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Biophysical study of a selected tract of land southeast of Helena Montana

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A BIOPHYSICAL STUDY OF A SELECTED TRACT OF LAND SOUTHEAST OF HELENA, MONTANA

By

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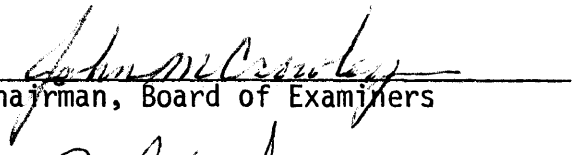

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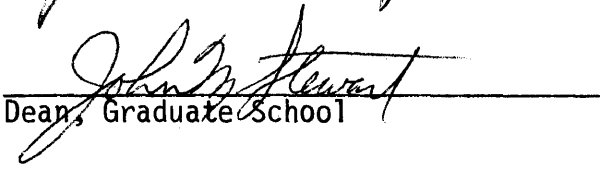

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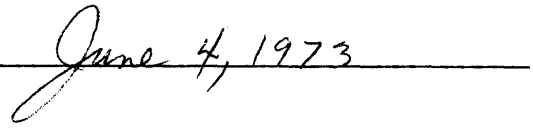

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All errors or inaccuracies in this manuscript are the sole responsibility of the author.

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CHAPTER I

ORIENTATION

Purpose and Philosophy

This study involves a description, mapping, and analysis of ecosystem units on a parcel of land which has significant potential for future development. The work is designed to make the complex land resource or life-community comprehensible. It is intended to provide much of the foundation needed for detailed land-use planning.

Many people are beginning to realize the place of man on this earth. Aldo Leopold described the community to which man belongs as a unit of interdependent parts within which he must compete for his rightful place.[1] Man must cooperate, as well, in assuring the functioning of the whole community. But Leopold continues:

> . . . land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land.

Perhaps this is a shocking thought to some who rebel at being considered the equal to that which they have so long willfully manipulated.

The metaphorical narrowing of this world increases the conspicuity of the other members of man's community, those members which he exploited

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[1]Aldo Leopold, A Sand County Almanac (New York: Oxford University Press, 1970), p. 204.

and often destroyed.[2] Perhaps man is beginning to realize that his destiny lies in the destiny of his fellow life-community members.

This study is an attempt to assess the non-human elements of the study area life-community as they, themselves, function interdependently. Further, it is to be utilized in the future planning processes so as to enhance the integrity and promote the stability of a true community.

The result is not the plan. It is a fundamental part of the information pool that must be evaluated in the planning process. Other elements which must be considered include socio-economic structures of the human community, cultural-historical aspects, existing land use, the interaction of the life communities, etc.

The Study Area

The study area lies immediately southeast of and adjacent to Helena, Montana (Figure 1). Situated within the bounds of two counties, Jefferson and Lewis and Clark, this 10,000-acre study area is herein referred to as the Diehl Development Corporation's S.E. Helena Project. It is delineated by I-15/U.S. 91 on the east, the Helena National Forest on the west, the built-up area of the City of Helena on the north, and private land holdings not owned by the Corporation to the south. This is an area of high, forested mountains and low, grassy hills, of narrow floodplains and broad ridges, of antelope and deer, of birds and ground

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[2]See for example, Ian Burton and Robert W. Kates, Readings in Resource Management and Conservation (Chicago: The University of Chicago Press, 1960), pp. 95-154; Donald R. Coates, ed., Environmental Geomorphology (Binghamton, New York: State University of New York, 1971), pp. 1-262; and Thomas R. Detwyler, ed., Man's Impact on Environment (New York: McGraw-Hill Book Company, 1971), pp. 2-731.

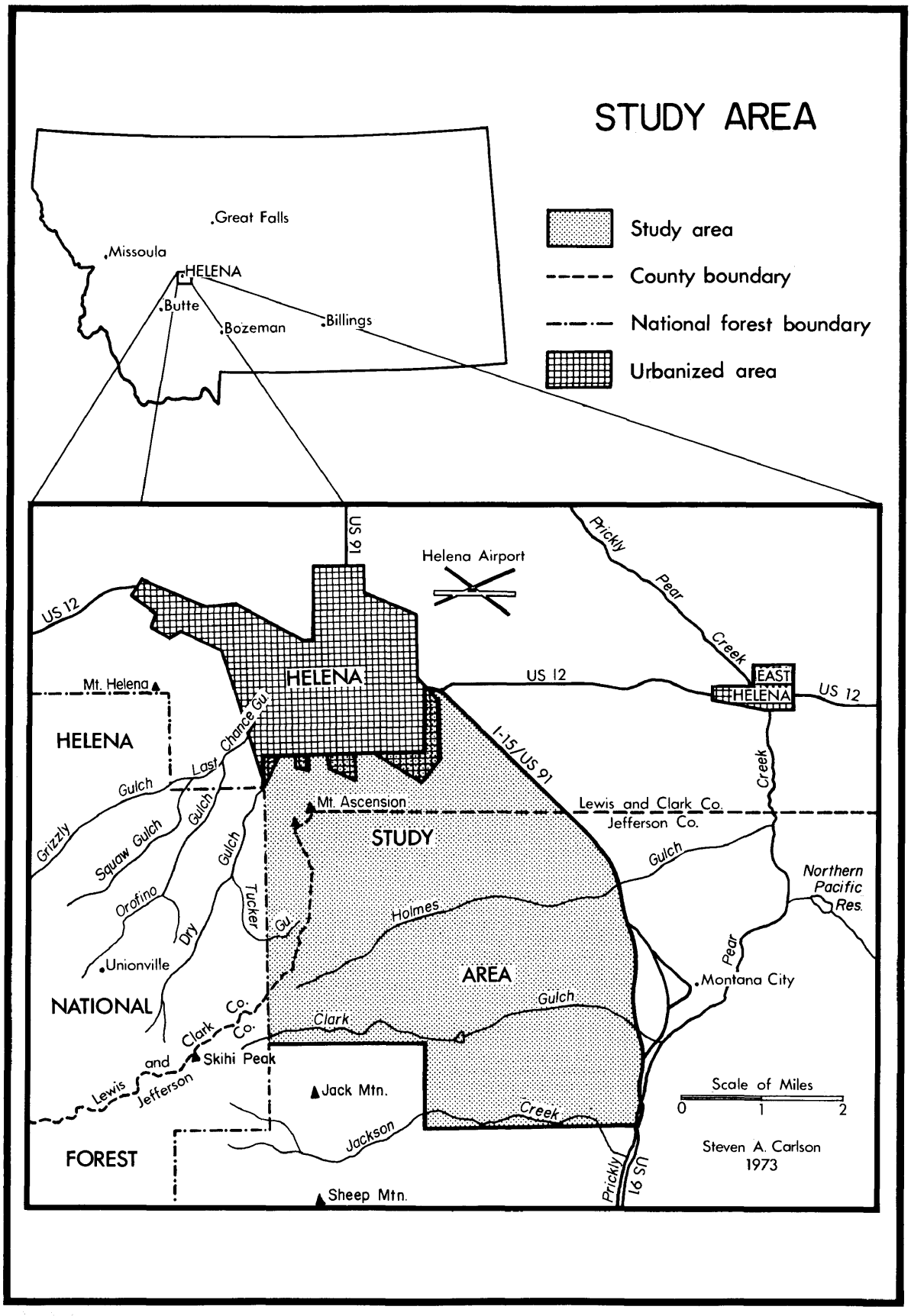
STUDY AREA
Study area
County boundary
National forest boundary
Urbanized area
Great Falls
Missoula
HELENA
Butte
Bozeman
Billings
US 91
Helena Airport
Prickly Pear Creek
US 12
HELENA
EAST HELENA
Mt. Helena
HELENA
Chance Gl.
Last Chance Gulch
Grizzly Gulch
Squaw Gulch
Orofino Gulch
Dry Gulch
Tucker Gl.
I-15/US 91
Mt. Ascension
Lewis and Clark Co.
Jefferson Co.
STUDY
AREA
Holmes Gulch
Northern Pacific Res.
Pear Creek
Montana City
Unionville
NATIONAL
FOREST
Co.
Clark
Co.
Lewis and Clark
Jefferson
Skihi Peak
Jack Mtn.
Jackson Creek
Sheep Mtn.
Prickly Pear Creek
US 91
Scale of Miles
0 1 2
Steven A. Carlson
1973

Figure 1

squirrels. It is an area of a rich and fevered mining history and of long removed herds of grazing sheep.[3] More recently, it was part of a large and prosperous cattle ranch.

The Diehl Development Corporation of Helena, Montana, has shouldered the role of "land ethic pioneer." With over 10,000 acres of prime "developable" land in its possession, it has refused to utilize the tried and true get-rich-quick method of indiscriminant subdivision and rape of the land. Instead, it has launched a comprehensive pre-planning program of resource analysis of which this study is a part.

The choice of the study area was not the result of a typical search for the well-defined, sufficiently diverse study area so often used for master's theses. Rather, this area simply has one bond--common ownership.[4] The results of the study are to be part of the information pool used for land-use planning. Thus, it becomes a practical application of a somewhat experimental methodology to a pragmatically determined parcel of land. Because of this, the many real problems and contingencies could not be avoided.

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[3]Joseph Kinsey Howard, Montana: High, Wide and Handsome (New Haven: Yale University Press, 1943), pp. 38-72; and K. Ross Toole, Montana: An Uncommon Land (Norman, Oklahoma: University of Oklahoma Press, 1959), pp. 64-94.

[4]Not all of the area is owned by the Corporation. However, those small parcels that are not in Corporation ownership will be affected and have an effect on the study area. Therefore, they were included in the study.

CHAPTER II

BIOPHYSICAL UNITS AND REGIONS

Theory and Previous Work

The life-community of which Leopold spoke is identical in concept to the ecosystem. Raymond F. Dasmann defines an ecosystem as "a combination of a biotic community with its physical environment . . . ."[5] Seven years later Robert L. Smith attempted to list some of the principles to which an ecosystem adheres. Number one on his list is that the ecosystem " . . . is a major ecological unit . . . has both structure and function."[6] Smith, Dasmann, Leopold, and many others realize that the basic life-supporting, functioning system on this earth is the ecosystem. It is within this system that all living things must function and coexist in order to survive.

Therefore, the optimal unit of analysis for planning purposes is the life-supporting unit--the ecosystem. In this study ecosystems are identified, described, and mapped. Although vegetative communities may exist along a continuum as J. T. Curtis and R. P. McIntosh contend, it is necessary for planning purposes to recognize discreet communities and to

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[5]Raymond F. Dasmann, Environmental Conservation (New York: John Wiley and Sons, Inc., 1959), p. 9.

[6]Robert L. Smith, Ecology and Field Biology (New York: Harper and Row, Publishers, 1966), p. 6.

delimit them.[7] This establishes the definitive boundaries needed for land-use decisions. To avoid the intellectual quibbling which this difference inevitably produces, the unit mapped can be considered a biophysical unit or geographical ecosystem.

Much of the methodology is borrowed from the unpublished research of John M. Crowley. Donald R. Cassie, et al., did a similar, though less detailed study of South Wellington County, Ontario.[8] The writer participated in a more detailed study of the lower Ninemile Valley near Missoula, Montana.[9] In January, 1973 the Forest Service released a task force study based on a similar point of view.[10]

Prominent planners (e.g., Ian L. McHarg, G. Angus Hills, and Philip H. Lewis) have recognized the importance of comprehensive resource analysis.[11] However, most do not use the integrated biophysical unit (ecosystem) as their unit of analysis. For example, McHarg analyzes the individual components of the biophysical units independent of other

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[7]J. T. Curtis and R. P. McIntosh, "The Upland Forest Continuum in the Prairie-Forest Border Region of Wisconsin," Ecology, XXXII (1951), 476-96.

[8]Donald R. Cassie, et al., "Geography of Ecosystems in South Wellington County, Ontario," Division of Environmental Studies, University of Waterloo, Waterloo, 1970, pp. 1-196.

[9]Steven A. Carlson, et al., "Geography of Ecosystems in the Lower Ninemile Valley, Northwest of Missoula, Montana," Department of Geography, University of Montana, Missoula, 1971, pp. 1-51.

[10]Robert D. Pfister and John C. Corlis (co-chairmen), "Ecoclass--A Method for Classifying Ecosystems," U.S. Forest Service Task Force, Various Experimental Stations, 1973, pp. 1-52.

[11]See for example, The Conservation Foundation, Three Approaches to Environmental Resource Analysis (Washington, D.C.: The Conservation Foundation, 1967), pp. 1-102; and Ian L. McHarg, Design with Nature (New York: Doubleday and Company, Inc., 1971), pp. 1-198.

components, assigns suitable "rankings" to the components, and overlays the resulting suitability ranks to arrive at a composite suitability class. Only a very minimal examination of the interrelationships of the biophysical components are considered. Further, most of the work has been done on a broad scale using computor analysis of arbitrary grids. Thus, while the integrated unit--the ecosystem--is recognized as the needed basis for planning, in reality only the components of the ecosystem are used and these are analyzed in the framework of arbitrary grids.

By understanding the ecosystem, impacts of future human alterations can be controlled, minimized, or made to benefit the community. These impacts are measured on the basis of someone's value judgments. Further, value judgments based on scanty knowledge frequently lead to faulty decisions. A major purpose of this study is to minimize the conditions of ignorance in the decision-making process.

The Biophysical Scheme

The biophysical unit of this study is a homogeneous land unit based on site associations (soil associations plus slope), present vegetation, and potential vegetation. These components are represented by the symbols found on the biophysical maps (see end folders). However, there are other ecosystem components which are implicit in a biophysical unit. Geology and geomorphology are reflected by the soil association units. Water or humidity is reflected in the type and productivity of the potential vegetation community. In addition, wildlife is included in that the biophysical units form part or all of the habitats of various species and

these species, in turn, affect the alteration and maintenance of the biophysical unit. Although the implicit elements are not included in the map symbol, they are described in the accompanying text. Thus, the biophysical unit, either explicitly or implicitly, includes most of the principal physical components which should be considered in land-use planning. Site association data provide essential information regarding engineering aspects of sites. Present vegetation is important in terms of short-term planning and is an indicator of past modification and present conditions. Potential vegetation has indicator value with regard to climate and site productivity and is important in long-term planning or management decisions. In addition, evaluation of the unit provides the bulk of the information needed for immediate management programs (e.g., erosion control, grass seeding, tree thinning, etc.).

For some purposes, biophysical units are too small and too numerous to handle individually. Therefore, biophysical regions were determined by aggregating biophysical units. These regions are broadly uniform in topography and vegetation. An inset map of the biophysical regions is presented on the biophysical map. The regions are further aggregated and viewed as landscape types, which are the basis of the chapter titles of the text. The organization of the analysis portion of this study is as follows:

Landscape type--chapter titles
  Biophysical regions--first order section headings
    Site associations--second order section headings

Within each regional section is found a biophysical profile which is designed to give the reader an overall view of the character of the

region.[12] Included in the profiles are all of the site association types, profiles of each of the principal soil series, and a representation of some of the present vegetation communities. It is important to note that this is a diagrammatic profile and not a real cross-section of the actual sequence of units across the region. This method of presentation depicts the principal regional components and alleviates developing a burdensome number of cross-sections to achieve the same end.

The Biophysical Map

The biophysical map was constructed from 1964 Soil Conservation Service (SCS) air photos, twenty-foot contour maps from the Upper Missouri River Basin Survey, and field work.

As is evident, the biophysical map is complicated. But it serves as a reminder that the land is also complicated and not easily understood. Each biophysical unit on the map is labeled with a six- or seven-digit symbol. The elements of these symbols are graphically explained in the map legend.

In order to identify the biophysical units efficiently, the legend of the biophysical map is divided into two major parts: 1) site associations and 2) present and potential vegetation. Two versions of the map are presented--one colored according to site associations and the other according to vegetation. The site associations are arranged from generally high-rugged to relatively low-smooth types. In the vegetation portion of the legend, the potential vegetation types are arranged from

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[12]For the legend to the biophysical profiles, see Appendix A.

the cooler, more moist communities to the warmer, drier communities. The major exception is the floodplain types which are a reflection of moist soil conditions rather than ambient atmospheric conditions. These communities are placed at the end of both legends because they occur altitudinally below the other types.

Coloration of the site association portion of the legend is designed such that hue indicates the soil association and density of pattern increases with steepeness of slope. Since blues are associated with coolness, shades of blue are used for the highest soil associations. Increasing warmth and decreasing moisture is portrayed by phasing into the greens, yellows, oranges, and reds (in that order). Thus, the warmest, driest sites are shades of red or pink. The purples are used for the floodplain types which are relatively warm and moist.

Similarly, in the vegetation portion of the legend, the blues represent the coolest, most moist climax communities of Douglas fir; the greens portray the warmer, moist ponderosa communities; and the reds depict the warmest, driest short grass steppe climax communities. Again, the floodplain types are represented by the purples.

Soil Associations

The soil association data were provided by the Lewis and Clark County office of the SCS. Completed in early June of 1972, it was somewhat disappointing because of the mapping of soil associations rather than soil series. Also received from the SCS were copies of their unpublished field sheets covering soil engineering properties.

Slope Categories

Considerable disagreement occurs in the formulation of meaningful slope categories for planning purposes. While many different groupings are used, no published research could be found that had objectively studied this problem.[13] The slope categories are patterned after the unpublished work of John M. Crowley. Resulting categories are as follows:

Very steep	> 45°
Steep	25.0°-45.0°
Moderately steep	13.0°-25.0°
Moderate	5.0°-13.0°
Gentle	2.5°- 5.0°
Nearly horizontal	0.0°- 2.5°

In the text the descriptive terms (e.g., steep) are used specifically to refer to these categories.

Before going into the field, a slope map was made from the topographic map. The slope map was subjected to continuous field checks. As a result, modifications were made, but the original map proved to be quite accurate.

Present Vegetation

Present vegetation communities were determined from field observations. Species identification was facilitated by many sources.[14]

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[13]See for example, U.S., Department of Agriculture, Soil Conservation Service, Soil survey interpretations, Lewis and Clark County, Helena, Montana; and Ian L. McHarg, Design with Nature (New York: Doubleday and Company, Inc., 1971), p. 37.

[14]John J. Craighead, Frank C. Craighead, Jr., and Ray J. Davis, A Field Guide to Rocky Mountain Wildflowers (Boston: Houghton Mifflin Company, 1963), pp. 1-277; A. S. Hitchcock, Manual of the Grasses of the United States (Washington, D.C.: U.S. Government Printing Office, 1950), pp. 1-1051; E. H. Moss, Flora of Alberta (Toronto: University of Toronto

Structural form of the vegetation was patterned after the work of Pierre Dansereau.[15]

There are a few species of plants of special note found throughout the area that escape mention in the accompanying text. In many of the drier drainageways, wax currant and skunkbrush share the importance of rose spp.[16] Wax currant and another "spiny" currant are found throughout the study area and are good sources of berries for birds. Basin wild rye, green needle grass, and green wheatgrass are found in the drainageways with the dominant bluegrass spp. Rocky mountain juniper is scattered throughout the area, especially on the drier ponderosa pine sites. On the very driest ponderosa sites of small hill crests, limber pine is significant. Important browse species of the dry grasslands include silver sagebrush and winterfat; and in the moist draws are found rocky mountain maple, mock orange, and chokecherry. Evidence of overgrazing and/or severe disturbance (e.g., cultivation) is indicated by snake broomweed and/or prickly pear on the drier sites and lupine on the more moist areas.

Potential Vegetation

The determination of potential vegetation types serves to: 1) give the map some degree of permanence, 2) indicate site productivity, 3)

Press, 1959), pp. 1-546; and C. Frank Brockman, Trees of North America (New York: Golden Press, 1968), pp. 1-280.

[15]Pierre Dansereau, "A Universal System for Recording Vegetation," Contributions, Institute de Botanique, Université de Montreal, Montreal, Canada, Vol. 72, pp. 1-58.

[16]For scientific names of all species used in the text, refer to Appendix B.

distinguish between seemingly similar present communities, and 4) act as a bioclimatic indicator.

Forest Types. The idea of potential vegetation--called habitat types by some people--was first promoted by the efforts of R. Daubenmire in his work on forests of eastern Washington and northern Idaho.[17] Recently, Robert D. Pfister has extended this concept to western Montana forests.[18] There has been no research on forest habitat types east of the continental divide. Therefore, forest types of the S.E. Helena Project site are based almost entirely on the western Montana data. Work on the forests east of the divide was begun in the summer of 1972. In initiating this work, a crew from the Intermountain Forest Experiment Station visited the study area. Bernard Kovalchik, an associate of Pfister, felt there would be few serious problems in using the western Montana habitat types for this study.[19] Habitat types developed by Pfister and found on the project site include (from generally moist to dry):

Douglas fir-snowberry forest
Douglas fir-kinnikinnik forest
Ponderosa pine-snowberry forest

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[17]R. Daubenmire and Jean B. Daubenmire, Forest Vegetation of Eastern Washington and Northern Idaho, Washington Agricultural Experiment Station, Technical Bulletin 60 (Pullman, Washington: Washington State University), pp. 1-104.

[18]Robert D. Pfister, et al., "Preliminary Forest Habitat Types for Western Montana," Intermountain Forest Experiment Station and Region One, Missoula, Montana, pp. 1-85.

[19]Personal interview with Bernard L. Kovalchik, Forest Ecologist, Intermountain Forest and Range Experiment Station, Missoula, Montana, June 12 and 13, 1972.

Douglas fir-bunchgrass forest
  Douglas fir-rough fescue forest[20]
  Douglas fir-bluebunch wheatgrass forest
Ponderosa pine-rough fescue forest
Ponderosa pine-bitterbrush forest
Ponderosa pine-bluebunch wheatgrass forest

Grassland and Brush Types. Work on habitat types of grasslands and brush is just beginning. Daubenmire has published a paper, Steppe Vegetation of Washington, based on the habitat-type approach.[21] No work has been published for Montana, although Meuggler, from the Intermountain Forest and Range Experiment Station in Bozeman, Montana, began work in this direction in the summer of 1972.[22] Because there were little data from which to work, a new, temporary classification had to be developed for the grassland and brush areas. In developing the classification scheme, many sources were utilized.[23] The resulting "habitat types" are as follows (from generally moist to dry):

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[20]While Pfister does not break down the Douglas fir-bunchgrass habitat types, it was felt that the two types were significantly different. When contacted later, Kovalchik said they tended to agree, but could not make the distinction on the basis of the small number of sample plots included in their western Montana research.

[21]R. Daubenmire, Steppe Vegetation of Washington, Washington Agricultural Experiment Station, Technical Bulletin 62 (Pullman, Washington: Washington State University), pp. 1-131.

[22]Personal interview with Walter F. Meuggler, Range Ecologist, Intermountain Forest and Range Experiment Station, Bozeman, Montana, May 25, 1972.

[23]R. Daubenmire, Steppe Vegetation of Washington, pp. 1-131; Henry J. Oosting, The Study of Plant Communities (San Francisco: W. H. Freeman and Company, 1948), pp. 235-355; Laurence A. Stoddart and Arthur D. Smith, Range Management (New York: McGraw-Hill Book Company, 1955), pp. 27-45, 114-29, 164-212; Personal interview with Melvin S. Morris, Professor Emeritus, School of Forestry, University of Montana, Missoula, Montana, April 26, 1972; and U.S., Department of Agriculture, Soil Conservation

Bitterbrush-rough fescue brush
Rough fescue-Idaho fescue prairie
Rough fescue-bluebunch wheatgrass prairie
Idaho fescue-rough fescue prairie
Idaho fescue-bluebunch wheatgrass prairie
Rose spp.-bluebunch wheatgrass brush
Bluebunch wheatgrass-rough fescue prairie
Bitterbrush-bluebunch wheatgrass brush
Big sagebrush-sandburg bluegrass brush
Bluebunch wheatgrass-sandburg bluegrass prairie
Needle and thread grass-sandburg bluegrass short grass steppe
Needle and thread grass-blue grama grass short grass steppe

Floodplain Types. In dealing with the floodplains and drainageways, there was no previous research on habitat types or climax communities. The most relevant research was an unpublished master's thesis by Geoffrey G. Foote entitled, "Phytosociology of the Bottomland Hardwood Forests in Western Montana."[24] From this research and field observations, the following floodplain communities were recognized:

Black cottonwood-Douglas fir forest
Black cottonwood-ponderosa pine forest
Quaking aspen-rose spp. forest
Rose spp.-bluegrass spp. brush

Zootic Climax Types. A major problem in delimiting habitat types was the extremely deteriorated condition of some of the biophysical units resulting from a long history of livestock grazing. Water on the project site is scarce and cattle concentrated within a half mile of any water source. In some of the pockets of trees, the ground surface consisted

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Service, Various range site technical descriptions, Lewis and Clark County, Helena, Montana.

[24]Geoffrey G. Foote, "Phytosociology of the Bottomland Hardwood Forests in Western Montana" (unpublished master's thesis, School of Forestry, University of Montana, 1962), pp. 1-140.

of dust and broken twigs where the cattle lounged in the heat of the day. Still in other areas the grazing pressure was so great that only a sod mat was left and species identification was impossible. Based on Daubenmire's comments on zootic climaxes, the range site descriptions of the SCS, and the ecology of the species present, two zootic habitat types are recognized:

Douglas fir-bluegrass spp. forest
Bluegrass spp.-prairie junegrass prairie

Anomalous Habitat Types. Three anomalous "habitat types" are described. The "Douglas fir, stagnant state"; and "ponderosa pine, stagnant state" types are areas where the trees are so thick and the duff layer beneath so deep that virtually no undergrowth is present. Finally, there are areas, generally with rock outcrops, where Douglas fir and ponderosa pine occur together, and both are likely to persist. This was called the mixed conifers-bluebunch wheatgrass woodland type.

Spatial Pattern. The occurrence of a particular habitat type depends on the interacting factors of slope, aspect, altitude, wind intensity, rainfall, grazing pressure, etc. The ponderosa pine habitat types are largely confined to and dominate the linear hard rock ridges and mountains of the Deer Ridges and Ascension Mountains Regions. Adjacent regions--the May Be So Foothill, Antelope Hills, and the northern portion of the Crossfire Plains Regions--have predominantly prairie types with rough fescue in the higher, more moist areas and bluebunch wheatgrass in the lower, drier areas. Fans and terraces of the Bull Run Bench, Clark Plains, and southern Crossfire Plains Regions support the

driest, short grass steppe types. The Big Indian Mountains and Jackson Hills Regions are moist areas as indicated by the humid Douglas fir types. In addition, these communities are found on the steep north slopes, deep protected ravines, and high pocketed areas throughout the study area. The brushy habitat types tend to be found on rockier sites than their prairie counterparts, while the rose spp. types are located along or near drainageways.

Bioclimate

One of the principal weaknesses of the overall pre-planning study for Diehl Development Corporation was the lack of specific climatic data due to the nonexistence of on-site meteorological stations. As a result, three courses of action were available: 1) The assumption could have been made that because the project site is spatially near and altitudinally within the range of four weather stations--East Helena, Helena Airport, Unionville, and Chessman Reservoir--the microclimates likewise should vary within the range established by the stations. Obviously such a generalization would provide little help in land-use planning of specific areas on the site. 2) It would have been possible to establish several weather stations on the project site and to record essential meteorological data. Three factors precluded this alternative: a) it would have been expensive to collect adequate data; b) time did not permit reliable long-run recording of seasonal and annual meteorological variations; and c) the need for specific data was determined not great enough to justify the time and high cost involved. 3) Vegetational indicators could be used to infer climatic differences relative to the

four weather stations. From this a bioclimatic map could be constructed. Because of the capital commitment to this detailed biophysical study and the usefulness of the biophysical approach in understanding microclimate, it was decided to develop a bioclimatic map.

Theory of Bioclimate

When talking about climate one speaks in meteorological terms about the atmospheric result of the interaction of heat, moisture, and air movement. Bioclimate, on the other hand, implies biotic response to the aggregate behavior of all climatic and physical variables in a particular geographical area. Pierre Dansereau devotes a major portion of his book, Biogeography: An Ecological Perspective, to the subject of bioclimatology.[25] In his book, he concedes that it is necessary to study climate per se, for climatology is a study in itself with its own methodologies and its own terms. However, he continues the discussion by stating:

> But the essential is the kind and intensity of the biological response, its relative harmony in the environment, and the adjustment of geographical units of some magnitude to the requirements of the landscape.

Thus, Dansereau establishes the relationship between climate and biotic response. To complement this, many researchers have shown the limits of certain plant species to coincide with various isotherms and isohyets and have demonstrated specific climatic-biotic relationships. However, previous work has tended to focus on the macroscale (e.g., worldwide). To my knowledge, the bioclimatic map is the first attempt to apply this concept on a microscale.

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[25]Pierre Dansereau, Biogeography: An Ecological Perspective (New York: The Ronald Press Company, 1957), pp. 56-123.

The bioclimatic approach infers relative differences indicated by potential vegetation communities and their distributions.[26] This approach does not allow the assigning of meteorological data to bioclimates. Rather, the bioclimates are the net result of the interaction of various climatic and physical variables. One of their most significant attributes is the effective, or available, moisture for plant use. The amount of water that can be used is limited, on the one hand, by a shortage of soil moisture and, on the other hand, by coolness of climate. This means that two different sites may have different meteorological inputs but a common biotic result.

Map Construction

As a result of biophysical field work, potential vegetation communities on the project site were determined and mapped. In addition, potential vegetation communities were identified at the site of three of the weather stations--Helena Airport, East Helena, and Unionville.[27] The project site communities were then aggregated and labeled according to their relationship to the communities adjacent to the weather stations. This relationship is shown in the legend of the bioclimate map (see end folder).

On the basis of knowledge of the ecology of the various potential vegetation types, one can ordinate nearly all of the types on a general

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[26]The relativity lies in using weather station data as a base and interpolating levels of climatic differences.

[27]Because it is believed that only the highest elevation of Big Indian Mountain may correspond climatically to Chessman Reservoir, the potential vegetation communities at Chessman Reservoir were not examined.

scale from warm-dry to cool-moist. For example, rough fescue prairie communities are a more humid type than bluebunch wheatgrass prairie communities.[28] One can infer, then, that a site on which rough fescue prairie is the potential type is more humid than one on which bluebunch wheatgrass prairie is the potential type. The bioclimate map was developed by this kind of inference.

Two basic problems arose in the construction of the bioclimatic scheme. First, the arithmetic gradient of the three weather stations was less than ideal. East Helena and Helena are very close on the bioclimatic scale and at times it is difficult to distinguish between the two. At the same time, the Unionville data lay at the opposite end of the bioclimatic scale with a wide gap between the two extremes. Therefore, intermediate relationships and aggregates become much more subjective than those nearer the weather stations' bioclimates. Second, vegetational disturbance resulting from intensive grazing on the study area is significant. Determination of present vegetation, let alone potential vegetation, was at times difficult. However, for the purposes of the bioclimatic map, the problem was not believed serious. Any significant misinterpretation should be located on the dry end of the scale where the climatic differences between Helena and East Helena are small.

Climatic inferences from the bioclimatic map can be made, but they must be made with caution. For instance, some of the swales in the higher hills exhibit the same vegetation as the steep, north slopes. The reasons are quite different, however. Whereas the swales tend to be

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[28]Daubenmire, Steppe Vegetation of Washington, p. 130.

snow-drift areas and catchments for water, the steep, north slopes receive less solar radiation and, therefore, lose less water to evaporation. Even so, by looking at both topographic and bioclimatic aspects of a particular site, valid inferences can be made.

Spatial Pattern of Biophysical Units

The regions of the study area range from approximately 600 to 2,500 acres in size (Figure 2). Most are long and linear with a northwest-southeast orientation. Cutting across the grain of the regions are two narrow floodplains--Holmes Gulch and Clark's Creek. A third floodplain--Jackson Creek--borders the southern edge of the study area.

The gently sloping Bull Run Bench Region is in the northeast corner. This area of fans and terraces is marked by draughty soils with short grass steppe communities. On the entire southwest perimeter is the moderately sloping May Be So Foothill Region. It is dominated by prairie grasses and a few scattered ponderosa pine both on thin soils derived from metamorphic bedrock. Also subtended by this bedrock are the Ascension Mountains and Deer Ridges Regions to the southwest of the May Be So Foothills. These moderately steep to steep regions are quite similar and have Douglas fir forests on steep, north slopes and ponderosa forest-woodland-savanna on the remaining slopes. The Ascension Mountains Region consists of high, angular mountains and exhibits less linearity, whereas the Deer Ridges Region is comprised of low, linear, hogback ridges.

To the south of the Deer Ridges Region is the gently sloping Crossfire Plains. Essentially similar to the Bull Run Bench, this plain

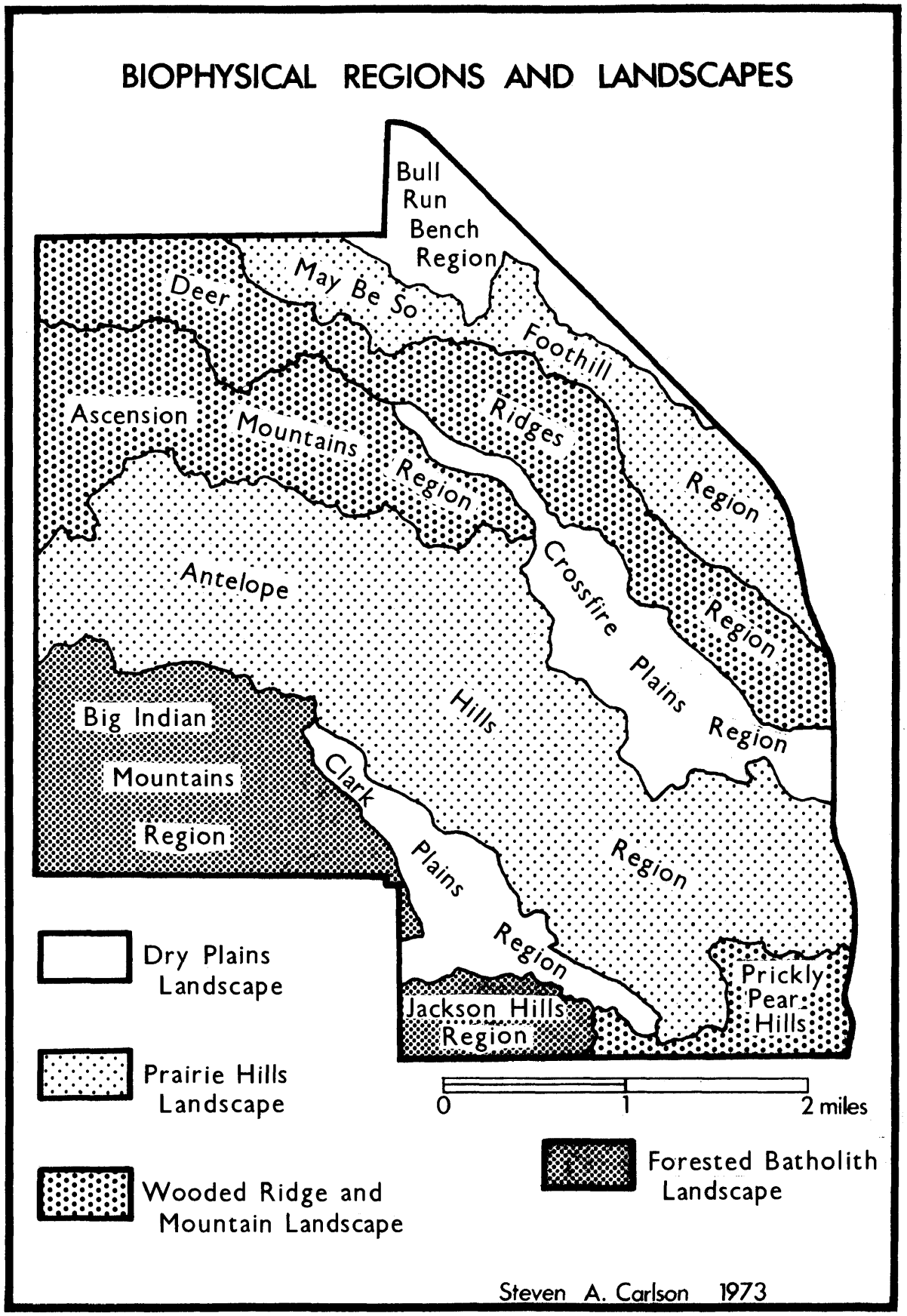

BIOPHYSICAL REGIONS AND LANDSCAPES
Bull Run Bench Region
Deer
May Be So
Foothill Ridges Region
Ascension Mountains Region
Antelope
Crossfire Plains Region
Hills Region
Big Indian Mountains Region
Clark Plains Region
Prickly Pear Hills
Jackson Hills Region
Dry Plains Landscape
Prairie Hills Landscape
Wooded Ridge and Mountain Landscape
Forested Batholith Landscape
0
1
2 miles
Steven A. Carlson 1973

Figure 2

has less draughty soils with vegetation ranging from prairie to short grass steppe. The next region to the southwest is the Antelope Hills. As the largest region, it has extensive prairies with pockets of trees in swales and on steep, north slopes. Except that the thin soil overlies igneous bedrock and the local relief is much greater, the region is akin to the May Be So Foothills. The central portion of the southwest border of the Antelope Hills is marked by the Clark Plains. Like the Bull Run Bench and Crossfire Plains, the gently sloping Clark Plains consist of fans and terraces, draughty soils, and short grass steppe vegetation.

To the west of the Clark Plains is an area of rugged mountains, pocketed soils, and thick forests--the Big Indian Mountains Region. A similar area with much less relief is the Jackson Hills Region bordered to the west by Big Indian Mountains and to the north by the Clark Plains. To the east of the Clark Plains and south of the Antelope Hills is the Prickly Pear Hills Region. It is similar to the Deer Ridges and Ascension Mountains Regions although bedrock consists of igneous materials. These three regions--Big Indian Mountains, Jackson Hills, and Prickly Pear Hills--do not exhibit the linearity of the other regions.

The regions of the study area can be grouped into four landscape types. The Bull Run Bench, Clark Plains, and Crossfire Plains Regions belong to the Dry Plains Landscape type. Adjacent to the plains' borders are members of the Prairie Hills Landscape type--the May Be So Foothill and Antelope Hills Regions. Areas with significant amounts of ecotonal communities make up the Wooded Ridge and Mountain Landscape type--Ascension Mountains, Deer Ridges, and Prickly Pear Hills. Finally, the

Big Indian Mountains and Jackson Hills Regions are humid, forested areas of the Forested Batholith Landscape type.

CHAPTER III

THE DRY PLAINS LANDSCAPE

The Dry Plains Landscape is comprised of three biophysical regions: the Bull Run Bench, the Crossfire Plains, and the Clark Plains Regions. This landscape is generally a rolling topography of gentle to moderate slopes on which the potential vegetation is the very dry needle and thread grass short grass steppe type.

Bull Run Bench Region

The Bull Run Bench Region stands above the Helena Valley floor on the northeast edge of the study area. To the south and west it is bounded entirely by the May Be So Foothill Region. This foothill area, as well as the hill and mountain regions beyond, is the source of water that has cut several prominent drainage channels across the bench region. Vegetation is characteristic of the Dry Plains Landscape with a predominance of the very dry needle and thread grass communities. Three site associations are present in the region: the Musselshell gravelly loam site association, the Musselshell stony loam site association, and the Crago cobbly loam-Musselshell gravelly loam site association (Figure 3). Figure 4 is a photograph of the region.

Musselshell Gravelly Loam Site Association

Nearly half of the Bull Run Bench Region is made up of the Musselshell gravelly loam site association. This site association type

BULL RUN BENCH REGION

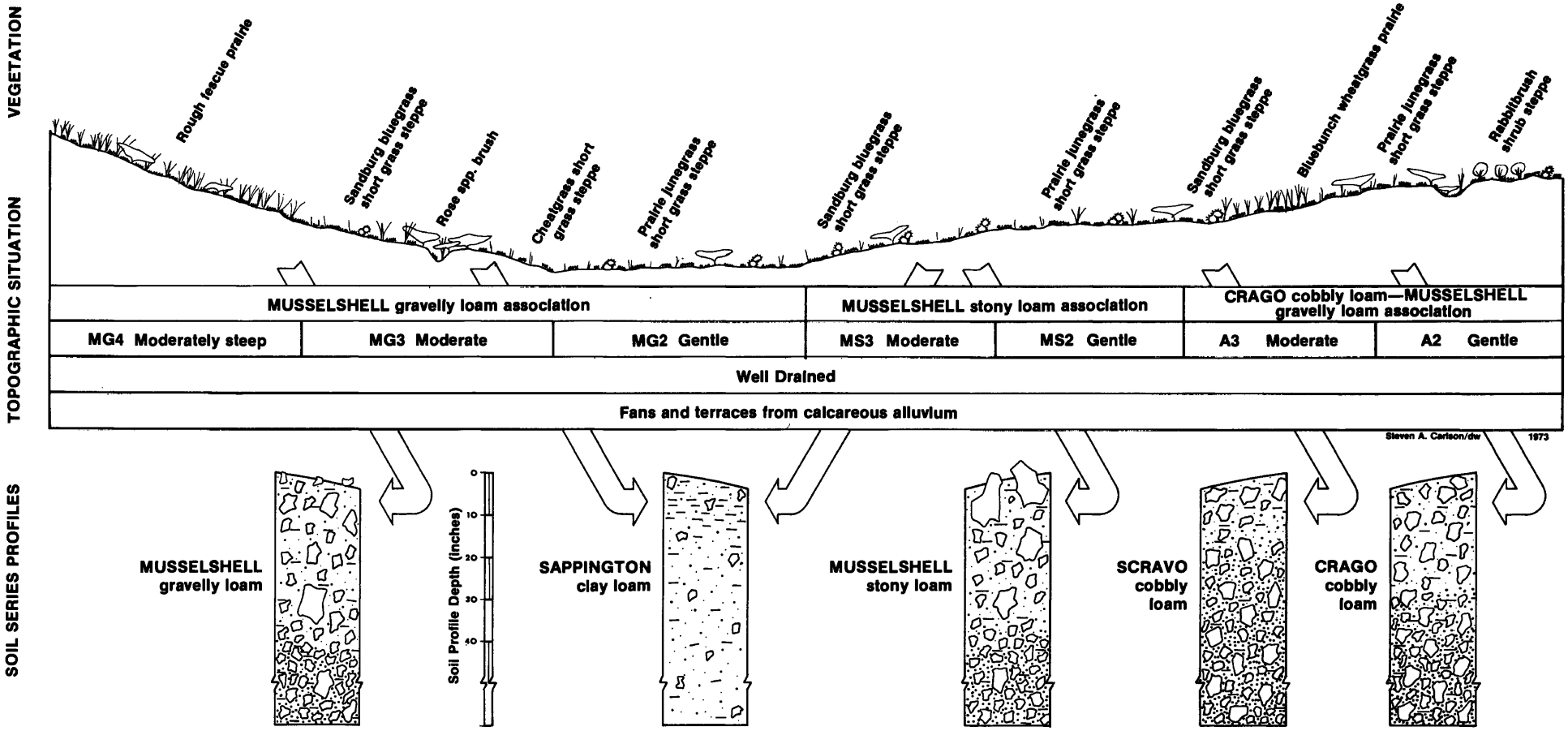
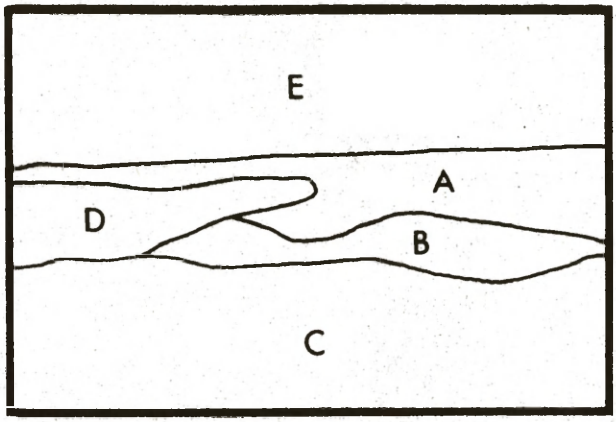


Figure 3



Direction of view: Northeast
Photograph taken from: Ascension Mountains Region
(Mt. Ascension)
Regions: A--Bull Run Bench Region
B--May Be So Foothill Region
C--Deer Ridges Region
D--Helena urbanized area
E--Helena Valley

Figure 4

corresponds to fans and terraces of old calcareous alluvium. It is developed in very deep deposits of Quaternary gravel. The rolling profile of gentle to moderate slopes has some moderately steep areas on terrace edges and in the gullies cut into the bench.

The profile of the Musselshell gravelly loam soil series is formed in deep, unconsolidated material with gravel content ranging from 5 to 35 percent. This well-drained soil will provide few restrictios for development.[29] However, in the profile there are only about five inches of topsoil, which will have to be zealously preserved during development. As a result, major landscaping will be difficult. Below the topsoil layer, the soil becomes strongly calcareous to a depth of about 40 inches. Also with depth, the sand and gravel content of the soil slowly increases and becomes a very gravelly, loamy sand at about 46 inches.

Included in the association are 10 to 30 percent Crago cobbly loam soils on low mounds and ridges and adjacent to drainageways and 10 to 20 percent Sappington clay loam on smooth slopes and concave areas. The Crago cobbly loam soil series is strongly calcareous throughout the profile. With a gravel and cobble content ranging between 35 and 60 percent, oversteepened slopes in trenches or excavations will be unstable. As in the case of Musselshell series, the topsoil layer is only about four inches deep and will have to be preserved if developed. The unconsolidated material is deep and becomes a very gravelly and cobbly loamy sand at about 35 inches. In the case of both Musselshell and Crago soils, subsurface gravels have lime casts on the undersides.

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[29]The word "development" implies the building of structures, attendant roads, etc.

The Sappington clay loam soil series has the highest clay content of any soil in the study area. Gravel throughout this well-drained soil ranges from 5 to 30 percent. The surface layer is a dark, noncalcareous loam which distinguishes it from the Musselshell and Crago soils. To about 10 inches below the topsoil layer, the horizons increase in clay content. Consequently, frost action plays a strong role in the characteristics of this soil. Houses with basements below the influence of the frost action will fair better than simple surface slabs or foundation footings. Roads may be subject to greater breakup if built on Sappington sites. Beneath the clay horizon the soil becomes strongly calcareous. The loamy material is at least 60 inches deep.

The vegetation cover of the sites of the Musselshell association is of the dry grass type, except along some of the brushy drainageways. This region is semi-arid and receives about 11 inches of precipitation in a year. Bioclimate ranges from similar to East Helena to similar to Helena. Low precipitation combined with porous soil accounts for the sparse vegetative cover. On the low slopes, which have little protection from the hot sun, the potential vegetation is needle and thread grass-sandburg bluegrass short grass steppe. There are no trees to give shade. With development, significant irrigation will be necessary for any lawns, shrubs, or trees. At present, due to a history of grazing, the short grass communities are dominated by prairie junegrass, sandburg bluegrass, and/or cheatgrass. Some areas need to be seeded to abate sheet erosion. On the moderately steep, north to northeast slopes a more mesic rough fescue prairie is evident. The gullies are mixed communities of rose spp. brush, skunkbrush, wax currant, and bluegrass spp. grasses.

Wildlife activity in the areas of the Musselshell association is somewhat limited due to spatial location and vegetation. Proximity to Helena and I-15 are effective barriers for any migrating or wandering animals. Likewise, the lack of browse or grazing material severely limits wildlife use. There is limited deer mice and hawk activity with coyote and owls occasionally present at night. The brushy gullies provide effective corridors for several types of small mammals and are good habitat for some songbirds.

The planning implications of the areas of the Musselshell association are diverse. High-density development is possible on the gentle slopes. Moderate slopes will require low-density, cautious development and careful management of the moderately steep slopes is necessary to avoid erosion problems. Since the topsoil layer is thin, it will have to be carefully preserved. Road development on all three soils poses no serious problems except for frost action in the case of Sappington soil. This also hampers slabs (tennis courts) or foundation footings (houses without basements). Crago sites will tend to be unstable on oversteepened banks and could present problems in the construction of foundation holes or utility trenches. Access to Helena from the lands under consideration is very good. There will be a moderate to severe noise problem due to the proximity to I-15. The biotic productivity could be improved with irrigation. Therefore, the area may be considered for a golf course to serve as green space between Helena and further development. Although permeability is high, there is apparently no groundwater pollution problem. With irrigation, the planting of trees and shrubs,

and the protection of the gullies, there could be a positive impact on small wildlife.

Musselshell Stony Loam Site Association

This association is essentially similar in all respects to the Musselshell gravelly loam site association just described, except that the Musselshell stony loam has a stony surface layer which poses additional engineering problems. Extra care, as a result of large stones, will be required when backfilling foundations, and road construction will be more costly. In addition, the topsoil problem becomes more acute and landscaping more difficult.

Crago Cobbly Loam-Musselshell Gravelly Loam Site Association

This association is also similar to the Musselshell gravelly loam site association previously described. The association includes about 50 percent Crago soils, 35 percent Musselshell (gravelly) soils, and 15 percent Scravo soils.

Scravo cobbly loam soil series is derived from calcareous loamy alluvium in the form of fans, terraces, and terrace edges. There is only six inches of cobbly topsoil above a gravelly and cobbly sandy loam layer. Depth to sand and gravel is about 15 inches with the overlying soil containing 20 to 50 percent coarse fragments. Like the Crago sites, oversteepened banks will be very unstable. The permeability of the soil is very high and could pose a groundwater pollution problem. All other characteristics of this association, including vegetation and wildlife, are identical to that of the Musselshell gravelly loam site association.

Crossfire Plains Region

The Crossfire Plains Region is a combination of a rolling bench area to the southeast and an interior valley to the northwest. The region is bounded on the northeast by the Deer Ridges Region and on the southwest by the Ascension Mountains and the Antelope Hills Regions. The vegetation is characteristic of the Dry Plains Landscape: very dry needle and thread grass communities in the southeast, dry bluebunch wheatgrass prairies in the central portion, and the northwest portion tending towards a bitterbrush-bluebunch wheatgrass community after a history of seeding to crested wheatgrass. Four site associations occupy this region: Hilger stony loam site association, Musselshell gravelly loam site association, Pen loam or gravelly loam site association, and the Lap stony loam site association (Figures 5-7).

Hilger Stony Loam Site Association

This site association occurs in the center of the Crossfire Plains Region. The Hilger stony loam is a deep, well-drained soil series found on fans and terraces. It was formed in calcareous gravelly and cobbly alluvium. The rolling topography consists of gentle to moderate slopes with moderately steep slopes on terrace edges. The sites of this association present few problems for the development of structures since the depth of unconsolidated material is very deep and the clay content generally low. However, the profile does contain 25 to 60 percent rock fragments. This will cause some problems in trenching for utilities and backfilling foundations. Topsoil depth is nearly 16 inches but has a high stone content. The amount of clay in the lower 6 to 10 inches of

CROSSFIRE PLAINS REGION

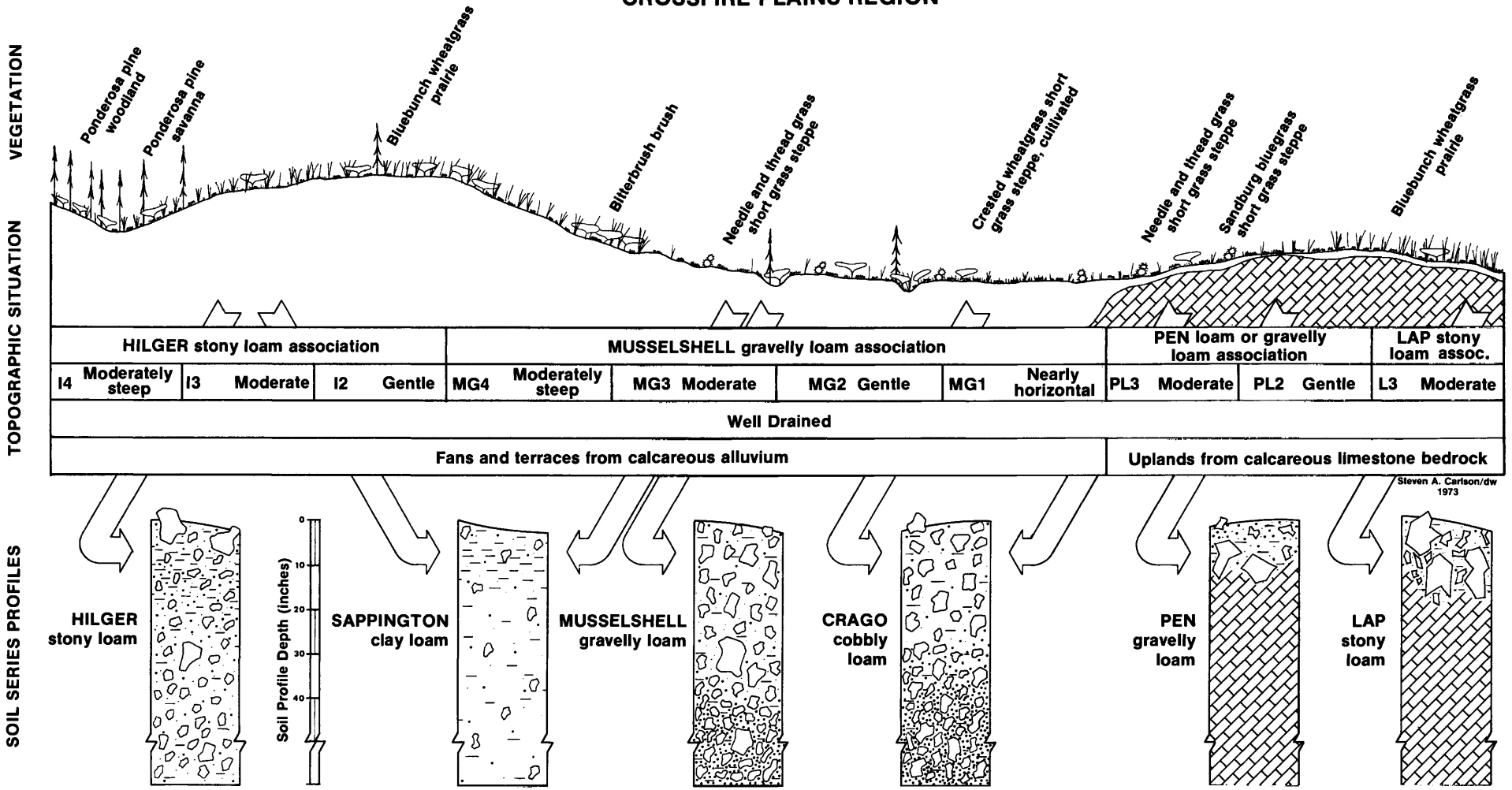
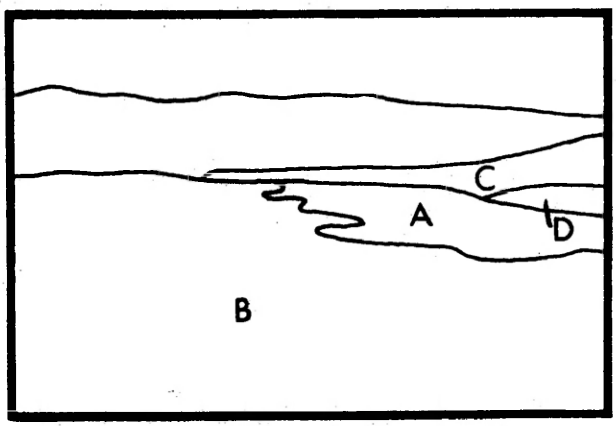
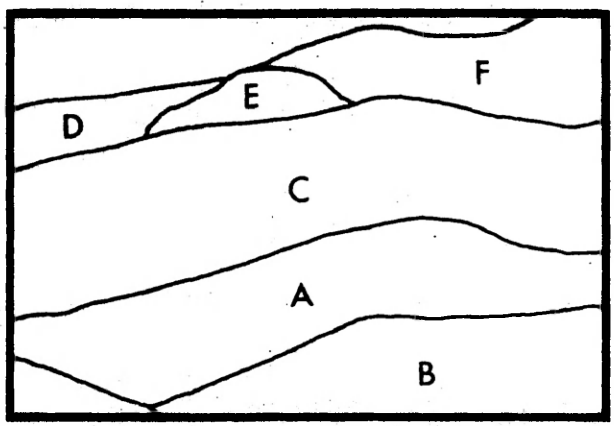


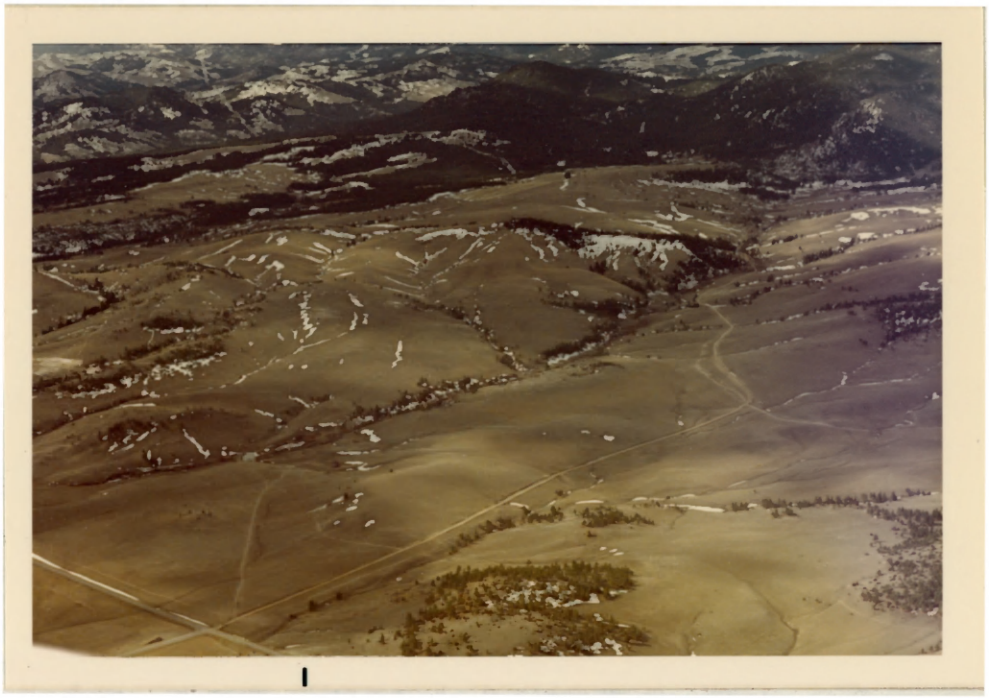
Figure 5



Direction of view: South-southeast
Photograph taken from: Deer Ridges Region
Regions: A--Crossfire Plains Region
(northwest portion)
B--Deer Ridges Region
C--Antelope Hills Region
D--Ascension Mountains Region

Figure 6





Direction of view: Southwest
Photograph taken from: Airplane
Regions: A--Crossfire Plains Region
(southeast portion)
B--Deer Ridges Region (outlier portion)
C--Antelope Hills Region
D--Prickly Pear Hills Region
E--Jackson Hills Region
F--Big Indian Mountains Region

Figure 7

topsoil does increase moderately but should pose no problems. Below 16 inches the soil becomes fairly calcareous. Depth to sand and gravel is greater than 60 inches. Included in the site association is about 20 percent Sappington clay loam which was previously described.

The vegetation of the sites of the Hilger association is generally bluebunch wheatgrass prairie and is near climax conditions. Communities of the ponderosa pine-bunchgrass seres are found along the drainageways and on some of the terrace edges. These could provide pleasant landscape features in a development. On the moderately steep, north-facing terrace edges, there are two stands of mixed conifers forest belonging to the Douglas fir-snowberry sere.

The bioclimate of the area is predominantly similar to that of Helena. Due probably to the concentration of water in gullies, the ponderosa pine-bunchgrass communities are cooler and more moist than Helena. The moderately steep, north slopes are similar to the Unionville shady slope and could be areas of high snow retention during the winter months. The few areas of trees on gentle slopes will greatly benefit any development. Less irrigation will be needed for planted trees and lawns than previously described sites.

The Hilger site association is a good, balanced wildlife habitat. Deer and antelope utilize the bitterbrush found in the gullies as well as the good stands of bunchgrasses. Striped skunk, coyote, red fox, deer mice, and songbirds will utilize the ecotones between woodlands and prairies. Two nests of meadowlarks were observed in the prairie vegetation. With development, impact on wildlife would be significant, although maintenance of the gullies would avoid total displacement.

The planning implications for this association are diverse. The soils are deep and relatively free of frost action except where Sappington soil is found. The topsoil has a high content of stone which may cause problems in backfilling, landscaping, and road building. Also the high gravel and cobble content may have some bearing on the stability of over-steepened soil banks. In general, cluster developments could be considered on the gentle slopes and low-density developments on the moderate slopes. The moderately steep slopes should be managed to maintain the good vegetation cover for erosion control and wildlife habitat. Road development will be hampered by the frost action of the Sappington sites and the stone content of the Hilger sites. Development would have a significant impact on wildlife, although surrounding non-developable areas support the same species. If developed, care will have to be exercised to control excess runoff that could destroy the gully vegetation, reduce the quality of wildlife habitat, and lead to gully erosion.

Musselshell Gravelly Loam Site Association

This association is repeated many times in the study area and is present on both ends of the Crossfire Plains Region. In the southeast portion of the Crossfire Plains Region, the Musselshell gravelly association is identical in all phases to that described in the Bull Run Bench Region subsection. On the other hand, the northwest portion, while retaining the same soil characteristics, exhibits slightly different attributes. Here almost all the sites have been cultivated and planted to crested wheatgrass. The fields have been left unattended for the past several years and, as a result, snake broomweed is slowly encroaching.

In its present state, the vegetation cover is sparse. Sheet erosion is a moderate problem which could be controlled by eradication of the snake broomweed and seeding to native grasses. To judge by neighboring communities and similar sites elsewhere, this area should be able to support a community at least as mesic as bluebunch wheatgrass prairie with possibly bitterbrush as a co-dominant. Therefore, the bioclimate is probably closer to that of Helena or more moist than Helena than its dry appearance of being similar to East Helena. Planted trees will require little care in this area and, with moderate irrigation, shrubs and lawns will be no problem.

Wildlife use of this parkland area is intensive. Deer and antelope graze year around. There are several colonies of Columbia ground squirrels present. In addition, many types of small mammals and their predators use this area frequently. Songbirds find the sites excellent for nesting and feeding. In addition to the displacement of wildlife, development will present a barrier for migrating deer although alternate routes are available.

The implications for planning on the southeast portion are not dissimilar from the Musselshell association described previously. However, there will be a significant tradeoff between development and wildlife use in the northwest portion. Cluster development is ideal for this isolated area, especially on the gentle slopes. Care should be taken to avoid unnecessary fencing which would reduce the feel of open space and lead to greater wildlife displacement. There may be a tendency for the development of a pollution pocket during winter inversion conditions due to fireplaces, etc. and the closed-in nature of the site.

Recreational opportunities surround the sites of this type as does ideal wildlife habitat. If possible, a good bunchgrass ground cover should be established and the snake broomweed eradicated on the steeper, undevelopable slopes. Road access is not difficult although the sites tend to be a long way from Helena.

Pen Loam or Gravelly Loam Site Association

Most of the southeast portion of the Crossfire Plains Region is occupied by the gently to moderately sloping Pen loam or gravelly loam site association. Included in the association are several very different soil components.

About 50 percent of the association consists of Pen loam or gravelly loam soils. These are shallow, well-drained, residual soils found on convex mounds and ridges. They are formed in calcareous material weathered from limestone bedrock. The limited depth of this soil presents severe restrictions for development. With generally less than 10 inches of gravelly soil over bedrock, basements and conventional septic tanks are not feasible and construction of roads or slabs will be very difficult. Only the upper six inches can be considered topsoil and even this tends to be quite gravelly.

Downslope from these shallow Pen soils are soils which are similar except that the depth to bedrock ranges from 20 to 40 inches. These occupy about 20 percent of the area of the association. Road development is feasible as is some slab or footing foundation development if a minimum amount of leveling is needed. Conventional septic tanks could

not be used and the burial of utilities will be difficult or impossible. Protection of the topsoil is a dominant problem.

In the smoother concave and low-lying areas occupied by the association, Musselshell gravelly soil and Crago soil occur. About 25 percent of the association consists of these deep soils. The restrictions of these soils are much less than those of the shallow Pen series. For a discussion of Musselshell and Crago soils, see Bull Run Bench Region section.

The vegetation of the sites of this association within the Crossfire Plains Region varies from the drier prairie types to very dry short grass steppe. The predominant potential vegetation is the needle and thread grass-sandburg bluegrass short grass steppe community. There are, however, several moderately sloping sites where potential vegetation is the more moist bluebunch wheatgrass-sandburg bluegrass prairie. Much of the land under consideration had been cultivated and planted to mountain brome and is now in a deteriorated state dominated by snake broomweed. The present vegetation of the remainder is largely sandburg bluegrass short grass steppe. Sheet erosion is significant and needs immediate attention. The bioclimate of the area is generally similar to dry East Helena with a few areas approaching that of Helena. Therefore, plenty of irrigation will be needed if lawns or shrubs are to be established and maintained.

Due to the lack of trees and browse on the sites of the Pen association, wildlife activity is minimal. Antelope occasionally graze or cross the area at night, but do not use it with any regularity. Small deer mice and hawks are present and these sites are the nocturnal haunt

of an incidental coyote, skunk, or owl. Songbird activity is very limited.

Intelligent planning of this region must be preceded by a more precise delineation of soil series. On the mounds and ridges, the shallow Pen soils preclude development and are best suited for open space. The steeper slopes will need to be seeded to help alleviate sheet erosion. The deeper Pen-like soils of lesser slope could support some road development and building. However, burial of utilities will be difficult and the depth of frozen ground may pose problems for water mains or sewer lines. Musselshell and Crago soils follow the same regimes previously described (see Bull Run Bench Region). By putting this gently rolling, thin soiled terrain under irrigation, the area may make an excellent golf course.

Lap Stony Loam Site Association

A small portion of the south end of the Crossfire Plains Region as well as a small, centrally located hill are part of the moderately sloping Lap stony loam site association. While this association is of very minor importance in this region, it is the dominant constituent of the Deer Ridges Region and the Ascension Mountains Region, and a major component of the Antelope Hills Region.

The shallow Lap soil is very similar to the Pen soil just described. Within this region, it is generally moderately sloping. Like the Pen soil, the Lap series is a well-drained soil of hills and uplands. It is derived from weathered limestone bedrock. From 50 to 70 percent of the profile consists of channery rock fragments. Underneath the 2-inch

topsoil layer is a stony loam horizon ranging from 4 to 18 inches thick. The underlying bedrock of limestone may or may not be highly shattered. About 20 percent of the association consists of bedrock outcrops. Any building attempted on this surface will prove to be expensive (both economically and environmentally) because of slope and shallow soils.

At the base of the hills that are Lap sites, the soil may increase in depth to 40 inches. Even here, roads and slabs will be difficult to place because of the high volume or rock fragments.

Potential vegetation is bluebunch wheatgrass prairie in the south portion and ponderosa pine-bitterbrush woodland on the central hill. There has been moderate grazing pressure over the past few years in the south portion, but the area should recover if carefully managed. The bioclimate is similar to Helena.

Wildlife activity on the southern sites is limited to occasional grazing by antelope and deer mice. All other activity is transient and minimal. The central hill, however, is part of a larger area of excellent deer and antelope habitat. In addition, songbirds, skunk, coyote, red fox, chipmunks, cottontail, and squirrel are present.

The planning implications of the area seem clear. Since development will be expensive and very harmful to the sites, the best uses include recreation, open space, and wildlife habitat.

Clark Plains Region

The Clark Plains Region is bounded on the northeast by the Antelope Hills Region and on the southwest by the Big Indian Mountains and

Jackson Hills Regions which occupy the northernmost edge of the Boulder Batholith.

Actually, the Clark Plains Region does not precisely fit the conception of a plains area. The region is split-level with the lower plains in the northwest and the upper plains in the southeast. Most of the rolling surface is covered by a dry needle and thread grass-blue grama grass short grass steppe community.

Except for a bisecting floodplain of the Slocum loam site association, the entire region is represented by the Brownlee rocky loam-Cheadle rocky loam site association as shown in Figure 8. The photograph in Figure 9 shows the lower plains portion.

Brownlee Rocky Loam-Cheadle Rocky Loam Site Association

There are three main soil constituents in this site association. The Brownlee and Cheadle rocky loams are well-drained, residual soils weathered from granitic bedrock. These noncalcareous soils make up 30 and 60 percent of the association, respectively. On the fans and terraces of the region is found the Breece gravelly and cobbly loam. A deep, well-drained soil the Breece series was also formed from granitic bedrock. Slopes in the association are generally gentle to moderate with some moderately steep areas on the terrace edges.

Found on mounds and side slopes, the moderately deep Brownlee rocky loam has some potential for development. Depth to bedrock is about 40 inches. Therefore, the site type has severe restrictions for houses with basements, conventional septic tanks, and utility trenches. However, barring an excessive problem with the rocky nature of the soil, slabs, footings, and roadbeds can be placed on the gentler slopes. There may be

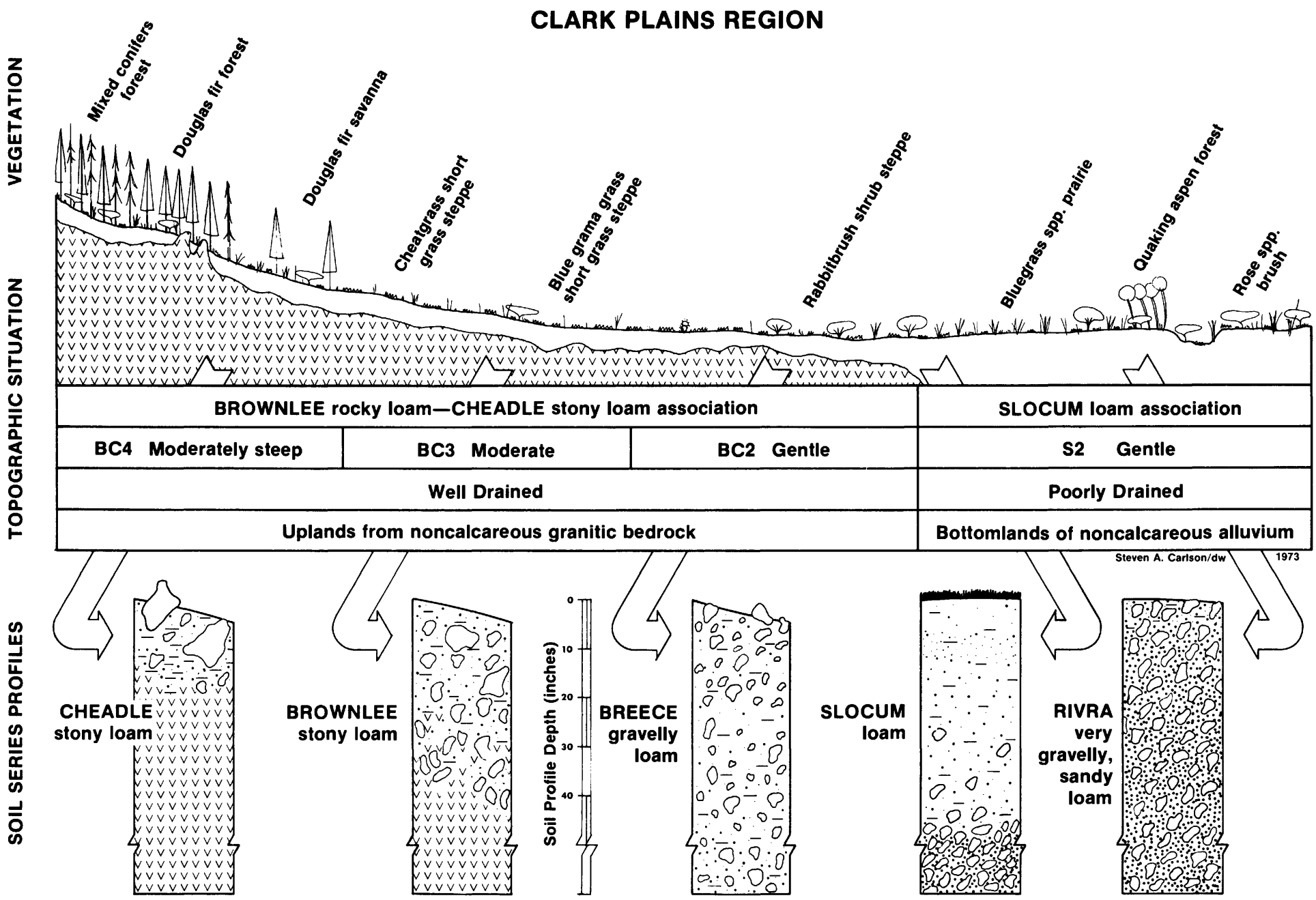
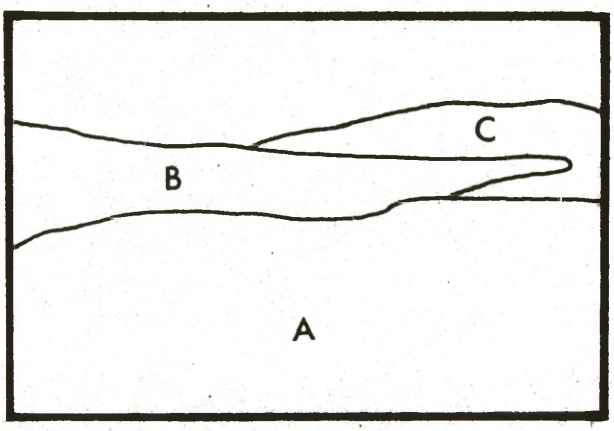

CLARK PLAINS REGION
VEGETATION
TOPOGRAPHIC SITUATION
SOIL SERIES PROFILES
Mixed conifers forest
Douglas fir forest
Douglas fir savanna
Cheatgrass short grass steppe
Blue grama grass short grass steppe
Rabbitbrush shrub steppe
Bluegrass spp. prairie
Quaking aspen forest
Rose spp. brush
BROWNLEE rocky loam—CHEADLE stony loam association
SLOCUM loam association
BC4 Moderately steep
BC3 Moderate
BC2 Gentle
S2 Gentle
Well Drained
Poorly Drained
Uplands from noncalcareous granitic bedrock
Bottomlands of noncalcareous alluvium
Steven A. Carlson/dw
1973
CHEADLE stony loam
BROWNLEE stony loam
Soil Profile Depth (inches)
0
10
20
30
40
BREECE gravelly loam
SLOCUM loam
RIVRA very gravelly, sandy loam

Figure 8



Direction of view: Northwest
Photograph taken from: Clark Plains Region
Regions: A--Clark Plains Region (lower plains portion)
B--Big Indian Mountains Region
C--Antelope Hills Region

Figure 9

a problem with water mains if the soil is not deeper than the frost line. The topsoil is generally about 20 inches thick, providing ample material for most landscaping projects. Throughout the profile coarse fragments of gravel and stone occupy 15 to 35 percent of the volume.

The Cheadle rocky loam soil series occurs on ridges and mounds and is much more shallow than the Brownlee series. With only seven inches of rocky topsoil and, at most, 15 inches of unconsolidated material, the Cheadle soils present significant barriers for development. Septic tanks, basements, and utility corridors would be expensive or infeasible. With so little surface material to manipulate, slabs and roadbeds would be very difficult to construct. In addition, if the good vegetation cover is not maintained, erosion could be a significant problem. Below the topsoil layer the horizons may be somewhat calcareous.

In the concave areas are found the noncalcareous Breece gravelly and cobbly loams. These are prime soils for development, but occur in only 10 percent of the region. The depth to bedrock is greater than 60 inches with a very fine gravel content between 15 and 35 percent. Topsoil will be no problem with 20 to 36 inches available for landscaping use. In general, few development problems exist.

The potential vegetation of most of the area of the Brownlee-Cheadle association is needle and thread grass-blue grama grass short grass steppe. The intensive, concentrated cattle grazing caused by the location of a reservoir in the midst of the region has resulted in a deteriorated vegetation condition. In the worst areas, cheatgrass has taken over, while less mutilated areas have a sparse cover of blue grama grass.

Because of the gentle topography and high soil permeability, erosion is not generally a problem. Along the southwestern edge of the lower plains area and merging with the forests of the adjacent Big Indian Mountains Region are discontinuous, open stands of the Douglas fir-bluebunch wheatgrass and ponderosa pine-bluebunch wheatgrass communities. These more moist communities receive runoff from the mountain above them. With development, the wooded areas could be used effectively for shade and landscaping. A strange phenomenon is the presence of narrow bands of Douglas fir-snowberry forest (the most humid community in the study area) on rocky ridges surrounded by needle and thread grass-blue grama grass steppe (the driest community of the study area). The explanation of this mystery is still unknown. Bioclimate for the region is generally similar to East Helena with small areas cooler and drier than the sunny slope at Unionville.

Wildlife of the region has been inhibited in the lower plains by the concentration of cattle near the reservoir. Nevertheless, black bear have been spotted along the floodplain and deer at the forest edge. Antelope range the upper plains freely and badgers are present on the terrace slope between the two levels. Deer mice and coyotes are present and an occasional mountain lion track has been found in the mud or snow.

The implications for planning are as varied as the three soils found in the association. If the deep Breece soils are present in the low concave areas, development problems are minimal. Where the moderately deep Brownlee soils occur, development will have to be restricted to gentle slopes and low-density housing. Septic tanks and houses with

basements will be infeasible. The shallow Cheadle soils are best left alone to be used as open space, recreation, and wildlife areas. Much of the lower plains area has morning sun and afternoon shade, while the upper plains has no protection from the sun. The sites are quite remote from Helena and are bordered on the south and west by other private land holdings.

Slocum Loam Site Association

Occupying the floor of the Clark's Creek floodplain is the gently sloping Slocum loam site association. The deep, poorly-drained Slocum loam soil series was formed in noncalcareous loamy alluvium. During most of the year, the water table is only 18 to 30 inches below the surface and flooding during the spring is almost certain. For this reason, no floodplain development should take place. The soil profile is topped with a 4-inch layer of root mat under which lies about 11 inches of loamy topsoil. Sand and gravel occur at a depth of 49 to 60 inches. Frost heaving on Slocum sites is significant.

Included in the association are about 30 percent Rivra very gravelly, sandy loam soils. Lying along the stream, this gently sloping, deep soil was formed in sandy, gravelly alluvium. The water table is near the surface all year and, during the spring, flooding is inevitable. Development, therefore, should be precluded on Rivra sites. There are only three inches of topsoil above a very gravelly sand.

In areas of heavy grazing, the vegetation is a dense sod of tolerant bluegrass spp. Often this sod has a brush layer of rose spp. Several other areas, especially the area just below the reservoir site, have

forest stands of quaking aspen with a tangled underbrush of rose spp. Interspersed with the aspen is an occasional black cottonwood or Douglas fir. Little can be said about bioclimate since vegetation response is due primarily to a high water table.

Many different species of wildlife use this narrow, sheltered corridor as a highway. This includes deer, antelope, small mammals, and their predators. Still others, such as black bear and the abundant songbirds, use the vegetation as a source of food. The primary inhibiting factor for wildlife is the presence of a road, parallel and adjacent to the corridor.

Because of the high water table, high potential for flooding and frost action potential, development on the floodplain should be avoided. Retaining the area in its natural state with provisions for summer picnics and hikes would seem to be the optimal use. Road banks and other nonvegetated banks will be severely undercut during the annual floods. There may be some potential for reservoir development along the site's narrow corridor.

CHAPTER IV

THE PRAIRIE HILLS LANDSCAPE

Much of the Prairie Hills Landscape consists of moderate to moderately steep hills and slopes covered with tall bunchgrasses. Pockets of trees are nestled in ravines, on steep north slopes, or in isolated depressions of the higher hills. Within this landscape type are two regions: the May Be So Foothill Region and the Antelope Hills Region.

May Be So Foothill Region

The May Be So Foothill Region lies sandwiched between the Bull Run Bench Region on the northeast and the Deer Ridges Region on the southwest. It is a transition region of low hills and footslopes between the lower benches and higher ridges. Much of the moderate to moderately steep slopes are covered with bunchgrass prairies while the ravines support stands of ponderosa pine. Characteristic upland site associations of the present region are the Tolman, Tolman-Crago, Musselshell stony, Musselshell gravelly, and Gravel associations. A bisecting floodplain is occupied by the Havre association. The relationship of these associations is shown in Figure 10. Figure 11 is a photograph of part of the region.

MAY BE SO FOOTHILL REGION

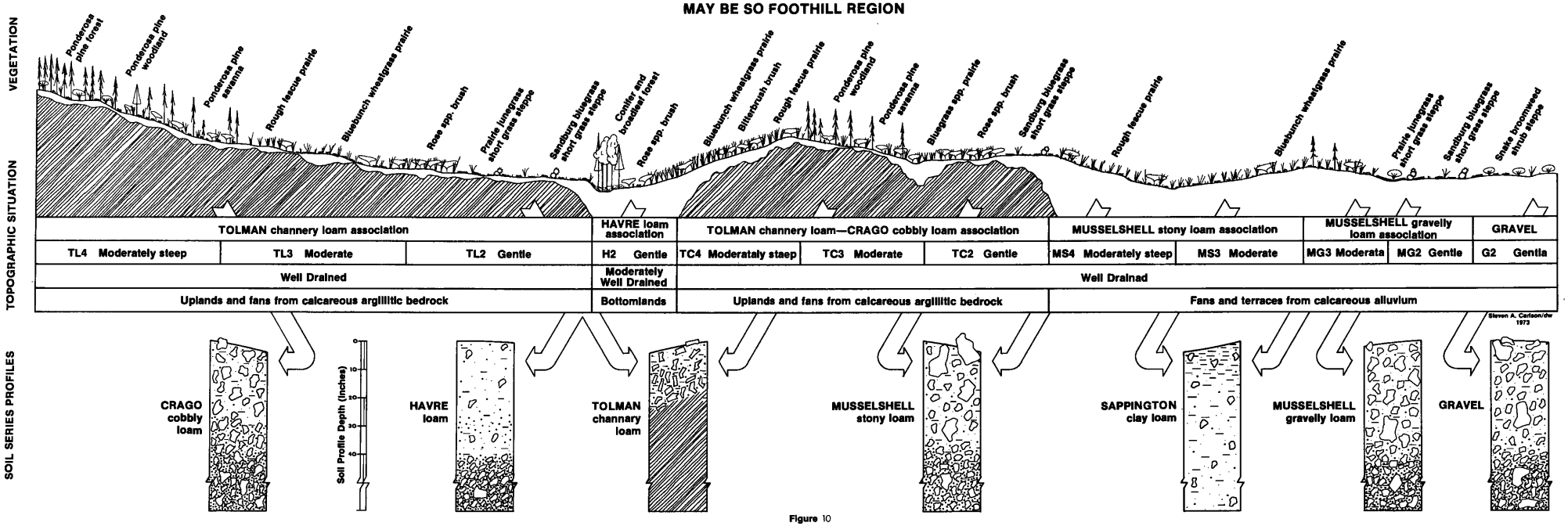
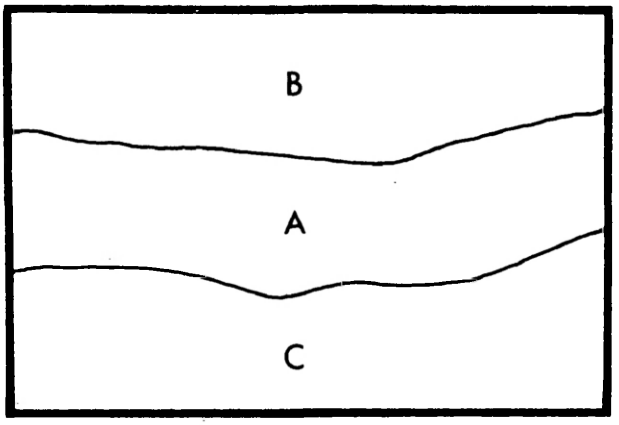


Figure 10



Direction of view: North-northeast
Photograph taken from: Ascension Mountains Region
Regions: A--May Be So Foothill Region
B--Deer Ridges Region
C--Helena urbanized area (including state capitol)

Figure 11

Tolman Channery Loam Site Association

This association includes a mix of soils not dissimilar to that found with the Pen loam or gravelly loam site association (see Crossfire Plains Region). About 80 percent of the Tolman association consists of the shallow Tolman soil series. The remaining 20 percent has the deeper Crago, Musselshell (gravelly), and/or Sappington soils (see Bull Run Bench Region).

On the uplands and mounds is found the well-drained Tolman channery loam soil series. It is a shallow soil located on moderate to moderately steep slopes and is formed in calcareous channery material from pre-cambrian argillitic bedrock. With only 7 to 18 inches of unconsolidated material overlying bedrock, development potential is marginal at best. Depth alone precludes basements, septic tanks, and utility trenches. In addition, the scarce 3 to 7 inches of topsoil, the high content of channery fragments, and the steep slopes do nothing to enhance its development potential. Below 7 inches the soil becomes a very channery, sandy clay loam. Without a good vegetative cover, erosion would be a significant problem.

Along the lower footslopes, fans, and drainageways there may be Crago, Musselshell (gravelly) or Sappington soils. More precise soil data is needed. Because this association is adjacent to the highly developable Bull Run Bench Region, a significant alteration of the land-use capabilities may occur on their common border.

On the very lowest and driest sites of this association are found short grass steppe communities of sandburg bluegrass and/or prairie junegrass. The potential of these dry sites is probably needle and

thread grass-sandburg bluegrass short grass steppe. Higher on the slopes, with an increase in effective moisture, prairie vegetation predominates. Included are near climax bluebunch wheatgrass-sandburg bluegrass and rough fescue-bluebunch wheatgrass prairie communities. On most of the moderately steep slopes and protected ravines, the potential vegetation is one of the ponderosa pine-bunchgrass or Douglas fir-bunchgrass types. Presently, ponderosa pine stands range from forests to savannas in good condition. Clearly, as one moves upslope, the bioclimate shifts from the very dry East Helena type to cooler and more moist than Helena with drier, cooler than Unionville types occurring in the most sheltered reaches.

Fauna of the Tolman association are abundant and quite active. With ecotones, produced by wooded slopes adjacent to prairie slopes, one finds the optimal wildlife habitat. Deer and antelope are frequently seen as are many species of songbirds and small mammals. The lower, drier slopes are used to a much lesser degree. Here one finds deer mice, coyotes, and infrequent transients.

The above described conditions provide obvious planning constraints. On the one hand, development may be considered on the Crago, Musselshell (gravelly) or Sappington sites of the footslopes and fans--provided one keeps in mind the limitations listed for the Bull Run Bench Region of Chapter III. This is especially desirable given the proximity to the highly developable Bull Run Bench Region and easy access from Helena. On the other hand, the Tolman sites of the slopes and hills should be reserved for wildlife and recreation. The potential for hiking, snow-shoeing, and other similar activities is excellent. Care is needed on

the moderately steep slopes to prevent serious erosion caused by loss of vegetation cover. Given the development of the Bull Run Bench Region and increased recreation pressure, the propensity for loss of vegetation may make the erosion situation a serious management problem.

Tolman Channery Loam-Crago Cobbly Loam Site Association

Lying in the northwest portion of the May Be So Foothill Region, this association is very similar to the Tolman association just described. The primary difference lies in the proportions of the soils. Only about 60 percent, rather than 80 percent, consists of the shallow Tolman series. The remainder is approximately 25 percent Crago and 15 percent Musselshell (gravelly) or Sappington soil. Slope varies from gentle to moderately steep. Tolman soil occurs on the ridges and mounds and deeper Crago, Musselshell (gravelly), and Sappington soils (see Bull Run Bench Region) are found on the fans, terraces, and drainageways. The soil profiles are similar to those previously described.

The vegetation is similar to that found on Tolman sites. However, the drier short grass steppe communities of the lower slopes and the more moist ponderosa pine communities of the upper slopes are less extensive. On the intermediate slopes, are near-climax stands of bitterbrush-bluebunch wheatgrass brush. Along the drainageways, there are climax stands of bluegrass spp.-prairie junegrass prairie. Generally, the bioclimate ranges from similar to Helena to cooler and more moist than Helena.

Wildlife use is more restricted than in the case of the Tolman channery loam site association because of the close proximity to the city

of Helena. Nevertheless, both deer and antelope venture onto the sites of the Tolman-Crago association. There is a permanent population of small mammals--deer mice, mountain cottontail, chipmunk, porcupine, and squirrels; and their periodic predators--red fox, coyote, and skunks. Songbirds are less prevalent.

Since there is a greater proportion of deeper soils in this site association, the opportunity for development likewise increases. In addition, much of this area is within the city limits of Helena. Again, a more detailed soil survey is needed to delineate potential development sites. Very few gentle slopes are present and, thus, development should be of a low-density type. For the most part, the shallow Tolman soils should not be developed. Tolman sites can be used for recreation but the steeper slopes will have to be protected against vegetation loss for erosion control.

Musselshell Stony Loam Site Association

This site association is the same as that described for the Bull Run Bench Region in Chapter III. In the May Be So Foothill Region, it occupies moderate to moderately steep slopes just downslope from the Tolman channery loam site association. Slopes generally preclude development.

Throughout the association prairie vegetation dominates and is at or near climax. Potential vegetation is rough fescue-bluebunch wheatgrass prairie on the steep upper slopes and bluebunch wheatgrass-sandburg bluegrass prairie on the lower, less steep slopes. The bioclimate is more moist to cooler and more moist than Helena.

Ecotones are formed with these prairies and the adjacent wooded areas. Wildlife use is heavy with deer and antelope appearing in the early morning and late evening. A red fox was seen scampering across the prairie probably in search of rabbits or other small mammals which abound on the sites. This is also an excellent area for meadowlark nests.

Slope will prohibit most development on this type of land. While the moderate slopes could sustain light development, the stony nature of the soil almost eliminates even that possibility. The best use is to retain its lush prairie character and the beauty of a now rare natural phenomenon.

Musselshell Gravelly Loam Site Association

On the southeastern edge of the May Be So Foothill Region is an undulating basin occupied by the Musselshell gravelly loam site association. This association has been encountered in previous regions. It occurs on moderately sloping hills and in two small areas of gently sloping ground.

All but one of the moderate slopes are in advanced stages of succession leading to a bluebunch wheatgrass-sandburg bluegrass prairie. The other moderate slope is on a northern exposure and is a ponderosa pine-bluebunch wheatgrass forest habitat presently occupied by a bluebunch wheatgrass prairie. On the two gently sloping areas, the vegetation is quite different. The first area is unprotected and very dry yielding a short grass steppe community of prairie junegrass. Potential vegetation is needle and thread grass-sandburg bluegrass short grass steppe. With a moderate amount of protection, the second area supports

a climax community of bluebunch wheatgrass-sandburg bluegrass prairie. If developed, significant irrigation will be vital to establish and maintain lawns, shrubs, or trees. Bioclimatically the lands of this association are generally similar to Helena.

During the early morning or late evening, antelope graze the area. Burrowing mammals are abundant with one colony of Columbia ground squirrels present. Predators should be active at night. There is little reason to suspect anything but scarce songbird activity.

Overall, this site association will support at least a low-density development. The gentle slopes may be large enough to consider cluster development (see Bull Run Bench Region). Access to Helena is fair. Recreation potential abounds in the neighboring areas. Some seeding is needed to alleviate a moderate sheet erosion problem.

Gravel Site Association

This is a small, gently sloping area in the midst of the Musselshell gravelly loam association. It is the result of scarification by bulldozers or other heavy equipment of what was, in all likelihood, a Musselshell site. The topsoil is absent and the shrub steppe vegetation of snake broomweed is indicative of the severe disturbance. From inference, the site should support needle and thread grass-sandburg bluegrass short grass steppe. Wildlife is virtually nonexistent.

In planning the best use for this site, the general guidelines for Musselshell gravelly sites should be followed. An additional constraint, however, is the lack of topsoil. Given the deteriorated condition, development could only greatly enhance its condition. At a minimum,

some vegetation cover of grasses needs to be reestablished to combat the excessive erosion now taking place.

Havre Loam Site Association

On both ends of the May Be So Foothill Region are narrow gullies of the Havre loam site association. A narrow band of this association transects several other regions in the center of the study area. This corridor is the floor of Holmes Gulch. The gently sloping Havre sites have deep, moderately well-drained soils formed in calcareous loamy alluvium and occur in the bottom of drainage channels. While the profile of the Havre soil series is very deep, there are only seven inches of topsoil above the first "C" horizon. Sand and gravel are found at 40 to 80 inches and the water table is 6 to 10 feet below the surface. The site type is subject to flooding both during spring runoff and intense summer storms. For these reasons, no structural development should occur. Road cuts or fills should also be avoided where flooding will undercut the banks.

Included within the association are about 15 percent Rivra soils (described in the Clark Plains Region) and 10 percent Fairdale loam. The latter is a deep, poorly-drained soil distinguished by a thick mat of grasses or aquatic vegetation on its surface. The topsoil, which is silt loam, is 18 inches deep. Within 40 inches, sand and gravel and the permanent water table are reached. This soil is subject to annual flooding and should be avoided for development purposes.

Historically, the gravels of the Havre site association yielded considerable gold and were worked and reworked. Consequently, much of

the vegetation has been highly disturbed, especially in the larger drainages. Several plant communities requiring high amounts of soil moisture are evident: for example, mixed forests of black cottonwood and ponderosa pine and rose spp.-bluegrass spp. communities. However, most communities are dominated by ponderosa pine with understories of bitterbrush and bluebunch wheatgrass--surprisingly close to climax considering the recent, extensive disturbances. Bioclimate tends to be cooler and more moist than Helena.

Within these narrow corridors, wildlife are very active. Deer and antelope browse the bitterbrush which squirrels also feed on and perpetuate its growth.[30] Many other small mammals abound and songbirds are especially abundant.

A high water table and potential flooding dictates that no permanent development take place. Unless carefully planned, roads may be washed out or undercut. This is an excellent hiking and picnic area. Therefore, the best use is to maintain it as a valuable wildlife and recreation area.

Antelope Hills Region

By far the largest region in the study area, the Antelope Hills are bounded on the north by the Ascension Mountains and Crossfire Plains Regions and on the south by the Big Indian Mountains, Clark Plains, and Prickly Pear Hills Regions. The region consists of a large, "bald"

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[30]Robert J. Sherman and William W. Chilcote, "Spatial and Chronological Patterns of *Purshia tridentata* as Influenced by *Pinus ponderosa*," *Ecology*, LXXX (1972), 294-97.

mountain in the northwest which wanes to smooth, rolling hills to the southeast. Most of the region exhibits the typical prairie vegetation of the Prairie Hills Landscape. However, pockets of trees are not infrequent on steep north slopes, in ravines, and along ridges. The region consists of the Woodrock stony loam, Cheadle stony loam, Brownlee stony loam, Breece cobbly loam, Lap stony loam, and Fairdale loam site associations as illustrated by Figure 12. The photograph in Figure 13 shows the east slope of "bald" mountain and Figure 14 is the lower hill area of the southeast portion of the region.

Woodrock Stony Loam Site Association

The sole member of this site association is the Woodrock stony loam site type. Found on moderately steep to steep north slopes, the soil of this site type is a well-drained, moderately deep soil formed in place from noncalcareous igneous bedrock. Because of slope, Woodrock sites are undevelopable. Even trails will be hard to establish. The pocketed soil of this site type is found under forest canopies and generally retains about a 3-inch litter layer. Beneath the litter, the topsoil is 6 to 20 inches deep with bedrock no more than 40 inches below. About 15 to 35 percent of the profile is coarse fragments. In addition, the bedrock outcrops on about 15 percent of the surface.

Both present and potential vegetation is Douglas fir forest with a variable understory of snowberry, bluegrass spp., or deep forest litter with no undergrowth. The stagnated areas, with litter so deep as to preclude undergrowth development, could be thinned to increase productivity and enhance wildlife use. Due to the low relative amount of solar

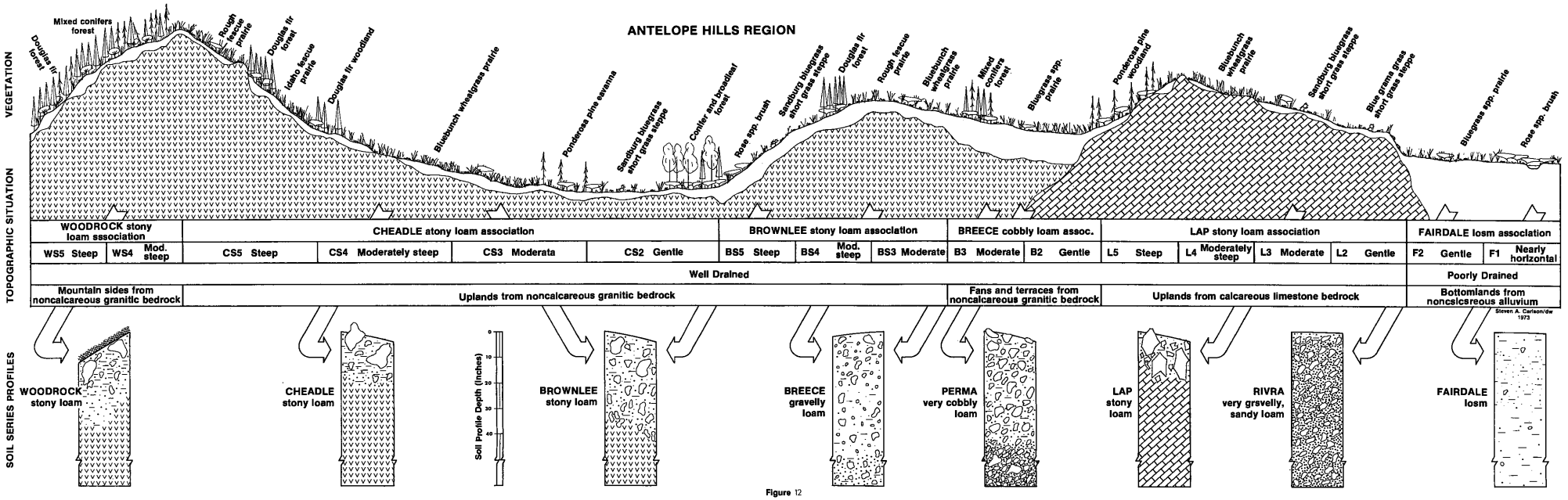

ANTELOPE HILLS REGION
VEGETATION
Douglas fir forest
Mixed conifers forest
Rough fescue prairie
Douglas fir forest
Idaho fescue prairie
Douglas fir woodland
Bluebunch wheatgrass prairie
Ponderosa pine savanna
Sandburg bluegrass short grass steppe
Conifer and broadleaf forest
Rose spp. brush
Sandburg bluegrass short grass steppe
Douglas fir forest
Rough fescue prairie
Bluebunch wheatgrass prairie
Mixed conifers forest
Bluegrass spp. prairie
Ponderosa pine woodland
Bluebunch wheatgrass prairie
Sandburg bluegrass short grass steppe
Blue grama grass short grass steppe
Bluegrass spp. prairie
Rose spp. brush
TOPOGRAPHIC SITUATION
WOODROCK stony loam ssociation
WS5 Steep
WS4 Mod. steep
CHEADLE atony loam association
CS5 Steep
CS4 Moderately steep
CS3 Moderata
CS2 Gentle
BROWNLEE stony loam association
BS5 Steep
BS4 Mod. steep
BS3 Moderate
BREECE cobbly loam assoc.
B3 Moderate
B2 Gentle
LAP stony loam association
L5 Steep
L4 Moderately steep
L3 Moderate
L2 Gentle
FAIRDALE losm association
F2 Gentle
F1 Nearly horizontal
Well Drained
Poorly Drained
Mountain sides from noncalcareous granitic bedrock
Uplands from noncalcareous granitic bedrock
Fans and terraces from noncalcareous granitic bedrock
Uplands from calcareous limestone bedrock
Bottomlands from noncsicsreous alluvium
Steven A. Carlson/dw 1973
SOIL SERIES PROFILES
WOODROCK stony loam
CHEADLE stony loam
Soil Profile Depth (inches)
0
10
20
30
40
BROWNLEE stony loam
BREECE gravelly loam
PERMA very cobbly loam
LAP stony loam
RIVRA very grsvelly, sandy loam
FAIRDALE losm

Figure 12

DEER RIDGES REGION

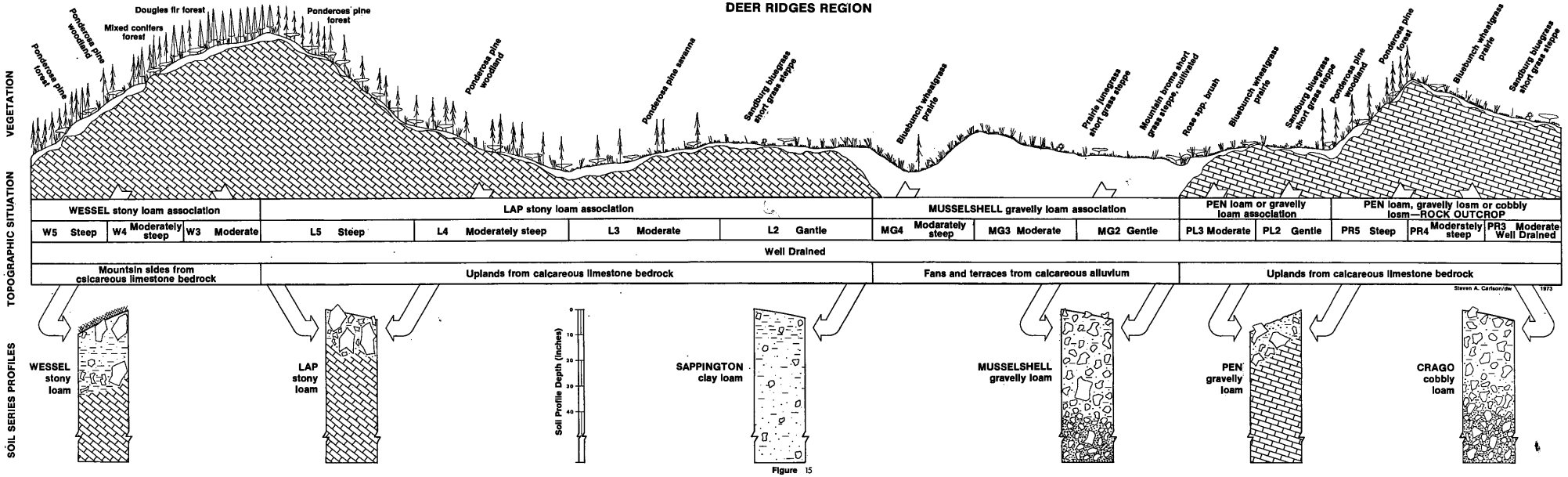
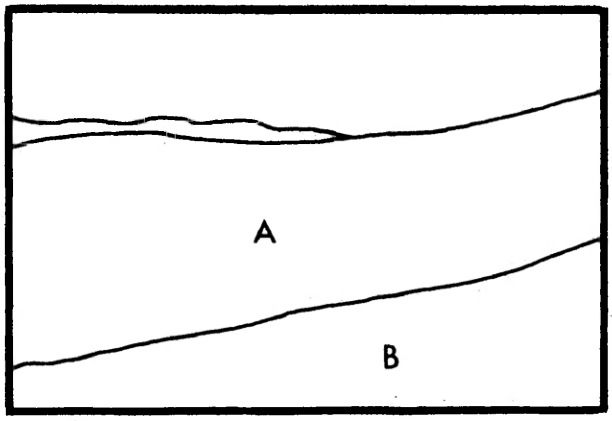
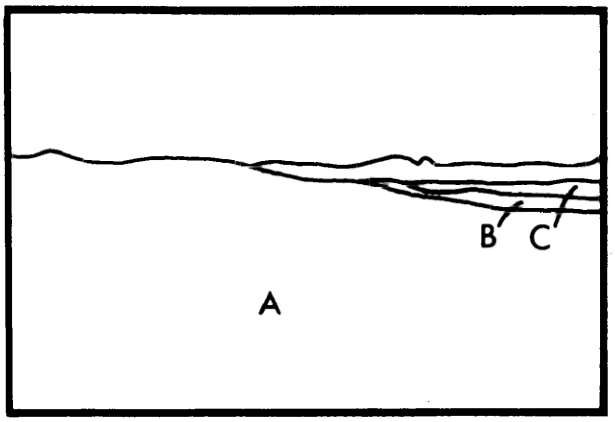


Figure 15



Direction of view: South
Photograph taken from: Ascension Mountains Region
Regions: A--Antelope Hills Region (high, northwest portion)
B--Ascension Mountains Region

Figure 13



Direction of view: Northwest
Photograph taken from: Antelope Hills Region
Regions: A--Antelope Hills Region (low, southeast portion)
B--Deer Ridges Region
C--Helena Valley

Figure 14

radiation received, the bioclimate is similar to that of the cool Unionville shady slope.

Wildlife use is limited to squirrels, transients, and the abundant songbirds.

The site type is best reserved for its beauty and the occasional hiker. Some attention may be given to grooming the area through thinning of trees and litter removal which will enrich the area for wildlife and tree production.

Cheadle Stony Loam Site Association

The Cheadle association comprises most of the Antelope Hills Region and occupies moderate to moderately steep slopes. Slope and/or difficult access preclude development in most of the area. The association includes the shallow Cheadle soil series (60 percent), the moderately deep Brownlee series (30 percent), and the deep Breece series (10 percent). All are weathered from granitic bedrock. These three soils were previously described in the Crossfire Plains Region.

The vegetation pattern is far too complex to describe in detail and the results would not merit the effort. In deep ravines, on steep north slopes, and in high pockets are wooded areas of Douglas fir and/or ponderosa pine. By contrast, the lower, gently sloping areas have dry short grass steppe communities. In between, the various prairie grasses predominate, varying with altitude and slope aspect. The driest prairie type, bluebunch wheatgrass, grades into the Idaho fescue prairie and then to the moist rough fescue prairie. Just as varied is the bioclimate. Whereas most of the region is similar to Helena, there are smaller areas

of more mesic conditions that compare to that of the cool Unionville shady slope.

As the regional name implies, antelope freely roam these hills. Mountain lion, bear, and deer also are found. In several areas, badger can be seen digging for burrowing rodents. Other predators, such as red fox, coyote, skunk, and hawks, are present. Songbirds are abundant along the drainageways.

Development on the sites of this association does not appear feasible. The shallow Cheadle soils on moderate to severe slopes are not feasible to develop. Erosion will be a significant problem if the vegetation is severely disturbed. Only in rare cases, where a Breece or Brownlee soil might be found, is it feasible to build a structure; but these areas are so small that they scarcely merit consideration. In addition, access would be extremely difficult. These lands are best left for the antelope and people to roam. Vehicle traffic should be barred in order to prevent degradation of the vegetation and to minimize conflicts with dwindling antelope range.

Brownlee Stony Loam Site Association

Surrounded by the Cheadle stony loam site association the Brownlee sites are islands of moderately deep soil. Included in the association are three soils: the shallow Cheadle stony loam (20 percent), the deep Breece stony loam (20 percent), and the moderately deep Brownlee stony loam (60 percent). The site types characterized by these soils offer little potential for development since they occupy moderate to steep slopes and are surrounded by the same.

Within the ravines and on certain north slopes are dense climax stands of Douglas fir-snowberry forest. Other areas, less able to retain moisture, support Douglas fir-bunchgrass woodlands and savannas. Most of the area is split between climax prairie communities of rough fescue and bluebunch wheatgrass. Along drainageways, where Douglas fir has not been established, are rose spp.-bluegrass spp. communities. Bioclimate ranges from cooler than Helena to the cool Unionville shady slope.

Wildlife use is identical to that of the above described Cheadle sites.

Because of moderate to steep slopes, difficult access, and very few deep soil pockets, this association can best be used for recreation--hiking, riding, snowshoeing, and nature study. While erosion potential is moderate, steep slopes could present significant problems if the vegetation is removed.

Breece Cobbly Loam Site Association

In the northwest portion of the Antelope Hills Region and at the base of the Big Indian Mountains Region are three pockets of the Breece cobbly loam site association. Though access is fairly difficult, some excellent development potential exists for the gently to moderately sloping sites of this association.

The deep Breece soils and moderately deep Brownlee soils which comprise 60 and 20 percent of the association, respectively, have been discussed several times previously. Twenty percent of the association is, however, of the Perma very cobbly loam soil series.

Similar to the Breece series, the Perma series is a deep, well-drained soil formed in noncalcareous gravelly alluvium. It occurs on fans and terraces, but usually along drainageways. With over 60 inches of loamy material lying over sand and gravel, there are only minor development problems. The major problem is the very gravelly and cobbly nature of the soil (35 percent at the surface, increasing to 80 percent with depth). Thus, problems can be anticipated with landscaping even though there are 14 inches of topsoil. As in the case of Scravo and Crago soils, the stability of oversteepened walls of trenches or excavation will be poor.

Over the past several years, the vegetation of the sites of this association has received considerable punishment from grazing and lounging cattle. Consequently, the very hardy bluegrass spp. have increased and produced a dense sod over much of the area. The resulting bluegrass spp.-prairie junegrass prairie community is considered a zootic climax. If developed, the lawns are already in place!

There are two wooded areas included in the area of this association. The first is a climax Douglas fir-kinnikinnik forest on a moderate slope, while the second is a gently sloping area of ponderosa pine and Douglas fir on a Douglas fir-rough fescue habitat. This latter area provides an excellent opportunity for houses "beneath the pines." Bioclimatically the sites of this association are probably more moist than Helena. Snow retention may be a problem because of high altitude and afternoon shade.

Due to the lack of browse, wildlife grazers are rare. Nearby there are bear, deer, mountain lion, badger, antelope, ground squirrels, squirrels, and songbirds. With some management and no develpment, this area

could support an increased deer population and would be excellent for elk.

Potential for development is fairly good except for the problem of access. But perhaps the remoteness increases its intrinsic value. Breece sites have a high potential for development while the gravelly and cobbly nature of the Perma sites and the moderate depth of soil on Brownlee sites pose some sticky problems. Moderate slopes will be difficult to develop as a result of snow retention. Even the gently sloping sites will need to be carefully planned. Erosion is not and should not be a problem except where vegetation is completely absent on steeper slopes. The opportunity for nature study is excellent in the surrounding areas--the rough, forested Big Indian Mountain to the south, and the smoother, prairie covered mountain to the north. Given these benefits, the Breece sites may be a prime location for a nature study lodge, summer camp, or similar facility. Perhaps local schools or colleges would be interested in this possibility.

Lap Stony Loam Site Association

Except that the bedrock of this association is limestone, its character is very similar to that of the Cheadle association. The soil is very shallow and gravelly with frequent outcroppings of bedrock. Development potential is, therefore, restricted and largely not feasible. The sole member of this association, Lap, was discussed in the section on the Crossfire Plains Region in Chapter III. In the present region, unlike the Crossfire Plains, Lap sites range from gently to steeply sloping with the majority being moderate to moderately steep. This adds to the negative development potential.

Altitudinally, these sites are situated somewhat lower than the sites of the Cheadle association, and the vegetation reflects that difference. The predominant prairie vegetation is made up almost entirely of climax bluebunch wheatgrass communities. Also, there are more extensive areas where the potential vegetation is needle and thread grass-sandburg bluegrass or blue grama grass short grass steppe. In some of the ravines or gullies are found forest communities of either the Douglas fir-snowberry sere or the ponderosa pine-snowberry sere. The rocky north slopes are covered with woodlands or savannas of the ponderosa pine-bitterbrush/bluebunch wheatgrass sere. In general, the bioclimate ranges from similar to East Helena to similar to Helena.

Antelope frequent Lap sites, especially in the late spring and early summer. Deer are rare or absent, but small mammals abound. Snakes are also abundant. The ever-present predators--skunks, coyotes, fox, and hawks--inhabit the site. Songbirds are not extremely active.

This site type should be reserved for recreation and management of its wildlife potential. The very shallow, rocky Lap soil is not suitable for structures and will even present problems in developing a roadbed. In addition, the moderate to steep slopes are effective constraints to development. If used for recreation, trails will have to be carefully planned, and the vegetation cover managed to prevent a significant erosion problem.

Fairdale Loam Site Association

In the form of a wide, nearly horizontal to gently sloping floodplain, the Fairdale association cuts across the regional grain at the

southeast end of the Antelope Hills. The association borders Clark's Creek on both sides. To the west it is joined by the Slocum association previously discussed in the Clark Plains Region. Included in the Fairdale association are two soils: the deep, poorly-drained Fairdale loam (see May Be So Foothill Region) and the deep, wet Rivra loam (see Clark Plains Region). Most of the unit is subject to annual flooding.

The potential vegetation of the floodplain is almost entirely the rose spp.-bluegrass spp. community due to extensive cattle use and the high water table. Lining the south side of Clark's Creek is a dense thicket of rose, willow, and quaking aspen. One small area is dominated by rabbitbrush because of drier conditions and intense grazing pressure.

Wildlife along the floodplain is represented by many songbirds and small mammals. Antelope frequent the gullies both for corridors of travel and for resting sites.

The best use of the floodplain is for recreation--picnics, hikes, and nature study. The high water table and flooding can only cause problems if development were undertaken. In addition, roads will be undercut or washed out. With steep banks on either side, the floodplain may be an excellent reservoir location.

CHAPTER V

THE WOODED RIDGE AND MOUNTAIN LANDSCAPE

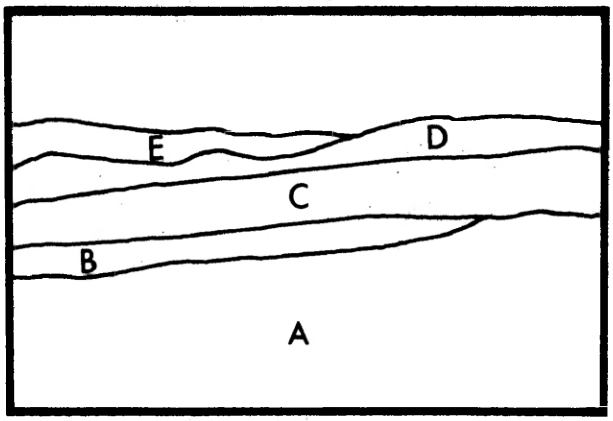
From low ridges to high mountains, this landscape is dotted or shaded by the permanent green of Douglas fir and ponderosa pine. Three regions comprise the moderate to steep landscape: the Deer Ridges, Ascension Mountains, and Prickly Pear Hills Regions.

Deer Ridges Region

The long, narrow Deer Ridges Region is squeezed between the May Be So Foothill Region to the northeast and the Ascension Mountains and Crossfire Plains Regions to the southwest. It consists of a main backbone ridge with numerous lateral ridges, especially in the northwest portion. Many of the moderate to moderately steep slopes are covered with woodlands and savannas of ponderosa pine. Several steep, north slopes are covered with Douglas fir forest. Figure 15, the biophysical profile of the region, reflects this character and displays five site associations: Lap stony loam; Wessel stony loam; Musselshell gravelly loam; Pen loam or gravelly loam; and Pen loam, gravelly loam, or cobbly loam-Rock Outcrop site associations. The photographs in Figures 16 and 17 are representative of the regional character.

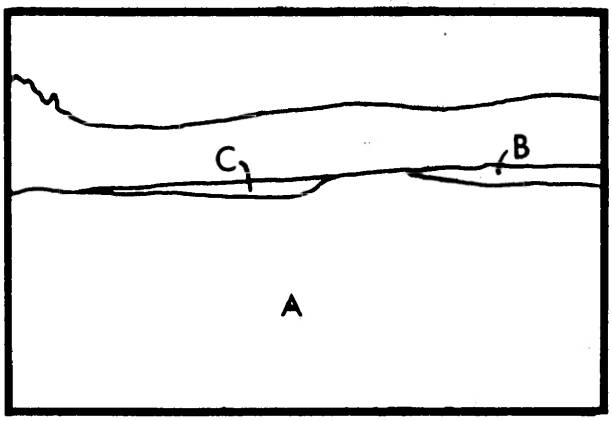
Lap Stony Loam Site Association

Most of the northwest two-thirds of the Deer Ridges Region is the Lap stony loam site association. Typical of the wooded landscape, the



Direction of view: West
Photograph taken from: Deer Ridges Region
Regions: A--Deer Ridges Region
B--Crossfire Plains Region
C--Ascension Mountains Region
D--Antelope Hills REgion
E--Big Indian Mountains Region

Figure 16



Direction of view: Southeast
Photograph taken from: Deer Ridges Region
Regions: A--Deer Ridges Region
B--Prickly Pear Hills Region
C--May Be So Foothill Region

Figure 17

sharp-backed ridges are moderately to steeply sloping. The site type occurs on a series of very steeply dipping metamorphosed sedimentary beds of cambrian limestone, dolomite, quartzite, and argillite. Much of the backbone of the main ridge is formed on the very hard Flathead Quartzite. Over 80 percent of the association consists of Lap stony loam with the remainder being rock outcrop. The very shallow, stony soil has little to offer for development (see Crossfire Plains Region).

Like the members of the Cheadle association, the Lap sites of this region cover a broad area and are extremely complex areas. Most of the vegetation of the area is relatively open woodlands and savannas of ponderosa pine with rough fescue and/or bitterbrush understories. The vegetation is at or near climax condition. There are north slopes and ravines having Douglas fir forest with an understory of kinnikinnik or snowberry; and there are grassy knolls or small open meadows of rough fescue or bluebunch wheatgrass. The rather open nature of the vegetation, the excellent understory of bitterbrush, and the many ecotones between prairie and woodland make this area an extraordinarily productive deer and antelope habitat (especially as winter range). Bioclimate is generally cooler and more moist than Helena.

In addition to the deer and antelope, there are various species of songbirds and small mammals. The abundant squirrel population is largely responsible for the maintenance of the bitterbrush--a delicacy to deer and antelope.

Because of the very shallow nature of Lap soil and the steep slopes, Lap sites should not be developed. Possibly the best use is to take advantage of their open, wooded nature for recreation and nature study.

Hiking, snowshoeing, cross-country skiing, and birdwatching could be very rewarding in such a rich natural area. Trails will need to be carefully planned to prevent erosion.

Wessel Stony Loam Site Association

Lying in the center of the Deer Ridges Region, the Wessel association occurs as moderately steep to steep north slopes. Therefore, development potential is not high. The association consists of over 70 percent Wessel stony loam, 20 percent Lap, and 10 percent rock outcrop.

The Wessel series is a moderately deep, well-drained, residual soil formed in strongly calcareous material weathered from limestone bedrock. About 25 inches of the profile is topsoil with the surface being very channery and stony. Immediately below the surface the soil is virtually free of coarse fragments, while below 20 inches there may be as much as 35 to 50 percent stone. Fractured limestone bedrock begins at about 36 inches.

The potential vegetation is about evenly divided between Douglas fir-rough fescue and ponderosa pine-rough fescue/bitterbrush communities. At present, these sites support ponderosa pine woodlands with well developed understories of bitterbrush/rough fescue. Bioclimate ranges from cooler and more moist than Helena to drier and cooler than the Unionville sunny slope.

As wildlife habitat, this area adds to and complements the excellent range found on the Lap sites just examined. Similarly, the sites of the Wessel association complement the recreation potential of the Lap sites. Neither should be developed because of moderately steep to steep slopes.

Erosion will be less of a problem on the Wessel sites but trails should be carefully planned.

Pen Loam, Gravelly Loam, or Cobbly Loam-Rock Outcrop Site Association

The southeast portion of the Deer Ridges Region is formed by two outlying, low ridges of the Pen-Rock Outcrop site association. Between and around the ridges are situated members of the Pen (gravelly) and Musselshell (gravelly) associations.

Within the moderately to moderately steeply sloping Pen association are three soil series. About 55 percent is the shallow Pen soil which is found on the mounds, ridges, and side slopes. At the base of these slopes, up to 20 percent of the association may be deep Crago or Musselshell soils. The remaining area is limestone outcrop.

The vegetation of these outlying ridges is similar to the Lap sites found in the northwest portion of the region. However, this area tends to be somewhat drier with rough fescue and bitterbrush being replaced by bluebunch wheatgrass. Many of the ponderosa pine stands are woodlands, with the trees younger and smaller than in the NW portion of the region. There are understories of rough fescue, but these are under the coolest forest canopies. Potential vegetation includes ponderosa pine-rough fescue and ponderosa pine-bluebunch wheatgrass. The steep, north slope area has a mixed Douglas fir-ponderosa pine stand on a Douglas fir-rough fescue site. Grassland patches are generally bluebunch wheatgrass prairies. One area is in a deteriorated condition and sandburg bluegrass is dominant. Bioclimatically the lands of the Pen association are cooler and more moist than Helena.

Wildlife do not use these outliers as much as they do the rest of the region. Surface water is absent, browse for deer and antelope is not particularly lush, and to get to the outliers game must expose themselves in open areas. Nevertheless, some deer and, especially, antelope are found. In addition, porcupines, rabbits, squirrels, coyotes, fox, and other small mammals are present. Songbirds are not especially abundant.

Development is generally precluded by steep slopes and the shallow, rocky nature of Pen soils. On the lower, moderate slopes, Crago or Musselshell (gravelly) soils may be present (see Bull Run Bench Region). While development is possible, the moderate slopes would tolerate only a low density. Although wildlife activity is not abundant, the area does afford good hiking potential, and, with the more developable slopes surrounding them, would provide valuable green space and picnic areas. Erosion will be a major problem if vegetation is removed or trails are poorly planned.

Pen Loam or Gravelly Loam Site Association

The Pen loam or gravelly loam site association surrounds the sites of the Pen-Rock Outcrop association. As a whole, the gentle to moderately sloping sites of the Pen loam association in this region are identical to those discussed in the Crossfire Plains Region in Chapter III.

Vegetation is dominated by very dry, deteriorated communities of sandburg bluegrass short grass steppe or climax bluebunch wheatgrass-sandburg bluegrass prairie. Sheet erosion is a serious problem and

needs immediate attention. In a gully along the southwestern edge of the region, the climax vegetation is ponderosa pine-bluebunch wheatgrass woodland. Bioclimate ranges from similar to East Helena to similar to Helena. New vegetation (especially trees, shrubs, and lawns) would require significant irrigation.

Wildlife use is minimal with an occasional antelope grazing in the early morning. A few small mammals support some predator activity. Songbirds find better cover and feed elsewhere.

The development potential of the sites is dependent on more detailed soil series mapping. For example, if a large, gently sloping parcel of Musselshell or Crago soil is present, cluster development would be possible. If not, the area may support lower density development. The shallow Pen soils should be avoided for development except in rare cases where a road may be placed on a "natural" roadbed. The adjacent islands of Pen-Rock Outcrop would insolate a development and provide green space for recreation and enjoyment. Sheet erosion is a serious problem and seeding as soon as feasible is recommended.

Musselshell Gravelly Loam Site Association

The soils of the Musselshell (gravelly) association in this region are no different than those previously discussed (see Bull Run Bench Region). This area separates the northwest portion of the region from the Pen outliers of the southeast. The slopes are gentle to moderate.

Much of the vegetation has been highly modified due to cultivation and grazing. On most of the gentle slopes, there has been seeding of mountain brome for hay production. However, the fields have been

abandoned for several years and are now infested with snake broomweed. Sheet erosion is a serious problem. The remaining sites of the association have been heavily grazed. Where needle and thread grass-sandburg bluegrass short grass steppe is the potential vegetation, there now exists prairie junegrass, sandburg bluegrass, or the cultivated field. This area is very dry and is bioclimatically similar to East Helena.

Because of the deteriorated condition of the vegetation, wildlife is limited to deer mice and an occasional predator. With proper care, however, this could be a valuable area for deer, antelope, songbirds, and many small mammals.

Wedged between the Havre floodplain on the north and the Pen outliers to the south, these sites of the Musselshell (gravelly) association are excellent for cluster development. Recreation benefits can be accrued from the neighboring Havre sites as well as Pen sites. The Antelope Hills Region to the west also provides significant recreation opportunities. Substantial irrigation will be needed for lawns, trees, or shrubs. In addition, all physical conditions are conducive to golf course development.

Ascension Mountains Region

This is an area of moderately steep to steep angular mountains with sharp-backed ridges radiating from their summits. It is located in the northwest portion of the study area between the Deer Ridges Region and the Antelope Hills Region. Vegetation is typical of the Wooded Ridge and Mountain Landscape although sunny slope-shady slope effects are much stronger. On south slopes are drier ponderosa pine woodlands and

savannas, while north slopes support thick forests of ponderosa pine and/or Douglas fir. Within the region there are four site associations: Wessel stony loam, Lap stony loam, Cheadle stony loam, and Musselshell gravelly loam site associations. The overall character of the region is presented in the biophysical profile in Figure 18 and the photographs in Figures 19 and 20.

Wessel Stony Loam Site Association

There are two main differences between the sites of the Wessel association in this region and those found in the Deer Ridges Region. First, they are more extensive in the Ascension Mountains Region and second, the vegetation tends to be more mesic and more dense than that found in the Deer Ridges Region. In this association, the moderately deep Wessel soils make up 70 percent of the hillsides, while shallow Lap soils comprise 20 percent of the area on ridges and mounds. The remaining 10 percent is limestone outcrop.

For the most part, the potential vegetation is Douglas fir-snowberry forest. However, because of various types of disturbances, the present vegetation ranges from ponderosa pine-rough fescue savanna to Douglas fir forest. On the lower, less steep slopes, the potential vegetation may be ponderosa pine-bitterbrush or Douglas fir-rough fescue. Most communities are at or near climax. As a result of a 1967 forest fire, the vegetation of one site is now very brushy and tangled. However, a few ponderosa pine and Douglas fir seedlings are present. Erosion has been checked on the steep hillside and plant succession is rapidly progressing. The Wessel association is one of the most moist of

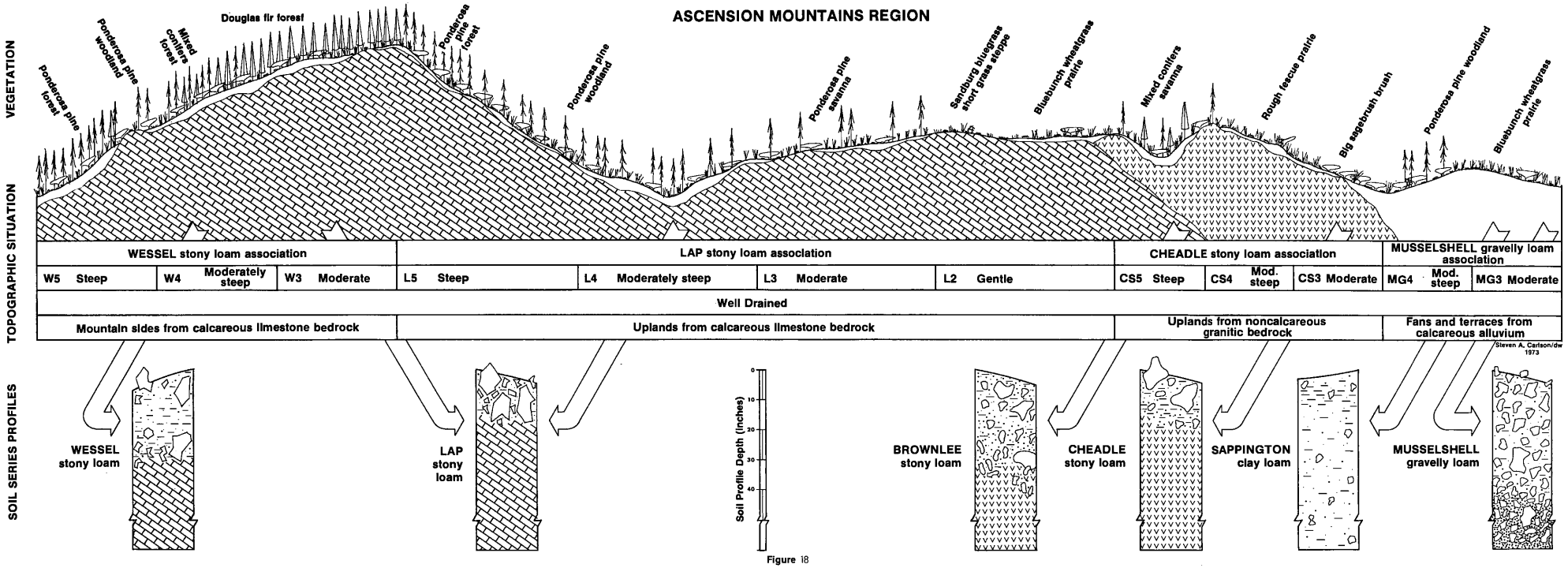
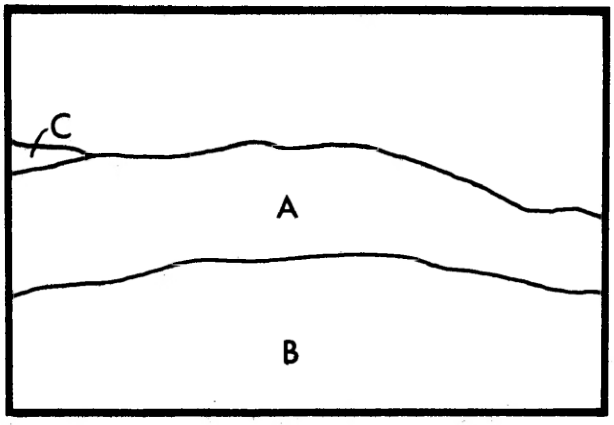
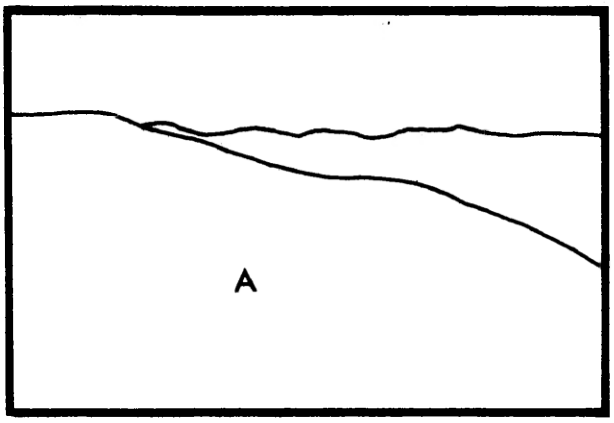

ASCENSION MOUNTAINS REGION
VEGETATION
TOPOGRAPHIC SITUATION
SOIL SERIES PROFILES
Ponderosa pine forest
Ponderosa pine woodland
Mixed conifers forest
Douglas fir forest
Ponderosa pine forest
Ponderosa pine woodland
Ponderosa pine savanna
Sandburg bluegrass short grass steppe
Bluebunch wheatgrass prairie
Mixed conifers savanna
Rough fescue prairie
Big sagebrush brush
Ponderosa pine woodland
Bluebunch wheatgrass prairie
WESSEL stony loam association
W5 Steep
W4 Moderately steep
W3 Moderate
LAP stony loam association
L5 Steep
L4 Moderately steep
L3 Moderate
L2 Gentle
CHEADLE stony loam association
CS5 Steep
CS4 Mod. steep
CS3 Moderate
MUSSELSHELL gravelly loam association
MG4 Mod. steep
MG3 Moderate
Well Drained
Mountain sides from calcareous limestone bedrock
Uplands from calcareous limestone bedrock
Uplands from noncalcareous granitic bedrock
Fans and terraces from calcareous alluvium
Steven A. Carlson/dw 1973
WESSEL stony loam
LAP stony loam
Soil Profile Depth (inches)
0
10
20
30
40
BROWNLEE stony loam
CHEADLE stony loam
SAPPINGTON clay loam
MUSSELSHELL gravelly loam

Figure 18



Direction of view: Northwest
Photograph taken from: Deer Ridges Region
Regions: A--Ascension Mountains Region
B--Deer Ridges Region
C--Antelope Hills Region

Figure 19



Direction of view: Southwest
Photograph taken from: Ascension Mountains Region
Region: A--Ascension Mountains Region (includes 1967 fire scar)

the study area and is similar, bioclimatically, to the Unionville shady slope.

Wildlife use is limited by the lack of edible understory species. Squirrels and songbirds are abundant while deer use the area as a corridor between Dry Gulch and the Deer Ridges Region. A few deer may use these sites as resting areas and utilize the browse of the drier Lap sites for food.

Due to steep slopes, development is precluded. However, because of the relatively high snow retention, the steep, north slopes are the optimal ski slopes of the region. As a result of limited snowfall, snow would have to be artificially produced. However, the manufactured snow and the small amount of snow that falls would remain longer than almost anywhere else in the study area. In addition, the soil surface can be easily cleared of stones to produce smooth slopes. The land would be more productive both vegetationally and for wildlife if the forests on some of the sites were thinned.

Lap Stony Loam Site Association

The main differences between the Lap sites of this region and those of the Deer Ridges Region is the altitude and the more irregular topography. Slopes are generally moderately steep. Vegetation is the same savanna-woodland-prairie ecotonal type found to be excellent for deer, antelope, and other wildlife in the Deer Ridges Region. Prairie or savanna communities are present on the south to west-facing slopes with ponderosa pine woodland on the north to east slopes. Potential vegetation ranges from rough fescue-bluebunch wheatgrass prairie to ponderosa pine-bitterbrush/bluebunch wheatgrass forest.

Obviously, the steep nature of the slopes combined with the shallowness of Lap soil makes development infeasible. However, there is excellent potential for maintaining the wildlife habitat as well as for recreation. This is an intriguing area for hiking, snowshoeing, and cross-country skiing. Also, the view of the Helena valley and surrounding areas is beautiful. Care will need to be exercised to retain the good vegetative cover both for erosion control and for wildlife use.

Cheadle Stony Loam Site Association

The sites of the Cheadle stony loam association of the Ascension Mountains Region are similar to those found in the more moist areas of the Antelope Hills Region. These moderately steep to steep sites are located in a small pocket in the southcentral portion of the Ascension Mountains Region. The shallow Cheadle soil comprises 60 percent of the association while the moderately deep Brownlee and deep Breece soils occupy 30 and 40 percent, respectively (see Antelope Hills Region). These latter soils are found in the concave areas and on low side slopes. It is suspected, however, that most of these moderately steep to steep sites have Cheadle soil and, therefore, provide little hope for development potential.

Vegetation ranges from a climax bluebunch wheatgrass-rough fescue prairie to a climax Douglas fir-snowberry forest. In between are communities of ponderosa pine woodland and savanna with understories of rough fescue and/or bitterbrush. Most of the stands are in good condition. On the northernmost parcel belonging to this association is a climax brush community of big sagebrush-sandburg bluegrass--the only one

in the entire study area. Bioclimate ranges from cooler and more moist than Helena to similar to the Unionville shady slope.

Wildlife utilize these Cheadle sites more than any other of the region. This is probably a result of the diversity of vegetation in such a small area. Here deer can find food and cover within a short distance, and difficult access provides minimal disturbance. Squirrels, small mammals, and songbirds are present and fairly abundant.

As for planning, this area should be utilized for management and/or recreation. The steep slopes need to be continually protected against potentially severe erosion, but this does not preclude hiking or other passive recreation. At present, the vegetation is in good condition.

Musselshell Gravelly Loam Site Association

Within the Ascension Mountains Region, the Musselshell (gravelly) association is quite different from other, drier areas of the Musselshell (gravelly) association in the study area. The soil characteristics remain the same, although the slopes range from moderate to moderately steep.

The vegetation reflects the better moisture conditions of this region. Present vegetation communities include bluebunch wheatgrass prairie; ponderosa pine forest, woodland and savanna, and mixed forests of Douglas fir and ponderosa pine. Potential vegetation is either ponderosa pine-rough fescue/bitterbrush forest or Douglas fir-rough fescue forest. This is dramatically different from the dry needle and thread grass communities found elsewhere. Kovalchik stated that he thought this area provides some of the best examples of natural prairie

left in the state of Montana.[31] Bioclimate is cooler and more moist than Helena to drier and cooler than the Unionville sunny slope.

Wildlife use of the area is heavy with deer finding this an ideal habitat. Rabbit, porcupines, skunks, and mice abound as do coyotes, fox, and hawks. Songbirds use the area for nesting and feeding.

The potential uses of this land are strongly conflicting. On the one hand, the area is ideal for low-density development. The soils are deep and stable, the view and bioclimate are excellent, and the area would receive morning sun and afternoon shade. The only moderate problems are a slight potential for snow retention and drifting in the winter and difficult access. In addition, there are recreational benefits surrounding the area. On the other hand, it may prove to harbor one of the last vestiges of native prairie found in Montana; and wildlife use is heavy. Perhaps this would best be preserved and managed as a study area for future generations. Without management, trees will invade the area and the prairie will be lost to the forest.

Prickly Pear Hills Region

Because of diverse land ownership, difficult access, and high costs given marginal benefits, the Prickly Pear Hills Region, Jackson Hills Region, and Big Indian Mountains Region were not studied in the field. However, they are included and will be discussed in general, somewhat speculative terms in order to complete the study area picture. The Prickly Pear Hills Region closely resembles the Deer Ridges and Ascension

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[31]Personal interview with Bernard L. Kovalchik, Forest Ecologist, Intermountain Forest and Range Experiment Station, Missoula, Montana, June 12 and 13, 1972.

Mountains Regions. The Big Indian Mountains and Jackson Hills Regions will be treated in Chapter VI.

For the most part, the sites of the Prickly Pear Hills Region are of the Cheadle family having shallow soils overlying igneous bedrock (see Antelope Hills Region). The region is located in the southeast corner of the study area and has rough terrain, numerous rock outcrops, and moderate to steep slopes. Vegetation is typical of the Wooded Ridge and Mountain Landscape with many open stands of trees believed to be ponderosa pine. Most likely the understory is rough fescue/bitterbrush. On the steep north and east-facing slopes there appears to be a thick stand of Douglas fir, probably with a snowberry understory. Bioclimatically this area should vary from cooler and more moist than Helena to similar to Unionville shady slope.

Given the above educated guess, this region should support a significant deer population. In addition, small mammals and songbirds should be abundant.

By reasons of slope, rugged topography, and shallow soil most of the region appears unsuitable for development. However, there may be pockets of the deeper Brownlee or Breece soils on gentle slopes that are developable. This is impossible to know without further field work. Development of adjacent private lands, not owned by the Diehl Development Corporation, could have adverse implication. There is a chance of downslope effects from erosion as well as a significant amount of trespassing (e.g., snowmobiles, motorcycles, four-wheel drive vehicles) which will need to be controlled.

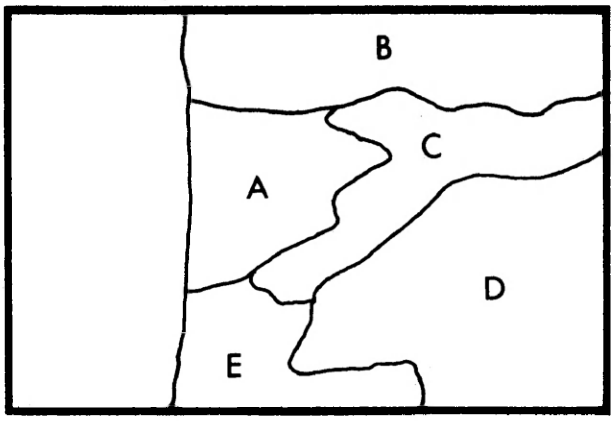
CHAPTER VI

THE FORESTED BATHOLITH LANDSCAPE

Neither the Jackson Hills Region nor the Big Indian Mountains Region was studied in the field, although a hike was made through part of the latter. This landscape type occurs on the northernmost tip of the Boulder Batholith which is almost completely covered with a dense vegetation of Douglas fir or quaking aspen forest. The rugged, bouldery terrain of moderately steep to steep slopes has both high mountain and low hill regions.

Jackson Hills Region

Less is known about this low, hilly terrain than about any other region in the study area. The Woodrock site type makes up the majority of the region with additional small areas of Brownlee and Fairdale site types (see Figure 21). For a discussion of these site types, see the Antelope Hills Region. Most of the region appears to be covered with a dense Douglas fir forest. This is probably of the snowberry type. The long Fairdale floodplain is grass covered, probably with bluegrass spp. prairie. There are also pockets of what appear to be quaking aspen or other deciduous, broadleaf trees. Portions of those areas delineated as the Brownlee sites are grass covered and apparently gently to moderately sloping. If this is so, there may be some development potential here.



Direction of view: West
Photograph taken from: Airplane
Regions: A--Jackson Hills Region
B--Big Indian Mountains Region
C--Clark Plains Region (upper portion)
D--Antelope Hills Region
E--Prickly Pear Hills Region

Figure 21

The potential vegetation, if similar to that of the Brownlee site types of the neighboring Clark Plains Region, would be needle and thread grass-blue grama grass short grass steppe. As a result, bioclimate would be similar to the Unionville shady slope with pockets of the dry East Helena regime.

Antelope and deer have been seen on the forest edge. A conversation with a local wildlife artist reveals that bear, mountain lion, songbirds, and small mammals are common as well.[32]

The region does not appear suitable for high-density development but may support low-density settlement. With a detailed field study, the areas of deep soils on gentle to moderate slopes could be delineated. These sites appear to be small and few. Most of the region is in non-corporation ownership with one area being considered for development. This may cause some problems to Diehl Development Corporation land. Development on the Fairdale floodplain is not prudent. Wildlife potential is high as is recreation potential.

Big Indian Mountains Region

Located in the southwest corner of the study area is the Big Indian Mountains Region. It is bounded by the Antelope Hills Region to the north and the Clark Plains Region to the east. To the south and west is the Helena National Forest which is, in part, similar to this region. The rugged, mountainous topography belongs to the Woodrock site association (see Antelope Hills Region) and can be seen in Figure 22.

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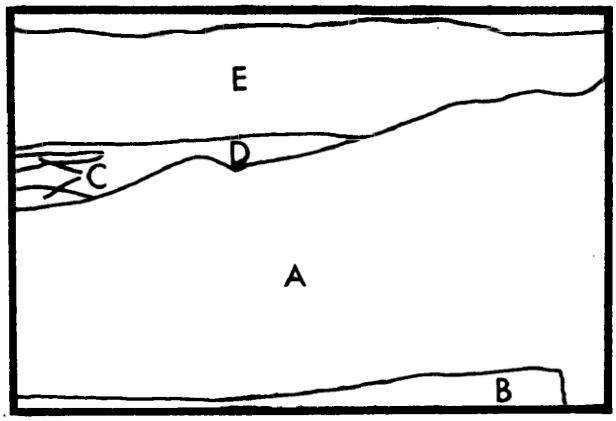
[32]Conversation with Tucker Smith, Wildlife Artist, August 2, 1972.



Direction of view: South-southeast
Photograph taken from: Antelope Hills Region
Regions: A--Big Indian Mountains Region
B--Antelope Hills Region
C--Clark Plains Region (upper plains portion)
D--Jackson Hills Region
E--Big Belt Mountains

Figure 22

In this area of moderately steep to steep slopes, there are many spectacular rock formations.

The vegetation is at least as mesic or more mesic than in any other portion of the study area. Most of the lower sites should potentially support a Douglas fir-snowberry forest. At present, there are stable Douglas fir forests or seral lodgepole pine or quaking aspen forests. The latter two types occur in areas with a fire history. Quaking aspen is located in pockets of deep soil, while lodgepole pine is found elsewhere. It should be noted that in this region the quaking aspen is considered seral to Douglas fir, whereas, on the floodplain, it is considered a climax constituent. On the very lowest slopes are found members of the Douglas fir-kinnikinnik forest sere. In the higher locations the vegetation is probably one of the wetter Douglas fir types (Douglas fir-ninebark, etc.) or possibly a grand fir type. Neither was found elsewhere in the study area. The region is an important watershed with bioclimate equal to or cooler and more moist than Unionville's shady slope. Although snow retention is high, the area is too rough to be considered for ski slopes.

Evidence has been found that several mountain lion inhabit the area. Also black bear have been observed. Bobcat, deer, squirrel, and other small mammals are present though not abundant. The area could support an excellent elk population especially if managed with the neighboring Antelope Hills Region. Many of the rock outcrops harbor a population of rattlesnakes.

This region, combined with the Antelope Hills and Ascension Mountains Regions, is an excellent microcosm of eastern Mountana

habitats. For this reason, it is again emphasized that this area could be set aside for study by youth of all ages. Access is somewhat difficult and vehicular traffic within the region is virtually impossible.

CHAPTER VII

FINAL COMMENTS

The Project Area

The state of today's highly sophisticated technology makes it impossible to say that any given parcel of land is undevelopable. With the appropriate amount of money, a house can be built virtually anywhere. However, given the marginal costs (capital and environmental) of certain building sites, it is possible to eliminate those sites which would be expensive to develop. With this in mind, it is felt that 70 to 80 percent of the study area would be best used if managed for its aesthetic qualities, wildlife, and recreation. The remaining 20 percent has various developmental possibilities as is noted below.

Fan and Terrace Site Associations

The site associations found on the fans and terraces of the study area have deep, well-drained soils and are mostly gently to moderately sloping. The sites of these associations tend to be draughty because of their excessively drained nature and lack of protection from the sun. Vegetation is primarily of the short grass steppe variety with some areas exhibiting the driest of prairie communities. Included in this site association group are the following:

Hilger stony loam site association
Musselshell gravelly loam site association
Musselshell stony loam site association
Crago cobbly loam site association
Breece cobbly loam site association

The site types of these associations pose few engineering problems. On the gentle slopes, high-density development is feasible and cluster development will tend to take advantage of the various recreational-aesthetic qualities of the total study area. The moderate slopes can be carefully planned to support a low-density type of development. Unfortunately, there are very few trees for cover on these sites, but neighboring sites are tree covered and will provide landscaping, scenic, and acoustical benefits to potential developments. Many gullies are cut into these sites and their brushy vegetation provides good small mammal and bird habitats. The gullies should be preserved in their natural state.

Hillside Site Associations

There are several site associations with moderately deep, well-drained soils. On the footslopes and low hillsides underlain by igneous material, is found the Brownlee association. Deeper soils of the Lap and Pen associations are found in the same relative position in areas subtended by limestones, dolomites, or other sedimentary rocks. On the steep limestone mountain slopes is found the Wessel association and, on steep igneous mountain slopes, the Woodrock associations.

Footslope associations have gentle to moderately steep slopes with vegetation of the prairie or savanna type. Exceptions are the Brownlee association found in the Clark Plains Region where the vegetation is

draught hardy short grass steppe. These associations are not generally suitable for high-density development but can support well-planned, moderately dense development on the gentle slopes. The moderately sloping sites can only sustain a low-density development while the moderately steep sites are too steep to develop without significant capital and environmental costs. In addition, the development potential of these sites will be largely a function of their situation. For instance, the Lap and Pen site types with moderately deep soils are found as transition zones between ridge site types and fan or terrace site types. Consequently, their use will probably be closely tied to the development of the contiguous deep soiled sites. On the other hand, the sites of the Brownlee association occur as large parcels surrounded by shallow soils and, thus, can be developed on their own merits. On the steeper slopes, unsuited for development, is a more lush prairie or savanna vegetation which should be managed for wildlife habitat and erosion control.

The mountain slope associations, Wessel and Woodrock, have moderately steep to very steep slopes and are, therefore, not feasible for development. Vegetation of these areas is generally dense forest providing escape areas for big game as well as valuable bird and small mammal habitat. Two of the large Wessel sites may be valuable for a small snow-ski run.

Hill, Ridge, and Mountain Site Associations

The hill, ridge, and mountain site associations have shallow soils and moderate to moderately steep slopes. With the very shallow layer of unconsolidated material located on generally steeper slopes, the sites

of these associations are largely undevelopable. Included in this grouping are the following:

Lap stony loam site association
Pen loam or gravelly loam site association
Tolman channery loam site association
Cheadle stony loam site association

On these lands attention is focused on wildlife and recreation possibilities. The Lap, Tolman, and Pen associations have woodlands and savannas intermixed with grasslands. These ecotone areas are excellent deer habitat as well as good habitats for small mammals, predators, birds, and antelope. The Cheadle association generally has prairie vegetation and provides excellent antelope habitat.

Floodplain Site Associations

There are three site associations of the gently sloping floodplains in the study area:

Havre loam site association
Slocum loam site association
Fairdale loam site association

Because of their position, the sites of these associations are subject to annual flooding and should not be developed. The canopy of aspen and cottonwood trees subtended by a diverse brushy undergrowth provides excellent habitat for various fauna and avifauna. These areas may be used for picnics and recreation of a transient nature.

Problems for Consideration

Before any intensive development takes place, additional information should be obtained. Since the soil survey provided a soil association map rather than soil series map, a detailed soil survey will need

to be made of those areas intended for development. This is especially true for the generally undevelopable Tolman association where significant parcels of the developable Crago and Musselshell sites are present. A five-foot contour map of proposed development areas is needed. In addition, a plaster model of the entire study area would prove extremely helpful in all future planning phases.

Several problems associated with deteriorated biophysical units were uncovered. The most significant problem is that of severe erosion in some areas. These areas need immediate treatment before further damage can occur. A range ecologist could provide the necessary information on types of grasses to plant, and when and how to plant. For the wooded sites, a forest ecologist should be consulted to determine a thinning program as well as other forest management programs for maintenance of plant vigor and wildlife habitat. This will also help avoid future catastrophes associated with forest fires, disease, etc.

The Biophysical Approach

The methodology utilized in this approach is based on the premise that man is an integral part of the ecosystem rather than a disassociated manipulator. Hopefully, this study provides a basis for understanding the study area ecosystems and can be used as input in the evaluative (planning) process.

Planners such as McHarg, Hills, and Lewis have recognized the need for an understanding of ecosystems. However, it is felt that their methodologies have several shortcomings for this type of detailed planning. Generally, the components of ecosystems are analyzed with little

regard to their functional interrelationships. At times, in forming plans for larger areas, the computor is used to analyze data and the output does not provide an understanding of the constraints involved in the decision process.

The integrated biophysical mapping approach also utilizes ecosystem components. However, the components are examined as part of a biophysical system--the functioning ecosystem. The unit is mapped in its integrated state to be analyzed as such in the planning process. Over two months were spent in the field obtaining detailed information and at the same time gaining "a feel for the land." This allows additional perceptions to be inserted in the ecosystem analysis--not found in hard data or on the computor. Thus, land-use planning of this study area can be based on the integrated, functioning ecosystem--of which man is a part. Man does not simply walk over a soil profile (one ecosystem component). Rather, he walks on a slope with a vegetative cover, subtended by a soil profile and geologic structure, surrounded by animals and climate, all dependent on a hydrologic scheme, etc.

This methodology is not limited to the detailed scale used in this study. Larger, more generalized eco-units (e.g., biophysical regions) can be delineated for almost any desired level of planning. Also, computerizing the data should not be discarded. However, a radical new approach to computor analysis of ecosystems is needed. The use of human perceptions should <u>not</u> be avoided when computors are used.

Throughout this study there have been allusions to planning implications of various biophysical units. <u>This study is not the plan, however</u>. The flow chart in Figure 23 will give some idea as to the role

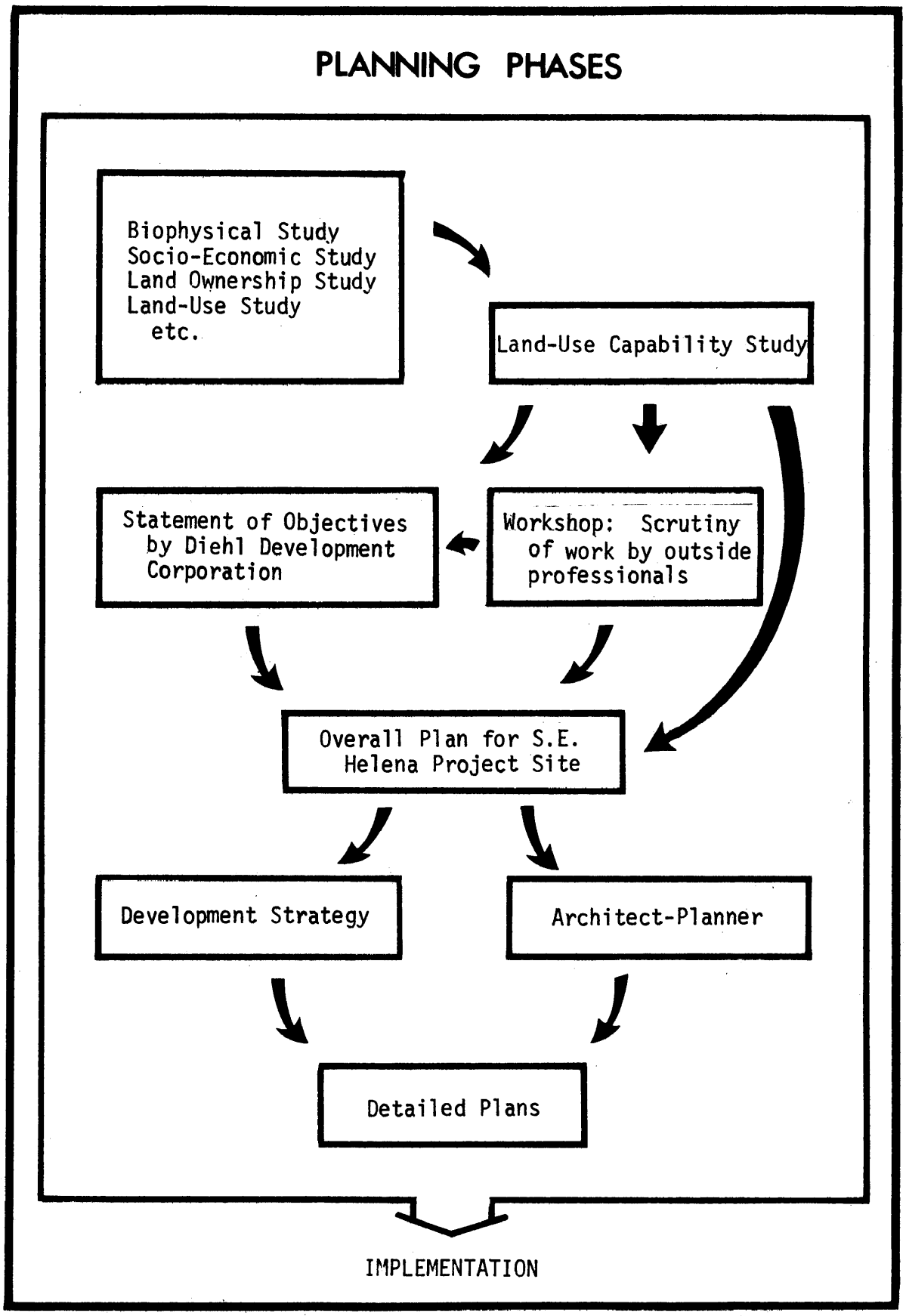

PLANNING PHASES
Biophysical Study
Socio-Economic Study
Land Ownership Study
Land-Use Study
etc.
Land-Use Capability Study
Statement of Objectives by Diehl Development Corporation
Workshop: Scrutiny of work by outside professionals
Overall Plan for S.E. Helena Project Site
Development Strategy
Architect-Planner
Detailed Plans
IMPLEMENTATION

Figure 23

of this study in the overall planning process. As noted, there is much left to do before the final plan is finished. The biophysical researcher should be involved through future steps.

Planning based on the biophysical character of the land offers the firm foundation needed for making land-use decisions. This is Thoreau's "land ethic."

APPENDIX A

BIOPHYSICAL PROFILES LEGEND

Plants


Douglas fir


Ponderosa pine


Black cottonwood


Quaking aspen


Brush


Shrub steppe


Prairie grasses


Short grasses

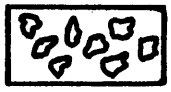
Soil Materials

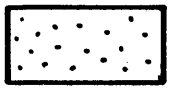

Forest duff layer

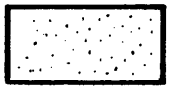

Root mat

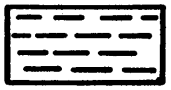

Stones, rocks (> 10")


Cobbles (3-10")


Gravel (< 3")

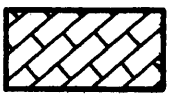

Sand

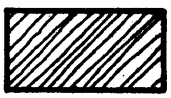

Silt


Clay

Bedrock


Granitic bedrock


Limestone bedrock


Argillitic bedrock

APPENDIX B

SCIENTIFIC NAMES OF FLORA AND FAUNA

Trees

Black cottonwood	*Populus trichocarpa*
Douglas fir	*Pseudostuga menziesii*
Grand fir	*Abies grandis*
Limber pine	*Pinus flexilis*
Ponderosa pine	*Pinus ponderosa*
Quaking aspen	*Populus tremuloides*

Grasses

Basin wild rye	*Elymus cinereus*
Bluebunch wheatgrass	*Agropyron spicatum*
Bluegrass spp.	*Poa* spp.
Blue grama grass	*Bouteloua gracilis*
Cheatgrass	*Bromus tectorum*
Crested wheatgrass	*Agropyron cristata*
Green needle grass	*Stipa viridula*
Green wheatgrass	*Agropyron inerme*
Idaho fescue	*Festuca idahoensis*
Mountain brome	*Bromus inermis*
Needle and thread grass	*Stipa comata*
Prairie junegrass	*Koeleria cristata*
Rough fescue	*Festuca scabrella*
Sandburg bluegrass	*Poa secunda* var. *sandburgii*

Shrubs, forbs, and other

Big sagebrush	*Artemesia tridentata*
Bitterbrush	*Purshia tridentata*
Chokecherry	*Prunus virginiana*
Kinnikinnik	*Arctostaphlos uva-ursi*
Lupine spp.	*Lupinus* spp.
Mock orange	*Philadelphus lewisii*
Prickly pear	*Opuntia polyacantha*
Rabbitbrush	*Chrysothamnus nauseosus*
Rocky mountain juniper	*Juniperus scopulorum*
Rocky mountain maple	*Acer glabrum*
Rose spp.	*Rosa* spp.
Silver sagebrush	*Artemesia cana*
Skunkbrush	*Rhus trilobata*

Snake broomweed	Gutierrezia sarothrae
Snowberry	Symphoricarpos albus
"Spiny" currant	Ribes spp.
Wax currant	Ribes cereum
Winterfat	Eurotia lanata

Wildlife

Badger	Taxidea taxus
Black bear	Ursus americanus
Bobcat	Lynx rufus
Chipmunk, Yellow pine or Redtail	Eutamias ruficaudus
Columbia ground squirrel	Citellus columbianus
Coyote	Canus latrans
Deer mouse	Peromyscus maniculatus
Elk	Cervus canadensis
Mountain cottontail	Sylvilagus nuttalli
Mountain lion	Felis concolor
Mule deer	Odocoileus hemionus
Porcupine	Erethizon dorsatum
Pronghorn	Antilocapra americana
Red fox	Vulpes fulva
Red squirrel	Tamiasciurus hudsonicus
Snowshoe hare	Lepus americanus
Striped skunk	Mephitis mephitis

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S. E. HELENA PROJECT

DIEHL DEVELOPMENT CORPORATION

BIOCLIMATE

As inferred from vegetational indicators

COOLER, MORE MOIST BIOCLIMATES

Similar to cool Unionville shady slope
- Douglas fir-snowberry forest sere
- Douglas fir-stagnant stete
- Douglas fir-bluegrass spp. forest sere
- Douglas fir-kinnikinnik forest sere

Similar to warm Unionville sunny slope
- Ponderosa pine-snowberry forest sere
- Ponderosa pine-stagnant state

Cooler and drier than Unionville sunny slope
- Douglas fir-rough fescue forest sere
- Douglas fir-bluebunch wheatgrass forest sere
- Mixed conifers-bluebunch wheatgrass woodland sere

WARMER, DRIER BIOCLIMATES

Cooler and more moist than Helena
- Ponderosa pine-rough fescue forest sere
- Ponderosa pine-bitterbrush forest sere
- Bitterbrush-rough fescue brush sere
- Rough fescue-idaho fescue prairie sere
- Rough fescue-bluebunch whaatgrass prairie sere
- Ponderosa pine-bluebunch wheatgrass forest sere

More moist than Helena
- Idaho fescue-rough fescue prairie sere
- Idaho fescue-bluebunch wheatgrass prairie sere
- Rose spp.-bluebunch wheatgrass brush sere
- Bluebunch wheatgrass-rough fescue prairie sere

Similar to Helena
- *Bluegrass spp.-prairie junegrass prairie sere*
- Bitterbrush-bluebunch wheatgrass brush sere
- Big sagebrush-sandburg bluegrass brush sere
- Bluebunch wheatgrass-sandburg bluegrass prairie sere

Similer to East Helena
- Needle and thread grass-sandburg bluegrass short grass steppe sere
- Needle and thread grass-blue grama grass short grass steppe sere

FLOODPLAIN BIOCLIMATE

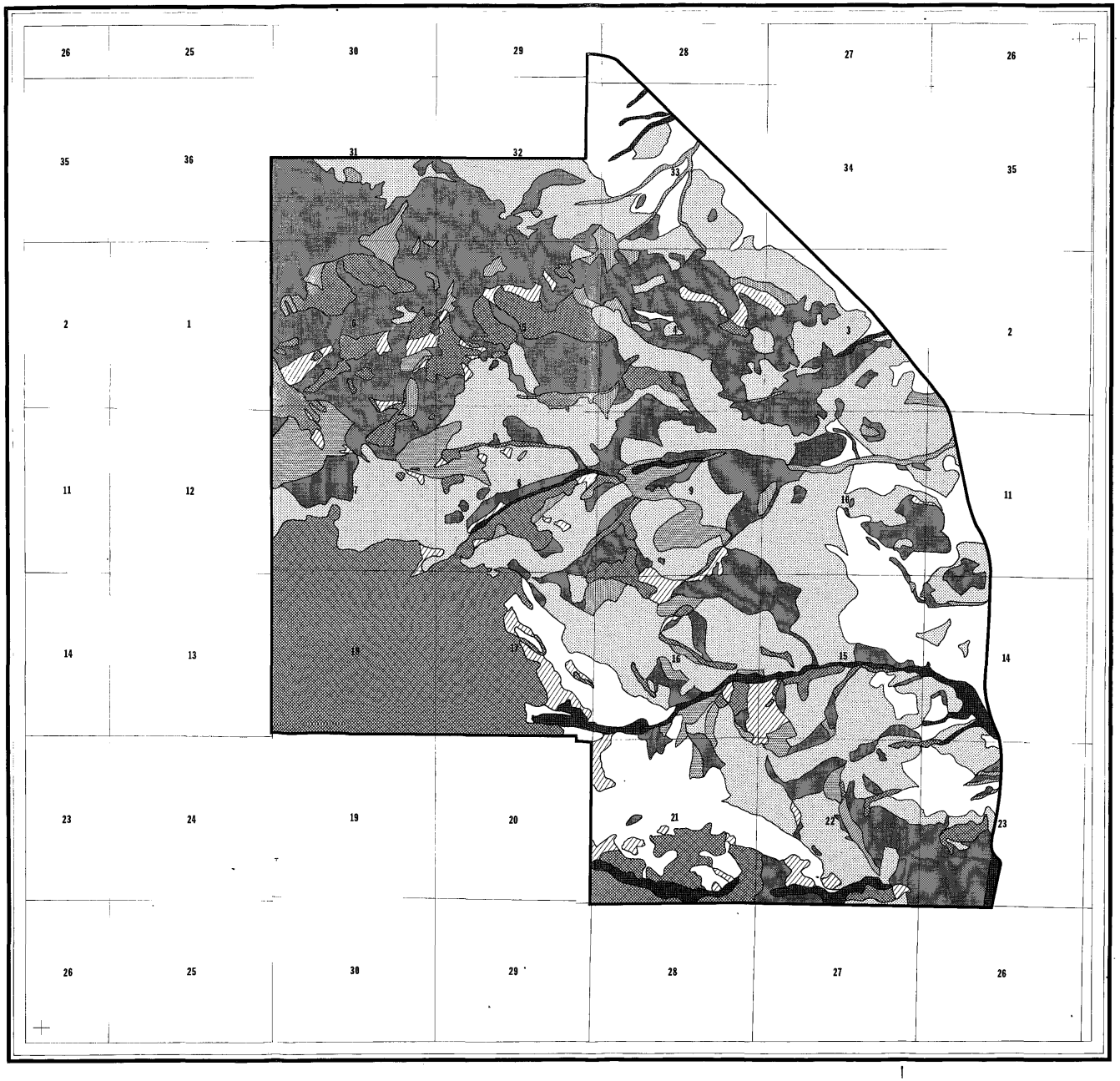
No weather station relationship
- Black cottonwood-Douglas fir forest sere
- Black cottonwood-ponderosa pine forest sere
- Quaking aspan-rose spp. forest sere
- Rose spp.-bluegrass spp. brush sere

Project boundary

Approximate Scale—1:12000

0 1 Mile

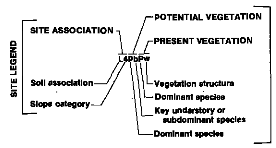
Constructed by Steven A. Carlson December, 1972.



S. E. HELENA PROJECT
DIEHL DEVELOPMENT CORPORATION

BIOPHYSICAL UNITS

COMPOSITE MAP SYMBOL



SLOPE CATEGORIES

6	Very steep*	> 45.0°
5	Steep	25.0° - 45.0°
4	Moderately steep	13.0° - 25.0°
3	Moderate	5.0° - 13.0°
2	Gentle	2.5° - 5.0°
1	Nearly horizontal	0.0° - 2.5°

*There were no very steep slopes (category 6) large enough to map.

VEGETATION STRUCTURE

f	Forest	(> 60% tree* cover)
w	Woodland	(25-60% tree cover)
s	Savanna	(10-25% tree cover)
b	Brush	
p	Prairie	
g	Short grass steppe	
t	Shrub steppe	

*"tree" > 25 ft.

SITE ASSOCIATIONS

RUGGED MOUNTAINS AND HILLS

WOODROCK sandy or stony loam—ROCK OUTCROP
- WR3,4,5 Undifferentiated moderately to steeply sloping

WOODROCK sandy or stony loam—CHEADLE stony loam
- WC4 Moderately steeply sloping
- WC3 Moderately sloping

SMOOTH MOUNTAINS AND HILLS

WOODROCK stony loam
- WS5 Steeply sloping
- WS4 Moderately steeply sloping

CHEADLE stony loam—ROCK OUTCROP
- CR3,4 Undifferentiated moderately to moderately steeply sloping

CHEADLE stony loam
- CS5 Steeply sloping
- CS4 Moderately steeply sloping
- CS3 Moderately sloping
- CS2 Gently sloping

BROWNLEE stony loam
- BS5 Steeply sloping
- BS4 Moderately steeply sloping
- BS3 Moderately sloping

BREECE cobbly loam
- B3 Moderately sloping
- S2 Gently sloping

HOGBACK RIDGES

WESSEL stony loam
- W5 Steeply sloping
- W4 Moderately steeply sloping
- W3 Moderately sloping

LAP stony loam—ROCK OUTCROP
- L5 Steeply sloping
- L4 Moderately steeply sloping
- L3 Moderately sloping
- L2 Gently sloping

PEN loam, gravelly loam or cobbly loam—ROCK OUTCROP
- PR5 Steeply sloping
- PR4 Moderately steeply sloping
- PR3 Moderately sloping

FOOTHILLS AND FOOTSLOPES

TOLMAN channery loam
- TL4 Moderately steeply sloping
- TL3 Moderately sloping
- TL2 Gently sloping

TOLMAN channery loam—CRAGO cobbly loam
- TC4 Moderately steeply sloping
- TC3 Moderately sloping
- TC2 Gently sloping

ROLLING BENCHES AND INTERIOR VALLEYS

BROWNLEE rocky loam—CHEADLE rocky loam
- BC4 Moderately steeply sloping
- BC3 Moderately sloping
- BC2 Gently sloping

PEN loam or gravelly loam
- PL3 Moderately sloping
- PL2 Gently sloping

HILGER stony loam
- I4 Moderately steeply sloping
- I3 Moderately sloping
- I2 Gently sloping

MUSSELSHELL gravelly loam
- MG4 Moderately steeply sloping
- MG3 Moderately sloping
- MG2 Gently sloping
- MG1 Nearly horizontal

MUSSELSHELL stony loam
- MS4 Moderately steeply sloping
- MS3 Moderately sloping
- MS2 Gently sloping

CRAGO cobbly loam—MUSSELSHELL gravelly loam
- A3 Moderately sloping
- A2 Gently sloping

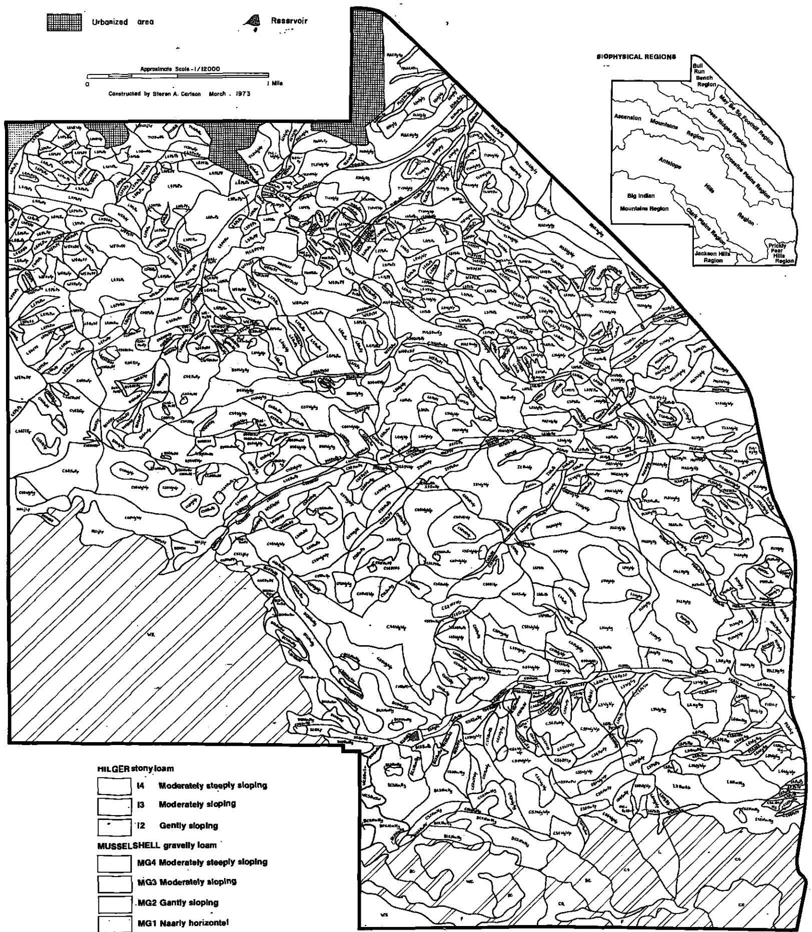
GRAVEL, highly scarified surface
- G4 Moderately steep
- G3 Moderate
- G2 Gentle

ALLUVIAL MATERIAL

SLOCUM loam
- S2 Gently sloping

FAIRDALE loam
- F2 Gently sloping
- F1 Nearly horizontal

HAVRE loam
- H2 Gently sloping



Note: At the southern edge and southwestern corner of the study area are large areas with diagonal lines. These areas were not studied in the field. The coloring approximates the biophysical units within the area as well as the relative proportion.

POTENTIAL AND PRESENT VEGETATION

MORE MOIST DOUGLAS FIR COMMUNITIES

Ds Douglas fir-snowberry forest sere
Dv Douglas fir, stagnant state
Dl Douglas fir-bluegrass spp. forest sere
- Forest: Df Douglas fir forest; Sf Mixed conifers forest; Pf Ponderosa pine forest
- Woodland: Dw Douglas fir woodland; Sw Mixed conifers woodland; Pw Ponderosa pine woodland
- Savanna: Ds Douglas fir savanna; Ss Mixed conifers savanna; Ps Ponderosa pine savanna
- Brush: Bb Bitterbrush brush
- Prairie: Fp Rough fescue prairie

Dk Douglas fir-kinnikinnik forest sere
- Forest: Sf Mixed conifers forest; Pf Ponderosa pine forest
- Woodland: Dw Douglas fir woodland

MORE MOIST PONDEROSA PINE COMMUNITIES

Ps Ponderosa pine-snowberry forest sere
Pv Ponderosa pine, stagnant state
- Forest: Pf Ponderosa pine forest; Tf Conifer and broadleaf forest
- Woodland: Pw Ponderosa pine woodland
- Savanna: Ps Ponderosa pine savanna

DRIER DOUGLAS FIR COMMUNITIES

Dt Douglas fir-rough fescue forest sere
- Forest: Df Douglas fir forest; Sf Mixed conifers forest; Pf Ponderosa pine forest
- Woodland: Dw Douglas fir woodland; Sw Mixed conifers woodland; Pw Ponderosa pine woodland
- Savanna: Ds Douglas fir savanna; Ss Mixed conifers savanna; Ps Ponderosa pine savanna

Dw Douglas fir-bluebunch wheatgrass forest sere
- Forest: Sf Mixed conifers forest
- Woodland: Dw Douglas fir woodland; Sw Mixed conifers woodland
- Savanna: Ss Mixed conifers savanna
- Prairie: Wp Bluebunch wheatgrass prairie

Sw Mixed conifers-bluebunch wheatgrass woodland sere
- Woodland: Sw Mixed conifers woodland
- Savanna: Ss Mixed conifers savanna

DRIER PONDEROSA PINE COMMUNITIES AND MORE MOIST PRAIRIE COMMUNITIES

Pf Ponderosa pine-rough fescue forest sere
- Forest: Pf Ponderosa pine forest
- Woodland: Pw Ponderosa pine woodland
- Savanna: Ps Ponderosa pine savanna
- Prairie: Wp Bluebunch wheatgrass prairie

Pb Ponderosa pine-bitterbrush forest sere
- Forest: Pf Ponderosa pine forest; Tf Conifer and broadleaf forest
- Woodland: Pw Ponderosa pine woodland
- Savanna: Ps Ponderosa pine savanna
- Brush: Bb Bitterbrush brush
- Prairie: Fp Rough fescue prairie; Wp Bluebunch wheatgrass prairie

Bt Bitterbrush-rough fescue brush sere
- Brush: Bb Bitterbrush brush

Fi Rough fescue-Idaho fescue prairie sere
Fw Rough fescue-bluebunch wheatgrass forest sere
- Prairie: Fp Rough fescue prairie

Pw Ponderosa pine-bluebunch wheatgrass forest sere
- Forest: Pf Ponderosa pine forest
- Woodland: Pw Ponderosa pine woodland
- Savanna: Ps Ponderosa pine savanna
- Brush: Rb Rose spp. brush
- Prairie: Wp Bluebunch wheatgrass prairie
- Short grass steppe: Gg Sandburg bluegrass short grass steppe

PRAIRIE COMMUNITIES

If Idaho fescue-rough fescue prairie sere
Iw Idaho fescue-bluebunch wheatgrass prairie sere
- Prairie: Ip Idaho fescue prairie
- Short grass steppe: Gg Sandburg bluegrass short grass steppe

Rw Rose spp.-bluebunch wheatgrass brush sere
- Brush: Rb Rose spp. brush
- Shrub steppe: Xt Rabbitbrush shrub steppe

Wf Bluebunch wheatgrass-rough fescue prairie sere
- Prairie: Wp Bluebunch wheatgrass prairie

DRIER PRAIRIE COMMUNITIES

Lj Bluegrass spp.-prairie junegrass prairie sere
- Prairie: Lp Bluegrass spp. prairie

Bw Bitterbrush-bluebunch wheatgrass brush sere
- Brush: Bb Bitterbrush brush
- Short grass steppe: Eg Crested wheatgrass short grass steppe, cultivated

Ag Big sagebrush-sandburg bluegrass brush sere
- Brush: Ab Big sagebrush brush

Wg Bluebunch wheatgrass-sandburg blue-grass prairie sere
- Prairie: Wp Bluebunch wheatgrass prairie
- Short grass steppe: Gg Sandburg bluegrass short grass steppe; Hg Cheatgrass short grass steppe
- Shrub steppe: Xt Rabbitbrush shrub steppe; Yt Snake broomweed shrub steppe

SHORT GRASS STEPPE COMMUNITIES

Ng Needle and thread grass-sandburg blue-grass short grass steppe sere
- Short grass steppe: Ng Needle and thread grass short grass steppe; Gg Sandburg bluegrass short grass steppe; Jg Prairie junegrass short grass steppe; Hg Cheatgrass short grass steppe; Eg Crested wheatgrass short grass steppe, cultivated; Ug Mountain brome short grass steppe, cultivated
- Shrub steppe: Xt Rabbitbrush shrub steppe; Yt Snake broomweed shrub steppe

Nm Needle and thread grass-blue grama grass short grass steppe sere
- Short grass steppe: Mg Blue grama grass short grass steppe; Hg Cheatgrass short grass steppe

FLOODPLAIN COMMUNITIES

CD Black cottonwood-Douglas fir forest sere
- Forest: Cf Black cottonwood forest; Tf Conifer and broadleaf forest

CP Black cottonwood-ponderosa pine forest sere
- Forest: Tf Conifer and broadleaf forest

Qr Quaking aspen-rose spp. forest sere
- Forest: Qf Quaking aspen forest

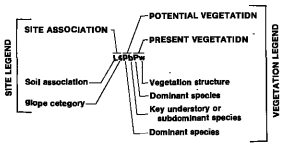
Rl Rose spp.-bluegrass spp. brush sere
- Brush: Rb Rose spp. brush
- Prairie: Lp Bluegrass spp. prairie
- Shrub steppe: Xt Rabbitbrush shrub steppe

S. E. HELENA PROJECT

DIEHL DEVELOPMENT CORPORATION

BIOPHYSICAL UNITS

COMPOSITE MAP SYMBOL



SLOPE CATEGORIES

6	Very steep*	> 45.0°
5	Steep	25.0° - 45.0°
4	Moderately steep	13.0° - 25.0°
3	Moderate	5.0° - 13.0°
2	Gentle	2.5° - 5.0°
1	Nearly horizontal	0.0° - 2.5°

*There were no very steep slopes (category 5) large enough to map.

VEGETATION STRUCTURE

f	Forest	(> 60% tree* cover)
w	Woodland	(25-60% tree cover)
n	Savanna	(10-25% tree cover)
b	Brush	
p	Prairie	
g	Short grass steppe	
l	Shrub steppe	

tree > 20 ft.

SITE ASSOCIATIONS

RUGGED MOUNTAINS AND HILLS

WOODROCK sandy or stony loam—RDCK OUTCROP
- WR3,4,5 Undifferentiated moderately to steeply sloping

WODDROCK sandy or stony loam—CHEADLE stony loam
- WC4 Moderately steeply sloping
- WC3 Moderately sloping

SMOOTH MOUNTAINS AND HILLS

WODOROCK stony loam
- WS5 Steeply sloping
- WS4 Moderately steeply sloping

CHEADLE stony loam—ROCK OUTCROP
- CR3,4 Undifferentiated moderately to moderately steeply sloping

CHEADLE stony loam
- CS5 Steeply sloping
- CS4 Moderately steeply sloping
- CS3 Moderately sloping
- CS2 Gently sloping

BROWNLEE stony loam
- BS5 Steeply sloping
- BS4 Moderately steeply sloping
- BS3 Moderately sloping

SREECE cobbly loam
- S3 Moderately sloping
- S2 Gently sloping

HOGBACK RIDGES

WEGGEL stony loam
- W5 Steeply sloping
- W4 Moderately steeply sloping
- W3 Moderately sloping

LAP stony loam—RDCK OUTCRDP
- L5 Steeply sloping
- L4 Moderately steeply sloping
- L3 Moderately sloping
- L2 Gently sloping

PEN loam, gravelly loam or cobbly loam—RDCK OUTCROP
- PR5 Steeply sloping
- PR4 Moderately steeply sloping
- PR3 Moderately sloping

FOOTHILLS AND FOOTSLOPES

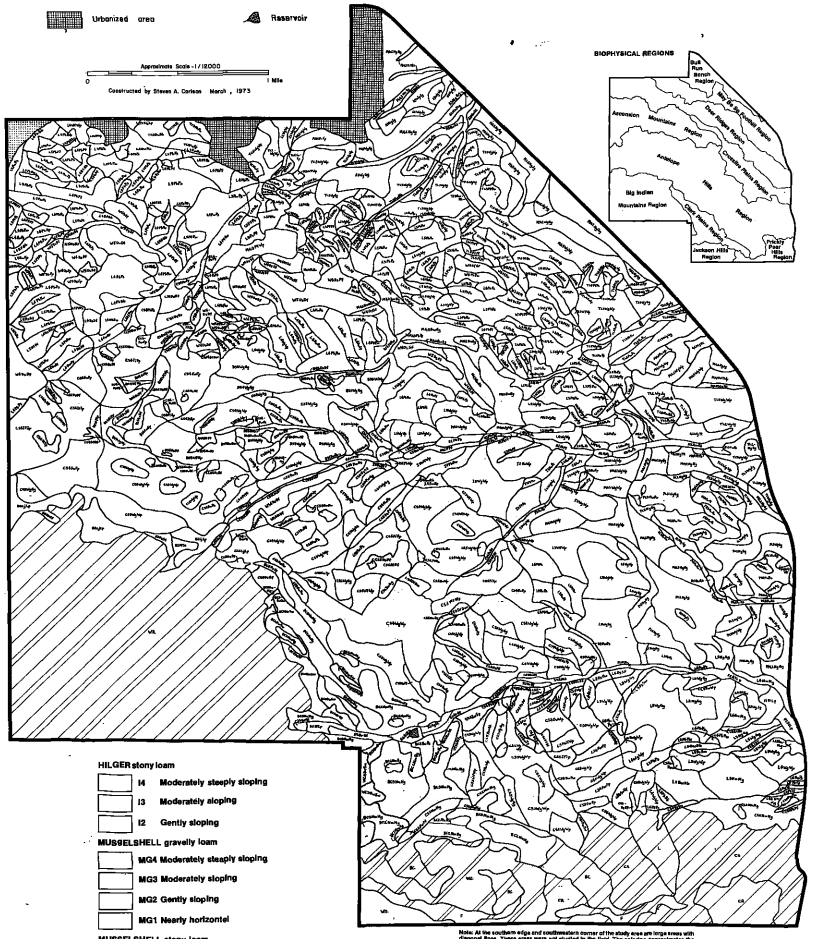
TOLMAN channery loam
- TL4 Moderately steeply sloping
- TL3 Moderately sloping
- TL2 Gently sloping

TOLMAN channery loam—CRAGO cobbly loam
- TC4 Moderately steeply sloping
- TC3 Moderately sloping
- TC2 Gently sloping

ROLLING BENCHES AND INTERIDR VALLEYS

BROWNLEE rocky loam—CHEADLE rocky loam
- BC4 Moderately steeply sloping
- BC3 Moderately sloping
- BC2 Gently sloping

PEN loam or gravelly loam
- PL3 Moderately sloping
- PL2 Gently sloping



Note: At the southern edge and southeastern corner of the study area are large areas with diagonal lines. These areas were not studied in the field. The coloring approximates the biophysical units within the area as well as the relative proportion.

HILGER stony loam
- I4 Moderately steeply sloping
- I3 Moderately sloping
- I2 Gently sloping

MUSSELSHELL gravelly loam
- MG4 Moderately steeply sloping
- MG3 Moderately sloping
- MG2 Gently sloping
- MG1 Nearly horizontal

MUSSELSHELL stony loam
- MS4 Moderately steeply sloping
- MS3 Moderately sloping
- MS2 Gently sloping

CRAGO cobbly loam—MUSSELSHELL gravelly loam
- A3 Moderately sloping
- A2 Gently sloping

GRAVEL, highly scarified surface
- G4 Moderately steep
- G3 Moderate
- G2 Gentle

ALLUVIAL MATERIAL

SLOCUM loam
- S2 Gently sloping

FAIRDALE loam
- F2 Gently sloping
- F1 Nearly horizontal

HAVRE loam
- H2 Gently sloping

POTENTIAL AND PRESENT VEGETATION

MORE MOIST DOUGLAS FIR COMMUNITIES

Ds Douglas fir-snowberry forest sere
Dv Douglas fir, stagnant state
Dl Douglas fir-bluegrass spp. forest sere
- Forest — Df Douglas fir forest; Sf Mixed conifers forest; Pf Ponderosa pine forest
- Woodland — Dw Douglas fir-woodland; Sw Mixed conifers woodland; Pw Ponderosa pine woodland
- Savanna — Ds Douglas fir savanna; Ss Mixed conifers savanna; Ps Ponderosa pine savanna
- Brush — Wb Bitterbrush brush
- Prairie — Fp Rough fescue prairie

Dk Douglas fir-kinnikinnik forest sere
- Forest — Sf Mixed conifers forest; Pf Ponderosa pine forest
- Woodland — Dw Douglas fir woodland

MORE MOIST PONDEROSA PINE COMMUNITIES

Pa Ponderosa pine-snowberry forest sere
Pv Ponderosa pine, stagnant state
- Forest — Pf Ponderosa pine forest; Tf Conifer and broadleaf forest
- Woodland — Pw Ponderosa pine woodland
- Savanna — Ps Ponderosa pine savanna

DRIER DOUGLAS FIR COMMUNITIES

Df Douglas fir-rough fescue forest sere
- Forest — Df Douglas fir forest; Sf Mixed conifers forest; Pf Ponderosa pine forest
- Woodland — Dw Douglas fir woodland; Sw Mixed conifers woodland; Pw Ponderosa pine woodland
- Savanna — Ds Douglas fir savanna; Ss Mixed conifers savanna; Ps Ponderosa pine savanna

Dw Douglas fir-bluebunch wheatgrass forest sere
- Forest — Sf Mixed conifers forest
- Woodland — Dw Douglas fir woodland; Sw Mixed conifers woodland
- Savanna — Ss Mixed conifers savanna
- Prairie — Wp Bluebunch wheatgrass prairie

Sw Mixed conifers-bluebunch wheatgrass woodland sere
- Woodland — Sw Mixed conifers woodland
- Savanna — Ss Mixed conifers savanna

DRIER PONDEROSA PINE COMMUNITIES AND MORE MOIST PRAIRIE COMMUNITIES

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CP Black cottonwood-ponderosa pine forest sere
- Forest — Tf Conifer and broadleaf forest

Or Quaking aspen-rose spp. forest sere
- Forest — Qf Quaking aspen forest

Rl Rose spp.-bluegrass spp. brush sere
- Brush — Rb Rose spp. brush
- Prairie — Lp Bluegrass spp. prairie
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