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Edith Leong Yang

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This study begins with a brief survey of the history of farmstead planning and a summary of the fundamental standards of farmstead planning.

The second part was devoted to the factors that influenced the farmstead design, the geographical features and the social-cultural features of the region. An examination of the building materials available revealed great possibilities for the many kinds of volcanic rock in the area. Of main interest was pumice, and rammed earth should prove an adequate building material for this area. Feasible schemes of prefabrication were suggested for this region.

In the third part the cooperator's farm was described, and his building requirements were analyzed. A construction system to offer flexibility for his farm structures was suggested.

The proposed farmstead plan was presented and the layout and proposed buildings were analyzed.
A PROPOSED FARMSTEAD PLAN
FOR AN IRRIGATED AREA
IN CENTRAL OREGON

by

EDITH LEONG YANG

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APPROVED:

[Signature]
Head of Department of Architecture
Professor of Agricultural Engineering

[Signature]
Chairman of Committee on General Studies

[Signature]
Dean of Graduate School
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A PROPOSED FARMSTEAD PLAN FOR AN IRRIGATED AREA IN CENTRAL OREGON

CHAPTER I
THE PROBLEM

Statement of the problem. The primary purpose of this study is to investigate the factors involved in farmstead planning and to incorporate these findings in a proposed farmstead plan for a cooperator situated in the newly irrigated Deschutes Project in central Oregon.

Justification of the problem. Man's most basic need is food. Now, more than ever, many war-ravaged countries look to us for food. During this post-war period of inflation, with ever mounting labor and material costs, efficient farmstead planning is a vital need to secure the best utilization of the factors of production: land, labor, and capital.

From a sociological viewpoint, better planned farmsteads will attract more people to a life in a primary community, where a greater degree of intimacy and a greater depth of bonds can be enjoyed. These contribute to the satisfaction of basic social needs for security, companionship, and recognition by others. A farm family has the opportunity to develop to its fullest traditions with work and industry; plenty of good farm-produced food and a country home to live in; planned industry and financial
security with pride of ownership; self-help through true cooperatives, where extra dividends go to the well-planned and organized farm. (49, p. 522) That the rural community offers a better adjusted life may be indicated by the fact that the ratio of suicides and mental disorders in places of fewer than 2500 persons are lower as compared with cities of more than 100,000. (48, p. 151)

In no small way a well-planned farmstead affects the value of the farmer's real estate by making the community in which he lives more attractive. The attractiveness of the community is often the determining factor that induces new people, business, and industry to settle there.

Scope of the study. Simple as the farmstead is commonly thought to be, there are forces so great and numerous at work here that its scope would provide material for volumes. This study is limited to an approach to farmstead planning from the architect's point of view, since the writer is an architectural student and finds a lack of contributions to this subject from the architectural profession.

The architect's point of view. Forty years ago, during the first emancipation from the vicious circle of eclectic imitation of past periods, the main interest
of architects fastened on aesthetic problems, questions of "style" and artistic articulation. Twenty years ago, the problem of functional expression of new materials and new construction methods held the stage. (49, p.4) The credo "Form follows function" was born, and it continues to dominate architectural education. Today, aesthetic as well as functional problems are overshadowed by one comprehensive urgency, namely, the integration of architecture with the social aspect.

The architect gathers, coordinates, and composes various ideas of specialists in every line, remembering that solutions, whether reached by individual planners or committees, once embodied in concrete, steel, wood, or other building materials, become powerful instruments for human happiness or discontent, efficiency or wasted efforts. To quote the already classical words by Winston Churchill, "We shape our buildings and afterwards our buildings shape us."

Therefore, the architect is concerned with the geographical and social-cultural features of the region in which he is designing in order to gain an insight into the present and future needs of his structures. In addition to financial, aesthetic, sociological, and functional considerations, he is always on the lookout for
new building materials and construction methods which may be developed in the specific region for which he is designing.

Organization of the study. This study is divided into three parts. The first part is devoted to a brief survey of farmstead planning and to the fundamental standards for farmstead planning. The second part is concerned with the factors that influence the farmstead design: the geographical features of the region, social-cultural features of the region, native building materials, prefabrication, the cooperator's farm, and the cooperator's building requirements. The third part is a presentation of the proposed plan, with a discussion of the farmstead layout, the structural system, and the plans for the proposed farm structures.
CHAPTER II

HISTORY OF FARMSTEAD PLANNING

The first farmstead. Farmstead planning began somewhere during the Neolithic period (4000–6000 B.C.), when primitive man first discovered how to domesticate wild animals and to plant the wild seeds he gathered. (6, p. 23)

The farmstead plan of Neolithic man was influenced by many factors, primarily geographical and social-cultural.

He always selected a site in a forested region so he could be assured of sport, a supplementary food supply, and timber for his buildings and furniture. Flint weapons, gigantic megalithic monuments, and pottery played an important part in his life, so proximity to flint mines, large stones, and clay beds were also determining factors in the selection of his site.

Neolithic man was forced to band together in large groups for protection from the common enemy. The immediate site for his buildings was either on land adjacent to a natural water supply or in the middle of a lake. (28, p. 61) If a land site was chosen, the buildings were enclosed by a thick wall of timber. If a lake site was chosen, the buildings were erected on
an island or on piles in the middle of the lake and connected to the shore by a bridge. In times of danger a section of the bridge was removed, and the enemy was thus isolated. (6, p. 20)

Neolithic man preferred the lake site; besides an immediate water supply it provided an easy means of sewage and garbage disposal, which attracted the fish and supplemented his food supply. Buildings on a land site, with no means of garbage disposal, had to be periodically burned to the ground and rebuilt on a new site. The lake site was also preferred because it was well-lighted. It also got away from rodents and had an unobstructed view of the gardens and animals on the shore. (28, p. 67)

Then, too, it provided an immediate lane of commerce, and Neolithic man easily traveled great distances in his simple dugout to barter his produce. Prerequisites of an ideal lake site included a sunny, sheltered shore, protected by hills from storms and action of waves, with the land on the immediate shore suitable for pasturage and easy cultivation, and the bottom of the lake conducive to the easy driving and holding of piles. (39, p. 70)

Neolithic man's weapons and implements were crudely fashioned from wood, bone, and pieces of flint. In working with wood, he often supplemented his implements with an intelligent use of fire. (27, p. 191) His
buildings were of four types: workshops, granaries, housing for his animals, and housing for his family. The workshops, granaries, and animal housing were simple one-room shelters. The family dwelling was divided into two rooms, the bedroom-living room and the kitchen-workshop. (28, p. 73)

Neolithic man discovered the ceramic and textile arts (28, p. 22), so his excess food was placed in clay containers and cloth sacks and stored in the granary. His buildings knew no pattern of orientation; they were grouped close to each other and to those of neighboring families on all sides.

Neolithic man laid out his fields in a clearing on the shores of the lake or stream. These fields were small and were cultivated primarily by the women, whose only implement was a planting stick. Neolithic man planted barley, wheat, and some millet. (6, p. 24) He knew nothing about the soil, laying out his fields only on the basis of proximity to his dwelling. When the soil was depleted, he moved a little further inland. His domesticated animals grazed on the nearby uplands during the day and were sheltered at night.

Other farmstead planning. Space does not permit a complete survey of the development of farmstead planning, a study which is equivalent in magnitude to a
history of civilization, for down through the ages, farmstead planning has varied with every change in geographical as well as social-cultural feature. These farmstead may be divided into several basic patterns: the individual farmstead, the large plantation, and the cooperative farm.

**Literature on farmstead planning.** In "Roman Farm Management" by Cato (234--149 B.C.) and Varro (116--128 B.C.) (10) may be found one of the earliest writings on the subject of farmstead planning. The authors' keen observations and analyses give us many of the standards we consider fundamental today.

There are quite a few government and state bulletins on farmstead planning which are brief and general in character. A great number of studies relating to this subject are contributed by specialists in farm management. Students of farm management here at Oregon State College have as one of their major projects the reorganization of a specific farm, and these studies give very comprehensive consideration to the factors involved in farmstead planning from the farm management standpoint. From an architectural point of view, the only thesis on farmstead planning was written by Mr. Mohsin at University of Oregon in 1947. His solution for a section of the Columbia Basin Project was for cooperative farming.
Since the individual farmstead is traditional in America, this thesis will be concerned with this specific type.
CHAPTER III

FUNDAMENTAL STANDARDS FOR FARMSTEAD PLANNING

Farmstead planning in our era involves the consideration of many factors.

A. SELECTION OF THE FARM

Climate. The climate of the area should be healthful and satisfactory for the family concerned. The growing season, rainfall, and temperature must be satisfactory for the kind of farming desired, and there must be an absence of unfavorable weather phenomenae. (25, p. 113)

Soil. The soil should be of adequate depth, underlain with satisfactory subsoil, and not broken up into too many types. It should be suitable for the combination of enterprises desired, be made to produce within a reasonable time and cost, and be suited for several different crops.

Water. The character of the water, whether alkali or sulphur, should be palatable to the farm family. There should be a sufficient water supply for home and farm use in the dry summer months and in the winter months. The water should be free from contamination. Water from a spring or infiltration gallery can be delivered by gravity, and such a system is ideal. However, a poor or undesirable farm should not be selected
simply because of a good water supply; a good supply can usually be had on any desirable site by drilling or digging a well. (19, p. 6)

**Topography.** The farm should have a gradual slope, with a slope to the south, southeast, or east preferred. It should be neither so high as to be difficult of access nor so low as to be damp, subject to frost, poor drainage, and lack of air circulation. (5, p. 8) When possible, the farm should be higher than the road. (19, p. 5) It should be suitable for cultivation, irrigation, and efficient use of machinery, and free from the likelihood of damage from erosion or sliding and flooding. (25, p. 113)

**Size.** The size of the farm should be suited to the owner's efficiency and ability. It should be the proper size for the enterprises chosen and to provide an adequate family income, using family labor primarily, following the system of farming that is most profitable for the locality, and using the kinds of machinery that are available for that type of farming. (1, p. 35)

**Financial considerations.** The farmer should be able to pay for the farm out of the farm earnings in a reasonable time. The kind of equipment needed, the cost and availability of labor, and the amount of
fencing needed, the adequacy of the existing plant, and the future costs of cutting brush, cleaning ditches, and leveling and irrigating the land are factors. (23, p. 33) The overhead should be small and the upkeep economical. The site should be able to be rented readily. Its future sales value should not decrease, since most farms in the United States change hands at least once every thirty years. (25, p. 96) The present owner should be able to transfer a sound title. Another concern should be the financial condition and tax situation of the county and other local units of government: their amounts of indebtedness, tax rates, total taxes collected, prospects for increased assessments, current and future plans for debt payments, public services, and other uses made of the taxes collected. (25, p. 95)

Transportation, marketing, and other facilities. There should be a good "all-weather road" convenient to the farm. Present and future channels of transportation should be considered: railways, bus lines, good highways, air lines, refrigerated cars, and commercial custom hauling. The availability of a good market for the kind of product it is desired to grow (for quality or quantity) should be considered. The distance to the market and the kind of product to be taken to market should be taken into consideration.

The availability of electric power, telephones,
Community considerations. In regard to the general environment, the neighbors must be congenial, progressive, cooperative, and desirable. Community traditions should be compatible, and the community healthful and free from diseases and pests. There should be good schools, churches, social centers, various forms of health and property protection, hospitals, available medical attendance, and opportunity for taking part in community affairs.

The prevailing type of farming in the area should be suitable, and the majority of the farmers should be successful owners rather than tenants. (23, p. 33)

The presence of cooperatives and the availability of storage and other facilities for farm produce are desirable features.

The use of adjacent lands should be considered.

B. SELECTION OF THE FARMSTEAD SITE

Topography. The farmstead site should have a slope in one or more directions sufficient to carry off all water from about the buildings and yards, thus insuring dry floors and comparatively dry paths and driveways in bad weather. (5, p. 8) It should be level enough for ample work areas and easy grade connections between buildings. (34, p. 98)
Location. A farmstead site should be located where refreshing and prevailing winds are secured and where a view of much of the farm and natural scenery is afforded. It should be located where an abundance of good water is available or where it can be readily secured. A grove of trees or a hill is a big advantage in saving feed and fuel, and natural windbreaks should be utilized whenever possible. (35, p. 6) Advantage should also be taken of native rock, timber, and prairie grass.

If conditions permit, a farmstead in the middle of the farm is the most economical in time consumed in traveling to and from the fields with implements or driving stock, in supplying water for the animals from a central supply, and in fencing, since no long lanes are necessary. This location provides for easy expansion in all directions.

A location close to the highway is desirable, since traffic is a source of considerable interest to the average farm family and promotes social intercourse and participation in community affairs, easier accessibility to the school bus, ease in marketing farm products, and closer connections with power and telephone lines. (5, p. 6)

A central location in a road frontage is preferred to one at a corner crossroads.

A farmstead site located back from the highway has the advantage that the highway does not determine the
location or orientation of the house. Thus, more sites are available for selection as compared with the sites available along a relatively short highway frontage. Thus, buildings can take advantage of the lay of the land, breezes, grove of trees, be nearer the fields, and be less subject to annoyances of dust, noise, and danger of fast-moving vehicles.

Soil. The soil occupied by the farm buildings may be the poorest on the farm, but it is essential that it drains rapidly, insuring family health and proper sewage disposal. (20, p. 6) Thus, gumbos or other heavy clays and impervious subsoils are generally to be avoided. Soil that is too sandy is objectionable; it encourages the establishment of fleas in dry spots, particularly under buildings, and makes the growing of lawn grasses, shrubs, and trees difficult. (23, p. 79) Light soil is preferred to dark soil on the assumption it is easier to clean.

Size and shape. The size and shape of the farmstead may be limited by the topography of the location. A farmstead deeper than it is wide usually gives the most efficient arrangement. (35, p.14)

View and natural growth. A location that affords a view of much of the farm is desirable. A view of the surrounding hills and natural scenery is worthy of consideration.
Relationship to the fields. The relationship of the farmstead to the fields is often influenced by farm practice.

The farmstead should open into as many fields as possible. It should permit easy access to the fields from the buildings. Dividing a field by the farmstead should be avoided.

C. ARRANGEMENT OF THE FIELDS

General considerations. The topography and contour of the land may dictate the shape of the fields to prevent erosion and to insure proper drainage. (5, p.6) The location of natural pasturage and woodland is often a controlling element in the arrangement of the fields, as is the kind of crops and the machinery to be used.

The land should be separated into fields according to soil types so that each type may get the proper treatment for its particular needs. An ideal arrangement is for the fields to be of uniform size and equal in number to the number of years in the rotation program, or a multiple of that number. (25, p. 300) However, sometimes the cropping system should be adjusted to the number of fields available. (23, p. 76)

Economical considerations. Fields should be laid out for the maximum irrigation efficiency and for efficient use of machinery and labor. Rocks, trees, and other
field obstructions should be removed, and mud holes should be filled. Crops requiring the most intensive culture and largest amount of hauling should usually be nearest to the farmstead. (2, p.351)

The fields should be arranged so one corner or end is as near the farmstead as possible. Rectangular fields are the best. They require less turning but more fencing than a square field. Irregular outlines require more labor and fencing, and corners less than ninety degrees should be avoided.

**Pastures.** Small, irregular fields should be used for pasture or hay.

One common plan is to have a small permanent pasture adjacent to the farmstead and to arrange the crop fields so that they open off this pasture. Such a plan facilitates the handling of livestock between the farmstead and fields. Another device is to provide a lane from the farmstead to some central point from which several fields can be entered. The lane should be as short as possible. (23, p.78)

**D. FARM STRUCTURES**

**General arrangement.** The location of all buildings, their arrangement and orientation, will be influenced by the lay of the land, the prevailing winds, the type of farming, farm practice, and efficiency of labor. (8)
The grouping of farm buildings in an orderly manner makes them more accessible and convenient, keeps them within reasonable distance of the residence, and gives the entire area a pleasing appearance, enhancing its value in the eyes of the visitors. (19, p.12) By lining up outside walls of buildings and enclosing the area with a fence, it is possible to graze between all the buildings, thereby eliminating small nooks that would grow up in weeds.

**Location of buildings.** Buildings should be located conveniently with respect to one another and to the fields so that farm business may be accomplished with the least labor. (34, p. 98) In most cases the position of the building ought to be determined by the driveway and the contour of the land. Consideration should be given to the visibility of the buildings from the kitchen window. Whenever possible, buildings should be located so that the machinery and equipment are out of public sight.

On dairy farms the barn and corral should be located so that it is possible to rotate pastures without a large amount of extra chore labor involved. Buildings that house livestock should be located so that it is not necessary to go through feed lots or corrals to reach them. (8, p.7) Bull pens should be located where the bull can have pasture and exercise, with the breeding
chute adjacent to the barn or corral. (14, p.12) Locating the hay barn to reduce the fire hazard should be considered.

To safeguard against objectionable odors, the house should be out of line of the prevailing winds in relation to the barn. There is no reason why the residence must be closer to the highway than the other buildings.

**Location of other elements.** The well is desirable close to the house, and should be located so that seepage from lots, cess pools, or outdoor toilets cannot gain access to it. The well may be within the open court and close to the stock tank at the barn.

The transformer should be located at or near the farm electric power load center to keep down wire sizes and costs. It must be sufficiently close to motors to give good voltage. Important factors affecting the transformer location are: the farmstead layout, voltage requirement, location of the large power consuming equipment, transformer pole protection, protection against possible fire damage, and non-interference with regular or seasonal work in the farmyard.

A convenient place for the farm platform scales is in the farm court adjacent to the corrals or feed lot. (8, p.7) In this position it is convenient for weighing livestock or loads of feed and supplies.
The manure pit should be located at least fifty feet from the barn, and should not be in line with prevailing winds in relation to certain buildings. The exercise yards for the cows should not be adjacent to the milking barn, and the lots, especially the hog lot or cattle feeding lot, should be located at the rear of the court.

**Distance apart.** The stock barns should be located farthest from the residence, ranging from one hundred to two hundred feet, because of objectionable odors and flies. Other buildings should be fifty feet apart or more if they are larger buildings and preferably not in line with prevailing winds for desirable fire protection. (35, p.14)

The poultry house should be located reasonably near the residence.

**Orientation.** The principle of orientation is the arranging of buildings and the various parts of the building so all shelters of human and animal life may receive the utmost benefit of the sun's rays during the winter and of the cooling breezes in the summer. Thus, buildings and yards should be placed far enough back from the road so the road does not dictate their orientation. A south or east orientation for the sun avoids the glare of the afternoon sun. An east-west axis for single row livestock buildings is all right, but it is desirable that
double row livestock buildings be placed on a north-south axis to provide maximum sunlight and ventilation in all parts of the building. A south slope is preferable for the loafing yard because it gives the maximum sun exposure and insures cleaner, drier yards.

Financial considerations. Normally, a saving may be made with open sheds and portable buildings. Temporary construction may fit present needs better until the farm income warrants permanent buildings. Money expended in barns and sheds for storage should bear a definite relation to the kind and amount of livestock and to the proportion of each they are to shelter as well as to the crops they are to store.

Each building must be suited to the long-time needs of the farm operations. Its cost and size must be in keeping with the size of the farm. It should pay a return above annual maintenance expenses. Its construction should not result in using funds needed for family use, as education for the children. Investments in land leveling, fertilizer, seed, equipment, and livestock are alternate investments that may bring greater immediate returns.

Construction considerations. The construction of the building should be economical of material and labor. The latest building and engineering technology should be used, and its design should conform to the latest develop-
ments in approved farm practices.

It should be built to reduce fire hazards, to pro-
vide for the maintainence of the correct temperatures,
ventilation, humidity, light, and sanitation, and to af-
ford protection from the weather, vermin, termites, birds,
and thieves. Livestock buildings should promote animal
health and assist the production of livestock and live-
stock products. Storage buildings should adequately house
each product, providing the most favorable conditions for
its preservation without lost of quantity or quality.
Housing for the farm family should contribute to the con-
venience, health, and happiness of the inhabitants.

**Flexibility.** Buildings should be designed for the
maximum flexibility. The following factors may call for
changes in the building design: new techniques in pro-
duction and other technological changes, changes in farm
enterprises due to changed economic conditions or other
factors, and changes in farm ownership.

**Work simplification.** Labor represents from forty
to seventy per cent of the cost of production. One-
third of all the farm work is done in and around the
buildings, so there is need for planning and arranging
the farm plant for efficient use and for maximum returns
from labor. (25, p. 142) According to Dr. G. E. Blanch,
Associate Professor of Farm Management at Oregon State
College, the 1945 wage of the average farm laborer increased
in comparison with the 1940 figure exactly 200%. The prices of Oregon farm products increased only 100% during the same period. In 1945, hired help represented 23% of the cost of producing agricultural products in Oregon. A total of 45 million dollars was spent for hired labor in Oregon in 1945, an increase of 22 million over 1939.

It is necessary to study the chores to be performed, the number of times they must be repeated, the time of day they are carried out, and the amount of energy that must be expended. The chore route inside each building should be reduced to a minimum. The buildings should include as much labor-saving equipment as is economically feasible.

E. CENTRAL COURT AND TRANSPORTATION ARTERIES

Central court. The central court should be directly behind the back yard of the house. Around this court are placed the major buildings and corrals of the farm. The farm court should be graveled or the earth stabilized. The lane leading to the fields as well as the one leading to the highway should have its beginning in this area. The central court has the following advantages: it allows a saving of time in doing chores, availability of a place in which to turn machinery, park automobiles and farm
machinery, spreads buildings for reasonable fire protection and so most of them will be in clear view from the kitchen window, provides an easy access to all buildings without opening gates or crossing corrals, and presents a pleasing appearance. (8, p.10)

**Lanes.** The location of the lane or lanes to the field will depend upon the shape and direction of the cultivated land and the rough land or permanent pasture. If possible, there should be a lane for the stock to come up to the barn lot from the pasture. The width of a cow lanes depends on the number of cows, the kind of soil, and the drainage. For twenty to thirty cows, three rods is sufficient. (2, p.353)

Diagonal lanes are a mistaken economy.

There should be easy access to all the fields from a central lane and the least possible conflict of farm roads and pasture lanes to avoid opening gates. A lane from the farmstead to some center from which several fields can be entered facilitates handling of livestock between the farmstead and the fields.

**Gates.** The location of gates should be in that part of the field nearest the farmstead or in the direction from which the farm operator most frequently enters his field. If used frequently, a gate swinging both ways is
desirable. Since opening gates wastes time, whenever the front of a farmstead must be fenced to keep out livestock, a cattle guard is more convenient than a gate. (8, p.7)

Fences. The farmstead should be fenced and so arranged so that it can be kept neat and free of weeds by grazing or mowing.

Electric and easily movable temporary fences should be used for rotation pastures and other than line fences.

Service drives and walks. If a drive is to accommodate double traffic, it should not be less than fourteen feet wide, with at least eight feet of gravel or paving. (19, p.14) The drive should lead to the garage and parking area without having to cross the yard. There should be by-passes to reach the house or service buildings where desired. A closed loop is desirable for turning.

The main walk to the average dwelling should be about four feet wide, the secondary walks narrower according to their importance.

E. LANDSCAPE, GARDEN, ORCHARDS WINDBREAKS

Planting. There should be a moderate amount of shade provided near the house to prevent radiation of heat from the ground. Fields that border the house and road as well as those that border the yard should be planted in permanent pasture, clover, or other close cover crops to
prevent dust from blowing into the house. Plants should not be crowded and should not be planted unless there is a reason for them, whether to unite, frame, shade, screen, separate or enclose, enhance a view, give a background for buildings, or act as a transition from the landscape to the house. The use of native material is recommended.

Grading. The ground should be graded as little as possible, using retaining walls, fills, and bench terraces only when they are necessary. Bench terraces should be located adjacent to the house or near the road and not across the middle of the yard.

Garden. One-half acre of garden will, if properly cared for, usually produce enough vegetables for the family of average size. It should be located adjacent to the lawn. (35, p.18)

Location of special purpose plots. The home poultry yard should be adjacent to the path from the house to the barns. The cold frames should be near the most-used path for frequent observation. The vegetable garden should be close to the kitchen. The small-fruit garden should be only slightly farther away. A desirable place for a flower garden is adjacent to or in the vegetable garden. It is desirable near the most used rooms.

Orchard. The orchard should be either small enough so hand equipment will take care of disease and insect
control, or large enough to justify the cost and use of power equipment. It can be located to help break cold winter winds.

**Windbreaks.** Windbreaks should be set approximately fifty feet from the boundary of the farmstead across the path of the prevailing winter wind. One or more rows of fast growing trees are usually also planted, to be cut out after the evergreens are mature.

Buildings form more efficient windbreaks than do trees and hills, and therefore should be placed so that they act as windbreaks to the yards at the same time being open to the sun. Board fences also are valuable in sheltering yards from the cold wind.
CHAPTER IV
GEOGRAPHICAL FEATURES OF THE REGION

The geographical region in which the cooperator's farm is located is the Columbia-Deschutes Plateau Province, part of the Walla Walla Plateau of the United States. (33, p.62)

Geology. The formations exposed, named in order from the youngest to the oldest are: the Intracanyon Basalt, the Cascan, the Madras, the Columbia River Basalt, the John Day, the Clarno formations. (21, map) The various rock types indigenous in this region will be discussed in Chapter VI.

The geological features of the region include the recent buttes and cones of volcanic matter, some of rather loose cinders and others, together with slag heaps of lava, exceedingly scarceous and rough. There are river canyons with their stupendous cliffs of lava, wonderful effects in vari-colored beds of volcanic ash, and fantastically erosion-carved pyramids and minarets in stone which resemble the Grand Canyon. The lava river tunnels and ice caves resemble the interiors of giant sewers. (33, p.65)

Topography. The topography of the region is unique. Broad inter-stream, irregular plateaus are cut by deep, impressive, intrenched canyons. The plateau has gentle
warps; the central portion is a perfect plateau; the eastern part has an advanced dentritic pattern. West of the Deschutes River, the later lavas of the Cascade Mountains produce a gentle consequent eastward dip slope. An old buried mountain range extends from the southeast to the northwest across the center of the area. The tops of its modified peaks emerge into such topographical features as Mutton Mountains, Pony, Teller, Grizzly, and Gray Buttes. To the south of these island hills the south up-slope of the plateau becomes pronounced, due to quite young lavas which pile up one on the other to form great steps.

Hydrography. Through the heart of this area flows the Deschutes River, remarkable because of its uniform flow of pure water, maintained by the cellular character of the lava flows and the spongy nature of the ash pumice and the gravel beds which lie between the lava flows and through which the river cuts. It drains over 9000 square miles, of which 6000 miles lie on the eastern slope of the Cascades. Its main tributaries on the west are the White, Warm Springs, and Metolius Rivers.

The Crooked River is the largest of the smaller tributaries. It has an inner and outer canyon as a result of the dammed waters which were caused at one geological age by a great flood of lava which obliterated a large part of its valley.
Flora and fauna. Much of the region is treeless, though fair stands of ponderosa pine occur near the Cascades and the Blue Mountains. Away from the few timbered tracts and cultivated areas, a coarse bunch grass (Agropyrom Spicatum) and sage (Artimisia tridentala) and the juniper (Juniperus occidentalis) grow.

Native animals of this region are the jack rabbit, coyote, badger, ground squirrel, northwest pocket mouse, Dalles and Columbia pocket gophers, Scheffer's mole, and the little canyon bat.

Soils. The soils of this region are largely residual and loess. The residual soil is due to disintegration of the basalt. The loess soil is largely of wind origin, though in places it shows stratification and contains some gravel, indicating local deposition by running water. (33, p.66)

Minerals. Gold, silver, and quicksilver have been reported. Coal is found near Heppner and is of an inferior grade. Diatomaceous earth is present in considerable quantities. Semi-precious stones, agates, and irridescent obsidian, are found on the "High Desert" east of Bend. Some good opals are found in Opal Springs on the Deschutes.

Pests and diseases. According to R. A. Hunt, Jefferson County Agent, the existing farm pests include a certain amount of cutworms and dry land wire worms which might
be expected to disappear after two or three years of irrigation. There are few plant diseases. One showed up to some extent in peas during the past year and was probably caused by some sort of organism. Of course, tuber and seed-borne diseases will always be introduced with new seedings. Coyotes, rabbits, and squirrels may become a major nuisance in the future.

**Climate of the Columbia Deschutes Plateau.** The winds are relatively warm and dry and seem to evaporate the little moisture present in the country. Annual precipitation is about twelve inches, though a little greater near the flanks of the Blue Mountains, and the heaviest rains come as accompaniments to summer thunder storms. The winds have full sweep in every direction over the high open country. The approximate range of mean temperature recorded was 110 deg. F. at Pendleton, and the lowest -38 deg. F. at Warm Springs in Jefferson County. Occasional dust storms, usually of short duration, occur during the summer months. (33, p.66)
CHAPTER V

SOCIAL-CULTURAL FEATURES

A. PEOPLE

Population. According to R. A. Hunt, Jefferson County Agent, the population of this area is small, with a distribution density of from seven to eight families per square mile of irrigated land. Due to the fact that part of the area is not irrigable, this means that there is slightly below this number. As a whole the people are young, that is, from twenty to thirty-five years of age. This is partially due to the fact that younger people have settled in the area where the original cost is less, but the development cost, which could be lowered in work, is higher.

Family composition. As a whole, families are quite small, with a number of unmarried men.

Education; recreational and religious preferences. The average educational level is a high school diploma. Recreational or religious preferences of the people in this area are not available.

B. ECONOMICS OF THE REGION

Agriculture. The agricultural future of this area is insured by the Main Canal, Deschutes Project, Oregon, which starts at a diversion dam just outside of the north
city limits of Bend and sixty-five miles later arrives at the North Unit: 50,000 acres of irrigable land surrounding Madras. Annual water costs average from seventy-five cents to $2.50 an acre. (12, p.4) According to F.L. Ballard, Director of Extension Service, Oregon State College, the top ranking income sources in Central Oregon from farm produce are: milk products, turkeys, potatoes, alsike clover seed, cattle, and calves. The following seed crops are important revenue sources: ladino clover, red clover, hairy vetch, crested wheat grass, and Austrian winter pea. Other farm commodities include: cattle, sheep, lamb, wool, chickens, eggs, hogs, horses, mules, fur, apiary products, farm forest products, hay, nursery crops, truck crops, gladiolus bulbs, peppermint, cut flowers, strawberries, cane berries, grains, and sweet corn.

Other industries. A minor resource in the northern part of the region are forest products. In the southern part, on the slopes of the many large and small buttes, there are stands of yellow and sugar pine, with some red fir and tamarack. Two large mills, the Brooks-Scanlon and the Shevlin-Hixon, operate on a large scale in the region south and northwest of Bend. In the Deschutes Valley and to the east great stands of juniper are found, which are used for curios, fuel, and fence posts. (33, p.67)

Diatomaceous earth, or diatomite, occurs in
able quantities at Terrebonne and on the Deschutes River, and is being mined and marketed. A substance resembling diatomite, but of volcanic rather than organic origin, is produced near Pendleton, and is used especially as a polishing powder.

The following concerns are digging pumice, cinders, and volcanic ash in central Oregon for use in construction materials: Deschutes Concrete Products Co., Redmond, Oregon, Mr. Ollie Grub, Bend, Oregon, Mr. Dillon Moore, Bend, Oregon, and Mr. H. W. Christy, Chemult, Oregon. This information was obtained from F. W. Libbey, Director of the State Department of Geology and Mineral Industries.

Transportation facilities. This area is well served by highway and railroad and fairly well served by river transportation. With the completion of the sea locks at Bonneville, the position of this region will be second only to the Willamette Valley. The Union Pacific and the Oregon Trunk give an outlet to the north and connections to the East; the Great Northern, connecting with the Western Pacific and Southern Pacific, gives a direct outlet to the California markets. United States Highways 97, 20, 28, 31, and 395 give Central Oregon an excellent network in every direction, especially between California points and the Pacific Northwest. It is expected that present air service will be augmented to meet modern
transportation needs as they arise. (12, p.5)

C. COMMUNITY CONSIDERATIONS

Available facilities. More than 80% of the farms in Central Oregon are served by electricity.

The towns in central Oregon include Bend, Redmond, Sisters, Prineville, and Madras.

Bend has a present estimated city-zone population of 12,500. It has a high school, junior high school, three grade schools, and two parochial schools. Twenty church denominations are represented, as are most fraternal orders. It has five city parks, paved streets, good hotels, and auto courts, and is the distributing center for Central Oregon. Industries include two large pine sawmills with re-manufacturing plants, a furniture factory, iron works, several toy and juniper novelty manufacturing plants, and fly-tying establishments.

Redmond, with a present estimated population of 2500, has a good union high school and grade schools. The principal church denominations are represented. Here, also, are located a sawmill, box factory and moulding plant, potato shipping facilities, seed-cleaning establishments, two up-to-date turkey packing plants, and various agricultural processing plants.

The Sisters has a population of from 500 to 600. It has a sawmill, and is the distributing point for the
attractive recreational area adjacent.

Prineville is the county seat of Crook county, with a 1940 population of 2,358.

Madras is the county seat of Jefferson county, with a 1940 population of 412. (12, p. 10)

In this region are many beautiful lakes, streams, and rivers, where fishing, boating, and water sports may be enjoyed. In season many a hunter gets his limit of China pheasants, quail, ducks, antelope, and mule deer. The magnificent scenery of volcanic origin provides a never-ending source of enjoyment. (33, p. 67)

Existing values. Jefferson County Agent R. A. Hunt reports that labor at the present time costs approximately $150.00 a month plus room and board.

In the newly-irrigated areas some of the new settlers have used materials from surplus army camps to build their dwellings. The trend of construction in many cases follow the pattern of housing that will later be utilized for a shop or other out-building.

Farm structures observed in this area are mostly of conventional frame construction with a gable roof. Pumice blocks are steadily increasing in popularity, and the favorite method of waterproofing them is with a coat of cement and two coats of Bondex. Some lava rock, either cut or laid up in its irregular shape, is evident throughout the region.
Property values and trends. Mr. Hunt states that property values in this area are of two types: first, that appraised by the Bureau of Reclamation, and second, that which is offered to potential buyers. The cost of the land in the first type is a maximum of $25.00 an acre; in the second type, the same land may be $125.00 an acre. So far, land values seem to be remaining about stationary.

There is considerable government-owned forest and range grazing lands.

In the irrigated areas it is generally considered that sixty acres of irrigated land is about the minimum unit to support a family by products of the usual diversified crops. Smaller acreage will suffice where emphasis is given to turkey, poultry, or seed production. (12, p.4).

Economic significance. According to E. R. Jackson, Extension Specialist in Farm Crops, Oregon State College, the area is outstanding in many crops. Alsike clover seed, its quality bringing the highest prices in Eastern markets, long has competed successfully with inferior seeds having freight advantages. Twenty per cent of the nation's supply of alsike clover is produced here. Potatoes are in much the same category, many farmers producing crops running ninety per cent as No. 1 grade. This area is one of the few that is free from potato
bacteria ring-rot, and potatoes produced here are sought after for seed. Hairy vetch find markets in the South; ladino clover is mostly destined for Northeast pastures. The dairy industry profits by the long period cows can be kept on irrigated pastures, which brings costs down to the lowest in the state. A marketing advantage is that this area, with direct rail connections, is one of the closest irrigated sections to the big California market. The deficit in dairy produce in California, coupled with the lower production costs in this area firmly establish dairy production here on a strong foundation for prospective increased development. Turkey production is also rising to a top place, due to the climate and feed conditions which establish low production costs.

The Jefferson County Chamber of Commerce predicts between 8000 to 13000 will call Jefferson county home when the area is fully developed, and that the yearly return per acre will be in the neighborhood of $80.00.
CHAPTER VI

NATIVE BUILDING MATERIALS

A. ROCK

Igneous rocks. This region is of particular interest because of the abundance of many different types of igneous rocks. According to Cyril S. Fox, an authority on engineering geology, almost any kind of rock can be used for building purposes if it is available in quantities. (17, p. 107) The possibilities of using the rocks in this region for building purposes have been virtually unexplored.

True igneous rocks have several modes of occurrence. If they are extruded from within the earth's crust to the surface, they may quietly overflow the country as lava, or they may be ejected with explosive violence and be blown to pumice and dust (ashes).

Henry Dewey Thompson distinguishes five textures in igneous rocks, which are determined by the rate of cooling of the parent rock. A glassy texture, like a piece of homogeneous glass, results when certain lavas chill so rapidly that no grains are evident. A fine texture results when lavas have cooled somewhat more slowly but still at a fairly rapid state, and crystallization takes place for a relatively short time so that all grains are so small
it is difficult to distinguish them without a microscope. A porphyritic texture results when in some rocks certain minerals grow into large and prominent grains while others remain small and more or less indistinguishable. A coarse texture results when the cooling process is slow, and all grains grow more or less uniformly large in size. A pegmatitic texture results when the lava is kept fluid so long that mineral grains grow to dimensions of several inches or even a few feet.

Igneous rocks are either crystalline, composed of crystals, or amorphous, composed of glass. Three fabrics may be distinguished in each category: crystalline massive, linear and graphic, amorphous compact, vesicular, and fragmental. (37, p.317-318)

Types of igneous rocks found. Many types of igneous rocks are found in this area. Rhyolites of a porphritic or fine texture are plentiful. In the pumiceous rhyolite flow on Rattlesnake Creek, the top of the flow member is red to pink in color as though oxidized while still hot; the base is glassy and gray in color.

Andesites are found of porphyric and fine textures. These are stones with a medium color range. Also found are their light-colored brother, the felsites.

Basalts are the most abundant. It is of fine texture, and in its true form is a dark shade of andesite,
dark gray, dark green, gray-green, yellowish-green, and black. There are basic gray olivine basalts found in which the groundmass is composed of elongated crystals of plagioclase with intervening areas of glass. In the Cori-
ba formation the basalts are black, fine, and even-grained with a vitreous lustre. Here, basaltic columns are of a large diameter at the base of each flow and two to five inches near the top, with right angle breaks frequent near the top.

Present in this area is a tuffaceous sandstone consisting of irregular quartz grains, glass, and pumice shards, fine-grained, massive, and cream-colored. There is also a pebbly buff-colored obsidian which resembles chunks of glass. Some obsidian is olivine in color, and some a startling fresh bottle green, rounded by absorption.

Different types of gravel are found. Some are baked red by their burial beneath molten basalts. Some are wa-
ter-rounded gravels coated with lime caliche.

There are occurrences of sand, cinder, and diatomaceous earth beds. Gabbro of a coarse texture is found in a few places. There are red and black cinders, and indi-
vidual fragments range from one-half inch to five or six inches in diameter.

Tuff is in abundance, and is formed when beds of volcanic ash are water-sorted and consolidated into firm
rock. There are many colors represented: green, maroon, red, yellow, cream, and white. (21)

**Use of rock for construction.** In this area many varieties of lava rock are available in angular fragments easily handled by the average layman. A visit to Peterson's Rock Gardens, a few miles outside of Redmond, will demonstrate what the novice can haul with a small trailer within a short radius. Peterson, a farmer whose hobby is an interest in rocks, has built a virtual fairy-land. Using rocks varying greatly in size and shape, texture, opacity, and color, he has constructed castles, mosaics, fountains, windmills, shrines, bridges, statues, and other panoramic spreads. His pavings, treatment of garden paths, and garden settings provide many ideas for the use of rock in landscaping.

Plates A, B, and C show some construction in this area in which igneous rocks were used, and demonstrate that the fragmental rock need not be trimmed but can be laid up in mortar in its natural form. Various degrees of trimming may be employed, from a slight straightening of the edges to a full dressing. Another scheme is the use of smaller fragments as a facing on a foundation of rubble or concrete. The simplest method is the building of a form and the incorporation of the rock
PLATE A

SCORIA

BASALT
PLATE B

VIEWS FROM PETERSON'S ROCK GARDENS
PLATE C

ANDESITE
in a concrete mix.

**Waterproofing the rock.** According to Cyril S. Fox, the porous or impervious nature of a rock is dependent on the size of the pore spaces. (17, p.47) Several structures in the area are built with scoria, a dark rock full of very large vesicles. The owners claim that not the slightest indication of dampness has been noticed during the most intensive rainfalls. It would appear that construction methods which reduce decay, prevent dampness, and carry effectively away storm water are more important than a waterproofing or preservative treatment.

The most economical waterproofing application is soap and alum. The coating should be renewed every few years. A good commercial preservative should have the following qualifications:

- It must penetrate easily and deeply into the stone and remain there on drying.
- It must not concentrate on the surface so as to form a hard crust, but at the same time must harden sufficiently to resist erosion.
- It must not discolor or in any way alter the natural appearance of the stone.
- It must expand and contract uniformly with the stone so as not to cause flaking.
- It must be non-corrosive and harmless in use.
- It must be economical in material and labor of application.
- It must retain its preservative effect indefinitely.

**Commercial use of volcanic matter for constructional materials.** The manufacture of pumice blocks has
grown to great proportions, and a separate section will be devoted to pumice.

Volcanic tuff has been quarried extensively in the past and used in the construction of most of the larger public and private buildings in the city of Baker. No trouble has been experienced from moisture in the buildings made from the blocks. The rock is soft and easily sawed or cut, but hardens on exposure. From the standpoint of structural strength, it is quite satisfactory, having a crushing strength in access of 300 pounds per square inch. The Luye Corporation in Portland, Oregon is engaged in the manufacture of the volcanic tuff into building blocks. These blocks are cemented firmly together with a thin film of plastic which penetrates into the pores of the blocks. When laid up in a wall, the blocks form a flat, even surface on which paint, plaster, or wallpaper can be applied directly. Many desirable features are possessed by these blocks: they are light, have good thermal insulation, and sound absorption. Minor imperfections caused by handling can be filled with a fast-drying spackle composed of powdered tuff and the plastic bond. The blocks may also be turned on a lathe and shaped easily. They may also be crushed and used for terrazzo floors.
Various companies are experimenting with red and black cinders in concrete blocks. Diatomaceous earth is sometimes used to smooth up mixtures.
B. PUMICE

Description. Pumice is a highly cellular volcanic rock formed in the craters of erupting volcanoes when considerable water vapor and other gases are being released from viscous lava. These gases, expanding as they reach the surface of the molten rock, create a froth which solidifies and breaks and during the explosive eruption is expelled from the crater as pumice. The lava cools so quickly that a non-crystalline or glassy material results. Some crystals are commonly present in pumice, but these result from previously crystallized materials being present or caught up in rapidly solidifying lava. Finer, dust-like particles or pumicite are also ejected from the crater during these eruptions. Pumice may fall a short distance from the crater or be blown by the force of the explosion or by the wind for many miles. (9, p.8)

The older pumice is ordinarily buff or light yellow in color, due to partial oxidation of contained iron. Younger pumice is unaltered, and is generally white to light gray. It also exists in pinks, reds, browns, and black. Its luster varies from a dull, earthy appearance to a bright silk-like sheen.

Availability. There is an almost unlimited quantity of pumice in this region. The volume erupted from Mt. Mazuma alone has been calculated by Howel Williams at
7.5 cubic miles. (42, p.31) When the pumice falls, it also segregates, and big pieces fall close to the vents and smaller ones proportionately away. Thus, the mining and processing of pumice is the essence of simplicity: digging and loading and screening and sizing to one quarter- or three eighths-inch mesh. The pumice is shipped in open railroad cars or trucks, and prices range from $1.25 to $1.85 per cubic yard loaded f.o.b. railroad cars or trucks.

Physical properties. Pumice has such a highly developed cellular structure that it will float in water. Construction blocks using pumice as an aggregate weigh 30% less than the regular concrete blocks of the same size. The light weight facilitates handling on the job and reduces trucking charges. Pumice also has high thermal and acoustic insulation values. The thermal conductivity factor of loose pumice ranges from 0.5 to about 1.0, depending on its apparent density. Comparatively, mineral wool ranges from 0.26 to 0.4, and wood shavings from 0.4 to 0.5. Pumice blocks of low density have a thermal conductivity factor ranging from about 1 to 2. Comparatively, ordinary concrete has a thermal conductivity of 6 to 9 and common brick, from 3 to 6. Pumice used as an aggregate in blocks give the block the ability to hold nails or screws, and ease of cutting or shaping.
It is resistant to fire, and in its natural form makes an attractive wall surface. (9, p.10)

**Pumicite.** Pumicite, sometimes called volcanic ash or volcanic dust, is composed of finely divided, usually angular fragments of glassy material of the same origin as pumice. The finest-grained pumicite passes through a 200- or a 300-mesh sieve. Its use in the building field has been restricted to admixture for concrete, resulting in greater uniformity of concrete. It increases workability, hinders the segregation of other aggregates, and facilitates slipping the forms upward. (9, p.59)

**The manufacture of pumice blocks.** Pumice blocks are enjoying an unprecedented boom as a result of high prices and the scarcity of other building materials. In the Portland area alone there are half a dozen plants which produce approximately 16,000 blocks a day. (29, p.11) Besides the conventional block, the mortarless block, keyed block, and interlocking block are also produced.

**Future possibilities.** The use of pumice and other volcanic matter in the manufacture of building materials is just in its infancy.

Pumice blocks require a coating of waterproofing, which changes its color, texture, and luster. Two investigations were attempted to remedy this, and the reader is referred to Appendix A and Appendix B for the findings.
Much research is needed in the proportioning of the blocks, the grading of the aggregates, and the activities of the aggregates due to vibrating.

Modern building and engineering technology should be employed to develop panels or entire walls in the factory. This walls can be as varied as the variations noted in the volcanic materials, and can employ the natural color or be colored integrally. Modular coordination should be given full consideration in such a development.

C. RAMMED EARTH

The possibilities for the use of rammed earth for farm structures in this area should not be ignored. Rammed earth, or pise de terre, results from tamping moist earth in place between wall forms.

Advantages. Rammed earth has the following advantages. The main material used for construction is obtained right on the site and costs nothing, an important item to be considered in these days of material shortages and high prices. Since the chief cost of the walls is the labor, more enclosed space is obtained for much less money, and the family doesn't need to economize on the floor area. A rammed earth structure is also simple in construction because of its monolithic nature. This simplicity is an asset to modern architecture. Because the
rammed earth structure requires unskilled labor, the family can capitalize on its own spare time. The walls will not sweat, are cool in the summer, are fireproof, and can be made to stand the abuse of time and weather.

History. Rammed earth has a history as old as civilization. The Chinese have used it from time immemorial. Roman structures of rammed earth are still standing, and rammed earth structures are evident in practically every country. In the United States the most appealing example of this kind of construction is the Millard Sheets residence in Claremont, California. Designed by the artist, it takes its place with the best in good modern architecture.

There are many articles on rammed earth structures in architectural magazines. Much research in this field has been done by experiment stations at the University of Kansas, University of Minnesota, University of Illinois, University of California, and South Dakota. There are publications by the Bureau of Standards, American Society for Testing Materials, U. S. Public Roads Administration, and the Bureau of Chemistry and Soils. Two commercial concerns, the Portland Cement Association and the American Bitumals Association, have worked on making rammed earth harder, more water-resistant, and more free from volumetric changes of shrinkage and swelling.

Composition of soil. Soil consists of fine granular
particles called gravel or sand interspersed with silt and clay. Almost any type of soil can be used in rammed earth structures, providing it contains between 30% to 75% of sand and gravel; 75% is considered ideal. As the percentage of 200-mesh material increases, shrinkage and swelling increases; below 30% it is negligible. (30, p.8) However, a defective soil can be used by adjusting the various elements.

The water absorbed by the clay and fine particles create cracks upon freezing or drying. In the past the solution to this problem has been the use of various exterior coats of waterproofing.

**Soil stabilization.** The research of the Portland Cement Association, started in 1934, is based on the stabilization of the soil with the addition of about 8% of cement, thus reducing the swelling character of the component clays. The research of the American Bitumals Association is concerned with the development of an asphaltic emulsion, which surrounds the clay particles and cuts them off from moisture changes. From 20% to 30% of the 200-mesh content is the quantity recommended to be added to the soil.

The addition of cement is preferred, because it preserves the natural color and character of the soil and is easier to mix. The asphaltic emulsion creates a dark-
Puddled earth. The rate of heat transfers of rammed earth walls are the same as for ordinary concrete of the same thickness. The K factor increases with the increase of density. (43, p.3) Various solutions have been tried to obtain an earth wall with better insulation value. Among them are the puddled earth wall and the soft-center wall.

The puddled earth wall has possibilities. Besides increasing the insulation value it eliminates the labor of ramming, thus reducing the construction to the operations of mixing and pouring. However, cracks are common in this kind of wall, and more research is needed to make it desirable.

Rammed earth structures are a solution for families who have more available labor than income to acquire needed buildings at an earlier date.
Prefabrication systems are of the following basic types: pre-cut lumber, concrete formed in situ, pre-cast unit, metal frame, panel, unitary, suspension, and cantilever.

Significance. Prefabrication in farm structures should secure more economical and better farm buildings. By simplifying and organizing standard construction into a system based on larger units the elimination of many operations will enable unskilled farm labor to put the buildings together at a minimum labor cost. Mass production encourages better engineering and selection of material. Further economy results with the elimination of site fabrication and the resulting material wastes, and the maximum space is obtained with the least material.

Materials and designs can be such that fire and wind resistance are built into the building. Insulation where needed can be included in the fabricated units, as well as considerations for lighting, ventilation, and heating. The module or standardized unit used in the system would create buildings which present a pleasing appearance through the repetition of certain measures and structural elements. The buildings would be flexible, with the addition or elimination of standard units easily accomplished.
A standard module for farm structures. In the selection of a standard module for farm structures, a 3'-4" unit would seem feasible. Table I compares the module with some common dimensions in farm structures and the house.

Prefabrication schemes for this area. The fabrication of entire walls on the site might be a feasible means of reducing labor in this area. Concrete walls would be the most logical, with the prevalence of pumice, volcanic ash, diatomaceous earth, and lava rock indicating interesting aggregates.

Two unique methods have been developed for pouring the wall in a horizontal position in metal forms and raising it to a vertical position after it has cured. They are the Tyrocrete method and the Wilson method.

Pouring the concrete wall in a horizontal position has many advantages. It saves the labor of erecting conventional wood forms and pouring from a height. The metal form can be used for many walls, and since the concrete settles evenly, the form consists of just one side. Bolts to tie in floors and roofs can be set in the walls, and openings for doors and windows can be placed. Electrical conduits and outlets, nailing or furring strips, dowels, bolts, or steel pins can be cast in the desired places. Ornamental rocks of any design can be placed in position, and the concrete can be smoothed by hand, providing
## Table 1

**COMPARISON OF COMMON DIMENSIONS AND STANDARD UNIT**

### Farm Structures:

<table>
<thead>
<tr>
<th>Item</th>
<th>Usual Variation</th>
<th>Standard Dim.</th>
<th>40&quot; Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior wall</td>
<td>8&quot;--14&quot;</td>
<td>10&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Dairy stall</td>
<td>3'-2&quot;--4'-0&quot;</td>
<td>3'-4&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Cross passage</td>
<td>&quot; &quot; &quot;</td>
<td>&quot; &quot;</td>
<td>1</td>
</tr>
<tr>
<td>Stairs</td>
<td>&quot; &quot; &quot;</td>
<td>&quot; &quot;</td>
<td>1</td>
</tr>
<tr>
<td>Single horse stall</td>
<td>5'-0&quot;</td>
<td>5'-0&quot;</td>
<td>1½</td>
</tr>
<tr>
<td>Double horse stall</td>
<td>8'-6&quot;--10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>3</td>
</tr>
<tr>
<td>Single box pen</td>
<td>10'-0&quot;</td>
<td>&quot; &quot;</td>
<td>3</td>
</tr>
<tr>
<td>Cattle pen</td>
<td>Variable</td>
<td>&quot; &quot;</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>6'-8&quot;</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>10'-0&quot;</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>13'-4&quot;</td>
<td>4</td>
</tr>
<tr>
<td>Equipment storage</td>
<td>Variable</td>
<td>&quot; &quot;</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>6'-8&quot;</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>10'-0&quot;</td>
<td>3</td>
</tr>
</tbody>
</table>

### House:

<table>
<thead>
<tr>
<th>Item</th>
<th>Measurement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double bed</td>
<td>6'-8&quot; x 4'-6&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Single bed</td>
<td>6'-8&quot; x 3'-3&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Tub, bath</td>
<td>5'-0&quot; x 2'-6&quot;</td>
<td>1½</td>
</tr>
<tr>
<td>Ironing board, extended</td>
<td>5'-0&quot; x 1'-4&quot;</td>
<td>1½</td>
</tr>
<tr>
<td>Fireplace</td>
<td>5'-0&quot; x 2'-6&quot;</td>
<td>1½</td>
</tr>
<tr>
<td>Lounge chair</td>
<td>2'-6&quot; x 2'-6&quot;</td>
<td>3/4</td>
</tr>
<tr>
<td>Meal table</td>
<td>3'-4&quot; x 4'-2&quot;</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3'-4&quot; x 6'-3&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Sink</td>
<td>2'-6&quot; x 2'-0&quot;</td>
<td>3/4</td>
</tr>
<tr>
<td>Crib</td>
<td>2'-6&quot; x 4'-6&quot;</td>
<td>3/4</td>
</tr>
<tr>
<td>Work table in basement</td>
<td>5'-0&quot; x 2'-3&quot;</td>
<td>1½</td>
</tr>
<tr>
<td>Door and window height</td>
<td>6'-8&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Construction width for door</td>
<td>3'-4&quot;</td>
<td>1</td>
</tr>
</tbody>
</table>
opportunity for any desired texture or treatment.

Tyrocrete method. The Tyrocrete method is unique in that it entails the pouring of the walls in a flat horizontal position in simple open forms laid on top of steel rockers. These are unbalanced by the weight of the concrete so that gravity pulls each wall into position.

The first step is the setting up of the forms for the footing and the floor. The footing has a trough slightly wider than the wall, set with metal shims. When the wall's foot rocks into the trough, the shims support it so that a narrow opening is left between the wall and the footing. This opening is filled with caulking and covered with cement when the wall is rocked into place.

A concrete floor is laid with reinforcements so it can support the rockers. The rockers must be accurately set so that the wall lands on the base. The metal wall form, which is ribbed every two feet, is bolted flat across the rockers and covered with oil to keep it from sticking to the concrete. Reinforcing mesh is set in place on top of the form and the concrete is poured. After curing the tackle which kept the rockers horizontal is loosened and gravity pulls the wall over to the vertical. One man can control the operation, which takes about a minute. Once upright the bolts attaching the wall to the form are loosened and gravity will go to work again, pulling the rockers back to horizontal. The rockers
are swung to the correct position at right angles to the first wall, and the next wall is ready to be rocked into place. (22, p. 115--117)

**Wilson system of prefabrication.** In this system the form is composed of a bottomless pan and portable, interchangeable, reusable, and collapsible elements which resemble steel channels and have bolt holes at regular intervals. This form can be used in the production of solid and ribbed sections, walls, floors, and roofs, which may be of any desired thickness. The form can be raised after the concrete has set by block and tackle, crane, or other methods.

**Community use of the systems.** Either of these systems can be bought and used economically by an entire community. Besides concrete walls of various mixes, with aggregates of igneous matter, perhaps earth walls can also use the system. With the reduction in labor and cost of materials, many a building program may be realized at a much earlier date.
CHAPTER VIII

THE COOPERATOR'S FARM

Location, boundaries, and roads. The legal location of the farm is the Southeast quarter of Section 21, Township 13 South, Range 13 East, Willamette Base and Meridian. The farm is a half mile square, or 160 acres, plus an additional five acres of unirrigated land across the east road to be acquired in the near future.

The farm proper is bounded on the north and west by all-weather roads. The south road joins U. S. Highway 97, a half mile from the western boundary of the farm. Since there is small chance that the adjoining farm will use it, this road may be considered a private road.

Climatic considerations. The climatic conditions affecting this farm are tabulated in Table 2.

Topography. The farm has a 1.97% slope to the west, dropping 52 feet in 2,640 feet. The highest area is along the east road, between one-hundred and three hundred feet north of the center of the farm.

View. The farm is favored with an inspiring panoramic view of mountain peaks on the western horizon: Three-Fingered Jack, Mount Washington, Three Sisters, Broken Top, and Bachelor.

Soil. At present, there are no soil maps of this area available. According to Jefferson County Agent Hunt, the
### Table 2

Climatic summary for Redmond, length of record, 23 years.

(40, p. 75-82)

<table>
<thead>
<tr>
<th>Temperature, deg. F</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual mean 48.0</td>
<td></td>
</tr>
<tr>
<td>Highest 99</td>
<td>Jl. 20</td>
</tr>
<tr>
<td>Lowest -2</td>
<td>Dec. 30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Precipitation, in.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total for yr. 6.80</td>
<td></td>
</tr>
<tr>
<td>Greatest mo. 1.15</td>
<td>Mo. Jan.</td>
</tr>
<tr>
<td>Least mo. 0.06</td>
<td>Mo. Jl.</td>
</tr>
<tr>
<td>Total snowfall 3.5</td>
<td></td>
</tr>
<tr>
<td>No. of rainy days: 56</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sky, No. of days:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear 197</td>
<td></td>
</tr>
<tr>
<td>Partly cloudy 122</td>
<td></td>
</tr>
<tr>
<td>Cloudy 46</td>
<td></td>
</tr>
</tbody>
</table>

Winds:

Prevailing direction of wind, northwest.

A record of the directions of the winds for Redmond over a period of ten years can be summarized as follows:

<table>
<thead>
<tr>
<th>Direction</th>
<th>No. Months</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>2</td>
<td>Jan.</td>
</tr>
<tr>
<td>W</td>
<td>16</td>
<td>All year</td>
</tr>
<tr>
<td>NW</td>
<td>78</td>
<td>All year</td>
</tr>
</tbody>
</table>
soil is sandy to silt loam, with soil analysis showing a relatively high amount of potash, a moderate amount of phosphate, and a quite low amount of available nitrates. Likewise, available sulphur is low. The depth varies up to sixty feet. The capacity of the land should support two to three head per acre during the summer months.

_Crop history._ The land has been in wheat and summer fallow alternately for ten years before acquisition by the cooperator. Last year the cooperator had 120 acres in alfalfa, oats, and barley, and a few acres in peas. The pea crop was a failure due to low fertility and fungus. This year the entire land is in alfalfa, oats, and barley.

_Reclamation problems._ According to Hunt, the organic content of the soil or at least the nitrate content of the soil must be raised considerable in order to produce row crops. This can best be done by the growing of legume crops, including alfalfa or clovers. These legumes would require an application of sulphur best applied in the fall season at the rate of approximately 100 pounds per acre, which would be a sufficient quantity to last probably three years. There are no other reclamation problems on the farm.

_Planting._ There is no natural planting or orchard on the farm. A small flower garden was started this year
next to the house.

Water. This farm is one of many in the area made irrigable by the Deschutes Project. Water for home and other farm use is furnished by a deep well with a jet pump operated by a two horsepower motor at a rate of from 600 to 700 gallons per hour. The well is situated 80 feet north of the center of the farm and approximately 25 feet from the east road.

Services. Electricity is available at 110 and 220 volts. The transformer is across the east road from the middle of the farm. Gasoline and oil is delivered from Madras and Redmond. Heating can be with oil, electricity, or slack coal and stoker. There is no mail delivery or telephone service.

Transportation and marketing facilities. Immediate transportation facilities include U.S. Highway 97, located half a mile from the farm, and a railroad siding at Opal City three miles away.

Redmond is 11 miles south on U.S. Highway 97; Bend is 16 miles beyond Redmond; Madras, the County Seat, is 18 miles to the north. With the completion of the road through Warm Springs, the distance to Portland from the cooperator's farm will be less than 130 miles.

Community facilities. Community facilities in the
immediate vicinity of the farm are not evident. Virtually no recreational activities are available, and children must attend school either in Culver or Terrebone. There are no religious, political, or cultural organizations in the area. The cooperator goes to Redmond for his social contacts and entertainment.

**Equipment and livestock.** The cooperator's equipment consists of a BN Farmall cultivation tractor, 1941, an Oliver 70 heavy tractor, 1946, a Dodge truck, 1942, flat-bed with rack, a Chrysler sedan car, 1941, a grain drill, a combine, a pick-up-hay-chopper, a disc and harrow, and a cultivator.

His present livestock consists of three bulls, two of which are boarded out, two cows, four yearlings, and three calves.

**Existing structures.** The farmstead at present consists of temporary structures. The house and pump house were erected using small units from an army rifle range formerly located just east of the farm. Temporary shelter for the livestock and for hay storage are of rough frame construction. Various equipment, machinery, and odds and ends are placed in the open behind the house and pump house. (See Plate D)

Since the layout is temporary, the chore route has no logic.
PLATE D

COOPERATOR'S FARM
(Looking west)

EXISTING STRUCTURES
The cooperator. The cooperator is quite prominent socially in his community. An indication of his personal abilities might be the fact that he was elected president of the Central Oregon Potato Growers Association and served in that capacity during its first trying year. He is an alumnus of the University of Oregon, holding a Bachelor in Business Administration and a Doctor of Jurisprudence in law. He practiced law for eight years at Nyssa, Oregon.

His entertaining consists of tea or dinner for two or three couples and occasional class reunions. His hobbies include wood finishing and amateur photography. He likes swimming, hunting, and fishing. He does plenty of reading and likes good music.

Future plans. Following a three or four year period of building up the soil the cooperator plans the organization of his farm thus: 40 acres of hay, 40 acres of grain, 30 acres of potatoes, 40 acres of clover seed, ½ acre of orchard and garden, a dairy herd of 20 to 25 cows, and a few chickens for his own use. He plans to keep one bull only on his farm.

He plans to solve his labor problems by acquiring a permanent tenant and by hiring temporary farm labor during busy seasons.
CHAPTER IX

BUILDING REQUIREMENTS

Storage requirements. The maximum storage requirements anticipated for the crops to be produced are as follows:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Acres</th>
<th>Max. yield per acre</th>
<th>total yield</th>
<th>lb./cu.ft.</th>
<th>total vol. cu. ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>hay</td>
<td>40</td>
<td>5--6 tons</td>
<td>240 tons</td>
<td>13</td>
<td>369,000</td>
</tr>
<tr>
<td>grain</td>
<td>40</td>
<td>40 bu.</td>
<td>1600 bu.</td>
<td>50</td>
<td>2,000</td>
</tr>
<tr>
<td>clover seed</td>
<td>40</td>
<td>6 bu.</td>
<td>240 bu.</td>
<td>48</td>
<td>300</td>
</tr>
<tr>
<td>potatoes</td>
<td>30</td>
<td>300 bu.</td>
<td>9000 bu.</td>
<td>48</td>
<td>11,250</td>
</tr>
</tbody>
</table>

The requirements of the farm machinery to be housed are as follows: (16, p. 284)

<table>
<thead>
<tr>
<th>Kind</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc and harrow</td>
<td>8'-0&quot; x 4'-0&quot; or 10'-0&quot; x 7'-0&quot;</td>
</tr>
<tr>
<td>Tractor</td>
<td>7'-0&quot; x 12'-0&quot;</td>
</tr>
<tr>
<td>Tractor</td>
<td></td>
</tr>
<tr>
<td>Cultivator</td>
<td>7'-0&quot; x 7'-0&quot;</td>
</tr>
<tr>
<td>Truck</td>
<td>3'-0&quot; x 26'-0&quot;</td>
</tr>
<tr>
<td>Grain drill</td>
<td>5'-0&quot; x 10'-0&quot;</td>
</tr>
<tr>
<td>Pick-up-hay-chopper ensilage cutter</td>
<td>7'-0&quot; x 14'-0&quot;</td>
</tr>
<tr>
<td>wagon</td>
<td>7'-0&quot; x 12'-0&quot;</td>
</tr>
<tr>
<td>combine</td>
<td>10'-0&quot; x 14'-0&quot;</td>
</tr>
<tr>
<td>manure spreader</td>
<td>16'-0&quot; x 7'-0&quot;</td>
</tr>
<tr>
<td>potato digger</td>
<td></td>
</tr>
<tr>
<td>potato digger</td>
<td></td>
</tr>
</tbody>
</table>

The requirements for feed and bedding for the 25 cows are:
<table>
<thead>
<tr>
<th></th>
<th>lbs./cow per yr.</th>
<th>lbs./25 cows per yr.</th>
<th>vol./cu.ft.</th>
<th>total vol. cu. ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>hay</td>
<td>7428</td>
<td>185,500</td>
<td>13</td>
<td>143,300</td>
</tr>
<tr>
<td>grain</td>
<td>2000</td>
<td>50,000</td>
<td>50</td>
<td>1,000</td>
</tr>
<tr>
<td>bedding</td>
<td>6000</td>
<td>150,000</td>
<td>10</td>
<td>15,000</td>
</tr>
</tbody>
</table>

**Building requirements for hay storage.** Taking into consideration the many months of available pasturage in this area and the infrequency of inclement weather, the housing of hay needs only a roof and such walls as are needed to shelter it from rain and winds. It was decided to provide storage for the 143,300 cu. ft. of hay required annually for the feeding of the 25 cows adjacent to the lounging shed and to store the excess hay in another area to reduce the fire hazard.

**Building requirements for grain and clover seed storage.** The requirements for grain and clover seed storage are much the same. There should be a convenient and economical way of loading and unloading the grain and clover seed. The structure should be insulated to prevent the too rapid lowering of the inside air and the temperature of the product next to the bin walls and roofs. There should be a means of removing the excess heat and moisture. Condensation against the walls should be taken care of. The building should be capable of resisting internal stress due to storage. The structure should permit effective fumigation for the destruction of insects. It
should be conveniently located in respect to the movement of trucks or wagons. The floors should be tight, smooth, and impervious, and the entire structure should be waterproof.

**Building requirements for potato storage.** The potatoes should be stored at 60 deg. F. for the first ten days, 45 deg. to 40 deg. for the first three to four months, and 38 deg. and 40 deg. at the end of that period. (36, p.2)

The temperature along the walls should be kept from falling much below the average house temperature. There should be adequate insulation and air circulation to protect against freezing and to equalize temperatures as much as possible. There should be openings to remove the heat and to provide for a circulation cycle along the walls. These ventilators should be protected from the weather and should be operated from the outside. The maintenance of desirable humidities should be accomplished with a minimum amount of attention.

The potatoes should be warmed before shipping to reduce injuries, so a means for heating the potatoes should be provided. The house should be wired for electricity, and all natural light should be excluded.

Small bins are preferred, with the use of ventilated shafts at intervals. The potatoes should be conveniently
and removed with the minimum number of handling operations and a minimum number of bruises. The structure should be durable and should provide for the maintenance of desirable storage conditions with a minimum of attention. (13, p. 4)

**Requirements for poultry housing.** The temperature should not exceed 85 deg. F. or fall below 32 deg. The relative humidity should be kept to some point below 50%. There should be provision for control of the air movement in the three situations to be provided for: roosting, feeding or exercising, and the nesting of the hens. (46, p. 87-89)

**Requirements for the dairy herd.** Weather and temperature have little effect on total milk production, and calves thrive in a cold barn as well as a warm barn. There should be easy access to a plentiful supply of feed and water at all times. (45, p. 83)

The advantages of the lounging shed and milking parlor, where adequate bedding is available, over the conventional stanchion dairy barn are: it is more economical to operate; it costs less to build; it provides for greater flexibility, improved sanitation, better working conditions, preservation and simplified handling of manure, greater comfort for the cows, less sore feet, reduced teat, hock, and knee injuries, and easily detected heat periods. (4, p. 6)
The lounging shed should provide at least fifty square feet per cow (46, p. 82), and the exercise yard at least one hundred square feet per cow. The heated water tank for twenty-five cows should be five feet by six feet. The central feeding alley should be between five and six feet wide, the driveway for wagon or spreader eight feet wide, all doors for the passage of livestock four feet wide, and all doors eight feet high. (16, p. 193) A twelve per cent ramp is preferred, with a fifteen per cent ramp the maximum allowable. There should be at least four square feet of glass per cow. (46, p. 67)

A calf pen ten feet by ten feet accommodates five calves. The feeding space for each calf should be from twenty to twenty-four inches. (16, p. 209) Full grown animals require from two and one-half to three feet of manger length. (46, p. 84) A single box pen is ten feet by ten feet. There should be one maternity pen for each twelve to fifteen cows. A bull pen should be sixteen feet by twenty-four feet, and the exercise yard sixty-eight feet by twenty-one feet. (16, p. 222)

The feed room should be adjacent to the milking parlor and directly opposite the end of the feed alley so that the feed cart may be run directly from the feed room to the mangers. A solid door should be between the milking
parlor and the feed room for elimination of feed dust in the milk room. Feeds should be unloaded directly into the feed room through an outside door or chute.

The feed room should provide for the storage of calf meal, powdered skim milk for the calves, and a supply of salt. There should be bins for at least two weeks' supply of ground feed. There should be space for the storage of feed carts and for equipment for grinding and mixing feed. There should be a special cabinet for medicines and instruments. (47, p. 290)

The breeding stall should be located adjacent to the bull pen. There should be a stock for trimming hoofs, de-horning, and examinations.

The milk house should be separated from the milking parlor by two self-closing doors which are far enough apart so both are never open at the same. For further regulations, see Oregon State Department of Agriculture Pamphlet No. 50, Oregon Laws Relating to Grades and Standards of Quality for Fluid Milk and Cream and Licensing of Dairies. (32)

The wash room should be adjacent to the milking parlor to insure frequent use.

Requirements for housing the farm family. The same principles that govern the planning of a city home apply to the planning of a farmhouse, with the following exceptions.
The kitchen must be adequate not only for the preparation of meals but also for the processing of much of the family's food supply. Since the homemaker is in the kitchen most of the time, it is necessary that she has a good view from her kitchen window, including an outlook towards the farm buildings, children's play area, and the road. Since a great amount of food processing is done, it is desirable to locate the kitchen in the north or northeast corner to offer the maximum protection from the heat of the sun.

There must be adequate storage for processed foods, purchased bulk foods, and fresh garden produce. Other storage facilities should be generous.

An ample work porch or utility room is needed to provide for laundry facilities, a place to work with meat, and a place for the men to wash up and to hang their work clothes.

There should be an area for the farm office easily accessible from the service entrance. The bathroom and bed rooms should be directly accessible from the kitchen or work porch. The living room should be large to accommodate social activities of visiting families and gatherings of church or social club members. The dining area should be capable of taking care of large groups. Since the average farm family is composed of five to six persons, three bedrooms is a necessity.

Special considerations should be given to the
recreational facilities, the hobbies of the farm family, and the outdoor areas. An important requirement is the provision for adequate accommodations for the farm help needed.

The following considerations for housing were noted by Maud Wilson, Agricultural Experiment Station Home Economist and Professor in Charge of Home Economics Research at Oregon State College, on a field trip to Deschutes and Jefferson Counties on June 14 and 15, 1946. During that period twenty-four women were interviewed. These rural women were living in a section adjoining the area to be irrigated and were asked what their advice would be to homemakers who were just getting established in the new area. The following comments were made:

1. A hard-surfaced walk is important.
2. Dust is a problem at all seasons.
3. Floors should be finished to withstand gritty dust. Rugs are used in the winter and taken up in the summer when men bring in so much dust.
4. Fireplaces are a favorite luxury.
5. There are few hot nights; cold is more of a problem than hot weather, and heat is often needed summer mornings. Heat is needed most of the days, either A.M. or P.M.
6. Electricity is quite cheap.
7. Eating in the dining room is desired.
8. Basements are favored.
9. Concerning the type of house, women were divided as to one story or not; one and a half was considered all right if the roof was insulated; one story with basement seemed the most practical.
10. Insulation is very important.
11. Water is secured from irrigation ditches and run into storage tanks; water is a problem for landscaping.
12. A utility room is desired which is permanently enclosed and heated. It should include the laundry facilities and a place for men's work clothes.
13. Shelter for the car is desired, preferably attached to the house.

Requirements for housing the farm help. The same considerations which enter into the planning of the farm home should be considered in the planning of the permanent tenant's house. Adequate accommodations insure the presence and cooperation of the permanent tenant during the seasons he is most needed.

Housing for the temporary labor needs only to provide for the barest essentials for protection against the weather, the preparation of food, eating, and sleeping. Water and toilet facilities should be conveniently located.
CHAPTER X

DISCUSSION OF THE PROPOSED PLAN

Farmstead site. The farmstead site chosen is located just north of the center of the farm and borders the east road.

This location was determined by several factors. It is on the highest spot on the farm and slopes in several directions, allowing for drainage about the farmstead and insuring dry floors, paths, and driveways. Refreshing and prevailing winds are secured with no obstructions. There is complete visibility over the entire farm, the buttes to the east and southeast, and the panoramic west horizon. There is ease of expansion to the north and west.

The well is in this area, and the transformer is directly across the east road. Being adjacent to the east road and to the central lane, there is convenient access to town and to the fields.

Arrangement of the fields. One-half acre of garden and orchard was located in a corner bordered by the east road and the central lane to provide a buffer from the noise and dust from these roads. The orchard also acts as a break for the cold southwest winds.

The crop acreage will be forty acres of alfalfa, forty acres of grain, forty acres of clover seed, and thirty acres of potatoes. The boundaries of the fields
are dictated by the irrigation system. A four-year rotation with pasturage is suggested, and the number of fields should be equal to a multiple of four.

Orientation and relationship of the buildings. The orientation of the buildings and their relationship to each other was determined by the direction of the winds and the magnificent panoramic view of snow-capped mountains on the western horizon. They were also influenced by reduction of the chore route, reduction of the fire hazard, and proximity to the road.

The prevailing winds are northwest, with winter winds south and southwest and occasionally southeast, and some west winds throughout the year. Thus, the lounging shed and exercise yard were placed to the north of the cooperator's residence, and the permanent tenant house was placed out of line of the prevailing winds to avoid the odors to these quarters. The hay and bedding were placed to the north to provide protection for the lounging shed and to prevent dust from these sources from blowing into the dairy section, the dwellings, or the machine shop. The excess hay storage was located across the east road to prevent dust contamination and to minimize the fire hazard. The lounging shed and machine shed open to the east to afford protection from dust from the prevailing winds and the cold winter winds. The potato storage house was located across the east road and to the north to avoid dust contamination.
The snow-capped mountains on the west horizon are so inspiring that all living quarters were faced west. In the cooperator's residence and the permanent tenant house the living areas also have southern exposures; most of the bedrooms open to the south.

The dairy buildings were placed 120 feet from the cooperator's residence to avoid objectionable odors and flies and in a position to be visible from the kitchen windows of both residences. The tenant house and the cooperator's residence were placed fifty feet from the east road to avoid dust and noise from the road.

The temporary labor housing was placed as a separate unit in the southeast corner of the five acres across the east road, thus providing for the maximum privacy and the least interference for the use of the rest of the land. In this location the temporary labor housing can be used conveniently as dressing rooms when the main canal is used by the farm family for swimming. With the location of the tennis court and outdoor toilet facilities here, this area becomes the outdoor recreational center for the farm family.

The excess hay storage was located along the east road for ease in loading and unloading. It was placed ninety feet from the required hay storage to minimize the fire hazard.

The milk room was placed in the southeast corner of the dairy unit for ease of access. The wash room is located
conveniently in relation to the milk room, milking parlor, and feed room, and readily accessible from the farm court. The pens face west for direct access to pastures; also, the bull can keep in view cows in pasture, and thus keep in good humor. The breeding chute, which can also be used for an examination stock, is adjacent to the bull pen and the corral.

The machine shed was located so the machine shop is close to the cooperator's kitchen door and so the interior is visible from the kitchen window. The poultry house was placed adjacent to the kitchen door with a south orientation. Grain and clover seed storage were conveniently located for loading and unloading from the farm court.

All buildings, lots, septic tanks, and outdoor toilets were located so there would be no seepage to the well.

Central court and transportation arteries. The central court is of stabilized earth, and was a natural evolution in the process of locating and orienting the buildings.

The east road, an "all-weather" road, opens into the central court and connects with the south road and with U.S. Highway 97 to the west.

There is a twenty foot apron behind the machine shed for driving through farm machinery. The drive and walk to the temporary labor area is 10'-0" wide and is of
stabilized earth. The parking area is 37'-0" x 60'-0"
and is also of stabilized earth. The walk to the coop-
erator’s house is 13'-0" wide, and the walk to the tenant
house is 6'-0" wide; both are of slabs of lava rock.
The drive to the required hay and bedding storage is
12'-0" wide, and the cow lane is 18'-0" wide; both are
dirt lanes. The road to the potato storage is an ex-
isting dirt road. All fields are entered from the cen-
tral lane, which is 18'-0" wide. Equipped with cattle
guards on the left side, it serves as a machinery lane
and cow lane combined. Electric fences are used for
rotation pastures.

Landscape, garden, orchard, windbreaks. In order
to provide a setting indigenous to the region, the use
of juniper, sagebrush, and native rocks are suggested
in the development of the outdoor areas of both the
cooperator’s residence and the permanent tenant house.
There are garden areas in the outdoor living areas of
both residences. In regard to the cooperator’s residence,
the flower garden is adjacent to the back door and is
visible from the dining and living areas. The garden
and orchard are planted bordering the east road and the
central lane to protect the cooperator’s residence from
dust and noise.
The orchard acts as a break for the cold winter winds. The machine shed and the dairy unit also act as windbreaks. (See Plate 1.) The outdoor area of the permanent tenant house is enclosed by a board fence. The outdoor areas of the cooperator's residence is sheltered by a rock wall laid without mortar; the bedroom private areas are enclosed by a flexible split cedar fence woven with heavy copper wire and prefabricated in eight foot rolls. (See Plates 5 and 6.)
CHAPTER XI

STRUCTURAL SYSTEM

Requirements. The main requirements of the structural system is for maximum flexibility and for economy of material and labor.

Flexibility is important so the farmer can increase the size of his buildings easily when the need arises and when it is economically possible for him to do so. It is also necessary for adaptation to changes due to changes in enterprises or in ownership as well as those due to the development of new technology.

The proposed system. The construction system chosen is based on the simple post and beam, with 12'-0" bents, and a flat roof. This system permits expansion in all directions horizontally with ease. Inside partitions are independent of the supports and can thus be easily moved. All structures are one story with no basement.

Improved means of insulation, of drainage, and of waterproofing now make the flat roof quite practical in almost every climate, and its use means a saving in material, more logical use of interior and exterior, and lower cost. (3, p.28) Flat roofs offer real rooms in the attic, greater facility in alterations or additions, sunny, airy recreation space, roof gardens, view of airways, and the
riddance of dead angles and fire risks of inclined roof structures. (3, p. 256) 25% of the total floor area in
the hip roof type may be considered available for storage, while in the gable roof type only 50% is available. (3,
p. 318)

**Structural components.** Posts are 4" x 4", placed 12'-0" on center. The foundations consist of concrete
piers under the posts. Beams are 4" x 12"; rafters are 2" x 6" and 16" on center.

**Floor.** A 4" Comfort-concrete Floor is suggested for
the floors to be laid in the living quarters, the machine
shop, and parts of the dairy unit.

The Comfort-concrete Floor, which was developed by
the John B. Pierce Foundation, consists of a combination
of portland cement, asphalt, and aggregates. The advan-
tages of this floor are: it absorbs ninety per cent of
the energy of impact, is not subject to the same inden-
tation as flooring with primary asphalt binders, does
not shatter under blows delivered to the surface as readily
as regular concrete under stress, is warmer to the touch,
with ten per cent less thermal conductivity, has a wear
resistance equivalent to that of hard maple, is easy to
clean, economical, and is unaffected by animal acids and
cleaning materials. (24)
Pumice is recommended as a base for the floor because it is so readily available in this area and provides extra insulation. However, the use of pumice aggregates in the concrete floor itself is not recommended because of its lack of wear resistance.

The concrete floor may be treated in many ways: it may be stained integrally with a metal oxide and polished to a high finish; it may be given a surface finish of terrazzo or plastic magnesium; or it may be laid with a wood floor in certain areas for variety. Native rock may be inserted for interest.

Exterior walls. At the present time pumice blocks are the most available material. A mason can lay an average of three hundred blocks a day on a straight wall. Thus, it is recommended for the cooperator's farmstead.

Although the use of Bondex with an undercoat of cement is very satisfactory and popular in this area, it is not recommended because it hides the natural color, luster, and texture of the block and is dishonest, making a monolithic structure out of block construction. The use of a transparent waterproofing compound, Hydrotex, is recommended. As shown in Appendix A, it compares favorably with other waterproofing compounds. If it is desirable to change the color of the block, this may be
accomplished by staining the block. The interior surface of the block needs no waterproofing, and in its natural state contrasts well with wood or the other materials used in interior partitions.

Joints. In regard to joints, the following information was obtained from Building Materials and Structures Report, BMS 7. (15)

A satisfactory mortar results from a $1:0.25:3$ by volume or a $1:0.011:2.6$ by dry weight of cement, lime and sand.

The workmanship of the joints is the most important factor. Mortar bed joints should be spread to a uniform thickness and not furrowed. The cross or head joint should be filled by applying mortar to the ends of stretchers, and after laying the brick in each course the filling of cross joints should be completed by working in the mortar from above. The face joints should be tooled by using a round metal bar of a diameter slightly larger than the thickness of the joint to pack the mortar, forming a hard surface. The junction of the vertical and horizontal joints should be watched, as $73\%$ of the leaks occur here.

The block should be wetted to limit absorption to a maximum of 50 grams to reduce the suction of the block before laying in mortar; the less absorption the less permeability.

If faulty joints develop, the following procedure is
the most effective. Wet the wall surfaces and mix by weight 40% high-early-strength cement, 15% powdered flint, 96% passing a No. 200 sieve, 45% sand passing a No. 30 sieve. Apply to the joints with a typewriter brush. Clean blocks with a sponge and cure by wetting daily for a week.

**Fireplace wall.** The very colorful rock so abundant in the area affords an interesting combination with the pumice blocks and is suggested for the fireplace wall in the cooperator's residence. The wall should be at least 16" thick, and the top of the concrete foundation wall just under the first course of stone should be waterproofed with a heavy coat of hot asphalt or damp-proof paint to prevent moisture in foundation walls from being drawn up into the stonework and staining due to the elements contained in the soil. For waterproofing of the rock, see Chapter VI.

**Interior walls.** The interior walls in the dairy unit are of pumice blocks and waterproofed on both sides. Pumice blocks are also used for interior walls in the temporary labor housing for more complete separation between the units.

In the cooperator's residence pumice blocks are used to separate the utility room from the rest of the house. The wall separating the living room from the master
bedroom in the cooperator's residence is of volcanic rock.

Interior partitions. All other interior walls in the cooperator's residence and the permanent labor house house are non-bearing and can be varied in position and substance depending upon aesthetics or changes in space needs.

Interior partitions may have curved, straight, or slanting surfaces and be of any texture which creates a harmonious relationship with the rest of the elements. Movable wardrobe and other closets form ideal partitions between bedrooms and other areas. Other possibilities for interior partitions are: corrugated metal or wire-glass, a hanging reed screen, plywood walls and all its variations, Modernfold-door partitions, sliding or folding screens or doors, interlaced vividly-colored metal rods, glass blocks laid up with wooden strips, built-in furniture, flexible wood-screen, mirrored partitions, curtain partitions, open wood partitions, folding and sliding partition of woven thin wood slats on a curved ceiling track, frosted glass or translucent glass or plastic, and combinations of different materials.

Doors and windows. A disadvantage in using pumice blocks is that dimensions have not yet been integrated in the building industry and as a result doors and windows are hard to fit into the size of opening dictated by the size of the block and the thickness of the mortar joint.
It is sometimes difficult to choose a window with dimensions that are related to the dimensions of the block.

Spanning wall openings calls for lintels, which is often a problem for the novice. Hence, the pier wall construction is recommended. In this system the walls are built in continuous sections, leaving openings from floor to ceiling between each section of a width suitable for receiving the size of door or window desired, or openings which are pleasing in proportion in which fixed windows may be employed. Openings above and below the window as well as above the door may be filled with another material, as plywood, corrugated metal, glass blocks, fluted glass, or louvers.

The construction as well as the design of the building is thus simplified, and windows no longer look like black holes in thick walls. There is more possibility of variety and interest in the interplay of different materials with the pumice blocks.
CHAPTER XIII

PROPOSED FARM STRUCTURES

A. DAIRY UNIT

The dairy unit consists of bedding and hay storage, a lounging shed and exercise yard, maternity, calf, and bull pens, a milking parlor, milk room, lavatory, feed room, and clover and grain storage. (See Plate 2)

This unit was designed to accommodate the needs of a twenty-five cow dairy herd and the grain and clover seed storage were designed to accommodate the maximum yield expected. Since feed racks form the boundary between the lounging shed and the exercise yard, the lounging shed can be decreased or increased readily. Unlike the conventional stanchion type dairy barn the lounging shed can serve as shelter for cattle or other enterprises.

The milk room is situated in the southeast corner of the unit and contains two sinks for washing the milk cans, a rack for drying the cans, a thirty gallon hot water tank, a cooler, a cabinet for the storage of machine milker parts, washing compounds, spare brushes, and strainer, and the cold storage room. The cooler is just within the door leading from the milking parlor.

The lavatory is easily accessible from the milking parlor, and provides a closet for work clothes. Easily
reached from the farm court, this lavatory can be used conveniently at all times by the cooperator and his hired help.

The feed room is adjacent to the milking parlor and has sufficient floor area for the mixing and grinding of feed. Feed ground into a hopper is readily accessible through a hole in the milking parlor wall. The cabinet along the south wall provides storage for equipment used in the mixing of feed and medicines and instruments. The feed room is readily accessible from the central court. A feed room door opens directly into the feed alley.

The clover seed storage consists of four bins; the grain storage is of plywood construction as described by F. C. Fenton in an article in an issue of the Agricultural Engineering Journal. The use of a Bazooka vertical elevator is recommended for filling the bins.

The milking parlor has a sky light to provide for additional daylight. The milking platform is two feet above the floor level and has four walk-through stalls. From the corral the cows walk up a ramp to the platform to be milked and return down a ramp to the lounging shed. As the shed fills up with manure, the ramp decreases in length until the floor approaches the level of the milking platform. A portable panel readily separates the cows to be milked from those who have already
been milked. The water tank is in the southeast corner of the lounging shed. The location of the portable gate and water tank make water available to both groups of cows.

The cooperator has his chore route all on one level. He fills his feed cart in the feed room and moves out directly into the feed alley, making stops at the bull, calf, and maternity pens. At the end of the feed alley he moves into the hay storage and fills the feed racks and his feed cart with hay. From the feed alley he can easily toss new bedding into the loafing shed and pens and supply the pens with fresh hay on his return to the feed room. A four foot wall separates the feed alley from the lounging shed.

The pens, feed alley, ramps, milking parlor, milk room, lavatory, and feed room all have Comfort-concrete floors. The lounging shed, exercise yard, hay and bedding storage have dirt floors.

The breeding chute is in a convenient location in to the cow lane and the bull pen. The breeding chute also acts as a stock for trimming hoofs, dehorning, and examinations.

**B. MACHINE SHED AND POULTRY UNIT.**

*In Plate 3 it may be readily seen that the dimensions of the farm machinery dictate 12'-0" bents.*
The machine shed contains a farm shop equipped with a forge, stove, and work bench. Two sliding doors makes it possible to drive farm machinery in for repairs. A coal bin adjacent to the machine shop provides for the storage of coal used by the forge. Since the shop is close to the cooperator's residence, it can be used conveniently for wood-working and other hobbies.

The machine shed has a drive-through section for ease of turning around and storing machinery. It has three sliding doors to provide protection from the winds. The north wall of the machine shed is of frame construction to provide for ease of expansion; the other two walls are of pumice block construction.

The poultry unit was set up according to the recommendations for the home unit poultry house found in Oregon State Extension Bulletin 625. (16) It is placed on the south wall of the machine shed and is close to the service entrance.

C. POTATO STORAGE

The potato storage building is shown on Plate 4. The floor of the building is 3'-0" below the level of the road. The wall of the building bordering the road is 5'-0" high; the wall opposite is 8'-0" high. Thus, the building extends 2'-0" above the ground on one side and 5'-0" on the opposite side. The excavated dirt is
piled around the building, providing economical and adequate insulation for the building. A dormer provides headroom for entering the building from the road.

There are four ventilator openings on the roof, each equipped with a cap. In order to fill the potato storage the cooperator walks up the cat wall on the roof and takes off the ventilator cap. By using a portable conveyor he can feed the potatoes into the building from his truck bed with the minimum of labor. A sack chute, made from a worn-out tire casing for and old sacks for the chute reduces the bruising of the potatoes.

The walls of the potato storage is of pumice blocks waterproofed with a coating of asphalt on the outside. Inside the block wall 7/8" boards are nailed 1" on center to 2" x 4" wall studs placed 32" on center to provide air space. Ventilated wooden floors are laid on joists to secure circulation of air beneath the bins. Panels separating the bins are made in sections 2'-0" high from 1" x 5" material with 1" space between. Each panel can be removed as the potatoes are graded.

A portable conveyor carries the graded and sacked potatoes to the bed of the truck parked outside the door.

D. COOPERATOR'S RESIDENCE

The construction system proposed makes the cooperator's
residence not a series of isolated rooms separated by permanent walls and used mostly for the storage of different kinds of furniture, but a unit of interrelated areas which can be varied in size and use and combined, affording a maximum use for all areas of the house.

Partitions vary according to their needs: a partition to conceal certain functions from the sight of the guest need only be as high as the eye level; and the substance of the partition varies according to the degree of privacy required.

Storage walls provide a very practical type of partition for complete isolation. Those in the bedrooms provide hanging space, drawers, and a pull-out board for writing. The one between the entrance area and dining area provides for guest wraps, storage of sewing and ironing equipment, games, and other storage. The one between the utility room and the carport provides storage for the dryer and water pump and general storage.

Since all walls can be readily moved, the farm family can easily make its own adjustments as the occasion demands. The farm family may take a hand in the creation of its own living quarters and to exercise its own design ideas and ingenuity.

The kitchen and farm office areas are combined so the homemaker can have the benefit of light from the east and an outlook to the east road. Thus, the kitchen becomes
more spacious, and the homemaker can use the farm desk for her planning desk.

From the kitchen the homemaker also has a view of the farm buildings, a view of the panoramic west horizon, and the south road, as well as direct supervision of the children's play area.

Only one dining area was provided, since the dining area is used only three hours a day. This area is located between the kitchen and living areas and has a view of the flower garden and the west horizon. Since the ell-shape kitchen was used, the dining area is in a direct line with the range and serving center. The dining area may be associated with the kitchen or living area, depending upon which side the screen is placed. During canning season the kitchen easily expands into the dining area; in entertaining a large crowd, the kitchen, dining, and living areas are easily thrown together into one uninterrupted space. Two different age groups can be entertained, dividing the area as is needed. For the homemaker, a dining area so closely associated with the kitchen is an ideal place to lay out her sewing. Her ironing can be done here conveniently, using the dining table and couch for folded and unironed garments and hanging ironed garments in the guest closet. The homemaker is thus not isolated when working. The dining area can also be used for
for a small child's play area under direct supervision.

The bed rooms open to a private outdoor sitting area. With simple and appropriate furnishings they can be used as private sitting rooms.

The bath room may be divided into two areas by a curtain.

The utility room includes space for hobbies, food storage, general storage, and facilities for washing. It also holds the heating plant and provides an area for children's rough play in bad weather.

Radiant heating by means of hot water circulating through coils embedded in the floor is suggested for heating the house.

E. TENANT HOUSE

All interior partitions are non-bearing as in the co-operator's house. The living unit is 26'-0" x 28'-0", the entire area uninterrupted except by a 4" x 4" post located 12'-0" from the north and east walls. The parent's bed room may be combined with the living area to provide a feeling of spaciousness and to put that area to more hours of use, an item worthy of consideration in small houses. If necessary, the couch in the living area provides for a third sleeping area; the wardrobe closet opening into the hall may be used in conjunction with this area. The living area opens into an outdoor area sheltered by a board fence.
The smaller bedroom has two bunks and a wardrobe closet with hanging space and drawers and a pull-out board.

The bathroom was located in the northeast corner to provide for more flexibility in changing the floor plan.

Storage for laundry supplies including a wash tub is provided for in a curtained closet in the kitchen, which also contains a low bench on which the tub is placed. When doing her wash, the homemaker is able to throw this area into the kitchen.

The work porch contains facilities for general and food storage and storage for cleaning equipment and work clothes are immediately outside the kitchen door. A work bench is provided in this area. A wash tub set on a low bench under the hose bibb located below the kitchen window provides a place for men to wash up.

The outdoor area includes play facilities for children, the clothes lines, poultry and rabbit housing, and the vegetable garden. A corrugated metal fence provides a certain amount of privacy for this area.

The house is provided with heating by a small oil furnace equipped with a fan below and a plenum chamber above, with hot air outlets to different areas. According to research by TVA, this is the most satisfactory heating system for small homes.
A check list prepared by Maud Wilson listing the functions of the farmhouse was used to determine the adequacy of the two houses. The functions listed were numbered consecutively and the numbers were placed on spots in each house plan which provided for each function.

The next step would be to study each area carefully in regard to the functions assigned to it. This usually results in some reassigning or redesigning.

F. TEMPORARY LABOR UNITS: BATH AND OUTDOOR TOILETS

There are five temporary labor units, each 16'-0" x 14'-0". Each unit contains the bare necessities: two strips of clothes hooks, a bench for food preparation, a small wood stove, a table and four stools, and two cots. (See Plate 7)

Showers and outdoor toilet facilities are provided for both sexes in this area. The water supply is adjacent to these facilities. (See Plate 1) A tennis court completes the layout of this area.

The location of the temporary labor housing is such that it can be used as dressing rooms when the main canal is used by the farm family for swimming. With the location of the outdoor toilet facilities and the tennis court in the same vicinity, this area becomes an ideal outdoor play area for the farm family.
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<table>
<thead>
<tr>
<th>No.</th>
<th>Author(s)</th>
<th>Title</th>
<th>Publication Details</th>
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42. Wagner, N. S. The lightweight aggregate, pumice. *Ore.-Bin.*, Vol. 9, No. 4, p. 29-34. April, 1947


44. Wilson System of Prefabrication, Los Angeles. Advertising literature on company's system.


APPENDIX A

Project No. 1 Materials Testing Laboratory Feb. 1947

Investigation of Exterior Waterproofing Materials on Pumice and Concrete Blocks

Object: To study different exterior waterproofing materials on pumice and concrete blocks.

Significance: There is no data available on the waterproofing of pumice blocks. Besides investigating the effectiveness of the waterproofing materials, it is important to observe how the coatings change the color and texture of the pumice block. A study of the effectiveness of transparent waterproofing materials is of importance in the preservation of the natural color, luster, and texture of the pumice block.

Materials and Apparatus:
20 pumice blocks, with cement content of 1:7 and lime content of 1:15, manufactured by I. M. Hostetter.
8 concrete blocks, Corvallis Sand and Gravel co.
Commercial waterproofing compounds:
Bondex
Extite
Armor
Aquella
Hydrotex
Other waterproofing materials:
suet and hydrated lime
paraffin and mineral spirits
linseed oil
whitewash
Still 6" paint brush
Small kitchen scrub brush
Scales
Electric kiln
Metal trays on stand

Procedure: The pumice and concrete blocks were first thoroughly dried in the plenum chamber for about a week. They were then weighed and their weights recorded. The pumice blocks were then paired off, taking the two extremes in weight and working in. The pumice blocks were numbered 1A and 1B, etc., while the concrete blocks were numbered consecutively 11, 12, etc.
The blocks to receive the Bondex, Extite, Armor, Aquella, and whitewash coatings were first dampened by spraying.

The different waterproofing materials were scrubbed thoroughly on the entire surface of the block, including the inside surface of the holes. Care was taken to fill all the small pores.

Some of the blocks received several coats, in which case each coat was allowed to dry thoroughly before the application of the next coat. In the case of the commercial waterproofing compounds, the directions given for their application were followed faithfully. The number of coatings and the composition of each coating are tabulated for each block in Table A.

After the coatings were applied, the blocks were air-dried for a week and weighed.

The blocks were submitted to three tests for absorption. In the first test the blocks were stood on edge in trays in the moisture chamber. The trays were filled with water so the level of the water rose up to the hole. The blocks were immersed thus for a one-half hour, then taken out and weighed.

In the second test the blocks were placed in the trays flat and completely immersed in the water for one-half hour, taken out, and weighed. The third test was the same as the second except that the blocks were immersed for one week.

After the third test the blocks were oven-dried twice to determine the oven-dried weight of each block with its waterproofing. The pumice blocks with the suet and lime and linseed oil coatings still weighed more than their recorded weight air-dried, so they were oven-dried a third time.

**Conclusions:**

The percent moisture content after each test and the rating was computed for each block and recorded.

It was decided to use the results of the first test, because the small corners in the holes of the blocks were hard to reach and therefore could have been vulnerable spots.
<table>
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<tr>
<th>Material</th>
<th>Avg % Absorp.</th>
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<tbody>
<tr>
<td>Armor</td>
<td>0.217</td>
</tr>
<tr>
<td>Linseed</td>
<td>0.652</td>
</tr>
<tr>
<td>Cement and Bondex</td>
<td>0.960</td>
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<tr>
<td>Suet and Lime</td>
<td>2.175</td>
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<tr>
<td>Hydrotex</td>
<td>2.97</td>
</tr>
<tr>
<td>Paraffin, m. sp.</td>
<td>3.50</td>
</tr>
<tr>
<td>Extite</td>
<td>3.80</td>
</tr>
<tr>
<td>Aquella</td>
<td>4.16</td>
</tr>
<tr>
<td>Sylvester</td>
<td>6.38</td>
</tr>
<tr>
<td>Whitewash, soap last</td>
<td>9.05</td>
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<tr>
<td>Bondex and sand</td>
<td>9.49</td>
</tr>
<tr>
<td>Bondex, no sand</td>
<td>9.83</td>
</tr>
<tr>
<td>Whitewash, alum last</td>
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<tr>
<td>Untreated</td>
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<table>
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<td>Aquella</td>
<td>0.3195</td>
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<td>Bondex</td>
<td>0.3225</td>
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### Table A

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<tr>
<th>Block No.</th>
<th>Coatings</th>
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<tr>
<td>lA</td>
<td>Beaver cement 300g 130cc water</td>
<td>Bondex 114g water 118cc</td>
<td>Bondex 226g water 236cc</td>
<td>Bondex 226g water 236cc</td>
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<tr>
<td>1B</td>
<td>Extite 100cc water 300cc</td>
<td>same as 1</td>
<td>no sand</td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td>Bondex 226½g ½ sand</td>
<td>same as 1</td>
<td>no sand</td>
<td></td>
</tr>
<tr>
<td>2B</td>
<td>Same as 2A but no sand</td>
<td>Same as 2A</td>
<td>no sand</td>
<td></td>
</tr>
<tr>
<td>3A</td>
<td>Armor 260g 390cc water ½ sand</td>
<td>Armor 260g water 325cc</td>
<td>Armor 260g water 325cc</td>
<td>Armor 260g water 325cc</td>
</tr>
<tr>
<td>3B</td>
<td>Same as 3A</td>
<td>Same as 3A</td>
<td>Same as 3A</td>
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<tr>
<td>4A</td>
<td>Aquella 540g water 390cc</td>
<td>Same as 1st coat</td>
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<td>same as 4A</td>
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<td>5A</td>
<td>suet 113.4g hydrated lime 756g</td>
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<td>Hydrotex</td>
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<tr>
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<td>&quot;</td>
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</tr>
<tr>
<td>9A</td>
<td>whitewash, alum last</td>
<td>whitewash, soap last</td>
<td>whitewash, soap last</td>
<td>whitewash, soap last</td>
</tr>
<tr>
<td>9B</td>
<td>&quot;</td>
<td>&quot;</td>
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</tr>
<tr>
<td>10A</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
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<td>10B</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
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<tr>
<td>Concrete blocks:</td>
<td>untreated</td>
<td>Hydrotex</td>
<td>Armor</td>
<td>&quot;</td>
</tr>
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<td>Armor</td>
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<td>13</td>
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<tr>
<td>17</td>
<td>Bondex</td>
<td>&quot;</td>
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<td>18</td>
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</table>
POSITION OF BLOCKS IN TEST I

POSITION OF BLOCKS IN TEST II AND III
PUMICE BLOCKS WITH EXTERIOR WATERPROOFING

CYLINDERS IN MOISTURE CHAMBER
APPENDIX B

Project No. 2  Materials Testing Laboratory  March, 1947

Study of Decreasing the Permeability of Pumice Blocks through the Use of Integrals

Object: To eliminate the use of exterior waterproofing materials by decreasing the permeability of pumice blocks through the use of integrals.

Significance: The expense involved in waterproofing the pumice blocks would be eliminated, and the texture and color of the blocks would be preserved.

Materials and Apparatus:
- pumice (passing through the No. 3 sieve and retained by the No. 10 sieve)
- punicite (passing through the No. 10 sieve)
- portland cement
- hydrated lime
- bentonite
- Embecc
- calcium oxychloride
- silica
- calcium chloride
- soap
- alum
- metal oxide, two shades of brick
- scales
- mixing bowl and spoon
- three-cylinder bronze mold
- sheet of glass
- wax
- Rhiele moisture chamber

Procedure: A basic mix was used, consisting of 270 cc of water, 263 g. pumice, 131 g. punicite, 133.5 g. cement, and 67 g. hydrated lime. In Mix No. 2, the lime was increased 100%; in the following mixtures various integrals were added, as indicated in Table B. Two shades of metal oxide were added to four of the mixes in varying amounts to note the variations in intensity of the colors.

After each mix was prepared, a three-cylinder mold was oiled, placed on a sheet of glass, and filled with the mix. The mold was numbered, and the joint between the mold and glass was painted with wax to
prevent the loss of water. Each mold was placed in the moisture chamber and allowed to cure for a week.

The cylinders were then taken out of the molds, numbered 1A, 1B, 1C, etc., air dried, and weighed. The cylinders were then oven-dried and weighed, and set in a shallow pan, which was filled with one inch of water. The pan with the cylinders was placed in the moisture chamber. The weight of each cylinder was recorded at the following intervals: $\frac{1}{2}$ hour, $1\frac{1}{2}$ hours, 2 hours, and 17 3/4 hours. The per cent moisture content based on the air dry and oven-dried weights were computed and recorded.

**Conclusions:** Cylinders 5A, 5B, and 5C, molded from the mix containing 10 grams of calcium oxycarbonate were the only cylinders which were not saturated at the end of 17 3/4 hours. They also indicated the least per cent moisture content.
<table>
<thead>
<tr>
<th>Mix 1:</th>
<th>Mix 2:</th>
<th>Mix 3:</th>
<th>Mix 4:</th>
<th>Mix 5:</th>
<th>Mix 6:</th>
<th>Mix 7:</th>
<th>Mix 8:</th>
<th>Mix 9:</th>
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<td>270.0 cc</td>
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<td>cement</td>
<td>133.5 g</td>
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<td>cement</td>
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<tr>
<td>lime</td>
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</tr>
</tbody>
</table>
proposed layout of farm
scale: \( \frac{1}{4000} = 1' - 0'' \)
plate e
potato storage
scale: $\frac{1}{16''} = 1'-0''$
plate 4
1. general storage
2. food storage
3. walk-in freezer
4. linen closet
5. books, magazines
6. formal office
7. cleaning equip.
8. work clothes
9. wardrobe
10. laundry supplies
11. toilet supplies
12. medicines
13. towels
14. h.w. tank
15. heater
16. water pump
17. radio
18. cooler
19. games
20. household tools
21. shoe cleaning equipment
22. dryer
23. sewing, rubber equip.
24. guest wringer

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cooperator's residence
scale: 1/8"=1'-0"

plate 5
one-family unit

bath & outdoor toilets

temporary labor unit
bath & outdoor toilets
scale: 1/2"=1'-0
plate 7