woodland Park Zoo

In 1900 the City of Seattle purchased Phinney's Woodland Park estate for $100,000 and created a furor. Vigorous protests insisted that the price was too high, and that the park was too far out of town. But the wisdom of the City Council's decision has proven to be of ever increasing value.

Guy Phinney was English by birth and invested $40,000 in his estate to develop a traditional English park. He built a large house and laid out a formal rose garden, constructed a pumphouse to bring water from Green Lake to his gardens, erected an impressive stone entrance on 50th Avenue, and installed an electric trolley line along Fremont Avenue for his private street car. The aristocratic tradition also demanded a deer park and by 1893, when Phinney died, a small herd had been established in the park.

The first zoo in Seattle was a small collection of animals owned by the Lake Washington Cable Railway and maintained in Leschi Park. Their animals were given to the City soon after they purchased Woodland Park, and it is interesting to note that Carkeek Park's first use was as a vegetable garden for the zoo animals.

The City fathers engaged the famous Massachusetts landscape architectural firm of the Olmsted Brothers to create a public park out of Guy Phinney's estate. The choice was apt since their work, which included Central Park in New York City, was an inspired outgrowth of the English landscape tradition.

They retained the formal gardens of the Phinney estate, laid out new pathways, and created several great spaces with animal quarters on the periphery, after the fashion of the day. Lower Woodland was left as an informal woods, but in 1930 City Engineer W.B. Barkuff developed a plan to bisect Woodland Park with a six-lane highway. Councilman George Hill, who had earlier taken City Engineer R.H. Thompson on a tour of Europe to "cure him of the habit of putting roads through parks", formed a coalition to defeat the highway plan and proposed an alternate route following the contours of the land. Despite a public referendum vote against the plan, Aurora Avenue was constructed and the park was divided.

Since that time Woodland Park Zoo has remained in "Upper" Woodland Park. During the Depression several WPA projects were built, including a commissary, beaver ponds and monkey island. In 1949, under the direction of Ed Johnson, the bear and feline grottos were designed. He also proposed a children's zoo at that time, but not until 20 years and five unsuccessful Park Bonds later, plus a controversy over theme design, was the first unit of the children's zoo opened in 1967.

The 1968 Forward Thrust Bond Issue provided $4.5 million for a list of specific zoo improvements. They were to be developed in accordance with a "comprehensive plan", and since no such plan existed, the city hired Architect G.R. Bartholick to develop long-range proposals. His excellent plan called for the extension of the zoo into Lower Woodland Park using a 700-foot zoological conservatory over Aurora Avenue to reunite the park. Paradoxically, a public initiative defeated this innovative proposal in November 1974.

Mayor Uhlman then appointed a zoo advisory committee to establish guidelines for new direction, and in the late spring of 1975 work began on a new plan under the direction of David Hancocks as Design Coordinator. Jones & Jones was hired that fall, and approval for their comprehensive plan was given by the City Council early in 1976. Forward Thrust development was at last ready to begin. First on-site work started in the summer of 1976 with a schedule calling for completion by the end of 1979.

Exhibition Theme: Social Biology

A zoo has to be more than a natural history museum, for it is concerned with live animals, and its unique aspect is its potential for exhibiting animal behavior. It is therefore essential to give the animals all necessary opportunities to engage in natural behavior, to the benefit of the animal and the zoo visitor.

As a coherent theme for the exhibition of wild animals and their behavior, the zoo has decided to base its collection on the disciplines of Social Biology, which has its roots in the sciences of ecology and ethology.

Ecology has made tremendous contributions to our general awareness of wildlife and wild habitats, and ethology is revealing new insights into human and animal behavior.

Social biology studies the social aspects of behavior. It requires a new way of looking at animals, not just as isolated individuals but as members of a complex society in which both the animal and its group has to learn to adapt and survive.

In terms of what the visitor will see at the zoo, the theme of social biology will mean new, large exhibition areas for social groups of animals. Whenever possible the zoo will aim to display natural-sized groups, for example, a whole pride of lions, a troop of baboons, a pack of wolves or a herd of antelope.

In this way the visitor will be able to observe not only the form, color or size of the animal, but also the interactive behavior and communications naturally elicited by social species when they have opportunity to share the companionship of their own kind.

It is also hoped that, by using the world of social animals as a mirror, the zoo visitor will be able to more easily reflect upon some of the problems and some of the benefits that come from living together; for humans, too, are a social species.

Acknowledgments

As in that moment, when, after swelling with unseen support, a drop breaks away and falls into the stream of things, this project has gained a future, collectively from the support of many to which we and the community owe a great debt.

It was the nature of this plan to evolve out of trust; without the guiding support, patience and foresight of David Towne, Superintendent of Parks and Recreation, it could not have happened. Without the dedicated members of the Mayor's Zoo Action Task Force, who formulated in April of 1975 a broad, responsive, and informed mandate for the future, it could never have begun.

It was David Hancocks who saw it through, the emissary. In addition to his original function as Design Coordinator when he established the presentation and exhibition themes developed herein, and later as Zoo Director, whose connection is obvious, his considerable support and direction and his perceptiveness in matters of zoo design made the occasional burden bearable, the success a collaborative pleasure. James W. Foster, DVM, as Interim-Director and later as Director of Science, helped by sharing his knowledge of animal care and behavior and was of great value to us in discussions of exhibit feasibility. Helen Freeman, Operations Director, furnished information about internal services and zoo operations as well as her encouragement and advice.

Members of the Zoo Steering Committee for Forward Thrust Projects, under the able direction of Chairman Dean Fournier, were the citizen guidance system, both the medium for accountability and continuity of intent. The Seattle Design Commission and its inimitable chairman, Ibsen Nelsen, oversaw our sometimes deliberate, sometimes hectic, path of discovery and measured out discipline and professional guidance to our form-giving. This creative and perceptive criticism of the concept was again found in the objective support offered by various people of informed background who had taken an interest in the progress of zoo planning for Woodland Park, including Dr. David Hellyer and Professor Richard Untermann. They, as well as many representatives from several community councils and citizen organizations, made statements which gave us encouragement.

Many prominent scholars and naturalists advised the team on exhibit scenarios, contributing their expertise about particular animals and environments, namely: Dr. George Schaller (original color slides most appreciated!), Dr. Dian Fossey, Dr. Birutė Galdikas and Rod Brindamour, Dr. Randall L. Eaton, and Dr. Donald Bruning. Dr. Ernst Lang, Director of The Zoological Garden in Basel, extended his hospitality and support for our concepts; his proven success in pioneering this landscape approach to zoo design encouraged us greatly.

Several professional consultants participated on the Design Team to which the authors extend their thanks: Donald Hogan, P.E., for his utility record search and masterminding of the proposed future utility concept; Joseph Witt, Consulting Botanist, for his recommendations on botanical simulation of life-zones; and Philip Osborn, Consulting Geologist, who provided research data for exhibit design.

We have had opportunity to benefit from the insight and expertise of many professional keepers on the Woodland Park Zoo staff, who helped us with various Forward Thrust projects, specifically Laurie Gledhill, Betty Bartleson, Ernie Wagner, David Castor, Greg Thompson, Pat Pichette and Mary Keiter, all to whom we wish to extend our particular thanks. Dr. Carolyn Wilson, Acting Assistant Professor of Psychology, University of Washington, coordinated a student project which generated an extraordinary collection of research data on environments for primates.

We wish to acknowledge William W. Griffin, Project Manager for Seattle's Department of Parks and Recreation, who provided the coordinative link with and between all the above and those on the Design Team staff, for all his skill, administrative swiftness and good-natured forbearance.

Partners and members of the staff of Jones & Jones, who during the last year have expended considerable physical, intellectual and psychic energy in completing the zoo design as well as production of this report deserve recognition for their contributions:

INVENTORY/ANALYSIS

Peter M. Harvard, Natural Resources
John Ady, Visual Resources and Pedestrian Circulation
John Swanson, Internal Services
Johnpaul Jones, Building Inventory and Architectural Recommendations
Sherry Azous, Plant Replication Research

DESIGN

John Swanson, Overall Site Design and Celebes Black Ape/Lion-tailed Macaque Exhibit
Johnpaul Jones, Gorilla Exhibit, Temperate Rain Forest Aviary
Brian A. Gray, Kenneth Caldwell and Nik Worden, Temperate Deciduous Forest Waterfowl Exhibit
David Walters, Temperate Rain Forest Aviary

REPORT PRODUCTION

John Swanson, Book Design, Graphics and Coordination of Production
Eric Schmidt, Report Graphics
Diana Sleeth and Wendy Duffy, Text Processing
Paula Culp, Project Accounting

Presentation Theme: Bioclimatic Zones

The traditional zoo concept of directing visitors to one part of the site to see all the birds, then to another building to see all the cats, and yet another area of the zoo for all the bears, or primates, or marsupials, goes against the grain of nature.

Wild animals live in a dynamic ecological relationship, and, although the zoo is only a substitute, it should attempt to reflect this complex order. Animals are generally confined within certain parts of the world by the combined effects of climate and vegetation.

Thus we find that animals living in the deserts of New Mexico, for example, are often very similar in form and behavior to desert animals from Egypt; similarly monkeys living in Asian forests have evolved in much the same way as monkeys found in African forest regions.

The divisions around the world created by climate and vegetation are the basis for the new plan concept for Woodland Park Zoo. Instead of dividing the zoo into different continents, or "zoogeographic" areas, a thorough analysis has been made to discover which bio-climates can be replicated, and where these should be located on the zoo site.

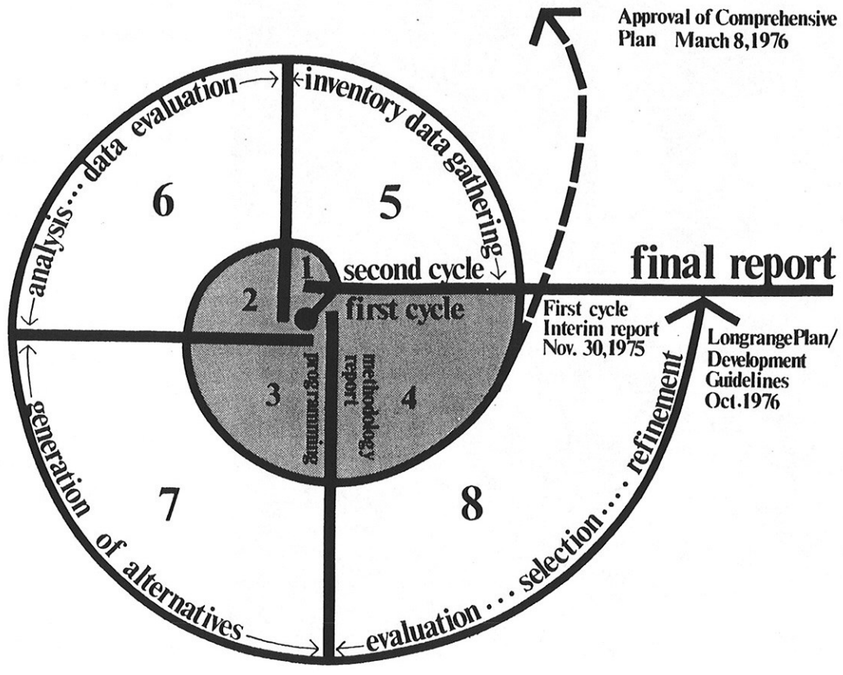
Seattle is fortunate in having a climate in which many different types of vegetation from a large number of the world's bioclimates can be grown, and in which many animal species from these zones can adapt to our weather patterns with minimal shelter requirements.

The concept plan therefore places major emphasis on natural vegetation and de-emphasizes large buildings whenever possible.

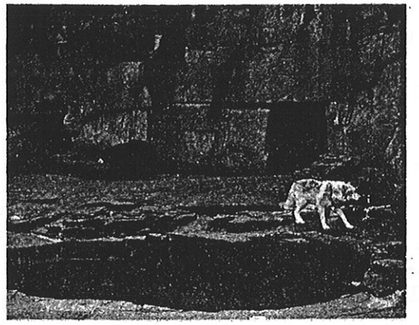
It is the intention of this presentation concept that visitors to the zoo will enjoy a total environmental experience and an opportunity to rediscover the beauty and value of natural fauna and flora in an urban oasis.

Methodology Summary

It is essential in a study of this nature to utilize an orderly sequential progression from initial field work to final recommendations so that each step in the process flows logically from preceding steps to succeeding ones without wasted or disproportionate emphasis on any one area. For this reason we recommend a helical methodology taking two cycles through the design sequence of 1) Data Inventory, 2) Analysis, 3) Generation of Alternatives and 4) Selection and Refinement of Alternatives. The first pass through the cycle produces preliminary findings, while the second cycle further tests and refines these conceptual findings against selected additional site data, opportunities and constraints and analysis of alternative variations of the preliminary concept. Simultaneous development of supportive detail studies, checklists, and criteria, occurring during the second cycle, culminate in the production of long-range planning guidelines and conceptual design recommendations for future development within the Woodland Park Zoo site. This two-cycle approach is responsive to the development sequence, and provides criteria for specific facilities and exhibit designs as well as for all other areas designated during the planning process.



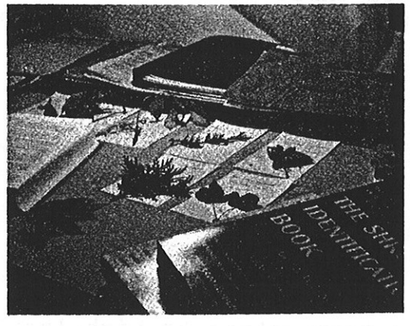
The Following Pages Document the Path of Discovery Taken to Create a New Zoo Plan.....



The Reading of the Actual Site to Reveal its Inherent Potential.....

The Transposition of Ecological Patterns in Nature to the Zoo Site ....

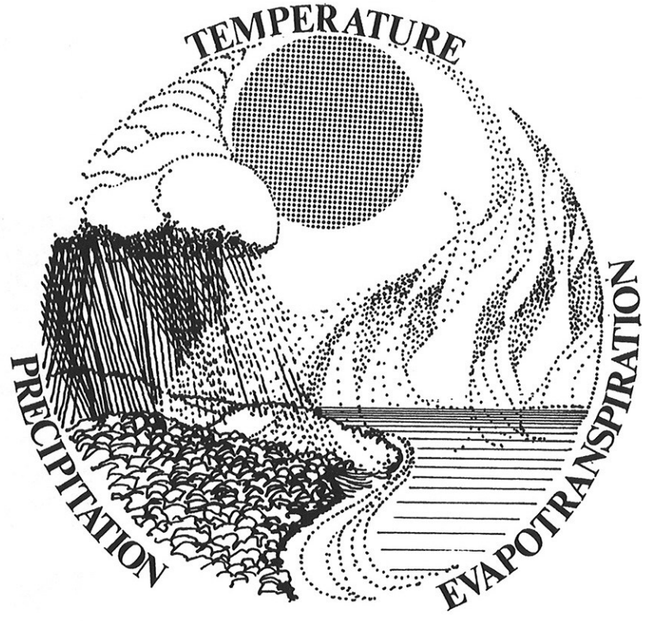
The Analysis of All its Parts Through Detailed Inventory and Research .....



The Selection of Animal Species Appropriate for Exhibition .....

.....and, Finally, Integration Through Design

The Bioclimatic Concept



As discussed in the presentation theme, animals are generally confined within certain parts of the world by the cause-and-effect relations of climate and vegetation. These create specialized habitats to which animals have adapted, ranging from tropical rain forests to dry deserts, from mountains to ocean shores, and from open prairies to hedgerows.

Because these habitats occur within different parts of the world, a thorough analysis has been made to define and locate them and to determine which bioclimatic zones can be replicated for the zoo.

Although many natural scientists have developed techniques to define world habitats, the subject has been dealt with most objectively by Holdridge (1972). He has devised a system for bioclimatic-zone classification using as his basis three parameters: 1) temperature; 2) precipitation; and 3) evapotranspiration.

Temperature

Temperature, one of the two important climate controls, varies in a regular and predictable manner with both latitude and altitude and is primarily responsible for the latitudinal and altitudinal climatic belts. An important difference, however, between its latitudinal and altitudinal variation involves seasonality. The seasonal range of temperature varies latitudinally, and because of this, tropical montane areas of equivalent mean annual temperature to high-latitude lowland areas may be quite different ecologically.

The oceans, with their great resistance to heating and cooling, act as ameliorating effects on temperature, so that continental climates show greater temperature variations, both annual and diurnal, than do maritime ones. The flow of currents in the ocean affects the temperatures in maritime areas, and the Japanese Current and Gulf Stream cause higher mean temperatures on the Pacific coasts of North America and Eurasia, while the Humboldt and Benguela Currents cause lower mean temperatures on the Pacific coasts of southern South America and southern Africa.

Precipitation

Water continually evaporates from the earth's water bodies, travels through the atmosphere as water vapor, and eventually condenses out as fog or falls as precipitation. Thus the world air circulation is instrumental in determining patterns of precipitation. The fact that air can hold less moisture as it cools is significant in determining where the water returns to the substrate as it travels around the atmosphere. First of all, the equatorial belt is characterized by extreme and constant heating, the sun remaining overhead during the daytime throughout the year, and this causes the air there to rise. As it rises, its moisture condenses out and falls as rain. This produces the equatorial rainy belt. As the thermal equator moves north and south with the changing seasons, the belt of extreme rains accompanies it, so that some seasonality in rainfall is characteristic of even this belt. As this equatorial air falls back to earth, it is generally vectored toward the west, causing the trade-wind belt just above the equatorial region. These easterly winds are very moisture-laden as they flow across the eastern edges of the continents at these latitudes, and where they hit even low coastal plains the air rises because the land is hotter than the water, and the eastern shores of tropical regions are thus wet.

The seasonality of precipitation is controlled by the moving of the thermal equator and the changes of wind directions characteristic of annual (and shorter) cycles. This is especially obvious in regions in which the wind flows from the ocean during some part of the year and from the interior during the other part. In low-latitude areas seasonality is entirely controlled by variation in precipitation, whereas with increased latitude both temperature and precipitation play a part, the former of increased importance with increase in latitude. Both the amount of precipitation and the time of the year it occurs are significant at higher latitudes, as for example whether the precipitation comes during the hot (growing) season or the cold (dormant) season. Both the amount of precipitation and its duration over the year (or conversely, the length of the dry season) interact to determine the climatic pattern in any area.

Potential Evapotranspiration

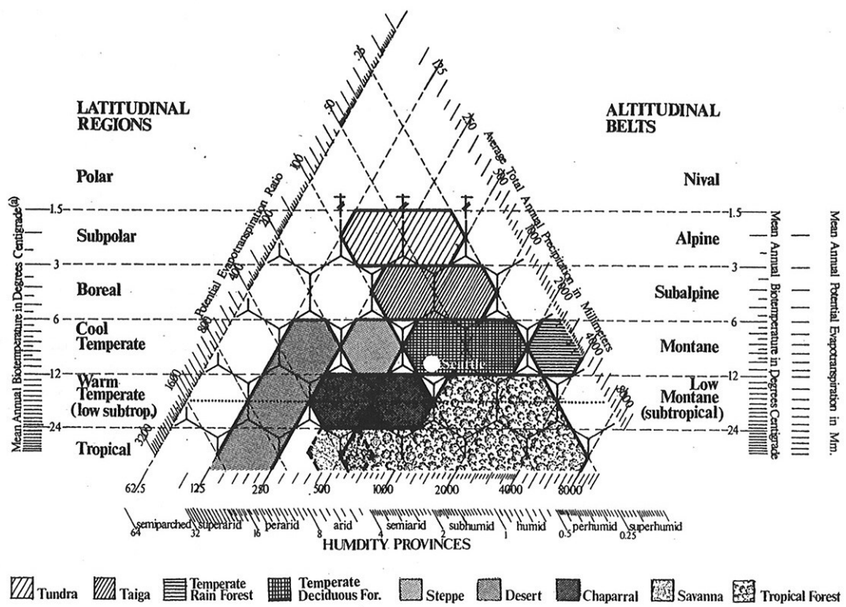
This parameter refers to the amount of water potentially evaporated from the environment and transpired by the vegetation at a given temperature under constantly optimal conditions of soil moisture and plant cover, i.e., climax vegetation. A simple formula for expressing potential evapotranspiration (PET) is: PET = mean annual temperature (degrees Centigrade) x 58.93, the PET expressed as mm rainfall. If rainfall and PET are equal, the PET/precipitation ratio is 1.0. Any region with a PET ratio greater than 1.0 can be considered dry, with a moisture deficit, and any region with this ratio less than 1.0 can be considered wet, with a moisture excess. The importance of this ratio is that it takes into account the interaction of temperature and precipitation in controlling soil moisture and humidity, of great importance to vegetation. For example, 250 mm of precipitation in the tropics would evaporate very rapidly with the high temperatures there, producing a very dry environment, whereas the same amount of precipitation in the Arctic would evaporate very slowly and produce a moderately wet environment.

Potential Bioclimatic Zones: Holdridge System & Others

As mentioned, Holdridge (1972) has devised an objective system of classifying life zones, or bioclimatic zones. By construction of a triangle, using the three parameters of temperature, precipitation, and evapotranspiration as the three axes of the triangle, any spot on earth with climatic records can be placed in one of the Holdridge life zones. The life zone designations are those of the "climatic association" characteristic of the zone, i.e., the normal climatic climax vegetation. This can be much modified by edaphic (non-climatic) factors so that many plant associations are possible within each life zone, but there should be only one type of climax vegetation.

The Holdridge system is of great value in being totally objective, although its utility has been tested and confirmed in tropical regions and only incompletely so in temperate regions. One of its values, however, lies in its two-dimensionality, so that any two sites can be plotted on it and compared.

Numerous other classification systems of life zones, or world vegetation zones, exist, of which Schimper and von Faber (1935), Odum (1971) and Walter (1973) have been examined in detail. There is major agreement among these systems, with differences reflecting the authors' attitudes toward the relative magnitudes of differences between plant associations and their significance. We have integrated these systems into the Holdridge model so that vegetation types can be looked at in terms of actual climatic variables. The following diagram integrates the bioclimatic zones chosen for replication at the zoo (see below) into the Holdridge system.



Simplification for the Zoo

The bioclimatic zones presented herein are of great importance in the evolution and distribution of plant communities and in turn of animal communities. However, birds and mammals, with their physiological homeostasis and well-developed dispersal powers, tend to range widely - larger species especially occur in a variety of plant associations. Because of this, the bioclimatic zonal system has been simplified for the purposes of animal exhibition at the zoo.

Ten bioclimates were selected for replication at the zoo: 1) Tropical Forest; 2) Savanna; 3) Desert; 4) Steppe; 5) Chaparral; 6) Temperate Deciduous Forest; 7) Temperate Rain Forest; 8) Taiga; 9) Tundra; and 10) Montane.

Biological Characteristics of the Bioclimatic Zones

Tropical Forest

TROPICAL FOREST. The trees are giants, reaching to 180' as emergents and over 100' as a continuous canopy. The vegetation is somewhat layered, with emergents, canopy, and understory trees and a less well-developed shrub and herb layer. In climax forest the understory is very open, easily permitting passage of large animals. The tree trunks are slender, but many of them have flaring buttress roots to increase their stability in the relatively shallow soil. The leaves of the canopy trees tend to be leathery and drought resistant, but the species within the canopy are much more subject to desiccation if removed from their very equable microclimate. Lianas and epiphytes are characteristic. The diversity of plant species is highest in this zone, with as many as hundreds of species of trees in a few acres in the best-developed forests. Palms are abundant in the New World, less so in Asia and virtually absent from African forests. Leaf cover is so extensive in this highly insolated zone that in many forests less than 1% of the available sunlight reaches the forest floor, and there are very few forest-floor herbs.

In the tropical deciduous forest the trees are lower (canopy 30-80') than in the evergreen ("rain") forest, and many or most of them are deciduous during the dry season, the degree of leaf-fall determined by the length of the drought period and the proximity of the trees to ground water. Some species, especially those of the understory, have small, hard leaves that are not dropped. This forest has a denser undergrowth than the evergreen forest, as there is much more light penetration. Lianas are less common, but drought-resistant epiphytes may be abundant, especially cacti, orchids and bromeliads. The Australian forests in this zone are characterized for the most part by evergreen *Eucalyptus*; this genus is primarily evergreen and furnished the raw material for the evolution of trees in the tropical deciduous zone in Australia, thus the forest there has a very different aspect from those elsewhere in the zone.

Thousands of species of trees of many, many genera in many families occur in the Tropical Forest Zone. Characteristic of many of them are smooth, light-colored trunks, buttressed bases and leaves with elliptic shape, entire margins and an elongate tip; in fact the similarity in leaf type among so many distantly related groups is remarkable. Gymnosperms are virtually absent (except cycads), herbs are relatively rare, and monocots are especially prominent, including tree-like (Palmae, Cyclanthaceae, Musaceae, Zingiberaceae, Marantaceae) and epiphytic (Araceae, Bromeliaceae, Orchidaceae) ones. Some indication of the diversity is provided by a list of dicot families that are very diverse in the tropics, with hundreds of species in each: Piperaceae, Moraceae, Annonaceae, Lauraceae, Capparidaceae, Leguminosae (mimosa- and cassia-types), Meliaceae, Anacardiaceae, Sapindaceae, Sterculiaceae, Guttiferae, Myrtaceae, Melastomaceae, Araliaceae, Myrsinaceae, Sapotaceae, Bignoniaceae, Gesneriaceae, Acanthaceae and Rubiaceae. These families are entirely or largely restricted to the tropics.

This zone supports a very high diversity of animals as well. This diversity extends to the higher groups (families and orders) as well as to species, as there are more ways for animals to "make a living" in this zone than in any of the others, as the vegetation is so complex and food resources so varied. Most of the species are relatively "rare," that is, their population density is low, but the total abundance of all individuals of all species is as great as in any zone. Activity is year-round, although breeding is often seasonal, its cycle controlled by rainfall cycles. The diversity of large mammals is not as great as it is in more open habitats, where vegetation is not so dense as to preclude rapid locomotion. Arboreal types are prominent, and these include climbers (monkeys, prosimians, sloths, anteaters, pangolins, squirrels and procyonids),

gliders (flying squirrels, anomalurids, flying lemur) and fliers (bats). Bats are very much more diverse in the tropical forests than elsewhere and are responsible for much of the increase in mammalian diversity toward the equator. Caviomorph rodents (agoutis, pacas and their relatives) and small deer and antelopes furnish food for the larger carnivores (jaguar, leopard and tiger). Birds are incredibly diverse, with several hundred species possible in a few acres of Amazonian forest. Many of the treetop species are large, conspicuous and brightly colored, but the great majority of the understory species are cryptically colored and most often detected by their calls. Typical groups of the tropical forest include guans, pheasants, pigeons, parrots, hummingbirds, hornbills, puffbirds, toucans, woodcreepers, ovenbirds, antbirds, cotingas, manakins, flycatchers, pittas, birds-of-paradise, babblers, bulbuls and tanagers.

Savanna

SAVANNA. This zone encompasses basically grassland with scattered trees, the latter growing in situations in which their roots can penetrate into the water table, as through cracks in hardpan soils; where these situations are prevalent, this habitat grades into tropical deciduous forest or thorn forest. In most tropical grasslands, trees are present in varying densities; hence "savanna" rather than "steppe" for this zone. Many of the trees are the same as those of the nearby forests, but some are peculiar to the savanna. The diversity of plants is low, as they must be fire-resistant. Seasonality is pronounced, with a flush of growth of the grasses and annual forbs at the beginning of the wet season.

With lowered diversity it becomes feasible to list characteristic genera. In this zone, in drier areas the grasses *Panicum, Pennisetum, Andropogon* and *Imperata* are important, and tree genera include *Prosopis, Acacia, Curatella, Byrsonima, Adansonia* and *Euphorbia*. In wetter savannas the grasses *Leersia, Oryza* and *Paspalum* dominate, and palms are the predominant tree form.

The combination of different plant life-forms, combining features of grassland and forest, provides an excellent environment for many species. This is the home of the largest mammals of the World, the many African ungulates and elephant, and the large carnivores that feed on them. The same environment on the other continents is less rich in animal life but still has some species modified for savanna existence. Ostriches, rheas and emus, for example, are ecological savanna/steppe equivalents in Africa, southern South America, and Australia respectively. Australia has a variety of kangaroos as equivalents to the African ungulates, but South America has no such present-day fauna, most of its savanna animals being relatively small. The hoofed animals are important in regulating the height and diversity of the grassland plants, and each species of mammal has its own distinctive food habits and way of feeding. Only because of this can so many species coexist. The open substrate lends itself as a home to a wide variety of burrowing mammals, and their burrows in turn are habitats for other animals such as reptiles. In this and other open environments hawks, with their long-range vision, are very successful. As the savanna is a very seasonal environment, parts of it are much more suitable for animals at some times of the year than others, so many of the large mammals migrate in Africa, and the same is true for many of the birds in Australia, where rainfall is even more unpredictable.

Desert

DESERT. Scattered, well-spaced shrubs with numerous branches from the ground level and small, thick leaves are characteristic of this zone. Two other plant life-forms also occur commonly: succulents that store water in their stems and quick-growing and -flowering annuals that sprout immediately after the infrequent heavy rains. Rainfall is always low but variable, from widely spread to seasonal to totally unpredictable. The soils are often highly alkaline because of the high evaporation rate and lack of run-off, and this further limits plant growth.

Characteristic members of the three plant life-forms of this zone include: (1) small-leaved shrubs--*Acacia, Prosopis, Cercidium, Larrea* and *Commiphora*; (2) succulents--*Opuntia* and other cacti, *Agave, Yucca, Aloe, Sanseviera, Crassula,* euphorbias and milkweeds; and (3) ephemeral annuals--grasses, *Mesembryanthemum* and members of the Polemoniaceae and Boraginaceae.

In this environment many of the animals possess special physiological and/or behavioral adaptations to allow them to exist with minimal water supply. Because of this, there is much convergence on certain life forms among the animals of the different deserts of the World. For example, medium-sized, long-legged, sandy-colored rats or rat-like animals with long tails occur in most of the major deserts, but they represent only distantly related groups--the kangaroo rats of North America, jerboas and gerbils of Africa and Asia, and dasyures of Australia. Other examples include kit foxes of America and fennecs of Africa; and jackrabbits of North America, caviids of South America and small kangaroos of Australia. Most of the mammals are nocturnal, active at a time when humidity is higher and predation by birds is reduced, but ground squirrels can be active during the hottest part of the day. The predominant color of small animals in this environment is that of the substrate, whether light or dark sand, as they are much subject to predation by visually oriented predators in this open environment. Reptiles are well adapted to dry climates and are well represented in deserts.

Steppe

STEPPE. This zone is widespread in the interiors of continents and characterized by the low stature of its plant species, composed of various grasses and forbs. It varies depending on rainfall from more open with shorter grass to very dense with tall grass. In the drier areas bunchgrasses predominate, with open space between the plants. This habitat is much subjected to grazing pressure from large mammals, and the grasses reproduce vegetatively to a large extent when this is the case. The spring is usually wet, with much flowering of the forbs, but many of the plants dry out by late summer, and brown is the prevailing color then. This habitat is also an edaphic climax where there is a high water table or much fire in wooded regions, and the edge between it and the deciduous forest or it and the taiga shifts depending on drainage patterns and fires.

The tall grasses of wetter areas include *Andropogon, Panicum, Sorghastrum* and *Spartina,* medium grasses of intermediate areas include *Andropogon, Stipa, Sporobolus, Agropyron, Koeleria* and *Oryzopsis,* and the short grasses of drier areas include *Buchloe, Bouteloua, Poa* and *Bromus.* Forbs of a wide variety of families are also present.

The colder grasslands, like the tropical savannas, support populations of large ungulates that move over the landscape in regular migrations, cropping grasses and forbs and moving on as the food resources become depleted. There are fewer herbivore species in this zone than in the savanna, and in particular fewer predators on them, the wolf and its smaller relatives the coyote and jackals. As in the savanna, there is a variety of burrowing herbivores, some of them colonial, and carnivores that specialize on them. The diversity of steppe birds is much lower than that of the lower-latitude savannas, only a few hawks, shorebirds and ground passerines being typical in the northern hemisphere. This habitat in South America supports more species, most of them of tropical origin and thus similar to or identical with the savanna species of that continent.

Chaparral

CHAPARRAL. This vegetation may be composed of very densely packed shrubs, as in California, or of these shrubs and trees to 40-50' canopy height, as in the original vegetation around the Mediterranean. Much of the latter has now been replaced by vegetation more like that in California, and the California chaparral may be a fire climax rather than a true climatic climax. The vegetation is evergreen, with small, thick leaves (sclerophyllous).

Characteristic trees include evergreen oaks *(Quercus), Olea* and *Cupressus;* shrubs, which are much more diverse, include *Adenostoma, Arbutus, Arctostaphylos, Buxus, Cistus* and *Ceanothus.*

Because of the density of this vegetation type, most of its mammals and birds are small, and the majority are cryptic. Wrens, sparrows, babblers, small squirrels and rabbits, and mice are characteristic, although all of these groups are common in other zones as well.

Temperate Deciduous Forest

TEMPERATE DECIDUOUS FOREST. These fairly tall forests are characterized by obligatory leaf-shedding during the cold season. The forest is multilayered, with 1-2 tree layers and a shrub and a herb layer. With the great amount of light penetration in early spring, there is an abundance of herbaceous species flowering at that time. Some of the tree species produce large edible nuts and characteristically drop great quantities of them ("mast") in certain years. Pines may form an edaphic climax in this zone, and the ecotones between it and the taiga and it and the steppe may be very wide.

This zone varies from single-species to multi-species dominance. Common genera are *Acer, Fagus, Quercus, Carya, Juglans, Fraxinus, Populus* and *Salix*. There is a great diversity of shrubs, some of them evergreen, and many herbs of the Orchidaceae, Liliaceae, Ranunculaceae, Rosaceae, Saxifragaceae and other families.

This is the most seasonal, in terms of environmental changes, of the habitats discussed thus far, and there is pronounced seasonality in its fauna. Many of the mammals hibernate, and some of the bats and over half of the birds migrate toward the equator in fall and back in spring. Food storage is feasible because of the ease in storing substances at low temperatures, and this adaptation is important to some mammals of this zone, in particular squirrels, which harvest the nuts produced by trees of the beech and maple families. These forests support a moderately diverse assemblage of animals from large carnivores and their ungulate prey through a great variety of small rodents and birds.

Temperate Rain Forest

TEMPERATE RAIN FOREST. The tallest forests in the World lie in this zone, on the Pacific coast of North America. The dominants are all conifers, but hardwoods play an important part during succession and are locally abundant. Some evergreen hardwoods occur in the understory, and the herb and shrub layers are well represented, as there is much more light penetration than in the tropical rain forests. The humidity is high, maintained by rainfall and coastal fogs, so epiphytes are abundant, although they are mostly mosses and lichens, as at high altitudes in the tropics. The forests in this zone in Australia and New Zealand are lush and dense, with a much higher proportion of hardwoods and superficially much like tropical forests.

Large conifers dominate in North America: *Abies, Tsuga, Picea, Pseudotsuga, Thuja* and *Sequoia*. Understory trees include *Alnus* and *Acer*, and shrubs of the Ericaceae are prominent. The herbaceous understory includes many ferns (Polypodiaceae) and species of Saxifragaceae, Liliaceae, Orchidaceae and many other families. In Australia and New Zealand *Eucalyptus* and *Agathis* predominate.

The fauna of this zone is not characterized by any special attributes, as most of its species are the same as or related to species of other zones. Its faunal distinctiveness is enhanced because it is well represented in Australia and New Zealand, which have very distinctive faunas, but even there no particular types of adaptations are evident. The species of this zone in the Pacific Northwest are the same as or closely related to those of the taiga and the temperate deciduous forest of the same continent.

Taiga

TAIGA. This high-latitude zone is characterized by extensive fairly dense stands of conifers, which reach sizes comparable to the trees of the temperate deciduous forest. They are often so dense that there is little understory vegetation, and the temperatures are low enough so litter accumulates faster than it is decomposed. Because of glacial scouring, ponds and lakes are extremely numerous in this zone.

With increased latitude the plant diversity decreases greatly, and at any one site there are only a few species of trees in this zone. The Pinaceae includes most of the dominants *(Abies, Picea, Larix, Pinus)*, but under many edaphic conditions broad-leafed trees may be abundant, in particular *Betula, Populus* and *Salix*. Ranunculaceae, Rosaceae and Saxifragaceae provide many of the herbaceous species.

This zone supports a low diversity of characteristic animals, many of them occurring throughout the World at high northern latitudes. Relatively large size, heavy insulation, hibernation and food storage are characteristic of many of the mammals, and most of the birds migrate out of this zone in the winter. Even in this relatively harsh climate, however, there are

species of songbirds and small rodents that remain active all winter, and many predators (cats, foxes, wolves, mustelids, hawks and owls) are similarly active. Large browsing mammals are as common as in the temperate deciduous forest and rain forest farther south. Cyclic population oscillations characterize some species of both this zone and the next one.

Tundra

TUNDRA. This is basically a two-dimensional habitat, like the steppe, but mosses and lichens are much more important components of the vegetation. In most areas the permafrost just below the ground surface traps the relatively small amounts of precipitation, so the landscape can be very wet, but ridges may be extremely dry with no plants other than scattered lichens. Grasses and sedges and many forbs are abundant, and dwarf willows in many areas form beds of low shrubs. Alpine tundra, with no permafrost and a different photoperiod regime, is still much like arctic tundra, but in the tropics the same zone is very different, as it receives no snow and has little seasonal temperature variation. The plant physiognomy is still similar, with grasses and low chaparral, and above them a cold desert with widely spaced low herbs.

Lichens of many kinds *(Cladonia, Cetraria, Thamnolia)* and mosses *(Polytrichum)* are characteristic, as are sedges *(Carex, Eriophorum)* and grasses *(Poa, Elymus)*. Dwarf species of *Salix* and *Betula* are shrublike to sprawling; otherwise only herbs are present. Common dicot genera include *Draba, Saxifraga, Dryas, Oxytropis* and *Pedicularis*.

This zone, with its very harsh climate and short growing season, supports a very low diversity of resident animals, but a surprisingly large number of birds, especially shorebirds, visit it in the summer to breed during the brief period of insect abundance. As in other open areas there are large herds of ungulates, but here the permafrost layer precludes burrowing in many areas. Hibernation is also impossible in high-arctic mammals, as temperatures are too low to sustain metabolism through the winter. Cold-blooded animals except insects and spiders are absent.

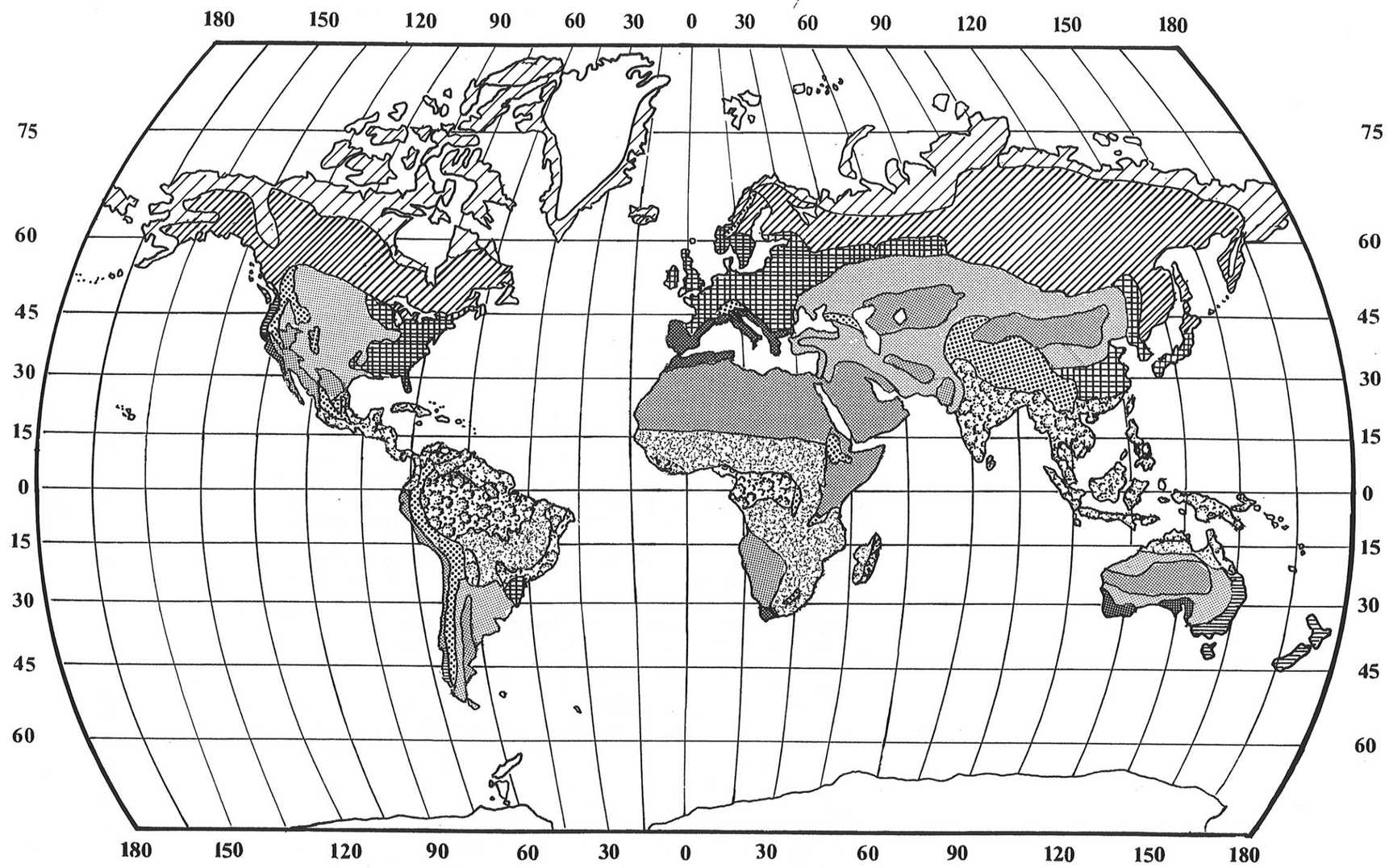
Montane

MONTANE. This zone is characterized by high relief and generally high altitudes. It contains elements of both taiga and tundra, its timberline much like the ecotone between those two zones. Many high-altitude areas are rugged and rocky, and talus slopes and scree fields are typical, but other areas are gentler and may lack rocks. Climate varies from equable at lower latitudes to extremely severe at high latitudes and altitudes. Precipitation varies considerably as well, depending on location of the mountain range.

Accordingly, a great variety of plants occur, in particular those with affinities to the flora of the taiga and tundra. In the temperate zone, conifers predominate in montane areas, often similar to related species of the taiga. Within and above the conifer zone, subalpine and alpine meadows and fell fields contain species of widely distributed northern genera such as *Phlox, Dryas, Lupinus, Oxytropis, Gentiana, Pedicularis* and others. However, the flora of equatorial montane areas is more often derived from the surrounding tropical lowlands, and the plants are thus quite different from ecologically equivalent plants in temperate montane areas.

As in the plants, the animals of the temperate-zone montane regions find their closest relatives in the arctic and subarctic, and adaptations for dealing with extreme temperature variations and long winters are emphasized. In addition, there is a premium on locomotory adaptations to traverse the rugged physiography. Ungulates are especially successful under these conditions, and there are many species of sheeps and goats at high altitudes. Pikas and marmots are widespread, and large birds of prey find the wind conditions ideal for soaring while hunting these same mammals. Again, in tropical montane regions the animals are derived from related species in the lowlands, and animals such as tapirs and leopards may ascend to considerable heights.

The map on the following page expresses the distribution of the major bioclimatic zones around the world. It has been adapted from the world map by Odum (1971) to fit our scheme for the zoo.



World Bioclimatic Zones

- Steppe
- Desert
- Chaparral
- Savanna
- Tundra
- Taiga
- Temperate Rain For.
- Temperate Deciduous For.
- Montane
- Tropical For.

Transitions between Bioclimatic Zones

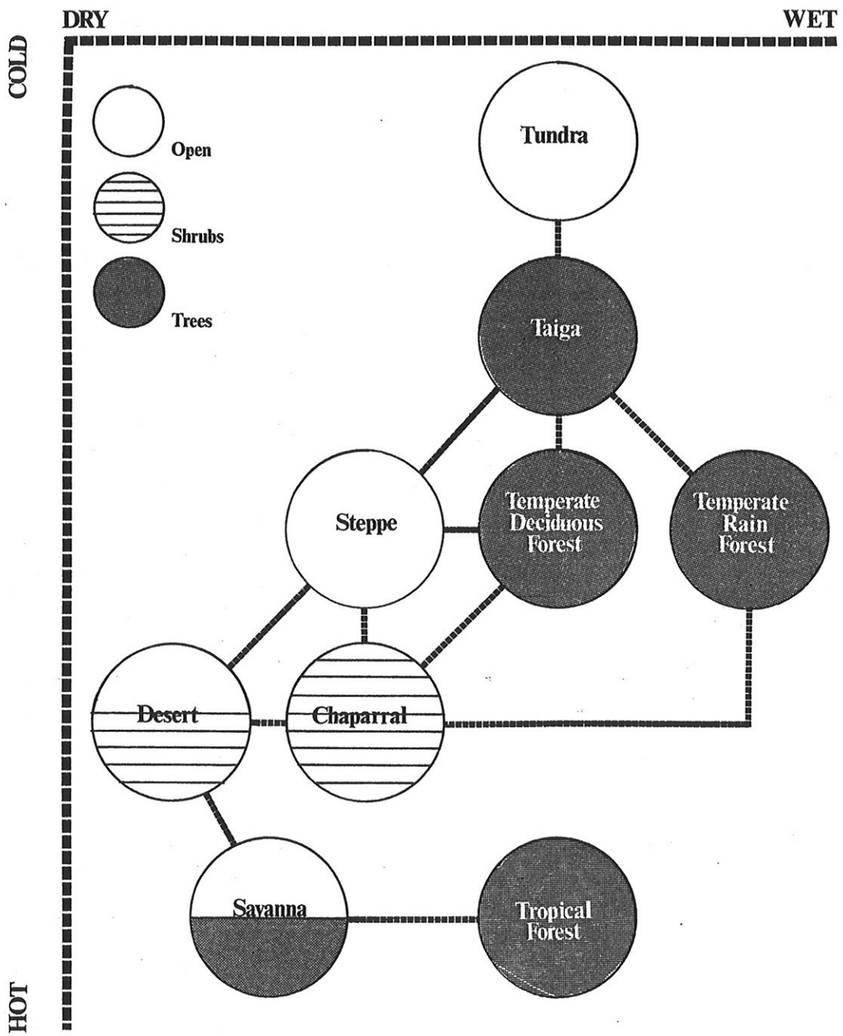
In nature most habitats interdigitate into one another in a complex manner. In some cases the transition is sharp, the ecotone (intermediate habitat) narrow or nonexistent, but in other cases there is a gradual transition from one type of environment into another. The same is true with the larger-scale bioclimatic zones. As would be suspected from the Holdridge diagram, a given zone may contact and intergrade with a number of other zones, varying with temperature and precipitation. In some cases this is only a potential contact, as barriers (mountains, ocean) prevent contact in areas in which it might occur, i.e., areas of climatic intermediacy.

The following analysis of transitions considers the zoo bioclimatic zones from the equator poleward. Tropical forests grade into savannas in all the regions in which the latter occur. As rainfall decreases, it becomes more difficult for trees to exist, and the wet forest gives way to deciduous and then thorn forest, which grades in turn into grassland with scattered trees at the low end of the rainfall gradient. Soil types may vary little along this gradient, but, as previously stated, tree growth may be precluded over the savanna areas by the presence of a hardpan layer beneath the surface that prevents their roots from reaching the water table. In other areas, as rainfall decreases a gradual transition from tropical forest through thorn forest to desert occurs. In the same manner savannas can grade into deserts.

Both hot and cold deserts in many parts of the world border on steppes, usually with an increase in rainfall. Under the same climatic regime, an increase in elevation produces the same gradient, as more moisture condenses out of the air under conditions of lowered temperature. The transition is a smooth one, the desert shrubs increasingly replaced by grasses and forbs. With progression toward the coast and increased precipitation, in particular in regions with only winter rainfall, desert shrubs grade into chaparral, which in turn interdigitates with other habitats such as temperate deciduous and rain forests as the mean temperature decreases with higher latitude. The rain forest conifers are replaced by those of the taiga toward the north in the northern hemisphere.

The steppes in turn border on both temperate deciduous forests and taiga, primarily by the interdigitation of forest and open vegetation rather than by a smooth transition. Patches of grassland within forests and forest within grasslands are common. This edge is controlled by factors that are not always understood, but probably both rainfall (higher in forested areas) and fire (maintaining grassland) are important.

With increased latitude deciduous forests become mixed and eventually predominantly conifers of the taiga, with a gradual change in the relative proportions of the two tree types. Pines and some other conifers are common throughout the deciduous forests, and birches and aspens grow widely in the taiga, so neither type is "pure". In some regions, these two forest types are separated by grasslands, as in the Great Plains of North America.



Finally, toward the north the taiga trees become shorter and shorter and grade into tundra, which in turn becomes less and less complex and lower and eventually disappears into areas of perennial ice and snow.

These same sorts of changes occur with increasing altitude in temperate-zone mountains, and in an amazingly short distance in western North America one can ascend from desert through grassland and increasingly wet coniferous forest to alpine tundra. Many of the plants and animals of each of these zones are the same as or close relatives of species characteristic of the zones at sea level at higher latitudes. Because of both climatic (wind direction, slope exposure) and edaphic (soil type, ground water, presence of fire) factors, a very complex pattern of intermingling of bioclimatic zones may occur in mountainous regions.

Duplication and Simulation of the Bioclimatic Zones

The Seattle Climate

Of obvious critical importance in determining whether various bioclimatic zones can be duplicated at the zoo is a consideration of the basic Seattle climate. Mean long-term figures for Seattle show a mean annual temperature of about 11°C. and a mean annual precipitation of about 800 mm. It thus has a PET ratio of about 0.8, making it a wet climate. The rainfall varies over the year considerably, from 131.1 mm. in the wettest month (December) to 14.2 mm. in the driest month (July). Thus the climate is not dissimilar to the Mediterranean (winter-rain) conditions prevailing farther south, but it is colder. Mean monthly temperatures vary from 4°.5 C. in January to 18.8°C. in July, with well-defined seasonality in temperature, although less than interior localities at the same latitude. The placing of Seattle on the Holdridge diagram allows us to assess the feasibility of duplicating bioclimatic zones of increasing distance away from the Seattle point on the diagram. Clearly the location of Seattle not too distant from the exact center of the life zones considered on the diagram accounts for the amazing variety of plants that can be grown horticulturally in this region, and it is important evidence for the feasibility of the planned presentation theme.

Bioclimatic Zones Duplicable with Little or No Modification

Seattle falls within the cool temperate latitudinal region on the Holdridge diagram, and any zone in that region should be duplicable if moisture regimes can be controlled. The deciduous forest and the coniferous forest zones (especially the temperate rain forest) are clearly totally feasible, as a great variety of temperate-zone conifers and hardwoods grow well in the Seattle area. By reducing soil moisture a steppe climate can be simulated with relatively little difficulty. Large tracts of grassland, kept in an early successional stage by grazing and/or mowing, exist in the Puget Sound lowlands, and soil type and drainage can be adjusted to provide either wetter (long-grass) or dryer (short-grass) situations.

Bioclimatic Zones Duplicable with Moderate Modification

In the same temperature zone, cold-desert (and thereby desert in general) conditions could be simulated by providing maximum drainage of surface soil water. Certain plants grown in Seattle because of their attractiveness *(Yucca, Kniphofia)* are characteristic of deserts, and additional plants from similar areas should grow here if the appropriate steps are taken. However, many of the typical plants of the hot deserts (most cacti, for example) will not grow outside in Seattle. Moving into the next colder temperature zone, the boreal, an environment of the nature of that of the true taiga will be possible, as trees of all the genera characteristic of that forest can grow in Seattle, for example spruce *(Picea)*, fir *(Abies)*, pine *(Pinus)*, larch *(Larix)*, and birch *(Betula)*. It will prove more difficult and challenging to duplicate a typical muskeg pond of this zone, but the plants that live at the edges of such a place are obtainable from acid bogs in western Washington if the acidity of the water can be controlled in the zoo situation.

Moving still farther north, the tundra zone is rather dissimilar to the Seattle region in climate, yet in physiognomy it is much like the steppe, which is easily simulated here. A major difference is the prevalence of lichens and mosses in the tundra and its generally wetter nature; the former may be more difficult to provide than the latter, but it may be feasible to import lichen-covered rocks for this purpose. This fortuitous similarity in physiognomy of two vegetation types under very different climatic regimes provides additional incentive for the presentation theme.

Tropical savanna can be simulated by combining grassland (previously discussed) with certain trees with the general appearance of savanna trees. For example, acacias are characteristic of many savannas, and the black locust *(Robinia)* that grows well in

Seattle has many of the features of acacias, which are in the same family. This similarity holds for typical thorn forest trees, many of which are in this group (Leguminosae).

The tropical rain forest is certainly the most difficult habitat to simulate outside at this latitude, as many of its characteristics are not duplicated in plants that can be grown outside here, for example the buttressed-rooted trees, the palms, the lianas and the epiphytes. The subtropical rain forests, found naturally between the tropical rain forests and the temperate deciduous forests, are intermediate between them in some aspects of physiognomy, but many of the plant species characteristic of the subtropical forests will grow in Seattle -- evergreen magnolias *(Magnolia)*, hollies *(Ilex)*, live oaks *(Quercus)* and other evergreen trees. For those tropical-zone animals that must be exhibited or that can be exhibited out-of-doors, these evergreen, glossy-leaved trees can provide some simulation of tropical forest.

Bioclimatic Zones Duplicable Only Indoors

As discussed above, very good duplication of the tropical forests and hot deserts may be possible only under controlled climatic conditions, and the same may be true for tundra. Approximate simulation should be possible out-of-doors, and there is every reason to believe that additional research will show additional species of plants that would contribute to such a simulation.

Plants Suggested for Simulating Zones Difficult to Duplicate

The following list includes plants that are known to grow in the Pacific Northwest that simulate plants not hardy here but characteristic of the warmer bioclimatic zones. Aquatic plants and grasses other than canes and bamboos are not listed. The list is by no means exhaustive but should provide a variety of ideas for later design development. *Care must be taken to determine if any of these species is potentially toxic to any animal with which it might be exhibited.* This applies as well to plants recommended in scenarios.

TROPICAL FOREST

Actinidia chinensis
Ailanthus altissima
Akebia quinata
Albizzia julibrissin
Arundo donax
Aucuba japonica
Azara microphylla
Bambusa spp.
Camellia japonica
Camellia sasanqua
Camellia sinensis
Catalpa bignonioides
Chamerops excelsa
Chamerops humilis
Choisya ternata
Clematis armandii
Diospyros kaki
Diospyros virginiana
Eriobotrya japonica
Euonymus fortunei radicans
Euonymus myriantha
Fatsia japonica
Ficus carica
Gunnera chilensis
Gunnera manicata
Hosta spp.
Hydrangea aspera
Hydrangea petiolaris
Hydrangea quercifolia
Ilex altaclerensis
Ilex chinensis
Ilex platyphylla balearica
Lagerstroemia indica
Laurus nobilis
Ligularia dentata
Ligularia tussilaginae
Ligustrum lucidum
Magnolia fraseri
Magnolia grandiflora
Magnolia macrophylla
Magnolia obovata
Magnolia tripetala
Magnolia virginiana
Nandina domestica
Parrotia persica
Paulownia tomentosa
Peltiphyllum peltatum
Petasites japonicus
Photinia glabra
Photinia x fraseri
Phragmites communis
Phyllostachys spp.

Pieris japonica
Polygonum auberti
Polygonum cuspidatum
Polygonum sachalinense
Prunus caroliniana
Prunus laurifolius
Prunus lusitanica
Prunus virginiana
Pyrus kawakami
Quercus laurifolia
Rhododendron spp.
Rhus tricolor
Sarcococca humilis
Sarcococca ruscifolia
Sasa spp.
Sophora japonica
Sycopsis sinensis
Ternstroemia japonica
Trachelospermum jasminoides
Trachycarpus fortunei
Trochodendron aralioides
Umbellularia californica
Viburnum rhytidophyllum
Vitis californica
Vitis coignetiae
Wisteria chinensis
Wisteria japonica

SAVANNA

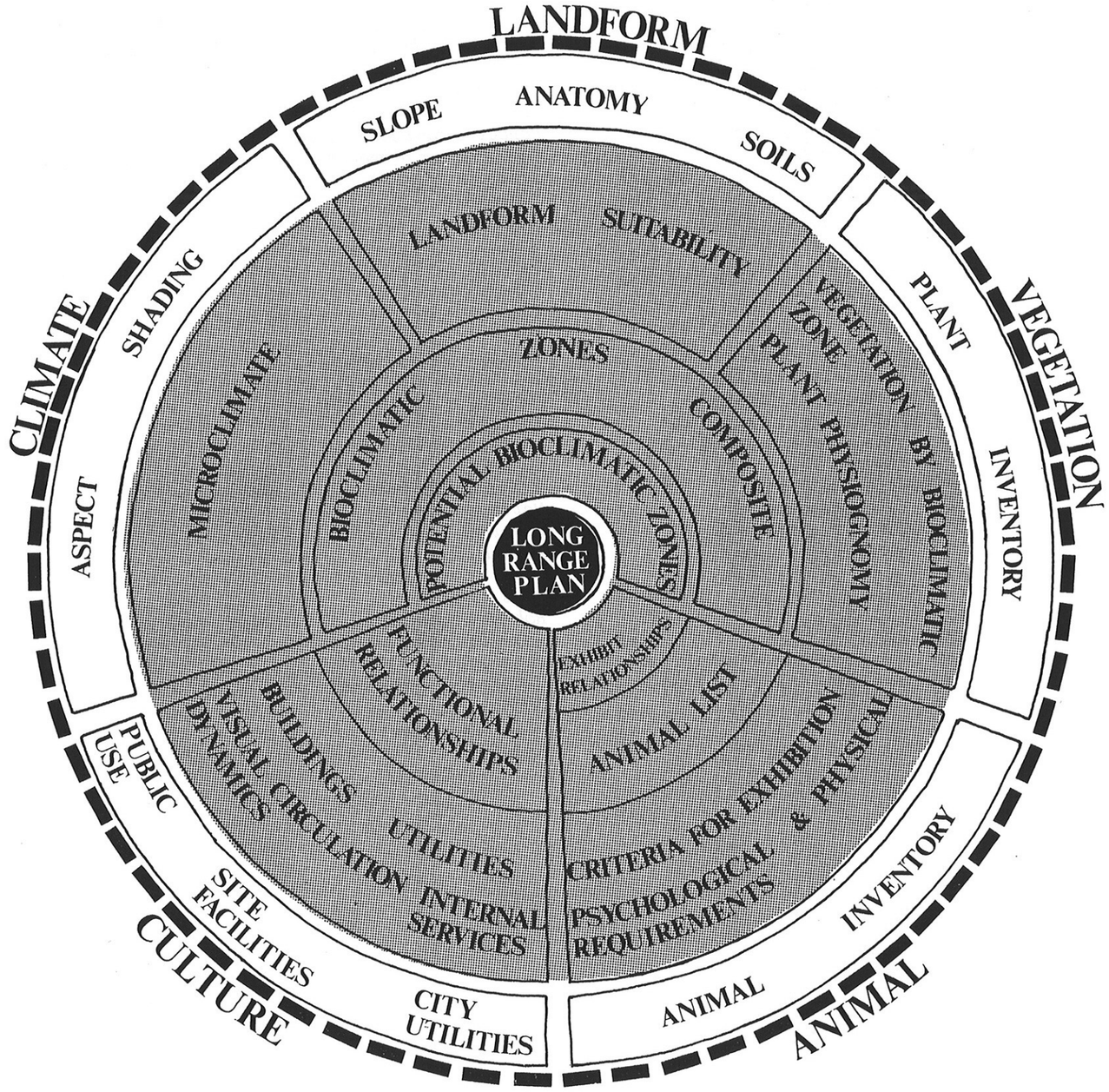
Ailanthus altissima
Albizzia julibrissin
Aralia elata
Aralia spinosa
Berberis thunbergii
Berberis triacanthophora
Caragana arborescens
Caragana pygmaea
Chaenomeles spp.
Crataegus crus-galli
Crataegus lavallei
Cydonia vulgaris
Elaeagnus angustifolia
Elaeagnus pungens
Elaeagnus umbellata
Eucalyptus niphophila
Genista hispanica
Gleditsia triacanthos
Hippophae rhamnoides
Lonicera tatarica
Lycium halimifolium
Maclura pomifera
Melia azedarach
Poncirus trifoliata
Prunus spinosa
Pyrus ussuriensis
Rhus typhina
Robinia hispida
Robinia pseudoacacia
Rosa acicularis
Shepherdia canadensis
Sophora japonica
Ulex europaeus

DESERT

Artemisia tridentata
Caragana spp.
Cistus spp.
Cytisus battandieri
Ephedra spp.
Genista hispanica
Genista horrida
Nolina microcarpa
Opuntia spp.
Pediocactus simpsonii
Tamarix spp.
Yucca spp.

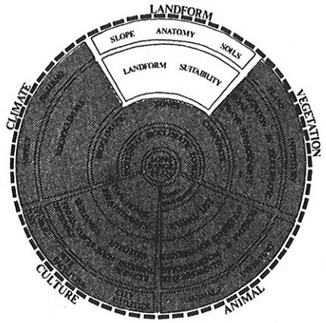
CHAPARRAL

Adenocarpus decorticans
Aesculus californica
Arbutus menziesii
Arbutus unedo
Arctostaphylos auriculata
Arctostaphylos columbiana
Arctostaphylos manzanita
Arctostaphylos stanfordiana
Baccharis spp.
Ceanothus griseus
Ceanothus incanus
Ceanothus jepsonii
Ceanothus thrysiflorus
Ceanothus veitchianus
Ceanothus velutinus
Cercis occidentalis
Cercocarpus ledifolius
Cistus spp.
Chrysolepis chrysophylla
Convolvulus mauritanicus
Cupressus bakeri
Cydonia vulgaris
Cytisus spp.
Elaeagnus angustifolia
Erica arborea
Genista hispanica
Hippophae rhamnoides
Juniperus communis
Juniperus phoenicea
Lavandula officinalis
Lithocarpus densiflora
Myrica californica
Pinus edulis
Pinus halepensis
Pinus miricata
Pinus pinea
Pinus sabiniana
Quercus garryana
Quercus lobata
Quercus wislizenii
Rhamnus alaternus
Rosmarinus officinalis
Umbellularia californica

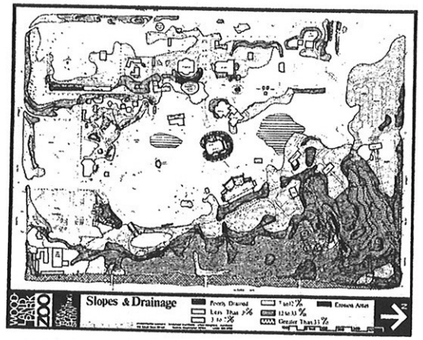


Design Framework For Development Of The Long-Range Plan

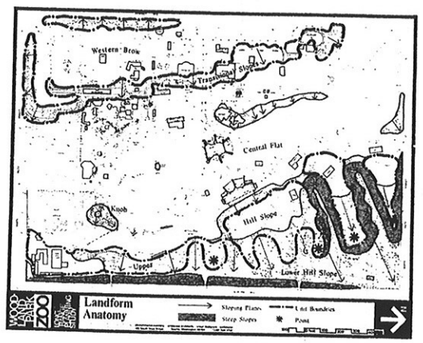
The mass of inventory data collected is organized into five interrelated groups of information: 1) Climate, 2) Landform, 3) Vegetation, 4) Culture, and 5) Animal Life. Each of these areas was first examined extensively (world and regional scale), then intensively (site scale). This centripetal process resulted in a sequential synthesis from *inventory* (cells in white outer band) through *analysis* (gray band), *generation of alternatives* (potential site bioclimatic zones) and *concept selection* (black central core). This sequence, explained in the METHODOLOGY SUMMARY as an expanding spiral of project development, is here shown inverted, emphasizing the focusing of generalized information towards the specific solution of project requirements. The study of world bioclimatic, animal and vegetational zones was previously discussed. The following pages record the major elements of the study applied to the site.



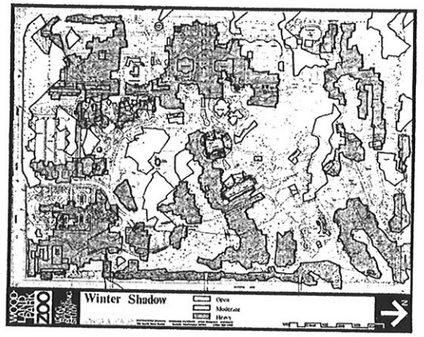
Landform

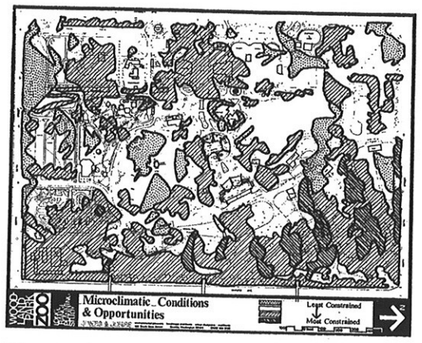


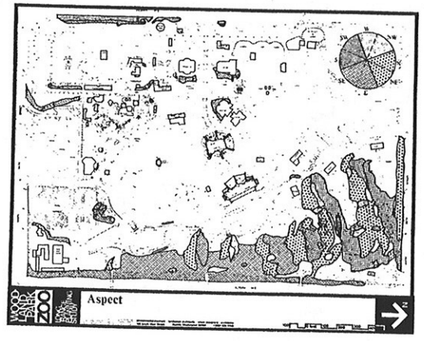
The inventory of microclimate includes mapping of SOLAR ASPECT AND INSOLATION along with WINTER SHADOW PATTERNS. SUMMER SHADE was also studied but proved to be less restrictive in this climate and was thus not included.

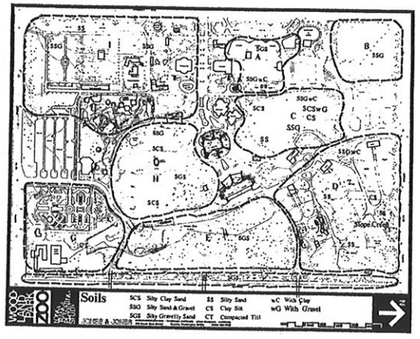


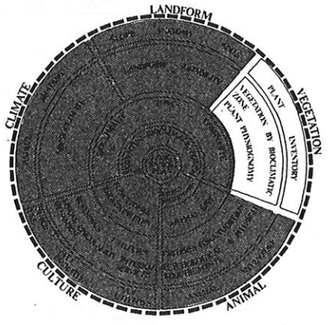
These maps record SITE ANATOMY, SOILS and SLOPES AND DRAINAGE. Soils are generally good, but are underlain by impervious hardpan at a depth of 3'-4'. The large central meadows have inadequate drainage and some erosion is found in the site's northeastern area.



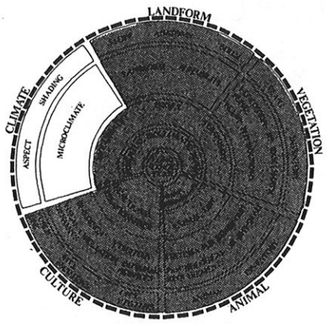




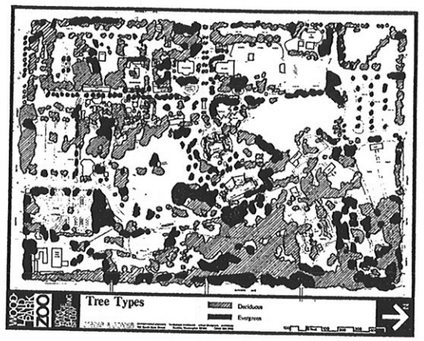




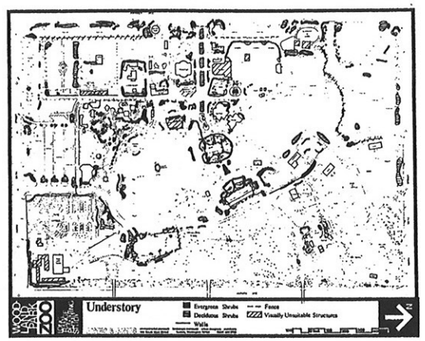
Vegetation

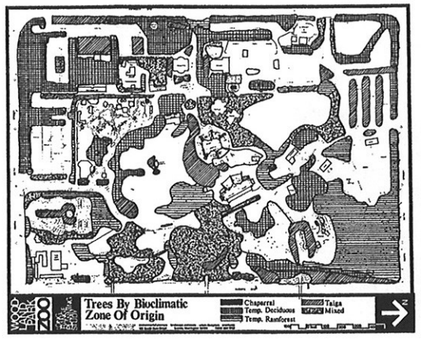


Microclimate



Existing vegetation at Woodland Park was intensively inventoried, including identification and notation of conditions, size and canopy height. Included here are maps of TYPE (deciduous, broad-leaved evergreen and coniferous trees) and UNDERSTORY. The site has many notable trees and groves.





Bioclimatic Matrix

MICROCLIMATE	SAVANNA	DESERT	STEPPE	CHAPARRAL	TEMPERATE DECIDUOUS	TEMPERATE RAIN	TAIGA	TUNDRA	MONTANE	
Warm	●	●		●						
Moderate		●	●	●	●	●			●	
Cool			●		●	●	●		●	
Cold							●	●	●	
Dry	●	●	●	●					●	
Wet					●	●	●	●	●	
SLOPE										
0 - 3%			●					●		
3 - 7%								●		
7 - 12%				●					●	
12+%				●					●	
TREE COVER										
Open	●	●	●	●				●	●	
Deciduous	●				●	●				
Coniferous						●	●		●	
TREES BY ORIGIN										
Temperate Deciduous					●					
Temperate Rain						●				
Taiga							●			

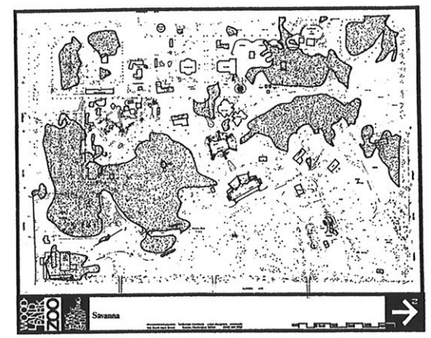
Establishing the Bioclimatic Zones

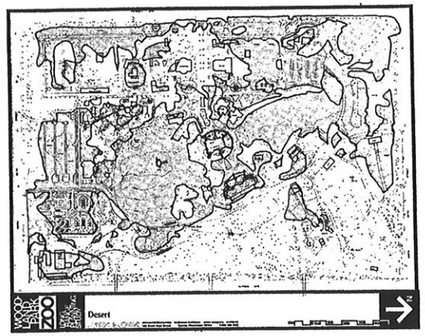
Analysis maps combined in this matrix identify areas most suitable for establishment of each zone. Areas having three or more overlapping attributes of a given zone (dots on the matrix) have primary suitability. Areas of secondary suitability are not shown but were used in the final determination of the Bioclimatic Composite.

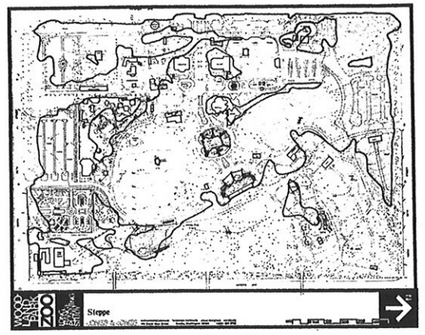
Once primary and secondary suitabilities were determined, potential zone areas were combined, first into Warm/Dry and Cool/Wet pre-composites and finally into a Bioclimatic Composite, which follow.

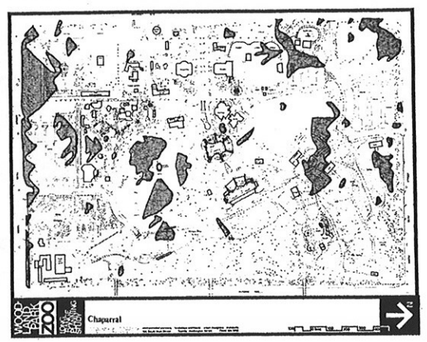
Individual Bioclimatic Zone Suitability

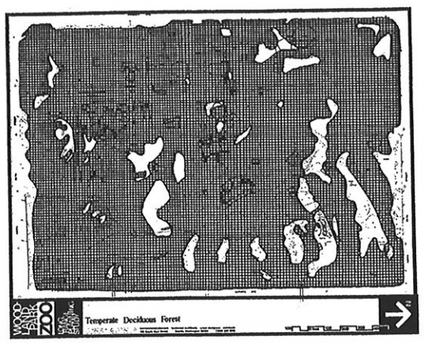
The results of the matrix interactions are shown on the following maps which locate areas best suited for replication of each bioclimatic zone.

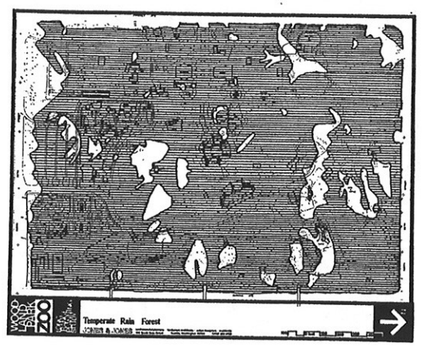


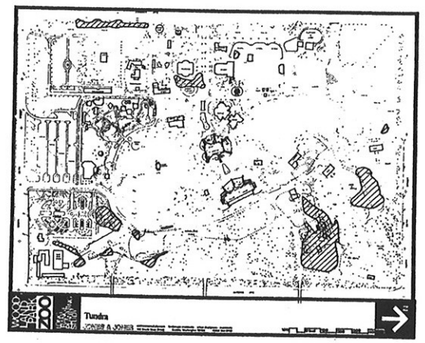


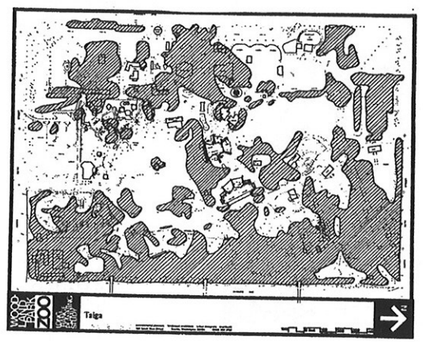


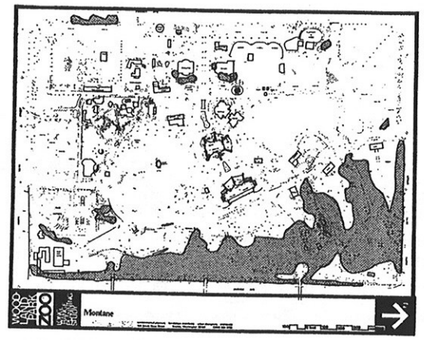












3. ABSORPTION
   Bioclimatic zones requiring a sense of open expansiveness (savanna, steppe, desert and tundra) require large areas which may absorb small islands suitable for other zones.

4. DELETION
   Areas too small to be feasible may be deleted and absorbed by surrounding zones.

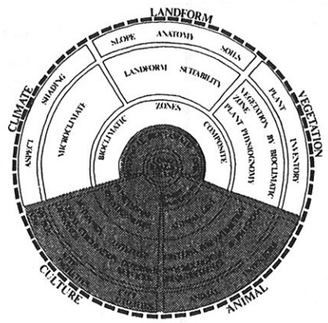
5. TROPICAL FOREST ZONE
   Because no areas of the site are exclusively suited to the replication of this zone, the following special selection criteria apply:

   a. Areas having a high spreading canopy of existing shade trees are preferred, this being a characteristic of tropical forests.

   b. Areas adjacent to existing structures exhibiting tropical animals (Reptile House, Nocturnal House and Feline House) are preferred.

   c. Areas located near the center of the zoo are preferred, allowing transitions to less exotic zones around the zoo boundaries.

Application of these criteria resulted in two separate equally suited areas.



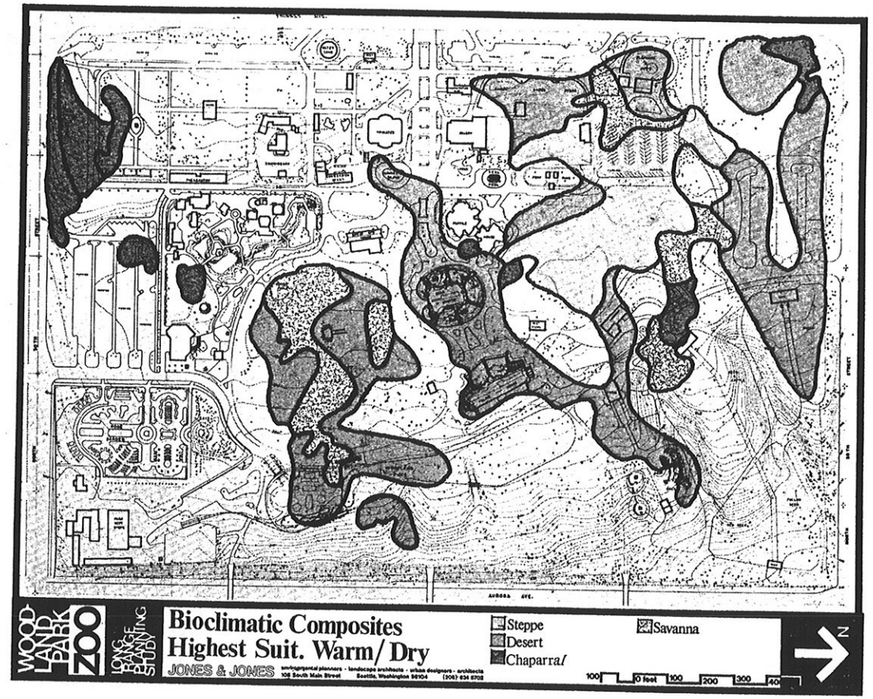
Criteria for Establishing Bioclimatic Composites

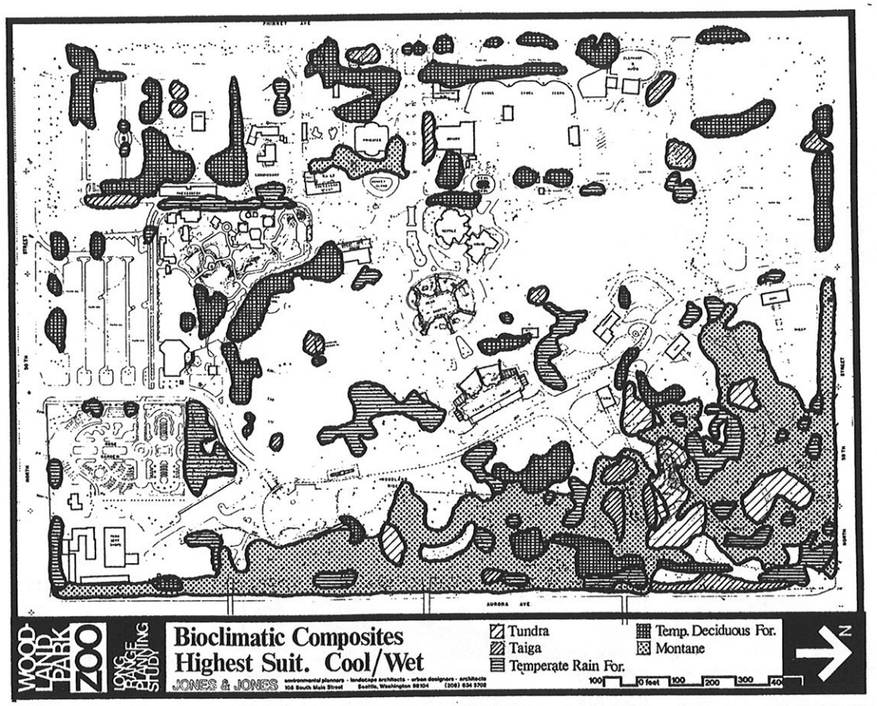
Criteria for Establishing Bioclimatic Composites

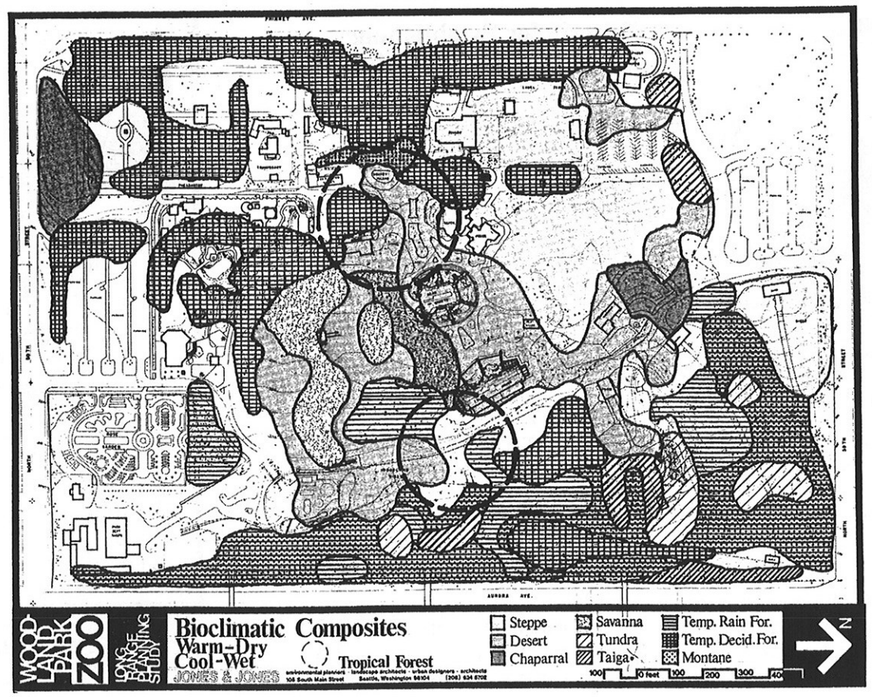
1. PRECEDENCE
   a. Areas of Primary Suitability have priority over areas of Secondary Suitability.

   b. Areas suitable for warm/dry bioclimates are more unusual in the Seattle area and therefore have priority over cool/wet areas.

2. LOCALIZATION
   All areas of a single bioclimatic zone should be localized to one contiguous area of the site except for tropical forest areas (see below).







Additional Criteria for Refining Bioclimatic Composites

The Bioclimatic Composite map just discussed is a purely diagrammatic representation of abstract patterns of relative suitability. At this point the previous criteria are reviewed and additional criteria applied through design studies to produce a refined concept representing the culmination of the Vegetation-Climate-Landform sectors of the study.

1. SIMPLIFICATION
   Areas of complex configuration unsuited to exhibit development or extending isolated fingers into adjacent classifications are absorbed by surrounding zones.

2. TRANSITION
   Priority is given to establishing bioclimatic zones which normally border one another in nature. Thus suitable transitions must be possible through adjacent zones in any direction.

3. Public input during Seattle City Council hearings substantiated the need for a local park at the southwestern corner of the site, which was deleted from the study area.

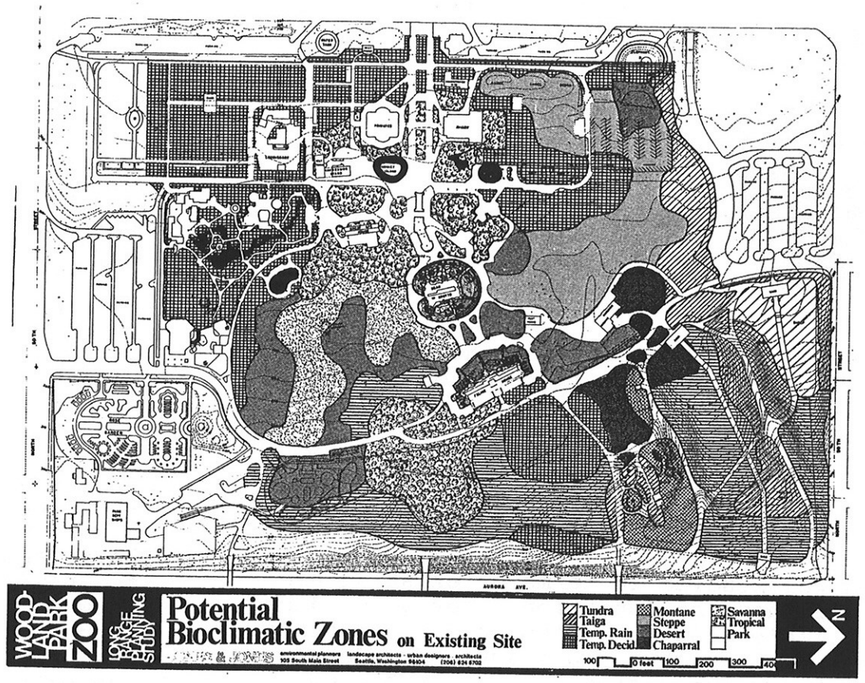
4. Areas outside future zoo boundaries are eliminated.

5. A contiguous perimeter buffer is deleted from the potential bioclimatic zones to provide public access from neighboring streets to lower Woodland Park.

6. Form is given to the two areas of the Tropical Forest Zone.

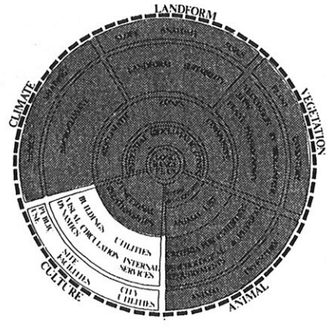
7. UNSUITABILITY
   Areas unsuitable for development of bioclimatic zones by virtue of any of the above criteria should be allocated to the most appropriate of the following uses:

   a. Public Activity Areas
   b. Passive Recreation Areas
   c. Service Areas
   d. Special Exhibit Areas



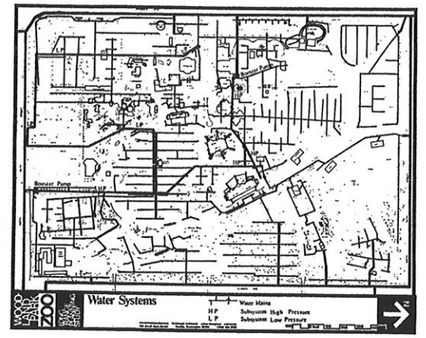
Existing Exhibit Distribution

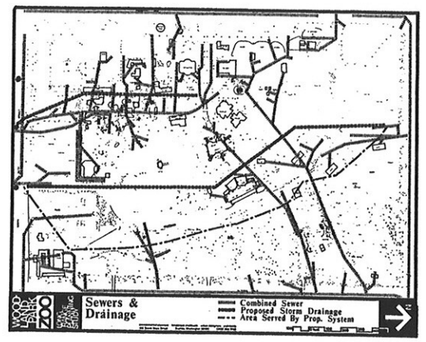
The animals presently exhibited in the zoo were assessed in terms of their suitability within the Presentation and Exhibition Themes. Existing exhibits were mapped according to the bioclimatic zone of origin of each species of animal, and the result shows little relationship to any bioclimatic or zoogeographic pattern.

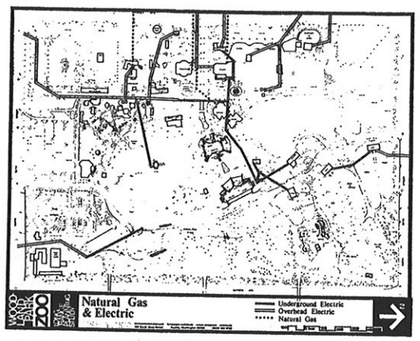


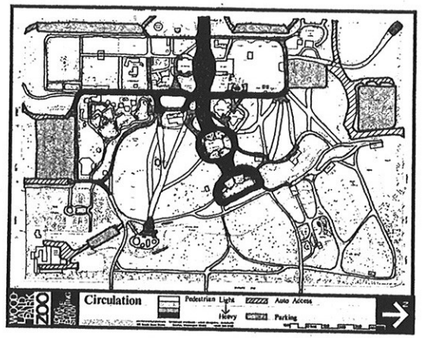
Culture

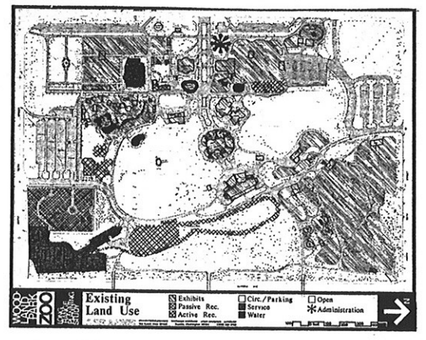
City and site utilities and facilities and public use were inventoried simultaneously. Also, visual dynamics and visual absorption were studied in relation to existing spaces, vistas and circulation patterns.

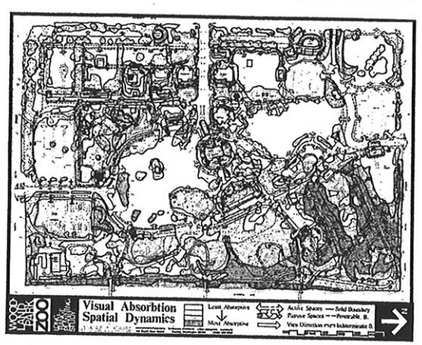








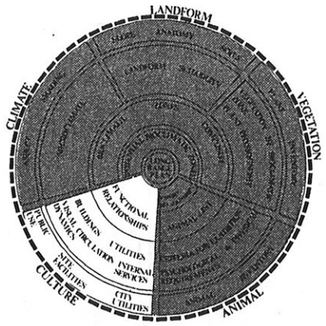




Criteria for Establishing Functional Relationships

Existing facilities were inventoried and analyzed and the resulting functional opportunities and constraints used to modify the Potential Bioclimatic-Zone map. The interaction of these, along with opportunities and constraints presented by our choice of animals for exhibition, resulted in the final Long-Range Plan and its Development Guidelines. A summary follows of functional relationships we considered important.

1. Buildings were assessed in terms of their struc-



Functional Relationships

tural and functional adequacy and their potential modification or elimination in relation to the potential bioclimatic zones.

2. Utilities were found to be largely outdated and inadequate. The potential bioclimatic zones were modified to allow for ease of servicing and phased development of new utilities.

3. Circulation was studied in terms of existing use patterns, adequacy and condition. Design studies expanded suitable existing walks into a network of loops within a hierarchy of primary, secondary and tertiary pathways integrated with the proposed bioclimatic zones.

4. Visual dynamics studies identified areas of "passive space" (large open spaces) and "active space" (major pedestrian movement patterns), together with major and minor viewpoints and landmarks. The "passive spaces" generally became animal exhibit areas or passive recreation clusters, while the "active spaces" became Public Activity Areas. Animal viewing structures and interpretive nodes generally coincided with the most ideal viewpoints identified (see *Development Guidelines*). Also, study of existing plantings and landforms led in part to the development of concepts for the use of these elements in future view control.

5. Internal servicing was studied to determine the best methods of servicing new facilities.

Criteria for Choice of Animals for Exhibition

The list of animals for exhibit in a zoo should be constructed with great care and insight, as the rationale for the very existence of a zoo can be found in its animal exhibits and their effects on their viewers.

In actuality a combination of desirability and practicality will determine the ultimate list. The list for Woodland Park Zoo was constructed by taking into consideration the following guidelines, not necessarily in order of importance.

1. Education: (a) Social Behavior -- this is an especially wise choice as the exhibit theme to be developed at the zoo, as we are a social species and can benefit from watching other ones. So much has been written recently about our relatives, the other social primates, and about social animals in general, that a well-read person can bring considerable insight into observations made on the animals themselves in the zoo setting.

   (b) Evolutionary Adaptations -- the products of evolution are the animals themselves, both what they look like and what they do. Many of the "why" questions asked by children find their origins here, and biologists spend much time attempting to answer these questions to their satisfaction. Viewing these animals as end-products of evolution can be an exciting endeavor to the layman also, and the zoo should provide not only the raw material in the form of the animals but also an abundance of interpretive material cast in this manner. Each of the bioclimatic zones is inhabited by animals with characteristic adaptations, and these can be emphasized in the choice of animals.

   (c) Convergent and Parallel Evolution -- many unrelated animals of equivalent zones on different continents have converged in appearance or behavior or both, and exhibiting them near one another for easy comparison will provide a source of wonder and thoughtful contemplation for the public.

   (d) Adaptive Radiation -- another course to follow, exactly the opposite of the previous one but no less educational, is to examine a particular group of animals to see how they have diverged in different bioclimatic zones. Rabbits provide an excellent example of this phenomenon, with different species having developed different sizes, colors, and ear and leg lengths as adaptations for different climates and habitats. This is an excellent rationale for emphasizing certain groups in the exhibits, for example primates, rabbits, cats, antelopes, waterfowl and gallinaceous birds, as has been done in the list of suggested animals.

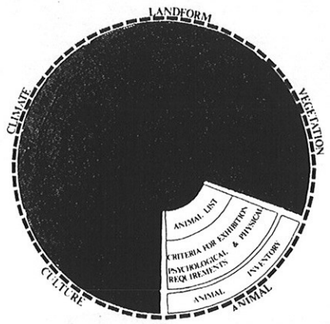
2. Interest: It is hard to separate this attribute from education, as most phenomena are interesting because we learn something new from them. This is another rationale for emphasizing social species, as they are more likely to interact with one another in complex behavior patterns than isolated individuals of different species would, thus furnishing activity to direct the attention of onlookers. Animals of bizarre shapes or bright colors fall in this category, providing fascination as well as material for greater understanding of nature.

3. Representation: There is a truly remarkable diversity of animals on the face of the earth, and attempting to exhibit a representation of this diversity furnishes material for both education and interest.

4. Research: Some species, especially those with secretive habits, can be effectively studied in a zoo environment, especially if it simulates nature in important respects. A zoo can furnish research material for any segment of the academic community from grade schools to universities, and it is no less valuable to any citizen who wants to learn more about nature in a systematic fashion.

5. Conservation: With increased concern over species that are rare or endangered, it is natural to turn to zoos as repositories of breeding stocks of as many of these species as possible, and it is logical that particular zoos emphasize particular species with which to work.

6. Present Animal Inventory: Whenever possible, animals already present on the zoo inventory were chosen for the long-range plan, providing their choice was consistent with the above guidelines.



Animal List

The animal list selected as a result of the foregoing criteria is presented on page 30 relative to exhibit locations under the Long-Range Plan.

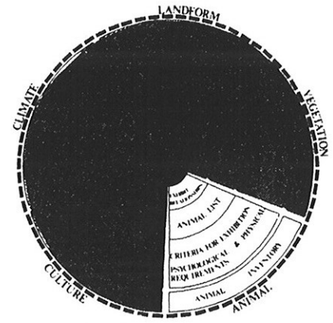


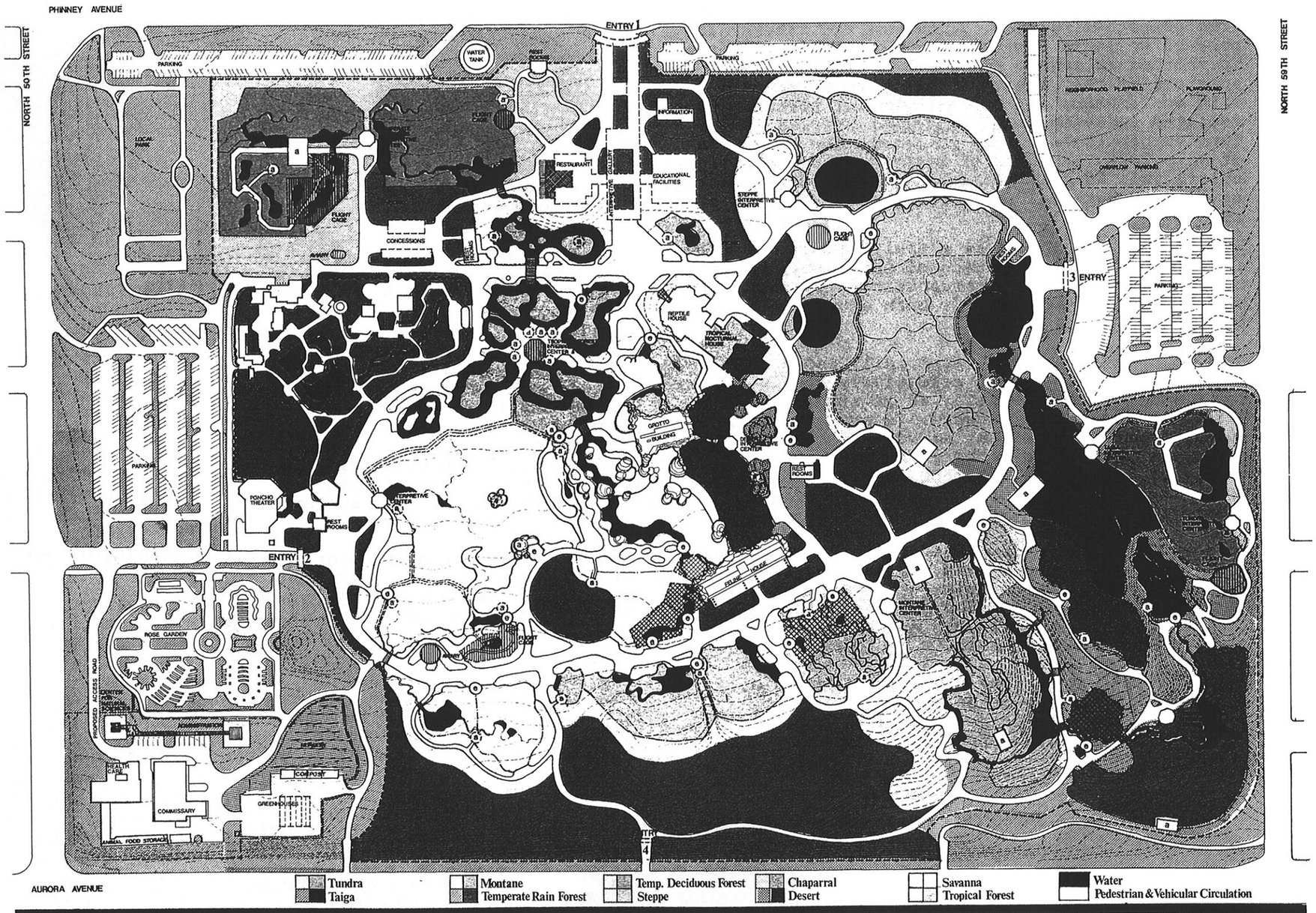
Exhibit Relationships as Design Criteria

In addition to the opportunities and constraints already outlined, the possibility of interpretive transition from one exhibit to another was an important consideration in determining the physical layout of the zoo. As many of the bioclimatic zones grade into one another in nature, so can they grade into one another in the zoo setting.

Whenever animals to be exhibited occur together or in adjacent regions in nature, an attempt has been made to duplicate such adjacency within the framework of the zoo design, resulting in a zoogeographically meaningful pattern within each bioclimatic zone and between zones if possible.

The interpretive transition within a bioclimatic/zoogeographic unit (e.g., African tropical forest) can be extended in either of two ways, where appropriate: (1) to another zoogeographic region within the same bioclimatic zone, and (2) to an adjacent bioclimatic zone within the same zoogeographic region. For example, from the tree kangaroo of the Australian tropical forest one can proceed to the wallaroo of the adjacent Australian savanna or to the Indian rhinoceros of the Asian tropical forest, either transition being one that can be covered by interpretive text and graphics. Similarly, the tiger of Asian tropical forest can be related to the rhinoceros or the axis deer of the adjacent Asian tropical forest or the snow leopard and takin of adjacent Asian montane forest. In addition, it can be related to the leopard, which, although in an African savanna exhibit, also occurs in Asian savanna and forest.

Other relationships lending themselves to interpretation include taxonomic, morphological and behavioral ones, all of which are abundantly represented in the proposed exhibits.



WOODLAND PARK ZOO
LONG RANGE PLANNING STUDY

Long-Range Plan
Exhibit Development

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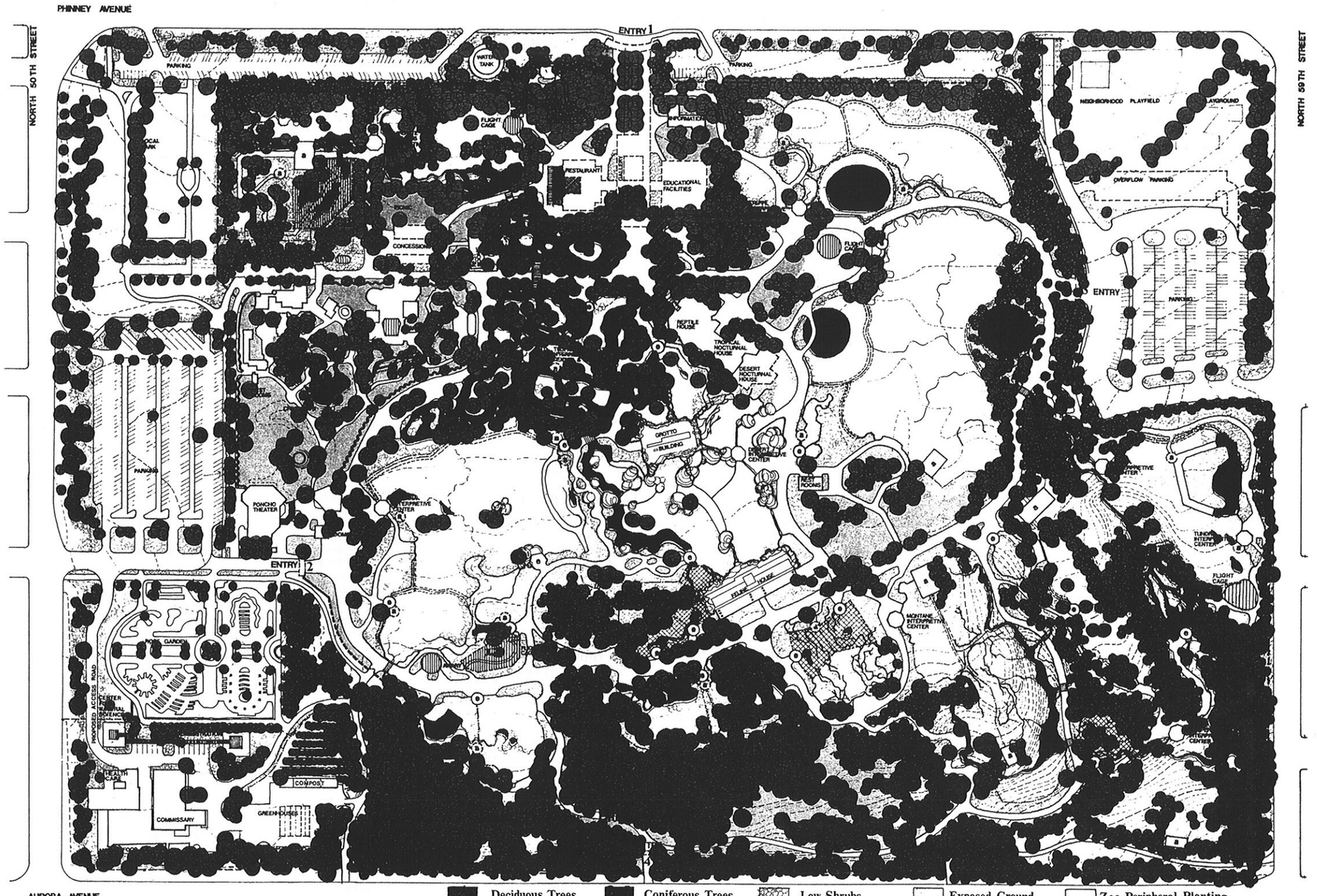
PHINNEY AVENUE
NORTH 50TH STREET
NORTH 59TH STREET
AURORA AVENUE
ENTRY 1
ENTRY 2
ENTRY
PARKING
WATER TANK
FLIGHT CAGE
RESTAURANT
CONCESSION
EDUCATIONAL FACILITIES
NEIGHBORHOOD PLAYFIELD
PLAYGROUND
OVERFLOW PARKING
REPTILE HOUSE
TROPICAL NOCTURNAL HOUSE
DESERT NOCTURNAL HOUSE
GROTTO
GROTTO BUILDING
PRIMATE INTERPRETIVE CENTER
CAT ROOMS
PONCHO THEATER
AFRICAN INTERPRETIVE CENTER
TUNDRA INTERPRETIVE CENTER
FLIGHT CAGE
FELINE HOUSE
MONTANE INTERPRETIVE CENTER
ASIAN VILLAGE CENTER
POND
ROSE GARDEN
CENTER FOR URBAN HORTICULTURE
HEALTH CARE
COMMISSARY
COMPOST
GREENHOUSES
Deciduous Trees
Broadleaf Evergreens
Coniferous Trees
Tall Shrubs
Low Shrubs
Exhibit Turf
Exposed Ground
Passive Recreation
Zoo Peripheral Planting
Water
October 1,1976
WOODLAND PARK ZOO
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Bioclimatic Zone
Interpretive Center
Exhibit Interp. Center
Animal Service Area
Flight Cages & Aviaries
Meshed Exhibit
Wall
Fence
Ha·Ha
Zoo Boundary F.
100 0 feet 100 200 300 400
N

Animal Exhibit List

KEY: s Social
af Africa
as Asia
au Australia
eu Europe
h Holarctic
na North America
sa South America

Tropical Forest (TF)

1 South American Primates (sa)

a. squirrel monkey (s)
woolly monkey (s)
capybara (s)
tinamou
great curassow
b. coati (s)
c. pacarana

2 Tropical Forest Aviary (sa/af/as)

a. (South American)
common trumpeter
sunbittern
jacana
blue-and-yellow macaw (s)
trogon
motmot
toucans
bellbird
honeycreepers
swallow-tanager (s)
tanagers
b. (African)
African pygmy goose
African gray parrot (s)
Schalow's turaco
Ross' turaco
wood-hoopoe
c. (Asian)
Palawan peacock-pheasant (s)
crested fireback (s)
Himalayan monal (s)
roulroul
crowned pigeon
bleeding-heart pigeon
barred cuckoo-dove
emerald dove
rainbow lorikeet
plum-head parakeet
Indian pied hornbill
pitta
blue magpie
laughing-thrush
shama thrush
Rothschild's starling

3 Gorilla (af)(s)

4 African Primates (af)

a. black-and-white colobus (s)
Diana monkey (s)
b. DeBrazza monkey (s)

5 Lemurs (af)

ring-tailed lemur (s)
ruffed lemur (s)

6 Okapi (af)

okapi
duiker

7 Orang-utan/Siamang (as)

8 Tree Shrew (as)(s)

9 Celebes Black Ape (as)(s)

10 Lion-Tailed Macaque (as)(s)

11 Tiger (as)

12 Tapir (as)

13 Axis Deer/Sloth Bear (as)

axis deer (s)
sloth bear
Indian peafowl (s)

14 Rhinoceros (as)

Indian rhinoceros
Sarus crane

15 Tree Kangaroo (au)

tree kangaroo
magpie goose
radjah shelduck
megapode

16 Tropical Forest Nocturnal House (several regions)

a. vampire bat (sa)
b. two-toed sloth (sa)
c. kinkajou (sa)
d. prehensile-tailed porcupine (sa)
e. lesser galago (af)
f. thick-tailed galago (af)
g. crested porcupine (af)
h. slow loris (as)

Savanna (S)

17 African Savanna (af)

giraffe
waterbuck (s)
gazelle (s)
zebra (s)
warthog (s)
rock hyrax (s)
secretary bird
helmeted guinea fowl (s)
vulturine guinea fowl (s)
crowned crane
Kori bustard
ground hornbill

18 Baboon (af)(s)

19 Patas (af)(s)

20 Lion (af)(s)

21 Leopard (af)

22 Hunting Dog (af)(s)

23 Meerkat (af)(s)

24 Hippopotamus (af)

hippopotamus (s)
Egyptian goose
white-faced tree duck
Cape teal

25 African Wader Flight Cage (af)

darter
egrets (s)
yellow-billed stork (s)
sacred ibis (s)
African spoonbill (s)
lesser flamingo (s)
black-winged stilt

26 African Savanna Aviary (af)

button-quail
blacksmith plover
spur-winged plover
Egyptian plover
cream-colored courser
pratincole
white-bellied go-away bird
mousebird (s)
bee-eater
oxpecker
violet-backed starling
glossy starling
superb starling
weavers (s)

27 Australian Savanna (au)

a. wallaroo (s)
emu
b. black swan

Desert (D)

28 Sonoran Desert (na)

a. antelope jackrabbit
antelope squirrel
Gambel's quail
roadrunner
b. collared peccary (s)

29 Barbary Sheep (af)(s)

30 Klipspringer (af)

31 Addax (af)(s)

32 Desert Nocturnal House (several regions)

a. ring-tail cat (na)
b. kangaroo rat (na)
c. degu (sa)
d. jerboa (af/as)
e. gerbil (af/as)
f. jerboa pouched mouse (au)

Steppe (ST)

33 Great Plains (na)

bison (s)
pronghorn (s)
white-tailed jackrabbit
ground squirrel
black-tailed prairie dog (s)
sharp-tailed grouse (s)

34 Alkaline Prairie Pond (na)

western grebe
white pelican (s)
cinnamon teal
ruddy duck
American avocet (s)

35 Patagonian Steppe (sa)

guanaco (s)
Patagonian cavy (s)
common rhea (s)
southern screamer

36 Maned Wolf (sa)

37 Vizcacha (sa)(s)

38 Patagonian Pond (sa)

black-necked swan
Chiloe widgeon
crested duck

Chaparral (C)

39 Chaparral (na)

brush rabbit
black-tailed jackrabbit
California quail

Temperate Deciduous Forest (TD)

40 White-Tailed Deer (na)

white-tailed deer (s)
eastern cottontail
ruffed grouse
turkey (s)

41 Waterfowl (na)

a. swamp
great blue heron
Canada goose
black duck
wood duck
ring-necked duck
bufflehead
common goldeneye
hooded merganser
b. marsh
pied-billed grebe
green heron
American bittern
common pintail
blue-winged teal
northern shoveler
king rail
Virginia rail
sora
common gallinule
American coot
red-winged blackbird

42 Red Deer (eu)

red deer (s)
European rabbit (s)
black grouse (s)

43 European Flight Cage (eu)

blackbird
nightingale
robin
hawfinch
goldfinch
bullfinch
chaffinch
tree sparrow

Temperate Rain Forest (TR)

44 Cougar (na)

45 Gray Wolf (na)

46 Wapiti (na)

wapiti (s)
blue grouse

47 Temperate Rain Forest Aviary (na)

band-tailed pigeon
chickadees
red-breasted nuthatch
brown creeper
winter wren
varied thrush
cedar waxwing
yellow-rumped warbler
evening grosbeak
purple finch
pine siskin
dark-eyed junco
white-crowned sparrow
fox sparrow
song sparrow

Taiga (T)

48 Brown Bear (na)

49 River Otter (na)

50 Wolverine (na)

51 Trumpeter Swan (na)

trumpeter swan
snowshoe hare
spruce grouse

Tundra (TU)

52 Tundra (h)

muskox (s)
caribou (s)
arctic hare
ptarmigan

53 Polar Bear (h)

54 Lemming (h)

brown lemming
collared lemming

55 Snowy Owl Flight Cage (h)

Montane (M)

56 Bighorn Sheep (na)(s)

57 Mountain Goat (na)

mountain goat (s)
hoary marmot
pika

58 Ibex (eu)(s)

59 Snow Leopard (as)

60 Lesser Panda (as)

61 Takin (as)

takin (s)
golden pheasant (s)

62 Tahr (as)(s)

Special Exhibits (SE) (independent of zone)

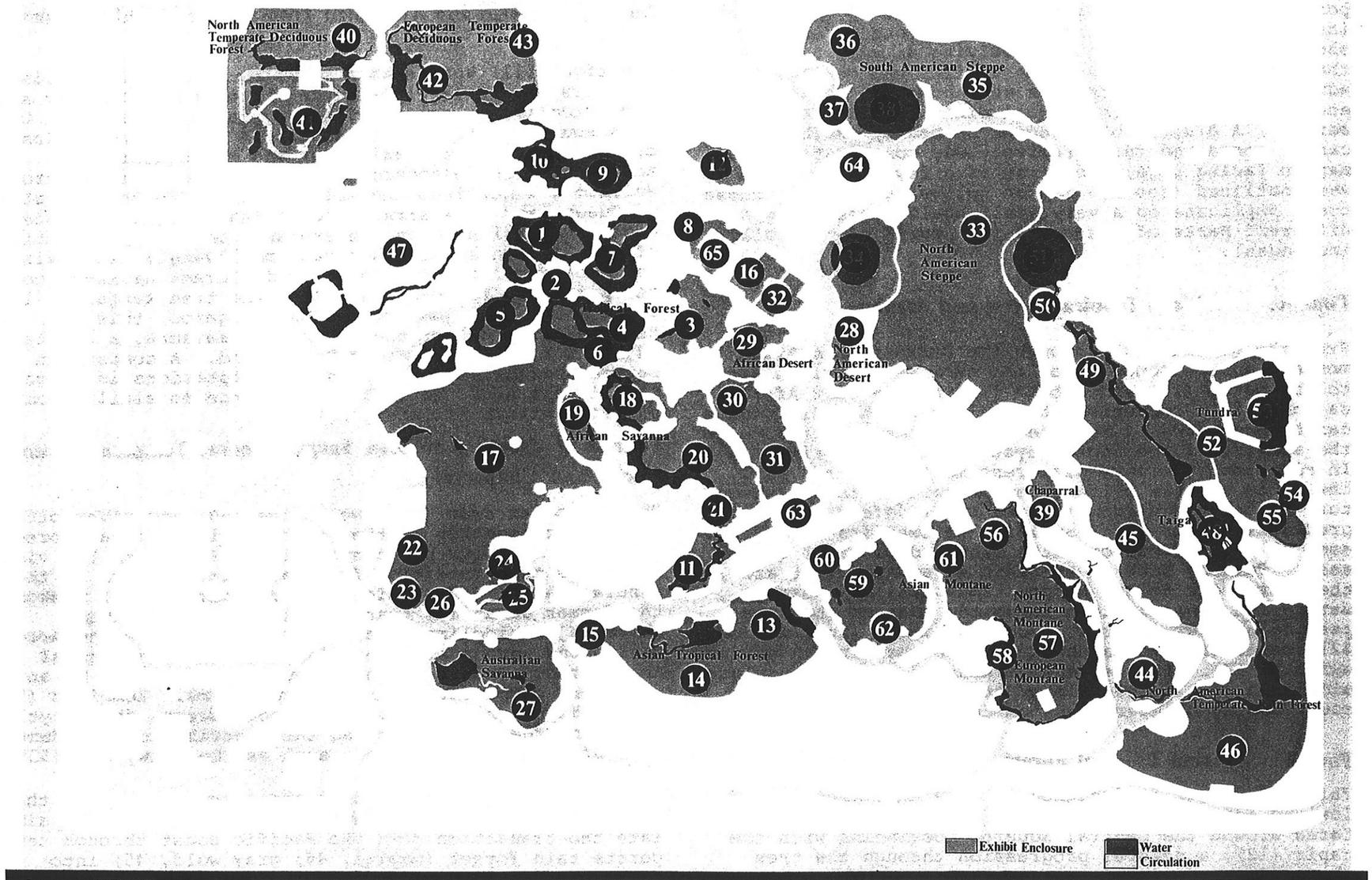
63 Small Carnivore House

a. ocelot (TF-sa)
b. serval (S-af)
c. genet (S-af)
d. black-footed cat (D-af)
e. Pallas' cat (ST-as)
f. weasel (T-h)

64 Raptor Flight Cage

a. bald eagle (TR-na)
b. golden eagle (M-h)
c. peregrine falcon (TU-h)
d. prairie falcon (D-na)

65 Reptile House



WOODLAND PARK ZOO

LONG RANGE PLANNING STUDY

Long-Range Plan
Animal Exhibits

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100 0 feet 100 200 300 400

N

Interpretive Opportunities and Sample Tours

As discussed under Exhibit Relationships, it will be possible to relate many of the exhibits to one another interpretively. The transition from one to another should be intellectually satisfying as well as aesthetically pleasing, and the visitor who desires an educational experience over and above his or her encounter with the individual exhibits will be served. A diagram of adjacent or nearby exhibits that can be connected interpretively was constructed (see map on facing page), and from it a few sample tours were outlined (see zoo map on following pages). These tours duplicate on a very small scale tours through different parts of the world (see world map on following pages).

Tour A: African Tropical Forest and Savanna

From the gorilla (3) through the DeBrazza and Diana monkeys and colobus (4) of the same west African forests to the patas (19) and baboon (18) of the east African savannas is a convenient tour along which a discussion can be presented of how the environments contribute to the shaping of the social systems of these primates. In addition, the very different morphology of, say, the patas and the colobus can be related to the structure of their environments and their defense against predators. With the transition to exhibits 20 and 21, some of these predators (the lion and leopard) can be seen. Turning back to the main savanna exhibit area, the tour leads to the hippopotamus (24) and through waterbirds (25) and then landbirds (26) of the area, passing smaller (meerkat, 23) and larger (hunting dog, 22) social carnivores on the way to the African savanna exhibit (17). This extensive area of savanna ungulates and birds is also visible at other points along the tour, adding greater cohesion to the experience.

Tour B: Asian Tropical Forest

This brief tour is designed to give an impression of lowland Asian tropical forests from the exhibits clustered around the Central Square. Beginning with the tapir (12), a natural progression through the tree shrew (8), orang-utan and siamang (7), and Celebes black ape (9) ends with the lion-tailed macaque (10). In particular, the primates present a wealth of opportunities for interpretation, varying from solitary to paired to highly social and from highly arboreal to essentially terrestrial. Correlates of coloration, behavior and vocalizations with environment and social systems can be made. For a continuation of the Asian tropical forest experience (see next tour), the visitor will have to circumnavigate the African savanna.

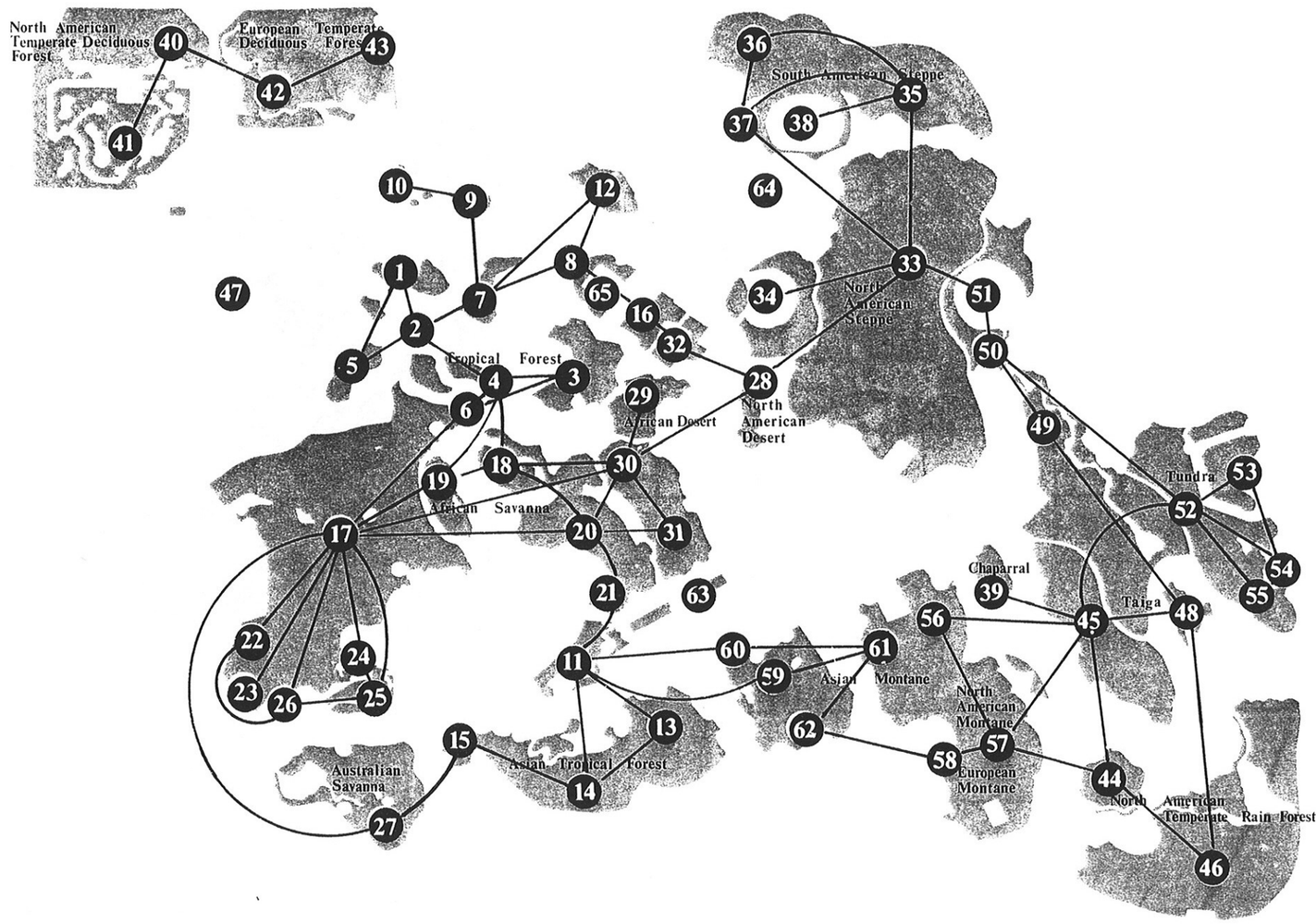
Tour C: Asian and Australian Tropical Forest and Savanna

The tiger (11) serves as a starting point for a variety of tours, as it is wide-ranging both geographically and ecologically, in common with many large predators. On this tour, the tiger's neighbors in the Asian tropics can be observed, the axis deer and sloth bear (13) and the Indian rhinoceros (14). The transition (across Wallace's line) from the Asian mainland to the forests of Queensland in Australia lends itself to interpretation, in particular to the explanation of the evolution of island faunas and how organisms living in such similar ecological niches can be as different as kangaroos and primates, for example. From the tree kangaroo (15) there is an easy jump to another kangaroo, this one the wallaroo (27) of the Australian savanna, a habitat adjacent to the forests of Queensland. A comparison between terrestrial and arboreal adaptations in kangaroos is apt here, as well as reference to similar comparisons within primates, cats, etc.

Tour D: North American Taiga, Tundra, Temperate Rain Forest and Chaparral

The trumpeter swan (51), wolverine (50) and river otter (49) occur together in the North American boreal forest, and their exhibits blend naturally. From them the visitor makes the transition from taiga into tundra in the tundra exhibit (52), which features caribou and muskox, the former an animal that normally wanders between these major bioclimatic zones. Proceeding to the Arctic coast, one encounters the polar bear (53), a coastal animal that wanders inland frequently enough to be an important component of Arctic ecosystems. Lemmings (54) are highly significant in these ecosystems, their cycles affecting the vegetation and the distribution and densities of their own predators such as the snowy owl (55).

The tour then drops back into the taiga to observe the brown bear (48) and proceeds through exhibits that simulate the transition down the Pacific coast through temperate rain forest (wapiti, 46; gray wolf, 45) into chaparral (39). In all these cases, the transition between vegetation types will be smooth, as is often the case in nature, but the central part of each animal exhibit will feature the typical vegetation of that zone.



WOODLAND PARK ZOO

LONG RANGE PLANNING STUDY

Long·Range Plan
Exhibit Relationships

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Bioclimatic Zone
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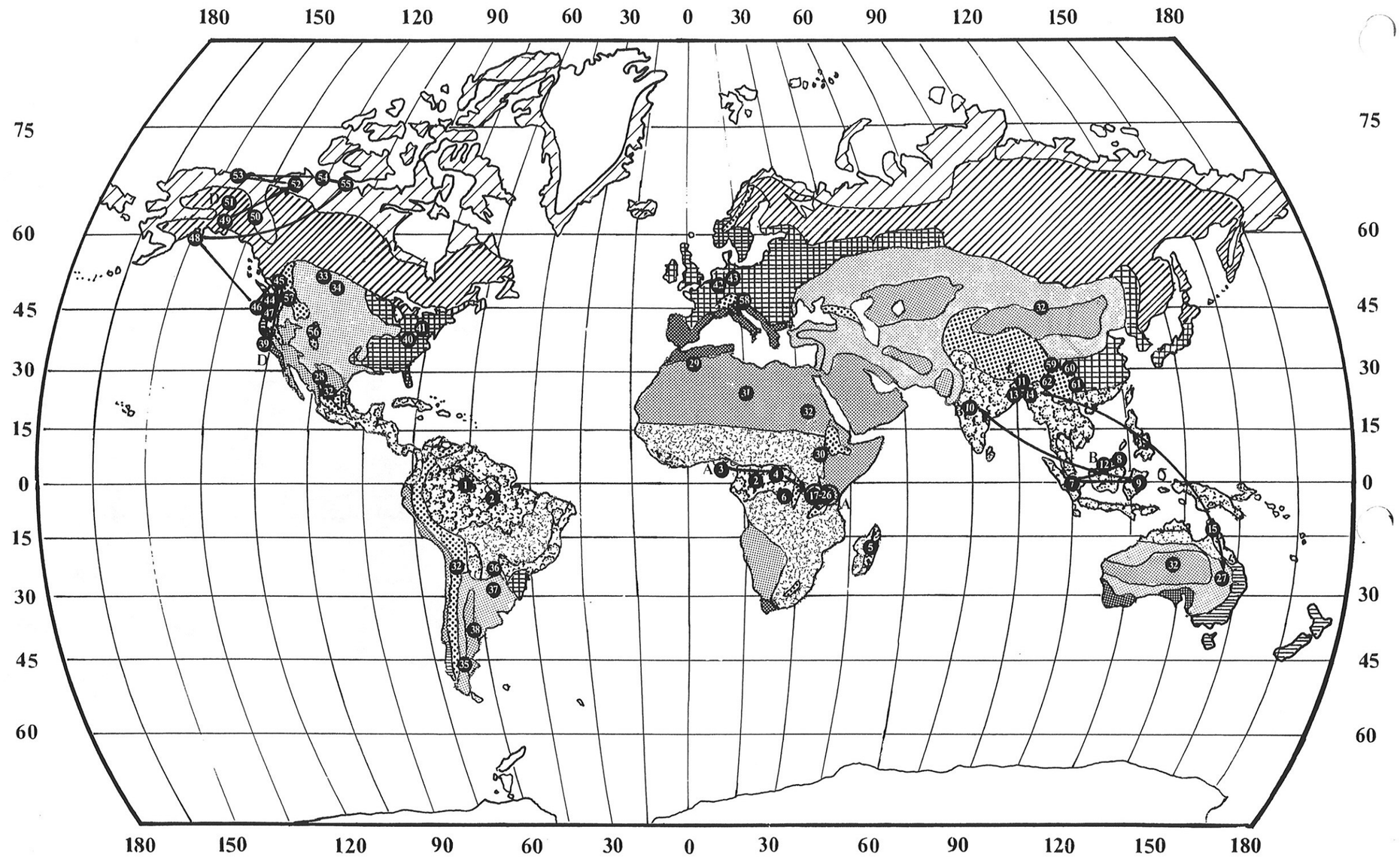
Exhibit Interp. Center
Animal Service Area
Flight Cages & Aviaries

Meshed Exhibit
Wall
Fence
Ha·Ha
Zoo Boundary F.

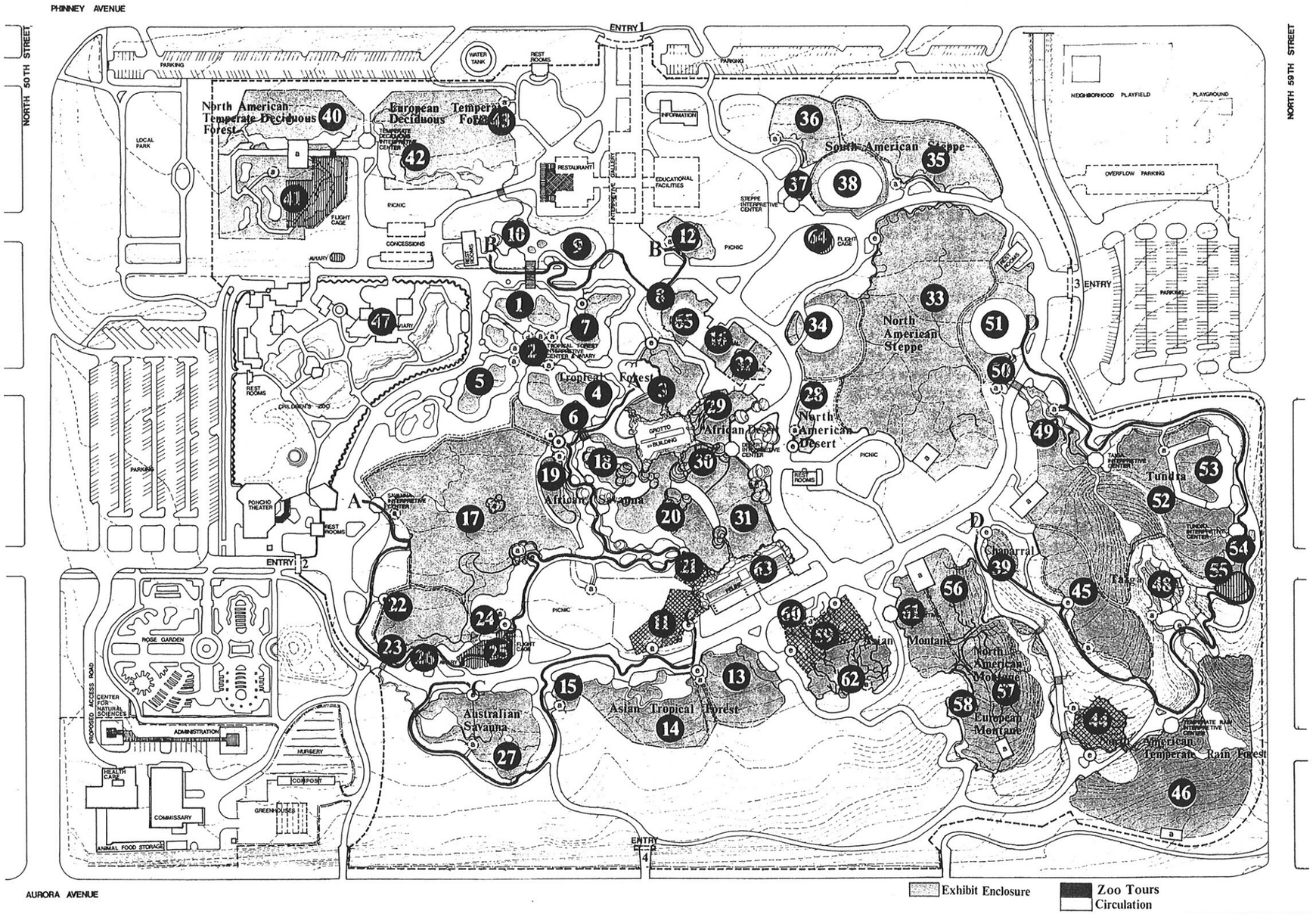
100 0 feet 100 200 300 400

N



World Tours

- Steppe
- Desert
- Chaparral
- Savanna
- Tundra
- Taiga
- Temperate Rain For.
- Temperate Deciduous For.
- Montane
- Tropical For.


PHINNEY AVENUE
NORTH 50TH STREET
NORTH 59TH STREET
AURORA AVENUE
ENTRY 1
ENTRY 2
ENTRY 3
ENTRY 4
North American Temperate Deciduous Forest
European Temperate Deciduous Forest
South American Steppe
North American Steppe
Tropical Forest
African Savanna
North American Desert
Tundra
Chaparral
Asian Montane
North American Montane
European Montane
Australian Savanna
Asian Tropical Forest
American Temperate Rain Forest
NEIGHBORHOOD PLAYFIELD
PLAYGROUND
OVERFLOW PARKING
PARKING
REST ROOMS
WATER TANK
INFORMATION
RESTAURANT
GALLERY
EDUCATIONAL FACILITIES
STEPPE INTERPRETIVE CENTER
PICNIC
CONCESSIONS
FLIGHT CAGE
AVIARY
TROPICAL FOREST INTERPRETIVE CENTER & AVIARY
CHILDREN'S ZOO
GROTTO
DESERT INTERPRETIVE CENTER
TUNDRA INTERPRETIVE CENTER
TAIGA INTERPRETIVE CENTER
TEMPERATE RAIN INTERPRETIVE CENTER
PONCHO THEATER
SAVANNA INTERPRETIVE CENTER
LOCAL PARK
ROSE GARDEN
PROPOSED ACCESS ROAD
CENTER FOR NATURAL SCIENCES
ADMINISTRATION
NURSERY
HEALTH CARE
COMPOST
COMMISSARY
GREENHOUSES
ANIMAL FOOD STORAGE
Exhibit Enclosure
Zoo Tours Circulation
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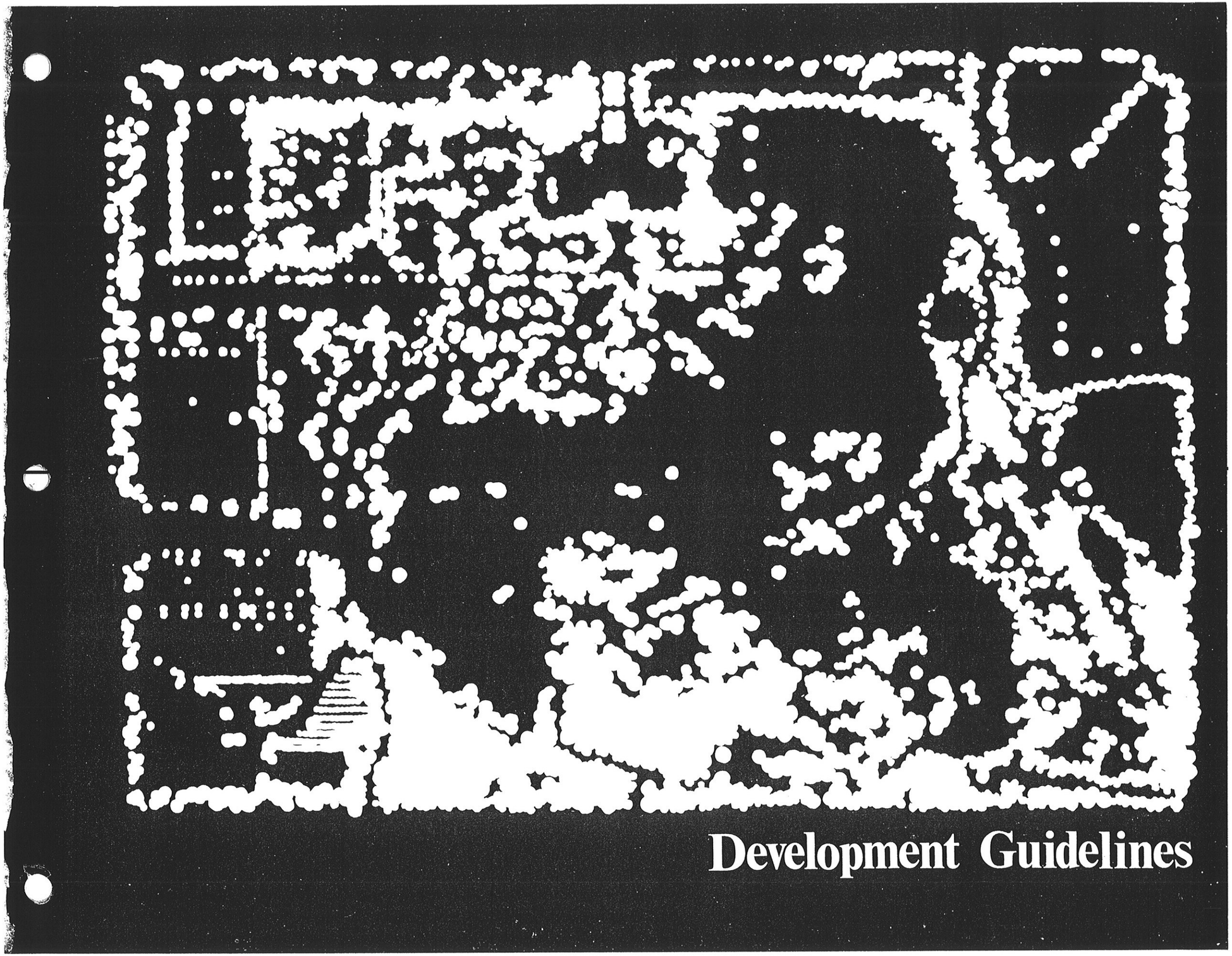
Zoo Boundary F.
100 0 feet 100 200 300 400
N

Thus far, discussion about Seattle's Woodland Park Zoo has dealt with a design method which synthesizes the goals and objectives of the long-range plan for a zoological garden. The Zoo Action Task Force in April 1975 set down the objectives for the zoo, delineated in terms of policies for education, conservation, research, recreation and physical development. To give form to these directives, two themes were established to guide the physical implementation of future facilities: 1) the Presentation Theme of simulating bioclimatic zones as exhibit habitats; and 2) the Exhibition Theme of stressing natural social behavior in the animals within these settings.

The design framework summarized in previous sections of this report was successful in testing these themes in terms of specific applications and within the constraints of the existing site, its essential existing utilities and facilities. The resulting new arrangement for future exhibits was approved by the Seattle City Council as the Comprehensive Plan, which after subsequent detailed analysis, has been refined into the detailed Long-Range Plan for all future development.

The plan is a union or optimization of the drafted goals. and objectives for the zoo, the presentation and exhibition themes which give shape to these, the existing site characteristics and needs of the community.

The Long-Range Plan is a flexible document intentionally framed to allow for change and modification. It establishes ground rules to insure that such changes will not contradict the established themes, application techniques and concepts, but rather will serve as refinements of the whole. It could be characterized as a "diagram" of developmental, locational and functional interrelationships. As such it will give direction to and provide a context for evaluation of day-to-day operations and maintenance, major new developments, fund raising and capital improvement programming, animal management and animal acquisition.



Development Guidelines

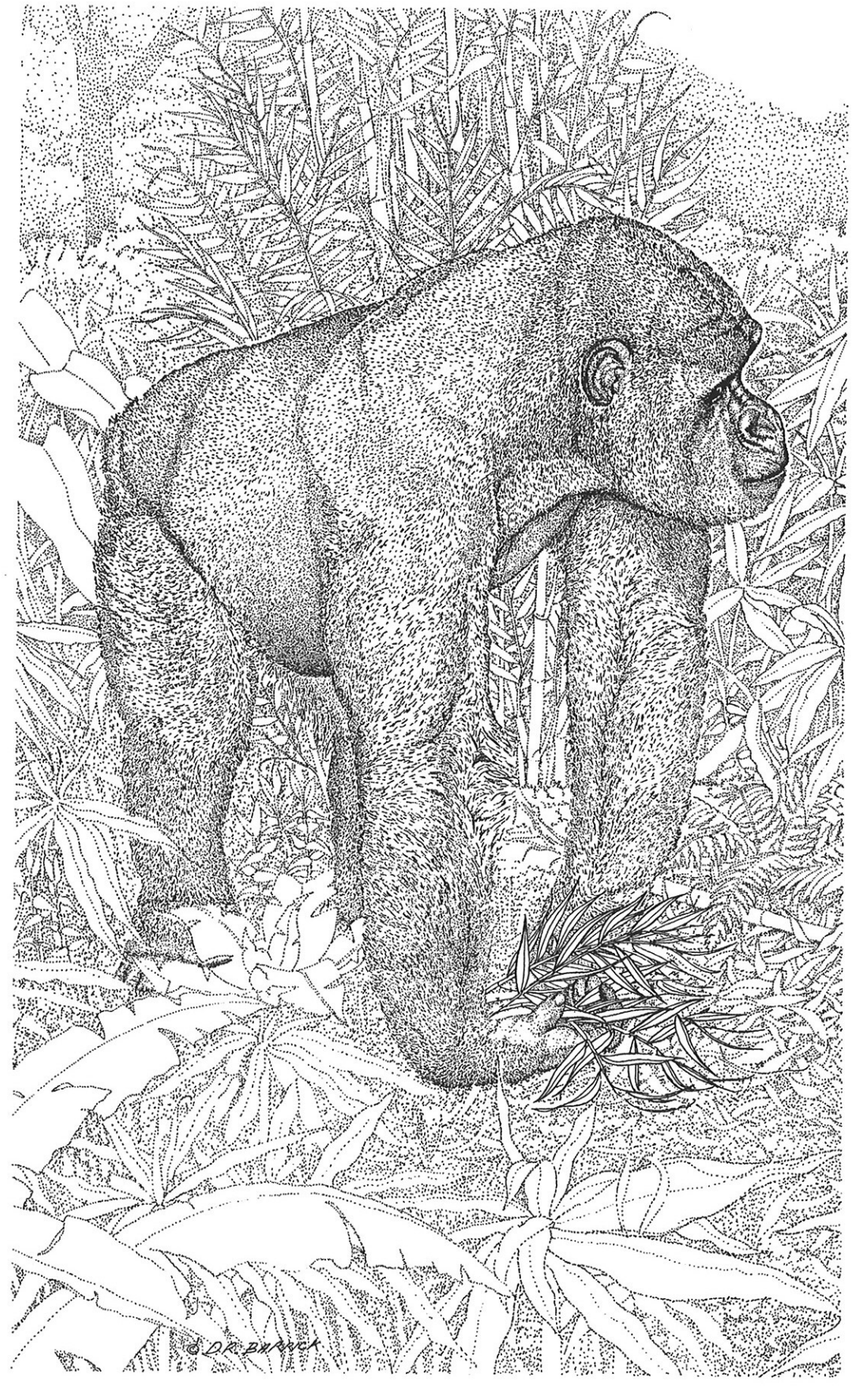
General Guidelines for Site Development
Introduction

In this section, Development Guidelines and Recommendations assuring continuity in implementation are set forth. The direction is given in two forms: GENERAL GUIDELINES FOR SITE DEVELOPMENT and EXHIBIT SCENARIOS.

General guidelines for site development represent fundamental principles and acceptable practices that have been officially adopted in terms of: 1) Circulation, 2) Exhibit Viewing, 3) Barriers, 4) Landscape Development and Site Furnishings, 5) Internal Services and Animal Service Areas, 6) Architectural Character and Materials, and 7) Utilities. For the most part, these general guidelines are not cast as dimensioned standards. They are design criteria established to guide future zoo development in terms of character, materials, function and visual or spatial experience.

The *exhibit scenarios* document and apply the research undertaken on specific animal habitats; they establish a verbal and/or graphic image of future exhibits and suggest specific techniques for implementing each. Each of these exhibit habitats offers an inherent flexibility; and although specific animal species are recommended for each, as in nature, a variety of animals can be accommodated within them, thus allowing for adjustment in the collection while maintaining a rational organization for it over time.

These scenarios, combined with the general guidelines, establish the spatial confinement, barrier and viewing concepts for each exhibit as well as defining the appropriate selection and use of plant materials, textures, landforms, soils, etc. that are essential to the replication of each particular exhibit habitat. Successful replication will result from careful adherence to the prescriptions set forth in each scenario.



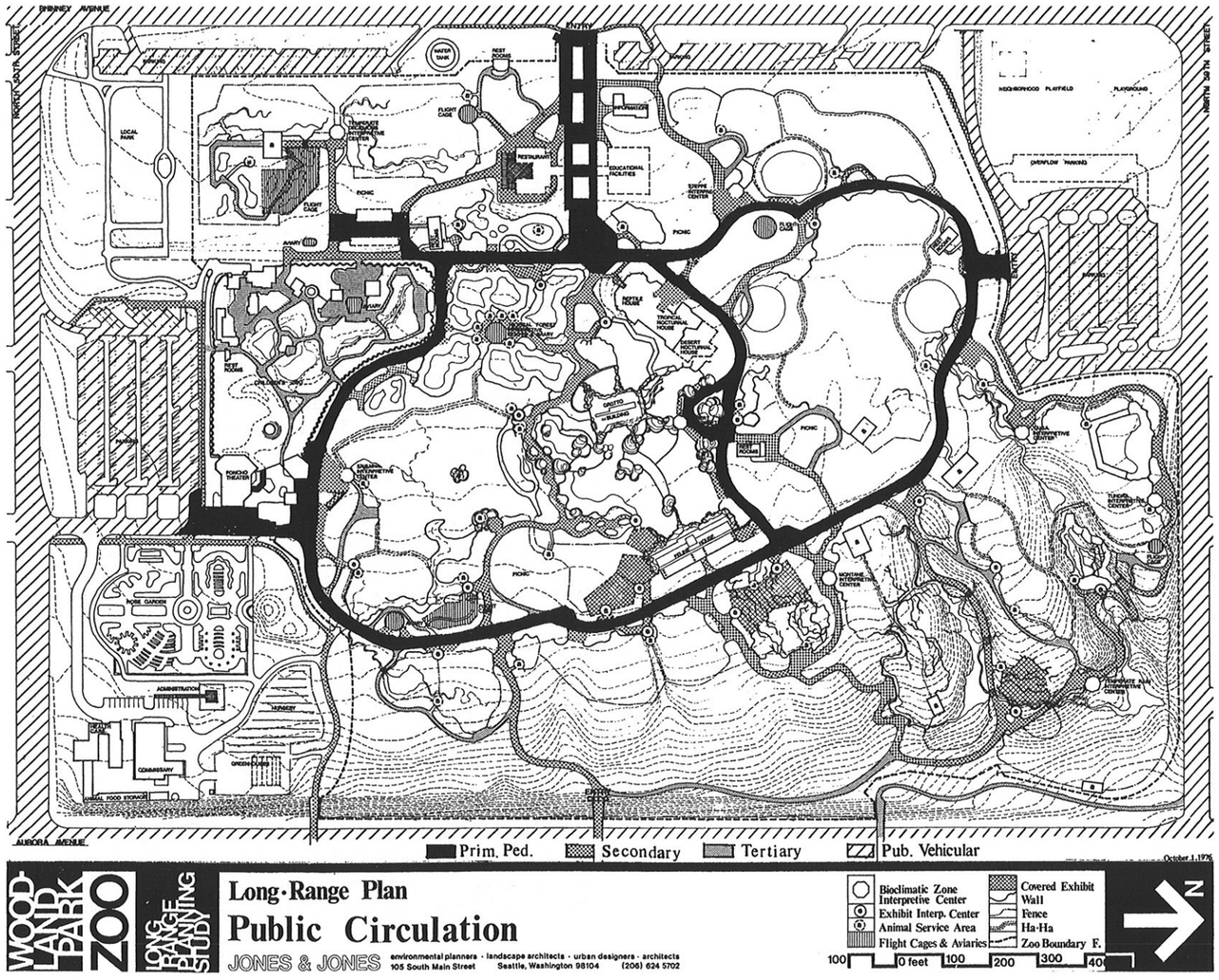
General Guidelines for Circulation

Clarity of organization and simplicity of movement are essential to visitor education and enjoyment, as well as for the efficient operation of the zoo. Therefore potentially conflicting circulation systems are separated either spatially or temporally. Thus, access and parking have been limited to the periphery of the site, and scheduled use of interior pedestrian and service paths eliminates any conflicts in the few cases where overlap is unavoidable, without compromising the zoo experience.

Since the zoo is small in area, cannot readily absorb noise and distracting activities, and relies on limited budget allocation, no mechanized public conveyances are programmed on the future zoo grounds, but it is intended that pedicab and/or ponycart transportation may be provided.

To summarize the circulation plan, both public and private vehicles arrive at one of the three entry points to the site with a fourth access provided to pedestrians from Lower Woodland Park. Service entries, roads and storage areas have been designed and buffered to minimize visual distraction. Near the main entry at Phinney Avenue North, an Interpretive Gallery with changing multi-media displays will offer the visitors a thorough insight to the zoo's organization, its animals and habitats, special interest topics and related zoological issues. The Educational Facility adjacent to the gallery will house additional educational exhibits as well as an auditorium and classrooms.

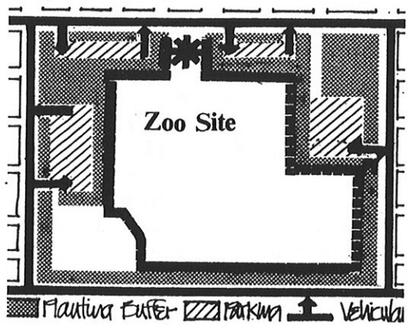
On entering the zoo habitats, zoo visitors are guided through sequential climatic zones of which the animals exhibited are characteristic. Paths, retaining the character and materials represented in the exhibit bioclimates, are designed to disperse the large numbers of visitors to the zoo, so that the animals and vegetation are dominant to people and facilities. Exhibit viewing nodes are interwoven with topography and vegetation to eliminate cross-viewing of people and unrelated exhibits, thus allowing for a total experience of the animal and its habitat.

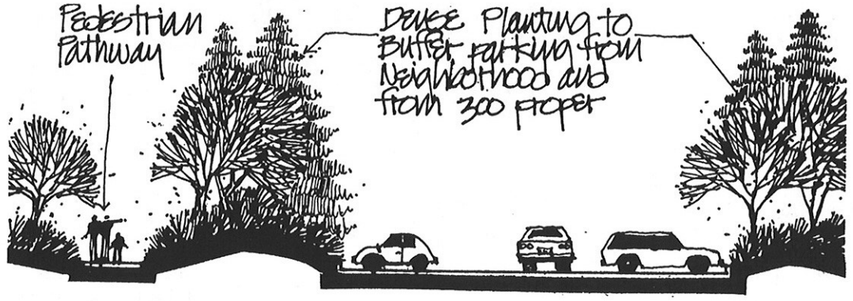


Guidelines for Parking

Since the City of Seattle and the Department of Parks and Recreation have established policy that existing levels of parking will be maintained and not expanded at the expense of the zoo site, no attempt will be made to provide on-site parking to meet occasional peak parking demands; nor will existing neighborhood roads be expanded to incorporate additional parking.

Existing parking areas will be reorganized and densified. In addition, all parking areas will be well buffered from the residential neighborhood and from zoo exhibit areas by earthforms and plant materials. Where possible, planting islands will be incorporated into the design of parking areas to lessen visual impact. Bicycle parking will be provided at all entrances.





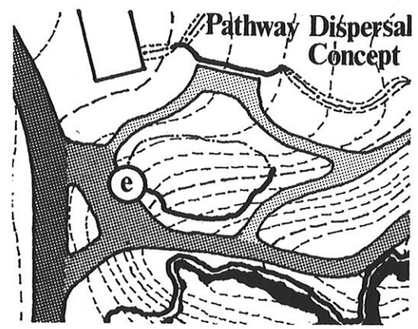
Guidelines for Pedestrian Pathways

Two objectives are central to the pedestrian circulation concept. First, the system must be developed to rapidly disperse the visitor onto minor paths free from the psychological impact of large crowds. Second, the system should lead the visitor through a natural bioclimatic sequence. The layout of the bioclimatic zones is such that they represent the same relationships to each other that occur in nature. Major and minor circulation patterns have been planned so that visitors can experience not only the bioclimatic zones but also the natural sequences of the bioclimates.

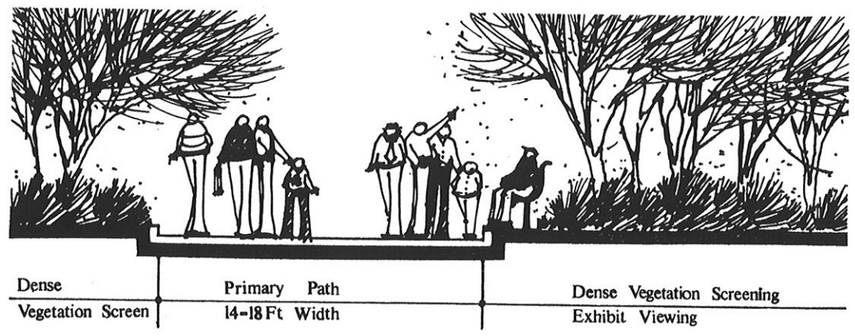
Dispersal Concept

A hierarchal system of paths will be developed to disperse crowds from entry areas along the primary circumferential pathway and out to secondary and tertiary routes.

Throughout the circulation system, activity nodes are located providing a hierarchy of services from concession and restroom facilities to display and exhibit viewing areas, to sitting and informal picnic areas. The intensity of activity at these nodes corresponds with their relationship to the primary, secondary or tertiary paths. Thus, the activity nodes along the primary route may be hard-surfaced providing drinking fountains, kiosks, benches, etc., much like a heavily used urban space; while along tertiary routes visitors may search out a rock on which to sit or a tree to lean against while viewing the animals or enjoying the landscape.

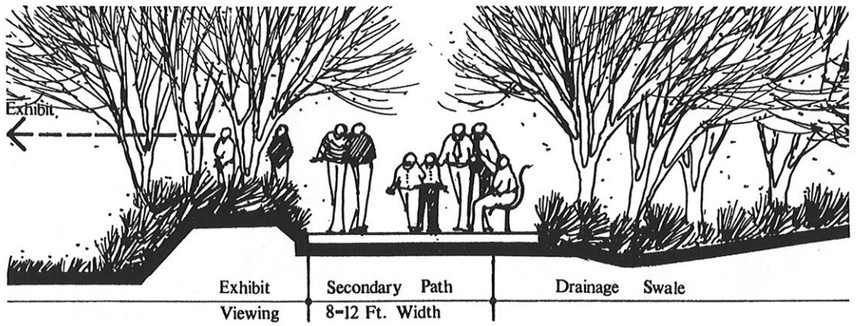


The primary pathway is designed as a loop system to provide a compact and basic family tour to include most exhibits (see previous plan). Essentially, it follows an existing route, retaining the current asphalt surfacing. Since large crowds will be handled along this route, its size is the maximum to be used in the park, varying in width from 14-18 feet. With a path of this magnitude, the alignment must eliminate long views of pavement through a curvilinear design, with planting and berming. It is along this system that the major public facilities are offered, such as information kiosks, restrooms, concession facilities and other core visitor

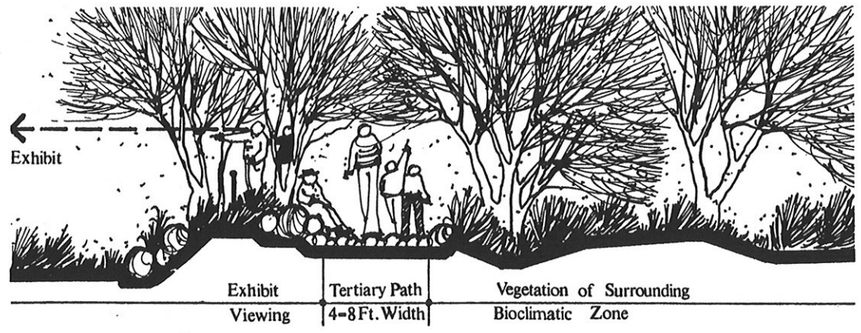


conveniences for sitting, conversing and/or eating. Animal exhibits should not be directly visible from primary pathways, though screened viewing areas may be nearby. Runoff from primary pathways should be collected in storm sewer systems.

The secondary circulation system is designed for more intimate visual experiences of the bioclimatic exhibit. Although retaining the continuous asphalt surfacing of the primary routes, it is much smaller in scale, varying from 8-12 feet in width. No public services are located along these routes, although passive rest or picnic areas are found along with many exhibit-viewing areas. Unlike the more urban primary pathways serving large numbers of people, the secondary system will carry dispersed groups through a natural landscape. These paths will be aligned and interwoven through this natural landscape carefully to avoid cross-viewing of paths or people as well as of inappropriate views of animals. In some cases, curbs and other appropriate drainage systems may be provided at intersections or large hard-surfaced areas, and at other points along the route where there is a potential of surface-water concentration. However, generally no curbs or drainage structures will occur along these paths, but landscaping appropriate to the bioclimate will be tight to path's edge and runoff will be locally absorbed.



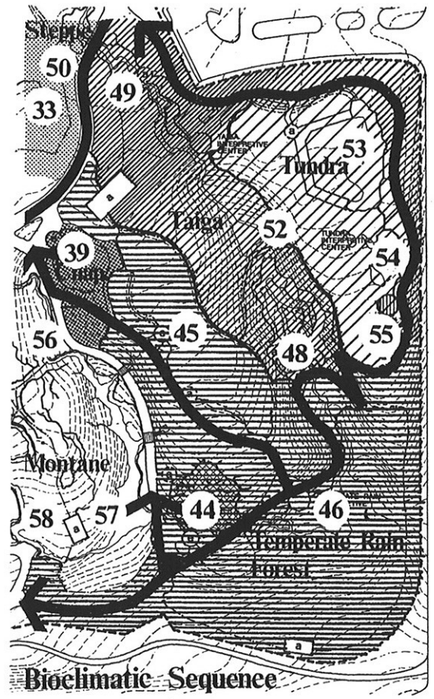
The tertiary system expresses the greatest harmony between exhibit, bioclimatic zone and visitor. Here the most intimate relationship is gained along unobtrusive trails (4 to 6 feet wide). In some areas even narrower paths resembling game tracks would be appropriate. All aspects of the design should be sensitive to the native environment of that designated area. Therefore, no services or furnishings will be provided along these routes with the exception of graphic panels. Materials will be natural, although all must stand the test of constant use in all types of weather and retain the character of the particular exhibit. Thus, cobblestone paths may be appropriate to montane exhibits; compacted red or white



sand to desert exhibits; while cinders, stabilized soil, gravel, wood decking, flagstone, etc., may be intrinsic to others. No areas will be provided for gatherings. Visitors will have to find a rock or log to sit on, or a tree to lean against if they wish to rest. Formal services which would disrupt the character of the natural area will not be provided. Finally, it should be noted that visitors will create minor pathways. These cannot be predicted by the designer, but as they become apparent, action should be taken either to develop them as one of the three circulation types or to prevent their further establishment.

Bioclimatic Sequence

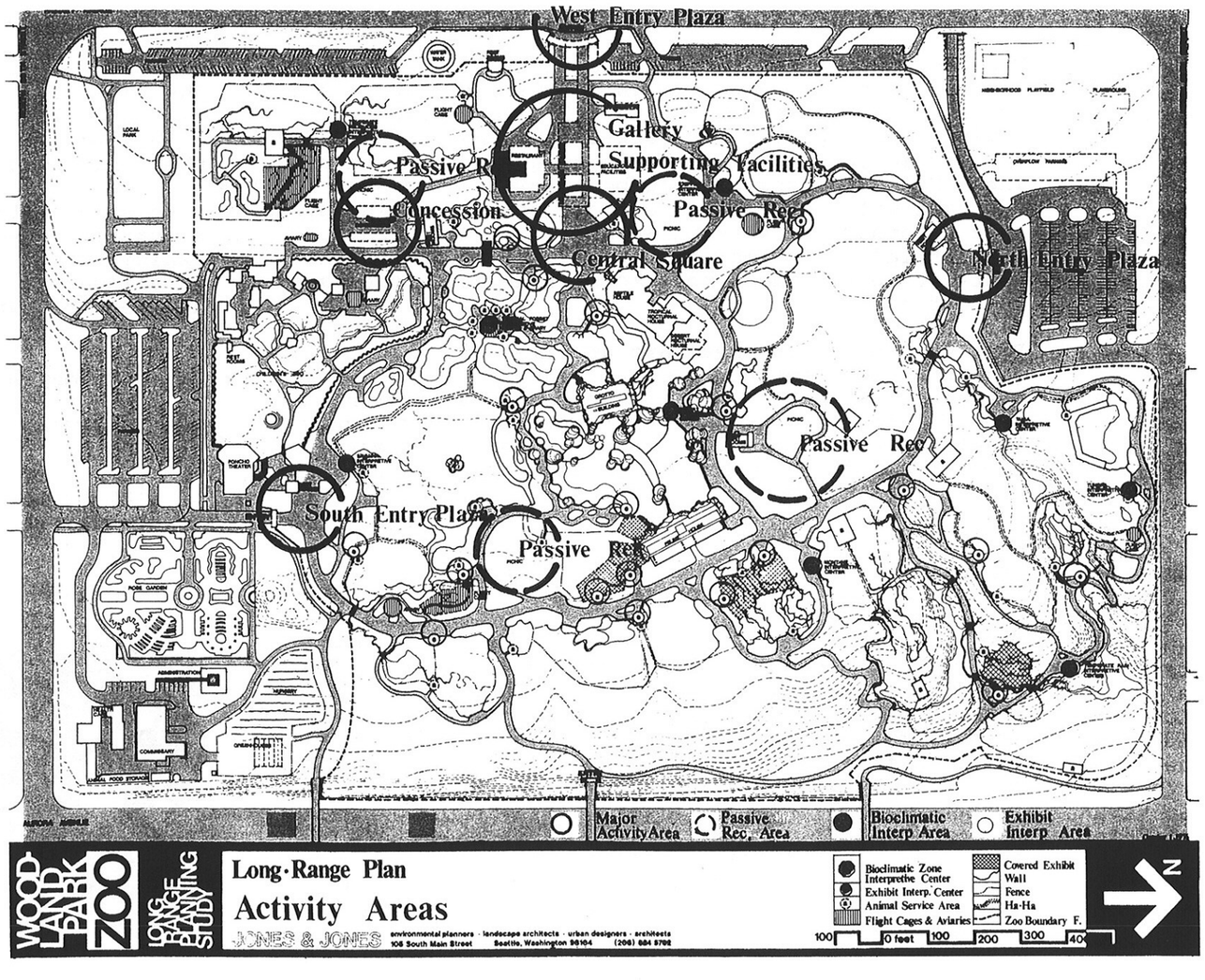
The bioclimatic zones have been located in such a way that tundra yields to taiga; taiga to temperate rain; temperate rain to temperate deciduous; and so forth. The circulation system follows this sequence. Careful attention has been given so that these logical sequential experiences occur along any course the visitor chooses. The adjacent example shown directs the visitor from the Alaskan tundra south along the western shores of North America. Thus world geography has been integrated into the bioclimatic organizational structure. This integration is essential and must be maintained throughout development of the Zoo



Guidelines For Activity Areas

The zoo as it exists today is a "park" with islands of animal exhibits. In the future it will be a series of animal exhibits with islands of "park" which will function as activity areas. Not all portions of the site are required for animal exhibits and not all portions lend themselves to specific bioclimatic zones; nor, as in nature, are the divisions between bioclimatic zones clear-cut. In almost all natural situations zones overlap. Opportunity has been taken to locate special activity areas for gathering and services, picnicking and sitting, etc. within these transition zones. These activity areas relate in size, texture, materials and intensity to their level of circulation; either primary, secondary or tertiary.

Public activity areas are intentionally distributed throughout the zoo site, taking advantage of existing facilities to increase the absorptive capacity of the site to accommodate large crowds for a diversity of uses occurring simultaneously. Structures and furnishings in these activity areas must complement the bioclimatic zone within which they are located, and because their function is separate, they should be densely buffered with landforms and plant materials. Activities of an intensive recreational character such as field sports and amusement rides are not appropriate at the zoo and will be gradually replaced.



Four types of activity area are designated on the adjacent plan: 1) major activity plazas; 2) passive recreation site; 3) bioclimatic interpretive centers; and 4) exhibit interpretive centers.

Major Activity Areas

Zoo gateways and major use areas separate from the exhibit sequence itself will be developed to a more urban scale. Since these *major activity areas* are functionally separate from the exhibit environment, they will be informally buffered from it by earthforms and screen plantings. These plazas are located at each of the three major zoo entries, along the Interpretive Gallery concourse with its adjacent supporting facilities, at the central square, and at the concession area. All these major activity areas

are interconnected by primary circulation.

These public activity areas are essentially visitor-related rather than exhibit-related, providing essential services such as food, general information and public conveniences. Because of their heavy use, these areas will be essentially urban in character. In most cases they will be partially canopied with tree bosques and surfaced with unit paving, and will provide areas for gathering, sitting and people-watching, and for fixed and rotating interpretive exhibits.

Passive Recreation Areas

The dashed circles shown on the preceding map indicate *passive recreation areas*. In contrast to other activity areas, these zones will be park-like with lawns or soft paving (sand, gravel, or bark-chips) and are designed for picnics, informal gatherings, quiet rest and relaxing. No active sports will be allowed and casual sports or games will be limited to those causing no inconvenience to other visitors or animals. Woodland Park Zoo is Seattle's only zoo, and there are many other excellent city parks where more boisterous activities are appropriate.

Passive recreation areas are at times situated to give distant views of exhibit areas. Where the park-like character of such an area is not compatible with the adjacent exhibit area, dense screen planting and/or earthform buffers will be used. Passive recreation areas occur on secondary or tertiary pathway systems.

Bioclimatic Interpretive Areas and Exhibit Interpretive Areas

The third and fourth types of activity areas relate directly to the animal exhibits and are represented as *bioclimatic interpretive areas* and *exhibit interpretive areas*. As implied, the function of these two kinds of interpretive areas is to provide in-depth information. relating to the animals and the simulated environments of a general bioclimatic zone (e.g., savanna) or of a specific exhibit (e.g., African savanna - hippopotamus). An interpretive center is planned for each bioclimatic zone and an exhibit interpretive center for each of the zoo's major exhibits. In each case, these areas are covered and provide all-weather viewing for an individual animal exhibit or grouping of related exhibits.

General Guidelines for Exhibit Viewing

Landscape Immersion: Ideally, the viewer should move through the characteristic landscape of the bioclimatic zone, seeing its sights and savoring its moods. Only then can we become aware that the landscape is also inhabited by animals, separated by unseen barriers. The success of this landscape immersion depends entirely upon two factors: 1) the completeness and correctness with which the characteristic landscape is projected, and 2) the care and accuracy with which the viewpoints and views are located and composed, concealing barriers, enhancing perspectives, composing light and shadow, and, most importantly, visually unifying animal space and visitor space.

The various methods appropriate to realizing this concept are illustrated in the following text and described in detail in each of the exhibit scenarios in the final section of this work.

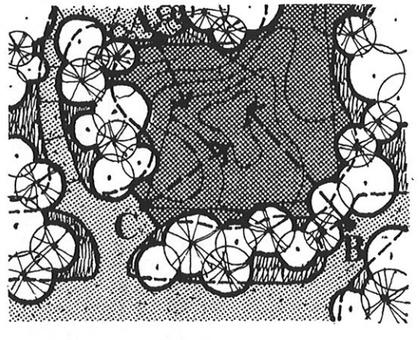
Like other activity areas, exhibit viewing areas occur at varying levels of circulation, though no views of the exhibits are allowed directly from busy primary paths. In all cases, viewing areas must relate to the individual exhibit and the larger bioclimatic zone.

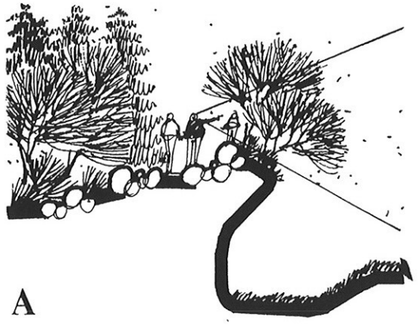
General Viewing Guidelines

The following guidelines are established for exhibit viewing:

1. Insure that animals are seen as only a part of the surrounding landscape which they co-occupy with the viewer.

2. Provide selected views only into the exhibits.





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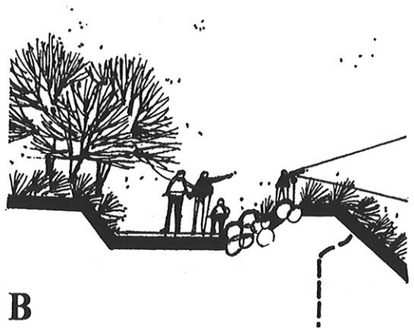

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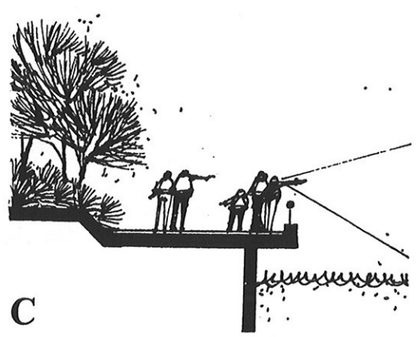
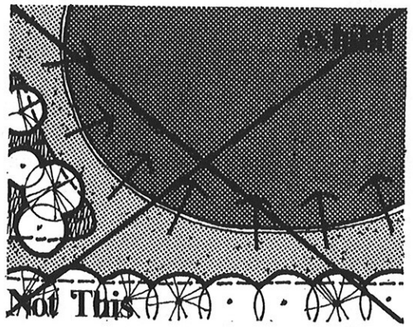


C

3. Eliminate continuous viewing of exhibit areas along circulation routes.



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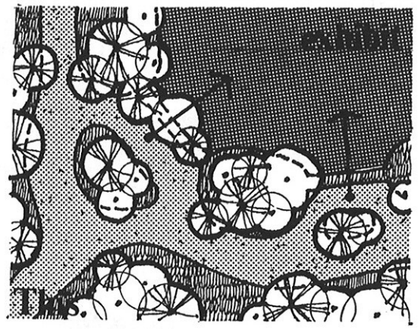

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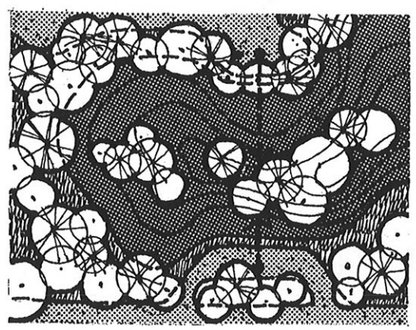
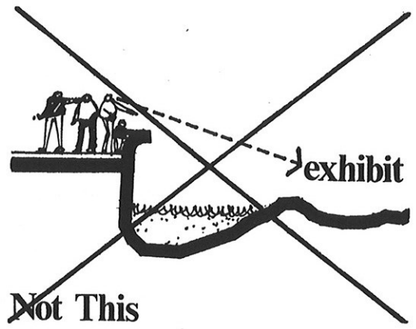
4. Augment sense of anticipation by sequential staging of approach views before animals are actually seen.

5. Screen out cross-viewing of other prople and exhibits.



6. Provide at least one major view location for interpretation of each exhibit; this must accommodate the special needs of all age groups and the handicapped.



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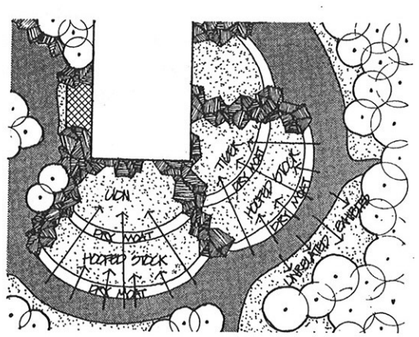
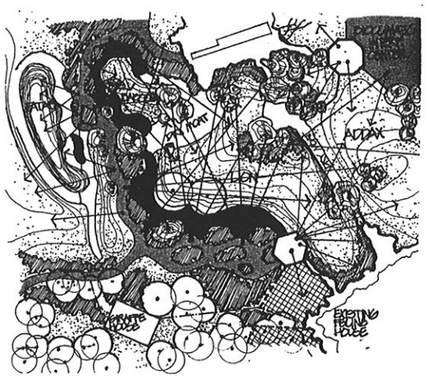
7. Avoid looking down directly on animals: they should be at or above eye level, the only exception being animals at or below the surface of water bodies.

8. Eliminate views of animals from outside the zoo and from parking and entry areas.

9. In summary, design exhibits to avoid static, set-piece views in which the entire extent of the animal area is obvious. Preferably, exhibits should be designed to unfold dynamically, view by view, from a variety of overlooks. In this way exhibits will appear continuous with their surroundings and indefinite, i.e., unlimited, in extent.

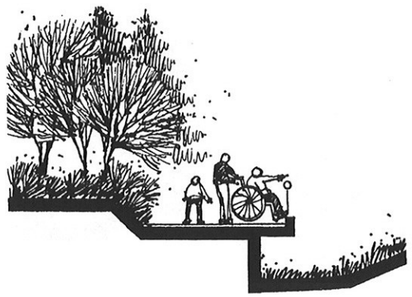
Comparison Diagram:



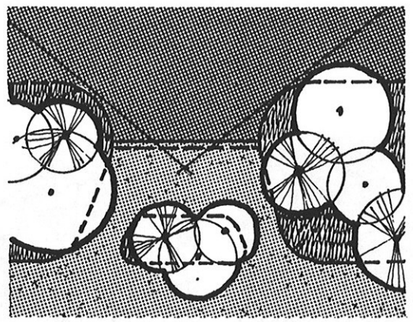


Illustrated Viewing Types

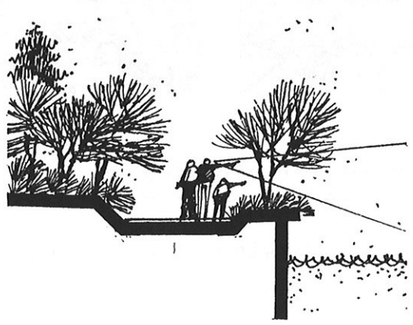
TYPE 1 VIEWING: OPEN EDGE



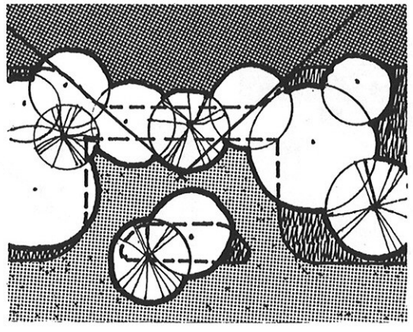
In this situation, foreground vegetation will be absent or below eye level to allow an unobstructed view of the animals exhibited. This type of viewing will be used when the objective is to: 1) get close to the animals, 2) view small animals, and/or 3) present an unobstructed view to children and people confined to wheel chairs. The viewing area will be set into dense planting to isolate it from other viewing areas.



TYPE 2 VIEWING: PARTIALLY SCREENED EDGE



A planted edge between animal exhibit and viewing areas, and a planted island between viewing areas and circulation routes is a typical viewing solution. The viewing area will be inset from the continuous exhibit edge to eliminate cross views from other viewing areas. When landforms or planting buffers are used, steps, boulders, logs, etc. will be incorporated to assist viewing by children.

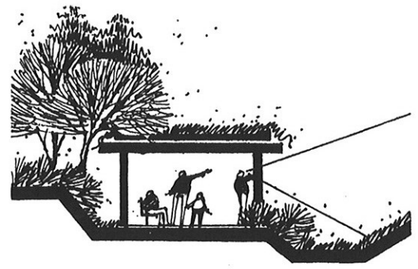


TYPE 3 VIEWING: MESH ENCLOSURE

Entire enclosures of glass or wire mesh are used in exhibits for the animal whose leaping distance exceeds the practicality of moats or other partial barriers - e.g., the leopard. Planting and landforms will screen and complement the view and buffer the exhibit from surrounding areas.

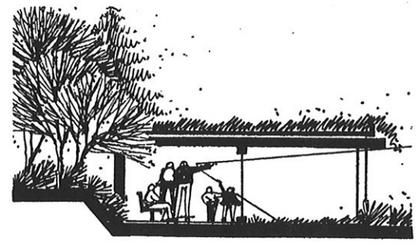
TYPE 4 VIEWING: SHELTER

Viewing shelters are used for major exhibits, in which visitors spend extended time. The structure will be in the character of the exhibit set against landforms and/or dense plant materials. See Architectural Guidelines.



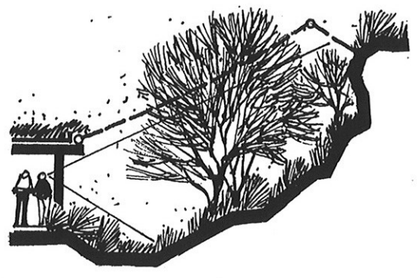
TYPE 5 VIEWING: ANIMAL DAY STRUCTURE

A combination viewing/animal structure can be used in exhibits in which animals accept close interaction with people - i.e., gorilla. The animal will not be enclosed in this structure. Rather, it will be a voluntary extension of its environment. See Type 4 Viewing and Architectural Guidelines.



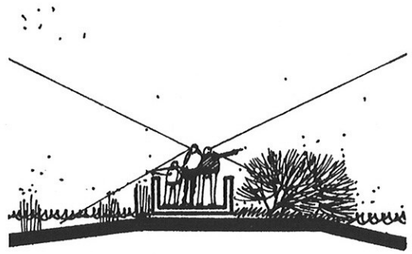
TYPE 6 VIEWING: COVERED VIEWING INTO MESH ENCLOSURE

This viewing type is a variation on Type 3 Viewing: Mesh Enclosure, with Type 4 Viewing: Shelter. Used together, the viewing structure frames out views of the mesh enclosure itself.



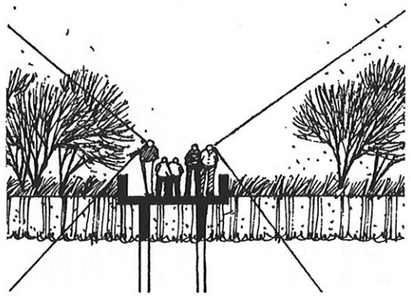
TYPE 7 VIEWING: BOARDWALKS

Boardwalks will be used only in marsh and aquatic exhibits. Plant massings appropriate to the exhibit will be used to camouflage the walk and the visitor from adjacent views, while allowing less dense areas for selected views of the exhibit.



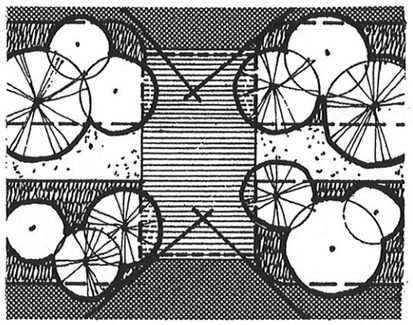
TYPE 8 VIEWING: BRIDGES

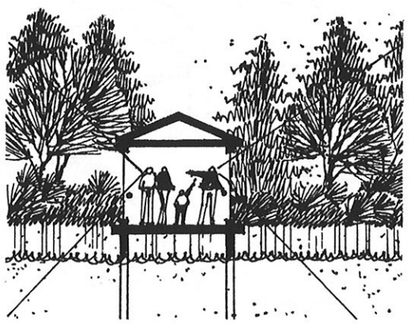
Bridges will be used in very limited situations with the viewing edge restricted to 20' in maximum length. This application allows a clear unobstructed view for the handicapped and children. As with Type 1 and Type 2 Viewing, the viewing area will be set into dense planting to isolate it from other viewing areas.



TYPE 9 VIEWING: COVERED BRIDGES

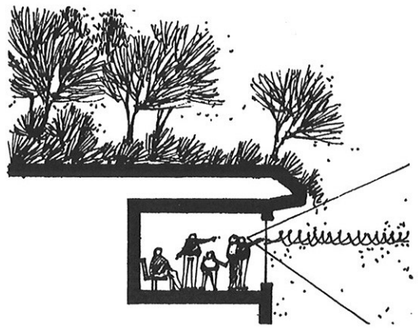
Covered bridges are used in connection with major exhibits where visitors may spend extended time at water-related exhibits. Where the bridge bisects exhibits of differing species, appropriate fencing material will be incorporated under the bridge deck to modulate and separate the two sides from each other.





TYPE 10 VIEWING: UNDERWATER

The expense of such exhibits makes their widespread use generally unfeasible, but they should be considered, as they add a very special dimension to the zoo experience.



General Guidelines for Barriers

Barriers are essential for both visitor and animal safety, but they should be designed and located to be as unobtrusive as possible.

The birds, mammals, reptiles and amphibians chosen for exhibit at Woodland Park Zoo represent a vast range of physical mobility and behavioral tendencies. Moreover, individuals within each species vary widely in their abilities and predispositions toward escape under a wide range of stimuli. Thus, to produce a detailed prescription for the containment of each of the species would involve an exhaustive study well beyond the scope of this report. However, the following general discussion and recommendations are pertinent.

Physical Barriers

These include walls, moats, fences, glass partitions and complete enclosures. Where barriers are intended to separate one species of animal from another, the selection of type must depend upon an understanding of the animals contained. Barriers intended to separate animals from the public must additionally consider human behavior.

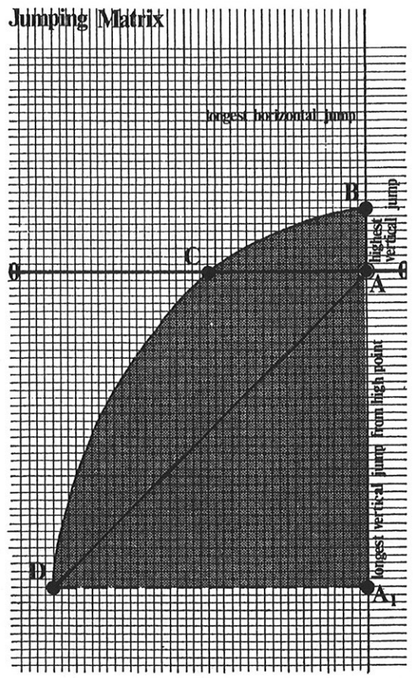
Jumping Matrix

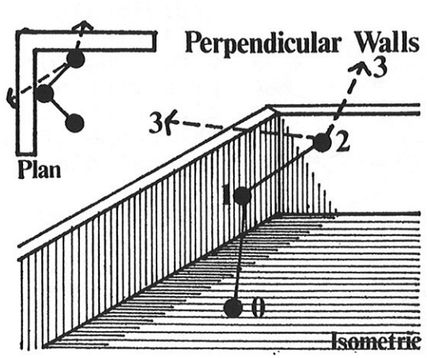
The following matrix is suggested as a tool to aid in the prediction of potential escape ranges from a variety of animal positions above, level with, and below barriers. With its use a varied combination of barrier heights and widths can be determined. This allows the designer to vary heights and widths as necessary to completely integrate the barrier into the overall exhibit design. In operation, A-B is plotted as the

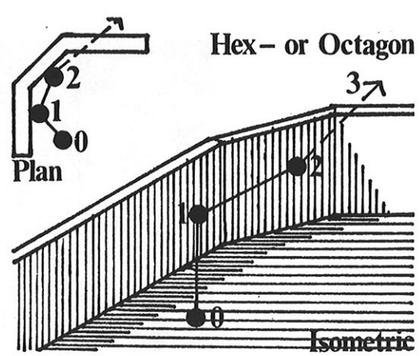
animal's highest possible vertical leaping distance. A-C is its longest possible horizontal leap and A-D is its greatest horizontal leaping distance from a high point A to a low point D. Note that A-D is 45° to A-C.

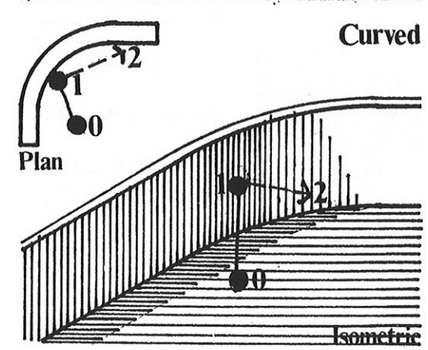
Problem Corners

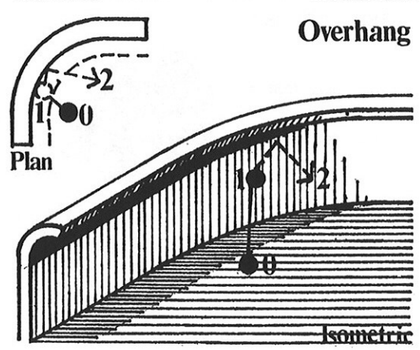
Right-angled or acutely angled corners should be avoided. Not only do they allow the possibility of subordinate animals being "cornered" by dominant individuals but they invite escape by agile animals. Many primates, ungulates, felids and others have the ability to leap against a corner wall and ricochet against an adjoining wall to an even greater height.











The usual after-thought approach is to build higher and more visible corner barriers. A far better solution is to avoid creating corners altogether.

Psychological Barriers

The behavior of all animals is partially determined by a web of psychological inhibitions that are both learned and innate. Kittens may become frightened of great heights while sloths avoid "floors". Bats avoid bright daylight while many birds will not enter a darkened space. Some reptiles will not cross a cold surface while elephants avoid a resilient or moveable surface and cattle will not cross a large perforated surface. These characteristics and others can be exploited successfully as "natural" barriers.

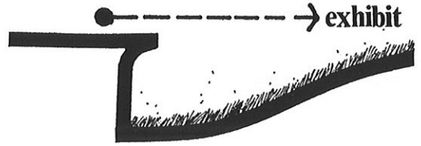
Modern technology has also supplied a variety of artificial means of inducing avoidance behavior. These include electric shocks, chemical odor and taste repellents, invisible glass or plastic barriers and ultra-sonic noise. Many of these techniques are unproven but may merit further research and development.

The aforementioned are essentially "external" controls. A wide variety of "internal" controls are also possible. These include formal training, social ranking within or between species, hunger and activity patterns and simply "habit".

Because individuals vary widely in their reaction to psychological barriers and because these barriers may lose their effectiveness when animals come under the extreme stress of a panic reaction, back-up physical barriers are usually needed.

Recommended Barrier Types

The following barrier types are specifically suggested for development at Woodland Park Zoo and are developed in more detail for each proposed exhibit in the exhibit scenarios.

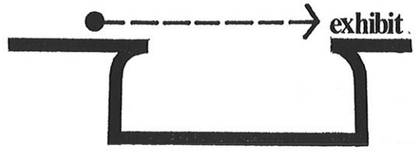


TYPE A BARRIER: MOAT

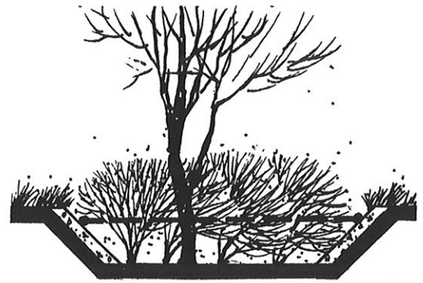
Type A-1a ONE-SIDED DRY MOAT
These types of moats allow animal access, having a gently sloping interior edge. In viewing areas they should be made to replicate natural landforms such as dry ravines or abandoned river-cut banks. Since they allow animal access, these moats should not be used for hidden or rear barriers.

Type A-1b ONE-SIDED WATER MOAT

Water moats are ideal for foreground barriers, for they can easily be made to resemble a variety of waterbodies ranging from sparkling mountain freshets to placid lily pools to nearly dry seasonal floodways. A few animals such as gibbons and woolly monkeys can be contained entirely with water; most often, however, the water barrier must be combined with overhanging "water-cut" banks. As a general rule, the moat should be deep enough to prevent escape when drained, and, in all cases, the edge nearest the animal area should be shallow, sloping gently to a deeper midstream and minimizing danger of drowning. Full water moats are not recommended because, having two steep walls, they constitute an obvious danger to animals.

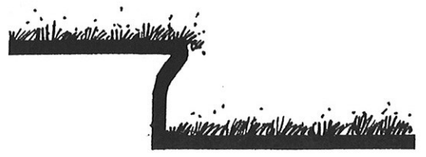


Type A-2 FULL DRY MOAT
Full dry moats are excellent barriers for the rear of animal areas, for they allow backgrounds of dense plantings or adjacent animal areas to be seen by the viewer. Properly sited, they will be completely invisible. Full dry moats are also useful for frontal barriers but are more difficult to integrate into exhibit design than are water moats.



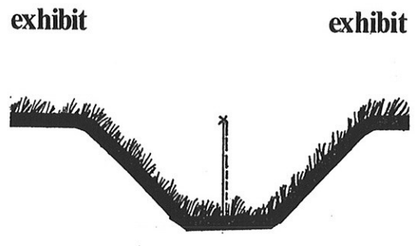
Type A-3 MODIFIED "CATTLEGUARD"

Barriers for exceptionally agile wild hoofed animals such as goats require special consideration. As a general prototype, a modification of the well-known "cattleguard" is suggested. A wide concrete-walled dry moat with steeply sloping sides would be covered transversely by loosely stretched steel rods or cables spaced 6" apart. The moat should be deep enough to prevent the animals from stepping between the rods, which would be too free-swinging to allow animals to balance on them. If they should fall into the moat, the closely spaced rods would support them until help arrived. These thin rods or cables would be much less visible than traditional cattleguard rails. Also, vegetation in the moat would help to obscure the rods, which, in turn, would protect plantings from animal browsing. This type of barrier could also be used as a tree guard.



TYPE B BARRIER: WALL

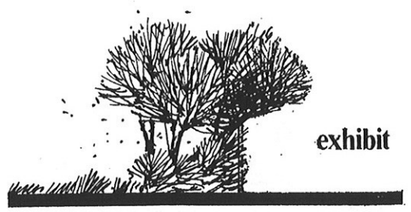
All walls that can be seen from public areas should resemble natural formations such as river-cut banks or rock outcroppings. In unseen areas, walls may be made of the most suitable construction.

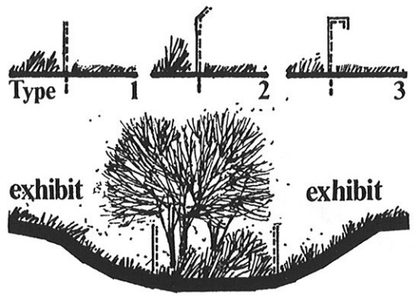


TYPE C BARRIER: HA-HA

The ha-ha is essentially a ditch or swale obscuring a fence or wall, and is best suited to background areas. Where possible, this swale should be filled with suitably repellent planting to prevent animals from using the areas.

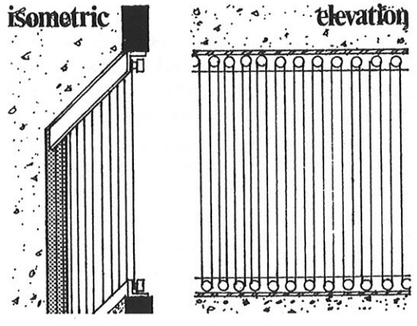
TYPE D BARRIER: FENCE
The type of fencing used depends upon the characteristics of the animals contained. Type D-1, vertical fence for easily contained animals. Type D-2, overhanging fence for more agile animals. A straight fence set with an inward incline serves this same function. Type D-3, double-overhanging fence is used for all but the most arboreal of climbing animals. The loose inner fabric contains the animal, thus preventing escape. The additional sketch shows fencing combined with screen planting.





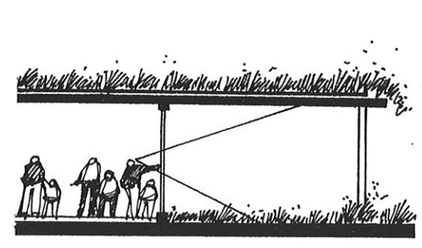
TYPE E BARRIER: HARP WIRE
Closely spaced, tightly tensioned vertical wire or fine cable can be used to restrain small mammals and birds and is much less visible than wire mesh. The combined load of these wires requires a sizable supporting frame and adjustable tension-setting mechanisms. Harp-wire systems can be insulated for electrification.

TYPE F BARRIER: ELECTRIC FENCE Controlled electric charges provided by commercially available fence chargers can be applied to any insulated metal, including mesh or individual wires or even coated glass. This produces a harmless but very effective electric shock when touched. Such barriers may be easily shorted, however, and should therefore not be used alone as primary barriers. Their chief usefulness is reinforcement to any of the other barriers listed above. Charges should be of the continuous or nonpulsating type as many animals are able to hear the pulse and learn to cheat the system.

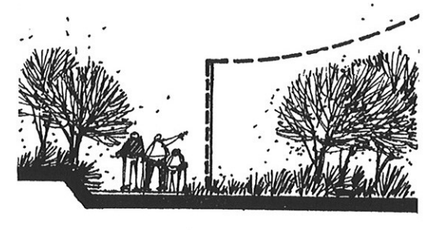


TYPE G BARRIER: RAILING
This type of barrier is principally useful as a barrier to visitors and may include rustic rail fences or low "kick-rails" depending upon the surrounding exhibit character.

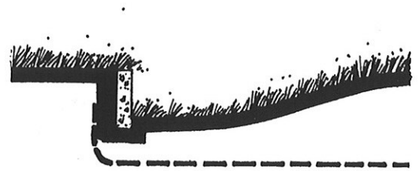
TYPE H BARRIER: GLASS
Properly designed and maintained, reinforced glass partitions can be the least visible solid barriers and have the advantage of preventing transmission of airborne disease organisms. However, severe problems of reflection can occur in improperly located windows, and desirable animal sounds and odors are restricted. Daily cleaning, inside and out, is required.



TYPE I BARRIER: NETTING OR MESH
This complete enclosure is required for birds or mammals so agile that alternate barrier types are impractical. Mesh overhead barriers may also be used in waterfowl exhibits to prevent access of unwanted local opportunistic species.



TYPE J BARRIER: BURIED MESH



Burrowing animals require an artificial "floor" barrier. Mesh has the advantages of allowing free drainage and being relatively inexpensive. Such materials should be non-corrosive. Buried shreds of rusted wire could pose a serious hazard to future generations of animals.

General Guidelines for Landscape Development and Site Furnishings

The use of the bioclimatic-zone concept is a clear, flexible, bold and effective means of presenting a comprehensive, consistent, educationally accurate and memorable zoo experience. Success will depend upon the consistency, thoroughness and accuracy with which landscape development is carried out. Superficial, misdirected or half-hearted attempts will not only produce mediocrity, but confusion and contradiction as well.

Successful development within this framework will not only require close adherence to these guidelines and to the exhibit scenarios, but will require thorough design development. No matter what aspect of the work is being advanced, it is essential it be approached with an attitude of disciplined creativity. Initially, an in-depth understanding must be gained of the natural forms and processes being replicated. What, for example, is the implied origin of an artificial rock face, or the implied successional stage of a forested exhibit?

The final product must be able to withstand reasonable scrutiny at every level. It must seem "right" to the child, the adult, the resident, the tourist, the scientist and the maintenance worker. Because most projects will require many years to mature, interim or successional methods must be employed that are also effective and appropriate to the fullest extent possible.

Landscape development includes horticultural aspects (plantings and their maintenance), earthforms, artificial rock work, water bodies, paving, and exterior furnishings.

General Guidelines

All of the landscape elements must be responsive to the following general criteria:

1. Appropriateness within the overall Bioclimatic-Zone Presentation Theme.

2. Appropriateness within its geographic, geologic, or ecologic setting as described in the exhibit scenarios (i.e., either a material or feature native to the setting or an accurate replication or simulation of the desired indigenous material or feature).

3. Appropriateness to the biologic setting into which it is placed (for plant materials, i.e., slope, exposure, soil type, moisture requirements, etc.).

4. Appropriate to the visual/aesthetic function for which it is intended (i.e., accent, background, screen, etc.).

5. Appropriate to the physical function for which it is intended (i.e., durability, strength, support, flexibility, etc.).

6. Appropriate to the educational or behavioral response intended (i.e., creates the required psychological response, historical reference or informational association).

7. Appropriate in all ways to the well-being of the resident animals and the visiting public directly or indirectly affected (i.e., non-poisonous, comfortable, safe, etc.)

Horticultural Recommendations

Plan Ahead

The exhibit scenarios suggest planting,specific or generic, most appropriate to the intended result. Some of these plant materials are indigenous to this area and others are designated replicators. Where possible, commonly available plants are suggested, but often species are required that may not be easily found in the quantities or sizes required. For this reason it is advisable to use these specifications as a means of anticipating future demands in order to seek out or pre-establish stocks of hard-to-acquire materials. Where substitutions must be made, sufficient research is required to substantiate that the substitutes have essential equivalency.

It may, at times, be possible to establish trees some years in advance of the actual exhibit development. At other times trees may be relocated within the site, often as a result of other new construction. These guidelines and scenarios, together with the Long-Range Plan, will make it possible to determine in general the best place to relocate such trees.

Special Supervision

The nature of the work suggested will eventually require a full-time staff overseer of special expertise (perhaps "Curator of Horticulture"), a person with sound credentials in plant science and traditional horticulture in addition to study and personal experience in understanding the visual and biological characteristics of a wide range of world climate zones. This person would provide long-term continuity for both major new projects and daily landscape maintenance operations. It would be this person who supervised the annual shearing of conifers in the alpine exhibits to replicate the effects of wind and snow and checked the underground irrigation/drainage system in the desert exhibits or helped keepers rebuild a beaver dam in a waterfowl exhibit.

Throughout this report the term "Exhibit Area" is used to mean the entire area developed consistently within the framework of the scenario. It thus includes public zones such as secondary or tertiary pathways, overlooks and interpretive areas and non-public zones such as screen and background planting areas as well as the animal zones traditionally referred to as "exhibits".

Planting Guidelines for Exhibit Areas

1. Plant materials and the manner in which they are planted shall be consistent with the scenario for the area of the work.

2. Because of the importance given to landscaping in the zoo presentation theme, construction budgets must allow significantly more funds for this area of the work than are normally allocated.

3. Whenever possible, a sum should be set aside from the construction budget to cover repair and replacement of landscape work damaged by animals during their initial occupancy. Also, plans must be carefully prepared but flexible and require adjustment to meet the needs of individual animals or improved maintenance practices.

4. No plant materials potentially harmful to the animals exhibited shall be used in the vicinity of the enclosures. Many zoos have lost valuable animals because the public has fed them poisonous plants from nearby ornamental plantings. Determination of toxicity can require very specific testing, for plants known to poison some species may be the traditional browse of others.

5. No formal or purely ornamental plantings are to be established in exhibit areas. However, the use of flowering and attractive plant materials appropriate to the bioclimatic zone and arranged to appear completely natural is to be encouraged if these contribute to the vividness and memorability of the exhibits.

Planting Guidelines for Major Activity Areas

The following discussion pertains to areas of public use not designated as exhibit areas.

1. Plantings should establish an atmosphere of quiet beauty and essential simplicity, as a fitting background for intensive human activity. They should not compete as an attraction themselves.

2. Plantings should be functionally selected for the purpose intended (shade, screening, etc.) and should be planted in ways minimizing maintenance.

3. Where ornamental accents are welcome (such as at zoo entry points), they should be concentrated for increased effect and reduced maintenance.

4. Plantings in activity areas should contribute to the essential concept of the prevailing adjacent bioclimatic one, or serve as a transition for it. For example, floral displays in the main entrance (Phinney Avenue Entry), which is in the Temperate Deciduous Forest bioclimatic zone, could use violets, spring-flowering bulbs and other ornamentals orginating in the temperate region. These should not be continued to the east end of the Interpretive Gallery, which lies at the edge of the Tropical Forest zone.

5. Turf areas are not appropriate in areas of intensive use such as entry plazas, the concession plaza, or the gallery concourse, where heavy use would create maintenance problems.

6. Turf areas are appropriate, however, in passive recreation zones such as picnic areas. However, where heavy shade prevents vigorous turf growth materials such as fir bark, composted bark chips or gravel

should be substituted.

7. Passive recreation zones should be developed to appear as natural areas. Informal plantings, slightly undulating lawns and the use of stumps, logs and rock outcrops for casual seating will encourage this impression.

Maintenance Recommendations

As Woodland Park Zoo develops with more attention devoted to the animal exhibit areas, there will be a considerable change in the mode of maintenance activities. Presently, grounds maintenance crews expend a preponderance of effort in upkeep of ornamental plantings, for example pruning roses, shearing hedges or mowing lawns, or in clean-up activities such as raking leaves. These activities are presently done with thoroughness and professional skill but do not contribute significantly to the presentation of animal exhibits. Future exhibits developed under the bioclimatic-zone concept will, on the other hand, be more nearly self-maintaining. In forested exhibition zones, leaves and organic litter will be allowed to accumulate, while in plains exhibition areas, grass will go naturally unmown. Future horticultural maintenance will stress establishment and maintenance of natural planting in exhibit areas, including both public and animal zones, and will include activities such as pruning and training "windblown" alpine trees and propagating unusual or commercially unavailable plants which are essential to establishing habitat realism. Acceptance of this new concept will require reorientation of staff and continuous direction by supervisory personnel.

Generally, the total area requiring constant attention will be greatly reduced as will the constant, repetitive chores of groundskeepers. The staff will become more expert, with greater need for tenure or long-term continuity.

Maintenance Guidelines for Exhibit Areas

1. Practices which leave the appearance of human activity (such as mowing, raking, spading, formal pruning, clean-up of organic debris, etc.) are not appropriate in exhibit areas. When such activities are essential they shall be done in a manner leaving no trace of human activity.

2. Horticultural maintenance within exhibit areas must be carefully coordinated with animal keepers and supervised by a Curator of Horticulture.

3. Horticultural maintenance operations should be restricted to non-peak visitor hours.

4. Irrigation systems should all be automatically timer-controlled but must have manual override capabilities. Systems must be zoned to consider animal needs, activities and safety. No irrigation equipment shall be installed within the reach of primates or animals such as rodents and carnivores which may be inclined to chew on exposed apparatus. Sprinkler heads used in ungulate areas should be of the type used for playfields to eliminate surface obstruction.

When possible, irrigation systems shall be operated during the night and early morning hours in order not to impact neighborhood use.

Maintenance of Public Activity Areas

1. High-maintenance ornamental plantings compete for funds and attention with exhibit areas and are to be generally discouraged, particularly those requiring continuous attention. (For exceptions and further discussion, see Planting Guidelines).

2. Planting or turf areas that become worn or damaged from over-use should be paved or otherwise reinforced rather than simply being annually replanted.

Natural and Artificial Rock Work

1. When possible, natural rocks should be used for foreground and small-area applications.

2. Artificial rock work is at present more economical and more controllable for large applications.

3. Concrete cast in latex molds taken from natural rock outcroppings should be used where large foreground rock formations are desired and where close public scrutiny is expected. These molds are especially suited to replicating stone with complex structure such as gneiss, schist and limestone.

4. Good gunite techniques require artisanship not easily found and should be used for background areas or rock forms that naturally resemble gunite, such as monolithic granite and sandstone. Gunite is especially suitable for simulating hardpan, clay and mud banks.

5. Generally, it is very difficult to mix natural stone with artificial stone in the same exhibit, for the

differences become obvious. However, vines or mosses can, if desired, obscure most of the surface, thus making it possible to mix new artificial stone with existing grottos.

6. In the last two decades there has been a trend away from literal copying of natural rock formations in favor of abstract forms. These have become somewhat stereotyped as one practitioner copies another rather than returning to the natural source. With improved techniques in guniting and especially with advancements in molding natural outcroppings, it is now possible to accurately and predictably reproduce exact copies of living stone - even to the transfer of surface crystals and fossils. Since accuracy in replicating natural environments is fundamental to the Bioclimatic-Zone Presentation Theme, these techniques and the literally accurate reproduction of natural stone are preferable to experiments in abstraction and artistic license.

7. Another very common and longstanding zoo practice is to enclose the animals in a landscape composed almost entirely of artificial rock. One commonly sees forest animals such as okapi and gorilla completely surrounded with stone, without a tree in sight. To avoid this unfortunate tendency, rock work should be used only where it is geologically appropriate and ecologically desirable. Where moat walls must be exposed, artificial overhanging clay and mud river banks which are much more typical of many tropical areas of the world can be used, rather than concrete monoliths out of context with nature.

Water Bodies

1. When concrete paving is required to line water bodies, exposed edges should be obscured by natural stones and overhanging turf or vegetation.

2. Paving which lines shallow, quiet, reflective pools should be dark colored, preferably with integral color additives and/or textures.

3. Marshy areas which can be expected to receive trampling from large animals should be paved with submerged gravel or cobbles, having the interstices planted to the appropriate marsh plants.

4. An expansive and continuous system of seemingly interconnected water bodies has been developed to add visual and topographic continuity throughout the zoo grounds. However, for reasons of animal health and hygiene, these water bodies are, in fact, not interconnected, each being recirculated within its own exhibit zone as described in detail in the Exhibit Scenarios. Pickup and discharge points must be carefully obscured from public view.

Paving

The following discussion includes a variety of uses of paving in public activity areas, circulation ways and within animal enclosures.

1. Paving of primary and secondary circulation areas (see previous discussion of Circulation) should be of Portland cement or asphaltic concrete of sufficient durability to allow passage of service trucks and emergency vehicles. These materials are available in a wide range of colors and textures, which should be chosen to compliment the nature of the surrounding development or match existing abutting paving. The continuous, plastic nature of these materials lends itself to a feeling of movement and dispersal.

2. Major activity areas should be surfaced with unit pavers to set them apart as areas in which to pause and gather. These unit pavers should be larger with more highly finished, easily cleaned surfaces. In all cases these pavers must be designed to meet heavy service traffic and to accommodate wheelchairs and strollers.

3. Secondary and tertiary circulation ways may be surfaced in a wide range of materials suitable to the bioclimatic zone or exhibit area which they traverse.

4. Just as appropriate transitions are required between plantings of adjoining bioclimatic or geographical areas, so also are appropriate transitions required between various paving styles and materials. In fact, these may be critical. The following suggestions are made:

   a. The closer a paved surface is to a major activity or circulation area (with increased use and speed of travel), the more refined and regular it should become (i.e., concrete pavers, asphalt paving), while more remote and dispersed areas should be paved with natural materials of rougher texture.

   b. Highly contrasting juxtapositions between pav-

ing materials should be avoided by the use of intermediate materials. A gradual progression should be made from one exhibit to another or from exhibits to major circulation pathways.

c. The surfaces of exhibit viewing areas and interpretive structures should be paved with materials closely related to materials used within the exhibit viewed.

5. The suitability of various paving materials for the use areas proposed is summarized in the following matrix.

6. Definition of various types of surfacing and paving:

a. Portland cement concrete
   1) Broom finished - homogeneous smooth surface used typically for sidewalks.
   2) Fine to medium exposed aggregate - exposing the gravel or seeding and troweling in selected gravel gives a more natural appearance. This process occurs naturally after many years of wear.
   3) Large exposed aggregate - large flat pebbles up to 4" in size and troweled into the surface; often used for stream beds and low-traffic areas of special interest.
   4) A wide range of color additives and colored aggregate materials are available.

b. Asphaltic concrete
   1) "Class B" is the standard surfacing used for roads and parking areas and contains fine-medium-sized aggregate which becomes exposed after years of use.

Paving Suitability Matrix	Paving	CONCRETE	Broom finish	Moderate exposed aggregate	Heavy exposed aggregate	Gunite/stone	Gunite/clay	ASPHALT	School mix	Regular mix	Special color mix	UNIT PAVING	Large pavers	Cobblestones	River cobbles	Flagstones	SOIL CEMENT	"Cintrex"	Sand	UNSTABILIZED GRANULAR MATERIAL	"Cintrex"	Crushed rock	Pit-run gravel	Sand	MISCELLANEOUS	Wood decking	Wood chips	Cobbles & turf	Cobbles & gravel	Gravel-reinforced turf	TURF	
Circulation And Activity Areas	Major Activity Area											●																				
	Primary Circulation		●	●					●	●																						
	Secondary Activity Area												●																			
	Secondary Circulation			●	●					●	●		●		●			●														
	Passive Recreation Areas																	●	●			●		●					●	●		
	Tertiary Circulation				●	●							●	●	●			●	●		●	●		●				●	●	●		
Exhibit Areas	Tropical Forest						●											●			●					●	●					
	Savanna					●	●											●			●									●	●	
	Desert			●	●	●								●				●	●				●	●				●	●			
	Steppe						●																							●	●	
	Chaparral					●												●	●				●						●	●		
	Temperate Deciduous For.																						●			●	●					
	Temperate Rain Forest						●																●			●	●					
	Taiga						●																●			●	●					
	Tundra				●										●	●							●	●					●		●	
	Montane					●								●	●	●							●						●	●	●	

2) "School mix" uses a fine aggregate and has been used for the walkway north of the Poncho Theater.

c. Unit paving - applies to a wide range of manufactured paving slabs, blocks or bricks and includes cut or split cobblestones and natural cobbles.

d. Soil Cement - used here to signify a variety of materials bound or stabilized by small quantities of Portland cement or chemical binders such as "Road Packer" and others. The finished surface greatly resembles the natural material used but is more resistant to wear and remains stable in wet weather. It can be made from any of the following inorganic materials.

e. Granular materials
   1) Pit-run gravel - contains a naturally graded mixture of fine silts, sand and rounded gravels which compact to a fairly durable and very natural appearing but rough surface.
   2) Crushed gravel - compacts more tightly than pit-run, also much more uniform and even.
   3) Sand - compacts well if finely graded in size.
   4) "Cintrex"

Exterior Furnishings and Graphics

Included in this category are the many useful facilities provided for the visitor such as benches, tables, trash receptacles, drinking fountains, information kiosks and general graphic features. Although the detailed specification of these elements is beyond the scope of this report, the following general guidelines are given:

1. Furnishings should generally be standardized as to type, size and overall character throughout the zoo to provide overall visual continuity and easy recognition. However, color and finish should vary from location to location in accordance with the character of the surrounding bioclimatic zone or activity area.

2. Facilities should be simple and functional, and, although clearly recognizable, should not call attention to themselves.

3. Furnishings should be designed to provide for the special needs of the handicapped, the young and the aged. For example, benches should have nearly level seats with comfortable backrests, as deeply reclining seats are difficult for older people to raise themselves from. Benches should be low to accommodate a full range of body dimensions.

4. Attempts should be made to integrate various necessary features into one object where their functional requirements are mutually supportive. For example, a sign kiosk could also incorporate a trash receptacle and/or lighting fixtures.

5. Materials should have primary or elemental character (e.g., stone, iron, wood, etc.) rather than highly manufactured or artificial character (e.g., plastic, stainless steel, enamel paint, etc.).

6. Amusement or novelty items such as trash receptacles resembling cartoon characters may be fine examples of contemporary popular art but are not appropriate for this site, for they call attention to themselves and thus detract from their surroundings.

7. Location of features should be coordinated with layouts of paving, drainage, etc.

8. All facilities should be located to minimize maintenance and allow for cleanup by powered sweepers.

9. Facilities should be carefully sited to enhance their usability, i.e., sign posts should be set before simple backgrounds, benches should provide for sitting in a variety of exposures and at viewing areas of interest.

10. Extensive lighting is not required, for in this location high-use summer evenings are naturally well lit while dark winter evenings are little used because of frequently inclement weather. Therefore, lighting should generally be restricted to moderate security needs.

11. A systematic, coherent concept of interpretive graphics should be developed for the entire zoo. It should contain the following elements:

    a) The primary message or identification should be given immediately and simply and at an elementary level.

    b) Additional interesting information should be given in a manner appealing to an average education level.

    c) Technical information (i.e., scientific names or specific information of interest principally to the specialist) should be provided as the least conspicuous element of the panel or in separate well-prepared guidebooks.

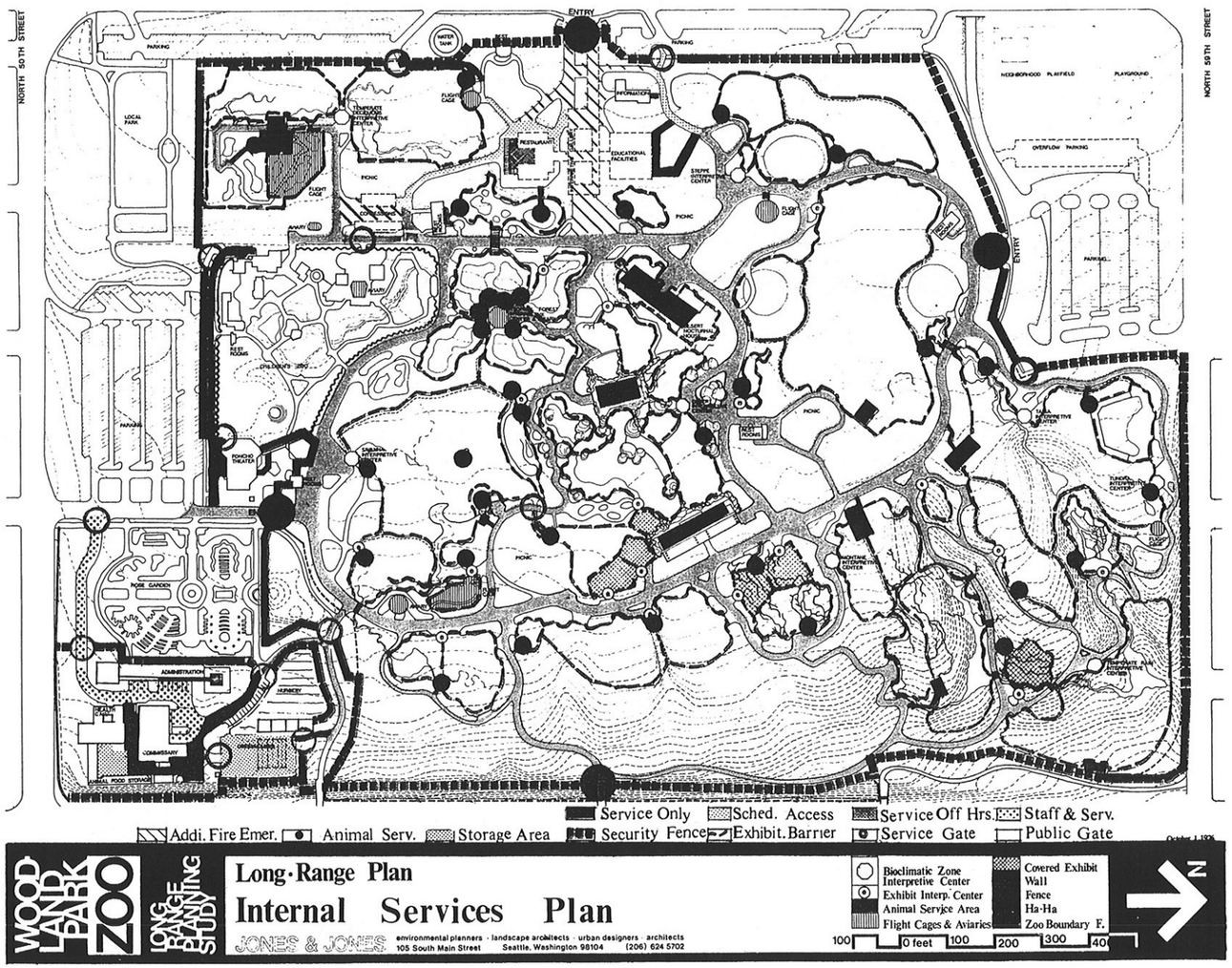
    d) Graphic panel sizes should be modular and inter-

changeable with provision for updating and replacement.

General Guidelines for Internal Services

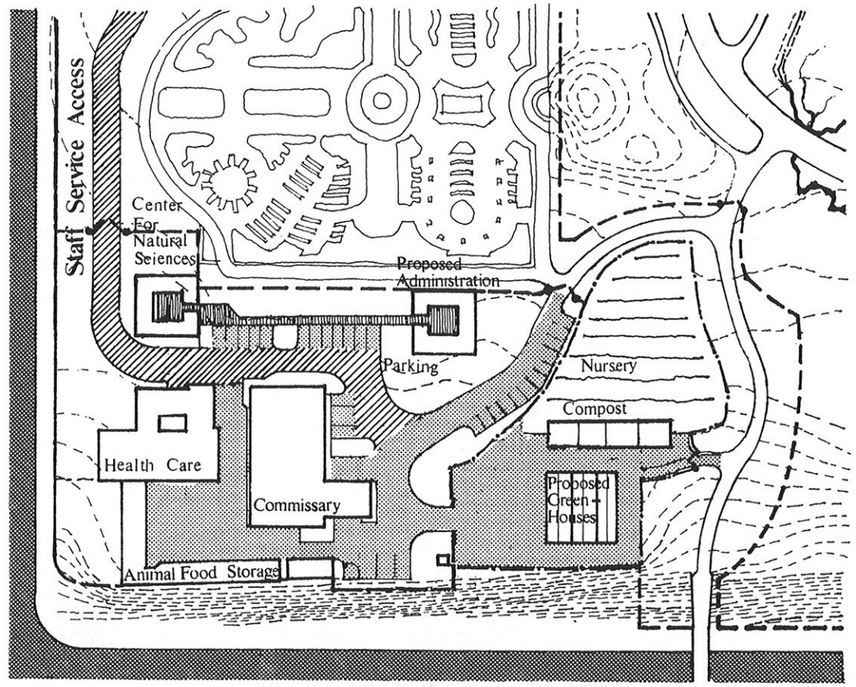
Internal services provide the functions and circulation necessary to the maintenance and operation of the zoo. Those services located in the Commissary Complex are shown on the following plans as: 1) Administration, 2) Animal Health Care, 3) Center for Natural Sciences, 4) Commissary and Storage Areas, 5) Greenhouses and Nursery, 6) Composting Area, and 7) Employee Parking.

The Internal Services Plan shows the locations of the remaining service features, including 1) Existing Building Service Areas, 2) Proposed Animal Service Areas, 3) Security Fencing, 4) Animal Exhibit Barriers, 5) Fires and Emergency Access, 6) Scheduled Service Access, 7) Off-Hours Service Access, and 8) Separate Service Roads.



Service Access

The zoo grounds will be entirely surrounded by security fencing with locations for four public entries. These are described under the subject of *Circulation*. The Commissary Complex is separately fenced and has separate service entry. Public circulation systems throughout the zoo make as much use as possible of existing pathways. They have been designed also to accommodate service vehicles. By using these pathways essentially during non-peak hours, conflicts with the viewing public can be averted. The dual use of these pathways avoids expensive redundancy in paving areas, but some separate service access will be required to the restaurant or concession facilities for use throughout the day. In all cases, service spurs, parking, storage areas and keeper access must be well screened from view. All exposed paving at service entry points should be compatible with the character of the exhibit area (see *Landscape Development)*. In addition to normal service, provision must be made to allow emergency access, including fire-fighting apparatus, to all buildings.



Food Storage

Central food storage will be located in the Commissary Complex. No other large decentralized storage areas should be used. Supplies should then be distributed throughout the zoo in small depositories located conveniently near the exhibits supported.

Waste Collection and Disposal

At present the zoo is serviced by a wide range of vehicles ranging from garbage compactor trucks to small three-wheeled utility vehicles with dump-beds. The compactor trucks are necessary for collection of the large quantities of trash from public areas while pickup trucks and utility vehicles
deal with general grounds maintenance operations.

Guidelines for Waste Collection and Disposal

1. Trash from public waste receptacles should be collected daily by compactor trucks during non-peak visitor hours.

2. With the development of larger, more natural animal enclosures, cleanup operations will shift from reliance on pressure hoses to far greater use of broom, fork, scoop and wheelbarrow. This will reduce loading on sanitary sewers and increase the volume of solid waste handled.

3. Animal wastes, garbage and inorganic trash will be picked up daily by utility vehicles and deposited for composting or disposal (in dumpsters) in the Commissary Complex.

4. Organic wastes resulting from grounds maintenance operations will be collected by larger vehicles if required and transported to the Commissary Complex for composting.

5. Incineration is the best means of disposal of animal carcasses and a suitable facility should be installed adjacent to the animal health care unit in the Commissary Complex.

Composting of Organic Wastes

The detailed presentation of a comprehensive composting system such as that used at the National Zoo in Washington, D.C., is beyond the scope of this report. However, the principal elements of the system are outlined as follows:

1. All compostable waste products will be converted to soil amendments for use on the zoo grounds.

2. Animal manures, together with organic materials such as animal bedding, grass clippings, leaves, prunings, and vegetable kitchen leavings would be composted aerobically in rain-protected open-fronted bins. The law requires that no waste products of African-born ungulates leave the zoo grounds. Thus, these especially should be composted.

3. These materials will be mechanically chipped or mulched as required to facilitate decomposition.

4. "Hot" manures (feces from carnivores) would be composted anaerobically in air-tight vented concrete vaults.

5. Both aerobic and anaerobic composting would be augmented by addition of appropriate enzymes and microorganisms and by thermostatically controlled heating cables.

6. The aerobically composting materials would be periodically turned and rotated from one bin to the next with a front-end loader through various stages of composting.

7. The finished materials, reduced 50% in weight and sterilized by the heat of decomposition, will be used to fertilize and condition lawn and planting areas throughout the zoo.

Animal Service Areas

The detailed discussion of the many specialized requirements for handling and maintaining the variety of animals exhibited is also beyond the scope of this report, but the following general guidelines are presented:

A. Animal Surveillance. In the proposed long-range plan, exhibits will be dispersed throughout the zoo grounds and closed-circuit TV monitors will be provided at each of the animal service areas and transmitted directly to the Commissary Complex in order to maintain constant animal surveillance when required. The camera(s) should be located to view both the den area and the outer enclosure.

B. Keeper Safety.

1) The service facilities themselves should conveniently and safely provide keeper access to the den areas and to the enclosures.

2) A separate access to the den area should be provided for the keepers and should be well protected from the animal areas.

3) To ensure keeper safety upon entering the exhibit area, a mesh or glass-enclosed vestibule should be provided so that the keeper may clearly observe the animals. There should be no possible areas adjacent to the vestibule in which an animal could hide and attack a keeper stepping from the structure.

4) In all cases, a double-door system should exist between the animals in the holding area and the zoo proper, such that an animal is confronted by a minimum of two barriers before it can escape.

5) The containment area should provide a temporary animal holding area, a main containment area and separate isolation cages that can readily be moved and relocated as necessary.

6) Provision must be made for safe access and operation to all areas within.

7) An area should be provided within the enclosure from which the keeper can observe the animals.

8) Space should be provided to store minor but necessary supplies and to prepare feed.

9) Direct visual access must be provided to all doors, gates and closures.

C. Animal Safety

1) Animal holding areas should be free from projecting objects which could cause injury during play or panic reaction.

2) When hoofed animals and large flightless birds are introduced into moated enclosures, they should be protected from the moats by highly visible temporary fencing until they become accustomed to the limits of their areas. Low permanent barriers such as stones or rails should line the edges of hidden moats, warning the animals of danger. These low barriers should be kept below the sight lines of viewers.

3) Slick or potentially slippery floor surfacing must be avoided in holding areas.

4) Sudden noises that could potentially initiate a panic reaction in high-strung animals must be prevented. These include fire alarms and warning buzzers, clanging steel gates and clamor of adjacent construction activities. Elimination of sudden noise is especially important in nursery areas.

5) No potentially poisonous substances such as certain paints or preservatives shall be used in or near animal holding areas. Rusty wire mesh or hardware must be replaced before animals could eat broken fragments; nails, which might work loose, should be rejected in favor of screws and bolts for wood construction.

D. Animal Comfort

1) Heating and ventilation must be zoned for local control of small units; for example, maternity dens and nursing areas. This is also necessary for the proper management of fragile animals.

2) Whenever possible, controlled amounts of natural light and ventilation should be used. Many animals, particularly ungulates and birds, are in no way naturally adapted to "indoor" conditions. Therefore, holding areas, though necessarily arti-

ficial, should provide a maximum of natural light and draft-free ventilation.

3) Holding areas should be kept at the cool range of most animals' tolerances; the difference between indoor and outdoor temperatures not exceeding 20°F., if possible. Most animals have means of adapting to consistently cool temperatures but may become dangerously chilled by sudden or dramatic contrasts between indoor/outdoor temperatures.

4) Proper design of acoustical properties of holding areas is just as important as design of heating, ventilating and containment characteristics of holding areas. All must be considered.

5) Floor surfaces must meet the specific needs of the animals housed. In many cases the floors should be resilient. They could either be high-impact gymnasium flooring or deep beds of dry peat or sawdust that could be changed periodically. Where this method is used, access for small front-end loaders should be provided.

6) Many species impregnate their holding areas with their characteristic scent, thus "staking out" their territory. In such cases the odor, while often objectionable to man, is essential to the animal's psychological well-being.

E. Animal Handling

1) Conditioning and training responses should be used whenever possible to move animals.

2) For small and medium-sized animals, removable catch cages should be located between outside entry points and holding areas so that the animals become completely accustomed to passing through them on a regular basis. Only then will intelligent animals enter catch cages predictably after once having been detained there.

3) Capture methods must be suited to the character and sensitivity of the animal.

4) Whenever possible, and as a standard policy, keepers should socialize their charges to the extent that they can safely enter the animal's enclosure and give it necessary routine care. Smell and sound are as important as visual familiarity. Care must be taken to assure that socialization does not lead to unnatural behavior or the replacement of essential intraspecific behavior.

5) Fire protection, detection, control and emergency exit for animals to safe exterior enclosures is essential. Even the smell of smoke can cause casualties from panic reactions.

General Guidelines for Architectural Character

Because of Seattle's equable climate, most exhibits can be established and maintained outdoors. Therefore construction of large, complex buildings will be unnecessary. Borrowing an analogy from ecology, successful architectural design will depend on *adaptation*. All structures must respond in form to their surroundings. This allows an emphasis on the naturalistic orientation of the Bioclimatic Presentation Theme, making it possible to avoid essentially unnatural and incompatible juxtapositions of wild animals with self-conscious buildings.

This approach supports a dominant, well-knit, natural landscape in which both man and animal exist on a nearly equal level. In fact, man will appear the intruder, peering from "hidden blinds" (viewing structures) or through semi-transparent screens of vegetation into enclosures the bounds of which are undiscernible. These viewing structures, which will be the most characteristic architectural elements of the proposed development, are essential to the educational experience and enjoyment of the zoo. They will be submerged below viny bowers, under sod roofs or low-canopied trees. The viewing structures will be essentially outward-looking places giving shelter and comfort without turning away from the world of plants and animals.

The following guidelines are presented in two sections: 1) General Architectural Guidelines and, 2) Existing Building Inventory-Review and Recommendations. Both sections are followed by matrices summarizing appropriate forms and materials.

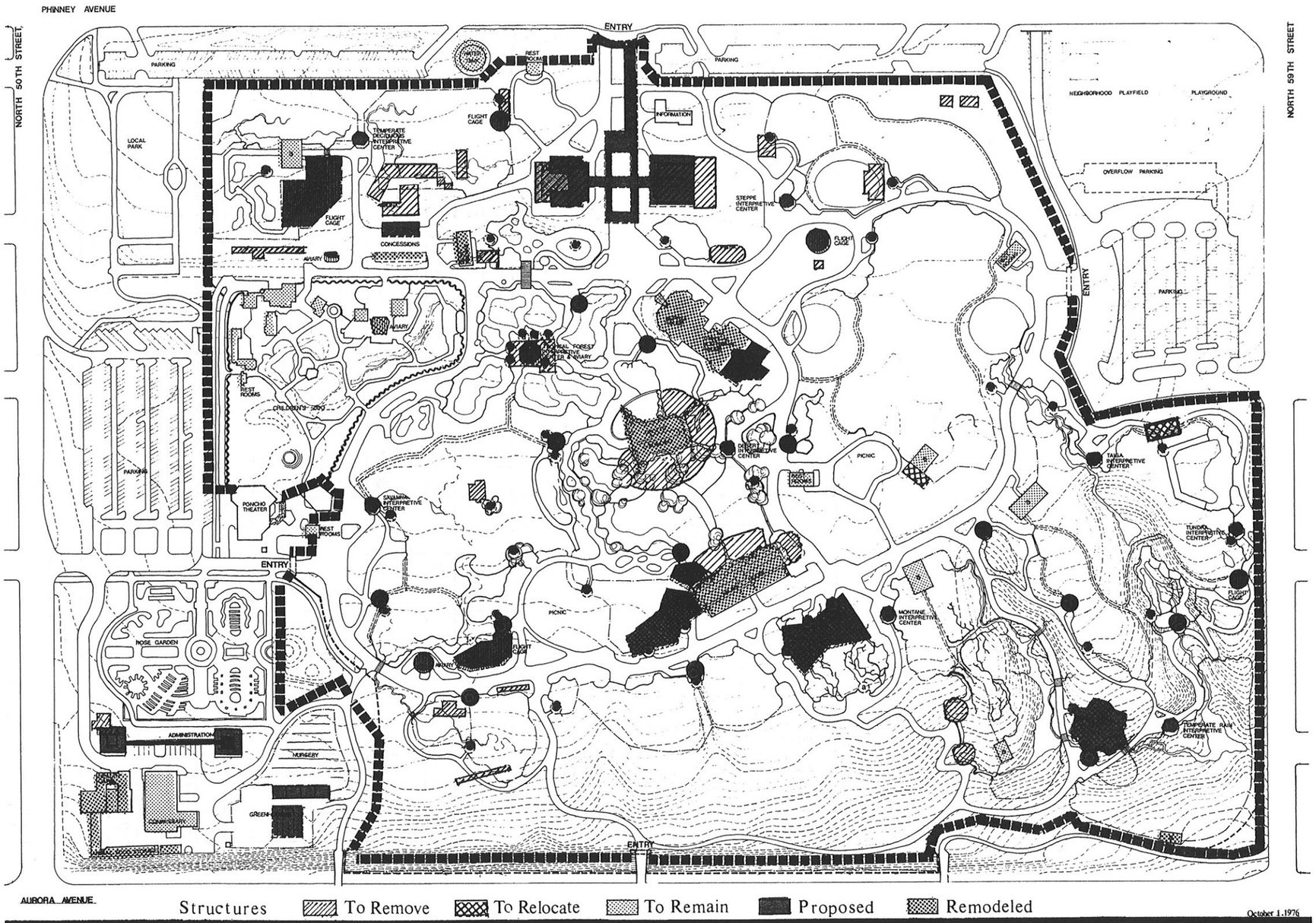
General Architectural Guidelines

A. Forms and Materials

1. All structures should appear to grow from the landscape.

2. All structures should appear subordinate to

Architectural Form and Materials Matrix	ROOF FORM	Flat or slight slope	Peaked or steep slope	Slight overhang	Broad overhang	ROOF MATERIAL	Sod or plants	Wood shingle	Transparent	WALLS	Concrete	Brick or adobe	Wood	Stone	FLOORING	Exposed aggregate concrete	Carpeting	Stone	Tile or unit paving	Wood	Packed earth	Gravel	SITING	Elevated	On grade	Partially buried	COLORS FOR STAINS	Warm tans, reds	Browns	Cool gray, slate	Rich deep greens	Drab olive green
PUBLIC ACTIVITY AREAS																															
Restaurant			●		●			●	●		●	●	●				●		●	●					●						
Concession Building			●		●			●				●	●						●						●						
Interpretive Gallery			●		●				●										●						●						
Education Center			●		●			●			●	●	●				●		●						●						
Restrooms			●		●			●			●	●	●						●						●						
EXHIBIT FACILITIES																															
Tropical Forest			●		●			●	●				●							●				●				●		●	
Savanna		●			●		●				●	●							●		●				●		●	●			
Desert		●			●		●				●	●		●					●		●				●		●		●		
Steppe		●			●		●					●	●						●		●				●		●	●			
Chaparral		●			●		●					●						●	●						●						●
Temperate Deciduous			●	●				●					●	●				●		●				●					●	●	
Temperate Rain			●		●			●					●							●				●				●		●	
Taiga		●			●			●					●							●		●		●					●		
Tundra		●		●			●							●		●		●				●		●					●		
Montane			●	●				●					●	●				●				●		●				●	●		


PHINNEY AVENUE
NORTH 50TH STREET
NORTH 59TH STREET
AURORA AVENUE
ENTRY
PARKING
LOCAL PARK
TEMPERATE DECIDUOUS INTERPRETIVE CENTER
FLIGHT CAGE
CONCESSIONS
AVIARY
INFORMATION
STEPPE INTERPRETIVE CENTER
NEIGHBORHOOD PLAYFIELD
PLAYGROUND
OVERFLOW PARKING
REST ROOMS
CHILDREN'S ZOO
PONCHO THEATER
AFRICAN INTERPRETIVE CENTER
PICNIC
TAIGA INTERPRETIVE CENTER
TUNDRA INTERPRETIVE CENTER
MONTANE INTERPRETIVE CENTER
TEMPERATE RAIN INTERPRETIVE CENTER
ROSE GARDEN
ADMINISTRATION
NURSERY
GREEN HOUSE
Structures
To Remove
To Relocate
To Remain
Proposed
Remodeled
October 1, 1976
WOODLAND PARK ZOO
LONG RANGE PLANNING STUDY
Long-Range Plan
Building Locations Plan
JONES & JONES
environmental planners · landscape architects · urban designers · architects
105 South Main Street Seattle, Washington 98104 (206) 624 5702
Bioclimatic Zone
Interpretive Center
Exhibit Interp. Center
Animal Service Area
Flight Cages & Aviaries
Covered Exhibit
Wall
Fence
Ha-Ha
Zoo Boundary F.
100 0 feet 100 200 300 400
N

and compatible with the surrounding landscape.

3. The use of strong contrast as a means of establishing individual architectural identity is fundamentally incompatible with the Presentation Theme.

4. Throughout the zoo structures should present an overall unity of character, while secondary variations in color, texture and material should be carefully integrated with the various landscapes of the bioclimatic zones.

5. Whenever possible, materials should be of an elemental, or at least primary, industrial nature, such as stone, wood, brick, concrete, iron, etc; highly finished or processed materials such as plastic, ceramic tile, aluminum, or stainless steel are not appropriate.

6. Structures should incorporate a minimum of materials, each specifically suitable to the visual and functional use it is designated to perform.

7. Materials should be self-maintaining. The use of paints and finishes requiring constant maintenance is to be discouraged.

8. Materials should encourage attachment by vines or covering vegetation. Textured concrete, brick and trellised wood structures are appropriate examples.

9. Buildings sited near existing trees must give "right-of-way" to the trees without damaging root or crown.

   a. Shallow grade beams supported by occasional posts or pilings are far less damaging to roots than are continuous spread footings.

   b. Building walls and eaves should be notched or otherwise modified to fit around existing trees.

10. Natural lighting and ventilation are to be exploited whenever possible, allowing controlled access to the natural variations of weather and season.

11. Roof forms should not dominate the skyline. Low, flat sod- or vine-covered roofs or pitched roofs of cedar shakes or shingles with low eaves and irregular or broken skylines are appropriate examples.

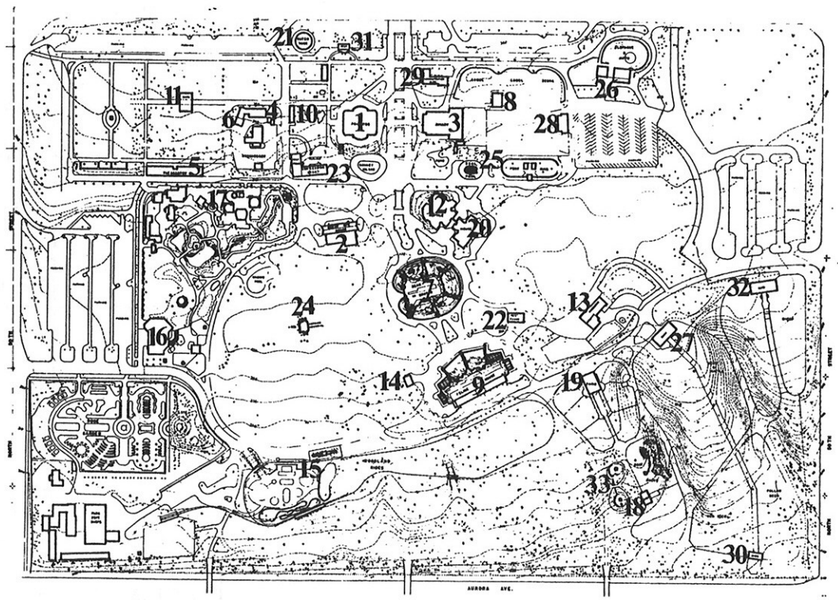
B. Fire Protection

Fire protection is essential for both public and animal areas. The following guidelines, together with municipal fire codes, are of utmost importance in providing for the safety of resident animals and the viewing public.

1. Smoke-detection systems should be used, which give warning without causing panic to the animals.

2. Sprinkler systems should be used where appropriate.

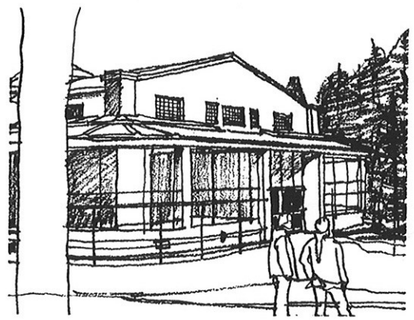
3. Proper smoke venting should be provided to prevent dangerous panic reactions by people and animals.



Existing Building Inventory: Review and Recommendations

This inventory of existing buildings at Woodland Park Zoo focuses on structural and mechanical conditions; architectural appearance; general compliance with building and fire codes of the City of Seattle; and general recommendations for disposition of each structure.

Condition of Existing Buildings		1. Primate House	2. Aviary	3. Great Ape House	4. Commissary	5. Dispensary	6. Guinea Pig Barn	7. Ratite Barn	8. Pheasantry	9. Zoological Soc. Bldg.	10. Concession Stand	11. Harding Memorial	12. Concession (Feline)	13. Woodland Rides	14. Farm Barn	15. Goat Shed	16. Beaver Grottos	17. Deer Shed	18. Elk Barn	19. Bison Barn	20. Giraffe/Kangaroo	21. Restroom (Grotto Area)	22. Feline House	23. Bear Grotto	24. Reptile House	25. Nocturnal House	26. Seal Rock	27. Pony Shed	28. Camel Barn	29. Elephant/Hippo	30. Administration Bldg.	31. Restroom (Main Gate)	32. Children's Zoo	33. Poncho Theater	34. Water Tank
NON-COMPLIANCE WITH CODE	Fire code	●	●	●	●	●	●	●	●	●				●	●	●		●	●	●	●		●	●				●	●					
	Building code	●	●	●	●	●	●		●			●			●	●													●					
STRUCTURE	Deteriorating	●			●		●		●			●		●	●	●	●										●		●	●				
	Needs Maintenance		●	●						●	●			●	●	●	●	●	●	●	●	●		●				●	●	●	●			
	Sound			●		●		●					●					●	●	●	●	●	●	●		●			●		●		●	●
EXTERIOR APPEARANCE	Unattractive	●	●	●		●				●	●	●	●	●	●	●		●			●			●			●	●	●	●				
	Deteriorating	●	●		●	●	●		●	●		●		●	●	●	●	●				●							●	●		●			
	Needs Maintenance			●				●			●		●		●	●	●	●	●	●	●	●	●	●					●	●	●	●			
	Satisfactory																●		●	●			●		●	●							●	●	
INTERIOR APPEARANCE	Unattractive	●	●	●		●			●	●	●				●	●		●			●		●	●			●		●	●	●			
	Deteriorating	●	●		●	●	●		●			●			●	●		●				●						●	●	●		●			
	Needs Maintenance			●				●							●	●		●	●	●	●	●		●				●	●	●	●	●	●		
	Satisfactory												●						●	●					●	●		●							
HEATING & VENTILATION SYSTENS	Outdated	●	●	●	●	●			●		●				●	●		●	●	●		●	●	●				●	●	●	●	●		
	Satisfactory																				●				●	●							●	●	
PLUMBING SYSTEM	Outdated	●		●	●			●	●						●	●	●	●	●	●		●		●	●	●	●	●	●	●	●			
	Satisfactory					●					●										●		●										●	●	
ELECTRICAL SYSTEM	Outdated	●	●	●	●		●	●	●			●		●	●	●	●	●	●	●		●		●			●	●	●	●	●	●		
	Satisfactory																				●		●		●	●							●	●	



1. Primate House

PRIMATE HOUSE
8,000 to 9,000 sq. ft.

Structure. A truss-roof structural system supported by exterior wall masonry and steel columns. Not one structural item is fire protected. The walls are wood frame and concrete construction with all exterior walls showing isolated wood-rot deterioration. The floor is concrete slab and wood. The floor supports show major signs of wood-rot deterioration; this is generally due to very poor air circulation and the age of the structure. Water damage exists to almost all structural members of the exterior cages.

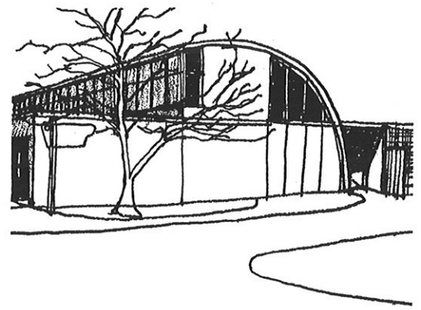
Exterior. Generally, all exterior walls are covered with stucco, with exposed wood and steel cages at most other locations. Cracking of the stucco is visible at isolated locations and could mean two problems: 1) structural damage due to earthquakes or foundation settling; 2) aging of stucco. Only an in-depth survey could confirm the source of the problem. All exterior cage ceilings and walls are in poor condition and show major signs of wood rot.

The overall exterior appearance of this structure is one of disrepair.

Interior. The ceiling material is broken and deteriorating beyond simple repair (water damage). The interior space suffers from inadequate ventilation for both animal and viewer. The mechanical system is seriously outdated.

Recommendation. Historically, the building has not been designated for preservation. The structure is unsound and lacking in minimum fire protection. The roof should be replaced to stop leaking; gutters and downspouts are not reparable. To re-use the building for zoo habitat space is unthinkable.

Immediate recommendation is to provide four fire extinguishers: two located in the public area and two at designated locations for the keeper. Also, two smoke-detection devices should be located adjoining the caged animal areas. The long-range recommendation would be to replace the building as rapidly as possible.



2. Great Ape House

GREAT APE HOUSE
6,000 to 7,000 sq. ft.

Structure. A reinforced-concrete-shell structure supported by steel columns and concrete walls; concrete floor slab. The service wing is concrete block walls, wood frame roof structure, concrete slab floor. Public viewing areas are wood frame with asphalt walking surface. The building is structurally sound; however, wood-rot was found in the existing public viewing area walls.

Exterior. Built-up rolled roofing needs to be replaced. Aluminum frame windows show signs of corrosion. Outdoor cage wood pole frame is showing signs of wood-rot at joint and footing locations. The outward architectural appearance of the structure is one of "army quonset hut".

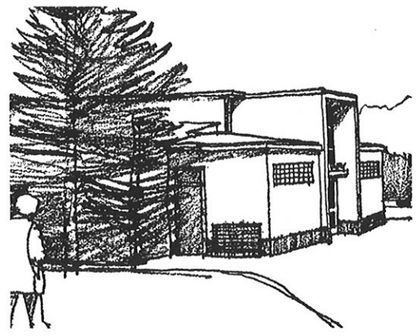
Interior. The public viewing area has asphalt walking surfaces with stucco walls and ceiling - much more suited for vehicular parking. The structure lacks adequate fire protection for both the public and caged animals. The consequences of a serious fire within this structure would be tragic. Natural and electrical lighting are not adequate. The animal areas are much too confined and lack all considerations for flexibility.

The sound characteristic of the animal area is loud and sharp; this would be due to all surfaces, walls, ceiling and floor, being composed of painted concrete. The mechanical system is inefficient and outdated for adequate air conditioning and venting. The plumbing system shows signs of heavy rust. The electrical system needs updating. The electrified windows require re-coating.

The general feeling of most public visitors is one of depression upon viewing the ape house.

Recommendation. The building is structurally sound and, given good maintenance, will last. However, renovation costs and difficulty of adding space to this type of inflexible structure make it less attractive. Adequate fire safety should be undertaken for both the public and caged animal. Recommend the removal of this structure to make room for a more natural habitat.

3. Aviary



AVIARY
8,500 to 9,500 sq. ft.

Structure. The main structure is wood frame. Generally, there are concrete floors throughout; cracks in slab exist in isolated locations. It is difficult to determine the structural condition of this building due to extensive renovation. However, due to its age, one should assume overall building deterioration.

Exterior. Recently installed built-up roof coating; however, the gutters and downspouts show signs of deterioration. Exterior walls are stucco with the main entry material being ashlar stone work, aluminum and glass with stucco ceilings. The building is an unpleasant, dated structure.

Interior. All walls and ceiling are surfaced with "bumpy stucco"; large glass viewing windows separate the public from the birds. Bare concrete floors. The mechanical systems including ventilation are not adequate; the interior space is stagnant. The electrical distribution is hopelessly outdated; most areas are "jury-rigged".

Probably the most critical problem is fire protection. The structure lacks code-required exits for public use, no protection for caged birds, and no overall fire protection for the entire structure.

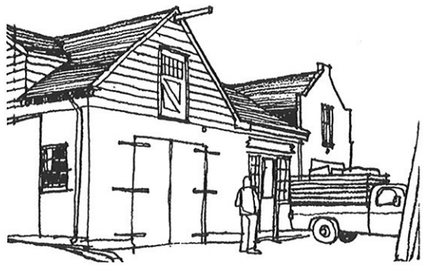
Recommendation. The building has been architecturally relined by its numerous renovations, making it unpleasant in appearance. The structure lacks adequate fire-code protection for viewer and caged bird. The mechanical systems are hopelessly outdated. The building should be removed; relocate the birds in a more natural habitat.

COMMISSARY
2,000 to 2,500 sq. ft.

Structure. Wood-roof structure supported by brick masonry walls; concrete slab floors. Numerous areas of wood-rot throughout the entire structure. Structural cracking in masonry walls, probably earthquake damage. Cracking of concrete floor slab due to age.

Exterior. Roof, gutter and downspouts need replacement. Generally,

4. Commissary

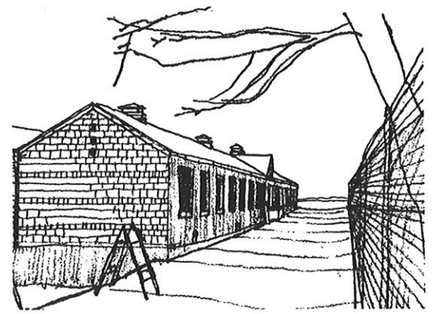


all wood windows show signs of wood-rot. The architectural appearance of the building is pleasant and it has not been ruined by renovation.

Interior. Due to age, door and window operation has been affected. Ventilation and heating are outdated and lacking. Generally, the entire structure lacks minimum fire protection; essential but nonexistent in the incinerator area.

Recommendation. The building is structurally unsound due to earthquake damage and lacks fire protection. It is architecturally pleasant but historically of minor importance. Remove the structure to make room for expanded public facilities.

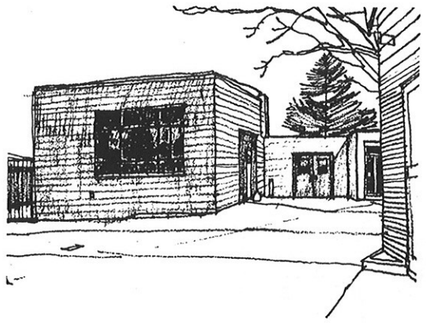
5. Pheasantry



PHEASANTRY
1,800 to 2,000 sq. ft.

Structure. Clay tile masonry wall units; wood frame roof structure with shingled roofing. Most overhangs show signs of wood-rot. Exterior metal cages are in poor physical condition. The building is a narrow, dark structure generally unsuited to its present use. No fire protection.

Recommendation. The age of the structure suggests that removal is long overdue.



6. Dispensary Compound

DISPENSARY COMPOUND
3,000 to 4,000 sq. ft.

Structure. Concrete block walls with wood-joist roof structure; concrete floors. Building appears to be structurally sound.

Exterior. Built-up roof needs to be replaced to stop isolated leaking. The architectural appearance of this structure is needlessly cold.

Interior. Painted concrete block walls with concrete slab floor. Venting and heating of all areas is not satisfactory; caged animal areas are damp, inadequately heated and lack simple air circulation. Controls not located properly. Electrical power outlets for everyday use in animal care areas are hopeless. Fire protection for caged animals is non-existent.

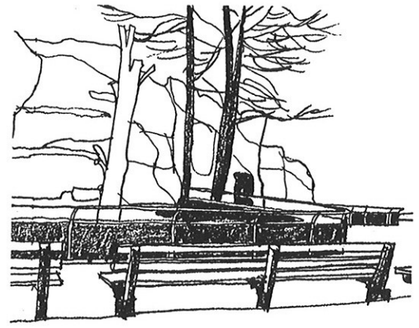
Recommendation. Most of the Dispensary equipment is movable at minor cost. Although the building is structurally sound, its spaces present major problems to animal health care, ventilation, heating, and electrical and power distribution. Recommend that the structure be removed.

BEAR GROTTO STRUCTURE
6,600 to 6,800 sq. ft.

Structure. Mainly reinforced-concrete floor, walls and ceiling. A very sound structure.

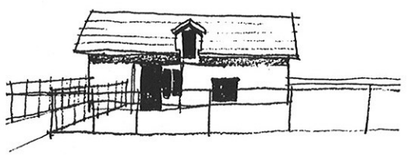
Exterior. Concrete animal grottos with small water pools; small underdeveloped and inconsistent plantings above grotto areas. Most animal dens missing vent caps or broken. Standing water at plugged roof drains.

Interior. Concrete slab floors. Animals exposed to cold and damp environment. Keeper exposed to animal hazard, mainly at den areas, gates and openings. Roof slab joints showing signs of deterioration from water; membrane roofing not water-tight. Keeper area heated by small furnace. Poor air circulation in storage area. Area damp and not heated.



7. Bear Grotto Structure

Recommendation. Animal service areas need substantial improvement in terms of heating, ventilation and acoustics. The Long-Range Plan calls for the exhibit areas to be greatly enlarged and renovated to house a variety of species appropriate to adjacent bioclimatic zones. (See the following Scenarios: 3, Gorilla; 18, Baboon; 20, Lion; 29, Barbary Sheep; 30, Klipspringer). Once the Gorilla Exhibit is installed, this grotto structure will no longer be experienced in the round.



8. Camel Barn

CAMEL BARN
1,200 sq. ft.

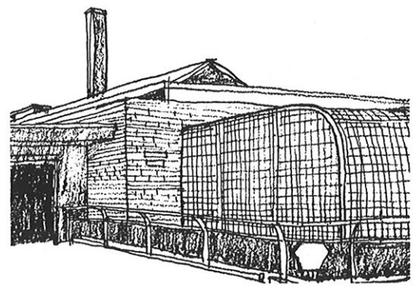
Structure. Wood joist structure; wood stud walls and concrete floor.

Exterior. Painted wood board-and-batten above. Metal (sheet coating painted); camels eating paint. Shingled roof; no downspouts; isolated weather damage. Doors in bad condition.

Interior. Open stud with loft. Electrical power (lights).

Recommendation. Remove or relocate to Commissary Complex.

9. Feline House



FELINE HOUSE
5,800 to 5,900 sq. ft. animal
1,600 to 2,000 sq. ft. public

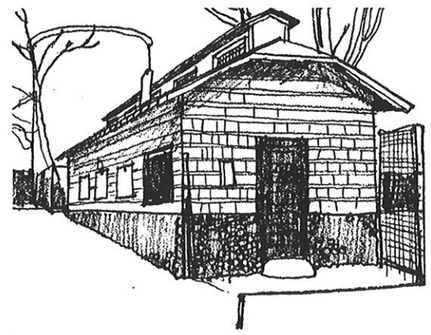
Structure. The structure is mainly reinforced concrete with metal cage supports. The central keepers' area is glass with metal truss skylight roof. The public areas are wood beam with stucco ceilings. All floors are concrete except for metal walking decks. A sound structure. Keeper has one fire extinguisher. No other fire protection visible.

Exterior. Concrete and cement grottos. Open metal cages. Public viewing east elevation. Low-pitch built-up roof. Ashlar stone work along east elevation. Well-developed plantings along top of grotto areas. The general exterior impression is one of not much roof, mainly grotto areas, with public close-up viewing along east area of building.

Interior. Heat and ventilation problems: the central keeper area has a heat gain problem during warm weather, lacks outlets in skylight. Mechanical system doesn't seem to be able to handle problem. Vent of interior is acceptable, but not healthy for confined animals. Sound characteristics are hard and sharp; concrete walls and floors. Recently installed oil-fired furnace, good condition. Electrical system is good. Public view of animals is of small concrete and terrazzo and tile cubicles. The animal is exposed to full public view. The public concourse is larger than animal holding areas. All internal animal exhibits are sterile, unimaginative and lacking any habitat character.

Recommendation. Heating and ventilation system can be adjusted and improved (refer to Jones & Jones mechanical engineer's report from Richard Stern, on file, zoo). Acoustical work should be undertaken throughout to dampen noise. Larger felines will be given greater exterior runs (see Scenarios 11, Tiger; 20, Lion; and 21, Leopard) and the many confined interior areas combined to form several larger more natural exhibits. The north wing is intended to become the Small Carnivore Exhibit (See Scenario 63). Removal of exterior wall in public viewing concourse will introduce light and landscape to these smaller exhibits (Small Carnivore) and should be implemented quickly.

10. Old Guinea Pig Barn

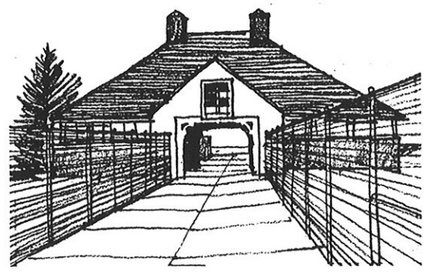


OLD GUINEA PIG BARN
750 to 800 sq. ft.

Structure. Wood frame structure, walls and roof, with low rock wainscot. Wood-rot and footing settlement seem to be the major structural problems to this building.

Recommendation. The structure has outlived its usefulness and is structurally not sound for exhibit space. Recommend removal to make room for expanded exhibit space.

11. Ratite Barn



RATITE BARN
2,400 to 3,000 sq. ft.

Structure. A wood-frame roof and wall structure with masonry foundation; wood shingled roof. The structure is sound.

Exterior. Horizontal wood siding; wood-rot at lower wall levels. Wood frame windows showing isolated wood-rot. Wood shingle roof needs replacement.

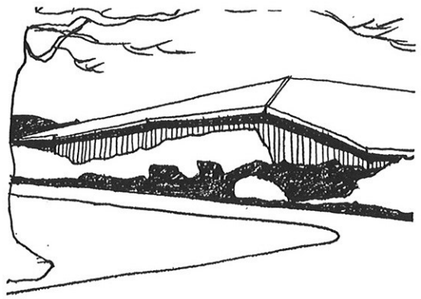
Interior. Hay loft above walk-thru passageway. Stucco and wood walls with concrete floor. No fire protection.

Recommendation. The building is a pleasant country barn structure that is readily adaptable to new exhibits. Recommend that this structure be retained. (See Scenario 41, Waterfowl)

REPTILE HOUSE
8,000 to 8,100 sq. ft.

Structure. Reinforced-concrete walls; wood beam-and-decking roof; concrete floor. Structurally sound.

Exterior. Concrete textured walls, well hidden by the landscape. Lines of roof obvious against sky, wood shingle with wood gutters and metal downspouts all in good, sound condition; only element



12. Reptile House

distracting from roof line is mechanical (metal) exhaust stack; the structure presents itself very well as part of the landscape.

Interior. Brick paver flooring in public areas; exposed concrete textured walls; skylight grotto areas; concrete floors grotto areas; concrete trees. Public viewing from both behind glass and open barriers, a difficult area for viewing by smaller children, i.e. alligator area. Vegetation could easily use the concrete textured walls to climb on; wood exposed ceiling. Heating system good but could be improved. Electrical service is up-to-date. No fire protection other than exterior units.

Recommendation. Interior exhibits should be reorganized to fit into bioclimatic and zoogeographic sequence. Automatic irrigation system would encourage plant growth and reduce maintenance. Unconvincing artificial rock work should be redone or completely screened by vegetation.

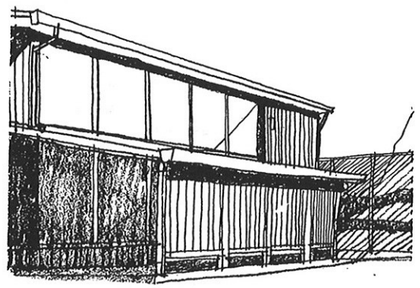
GIRAFFE/KANGAROO HOUSE
3,500 to 3,600 sq. ft.

Structure. Giraffe area is a wood truss-and-joist structure with wood decking supported by wood stud walls; concrete supports. A sound structure. Kangaroo area is a beam-and-joist ceiling structure with wood decking; wood stud walls with stone wainscot. Concrete floors. A sound structure.

Exterior. A built-up roof structure with glass skylights; board-and-batten siding with closed soffits. Ashlar low stone work with glass viewing windows, vents in giraffe area. A straight-line architecture structure, somewhat dated.

Interior. Kangaroo area is heated, giraffe not. All service is in sound condition. However, building degraded by poor maintenance and service storage area. Concrete floors with wood stud walls. No fire protection visible. Giraffe area is concrete floors with gravel surfacing; painted hardwood walls. No fire protection.

Recommendation. Relocate Giraffe House adjacent to the African Savanna Exhibit as shown on the Long-Range Plan for continued use



13. Giraffe/Kangaroo House

by giraffes. Renovate the Kangaroo House for Great Plains Exhibit possibly in combination with the relocated Bison Barn.

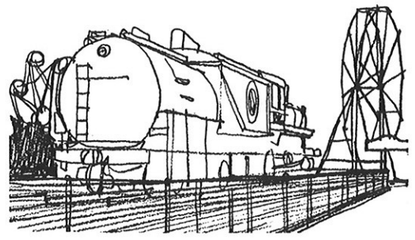
CONCESSION STAND (NEAR FELINE HOUSE)
1,500 sq. ft.

Structure. Built in 1969. Painted concrete block walls with low-slope wood roof structure; built-up roof; concrete slab floor. Structurally sound.

Recommendation. This structure is confused architecturally and out of place. However, it is structurally sound. Recommend that it be phased out.

14. Concession Stand (Near Feline House)

15. Woodland Rides

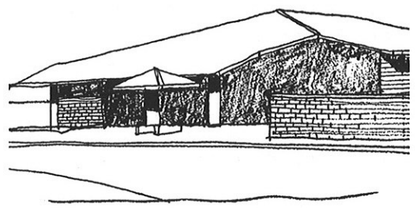


WOODLAND RIDES

Structure. Generally, the walking surface is asphalt surfaced. The structures are either mechanically powered kiddy rides or simple wood overhead structures supported by columns. The only substantial structures in the area are: (1) a steam locomotive weighing 145 tons; (2) a small wooden caboose used as public rest-room; and (3) the concrete retaining walls and railroad bridge structure at the main entrance to the ride area.

Recommendation. Recommend that the rides be removed from the zoo and the area be given over to expanded animal exhibits.

16. Poncho Theater

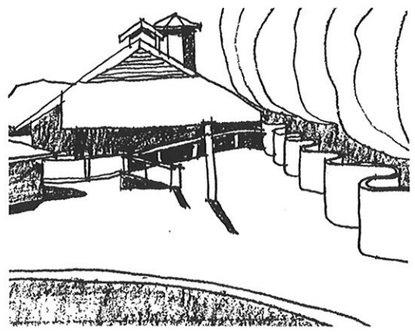


PONCHO THEATER

Structure. Basically brick and wood structure with shingle roofing. Low profile. Good entry structure, i.e. first impression of zoo from public parking lot. The structure is well adapted to the land-scape from all points of view.

Recommendation. Enclosed asphalt areas (catered party areas) don't seem to work, rather empty and barren for children. Use of these enclosed areas should be reviewed and other functions proposed, e.g. information and zoo thematic interpretation.

17. Children's Zoo



CHILDREN'S ZOO(inventoried as one unit)

Structure. Buildings wood timber or brick with concrete piers. Asphalt and concrete floors. Area is fire-protected by sprinkler system. Some buildings are not protected. All of the structures are sound.

Exterior. Board-and-batten siding with shake roofs. Almost all of the structures have brick masonry walls. The roof is always the dominant design element. Roof drains often discharged onto paving, causing difficulties for pedestrians.

Interior. Three or four structures are heated (electric). Concrete or asphalt floors with brick and wood walls. Glass viewing into heated areas. The building materials used seem to be holding up despite animal and public abuse. However, wood fences are being damaged by animals and public alike.

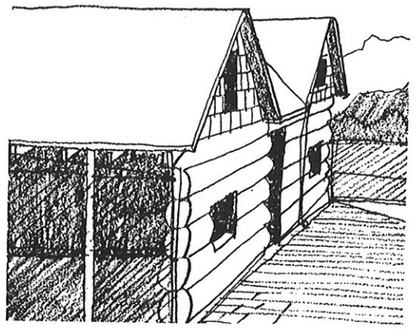
Recommendation. Maintain existing facilities, develop a more agricultural character to adjacent landscaping. Roof drains should be picked up by storm sewer system.

GOAT SHED AND ROCK
1,000 to 1,200 sq. ft.

Structure. The shed is a wood-joist roof structure with wood cross-ties, wood-rot on their ends. This supports a small lost space. Round wood columns support the roof and are supported by small concrete footings. Wood-rot seems to have penetrated everywhere. Built in 1938 and is not sound.

Exterior. Tar-paper roof over existing wood shingles; no gutters or downspouts; log-cabin construction. Most walls have wood-rot, and wood shingles up high on most walls; plywood addition to the north does no justice to the structure; overall appearance is one of disrepair. A good amount of the ground paving in the areas is broken asphalt.

Interior. Concrete floor slab; goat eating areas east and west



18. Goat Shed and Rock

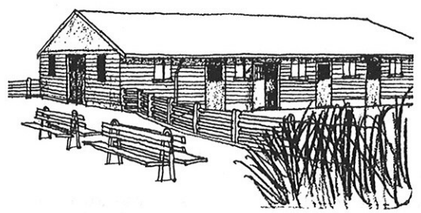
sides; hay storage above and down the center. Most walls are wood and in disrepair. No heating or electrical service. Goat rock is composed of small granite rocks set in concrete.

Recommendation. Renovate and re-use for future exhibit. (Scenario 58, Ibex)

FARM BARN
2,400 to 2,600 sq. ft.

Structure. Wood structure with concrete floor slab on grade and concrete exterior wainscot walls. Some isolated wood-rot damage due to past roof leaks. Structure is sound but needs repair.

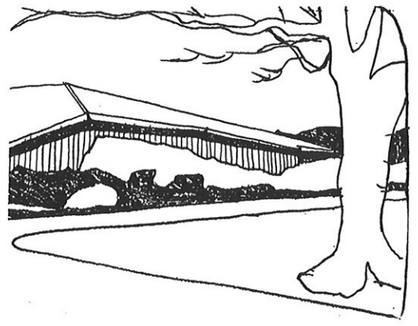
19. Farm Barn



Exterior. Roll tar-paper roofing on low-pitch roof, laid over existing cedar shingles. Isolated signs of wood-rot damage along all sides of the building reparable. Water damage to roof eaves; most doors have been damaged by animals and have plywood nailed over the old frame as protection.

Interior. Four small household-type fire extinguishers visible. Previous fire damage was noted. Wood stud partitions with wire stalls; concrete floors. No heating system; electrical panel not visible.

Recommendation. Renovate and re-use for future exhibit. (See Scenario 61, Takin; and 56, Bighorn Sheep)



20. Nocturnal House

NOCTURNAL HOUSE
5,800 to 5,900 sq. ft.

Structure. Similar to reptile house.

Exterior. Similar to reptile house.

Interior. Narrow public passage; carpeted floors, glass enclosure around entire public passage. Animal areas: coated concrete floors with fiberglass walls, plastic plants. Heating and venting seem to be up to date. Sump pump in basement area inadequate. Semi-dark entry area is not fully adequate to accustom visitors to the darkness.

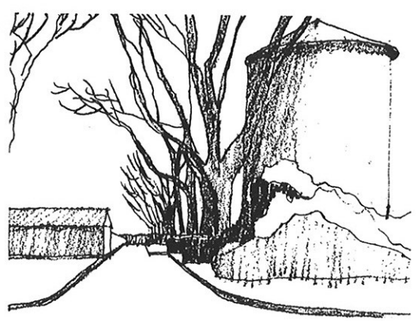
Recommendation. Unite entry area to Reptile House exit with a covered, light-reduced gallery.

NOTE: Proposed Desert Nocturnal House is an extension of present Nocturnal House (see Scenario 32).

WATER TANK

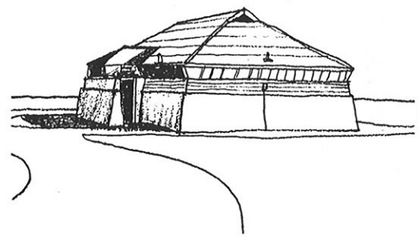
Structure. A 50-foot-diameter by 70-foot-high metal water tank; painted gray.

Recommendation. Suggest that a graphic element be added to identify the zoo.



21. Water Tank

22. Restroom (Grotto Area)



RESTROOM (GROTTO AREA)
1,200 to 1,300 sq. ft.

Structure. A wood-joist roof structure with concrete and stucco walls. Concrete floors. Structure seems sound; however, there is isolated weather damage along exterior joist ends.

Exterior. Stucco walls, wood windows; wood shingle roofing needs replacing; isolated wood-rot at windows and eaves.

Interior. Somewhat out of date, but usable; small cracks in concrete floor; toilet partition damage; painted stucco walls, not heated.

Recommendation. Restore and maintain in use.

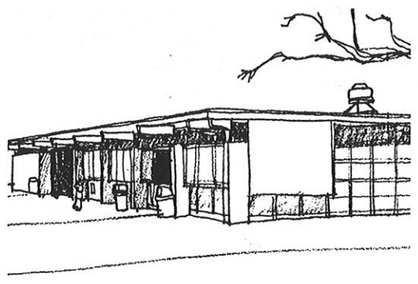
CONCESSION STAND
2,400 sq. ft.

Structure. Wood post-and-beam structure with stone masonry wainscot walls; wood stud walls above stone. Concrete slab on grade. Low-pitch built-up roof.

Recommendation. The building is structurally sound with isolated wood-rot along the western elevation. The structure imposes itself upon the animal exhibits in its vicinity and seems to be much larger than needed for the activity it supports.

Recommend that the structure be removed to make room for expanded exhibits. Restrooms at south end could remain, refurbished and refinished for continued use.

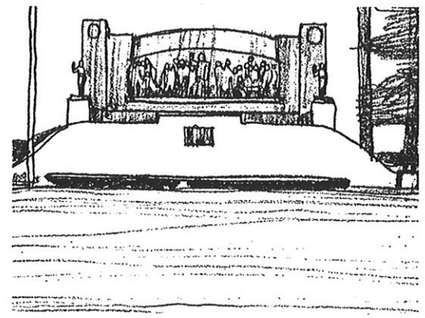
23. Concession Stand



HARDING MEMORIAL

Structure. Basically a reinforced-concrete structure surfaced with stucco. Structural shear cracking visible along back elevation with isolated footing settlement.

24. Harding Memorial



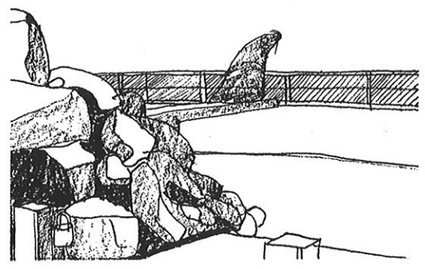
Recommendation. The structure is not as sound as it appears. Recommend its removal, with any part (for example, the boy scout and girl scout statues) donated to sponsoring organizations as appropriate.

SEAL ROCK

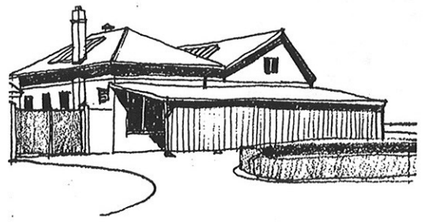
Structure. A concrete pool structure with a rock island in the middle. Small wood deck and concrete platforms. Chain-link fence around entire structure. A very dated structure. Keeper area and pumping station located underground west of pool.

Recommendation. Removal.

25. Seal Rock



26. Elephant and Hippo House



ELEPHANT AND HIPPO HOUSE
1,500 to 1,600 sq. ft. House
800 to 1,000 sq. ft. Shed

Structure. Elephant house concrete walls with wood joist-and-beam ceiling and roof structure. Concrete slab floor. Shed wood truss with stud walls. Concrete floor.

Exterior. Asphalt roofing over wood shingles; board-and-batten and concrete walls. Wood joist ceiling; wood stud wall with glass viewing and concrete walling surfaces. Plenty of wood-rot along all sides.

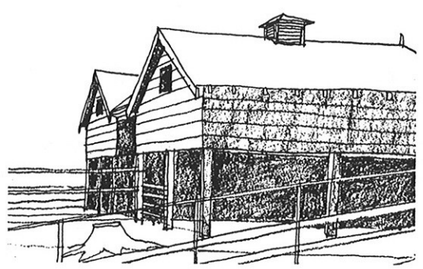
Interior. Heated by old space heater and oil furnace, both outdated. Concrete floors, painted concrete walls with plywood ceiling. Ceiling is broken in places. Electrical system is outdated.

Recommendation. Removal for expansion of east peripheral parking area.

ELK BARN
2,500 to 2,600 sq. ft.

Structure. Simple wood truss structure with wood beams and support columns supported on concrete piers. Structure is in need of repair, especially the roof of north building; generally a sound structure.

27. Elk Barn



Exterior. Wood shingled siding; asphalt shingled roof over existing wood shingles. No gutters or downspouts. Rafter ends show signs of wood-rot. Most damage from weather is reparable.

Interior. Wood walls and feeding bins with concrete footings. Animal walking surface cobbles, keeper area concrete. No heat or electric service working.

Recommendation. Renovate and re-use for future exhibit. (Scenario 52, Tundra)

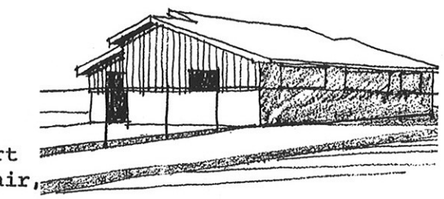
PONY SHED
(pony ride area)
1,800 to 1,900 sq. ft.

Structure. A simple wood structure, post and beam; concrete block walls with wood studs above.

Exterior. Board-and-batten siding with low concrete block wainscot walls; asphalt shingled roof with metal downspouts and gutters. Some weather and animal damage along south side. Surfacing for public around exterior is asphalt. Isolated wood-rot along eaves and fascia boards.

Interior. Concrete slab floor, with wood stalls and chain link fence separation up high. Roof leaking along northwest corner.

28. Pony Shed



Electrical power, but not heated. Pony damage to doors and stalls.

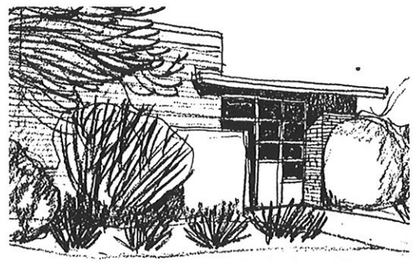
Recommendation. Remove or relocate to Commissary Complex.

ADMINISTRATION BUILDING
2,200 to 2,300 sq. ft.
Not including trailer

Structure. Wood joist roof structure; wood frame walls; concrete foundation; structure is sound.

Exterior. A dated structure; rather ugly but acceptable due to

29. Administration Building



well-maintained landscaping. Stucco walls with wainscot of ashlar stone; built-up flat roof, aluminum windows, metal doors.

Interior. Gypsum board walls painted. Small offices, poor internal circulation unacceptable. Structurally sound.

Recommendation. Many of the present administrative functions will be relocated to the new Commissary area. The building should then be remodeled as a public general information and services area.

DEER SHED
900 to 1,000 sq. ft.

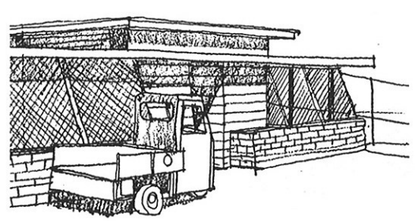
Structure. A wood-joist flat-roof structure with concrete block support walls. 4" steel pipe columns along north and south feeding areas. A sound structure, though not pleasing architecturally.

Exterior. Built-up roof; beveled wood siding with low stone wall, chain-link fencing. Roof drains are plugged and water standing and running over fascia; some isolated wood-rot.

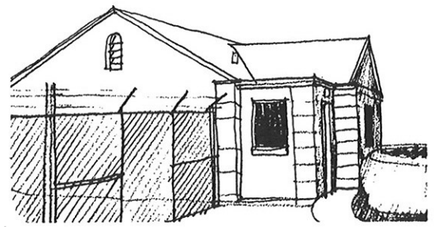
Interior. No utilities working except water.

Recommendation. Renovate as animal service area for future Wapiti Exhibit (Scenario 46)

30. Deer Shed



31. Restroom (Main Gate)



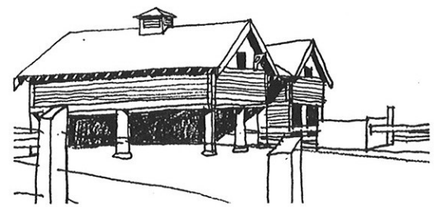
RESTROOM (MAIN GATE)

800 to 900 sq. ft.

Structure. A simple brick-on-concrete structure; wood roof joist system. Structure sound. Wood shingle roof in need of repair. Interior in poor condition and in need of repair work.

Recommendation. Renovate.

32. Bison Barn



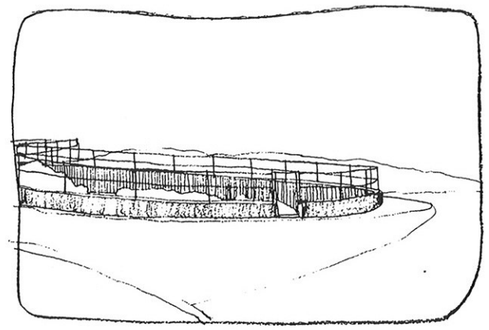
BISON BARN
2,700 to 2,800 sq. ft.

Structure. Same kind of support as Elk Barn, but in better condition.

Exterior. Shingled wood siding with asphalt roof. Wood-rot along overhang. The structure is very pleasing architecturally.

Interior. Same as Elk Barn; no heat or electrical service.

Recommendation. Relocate to Great Plains Exhibit for animal service or to the Asian & North American Montane as an interpretive center or animal service building.

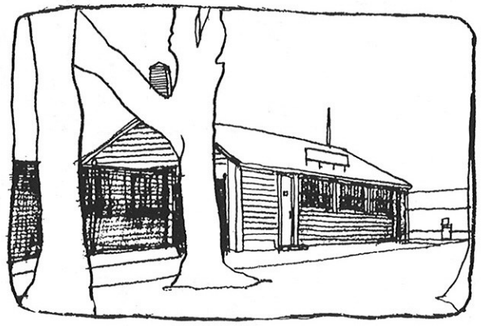


33. Beaver Grottos

BEAVER GROTTOS
(not in use)

Structure. A stone and concrete structure with low chain-link fence around entire exhibit. Stone-and-concrete beaver lodge in the center. Most concrete work in disrepair; W.P.A. Project.

Recommendation. Use as temporary exhibit area for river otter, then phase out and remove.



34. Zoological Society Building

ZOOLOGICAL SOCIETY BUILDING
1,000 sq. ft.

Structure. A wood-frame wall and roof structure; asphalt shingle roofing. The building appears to be structurally sound; however, most buildings of this age generally have foundation beam wood-rot and no fire protection.

Recommendation. Remove the structure to make room for expanded animal exhibit.

General Guidelines for Utilities

Existing utilities, including water, storm and sanitary sewer and electrical/communications, have been hopelessly compromised by generations of *ad hoc* alterations and will require substantial reorganization and extension. The following general guidelines for utility development are suggested:

1. In order to realize the necessary improvements in utilities without unfairly burdening initial exhibit development projects, it is proposed that both utility and exhibit development be phased consecutively and sequentially so that an efficient and functional balance is maintained.

2. All utilities should be planned to facilitate future extension.

3. Access points to utilities should be located in planting areas near pathways or in the pathways themselves where planting areas will contain large permanent vegetation. No major access points should be located in animal areas.

4. All exposed utility appurtenances shall be well screened from viewing and public areas.

5. No utility structures shall be located or constructed in a manner that could cause injury to animals or, conversely, so that animals could damage the equipment.

Guidelines for specific types of utilities follow:

Water

1. The current on-site water system has two basic grids that are pressurized by inadequate booster pumps. These and much of the existing main line and distribution system will have to be replaced, although pressures in many lines can be upgraded and service improved through selective changes in direction of flow and location of primary sources.

2. The existing off-site City mains can supply the water quantity demands of the Zoo but not necessarily at an adequate pressure. Therefore, water pressure must continue to be boosted by on-site pumps. Two new pumping facilities will be located in well-screened, above-ground structures near Phinney Avenue as shown on the Utility Plan. These

will eventually replace existing booster pumps located near the existing Sea Lion Exhibit and the Rose Garden. These will insure that zoo activities will not diminish neighborhood water pressure.

3. The proposed main distribution system should be constructed in a series of phased, interconnected pressure-balancing loops.

4. Most zoo areas will require irrigation, which should be fully automatic with flexible manual override controls. The design of irrigation and control systems must be completely integrated with exhibit design (see *Scenarios*).

5. Automatic irrigation should occur in night or early morning hours to minimize competition for water volume with the surrounding neighborhood.

6. Because of the large amounts of water anticipated for the zoo, the feasibility of on-site wells should be explored.

Sewer Separation

1. All new utility development should separate sanitary wastes from storm water.

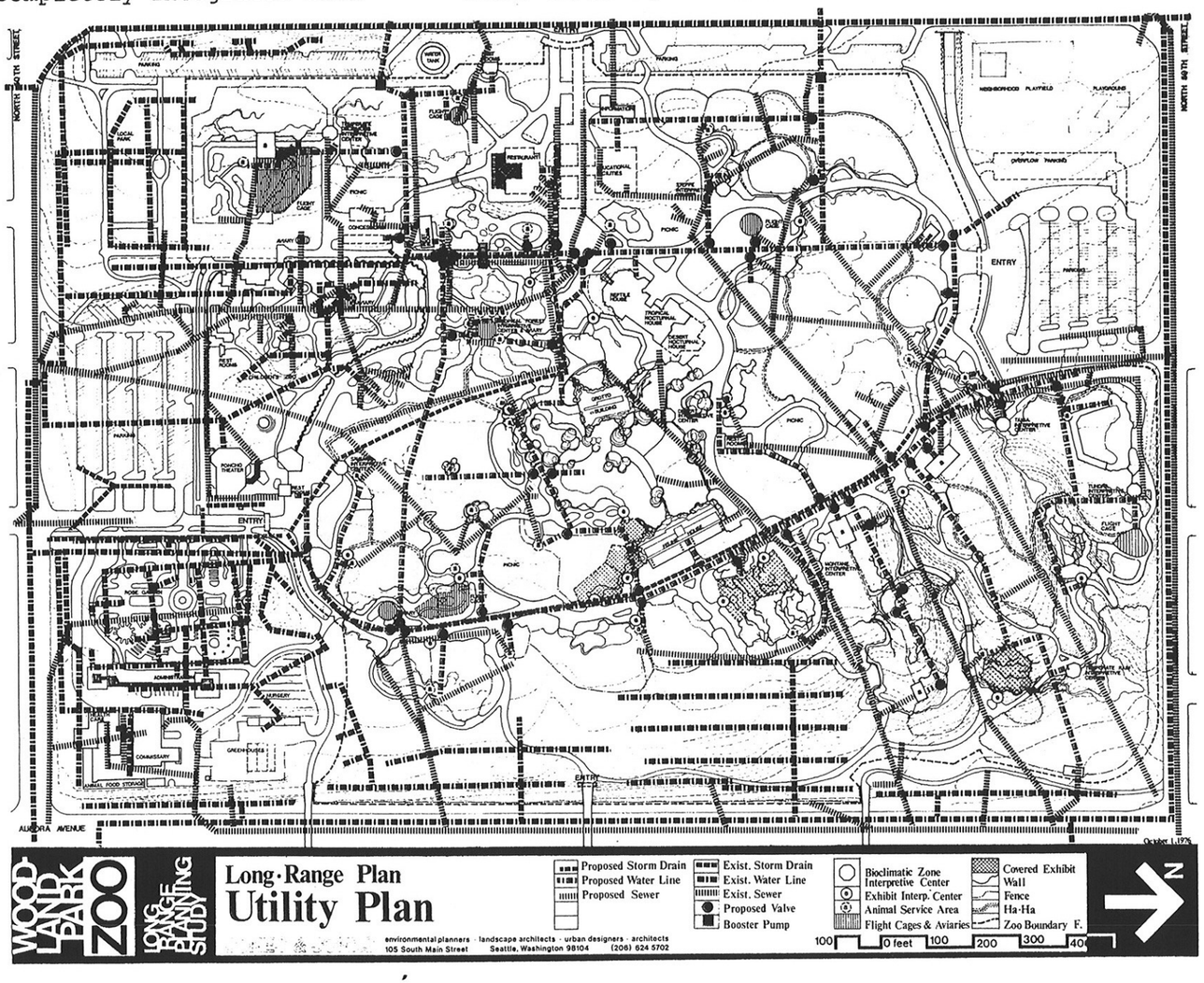
2. Once the initial new sewer main system is installed, this separation should be phased on a project-by-project basis with the extension of laterals coinciding with new development demands.

Sanitary Sewers

1. In most cases surface and subsurface runoff from animal areas should be directed to sanitary sewers. Sand and gravel drainage beds in under-drained animal areas are insufficient to filter out all wastes.

2. Large or frequent amounts of coarse waste products such as straw and manure expected to enter sewer lines (such as from the Hippo Exhibit, Scenario 24), should be processed through a masticator.

3. The initial sanitary trunk system draining to City trunks at North 50th Street will service most new exhibit areas when combined with existing sewer lines draining to the Aurora Avenue City mains.



However, new exhibits located in the Steppe, Taiga, Tundra and Temperate Rain Forest bioclimatic zones of the northeast corner of the site anticipate future plans for sewer separation and improvements in Aurora Avenue by the City.

Storm Drains

1. All roof drain, surface and subsurface runoff from non-animal areas should be discharged locally or directed to the storm drain system according to the following criteria:

   a. Discharge from roof drains of viewing structures and interpretive centers located in heavily vegetated areas should be intercepted in drywells or exhibit ponds.

   b. Runoff from secondary or tertiary pathways should be dispersed into adjacent planting areas (see discussion of Circulation).

   c. Runoff from roof drains and walks in primary activity areas and primary pathways should be conducted to the storm drain system (see discussion of Activity Areas).

2. The initial storm drain trunk line and its phased extensions draining to North 50th Street will meet the needs of expanded zoo facilities requiring storm drainage.

3. Adequate existing combined sewers will be converted to sanitary sewers whenever possible.

Electrical/Communications

1. The existing 5-KV overhead primary electrical distribution system will be converted to a 26-KV underground system. Secondary distribution will be at 480 Y/277V from several strategically located well-screened power transformers. The remaining 5-KV underground distribution system will also be up-dated to 26-KV. Service to individual structures will be a 480-volt, single or 3 phase. A local dry-type transformer will be supplied in existing structures so that existing voltages can be maintained.

2. Emergency standby power should be provided to maintain key facilities in the event of power failure.

3. Provisions will be made for communication raceways to all exhibit structures. This will allow the installation of a closed circuit T.V. system throughout the Zoo which will be monitored from a central control point in the Commissary Complex (see discussion of Internal Services). This T.V. system will also service public interpretive areas.

4. Intra-staff communication will continue to be by radio and telephone.

5. Direct communication with the public will continue via the existing public address system, controlled from the Administration Building.

Fuel

Existing heating plants use a combination of electrical heat, fuel oil and natural gas. Future heating should be standardized to electric heat.

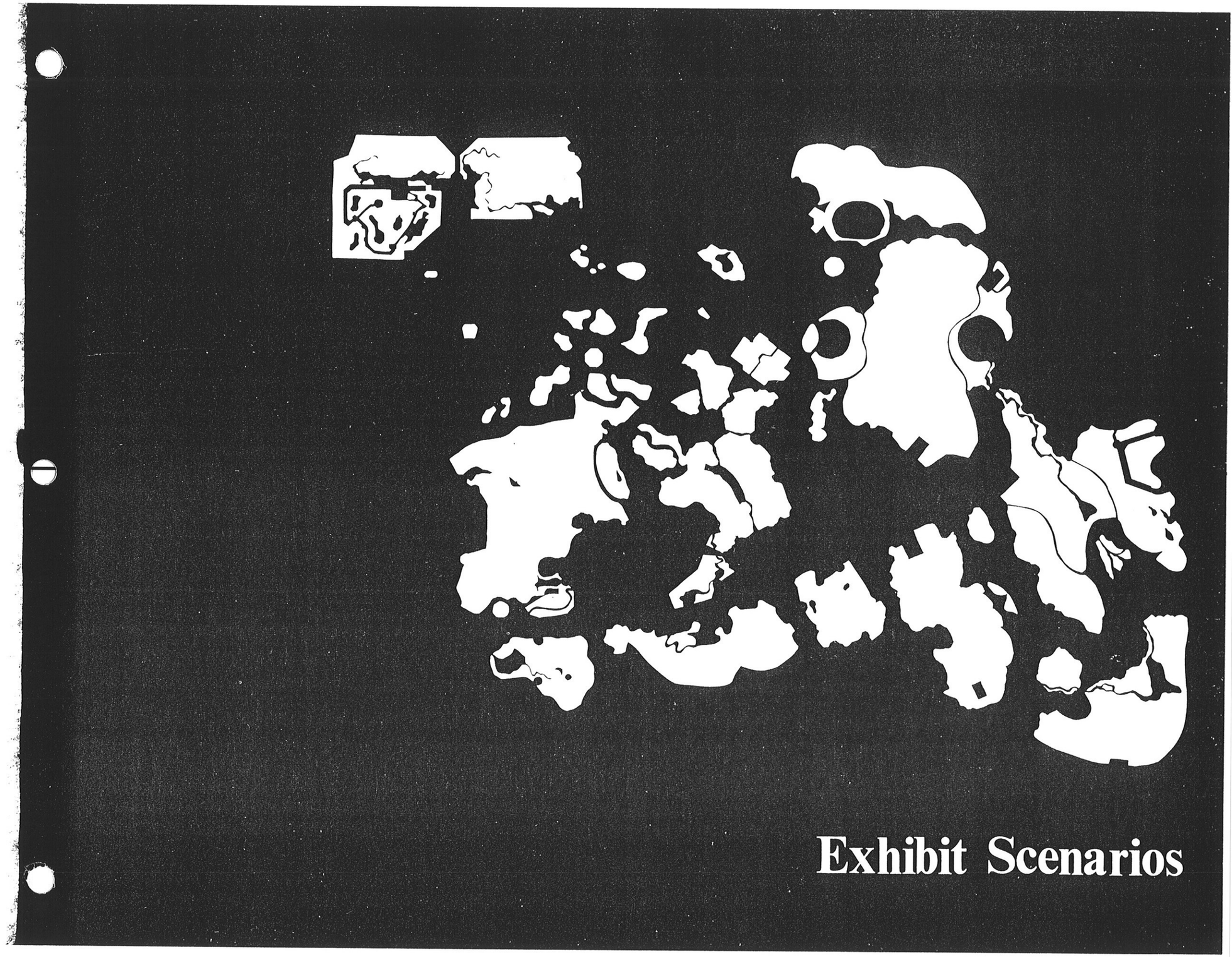


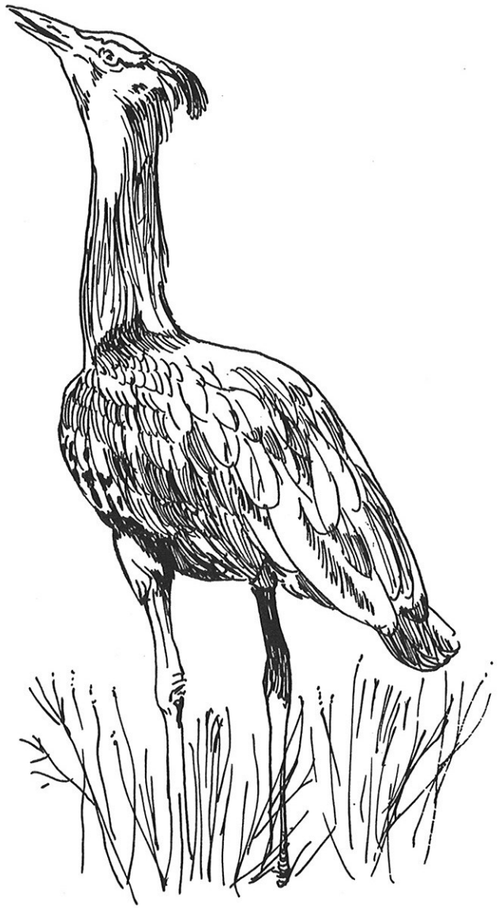
Exhibit Scenarios

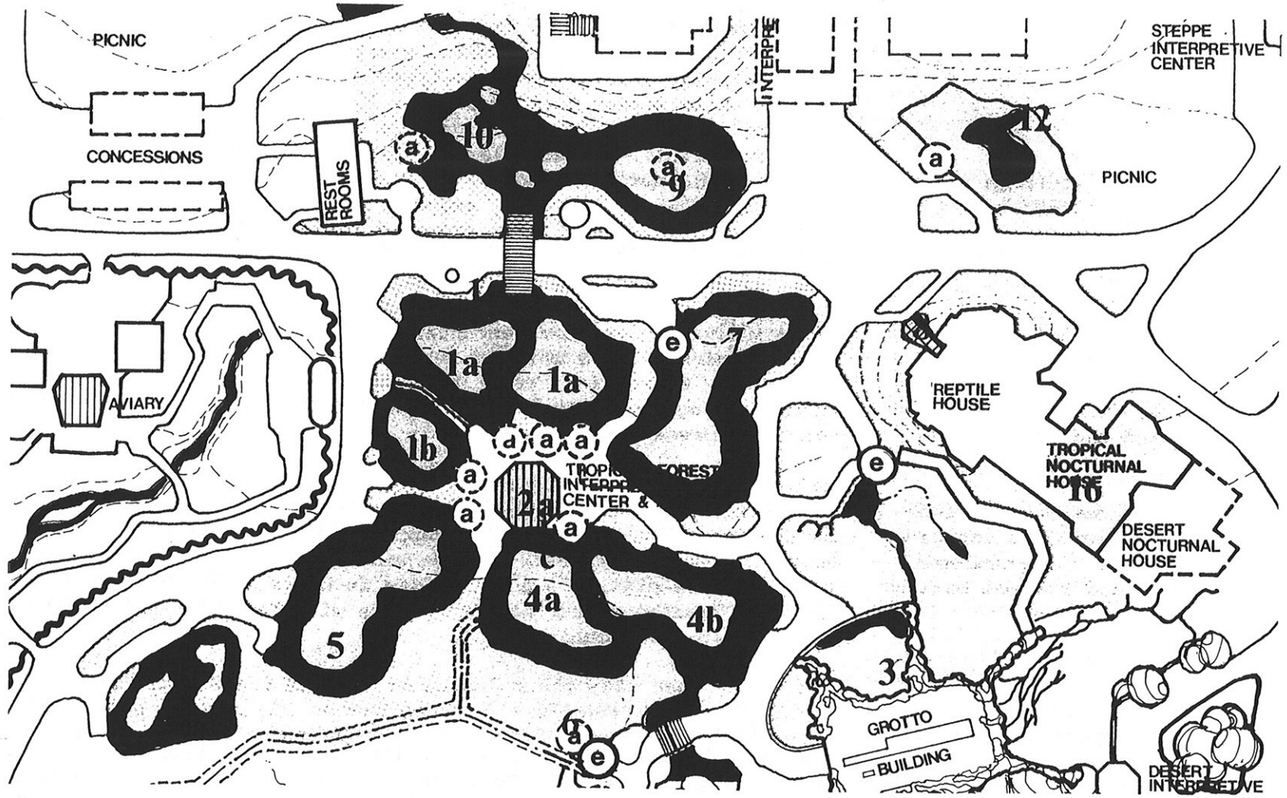
Exhibit Scenarios

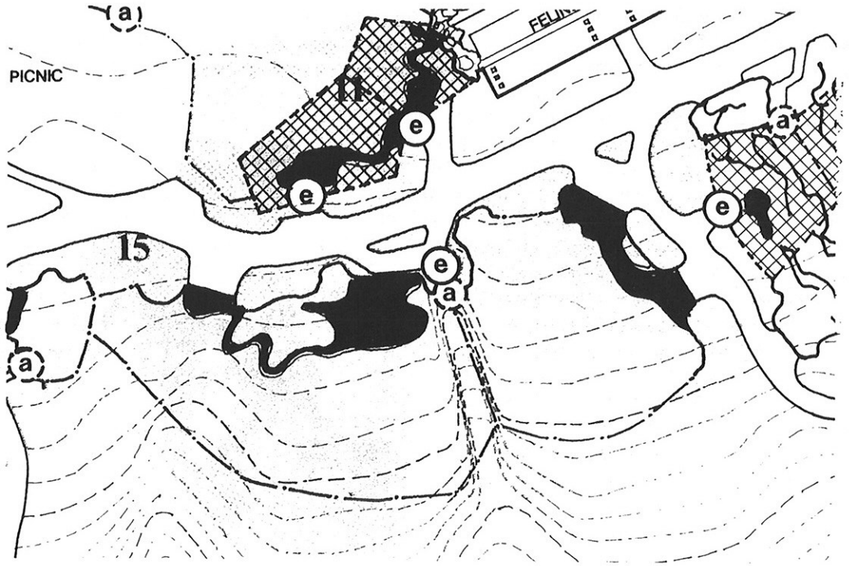
Educationally empty and ecologically naive exhibits are all too commonly found in zoos. Thus, the importance of faithfully maintaining design continuity in the execution of these scenarios, both in spirit and in form, cannot be overemphasized. The scenarios place each exhibit and related groups of exhibits in a consistent environmental context. They establish fundamentals and prescribe an approach which when understood and followed will produce exhibits appropriate and responsive to their intent. Superficial or arbitrary renditions must be avoided. Research and experimentation must proceed in concert with design development and should continue after initial construction and occupancy of the exhibits. This will provide a basis for evaluation and, if required, modification.

Recommendations are made in the following subject areas:

1. Animals exhibited.
2. Setting (geographic location, plant community).
3. Terrain (topography and geology).
4. Soil (inferred type and functional requirements).
5. Water (features such as streams, ponds and marshes).
6. Vegetation
7. Viewing (overlooks or viewing types).
8. Barriers (moats, walls).
9. Animal service areas.
10. Utilities.







Tropical Forest

1. South American Primates

a. squirrel monkey
woolly monkey
capybara
tinamou
great curassow
b. coati
c. pacarana

2. Tropical Forest Aviary

a. (South American)
common trumpeter
sunbittern
jacana
blue-and-yellow macaw
trogon
motmot
toucans
bellbird
honeycreepers
swallow-tanager
tanagers
b. (African)
African pygmy goose
African gray parrot
Schalow's turaco
Ross' turaco
wood-hoopoe
c. (Asian)
Palawan peacock-pheasant
crested fireback
Himalayan monal
roulroul
crowned pigeon
bleeding-heart pigeon
barred cuckoo-dove
emerald dove
rainbow lorikeet
plum-head parakeet
Indian pied hornbill
pitta
blue magpie
laughing-thrush
shama thrush
Rothschild's starling

3. Gorilla

4. African Primates

a. black-and-white colobus
Diana monkey
b. DeBrazza monkey

5. Lemurs

ring-tailed lemur
ruffed lemur

6. Okapi

okapi
duiker

7. Orang-utan/Siamang

8. Tree Shrew

9. Celebes Black Ape

10. Lion-Tailed Macaque

11. Tiger

12. Tapir

13. Axis Deer/Sloth Bear

axis deer
sloth bear
Indian peafowl

14. Rhinoceros

Indian rhinoceros
Sarus crane

15. Tree Kangaroo

tree kangaroo
magpie goose
radjah shelduck
megapode

16. Tropical Forest Nocturnal House (several regions)

a. vampire bat
b. two-toed sloth
c. kinkajou
d. prehensile-tailed porcupine
e. lesser galago
f. thick-tailed galago
g. crested porcupine
h. slow loris

Tropical Forest Island Complex

ANIMAL SPECIES: see exhibit scenarios 1, 4, 5 & 7

TERRAIN, SOIL AND WATER:

An indolent tropical river will undulate languidly through a maze of meandering channels and backwaters, capturing numerous bars and islands. The river will appear at low flow, exposing high shaded cutbanks of dark red clay on outside curves as a mute testament to the vigor of its seasonal flood.

Although appearing continuous, the river actually will be a series of separate looping moats of independently recirculating water. They will vary from 18-25' wide, uniformly 3' deep along the outside edge and very shallow on the island side. The sides and base of the river will be lined with concrete tinted and troweled to resemble red clay and gravel.

Between islands of geographically separated species, narrow peninsulas of screen planting edged with moated banks will be constructed, isolating oxbows for each exhibit. This will allow animals such as the capybara to swim in the river moat and bask on bars of sand or gravel beneath the overhanging riverbank walls.

VEGETATION:

Although the tropical forests of South America, Africa and Asia appear superficially very similar, there are noteworthy differences that will be emphasized in the exhibits. For example, while all three areas have abundant trailing lianas, only South and Central America have bromeliad-festooned branches, while Africa is generally poorer in forest palms and Asia predominates in reeds, canes and bamboos. Therefore, these differences will be dramatized through the strategic placement of artificial bromeliads in the foreground of South American tropical displays, the location of palms in South American and Asian displays during the summer (being moved to indoor shelter during the winter), and the planting of bamboos and tall reeds in the Asian areas. Compound-leaved plants are common in all tropical forests as well as in more arid zones. Such simulators as black locust *(Robinia pseudoacacia)*, honey locust *(Gleditsia triacanthos)*, ailanthus *(Ailanthus altissima)*, aralia *(Aralia spinosa)*, Kentucky coffee tree *(Gymnocladus dioica)*, and silk tree *(Albizzia julibrissin)* are suitable throughout the tropical exhibits. It is of greater importance to demonstrate something of the incredible variety of species in tropical areas than to attempt to differentiate areas by using a restricted plant palette. Also, a tree of any species will look very different crowded into a dense forest or standing alone upon a savanna, so that no confusion should occur by using some of the types listed in both these bioclimatic zones.

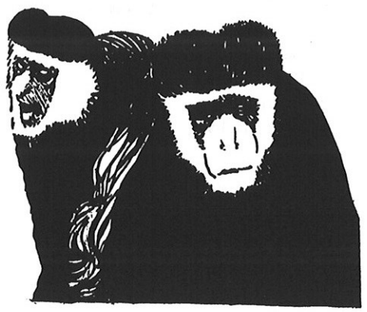
Throughout the tropical exhibits, small-leaved evergreen (not coniferous) trees such as Portugal laurel *(Prunus lusitanica)*, privet *(Ligustrum* spp.), Carolina cherry *(Prunus caroliniana)* and California bay *(Umbellularia californica)* are appropriate as dense fillers while accent foliage such as *Fatsia, Fatshedera, Gunnera,* knotweed *(Polygonum* spp.) and devil's club *(Oplopanax horridum)* are also useful. Suitable large-foliaged trees also include *Magnolia, Paulownia* and *Catalpa*. Vines such as evergreen *Clematis, Actinidia, Akebia, Wisteria,* grape *(Vitis* spp.) and *Polygonum* will provide excellent results in creating "impenetrable tangles" as well as hiding structures and softening artificial rock. In addition, annual and perennial vines such as hops *(Humulus lupulus)*, scarlet runner bean *(Phaseolus coccineus)*, and even morning glory *(Convolvulus sepium)* and nasturtium *(Tropaeolum majus)* will be used as quick fillers while more permanent plants are becoming established. Where vines trail into exhibits they must be fine-stemmed enough to break off if the exhibited animals try to use them as an escape route.

Palms and palm-like plants such as bananas *(Musa* spp.) could be used with very dramatic results. They would be planted permanently in tubs and kept in the Reptile House, Tropical Forest Aviary, greenhouses, etc. for the winter. During each summer they could be placed in the exhibits in holes previously dug for them. A limited number of such plants will be used, carefully situated in foreground areas.

Bamboo and cane-like plants suitable for use include timber bamboo *(Phyllostachys bambusoides)*, golden bamboo *(P. aurea)*, black-stem bamboo *(P. nigra)*, dwarf bamboo *(Sasa pygmaea)*, heavenly bamboo *(Nandina domestica)*, cane *(Arundo donax)* and common reed *(Phragmites communis)*, and reed-like giant knotweeds *Polygonum sachalinense* and *P. cuspidatum)*. These plants are all very invasive and, although a strong immediate effect is desired, some thought must be given to their ultimate containment. Also, as a general rule, these plants will not be used together with permanent slow-growing species.

There are no broad-leaved evergreen trees growing in the Puget Sound area that naturally simulate the great plank buttresses typical of many tropical forest trees. Yet these and other types of buttresses are so typical of tropical forests that their inclusion is very important. The following sketch illustrates how such trunks could be simulated.

The primary structure would be supplied by stacked, mortared, 48"-diameter concrete sewer pipes. To this trunk would be added gunite or plaster plank



buttresses on armatures of reinforcing rods and plaster mesh. The trunk and root surface would then be textured and tinted to reproduce the natural tree as closely as possible. This type of artisanry is innovative and difficult, and it will be a challenge during exhibit development. Two alternate approaches also suggest themselves: 1) cover the concrete structure with a colored latex skin which would resemble the hard rubbery texture of some tropical bark; 2) take a casting of an existing tree buttress somewhere and re-mold it on the site in various locations.

CLIMBING STRUCTURES:

Whenever possible, the exhibit islands have been designed to incorporate large existing trees. Where existing trees are unsuitable or not present, large suitable trees will be transplanted from elsewhere on the zoo grounds. In addition to these, a variety of large dead trees and climbing apparatuses will be incorporated where appropriate. These climbing structures should have the characteristic form and components of forest trees and groves, including structural hierarchy, flexibility, resiliency, variety and integration of structural and use features. They should provide a suitable framework for the natural movement and behavioral characteristics of the animals served as well as a wide variety of movable or interchangeable feeding stations operable by keepers from the ground.

ANIMAL SERVICE AREAS:

All of the tropical forest primates except the gorillas, Celebes apes and lion-tailed macaques will be housed and serviced in a series of holding areas integrated into the lower level of the centrally located Tropical Forest Aviary. The primate exhibits can be constructed before the aviary by completing these holding facilities in a coordinated sequence with utilities considered in advance.

In general, the holding areas will be small shed-like structures well screened from public areas. They are located off the islands but accessible to the primates by log bridges. See exhibit scenarios for further discussion of layout.

UTILITIES:

Although a general irrigation system will be required to replicate the Tropical Forest zone, there is a wide variety of existing specialty irrigation techniques that could be adopted to create a "rain forest." Among these is the mist system used to humidify greenhouses, which could be modified to encourage rapid growth of mosses and such lichens as beard lichen *(Usnea)*, which looks like the tropical bromeliad "Spanish moss" *(Tillandsia usneoides)*, in the area of the Gorilla Exhibit and other tropical areas. These could also be used on warm days to give the humid feel and smell of tropical forests and to create rainbows near waterfalls.

Apparatus is also available that continually feeds minute amounts of chemical fertilizer into the irrigation system, thus continually fertilizing plants through both leaves and roots for maximum growth. Such a system would be especially effective in growing moss on artificial rock faces, logs and large existing trees.
(Note: Special investigations will be made in each individual instance to determine if such a system could endanger animal health if used within animal enclosures).

Exhibit: 1 South American Primates

ANIMAL SPECIES: a. Squirrel monkey
Woolly monkey
Capybara
Tinamou
Great curassow
c. Pacarana
b. Coati

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Amazon Basin

EXHIBIT LOCATION:

A series of three islands, one pair separated only by water and a third separated from the other two by moat walls. The squirrel and woolly monkeys will inhabit the first pair and the coati the third island. The coati is a carnivore and should be separated from the primates. It is placed in this exhibit because of its sociality and its similarity, in certain characteristics, to the ring-tailed lemur, adjacent to it in the Lemur Exhibit. The monkey islands are linked to each other by the planting of large trees overhanging the separating channel, allowing the monkeys to leap overhead across the axis of one of the major views. (see Brown, 1965: fig. p. 124)

The pacarana will be exhibited separately on a peninsula between islands, but the birds and capybaras will be allowed to move from island to island or along the river banks.

ENCLOSURE AREA: 11,500 square feet

TERRAIN:

Generally flat alluvial plain heavily dissected by river meanders with resulting islands, oxbows and backwater channels. It will appear that seasonal deluges and resulting floods have cut steep-sided river banks on outside curves and deposited bars and gently sloping banks inside river bends.

SOIL:

That exposed by river cutting will be typically rust-red or red-brown showing some bedding of sands and gravels. Dense tangles of roots in the upper layers of soil will help bind the surface and result in overhung banks.

WATER:

Black and reflective, will flow slowly past mossy banks and islands of water lilies *(Nymphaea)*, its current barely detectable. Mechanically, the water will be recirculated continuously and aerated by spraying within a vault under the bridge that appears to connect this stream with the waters of the Lion-tailed Macaque Exhibit. The stream bottom will be formed of very dark concrete to enhance reflectivity.

ANIMAL SERVICE AREAS:

Will be located behind the islands and connected to them by a log bridge across the moat. The structures themselves will be simple low shed-like buildings set partly below the moat wall and well screened behind dense plantings of evergreen shrubs and vines. The layout of this and adjacent primate exhibits will allow the structures to be clustered together for ease of service; eventually they will all be incorporated beneath the Tropical Forest Aviary. See Tropical Forest Aviary scenario for further discussion.

BARRIERS: Will be type A-1b water moats.

VEGETATION:

Will be much like that of other tropical forest exhibits except that lianas (made from fiberglass-reinforced polyurethane ropes unbraided to form branchings) and bromeliads (artificially made and commercially available) will provide otherwise unattainable enrichment to important views. Again, some potted palms will be put out in the summer, their bases concealed by permanent vegetation or temporary fill material.

VIEWING:

Overlook type 2 viewing areas will be screened from intensive use areas by dense vegetation which will completely overhang the overlooks.

Exhibit: 2 Tropical Forest Aviary

ANIMAL SPECIES:

Common trumpeter	Palawan peacock-pheasant
Sunbittern	Crested fireback
Jacana	Himalayan monal
Blue-and-yellow macaw	Roulroul
Trogon	Crowned pigeon
Motmot	Bleeding-heart pigeon
Toucans	Barred cuckoo-dove
Bellbird	Emerald dove
Honeycreepers	Rainbow lorikeet
Swallow-tanager	Plum-head parakeet
Tanagers	Indian pied hornbill
African pygmy goose	Pitta
African gray parrot	Blue magpie
Schalow's turaco	Laughing-thrush
Ross' turaco	Shama thrush
Wood-hoopoe	Rothschild's starling

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Tropical South America, Africa and Asia

EXHIBIT LOCATION:

Central to the TROPICAL FOREST ISLAND COMPLEX (exhibit numbers 1, 4,5, & 7), this major exhibit will be built in the location presently occupied by the Great Ape House.

ENCLOSURE AREA: 8,000 square feet.

SCENARIO SUMMARY:

This aviary will exhibit birds of the three tropical regions of the world in adjacent enclosures within a common temperature-controlled walk-through structure having a transparent roof. See accompanying drawing for generalized layout.

A generally continuous landscape of slopes, small water features and lush tropical vegetation located accurately in its ecologically and geographically equivalent area will give continuity throughout. Enclosures will range from large walk-through areas occupied by many special facilities to isolated areas. Viewing will be from ground level and from "tree-top" overlook balconies. There will also be outward views of the black-and-white colubus and Diana monkey island as well as other hidden viewports to other surrounding primate exhibits (these small recessed windows will allow viewers to look out without being seen by other viewers on the perimeter of the primate exhibits).

Indoor holding facilities for the primates mentioned will be located in the lower service level of the structure. These will not be open for public view.

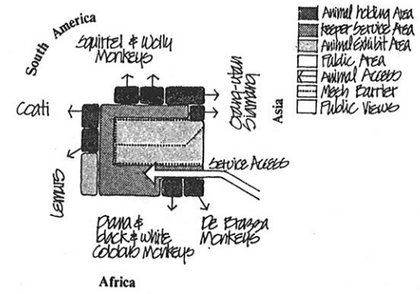


Diagram of Lower Level

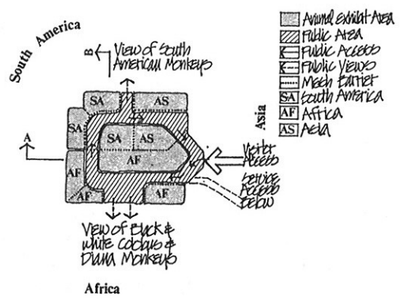


Diagram of Upper Level

The Tropical Forest Aviary will be largely screened by dense plantings and its exterior surface and form will be as inconspicuous as possible, being intentionally designed to seek concealment beneath vines and other vegetation.

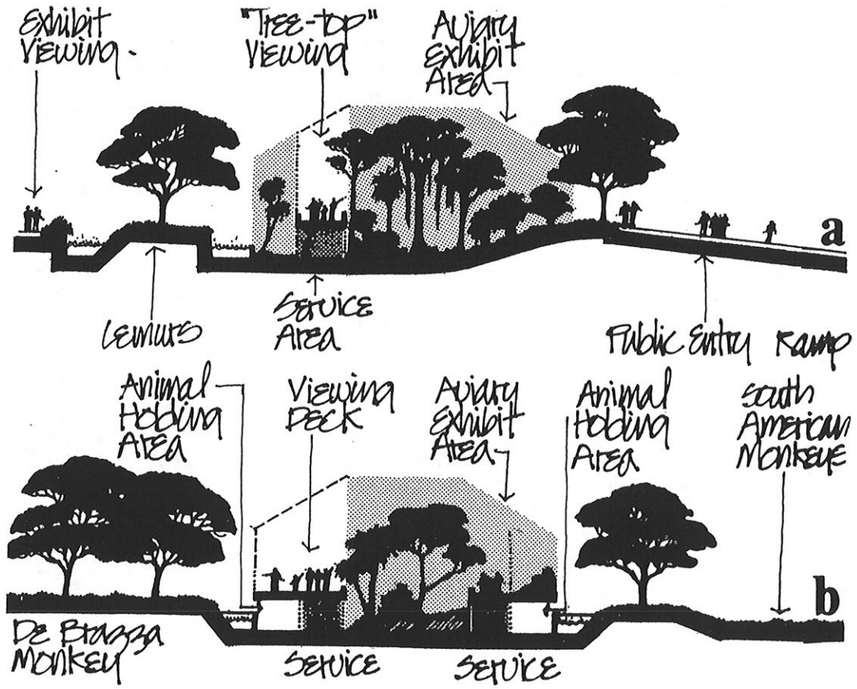


Exhibit: 3 Gorilla

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Upland forest in granitic highlands of Rio Muni, West Africa.

EXHIBIT LOCATION:

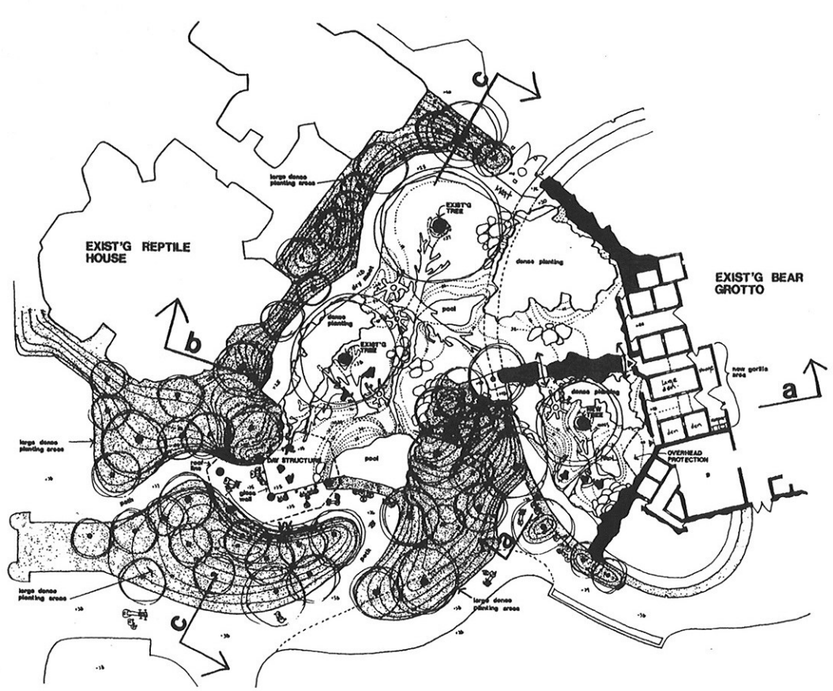
Extends from the existing Wolf Grotto and along the east side of the present Reptile House, also adjacent to the TROPICAL FOREST ISLAND COMPLEX.

ENCLOSURE AREA: 18,000 square feet.

TERRAIN:

Steep-sided stream-cut valley with a few huge worn artificial granite boulders. A freshet will flow from an unseen source up a side canyon and be intermittently visible on the hillside as it finds its way through many ill-defined paths among boulders and grassy banks to fall at last as a trickling curtain into a lower pool in the valley.

The hillside from its crest to the valley stream will appear to have been cleared in the preceding decade according to the ancient



tropical tradition of "slash and burn" by itinerant agriculturalists. Tall rank grass will overgrow small abandoned clearings, half hiding ruins of the fallen forest. Several great trees will have been subsequently overthrown, root and mossy bough exposed to lie broken across the boulder-strewn slope. Some will have fallen against companion trees and ramp upward from the grass and herb cover into the crowns of these tall forest relics.

From the overlook there will be a cliff dropping some 14' to a shallow pool in the exhibit. On the viewer's right the granite cliff wall continues upward another 8-12' from which a continuous trickle of sparkling water falls and splashes into the pool below.

SOIL: A mixture of 70% fine sand and 30% composted sawdust.

WATER: See TERRAIN, above.

VEGETATION:

Here, on the thin soil cover, the forest has never been dense or continuous, but several large spreading trees will have found pockets of deeper soil and now dominate the scene. On surrounding hillsides (outside the unseen dry moat) crowded seedlings of broad-leaved evergreens (*Prunus virginiana, Ligustrum lucidum, Magnolia* spp., etc.) together with bamboos and *Fatsia* will represent a phalanx of forest colonizers beginning the invasion of the abandoned fields. In protected pockets above the far cliff face (old Bear Grotto wall), accent plants will spread their broad banner leaves. The cliffs themselves (visible moat walls) will be stained by weathering and fleshed green by mosses and ferns along their upper side where frequent trickles and seeps stain their faces. Here and there curtains of thin-stemmed *Akebia* and evergreen *Clematis* will veil the ancient rock faces. Above the stream-cut cliffs the forest will canopy occasional overlooks from which visitors may view areas of the opposite hillside and the gorilla band foraging below the lush regenerating vegetation.

Visitors will approach the gorilla exhibit along curving paths overhung with large-leaved magnolias and feather-leaved *Albizzia*. At a point of emphasis a cluster of palms will be in prominent view, planted in tubs buried into the slope but removed every winter into the greenhouses.

VIEWING:

It is intended that the visitor be slightly disoriented by the twisting pathways and dense growth so that when he comes upon a view of the exhibit, it may catch him by surprise, as if breaking into a clearing he found he was not alone!

Visitors approaching from the east (main zoo entry area) will find that the trail has slipped under a vine-covered pavilion from which the gorillas are clearly visible through large panes of tempered glass such as are now found in the existing Great Ape House.

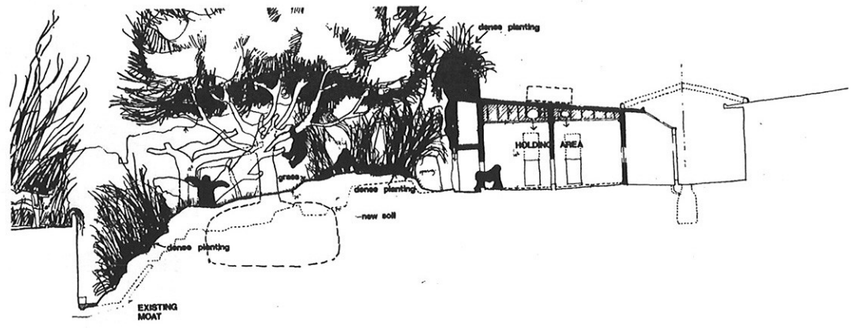
This shelter will be furnished with casual seating areas and heat elements for inclement weather, as well as interpretive displays. The same structure will furnish warmth and cover for the gorillas although they may come and go as they please from the open-ended structure into outdoor areas of their enclosure.

Upon leaving the structure the visitor will find himself in a clearing overhung by large honey locusts planted diagonally into the hillside behind him. The view from this point, through a light screen of bamboo and *Albizzia*, will encompass much of the exhibit area.

Continuing onward, the visitor will once more enter the young "tropical forest" with views of the colobus monkey exhibit before his attention is caught by another overlook into a second inter-connected gorilla exhibit. From near this point a small trail will lead from a turnstile up a steep natural stone stair to a small high overlook. This area should be automatically restricted to no more than five persons at a time. It will be the only viewing area in this exhibit unapproachable by the handicapped.

ANIMAL SERVICE AREA:

Keeper and animal service facilities will be provided in completely remodeled areas of the existing Bear Grotto building forming the eastern edge of the exhibit.



BARRIERS:

The gorilla exhibit will be enclosed by a variety of structures including vertical walls (Type B), tempered glass (Type H), and a hidden dry moat (Type A-2). The bottom of the dry moat would be filled with sawdust to ease the impact in the event a gorilla should fall.

UTILITIES:

The entire exhibit will be irrigated using a variety of techniques described in the TROPICAL FOREST ISLAND COMPLEX summary. All sprinkler apparatuses must be kept out of reach of the animals.

Exhibit: 4 African Primates

ANIMAL SPECIES: a. Black-and-white colobus
Diana monkey
b. DeBrazza monkey

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Riparian tropical forest of the Congo Basin, Africa

EXHIBIT LOCATION:

Exhibits a and b each consist of a single island in the water complex, separated from one another by dense plantings as well as moats. The exhibit with the colobus monkeys will be adjacent to that with the ruffed lemurs so the similarities in their striking black and white coats can be seen by the viewer.

ENCLOSURE AREA: 14,200 square feet.

TERRAIN: see TROPICAL FOREST ISLAND COMPLEX

SOIL: see TROPICAL FOREST ISLAND COMPLEX

WATER: see TROPICAL FOREST ISLAND COMPLEX

VEGETATION:

At present there are no suitable trees in this area. Several large trees will have to be relocated from elsewhere in the zoo for these highly arboreal animals; for example, the ailanthus grove in the kangaroo area. The DeBrazza monkeys are more comfortable at lower canopy heights than are the Dianas and colobus, so they may be given smaller, closely spaced trees and may require a less extensive barrier system.

VIEWING:

The DeBrazza monkeys will be seen from a pathway adjacent to the Gorilla Exhibit (overlook type 2), while the black-and-white colobus and Diana monkeys will be viewed from an upper level terrace in the Tropical Forest Aviary.

BARRIERS:

These monkeys may leap up to 40', a distance which should be maintained between their exhibit trees and any other elevated structures or plants.

ANIMAL SERVICE AREA: see TROPICAL FOREST ISLAND COMPLEX

Exhibit: 5 Lemurs

ANIMAL SPECIES: Ring-tailed lemur
Ruffed lemur

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Open gallery forest of the Malagasy Republic

EXHIBIT LOCATION:

This exhibit will represent the dry extreme of the African forest exhibits, just as the coati adjacent to it represents a similar habitat in tropical America. The unrelated but surprisingly similarly adapted coati will be viewable from nearby, the two species providing an opportunity for interpretive material on convergent evolution while bridging the continental gap between Africa and South America. The ring-tailed lemur prefers the ground and lower branches, while the ruffed lemur is more wholly arboreal; thus a desirable separation can be obtained. The two species of lemurs will be exhibited on one large linear island surrounding three large existing beech trees.

ENCLOSURE AREA: 11,200 square feet.

TERRAIN: see TROPICAL FOREST ISLAND COMPLEX

SOIL: see TROPICAL FOREST ISLAND COMPLEX

WATER: see TROPICAL FOREST ISLAND COMPLEX

VEGETATION

The exceptionally large durable beech *(Fagus sylvatica)* trees should provide an ideal exhibit habitat to simulate the deciduous forests of Madagascar. Lemurs, though omnivorous, are thought not to eat leaves excessively if provided with adequate favored fruits and other food. The ground under the beech is normally too dry and shady to support dense vegetation. The resulting accumulation of leaf litter and sparse grass will naturally simulate gallery forest

understory in areas frequented by the ring-tailed lemur. During the summer, while in leaf, the beeches will suggest the small-leaved tropical forest trees of the somewhat wetter parts of Madagascar that support the ruffed lemur.

VIEWING: Will be from path-side overlooks (type 2)

BARRIERS: Will be water moats (type A-1b)

ANIMAL SERVICE AREA: see TROPICAL FOREST ISLAND COMPLEX

Exhibit: 6 Okapi

ANIMAL SPECIES: Okapi
Duiker

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Floodplain forest in Congo Basin

EXHIBIT LOCATION:

The okapi and duiker will occupy a forested zone along the river opposite the DeBrazza monkey exhibit for which they partially form a background. The exhibit will simulate mature tropical forest with dense shade and little understory.

ENCLOSURE AREA: 7,900 square feet

TERRAIN: Flat forest floor

SOIL:

Well-drained mixture of 70% sand and 30% composted sawdust.

WATER: None

VEGETATION:

As there are presently no suitable trees in this area, planting should proceed as soon as possible even though the exhibit may not be developed for some time in the future. Basically, the exhibit will be two interconnected parts: 1) a tall grove of emergent trees, including the trunk of a buttressed giant (see description under TROPICAL FOREST ISLAND COMPLEX), its top lost in the canopy above; 2) a smaller thicket of lower plants seeking to fill the overhead void left by the fallen giant.

VIEWING:

Hidden in the edge of the forest will be a small overlook structure from which visitors may obtain a 120-degree view into both areas of the exhibit as if from a blind.

BARRIERS:

The small duikers will be able to pass through broken sections of an artificial fallen log and use both areas while the larger okapis are restricted to the open glade, thus preventing them from over-browsing the thicket.

ANIMAL SERVICE AREA:

A simple shed-like structure will be built out of view onto the back of the overlook structure.

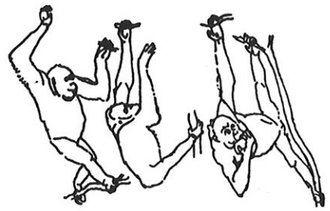


Exhibit 7 Orang-utan/Siamang

ANIMAL SPECIES: Orang-utan
Siamang

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Coastal lowland forest along a backwater river channel in Sumatra

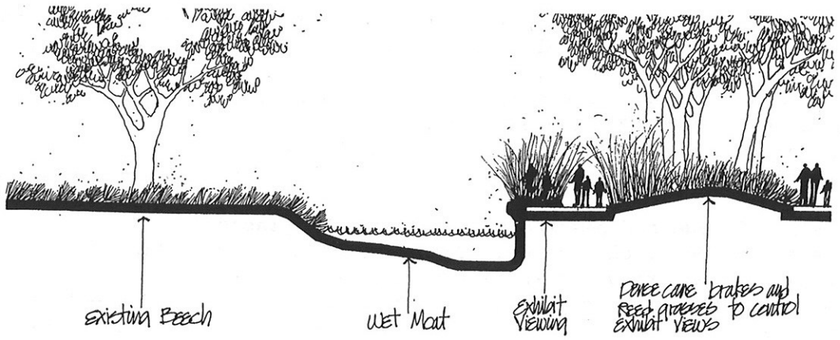
EXHIBIT LOCATION:

A long island surrounded by water, one end of it encompassing the large existing beech tree. This exhibit will complete the ring of islands in the Tropical Forest Island Complex and can be related interpretively to the other primates in general or to the tropical Asian ones to the west of the complex. The orang will be across from its great-ape relative, the gorilla, out of sight of each other. The contrast between the largely terrestrial and the largely arboreal species should be dramatic.

ENCLOSURE AREA: 11,000 square feet.

TERRAIN:

Canebrakes along the water's edge will indicate a variable water level caused by tidal action many miles downstream. Paths cluttered by water buffalo and wild pig footprints (cast into a thin,



colored concrete paving) will wind and twist among the tall canes and disappear into the dense forest on slightly higher ground. Generally the flatness of the lowland tropics will be emphasized.

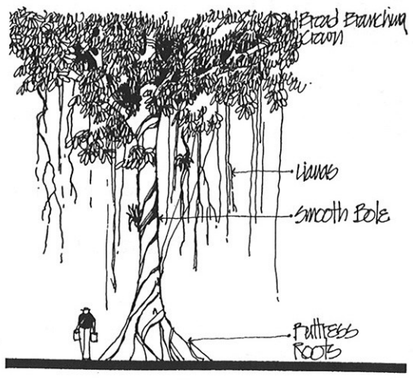
SOIL:

The ground will be packed brown "earth", simulating the soils of the Asian wet tropical region. See TROPICAL FOREST ISLAND COMPLEX.

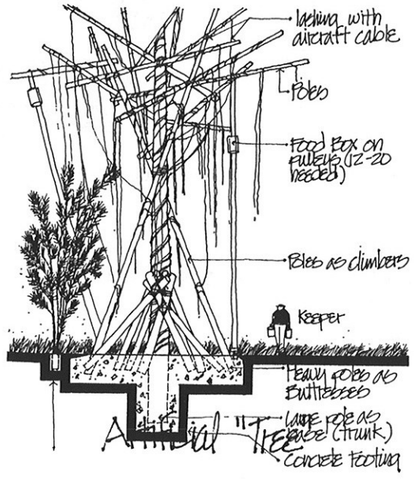
WATER: see TROPICAL FOREST ISLAND COMPLEX

VEGETATION:

Initially, the animals will be allowed access to the large existing beech tree. Should they prove too damaging, inconspicuous means will be found to limit access for either the orangs or for both species, maintaining the tree as a major visual component of the exhibit. A large area of tall spreading artificial tree-like climbing structures (see description in TROPICAL FOREST ISLAND



Typical Tropical Forest Tree



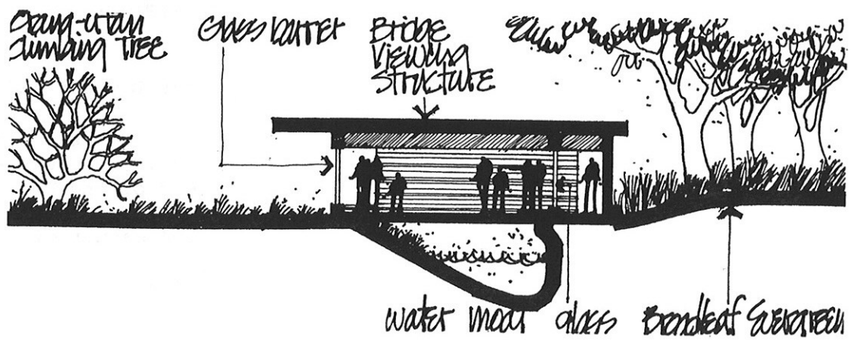
Artificial Tree

COMPLEX) will be provided to give the animals ample opportunity to use and demonstrate their special arboreal locomotion.

VIEWING:

The visitor should lose himself along a path simulating a game trail. Suddenly the track will widen and converge with others as the view opens out over the river. Canes still obscure some of the view, but clearly visible will be a large, dark-foliaged tree and then the complex climbing "forest" of the animal area.

On the far side of the exhibit island, out of view from the previously described overlook, will be a structure that superficially



resembles a covered bridge spanning the river moat. Visitors entering this structure would find it a viewing room much like that described for the gorilla exhibit. Like the former, it will provide shelter for both viewers and exhibited animals, which are separated by glass salvaged from the present Great Ape House. The structure will have wide, sweeping eaves and smooth exterior walls to prevent escapes from over the roof.

FEEDING:

To stimulate activity in the inhabitants, feeding stations will be set up high in the trees. The feeding stations are small, bright-

ly colored cylinders (with some attention paid to making them orang-proof) hung on sloping cable-and-pulley systems. Each will be filled by the keepers and hoisted into any of a variety of locations. Some contain mechanisms allowing only one or two handfuls of food to be removed every 10 or 20 minutes, allowing the apes to move from one feeder to the next for their meals and thus reinforcing natural feeding and activity patterns.

Fresh leafy branches for forage and nesting material will be placed at intervals in several buried steel sleeves. The material will be securely clamped in place, requiring the animals to tear out individual pieces as they need them. These sprouting "thickets" will add visual greenery as well as useful materials for the apes.

BARRIERS:

The island is surrounded by a water moat (type A-1b).

ANIMAL SERVICE AREA:

See TROPICAL FOREST ISLAND COMPLEX. These facilities will be accessible to the apes over a well-branched log bridge.

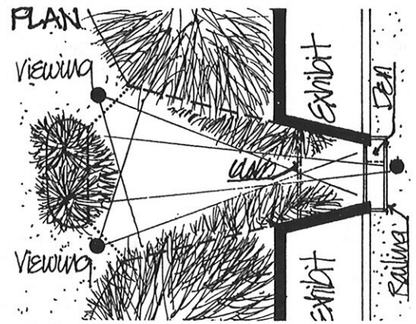
Exhibit: 8 Tree Shrew

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Rain forest in Malaysia

EXHIBIT LOCATION:

This exhibit will make use of an inside gallery at the southwest end of the Reptile House and an outside area entirely meshed in the manner of a flight cage.



ENCLOSURE AREA: 400 square feet

TERRAIN: Sloping with shrub-covered hummocks.

SOIL:

Reddish-brown concrete overlain by composted sawdust resembling dark brown leaf litter.

WATER: None required except a depression for drinking and bathing in each part.

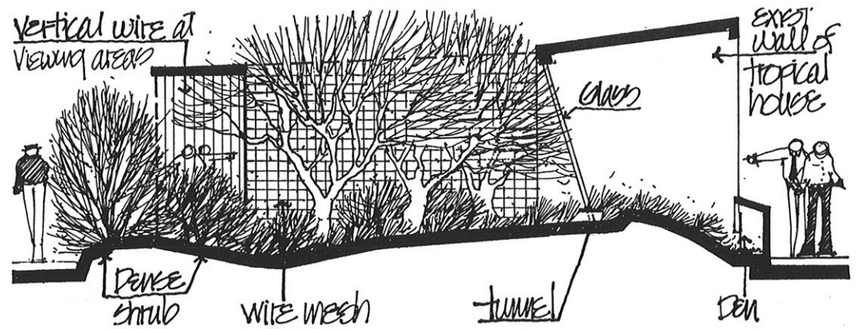
VEGETATION:

Dead branches of the top of a fallen tree will extend above small evergreen shrubs and trees. A variety of tropical plants will be installed in the inside section, especially ferns and other rock-climbers on rough existing concrete walls. If the tree shrews are destructive of vegetation, these walls should be made inaccessible to them.

Dense plantings will encroach on either side of the outside structure.

VIEWING:

A down-slanted (to reduce reflections) glass dividing the inner and outer exhibit areas will allow clear viewing as will the harp



wire front of the outside viewing area. The animals should be given climbing structures to encourage their being at visitor eye-level. Walls of both inside and outside sections will be heavily planted.

BARRIERS:

Tensioned harp wire will suffice to keep the animals inside the outer enclosure at viewing areas. Otherwise, fine wire mesh will be used.

ANIMAL SERVICE AREA:

Denning boxes can be provided out of sight at the foot of the inside viewing window.

UTILITIES:

Automatic irrigation will be required and must be controlled with separate zones for indoor and outdoor exhibit areas.

Exhibit: 9 Celebes Black Ape

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Celebes Island

ENCLOSURE AREA: 6,000 square feet.

NOTE: the following scenario applies also to

Exhibit: 10 Lion-Tailed Macaque

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: India

ENCLOSURE AREA: 7,000 square feet

EXHIBIT LOCATION: Across from South American Primates Exhibits.

Both species of ape will occupy separate islands within the combined exhibit area, one island being the refurbished existing Monkey Island.

TERRAIN:

High overhanging river-cut clay banks will enclose a sweep of active river rapids and rocky islands.

SOIL: see TROPICAL FOREST ISLAND COMPLEX

WATER:

Abundant falls and rapids would attest to the relatively high rainfall and rapid runoff from shallow soils. The higher falls (8-10') will show relatively low flows (3-10 gpm) because of their smaller drainage areas. Falls in the main channels of the river will be much wider (10-20') and lower (6"-4'), falling in wide pale sheets over exposed horizontal ledges. Again, the flow

will not be great for its purpose is to provide a quiet idyllic background for the primates rather than a boisterous main attraction in itself.

VEGETATION:

Vegetation on the thin soil on and around the rock outcroppings will be sparse, mostly grasses and herbs with a few droughty shrub-like trees growing in favored niches of gravels and deeper soils. These relatively impoverished plants may appear in contrast to the rich luxuriance of surrounding areas where deep soils overlie the resistant strata creating the rapids.

There will be, however, some benefit to the particularly hardy grass and trees on the islands; they are most resistant to animal damage.

Grass such as quackgrass *(Agropyron repens)* and, near the water, reed canary grass *(Phalaris arundinacea)* and sedges are suggested. In a few areas near the center of the exhibit, larger trees such as honey locust *(Gleditsia triacanthos)* or ailanthus *(Ailanthus altissima)* would allow the animals vertical mobility.

In order to provide sufficient climbing areas and decrease wear, it is suggested that a large quantity of dead trees be set among the living so that the whole resembles tight groves of naturally stressed vegetation.

VIEWING:

Selected viewing would be from overlook areas facing westward and uphill. Afternoon sun would highlight the spray while throwing the surrounding background vegetation into shadow with penetrating rays, emphasizing both the density and apparent depth of the surrounding forest, as if this open riverside were a special place in the vast tropical forest. Perhaps, one might imagine the apes had been foraging along the riverside and found the sunny islands a pleasant place to pass the afternoon.

Near the center of the exhibit the waters would collect in a large basin-like pool and flow from there under a bridge, across the main existing mall, and apear to continue into the South American Primate Exhibits. Under the bridge would be a large sump and pump vault from which the water would be returned to recirculate throughout the black ape and macaque exhibits. The bridge would provide an excellent open low-level view into the central area of the exhibit.

ANIMAL SERVICE AREA:

Service areas should be buried out of sight under the overhanging banks so that keepers may enter the service directly without

public exposure.

Although holding areas would be off exhibit, small protected pockets in the rocks would be provided with replaceable heat pads, allowing the apes opportunity to remain on exhibit during all but the most inclement weather.

BARRIERS: Water moats Type A-1b.

Exhibit: 11 Tiger

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Low-lying swampy forest in northern Bangladesh

EXHIBIT LOCATION: Across from Rhinoceros and Axis Deer/Sloth Bear Exhibits

ENCLOSURE AREA: 9,300 square feet.

TERRAIN: Hummocky and swampy.

SOIL: Well-drained mixture of 70% sand and 30% composted sawdust.

WATER:

The pond structure will be surfaced with a dark-tinted gunite into which recesses for water lily boxes will be set. In other areas the pond bottom will surface around planting areas for cane and reeds. These islands will be irrigated by buried trickle heads and covered with compacted sand. The water area need be neither large nor deep. Integration with planting and earthforms will have the effect of obscuring its total extent making it appear much larger. The water will be constantly supplemented and wasted to insure cleanliness.

VEGETATION:

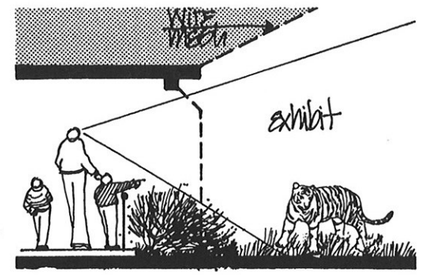
Dense canebrakes of *Arundo donax, Phragmites communis* and giant knotweed *(Polygonum* spp.)will emerge from dark swamp pools. The afternoon light, filtered by the cane, will fall in spots and sparkling patterns among the pond lilies and duckweed, warming a great worn log lying across the water. To the right the ground will rise steeply over the upturned root mass, covered by a sunny carpet of coarse grass and lilies. A well-worn game trail will skirt the mound and enter the shallow pool. The submerged trail will re-emerge from the pond a short distance to the left, into a narrow break between the canes. The duckweed covering the pool should be collected before draining and re-installed after periodic maintenance operations.

VIEWING:

Visitors will view the two sections of the Tiger Exhibit from enclosed viewing areas (Overlook Type 6) containing interpretive materials. More importantly, no views of the mesh tent enclosing the animals would be possible from these structures. The intent is for the visitors in fact to feel that they are in a steel-barred "blind" and that the tigers are living in the world "outside."

BARRIERS:

Because the tigers can be expected to spend nearly all of their time outdoors, daily maintenance operation can be minimized and high-maintenance features such as viewing windows can be eliminated. A steel-bar grid, such as is presently used for the leopard enclosures, will project like a bay window into the exhibit, giving the impression that the viewer, rather than the animal, is being contained. A guard rail and planting area will be located to hold back visitors.



ANIMAL SERVICE AREA:

Existing servicing facilities in the Feline House will be maintained.

UTILITIES:

Full irrigation will be required, some specific applications of which have been described above (see Water).

Exhibit: 12 Tapir

ANIMAL SPECIES: Malayan tapir

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Rain-forest pool in Malaysia.

EXHIBIT LOCATION:

Between the Reptile House and the future Interpretive Gallery across from related forest exhibits for tree shrew, orang, siamang, and Celebes ape.

ENCLOSURE AREA: 5,500 square feet

TERRAIN:

Flat lowland swamp forest surrounding shaded pool in a seasonally

flowing stream bed, its banks overhung by tall grasses and reeds. The general character of the exhibits in the Tropical Forest Island Complex, in particular the Asian ones, will be duplicated.

SOIL: see TROPICAL FOREST ISLAND COMPLEX

WATER:

The presently existing waterfowl pond will be modified to serve as the tapirs' bathing and wallowing pool with the addition of a pump to recirculate the water.

VEGETATION:

The tapirs will probably browse most plants in their exhibit, but dense plantings of evergreen shrubs inaccessible to them will contribute a tropical forest aura. The horse chestnut and maple in the exhibit, although deciduous, are considered indispensable for their summer shade and green luxuriance, unless the horse chestnut is found to be toxic to tapirs. Above the back and side borders of the exhibit and sparingly in the front will be thickets of common reed *(Phragmites)* and giant reed grass *(Arundo)*.

VIEWING:

Viewers will walk onto the overlook at the southeastern edge of the exhibit through the shrubbery buffering the Interpretive Gallery. Sunlight coming through the large trees will dapple the water and dark soil with sunflecks, especially appropriate for the spotted young tapirs. The impression conveyed is to be of an open area at a stream pool in otherwise dense forest, with just enough openings in the canopy to allow the grasses to prosper.

BARRIERS:

The present wall around the exhibit is aesthetically pleasing and should be adequate to retain these animals. It can easily be raised if necessary.

ANIMAL SERVICE AREA:

Located under the viewing overlook.

Exhibit: 13 Axis Deer/Sloth Bear

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: India

EXHIBIT LOCATION: Adjacent to the Rhinoceros Exhibit

ENCLOSURE AREA: 19,500 square feet

TERRAIN:

Gently sloping with slight subtle undulations for improved surface drainage, dropping steeply away at the far side of the exhibit area.

SOIL:

Well drained with gray-brown crushed gravel covering animal trails to provide adequate hoof abrasion. Sand wallows will also be provided in locations initiated by the animals.

WATER:

Water moats similar to those described in the Red Deer Exhibit will be the only water features proposed.

VEGETATION:

Forests of the area replicated are characterized by mixed broad-leaved evergreen and deciduous trees. The former will be represented by the large-leaved *Magnolia grandiflora*, perhaps "Majestic Beauty", and the latter by *Ulmus glabra* (several of which already occupy the site) and *Ulmus pumila* which closely resembles it. These trees would be planted in clusters by type to form multi-trunked thickets, each protected by a type A-3 moat barrier. A similar barrier, but more ridged, would protect large existing trees from the deer while allowing bear access. In a prominent location near the Exhibit Interpretive Center a large dead tree should be erected with a conspicuous "bee hole" into which occasional treats (including honey!) would be placed for the bears. Also, large rotted logs will be placed in the enclosure from time to time for the bears to demolish in search of termites.

VIEWING:

Both the Rhinoceros and the Axis Deer/Sloth Bear Exhibits are viewed by an Exhibit Interpretive Center while two overlooks (type 2) also provide views.

BARRIERS:

The area will be enclosed by a double-overhung mesh fence (Barrier Type D-3) set below the crest of the hill or in a swale separating it from the Rhinoceros Exhibit. Foreground barriers will be Type A-1b water moats. Type A-3 modified "cattleguard" moats will protect planting areas as described under Vegetation above.

ANIMAL SERVICE AREAS:

Sloth bears will have a holding area beneath the Interpretive Center while the deer will have a rough lean-to shelter of deadfall and boughs obscured among the forest trees at the rear of the exhibit to protect them from the most inclement weather.

Exhibit: 14 Rhinoceros

ANIMAL SPECIES: Indian rhinoceros
Sarus crane

BIOCLIMATIC ZONE: TROPICAL RAINFOREST

SETTING: Marshes of the Brahmaputra River, India

EXHIBIT LOCATION:

Adjacent to Axis Deer and Sloth Bear Exhibit and across walkway from Tiger Exhibit, all of them representing the heart of the wet Asian tropics.

ENCLOSURE AREA: 29,200 square feet

TERRAIN: Flat, low-lying floodplain marsh and pond.

SOIL:

All soil for turf areas (inaccessible to rhinos) will be very well-drained to withstand compaction by the cranes. Surfacing on upper animal walkway areas would be red "cintrex".

WATER:

The pond will be relatively large and gently sloping from its back edge to a maximum depth of 5' along the front edge (moat wall). It will be concrete-lined for ease of cleaning and have a roughened surface for good traction. Several large free-form islands will be constructed with vertical concrete walls. These will each be surrounded at a distance of 4-5' by a submerged railing of heavy iron pipe to prevent the rhinos from browsing the island vegetation. Also, a large central area of the pond will similarly be isolated by a submerged railing. This area will be planted to water lilies in submerged boxes which will be set on a slightly raised area for rapid draining when the pond is drained.

It is assumed that constant agitation and defecation by the animals would reduce the transparency of the water so that submerged structures such as railings and island walls would not be visible. In any case, none of the structures will be located closer than 20' from viewing areas and all will be painted with suitable underwater camouflage colors and patterns.

VEGETATION:

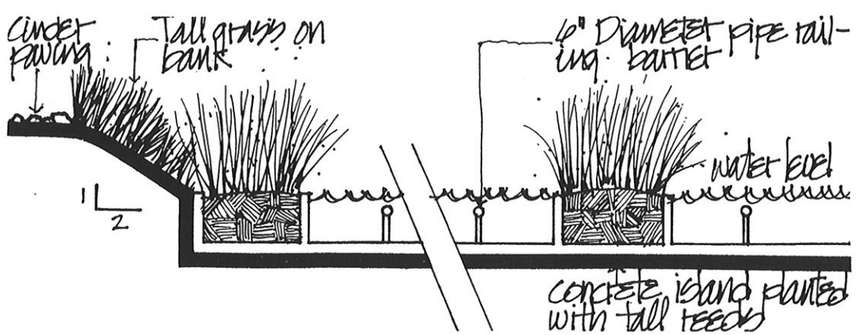
Tall dense cane brakes of *Phragmites* will be planted on pond islands and as screening between the walkway and pond between viewing areas. Thinner stands will provide a semi-transparent screen through which visitors would view the animal areas. Water lilies most appropriate for the exhibit are of the genus *Nymphaea*, widespread in both temperate and tropical regions.

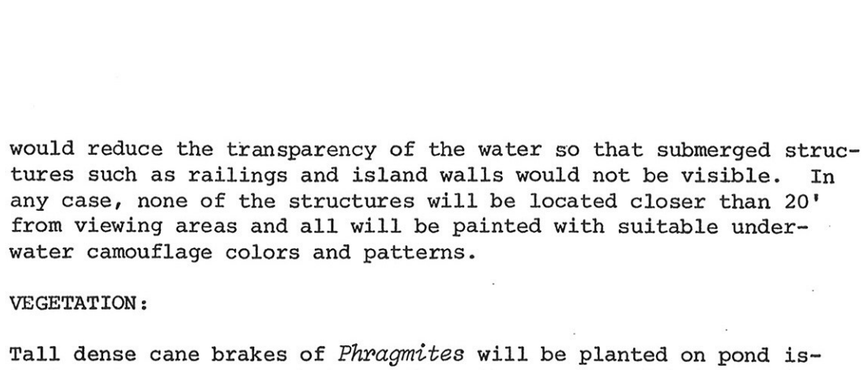
Background planting beyond the animal walking areas will be of timber bamboo *(Phyllostachys bambusoides)*, cane *(Arundo donax)* and giant knotweed *(Polygonum* spp.). Several dead ("drowned") trees will be set in and near the pond as roosting places for the cranes and rubbing surfaces for the rhinos.

VIEWING:

It has been noted in other zoos that no turf grows in areas habitually trampled by rhinos. It was also seen that rhinos avoid steep slopes, where grass grew abundantly. These clues suggest the following arrangement: pave areas accessible to the animals with red "cintrex" material (which will tend to coat the hides with appropriate red dust) and elevate these flat walking areas slightly above the eye level of the viewers, thus obscuring them. Turf-clad slopes can then be maintained between the walking areas and the pond. Paved ramps connecting these use areas will be hidden behind the tall reed islands in the pond.

It should be noted that the existing hillside slopes downward rather steeply behind the exhibit area. This allows the opportunity to plant smaller species of bamboo immediately behind the exhibit with taller species farther down the slope so that a nearly constant height of dense vegetation can be maintained near-





ly to the horizon. This should give a clear visual effect of open-expanse wetlands with scattered trees.

BARRIERS:

The vertical wall along the front of the pond (generally hidden behind rushes) and the fence below and behind the animal area (hidden by the rear slope and bamboo plantings) will serve to contain the animals. The sarus cranes would be pinioned.

ANIMAL SERVICE AREA:

Will be located under the Exhibit Interpretive Center.

Exhibit: 15 Tree Kangaroo

ANIMAL SPECIES: Tree kangaroo
Magpie goose
Radjah shelduck
Megapode

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Lowland moist forest in Queensland

EXHIBIT LOCATION:

Adjacent to the Indian rhinoceros and across the path from the Australian Savanna Exhibit, this exhibit will bridge the geographical gap between Asia and Australia and the ecological gap between the tropical forest and savanna.

ENCLOSURE AREA: 3,000 square feet.

TERRAIN:

Basically flat, as in a tropical lowland forest area.

SOIL:

Brown, fine-textured, but well-drained.

WATER:

In the front moat, as a forest-swamp pond, for the waterfowl.

VEGETATION:

Large-leaved deciduous trees of tropical appearance, such as *Catalpa, Paulownia* and *Magnolia macrophylla*, planted densely enough for complete cover in the center of the exhibit, more open toward the back and front. Although the kangaroos are browsers, trees can be planted which they are unlikely to eat. The exhibit will have a dense backdrop of trees and shrubs, many of which are already present, simulating tropical forest.

VIEWING:

From the southwest corner over the wet moat and waterfowl. The kangaroos should spend most of their time in the larger branches of the trees, even well above the viewers.

BARRIERS:

Moat wall (Type A-1b) in front joining fence (Type D-3) hidden in dense shrubbery in back. The largest of these animals can jump substantial distances from tree to tree and from a tree to the ground, but they are not especially inclined to do so. They are not particularly good climbers or jumpers from the ground, and 5'-high barriers should contain them. Tree canopies, at least the larger branches, will be limited to no closer than 10-15' from the edges of the exhibit.

ANIMAL SERVICE AREA:

Underground near the end of the moat, with separate path and entrance for keeper.

Exhibit: 16 Tropical Forest Nocturnal House

ANIMAL SPECIES: Vampire bat
Two-toed sloth
Kinkajou
Prehensile-tailed porcupine
Lesser galago
Thick-tailed galago
Crested porcupine
Slow loris

BIOCLIMATIC ZONE: TROPICAL FOREST

SETTING: Tropical forest areas of South America, Africa and Asia

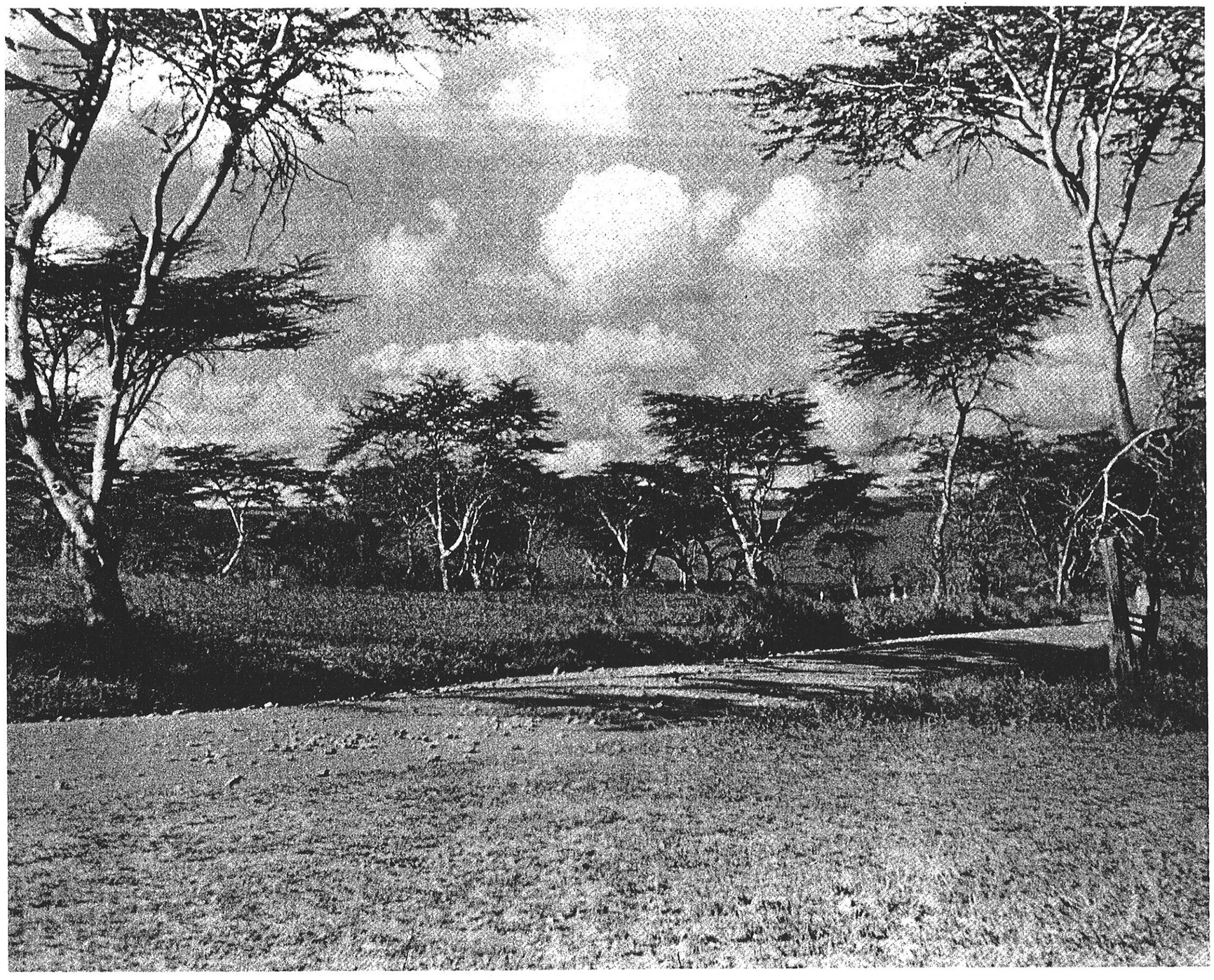
EXHIBIT LOCATION:

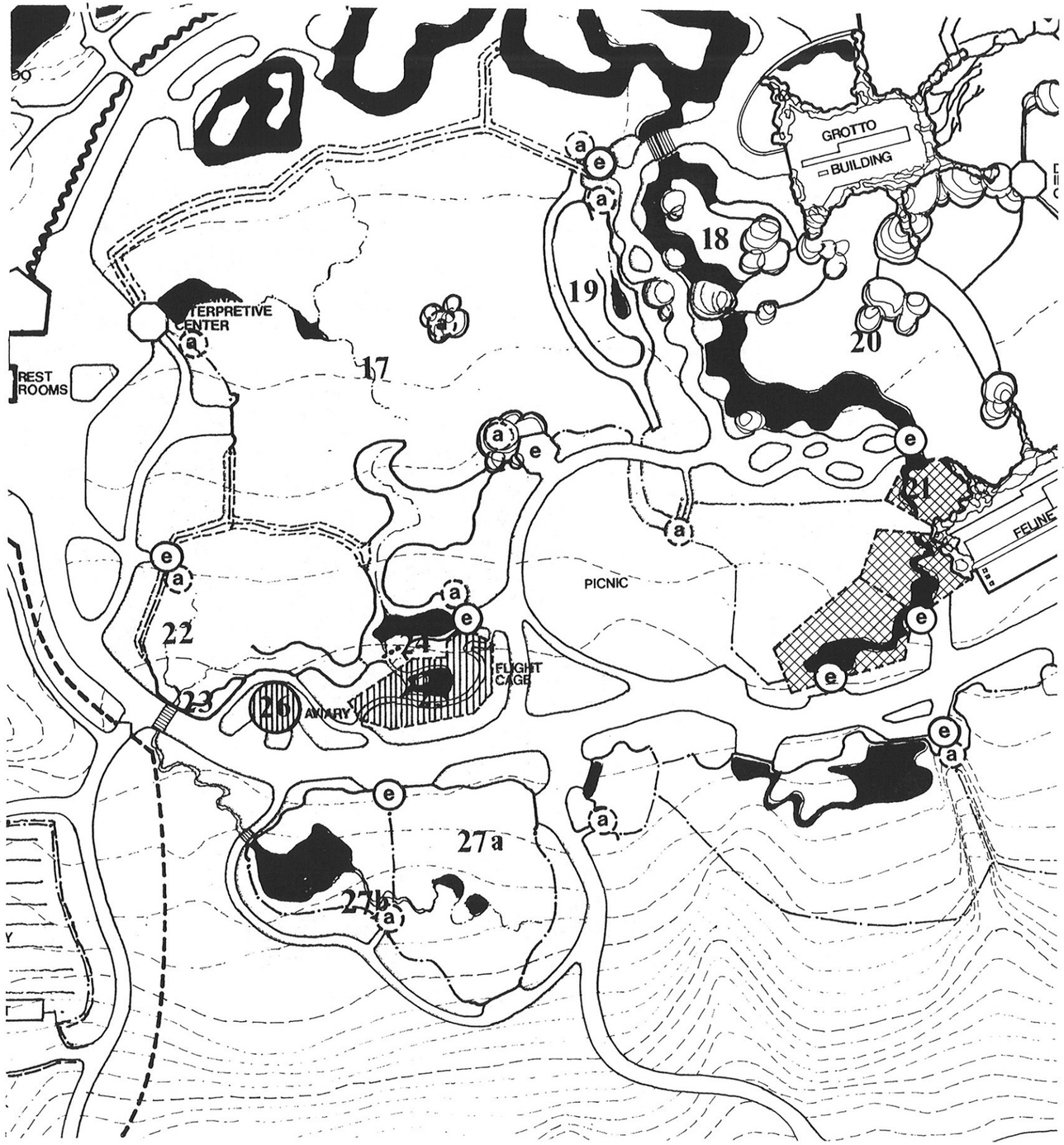
This exhibit was constructed in conjunction with the Reptile House and opened in 1976, previous to this study. It is included here because it coincides with the concepts of this report and is appropriately consistent with the future development of the zoo.

ENCLOSURE AREA: 5,500 square feet.

SCENARIO SUMMARY:

The animal exhibits have been arranged along an artificial stream bed, some below the viewing gallery and others above. Mirrors are used to give an impression of spaciousness to the relatively small exhibits in the low light levels. Artificial plants are used throughout.





Savanna

17. African Savanna

giraffe
waterbuck
gazelle
zebra
warthog
rock hyrax
secretary bird
helmeted guinea fowl
vulturine guinea fowl
crowned crane
Kori bustard
ground hornbill

18. Baboon

19. Patas

20. Lion

21. Leopard

22. Hunting Dog

23. Meerkat

24. Hippopotamus

hippopotamus
Egyptian goose
white-faced tree duck
Cape teal

25. African Wader Flight Cage

darter
egrets
yellow-billed stork
sacred ibis
African spoonbill
lesser flamingo
black-winged stilt

26. African Savanna Aviary

button-quail
blacksmith plover
spur-winged plover
Egyptian plover
cream-colored courser
pratincole
white-bellied go-away bird
mousebird
bee-eater
oxpecker
violet-backed starling
glossy starling
superb starling
weavers

27. Australian Savanna

a. wallaroo
emu
b. black swan

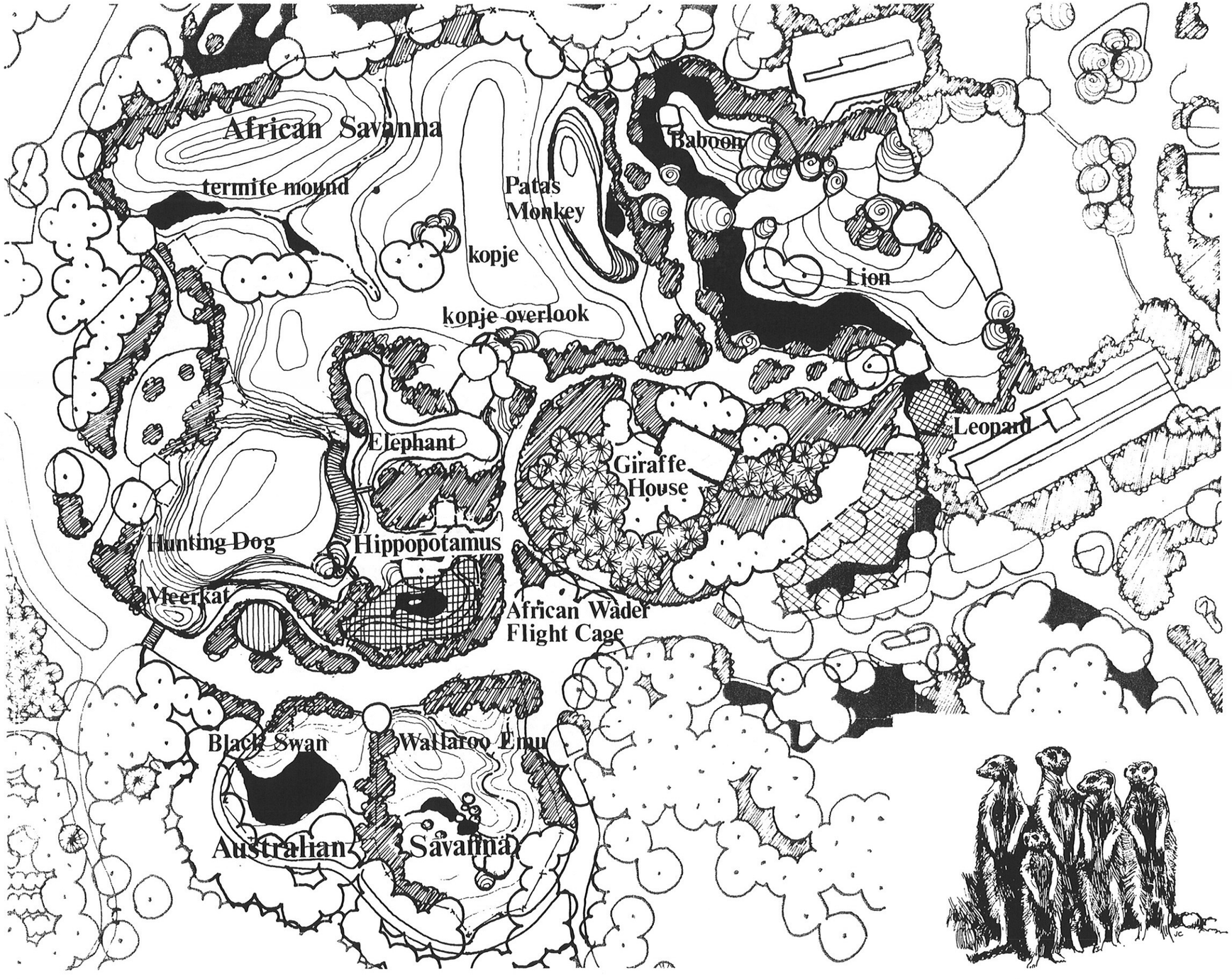

African Savanna
termite mound
Patas Monkey
kopje
kopje overlook
Baboon
Lion
Leopard
Elephant
Giraffe House
Hunting Dog
Hippopotamus
Meerkat
African Wader Flight Cage
Black Swan
Wallaroo
Emu
Australian Savanna

Exhibit: 17 African Savanna

ANIMAL SPECIES:
Giraffe
Waterbuck
Gazelle
Zebra
Warthog
Rock hyrax
Secretary bird
Helmeted guinea fowl
Vulturine guinea fowl
Crowned crane
Kori bustard
Ground hornbill

BIOCLIMATIC ZONE: SAVANNA

SETTING: Short-grass grassland in Serengeti, Tanzania

ENCLOSURE AREA: 80,500 square feet.

EXHIBIT LOCATION:

Occupies the large existing open area bounded by the Poncho Theater on the south, the Great Apes Building on the west, the Bear Grotto and Feline House structures on the north and the amusement ride area on the east.

VISUAL CHARACTER:

African Savanna varies from vast open grasslands with few or no trees, through park-like wooded grassland to orchard-like savanna woodland. It occurs in the tropics where there are frequent fires and a pronounced dry season (climatic savanna), where scant or waterlogged soil precludes the growth of trees (edaphic savanna) or where grazing by man's stock and set fires are endemic (derived savanna). The driest areas, carrying thornwood or scrub, grade into semi-arid desert. The wettest areas, carrying savanna woodland, adjoin tropical forest. Midway, as on the Serengeti Plains, the savanna is a rich, sometimes park-like grassland.

TERRAIN:

This exhibit will be a grass plain including a watercourse, a water hole and a dry valley. These border a sunken stream bed containing a hippopotamus wallow and wading-bird flight cage in separate exhibits. The area will be bordered by thorn scrub, gallery forest and savanna woodland with a swamp pool. The plain will visually extend east along a flat ridge which separates a parallel dry valley to the southeast from the hippopotamus wallow on the northeast. Two light gray granite boulder mounds *(kopjes)* about 6-8' high, 6-10'-high replica termite mounds and several isolated trees will interrupt the expanse. One of the *kopjes* will incorporate a lookout, described under viewing. To the northeast, the grassland will graduate via thorn scrub into dry savanna woodland (partly screening the Giraffe House and evergreen grove); to the west the plain will drop into a gallery forest in valleys emerging from the tropical primate exhibits. The plain will abut savanna woodland (partly screening the conifer knoll) containing in the southwest a shallow swampy pool.

SOIL:

Existing site soils will be reconstructed with fine soils over a coarse-textured subsoil to give a surface resistant to constant trampling, and fast draining to simulate the results of high evaporation. Red and yellow latosols will be simulated. Soils immediately around *kopjes* and decaying termite mounds will be richer. The following characteristic soil catena is to be replicated and part of it exposed in section in the cutbank above the waterhole.

a) Light gray granite boulder mounds with rock debris, from parent bedrock;
b) red laterite crust, bare in places;
c) red to pale red fine loam over crumby red clay;
d) yellow-brown very sandy loam;
e) brown heavy basic loam with calcareous nodules (savanna woodland soils);
f) pale coarse sand underlain by clay pan, seasonally waterlogged;
g) gray-black basic alluvial clays; high shrink-swell gives hummocks (watercourse, swamp and gallery forest soils); and
h) fallen laterite debris.

Thorn-scrub soils: gray-brown droughty sand loam, hard and bare in places. Underlain by calcareous hardpan.

WATER:

The permanent watercourse will be a slow-flowing shallow stream with 1-2'-deep occasional pools, one just beneath the interpretive center, and a smooth bed. It will meander east from the gallery forest edge in a gentle valley 10' below the crest of the plain. In midsite, it would slip between banks incised into the plain and appear to flow into the hippopotamus wallow, though ending at a bank connecting the plain and the ridge. The pool edges would be constructed of concrete tinted to resemble worn, bare gray-brown earth. The swampy pool will be shallow and about 100' x 60' in extent. It will contain floating islands of vegetation.

VEGETATION:

The savanna will replicate a short grassland, sparsely dotted with trees. Where not grazed short, the grass is parched tawny brown, with silvery flower spikes during the dry season. Trees are small (30-50') and are predominantly to resemble

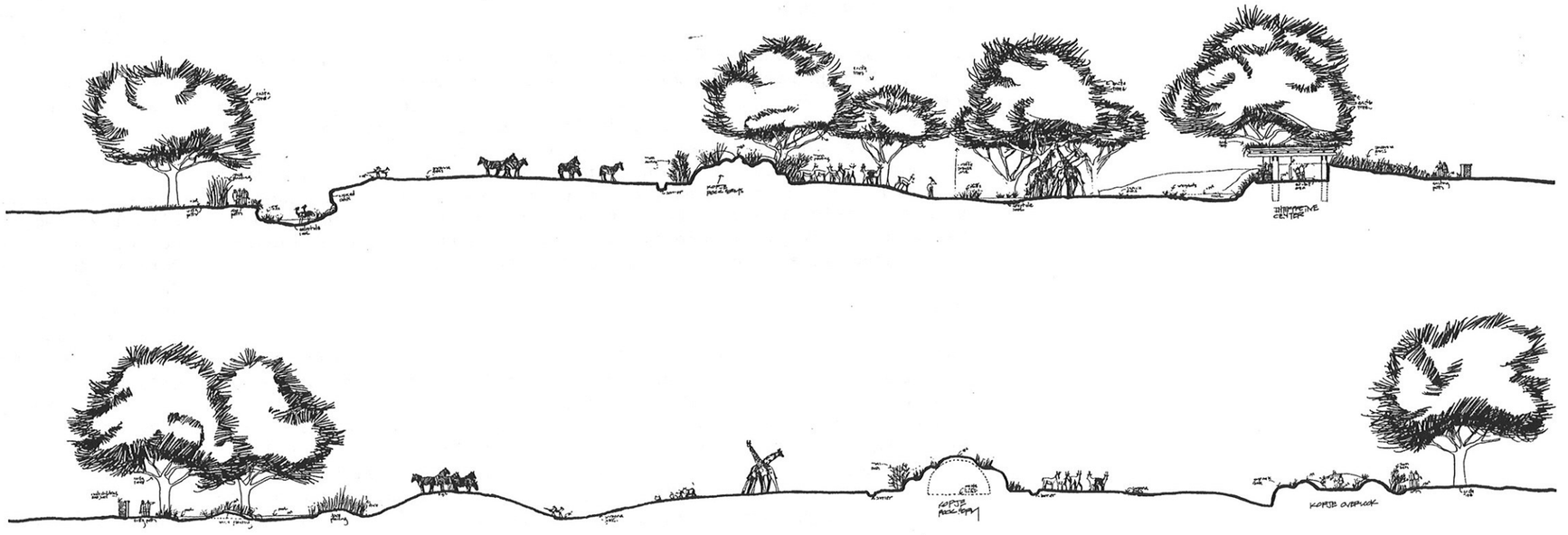
thorny legumes, flat or umbrella-topped, vase-shaped, with small feathery leaves and gnarled corky bark. They look dead in the dry season. These should include whistling thorns (ant-gall acacias) and carry weaverbird nests. Several existing trees will be retained, perhaps pruned to look more like acacias, until planted simulators grow large enough to replace them. Shrubs have leathery leaves and are thorny, deterring browsers. The grass, which grows high in the wet seasons (where not grazed short), tends to grow in 2-5'-high separate tufts and forms a deep root mat.

The vegetation type will change with soil type. Bare laterite will occur on the crest of the plain, latosols around the waterhole and in cutbanks and bare stony soil in the northern corner of the low thorn scrub and sparse clumps of grass. *Kopjes*, decaying termite mounds and the foot of perimeter fencing will harbor the only shrub thicket and, where possible, trees. The slope-foot brown soils are more fertile and should support some scrub. Thorn brush will be used to provide a visual warning at the edge of the hippo wallow. Watercourse grasses will be coarse, up to 7' tall, mixed with reeds, wild rice *(Zizania aquatica)*, sedges and shrub thickets along the stream bank and around the swamp. Waterlilies *(Nymphaea* spp.), containerized to limit their spread, will be planted in the pool.

The surrounding woodlands are to be of three types. Thorny savanna trees would be thickly planted against the existing evergreen grove and Giraffe House as a visual buffer and to give an arcade above the public pathway. The gallery forest is to be 50-80' high, dense, with some vines resembling lianas and little ground cover. It will end abruptly at the edge of the valley containing it. The savanna woodland is to be orchard-like, with a light grass cover. The trees will be open and acacia-like but of more regular branching and canopy pattern. Decaying termite mounds will support small thickets of vegetation, high grasses, shrubs and trees on the edge of open savanna. Visitors are to be dispersed on several small paths through this area, immersing them in the savanna experience.

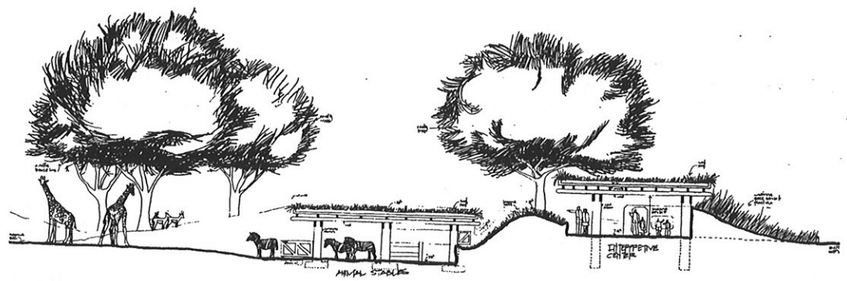
VIEWING:

All viewpoints will emphasize the wide open expanses and the smooth, flatly rolling contours characteristic of savanna landscape. The high horizon line and edge planting of acacia-like trees to screen or buffer incongruous groves should limit the views more or less completely to the savanna, and minimize the chance of visitors being seen across the exhibit. However, a *kopje* overlook (described below) may be an acceptable deviation from this rule. It is in this *kopje* that the colony of rock hyrax will be located, and they will doubtless spread to the other *kopjes* in the exhibit, adding a great deal to the diversity of life visible. Intricate vegetative detail framing



the view will be almost entirely in the ungrazed public areas unless protected by barriers. The permanent and dry watercourses and waterholes are to be visually part of the plains exhibit, with wetland grasses or bare soil as appropriate.

The *kopje* nearest to the Giraffe House, about 10' high and made of gunite simulating granite, will be part of the overlook structure itself. The sides of the rock will be a sheer 4-6' barrier, and a railed extension from the building will give wide views west and a view southeast. A large boulder will block the view of visitors from the nearest viewpoint across the ridge. The rocks will be interplanted with thorn trees and shrubs.



BARRIERS:

All perimeter fencing will be the standard gauge wire mesh cyclone fence installed so as to be as inconspicuous as possible.

a) Mesh: coated or painted with black or khaki vinyl.
b) Screen: interwoven with 2" cedar slats stained in several natural shades, installed at random.
c) Electric wire: three-strand low barrier of dark-colored aluminum wire on natural-form posts.
Only used to protect vegetation within enclosure.
d) Gallery forest edge: mesh sandwiched between vegetation protected by electric wire within enclosure.
e) All other fencing: either black mesh or slab screen fore-planted with fence-high savanna vegetation.
f) Moats: 6-8' deep along the north side of the dry ravine and east end of the dry watercourse, revealing sections through laterite. Railing above moats: 6" x 6" weathered timber post-and-rail with black wire mesh infill.
g) Hippo wallow cutbanks: see under Hippo Exhibit.
h) Mid-exhibit islands of trees and shrubs to be protected either by a cattlegrid plus a 3' bare soil warning strip, by a ring of turfed spring-platforms or by electric wires or fiberglass 'trunks'.

ANIMAL SERVICE AREAS:

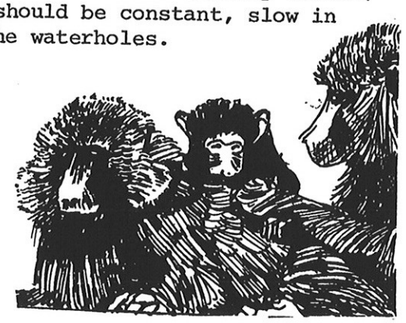
a) Giraffe House: The existing house with an added low structure for antelopes will be resited parallel to the evergreen grove. It will be stained in a vertical random pattern of earth colors and planted all around with screening savanna trees and brush to visually absorb its bulk.

b) Interpretive Centers/Overlooks: Dens will be built into the cutbanks under these centers, approached on the blank side of the buildings. These will be functional and not for public viewing, but their entrances will look natural. The centers will have wide windows onto the plain flanked by explanatory panels against the blank outside walls on which screening vegetation will abut. Lesser windows may be put in to reveal exhibits of smaller animals confined on the savanna edge (e.g. agama lizard on sunny rocks). Outside the center, in the area found to be least frequented by animals, a ground salt lick could be installed.

UTILITIES:

Irrigation systems for each section and watercourse will be separately operated. The plains should be supplied with only enough water to keep the grass roots alive, and their irrigation should be turned off as early in the year as feasible to simulate dry-season parching. The thorn scrub area should be noticeably drier. *Kopje* areas and shrub thickets should be better supplied with water; savanna woodland and gallery forest, well supplied. Water circulation should be constant, slow in the watercourse and very slow in the waterholes.

Exhibit: 18 Baboon



ANIMAL SPECIES: Anubis baboon

BIOCLIMATIC ZONE: SAVANNA

SETTING: African savanna (Serengeti)

EXHIBIT LOCATION:

Adjacent to the Lion Exhibit and the Patas Exhibit at the edge of the African savanna area and associated with the granitic outcroppings or *kopjes* described previously in the African Savanna Exhibit.

ENCLOSURE AREA: 8,300 square feet.

TERRAIN:

Naked red clay banks will rise from the edge of a river meander to be clothed in short tufty grass as they climb steeply to a shoulder ridge of heavily weathered granite (Brown, 1972: Figs.

pp. 48-49, 108-109). The ellipsoidal or spheroidal forms of the long-exposed bedrock, typical of tropical weathering, should be darkly stained and deeply etched. Some of the outcrops will be quite large, rising like domed helms, 15' above the knoll top and crowded about by lesser boulders. Some of these will appear to be recently split from the parent while others lie wholly independent of the original formation. This variety of heights and surfaces will give the baboons many choices of micro-relief upon which to play, feed, rest, sun or seek shelter. Beyond the hilltop (separated by a dry moat) the land will rise again to the central mass (the existing Bear Grotto structure), the outlines of which can be determined through the heavy rough hood of scrub and thorn trees.

SOIL:

(See African Savanna Exhibit relative to soils typical of *kopjes*). Structurally, the soils must be very well drained to give a droughty appearance to covering grasses and to withstand the mechanical abuse of the baboons without becoming muddy.

WATER:

The seasonal meandering watercourse that cut the steep clay banks (moat walls) and contributed to the original bedrock exposure will appear to flow now with modest force, its earthshaping powers hidden beneath cocoa-colored ripples. As it passes the young baboons playing at its side, the water will be only a few inches deep, but near the undercut far bank 15-20' away it is to be 4' deep.

VEGETATION:

Whether foreground, middleground or background, the planting pattern is very simple:

a) Grasses - near the water a few clumps of fountain grass (*Pennisetum setaceum*) will be planted while partially submerged areas of rushes (*Juncus* spp.) will be found on shallow bars and protected edges. Higher up, the well-drained slopes are to be thinly covered by low tufts of fescue (*Festuca ovina*).

b) Thorn scrub and thorn trees should be composed of *Caragana pygmaea, Caragana arborescens, Rosa acicularis, Ailanthus altissima* saplings and *Aralia spinosa* and *elata*.

The background vegetation, screening and softening the existing artificial rockwork of the Bear Grotto, will also be planted in the area now used as the Sloth Bear Exhibit.

VIEWING:

The large baboon troop will be seen through clearings in the thornbushes exposing views across the river (moat). Foreground plantings and stone outcroppings will provide continuity between the viewer and the subject, encompassing both in the exhibit development.

From some viewing areas higher portions of the lion enclosure will be visible beyond the baboon rocks, allowing the lions to be on view as occasional background interest. Other viewing areas show the primates against a varied background of more distant rock outcrops and brush. Here the protective coloration of the baboons' coat may be noted.

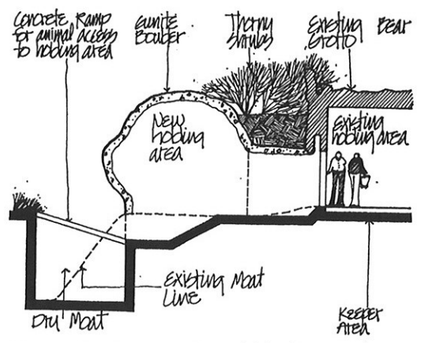
All views will show overlapping areas of the exhibit, yet none will show the whole, thus giving a distinct impression that the animals are in fact not entirely enclosed.

BARRIERS:

The front barrier is to be formed by the river (water moat type A-1b) while the back of the exhibit is to be enclosed by smooth-sided dry moat 15' wide and 10' deep on the animal side, the far side to be 3' higher. This dry moat could be adapted from the existing sloth bear moat.

ANIMAL SERVICE AREA:

The baboon holding quarters will be located in a new dome-shaped artificial rock structure built onto the existing Bear Grotto building in the area presently housing the sloth bear and are to be accessible from the exhibit by a hidden gangplank across the dry moat to an entrance hidden beneath an overhang in the sheer stone wall. The existing bear holding areas would be considerably refurbished to meet the needs of the large baboon population, though few major structural changes should be necessary.



Within the exhibit area itself sheltered overhangs will be provided with heating elements. Timed-release feeding machines will be hidden in crevices and among thorn bushes.

UTILITIES:

Irrigation will be required because of the fast-draining soil provided. These units must be located outside the exhibit itself and well screened from view when not in use.

Exhibit: 19 Patas

ANIMAL SPECIES: Patas monkey

BIOCLIMATIC ZONE: SAVANNA

SETTING: African savanna (Serengeti)

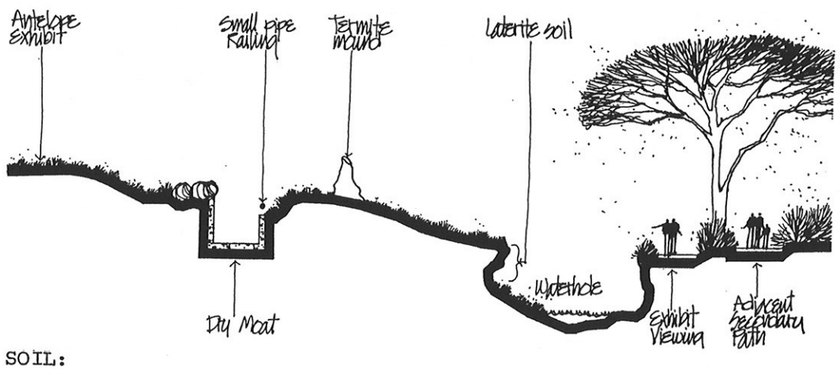
EXHIBIT LOCATION:

The patas monkey area would be in the foregound of the African savanna exhibit as viewed from the north. Across the path would lie the baboon and lion areas, submerging the visitor in a savanna experience.

ENCLOSURE AREA: 9,000 square feet.

TERRAIN:

The savanna plain will be cut abruptly by a ragged red ravine carved by intermittent downpours, thus forming an elaborate dry moat. The dry valley, its bed flat and stoneless, will be 20-40' wide, dropping to 15' below the ridge and running between 6-8' cutbanks at places, showing evidence of its flashflood origin. At its deeper eastern end, below the public path, there will be a small waterhole.



SOIL:

Above the seasonal waterhole the ravine will be undercut at the base where there is a small mound of laterite debris. The bare red soil will be continuous across the moat and the path. The cutbank is to be constructed of separate compacted layers of soil-cement containing varied colors of "cintrex" granular material and varied proportions of Portland cement. Certain horizons would also contain lime nodules. This material would be exposed with a high-pressure hose before final curing. The horizontal bands thus formed would faithfully replicate characteristics of the soil horizons formed in laterite soils and would be of considerable interpretive interest.

WATER:

The seasonal waterhole, about 20' by 40' in size, would occur at the deepest part of the dry ravine which forms a moat along the north edge of the exhibit. The pool is to be only 6-24" deep with a shallow cross-section. The concrete lining would be tinted a red somewhat darker (wetter) than the surrounding ravine and it is the color of this lining that would give the pool its color.

VEGETATION:

Would be similar to that described for the anubis baboon except that there would be few shrubs in the ravine and none on the plain above. The grass would not need to be kept perennially green and could be allowed to turn buff and golden naturally as its seed ripens. No grasses containing fur-clinging seed heads shall be used.

VIEWING:

Patas monkeys are among the most terrestrial of primates and their ability to run, chase, and leap will be well displayed within the varied landforms of this exhibit. The first patas to be sighted may be the sentinel perched atop the termite mound. Others may then be seen foraging among the tufted grasses of the upper plain below him, their buff coats blending with the blond grass, while antelope may be seen beyond the obscured rear dry moat. Like the baboon exhibit, no one view will show the entire area and each overlook will be carefully developed to prevent views into recognizable barriers.

BARRIERS:

The dry moat between the patas area and the ungulates of the African savanna will be 8' deep and 15' wide. On both sides there will be a line of boulders or a low rail to guard the edge, which is to be kept below sight line.

ANIMAL SERVICE AREA:

The keepers' facilities are to be buried beneath the landscaped area along the walkway, accessed by a steep well-screened path leading to the ravine where a hidden wall and door open into the exhibit. Animals will enter the holding structure from the ravine itself. Timed-release feeding mechanisms should be installed within special areas about the site, for example within the termite mound or in buried vaults under the grass.

Exhibit: 20 Lion

BIOCLIMATIC ZONE: SAVANNA

SETTING: African savanna (Serengeti)

EXHIBIT LOCATION:

Adjacent to Baboon and Leopard Exhibits in the savanna and to the Addax Exhibit in the Desert Bioclimatic Zone, the margins of which lions previously inhabited during historic times. (Lions also border the Kalahari Desert in southcentral Africa where they hunt the addax' close relative, the oryx). The exhibit area includes the entire existing outdoor Lion Exhibit of the Feline House and the existing grizzly bear area of the Bear Grotto building, plus the existing public circulation space between.

ENCLOSURE AREA: 31,200 square feet.

TERRAIN:

Very similar to that described in detail for the Baboon Exhibit. It will be built upon the same geologic foundations and bordered by the same slow brown river. The majority of the exhibit area will be turfed except for the back side of the low ridge obscuring the dry moat adjacent to the Addax Exhibit. This slope will be visible from the desert viewing areas across the sandy expanse of the addax area and thus should be covered by a similar sandy material. This material will not be visible from the savanna viewing areas.

SOIL AND WATER:

Described above, under the Baboon Exhibit.

VEGETATION:

Also very similar to that of the Baboon Exhibit except for two large *Robinia* trees now growing there. These large savanna trees must be carefully protected during construction, and it is their specific location that determines the location and layout of the river moat. Also, several dead logs or dead standing trees should be provided for scratching posts to reduce damage to the *Robinia*.

VIEWING:

The lion pride will be seen from a variety of viewing conditions. Views from across the river moat will be very similar to those described in the baboon scenario, while views from inside the overlook structure would provide excellent opportunity for close-up observation, perhaps through a grid of steel rods or highly tensioned, electrified stainless steel wire (this solution requires additional technical development). The concept of using high-impact glass has been discarded because of the problems of reflections, cleaning and isolation from animal communication.

The viewing structure itself would be similar in type to those proposed for the savanna overlooks (Overlook Type 4) except that it would have a roof pitched upward toward the exhibit allowing walls 16' high to prevent lions from leaping onto the roof. Visitors would enter the structure from the rear under the low eaves through a break in the dense screen planting; the roof surfaces would be grass- and shrub-covered.

The Leopard Exhibit would share this viewing structure.

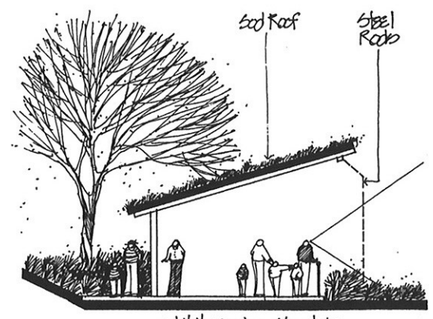


exhibit viewing structure

BARRIERS:

The river moat (Barrier Type A-1b) would appear to be a natural continuation of the river passing the baboons although it will be in fact discontinuous and recirculated only within the Lion Exhibit. The moat will drop steeply from the interior shore to a depth of 4' within 6' of the shore. From there it will continue to a depth of 8' at midstream which is maintained to the outside moat wall. Between the lions and the baboons and the addax, a dry moat 25' wide and 14' deep will be constructed.

ANIMAL SERVICE AREA:

Existing indoor holding areas in the Feline House will be maintained. Additional areas in the Bear Grotto building could also be renovated as additional space was needed, though this would separate maintenance unnecessarily.

UTILITIES:

The Lion Exhibit will be irrigated by high pop-up rotary sprinklers.

Exhibit: 21 Leopard

BIOCLIMATIC ZONE: SAVANNA

SETTING: African savanna (Serengeti)

EXHIBIT LOCATION: Adjacent to the lion and viewed from the same exhibit-overlook structure.

ENCLOSURE AREA: 2,400 square feet.

TERRAIN:

Like the lions and baboons, the leopard would also inhabit an area of granite boulders and bedrock outcroppings building up to a high rocky ridge (the existing Feline House grotto walls). However, in this case the exhibit features the cliff base itself which was only developed as background in the previously mentioned projects.

SOIL: Should be sandy and of a reddish color.

WATER:

No water features are required in this exhibit although small pools for drinking and perhaps a flush "toilet" pool should be provided.

VEGETATION:

It is of utmost importance that thorny savanna-like plants be heavily used in this exhibit in order to demonstrate the function of the leopard's distinctive coloration. In addition, a large gnarled *Robinia* tree presently located near the existing polar bear area will be transplanted into the heart of this exhibit. This tree will provide ideal long low limbs for sleeping perches and will naturally fit in with the three large existing *Robinia* in the Lion Exhibit and public area.

VIEWING:

All viewing of the leopards will be from within the same exhibit-overlook structure described for the lion. The structure framing the viewing window will eclipse any views of the mesh tent enclosing the animals, as in Overlook Type 6.

BARRIERS:

Leopards are among those animals found to be so agile and so dangerous that they must be entirely enclosed by mesh. Therefore, a steel-mesh tent structure is proposed which will be much larger than the existing cage. The existing cage structure will be dismantled.

ANIMAL SERVICE AREA:

The existing holding facilities in the Feline House will be adequate.

UTILITIES:

Full irrigation will be required.

Exhibit: 22 Hunting Dog

BIOCLIMATIC ZONE: SAVANNA

SETTING: African savanna (Serengeti)

EXHIBIT LOCATION: The southeastern edge of the African Savanna Exhibit

ENCLOSURE AREA: 20,500 square feet.

TERRAIN:

Generally as described in the savanna narrative, the area will be composed of a shallow swale draining eastward along a dry watercourse slightly indented below the general level of the plain, some of which is also encompassed within the exhibit. The general overall impression is to be one of flatness sloping gently away from the viewer to best present the animals. A few special features such as termite mounds and shallow warthog excavations (concrete-lined to discourage enlargement) will provide minor landmarks.

SOIL:

As described. Mechanically, the soil should be well drained, and special underdrainage will be necessary.

WATER:

The dry drainage-way will end in a shallow watering hole. This pool and its borders are to be lined with concrete tinted to match adjoining earth, into which have been impressed the "footprints" of savanna animals such as buffalo, giraffe, zebra and antelope.

VEGETATION:

This area is to be essentially a grassland. The only shrubs that will be present are those planted to hide barrier fencing.

VIEWING:

The Hunting Dog Exhibit may be viewed from three locations. The first will be a small exhibit-overlook structure facing

north across the plain with zebra, giraffe and other hoofed stock seen in the background across a hidden ha-ha fence. The hunting dogs would be separated from visitors by an electrified harp-wire screen.

The second viewpoint is to be located on a bridge at the eastern edge of the exhibit, allowing the visitor to look northwestward with an uninterrupted view for 250'. Again, savanna ungulates will add interest and integration to the background.

The third overlook will be from the elevated area west of the savanna aviary. From this point the view is due west across a steep-sided ravine. These three vantages will provide excellent coverage from which to watch the remarkable social development of these canids.

BARRIERS:

Generally the hunting dogs are to be enclosed within a 6' chain link fence with a 2' inward inclining return of the same material. These fences are to be set in ditches (ha-has) planted with such plants as rose and nettle to discourage the dogs from "fence-running" in the ditches. It may be necessary to run low outrigger fences perpendicular to the barrier within the ditch as well.

It has been mentioned elsewhere that the entire site is underlain with dense hardpan at a depth of 3' to 4'. Future excavations may prove the feasibility of developing naturally standing moat walls with a chemically or gunite-stabilized surface as a low-cost alternative to the sunken fencing. These dry moats should probably be 6' to 8' deep and 12' to 16' wide and could also be filled with low dense plantings such as rose and nettle.

ANIMAL SERVICE AREA:

Dens for hunting dogs can be simply built by burying concrete sewer pipe into a south- or west-facing bank. It is suggested that the den be located near an outside fence, giving keeper access to the den from outside the enclosure.

UTILITIES:

Irrigation and sub-drainage should both be provided. The hunting dogs are quite active, showing the characteristic restless pacing of cursorial predators, and without proper management muddy areas could become a serious problem.

Exhibit: 23 Meerkat

BIOCLIMATIC ZONE: SAVANNA

SETTING: South African savanna/grassland.

EXHIBIT LOCATION: Between the savanna aviary and Hunting Dog Exhibit with savanna ungulates in the background. The exhibit measures approximately 20' x 40'.

ENCLOSURE AREA: 800 square feet.

TERRAIN:

This small exhibit will occupy typical savanna terrain, slightly elevated for drainage.

SOIL:

Typical red laterite as described in the savanna narrative. The soil must be very fast-draining and should be underdrained. It should be made of well-graded materials with good standing characteristics to allow tunneling by the meerkats.

WATER:

No water feature will be required.

VEGETATION:

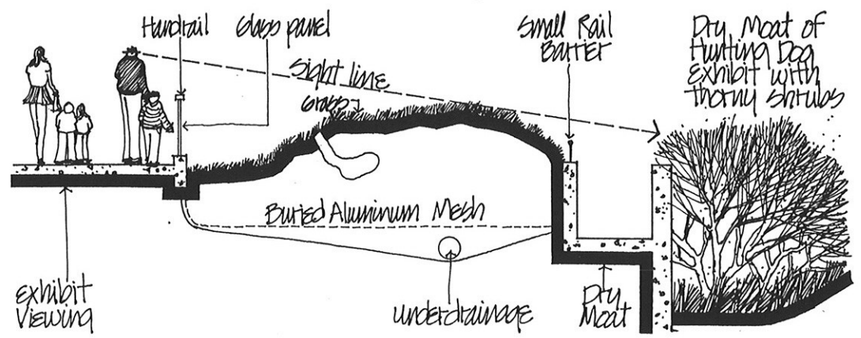
Should be grassland with very few shrubs (open and thorny).

VIEWING:

Will be through and over a glass-enclosed handrail.

BARRIERS:

The handrail should be 3' 6" high and set on a concrete curb such that the inside height is 4' 6". The entire exhibit area should be underlain at a depth of 3' with 1" aluminum chain link mesh. The back wall of the exhibit is a hidden dry moat 4' deep by 3' wide.



ANIMAL SERVICE AREA:

None is required.

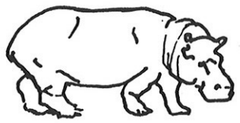


Exhibit: 24 Hippopotamus

ANIMAL SPECIES: Hippopotamus
Egyptian goose
White-faced tree duck
Cape teal

BIOCLIMATIC ZONE: SAVANNA

SETTING: Pool and bottomland grass thicket in Serengeti, Tanzania

EXHIBIT LOCATION: Between African Wader Flight Cage and the *Kopje* Overlook.

ENCLOSURE AREA: 3,000 square feet.

TERRAIN:

This is to appear as the gray-black clay bed of a meandering watercourse sunk below the surrounding savanna within 4-6' cut-banks. A removable fallen log will separate the planted water-fowl area in the southeast corner from the rest of the exhibit.

SOIL:

The bottom soils will look like smooth gray-black alluvial clays of high shrink-swell character. The cutbanks will reveal the soil sequence described in the Savanna Exhibit above, from the pale red latosol layer downwards. The replication will be in compacted layers of soil cement, hosed before curing as described in the savanna soils section above.

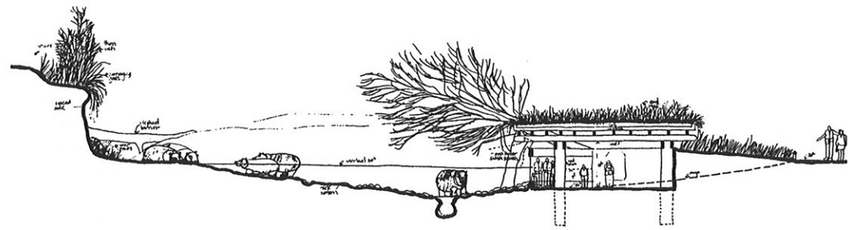
WATER:

The stream is to be an apparent continuation of the permanent watercourse from the gallery forest starting visually only at the bank connecting the plain and the ridge. Water will flow only within a large pool of about 40' x 30' by 5' deep. The pool will have a separately operated water system able to quickly empty, flush and fill the large pool with clean water.

VEGETATION:

The vegetation will be a mixture of coarse wetland grasses, sedges and reeds bordering the stream, then coarse 6-8'-high grasses and shrub thicket around the waterfowl area. Water lilies *(Nymphaea)*, containerized to limit their spread, will grow in this shallow area of the pool, blocked off from the hippos by a floating log. Above the cutbank there will be a barrier of thorn scrub including occasional acacia-like trees, especially at the innermost end and at the northeast corner of the exhibit.

VIEWING:
From the east the animals will be seen beyond a decorative fringe of vegetation and waterfowl and from the north across a cutbank through a veil of vegetation. Principal viewing of the hippos, however, will be from a large underwater bay window. One third of the view will look into shallow water protected from the hippos by a large floating log and containing waterlilies. As a special foreground it is suggested that an aquarium of appropriate tropical fish and amphibians be sandwiched into the underwater viewing window.



BARRIERS:

The 4-6' cutbanks are to be the chief barriers, the exhibit being virtually a moat. On a continuous ledge above the bank 3-4' wide and sunk about 2' below the level of the plain there would be a dense 4' thorn-scrub barrier to warn savanna grazers away from the edge. Elephants will be penned in the enclosure from time to time and the foot of the cutbank to the north is to be lined with boulders to provide a barrier to keep the elephant more than trunk-reach from the public.

Within the exhibit the waterfowl area is to be separated from the wallow by a heavy fallen log sufficient to contain the hippo and prevent it from damaging the vegetation. This will not prevent the birds from walking to the rest of the pool. There will be paths on hillsides for the waterfowl to gain access to areas where the hippos cannot follow whenever they choose to inhabit the main pool.

ANIMAL SERVICE AREA:

A simple stable-like holding facility will be buried under the bank adjacent to the viewing area.

Exhibit: 25 African Wader Flight Cage

ANIMAL SPECIES: Darter
Egrets
Yellow-billed stork
Sacred ibis
African spoonbill
Lesser flamingo
Black-winged stilt

BIOCLIMATIC ZONE: SAVANNA

SETTING: Serengeti

EXHIBIT LOCATION: Between the African Savanna Aviary and the Hippopotamus Exhibit.

ENCLOSURE AREA: 5,700 square feet.

SCENARIO SUMMARY:

A shallow clear stream originating in the ravine (moat) west of the savanna flight cage will flow casually in a series of loose meanders to be lost briefly in a tall marsh of *Phragmites*. Emerging once again it will continue under a pedestrian bridge and, gaining speed and gradient, it will pass beneath a large fallen log blocking a narrow bank cut ("hippogate") and appear to tumble into the hippo's pool. (Actually, the flow will be picked up under the log gate and recycled).

A typical "trodden earth" path of red "cintrex" cemented with pressed-in "tracks" of large birds, buffalo, hippo and lion will simulate a game trail through the marsh to the hippo pool.

The entire area will be enclosed in a fine dark mesh to allow the birds a free-flight environment and to exclude unwanted local species.

Exhibit: 26 African Savanna Aviary

ANIMAL SPECIES: Button quail
Blacksmith plover
Spur-winged plover
Egyptian plover
Cream-colored courser
Pratincole
White-bellied go-away bird
Mousebird
Bee-eater
Oxpecker
Violet-backed starling
Superb starling
Glossy starling
Weavers

BIOCLIMATIC ZONE: SAVANNA

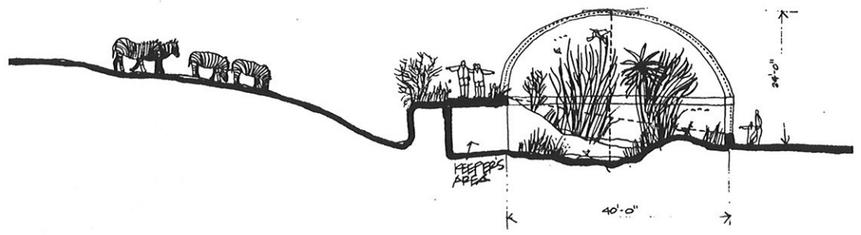
SETTING: Serengeti

EXHIBIT LOCATION: East end of the African Savanna Exhibit.

ENCLOSURE AREA: 1,100 square feet.

SCENARIO SUMMARY:

The aviary will be constructed as a 40'-diameter fully heated plastic and steel dome as produced and marketed by the Lord & Burnham greenhouse manufacturers. The structure will be sited on a slope with interior grades continuing adjacent outdoor contours. Because the structure will be mechanically heated, the natural African plant materials characteristic of the Serengeti will be used which best provide habitat for the birds exhibited. Viewing will be from indoor pathways.



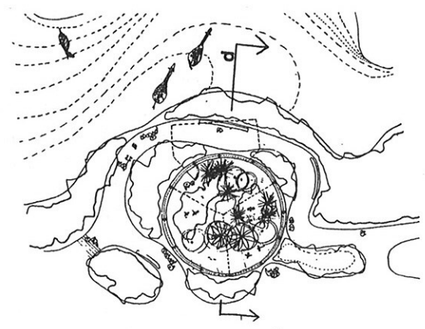


Exhibit: 27 Australian Savanna

ANIMAL SPECIES: a. Wallaroo
Emu
b. Black swan (in separate area)

BIOCLIMATIC ZONE: SAVANNA

SETTING: Murray-Darling River Basin, east-central Australia

EXHIBIT LOCATION: Across from African Savanna, adjacent transition to S.E. Asian Tropical Forest Exhibits.

ENCLOSURE AREA: a. 18,000 square feet.
b. 9,000 square feet.

TERRAIN:

Gently rolling plain draining in a series of soft swales to a dry channel (Keast, 1966: p. 89) giving way in turn to an apparently seasonally inundated lagoon (separated for the black swans) (ibid.: p. 155). Near the center of the open grasslands (wallaroo and emu area), the dry wash will constrict as it rounds the base of a large cinnamon-colored rock outcropping. Beehive shaped and heavily worn by wind and chemical weathering, the massive features will be constructed of gunite to replicate creased and pitted sandstone (ibid.: p. 164-165), and will house holding areas for the emus and wallaroos. This feature, strikingly characteristic if not common in Australian savanna, is in many ways the counterpart of the granite *kopjes* of the African savanna.

SOIL:

Rounded cobbles of red-brown material (matching the beehive dome) pave the slopes around this feature and litter the bed of the dry stream channel. The sand in the channel and surrounding exposed soil (animal trails, dust wallows, etc.) will be surfaced with a strongly colored yellow sand derived from "cintrex" material.

WATER:

The black swan lagoon or "billabong" will be shallow, yet dark surfaced, reflecting in curving patterns the overarching boughs of twisted trees. The lagoon bottom will be concrete-lined for ease of cleaning. A quiet stream appearing to flow from the drainage of the African savanna area enters the lagoon from the south. A second small stream connecting a series of shallow waterholes appears to trickle into the lagoon from the north wallaroo/emu area, but would be recirculated before entering (and contaminating) the black swan area.

VEGETATION:

Plant Materials: Several species of eucalyptus are considered sufficiently frost-hardy for our climate. The following are suggested for use in this exhibit: *E. gunnii, E. microtheca, E. niphophila* (grown at the University of Washington Arboretum), *E. urnigera* (Kennedy Arboretum, Ireland). In addition, Russian olive *(Elaeagnus angustifolia)*, a small tree, and *Elaeagnus* "Coral Silver", a large shrub, are both silver-leaved replicators of many Australian acacias and should be used throughout the exhibit in areas where screening vegetation is required. In the background beyond the eastern margin of the area silver-leaved willows *(Salix* spp.) will be planted as animal-forage producers and will provide a suitable backdrop to the exhibit. The following trees may also be used if the eucalyptus prove unavailable: *Albizzia, Robinia hispida, Gleditsia, Koelreuteria,* and *Populus simonii*. The spiny grass *Triodia* is very typical of Australian savanna and should be used in foreground viewing areas and, to a limited extent, in the animal areas if available.

Planting Concept: The open grassland area of the emu and wallaroo will have widely spaced gum trees, but the overall appearance will be one of openness. Along the dry stream the same trees will be more numerous, many growing directly in the streamcourse itself. Surrounding the lagoon these trees will be set in a more or less regular spacing of 20-30', and will be planted to angle out over the water. Several of these trees will be located on small islands in the lagoon barely above the water's surface, appearing to be inundated by the seasonally high water. Golden-yellow floating-hearts *(Limnanthemum)* will be growing in drifts and masses of warm color giving a sparkling backdrop to the black swans. Outside the animal area, eucalyptus will line pathways and overhang overlooks, giving visitors an opportunity to closely examine these unusual trees.

VIEWING:

The black swan lagoon will be seen from the Exhibit Interpretive Center (Overlook Type 4) and from a bridge over the stream entering the exhibit. The birds will be naturally front-lit during midday and the early afternoon so that they will stand out somewhat from the dark water and brightly colored floating-hearts.

The grassland exhibit will also be viewed from the Exhibit Interpretive Center and from type 2 overlooks along the west, north, and northeast sides of the exhibit. They will be screened from each other by plantings and by the "bee-hive" rock. Views from these angles will accent the effect of sunlight on the silver-gray foliage of the eucalyptus and Russian olives.

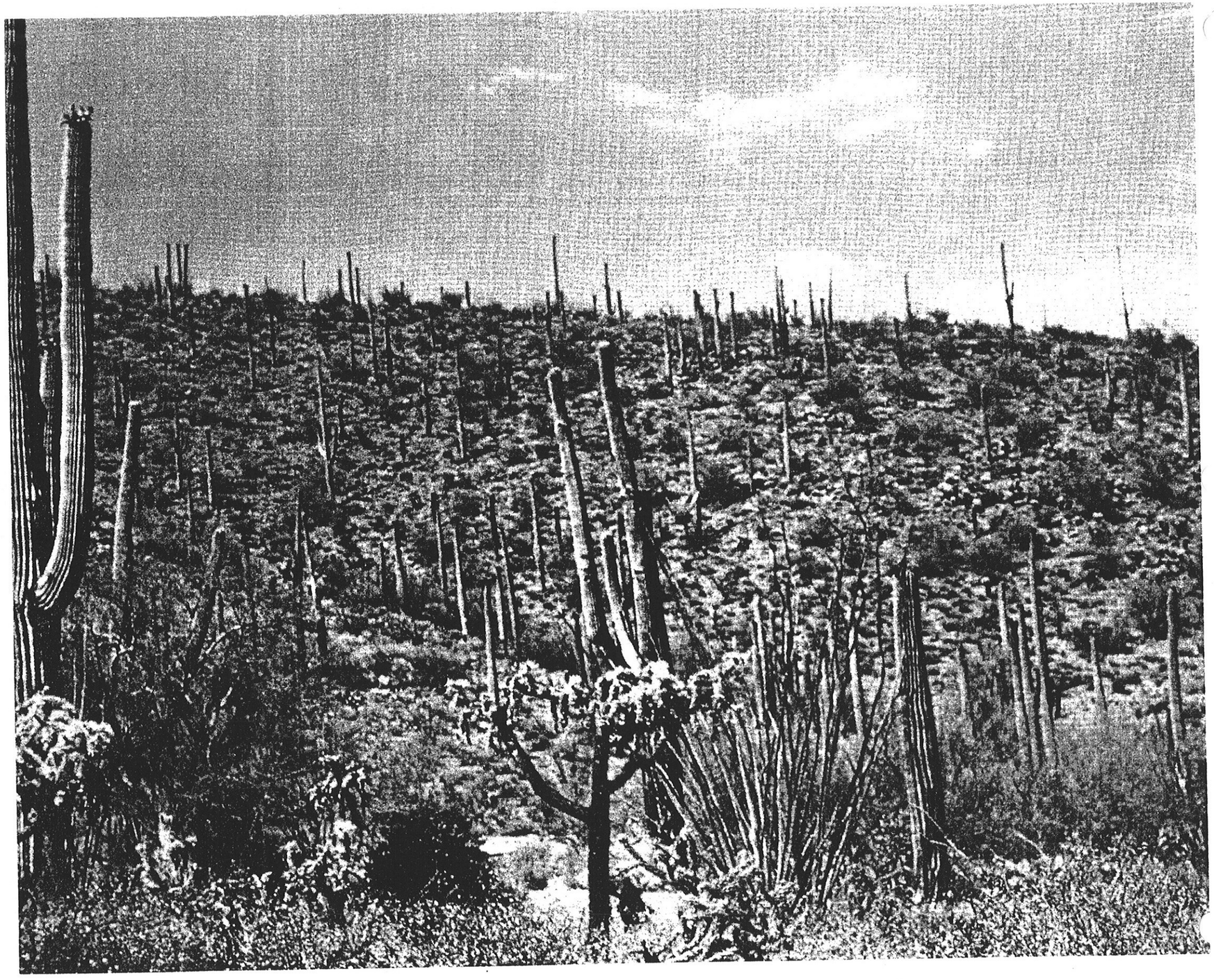
ANIMAL SERVICE AREA:

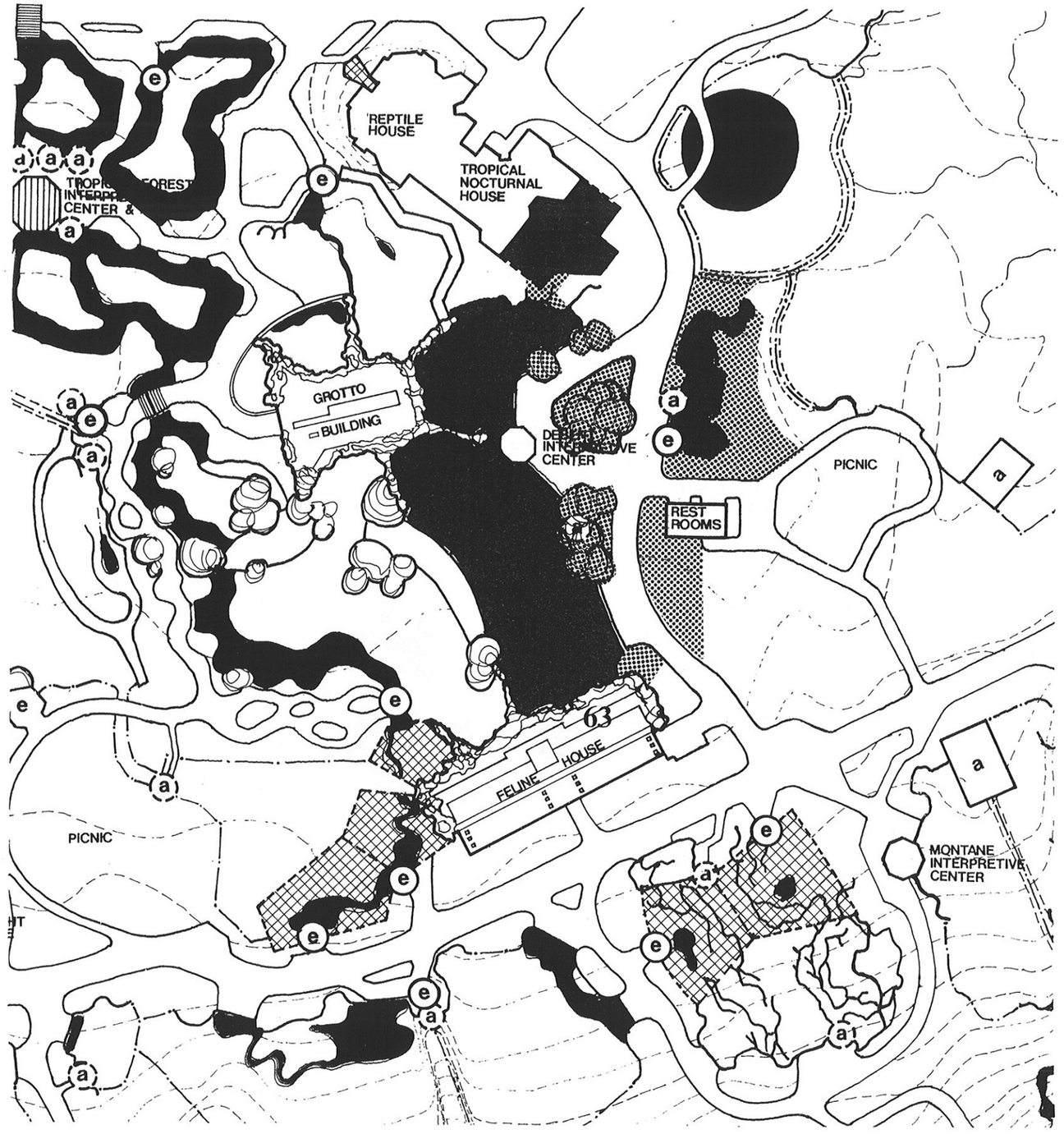
Holding facilities for the wallaroo will be buried under a bank near the east side of the exhibit. The black swans will find protection, if required, under the bridge at the south side of their area.

BARRIERS:

The exhibits will be surrounded with mesh fencing screened by dense plantings. Overlooks will be type A-3 dry moats planted to low shrubs, enabling viewers to stand on the same level with the animals.

UTILITIES: Irrigation will be required.





Desert

28. Sonoran Desert

a. antelope jackrabbit
antelope squirrel
Gambel's quail
roadrunner
b. collared peccary

29. Barbary Sheep

30. Klipspringer

31. Addax

32. Desert Nocturnal House (several regions)

a. ring-tail cat
b. kangaroo rat
c. degu
d. jerboa
e. gerbil
f. jerboa pouched mouse

Special Exhibits (independent of zone)

63. Small Carnivore House

a. ocelot
b. serval
c. genet
d. black-footed cat
e. Pallas' cat
f. weasel

Exhibit: 28 Sonoran Desert

ANIMAL SPECIES:
a. Antelope jackrabbit
Antelope squirrel
Gambel's quail
Roadrunner
b. Collared peccary

BIOCLIMATIC ZONE: DESERT

SETTING: Dry wash in Sonoran Desert of Southern Arizona

EXHIBIT LOCATION: Across from African Desert, with a distant backdrop of the North American steppe.

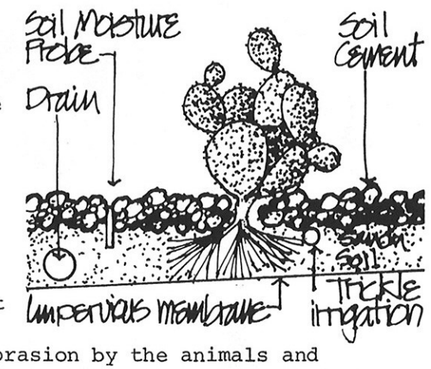
ENCLOSURE AREA: 3,500 square feet.

TERRAIN:

The area will be divided into two parts, one a steep-sided drywash inhabited by the peccaries and the other an apparent extension of the same drywash for the smaller animals. On the far side the land will continue to rise before dropping off steeply into the ha-ha forming the barrier of the Great Plains Exhibit.

SOIL:

Sandy gravel cemented with chemical soil builders or soil cement. Rust-red basaltic rubble will lie scattered about the base of a continuous low bedrock outcropping of the same material. Wash banks are to be formed of cemented soils exposed and water-washed before curing.



The artificially produced "desert pavement" is intended to resist excessive burrowing and abrasion by the animals and prevent penetration of over-abundant rain water. Desert plants are generally intolerant of wet soils and should be rooted in a very fast-draining sandy loam beneath the impervious surface. Subsurface water and fertilizer requirements are to be met by buried "trickle" irrigation automatically controlled by soil-moisture-sensing probes. Excess soil moisture would be taken off by agricultural drainlines.

This system of impervious surfacing and subsurface irrigation/drainage should discourage undesirable weed growth. Nevertheless, the surface should be treated with a pre-emergent herbicide.

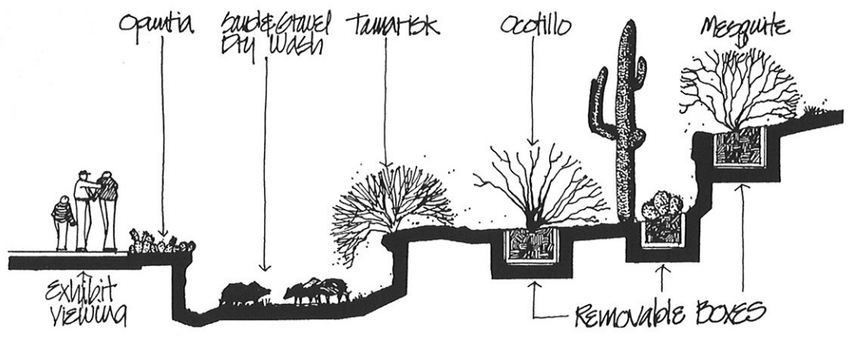
WATER:

Would be restricted to a very small water hole in the wash surrounded by concrete surfacing treated to resemble dried mud. Otherwise, the ephemeral presence of water would be shown by the water-cut banks and water-sorted sands and gravels in the wash.

VEGETATION:

Shrubs planted on both sides of the wash will include those that simulate some of the characteristic Sonoran types such as creosote bush *(Larrea)* and mesquite *(Prosopis)*. Several species of sword-leaved yucca *(Yucca glauca, Y. harrimaniae, Y. whipplei)* native to the Southwest are hardy in our area and should be used, along with cold-tolerant cactus such as *Opuntia* which would be used to keep viewers to the public pathways. The dry wash itself is to be bare of vegetation except for a few drifts of tumbleweeds and a large half-buried bush that looks as if it fell when its roots were undercut by a flash flood. Also, large potted barrel cactus *(Ferocactus* spp.), ocotillo *(Fouquieria splendens)*, cholla *(Opuntia* spp.) and other frost-tender specimens could be set out in predesigned sunken receptacles during the summer.

Of special interest in this exhibit would be the creation of several artificial saguaro cacti *(Cereus giganteus)*. These would be either concrete-cast from living specimens using latex moulds



or built on a steel armature and fleshed with urethane or latex. Properly made, these elements should be indistinguishable from living specimens. Also, dead ocotillo (which closely resemble dormant living plants) could be interspersed with other exhibit plantings.

Plant spacing is very important in replicating desert conditions. All plants should be set between 8' and 15' apart with bare sandy gravel exposed between them.

VIEWING:

The path will wind across the desert floor between scattered

plantings as it approaches a small roofed viewing structure overlooking the exhibit. This structure allows views into both the small-animal exhibit on the right and the Peccary Exhibit on the left. A wall between these two viewing ports will hide the barrier between the peccaries and the other animals, but it will look as if the dry wash were continuous between them. Considerably more shrubbery will be introduced into the small-animal part, where it should not be killed by browsing and can serve as shelter for these animals, which will not have an interior service area.

BARRIERS:

To be formed by the steep walls of the wash.

ANIMAL SERVICE AREA:

A small buried structure accessible from outside the animal areas will serve the minimal needs of the peccaries which will enter it from a hidden break in the near bank of the wash.

UTILITIES:

Discussed in this scenario under SOIL.

Exhibit: 29 Barbary Sheep

BIOCLIMATIC ZONE: DESERT

SETTING: North Africa

EXHIBIT LOCATION: Adjacent to the klipspringer and occupying the existing Polar Bear Grotto.

ENCLOSURE AREA: 8,000 square feet.

TERRAIN:

Artificial rock and stonework will be much like that described for the Addax Exhibit, but with hues ranging more to tans and grays to blend with existing grotto walls. Large lodged boulders will form a rubble slope beneath existing walls which in turn give way to a lower area of informally set cobbles into which grass will be planted.

SOIL: Well-drained.

WATER: None.

VEGETATION:

In addition to the dwarf caragana and tamarisk used in the adjacent Klipspringer Exhibit, plants such as low-growing brooms *(Genista horrida, G. hispanica* and *Cytisus praecox)* could be used along with the taller Atlas broom *(Cytisus battandieri)*. Rockrose *(Cistus* spp.) is also appropriate. Thin desert grasses could be simulated with blue fescue *(Festuca ovina 'glauca')* planted between natural cobbles. All of these species, together with bright flowers of the family Compositae native to Mediterranean Africa will be planted in foreground areas and along the top of the existing grotto wall, but only the grass will be planted within the animal area.

VIEWING:

Will be from a type 1 overlook.

BARRIERS:

Animals will be contained by existing and extended grotto walls and by a type A-3 planted dry moat in the foreground.

ANIMAL SERVICE AREA:

Will be located within a refurbished area of the Bear Grotto structure.

UTILITIES:

Underground irrigation and drainage will be necessary for planting in pockets of rock and concrete.

Exhibit: 30 Klipspringer

BIOCLIMATIC ZONE: DESERT

SETTING: Rocky desert in Northern Kenya

EXHIBIT LOCATION: Between Addax and Barbary Sheep Exhibits including existing Bear Grotto.

ENCLOSURE AREA: 5,600 square feet.

TERRAIN AND SOIL:

Similar to Addax Exhibit except that there will be preponderance of dun-colored rock surfaces and less desert sand. The emphasis here will be on the vertical, but rather than featuring high cliffs and overhanging ledges, there should be the character of large wind-blasted boulders built onto each other such that they appear semi-detached yet will not provide excessive opportunities for animals to hide from viewers.

WATER: None.

VEGETATION:

Foreground plantings of prickly acacia-like *Caragana pygmaea*

and droughty tamarisk (*Tamarix* spp.) will appear appropriate. The same species can be used effectively in planting areas on the existing bear grotto walls, provided the tamarisk is not allowed to grow too tall.

VIEWING:

The Desert Interpretive Center overlooks the area.

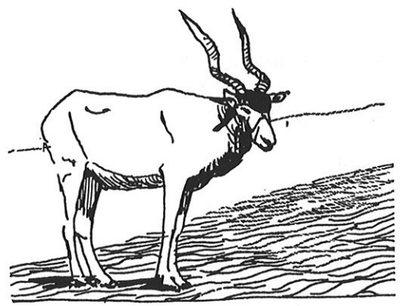
BARRIERS:

The rear of the exhibit is contained by the existing Bear Grotto walls. Large lodged boulders and shallow dry moat (type A-3) will prevent passage of klipspringer into the addax area.

ANIMAL SERVICE AREA:

The service facility for the klipspringer will be built into the gunite boulders below and adjacent to the Desert Interpretive Center.

Exhibit: 31 Addax



BIOCLIMATIC ZONE: DESERT

SETTING: Sahara Desert

EXHIBIT LOCATION: Adjacent to Klipspringer Exhibit.

ENCLOSURE AREA: 15,000 square feet.

TERRAIN:

Light copper-colored sand will lie in shallow, wind-drifted undulations below a pitted wall of dark copper sandstone. The wall, sharply undercut by sand blasting for the lower 4', will slope upward in rounded bellies and hollows of honeycomb etching to a rounded top some 15' above the desert floor. The sand and sandstone are both constructed from the same source. "Cintrex", a commercially available industrial by-product, would be screened to a particle size passing between a ¼" and a #35 sieve. The rock face would be formed by the gunite process on a steel armature using this same "cintrex" product as the aggregate and employing a like-hued color additive to the cement. After application the whole surface would be sandblasted to expose the fine aggregate and then treated with an appropriate darkening agent to produce the uneven stain typical of chemical weathering in an arid climate. The surface should also be treated with a moss-inhibiting product (See photos, Brown, 1965: p. 26, and Mather, 1965: p. 70).

SOIL: See above.

WATER: None visible.

VEGETATION:

Planting areas screening the Feline House and the existing restroom structure north of the exhibit will consist of dense masses of tamarisk (*Tamarix* sp.). No planting will occur within the animal area.

VIEWING:

Two overlook areas (Type 2) will provide surveillance of overlapping portions of the animal enclosure so that the entire compass of the exhibit cannot be guessed from a single viewpoint. Both overlooks will present distant views of the more remote areas of the Lion Exhibit including a backslope of sand and boulders designed to blend with the materials used in this exhibit.

BARRIERS:

The frontal moat will be a Type A-1a dry moat obscured by a foreground of low stones and wind-eroded boulders. The back of the animal area will be enclosed by the previously described wall and by an obscured dry moat (Type A-2). Access for the addax into the klipspringer area will be excluded by boulder masses.

ANIMAL SERVICE AREAS:

Holding areas will be built into the artificial stone between the two viewing areas and will have keeper access from the tamarisk screen planting area.

UTILITIES:

Large (1½" diameter) hose connections should be provided for watering down the exhibit to reduce dust, should this become a problem.

Exhibit: 32 Desert Nocturnal House

ANIMAL SPECIES: Ring-tailed cat
Kangaroo rat
Degu
Jerboa
Gerbil
Jerboa pouched mouse

BIOCLIMATIC ZONE: DESERT

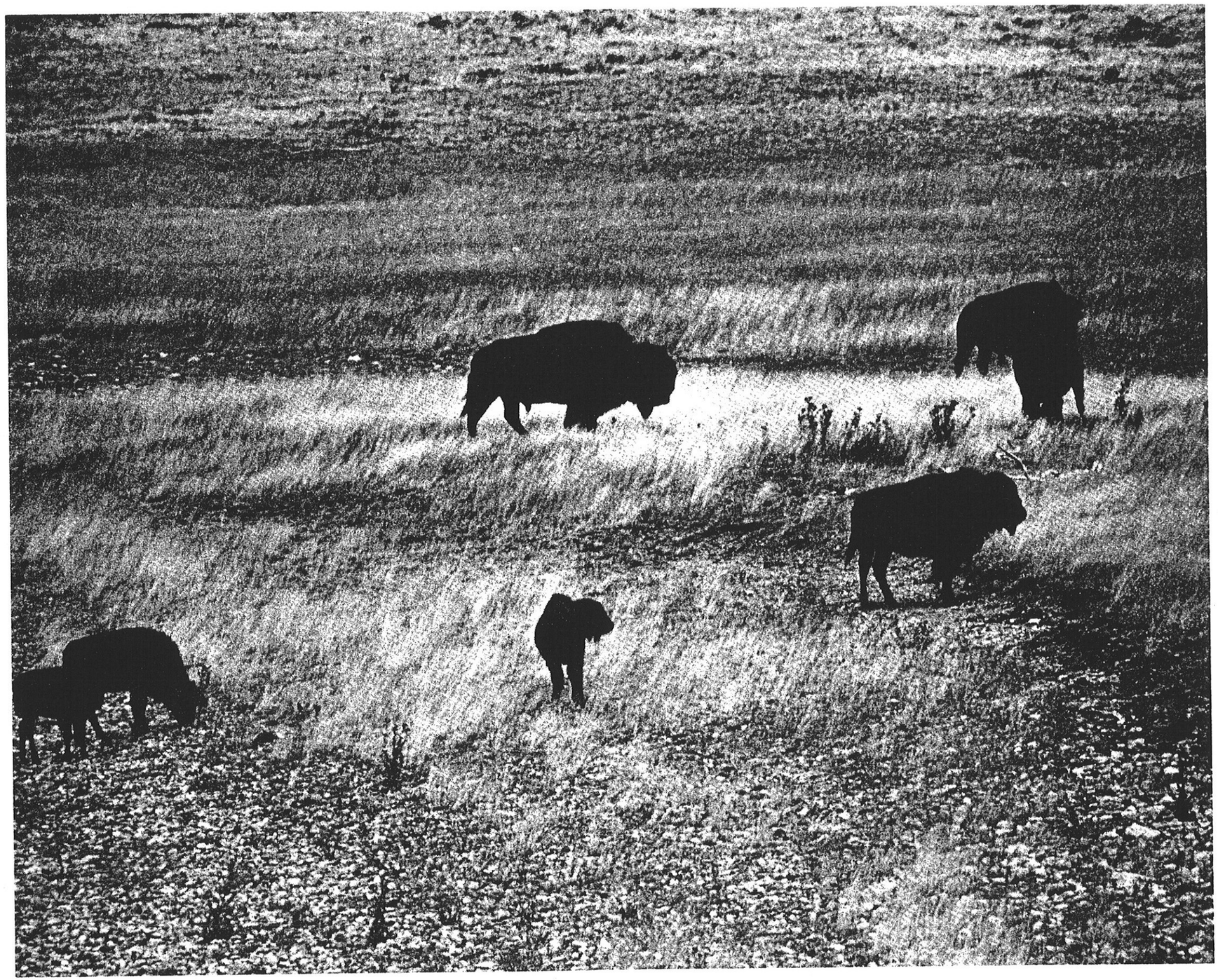
SETTING: Appropriate desert of North and South America, Africa, Asia and Australia

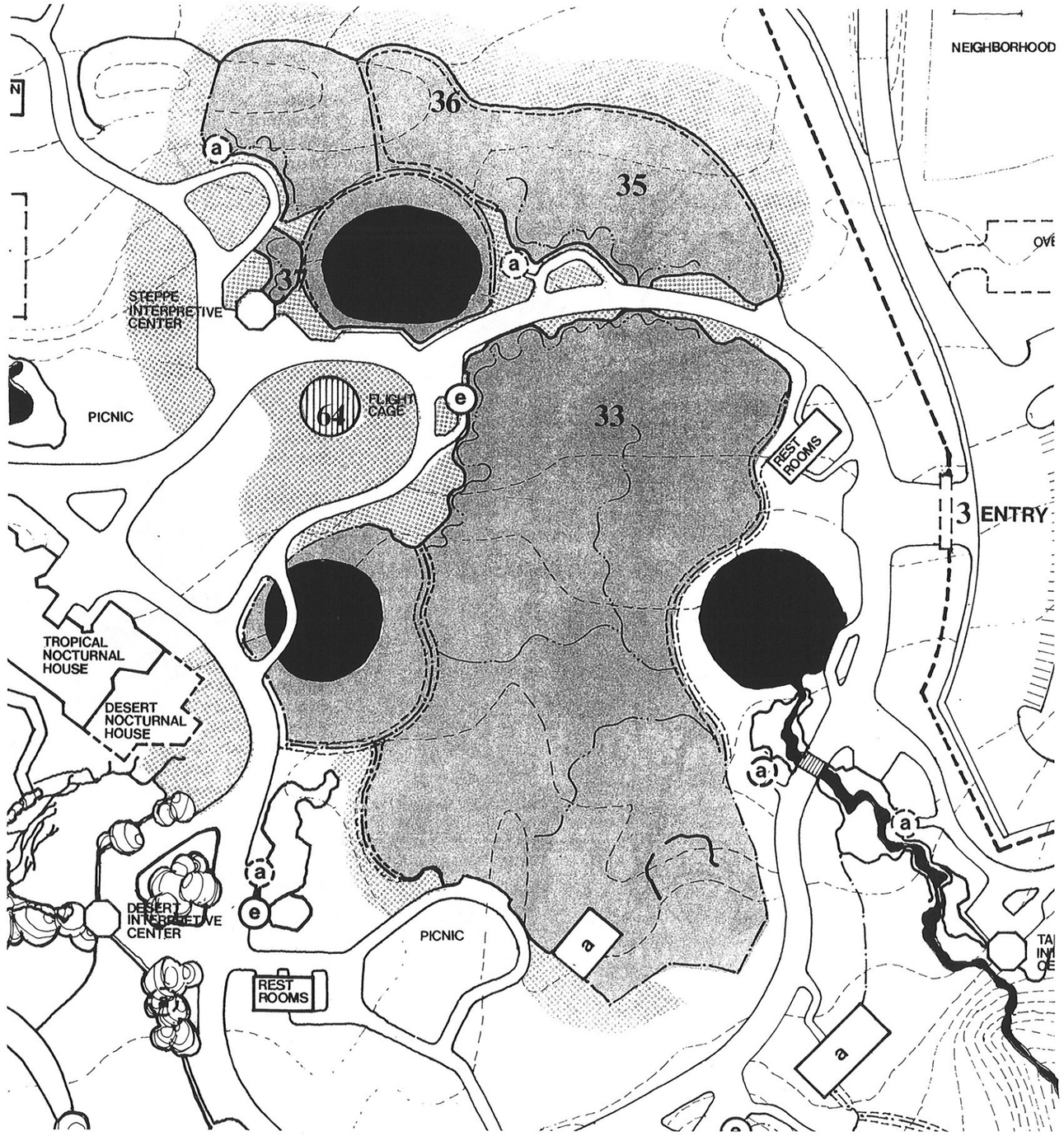
EXHIBIT LOCATION: Extension of existing Nocturnal House which exhibits animals of the tropical forest.

ENCLOSURE AREA: 5,000 square feet.

SCENARIO SUMMARY:

As required to best display these animals under reversed day/night (nocturnal) conditions, with emphasis on adaptive mechanisms, both convergent and divergent, by which life in the world's deserts is made possible. As this will be an enclosed, climate-controlled structure, it should be possible to feature species of plants typical of the homeland of each animal species.





Steppe

33. Great Plains

bison
pronghorn
white-tailed jackrabbit
ground squirrel
black-tailed prairie dog
sharp-tailed grouse

34. Alkaline Prairie Pond

western grebe
white pelican
cinnamon teal
ruddy duck
American avocet

35. Patagonian Steppe

guanaco
Patagonian cavy
common rhea
southern screamer

36. Maned Wolf

maned wolf

37. Vizcacha

38. Patagonian Pond

black-necked swan
Chiloe widgeon
crested duck

Special Exhibits (independent of zone)

64. Raptor Flight Cage

a. bald eagle
b. golden eagle
c. peregrine falcon
d. prairie falcon

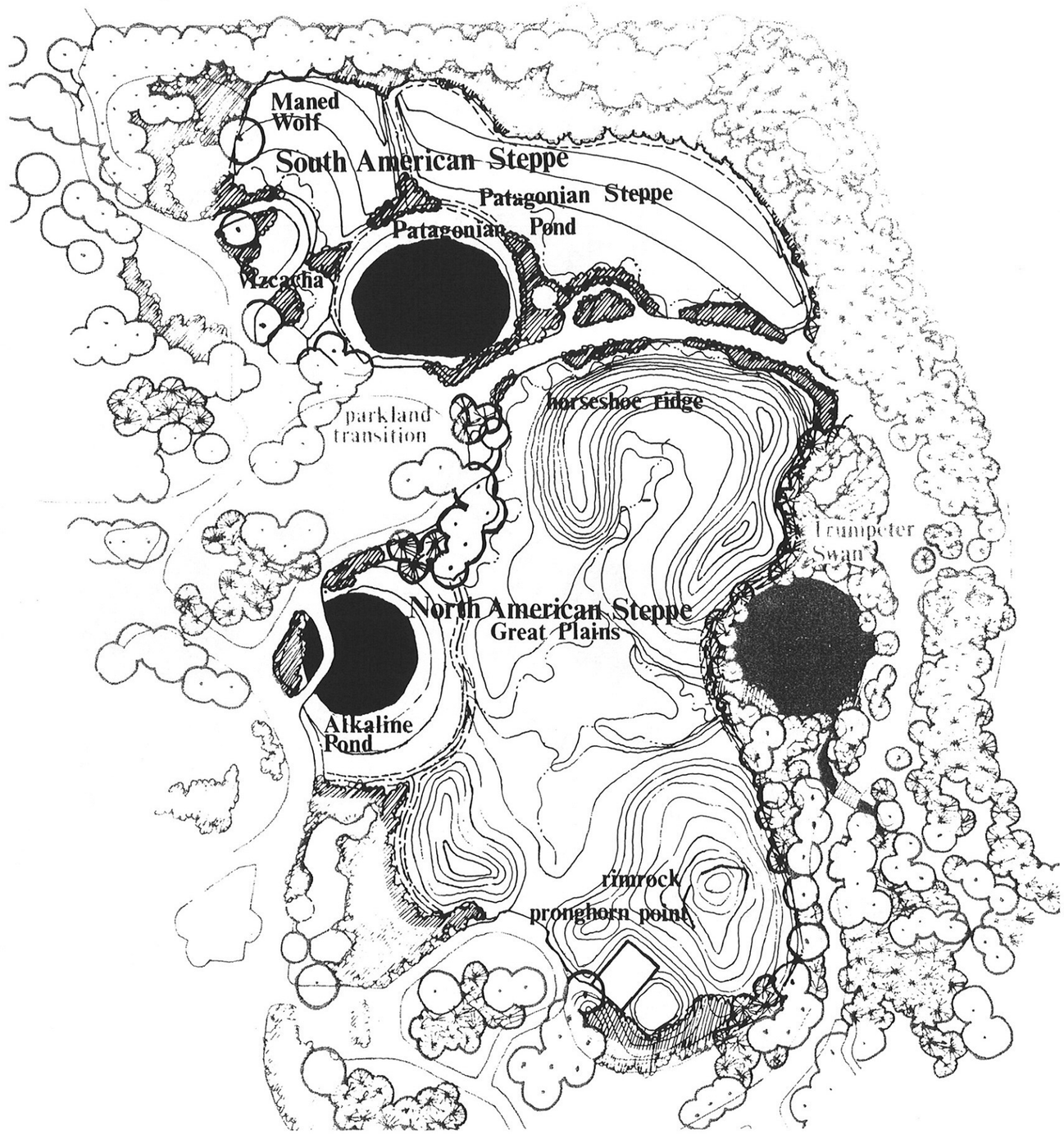


Exhibit: 33 Great Plains

ANIMAL SPECIES:

Bison
Pronghorn
White-tailed jackrabbit
Ground squirrels
Black-tailed prairie dog
Sharp-tailed grouse

BIOCLIMATIC ZONE: STEPPE

SETTING:

North Dakota short-grass prairie

EXHIBIT LOCATION:

Adjoining the Alkaline Prairie Pond, Patagonian Steppe, Trumpeter Swan Pond and Sonoran Desert

ENCLOSURE AREA: 121,500 sq.ft.

TERRAIN:

Undulating, with rounded hills surrounding well-defined drainage ways, whole encompassing approximately three acres. The highest hill ("Pronghorn Point") would be some 25' above existing grade, while "Horseshoe Ridge," forming the western edge of the area, would be some 15' high. In several locations large, darkly weathered erratic boulders should be half-buried to provide "buffalo rubs."

SOIL:

Should be gravelly and well drained to provide hoof abrasion and avoid hoof-rot problems (a very important consideration with pronghorns). At least 6-8" of this fast-draining surface material should be provided.

WATER: None.

VEGETATION:

Native short-grass-prairie species such as buffalo grass *(Buchloe dactyloides)*, blue grama *(Bouteloua gracilis)*, little blue stem *(Andropogon scoparius)*, and western wheat grass *(Agropyron smithii)* should be used along with forbs such as lupines and composites of various genera along public areas out of reach of the animals. Within the animal areas, locally adapted durable grasses such as bent grass *(Agrostis* sp.) and perennial rye *(Lolium perenne)* should be planted. This would result in an appearance of perennial spring, but unfortunately, grasses that die back every summer could not tolerate the heavy use to which they would be exposed.

Grass planting should be done in the following steps: 1) seed sown normally onto 6" of very well-drained sandy, gravelly topsoil; 2) after the grass is established cover with one inch of washed pitrun gravel; 3) when the grass has penetrated the gravel and is again well established. cover with an additional two inches of unwashed pitrun gravel.

Where slopes are too steep for the efficient repeated spreading of gravel, the seed should be applied directly to the full gravel bed and generously mulched with sand and peat.

Shrubs such as chokecherry *(Prunus virginiana)*, Saskatoon serviceberry *(Amelanchier alnifolia)*, and wolf willow *(Elaeagnus commutata)* would be planted on north-facing protected slopes and along dry water courses along with aspen *(Populus tremuloides)*, while drought-tolerant plants such as sage *(Artemisia* spp.) and cactus *(Opuntia* spp.) could be planted in well-drained pockets of very sandy soil along hillsides. In Parkland transition areas lodgepole pine *(Pinus contorta)* joins the aspen. All of the above should be restricted to areas outside the reach of bison and pronghorn.

VIEWING:

The large area of this exhibit will be seen primarily from three areas: 1) as the backdrop to the view looking north over the Alkaline Prairie Pond; 2) from a series of overlooks looking east and northeast from the southwest corner of the exhibit; and 3) from a viewing area on the east side looking northwest. The Prairie Pond Overlook will be discussed in that scenario. The others are summarized as follows:

1. The southwest overlook is located in a transitional grove of mixed aspen and lodgepole pine (Parkland) from the flickering shade of which the viewer surveys an exposed expanse sloping towards a central draw curving gently towards the east until it disappears from sight behind Pronghorn Point. Joining the draw near the center of the view will be a shallow swale emerging from between the flanks of Horseshoe Ridge on the west. From this location the attentive viewer could survey over 70% of the exhibit, yet nowhere is it possible to encompass the entire area or even to guess at its limits. Horizons of hill or ridgetops and the valleys that disappear behind them will show no sign of barriers or other onlookers, for they deliberately will transect sightlines before the full limits of the site are exposed. The bison and pronghorn may be near at hand or they may be seen at a distance or even be obscured, in which case they will be nearer to another overlook. The foreground of this overlook is to formed by the side of a steep draw flowing around the western edge of Horseshoe Ridge towards the prairie pond. Across this ravine (dry moat), side draws will climb roughly up to the floor of the prairie. Farther on, the ravine will disappear behind a thicket and turn abruptly away into the exhibit where it will form the ditch concealing a fence separating the bison and pronghorn from the Alkaline Prairie Pond.

2. The eastern overlook is to be much like the one just described except that the overhead canopy is lacking.

In addition, the far western overlook will allow views of the prairie dog town in the foreground with a flat ridge at the skyline immediately beyond that. The ungulates will be visible only if they happen to be in the immediate vicinity, most of the interest here being generated by the prairie dogs.

BARRIERS:

Dry moat (Type A-1a) and ha-ha fence.

ANIMAL SERVICE AREA:

The existing kangaroo barn will be remodeled as quarters for the bison and pronghorn. It will be obscured from view by plantings and horizon lines.

UTILITIES:

The gravel-reinforced turf surface previously described should provide adequate under-drainage on slopes. However, on flat slopes (2% and less) and bottom lands, agricultural type underdrainage will be required. The wastes from this system would have to be discharged into the sanitary sewer system because of its load of dissolved animal wastes.

Irrigation will be required within the animal area in order to maintain the turf.

Exhibit: 34 Alkaline Prairie Pond

ANIMAL SPECIES:
Western grebe
White pelican
Cinnamon teal
Ruddy duck
American avocet

BIOCLIMATIC ZONE: STEPPE

SETTING: Alkaline prairie pond in North Dakota

EXHIBIT LOCATION: Adjacent to the Great Plains Exhibit

ENCLOSURE AREA: 22,000 square feet

TERRAIN:

A shallow basin centered with a circular pond approximately 100' in diameter. The land rises gently on the far side, then drops abruptly below sight into a ha-ha with invisible fencing.

SOIL:

Existing site soil mixed with sand for better drainage will be adequate. Soil near the pond edge should be periodically limed to give the impression of alkali.

WATER:

In order to create the correct impression of an alkali pond, it is recommended that the pond have a concrete lining that can be colored appropriately, although this should be the subject of further research during future design development of the exhibit. In any case, the shoreline should be very shallow with broad flats of periodic inundation planted to alkali-tolerant grasses - like salt grass, *Distichlis stricta*, and ryegrass, *Elymus cinereus* - and sedges. These flats should be underlain with an impermeable membrane.

VEGETATION:

Bulrush *(Scirpus validus* or *S. acutus)* heavily planted in a portion of the pond.

VIEWING:

The pond shoreline is approached from the southeast or southwest, the former from between high turf banks, the latter from a parkland (aspen/pine) grove. A secondary trail turns in at simple ranch-style gate from which the visitor reaches the shoreline on a path resembling the twin tracks of a farm road. The roadbed is slightly elevated above the pond level. Because alkali ponds occur in the flattest, most exposed reaches of the plains, there is no opportunity for concealment. The visitors simply "walk through" enjoying the waterfowl and the view across the pond into the Great Plains Exhibit. The entry gate would automatically limit the number of visitors allowed within the exhibit area.

BARRIERS:

Low range fencing (preferably collected in weathered state or painted to appear rusted) or thin wood posts surround the area. In the background the fencing will slip behind a thicket of low willow and enter a swale to become an unseen ha-ha (Barrier Type C).

ANIMAL SERVICE AREAS:

Several small roofed pens will be located in an area screened by willows, but generally all special holding activities will be carried out in the animal service area of the Waterfowl Exhibit.

UTILITIES:

Irrigation will be required.

Exhibit: 35 Patagonian Steppe

ANIMAL SPECIES: Guanaco
Patagonian cavy
Common rhea
Southern screamer

BIOCLIMATIC ZONE: STEPPE

SETTING: Short-grass steppe in Patagonia

EXHIBIT LOCATION: Adjacent to Patagonian Pond Exhibit

ENCLOSURE AREA: 33,300 square feet.

TERRAIN:

Large shallow amphitheater with very gravelly soil. Overall section similar to Maned Wolf Exhibit, but somewhat more irregular and asymmetrical. The artificial horizon screening the rear fence should be perfectly horizontal, as if the exhibit area were a slight draw below the general level of the plain.

SOIL:

Well-drained sharp gravelly soil to avoid hoof problems.

WATER: None.

VEGETATION:

Tufted grassland (*Stipa* or some substitute) with 75% of the surface exposed gravel. In foreground areas beyond the reach of the guanaco are low windswept thickets (shaped by pruning, with a majority of dead wood). These thorny shrubs (*Berberis darwinii)* form the barrier between the viewers and the animal area and direct the views. The thickets should be more than a hedge parallel to the path, but should have substantial depth in places with other areas being open enough for viewing.

VIEWING:

Will be from path-side overlooks through intermittent screen planting.

BARRIERS:

Foreground barriers will by Type A-3 planted "cattle guards".

ANIMAL SERVICE AREA:

Simple flat-roofed grass-covered shed built out of sight into the slope between the guanaco exhibit and the Patagonian Pond Exhibit which it would also serve.

UTILITIES:

Irrigation will be required.

Exhibit: 36 Maned Wolf

BIOCLIMATIC ZONE: STEPPE

SETTING: Grassland of Southern Brazil

EXHIBIT LOCATION: Adjacent to Vizcacha Exhibit

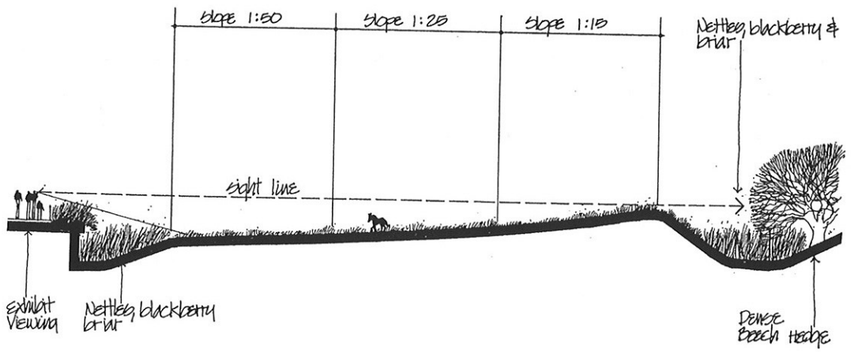
ENCLOSURE AREA: 13,100 square feet.

TERRAIN:

The ground should form a perfectly smooth-graded shallow amphitheater with the viewing area on an elevated podium in the center and the ground sloping gradually up and away to a perfectly level horizon before dropping steeply out of sight to conceal a high fence.

SOIL:

Well drained, animal pathways will be surfaced with pea gravel for drainage and foot conditioning.



WATER:

No water features will be included.

VEGETATION:

Two types of grass: 1) low tussock-forming feathergrass *(Stipa* spp.) 18-24" tall; 2) pampas grass *(Cortaderia selloana)* 6-8' tall used in dense masses to screen fencing and holding areas. Here and there lower fountain grass *(Pennisetum setaceum)* and orchard grass *(Dactylis glomerata)* would open views out across an open grassland with a ridgeline (horizon) of tufted grass. All types are also used in the public viewing area.

VIEWING:

The visitor would approach along the primary pathway, turning off along a secondary path between head-high growths of pampas grass. After a short passage among the saw-toothed silver leaves and great plumed flowering heads, he would emerge into a small clearing surrounded by thick high tussocks.

BARRIERS:

Dry moat (Type A-1a) along the front and ha-ha (Type C) along the rear perimeter.

ANIMAL SERVICE AREA:

The maned wolves' den and service area would be buried under the viewing area and accessible by a side path behind the screening vegetation. Maned wolves are solitary creatures, though a pair can be kept together. Nevertheless, it would be wise, until more is learned about their behavior, to have separate dens with separate entry tunnels.

Exhibit: 37 Vizcacha

BIOCLIMATIC ZONE: STEPPE

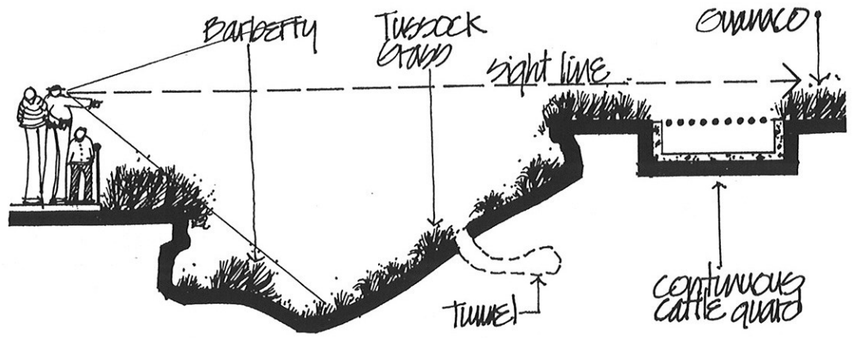
SETTING: Pampas of Central Argentina

EXHIBIT LOCATION: Adjacent to the Maned Wolf Exhibit

ENCLOSURE AREA: 1,300 square feet.

TERRAIN AND SOIL:

Steep-sided gully leading toward the Patagonian pond in a southerly direction. Steep, 3'-high overhanging banks to expose lightly grained pale-colored soil with horizontal bands of fine gravel till. Below the cutbanks, rough irregular slopes witness the hasty passage of seasonal cloudbursts. Scattered



along the watercourse will be a few small boulders, but generally soils are to be fine but well-drained, and only a little sand and gravel line the dry bottom of the intermittent stream.

A side gully will enter the area and extend out of sight into the surrounding plains (this gully to contain the barrier for the adjacent Patagonian Steppe Exhibit).

WATER:

None.

VEGETATION:

Above the cutbanks the undisturbed tussock grass (*Stipa* spp.) of the steppe will be seen in the background. Within the gully (exhibit area) will be scattered clumps of the same grass, while a low ragged thicket of califate (*Berberis darwinii*) will crouch under the protection of a cutbank.

VIEWING:

Will be from an overlook (Type 1) with a foreground planting of tussock grass.

BARRIERS:

Four-foot-high vertical undercut banks of gunite simulating clay to provide the principal barriers. In one area lower, less steep banks allow the rodents access to a small area at the level of the surrounding steppe. Beyond this a second, much smaller side gully (mentioned earlier) will obscure a 3'-high electrified fence. The entire animal area will be underlain with rustproof wire mesh.

ANIMAL SERVICE AREA:

Vizcacha, being burrowing creatures, would be free to provide suitable burrows for themselves in the well-drained sloping soil.

Exhibit: 38 Patagonian Pond

ANIMAL SPECIES: Black-necked swan
Chiloe wigeon
Crested duck

BIOCLIMATIC ZONE: STEPPE

SETTING: Patagonian steppe

EXHIBIT LOCATION: Adjacent to Patagonian Steppe Exhibit

ENCLOSURE AREA: 16,300 square feet

TERRAIN AND SOIL:

A shallow oval pond with surrounding areas sloping gently and evenly away at a gradually accelerating rate reaching a height sufficient to hide the fence between this exhibit and those of the guanaco and maned wolf. The surface of foreground areas should be covered with a thin layer of fine gravel.

WATER:

The pond should measure approximately 80' x 100' and have an average depth of 4' with steep side-slopes to discourage growth of unwanted pond weeds. The pond bottom would be of clay or bentonite or possibly a waterproof membrane covered by sand. It is anticipated that a pond of this size would not require regular draining and would be essentially self-maintaining. Islands are not typical of such ponds and nesting areas should be in several areas of shallows developed on the far shoreline.

SHORELINE VEGETATION:

Intermittent clumps of tall reeds (planted in concrete sewer tiles to prevent their spreading) would dot the shore and reach well back on the far shore. Between these, lower-growing rushes *(Juncus)* and sedges *(Carex)* provide cover while allowing views across the pond.

BACKSHORE VEGETATION:

Should be low tufted grass such as that used in the Maned Wolf Exhibit. Extensive use of the tall pampas grass *(Cortaderia)* would be inappropriate for this transitional southern pampas, but it would be seen along the common margin of the exhibit shared with the maned wolf.

In foreground plantings the grass tussucks should be well spaced with the gravelly soil well exposed as if incessant winds had blown away all remnants of finer materials. The grass tufts may have to be planted through a polyethylene membrane under the gravel to prevent invasion of local weeds.

VIEWING:

The pond would be viewed from two locations. The first is a cul-de-sac from which the vizcacha displays will be viewed and would have the pond as a backdrop. The second viewing area would be along a "walk-through" path among the reeds and would be screened from primary circulation areas. This winding tertiary path of packed peat would venture to the water's edge in several locations, giving a variety of views along the shoreline as well as across the pond.

BARRIERS:

The entire area will be enclosed in a simple rough-style wire fence similar to that described in the Alkaline Prairie Pond. It too would disappear into a hidden ha-ha, this time behind a dense growth of tall grass.

ANIMAL SERVICE AREA:

None will be provided here. Expansion of facilities already proposed for the Waterfowl Exhibit will meet special servicing requirements.

Exhibit: 39 Chaparral

ANIMAL SPECIES: Brush rabbit
Black-tailed jackrabbit
California quail

BIOCLIMATIC ZONE: CHAPARRAL

SETTING: Coastal California near Mt. Tamalpais

EXHIBIT LOCATION:

Between temperate rainforest and Bighorn Sheep (interior North American Montane) exhibits.

ENCLOSURE AREA: 4,000 square feet

TERRAIN:

South-facing hillside sloping gently at the toe and more steeply (3' horizontal to 1' vertical) to an elevation of 15' at the crown, then sloping back to the lower path. The crown would be composed of weathered exposed serpentine bedrock set in the soft yellowish melange resembling the Franciscan formation.

The exhibit will include a smaller central animal enclosure surrounded by a more extensive zone of chaparral vegetation.

SOIL:

Yellowish sandy clay, relatively impoverished. Good drainage to be provided under shrub and tree planting areas.

WATER: None

ANIMAL SERVICE AREAS: None required.

VEGETATION:

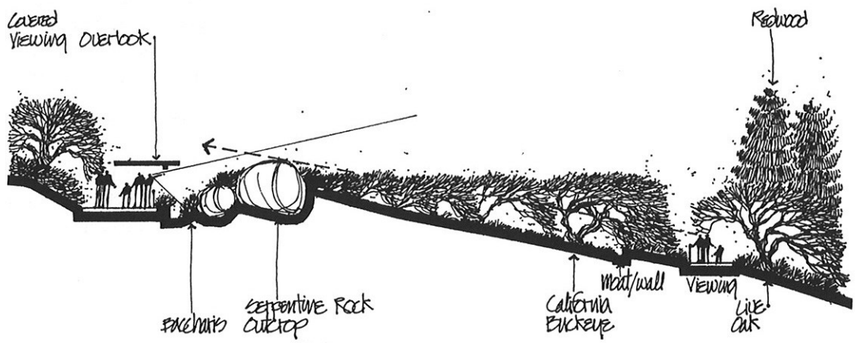
The south-facing slope would be principally covered with bunch grass *(Calamagrostis purpurascens* and *Melica torreyana)*. Characteristic shrubs of south-facing habitats are ceanothus *(C. jepsonii)*, manzanita *(Arctostaphylos montana)* and leather oak *(Quercus durata)*. Species similar to these are commercially available.

In sharp contrast to the sunny, exposed southwest slope, the northeast slope and protected draw through which the lower path passes will be high-canopied and with dense shade. Aromatic bay laurel *(Umbellularia californica)* overhangs the path, while the twisted boughs and stems of canyon live oak *(Quercus chrysolepis)* and California buckeye *(Aesculus californica)* reach overhead. The transparent large leaves of the deciduous buckeye contrast with the dense small evergreen leaves of oak and bay, demonstrating alternative responses to the dry summer climate of the chaparral landscape.

VIEWING:

In this exhibit, the small mammals and ground birds, though important, are not themselves outstanding. Rather, it is suggested that the viewer gain a more casual, less directed experience by walking the paths and brushing against the foliage, with many smaller views and informal overlooks.

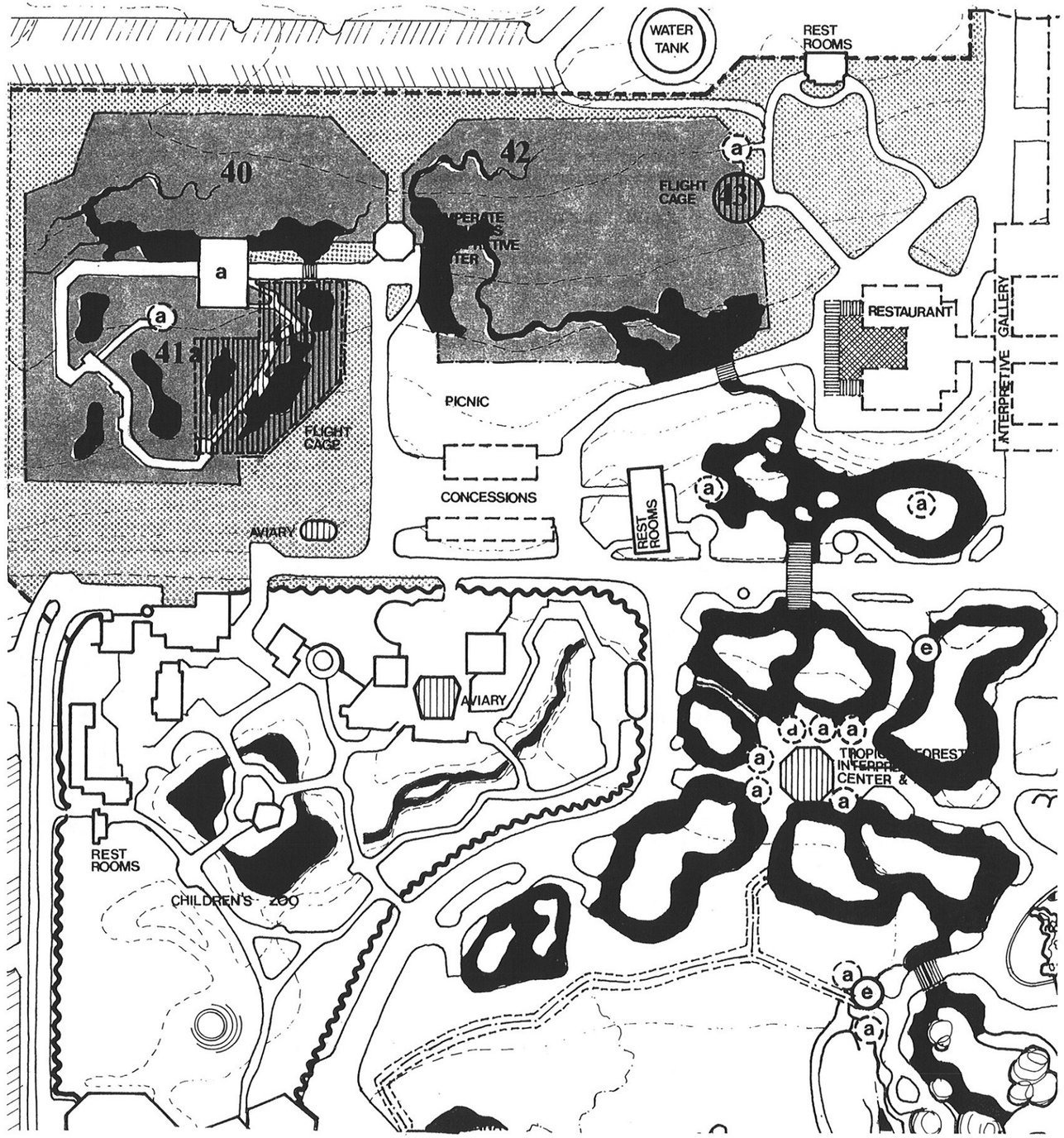
BARRIERS: Type A-1a (dry moat).

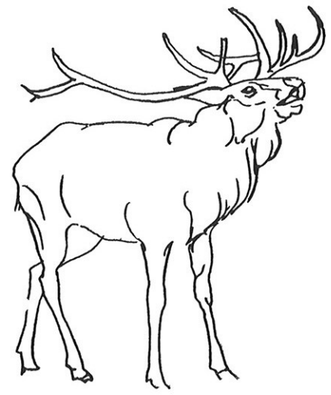


Chaparral

39. Chaparral

brush rabbit
black-tailed jackrabbit
California quail





Temperate Deciduous Forest

40. White-Tailed Deer

white-tailed deer
eastern cottontail
ruffed grouse
turkey

41. Waterfowl

a. swamp
- great blue heron
- Canada goose
- black duck
- wood duck
- ring-necked duck
- bufflehead
- common goldeneye
- hooded merganser

b. marsh
- pied-billed grebe
- green heron
- American bittern
- common pintail
- blue-winged teal
- northern shoveler
- king rail
- Virginia rail
- sora
- common gallinule
- American coot
- red-winged blackbird

42. Red Deer

red deer
European rabbit
black grouse

43. European Flight Cage

blackbird
nightingale
robin
hawfinch
goldfinch
bullfinch
chaffinch
tree sparrow

Exhibit: 40 White-Tailed Deer

ANIMAL SPECIES: White-tailed deer
Eastern cottontail
Ruffed grouse
Turkey

BIOCLIMATIC ZONE: TEMPERATE DECIDUOUS FOREST

SETTING: Connecticut

EXHIBIT LOCATION:

Adjacent to the Waterfowl Exhibit and the Red Deer Exhibit.

ENCLOSURE AREA: 27,500 square feet.

TERRAIN, SOIL AND WATER:

Similar to that described in the Red Deer Exhibit below.

VEGETATION:

Similar to that described in the Red Deer Exhibit except that North American counterparts will be used, such as paper birch *(Betula papyrifera)*, swamp white oak *(Quercus bicolor)*, red oaks *(Quercus alba* and *Q. borealis)*, sugar and red maple *(Acer saccharum* and *A. rubrum)*, and eastern white pine *(Pinus strobus)*.

VIEWING, BARRIERS, ANIMAL SERVICE AREA & UTILITIES:

Similar to Red Deer Exhibit.

Exhibit: 41 Waterfowl

"Waterfowl" in some technical usage applies only to swans, ducks and geese (dabbling and diving birds); however, this exhibit will include other diving birds such as grebes and coots, as well as wading birds (herons, bitterns, rails and gallinules) and red-winged blackbirds, all of which are at home in marshes.

ANIMAL SPECIES:

a. Swamp
Great blue heron
Canada goose
Black duck
Wood duck
Ring-necked duck
Bufflehead
Common goldeneye
Hooded merganser

b. Marsh
Pied-billed grebe
Green heron
American bittern
Common pintail
Blue-winged teal
Northern shoveler
King rail
Virginia rail
Sora
Common gallinule
American coot
Red-winged blackbird

BIOCLIMATIC ZONE: TEMPERATE DECIDUOUS FOREST

SETTING:

Wooded swamp and freshwater marsh near an abandoned homestead in lower New England (northern Pennsylvania northeast toward central Massachusetts). Three subcommunities of the eastern beech-maple forest are to be represented - inland freshwater marsh, wooded swamp, upland transitional forest.

EXHIBIT LOCATION:

East of the existing walk-through barn in the southwestern area of the site, occupying the present duck yard and axis deer compound.

ENCLOSURE AREA: 34,100 square feet

TERRAIN:

The marsh will be dominated by open expanses of ponds bordered by low emergent marsh vegetation with a backdrop of low shrublike willows to help screen the fence which surrounds the marsh. An overhead net, finely woven and stretched tight, is meant to be inconspicuous from the marsh walk. All vegetation within the fence will be low, the full natural lighting not blocked by an overhead tree canopy. The open character of the marsh is to be

contrasted and enhanced by the surrounding stands of mature trees.

The swamp exhibit, in contrast to the marsh, will consist of a mature stand of water-tolerant deciduous trees standing near small, depressed ponds. Logs from fallen trees and numerous broken stumps near the pond edges will reinforce the image of a "flooded forest". Signs of beaver activity will remain, including a beaver dam which the path follows for a short distance, an abandoned lodge, and beaverhewn log tips. The understory will consist mainly of grassy hummocks and a few water-tolerant herbs, with occasional woody thickets. The overall vegetative image is to be one of an unmanaged wood tangled with brush, rather than a neat grassy carpet under individual specimen trees.

The walks and bridge through the marsh should be as narrow as possible while still allowing for comfortable passage and viewing. All paths in the waterfowl exhibit should be kept narrow to enhance the wild/unmanaged landscape character; this will be accomplished by using one-way circulation.

SOIL:

Alluvial/lacustrine silts and clays.

WATER:

Natural ponds and beaver ponds at depths varying from 2-4' will be interconnected by wet swales of moisture-loving plants. An inlet into the marsh will appear to enter through a stone culvert from the Whitetail Deer Exhibit.

All ponds will be constructed of gunite sloping toward individual drains. The upper edge of the gunite will be 12" below water level, the upper submerged area being lined with an impervious membrane and consisting of rich loamy planting mix covered with sand and gravel in which emergent plants will be located.

Only the water of the main pond in the marsh area will be recirculated.

VEGETATION:

The Waterfowl Exhibit will maintain the predominant theme of native broad-leaved trees and herbaceous understory within the framework of a poorly drained lowland which has been converted to wooded swamp (a sunken forest of mature water-tolerant species) and a freshwater marsh (an inundated, open, herb-dominated landscape).

Floating plants to include water lilies *(Nymphaea)*, spatterdock *(Nuphar advena)*, pondweed *(Potamogeton)*, and duckweed *(Lemna)*. Emergent-zone vegetation to consist of cattails *(Typha latifolia)*, reeds *(Scirpus)*, rushes *(Juncus)*, arrowhead *(Sagittaria)*, giant bur-reed *(Sparganium)*, spiderlily *(Crinum americanum)*, pickerelweed *(Pontederia)*, wild rice *(Zizania aquatica)*, sedges *(Carex)*, purple loosestrife *(Lythrum salicaria)*, buttonbush *(Cephalanthus occidentalis)*, fringed gentian *(Gentiana crinita)*, and steeplebush *(Spiraea tomentosa)*. The shrub-tree zone to exhibit pussy willow *(Salix discolor)*, cranberry *(Viburnum trilobum)*, blueberry *(Vaccinium)*, elderberry *(Sambucus)*, spicebush *(Lindera benzoin)*, sweet pepper bush *(Clethra)*, black willow *(Salix nigra)*, and red maple *(Acer rubrum)*.

The understory will consist of mosses and hummocky grasses, skunk cabbage *(Symplocarpus foetidus)*, jack-in-the-pulpit *(Arisaema triphyllum)*, purple-fringed orchis *(Habenaria psycodes)*, fringed gentian, and jewelweed *(Impatiens biflora)*. The lowland canopy will contain red maple, black willow, green ash *(Fraxinus pennsylvanica)*, and black gum *(Nyssa sylvatica)*. The upland canopy will include witch hazel *(Hamamelis virginiana)*, American elm *(Ulmus americana)*, black locust *(Robinia pseudoacacia)*, yellow birch *(Betula lutea)*, silver maple *(Acer saccharinum)*, and American beech *(Fagus grandifolia)*.

VIEWING:

Views from the walk twisting through the swamp and marsh are to be presented in a sequence to allow both close-up and more distant observation of the birds. Dabblers and diving birds will be seen on the surface of open ponds and pond edges, while the wading birds frequent the shallow edges and bordering emergent vegetation. The edge zone of emergent vegetation will be narrow and held close to the pond edge by the fence to allow some of the more reclusive wading birds, such as rails and bitterns, to be seen. Small islands in the ponds will offer resting and nesting places; some birds prefer to nest on platforms in the emergent crotches of tree branches and shrubs away from the water's edge.

BARRIERS:

The outer perimeter fence about the entire zoo should be placed beyond the trees near the public park south of the waterfowl area. Eventually public access from the main parking lot southeast of the Waterfowl Exhibit will be severed and the existing pheasantry area converted to temperate deciduous forest and a dense stand of conifers. The marsh will be fenced about its perimeter with an inconspicuous dark wire mesh, and an overhead net stretched to prevent marsh birds from being preyed upon by owls and gulls. Netting will also keep out wandering pigeons and crows and allow most of the birds in the marsh exhibit to fly unpinioned within the area. Gates to exclude dogs and cats are required for both the marsh and swamp exhibits. The swamp exhibit should have its own gates and perimeter fence of inconspicuous dark wire mesh. Low rails will encourage the public to stay on the path.

ANIMAL SERVICE AREA;

The Waterfowl and Whitetail Deer Exhibits will be serviced from the existing old homestead barn; service yards should be provided and minor modifications to the barn will be necessary to convert it to these new uses.

UTILITIES:

The marsh shrub-tree zone and the lowland areas of the swamp may require irrigation in the summer to maintain the desirably wet rooting conditions necessary for these species.

Exhibit: 42 Red Deer

ANIMAL SPECIES: Red deer
European rabbit
Black grouse

BIOCLIMATIC ZONE: TEMPERATE DECIDUOUS FOREST

SETTING: Central Europe

EXHIBIT LOCATION: Adjacent to the North American Temperate Deciduous Forest Exhibits

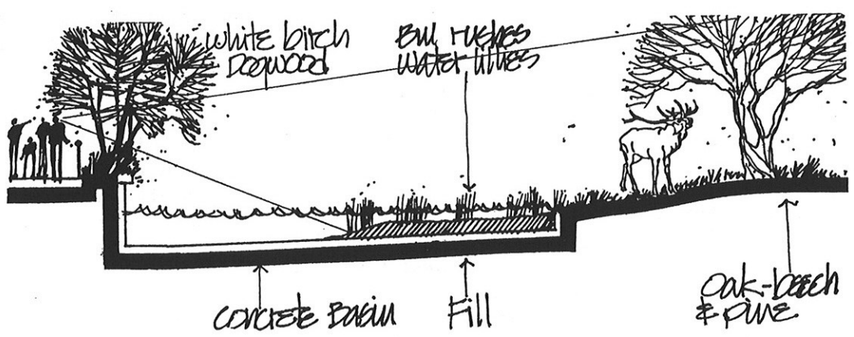
ENCLOSURE AREA: 51,000 square feet.

TERRAIN:

A low undulating meadow beside a marsh. The ground will slope gently toward the rear of the exhibit providing good drainage for upland forest types.

SOIL:

Very well drained with under-drainage in lower areas to prevent destruction of soil structure by trampling. Also, the gentle undulations of the land will provide positive surface drainage.



WATER:

Dark quiet lily ponds edge public viewing areas. These will be 4' deep at the outer wall and concrete-lined to provide open water. Near the shoreline the water will become more shallow, with soil supporting aquatic and emergent plantings. These ponds will not be recirculated and will rarely be drained.

VEGETATION:

Water plants will include bulrushes *(Scirpus)* and waterlilies *(Nymphaea)*; turf will be of ryegrass and red fescue *(Lolium perenne* and *Festuca rubra)*. No shrubs will be maintainable within the deer area, but plantings outside animal barriers will include shrub dogwood *(Cornus stolonifera)*.

Trees will include white birch *(Betula verrucosa)* hanging over the water moat from the viewing area and trees such as oak *(Quercus robur)*, beech *(Fagus sylvatica)* and pine *(Pinus sylvestris)* on better-drained slopes, with dense pine groves providing shelter and screening perimeter fencing from both within and without the animal area, as well as obscuring the parking area beyond. Tree trunks will be protected with steel-reinforced synthetic fiber-glass or urethane molded outer "bark" constructed to allow for normal expansion and growth.

VIEWING:

Viewing will be from overlook points (type 2) beside still dark waters and thrusting spears of bulrushes. These permanent ponds should harbor natural populations of aquatic insects and amphibians with darting swallows adding foreground interest. The exhibit area will be bisected by a dark central gathering of pines so that a distinct portion of the area may be seen from each of the two overlooks without the viewer fully realizing the total extent of the area.

BARRIERS:

Barriers at overlook points will be formed by water moats (Type A-1b), while background barriers will be chainlink fencing (Type D-1) without top rail and painted in suitable camouflage patterns and heavily planted with shrubs penetrating the fence from the outside. Even if these are browsed off at the fence line, they will greatly help to obscure the mesh when seen from a distance.

ANIMAL SERVICE AREA:

A low, simple three-sided shelter will be provided in a dense pine grove out of view and accessible to service behind the European Flight Cage.

UTILITIES:

The entire exhibit area will require irrigation.

Exhibit: 43 European Flight Cage

ANIMAL SPECIES: Blackbird
Nightingale
Robin
Hawfinch
Goldfinch
Bullfinch
Chaffinch
Tree sparrow

BIOCLIMATIC ZONE: TEMPERATE DECIDUOUS FOREST

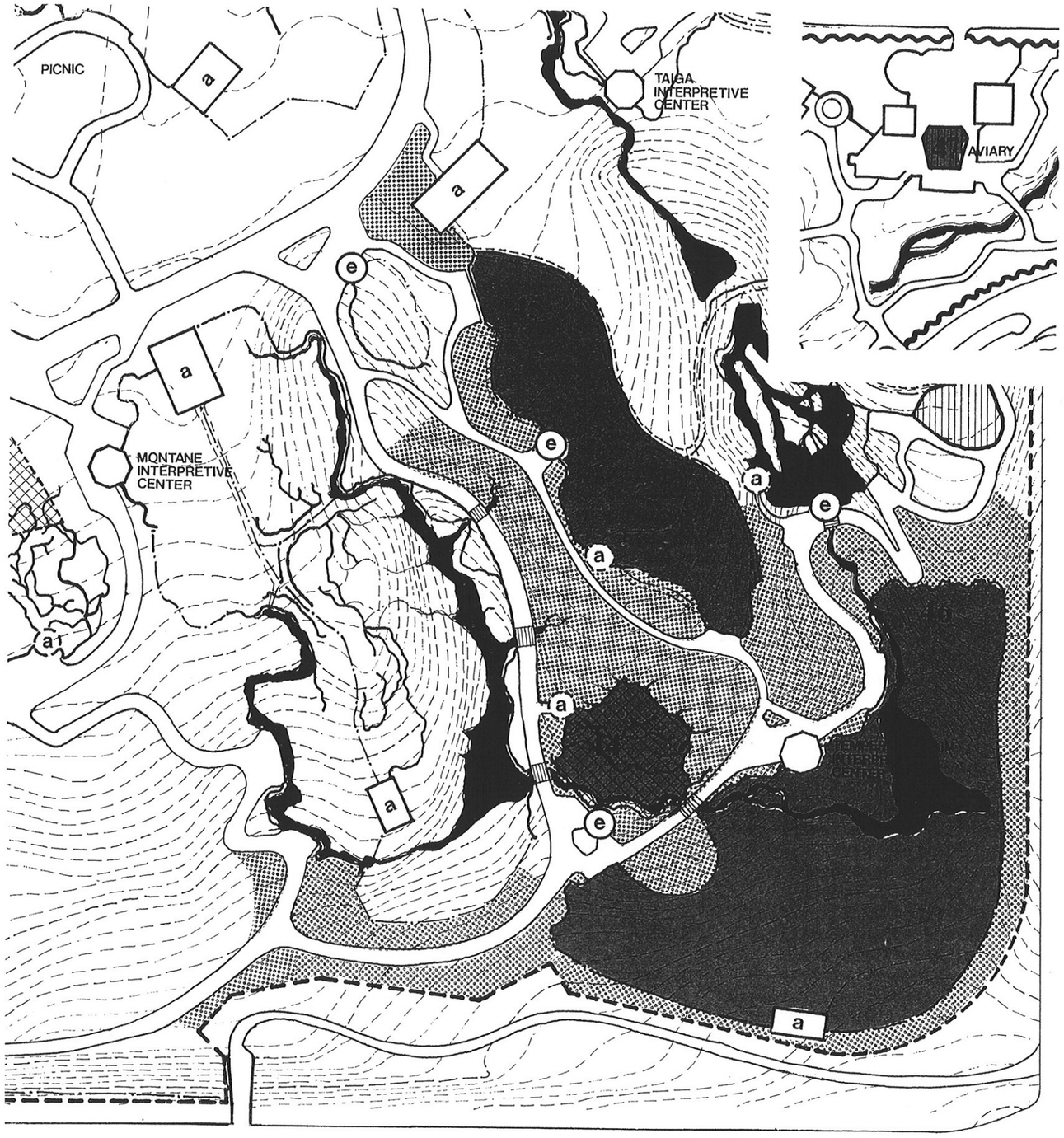
SETTING: Central Europe

EXHIBIT LOCATION: Adjacent to the Red Deer Exhibit

ENCLOSURE AREA: 1,100 square feet

SCENARIO SUMMARY:

The landscape within the walk-through flight cage should be a natural yet more intensely vegetated extension of the surrounding outside landscape as described in the Red Deer Exhibit. Interior development should be a literal replication of the landscape with building elements being clearly subservient and, where possible, nearly unnoticeable. The structure will not be climate-controlled, although interior irrigation will be mounted along the ceiling.



Temperate Rain Forest

44. Cougar

45. Gray Wolf

46. Wapiti

wapiti
blue grouse

47. Temperate Rain Forest Aviary

band-tailed pigeon
chickadees
red-breasted nuthatch
brown creeper
winter wren
varied thrush
cedar waxwing
yellow-rumped warbler
evening grosbeak
purple finch
pine siskin
dark-eyed junco
white-crowned sparrow
fox sparrow
song sparrow

Exhibit: 44 Cougar

BIOCLIMATIC ZONE: TEMPERATE RAINFOREST

SETTING: Lower slope of Olympic Mountains

EXHIBIT LOCATION:

Between Wapiti (Temperate Rainforest) and Mountain Goat (Montane) Exhibits. This large predator bridges the zones in its wanderings.

ENCLOSURE AREA: 8,400 square feet

TERRAIN:

Steep, well-drained southeast-facing slope ending in a jumbled mass of lodged boulders, colluvium and shattered logs from an old landslide.

SOIL:

Should be quite fast-draining and stable.

WATER:

A stream originating in the Bighorn Sheep and Mountain Goat Exhibits will appear to enter the Cougar Exhibit after passing under a bridge in the pathway (where recirculating pumps are to be housed). Though not great in volume, the stream will be fast-flowing and flecked with spray as it tumbles off rough-edged rubble at the base of the slide.

VEGETATION:

A large existing bigleaf maple *(Acer macrophyllum)* will provide a peaceful perch for the sleeping cougar. Below the tree, beside the piled rubble and in protected niches among scattered dead-fall, sword fern *(Polystichum munitum)* and bracken *(Pteridium aquilinum)* will crowd to catch the ephemeral sunlight. A tall fir snag, its roots buried beneath the rubble fall, can serve as a scratching post. Near the limits of view, flowing drapes of young hemlock *(Tsuga heterophylla)* will screen the enclosing mesh, their somber hue contrasted by bright-leaved foreground vine maple *(Acer circinatum)* overhanging the stream and invading lower rubble slopes. Throughout lower portions of the exhibit, rocks and fallen logs will be bright-fleshed with light green carpets of feather moss and small ferns. Huckleberry *(Vaccinium)* and salal *(Gaultheria shallon)* are to be also abundantly represented. Exposed upper slide slopes are to be carpeted, in contrast, with short dry grass and bracken with scattered fir seedlings.

VIEWING:

The only views of the Cougar Exhibit will be from within a small covered interpretive center. The structural frame of the viewing portal will eclipse all views of the mesh tent completely covering the exhibit. This arrangement is similar to that described for the Leopard Exhibit and is described as viewing type 6 in the Development Guidelines.

BARRIERS:

Barrier type H.

ANIMAL SERVICE AREA:

Holding quarters for the cougar will be built into the rockfall with keeper access from a hidden service path.

Exhibit: 45 Gray Wolf

BIOCLIMATIC ZONE: TEMPERATE RAINFOREST

SETTING: Southeastern Alaska southward to northern California

EXHIBIT LOCATION:

Centrally located between the Tundra, Mountain Goat, Bighorn Sheep and Chaparral Exhibits, emphasizing only a portion of the range and adaptability of this versatile carnivore.

ENCLOSURE AREA: 28,400 square feet

TERRAIN:

Existing relatively flat ridge line overlooking ravines both northward and southward and giving the wolves a commanding view of the entire northeastern area of the site. (Adjacent large ungulates occupy adjoining ridges or are sufficiently distant to prevent psychological stress).

SOIL:

Generally, existing soil is adequate. Where animal paths develop, they will be covered with pea gravel to aid in conditioning the wolves' feet and preventing compaction of soil over tree roots.

WATER:

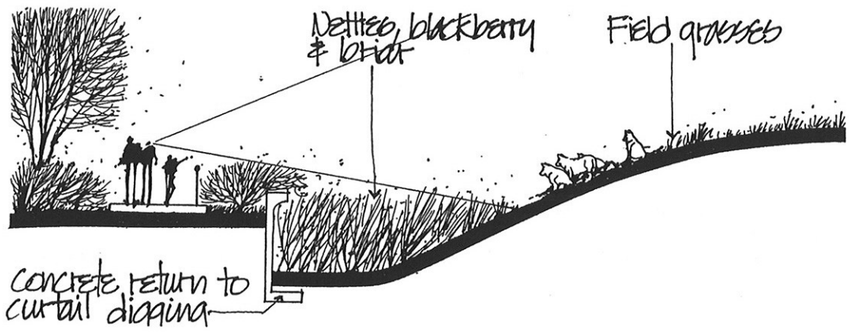
No water feature required.

VEGETATION:

Large existing trees will be maintained and their bases protected from soil compaction by deep layers of bark chips. Additional trees will be planted consistent with natural plant community transitions bordering on the temperate rainforest. Thus, Engelmann

spruce *(Picea engelmannii)* and aspen *(Populus tremuloides)* will crown the hill overlooking the taiga section of the caribou exhibit. Maple *(Acer macrophyllum)*, cedar *(Thuja plicata)*, Douglas fir *(Pseudotsuga menziesii)* and hemlock *(Tsuga heterophylla)* will be concentrated in the lower area near other temperate rain forest exhibits of cougar and wapiti, and plantings of madrona *(Arbutus menziesii)*, bay laurel *(Umbellularia californica)* and oak *(Quercus garryana)* will blend into the Chaparral Exhibit.

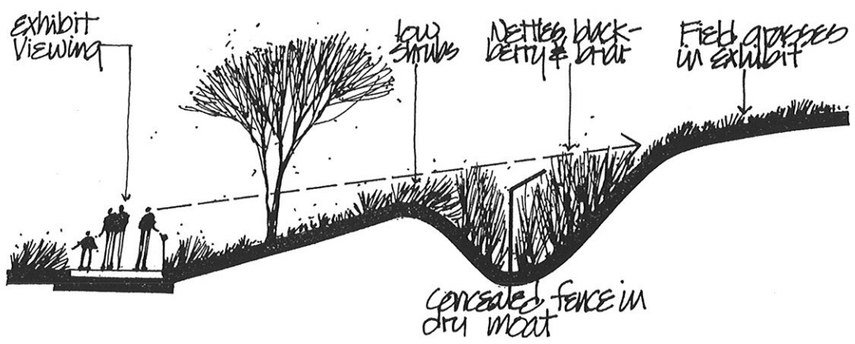
The majority of these plantings will be near the perimeter of the exhibit on both sides of the animal enclosure. Plantings of shrubs and understory will be limited in order not to obscure the wolves. Ground cover of field grasses (avoiding species with "fox tail" -



like seed heads) and wild flowers with some areas of bracken are suggested. Moats and fence lines will be planted to nettles, blackberry and briar to discourage the wolves from running along the fences or hiding in moats.

VIEWING:

Exhibit overlooks will be located at the lower, central and upper areas of the exhibit with correspondingly differing views. Since the animal area is relatively narrow, it often serves as a foreground to farther views of distant ridgetops, the hilltop itself obscuring views of fencing at the rear of the exhibit.



The central viewing area will be housed in an Exhibit Overlook Structure containing special interpretive displays describing the highly evolved social behavior patterns of wolves. Special viewing apparatus could include mounted telescopes or binoculars to enable close examination of facial expression and interaction.

BARRIERS:

Fence type D-2 and dry moat type A-1a are recommended here with provision to prevent digging out.

ANIMAL SERVICE AREA:

A den structure will be built with buried concrete 3'-diameter sewer pipe in the form of a "T" with a "Y" entry similar to that described for the African hunting dogs. The interior portion of the den will project outside the animal fence below ground level and have keeper access from a manhole located in a small fenced holding area screened from overlooks. The same manhole would provide access to a chamber for direct observation of the den and for TV and other recording devices.

UTILITIES:

No irrigation should be required once new planting becomes established.

Exhibit: 46 Wapiti

ANIMAL SPECIES: Wapiti
Blue grouse

BIOCLIMATIC ZONE: TEMPERATE RAIN FOREST

SETTING: Olympic Peninsula

EXHIBIT LOCATION:

At the lower end of the ravine extending from the tundra (musk ox/caribou) and taiga (brown bear) exhibits. The area is also adjacent to the Cougar Exhibit.

ENCLOSURE AREA: 69,200 square feet

TERRAIN:

Existing areas of hillside and lower slopes will be largely maintained in their present conformation. The viewing pathway, however, will be built out from the slope with a steep stone wall maintaining the lower edge and forming the limit of the animal area. A pond will be formed to terminate the watercourse descending from farther up the ravine and to join it to the stream originating in the montane area. This wall would merge into a

steep exposed sand bank at the head of what will appear to be an old earth slump.

SOIL: Existing soils are adequate.

WATER:

A large, boisterous stream descending from the bridge overlooking the Brown Bear Exhibit would tumble through a deeply incised cliff overhung with mosses and ferns, coming only occasionally into sight. The sound of this rushing water so close to the path will help to mask the serious traffic noise from the adjacent roadway.

At the lower end of the ravine near a path-side overlook the stream would fall 6-8' over a rock ledge into the pond. From here there would be an almost detectable current flowing across the pond to its outfall along an old beaver dam (artificial), whence it would disappear from sight to be recirculated once more to the covered bridge at the Brown Bear Exhibit.

A second stream, much smaller and quieter than the first, enters the pond from the south through a narrow flat, having crossed the path under a bridge near the Cougar Exhibit. This stream too is recirculated from the pond to the bridge.

VEGETATION:

Existing trees in the animal area will be protected by a replaceable fiberglass outer "bark." Banks of salal *(Gaultheria shallon)*, huckleberry *(Vaccinium* spp.), ocean spray *(Holodiscus discolor)* and sword fern *(Polystichum munitum)* will cascade over barrier walls and crowd corners, protected by dense fence-like barriers of deadfall. Nettles *(Urtica dioica)*, one of the few spurned native plants, will hedge in these barriers and maintain clumps obscuring fencing and service areas.

The principal vegetation of the animal area will be grass, and the area will resemble an open elk pasture, a contrast to the surrounding dense forest through which the pathway passes.

The area of the exhibit outside the animal enclosure will be densely planted with typical vegetation of the Olympic rain forest. In addition to those already existing on the site, large forest snags and nurse logs will be arranged in this area.

VIEWING:

A great variety of overlooks and viewing areas survey this large exhibit, varying from a high brief encounter on a hillside switchback to an extended prospect from the Temperate Rain Forest Interpretive Center. Each of the views is unique and none encompasses the entire area, thus encouraging the impression that the exhibit is not completely enclosed.

ANIMAL SERVICE AREAS:

The existing deer shelter will be refurbished and screened from viewing area.

BARRIERS:

Along the upper slopes animals are contained by very steep banks of gunite resembling landslide slip faces or by stone walls supporting the pathway. Lower exhibit areas are fenced with wire mesh painted in camouflage patterns and heavily planted along its outside edge. Nowhere are these fences nearer than 80-100' from the viewers.

UTILITIES:

Irrigation will be required to prevent the wapiti from overwhelming grass areas. Also, sprayheads in dense rain forest exhibit areas outside the animal compounds will encourage epiphytic old man's beard *(Usnea)* and lush ferns and mosses.

Exhibit: 47 Temperate Rain Forest Aviary

ANIMAL SPECIES:

- Band-tailed pigeon
- Chickadees
- Red-breasted nuthatch
- Brown creeper
- Winter wren
- Varied thrush
- Cedar waxwing
- Yellow-rumped warbler
- Evening grosbeak
- Purple finch
- Pine siskin
- Dark-eyed junco
- White-crowned sparrow
- Fox sparrow
- Song sparrow

BIOCLIMATIC ZONE: TEMPERATE RAINFOREST

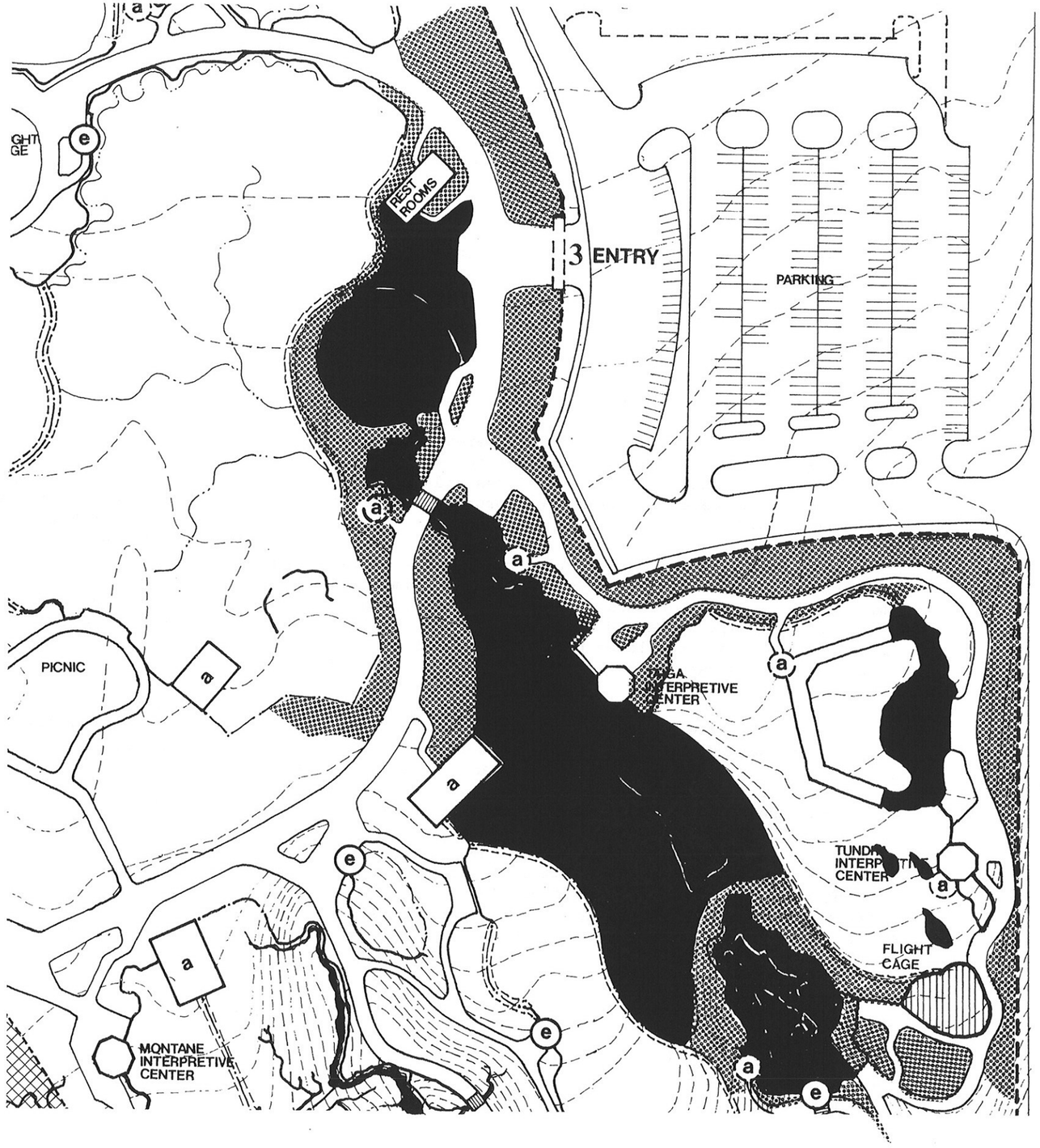
SETTING: Olympic Peninsula

EXHIBIT LOCATION: Childrens' Zoo (NOTE: this exhibit was constructed during the spring of 1976 and was the first exhibit constructed under the basic tenets outlined in this report.

ENCLOSURE AREA: 1,100 square feet.

SCENARIO SUMMARY:

The exhibit was constructed within the existing shell of the previously dismantled Children's Zoo Aviary. It replicated a forest setting beside a small stream with a great huckleberry-topped fir stump and a tall snag, both surrounded with lush plantings of typical temperate rainforest vegetation expressing various stages of natural succession.



Taiga

48. Brown Bear
49. River Otter
50. Wolverine
51. Trumpeter Swan

trumpeter swan
snowshoe hare
spruce grouse

Exhibit: 48 Brown Bear

BIOCLIMATIC ZONE: TAIGA

SETTING:

Coastal spruce-hemlock forests of the Kenai Peninsula, southern Alaska.

EXHIBIT LOCATION:

Below the Tundra and above the Wapiti Exhibits in the existing narrow valley in the northeastern area of the site.

ENCLOSURE AREA: 11,500 square feet

TERRAIN:

Deeply incised river gorge with waterfalls and rapids. In order to allow for the substantial vertical moat height required to contain brown bear while providing sunny areas for the bears above visitor eye height, it is suggested that the exhibit have two principal levels connected by steep slopes and waterfalls, all within the containment of a river-cut gorge of exposed (simulated) graywacke bedrock.

The upper level will contain a series of lesser and greater river bars through which braided stream channels pass immediately before tumbling down steep broken cascades into the lower river channel. The cascades should be varied and dramatic, yet should appear passable to salmon, with lower broader falls not exceeding 3' in height, while highest narrow cascades could fall sheer for up to 14'.

The lower rivercourse will be near tne downstream front area of the exhibit and would be composed of a wide deep pool and bordering gravel bar under the nearside cliff/terraces so that it would not be visible for viewers from the principal overlook, thus giving the appearance that the bears had wandered out of the forest beyond.

Dry sand bars would provide places for the bears to wallow and dry their coats. Abundant quantities of bleached driftwood should be trapped at the top of the falls and lodged on river bars to provide rubbing, scratching, and claw-sharpening surfaces for adult bears and climbing toys for young animals.

SOIL:

The understructure of the entire exhibit would be of concrete with river-sorted gravel bars and heavily exposed aggregate concrete with carefully placed boulders containing the watercourses. Planting pockets will be provided on the upper end of the largest river bar and in niches of the river cliffs.

WATER:

In order for this exhibit concept to be fully developed, a great deal of water must be mechanically recirculated. The salmon stream must show a powerful, rambunctious flow, full of spray and thunder, with scale appropriate to majesty of the great bears. The rate of flow should be variable so that maximum performance can be shown during peak summer visitor days while a somewhat lessened flow would expose more dry land habitat for the bears during summer weekdays and could be considerably curtailed during winter months of low visitation.

The water would originate from a discharge pipe (or pipes) obscured from view in the river course above the exhibit and after flowing over and around the rapids would flow into a deep quiet pool and from there under the overlook bridge and around another river bend from which it would be recirculated again to its point of origin.

VEGETATION:

Areas above apparent flood level will be planted to coarse sedges such as *Carex*, and grasses such as *Calamagrostis canadensis*. Fireweed *(Epilobium angustifolium)* should be abundantly planted in these open areas as well. Near the water source on gravel bars, very dense thickets of low-growing willow *(Salix* spp.) should be planted in buried vertical concrete sewer-pipe sections to make it more difficult for the bears to dig up the plants.

Dense stands of Sitka spruce *(Picea sitchensis)* and mountain and western hemlock *(Tsuga mertensiana* and *T. heterophylla)* should crowd the slopes above the cliffs and hang out over the river below. Devil's club *(Oplopanax horridum)* and Sitka alder *(Alnus sinuata)* could also be used, the devil's club along wet seeps and the alder in solid masses overhanging the rear moat and extending up the valley above the exhibit. In the river-bank area adjacent to the overlook bridge, a stand of Alaska yellow cedar *(Chamaecyparis nootkatensis)* will be planted.

VIEWING:

The upper overlook will be reached along the path from the Polar Bear and Tundra Exhibits (northern Alaska) and would look down upon the entire exhibit (obscure the rear moat with Sitka alder). There will be a small viewing area set well back from the exhibit and views will be through foreground plants of hemlock, spruce and devil's club. The path will then proceed down the hillside by switchbacks giving views toward the wapiti enclosure.

The major views will be through glass from within a covered-bridge structure right over the deep lower pool at its exit towards the Wapiti Exhibit. Benches for longer observation will be provided as well as interpretive information about the bears and their relationship to the salmon and to native hunters and native arts.

Views from this structure will be westward up the river into the afternoon sun, with the rapids and falls above the viewer, their spray throwing halos of rainbows and froth.

BARRIERS:

A substantial moat wall (14' high) simulating a stream-cut gorge will surround the exhibit, except at the covered bridge which would be fronted with heavily tempered glass allowing the visitors close looks at the bears on adjacent bars while preventing unwanted feeding or harassment of the animals.

ANIMAL SERVICE AREA:

An enclosed den in the south bank of the gorge with separate entrances for bears and keeper.

Exhibit: 49 River Otter

BIOCLIMATIC ZONE: TAIGA

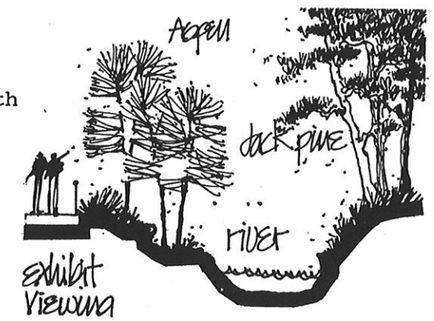
SETTING: Riparian community in boreal forest of Central Alaska

EXHIBIT LOCATION: Adjacent to the Wolverine Exhibit

ENCLOSURE AREA: 4,100 square feet

TERRAIN:

Steeply incised stream course; cut-bank overhanging far side with exposed compacted glacial till soil, near side with gravel bars and shallows. Some banks with vertical standing faces could appear to be stratified sand and show the typical pitting of bank swallow nests.



SOIL:

Free draining and should be composed of 50% coarse sand and gravel and 50% sandy loam.

WATER:

Swift-flowing and shallow above the bridge, the stream will fall over low waterworn boulders into a deep (4') clear quiet pool immediately 20' beyond the the bridge (overlook). It should appear to be the same stream that drains the swan pond above, but the waters from the two exhibits must be separated for hygienic reasons. The possibility of filtration should be explored. The stream bottom will be formed of exposed aggregate concrete with aggregate size varying from large cobbles to small gravel and sand, sorted, as if by nature, according to stream hydrodynamics. Gravel bars should be similarly sorted.

A wide variety of waterforms should be produced, including fast-flowing chutes, riffled shallows, quiet shallows and the quiet deeper pool mentioned. The pool should make up no more than 20% of the site, with the stream comprising another 10%.

A large log, shattered and bleached, will extend across the gravel bar into the pool, providing both a play object and a place for sunning and preening for the otters. Upstream and downstream, beyond view, the stream will terminate in mechanical circulation pick-up and discharge points.

VEGETATION:

The gravel bar will be bare of vegetation except for a single dense clump of dwarf willow *(Salix* spp.). Other streamside locations should include these as well as prickly rose *(Rosa acicularis)*, buffaloberry *(Shepherdia canadensis)*, and cinquefoil *(Potentilla fruticosa)*. A large balsam poplar *(Populus balsamifera)* will be planted just above the gravel and its seedlings allowed to sprout among the stones of the bar. Nearby a large old "beaver-cut" poplar stump should imply the presence of these characteristic creatures.

South-facing slopes should remain grass-covered and mostly open with scattered aspen *(Populus tremuloides)* and a few lodgepole pine *(Pinus contorta)*. Clumps of silverberry *(Elaeagnus commutata)* and buffaloberry are appropriate, and especially droughty slopes will be planted with kinnikinnick *(Arctostaphylos uva-ursi)*, common juniper *(Juniperus communis)* and creeping juniper *(J. horizontalis)*. East- and northwest-facing slopes should be covered by dense white spruce *(Picea glauca)* and paper birch *(Betula papyrifera)* stands grading to black spruce *(Picea mariana)* on cold north-facing slopes. Ground cover here would be Labrador tea *(Ledum groenlandicum)* and prickly rose.

Upper slopes, including those above the river cutbanks, will be planted to white spruce, paper birch, and balsam poplar, some of the roots of which could be exposed above the stream. This might be done many years after the trees are planted.

VIEWING:

The principal viewpoint proposed is from the bridge over the stream. This would provide a reasonable and barrier-free view of the animals, one that could certainly be encountered in many natural circumstances.

The exhibit should be viewed in such a way to minimize glare and reflections on the water surface which would obscure submerged animals. The main viewpoint, from the southwest, will accomplish this. Also, vegetation and overhanging banks should be so placed as to prevent the accumulation of large shadowed areas on the water. This is especially true during the high use early afternoon hours.

BARRIERS:

Within the viewing area the vertical overhanging cutbanks should be designed to contain the otters. Out of view, behind evergreen trees and shrubs, a double overhung fence (Barrier Type D-3) should be used. Wire mesh should also be installed out of sight under the bridge to separate the exhibit from the Wolverine Exhibit upstream.

ANIMAL SERVICE AREA:

A small bunker-like structure will be built into the berm that forms the stream bank. This structure gives service access to the otters' heated dens, catch pens and utilities. From the public overlook the den entries should appear to be dug into the gravel bank beneath some treeroot or driftwood mass. They should be in a sunny location well above the water and have a dry sandy grooming and drying area immediately before the entrance.

UTILITIES:

Permanent irrigation should not be required after vegetation has become established.

Exhibit: 50 Wolverine

BIOCLIMATIC ZONE: TAIGA

SETTING: Northwest Territories, Canada

EXHIBIT LOCATION: Between River Otter and Trumpeter Swan Exhibits

ENCLOSURE AREA: 2,100 square feet.

TERRAIN:

Stream-side flat with overhung fill banks cut at higher levels before being abandoned by changes in the river course. Actual stream banks will be low and accessible to the animals, while sandy bars will provide areas for wallows.

SOIL: Principally sand and gravel with a thin topsoil in turf areas.

WATER:

A stream (as described in detail in the River Otter Exhibit) will flow through the area in a series of shallow riffles connecting two larger pools (10'-15' long x 6'-8' wide). The water will be re-circulated within the exhibit, but will appear to originate at the acid bog pond (Trumpeter Swan Exhibit) and will flow beneath a bridge under which it will be collected and returned to its origin at the upstream limit of the exhibit.

VEGETATION:

Similar to that described in the River Otter Exhibit except that the Wolverine Exhibit will have less area of water and more of planting, particularly mature aspen *(Populus tremuloides)*. Lower vegetation, when present, will not be abundant for it would tend to obscure the animals.

VIEWING:

The overlook bridge (Overlook Type 8) will provide the only view into this small exhibit. The view will be directed westward, with the aspen, quick with light and movement, only partially obscuring the glitter of light on the dark water of the adjacent pond.

BARRIERS:

Will be dry moats and overhung water-cut banks (Barrier Types A-1a and A-1b).

ANIMAL SERVICE AREA:

A den will be formed in one bank, the interior of which will be constructed of concrete sewer pipe with keeper access from the outside and provision for observation and TV monitoring.

UTILITIES:

No irrigation will be required after plants are established.

Exhibit: 51 Trumpeter Swan

ANIMAL SPECIES: Trumpeter swan Snowshoe hare Spruce grouse

BIOCLIMATIC ZONE: TAIGA

SETTING: Lowland reed marsh with adjoining black spruce bog in boreal forest of central Alaska.

EXHIBIT LOCATION:

Northern edge of the site, adjacent to the Great Plains Exhibit.

ENCLOSURE AREA: 5,500 square feet.

TERRAIN:

Shallow basin in generally flat terrain sloping gently eastward. The outfall of the pond would be on the east over a structure constructed to resemble abandoned beaver works.

SOIL:

Existing site soils are similar to those found in the taiga, for both are of predominantly glacial origin. Soil modification, if any, should be determined during future design development. Soils for the black spruce bog should be 3' deep and be prepared from approximately one third natural unprocessed peat, one third sand and one third loam. A 6"-deep surface layer of 70% peat, 15% sand and 15% loam should be used as the rooting medium for ericaceous

shrubs. An impervious membrane of polyethylene film should separate the reeds from the bog in order to prevent them from invading the bog community.

WATER:

Pond generally circular, with about 100-120' diameter, gently sloping sides and no beach development. From water's edge the pond bottom should drop to a depth of 4' in 20-25', then taper more gently to a central low point at a depth of 5-6'. This should restrict the growth of water weeds and rushes to the pond margins. A clay or bentonite bottom is proposed. Although it would be impossible to regularly clean this surface, it is felt that the proposed pond is too large to be regularly emptied and that its volume and extensive surface should allow for sufficient natural aerobic self-cleaning. Possible algal blooms would have to be treated chemically.

"Floating peat islands" would be provided for waterfowl nesting sites. These would be constructed by suspending nylon netting between a rigid polygonal framework supported by styrofoam floats. The netting could be filled with peat and planted with cattails and reeds.

VEGETATION:

Waterlilies should be planted in tubs in deep water. This would prevent their unconditional take-over of the entire pond surface. Pond margins should be planted primarily to reeds with scattered accents of cattails. One large area of wild rice should also be provided near the viewing area. Plants should range concentrically from a depth of three feet below water level to one foot above.

The immediate shoreline should include thickets of dwarf willow, dwarf birch and red-osier dogwood. The backshore (elevation 1-2' above pond level) should be planted to eventually form a continuous forest of random plantings composed of approximately 50% paper birch, 20% willow, 20% balsam poplar and 10% white spruce.

Shrubs would include prickly rose, Saskatoon serviceberry and red-osier dogwood. Sedges would include *Carex* and others. Close-up plantings near overlook and pedestrian areas should have low shrubs such as cinquefoil, Labrador tea and bog cranberry, to list only a few. Bog areas should have a ground cover of feather and *Sphagnum* mosses with hummocks of Labrador tea. Bog trees should include a random mixture of 70% black spruce, 20% paper birch and 10% larch, forming a very dense close canopy with the birch tending toward openings and edges. Dead bleached coniferous snags could be spotted in the pond near the bog to resemble black spruce drowned by advancing water due to beaver activity.

VIEWING:

A. General: The exhibit should present the swans on an open, brightly lit pond surrounded on the southwest, west and northwest by very dark, dense coniferous forest. Principal viewpoint should face south, southeast or southwest so that the spruce are in their own shadow and appear very dark. An opening should be left in the northwest to allow the summer setting sun to spotlight the swans against the darkened shaded evergreens. Deciduous trees should be backlit and luminous, and water surfaces sparkle with reflected light. If possible, pond-side vegetation should show characteristic concentric development.

B. Foreground should show detailed natural plants including herbaceous and shrub materials on the public side of the barriers, protected from trampling by a low railing.

C. Middleground (exhibit area) would include pond and some spruce forest. Distant areas of forest floor should slope slightly away from viewer so that it is not quite visible. This would conceal the fact that it is not carpeted with feather mosses. Forest area should be deep enough to completely hide barrier fencing (approx. 30').

BARRIERS:

A low fence separating the exhibit from the Great Plains area would be hidden in a depression and not visible to viewers. The front edge of the exhibit will be bounded by a combination of deadfall and fencing out of sight in shrubs and trees.

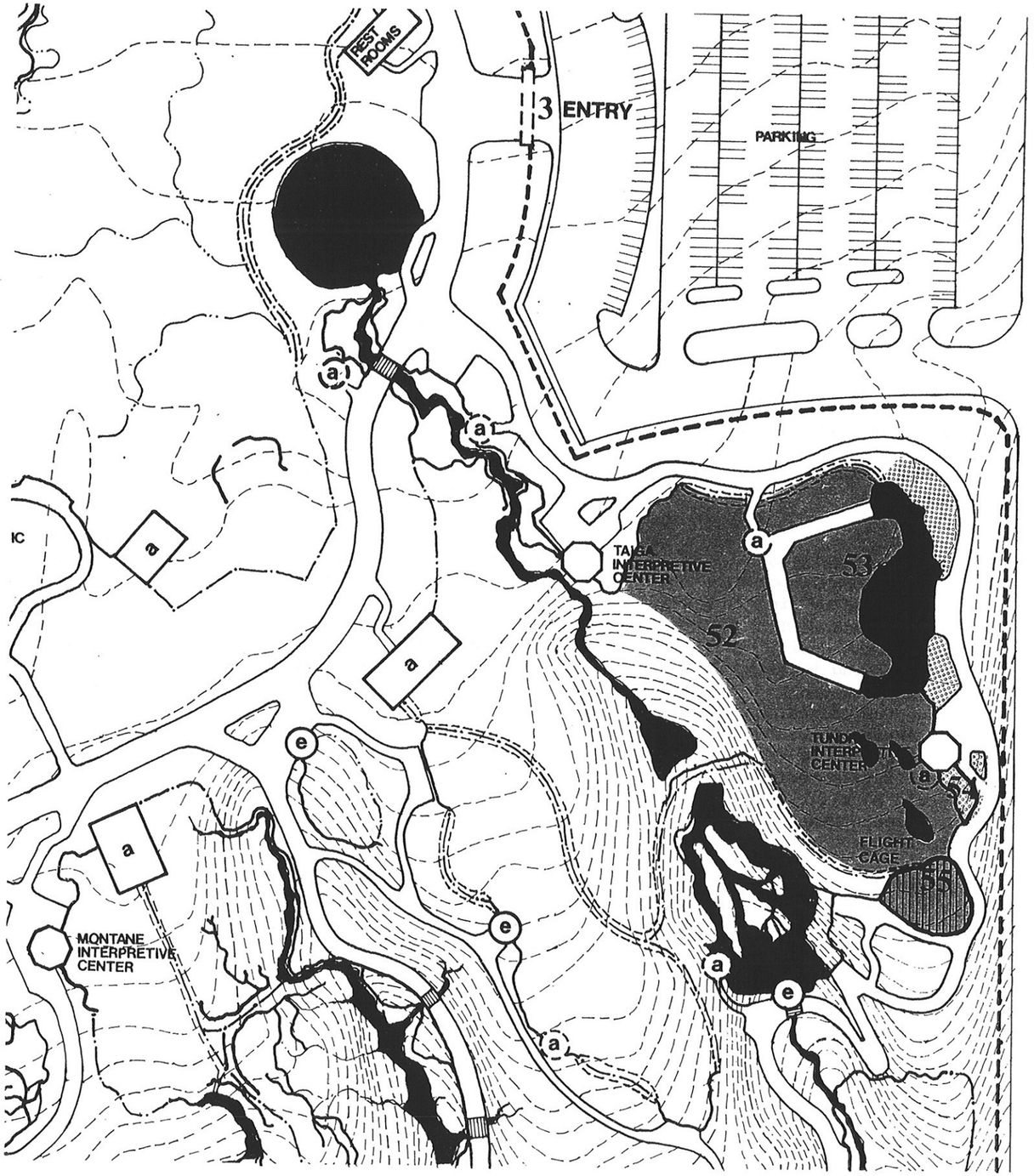
ANIMAL SERVICE AREA:

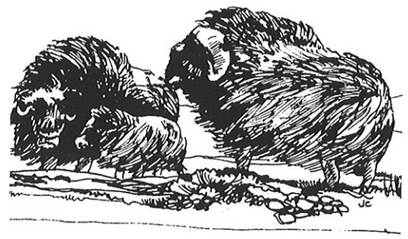
Special pens may be located in the exhibit area, screened by vegetation, but generally all special holding activities will be carried out in the animal service area of the Waterfowl Exhibit.

UTILITIES:

Irrigation will be necessary throughout the taiga zone, for although dry summers are often typical of this region, the growth of typical mossy ground covers would otherwise be retarded, giving unwanted advantage to weedy invaders. In bog areas spray heads should be set closely and low, giving a high velocity mist. They should be timed for frequent sprays of short duration to maximize low-level humidity and retard transpiration from low levels of planting.

Total annual precipitation levels of 15" are typical of the taiga and are far less than can be expected in the Seattle area. Nevertheless, retarded evaporation in the cool climate zone results in a very similar soil moisture regime, and will require no winter irrigation or special soil drainage.





Tundra

52. Tundra

muskox
caribou
arctic hare
ptarmigan

53. Polar Bear

54. Lemming

brown lemming
collared lemming

55. Snowy Owl Flight Cage

snowy owl

Exhibit: 52 Tundra

ANIMAL SPECIES: Caribou Muskox Arctic hare Ptarmigan

BIOCLIMATIC ZONE: TUNDRA

SETTING: Tundra/Taiga interface in northern mainland Northwest Territories, Canada

EXHIBIT LOCATION:

Northeastern area of the site including the area now used by the existing bison compound.

NOTE: The lower valley area of this exhibit is classified as Taiga. This is appropriate since the dominant animals in the exhibit, especially the caribou, may seasonally inhabit both bioclimatic zones.

ENCLOSURE AREA: 74,000 square feet.

TERRAIN: The exhibit is subdivided into three fairly distinct yet interconnected areas:

a. Tundra backshore (behind and adjacent to Polar Bear Exhibit) would be composed of semiconglomerated gravels and cobbles scoured by winter pack ice driven on shore and rilled by meltwater. The semiconglomerated till could be formed of concrete using very little Portland Cement in the mix and exposing the surface with a high-pressure hose before final setting occurs. Flatter areas of remnant till soil would show polygonal patterning typical of underlying ice wedges. These "sorted polygons" become "sorted steps" (Fairbridge, 1968: 373-376) on slopes and are characterized by cobble and gravel accumulations along the risers with finer material between. The central area of the exhibit should be slightly domed and would be the highest point around, allowing the muskoxen complete surveillance of their surroundings.

b. Well-drained upland flat behind the Otter Exhibit and near the existing Animal Barn.

c. Existing steep-sided valley leading to small artificial beaver pond.

SOIL:

a. Tundra backshore soil should be provided with planting-soil pockets for shrubs in protected and low-lying areas. The soil should be slightly acid, being formed of approximately one third peat, one third sand and one third loam. Soils for cotton-grass and sedges should be sandy and underlain by an impervious layer to maintain high levels of soil moisture.

b. Upland flat areas should be covered with 6" of well drained topsoil to resist compaction. Steep-sided valley. Soils on the slopes will be difficult to stabilize because of their slope. Rather than attempting to resurface the entire slope face it would be preferable to gravel-line animal trails as they occur on the slope. This should prevent or reduce erosion while providing abrasive surfaces for hoof conditioning. Applications of fertilizer and irrigation will greatly increase the vigor of existing turf on the slopes which, though heavily grazed, should then be able to stabilize the slope.

WATER:

a. The tundra backshore should contain several small pools or basins in low points where permafrost would impede drainage. These would serve as drinking areas and, most important, as wallows where animals can bathe in hot weather. The pools would be formed of heavily exposed aggregate concrete.

b. The upland flat would be cut by a stream which appears to be a continuation of the flow originating at the acid bog in the Trumpeter Swan Exhibit and passing through the Wolverine and Otter Exhibits. The stream, though not large, should flow rapidly over rounded exposed rocks over a gravel bed of heavily exposed aggregate concrete.

c. As the stream encounters the steep existing hillside drainage-way it will tumble and cascade over exposed boulders and cemented cobbles in a narrow, deeply incised channel. As the valley flattens out, the rushing water will enter the small beaver pond and flow through and over the top layers of this artificial structure, tumbling into a concealed pump vault from which it will be returned to its starting point at the upper end of the exhibit.

VEGETATION:

a. Tundra vegetation would comprise principally cottongrass *(Eriophorum)* and other sedges and grasses with a variety of forbs, especially *Saxifraga* and *Draba* but including a wide variety of cushion plants. The driest sites should include resin birch *(Betula glandulosa)*, Arctic willow *(Salix arctica)*, narrow-leaf Labrador tea *(Ledum decumbens)* and similar low-growing shrubs. Because of the small-scale nature of the planting and probable intensive browsing, plantings other than grasses and sedges should be restricted to areas outside the reach of the animals along pedestrian paths.

b. Vegetation in the well-drained flats would be characterized by a grassy turf with mixed open groves of paper birch *(Betula papyrifera)* and white spruce *(Picea glauca)*. Some existing Norway spruce and a memorable leaning larch will be retained

in this area.

c. Hillside plantings will include, on the north-facing slope, only white spruce. The south-facing slope will be turf covered with extensive plantings of creeping juniper *(Juniperus horizontalis)*.

VIEWING:

a. In the tundra area where distances are not great, visitors should always view the muskoxen and caribou from an inferior position. These barren-land ungulates find security in early detection of approaching danger and may experience undesirable stress if potential predators (man) are allowed to look down upon them from nearby or approach closely unseen. Recent experience of muskox cooperatives in Alaska has shown these animals to be readily trainable, but the choice of close approach to visitors should be left to the muskoxen themselves. In any case, the polar bears must not be allowed a higher elevation than these ungulates.

b. Views of the upland flat area and the lower hillside and valley are obtained from a simple overlook structure (Type 4). In this case, viewers would be farther from the animals and partially concealed, making the overlooking position acceptable.

BARRIERS:

The animal area is enclosed by a variety of barriers, including dry moats (Type A-1a), ha-has (Type C) and fencing (Type D-1).

ANIMAL SERVICE AREA:

The existing elk and deer barn will be refurbished for this exhibit.

UTILITIES:

Complete irrigation will be required.

Exhibit: 53 Polar Bear

BIOCLIMATIC ZONE: TUNDRA

SETTING: Arctic Ocean beach in northern Alaska.

EXHIBIT LOCATION:

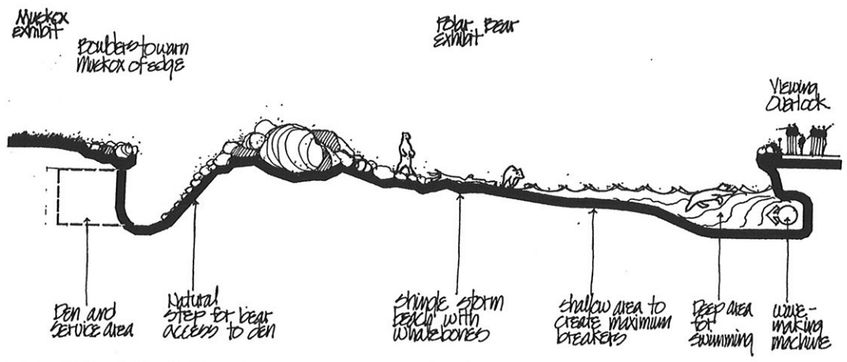
Occupying the area presently used by bison, adjacent to the Tundra Exhibit.

ENCLOSURE AREA: 16,700 square feet.

TERRAIN:

Steep shingle storm beach exposed to the Arctic Ocean. Small pieces of driftwood, bleached whale bones and torn rags of seaweed lining the high-tide line. The back slope of the storm beach will drop away quickly, concealing a deep moat separating the bears from the muskoxen and caribou of the adjacent exhibit, the terrain of which rises still higher in a series of flattened conglomerate ridges, their backs laid bare and broken as if by pack ice driven high on the shore by winter storms.

The beach would be constructed with a concrete slab base stepping



seaward with irregular terraces of about 1' vertical to 5' horizontal. These steps are necessary to prevent the gravel covering from gradually slumping under the continual traffic of the bears. Covering the steps would be a continuous slope of coarse water-washed gravel with a minimum depth of 12". Covering the gravel would be an additional 12" of dark rounded and ellipsoidal shingle of cobbles graded evenly with the largest stones (8" - 12") at and below water level and smaller stones and gravels at the summit of the beach ridge. This grading and sorting of stones would not only simulate the natural sorting of wave action but also visually enhance perspective, causing the beach to appear more extensive.

Several large boulders of weathered conglomerate rock (artifically created with exposed aggregate concrete) would be half buried near the top of the beach slope as if lodged there by sea ice. These would provide rubbing surfaces for the bears and objects for cubs to play around and on.

SOIL:

No soil required.

WATER:

The exhibit would be separated from the public by a frontal water moat, yet this would be far more than merely a barrier. With a

little imagination the water could become a channel of the Arctic Ocean, with the viewer standing on some close-in barrier island. The water would penetrate the exhibit with a deep bay allowing the bears 30% of their exhibit area for swimming. Like the Arctic Ocean, the water would be set in constant rhythmic motion by small wave-making machines such as are now in some public swimming pools.

VEGETATION:

No vegetation required, except occasional rockweed *(Fucus)* remnants at the "high tide" line.

VIEWING:

The overall character of the exhibit has already been described. Viewing should ideally be from the north to backlight the bears' white coats against the dark gravel beach and emphasize the sparkle and motion of the water. Provision should be made to allow access to the lower angles of the setting sun for the most dramatic natural lighting. The barrier beach itself could be crescent-shaped around the swimming bay, so that some of the beach would be constantly in shadow while some is sunlit.

BARRIERS:

The frontal barrier is a modified Type A-1b water moat while the rear barrier is a Type A-2 dry moat, except for a short separate section of Type A-1a dry moat giving the bears access to their dens.

ANIMAL SERVICE AREA:

The den and service facilities for the polar bears would be located under the Tundra Exhibit and entered by the bears from the moat behind the barrier beach. Maintenance access to the facility would be via an access tunnel from between the Polar Bear and Tundra Exhibits.

Exhibit: 54 Lemming

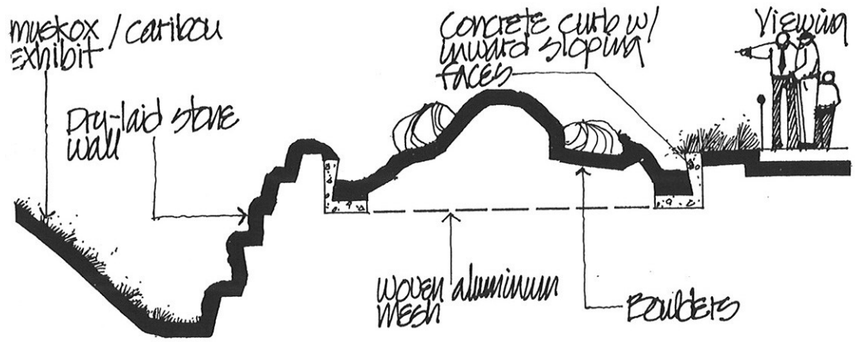
ANIMAL SPECIES: Brown lemming
Collared lemming

BIOCLIMATIC ZONE: TUNDRA

SETTING: Northern mainland, Northwest Territories, Canada

EXHIBIT LOCATION: Adjacent to Tundra Interpretive Center

ENCLOSURE AREA: 1,000 square feet.



TERRAIN:

A rockpile of frost-shattered boulders and stone chips set on a gravel mound above a lower area of poorly drained wet tundra.

WATER:

A small, very shallow pool would be maintained in the center of the wet area.

VEGETATION:

The upper area of the animal enclosure would be largely unvegetated, as if emerging too recently from the ice to support higher plants, and even the lichens homesteading protected crevices in the angular stone faces should be poorly developed.

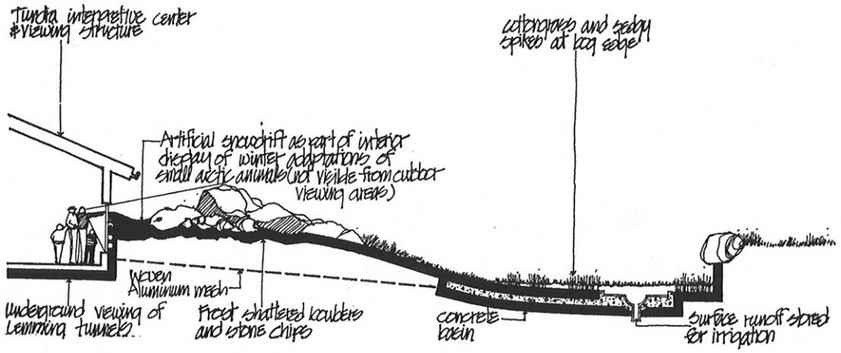
Low pillows of dwarf Alaska blue willow *(Salix purpurea gracilis* 'nana'), sheared to appear wind-pruned, would huddle in the protection of rocks and low ridges in areas of intermediate elevation, along with saxifrage *(Saxifraga)* and Arctic poppy *(Papaver radicatum)*. Lower still, airy clumps of cottongrass *(Eriophorum)* and sedge spikes would mark the boggy area. The same plants would be used in similar settings outside the animal area, especially between the walkway and the exhibit moat.

VIEWING:

The exhibit will be viewed from two quite different aspects:

1. Within the Tundra Interpretive Center, visitors will be able to watch lemmings moving within their underground and undersnow tunnels through a special buried glass window. The mantle of snow would be artificial and not visible from outdoor areas. A demonstration of undersnow activities is very important in interpreting the lemmings' special adaptations to 9 months of Arctic winter.

2. Outdoor viewing will be from along a pathway across a very low moat with views of the Tundra Exhibit beyond.



BARRIERS:

The entire animal area will be encompassed within a curving 12'-high inwardly inclining curb. The curb will be overhung with rocks or low plants. The area of sedges will be lined with a thin lining of concrete, and the remainder of the animal area will be built over a buried mesh of fine rustproof woven aluminum.

Between the Lemming Exhibit and the Tundra Exhibit a 6'-deep ha-ha with a drylaid stone wall will supply required separation.

ANIMAL SERVICE AREA:

None required.

UTILITIES:

Irrigation will be required.

Exhibit: 55 Snowy Owl Flight Cage

BIOCLIMATIC ZONE: TUNDRA

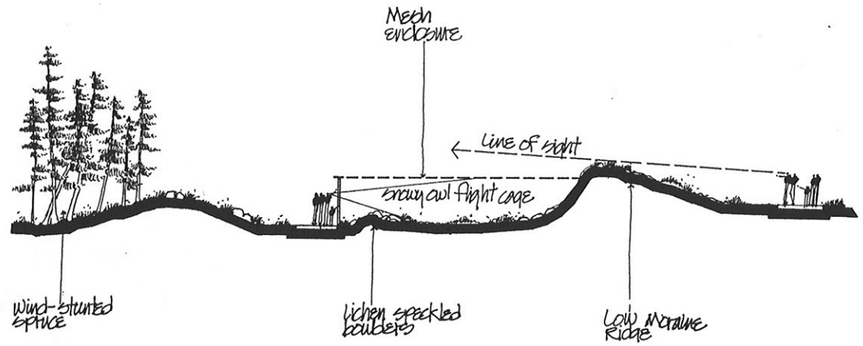
SETTING: Northern mainland, Northwest Territories, Canada

EXHIBIT LOCATION: Eastern margin of tundra exhibits.

ENCLOSURE AREA: 3,100 square feet.

TERRAIN:

Gently sloping area between a steep gravel bank on the west and a more rounded rise on the east. Here and there clusters of rock and cobble will rise above the surface. One of these, larger than the rest (4' high), will serve as the principal perch for the owls.



SOIL, WATER & VEGETATION:

Similar to that described in the tundra area of the muskox/caribou exhibit.

VIEWING:

The path passing the Polar Bear Exhibit, Tundra Interpretive Center and Tundra Exhibit will continue around a sloping curve past the end of a low moraine. From this point the viewer will first glimpse a large level area overlooked by the moraine ridge. The path approaches the owl roosting rock obliquely, then circles past it at a distance of some 15', bearing south toward the taiga and temperate rain forest exhibits. Viewing is through a series of portals in the mesh enclosure, each provided with taut fine harp wire. Between viewing areas the path pulls slightly away from the fencing, which is partially obscured by plantings of Arctic willow and wind-stunted spruce.

BARRIERS:

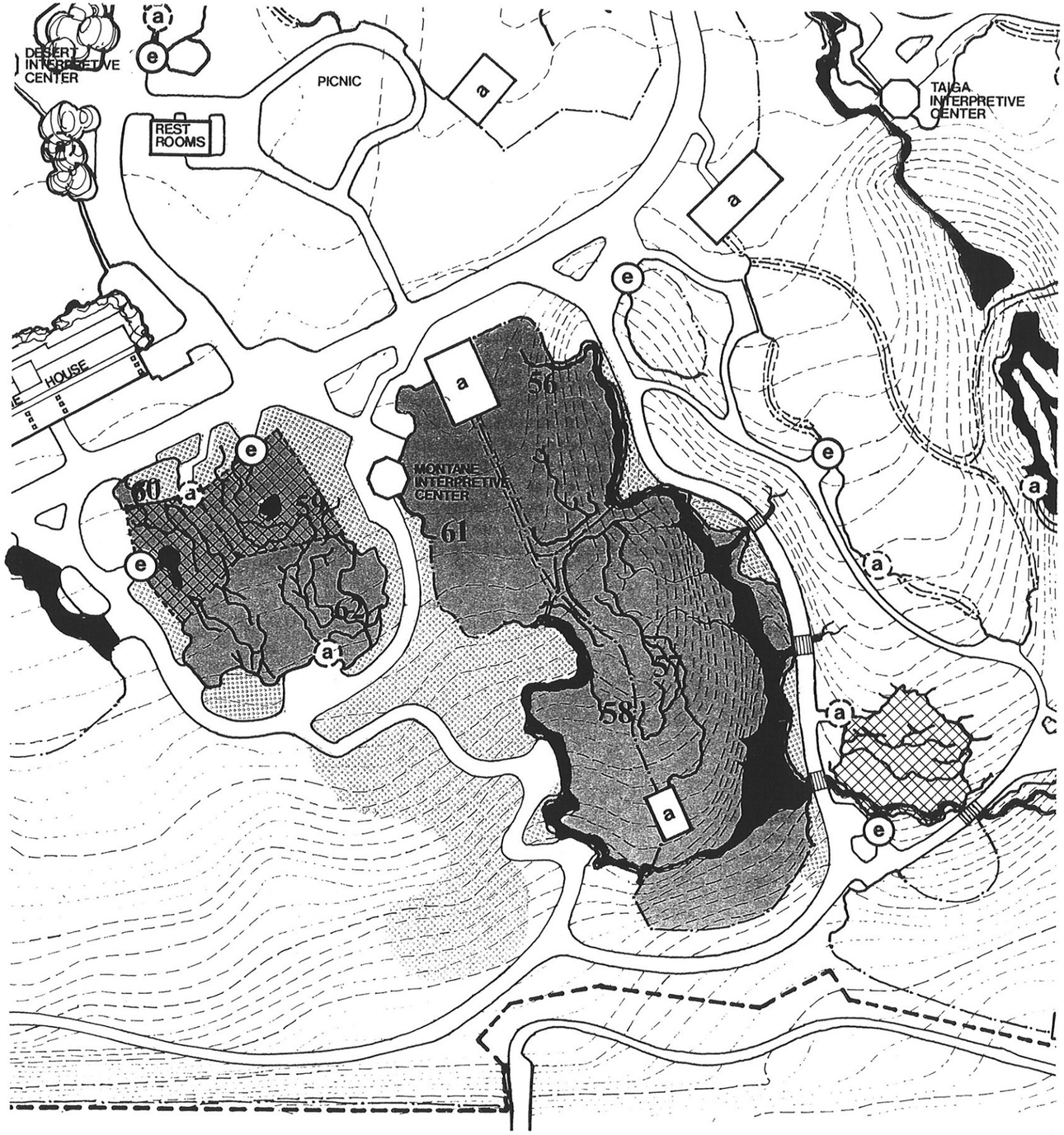
The entire flight cage is enclosed by a horizontal tent-like cover of fine nylon mesh supported by steel cable as conceptualized in the above sketch. The mesh should be fine enough to exclude crows and starlings.

ANIMAL SERVICE AREA:

None required. Several of the rocks could be arranged with a slight overhang to give some protection from heavy or driven rain.

UTILITIES:

Irrigation will be required.



Montane

56. **Bighorn Sheep**
57. **Mountain Goat**

    mountain goat
    hoary marmot
    pika
58. **Ibex**
59. **Snow Leopard**
60. **Lesser Panda**
61. **Takin**

    takin
    golden pheasant
62. **Tahr**

Montane Complex

ANIMAL SPECIES: see exhibit scenarios 56-62

TERRAIN:

Although each exhibit will vary, the following general elements occur in each.

1. Cliff faces and narrow ledges will provide an essentially vertical environment in which the animals can display their highly evolved adaptations to alpine life. The forms constructed should approximate as closely as possible the natural geological and visual characteristics of the habitat intended. The degree of difficulty encountered by the animals in negotiating the terrain should vary with the full range of the animals' ability, from the inconsequential to the insurmountable.

2. Talus slopes and avalanche chutes should be constructed of large lodged boulders anchoring a surface layer of much smaller angular shattered debris matching the material of the cliff faces. The vertical angle of the talus slopes should very nearly match the natural repose angle this material assumes when dumped in stockpiles. The anchoring boulders should prevent the talus from slumping under the traffic of passing animals. The talus should appear to fill upper drainage-ways and spread in characteristic fans where they emerge at the base of cliffs. In areas protected from slopewash and avalanche by salient rockfaces, alpine-appearing vegetation should be established as described in the individual scenarios.

3. Lower boulder fields: on high mountain hillsides, large boulders, once loosened, fall and tumble farther downslope than do smaller rocks due to their greater momentum. It is thus common to see talus slopes graded by size, with fine sands and gravels at the highest points and great boulders lodged in chaotic accumulation at the base of the slope or scattered widely over lower alpine meadows. It is of interest to note that whether dealing with vast talus fans at the base of towering pinnacles or minor accumulations of slopewash at the base of an insignificant rock face, the positions and proportions of materials making up the slopes are similar and can lead frequently to confusions of scale and distance. The same phenomenon that causes alpinists to underestimate distances in high mountain areas can cause zoo visitors to overestimate the size and extent of a well-designed exhibit, even with animals present to give a scale reference.

4. Mountain rills and cascades will be used in all exhibits to a greater or lesser extent. In the semiarid Bighorn Exhibit water will be limited to a narrow stream paralleling the path at the base of the exhibit, while the abundant web of meltwater runnels and sparkling rills will enmesh portions of the mountain goat hillside.

In all cases, the volume of water must be proportional to the area of the drainage and its source must be shown or clearly and believably implied.

5. Artificial snow: The primary source of surface water in alpine areas is snow and ice. Typically, following a high mountain rivulet to its source, one finds a glistening, pocked snow field with a small black-holed ice cave at its source, from which the stream emerges sparkling into the sunlight. Such an ice field, if small and located some distance from viewers, could be very realistically replicated using white plastered concrete such as is used to line swimming pools or fiberglass or a combination of the two. A mold taken from a natural snowfield could even be used to form the artificial surface. In addition to this "permanent" snowfield, future research may prove the feasibility of placing machine-produced snow, allowing it to be used in the tundra exhibits as well.

6. Construction of the mountains: Two large mountain forms are planned. They may be formed on extensive compacted earth fills (possibly of material collected and stockpiled in advance) or may have a skeleton of steel girders. Actual construction recommendations require research beyond the scope of this report, but mention of these alternatives may encourage useful future considerations. In both cases, an artificial rock skin will in all likelihood be more versatile and less expensive than individually placed natural boulders of the size required.

Exhibit: 56 Bighorn Sheep

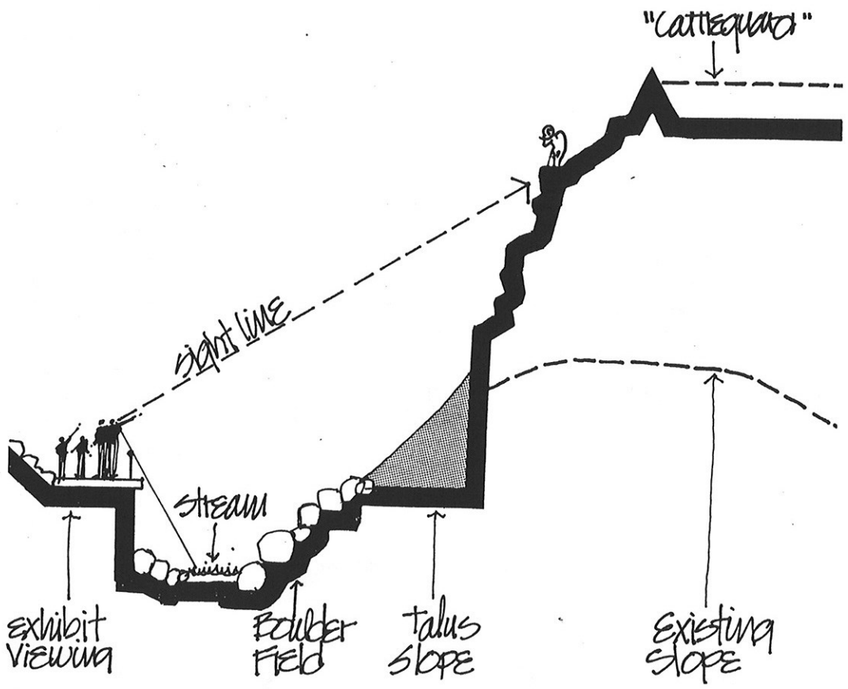
BIOCLIMATIC ZONE: MONTANE

SETTING: Colorado Rockies

EXHIBIT LOCATION: Between Chaparral Exhibit and Mountain Goat Exhibit

ENCLOSURE AREA: 15,100 square feet

TERRAIN:



Steep cliffs and ledges of dark brown basalt or rhyolite skirted with talus fans and broad boulders reaching down into a quick sparkling stream. The cliffs rise almost immediately above the stream and in fact, some overhang it, presenting the animals very close to, and high above, the viewers on the trail across the stream.

SOIL:

Angular stones, gravels and finer debris of crushed material matching the cliff faces and boulders.

WATER:

The stream, tumbled and blocked by innumerable boulders obscuring its concrete channel will be collected in a series of small pools behind obstructing rockfalls and surrounded by grassy meadows. The water will be recirculated within the limits of the exhibit but will appear continuous with the stream flowing on by the Mountain Goat Exhibit.

VEGETATION:

Protected (moated) pockets and areas within the exhibit on the visitor's side of the stream, beyond reach of the sheep, will be planted to ponderosa pine *(Pinus ponderosa)*, scrub oak *(Quercus gambelii)*, pinyon pine *(Pinus edulis)* and Rocky Mountain juniper *(Juniperus scopulorum)*. Some of these will also be planted in well-drained pockets on inaccessible ledges in the cliff face itself. Foreground areas will be planted with a wide variety of annual and perennial wild flowers including *Lupinus*, *Aquilegia*, *Penstemon*, etc.

VIEWING:

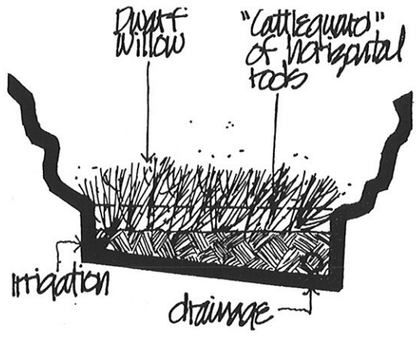
Will be from the trail with several overlook points. The trail will be made of close-fitting flagstones and angular split rocks carefully set on a compacted sand base. The path would be elevated above the stream (moat) by a drylaid stone wall of similar material, such as are found along high handmade trails in mountain areas.

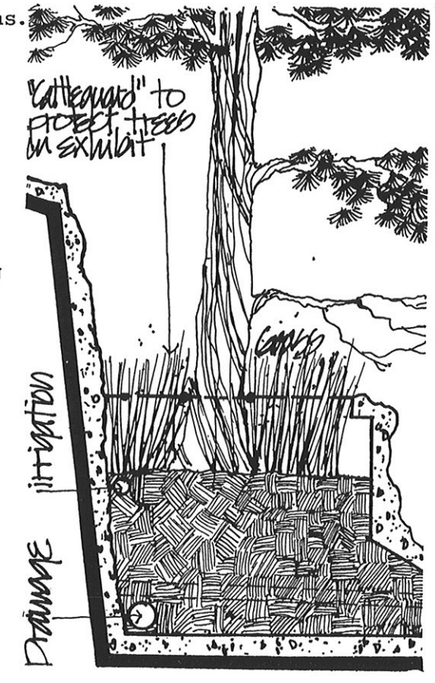
BARRIERS:

As have been discussed in the general MONTANE COMPLEX description (Barrier Type A-3).

ANIMAL SERVICE AREA:

Will be provided by the existing barn structure.





UTILITIES:

Irrigation will be required to maintain turf within the animal area, and special trickle irrigation will be required along with excellent drainage for vegetation planted in cliffside niches.

Exhibit: 57 Mountain Goat

ANIMAL SPECIES: Mountain goat
Hoary marmot
Pika

BIOCLIMATIC ZONE: MONTANE

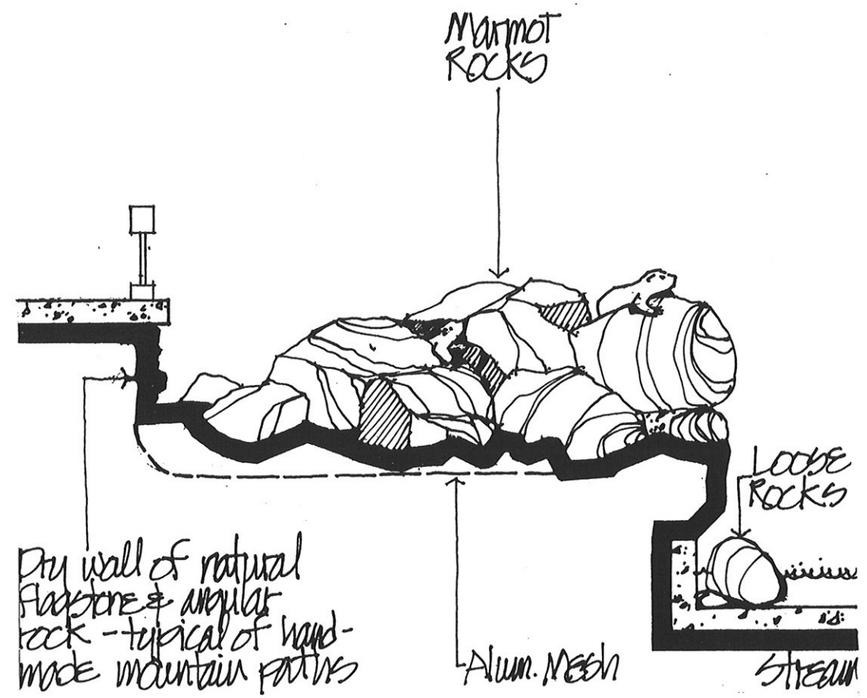
SETTING: Cascade Mountains

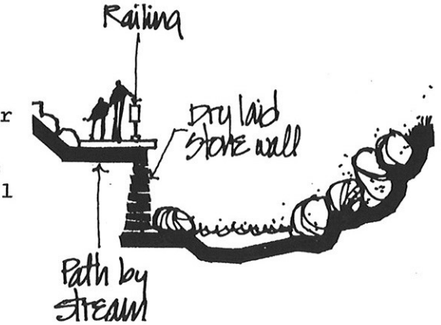
EXHIBIT LOCATION: Adjacent to Bighorn Sheep Exhibit and Cougar Exhibit

ENCLOSURE AREA: 43,300 square feet

TERRAIN:

Peaks and ridges with long sweeping talus slopes and abundant sparkling rivulets. Other small cascades will descend the opposite ridge (below the Gray Wolf Exhibit) and pass beneath the trail under simple bridges to join the pools and stream bordering the animal area. A crescent-shaped moraine deposit will contain the lowest and largest of the ponds and will direct the main stream back under the path and toward the Cougar Exhibit. Boulder piles near the trail overlooking the stream will house marmot and pika exhibits.





SOIL:

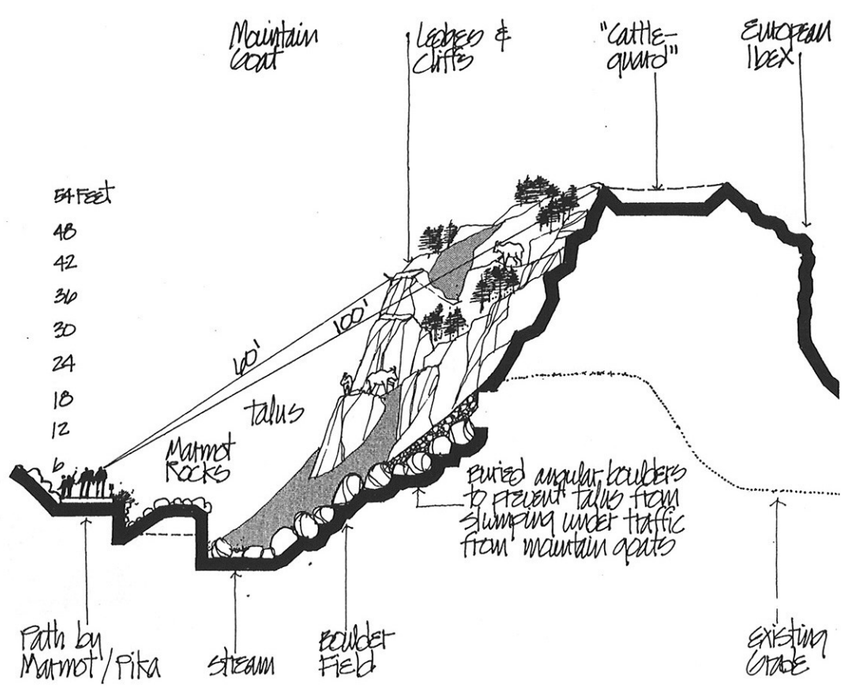
Coarse and well-drained.

WATER:

Ponds and streams will be concrete-lined and recirculated within the limits of the exhibit.

VEGETATION:

Foreground plantings will include *Luetkea pectinata, Phyllodoce empetriformis, Cassiope mertensiana* and others characteristic of the Cascade Mountains alpine zone. These same plant materials will be used in inaccessible or protected niches within the animal area. Otherwise planting will be limited to turf interplanted with low flowering forbs such as *Lupinus latifolius, Valeriana sitchensis,*



and *Veratrum viride*. Sedges *(Carex)* and rushes *(Juncus)* will be used in wetter areas.

VIEWING:

Will be from the trail and informally developed overlooks.

BARRIERS:

As have been described in the MONTANE COMPLEX general summary (Barrier Type A-3).

ANIMAL SERVICE AREA:

The existing pygmy sheep area will be refurbished and possibly enlarged to hold both mountain goat and ibex.

UTILITIES:

The exhibit will require irrigation. In addition, rain water should be channeled and held to provide as much of the irrigation as possible to hard-water-intolerant alpine plants.

Exhibit: 58 Ibex

BIOCLIMATIC ZONE: MONTANE

SETTING: Alps

EXHIBIT LOCATION: Between Mountain Goat and Takin

ENCLOSURE AREA: 14,600 square feet

TERRAIN:

High alpine meadows with a backdrop of great granite boulders bedded in grass-covered moraine material. Steep stream-cut banks form the moated frontal barrier.

SOIL:

Very fast-draining to prevent hoof problems and to minimize turf damage from trampling. Pathways worn by animals will be surfaced with sharp crushed gravel to aid in hoof abrasion. Natural cobbles will be set in sedge and marshy areas to prevent destruction of the soil.

WATER:

A small quiet stream will flow through soft meadows and sedge-edged banks into small pools with occasional granite boulders set in the water and along the banks. The stream will be concrete-lined with a surface of exposed cobbles. The water will be recycled within the exhibit but will appear to continue on to the Mountain Goat Exhibit.

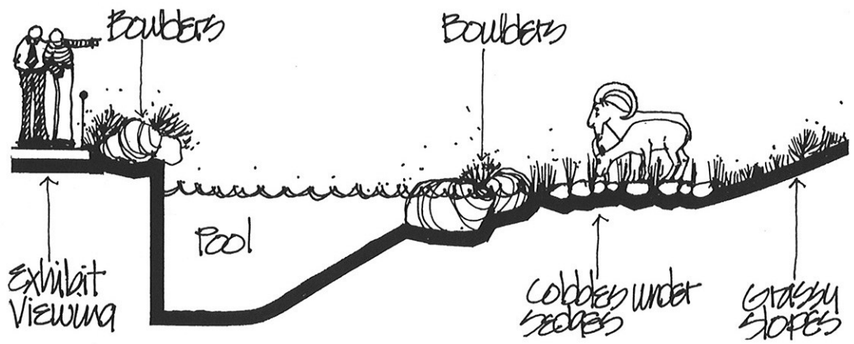
VEGETATION:

Within the exhibit will be principally grasses and low flowering forbs, in particular those characteristic of the European montane zone.

An existing slump of Swiss mountain pine *(Pinus mugo)* will be used in a foreground setting among a clump of boulders while clumps of this same species will be planted in protected locations. An existing stand of Norway spruce *(Picea abies)* forms a natural backdrop for the lower portions of the exhibit. Dwarf birch *(Betula nana)*, alder *(Alnus viridis)*, stone pine *(Pinus cembra)* and larch *(Larix decidua)* will be planted in dense low isolated clumps, pruned to show the effects of their harsh environment. In the foreground areas plantings of European alpine wild flowers will be made to include species of primrose *(Primula)*, gentian *(Gentiana)*, buttercup *(Ranunculus)*, campanula *(Campanula)*, silver thistle *(Carlina acaulis)* and of course edelweiss *(Leontopodium alpinum)*.

VIEWING:

Two overlooks (Type 2) will provide views across a wet moat containing the quiet pools described above.



BARRIERS:

The frontal barrier will be composed of the stream with its high banks and the pools (wet moat type A-1b) with lower banks. Planting areas and rear drymoats will be covered with modified "cattleguard", (Barrier Type A-3).

ANIMAL SERVICE AREA:

The existing small log-surfaced barn will be re-roofed with sod and refurbished for the ibex.

UTILITIES: Irrigation will be required.

Exhibit: 59 Snow Leopard

BIOCLIMATIC ZONE: MONTANE

SETTING: Nepal

EXHIBIT LOCATION: Adjacent to Tahr and Takin Exhibits. The Snow Leopard Exhibit will be divided into two separate enclosures, one facing south and the other north.

ENCLOSURE AREA: 11,100 square feet

TERRAIN:

Both areas will show very steep terrain with high sunny exposed ledges of red rhyolite and basalt. The south exhibit area will represent a high rough landscape recently emerged from the glacial domain. Rocks will appear unstable and a small talus fan will grow out of a deep cleft in the cliff face. The north exhibit, in contrast, will be softer with stone edges more rounded and worn. Vegetation will cover lower slopes and burst forth from protected locations under boulders and above cliff faces.

SOIL:

In the south exhibit will be principally basalt gravel. In the north area very freely draining soils will be required to keep the area dry despite heavy areas of planting.

WATER:

Small pools are found in both exhibits. The north area pool will be fed by a small trickly rivulet arranged to sparkle in the afternoon sun of summer. It would not be operated at other times of the year and would not be great enough to noticeably affect humidity.

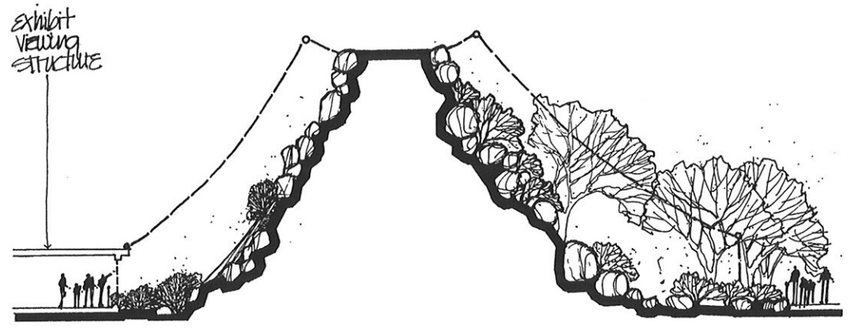
VEGETATION:

Planting in the south exhibit area will be limited to low twiggy and spiny shrubs such as *Lonicera pileata; Juniperus communis*, and *Artemisia*, with one thick mass of evergreen oak *(Quercus hypoleuca)* and tartarian honeysuckle *(Lonicera tatarica)*.

The north-facing exhibit will replicate a lower, moister and more heavily vegetated habitat. Several clumps of evergreen oak *(Quercus hypoleuca)* will be opened up by pruning to give the appearance of heavy browsing by wild goats. Dense plantings of *Rhododendron* and tea *(Camellia sinensis)* will frame views and obscure barrier mesh. Colorful ground covers of *Cotoneaster congesta* and *C. dammeri* will cover steeper slopes.

VIEWING:

The south exhibit area will be viewed from a covered Exhibit



Interpretive Center (Overlook Type 6) designed so that its structure eclipses all views of wire mesh. The north exhibit will be viewed from a tertiary path of gravel through a curtain of protective mesh.

BARRIERS:

Both areas will be completely enclosed in tent-like structures of draped mesh similar to that described for the leopard and cougar.

ANIMAL SERVICE AREA:

Will be located within the base of the "mountain".

UTILITIES:

Subsurface irrigation and drainage will be required within the exhibits.

Exhibit: 60 Lesser Panda

BIOCLIMATIC ZONE: MONTANE

SETTING: Moist mountain forest in the Himalayas

EXHIBIT LOCATION:

Between the southwest corner of the Snow Leopard Exhibit and the primary circulation pathway. This exhibit carries the visitor through the transition from wet southeast Asia to the equally wet Himalayan heights.

ENCLOSURE AREA: 1,200 square feet

TERRAIN:

As one edge of the massif supporting the Snow Leopard and Tahr Exhibits, this area features ledges, hollows (one of which leads to the interior) and montane vegetation. Sloping rather sharply up

from path level, it terminates in an overhang covered by cascades of vines and colored by lichens.

SOIL:

Primarily bedrock, dark gray to paler metamorphics (gunite-simulated) and dark soil in plantings.

WATER:

Small pool on one ledge for bathing and drinking, fed by trickle and draining to bottom of exhibit, where it will be recirculated.

VEGETATION:

A variety of ericaceous shrubs, small junipers, *Podocarpus* and small bamboos will furnish the dominant vegetation in the exhibit, with an attempt made to discover plants shunned by these herbivorous animals. The cliff overhang can be planted with vines, ferns and mosses.

VIEWING:

An open overlook on the west side (below) will allow close views of the pandas in small trees or on ledges. The top of the massif will obscure the mesh of the Snow Leopard Exhibit beyond. Adequate openings in the vegetation above the exhibit should allow basking in the afternoon sun by both pandas and viewers.

BARRIERS:

Moat wall in front, cliff overhang behind.

ANIMAL SERVICE AREA:

Combined with the snow leopard area in the interior of the massif.

UTILITIES:

An irrigation system to keep the rockface plants moist during dry periods will be necessary.

Exhibit: 61 Takin

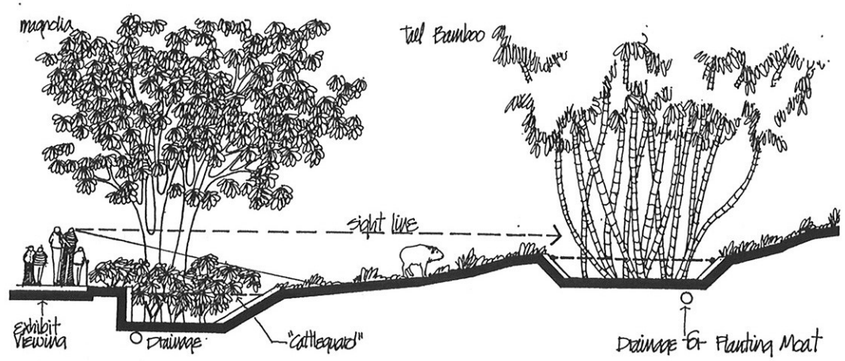
BIOCLIMATIC ZONE: MONTANE

SETTING: Szechwan, Eastern Himalayas

EXHIBIT LOCATION: Across from Snow Leopard Exhibit

ENCLOSURE AREA: 14,100 square feet

TERRAIN: Forested saddle of gently sloping land.



SOIL:

Dark, well drained to resist compaction. Sharp textured sand and fine dark crushed gravel will be used to surface animal trails and worn areas.

WATER: No water features are planned for this area.

VEGETATION:

Several sun-speckled clearings will be overhung with long-caned bamboos *(Phyllostachys bambusoides)*, tall rhododendrons *(R. arboreum, R. campanulatum)* and magnolias *(M. campbellii* varieties) underplanted with tea *(Camellia sinensis)*. Strong-growing vines such as *Stauntonia hexaphylla* (which resembles the climate-zone native *Holboellia)* and *Clematis chrysocoma* and *C. montana* will be planted to climb the existing maple trees in the exhibit.

VIEWING:

Visitors will stand in the dappled shade of rich overhanging foliage observing the animals (Type 2 Overlook) through a semi-transparent screen of bamboo.

BARRIERS:

The forward edge of the animal area will be contained by a Type A-1b dry moat with side transitions through Type B walls to Type D fence and finally to Type C ha-ha along the rear of the exhibit.

ANIMAL SERVICE AREA:

One section of the existing farm barn will be refurbished for the Takin.

UTILITIES:

Irrigation and drainage will be required in all planting areas.

Exhibit: 62 Tahr

BIOCLIMATIC ZONE: MONTANE

SETTING: Nepal

EXHIBIT LOCATION: Share mountain with Snow Leopard Exhibit.

ENCLOSURE AREA: 13,500 square feet

TERRAIN:

Bare steep cliff and ragged boulder piles of red rhyolite and basalt, similar to the south Snow Leopard Exhibit, but more coarse and broken.

SOIL:

Broken stone chips and scree anchored to slopes by a layer of rough buried boulders.

WATER:

No water features are required.

VEGETATION:

Where occurring, the vegetation will be very similar to that of the south snow leopard area. Evergreen oak *(Quercus hypoleuca)* and tartarian honeysuckle *(Lonicera tatarica)* will form dense masses screening the mesh of adjacent snow leopard enclosures. Lower plantings of juniper *(Juniperus communis)*, honeysuckle *(Lonicera hypoleuca* and *L. obovata)* and pruned evergreen oak will be planted in the frontal dry moat. Behind and around the viewing area, dense stands of evergreen oak and tall juniper *(J. scopulorum)* will surround the viewer.

VIEWING:

Onlookers will view the tahr across the planted frontal dry moat. If the animals are on higher cliffs, they will be silhouetted against the bright western sky, emphasizing the height and steepness of their habitat.

BARRIERS:

All barriers will be of the stretched rod "cattleguard" type of planted dry moat (Barrier Type A-3).

ANIMAL SERVICE AREA:

Shall be located under a massive rockslide within the structural framework of the "mountain".

UTILITIES:

All planting areas will require subsurface irrigation and drainage.

Special Exhibits

Exhibit: 63 Small Carnivore House

ANIMAL SPECIES: Ocelot
Serval
Genet
Black-footed cat
Pallas' cat
Weasel

BIOCLIMATIC ZONE: VARIOUS

SETTING: Various

EXHIBIT LOCATION: Within existing Feline House

ENCLOSURE AREA: 1,500 square feet

SCENARIO SUMMARY:

It is proposed that one-half of the existing Feline House be renovated to exhibit carnivores which are too small or too delicate for outdoor display. They would be shown in small climate-controlled enclosures and wherever possible would be surrounded by living vegetation from their native habitat. Although a wide range of bioclimatic zones would be demonstrated, they would be arranged in naturally occuring sequence with appropriate transitions and juxtapositions, consistent with the overall zoo presentation theme.

Development of living indoor habitats will require an extensive infrastructure of utilities, each exhibit zoned separately.

Exhibit: 64 Raptor Flight Cage

ANIMAL SPECIES: Bald eagle
Golden eagle
Peregrine falcon
Prairie falcon

BIOCLIMATIC ZONE: VARIOUS

SETTING: Various

EXHIBIT LOCATION:

In the area now occupied by the pony rides.

ENCLOSURE AREA: 2,800 square feet.

SCENARIO SUMMARY:

The raptor species listed naturally range over portions of the earth encompassing several bioclimatic zones. Thus, arbitrary assignment to a specific zone would not accurately describe the compass of their activities and influence. Therefore, these raptors are exhibited together for reasons of efficiency of common need and special supervision, sharing alternately a large free-flight cage from adjoining smaller holding areas, themselves of generous dimensions.

Perches within the enclosure will be provided from substantial dead snags with horizontal branching. Several large trees existing in the area will be included in the central flight cage.

Exhibit: 65 Reptile House

ANIMAL SPECIES: (Existing collection of reptiles and amphibians)

BIOCLIMATIC ZONE: VARIOUS

SETTING: Various

EXHIBIT LOCATION: Existing Reptile House

ENCLOSURE AREA: 5,500 sq. ft.

SCENARIO SUMMARY:

Existing exhibits for reptiles and amphibians presently have no overall sense of organization. Therefore it is recommended that exhibits be reorganized first into bioclimatic zones, and second into zoogeographic displays with appropriate transitional relationships defined. Development of each of these small display areas should be guided by individual scenarios which are beyond the scope of this report. These would include, where appropriate, addition of bird and insect species to more accurately reveal the diversity of life forms within. Also, characteristic living plants would be more widely used in both animal and public areas. If these modifications were adopted, it would require modification and extension of skylights. The possibility of an automatic irrigation system would also need detailed investigation. Also, existing artificial rocks and trees should be completely covered with vegetation or replaced with better replications or wholly natural materials.

(See *Scenario* 8, Tree Shrew)

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List of Animals

Systematic List of Mammals and Birds for Exhibition

ORDER / FAMILY	COMMON NAME	SCIENTIFIC NAME	ZONE	EXHIBIT
	MAMMALS			
MARSUPIALIA				
Dasyuridae	jerboa pouched mouse	*Antechinomys laniger*	D	32f
Macropodidae	wallaroo*	*Macropus robustus*	S	27a
	tree kangaroo	*Dendrolagus sp.*	TF	15
CHIROPTERA				
Phyllostomatidae	vampire bat*	*Desmodus rotundus*	TF	16a
PRIMATES				
Tupaiidae	tree shrew	*Tupaia montana*	TF	8
Lemuridae	ring-tailed lemur*	*Lemur catta*	TF	5
	ruffed lemur*	*Lemur variegatus*	TF	5
Lorisidae	slow loris*	*Nycticebus coucang*	TF	16h
	lesser galago*	*Galago senegalensis*	TF	16e
	thick-tailed galago*	*Galago crassicaudatus*	TF	16f
Cebidae	squirrel monkey*	*Saimiri sciureus*	TF	1a
	woolly monkey	*Lagothrix lagothricha*	TF	1a
Cercopithecidae	Diana monkey*	*Cercopithecus diana*	TF	4a
	DeBrazza monkey*	*Cercopithecus neglectus*	TF	4b
	patas monkey*	*Erythrocebus patas*	S	19
	Celebes black ape*	*Cynopithecus niger*	TF	9
	lion-tailed macaque*	*Macaca silenus*	TF	10
	anubis baboon	*Papio anubis*	S	18
	black-and-white colobus	*Colobus abyssinicus*	TF	4a
Pongidae	siamang*	*Symphalangus syndactylus*	TF	7
	gorilla*	*Gorilla gorilla*	TF	3
	orang-utan*	*Pongo pygmaeus*	TF	7
EDENTATA				
Bradypodidae	two-toed sloth*	*Choloepus didactylus*	TF	16b

KEY: TF - Tropical Forest
S - Savanna
D - Desert
ST - Steppe
C - Chaparral
TD - Temperate Deciduous Forest
TR - Temperate Rain Forest
T - Taiga
TU - Tundra
M - Montane

* - On zoo inventory January 1976

LAGOMORPHA				
Ochotonidae	pika	*Ochotona princeps*	M	57
Leporidae	arctic hare	*Lepus arcticus*	TU	52
	snowshoe hare	*Lepus americanus*	T	51
	white-tailed jackrabbit	*Lepus townsendi*	ST	33
	black-tailed jackrabbit	*Lepus californicus*	C	39
	antelope jackrabbit	*Lepus alleni*	D	28
	European rabbit	*Oryctolagus cuniculus*	TD	42
	eastern cottontail	*Sylvilagus floridanus*	TD	40
	brush rabbit	*Sylvilagus bachmani*	C	39
RODENTIA				
Sciuridae	antelope squirrel	*Ammospermophilus sp.*	D	28
	ground squirrel	*Spermophilus sp.*	ST	33
	black-tailed prairie dog	*Cynomys ludovicianus*	ST	33
	hoary marmot	*Marmota caligata*	M	57
Caviidae	Patagonian cavy	*Dolichotis patagonica*	ST	35
Hydrochoeridae	capybara	*Hydrochoerus hydrochaeris*	TF	1a
Dinomyidae	pacarana	*Dinomys branicki*	TF	1c
Chinchillidae	vizcacha	*Lagostomus maximus*	ST	37
Octodontidae	degu*	*Octodon degus*	D	32c
Erethizontidae	prehensile-tailed porcupine*	*Coendou prehensilis*	TF	16d
Cricetidae	gerbil	*Gerbillus* or *Tatera sp.*	D	32e
	brown lemming	*Lemmus trimucronatus*	TU	54
	collared lemming	*Dicrostonyx groenlandicus*	TU	54
Dipodidae	jerboa	*Jaculus* or *Allactagus sp.*	D	32d
Heteromyidae	kangaroo rat	*Dipodomys sp.*	D	32b
Hystricidae	crested porcupine*	*Hystrix galeata*	TF	16g
CARNIVORA				
Canidae	gray wolf*	*Canis lupus*	TR	45
	maned wolf	*Chrysocyon brachyurus*	ST	36
	hunting dog	*Lycaon pictus*	S	22
Ursidae	brown bear*	*Ursus arctos*	T	48
	polar bear*	*Ursus maritimus*	TU	53
	sloth bear*	*Melursus ursinus*	TF	13
Procyonidae	ringtail cat	*Bassariscus astutus*	D	32a
	coati	*Nasua sp.*	TF	1b
	kinkajou*	*Potos flavus*	TF	16c
	lesser panda	*Ailurus fulgens*	M	60
Mustelidae	weasel	*Mustela sp.*	T	63f
	river otter*	*Lutra canadensis*	T	49
	wolverine	*Gulo luscus*	T	50
Viverridae	genet	*Genetta sp.*	S	63c
	meerkat	*Suricata suricatta*	S	23
Felidae	Pallas' cat	*Felis manul*	ST	63e
	black-footed cat	*Felis nigripes*	D	63d
	ocelot*	*Felis pardalis*	TF	63a
	serval	*Leptailurus serval*	S	63b
	cougar*	*Puma concolor*	TR	44
	snow leopard*	*Uncia uncia*	M	59
	leopard*	*Panthera pardus*	S	21
	tiger*	*Panthera tigris*	TF	11
	lion*	*Panthera leo*	S	20

HYRACOIDEA				
Procaviidae	rock hyrax	*Procavia capensis*	S	17
PERISSODACTYLA				
Equidae	zebra*	*Equus burchelli*	S	17
Tapiridae	Malayan tapir	*Tapirus indicus*	TF	12
Rhinocerotidae	Indian rhinoceros	*Rhinoceros unicornis*	TF	14
ARTIODACTYLA				
Tayassuidae	collared peccary	*Tayassu tajacu*	D	28
Suidae	warthog	*Phacochoerus aethiopicus*	S	17
Hippopotamidae	hippopotamus*	*Hippopotamus amphibius*	S	24
Camelidae	guanaco	*Lama guanicoe*	ST	35
Cervidae	red deer	*Cervus elephas*	TD	42
	wapiti*	*Cervus elephas*	TR	46
	axis deer*	*Axis axis*	TF	13
	white-tailed deer*	*Odocoileus virginianus*	TD	40
	caribou	*Rangifer tarandus*	TU	52
Giraffidae	okapi	*Okapia johnstoni*	TF	6
	giraffe*	*Giraffa camelopardalis*	S	17
Antilocapridae	pronghorn	*Antilocapra americana*	ST	33
Bovidae	bison*	*Bison bison*	ST	33
	duiker	*Cephalophus sp.*	TF	6
	waterbuck	*Kobus defassa*	S	17
	gazelle	*Gazella sp.*	S	17
	klipspringer	*Oreotragus oreotragus*	D	30
	addax	*Addax nasomaculatus*	D	31
	muskox	*Ovibos moschatus*	TU	52
	ibex	*Capra hircus*	M	58
	bighorn sheep	*Ovis canadensis*	M	56
	Barbary sheep*	*Ammotragus lervia*	D	29
	tahr	*Hemitragus jemlahicus*	M	62
	takin	*Budorcas taxicolor*	M	61
	mountain goat	*Oreamnos americanus*	M	57

BIRDS

RHEIFORMES				
Rheidae	common rhea	*Rhea americana*	ST	35
CASUARIIFORMES				
Dromiceiidae	emu*	*Dromiceius novaehollandiae*	S	27a
TINAMIFORMES				
Tinamidae	tinamou	*Crypturellus* or *Tinamus sp.*	TF	1a
PODICIPEDIFORMES				
Podicipedidae	western grebe	*Aechmophorus occidentalis*	ST	34
	pied-billed grebe	*Podilymbus podiceps*	TD	41b
PELECANIFORMES				
Pelecanidae	white pelican*	*Pelecanus erythrorhynchos*	ST	34
Anhingidae	darter	*Anhinga rufa*	S	25

CICONIIFORMES				
Ardeidae	great blue heron	*Ardea herodias*	TD	41a
	green heron	*Butorides virescens*	TD	41b
	egrets	*Egretta spp.*	S	25
	American bittern	*Botaurus lentiginosus*	TD	41b
Ciconiidae	yellow-billed stork	*Ibis ibis*	S	25
Threskiornithidae	sacred ibis	*Threskiornis aethiopicus*	S	25
	African spoonbill	*Platalea alba*	S	25
Phoenicopteridae	lesser flamingo*	*Phoeniconaias minor*	S	25
ANSERIFORMES				
Anhimidae	southern screamer	*Chauna torquata*	ST	35
Anatidae	magpie goose	*Anseranas semipalmata*	TF	15
	white-faced tree-duck	*Dendrocygna viduata*	S	24
	black swan*	*Cygnus atratus*	S	27b
	black-necked swan*	*Cygnus melanocoryphus*	ST	38
	trumpeter swan*	*Cybnus buccinator*	T	51
	Canada goose*	*Branta canadensis*	TD	41a
	Egyptian goose	*Alopochen aegyptiacus*	S	24
	radjah shelduck*	*Tadorna radjah*	TF	15
	African pygmy goose*	*Nettapus auritus*	TF	2b
	Chiloe wigeon*	*Anas sibilatrix*	ST	38
	Cape teal*	*Anas capensis*	S	24
	crested duck*	*Anas specularioides*	ST	38
	common pintail	*Anas acuta*	TD	41b
	black duck	*Anas rubripes*	TD	41a
	blue-winged teal	*Anas discors*	TD	41b
	cinnamon teal	*Anas cyanoptera*	ST	34
	northern shoveler*	*Anas clypeata*	TD	41b
	wood duck	*Aix sponsa*	TD	41a
	ring-necked duck	*Aythya collaris*	TD	41a
	bufflehead	*Bucephala albeola*	TD	41a
	common goldeneye	*Bucephala clangula*	TD	41a
	hooded merganser	*Lophodytes cucullatus*	TD	41a
	ruddy duck	*Oxyura jamaicensis*	ST	34
FALCONIFORMES				
Accipitridae	bald eagle*	*Haliaeetus leucocephalus*	TR	64a
	golden eagle*	*Aquila chrysaetos*	M	64b
Sagittariidae	secretary bird	*Sagittarius serpentarius*	S	17
Falconidae	peregrine falcon*	*Falco peregrinus*	TU	64c
	prairie falcon*	*Falco mexicanus*	D	64d
GALLIFORMES				
Megapodiidae	megapode	*Megapodius* or *Alectura*	TF	15
Cracidae	great curassow	*Crax rubra*	TF	1a
Tetraonidae	black grouse	*Lyrurus tetrix*	TD	42
	blue grouse	*Dendragapus obscurus*	TR	46
	ptarmigan	*Lagopus sp.*	TU	52
	spruce grouse	*Canachites canadensis*	T	51
	ruffed grouse	*Bonasa umbellus*	TD	40
	sharp-tailed grouse	*Pedioecetes phasianellus*	ST	33
Phasianidae	California quail	*Lophortyx californica*	C	39
	Gambel's quail*	*Lophortyx gambeli*	D	28

	roulroul*	*Rollulus roulroul*	TF	2c
	golden pheasant	*Chrysolophus pictus*	M	61
	Himalayan monal*	*Lophophorus impeyanus*	TF	2c
	crested fireback*	*Lophura ignita*	TF	2c
	Palawan peacock-pheasant*	*Polyplectron emphanum*	TF	2c
Numididae	Indian peafowl*	*Pavo cristatus*	TF	13
	helmeted guineafowl*	*Numida meleagris*	S	17
	vulturine guineafowl	*Acryllium vulturinum*	S	17
Meleagrididae	turkey	*Meleagris gallopavo*	TD	40
GRUIFORMES				
Turnicidae	button-quail	*Turnix sylvatica*	S	26
Gruidae	Sarus crane	*Grus antigone*	TF	14
	crowned crane	*Balearica regulorum*	S	17
Psophiidae	common trumpeter*	*Psophia crepitans*	TF	2a
Rallidae	king rail	*Rallus elegans*	TD	41b
	Virginia rail	*Rallus limicola*	TD	41b
	sora	*Porzana carolina*	TD	41b
	common gallinule	*Gallinula chloropus*	TD	41b
	American coot	*Fulica americana*	TD	41b
Eurypygidae	sunbittern	*Eurypyga helias*	TF	2a
Otididae	Kori bustard	*Ardeotis kori*	S	17
CHARADRIIFORMES				
Jacanidae	jacana	*Jacana sp.*	TF	2a
Charadriidae	blacksmith plover*	*Vanellus armatus*	S	26
	spurwing plover*	*Vanellus spinosus*	S	26
Recurvirostridae	black-winged stilt	*Himantopus himantopus*	S	25
	American avocet	*Recurvirostra americana*	ST	34
Glareolidae	Egyptian plover*	*Pluvianus aegyptius*	S	26
	cream-colored courser	*Cursorius cursor*	S	26
	pratincole	*Glareola pratincola*	S	26
COLUMBIFORMES				
Columbidae	band-tailed pigeon*	*Columba fasciata*	TR	47
	barred cuckoo-dove*	*Macropygia unchall*	TF	2c
	emerald dove*	*Chalcophaps indica*	TF	2c
	bleeding-heart pigeon*	*Gallicolumba criniger*	TF	2c
	crowned pigeon*	*Goura sp.*	TF	2c
PSITTACIFORMES				
Psittacidae	rainbow lorikeet*	*Trichoglossus haematod*	TF	2c
	plum-headed parakeet*	*Psittacula cyanocephala*	TF	2c
	African gray parrot*	*Psittacus erithacus*	TF	2b
	blue-and-yellow macaw*	*Ara ararauna*	TF	2a
CUCULIFORMES				
Musophagidae	Schalow's turaco*	*Tauraco schalowi*	TF	2b
	Ross' turaco	*Musophaga rossae*	TF	2b
	white-bellied go-away bird	*Crinifer leucogaster*	S	26
Cuculidae	roadrunner	*Geococcyx californianus*	D	28
STRIGIFORMES				
Strigidae	snowy owl*	*Nyctea scandiaca*	TU	55

COLIIFORMES				
Coliidae	mousebird	*Colius sp.*	S	26
TROGONIFORMES				
Trogonidae	trogon	*Trogon sp.*	TF	2a
CORACIIFORMES				
Momotidae	motmot	*Momotus* or *Eumomota*	TF	2a
Meropidae	bee-eater	*Merops* or *Melittophagus*	S	26
Phoeniculidae	wood-hoopoe	*Phoeniculus sp.*	TF	2b
Bucerotidae	Indian pied hornbill*	*Anthracoceros malabaricus*	TF	2c
	ground hornbill	*Bucorvus abyssinicus*	S	17
PICIFORMES				
Ramphastidae	toucans	*Pteroglossus* or *Ramphastos*	TF	2a
PASSERIFORMES				
Cotingidae	bellbird	*Procnias sp.*	TF	2a
Pittidae	pitta	*Pitta sp.*	TF	2c
Corvidae	blue magpie*	*Urocissa erythrorhyncha*	TF	2c
Paridae	chickadees	*Parus spp.*	TR	47
Sittidae	red-breasted nuthatch	*Sitta canadensis*	TR	47
Certhiidae	brown creeper	*Certhia familiaris*	TR	47
Timaliidae	laughing-thrush	*Garrulax sp.*	TF	2c
Troglodytidae	winter wren	*Troglodytes troglodytes*	TR	47
Turdidae	blackbird	*Turdus merula*	TD	43
	nightingale	*Luscinia megarhynchos*	TD	43
	robin	*Erithacus rubecula*	TD	43
	shama thrush*	*Copsychus malabaricus*	TF	2c
	varied thrush	*Ixoreus naevius*	TR	47
Bombycillidae	cedar waxwing	*Bombycilla cedrorum*	TR	47
Sturnidae	oxpecker	*Buphagus sp.*	S	26
	violet-backed starling*	*Cinnyricinclus leucogaster*	S	26
	glossy starling*	*Lamprocolius sp.*	S	26
	superb starling	*Spreo superbus*	S	26
	Rothschild's starling*	*Leucopsar rothschildi*	TF	2c
Coerebidae	honeycreeper*	*Cyanerpes sp.*	TF	2a
Parulidae	yellow-rumped warbler	*Dendroica coronata*	TR	47
Ploceidae	weavers*	*Ploceus* or *Euplectus*	S	26
	tree sparrow	*Passer montanus*	TD	43
Icteridae	red-winged blackbird	*Agelaius phoeniceus*	TD	41b
Tersinidae	swallow-tanager	*Tersina viridis*	TF	2a
Thraupidae	tanagers	*Tangara*, other genera	TF	2a
Fringillidae	evening grosbeak	*Hesperiphona vespertina*	TR	47
	hawfinch	*Coccothraustes coccothraustes*	TD	43
	purple finch	*Carpodacus purpureus*	TR	47
	pine siskin	*Spinus pinus*	TR	47
	goldfinch	*Carduelis carduelis*	TD	43
	bullfinch	*Pyrrhula pyrrhula*	TD	43
	chaffinch	*Fringilla coelebs*	TD	43
	dark-eyed junco	*Junco hyemalis*	TR	47
	white-crowned sparrow	*Zonotrichia leucophrys*	TR	47
	fox sparrow	*Passerella iliaca*	TR	47
	song sparrow	*Melospiza melodia*	TR	47

Index to Animal Species