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ABSTRACT

The economic and physical realities of an energy shortage have caused many educators to consider alternative sources of energy when constructing their schools. This book contains studies and designs by fifth-year architecture students concerning the proposed construction of a zero energy-use elementary school in Albany, Oregon. "Zero energy use" is defined as the total use of on-site energy. A zero energy-use school might use solar reflectors, composting toilets, and natural ventilation. The book is divided into 10 sections, representing 10 separate student projects. Each student explores energy alternatives for heating, lighting, cooling, ventilation, sewage disposal, and water for the proposed school, and completes his or her chapter with detailed drawings. Although the book cannot be used by an architect or a school district as actual construction documents, its projects do open the door to the possibility of constructing an energy-efficient school. (Author/LD)

zero energy use school

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zero energy use school

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preface

W. G. Wilmot, Jr.

Philip K. Piele

The following studies and designs are the work of a 5th year, two-term design studio at the University of Oregon, School of Architecture and Allied Arts. The project goals were to explore and, if feasible, design a zero energy-use elementary school for a proposed site in Albany, Oregon.

The studio met during the fall and winter terms in the school year 1979-80. Bill Wilmot, Architect, working with the Oregon State Department of Education, and Professor Philip Piele, Professor of Education and Director of the ERIC Clearinghouse on Educational Management at the University of Oregon, aided the design studio throughout the project. Their input was invaluable. Professor John Reynolds, Department of Architecture, University of Oregon, also offered encouragement and his expertise in energy-conserving design throughout the studio's progress.

The definition of "zero energy use," for the purposes of the project, is as the title implies. The school must function without the aid of produced energy unless site-produced. The class explored the areas of heating, lighting, cooling, ventilation, sewage disposal, and water, and the feasibility of using natural or nonenergy-dependent means to support a grade school.

The class was at liberty to change the calendar school year and school hours, as required, to support the zero energy use concept.

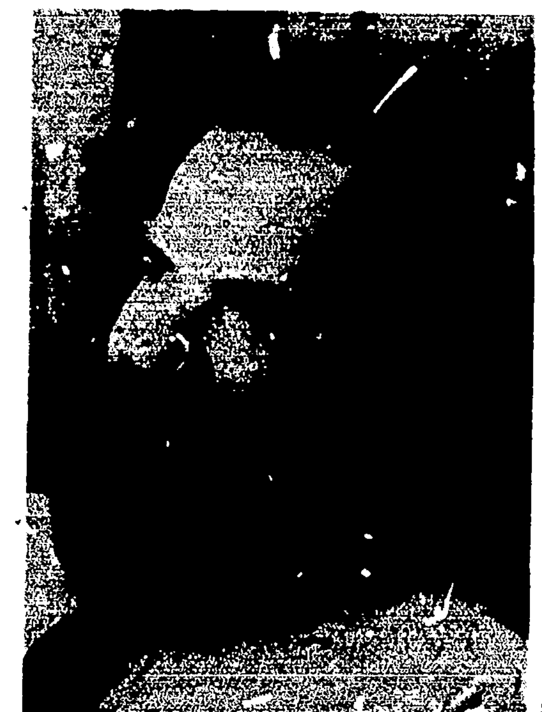
As one examines the design solutions, it is important to understand that these were student projects and studies to explore means to achieve our goals and the design implications. The projects are certainly not at a state where they could be used by an architect or a school district as construction documents.

However, the class study has opened the door to the possibility of a zero energy use school in the Oregon valley region—and the findings are optimistic.

It appears that initial construction costs may be higher than a conventional school building, but hopefully these differences would be realized in a short period of time.

Furthermore, the costs involved with more specific research, study, and construction, should not necessarily be borne by any particular school district. Rather, state or federal grants should be sought. Then portions of the building should be constructed, tested, and studied, both from an energy use standpoint, and for the educational benefits. Modifications could then occur based on the test results, and, finally, the completed school could be constructed.

Otto P. Poticha



Otto P. Poticha

acknowledgments

When we began this project, few of us had dealt with either education facilities or alternative energy systems. The combination of both became the focus of our final design experience at the University of Oregon.

During the course of our study, many people shared with us their knowledge and experience; to these people we wish to extend our sincere appreciation:

OTTO POTICHA, A.I.A., Professor of Architecture, University of Oregon

PHILIP K. PIELE, Profesor of Education and Director, ERIC Clearinghouse on Educational Management, University of Oregon

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JOHN REYNOLDS, Professor of Architecture, University of Oregon

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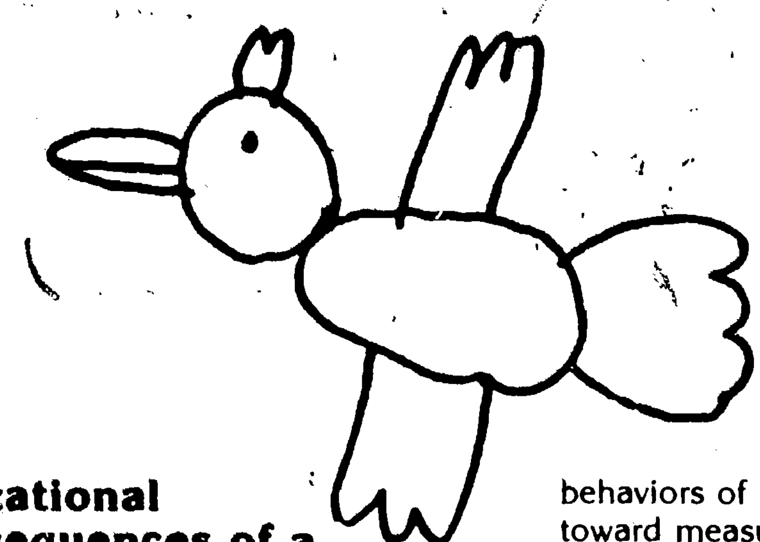


prologue

Educational Consequences of a Zero Energy School

It is difficult, if not impossible, to say with any degree of certainty what the educational consequences of a zero energy school might be without the benefit of actual experience of teachers and students operating in a zero energy school environment. Nevertheless, it seems useful to provide some predictions based on the cumulative impact of the school designs in this book.

One of the major anticipated outcomes of a zero energy school is to heighten students' and teachers' awareness of the environment. That is to say that the variations in light, temperature, and wind velocity will be much more directly felt by students and teachers. Students should have an opportunity to manipulate the physical accoutrements of the school to increase or decrease light, heat, and ventilation provided by the natural forces of the environment.

A consciousness raising impact on those who daily work in a zero energy environment is anticipated. But precisely how the living laboratory of a zero energy school will impact upon the attitudes and behaviors of teachers and students toward measures of self-reliance and security in a future of fossil energy scarcity is difficult to anticipate. Surely, however, students will begin to appreciate the natural rhythm of the seasons evidenced by such elements as the changing quality of light and temperature provided by the sun, the impact of cloud-covered days, and the cooling effect of the summer breezes on the working environment of the school.

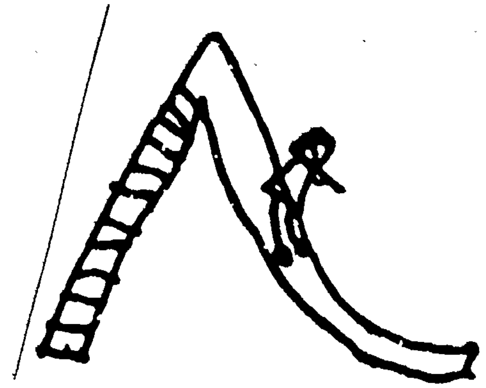
It may also be anticipated that for the teachers and pupils of a zero energy school flexibility, spontaneity, and fluidity will characterize the learning environment. By flexibility, I mean the ability of the teacher and pupils to adapt to the changing curricular requirements influenced by the conditions of the temperature and available light. Learning activities previously based on constant light and heat or cooling generated through artificial means will now become more influenced by the natural environment. Spontaneity of the activities based on external environmental conditions will be another attribute of the zero energy school. The designs presented in this book suggest solutions to variations in temperature that range from movement from small spaces into larger to accommodate the cooling/warming continuum and from large to small spaces to accommodate a warming to cooling trend.

What precise impact these changes in physical spaces will have on the curriculum and learning outcomes is uncertain. The research evidence in similar cases suggests only that extremes of heat or cold have a measurable impact on achievement and also that long-term conditions of extreme crowding in the schools create serious behavior problems for many students. Whether the designs presented and solutions to zero energy use are sufficient to accommodate the problems of crowding and extremes of heat and cold are yet to be determined.

It is also evident from an analysis of the enclosed designs that there is an anticipation of school closings or limited schooling during the cold months of the year, approximately a nine-week period beginning November 15 and ending January 15. It is anticipated that additional time needed to achieve the 175-day requirement for education will be made up by beginning school earlier in the year and ending it later. The length of school days during the colder months may also be shortened, because temperature conditions may compel beginning school at ten or eleven a.m. rather than eight. Research evidence on shortened school days suggests that learning as measured by standard achievement tests in reading and math was not affected by shortened school days over an extended period (one to two years). Indeed, whether the mix of temperatures and shortened days will affect the learning outcomes is unknown.

In all, the learning environment of a zero energy school can be characterized by flexibility, uncertainty, spontaneity, creativity, and a good deal of excitement and opportunities for achievements in both teaching and learning that are unknown at this point. Certainly the educational benefits of such an environment would seem to far outweigh the costs and/or the possible negative effects.

Philip K. Piele



introduction

Through The Looking Glass

Our present civilization is currently on a path that is frighteningly similar to that of Alice in Lewis Carrol's *Alice's Adventures in Wonderland.* Amazed, confused, and distracted, we do not know where we are, where we are going, or what lies ahead. Just as we seem to have a realistic grasp of the situation, things change.

Perhaps most importantly, we are like Alice in not having any clear idea of where we want to go. Like Alice asking the Cheshire Cat which way she ought to go to get "somewhere," without really caring where, we often wonder about what path to take without really knowing where we want to be.

After Alice admitted to the Cheshire Cat that she didn't care where she ended up, the cat sagely observed that in that case, it didn't matter which way she went. Although it may not matter what path one takes in Wonderland, in the world of today's energy problems, taking the wrong path into the future may be disastrous. If we choose a path that causes us to run out of fuel before we are properly prepared to do without it, our future will be dark and perilous.

Unlike Alice, we need to give some thought to where we would like to go. Although we can't predict the future, we can imagine many possible futures and determine which ones would be the most desirable.

Where Do We Want To Go?

One nice place to get to would be an enlightened, technological society, totally fueled by renewable energy equal to about 10 percent of our present use and having a comfortable standard of living and an environment that is peaceful, healthful, clean, and beautiful. Although such a society may now sound impossible, we must eventually arrive there, because no other kind of society can sustain itself. We do, however, have at least two choices of how to get there: we can take a long, dark, perilous path of suffering and deprivation, or we can get there directly, in only a few steps.

How we get to where we want to go depends ultimately on today's children. If we can educate them to head in the right direction, the second dark age may be avoided. If today's children are to follow a good path, they must grow up with a realistic, accurate, knowledgeable, and above all, intuitive sense of energy values. The zero energy school provides a perfect vehicle to achieve these ends.

What Is A Zero Energy School?

A zero energy school is one that uses no "accountable" energy. That is, it does not use energy that is purchased or obtained from an off-site source. Instead, it operates on the free natural energy forces existing around and within it.

Almost every building built in the last two decades has been 100 percent energy dependent. That is, without accountable energy, we can't use any of the building any of the time. Some buildings, usually older ones, can be used some of the time without energy. In most cases, we should be designing buildings so that most of the building will work most of the time without energy. A zero energy school, however, is designed so that all of the building will work without accountable energy some of the time—enough of the time to have school.

Why Zero?

First, zero is understandable. In today's society, many people can't differentiate between using "some" energy and "a lot" of energy. It is clear, however, what it means to use "no" energy. After we learn how to function without using any energy, we will be ready to learn what it means to function using some.

A zero energy school will also provide security. Faced with the exhaustion of fossil fuels within their lifetime, children in a zero energy use school will have the security of knowing that they will get along very nicely without such fuels.

Finally, a zero energy school is a living laboratory that demonstrates the concept of "energy independence" as a practical, comfortable, and successful way of life.

W. G. Wilmot, Jr.

program description

The program generally adapted was a compilation of sources. The primary directive was the program provided by Bill Wilmot, Architect, Oregon State Department of Education with Lutes/Sanetel's 66th Street School, Springfield, Oregon, program being used for spatial definition. Finally, class discussions with Otto Poticha, Bill Wilmot, and Phil Piele refined concepts about what typically happens in an elementary school. In abbreviated form, the adapted program is as follows.

Energy

All energy needs should be met with sources available on the site.

Transportation:
While, ideally, it would be appropriate that students travel by means not requiring the use of accountable energy, the school would not be in the position to designate transportation modes.

User Population

The student population is to be kindergarten through 6th grade, organized as 2 classes per grade level, 22-25 students per class. This yields a total of 300-350 students, kindergarten students to be considered as half-day occupants.

Staff:
14 regular "classroom" teachers
4 full-time teacher aides
1 P.E. instructor
1 music instructor
1 art instructor
1½ librarian and part-time aide
1 administrator
1½ secretary/clerical
1 Title 1/specialist teacher
2 custodians
28 plus kitchen staff

Typical Elementary School Activities/Spaces

A. Classroom

1) Teaching philosophies vary between discipline and learning-as-discovery, among individuals as well as over time. Therefore, classrooms should be able to accommodate a variety of teaching methods and activities

2) All students focus on teacher for lecture/demonstration, while being able to read and write

3) Students form small groups (3-10) with teacher, while other students do individual work, or form a group with teacher aide

4) Students work with teaching "machines"

5) Spatial guidelines:

instructional area	895 sq.ft.
entry/storage/small group instructional alcove	160
total	1055 sq.ft.

B. Library and Instructional Media

1) Instruction: for student/group reading and problem-solving, as well as training in library/media usage

2) Service: as a depository for printed materials, electronically stored materials, physical models, maps, etc.
—preparation of learning aids of all kinds
—centrally order and receive books, visual aids, teaching materials

3) Elementary school libraries do not have precious books

4) Spatial guidelines:

reading room (accommodate one class for instruction)	2000 sq.ft.
library storage/workroom	500
librarian's office	200
audio-visual storage room	400
instructional materials room	200
conference room	250
total	3550 sq.ft.

C. Physical Education

1) For group instruction/physical activity apart from athletics, such as exercise, dance, gymnastics, etc., and storage of equipment

2) As the space the public primarily uses in an elementary school, provision for public access needed

3) Provide dressing and shower facilities for 5th and 6th graders

4) Spatial guidelines:

gymnasium	4000 sq.ft.
storage rooms	800
dressing rooms	1200
toilets/custodial	400
total	6400 sq.ft.

D. Cafeteria

1) Provide hot-lunch if possible, at least part of the time

2) Lunch should be a positive social experience, dining as opposed to feeding. It should be nourishment for the soul as well as the body—attractive, pleasing, and wholesome—and consumed like ladies and gentlemen.

3) While theatre is an excellent medium for culture, writing, and personal development/fulfillment through acting, the full-scale traditional auditorium no longer exists in the new schools as an independent space. Dining and auditorium activities can work together if handled carefully.

4) After the gym, the auditorium/cafeteria spaces are the most frequently used by the public, and, therefore, public access is needed.

5) Spatial guidelines:

cafeteria	3600 sq.ft.
kitchen (for potential of 540 students and 48 staff)	1100
total	4700 sq.ft.

E. Special Programs

1) Title I/specialist teacher: as office and instructional space spatial guideline 200 sq.ft.

2) Counseling: counselor's office spatial guideline 120 sq.ft.

F. Music/Art

1) Music is divisable as instrumental and listening/vocal activities. Special study is required.

2) Art is presently taught only to kindergarten, 1st, and 2nd grades. Special study is required.

G. Administration

1) The principal requires a personal, private space to conduct school business and consult with students, staff, parents, and others.

2) The administrative staff needs to greet the public, attend to students' needs, keep records, type, reproduce documents and notices, and generally conduct school business.

3) Visual control of the main entrance is desirable.

4) Provide some form of intercom/time display/signal system/alarm system.

5) Spatial guidelines:

main office and reception	400 sq.ft.
principal's office	120
administrative conference room	200
sick room	180
nurses area	80
toilet	75
total	1055 sq.ft.

H. Faculty Facilities

1) Semi-isolated areas for group meetings, relaxation, and eating.

2) Workroom for class preparation and personal storage. Locate close to library/media spaces.

3) Spatial guidelines:

meeting/lunch room	360 sq.ft.
teachers/aides workroom	600
faculty toilet facilities	200
total	1160 sq.ft.

I. Toilet and Custodial Rooms

1) Toilet and custodial rooms will be distributed throughout classroom area.

2) One pair of toilet rooms will be located adjacent to two classrooms.

3) Spatial guidelines:

toilet rooms at 100 sq. ft. per	1400 sq.ft.
custodial rooms at 100 sq. ft. per	200
total	1600 sq.ft.

J. Equipment and Custodial Facilities

1) Operation is to be by users, students and teachers.

2) Maintenance and custodial work is to be by staff people under district supervision.

3) Because of the variety of alternative solutions to energy/mechanical needs, spatial and equipment requirements will be determined individually.

Time of Operation

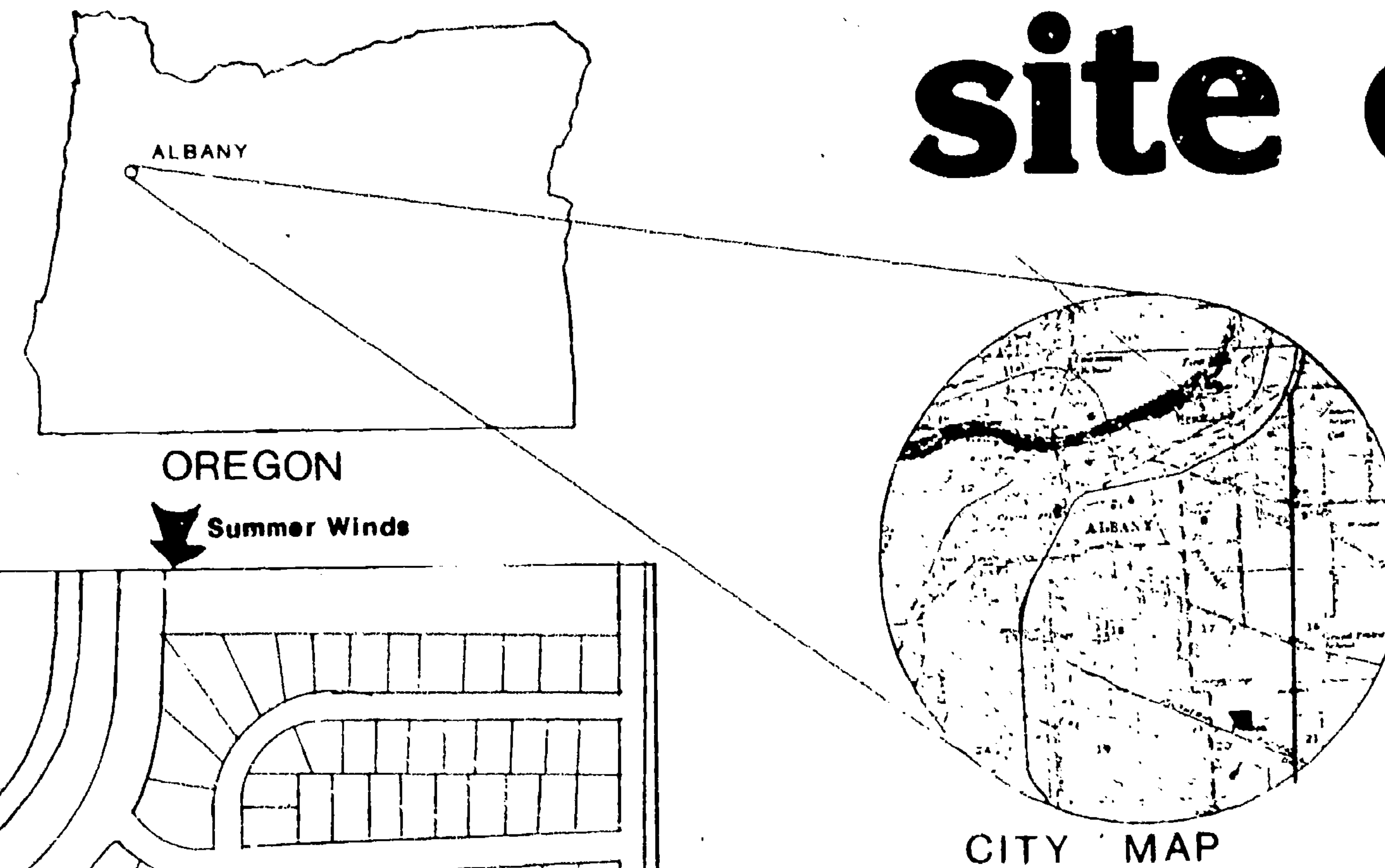
The state requires 175 school days per year, providing a "day" of at least 7 usable hours for students and 9 for staff. Extended usable hours for community use is desirable. The time of year and day that school is "in session" is to be program determined, the "day" varying seasonally, even weekly, if need be.

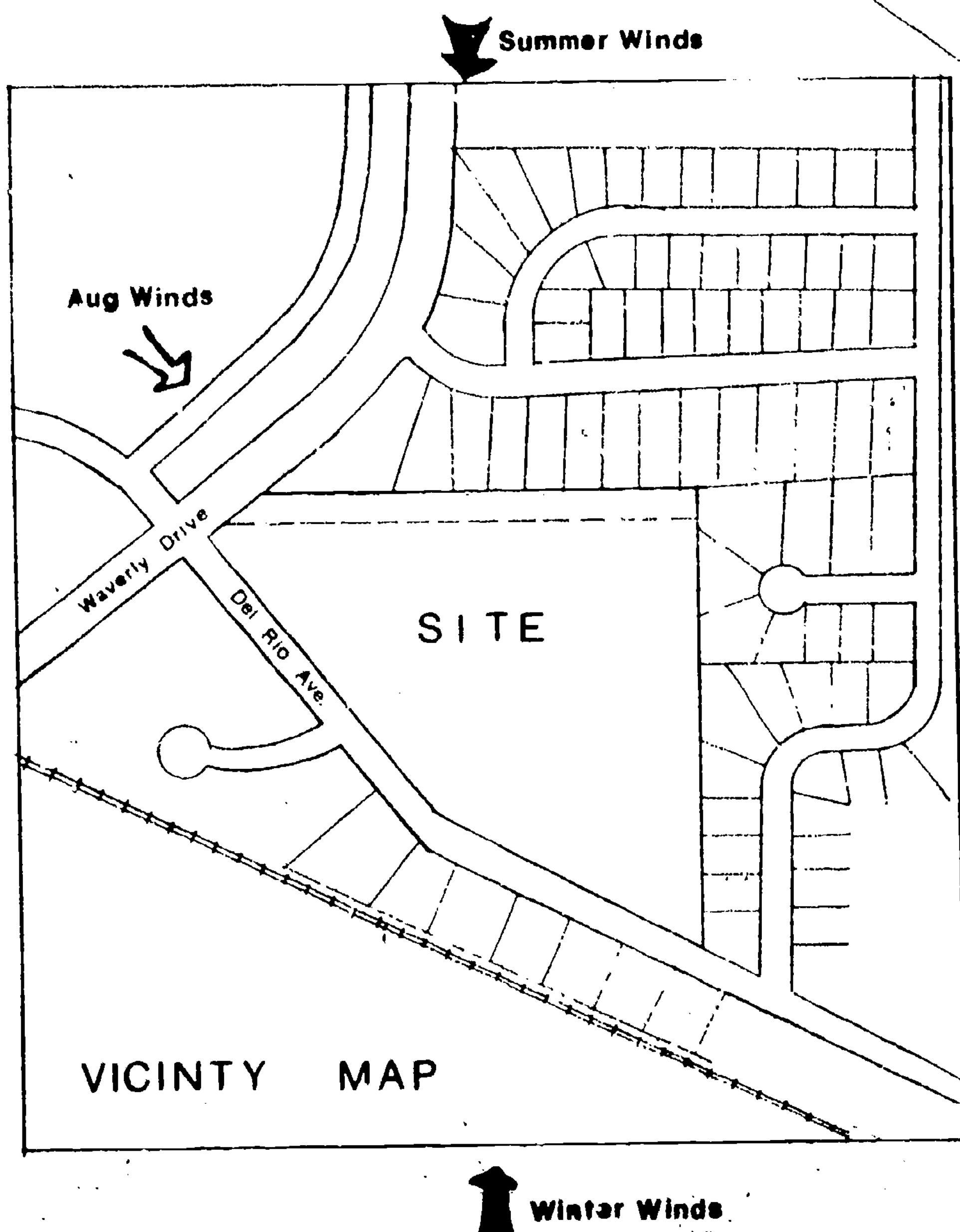
Time of use must consider natural conditions *and* social conditions. While daily and seasonal weather changes will vary the "day," the results must be practical and acceptable to an orderly society.

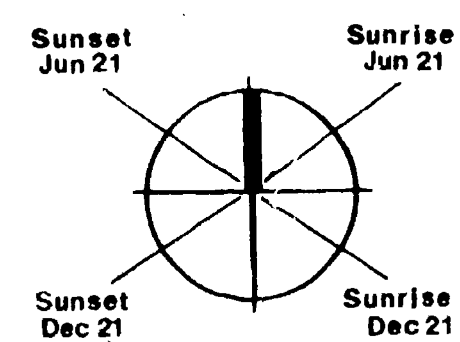
Consider the student's other family-members' lifestyles and needs—use of time, meal schedules, babysitting, work schedules, etc. Harvesting of crops and other seasonal factors should also be weighed.

The overall message here is that "this is how we're going to do it now—we're going to work with nature, follow what's happening outside." Because zero-energy is the goal, the general public will tend to view this as a backward step. The school should be a physical manifestation that this is a forward step. It should not be crude or primitive, but employ technology in its highest and best sense to work with nature. Above all, let it be a fun, exciting, and imaginative place for children, its technology artfully woven to make naturally apparent how and why things work the way they do.

site context







**The Site:
Albany, Oregon,
44° 37' N,
123° 07' W**

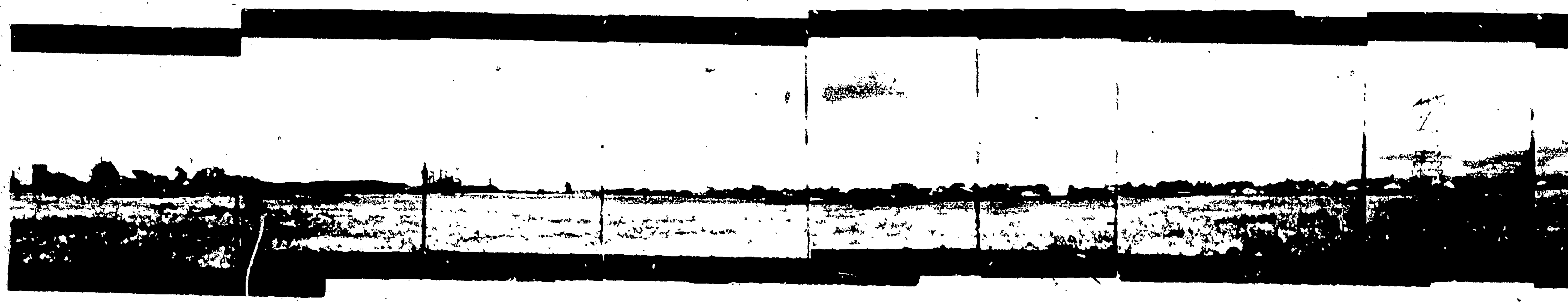
Albany is located in the middle of the Wilamette Valley some 60 miles east of the Pacific Ocean. The valley here is approximately 50 miles wide with the city about equidistant from valley walls, formed by the Coast Range on the west and the Cascades on the east.

Our site is located 3 miles southeast of the Albany downtown nestled in a newly developed area zoned R-1, bordered to the west by commercial zoning.

The topography of the 9.2 acre site is essentially flat and uneventful. Bordered on the north by a North Bonneville Power Administration Primary Transmission Line. Due east 1 mile is I-5, and Southern Pacific Railroad is to the south. (see vicinity map)

Vehicular access to the site will be from Waverly Drive to the west, and Del Rio Avenue to the south.

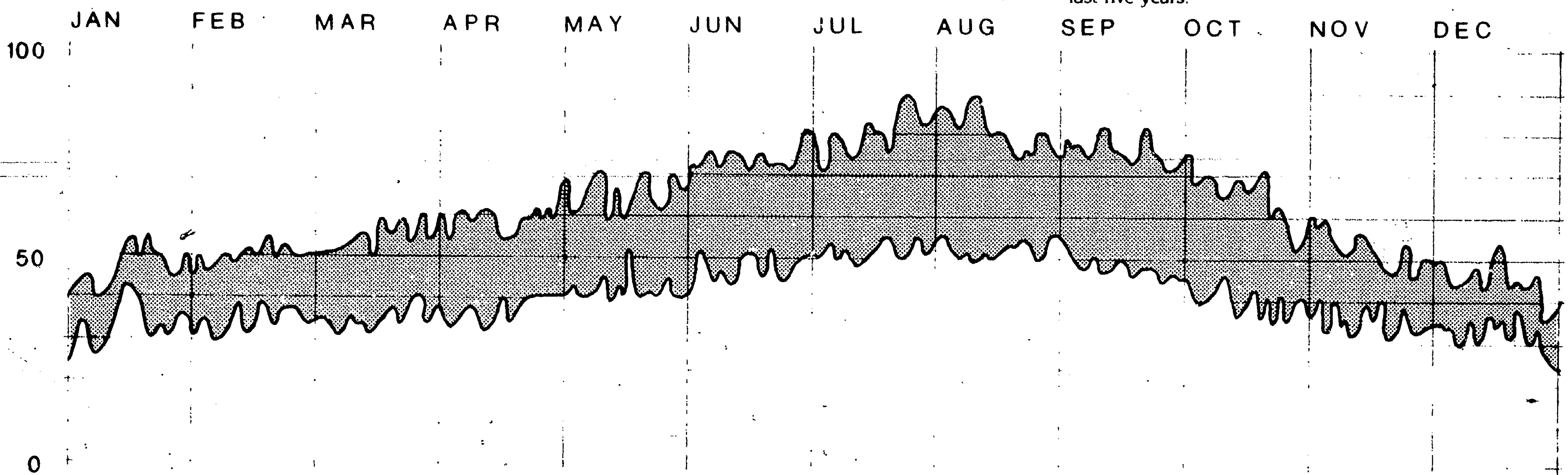
Pedestrian access to the site will also be from Waverly Drive and Del Rio Avenue.

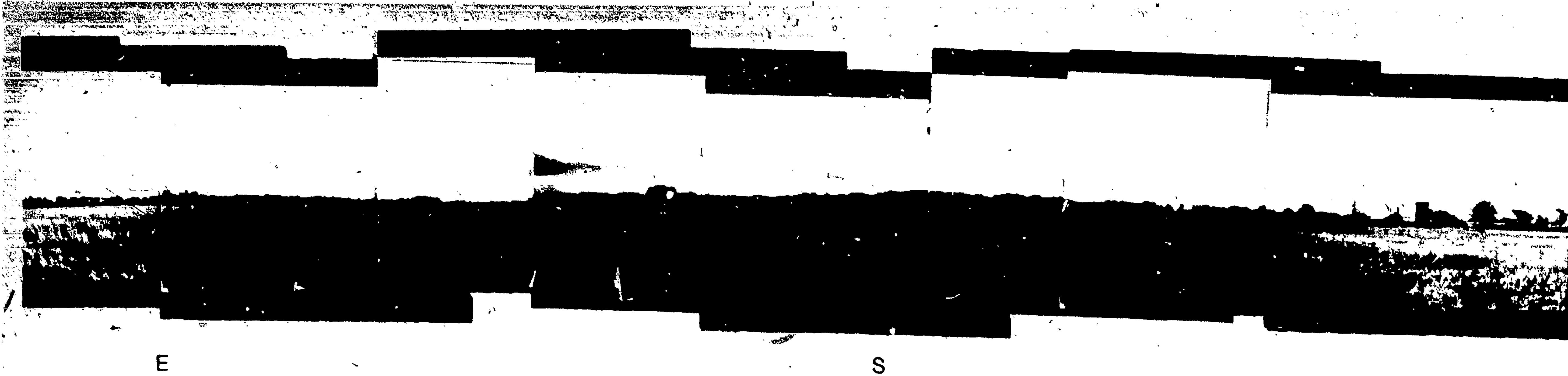


This is a 360° view of the Albany site taken on February 20, 1980.

N

This graph shows the daily high and low temperatures, averaged over the last five years.





Normals, Means, And Extremes

Month	Temperatures °F – Normal – Daily maximum	Daily minimum	Monthly	Extremes – Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F – Heating	Cooling	Precipitation in inches – Water equivalent – Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year
(a)				14		14					30		30		30	
J	45.3	32.2	38.8	64	1971	6	1974	812	0	6.90	15.40	1955	0.57	1949	3.07	1972
F	51.4	34.4	42.9	72	1968	15	1971	619	0	4.79	12.31	1949	0.78	1964	3.16	1949
M	54.9	35.4	45.2	75	1969	12	1971	614	0	4.33	8.42	1938	0.87	1965	3.03	1943
A	61.0	38.5	49.8	84	1966	23	1968	456	0	2.29	5.18	1955	0.39	1939	2.22	1971
M	68.1	43.3	55.7	92	1963	30	1965	295	7	2.09	4.58	1942	0.18	1947	1.84	1963
J	74.0	48.4	61.2	100	1969	34	1973	135	19	1.39	3.60	1947	0.01	1951	1.60	1950
J	82.4	50.7	66.6	104	1965	37	1962	43	92	0.35	1.80	1974	0.00	1967	0.87	1961
A	81.3	50.9	66.1	104	1972	38	1969	53	87	0.57	4.17	1968	T	1970	1.25	1945
S	76.5	47.3	61.9	99	1975	26	1972	120	27	1.46	3.98	1971	0.00	1975	1.86	1951
O	64.1	42.3	53.2	95	1970	23	1971	366	0	5.98	11.17	1947	0.70	1972	2.84	1955
N	53.0	37.4	45.2	72	1970	17	1969	594	0	6.08	15.25	1975	0.84	1939	2.82	1950
D	47.1	34.7	40.9	62	1972	-12	1972	747	0	6.85	12.40	1964	2.57	1944	2.72	1964
YR	63.3	41.3	52.3	104	AUG 1972	-12	DEC 1972	4852	232	41.06	15.40	JAN 1955	0.00	SEP 1975	3.16	FEB 1949

Month	Snow, Ice pellets – Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity pct. – Hour 04 (Local time)	Hour 10	Hour 16	Hour 22	Wind – Mean speed m.p.h.	Prevailing direction	Fastest mile – Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days – Sunrise to sunset – Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ½ mile or less	Temperatures °F – Max. – (b) 90° and above	Max. – 32° and below	Min. – 32° and below	Min. – 0° and below	Average station pressure mb. Elev. 201 feet m.s.l.
(a)	30		30		13	13	13	13	27	15	26	26			31	30	30	30	30	30	30	30	13	13	13	13	3
J	32.8	1950	10.8	1943	85	83	76	85	8.9	S	40	18	1966		8.4	2	5	24	19	1	*	6	0	1	13	0	1010.9
F	8.4	1962	5.4	1962	87	81	68	84	7.8	S	46	18	1958		8.1	3	5	20	17	*	*	4	0	0	12	0	1009.8
M	10.9	1951	8.5	1960	86	74	60	80	8.2	S	40	19	1971		7.9	4	6	21	17	*	*	2	0	0	12	0	1007.5
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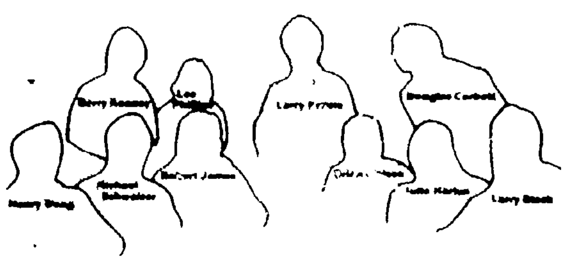
N	5.8	1955	4.0	1955	90	85	77	88	7.5	S	38	18	1951		8.1	3	5	22	18	*	*	7	0	*	7	0	1008.7
D	14.6	1972	9.4	1972	87	86	81	86	8.4	S	45	23	1953		8.8	2	3	26	20	1	*	7	0	1	11	*	1012.5
YR	32.8	JAN 1950	10.8	JAN 1943	86	72	59	79	7.3	S	58	18	OCT 1962		6.9	78	82	205	150	2	6	37	18	3	68	*	1010.2

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 108 in July 1941; maximum monthly precipitation 17.54 in December 1933; maximum precipitation in 24 hours 4.30 in December 1933; maximum snowfall in 24 hours 25.0 in February 1937.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.



larry black

Zero Energy

Zero energy use buildings are a concept whose time has come. Faced with the harsh economic and physical realities of an energy shortage we are finally willing to seriously consider changing our life style. A change to zero energy use is often equated with a lowering in lifestyle or decrease in creature comforts. It seems to be impossible for many Americans to imagine living on as little as does the majority of the world's population. We are faced with an obsessive need to consume. To consume is to exist. Many of us simply can't imagine existing without our myriad of electrical toys, our cars, and our isolation from a world wide reality.

I see the primary objective of a zero energy use school being that of bringing about a fundamental change in our perception of nature and mankind's place in the scheme of things. Our false sense of having conquered nature is being recognized more and more as being just that. School should stress the subtle web of interrelationships of our living earth. A strongly ingrained sensitivity to these interconnections means that man views himself as part of the flow and takes responsibility for his actions, not only for today but for long after his body has returned to the earth. It means a celebration and love of life.

At the grade school level these ideas need to be demonstrated and experienced by the students. A zero energy use school should stress how a building can fit into energy systems with a minimum of impact. A building which needs to consume only a minimal amount to function and be a comfortable, stimulating environment in which to learn will serve as a model or example for children which is sadly lacking in our present built environment. It will demonstrate that things can be different, that we can change our lives without having to return to the Stone Age.

Of course, this project is based on the hard economic and physical realities of schools simply being unable to function in the near future unless they change. The educational process might be what actually has to change in our future society. The larger issue is not one of making a school more efficient but whether the school system should even be as it now exists.

For the sake of confining this project to a more easily explored issue, I have attempted to see what would have to change in order to make a zero energy school work. The trade-offs in comfort or life-style which result from this have to be weighed against the ultimate goal. People normally don't change until they have to. My objective was to discover what they might have to change.

Building Philosophy

The initial use of energy takes place before the building even begins operation. A building takes a tremendous amount of energy to build. Assuming the need is great enough to justify building it, a building which fits into the philosophy of zero energy use should be constructed of materials which require the least amount of energy to be delivered to the job site even though it means more labor during construction. We have plenty of available labor if the unemployment figures are correct, and although it might increase the cost of the building over a less labor intensive building the actual cost to our environment will be less in the long run. [illegible]proximity of brick works and sawmills make brick and wood two of the materials lowest in energy used during production. Materials which require more energy to produce (such as steel) should be used as efficiently as possible (as in steel reinforcing). Wood and brick are also more readily recyclable than more highly manufactured materials, as well as concrete. I have attempted to limit concrete use to areas such as footings or where it is required for structural reasons. The ability to recycle once again is important when one accepts a long range accountability.

The type of labor also is important. Skilled labor is expensive and should be used where necessary. If the building system is not complex then less highly skilled laborers can be employed in greater numbers, increasing human energy as opposed to the energy needed to manufacture a more complex building system.

Site

The full utilization of the site is essential to an educational program which accepts that the learning process of a child is enhanced by teaching which occurs not only inside but outside the classroom as well. To obtain the awareness of nature and man's relationship to it, the study of plants and ecosystems must be an integrated aspect of the classroom experience.

The school is a variation of the campus plan. The classrooms have been detached from the major support spaces and interfaced with the outdoor learning areas including a nature walk, pond, and gardens, as well as outdoor areas where the more structured lecture situation can occur. While causing the building to be more spread out, long indoor hallways have been eliminated, thus decreasing enclosed floor area. Circulation is provided for by covered pathways on the north side of the classrooms (sheltered by the classroom from the winter winds) and by gravel paths which are based on the human tendency to take the shortest path between any two points. These gravel paths connect the indoor classrooms with outdoor learning centers by direct routes. Students can also enter the site from any side and travel directly to their class along these paths without tracking mud into the class.

The school has been located as far to the north as possible to increase the open areas on the south side of the classrooms to insure unobstructed winter sun penetration.

Emergency and service access to the site is off Del Rio Ave. to the north of the school with parking located in B.P.A. easement. This is also the access route for bicycles, and a bicycle shed is located near the end of the access road. This access road passes by the windmill and water tower located near the intersection of Waverly Drive and Del Rio Ave. where winds should be least obstructed by trees on site and where they are highly visible to the community.

A pond is located near the water tower and acts as overflow for the water wheel electrical generating system (see energy systems) as well as the focus for experiments and instruction in pond ecology. During August when the hottest temperatures are most likely to occur, the winds are often from the west and the pond helps to cool the breeze entering the site.

The outdoor learning areas are located mainly between the classroom wings; a sense of enclosure is provided by screens of trees at the ends of these open areas. Trees are situated on the north edge of the site to direct wind flow into the buildings for summer cooling and in belts along the southern side to "shelter" the school from winter winds.

A half mile sawdust jogging trail surrounds the site and is for community as well as school use. Parking is provided for visitors and community in the southwest corner of the site and is next to playing fields and the school meeting hall for ease of access. A large sundial next to this parking draws attention to the fact that the school is on solar time.

Sugar beet fields are scattered around the site, and crops are processed and distilled in the barn to make ethanol.

Energy Systems

The school is designed to operate without using nonrenewable finite energy resources.

1. WATER:

A well will be drilled on site for the school water supply. Pumping will be done by a windmill, which will pump the water up to an elevated storage tank. Water would then be gravity fed to sinks located between classrooms at the compost toilets and to the kitchen and health care building.

2. SEWAGE:

All human wastes and kitchen wastes will be composted in compost toilets similar to clivus multrums, which will be constructed on site to save costs. Three composting toilets will be located between each classroom cluster. This provides a backup toilet in case one or two are contaminated. Compost will be emptied approximately every six months and placed in sugar beet fields. Warm air to maintain the composting toilets at a 65° minimum will be tapped from entry foyer or from the classroom itself during extreme cold spells.

3. LIGHTING:

A. Classrooms: daylight through south facing clerestories and greenhouse windows and monitor along north wall. Reflective surfaces are to be located on roof directly in front of clerestories and equal to clerestory height for increased sunlight penetration. See daylight calculations.

B. Office/Health Care Building: daylight through windows on south and north side and through south facing clerestory.

C. Library: daylight through south water wall and south facing clerestory. Offices at north side are to be lit by windows in north wall. Conference room lit by south and north facing windows.

D. Meeting Hall: daylight through upper south and north walls. Upper south windows to have manually operated blinds.

E. Gymnasium: open on north, east, and west walls. Locker rooms lit by south facing clerestory.

Windows are sized to meet winter minimum lighting needs. Shading devices will be used the rest of the year. A minimum of 30 ft.c. during all scheduled hours has been provided in classroom during entire year although reading might be scheduled when there is more light.

4. HEATING:

A. Classroom: passive system storing solar energy passing through south clerestories on brick walls and floor. Tromb wall and water wall in greenhouse on south of classrooms heat adjacent spaces. Fresh air passes through underfloor masonry ducts before entering classrooms. Exhaust air passes through underfloor masonry ducts before being vented through chimney. Fresh and exhaust air use alternate ducts. Heat exchange thus preheats fresh air in winter. A rock storage bed heated by a thermal siphon is located under floor next to tromb walls. Room air is circulated through rock bed when sun does not shine for 3 consecutive days, the rock bed acting as an auxiliary heating system during extended cloudy weather. Rock bed is located only in west half of dual classroom. On extremely cold days both classes would move to west half of cluster to benefit from rock storage. West half would be closed off from east half of classroom under such conditions.

B. Office/Health Care Building: passive storage in masonry wall and floor along center of building under skylight. Solar wall heater for rooms along south wall. Fireplace to be used during extended cold spells or cloudy weather.

C. Library: passive storage in water wall consisting of tall cylinders along south wall. Passive storage in brick wall and floor entering from sunlight clerestory above in center of building.

D. Meeting Hall: tromb wall on south side. Passive storage in brick north wall from sunlight entering through upper south wall.

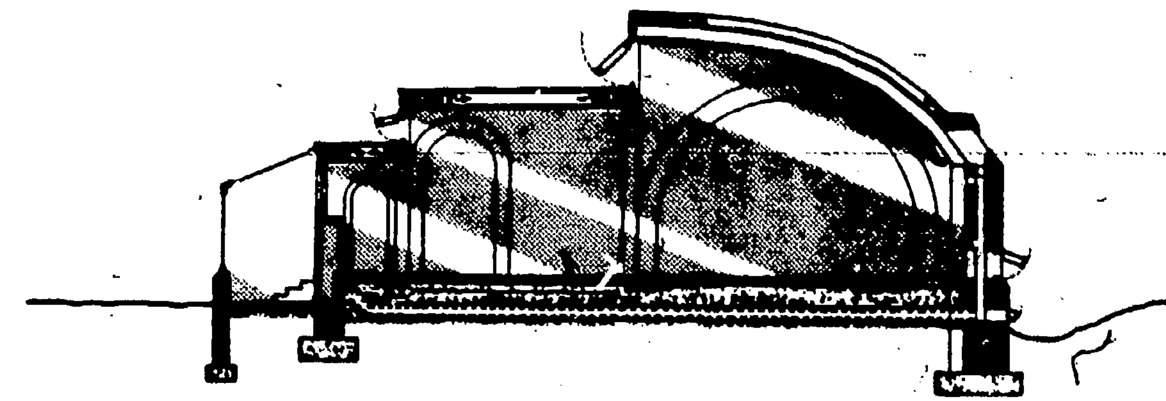
E. Gymnasium Locker Rooms: passive storage in masonry walls of sunlight entering through south clerestory.

Passive storage in masonry or

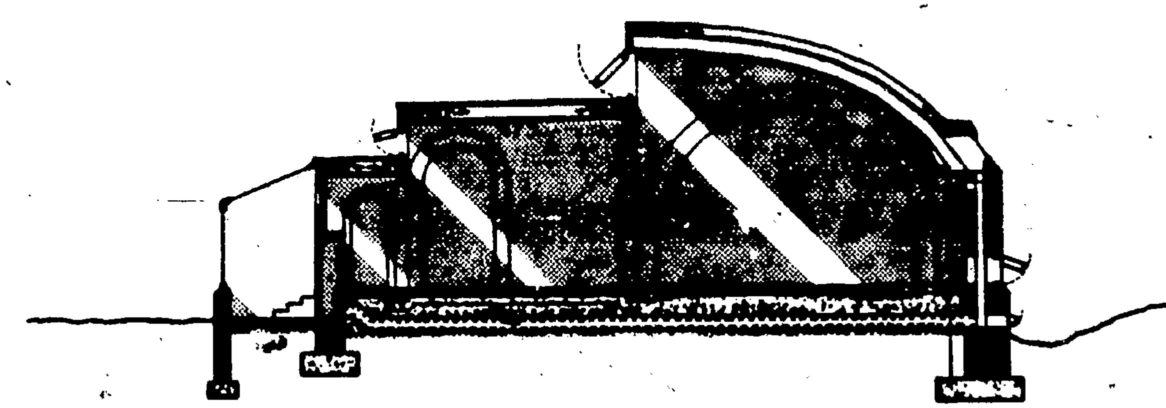
water walls has been incorporated in all spaces. Additional heat from solar wall heater and thermo siphon is used in certain spaces. A variety of passive systems have been used to help demonstrate different methods of heat storage from sun. Mass storage has been sized large to maintain low temperature fluctuations during cloudy weather. Backup rock storage provided for classrooms only. During extended cold periods auxiliary spaces such as the meeting hall and library would not be used or would be used cold. Classroom storage should maintain a 65° minimum except under most extreme conditions.

5. COOLING:
All cooling to be by natural ventilation. All clerestory windows also act as vents. Lower north wall opens up to allow breeze through class in conjunction with clerestory vents. Class would be cooled at night by flushing with cool nighttime air. Buildings are oriented to utilize summer breezes for cooling.

DEC 21



MAR 21
SEP 21



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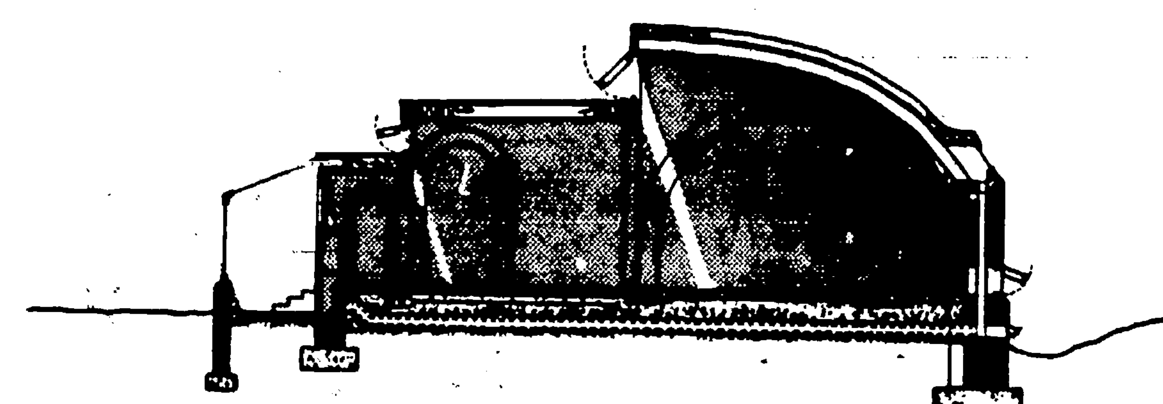

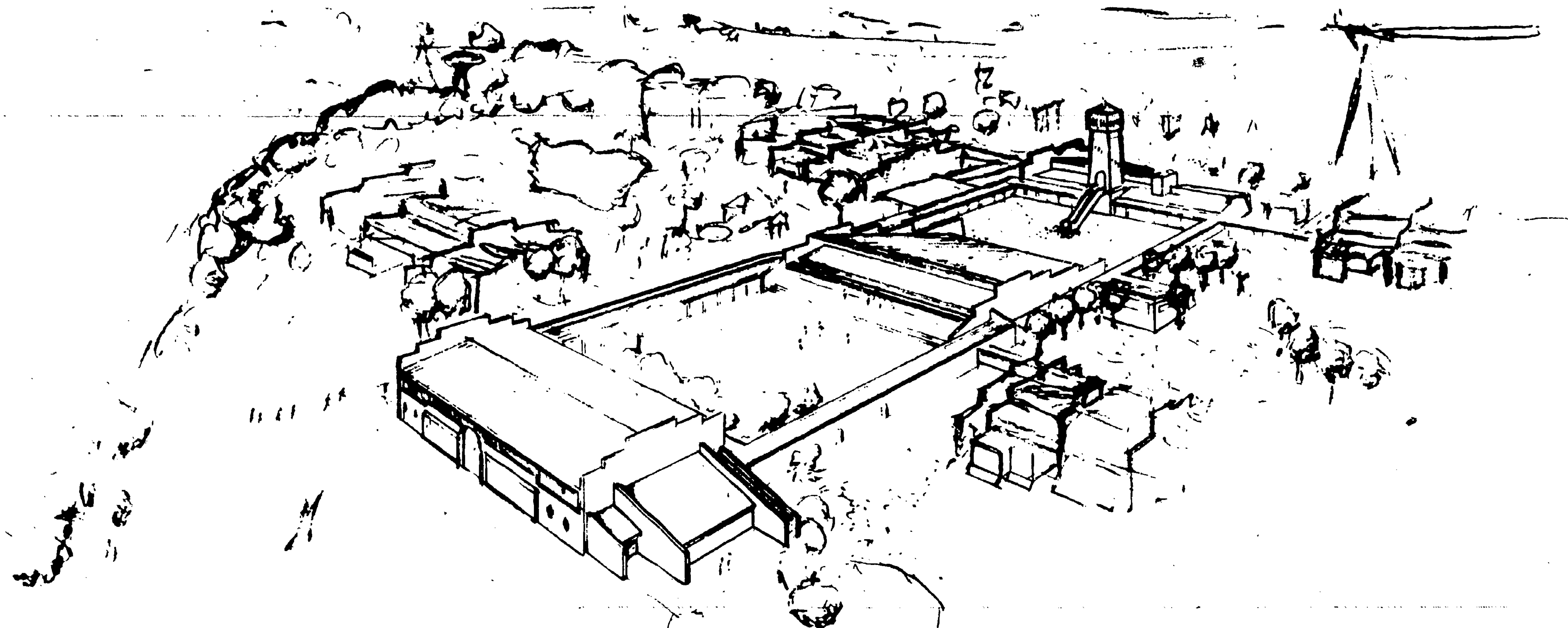

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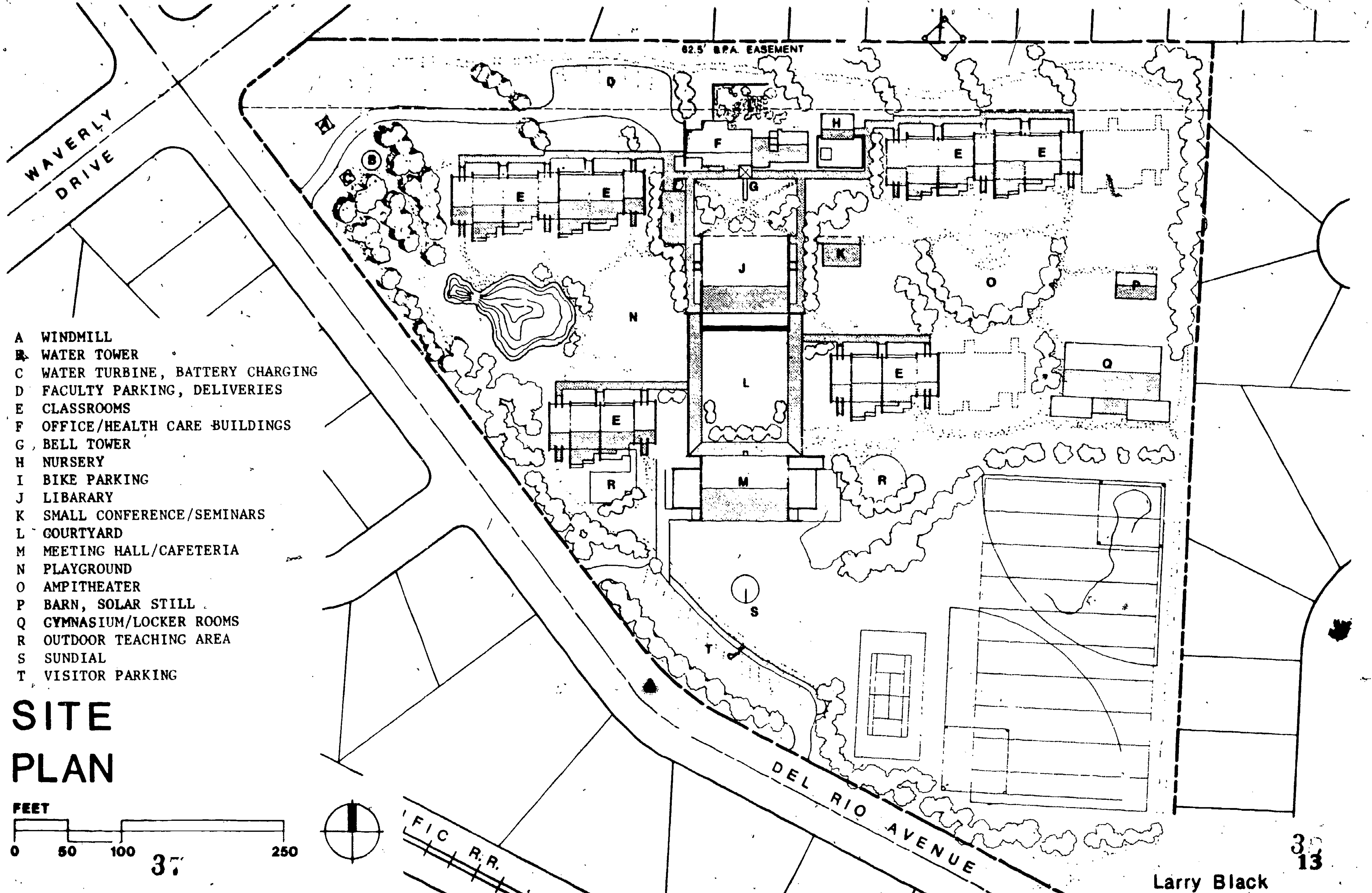
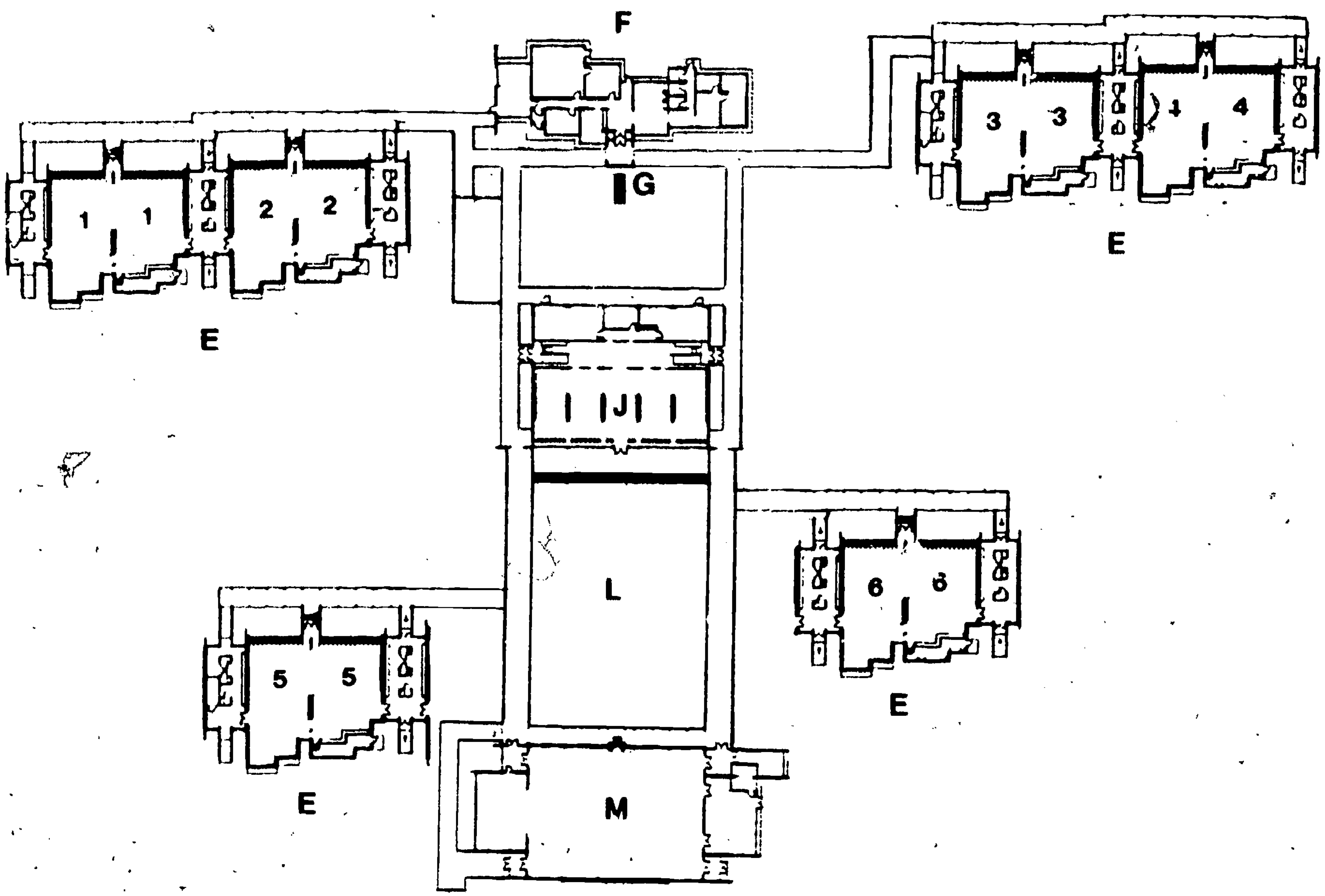
36 Larry Black



62.5' B.P.A. EASEMENT
WAVERLY DRIVE
DEL RIO AVENUE
FIC R.R.
A WINDMILL
B WATER TOWER
C WATER TURBINE, BATTERY CHARGING
D FACULTY PARKING, DELIVERIES
E CLASSROOMS
F OFFICE/HEALTH CARE BUILDINGS
G BELL TOWER
H NURSERY
I BIKE PARKING
J LIBARARY
K SMALL CONFERENCE/SEMINARS
L COURTYARD
M MEETING HALL/CAFETERIA
N PLAYGROUND
O AMPITHEATER
P BARN, SOLAR STILL
Q GYMNASIUM/LOCKER ROOMS
R OUTDOOR TEACHING AREA
S SUNDIAL
T VISITOR PARKING
SITE PLAN
FEET
0 50 100 250
Larry Black



Larry Black

SCHOOL

The school is arranged similar to a campus plan for a number of reasons in addition to those already mentioned. When the school is divided into separate blocks only that portion of the building which is to be used needs to be open. Those portions which would be used by the community besides the playing fields are the meeting hall, the office/health care building, and the library. The layout is such that the public can use these facilities during the day while school is in session without disrupting class. These portions of the school have been placed on an axis in the center of the school layout. Community members would enter the site from the parking area in the southwest corner. A walkway leads directly to the meeting hall which would be used most often and thus should be most easily accessible. The facade makes it hard to miss and easy to describe.

Past the meeting hall the library is reached by walkways on either side of the courtyard. The library could be open on weekends to the public with possible access to the audio visual facilities. The office/health care building is identified by the bell tower. The bell tower would be visible from most portions of the site. Not only would it provide orientation for new visitors but it makes directions to the reception area and health facilities very simple--"go to the bell tower". The community would be encouraged to visit the school as it would be a desirable facility for seminars. After hours use would be limited to daylight hours unless the users were willing to supply their own lighting. Ethanol produced on site could be used for lighting but frequent night time use would deplete this resource.

CLASSROOMS

The classroom has been designed as the functional heart of the school. While the meeting hall or library might not be usable in extremely cold weather, the classroom is designed to be used at all times. It is in the classroom that students spend most of their time.

The classroom is also what really determines the success of the school. The classroom not only needs to function all the time at zero energy use but it must be able to accommodate various teaching methods now employed as well as be flexible enough to respond to future changes in teaching methods.

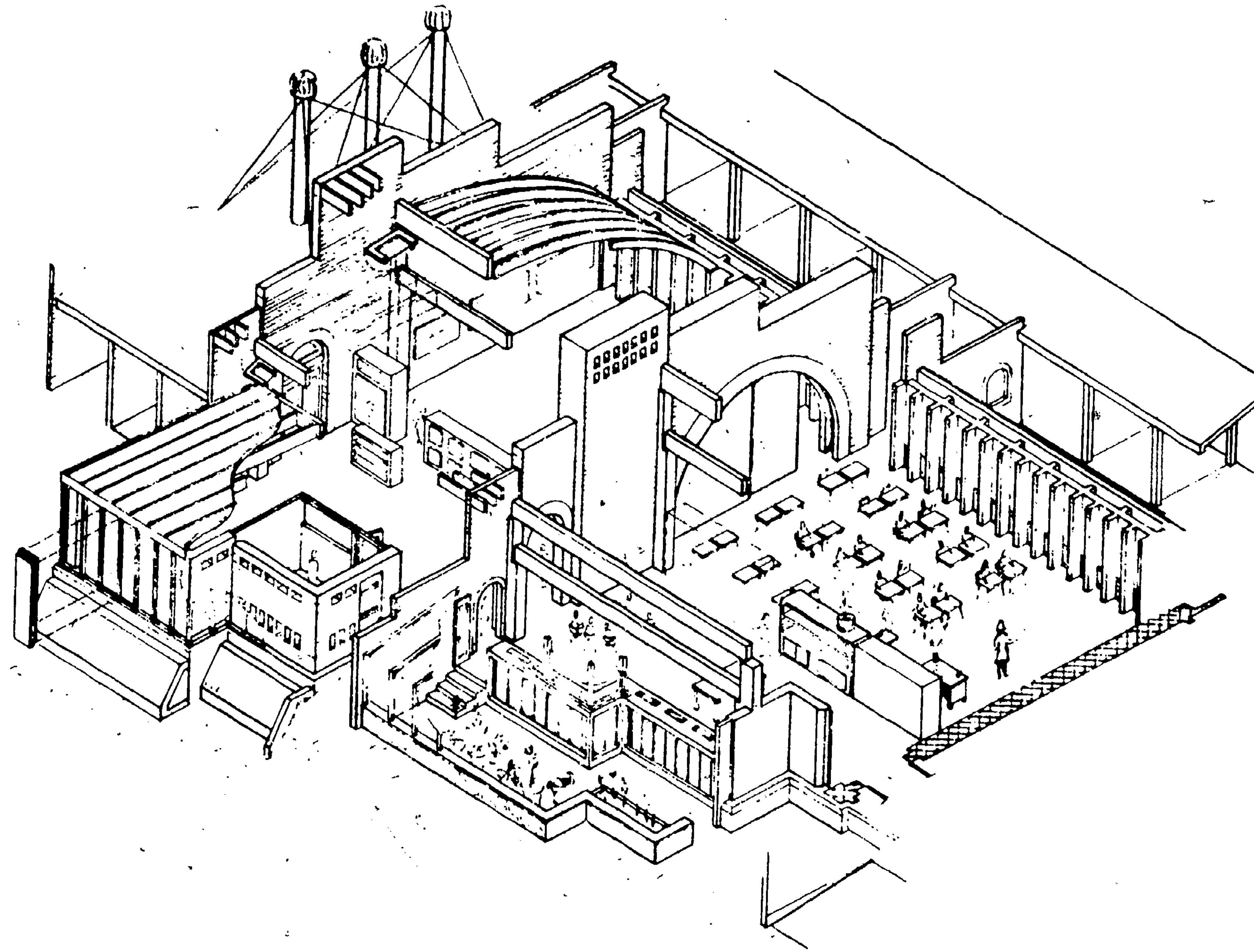
First of all, the energy systems should be visible and understandable to the students. A number of different heat systems have been incorporated into the classroom (as well as the other spaces) so that the student might gain as much exposure to different passive systems as possible (see energy systems). Students and teacher have direct control over lighting, heating, and ventilation in their classroom and are responsible for operating it during the school day. Maintenance personnel would place insulating panels in place after hours. An operating manual would accompany the classroom, and training sessions would have to be held for new instructors.

School should also educate the children in terms of spatial awareness. A variety of shapes, heights, openings, and materials have been employed to increase the spatial experience of the child.

The classrooms are arranged in clusters of two and are separated by an arched opening with rolling wall partition. The south wall is half tromb wall and half greenhouse. The area by the tromb wall could be divided up into small rooms for individual and/or small group instruction with the teacher, Title I Specialist, or counselor.

The greenhouse provides heat and brings living instruction models into the classroom. The space beside the greenhouse has direct sunlight on sunny mornings in fall, spring, or winter and would be large enough to accommodate both classes for storytelling, show-and-tell, etc. This space can be enlarged or decreased by the position of the wall between it and the more formal classroom. This wall could be a regular stud wall or simply bookcases as the ceiling is supported by the masonry walls at the ends and the middle.

The classroom clusters are separated by entry foyers where students' cloaks and boots are removed and stored. This foyer serves as an air lock between the classroom and outside to help insulate the classroom. Also located here are composting toilets similar to clivus multrums. A tunnel underneath provides access to the composted waste.



Iscmetric Detail Cutaway Drawing

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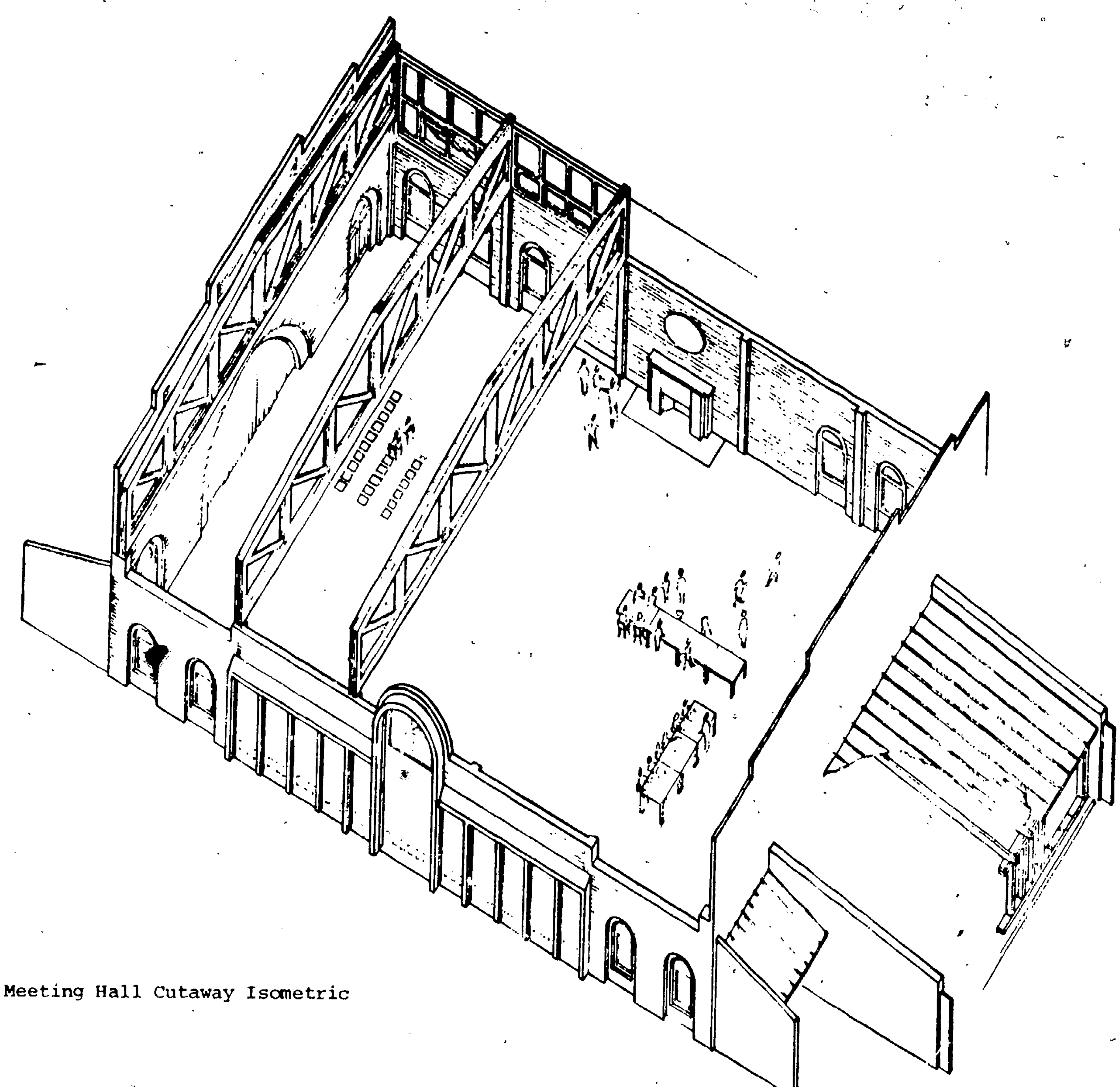
4

THE MEETING HALL

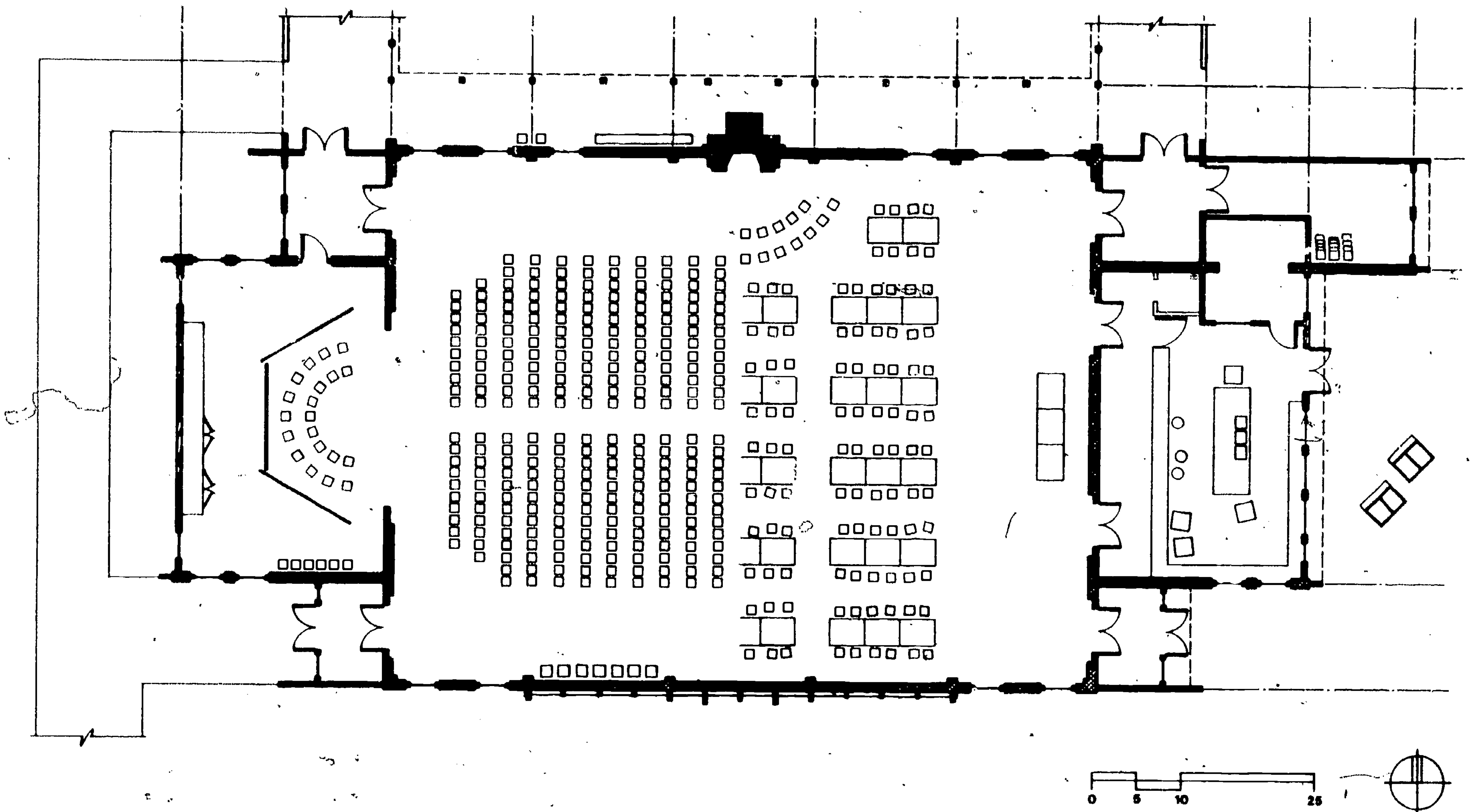
The meeting hall serves a variety of large group activities. The school would use it for assemblies, a cafeteria, band rehearsal, dancing, etc. The public could reserve the hall for use on weekends or during the day when not scheduled for use by the students, and would have use of the kitchen if desired. On the west side of the building is a band equipment and miscellaneous storage room which also doubles as a stage. On the east side is the kitchen as well as additional storage.

The kitchen would have no refrigerator and would rely on solar ovens for cooking. A natural nutritious diet consists of simple grains, vegetables, and fruit and really needs little cooking. The kitchen should become a demonstration model for preparing meals which require little energy yet provide more nutrition than many American diets. On clear sunny days the students could expect something cooked in the solar oven located on a patio . n the eastern side of the kitchen fc . rning sun.

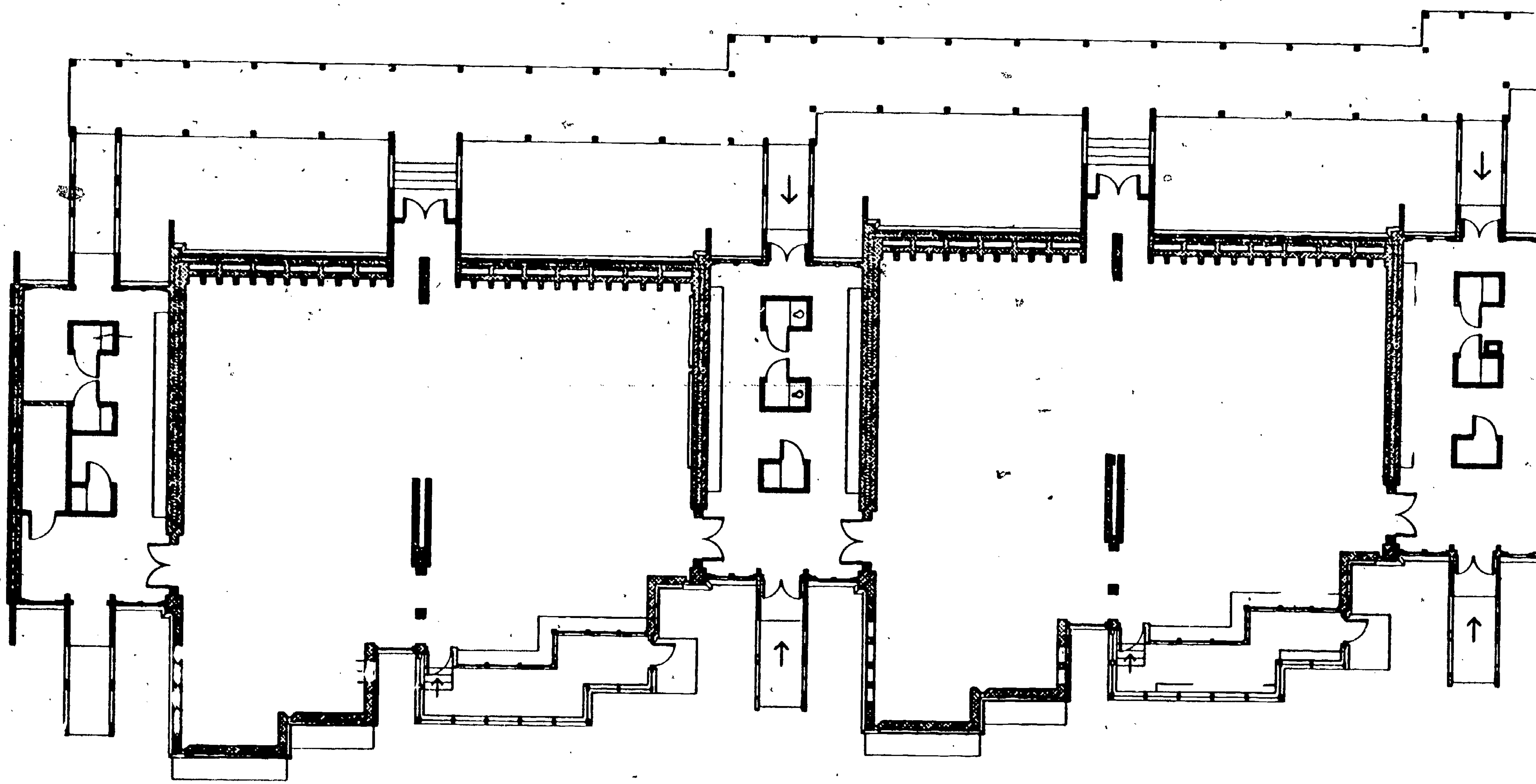
The meeting hall is lit by strips of windows on the north and south sides between the trusses. The light is thus entering the hall above eye level to reduce glare and aid in diffusing. These windows also open to provide high cross ventilation. Part of the south wall is a 10' tromb wall, and the north wall on the interior is masonry for storing heat from the sun entering through the upper south windows in winter. The meeting hall is designed to be used when the weather is not extremely cold. Undoubtedly it would be unusable for a portion of the winter.



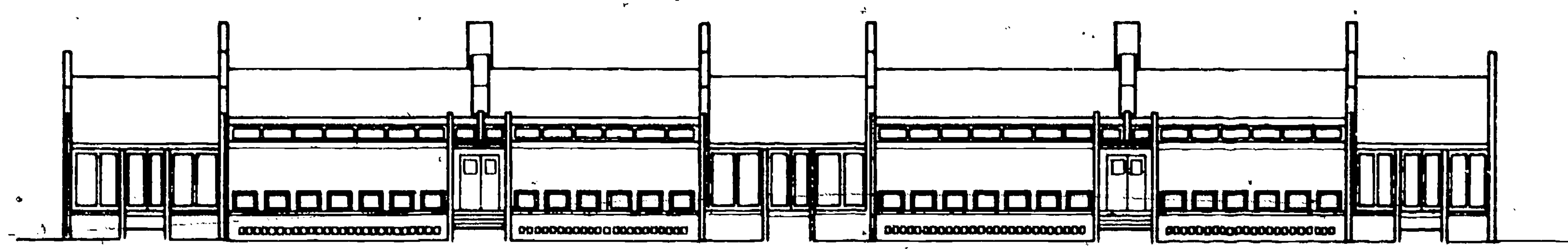
Meeting Hall Cutaway Isometric



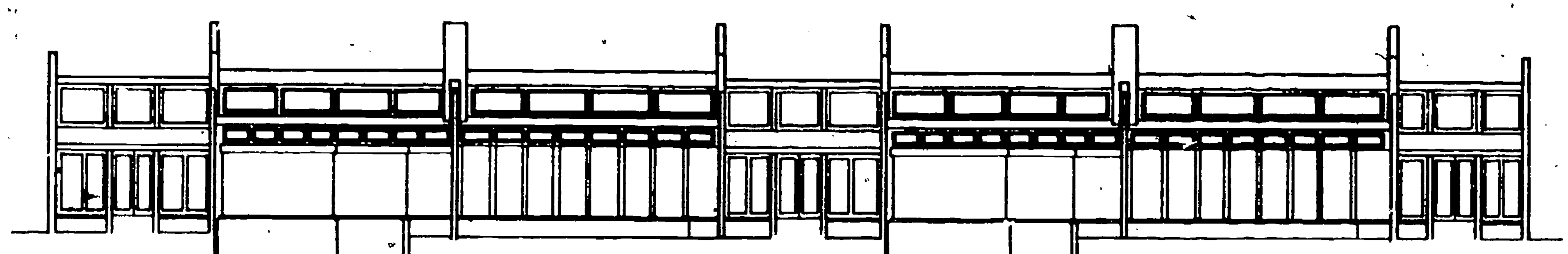
Meeting Hall Plan



TYPICAL CLASSROOM



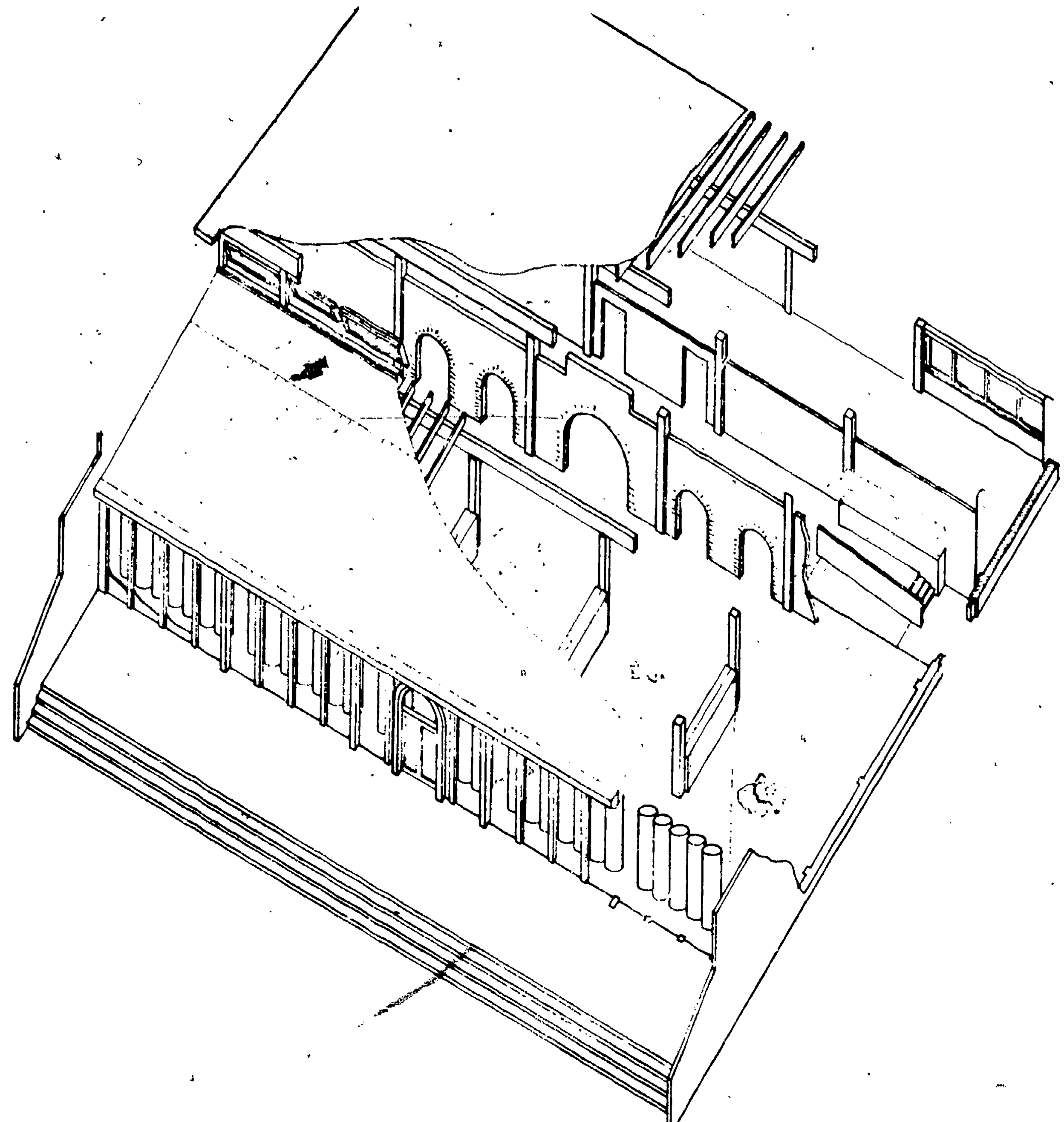
NORTH ELEVATION

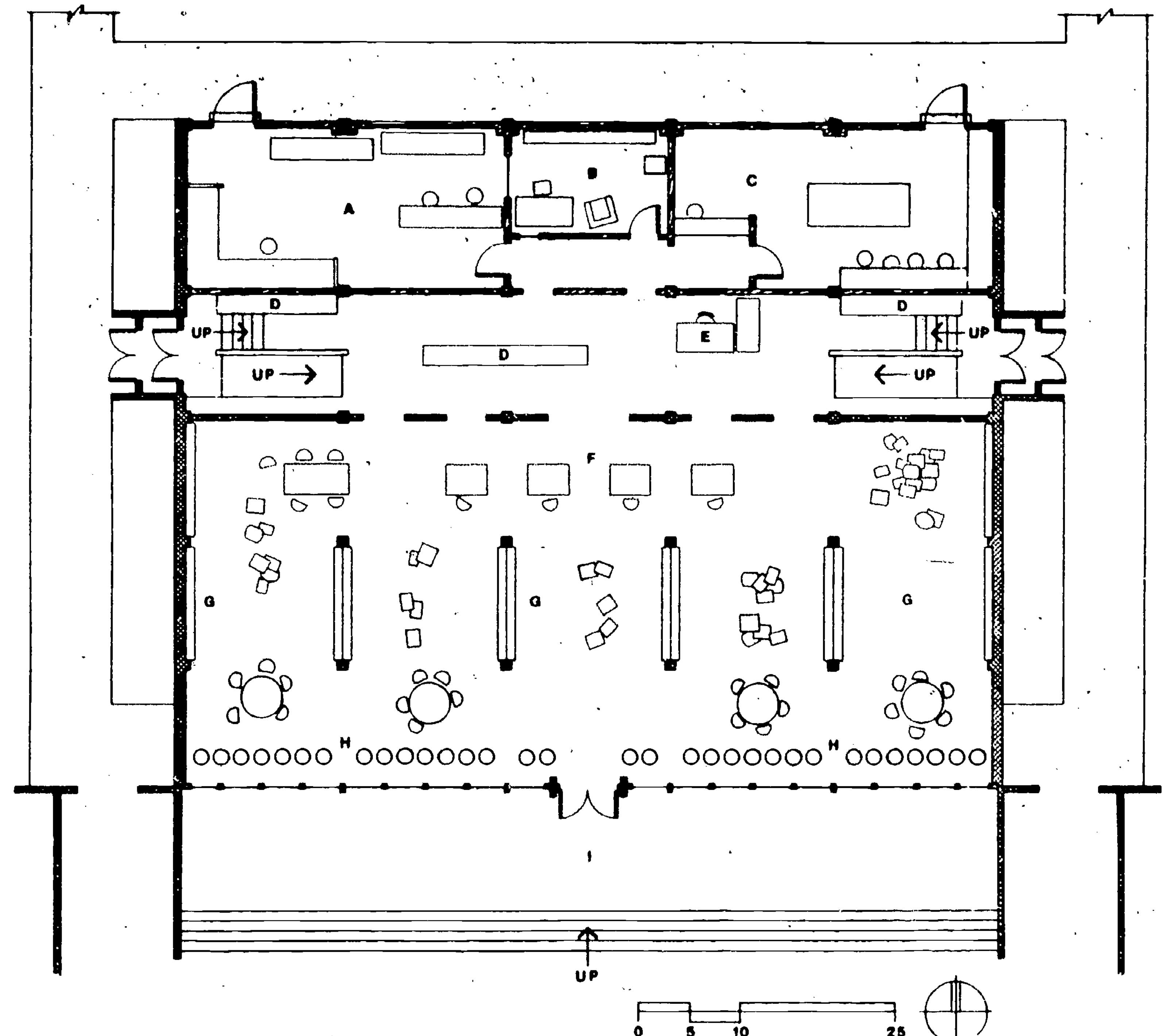


SOUTH ELEVATION

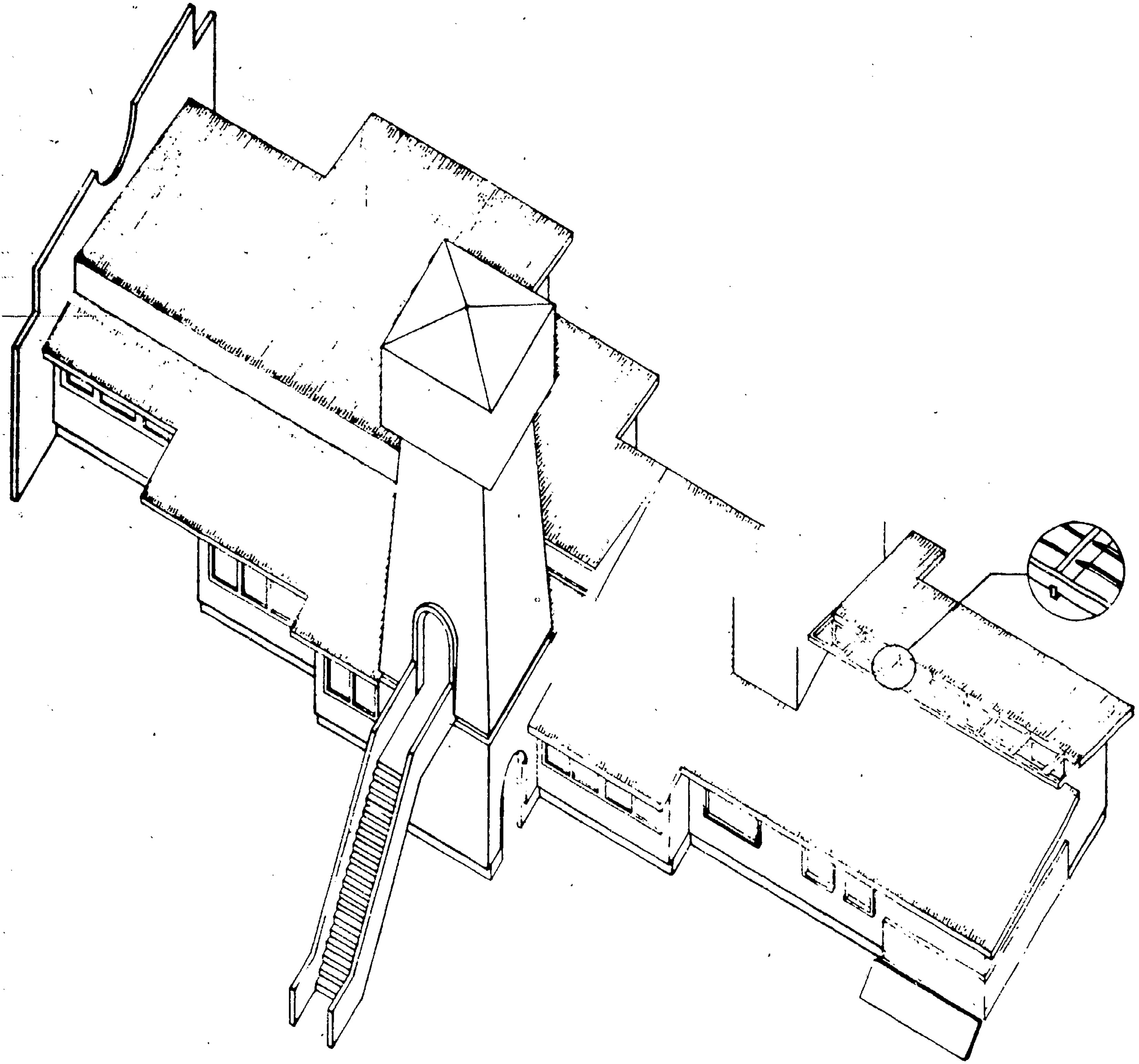
THE LIBRARY

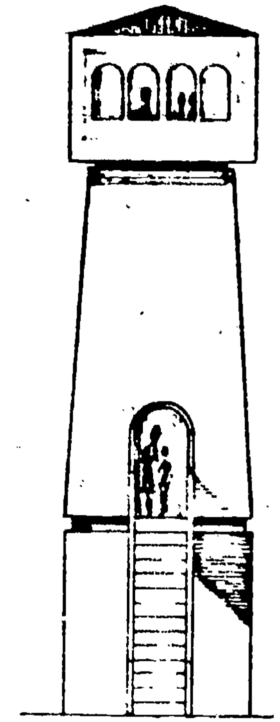
The library is heated by a water wall along its southern wall as well as an interior masonry wall which divides the reading room from the circulation and display area. Walls between the workrooms and audio-visual rooms and the rest of the library do not extend to the ceiling in order to allow light to flood across the top and warm air to rise to the center clerestory where it is vented. Rooms along the north side are narrow in the north-south direction to insure adequate light penetration from the north. Outside the library to the south is a wood deck which can be used by students who want to read outside on nice days. The wood deck also acts as a platform/stage for the surrounding courtyard.





A WORK ROOM/STORAGE
B LIBRARIAN'S OFFICE
C AUDIO-VISUAL/STORAGE
D DISPLAY
E CHECK-OUT
F CARD FILES/REFERENCE
G STACKS
H WATER WALL
I WOOD DECK





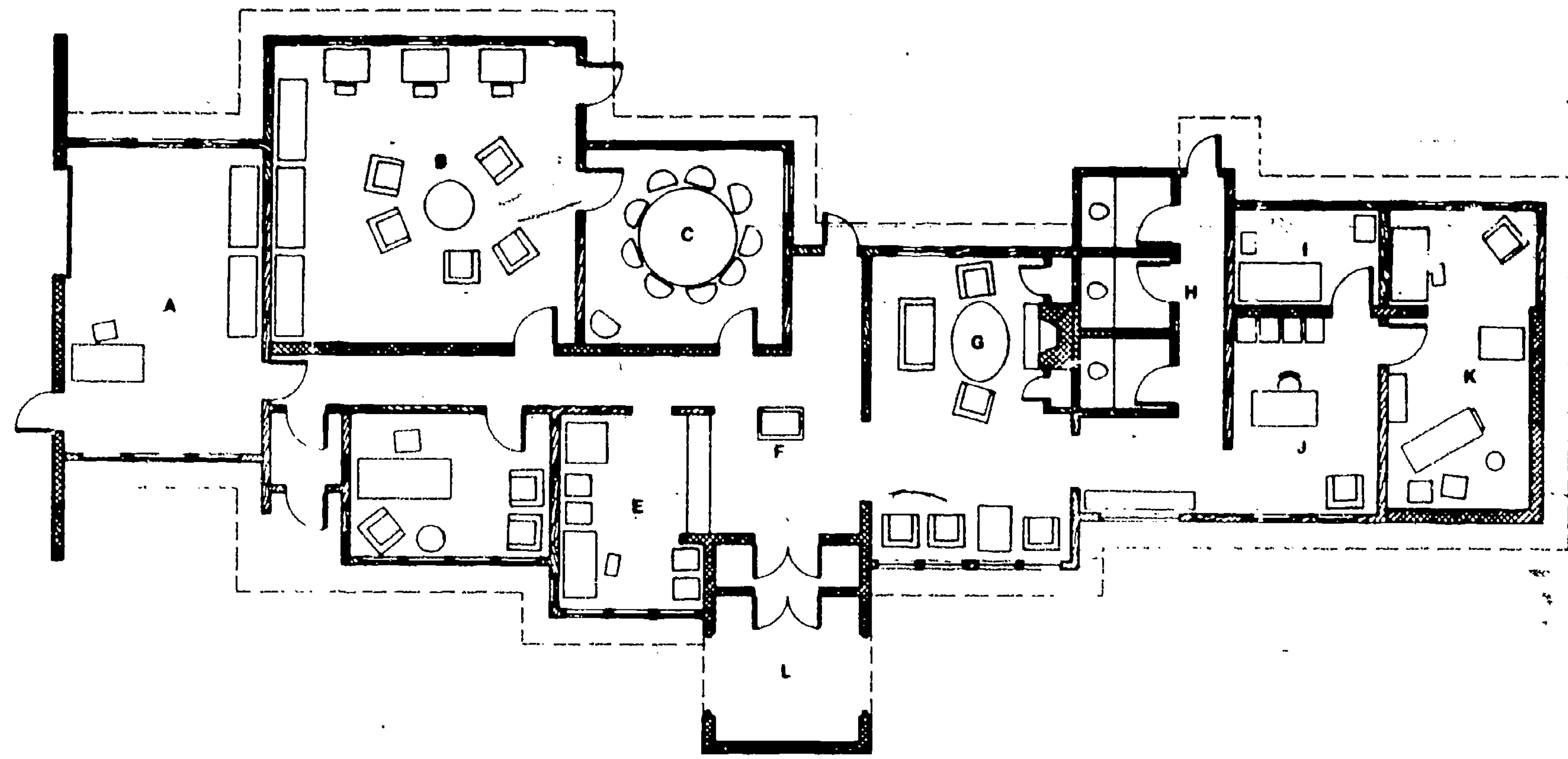
OFFICE/HEALTH CARE BUILDING

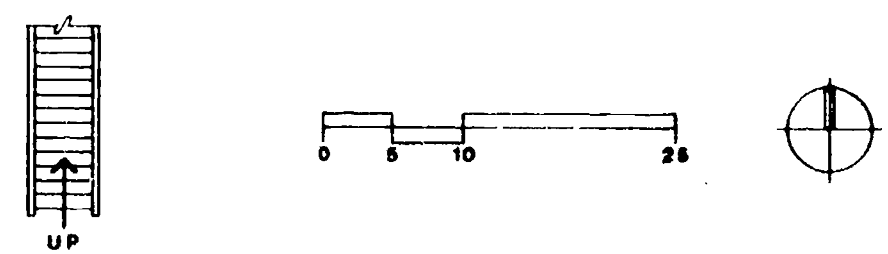
The office/health care building is grouped around a reception area which has a lounge with a fireplace for a more comfortable informal atmosphere. Parents and public would be encouraged to visit the school frequently and the lounge would be their home away from home. Here they could meet with teachers without disrupting classes and relax while they were waiting to pick up a child. This lounge also would serve the health care facilities and could become an informal setting for small group discussions on health care topics which would be encouraged as part of the program to open the school buildings to the public.

The bell tower creates a symbol for the school, a school which is advanced in terms of energy use yet very similar in ways to the little red schoolhouse of yesteryear. The tower links the two. Children's fantasies and spatial experiences are also enriched through the tower.

The tower is also a classroom and an important one. The tower used in conjunction with landmarks in the landscape allows children to witness sunrise and moonrise and notice the changes which take place in the locations where the risings and settings happen. It would be much more powerful for a child to actually observe that the sun rises in the north east in the summer and the south east in the winter than by reading about it in class.

Students would be allowed to rise above normal consciousness and become aware of much larger systems of which they are a part. This is what the entire school is striving to do, to expand awareness of our earth and universe so that children might learn of the interconnectedness of things, so that they might begin to associate the body of the sun with the energy which eventually heats and lights their school. Looking due south from the tower one will see the top of the sun dial just over the roof of the meeting hall, a link which emphasizes which direction to look toward for the future.





A RECEIVING/STORAGE
B TEACHERS LOUNGE
C CONFERENCE
D PRINCIPAL
E RECEPTION/SECRETARY
F DISPLAY/LOBBY
G LOUNGE
H COMPOSTING TOILETS
I OBSERVATION ROOM
J NURSE/RECEPTION
K EXAM[illegible] ROOM

douglas corbett

Design

This scheme attempts to minimize the exterior surface of the school, reducing heat loss and preserving the site as a public park. It is also an effort to explore the potential in a two-storey, large scale solar building. The school would operate on a slightly modified calendar year, with a longer Christmas vacation, and extended hours in the spring and fall.

The building is located in the northwest corner of the site, reducing the impact of Waverly Drive, and to give special definition to Del Rio Avenue (see figure B). This location allows a potential link to the proposed neighborhood commercial zone across Waverly Drive.

The site layout assumes that the B.P.A. easement will become the principal pedestrian circulation spine for the neighborhood. The B.P.A. easement forms a ring around South Albany and is an opportunity for public gardening space and bike paths. The covered walkways provide sheltered circulation from the bus shelter and car-drop off to the school, enclosing the kindergarten play area, screening cars from the site.

The school consists of a two-storey block of classrooms oriented to the southeast for early morning solar gain (see figures C and D). The administrative offices, kitchen, and librarian's office form a one-storey block to the north of the classrooms. These are oriented due south because their heating requirements are different from those of the classrooms.

The cafeteria and library are incorporated into a series of terraces that connect the administrators to the classrooms. The gym is to the east of the building and forms an east-facing courtyard. Student access is primarily from this space and the B.P.A. path systems. Car users would approach from the walkways past the administration.

Energy Considerations

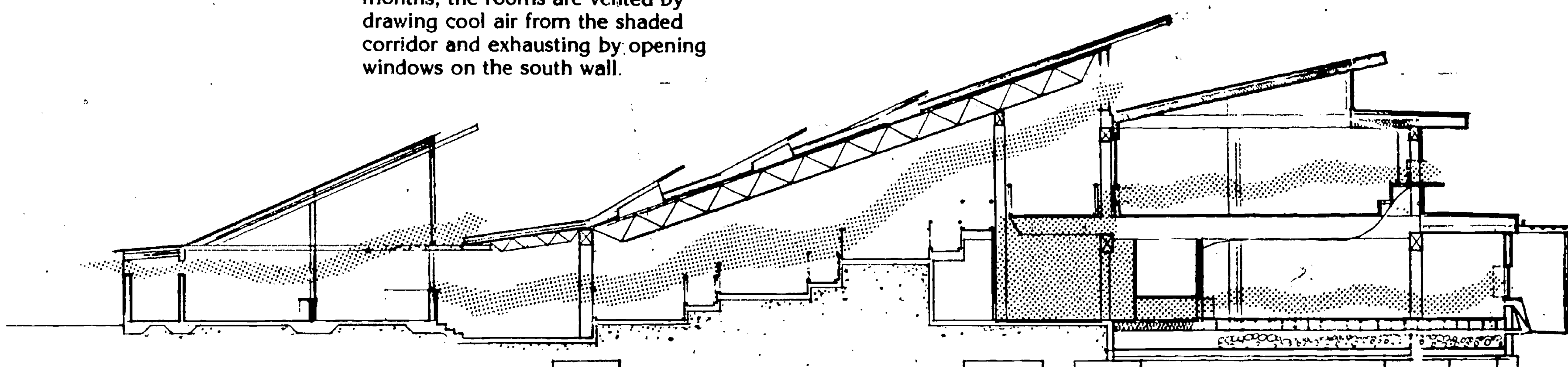
The classrooms are heated by direct gain. At night the insulating shades would be drawn, and the foam floor cushions hung over the windows. Light can be controlled by adjustable shades, diffusing glass, and clerestories. During the winter months, fresh warm air is provided by bringing the cold outdoor air through a solar heating panel. The warm air is then directed into the lower classrooms by means of natural convection. This air naturally rises and can be supplied to the upper classrooms via the greenhouse. During warmer months, the rooms are vented by drawing cool air from the shaded corridor and exhausting by opening windows on the south wall.

The nonflushing toilet eats up the human waste in containers. Each night they are emptied and the organic material collected for methane production. This methane is used for kitchen cooking.

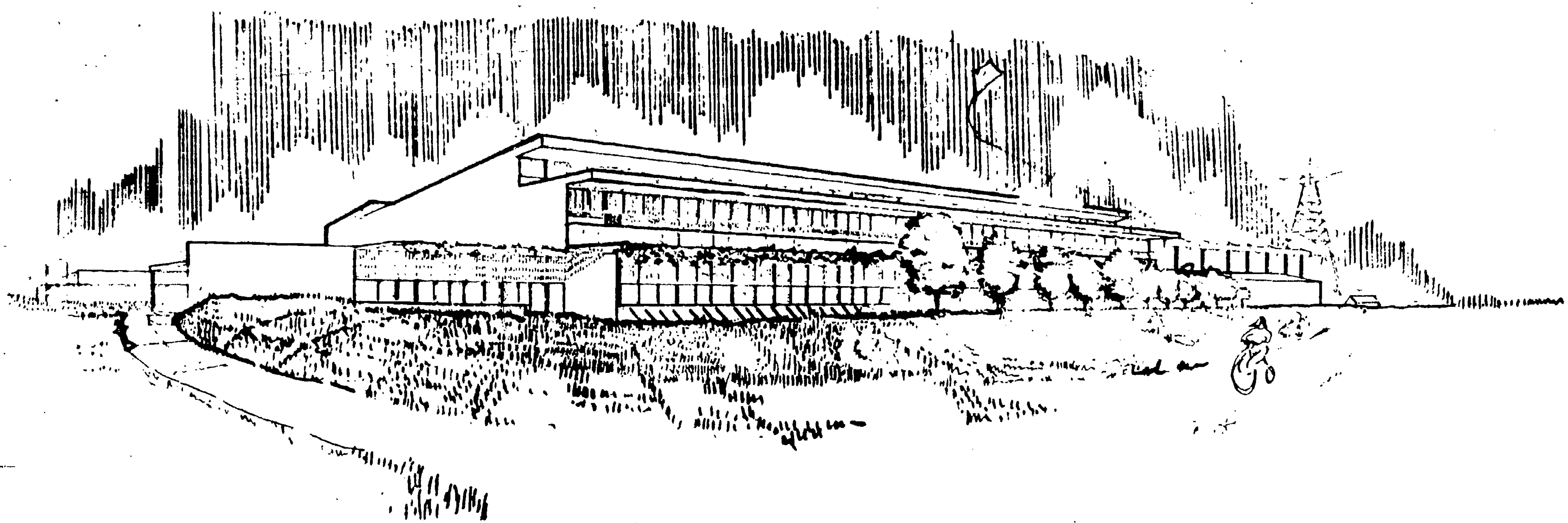
Water is provided by a windmill, pumping water to a storage tank, then it is gravity fed to the classrooms.

Electricity is provided by solar cells installed on the roof and stored in battery carts for audio-visual use. These solar cells also power fans which pull the hot air from the top of the classrooms back down into a rock storage bed beneath the lower classrooms.

The classrooms are based on a quick morning heatup. This is accomplished by using diffusing glass to let in heat but reduce harsh light. A strip of clear glass is provided at table height for view to the outside. Wood construction is used as much as possible to reduce the amount of mass that must be warmed before the air in the classroom begins to heat up. A clerestory permits heat and light to penetrate to the northern side of the room. An acoustic ceiling is hung to reduce sound transmission and aid in the diffusion of light.

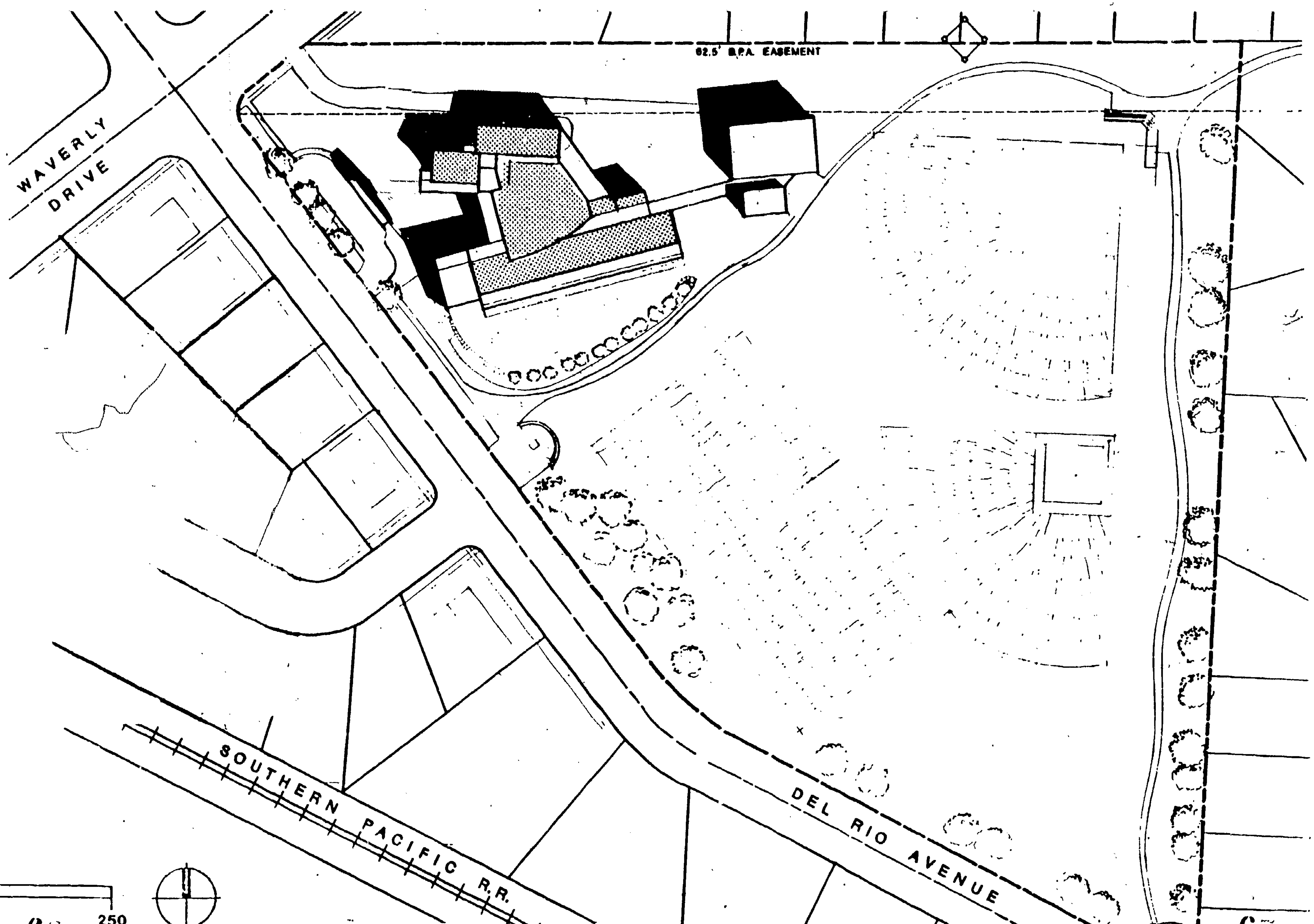


Energy System Drawing



Exterior Perspective

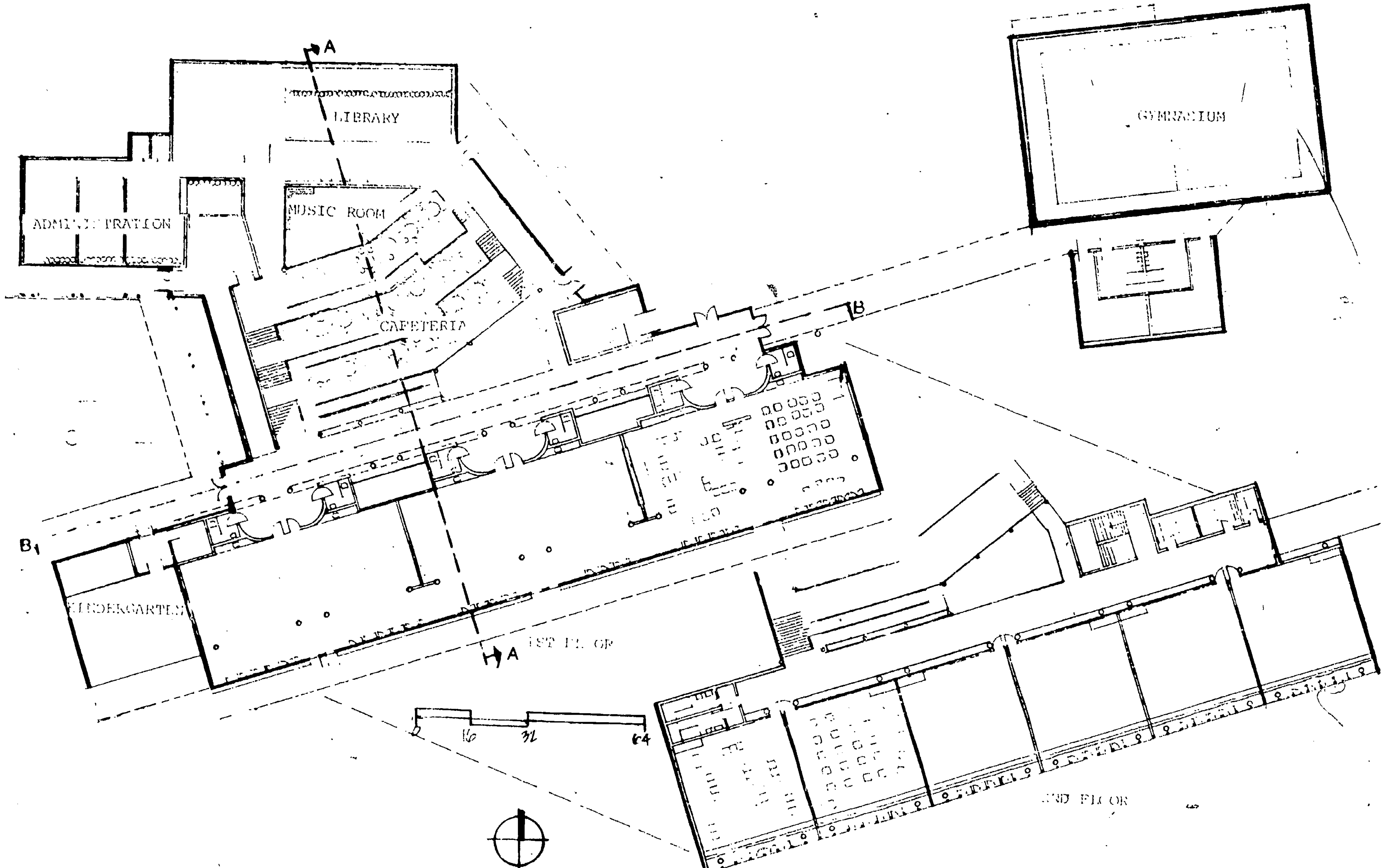
Douglas Corbett



SITE PLAN

FEET

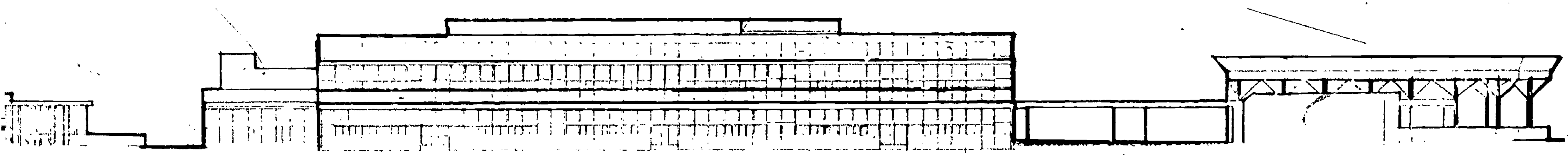
0 50 100 250



6

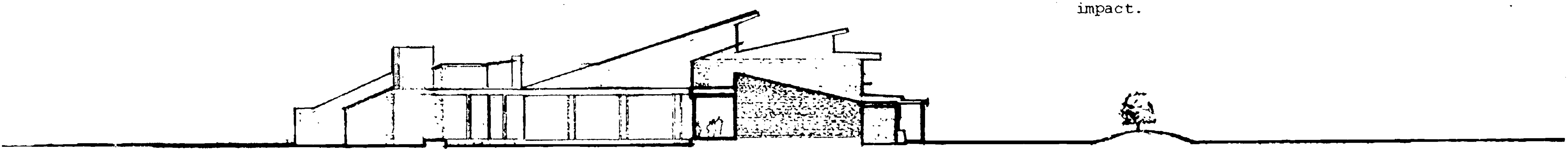
Plan

Douglas Corbett
6
29



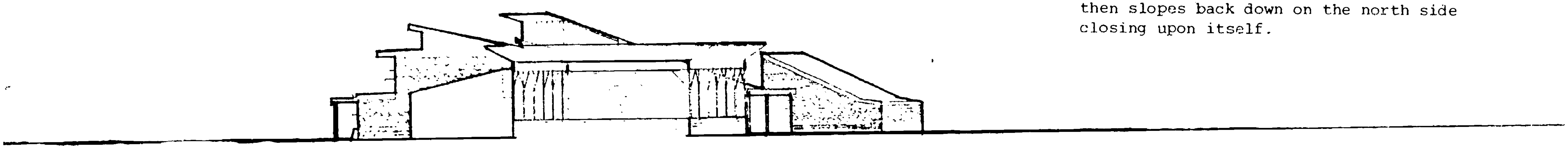
South El.

The southeast facade of the building is two storeys, but it faces the park area and away from the street to reduce impact.



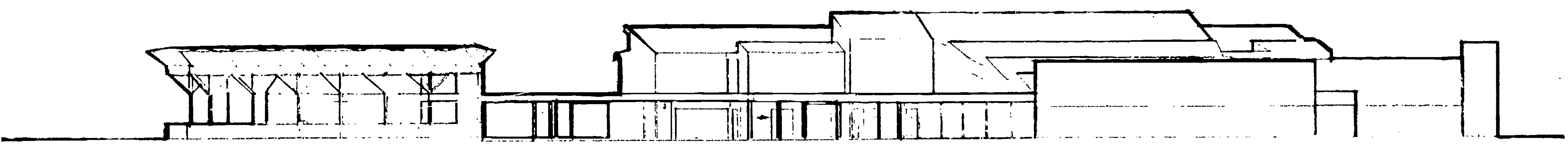
West El.

The east and west elevations show how the building steps up from the south and then slopes back down on the north side closing upon itself.



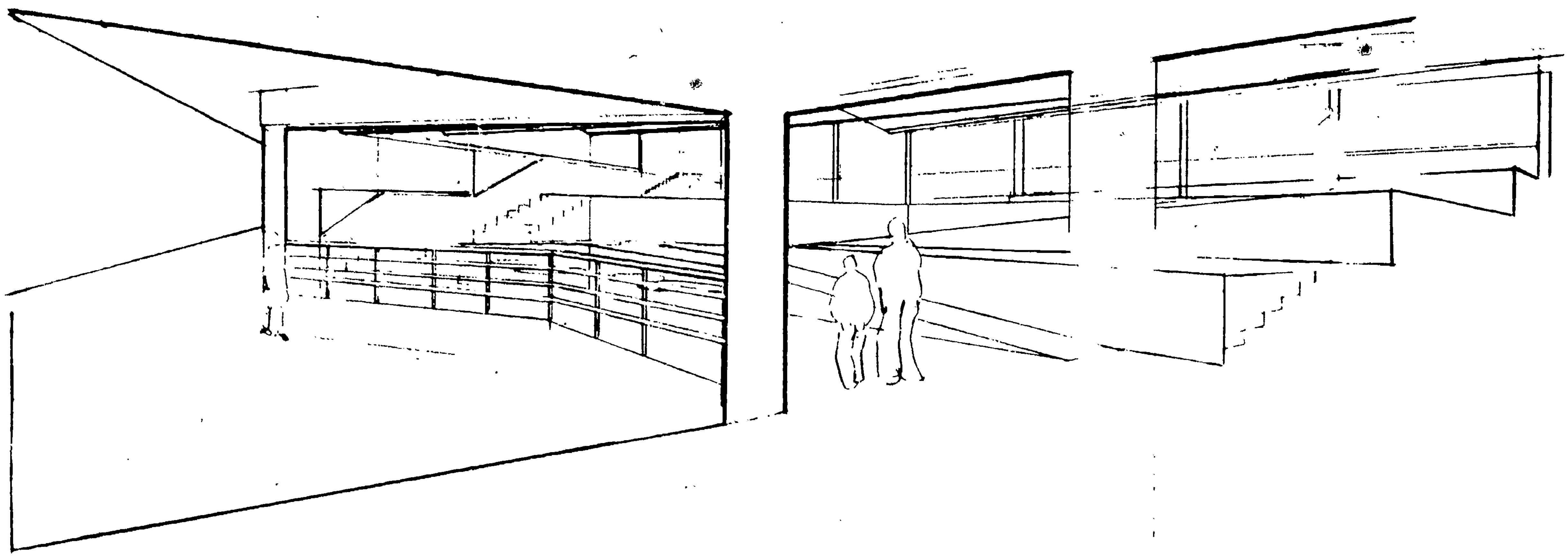
East El.

The north elevation is low, reducing heat loss while maximizing the area of south facing glass.



North El.

Elevation Douglas Corbett

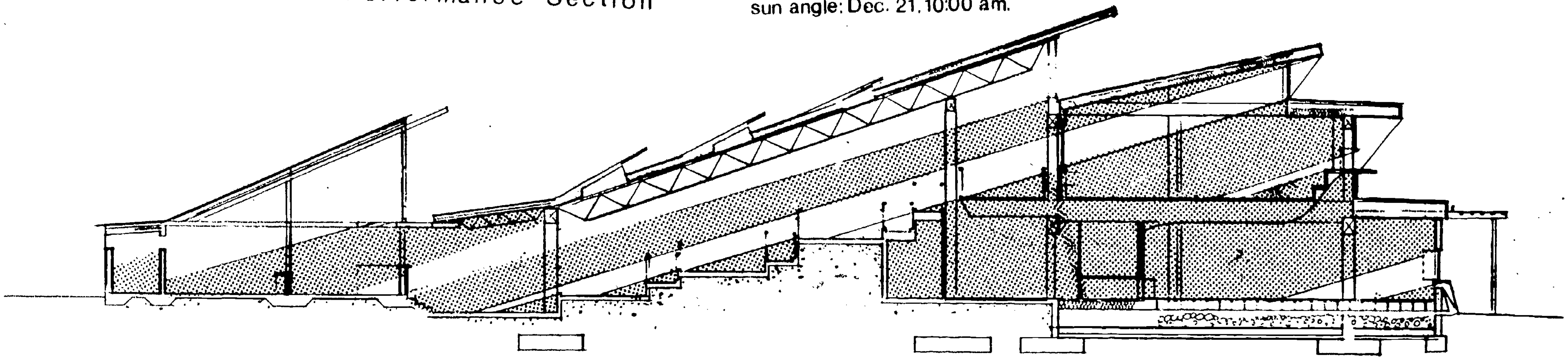


This drawing shows the cafeteria/ library space. The terraces focus toward the librarian's office and kitchen. This space can also serve as an auditorium, and would be heated by direct gain from the high south glass.

Interior Perspective

Segmented Performance Section

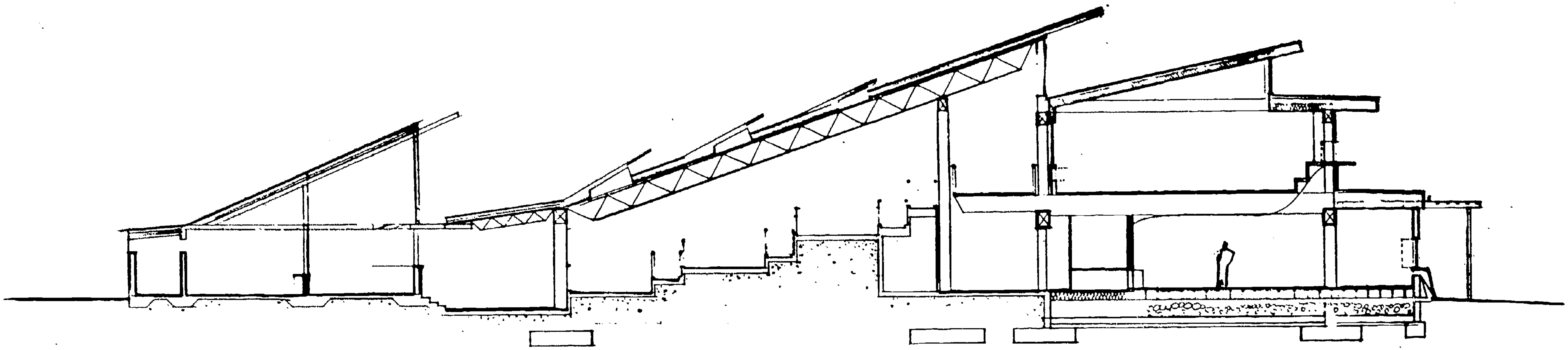
sun angle: Dec. 21, 10:00 am.



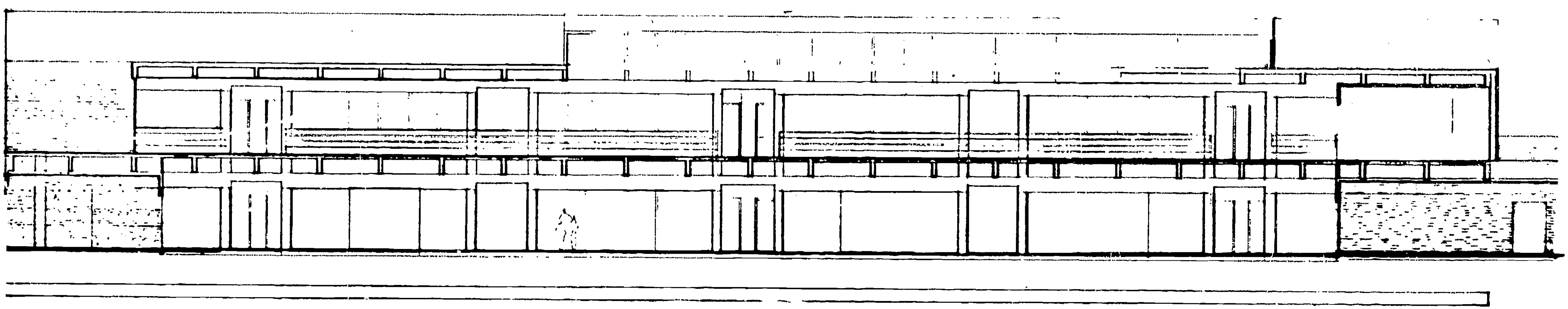
Douglas Corbett

74

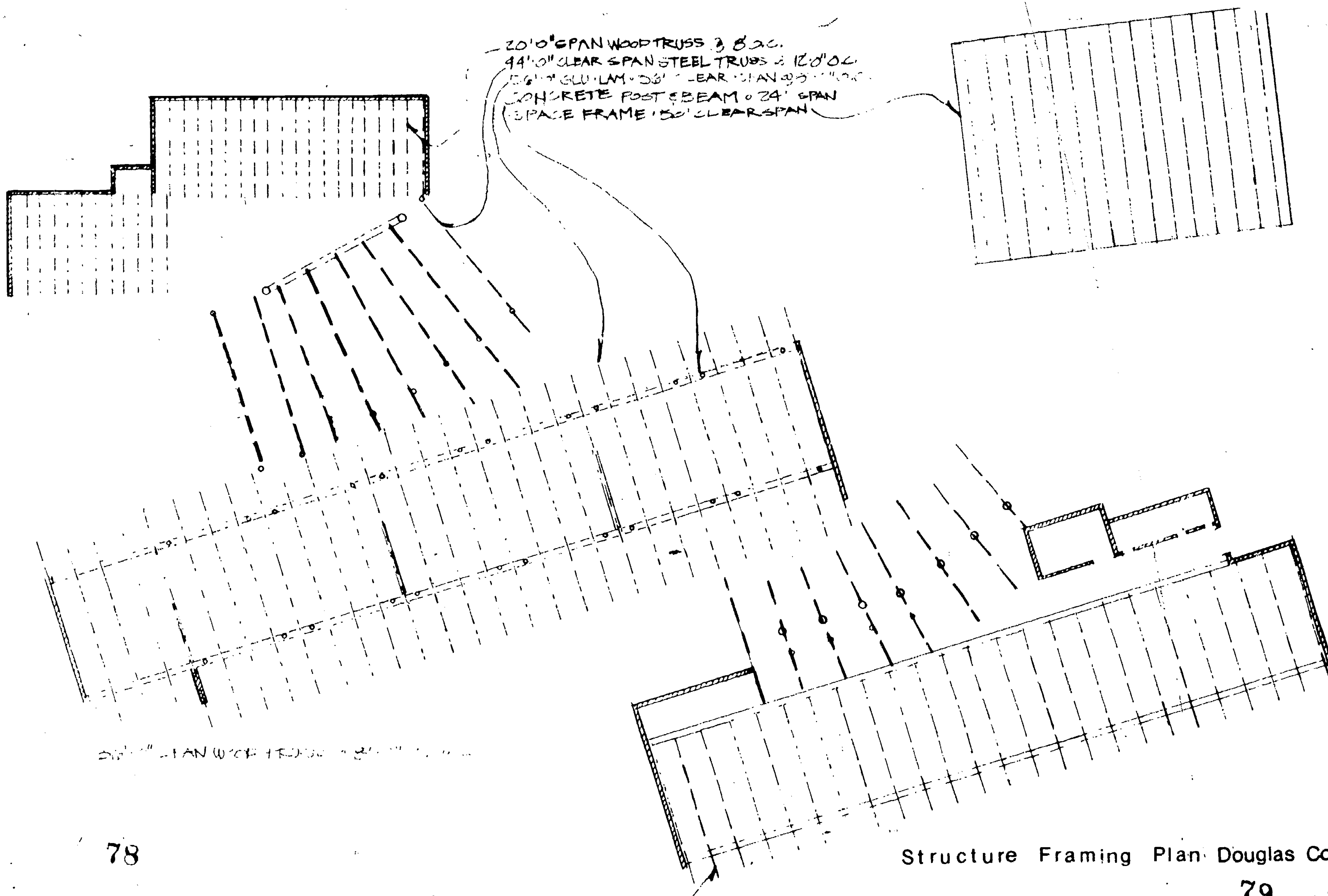
75



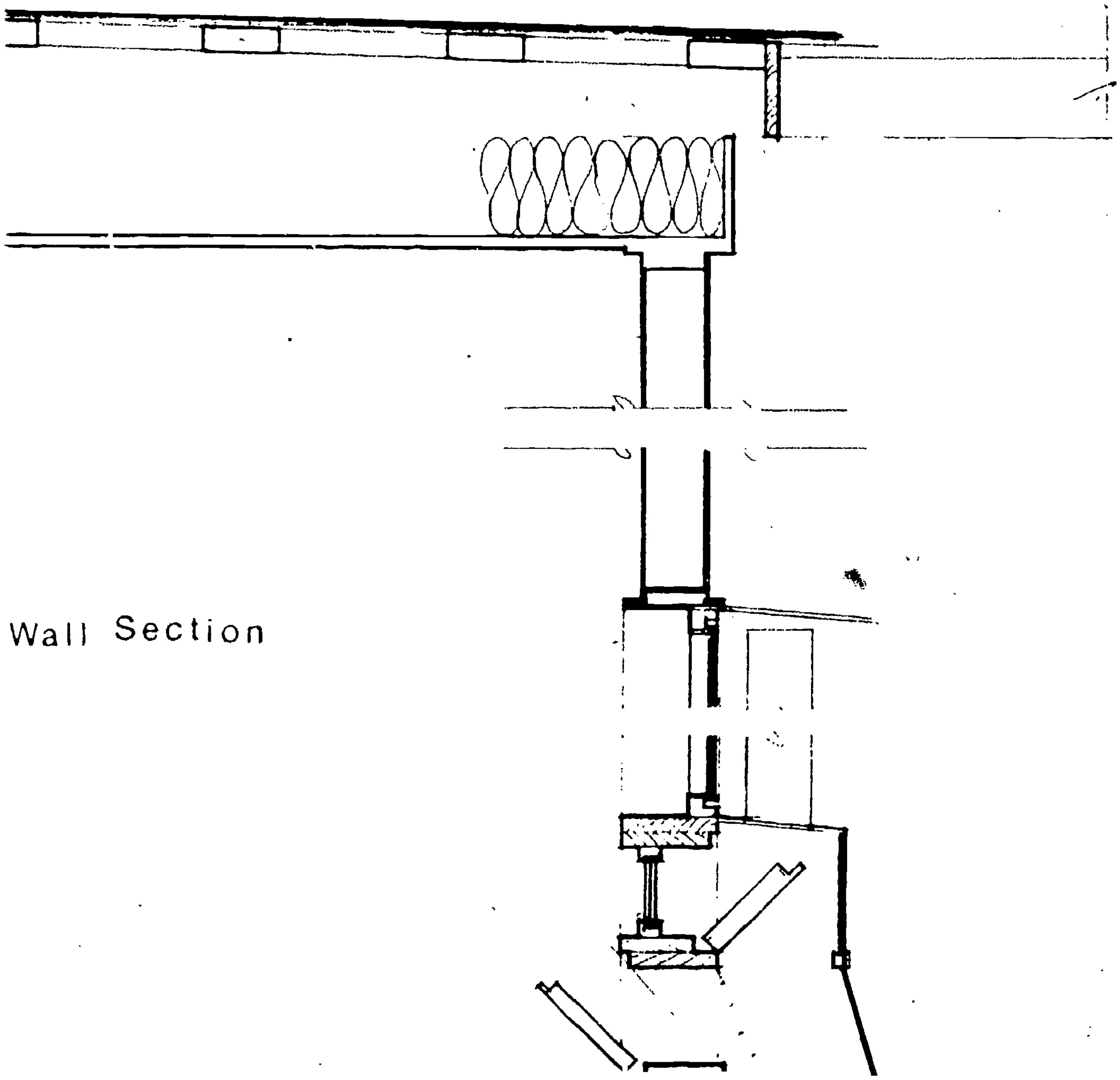
Section AA



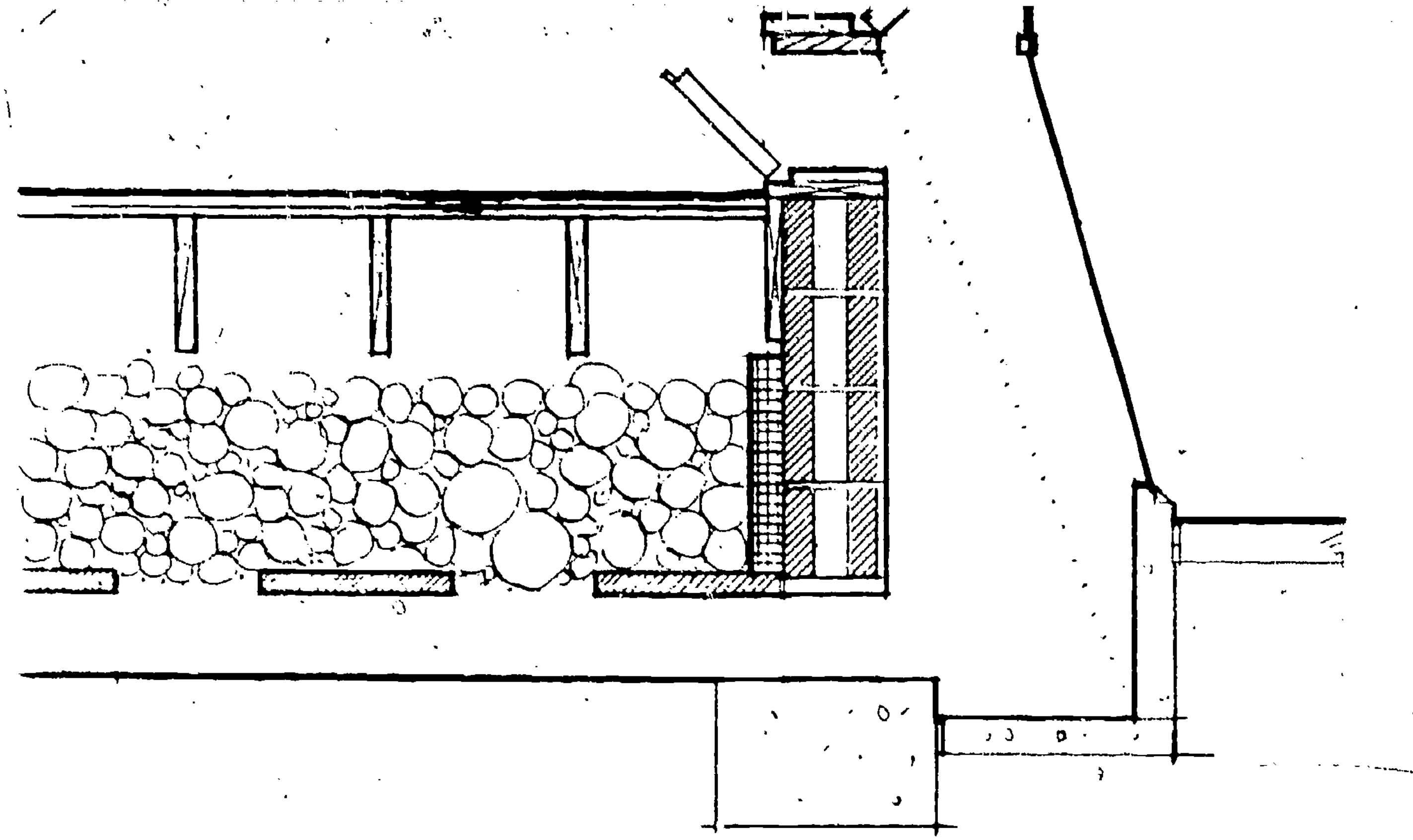
Section BB



Structure Framing Plan Douglas Corbett



Wall Section



The lower classrooms are open plan with a raw sienna colored carpet and pale yellow walls. The rooms are divided by movable storage units painted in primary colors. Foam rubber seating pads are provided; they are covered with blue vinyl and are hung at night over the windows to prevent heat loss.

The upper classrooms are partitioned from each other. Each has a continuous window seat and a shallow greenhouse that can become part of the room by moving sliding glass partitions. The color scheme is the same.

larry fritzie

Design

The design of a "Zero Energy Use School" is a delicate balance of creating superior spaces for educating elementary students, as well as a structure that has the capabilities to utilize the natural systems of heating, lighting, ventilating, and cooling.

Below are listed some of the major architectural concerns I've developed; further explanations in regards to natural energy systems used will be presented to assist with corresponding drawings.

Building Form
A compact structure is intended to reduce exterior wall area, which decreases heat loss and inversely reduces the heat gain necessary to maintain a temperate condition inside.

Orientation
Larger south facing facade than north, east-west axis for greatest solar utilization. The building broke into three fans: s; 10°E of S; 10° W of S.

1. The center spoke is facing due south for a consistent daylong heat gain.

2. 10° east of south which supports the cafeteria. This is for quick solar gain in the morning to insure comfortable dining by lunch break.

3. 10° west of south supports the administration for longer solar gain hours in afternoon for after school class preparation.

Performa

GENERAL:
This school attempts to meet strict energy guidelines; the use of non-renewable finite energy resources is prohibited.

1. WATER:
City water from local water main.

2. SEWAGE:
City sewage due to light load.

3. LIGHTING:
Total natural light
a. Classrooms: almost entirely top lit via sawtooth roof form; with diffused light thru atrium corridor.

b. Administration, Library & Cafeteria: receive light from direct southern exposure, as well as diffused light thru atrium corridor.

c. Gym: entirely lit by north facing skylights and windows.

d. South exposure is controlled by shutters or blinds manually operated.

4. HEATING:
Passive and active solar collection
a. Active collectors located on south wall of classrooms; water medium to floor mass. Photovoltaic cells used to run water circulation pump thru collectors.

b. Direct gain to thermal mass thru south greenhouse on ground level, solar gain thru classroom sawtooth roof.

The advantage of incorporating these two solar heat systems is to insure a more consistent comfort zone throughout the day. The direct gain is for quick warm-up, which, coupled with physical activity by the students, will produce a comfortable morning environment. The active system is to produce a more constant and extended period of radiant heat.

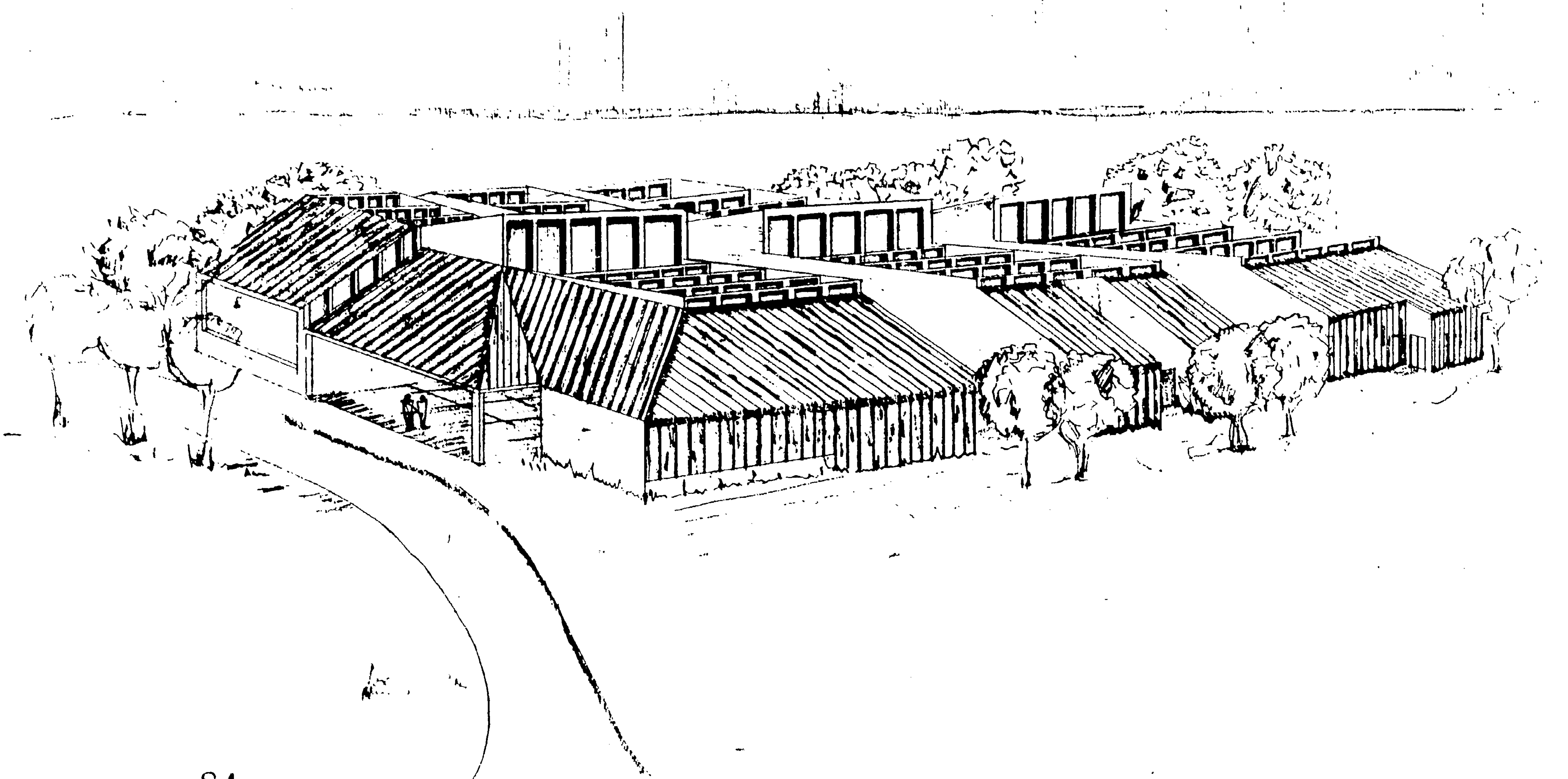
5. COOLING:
Natural ventilation
a. Manually operated vents located low on north walls for summer breeze and roof to draw warm air out.

b. Winter ventilation will occur, by opening to atrium space, a more controlled environment than the outdoors.

6. CONCLUSIONS:
For a building of this nature located in our climate, certain trade-offs must be made in order for a comfortable learning environment.

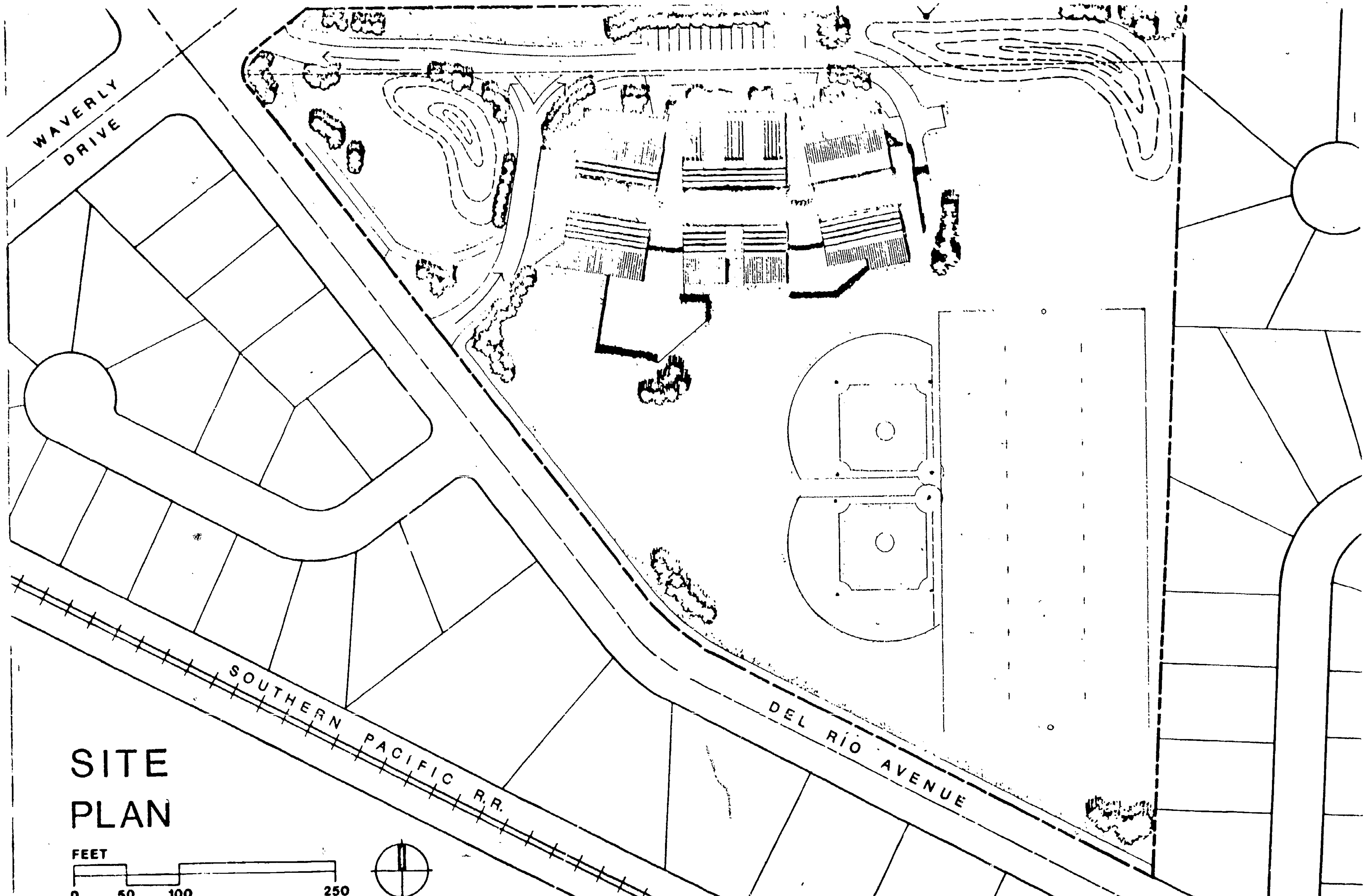
Alter the school year to open during the moderate months: Sept. thru Nov. - 3 months; Feb. thru July - 6 months.

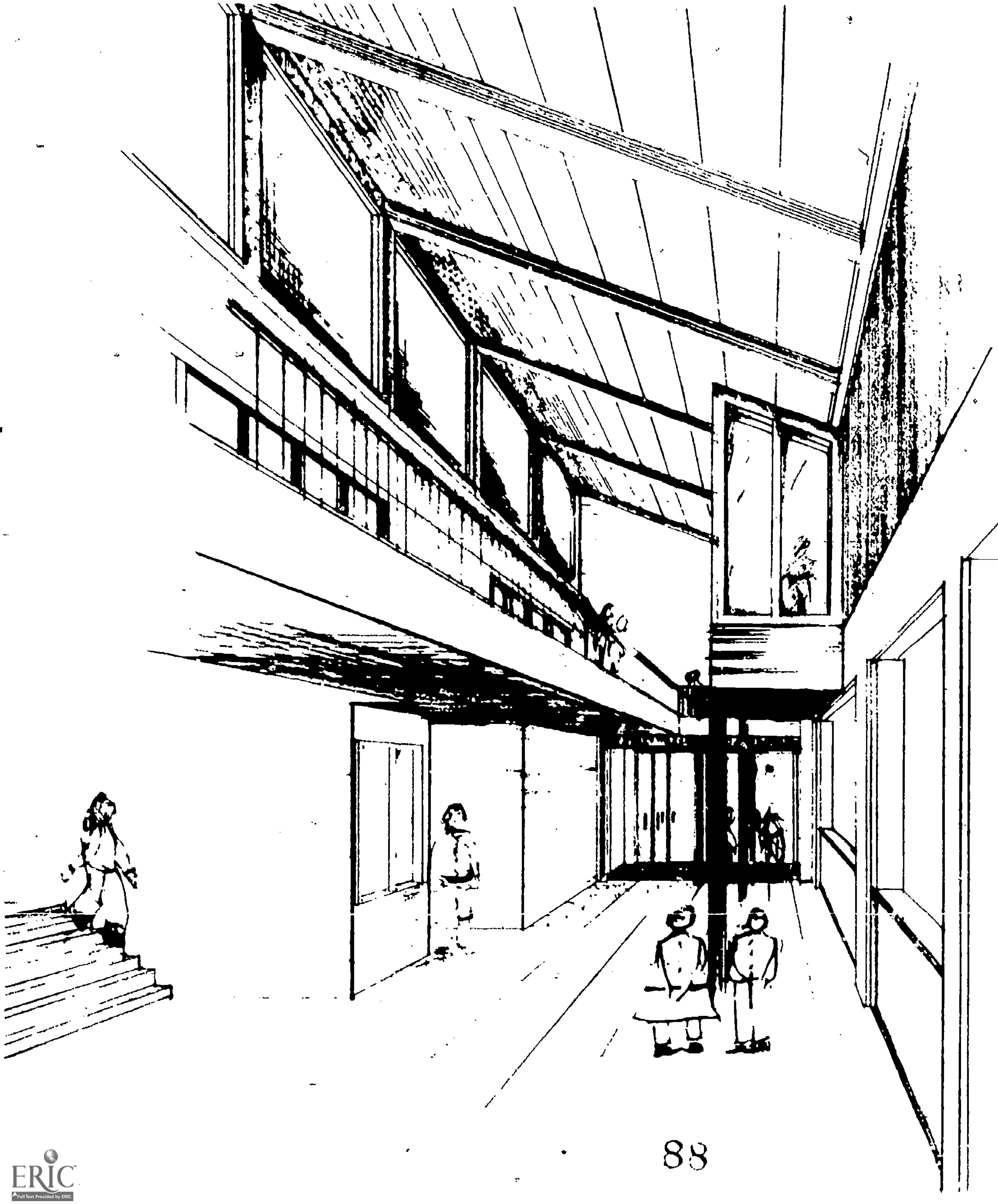
Vacations: Dec., Jan., Aug. - 3 months. This arrangement eliminates the most severe heating and cooling periods of the year.



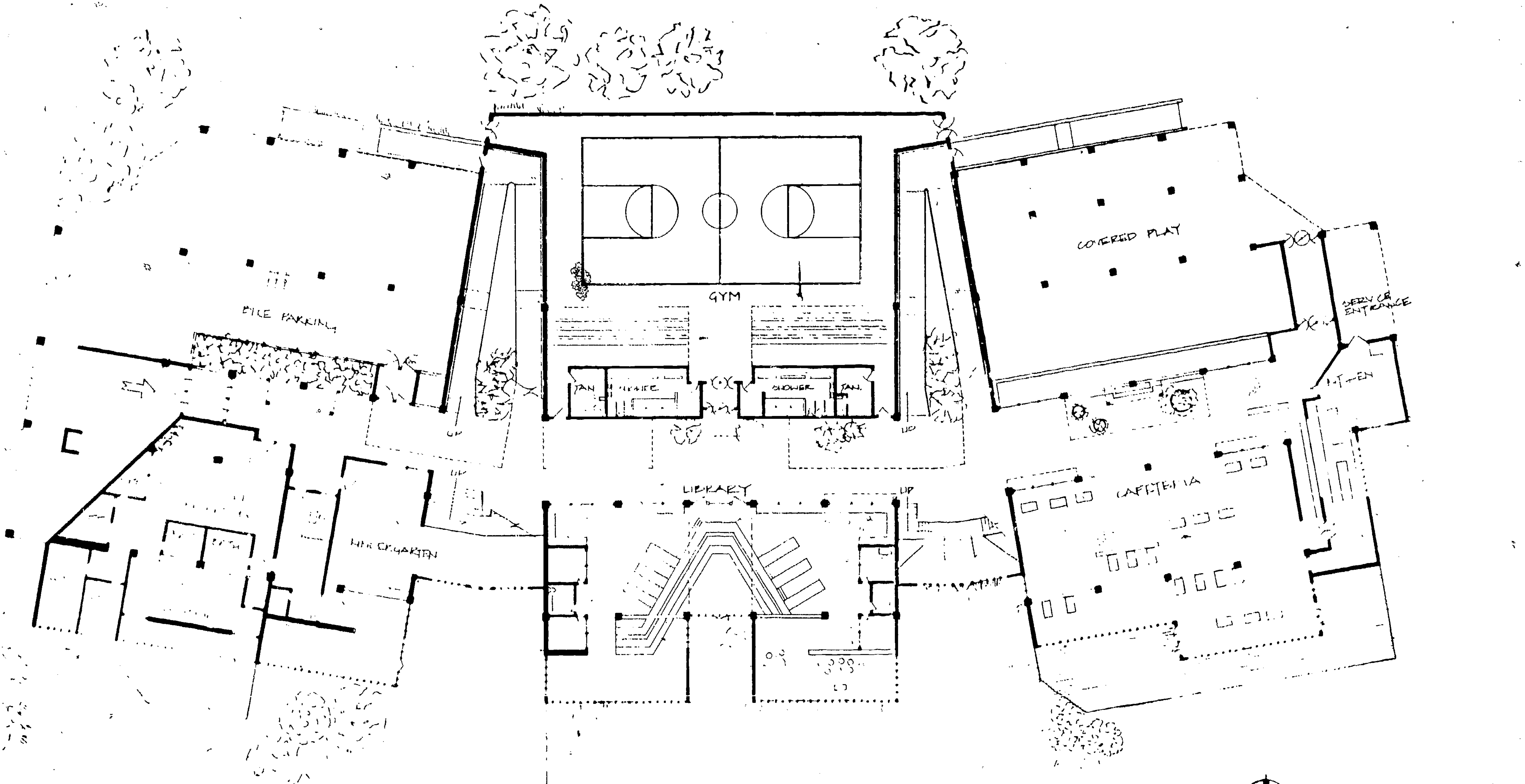
84

85 Larry Fritzie

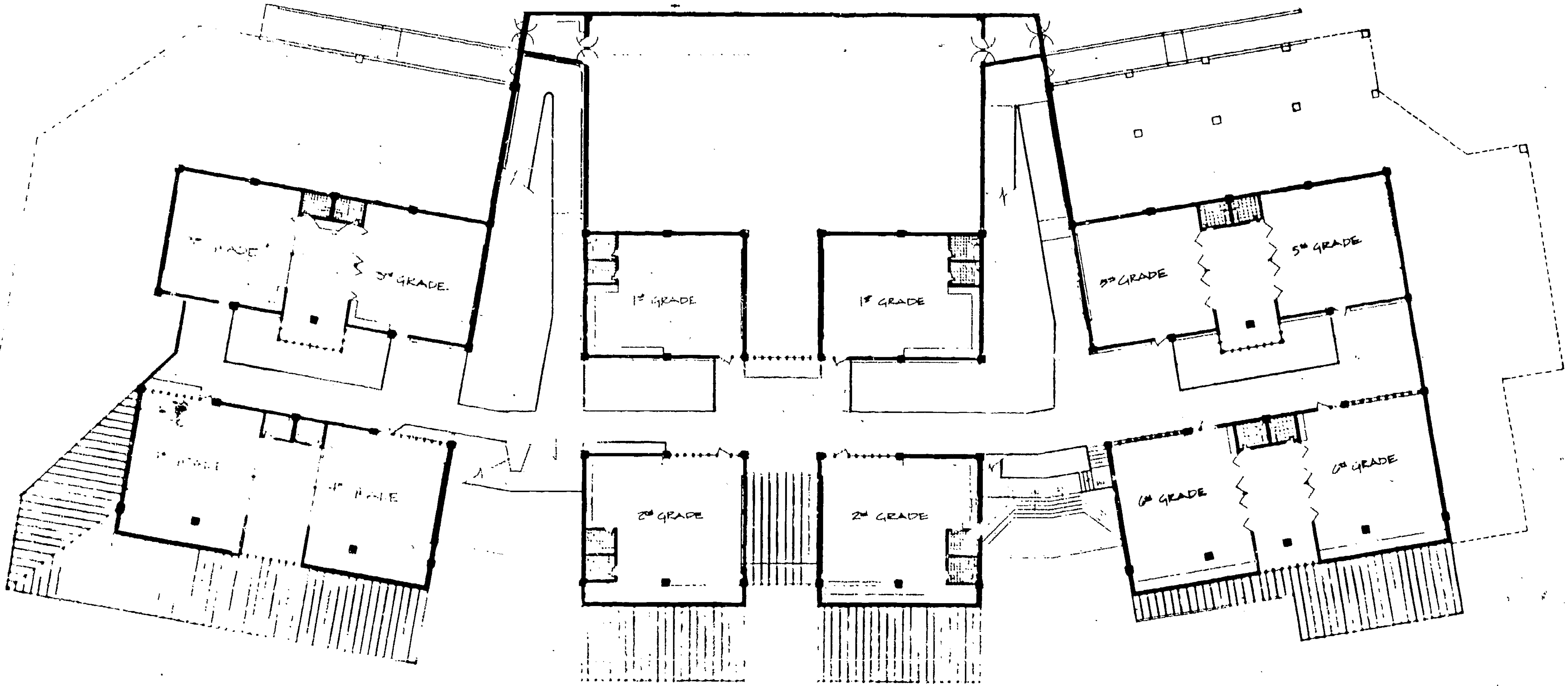

WAVERLY DRIVE
SOUTHERN PACIFIC R.R.
DEL RIO AVENUE
SITE PLAN
FEET
0
50
100
250



Larry Fritzie

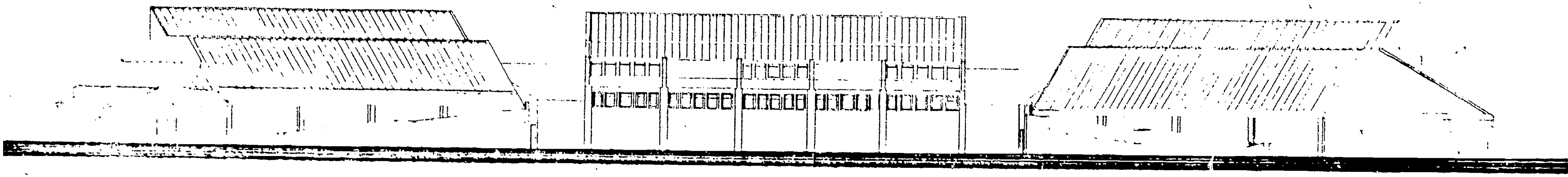


FIRST FLOOR PLAN

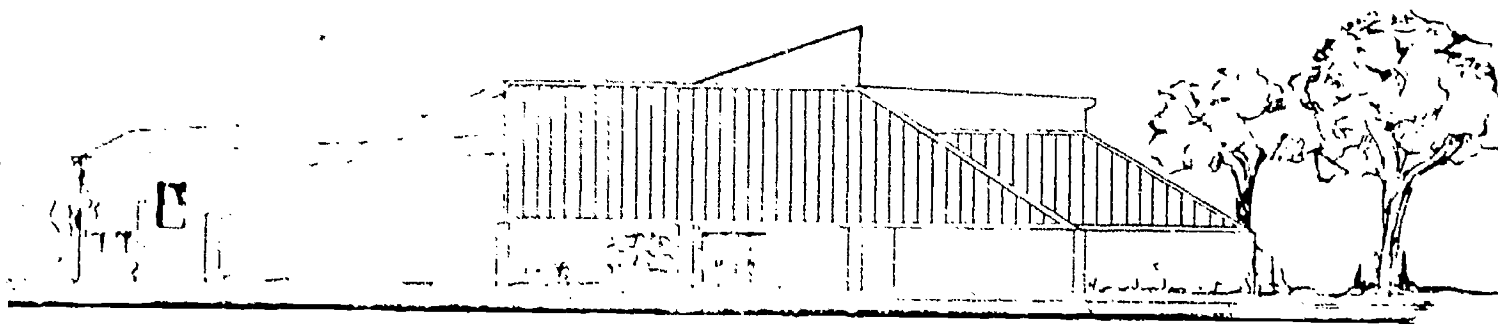


SECOND FLOOR PLAN

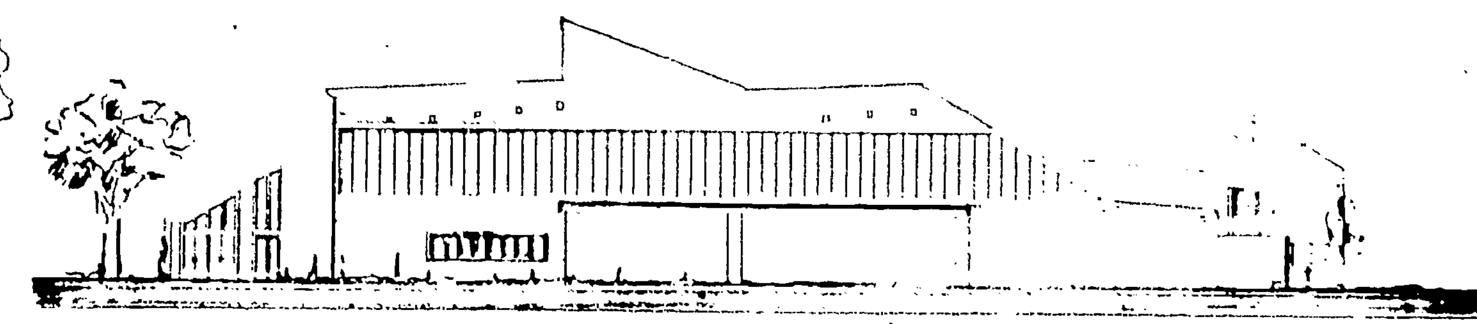
92 Larry Fritzie



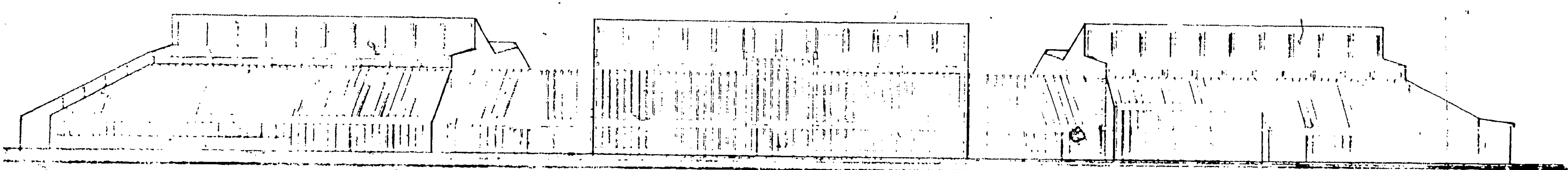
NORTH ELEVATION



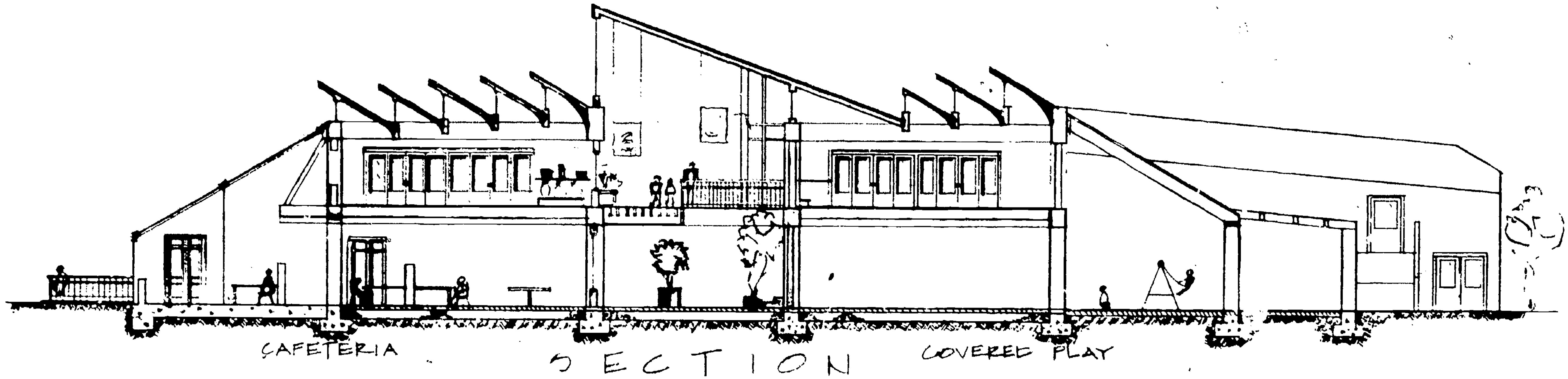
WEST ELEVATION

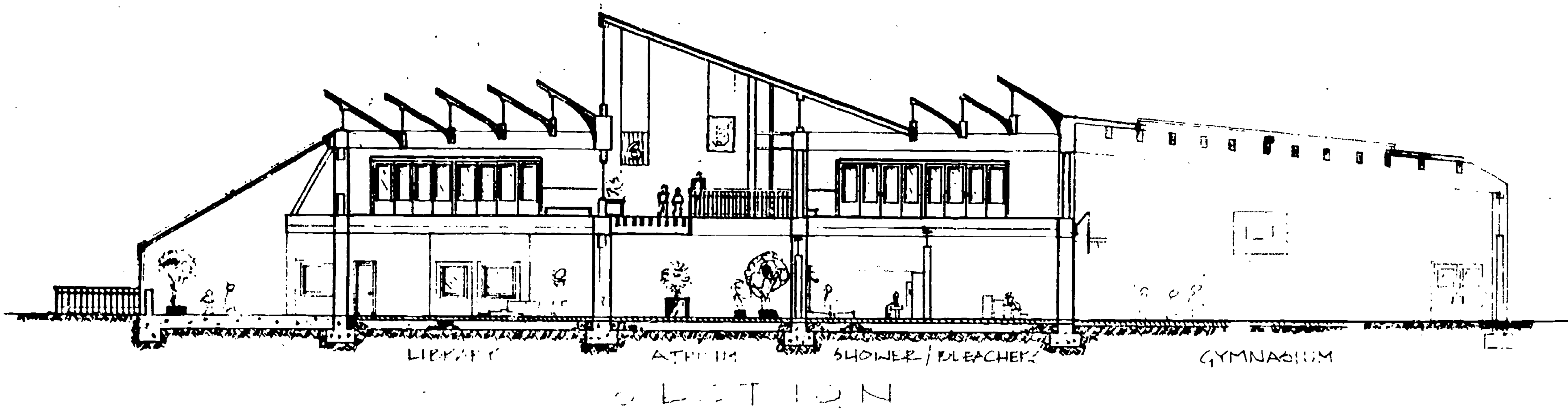


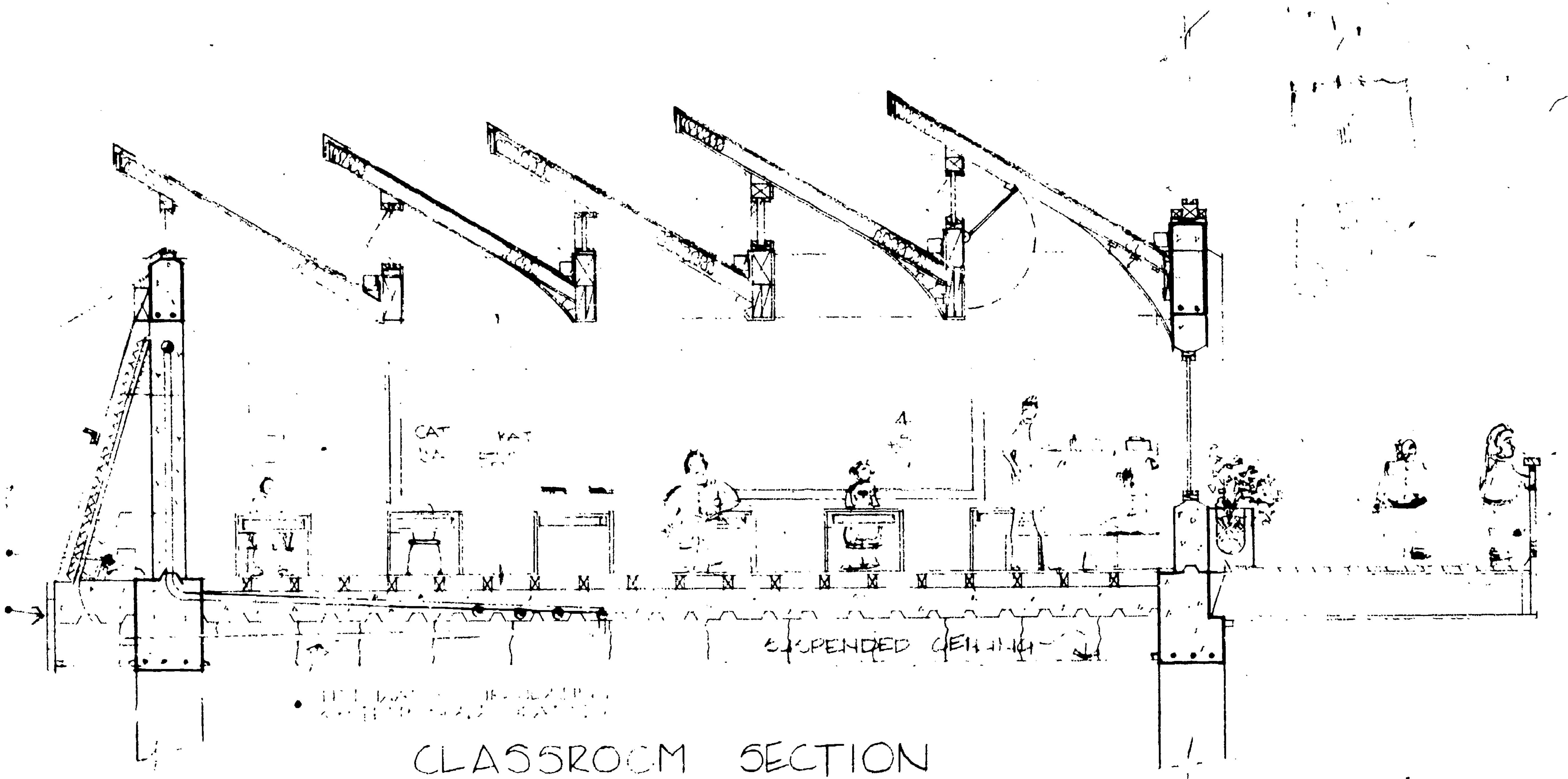
EAST ELEVATION



SOUTH ELEVATION


CAFETERIA
SECTION
COVERED PLAY

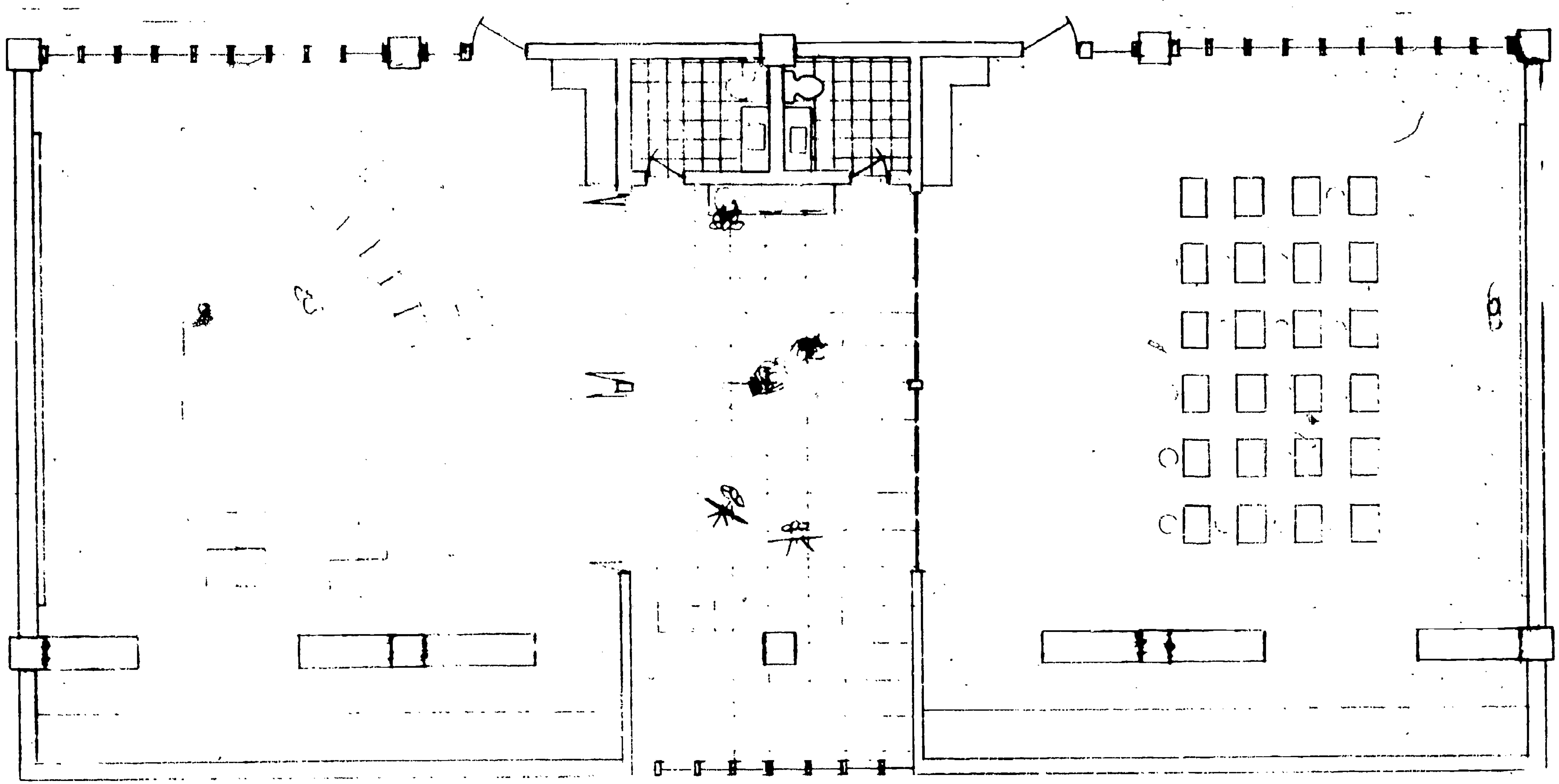

SHOWER / BLEACHERS
GYMNASIUM



CLASSROOM SECTION

97

98

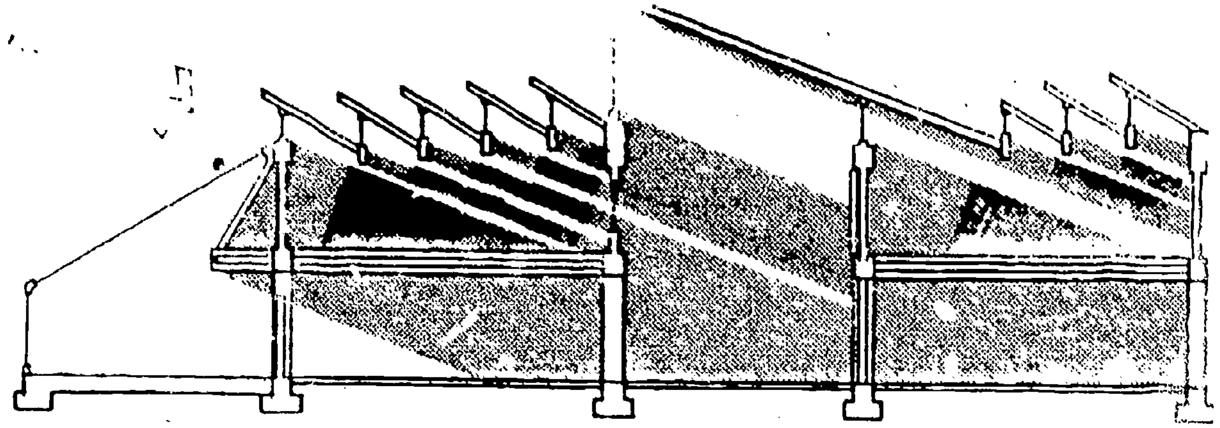


CLASSROOM ACTIVITY PLAN

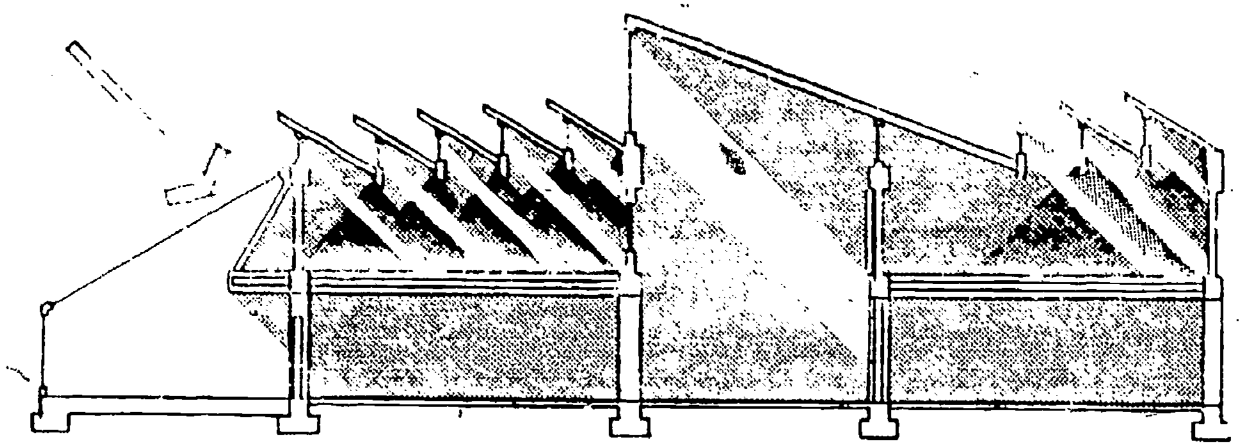
99

100

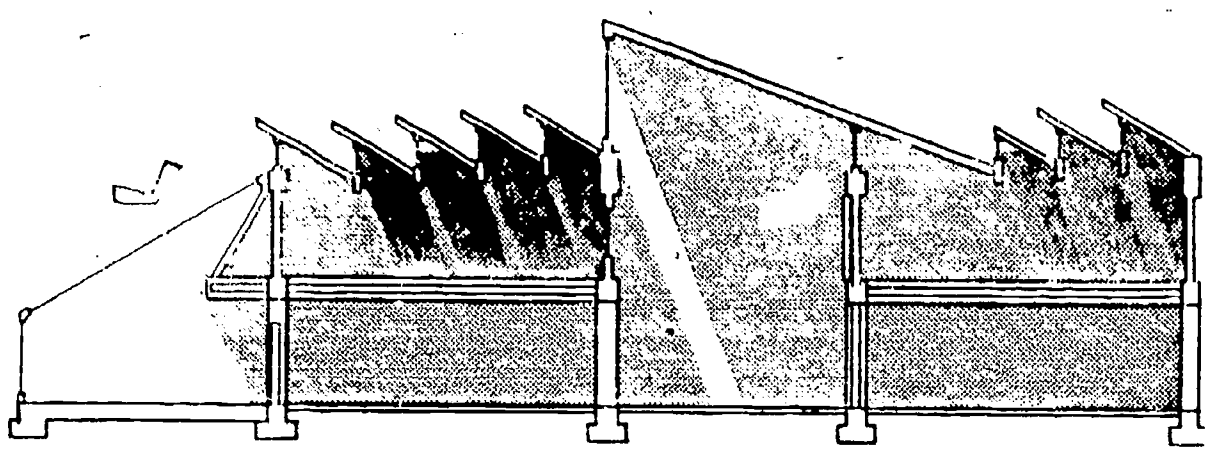
Larry Fritzie



WINTER SOLSTICE 21°



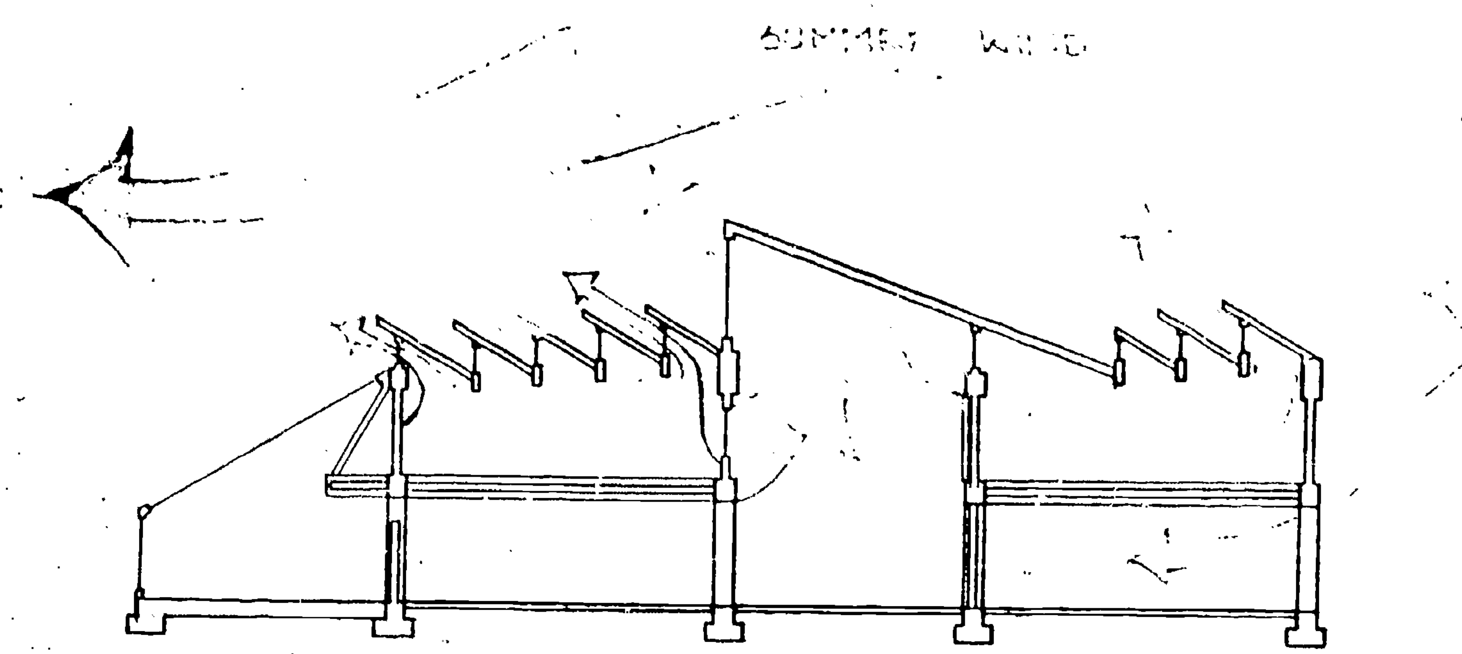
EQUINOX 45°



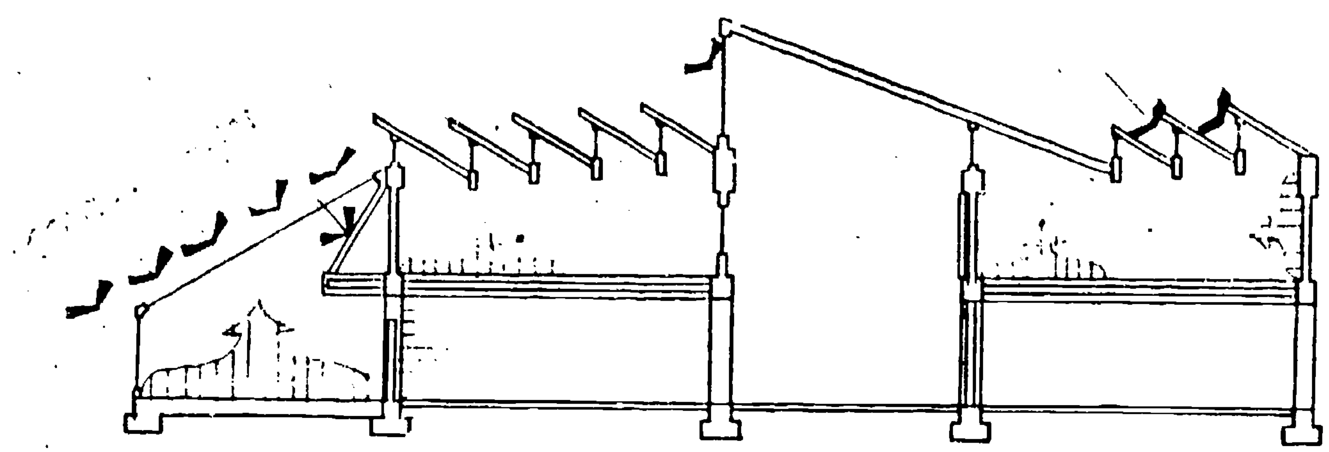
SUMMER SOLSTICE 69°

SOLAR PENETRATION

101



VENTILATION



HEATING FLOW

Larry Fritzie

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julie harlan

Context
The site is located in a new, developing residential district of southeast Albany, Oregon. The elementary school will be supported by approximately 1200 families.

Approach To Site
Any elements set on a flat site are of strong visual importance, as is their relationship to each other, since each assumes a sculpturistic quality. I chose to explore the "campus plan" design on this project with the intent of developing a small school within a school. Outdoor traffic flow is required which reduces the amount of corridor and stairs area in the building. The covered walkways between the buildings permit free and comfortable student traffic flow during inclement weather. The school complex was set back to the north of the site to ensure the building areas placed to the south would receive adequate winter sun and help minimize the possibility of shading the buildings in the future by off-site developments. The buildings were elongated along an East-West axis exposing the long southside of the buildings to maximum heat gain during the winter months, while exposing the shorter East-West sides to minimum heat gain in the summer months, when the sun is not wanted. The south facing windows are the primary source of lighting, restricting the depth of the spaces to 2½ times the height of the windows to assure sunlight will reach the entire space.

Approach To Education
There is the opportunity here to expose and explore with the future generation a new lifestyle and environment. It is intended that the buildings be educational in use and in function. The children will interact with the buildings in pursuit of a comfortable environment. They will learn to adjust, move and change with the weather. In this method a child will gain a better understanding of alternatives to his/her present energy lifestyle.

Climate Response
Albany, Oregon, is located in an area of mild temperatures. Seventy percent of the annual 35-45 inches of rain falls during November through March.

Eighty percent of December and January experiences extensive cloud cover. Designing for cloudy day heat storage became impractical, since it takes a period of consecutive sunny days to build up temperatures in a large (thick) thermal mass. The school calendar has been adjusted to avoid the inconsistencies involved with operating the school during December and January. Classes will be closed during December and January; the school year will in turn open earlier and end later in the year. During the cold winter months, classes will begin later—9 a.m.—and end later—3 p.m.—since approximately 90 percent of the sun's energy output occurs during these hours. In warmer months, classes will begin earlier in the day and end earlier to avoid the overheated hours of the day.

I have chosen the use of direct gain as an approach to passive solar heating. This method involves glazing areas and minimizing mass thickness, south facing windows, masonry heat storage, interior waterwalls, and greenhouses throughout the school.

Comfort in the warmer months is achieved by natural ventilation throughout the buildings, from the north-northeast breezes, interior adjustable shading devices, vine-covered trellised overhangs, and deciduous trees and plantations to the south, east, and west of the buildings. Vegetation more closely follows climatic rather than solar variations, supplying cover with their leaves in the summer and turning bare to allow the sun through in the winter.

Performa

A. SEWAGE:

Composting toilet designed to decompose toilet (and kitchen) wastes into soil amendments. It is placed in the warm area to progenerate decomposition action.

WATER:

Use of hand pumps throughout the complex.

LIGHTING:

Natural lighting—depth of rooms restricted to allow sufficient ling levels.

B. HEATING:

The complex is oriented east to facilitate early morning heating.

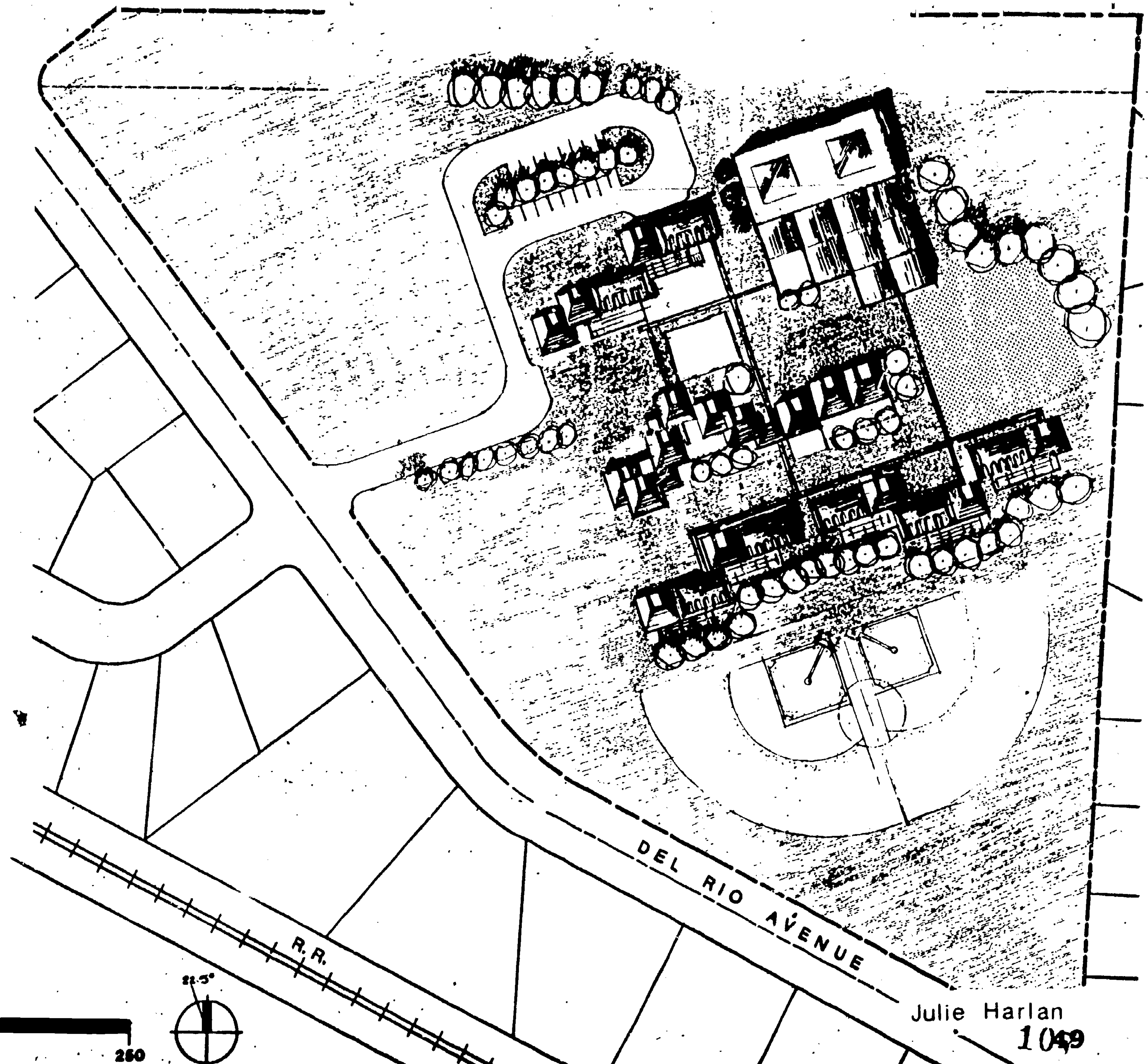
Greenhouse supplies warm air to the second floor. The air passes over rock storage and along tromb wall. The classroom obtains 51° indoors during a six hour period on an average 35° winter day. On cold days when the passive heating systems are unable to keep the spaces at a workable level two classes will condense into one common area.

C. COOLING:

Cooling is achieved by natural ventilation, shading vine covered trellises, and open shaded outdoor areas to which the classes may move.

LIFE STYLE TRADE OFFS:

Classes will be closed during the coldest months—December and January—and reopen until June. The school year will again begin the first part of August.

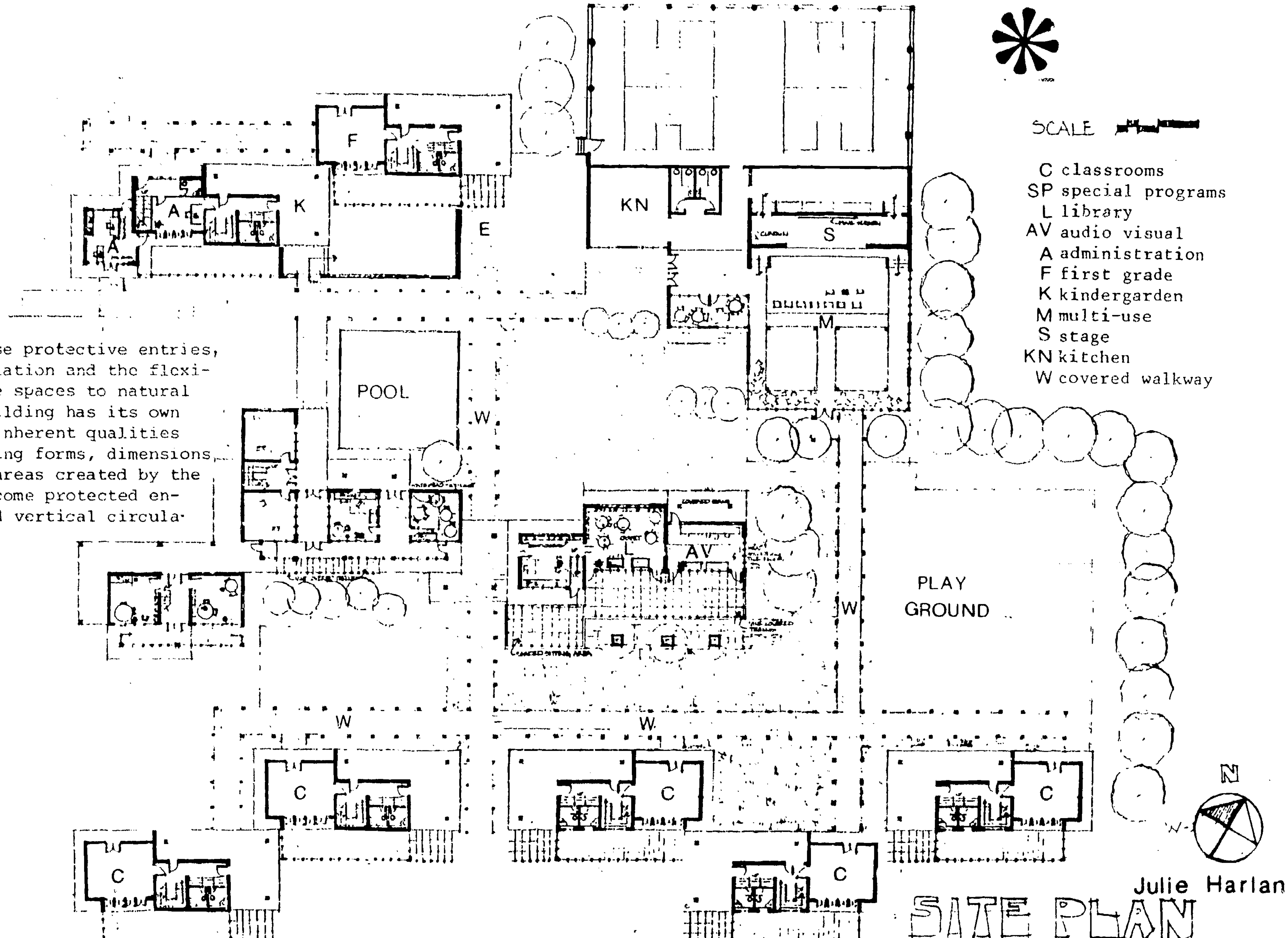


SITE PLAN

FEET
0 50 100 250

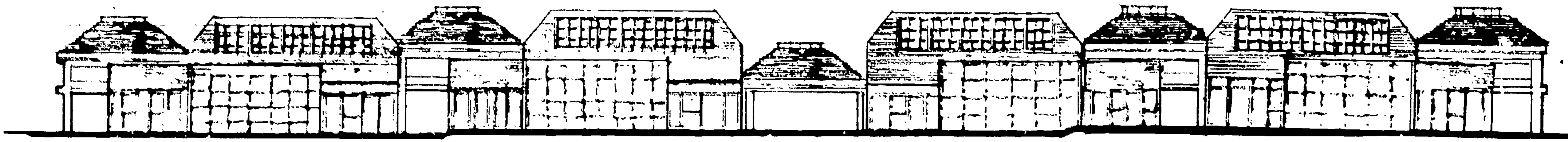
Julie Harlan

The buildings use protective entries, minimal north articulation and the flexibility of opening the spaces to natural conditions. Each building has its own identity yet shares inherent qualities such as basic repeating forms, dimensions, and materials. The areas created by the shifting of forms become protected entry support areas and vertical circulation.

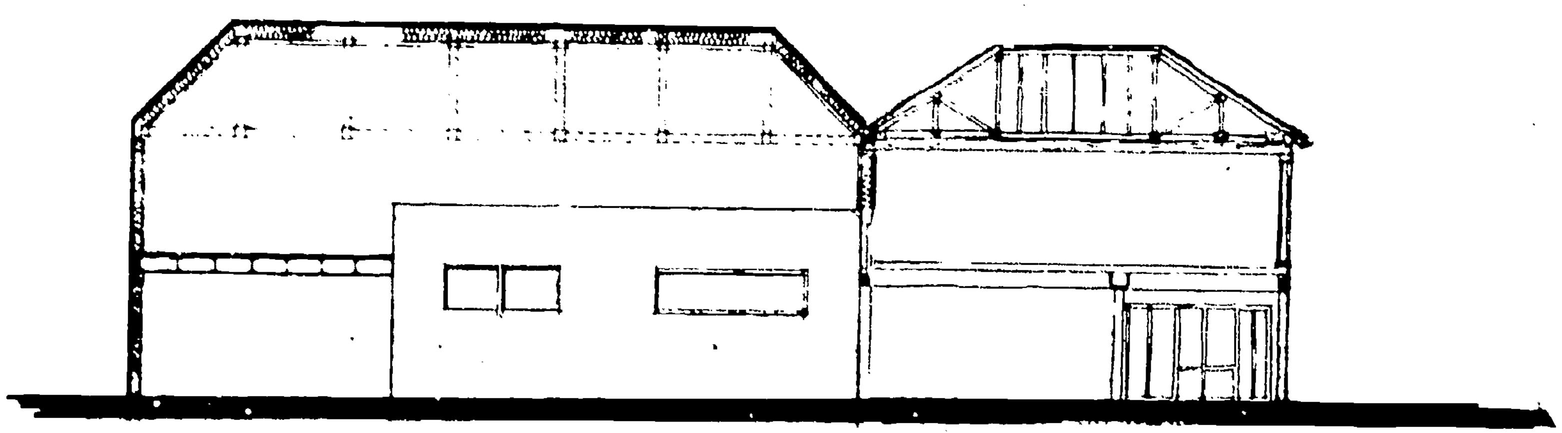


Julie Harlan

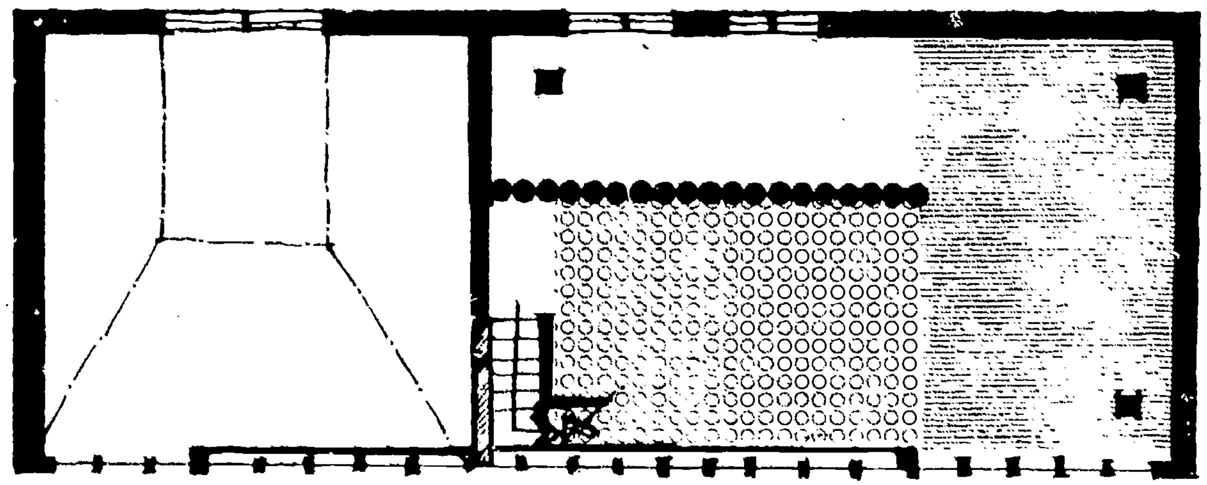
SITE PLAN



SOUTH ELEVATION 1/16"=1'-0"



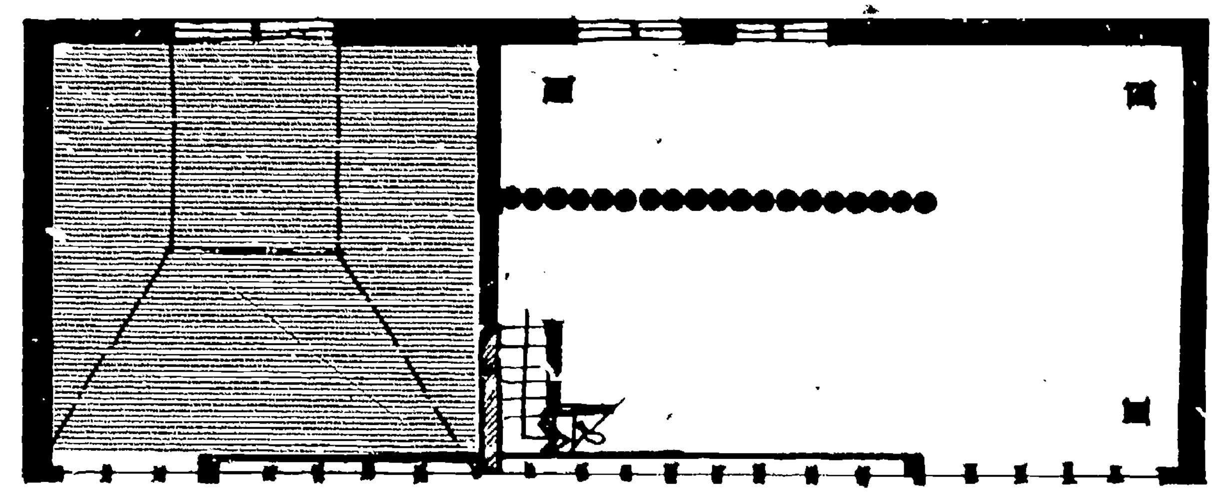
CLASSROOM SECTION 1/8"=1'-0"



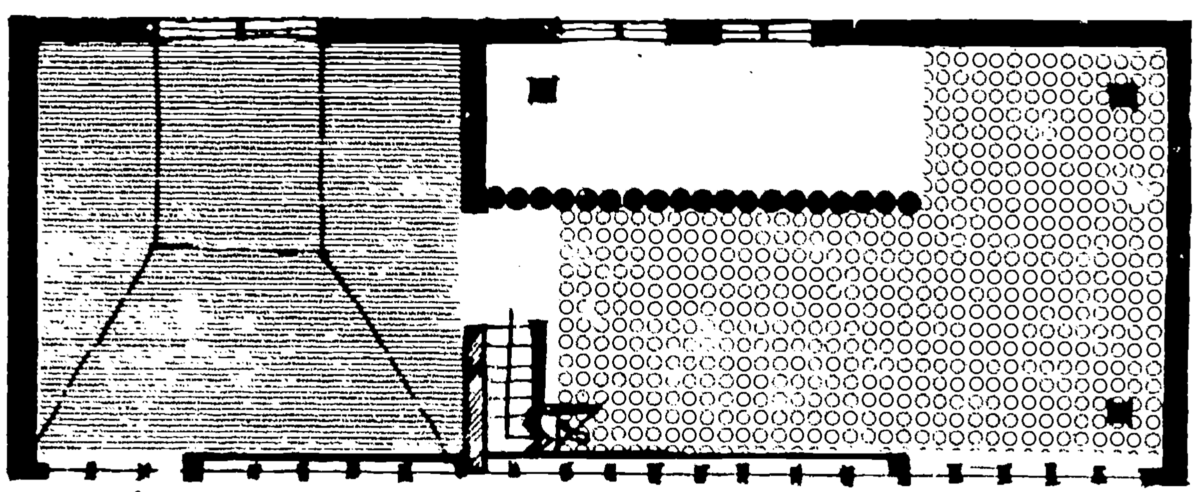
Winter day - capacity of passive heating elements is reached. The children of both classrooms will consolidate into the larger room to take advantage of each others' body heat. 22 sq. ft. per student.

SECOND FLOOR

MIGRATION SCHEDULE

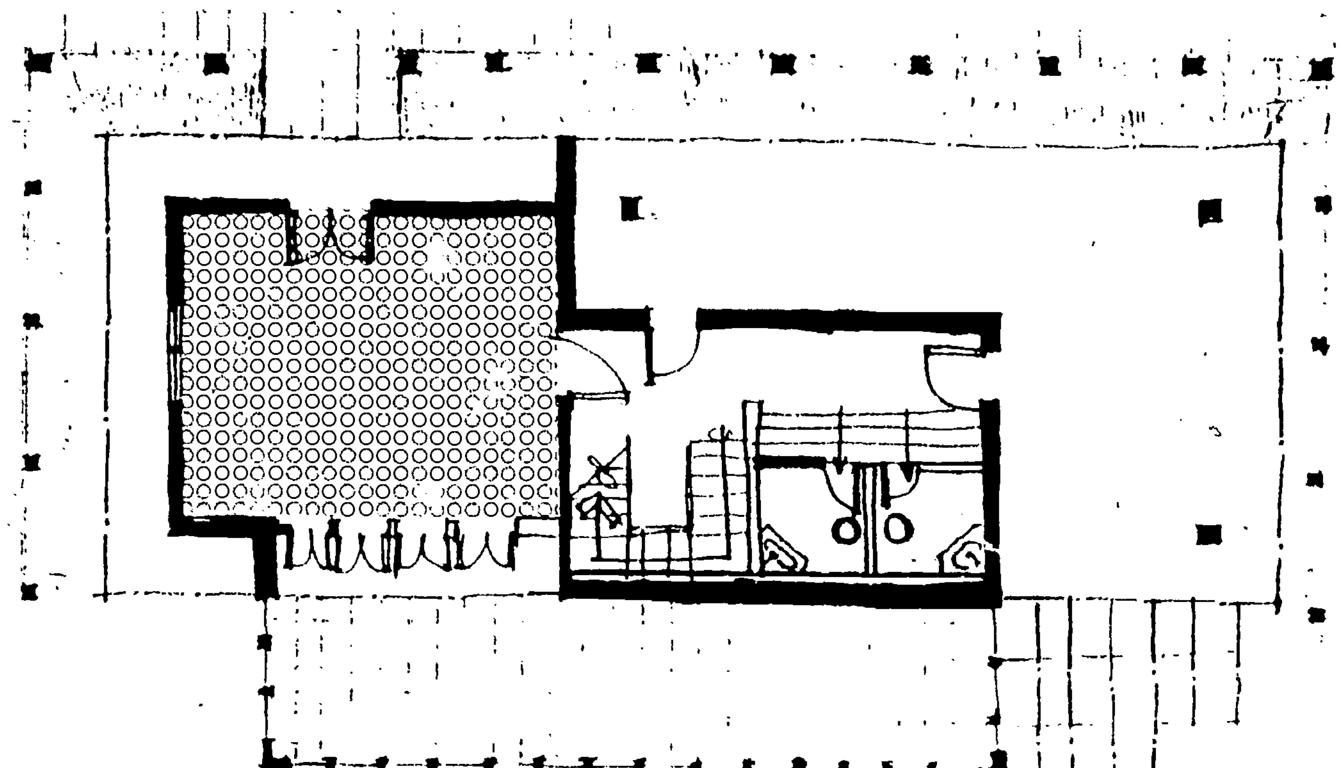


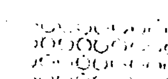
Spring/fall warm day - students vacate overheated classrooms and occupy both upper and lower levels of classroom cluster, which are vented and do not receive direct overhead solar exposure.



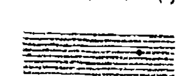
SECOND FLOOR

Winter day - passive heating systems are supplying sufficient heat to allow the students to occupy larger areas and still be comfortable. 40 sq. ft. per student.





25 STUDENTS



25 STUDENTS

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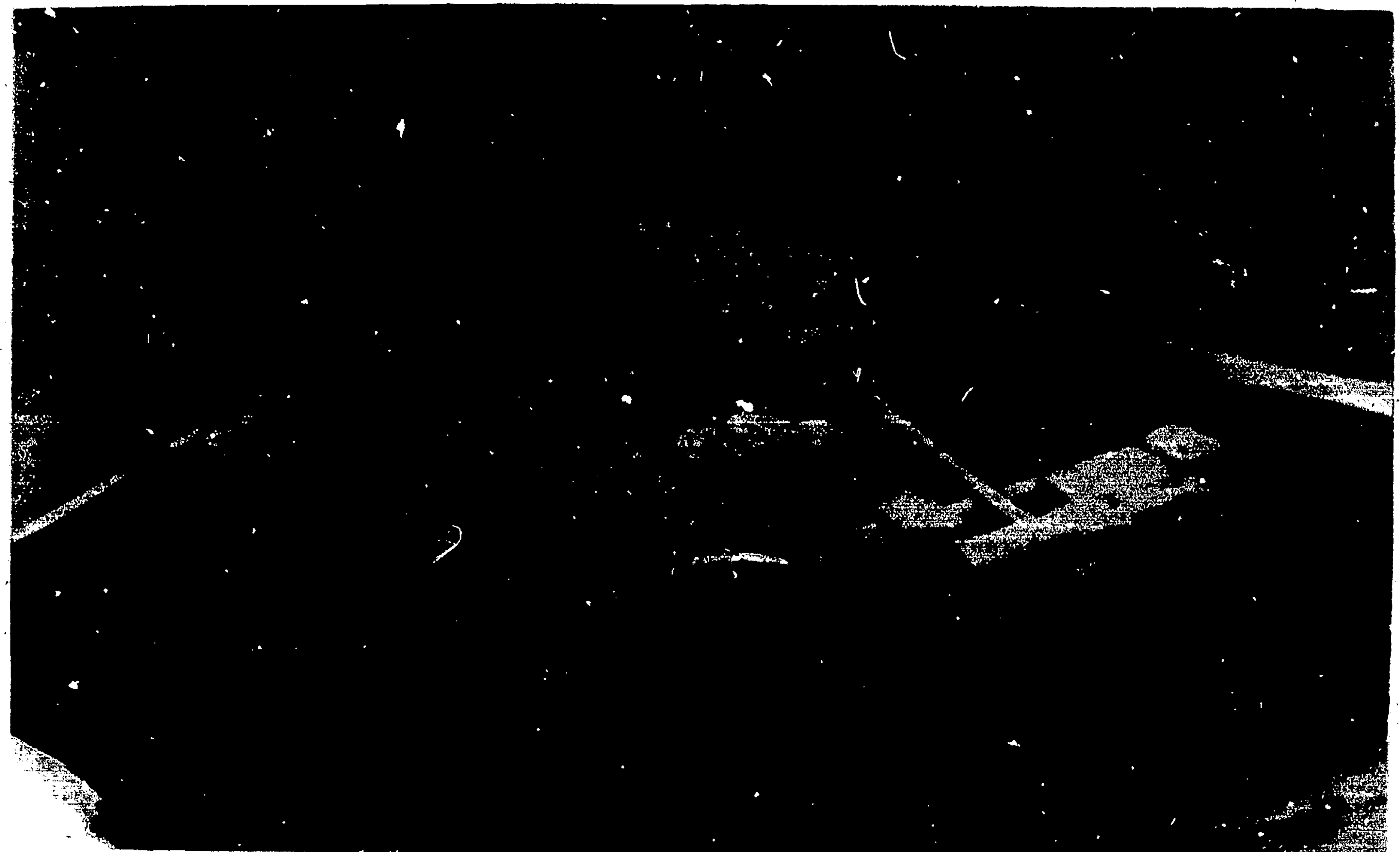
CLASSROOM



SITE MODEL/PERSPECTIVE

Julie Harlan

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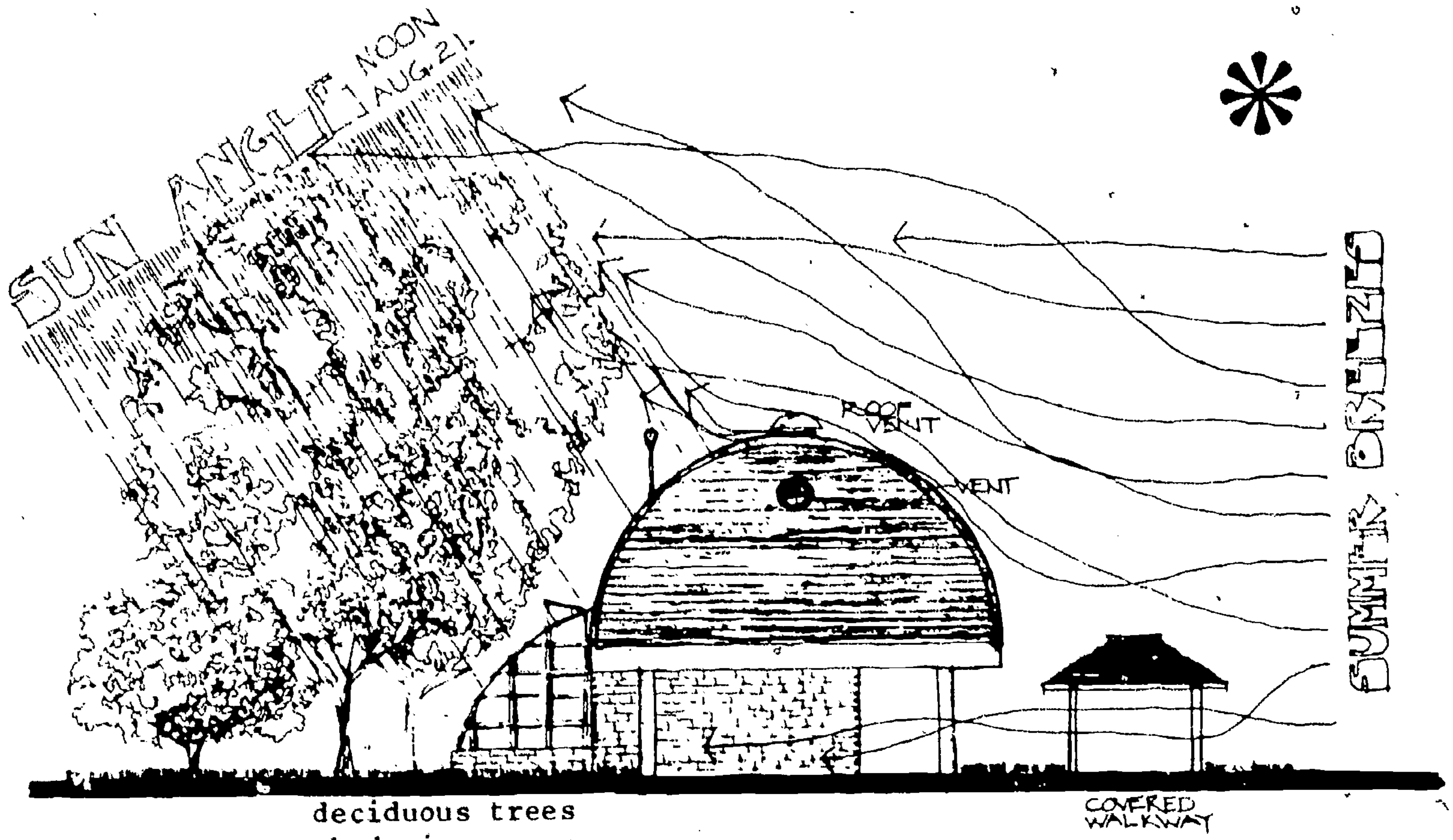
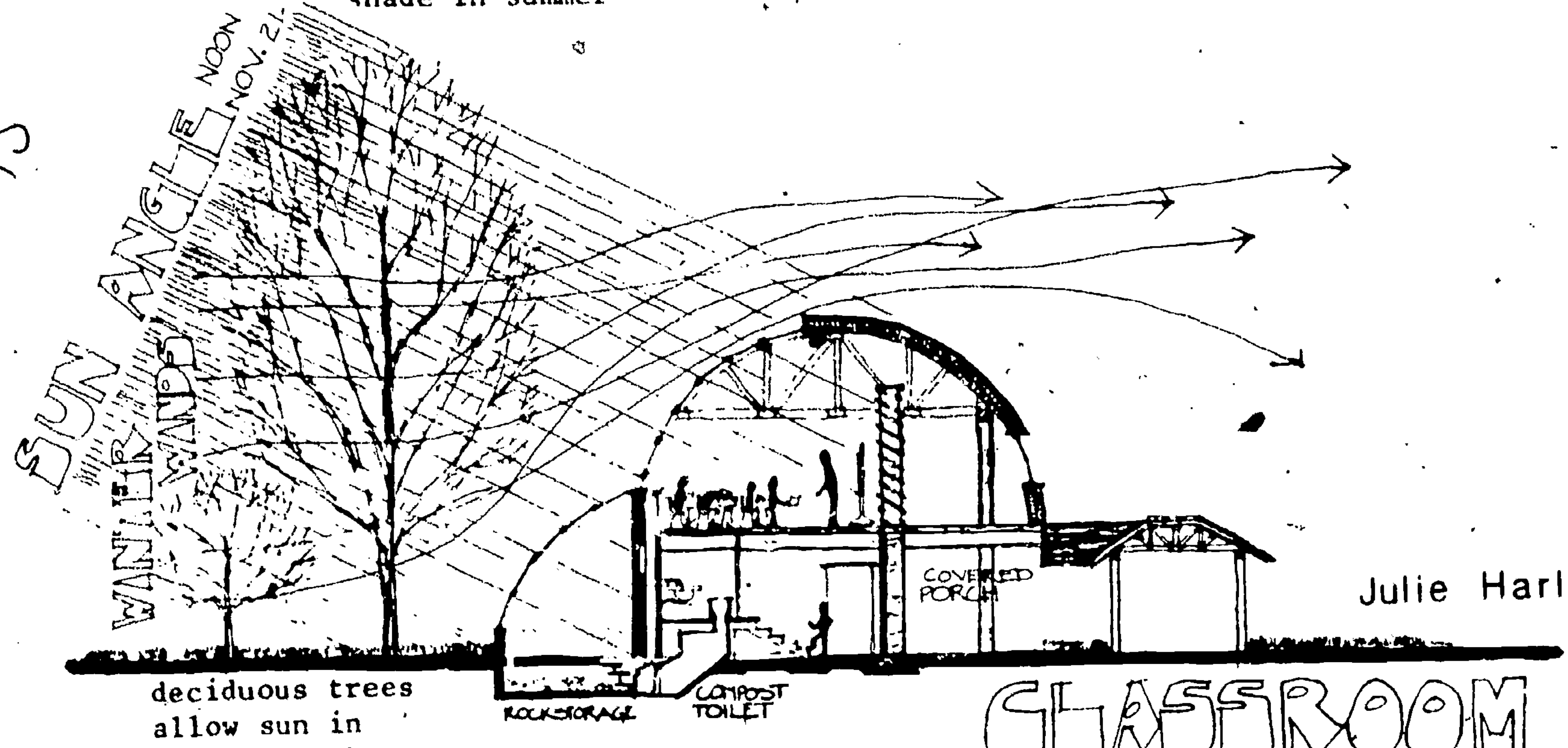


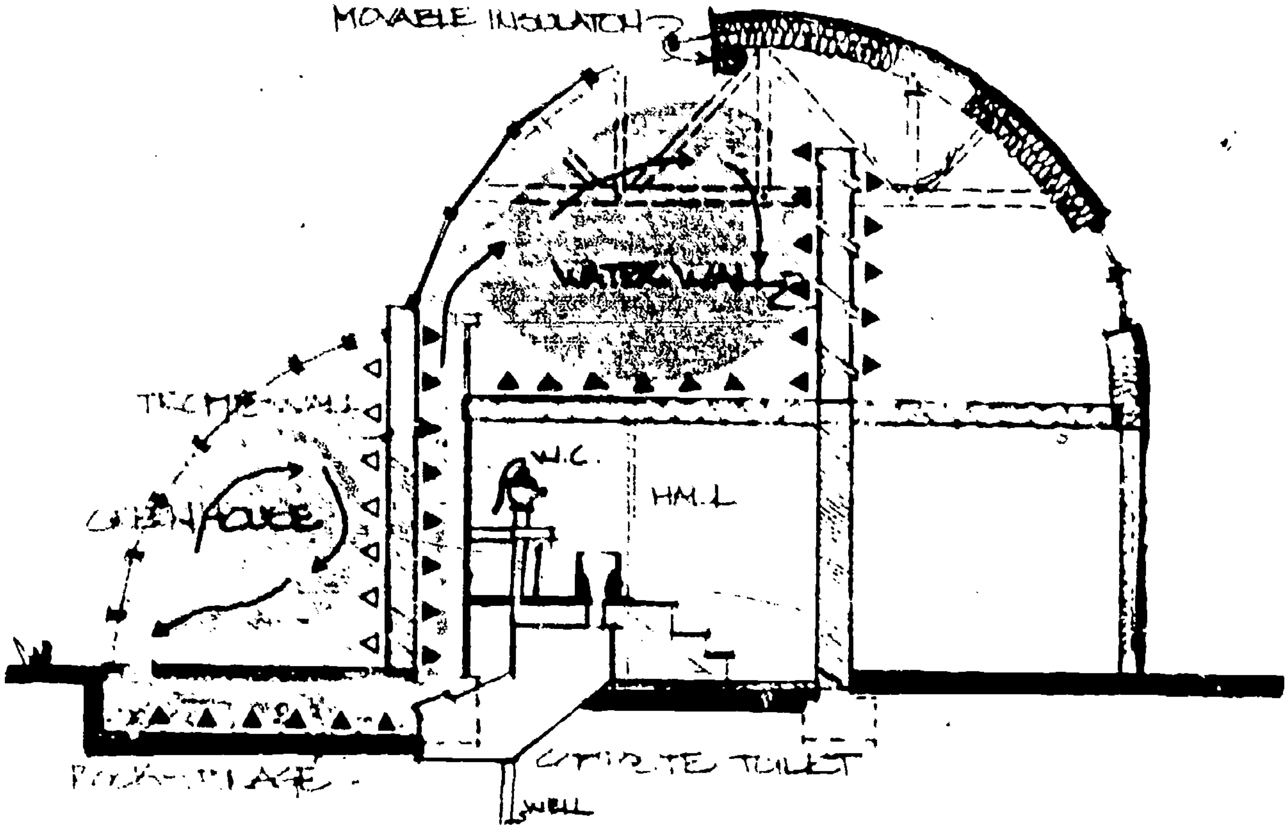
deciduous trees
shade in summer



deciduous trees
allow sun in
cooler months

Julie Harlan

CLASSROOM



CLASSROOM SECTION

SOLAR PERFORMANCE

WINTER

warm air travels by convection through an operatable plenum from the greenhouse to the classroom.
quick heating of spaces is supplied by direct solar gain and the water walls.
concrete flooring retain direct solar radiation.
thermal insulation should be rolled down during the evening to prevent excess heat loss.

SPRING - FALL

windows are operatable to allow air to draw through the roof vents.
the greenhouse would be closed and vented through the roof to prevent over heating

SOUTH SECTION/ELEVATION

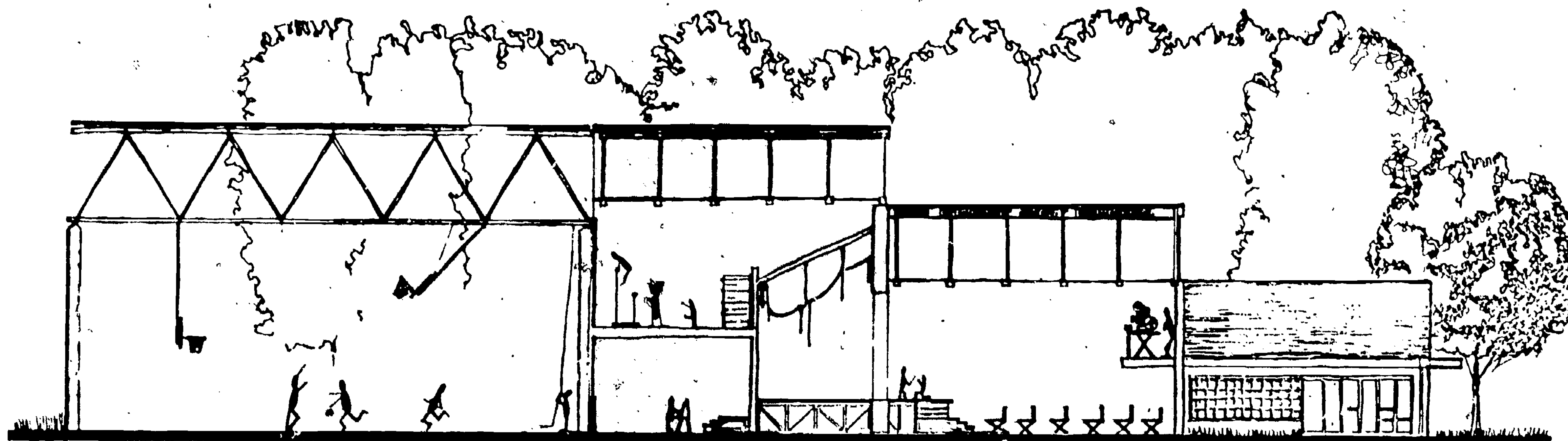
EAST SECTION/ELEVATION

● WINTER NOON NOV.21

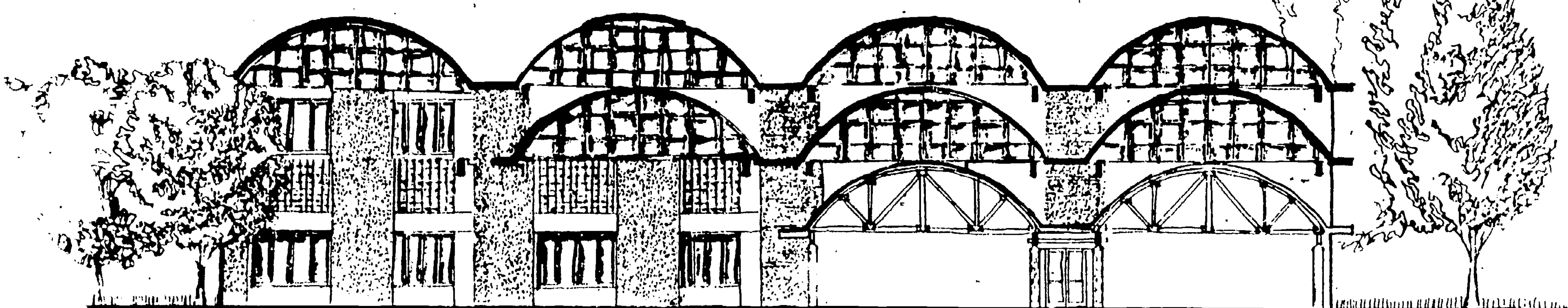
○ SUMMER NOON AUG.21 1/8"=1'-0"

Julie Harlan

SPECIAL PROGRAMS



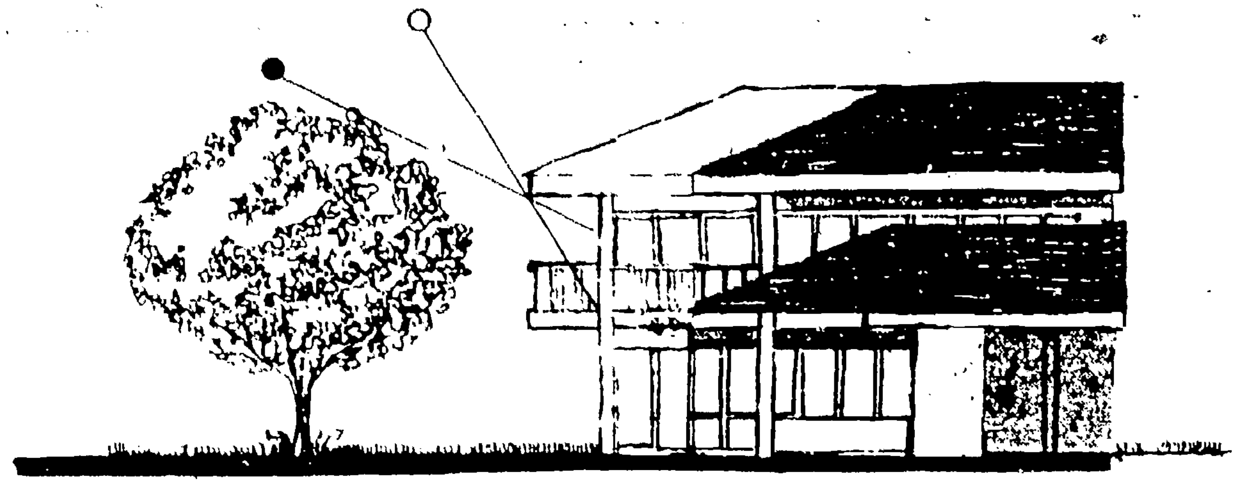
WEST SECTION/ELEVATION



SOUTH ELEVATION/SECTION

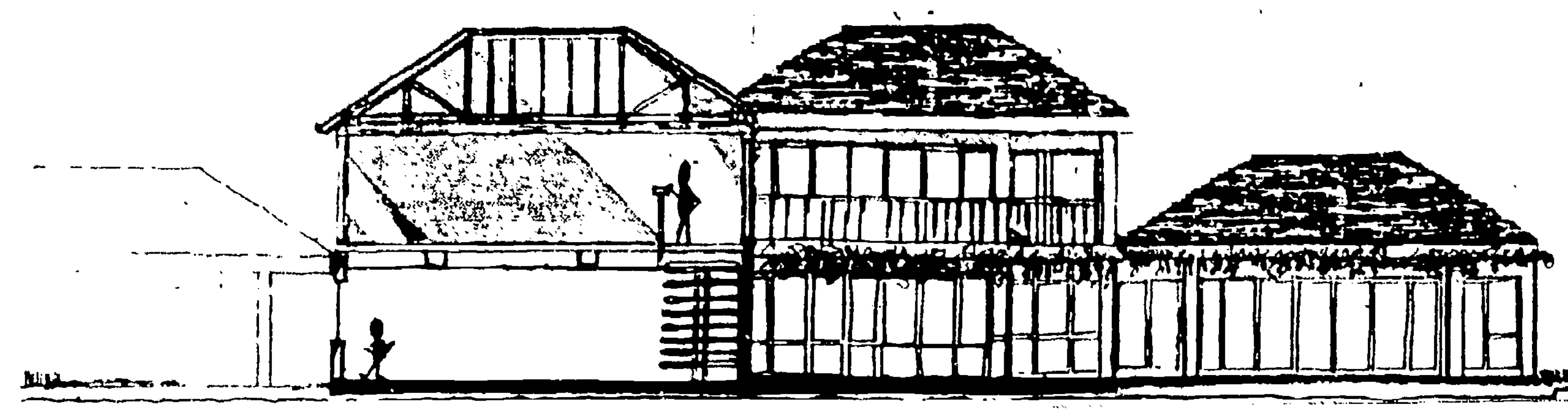
Julie Harlan

MULTI-PURPOSE



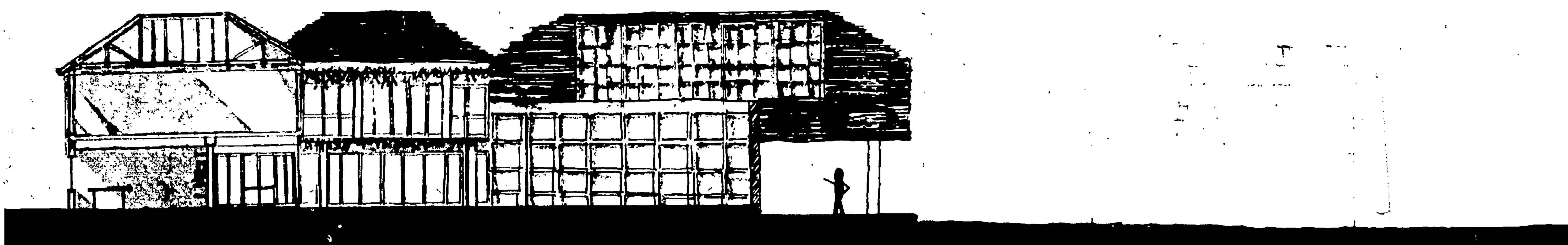
EAST ELEVATION

● WINTER NOON NOV.21
○ SUMMER NOON AUG.21 1/8"=1'-0"



SOUTH SECTION/ELEVATION

LIBRARY



Julie Harlan

ADMINISTRATION · CLASSROOMS

Classroom Performance

temperature change=60°-35°=20°(design temp.)

wall

	outside air(15)....	.17
	wood siding........	.81
	plywood............	.59
	2x6	
	batting............	22.00
	gypsum lath........	.32
	plaster............	.09
	inside air space...	.68
		24.66
		1/r=u=.041

22,00x20x.041=1889.0 btu/hr

glass — dbl. pane..u=.60 w/insulated shutters

878x20x.60=10536 btu/hr

doors — solid core..u=.50

36x30x.50=360btu/hr

floor

outside air........	.17
gypsum plaster.....	.39
insulation.........	12.00
3" concrete deck....	1.25
inside air.........	.92
	14.73
	1/r=u=.068

1597x20x.068=2172 btu/hr

roof

outside air........	.17
cedar shakes........	.94
air space	.85
ridged insulation..	2.78
decking	3.28
insulation.........	30.00
gypsum ceiling.....	.31
inside air.........	.92
	36.47
	1/r=u=.027

1630x20x.027=880.20btu/hr

infiltration..19703(.018)x20=
7093.08 btu/hr

total heat loss for classroom

total heat loss for classroom on an adv. winter day(nov.21,9am-3pm)

22930.28 btu/hr•6hrs=137581.68 btu/day/F°

137581.68/19703=6.98

heat gain(assume 50% storage eff.) between 9am-3pm at 22.5°E of S

greenhouse — 915x1361btu/day/ft=..5=623003 btu/day

direct gain — 878x1361btu/day/ft=1195621 btu/day

people gain — (#people)(btu/person)
50 x 250=12500 btu/hr•6hrs= 75000btu/ btu/day

waterwall — 30% eff. 878 (window area) 1361 x.3= 358,686btu/day

total heat gain for classroom

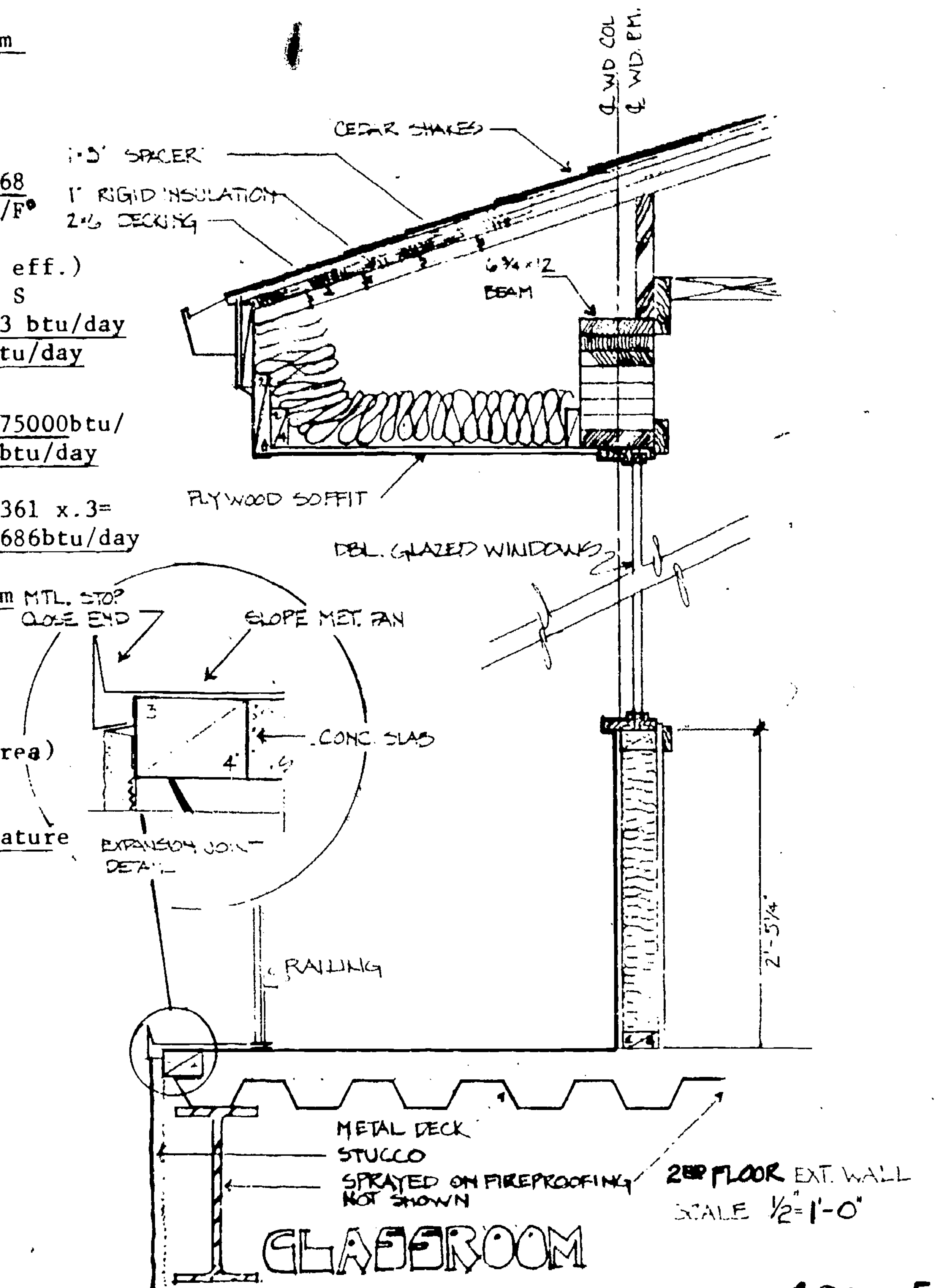
total heat gain for classroom on adv. winter day mean cloud cover between 9am-3pm

2252310btu/day/19703(floor area) = 114.31

■ adverage daily indoor temperature

$\frac{\text{heat gain}}{\text{heat loss}}$ + adv.outdoor temperature

$\frac{114.31}{6.98}$ + 35= 51°



robert james

Goals

To provide a visual statement on the landscape that would give the neighborhood a physical focal point as well as a sense of identity.

To design an academic environment that reinforces a positive learning experience, is spatially diverse, and functions as close as possible within the needs of the modern curriculum.

To provide a prototype zero energy education facility that utilizes only the resources contained within the site, and then use this facility as an educational laboratory for the children as well as the general public.

A personal desire to improve my knowledge and experience concerning these issues.

Site

It was my desire to design the school to literally act as a focal point in a neighborhood that has no focus—it should be in a place where not only children gather but where the community can also get together. As a result, I incorporated a community park into the design thus making elements such as the playing fields, the gymnasium, and cafeteria available to the general public.

The design itself incorporates a dual axis layout: The linear axis contains the large scale, noisy, "community"-school elements: gym, play area, soccer field; a spiral axis contains the more specific school-related elements such as classrooms, administration, etc.

They both intersect at the library and as such it becomes the focal point for the school.

I chose the spiral layout for a number of reasons: It lends itself well for solar orientation; I found the spatial quality of the interior exciting; also, whereas the linear axis terminates after the soccer field, the spiral form (by incorporating both the building and landscape) continues as a symbolic gesture to interact with the neighborhood.

The school is positioned on the site so that the soccer field and gymnasium act as a buffer zone from Waverly Street and the proposed commercial district due west. The softball fields protect the building in the advent of a multi-story structure due south of the site.

The trees north of the concrete play area serve the purpose of enclosing the large outdoor space formed by the buildings while at the same time they buffer the dominant nature of the Bonneville power lines.

Parking is located on the extreme west side of the site where it relates to Waverly Street and the commercial district.

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Energy Considerations

HEATING:

The classrooms are designed so that certain areas will heat up rapidly in the morning (through direct solar gain). Therefore classes will use a migration principle—that is, students will move to a section of the classroom for their studies depending on the temperature conditions in that area. Due to the need for the quick morning heatup, the school will be built primarily of wood frame construction.

A question arises at this point concerning the use of masonry construction due to its heat storing capacity. This type of construction is common in the design of passively heated solar homes due to the need for heat during the night. However, since the school will be used only during the day, this lag period is not as crucial. What is important is the quick morning heatup, which is inconsistent with masonry. It is important to note, however, that the large temperature differential that would occur from day to night with wood construction is also not desirable. Therefore, I have incorporated into the construction a masonry bearing wall in each classroom (light-colored brick for reflectance) and a concrete slab (carpeted) for the floor. It is hoped that this combination in conjunction with the use of window shutters at night will give the benefits of a lag period for heat loss as well as the convenience of early morning heatup. The brick will also provide texture variation in the classroom. Besides flexibility of the classroom, flexibility of school schedules must also be investigated. Some days it may be advantageous to begin class two hours late so that the classroom has time to heat up.

COOLING:

It is expected that during the summer months there may be overheating problems especially in the greenhouse. As a result, most of the windows are operable. Adjustable louvers have been incorporated with all south facing glass, and vents have been placed at the ridge of the greenhouse and the classrooms that will draw cool air from underground. Ventilation of the classrooms can be achieved in a similar manner. Various plantings such as deciduous trees or a grape arbor could also aid solar protection.

LIGHTING:

The classrooms are lit by the use of south facing windows and a series of skylights designed to bounce the light off the ceiling. The south classrooms would also be lit through windows in the north wall due to the buffer offered by the greenhouse. It is important to understand that light enters the classrooms for the most part through south exposure for direct heat gain purposes. However, direct south light is very harsh and is difficult to work with, therefore all light that enters the main classroom is either bounced once off the ceiling or transmitted through diffused glass.

WATER:

Water is supplied to the bathrooms and classrooms by a storage tank located above the library. Water is raised up to the tank by a wind-driven pump and then gravity fed to the outlets. Due to the undependability of the wind, however, the tank should be oversized so that the water will be plentiful on those days when the wind refuses to blow.

SANITATION:
Composting toilets are located outside each classroom. For efficiency, it would probably be advantageous to group the toilets in two main areas. However, I felt it was important that the bathrooms for children this age be located near the classrooms. Also these individual bathrooms act as a spatial definer for the circulation pattern as well as the classroom extension in the greenhouse. Pipes would be attached to the support columns and vent at the ridge of the greenhouse. Hopefully with proper care there would be no odor problems.

FOOD:
The kitchen facility would accommodate a cold lunch program. Children would wash their own dishes or a class could be assigned each week to clean up.

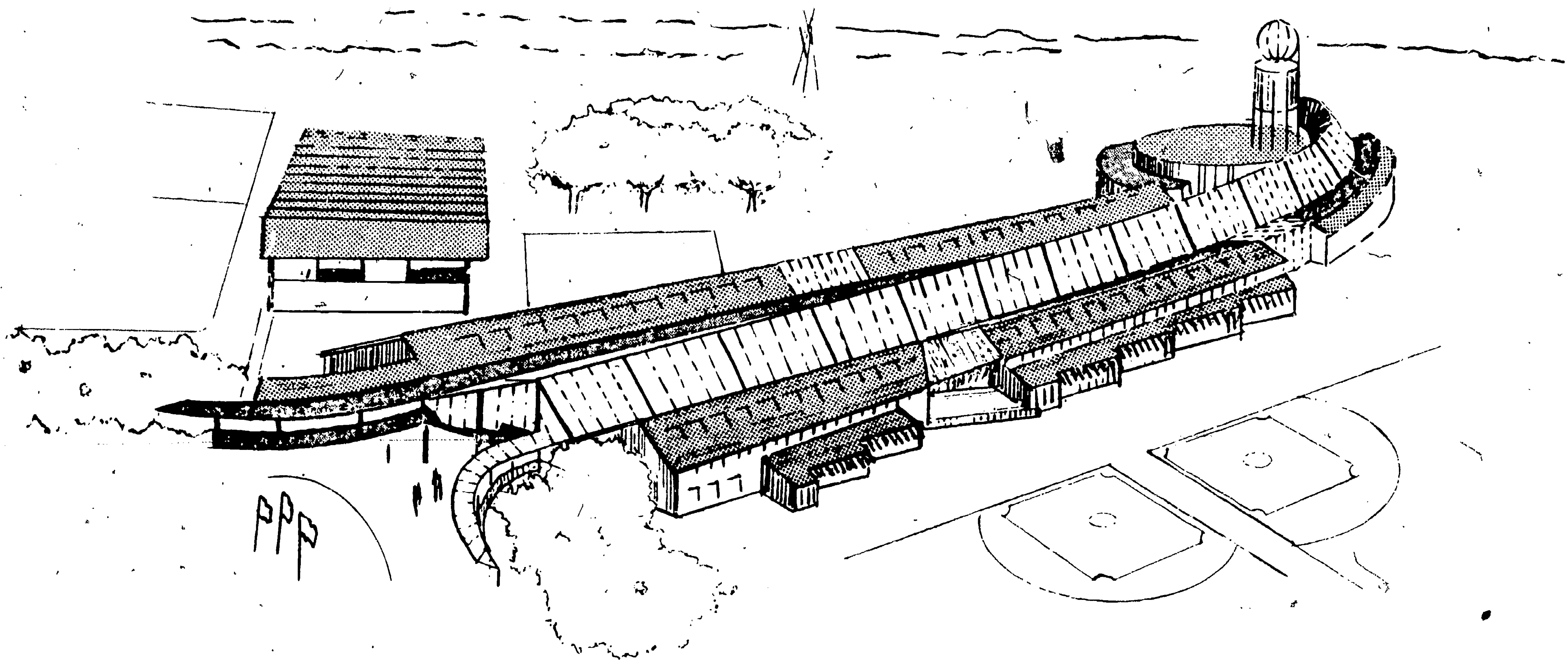
CUSTODIAN:
He would take care of his normal duties, but the children should be responsible for cleaning the classrooms and the immediate area outside. This type of student activity should become commonplace in a zero energy school.

Closing Thoughts

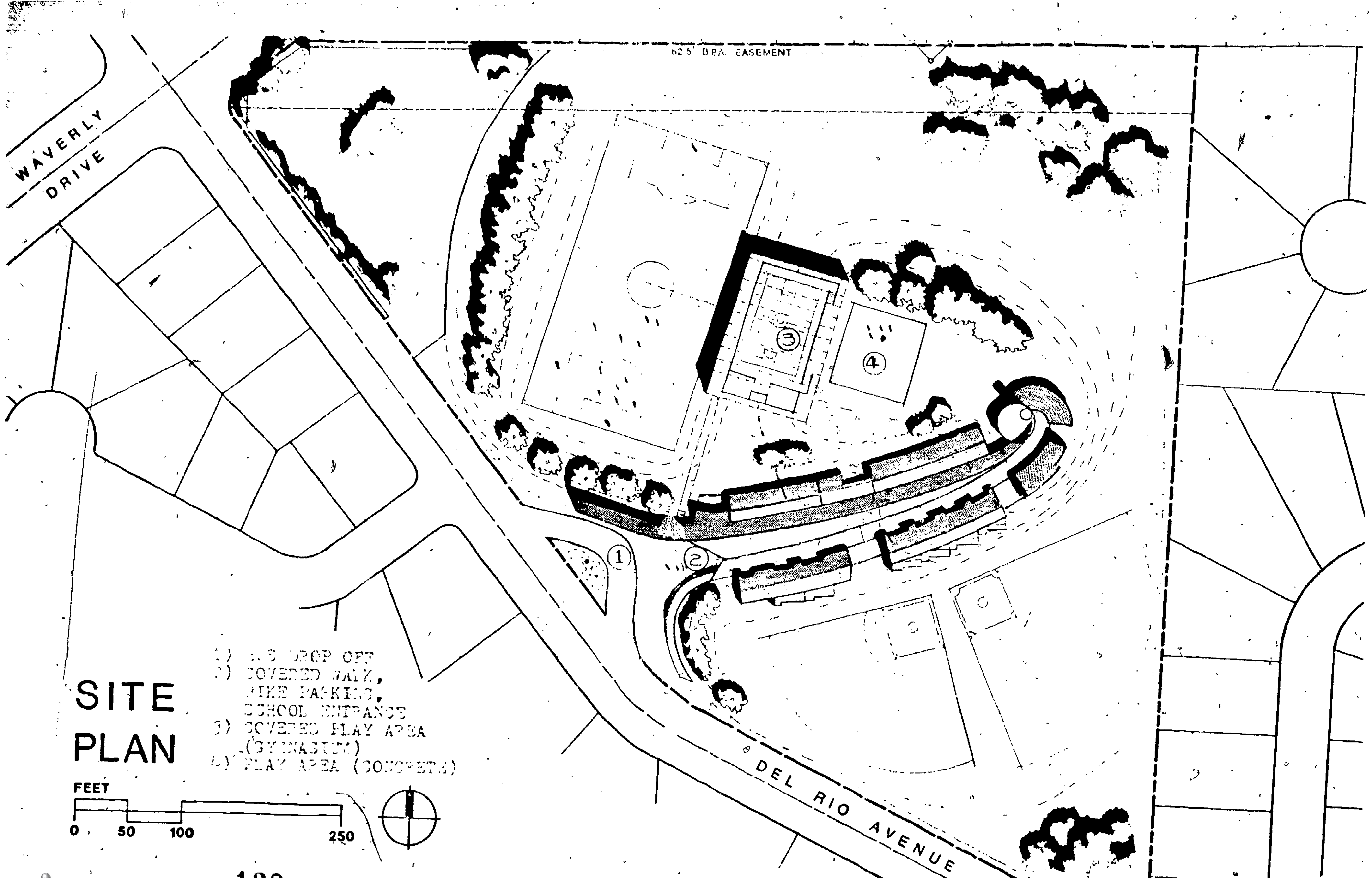
The potential of this project is enormous, and the advantages far outweigh the adjustments that will be needed for such a school to succeed. It seems, after spending five months on this project, I've only touched the surface with respect to the opportunities that are offered. New sources of energy could easily be incorporated.

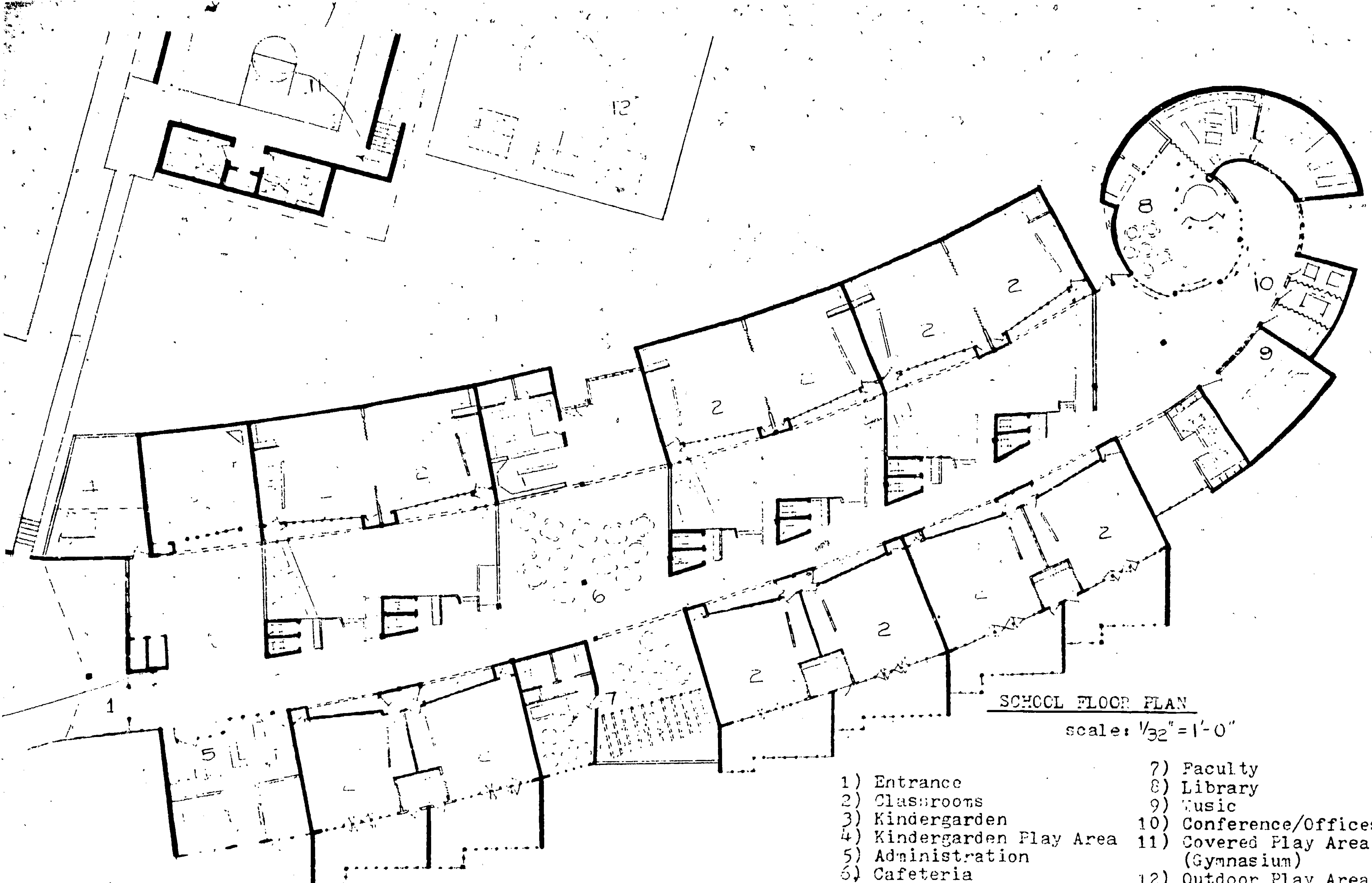
METHANE FOR COOKING: Photovoltaic cells or batteries (recharged by the windmill) could be used to power audio-visual equipment, calculators, etc., items so essential for today's learning process.

But what's really exciting is the spirit that could overtake the students and faculty as they learn to work not only within a building but with a building and work with nature instead of against her.



A ZERO ENERGY USE SCHOOL IN ALBANY, OREGON


WAVERLY DRIVE
DEL RIO AVENUE
SITE PLAN
1) BUS DROP OFF
2) COVERED WALK, BIKE PARKING, SCHOOL ENTRANCE
3) COVERED PLAY AREA (GYMNASIUM)
4) PLAY AREA (CONCRETE)
FEET
0 50 100 250



SCHOOL FLOOR PLAN

scale: 1/32" = 1'-0"

1) Entrance
2) Classrooms
3) Kindergarden
4) Kindergarden Play Area
5) Administration
6) Cafeteria
7) Faculty
8) Library
9) Music
10) Conference/Offices
11) Covered Play Area (Gymnasium)
12) Outdoor Play Area

School Layout:

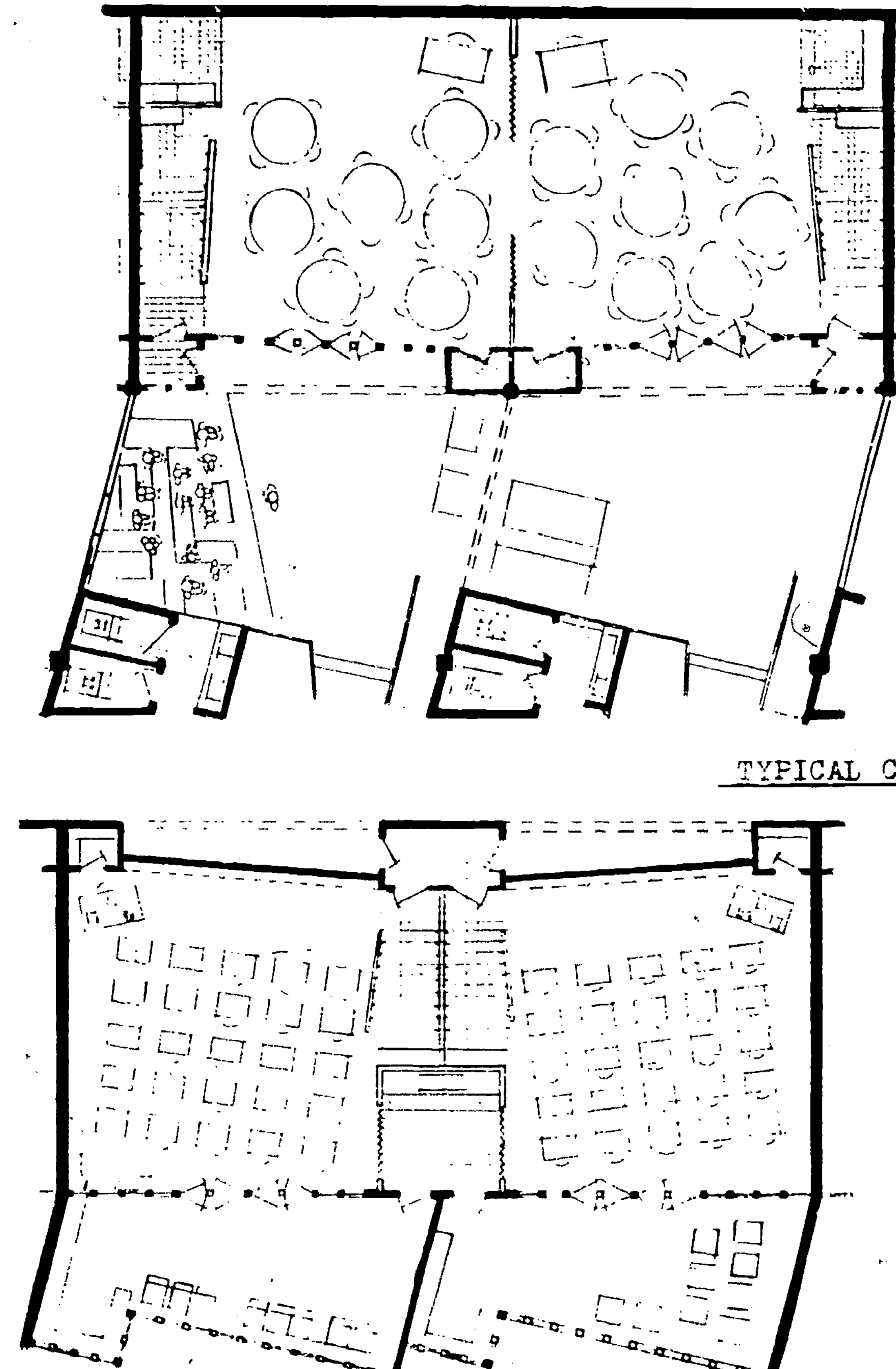
As I stated earlier, the main school elements are contained within the spiral form, which consists of a central greenhouse space (acting as a heat sink) with the classrooms aligned along it. The main entrance to the school is at the mouth of the spiral (as is the administration) with the library being at its vertex. The cafeteria is located in the large central area and can be used for assemblies, public meetings, etc. The music room is located near the library and is semi-isolated to reduce sound problems.

Circulation is contained in the greenhouse.

It is primarily a one-story building for lighting reasons and the building elements are positioned side by side for heat loss considerations.

The school layout is designed for maximum flexibility with respect to interaction between the classrooms. With the use of moveable partitions, space is available for individual class instruction, combining one grade together for group instruction, and also combining two grades together (5th and 6th, e.g.).

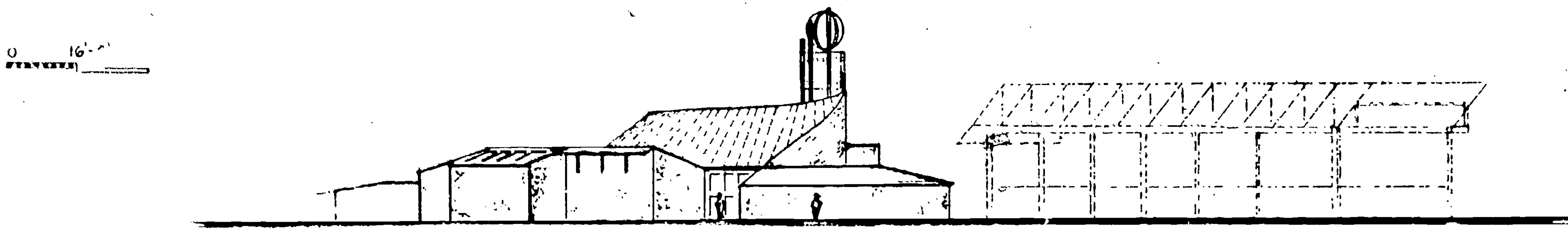
The individual classroom layout consists of a main lecture space along with a secondary instructional area directly south. This space, while acting as a buffer zone for the main classroom, can serve a variety of purposes including small group meetings, covered play area (in greenhouse), assembly area when two or more classes get together for group instruction, etc. This flexibility was a major design criteria.



TYPICAL CLASSROOMS

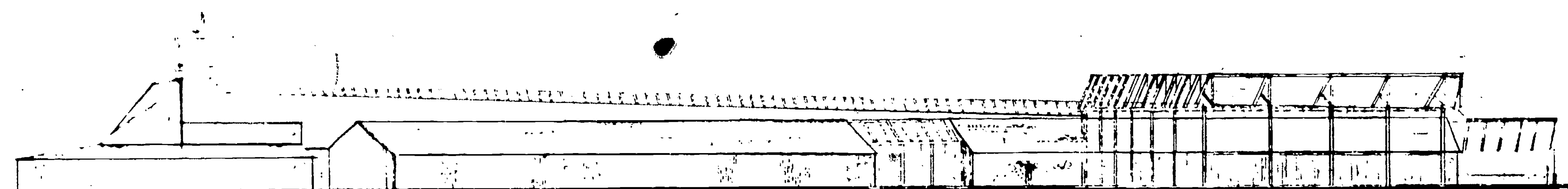
scale: 1/16" = 1'-0"

Robert James

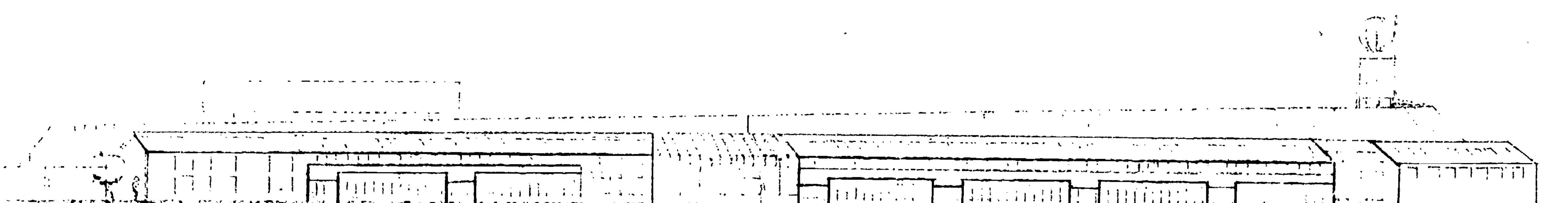


EAST ELEVATION

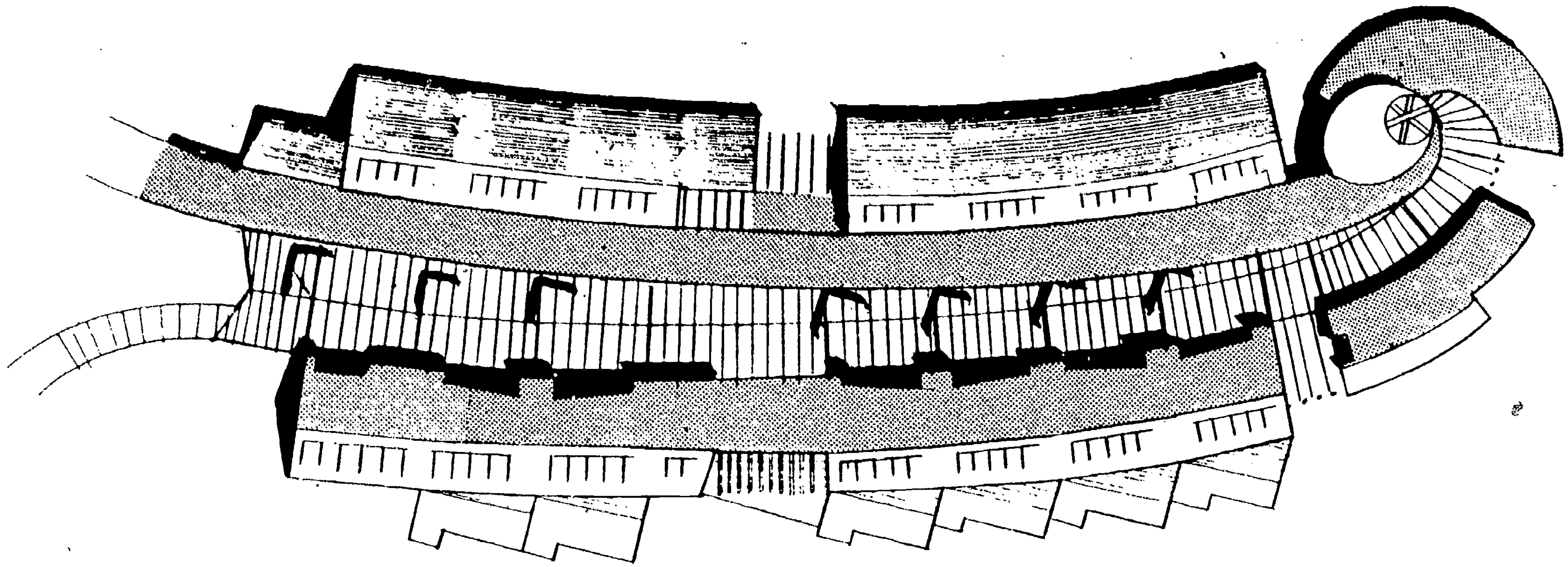
WEST ELEVATION



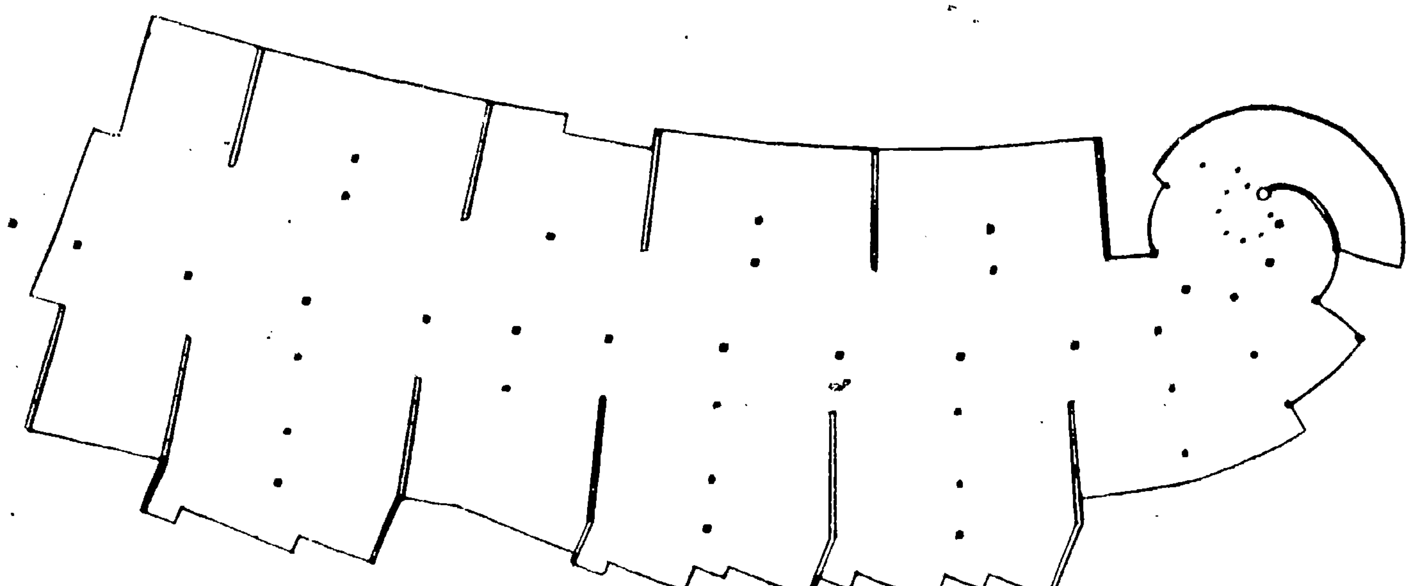
NORTH ELEVATION



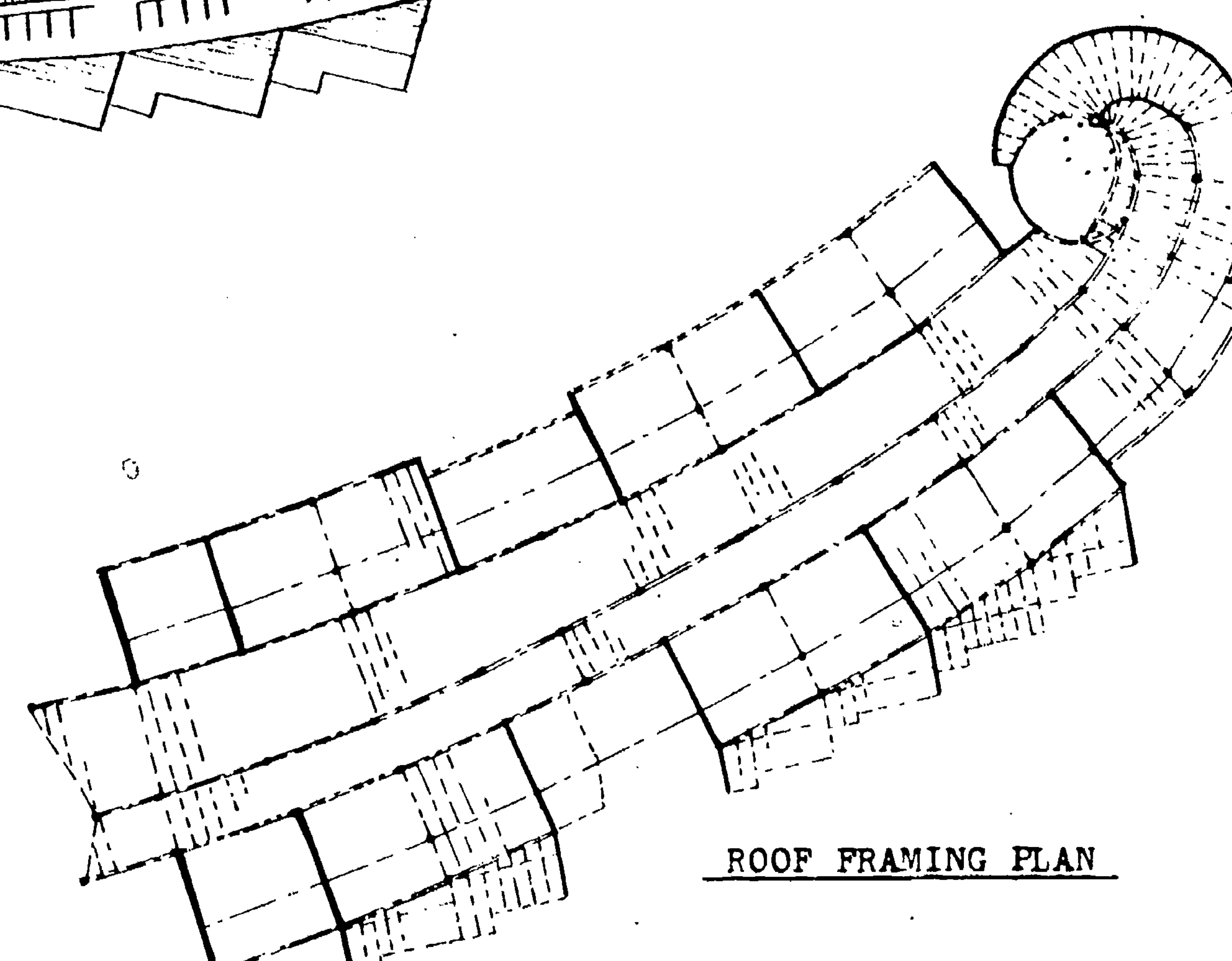
SOUTH ELEVATION



ROOF LAYOUT



GROUND SLAB w/ COLUMNS & BEARING WALLS



ROOF FRAMING PLAN

Robert James
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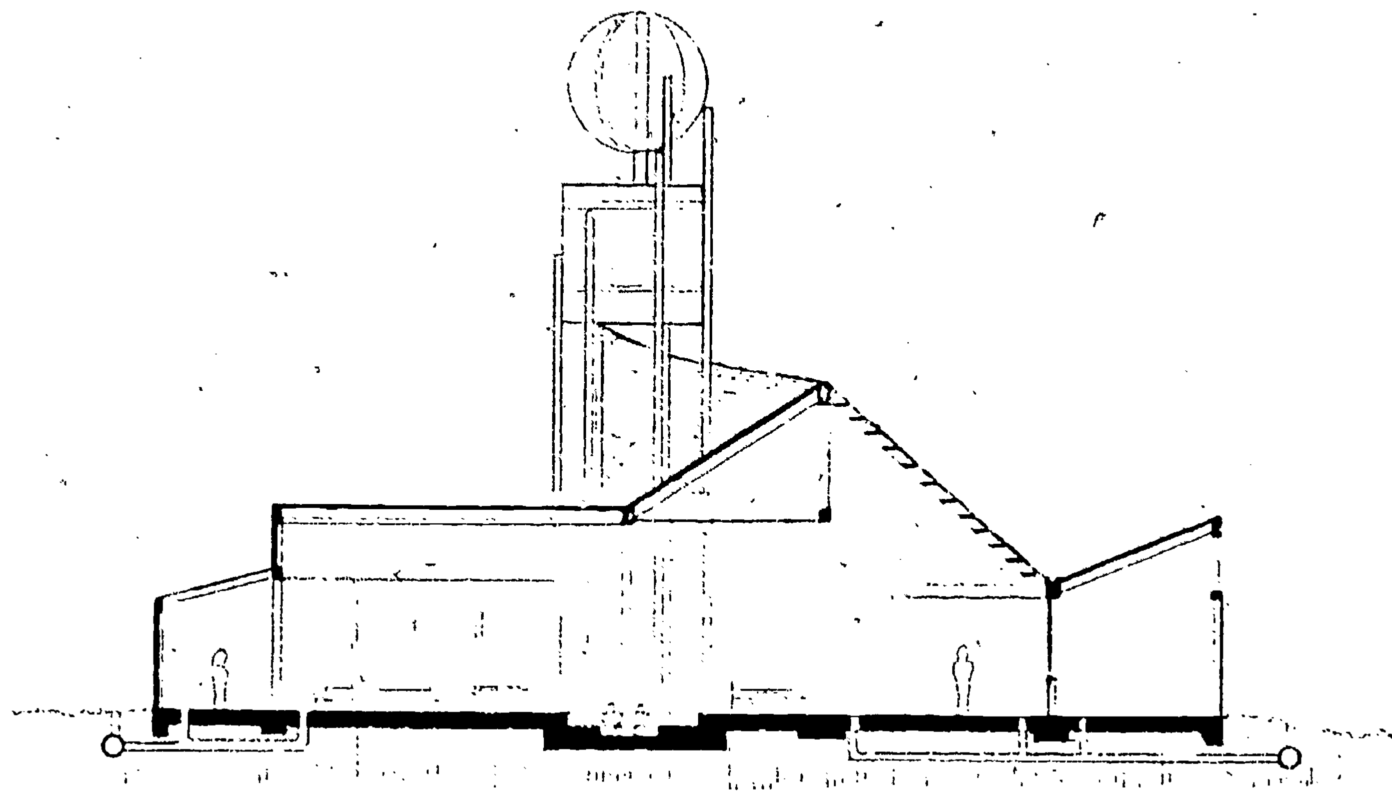
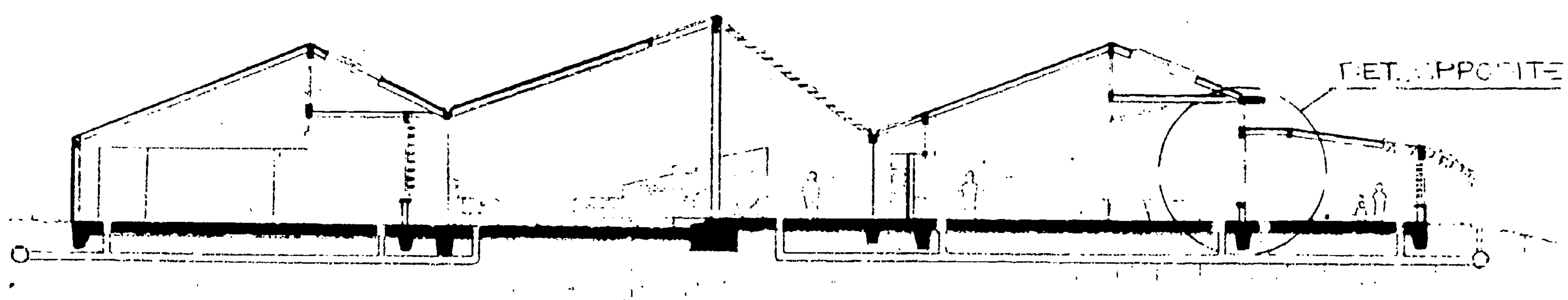


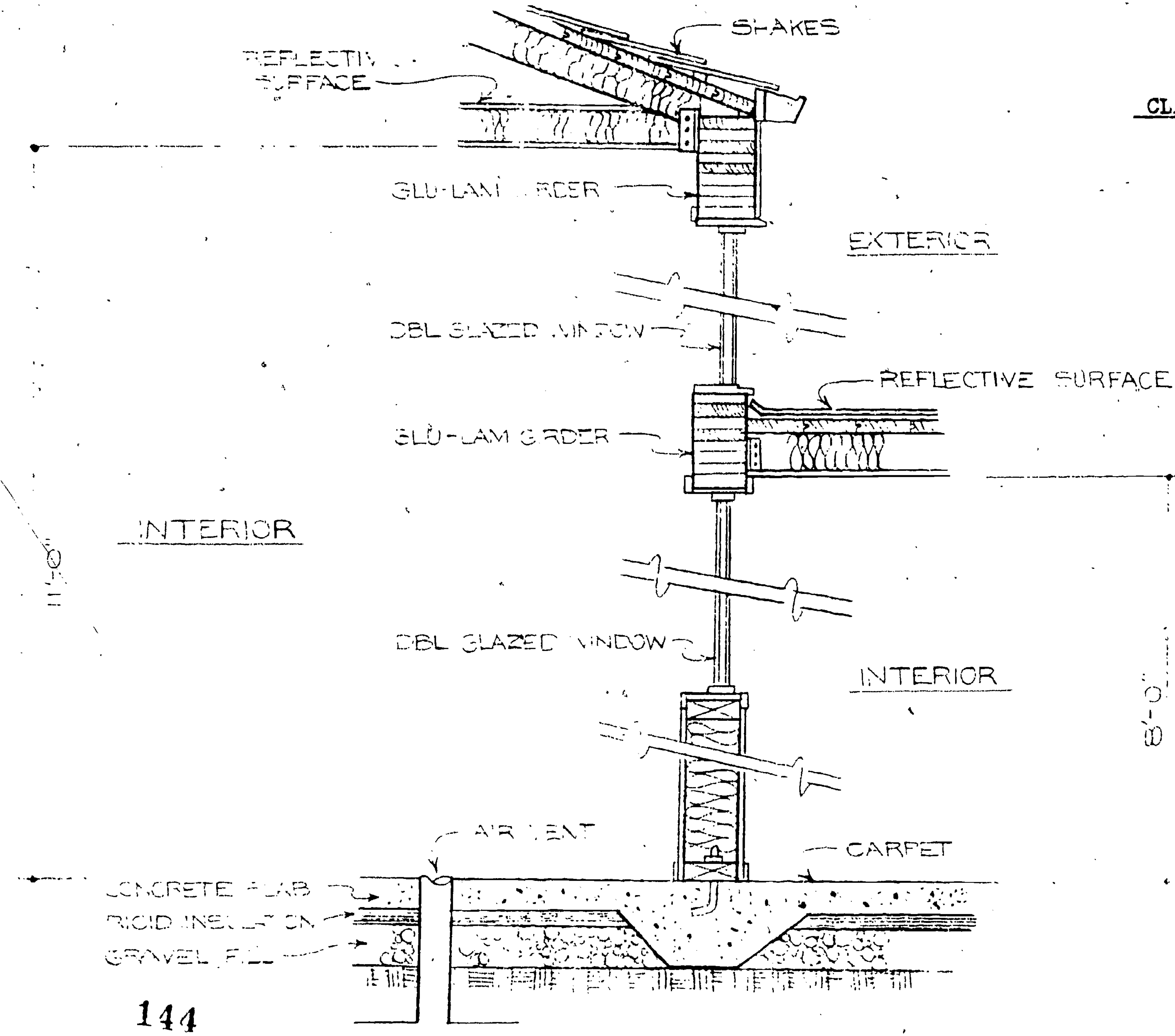
LIBRARY SECTION

scale: 1/16" = 1'-0"



CLASSROOM SECTION

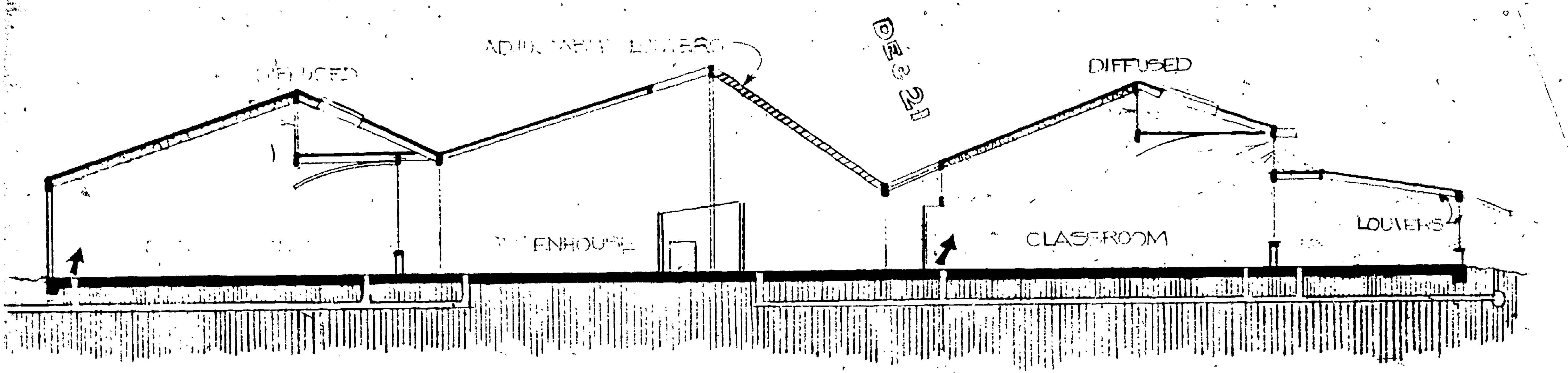
scale: 1/16" = 1'-0"



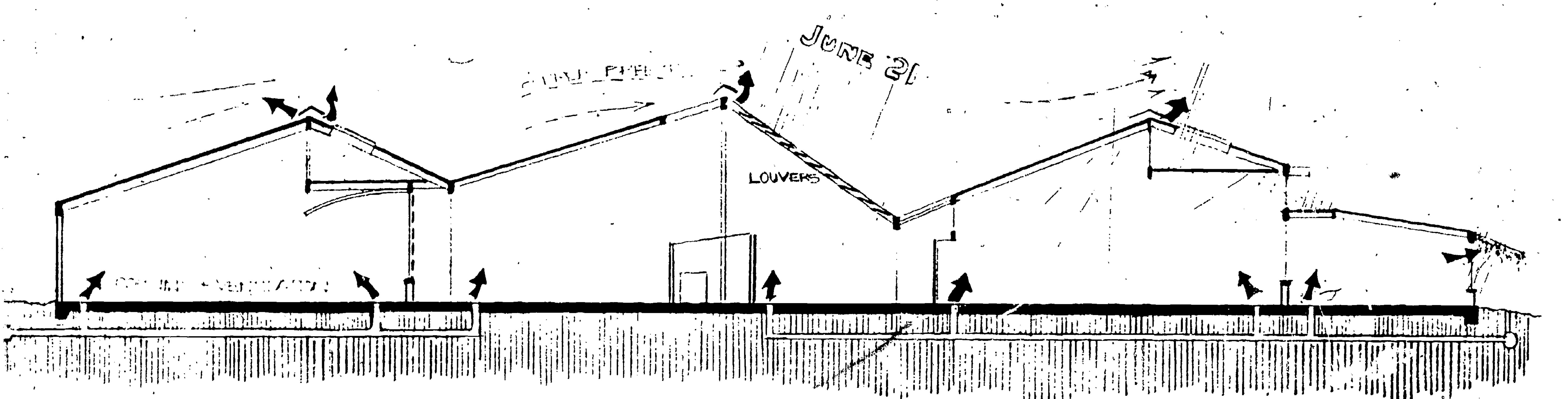
CLASSROOM WALL SECTION

scale: ½" = 1'-0"

Robert James



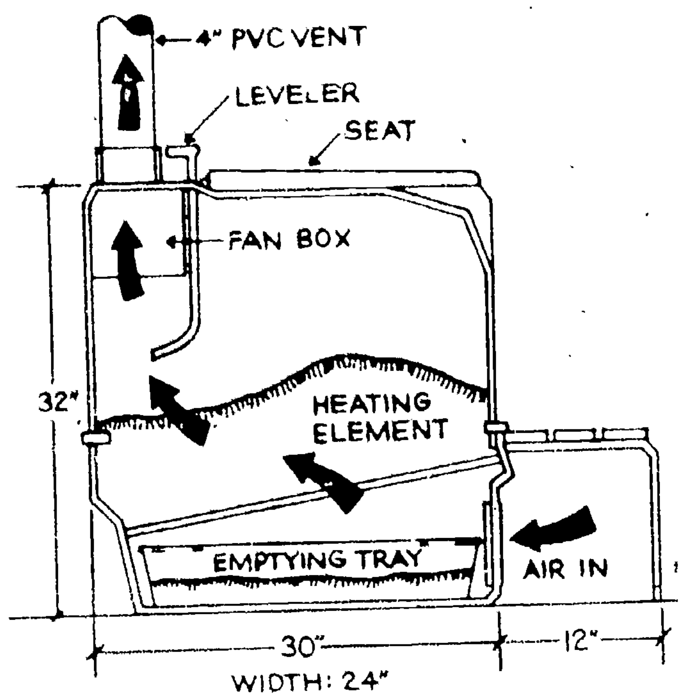
LIGHTING AND DIRECT GAIN HEATING (WINTER)



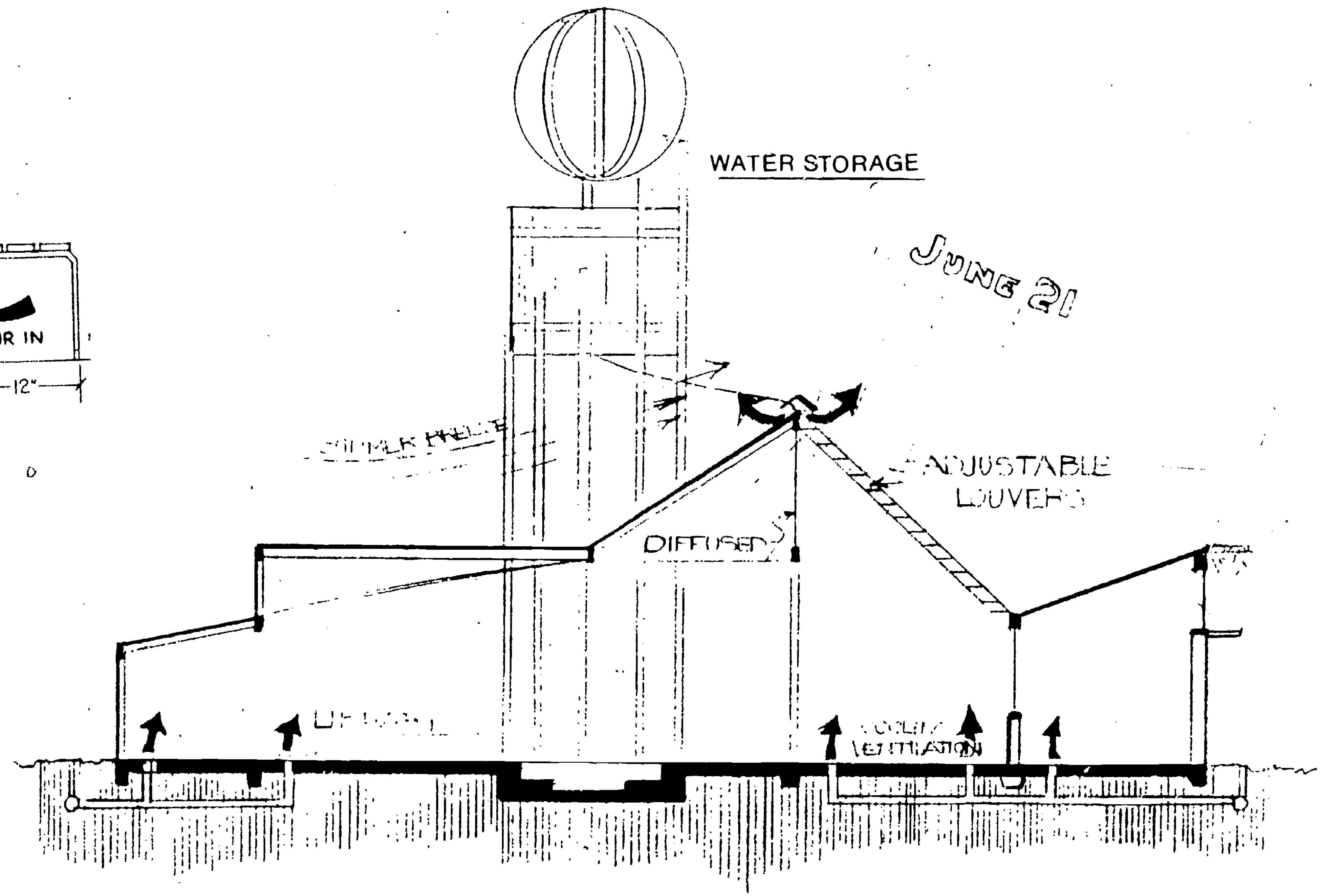
LIGHTING AND COOLING (SUMMER)

PERFORMANCE SECTION

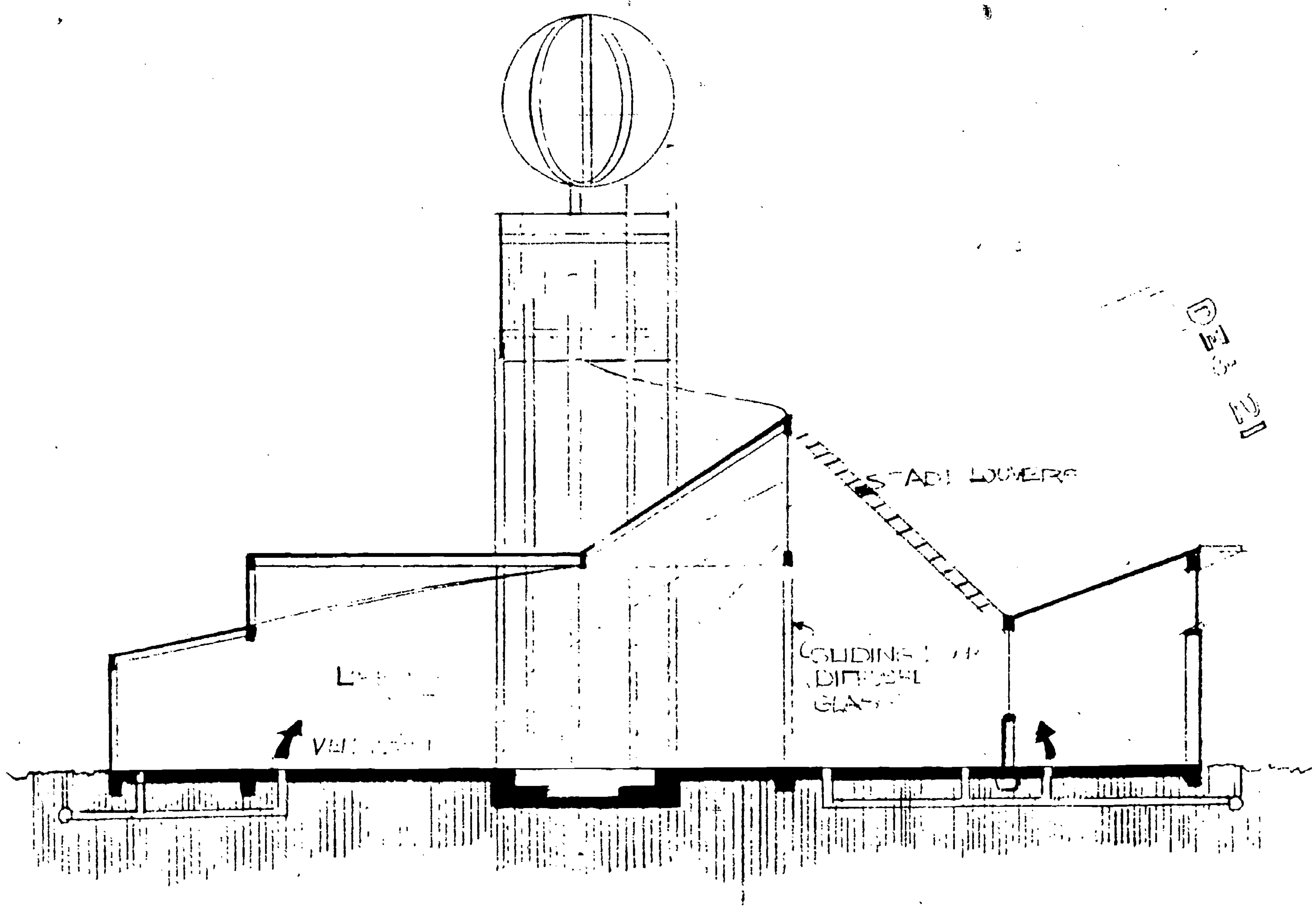
Robert James



COMPOST TOILET

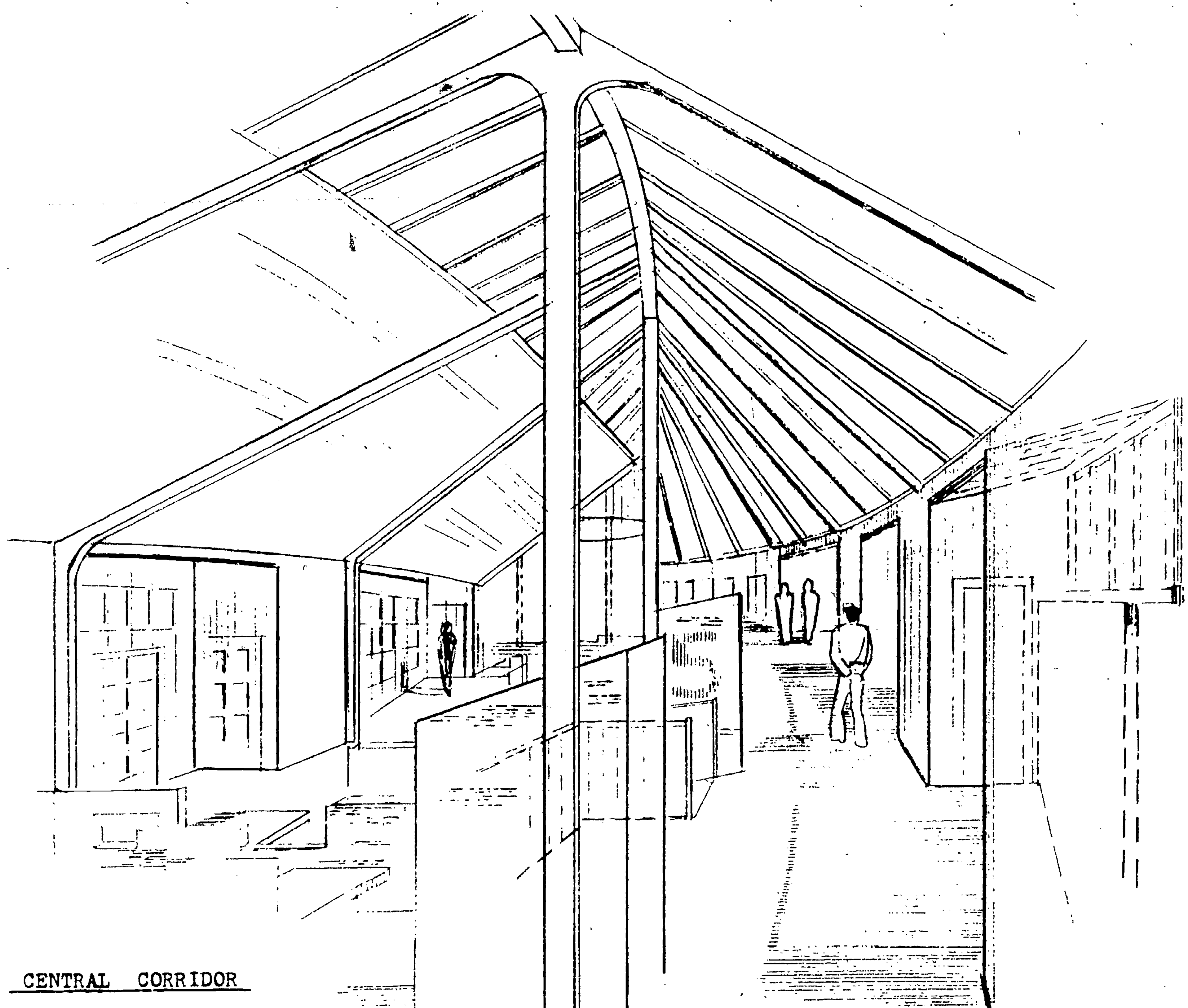


LIBRARY: LIGHTING AND COOLING



LIBRARY: LIGHTING AND DIRECT GAIN HEATING (WINTER)

Robert James



CENTRAL CORRIDOR

Robert James 74

barry keeney

Design

The intention of this design proposal is to combine the two primary issues, education and passive solar energy, in such a way as to further increase the basic fundamental education of youth. Understanding how to read, write, and do calculus is one thing, but knowing how a building (or shelter) can function properly and comfortably without nonrenewable energy resources is of equal importance.

The project is called a "Corridor Greenhouse." The design philosophy behind the central corridor of the school used as a greenhouse is based on an early morning immediate warm-up, or quick warm-up period, and on regulating the interior atmosphere by ventilation throughout the day. Storing heat until the following morning is also implemented to help minimize the daily change in temperature. The various spaces adjacent to the greenhouse draw heat from it either through direct air ventilation or indirect radiation through the walls or floor. Since, the greenhouse is used primarily for circulation through the building, its temperate range can vary to larger extremes than the active user spaces. Each room or space then, in turn, regulates its temperature accordingly.

The educational combination of *school* and *energy* is achieved in a number of ways.

1. All the regulating devices (vents, solar shutters, awnings, and even the clothes students wear) are controlled by the students themselves. Students are "taught" to open the proper vents to create a draft of either warm or cool air. Solar shutters are opened to allow heat and light when necessary and closed to prevent heat loss when not needed. Students operate all the devices.

2. Varying the clothing units may be one form of moderating temperature fluctuations.

3. The school schedule may have to alter from tradition to compensate for climatic conditions.

4. Learning how to function properly and reliably in a natural environment rather than artificial.

5. Some crops may be harvested on site, another step back to self-sustainment.

6. Migrating to a warm zone in the school will simply be an exercise in understanding natural life support systems.

The building is oriented 10° east of south allowing greater morning gain. Its southern facade erodes from a sunken courtyard, and the structure rises toward the north in a wedge progression.

Design Strategy

Administration
Offices
Health
Special classes
Kindergarten
Library

Education
Classrooms

Physical Recreation
[illegible]
Indoor play area
Dining

Performa

A. GENERAL

All energy needs for this school will be satisfied by on-site provisions, independent of Albany's city services.

1. WATER:
Windpower draws well water from the site up to an elevated storage tank (medium capacity). The water is used in restrooms and kitchen by gravity flow. (A variance is taken to centralize water to these areas only.)

2. SEWAGE:
A methane digestive toilet system is provided for possible use in the kitchen.

3. LIGHTING:
Total natural lighting.

a. The corridor receives direct light most of the year supplying indirect (reflected) light through either windows or french doors to adjacent spaces.

b. Most spaces are top lit and side lit from two sides.

c. Skylights are designed to reflect light into the space below and trap heat.

d. All aperatures are covered with manually operated shutters.

B. HEATING

Totally passive
Methods:
greenhouse corridor
attached greenhouse
trombe wall w/storage
air plenum (thermal syphon) w/storage
metabolic heat from children

1. Greenhouse areas are generally the first spaces warmed up in the morning and are therefore best suited for early morning routines.

2. Delayed heat systems (mass wall, water wall, plenum) will regulate heat in other spaces as the day progresses.

3. Storage—classes on south side and offices all have below grade delayed heat collectors with a pebble rock storage medium under floors. One-day, possibly two-day, storage capacity.

4. Comfort range—during periods of solar absence, temperatures may fall below a typically comfortable level. Extra articles of clothing may become necessary and therefore part of the educational process.

C. COOLING

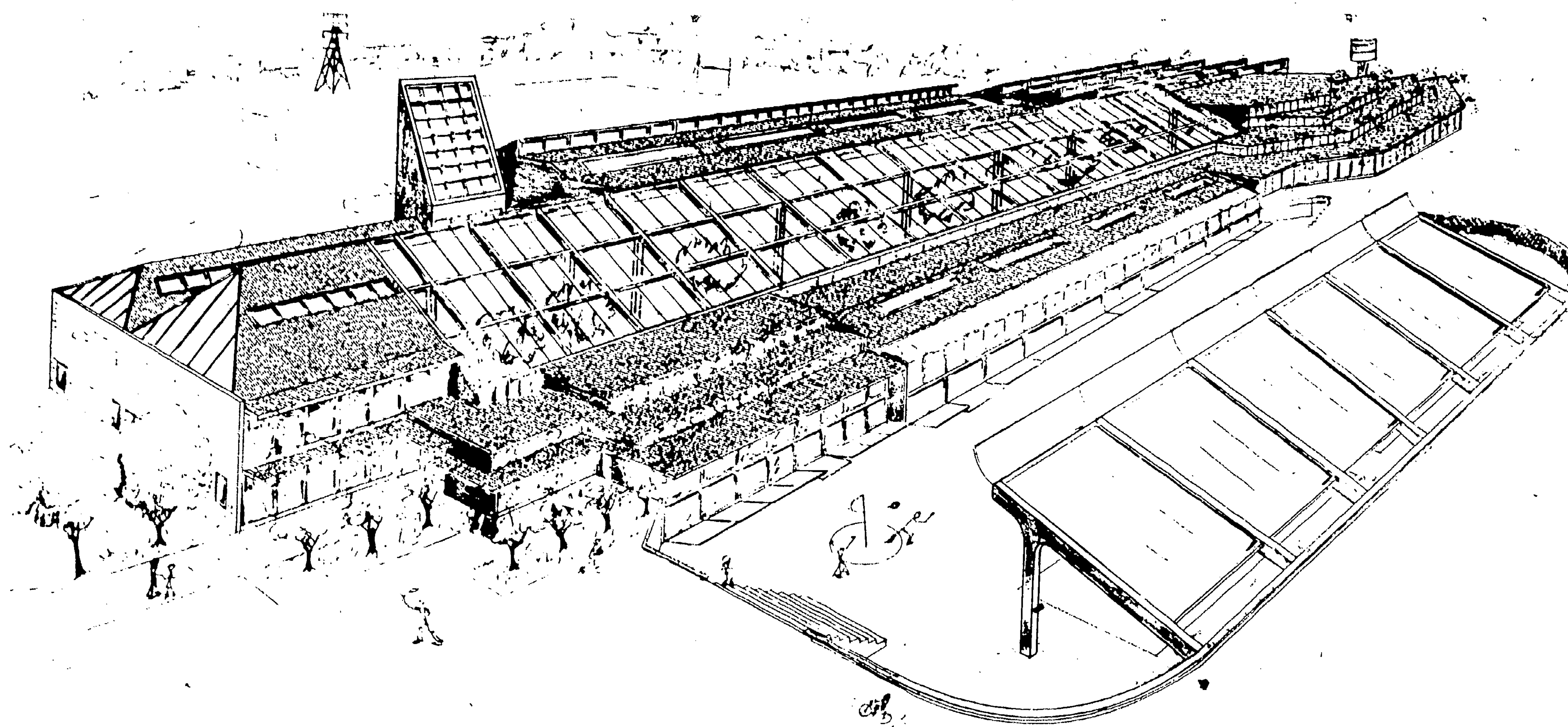
Ventilation by convection. Wind directed vents on the roof draw warm air out when opened up. Vents at top of greenhouses operate similarly.

D. CONCLUSIONS

The average temperature of this building will remain between 65° and 75° about 80 percent of the year. To regulate this, the school should be scheduled to exclude periods of extreme cold and absence of solar insulation (refer to proposed school year).

Typically the school day would start in a greenhouse space (immediate heat) and expand to major classroom areas as the day progresses.

After students understand how venting and thermal cycles operate with proper maintenance of shutters, the school's efficiency could be 100 percent (give or take a sweater factor or two).



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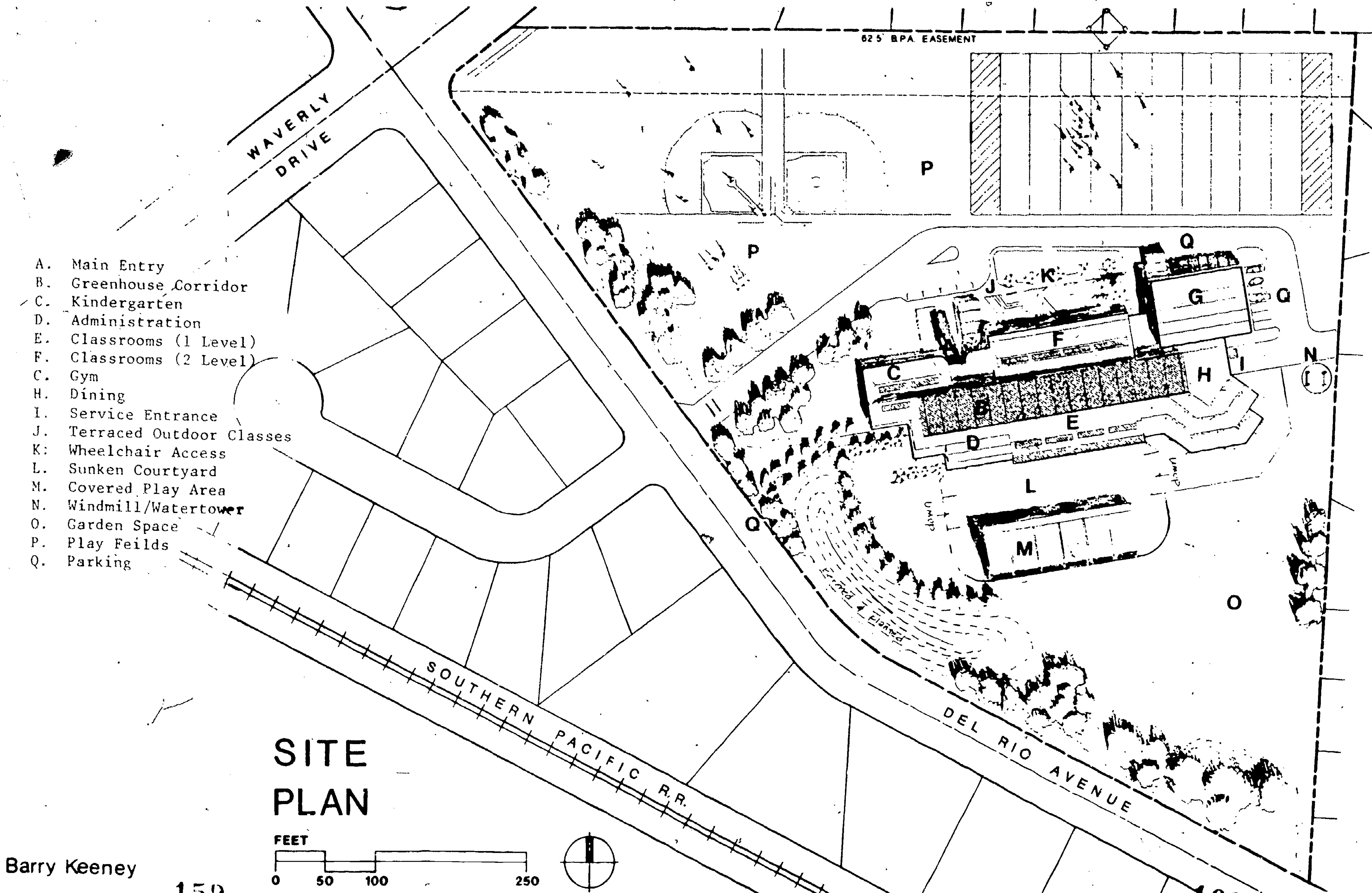
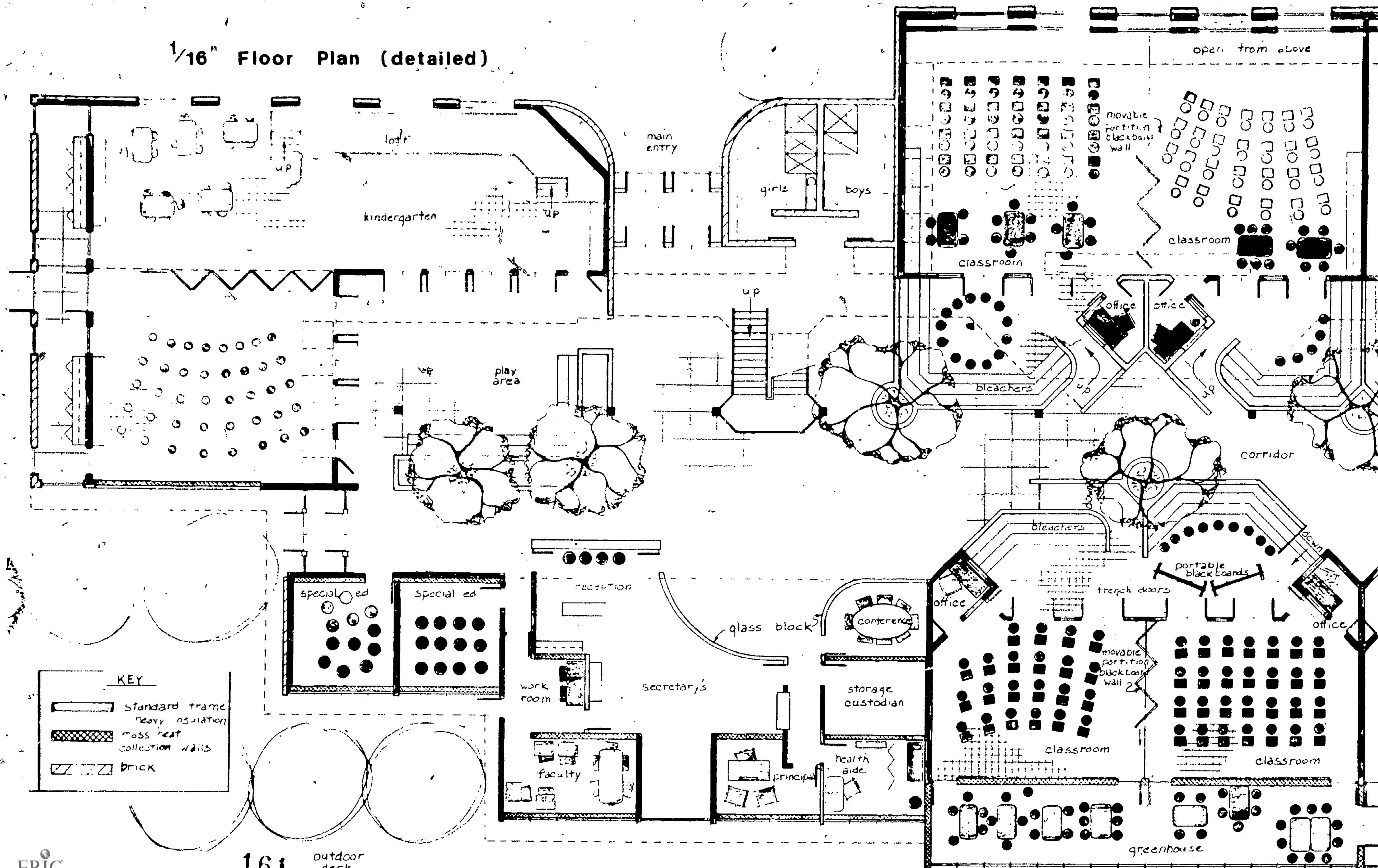
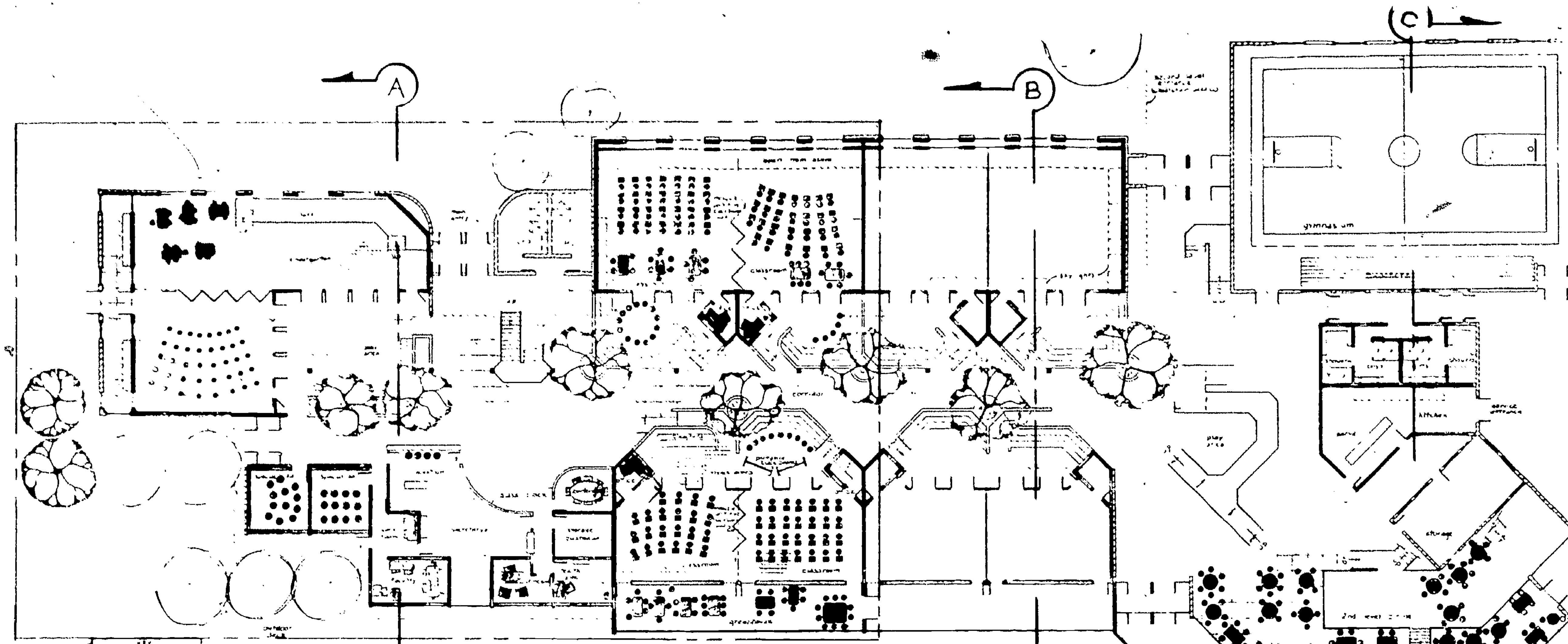
Barry Keeney



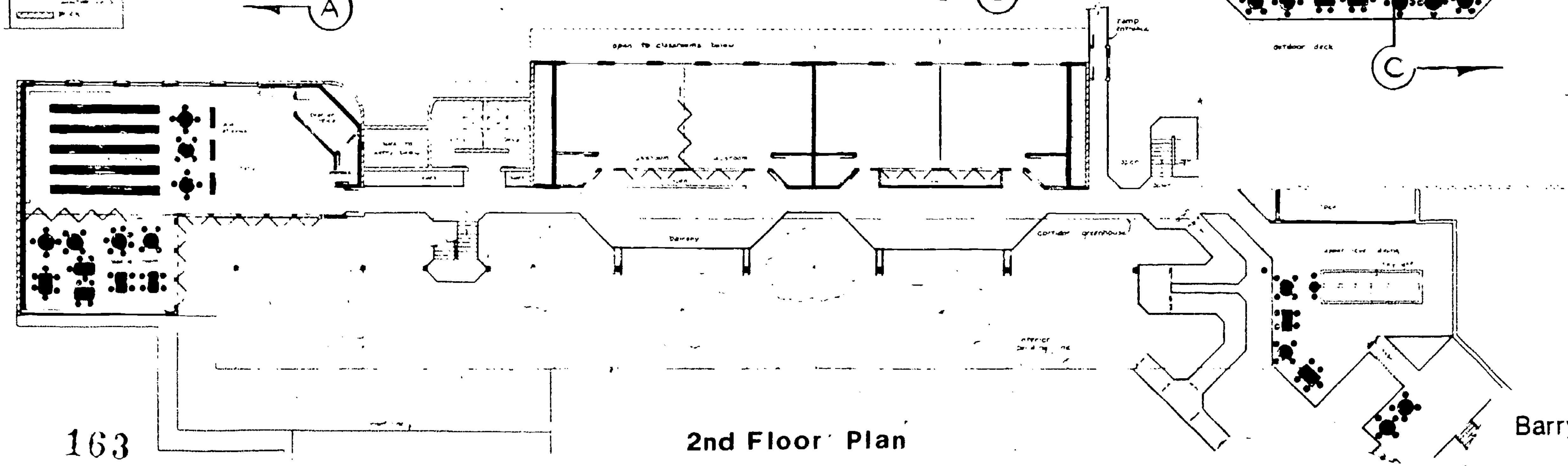
Barry Keeney

1/16" Floor Plan (detailed)



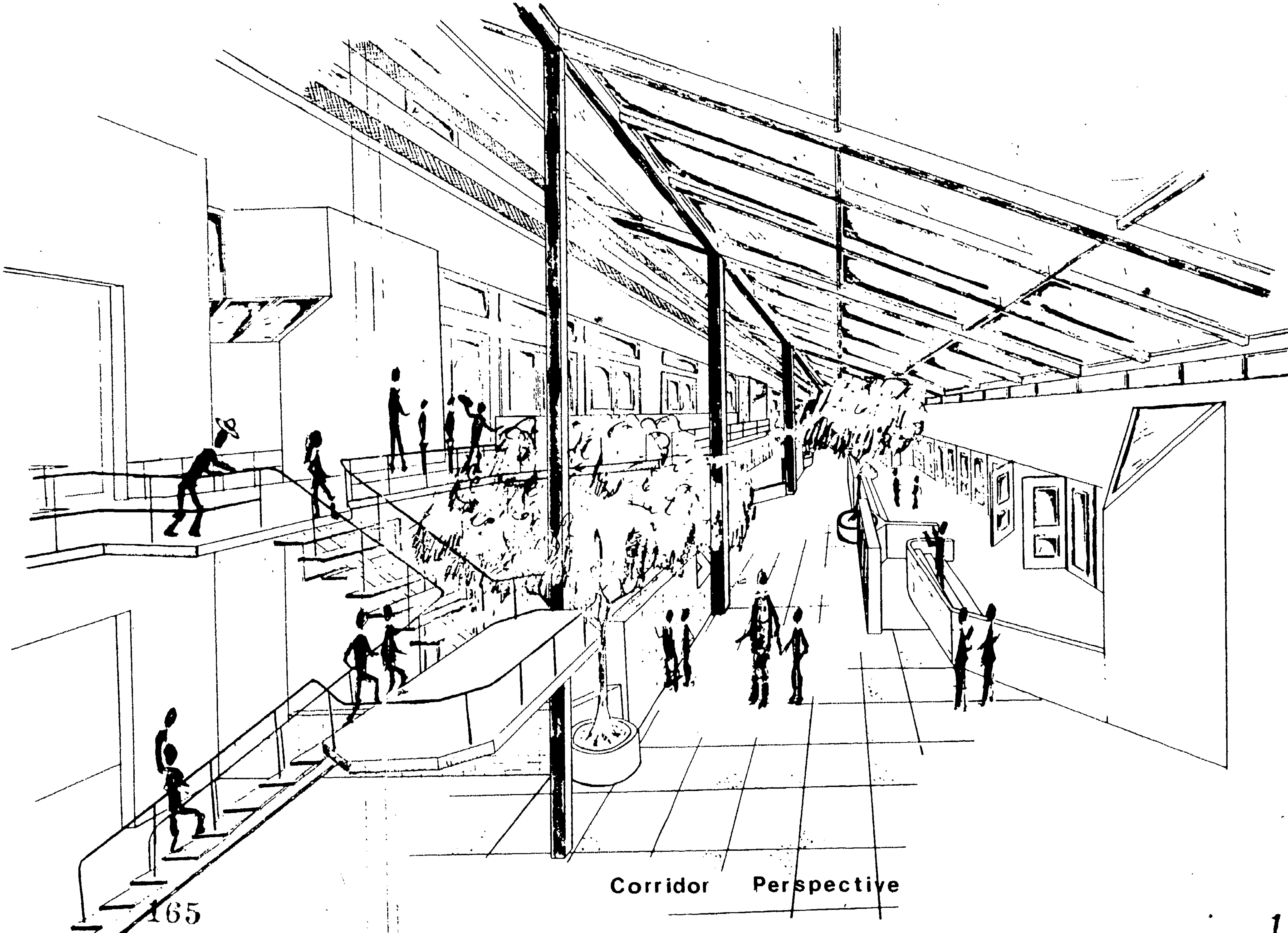


1st Floor Plan

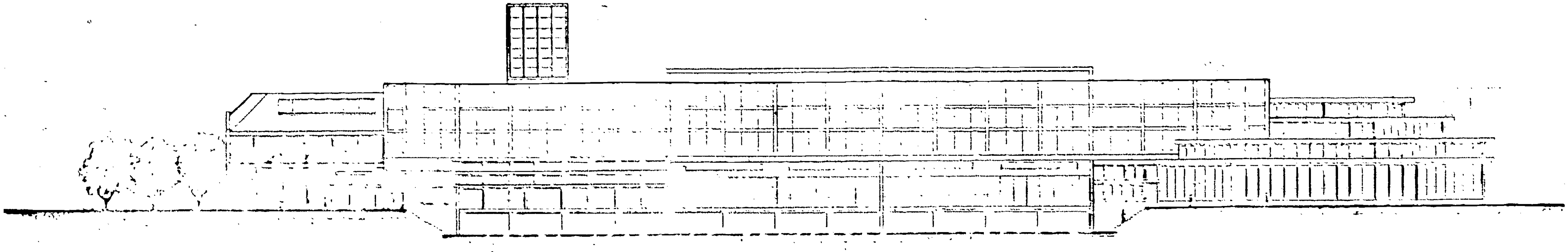


2nd Floor Plan

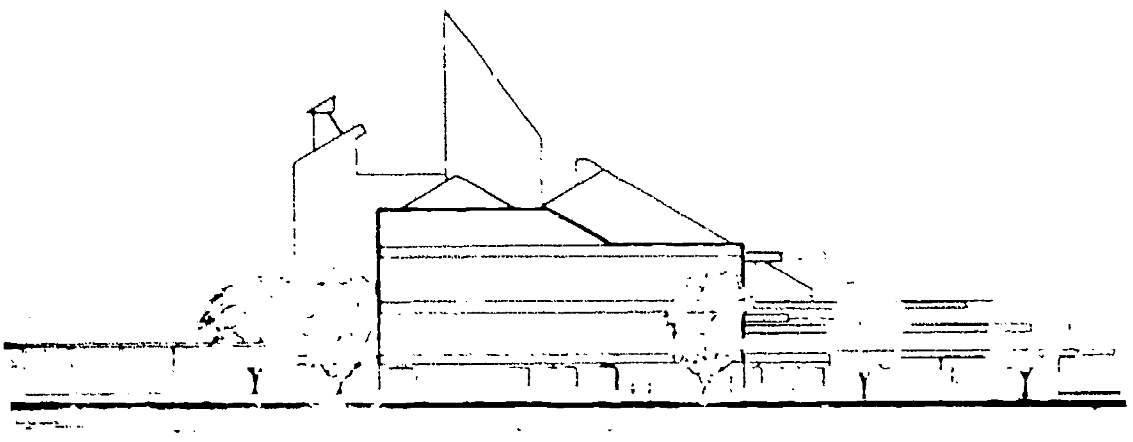
Barry Keeney



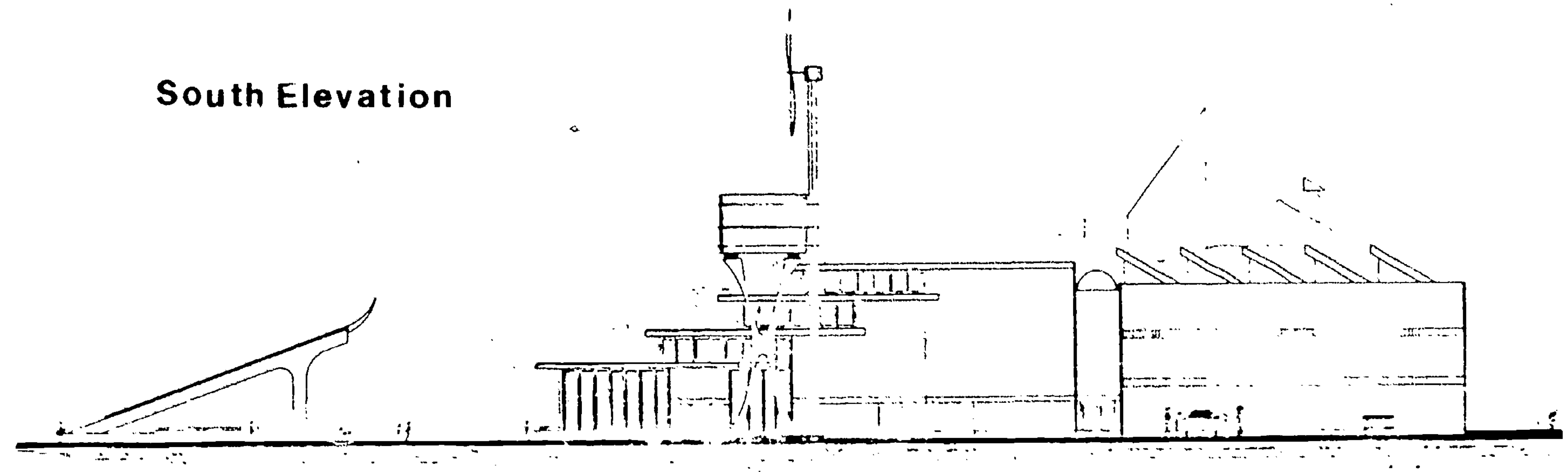
Corridor Perspective



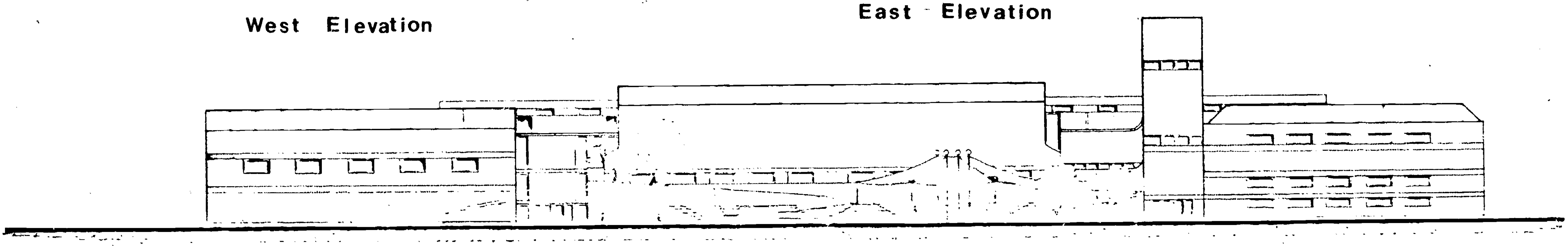
South Elevation



West Elevation

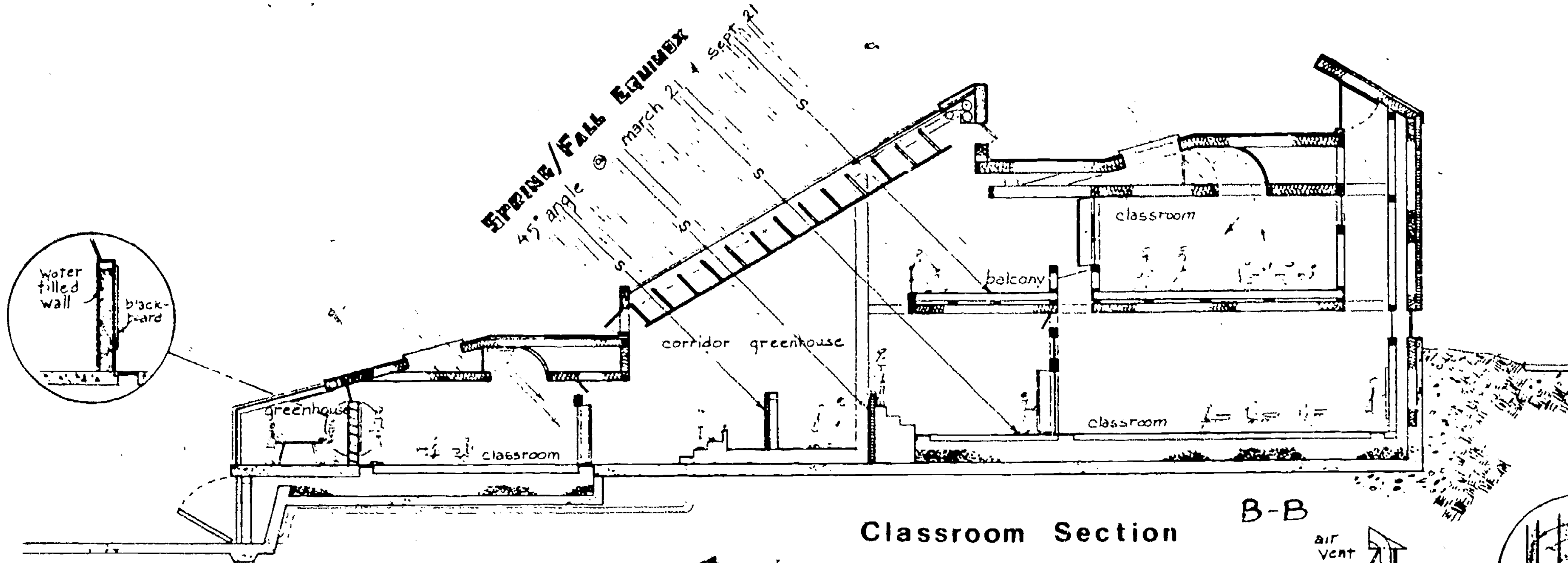


East Elevation

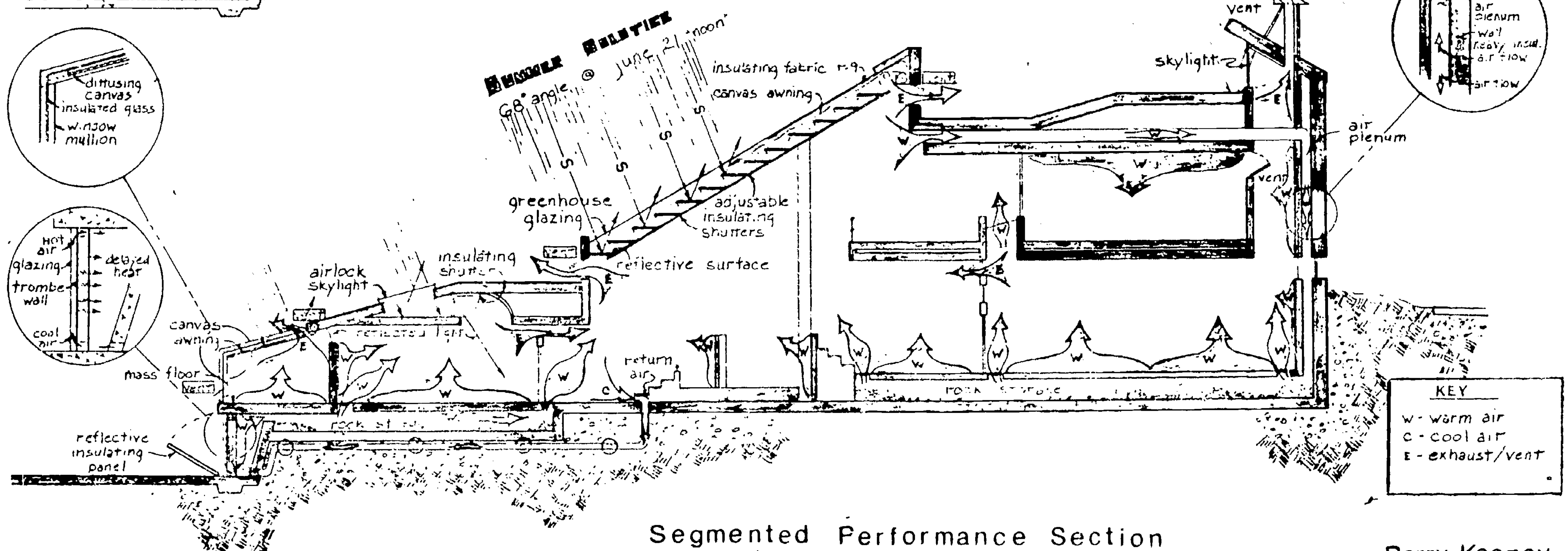


North Elevation

Barry Keeney



Classroom Section B-B



Segmented Performance Section

PROPOSED SCHOOL YEAR

Albany School District - 8J
1979 - 1980 (typical)

<u>1st & 2nd term</u> -

August 6, 1979 - December 7, 1979

18 weeks (90 possible school days with vacation days)

Working day/hourly schedule:

Aug. 6 - Nov. 2 ..... 8:30 till 5:30 p.m.
Nov. 5 - Dec. 7 ..... 9:30 till 5:00 p.m.

<u>Winter Break</u> -

December 10, 1979 - February 8, 1980

9 weeks, holiday and cold season's

<u>3rd & 4th term</u> -

February 11, 1980 - June 13, 1980

18 weeks (90 possible school days with vacation days)

Working day/hourly schedule:

Feb. 11 - April 11 .... 9:30 till 5:00 p.m.
April 14 - June 13 .... 8:30 till 5:30 p.m.

<u>Summer Break</u> -

June 16, 1980 - August 1, 1980

7 weeks, vacation

DESIGN PARAMETERS:

A. 175 days - Full (9 hr.) school/working day per year.

B. 4 Education quarters per school year (August - June)

C. Approximately 9 weeks per quarter

D. Comfort zone [C.Z.]
Normal .... 65° - 75°
Sweater Factor .... 57° - 65°

E. Passively heat from 45°, approximately (20° below C.Z.)

F. Passively cool from 90°, approximately (15° above C.Z.)

G. Vacation time at major holidays.

H. Vacation time through most of summer.

DESIGN DATA:

Average Monthly Temperatures -
5 year period (1974 - 1979)

Jan	40°	July	65°
Feb	44°	August	66°
March	47°	Sept.........	54°
April	50°	Oct	50°
May	55°	Nov..........	44°
June	63°	Dec..........	39°

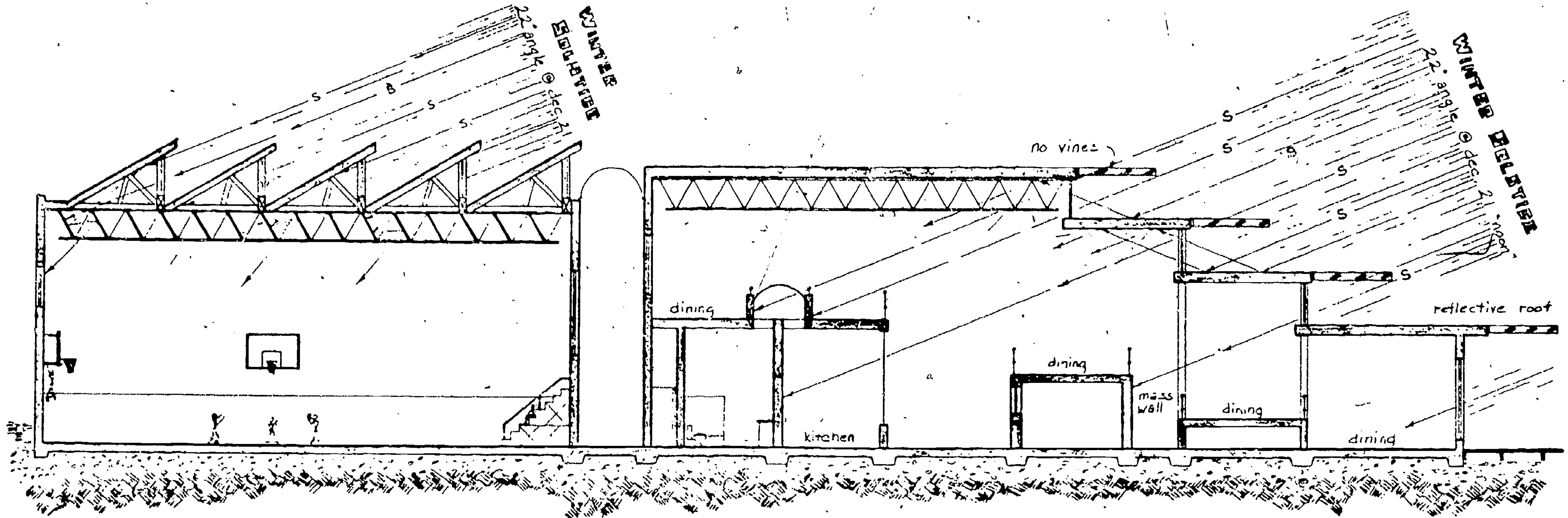
Average Daily Temperatures -

for Nov./Dec./Jan./Feb./March (critical months due to low temperatures and high average cloud cover.)

REFERENCES:

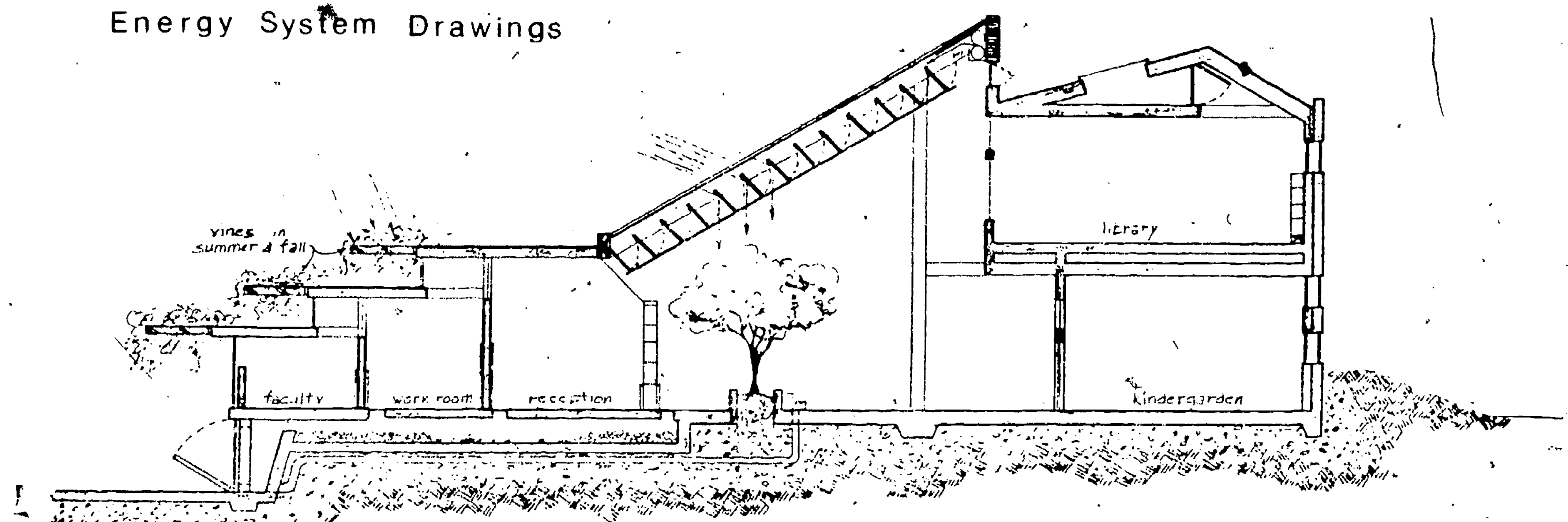
LOCAL CLIMATOLOGICAL DATA
U.S. Department of Commerce

Salem, Oregon
National Weather Service
McNary Field
.... 1974 - 1979......



Gym / Dining Section C-C

Energy System Drawings

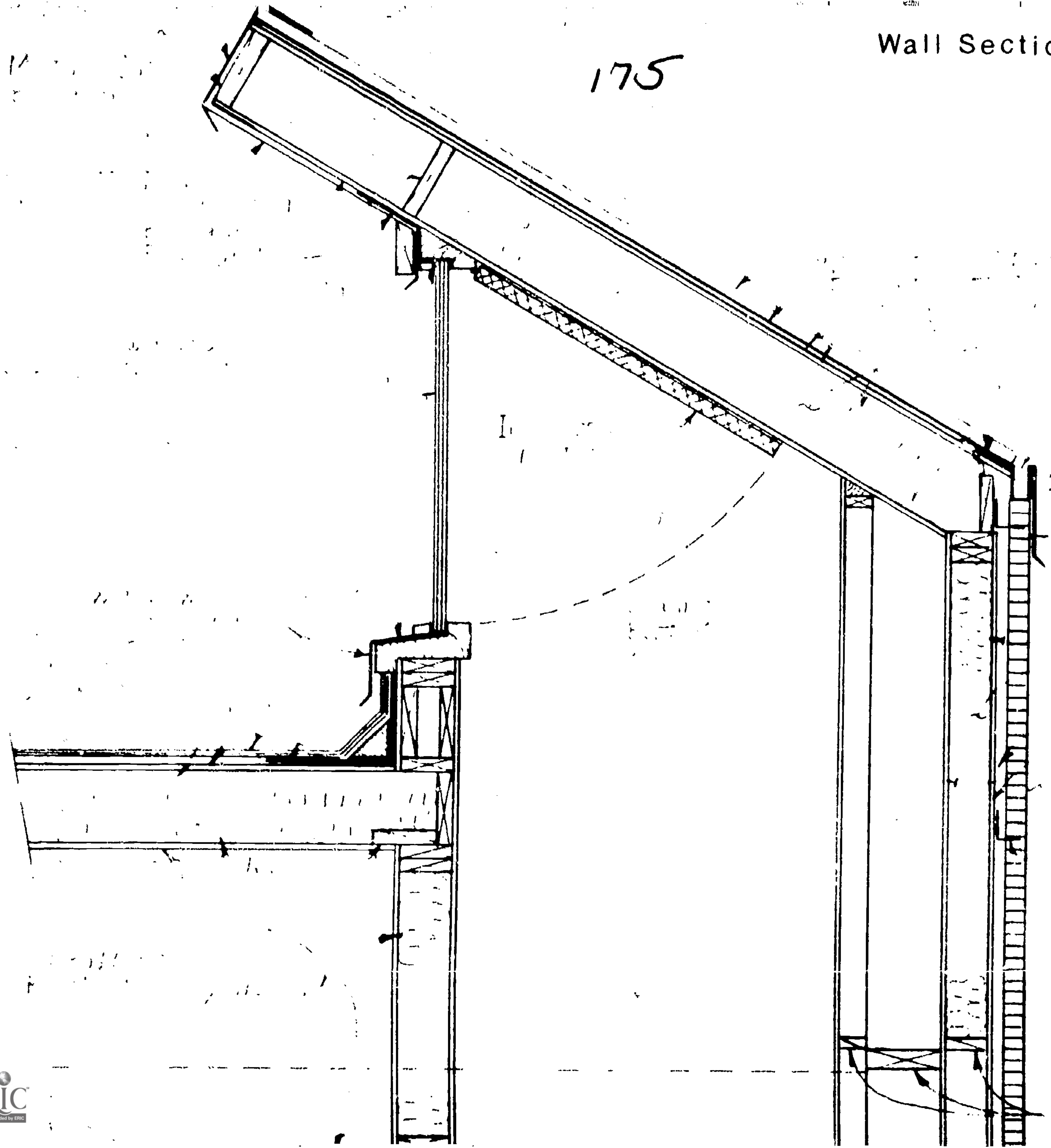


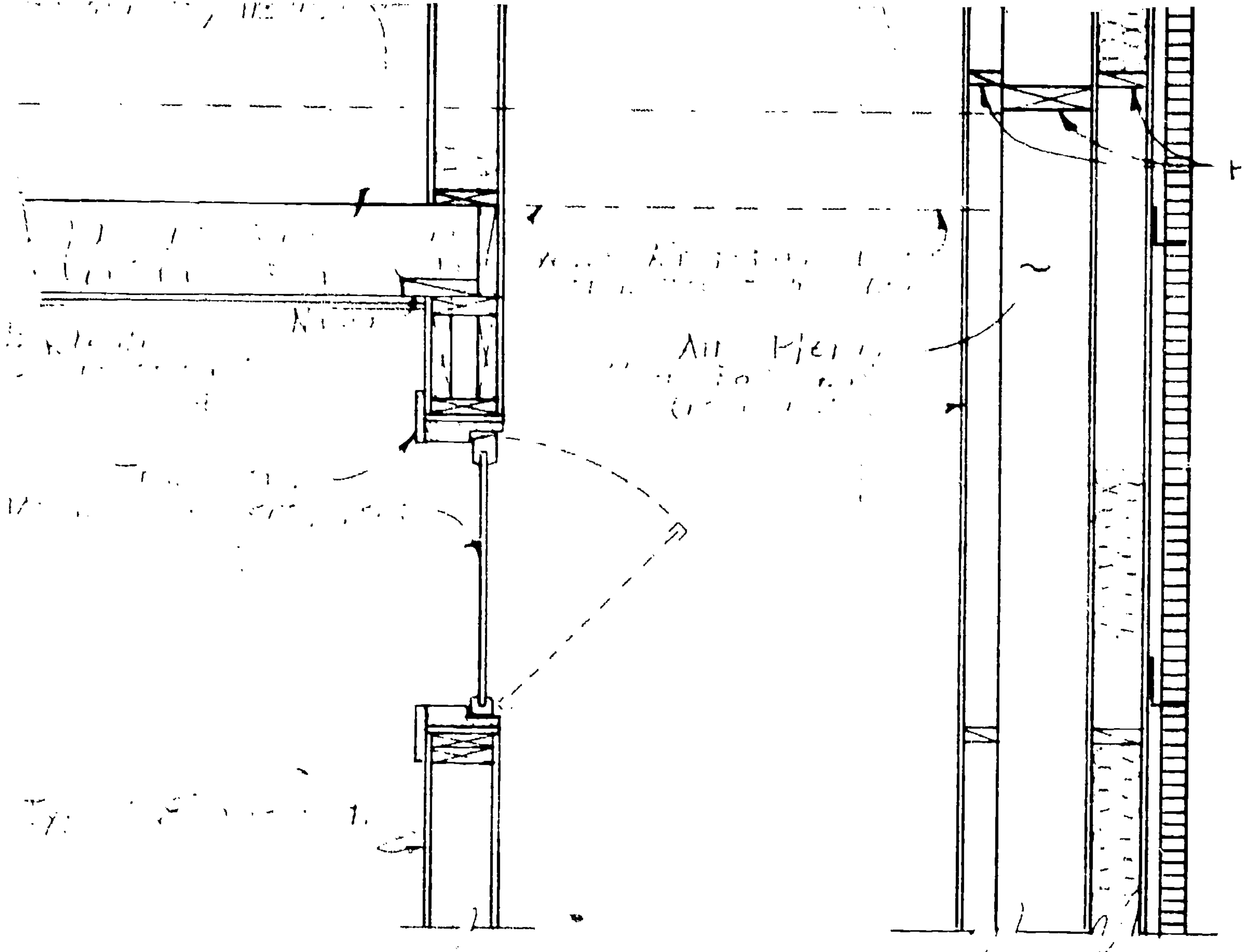
Library / Admin. Section A-A

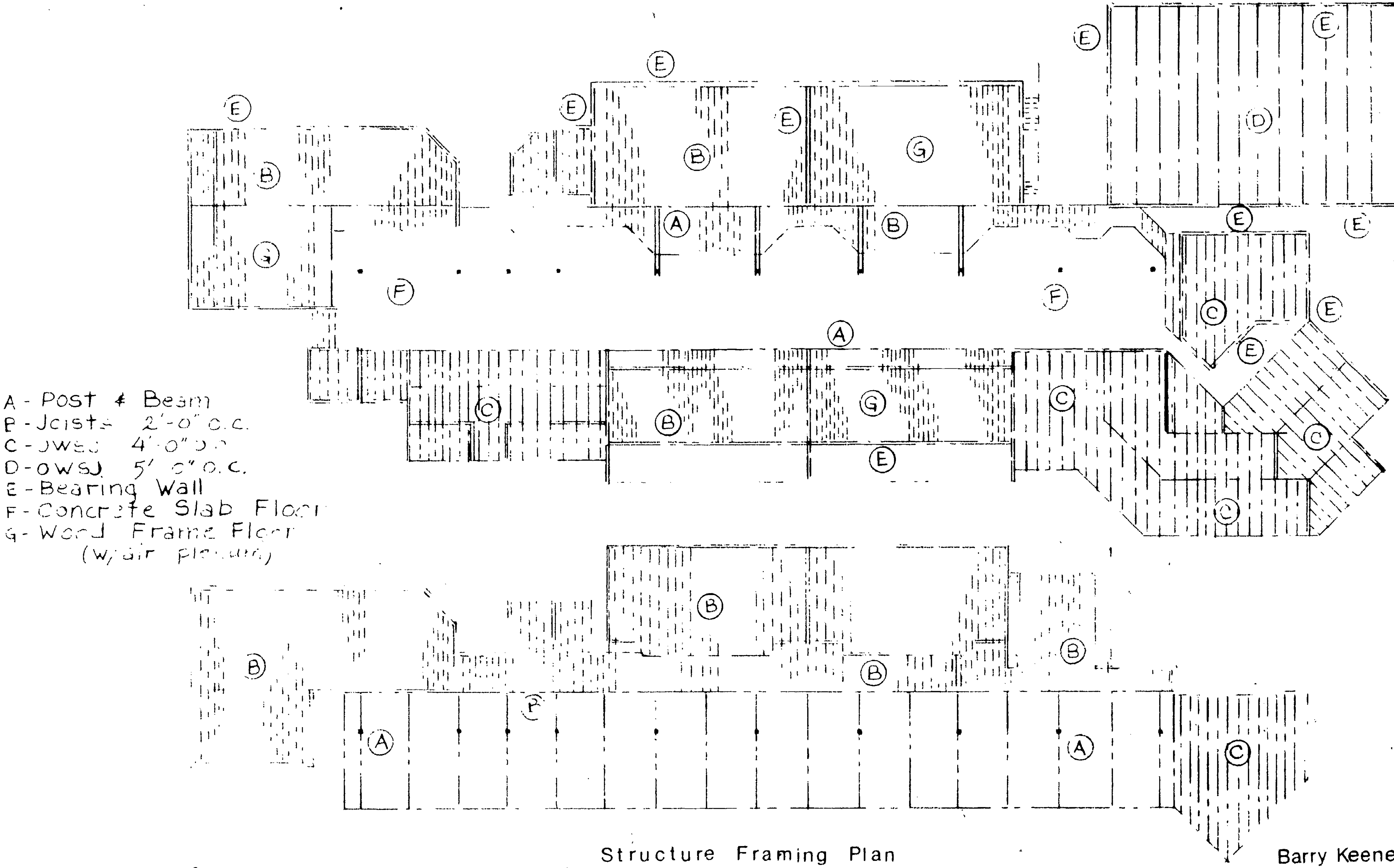
Barry Keeney
85

Wall Section

175







Structure Framing Plan

Barry Keeney 87

brian nelson

Design

The form of my building has taken an east-west orientation and is organized around a central courtyard. Community oriented spaces (administration, gym, library, cafeteria) surround the courtyard, with classroom wings to the east and west. Athletic fields are located on the north of the site to offset the B.P.A. easement. On the major axis of the courtyard to the west is the main entrance, a covered breezeway that connects the two buildings. Past the water tower and through the archway on the west is the main playground. To the south of the building is open ground that can be used for gardening or possible future expansion of the school.

Performa

A. GENERAL

All energy needs will be provided by on-site natural energy systems.

1. WATER:

A catenary rotor windmill is used to pump well water into an elevated storage tank. The height of the windmill is necessary because airflow is less retarded by ground level friction. Water is provided by gravity flow throughout the building. Hot water is produced by thermosiphon solar water heaters and by direct gain onto water barrels.

2. SEWAGE:

On-site organic and human waste is periodically collected and continuously fed into a displacement digester. Methane is the byproduct of an aerobic decomposition of organic waste. The materials suitable for digestion can be animal or human manure, garbage (vegetable, leftovers, spoiled food), grass clippings, leaves, or any material acceptable for a normal compost pile. One person produces 1.2 cubic feet of gas a day. With a staff and student population of over 350 people, enough methane should be produced to meet cooking requirements.

Human waste is collected from bathrooms that have a high air change rate, otherwise conventional flush toilets are used. Removal of the waste is done manually from "packing" toilets. Paper or plastic bags are used, sealed, then placed into a larger bag. No water or electricity is needed but the large bag must be dumped at intervals. After digestion and methane production the remaining sludge is used as fertilizer.

3. LIGHTING:

The majority of the lighting is provided by natural light. Electricity produced by photovoltaic cells can be stored in batteries to provide occasional night lighting. In spaces that are actively heated skylights provide top light and south facing windows provide side light. All top lighting is reflected at least once. In passively heated spaces sawtooth skylights that are 30 percent open to the sky use diffuse glazing for even lighting. All openings (except for the gymnasium), are covered at night with manually operated thermal shutters.

B. HEATING

A combination of passive and active systems is used. I chose to use a hot air system with a 2-3 day rock storage to offset intermittent cold spells that could interrupt normal school programming. The proximity of the collector to the storage could operate the system on a slow thermosiphon effect if there is enough direct gain. Efficiency is increased if air is forced through the system by fans. Electricity for the fans is provided by photovoltaic cells.

The electricity can also be used for business machines, instructional aids, ventilation, and lighting. If there is no demand for it, the electricity could be stored directly into the batteries or conducted into the rock storage as heat.

Delayed heat release is provided by mass walls and mass floors that intercept direct solar gain in winter.

The cafeteria, kitchen, and gym use only passive solar gain for heating. The kitchen will provide most of its heating needs from the cooking process. Additional heat could be drawn from stratified warm air in the gym.

C. COOLING

Ventilation is by convection and chimney effect. Rock storage can be used for cooling by exposing it to cool night air, and then circulating air over the rocks during the day.

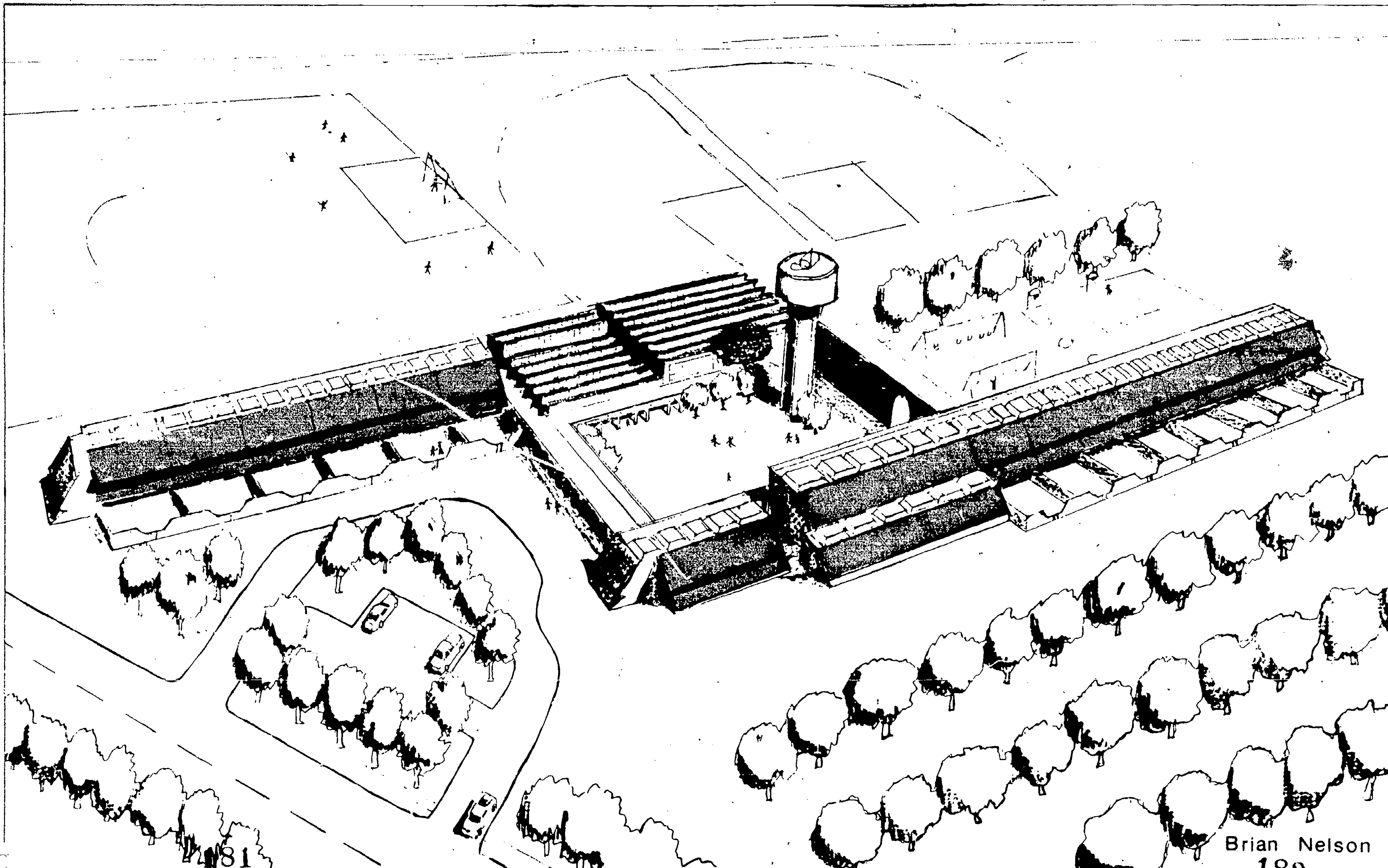
D. CONCLUSIONS

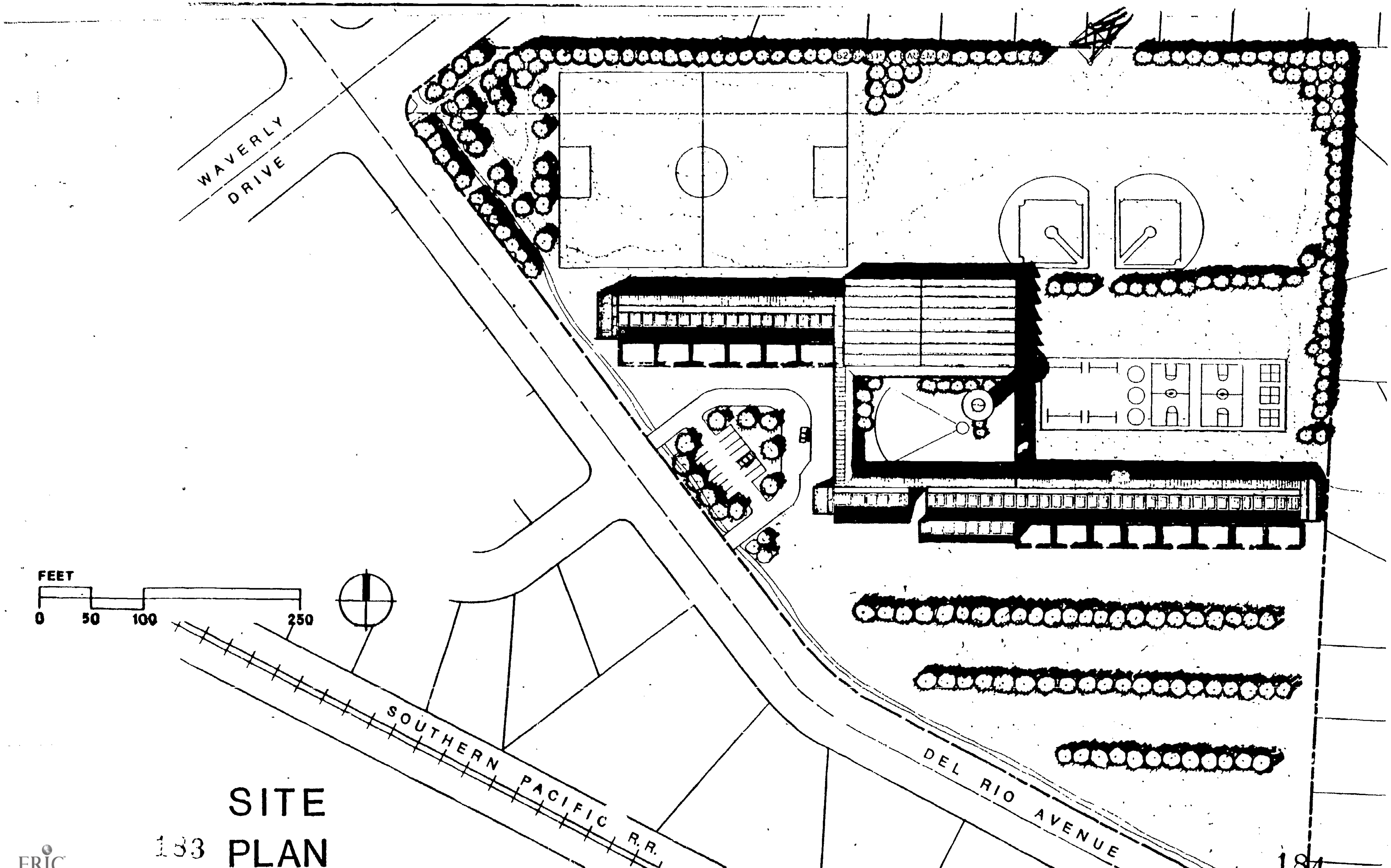
Although I have had little or no experiences with the complexity of active systems, rough calculations have shown that the temperature of the classroom will remain between 65° and 75° for 70-75 percent of the year. True indication of the building's performance can be obtained only through construction and monitoring of some of its parts.

The school year and day should be regulated around those times when the temperature does not fall within the comfort zone for extended periods of time.

Migration

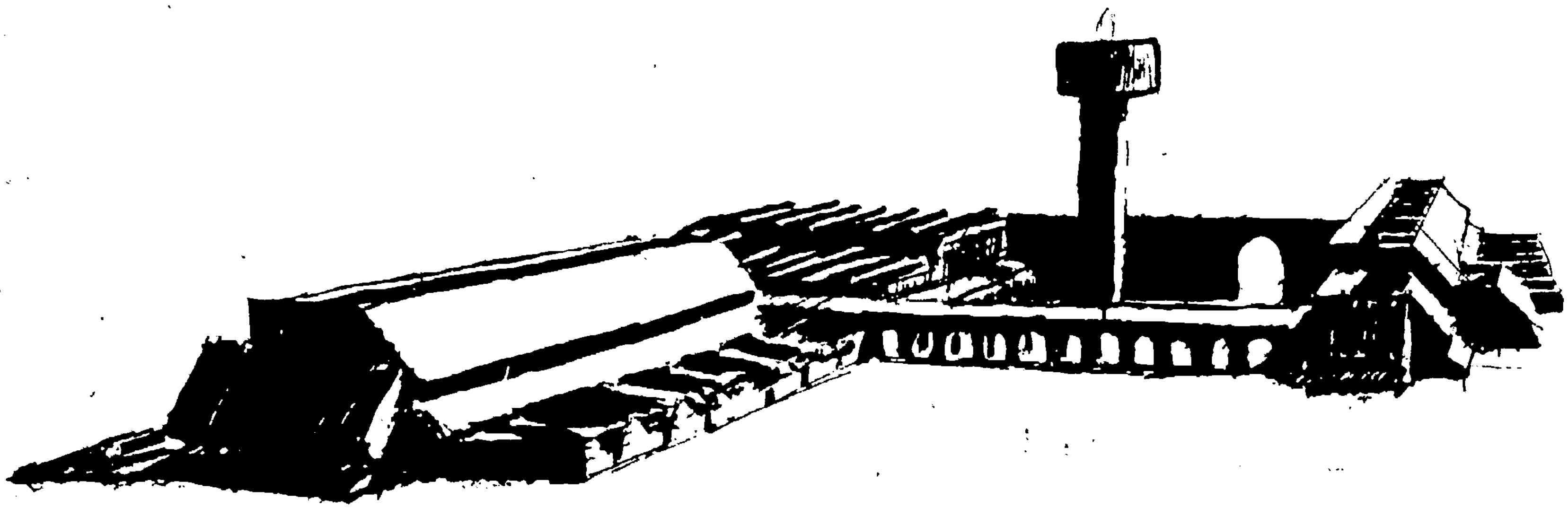
During periods of extreme cold when the classroom cannot be completely heated, classes will operate at half attendance on alternating days. Class will be conducted on the second level of the classroom where any heat that is collected will be allowed to stratify. Service doors to the rock storage are opened to allow direct radiation of heat to the class.


Brian Nelson

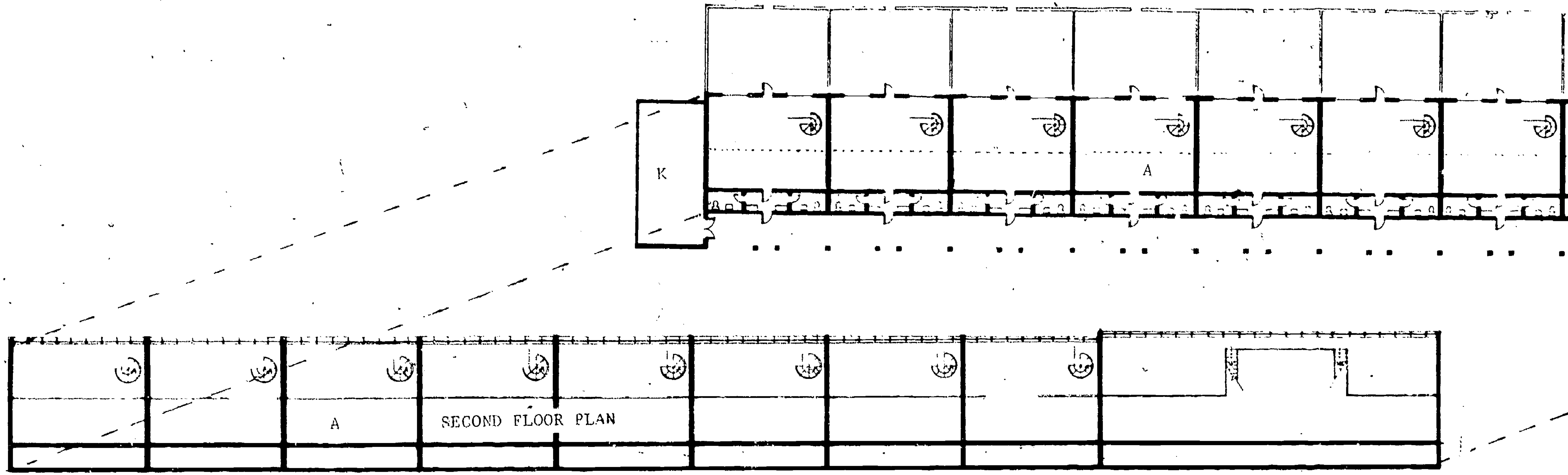


183 SITE PLAN

184

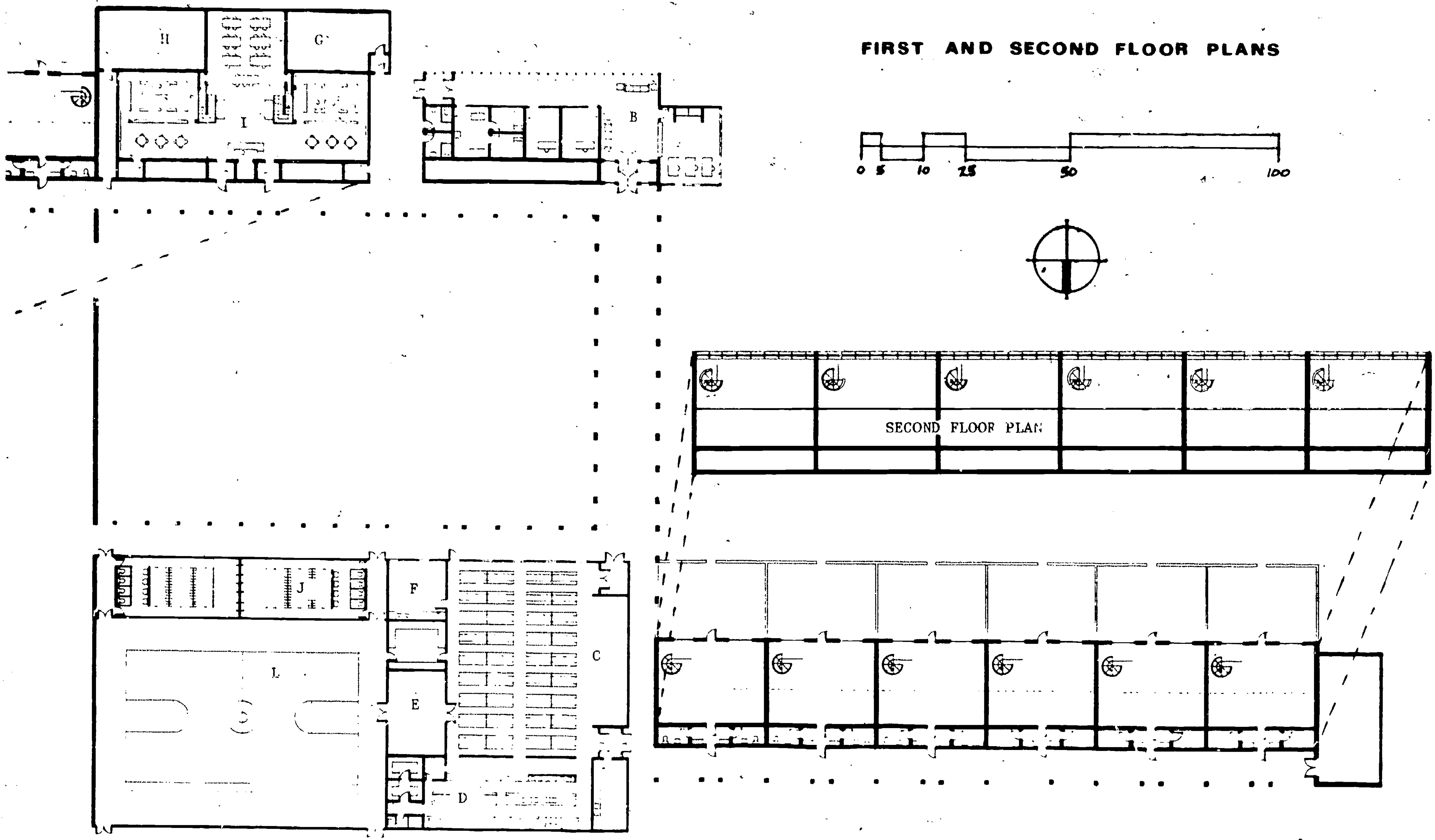


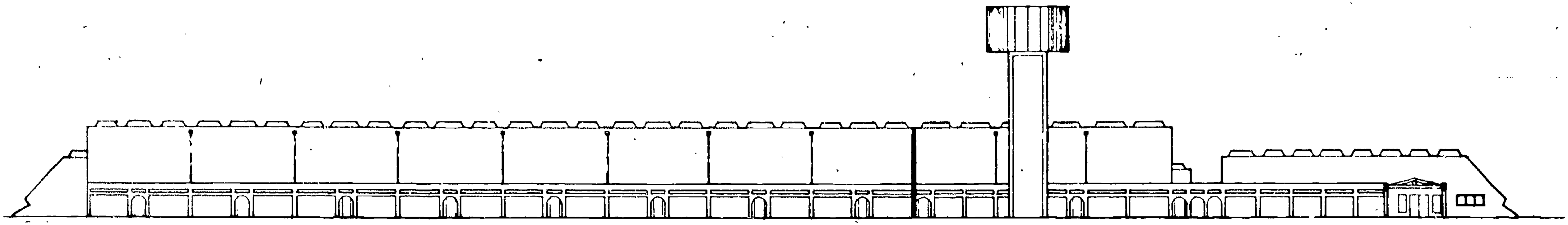
EXTERIOR PERSPECTIVE LOOKING EAST



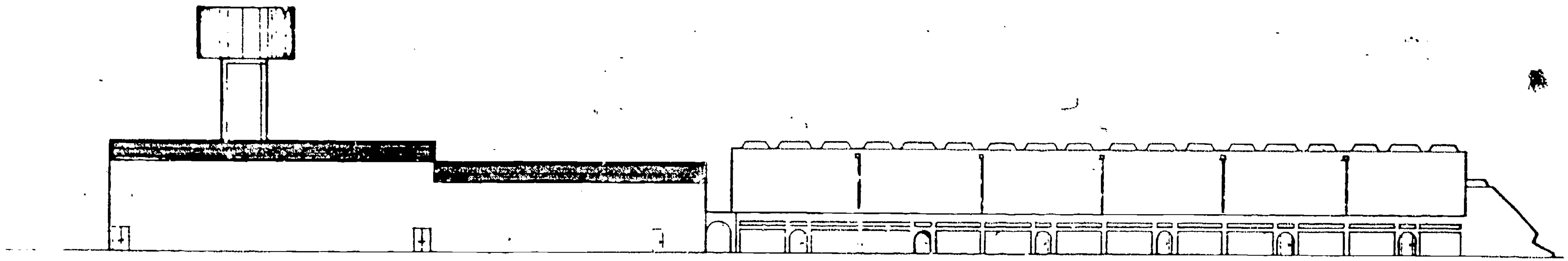
A. CLASSROOM
B. ADMINISTRATION
C. CAFETERIA
D. KITCHEN
E. STORAGE
F. FACULTY LUNCHROOM
G. MUSIC ROOM
H. ART ROOM
I. LIBRARY
J. LOCKER ROOM
K. JANITOR
L. GYMNASIUM

FIRST AND SECOND FLOOR PLANS

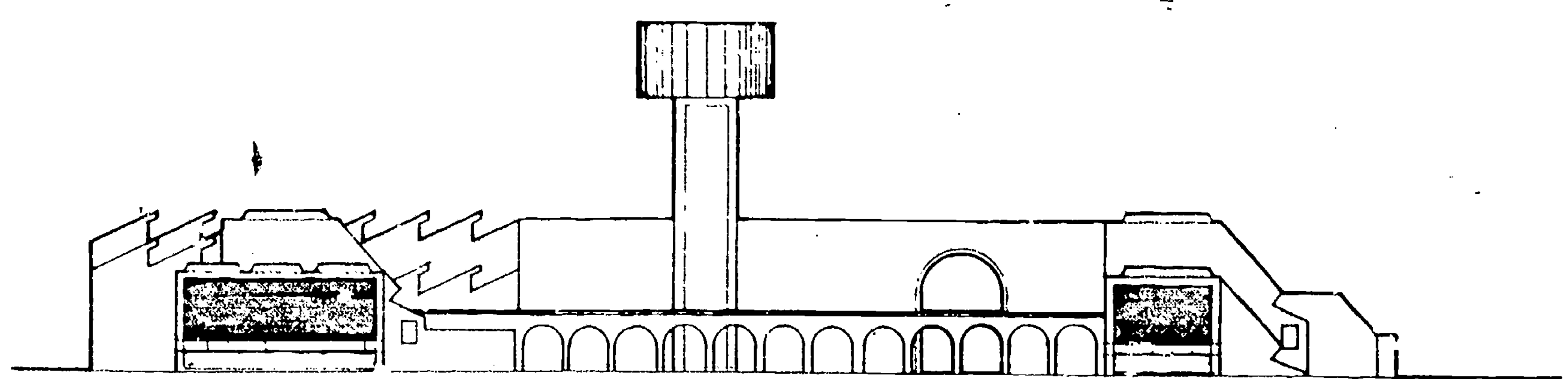




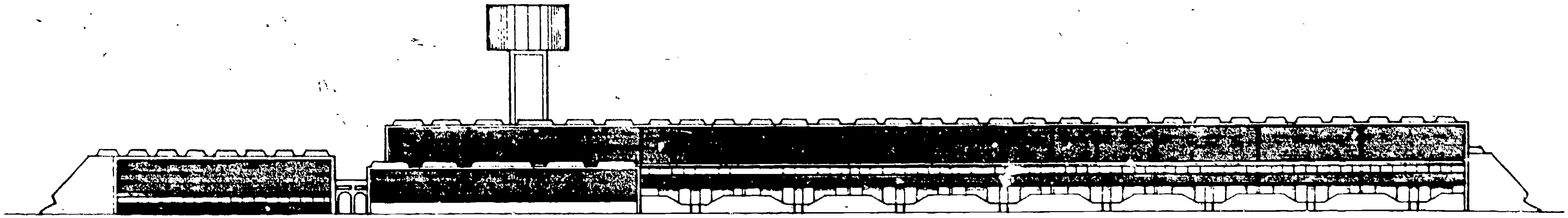
NORTH ELEVATION - SOUTH BUILDING



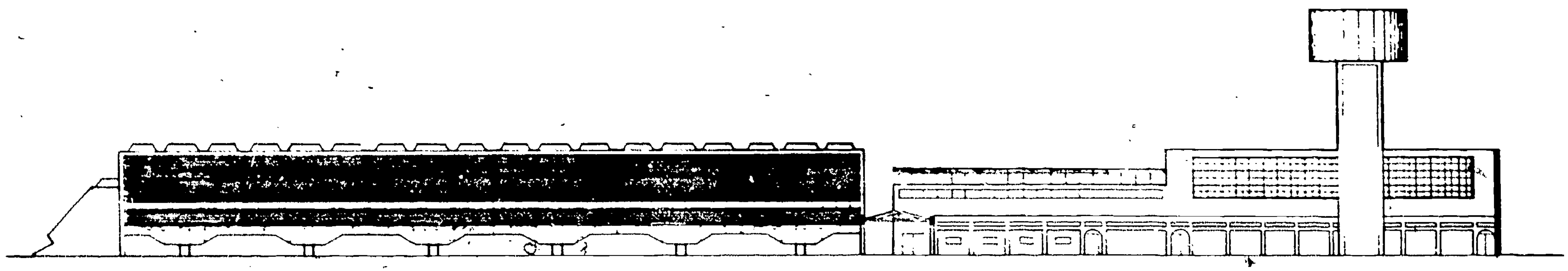
NORTH ELEVATION - NORTH BUILDING



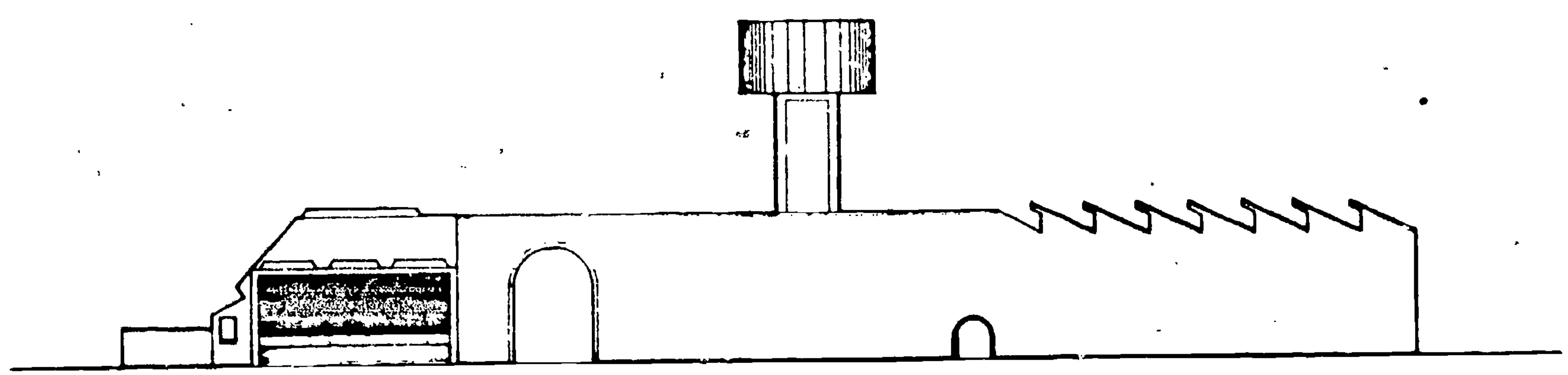
WEST ELEVATION



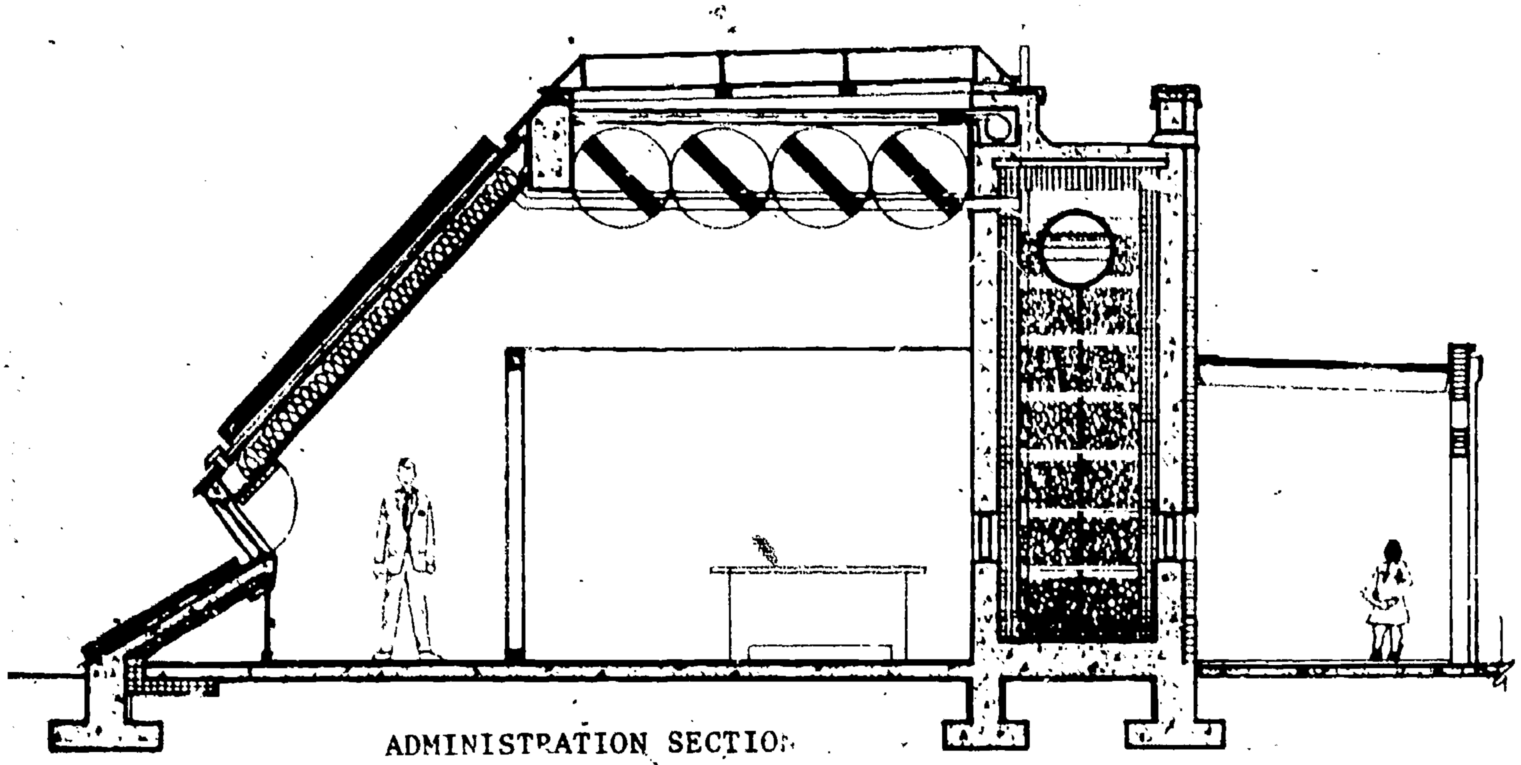
SOUTH ELEVATION - SOUTH BUILDING



SOUTH ELEVATION - NORTH BUILDING

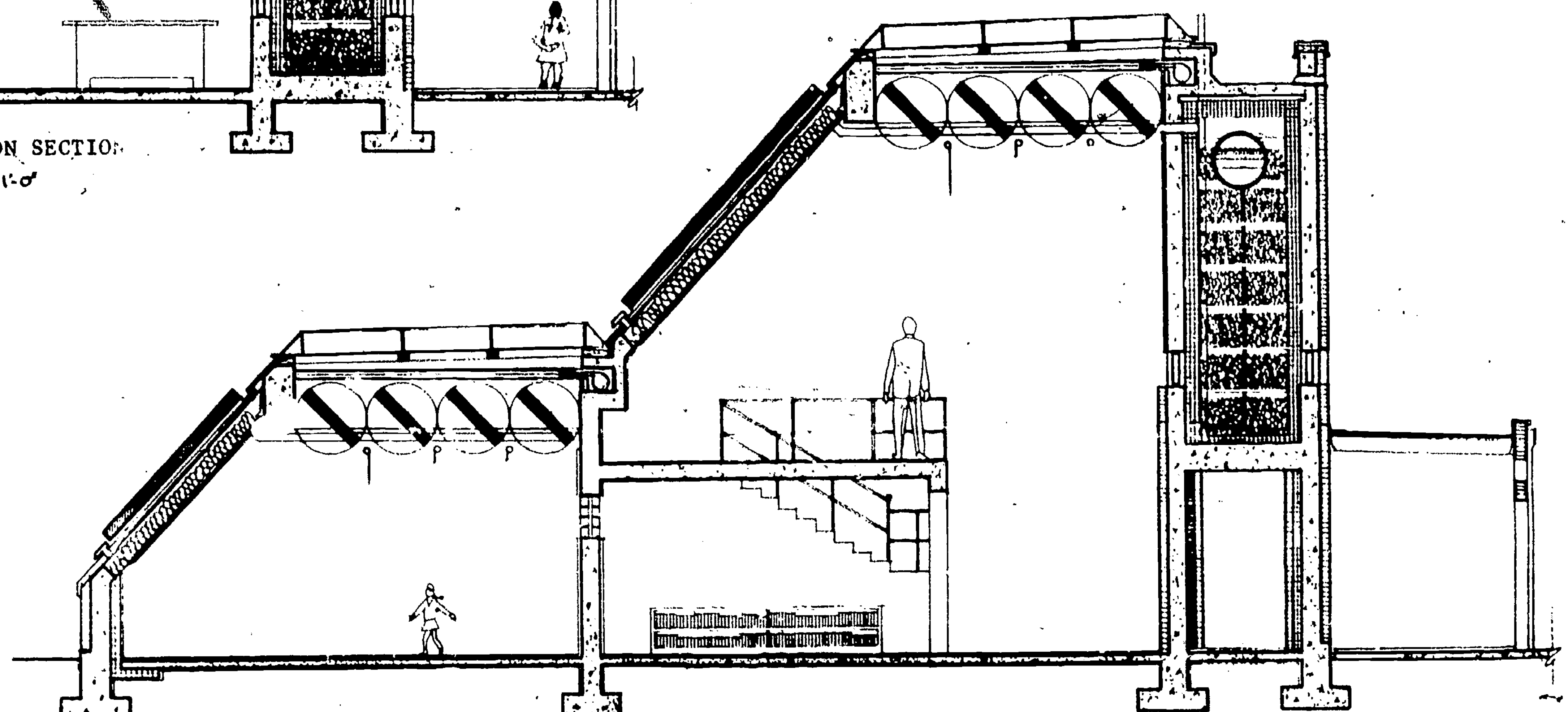


EAST ELEVATION



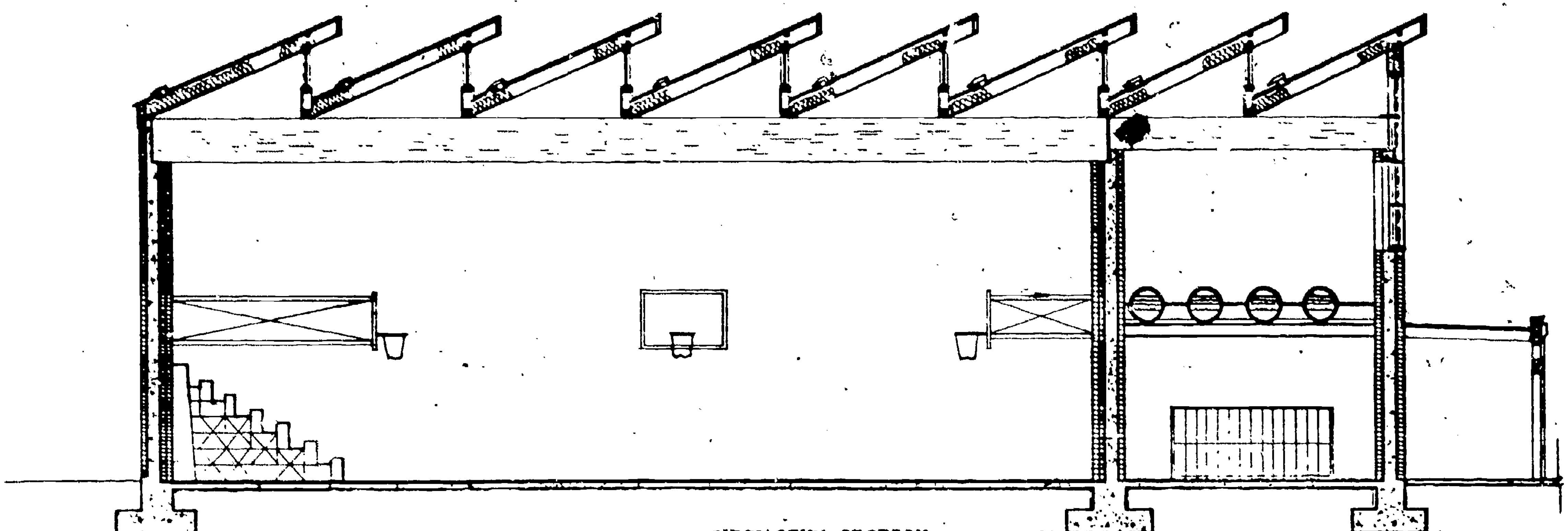
ADMINISTRATION SECTION

SCALE: 1/8" = 1'-0"

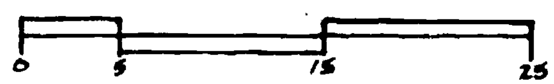


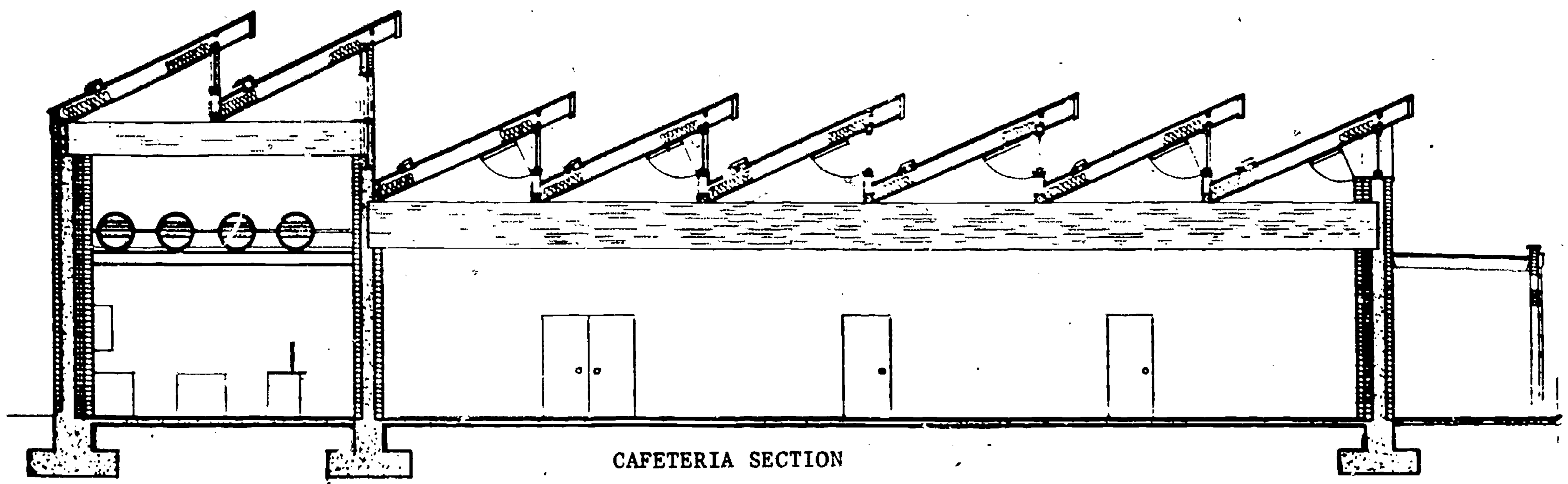
LIBRARY SECTION

SCALE: 1/8" = 1'-0"

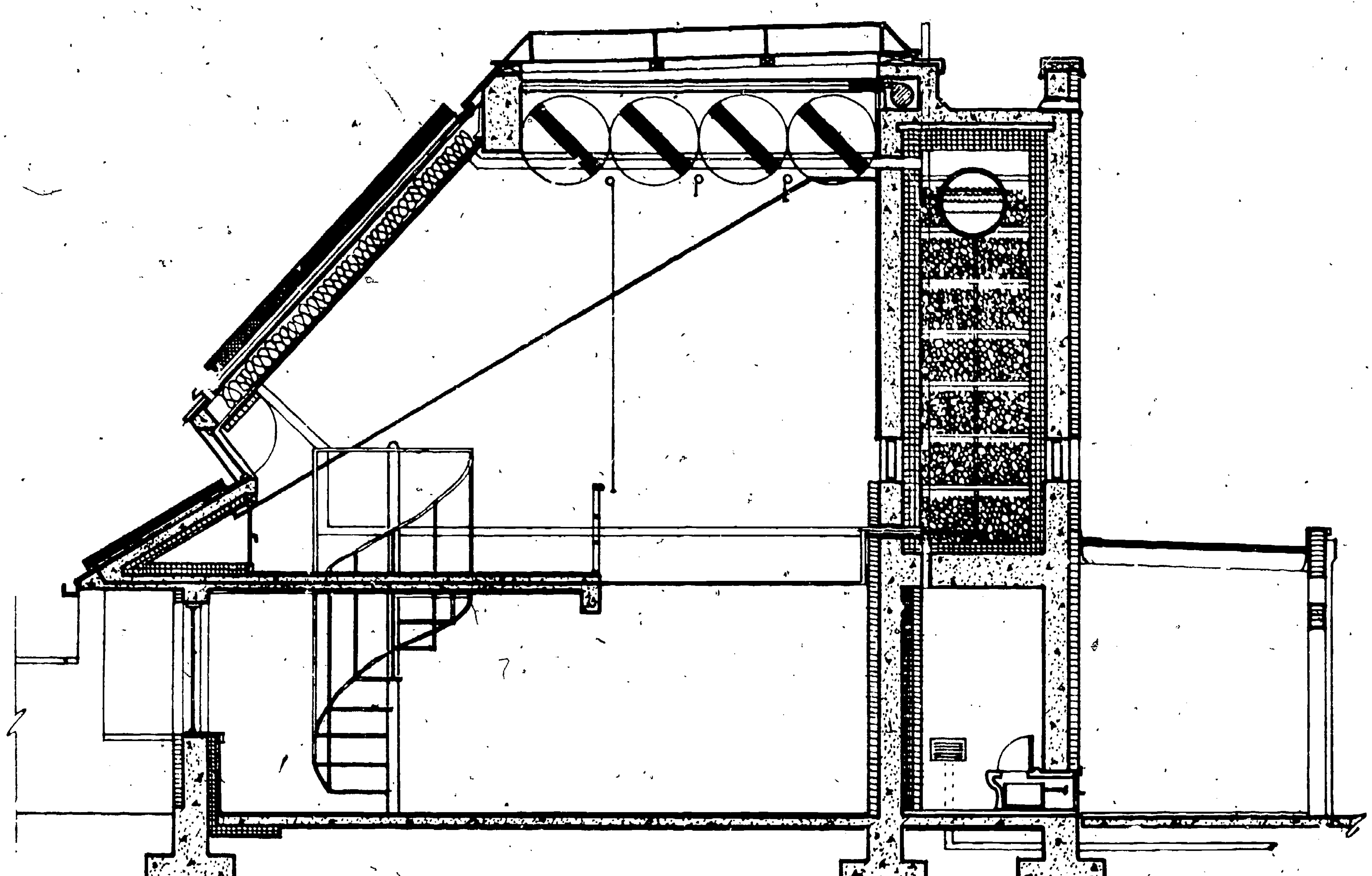


GYMNASIUM SECTION

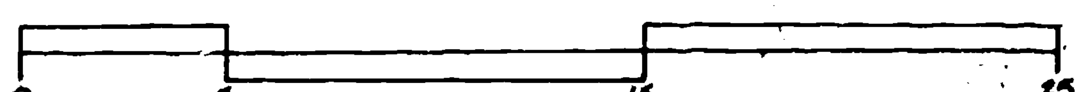




CAFETERIA SECTION



CLASSROOM SECTION



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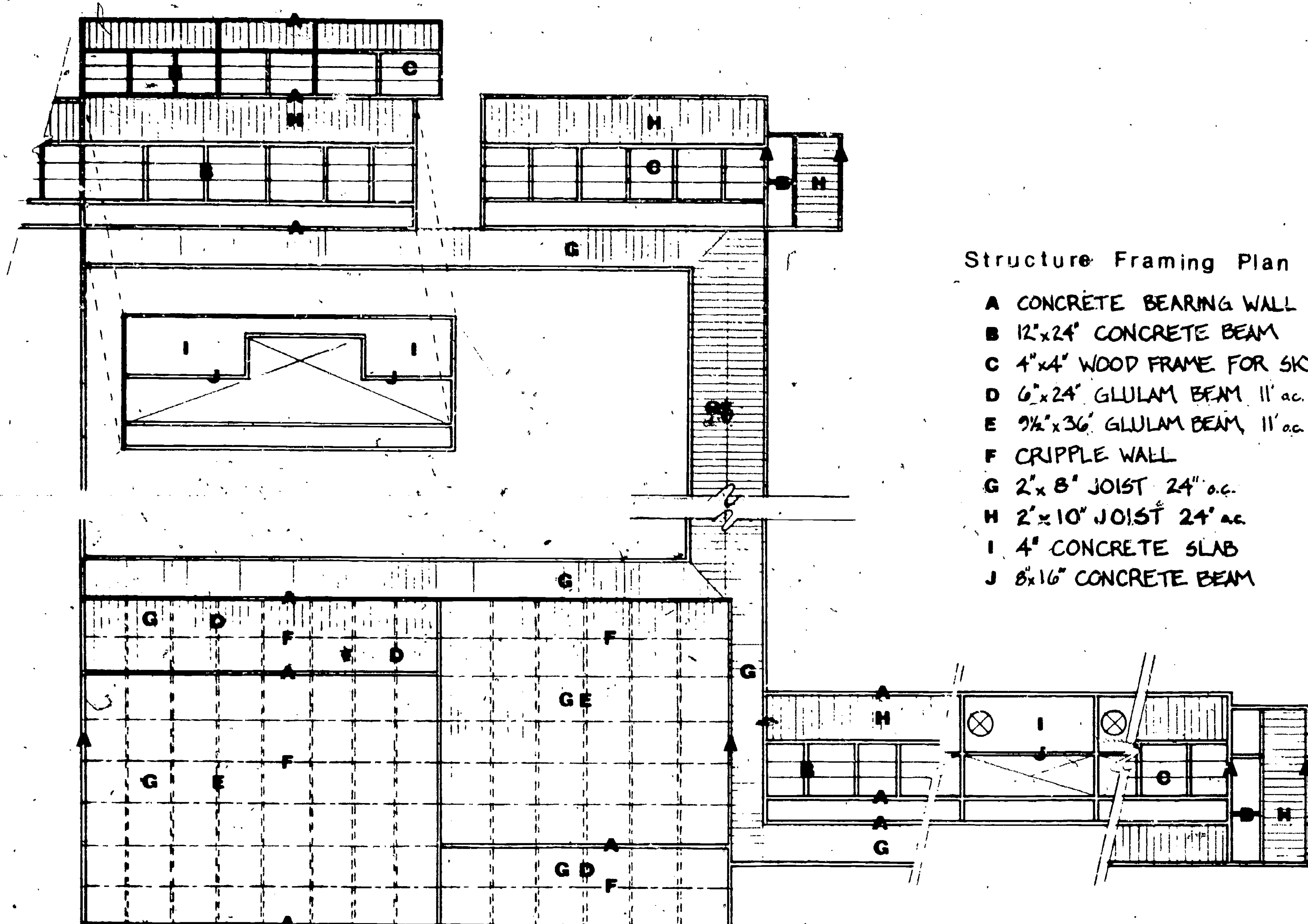
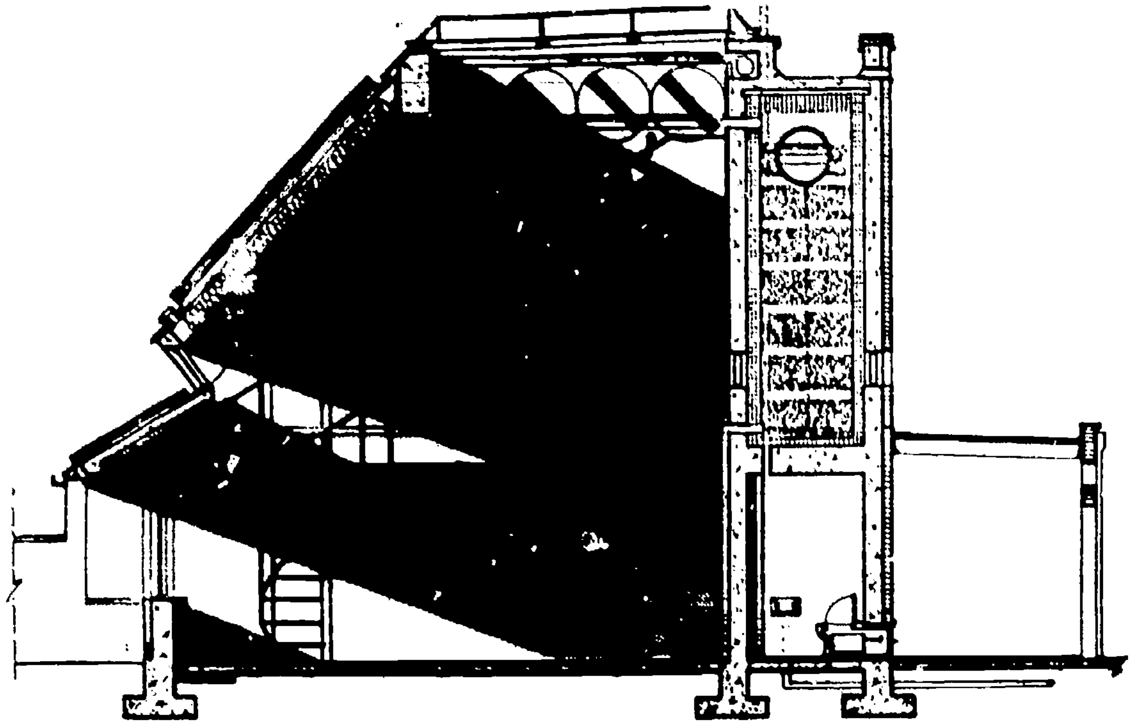
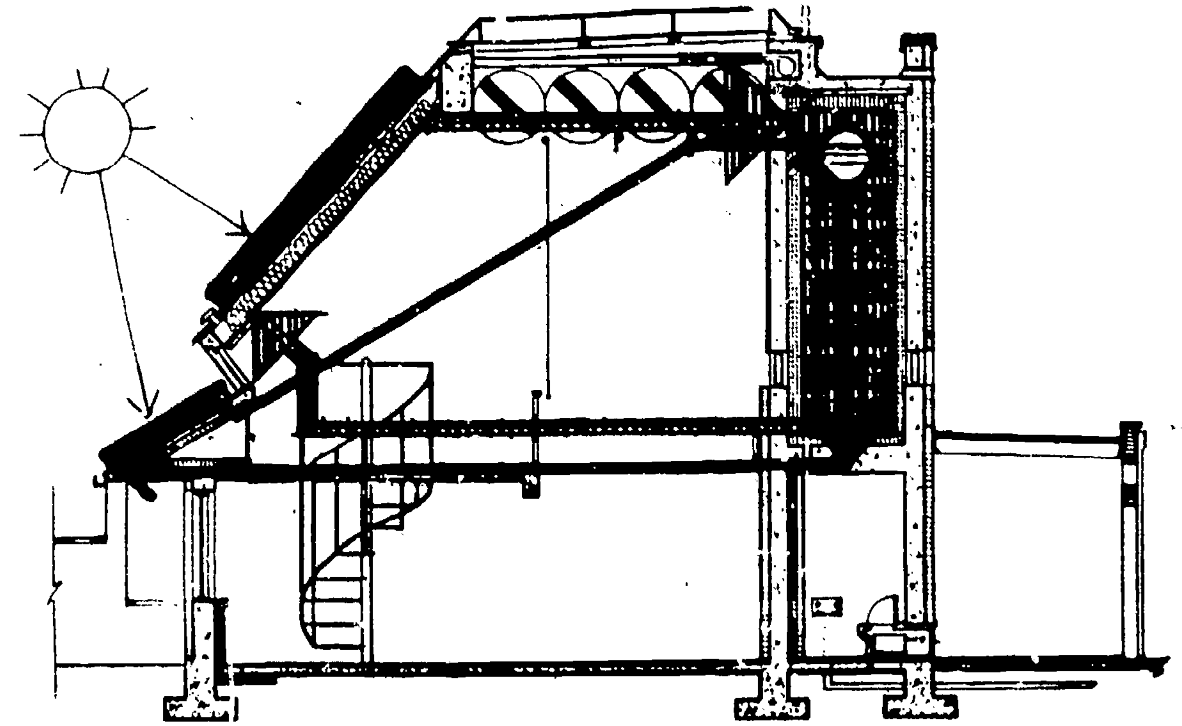


Structure Framing Plan

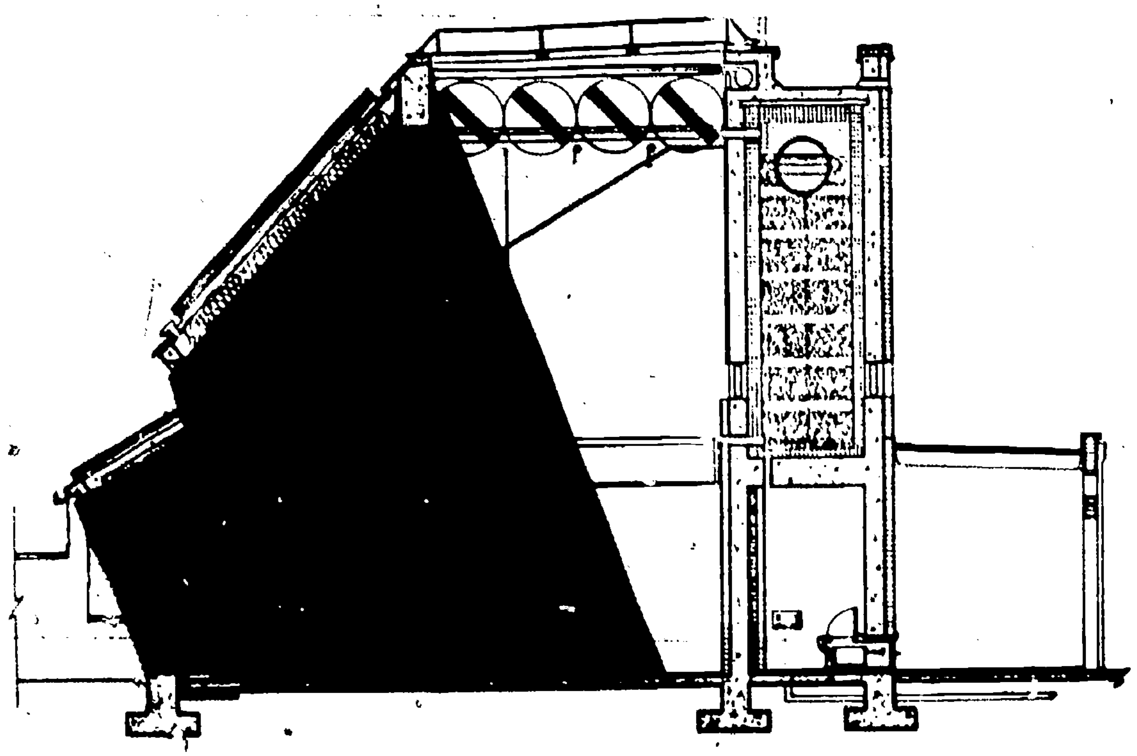
- **A** CONCRETE BEARING WALL
- **B** 12"x24" CONCRETE BEAM
- **C** 4"x4" WOOD FRAME FOR SKYLIGHT
- **D** 6"x24" GLULAM BEAM 11' o.c.
- **E** 9½"x36" GLULAM BEAM 11' o.c.
- **F** CRIPPLE WALL
- **G** 2"x 8" JOIST 24" o.c.
- **H** 2"x 10" JOIST 24" o.c.
- **I** 4" CONCRETE SLAB
- **J** 8"x16" CONCRETE BEAM



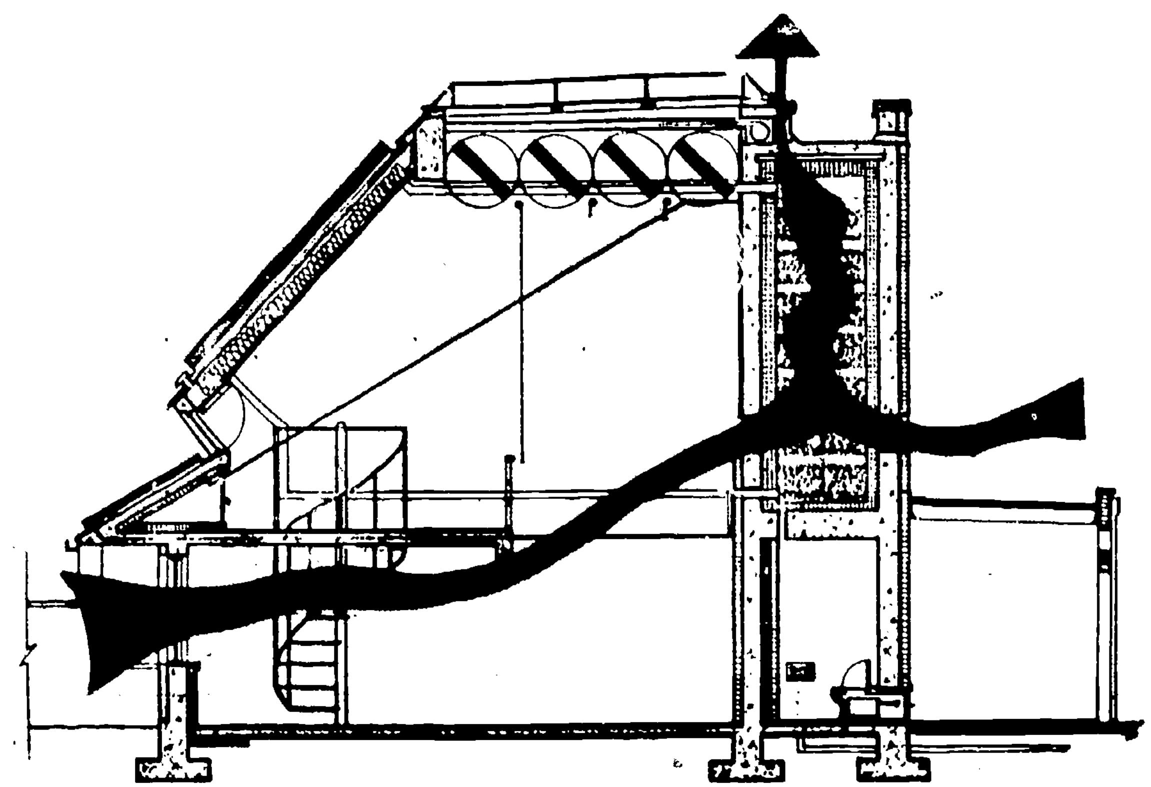
LIGHT PENETRATION - WINTER SOLSTICE



ENERGY SYSTEMS



LIGHT PENETRATION - SUMMER SOLSTICE



NIGHT AIR CIRCULATION FOR SUMMER COOLING

lee phillips

Problem Statement:

To provide a prototype energy self-sufficient learning environment, recycling resources available on site and within the surrounding community.

To make energy self-sufficiency a visible and integral aspect of the curriculum and learning experience for the children.

To provide a visible focus for the community to gain awareness and involvement with energy and recycling issues.

Strategy: Area and Site Context

The site is located on the south edge of a new low density subdivision on the south outskirts of Albany. Some portion of the school population will be drawn from the surrounding rural areas until residential development occurs further to the south as planned.

It is desirable to integrate the school site with the neighborhood as a community open space, playground and recycling centre, and to tie it into the area pathway networks by providing walkways/jogging path/bike path so as to make it convenient to pass thru and into the site rather than around it. It is also desirable to provide an opportunity for the neighborhood to use the building for community meetings and other public activities and to view it as a focus for the neighborhood visually and functionally.

The building should be concentrated as much as possible rather than spread out—to keep energy losses down and to preserve as much of the site as possible for open space, an informal community park, and potential additions to the facilities. The parking and access should be concentrated and protected from the open spaces and playgrounds both visually and physically. The site is to be protected from easy access to the BPA power towers which run along the north boundary, by a buffer zone of berm and hedgerow planting and trees, and then another buffer zone consisting of the walkway/bike path corridor. The site is to be sloped to drain toward a pond on the northeast edge of the site and the water used in methane digesting process for treating the school sewage wastes. This pond can also be used at a later date for community aquaculture and should be built to drain to the street storm drains. Access to the water can be controlled by means of plantings.

Energy Systems

The building utilizes a double shell construction forming a continuous air plenum which envelopes the inner spaces, with greenhouses on south faces as heat collectors, as well as south facing roof glass in the exterior face of the plenum. The plenum provides insulation, and the south facing glass in the roof heats air which moves through plenum and down north plenum walls and into rock storage under the floor of main spaces. This warm air heats the interior wall and ceiling surfaces which act as radiant heat sources during the day. At night the glass in the roof of the building is covered by roll down insulating shutters and by wood sliding shutters in the vertical glass faces.

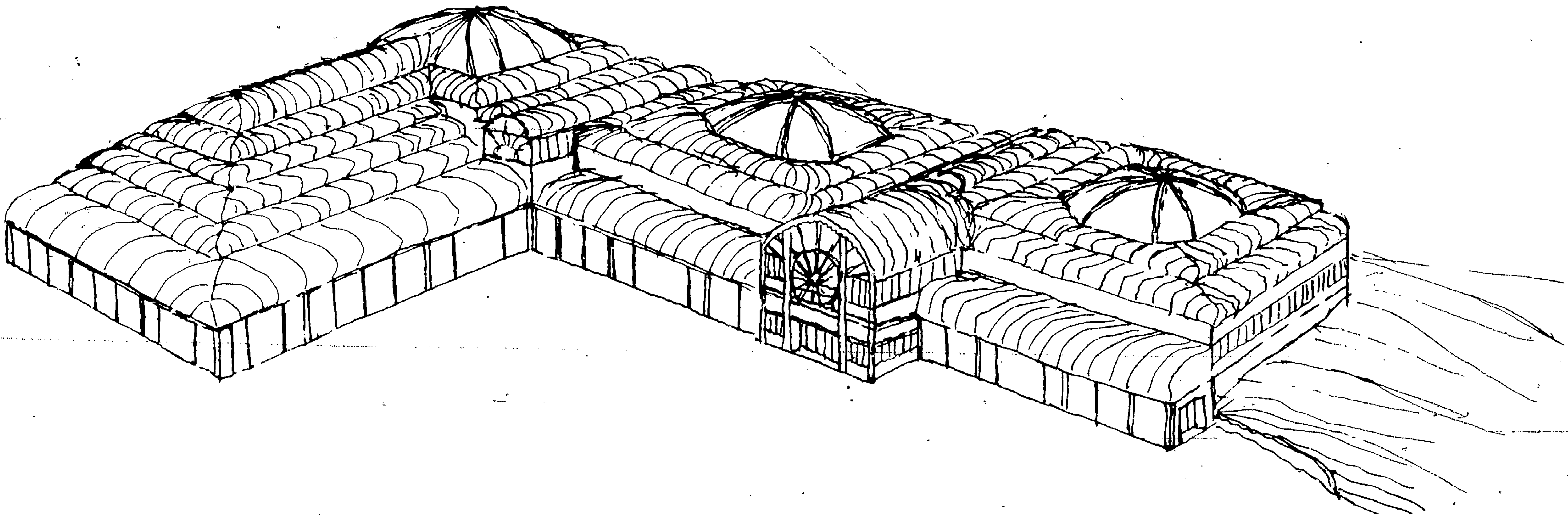
The classrooms are closed up at night and the heat stored under the building is directed entirely to the classrooms in the worst weather by manually controlled vents and natural air movement upward. The classrooms will be warm in the morning and as the plenum starts to heat up later in the morning, the open spaces will become more comfortable.

Each classroom downstairs has light wells two feet wide minimum along two edges of the room as well as openable shutters toward the atrium for light and to open up the entire block for team teaching if occasion presents itself. There are skylights at selected areas in the ceiling, though only about one-third of the ceiling area is in skylights relative to what is glazed in the outer roof.

In summer, the greenhouse vertical walls and the commons/cafeteria walls open entirely up for ventilation. The plenum opens at the peak of the roof to the inside to induce natural draft up through the atrium spaces. Also select areas of glazing in the outer plenum skin are openable to vent the plenum itself. This creates a draft in the plenum which can be utilized to draft air from the rock storage into the spaces—the rock storage is cool because air is drafted from underground at night through the rocks. The roof glass is shuttered during the day except where light is necessary by the external roll down metal shutters.

The heat loss for a 24-hour period in the worst part of winter is offset by four times the plenum heat gain on a sunny day. This should be sufficient with transfer losses and cloudy days, etc. to heat at least the classrooms to a useable 65° temperature during the worst times. Some areas of the building may be slightly cooler than comfortable during extended cloudy periods, but the critical use areas should be reasonable to work in. Most of the time in the winter, the classrooms will be warmest in the morning, and the other spaces will start to warm up by mid-morning or noon. There may need to be some minor changes in scheduling during the worst weather. But primarily the curriculum will have to adjust to deal with organization of tasks depending on light availability rather than to add scheduling of days depending on weather conditions.

Exterior Perspective



Proposal: A Zero Energy Elementary School
for Albany, Oregon

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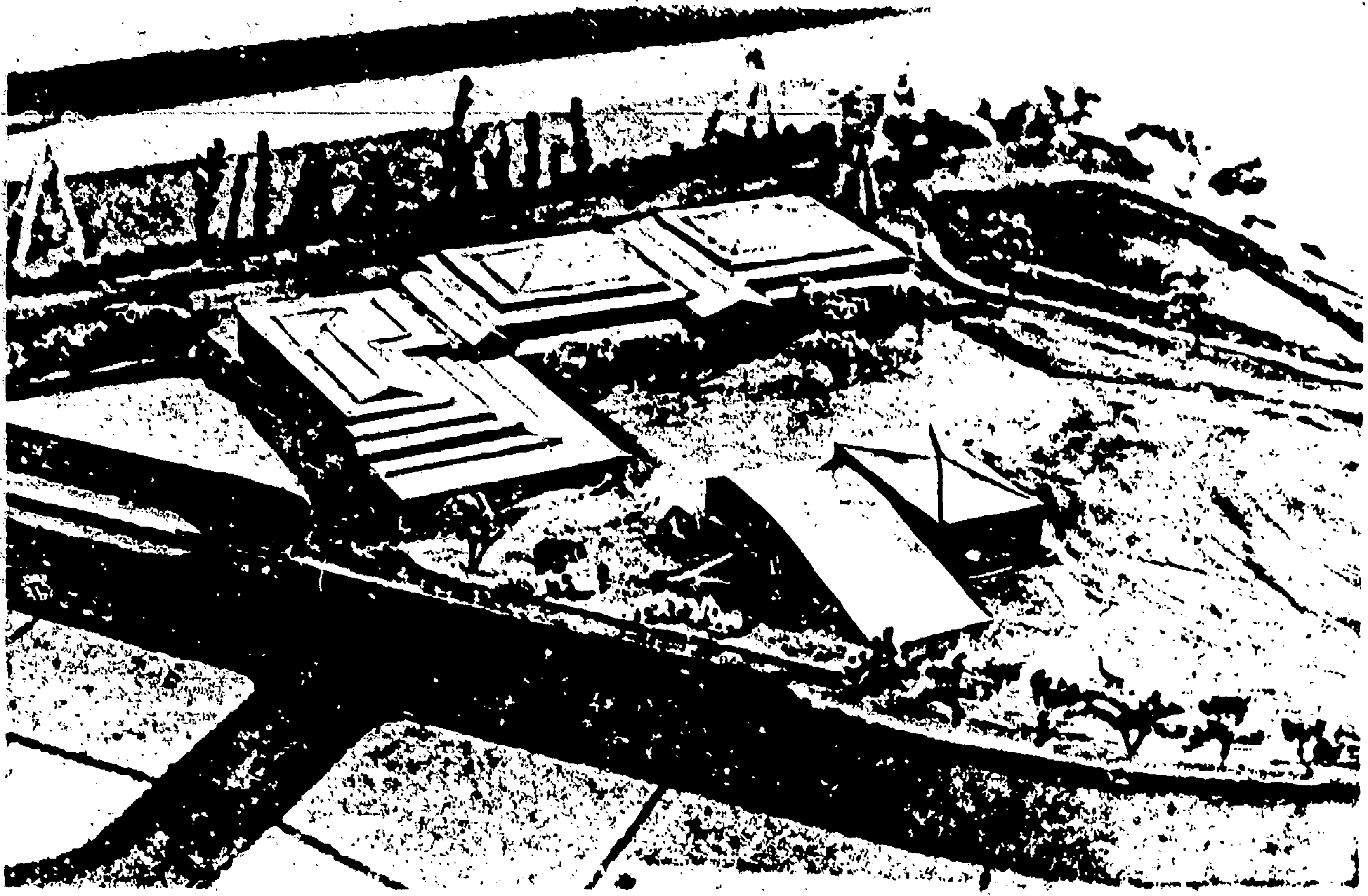
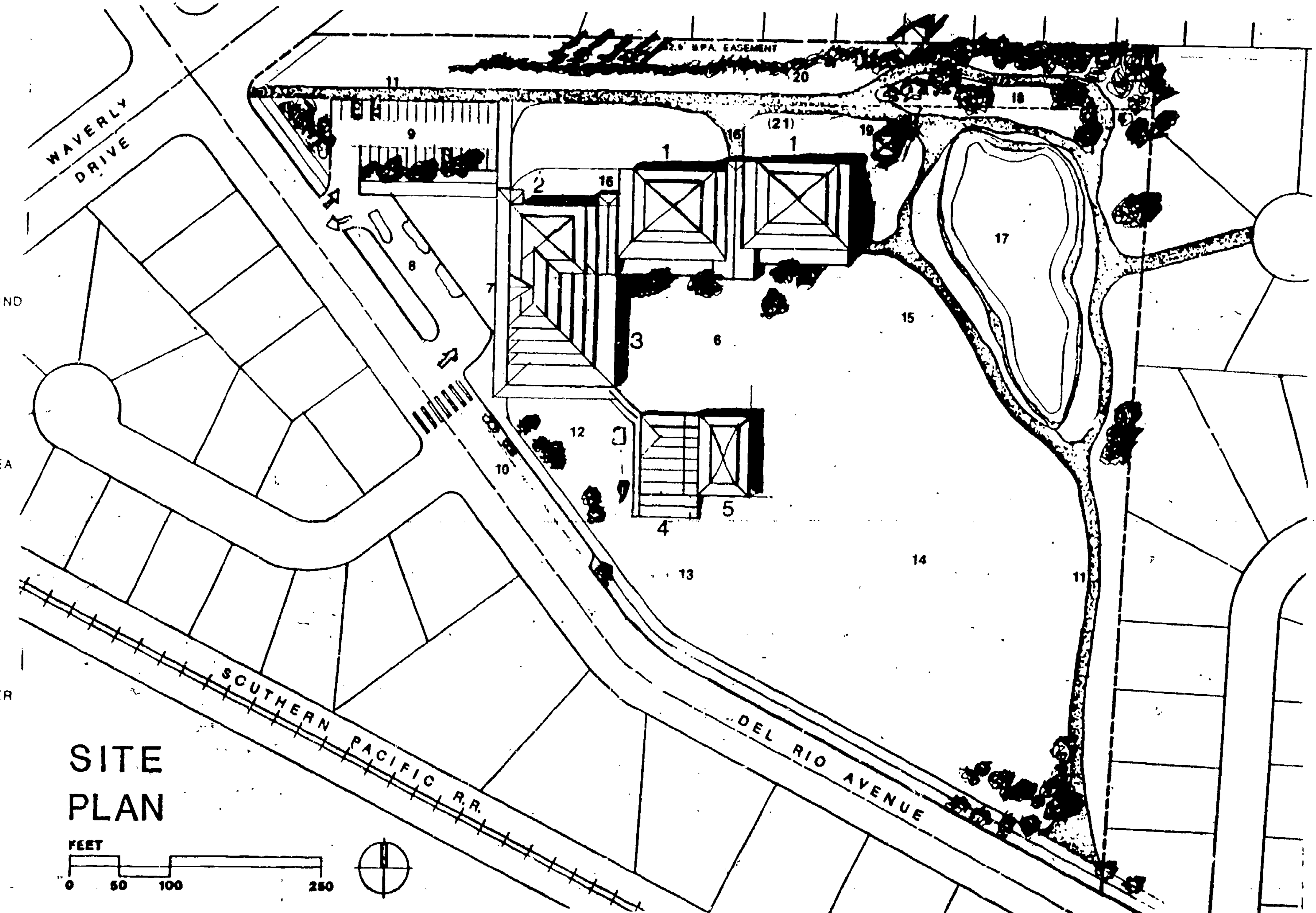
Lee Phillips



SITE & FORM STUDY MODEL

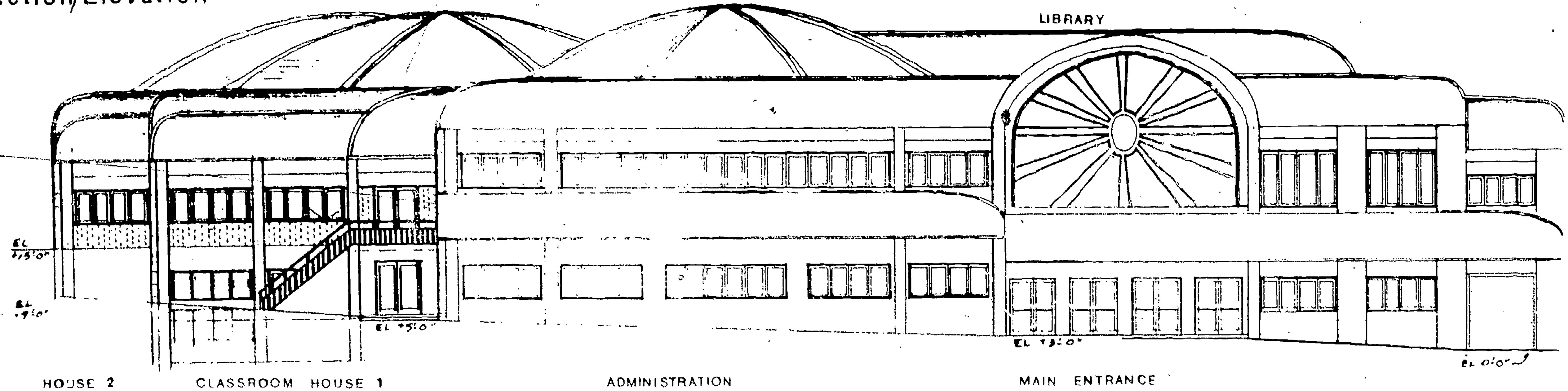
1 CLASSROOM HOUSE
2 ADMINISTRATION
3 LIBRARY / COMMONS / CAFETERIA
4 KINDERGARTEN
5 GYMNASIUM

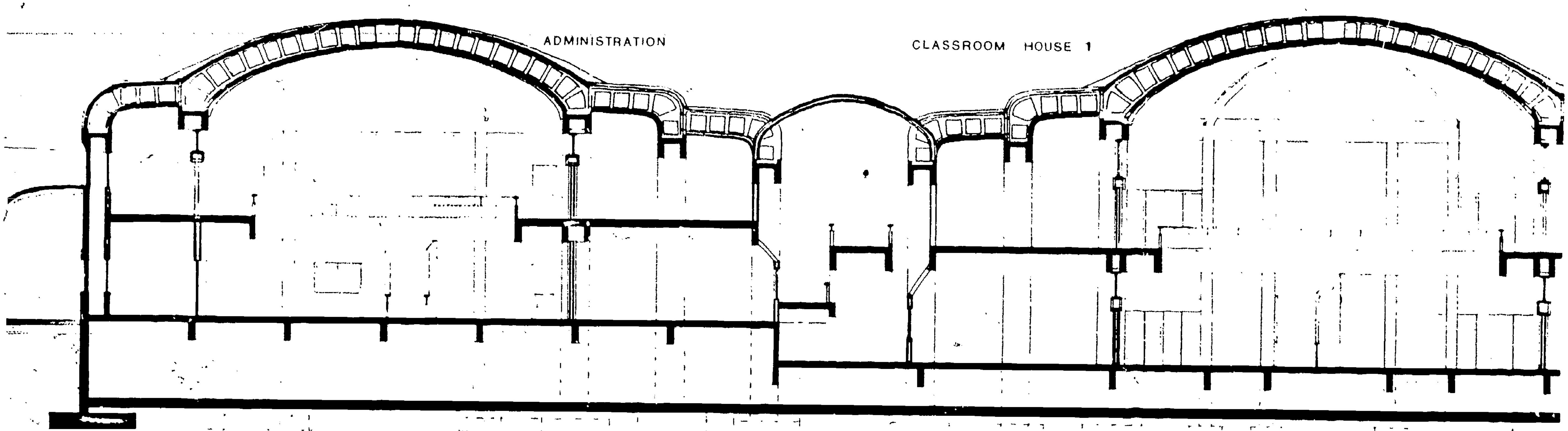
6 COURTYARD PLAYGROUND
7 MAIN ENTRANCE
8 BUS DROP-OFF
9 PARKING
10 CAR DROP-OFF
11 PUBLIC PATHWAY
12 KINDERGARTEN PLAY AREA
13 PHYS. ED. OUTDOOR PROGRAMS AREA
14 PLAYING FIELDS
15 SAND AREA
16 HANDICAP ACCESS TO SECOND FLOOR
17 POND
18 WOODLOT & BERM
19 WINDMILL & WATERTOWER
20 HEDGEROW & BERM
(21) METHANE DIGESTER UNDER HILL

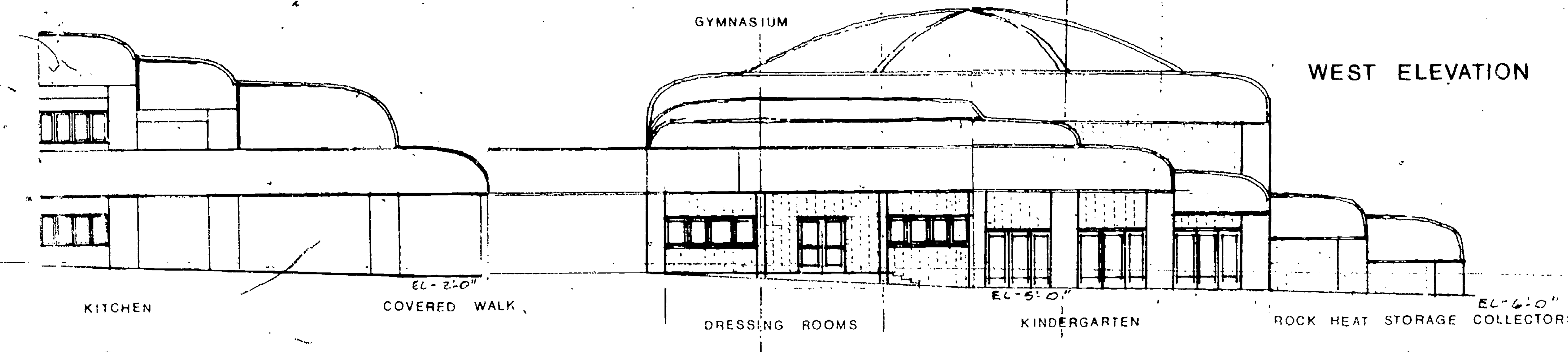


SITE PLAN

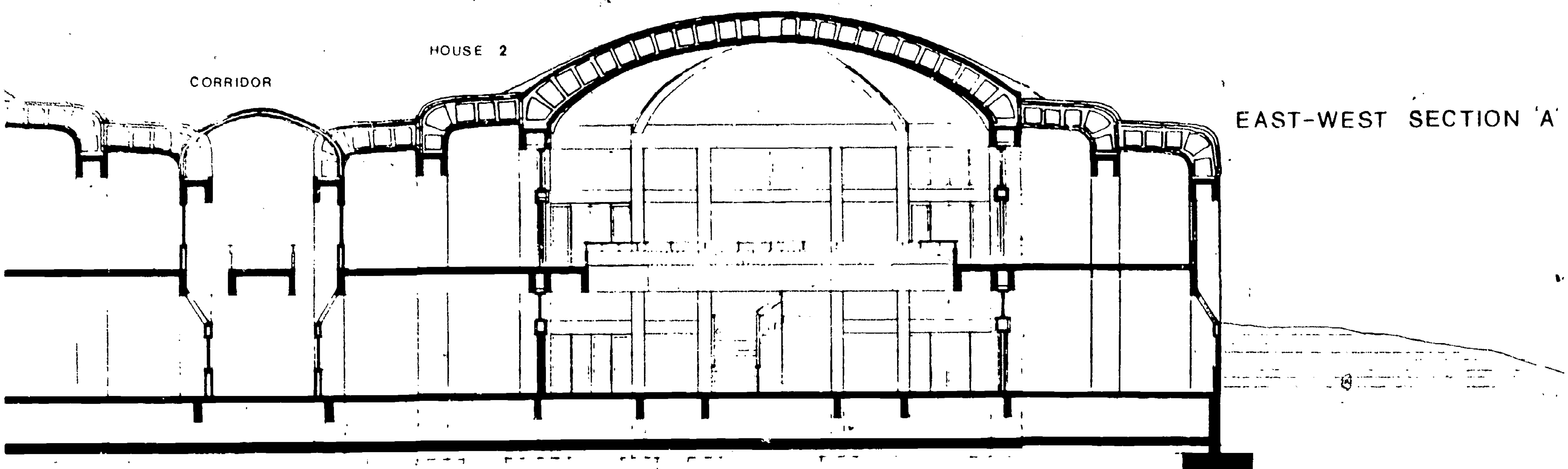
Section/Elevation







WEST ELEVATION



EAST-WEST SECTION 'A'

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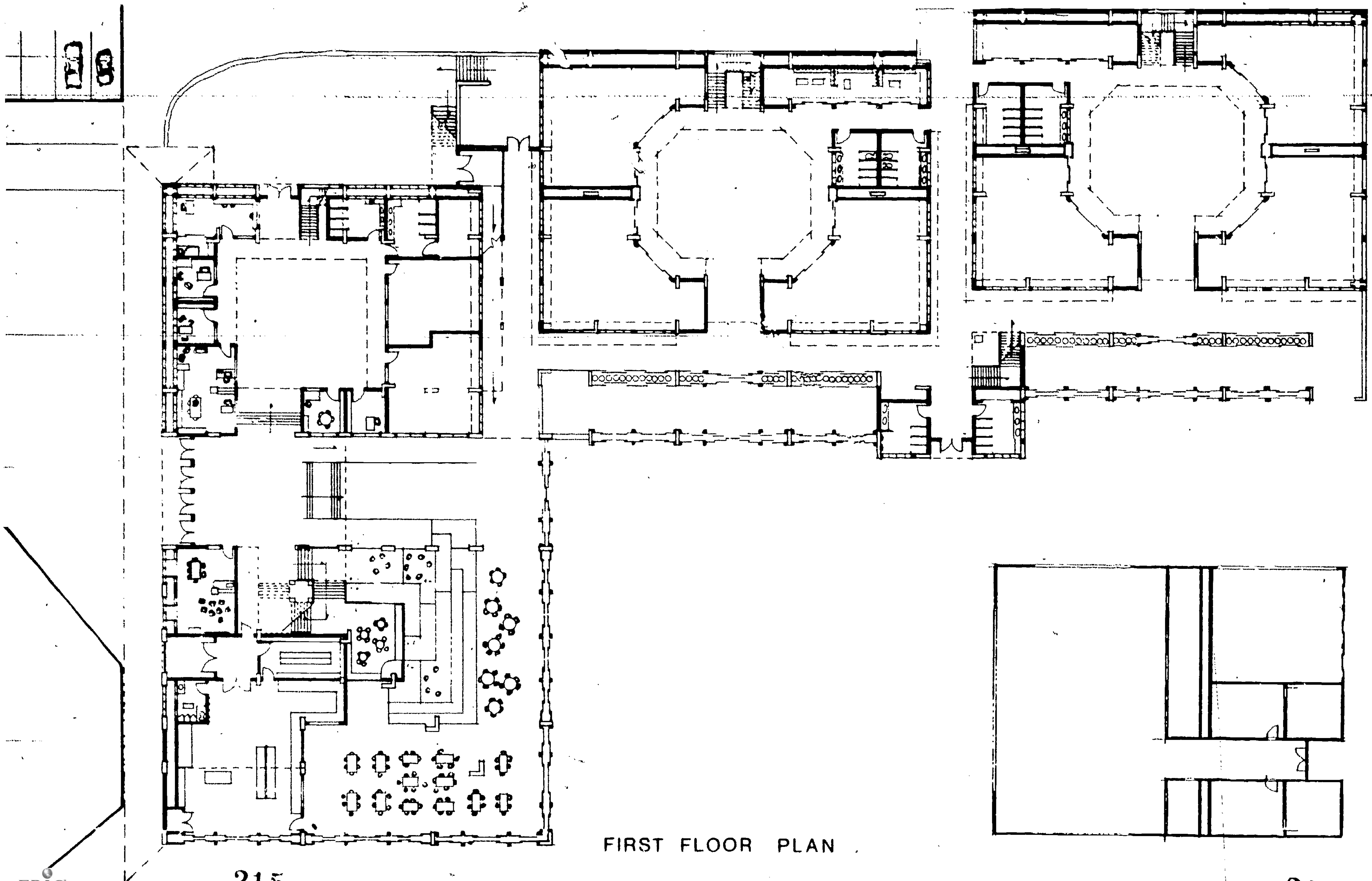
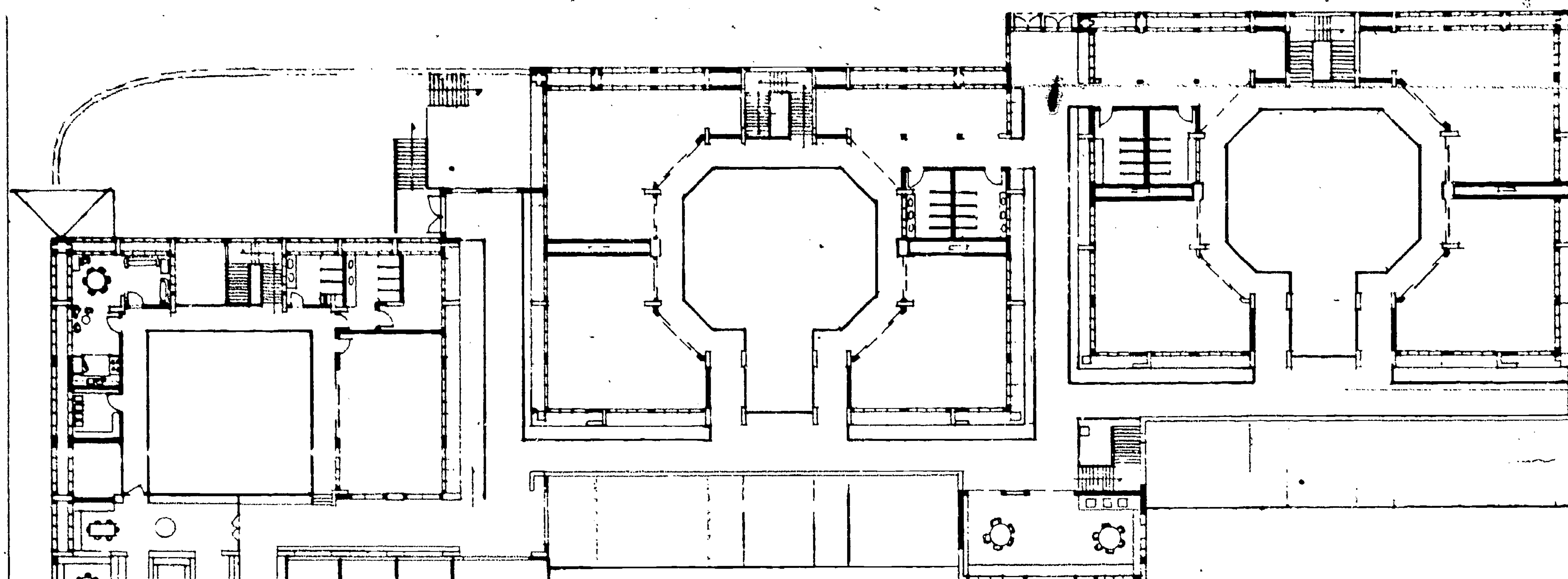
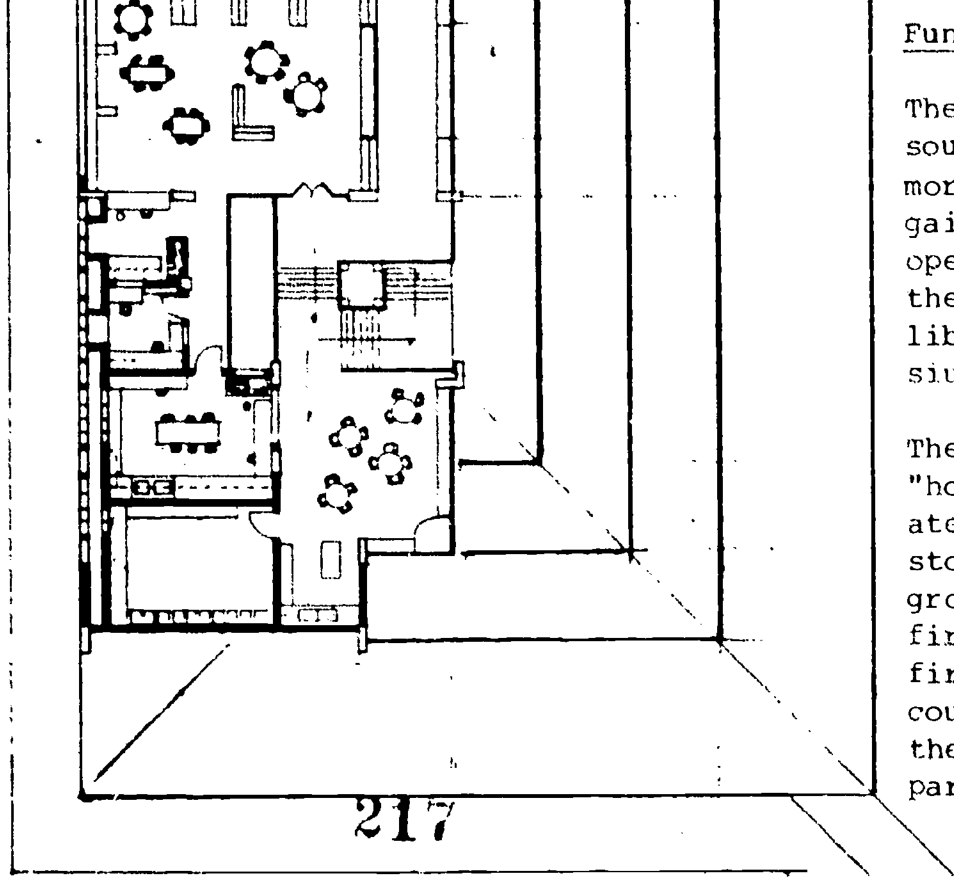


FIRST FLOOR PLAN





Functional Organization

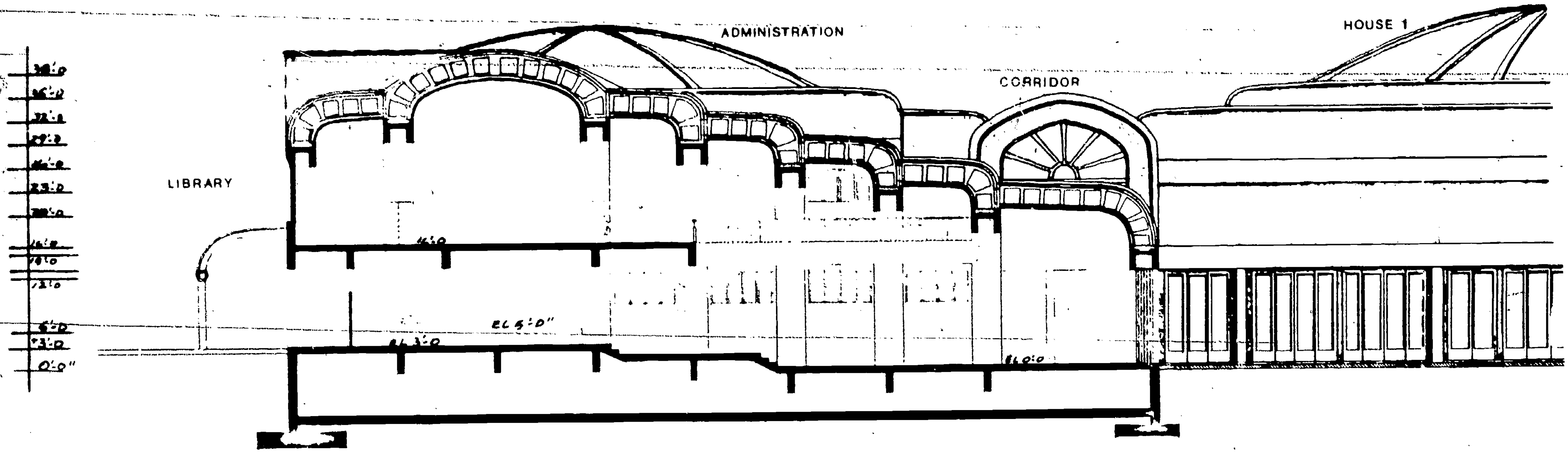
The school is oriented toward maximum south and east sun exposure to maximize morning heat and minimize afternoon heat gain. It is arranged in a U formation opening toward east--the classrooms on the north arm, the administration/entrance/library commons on western end, the gymnasium and kindergarten on the south arm.

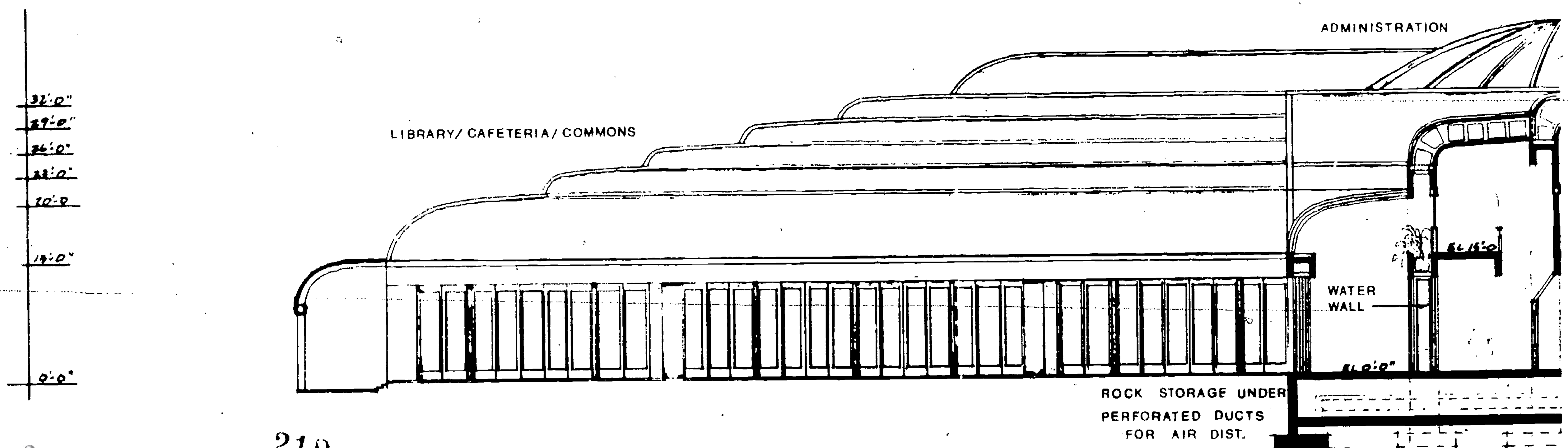
The classrooms are organized into two "houses," connected but visually delineated in the north wing; they are in two stories, set into berm on the north side for ground floor access from the 2nd story (for fire and handicapped access), while the first floor has ground floor access to the courtyard playgound area in the center of the U. The public access is to the west--parking lot, bus drop zone, and entrance forming a buffer zone to Evergreen Drive and Del Rio.

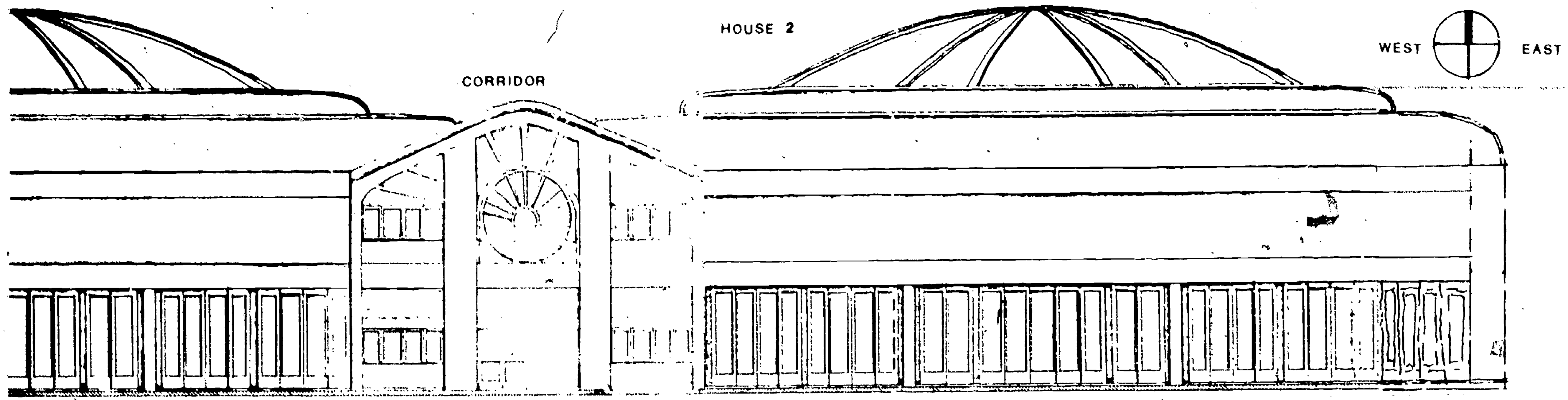
The west wing has administration and special program facilities grouped on the north end around an atrium light well. Library facilities over the entrance and kitchen tier down by levels into the open commons/cafeteria/assembly space. The south wing consists of the gymnasium, dressing rooms, and kindergarten--with separate entrance from street for public use of these areas.

The eastern portion of the site is developed as park and open space with the pond, recycling center, water tower, and methane digestion facility to the north end.

SECOND FLOOR PLAN

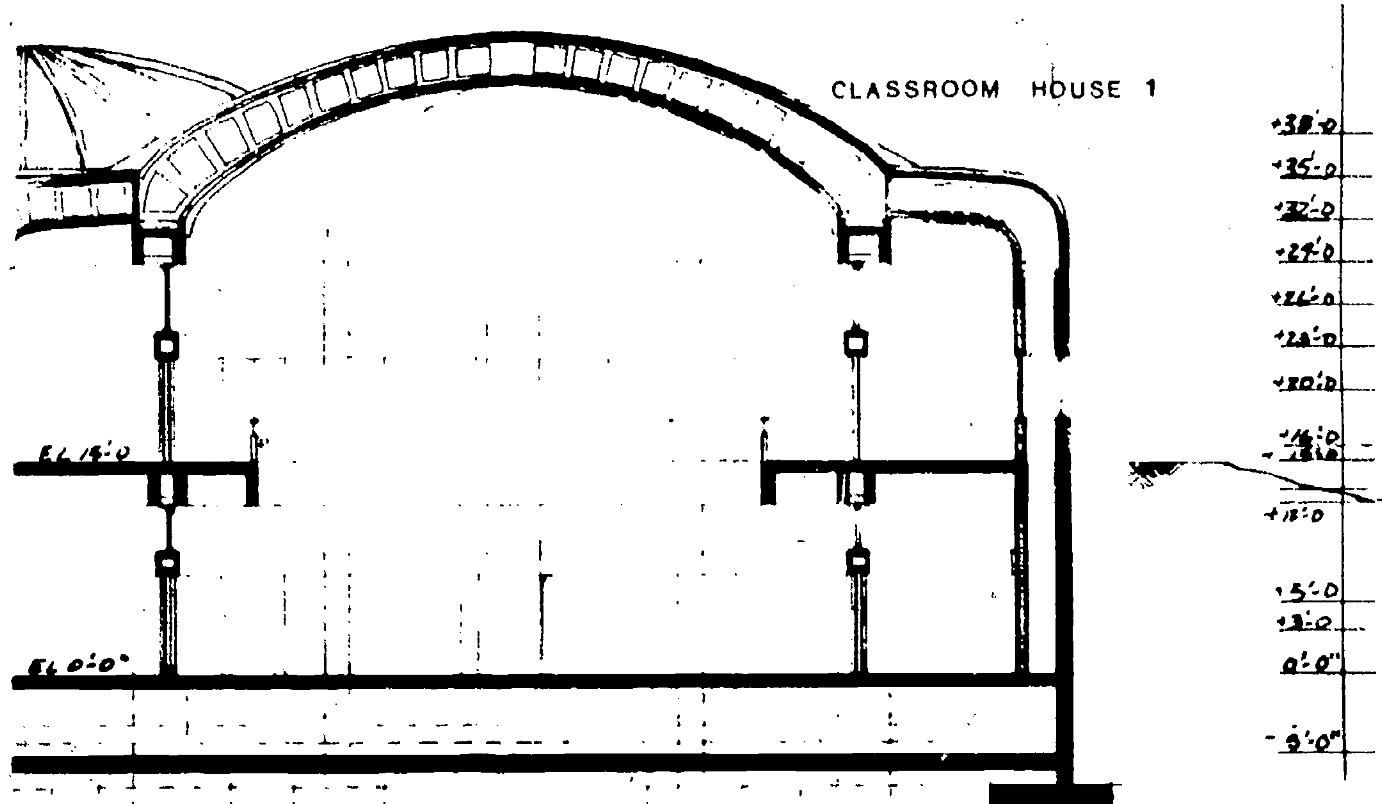

ADMINISTRATION
HOUSE 1
CORRIDOR
LIBRARY


ADMINISTRATION
LIBRARY/ CAFETERIA/ COMMONS
WATER
WALL
ROCK STORAGE UNDER
PERFORATED DUCTS
FOR AIR DIST.



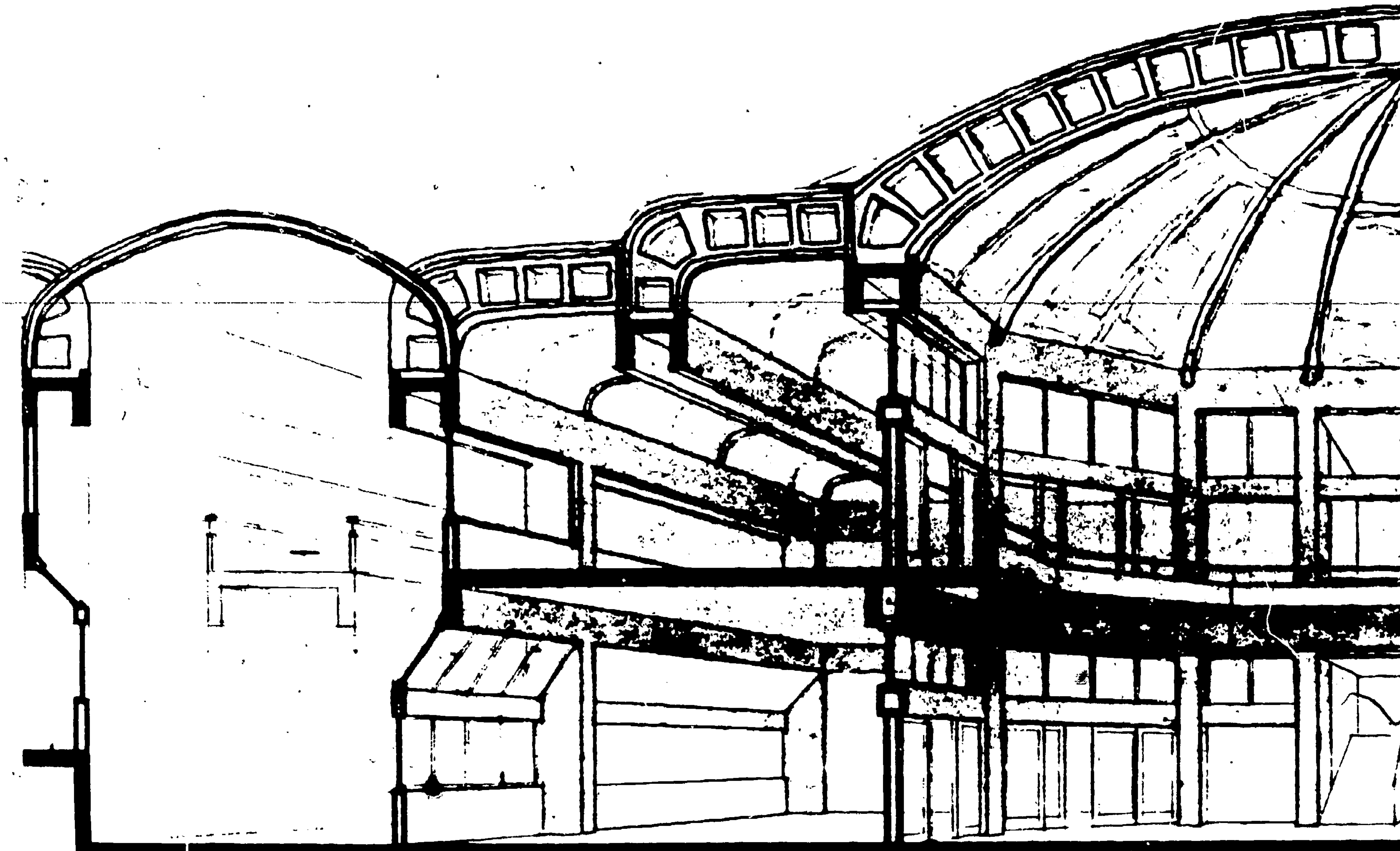
EAST-WEST SECTION C THRU LIBRARY

& SOUTH ELEVATION CLASSROOMS



NORTH-SOUTH SECTION B THRU CLASSROOM HOUSE 1 ATRIUM

& EAST ELEVATION LIBRARY / COMMONS



INTERIOR PERSPECTIVE

THRU CLASSROOM HOUSE

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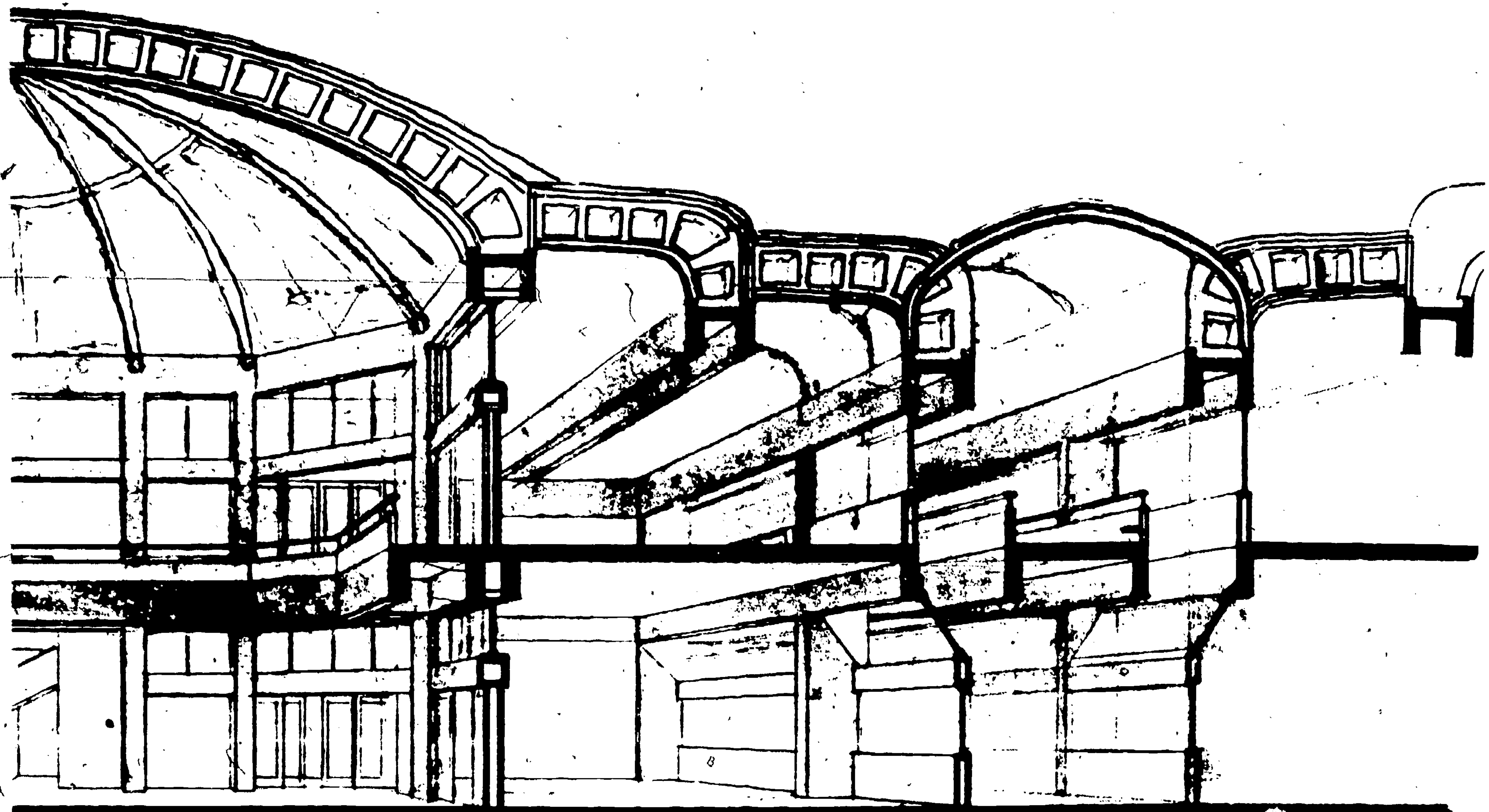

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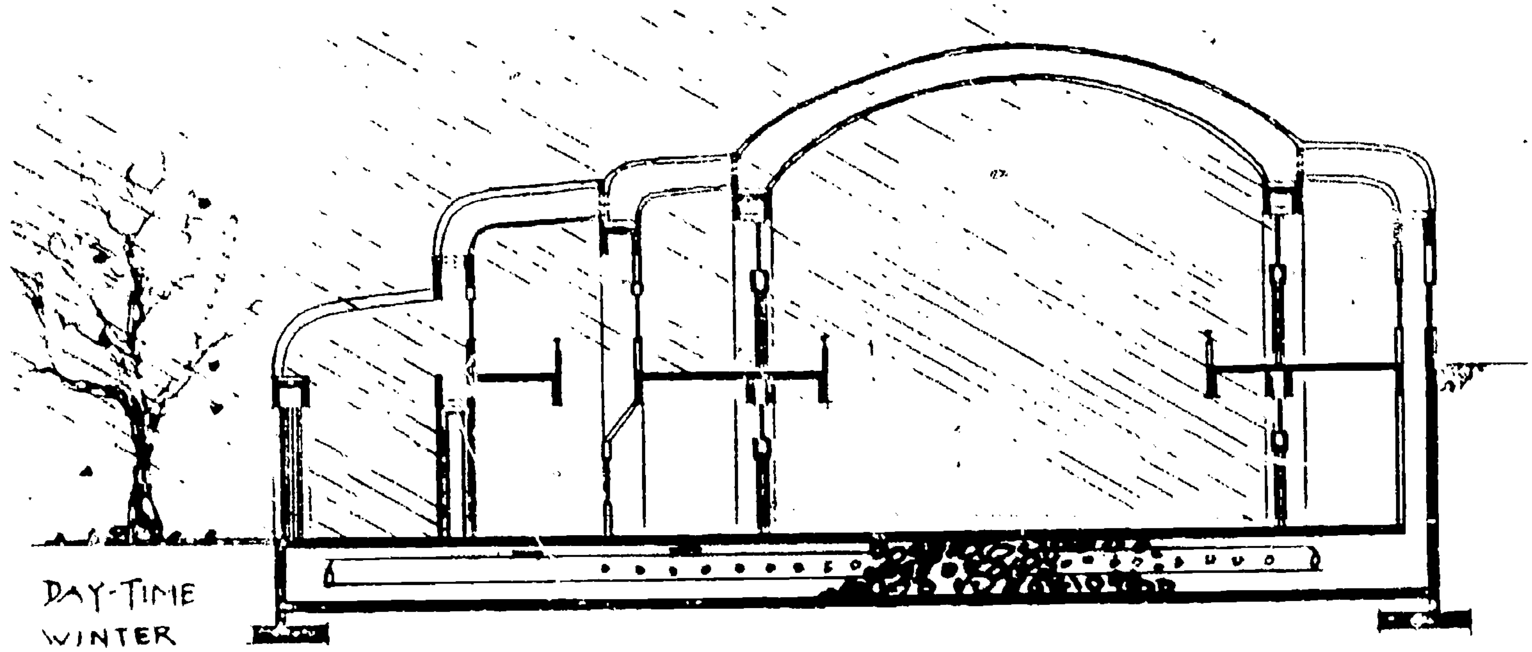
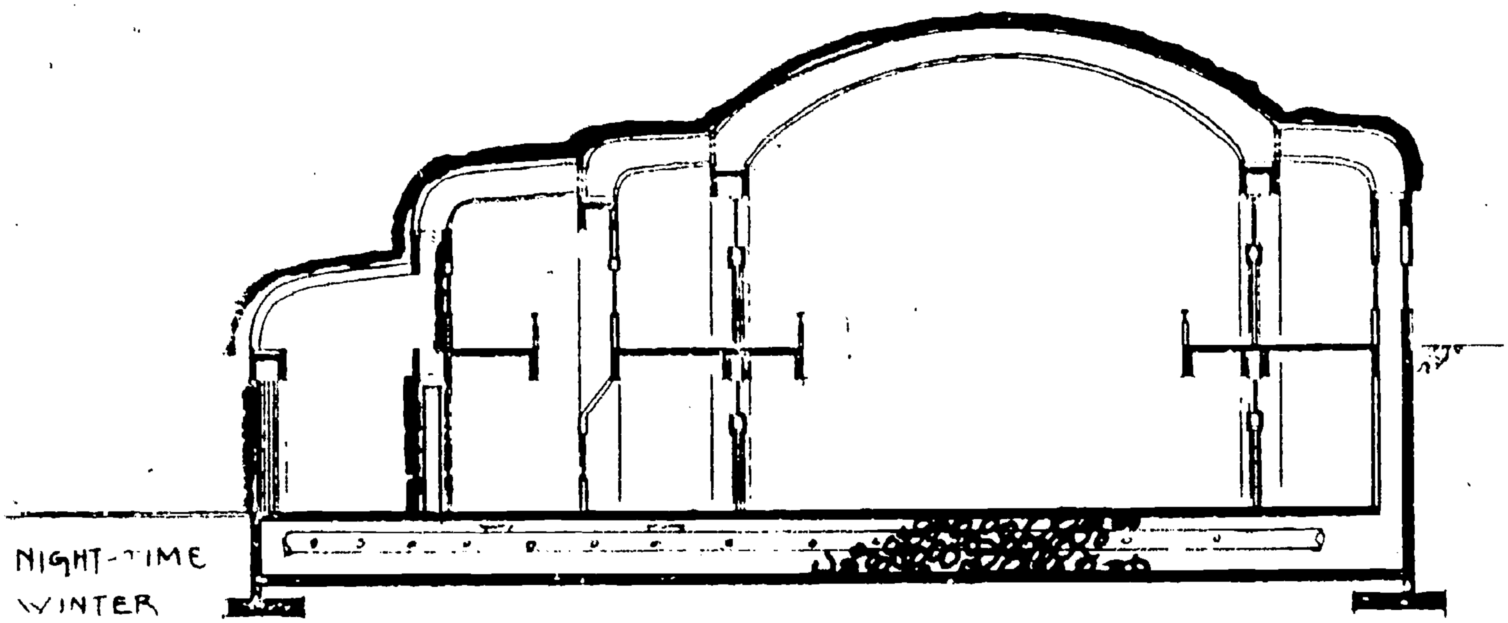
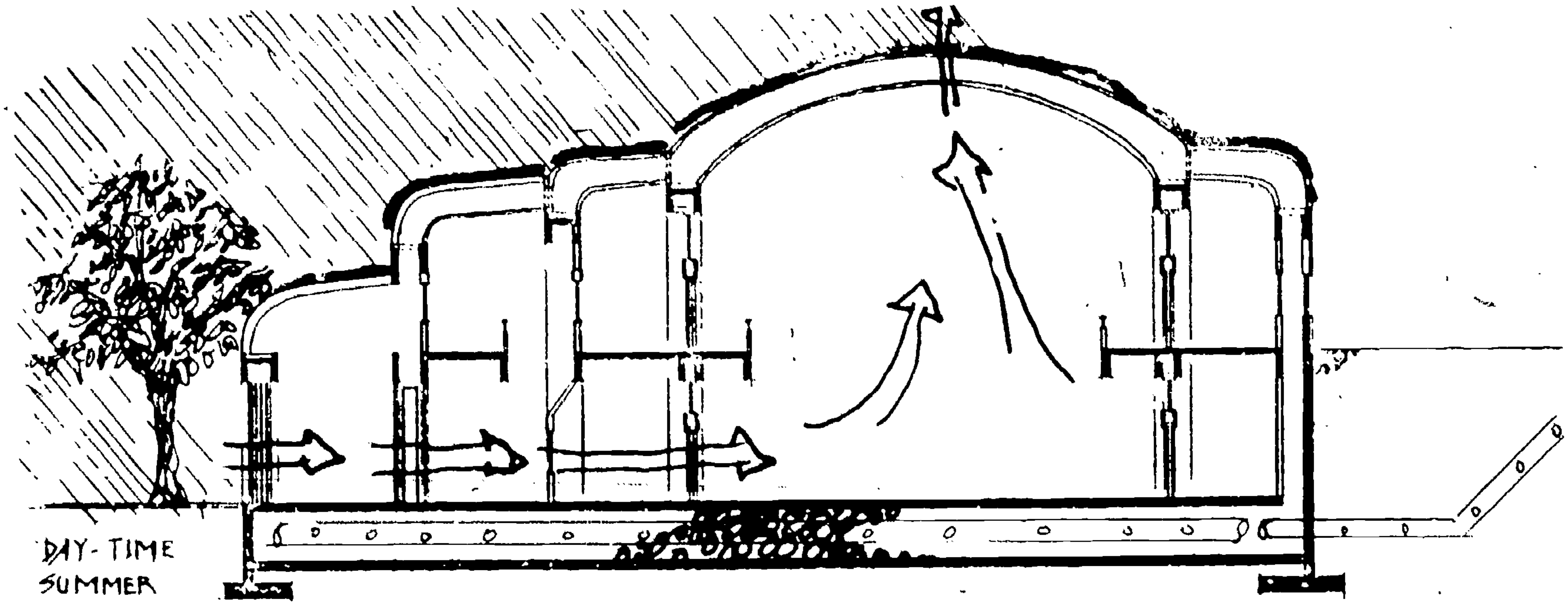
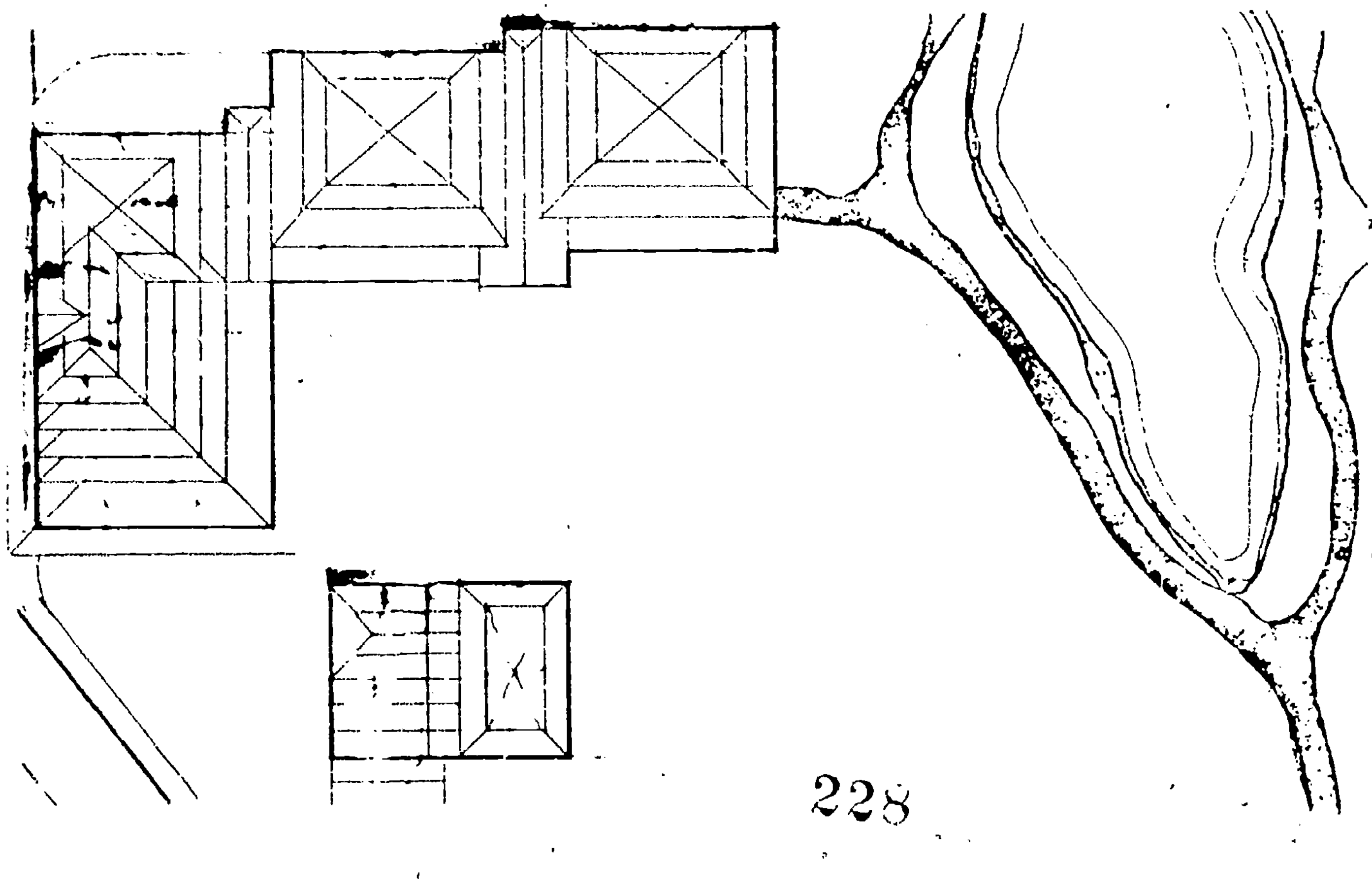

DAY-TIME
WINTER


NIGHT-TIME
WINTER

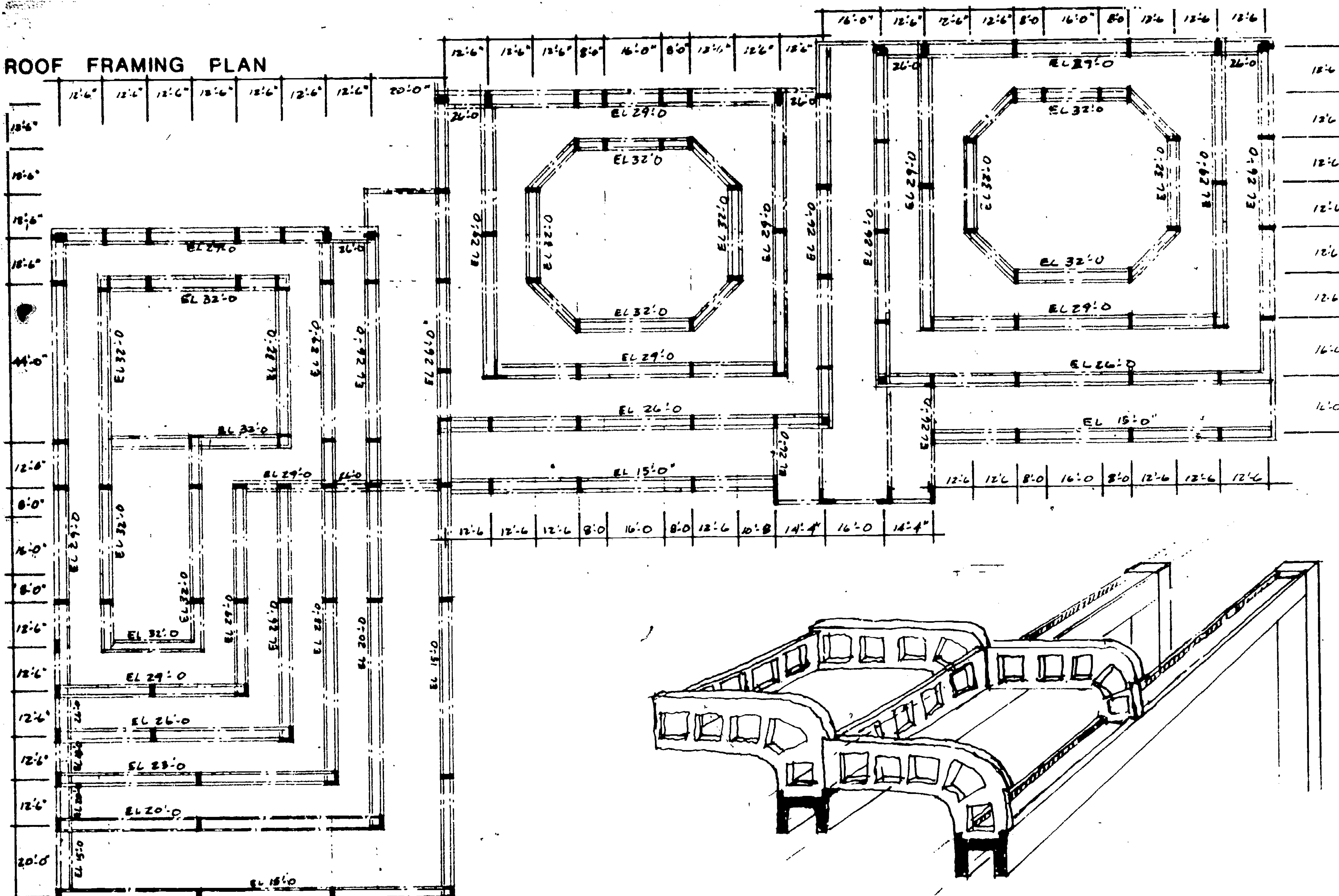


DAY-TIME
SUMMER

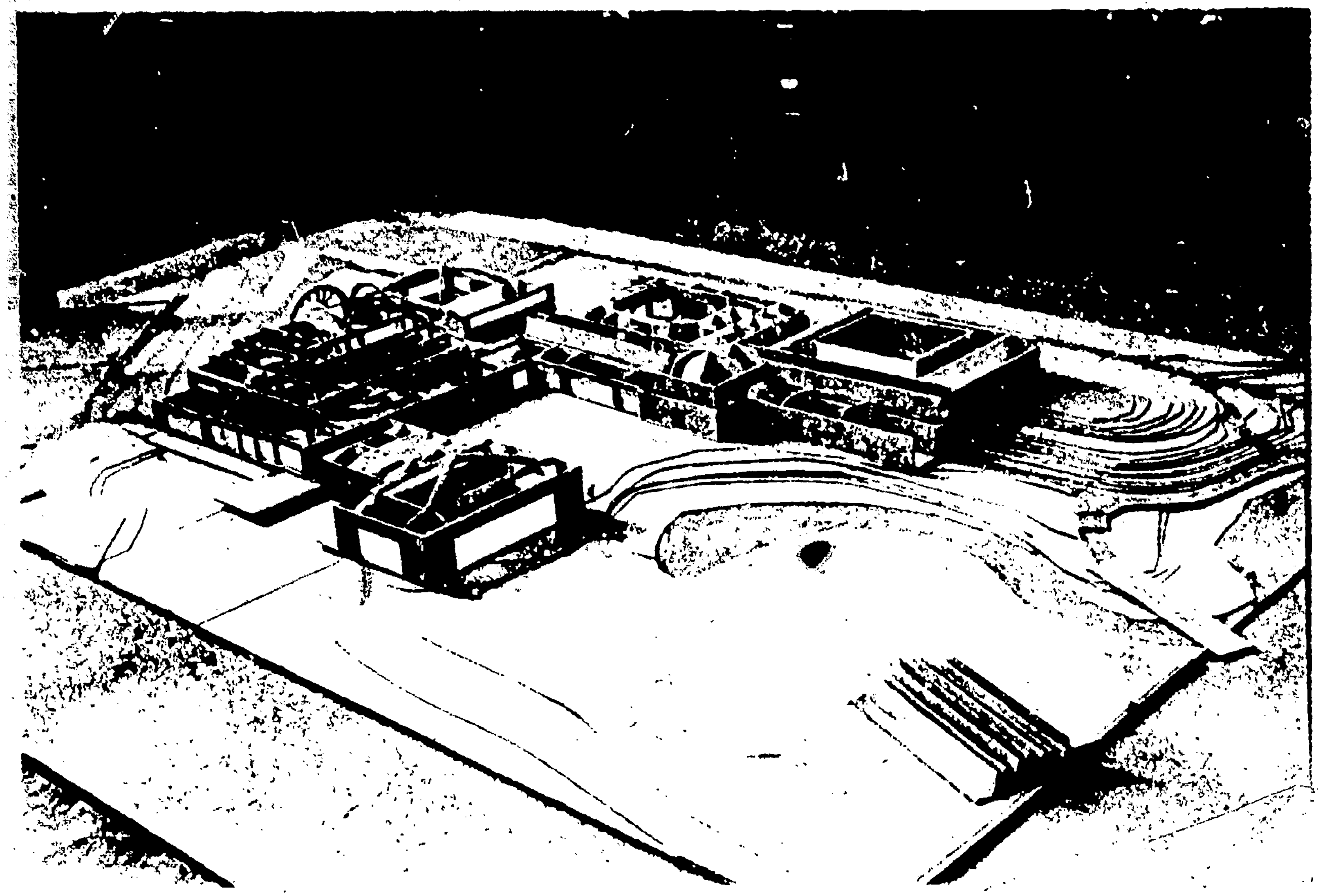
AIR CIRCULATION
PATTERNS
THRU ROOF
PLENUM INTO
PLENUM WALLS



ROOF FRAMING PLAN

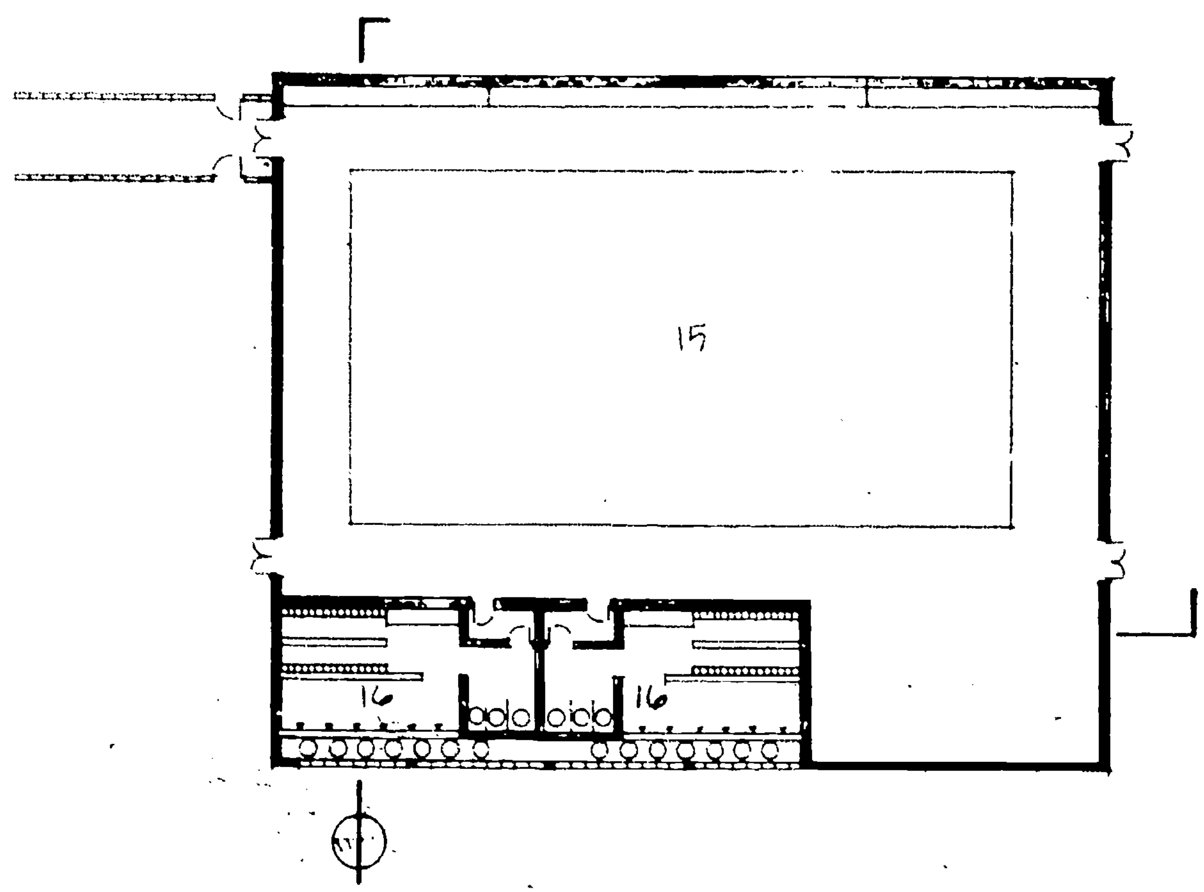


SKETCH - ROOF FRAMING MODULE



CONTOUR & FRAMING STUDY MODEL

michael schweizer



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Design

My approach to the design of a zero energy use school is that the building must first be effective as an educational facility and secondly perform in its role as an energy efficient structure.

The school is to function as an educational facility in more than an academic way. Staff and students, through active participation, will be responsible for the day-to-day operation of the various systems. The community will be made aware of the conservation practices through actual contact, through their children or through the media. The building itself will be an educational tool acting as a model for further testing and refinement.

In developing my building, I formulated and attempted to carry out several concepts that include: attention to the children who will use the school; buildings within buildings or zones within buildings; using a space for more than one purpose; clarity of form and structure.

These ideas have resulted in a main building that consists of a solar oriented building of post and beam construction, heavy perimeter walls and infill interior walls. What was once outdoor space between the classroom wings is now an enclosed space that contains cafeteria/auditorium, play areas, art space, etc.

Through the use of dropped ceilings, level changes, large and small spaces, ramps, stairs, etc., I have attempted to make an inside place that the kids can use and have fun in. The center zone also functions as a solar collector and thermal barrier for the classroom and administration areas. The zones are represented by the center greenhouse section, the classrooms, library and administration and the small greenhouses. The theory is such that as one moves from a larger to a smaller space the difficulty of heating and lighting a space lessens.

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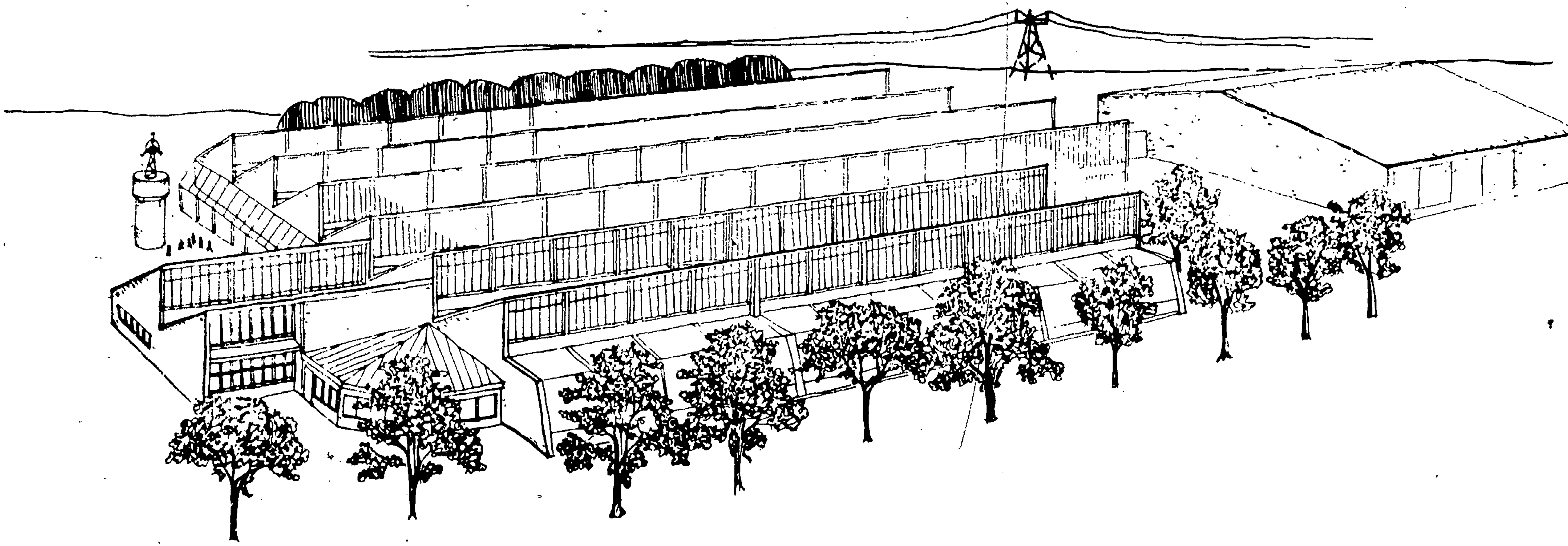

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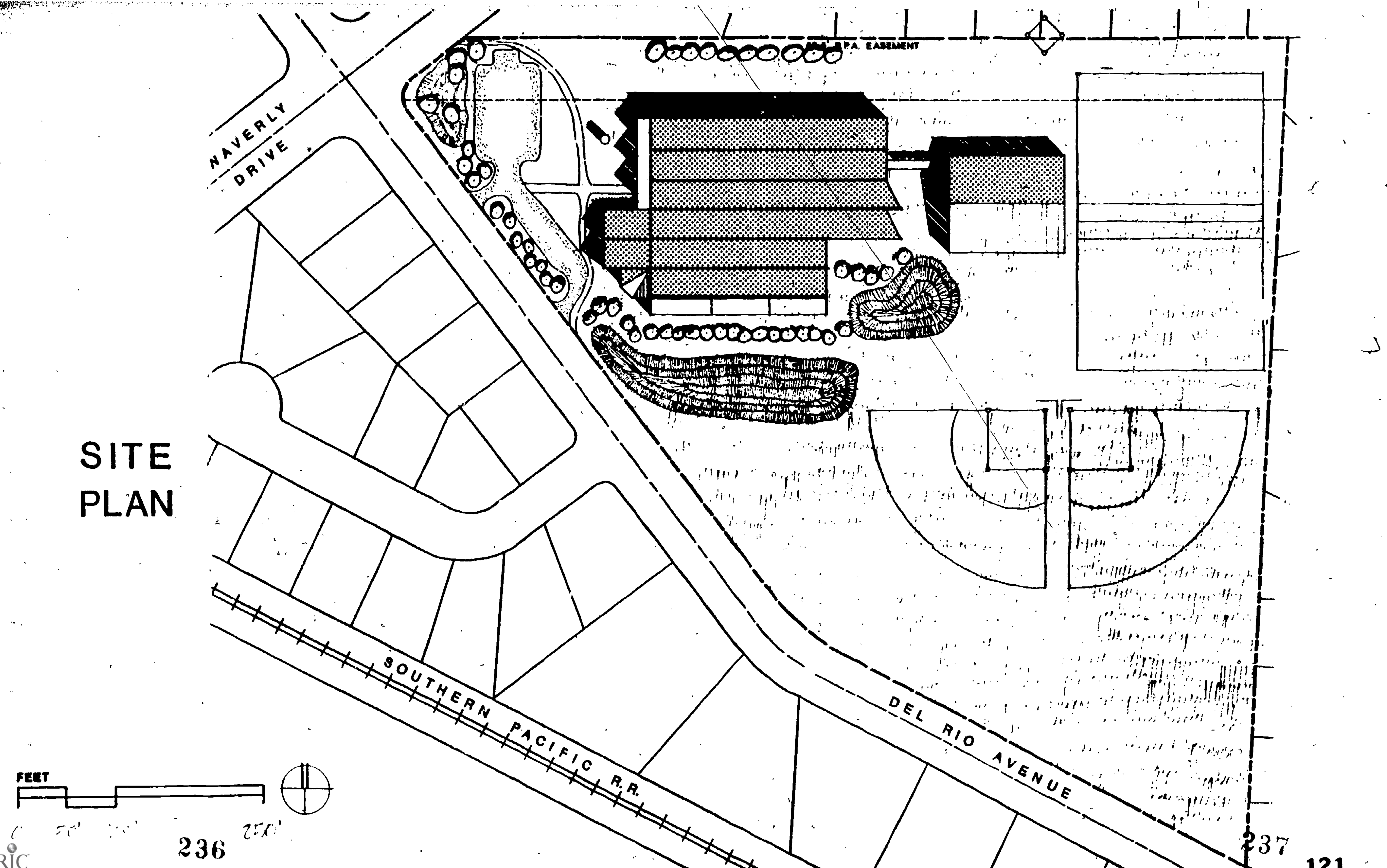
Michael Schweizer

SITE PLAN



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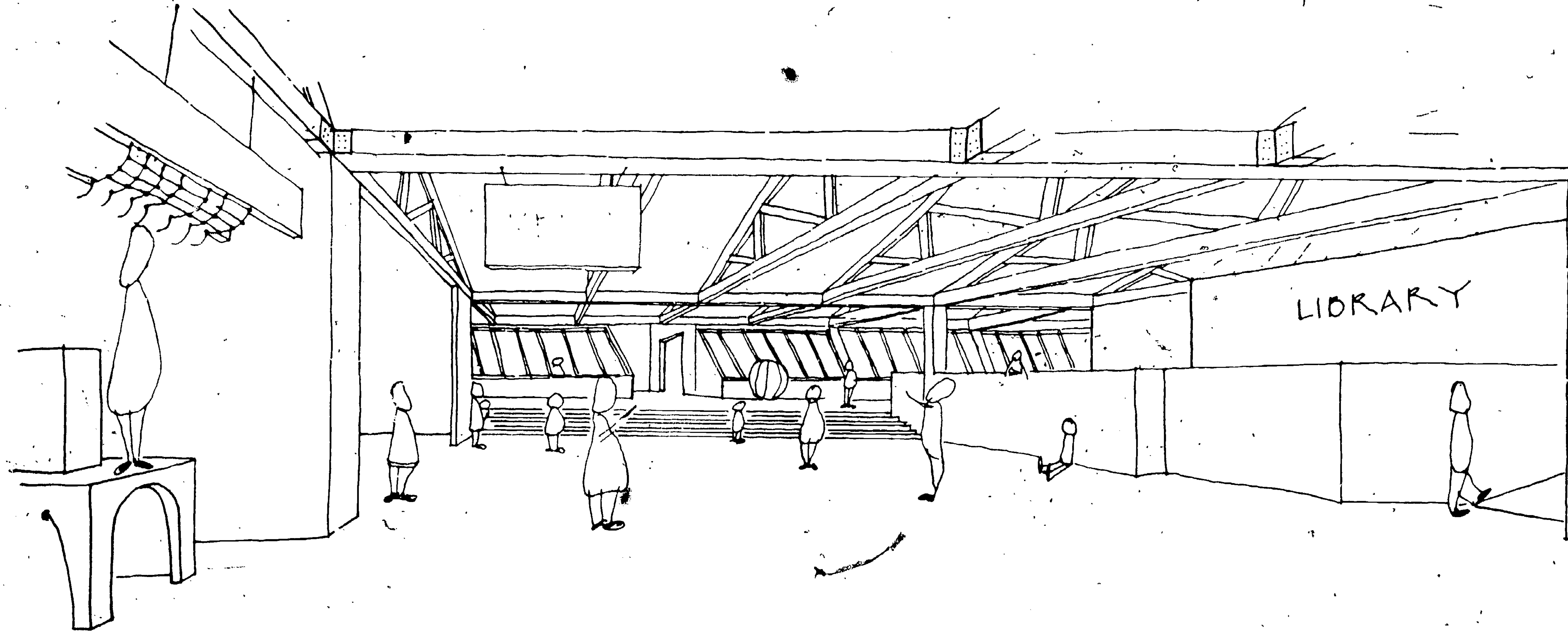
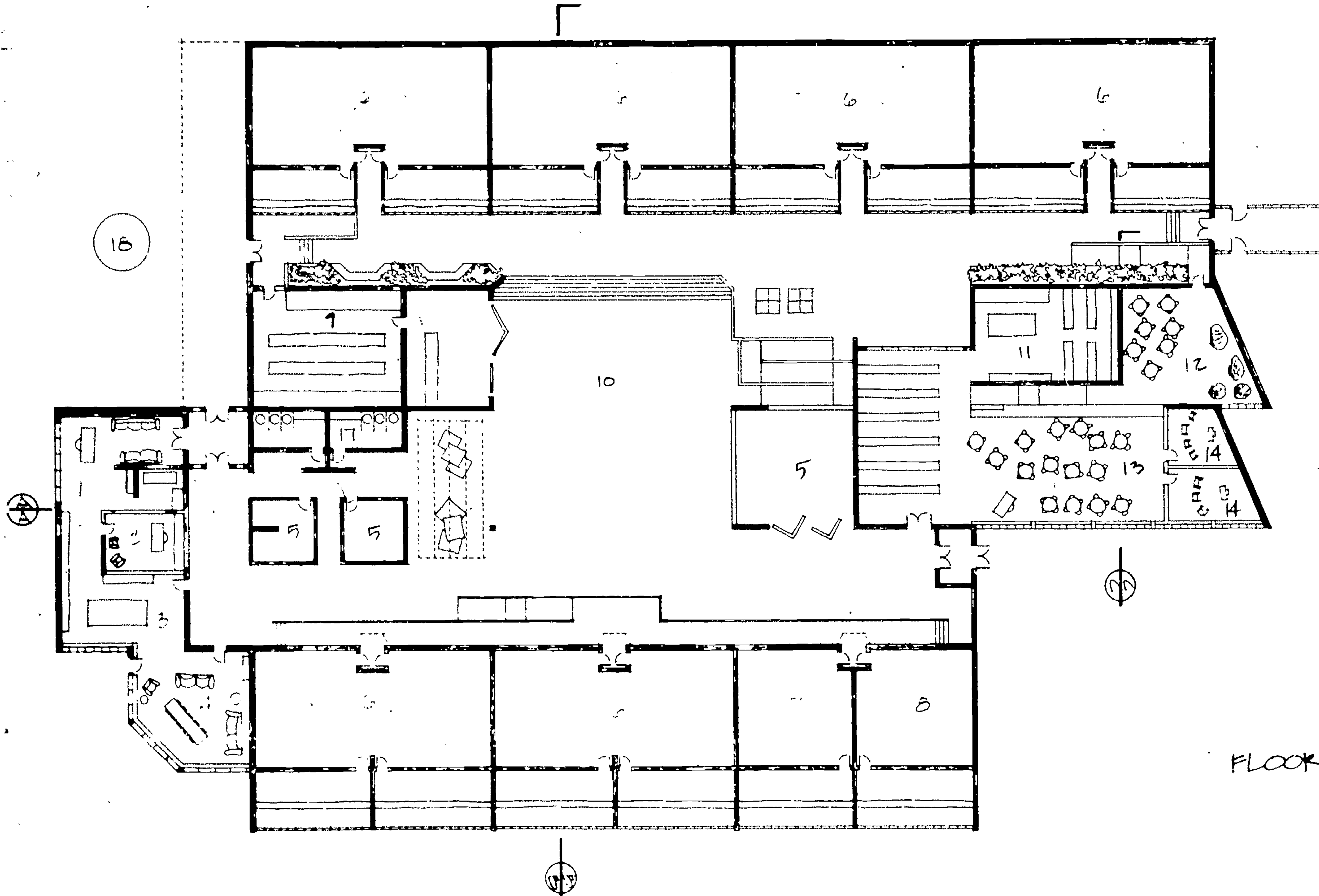

LIBRARY



1. OFFICE
2. PRINCIPAL
3. WORK ROOM
4. TEACHERS LOUNGE
5. STORAGE
6. CLASSROOMS
7. KINDERGARTEN
8. REMEDIAL ROOM
9. KITCHEN
10. MULTI-USE
    - PLAY SPACE
    - LUNCH ROOM
    - CLASS ROOM
    - SOLAR COLLECTOR
    - ETC.
11. LIBRARIAN OFFICE
12. UPPER LEVEL
13. MAIN FLOOR BOOK STACKS
14. SMALL CLASSROOMS
15. GYM
16. SHOWER ROOMS
17. COMPOSTING TOILETS

    *GRAY WATER TO SEPTIC TANK
18. WATER TOWER

FLOOR PLAN

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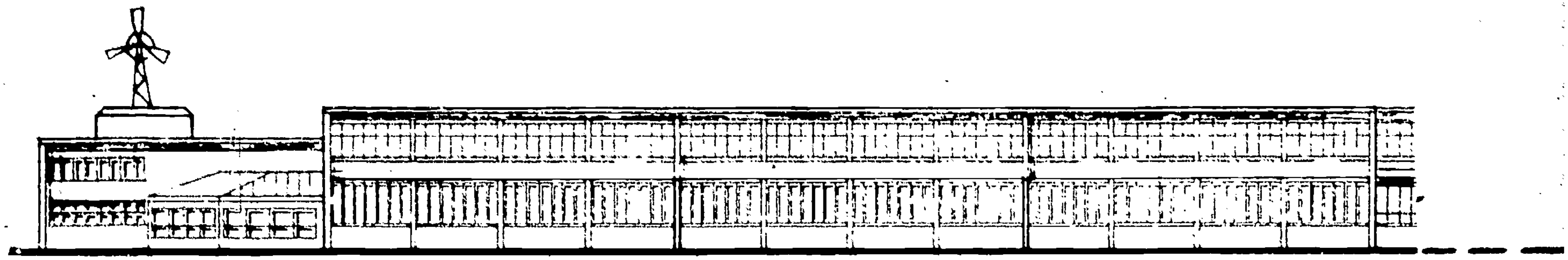
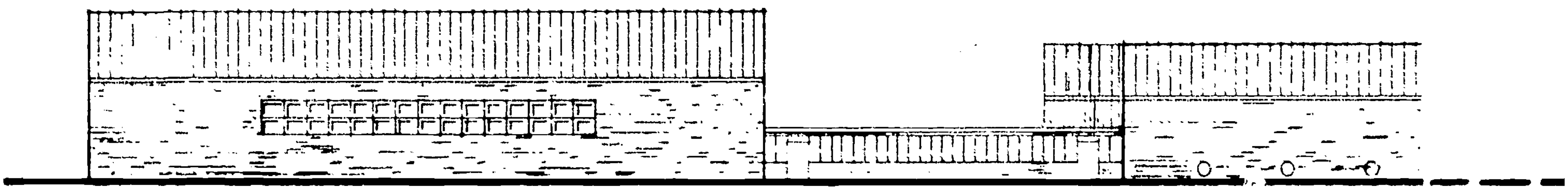
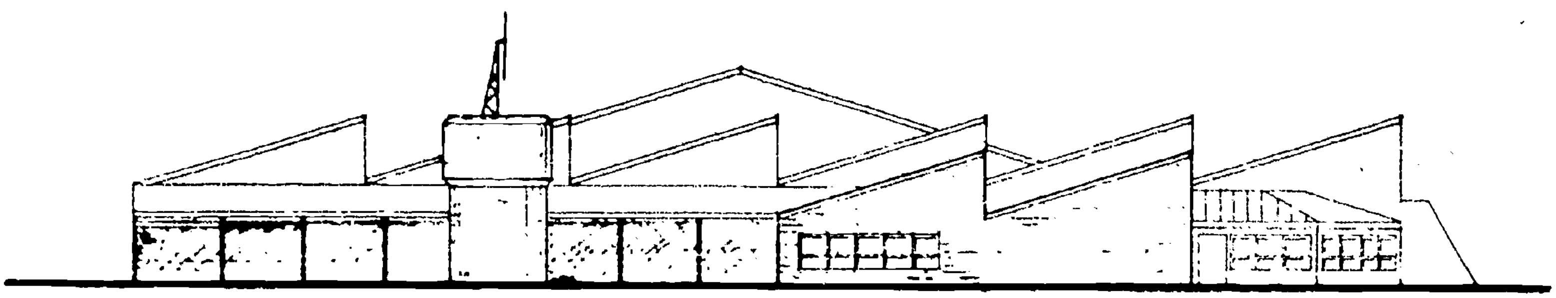


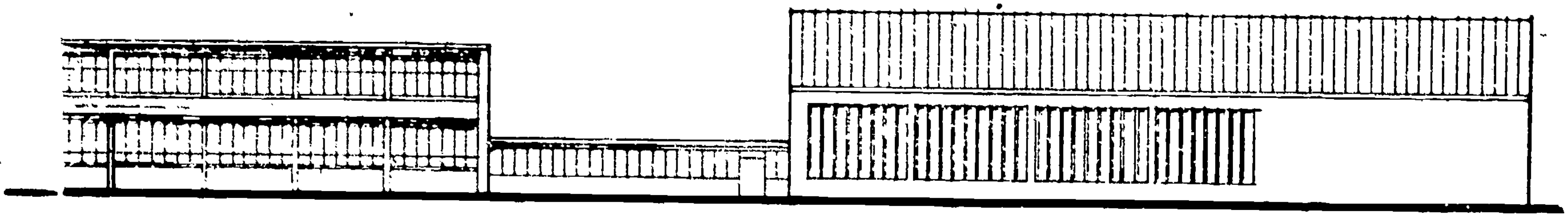
SOUTH



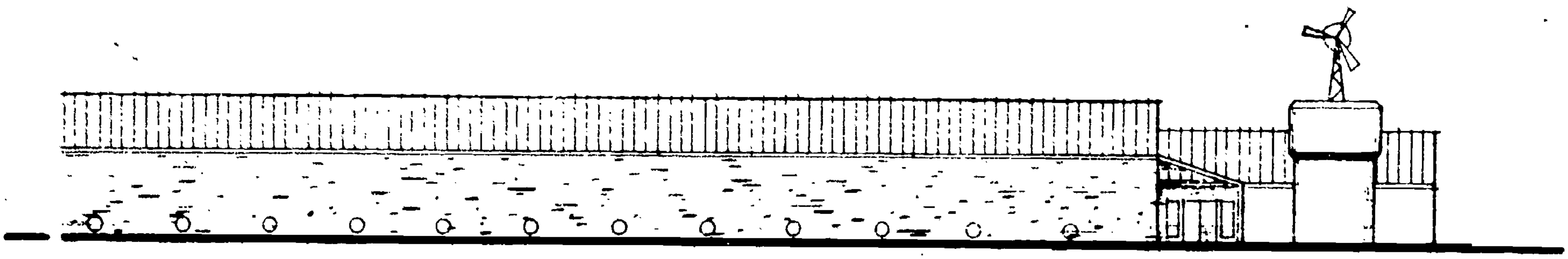
NORTH



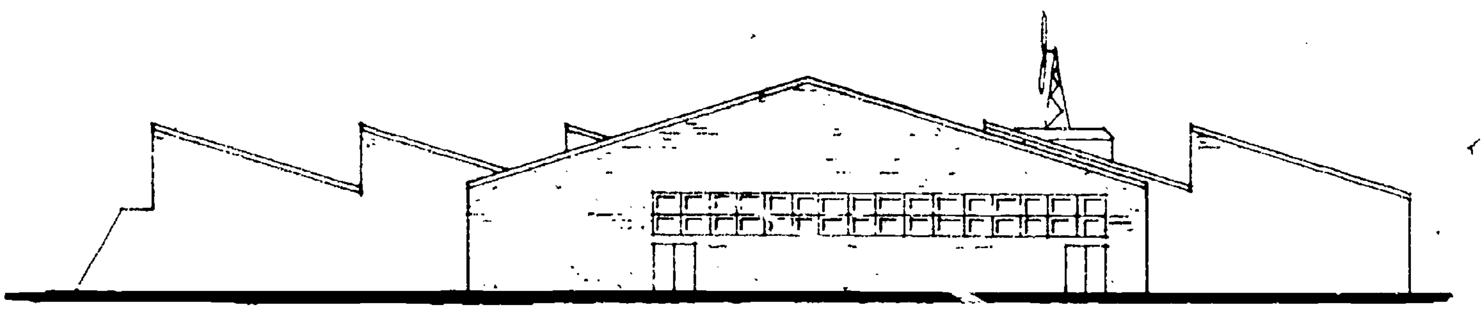
WEST ELEVATION



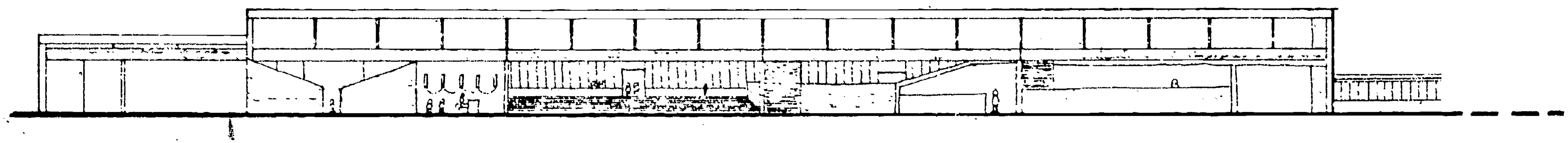
ELEVATION



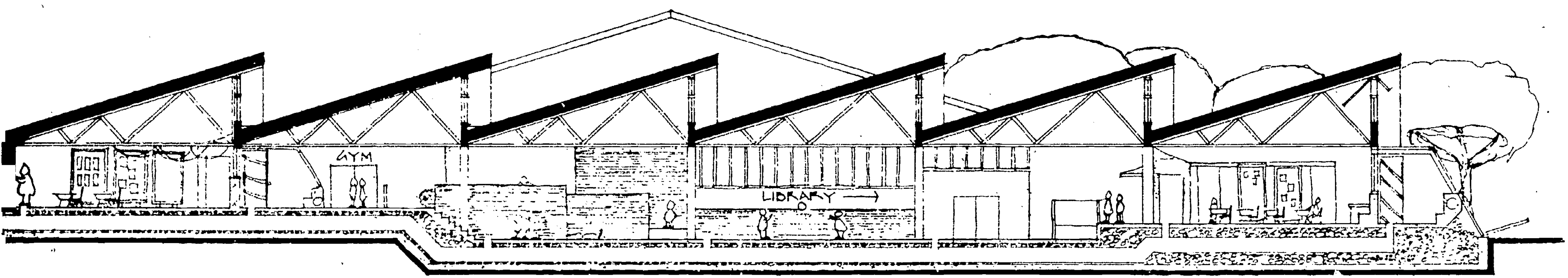
ELEVATION



EAST ELEVATION

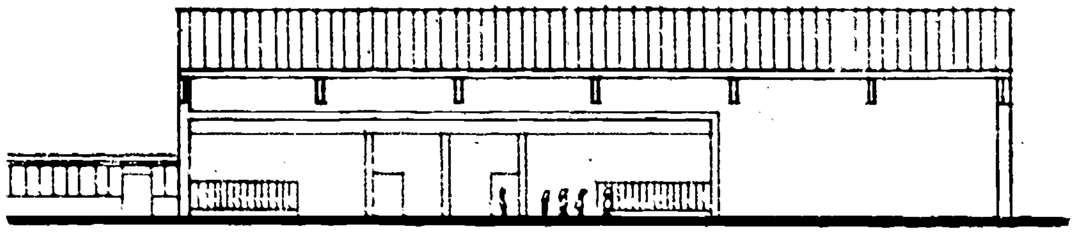


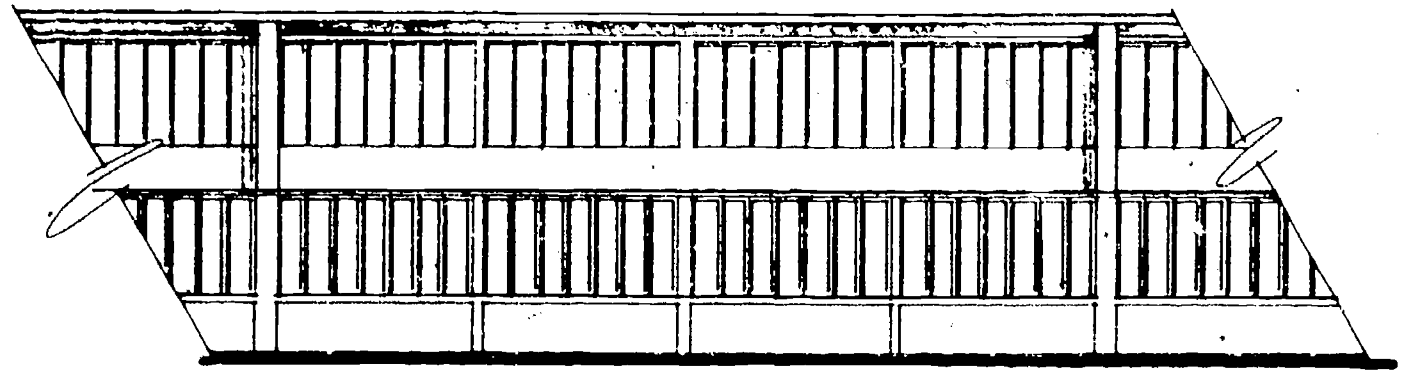
SECTION



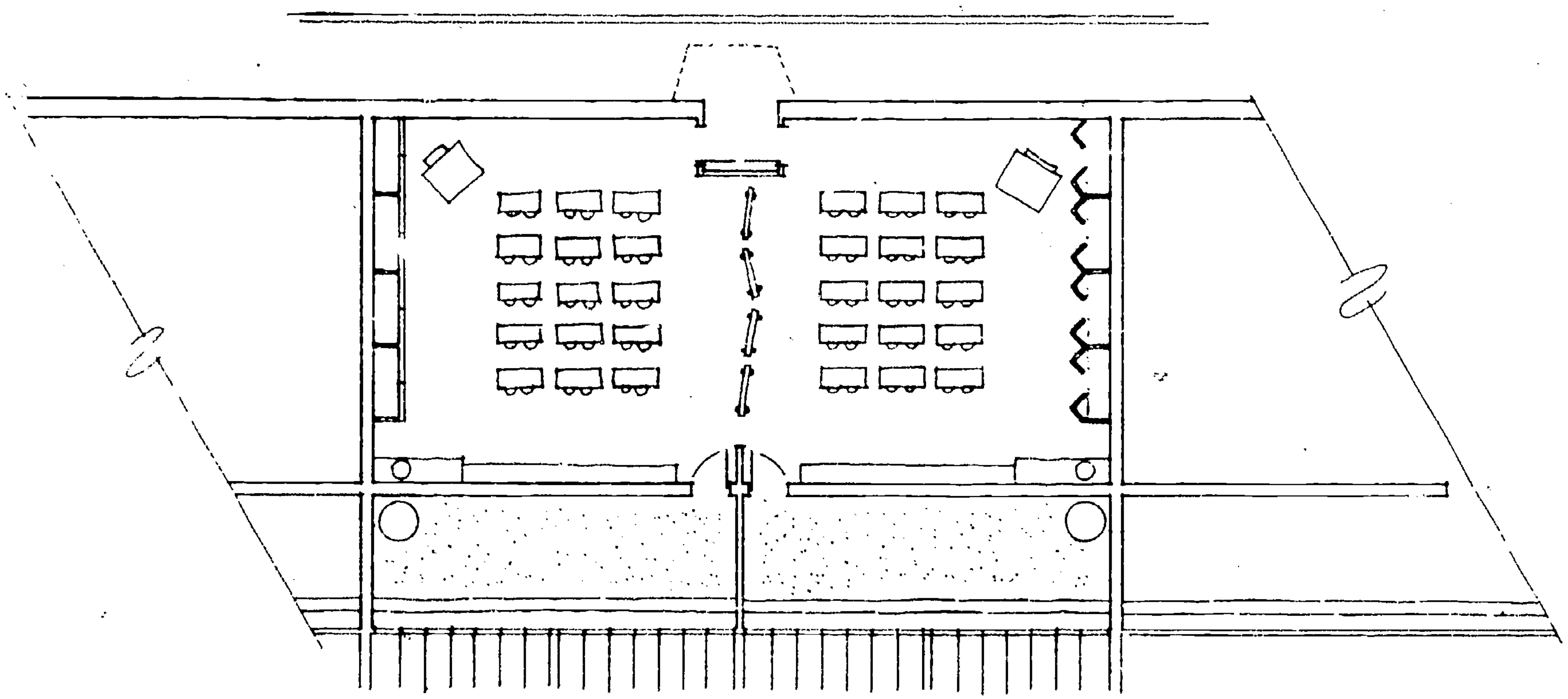
SECTION

244 245





PARTIAL ELEVATION



CLASSROOM FLOORPLAN

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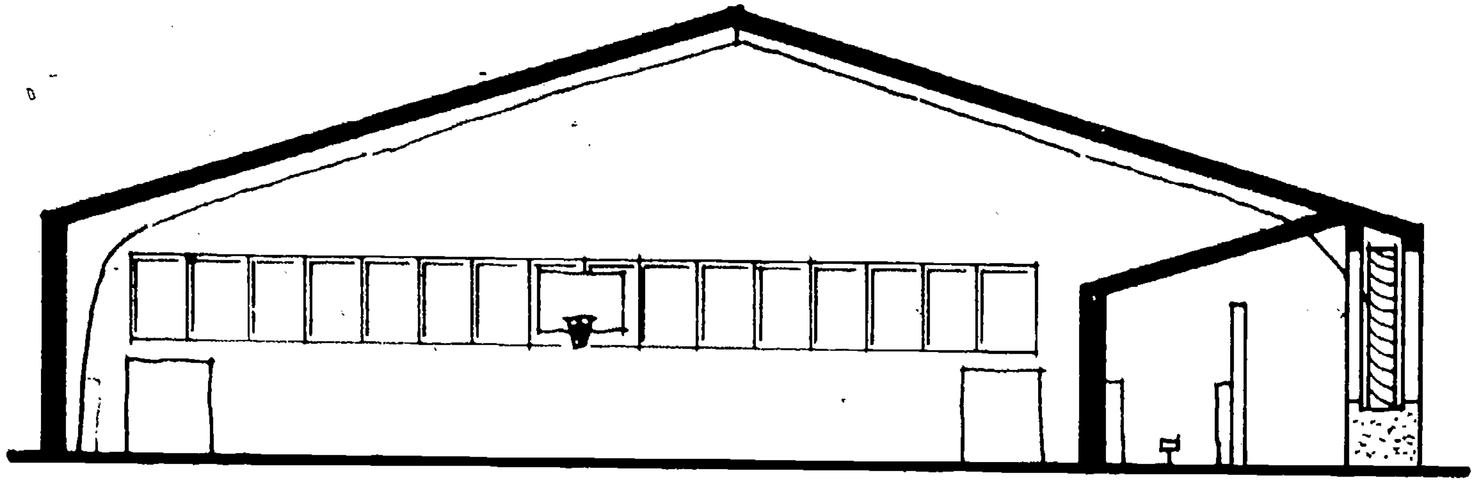
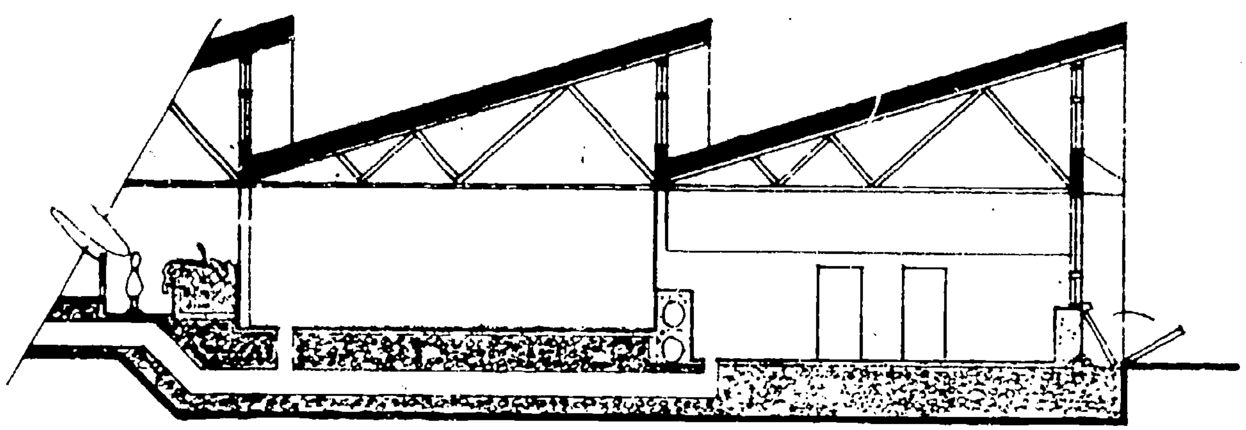


GYM SECTION

GYM: Not heated except for gain through east and west windows. The shower room has a large glazing area to facilitate heating the room plus hot shower water. Comfortable water temperatures are attainable providing a prolonged cloudy period is not realized.



LIBRARY SECTION

LIBRARY: A rock storage bin plus two interior mass walls collect and store available solar radiation. On a clear day the south space can be allowed to over-heat to build storage capacity. At this time occupants can move to a cooler space behind and above the main floor. Light is controlled by fixed overhangs and removeable shades. Inside, refracting louvers are adjustable (see performance section) to fit immediate needs.

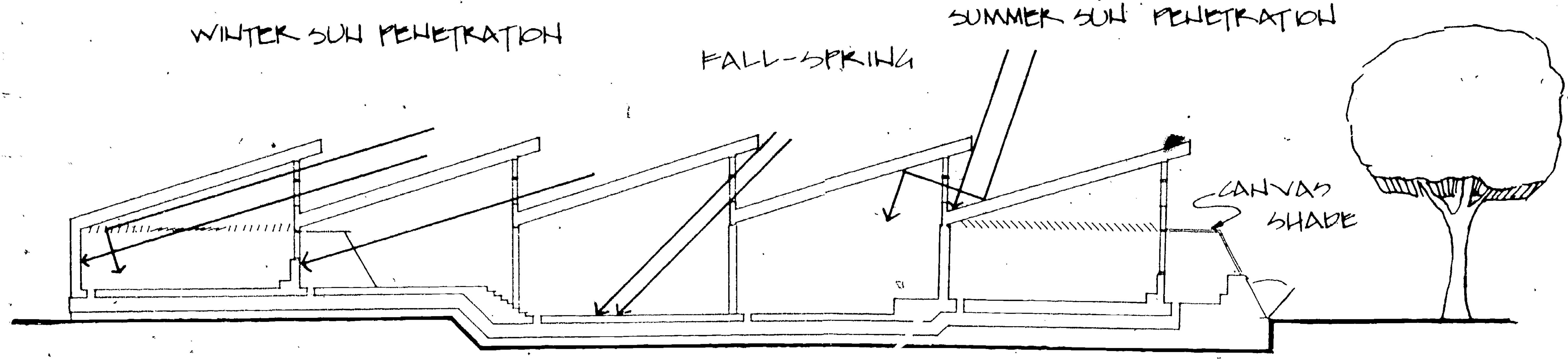
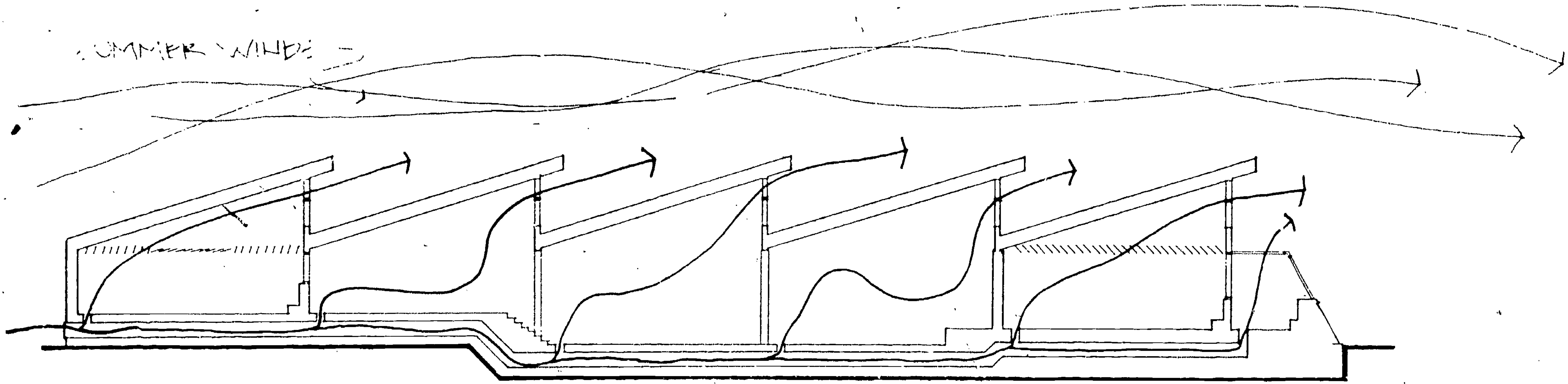


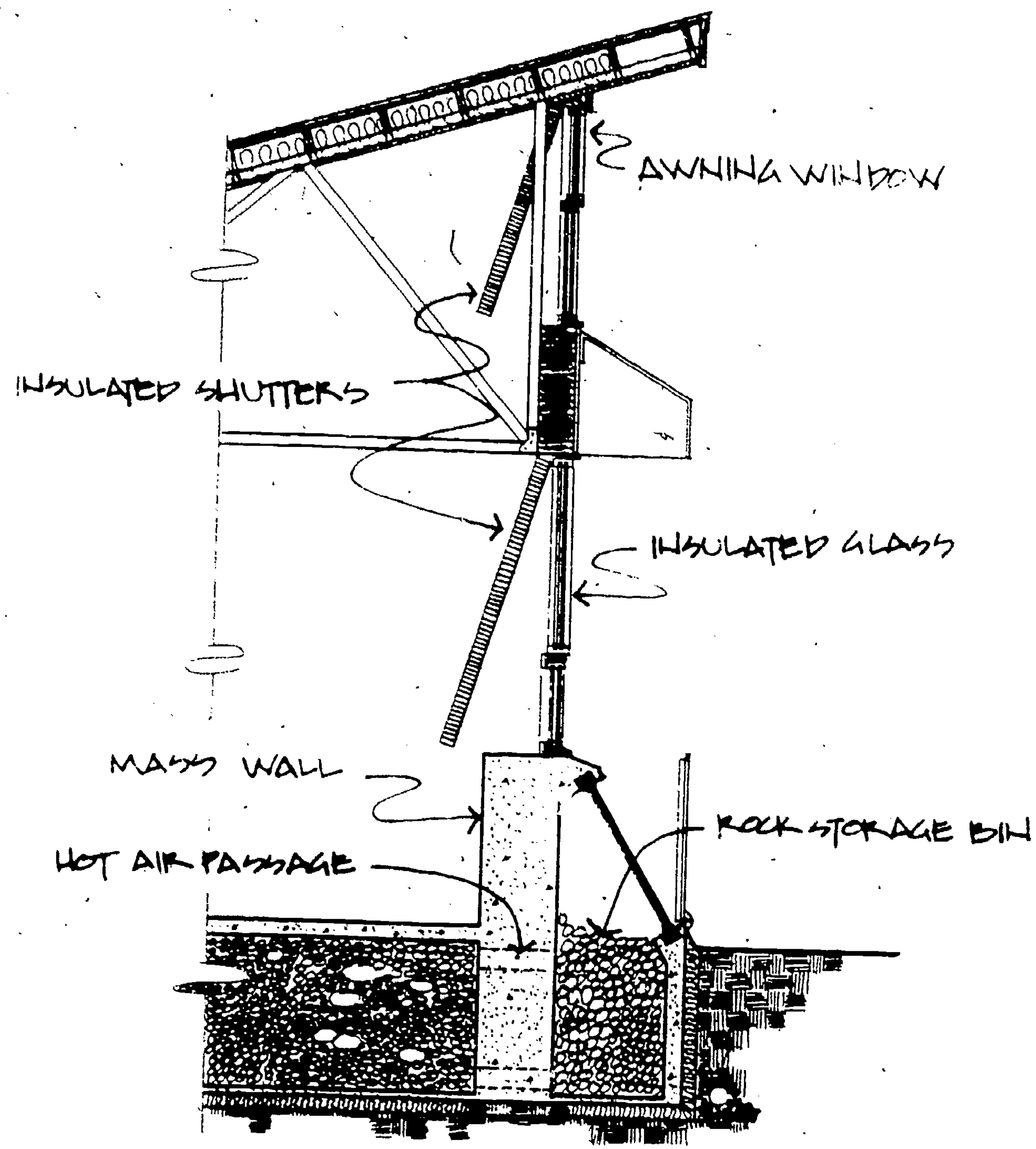
DIAGRAM OF SEASONAL SUN PENETRATION

PERFORMANCE SECTIONS



NATURAL VENTILATION AIR FLOW

250 251



WALL SECTION

NOTE:

Calculations indicate a temperature of ±61° is generally possible. Except during the coldest part of December, the school year is basically intact except for a 0900 starting time. Summer cooling is achieved through convection, and indications are at totally acceptable temperatures are easily reached. Through my involvement with this project, I firmly believe energy savings of 80+% are possible through energy conscious design.

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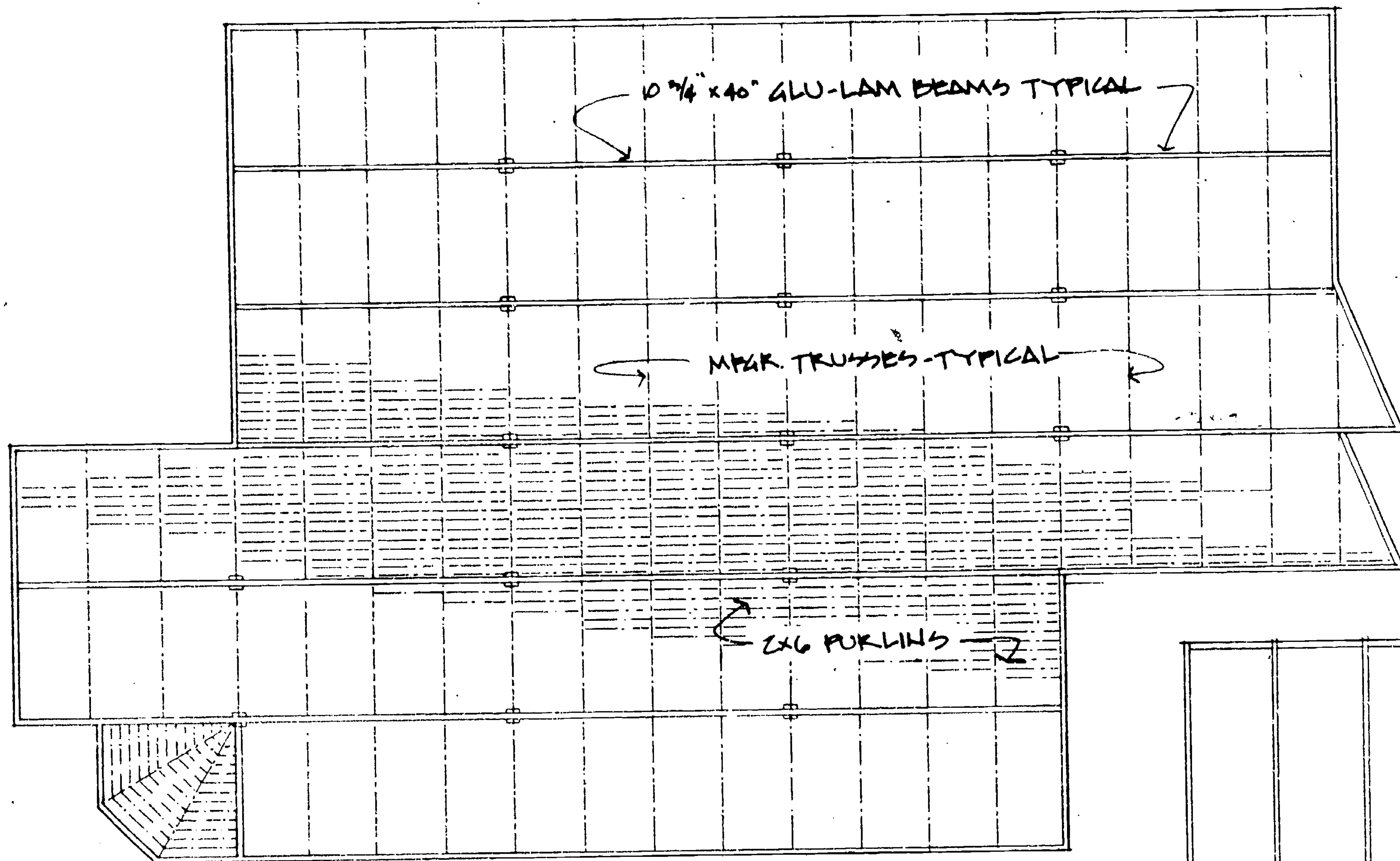

FRAMING PLAN

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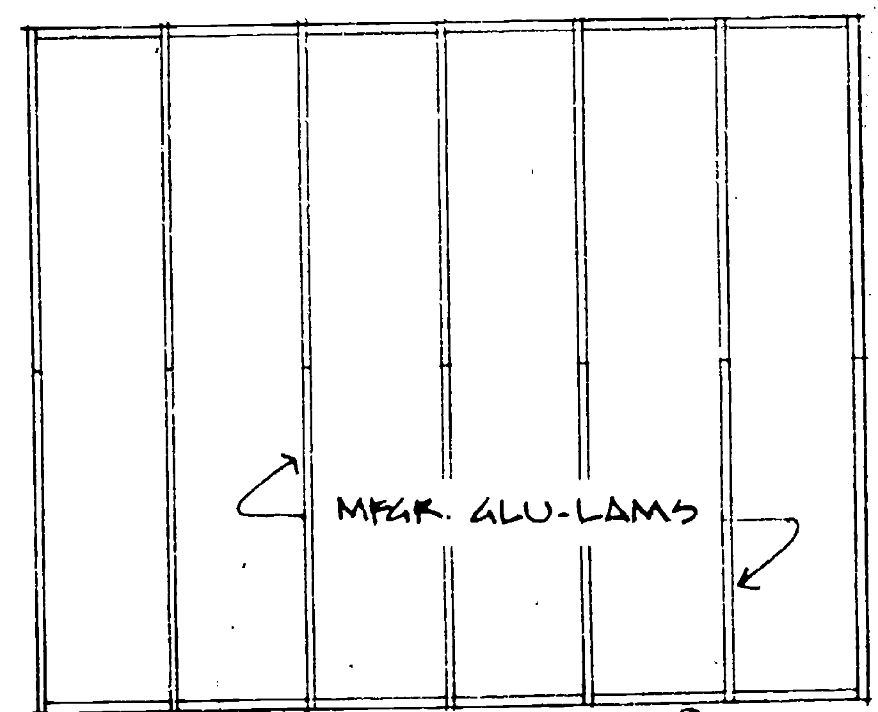

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henry wong

Design

Although this project (and those of my colleagues) shows that it is possible to adapt solar heating and cooling methods to replace the HVAC and lighting systems of the building, I feel that I should point out a few drawbacks of this concept.

To provide just the right comfort level and lighting constitutes only part of the operational requirement of a school (or any other building). Modern teaching methods involve the use of various teaching aids, including electrical machinery (projectors, record players, and in the future, microcomputers), the power for which, under the program, is difficult to obtain.

Another aspect involves the maintenance of the building. For the present design, vinyl flooring is used, mainly because most of the other materials require the use of electrical machinery for maintenance (e.g., to use carpet would require a vacuum cleaner).

Another requirement is to provide hot lunches to the students, at least once a month. But how do you prepare food for those 350-400 students and staff under the "Zero Energy Use" restrictions? To use solar furnaces would be impractical for the amount of food and its complexity involved. And what about the dishes? Imagine hand-washing 700-800 dishes! One way out is to use disposable dishes, but then it would not be consistent with the philosophy of the Zero Energy Use. Another way is to have food (prepared) and dishes transported from a "center" outside the site, and the dishes be returned there to be cleaned. But this is only side-stepping the issue without giving a real answer.

All the above issues involve a power source, electricity.

It seems possible at first glance to solve all these problems by using photovoltaic cells to generate enough electricity. But at present the efficiency of photovoltaic cells is fairly low. A large collector area would be required for a modest wattage of electricity.

Another way, mainly pertaining to the maintenance of the building, is to go labor intensive. Although admittedly this might do the job, the cost might be prohibitive. And since this building is naturally lighted, the building janitors have to finish all their duties between the end of school day and sunset—which might be between 0 to 6 hours depending on the season.

In conclusion, I feel that a zero energy use school is possible, but its associated problems can only be fully solved with technology as yet unavailable.

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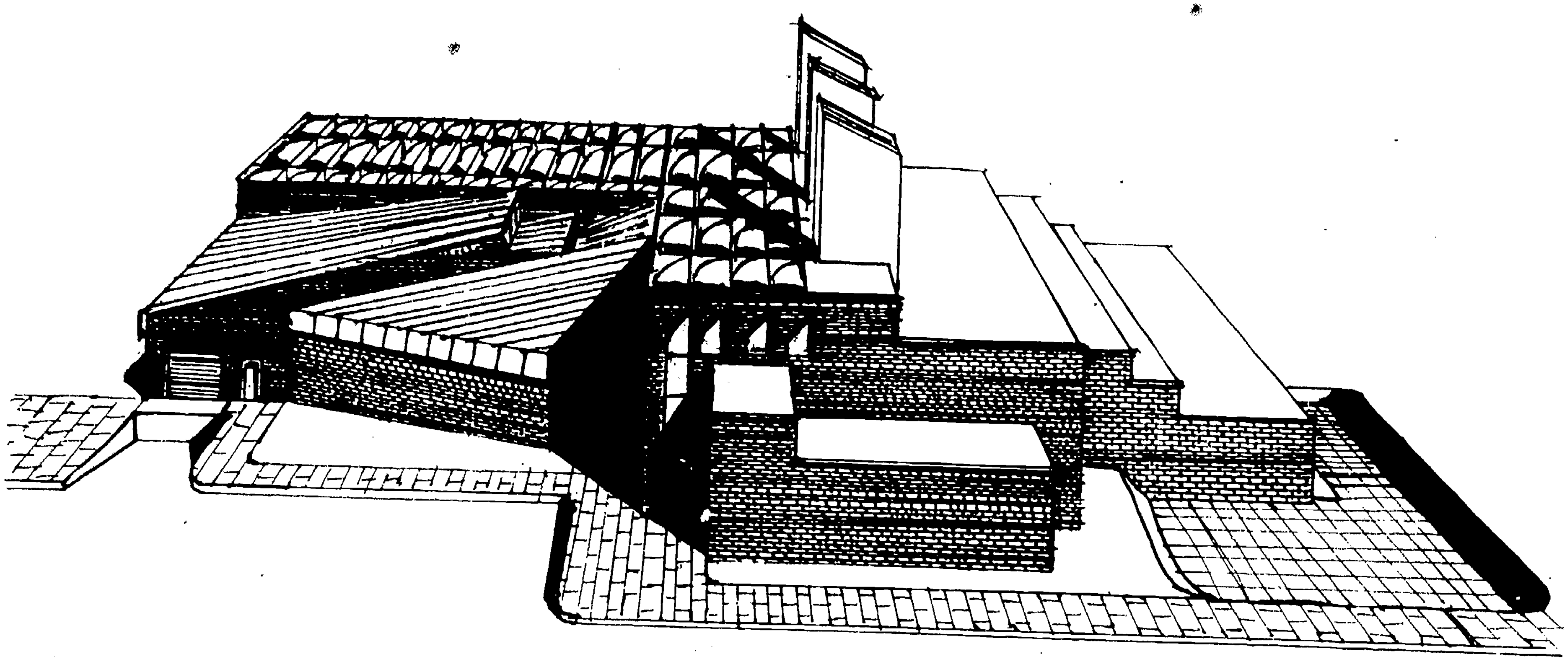
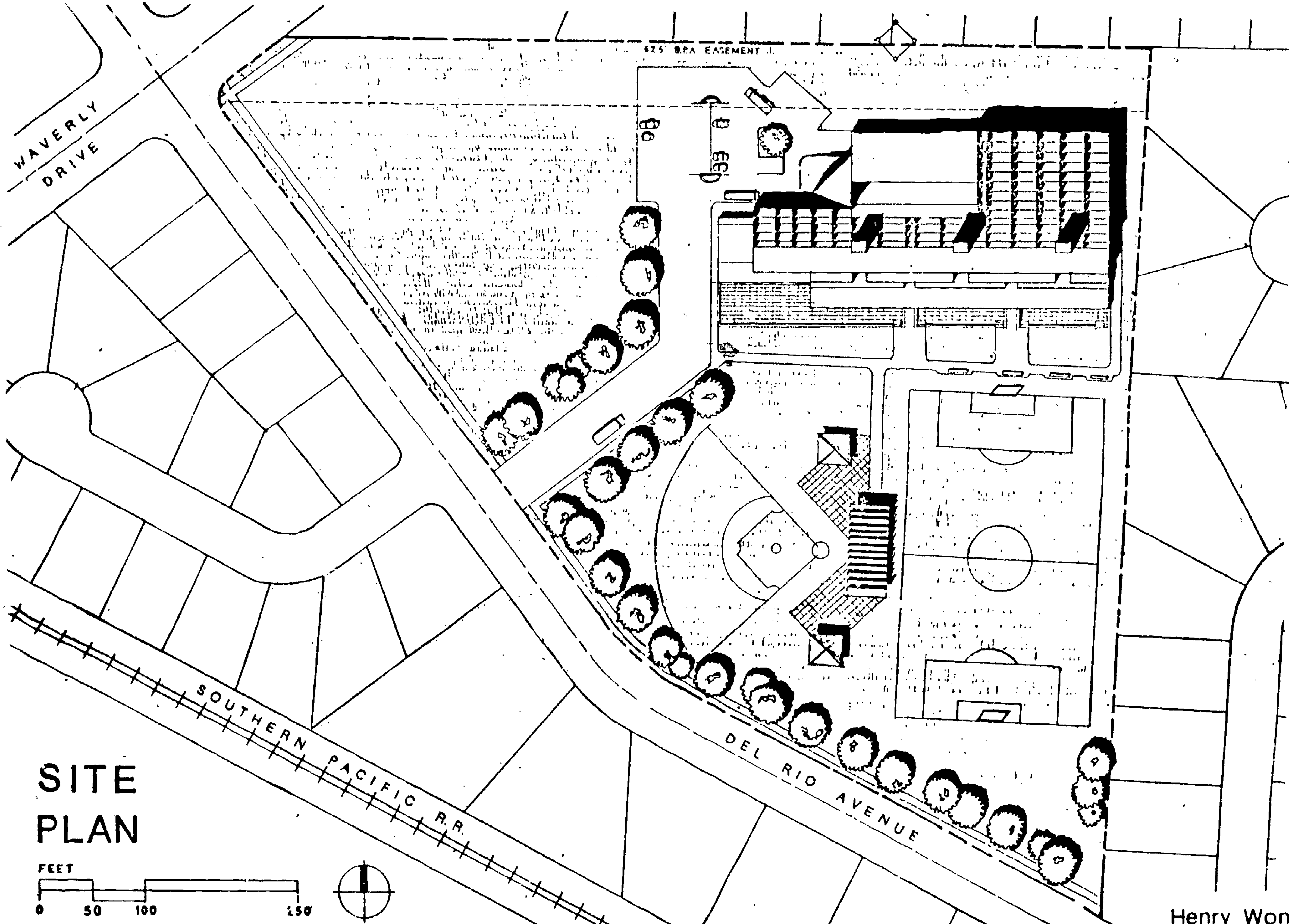
Reynolds, J. S., and Brown, G. Z. *Inside Out*, University of Oregon, Eugene. 1978.

Reynolds, J. S. *Solar Energy for Pacific Northwest Buildings*, Center for Environmental Research, University of Oregon, Eugene. 1974.

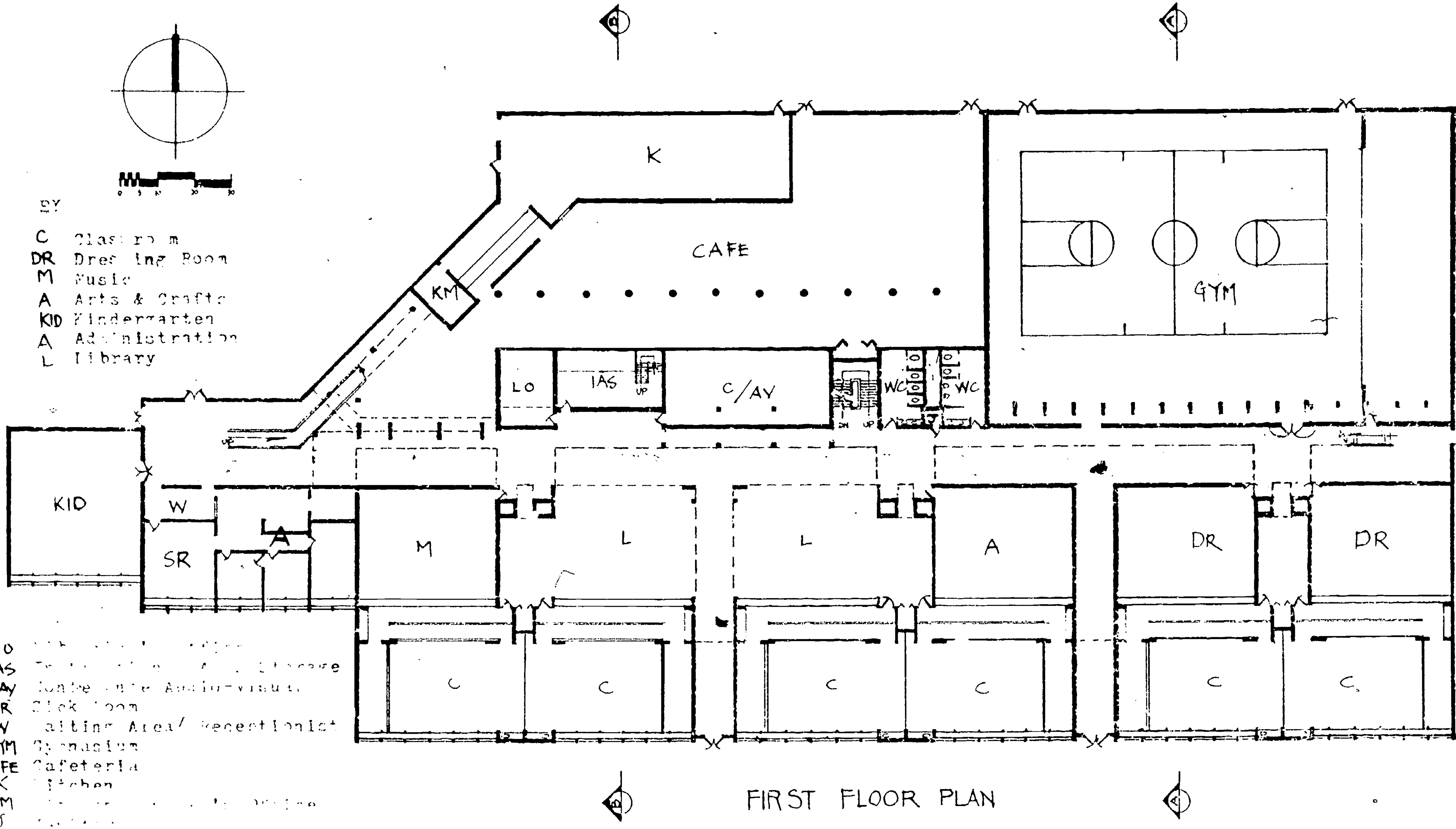


Henry Worg



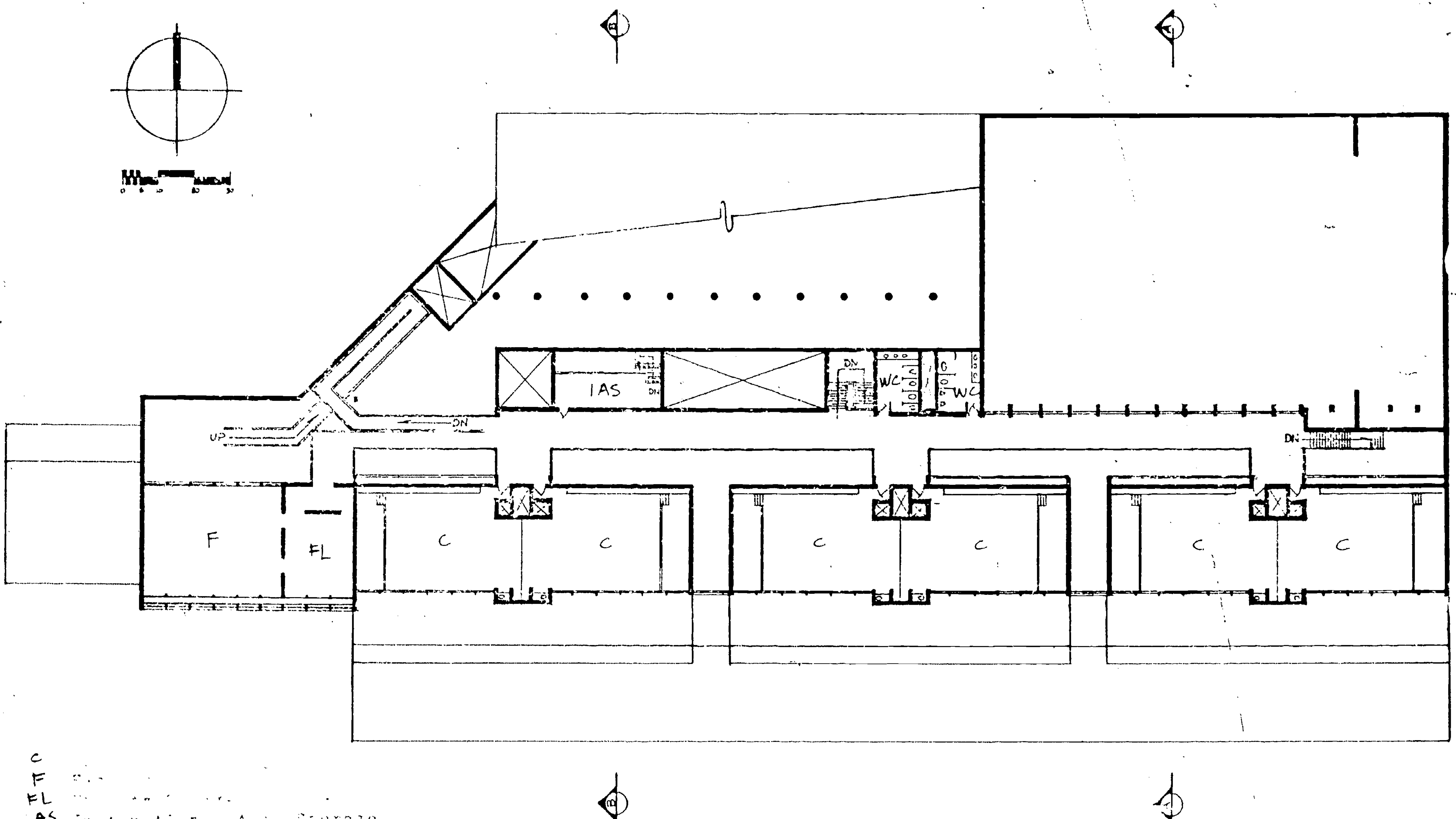
SITE PLAN

Henry Wong



FIRST FLOOR PLAN

Henry Wong



SECOND FLOOR PLAN

Henry Wong

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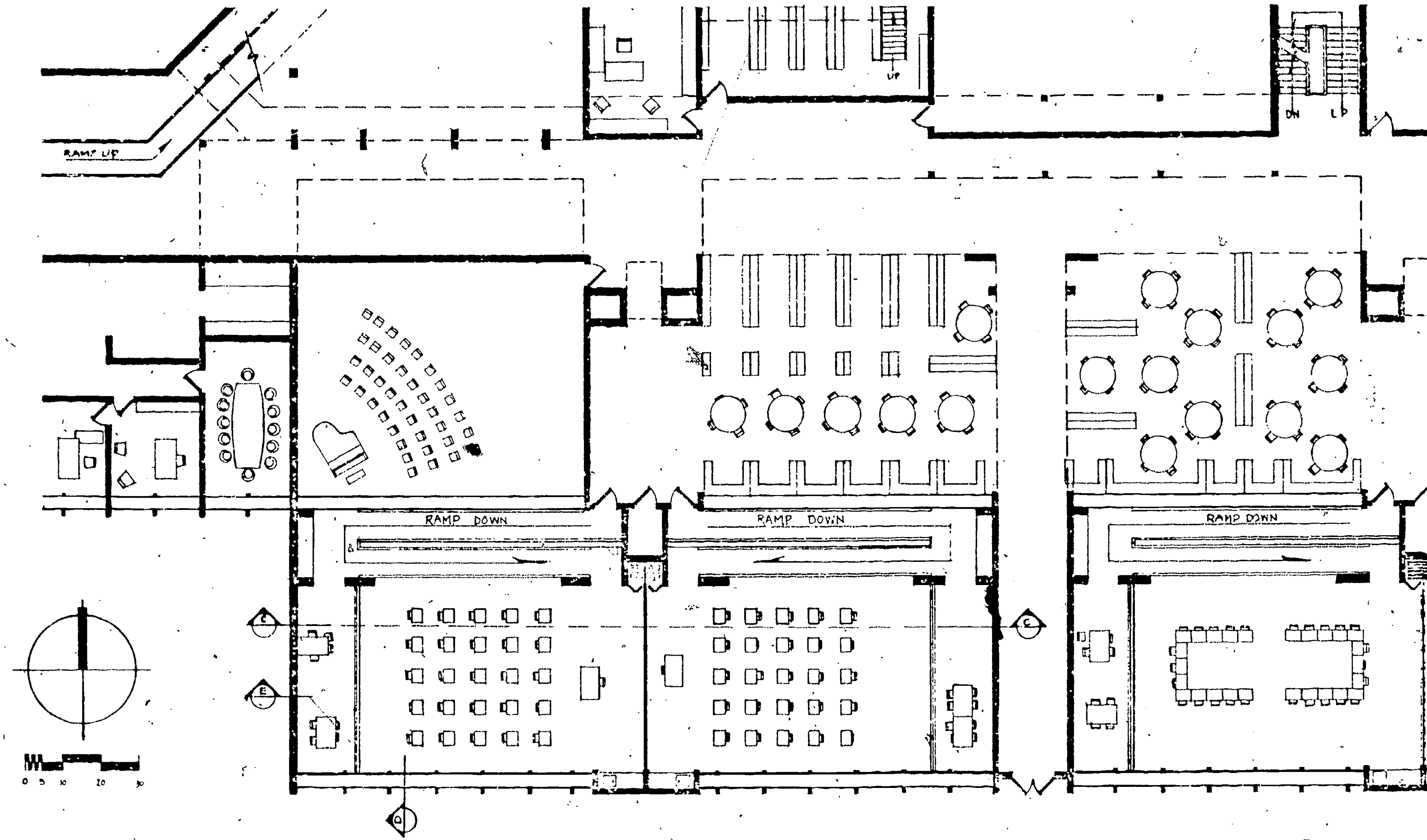

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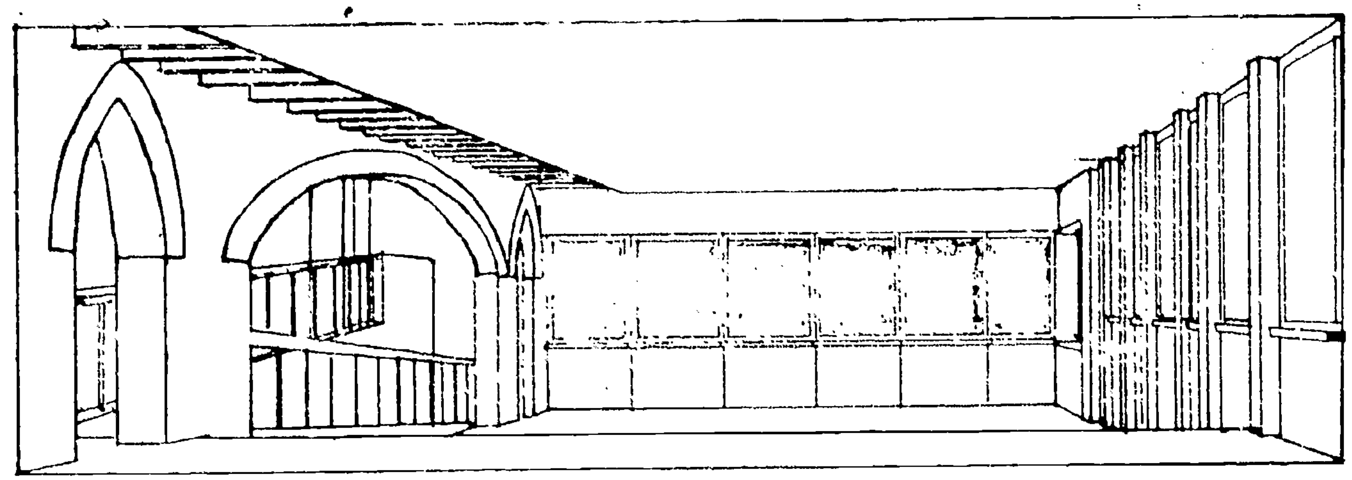
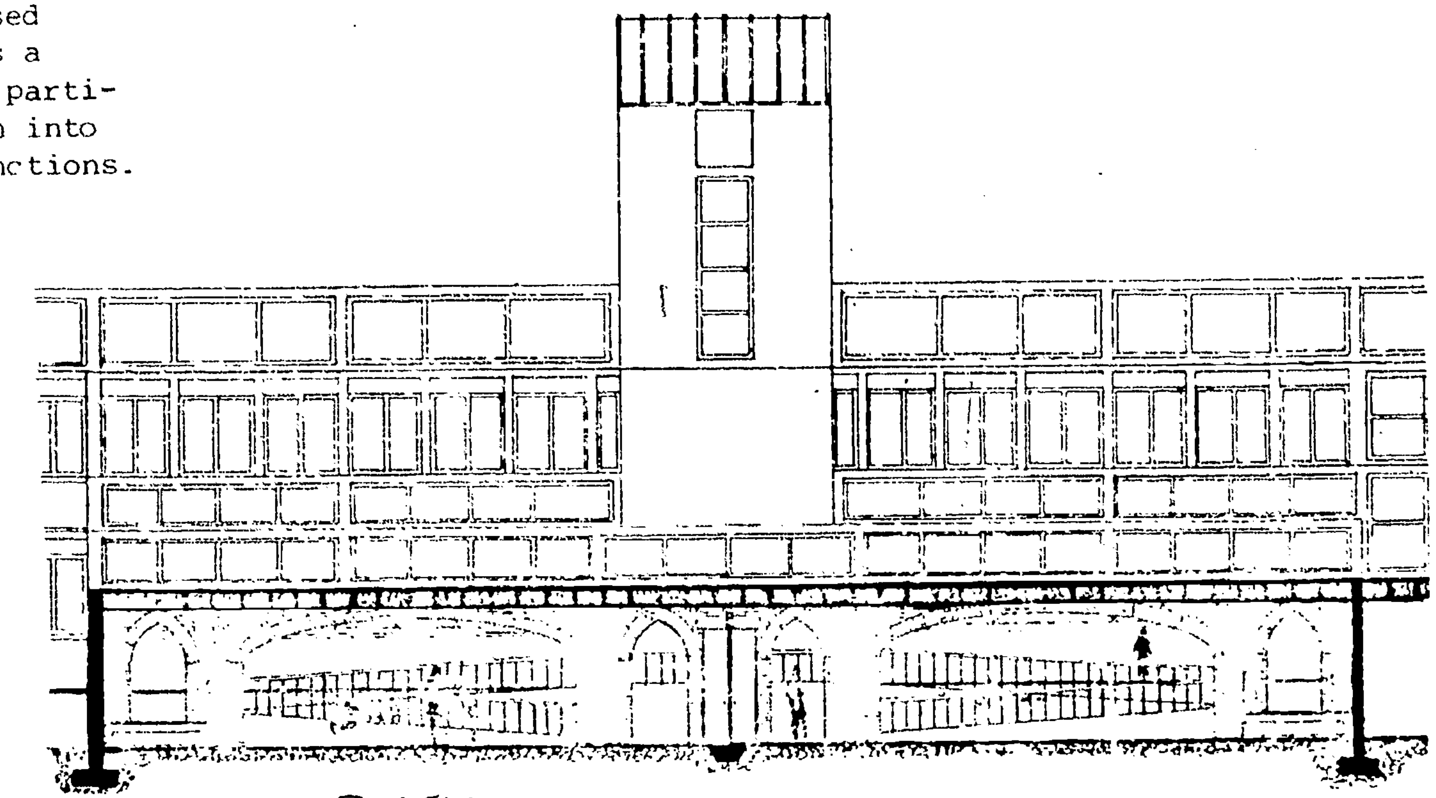
267 Henry Wong



LOWER LEVEL CLASSROOM - PRESPECTIVE

LOWER LEVEL CLASSROOMS--In order to allow sunlight to penetrate to the rooms at the back, these rooms are at a level change of four feet lower. Access to these lower level classrooms is by ramps in each room, separated from the main space by a brick arch, which also serves as a load bearing element. A raised platform at the end of the classroom serves as a space for small group activities. A moveable partition between two classrooms enables it to open into a larger space for group teaching or other functions.



SECTION C-C

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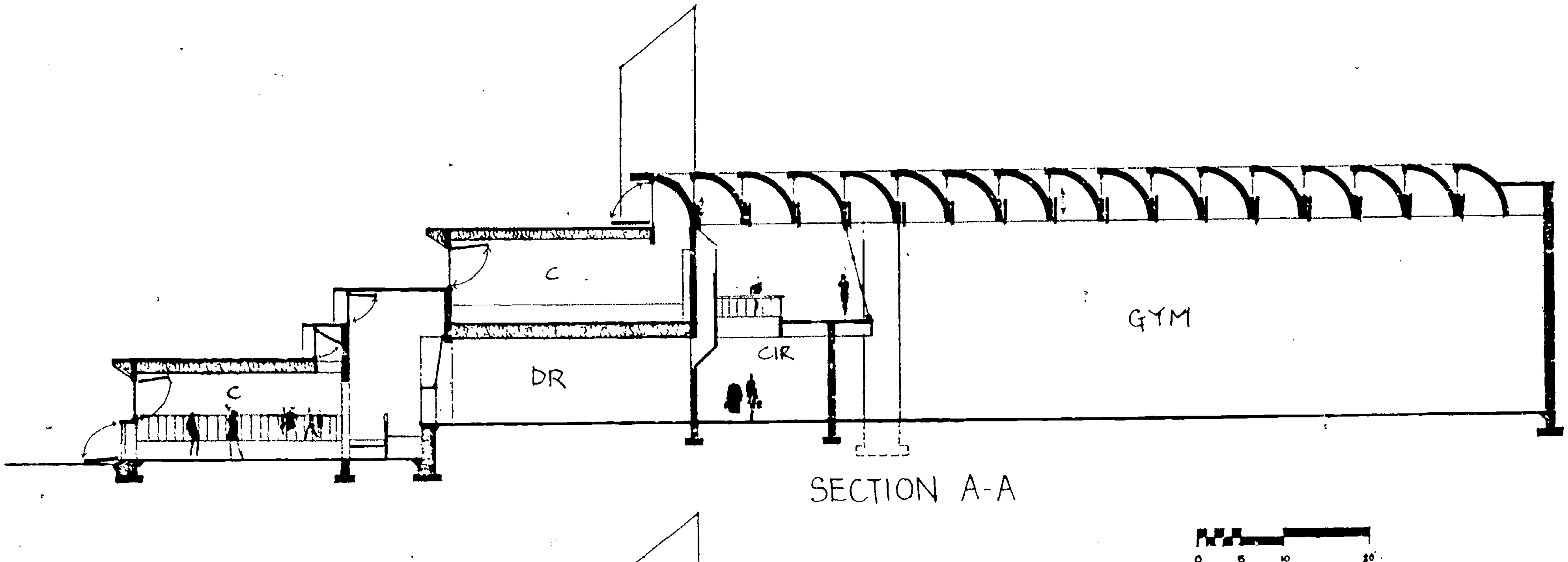
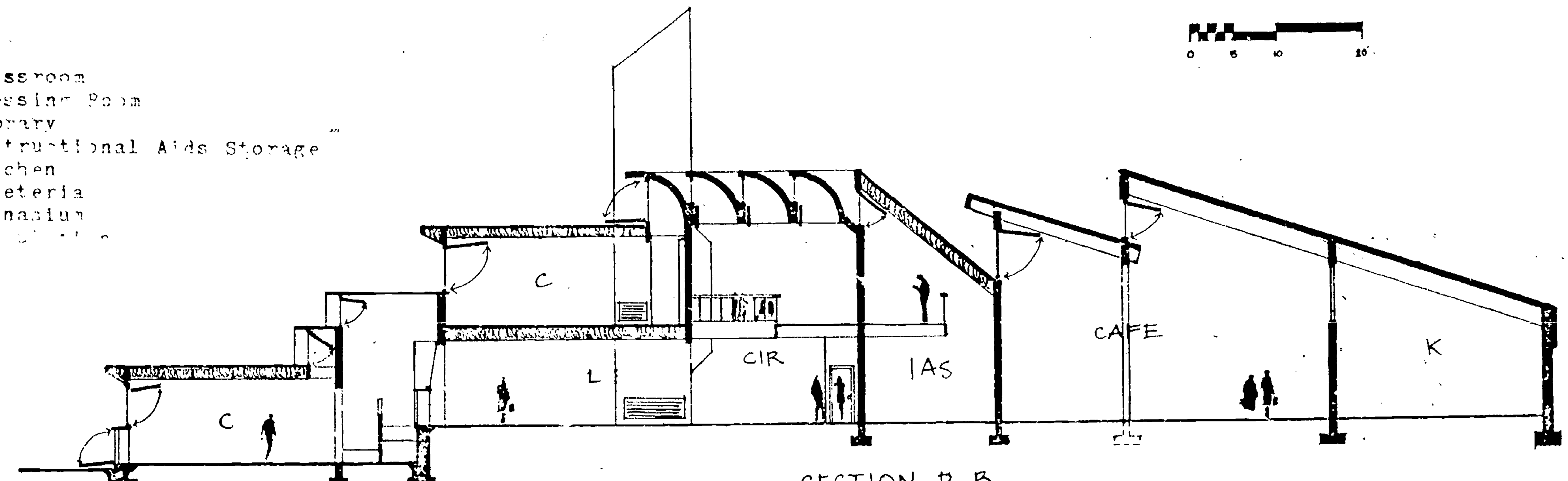
Henry Wong



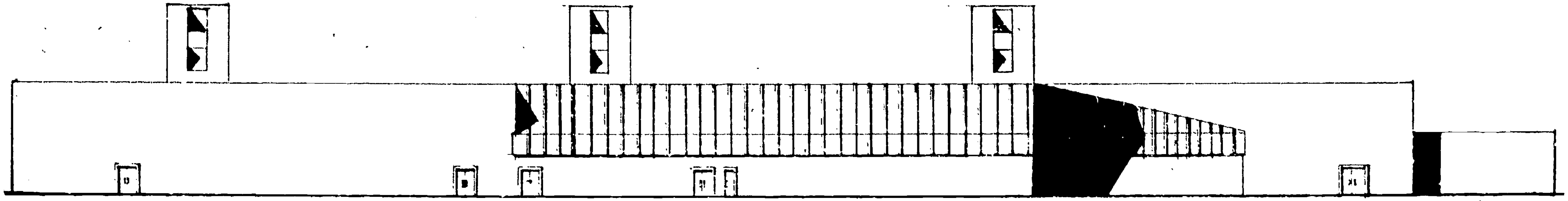
SECTION A-A

C Classroom
DR Dressing Room
L Library
IAS Instructional Aids Storage
K Kitchen
CAFE Cafeteria
GYM Gymnasium
CIR [illegible]

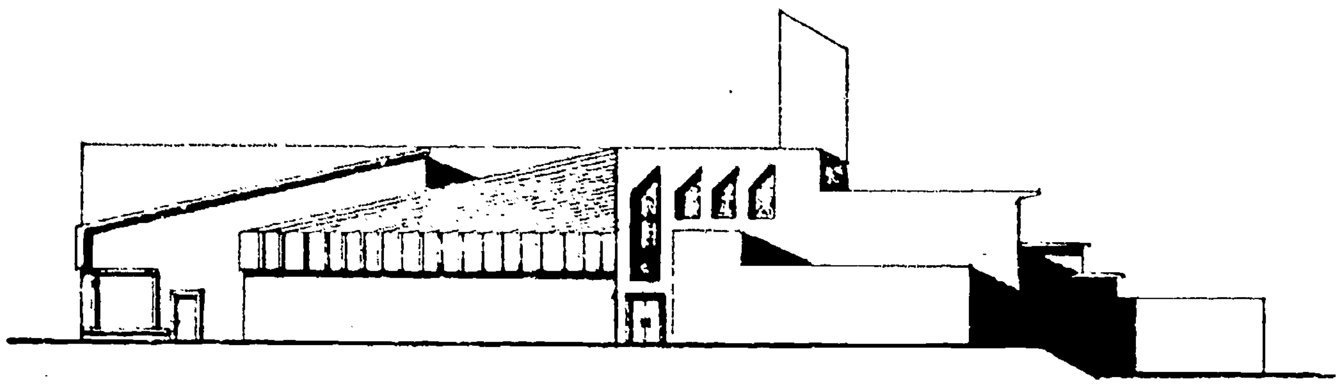


SECTION B-B

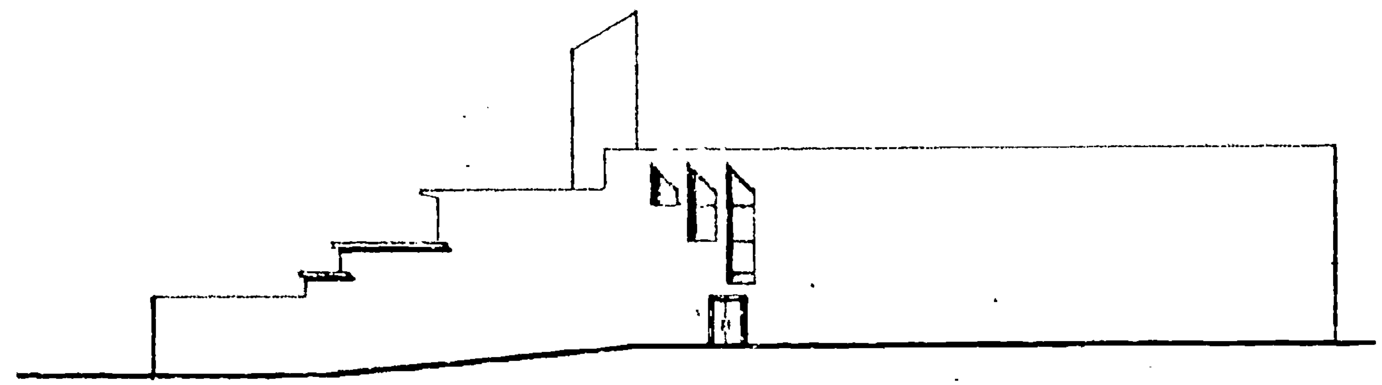
Henry Wong



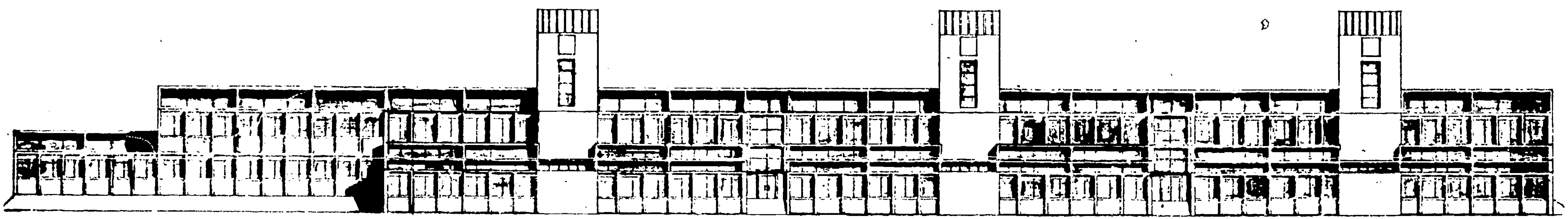
NORTH ELEVATION



WEST ELEVATION

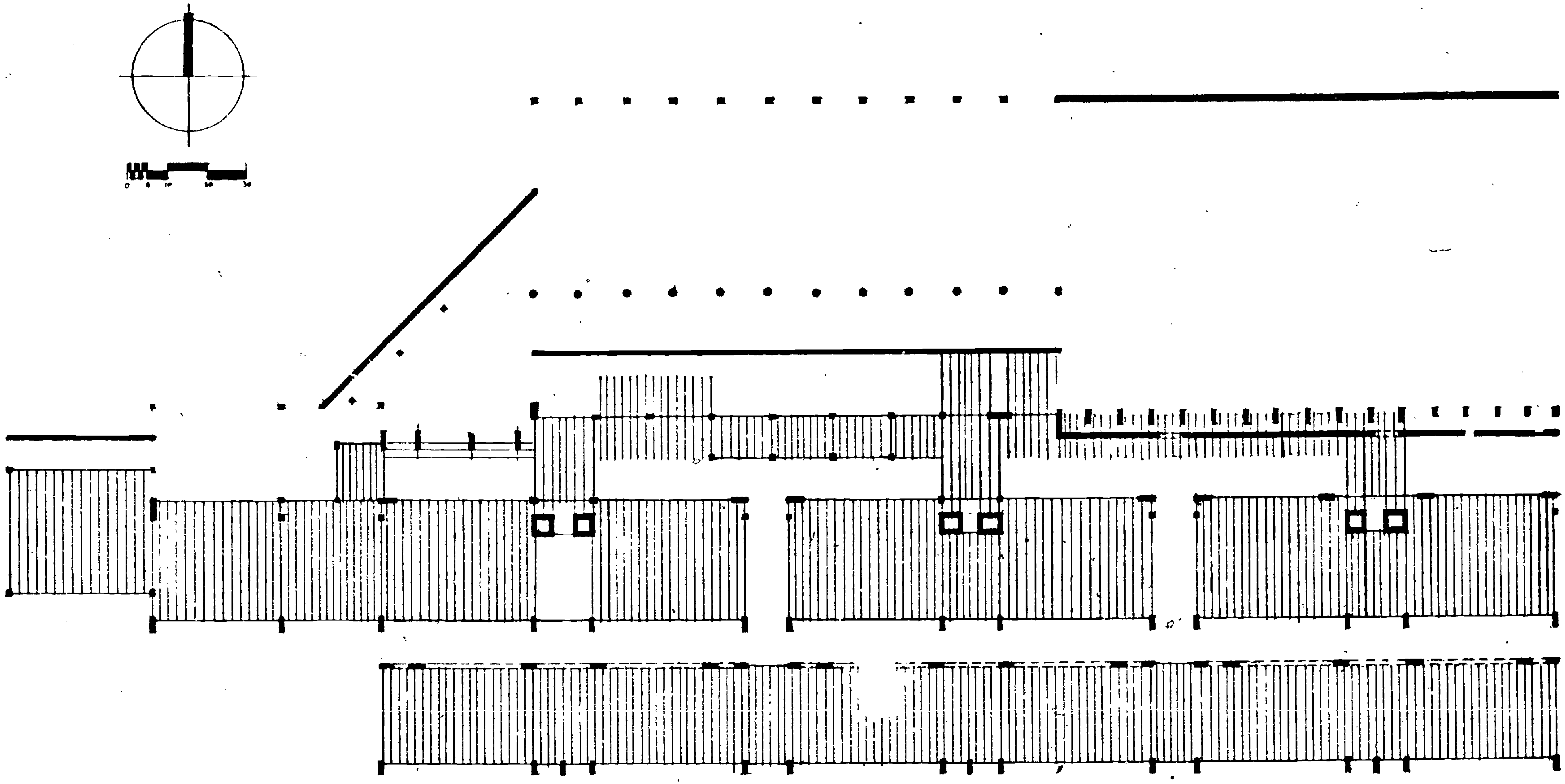


EAST ELEVATION



SOUTH ELEVATION

Henry Wong



SECOND FLOOR FRAMING PLAN

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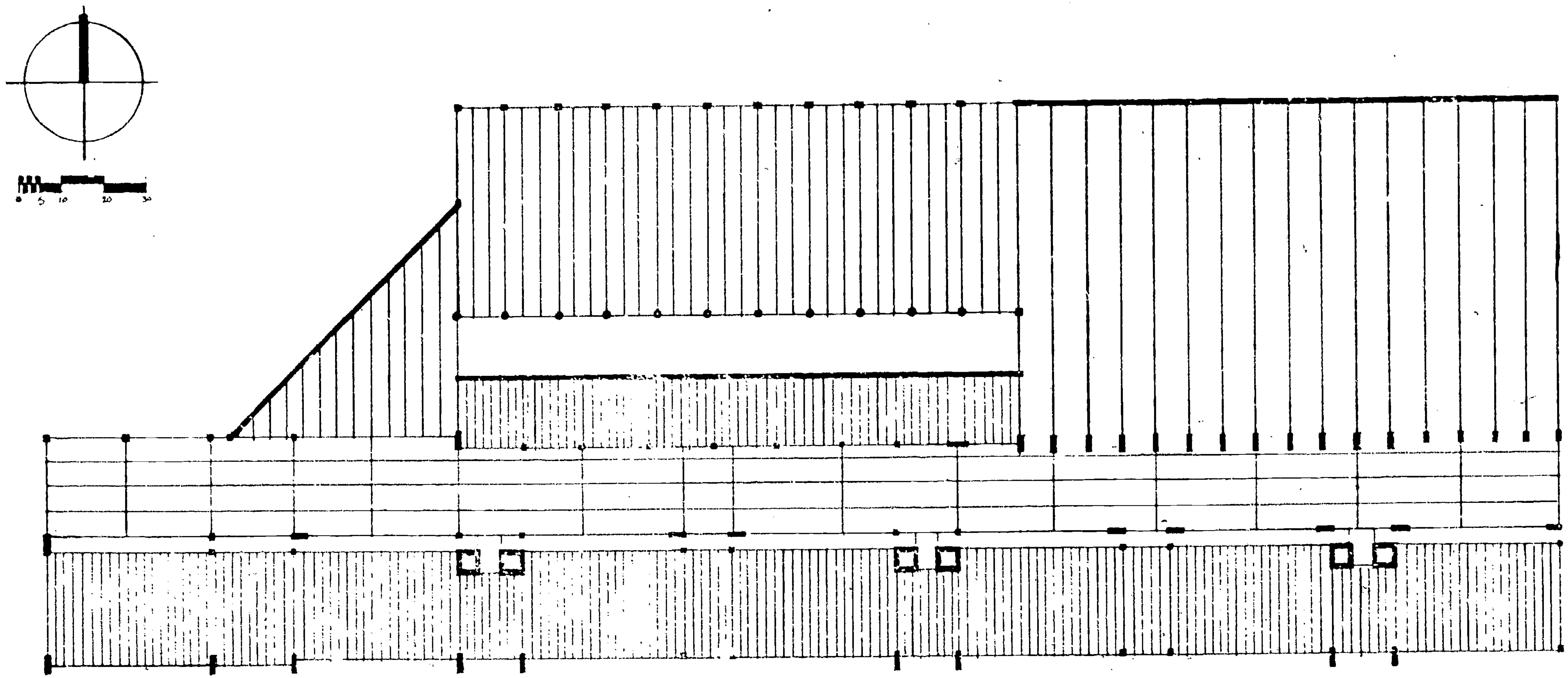
275 Henry Wong



ROOF FRAMING PLAN

Henry Wong

U-Values Calculation:

ROOF: outside surface	.17
build up roof	.33
3/4" plywood	.93
$9\frac{1}{2}$" insulation (batt)	29.64
1/2" gypsum board	.45
inside surface	.61
	32.13

U = 1/R = .031

WALL: outside surface	.17
4" brick veneer	.44
1" airspace	1.01
1/2" plywood	.62
5-1/2" insulation	17.16
1/2" gypsum board	.45
inside surface	.68
	20.53

U = 1/R = .049

INSULATING SHUTTERS: outside surface (reflective)	1.35
4" insulation (foam)	16.00
1-1/2" airspace (one reflective surface)	3.30
inside surface	.65
	21.30

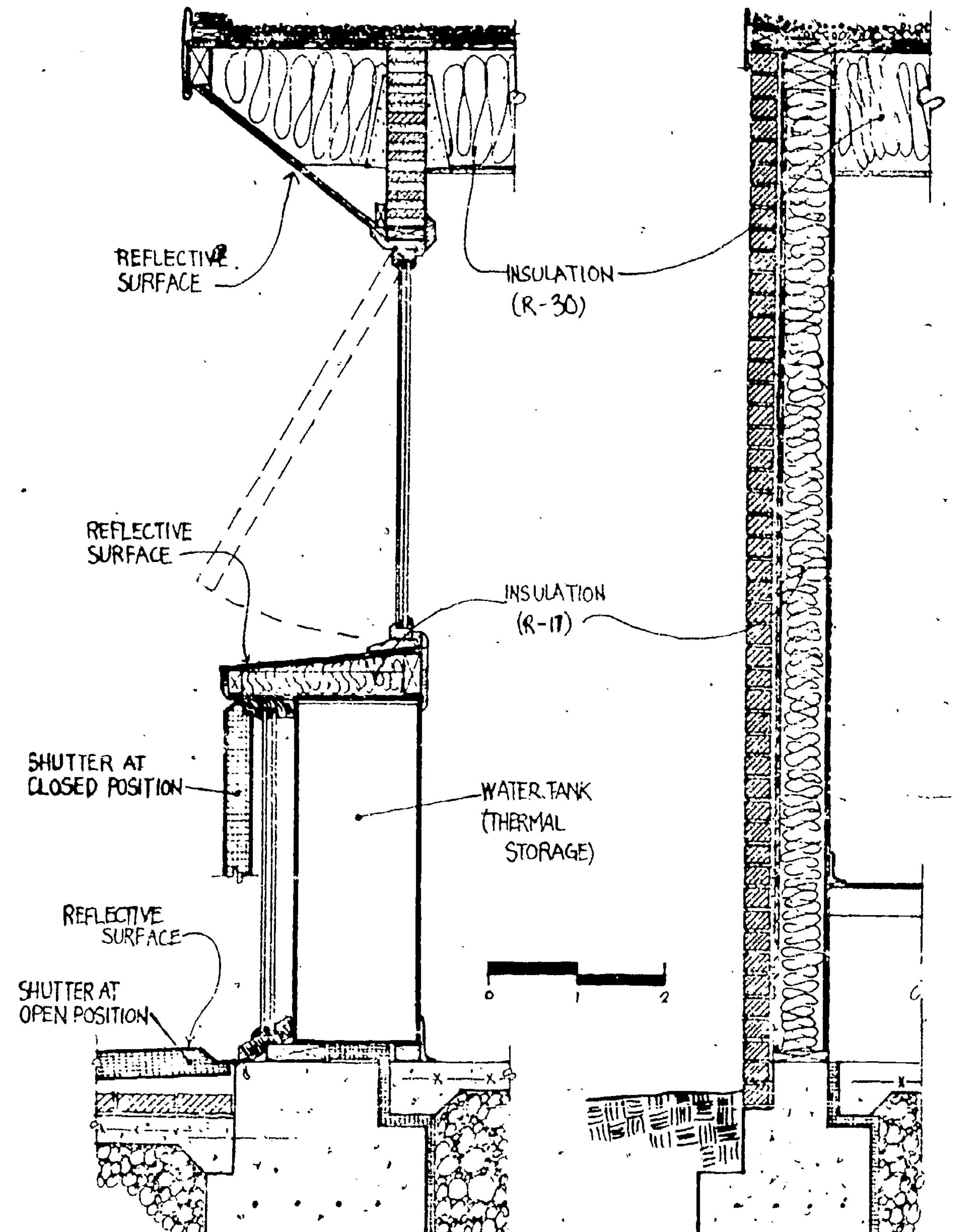
U = 1/R = .047

GLASS: double glazed, insulating glass, $\frac{1}{2}$" airspace, U = .58

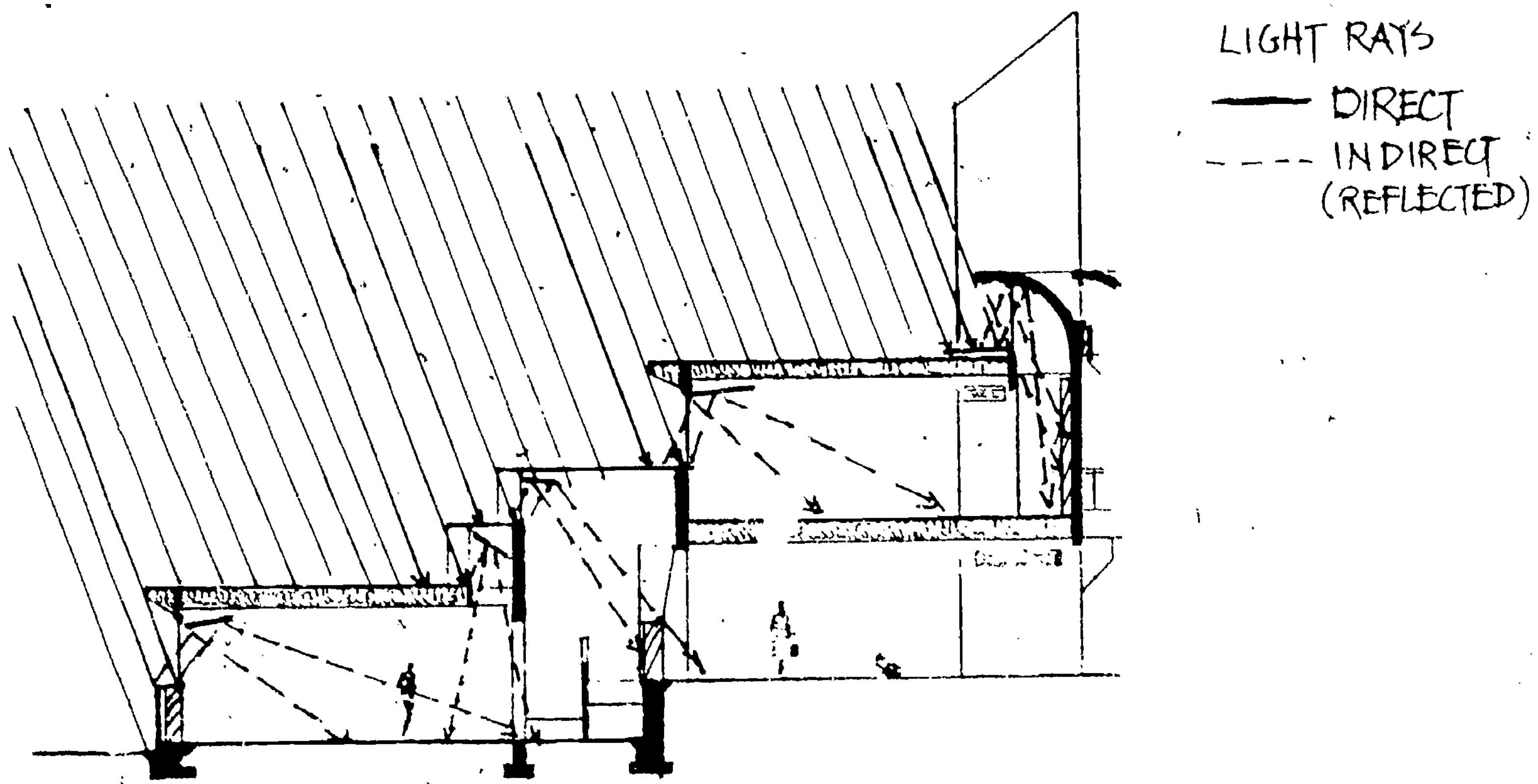
All glazed area = 8 hours exposed, 16 hours shuttered,

$$\text{Aveg. } U = \frac{.58 \times 8 + .047 \times 16}{24}$$

= .225



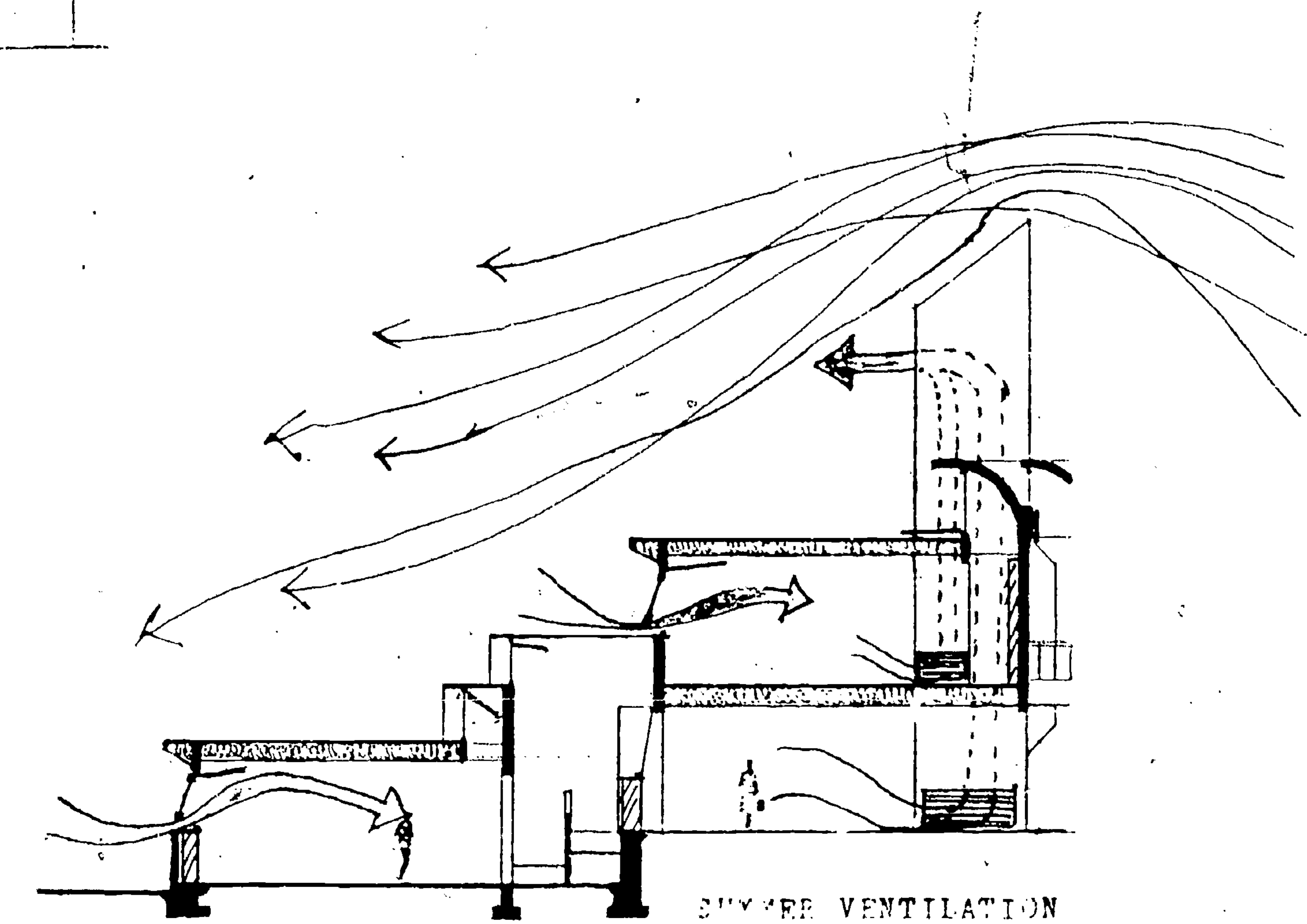
Henry Wong



SUN PENETRATION: JUN 21 (70°)

In summer, the overhangs shade the windows from the sun; the only light allowed into the rooms is reflected light.

Cooling is achieved through the stack effect of the towers, with a venturi neck designed into the outlet to increase its efficiency



SUMMER VENTILATION

HEAT LOSS:

Item	Area (sq.ft.)	U	ΔT (°F)	Loss (Btuh)
S. Wall	80.5	.049	25	98.6
Roof	456.0	.031	25	353.4
	184.0	.031	25	142.6
	1012.0	.031	25	784.3
Glass	129.2	.225	25	726.8
	156.4	.225	25	879.8
	176.0	.225	25	990.0
	156.4	.225	25	879.8
Slab Edge	46.0ft	21/ft	--	966.0
				5821.3

Infiltration:
Vol. 20424
Q 1x20424=20424
Loss 20424x.018x25 = 9190.0
15011.3

Loss per day = 360271.2Btu

Heat Gain from people:
20 student @ 250Btu/person
for 8 hour day:

20x250x8=40000 Btu

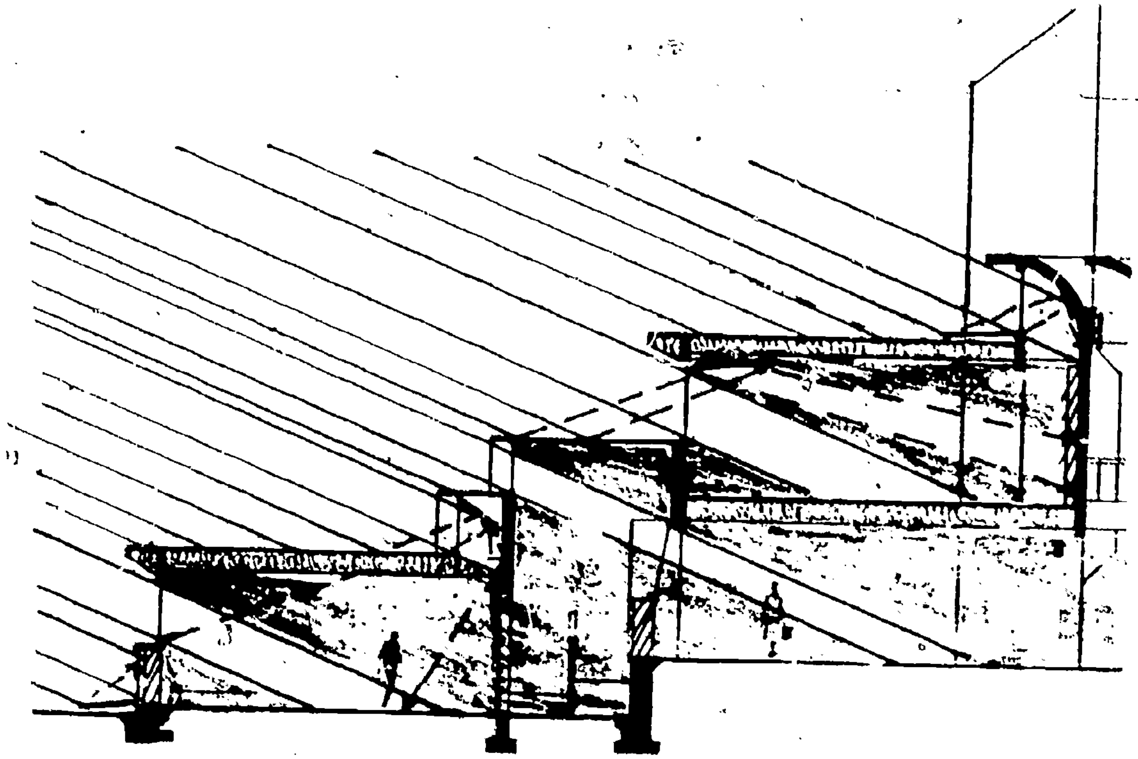
Modified Heat Loss:

360271.2-40000 =320271.2Btu

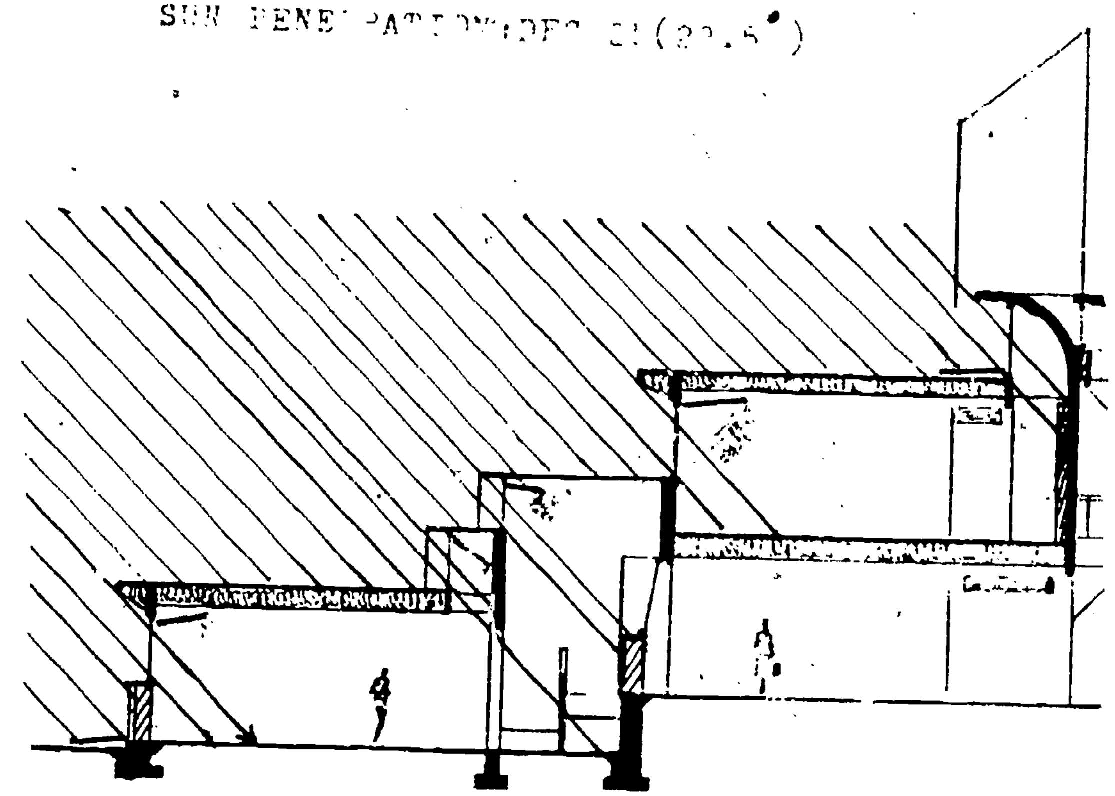
Building Loss Coefficient

$\frac{320271.2}{25}$ = 12811 $\frac{\text{Btu}}{\text{Degree Day}}$

—— DIRECT
--- INDIRECT (REFLECTED)



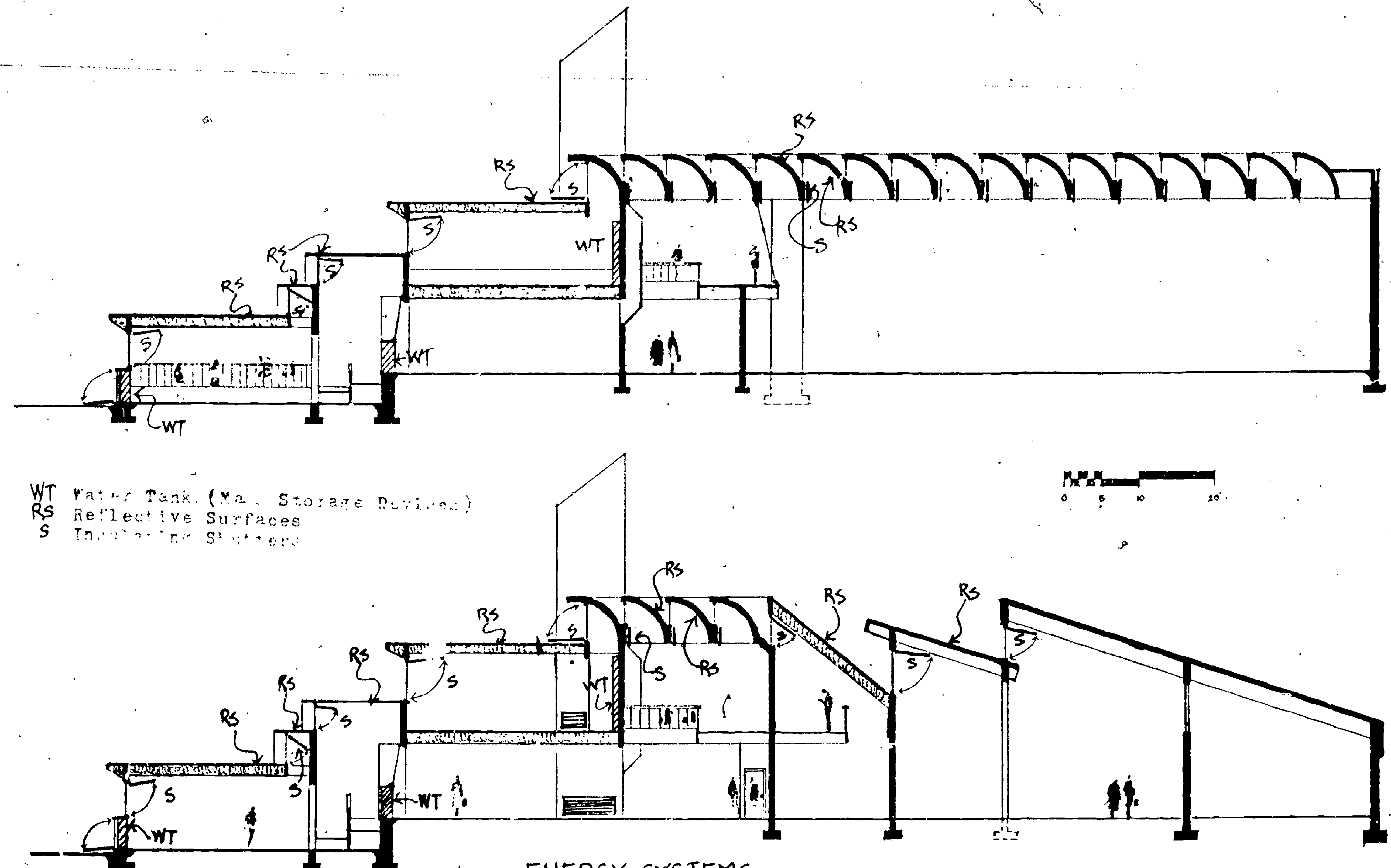
SUN PENETRATION: DEC 21 (23.5°)



SUN PENETRATION: FALL & SPRING (44°

HEAT GAIN (INT: Typical First Floor Interior Classroom)

Month	Deg. Days	Gross Mo. load	Rad. on horz surface	Solar Aperature	Lat Correction factor	Correction factor for reflectors	Solar rad. absorbed	Solar load ratio	Solar Heating fraction
		MBtu/mo.	Btu/mo-ft²	ft²			MBtu/mo		
Dec	717	9.19	7874	129.2	1.46	1.34	1.99		
			"	156.4	"	1.34	2.41		
			"	176.0	"	----	2.0[illegible]		
			"	156.4	"	1.34	2.41		
						total	[illegible].83	.96	.70



ENERGY SYSTEMS

Henry Wong