# TOWARDS SUSTAINABLE BUILDING:

## COMMUNITY ECONOMIC IMPACT USING INDIGENOUS AFFORDABLE HOUSING STRATEGIES

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ABSTRACT

A planning tool is proposed integrating the use of indigenous technologies as the basis for sustainable development in the building sector. The use of physical land planning procedures combined with the spatial recording of the base resources used for indigenous technologies brings together two vital study areas for ecological land planning and community economic development Due to the space allocated for this paper, only the materials component of the housing sector in a seven county area of Central Texas is discussed.

1. RESOURCE PLANNING 1.1 Planning Assumptions

The evolution of modern society is based primarily on a political-economic reward system. This system in turn depends on a technological reverence which views the envirnoment as having an infinite resource producing and waste assimilation capacity. The procedure for redirecting this evolution must require a new understanding of the human processing components. Its functions must integrate its own waste as resource potentials and relate the intensity of its processes so they may better connect to the natural world to create a new order of ecosystem development.

By imagining our processing components as metabolic units that contain inputs, transformation processes, and outputs (i.e. products and by-products), one can begin to mold and remold one's activities in a more integrated, sustainable manner by linking together these metabolic units. Within a healthy ecosystem, each metabolic process utilizes as inputs the products or by-products of other metabolic units.

Building and, more specifically, housing, is one of several life support activities or sets of metabolic processes that may be planned as an ecological unit However, as soon as all components within a given life support activity such as housing are considered, both from the standpoint of raw materials and waste processes as deriving from and excreting into the region itself, both a responsibility and some obvious benefits accrue from the discrete yet associated realms of economics, ecology, and politics.[1,2]

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1. Koenig, Herman E., William E. Cooper, James M. Falvey. " Engineering for Ecological, Sociological, and Economic Compatibility," IEEE Transactions on Systems, Man, and Cybernetics, Vol. SMC-2, No. 3, July 1972, pp. 319-331.
2. Haynes, Kingsley. "A Conceptual Approach to Waste Control," Ekistics volume unknown.

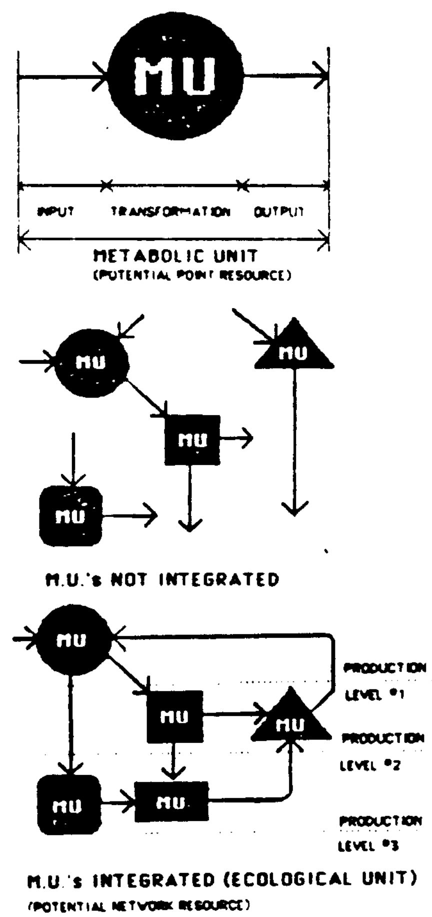


**Fig. 1. Metabolic Units**

1.2 Planning Objectives

A sensible objective, growing out of the assumptions stated above, would be to bring together directly two rarely combined, but major development components: economic development and land planning. In most all environmental land planning procedures, these two components influence each other only from the standpoint of environmental protection, not from the standpoint of use. The fact is that resources usually exist in every region that can be used to fulfill basic life support requirements with the coupling of an appropriate technology. According to our assumptions, these technologies must be indigenous technologies and, therefore, can be spatially represented. This, then, enables economic development efforts to be placed within the physical land planning framework. When the two components of economic development and land planning are combined into a single procedure with the principal objective of limiting development strategies so that they can be linked together as to inputs and outputs, then we have what might be referred to as an ecological/ economic development strategy.[3]

1.3 Planning Methodology

It is obvious that without respecting the expressed needs of a population within a region, one has little chance to develop either a successful program or of assembling the necessary constituency for political change. It is natural, therefore, to find that the development of a methodology for sustainable building hinges on an initial undertaking of a needs assessment. In actuality, "needs" could cover a wide range of life support activities such as food, waste, clothing, sanitation, etc. Once this assessment is accomplished, one can begin to compare the identified needs with a regional inventory of existing physical and biological resources. We use the phrase Area Resources to describe such an inventory when spatially organized in mapped form.

This comparison procedure must first take into account all those local technologies (businesses) that depend on the region for their raw materials and fulfill the identified need(s). When a business depends on the resources of the region of which it is part, we refer to it as a Point Resource. If such local businesses do not exist, then new businesses should be created, from material processing on through to manufacturing and use.

At times it is difficult to identify a suitable new technology that satisfies a region's human and physical resource needs. At this point, a global referencing system is used, based on the biogeographic realms established by the International Union for the Conservation of Nature and Natural Resources, which received its initial funding from U.N.E.S.C.O. This mapping approach essentially establishes an indexing system based on the natural patterns of similar sub-categories found throughout the world, and which uses vegetative resources as the basis for comparison. Succinctly stated, if one needs to locate a technology not obvious within one's own region, one can identify parallel regions in the world endowed with the same natural resource combinations and pursue information from their regional resource groups, institutes, etc. that relate to a particular topic.[4]

A single pattern such as this which recurs on a global level is termed a biome. Central Texas, for example, belongs to the temperate grasslands biome. A worldwide biome inventory of indigenous technologies related to conservation practices, waste recycling, materials techniques. etc. as they relate to building therefore have a high likelihood of being relevant in our locale. A

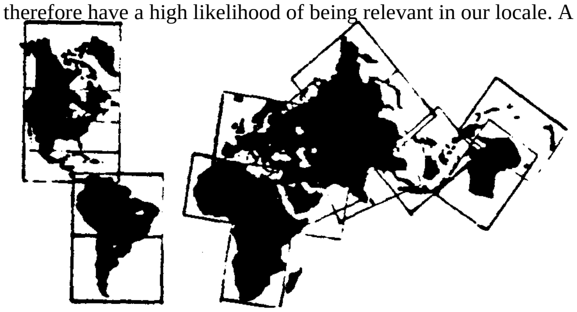

**Fig. 2. Biogeographic World Map**

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3. Foin, Theodore C. Jr. Ecological Systems and the Environment, Boston, 1976.
4. Fisk, Pliny. "Bioregions & Biotechnologies: A New Planning Tool for Stable State Economic Development," New Perspectives on Planning in the West, Arizona State University. 1983.

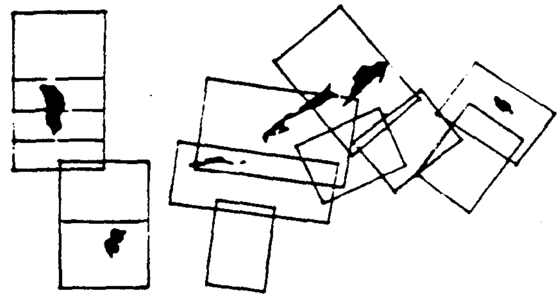

**Fig. 3. Grassland Biome**

further stage in analysing the region is to assess the degree to which point resources are connected, both from the standpoint of their raw material base and to each other, much in the same manner as our interconnected metabolic units. When we are faced with such an occurrence, we refer to it as a Network Resource since it is a resource category in the same sense as the area and point resources which we can use and on which we can depend.

AREA-POINT-NETWORK RESOURCE PLANNING

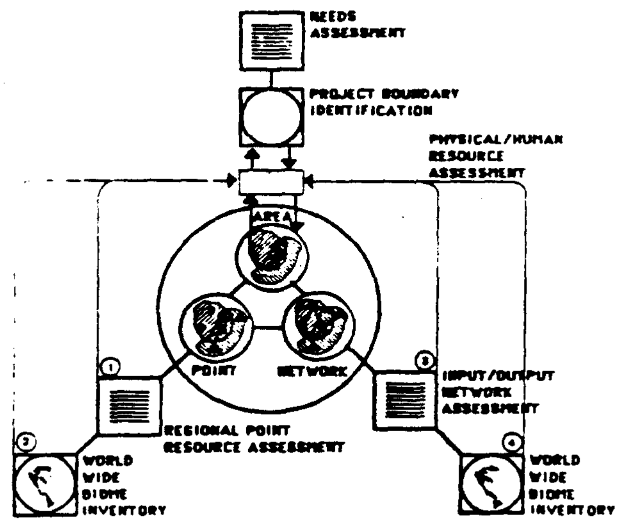


**Fig. 4. Area - Point - Network Resources Planning Process**

As we progress from area to network resources, we realize that as more complex relationships occur, the region's stability is enhanced so that, in a sense, the more grounded the human institutions are to each other and to the region they serve. This, then, can be used as a gauge to determine the amount of work that must be done to bring the region into a stable and sustainable state: the more interconnections, the more stable and therefore less work that is required.

## 2. NEEDS ASSESSMENT: HOUSING MATERIALS IN CENTRAL TEXAS

The following summarizes information collected concerning housing in both rural and urban areas of Central Texas. We have limited our assessment for the purposes of this paper to insulation and structural materials.

**GENERAL**
**Total population (7 counties): app. 650,000**
**Ave. growth rate per year: 21,500-50,000**
**New housing required per year: 8,600-20,000**
**Weatherization required: 13,000 units**
**Repair/rehab required: 13,000 + 6% annual increase**

**INSULATIVE MATERIALS**
**Total insulation required per year:**
**21.6x10$^6$ ft$^3$ - 33x10$^6$ ft$^3$ (R-3.5 average)**
**Total weatherization: 13x10$^6$**

**STRUCTURAL MATERIALS**
**Cementitious materials: 1.56x10$^6$ million tons**
**Brick, stone, lime, sand, aggregate: N.A.**

In addition to the above data, some significant findings from our study showed that: (1) The percent increase over the last decade of substandard housing was greater than that of standard housing; and (2) Issues of structural deterioration were as important as the need for weatherization.

The housing needs assessment involved more than materials. Our study, for example, included utility issues such as costs for space heating and cooling and water heating as compared to other housing costs, water costs, conservation needs and sanitation requirements.

## 3. REGIONAL AND INTERBIOME TECHNOLOGY INVENTORY

### 3.1 Insulative Materials

A wide range of insulative materials and technologies are possible beyond those of mineral wool, fiberglass, and plastic petroleum-based approaches. The most well known is cellulose, but our choice can be expanded further into agricultural wastes[6,7] and industrial wastes.[8] Thus we find straw chaff of various types, including wheat, oat, and barley, being applicable utilizing the European straw-clay technology. Cotton hull and cotton lint are also possible, as is sawdust. Since many of these materials are by-products, they each represent a metabolic output that can be redirected as an input to the building industry.

### 3.2 Structural and Massive Materials

Alternative cements in the form of fly ash, sulphur, and pozzolan are available in our region, the first two as a result of coal combustion processes. This means that an integration between energy production metabolic units and the construction industry is possible. Sulphur especially is important due to the acid rain resulting from the burning of coals, particularly lignite.

Another naturally-based material useful in arid/semi-arid zones is a material called caliche, a pre-limestone formation that is capable of being easily stabilized, particularly with fly ash and pozzolan cements. Adobe, rammed earth and poured earth are other relevant

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5. "Austin Housing Condition Report 1970-1980," City of Austin Department of Planning, 1981.
6. "Use of agricultural and industrial waste in low-cost construction, " U.N. Dept of Economic and Social Affairs, 1976.
7. Volhard, Franz. Leichtlehmbau, Unter Mitarb. von Ute Schauer, Karlsruhe: Muller, 1983.
8. Arends, Ir GJ., Dr S.S. Donkersloot-Shouq. An Overview of Possible Uses of Sawdust TOOL Foundation, The Netherlands, 1985.

technologies for massive and load bearing applications, as well as stone, which should be present in the form of limestone.

## 4. AREA / POINT RESOURCE POTENTIALS IN CENTRAL TEXAS

### 4.1 Insulative Materials

The quantity of cellulose presently recycled in our region is .74x10$^6$ ft$^3$ per year, and is presently being processed as well in the region. The total quantity possible is perhaps as much as five times this amount, but we find some of the other materials mentioned previously as possibly equal candidates. Sawdust could amount to 1. 32x10$^6$ ft$^3$ per year, but is presently only used as a bedding material for animals. Wheat and oat chaff, however, are already gathered at the mill and amount to 12.5x10$^6$ ft$^3$ per year. Cotton bull is also available and collected with a total of .08x10$^6$ ft$^3$ available at the mill. The technology for fireproofing, spraying, and bulk filling with these substances is available, and can be the same base technology as that used for cellulose.[9,10] The potential for foaming fly ash into a fireproof insulative material using agricultural and animal husbandry by-products is also possible.[11]

### 4.2 Structureal/Masive Materials

Depending on the type, fly ash may be used directly as a replacement for portland cement or mixed with sulphur. Typical mixes surpass foundation requirements by two to three times (up to 6500 p.s.i.). The quantity available in our region is .33x10$^6$ with a possible total of .7x10$^6$. With the addition of badly needed precipitators on lignite coal burning plants, an additional .09x10$^6$ is possible, thus preventing this quantity of SO2 from entering our airshed.

The addition of caliche contributes another 5x10$^6$ tons per year in one county alone, while adobe, poured earth and rammed earth add up to another 19,160 acre feet in this same county.

### 4.3 Result of Area - Point - Network Planning Methodology in the Materials Sector

By comparing the existing needs with localized low energy materials, we find that in the insulation sector of the materials economy a total of 14.64x10$^6$ ft$^3$ can be produced annually, or enough to satisfy all low-income weatherization requirements in one year. Under normal circumstances and with the projected growth rate, we find that from 44% to 67% of insulation needs can be supplied from the local sector. If a sustainable balance were reached between land actually needed to support food needs and building materials, it seems evident even in a grassland environment that all housing and food requirements could be met if population growth were controlled in the future.

In the massive and structural material sector, we find "indigenous" recycled cement at a possible .79x10$^6$ total, supplying 50.6% of cement needs. Caliche and adobe soils seem to be able to supply all housing requirements for the region. If these materials were mixed at optimum proportions with cementitious materials for stabilization, all housing needs could be supplied for several generations.

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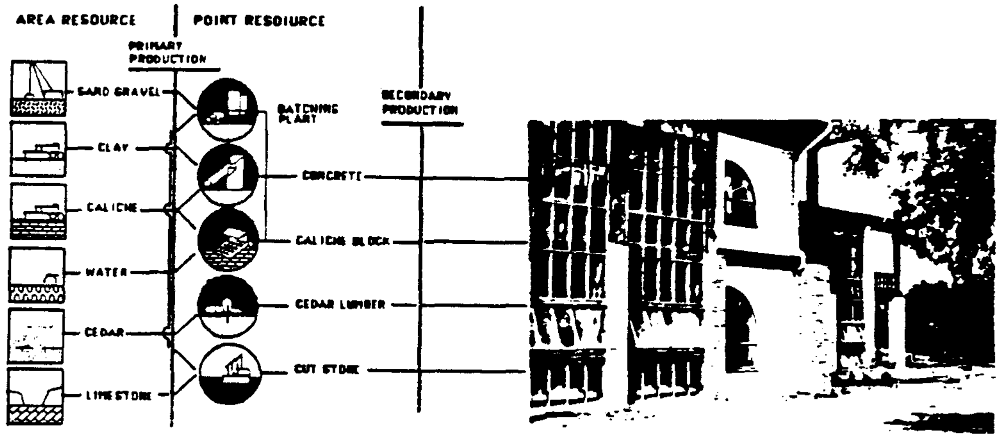
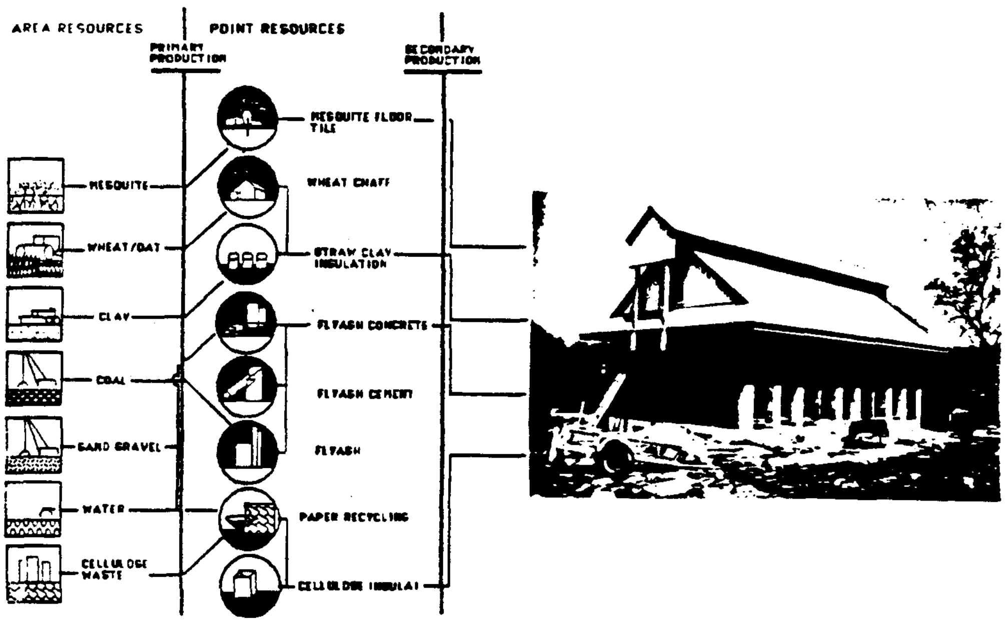
9. Ibid
10. Direct communication, Ark-Seal. Inc. International, Denver, Colorado.
11. Center for Maximum Potential Building Systems, Austin, Texas.

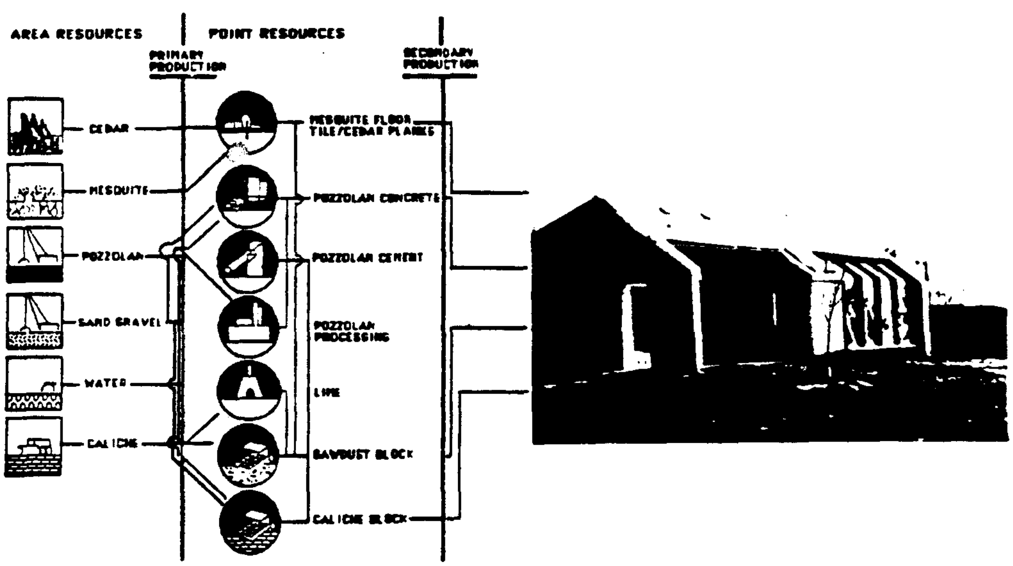
NETWORK RESOURCE - CALICHE SCHOOL DORMATORY

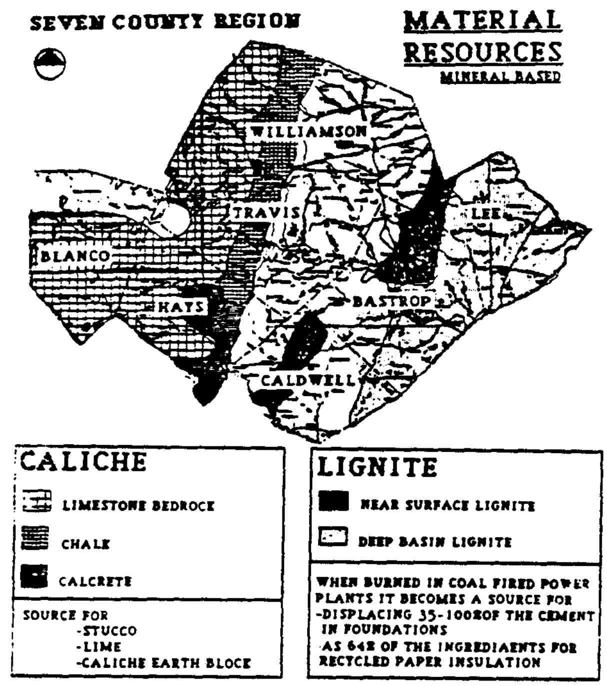


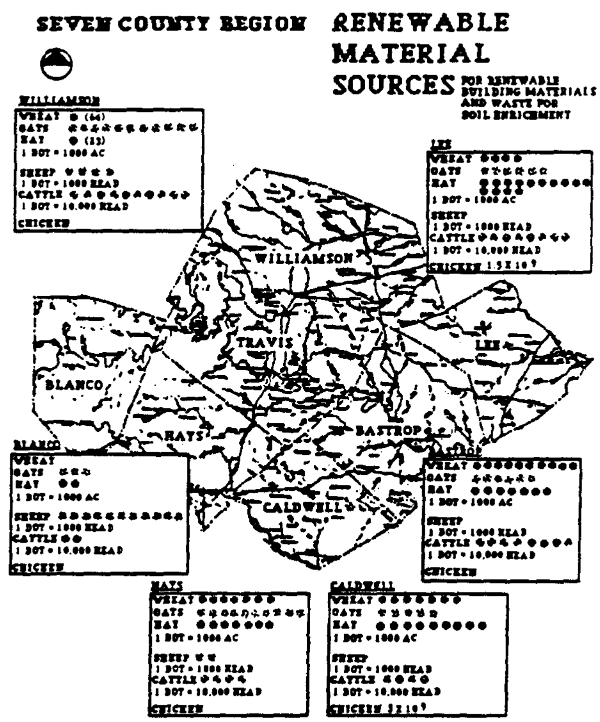

NETWORK RESOURCES - STRAW/CLAY HOUSE

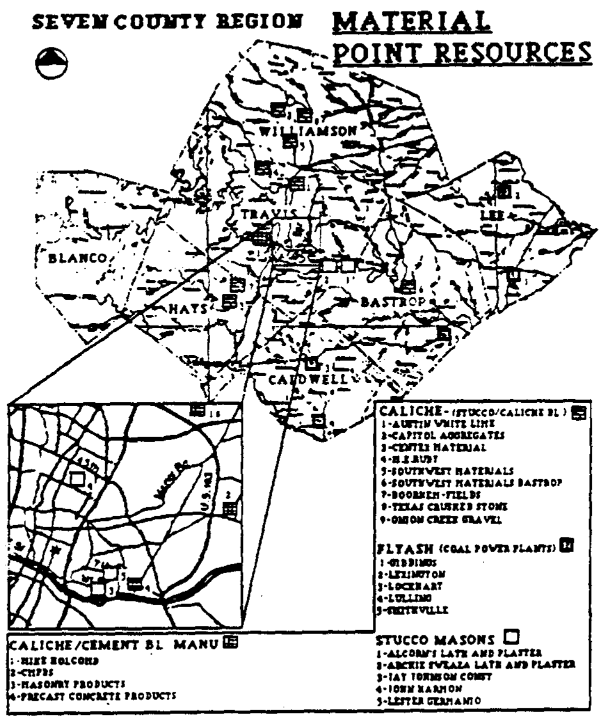


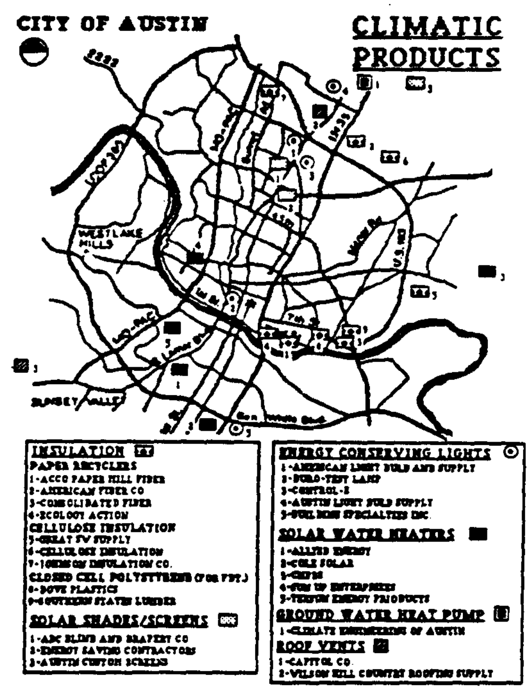

NETWORK RESOURCES - SAWDUST/CALICHE SCOUT QUARTERS



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(8) Arends, Ir. G1., Dr. S.S. Donkersloot-Shouq. An Overview of Possible Uses of Sawdust, TOOL Foundation, The Netherlands, 1985.