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Academic requirements and criteria are discussed, as well as physical planning response, incremental growth to a campus for 12,000 full time equivalent students, (FTE), environmental character, technical requirements, and the estimated capital costs for California State College at Bakersfield. Specific sections include--(1) site location, (2) site and its relation to the surroundings, (3) guiding principles of the master plan, (4) master plan objectives, (5) spatial organization, (6) space relationships, (7) space distribution, (8) diagrammatic plan, (9) access, circulation and parking, (10) incremental growth, (11) master plan: 12,000 FTE, (12) architectural character, opportunities and restraints, (13) master plan of landscaping, (14) master plan of site development, (15) development costs, and (16) building systems for campus structures. Appendix A contains an analysis of the traffic and parking requirements for the 12,000 FTE (8-5) campus. Appendix B presents a comparative analysis between load centers and central plant for heating, ventilating, and air conditioning. Appendix C describes a reconnaissance of building systems applicable to college development. (RK)

CALIFORNIA STATE COLLEGE - BAKERSFIELD

MASTER PLAN - SEPTEMBER 1968

VICTOR GRUEN ASSOCIATES

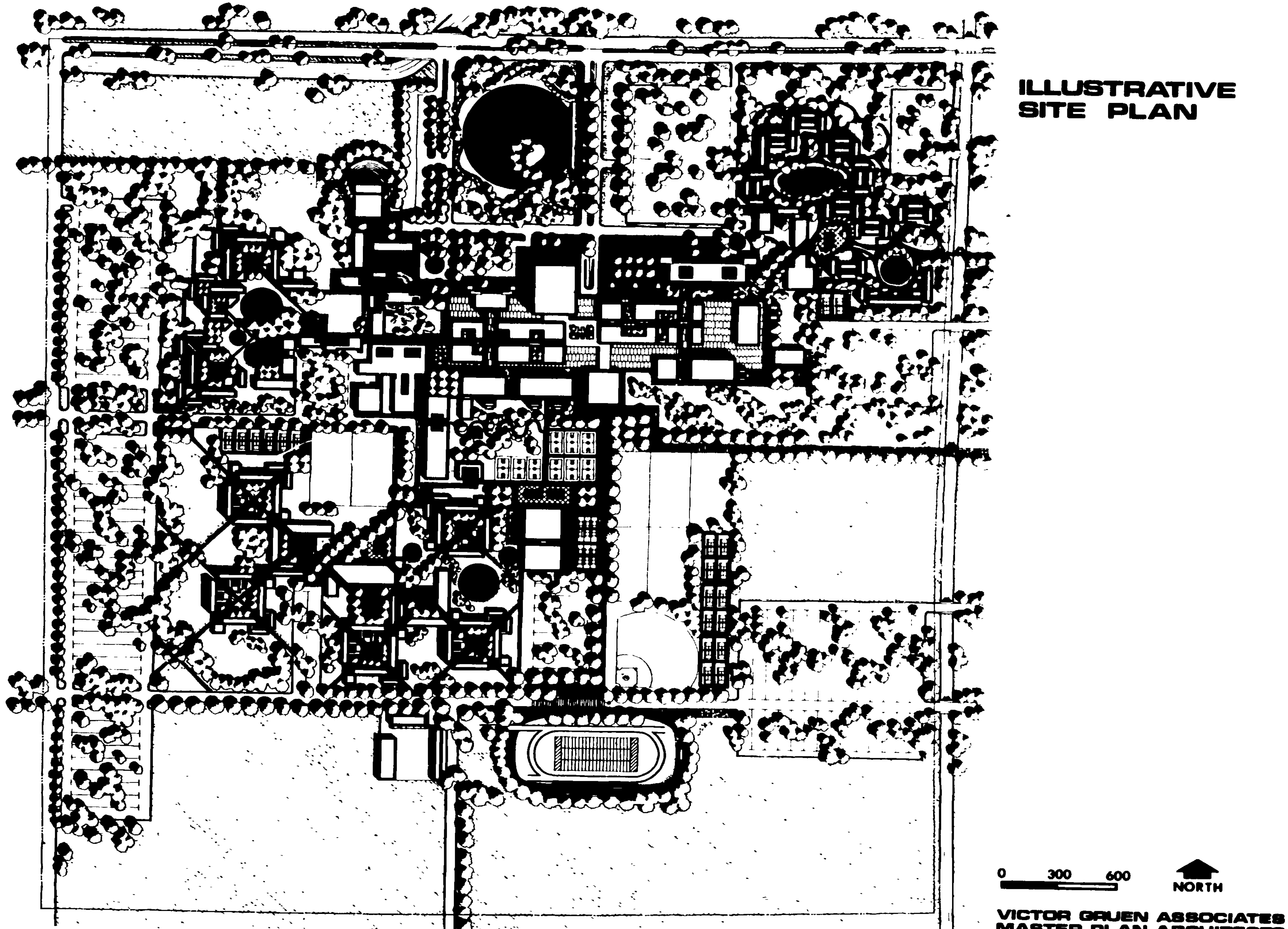
REPORT ON MASTER PLANNING FOR: THE CALIFORNIA STATE COLLEGE - BAKERSFIELD

Indicating The Academic Requirements and Criteria, The Physical Planning Response, The incremental Growth to A Campus for 12,000 Full Time Equivalent Students, The Environmental Character, The Technical Requirements, and The Estimated Capital Costs.

Prepared For: The Board of Trustees of The California State Colleges

Victor Gruen Associates

September 1968



CALIFORNIA STATE COLLEGE, BAKERSFIELD

FOREWORD

This 375-acre college site was offered as a gift from the Kern County Land Company and formally accepted by the Trustees in the summer of 1967. An agreement between Kern County Land and the Trustees setting forth certain principles, procedures, responsibilities and restrictions regarding the planning and development of about nine square miles surrounding the college site accompanied the transfer of land and for the first time in the State system, a college was provided with a considerable degree of control (and responsibility) in the development of a new college community surrounding its campus.

In July of 1967, Dr. Paul F. Romberg was appointed President of the new college and shortly thereafter Dr. Romberg and members of his staff opened offices in Bakersfield and commenced the planning process.

With the appointment of Victor Gruen Associates as Master Plan architects and Victor Gruen Associates with Eddy and Paynter Associates as architects for the Initial Complement of Buildings, programming, planning and design was carried on with the College as it developed its academic philosophy and plan. By May 1968, all major aspects of the Academic and Physical Plans reached a point of resolution and in June the College presented its Academic Master Plan to the Trustees and gained approval.

In July, an Interim Master Plan Report was presented to the Trustees for review together with schematic plans for the Initial Complement of Buildings. The Initial Buildings were approved by the Trustees on July 24 and preliminary plans were submitted to the Chancellor's office on August 1. These plans gained the necessary approvals and working drawings are now in process. All work for the Initial Buildings is on schedule and the College should receive students in September of 1970.

Trustee approval in July of the non-State funded program has enabled the initial residential program to move forward and the College expects to provide housing for 360 students in the fall of 1971.

Obviously, planning for this college has proceeded on a highly accelerated time schedule. With site selection in 1967 and opening scheduled for 1970, the time for academic and physical planning has been compressed to the point where only the closest possible coordination on the part of all concerned could make this schedule conceivable. President Romberg and his staff have consistently responded to informational requests under unbelievable schedules and then followed through with leadership and enthusiasm during the many trying days of necessary conferences until the complex translation from academic to physical planning was accomplished.

The Chancellor's office often interrupted its many duties to provide timely assistance in this accelerated effort by guiding us through the procedural intricacies and providing us with the benefit of its considerable operational and planning experience. Without this design partnership with the College and the continued assistance of Facilities Planning, the schedules could not have been met and certainly the results would have been far less.

Ben H. Southland, A.I.A.
Victor Gruen Associates

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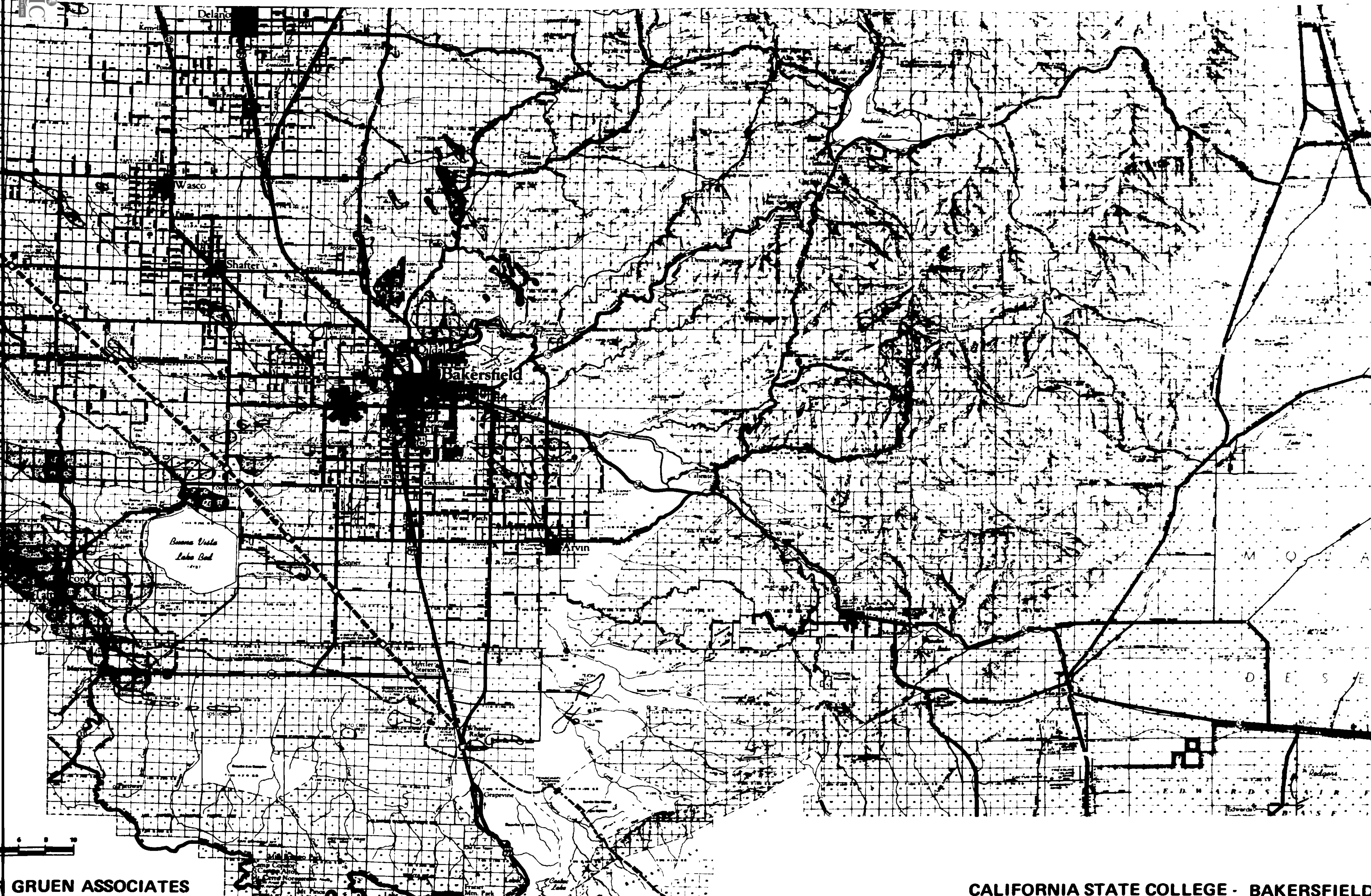
SITE LOCATION

This map shows the location of the campus and its relation to the area. It is in the southeast section of the San Joaquin Valley, about five miles west of central Bakersfield, and surrounded by the towns of Arvin, Taft, Shafter, Oildale, Wasco, and Delano. To the southeast lies Tehachapi and beyond it, Mojave, Ridgecrest, and other desert communities.



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CALIFORNIA STATE COLLEGE - BAKERSFIELD

THE SITE AND ITS RELATION TO THE SURROUNDINGS

A closer view shows the site and its relationship to existing and proposed roads and the general pattern of urbanization.

U.S. 99 Freeway is the existing regional north-south arterial with Stockdale Highway being the primary east-west road directly serving the site. Symptomatic of regional cooperation in the development of the College is the fact that a project is now underway to widen Stockdale to four lanes past the college site.

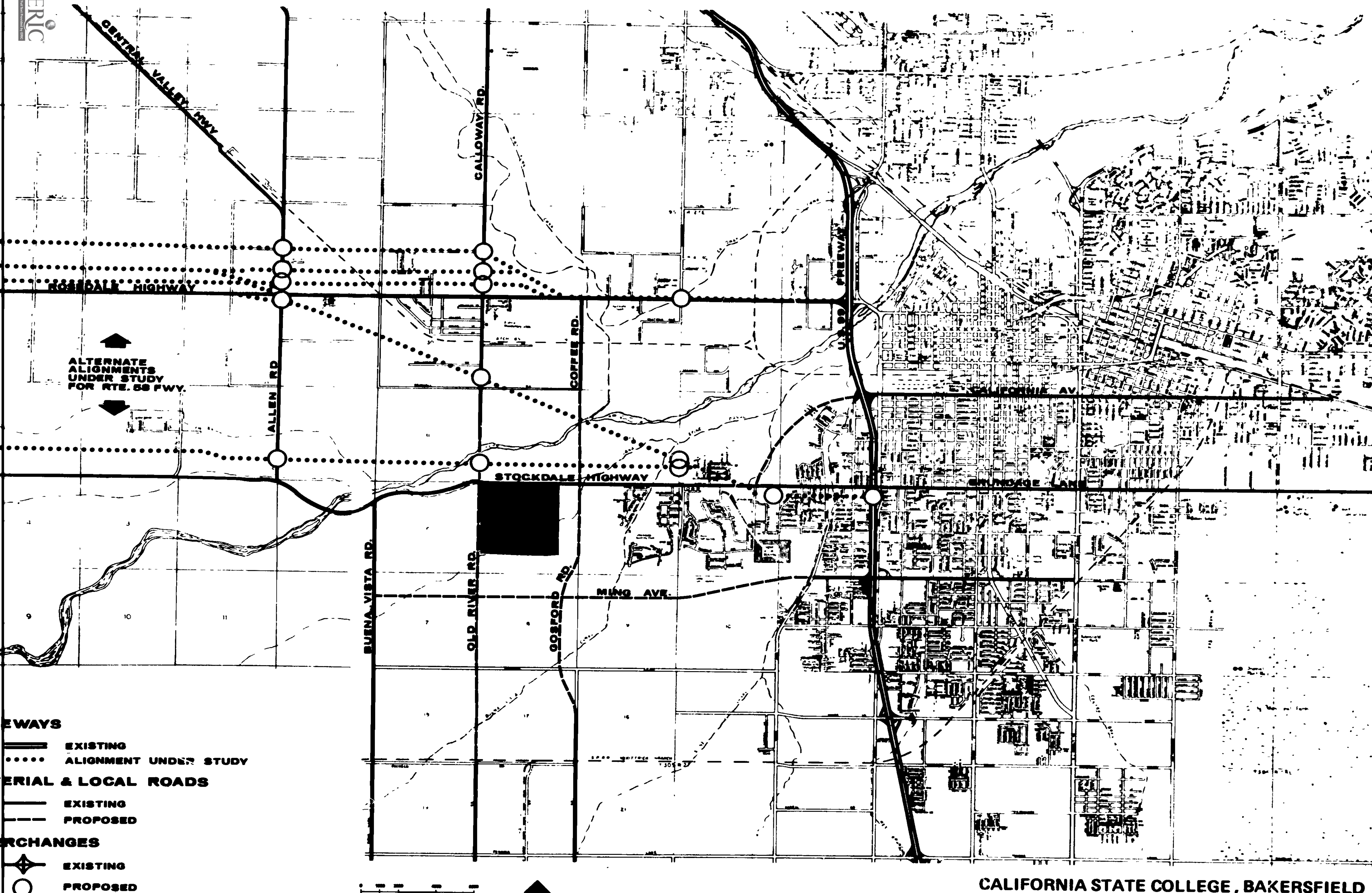
Route 58 is under study, and when completed in the late 1970's will relieve U.S.99 and provide college access to the considerable student population north and west of the site.

Ming, Gosford and Old River Roads will act as important north-south east-west ties and though not yet improved, both government and the land owner have given assurances that they will be in place when required by the college - perhaps before.

The site contains about 370 acres measuring approximately 4,000 feet along Stockdale Highway and 4,200 feet from Stockdale south. It has no distinctive topographical features. Although it appears flat, there is an imperceptible fall to the southwest corner (about 9 feet total or a grade of .136%). Vegetation is limited to irrigated crops.

A major irrigation canal and an electric transmission line lie just outside the east property line. A second irrigation canal parallels Stockdale Highway, enters the western portion of the site and parallels the boundary line. Two water wells are now in operation on the site and funds for a third donated by Kern County Land are on deposit with the Trustees.

Utilities, as per the gift agreement, will be brought to the eastern boundary of the campus. Drainage at present is by sheet flow across the property and an agreement exists with Kern County Land for an off-site permanent drainage system.



CALIFORNIA STATE COLLEGE, BAKERSFIELD
VICTOR GRUEN ASSOCIATES - MASTER PLAN ARCHITECTS

GUIDING PRINCIPLES OF THE MASTER PLAN

The single purpose of a Physical Master Plan is to guide a growth process through time in such a way as to avoid foreseeable conflicts, leave open the inevitability of change but create from the beginning a recognizable symbol around which ideas and the results of those ideas can flourish.

The challenge of master planning is to allow the creation of a situation viable enough to respond to change yet definitive enough to insure continuity, eliminate wasteful conflicts, and offer a constant challenge to the participants. At the same time, a Master Plan must be the anchor around which the tides of change might rise, drop or flow but so far as that particular anchor is involved, the tides will not be aimless.

The solution of a master planning problem involves both art and science - art in inspiration and leadership; science in the application of technology and implementation.

The ingredients of a Master Plan for the College at Bakersfield are many and diverse. The most important of these are the following:

- The academic philosophy, the resultant Academic Plan and the space allocations needed to implement that plan.
- The spatial relationship between academic disciplines, ancillary facilities and housing.
- The growth pattern and move sequence from initial to ultimate development.
- A circulation system for cars, pedestrian, bicyclist and service vehicles.
- A mechanical system for production, distribution and disposal.
- Capital outlay budgets and priorities.
- Area ecology and site characteristics.
- Environmental character - scale, physical relationships, architectural expression, landscape, varying physiological response.
- Flexibility - in scheduling of space use, rate of growth, curriculum change, teaching technique, esthetics, population density.
- The relationship between the campus and its community.

As a guide for evaluating the optional blends of these essential Master Plan ingredients, the College and the planners developed a set of criteria based on the ingredients of a Master Plan but specifically directed toward identifiable responses called for in the formulation of a development program for the College at Bakersfield.

With this as background, master planning has proceeded through its full initial effort and the results of this seminal study are summarized in this report. However, master planning is a process, not a statement, and the growth of the Plan requires systematic surveillance and appraisal, the adjustment of foreseeable requirements, an evaluation of possible or potential needs, and a continual reassessment of the educational philosophy. As this self-perpetuating process progresses, so will the Master Plan be modified. The input for modification will be continuous: the output in the form of a revised plan will be periodic, probably each two years. With the built-in adaptability that the plan now possesses and with the strong philosophical base upon which it was erected, the underlying principles are not expected to change. Change when it comes, has already been accounted for and will not alter the concept.

THE MASTER PLAN OBJECTIVES

1. Program the plan to fit the foreseeable short-range academic space needs, develop a technique for immediate response to shifts in student load and curriculum changes, and allow for maximum flexibility in room scheduling. Conversely, eliminate excessive anticipatory construction (buildings partially filled with interim uses), minimize departmental move sequences, and shorten the lead time for expansion.

2. Provide for an orderly and efficient progression of growth from an initial enrollment capacity of abou[illegible]25 full time equivalent students (FTE) to 12,000 FTE with a reserve possibility for even further development.

3. Relate the instructional, support and social areas to encourage the maximum interchange between disciplines and between students.

4. Provide an environmental scale within the overall institution intimate enough to induce maximum personal identification by both resident and commuter students.

5. Establish from the outset a strong plan form that will operate and appear as a finished entity at any stage of its long range development, avoid unnecessary site gaps reserved for later construction amid completed buildings, and shape the plan so that as it accommodates to change its basic intent is not lost.

6. Create an architectural vocabulary that reflects the functions of the plan, allows for individual architectural expression and innovation, yet keeps all elements of the campus in scale and harmony as growth occurs over the extensive development period.

7. Employ all possible means in site planning, architecture and engineering to minimize capital and operating costs of the physical plant without restraining instructional capacity or diminishing the prestige of this major investment in higher education.

8. Make fullest use of the most advanced technology applicable to the building and educational programs and prepare to adopt advances as they occur.

9. Employ an on-campus system for a continuing evaluation of the existing establishment - its space utilization, its adaptability to the academic program, its deficiencies, its overages, its efficiency, and its operational problems and possibilities. Together with this continuous evaluation of the existing facility, a concurrent study of immediate short range needs based on foreseeable enrollment, teaching capability, techniques and known educational goals. And lastly, long term speculation about changing values and academic roles with a translation into possible physical plant requirements. All of this to be reflected annually in the five-year capital outlay program.

THE PLANNING RESPONSE TO THESE PRINCIPLES AND OBJECTIVES IS DESCRIBED IN THE FOLLOWING TEXT, TABLES, DIAGRAMS AND PLANS.

THE MASTER PLAN

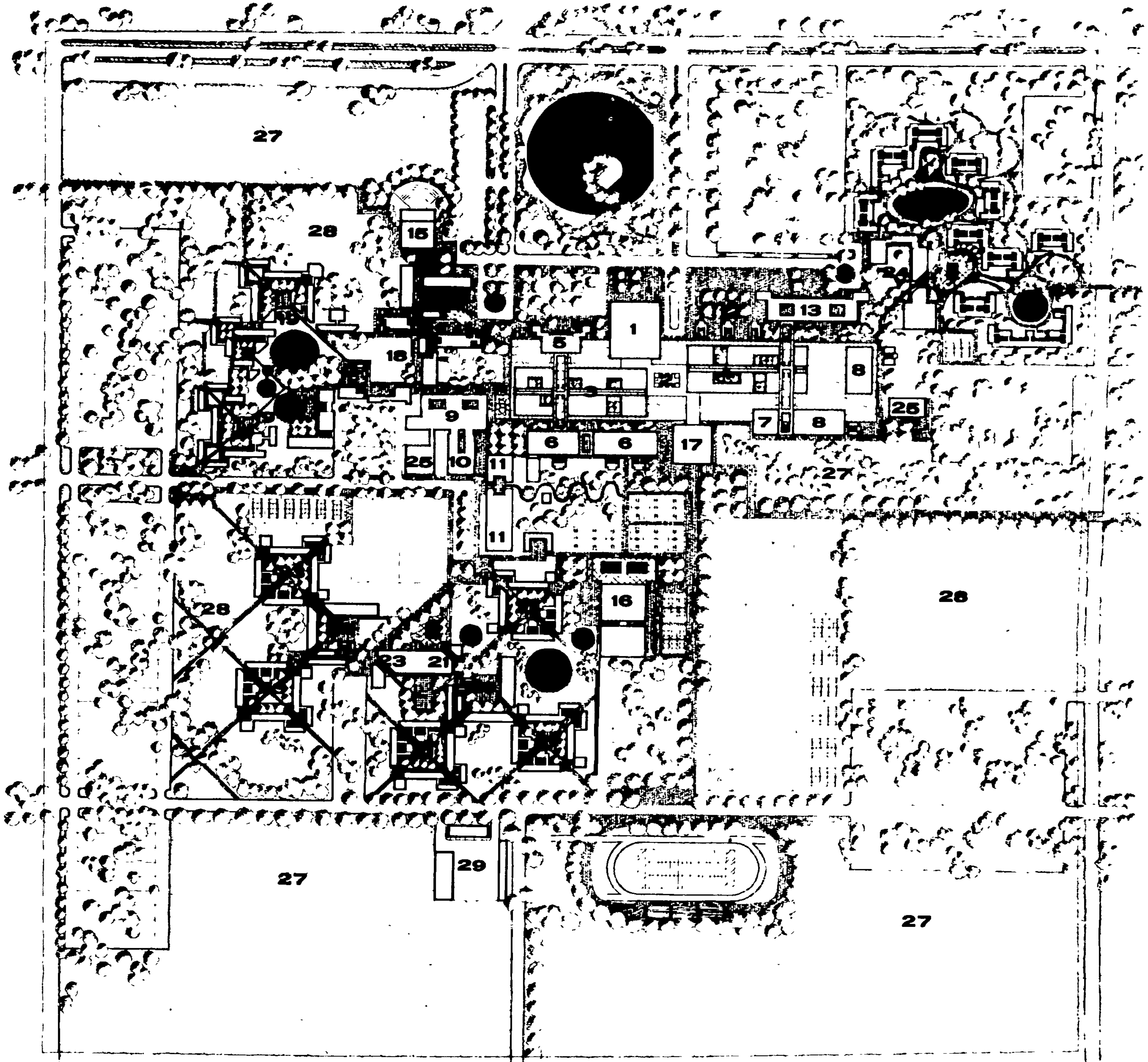
The plan opposite shows all of the elements of the 12,000 FTE campus in context and placed on the 375-acre site. It was evolved through the application of the guiding principles and objectives to various alternate physical configurations of the short-term academic plan and the long-term academic philosophy. Of the several alternate study plans that held promise, this one far exceeded all others in its response to the complex challenges of a college master plan.

While composed of many elements, the basic structure of the plan is extremely simple: it consists of a major central spine serving and connecting a series of special discipline areas that together form a very compact academic core; a series of villages for teaching, living, study, sports and recreation radiating out from the core; a series of areas reserved for expansion and/or change; and a peripheral system of parking that penetrates the site without encroaching on the pedestrian zone which encompasses all of the core and village areas.

The main entrance to the campus is from Stockdale Highway on the north and supplemental access is provided from all sides.

Initial development will occur in the northwest sector of the site with a steady progression of growth eastward through the academic core and south through physical education and the academic villages. According to present population estimates based on data available from the California State College Chancellor's office, the campus will reach the stage of development shown here shortly after the year 2000.

MASTER PLAN: 12000 FTE (8-5)



1. LIBRARY
2. CENTRAL PLAZA, BOOKSTORE, CAFE
3. WEST GALLERIA CLASS ROOMS
4. EAST GALLERIA CLASS ROOMS
5. HUMANITIES
6. NATURAL SCIENCES
7. BUSINESS
8. IND TECHNOLOGY + APPLIED SCIENCE
9. EDUCATION
10. NURSING AND MEDICAL TECHNOLOGY
11. HEALTH SCIENCE AND PHYSICAL EDUCATION
12. BEHAVIORAL SCIENCES
13. ADMINISTRATION
14. ART, SPEECH AND DRAMA
15. LITTLE THEATRE
16. FIELD HOUSE AND GYM
17. COLLEGE UNION
18. VILLAGE NO 1 ACADEMIC
19. VILLAGE NO 1 RESIDENTIAL
20. VILLAGE NO 2 ACADEMIC
21. VILLAGE NO 2 RESIDENTIAL
22. VILLAGE NO. 3 ACADEMIC
23. VILLAGE NO. 3 RESIDENTIAL
24. UPPER DIVISION AND MARRIED STUDENT RESIDENTIAL
25. CENTRAL PLANTS
26. ENTRANCE GARDEN AND ROADS
27. ACADEMIC RESERVES
28. RESIDENTIAL RESERVES
29. CORPORATION YARD

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RUSSELL Y. IWANAGA A.S.L.A.
LANDSCAPE ARCHITECT

CALIFORNIA STATE COLLEGE, BAKERSFIELD

SPATIAL ORGANIZATION

"The Academic Master Plan for California State College, Kern County" (Bakersfield) was approved by the Trustees in June 1968. This document established a functional base for estimating the types and amount of space required to implement the initial academic program. In addition, the College and the planners analyzed the projected incremental space requirements for 3000, 6000 and 12,000 FTE in regard to student stations, distribution by discipline, staffing, functional requirements and overlap. Out of this effort grew one of the basic concepts of the Master Plan - the separating out from each discipline of two basically different types of space, "universal" and "special".

Universal Space is simply instructional space that requires little or no equipping or modification to make it multi-disciplinary and interchangeable. It can range in size from siminar or conference rooms to major lecture halls.

Special Space is area requiring special equipment (laboratories) or area designed for a specific purpose,such as libraries, faculty offices, administrative space, etc. It is not, in the main, either multi-disciplinary or interchangeable.

The reasons for sorting out the types of space in this manner relate directly to the principles and objectives mentioned at the outset. They are flexibility, economy, building technology and the desire for maximum action and reaction between disciplines. The Bakersfield plan groups all its *universal* space into one major building and then rings this multi-disciplinary block with identifiable special structures devoted to specific purposes within a given discipline or within a group of compatible disciplines.

By combining all multi-purpose space into one structure, several advantages accrue:

1. The maximum flexibility in matching lecture room assignments to a changing student curriculum pattern can be achieved and high and low room loadings can be balanced better than if lecture room space is spread campus-wide and "assigned" to a discipline or building. (Flexibility and efficiency.)

2. Student contact becomes campus-wide with the encounter occurring on the neutral ground of the universal space rather than under the environmentally upsetting circumstances of an English major taking a Literature course in a Science lecture room or vice versa. (Interdisciplinary involvement.)

3. Walking distances are substantially shortened because the spaces between buildings are partially eliminated. (Economy and efficiency.)

4. One large *"megastructure"* with a minimum of columns and enclosing walls is highly adaptable to internal rearrangement. (Flexibility.)

5. Lecture space built on one level with a uniform section and bay size is the most economic of all building types. (Economy)

6. A uniform structure composed of standard pre-designed modules can reduce the lead time for building additions by about one year. (Rapid response to schedules.)

ecial space can be subdivided into two types - laboratories and instruc-onal support (faculty offices and clerical spaces). Although a minor mount of instructional support space can be efficiently and appropriately ontained in the universal space, the bulk of it and all of the laboratories annot be economically intermixed with lecture space. These require pecial buildings radically different from the lecture room building and om each other.

aboratory spaces require special plumbing, wiring, climate control, xhausts and other technical services. These services must be supplied om walls, floors and ceilings and since laboratory requirements change s fast or faster than technology itself, the type and location of services must be changeable. All this demands peripheral service areas never alled for in lecture space and, aside from contiguity requirements, would all for an axiom that general lecture rooms would never be mixed with aboratory spaces.

As mentioned before, the universal space (lecture rooms, seminar and onference rooms) can be housed most efficiently in a one-story building. This is seldom true for laboratory spaces. Here the servicing requirements re mainly vertical - utility risers, gravity waste systems, and external xhausts. The costs for distributing these systems throughout a laboratory omplex are almost always cheaper as a vertical system than a horizontal ne. They are so much more economic vertically that they more than bsorb the additional structural costs involved in a multi-story building. The costs of vertical transportation could be allowed to seriously erode or ven ruin the economies of vertical laboratories, but this will not happen f spatial functions are separated (laboratorics separate from lecture ooms and offices separate from both) and if even those spaces structurally daptable to multi-story (laboratories and offices) are limited to three or, t the most, four stories. This height limitation eliminates the need for mass movement by elevators and is in keeping with the nature of the Bakersfield campus in that land is not a critical problem.

Although laboratories need considerable flexibility in their servicing re-quirements, their dimensional requirements tend to remain quite stable. Given a reasonable clear span, say 40 feet, and floor to ceiling height of about 10 feet; and given a nearly unlimited service capability, all but the most exotic laboratory work can be conducted without inhibitions imposed by the building. This is a far different set of architectural criteria than that applied to universal space and it certainly implies a second system of buildings.

A third system of buildings is one that houses the instructional support facilities. Aside from the major identifiable facilities for Library, General Administration and Student Activities, this system contains space for faculty, departmental administration and clerical assistance. It is fine-grained and intimate in character, quite free of the type of service require-ments demanded of laboratory space and not subject to the spatial flexibility and sudden response to change asked of lecture spaces. However, this type of space has some very special requirements of its own. First it is the instructor's office, workroom, study and his home on campus. Second, it is the meeting place for personal contact between teacher and student and between teacher and teacher. And, third, it houses the facilities for departmental administra-tion that range from academic leadership to the routine of typing, filing and record keeping. This space is in many ways the true meeting place between several worlds - the world of the student, the academic world, and those many worlds outside. If it is to assume this role, it must be given something more than simply the space within which it can exist. It must be given a symbolism reflective of its actual role in the academic endeavor Unfortunately, State standards somewhat limit the extent of such construction, but these standards do not overly inhibit the idea employed in this plan - that in-structional offices cease being a numbered door off a lonely corridor and assume an identifiable campus presence commensurate with the many roles that faculty must play outside of class. This is the third category of space.

The Physical Master Plan assumes three types of space as described above, these are -

- A central academic spine containing all or most of the multi-disciplinary lecture space in a single level, modular building with a minimum of columns and other fixed elements.

- Specialized space located in structures defined by function and discipline, two to four stories in height, capable of mechanical servicing from walls, floors and ceilings, large-scaled for efficiency and flexibility in plan, free of fixed internal elements, and closely related to the academic spine.

- Small-grained academic space with instructional offices as the module, scaled for individual use, related internally with the teaching areas and externally to the student as well as the off-campus world. Only in special cases would this type of space be absorbed into either universal or laboratory space - instead it would assume, architecturally, a singular role of its own and as such would have its own identity.

This summarizes one of the basic concepts of the Physical Master Plan - a differentiation of space by function ranging from the inclusive, multi-purpose, uniform, interchangeable *universal* space; through the highly *specialized* technological, mechanized loft space; and to the individualistic person-to-person, private academic meeting ground. These three types of space form a continuum of related parts that gives to each its own best function, scale, and physical expression.

LIVE AND LEARN

A second concept of the Physical Master Plan, also inherent in the Academic Plan, is the Live and Learn village. The Academic Plan for Bakersfield states

> "In order to supplement the educational benefits that can be derived from formal instruction, the Plan is designed to insure that to the maximum extent possible this new college will constitute a cohesive academic community. As a means to this end, the Plan calls for a system of living-learning, and living-study centers in which both residential and commuting students can receive the benefits of a multi-faceted educational experience. The arrangements which are proposed will, without increasing either operating or capital fund requirements at this college, increase the impact of the college's program ,They will provide insurance against the frustration generating atmosphere of impersonality that has recently led to difficulties in many areas of higher education."

The impact of this statement on the Physical Master Plan is so powerful and all-encompassing that it, like the space differentiation described above, demands an entirely new approach to the basic idea of a Master Plan. Whereas the concept of spatial separation by function and type requires a redistribution of assignable space based on a different plane of analysis, this concept of living-learning, living-study requires an integration of academic and residential activities rarely achieved today.

The translation of this institutional goal into a physical plan has been one of the most interesting of the many posed by the College. The solution is very complex but the basic ingredients are as follows:

- Lower Division Students need and gain more from personal involvement at their own level than do the older more self-oriented Upper Division and Graduate Students. So, it is at this Lower Division level that the most is to be gained by creating colleges within colleges sized to a level that will allow the student to identify and be at home in a new environment that must be invigorating but is too often hostile. It is not enough to limit this scale and identity to the resident student. The Lower Division commuter student is even more susceptible to emotional separation because, in addition to the problems faced by a new resident student, he/she has little or no sense of *"place"* on campus.

So, for Lower Division Students, a series of three academic villages will be provided. Within these precincts, Lower Division Students can and will spend most of their hours. Most of their required classes will be held within the village, some of their instructors will be housed inside the village quadrant and so will the needed administrative and service facilities. Housing will be provided for about half of the village population and for the non-resident half, study spaces, dining and recreational facilities will be incorporated into a system of campus "houses" designed to narrow the gap between resident and non-resident students.

By design as well as necessity, Lower Division village students will actively participate in programs built into the academic core. Though they will have their village as a home base for study, living, learning and relaxation, they will still enjoy the formal and impromptu opportunities of the central campus for laboratory courses, electives, campus-wide student activities, dining, and above all, the central library. This mix between intimate and universal is purposefully designed to bridge the gap from home to college, teen-age to maturity, and from general learning to the entirely new world of advanced knowledge.

Based on a total college population of 12,000 FTE (8-5), the Master Plan outlines three Lower Division academic villages each containing about 700 resident and 700 commuter students for a total of 2,100 residents and 2,100 commuters (35% of the total FTE). Knowing that this ultimate figure cannot be predicted throughout a period of some thirty years, the plan provides for substantial increases or decreases. However, the academic village idea remains as an important element of the Master Plan regardless of its possible range in size.

— Upper Division Students will also enjoy the privileges of - village, but the orientation will be much different. Whereas the Lower Division villages will be heavily oriented to living and *learning*, the Upper Division village will concentrate on providing the facilities for living and *study*. There will be no formal instructional spaces within the Upper Division residential areas because Upper Division students will be mostly occupied with specialized courses not practicable in individualized sectors of the College.

The concept of incorporating the commuter student into the total life of the College will, however, not change. Provisions for study, lounge and recreational facilities for these students will continue in response to the need for an individual to find a psychological as well as a physical "place" within a major institution.

Although no formal instructional spaces are intended within the Upper Division villages, informal seminar and conference rooms are considered indispensable. These are planned within the "commons" areas normally associated with collegiate housing but provisions have been made for the expansion of these facilities when and if such expansion is justified.

Physically, the Master Plan indicates only one Upper Division village capable of housing some 1,500 students. However, the Plan provides for a doubling of this figure. The final configuration will depend largely upon what peripheral, off-campus housing is provided and what changes occur in the life styles of Upper Division Students. The Plan stands ready to accommodate change in either quantity or style.

SPACE RELATIONSHIPS

The basic disciplines contained in the Academic Master Plan are --

Behavioral Sciences
Fine Arts
Humanities
Natural Sciences
Business
Education
Nursing and Medical Technology
Industrial Technology and Applied Sciences

In the diagram opposite, these eight disciplines are shown in a way reflective of the Academic and Physical Plan objectives. The arrangement shown does not indicate size or emphasis, but does, by the overlapping of disciplines, present the idea of a multi-disciplinary college within which students are continuously exposed to the entire range of institutional activities; and it also expresses the fact that each specialty is important unto itself, regardless of size. The process of merging these disciplines together for maximum exposure and concurrently retaining within each the facilities and spirit that will foster dedication is another of the challenges faced by planning.

This same diagram illustrates the ways by which these challenges will be met. These are --

— The merging of disciplines at the level most common to all, the lecture room and the seminar. This area, appropriately grouped around library and student commons, is the multi-use, interchangeable space that forms the base of the academic pyramid and it is here, at the base, that the maximum interchange is expected. This inner ring is designated *universal space*, as described before.

— Radiating out from the universal space are the truncated ends of the individual disciplines that contain spaces devoted to the specialized needs of a particular area of study. These are the laboratories and the instruction support spaces also previously described.

The diagram also shows the Live and Learn academic villages. For physical as well as social reasons, these villages will be separate from the College core, but academically, they will be closely associated. All Lower Division Students will be constantly exposed to activities within the core and, from time to time, Upper Division Students will find instructional (and other) reasons to participate in village activities.

Upper Division residences are indicated on the right of the diagram. These differ from the Live and Learn villages in that no formal instruction is intended within them. But, these will be living-study centers, not simple residence halls, and every possible means will be used to make these Upper Division residential areas significant branches of the core area academic tree.

Physical Education as an instructional entity is shown near the core and between the Upper and Lower Division residence areas. Actually, it is intended to extend formal Physical Education activities into or at least near the residential areas and to merge the residential recreational facilities with the instructional areas in order to form an extended campus-wide system of formal and impromptu sports and play.

The concepts expressed in this diagram are --

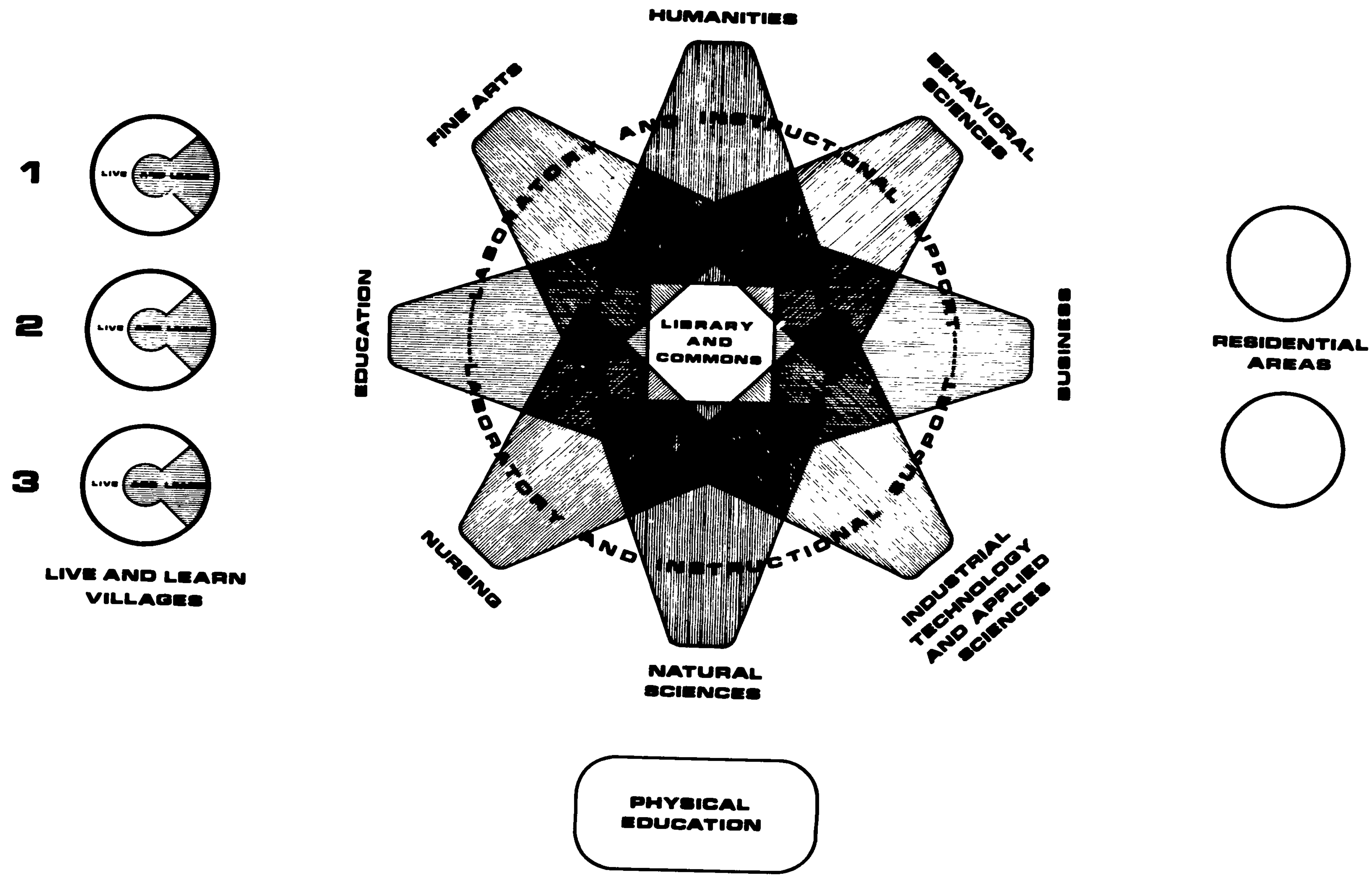
— The eight basic disciplines, their identity, their relationship and their interaction.

— The sorting out of space into universal, laboratory and instructional categories.

— The Live and Learn villages for Lower Division Students that group resident and commuter students into a small-scaled and complete academic environment.

— The Live and Study villages for Upper Division Students that have strong ties with the academic core, contain facilities for the commuter student and provide strong incentives for study and augmented learning within them.

SPACE RELATIONSHIP DIAGRAM



CALIFORNIA STATE COLLEGE, BAKERSFIELD

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

SPACE DISTRIBUTION

The chart opposite summarizes in graphic form the projected instructional space requirements by discipline, by type and by location for 12,000 full time equivalent (FTE) students, 8 a.m. to 5 p.m. Each square represents 5,000 assignable square feet (ASF) computed in accordance with present standards of the Coordinating Council for Higher Education. These estimates have been used in the formulation of the Physical Master Plan because they represent a considered projection of curriculum requirements into a future some thirty years hence. Neither the College that estimated them nor the planners that used them expect that they will remain unchanged. They are not a goal, but they are, in a very important way, a base against which trends can be plotted and change can be measured, and they provide a frame of reference for innovation and conjecture. These space allocations will be modified continuously as a standard part of the master planning process, but, in accordance with the master planning process, no single figure will be modified without consideration of all the others that might be affected by the change.

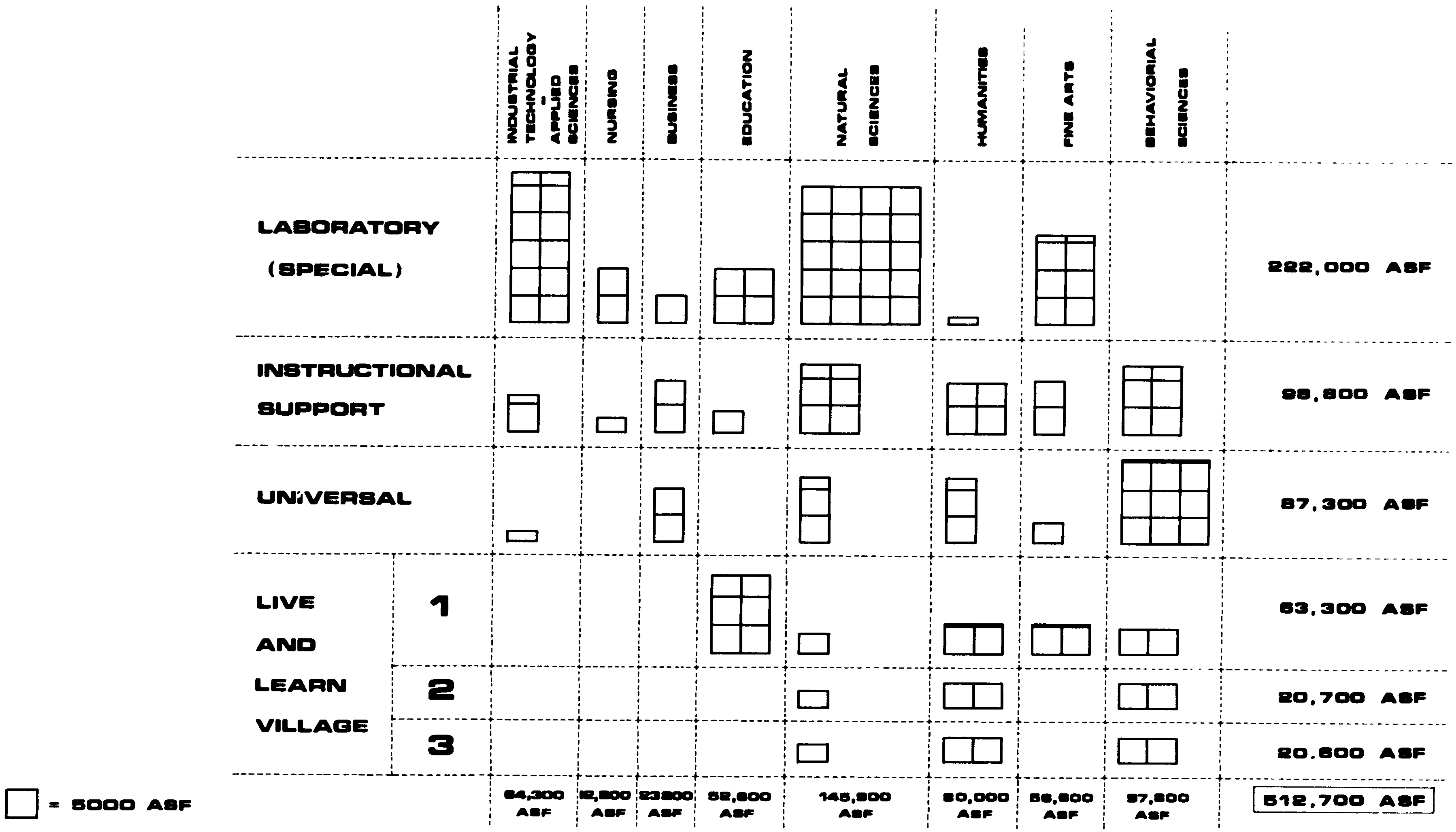
In order that the Master Plan can be physically responsive to this continuous input and feedback process, provisions must be made for both the expected as well as the unexpected. The Master Plan outlined in this report uses the following projections as a base for area assignments but provides within each sector an open end or ends, (one, two or three) capable of accommodating shifts in programming by time, by size or by function. The plan also provides for the introduction of new unforeseen academic elements and even the phasing out or diminution of current programs.

Flexibility to this degree might suggest that there should not be, in effect, any plan at all. Fortunately, the process of higher education does not demand a chaotic environment to house its constantly changing needs. Certainly space distribution is one of the many components that probably will be subject to dramatic change, but such change is expected and can be accounted for. The chart opposite is the tool for measuring the campus-wide impact of spatial shifts.

The two tables following (Table 1: Summary of Instructional Space Distribution, and Table 11: Support Space, Incremental Growth) add the dimension of growth of ancillary requirements to the basic instructional and faculty spaces. Together they chart the growth of the College through specific increments based upon current estimates of future needs.

Like the preceding diagram, these tables are planning tools, not goals. They now serve an immediate and important purpose by outlining a probable sequence of development and a reasoned balance between enrollment and physical facilities. They have actually served as the program for the entire growth sequence presented later. But, equally important for planning purposes, they have been composed to act as a guide in detailed reevaluations of space assignments by major disciplines, type of space, campus location and conversions from assignable square feet (ASF) to gross square feet (GSF).

SPACE DISTRIBUTION 12000 FTE (8-5)



CALIFORNIA STATE COLLEGE, BAKERSFIELD

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

TABLE I - SUMMARY OF INSTRUCTIONAL SPACE DISTRIBUTION (By Discipline and Type of Space)

A = Lecture
B = Laboratory
C = Instructional Support

3000 FTE (8-5)

Academic Area	Type Space	Total ASF	Total GSF	(1)	(2)	(3)	Universal	Special
Behavioral Sciences	A	8,000		4,300	-	-	3,700	
	B	8,800		2,000	-	-	6,800	
	C	9,200		2,600	-	-	400	6,200
		26,000	37,100	8,900	-	-	10,900	6,200
Fine Arts	A	1,200		400	-	-	800	-
	B	9,600		6,300	-	-	-	3,300
	C	2,000		-	-	-	-	2,000
		12,800	18,300	6,700	-	-	800	5,300
Humanities	A	7,900		4,300	3,600	-	-	-
	B	3,200		2,800	100	-	-	300
	C	7,900		3,800	1,300	-	-	2,800
		19,000	26,800	10,900	5,000	-	-	3,100
Natural Sciences	A	4,600		2,200	700	-	1,700	-
	B	27,000		200	-	-	200	26,600
	C	6,800		1,100	-	-	-	5,700
		38,400	54,900	3,500	700	-	1,900	32,300
Business	A	1,500		-	-	-	1,500	-
	B	1,200		-	-	-	1,200	-
	C	1,600		-	-	-	-	1,600
		4,300	6,200	-	-	-	2,700	1,600
Education	A	2,100		1,900	-	-	-	200
	B	5,300		2,100	-	-	-	3,200
	C	3,700		3,000	-	-	-	700
		11,100	15,900	7,000	-	-	-	4,100
Nursing	A	100		-	-	-	-	100
	B	1,000		-	-	-	-	1,000
	C	400		-	-	-	-	400
		1,500	2,200	-	-	-	-	1,500
Industrial Technology & Applied Sciences	A	600		-	-	-	400	200
	B	8,400		-	-	-	-	8,400
	C	700		-	-	-	-	700
		9,700	14,000	-	-	-	400	9,300
Subtotals	A	26,000		13,100	4,300	-	8,100	500
	B	64,500		13,400	100	-	8,200	42,800
	C	32,300		10,500	1,300	-	400	20,100
TOTALS		122,800	175,400	37,000	5,700	-	16,700	63,400

ASF @ 3,000 FTE - 122,800
GSF @ 3,000 FTE - 175,400

6000 FTE (8-5)

Academic Area	Type Space	Total ASF	Total GSF	(1)	(2)	(3)	Universal	Special
Behavioral Sciences	A	15,500		4,300	4,300	-	6,900	-
	B	16,800		2,000	2,000	-	12,800	-
	C	17,600		2,600	2,600	-	700	11,700
		49,900	71,400	8,900	8,900	-	20,400	11,700
Fine Arts	A	2,500		800	-	-	1,700	-
	B	19,700		9,800	-	-	-	9,900
	C	4,400		-	-	-	-	4,400
		26,600	38,100	10,600	-	-	1,700	14,300
Humanities	A	14,300		4,300	4,300	4,200	1,300	200
	B	5,700		2,800	2,300	-	-	600
	C	14,700		4,000	1,800	1,300	-	7,600
		34,700	49,700	11,100	8,400	5,500	1,300	8,400
Natural Sciences	A	9,900		2,200	2,200	1,000	3,800	700
	B	51,700		200	200	-	300	51,000
	C	13,700		1,100	500	-	-	12,100
		75,300	107,600	3,500	2,900	1,000	4,100	63,800
Business	A	4,300		-	-	-	4,300	-
	B	2,500		-	-	-	2,300	200
	C	4,000		-	-	-	-	4,000
		10,800	15,500	-	-	-	6,600	4,200
Education	A	4,500		4,100	-	-	-	400
	B	13,200		5,900	-	-	-	7,300
	C	8,100		6,300	-	-	-	1,800
		25,800	36,900	16,300	-	-	-	9,500
Nursing	A	300		-	-	-	-	300
	B	2,700		-	-	-	-	2,700
	C	1,100		-	-	-	-	1,100
		4,100	5,900	-	-	-	-	4,100
Industrial Technology & Applied Sciences	A	1,500		-	-	-	900	600
	B	19,700		-	-	-	-	19,700
	C	2,700		-	-	-	-	2,700
		23,900	34,200	-	-	-	900	23,000
Subtotals	A	52,800		15,700	10,800	5,200	18,900	2,200
	B	132,000		20,700	4,500	-	15,400	91,400
	C	66,300		14,000	4,900	1,300	700	45,400
TOTALS		251,100	359,300	50,400	20,200	6,500	35,000	139,000

ASF @ 6,000 FTE - 251,100
GSF @ 6,000 FTE - 359,300

12,000 FTE (8-5)

Academic Area	Type Space	Total ASF	Total GSF	(1)	(2)	(3)	Universal	Special
Behavioral Sciences	A	31,300		4,300	4,300	4,300	18,400	
	B	33,100		2,000	2,000	2,000	27,100	
	C	33,400		2,600	2,600	2,600	1,400	24,200
		97,800	139,800	8,900	8,900	8,900	46,900	24,200
Fine Arts	A	5,400		1,600	-	-	3,800	-
	B	41,400		9,800	-	-	-	31,600
	C	9,800		-	-	-	-	9,800
		56,600	81,000	11,400	-	-	3,800	41,400
Humanities	A	24,800		4,300	4,300	4,200	12,000	-
	B	9,500		2,800	2,800	2,800	-	1,100
	C	25,700		4,000	1,800	1,800	-	18,100
		60,000	86,000	11,100	8,900	8,800	12,000	19,200
Natural Sciences	A	19,200		2,200	2,200	2,200	11,300	1,300
	B	100,500		200	200	200	800	99,100
	C	26,200		1,100	500	500	-	24,100
		145,900	208,500	3,500	2,900	2,900	12,100	124,500
Business	A	7,900		-	-	-	7,900	-
	B	6,300		-	-	-	2,300	4,000
	C	9,100		-	-	-	-	9,100
		23,300	33,300	-	-	-	10,200	13,100
Education	A	8,800		7,700	-	-	-	1,100
	B	28,200		9,100	-	-	-	19,100
	C	15,600		11,600	-	-	-	4,000
		52,600	75,200	28,400	-	-	-	24,200
Nursing	A	900		-	-	-		900
	B	8,500		-	-	-	-	8,500
	C	2,800		-	-	-	-	2,800
		12,200	17,500	-	-	-	-	12,200
Industrial Technology & Applied Sciences	A	3,600		-	-	-	2,300	1,300
	B	54,000		-	-	-	-	54,000
	C	6,700		-	-	-	-	6,700
		64,300	91,900	-	-	-	2,300	62,000
Subtotals	A	101,900		20,100	10,800	10,700	55,700	4,600
	B	281,500		23,900	5,000	5,000	30,200	217,400
	C	129,300		19,300	4,900	4,900	1,400	98,800
TOTALS		512,700	733,200	63,300	20,700	20,600	87,300	320,800

ASF @ 12,000 FTE - 512,700
GSF @ 12,000 FTE - 733,200

CALIFORNIA STATE COLLEGE . BAKERSFIELD
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TABLE II · SUPPORT SPACE: INCREMENTAL GROWTH

LIBRARY AND AUDIO-VISUAL

Type Space	Initial ASF 700 FTE	ASF:3000 FTE	ASF:6000 FTE	ASF:12,000 FTE
Stacks	8,125	17,800	35,600	71,200
Reader Stations	4,380	18,700	37,400	74,800
Tech. Services	3,800	4,300	8,500	17,100
Audio-Visual	1,750	3,200	6,500	12,900
Total: Library and A-V	18,055	43,000	87,000	176,000
GSF @ 70% Efficiency	N.A.	62,200	124,400	251,700

ADMINISTRATION AND STUDENT SERVICES

Type Space	Initial ASF 700 FTE	ASF:3000 FTE	ASF:6000 FTE	ASF:12,000 FTE	
Administration	6,990	12,000	18,000	32,500	
Student Services	8,420	12,000	17,000	30,500	
	15,410	24,000	35,000	63,000	
GSF @ 65% Efficiency	N.A.	37,000	53,900	97,000*	(*20,000 GSF in Universal Space) (77,000 GSF in Spec. Bldg.)

GYMNASIUM (GSF)

Type Space	Initial GSF 700 FTE	GSF:3000 FTE	GSF:6000 FTE	GSF:12,000 FTE
GYMNASIUM	0	27,500	49,000	49,000

CORPORATION YARD

Type Space	Initial ASF 700 FTE	ASF:3000 FTE	ASF:6000 FTE	ASF:12,000 FTE
Buildings	3,000	7,500	15,000	30,000
Screened Yard	9,000	25,000	25,000	50,000

RESIDENTIAL (Including Dining)

Location	Units @ 700 FTE	Units @ 3000 FTE	Units @ 6000 FTE	Units @ 12,000 FTE
1. Villages	No living, interim dining only.	525 L.D. Units. 650 U.D. Units. Permanent Dining. 525 Commuters.	1050 LD Units. 1050 UD Units. Perm. Dining. 1050 Commuters	2100 LD Units. Perm. Dining. 2100 Commuters.
2. U.D Housing			250 Units. Perm. Dining.	250 to 2930 as required. Perm. Dining.

CALIFORNIA STATE COLLEGE, BAKERSFIELD
VICTOR GRUEN ASSOCIATES - MASTER PLAN ARCHITECTS

DIAGRAMMATIC PLAN

The theory of a central spine composed of universal space surrounded by special structures and the relationship of this academic core to the Lower Division Live and Learn villages and the Upper Division residential areas is represented in the diagram opposite.

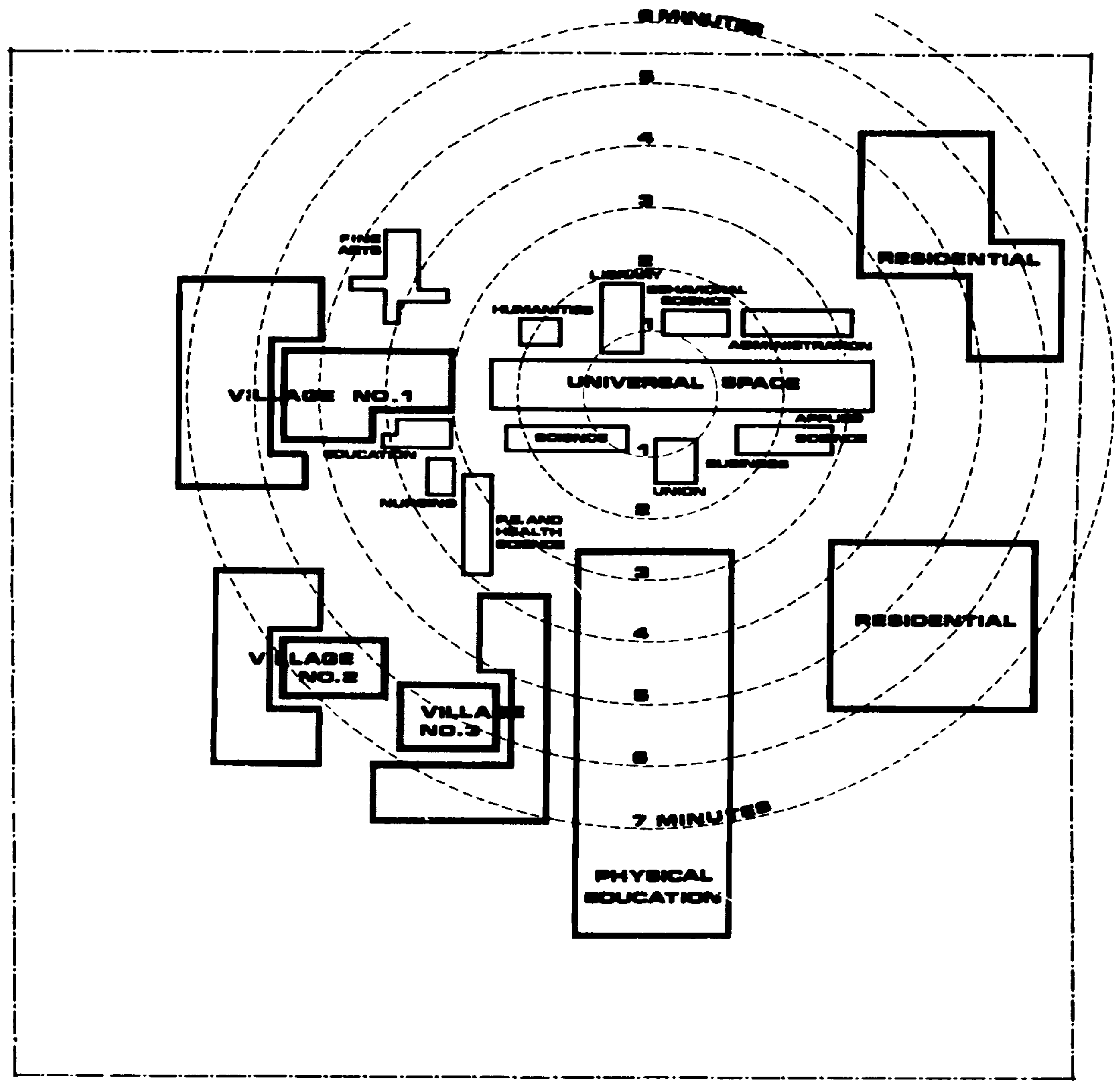
This diagram summarizes the considerations of relationships, types of space and ultimate size. Further, it assigns building stories, assumes separations between buildings and locates the total complex on the site.

The heights assigned are as follows:

Universal Space	1 story
Humanities	2 stories
Library	4 stories and basement
Behavioral Sciences	1 and 3 stories
Administration	2 stories
Applied Science & Technology	1 and 3 stories
Business	1 story
Physical Education & Health Science	1 story
Fine Arts	1 and 3 stories
Nursing & Medical Technology	1 story
Live and Learn Villages	1 and 3 stories
Residential	3 stories

This plan is the result of analyzing those alternate configurations that met the basic campus requirements in order to find the optimum balance between building heights, walking times and land assignments. The finding is that a campus of 12,000 FTE can be developed with low rise buildings, incorporate the residential areas and still retain walking times well within the fifteen minute maximum. This compaction is accomplished by assembling all lecture space into one single structure, thereby eliminating all distances between classroom buildings, and by ringing this central spine with specialized buildings in close proximity, the operational and capital outlay advantages of this scheme are significant. There are time savings for students, faculty and staff and there are cost savings in structure, vertical transportation and site development. The obvious disadvantage, that of being locked in, can readily be overcome by leaving open ends within each element, including the universal space. These open ends are an integral part of the Master Plan.

DIAGRAMMATIC PLAN



1 MINUTE WALKING TIME - 250 FEET

CALIFORNIA STATE COLLEGE, BAKERSFIELD

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CESS, CIRCULATION AND PARKING

cess to the site will be from four arterials - Stockdale Highway on the rth, Gosford Road on the east, Ming Road on the south, and Old River ad on the west. Of these, Stockdale Highway will carry the heaviest ffic volumes. All of these arterials are or will be four-lane divided hways with sufficient right-of-way for future widening.

e internal road system is composed primarily of a series of cul-de-sacs loops that terminate in or else feed the dispersed parking areas. Both streets and the parking areas penetrate the campus rather deeply in der to provide close-in vehicular access and reduce walking distances. wever, no road or parking area cuts any major pedestrian path. Service l emergency traffic within the campus is by widened paths of suitable terial. No private vehicles would be allowed on these inner drives.

king is peripheral but, so far as possible, is not continuous. The aim o provide maximum, uninterrupted contact with the surrounding com- nity by landscaped areas, foot and bicycle paths. These contacts are de on the east, west, and south, but Stockdale Highway, on the north, n important vehicular feeder and traffic signals will be required for e transfer between the campus and the proposed Riverbed Park. e parking requirement is estimated at 7,200 stalls.

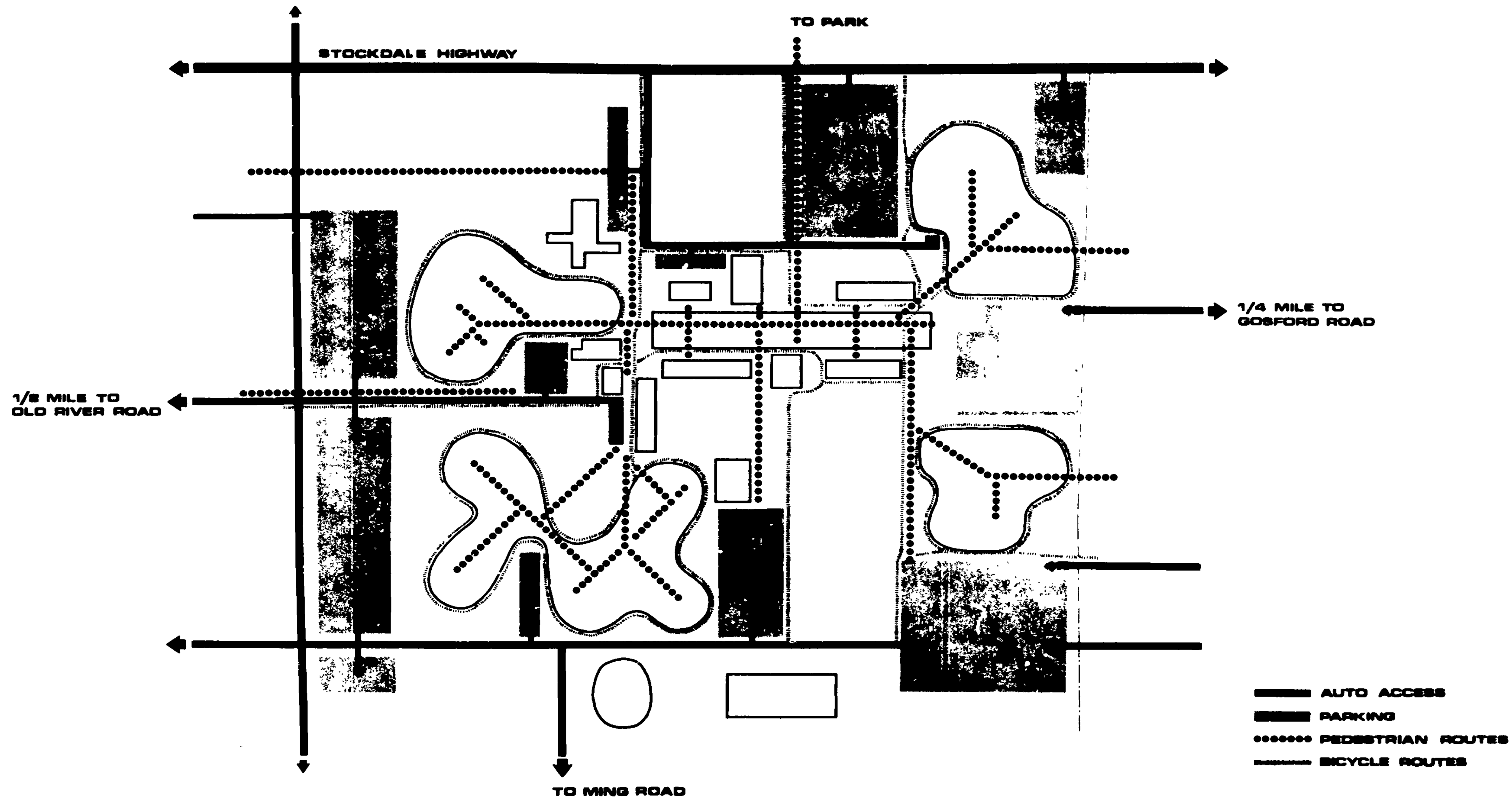
thin buildings, pedestrian circulation is primarily internal and weather- tected both for the comfort of the pedestrian and as a protection inst cooling losses to the outside. Between buildings, paths connect entrances by a combined rectilinear and diagonal pattern designed as shortest distance between given points. Where these paths coincide h grounds servicing routes, they are widened accordingly. The universal ce will have an east and west galleria as its prime circulation route, nected by north-south "bridges" to the special buildings.

Bicycle paths connect all elements of the campus and are separated from the major pedestrian walks. Parking racks will be provided at appropri- ate points around both the academic and residential buildings. Motor bikes or scooters will be limited to the vehicular roads and regular parking areas. Because of the relatively short distances between residential and academic activity points within the campus, bicycle traffic is not expected to be heavy.

Land planning for the Zone of Influence is now underway and until it progresses further, some peripheral conditions cannot be exactly deter- mined. However, the Master Plan provides for flexibility in boundary conditions and modifications will be made as community planning work progresses.

For details and calculations, see Appendix A.

ACCESS-CIRCULATION-PARKING DIAGRAM



CALIFORNIA STATE COLLEGE, BAKERSFIELD

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INCREMENTAL GROWTH

One of the most important and complex planning problems for a college programmed for long-term growth is designing the sequence of development for a highly organized institution that must be operable, efficient and complete at each stage even though the exact program, capacity and year cannot be accurately predicted over the long term. The concept for this campus (a multi-use spine with peripheral specialized structures) greatly simplifies the often unpredictable problems of growth. Nevertheless, a great deal of attention has been given to incremental growth, always with the requirements of an expanding academic program as the guide. The following sequential plans were derived with the principal input being from the college as it traced its probable evolution from the initial academic village with about 700 FTE to the ultimate campus for 12,000 FTE.

The growth pattern has been designed in two degrees of detail - a rather specific plan for the short term development 1970 through 1973; and a more generalized plan for the college at its 3,000, 6,000, and 12,000 FTE levels. The detailed series is referred to as "Status" and relates to actual dates. The later series is referred to as "Development Program" and relates to enrollment level rather than specific years.

STATUS: FALL 1970

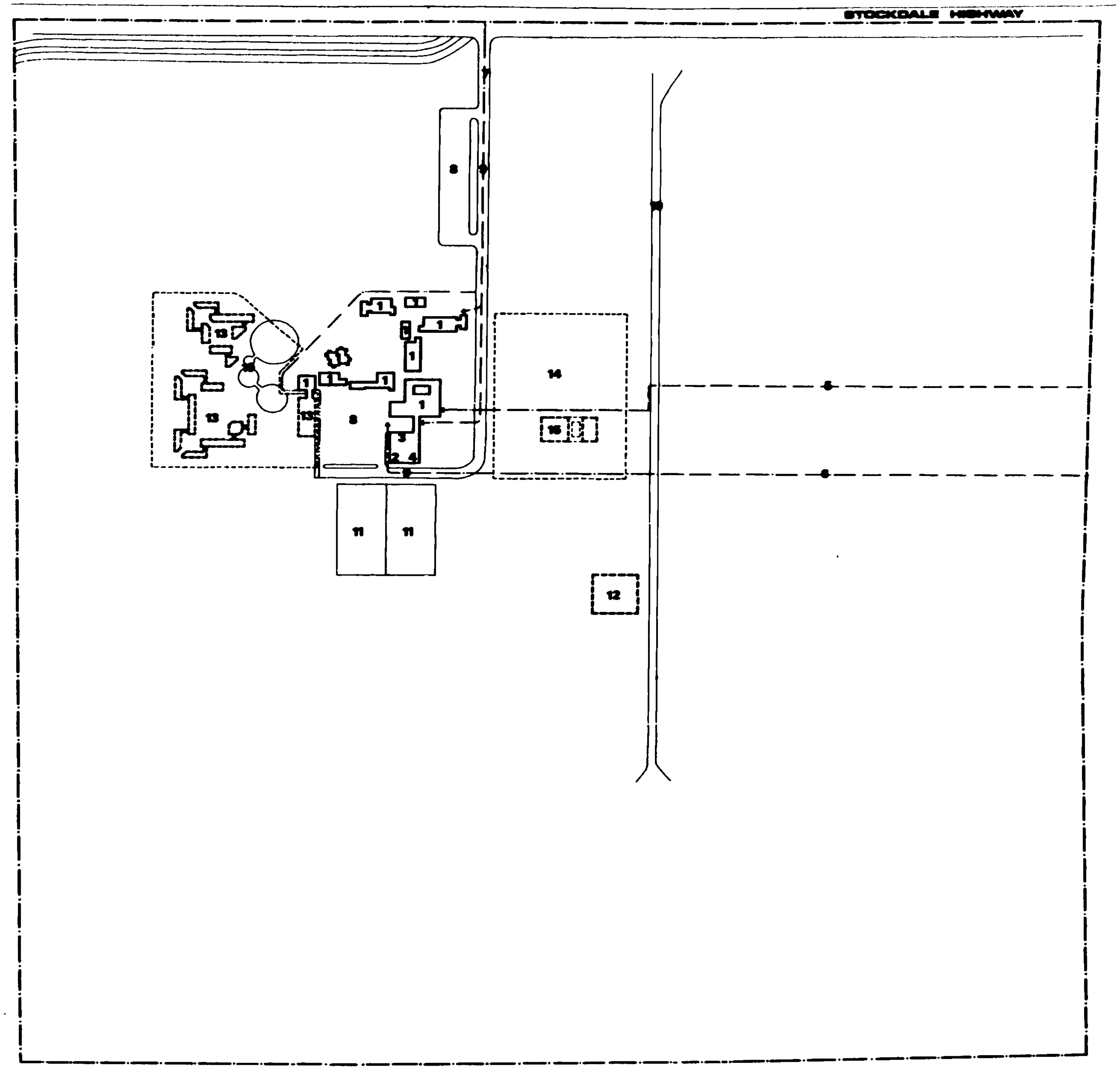
The drawing opposite indicates the status of the campus when it opens in September of 1970. The initial complement of buildings, capable of handling 726 FTE will be in operation.

In addition, important elements of the campus will be in various stages of construction. The first residential clusters will be in advanced construction while the initial gymnasium and science building will be in early construction.

All main utility trunks except water will be in place and site drainage for the building areas will be operable. Parking for 350 cars and an entrance road, with landscaping, will be available. Two multi-purpose fields provide outdoor physical education. Landscaping is confined to the academic area of Village No. 1. Most of the non-used area will remain in agriculture.

The solid lines indicate facilities in operation and dotted lines show facilities under construction.

(NS) indicates non-state funded facilities.



STATUS:

FALL 1970
726 FTE (8-5)

1 INITIAL COMPLEMENT OF BUILDINGS IN OPERATION
2. INITIAL OPERATIONS FACILITY COMPLETE
3. SKELETON CENTRAL PLANT IN OPERATION
4 NEW WATER WELL IN OPERATION NS (NON-STATE FUNDS)
5 UNDERGROUND ELECTRICAL AND TELEPHONE IN PLACE
6. SEWER TRUNK IN PLACE
7 GAS SERVICE IN PLACE
8. 350 PARKING STALLS AVAILABLE
9 PARTIAL ENTRANCE ROAD IN SERVICE
10 STORM RETENTION BASIN AND DITCH
11 TWO MULTI-PURPOSE PLAYING FIELDS COMPLETED
12 INITIAL GYM UNDER CONSTRUCTION
13. ± 340 UNIT RESIDENTIAL, DINING AND COMMONS UNDER CONSTRUCTION NS
14. SITE PREPARATION AREA FOR EXPANSION
15 SCIENCE BUILDINGS UNDER CONSTRUCTION

CALIFORNIA STATE COLLEGE, BAKERSFIELD

VICTOR GRUEN ASSOCIATES
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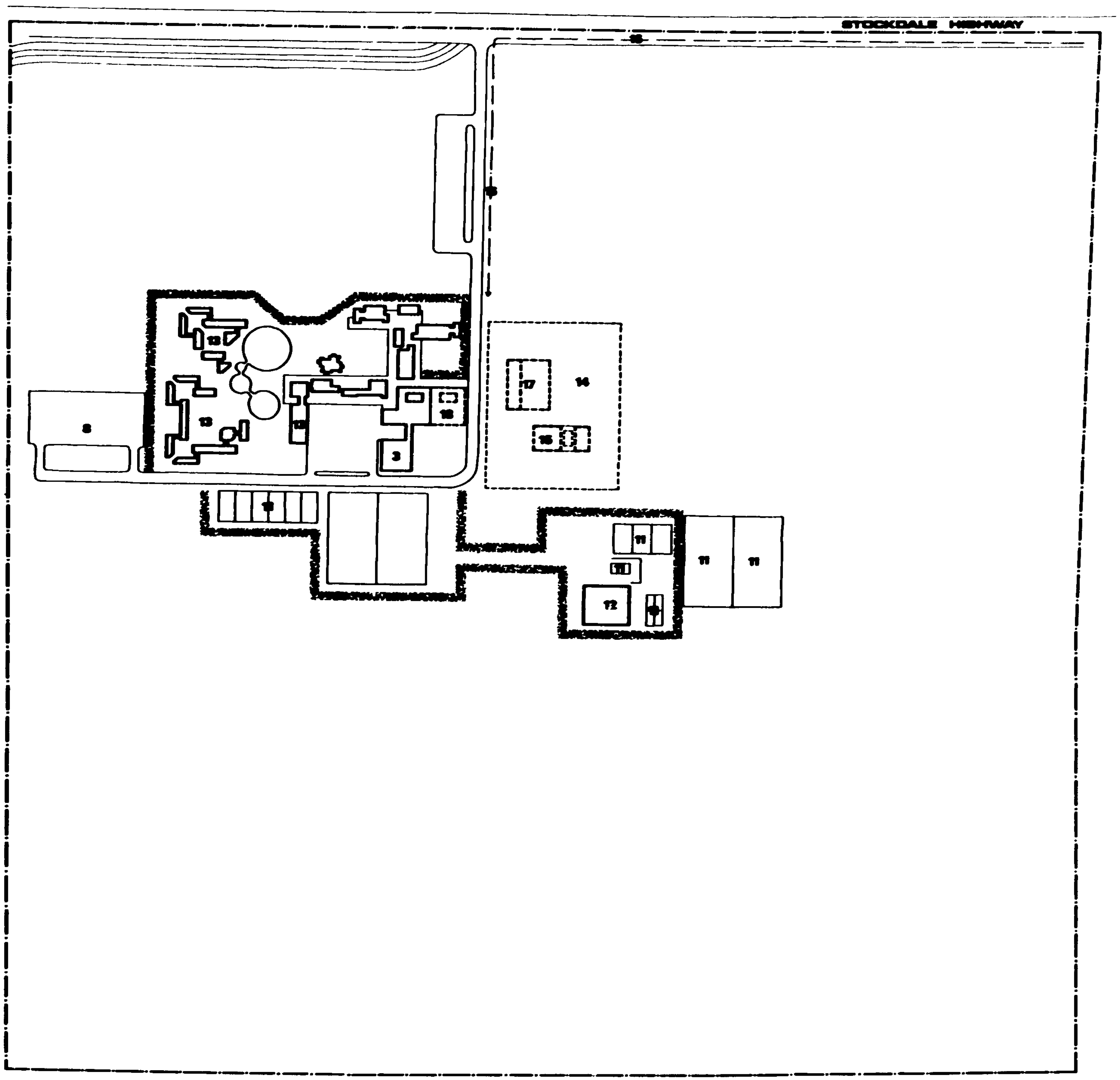
STATUS: FALL 1971

One year after opening, the status of the campus will be as indicated by the plan opposite. (For identification, the numbers used on the original status plan are continued here for the same or similar facilities; the numbers for projects completed have been dropped and new numbers added for projects being initiated.)

At this time, Village No. 1 is nearly complete and the Live and Learn concept of the Academic Master Plan commences. The initial gym and additional outdoor physical education have been opened (Nos. 11 and 12). The science building (No. 15) is in advanced construction and two new projects - a classroom-office segment and a library addition - have been initiated. The classroom-office space (No. 17) is the first element of the academic spine and as such will begin to define the *"universal space"*.

Landscaped areas have been extended to include the completed gym unit and enclose the play fields. Parking has been increased by 200 stalls servicing the residential areas (No. 8).



STATUS:

FALL 1971
726 FTE (8-5)

3 ADDED CAPACITY TO CENTRAL PLANT
8 ADD 200 PARKING STALLS
11 ADD TENNIS COURTS (± 6)
MULTI-PURPOSE FIELDS (± 2)
POOL (± 1)
HANDBALL (± 4)
BASKETBALL (± 3)
12 OPEN INITIAL GYM
13 OPEN INITIAL RESIDENTIAL, DINING AND COMMONS NS
14 SITE PREPARATION AREA FOR EXPANSION
15. SCIENCE BUILDINGS UNDER CONSTRUCTION
16. EXTEND STOCKDALE WATER MAIN
17 CLASSROOM-OFFICES UNDER CONSTRUCTION
18 LIBRARY EXPANSION UNDER CONSTRUCTION

0 300 600

NORTH

CALIFORNIA STATE COLLEGE, BAKERSFIELD

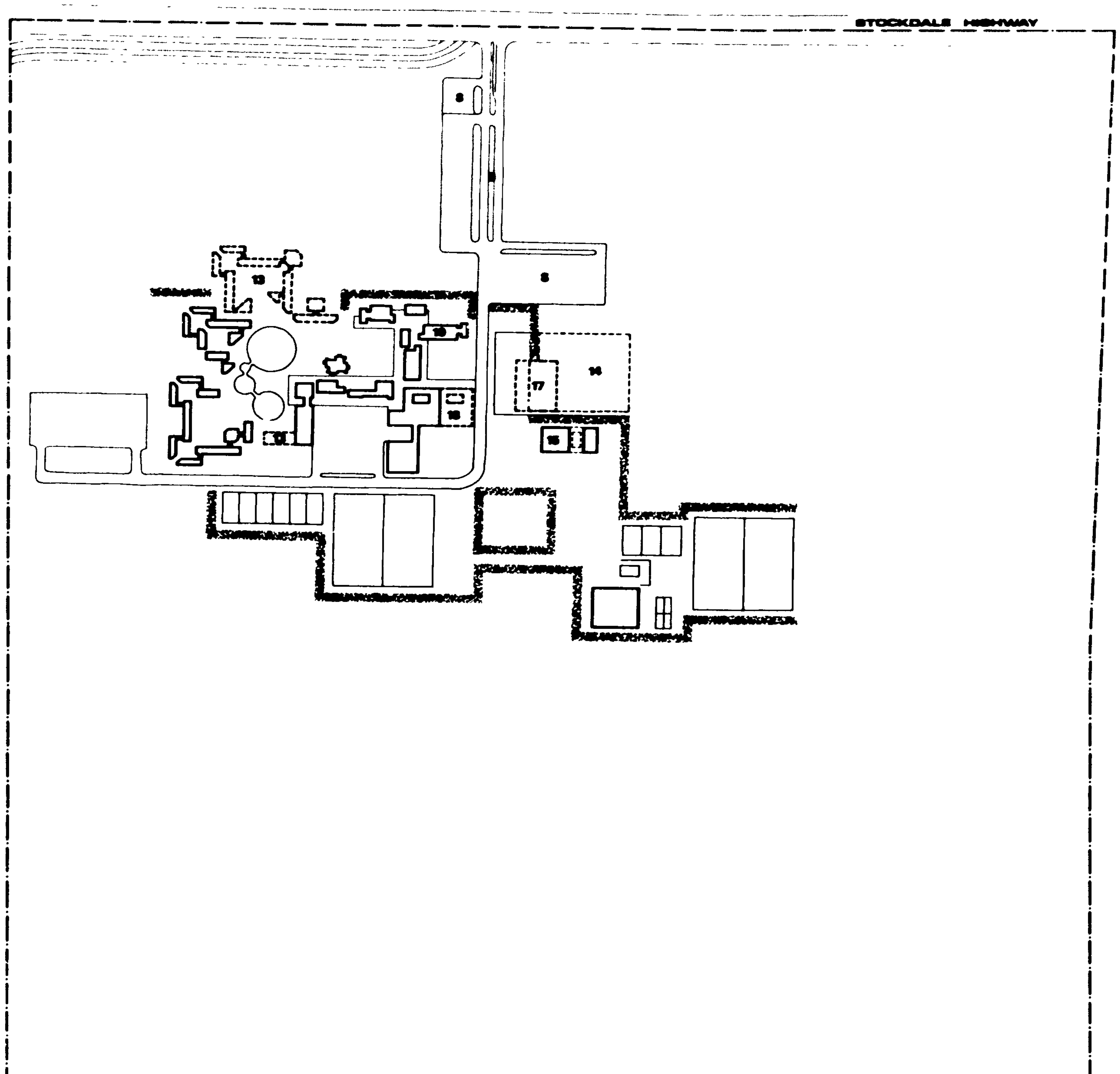
VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

STATUS: FALL 1972

The second year after opening brings the Science Building on line (No. 15) and frees the science space in Village No. 1 (No. 19) for conversion to Fine Arts. The classroom-office space and the Library expansion are in advanced construction and a new program, additional residential, has moved into the construction stage.

Road facilities have been extended and improved and parking has been increased by 150 stalls. The landscaping has been extended to encompass the new facilities. As shown here, the campus has a capacity of 1,081 FTE (8-5).

Site preparations are under way for extension of the campus to the east.



STATUS:

FALL 1972
1081 FTE (8-5)

8 ADD 150 PARKING STALLS NS
9 COMPLETE ENTRY ROAD
13 ± 340 RESIDENTIAL UNITS AND DINING ENLARGEMENT UNDER CONSTRUCTION NS
14 SITE PREPARATION AREA FOR EXPANSION
15 OPEN SCIENCE BUILDINGS
17 CLASSROOMS AND OFFICES UNDER CONSTRUCTION
18 LIBRARY EXPANSION UNDER CONSTRUCTION
19 REMODEL INITIAL SCIENCE BUILDING FOR ART EXPANSION

CALIFORNIA STATE COLLEGE, BAKERSFIELD

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MASTER PLAN ARCHITECTS

STATUS: FALL 1973

The third year of operation presents a campus scoped for 1,292 FTE and with three projects under construction. In this year, the first classroom-office segment of the academic spine is open and an easterly expansion is under construction. The corporation yard, initially located adjacent to Village No. 1 has by now outgrown its original space and incremental expansions of the central plant are about to occupy all of the available space formerly devoted to operations. A permanent corporation yard (No. 20) is under construction.

Residentially, Village No. 1 has opened its final unit and is now a completed entity. A portion of Village No. 2 is under construction (No. 21).

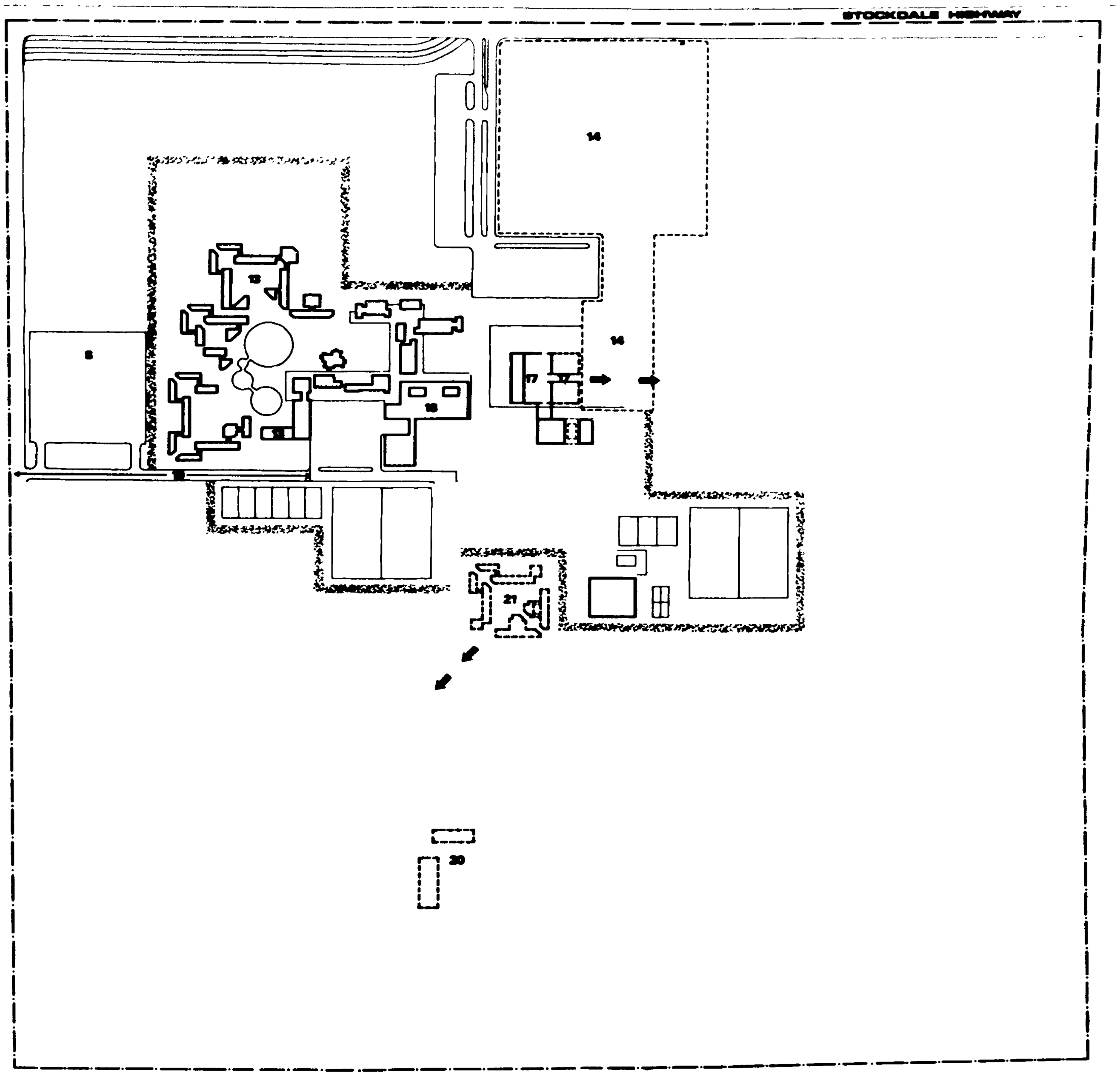
The library addition has been completed and is ready for occupancy (No. 18).

Ming and Old River Roads should have been improved by the county or city and a vehicular tie to the west boundary is available (No. 19). The temporary road running between Village No. 1 and the central campus is closed and this area, the West Court, becomes a pedestrian compound.

Site preparations continue to the north and east. Parking for 200 cars has been added.

Beyond this year it is not especially meaningful to detail the year-by-year status because it is not possible to predict detailed planning modifications that might occur over the very long run. This series has carried the plan through the five-year capital outlay program and even though it may be revised as actual operating experiences develop, it will still have performed an important contemporary function in pointing out those areas scheduled for immediate development. As such, it will be a positive guide for almost any type of short term (5 year) planning ranging from the placement of lawn sprinklers to the site preparations necessary for the installation of a major building.

From this short range growth sequence, consideration next moves to the long term *"Development Program"*.



STATUS:

FALL 1973
1292 FTE (8-5)

8 ADD 200 PARKING STALLS NS
13 OCCUPY ± 340 RESIDENTIAL UNITS AND DINING NS
14 SITE PREPARATION AREA FOR EXPANSION
17 OCCUPY CLASSROOM OFFICES CLASSROOM ADDITION UNDER CONSTRUCTION
18 OCCUPY LIBRARY ADDITION
19 EXTEND ACCESS ROAD TO OLD RIVER ROAD AND CONNECT TO COUNTY IMPROVED MING AND OLD RIVER ROADS
20 CORPORATION YARD UNDER CONSTRUCTION
21 INITIAL RESIDENTIAL CONSTRUCTION VILLAGE NO 2
⬅ AREAS OF GROWTH TO 3000 FTE

CALIFORNIA STATE COLLEGE, BAKERSFIELD

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

DEVELOPMENT PROGRAM: 3,000 FTE (8-5)

This plan shows the development of the campus at about one-fourth of its ultimate size. We have purposefully not indicated the year at which this might occur because a date is not as important as the balance between enrollment and facilities. A continuing appraisal (as will be done through the five-year short term planning) will keep budgeting schedules current and, further, will successively bring the 3,000 FTE date into sharper focus.

However, if one uses the base figures prepared by the Chancellor's office and projects them on a straight line basis, the level of 3,000 FTE would occur about 1980.

Several important additions and changes will have taken place since the last status plan (1973: 1,292 FTE).

In several successive stages, the academic spine has by now been extended through the central plaza and beyond. The bookstore and audio-visual space have been moved into this area in order to free the library building for needed expansion, behavioral sciences has been established in its permanent location, and a student cafeteria is in operation off the central plaza.

Disciplines now functioning in the spine are -

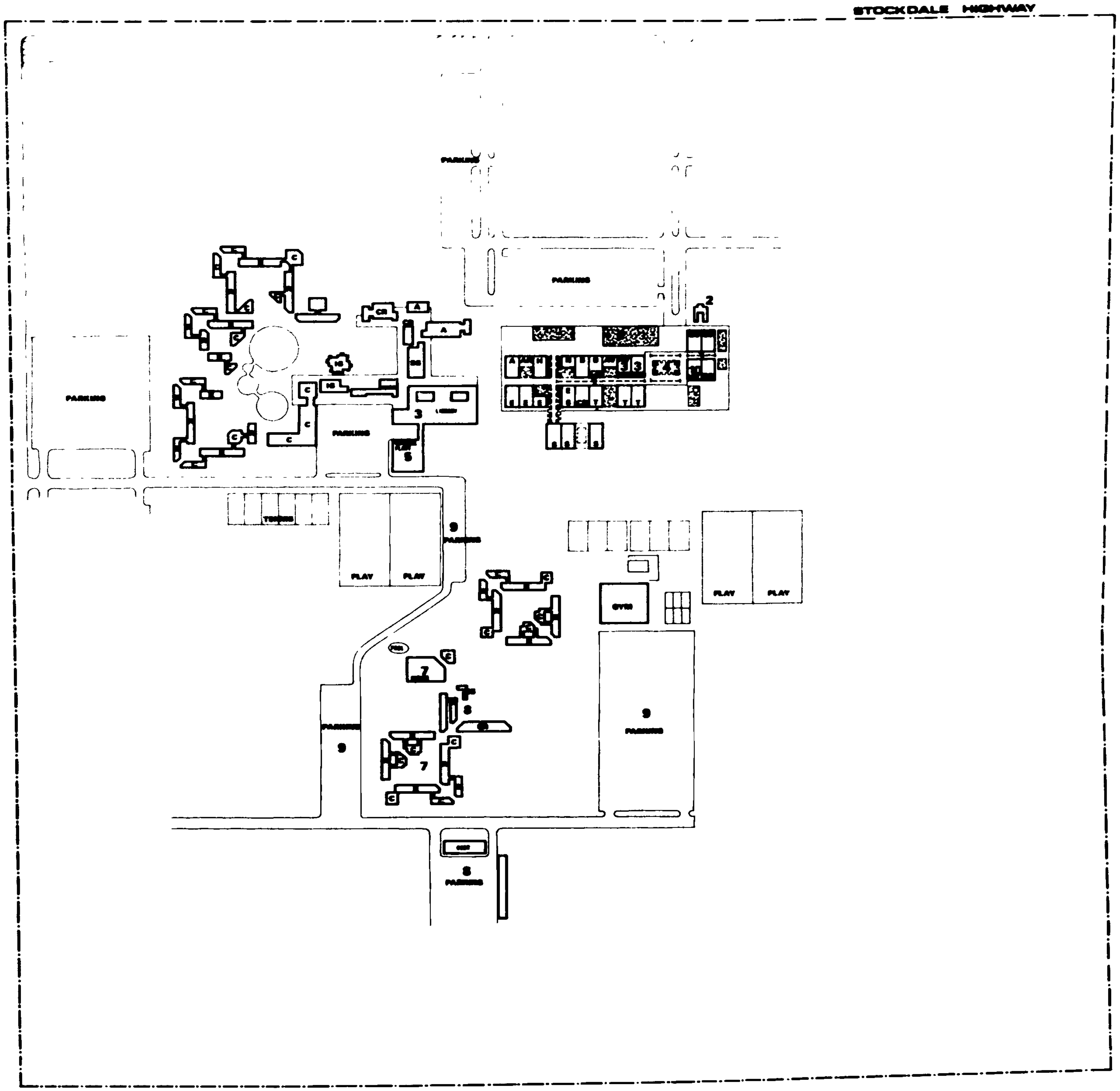
Art (A)
Humanities (H)
Education (E)
Nursing (N)
Science (S)
Industrial Technology (T)
Behavorial Sciences (BS)
plus some general classroom space (CR)

The main entrance roads and garden have been completed.

Village No. 1 has not changed (except for the library enlargement mentioned earlier), but the second Live and Learn Village is over one-half complete with residence halls (R), commons (C) and instruction areas (IS).

Parking has been added near all buildings with the total now at 1,700 stalls. The corporation yard has been in operation for some time. Some outdoor physical education has been added.

DEVELOPMENT PROGRAM:
3000 FTE (8-5)



1. EXTEND UNIVERSAL SPACE THROUGH PLAZA AND ABOUT 100 FEET BEYOND INITIATE BASEMENT CENTRAL RECEIVING AND CONSTRUCT MEZZANINE LEVEL IN PLAZA
2. BUILD INITIAL INSTRUCTIONAL SUPPORT BUILDING FOR BEHAVIORAL SCIENCE
3. MOVE A V AND BOOK STORE INTO UNIVERSAL SPACE AND DEVOTE VACATED AREA TO LIBRARY EXPANSION (BOOKS NS)
4. INSTALL ADMINISTRATIVE SPACE IN PLAZA MEZZANINE AND BASEMENT
5. FINAL ENLARGEMENT OF WEST CENTRAL PLANT
6. OCCUPY INITIAL UNIT OF PERMANENT CORPORATION YARD
7. ADD HOUSING UNIT VILLAGE NO 2 (INCLUDING DINING) NS
8. ADD FIRST ACADEMIC UNIT IN VILLAGE NO 2
9. INCREASE PARKING TO 1700 NS
10. ADD CAFETERIA (5000+) STATE FUNDED

CALIFORNIA STATE COLLEGE, BAKERSFIELD

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

DEVELOPMENT PROGRAM: 6,000 FTE (8-5)

Here the campus is shown about halfway through its total development and all major elements have been established.

The universal space in the central spine has continued its growth to the east, laboratories and special buildings have been added for natural and behavioral sciences, and a reassignment of universal space has taken place to accommodate departmental growth into space vacated by education, nursing and fine arts as these move into new quarters.

The initial unit of the permanent library is now in operation and education and nursing have moved to its former location.

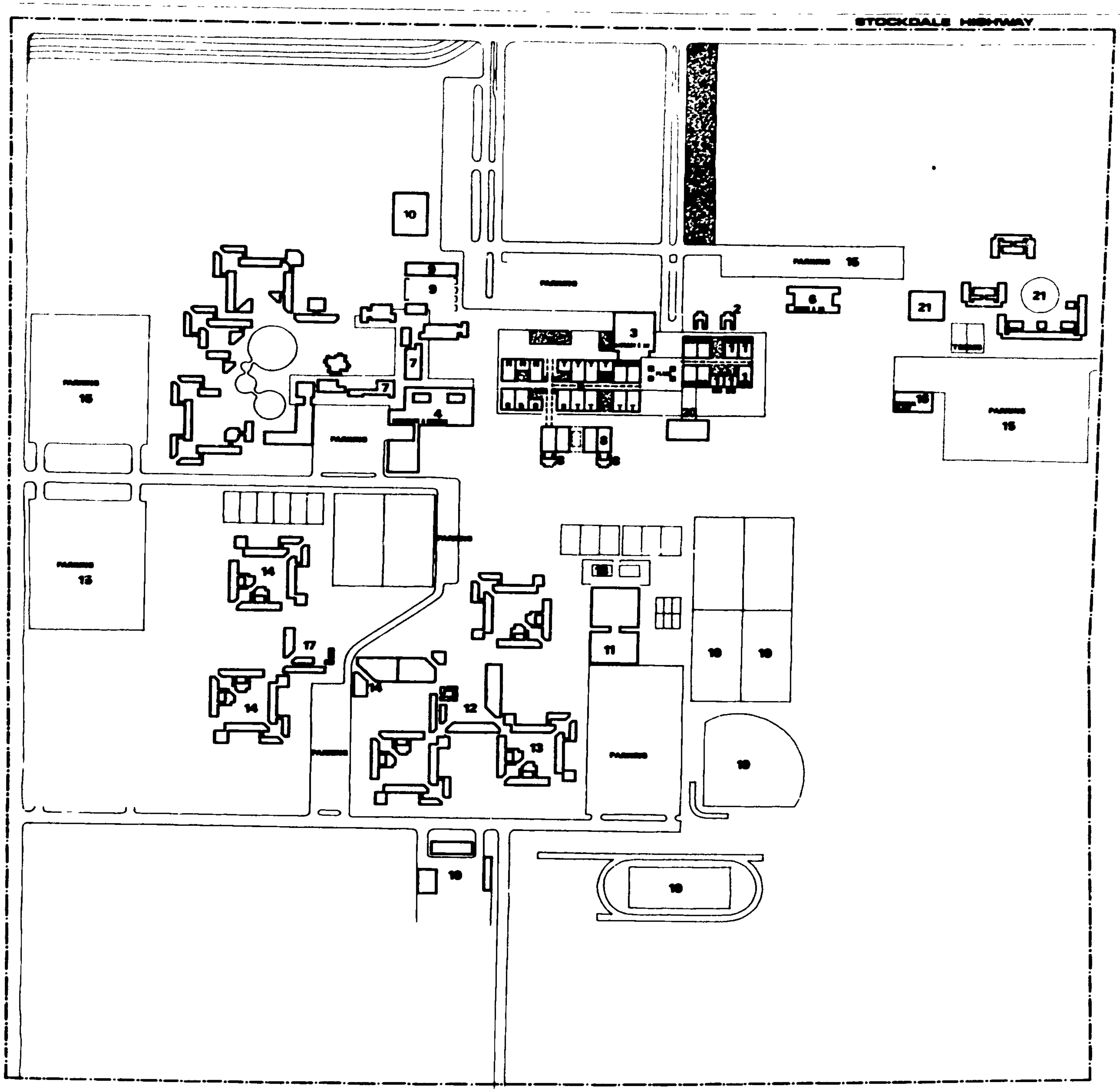
The initial unit of the permanent administration building is operating thus freeing the original administration space in Village No. 1 for conversion to classrooms.

A fine arts building and a little theatre have been added and a strong nucleus of the speech, art and drama group is now established.

Additions have been made to both indoor and outdoor physical education. A second central plant is in operation and increases of the corporation yard have been accomplished. All three Live and Learn Villages are now complete and the housing program has extended into the first upper division live and study clusters. An initial student union element has been installed off the central plaza and connected with the cafeteria that was built earlier.

Parking has been expanded to a total of 3,200 stalls.

If straight line projections of enrollment based on early studies by the Chancellor's office were continued, this stage of development would exist by about 1990.



DEVELOPMENT PROGRAM: 6000 FTE (8-5)

1. EXTEND UNIVERSAL SPACE APPROXIMATELY 150 FEET FOR BEHAVIORAL SCIENCE ADDITION
2. ADD BEHAVIORAL SCIENCE INSTRUCTION
3. BUILD INITIAL UNIT OF PERMANENT LIBRARY
4. MOVE EDUCATION AND NURSING TO VACATED LIBRARY SPACE
5. ADJUST UNIVERSAL SPACE (WEST WING) TO ENLARGE TECHNOLOGY HUMANITIES BUSINESS SCIENCE AND THE BOOK STORE INTO AREA VACATED BY EDUCATION NURSING AUDIO VISUAL AND ART (BOOKS NS)
6. BUILD INITIAL UNIT OF ADMINISTRATION AND S.S. BUILDING
7. REMODEL VILLAGE NO 1 ADMINISTRATION AND S.S. SPACE INTO CLASSROOMS
8. ADD TO SCIENCE BUILDINGS AND BUILD INSTRUCTIONAL SUPPORT SPACE
9. BUILD FINE ARTS BUILDING NEAR OTHER ART IN VILLAGE NO 1 AND COMPLETE ART COURT
10. BUILD LITTLE THEATRE
11. COMPLETE GYM
12. COMPLETE ACADEMIC AREA VILLAGE NO 2
13. BUILD FINAL HOUSING UNITS IN VILLAGE NO 2 NS
14. BUILD RESIDENTIAL UNITS IN VILLAGE NO 3 INCLUDING DINING NS
15. INCREASE PARKING TO 3,200 STALLS NS
16. BUILD SECOND CENTRAL PLANT
17. BUILD ABOUT ONE-HALF OF VILLAGE NO 3 ACADEMIC AREA
18. INCREASE CORPORATION YARD
19. ADD TO OUTDOOR PHYSICAL EDUCATION
20. BUILD INITIAL UNIT OF STUDENT UNION NS
21. UPPER DIVISION AND MARRIED STUDENT HOUSING AS REQUIRED (INCLUDES DINING) NS

0 300 600

NORTH

CALIFORNIA STATE COLLEGE, BAKERSFIELD

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

DEVELOPMENT PROGRAM: 12,000 FTE (8-5)

Here the plan has completed its programmed development. On the straight line projection method mentioned before, the year would be about 2010.

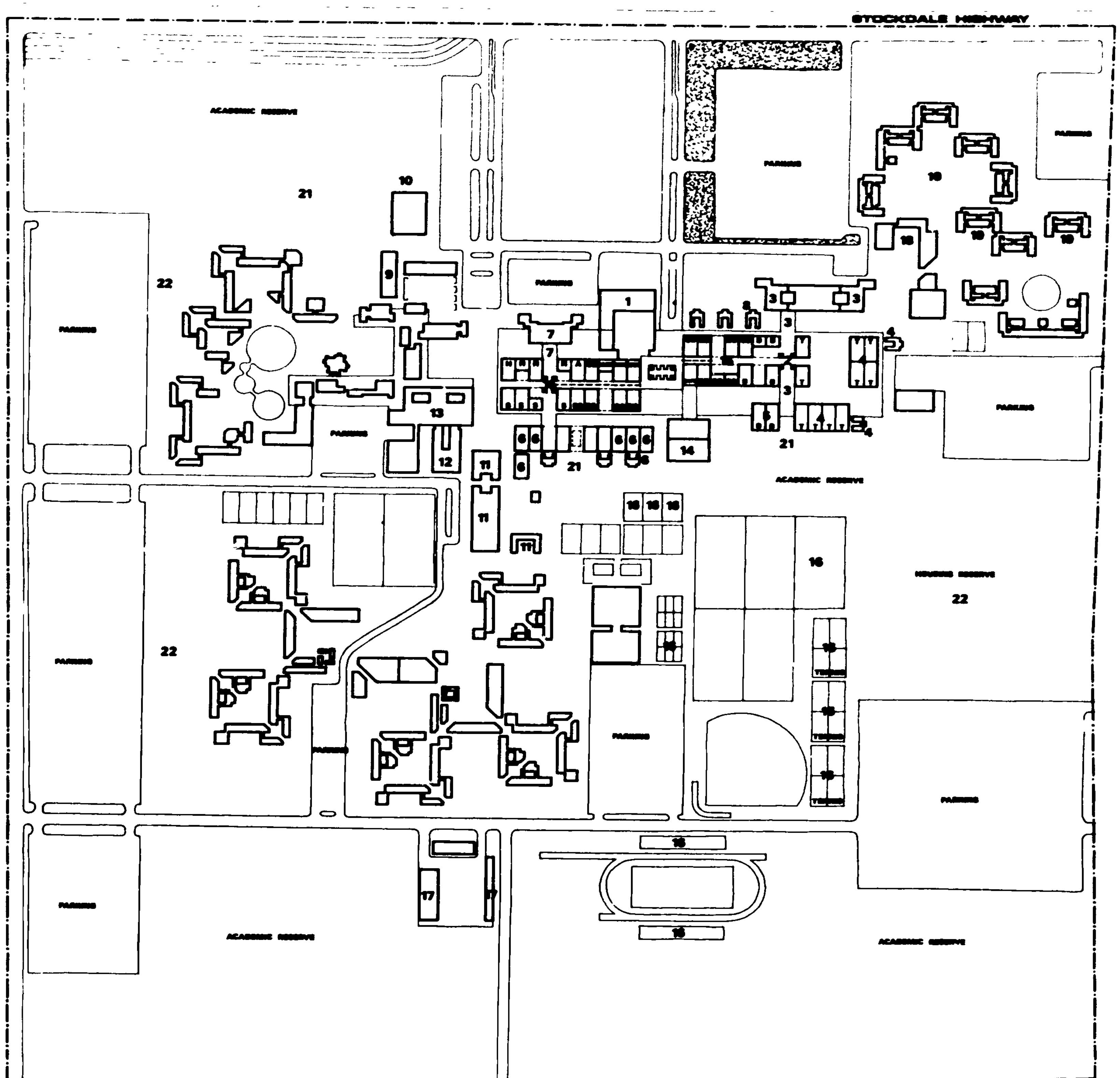
Within the academic core, expansion has continued to the east and peripheral additions have been made to the library, administration, sciences and the student union. New buildings have been initiated for humanities, business, and industrial arts and technology.

The speech, art and drama area has installed its final structure. A new building for nursing and medical technology has been completed and education has expanded into the vacated area. A health science and physical education complex is complete and additional outdoor physical education has been added.

Additions to the corporation yard have been made, the road system expanded and parking capacity brought up to its total of 7,200 stalls.

All three academic villages had been previously completed but additions to upper division housing have continued and approximately 1,500 upper division units are now in place. But in case private developers have left an on-campus demand in excess of this, the number could be readily doubled. Additions to lower division housing above the 2,100 units now shown can also be accomplished by augmenting the existing villages with medium rise structures.

Academic expansion beyond the presently programmed 12,000 FTE can take place in any or all of the four major areas shown or even within certain areas of the core itself. 20,000 FTE could be accommodated on the site but some relocation of parking areas and playfields would be required.



CALIFORNIA STATE COLLEGE, BAKERSFIELD

DEVELOPMENT PROGRAM: 12000 FTE (8-5)

1 COMPLETE LIBRARY
2 EXTEND UNIVERSAL SPACE, BY INCREMENTS, TO ULTIMATE
3. EXTEND ADMINISTRATION AND S.S SPACE BOTH WITHIN UNIVERSAL SPACE AND IN SPECIAL BUILDING
4 BUILD SPECIAL BUILDINGS FOR APPLIED SCIENCES AND TECHNOLOGY
5. BUILD SPECIAL BUILDINGS FOR BUSINESS
6 ADD TO SCIENCE BUILDINGS
7 BUILD SPECIAL HUMANITIES BUILDING AND BRIDGE TO UNIVERSAL SPACE
8. BUILD INSTRUCTIONAL SUPPORT TOWER IN BEHAVIORAL SCIENCE
9 BUILD MUSIC, SPEECH AND DRAMA BUILDING
10. ADD OUTDOOR AMPHITHEATER
11. BUILD HEALTH SCIENCE AND PHYSICAL EDUCATION BUILDINGS
12. BUILD NURSING AND MEDICAL TECHNOLOGY UNIT
13. REMODEL EDUCATION BUILDING TO EXPAND INTO AREA VACATED BY NURSING, HEALTH SCIENCE AND PHYSICAL EDUCATION
14. COMPLETE COLLEGE UNION NS
15. SHIFT UNIVERSAL SPACE ALLOCATIONS TO FIT CURRENT DEMAND
16. ADD TO OUTDOOR PHYSICAL EDUCATION
17 ADD TO CORPORATION YARD
18. ADD TO UPPER DIVISION COMMONS AND DINING NS
19. ADD TO UPPER DIVISION HOUSING NS
20. ADD TO PARKING FOR TOTAL OF 7,200 STALLS NS
21. AREAS FOR POSSIBLE ACADEMIC EXPANSION BEYOND 12,000 FTE
22. HOUSING RESERVES

0 300 600

NORTH

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

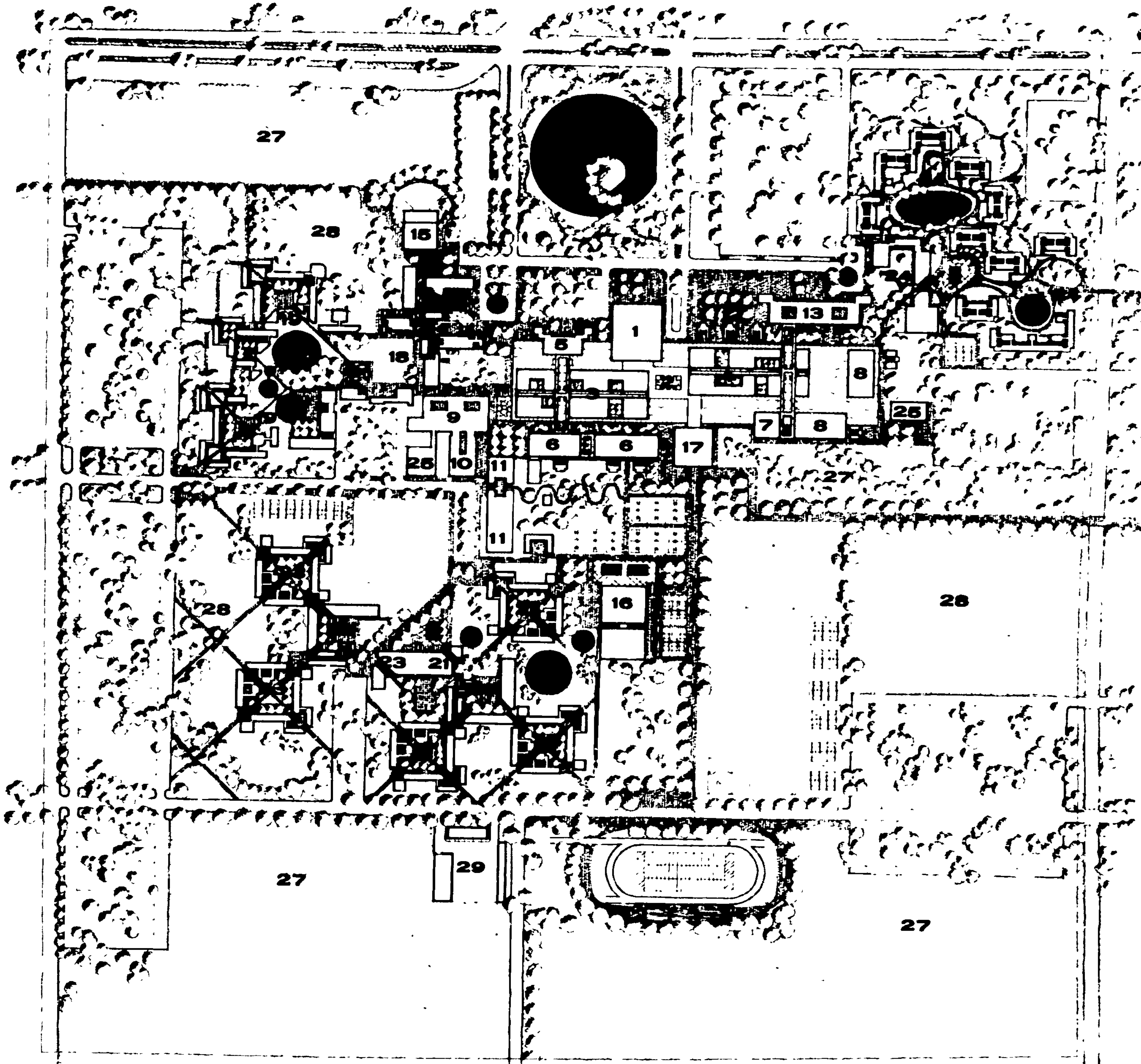
MASTER PLAN 12,000 FTE (8-5)

Upon completion of the growth process just described, the College at Bakersfield will assume a character based on the concepts described in this report even though it will most certainly differ in detail. The plan to the right indicates about how the campus will be with an enrollment of 12,000 full time students sometime near the year 2000. The growth has been intentionally planned to follow a lineal pattern. It started with a strong anchor on the west, moved eastward through a strong basic spine with academic augmentation in specialized structures being added as needed and in accord with the then foreseeable requirements and completed its prescribed growth by reaching its western limit while adding onto its disciplinary centers. This process, using today's estimates, will take about two generations to complete. By then the initial buildings will be some thirty to forty years old and we can be quite certain that the ideas that brought them into being will be quite different. It is entirely possible that these first buildings will be obsolete, at least to some degree. If they are not, then nothing is lost and the College continues its operation without difficulty. But if they are obsolete or nearly so, then the Master Plan must be prepared for a second cycle - a regeneration.

This plan is designed for exactly that. It proposes that its initial units be designed for a life of about two generations, that its universal space have a structural ability to survive much longer, but that it be capable of adapting to radical change in arrangement, that its special spaces be considered as efficient servants to an ever-changing technology and teaching technique, and that its faculty offices provide a secure and solid environment as background for the ceaseless and hurried pressures of academia.

We see no planning difficulty in coping with time or the changes time might bring about. In fact, the plan is quite capable of encouraging change let alone welcoming it.

MASTER PLAN: 12000 FTE (8-5)



1. LIBRARY
2. CENTRAL PLAZA, BOOKSTORE, CAFE
3. WEST GALLERIA CLASS ROOMS
4. EAST GALLERIA CLASS ROOMS
5. HUMANITIES
6. NATURAL SCIENCES
7. BUSINESS
8. IND TECHNOLOGY + APPLIED SCIENCE
9. EDUCATION
10. NURSING AND MEDICAL TECHNOLOGY
11. HEALTH SCIENCE AND PHYSICAL EDUCATION
12. BEHAVIORAL SCIENCES
13. ADMINISTRATION
14. ART, SPEECH AND DRAMA
15. LITTLE THEATRE
16. FIELD HOUSE AND GYM
17. COLLEGE UNION
18. VILLAGE NO. 1 ACADEMIC
19. VILLAGE NO. 1 RESIDENTIAL
20. VILLAGE NO. 2 ACADEMIC
21. VILLAGE NO. 2 RESIDENTIAL
22. VILLAGE NO. 3 ACADEMIC
23. VILLAGE NO 3 RESIDENTIAL
24. UPPER DIVISION AND MARRIED STUDENT RESIDENTIAL
25. CENTRAL PLANTS
26. ENTRANCE GARDEN AND ROADS
27. ACADEMIC RESERVES
28. RESIDENTIAL RESERVES
29. CORPORATION YARD

0 300 600

NORTH

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

RUSSELL Y. IWANAGA A.S.L.A.
LANDSCAPE ARCHITECT

CALIFORNIA STATE COLLEGE, BAKERSFIELD

THE ARCHITECTURAL CHARACTER, OPPORTUNITIES AND RESTRAINTS

There is probably no more difficult master plan element to define than the one dealing with architectural character. And very few other elements are as important to the overall campus environment. The difficulty stems from several roots: almost all judgements in this area are qualitative and therefore highly subjective; judgements made now are intended to guide project designs over a long period of time and there are few among us equipped with foresight strong enough to see some 30 or 40 years ahead; and there is the matter of degree of control. If controls are definitive and specific, then the campus is faced with generations of designs that in all probability will successively deteriorate as later buildings, lacking the infusion of fresh spirit, become faded copies of the original ones. If, to take the other extreme, controls are general and vague, then the result to be expected would be confusion if not outright chaos.

Even a middle ground has its difficulties as anyone who has served on or been subjected to a review board, layman or professional, can testify. In fact, this seemingly sensible middle-of-the-road approach is too often the most frustrating, time-consuming, expensive inefficient and dullest of all.

Since this problem was recognized from the outset and its solution listed as a major objective, it has been possible to consider it at every step of the actual planning process and thereby gain a tremendous advantage by adding the *plan* itself as a governing framework for architectural expression. By using this additional tool and augmenting it with a statement of the environmental philosophy and operational principles, we believe that a functional, harmonious, exciting, livable and beautiful campus can be achieved. It cannot be achieved, however, without the continuous and inspirational input of individual project architects doing their work as the college moves through its extended growth period.

The subdivision of space by function as well as academic identification is the most significant planning input affecting the architectural process. The Master Plan specifically identifies several types of space by function and location. These have been described earlier in the report, but they are restated here in terms of architectural significance.

Universal Space: A single major low-level structure extending some 1300 feet from one end of the academic core to the other devoted primarily to multi-disciplinary classroom use but including some faculty offices and student services, and serving as the primary circulation route between all elements of the institution. This is not a simple extended continuum of uniform space. It is enclosed in a standardized structure, but the very standardization of this structure provides for an interspersed system of open and closed courts (the locations of which are to be determined as each successive increment is planned), service and office banks on two levels (with the exact locations fixed only when these can be determined), a main galleria that extends the full length of the structure offering access to lecture and seminar rooms of various sizes and access to specialized facilities and faculty offices, a second level of circulation primarily for faculty and staff (but available to all) that augments the main circulation system and provides immediate access to the upper levels of peripheral buildings.

In anticipation of possible change, this single structure is actually divided into two parts. The first on the west, the second to the east. The two segments are slightly offset and so allow for modifications to the initial section should modifications prove necessary. The point of offset becomes the major court of the college. This area is the central gathering point for students, the main entrance to the campus, the library and the college union. It is flanked by these facilities plus the college book store and the cafe, as well as the entrances to the east and west gallerias. On the balconies surrounding it there will be special student activity offices and student lounging areas.

This special central place deserves an architectural expression quite different from the standardized spaces that flank it east and west (universal space) nd also quite different from the library to the north and the college union the south. In fact, the architectural program for this space, including its xterior terraces and approaches, would include a solution for the tying to- ether of the contiguous elements (along with its other internal requirements) his kind of architectural assignment does not pose the types of problems aced by the designer of free-standing structures. We have no doubt that an mportant expression such as this central hall can fulfill its demanding archi ectural requirements *provided* the frame of reference is established. The aster plan, in effect, says that this frame is set, first by the design of the itial universal structure, second by the assignment of contiguous spaces by ze and location and thirdly by the operational and space needs as can be edicted at the time of its design.

he architectural program for the universal space itself is equally well defined. his space plays an important role in the campus design by acting as the ajor architectural unifying element. In order to do this with the greatest ssible strength, it will have a uniform external character from one end to e other, a length of about 1300 feet. There is no doubt that a building this dimension, even though it is actually two buildings joined in the middle the central hall, will be powerful enough to unify the various shapes and es of the specialized wings attached to it; but to make doubly certain r reasons in addition to esthetics), the universal space structure is set on earth podium about four feet higher in elevation than the structures rounding it.

the growth program goes as expected, this central spine will be practically mplete in about twenty years. Even knowing that there will be many anges in the next twenty years, the master plan proposes that this particu- building not change its character at all. If this principle is adhered to, then ysical change can be more freely accommodated in the areas where it is ely to be the most radical—the special buildings. To put it another way - more discipline exerted on the central spine, the more freedom avail- e for the attached wings.

The idea of absolutely defining a building some twenty years in advance of its completion is shocking, unless the circumstances concerning this particular situation are considered in detail and unless the design is a match for the challenges that time will force upon it. Taking these factors into account, the design program for universal space is as follows:

1 As presently estimated, this building will house about 88,000 assignable square feet devoted almost entirely to lecture, seminar and conference use The figure of 88,000 square feet must not be considered as a given (differences of 20,000 square feet above or below the estimated size should be anticipated), but the basic function of the building - classrooms is assumed to remain constant

2 The structure must be capable of providing facilities for large and small rooms ranging in capacity from twenty to five hundred (300 square feet to 7,500 square feet) These spaces will be originally subdivided in accordance with the then prevailing academic program requirements but the subdivision must be capable of change and resubdivision if the program is modified The building must recognize the widely varying requirements between small and large spaces and allow for changed ceiling heights and stepped or sloping floors The lead time for these resubdivisions should be held to a maximum of one year from program definition to physical accommodation.

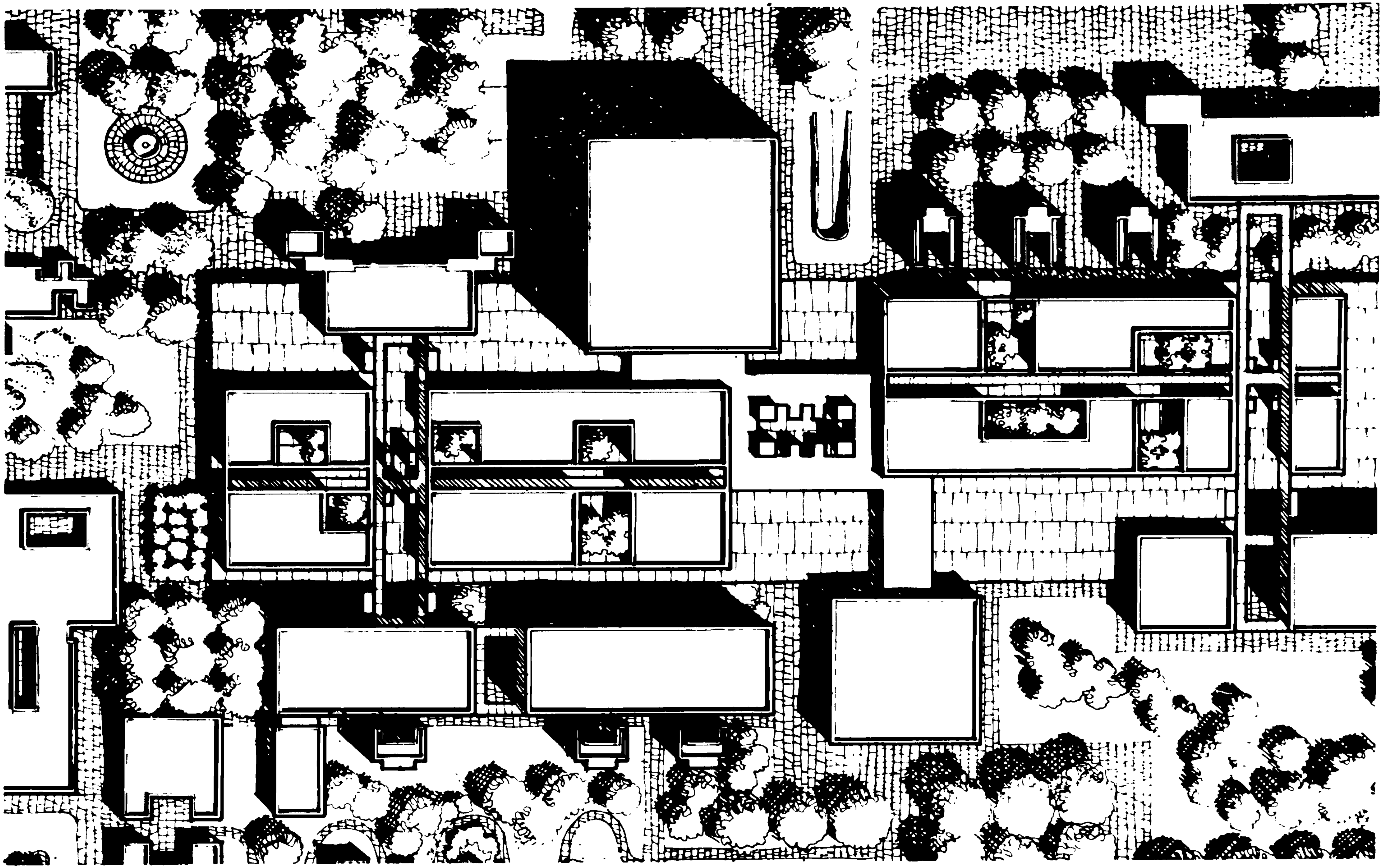
3. All spaces within the universal structure must be capable of adapting to technological advance and changing teaching—learning techniques (TV, visual projections, audio-communications, teaching machines, data retrieval, microclimatic and environmental control, changed seating attitudes, and radically different teacher station requirements). State standards do not yet, and for good reason, permit this kind of undefined flexibility for a programmed facility. But nothing in the standards inhibits the provision for change once that change becomes an approved program. The particular problem here involves living with accepted norms while making certain that radical change is possible.

4. Service and ancillary spaces for the classroom activity (toilet rooms, mechanical equipment rooms, custodial spaces, etc.) must be contained within the universal envelope. Aside from the strictly utilitarian requirements, provisions should also be made for rest, study and social gatherings; displays, notices and other communications opportunities; the housing of faculty closely associated with the teaching activity in this space, and offices for student services and student activities.

5. Universal space will define the primary circulatory paths of the campus. Since it is the academic spine, it will contain a primary internal pedestrian traffic route connecting all elements of the universal space itself and, in addition, it will provide the major connections to the specialized buildings surrounding it. External paths on and beside the podium will augment the internal system by accommodating bicycles, ramps for the handicapped, and short-cuts between the peripheral structures. A second circulatory augmentation is provided at a mezzanine level. This upper level will not serve the standard classrooms but it will interconnect the second stories of the specialized buildings, provide access to offices, provide additional impromptu seating areas, and introduce another web of circulation available for short-cuts and the absorption of main level overloads. Further, this mezzanine balcony is so positioned as to serve the high end of stepped or sloped major lecture halls.

6. The architectural role of this structure demands that it be uniform in character, contained within a modular envelope, and by its design be capable of binding together other physical elements of the campus that differ in function and will be built over an extended period of time.

THE MASTER PLAN RESPONSE TO THIS PROGRAM FOR UNIVERSAL SPACE IS A STEEL-FRAMED BUILDING APPROXIMATELY 1300 FEET LONG, WEST TO EAST, AND 200 FEET DEEP, NORTH TO SOUTH, ARRANGED WITH AN OFFSET ALONG THE LONGITUDINAL AXIS. ALL SPECIAL SPACES ARE DIRECTLY CONNECTED TO THIS SPINE (SEE PLAN OPPOSITE).

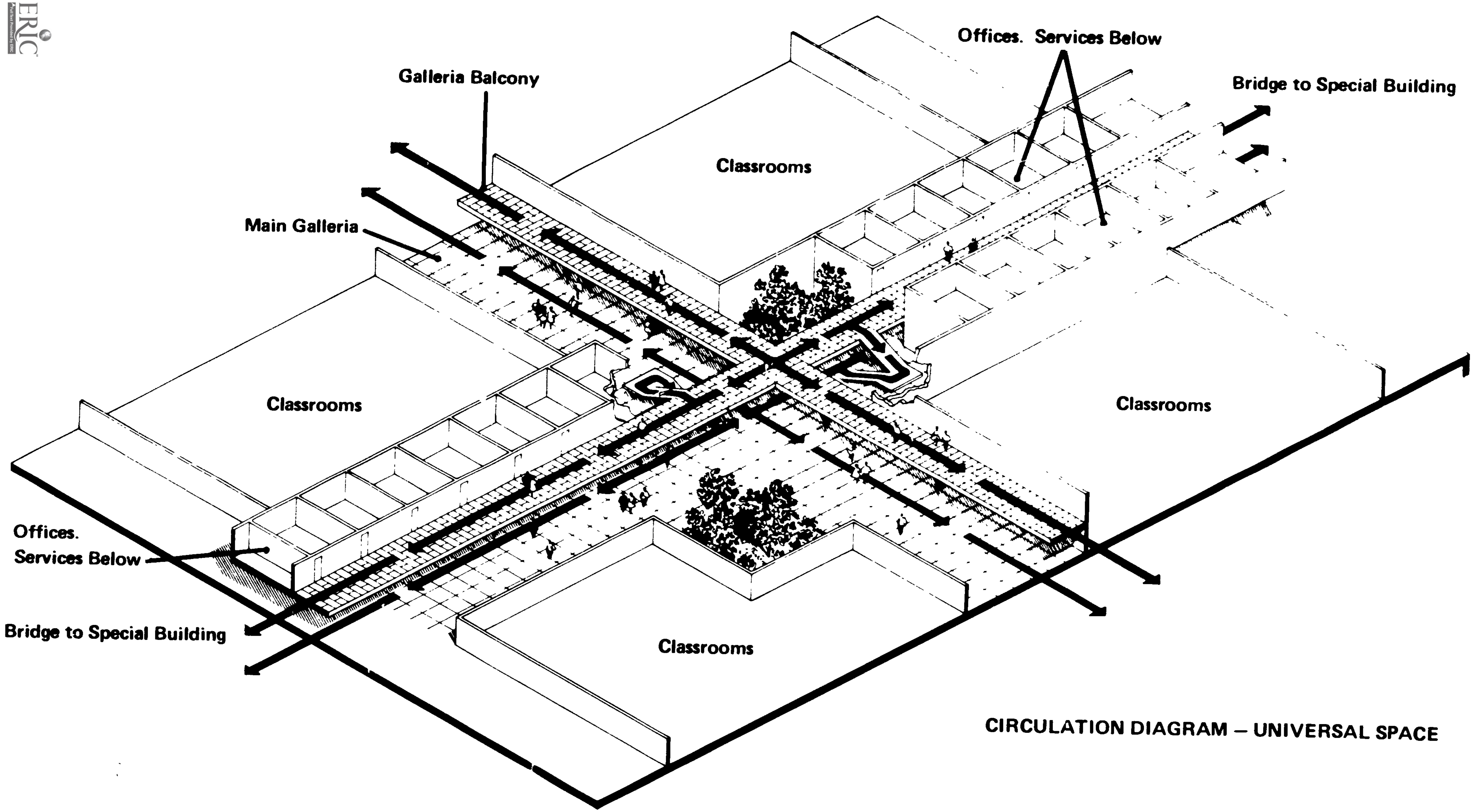


PLAN OF UNIVERSAL SPACE

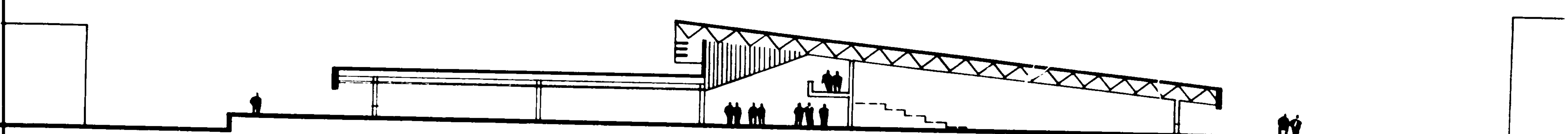
A double-loaded central corridor, the galleria, extends from the western (initial) end to a central hall and from this hall to the eastern (ultimate) end of the structure. This galleria is crossed by branch corridors leading north or south to close-coupled special buildings each housing individual academic disciplines. The central galleria has a balcony on an upper level that connects all branch corridors with each other and the central hall.

The main level of the galleria serves classrooms and lecture halls ranging from small (about 300 square feet) to large (about 7,500 square feet). The larger halls are located on the south side of the galleria where higher ceiling spaces are provided and where upper level access from the balcony can be provided at any point. Smaller rooms will be placed on the north side of the galleria in a section with a uniform standard ceiling height. Access to any room not contiguous to the galleria will be from the cross corridors, from a series of open and closed courts extending throughout the universal space, or from short connecting halls branching off from the galleria. Emergency exits to the perimeter offer regular access to rooms or cross corridors from the peripheral open walk (see section opposite).

The cross corridors are lined with the necessary service facilities and with offices and student facilities appropriate to that particular location. These cross corridors are also the principal internal entrances to individual schools or academic disciplines and, being on two levels, access from the low universal space to the multi-storied special buildings is designed to minimize vertical transportation. This is accomplished by raising the universal space about four feet above the natural ground plane and by keeping the upper circulation level -galleria balcony and cross corridors—at a level consistent with the low-ceilinged rooms (offices, etc.) adjoining the corridors. This results in a split-level arrangement that places the lowest level of specialized buildings only four feet below the main level of universal space, the second level of special space at the galleria level, and the third level of special buildings one level above this. Under these conditions, elevatoring can be reduced to satisfying the special demands of servicing and the accommodation of the handicapped and other special cases.



CIRCULATION DIAGRAM — UNIVERSAL SPACE



SCHEMATIC SECTION THROUGH THE UNIVERSAL SPACE xternally, the universal space takes on a definitive character by plan requirements alone. However, these are not, by themselves, a sufficient description the program. The ways in which this building can meet its internal functonal objectives have already been outlined and it is a matter of detailed udy (to be undertaken at the time of actual program definition) that will ally decide the exact configuation of this structure. The task of the master an is not to actually design this building but rather, to make certain that hen it is designed, the parameters governing that design are fully described. meet this requirement, the description of universal space must go further.

nder existing and foreseeable construction techniques, a system of steel aming is clearly indicated for a single-story building requiring long spans d relatively small longitudinal extensions. The plan proposes that a commitent be made now to long-span (about 100 feet) steel framing on the southern rtion of universal space and that shorter spans of steel framing (about 30 et) be employed in the northern portions. Longitudinal modular extensions st-west) are flexible so far as structure is concerned (the unit could vary om 10 feet to 30 feet depending upon whether steel decking or joists are ed), but from an architectural standpoint, a specified lateral unit must be tablished initially and carried through to completion. Based on room sizes d structural considerations, the plan proposes a standard module of 15 feet.

smic problems in a single story building are not structurally significant, t it is important that the absorption of horizontal stresses not interfere th internal flexibility. Consequently, the master plan proposes that all rizontal forces (wind and seismic be taken into rigid frames without reance on shear walls or cross bracing that might hamper the normal flexibility the space.

far as conventional utilities are concerned, the program already outlined esents no special problems. Gravity wastes and pressurized supplies will be ndled conventionally because, once use is specified, the requirements can be ticipated almost exactly. By the separation of function, universal space ot expected to provide for the distribution of exotic utilities.

Air handling is, however, a complicated situation. The problem within the universal space is to supply and exhaust the properly conditioned air for rooms varying in capacity from twenty to five hundred people with full recognition of the fact that these rooms will, over time, change in size, number and proportion. With steel framing and the types of attic spaces proposed in the section shown before, no problems are anticipated in satisfying these internal requirements.

There remains, even so, the problem of supplying conditioned air to the special buildings surrounding the universal space. This could be done by external tunnel distribution or by other means, but with universal space already acting as a physical link with all major structures, it is a matter of simple logic to ask this building to act as the distributor of heating and cooling for all the structures attached to it. By so doing, the need for utility tunnels and underground distribution can be virtually eliminated. The master plan proposes that the universal space perform the utility distribution function without resort to expensive tunnels and buried lines

Finally, in regard to universal space, the master plan sets forth the architectural guidelines for the designer entrusted with this space. First, it must fulfill the technical requirements described above. Second, it must fulfill the unifying role also described previously. And, third, it must provide an architectural guide or inspiration for the spaces that are linked to it. Most aspects of these criteria have already been stated, but some, mainly in the architectural realm, need additional comment.

The section shown through the universal building indicates quite clearly the design opportunities open to the architect of this academic *"main street"*, the galleria. This is a high and generous space with a balcony and intermittently spaced clerestory windows adding interest to its vertical dimensions. Horizontally, it is punctuated by a series of landscaped courts for the encouragement of impromptu meetings between students, student and faculty, commuter and resident and all other members of the college society. In special cases, these courts can also be used for formal instruction or scheduled student meetings, but their primary function will remain as informal breathing spaces dotted throughout a high density general academic area.

The isometric drawing of a typical intersection between the galleria and two of its cross corridors or bridges shows the three dimensional design possibilities inherent in the plan. This is not intended to be a simple corridor, though it certainly has that function. It is, in addition, a place charged with the environmental responsibility of providing a lively character and a personality reflective of the college's philosophy - multi-disciplined, academically involved personally, and with physical facilities scaled to the individual rather than to the major institution that it is. This is not always feasible within the rigid formalized teaching spaces themselves but in the galleria the spirit of interchange, activity and scale can be clearly demonstrated.

Around the perimeters of the universal space, the plan proposes a second circulatory system with an entirely different character. Because of the raised podium, universal space is elevated some four feet above the ground level of the specialized buildings surrounding it. In addition to strengthening the architectonic values of universal space as a unifying force, this change of level offers circulatory advantages and provides for the individualized design of the important connecting link between general and specialized structures.

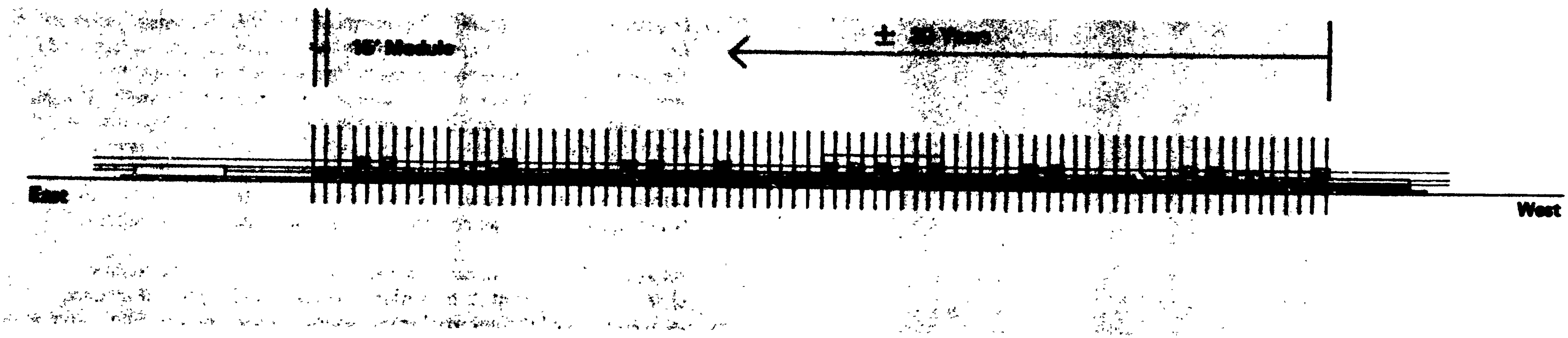
The schematic elevations on the right indicate the proportion and scale of universal space when viewed longitudinally. The upper diagram shows the academic spine by itself, the lower shows how it relates to the possible configurations of the special buildings surrounding it.

These two diagrams set a definite frame of reference for design.

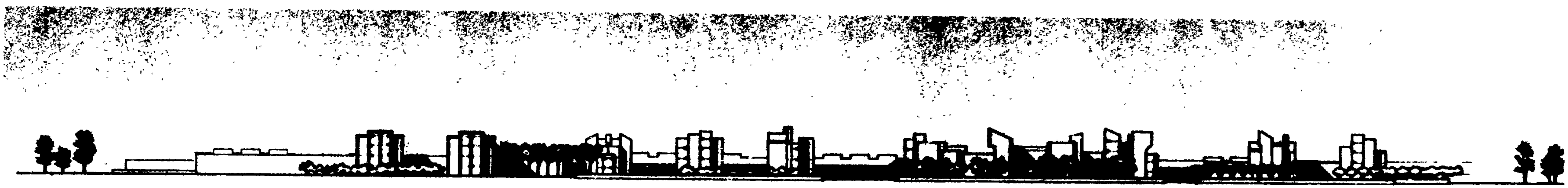
Because of incremental additions in standard units, a module, expressed vertically, is appropriate from a design standpoint and practicable for construction reasons.

The expression of vertical divisions in the design of a horizontal building made even more horizontal in feeling by the podium on which it rests, opens the possibility of highly sophisticated designs that employ vertical accents played against a horizontal background that itself contains echoes of verticality—those echoes being reflected in the modular separations, the clerestory windows into the galleria, and in the upper level bridges tying the central to the peripheral spaces. These architectural expressions are implicit in the upper diagram.

The lower diagram illustrates ways in which this design system can be extended into the peripheral structures. Note here that the combination of horizontal and vertical elements is extended into the highly mechanized spaces containing laboratories but that no standardization is expected among these specialized spaces. The design system shown progresses next to the office and other instructional support spaces. These are small-scaled spaces and they are expected to express diversity within a structured frame. This would be difficult to achieve in the standardized anchor of universal space and not always possible or even practical in the mechanically oriented laboratory blocks. And so the third design element is introduced. Here verticality has been selected as the appropriate dominant form of expression but a strongly expressed horizontal base is used as the means for the foreground assembly of buildings grouping them into a recognizable identifiable symbol of the adacemic specialty housed within. The continuous and contiguous universal space, shown here in silhouette is the all-encompassing background tie between the groups.



SCHEMATIC NORTH ELEVATION — UNIVERSAL SPACE

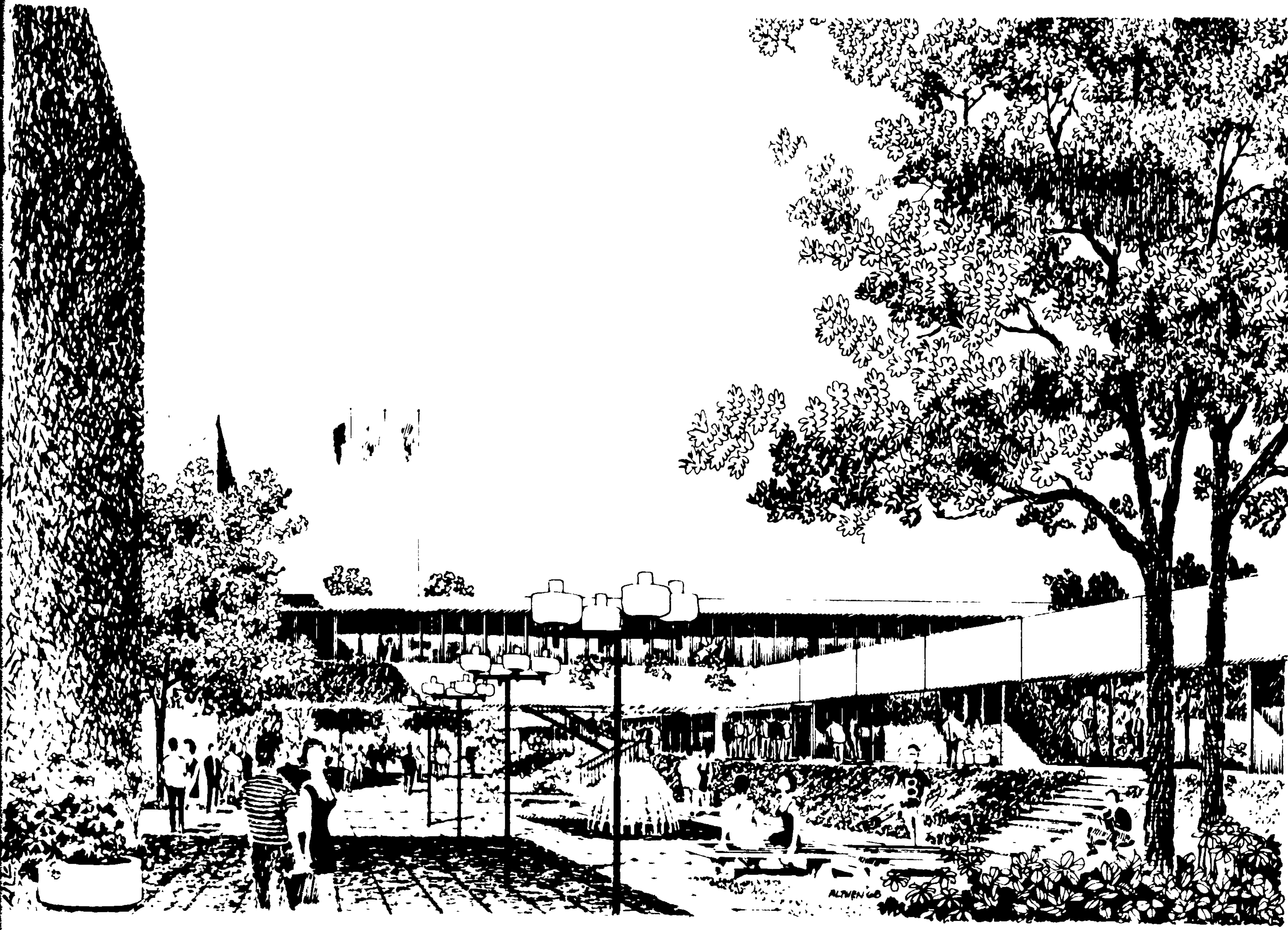


SCHEMATIC OVERALL NORTH ELEVATION

Previous sketches and diagrams have indicated the internal and exterior character of the structural components of the central campus. However, between these two environments there is a third important enough to deserve special attention—that is, the bridge or link from central to special facilities. This is a multi-level continuum of courts, walks, bridges, ramps and stairs that together form the important meeting ground between two distinguishably different parts of the campus. When this space is considered longitudinally, it is an important split-level, all-campus circulation route. Viewed laterally, it is the operational link between special and general areas within a given academic discipline.

As a part of the overall campus system it will assume a *"throughway"* character reflective of its operational demands and expressed, in part, by the design of the universal space exterior (shown on the right). But, in response to its lateral function, it will naturally take on the varying characteristics of the individual special wings being served.

This sketch shows the scale and basic elements of a typical connection. The exact definition of details has been avoided here—these will remain for the then current academic program and architectural creativeness to resolve.



THE CONNECTION: LABORATORIES - UNIVERSAL SPACE

CALIFORNIA STATE COLLEGE - BAKERSFIELD

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

oratory Space: Heavily equipped spaces grouped according to disci-e, multi-level and highly specialized by function. These areas present ry different architectural problem from that of universal space. tial flexibility as required between large demonstration labs, small arch labs and normal teaching labs can certainly be expected and will forever, a major problem. In addition, flexibility of servicing require-nts for all types of labs is and will continue to be highly complex. s is a much more involved problem in prediction than is the case for versal space and in recognizing this the master plan program for the gn of these spaces is very different from that evolved for lecture ces. The universal space program, with considerable assurance, pro-s itself two or even three generations hence. Any such extensions of grams for highly mechanized, very specialized spaces would be both rictive and presumptive. Laboratory spaces need long-range special grams of their own. The laboratory program for Bakersfield is as ows:

As presently estimated, labs will ultimately total over 300,000 ASF housed in eight locations arranged in this manner -

Behavioral Sciences	± 24,000 ASF, one and three stories
Fine Arts	± 41,000 ASF, one and three stories
Humanities	± 19,000 ASF, two stories
Natural Sciences	± 125,000 ASF, one and three stories
Business	± 13,000 ASF, one story
Education	± 24,000 ASF, one story
Nursing	± 12,000 ASF, one story
Industrial, Tech. and Applied Science	± 62,000 ASF, one and three stories

Since definitive academic programs for these lab structures have not yet been formulated, the size and number of stories are subject to change. In the placement of these structures within the master plan, allowances have been made for major revisions in the program.

2. Requirements for the wide diversity of functions and operations suggested by the above list cannot be reduced to common denominators and any attempts at standardization would seriously impair the entire laboratory program. Nevertheless, the plan proposes certain guidelines for lab development that are intended to insure compatibility between elements, not restrict individual programs.

3. For one-story buildings, steel framing similar to that employed in the universal space offers maximum flexibility at lowest cost and should be used except where special requirements dictate a different framing system. Rigid frames eliminating the necessity for inhibiting shear walls are to be used wherever possible. Multi-story buildings (none are proposed as high rise), based on today's technology, should be concrete. Current investigations indicate waffle or pan joist construction using bays about thirty feet square are economic and highly adaptable to most teaching needs. However, in spaces that have heavy and complex mechanical servicing requirements, pre-cast pre-stressed tees provide the greatest opportunities for the orderly and efficient distribution of utilities.

4. The same principle employed in the campus plans, that of grouping similar spaces together into a common block and separation of those that are special, should also apply to the laboratory complexes. In most cases, this will result in a uniformly framed central core with individualized extensions or wings. Even though the finished structure might be unconventional in the sense that it is non-traditional, if done with integrity and grace, it will be in accordance with the master plan. Lab buildings separated by type of space into articulated forms will ultimately form a complex or village, rather than a single building, and this type of differentiation and reduction of scale answers exactly one of the principal goals of the master plan.

5. The space needs related to time indicate that it is very unlikely that any special purpose building would be built in a single

construction phase. Most if not all campus structures will open an initial unit and then add to it as programs and enrollment expand. This type of growth has many physical and operational difficulties and in the case of conventional buildings they are often so intense that initial programs are expanded to include temporary or interim uses in order that the ultimate building envelope may be completed at once. In certain cases this is a justifiable strategy, but the Bakersfield plan proposes that this be a rare exception and never a rule. The articulated type of building described in the preceding paragraph can accommodate incremental additions and if these additions are of sufficient scope to be economic, they minimize the need for costly remodeling and moving and eliminate the danger that as additional space is needed it may no longer fit the physical form pre-built to accommodate it.

Instructional Support Space: Small-grained spaces containing faculty offices, departmental administration offices, clerical support areas and conference rooms. The operational role of this space—as an intermediately individualized transition between teaching and learning—has already been described. But, as with the other major categories of space, this special type warrants an architectural program of its own.

1. According to the current program, this type of space will involve nearly 100,000 ASF. This is slightly more than all lecture spaces combined but is only about one-half of the laboratory requirement. By either measure, it represents a considerable segment of campus space.

2. It is distinctive from lecture or laboratory spaces in that the degree of flexibility and adaptability to change is markedly reduced. In fact, there are many advantages to be gained by retaining this type of space as an environmental mainstay not subject to the quick and drastic shifts that must be accommodated elsewhere on campus. This is not to say that it be incapable of responding to technological innovation. Such response is mandatory but flexibility here is not in the order demanded of universal space (where major shifts in room sizes must be anticipated) or laboratory space (where utility distribution systems as well as room sizes are subject to change). In relation to these, instructional support space can be considered quite stable.

3. Being composed primarily of small rooms—110 square feet to perhaps 500 square feet, the structural system to be employed relates only to the incremental problem at hand—it has no campus-wide or long-run significance.

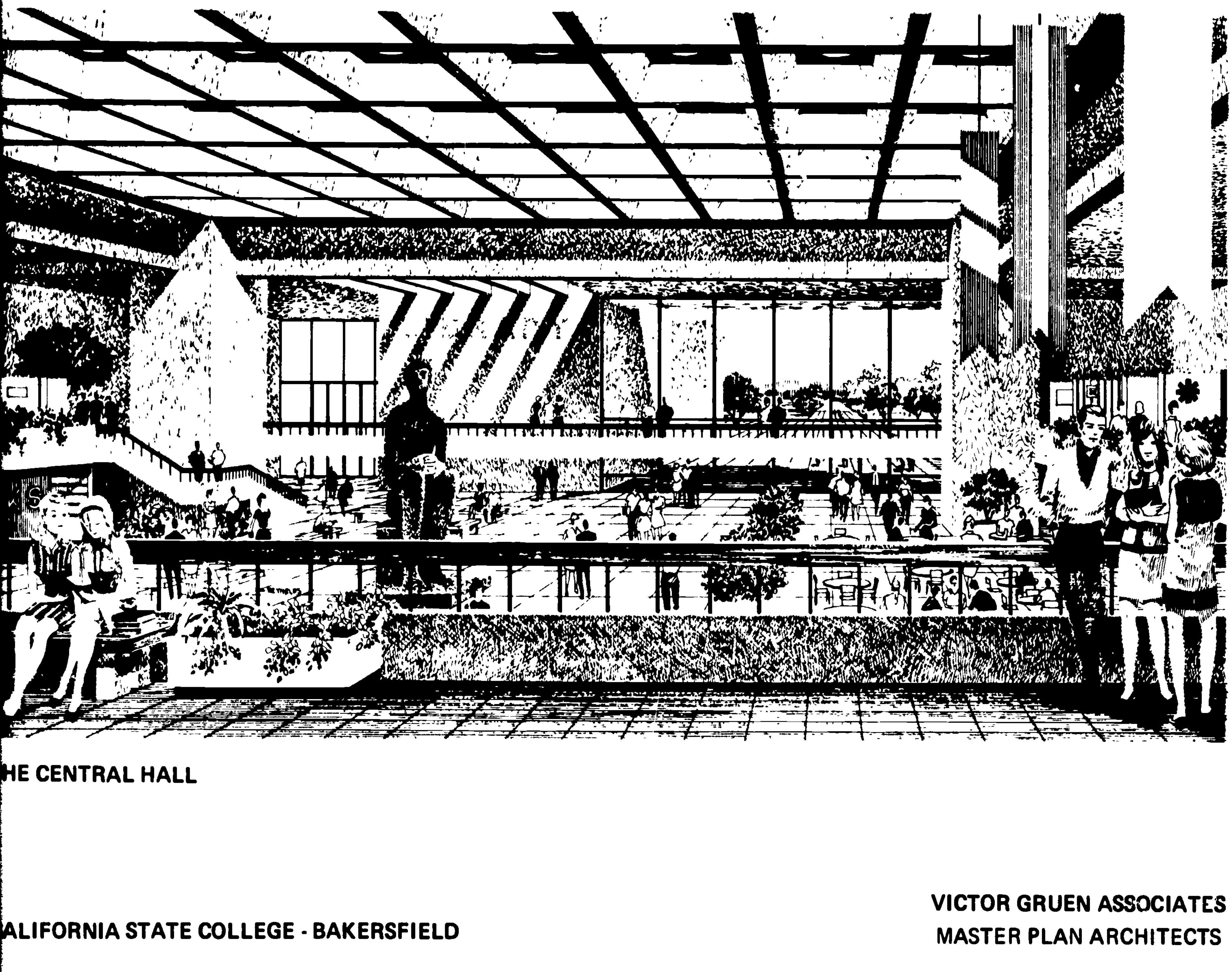
4. Exceptions to the general idea of stability and relative freedom from high degrees of flexibility, will be those faculty offices serving dual roles as research laboratories such as might be found in most

of the disciplines. The master plan recognizes this and allows for the incorporation of some office space into both the universal and the laboratory spaces. Offices so located will naturally assume the general character of their surroundings but the cross-corridor locations in universal areas and the articulated designs of laboratory buildings will allow for proper location and identification without disruption of the overriding system.

5. So far as the unincorporated offices are concerned, and these are presumed to comprise the majority, they will be housed in identifiable structures of their own. The sizes and configurations are open to the requirements of detailed future programs but, out of respect for the environmental elements of the master plan, the accent should be vertical and the scale small.

Preceding diagrams of the universal space and its relation to laboratory and office spaces explains the horizontal-vertical design philosophy and the hierarchy of scales to be employed.

BEFORE ENDING THIS DESCRIPTION OF THE ACADEMIC CORE AND THE ELEMENTS COMPOSING IT, THE SKETCH ON THE RIGHT IS INTENDED AS A REMINDER THAT THE SPACES DESCRIBED, THOUGH SEPARATE IN FUNCTION AND EXTENDED WELL OVER ONE–QUARTER OF A MILE, ARE ALL PARTS OF A SINGLE, INTEGRATED ENTITY: THE CENTRAL HALL SHOWN HERE IS THE SYMBOL OF THIS DIVERSITY AND INTEGRATION.



HE CENTRAL HALL

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The Live and Learn Villages form another definition of space totally unlike that of the academic core. These are small semi-independent "colleges" each with a capacity of about 1400 lower division students. Half of these students will live in the village and the half that commute will be provided with a full range of study, recreation, lounge and dining facilities. All students within a village will share a common group of dining spaces served by a central kitchen. The major lounge area will also be in this dining group.

The residential portion of the villages will be formed by clusters of houses sized for 30 to 40 resident students each. Individual houses will have their own lounge, study and service areas. These common areas will include spaces for all commuter student needs, except sleeping. Each house would contain quarters for proctors or preceptors.

Densities reasonable for this campus can be achieved by maintaining a range of one to three stories—one and two stories for the common spaces, two and three stories for the bedrooms.

The academic portions of the villages are composed of classrooms, conference or seminar rooms, faculty offices and offices for departmental and village administration. All of these, with possible exceptions in office areas, will be one-story buildings designed for total compatibility with the residence buildings.

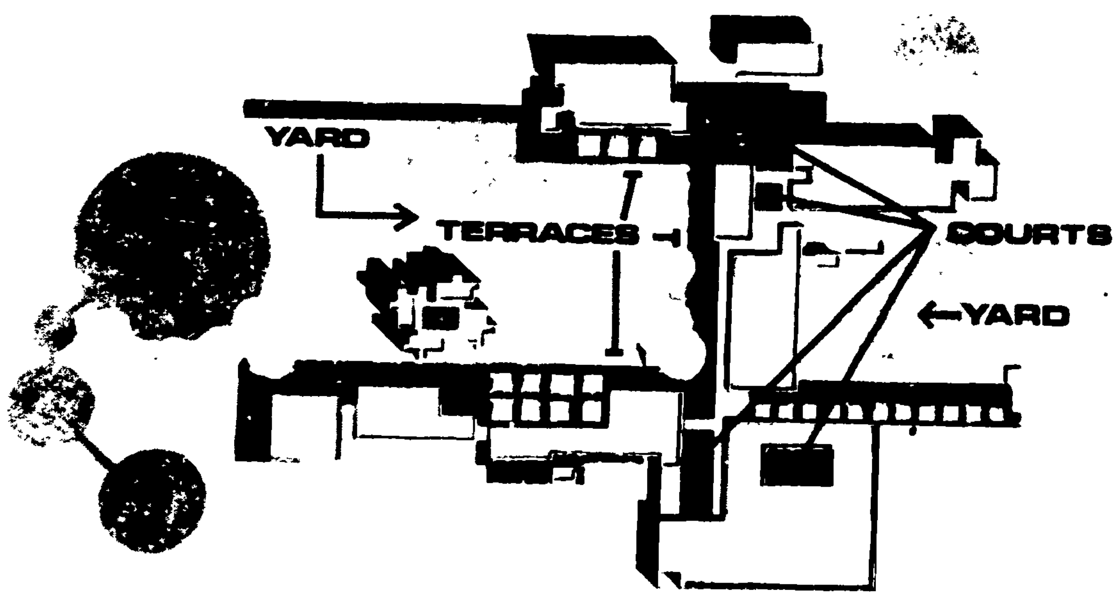
As an example of village character, the academic portion of the first village scheduled for opening in the fall of 1970, is described on the following pages.

The next two drawings represent the design elements employed in the initial buildings and intended for application to the residential sector of the first village.

1. Generally, the design will reflect a definite recognition of the California heritage. The ideas of protected and shaded areas; of contrast between the simple but very solid wall with richly patterned sun control devices; the further contrast of intimate patios with spacious loggias; the enhancement of heavy timber work with the unbroken wall as a background; and the play of color—these are all a sensible part of our heritage in California and especially the San Joaquin Valley.

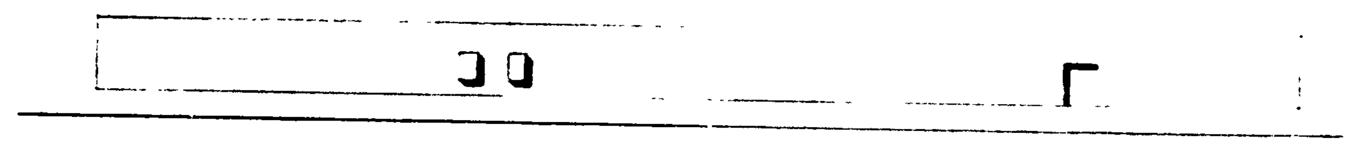
2. The plan illustrates the idea of using courts, terraces and yards as positive architectural elements. . . . . . .

DESIGN ELEMENTS - INITIAL BUILDINGS

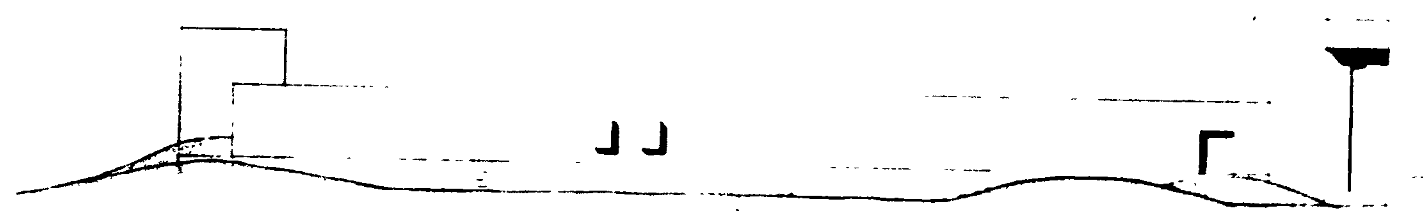


SPACE DEFINITION

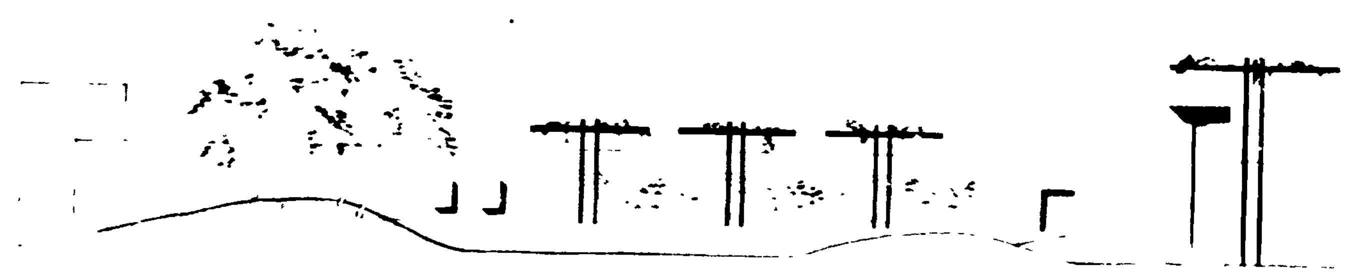
1 COURTS
2 TERRACES
3 YARDS



4 CHANGE OF GRADE
5 WALL
6 OPENINGS



7 VERTICAL BUILDING ELEMENTS
8 PODIUM
9 LANDSCAPED BERMS
10 STEPS



11 SHADING DEVICES
12 LANDSCAPING

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3. This diagram introduces the concept of a podium raised about four feet above the existing ground plane. This relieves the features of the site and provides positive drainage—but it also offers the opportunity for a strong unifying base running throughout the village. The base, as shown, can be treated in a number of ways—sloping lawns, planted mounds, steps, or walls.

4. Shadow—casting foreground elements like trellises give shade, texture and interest.

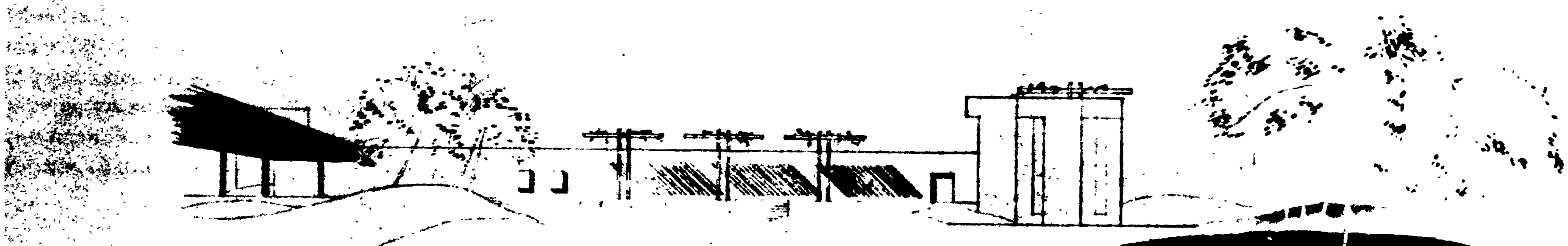
5. Vertical building elements are used for accents and house multi-level faculty offices andmechanical equipment spaces.

6. Landscaping, as always, will play an important role with the use of water being an important (and welcome) feature.

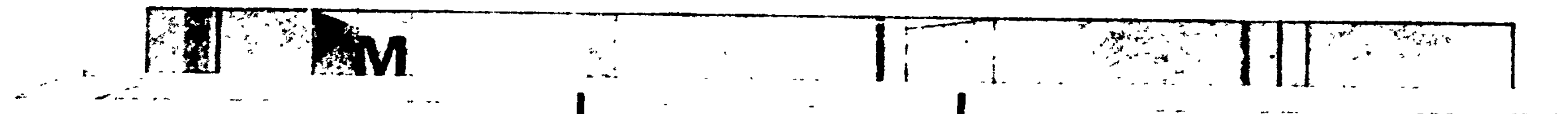
7. Covered walks for protection on the western exposures will also be major design elements.

8. Color and graphics will be an integral part of the design.

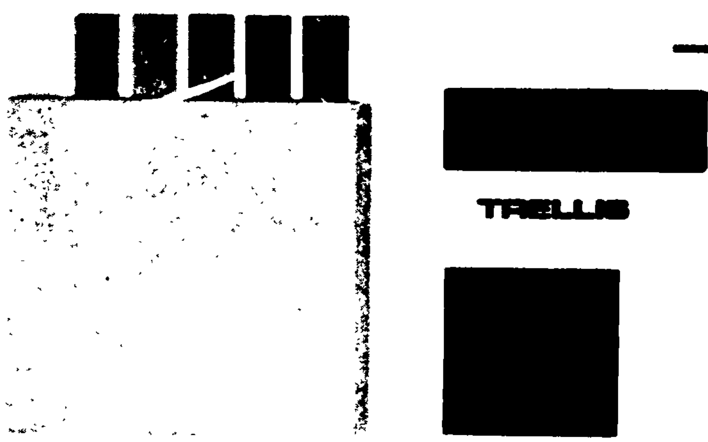
DESIGN ELEMENTS - INITIAL BUILDINGS



13 COVERED WALKWAY
14 WATER



COLOR SAMPLES

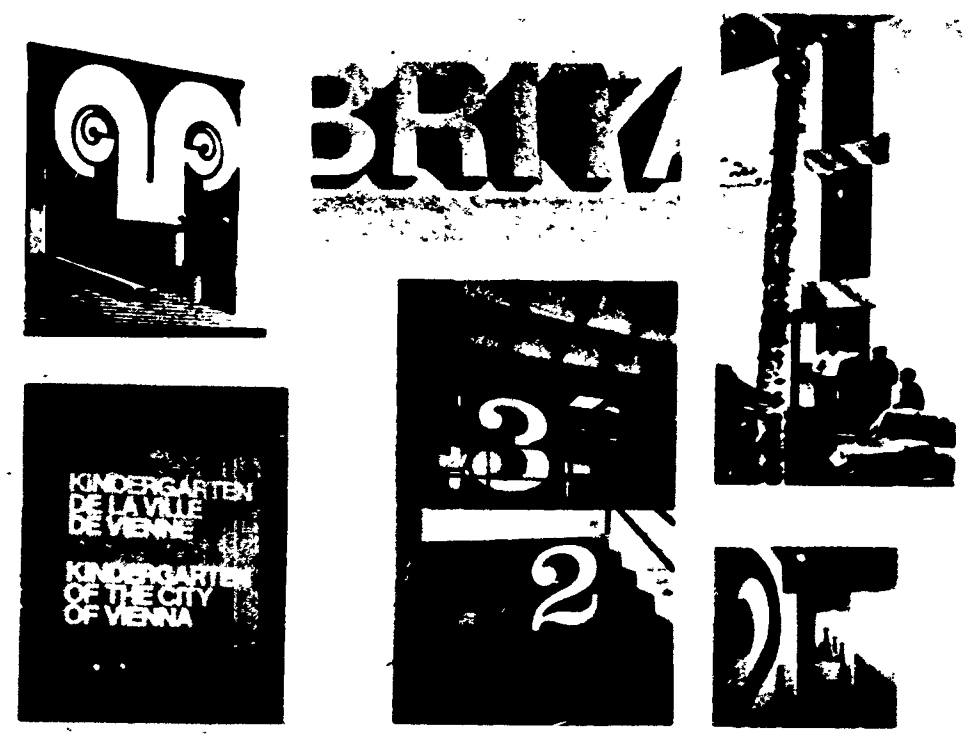


WALL

TRELLIS

PAVING

GRAPHIC EXAMPLES



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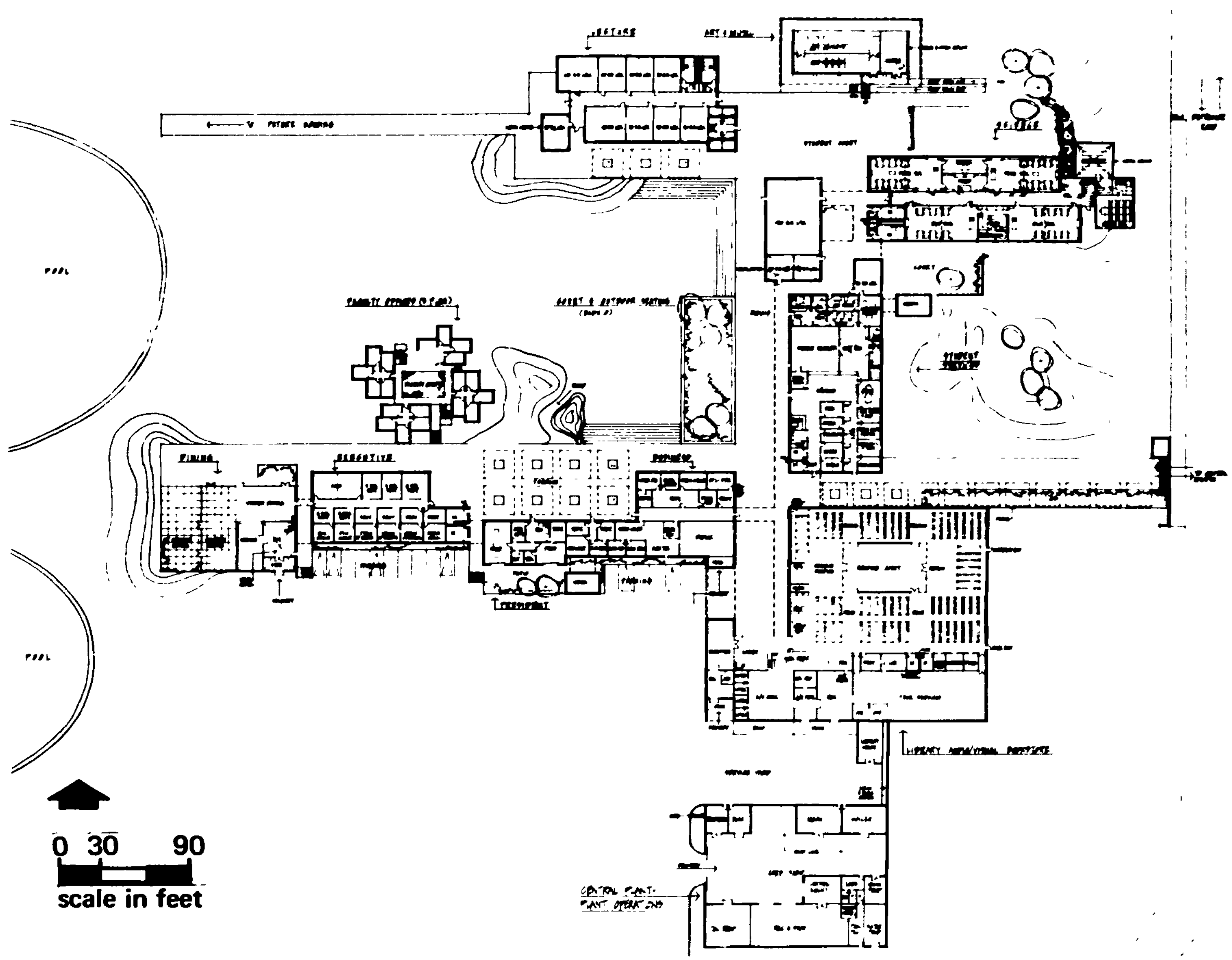
This floor plan indicates the facilities as they will be on opening. At the time of opening approximately 360 residential units will be under construction immediately to the west. Upon completion of these plus a subsequent unit to the northwest, this first village will have completed its growth. However, internal changes will occur as laboratories, administrative and executive offices and the library move to permanent quarters in the academic core. The space freed by these moves will be converted to classrooms.

INITIAL BUILDINGS - SCHEMATIC FLOOR PLAN



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This view shows the main court of the academic area as seen from the residences. The initial classroom wings are to the left, administration and executive spaces (later to be converted to classrooms) are in the center, and a three-storied faculty group is to the right. Most of the design elements can be identified in this sketch.

CENTRAL COURT - VILLAGE NO. 1

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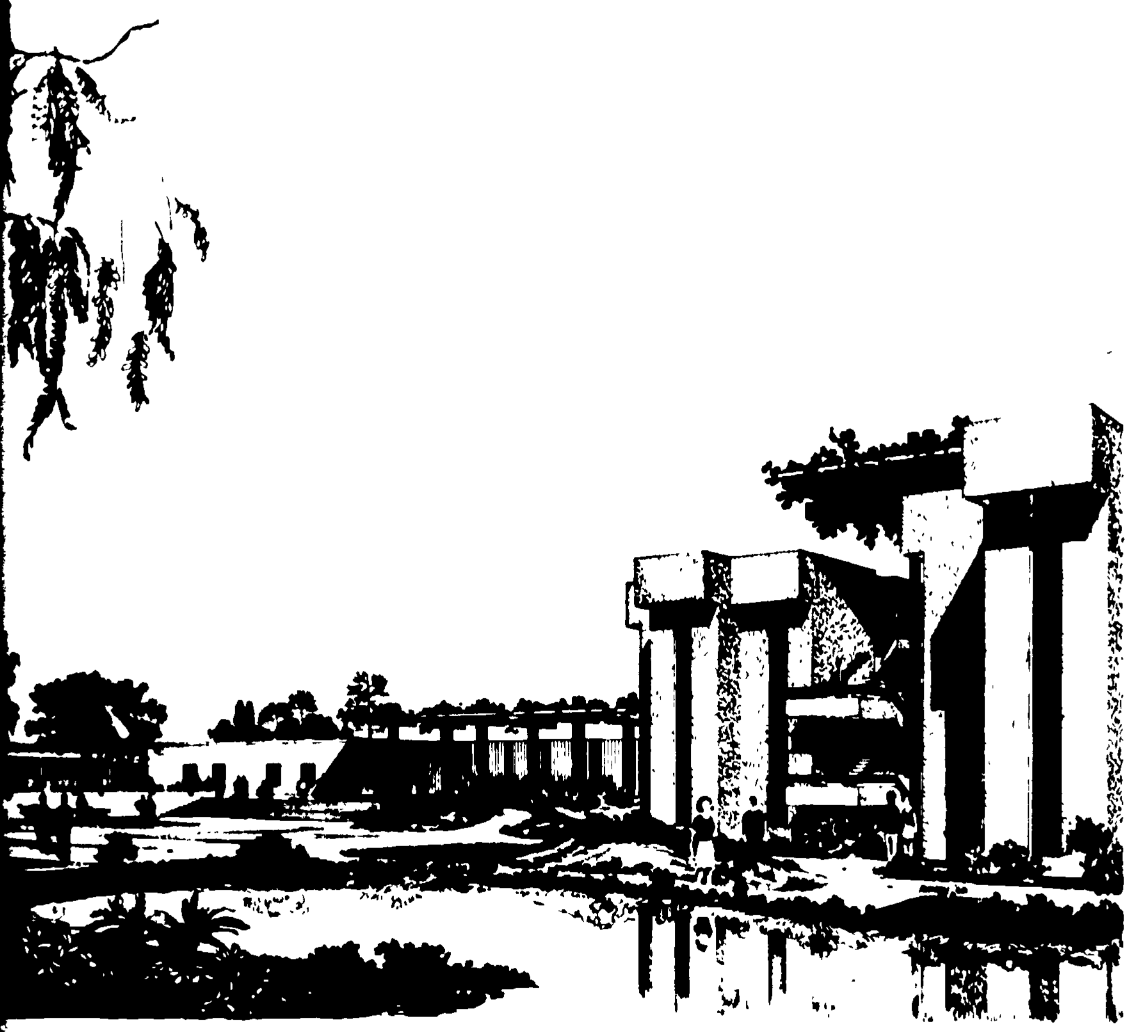

BAKERSFIELD

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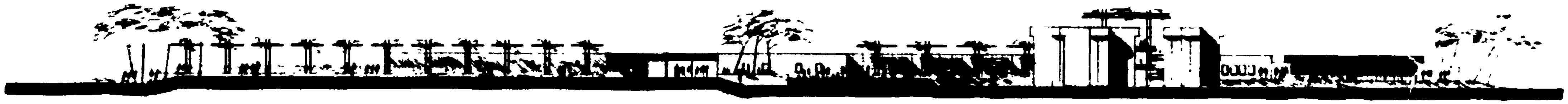
This sheet of building elevations shows how the various elements relate to each other and the general architectural character achieved.

- - - - - - - - - - - -

It is not intended that subsequent live and learn villages will seek this same character. In fact, there are many reasons why they should not. Operational experience will result in plan changes and refinements. These in turn will have impacts on design. More importantly though is the academic philosophy of these villages that, in part, charges them with providing points of personal identification for the younger students. Certainly, architectural variations from village to village will help in meeting this responsibility.

Regardless of variations, however, all of the villages will have much in common. Variations in size are not likely to be very great. Densities will remain about the same. None will be subjected to the rigors of very long-term incremental growth and can, therefore, achieve an immediate inner harmony, and the basic functions of living and learning are not likely to change. These circumstances combine to produce groups of buildings that might be very different in detail but quite alike in feeling. Echoes or even repeats of certain selected elements between the villages will be enough control to assure overall harmony without restricting architectural innovations or affecting the level of quality.

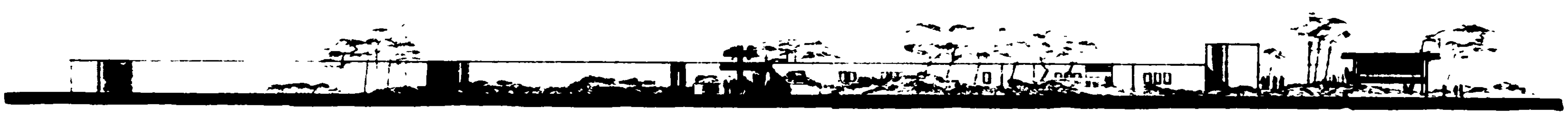
ELEVATIONS - INITIAL BUILDINGS



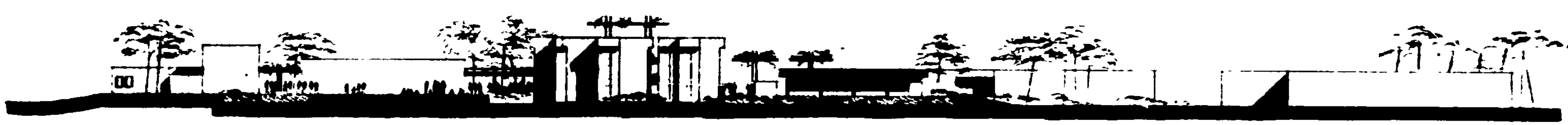
NORTH ELEVATION THRU CENTER

NORTH ELEVATION

SOUTH ELEVATION



EAST ELEVATION



WEST ELEVATION

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THE MASTER PLAN OF LANDSCAPING

The dominating feature of the campus site and its surroundings is its open, flat-land character. The basic landscape approach is to create an area that will be in contrast to this character. The total effect of the campus, with the maturing of the plant materials, will be of buildings situated in a landscaped setting of bermed earth forms, ponds and lagoons, varied greens and assorted textures; the impression gathered as one enters the campus will be of entry into a sheltered, ponded, shaded, rolling, green environment.

The campus design is a deliberate separation of building types into clusters and groups joined to a strong central spine placed on an elevated podium. The effect of trees with their irregular and softening shadows against this forceful architectural presence will present a dramatic contrast in line and form. The component complexes, with their individual identities, will be linked to the central core and to each other by avenues of trees.

The introduction of pools and ponds in conjunction with surface water control will create microclimatic situations that will extend the list of suitable plant materials and the water itself will offer welcome relief from the general dryness of the area. The major pool, situated at the main drive, will be surrounded by an arboretum and may well become not only one of the most distinctive features of the campus, but a landmark along the major highway.

The general design features trees planted in large stands or groups in order to create large areas of shade, to act as windbreaks, and to be of sufficient size and scope to relate in scale with the buildings. Trees will be used to frame and delineate, to flow between buildings and to knit areas together. Trees crossing the boundaries of the site will tie with landscape plans of off-campus developments, relating the whole campus to its environs.

The campus is located in a general area subjected to the extremes of summer sun and winter freezing and to frequent winds. These conditions together with the design considerations form the framework within which plant selections will be made.

There will be trees which, because of their particular character, will be used as structural elements in the design. Comprising this list, within their respective genera, will be pines, eucalyptus, pepper, olive, oak, elm, cypress, catalpa, and sycamore. There will be much use of the stone pine, Aleppo pine and eucalyptus varieties. To provide seasonal diversity and color, flowering trees will be used to accent and as contrasts; these will include the Gingko, Koelreuteria, crape myrtle, Albizzia and the locust. Bottlebrush, oleander, Raphiolepsis, Acacia, dwarf forms of crape myrtle and flax will be used for masses and lines of color in plantings of lower height.

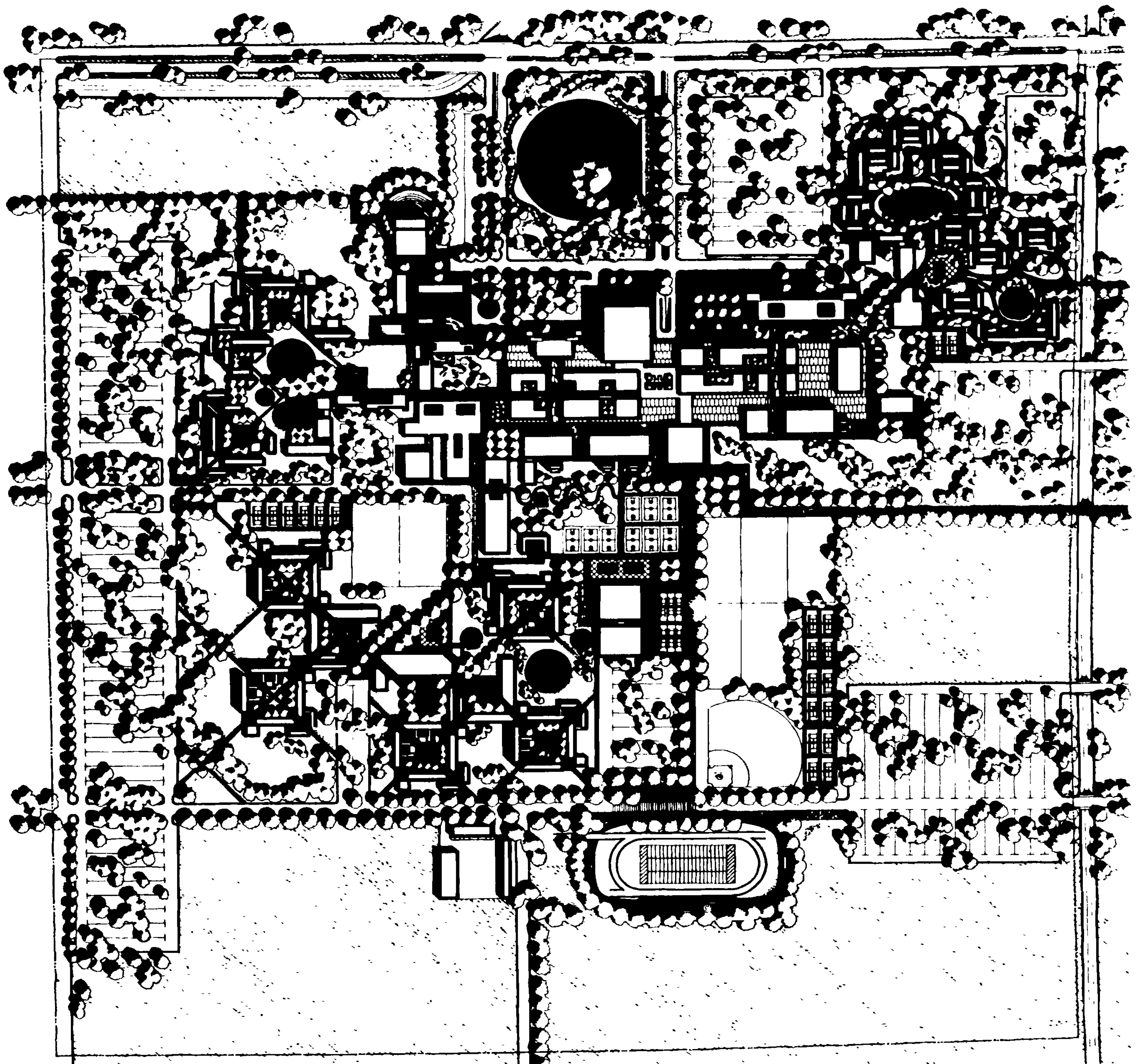
Large, open spaces will be planted in turf and lawn to serve as play and relaxation areas. Turf, together with groupings and clusters of trees will be inviting places in the many warm days of the year and to the passer-by will provide constantly changing vistas.

With the maturity of trees and the resulting change in the growing conditions will come the possibility of using many plant materials that might be questionable at the outset of the landscape program. As the trees grow, the list of plants will expand.

Maintenance considerations will be an important factor in plant selection and location. It is intended that the campus grounds have nearly unrestricted use and it is hoped that the use will be heavy. Also, the grounds will be designed for the lowest possible maintenance costs.

The plan opposite shows the basic elements of the Master Plan of landscaping.

ILLUSTRATIVE SITE PLAN



0 300 600

NORTH

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RUSSELL Y. IWANAGA A.S.L.A.
LANDSCAPE ARCHITECT

CALIFORNIA STATE COLLEGE, BAKERSFIELD

HE MASTER PLAN OF SITE DEVELOPMENT

OPOGRAPHY

eference: Kern County Land Company drawing—file No. H170/7910 dated 4-12-66.

he site is extremely flat, sloping in a southwesterly direction at an approxi-nate rate of 1.4 feet of drop in elevation per thousand feet of horizontal istance.

xisting vegetation consists of low-growing irrigated crops. The entire ite is presently under cultivation and being fed from on-site water wells. here is no other culture on the site.

he irrigation lines and the on-site existing James Canal which are indicated n the existing survey either will be, or have been, abandoned prior to any onstruction operations.

ff-site areas do not normally contribute drainage runoff to the site, such unoff being intercepted by the Kern River and Stockdale Highway on the orth, and the Arvin-Edison Canal on the east.

new topographic survey with detailed elevation control for the north-est section of the site is in process and will be completed for use in con-ection with the initial buildings.

OIL CONDITIONS

he following information, pertinent to the Master Plan, was excerpted om a geological and soil investigation report dated February 9, 1966, by . T. Frankian and Associates:

oil Conditions: The soils underlying Site 1 were deposited as recent luvial fan deposits from the Kern River. Borings drilled along the Arvin-Edison Canal (Ref. 9) on the east side of the site disclosed that the upper two to seven feet consists of silty to clayey sand, underlain by poorly graded, dry sands to the depth of the borings (25 feet). Consolidated deposits are not expected to be encountered within a depth of 400 feet.

"It appears that the effect of cultivation has extended to a depth of approximately three feet. Within that depth the soils are soft and compressible. Below the zone disturbed by cultivation the soils are expected to be moderately dense and would provide good to moderate support for foundations."

"*Ground Water:* Investigation borings drilled adjacent to the Kern River north of section 5 encountered ground water at a depth of 15 feet. Further south of the river, borings drilled to a depth of 25 feet did not encounter ground water.

". . . it is not expected that seepage from the canals will have a large influence on the ground water levels of the site."

"*Site Preparation and Grading:* Past cultivation of the site will require that in the area of construction the top two feet be removed, the exposed surface rolled until compacted, and then the top two feet be replaced as a compacted fill. Except for this site preparation grading will be relatively minor and related to that necessary to establish drainage.

"The soils on the site will be easy to compact and will result in a good fill. All on-site soils appear to be usable; organic content is relatively small. The compacted fill will offer good sub-base and concrete slab support."

"*Foundations:* It is expected that conventional foundations may be used to support the proposed structures. Conventional foundations would include spread footings, mats or footings supported by drilled, cast-in-place concrete piles.

"It is expected that spread footings could be supported at a depth of two feet in the compacted fill or on the natural soil below three feet. Bearing values on the order of 3,000 pounds per sq. ft. should provide an adequate safety factor and minimize settlements. For heavily loaded footings drilled, cast-in-place piles may be required to reduce settlements. An average skin friction of 500 pounds per sq. ft. for piles at least 25 feet deep would be reasonable for this site. Caving of the dry sands below 25 feet may limit the pile length.

"If a bearing value for spread foundations higher than 3,000 pounds per sq. ft. is desired, the material for a depth of one footing width may be removed and recompacted. It is expected that the bearing value associated with acceptable settlements would be approximately 4,000 pounds per sq. ft.

"It is expected excavations for utilities below a depth of about five feet will require shoring or sloping of the cut banks on a gradient of at least ¾ horizontal to 1 vertical."

"*Subsidence:* There are no signs of significant subsidence occurring at this site due to the withdrawal of soil or ground water."

"*Earthquakes:* . . .a high seismic design factor may be required for structures on this site."

"*Facility Development Considerations:* ...the soils are capable of absorbing a large quantity of effluent due to their high permeability.

. . . A holding reservoir near the low end of the site which would drain by seepage and evaporation may be useful."

A detailed soils investigation covering the area of the initial buildings has been authorized and is now in process.

FLOOD HAZARD

A Flood Hazard report dated April 26, 1967, was submitted by the consulting civil engineer firm of Bookman and Edmonston. The basic data submitted on June 19, 1967, in support of the report includes the following condensed conclusions:

1. The site has never experienced flooding from the Kern River during the period of available streamflow records (since 1912) nor would flooding have occurred given present upstream conditions.

2. A flood of magnitude equal to that which would occur once in 180 years would rise to the existing elevation of Stockdale Highway, but would not flood the area. Proposed plans for improvement of Stockdale Highway are said to involve raising the Highway elevations.

3. The College should maintain surveillance of the Kern River to assure against adverse changes to the channel.

GRADING PLAN

The architectural and planning concept envisions each building complex set on a podium approximately four feet above the surrounding ground. This concept will be achieved by constructing a compacted fill using material obtained from either on-site excavation or import from the Kern River just across Stockdale Highway, adjacent to the site.

The podium concept will allow surface drainage to flow away from the buildings on all sides. Court areas and landscaped areas can generally be drained by sheet flow.

Import from the Kern River will be accomplished during early stages of development and will be reduced during later stages in order to minimize truck traffic crossing Stockdale Highway and traversing built-up portions of the campus.

The on-site fill material source will be generated from excavation for pools, drainage ponding basins and fire protection reservoirs.

The sloped banks at the edge of the podium will be graded on a maximum slope of 2 horizontal to 1 vertical and will be planted. In certain areas the podium will be stepped or otherwise given architectural treatment.

Each phase of development should be preceded by a grading project which will develop the filled pad area in advance of the building. Although there may be some advantages in preparing large areas in this manner, the scope of this work should be limited by the building projects being immediately planned, in order to avoid undue dust and having fallow areas not under irrigation. It is understood that areas not being used will be continued under cultivation for the above reason in addition to providing a source of funds to the College.

STORM DRAINAGE

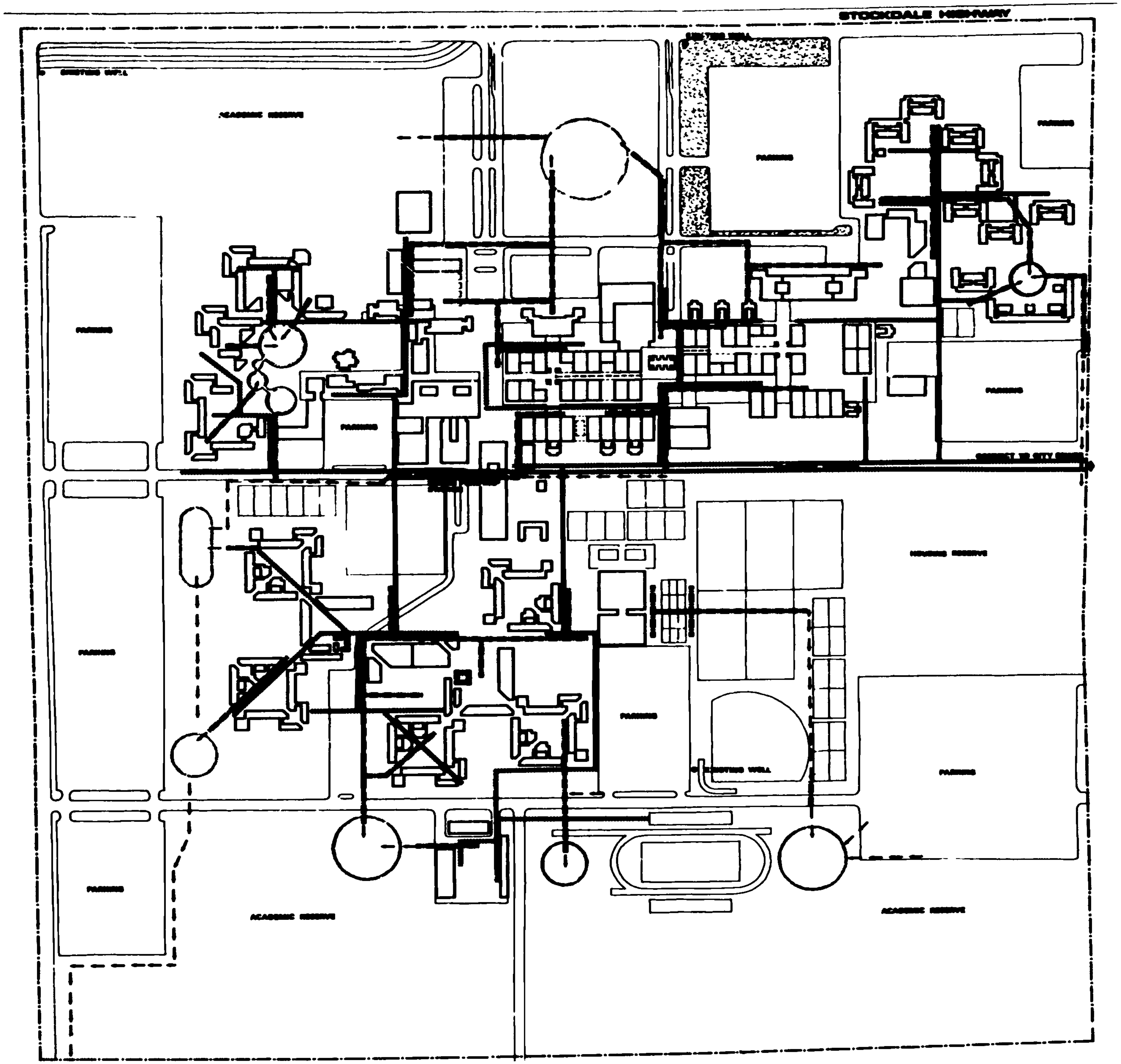
Since, according to the above cited Flood Hazard Report, major flood hazard probabilities are very low, the storm drainage facilities required will be confined to providing devices necessary to collect and dispose of locally developed improvements. A provision for off-site disposal has been included in the agreement between the College Trustees and the Kern County Land Company. However, the grading and storm drainage concept presented herein will probably not require such a facility until the very later stages of development, if at all. If this off-site facility is needed, it should consist of an overflow outlet at the southwest corner of the site.

Generally, the on-site storm drainage runoff will be disposed of to ponding basins constructed by excavation at various locations removed from the building complex sites. The water will be gradually dissipated by either leaching into the ground or by evaporation. The dry underlaying sand is capable of receiving the runoff in this manner, and this method of storm water disposal is common in Kern County.

Suitable overflows will be constructed to prevent short-term high flows from exceeding expected high water lines.

In order to minimize the expense of a complex underground system, the general manner of handling local runoff will be by grading to provide sheet flow. When concentration of runoff occurs such as in confined court areas or at roof drain outlets at paved walks and arcades, underground pipe will be used to convey the water to the nearest available disposal area or other outlet. Generally, catch basin inlets and underground piping will only be used to prevent hazards or hindrances to pedestrian or vehicular traffic. Where feasible, concentrated flows may be carried in swales or shallow ditches.

MASTER PLAN OF UTILITIES: 1



SANITARY SEWER
STORM DRAINAGE PIPE
STORM DRAINAGE SMALL CHANNEL
PONDING BASIN

0 300 600

NORTH

CALIFORNIA STATE COLLEGE, BAKERSFIELD

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WATER SUPPLY

Sources of Supply: Adequate supplies of ground water are available on the site. Three producing wells are now operating for irrigation service and two can be converted to domestic usage by sealing the top 70 to 80 feet from infiltration of possible contamination from surface usages. Additionally, Kern County Land Company has provided funds for drilling a new well at an appropriate location, as a part of its agreement with the College. The Master Plan calls for the new well to be drilled at the corporation yard. Cost of producing water from on-site wells is estimated to be five cents per 1,000 gallons.

The Ashe Water Company will supply water to the site as required. A commitment has been made for providing an emergency fire protection 10-inch main to the site at a cost representing the difference between the cost of the 10-inch line and the cost of a 6-inch line from the nearest present point of service east of the College site (approximately 3,000 feet). If the College requires the 10-inch main prior to development of the intervening area, the entire cost of the 10-inch main must be borne by the College pending development. Indications are that such development will not occur until approximately 1975. A connection to the Water Company may also be provided on the west side of the site when that area is developed, but indications as to the timing for such a connection are not presently available. Anticipated charges for water from the Ashe Water Company have been stated to be approximately 11 cents per 1,000 gallons.

Relative Advantages of Sources of Supply: The economics of both capital costs and operational costs would indicate the use of on-site well water in lieu of water from the Ashe Water Company. However, there is a possibility of ground water depletion in the future as water usages in the general area increase with population, and the ground water level drops. In the future the expense of on-site well water may increase, whereas the introduction of Feather River water may provide a measure of added reliability to the use of the Ashe Water Company source. At such time as fire protection demand increases to the point where storage facilities will be required, the use of the emergency fire protection connection may be more economical as an alternative. The principal additional consideration that should be given to making the Ashe Water Company connection would involve the possible additional reliability of using a public source rather than relying on maintenance forces, operating under the College administration.

DEMAND

The following water demands are estimated, calculated from population, estimated usage and accepted standards for domestic and fire water flows:

	Domestic & Irrigation		Fire
FTE Population	Max. GPM	Total GPD	GPM
700	465	138,000	1,000
3,000	1,775	760,000	1,500
6,000	3,400	1,503,000	2,000
12,000	5,600	2,375,000	3,850

WATER SUPPLY PHASING

FTE 725 (Initial Buildings)

1. A new well will be drilled at the initial central plant location for the purpose of domestic water production. It will be equipped with an electric motor of at least 500 GPM capacity.

2. The service pump will discharge directly into the system against a maximum line pressure of 100 psi. It is contemplated that the pump will either be run continuously to supply the water demand through a pressure regulating valve, or run through a 5,000 gallon pressure tank riding on the system. To provide an auxilliary supply, the existing well in the center of the site adjacent to Stockdale Highway will be sanitized, provided with a gas engine drive, and connected to the system. This will satisfy the agricultural requirements and, in addition, will provide emergency water and fire protection service in case of electric energy failure.

FTE 3000. The discharge capacity of the new well will be increased to at least 1000 GPM against a maximum line pressure of 100 psi.

In order to complement the fire protection capabilities on-site, the ponding basins located between the initial building complex and Residence Village No. 1 will be lined and the water made available for fire protection by means of wharf-type hydrants accessible below water level. Overflows of adequate size will be provided so that rainfall runoff can still be accepted and disposed of into the downstream system.

FTE 6000. At this stage of development the growth of building areas will have been great enough to make the connection to the Ashe Water Company feasible. Possibly the off-site development will also have extended to the property and no additional off-site cost will be involved in making the connection. The connection will consist of a detector check with a small sized metered by-pass for measuring any low flows which may be required.

If the on-site well system has continued to provide satisfactory production, the remaining existing wells should be developed to provide a total supply of not less than 3000 GPM pumped electrically. With the connection to the Ashe Water Company, the standby gas engine unit will then be retired from service.

The timing for connecting to the Ashe Water Company must consider the availability of State funds which have been provided for this purpose relative to the need and within the larger framework of the economics of on-site development. However, since the connection will ultimately be advisable, communication with the Ashe Water Company should be maintained to assure the installation of the proper size main as the private sector development occurs.

FTE 12,000. Operating experience in maintaining the water supply and distribution will dictate detailed design of the final system. However, the Master Plan envisions that the complete system will consist of 10-inch diameter loops around all principal building complexes with the four wells operating at optimum capacity, and a connection to the Ashe Water Company at each north-south property line. The output from the wells may be basically used to provide the heavy needs of irrigation. The water from the Ashe Water Company may then be principally used for domestic and fire protection purposes. However, each source will augment the other source, and in such manner that the cost of water at the time of delivery will determine the most feasible source from which to concentrate usage. This will be done by controlling output at wells by means of the size of the connection meter. Balancing flows within the campus will be achieved by proper sizing of the pipe network.

SANITARY SEWERS

Under one of the electives offered by the agreement between the Trustees and Kern County Land Company, the City of Bakersfield will bring a sewer trunk line to the site and will dispose of sanitary sewage. The connection at the east property line will be made at an invert elevation 12 feet below existing ground at that point, approximately 2,000 feet south of the northeast property corner.

The on-site sewer main connecting to the City trunk line will be located along an east-west line south of the academic "spine" building complex. In view of the limitation placed on the depth of the connection by the City because of local soil conditions and the extremely flat terrain, it will be necessary to construct a pumping facility near the site of the initial corporation yard to lift the sewage to a nominal depth at that point.

The pump station will consist of a totally underground "packaged" unit consisting of wet well, dry well, duplex pumps, de-humidifiers and exhaust blowers, designed to eliminate all obnoxious odors, and capable of expansion to increased loads.

The sewer system upstream from the above described pump station will be an all-gravity system. However, it will be necessary to maintain minimum gradients in order to conserve depth. Downstream from the pump station development will drain by gravity into the sewer main at the minimum gradient consistent with local practice.

Sewage Loads:

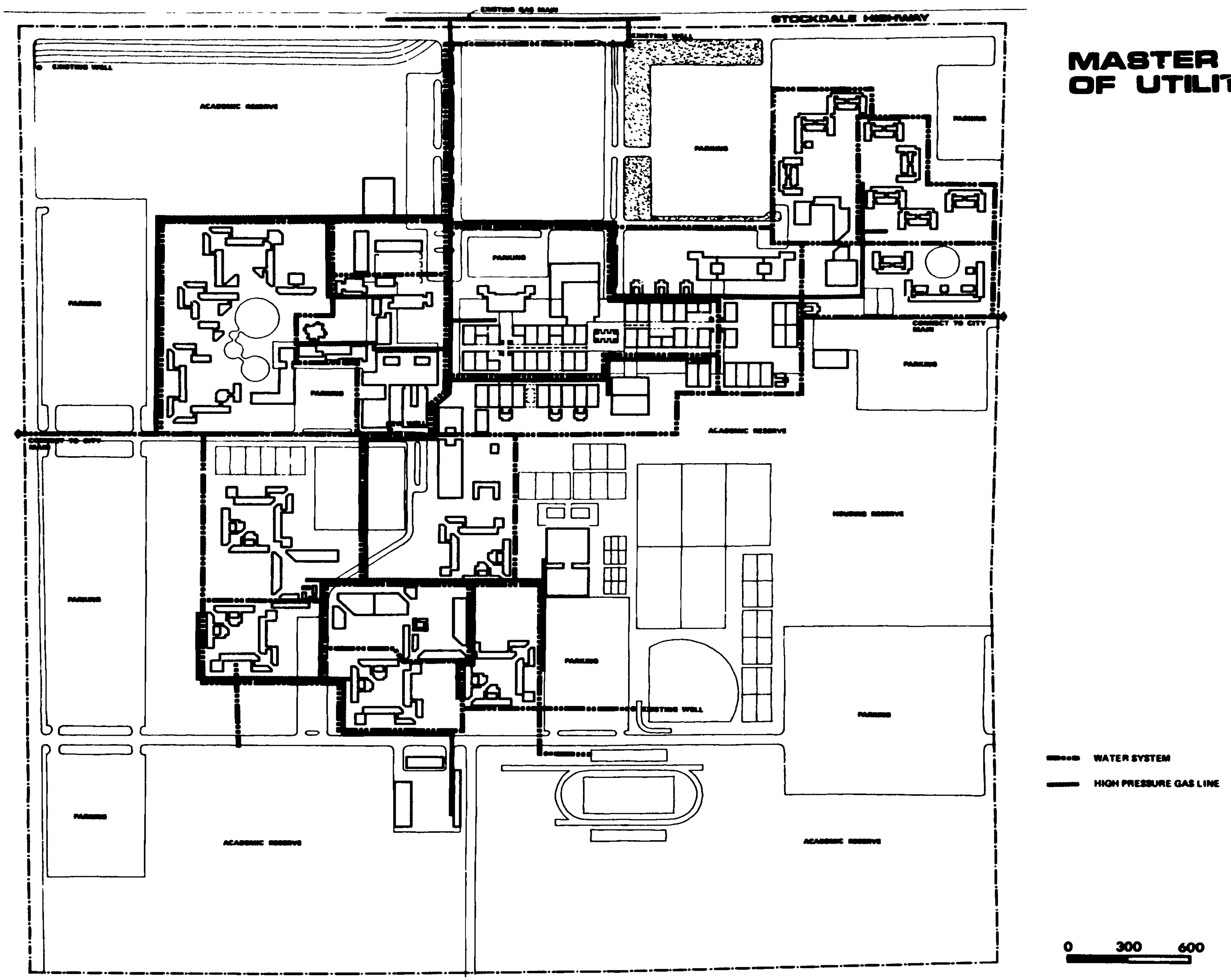
	Peak Load GPM	Max. Daily Load GPD
725 FTE	150	30,000
3,000 FTE	600	120,000
6,000 FTE	1,100	220,000
12,000 FTE	2,300	480,000

At 3,000 FTE, it will be necessary to provide an additional larger sewer relief main between the pump station and the City connection in order to serve the future heavier loads.

GAS

Gas will be provided by the Southern California Gas Company in the quantities required for heating (discussed separately), food preparation, and laboratory use. The heating and cooking loads will generally govern the sizing of pipes. A medium pressure line (at least 5 psi) will be brought to a centrally located meter at the Gas Company expense. Distribution will be continued at medium pressures (3 to 5 psi) to minimize line sizes, with pressure reducers to be provided at individual buildings as required.

MASTER PLAN OF UTILITIES: 2



CALIFORNIA STATE COLLEGE, BAKERSFIELD

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

ELECTRICAL SERVICE AND DISTRIBUTION

On-site distribution system will be underground.

Pacific Gas and Electric Company will serve the site from the east property line at 12,000 volts primary voltage through duct banks provided by College.

Estimated demand for the ultimate (12,000 FTE) campus is 13,000 KVA$\pm$ assuming electric drive air conditioning.

At the 12,000 volt service level a minimum of two primary lines will be required and these should originate from different sub-stations and should be brought to the site over different paths to assure service reliability.

Two primary service cubicles shall be provided at the east property line at which point primary metering will be located. These shall each serve primary distribution switchboards utilizing load break fused switches protecting primary feeders.

To maintain the service reliability throughout the system, a modified primary selective system is proposed.

Major transformer stations shall be located at central plants No. 1 and No. 2 respectively. Each bank shall consist of two transformers providing utilization voltage of 460/265 volts, 3 phase, 4 wire, and each serving a portion of the central plant. In addition, buildings reasonably close to the central plants will be served from the same stations at secondary voltage. Each transformer shall be fed from a different primary source and secondary ties shall be provided in the event of the loss of one line.

Buildings remote from the central plant shall have individual sub-stations fed by both primary sources and equipped with primary selector switches to extend primary system reliability. For economy, several small buildings should be served by a common sub-station where possible, with secondary distribution between buildings.

Primary sub-stations shall be incorporated within building structure or located in service areas on the exterior.

Utilization voltages shall be 460/265 volts for academic buildings and 120/208 volts for residential buildings.

Academic buildings shall utilize 460 volts for motors, 265 volts for fluorescent lighting and 120 volts obtained from small dry type transformers for receptacles and incandescent lighting.

PUBLIC TELEPHONE

Pacific Telephone Company will serve the site from the east property line. A duct bank shall be provided by the college in common trench with primary conduit system.

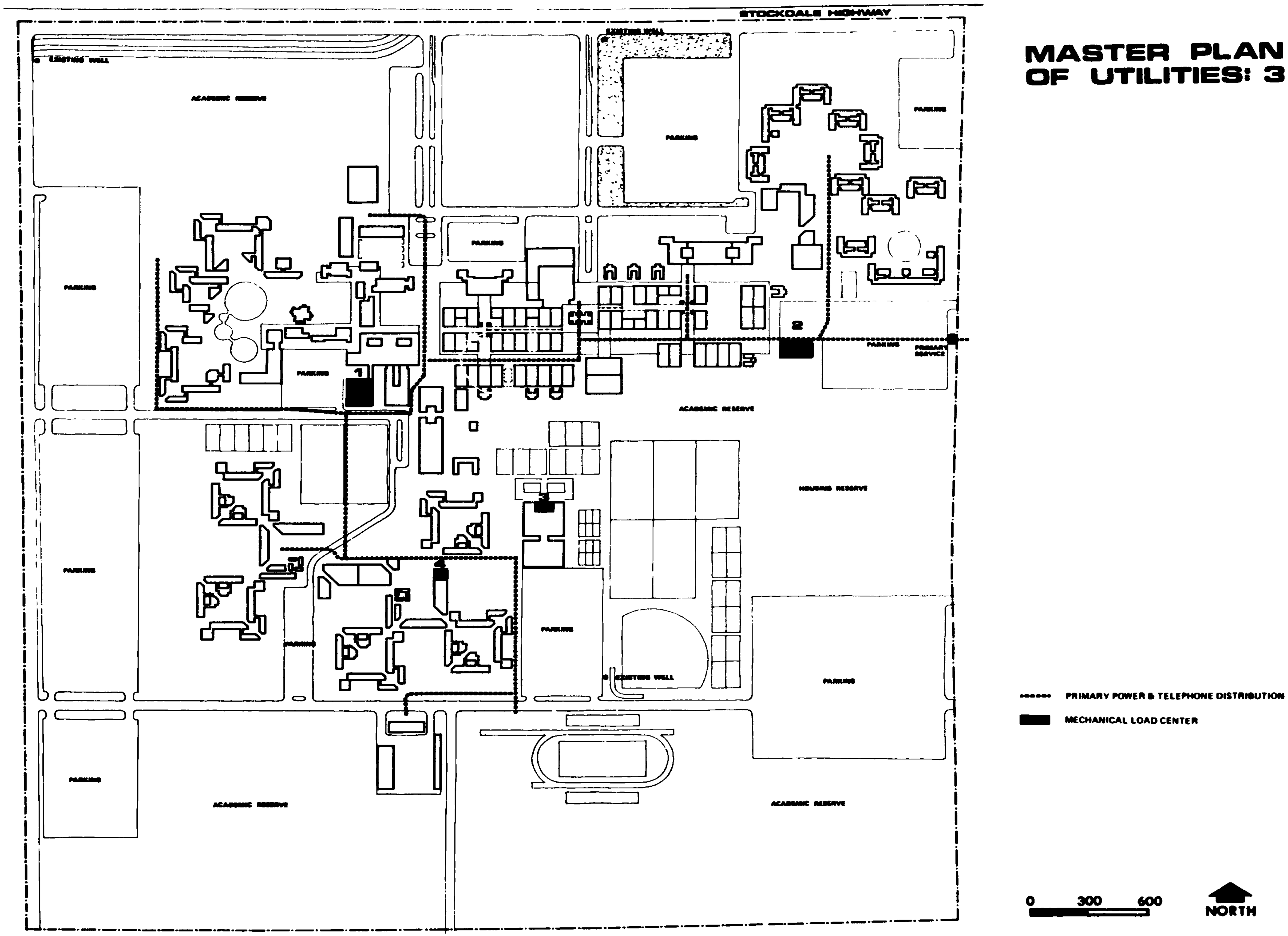
Route of duct bank will be through ultimate heart of campus and will serve ultimate development.

Central telephone equipment room for Centrex system shall be provided in location of central plant No. 1, and shall be expandable for ultimate campus.

SIGNAL SYSTEMS

Master equipment for central fire alarm and communication systems shall be located in central plant No. 1.

MASTER PLAN OF UTILITIES: 3



CALIFORNIA STATE COLLEGE, BAKERSFIELD

VICTOR GRUEN ASSOCIATES
MASTER PLAN ARCHITECTS

Distribution between buildings shall be through attic spaces insofar as possible and shall utilize spare telephone ducts between separated buildings.

LIGHTING

Streets shall be lighted utilizing 250 watt color corrected mercury vapor street lighting luminaires on prestressed concrete poles mounted at approximately 30-foot mounting height on an average of 150-foot centers. Ballast voltage shall be 460 volts.

Parking lots shall be lighted with units similar to street lights to intensity of 0.5 F.C. ± average maintained.

Pedestrian walks adjacent to buildings shall be lighted from buildings. Walks and courts not adjacent to buildings shall be lighted with decorative post-top units utilizing 100 to 175 watt mercury vapor lamps with 265 volt ballasts.

Exterior lights shall be controlled by photocells.

Conduits shall be stubbed into larger planter areas from buildings for planter lighting to be provided under landscape work.

INITIAL STAGE (725 FTE)

Electrical Service and Distribution:

Initial transformer station at central plant No. 1 shall be provided by the Utility Company, and college shall purchase secondary voltage at 460/265 volts. Utility will own primary conductors.

Initial phase buildings shall be served at 460/265 volts from central plant distribution switchboard.

3,000 FTE

Electrical Service and Distribution:

At this stage it becomes necessary to convert to primary service. Primary cubicles shall be placed at east property line.

College shall purchase or replace Utility Company primary conductors and transformer station at central plant No. 1. Second transformer station shall be provided at central plant No. 1 and secondary tie provisions shall be made.

Individual sub-stations shall be provided for universal classroom building, gymnasium, student dining, corporate facilities and for each of four residential groupings.

Transformer investment at this point is in excess of actual need, but allows for expansion of respective facilities without major transformer replacements.

Estimated demand at this point is 3500 KVA±. Purchased transformer capacity is estimated in excess of 7000 KVA. Two primary feeders are required at this stage.

6,000 FTE

Electrical Service and Distribution:

First transformer station is required for central plant No. 2.

Estimated demand is 7000 KVA$\pm$. Purchased transformer capacity is estimated in excess of 15,000 KVA. Two additional primary feeders are required.

12,000 FTE

Electrical Service and Distribution:

Second sub-station is required for central plant No. 2.

Estimated demand is 13,000 KVA$\pm$. Purchased transformer capacity is in excess of 20,000 KVA.

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Single line diagrams for the electrical system at its initial, 3,000 FTE, 6,000 FTE, and 12,000 FTE stages have been prepared and are available when needed.

HEATING, VENTILATING AND AIR CONDITIONING

The Master Plan for heating, ventilating and air conditioning proposes a system of dispersed *load centers* located in close proximity to the area they serve. Service for the academic portions of the campus (not including residences) will require a water chilling capacity of 3,800 tons and a cooling coil capability of over 5,000 tons. Heating will require a gross boiler output of 46,000 BTUH and a total heating oil capability of over 66,000,000 BTUH.

The plan proposes that these demands be divided between four load centers - one serving about 550,000 G.S.F. of academic space located in the western sector of the campus, a second of similar size serving the eastern portion of the campus, a third located in or near the physical education buildings serving 50,000 G.S.F., and a fourth located between Villages No. 2 and No. 3 serving about 120,000 G.S.F.

There are many reasons for adapting this type of system (already operating in commercial facilities) to the Bakersfield campus. Primary, of course, is economy. Beyond that, however, is added flexibility in growth, the ability to incorporate equipment advances as new machines are developed, the minimizing of heavy first costs for the installation of equipment in advance of need, and the opportunity to absorb even modest building increments into the system quickly and efficiently (no later abandonment of inefficient "temporary" installations).

The Bakersfield campus, low density and with an extended growth period, is especially suited to a departure from the conventional "central plant". A detailed comparison between the load center plan and the central plant indicates a savings of about 20%. See Appendix B for this study.

DEVELOPMENT COSTS

1. INITIAL BUILDINGS

The initial buildings were programmed in late 1967. In March 1968, a budget of $1,688,000 was set for the buildings and Group I equipment. Site development costs were set at $398,482 for a total of $2,086,582 at 1100 ENR.

The aim in the design of the initial buildings is to build the most economical group of buildings possible regardless of budget allowances. We believe that the design concept proposed will (first) meet the academic and environmental requirements, and (second) meet the present budget allocation with one exception. The initiation of a central plant will exceed the initial budget by about $50,000. This increase has been approved by the Board of Trustees.

Detailed estimates have been prepared in cooperation with the college for the five year program. These relate to the "status" plans included in this report. For details, please see the Five Year Capital Outlay Program for Bakersfield.

2. *SUBSEQUENT DEVELOPMENT*

Tables III and IV following indicate the total project costs by discipline, type of space, by FTE increment (3,000, 6,000, and 12,000 FTE) and by state or non-state funded categories. The dollar figures used on these tables relate directly to the space requirements shown on Tables I and II for direct comparisons between facility size, type and cost.

Most unit costs were derived by using the standard values and formulas as developed by the Chancellor's office (CO-4. 102, CO-5. 106, CO-5. 107) as revised in January 1968 and based on an ENR of 1170.

Although we believe that the Master Plan concept offers the opportunity for cost reductions in several areas (low rise, compactness, like spaces grouped together, standardized building elements, etc.) we are hesitant at this time to deviate from existing average costs as listed in CO-4. 102 (and shown in the column, "Project Cost Per ASF") with one exception: By grouping all lecture space into the multi-use universal structure, we are assuming a per-squre-foot cost reduction of $2. Since this building is not yet designed, there is no assurance that this reduction will be achieved, but it seems to be a reasonable expectation. Similar reductions might be forthcoming in other elements but until actual design takes place, they cannot be foreseen. It is the intent of the Master Plan that areas of possible capital savings will be pointed out to project architects and that a part of all architectural assignments will list an investigation of this potential in the scope of services.

Site development costs are based on conceptual plans as shown in this report and are, therefore, subject to modification throughout the development period. However, the unit costs used have been tested against prototype areas within the campus and found acceptable. The great uncertainty of these site development figures exists in the realm of paving and landscaping. Within the three scales considered (high, medium and low), we chose a medium-low figure. This was not by choice, but was instead an attempt to recognize the priority of dollars and the special efforts of the Bakersfield Campus to interest the community in college development. This site development estimate will require substantial assistance from the community. Since this seems to be forthcoming, we have counted on it.

The residential costs come directly from the college document, "Residence Halls and Dining Facilities, Phase I (non-state funded)" dated June 1968. This report outlines in detail the academic philosophy of the Live and Learn Village and the seminal idea of incorporating the commuting student into the college society.

Student unions are always a special situation depending totally upon shifting criteria. We have not attempted to name the year or size of the union. The plan does, nevertheless, hold its location and allow it to tie with supporting and fortifying facilities. Its size has been estimated, but even this must be subject to change and the plan allows for considerable deviation. It is quite possible that with the importance placed in the residential villages, both live and learn (lower division) and live and study (upper division) plus decentralized dining, and the commuter student's facilities in the villages, that the historical role of the student union will be lessened, or it might be strengthened. In either event, the plan can accommodate the shift.

3. *COST SUMMARY*

Table III lists direct instructional capital costs and Table IV details instructional support capital costs for both state funded and non-state funded projects. Derivations from these tables are of interest.

A. *Capital Cost Per FTE (8-5), State Funded Facilities*

3,000 FTE	=	$ 8,696,000 (Table III)
		9,479,000 (Table IV)
		$18,175,000/3000 = $6,060 per FTE
6,000 FTE	=	$17,669,000 (Table III)
		18,243,000 (Table IV)
		$35,912,000/6000 = $5,985 per FTE
12,000 FTE	=	$36,226,000 (Table III)
		29,292,000 (Table IV)
		$65,518,000/12,000 = $5,459 per FTE

B. *Total Capital Costs by Increments, Combined Funding*

3,000 FTE (8-5) State Funded	=	$18,175,000 (see Summary A)
Non-State Funded	=	$ 9,954,000 (Table IV)
		$28,129,000
		or $9,376 per FTE
6,000 FTE (8-5) State Funded	=	$35,912,000 (see Summary A)
Non-State Funded	=	$21,809,000 (Table IV)
		$57,721,000
		or $9,620 per FTE
12,000 FTE (8-5) State Funded	=	$65,518,000
Non-State Funded	=	$25,057,000 (Housing stays at 2350 units same as 6000 FTE level)
		$80,575,000
		or $6,714 per FTE

or, if housing expands to 5,040 units, then non-state funding rises to $46,765,000, the combined total goes to $112,283,000, and the expenditure per FTE becomes $9,356.

It is not surprising that the first summary (A) shows a decline in state funded costs per FTE as the college grows, but it is interesting that the total drop from 3,000 to 12,000 FTE is only about 10 percent with most of this reduction occurring beyond 6,000 FTE. Probably a sharper decline would show in operating costs per FTE as enrollment increases but so far as capital costs are concerned, no significant decrease is indicated until beyond the 6,000 FTE level.

Summary (B) is not relevant to cost-size ratio because the differences here are primarily reflections of the amount of on-campus housing provided. However, it does indicate the proportion between state and non-state funds and shows that the ultimate (12,000 FTE) combined funding will be between $80 and $110 million.

If the Chancellor's study on enrollment is continued on a straight line basis, *combined* capital expenditures on this campus will be about as follows:

By 1980 - $28 million (3,000 FTE)
By 1990 - $58 million (6,000 FTE)
By 2010 - $81 to $112 million (12,000 FTE)

TABLE III SUMMARY OF ESTIMATED INSTRUCTIONAL SPACE PROJECT COSTS * (By Discipline and Type of Space) ENR 1170

A = Lecture Space
B = Laboratory
C = Instructional Support

ACCUMULATED COSTS 3,000 FTE (8-5)

Academic Area	Type Space	Project Cost Per ASF	Total Project Cost	(1)	(2)	(3)	Universal	Special
Behavioral Sciences	A	$ 49.08	$ 393,000	$ 211,000	$ -	$-	$ 182,000	$ -
	B	86.45	761,000	173,000	-	-	588,000	-
	C	59.38	546,000	154,000	-	-	24,000	368,000
			$1,700,000	$ 538,000	-	-	$ 794,000	$ 368,000
Fine Arts	A	$ 49.08	$ 59,000	$ 20,000	$ -	-	$ 39,000	$ -
	B	72.25	693,000	455,000	-	-	-	238,000
	C	59.38	119,000	-	-	-	-	119,000
		$	$ 871,000	$ 475,000	-	-	$ 39,000	$ 357,000
Humanities	A	$ 44.08	$ 388,000	$ 211,000	$177,000	$-	$ -	$ -
	B	56.23	180,000	157,000	6,000	-	-	17,000
	C	59.38	469,000	226,000	77,000	-	-	166,000
			$1,037,000	$ 594,000	$260,000	-	-	$ 183,000
Natural Sciences	A	$ 49.08	$ 226,000	$ 108,000	$ 34,000	$-	$ 84,000	$ -
	B	102.26	2,761,000	20,000	-	-	20,000	2,721,000
	C	59.38	404,000	65,000	-	-	-	339,000
			$3,391,000	$ 193,000	$ 34,000	-	$ 104,000	$3,060,000
Business	A	$ 49.08	$ 74,000	$ -	$ -	$-	$ 74,000	$ -
	B	63.48	76,000	-	-	-	76,000	-
	C	59.38	95,000	-	-	-	-	95,000
			$ 245,000	-	-	-	$ 150,000	$ 95,000
Education	A	$ 49.08	$ 103,000	$ 93,000	$ -	$-	$ -	$ 10,000
	B	59.51	315,000	124,000	-	-	-	191,000
	C	59.38	222,000	178,000	-	-	-	42,000
		$	$ 638,000	$ 395,000	-	-	-	$ 243,000
Nursing	A	$ 49.08	$ 5,000	$ -	$ -	$-	$ -	$ 5,000
	B	102.26	102,000	-	-	-	-	102,000
	C	59.38	24,000	-	-	-	-	24,000
		$	$ 131,000	-	-	-	-	$ 131,000
Industrial Technology & Applied Sciences	A	$ 49.08	$ 29,000	$ -	$ -	$-	$ 19,000	$ 10,000
	B	72.88	612,000	-	-	-	-	612,000
	C	59.38	42,000	-	-	-	-	42,000
			$ 683,000	-	-	-	$ 19,000	$ 664,000
Sub-Totals	A		$1,277,000	$ 643,000	$211,000	-	$ 398,000	$ 25,000
	B		5,500,000	929,000	60,000	-	684,000	3,881,000
	C		1,919,000	623,000	77,000	-	24,000	1,195,000
TOTALS			$8,696,000	$2,195,000	$294,000	-	$1,106,000	$5,101,000

ACCUMULATED COSTS 6,000 FTE (8-5)

Academic Area	Type Space	Total Project Cost	(1)	(2)	(3)	Universal	Special
Behavioral Sciences	A	$ 761,000	$ 211,000	$ 211,000	$ -	$ 339,000	$ -
	B	1,453,000	173,000	173,000	-	1,107,000	-
	C	1,045,000	154,000	154,000	-	42,000	695,000
		$ 3,259,000	$ 538,000	$ 538,000	-	$1,488,000	$ 695,000
Fine Arts	A	$ 122,000	$ 39,000	$ -	$ -	$ 83,000	$ -
	B	1,423,000	708,000	-	-	-	715,000
	C	261,000	-	-	-	-	261,000
		$ 1,806,000	$ 747,000	-	-	$ 83,000	$ 976,000
Humanities	A	$ 702,000	$ 211,000	$ 211,000	$206,000	$ 64,000	$ 10,000
	B	320,000	157,000	129,000	-	-	34,000
	C	873,000	238,000	107,000	77,000	-	451,000
		$ 1,895,000	$ 606,000	$ 447,000	$283,000	$ 64,000	$ 495,000
Natural Sciences	A	$ 486,000	$ 108,000	$ 108,000	$ 49,000	$ 187,000	$ 34,000
	B	5,287,000	20,000	20,000	-	31,000	5,216,000
	C	814,000	65,000	30,000	-	-	719,000
		$ 6,587,000	$ 193,000	$ 158,000	$ 49,000	$ 218,000	$ 5,969,000
Business	A	$ 211,000	$ -	$ -	$ -	$ 211,000	$ -
	B	159,000	-	-	-	146,000	13,000
	C	238,000	-	-	-	-	238,000
		$ 608,000	$ -	-	-	$ 357,000	$ 251,000
Education	A	$ 221,000	$ 201,000	$ -	$ -	$ -	$ 20,000
	B	786,000	351,000	-	-	-	435,000
	C	481,000	374,000	-	-	-	107,000
		$ 1,488,000	$ 926,000	-	-	-	$ 562,000
Nursing	A	$ 15,000	$ -	$ -	$ -	$ -	$ 15,000
	B	276,000	-	-	-	-	276,000
	C	65,000	-	-	-	-	65,000
		$ 356,000	-	-	-	-	$ 356,000
Industrial Technology & Applied Sciences	A	$ 74,000	$ -	$ -	$ -	$ 44,000	$ 30,000
	B	1,436,000	-	-	-	-	1,436,000
	C	160,000	-	-	-	-	160,000
		$ 1,670,000	-	-	-	$ 44,000	$ 1,626,000
Sub-Totals	A	$ 2,592,000	$ 770,000	$ 530,000	$255,000	$ 928,000	$ 109,000
	B	11,140,000	1,409,000	322,000	-	1,284,000	8,125,000
	C	3,937,000	831,000	291,000	77,000	42,000	2,696,000
TOTALS		$17,669,000	$3,010,000	$1,143,000	$332,000	$2,254,000	$10,930,000

ACCUMULATED COSTS 12,000 FTE (8-5)

Academic Area	Type Space	Total Project Cost	(1)	(2)	(3)	Universal	Special
Behavioral Sciences	A	$ 1,536,000	$ 211,000	$ 211,000	$ 211,000	$ 903,000	$ -
	B	2,862,000	173,000	173,000	173,000	2,343,000	-
	C	1,983,000	154,000	154,000	154,000	83,000	1,438,000
		$ 6,381,000	$ 538,000	$ 538,000	$ 538,000	$3,329,000	$ 1,438,000
Fine Arts	A	$ 266,000	$ 79,000	$ -	$ -	$ 187,000	$ -
	B	2,991,000	708,000	-	-	-	2,283,000
	C	582,000	-	-	-	-	582,000
		$ 3,839,000	$ 787,000	-	-	$ 187,000	$ 2,865,000
Humanities	A	$ 1,217,000	$ 211,000	$ 211,000	$ 206,000	$ 589,000	$ -
	B	533,000	157,000	157,000	157,000	-	62,000
	C	1,527,000	238,000	107,000	107,000	-	1,075,000
		$ 3,277,000	$ 606,000	$ 475,000	$ 470,000	$ 589,000	$ 1,137,000
Natural Sciences	A	$ 942,000	$ 108,000	$ 108,000	$ 108,000	$ 554,000	$ 64,000
	B	10,277,000	20,000	20,000	20,000	82,000	10,135,000
	C	1,556,000	65,000	30,000	30,000	-	1,431,000
		$12,775,000	$ 193,000	$ 158,000	$ 158,000	$ 636,000	$11,630,000
Business	A	$ 388,000	$ -	$ -	$ -	$ 388,000	$ -
	B	400,000	-	-	-	146,000	254,000
	C	540,000	-	-	-	-	540,000
		$ 1,328,000	-	-	-	$ 534,000	$ 794,000
Education	A	$ 432,000	$ 378,000	$ -	$ -	$ -	$ 54,000
	B	1,678,000	541,000	-	-	-	1,137,000
	C	926,000	689,000	-	-	-	237,000
		$ 3,036,000	$1,608,000	-	-	-	$ 1,428,000
Nursing	A	$ 44,000	$ -	$ -	$ -	$ -	$ 44,000
	B	869,000	-	-	-	-	869,000
	C	166,000	-	-	-	-	166,000
		$ 1,079,000	-	-	-	-	$ 1,079,000
Industrial Technology & Applied Sciences	A	$ 177,000	$ -	$ -	$ -	$ 113,000	$ 64,000
	B	3,936,000	-	-	-	-	3,936,000
	C	398,000	-	-	-	-	398,000
		$ 4,511,000	-	-	-	$ 113,000	$ 4,393,000
Sub-Totals	A	$ 5,002,000	$ 987,000	$ 530,000	$ 525,000	$2,734,000	$ 226,000
	B	23,546,000	1,599,000	350,000	350,000	2,571,000	18,676,000
	C	7,678,000	1,146,000	291,000	291,000	83,000	5,867,000
TOTALS		$36,226,000	$3,732,000	$1,171,000	$1,166,000	$5,388,000	$24,769,000

*Includes building, Type I and Type II equipment, landscape and site work in immediate building area, fees and contingencies.

CALIFORNIA STATE COLLEGE - BAKERSFIELD
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TABLE IV - SUMMARY OF ESTIMATED COSTS FOR SUPPORT SPACE (BY TYPE) 1170 ENR[1]

State Funded	Project Cost Per ASF[2]	Accumulated Cost at 3000 FTE	Accumulated Cost at 6000 FTE	Accumulated Cost at 12,000 FTE
Library and Audio-Visual	$56.24	$2,418,000	$ 4,893,000	$ 9,989,000
Admin. and Student Services	$59.20	$1,420,000	$ 2,072,000	$ 3,730,000
Gymnasium	$46.40	$1,276,000	$ 2,274,000	$ 2,274,000
Little Theatre (18,000 ASF)	$73.14	-	$ 1,316,000	$ 1,316,000
Corporation Yard	$24.64 bldg. .65 yard	$ 201,000	$ 386,000	$ 1,511,000
Cafeteria (5,000 - 10,000 - 20,000 ASF)	$67.97	$ 340,000	$ 680,000	$ 1,360,000
Central Plants and Elec. Transformation (Not Incl. Residential)	NA	$1,056,000	$ 1,860,000	$ 2,646,000
Site Develop. (Not Incl. Res.)	NA	$2,768,000	$ 4,762,000	$ 6,557,000
TOTAL STATE FUNDED		$9,479,000	$18,243,000	$29,292,000
Non-State Funded				
Residential and Dining	$8070/Res. Student	$9,482,000 (1175 units)	$18,965,000 (2350 units)	$18,965,000 (2350 units) to $40,673,000 (5040 units) as required.
Parking	$350/stall	$ 472,000 (1350)	$ 997,000 (2850)	$ 2,397,000 (6850)
Student Union	$61.59		$ 1,847,000 (30,000 net)	$ 3,695,000 (60,000 net)

1. Costs include buildings, Type I and Type II equipment, site preparation and landscaping in immediate building area, fees and contingencies.
2. Calculated in accordance with the "Estimating Cost Guide for the 5-year Capital Outlay Program", Calif. State Colleges.

BUILDING SYSTEMS FOR CAMPUS STRUCTURES

One special component of the Master Plan Study has been a reconnaissance of building systems or systems building as such systems might adapt to collegiate use. The results of this investigation are contained in Appendix C.

The task here was to investigate the status of *"systems"* and determine whether or not these technological innovations were applicable to first, the Bakersfield campus; and second, the California College System as a whole.

An interim report, submitted in mid-March of 1968 concluded, "... we have found no magic in the application of current construction 'systems' to the problems of initial buildings. The sizes of these projects, the geographic and time spread involved, and the state of the art in construction techniques all lead us to believe that traditional conventional methods are those most suitable for these small scale projects. Although there are existing 'systems' available for buildings of this scope, we find no evidence that there is an assured cost savings."

So far as initial building complements are concerned, this conclusion was simply a reaffirmation of existing college procedures. "However," the interim report noted, "when one looks at the statewide system of college construction, a very different horizon appears. Here we see nearly $50 million of construction per year." While recognizing the highly specialized nature of each component of this annual capital outlay program, the volume alone warranted an analysis. This analysis is included in two appendices - Appendix B for the Central Mechanical Plant, and Appendix C for Building Systems.

Regarding Appendix B, this began as a straight analysis of the central plant requirements for the Bakersfield campus but because the Bakersfield design differed markedly from so many college central plants, the Physical Planning and Development section of the Chancellor's Office suggested that the design be compared with a *"conventional"* central plant and that sufficient data be included so that the findings would be available for other developments if applicable. This was done and the resultant analysis is a significant portion of the Building Systems Study. A few comments on the background of this study might help to place it in the perspective of the Master Plan.

From the outset the plan concerned itself with the location of a central plant because (1) the locational requirements were in direct conflict with the academic requirements (for mechanical efficiency, the central plant should be in the middle of the mechanical loads but, of course, this is exactly where the greatest academic activity should occur); (2) even if a central plant was located centrally so far as the ultimate campus was concerned, it would not be central to the first decade or two of development; and (3) how could major investments in advance of need be justified? Concurrently, the Master Plan engineers were seeking ways to minimize mechanical tunnels, shorten runs, utilize advanced equipment and automation, and retain ultimate central plant efficiency without raising (and hopefully decreasing) operating costs. The end result was a system of dispersed, automated load centers. This system is described in detail in Appendix B. The cost savings is significant. From a *"systems"* standpoint, the mechanical plan is important only where similar criteria exist. But these conditions are very likely to be encountered in many new, low density, long-range campuses.

Regarding construction systems (Appendix C), the areas of choice are much wider, more controversial, subjective and questionable. In fact, this study of current systems finds no directly applicable method. Such is the state of the art. The subject might be allowed to end with this reconnaissance, but during the evolution of the Bakersfield plan opportunities both limited and large were investigated. We did *not* find it possible to recommend the campus-wide use of any known system or standard component. We did, however, propose the grouping of similar spaces into major structures that (by uniform cross section and modular lengths) are highly adaptable to efficient fabricating and erection techniques. Although steel is recommended for the standardized universal space, uniform pre-cast concrete could enjoy the same economies in multi-level buildings.

There is no way to say how widespread the use of modular construction might be on a state-wide basis because the structural economies achieved may never compensate for possible violations of or infringements on the Academic and Physical Master Plans. The Bakersfield case is a fortunate one because both the Academic and the Physical Plans lend themselves perfectly to a standardized core. Wherever else this happy combination of circumstances might exist, construction economies due to an individualized (campus by campus) system can be expected.

At the present time, we find little hope for applying systems building to laboratory buildings, libraries, office buildings, or other specialized structures. There is a very real opportunity in applying standardization to parking structures but this is already being done almost as a matter of course. Wherever it is not being done within the design program, it ought to be. After all, this is one building type that has come down in cost as building technology advances. In housing, the California university system is far along the path of applying systems. The *"URBS"* program is a highly developed attempt to combine industry, technology, individual expression and economics into a single performance package. So far, the response from the construction industry has not been especially encouraging. But, the door has not been closed. It seems clear that even though not very much in the way of building systems or systems building is available to the college today, important and drastic changes are very likely to occur within the next two or three years. Some limited efforts on a campus-by-campus basis could be started now, but the economic benefits will, at best, be restricted. Chances are that an entry into systems at this stage of the game, will have an economic penalty - even though such penalty might be short lived. The immediate interest of the colleges as a state institution should be to continue a serious monitoring of this rapidly changing scene and to ask the architects to address themselves to the systems approach as they plan a campus or design a building. From our initial reconnaissance, we would expect that in most cases, such as those dealing with individual structures, little if anything new will evolve. After all, this type of investigation is a normal part of the architect's work. The field of general monitoring of a systems approach as it relates to collegiate buildings is not necessarily the responsibility of the project architects and is probably best assigned to the Chancellor's office.

If changes are to be made in design and construction on a statewide basis, they will probably come about through a *total* change rather than through refinements and modifications of existing techniques. This type of change would entail a systems approach to the entire idea of educational facilities development. If this happens at all, it would start with site acquisitions on a long term basis, lead to construction based on performance specifications, and end with facilities and operations maintenance as an ongoing activity. Most probably such a system would include financing. Obviously, the consideration of any such idea is far beyond the scope of this assignment. But the very fact that such an eventuality exists, should signal the college system to be ready for a response - whether this response be one of rejection or acceptance. To our knowledge, the college system is not yet addressing itself to this type of change. We suggest, that in addition to the monitoring of building systems, it explore the pros and cons of systems building.

APPENDIX A

AN ANALYSIS OF THE TRAFFIC AND PARKING REQUIREMENTS FOR THE 12,000 FTE (8 - 5) CAMPUS.

California State College, Bakersfield

The purpose of this report is to examine the ingress and egress traffic requirements of this institution and to estimate the parking demands for students, staff and visitors throughout the development period from 1970 through the year 2000. In addition, estimates of pedestrian flow in high design areas (The Galleria) are included as a planning guide.

ACCESS AND PARKING

The access and parking facilities which the college requires is a direct function of the size of the college, its academic composition and the proportion of students residing on campus. This report presumes 12000 FTE (8–5) and a staffing ratio based on current standards. It is also based on a resident population of approximately 4500 students or 37% of the student body. Lower Division students represent 35% of the students of which half is in residence. (17.5% of the total campus). Upper Division and graduate students compose the remaining 65% and 31% of these (20% of the total number of students) also live on campus (Table I).

The size of the faculty and staff will be equivalent to about 25% of the FTE student body when the college opens. This percentage figure will steadily decrease to eventually reach 12%, although in absolute figures the faculty and staff will continually grow from an initial 175 persons to an estimat ed 1440 people. The ultimate college population of 12,000 FTE will consist of 4,500 on–campus residents and 7,500 FTE commuting students for a total population including faculty and staff of 13,440.

The car ownership pattern of resident students will vary markedly with the students' academic level and the campus parking policies and fees. Assuming typical regulations and average fees, studies of other campuses indicate that approximately one car for each five on–campus lower division students can be expected. Upper division students and graduate students will own approximately one car for each two that reside on–campus. Based on these assumptions, the resident parking requirement grows from 95 spaces initially to 1620 spaces for the ultimate student body. (Table 2).

Since the commuting students exceed those in residence by two–thirds and are additive to the faculty, staff and visitors which drive to and park at the campus each day, the number of spaces needed for commuters of all types substantially exceeds the number of spaces required for residents. This is true even though the students will tend to car pool and, therefore, maximize the use of the commuting automobile. It also reflects the fact that no more than 70% of the students are likely to be on–campus at any one time and takes into account an actual–to–FTE student ratio of 1.25:1 for commuting students which is typical of a state college in a similar environment. When these and other appropriate assumptions are calculated, the number of parking spaces for commuters vary from 375 when the campus first opens, to an ultimate need of 5560. The total number of spaces initially required for both residents and commuters is 470 increasing to an ultimate requirement of 7180. These figures round off to 500 and 7200 spaces respectively.

The number of automobile trips to and from the campus is related to the number of vehicles which will be parked there and reflects the different trips to characteristics which can be expected from the on–campus and off–campus students, and from the faculty and staff. Approximately 1,160 trips to and from the campus are expected per day when the college first opens. This figure will increase to 17,550 trips daily when the student body reaches its ultimate size. Approximately four–fifths of this traffic is generated by commuters of all types. This commuting traffic is primarily composed of students, with almost three student cars for every one containing faculty, staff or visitors. (Table 3)

The anticipated peak hour traffic characteristics of the college will be substantially more severe than most land uses of equal size. However, the heaviest hourly volumes from other uses normally occur in the evening, while the college will generate its maximum flows in the morning, coincident with the morning peak hour of the metropolitan area. Prior to the first class period, 75% of the faculty and staff and 33% of the commuting students will be traveling to the campus. For the ultimate 12,000 FTE student body, this results in approximately 2500 cars per hour. This volume requires approximately four lanes in the direction of the college, or eight lanes of two–way road, exclusively for college use. In contrast, in the early 700 to 1000 FTE stages, the college can readily share a two–lane, two–way roadway with other traffic. As can be expected, as the college grows it consistently has greater road requirements.

The location of the college, at the easterly fringe of the Bakersfield Metropolitan area, makes it dependent upon its highway ties to the East. At the present time only Stockdale Highway links the college to the city.

In order to meet the emerging traffic needs of the college, the County has consented in an agreement with the college and the Kern County Land Company, to make several road improvements within the five year period ending in 1972. They have also agreed to make other road improvements as they are required by the traffic loads. The five year commitment covers the following facilities:

1. Stockdale Highway will be widened from El Rio Road westerly to approximately Buena Vista Road. This will provide four divided lanes from U. S. 99 to, and beyond, the college.

2. Ming Road will be constructed with two lanes from its present westerly terminus to Gosford Road.

3. Gosford Road will be constructed with two lanes from Ming Road to Stockdale Highway.

These facilities will provide adequate service to meet the traffic demands in the vicinity of the college to well beyond the 3000 FTE stage, assuming an average growth in the surrounding area. However, ultimately Stockdale Highway will require further widening and Ming Road will require both widening and extension to the west.

California Avenue is currently budgeted in the coming fiscal year (1969–1970) for a four lane divided roadway extension to the west which will curve to Stockdale Highway. Ming Road immediately west of U. S. 99 is under consideration for widening by assessment district. Both of these improvements are highly desirable to bypass or eliminate existing bottlenecks which could impede traffic from certain areas of the city.

Because of the heavy traffic which will ultimately be generated by the college, it is desirable that the Route 58 Freeway be aligned as close to the college as possible and that a north–south highway, preferably Old River Road, be extended to interchange with the Freeway. This could eventually provide an excellent uncongested means of access to the college and assure that the growth of the college will not overly tax the existing highway facilities.

TABLE 1

RESIDENCE DISTRIBUTION

	ON–CAMPUS RESIDENTS			COMMUTERS (FTE)					
FTE	LD	UD & Grad	Total	LD	UD & Grad	Student Total	Fac.–Staff	Total	TOTAL STUDENT–FACULTY–STAFF
700	125	140	265	125	310	435	175	610	875
1000	175	200	375	175	450	625	210	835	1210
3000	525	600	1125	525	1350	1875	540	2415	3540
10000	1750	2000	3750	1750	4500	6250	1300	7550	11300
12000	2100	2400	4500	2100	5400	7500	1440	8940	13440

TABLE 2

CAMPUS PARKING REQUIREMENTS

	Resident Parking Spaces (1)			Commuter Parking Spaces (2)					
FTE	LD	UD & GRAD	Total	LD	UD & GRAD	Fac.–Staff	Visitors	Total	Total Resident & Commuter Spaces
700	25	70	95	75	180	110	10	375	470
1000	35	100	135	105	260	135	20	520	655
3000	105	300	405	305	790	350	60	1505	1910
10000	350	1000	1350	1170	2630	840	200	4840	6190
12000	420	1200	1620	1230	3160	930	240	5560	7180

(1) Resident Car Ownership Assumptions in cars/student:

LD – .2
UD & Graduate students – .5

(2) A. Based on actual students . 1.25 actual commuting students to 1.0 FTE.

B. Car occupancy: Faculty–Staff = 1.40 persons/car
Students = 1.50 persons/car

C. Maximum on–campus accumulation:
Faculty–staff = 90%
Students = 70%
Visitors = 2% of FTE

TABLE 3

TRAFFIC GENERATION

	Daily Car Trips To & From Campus Commuters (2)					First Period Peak Hour Car Trips To Campus		
FTE	Residents (1)	Students	Fac.–Staff	Visitors	Total Trips	Students	Fac. Staff	Total
700	210	655	225	70	1160	110	85	195
1000	300	935	270	100	1605	155	100	255
3000	900	2810	695	300	4705	465	260	725
10000	3000	9740	1670	1000	15410	1630	625	2255
12000	3600	10800	1850	1300	17550	1800	700	2500

(1) 3 weekday trips/week
Occupancy 1.5 persons/car

(2) 90% of actual students x 2 trips/day, occupancy 1.5 persons/car
90% of Faculty–staff x 2 trips/day, occupancy 1.4 persons/car
10% of FTE = visitors

WIDTH OF THE GALLERIAS

The gallerias are important pedestrian elements of the campus plan. They are not only the "spine" which links clusters of classrooms, but they also provide convenient routes for intra–campus pedestrian movement. It was for these reasons that the width of these important spaces were subjected to analysis in order to assure their adequacy.

The two components of the study of the galleria width were:

Demand -- How many students, faculty and staff would desire to use the gallerias during the peak activity periods when the college is at ultimate size.

Capacity -- How many people could be conveniently and efficiently served by various galleria widths.

DEMAND — For purposes of analysis the west galleria was studied since it will be subjected to the heaviest galleria movements.

The complete variability of pedestrian movement, subjected as it is to constantly changing motivations which fluctuate with impulse, weather, social and other reasons, makes it necessary to examine it in a broad generalized manner. Three approaches using different assumptions were utilized. The class break between the second and third periods was assumed to be the design peak period based upon other college studies, and estimated to be of ten minutes' duration.

RELATIVE APPROACH: On campus there are roughly two educational units, as measured in classroom chairs, library seats, or laboratory positions per FTE student. Approximately 85% or 19,000 of these are close enough to the west galleria to be considered tributary to this mall. These facilities vary in relation to the galleria so that a factor was applied based on their proximity, revealing that one-third of those in the tributary area or 37% of the campus may utilize the galleria during the ten-minute design period. This results in a projected demand of 3,200 students.

GENERAL APPROACH: Studies on other campuses indicate that 70% of the student body or 8,400 students will be in the academic areas during the peak period. Subjectively, it seems unlikely that any one galleria would be required to serve more than one–third to one–half of the students during a class break. This suggests a maximum demand of 2800 to 4200.

ABSOLUTE DEMAND: On each side of the galleria there are facilities for 2,900 students of which 70% or about 2,000 are estimated to be occupied during the peak period. Four–fifths of these, or 1,600, may utilize the galleria rather than exterior exits. Assuming that the galleria-oriented students are matched by an equal number of students walking through from one section of the campus to the other, a demand of about 3,200 is obtained.

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The three approaches varying from subjective to semi–analytical result in the same order of demand -- from 2,800 to 4,200 people in the galleria per 10 minutes. Taking into account the order of accuracy for design purposes 3,000 people have been used. This recognizes that several outside alternate and parallel paths to the galleria will be available and that a mezzanine level also parallels the galleria. These act as "safety valves" to the galleria itself. Another possibility is the widening of the galleria in the later stages of development if experience indicates it is desirable. This phases well with the demand since the heavier pedestrian volume areas are to be built in the later stages of college development.

CAPACITY

Studies indicate a walking person occupies about 7.0 sq. ft. but with a restricted walking speed. For design purposes a value of 15 sq. ft. per person is recommended, which reflects a desirable rather than a minimum level of pedestrian movement.

Pedestrian speeds vary between 3.5 and 5.5 ft. per second. The slower figure is preferred to reflect leisurely movement characteristic of people walking while maintaining conversations.

Utilizing an automobile analogy, pedestrians are often considered to occupy a 2′ wide lane. Measured capacities vary from 600 people/lane/hour to 2,400 or more. The former is a promenade; the latter is a heavy flow. 1,200 is considered a desirable level for a galleria.

> RECOMMENDATION: These factors indicate that during a 10–minute break the 500 ft. gallerias can turn over 3.2 times, taking into account the transitional fill–up and exiting time at each end of the break. Approximately 30 to 35 people will occupy the mall per foot of mall width at any moment, and therefore, about 100 people per foot of mall width is the approximate capacity. Thus a 30 ft. mall is required to satisfy the 3,000 person demand in the gallerias and should be adequate for the ultimate needs of the college. An additional 2.5′ should be added on each side to account for obstacles or restrictions.

APPENDIX B

A COMPARATIVE ANALYSIS BETWEEN LOAD CENTERS AND A CENTRAL PLANT FOR HEATING, VENTILATING AND AIR CONDITIONING.

California State College, Bakersfield

The object of this report is to describe a typical central plant and the load center system proposed and to compare their characteristics, capital costs and operating costs.

CONCLUSION

This report has implemented a recommendation for a commercial type load center system by drawing comparisons with a conventional central plant which is typical of those recommended for California State College campuses. The report indicates a substantial decrease in initial costs plus lower operating costs for the load center system.

Specific recommendations for load center equipment and load center plant locations have been given. Alternate load center equipment selections to reduce service costs have been discussed, and recommendations are deferred pending studies which do not constitute a portion of this report.

A situation not covered in this report is the possibility of a single load center facility providing an optimized system. This is not the case for the Bakersfield campus, but might be justified for a campus with a more dense occupancy in a smaller area.

Another situation not discussed is the traditional approach to systems selections and equipment selections. The traditional campus approach seeks the lowest combination of owning and operating costs, and in so doing usually assumes unlimited availability of capital. However, for many commercial systems, there is a scarcity of capital; either due to a loan limitation, a favorable alternate for investment or a tax benefit. As a result, the owner uses his judgement in weighing the importance of owning costs in respect to operating costs before final systems or equipment selections are made. Needless to say, capital is not unlimited for the California State College systems. If judgement is to be used in weighing the importance of initial costs, it should be exercised by the people responsible for directing the colleges. In this respect the significant reduction in initial costs afforded by the load center concept should not be ignored.

GENERAL DESCRIPTION OF PLANNED SYSTEM

The planned system consists of several efficient central chilled water/hot water plants, each plant located within a high usage area of the campus having heavy air conditioning and heating loads. Determination of the number of central plants and their locations results from optimizing the initial costs of equipment, distribution and supporting facilities. This is accomplished without creating the maintenance and nuisance problems associated with equipment which depreciates quickly and, generally, without locating water chilling and heating equipment within individual buildings in high density areas.

Economy in operation is achieved through automation, the use of relatively unsophisticated equipment and systems, the lower costs of distributing energy through short distribution systems and the ability to operate very efficiently at low loads.

The planned system featured in this report will be defined in the following portions of the report as a *load center* system. In contrast, the familiar single, central cooling/heating plant in a location remote from the heavy density areas of the campus will be defined as a *conventional central plant*.

IMPLEMENTATION OF REPORT

This section of the report will discuss in detail the attributes of the load center concept and will draw comparisons with the conventional central plant. Details of the load center system will be presented. Initial costs will be estimated and compared to those of a typical central plant which might serve the Bakersfield campus. Operating costs will be discussed, and guidelines will be presented which will cover the selection of alternate energy source load center systems.

The following lists the subsections in this section of the report:

A. DESIGN OBJECTIVES FOR LOAD CENTER SYSTEM

B. CONCEPTIONS ASSOCIATED WITH THE CONVENTIONAL CENTRAL PLANT CONCEPT

C. DETERMINATION OF EQUIPMENT CAPACITIES AND LOCATIONS FOR THE BAKERSFIELD MASTER PLAN

D. PHYSICAL AND OPERATING DETAILS OF THE BAKERSFIELD CAMPUS LOAD CENTER SYSTEM
   1. Chilled Water
   2. Condenser Water
   3. Heating Hot Water
   4. Control Air Distribution and Signal Transmission
   5. Criteria for End Use in Buildings

E. PHYSICAL AND OPERATING DETAILS OF A COMPARISON CONVENTIONAL CENTRAL PLANT FOR THE BAKERSFIELD CAMPUS

F. INITIAL COSTS
   1. Load Center System
   2. Typical Conventional Central Plant

G. OPERATING COST COMPARISONS
   1. Maintenance and Labor Costs
   2. Service Costs

H. ALTERNATE LOAD CENTER EQUIPMENT
   1. Combination Electric Centrifugal Compressor—Absorption Unit Water Chillers
   2. Gas Engine Driven Centrifugal Compressor Water Chillers

A. DESIGN OBJECTIVES FOR LOAD CENTER SYSTEM

The following lists design objectives which are disciplines not usually implemented with a conventional central plant. These disciplines are useful towards reducing intial and operating costs.

1. Locate each load center within the high usage area it will serve; keep distribution to a minimum.

2. Use only equipment which can be operated safely and conveniently for prolonged periods without attendance, and which does not require attendance by codes or governing regulations.

3. Provide a completely automated system. This does not mean that attendance is not recommended; however, it does permit intermittent attendance on a single shift, 40 or 44 hour week basis with equipment automatically starting and stopping at all times, including weekends and during late evenings and early mornings.

4. Provide for efficient operation of heating and cooling equipment from maximum load down to the minimum anticipated evening or weekend loads.

5. Provide efficient chilled water and hot water distribution systems which deliver energy to loads at minimum operating cost and with reduced pipe sizes.

6. Utilize proven central plant *commercial* quality equipment instead of industrial quality equipment to provide lower initial costs without increasing maintenance costs.

7. Arrange equipment and distribution systems so that their planned increases in capacities will be commensurate with the growth of the campus. *Large increases in equipment capacities and piping systems should not precede the construction of buildings they will serve.*

8. Design and arrange piping distribution systems so that the cost of equipment in buildings using heating hot water and chilled water will be minimum.

B. CONCEPTIONS ASSOCIATED WITH THE CONVENTIONAL CENTRAL PLANT CONCEPT

The following briefly discusses some conceptions frequently associated as being favorable towards the use of a conventional central plant. The purpose of this discussion is to clarify how the load center system will compare or improve upon many of the objectives of a conventional central plant system. In the following, the conceptions associated with conventional central plant design are italicized, and the discussions of these conceptions appear immediately thereafter.

1. *The conventional central plant serving a larger area permits greater diversification in the use of equipment, and consequently this results in an overall total reduction in central plant equipment capacities.* Theoretically this is true. In actuality, this concept is seldom if ever fully implemented.

   A typical conventional central plant would have a cooling capacity based on 36 BTUH per sq. ft. gross area for Bakersfield; and this would be based on a 75% diversity in loads within and between buildings. Based on commercial experience the load center system would also have a total capacity based on 36 BTUH per sq. ft. gross area, but would be designed for a diversity of 80%.

   The conventional central plant typically has a boiler capacity far in excess of any campus heating needs. Capacities of 50 BTUH or greater per sq. ft. gross area are not uncommon, particularly when absorption cooling units are considered. In comparison, commercial central plants (load centers) in Minnesota and Michigan have been designed for less than 40 BTUH per sq. ft. and this allows for significant standby protection.

2. *The initial cost per unit capacity is less for the larger capacity equipment featured in the conventional central plant.* Generally, this is not the situation, except for individual equipment items of very large capacity which would not be suitable for the Bakersfield 12,000 FTE campus having a 40-year growth pattern.

   More often, a commercial central plant (load center) utilizes motor driven centrifugal compressor water chilling units ranging in capacity from 600 to 1200 tons each. The current non-installed cost to the contractor for these units ranges from about $60.00 to $65.00 per ton plus wiring. Absorption units which are frequently featured in conventional central plants likewise cost between $60.00 to $65.00 per ton, but almost always require larger and more sophisticated boiler plants and greater cooling tower capacity. Open drive industrial quality centrifugal compressor water chilling units also frequently featured in conventional central plants cost about $80.00 per ton when less than 2000 tons capacity.

   The commercial central plant (load center) uses low pressure hot water Scotch Marine or steel fire tube boilers costing a contractor about $35.00 per boiler horsepower. In contrast, the conventional central plant uses high pressure water tube boilers which would cost about $50.00 per boiler horsepower for sizes suitable for the Bakersfield campus, and which require a relatively high additional investment in installation and accessory equipment. The result is a conventional central boiler plant requiring an initial investment of 200-to-400% above that of a commercial type load center heating plant.

3. *The larger industrial type equipment and systems featured in conventional central plants are of superior quality.* This implies fewer operating problems and less maintenance. Perhaps a more definitive description would be that the conventional central plant equipment and systems are more sophisticated and are capable of operating under more severe operating conditions.

   A commercial central plant (load center) utilizes simpler equipment and systems than the conventional central plant, and the sophistication required by the larger industrial equipment and systems are not needed. Likewise, the load center heating systems function under less severe operating conditions than those of the conventional central plant, and the superior design features and rugged construction of the industrial systems would be wasted, if used.

   Obviously, the simpler central plant type equipment and systems associated with load centers require less supervision since they can be automated. Recourse to organizations who specialize in maintenance will also show that, generally, these simpler, less sophisticated equipment and systems will have lower maintenance costs per unit capacity.

4. *The conventional central plant provides greater standby capability, since centralization of equipment permits either partial equipment operation or alternate equipment operation in the event an item of major equipment fails to function.* Generally, this is true, since a load center will incorporate effective standby capability only after it has grown to its ultimate size.

The principle of a shortage of standby capability during the growth period of the campus results in the least commitment of major cooling and heating equipment prior to the construction of buildings. The conventional central plant which provides standby capability at all times must incorporate a great overcapacity in equipment during most of the campus growth period. The load center concept, however, minimizes this overcapacity. In this case, if there is an outage of a major equipment item in a load center, only a portion of the campus will be affected.

5. *High pressure steam or medium or high temperature water produced in a conventional central plant can serve the special requirements of kitchens and laboratories.* These special requirements can also be effectively served by local heating equipment using gas or electricity as the source of energy. Usually, the initial cost of the local equipment is less than the heat exchangers, control valves, and/or appurtenances, plus piping, necessary to utilize the high pressure steam or hot water for the process. The maintenance required by the local equipment will be greater, but this is a very minor factor when compared with the overall benefits of using central plant type (load center) low pressure equipment for space heating purposes.

6. *Use of a conventional central plant will result in a more economical operation due to load trimming and, in some cases, the use of a more economical energy source.* Load trimming in a load center operation is equal to that of a conventional central plant during normal day operation, and it is vastly superior to that of a conventional central plant for low cooling load operation during evenings and weekends. Furthermore, the cost of distributing chilled water and hot water is less for the load center operation.

The load center system includes options for using an alternate energy source. Generally, a deviation from the use of commercial quality motor driven centrifugal compressor water chilling units for cooling and gas or gas/oil fired boilers for heating will result in a higher initial cost and a higher maintenance cost; but can result in a lower energy source cost. The subject of using an alternate energy source with consequent change in equipment will be discussed in further detail in a subsequent portion of this report.

7. *The conventional central plant in a location remote from the area of main campus activities provides for greater campus efficiency and improved architectural designs. Furthermore, the noise and functional unsightliness of a central plant are not obvious due to its remote location.* During the last fifteen years, commercial central plants (load centers) in general have moved to immediate proximity or to within the areas they serve. This is to take advantage of the decreased initial costs and lower operating costs associated with equipment designed for less severe operating conditions and shorter distribution systems.

Simultaneously, practical engineering disciplines and applications of noise and vibration controls have evolved, and these are reflected not only in the designs of most of today's chilled and hot water systems, but also as features of the mass produced, commercial type central plant equipment presently being marketed.

Noise transmission and vibration transmission presently are successfully designed out of load center installations in a practical manner. Furthermore, compact load centers are successfully integrated into overall architectural schemes without unpleasant effects or loss of desired building or area efficiencies. The challenges to accomplish these features are greater, but these challenges are being successfully met to achieve the goal of less costly mechanical systems.

8. *The conventional central plant using less total items of equipment requires less total area for equipment space; therefore, the cost for central plant building and structure will be less.* The load center features equipment which can be located on a flat slab with simple housekeeping pads in a 20 ft. high building Most central plants require buildings of considerably greater height, plus special trenches, pits and mezzanines to accommodate equipment. Furthermore, the central plant requires increased and special structural provisions to accommodate the larger size pipes. Generally, the total cost of load center buildings will not exceed or will be less than the equivalent central plant building.

C. DETERMINATION OF EQUIPMENT CAPACITIES AND LOCATIONS FOR THE BAKERSFIELD CAMPUS

1. *Load Center System.* Total gross area served will be about 1,270,000 sq. ft. for the 12,000 FTE campus. This will consist of 1,140,000 gross sq. ft. of instructional, library and audio-visual, administration and student services, and gymnasium spaces, plus a balance of spaces made up of large dining and common area structures associated with the residential villages and the upper division housing. Dormitories and dwelling units will not be assumed to be served from the load center system, although modifications would allow this extension.

   Water chilling capacities are based on 36 BTUH per sq. ft. gross area and a 75% diversity in load between air handling unit cooling coils located throughout various campus buildings served by the load centers. This provides for a total water chilling systems capacity of 3,800 tons and a total cooling coil capability of over 5,000 tons. It is anticipated that the maximum average demand on the water chillers will never exceed 90% of the 3,800 installed tons.

   Gross boiler heating output capacities are based on 36 BTUH per sq. ft. gross area and a 65% diversity factor in load between heating coils located throughout the various campus buildings served by the load centers. This provides for a total gross boiler heating output of 46,000 mbh and a total heating coil capability of over 66,000 mbh. It is anticipated that the maximum average demand on the boilers will never exceed 70% of their installed capacities.

   At this time the following four recommended load center locations and the amount of area each will serve are listed below:

   a. Location at western tip of Universal Space; area served 550,000 sq. ft.

   b. Location at eastern tip of Universal Space; area served 550,000 sq. ft.

   c. Location at gymnasium; area served 50,000 sq. ft. This load center facility to include water heating facilities for showers, filtering system and heaters for pools, etc.

   d. Location between Village No. 2 and Village No. 3; area served 120,000 sq. ft.

2. *Conventional Central Plant.* This system is presented for cost comparison purposes.

   Total gross area served will be identical to the load center system, and will consist of the same 1,270,000 sq. ft. for the 12,000 FTE campus. No dormitories or dwelling units are included.

   Water chilling capacity and diversity are the same as the load center system; 36 BTUH per sq. ft. and 75% diversity in load between air handling units.

High pressure steam boilers are utilized to serve a 3,800 ton cooling system consisting of absorption units receiving their supply of steam from a turbine driving a centrifugal compressor water chilling unit. Three boilers provide 50% standby capability at full load, based on a 12.5 lb/hr per ton steam rate for this system.

Heating is by medium temperature hot water generated by direct contact heat exchangers. Capacity and diversity are the same as the load center system; 36 BTUH per sq.ft. gross area and a 65% diversity in load between air handling units.

Location of the conventional central plant is assumed adjacent to the corporation yard.

D. PHYSICAL AND OPERATING DETAILS OF THE BAKERSFIELD CAMPUS LOAD CENTER SYSTEM

This portion of the report will describe and illustrate in detail one of the recommended load centers which serves 550,000 G.S.F. This load center will be typical of the two that together will serve more than 85% of the non-residential portions of the campus.

A third small load center, serving the gymnasium, should be an efficient, automated chilled water/hot water plant located within the gymnasium structure. It is probable that at least two water chilling units and three boilers serving air handling units and perhaps shower and pool heating facilities, should be most acceptable for the ultimate expansion of the gymansium facilities. Location and operation of this equipment should be coordinated with the mechanical facilities required for pools, showers, etc. Few additional comments regarding the gymansium load center will be presented, since these would have little relevance to the master plan and small importance to the economic significance of this report.

The fourth and last load center which serves the non-residential portions of Village No. 2 and Village No. 3 will be a miniature of the load center serving a 550,000 G.S.F. In this case, however, the optimum ultimate equipment arrangement probably will consist of two water chilling units and three small hot water boilers. As before, the load center will be automated.

The following describes and illustrates the load center which serves 550,000 G.S.F.

1. *Chilled Water (Figures 1, 2 and 3).* Figure 1 illustrates the water chilling system suitable for the initial group of buildings. This equipment is retained and utilized as the load center grows in size to serve additional buildings (Figure 2) and reaches its final ultimate size (Figure 3).

   Figure 3 illustrates an optimum arrangement for an efficient automated load center—two large chillers in series and the small initial chiller in parallel. For maximum load during the day, all three chillers can operate through two of the large chilled water pumps; although during almost all of the daytime hours, it is anticipated that only one or both of the large chillers will run. During late evenings and weekends when most academic buildings are unoccupied, only the small initial chiller operates through its initial chilled water pump. Sequencing and changeover of water chillers is simple and entirely automatic (no automatic equipment shutoff valves are required) and coordinated with the operation of air conditioning systems within the buildings served by the load center.

   The staged installation of equipment and piping distribution for a load center is dependent on the expansion of that portion of the campus served by the load center. It is conceivable that at the time one load center has reached its ultimate size, another load center at least will be in operation with its initial small chiller.

This portion of the report is based on all water chilling units being commercial quality, electric motor driven, centrifugal compressor types (either accessible hermetic or open type). A subsequent portion of the report will discuss deviations from this premise.

Wherever possible, piping distribution will be above ground within buildings or walkways. Only about 20% of the piping distribution systems serving the two large load centers are anticipated to be underground. None of the piping serving the gymnasium load center will be underground. A substantial portion of the piping serving the small load center between Village No. 2 and Village No. 3 probably will be underground.

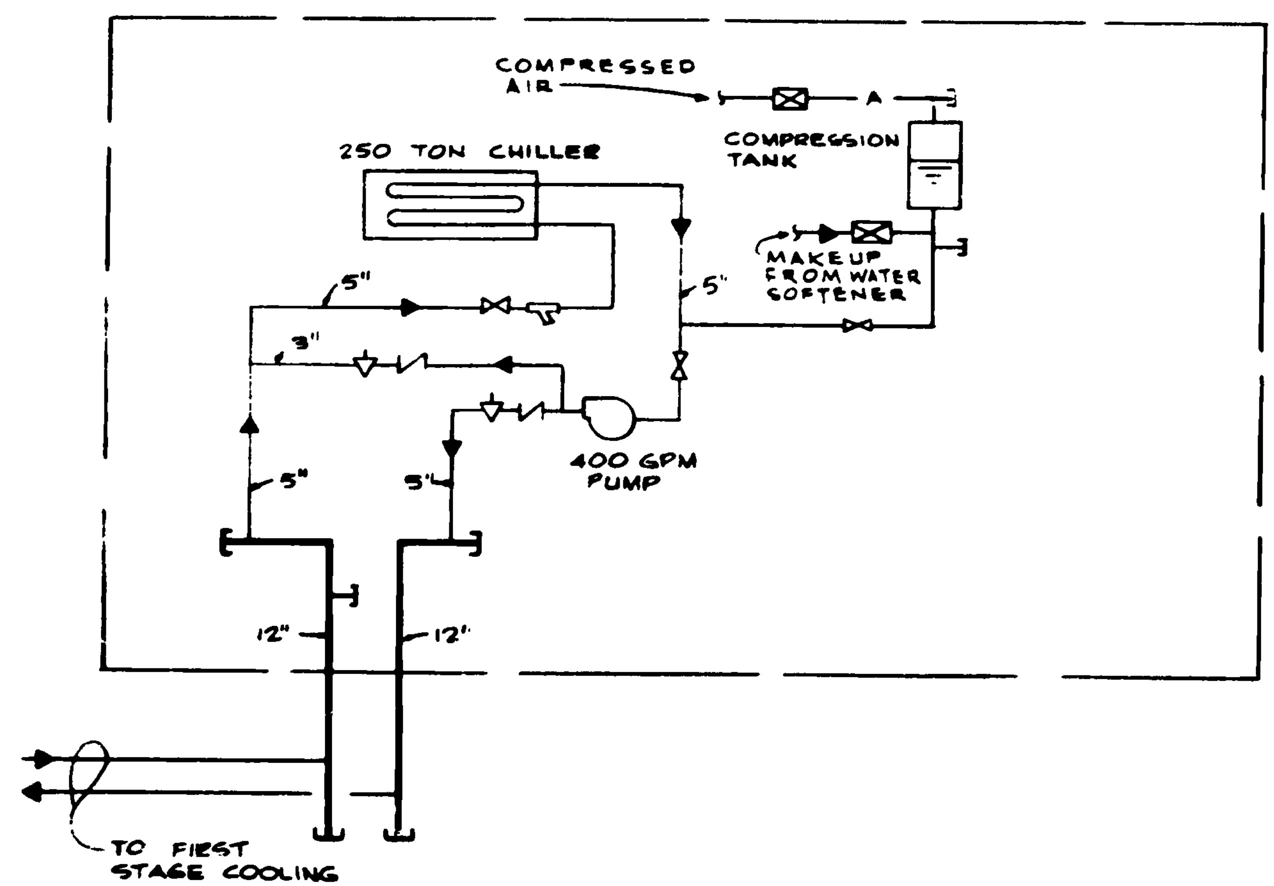


Figure 1 1ST STAGE CHILLED WATER

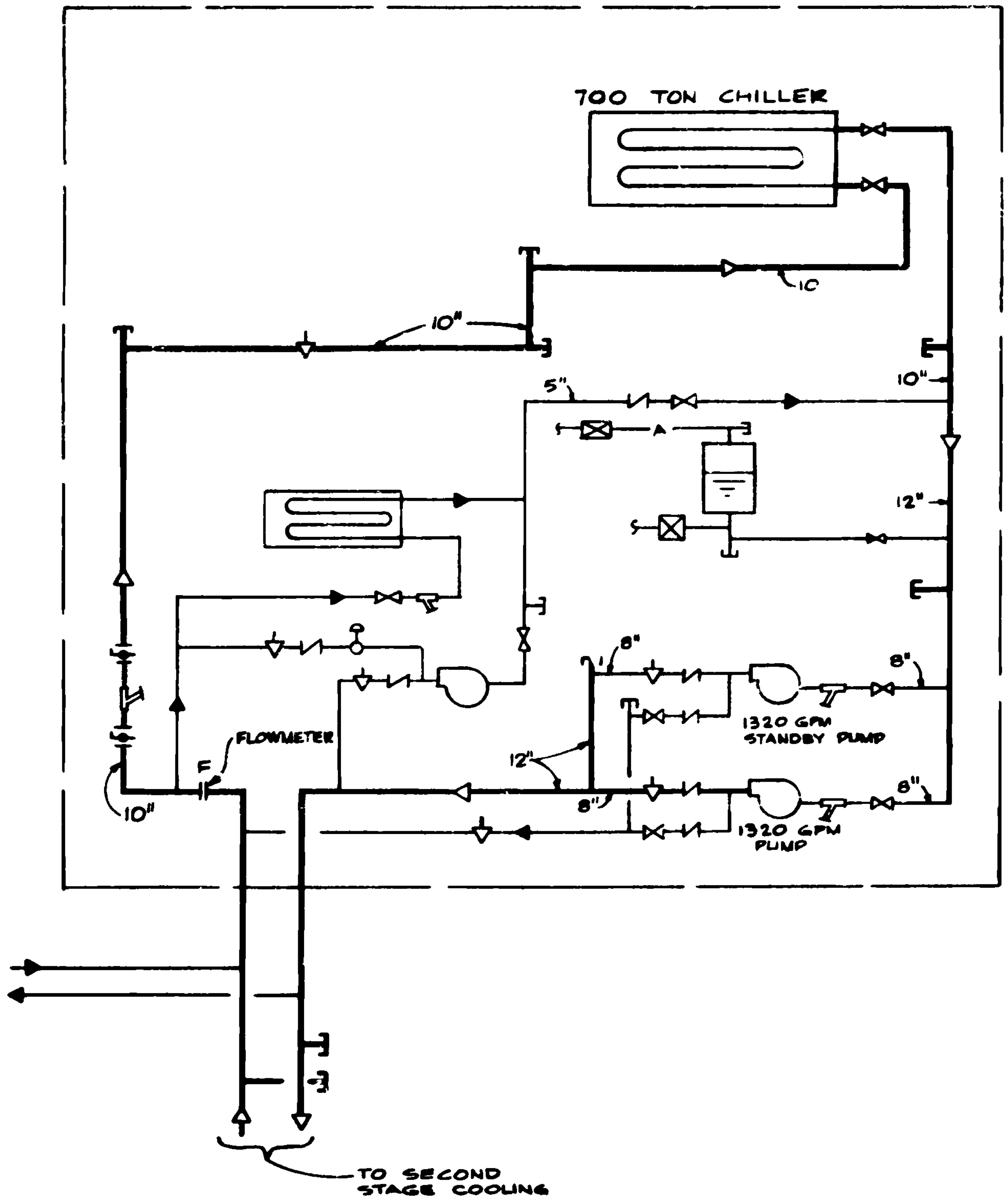


Figure 2 2ND STAGE CHILLED WATER

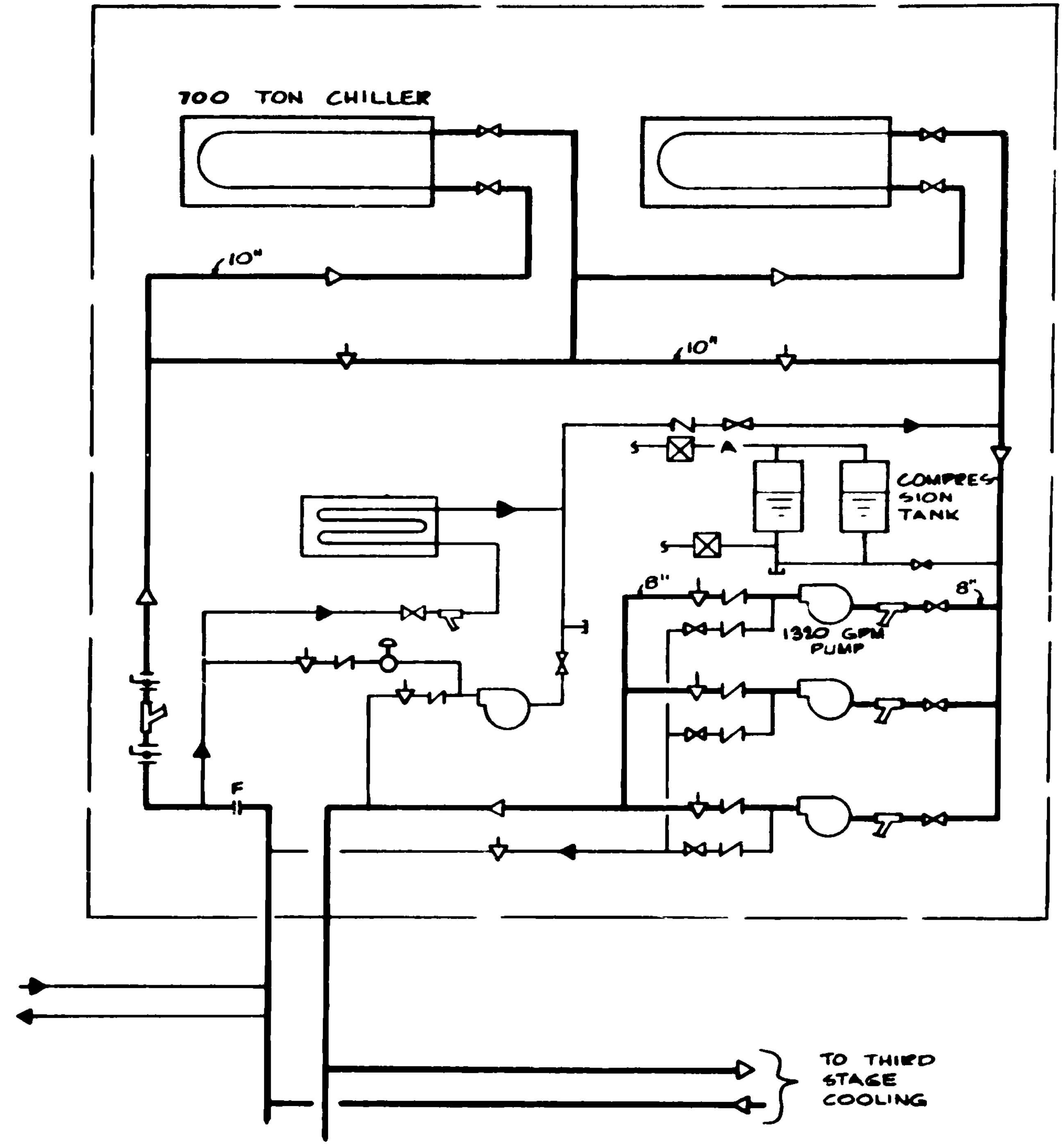


Figure 3 3RD STAGE CHILLED WATER

2. *Condenser Water (Figures 4, 5 and 6).* Figure 4 illustrates a condenser water system which might be suitable for the small initial water chiller. In this case, well water is used as the condensing medium, and the waste water can be utilized for irrigation.

Figures 5 and 6 illustrate the staged installation of cooling towers and the two large water chilling units as they are added to the load center.

At the time the first large water chiller is added it might be desirable to convert the condenser of the small, initial chiller from a well water supply to a cooling tower supply. This could be accomplished by increasing the capacity of the cooling tower and providing a separate discharge header within the tower for the small chiller. A small condenser water pump to serve the small chiller would also be added.

Operation of cooling towers and condenser water pumps would be entirely automatic.

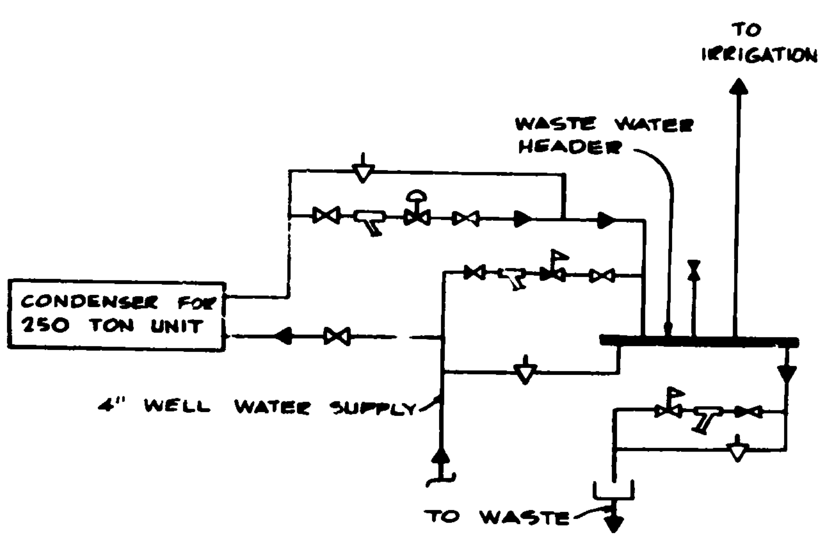


Figure 4 **1ST STAGE CONDENSER WATER**

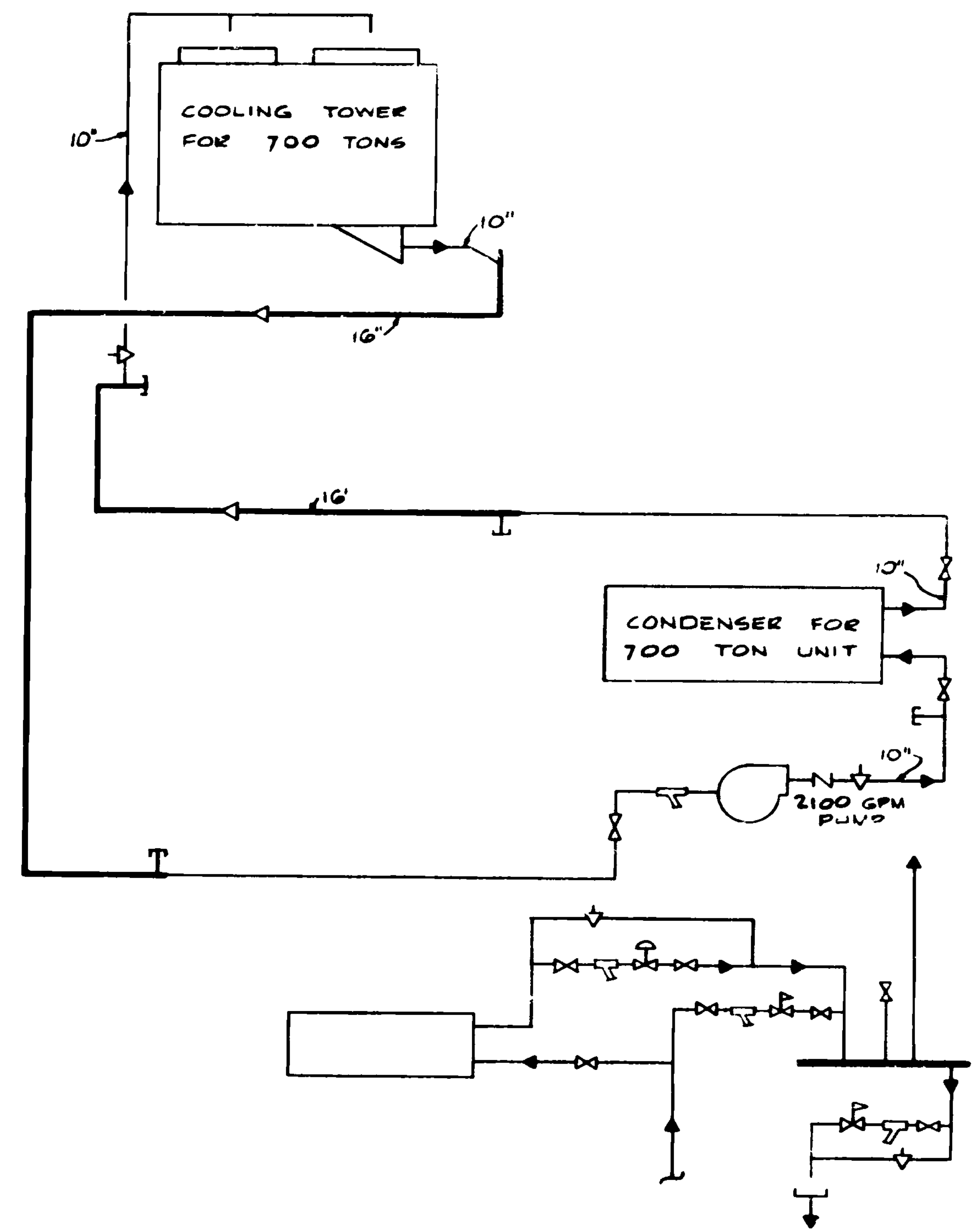


Figure 5 **2ND STAGE CONDENSER WATER**

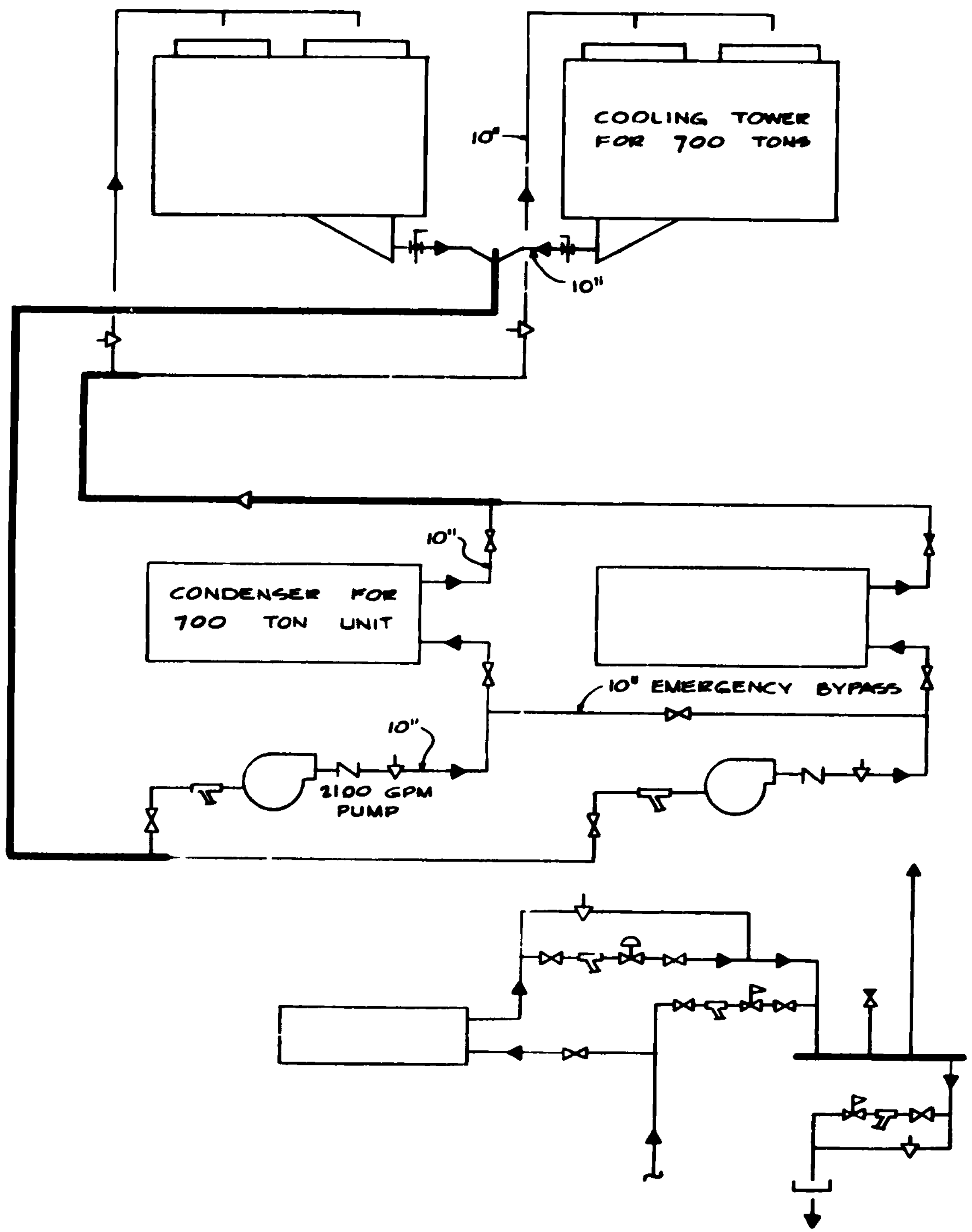


Figure 6 3RD STAGE CONDENSER WATER

3. *Hot Water (Figures 7, 8 and 9).* Figure 7 illustrates the hot water boiler and pump installation for the initial group of buildings. The boiler and pump will be somewhat oversized for this initial installation, but the equipment will be retained and utilized as the load center grows in size to serve additional buildings (Figure 8) and reaches its final ultimate size (Figure 9).

Figure 9 illustrates an emerging concept for an efficient, automated load center—hot water boilers in series. The several advantages for this arrangement are listed below.

a. It is impossible to thermal shock a boiler; good water circulation is assured at all times, and hot water cannot come into contact with a cold boiler, and cold water cannot come into contact with a hot boiler.

b. Large system design temperature conditions can be achieved with low temperature (250°F maximum) boilers without causing a large temperature difference to occur across any boiler. This is accomplished without the necessity of using primary boiler hot water circulating pumps.

c. Automatic shutoff valves are not required to prevent bypassing of relatively cool return water through an idle boiler into the common hot water supply.

The advantages listed above result in an efficient, low initial cost installation which features minimum severity of boiler service conditions and is specially suited for automation due to the simplicity of equipment arrangement.

Hot water piping distribution from load centers will parallel the chilled water piping mains previously discussed. As before, the greater portion of piping distribution will be above ground.

In order to obtain a preferred gas fuel rate, it is probable that an interruptible gas service should be obtained at about the time the campus reaches its 3,000 FTE growth. Consideration at that time should be given towards the use of a single propane/air dilution and vaporization station to serve the load centers, located close to the point where the gas service is metered to the entire campus. Although local No. 2 fuel oil standby tanks and pumps could be effectively utilized for the load centers, the propane standby plant would provide for a simple change-over operation and would eliminate the nuisance of firing boilers with fuel oil.

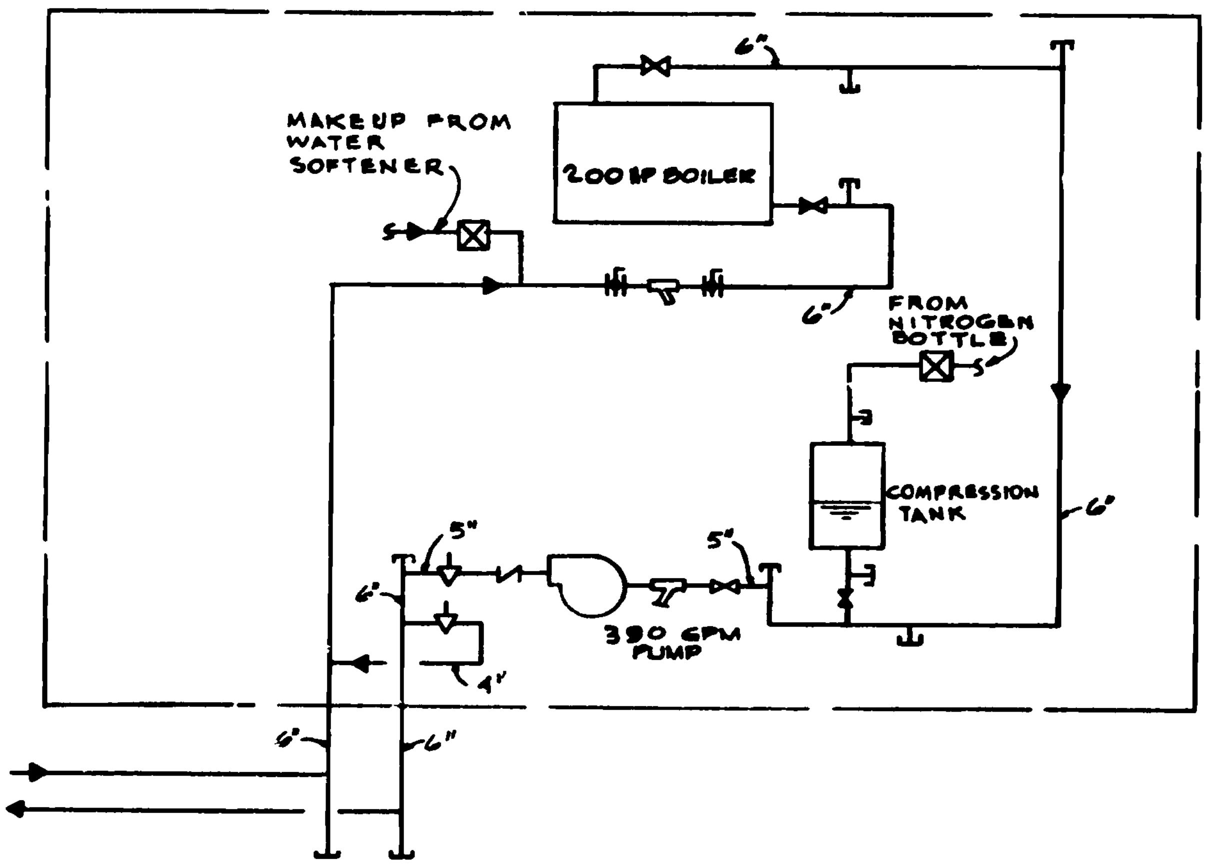


Figure 7 1ST STAGE HOT WATER

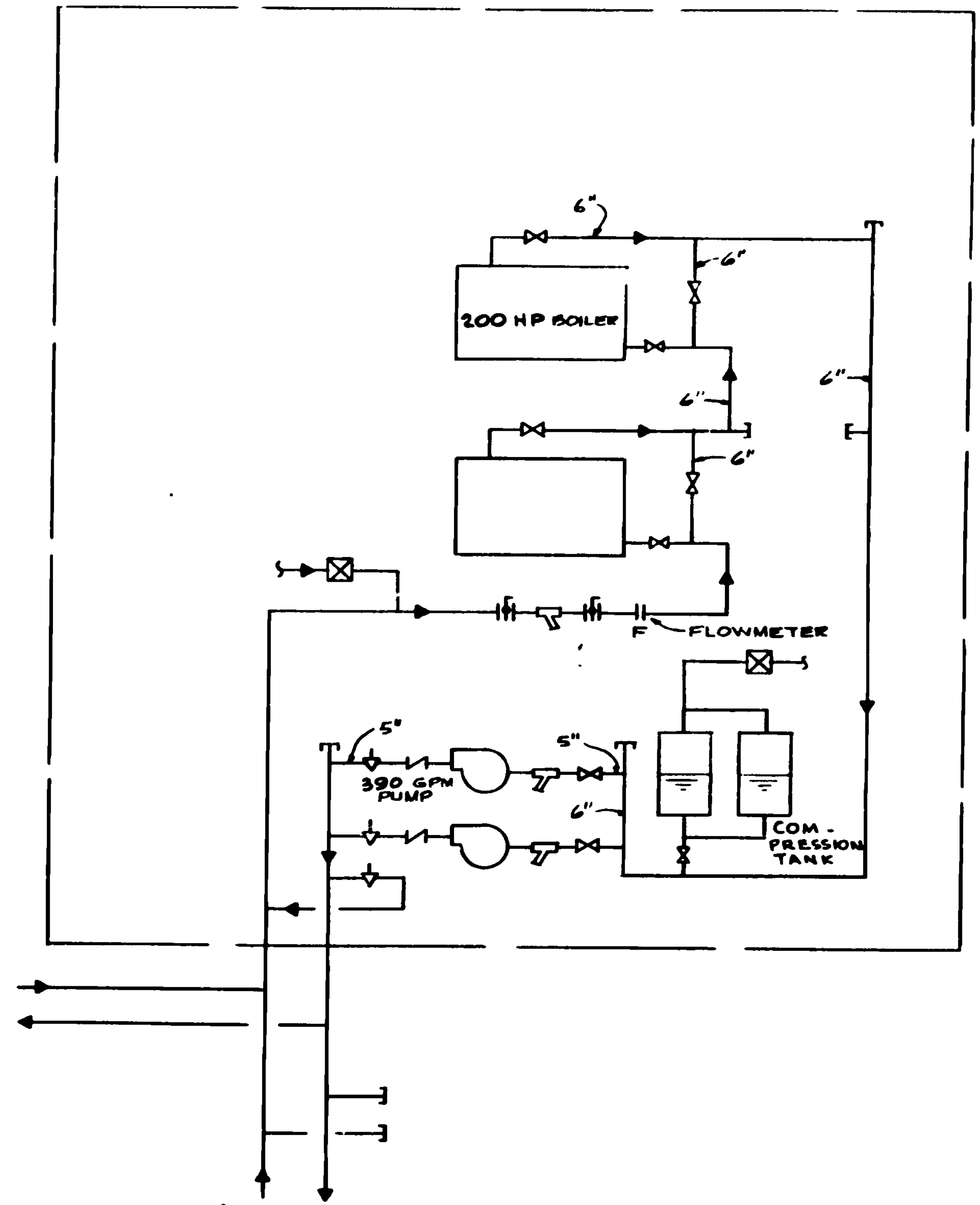


Figure 8 2ND STAGE HOT WATER

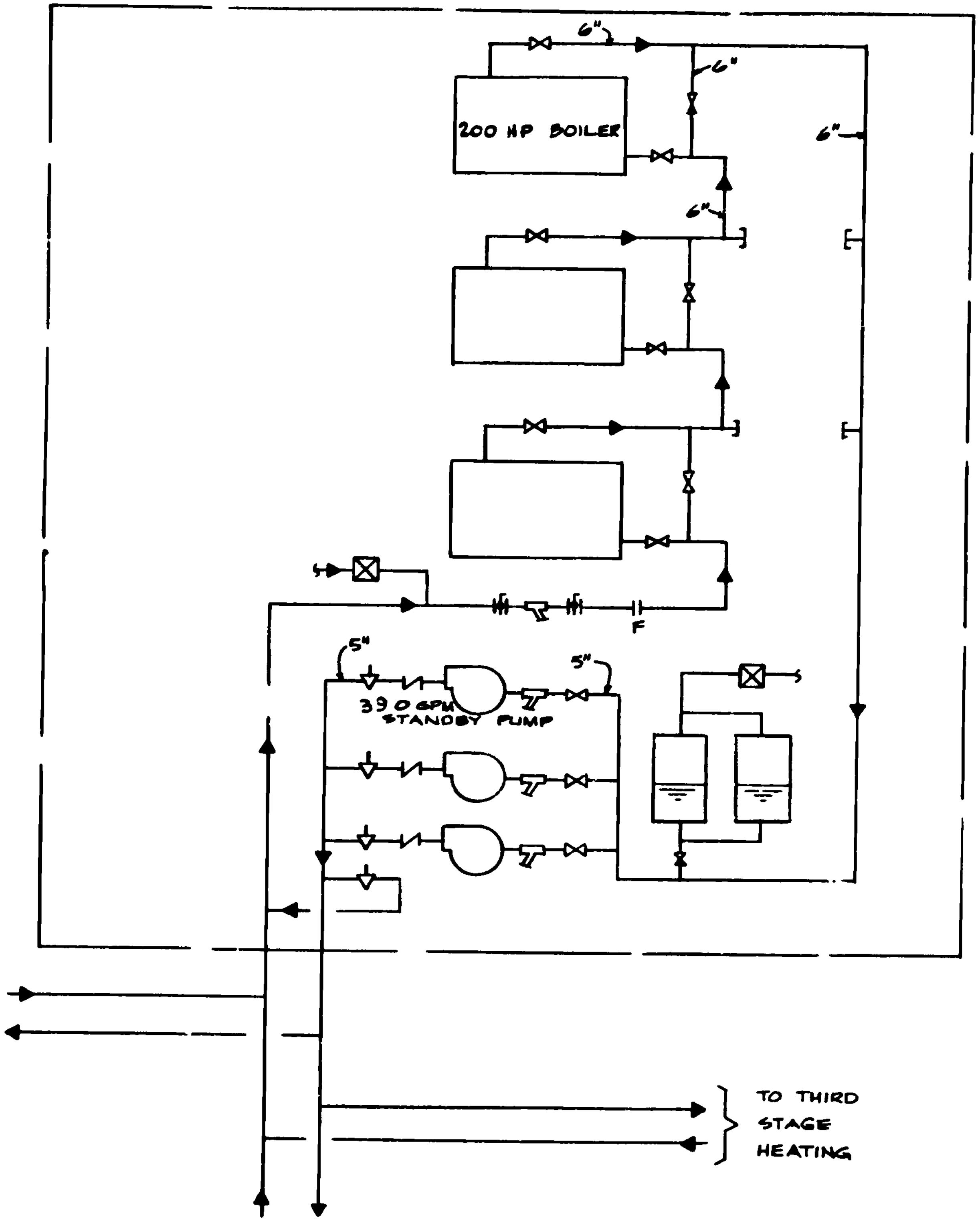


Figure 9 3RD STAGE HOT WATER

4. *Control Air Distribution and Signal Transmission (Figure 10).* A compressed air system located in each load center will supply the temperature control systems within campus buildings served by the load center. Capacity of the compressed air system will grow with the staged development of the load center. Quality control air will be insured by the use of filters and mechanical refrigeration air dryers, or their equivalent.

In the absence of a comprehensive campus automation center incorporating effective signal transmission to and from buildings, the control air supply will be utilized to coordinate building air conditioning systems with central plant operation (Figure 10). A change in supply air pressure from a load center will signal the prearranged day or night operation of air handling units and/or cooling systems within buildings. At this time, the load center cooling plant automatically will change from full day operation to minimum night operation, or vice versa. When appropriate, the cooling and heating equipment in a load center will shut down completely during evenings and/or weekends, and will restart automatically when required.

Anticipatory system malfunction and equipment malfunction annunciation systems are mandatory for the automated load centers. Failure of equipment to function properly, or the failure of systems' performance to approach acceptable conditions, will be signalled to a supervisory agency on a 24-hour, seven-day week basis. The agency might be a campus facility or an outside contracted organization. The facility or organization must be prepared to initiate remedial actions as warranted.

The mechanical annunciation systems can be incorporated effectively into an overall campus security, fire and lighting surveillance system. The mechanical annunciation systems can also function independently, if desired, and in this case can be provided at a relatively low initial cost.

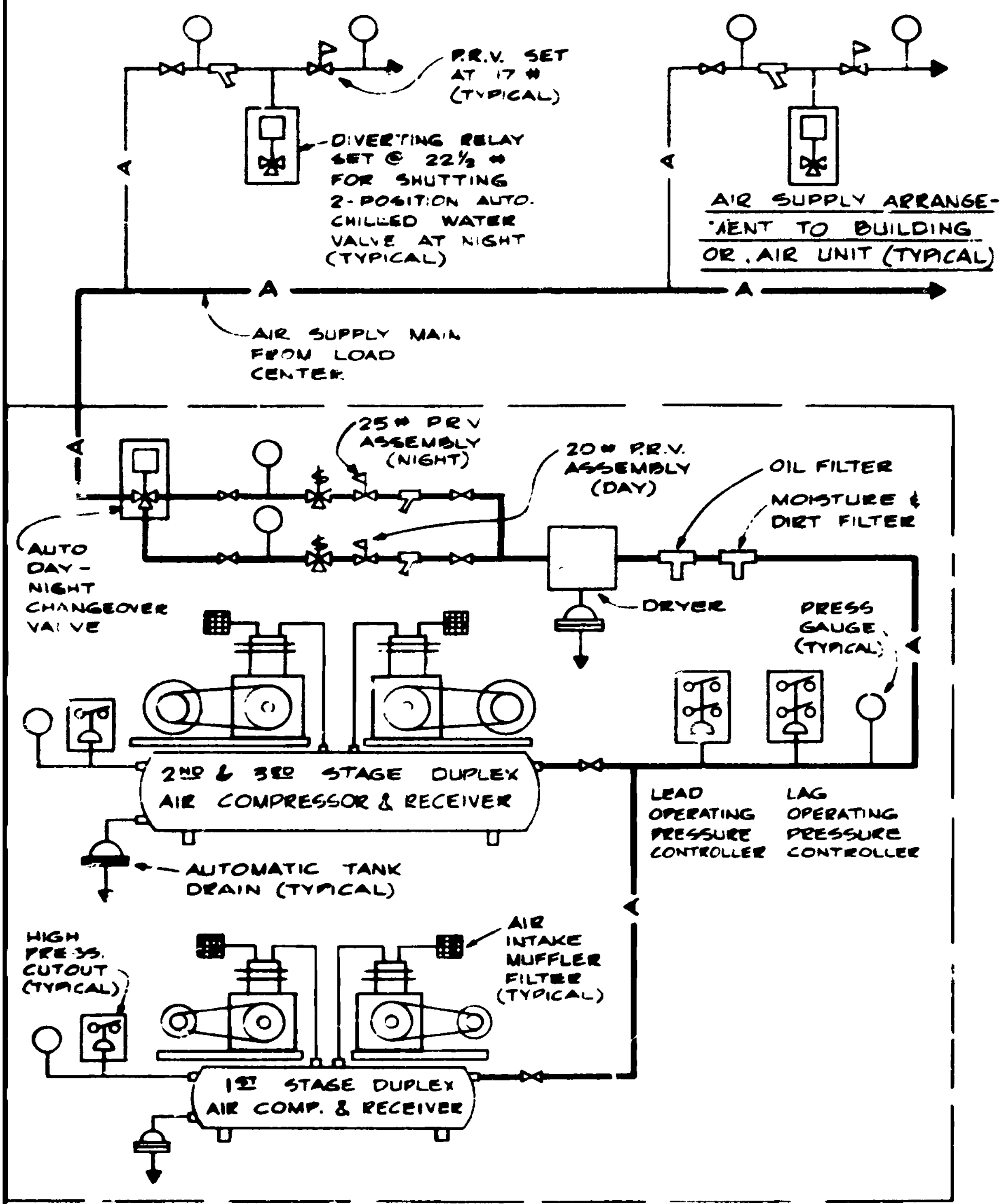


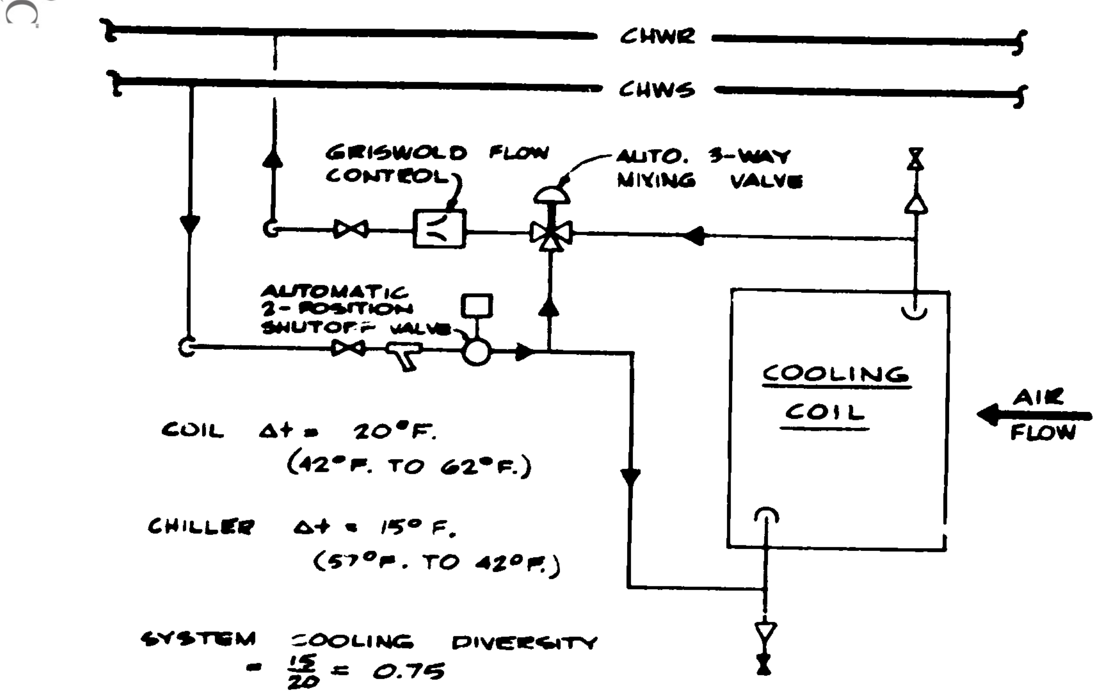
Figure 10 TEMPERATURE CONTROL AIR SUPPLY

5. *Criteria for End Use in Buildings (Figures 11, 12 and 13).* Diversity in any type central plant or load center system is estimated from the characteristics of the loads being served and is implemented by the design of the water distribution systems. The load center system uses constant water flow distribution. In order to achieve diversity with constant water flow, the design temperature drop through the assembly of water chilling equipment must be less than the design temperature rise through the branches feeding end use cooling coils. Likewise, the design temperature rise through the assembly of boilers must be less than the design temperature drop through the branches feeding end use heating coils.

Figure 11 indicates a 75% system cooling diversity achieved by utilizing a 20°F design temperature rise through cooling coils and a 15°F design temperature drop through the assembly of water chillers. Likewise, Figure 11 indicates a 65% system heating diversity achieved by utilizing an 80°F design temperature drop through branches serving heating coils and a 52°F design temperature rise through the assembly of boilers.

Water balancing through branches is achieved by using Griswold flow controls. The majority of cooling coils will be out of use when only the initial small chiller and its pump operates evenings and weekends. At this time, these cooling coils will have their supply of chilled water shut off by automatic two-way control valves actuated from a signal from the load center. The remaining cooling coils will continue to be balanced by the flow controls (see Figure 11).

Heating coils will utilize secondary pumps to achieve good circulation through tubes. Based on an 80°F temperature difference, water flow in the branches to the coil would be insufficient for this purpose without the secondary pump. Branch water flow will be balanced by using Griswold flow controls. The relatively



CRITERIA FOR LARGE CHILLED WATER COILS

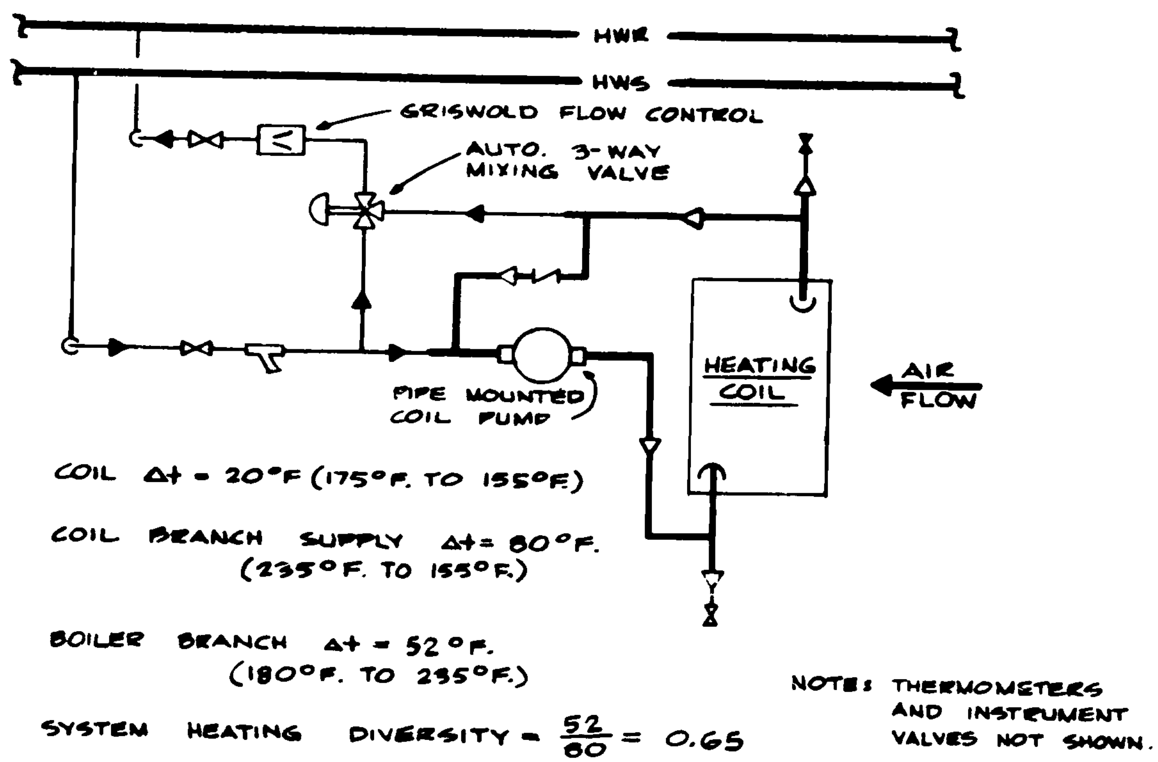


Figure 11 CRITERIA FOR LARGE HOT WATER COILS

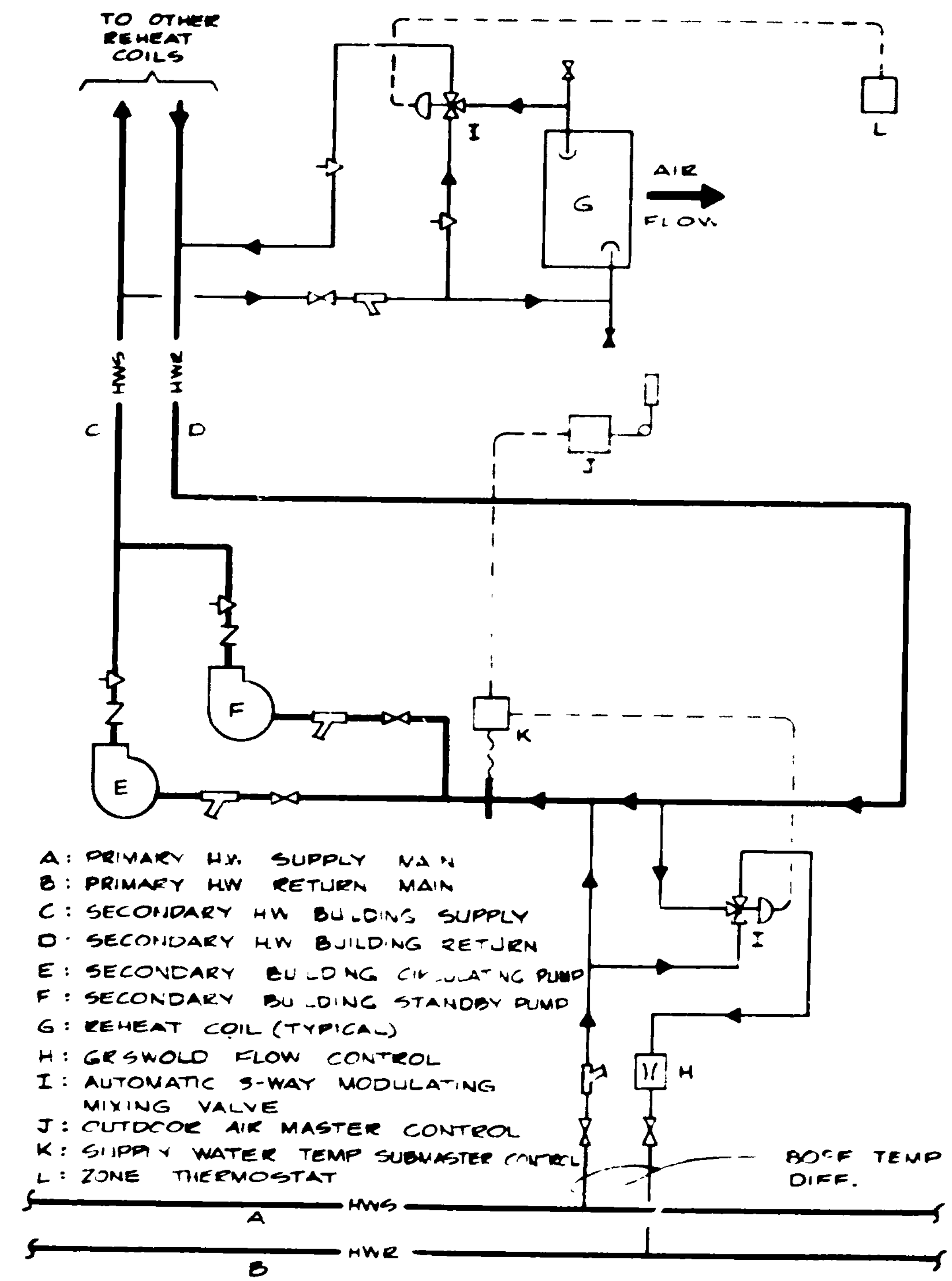


Figure 12 CRITERIA FOR BUILDING PRIMARY REHEAT SYSTEM

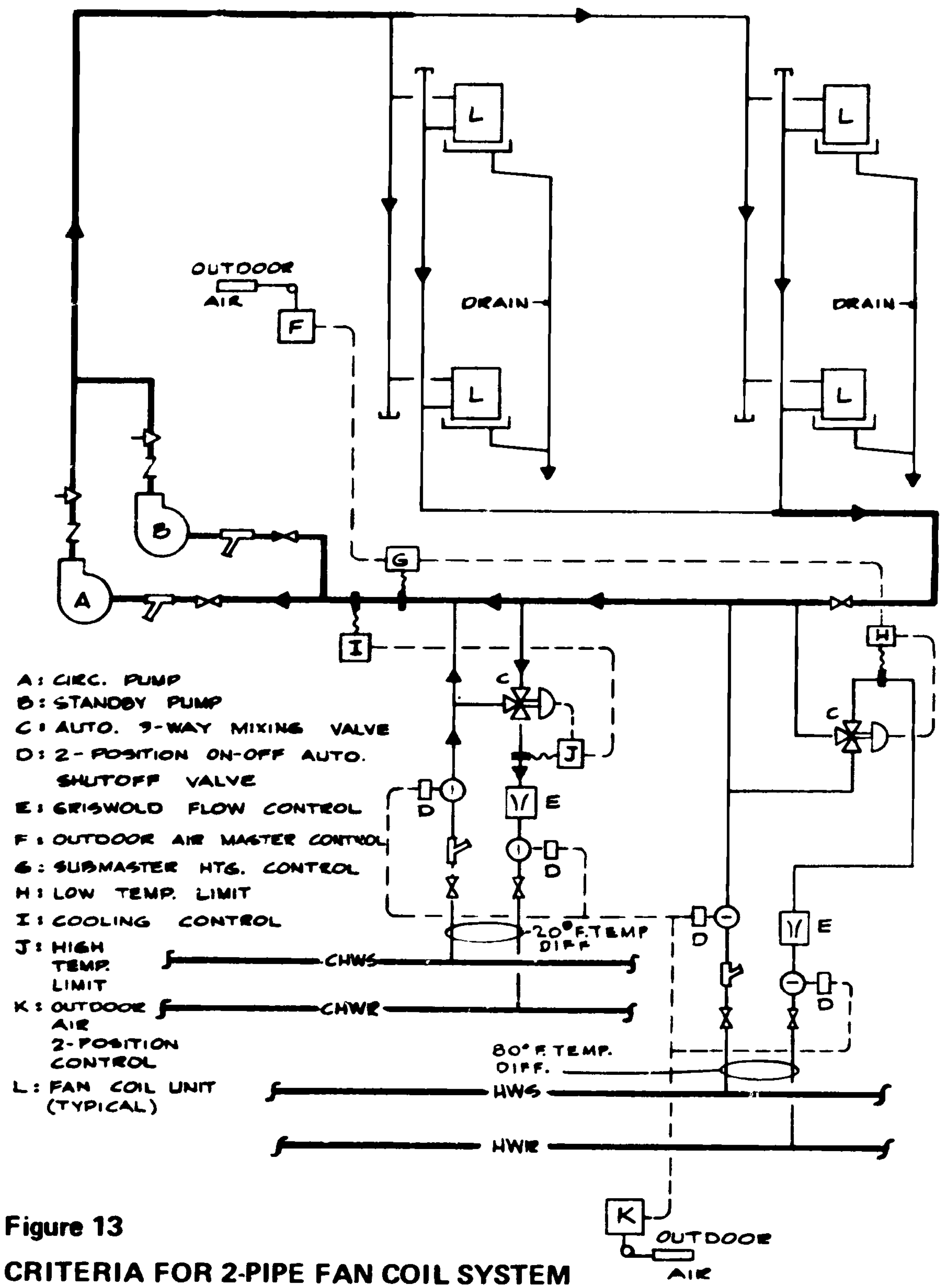


Figure 13

CRITERIA FOR 2-PIPE FAN COIL SYSTEM

small system hot water circulation from the load center does not make a reduction in total flow worthwhile during evenings and weekends (see Figure 11).

Figure 11 illustrates the branch piping and coil piping for cooli coils and heating coils associated with large double-duct, multi-zone and single-zone air handling units and for cooling coils associated with air handling units of primary reheat systems.

Figure 12 illustrates the branch piping and the application of main secondary pumps serving the hot water heating coils of a re-heat system. In this case, individual secondary coil pumps are not required.

Figure 13 illustrates the branch piping and secondary pumps of a system which conceivably could be utilized for the specialized faculty buildings. This two-pipe fan coil system would be practical only if each faculty office had a large exterior window which could be opened during mild outdoor temperature conditions.

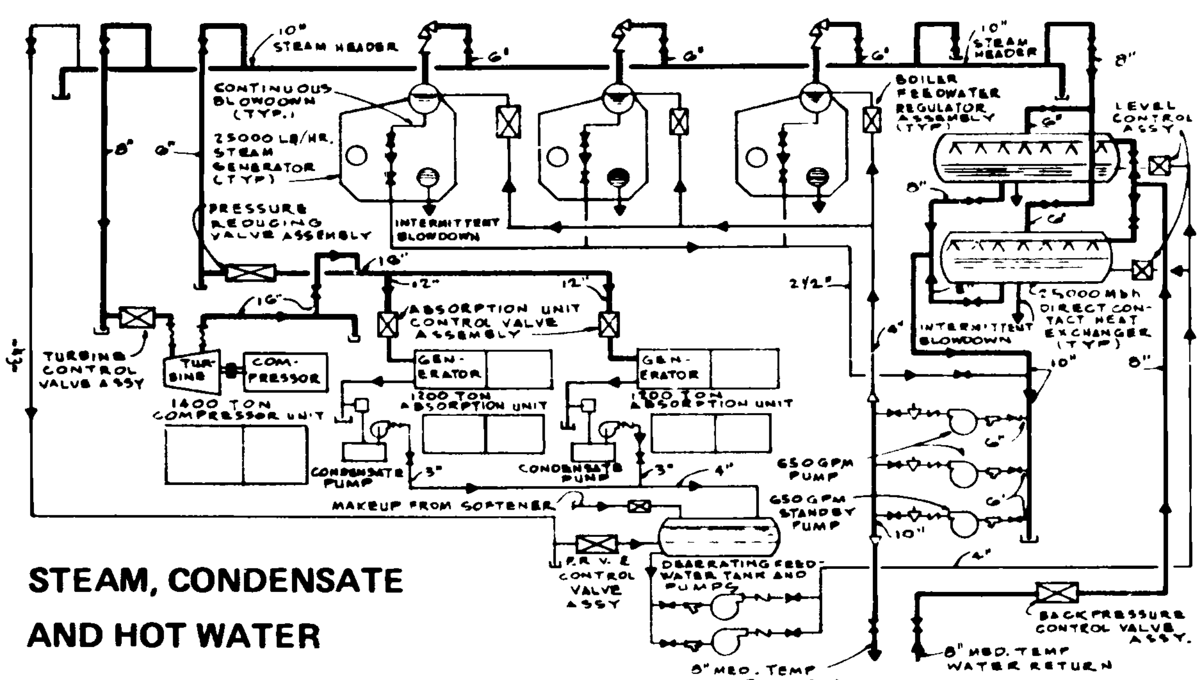
E. PROBABLE PHYSICAL AND OPERATING DETAILS OF A CONVENTIONAL CENTRAL PLANT FOR THE BAKERSFIELD CAMPUS

Figures 14, 15 and 16 illustrate a typical conventional central plant serving the 12,000 FTE campus, and it is presented for *comparison* with the recommended load center system. Location of the conventional central plant would be immediately adjacent to the corporation yard (see master plan).

Construction of the conventional central plant would commence after completion of the initial stage of buildings serving the 726 FTE campus. The approximate 250 tons of water chilling capacity, plus the boilers and pumps serving the initial stage of buildings, would not be used after the central plant would begin operation; and this initial equipment would be removed from the site.

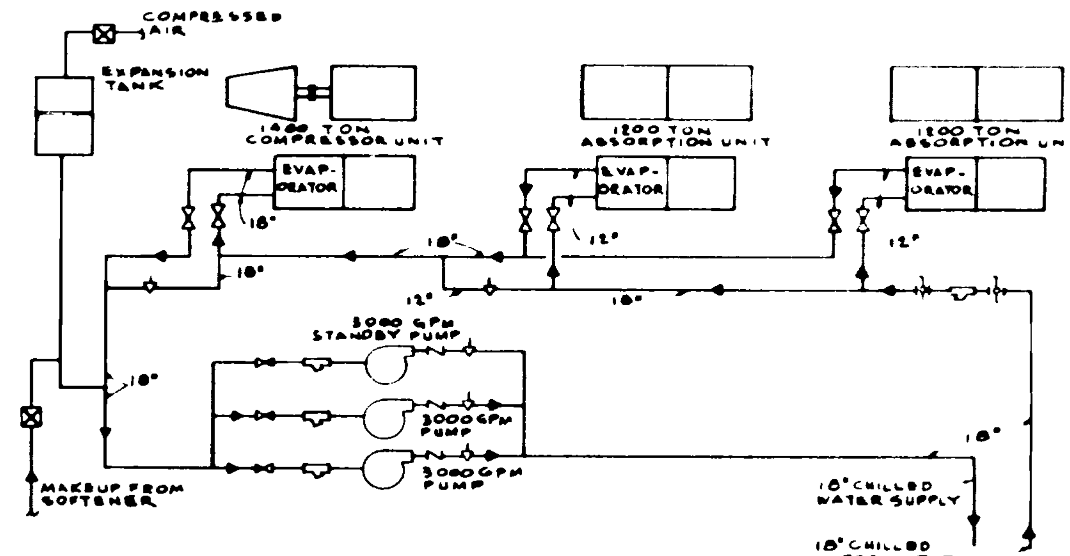
The initial central plar.. installation would include at least the following listed equipment and related piping systems:

1. Two steam generators.
2. One absorption cooling unit.
3. Deaerating feedwater tank and pumps.
4. One direct contact heat exchanger.
5. Two main hot water circulating pumps.
6. Two cooling tower cells.
7. Two absorption unit condenser water pumps.
8. Two main chilled water circulating pumps.



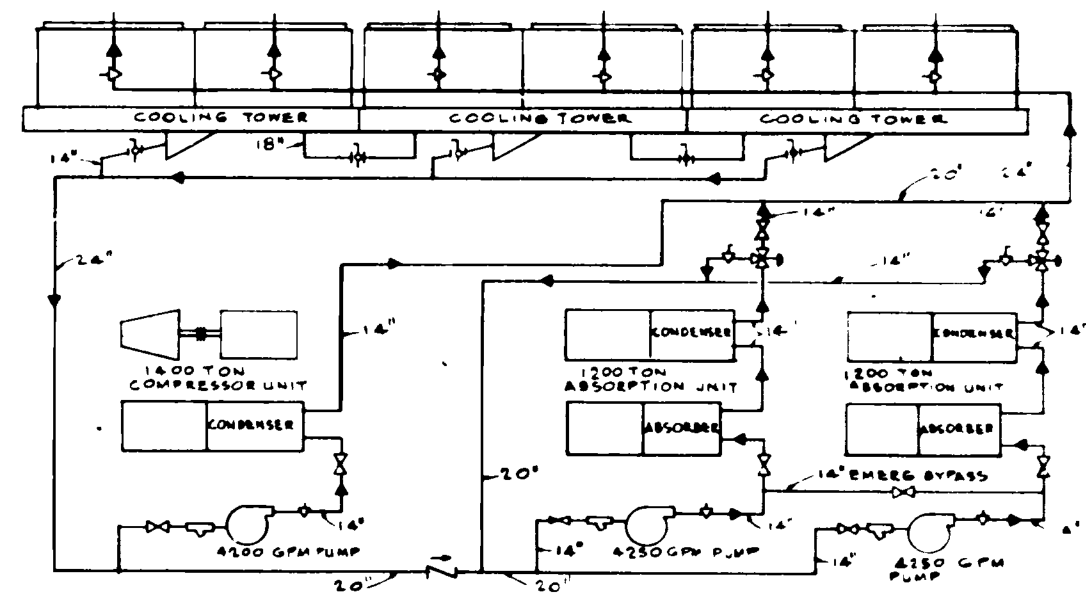
STEAM, CONDENSATE AND HOT WATER

Figure 14 CONVENTIONAL CENTRAL PLANT



CHILLED WATER

Figure 15 CONVENTIONAL CENTRAL PLANT



CONDENSER WATER

Figure 16 CONVENTIONAL CENTRAL PLANT

9. 8-inch underground hot water supply and return mains from central plant to Universal Space with extensions to buildings, as required

10. 18-inch underground chilled water supply and return mains from central plant to Universal Space with extensions to buildings, as required.

End use chilled water coils are designed for a 20°F temperature difference, and the chilled water distribution system is designed for a 15°F temperature difference; therefore, a 75% diversity is achieved

Heat exchangers and pumps in buildings are utilized to convert the medium temperature hot water distribution from the central plant to the lower temperatures suitable for hot water coils in air units. The design temperature difference for branches to heat exchangers from central plant mains is 154°F, and the hot water distribution system is designed for a 100°F temperature difference; therefore, a 65% diversity is achieved.

F. INITIAL COSTS

This subsection compares the initial costs of mechanical and electrical work for the load center system with the mechanical and electrical work for the conventional central plant.

Costs are for purposes of comparison only; today's prices are used, and one-time construction of the ultimate sized plants are assumed.

Pricing for the load center system is based on the sketches included in this report. Lengths of pipes for estimating are based on a machine room layout for a load center plant serving 550,000 G.S.F., plus a sitework piping plan serving this same area. The total cost for all load centers is determined by multiplying the cost of the considered load center by the ratio 1,270,000/550,000, which is total area divided by area served by the considered load center.

Pricing for the conventional central plant is based on the sketches included in this report. Lengths of pipes for estimating are based on a machine room layout for a central plant serving the entire 1,270,000 G S F., plus a sitework piping plan serving this same total area

Estimated costs for equipment include setting in place, piping connections with service valves, testing and adjusting, and electrical motor starters. Estimated costs for piping are based on the following

1 Underground Piping

a. Chilled Water: Class 200 epoxy lined cement asbestos w/1-½ in. urethane insulation and roofing felt jacket for direct burial.

b. Hot Water: Schedule 40 black steel w/ hydrous calcium silicate insulation in coated galvanized steel conduit (Ric-Wil) for direct burial.

c. Control Air: Type L copper tubing.

2. Above Ground Piping

a. Chilled Water: 0.375 in wall thickness or Schedule 40 black steel w/ glass fiber insulation.

b. Hot Water (350°F): Schedule 40 black steel w/ hydrous calcium silicate insulation.

c. Hot Water (235°F): Schedule 40 black steel w/ glass fiber insulation.

d. High Pressure Steam: Schedule 80 black steel w/ hydrous calcium silicate insulation.

e. Low Pressure Steam: 0.375-in. wall thickness or Schedule 40 black steel w/ glass fiber insulation.

f. Boiler Feed and Steam Condensate: Schedule 80 wrought iron w/ glass fiber insulation.

g. Condenser Water: 91375-in. wall thickness or Schedule 40 black steel.

h. Control Air: Type M copper tubing.

Underground piping includes trenching, backfill, thrust blocks where required, anchors, expansion loops where required, etc. A considerable amount of above-ground distribution piping is permitted within connections and walkways between buildings and within buildings themselves, particularly in the Universal Space. The above-ground distribution piping is reflected in the estimates both for the load center system and the conventional central plant.

The conventional central plant requires a heat exchanger for each building to convert medium temperature water to low temperature water. The additional cost of the heat exchangers is included in the estimate.

Electric power wiring is estimated at $35.00 per KVA, including sitework distribution. The KVA is based on 90% motor efficiency and 85% power factor applied to motor nameplate ratings. This $35.00 cost breaks down as follows:

a. $ 5.00 distribution
b. $15.00 transformer
c. $ 5.00 motor circuit switch
d. $10.00 in-building wiring

The above figures probably are slightly high for the load center system, since the load centers are in the same locations as building transformers. As a result, the distribution and possibly transformer costs would constitute increments of added capacities which have lower costs than those listed above. On the other hand, the conventional central plant would require its own, independent transformers and distribution supply, and these costs probably would be greater per KVA than those of the load centers. For purposes of simplification, the $35.00 per KVA figure is used for both systems.

The following preliminary, pre-design estimate sheets covering *today's prices and one-time installation of ultimate systems* show an initial cost difference of $315,000 favoring the load center system (1100 ENR).

This difference in today's costs would be significantly greater if the following traditional conditions were imposed on the central plant system.

a. Underground pipes in pipe tunnels.

b. Chilled water circulation based on 10^{O}F to 14^{O}F through cooling coils.

c. Excessive capacity in heating distribution piping system.

The initial cost estimates do not take into account the economic penalty for a central plant installation which requires a large portion of its total installation during the early years of campus growth.

LOAD CENTER PLANT ESTIMATE

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
250 ton centrifugal chiller	1	EA	$27,000	$ 27,000
700 ton centrifugal chiller	2	EA	56,000	112,000
2100 GPM 95/85°F, 2-cell cooling tower, total 40 HP	2	EA	14,000	28,000
200 HP H.W. boiler (5 HP fan)	3	EA	12,000	36,000
Circulating pumps, per detail:				
400 GPM Ch.W.; 25 HP	1	EA	1,500	1,500
1320 GPM Ch.W.; 125 HP	3	EA	4,000	12,000
2100 GPM Cd.W.: 60 HP	2	EA	3,000	6,000
390 GPM H.W.; 40 HP	3	EA	1,700	1,700
Boiler Vent	3	EA	500	1,500
Compression tanks w/nitrogen bottle or air comp.	–	–	2,500	2,500
Universal-Interlock water treatment control system	1	EA	5,000	5,000
Water Softener	–	–	1,500	1,500
Chilled water piping, incl. fittings & insulation:				
12" size	120	LF	33.00	3,960
10" size	260	LF	29.00	7,500
8" size	160	LF	22.00	3,520
6" size	100	LF	16.00	1,600
5" size	120	LF	12.00	1,440
3" size	20	LF	9.00	180
Miscellaneous (15%)		–	–	2,720
Condenser water piping, including fittings:				
16" size	120	LF	22.00	2,640
10" size	300	LF	13.00	3,900
4" size	200	LF	4.50	900
Miscellaneous (15%)	–	–	–	1,120

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
Low temp. hot water piping, including fittings & insulation				
6" size	220	LF	$11 50	$ 2,540
5" size	100	LF	9.50	950
3" size	20	LF	6.00	120
Miscellaneous	–	–	–	400
Gas piping	–	–	–	1,000
Machine room ventilating systems	–	–	–	1,500
Instrumentation and temperature controls, incl. air compressors and portable flow meters	–	–	–	8,000
Automation and supervision panels	–	–	–	15,000
Electric power wiring (2385 HP)	2320	KVA	35.00	81,000
Electric control wiring	–	–	–	15,000
SUB TOTAL				$389,700

CONVENTIONAL CENTRAL PLANT ESTIMATE

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1400 ton 2-stage steam turbine drive centrifugal chiller	1	EA	$130,000	$130,000
1200 ton absorption unit (18 HP)	2	EA	100,000	200,000
4300 GPM, 102/85°F 2-cell cooling tower, total 60 HP	3	EA	29,000	87,000
25,000 lb/hr high press. steam generator (20 HP fan)	3	EA	50,000	150,000
25,000 lb/hr direct contact heat exchanger	2	EA	9,000	18,000
Deaerating feedwater tank and pumps	1	EA	21,000	21,000
Condensate pumps	2	EA	1,000	2,000
Circulating pumps, per detail:				
3000 GPM Ch W.; 450 HP	3	EA	16,000	48,000
4250 GPM Cd.W.; 125 HP	2	EA	9,000	18,000
4200 GPM Cd.W.; 100 HP	1	EA	8,000	8,000
650 GPM process H.W.; 150 HP	3	EA	5,000	15,000
Breeching and stack for steam generator	3	EA	2,000	6,000
Compression tank w/air comp.	–	–	1,500	1,500
Universal-interlock water treatment control system	1	EA	5,000	5,000
Water softener	–	–	2,000	2,000
Chilled water piping, incl. fittings & insulation:				
18" size	440	LF	44.00	19,400
12" size	160	LF	33.00	5,280
Misc. (15%)	–	–	–	3,700
Condenser water piping, incl. fittings:				
24" size	180	LF	33.00	5,940
20" size	100	LF	29.00	2,900
18" size	60	LF	26.00	1,560
14" size	400	LF	20.00	8,000
10" size	100	LF	13.00	1,300
Misc. (15%)	–	–	–	2,960
High Press. steam piping, incl. fittings & insulation:				
10" size	120	LF	27.50	3,300

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
8" size	100	LF	22.00	2,200
6" size	180	LF	15.50	2,790
Misc., incl. P.R.V. station drips etc. (20%)	–	–	–	1,660
Low press. steam piping, incl. fittings & insulation:				
16" size	80	LF	27.50	2,200
12" size	40	LF	24.00	960
Misc., incl. drips, etc. (20%)	–	–	–	632
Steam condensate and boiler feed piping, incl. fittings & insulation:				
4" size	240	LF	14.00	3,360
3" size	40	LF	11.00	[illegible]40
Misc. (15%)	–	–	–	570
Med. Temp. hot water piping, incl. fittings & insulation:				
10" size	80	LF	17.50	1,400
8" size	140	LF	13.00	1,820
6" size	160	LF	12.00	1,920
4" size	120	LF	9.00	1,080
3" size	60	LF	6.50	390
2½" size	120	LF	5.50	660
2" size	60	LF	4.50	270
Misc. (15%)	–	–	–	1,130
Gas piping	–	–	–	4,000
Machine room ventilating systems	–	–	–	5,000
Instrumentation, temperature, controls & control system connections, inc. the following: multi-point temp. indicator, turbine steam supply, absorption steam supplies, heat exchanger levels, hot water back pressure, cooling tower bypasses, flow meters, air compressors	–	–	–	30,000
Electric power wiring (2426 HP)	2370	KVA	35.00	83,000
Electric control wiring	–	–	–	5,700
Initial plant of 250 tons	–	–	–	30,000
Serving initial buildings; assume 50% salvage value				
SUB TOTAL				$947,000

LOAD CENTER SITEWORK ESTIMATE

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
Chilled water underground pipe				
12" size	0	LF	–	–
10" size	0	LF	–	–
8" size	0	LF	–	–
6" size	600	LF	11.00	6,600
4" size	2000	LF	10.00	20,000
3" size	800	LF	9.00	7,200
Chilled water above ground pipe				
12" size	500	LF	22.00	11,000
10" size	1200	LF	17.50	21,000
8" size	500	LF	15.50	7,750
6" size	1500	LF	12.00	18,000
4" size	300	LF	11.00	3,300
3" size	0	LF	–	–
Hot water underground pipe				
6" size	0	LF	–	–
4" size	400	LF	16.50	6,500
3" size	200	LF	14.00	2,800
2½" size	1100	LF	13.00	14,300
2" size	0	LF	12.00	–
Hot water above-ground pipe				
6" size	2100	LF	12.50	26,200
4" size	700	LF	10.50	7,350
3" size	1000	LF	9.00	9,000
2½" size	700	LF	8.50	5,950
2" size	1400	LF	6.50	9,100
Control piping	3500	LF	1.50	5,250
Connex to buildings	29	EA	1,000	29,000
SUB TOTAL				$210,300

CONVENTIONAL CENTRAL PLANT SITEWORK ESTIMATE

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
Chilled water underground pipe				
18" size	1800	LF	35 00	63,000
16" size	2500	LF	27 50	68,700
14" size	0	LF	–	–
12" size	0	LF	–	–
10" size	0	LF	–	–
8" size	0	LF	–	–
6" size	4800	LF	11 00	52,800
4" size	1200	LF	10 00	12,000
3" size	100	LF	9.00	900
2½" size	700	LF	9 00	6,300
Chilled water above-ground pipe				
18" size	0	LF	–	–
16" size	700	LF	31.00	21,600
14" size	0	LF	–	–
12" size	100	LF	22.00	2,200
10" size	1000	LF	17.50	17,500
8" size	1900	LF	15.50	29,400
6" size	2100	LF	12.00	25,200
4" size	900	LF	11 00	9,900
3" size	600	LF	10.00	6,000
2½" size	300	LF	9.50	2,850
Hot water underground pipe				
8" size	4300	LF	29.00	125,000
6" size	0	LF	–	–
4" size	550	LF	16.50	9,100
3" size	2100	LF	14.00	29,400
2½" size	1200	LF	13.00	15,600
2" size	3400	LF	12 00	40,800
Hot water above-ground pipe				
8" size	0	LF	–	–
6" size	1600	LF	13.00	20,600
4" size	2500	LF	11.00	27,500
3" size	1100	LF	9.50	10,500
2½" size	450	LF	9.00	4,000
2" size	1500	LF	7.00	10,500
Control piping	10,000	LF	1.50	15,000
Connections to buildings	53	EA	1,000	53,000
Hot water building heat exchangers	53	EA	1,500	79,000
SUB TOTAL				$758,000

SUMMARY INITIAL COST ESTIMATE

Load Center

Plant sub-total	$389,700
Sitework sub-total	210,300
Grand Sub-Total	$600,000
TOTAL = $\frac{1,270,000}{550,000}$ x $600,000 =	$1,390,000

Conventional Central Plant

Plant sub-total	$947,000
Sitework sub-total	758,000
TOTAL	$1,705,000

Difference (1100 ENR)	$315,000

As pointed out, the initial cost estimates are for comparison purposes and are based on a one-time installation using today's prices. Roughly, based on prices at the time of installation and recognizing the additional costs for construction in incremental stages, the total of costs should be about double the figures appearing on the summary initial cost sheet.

G. OPERATING COST COMPARISONS

For the most part, fixed charges are annual costs associated with the financing and the value of the physical plant. It has been shown that the initial costs of a load center system for the Bakersfield campus would be considerably less than those of a comparable conventional central plant system; correspondingly, the fixed charges for a load center system would be considerably less.

Attention in this portion of the report will be directed to operating cost comparisons between a load center system and a conventional central plant system In general, these operating costs can be subdivided into the categories of maintenance and labor costs, plus service costs.

1. *Maintenance and Labor Costs.* The relationship of maintenance costs and labor costs in any major central plant or load center installation usually depends on the operations policies dictated by management. Those plants which provide in-house maintenance using skilled personnel have less need for the use of outside maintenance services; however, the labor costs might be relatively high. Conversely, those plants which utilize unskilled personnel for operating equipment, or those plants which are automated might be dependent on outside maintenance service work, and consequently the labor costs could be low, but the maintenance costs high.

Very generally, a conventional central plant with high pressure or high temperature boilers requires an assignment of at least six men on a year round basis. At today's prices, including benefits, the annual labor costs exceed $55,000. Ideally, at least one of these men is qualified to direct heavy maintenance.

Although equipment in a load center can start and stop without attendance, experience indicates that routine attention from personnel is desirable to minimize the cost of outside maintenance work. This attention is given on an intermittent 5½-day-week basis, with equipment running completely unattended at all other hours. An assignment of three men normally would be sufficient to handle a load center system such as recommended for the Bakersfield campus, and in addition, would provide for some maintenance of equipment, such as air handlers, which are outside the load center. Ideally, at least one of these men would be qualified to direct heavy maintenance.

Other maintenance costs, particularly reserves for replacement of original equipment components, should slightly favor the conventional central plant However, this credit would not approach the additional labor costs required for conventional central plant operation.

The above comparisons have been based on mechanical plants which approach their ultimate growth after the 6000 FTE period. Before that time, the relatively large commitment of equipment and distribution systems required for the conventional central plant would result in an additional penalty in labor and maintenance costs when compared against a load center system.

2. *Service Costs.* Service costs generally include the charges for fuel and purchased energy, and the cost of water.

The cost of water and chemicals for water treatment are lowest for a system which utilizes electric motor driven water chilling units. Generally, the significance is not great when comparing systems' performances Likewise, the electrical power costs for pumps and cooling towers are lowest for systems using electric motor driven water chilling units when compared with absorption systems or steam turbine or gas engine driven water chilling systems. In this case, the significance can be great when a load center is compared with a conventional central plant.

The Bakersfield example for the ultimate growth load center would require approximately 600 operating horsepower to circulate chilled water and hot water through all distribution mains. The ultimate conventional central plant would require approximately 1050 operating horsepower to do the same, and this takes credit for the decreased hot water circulation permitted by its higher design temperature drop. The length of piping distribution systems of the conventional central plant would exceed by more than three times the lengths of those required by load centers, and this accounts for the operating horsepower differences. Assuming 3000 operating hours per year, an electrical energy cost of 1.25 cents per KW-hr. and a 90% average motor efficiency, the annual additional electrical cost for circulating chilled and hot water from a conventional central plant to the 12,000 FTE campus amounts to $14,000.

The following portion of this sub-section concerns itself with the relative system costs of electrical energy and/or fuel for the water chilling units. Fuel costs for heating are assumed to be equal between the various systems and, therefore, cancel out in a comparison of system costs. The influence of costs for water and chemicals for water treatment and for power for pumps and cooling towers has been discussed in the preceding paragraph.

As a means of comparing energy and fuel efficiencies between various type water chillers, Table 1 has been prepared listing the electrical power rate and the gas fuel rate that provide each of four systems with an equal cost per unit of cooling energy output. A description of the four systems and the basis for determining energy and fuel efficiencies follows:

a. System 1: electric motor driven centrifugal compressor water chillers; 0.95 BHP per ton; 90% motor efficiency.

b. System 2: absorption water chillers; 18.5 lb. steam per hour per ton supplied from 200 lb. operating boiler plant; 75% boiler plant efficiency.

c. System 3: absorption water chillers in conjunction with topping turbine driving centrifugal compressor water chiller (piggy back system); 12.5 lb. steam per hour per ton supplied from 200 lb. operating boiler plant; 75% boiler plant efficiency

d. System 4: gas engine driven centrifugal compressor water chillers; 0.95 BHP per ton; 10,000 BTUH input to engine per BHP.

TABLE 1
(in cents)

System 1 Cost per KW-hr	System 2 Cost per Therm	System 3 Cost per Therm	System 4 Cost per Therm
2.0	6.2	9.2	16.6
1.5	4.7	6.9	12.4
1.25	3.9	5.8	10.2
1.0	3.1	4.6	8.3

An interpretation of Table 1 is given by referring to the line showing System 1 Cost per KW-hr to be 1.5 cents. In this case, System 2 will have a lower fuel cost per unit of cooling output if the gas fuel rate is less than 4.7 cents per therm; System 3 will have a lower fuel cost per unit of cooling output if the gas fuel rate is less than 6.9 cents per therm; and System 4 will have a lower fuel gas cost per unit of cooling output if the gas fuel rate is less than 12.4 cents per therm.

Normally, an incremental electric rate of 1.25 cents per KW-hr can be achieved for System 1, based on consumption plus demand. An automated load center control system would program operation of chillers with street, parking lot and exterior building lights to insure low demand charges.

Normally, the best possible incremental gas rate obtainable for System 2 would be from 3.5 cents to 4.0 cents per therm, based on interruptible or summer air conditioning rates and ultimate campus growth. Reference to Table 1 will show that using this rate, the fuel cost for System 2 roughly would equal the electrical energy cost of System 1. The additional cost of water, water treatment chemicals and power for pumps and cooling towers for System 2 adds a burden which usually causes System 2 to have higher service costs. This, together with a system which is more difficult to automate and has no initial cost advantages makes System 2 less desirable than System 1.

System 3 is represented by the conventional central plant featured for comparison purposes in this report. Contrary to conclusions which might be derived from Table 1, System 3 actually operates with little improved efficiency over System 2. The following lists two reasons for this:

a. The topping turbine is the last water chilling unit added to the central plant, and it is anticipated that installation would not occur until after the 6000 FTE campus growth period. Up to this time, the absorption units would be supplied with steam through pressure reducing valves, and the cooling efficiency would be identical to that of System 2.

b. After the topping turbine would be installed, the desired 12.5 lb/hr cooling system steam rate would be achieved only for brief periods when the load on the central plant approached maximum. At all other times, either the turbine would be operating inefficiently, resulting from steam throttle valve control, or it would be bypassed entirely and the cooling efficiency would be identical to that of System 2.

The practical value of a topping turbine (piggy back) system is that it reduces the demand on the boiler plant and, consequently, reduces initial costs. In this case, if absorption units were used without the topping turbine, the three 25,000 lb/hr steam boilers would provide no excess standby capacity. A significant disadvantage of the topping turbine system is that it requires the greatest attention from operating personnel.

It already has been shown that System 3 is considerably higher in initial costs than System 1. Since labor and maintenance costs are higher than those of a load center system, and since there are no real savings in service costs, System 1 applied to load centers is preferred.

Reference to Table 1 shows that the service costs for System 4 would be lower than those of Systems 1, 2 or 3 if a fuel gas rate of less than 10 cents per therm could be obtained. Obviously, with a probable fuel gas rate approaching 4 cents per therm, the savings in service costs could be considerable. System 4 has the additional advantage of lending itself to automated operation within the load center concept. It has the disadvantages of higher initial cost and greater maintenance costs. Additional attention to the application of gas engine driven centrifugal compressor water chillers to the load center concept is given in a following sub-section of this report.

H. ALTERNATE LOAD CENTER EQUIPMENT

1. *Combination Electric Centrifugal Compressor-Absorption Unit Water Chillers.* A water chilling system which utilizes electric motor driven water chillers should have a programmed operation which minimizes demand charges from the electrical utility. A load center system can automatically coordinate the operation of chillers with street lights, parking lot lights, exterior building lights and even some interior building lights to help accomplish this. Load centers also can provide a slow pulldown well in advance of heavy loads by automatically initiating the operation of only a portion of a water chilling plant.

   Sometimes, a substitution of equipment can have a significant effect on the reduction in demand charges. An absorption unit preceding an electric chiller in a series arrangement sometimes can provide this advantage. In this case, a boiler plant sized for winter heating in Southern California will have more than sufficient capacity to handle an absorption unit which comprises less than half the cooling load of the same system. Furthermore, locating the absorption unit upstream in the series arrangement permits its nominal rating to be achieved when supplied with 235°F or 240°F boiler water to the absorption unit generator.

   Figure 17 shows the previous third stage load center hot water boiler plant modified to serve an absorption unit which would be in series with an electric chiller. Figure 18 shows modifications to the condenser water system. The costs of the additional hot water pumps, the larger cooling tower and cooling tower pump, the increased piping and the additional controls would be offset partially by savings in wiring the electric chiller replaced by the absorption unit.

   For the college at Bakersfield, a partial absorption unit installation would be limited to the two large load centers. In this case, the load center for the gymnasium and the load center located between Village No. 2 and Village No. 3 would continue to have only electric chillers.

2. *Gas Engine Driven Centrifugal Compressor Water Chillers.* The potential for savings in service costs by using gas engine driven centrifugal compressor water chillers was pointed out in a previous portion of this report.

   For this installation, gas engines would not be recommended for the initial 250 ton chillers of each of the two large load centers. These small chillers could be operating for long hours unattended during evenings and weekends, and electric motor drive equipment is more suitable for this purpose. Gas engines also would not be recommended for the gymnasium load center or the load center located between Village No. 2 and Village No. 3, since the relatively small size of equipment involved would not warrant the increased attention and maintenance required for multiple, dispersed engines.

   This leaves four 700 ton water chillers in the load center system to be engine driven, or a total of 2800 tons of engine driven equipment out of a total installation of 3800 tons.

ALTERNATE 3RD STAGE ABSORPTION UNIT

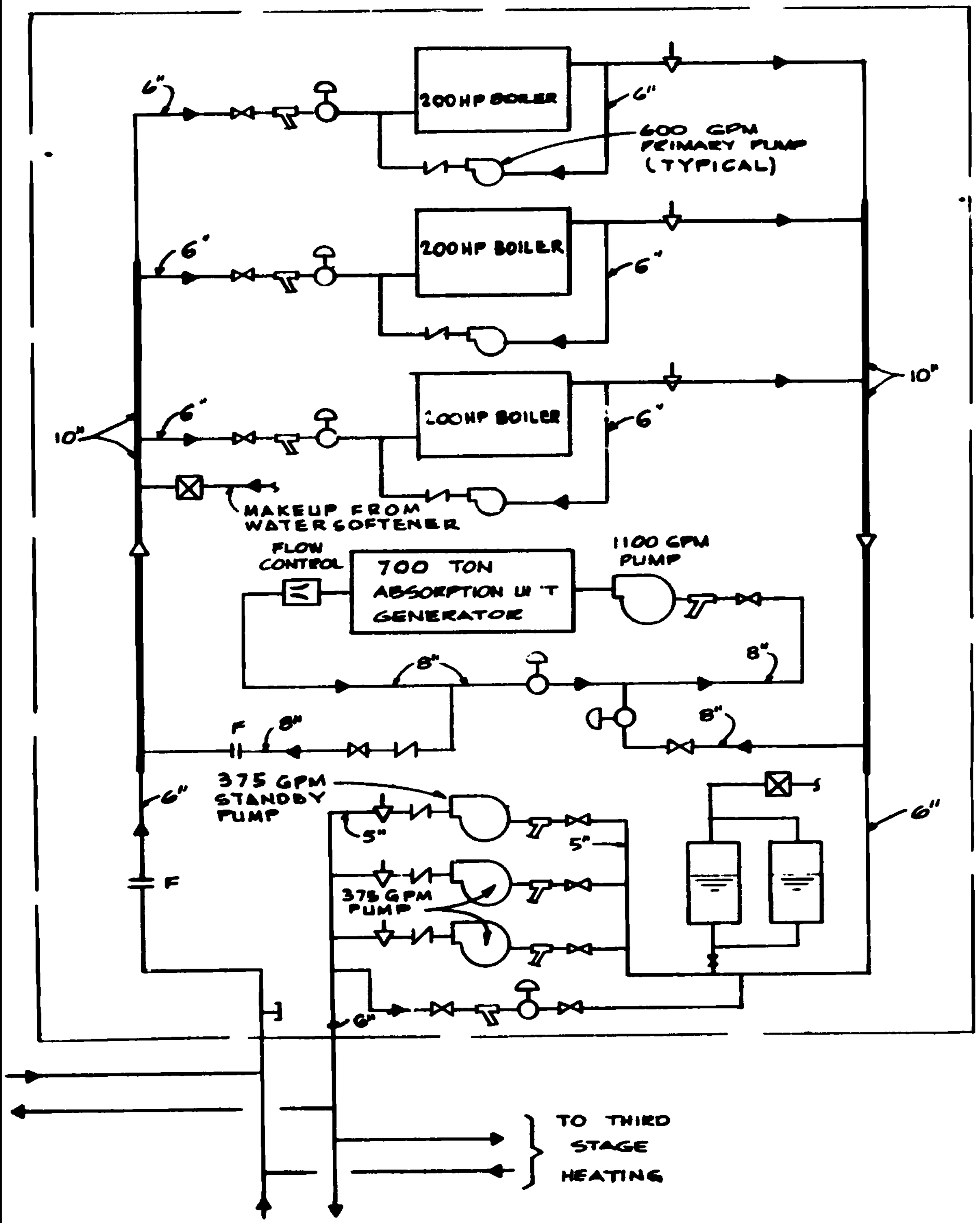


Figure 17 3RD STAGE HOT WATER

ALTERNATE 3RD STAGE ABSORPTION UNIT

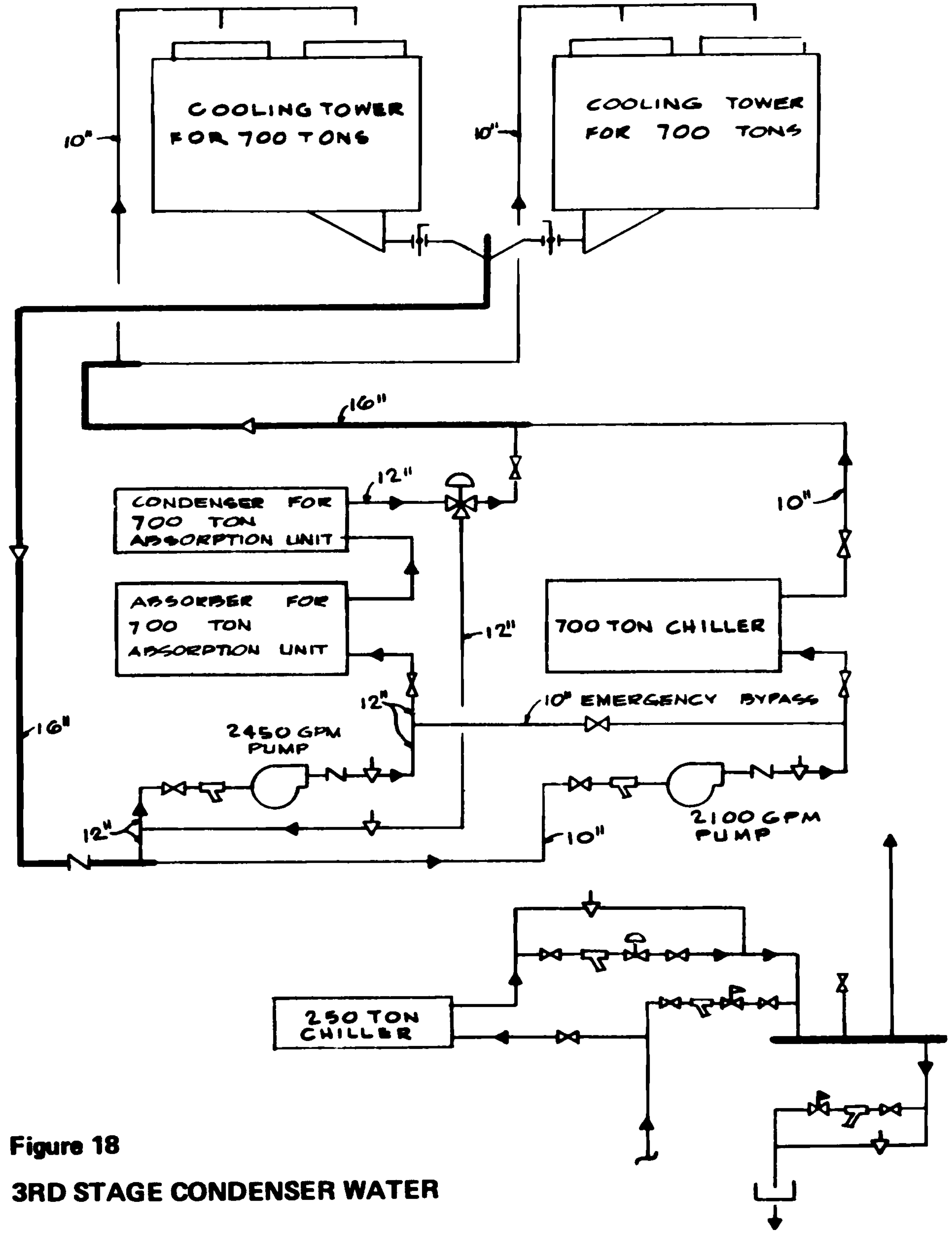


Figure 18

3RD STAGE CONDENSER WATER

For comparison purposes, the electrical energy and fuel costs of *chillers* for the following two systems will be estimated.

a. System A: 3800 installed tons of electric motor driven water chillers; 0.95 average BHP per ton; 90% average motor efficiency.

b, System B: 2800 installed tons of gas engine driven water chillers and 1000 installed tons of electric motor driven water chillers; 0.95 average BHP per ton; 10,000 BTUH input to engine per BHP; 90% average motor efficiency.

Electrical energy costs are based on an average incremental rate of 1.25 cents per KW-hr. Fuel gas costs are based on an average cost of 4.0 cents per therm. An estimated 1000 equivalent full load operating hours is used. The following lists the annual electrical energy costs for operating the *chillers* of System A and the annual fuel gas costs plus electrical energy costs for operating the *chillers* of System B.

a. System A: $37,300

b. System B: $20,500

Roughly, the use of gas engines will save $17,000 annually in energy costs for operating the chillers. A slight additional energy cost saving might be achieved by heat recovery of the engine jacket water.

Against the savings in energy costs are an additional initial investment of about $115,000 for the engine driven chillers, which includes a credit for wiring the chillers of the all-electric system. Further, although the chillers can be and should be automated, their use will require an increase in the maintenance and labor costs.

A detailed month-by-month electrical energy and fuel gas operating cost study, based on utility rates, local weather data and campus operating hours would be necessary if further consideration of gas engines is to be given. This detailed study is beyond the scope of this report. If the study is to proceed, it should be complete before the second stage of the initial load center is designed.

APPENDIX C

A RECONNAISSANCE OF BUILDING SYSTEMS APPLICABLE TO COLLEGE DEVELOPMENT.

California State College, Bakersfield

The purpose of this report is to examine the appropriateness and applicability of standard building systems and materials relative to academic and student housing requirements.

CONCLUSIONS

1. The scope of state-wide college construction is of sufficient magnitude to consider the application of specific building systems and/or building components, and a bulk purchasing of either systems, components - or both.

2. The possibility exists that by the application of systems (in varying ways) there could be a savings in capital outlay and an increase in academic flexibility due to greater physical freedom. A faster time response would be natural.

3. Systems application to an individual campus does not appear to offer very much in dollar savings because the structures are highly specialized and the increments are relatively small. Even so, there are applications that can increase flexibility and decrease costs. For example, large-scale classroom buildings and parking structures.

4. If any worthwhile effort in the direction of systems is to be undertaken, it should be on a statewide basis. And if such an effort is to be considered, it ought to concern itself not merely with building technology, but, instead, with the total program from acquisition of land through the operations of a completed facility.

5. At the present time, there is no important construction breakthrough in sight either on a limited (per campus) or massive (statewide) level. However, strong forces and new incentives are steadily at work to achieve a breakthrough and it is incumbent upon anybody entrusted with major development programs to (at the minimum) keep informed by surveillance and monitoring; or stay ahead by posing challenges that systems development might answer.

6. The recommendation of this study is that the Trustees address themselves to a consideration of *"systems"* and through their resources, individual or otherwise, decide upon a course of action. Should the decision be that systems are not likely to play a significant role in campus development, then a routine, formalized monitoring process such as can be carried on through the Chancellor's office with the assistance of the consulting architects should be sufficient Even this step, however, will add appreciably to the staff work load On the other hand, if the Trustees should wish to fully explore the idea of a systems approach to statewide campus development, this would require a definite increase in staff responsibility covering such items as advanced land acquisition based upon state population projections and a knowledge of current real estate developments, a swath of knowledge about what major entrepreneurs are getting ready to do (and these people are as uncertain about what they should do as the college system might be), and a far more definitive academic input that has surfaced up until now. There is no question but what each college has given a lot of internal digestion to its own physical problems but we see little evidence that this introspective attitude even considers that there is an entire universe of problems, many of which are common to most.

7. In conclusion and in summary, there is no ready grab-bag overlooked by the system. But radical changes are in the offing. The college system will be prepared to evaluate these changes only if the colleges themselves are sufficiently prepared to respond. This response will require considerably more than is evidenced today.

THE INTERIM REPORT

The Interim Report on Building Systems dealt almost entirely with the subject of initial buildings. The reason for this specialization had to do with the fact that the initial buildings for Bakersfield had to move very quickly through preliminary acceptance. This speed-up, however, had no effect on the findings of the study.

The findings, as might have been anticipated without a study, were that so far as initial buildings were concerned, to continue to do as has been done. Initial buildings are far more important to the academic program than they are to the physical program. If there is anything that might be said about these buildings it is that they should be totally integrated within the Master Plan from the outset (after all, they will be there, like it or not, for some thirty or forty years) or else place them (from day one) in a temporary status which means trailers or tents or camps.

There are several new campuses now in process and the initiation of additional ones will be on an accelerated basis. Our conclusions are simply, if an over-simplification be allowed, that unless initial buildings are planned as a permanent element of the campus, they should not be considered as buildings at all. There is no such thing as a temporary building. Further, these initial buildings because of size and complex internal requirements do not lend themselves to the systems approach.

At Bakersfield, the academic plan and the educational philosophy made it possible to consider *"initial buildings"* as a positive, long-lived element of the total campus. On other campuses this might not be the case, and if it isn't, then the initial buildings must still be planned as *permanent*. There should be no nonsense about temporary usage.

The *"Building Systems Interim Report"*, dated March 15, 1968, is available for those interested in the analysis of initial buildings.

METHOD

The five-year major capital improvement program of the California State Colleges has been analyzed in order to establish the scope of the building program and its composition with regard to different building types.

The general and specific building requirements have then been examined. (Since it was found that the question of heating, air conditioning and central plant for college campuses was a specific problem of a different kind from that of general construction, and required a very different kind of analysis, it was decided to make this study into a separate report, see Appendix B.) The reason for and principles of the systems approach to construction are listed herein. Building systems, operational and under development, are described and analyzed as to their applicability and the implications of using building systems are explained.

PROGRAM ANALYSIS

This program analysis is based on the following documents of the California State Colleges:

1. 1969-70 Capital Outlay Program and Five-Year Major Capital Improvement Program 1969-73; State Funds, Volume 1; Non-State Funds, Volume 2.

2. Estimating Cost Guide for the Five-Year (1969-74) Capital Outlay Program.

Since any construction scheduled for the year 1969-70 is necessarily already in an advanced stage of planning and can therefore not be subject to any recommendations of this report, only projects for the four years (1970-71 to 1973-74) have been included in the following summaries.

Projects have been grouped into certain building types. These types will be analyzed as to their requirements. Central plants, corporation yards, remodeling and minor additions to existing buildings have been excluded from Table 1 (State Funds); Student Unions and Special Projects, have been excluded from Table 2 (Non State Funds), since these building types do not lend themselves to standardization, though it may sometimes be possible that building systems applicable to other building types can be used for a building of these types (e.g., a student union has been built in Hayward with components of the SCSD system.)

Tables 1 and 2 following outline the statewide college construction program as defined in the most recent five-year capital outlay program.

TABLE 1

SUMMARY OF CONSTRUCTION PROJECTS ACCORDING TO THE 5–YEAR IMPROVEMENT PROGRAM

STATE FUNDS

YEAR	1 CLASSROOMS, LECTURE, LABS, FACULTY OFF. $	NO. OF PROJ.	2 ART–MUSIC–THEATER–RADIO TV–ETC., $	NO. OF PRO.	3 LIBRARIES $	NO. OF PROJ.	4 ADMINISTRA–TION $	NO. OF PROJ.	5 P E. $	NO. OF PROJ	6 CAFETERIA $	NO OF PROJ	7 TOTAL
1970/71	25,330,000	9	5,918,000	3	6,783,000	1	–		2,658,000	1	528,000	1	41,217,000
1971/71	24,250,000	9	1,825,000	2			5,489,000	2	1,663,000	1			33,227,000
1972/73	9,712,000	6			3,296,000	1	1,150,000	1	2,000,000	1			16,158,000
1973/74	26,767,000	8	2,908,000	3			4,335,000	2	2,086,000	2	1,190,000	1	37,286,000
TOTAL 4 YEAR PROGRAM	86,059,000		10,651,000		10,079,000		10,974,000		8,407,000		1,190,000		127,888,000
APPROX. GROSS SQ. FT. BLDG.	3,000,000	32	350,000	8	325,000	2	350,000	6	280,000	5	35,000	2	
APPROX.ACTUAL CONSTR.COST	66,000,000		7,700,000		7,000,000		7,700,000		6,200,000		900,000		95,500,000

TABLE 11

NON STATE FUNDS

	1		2		3		4
	HOUSING $	NO.OF PROJ.	DINING FACILITIES $	NO.OF PROJ.	PARKING $	NO.OF PROJ.	TOTAL $
1970/71	21,718,000	6	2,171,000	5	2,425,000	1	
1971/72	18,511,000	5	2,738,000	4	9.101,000	2	
1972/73	12,757,000	3	1,526,000	3	5,785,000	2	
1973/74	17,661,000	5	1,914,000	3	3,094,000	1	
TOTAL 4-YEAR PERIOD	70,647,000		8,349,000		20,405,000		99,401,000
APPROX.GROSS SQ.FT.BLDG.	2,300,000	19	280,000	15	9,000 CARS	6	
APPROX.ACTUAL CONST. COST	53,000,000		6,200,000		13,700,000		72,900,000

NOTES TO TABLES 1 AND TABLE 11:

The difference between the amounts shown as "Total 4—Year Program" and as "Approx. Actual Construction Cost" derives from the former (including fees, administrative and other incidental expenses).

The totals shown in the tables should not be taken at their face value as a one-time building program, but rather as an indication of the order of magnitude of a continuing building program. No material was available to evaluate the building requirements for the state college system beyond the year 1975. However, from perusal of the "Plan For Higher Education In California 1960/1975" it appears reasonable to assume an approximate increase of about 30,000 FTE over each 5-year period.

It is obvious from Table 1 that only the building types shown under column 1 warrant systems consideration. The other building types repre sent special purpose buildings, where the number of projects per year is not large enough to make standardization an economic proposition. Again, this does not exclude the use of standard components evolved for other types, when applicable.

Similarly, in Table 11, housing only would appear to warrant standard-ization, dining facilities are special purpose buildings of limited scope and are not especially adaptable to systems building. Parking structures will be dealt with subsequently.

BUILDING REQUIREMENTS - GENERAL

A. LOCATIONAL AND ENVIRONMENTAL

Of the 19 campuses of the California State Colleges, 11 are located in Southern California, 5 in the San Francisco-Sacramento area, and 3 in outlying locations. While climatic conditions vary considerably in these areas, these differences are not of a kind which would require different constructional systems, but rather different detail treatment with respect to insulation, exposure, shading devices, air conditioning criteria, etc.

B. LEGAL AND SAFETY

State colleges are not subject to the building codes of the local authorities in whose area they are located. Neither are they subject to the rules and procedures of the Field Act which is applicable to schools up to and including junior colleges only.

They are, however, under the jurisdiction of the State Fire Marshal for all matters pertaining to fire safety, fire protection, exit requirements, etc., as spelled out in Title 19 of the California Administrative Code. In addition, the electrical work has to conform to the National Electrical Code, air conditioning and heating work has to conform to Pamphlet 90A, both issued by the National Fire Protection Association.

Though no supervisory authority exists as far as structural requirements are concerned, all construction should conform to the Uniform Building Code, 1967 Edition.

Where applicable (mechanical plant, etc.) construction shall also conform to the General Industrial Safety Orders as contained in Title 8 of the California Administrative Code.

While the above conditions embody the basic safety requirements which indeed are mandatory for any building generally and educational buildings especially, it is obvious that college construction is free from the more cumbersome and bureaucratic restrictions of local codes which are often accused of prohibiting a progressive and adventurous approach to building problems.

C. FLEXIBILITY AND OBSOLESCENCE

It is generally agreed that buildings requiring a considerable investment of capital should have an economically useful life of at least 40 years. At the rate of change in educational aims, methods and technology today, this is an extremely long period and most buildings will be educationally obsolete long before the end of this period unless flexibility is built into them. It is revealing in this context, that a survey of 285 unsatisfactory schools in Michigan in 1953 showed that "a greater number of seriously defective schools were suffering from educational obsolescence rather than from any other types of deficiency...this defect means that the general arrangement of the building components and spaces is not suitable for current educational requirements." (Economic Planning for Better Schools by B. Handler, Department of Architecture Research Publication, University of Michigan)

The required remodeling of such obsolete buildings will very often cost nearly as much as a new building and therefore make the original investment uneconomic.

Flexibility should therefore be considered as insurance against premature obsolescence. It is in order here to define what is meant by *"flexibility"*. Too often it is thought of as meaning the use of movable partitions only, which then are brushed off as *"too expensive"* and *"we don't move our partitions that often"*. This is a basic misconception since movable partitions are just one item - and not at all the most important one - concerning flexibility.

To quote the above mentioned study again: "Basically, flexibility is required for two reasons: to meet essential educational needs, and to achieve lower long-run costs. For these ends, two types of flexibility are needed: versatility and adaptability." We are, here, mostly concerned with adaptability, which refers to interior changes as well as to expandability. This kind of flexibility can be achieved by:

1. Consistent use of a modular planning grid
2. Use of standard components
3. A structural system with spans wide enough to allow free rearrangement of spaces
4. A mechanical system planned for adaptability.

D. MAINTENANCE AND OPERATIONAL

The minimizing of maintenance has always been a prime requirement of college buildings, though this has to be tempered by the knowledge that the availability of investment capital is not unlimited. Standard building components will help reduce maintenance cost through exchangeability and quality control.

BUILDING TYPE ANALYSIS - PERFORMANCE REQUIREMENTS

A. CLASSROOM - LECTURE HALLS

The basic educational unit on college campuses is the classroom-lecture hall building. This generally includes offices for faculty and departmental administration. Clearly, then, any building system to be used should be flexible enough to accommodate the different sizes of spaces required in such buildings; i.e., it should be able to span up to 75 or 100 feet and should generally be capable of construction on three floors. It is not intended, here, to prejudge the question of high rise construction for colleges. Suffice to say that at the present time, not taking the cost of land into consideration, high rise construction is considerably more expensive, due to the need for fireproof construction, elevators, seismic forces, etc. In any case, no one building system could economically serve both low rise and high rise construction.

B. LABORATORIES

Except for more elaborate fixturing and mechanical and electrical equipment, laboratories are basically classrooms, and any building system appropriate to classroom buildings should therefore be applicable to most laboratories. It is for this reason that, in the above building program analysis, laboratories have been included with classroom-lecture halls. (Out of the total shown in column I, table I, 20% to 25% are for laboratories). It should be noted that laboratories, in spite of all the required equipment, can be planned with a large degree of flexibility if certain rules are observed. Mechanical and electrical installations should be kept as far as possible out of interior walls and arranged in ceiling spaces and at - and parallel to - exterior walls. This, together with well planned modularly coordinated fixturing, will enable a large degree of flexibility, even in spaces generally considered inflexible.

C. HOUSING

Here, again, it is assumed that at the present stage of campus planning, low-rise buildings of up to 3-floors only, are under consideration.

Similar to educational buildings, flexibility is of importance for student housing to make it economic over the long range. Requirements will change in an unforeseeable way: the mix of unmarried and married students to be housed, of single, double or triple occupancy per room, the grouping of rooms in smaller or larger groups as separate units, etc. Such flexibility can economically only be provided by the use of modularly coordinated building systems.

D. PARKING

The number of required parking structures for the college campuses is not very large. Fortunately, there are building systems available that have been so widely and successfully used as to almost be called conventional. This system uses wide-span pre-cast pre-stressed concrete single or double T bars with up to 60-feet span which make column-free parking aisles possible. These beams are industrially manufactured in many widely dispersed pre-cast concrete plants. Such garages can be built - normal soil conditions assumed - at a cost of $5.00 - 5.50 per square foot of structural floor; or - assuming a three-level parking deck at $1,200 to $1,400 per car (all prices are at ENR = 1170).

CONVENTION TECHNOLOGY

A THE STATE OF THE ART

While it is recognized that productivity in the building industry has been increased considerably over the last decades by introducing more and more mechanical equipment on the building site and by sophisticated management tools (CPM), it can not be denied that the basic principles of building have not greatly changed since the middle ages: the putting together of singular buildings, custom designed according to a more or less fixed program, composed of numerous partly prefabricated but uncoordinated components which are to be cut and fitted on site by individual craftsmen of the different trades involved, so as to make up this particular building for purposes as stipulated at this particular time. This can be compared only to the manufacturing of automobiles before Ford.

These procedures are inadequate to deal with the huge building programs we will have to face in the immediate future generally and with the California State College building program especially. They are inadequate economically for two reasons:

1. They do not take advantage of the lessons of industrialization with respect to mass production.

2. The resulting buildings are not flexible enough to prevent fast obsolescence due to accelerated changes in education aims, methods and technology.

B. INDUSTRIALIZED BUILDING

The answer to the first point is the industrialization of the building process. The basic premises of industrialization are standardization. Since the requirements for most buildings - with possible exception of individual residences - are too differentiated to be satisfied by complete prefabricated buildings, another approach has to be taken. That is the systems approach, which was described in our interim report as a "comprehensive systems of coordinated components which can be put together in a variety of ways - though not arbitrarily - to make up the desired building. Such systems may involve any or all of the following: structure, partitions, walls, ceilings, mechanical, electrical, plumbing sub-systems, etc. Two points should be clarified, however:

1. Building systems are different from prefabricated buildings in that they allow the building designer freedom - though within a delimited modular discipline - to manipulate spaces, plan configuration and exterior appearance.

2. No one system will necessarily do for all building types.

The essence of system building is the working out of performance specifications which will satisfy the requirements of a building type and its users, and the tooling up of the necessary manufacturing plant for its economic production. This is not a minor and inexpensive proposition. To make it an economic possibility, a guaranteed market is a vital necessity. Comprehensive building systems will eliminate the need for cutting and fitting on the construction site with consequential savings in labor and material (no waste) and, even more important, more of the work will be transferred from site to manufacturing plant with the result of increased productivity and of reducing the need for skilled labor on site and in plant.

C. THE ECONOMICS OF SYSTEMS BUILDING

A discussion of the economics of system building has to begin with the elimination of a fundamental misunderstanding. Systems *initially* will not cost less than conventional buildings. Only in consecutive stages, after the development costs have been absorbed by the first production run, will the cost be lower. The target figure at the initial stage will be the cost of conventional construction. But even so, the resulting buildings will be of higher quality and in the long run of greater economic value owing to the built-in flexibility, which would be an important part of the originating performance specification

PRESENTLY AVAILABLE BUILDINGS SYSTEMS - DESCRIPTION AND ANALYSIS

It is quite obvious from perusal of technical and professional publications, that building systems *"are in the air"*. There is seldom an issue of an engineering or architectural magazine which does not mention some new proposed system, some new development or sponsorship by one governmental agency or another. However, most of these notices refer to *"intentions"*, studies more or less developed, ideas and pilot projects. The latter are mostly too small in scope to allow any real economic evaluation of the promoters claim with regard to cost *"in case of mass production"*.

There are, however, some more advanced systems available. These can be roughly classified under two groups:

- Prefabricated boxes, completed to various degrees in a factory and grouped and/or stacked to compose the building.

- Modularly coordinated component systems of structure, interior partitions, ceilings, mechanical equipment, etc.

A. BOX TYPE CONSTRUCTION

Generally, box type construction is applicable to housing only. The prototype of this construction is Habitat of the Montreal Expo. This type is now being developed in different directions with a view of lowering the weight of the units, and one project of this kind has been built in Richmond, California. Basically, these methods involve precasting of concrete boxes in the vicinity of the project. The plant required for this type of operation would make this method economical only for projects of a scope far in excess of the average college housing unit. It should be also noted that this method, by nature, does not allow much flexibility in its future life.

Several plants are manufacturing lightweight, relocatable box units, made of steel framing and plywood panels and transported either as a completed and finished box, or as a folded and hinged package which can unfold on the construction site as a completed section Several firms operate in California such as Designed Facilities Corporation of El Monte, and Speedspace Corporation of Santa Rosa Both have erected classroom buildings and offices for schools and junior colleges. However, these are basically movable (as opposed to permanent) units, and, while their life expectancy may be 20 30 years, and they can be stacked to compose two-story buildings, they cannot be considered as satisfactory for permanent college construction. They have so far not been used for any residential construction. While their exterior shell is standardized, all partition work is custom made as in any conventional construction, only that it is installed at the manufacturing plant. Finally, for this type of light construction, their price is unattractive: $12 00 - 13 00 at bulk purchase, including air conditioning units, but excluding any other equipment. Its one great advantage (and it is for this reason that it sells well) is its very fast construction: 90 days from placing of order

B. COMPONENT CONSTRUCTION

From examining the basic premises of industrial production there can be no doubt that comprehensive building systems of coordinated components is the most promising approach - an approach that already has proven its success in many countries in Europe

1. Steel Structures

The only fully operational system in this country is the SCSD[1] system. It was a pioneering effort and as such must be considered a success. It is interesting to note in this connection that, while the initial building program (1,500,000 square feet) has been completed and the original contractor for the structural system closed his modular systems department, three other firms (one of them an unsuccessful bidder on the original program) have built 2,250,000 square feet of school buildings all over the United States with building systems conforming basically to the SCSD system, with various degrees of using the other constituent system's parts (partitions, ceilings, HVAC)[2]. It should also be

1. SCSD - School Construction Systems Development
2. HVAC - Heating, Ventilating and Air Conditioning

noted that this has been done on a purely retail, not a wholesale approach

The SCSD system brought, for the first time, different industries together in order to work out a construction system with mutually compatible components: structure, ceiling-lighting, partitions and H.V.A.C. The system uses a steel structure on a 5′ x 5′ planning grid with spans of up to 75′ with a 36″ structural height (ceiling to floor above) and up to 120′ span with 60″ structural height. Vertical dimensions are standardized at 1′ increments. The system accommodates one and two-story construction. The lighting-ceiling consists of 5′ x 5′ components fastened to the underside of the ceiling trusses, which also allow for fastening of the partitions on the 5′ gridlines in any direction. The air conditioning distribution is accommodated within the ceiling space, with the units placed on the roof. Exterior walls are not part of the system. These are left to the discretion of the architects.

Three firms are producing the structural system, different in details but all compatible with all the other components.

(1) Rheem Flexible Space Systems (500,000 sq.ft. of schools built)

(2) Macomber V-Lok (1,000,000 sq.ft. of schools built)

(3) Butler Space Grid (750,000 sq.ft. of schools built)

The Butler system accommodates one story construction only. The others two-story construction. All systems have occasionally been used for building of one more story by building the first floor of conventional concrete construction.

Partition component systems are manufactured by:

(1) E. F. Hauserman Company

(2) Donn Products, Inc.

(3) Hough Manufacturing Corporation (operable partitions)

Lighting-ceiling component Systems are manufactured by:

(1) Luminous Ceilings, Inc.

(2) Armstrong Cork Company

H.V.A.C. components systems are manufactured by:

(1) Lennox Industries

(2) Hayes Nesbitt - ITT

The air conditioning system, developed for use in individual schools, is not recommended for college buildings. The system developed Appendix B can, however, easily be accommodated within the ceiling spaces of this structural system.

Cost

Schools using the SCSD systems and their later derivatives have generally been built within the $16.00-18.50/sq.ft. bracket, which is not different from construction cost of conventional construction. It has to be recognized, however, that these schools represent a much higher long-range value owing to their built-in flexibility which will prevent early obsolescence through adaptation at a very low cost Also, it should be noted that all the second-generation schools - after the completion of the original SCSD program - were purchased on a strictly retail basis, one at a time. Bulk purchase for a large building program would undoubtedly reduce the price of the components which comprised about 50% of the total construction cost including the H.V.A.C. and 30% without the H.V.A.C. system.

In addition, advance bulk purchase of components would also cut construction time. Since all components are manufactured by more than one firm, competitive bidding for bulk purchase is possible. Savings on construction time should also reflect savings in construction cost. Cost comparisons of individual items and components cannot be conclusive. It is the essence of the systems approach to look at the construction process as a whole - and it is here that savings will accrue, though maybe not immediately, through smoothing out a spotty development program into a more continuously flowing production pattern.

There is one serious disadvantage to the SCSD system as far as college construction is concerned, which may seriously restrict its possible use, and that is: its limitation to two-story construction.

It is unfortunate that the SCSD system has had a *"bad press"*. Most of the criticism, however, was due to certain childhood diseases, to be expected with any new method, and to managerial shortcomings (delayed deliveries, etc.), which do not invalidate the principles employed.

2. Concrete Structures

Most concrete structural systems under development fall under the classification of *"Large panel systems"*. These systems employ precast concrete bearing walls - mostly transverse to exterior walls so as not to include the latter in the system - and precast prestressed concrete floor slabs. Due to the solid transverse bearing walls, such systems are applicable only to fixed configurations.

a. Techcrete

The most advanced system of this kind is Carl Koch's Techcrete, developed together with Kaiser Industries, for the Department of Defense. The savings claimed by its sponsors are considerable and it includes all interior subsystems, exterior curtain walls, etc. But any large concrete panel system requires (due to the large components which cannot be economically moved over great distances) an industrialized on-site manufacturing plant. And, just as with precast box construction, such a plant is economically feasible only with much larger projects than are contemplated for student housing or other increments on the college campuses. Projects of 500 dwelling units are generally considered as a minimum size for such a method.

b. URBS

Another concrete system has been worked out for URBS (University Residential Building System) for the University of California.

Without going into detail it must be stated that the price quoted for this system - approximately $4.20/square foot for structure only - is completely out of scale. Since the bidding results exceeded the estimates greatly, the University of California has not yet made a decision, and the proposed system is still under consideration. It cannot be denied that the results of the URBS bidding presents a serious setback to the system building approach. However, no hasty conclusion should be drawn from this. It appears that the following reasons caused these results:

(1) The originating performance specifications tried to achieve too many things within one system, e.g., high-rise as well as low-rise buildings.

(2) Too many and too frequent changes were introduced during the bidding period, which caused large development work done by some competitors to be invalidated. A large number of interested competitors, therefore, abandoned the bidding.

c. Others

Finally, some development work has been done by different groups with respect to a precast concrete system consisting of columns, beams and floor planks. This approach appears to be - as is the SCSD steel system - promising for non-housing building. Since, in such a system, the components are smaller and lighter than in large panel systems, their manufacture can be organized in stationary plants, and transported to building sites, and so should be economically feasible for small projects. (One such system has proven to be very successful in England). None of these systems is in active operation yet, and no detailed information is available.

IMPLICATIONS OF USING SYSTEMS

A. MODULAR COORDINATION AND PLANNING GRID

The most important aspect of building systems is that it forces the architect to design within a strict modular discipline. Any deviation from this discipline will cause a heavy penalty to be paid with respect to construction cost. But modular coordination is the essence of the systems approach since it is the means that leads to economy through standardization, elimination of the cut-and-fit process, and site installation by unskilled labor. The additional, and not less important, result is a much increased flexibility of the resulting buildings and their adaptability to interior changes and exterior adaptions. Such discipline should not be thought of as restriction of architectural freedom, but as another aspect of functionality. It is the basis without which the industrialization of the process is impossible.

B. BIDDING PROCEDURES

Bidding procedure will have to be adapted, but no basic difficulties arise. Bidding will generally be a two-stage procedure. In the first stage, bidding is for systems components only, prices to include installation, on a bulk purchase basis for large building programs extending over prolonged periods.

In the second stage, bidding is for individual projects, but the prices for the systems components from the first stage bidding, will be given to the second stage bidders to be used in their calculations as sub-contractor bids. Such procedures have been used successfully in the SCSD program.

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This completes a current survey of today's systems as they relate to collegiate buildings. Clearly, there is no existing panacea However, many forces are at work trying to bring construction abreast of other technologies and the review presented here will change by the year if not by the month. This report must bear its date, September 1968. A later review could draw conclusions quite different from the rather pessimistic outlook of today.

Not covered here because it involves policy direction with implications far beyond the matter of construction, is the entire matter of systems development. Any consideration of this would require a total re-evaluation of the entire college system and could only be initiated at the highest (academic) level. As radical as this might seem, we believe it worthy of consideration.